Campus Sustainability Integrated Assessment

Interim Report

August 2010

A partnership project of the
Graham Environmental Sustainability Institute and the Office of Campus Sustainability

IMPORTANT NOTE ABOUT THIS DOCUMENT

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Executive Summary

In October 2009, University of Michigan (U-M) President Mary Sue Coleman elevated the University's commitment to sustainability in teaching, research, operations and engagement through the creation of the Environmental Sustainability Executive Council. One of the first actions of the Council was to approve an Integrated Assessment (IA) to identify long term goals for sustainable campus operations at the U-M. This IA builds on a history of sustainability accomplishments in campus operations.

The purpose of the IA is to collaboratively develop practicable ideas and stretch goals to guide campus sustainability efforts and help solidify U-M as a global leader for sustainable operations. During Phase 1 of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: *Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.* While conducting their reviews of literature, benchmarking, and U-M practices, Analysis Teams also consulted with U-M operations personnel to gain institutional perspectives regarding their areas of study. At the conclusion of Phase 1, the Analysis Teams submitted comprehensive reports and suggested ideas for further study in Phase 2. The Integration Team reviewed the reports and conducted multiple meetings with the Analysis Teams to identify areas of intersection across ideas.

After reviewing Analysis Team reports and categorizing the ideas, a number of common themes began to emerge that cut across all team reports. In looking across the reports, the Integration Team was able to classify all ideas as having benefits in five key sustainability theme areas: *Climate; Human Health; Ecosystem Health; Materials Footprint; and Community Awareness*

By focusing on these five themes, Analysis Team ideas no longer reside within the silo of that team. Rather, ideas from multiple teams now map to higher level themes and show how team activity can intersect in Phase 2. Sample commitment/goal statements for each of the themes are provided below. Phase 2 will refine these broad statements with specific goals and commitments based on further team analysis and feedback from U-M leadership.

Climate: *U-M will develop an energy and carbon reduction plan, including goals for energy and greenhouse gas emissions reduction and utilization of locally available renewable energy.*

Human Health: *U-M will pursue sustainability planning and policy development that promotes human health and well-being.*

Ecosystem Health: *U-M will adhere to and promote policies and practices that protect the health of ecosystems on U-M properties and within the region.*

Materials Footprint: *U-M will reduce environmental impacts associated with the materials it uses through efficient sourcing, use, reuse, recycling, and disposal.*

Community Awareness: *U-M will develop and promote a culture of sustainability by increasing community engagement, education, and training while assessing progress over time.*

Significant analysis is required in Phase 2 to help establish stretch goals for the five theme areas. Phase 2 will also focus on actions that that most closely align with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for U-M to display leadership). As appropriate, staff from Facilities & Operations and other campus units will join the teams to work on these issues. Recommended foci for Phase 2 efforts (by team) are shown below:

Buildings: *1) Develop a detailed action plan for prioritizing and implementing sustainable building practices on renovation projects costing less than $10 million; 2) Assess the viability and develop a plan for expanding the scope of Planet Blue buildings teams to include a broader range of environmentally-responsible upgrades.*

Energy: *1) Develop a detailed action plan and associated targets for expanding U-M's renewable energy sources for heating, cooling, and electricity needs; 2) Develop an action plan and associated targets for expanding use of alternative fuels in U-M's vehicle fleet.*

Land and Water: *1) Develop an action plan and associated targets for decreasing the use of herbicides, pesticides and grounds-related water use; 2) Develop a detailed action plan and associated targets for altering campus landscapes to increase biodiversity and decrease runoff.*

Food: *1) Develop an action plan and associated targets for significantly expanding the percentage of locally-sourced food U-M purchases; 2) Develop an action plan and associated targets for reducing food waste and introducing campus-wide post-consumption composting.*

Transportation: *1) Develop plans for optimizing campus land use and transportation modes to most effectively use and integrate multiple Ann Arbor campuses*

Purchasing and Recycling: *1) Develop an action plan and associated targets to improve the efficiency of Property Disposition; 2) Develop an action plan and associated targets to improve waste management traceability and efficiency, and improve landfill diversion rates.*

Culture: *1) Develop a set of cultural metrics to assess sustainability awareness and behavior among U-M students, faculty and staff; 2) Develop an action plan outlining resource requirements and responsibilities for collecting, interpreting, and reporting on these metrics.*

After obtaining feedback and endorsement of Phase 2 plans from the Steering Committee and Executive Council, the Integration Team will identify staff from Facilities & Operations and other campus units to join the teams and work on these topics. Their involvement in Phase 2 is essential to ensure outcomes that are technically and financially achievable. The Integration Team will also work with Analysis Team faculty leads to staff their teams and develop detailed work plans for Phase 2. In the fall, teams will pursue detailed analyses, including costs and potential benefits, technical guidance, evaluation of uncertainties, and implementation timeframes. Phase 2 is expected to be complete in December 2010, with integration of that analysis into a final IA report that will be delivered to the Executive Council in February 2011. The final report will include a suite of recommendations and stretch goals to help define a 10-year roadmap for University of Michigan campus sustainability efforts.

Project Overview

Background

In October 2009, University of Michigan (U-M) President Mary Sue Coleman elevated the University's commitment to sustainability in teaching, research, operations and engagement. Through this effort, the U-M is creating and expanding academic courses and research opportunities, strengthening its efforts to reduce its environmental footprint, connecting academic and operational activities to make the campus a living laboratory for sustainability, and more effectively engaging external partners to define and solve complex sustainability challenges on local-to-global scales. The U-M Sustainability Initiative is overseen by an Environmental Sustainability Executive Council comprised of University executive officers and chaired by President Coleman. Staffing support is provided through a collaborative partnership between the Graham Institute and Office of Campus Sustainability.

One of the first actions taken by the Environmental Sustainability Executive Council was to approve an Integrated Assessment project proposed by the Graham Environmental Sustainability Institute to identify long term goals for sustainable campus operations at the University of Michigan. This has been no small task. The University of Michigan-Ann Arbor owns 3,070 acres of land and 377 buildings comprising 31.4 million square feet. In 2009, these buildings and their 79,174 occupants consumed 6.4 trillion BTUs of energy and 1.2 billion gallons of water. Additionally, greenhouse gas emissions from U-M buildings totaled 263,181 Metric Ton CO_2 Equivalents. The magnitude of energy consumption, water usage and greenhouse gas emissions generated by the U-M suggest that aggressive sustainability goals for University campus operations could have significantly positive environmental and health impacts.. The geographic scope of the Integrated Assessment encompasses the five Ann Arbor campuses (South, Central, Medical, North and East Medical) and other Ann Arbor area U-M properties. A map illustrating these properties is located in Appendix 1.

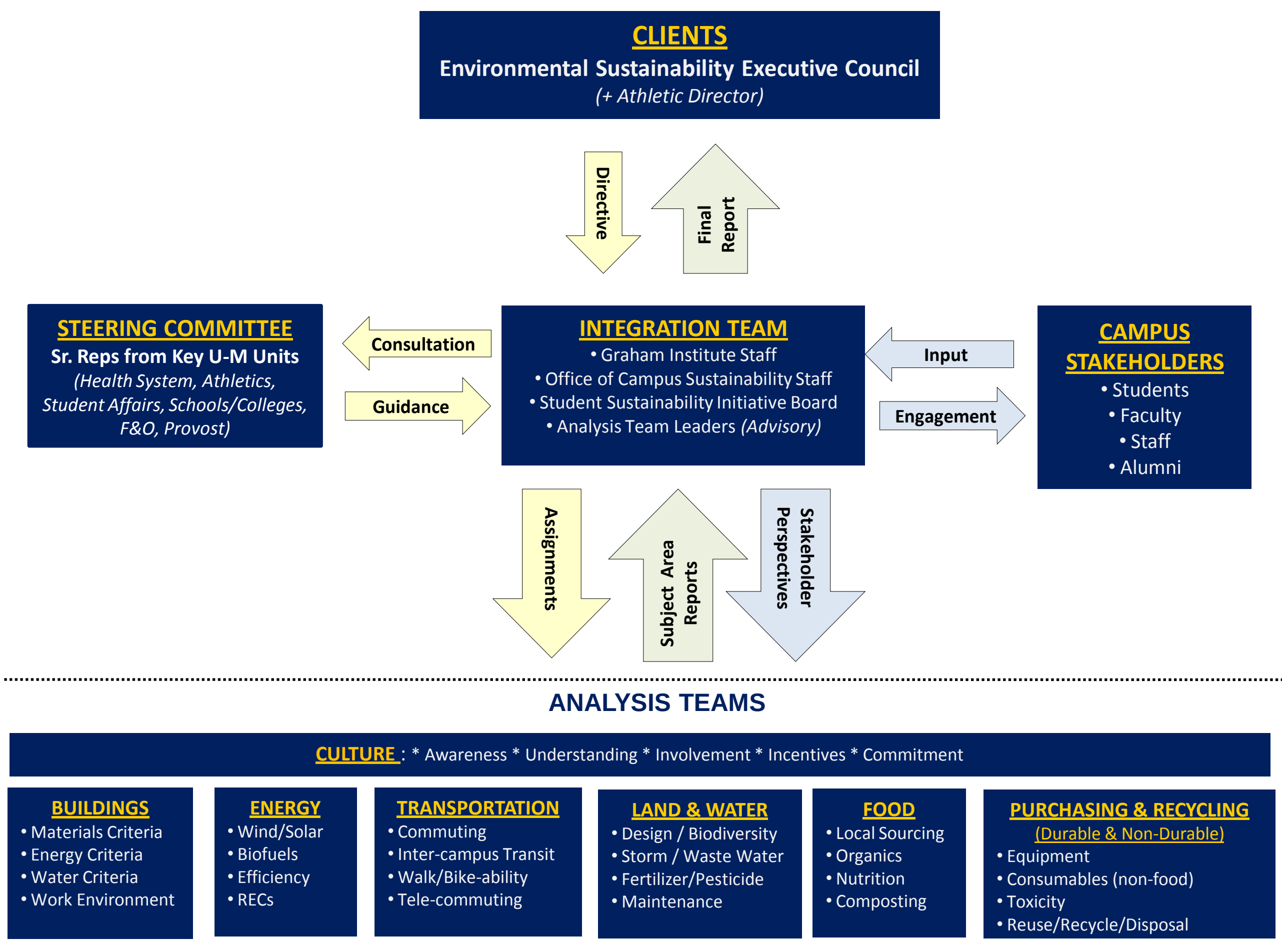
This Integrated Assessment builds on a history of sustainability accomplishments in campus operations. Over the years, the U-M has implemented a number of building sustainability initiatives to improve existing building operations and address new building construction practices. Beginning with cogeneration operations at the Central Power Plant in the 1960s, through EPA Green Lights and Energy Star programs in the 1990s, and up to the present day the U-M continues to address sustainability in its facilities. The University recently adopted LEED v2009 Silver certification as its standard for new non-clinical construction projects where the construction value exceeds $10M. Once the LEED v2009 for Hospitals and Health Care Facilities is released, an evaluation is planned to determine its relevance for clinical facilities. The new policy builds upon an already adopted U-M policy to exceed by 30 percent the ASHRAE 90.1 (2007) energy conservation standards, giving the University one of the most rigorous construction standards among higher education institutions in the nation. Additionally, the University’s design guidelines that were in place prior to adopting the LEED v2009 policy include robust Sustainable Design & Environmental Stewardship requirements focusing on energy and water conservation on all construction projects, regardless of size (for additional U-M sustainability accomplishments, see Appendix 2).

Purpose and Structure

The purpose of the Integrated Assessment (IA) is to collaboratively develop practicable ideas to guide campus sustainability efforts that will help solidify the U-M as a global leader. The Campus Sustainability Integrated Assessment involves students, faculty, and staff throughout the U-M community to:

1. Establish broad goals and specific targets for U-M campus sustainability efforts.
2. Develop frameworks to help guide U-M's overall campus sustainability strategy.
3. Identify opportunities to use the U-M campus as a sustainability learning laboratory.
4. Identify potential demonstration projects to foster campus sustainability research and learning.
5. Educate the U-M community on sustainability issues and help change culture as appropriate.
6. Publish a final report to share what we have learned as a community.

The operational structure and process for the Campus Sustainability IA are depicted in the schematic below. A complete description of these project components and an activities timeline can be found in Appendix 3 of this report. A listing of project milestones is in Appendix 4.



Process

During Phase 1 of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: *Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.* Each Analysis Team was led by a faculty member with expertise in the respective focus area and received valuable input from U-M operations personnel. Team leads selected students on a competitive basis to help them with the data gathering and analysis. The Graham Institute hired students from a cross section of campus, representing multiple departments and a mix of undergraduate and graduate levels. In total, 43 students worked on the project completing over 4,500 hours in Phase 1.

The primary task for the Analysis Teams in Phase 1 was to propose:

- ***What*** things could the U-M do to significantly advance campus sustainability?
- ***Why*** should the U-M consider these actions?

To address these questions, the teams completed benchmarking for their topic against U-M peer institutions and other institutions with exemplary and aggressive sustainability initiatives in the respective areas of study. They then considered relevant literature and interviewed operations staff to articulate the status/trends and challenges/opportunities of existing U-M practices. Students, faculty and staff from across the Ann Arbor campus had several opportunities to submit their comments and ideas to teams throughout this process. More than 350 faculty, students and staff attended two Town Hall meetings that were held in early 2010. These events presented the goals and objectives of the IA and engaged the community in an idea-exchange process. Campus stakeholders have also been encouraged to contribute ideas through an online Comments and Ideas submission process. More than 175 comments and ideas were received and directed to the appropriate Analysis Team(s) for review and comment. Everyone who submitted an entry will receive a response at the end of Phase 2. A sampling of the comments and ideas received to date and an initial response from the Analysis Teams can be found in Appendix 5.

At the conclusion of Phase 1 in June 2010, each Analysis Team submitted a comprehensive report and suggested ideas for further study in Phase 2. The Integration Team reviewed the reports and conducted multiple meetings with the Analysis Teams to identify areas of intersection across ideas. The Integration Team also received feedback from the Steering Committee and members of the U-M Sustainability Executive Council to help focus team efforts in Phase 2. The outcomes of these discussions with Analysis Teams and U-M Administrators are reflected in the final section, “Charting a Course for Phase 2”.

Prior to finalizing recommended focus areas for Phase 2, the Graham Institute and Office of Campus Sustainability (OCS) hosted a summer advisory meeting with external contacts. The objectives of this meeting were to:

- Share preliminary findings from Phase 1;
- Consult with and learn from key corporate, academic, and government representatives who have experience with institutional sustainability efforts;
- Facilitate/strengthen relationships and collaborative spirit with local institutions; and
- Enhance relationships with partners who are leaders in sustainability and have an interest in U-M sustainability programs.

Presenters included sustainability staff from the University of North Carolina - Chapel Hill, the University of Minnesota – Twin Cities, The Dow Chemical Company, and Stonyfield Farms. More than 50 people attended the event representing 25 institutions. In general there were favorable reviews of the IA and high-level U-M support for the IA with recommendations to set significant goals and to more fully engage operations staff. Highlights from the discussion and a list of participants can be found in Appendix 6. The event also included a public forum to provide an update to the campus on the IA as well as the perspectives of the presenters on sustainability efforts at their institutions. Approximately 100 people attended the forum.

In the fall of 2010, following Phase 2 approval by the Steering Committee and Executive Council, teams will pursue more detailed analysis of priority ideas including research that describes cost-benefit analysis, technical guidance, evaluation of uncertainties, and implementation timeframes. This may involve some team reconfiguration and will require that key operations staff are assigned to work as active analysis team members in Phase 2.

Throughout Phase 2, public comments and ideas will continue being gathered and incorporated into the reporting. Analysis Teams will submit their Phase 2 reports in January 2011. A second integration phase will then commence to produce a final IA report that outlines a suite of feasible stretch goals and resulting recommendations. This report will be reviewed by the Steering Committee, given to the Environmental Sustainability Executive Council for endorsement, and presented to the campus community in a final Town Hall meeting in Spring 2011.

Analysis Team Reports from Phase 1

The material below provides highlights of the major findings from the Phase 1 Analysis Team reports and each team's priority ideas for Phase 2. Full team reports, including additional and related ideas that support team integration can be found at: http://www.graham.umich.edu/ia/campus-reports.php. *The next section of this report identifies how team ideas can be described within cross-cutting sustainability themes.*

Buildings Team Report Highlights

Given the environmental impact that building construction and operations can have on the environment, aggressive building sustainability goals should be a critical component of U-M's plan to become a global leader in campus-wide sustainable practice and innovation. In light of the fact that nationally buildings contribute 38% of all carbon dioxide emissions, approximately 75% of institutions of higher education have established green building policies.

Through programs like Planet Blue Teams, the University has reduced energy use per square foot by 10.1% and per capita water use by 7.1% from 2004-2009. With precise energy monitoring, stakeholder education, and gradual building upgrades, the University has:

- Reduced energy use from 3.22 BTU per person per sf in 2004 to 2.62 BTU per person per sf in 2009
- Reduced greenhouse gas emissions by 3.8% since 2004

- Reduced per capita water use by 7.1% since 2004.

The Buildings Team engaged in the following activities to formulate their ideas:

- Researched sustainability initiatives at 38 national and international peer institutions.
- Analyzed existing practices, policies and processes used by the University of Michigan for building planning, design, construction, operations and maintenance.
- Compared merits of national and international building sustainability rating systems
- Researched emerging and best practices regarding building sustainability and environmental quality.

Appendix C, D, and F of their full report contain useful tables that summarize their benchmarking and illustrate comparative analysis between institutional policies.

Priority Ideas for Phase 2

The Buildings Team developed the following list of ideas after reviewing sustainability initiatives at peer institutions, analyzing existing U-M practices and policies and researching emerging and best practices regarding building sustainability and environmental quality.

1. *Establish a Design Review Committee as a form of peer review to assess the quality of proposals for construction throughout the University.*
2. *Through the adoption of LEED v3.0 Silver plus 30% better than ASHRAE 90.1 energy performance as the standard for all building projects, maintain the ongoing goal of out performance of this baseline, addressing ideas for research and study outlined herein.*
3. *Develop a framework for directing building development that recognizes the unique challenges and opportunities associated with a distributed campus of diverse composition, including distinct ecological and urban contexts.*
4. *Assess and create targets for reduction of non-renewable energy for the University that correlates energy use with dynamic building occupancy. Set short term goals to be achieved by 2015, with the long term goal of carbon neutrality.*
5. *Prioritize renovations across University buildings based on need for improvement of environmental performance.*
6. *Position the University of Michigan campus as a 'living laboratory' with the goal of expanding current curricula and advancing student initiatives of research that engages the built environment.*

In addition to these priority ideas, it is important to note that the full Buildings Team report has a diverse set of additional ideas that are important to consider since they support concepts of team integration and the project's overall sustainability themes. All team ideas seek to encompass priorities for sustainable building practices across the University, ranging from broad scope at the scale of the University campuses, to fine-grained idea for advancing the University's action plan. Their complete set of ideas fall within the scope of the following five strategies: 1) overarching sustainable design and buildings issues; 2) tools for benchmarking and metrics; 3) campus planning; 4) existing and new buildings; and 5) curriculum development and research.

Energy Team Report Highlights

During Phase 1 of the Integrated Assessment, the Energy Team focused on benchmarking renewable energy use at other universities and institutions, examining the U-M's renewable and total energy supplies, and developing ideas for the University to pursue in collaboration with their team during Phase 2.

In 2008, 84% of energy consumption in the U.S. was met by fossil fuel combustion and 86% of greenhouse gas (GHG) emissions were energy related. Currently only 7% of the U.S. energy supply is derived from renewables. If the nation's carbon footprint is to be improved, reducing the carbon intensity of the energy supply must be a top priority. As shown in Figure 1, a majority of the currently reported greenhouse gas emissions at the U-M are from stationary power sources (i.e. electricity and steam production). Although GHGs from mobile sources are relatively small by comparison, there are also many opportunities for improvement in this sector.

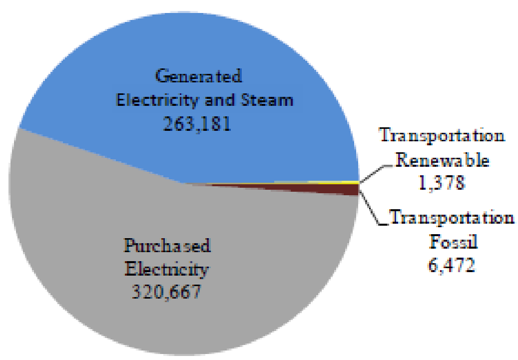


Figure 1. U-M reported GHG emissions by source, 2009 (metric tons CO_2-equivalence)

The University has already begun documenting greenhouse gas emissions, which will support the Integrated Assessment goal setting process by serving as a point of reference. However, developing a more detailed report of emission levels per building or activity would support behavior-targeted change. Additionally, if data are readily available and consistent in assumptions with sound science, the sustainability report could be expanded to include upstream processes such as commuting to campus, life cycle greenhouse gas emissions for biofuels (in accordance with federal policy trends), and other emission sources such as grounds keeping equipment. This issue is discussed in greater detail in the recommendations section of the complete Buildings Team report.

University emissions reduction plans should focus on developing a low carbon energy supply combined with energy conservation and efficiency strategies to reduce gross energy demand and energy demand per person and per research project. The U-M has reported an almost 10% reduction in Btu consumption per person from FY2004-FY2009, as well as an 8.7% reduction in CO_2 emissions per square foot. Table 2 in the Energy Team's full report shows the GHG reduction targets put forth by other universities. This benchmarking can be used to help the U-M develop its own energy plan.

Priority Ideas for Phase 2

The findings from Phase 1 research informed the following Energy Team ideas for further study:

1. *Given the impact of climate change and expected carbon regulations and markets, the University should develop a comprehensive energy and carbon reduction plan, including goals for reducing carbon emissions and expanding the renewable energy supply.* These goals will be developed by further analyzing the feasibility and scalability of the technologies outlined in recommendations 2-4.

2. *Reduce natural gas consumption by implementing two key renewable technologies: geothermal heating and cooling and solar thermal water heating.* An investigation of large-scale geothermal systems is underway at this time by the Utilities Department, supported by an Energy Team student member. Solar thermal water heating should be similarly explored in Phase 2.

3. *Reduce natural gas consumption and electricity purchasing by implementing solar photovoltaic systems on campus rooftops, particularly the football stadium roof, and biomass electricity production at the central power plant.* These options are likely to be more cost-effective than producing electricity from wind turbines on campus.

4. *Improve the transportation fuel mix by increasing the ratio of biofuel to fossil fuel consumption in the short-term, and transition to fleet and bus electrification over the long-term.* U-M already owns hybrid electric vehicles and should continue integrating them into the fleet. Biodiesel could also be produced on-campus from waste grease.

Land and Water Team Report Highlights

The Land and Water Team took a “landscape scale” approach that focused on three critical components: 1) the University of Michigan, as a landscape, sits within a larger, regional landscape that is diverse and complex; 2) ecosystem health, function, and connectivity in both the short and long term is an imperative that provides the foundation for all of the ideas formulated; and 3) human beings are a critical component in the realization of any and all ideas, and therefore their role in actively supporting the enhancement of ecological health within and beyond the campus landscape cannot be over-stated.

The team also identified five overlapping goals as a framework to organize their specific ideas. These goals are offered by the team as a vehicle for readers to better understand the range, scope, and interconnectedness of their work and include:

- Transforming the University of Michigan into an exemplar of sustainable urban design; Reducing stormwater runoff and increasing stormwater quality through the use of best management practices such as bioswales and permeable paving;
- Increasing biodiversity through the use of native plants in campus landscapes;
- Reducing the amount of „excess' lawn throughout campus, replacing it with either a more ecologically sustainable substitute such as „Eco-lawn' or with planting beds; and
- Decreasing the use of chemical fertilizers, pesticides, herbicides, and fungicides; eliminating their use completely by 2020. Increasing the amount of non-mechanized maintenance practices to reduce fuel consumption.

The team's benchmarking and background research describes approaches being implemented at other institutions (e.g., Duke, Stanford, Cornell, Arizona State, and Indiana) and also the status and trends of land and water use at U-M. The Land and Water team also worked from the premise that a variety of landcover types exist across U-M property, including the: 1) Traditional Campus (e.g., Central campus, North Campus); 2) Forested and/or lower use Non-traditional Campus (e.g., Arboretum, Botanical Gardens, Saginaw Forest); 3) Athletic Facilities/Grounds (e.g., Michigan Stadium, Golf Course, Tennis Center); and 4) Campus Institutional (e.g., Medical Center, North Campus Research Complex). These landscape types are meant to be a guide that respects the diversity of landscapes, uses, and their different management techniques. Each of these landcovers should be considered within the five different (yet overlapping) ideas for the Land and Water Team.

<u>Priority Ideas for Phase 2</u>

1. *Ideas for land use planning: campus as an exemplar of sustainable design*
   This idea involves developing and raising visibility of an overarching *Campus Master Plan* to guide development on all University landholdings; requiring an environmental sustainability component in all future campus plans and planning policies; creating a consistent process for meaningful and transparent student and *user participation* in the creation of future master plans, planning policies, building plans, and site selection.

2. *Ideas for vegetative cover: campus biodiversity*
   A multi-tiered concept for campus vegetative landcover reform proposes to increase campus ecosystem health through: a *reduction in lawn coverage* by 35%; a new *native plant policy* to promote an increase in both the quantity and diversity of native plant cover over a period of ten years; a new *tree replacement policy* that strictly requires inch for inch replacement of woody species on campus, as well as strict goals for urban forest diversity within any given campus planting zone; and a *watershed policy* to give special consideration to U-M property existing within 300' of the Huron River, 25' from a stream or other body of water, such that vegetation promotes optimal water quality protection and enhancement, floodwater infiltration (if possible), prevents erosion, and that aims to functionally connect with other habitat patches.

3. *Ideas for stormwater management: campus watershed protection*
   The Land and Water Team proposes a two-tiered concept intended to protect and restore watershed health through: a) *reducing runoff quantity* by decreasing impervious surface

area on campus properties by approximately 25% in order to achieve a total impervious surface area of 35%; b) *improving water quality* by promoting the biological infiltration of stormwater (i.e. uptake through plants) with construction of raingardens, bioswales, and other vegetated retention/detention.

4. *Ideas for landscape management and maintenance: campus stewardship*
   Maintenance ideas include the following: decrease the use of chemical fertilizers, pesticides, herbicides, fungicides, and other *toxic inputs* by 50% by the year 2015, and eliminating their use altogether by the year 2020; institute a large-scale campus *composting facility* to receive all vegetative matter from the U-M, including food waste, which can be used in a organic soil management regime as an alternative to synthetic fertilizers; institute a *hand-weeding policy* that encourages staff to rely more on „person-power' than chemical or mechanized methods; decrease water use in the landscape by 50% in the year 2015. This can be achieved through implementation of the native plant policy.

5. *Ideas for environmental education: campus as a classroom*
   Ideas in support of increasing human awareness, understanding, and appreciation for sustainability in landscape planning, design and maintenance include the following: increase opportunities for both passive and active learning about sustainability through the use of the U-M campus as teaching precedent; take advantage of new projects, and/or project renovations/retrofits, to create highly visible, „eco-revelatory' installations that elevate the visible presence of sustainable practice, and of ecosystem health and function, on the U-M campus; encourage students and faculty to utilize the campus landscape for research on topics pertaining to sustainability, and then publicize the work, and utilize the work to deepen our own understanding of „how we are doing'; require all undergrad students to meet a *Sustainability and Community* requirement.

Food Team Report Highlights

The Food Team's research focused on four actions in Phase 1:

1. Compile a comprehensive set of data about current U-M practices relating to food.
2. Learn as much as possible about innovative food sustainability practices at institutions across North America. Identify challenges and opportunities relevant to the U-M.
3. Engage with the community to find out what food issues are most important to students, faculty, staff and area residents.
4. Identify five policy ideas that will enhance the sustainability of the U-M campus. Consider environmental, cultural, and economic factors that contribute to sustainability when developing ideas.

The Food Team conducted twelve detailed case studies of food sustainability practices at a variety of institutions (see matrix on pages 17-19 and Appendix 3 of their full report). Two different types of educational institutions were examined: five large universities comparable in student population, annual food spending, and complexity of food service operations (UC Berkeley, Indiana, Michigan State, Ohio State, and Toronto) and seven smaller liberal arts colleges (Bates, UC Santa Cruz, Emory, Stanford, Vermont, Washington, and Willamette). This research was useful for identifying the following progressive trends in campus food practices and can be found in the full team report:

- Defining “local” by determining geographic area and the inclusion of processing;
- Differentiating the meanings of local food/sustainable food/and local, sustainable food;
- Incorporating local producers into large food wholesalers;
- Producing food on campus;
- Finding innovative ways to reduce waste;
- Composting post-consumption food waste; and
- Describing Michigan agricultural diversity and technology.

Essential to the progress of the Food Team’s assessment thus far has been the engagement of both the campus and the wider Ann Arbor/SE Michigan community. Team members contacted student sustainability groups, participated in community local food meetings and attended regional food conferences. Before generating ideas regarding food sustainability at U- M, it was necessary for the Food Team to learn the details as to how the current system operates. This was accomplished through interviews with Residential Dining Services, University Unions and Catering, University Hospitals, and Sysco Detroit (available in the appendix of the Food Team’s report). Some of this information was quite amazing - a reminder of the staggering scale of foodservice operations at the U-M. For example, Residential Dining provides an average of roughly 70,000 meals each week. The hospitals dispense nearly 50,000 disposable straws and napkins weekly. Additionally striking is the degree of decentralization in food purchasing at the University. Sysco Detroit, the primary food service vendor, currently accepts orders from over 200 separate purchasers within the U-M. It became clear that a useful part of the Food Team’s task would be to aid the University in developing resources for these 200 entities to both identify and source local, sustainable products in a coordinated way.

<u>Priority Ideas for Phase 2</u>

1. *Eliminate Bottled Water from Campus*
   For bottled water consumed within the region where it is packaged, 70% of the total energy expended is attributed to the plastic bottle’s creation. For bottled water consumed outside the region or outside the country where it is packaged, the largest amount of energy-use is attributed toward transportation. Research from 2006 estimated that only 23% of water bottles get recycled. Eliminating bottled water would make a strong statement about the need to live appropriately within a watershed and remind everyone that locally available potable water is natural resource worthy of concern and protection.

2. *20% Local Food by 2020*
   Michigan’s diversity of food production is second only to the State of California. This presents the U-M with an opportunity to source diverse food offerings. However, any effort to increase local food purchasing and consumption quickly leads to the definition of what is local food. The team’s research suggests defining local food as “food either produced or processed in the State of Michigan or within 150 miles of Ann Arbor, Michigan.” This would allow us to purchase food from nearby portions of Indiana, Ohio, and Ontario, Canada. Currently, SYSCO supplies approximately 85% of the University’s food. Sysco estimates that 6% of this food is local.

3. *Establish a Farm on Campus*
   The most progressive universities that were profiled each incorporated an active farm into their campus landscape. Some of these farms also incorporated orchards. Although rarely discussed, the primary reason for operating these farms relates to student and community education. These „farms' often highlight sustainable practices, course-based educational programs, composting opportunities, and community engagement.

4. *Reduce Food Waste on Campus and Introduce Post-Consumption Composting*
   Currently, major food providers on campus (Residential Dining Services, Unions, and the Michigan Health System) compost food waste acquired in the preparation phase (pre-consumption food waste). This pre-consumption food waste compost is sent to the City of Ann Arbor's municipal facility. In the on-line feedback submitted as part of the Integrated Assessment project's community input, many comments addressed the desire to reduce food waste. The team suggests exploring tray-less dining as a way to reduce food waste. Implementing post-consumption food waste composting would require a significant investment in educational programming and may be worth exploring.

5. *Comprehensive Food Labeling System*
   Many labels exist and many interested consumers are confused by their meaning and uncertain criteria. At the University of Toronto, the label "Local and Sustainable" was initiated by the institution to overcome this problem of uncertainty. The label's clarity of criteria and combination of local sourcing and sustainable practices has proven successful. The team suggests developing a "local, sustainable" food label.

Transportation Team Report Highlights

The assessment of sustainable U-M transportation options centers on five principal areas:

1. Parking Policy: A sustainable transportation policy requires that parking be allocated so as to facilitate the use of alternatives to drive-alone commuting to the University of Michigan campus, whether occasionally or regularly.

2. Land Use: For many people, commuting via alternatives to driving depends in part on the environment around their workplace. In walkable environments offering easy access to commercial uses, people may not need their automobile mid-day in order to get a meal or perform errands.

3. Transit: Ann Arbor currently has two transit operators whose service is largely uncoordinated: the Ann Arbor Transportation Authority and the U-M. The goal of transit policy should be to provide seamless transit mobility both between the Ann Arbor campuses and between campus and the rest of Ann Arbor and Washtenaw County.

4. Pedestrian and Cycling Environment: A number of physical and organizational innovations can increase the accessibility of U-M campuses to pedestrians and cyclists.

5. Other areas, including out-of-town travel and goods movement on campus.

The Transportation Team researched subsidies and incentives around driving to campus, current biking infrastructure, campus transit times and speeds, utilization of open space and methods of land use, and the impact of off-campus travel and resource sharing. Current practices around transportation were benchmarked against peer institutions, analyses were conducted, and information around community support gathered.

Priority Ideas for Phase 2

Upon completion of Phase 1, the Analysis Team generated four key ideas for the University of Michigan around transportation sustainability:

1. *Eliminate subsidies and incentives for driving in single-occupancy vehicles.*
   This concept can be met by restructuring parking fees from annual or monthly rates to daily ones (i.e.: convert annual blue pass at $749 to $3-$4 per day). This will require equipping all vehicles and lots on campus with AVI devices, eliminating required subsidy from departments to the parking passes of their employees, and maintain parking subsidies only to low-paid staff members. Relevant unit: Parking and Transportation Services (PTS).

2. *Reduce the need to drive on campus.*
   This idea can be met by altering land use and travel environments on and between the campuses. By introducing mixed land use by leasing space to various businesses on all campuses, the need to drive off campus for errands, etc, can be reduced. For travel between campuses, bicycle travel needs to be made easier by improving bicycle parking with covered and secure options, adding bike lanes, and providing bikes to those who need them through a leasing/sharing program. Relevant Units: Architecture, Engineering, and Construction, AEC and PTS. Driving on campus can also be reduced by consolidating courier services across the University. Mail Services might be best positioned to provide this service.

3. *Reduce the need to drive to and from campus.*
   Improving efficiencies in existing alternative transportation is crucial to increased use. Transit planning should focus simultaneously on the problem of moving people between campuses and moving people from town to campus. This implies integrating town-to-campus movements with the high capacity corridor currently under consideration. Technologies that improve movement between town and campus should be preferred over those primarily oriented towards shuttling passengers between campuses. Relevant unit: PTS. Consider cooperative agreement with airport transportation provider such as Michigan Flyer.

4. *Track transportation habits on campus.*
   In order to track progress in meeting our sustainability goals, tracking transportation is key. We need to track off-campus travel for University business, demand for particular transit routes, both on and off campus, and commuting transportation habits. This information can provide insight into what is working and what can be improved.

For Phase 2, the Analysis Team will conduct further research based on key ideas from Phase 1. Methods for next steps include:

1. Land use: a GIS analysis of walking proximity to campus destinations;
2. Transit: a speed analysis of the campus system (dependent on data);
3. Transit: analysis of the impact of city-campus transit integration in East Lansing/MSU;
4. Cycling/pedestrian environment: comprehensive set of photos documenting areas needing improvement; areas of inadequate bike parking (or unused potential for covered parking);
5. Off-campus travel: detailed proposal from Michigan Flyer about a potential bulk purchase covering all U-M students, faculty, and staff for airport travel (akin to the AATA M-Ride), together with cost analysis; and
6. Parking: analysis of cross-subsidies between structured and surface parking, when land costs are incorporated (dependent on data).

Purchasing and Recycling Team Report Highlights

Purchasing and recycling is an integral part of campus sustainability and can contribute significantly to the total environmental impact. The Purchasing & Recycling Team explored the life cycle impacts of the purchase, use and disposal of materials on the U-M Ann Arbor campus. The U-M spends nearly $2 billion on goods and services annually.

A screening life cycle analysis (LCA) based on the U-M's spending and energy consumption is shown below in Figure 2A. Spending is divided into four broad categories; purchasing accounts for nearly 60% of expenditures. Figure 2B shows the associated equivalent life cycle CO_2 emissions for the same categories. The use of electricity and natural gas has a significant impact, but purchasing, within University departments and plant operations, accounts for 1/3 of total impacts for fiscal year 2009 and construction is also significant. Travel and hosting represents 6% but the numbers do not account for commuting impacts at this stage.

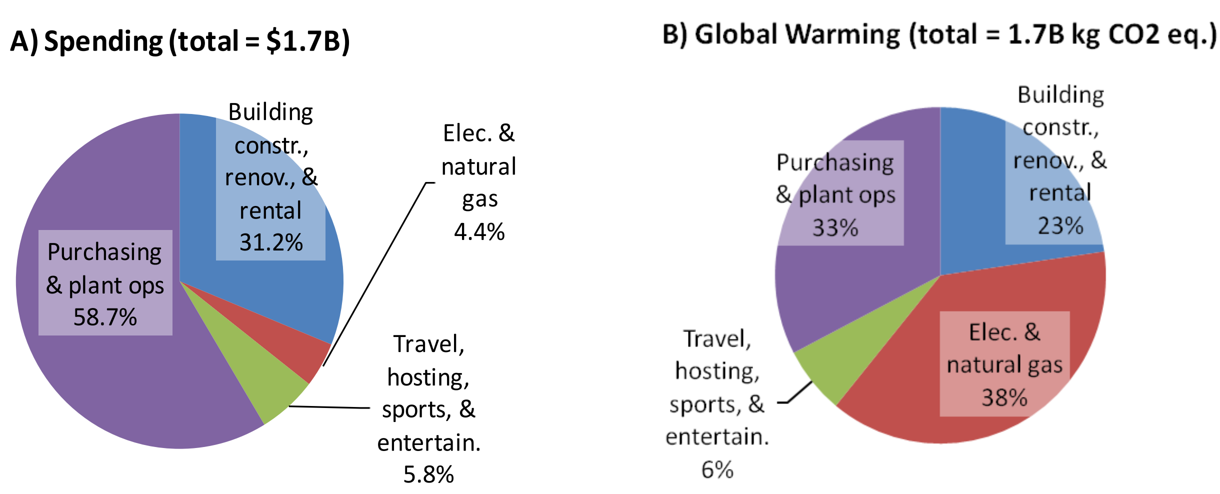


Figure 2: A) Spending and B) Global Warming for the U-M in FY2009

Currently, the U-M has multiple non-coordinated efforts aimed at improving portions of the University purchasing process, e.g., Climate Savers or the voluntary Vendor Code of Conduct. Establishing understandable rating systems for green products; keeping the up-front cost of these products competitive; and providing a platform for users to purchase such products will be a challenge. A cultural change will also be needed as the University encourages purchasers to shift from on-demand, next-day ordering to more infrequent deliveries per week.

Although the U-M has a respectable recycling rate, there is room for improvement in handling of and minimization of waste. Reducing waste streams can be accomplished both by increasing the recycling rate and also by increasing reuse. Programs such as RecycleMania increase awareness of recycling, but organizational and institutional change is necessary, as well. Currently, waste tracking is incomplete and reuse of goods within the U-M is inefficient.

Trends in sustainable purchasing and recycling show that schools around the nation are beginning to adopt policies that support sustainable procurement. The U-M has the opportunity to build on its faculty and staff expertise, student engagement, and community interest, as well as its history of forward-thinking policies by setting sustainability policies and becoming a nationally-recognized leader in this area.

<u>Priority Ideas</u>

1. *Make sustainable purchasing an institutional priority and policy*
   The U-M can only improve the chance of environmental, social and financial benefits offered by sustainable purchasing if a comprehensive sustainable purchasing policy is adopted. Such a policy should be the product of ongoing review and improvement by a dedicated task force.

2. *Centralize purchasing to reduce costs and improve delivery efficiency*
   Requiring use of a system such as M-Marketsite has several benefits: it consolidates ordering so that the Procurement department can negotiate lower costs; it facilitates data tracking; and it is a necessary condition for reduction in redundant deliveries (i.e., by half-full trucks).

3. *Strengthen the Property Disposition system*
   If the transfer of useable goods within the U-M can be improved, significant financial and environmental savings can be realized. Current costs for using Property Disposition are prohibitive, and members of the U-M community may not be aware of this service, leading to purchase of new items, incurring high cost and new environmental impacts.

4. *Pursue waste reduction and improve recycling*
   Reduction in the material flow going to landfills will require both institutional and individual changes. Individuals must be nudged to make green choices (e.g., compost in the dining hall, double-sided printing), and the U-M can improve the tracking of waste data and the handling of waste streams that are currently minimally managed.

5. *Define key research directions*
   Building on the present Life Cycle Analysis, conduct in collaboration with the other teams, a full LCA of the U-M including commuting, waste and energy production. Such a study will provide a scientifically-grounded and consistent method to evaluate sustainability aspects of proposals to improve the U-M.

6. *Investigate opportunities for improvement with respect to equipment sharing*
   Currently, budgeting may incentivize researchers to purchase redundant equipment. Interviews with the Office of the Vice President for Research and the Division of Research Development and Administration, will help the team identify room for improvement.

Culture Team Report Highlights

The primary goal of the Culture Team during Phase 1 of the Integrated Assessment was to develop ideas that will foster a "culture of sustainability" at the University of Michigan. The team defines culture of sustainability as a culture in which individuals are aware of major environmental challenges, are behaving in sustainable ways, and are committed to a sustainable lifestyle for both the present and the future. In order to develop their ideas, the team explored, synthesized, and analyzed information in three key areas: (1) research in environmental psychology and behavior, (2) trends at other colleges and universities throughout the United States, and (3) activities at the University of Michigan.

Because of the overarching nature of "culture" in the Integrated Assessment, the Culture Team relied on establishing linkages with each of the other assessment teams. A Culture Team member joined and participated in each of the other team meetings with the intent of: (1) learning of their focus, activities, and informational needs, particularly with reference to the behaviors, perceptions, and intentions of U-M students, faculty, and staff; (2) learning about past and current activities at the U-M aimed at dealing with sustainability and involving students, faculty, and staff; and (3) reminding the team that their work and ideas would have behavioral implications. Because of the central role of students in many of the University's sustainability efforts, another team member was assigned to learn about and monitor various student organizations and the role of residence halls in promoting sustainable behaviors.

The team also conducted literature reviews, which indicate that many factors can positively influence individuals to undertake pro-environmental behaviors: awareness of environmental challenges, procedural knowledge for addressing these challenges, reminders to conduct these actions, social motives, and material incentives. Campuses around the country, including the University of Michigan, have policies and programs capable of achieving these outcomes, such as comprehensive recycling programs, sustainability-oriented coursework, and environmentally-oriented community groups and projects. However, the team's research indicates that no colleges or universities have either implemented a broad-based program aimed at developing a culture of sustainability (as defined above) or assessed the cultural impact of their current programs. Their ideas are designed to do both of these and position the University of Michigan as the leaders and best in both research and practice in developing a culture of sustainability.

<u>Priority Ideas for Phase 2</u>

The Culture Team defines their priority ideas within three distinct objectives: (1) engagement, (2) education/training, and (3) assessing/monitoring.

1. *A full-time cultural liaison position should be created in the Office of Campus Sustainability (OCS) to engage students, faculty, and staff, harness and evaluate their conservation minded efforts and ideas, help bring those ideas to fruition, and understand the experimental nature and process of moving toward a culture of campus sustainability.* This staff member would be responsible for coordinating all initiatives aimed at building a culture of sustainability and work closely with the OCS director, other OCS staff, and a cultural advisory panel. Among the responsibilities, he/she would be charged with soliciting and uncovering existing ideas from middle management throughout the U-M. These ideas would then be brought before an ad hoc working group of administrators who would discuss & assess them and develop strategies for implementing the most promising ideas. This individual would be the point person for developing cultural metrics (indicators) on sustainability and for tracking them over time.

2. In order to create a strong cadre of upper classmen who are committed to sustainability practices and could serve as mentors, and role models for freshmen, University Housing in connection with OCS and possibly the Center for Research on Learning and Teaching and the School of Education, should design and implement a sustainability *training program for resident hall advisors and Eco-Reps*.

3. *The Office of the Provost in consultation with deans of academic units should explore the feasibility of a "global awareness" or "ecological literacy" requirement for all undergraduate students, similar to the current race and ethnicity requirement in LSA.* A sustainability requirement would not be limited to SNRE classes but could draw from existing and new course offerings in different parts of the University. Faculty from all units should be encouraged and rewarded for developing new courses in their respective fields or incorporating sustainability topics in current courses.

4. *OCS should establish a program of cultural metrics (indicators) to supplement their program covering environmental metrics.* The program should be designed to measure and assess progress in creating a culture of sustainability at the U-M. While OCS has been good at tracking changes in energy use, green house gas emissions, water use, and recycling over time using hard measures, it needs additional measures or indicators that reflect various social dimensions of the University's culture with respect to sustainability. Such cultural metrics can come from periodic surveys aimed at tapping levels of awareness and understanding, degrees of commitment and involvement, values, world-views, and sustainable behaviors.

5. *As part of the work in developing cultural metrics, OCS should launch a study designed to tap faculty, staff, and student perceptions of the campus including views on its sustainability efforts with regard to its landscape character, buildings, waste management, food offerings, etc.* Findings from such a study would help in determining what cultural metrics are most appropriate. They could also reveal the extent to which people's views on the U-M's sustainability efforts influenced decisions to come to the U-M (as students or employees) and remain here. As a first step toward implementing this idea, a series of focus groups should be initiated.

While the Culture team identified these five priority recommendations, it is important to note that (like the Buildings Team) they articulated fifteen additional ideas in their full report.

Integrating Phase 1 Ideas

After the completion of Phase 1, the Integration Team reviewed each Analysis Team report to compare and contrast the diverse suite of ideas across all teams. Through this process, a number of overlapping ideas emerged:

- Raise the visibility of existing University sustainability efforts (all teams),
- Develop assessment, monitoring, and tracking mechanisms (all teams),
- Use the campus as a classroom and creating a "living laboratory" (all teams),
- Enhance sustainability curricula (all teams),
- Conduct a full Life Cycle Assessment of the U-M (all teams),
- Administer surveys to determine support for changes in things like transportation habits, land use/management regimes, or post consumer food composting (all teams),
- Develop a comprehensive energy and carbon reduction plan (Energy, Buildings and Transportation Teams),
- Develop University purchasing policies (Food, and Purchasing/Recycling Teams),
- Prioritize renovations across University buildings based on the need for improvement of environmental performance (Buildings and Energy Teams), and
- Reduce stormwater runoff quantity, decrease impervious surface area, and improve water quality (Buildings and Land/Water Teams).

During the integration phase, it also became apparent that Analysis Teams had proposed wide-ranging ideas that varied in both type and complexity. To more clearly designate the type of idea put forth, the Integration Team classified each idea within one of three categories: 1) Goal, 2) Policy, or 3) Action. This effort was helpful in showing that many "action ideas" could potentially be pursued in support of a larger policy or goal statement.

After categorizing the ideas by type, a number of common themes began to emerge that cut across all team reports. For example, ideas from all the teams had implications for greenhouse gas reduction. In looking across the reports, the Integration Team was able to classify all ideas as having benefits in five key sustainability theme areas:

1. **Climate**
2. **Human Health**
3. **Ecosystem Health**
4. **Materials Footprint**
5. **Community Awareness**

By focusing on these five overarching sustainability themes, the ideas of specific Analysis Teams no longer need to reside within the silo of that team. Rather, ideas across multiple teams are now mapped to the higher level themes (as illustrated below). **NOTE:** This does not imply that the Analysis Teams will be significantly reconfigured for Phase 2. However, team activities will be directed such that they focus on developing and refining key components of "stretch" goals associated with the larger themes. Each theme is listed below with a sample commitment / goal statement that will be fine-tuned after integrating the work conducted in Phase 2. Appendix 7 provides a comprehensive list of all team ideas and how they map to the five themes.

Climate: *The University will develop a comprehensive energy and carbon reduction plan, including goals for energy and greenhouse gas emissions reduction and utilization of locally available renewable energy.*

- 7 of 7 teams proposed a total of 22 Climate-related ideas in Phase 1.

Human Health: *The University will pursue sustainability planning and policy development that promotes human health and well-being.*

- 7 of 7 teams proposed a total of 15 Human Health-related ideas in Phase 1.

Ecosystem Health: *The University will adhere to and promote policies and practices that protect the health of ecosystems on U-M properties and within the region.*

- 4 of 7 teams proposed a total of 11 Ecosystem Health-related ideas in Phase 1.

Materials Footprint: *The University will reduce environmental impacts associated with the materials it uses through efficient sourcing, use, reuse, recycling, and disposal*.

- 6 of 7 teams proposed 13 Materials Footprint-related ideas in Phase 1.

Community Awareness: *The University will develop and promote a culture of sustainability on campus by increasing community engagement, education, and training while assessing progress over time.*

- 7 of 7 teams proposed 22 Community Awareness-related ideas in Phase 1.

Charting a Course for Phase 2

During the integration phase, the Integration Team met with and received valuable input from both the IA Steering Committee and members of the Environmental Sustainability Executive Council. Key points and recommendations from those meetings included:

- *General support for using the five sustainability themes for organizing and integrating the ideas from Phase 1, and crafting a work plan for Phase 2.*
- *More clearly articulating the nature of each theme, their boundaries, and associated goals and commitments.*
- *Better articulating synergies across relevant Phase 1 ideas within each of the theme areas.*
- *Prioritizing ideas that have measurable outcomes in support of the overarching goals, and present the opportunity for U-M to display leadership.*

- *Aligning operations personnel and other U-M staff with key subject matter expertise as active members of the Phase 2 Analysis Teams, focusing on operations actions we have the ability to influence.*
- *Involving business/finance expertise in Phase 2 to focus on evaluating the costs and benefits in aggregate across all teams.*

This guidance from the Steering Committee and Executive Council members was incorporated into the Phase 2 plans presented here. Most notably, the fourth bullet above was used to prioritize Phase 1 ideas for focus in Phase 2. Note: a table illustrating the prioritization process can be found in Appendix 7.

Recommended Foci for Analysis Teams in Phase 2

Significant analysis in many areas is required during Phase 2 to help the University establish stretch goals in each of five overarching theme areas. While all ideas presented by the Analysis Teams in Phase 1 were extremely thoughtful and insightful, it is not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment. Therefore, Phase 2 will focus on ideas that most closely align with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for U-M to display leadership), and where it is believed significant progress can be made during Phase 2. Based on these parameters, **the recommended foci for Phase 2 are outlined below** (**note**: At least 80% of team effort should focus on items shown in regular font, *with up to 20% of effort directed toward items in italicized font or other ideas from Phase 1*). For each item shown in regular font (except those for the Culture team), appropriate staff from Facilities & Operations (F&O) and other campus units will join the corresponding team to work on these issues. The focus areas are also coded to show which of the five sustainability themes they support**:** C (Climate), H (Human Health), E (Ecosystem Health), M (Materials Footprint), CA (Community Awareness).

<u>Buildings Team</u>

- Develop a detailed action plan for prioritizing and implementing sustainable building practices on renovation projects costing less than $10 million, [C, H, M, E, CA].
- Assess the viability and develop a plan for expanding the scope of Planet Blue buildings teams to include a broader range of environmentally-responsible upgrades, [C, H, CA].
- *Assess the viability, complexity and resource requirements associated with developing and maintaining GIS-based database for U-M's building inventory and real estate holdings, [C, E].*

<u>Energy Team</u>

- Develop a detailed action plan and associated targets for expanding U-M's renewable energy sources (e.g., geothermal, solar thermal, photovoltaics, wind, biomass) for heating, cooling, and electricity needs, [C].
- Develop a detailed action plan and associated targets for expanding use of alternative fuels in U-M's vehicle fleet, [C, H].

<u>Land and Water Team</u>

- Develop a detailed action plan and associated targets for decreasing the use of herbicides, pesticides and grounds-related water use on campus, [H, E, M].
- Develop a detailed action plan and associated targets for altering campus landscapes to increase biodiversity and decrease runoff, [C, E, CA].
- *Develop recommendations for prioritizing sustainability and ecological function across campus planning projects, [H, E, CA].*

<u>Food Team</u>

- Develop a detailed action plan and associated targets for significantly expanding the percentage of food U-M purchases from local sources, [C, H, CA].
- Develop a detailed action plan and associated targets for reducing food waste on campus and introducing campus-wide post-consumption composting, [M, CA].
- *Assess the viability and associated impacts of eliminating bottled water on campus, [C, M, CA].*
- *Assess the viability, complexity and resource requirements associated with designing and implementing a comprehensive food labeling system on campus, [H, CA].*

<u>Transportation Team</u>

- Develop plans for optimizing campus land use and transportation modes to most effectively use and integrate multiple Ann Arbor campuses, [C, H, E, CA].
- *Assess viability, stakeholder receptivity, and associated impacts of restructuring parking fees on campus, [C, H, CA].*
- *Design a strategy / methodology for tracking transportation habits of campus stakeholders, [C, CA].*

<u>Purchasing and Recycling Team</u>

- Develop a detailed action plan and associated targets to improve the efficiency and profitability of Property Disposition by reducing transport and increasing resale of goods, [C, H, M, CA].
- Develop a detailed action plan and associated targets to improve waste management traceability and efficiency, and improve landfill diversion rates, [M, CA].
- *Develop guidelines for implementing a University-wide sustainable purchasing policy, [H, M, CA].*
- *Assess the viability, complexity and resource requirements associated with conducting a full Life Cycle Assessment and footprint of the University of Michigan, [C, M].*

<u>Culture Team</u>

- Develop a comprehensive set of cultural metrics to assess sustainability awareness and behavior among University of Michigan students, faculty and staff, [C, H, E, M, CA].
- Develop a detailed action plan outlining resource requirements and responsibilities for collecting, interpreting, and reporting on these metrics[C, H, E, M, CA].
- *Launch a pilot study to assess current perceptions of campus sustainability efforts, [CA].*

Proposed Next Steps

1. Gain feedback and endorsement of Phase 2 plans from the Steering Committee and Executive Council.

2. Graham Institute and OCS staff will develop strategies for involving key staff from F&O and other units as team members in Phase 2. The involvement of operations personnel is essential to ensure outcomes that are technically and financially achievable.

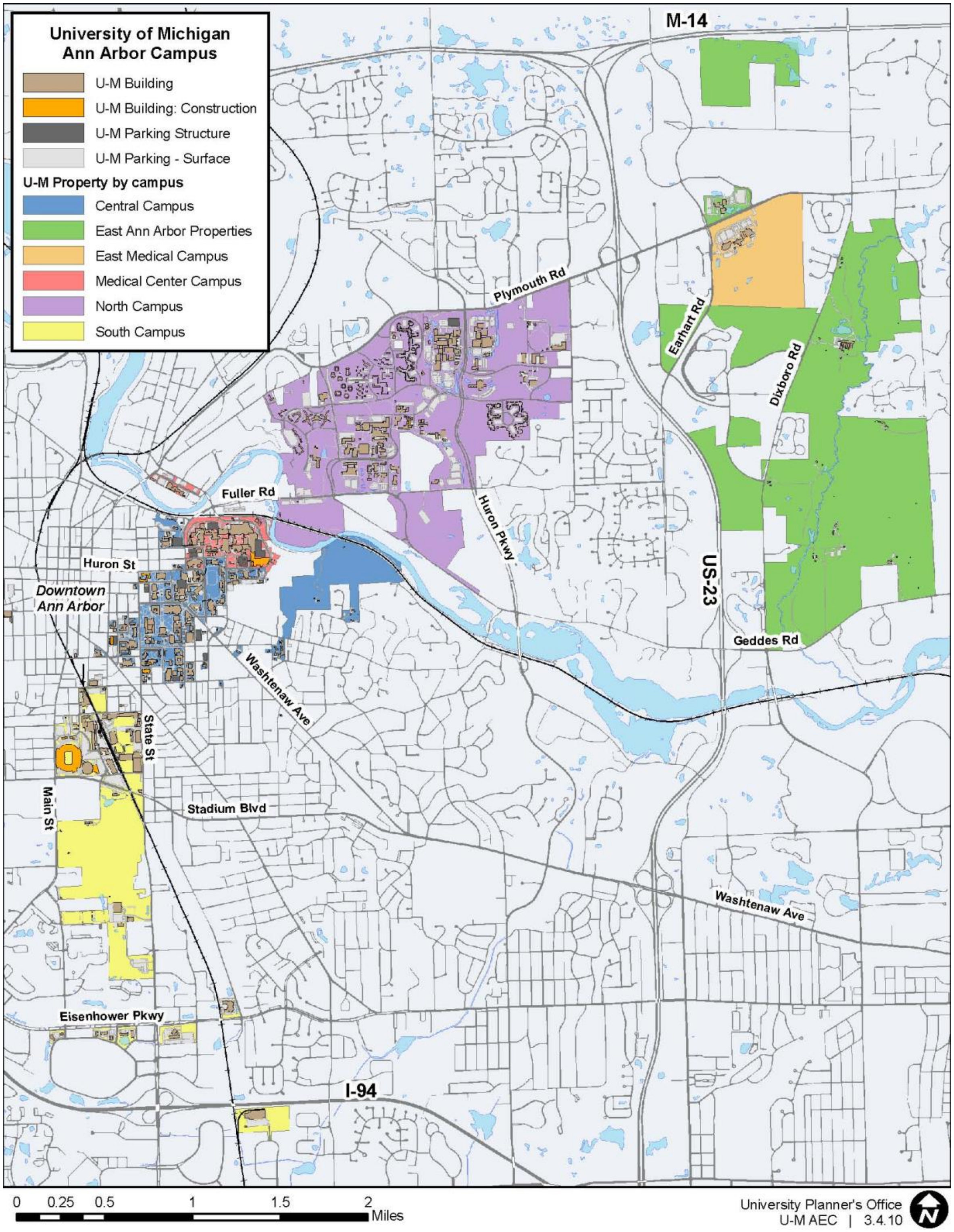
3. The Integration Team will work with Analysis Team faculty leads to develop Phase 2 work plans that match the focus areas above. While the teams will continue to refine their team-specific work plans for Phase 2, they will also continue cross-team collaboration where their efforts map to common sustainability themes.

4. The Integration Team will identify opportunities to use materials developed in past and future ENV 391: Sustainability and the Campus classes. Results of student projects from this course - especially overlapping case studies - can add valuable insight to the IA project.

5. The Graham Institute and faculty leads on the Analysis Teams will identify the student composition for teams in Phase 2, including re-hiring and hiring new students to begin work in September.

In the fall, teams will pursue more detailed analysis of the ideas, including describing costs and potential benefits, technical guidance, evaluation of uncertainties, and implementation timeframes. Phase 2 is expected to be complete in December 2010, with integration of that analysis into a final IA report that will be delivered to the Environmental Sustainability Executive Council in February 2011. The final IA report will include a suite of recommendations and stretch goals that help define a roadmap for U-M campus sustainability efforts.

Appendix 1: IA Geographic Scope



Appendix 2: Sample U-M Campus Sustainability Accomplishments

1907 Botanical Gardens and Arboretum established.

1909 University of Michigan Biological Station founded.

1945 Campus bus system introduced.

1970 First Earth Day celebration organized.

1970 U-M begins sponsoring vanpools for employee commuting.

1973 Project Community launched.

1979 UM Biological Station designated as a Biosphere Reserve by UNESCO.

1987 Energy Conservation Project Account created, a self-sustaining fund providing resources for energy improvements in UM buildings.

1989 Recycling program launched.

1995 Energy Fest, an annual event designed to educate the campus concerning energy saving, is first held.

1998 Energy Star program launched.

2000 Ethanol pumps on campus installed, fueling one of the largest alternative fuel fleets in the country.

2003 President Mary Sue Coleman formed the Environmental Task Force to "develop a plan for the U-M to create a more sustainable future."

2004 U-M received EPA Energy Star Partner of the Year Award.

2004 The renovation of the Samuel T. Dana Building, home to the School of Natural Resources and Environment, earned a Gold LEED certification - the University's first.

2005 M-Ride program allowed campus population to ride AATA bus system free of charge.

2007 Six-point Environmental and Energy Initiatives plan introduced.

2007 Inaugural issue of the University of Michigan Annual Environmental Report published.

2008 Planet Blue Teams held first building "kick-off" at Institute for Social Research Building.

2008 A 146,000 BTU/hr solar collector is installed on the Central Power Plant.

2009 University's Office of Campus Sustainability formed.

2009 University announced new building standard requiring ASHRAE 90.1 2007 plus 30% for new construction exceeding $10M in construction value.

2010 University announced that it will purchase the renewable energy produced by two wind turbines through the DTE Energy Green Currents program.

2010 University announced new building standard requiring LEED Silver certification for new non-clinical construction projects exceeding $10M in construction value.

Appendix 3: IA Project Components and Timeline

Analysis Teams

- Students at all levels – and from all areas – of the University have been involved in the majority of the data gathering, analysis, and report preparation. Through Phase 1 of the CSIA, 43 students have completed more than 4,500 hours of Analysis Team work. Students in ENV 391: Sustainability and the Campus, also contributed to the CSIA.

- The work of each team has been led by faculty members with expertise in the respective focus areas and informed by appropriate U-M operations personnel.

- Analysis Teams worked through the Graham Institute and Office of Campus Sustainability to coordinate data requests and gather input regarding relevant activities/initiatives within major University units (e.g., Student Affairs, Health System, Athletics, Schools & Colleges, Business & Finance, etc.).

- All involvement of U-M Business & Finance (B&F) personnel and associated requests for operations data were coordinated through the OCS, so as to minimize disruptions to normal job duties of B&F personnel.

- Each Analysis Team produced a comprehensive report covering their specific areas of study that include ideas or options for goals and targets for the University to pursue.

- Team Leaders:

Team	Faculty Lead	Primary Affiliation
Building Standards	Geoffrey Thun	Taubman – Architecture
Energy	Greg Keoleian	SNRE – Sustainable Systems
Water & Land	Stan Jones	SNRE – Landscape Architecture
Food	Larissa Larsen	Taubman – Planning
Transportation	Jonathan Levine	Taubman – Planning
Purchasing & Recycling	Olivier Jolliet	Public Health – Env. Health
Culture	Bob Marans	Institute for Social Research

Integration Team

- The team is staffed by Graham Institute, Office of Campus Sustainability, Student Sustainability Initiative, and select other operations representatives. All Analysis Team leaders are also active members of the Integration Team.

- Responsibilities include:
  - Scoping, staffing, and coordinating the Integrated Assessment effort.

  - Identifying U-M operations personnel and faculty members to guide Analysis Team work.

- Meeting with all Analysis Team leaders approximately every 4-6 weeks to ensure work is progressing satisfactorily with effective coordination across teams.

- Working with each Analysis Team to ensure products meet guidelines and deadlines.

- Developing a comprehensive interim document (this report) that:
  - Synthesizes and integrates work from each Analysis Team
  - Identifies themes and opportunities for achieving campus-wide efficiencies (i.e., can ideas from various areas be combined for better use of limited resources)
  - Proposes broad goals and standards for sustainable campus operations
  - Prioritizes proposed goals for Environmental Sustainability Executive Council consideration.

Steering Committee
To ensure that the IA process facilitates an appropriate balance between meeting the U-M's day-to-day operational demands and supporting the IA Analysis Teams, the IA process is advised by a Steering Committee that:

- Consists of senior representatives from key operating units
- Meets approximately every 6 weeks to discuss the IA activity
- Provides the Integration Team with broad-based, high-level input to effectively design and execute the IA process
- Ensures the project is proceeding in an effective manner without adverse consequences
- Identifies whether process modifications are required to execute the project effectively or if additional resources are to be requested of the Environmental Sustainability Executive Council

- Committee Members:

Faculty / Staff Member	Unit Represented
Tony Denton	Health System
Loren Rullman	Student Affairs
Rob Rademacher	Athletics
Brad Canale	College of Engineering
Knute Nadelhoffer	College of Literature, Science, and the Arts
Phil Hanlon/Martha Pollack	Office of the Provost
Hank Baier	Facilities and Operations
Don Scavia	Graham Sustainability Institute
Terry Alexander	Office of Campus Sustainability

Project Timeline

Timing	Activities
July – October 2009	• Met with representatives from key units across campus to solicit input for properly scoping the project and gain the necessary buy-in to move the project forward
November – December 2009	• Discussed and gained support for proposed study at Environmental Sustainability Executive Council meeting • Ironed out logistics • Recruited Faculty and Negotiate Contract Terms • Recruited Students
January 2010	• Finalized Analysis Teams and meet to begin scoping project work • Provided each Analysis Team with a specialized summary of relevant U-M data based on area being studied • Developed a general framework for all Analysis Teams to follow • Analysis Teams began conducting research efforts • Convened 1st Steering Committee meeting • Communicated process with unit leaders and issue data request survey
February – March 2010	• Analysis Teams continued research efforts and identify data gaps • Analysis Teams developed follow-up data requests • Integration team facilitated administration of data request and response process between Analysis Teams and key units (e.g., Student Affairs, Health System, Athletics, Schools & Colleges, B&F) • Convened 2nd Steering Committee meeting • Convened 2nd and 3rd meetings with all Analysis Team Leads
April-May 2010	• Analysis Teams completed initial analysis and draft their final phase one reports
June – July 2010	• Integration Team worked with Steering Committee, Team leads and others to: o Reviewed the reports from each Analysis Team o Solicited additional information, where needed o Drafted an interim report that cuts across and integrates content from the team reports and identifies priority areas for Phase 2 analysis

Timing	Activities
August 2010	• Begin scoping Phase 2 work plans • Present interim report to Steering Committee for support to pursue Phase 2
September –	• Present preliminary findings to Environmental Sustainability Executive Council for support to pursue Phase 2 • Develop strategies for involving key staff from F&O and other units as team members in Phase 2. • Work with Analysis Team faculty leads to develop Phase 2 work plans that match the focus areas above. • Identify the student composition for teams in Phase 2, including re-hiring and hiring new students to begin work in September.
September - November 2010	• In collaboration with Steering Committee, OCS, Analysis Teams, etc., pursue a more detailed analysis of options, focusing on the priority areas resulting from Phase 1 efforts. Phase 2 efforts are expected to feature more "hands-on" involvement and leadership from F&O personnel to ensure that potential goals are technically and financially achievable.
December 2010	• Each Analysis Team submits a final report for their area that articulates: o Achievable goals based upon sound use of available technology to achieve/maintain prominence in the focus area o Forecasts of likely environmental, social, and economic benefits weighed against the cost of implementation o Technical guidance for cost effective means of implementation, taking into account possible risks and payback periods to assist decision making process o Evaluations of uncertainties and concerns associated with the analysis
January – February 2011	• Integration Team develops final report that synthesizes and integrates the final reports of each Analysis Team, and proposes a set of cross-cutting campus operational sustainability goals that are practicable and informed by the campus community. • Final report is presented to the Environmental Sustainability Executive Council for review, modification, rejection, or approval

Appendix 4: IA Project Milestones

Activity: Campus IA Internal Scoping Meetings
Timing: July – October 2009
Description: Graham Institute and Office of Campus Sustainability (OCS) representatives met with key units across campus to solicit input and gaining the necessary buy-in to move the project forward. The proposed project was also discussed at Environmental Sustainability Executive Council meetings to gain support.
Outcome: CS IA Plan draft with project organization schematic depicted
Related Link: http://www.graham.umich.edu/ia/campus-ia.php

Activity: Faculty Recruitment
Timing: November-December 2009
Description: Graham staff identified and prioritized a list of faculty for each of the seven Campus IA focus areas using the Graham Institute's faculty directory (the directory identifies faculty who are interested in or working on sustainability topics). Meetings were held with faculty to describe the history of campus sustainability efforts so far and determine their interest and availability in working on the project. Their involvement was presented as an opportunity to both provide service to the University and advance their research goals. The project framework, partners, and general timeline was discussed and each faculty was asked to identify their level of commitment over the next year and desired student staffing needs.
Outcome: Seven faculty leads were chosen

Activity: Student Recruitment
Timing: January 2010
Description: The Graham Institute created an online application and held a project orientation meeting for 80 interested students. Faculty ultimately picked the students to staff their teams from more than 115 applications.
Outcome: A total 43 students were hired to staff the seven teams

Activity: Integration Team Meetings
Timing: Monthly meetings
Description: The Integration Team is staffed by the Graham Institute, OCS, Student Sustainability Initiative representatives, and faculty leading each of the Analysis Teams. This team's role is to scope and coordinate the IA effort along with communicating activities happening across the teams. The Integration Team works to ensure the IA is progressing and that team products meet the deliverable goals. These monthly meetings provide a forum for the team leads to ask questions and discuss interests, progress, concerns, areas of team overlap, and define next steps.
Outcome: Monthly planning meetings

Activity: Meetings Involving Staff from OCS, Graham Institute and Student Sustainability Initiative.
Timing: Bi-weekly meetings
Description: Every two weeks a core group of the Integration Team meets to discuss project planning and logistics. Overall, discussions focus on ensuring the project is proceeding in an

effective manner with meeting planning, report review, information flow, and key collaborations being part of the focus.
Outcome: Bi-weekly planning meetings

Activity: Steering Committee Meetings
Timing: 4-6 weeks
Description: The IA process is advised by a Steering Committee to ensure the project includes an appropriate balance between meeting the U-M's day to day operational demands and supporting the IA Analysis Teams. The Steering Committee consists of senior representatives from key operating units on campus who meet to provide the Integration Team with high-level input to design and execute the IA process.
Outcome: Regular planning and review meetings

Activity: IA Phase 1
Timing: January – May, 2010
Description: In Phase 1, Analysis Teams collected and evaluated data and produced comprehensive reports for seven selected areas, including energy, buildings, transportation, land and water, food, purchasing and recycling, and culture. Faculty members with relevant expertise lead the analysis teams, which were staffed by four to six students per team. Phase 1 reports were submitted by each team in the end of May and set the stage for additional analysis and more specific recommendations to be worked on in Phase 2.
Outcome: Seven Analysis Team reports
Related Link: http://www.graham.umich.edu/ia/campus-reports.php

Activity: Town Hall #1
Timing: January 28, 2010
Description: Over 200 people attended the first Town Hall to hear from U-M sustainability leaders and also faculty heading analysis teams about how they planned to address specific topics such as energy, land use and human behavior. Comments from students and the public were heard and recorded as part of the meeting.
Outcome: This event gave more than 200 participants an opportunity to contribute ideas and hear about the Campus IA project
Related Link: http://www.graham.umich.edu/news/article.php?nid=241

Activity: Comment and Ideas Online Submission Form
Timing: January – May, 2010
Description: During Phase 1, an online Campus Sustainability Idea Submission Form on the Graham Institute Web site was posted to solicit ideas for ways to improve sustainability efforts on campus. This call for ideas is part of the project's effort to actively involve U-M students, faculty, staff and other stakeholders.
Outcome: Over 175 comments and ideas were submitted in Phase 1
Related Link: http://www.graham.umich.edu/news/article.php?nid=211

Activity: Data Request and Response Process
Timing: January – May, 2010
Description: During Phase 1, each team designated a data request lead. Requests were submitted via an online form through the project's CTools site and submissions were routed through the

Graham IA database. After review, the submissions were sent to OCS who reviewed and responded to each data request.
Outcome: Data request responses to Analysis Teams

Activity: Town Hall #2
Timing: April 12, 2010
Description: Campus Sustainability IA Analysis Teams presented preliminary findings and proposed action plans for their specific project areas. After these brief reports, attendees were invited to participate in up to two different Analysis Team Breakout Sessions to learn more about the project areas, as well as to offer comments and suggestions for those projects.
Outcome: This event gave more than 150 participants an opportunity to contribute ideas and hear about the Campus IA project
Related Link: http://www.ur.umich.edu/update/archives/100414/townhall

Activity: Campus Sustainability Integrated Assessment review panel meeting
Timing: April 23, 2010
Description: This meeting was designed to be a forum where faculty leading the Analysis Teams could present their findings and get feedback from key administrative and operations staff. Each faculty and student lead had 30 minutes for direct discussion with the review panel. Other student members of the analysis teams attended and observed the review to learn about the work of other teams.
Outcome: Feedback to guide final Analysis Team Phase 1 reporting.

Activity: Advisory Meeting with External Contacts
Timing: July 26, 2010
Description: Organized in order to receive input from representatives of key corporate and academic institutions who have significant experience with sustainability efforts. More than 50 people attended the event representing 25 institutions. The event also included a public forum to provide an update to the campus on the IA as well as the perspectives of the presenters on sustainability efforts at their institutions. Approximately 100 people attended the forum.
Outcome: Feedback from other institutions and partners along with general campus update
Related Link: http://sustainability.umich.edu/news/innovative-sustainability-efforts-explored-forum

Activity: Integration Phase
Timing: Summer 2010
Description: At the conclusion of Phase 1 in June 2010, each Analysis Team submitted a comprehensive report and suggested ideas for further study in Phase 2. The Integration Team reviewed the reports and conducted multiple meetings with the Analysis Teams to identify areas of intersection across recommendations. The Integration Team also received feedback from the Steering Committee and members of the U-M Sustainability Executive Council to help focus team efforts in Phase 2. Using this feedback and five, high level themes as guideposts, the Integration Team selected ideas for teams to focus on their Phase 2 analysis. The five themes and recommended foci for each team's Phase 2 efforts are described in an Interim Report, along with a short summary from each team's Phase 1 report.
Outcome: Interim Report
Related Link: http://www.graham.umich.edu/ia/campus-reports.php

Appendix 5: Sample Comments and Ideas Summary

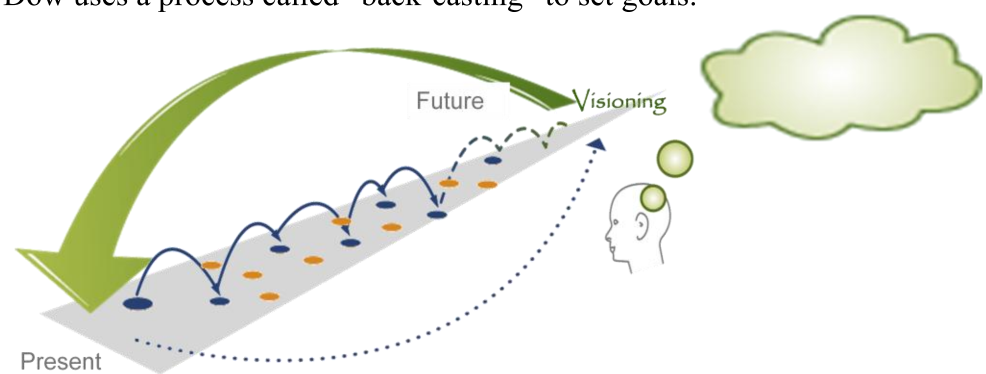
Sustainability Topic	Commenting Team: Culture	Energy	Transpor-tation	Food	Land and Water	Purchasing and Recycling	Buildings	Initial Response from Analysis Teams
Upgrading recycling containers on campus (make more clear what is able to be recycled & have more of them)						x		P&R- In July 2010, the City of Ann Arbor is changing its recycling system, which means that U-M will be changing as well. We hope that the new labeling will be understandable. We will work with Waste Management Services to ensure that sufficient recycling receptacles are available.
Change default font for email to century gothic & default printers on all computers to 2-sided						x		P&R- We are hoping to work with ITCS on double-sided printing (see http://www.itd.umich.edu/sites/printing/duplex.php). Changing email font is something that many users may be resistant towards.
Composting leftover food or sell as animal feed				x		x		Food- Addressed in Phase I report - Recommendation #4: Reducing Campus Food Waste P&R- In Phase I, this was addressed by the Food team; in Phase II, we hope to include a study of composting as part of a U-M Life Cycle Analysis.
Native Landscapes					x			L&W- In our Phase 1 report, we are promoting a strict native plant policy to enhance campus biodiversity
Use only recycled and biodegradable food packaging, or use washable utensils				x		x		Food- Addressed in Phase I report - Recommendation #4: Reducing Campus Food Waste P&R- This was beyond the scope of the Purchasing & Recycling team's analysis for Phase I. In Phase II, we will work with the Food team to address this suggestion.
Create conditions that favor public transportation like walking & biking			x					Transportation- The Transportation team recommends that conditions that favor walking and biking be implemented into all future master plans for the University.
Motion-activated lights & power strips @ work stations		x						Energy- This comment should be redirected to Buildings team.
On-campus farm	x			x	x			Culture- The food team has suggested this as one of their major recommendations, and the Culture Team envisions the possibility of integrating this into sustainability courses (recommendation #3) and studies of how this farm might influence various stakeholders' perceptions of our campus (recommendation #5, additional recommendation # 11). Food- Addressed in Phase I report - Recommendation #3: Establish a farm on-campus L&W- The food team is addressing this, though we will likely collaborate with them on choosing a location in Phase 2
Reduction/elimination of bottled water	x			x		x		Culture- "Eco-reps" and Ras could help to prepare students to accept this policy and its rationale (recommendation #2), and through sustainability training, faculty and staff could learn the same (additional recommendation #2). In this way, these stakeholders would also be encouraged to reduce or eliminate their own use of bottled water beyond the campus community. Food- Addressed in Phase I report - Recommendation #1: Elimination of bottled water from campus P&R- In Phase I, the Food team addressed bottled water. In Phase II, we hope to look into the possibility of setting a U-M policy to reduce (or eliminate) its use.
Bus system changes: routing, solar powered transit system/rapid transit			x					Transportation- The Transportation team researched the implementation of streamlining the city bus system with that of the campus bus line as demonstrated by Michigan State University. The team has also recommended increases in both transit speed and inter-modal connections.
Use new technologies to reduce waste & increase energy (BigBelly Solar compactors, Plasma gasification tool to convert trash into electricity, recirculating)		x				x	x	Energy- Thank you. We have discussed waste-to-energy at the power plant. The feasibility of this idea needs further analysis. Re: PropID 625 - We agree that moving toward a standardized and transparent GHG reporting framework is the way to go. We already have a good start on this effort. GHGs, among other indicators, are currently reported in the publicly accessible Environmental Data Repository (click on "Raw Data Overview" http://www.oseh.umich.edu/reporting.html). We will recommend expanding the boundaries of this GHG accounting framework and advocate that this data be used more effectively as drivers for renewable energy implementation on campus. P&R- This is beyond the scope of the Purchasing & Recycling team's analysis. However, Waste Management Services would be interested in such technologies, provided they are cost-effective. Buildings- Our Phase I recommendations include a requirement to evaluate the feasibility of installing on-site renewable energy production whenever there is a new construction or major renovation project. We also recommend strategies to encourage building material salvaging and reuse.
Curriculum changes to encourage sustainability in students	x							Culture- Our report's third recommendation incorporates this by encouraging the development of a "global awareness" or "ecological literacy" requirement for all undergrads

Appendix 6: Highlights from the Summer Consultation Meeting

July 26, 2010

Process Feedback:

- Sustainability needs to have high-level institutional buy-in to be successful.
- To create a culture of sustainability, an organization should have commitment, knowledge, and accountability.
- All speakers had a favorable review of the U-M Integrated Assessment – seeing it as a project that sets a structure/process to institutionalize sustainability efforts with valuable data gathering and aspirational goal setting. Having the highest level of U-M leadership is important and will continue to be an essential ingredient for making big impacts.
- A U-M definition of sustainability or "vision statement" would help frame the goals/actions.
  - Univ. Minnesota example: "Sustainability is a continuous effort integrating environmental, social and economic goals through design, planning and operational organization to meet current needs without compromising the ability of future generations to meet their own needs."
- Dow uses a process called "back-casting" to set goals.



  - Clarify long-term goals and fit activities within the goals.
  - Identify measurable goals.
  - Measure what you value.
  - Assign an "accountable executive" for each goal – who owns it and will track progress?
  - Goals need to be aspirational, ambitious, and creative – set them and find viable ways to get there. Don't spend too much time "over-analyzing" and worrying about whether goals can be met – they can be changed if they turn out to be unrealistic. Set goals with the realization that you can adapt them.
- The importance of measuring progress and success was emphasized throughout the day.
  - The AASHE STARS sustainability assessment tracking program was mentioned several times as a way to measure impacts of sustainability projects and an important method of comparing U-M progress with other universities.
  - Univ. of Minnesota measures activities in categories of curriculum, research, and operations (energy, waste, dining, purchasing, residential living, transportation, student involvement, life cycle assessments, and GHG emissions). Dining services example: 35% of packaging biodegradable, 125 tons of food composted

annually, tray less dining savings = ½ gallon of water per tray, 1.5 oz less food waste per person.

- Several speakers communicated the importance of targeting easily accomplishable actions early to engage the community about why sustainability is important. The early accomplishments will illustrate short-term successes and garner support for more commitment and long-term actions. For example, Univ. of Minnesota short-term energy goals were to: 1) reduce energy use 5% by 2010, 2) improve energy efficiency in 40 buildings/year, 3) collect 10,000 energy pledges. They were able to show both CO2 and cost reductions as being ahead of schedule and surpassing original goals.
- Analysis needs to convey cost savings (and associated reductions in waste, energy, water, etc.) in relation to sustainability goals.
- Staff accountability is an important part of goal setting and can be achieved through job descriptions, performance reviews, incentives, and bonuses.
- While the Integrated Assessment (IA) has a strong focus on "responsible operations" the University needs to identify long-term actions that have societal benefits to achieve its public mission (sharing technological innovations, establishing external partnerships).
- U-M is embarking on a bold "journey" that will exist beyond the life of Phase 2.
    - U-M leadership will need to establish working groups and identify ways to carry on aspects of the project in the future.
    - While students and faculty are important to continue engaging, annual action plans/work plans should be created that engage staff and keep momentum for creating the culture of sustainability on campus.

Goals Feedback:

<u>Climate</u>

- Goal setting should be on a shorter timeframe (2015) rather than long-term (2020) because when practices are implemented, it will be surprising how quickly U-M will reach (and possibly even surpass) goals. *See Univ. of Minnesota presentation.*
- Most "low-hanging fruit" comes in the form of energy efficiency projects. Think about energy savings by retrofitting old buildings first (especially insulation – see Dow presentation for graph justification). These projects aren't as "sexy" as new LEED construction and renewable projects, but they have greater impact with less cost.
- Though it will be impossible to reduce the footprint by focusing only on increasing energy efficiency - some combination of renewables will be required.
- U-M should also look at the diversity of their energy supply to make smaller impacts that add up: alternative sources on campus, purchasing greener energy from utility companies, implementing renewable energy projects (solar hot water, geothermal, etc).
- Ultimately, addressing climate goals will require both infrastructure change and also change in human behavior (materials management, transportation, etc.).
- While it is hard for an organization to grow and reduce their carbon footprint, it's important to illustrate efforts in that direction. In the short term, the commitment might be illustrated by having a goal of level carbon emissions during the period of growth with actual reduction being the long-term goal (UNC illustrated that while there was great energy consumption with their growth, there was an overall energy decrease per square foot. Also see Dow presentation which indicates that "absolute" GHG reductions are most important to communicate).

- Health system and medical research facilities are important to incorporate because they typically use more energy and materials than other campus facilities.
- UNC Master Plan identified surface parking areas that could be converted to both buildings and green space. One new building project was discussed as a mixed use development project -showing how it is possible to combine uses in new construction to reduce transportation needs (e.g. UNC's new campus recreation building combines parking, recreation, grocery, and retail – this building is also a connection point between their two campuses to service a larger walking community and is LEED certified).

Human Health

- Actions should go beyond food consumption and address other human health conditions.
- The project's focus on "Human Health" should include a nutritional component.

Ecosystem Health

- Projects should address invasive removal on existing forested properties to enhance ecosystem function and increase recreational value.
- Native plantings should reflect the changing climate.
- GIS maps of existing stormwater BMPs and possible future sites would be an important project for the Land and Water Team in Phase 2.
- The new U-M North Campus Research Complex can be a living-learning lab to demonstrate projects.

Materials Footprint

- U-M can identify list of desired "green criteria" and then screen out vendors based on this minimum list. Beyond that, U-M should make vendors responsible for demonstrating how they will meet a "desired" list of criteria.
- Foundation support should be explored for an "innovative green product development contest" (discussed in the context of recycled glass products).

Community Awareness

- Creating a campus culture involves curriculum planning, a learning laboratory approach, sustainability research support, a sustainability "minor" available to all students, and community engagement (e.g. UNC's formal "energy pledge" that people sign to receive a free water bottle).
- Cultural components should be assessed with measurements such as "X students reached" through curricula.
- Awareness events should be creative and on a scale that attracts attention (MN's garbage dump and recycle mania tournament).
- A key to success is the communication of project goals and activities to stakeholders – community input and buy-in along the way is essential. One example illustrating student "buy-in" is UNC's student sustainability group funding projects through a $4 student self-imposed fee.
- Rental housing could be mapped in relation to bus lines to decrease transportation needs.
- Apartment units could have a "sustainability rating". Students can use this as a tool to choose housing based on their rating and promote a connection between campus sustainability and the surrounding community (see Chapel Hill Chamber of Commerce that has a green rating system to certify small business).

Summer Consulatation Meeting Participants

Last	First	Organization	Title
Presenters			
Drake	Lisa	Stonyfield Farm, Inc.	Natural Resources Director
Hawkins	Neil	The Dow Chemical Company	Vice President of Sustainability and Environment
Shea	Cindy	UNC-Chapel Hill	Director, Sustainability Office
Short	Amy	University of Minnesota	Director of Sustainability
Participants			
Battle	Jennifer	Michigan State University	Assistant Director Campus Sustainability
Black	Terry	Ann Arbor Transit Authority	AATA Maintenance Manager
Boyd	Skiles	DTE Energy	Vice President, Environmental Management & Resources
Brass	Kate	GE Energy	Ecomagination Program Manager
Canfield	John		Facilitator
Connell	Nancy	University of Michigan	Director of Strategic Communications
Davidson	Hilary	Duke Energy	Director, Sustainability & Community Affairs
Drabczyk	Laura	University of Michigan- Dearborn	Director of Environmental Health Safety & Emergency Management
eleby	Michelle	University of Michigan	Senior Staff Associate, UM Hospitals
Erb	John	Erb Family Foundation	President
Garfield	Mike	Ecology Center	Ecology Center Director
Hallberg	Jan	Ann Arbor Transit Authority	AATA Information Technology Manager
Halloran	Elizabeth	University of Michigan	Assistant Vice President, Development
Johnson	Keith	University of Michigan	General Manager Fleet and Garage Operations
Jordan	Renee	University of Michigan	Fleet Manager Intermediate
Lampe	David	University of Michigan	Vice President for Communications
Lane	Mike	University of Michigan-Flint	Environmental Health & Safety Manager
McCormick	Sue	City of Ann Arbor	Public Services Area Administrator
McDaniel	Verna	Washtenaw County	County Administrator
Michels	Kallie	University of Michigan	Associate Vice President for Communications
Miller	Carol	Wayne State University	Professor & Chair
Miller	Jay	VA Ann Arbor Healthcare System	Chief, Facilities
Moore	Steven	Eastern Michigan University	Energy & Sustainability Manager
Naud	Matthew	City of Ann Arbor	Environmental Coordinator
Peterson	Tom	University of Michigan	UMHS Associate Director of Operations & Support Services
Petty	Dale	Washtenaw Community College	Professional Faculty
Raymond	Dave	St. Joseph Mercy Hospital	Service Delivery Leader for Planning
Robben	Richard	University of Michigan	Executive Director for Plant Operations
Rubin	Laura	Huron River Watershed Council	Executive Director
Shields	Susan	University of Michigan	Senior Director, Business Engagement Center
Shriberg	Mike	University of Michigan	Graham Institute Education Director
VanDerworp	Tony	Washtenaw County, Planning & Environment	Director, Economic Development & Energy
Wallin	Anne	The Dow Chemical Company	Director, Sustainable Chemistry
Westcott	Craig	Darrow School	Director, Samson Environmental Center
Wilbanks	Cynthia	University of Michigan	Vice President for Government Relations
Integrated Assessment Integration Team			
Anderson	Alphonse	University of Michigan	Research Associate
Berki	Andrew	University of Michigan	Manager, Office of Campus Sustainability
Callewaert	John	University of Michigan	Integrated Assessment Program Director, Graham Institute
Fassia	Anika	University of Michigan	Analysis Team Member
Hagan	Barbara	University of Michigan	Admin Assistant, Office of Campus Sustainability
Henderson	Andrew	University of Michigan	Analysis Team Member
Horning	Drew	University of Michigan	Deputy Director, Graham Institute
Keeler	Kenneth	University of Michigan	Senior Sustainability Representative, Office of Campus Sustainability
Larson	Larissa	University of Michigan	Analysis Team Faculty Lead
Levine	Jonathan	University of Michigan	Analysis Team Faculty Lead
Lund	Katie	University of Michigan	Integrated Assessment Specialist, Graham Institute
Marans	Robert	University of Michigan	Analysis Team Faculty Lead
McCoy	Kevin	University of Michigan	Analysis Team Member
Michels	James	University of Michigan	Marketing Communications, Office of Campus Sustainability
Romanski	Sarah	University of Michigan	Admin Assistant, Graham Institute
Integrated Assessment Steering Committee			
Alexander	Terry	University of Michigan	Executive Director, Office of Campus Sustainability
Baier	Hank	University of Michigan	Associate Vice President for Facilities & Operations
Gott	Sue	University of Michigan	University Planner
Nadelhoffer	Knute	University of Michigan	Director, UM Biological Station
Pollack	Martha	University of Michigan	Vice Provost for Academic & Budgetary Affairs
Rullman	Loren	University of Michigan	Associate Vice President for Student Affairs

Appendix 7: Phase 1 Ideas Organized by Phase 2 Criteria

Themes: C (Climate), H (Human Health), E (Ecosystem Health), M (Materials Footprint), CA (Community Awareness)
Related Ideas: Ideas with similar color-coding show areas of integration and connection between Phase 1 ideas.

Phase 1 Analysis Team Ideas	Team Source	Measureable Impact on Theme Outcomes	Displays U-M Leadership	Relevant Themes	Operations Issue	Academic or EO Issue	Related Ideas
Establish cultural metrics to be measured and included in the Annual Environment Report.	Culture	Higher	Higher	C,H,E,M,CA		X	
Purchase 20% local food by 2020.	Food	Higher	Higher	C,H,CA	X		
Improve efficiency and profitability of Property Disposition by reducing transport and increasing resale of goods.	Purchasing and Recycling	Higher	Higher	C,H,M,CA	X		
Eliminate bottled water from campus.	Food	Higher	Higher	C,M,CA		X	
Evaluate expansion and constraints of transportation fuels: biofuels, vehicle electrification.	Energy	Higher	Higher	C,H,M	X		
Reduce food waste on campus and introduce post-consumption composting.	Food	Higher	Higher	M,CA	X		
Decrease chemicals by 50% by 2015, 100% by 2020, institute campus composting facility, institute hand weeding policy, decrease water use 50% by 2015, new training for grounds staff.	Land and Water	Higher	Higher	H,E,M	X		
Create a comprehensive food labeling system.	Food	Higher	Higher	H,CA	X		
Reduce lawn coverage by 35%, 10 year plan to promote increase in quantity and diversity of native plant cover, new tree replacement policy, special consideration to properties near Huron River.	Land and Water	Higher	Higher	C,E,CA	X		
Reduce the need to drive on campus by altering land use and travel environments on and between campuses.	Transportation	Higher	Higher	C,H,CA	X		
Through the adoption of LEED v3.0 Silver plus 30% better than ASHRAE 90.1 energy performance as the standard for all building projects, maintain the ongoing goal of outperformance of this baseline.*	Buildings	Higher	Higher	C,M	X		
Institutionalize sustainable purchasing (including food), by adopting a sustainable purchasing policy.	Purchasing and Recycling	Higher	Higher	H,M,CA		X	
Promote waste reduction and recycling, improve waste management traceability and efficiency, and improve landfill diversion rates.	Purchasing and Recycling	Higher	Higher	M,CA	X		
Conduct a full Life Cycle Assessment and footprint of the University of Michigan.	Purchasing and Recycling	Higher	Higher	C,M		X	
Assess and create targets for reduction of non-renewable energy that correlates energy use with dynamic building occupancy. Set short term goals to be achieved by 2015, with the long term goal of carbon neutrality.	Buildings	Higher	Higher	C	X		
Develop a comprehensive energy and carbon reduction plan including goals for C reduction and renewable energy (50-85% reduction GHG by 2050).	Energy	Higher	Higher	C	X		
Create a strategic plan for integrating heating and cooling systems: geothermal, solar thermal water heating.	Energy	Higher	Higher	C	X		
Continue the analysis of renewable energy options: solar voltaics, biomass energy, wind.	Energy	Higher	Higher	C	X		
Reduce stormwater runoff quantity, decrease impervious surface area, improve water quality by promoting biological filtration.	Land and Water	Higher	Higher	E	X		
Prioritize renovations across University buildings based on need for improvement of environmental performance.	Buildings	Higher	Higher	C		X	
OCS launch studies to determine current perceptions of campus sustainability efforts.	Culture	Higher	Lower	CA	X		
Centralize purchasing to enhance buying power and coordinate efficient delivery.*	Purchasing and Recycling	Higher	Lower	C,CA		X	
Direct building development with a framework (including buildings database and space utilization studies) that recognizes diverse campus composition with distinct ecological and urban contexts.	Buildings	Higher	Lower	C,E	X		
Eliminate subsidies and incentives for driving in single occupancy cars.	Transportation	Lower	Higher	C,H,CA		X	
Position the University of Michigan campus as a 'living laboratory' with the goal of expanding current curricula and advancing student initiatives of research that engages the built environment.	Buildings	Lower	Higher	H,E,CA		X	
Explore the feasibility of a global awareness or ecological literacy requirement for all undergraduates.*	Culture	Lower	Higher	CA		X	
Create a full-time cultural liaison position in the Office of Campus Sustainability (OCS).	Culture	Lower	Lower	C,H,E,M,CA	X		
Design and implement a sustainability training program for RAs and Staff	Culture	Lower	Lower	C,H,M,CA	X		
Establish a farm on campus.	Food	Lower	Lower	H,E,CA		X	
Reduce the need to drive to and from campus.	Transportation	Lower	Lower	C,H,CA		X	
Track transportation habits on campus.	Transportation	Lower	Lower	C,CA	X		
Establish a design review committee as a form of peer review to assess the quality of proposals for construction throughout the University.	Buildings	Lower	Lower	C,E	X		
Raise visibility of overarching campus master plan and create a process for student and user participation, while increasing transparency. Require environmental sustainability component in all future campus plans.	Land and Water	Lower	Lower	H,E,CA	X		
Encourage and expand using campus as a classroom with UM campus as a teaching precedent for ecorevelatory installations, sustainability research, Planet Blue, "sustainability and community" requirement.	Land and Water	Lower	Lower	E,CA		X	
Encourage sharing of equipment and resources.	Purchasing and Recycling	Lower	Lower	M,CA		X	

Appendix 8: Phase 1 Analysis Team Reports

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

Please direct comments or questions to: GrahamInstitute-IA@umich.edu

For more information on the Campus Sustainability Integrated Assessment, please visit:
http://graham.umich.edu/ia/campus-ia.php

Buildings Team - Phase 1 Report

Integrated Assessment for Campus Sustainability

Graham Environmental Sustainability Institute
University of Michigan
Ann Arbor MI

Faculty Lead: Geoffrey Thun

Student Team: Zain AbuSeir
Thao Do
Tarlton Long
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Mary O'Malley
Dan Weissman

June 14, 2010

DRAFT

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EXECUTIVE SUMMARY

Given the massive environmental impact that building construction and operations can have on the environment, aggressive building sustainability goals are a critical component of the University of Michigan's plan to become global leader in campus-wide sustainable practice and innovation. In light of the fact that buildings contribute to 38% of all carbon dioxide emissions in the United States, approximately 75% of institutions of higher education have established green building policies, many of which incorporate the adoption of the U.S. Green Building Council's LEED rating system.

The University of Michigan has already implemented a number of building sustainability initiatives to improve existing building operations, new building construction and academic programs related to the built environment. Through programs like Planet Blue, the university reduced energy use per square foot by 10.1% and per capita and water use by 7.1% from 2004-2009. Additionally, the university's design guidelines include robust Sustainable Design & Environmental Stewardship requirements focusing on energy and water conservation. The School of Natural Resources & Environment's Dana Building is LEED-Gold Certified and the Ross School of Business is LEED-Silver certified. Additionally, the under-construction Mott Children's Hospital building is designed to achieve LEED-Silver standards.

The *Buildings Team* developed a series of recommendations after reviewing sustainability initiatives at peer institutions, analyzing existing University of Michigan practices and policies and researching emerging and best practices regarding building sustainability and environmental quality.

These recommendations seek to encompass priorities for sustainable building practices across the University, ranging from broad scope at the scale of the University campuses, to fine-grained recommendations for advancing the University's action plan. *Complete recommendations are available in section 4.* All recommendations fall within the scope of the following five strategies:

1. Overarching Sustainable Design and Building Issues
Attain and maintain excellence in architectural design, environmental responsibility and fiscal sustainability through life-cycle assessment and integrated building design, while promoting opportunities for research and learning that position the university as a national leader in the sustainable built environment.

2. Tools for Benchmarking and Metrics
Advance sustainable building standards for construction and maintenance of the University's existing and proposed building stock beyond the minimum benchmark of LEED Silver plus 30% reduced energy allowance. Perform a comprehensive assessment of properties and continuously track the University's improved annual performance and progress against peer institutions across a series of relevant metrics through advanced techniques of monitoring and assessment.

3. Campus Planning
Prioritize the efficient use of existing spaces while accommodating future needs with design strategies that provide for variety of uses. Densify existing campus spaces over time while

increasing heterogeneity of program and services and integrating with ecological fabrics across the University.

4. Existing and New Buildings
Develop superior living and working spaces by prioritizing buildings with outstanding ecological performance, low resource consumption, and high indoor environmental quality.

5. Curriculum Development and Research
Develop the University as a 'living laboratory,' using buildings as both a key element in promoting curricular and extra-curricular program development and as assets for attracting and maintaining top academic talent. Create a Center of Excellence for the Built Environment that aims to reduce environmental impacts and improve human welfare by advancing and synthesizing innovations that integrate technological and materials research with engineering systems, advanced controls, and human occupant feedback.

The sustainable building strategies recommended here are intended to complement the University of Michigan's larger ambitions for excellence in research, education, athletics and student life and seek to establish the University of Michigan as the leader in sustainable building practice and innovation.

1.0 INTRODUCTION

In recent years, the building performance issues have received increased attention due to the scale of their impact on the environment. Buildings are responsible for 38% of U.S. carbon dioxide emissions and represent 72% of U.S. electricity consumption, making the built environment a major driver of global warming and environmental degradation[1]. Advancing the performance of buildings benefits the environment, economy, as well as health and productivity of their occupants. The clear imperative to make changes to the design and operations of our built environment lead to the creation of the U.S. Green Building Council in 1993 and the *LEED* green building rating system in 1998. Rating systems and standards for sustainable building were concurrently being developed internationally, including *BREEAM* in the UK, *Green Star* in Australia and *HQE* in France. Universities, as major consumers of resources with vast long-term holdings, have become leaders in prioritizing sustainable building. According to the Sustainable Endowments Institute's 2010 *College Sustainability Report Card*, 44% of the 332 higher-education institutions surveyed have at least one LEED-certified building completed or under construction and 75% have adopted a campus-wide green building policy.[2]

The University of Michigan owns 3,070 acres of land and 377 buildings comprising 31.4 million square feet. In 2009, these buildings and their 79,174 occupants consumed 6.4 trillion BTUs of energy and 1.2 billions gallons of water. Additionally, greenhouse gas emissions from University of Michigan buildings totaled 263,181 Metric Ton CO2 Equivalents[3]. The magnitude of energy consumption, water usage and greenhouse gas emissions generated by the University of Michigan suggest that aggressive sustainability goals for university building construction, operations and maintenance could have a significantly positive environmental impact on the Ann Arbor campus and Huron River valley. At the same time, the university's 41,028 students, 23,909 university faculty and staff, and 14,237 medical staff, are sufficient cause to seek better environmental quality in service of health, education and research.[3]

Within the context of the integrated assessment, the *Buildings Team* has sought to find ways for the University to reinforce its mission of energy reduction and sustainable planning and building through a set of recommendations that point to specific targets in which the University may attain excellence in design and research, to be a leader among peer institutions while continuing its track record of financial sustainability.

The *Buildings Team* engaged in the following activities to formulate our recommendations:

1.0 Researched sustainability initiatives at 38 national and international peer institutions
2.0 Analyzed existing practices, policies and processes used by the University of Michigan for building planning, design, construction, operations and maintenance
3.0 Compared merits of national and international building sustainability rating systems
4.0 Researched emerging and best practices regarding building sustainability and environmental quality

The recommendations stress that, within the context of a top-tier research institution with a large quantity of real estate holdings, opportunities exist to incorporate research and curriculum agendas into building design and operations considerations. Recommendations therefore suggest opportunities for research wherever possible. Additionally, as a minimum benchmark is accepted of LEED Silver plus 30% better than ASHRAE 90.1-2007, the University should commit to outperformance goals to continually decrease its environmental footprint, while balancing financial and economic models with design excellence.

Our goals are aggressive and in some cases may require significant financial investment. However, the goals are crafted with the understanding that the collective benefits to the university of implementing such sustainability measures outweigh the financial costs. While some measures have clear, short-term financial benefits, such as reduced energy and water expense, others have long-term, strategic benefits. A holistic view recognizes the value that a sustainable built environment can contribute to research, classroom learning, student and faculty health, and the recruitment of top talent, consistent with the University of Michigan's perogative to be the *leaders and the best*.

2.0 STATUS AND TRENDS

The University of Michigan has instituted a number of progressive policies and practices aimed at reducing building resource consumption, environmental impact, and improving health and productivity levels of the occupants. Efforts of the university to date address existing building operations, new building design and construction, and academics.

2.1 Existing Building Operations

The Office of Occupational Safety and Environmental Health has instituted programs to assess the University's impact on the environment and implement new strategies to reduce that impact. These programs include a Six-Point Environmental Initiative, a Pollution Prevention recycling initiative, and the Energy Conservation Measures Fund, a self perpetuating funding mechanism for supporting projects that reduce energy consumption in U-M buildings.

The Energy Management Section (EMS) of Plant Operations Division monitors over 100 buildings on the Ann Arbor campus, intensively tracking electricity, steam, gas, and water consumption on an annual and monthly basis. Since 1997, the EMS has instituted a series of programs to renovate and retrofit campus facilities with optimum lighting, mechanical and HVAC systems to increase energy cost savings. Cumulatively, these programs are estimated to save the University $6.7 million annually.

In addition to equipment updates, since 2007 the University has worked to reduce energy use by influencing student, faculty, and staff behavior through the Planet Blue program. Planet Blue holds educational events in each building to keep occupants aware of behavioral impact on environmental performance. Through the program's website, university stakeholders can access all of the data collected by EMS regarding resource consumption to track the performance of their building. Planet Blue achieved a six percent average reduction in energy consumption in the first full year for its initial group of five pilot buildings.

Through precise energy monitoring, stakeholder education, and gradual building upgrades, the University has:

- Reduced energy use from 3.22 BTU per person per sf in 2004 to 2.62 BTU per person per sf in 2009
- Reduced greenhouse gas emissions reduced by 3.8% since 2004
- Reduced per capita water use by 7.1% since 2004 [3]

Currently, the University's approach to energy management in existing buildings is on par with most of the peer institutions reviewed. Nineteen out of twenty-five schools researched instated aggressive programs in the last ten years to update lighting, plumbing, and HVAC systems and have tracked significant financial savings tied to these improvements. Three of these institutions have adopted LEED standards for Existing Buildings, Operations, and Maintenance (EBOM) as a way to track their improvements and insure continued performance. LEED EBOM "addresses whole-building cleaning and maintenance issues (including chemical use), recycling programs, exterior maintenance programs, and systems upgrades" and provides a benchmark for environmental impact.[4] Adopting these guidelines as a minimum performance standard is currently one of the strongest indicators of a University's commitment to comprehensive sustainable building practices. The University of Michigan would benefit from instating such a program both to highlight existing efforts and establish clear pathways for improvement.

2.2 New Building Design & Construction

Outside of simply tracking building performance, the Architecture, Engineering, and Construction office (AEC) at University of Michigan has instated Design Guidelines to establish policies for building performance on new construction and renovation projects. UM requires compliance with ASHRAE 90.1-2007 for all new construction on campus, and for all projects with a construction cost exceeding $10 million the design must exceed AHSRAE 90.1-2007 by 30%. Projects over $5 million construction cost are subject to an environmental review process to help guide the design from a sustainable practices standpoint. At the conclusion of schematic design, the architect is required to develop a preliminary LEED score, using accredited personnel. The AEC Design Guidelines also identify mandatory energy conservation measures (from providing interior blinds to performing thermal scanning), mandatory energy evaluations (from reviewing below grade insulation potential to use of occupancy sensors to energy recovery), and consideration of energy conservation opportunities (including optimized building aspect rations, daylighting, and surface reflectivity). Special attention is also given to water conservation methods and the incorporation of low-flow plumbing fixtures. Through the efforts of the AEC, the University has completed one LEED Gold Certified building (the Dana Building, completed 2007) and two more buildings are slated for LEED Silver Certification in the next few years.[5]

Of the 25 reviewed peer institutions, all but four have listed green building as a priority in their environmental action plan, and all but four have adopted some form of LEED building guidelines as a requirement for all new construction and renovation. Most of these institutions require a minimum certification level of LEED Silver and have established certain credits as prerequisites, including baseline energy performance standards over the required code (i.e. 30% improvement over ASHRAE 90.1. or similar). The University of Michigan has slowly incorporated sustainable guidelines into its building standards, and pending adoption of LEED Silver Certification for all new construction will bring the University's stated commitment to sustainability to the level of its peers. However, to establish itself as a leader among universities in design excellence, UM will need to carefully consider prioritizing certain goals beyond energy reduction, including waste and recycling management, indoor environmental quality, and innovation in design.

2.3 Academics

The University of Michigan supports numerous research efforts and curriculum programs that address issues of sustainability. Courses related specifically to sustainability and the built environment are currently distributed between several departments and individual researchers. The A. Alfred Taubman School of Architecture and Planning offers courses at the undergraduate and graduate level in environmental building technology, planning, policy, and landscape. Faculty-initiated experimental courses may spend a semester addressing an area of sustainable design. The School of Natural Resources and the Environment offers courses on sustainable development and ecological planning that are open to all students and frequently cross-listed with other departments such as Urban Planning, the School of Public Health and the Ross School of Business.

Many of the peer institutions reviewed are in a similar state regarding research and curriculum related to sustainable building and development. The majority of universities offer a few courses in disparate departments, and a few also sponsor inter-disciplinary, extra curricular projects such as the Solar Decathlon to promote innovative approaches to ecological building design. A few institutions, including Harvard, Stanford, and Arizona State University offer full degree tracks for sustainable design, engineering, and construction, typically at the masters, professional, or post-professional level. Arizona State has established the *School of Sustainable Engineering and the Built Environment* within the school of engineering to establish a forum for collaboration between the civil engineering and construction departments. More universities are recognizing the significance of interdepartmental alliances to develop new approaches to sustainable development.

With this robust mix of academic development, construction policies, and energy savings initiatives, the University of Michigan is poised to become a leader among institutions in sustainable development. The following recommendations seek to build on the existing infrastructure of environmental commitment at the University by strengthening building performance guidelines, identifying research opportunities, and providing strategies for further reducing energy consumption and increasing ecological awareness.

3.0 CHALLENGES AND OPPORTUNITIES

The University is faced with several unique challenges and opportunities given its role as a public university located in the state of Michigan. The University's position as a premier research institution dedicated to the creation and transfer of knowledge further defines the context in which building sustainability recommendations are developed and implemented. Additionally, the physically distributed nature of the University of Michigan campus presents a set of challenges and opportunities for improving the built environment not applicable to many of the university's peers.

3.1 Role of Public University

As the manager of the second largest endowment of any public institution in the United States, the University of Michigan has a particular charge to fulfill its obligations as a public university. Creating a diverse and collaborative university culture, engaging local and national communities, and generally making opportunity as broadly available as possible remain priorities for UM as the University seeks to fulfill its research and academic goals. President Mary Sue Coleman has prioritized a series of initiatives to support the University's service to the state of Michigan including a Sustainability Initiative and Multidisciplinary Learning and Team Teaching Initiative.[6] Emphasis on these territories as part of the University's mission establish great opportunities for advancement in sustainable building research and development.

3.2 Specific context in Michigan – Economy, Ecology, Technology

The University of Michigan inhabits a unique physical and cultural context within the United States.The current economic conditions within Michigan presents its own challenges and opportunities in many realms that the University engages. Southeastern Michigan has been heavily dependent on the auto industry which has faced intense financial pressures resulting in bankruptcy at GM and Chrysler, and now must adapt to the shift to alternative income generators. In addition, Michigan now has the highest unemployment rate in the country at 14.1%.[7] A Detroit News examination of U.S. Census Bureau and Internal Revenue Service data showed that "every day, Michigan gets less populated, less educated, and poorer because of outmigration."[8] Currently, the University of Michigan fosters a number of programs dedicated to state outreach and economic development including the University Research Corridor, an alliance with other Michigan universities to contribute to the transformation of Michigan's economy, and CLOSUP, which sponsors interdisciplinary research projects around issues that confront state and/or local policymakers. Development at the University should further support economic growth of the state, potentially by engaging local manufacturers and construction talent. The state of Michigan's connection to the Great Lakes system enhances the environmental stewardship imperative and necessitates sensitive development to protect the diverse ecology of the region. Historically, the Detroit region has been a major center for industrial and technological advancement, and the University of Michigan contributed in many ways to development in these fields. Building on existing industrial knowledge and infrastructure, UM could provide a significant resource for re-imagining the manufacturing industry sustainably and renew Michigan's place at the center of ground-breaking industry.

3.3 Premier research institution

By its position as a premier research institution in the United States, the University of Michigan attracts a diverse and rich collection of faculty, students and staff as well as a variety of funding to support innovative research. Currently, research in ecological design, construction, and development is distributed through several departments and institutions. By drawing all of these interests together, Michigan is positioned to become a leader in progressive research and development in the building sciences. Projects resulting from such collaborations would benefit sustainability efforts both at the University and throughout national and global communities.

3.4 Student learning / curricula

One of the University's primary commitments is the continuing education of their student constituency - as President Mary Sue Coleman states, "above all, we educate young people seeking to better themselves through knowledge and new perspectives."[9] The President's Sustainability Initiative emphasizes teaching and hands-on engagement "to inspire our students to acquire the knowledge and insight that will empower them to address the many complexities of sustainability in their chosen careers."[6] Curriculum integration and development should be a key component of any sustainable advancements at the University, both for the enhancement of the research and the development of student knowledge. With leading undergraduate and graduate programs in architecture, planning, engineering, and development, integrated curricula will contribute to fulfilling the University's goal of educating future leaders in ecological design.

3.5 Distributed physical resources

The University of Michigan in Ann Arbor retains 3,070 acres of property in Ann Arbor spread among six distinct campuses, each with their own character and resources. The distributed nature of the University's development splits energy, transportation, real estate, and services between multiple locations, resulting in lost efficiency and greater resource consumption. The campus dispersion also presents a challenge for generating a cohesive academic community and inter-department collaboration. However, within this structure, there are opportunites for heterogeneous development and the cultivation of diverse services for UM and the surrounding community. Recent property acquisitions include many top quality research laboratories and office facilities that could be used to support new research in sustainable science. A complex approach must be reinforced, as the different types of conditions and zones require multiple approaches to minimize ecological impact and create livable, walkable campuses and neighborhoods. Cultivating an effective network of research and learning campuses will reinforce the mission of the University and insure responsible integration with the city of Ann Arbor.

3.6 Conclusion

In order to become a leader in sustainability, the University of Michigan will have to take a stronger position on its commitment towards the creation of new sustainable building designs to attain the prestigious position of leader among peer institutions. These decisions may not be easy. This commitment will require continued reassurance to key financial players that foregrounding sustainable design measures throughout the design, construction and continued operations of all buildings on campus creates an upward spiral intended to project the University of Michigan as a leader, while lowering operating costs, attracting new waves of talented faculty and students, and expanding research agendas across disciplines.

TABLE OF RECCOMENDATIONS

4.0 RECOMMENDATIONS

The following recommendations span five major categories: Overarching Sustainable Design Goals, Benchmarking and Metrics, Campus Planning, Existing and New Buildings and Curriculum and Research. Individual recommendations are then organized into the following structure: Each category contains at least one specific recommendation, followed by (a) a summary elaborating on the statement, (b) references giving context to the content of the recommendation, (c) research opportunities that could substantiate the recommendation where applicable, and (d) the anticipated time frame for implementation and audience responsible (see below):

Example:

0.1.1.1 Recommendation

0.1.1.1a Summary:

0.1.1.1b References:

0.1.1.1c Research Opportunity:

0.1.1.1d Time frame:

Under ‘Time Frame’, projects are identified as short term (1 year), medium term (1-5 years), or long term (5-15). Also, the party primarily responsible for implementing the recommendations is identified in this section. Though almost all of these changes will need to occur at an Institutional level, in some locations opportunities to engage outside consultants, initiate research projects, or develop student projects are noted. [Refer to Appendix B for a chart comparing time frame and project type for each recommendation]

The sustainable building strategies recommended here are intended to complement the University of Michigan's larger ambitions for excellence in research, education, athletics and student life.

4.1 OVERARCHING SUSTAINABLE DESIGN AND BUILDING ISSUES

Attain and maintain excellence in architectural design, environmental responsibility and fiscal sustainability through life-cycle assessment and integrated building design, while promoting opportunities for research and learning that position the university as a national leader in the sustainable built environment.

4.1.1 Design Excellence

To achieve the sustainable design ambitions of the Ann Arbor campus, the University of Michigan should adopt a standard of design excellence that reflects the goals of the integrated assessment and addresses the whole life-cycle of building design, construction, operations and de-commissioning. The University of Michigan standard of design excellence should aim to meet several goals simultaneously:

- Minimize the impact of University building activities on the earth's ecology
- Maximize the ability for students and faculty to learn, teach and research
- Visibly reflect the University's commitment to innovation and sustainability
- Reconcile financial return-on-investment with environmental stewardship

4.1.1.1 Establish a Design Review Committee as a form of peer review to assess the quality of proposals for construction throughout the University.

4.1.1.1a Summary
The University should cultivate a leadership role in the institutional building design market through a critical design review committee with the intent of evaluating any project slated for construction on university property. The Design Review Committee should include members of the faculty of Schools of Architecture, Urban Planning and Engineering, as well as notable practitioners of the design community. The Committee would operate in concert with AEC for design considerations, and be appointed on a yearly basis.

The committee would be responsible for establishing the *architectural competition* as method for identifying best design solutions for flagship projects, increasing the profile and notoriety of University of Michigan. The committee will review all building project submissions, with attention paid to sustainable design measures/methods.

4.1.1.1b References
The Federal General Services Administration Design Excellence program outlines three methods for selecting external design teams. For mid-size projects, a two-stage selection process involves holding a design charrette at the end of which the design visions are blindly evaluated and ranked by an independent jury comprised of private-sector design professionals on the GSA National Register of Peer Professionals. The A/E Evaluation Board then incorporates the charette rankings into their recommendations to the GSA. For larger projects, a three-stage selection process is adopted that involves inviting design firms to participate in a design competition. The competition entries are then blindly evaluated and ranked by an independent jury as in the charrette model. The A/E Evaluation Board is comprised of five individuals: a regional architect, a regional engineer, an OCA design professional, a National Peer Professional and a customer representative. The GSA project manager is intentionally excluded from A/E evaluation board.[10]

The University of Pennsylvania has a Design Review Committee chaired by the dean of the Graduate School of Fine Arts and comprising the vice president of facilities, the university architect, university planning consultants, faculty members that are design professionals and outside architects.[11]

The City of Toronto has instituted a permanent Design Review Panel after a two-year pilot program from 2007-2009 showed a positive effect on the city's development process.

> "The Design Review Panel is set up as an advisory body to City staff, and takes place as an additional stream of consultation within the existing framework of development review ... The process of design review does not affect approval timelines, and the process of community input and the role of Council to approve development remain unchanged."

The panel is comprised of 13 volunteer members who are appointed to two-year terms. All panel nominees were required to have a minimum of 15 years of professional experience and membership in professional design associations. The panel reviews projects twice during the schematic design phase (once at the beginning and once at the end) for all projects deemed to have "significant public realm impacts." According to the City of Toronto:

> "Implementing a permanent DRP will improve the overall design quality within the City both through means of civic leadership, by raising awareness and giving design the priority it deserves, and through the planning process, by encouraging higher design standards." [12]

4.1.1.1d Time Frame
This is a medium term recommendation to be undertaken by Institutional Administration.

4.1.1.2 Employ 'Integrated Design' strategies throughout the design process.

4.1.1.2a Integrated design strategies focus on fostering ongoing communication between various constituents of the design team through scheduled meetings and charettes, allowing for "active and continuing participation of users, code officials, building technologists, cost consultants, civil engineers, mechanical and electrical engineers, structural engineers, specifications specialists, and consultants from many specialized fields. The best buildings result from active, consistent, organized collaboration among all players."[13]

The university should become an active client, promoting integrated design process between the various actors throughout the design and implementation process for all building projects as a critical method for executing sustainable design measures, as well as lowering costs.

4.1.1.2b References
According to Nils Larsson, Executive Director of the International Initiative for a Sustainable Built Environment:

> "When carried out in a spirit of cooperation among key actors, this results in a design that is highly efficient with minimal, and sometimes zero, incremental capital costs, along with reduced long-term operating and maintenance costs. The benefits of the IDP process are not limited to the improvement

of environmental performance. Experience shows that the open inter-disciplinary discussion and synergistic approach will often lead to improvements in the functional program, in the selection of structural systems and in architectural expression."[14]

4.1.1.2d Time Frame
This is a medium term recommendation to be undertaken by Institutional Administration.

4.1.2 Research Excellence

4.1.2.1 Foster new and cultivate existing areas of faculty research by constructing buildings that provide opportunities for future study.

4.1.2.1a Summary
As one of the world's premier research institutions, the University of Michigan seeks to cultivate opportunities for knowledge creation. Investment in sustainable building design should therefore seek to advance research agendas wherever possible, involving the university community in the life-cycle processes of buildings as imbued learning opportunities.

Research in building technologies may engage specific building systems found on campus, such as monitoring elements of the double-skinned facade on the Biomedical Building for data pertaining to air-flow rates or solar heat gain over time.

4.1.2.1b References
At Stanford University, a myriad of programs foster student and faculty research towards sustainable agendas:

- The Goldman Honors Program brings together upper-division undergraduate students in small-group seminars to analyze environmental problems, with project-focused work tied to policy and ongoing research.
- Haas Center for Public Service provides service opportunities, integration of service experience with classroom learning, community-based research, public service leadership training, community programs serving children & youth, and advising on national service options. The center supports 20 programs and many student organizations, and works with faculty who offer 75 service-learning courses and community-based research projects.
- The Mel Lane Student Program Grants provide funding to students for group projects that try to solve environmental issues related to the university.
- The Environmental Undergraduate Research Program offers internship opportunities for undergraduates to work on projects with Stanford faculty and research staff, finding solutions to environmental problems.[15]

4.1.2.1c Research Opportunities
Specific research agendas to pursue with regards to sustainable building design are outlined throughout the remainder of this section, including studies associating health and productivity to Indoor Environmental Quality (Section 4.2.2), energy performance

monitoring (Section 4.4.2) and correlation between talent retention and building design quality (Section 4.5.3)

4.1.2.1d Time Frame
This is a medium term to long term recommendation to be undertaken by collaboration between Institutional Administration and external Consultants with long term impacts

4.1.3 Excellence among Peer Institutions

4.1.3.1 Achieve and maintain #1 ranking among North American higher educational institutions in total sustainable practices for campus buildings.

4.1.3.1a Summary
The University is committed to becoming the leader toward carbon-neutral building, lowering energy use and expenses and carbon footprint reductions. In doing so, it is helpful to benchmark our progress against our peer institutions (refer to Appendix C). Comparison to other universities should be undertaken using an accepted benchmark across North American universities, such as STARS or the College Sustainability Report Card, with the intent to be the undisputed leader in the near future.

4.1.3.1b References
STARS, or Sustainability Tracking Assessment and Rating System, provides a framework for assessment of the University in regards to its peer institutions throughout North America beyond building practices. STARS requires universities to register and self-report. (Note: The Office of Campus Sustainability has recommended to the University that they register with STARS)[16]

The College Sustainability Report Card automatically includes all North American Universities with the top 300 endowments. Additional surveys allow individual schools to more accurately report their progress.[17]

4.1.3.1c Research Opportunity
Both STARS and the College Sustainability Report Card rank green building performance based in part on the extent that LEED for New Construction, LEED for Existing Buildings (Operations & Maintenance) and LEED for Commercial Interiors standards have been applied to university buildings. Other ranking criteria include energy-efficiency and water conservation measures, indoor air quality, and diversion of construction waste from landfills. While these metrics are all consistent with the recommendations outlined in this document, additional research will be required to identify the most appropriate inter-university metrics and target date to pursue in order to obtain the the #1 ranking.

4.1.3.1d Time Frame
This is a medium-to-long term recommendation that will require the efforts of Students, Faculty, the Institution, and outside consultants with long term impact.

4.1.3.2 Maintain at least one project with campus-wide presence under development at any given time that will substantially outperform baseline sustainability requirements to demonstrate to the University community our commitment towards sustainable design.

4.1.3.2a Summary
The University can best demonstrate its leading role in sustainable innovation when it can refer to a current project that is an exemplar of cutting-edge environmental excellence. Identifying flagship projects will serve to promote the University's environmental commitment while providing ample opportunities for learning and research. The University of Michigan might achieve high performance goals on flagship projects by seeking LEED Platinum certification or by identifying a series of performance goals that are closely tied to research and education agendas. The double-skin facade of the Biomedical Science Research Building is an example of a highly-visible investment that is linked with broader institutional goals such as social collaboration in scientific research.

4.1.3.2b References
The University of Pennsylvania's Design Guidelines assert that "The university intends to be a leader and champion of environmentally sensitive design, demanding innovation and creativity from our design consultants and helping to educate our community." Likewise, the University of Michigan must push the boundaries of environmental design in order to be a leader in building sustainability innovation.[11]

While Arizona State University is able to boast 33 buildings that meet LEED criteria according to the College Sustainability Report Card website, it is unlikely that the University of Michigan will be able to match such numbers in the short-term given limits to new construction needs. Developing a smaller number of buildings that greatly surpass sustainability baselines set by the University of Michigan and its peer institutions is a more plausible strategy for positioning the University of Michigan as a leader in sustainable building. Moreover, flagship projects go beyond demonstrating the university's commitment to sustainability by reinforce the University's role as a premier research institution advancing new areas of knowledge.[2]

4.1.3.2d Time Frame
This is a medium term recommendation to be undertaken by Institutional Administration with long term impact.

4.1.4 Financial Sustainability

Design excellence is achievable only to the extent that it is financially feasible. As a result, the University requires a mechanism to both review and support the financial feasibility of building projects that parallel the University of Michigan’s sustainable design goals.

4.1.4.1 Calculate building Life Cycle costing in terms of capital budget, operational costs and other benefits.

4.1.4.1a Summary
A holistic approach to calculating return-on-investment takes into account payoffs like the creation of strong resources for sustainable/environmental study and the ability to attract highly sought-after researchers. While further study may be required to develop methods for accounting for such payoffs, life-cycle costing methods can be used immediately to prioritize sustainable building investments that have financial payoffs over the long-term. The time horizon for calculating such payoffs should be consistent with the fact that most university buildings are in operation for at least 100 years and are thus able to support long payback timeframes.

4.1.4.1b References
Within University of Colorado's "Conceptual Plan for Carbon Neutrally," Appendix 5 outlines specific cost-benefit analyses, including LEED Gold Plus for New Buildings and Major Capital Renovations, and a series of renewable energy sources. This report makes the fiscal case for use of such sustainable initiatives within the University context.[18]

University of Calgary's Child Development Center is an example of an investment with pay-offs that go beyond operational savings. Since receiving LEED Platinum certification, the building has been used as an advertising tool to promote sustainability at Calgary and acts as a hand-on resources for the environmental curriculum. With the aid of the building, the University expects to attract researchers interested in high performance buildings. The engineering and environmental faculties will also use the building for ongoing applied research.[19]

4.1.4.1c Research Opportunities
A significant opportunity exists to engage students and faculty in finance and business economics to develop and pioneer methods for accounting for paybacks beyond facility operations budgets (such as paybacks to recruitment or development budgets).

4.1.4.1d Time Frame
This is a medium-to-long term recommendation that could be undertaken by Students & Faculty, or under Institutional Administration with long term impact.

4.1.4.2 Establish incentives to prioritize sustainable building practices across university departments as a supplement to sustainable design mandates.

4.1.4.2a Summary
While recommendation 4.1.4.1 suggests ways to review the financial feasibility of projects in a way that supports sustainable projects, this recommendation suggests the use of both non-financial and financial incentives to drive individual units towards sustainable design decisions.

For example, a financial incentive structure might establish a university-wide sustainability fund that assists units in achieving sustainability goals that would otherwise be threatened due to economic constraints. The University may encourage colleges and academic units to actively engage in sustainable practices to reduce energy costs, where surplus funds from energy saved would become part of the schools own budget as a reward. These principles may be expanded on by the *Culture Team*, and by existing programs such as *Planet Blue*.

Non-financial incentive structures might involve fast-tracking the approval process for capital projects that meet certain sustainability objectives. The non-financial incentives thus provide a "pay-off" for units to invest in sustainable measures even though a traditional pay-off might not exist. Ideally, the incentive system would take need into account, providing greater rewards for major upgrades to the university's lowest performers (refer to section 4.4.5.1 for more information on prioritizing investments based on environmental performance).

4.1.4.2b References

Harvard's Green Campus Loan Fund (GCLF) is a $12M revolving loan fund created to support the initial capital costs of sustainable projects. The fund makes sustainable building investments more attractive and feasible for the unit undertaking the capital project. At the same time, the revolving loan fund is financially self-sustainable because it is repaid by the unit as operational savings are realized. The University of Michigan's Energy Conservation Measures Fund has played a similar role in enhancing the feasibility of energy-conservation investments.[20]

At the University of Pennsylvania, the Penn Green Fund is a program that provides one-time grants to implement innovative student, faculty or staff ideas that help the University of Pennsylvania reach sustainability goals identified in their Climate Action Plan. Projects that result in monetary savings must repay the grant as if it were a loan. The review board for the Green Fund includes representatives from Facilities and Real Estate Services as well as the School of Design.[21]

Stanford University provides a financial incentive for effective space utilization by charging schools for underutilized space. While this financial penalty system may not be directly translatable to the University of Michigan, it is an example of creative incentive structuring to drive unit behavior that is consistent with the university's sustainability goals.[15]

4.1.4.2c Research Opportunities

Investigate sources to supplement unit budgets in order to drive sustainable innovation beyond existing budget projections. Consider possible award systems and partnerships with the State of Michigan and other funding sources.

4.1.4.2d Time Frame

This is a short-to-medium term recommendation to be coordinated by Institutional Administration with potential for immediate impact.

4.1 SUMMARY

The following recommendations are policy changes that can be implemented in the **short-to-medium term** and will carry immediate impact:

- *4.1.4.2 Establish incentives to prioritize sustainable building practices across university departments as a supplement to sustainable design mandates.*

The recommendations below are intended for more **medium-term** implementation that will carry medium-to-long term impact across multiple departments of the University:

- *4.1.1.1 Establish a Design Review Committee as a form of peer review to assess the quality of proposals for construction throughout the University.*
- *4.1.1.2 Employ 'Integrated Design' strategies throughout the design process.*
- *4.1.3.2 Maintain at least one project with campus-wide presence under development at any given time that will substantially outperform baseline sustainability requirements to demonstrate to the University community our commitment towards sustainable design.*

The recommendations below will require **medium-to-long** term investment, with long term results:

- *4.1.2.1 Foster new and cultivate existing areas of faculty research by constructing buildings that provide opportunities for future study.*
- *4.1.3.1 Achieve and maintain #1 ranking among North American higher educational institutions in total sustainable practices for campus buildings.*
- *4.1.4.1 Calculate building Life Cycle costing in terms of capital budget, operational costs and other benefits.*

4.2 TOOLS FOR BENCHMARKING & METRICS

Advance sustainable building standards for construction and maintenance of the University's existing and proposed building stock beyond the minimum benchmark of LEED Silver plus 30% reduced energy allowance. Perform a comprehensive assessment of properties and continuously track the University's improved annual performance and progress against peer institutions across a series of relevant metrics through advanced techniques of monitoring and assessment.

4.2.1 Use of Standards

High performance building standards as outlined by LEED shall assist design teams in decision making regarding energy performance, indoor environmental quality, materials selection etc. Enforcement will be based on documentation of design, commissioning and post-occupancy monitoring. Standards shall be reviewed on an annual basis by the AEC to maintain current applicability.

4.2.1.1 Through the adoption of LEED v3.0 Silver plus 30% better than ASHRAE 90.1 energy performance as the standard for all building projects, maintain the ongoing goal of outperformance of this baseline, addressing recommendations for research and study outlined within this document. The most current version of LEED standards for all new construction, retrofit, facilities opperations and maintenance on Campus should be adopted as they become available, or until an alternative standard is identified.

4.2.1.1a Summary

Leadership in Energy and Environmental Design, or LEED is the most widely accepted rating system for for sustainable building design for the United States. For purposes of utilizing the American standard, the University of Michigan shall maintain the use of the LEED criteria as the baseline for high performance building. However, a comprehensive evaluation of building and campus sustainability standards is available in which includes LEED, BREEAM, Green Globes, ASHRAE Standards, GSA Design Excellence, CHPS Criteria etc. Close examination of these and other standards over time may continue to help inform the University's use of standards.

[Additional information regarding 'Michiganizing' of LEED criteria may be found within section 4.4.]

4.2.1.1b References

A series of peer institutions have specific high performance building targets:

Univ of Colorado: LEED Gold plus 40% improvement over ASHRAE 90.1
UCLA: LEED Silver w/ 20% improvement on Title 24 required, LEED Gold w/ 30% improvement on Title 24 Preferred
Berkeley: LEED Silver with 20% improvement on Title 24

Cornell: LEED Certified + 50% Improvement on ASHRAE 90.1
Johns Hopkins: LEED Silver with customized JHU guidelines

[See Appendix D for complete comparative benchmarking matrix across 22 peer institutions.]

4.2.1.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration with long term impact.

4.2.1.2 Encourage all personnel engaged in University building design practices to become LEED accredited by 2012.

4.2.1.2a Summary
LEED accreditation signifies a baseline professional competency in sustainable building practices. Staff competency in sustainability issues is critical not just for instituting a LEED Silver plus 30% over ASHRAE standard, but also for exploring ways to advance sustainability in ways that go beyond the minimum standard. For this reason, the University should aim to have all design-related staff LEED accredited by 2012. Having widespread awareness of building sustainability practices will create opportunities for collaboration and problem solving and will help safeguard against problems when implementing newer technologies and systems. While LEED accreditation will not make all staff sustainability "experts," the baseline level of knowledge associated with accreditation will complement the expertise of highly experienced staff and create a culture imbued with sustainability values and knowledge.

4.2.1.2b Reference
"LEED Professional Credentials demonstrate current knowledge of green building technologies, best practices, and the rapidly evolving LEED Rating Systems." The current, three-tiered version of the LEED AP credentialing program - described below - is meant to distinguish and set a level of specialization.

LEED Green Associate denotes basic knowledge of green building principles/practices and of the LEED rating system.

LEED AP with designation (Building Design & Construction, Homes, Operations & Maintenance, etc): for professionals directly participating in the design and construction of high-performance buildings; candidates are required to have documented experience with LEED registered or certified projects

LEED Fellow: a distinction still under development, the GBCI will use the Fellow credential to recognize leaders in the field of green building

The Credentialing Maintenance Program (CMP) is a new continuing education requirement for both LEED Green Associates and LEED APs. GBCI points to CMP as a means to maintain the integrity of the credentials and keep professionals current in a rapidly evolving industry.[22]

4.2.1.2d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration with potential for long term impact.

4.2.2 Understanding Existing Conditions

4.2.2.1 Perform comprehensive audits of campus buildings with the goal of gathering data to assist in prioritizing future building renovations and retrofits. Foster learning opportunities where possible. Prioritize locations where improvements will affect the greatest net performance benefits.

4.2.2.1a Summary

Although audits are currently performed on existing buildings for specific assessments, the University should broaden and deepen the scope and quantity of audits performed, with the potential to undertake an all-inclusive study of University facilities, prioritizing energy/lighting, indoor air quality and building life span to build expertise and gather consistent data across University buildings.

Although initial auditing studies may be streamlined if performed by consultants, development of skills for University personel to perform specified audits is critical to the long-term goal of a sustainable campus. The University should set objectives to train appropriate staff to begin comprehensive audits by 2012.

Renovations and retrofits shall be prioritized according to comprehensive audits – See section 4.3.1.2.

4.2.2.1b References
The Facilities Maintenance department at the University of Michigan has a "staff of more than 400 employees provides around-the-clock building maintenance, operation and environmental monitoring for over 29 million square feet of facilities that serve the University campuses, hospital and health centers."[23]

Harvard University has a dedicated Building Energy Auditing Service that bids against outside consultants:

> "After completing an assessment at [Harvard Divinity School's] Andover Library over the summer of 2009, the audit team won a competitive bid to perform an energy audit of the school's remaining six buildings. Harvard's audit team is a great example of collaboration between Harvard departments. The technical staff is comprised of members from Facilities Maintenance Operations"....and members of the Office for Sustainability, who "aid in the inspections of buildings, perform critical energy analyses and draft findings. The audits meet or exceed all requirements of the ASHRAE Level II audit standard. Each energy-saving recommendation is supported with complete financial payback analysis and projected GHG reductions."[24]

4.2.2.1c Research Opportunities
Data acquired may be utilized in research studies such as GIS based applications sited in recommendation 4.2.2.4. Conversely, research agendas may facilitate future audits, with the potential for faculty and students to perform audits as testing grounds for new techniques and technologies.

4.2.2.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration with potential for immediate impact.

4.2.2.2 Develop a stream of public health research aimed at correlating indoor environmental quality to student and worker health and productivity, including air quality, daylight quantity, quality and views, specifically utilizing University buildings, faculty, staff and students as participants in order to assess policy decisions regarding performance targets and economic benefits.

4.2.2.2a Summary
Engage academic units within the University apt to develop studies specifically tailored to understanding relationships between indoor environmental quality and productivity.

Air Quality:

The School of Public Health and the University of Michigan Health Department may access health records of University employees and students to assess symptoms reflecting poor indoor air quality. Evaluate available data regarding student/faculty/staff sick days/ absenteeism, and productivity against an evaluation of the specific indoor environmental quality of a select set of buildings on Campus with a comparable set of programs (to inform decision making regarding healthy building assessment and financial targets for sustainable objectives.)

Daylighting and Views:

The Heschong Mahone Group studies correlate daylight and views to improvements in student learning in K-12 environments, as well as the increase in worker productivity in call centers. However, data does not exist correlating improvements to upper level education with daylight and views. The University should sponsor a stream of research aimed at identifying how daylight and views within educational spaces positively or negatively effect learning, work productivity and general wellbeing.

4.2.2.2b References
Few studies exist correlating the influence of ventilation rate on worker performance. Evidence exists showing strong association of ventilation rates with health, such as lower respiratory symptoms. In turn, health can influence productivity:

> "Increased adverse health effects increase health care costs, may increase absence from work, and may decrease performance of workers while mildly ill but at work....Increased sick leave clearly reduces productivity. In a study of office buildings, lower ventilation rates of 24 cfm per person were

> associated with a 50% increase in short-term absence (considered a surrogate for sick leave), relative to ventilation rates of 48 cfm per person."[25]

In regards to Daylight And Views, according to the Heshong Mahone group found that:

> "Students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests in one year than those with the least. Similarly, students in classrooms with the largest window areas were found to progress 15% faster in math and 23% faster in reading than those with the least. And students that had a well-designed skylight in their room, one that diffused the daylight throughout the room and which allowed teachers to control the amount of daylight entering the room, also improved 19-20% faster than those students without a skylight. We also identified another window-related effect, in that students in classrooms where windows could be opened were found to progress 7-8% faster than those in rooms with fixed windows. This occurred regardless of whether the classroom also had air conditioning. These effects were all observed with 99% statistical certainty." [26]

[See section 4.4.1.1 for recommendations concerning the use of daylighting and views in building design.]

4.2.2.2d Time Frame
This is a medium term recommendation to be undertaken as a Research Project with potential for long term impact.

4.2.2.3 Reevaluate measurement tools and technologies on an annual basis to ensure best practices of building performance audits.

4.2.2.3a Summary

Multiple tools, techniques and technologies exist for measuring various aspects of building performance, such as the use of Blower door or Tracer gas methods for measurement of air ventilation Rates. The University shall promote studies to evaluate best practices used to evaluate building performance, to increase accuracy of sustainable practices and for benchmarking in accordance with peer institutions and the private market.

4.2.2.3b References
The Interior Environment Department of Lawrence Berkeley National Labs:

> "Conducts research on energy-efficient ventilation, pollutant transport, particle control, and health and productivity in commercial buildings. The research methods employed by this department include controlled laboratory studies, extensive multi-disciplinary field studies, modeling, and reviews and syntheses of data.Associated research topics include the following: Ventilation Rates and Technologies, indoor VOCs, Sick Building Syndrome and Filtration for Particles and Other Pollutants.[25]

4.2.2.3d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration, potentially under the direction of Consultants.

4.2.2.4   Develop a comprehensive assessment of and database for the University's buildings inventory and real estate holdings. Use Geographic Information Systems Software (GIS) as well as other visualization and analysis tools to better represent and spatialize sets of university data and mappings regarding sustainable initiatives and all ongoing proposals. Model data should be shared with faculty, students and staff of the University to encourage and support internal research.

4.2.2.4a Summary

Visualization models will serve three purposes.

- For the University facilities management to better understand and benchmark holdings and their interrelationships.
- For designers to utilize in future building projects
- For students to use as a learning tool to better understand the meaning and implications of design decisions on the performance and efficiency of buildings, and their interrelationships.

4.2.2.4 b References

ArcGIS 3D software is being deployed during the planning, construction, and operations phases of a new carbon-neutral, zero-waste, planned city in the United Arab Emirates. The new city, titled Masdar, was commissioned by the Abu Dhabi future Energy Company and is being designed by Foster + Partners with the CH2M Hill acting as program manager. Shannon McElvaney, Site Control and GIS Manager for CH2M Hill, directed the development of a highly detailed "6D" model of the entire city. The model tracks the physical characteristics of the city in three dimensions, while also tracking costs, time, and carbon emissions. This 3D model assisted in locating facilities (recycling, geothermal wells, etc) for maximum efficiency; modeling water and power usage over a period of 10 years to size service lines and predict use patterns; and to document the construction process to optimize the location of building materials and timing of activities to keep costs and carbon emissions down. Carbon emissions and costs are monitored dynamically in correlation with physical changes to the model, allowing the design and construction team to play out multiple scenarios and determine the best balance of financial and environmental impact.

Information about emissions and energy consumption can be tracked on a building-by-building basis. When the city is fully operational, the ArcGIS model will interface with Building Information Models (BIM) developed during the design phase to track gas pipes, electrical cables, clean and wastewater networks, and the transportation infrastructure. "The GIS will be integrated with a Computerized Maintenance Management System (CMMS) which will automatically generate work orders that are sent directly to technical engineers who will then carry out work."[27]

4.2.2.4 c Research Opportunities

The University should sponsor research studies to acquire specific data, with the goal of organizing the University's buildings by typologies, occupancy type, mechanical systems, etc. Models should encompass all energy and lifecycle data available, and add additional data sets as they become available. For example, a specific study may evaluate post-occupancy and performance data to compare different buildings across university holdings.

Modeling software with capabilities like ArcGIS 3D would allow the University of Michigan to quantify the potential ecological and monetary benefits of construction, renovation, and retrofit projects across the entire campus. At one scale, the impact of individual projects can be analyzed in aggregate, and at another scale, the University can test the financial pay off of campus-wide planning or construction initiatives. Moving forward, an accurate GIS model of the campus could be used to track construction and develop to improve environmental performance and locate new resources more effectively.

4.2.2.4d Time Frame
This is a short term recommendation that could be undertaken as a Student Project with potential for long term impact.

4.2.2.5 Expand long term monitoring and testing protocols across sustainable project initiatives to assess building performance beyond construction for the lifetime of the building.

4.2.2.5a Summary
LEED-BD+C v3.0 Energy and Atmosphere Credit 5 offers three points for monitoring and verification of systems for the first year after building occupation (to be expanded beyond energy performance monitoring). This credit should be attained as a baseline, however, long-term monitoring of University facilities will not only assist in maintaining building systems throughout the building's life span, but also produce data sets available for internal research by faculty and students as suggested in recommendation 4.2.2.4.

4.2.2.5b References
Currently, the Plant Operations Division at the University of Michigan maintains and monitors air conditions and energy performance across many buildings, and continues to grow the system. The information for each building's energy use is available online. "Building Automation Services (BAS) is part of the University of Michigan’s Facilities Maintenance department. BAS serves nearly all of the University's General Fund Buildings, and a few non-general fund buildings (for a fee). BAS implements schedule and operational changes for various types of equipment, and monitors alarm conditions and energy efficient system operation.[23]

A chart of University growth in testing is available on the Plant Operations Website: http://www.plantops.umich.edu/maintenance/shops/BAS/bas_growth.html

4.2.2.5d Time Frame

This is a short-to-mid term recommendation that would be undertaken by Institutional Administration with potential for long term impact.

4.2 SUMMARY

The following recommendations can be implemented in the **short term** and would carry immediate impact:

- ***4.2.1.1*** *Through the adoption of LEED v3.0 Silver plus 30% better than ASHRAE 90.1 energy performance as the standard for all building projects, maintain the ongoing goal of outperformance of this baseline, addressing recommendations for research and study outlined within this document. The most current versions of LEED should be adopted as they become available, or until an alternative standard is identified.*
- ***4.2.2.4*** *Develop a comprehensive assessment of and database for the University's buildings inventory and real estate holdings. Use Geographic Information Systems Software (GIS) as well as other visualization and analysis tools to better represent and spatialize sustainable initiatives and all ongoing proposals. Model data should be shared with faculty, students and staff of the University to encourage and support internal research.*

The following recommendations can be implemented in the **short-to-medium** term and would show results in the medium term:

- ***4.2.1.2*** *Encourage all personnel engaged in University building design practices to become LEED accredited by 2012.*
- ***4.2.2.5*** *Expand long term monitoring and testing protocols across sustainable project initiatives to assess building performance beyond construction for the lifetime of the building.*

The recommendations below are intended for more **medium-term** implementation that will carry medium-to-long term impact across multiple departments of the University:

- ***4.2.2.1*** *Perform comprehensive audits of campus buildings with the goal of gathering data to assist in prioritizing future building renovations and retrofits. Prioritize locations where improvements will affect the greatest net performance benefits.*
- ***4.2.2.2*** *Develop a stream of public health research aimed at correlating indoor environmental quality to student and worker health and productivity, including air quality, daylight quantity, quality and views, specifically utilizing University buildings, faculty, staff and students as participants in order to assess policy decisions regarding performance targets and economic benefits.*

The following recommendation can be implemented in the **short term**, but will require **long-term, ongoing review**:

- ***4.2.2.3*** *Reevaluate measurement tools and technologies on an annual basis to ensure best practices of building performance audits.*

4.3 FACILITIES/CAMPUS PLANNING (FUTURE AND EXISTING PLANNING)

Prioritize the efficient use of existing spaces while accommodating future needs with design strategies that provide for variety of uses. Densify existing campus spaces over time while increasing heterogeneity of program and services and integrating with ecological fabrics across the University.

4.3.1 Space Utilization

4.3.1.1 Undertake a comprehensive space utilization study of University spaces with the goal of expanding the existing Space Utilization Initiative to consider the full range of space types on campus, to more effectively and efficiently take advantage of existing space.

4.3.1.1a Summary
Efficient space utilization is key to minimizing wasteful new construction spending and mitigating the environmental impact of overbuilding. The existing 2007 Michigan Space Utilization Initiative allows general purpose classrooms to be utilized by any course across academic units in need of space. This program should be expanded to include all space types available on campus, including office space, meeting rooms, labs and other potentially useful space types across disciplines.

4.3.1.1b References
The 2007 Michigan Space Utilization Initiative focuses on utilizing general purpose classrooms more intensely with a target goal of 70% classroom utilization and 65% seating capacity utilization. A "8am-12pm Shared Classroom" policy will be in effect starting in the Fall of 2010 as a means to these achieve goals.[28]

Stanford University requires selected schools to pay a charge for underutilized space. Furthermore, before building projects commence, Stanford conducts rigorous space-utilization studies to recover space in existing buildings through renovation to create space for new needs, with the goal to recover 5–10 percent of space throughout campus buildings. Studies have found that offices applying these guidelines could recover up to 10 percent of their space.[15]

4.3.1.1d Time Frame
This is a short-to-long term recommendation to be undertaken by Institutional Administration with potential for immediate impact.

4.3.1.2 When space utilization studies determine new space requirements for units or departments, prioritize existing building acquisitions and departmental trades over new construction.

4.3.1.2a Summary
Prioritizing the utilization of existing buildings and infrastructure over development of open space has clear financial and environmental benefits, including reduction of material

use, construction wastes and impacts, and the elimination of costs associated with open space development such as infrastructural expansion.

The Pfizer facility acquisition, when repopulated with related University programs, will serve as a case study for utilizing existing structures as a means to reduce new construction costs and environmental impacts.

4.3.1.2b References
1998 UM Campus Plan "Using an existing building more intensively may obviate the need to build a new building and save the lifetime costs of maintaining and operating two buildings."[29]

Princeton University's Sustainability Plan emphasizes recycling old buildings where possible prior to commencing with new construction to accommodate growing space and program needs.[30]

4.3.1.2c Research Opportunity
Conduct a study that identifies particular buildings at University of Michigan and throughout the Ann Arbor real estate market that are best suited for acquisition or for departmental trades of space.

4.3.1.2d
This is a short term recommendation to be undertaken by Institutional Administration with potential for immediate impact.

4.3.1.3 Generate long-term spatial flexibility in new building projects through typology-based planning.

4.3.1.3a Summary
New projects that can accommodate flexible interiors, such as general purpose classrooms and offices will extend the utility of the building and maximize space utilization. Additionally, optimizing design to make use of smaller spaces and utilize materials efficiently reduces costs and material use.

4.3.1.3b References
1998 UM Campus plan: "Many campus buildings have changed their uses over and again, their simple, generic loft like plans and structures allowing them to do so."[31]

4.3.1.3d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration under the guidance of Consultants with potential for long term impact.

4.3.2 Campus Planning: Context, Density, Programming and Open Space

Commit to ecological protection and environmental stewardship of surrounding campus and town open space. While elements of this recommendation are covered by the *Water and*

Landscape Team, building design and planning have a significant impact on local ecologies. Dense planning, space utilization, and prioritizing renovation of existing buildings over new construction all help protect open space, local ecology, and watershed throughout Ann Arbor.

4.3.2.1 Work through the campus Master Plan to develop a framework for directing building development that recognizes the unique challenges and opportunities associated with a distributed campus of diverse composition, including distinct ecological and urban contexts.

4.3.2.1a Summary
The University shall develop a set of policies and guidelines to determine how development of campus buildings and properties surrounding the campuses should proceed to establish and support a desirable environment. Guidelines should focus on supporting non-university developments surrounding each campus, the constituent population served, and uses to establish need for densification and program heterogeneity.

For example, development on the University's North Campus may benefit from incorporating more third-party retail-based services at the North campus edges and along its thoroughfares to service the residential population and integrate with the surrounding development. Increased density and heterogeneity of program would serve to minimize land disturbances and impervious surface area, protecting the existing ecology while increasing access to goods and services within a walking radius (also refer to the *Transportation Team's* Land Use recommendation). On the other hand, development associated with the Athletic Campus would need to consider the predominately non-University residential context and the cyclical nature of campus occupation.

4.3.2.1b References
UC Berkeley developed campus planning and programming guidelines called the New Century Plan in 2002. This plan lays out development policies that are intended to preserve the core campus character while integrating campus activity into the low-rise urban fabric surrounding the campus. These policies promote densification of the campus and increased heterogeneity of function. However, the school recognizes that certain functions might not be appropriate for the core campus. UC Berkeley has also established Location Guidelines that suggest program typologies that can be located away from the central development area. Some units do not require physical proximity, while others are unsuitable for the campus and its urban environs due to scale, service requirements, safety hazards or environmental impacts.[31]

The University of Pennsylvania actively seeks partnerships with third-party, private capital for development projects around the Philadelphia campus ranging from mixed use to housing to research. For example, the 2007 UPenn University City Development project established a relationship between the university and a private developer to develop a mixed use project that included retail space, luxury apartments, and parking space.[32]

The University is also planning a series of development corridors that will extend the activities of the central campus into the surrounding city fabric. These corridors "extend and enhance the successes of previous planning and design initiatives that have transformed the campus". "The creation of concept corridors, or "Bridges of Connectivity," enlivens the pedestrian experience and creates opportunities for vibrant development."[33]

Ryerson University in Toronto, Ontario developed an aggressive Master Plan to guide development of their urban campus:

> "The Master Plan is a flexible, innovative framework that will guide future decisions about the growth of the University and its precinct… It is not a building plan or an architectural plan, nor does it focus on the allocation of space within the University. Rather, it establishes three broad goals and a comprehensive set of principles that form a framework within which the University will evaluate future opportunities and make decisions about campus growth. The three goals of the Master Plan are: Urban Intensification; Pedestrianization of the Urban Environment; and A Commitment to Design Excellence."

As a component to the Masterplan,

> "Ryerson seeks to build on RU's reputation as a 'city builder'. By virtue of its location, the RU campus is inevitably interwoven with a highly active portion of downtown; every aspect of campus development should take advantage of opportunities for synergies, co-development, and connections to the various networks and uses surrounding the campus, hence strengthening community integration and interdependence."[34]

One example of these policies in practice is the Toronto Life Square. This building contains a mix of retail, restaurants, offices and a 24-screen AMC movie theatre. 12 of these theatres are used by Ryerson as lecture halls during the school year. On the opposite side of this building is Yonge and Dundas square. Every year over 56,000,000 people frequent its immediate area and 20,000,000 subway trips either start or end at the Dundas Subway station.

4.3.2.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration under the guidance of Consultants with potential for long term impact.

4.3 SUMMARY

The following recommendation can be implemented in the **short term**, but will require **long-term, ongoing review**:

- ***4.3.1.1*** *Undertake a comprehensive space utilization study of University spaces with the goal of expanding the existing Space Utilization Initiative to consider the full range of space types on campus, to more effectively and efficiently take advantage of existing space.*

The following recommendations can be implemented in the **short term** and would carry immediate impact:

- ***4.3.1.2*** *When space utilization studies determine new space requirements for units or departments, prioritize existing building acquisitions and departmental trades over new construction.*
- ***4.3.1.3*** *Generate long-term spatial flexibility in new building projects through typology-based planning.*

The following recommendations can be implemented in the **short-to-medium term** and would show results in the medium term:

- ***4.3.2.1*** *Work through the campus Master Plan to develop a framework for directing building development that recognizes the unique challenges and opportunities associated with a distributed campus of diverse composition, including distinct ecological and urban contexts.*

4.4 EXISTING AND NEW BUILDING

Develop superior living and working spaces by prioritizing buildings with outstanding ecological performance, low resource consumption, and high indoor environmental quality.

To attain this goal, the University shall adopt high performance building criteria as outlined by LEED (see section 4.2.1.2). However, the the University of Michigan is in a unique position, due to the quantity and quality of its existing building stock holdings, to augment LEED criteria, providing additional targets specific for the University as a means to drive increased performance over time, as well as to suit the range of research, teaching, and working contexts of the University. LEED points should be attained where appropriate, and not chased after to the detriment of the overall design strategy.

The University's *Special Instructions to Designers* (SID-D: Energy and Water Conservation & SID-K: Sustainable Design & Environmental Stewardship) makes specific demands for new building designs, renovations and retrofits. The recommendations outlined within this document are meant to supplement those already invested by the University, with the intent of making specific requirements and recommendations more robust while also addressing holistic and broad-scope issues.

4.4.1 Water

4.4.1.1 Undertake a a coordinated assessment of stormwater issues on campus as they relate to building design to determine appropriate and novel practices for water retention within building sites using various technologies.

4.4.1.1a Summary
Consistent with recommendations from the Land and Water Team regarding the reduction of impervious surfaces on campus, building construction and renovations should aim to minimize impervious surfaces, and provide integrated systems of stormwater channeling and recapture to mitigate urban run-off and surface erosion conditions.

4.4.1.1b References
At Duke University, in the Cancer Center Addition and the Cancer Center Project (both LEED certified properties), a large volume cistern system that will store stormwater runoff for reuse in the Medical Center’s irrigation system. Also intensive green roof systems are employed to provide aesthetic and water quality benefits. Rooftop runoff will be stored for use in each building’s cooling towers as well as a limited gray water system. At the French Family Science Center, two green roofs comprised of vegetation, soil, gravel and water-tight insulation, combined with plumbing fixtures that save two million gallons of water annually.[35]

4.4.1.1d Time Frame
This is a short term recommendation that could be undertaken as a Student Project.

4.4.1.2 Improve water consumption guidelines to a minimum of 30% reduction through both education and technology improvements.

4.4.1.2a Summary

The University's current design guidelines enforce specific water reduction goals of 20%. This goal should be increased to 30% minimum with the goal of attaining a minimum (2) points for LEED BD+C v3.0 WE Credit 3. Retrofits should be undertaken to update all water supplies within existing buildings to the most current standard by 2020.

Education of building occupants is critical to change behavior. Initiatives such as Planet Blue should continue to actively promote and enforce water reduction education programs for long-term success.

4.4.1.2b References

According to the University of Michigan Guide to Designers:

> "Projects shall employ water conservation strategies that in aggregate use 20 percent less water than a baseline water use (not including irrigation) based on Energy Policy Act of 1992 fixture performance requirements (which are incorporated into the Michigan Plumbing Code 2006). All projects shall incorporate the following water conservation measures:
> • Dual flush water closets
> • Waterless or 1/8 gallon per flush urinals
> • 1/2 GPM aerators for lavatory faucets
> Additional measures may be required to meet the 20 percent water conservation target." [36]

At the University of Maryland, three green roofs were constructed in 2008. Additionally, Bathroom faucets in the Adele H. Stamp Student Union were recently replaced with sensor-driven units to save water, 100 new faucets in the Union will save approximately 1.2 million gallons of water per year and 29 million BTU of energy from reduced hot water usage. The total project cost of $26,000 will be paid back through savings in a little more than two years. Installed a 10,000 gallon cistern to provide drip irrigation for the landscaping around the Washington Quad. [37]

4.4.1.2c Research Opportunities

The University should actively monitor water usage within buildings across campus, and set specific reduction targets based on current usage as baseline. Incorporate water usage data into GIS models as outlined in section 4.2.2.4.

4.4.1.2d Time Frame

This is a short term recommendation to be undertaken by Institutional Administration with immediate impact.

4.4.2 Energy

As buildings consume more energy than any other asset of the university, the creation of high performance buildings that minimize energy use is critical. But energy use reduction must be balanced with the creation and use of renewable energy sources, which may be incorporated within building designs or brought to site from remote locations. Recommendations specific to building energy reduction and creation may be found in this section. Detailed recommendations for novel energy creation across the University may be found in the Energy Section.

4.4.2.1 Assess and create targets for reduction of non-renewable energy for the University that correlates energy use with dynamic building occupancy. Set short term goals to be achieved by 2015, with the long term goal of carbon neutrality.

4.4.2.1a. Summary
Energy consumption across the university varies greatly dependent on building constituents required load types for space typologies, etc. In order to better understand its energy consumption rates over time, the University has detailed a refined set of metrics that correlate energy use per person per square foot since 2004. The University should continue its trend of energy consumption reduction with a more robust metric of energy use per person per square foot per occupancy hour. Although energy reduction should be an ongoing goal, this metric should differentiate energy consumption of renewable sources from non-renewable sources, prioritizing energy efficiency to minimize waste.

4.4.2.1b. Reference
"Over the last six years the university has succeeded in keeping total energy use stable despite a 9 percent increase in population and an 11 percent increase in building area." -University of Michigan 2009 Anual Environmental Report.[38]

4.4.2.1c. Research Opportunities
A study should be undertaken assessing the impact of separating connected loads, such as lighting or HVAC, from plug loads, such as computer use, with the intent of enabling the university to further fine-tune its energy conservation practices and suggesting new and novel methods for reduction of loads associated with the uncontrollability of plug-in power usage.

4.4.2.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration.

4.4.2.2 At the initiation of new building projects, renovations or retrofits, a*ssess the potential for on-site generation of alternative and renewable energy sources.*

4.4.2.2a. Summary
The University should find opportunities during the building design phase to include on-site energy creation using alternative and renewable energy sources wherever feasible. These sources could supplement or replace remote energy acquisition, minimizing impacts of non-renewable sources off-site, waste from transmission, and give the University buildings increased independence and control over its power supply. Specific recommendations for sources and methods may be found in the recommendations of the *Energy Team*.

4.4.2.2b References
University of Minnesota:

> "Require a minimal use of on-site renewable energy, and encourage the broader consideration and use of renewable energy sources and cleaner forms of hydrogen and hydrocarbon-based distributed generation systems to reduce atmospheric pollution. This can provide a stimulus to the State's economy through investments in local jobs and materials while reducing the State's expenditures on imported fuel and power. The language of this guideline is intended to align with Minnesota legislation that requires and economic analysis of onsite solar-and-wind-derived renewable energy systems sufficient to offset 2% of predicted energy demand (LAWS 2008, Chapter 179, Section 29). This legislation requires the installation of such systems unless explicit reasons are provided that rule out installation."[39]

4.4.2.2c Research Opportunity
Conduct a series of studies that pinpoint optimal locations for on-site power generation across university holdings. Incorporate into GIS models as outlined in section 4.2.2.4.

4.4.2.2d Time Frame
This is a short-to-medium term recommendation to be undertaken by Institutional Administration, with potential for integration with a Student Project.

4.4.3 Materials

4.4.3.1 Develop a strategy for material reuse and recycling of building components that could include partnerships with local recyclers as well as in-house materials collection and storage for materials identified to be reused in new University projects, with an ongoing inventory of all material resources available for reuse in new projects.

4.4.3.1a Summary
As an entity with substantial building holdings, the University is in a unique position to retain materials from deconstruction projects for future use. The University should institute a materials warehouse, either within underutilized warehouse space or through the creation of a new facility, to become the default repository for any potentially reusable materials removed from renovation or building demolition projects, excluding toxic materials. Any materials unable to be reused should be recycled by a local recycler.

An ongoing inventory of materials should be given to all design teams working on any University building project for consideration of material reuse.

4.4.3.1b References
Stanford diverts 50% of its waste from landfills. Employing the waste management perspective from early stage of building development could further alleviate the impact of construction waste on the environment.[15]

Additional references may be found at the The Building Materials Reuse Association www.bmra.org

4.4.3.1d Time Frame
This is a medium term recommendation to be undertaken by Institutional Administration.

4.4.3.2 *Establish long term relationships with sustainable construction material suppliers, prioritizing suppliers in the 500 mile radius Great Lakes Megaregion.*

4.4.3.2a Summary
The university should partner with manufacturers of building materials that show a commitment to sustainable production practices within the Michigan Region where possible. For less durable products, preference should be shown to manufacturers that offer a holistic return and recycle program. For more durable products, life-cycle costing should weigh embodied energy against the anticipated life of the building to minimize environmental impact. See the *Purchasing Team's* recommendations for additional information.

4.4.3.2b References
The University of Michigan has a Preferred List of Manufacturers organized by construction specification division. Selections of preferred manufacturers are based on specification requirements, quality level, and project schedule commitment. Adding specific requirements relating to energy, recycling, and material content maintains minimum standards for performance that the design team must comply with. BEES (Building for Environmental and Economic Sustainability) software, available from National Institute of Standards and Technology, is a nationally accepted tool for assessing environmental impacts and cost implications of building materials that may be useful to the University of Michigan in measuring specific material choices against sustainability goals.[40]

The United States Federal Mandates for New Construction identify four areas of focus when selecting building materials for reduced environmental impact:

- Recycled Content: Use products meeting or exceeding EPA's recycled content recommendations
- Bio-based Content: Use products meeting or exceeding USDA biobased content recommendations, and/or use biobased products made from rapidly renewable resources and certified sustainable woods
- Waste and Material Management: during project planning, identify how materials could be salvaged or recycled both during construction and during the life of the building
- Ozone Depleting Compounds: Eliminate the use of ozone depleting compounds and volatile organic compounds within building products [41]

4.4.3.2d Time Frame
This is a medium-to-long term recommendation to be undertaken by Institutional Administration.

4.4.4 Indoor Environmental Quality

In the execution of new buildings, renovation or retrofit on campus, the following series of recommendations aim to create indoor environments that optimize learning, teaching and research, based on studies suggested in recommendation 4.2.2.2.

4.4.4.1 Maximize beneficial daylighting and views while minimizing glare and heat gain. Balance issues of daylight quality and quantity with necessity for energy load reduction through integrated design strategies.

4.4.4.1a Summary
LEED BD+C IEQ Credit 8.1 intends to provide for the building occupants a comfortable luminous environment in regularly occupied areas of the building, while minimizing glare and heat gain through the use of manual and automatic shading devices. However, energy reduction calculations used to attain LEED credits in the Energy and Atmosphere section are often at odds with IEQ Credit 8.1, as increased daylight may equate to higher thermal loads.

Designs should exemplify holistic daylighting approaches beyond the merely prescriptive that balance energy loads with the need for occupants to experience quality day-lit spaces with views. The University of Michigan shall require that designers use advanced calculation and modeling techniques to design buildings for daylight, with the intent that design teams balance issues of heat gain throughout the design process.

4.4.4.1b References
"Optimizing a building with respect to daylight/glazing factor and view to the outside does not necessarily promote good daylighting design but merely leads to a one-dimensional, “the more the better” design philosophy. Even if the avoidance of direct sunlight is added as an additional design criterion, some key design parameters are neglected, which puts some daylighting techniques at an arbitrary disadvantage compared to others." [42]

4.4.4.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration with direction from Consultants.

4.4.4.2 Ensure controllability and responsiveness of systems. Allow users to control thermal and daylight systems where possible, using automated controls to ensure maximum efficiency.

4.4.4.2a Summary
LEED BD+C IEQ Credit 6.1-6.2 intends for controllability of systems. However, manually adjusted systems may not be advantageous to overall energy efficiency or productivity of occupants at all times. For example, shade devices create the potential for shutting out helpful daylight contribution beyond times of day/year that glary conditions exist (Reinhart et al). Manually controlled shading should be limited to areas that receive

constant attention of occupants, such as private offices, or areas of glazing immediately abutting task planes.

4.4.4.2b References
"Research on occupant use of shading devices revealed that once direct sunlight is incident on a VDT surface, blinds are lowered for hours, days or even months afterwards (Rea M S, 1984; Rubin A I, Collins B L, & Tibott R L , 1978). Even in the case of an 'active' user, blinds remain routinely closed for hours after glare conditions have disappeared (Inoue T, Kawase T, Ibamoto T, Takakusa S, & Matsuo Y, 1988; Rea M S, 1984; Reinhart C F & Voss K, 2003). As a consequence, the daylighting intent is compromised, the connection to the outdoors is diminished, and the electric lighting is routinely switched on in many buildings even during daylit hours."[42]

4.4.4.2d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration with direction from Consultants.

4.4.5 Existing Building Update and Modification

Over the past decade, the University has invested $396 million a year on average dedicated to updating or replacing the existing building stock.[43] Within this category of construction, three tiers of building updates may occur: Retrofits, Recommissioning and Renovation. Retrofit refers to the update of a singular system within a building to increase performance (replacements of urinals for water use reduction or lighting equipment for better energy performance). Recommissioning refers to updating a significant number of systems within a building encompassing potentially significant modifications to the building, but where the primary goal is performance improvement. Finally, renovation refers to the reallocation of space as required by individual academic units to suit their changing needs, where the primary goal is not environmental performance. In the ladder, performance improvement is expected regardless of its priority.

4.4.5.1 Prioritize renovations across University buildings based on need for improvement of environmental performance as defined by audits outlined in section 4.2.2.

4.4.5.1a Summary
Although building renovation projects are prioritized based on multiple factors beyond performance (space allocation, inter-unit relationships, etc), the University should commit to reorder renovation projects based on performance criteria.

4.4.5.1b References
University of Pennsylvania encourages responsible stewardship of all existing University buildings: "Each renovation project, therefore, should include an investigation of all aspects, systems and features impacted by the specific intervention. Conditions discovered during project evaluation, design or construction that are in need of improvement cannot be ignored. Even in cases where budgetary or schedule constraints necessitate only a partial remediation, any building deficiencies brought to light are to be

examined and documented so that they may be addressed at a future time. Such proactive management reflects the University's commitment to maximizing the efficiency of its built environment. In working to sustain its existing capital investments, the University proves the principle that the greenest building is the one you do not have to build." [44]

4.4.5.1d Time Frame
This is a short-to-long term recommendation to be undertaken by Institutional Administration.

4.4.5.2 Continue to implement a comprehensive building retrofit and recommissioning program, prioritizing projects as indicated by 4.4.5.2, based on updating all existing buildings to the baseline as outlined in section 4.2.1.1.

4.4.5.2 a Summary
The University shall commit to updating its existing building stock to the baseline of LEED Silver & 30% improvement over ASHRAE 90.1 2007, scheduled based on a set of target buildings grouped in phases according to need. In applicable buildings, the value of historic fabric must be balanced with energy performance, the life-cycle value of historic vs. new materials, and constrains of historic building and landscapes. As outlined in section 4.1.3, the University should pursue funding that advances projects based on performance improvements where existing modes of funding may not support such projects.

Retrofit/Recommissioning should focus on four main categories following audits:

- Lighting/Water Updates (for energy/monetary savings)
- Improving IAQ (for campus health and reduced liability claims)
- Material assessment/durability (for recurring energy/maintenance savings, IAQ improvements)
- HVAC updates (for energy/monetary savings)

4.4.5.2b References
University of Michigan 1997 Energy Star/ Green Light building retrofit program: a comprehensive building retrofit program for General Fund Facilities only, comprising of 119 buildings and 12 million square feet of space. 5 step programs completed over 6 years focusing on lighting retrofits, building mechanical systems tune-ups, and HVAC reductions and improvements. Total budget of program: $24.5 million with projected annual energy savings of $5.7 million.[45]

2004 Energy Conservation and Outreach (ECO) program: 5 year program, again for General Fund buildings only. Goal: $1 million energy cost savings per year with an 8 year payback target. Program also includes behavioral changes goals and feasibility studies for pilot projects.[45]

University of British Columbia: the UBC ECOTrek project involved rebuilding and retrofitting the infrastructure of 288 academic buildings. Completed in 2008, the project reduces energy by 20% annually, cuts annual CO2 emissions by 15,000 tons and water use by 30 percent and saves the university $2.5 million annually in operating costs, producing an approximately 15 year payback.[46]

University of Pennsylvania Section 5.5.e: "recommission eight buildings each year, and add [energy] meters to an additional eight buildings." - Based on 10% energy saving in campus buildings once recommissioning is completed. Projects to be completed after report are detailed.[44]

4.4.5.2d Time Frame
This is a short-to-long term recommendation to be undertaken by Institutional Administration.

4.4.6 Operation and maintenance

4.4.6.1 Adopt LEED for Existing Buildings, Operations and Maintenance protocols for operations and maintenance regimes for all facilities and units throughout the University.

4.4.6.1a. Summary
As noted by the USGBC, "The LEED for Existing Buildings Rating System helps building owners and operators measure operations, improvements and maintenance on a consistent scale, with the goal of maximizing operational efficiency while minimizing environmental impacts. LEED for Existing Buildings addresses whole-building cleaning and maintenance issues (including chemical use), recycling programs, exterior maintenance programs, and systems upgrades. It can be applied both to existing buildings seeking LEED certification for the first time and to projects previously certified under LEED for New Construction, Schools, or Core & Shell."[4]

4.4.6.1b References
Facility User Network (FUN) group has initiated training regimes across the University campus towards a more sustainable approach to facility maintenance and operations.[47]

4.4.6.1c Research Opportunities
Research carefully the relationship between materials selection and space design in relative to maintenance costs / occupant health in undertaking maintenance regimes.

4.4.6.1d Time Frame
This is a short term recommendation to be undertaken by Institutional Administration.

4.4 SUMMARY

The following recommendations can be implemented in the **short term**, but will require **long-term, ongoing review**:

- ***4.4.5.1*** *Prioritize renovations across University buildings based on need for improvement of environmental performance as defined by audits outlined in section 4.2.2.*
- ***4.4.5.2*** *Continue to implement a comprehensive building retrofit and recommissioning program, prioritizing projects as indicated by 4.4.5.2, based on updating all existing buildings to the baseline as outlined in section 4.2.1.1.*

The following recommendations can be implemented in the **short term** and would carry immediate impact:

- ***4.4.1.1*** *Undertake a a coordinated assessment of stormwater issues on campus as they relate to building design to determine appropriate and novel practices for water retention within building sites using various technologies.*
- ***4.4.1.2*** *Improve water consumption guidelines to a minimum of 30% reduction through both education and technology improvements.*
- ***4.4.2.1*** *Assess and create targets for reduction of non-renewable energy for the University that correlates energy use with dynamic building occupancy. Set short term goals to be achieved by 2015, with the long term goal of carbon neutrality.*
- ***4.4.4.1*** *Maximize beneficial daylighting and views while minimizing glare and heat gain. Balance issues of daylight quality and quantity with necessity for energy load reduction through integrated design strategies.*
- ***4.4.4.2*** *Ensure controllability and responsiveness of systems. Allow users to control thermal and daylight systems where possible, using automated controls to ensure maximum efficiency.*
- ***4.4.6.1*** *Adopt LEED for Existing Buildings, Operations and Maintenance protocols for operations and maintenance regimes for all facilities and units throughout the University.*

The recommendations below are intended for more **medium-term** implementation that will carry medium-to-long term impact across multiple departments of the University:

- ***4.4.3.1*** *Develop a strategy for material reuse and recycling of building components that could include partnerships with local recyclers as well as in-house materials collection and storage for materials identified to be reused in new University projects, with an ongoing inventory of all material resources available for reuse in new projects.*
- ***4.4.2.2*** *At the initiation of new building projects, renovations or retrofits,* assess *the potential for on-site generation of alternative and renewable energy sources.*

The following recommendation can be implemented in the **medium term**, but will require **long-term, ongoing review**:

- ***4.4.3.2*** *Establish long term relationships with sustainable construction material suppliers, prioritizing suppliers in the 500 mile radius Great Lakes Megaregion.*

4.5 LONG TERM CURRICULUM DEVELOPMENT AND RESEARCH

Develop the University as a 'living laboratory,' using buildings as both a key element in promoting curricular and extra-curricular program development and as assets for attracting and maintaining top academic talent. Create a Center of Excellence for the Built Environment that aims to reduce environmental impacts and improve human welfare by advancing and synthesizing innovations that integrate technological and materials research with engineering systems, advanced controls, and human occupant feedback.

4.5.1 Knowledge Management

4.5.1.1 Prioritize the retention of knowledge and 'lessons learned' from sustainable construction projects to inform future decision making.

4.5.1.1.a Summary
Revise consultant contracts to acquire all research performed that lead to decisions on specific sustainable strategies for future reference library. Develop a comprehensive resource repository available to the university community that compiles information on materials, construction practices, case studies, and performance monitoring to assist the construction team in implementing sustainable strategies during the design and construction process.

4.5.1.1.b References
Harvard University's *Green Building Resource* website. The website clearly highlights all criteria that designers and consultants must accomplish to comply with Harvard's Green Building Guidelines, including any formwork to be submitted and calculation methods for life cycle costing and energy modeling. While there have not been any quantitative studies assessing the impact of the *Green Building Resource*, the website is a valuable educational tool for students and practitioners, as well as a useful method of insuring sustainable practices are evolving as new research emerges.[48]

4.5.1.1c Research Opportunities
Formalize data retention around sustainable initiatives in UM Library Digital Archives including data sets, GIS Mappings, energy audits with the goal of promoting research and access among students, faculty and staff. See section 4.2.2.4 for more information on this research opportunity.

4.5.1.1d Time Frame
This is a short-to-long term recommendation to be undertaken by Institutional Administration, with the potential for a Student Project.

4.5.2 Talent Recruitment and Retention

4.5.2.1 Assess the impact of sustainable building practices on the recruitment and retention of new faculty and students in order to help quanitfy the value associated with sustainability-driven *decision making.*

4.5.2.1 a Summary
The shift of sustainability from a marginal interest to a mainstream concern has led to increased prioritization of sustainable practices. Contemporary marketing and social responsibility strategies point to this across corporate America, and is evident in popular media promoting the experience economy. As the University commits more resources towards sustainable initiatives, it is imperative to understand incentives beyond direct financial gain from energy reduction. The University's primary asset is its faculty and students. Therefore, recruitment and retention of top talent is critical to maintaining the University's position as a lead research institution.

With the proliferation of ecological building practices, significant opportunity exists to study the relationship between such practices and talent recruitment and retention. The University's expansion of sustainability-focused educational opportunities is already attracting new academic talent to the school and increasing the involvement of current students and faculty in University research projects. Sustainable buildings and spaces may also contribute to help attract new talent by promoting high quality work environments and supporting sustainable lifestyles.

4.5.2.1b References
The Princeton Review has added a single line question asking students and parents “If you (your child) had a way to compare colleges based on their commitment to environmental issues (from academic offerings to practices concerning energy use, recycling, etc.), how much would this contribute to your (your child’s) decision to apply to or attend a school?”. Overall, 66% of respondents said they would favor having such information (up 3% from in 2008), and 24% said it would “Strongly” or “Very Much” contribute to their assessment of a school. Students placed higher value on this information than parents did. [49]

The Erb institute at the Ross School of Business at the University of Michigan, is exemplary of the growth of sustainable curricula on campus, with recruitment figures to support the claim. Founded in 1996 with "small-scale activities related to sustainable enterprise," the program has grown significantly:

> "The 2007-2008 MBA/MS program grew 30 percent over 2006-2007...The program has been growing steadily over the years, especially since 2004, but still this was such a big jump that it took me by surprise,' said Erb Institute director, Tom Lyon... environmental issues are being driven deeper into economic markets and forcing corporations to address these issues in a more significant and strategic way." [50]

4.5.2.1c Research Opportunities
Develop a stream of behavioral science social/psychology research that correlates worker productivity and happiness to design excellence of work space.

4.5.2.1d Time Frame
This is a short-to-long term recommendation to be undertaken as a Research Project.

4.5.3 Curricula Expansion through UM Living Laboratory

4.5.3.1 Position the University of Michigan campus as a 'living laboratory' with the goal of expanding current curricula, advancing student initiatives of research that engages the built environment.

4.5.3.1a Summary
Incorporate Sustainability issues at a more advanced level into Courses and Studios offered throughout the University, with specific focus on building based curriculums within the Taubman College of Architecture and Urban Planning, College of Engineering, and School of Natural Resources & Environment.Use sustainable building projects to advance research initiatives, material research and assessment methods with the intent to raise awareness and educate the university community. For example a construction course within the architecture program could work directly with a building construction project on campus, allowing students to engage the building process directly and repeatedly throughout the course.

4.5.3.1b References
At the University of California at Berkeley, Cris Benton teaches an architecture course entitled:

> "The Secret Life of Buildings...an architecture class addressing the post-occupancy performance of buildings. Students are examining architectural, lighting, and mechanical systems in existing buildings with attention to energy use, occupant well being, and architectural spacemaking. In spring 2009, students examined lighting, ventilation systems, and possible behavioral changes through projects in Wurster Hall and posted their reports and findings online."[51]

Students in University of Illinois courses NRES 199 and 599 designed a Illinois Carbon Registry that the university hopes to use as a model for a campus Greenhouse Gas Registry, with the intent of allowing "colleges, units, and individuals to participate in a GHG credit trading system, allowing them to offset their emissions while providing revenue to sustainability projects and programs. This would provide additional incentives for emission reductions, and could also encourage donations from alumni and friends of the university who wish to offset their own emissions. Educational opportunities could be provided to students in developing and maintaining this program."[52]

4.5.3.1d Time Frame
This is a medium-to-long term recommendation to be undertaken by Institutional Administration, with the potential for a Student Project.

4.5.3.2 Create a Centre of Excellence for a Sustainable Built Environment to support and grow UM’s reputation and recruitment agendas associated with sustainable design.

4.5.3.2a Summary
Create a center that formalizes interdisciplinary research relationships critical to advancing knowledge about environmental challenges and possible solutions within the

built environment. Co-locate faculty researchers to facilitate information exchange across academic units and generate new partnerships. Consider housing advanced environmental tools and technologies within in the Center that will enable the most robust research while also providing opportunities to engage with students and community partners.

4.5.3.2b References
At the University of Florida:

> “The Powell Center for Construction and Environment is primarily a research organization dedicated to the resolution of environmental problems associated with planning and architecture activities and the determination of optimum materials and methods for use in minimizing environmental damage. The Center develops sustainable building codes for residential construction, conducts seminars, symposia, professional conferences and courses on the subject sustainable development and construction related environmental regulations, activities and research. We also serve as a clearing house for information on planning, architecture and construction matters related to sustainable development.” Encompasses: Reclaimed Water, Building Energy Analysis, Life Cycle Analysis, Industrial and Construction Ecology, Green Building Materials, Deconstruction and Building Materials Reuse, Sustainable Architecture, Urban and Community Planning, and Sustainability Indicators. Professors in the fields of architecture, engineering, construction, business, and ecology."[53]

At Arizona State University, the Decision Theatre integrates building design, technology, research and community outreach into one program focused on tackling sustainability issues across departments. Housed in a single facility, the Decision Theatre features "state-of-the-art simulation, visualization and collaboration tools" designed to advance research about emerging and complex sustainability issues that span disciplines such as bio-physics, cognitive psychology, geology, public policy and engineering. The Decision Theatre also engages partners outside of the university that can benefit from the center's advanced tools and intellectual talent. As a result, the Decision Theatre has also been successful at cultivating its own, ongoing donor campaign.[54]

At the University of California Berkeley, the Center for the Built Environment seeks to "improve the design, operation, and environmental quality of buildings by providing timely, unbiased information on building technologies and design techniques."
Their projects:

> "fall into two broad program areas: First, our research team and industry partners are developing ways to "take the pulse" of occupied buildings - looking at how people use space, asking them what they like and don't like about their indoor environment, and linking these responses to physical measurements of indoor environmental quality. This feedback is highly valuable those who manage, operate, and design buildings. Secondly, we are studying technologies that hold promise for making buildings more environmentally friendly, more productive to work in, and more economical to operate. This helps our manufacturing partners to target their product offerings, and facility management and design partners to apply these new technologies effectively."[55]

4.5.3.2d Time Frame
This is a short-to-long term recommendation to be undertaken by Institutional Administration, with the potential for a Student Project.

4.5 SUMMARY

The following recommendations can be implemented in the **short term**, but will require **long-term, ongoing review**:

- ***4.5.1.1*** *Prioritize the retention of knowledge and 'lessons learned' from sustainable construction projects to inform future decision making.*
- ***4.5.2.1*** *Assess the impact of sustainable building practices on the recruitment and retention of new faculty and students in order to help quanitfy the value associated with sustainability-driven decision making.*
- ***4.5.3.2*** *Create a Centre of Excellence for a Sustainable Built Environment to support and grow UM's reputation and recruitment agendas associated with sustainable design.*

The following recommendation can be implemented in the **medium term**, but will require **long-term, ongoing review**:

- ***4.5.3.1*** *Position the University of Michigan campus as a 'living laboratory' with the goal of expanding current curricula, advancing student initiatives of research that engages the built environment.*

CONCLUSION

The recommendations above define a body of work to be undertaken over many years. As detailed in the summaries of each section, the policies, projects, and goals operate on a range of time scales, from one to five to fifteen years and beyond. Several of the identified short-term goals are policy changes that could be implemented immediately and would generate rapid University-wide results, while others will need to be cultivated over many years with collaborations between Institutional parties, faculty, students, and outside consultants. All of the methods described will need to be re-evaluated as new research comes to light and as the goals and environmental conditions of the University evolve.

Most of these goals require action or changes at the Institutional scale to be truly effective, while others could prove effective engines for the integration of sustainable practices and student research and curriculum. Additionally, moving in to Phase II of the Integrative Assessment for Campus Sustainability, the *Buildings Team* could start to lay the groundwork for larger changes to come. Appendix A to this document outlines the relationships between all of the recommendations, identifying which operate as frameworks for change and which can be implemented more quickly in support of these frameworks. During Phase 2, the *Buildings Team* will work with teams of other students, administrators, facilities managers, and outside consultants to develop these frameworks into clear goals and their support recommendations into effective plans of action.

The recommendations outlined above, combined with those from the six remaining sections and the ongoing work of Phase II, will redefine the University of Michigan as a leader in environmental stewardship. The University's unique position both politically, as a premier public research institution, and geographically, as a member of the Great Lakes ecosystem, comes with significant responsibility to set the bar for sustainable practices. Through these aggressive policy changes, pioneering research initiatives, and cross-department curriculum integration, the University of Michigan can fulfill its charge to protect and enhance life on earth and educate the students of today to tackle the "wicked problems" of the 21st century.

BUILDINGS TEAM

The Buildings team is comprised of six graduate students and a faculty member of the Taubman College of Architecture and Urban Planning. Although our collective background is architecture, we have a diverse set of knowledge brought to the table, including business administration, high performance building design, lighting design, large scale territorial landscape and infrastructural planning, materials research and graphic design.

Faculty Lead:
Geoffrey Thun, LEED AP

Team Members:
Zain AbuSeir
Thao Do
Tarlton Long
Mary O'Malley
Katie Miller, LEED AP
Dan Weissman

Culture Team Liaison:
Julie Janiski, LEED AP

Zain AbuSeir received a Bachelor of Science in Architecture [2007] and a Master of Science in Architecture with distinction for high GPA standing [2009], both degrees from the University of Michigan. Zain was an editor of *Dimensions 20* and *Dimensions 21*, *Dimensions* is an annual journal student-produced journal of architecture at the University of Michigan, which helped bring team work and organization to the team. Zain received a Program Distinction Award from Taubman College of Architecture in Graduate school of Architecture; a Raoul Wallenberg Certificate of Award for her B.S. Arch 07 thesis project [*Coded Space*]; and a Willeke Award for her design portfolio[2007]

Thao Do is currently pursuing her Master of Architecture at the University of Michigan, after received her B.A from Massachusetts College of Art and Design with Distinction Award from the school for high GPA standing and Distinguished Student Award from the Architectural Department for high achievements in the major. During her undergrad study and internship, Thao has participated in sustainable projects with focuses on construction materials, green roof design, solar and wind technology, land and water strategies.

Tarlton Long will be entering his second year of the Master of Architecture 3G program in the Fall of 2010. In 2008, he received a BA in Studio Art from Davidson College in Davidson, North Carolina. Prior to his studies at Michigan, Tarlton worked for two very different firms in the San Francisco Bay area. While one specializes in large institutional, commercial, and mixed use projects, the other is landscape design firm. During his time at these two firms, a portion of his work focused on researching sustainable building materials for both particular projects and broader applications.

Katie Miller, LEED AP, has a Master of Business Administration [2010], Master of Architecture [2010] and BS in Architecture [2003], all from the University of Michigan. Katie contributed to the *Buildings Team* her expertise in management, strategy, finance and accounting in addition to her knowledge of sustainable building practices. Prior to graduate school, Katie was a Project Manger at a nonprofit community development corporation, where she helped develop and implement strategies for the physical and economic revitalization of Detroit's neighborhoods. Katie was recently honored with the Weiser Family MBA Entrepreneur of the Year Award.

Mary O'Malley completed her Master of Architecture at the University of Michigan in May 2010, where she received the Marian Sarah Parker Memorial Award to the outstanding woman M.Arch. degree candidate. She received her undergraduate degree in Architecture from Washington University in St. Louis in 2004. Prior to beginning her graduate studies, Mary worked as a lighting designer in New York, developing sustainable solutions for projects ranging from single-room offices to campus master plans. Her research and studies have covered a broad range of topics, including construction practices, urban ecology, and environmental policy.

Dan Weissman has a Master of Architecture from the University of Michigan [2010], where he was awarded the AIA Henry Adams Medal, and a BA in Architecture from Washington University in St. Louis [2005]. Dan's experience as a lighting designer has been a significant contribution to the *Buildings Team*, assisting in crafting of recommendations relative to high performance building and analysis. He leaves the *Buildings Team* to pursue a Master of Design Studies in Sustainable Design at Harvard University's Graduate School of Design beginning fall 2010, with a focus on advanced daylighting analysis and regional and landscape urbanism.

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[1] United States Green Building Council. [Internet] Washtington, D.C. USGBC; c2010 [cited 2010 May 12]. Available from: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718

[2] Arizona State University. The College Sustainability Report Card. 2009 July 30 [cited 2010 May 9]. Available from: http://www.greenreportcard.org/report-card-2010/schools/arizona-state-university-tempe/surveys/campus-survey

[3] University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor, MI: Occupational Safety and Environmental Health; c2009 [cited 2010 May 9]. Available from: http://www.oseh.umich.edu/09AERrawdata.html

[4] US Green Building Council [Internet]. Washington (DC): c2010 [cited 2010 May 7]. Available from: www.usgbc.org

[5] Office of Campus Sustainability [Internet]. Ann Arbor, MI: University of Michigan; c2010 [cited 2010 May 9]. Available from: http://sustainability.umich.edu/campus.

[6] University of Michigan Office of the President [Internet]. Ann Arbor, MI: Regents of the University of Michigan; c2010 [cited 2010 May 12]. Available from: http://www.umich.edu/pres/init/index.php.

[7] Bureau of Labor Statistics [Internet]. Washington DC: United States Department of Labor; c2010 [cited 2010 May 12]. Available from: http://www.bls.gov/web/laus/laumstrk.htm.

[8] French Ron, Wilkinson Mike. Leaving Michigan Behind: eight-year population exodus staggers state. The Detroit News [Internet]. 2009 April 2 [Cited 2010 May 13]; [about 4 screens]. Available from: (http://detnews.com/article/20090402/METRO/904020403/Leaving-Michigan-Behind--Eight-year-population-exodus-staggers-state#ixzz0nwRxZ0ZS)

[9] Coleman, Mary Sue. Five Years Forward: An Address to the University of Michigan Community. Office of the President [Internet]. 2007 November 15 [cited 2010 May 9]; [about 7 screens]. Available from: http://www.umich.edu/pres/vision.php

[10] US General Services Administration. Washington (DC): c2010 [cited 2010 May 10]. Available from: http://www.gsa.gov/graphics/pbs/Design_Excellence_Policies_and_Procedures_Chapter6.pdf

[11] Design Review Guide. University of Pennsylvania. Philadelphia (PA): c2002 Feb 26 [cited 2010 May 10] Available from: http://www.upenn.edu/almanac/v48/n24/FC-DesignGuide.html

[12] Design Review Panel. Toronto.ca. c2010. [cited 2010 May 10] Available from: http://www.toronto.ca/planning/designreviewpanel_background.htm

[13] Whole Building Design Guide Aesthetics Subcommittee. [Internet] Washington DC: Whole Building Design Guide; 2010. Engage the Integrated Design Process; 2009 August 8 [cited 2010 May 14]; [about 4 screens]. Available from: http://www.wbdg.org/design/engage_process.php

[14] International Initiative for a Sustainable Built Environment (iiSBE), Ottawa, [January 31, 2004] prepared by Nils Larsson, Executive Director. Available from: http://greenbuilding.ca/down/gbc2005/Other_presentations/IDP_overview.pdf

[15] Sustainable Stanford [Internet]. Palo Alto (CA): Stanford University c 2008; [cited 2010 May 10]. Available from: http://sustainablestanford.stanford.edu/index.php

[16] Association for the Advancement of Sustainability in Higher Education [Internet]. Lexington (KY): c2005-2010 [cited 2010 May 10]. Available from: http://www.aashe.org/

[17] College Sustainability Report Card [Internet]. Cambridge (MA): Sustainable Endowment Institute; c 2007-2010. [cited 2010 May 10]. Available from: http://www.greenreportcard.org/

[18] CU Carbon Neutrality Working Group. Conceptual Plan for Carbon Neutrality at the University of Colorado at Boulder August 2009 [Internet]. Boulder (CO): The University of Colorado; 2009.

[19] Office of Sustainability. University of Calgary Campus Sustainability Assessment 2007 [Internet]. Calgary (Alberta): University of Calgary; 2007. [cited 2010 May 10]. Available from: http://wcmprod1.ucalgary.ca/sustainability/files/sustainability/2007%20CSARR%20LP.pdf

[20] Sustainability at Harvard [Internet]. Cambridge (MA): Presidents and Fellows of Harvard College; c 2009. [cited 2010 May 7]. Available from: http://green.harvard.edu/loan-fund

[21] Penn Green Campus Partnership [Internet]. Philadelphia (PA): University of Pennsylvania; c 2009. [cited 2010 May 7]. Available from: http://www.upenn.edu/sustainability/greenfund.html

[22] The Green Building Certification Institute [Internet] c2010 [Cited, 5/13/10] Available from: www.gbci.org

[23] Plant Operations Division at the University of Michigan, Facilities Maintenance [Internet]. Ann Arbor (MI): The University of Michigan; c2008. [cited 2010 May 10]. Available from: http://www.plant.bf.umich.edu/maintenance/shops/BAS/

[24] Bright, Kevin. Energy Audit Team Completes Divinity School Assessment. Sustainability at Harvard [Internet] Harvard University, Cambridge (MA) 2010. Feb 4 [Cited on 14 May 2010] Available From: http://www.green.harvard.edu/node/650

[25] Commercial Building Ventilation and Indoor Environmental Quality [Internet]. Berkeley (CA). Available from: http://eetd.lbl.gov/ie/viaq/v_rates_2.html

[26] Heschong Mahone Group. Windows and Classrooms: A Study of Student Performance and the Indoor Environment October 2003 [report on the Internet]. Fair Oaks (CA): California Energy Commission; 2003 [cited 2010 May 10]; [pg 8 of 131]. Available from: http://www.h-m-g.com/downloads/Daylighting/A-7_Windows_Classrooms_2.4.10.pdf

[27] Environmental Systems Research Institute UK [Internet]. Aylesbury (UK): ESRI c2006-2009. Masdar City: the World's First Carbon Neutral City; [cited 2010 May 14]; [about 6 pages]. Available from: http://www.esri.com/industries/facilities-management/pdfs/masdar.pdf.

[28] Space Utilization Initiative [Internet]. Ann Arbor (MI): University of Michigan Office of the Provost; c 2010. [cited 2010 May 6]. Available from: http://www.provost.umich.edu/space/index.html

[29] Venturi, Scott Brown and Associates, Inc. The University of Michigan Campus Plan [Internet]. Ann Arbor (MI): The University of Michigan; c 1998. [cited 2010 May 7]; [about 92 pages]. Available from: http://www.umaec.umich.edu/campus.plans/Phase1 /Phase1%20Overview%20-%204-22-98.pdf

[30] Princeton Environmental Institute. 2000 Environmental Audit of Princeton University [Internet]. Princeton (NJ): Princeton University; c 2000. [cited 2010 May 6]; [about 81 pages]. Available from: http://web.princeton.edu/sites/pei/PDF/EAD.pdf

[31] The New Century Plan Advisory Committee. The University of Michigan Campus Plan [Internet]. Ann Arbor (MI): The University of Michigan; c 1998. [cited 2010 May 7]; [about 92 pages]. Available from: http://www.umaec.umich.edu/campus.plans/Phase1/Phase1%20Overview%20-%204-22-98.pdf

[32] News and Communications, University of Pennsylvania, Sorrentino, Tony " Penn Announces $100 Million Mixed-Use Development in University City" [Internet] 18 March 2005. Available from: http://www.upenn.edu/pennnews/news/penn-announces-100-million-mixed-use-development-university-city

[33] University of Pennsylvania: PennConnects [Internet]. Philadelphia (PA): The University, c 2007-2010 [cited 2010 May 7]. Available from: http://www.pennconnects.upenn.edu/index.php

[34] Kuwabara Payne McKenna Blumberg Architects et. al. Ryerson University Master Plan [Internet]. Toronto (ON): Ryerson University, c 2008 [cited 2010 May 7]. Available from: http://www.ryerson.ca/about/masterplan/Ryerson%20MP_march2008.pdf

[35] Duke Sustainability [Internet]. Durham, NC: Duke University; c2010 [cited 2010 May 10]. http://sustainability.duke.edu

[36] Architecture, Engineering, and Construction. Energy and Water Conservation May 2009 [report on the Internet]. Ann Arbor (MI): The University of Michigan; 2009 [cited 2010 May 10]; [9 pages]. Available from: http://www.umaec.umich.edu/desguide/sid/sid_d.pd

[37] University of Maryland Office of Sustainability. Campus Sustainability Report 2008 [report from Internet]. College Park (MD): The University of Maryland; 2008 [cited 2010 May 10]; [44 pages]. Available from: http://www.sustainability.umd.edu/documents/Campus_Sustainability_Report_2008.pdf

[38] The University of Michigan Environmental Report 2009 [report from Internet]. Ann Arbor (MI): The Regents of the University of Michigan; 2009. [cited 2010 May 10]; [8 pages]. Available from: http://www.oseh.umich.edu/pdf/09_report.pdf

[39] The State of Minnesota Sustainable Building Guidelines, Version 2 .1. University of Minnesota, Twin Cities Campus; December 21, 2009. Available From: www.msbg.umn.edu

[40] University of Michigan Architecture, Engineering and Construction [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c 2010 [cited 2010 May 10]. Available from: http://www.aec.bf.umich.edu/desguide/prefman.html

[41] Federal Mandates for New Construction [Internet]. Washington, DC: Department of Veterans Affairs, Office of Construction and Facilities Management; c 2010 [cited May 13 2010] Available from: http://www.wbdg.org/ccb/VA/VADEMAN/dmsustain.pdf

[42] C.F Reinhard, J. Mardaljevic, Z. Rogers. Dynamic Daylight Performance Metrics for Sustainable Building Design, NRCC-48669 [Internet]. 2006 July. [cited 2010 May 7]; [page 3 of 25]. Available from: http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc48669/nrcc48669.pdf

[43] Office of the Executive Vice President and Chief Financial Officer. University of Michigan 2009 Financial Report. [Internet] Ann Arbor, MI: Regents of the University of Michigan; c2009 [cited 2010 May 14]; [about 84 pages]. Available from: http://www.finops.umich.edu/reports/2009/pdfs/FinRepoFY09lores.pdf

[44] Penn Green Campus Partnership. University of Pennsylvania Climate Action Plan [Internet]. Philadelphia (PA): The University of Pennsylvania; c2009. [cited 2010 May 7]; [page 65 of 138 pages]. Available from: http://www.upenn.edu/sustainability/Climate%20Action%20Plan%20FINAL.pdf

[45] Plant Operations at The University of Michigan, Energy Management [Internet]. Ann Arbor (MI): The University of Michigan; c 2007 [cited 2010 May 7]. Available from: http://www.plantops.umich.edu/utilities/energy_management/programs/energystar_greenlight.html

[46] The University of British Columbia Sustainability [Internet]. Vancouver (BC): The University of British Columbia; c2010 [cited 2010 May 7]. Available from: http://www.sustain.ubc.ca/campus-sustainability/greening-the-campus/ecotrek

[47] Facilities Users Network Group. Facilities Users Network (FUN) Meeting [Internet]. Ann Arbor (MI): The University of Michigan; c 28 Jan. 2010 [cited 2010 May 7]; [39 pages]. Available from: http://www.plantops.umich.edu/director/info/FUN/FY_2010/201001/FUNpresentation201001.pdf

[48] Harvard University Office for Sustainability Green Building Resource [Internet]. Cambridge (MA): Presidents and Fellows of Harvard College; c2006-2010. [cited 2010 May 7]. Available from: http://green.harvard.edu/theresource/

[49] The Princeton Review. Princeton Review's Guide to 286 Green Colleges. Pinceton (NJ): The Princeton Review, Inc; 2010.

[50] Erb Wire: Fall 2008. The Erb Institute University of Michigan. c2008 [cited 14 May 2010] Available from: www.erb.umich.edu

[51] UC Berkeley Sustainability [Internet]. Berkeley (CA): University of California Regents; c 2010 [cited 2010 May 10]. Available from: http://sustainability.berkeley.edu/pages/built_environment/overview.shtml

[52] The Strategic Opportunity in Global Sustainability Challenges: A Vision for the University of Illinois at Urbana-Champaign [Internet]. Urbana (IL): The University of Illinois at Urbana-Champaign; c2009 [cited 2010 May 7]; [42 pages]. Available from: http://sustainability.illinois.edu/UIllinois%20Sustainability%20Draft%20Vision%209-29-09.pdf

[53] Powell Center for Construction & Environment [Internet]. Gainesville (FL): The University of Florida; c2008. [cited 2010 May 7]. Available from: http://www.cce.ufl.edu/

[54] Decision Theater [Internet]. Tempe (AZ): Arizona State University; c2010 [cited 2010 May 7]. Available from: http://dt.asu.edu/

[55] Center for the Built Environment [Internet]. Berkeley (CA): The University of California at Berkeley; c2006 [cited 2010 May 13]. Available from: www.cbe.berkeley.edu

APPENDIX A: RECOMMENDATIONS PRIORITIZED FOR IMPLEMENTATION

The recommendations included in this document operate on varying levels and scales. Some operate as goals while others provide frameworks for policy and research developments that will help the University achieve its mission of environmental stewardship. Still others are intended as implementation strategies that will insure both the immediate success of the goals and frameworks, as well as insure responsible adaptation to changing conditions in the future. All of the recommendations are interdependent and the success of each is linked to the success of others; prioritizing one guideline over the other undermines the complex approach necessary to activate meaningful advancement in creating a sustainable built environment. Instead, they are perhaps best understood by their scale of implementation and relationships to one another. The following summary begins to identify the connections between the recommendations and the role they will play in positioning the University of Michigan as the leader among higher educational institutions in sustainable building.

Goal:

4.1.3.1 *Achieve and maintain #1 ranking among North American higher educational institutions in total sustainable practices for campus buildings.*

Framework 1:

4.1.1.1 *Establish a Design Review Committee as a form of peer review to assess the quality of proposals for construction throughout the University. The Design Review Committee should include members of the faculty of Schools of Architecture, Urban Planning and Engineering, as well as notable practitioners of the design community. The Committee would operate in concert with AEC for design considerations, and be appointed on a yearly basis.The committee would be responsible for establishing the architectural competition as method for identifying best design solutions for flagship projects, increasing the profile and notoriety of University of Michigan. The committee will review all building project submissions, with attention paid to sustainable design measures/methods.*

Related Recommendations:

4.1.1.2 *Employ 'Integrated Design' strategies throughout the design process.*
4.1.3.2 *Maintain at least one project with campus-wide presence under development at any given time that will substantially outperform baseline sustainability requirements to demonstrate to the University community our commitment towards sustainable design.*
4.1.4.1 *Calculate building Life Cycle costing in terms of capital budget, operational costs and other benefits.*
4.2.1.2 *Encourage all personnel engaged in University building design practices to become LEED accredited by 2012.*

A Design Review Committee, or a similar structure to insure rigorous peer review of major new construction projects, will increase the visibility and competitive edge of high performance building design on campus. Establishing a committee of experts to evaluate submissions in a blind competition format that prioritizes sustainable building practices and strong design integration will insure that new buildings on campus are of the highest quality possible, and will publicly establish the University of Michigan's commitment to advancing sustainable building science.

Framework 2:

4.2.1.1 *Through the adoption of LEED v3.0 Silver plus 30% better than ASHRAE 90.1 energy performance as the standard for all building projects, maintain the ongoing goal of outperformance of this baseline, addressing recommendations for research and study outlined within this document. The most current version of LEED standards for all new construction, retrofit, facilities opperations and maintenance on Campus should be adopted as they become available, or until an alternative standard is identified.*

Related Recommendations:

4.1.1.2 *Employ 'Integrated Design' strategies throughout the design process.*
4.2.1.2 *Encourage all personnel engaged in University building design practices to become LEED accredited by 2012.*
4.2.2.3 *Reevaluate measurement tools and technologies on an annual basis to ensure best practices of building performance audits.*
4.4.1.2 *Improve water consumption guidelines to a minimum of 30% reduction through both education and technology improvements.*
4.4.3.1 *Develop a strategy for material reuse and recycling of building components that could include partnerships with local recyclers as well as in-house materials collection and storage for materials identified to be reused in new University projects, with an ongoing inventory of all material resources available for reuse in new projects.*
4.4.3.2 *Establish long term relationships with sustainable construction material suppliers, prioritizing suppliers in the 500 mile radius Great Lakes Megaregion.*
4.4.4.1 *Maximize beneficial daylighting and views while minimizing glare and heat gain. Balance issues of daylight quality and quantity with necessity for energy load reduction through integrated design strategies.*
4.4.6.1 *Adopt LEED for Existing Buildings, Operations and Maintenance protocols for operations and maintenance regimes for all facilities and units throughout the University*.

As the benchmarking exercise from Phase I indicated, requiring LEED Silver Certification plus a minimum energy performance level will bring the University of Michigan in line with its peer institutions. However, the methods by which LEED Silver is achieved on each project require close attention. By establishing standards for water consumption, energy efficiency, reuse and recycling, material selection, and indoor air quality, the University can insure the LEED Silver indicates significant positive environmental impact. Credits should be prioritized by what they can achieve, not by how simply they can be accomplished.

Framework 3:

4.3.2.1 *Work through the campus Master Plan to develop a framework for directing sustainable building development that recognizes the unique challenges and opportunities associated with a distributed campus of diverse composition, including distinct ecological and urban contexts.*

Related Recommendations:

4.2.2.4 *Develop a comprehensive assessment of and database for the University's buildings inventory and real estate holdings. Use Geographic Information Systems Software (GIS) as well as other visualization and analysis tools to better represent and spatialize sets of university data and mappings regarding sustainable initiatives and all ongoing proposals. Model data should be shared with faculty, students and staff of the University to encourage and support internal research.*
4.3.1.1 *Undertake a comprehensive space utilization study of University spaces with the goal of expanding the existing Space Utilization Initiative to consider the full range of space types on campus, to more effectively and efficiently take advantage of existing space.*
4.3.1.2 *When space utilization studies determine new space requirements for units or departments, prioritize existing building acquisitions and departmental trades over new construction.*
4.3.1.3 *Generate long-term spatial flexibility in new building projects through typology-based planning.*
4.4.1.1 *Undertake a a coordinated assessment of stormwater issues on campus as they relate to building design to determine appropriate and novel practices for water retention within building sites using various technologies.*

Overall campus planning strategies can have a large impact on environmental performance. Prioritizing ecological protection, reducing resource consumption and redundancy, and designing and constructing buildings for long term re-use will help minimize the environmental footprint of the University in the long-term. Additionally, the development of facilities and services adjacent to each campus should be carefully examined to create dense, walkable environments where they will benefit the largest possible population.

Framework 4:

4.4.2.1 *Assess and create targets for reduction of non-renewable energy for the University that correlates energy use with dynamic building occupancy. Set short term goals to be achieved by 2015, with the long term goal of carbon neutrality.*

Related Recommendations:

4.2.2.3 *Reevaluate measurement tools and technologies on an annual basis to ensure best practices of building performance audits.*
4.2.2.5 *Expand long term monitoring and testing protocols across sustainable project*

> *initiatives to assess building performance beyond construction for the lifetime of the building.*
> ***4.4.2.2*** *At the initiation of new building projects, renovations or retrofits,* assess *the potential for on-site generation of alternative and renewable energy sources.*
> ***4.4.4.2*** *Ensure controllability and responsiveness of systems. Allow users to control thermal and daylight systems where possible, using automated controls to ensure maximum efficiency.*

Buildings are responsible for 38% of U.S. carbon dioxide emissions and represent 72% of U.S. electricity consumption. Energy efficiency in building operation is essential for sustainable development. Plant Operations, working with Planet Blue, has already made significant strides in increasing the performance of many buildings on campus. Future targets for energy reduction will need to consider many facets of a building's condition, including use, age, and operational hours, to insure meaningful improvements. The energy required to serve certain space types may be much easier to reduce without affecting productivity than others. Developing a fine-grained strategy for improving energy efficiency will identify where investments to reduce energy consumption will prove the most fruitful.

<u>Framework 5</u>:

4.4.5.1 *Prioritize renovations across University buildings based on need for improvement of environmental performance as defined by audits outlined in section 4.2.2.*

> <u>Related Recommendations</u>:
>
> ***4.1.4.1*** *Calculate building Life Cycle costing in terms of capital budget, operational costs and other benefits.*
> ***4.1.4.2*** *Establish incentives to prioritize sustainable building practices across university departments as a supplement to sustainable design mandates.*
> ***4.2.2.1*** *Perform comprehensive audits of campus buildings with the goal of gathering data to assist in prioritizing future building renovations and retrofits. Foster learning opportunities where possible. Prioritize locations where improvements will affect the greatest net performance benefits.*
> ***4.2.2.3*** *Reevaluate measurement tools and technologies on an annual basis to ensure best practices of building performance audits.*
> ***4.2.2.5*** *Expand long term monitoring and testing protocols across sustainable project initiatives to assess building performance beyond construction for the lifetime of the building.*
> ***4.3.1.2*** *When space utilization studies determine new space requirements for units or departments, prioritize existing building acquisitions and departmental trades over new construction.*
> ***4.4.6.1*** *Adopt LEED for Existing Buildings, Operations and Maintenance protocols for operations and maintenance regimes for all facilities and units throughout the University.*

Currently, renovations are motivated by the requests of individual campus units and scheduled through the AEC. Future retrofits and renovations should prioritize the facilities with the lowest-performing energy systems to bring the quality of campus building up to date as quickly as possible. The LEED for Existing Buildings Rating System helps building owners and operators measure operations, improvements and maintenance on a consistent scale, with the goal of maximizing operational efficiency while minimizing environmental impacts. Adopting these standards would provide a framework for ongoing improvement and a quantifiable benchmark for the University to track its performance against its peer institutions. The standards for energy efficiency and environmental stewardship will gradually rise as the LEED Existing Buildings system matures, and will slowly raise the bar of the University's building stock.

Framework 6:

4.5.3.1 *Position the University of Michigan campus as a 'living laboratory' with the goal of expanding current curricula and advancing student initiatives of research that engages the built environment.*

Related Recommendations:
4.1.1.2 *Employ 'Integrated Design' strategies throughout the design process.*
4.1.2.1 *Foster new and cultivate existing areas of faculty research by constructing buildings that provide opportunities for future study.*
4.2.2.2 *Develop a stream of public health research aimed at correlating indoor environmental quality to student and worker health and productivity, including air quality, daylight quantity, quality and views, specifically utilizing University buildings, faculty, staff and students as participants in order to assess policy decisions regarding performance targets and economic benefits.*
4.5.1.1 *Prioritize the retention of knowledge and 'lessons learned' from sustainable construction projects to inform future decision making.*
4.5.2.1 *Assess the impact of sustainable building practices on the recruitment and retention of new faculty and students in order to help quanitfy the value associated with sustainability-driven decision making.*
4.5.3.2 *Create a Centre of Excellence for a Sustainable Built Environment to support and grow UM's reputation and recruitment agendas associated with sustainable design.*

The University has stated its commitment to sustainability through policy, research, and education. Developing high-performance building technologies would not only reduce the ecological footprint of the University's operation, it would also provide ideal opportunities for faculty and students to learn how these systems work or can be more successfully implemented. The improvement of the quality of the University's building stock as well as the development of new streams of research around sustainable building science will help attract and retain talented students and faculty. Interdisciplinary collaborations should be encouraged wherever possible to address the complex issues of sustainability in the built environment.

APPENDIX B - TIME FRAME FOR BUILDINGS TEAM RECOMMENDATIONS

	short term (1 year)	*medium term (1-5 years)*	*long term (5-15 years)*
Section 4.1		*4.1.1.1*	
		4.1.1.2	
		4.1.2.1	
			4.1.3.1
		4.1.3.2	
			4.1.4.1
		4.1.4.2	
Section 4.2	*4.2.1.1*		
		4.2.1.2	
		4.2.2.1	
		4.2.2.2	
	4.2.2.3		
	4.2.2.4		
		4.2.2.5	
Section 4.3	*4.3.1.1*		
	4.3.1.2		
	4.3.1.3		
		4.3.2.1	
Section 4.4	*4.4.1.1*		
	4.4.1.2		
	4.4.2.1		
		4.4.2.2	
		4.4.3.1	
			4.4.3.2
	4.4.4.1		
	4.4.4.2		
	4.4.5.1		
	4.4.5.2		
	4.4.6.1		
Section 4.5	*4.5.1.1*		
	4.5.2.1		
			4.5.3.1
	4.5.3.2		

= Policy Change *= Inst. Project* *= Student Project* *= Research Project*

APPENDIX C - COMPARATIVE MATRIX OF PEER INSTITUTIONS - EXISTING MICHIGAN POLICIES vs. RECOMMENDED

Strategies for Sustainable Design and Planning / INSTITUTION	**Michigan - current**	**Michigan - proposed**	Harvard	Stanford	Arizona State	Penn	Univ. Colorado	Univ. Washington	Princeton	NYU	U. Cali. Berkeley	Univ. North Carolina	Cornell	Univ. Maryland	Univ. Virginia	MIT	Yale	Duke	Univ. Texas	Univ. of Wisconsin	Univ. Illinois UC	Columbia	John Hopkins	Caltech	Univ. of Minnesota	UCLA	Univ. Chicago
Green Building listed as priority	□	■	■	■	■	■	■	■	■	□	■	■	■	■	■	□	■	■	□	■	□	■	■	■	■	■	□
Requires LEED Certification	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	■	■	■	■	□
Performance requirements in addition to LEED	□	■	■	□	■	■	■	□	■	□	■	■	■	□	□	■	□	□	□	□	□	□	■	□	□	■	□
Completed LEED projects	■	■	■	□	■	□	■	■	□	■	□	■	■	■	■	■	■	■	■	■	□	■	□	□	□	□	□
Construction Waste Diversion/Recycling	□	■	■	■	□	□	■	■	■	■	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□	□
Commitment to densification/Infill development	□	■	□	■	□	■	■	□	■	□	□	□	□	□	■	□	□	■	□	□	■	□	□	□	□	□	□
Green Cleaning Methods/Products	□	■	■	■	■	□	□	□	■	□	□	■	■	■	□	□	□	□	□	□	□	■	□	□	□	□	□
Incentive or Education programs for buiding occupants	■	■	■	■	■	■	□	■	□	■	■	□	□	□	□	■	■	□	■	■	■	□	■	□	□	□	□
Lighting and Plumbing Retrofit programs	■	■	■	■	■	■	■	■	■	■	■	■	□	■	■	□	□	□	■	■	■	■	□	■	■	■	□
Green building integrated with curriculum	■	■	□	■	□	□	□	□	□	□	■	□	■	■	□	□	■	■	■	□	□	□	□	■	□	□	■
Design Review Board	□	■	□	□	□	■	□	■	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Integrated Design Process	□	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

■ = Yes

□ = No

PEER INSTITUTIONS	ENERGY	LEED APs	LEED Req.	LEED NC cert.	LEED EB cert.	LEED CI cert.	STARS 1.0 (reg)	Talloires Signatory	ACUPCC Signatory
California Polytechnic State U		6	not clear	0	1	0	12/17/2009	yes	yes
Columbia U		23	not clear	1	0	0	n/a	no	no
Cornell U	ASHRAE 90.1 +30-50%	10	yes	3	0	0	n/a	no	yes
Duke U		5	NC Silver	9	0	0	10/30/2009	no	yes
Harvard	ASHRAE 90.1 +28%	51	NC Silver	6	1	7	n/a	no	no
Johns Hopkins U		11	EB Silver	0	1	0	n/a	no	no
MIT		2	NC Silver	0	0	0	n/a	no	no
New York U		6	NC Silver	0	0	0	1/27/2010	no	yes
Northwestern U		6	NC cert	1	0	1	n/a	no	no
Pennsylvania State U		21	NC cert	1	0	0	12/6/2009	no	no
Princeton U		24	NC Silver	0	0	0	n/a	no	no
Stanford U	current code +30%	39	NC Gold	0	0	0	n/a	no	no
U of California-Berkeley	CA Title 24 +20%	3	NC cert	1	0	1	n/a	no	yes
U of California-LA	CA Title 24 +20%	2	NC Silver	0	0	0	9/21/2009	no	yes
U of Chicago		4	NC Silver	1	0	0	n/a	no	no
U of Maryland		9	NC Silver	2	0	0	n/a	no	yes
U of Michigan	ASHRAE 90.1-2007 +30%	10	no	1	0	0	not offiicially	no	no
U of Minnesota		8	NC Silver	2	0	0	12/28/2009	no	yes
U of North Carolina, CH	ASHRAE 90.1-2004 +30%	11	not clear	2	0	0	12/3/2009	yes	yes
U of Texas-Austin		14	not clear	1	0	0	10/4/2009	no	no
U of Virginia		9	NC cert	0	0	0	n/a	yes	no
U of Wisconsin		6	Silver	0	0	0	12/23/2009	yes	yes
Yale U		7	NC Silver	3	0	1	n/a	no	no
	*as of May 2010; compiled from various sources, accurate to the best of our knowledge	*as of 5/13/2010, GBCI LEED AP directory, organization search, does not include those identified as students	*as of May 2010; compiled from various sources, accurate to the best of our knowledge	*as of 5/13/2010, USGBC certified project directory, owner org. search	*as of 5/13/2010, USGBC certified project directory, owner org. search	*as of 5/13/2010, USGBC certified project directory, owner org. search	*as of 5/03/2010, from AASHE website	*as of 5/03/2010, from Talloires website	*as of 5/03/2010, from ACUPCC website

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Ref Type	Governing Body / Author	Website	Relationship to UM/Peer Institutions
Hannover Principles	principles	William McDonough & Michael Braungart	http://www.mcdonough.com/principles.pdf	n/a
Wildnerness-based checklist	principles	Malcolm Wells	http://www.malcolmwells.com	n/a
Principles of Green Architecture	principles	Brenda and Robert Vale	n/a	n/a
GSA Design Excellence	principles/guidelines	US General Services Administration	http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=8145	n/a
Talloires Declaration	signed statement	University Leaders for a Sustainable Future (ULSF)	http://www.ulsf.org/talloires_declaration.html	four peer institutions are signatories - see APPENDIX D
American College & University Presidents' Climate Commitment (ACUPCC)	signed statement	AASHE-support; Second Nature-fiscal	http://www.presidentsclimatecommitment.org/	ten peer institutions are signatories - see APPENDIX D
Leadership in Energy and Environmental Design (LEED) - New Construction and Major Renovation (NC)	rating tool: buildings	US Green Building Council (USGBC)	http://www.usgbc.org/	numerous peer institutions use and/or require LEED-NC for new buildings and major renovations - see APPENDIX D
Leadership in Energy and Environmental Design (LEED) - Existing Buildings Operations and Maintenance (EBOM)	rating tool: buildings	US Green Building Council (USGBC)	http://www.usgbc.org/	numerous peer institutions use and/or require LEED-NC for new buildings and major renovations - see APPENDIX D
Sustainability Tracking and Assessment & Rating System (STARS)	rating tool: colleges and university campuses	Association for the Advancement of Sustainability in Higher Education (AASHE)	http://stars.aashe.org/	numerous peer institutions have registered for STARS - seeAPPENDIX D
Building Research Establishment Environmental Assessment Method (BREEAM)	rating tool: buildings	Building Research Establishment (BRE), formerly gov agency now private org	http://www.breeam.org/	University of Cambridge
CHPS Criteria	rating tool: buildings, schools	Collaborative for High Performance Schools (CHPS)	http://www.chps.net/	n/a; applicable to K-12 schools
Green Globes	rating tool: buildings	Green Building Initiative (GBI) in the US	http://www.greenglobes.com/	n/a
Dow Jones Sustainability Index	assessment tool: corporate sustainability	cooperation of Dow Jones Indexes, STOXX Limited and SAM	http://www.sustainability-index.com/	n/a
Residential Environmental Assessment Program (REAP)	rating tool: buildings, residential	University of British Columbia	http://www.planning.ubc.ca/licensing__permits/policies__procedures/reap_guidelines.php	University of British Columbia: residence halls
ASHRAE Standard 90.1	standard: energy	American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)	http://www.ashrae.org/education/page/1834	referenced by numerous peer institutions; UM currently requires new building projects over $10 million to surpass ASHRAE 90.1-2007 requirements by 30%
California Energy Code: Title 24-2005, Part 6	standard: energy	The California Energy Commission	http://www.energy.ca.gov/title24/	University of California schools use this standard
ASHRAE Standard 62.1	standard: ventilation rates	American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)	http://www.ashrae.org	referenced in LEED rating system
ASHRAE Standard 55	standard: thermal comfort	American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)	http://www.ashrae.org	referenced in LEED rating system
ASHRAE Standard 189.1	standard: green buildings	sponsored by ASHRAE, IESNA and USGBC	http://www.ashrae.org	newly published; implementation cases not known

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Original Version	Current Version	Upcoming version
Hannover Principles	copyright 1992, presented at Expo 2000 in Hannover	new edition released 2003	no known updates planned
Wildnerness-based checklist	copyright 1969 (checklist scale)	"ecologic standards for construction" published in Appendix F of 'Alternative Natural Energy Sources in Building Design' 1974; widely recognized in 'Gentle Architecture' 1981	MW passed away in 2009
Principles of Green Architecture	1991, in Green Architecture	same	no known updates planned
GSA Design Excellence	1994; building on 1962 (JFK) 'Guiding Principles for Federal Architecture'	current version (2006) replaces 2000 desk guide	not known
Talloires Declaration	1990	n/a	n/a
American College & University Presidents' Climate Commitment (ACUPCC)	2006	n/a	n/a
Leadership in Energy and Environmental Design (LEED) - New Construction and Major Renovation (NC)	2000	LEED 3.0 (2009)	planned updates every two years
Leadership in Energy and Environmental Design (LEED) - Existing Buildings Operations and Maintenance (EBOM)	pilot 2002	LEED 3.0 (2009)	planned updates every two years
Sustainability Tracking and Assessment & Rating System (STARS)	pilot projects beginning February 2008	STARS 1.0, launched January 2010	AASHE anticipates new version releases every 2-3 years
Building Research Establishment Environmental Assessment Method (BREEAM)	1990	BREEAM 2008	not known
CHPS Criteria	1999	CHPS Criteria for: California, Colorado, Massachusetts, New York, The Northeast (NH, RI, CT, MA, VT), Texas, Washington, and Relocatable Classrooms Operations Report Card for: existing schools	NY CHPS currently 1.1 (Sept 2007); version 1.2 due soon (slated for fall 2009, still forthcoming) Further description of CHPS is based on the NY-CHPS v1.1 Guidelines
Green Globes	2000; from BREEAM UK, to BREEAM Canada to BREEAM GreenLeaf, now known as Green Globes	unclear	unclear
Dow Jones Sustainability Index	DJSI World launched Sept 1999 DJSI World 80 launched August 2008 plus additional indexes, see website for more information	2010 assessement questionnaires due June 2010, announcement of new members October 2010	annual assessments
Residential Environmental Assessment Program (REAP)	2005 beta	2.1, July 2009	not known
ASHRAE Standard 90.1	1975	2007; typically estimated just below 10% more stringent than then previous 2004 version	2010; goal to result in 30% total energy cost savings compared to 2004
California Energy Code: Title 24-2005, Part 6	1978	2008; effective Jan 1 2010	not known
ASHRAE Standard 62.1	1973	2007	2010

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Original Version	Current Version	Upcoming version
ASHRAE Standard 55	1966	2004	not known
ASHRAE Standard 189.1	2009	2009; published Jan 2010	not known

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Building Type	Project Type	Key targets	Primary Categories
Hannover Principles	(all)	(all)	"It is hoped that the Hannover Principles will inspire an approach to design which may meet the needs and aspirations of the present without compromising the ability of the planet to sustain an equally supportive future."	1. Insist on the rights of humanity and nature to co-exist. 2. Recognize interdependence. 3. Respect relationships between spirit and matter. 4. Accept responsibility for the consequences of design. 5. Create safe objects of long-term value. 6. Eliminate the concept of waste. 7. Rely on natural energy flows. 8. Understand the limitations of design. 9. Seek constant improvement by the sharing of knowledge. ALSO: Earth, Air, Wind, Fire, Spirit
Wildnerness-based checklist	(all)	(all)	Design and Construction are measured against nature as a creator of space	Be certain that the project: 1. Creates pure air. 2. Creates pure water. 3. Stores rainwater. 4. Produces its own food. 5. Creates rich soil. 6. Uses solar energy. 7. Stores solar energy. 8. Creates silence. 9. Consumes its own wastes. 10. Maintains itself. 11. Matches nature's pace. 12. Provides wildlife habitat. 13. Provides human habitat. 14. Moderates climate and weather. 15. ...and is beautiful.
Principles of Green Architecture	(all)	(all)	holistic approach and learning from vernacular architecture	1. Conserving Energy 2. Working with Climate 3. Minimizing new resources 4. Respect for users 5. Respect for the site 6. Holism
GSA Design Excellence	federal architecture	new construction, major renovations, preservation, adaptive re-use	buildings that express the vision, leadership, and commitment of the government to serving the public and the values of the nation; buildings must be LEED Silver at a minimum	• Providing best value to our customer agencies and the American taxpayer. • Developing safe, productive, and attractive workplaces. • Operating efficiently and effectively—keeping projects on time and on budget. • Ensuring that projects respond positively to national urban and environmental policies. • Selecting America's best designers and artists to create facilities that ultimately become respected landmarks.

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Building Type	Project Type	Key targets	Primary Categories
Talloires Declaration	colleges and universities	teaching, research, operations and outreach	a ten-point action plan for colleges and universities committed to promoting education for sustainability and environmental literacy	1. Increase awareness of environmentally sustainable development 2. create an institutional culture of sustainability 3. educate for env. responsible citizenship 4. foster env. literacy for all 5. practice institutional ecology 6.involve all stakeholders 7. collaborate for interdisciplinary approaches 8. enhance capacity of primary and secondary schools 9. broaden service and outreach nationally and internationally 10. maintain the movement
American College & University Presidents' Climate Commitment (ACUPCC)	colleges and universities	exerting leadership in addressing climate disruption	climate change: We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality.	1. Initiate the development of a comprehensive plan to achieve climate neutrality as soon as possible. 2. Initiate two or more (specific) tangible actions to reduce greenhouse gases while the more comprehensive plan is being developed. 3. Make the action plan, inventory, and periodic progress reports publicly available by providing them to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination.
Leadership in Energy and Environmental Design (LEED) - New Construction and Major Renovation (NC)	all except K-12 schools, healthcare and single-family homes	new construction, renovation, operations and maintenance	Project certification: Certified, Silver, Gold, Platinum Requirements include: - 20% reduction in potable water use - basic commissioning - 10% better than 90.1 for new buildings, 5% for existing buildings	1. Sustainable Sites 2. Water Efficiency 3. Energy & Atmosphere 4. Materials & Resources 5. Indoor Environmental Quality 6. Innovation & Design
Leadership in Energy and Environmental Design (LEED) - Existing Buildings Operations and Maintenance (EBOM)	all	existing buildings	Project certification: Certified, Silver, Gold, Platinum Requirements include: -minimum indoor plumbing efficiencies - minimum energy efficiencies - policies on sustainable purchasing, solid waste management and green cleaning	1. Sustainable Sites 2. Water Efficiency 3. Energy & Atmosphere 4. Materials & Resources 5. Indoor Environmental Quality 6. Innovation & Design
Sustainability Tracking and Assessment & Rating System (STARS)	university and college campuses specifically	all	a voluntary self-assessment tool to provide a clear and thorough system by which higher education institutions can benchmark where they are and set goals for the future recognizes "popular representation of sustainability" - the triple bottom line of economy, environment and society	1. Education and Research (co-curricular education, curriculum, research) 2. Operations (buildings, climate, dining services, energy, grounds, purchasing, transportation, waste, water) 3. Planning, Admin and Engagement (coordination and planning, diversity and affordability, human resources, investment, public engagement) 4. Innovation

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Building Type	Project Type	Key targets	Primary Categories
Building Research Establishment Environmental Assessment Method (BREEAM)	retail, offices, education, prisons, courts, healthcare, industrial, multi-residential	new construction, renovation	· To mitigate the impacts of buildings on the environment · To enable buildings to be recognised according to their environmental benefits · To provide a credible, environmental label for buildings · To stimulate demand for sustainable buildings	1. Management 2. Health & Wellbeing 3. Energy 4. Transport 5. Water 6. Materials 7. Waste 8. Land Use and Ecology 9. Pollution 10. Innovation
CHPS Criteria	K-12 school building	new construction, major renovation	provide an outstanding learning environment durable facilities easily maintainable facilities design to preserve natural resources renovation as opportunity for high performance long-term benefits to students, teachers	1. Site 2. Water 3. Energy 4. Materials 5. IEQ 6. Operations and Maintenance 7. Extra Credit
Green Globes	all	new construction, existing buildings	Building certification Third-party assessment ANSI standard Use less energy Conserve water Emit fewer pollutants	1. Energy 2. Indoor Environment 3. Site 4. Resources 5. Water 6. Emissions & Effluents 7. Project Management
Dow Jones Sustainability Index	n/a; relative to corporate sustainability practices and strategies	business approach	1. Strategy: Integrating long-term economic, environmental and social aspects in their business strategies while maintaining global competitiveness and brand reputation. 2. Financial: Meeting shareholders' demands for sound financial returns, long-term economic growth, open communication and transparent financial accounting. 3. Customer & Product: Fostering loyalty by investing in customer relationship management and product and service innovation that focuses on technologies and systems, which use financial, natural and social resources in an efficient, effective and economic manner over the long-term. 4. Governance and Stakeholder: Setting the highest standards of corporate governance and stakeholder engagement, including corporate codes of conduct and public reporting. 5. Human: Managing human resources to maintain workforce capabilities and employee satisfaction through best-in-class organisational learning and knowledge management practices and remuneration and benefit programs."	Economic: codes of conduct/compliance corporate governance risk & crisis management industry specific criteria Environment: environmental reporting industry specific criteria Social: corporate citizenship/philanthropy labor practice indicators human capital development social reporting talent attraction and retention industry specific criteria
Residential Environmental Assessment Program (REAP)	on-campus residences	new construction	By using its own rating system, UBC is also able to change requirements as needed to ensure that construction continues to address the most pressing environmental concerns. Building Certification: Basic, Bronze, Silver, Gold, Platinum	1. Sustainable Sites 2. Water Efficiency 3. Energy & Atmosphere 4. Materials & Resources 5. Indoor Environmental Quality 6. Construction 7. Innovations and Design Process

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Building Type	Project Type	Key targets	Primary Categories
ASHRAE Standard 90.1	all except low-rise residential buildings	new buildings, portions of buildings, systems and equipment	major changes from 2004 version include DCV requirements, boiler efficiency improvements, increased fan power limits, more stringent opaque and fenestration elements	Chapter 5: Building Envelope. Chapter 6: Heating, Ventilating, and Air-Conditioning. Chapter 7: Service Water Heating. Chapter 8: Power. Chapter 9: Lighting. Chapter 10: Other Equipment. Chapter 11: Energy Cost Budget Method. Appendix G: Performance Rating Method
California Energy Code: Title 24-2005, Part 6	residential and non-residential	all	To respond to Assembly Bill 32, the Global Warming Solutions Act of 2006, which mandates that California must reduce its greenhouse gas emissions to 1990 levels by 2020	Mandatory requirements for: manufacture, construction and installation of systems, equipment and building components; space conditioning and service water-heating systems and equipment; lighting systems and equipment; performative and prescriptive compliance approaches for achieving energy efficiency; additions, alterations and repairs;
ASHRAE Standard 62.1	all except low-rise residential buildings	all	major changes from 2004 version include * Clarifies dehumidification analysis requirements * Corrects occupant category inconsistencies * Updates references, clarifies the text * Updates information to be consistent with the U.S. EPA * Includes a new informative appendix . * Requires proper design for buildings that contain both ETS and ETS-free areas	Outdoor air quality Systems and equipment Procedures Ventilation Rates Construction and system start-up Operations and maintenance
ASHRAE Standard 55	all	all	The standard specifies conditions in which a specified fraction of the occupants will find the environment thermally acceptable. The standard is intended for use in design, commissioning, and testing of buildings and other occupied spaces and their HVAC systems and for the evaluation of thermal environments.	Six primary thermal comfort variables: metabolic rate, clothing insulation, air temperature, radiant temperature, air speed, humidity General requirements Compliance Evaluation of the Thermal environment PMV very limited guidance on natural ventilation / adaptive model
ASHRAE Standard 189.1	all except low-rise residential buildings	new buildings, additions, renovations	compliment green building rating programs; establish mandatory criteria in all topic areas Standard 189.1 will provide a 'total building sustainability package' for those who strive to design, build and operate green buildings. From site location to energy use to recycling, this standard will set the foundation for green buildings through its adoption into local codes.	site sustainability water use efficiency energy efficiency indoor environmental quality (IEQ) building's impact on the atmosphere, materials and resources construction and operation plans Mandatory requirements are in line with many LEED prerequisites and credits; thresholds are re-worked to be less stringent when mandatory

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Design	Site/Land/Transp	Water	Energy	Materials
Hannover Principles	responsibility material selection flexibility	wind patterns pervious ground cover stormwater runoff	efficiency reduce potable use protect sanitary grey water waste water groundwater discharge quality	renewable energy net exporters on-site production water heating transportation local power grid	recycled content no animal testing resource mgmnt low-toxicity embodied energy life-cycle
Wildnerness-based checklist	beauty organic rightness protect exposed surfaces earth architecture century-long life cycle	natural selection let it go wild porous paving percolation beds retention basins store rainwater improve topsoil local wildlife microclimate	underground arch.	solar energy insulation thermal storage	n/a
Principles of Green Architecture	work with climate holism	"touch-this-earth-lightly"	n/a	minimize fossil fuel use natural energy sources	- minimize use of new resources - act as recycled materials at the end of its useful life
GSA Design Excellence	exceptional design that should flow from the architectural profession to the Government, and not vice versa	_contribute to community development - maximize potential for distinguished design character - support effective sustainable design strategies - meet current security standards	n/a	n/a	n/a
Talloires Declaration	n/a	n/a	n/a	n/a	n/a
American College & University Presidents' Climate Commitment (ACUPCC)	n/a	n/a	n/a	n/a	n/a
Leadership in Energy and Environmental Design (LEED) - New Construction and Major Renovation (NC)	innovation regional priorities	site selection development density community connectivity brownfield redevelop. public transit parking biking/showering vehicle selection open space natural habitat stormwater control heat island effect light pollution	landscaping wastewater potable water low-flow low-flush	commissioning refrigerant mgmnt efficiency on-site renewable measurement green power	building reuse material reuse recycled content regional - 500m rapidly renewable certified wood

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Design	Site/Land/Transp	Water	Energy	Materials
Leadership in Energy and Environmental Design (LEED) - Existing Buildings Operations and Maintenance (EBOM)	innovation regional priorities	building exterior maintenance hardscape management integrated pest mgmnt erosion control landscape management alternative commuting stormwater quantity control heat island reduction light pollution reduction	landscaping potable water low-flow low-flush cooling tower mgmnt	energy auditing refrigerant mgmnt energy efficiency commissioning building automation system level metering renewable energy production	- purchasing: consumables, durable goods, alterations and additions, mercury in lamps, food - solid waste mgmnt: waste stream audit, consumables, durable goods, alterations and additions
Sustainability Tracking and Assessment & Rating System (STARS)	LEED certified buildings	greenhouse gas emissions integrated pest management campus fleet student and employee commute	water consumption stormwater management	building energy consumption renewable energy	waste reduction/diversion electronic waste recycling program hazardous waste management
Building Research Establishment Environmental Assessment Method (BREEAM)		flood risk watercourse pollution external noise pollution external light pollution site selection ecological protection ecological enhancement	quality consumption leak detection reuse and recycle	commissioning refrigerant use NOx emissions CO2 emissions zero/low-carbon sub metering efficiency	embodied life cycle reuse responsible sourcing robustness
CHPS Criteria	design to use components of the building as a laboratory design to use as a red cross/community shelter innovation credits under extra credit	code compliance joint use of facilities ecological impact/site selection reduced building footprint construction erosion/sedimentation control stormwater management exterior light pollution transportation: public, minimize parking	landscaping irrigation potable water for landscaping indoor water use	minimum performance requirements HVAC system sizing on-site energy generation commissioning and training tracking energy costs system controls submetering and monitoring	wallboard and roofdeck floor systems* interior/exterior wall systems* roof/other systems* storage/collection of recyclables site construction waste management building reuse *based on life cycle cost
Green Globes	project mngmnt integrated design innovation	development area ecological impact watershed features site ecology improvement public transport pedestrian/cyclist facilities travel plans/info	conservation on-site treatment sewer/waterway protection	commissioning energy star rating reduce demand efficiency renewable energy transportation CO2	LCA tools renewables building reuse durability, disassembly recycling purchasing
Dow Jones Sustainability Index	n/a	n/a	n/a	n/a	n/a
Residential Environmental Assessment Program (REAP)	exceed requirements pioneer new practices	stormwater runoff pesticides car-sharing	efficienct irrigation low-flush toilets low-flow facuets	extra insulation energy-efficient windows Energy Star applicances	refurbish, salvage reuse regional - 500m renewable hardwood

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	Design	Site/Land/Transp	Water	Energy	Materials
ASHRAE Standard 90.1	n/a	n/a	n/a	each section includes mandatory requirements; a project team can then also follow prescriptive requirements or complete a whole-building energy model to prove a performance-based level of efficiency	n/a
California Energy Code: Title 24-2005, Part 6	n/a	n/a	n/a	A 2008 California Energy Commission study of 959 buildings reported that the average Title 24-2008 building is 21% more energy efficient than the ASHRAE 90.1-2004 building	n/a
ASHRAE Standard 62.1	n/a	n/a	n/a	n/a	n/a
ASHRAE Standard 55	n/a	n/a	n/a	n/a	n/a
ASHRAE Standard 189.1		site selection brown/grey/greenfields heat island effect development rules light pollution pervious paving development footprint	irrigation low-flow low-flush potable water appliance HVAC systems metering	ASHRAE 90.1 on-site renewable refrigerants commissioning	SRI recycled content regional - 500m biobased products wood components LCA low-toxicity

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	IEQ	Construction	Operations	Cost	Food	People
Hannover Principles	air pollution noise pollution air exchange prioritize nat. vent.	waste	waste	short and long term cost benefits	n/a	n/a
Wildnerness-based checklist	create oxygen absorb CO2 filter air silence	waste	waste	n/a	on-site production	privacy
Principles of Green Architecture	human health	n/a	n/a	n/a	n/a	human needs human labor
GSA Design Excellence	n/a	n/a	n/a	"The Government should be willing to pay some additional cost to avoid excessive uniformity in design of Federal buildings."	n/a	n/a
Talloires Declaration	n/a	n/a	n/a	n/a	n/a	n/a
American College & University Presidents' Climate Commitment (ACUPCC)	n/a	n/a	n/a	n/a	n/a	n/a
Leadership in Energy and Environmental Design (LEED) - New Construction and Major Renovation (NC)	minimum IAQ Tobacco control monitoring increased ventilation low-emitting chemical control acoustic (schools)	site protection waste IAQ Plan	store recyclables	life cycle cost analysis?	n/a	thermal control lighting control daylight direct views LEED AP
Leadership in Energy and Environmental Design (LEED) - Existing Buildings Operations and Maintenance (EBOM)	minimum IAQ tobacco control green cleaning outdoor air delivery increased ventilation reduce particulates occupant survey	minor alterations and additions only	(all)	document sustainable building cost impacts	see purchasing: food	lighting control daylight direct views LEED AP
Sustainability Tracking and Assessment & Rating System (STARS)	indoor ait quality management policy	n/a	purchasing (computers, cleaning products, office paper) vendor code of conduct	n/a	food purchasing	student sustainability educators program sustainability in new student/staff orientation sustainability-related courses/programs sustainability literacy assessment interdisciplinary, sustainability research strategic plan and coordination diversity and affordability employee satisfaction and compensation community service and partnerships
Building Research Establishment Environmental Assessment Method (BREEAM)	acoustics IAQ	site impact waste recycled aggregate recycling facilities	recycling facilities	n/a	n/a	n/a

APPENDIX E - COMPARISON OF CAMPUS AND BUILDING SUSTAINABILITY CHECKLISTS

Reference	IEQ	Construction	Operations	Cost	Food	People
CHPS Criteria	walk-off grills/mats filter efficiency, construction and operations drainage irrigation design duct insulation air intakes low-emitting materials pollutant source control continuous air monitoring acoustical performance	waste maangement erosion/sedimentation control filter efficiency	energy plan and benchmarking LEED EB updates continuous commissioning maintenance plan green cleaning integrated pest management plan indoor env. Management plan	life cycle cost in material selection	n/a	thermal control ASHRAE 55, thermal comfort views daylighting training (HVAC, energy) certified superintendent of buildings/grounds
Green Globes	air emissions ozone depletion pollution control ventilation acoustic comfort	demolition waste	n/a	n/a	composting	emergency response plan lighting control thermal control BREEAM AP
Dow Jones Sustainability Index	n/a	n/a	n/a	n/a	n/a	n/a
Residential Environmental Assessment Program (REAP)	low-emitting ventilation	control erosion and sediment minimize truck traffic on/off-site divert waste	n/a	n/a	n/a	n/a
ASHRAE Standard 90.1	n/a	n/a	n/a	n/a	n/a	n/a
California Energy Code: Title 24-2005, Part 6	n/a	n/a	n/a	n/a	n/a	n/a
ASHRAE Standard 62.1	requirements for ventilation and air-cleaning system design, installation, commissioning, and operation and maintenance (insert prescriptive elements here?)	n/a	MERV filter rating requirements	n/a	n/a	n/a
ASHRAE Standard 55	quality of air in terms of thermal comfort	n/a	n/a	n/a	n/a	thermal comfort
ASHRAE Standard 189.1	ASHRAE 62.1 filtration ozone ETS control moisture control	waste mgmnt testing IAQ Plan	storage/collection of recyclables Plans: Operations, Maintenance, Service Life, Transportation Mgmnt	n/a	n/a	Tenants

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Green Report Card Grade	Campus size (Area)	Real Estate Portfolio (# BLDGS/GSF)	Institutional Population			Sustainability Plan		
				Student	Faculty	Staff	Plan Title - Date Established	Description	Guidelines
Arizona State Tempe, AZ	A	642 acres	343 buildings / 12.4 million GSF	51,614	2,862	6,848	Global Institute of Sustainability established 2004; Carbon Neutrality Action Plan - January 2010	_Carbon neutrality (target date 2025 w/ 2006-2007 baseline); _ Zero Solid & Water Waste _Active Engagement (of students) _Principled Practice (campus operations)	LEED Silver Plus ASU Design Guidelines New Construction and Renovation
Caltech Pasadena, CA	B	124 Acres	125 buildings / 3.9 million GSF	2,126	1,348			Themes: Energy, Climate, Water, Materials, Transportation, Buildings, Research and Education.	LEED New Construction Multi-building / campuses Existing Buildings (pilot phase)
Columbia New York, NY	B (survey results not published)	295 acres		26,399	3,566	n/a	Department of Environmental Stewardship, est. 2006	Reducing GHG emissions by 30% by 2017 Green Building Green Roofs Recycling, Student Involvement, Transportation Sustainable Neighborhood Development	Not specified
Cornell Ithaca, NY	B	745 acres	228 buildings / 16.3 Million GSF	20,633	1,594		Climate Action Plan issued Sept 2009	_Seeking climate neutrality by 2050 _Themes: Green Development, Energy Conservation, Alternative Transportation, Fuel and Renewable energy sources, and offsetting actions.	LEED Certified with 50% improvement in energy performance over ASHRAE 90.1
Duke Durham, NC	B+	8610 acres	220 buildings	13,662	3,031	33,325	Evironmental policy was signed on March 1st, 2005; Climate Action Plan passed 2008	_Goal is to reach climate neutrality by 2024. _ Redevelopment of Central Campus will work to preserve and protect the natural environment, design buildings that conserve energy and minimize theenvironmental footprint. _Themes: Transportation, Energy Carbon Offsets, Education, Research and Community Outreach, Communication encourage interdisciplinary education and research on environmental topics.	LEED Certified New Construction
Harvard Cambridge, MA	B	380 acres	391 buildings / 14.6 million GSF	20,230	2,107	23,171	Sustainability Principles established 2004	Themes: Energy and Greenhouse Gas, Food, Green Building, Reducing Waste, Renewable Energy, Transportation, Water	LEED Silver New Construction and Renovation over $5 million
Johns Hopkins Baltimore, MD	B-	140 acres	200+ buildings	19,019	3,100	15,000	2007: goal of carbon neutrality set by president.	Report is viewed as a "living document" that continually evolves by setting in place an ongoing process in which updates are implemented and planned projects are highlighted. Buildings: building energy audits be compiled at regular intervals (e.g., every five years) to capture the next grouping of high ranking candidate buildings for retrofits or upgrades.	LEED Silver New Construction; Customized guidelines based on desirable credits
MIT Cambridge, MA	B+	168 acres	144 buildings / 11.4 million GSF	10,300	1,009		Green Building Task Force est. in 2000; Sustainability Goals developed October 2001	Themes: energy conservation, emissions reduction, indoor air quality, community outreach, and education. Individual task forces for recycling, conservation, food composting, purchasing, green building, construction and demolition, and stormwater.	LEED Silver Plus
New York Univ. New York, NY	B	**229 acres**	~100 buildings	50,917	6,755	15,286	NYU Green - Established 2006 Climate Action Plan	Reducing GHG emissions by 30% by 2017 Energy reduction Clean energy generation Climate neutrality. Green Grants provides funding for research and efforts toward energy, food, landscape, outreach, procurement, transportation and waste. Building and Campus Planning	LEED Silver New Construction and renovation

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Green Report Card Grade	Campus size (Area)	Real Estate Portfolio (# BLDGS/GSF)	Institutional Population			Sustainability Plan		
				Student	Faculty	Staff	Plan Title - Date Established	Description	Guidelines
Princeton Princeton, NJ	B	500 acers	180 buildings	7,567	1,103	1,172	Sustainability Plan established 2008; goal is to return to 1990 emissions levels by 2020	_Reduce Green House Gas emissions to 1990 levels by 2020 _Greenhouse Gas reduction through transportation and utilities initiatives _Resource Conservation through purchasing, dining, water, recycling and green building _Research and Education through academic programs, campus programs, student initiatives, and communications.	LEED Silver + 50% improvement on building code New Construction
Stanford Palo Alto, CA	A	5,178 acres	665 buildings / 13.6 million GSF	18,498	1,023		Energy & Climate Plan submitted May 2009 And Environmental Venture Projects[2004]	Themes: Energy and Atmosphere, Water, Green Buildings, Alternative Transportation, Zero Waste, Green Purchasing, Food, Sustainable IT, Communications, and Green Fund.	LEED Gold New Construction
Univ. of California Berkeley, CA	B	6,651 acres		50,024	4,016	26,139	Campus Sustainability Plan established 2009	Themes: Water Use, Green building, Energy reduction, and GHG Emissions	LEED Silver New Construction Outperform Title 24 by 20%
Univ. of California Los Angeles, CA	B	419 acres	185 buildings / 16.9 million GSF	38,476	4,016	26,139	UCLA Climate Action Plan: 12-18-2008 UC System Policy on Sustainable Practices: Sept. 1 2009	Themes: planning, financing, design, construction, renewal, maintenance, operation, space management, facilities utilization, and commissioning of facilities and infrastructure	LEED Silver Minimum, Gold preferred 20% improvement on Title 24 required, 30% preferred
University of Chicago Chicago, IL	C		257 buildings / 7.6 million GSF	11,933			Office of Sustainability established 2008	Themes: Buildings, planning, dining services, energy, landscaping, purchasing, recycling and transportation.	None required; using LEED as a metric
Univ. of Colorado Boulder, CO	A-	786 acres	337 buildings / 10,334,473 GSF	29,709	1,075		Conceptual Plan for Carbon Neutrality	_20 percent energy, vehicle fuel, and materials reduction by 2012 _Phase 1, Conservation and Cogeneration (2010–2020): Goal: 20 percent GHG reduction by 2020 _Phase 2, Large-Scale Renewables (2020–2030): Goal: 50 percent GHG reduction by 2030 _Phase 3, Innovative Technologies (2030+): Goal: 80 percent GHG reduction by 2050 _"Select environmentally sensitive architects to design CU-Boulder	LEED Gold + 40% over ASHRAE 90.1 in E&A New Construction and Renovation
Univ. of Illinois Urbana-Champaign, IL	B-	1,450 acres	559 buildings	41,495	3,081	8,595	Office of Sustainability and the Sustainability Council established 2008	_Goal 1: Create a new forum for in-depth, cross-disciplinary engagement on the sustainability grand challenges. _Goal 2: Create and implement a sustainable campus operations plan that maintains or restores natural ecosystem function and supports impoverished communities. _Goal 3: Infuse sustainable thinking into campus missions through new education activities. _Goal 4: Create incentive programs that spur sustainability activities to meet the above goals. _Goal 5: Create a viable financial plan for sustainability activities.	

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Green Report Card Grade	Campus size (Area)	Real Estate Portfolio (# BLDGS/GSF)	Institutional Population			Sustainability Plan		
				Student	Faculty	Staff	Plan Title - Date Established	Description	Guidelines
University of Maryland College Park, MD	B+	1250 acres		37,000	3,867	5,171	10-year campus strategic plan "Transforming Maryland: Higher Expectations." established in 2008	_Reduce greenhouse gas emissions to 15 percent below 2005 levels by 2012. _Ultimate goal is to operate within a carbon neutral campus (no date has been set)	LEED Silver New Construction
University of Minnesota Minneapolis, MN	A-	2730 acres		60,000	3,000		Sustainability Policy presented to the Board of Regents in 2004	_Reduce energy consumption to 5 percent below 2008 levels by 2010 [partly through retrocommmissioning]. _Themes Climate Change and Energy, Hydrogen fuel cells, Bioenergy and bioproducts, Policy, economics and ecosystems; and Conservation and efficient energy systems.	LEED Silver equivalency Xcel Energy Building Recommissioning Program
Univ. of North Carolina Chapel Hill, NC	A-	729 acres	453 buildings / 18 million GSF	23,788	3,508	8,696	Campus Sustainability Policy 2005	Themes: Buildings, Climate Change, Energy, Grounds, Materials and Recycling, Purchasing, Students, Transportation, and Water	LEED Silver Performance Customized UNC design guidelines based on desirable credits
University of Pennsylvania Philadelphia, PA	B	992 acres	368 buildings	20,128	4,049	2,278	Penn Climate Action Plan, 2007	_Reduce energy usage by 5 percent from the 2007 baseline in fiscal year 2010 _17 percent decrease from the 2007 baseline by 2014. Utilities and Operations _Physical Environment _Transportation, and Waste Minimization and Recycling.	LEED Silver New Construction and Renovation
University of Texas Austin, TX	C+	350 acres	600 buildings / 19.6 million GSF	50,995	3,023	21,754	Campus Sustainability Policy issued 2008 First greenhouse gas inventory in March 2009	Themes: Academics, Operations, Campus Planning, Administration, Outreach, Implementation	LEED Certified New Construction
University of Virginia Charlottesville, VA	B-	1,682 acres		19,784	2,012		University Energy Plan established 2006	Themes: land use & built environment, energy, dining & housing, water, administration, recycling, and transportation. Achieve long-term economic benefits and savings by maximizing energy efficient design in new facilities. Aim to reduce the total energy consumed for existing buildings and	LEED Certified New Construction and Renovation
Univ. of Washington Seattle, WA	A-	703 acres	19,191 GSF	42,907	5,803	16,174	Climate Action Plan Sept. 2009	_36% Emmission reduction by 2035 (below 2005 levels) _57% Emmission reduction by 2050 _Themes: Curriculum development, Research, and Talent recruitment and retention	LEED Silver New Construction and Renovation
Univ. of Wisconsin Madison, WI	B	933 acres	204 buildings	42,030	2,054		Sustainability @ Wisconsin Website launched last year; Sustainability Task Force to develop an inventory of initiatives on campus by end of 2010	Themes: Agriculture, Business, and Industry; Energy, Transportation and Infrastructure; Human Welfare and Society; Natural Systems and Environmental Quality	Not specified

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Green Report Card Grade	Campus size (Area)	Real Estate Portfolio (# BLDGS/GSF)	Institutional Population			Sustainability Plan		
				Student	Faculty	Staff	Plan Title - Date Established	Description	Guidelines
Yale **New Haven, CT**	A	310 acres	330 buildings	12,495	3,619	9,176	Plan for Reduction in Greenhouse Gas Emissions 2005	Themes: Energy, Green house Gas Emissions, Fuel efficiency, ecosystem health, human health, built environment, Food systems, landscape/land use, buidling design and construction, integrated waste management, transportation, and procurement.	LEED Silver New Construction for projects greater than $4 million

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Design Excellence Commitments	Benchmarking and Metrics Benchmarking & Metrics
Arizona State Tempe, AZ	_Developed Design Guidelines and Sustainable Design Advisory Committee; _Decision Theater simulates 3D environment for decision making	_LEED Silver mandate for all new buildings; Created own Design Guidelines and Design Advisory Board - ASU guidelines
Caltech Pasadena, CA	NI	NI
Columbia New York, NY	_Committed to reducing carbon emissions to 30% below 2005 levels by 2017.	_Uses LEED standards as a guideline for building design and construction.
Cornell Ithaca, NY	_Each project must undergo, sometime prior to Design Development, a Design Charrette (workshop) focused on sustainability. _Energy modeling is required for all projects which include new systems or equipment which are anticipated to impact future energy use.	_Water Efficient Landscaping; Innovative Wastewater Technologies; Water Use reduction _LEED Silver Certification for all new construction projects; 30% energy efficiency increase over ASHRAE 90.1
Duke Durham, NC	_Committed to carbon neutrality _Became the fifth largest university purchaser of green power _Push beyond the current LEED™ building policy to establish green building energy consumption standards and an approval protocol for building energy consumption review. Duke should implement, measure and report on energy use targets by internal Building Tech Rating _Implement energy conservation measures (ECMs) in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030)	_Meet or exceed Energy Use Intensity performance level of 160 KBtu/GSF . _Strive to achieve 4 out of possible 10 energy points in LEED v2.2 rating system.
Harvard Cambridge, MA	_Green building guidelines establish consistent protocol for sustainable design and construction project _Integrated Design approach must be adopted _Life Cycle Costing, Energy modelling, and ongoing commissioning are all required _Implementation of University wide temperature policy, sustainability principles, and green building policy	_Reduce Green House Gas emissions by 30% 2006-2016
Johns Hopkins Baltimore, MD	_Developed a set of "Design Guidelines" that would be universally employed as the basis to select the energy efficiency measures that would become the "basis of design" (BOD) before consulting architects and engineers begin actual design work. _Main focus of their sustainability program is the reduction of Greenhouse Gas emissions. Provide a specific set of guidelines for different components of the built environment: HVAC, Building control systems, lighting control systems, building envelope, utility systems, equipment, and wate . _The Sustainable Hopkins Infrastructure Program funds campus efficiency projects, and the university has several peer-to-peer education programs to encourage behavioral change. _"Energy Efficiency and renewable energy; Water efficiency; Waste reduction;	_Reduce emissions 51 percent below 2008 levels by 2025. _Facility Water Usage 40% less than baseline code requirements
MIT Cambridge, MA	The MIT experts, client team and designers are involved in the consultation and review projects at the earliest stages of the design concept development as well as throughout the design process, in order to incorporate 'objectives and mechanisms for achieving MIT's long-term environmental goals in projects and to evaluate total costs.	_MIT requires that all new construction and major renovations to be [or exceed] LEED Silver standards.
New York Univ. New York, NY	_Develop an incentive policy that will encourage university clients to invest in energy and water efficient design strategies and systems _Convey need for greater inclusion of sustainability as a vital perspective in all major university decision that affect environmental performance. _Create a long-range classroom planning strategy. _Establish a protocol for the review and advancement of sustainability projects that require university space. _Involve the Sustainability Task Force in initial and ongoing planning processes	_LEED Silver required on all New Construction and Major Renovation projects _NYU is a Charter Signatory member of the ACUPCC _Member of Mayor Bloomberg's PlaNYC Challenge - reduce GHG emissions by 30% below 2005 levels by 2017 _Comprehensive Climate Action Plan to achieve net carbon neutrality before 2050 with minimal use of offsets
Princeton Princeton, NJ	_Increase efficiency of new building and renovation projects to lower demand on central plant _Aggressively pursue energy conservation retrofits in existing buildings across campus.	_Commenced audit of the campus in the spring of 1994, which began a series of subsequent audits to establish a very loose set of environmental goals with an emphasis on economic benefits for the university. _Use 50% less energy then the required code
Stanford Palo Alto, CA	_Use Microclimate and Environmentally Responsive Site Design Strategies Use Native or Drought-Tolerant Trees, Shrubs, Plants, and Grasses _Optimize Building Placement and Configuration for Energy Performance _Maintain and Enhance the Biodiversity and Ecology of the Site _Guide Development to Environmentally Appropriate Infill Areas	_30% more energy efficiency over California code _Use 25% less potable water than similar traditional buildings.

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Design Excellence Commitments	Benchmarking and Metrics Benchmarking & Metrics
Univ. of California Berkeley, CA	_2009 Climate Action Plan documents plans to reduce emissions by one-third and achieve climate neutrality. _Committment to reducing greenhouse gas emissions to 1990 levels by 2014	_All new buildings must meet LEED Silver criteria _All buildings to perform better than California's Title 24 energy code by min of 20% _All campuses to submit one pilot building for LEED for Existing Buildings Operations and Maintenance certification.
Univ. of California Los Angeles, CA	NI	_Min 2 credits for water efficiency required _Title 24 + 20% minimum, 30% prefered / LEED silver minimum, Gold prefered
University of Chicago Chicago, IL	_The university is currently developing a green building policy and sustainable building standards.	NI
Univ. of Colorado Boulder, CO	_The four main areas that the University is focusing on are : site development, material selection and minimization, energy efficiency, and indoor air quality. _Make sure to select environmentally sensitive architects to design university buildings _Stay up-to-date with the building codes being followed as well as the campus construction standards. _The Environmental Center put together a Green Design Checklist addressing numerous aspects of green building, while some guidelines overlap with some of	_LEED Gold Plus - New Buildings & Renovations (p37); LEED Gold + 40% over ASHRAE 90.1 in E&A _Overall, energy conservation provides the best strategic position based _Reduce CU-Boulder's greenhouse gas emissions
Univ. of Illinois Urbana-Champaign, IL	_Create a new forum for in-depth, cross-disciplinary engagement on the sustainability grand challenges _Create and implement a sustainable campus operations plan that maintains or restores natural ecosystem function and supports impoverished communities. _Infuse sustainable thinking into campus missions through new education activities _Create incentive programs that spur sustainability activities to meet the above goals _Create a viable financial plan for sustainability activities.	_LEED Certification for all new buildings _Potential for retrofitting all campus buildings to LEED standards _Adoption of LEED ND to be explored
University of Maryland College Park, MD	_High Performance Buildings Act in Maryland requires specified buildings constructed or renovated solely with State funds, such as University buildings, to be “high performance” buildings. Both internal benchmarks and state benchmarks drive design of new buildings. _ The university has entered into a contract with two energy service companies to improve energy conservation and is working to identify potential on- and off-campus renewable energy projects. Heat and power are provided by an Energy Star cogeneration plant.	_LEED silver for all new project. _reduce greenhouse gas emissions to 15% below 2005 levels by 2012
University of Minnesota Minneapolis, MN	_The state of Minnesota has set specific green building guidelines for public institutions that are approximately equivalent to LEED Silver certification criteria. _Joined the Chicago Climate Exchange (CCX), a voluntary, legally binding multisector market for reducing and trading greenhouse gas emissions.	_Xcel Energy Building Recommissioning Program
Univ. of North Carolina Chapel Hill, NC	NI	_Meet LEED Silver Standards including 31 specific LEED Points; Healthcare buildings to meet or exceed minimum LEED for Healthcare criteria _LEED Silver; LEED for Healthcare; ASHRAE 90.1 2004; 2006 North Carolina Plumbing Code; Energy Star _Reduce Energy Consumption by at least 30% relative to ASHRAE 90.1 2004 _Reduce indoor potable water consumption by at least 20% and total outdoor consumption by at least 50% reltive to 2006 North Carolina Plumbing code.
University of Pennsylvania Philadelphia, PA	_intends to be a leader and champion of environmentally sensitive design _Developed and implemented sustainable protocols/practices for site planning, open-space design and landscape maintenance. _Timeline and authority structure to review campus wide practices and ensure that the most up-to-date standards are utilized _Created a committee of related professionals to evaluate existing practices, with support of consultants if required; _comprehensive analysis of each project to diminish the use of energy and reduce the use of non-renewable resources. _High Performance building practices incorporated into Instructions to Design Professionals and construction guidelines.	_Adopt LEED Silver Certification, with Penn-specific goals, as a minimum standard for new construction and major renovations; _Adoption of Energy Star 75 or better _Adopt LEED Existing Buildings: Operations and Maintenance (EB: OM), with Penn-specific goals as a minimum standard for building maintenance _LEED CI for fit-out projects

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Design Excellence Commitments	Benchmarking and Metrics Benchmarking & Metrics
University of Texas Austin, TX	_Comply with all relevant environmental laws and regulations and aspire to go beyond compliance by integrating values of sustainability, stewardship, and resource conservation into activities and services. _Evaluate the impact of its construction projects; incorporate green building and design methods. _Goals that inform administrative policies and procedures in the areas of planning, decision-making, assessment, reporting, and alignment. _Share with outside communities the knowledge generated from sustainability research, education, and practice. _Establish near and longer term procedures and mechanisms, including an oversight structure, to review the status of each element of this policy and to ensure its implementation	_Each institution will record and monitor annual waste and recycling quantities, implement procedures to reduce campus waste and set a goal to increase campus recycling each year.
University of Virginia Charlottesville, VA	_FP&C maintains state-of-the-art energy conservation and design criteria with its Facilities Design Guidelines.These guidelines include direction on lighting, controls, mechanical and electrical systems, recycling and other sustainable practices, providing a reference for architects and builders working at the University.	_The University's Board of Visitors adopted the LEED standards for new construction in 2007.
Univ. of Washington Seattle, WA	_The University of Washington aims to reduce GHGs through three approaches, student and faculty behavioral adjustments; technology advances to decrease direct emissions of gases; where the first two cannot be applies, "the University can purchase and retire allowances issued in GHG regulatory systems, or purchase open-market GHG offsets, to induce reductions outside of the UW campus and community."	_All publicly funded new buildings must meet at least LEED Silver standards, per High Performance Public Buildings Law
Univ. of Wisconsin Madison, WI	_Over-arching planning goals include replacing aging buildings, renovating / rebuilding unions, adding recreation facilities, insure new construction is flexible enough to be used for a century, protect open space, limit added parking, plan infrastructure for utilities and mass trans	_LEED Silver certification for all new construction projects, and eight new buildings are expected to meet LEED criteria
Yale New Haven, CT	_Develop a portfolio that leads to long-term greenhouse gas emission reductions and monetizers carbon _Build high-performance, long-term, cost-effective, environmentally responsible facilities _ Integrate life-cycle cost analysis into procurement while minimizing reuse and recycling _Develop and implement water conservation +management standards _Manage campus landscape [aesthetics, ecology, economy]	_Reduce greenhouse gas emissions 10% below 1990 levels by the year 2020

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Facilities and Campus Planning		
	Facilities and Maintenance Policies	**Performance Improvements**	**Planning strategies**
Arizona State Tempe, AZ	_Green Purchasing Policy requires 100% recycled carpeting and a 5% preference for recycled products in general _Moving to many Green Seal products _Aim to reduce per capita energy consumption. _Installed campus-wide whole building monitoring Energy Information Systems (EIS) _Green Purchasing Policy prioritizes Energy Start products	_1.7 megawatts of solar power arrays to reach 20 megawatts by 2011	_Moving from a commuter campus to on-campus living options [ongoing] _ Support and encourage to support hybrid and alternative fuel vehicles[charging posts, alternative fuel pumps] by designing and building infrastructure.
Caltech Pasadena, CA	_Caltech's heating plant is a cogeneration plant, which converts waste heat into electricity.	NI	NI
Columbia New York, NY	_has been buying and using "green" cleaning products and solutions since 2000. _Indoor air temperature mandated across campus to conserve energy	NI	NI
Cornell Ithaca, NY	_Utilize cleaning chemicals, equipment, and protocol to protect the health of the Cornell community without harming the environment.	_Waste sent to landfill declined by 40% since 1990, CO2 emissions reduced by 50,000 tons a year since 1980	NI
Duke Durham, NC	_Energy conservation measures (ECMs) in existing buildings with the goal to realize a 15% reduction in energy use over a 20 year period (2010 – 2030) _Discontinue the use of coal as soon as possible - convert to gas-fired steam plants and photovoltaics _Pursue plant efficiency improvements with tactics such as: distribution system upgrades, thermal storage, chilled water expansion and upgrade, and boiler plant heat recovery	_Collected 7 different types of recyclables, diverting more than 1,200 tons annually from the landfill _Renovated campus steam plant will reduce coal use by 70 percent and expand opportunities for fuel-switching in the future to biogas. _Since 2007, water consumption has decreased by close to 50 percent.	_Limit expansion, use infill development _Preserve natural areas _Prioritize non-vehicular transportation _"Be a leader in implementing environmental stewardship and sustainability principles in the design, development and management of the Duke environment."
Harvard Cambridge, MA	_Procedures and products are utilized which contribute to healthy surroundings for building occupants and cleaning staff; "Green Seal" cleaning products utilized	_5% Reduction in GHG since 2006 _25 certified green offices on campus _15.7 % electricity harvested from renewable resources _55% waste recycled	NI
Johns Hopkins Baltimore, MD	_Conducting feasibility studies for use of photovoltaics and wind turbines on existing buildings. Lighting upgrades to LEDs starting in year 2012, from 2013, will begin large-scale upgrades to LED lighting technology and daylighting. _Efficiency initiatives include the installation of 20 megawatts of cogeneration facilities, lighting and equipment upgrades, building occupancy schedule adjustments, temperature setbacks, and peak demand management. _Minimize Irrigation _Consider Utilize Greywater for Non-potable applications _No potable water for once-through cooling of equipment	_JHU reduced emissions by 17,000 tons over three years despite campus growth _CU University Memorial Center [1.2 million pounds of construction kept out of landfills	NI
MIT Cambridge, MA	NI	NI	NI
New York Univ. New York, NY	NI	_NYU has been the largest university purchacer of wind energy in US for pas 2 years _Reduced emissions by more than 7,300 tons since 2007	_Campus planning design will promote landscaping
Princeton Princeton, NJ	_Uses only Green Seal-certified cleaning supplies _Installation of photovoltaic panels on the library, changed purchasing policies, feasibility studies of more drastic changes _HVAC systems computer controlled to manipulate indoor temperatures of entire buildings. _University only purchases Energy Star-certified appliances	NI	_Emphasize building reuse in order to save minimize the environmental impact of materials associated with new building projects _Recycle old building where possible before commencing with new construction.

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Facilities and Campus Planning		
	Facilities and Maintenance Policies	**Performance Improvements**	**Planning strategies**
Stanford Palo Alto, CA	_The Green Cleaning Program replaced harmful chemicals with Green Seal–certified products. Stanford staff use microfiber cloths and vacuums with HEPA filters, reducing paper waste and improving air quality. _Stanford's Energy Retrofit Program promotes the purchase of Energy Star office equipment and appliances. _ Stanford encourages purchasing energy-efficient desktop computers, servers, copiers and other office machines when older machines need to be replaced.	_The water conservation program has reduced use by 15 percent over the past 8 years. _Domestic water consumption reduced by 15% since 2001. _Over the last 15 years, the waste diversion rate increased from 30% to 64%.	_Recover 5–10 percent of the space in campus buildings
Univ. of California Berkeley, CA	_Building managers, project managers, and physical plant staff are given hands-on, detailed courses on building commissioning to ensure persistence of energy savings.	_Almost all incandescent fixtures have been replaced with fluorescent. [200 projects saving $3 million a year in energy costs.] _Water usage per square foot has dropped 30 percent since 1990, and 80 to 90 percent of demolition waste is diverted from the landfill. _Solid waste going to the landfill dropped by 1% last year and 8% since 1990 _Recycled waste and/or composted more than tripled.	NI
Univ. of California Los Angeles, CA	NI	NI	NI
University of Chicago Chicago, IL	NI	NI	NI
Univ. of Colorado Boulder, CO	_The Design and Construction division of Facilities Management assists campus clients through construction projects on campus, by providing management and professional services. _The Design and Construction division manages and monitors projects "from inception to closeout", this includes coordinating budding process, facilitating consulting services, managing contracts, budgets and schedules.	_According to the greenreportcard website: _Reduce greenhouse gas emissions 20% by 2020 and 80% by 2050. _By 2012, the university's goal is to decrease energy and fuel use 20%. _More than 75 buildings on campus have been retrofitted for energy efficiency.	_Capital Planning Mission: To plan for a body of capital improvement projects forecasting real facilities needs of the Boulder campus over current and projected planning periods." _"Campus Planning Mission: To maintain and update the Campus Master Plan and numerous other associated master plan documents, including analyses of development, density, and supporting infrastructure requirements." _"Facilities Planning Mission: To plan for and coordinate physical change to the use of Boulder campus buildings and grounds, and to people and vehicular circulation into and around campus, so that each alteration will comply with master plans, policies, procedures, and processes of the CU-Boulder campus."
Univ. of Illinois Urbana-Champaign, IL	NI	NI	NI
University of Maryland College Park, MD	_Utilize green cleaning products (Green Seal) _First university housekeeping program to achieve the Cleaning Industry Management Standards Green Buildings certification	_Campus emissions decreased 4.2 percent from 2005 to 2008. _A massive hallway lighting retrofit is saves more than 5,200 tons of carbon emissions each year _Storm water irrigation system was recently installed in the Washington Quad.	NI
University of Minnesota Minneapolis, MN	_Ongoing green lights program to change out older, less efficient lighting as buildings are remodeled at all campuses and facilities. _The Material Review Board (MRB) centralizes purchasing of custodial supplies and to reduce the number of different products used by their employees to optimize supply management and enhance worker safety and environmental friendliness through a product selection process. _Energy Management has created schedules for most of the heating/cooling systems on campus. The systems are digitally programmed to shut off when buildings are unoccupied. _All heating/cooling systems and controls in campus buildings are evaluated to identify opportunities for efficiency improvement.	_Carbon dioxide emissions from on-campus steam production were reduced by 28 percent since 1998. _University generates approximately 4 percent of its electricity from oat hulls burned for biofuel. _Over 160 new efficient washers were installed in residence halls, saving 3.5 million gallons of water each year.	NI

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Facilities and Campus Planning		
	Facilities and Maintenance Policies	Performance Improvements	Planning strategies
Univ. of North Carolina Chapel Hill, NC	_32 buildings (2M sqft and 19% of bldg space) converted to OSI housekeeping protocol -- includes use of Green Seal certified housekeeping products. _Energy Efficient Purchasing Policy requires Energy Star equipment _Energy Efficient Lighting Policy requires CFLs/prohibits incandescent bulbs _Required to meet 6 specific LEED points related to energy optimization	_PACRAT[Performance And Continuous Re-commissioning Analysis Tool] Continuous Commissioning Software _PACRAT continually monitors the performance data of buildings and compares it to the model building performance. The data will reveal what is not functioning well, with potential causes, and cost estimate of running the building without fixing the problem, and after fixing the problem [as a comparative analysis tool]	Campus Master Plan: _Approved by UNC in 2001 and will implements the beginning steps in 2010. _Addresses: Environmental issues, storwmwater, transportation and utilities. _
University of Pennsylvania Philadelphia, PA	_Improve snow removal methods for minimal waste and damage to plants and landscape (using brine instead of salt for snow melting) _Recycle more landscape waste material _Provide more efficient campus lighting _Develop a more comprehensive tree appreciation program; _Improve landscape maintenance procedures and protocols _Improve maintenance and requirements for donor gardens and projects _Provide training to Penn staff regarding sustainable practices in building design and operations/maintenance	_Completed all irrigation repairs recommended in the 2008 audit of the current system	_Evaluate the new Sustainable Sites Initiative for possible implementation on campus. _Partnerships with third-party, private capital for development projects ranging from mixed use to housing to research. _Planning focuses on creating civic and open space, Identifying land use and development zones, improving physical connections for pedestrians, automobiles, and bicycle
University of Texas Austin, TX	NI	_$15.1 million upgrade of campus water and lighting components saves the University $2.7 million per year in utility costs.	NI
University of Virginia Charlottesville, VA	_Temperature set points have been established to conserve energy. _The university has reduced water use by collecting cooling tower condensate water for irrigation during periods of low rainfall.	"Recognize that total building contents and local use conditions contribute to environmental quality Ensure Good Visual Quality Avoid off-gassing and VOC-emitting Materials Reduce and Control Moisture to Prevent Microbial Growth Ensure Proper Acoustical and Vibration Conditions"	"Promote development that conserves and is compatible with natural systems and existing infrastructure. Enhance and/or restore existing conditions of natural systems. Relate future development with existing campus circulation systems. Select adaptive reuse/renewal of existing facilities over demolition and new development, whenever economically feasible. Planning and design of buildings should respond to microclimatic conditions and natural landscapes. Reduce energy consumption, including external transportation to the site and site maintenance."
Univ. of Washington Seattle, WA	_Irrigation systems are computer centrally controlled and include water conservation measures, e.g., moisture and flow sensors.	_reduce GHGs _ _Discourage Non-Electric Interconnections _Measure and Monitor Building Performance	NI
Univ. of Wisconsin Madison, WI	_Rehabilitative instituted CURB and CARE programs focussing on HVAC updating	_Reduced carbon emissions by 72,000 tonnes between 2006-2009 _10% of energy comes from wind power since 2006 _$7 million reduction in energy cost since 2006 _178 million gallons water reduction since 2006 _10,000 gallons fuel reduction since 2006	NI
Yale New Haven, CT	_The university allocates renewable energy credits to offset some of the energy used by residential colleges. _For every 5% of reduction at residential colleges the University will allocate renewable energy certificates to offset 1/3rd of the electrical energy used by residential colleges.	_Reduction of 43% in green house gas emissions from 2005	NI

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Existing and New Buildings		
	Completed Projects	Renovations / Retrofits	Construction Policies
Arizona State Tempe, AZ	_6 LEED certified buildings; 25 buildings that meet LEED criteria but aren't certified; 2 LEED-EB projects	_Retrofitted 80 buildings to increase energy efficiency; 40,000 light fixures in 3M sf replaced; installation of occupancy sensors for lighting control; installation of whole building monitoring EIS	_Low-flow faucets and waterless urinals in all new builds
Caltech Pasadena, CA	NI	_Roughly 50% of existing buildings are currently undergoing at least one phase of retro-commissioning _Parking garages are being retrofitted with LED lighting _Projects have been initiated to replace central plant boilers and chillers with more efficient models _Caltech is replacing air handling equipment with high-efficiency chillers and motors, retrofitting buildings with CFLs, installing motion sensors in buildings, re-roofing buildings with reflective materials to prevent excess heat from being absorbed, and replacing appliances with more energy-efficient ones.	NI
Columbia New York, NY	_ Installation of "green roofs"-lush vegetative roof tops-at 423 West 118th Street and 635 West 155th Street, where the Office of Environmental Stewardship is located. _Comer Lab LEED Silver Certification _Faculty House LEED Gold certified _14 LEED certified buildings on campus	_Columbia buildings have been phasing in low-flow plumbing, and efficient water heaters have been installed. _Low flush toilets, shower heads, efficient wasing machines (front loading). Variable speed pumping of 10,000 ft long domestic water loop. $40,000 savings a year	NI
Cornell Ithaca, NY	_Weill Hall, completed 2008, Alice H. Cook House, LEED certified, nine other buildings pursuing certification	NI	_For projects causing changes to a site, the project designer shall review the measures included in the Site Strategy Templates and show an effort to improve the sustainable use of the site. Measures which will be incorporated into the project shall be documented using the applicable
Duke Durham, NC	_Cancer Center Addition and Cancer Center Project (LEED certified) French Family Science Center _Three green roofs were constructed in 2008. _Camille Kendall Academic Center has been LEED Gold-certified _Two other buildings will achieve LEED Gold certification upon completion in 2009.	_Bathroom faucets in the Adele H. Stamp Student Union were recently replaced with sensor-driven units to save water, 100 new faucets in the Union will save approximately 1.2 million gallons of water per year and 29 million BTU of energy from reduced hot water usage. _Installed a 10,000 gallon cistern to provide drip irrigation for the landscaping around the Washington Quad. _Performed HVAC system upgrades and 10 buildings on campus are undergoing retrofits for energy efficiency.	NI
Harvard Cambridge, MA	_Three LEED platinum, nine LEED gold, four Silver, four Certified	NI	_Divert 75% construction waste from landfill _Reduce lighting power density 25% below standard, Optimize HVAC performance, 70% Energy Star appliances _IAQ management plan, low-emitting materials adhesives, paints, carpets, Indoor chemical and pollutant source control
Johns Hopkins Baltimore, MD	NI	NI	_Broke down a set of new building guidelines into categories: HVAC, Building control systems, lighting control systems, building envelope, utility systems, equipment, and water. Each category has a specific, detailed set of recommendations. Refer to document placed in web references for specific details.
MIT Cambridge, MA	_Two completed LEED Silver buildings _Three buildings in process anticipating LEED gold certification _Ashdown House: LEED-Gold certification from the U.S. Green Building Council. _LEED Silver Certification for the Brain and Cognitive Sciences Complex	NI	NI
New York Univ. New York, NY	_Gallatin School of Individualized Study LEED Certified	_Retrofit residence hall showers and faucets with water-saving fixtures	_NYU is committed to tracking Construction and Demolition Waste

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Existing and New Buildings		
	Completed Projects	Renovations / Retrofits	Construction Policies
Princeton **Princeton, NJ**	_Retrofit old plumbing fixtures with new, water saving devices. _Goal to add individual room temperature controls in existing building; proposal recognizes the expense of this goal and how unlikely a campus-wide change would be _Emphasis on site water collection and retention for new building projects. Efficient fixtures.	_Princeton has used lighting retrofits, heat recovery, continuous commissioning of HVAC systems, roof replacements, demand-controlled ventilation, and domestic hot water reduction to improve the energy efficiency of existing buildings.	_Proposed material vendor guidelines recommend using green and recycled materials where possible and add environmental criteria to material selection. Aid development of green building material markets. _Recycle and reuse construction waste; monitor contractors' construction waste habits. Hire additional staff to monitor construction disposal and material selection. _New buildings will attempt to have HVAC individually controlled on a room by room basis. _All new construction projects to be 50% more energy efficient than min. building codes. All new projects should be LEED silver minimum.
Stanford **Palo Alto, CA**	_Graduate School of Business complex is expected to be LEED Platinum and the Stanford Hospital to meet LEED Silver equivalency. _The Jerry Yang and Akiko Yamazaki Environment + Energy Building uses 38 percent less energy and 90 percent less total site water use than a similar building with traditional fixtures and systems. _The 360,000-square-foot Knight Management Center, slated to open in 2011, is expected to exceed current energy efficiency standards by at least 40 percent and use half the potable water of a similar building with traditional fixtures and systems.	_Standard dishwashers in dining facilities replaced with trough conveyers, cutting water use by 51%. Saved 0.174 million gallons per day by replacing once-through cooling systems in labs with recirculating systems that reuse the cold water _The university purchased new, energy-efficient lab freezers for the medical school to replace older, less efficient models. _Outside the quad area, renovations must have over 25% more water efficiency over california code _Major renovations must use 30% less energy [LEED Gold standard. Energy use in new and significantly renovated buildings must be 30 percent more efficient on average than current energy code requirements	_Outside the quad area, new buildings must have 25% more water efficiency over california code _Buildings on campus to use flushed out water from the Central Energy Facility. _Aim to divert 75% of waste from landfills, working towards a zero-waste goal. Over the last 15 years, the waste diversion rate increased from 30% to 64%. _New buildings must use 30% less energy [LEED Gold standard. Energy use in new and significantly renovated buildings must be 30 percent more efficient on average than current energy code requirements
Univ. of California **Berkeley, CA**	_The LeConte Hall renovation was designed with material reuse as a priority _One LEED SIlver building _14 LEED buildings _Five Star "Green Star" rating is to be achieved in the Economics and Commerce Building	_for the College of Chemistry: low-power fume hoods will be installed in the new labs, along with solid-state lighting and other energy-saving features. _All UC renovation projects with budget exceeding $5million must be LEED for Comerical Interioirs Certified level	_All new buildings must meet LEED Silver criteria _All buildings to perform better than California's Title 24 energy code by min of 20%
Univ. of California **Los Angeles, CA**	NI	NI	NI
University of Chicago **Chicago, IL**	NI	NI	NI
Univ. of Colorado **Boulder, CO**	_Five Total LEED-certified buildings _16 buildings on campus qualify for LEED certification, and one Energy Star-labeled building. _The university installed motion sensors, insulating windows, and water-saving technologies in existing buildings. _Water use was reduced by 30% _The Environmental Living and Learning Center [waterless composting toilets; furniture made from recycled material; 20kW wind tower and solar panels producing 8% of the dorm's power and reduced the water-heating costs by almost 30%] _Oberlin College-new Environmental Studies building [goal was to achieve balance between nature and human education; 69,000 kWh/year PV system, site wastewater purifier; efficient HVAC system; use of sustainable products; utilizing day lighting and passive solar heating methods; end result : " building that uses one-fifth as much energy, while still providing an excellent learning environment for students] _UC Environmental Science building [LEED certification from the US Green Building Council] [naturally lit, heated and cooled; constructed with "materials manufactured from recycled and renewable sources" ; generates its own electricity with a fuel cell and photovoltaic.]	_Existing buildings restroom have been modified with "Conservo-Kit" to reduce the water flow. _Campus potable water consumption has been reduced from 412 million gallons per year to 290 million gallons per year since 2003.	_Eighth of Gallon urinals or water free urinals and dual-flush toilets in all new buildings. _Adopt a goal of “Zero-Waste” from construction of new buildings and operation and renovation of existing facilities (current waste diversion rate for new construction is >75%)

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Existing and New Buildings		
	Completed Projects	**Renovations / Retrofits**	**Construction Policies**
Univ. of Illinois Urbana-Champaign, IL	_One LEED Platinum project awaiting certification. Nine projects in design or construction attempting to achieve LEED silver.	_Installed Super T8 lamp and ballast systems in over 40,000 fixtures in 24 buildings. These buildings have an area of 3 million square, representing 15% of total space. Another 50,000 fixtures in 31 buildings will be complete in the next few years, accounting for an additional 4 million square feet. _Installed occupancy sensors and have installed them in classrooms in three buildings. Another 7 buildings will be completed shortly. _Installed low flow 0.5 gpm lavatory faucets in the restrooms of 130 buildings this year. Completed the retrofits in 88 buildings. _A handful of buildings have had low flow urinals, dual flush toilets, and low-flow showerheads installed.	NI
University of Maryland College Park, MD	_Knight Hall College of Journalism - LEED Gold completed 2008. _Camille Kendall Academic Center - LEED Gold completed 2007	_Significant hallway lighting retrofit underway, mostly completed. Installed a Green Roof on Cumblerland hall to reduce energy needs among other advantages. _Replaced all “EXIT” signs with energy saving LED or light emitting diode signs. The conversion will reduce energy consumption by 30 percent. _Lighting retrofit at the Eppley Recreation Center West Gym and Ritchie Arena that converted 400 Watt lights to 320 Watt Pulse Start lights.The conversion is projected to save approximately 61,100 kwh and $6,600 per year in the West Gym and 30,400 kwh and $3,300 annually _Replacing carpet with an environmentally preferable carpet. The carpet is made with eco-friendly materials including bio-based renewable resources, installed with a low VOC adhesive , cleaned with hot water, and is readily recyclable at the end of its useful life.	_Design Criteria/Facilities Standards (DCFS) are University standards and design guidelines for new construction and building renovations on the College Park campus are being revised to address environmental stewardship and LEED design criteria.
University of Minnesota Minneapolis, MN	_15-kilowatt photovoltaic solar collector system installed on the roof of the Ralph Rapson Hall for the College of Architecture and Landscape Architecture. _The university is awaiting LEED certification on its new stadium. _Over 160 new efficient washers were installed in residence halls, saving 3.5 million gallons of water each year.	NI	NI
Univ. of North Carolina Chapel Hill, NC	_Carrington Addition - LEED certified _North Carolina Botanical Garden Education Center (meets LEED Platinum criteria, completed August 209); _Dental Sciences Building, Genome Science Building, Biomedical Research Imaging Building (3 lab buildings - 769,000 sqft - in design phase and registered for LEED Silver Certification) _Morrison Residence Hall - 2009 tune-up of solar and building systems	_Indoor Air Quality [to use low VOC paints according to GreenSeal's Standard GS-11, LEED credit Environmental Quality 4.2.] _Manifold fume hoods [savings in energy use, materials, labor, operation and maintenance, and space.] Zinc roofing on the Student Union ["Zinc roofing is 100% recyclable; often made with recycled/salvaged material; nontoxic (in fact, it is a vital mineral often lacking in the body), especially as compared to lead-coated copper roofing; and uses ½ of the energy in production compared with copper roofing, another metal roofing alternative. It also has a life cycle of 50 to 100 years, bringing its life cycle costs down below shingles or stainless steel.]	NI
University of Pennsylvania Philadelphia, PA	_The Music Building, an existing historic 1892 structure, is being renovated and modernized, with double the number of practice rooms, upgraded wiring and basic systems, and improved lighting and soundproofing. _The Fisher Translational Research Center is an eight-story medical facility containing 300,000 square feet devoted to basic, clinical, and translational research. _The new Horticultural Center at Morris Arboretum is Penn’s most comprehensive assay into sustainable design and construction. The new $20 million complex is targeting Platinum LEED certification.	_Commitment to recommissioning/retrofitting 600,000SF anually (8 buildings)	_Green Roofs to catch rainwater

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Existing and New Buildings		
	Completed Projects	**Renovations / Retrofits**	**Construction Policies**
University of Texas Austin, TX	_Institute for Geophysics, Certified 2007, Belo Center for New Media will be completed in 2012 _Student Activities Center slated for completion in spring 2011 expecting LEED silver	NI	NI
University of Virginia Charlottesville, VA	_The Clinical Office Building on campus is one of the largest buildings in Virginia using a geothermal cooling system _18 new construction or renovation projects anticipating LEED	_Building retrofits are underway for efficiency, and temperature set points have been established to conserve energy.	NI
Univ. of Washington Seattle, WA	_Seven LEED Gold certified projects; Two LEED Silver Certified; Two LEED Certified ; 22 additional projects are LEED-registered.	_Non-chemical water treatment systems for water cooling towers increases the intervals between “blow down” (draining, cleaning and re-filling), saving water. _7 residence halls with approximately retrofitted with low flow showerheads providing 2.0 gal/min (25% below code). Approximately 150 of 600 sinks have aerators installed limit flow to 0.5gal/ minute. All washing machines approximately 125 in the laundry are front loading EnergyStar and qualify for water reduction rebates. _UW Tower Lighting Retrofit resulted in 1,299,000 kWh savings = 778 MT of CO2 savings _Triangle Garage Lighting Retrofit, conversion from incandescent to flourescent, resulted in savings of 113,903 kWh = 68 MT of CO2. _Ongoing Campus Retrofit program completed 12 of 67 buildings, resulting in 987,000 kWh Electricity Savings = 591 MT of CO2 Savings	_75 % construction waste recycling on LEED projects. _High efficiency toilets – 1.6 gallon per flush (85% of all fixtures replaced) _High efficiency urinals – Combination of 1/2 gallon and 1/8 gallon per flush fixtures (60% of all fixtures replaced to date. This project is still in progress with an outcome goal of 85%). Water-Mizer technology (http://www.rpiparts.com/water-mizer/index.htm) on sterilizers (90%)
Univ. of Wisconsin Madison, WI	_One new LEED Silver Certified building and four new LEED Gold certified buildings anticipating completion in the next year	NI	NI
Yale New Haven, CT	Yale currently has one LEED Silver, two LEED Gold, and one LEED Platinum-certified building on campus. Two laboratories are certified as LEED-CI Gold and two are pending certifications. _The Yale School of Forestry and Environmental Studies purchases renewable energy credits. _Ten micro-wind turbines were recently installed at the Becton Engineering and Applied Science Center which require only 7 mile-per-hour breeze to produce electricity _Art and Architecture building recieved LEED Gold _New type of solar energy system on the roof of Swing Space dorm. [thin film pv mdules manufactured by Uni-Solar Ovanic] and will produce 3-5%of the dorm's electric power needs _Eleven campus buildings are candidates for LEED design and certification	_HVAC systems in 90 buildings were retrocommissioned for efficiency. Geothermal wells are included in two new building projects.	_New construction projects with a budget of more than $4 million are required to achieve LEED Silver certification.

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Long Term Planning, Curriculum, and Research	
	Curriculum	Research
Arizona State **Tempe, AZ**	NI	NI
Caltech **Pasadena, CA**	NI	NI
Columbia **New York, NY**	_Graduate School of Architecture, Planning and Preservation currently fosters an Interdisciplenary Initiative in Urban Ecology _Earth Institute sponsors the Center for Sustainable Urban Development	NI
Cornell **Ithaca, NY**	NI	NI
Duke **Durham, NC**	_Sustainability and Climate Neutrality Become a Part of Every Student Experience -Provide Opportunities for Students with Passion, Commitment and Interest -to Reach Students with Environment as a Professional Goal a Any Level	_Leverage research into alternative technologies and explore and implement conversion to biogas, solar PV, solar thermal, combined heat and power or other technologies by 2030
Harvard **Cambridge, MA**	NI	NI
Johns Hopkins **Baltimore, MD**	NI	NI
MIT **Cambridge, MA**	_GreeningMIT : promotes energy conservation and sustainability.	NI
New York Univ. **New York, NY**	NI	NI
Princeton **Princeton, NJ**	NI	NI
Stanford **Palo Alto, CA**	_Goldman Honors Program brings together upper-division undergraduate students in small-group seminars to analyze environmental problems, with project-focused work tied to policy and ongoing research. _Haas Center for Public Service provides service opportunities, integration of service experience with classroom learning, community-based research, public service leadership training, community programs serving children & youth, and advising on national service options. The center supports 20 programs and many student organizations, and works with faculty who offe 75 service-learning courses and community-based research projects. _The upcoming Green Dorm will be a living laboratory for sustainability and represent the latest in sustainable building technology and practice. It’s expected to generate more electricity than it uses, emit no net carbon and use half the water of comparable dorms. _New students receive a guide to sustainable living at Stanford, and orientation includes a zero waste lunch and a discussion on environmental stewardship moderated by the university president. Stanford has 17 environmental organizations. The student government has a Sustainability Executive Chair.	_The Mel Lane Student Program Grants provide funding to students for group projects that try to solve environmental issues related to the university. _The Environmental Undergraduate Research Program offers internship opportunities for undergraduates to work on projects with Stanford faculty and research staff, finding solutions to environmental problems. _Environmental Venture Projects:developing biodegradable synthetic wood products _Woods Institute offers opportunities for students to pursue sustainability research and projects
Univ. of California **Berkeley, CA**	_The College of Chemistry : "green chemistry" + sustainability concepts into both the design of the laboratories and the new curriculum. _The Building Sustainability at Cal (BS@C) Program – a student-initiated and -run program – trains students to help reduce the environmental footprint of campus buildings. _The Secret Life of Buildings is an architecture class addressing the post-occupancy performance of buildings. "Students are examining architectura lighting,and mechanical systems in existing buildings with attention to energy use, occupant wellbeing, and architectural spacemaking. In spring 2009, students examined lighting, ventilation systems, and possible behavioral changes through projects in Wurster Hall and posted their reports and findings online. In addition, a LEED™ DeCal course in spring 2009 was studenttaught and attended by four campus project managers.”	_Two University of California, Berkeley, faculty members will receive $30 million over the next five years from the U.S. Department of Energy to find better ways to separate carbon dioxide from power plant and natural gas well emissions _Three scholars from the University of California, Berkeley, have been appointed to the state's new Economic and Allocation Advisory Committee, a group charged with helping California implement the Global Warming Solutions Act of 2006 (AB32).
Univ. of California **Los Angeles, CA**	NI	NI
University of Chicago **Chicago, IL**	NI	NI

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Long Term Planning, Curriculum, and Research	
	Curriculum	Research
Univ. of Colorado Boulder, CO	_The University of Colorado Foundation makes a list of external managers and mutual funds available to the public online. Proxy voting information is accessible at the investment office to the board of directors, senior administrators, and other select members of the school community. The foundation aims to optimize investment return and is currently invested in renewable energy funds.	NI
Univ. of Illinois Urbana-Champaign, IL	_Create a Greenhouse Gas (GHG) Registry that would allow colleges, units, and individuals to participate in a GHG credit trading system, allowing them to offset their emissions while providing revenue to sustainability projects and programs. This would provide additional incentives for emission reductions, and could also encourage donations from alumni and friends of the university who wish to offset their own emissions. Educational opportunities could be provided to students in developing and maintaining this program. Students in NRES 199 and 599 are currently designing an Illinois Carbon Registry that may provide a usefu model.	NI
University of Maryland College Park, MD	_The Chesapeake Project is an initiative to integrate sustainability across the curriculum of the University of Maryland. Central to the project is a two-day workshop developing ideas across departments. Sponsored by the Office of Sustainability. _Living and Learning programs integrate academics, student living, and environmental education.	_Multiple Centers for research, ranging from community to global scales, including Center for Environmental Energy Engineering, Earth System Science Interdisciplinary Center, and Joint Global Change Research Institute
University of Minnesota Minneapolis, MN	_Energy Efficiency Student Alliance sponsors energy audits	_Methane Digester: The University, through the Department of Biosystems and Agricultural Engineering provides research, education and guidance in the area of anaerobic digestion of organic waste to produce methane as a fuel for energy generation. _Oat Hulls: considerations of using biomass fuel, specifically, oat hulls, at its Minneapolis campus heating plant. Emissions pilot testing completed at the University during the summer of 2003 demonstrated that oat hulls burn cleaner than coal.
Univ. of North Carolina Chapel Hill, NC	NI	NI
University of Pennsylvania Philadelphia, PA	_Create a policy to maintain quality assurance for general facilities practices _Educate University personnel, both directly and indirectly involved in the project process, on the importance of these policies and what they mean to the University as a whole, and provide updates as required.	NI
University of Texas Austin, TX	_The University will strive for excellence in sustainability education and research by integrating sustainability concepts into curricula; supporting interdisciplinary scholarship, research and faculty hires; increasing faculty and student awareness of sustainability issues; and enhancing sustainability educational offerings. _The University will share with outside communities the knowledge generated from sustainability research, education, and practice.	NI
University of Virginia Charlottesville, VA	NI	NI

APPENDIX F - FULL PEER INSTITUTION COMPARISONS

Institution [location]	Long Term Planning, Curriculum, and Research	
	Curriculum	Research
Univ. of Washington Seattle, WA	_The Environmental Stewardship Advisory Committee consists of senior administrative and academic leaders, and their responsibilities consist of including new policies, setting goals and priorities, and finding funding sources. _In order to move the Climate Action forward, the Environmental Stewardship Advisory Committee (ESAC) will work with Climate Action Teams [including faculty, staff and students] in order to carry out the planning and implementation. [UW Climate Action Plan 091509 proposes to "Create and adopt a revised governance structure for ESAC, CAP implementation and UWESS office"] _The Vision Statement states five goals labeled as Grand Challenges : attracting diverse and excellent student body and faculty in order to achieve a rich learning experience, encourage interdisciplinary research, and expand the project reach to advance global involvement and competitiveness. UW also "requires integration of UW's physical infrastructure with academic and administrative priorities and policies to identify and make the required tradeoffs to create an effective and self-perpetuating path forward." [UW Climate Action Plan 091509]	NI
Univ. of Wisconsin Madison, WI	NI	NI
Yale New Haven, CT	_New Haven Action and the Student Task Force for Environmental Partnership,to educate students on how to participate in advancing our goals for energy conservation.	NI

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

Please direct comments or questions to: GrahamInstitute-IA@umich.edu

For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

University of Michigan

Campus Sustainability Integrated Assessment: Phase I

Energy Team

May 31, 2010

This publication is a result of work sponsored by the Graham Environmental Sustainability Institute and U-M Office of Campus Sustainability.

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We would especially like to thank Mr. John Callewaert and Ms. Katie Lund for their efforts in guiding us through Phase I of this Integrated Assessment process, and Mr. Andy Berki, Mr. Bill Verge, Mr. Ken Keeler, and Mr. Keith Johnson for sharing their expertise and insights with us this semester.

1.0 EXECUTIVE SUMMARY

The purpose of the Campus Sustainability Integrated Assessment is to understand the impacts of the University of Michigan Ann Arbor campus' operations, and to develop stretch goals for significantly reducing these impacts. The primary impacts related to energy are the depletion of non-renewable resources and greenhouse gas emissions. The Energy Team's focus is on the university's energy supply and our task is to recommend actions the university can take to reduce its fossil fuel consumption and greenhouse gas emissions, in pursuit of goals that we will help develop. Goal setting will be initiated in Phase III of this project. This activity should be conducted by relevant university departments such as Utilities & Plant Engineering, the Academic Units, and the Office of Campus Sustainability with guidance and input from the Energy Team and other teams focused on energy demand.

For Phase I of this project, the Energy Team focused on benchmarking renewable energy use at other universities and institutions, examining UM's renewable and total energy supplies, and developing recommendations for the university to pursue in collaboration with our team during Phase III. The findings of our Phase I work, which informed our recommendations, are contained in this report. Our recommendations are summarized here:

1. Given the impact of climate change and expected carbon regulations and markets, **we recommend that the University develop a comprehensive energy and carbon reduction plan**, including goals for reducing carbon emissions and expanding the renewable energy supply. These goals will be developed by further analyzing the feasibility and scalability of the technologies outlined in recommendations 2-5.
2. Reduce natural gas consumption at the central power plant by implementing two key renewable technologies on campus: **geothermal heating and cooling** and **solar thermal water heating**. An investigation of large-scale geothermal systems is underway at this time, supported by an Energy Team student member. Solar thermal water heating should be similarly explored in Phase III.
3. Reduce natural gas consumption at the central power plant and electricity purchasing by implementing **solar photovoltaic systems** on campus rooftops, particularly the football stadium roof, and **biomass electricity** production at the central power plant. These options are likely to be more cost-effective than producing electricity from wind turbines on campus.
4. Improve the **transportation fuel mix** by increasing the ratio of **biofuel** to fossil fuel consumption in the short-term, and transition to fleet and bus **electrification** over the long-term. The university already owns hybrid electric vehicles and should continue integrating them into the fleet. Biodiesel could also be produced at a student operated facility on campus from waste grease.

The next steps in this project will be to analyze the technologies in recommendations 2-4 in terms of their costs, payback periods, technical integration issues, and potential for reducing fossil fuel consumption and greenhouse gas emissions. The analysis should be performed in partnership with campus departments that have expertise in each respective area. This will ensure that the analysis is useful and can be applied to a strategic plan that establishes appropriate goals.

2.0 INTRODUCTION

The Energy Team is focused on the University of Michigan's energy supply, including electricity generation and purchasing, steam generation, and transportation fuels. Issues related to reducing energy demand and efficiency of end use were explored by other assessment teams. Our scope is outlined in Figure 1.

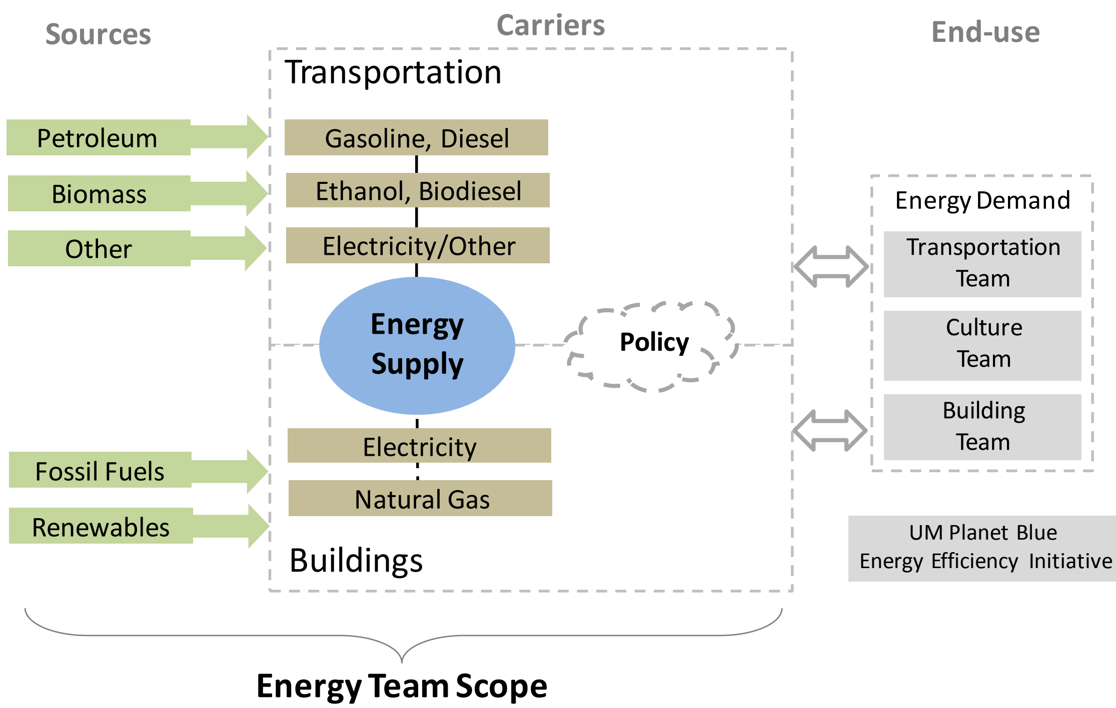

Figure 1. Energy Team Scope - Sources and Carriers of Energy Used at UM.

The Energy Team is led by Professor Greg Keoleian and Alphonse Anderson of the Center for Sustainable Systems and has six members: Mike Anderson, Jarett Diamond, Patty Liao, Claire Santoro, Dave Thoman, and Ajay Varadharajan. Additionally, Ryan Smith of the Culture Team and Brennan Madden of the Transportation Team both attended Energy Team meetings throughout Phase 1 and made valuable contributions. Energy is a large domain to analyze; each team member focused on one or two of the following areas:

- Geothermal Heating and Cooling
- Solar Thermal Water Heating
- Biomass Electricity
- Wind Electricity
- Solar Photovoltaic Electricity
- Transportation Fuels
- Energy Policy and Economics

The Energy Team investigated the fossil fuel and greenhouse gas reduction actions taken at relevant universities and institutions. University of Michigan energy use trends were also reviewed. As a result of this review, a set of prioritized recommendations were developed for UM and our team to pursue during Phase III of this project.

3.0 STATUS AND TRENDS

3.1 Energy Trends

In the U.S. in 2008, 84% of energy consumption was met by fossil fuel combustion and 86% of greenhouse gas emissions were energy related[1]. Currently, as shown in Figure 2, only 7% of the U.S. energy supply is derived from renewables. If the nation's carbon footprint is to be improved, reducing the carbon intensity of the energy supply must be a top priority.

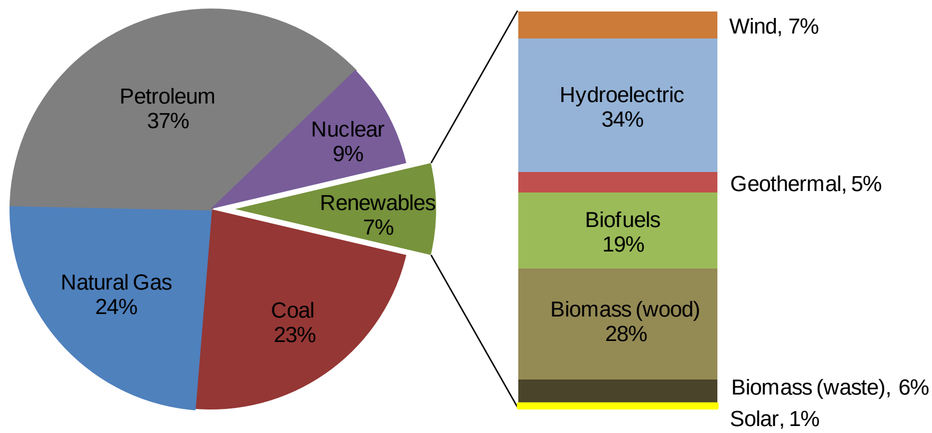

Figure 2. United States energy consumption by source, 2008.[2]

This section focuses on renewable energy use at UM, benchmark universities, and institutions.

3.2 Renewable Electricity

3.2.1 Wind Energy: Trends and Development

In recent years, wind development in the U.S. has increased dramatically, from 2,472 MW in 1999 to 34,863 MW in nameplate capacity by the end of 2009. The Wind Powering America initiative set a national goal for wind power to provide 5% of the U.S.'s energy by 2020.[3] Current installed wind capacity accounts for about 1% of U.S. electricity consumption, on average, which means that wind installations need to increase by a factor of five within a decade[4,[1]]. To achieve this growth, federal tax credits as well as state-level renewable portfolio standards (RPSs) and tax credits have been created to encourage wind farm development.

The State of Michigan currently has 138 MW of wind capacity installed,[5] accounting for less than 0.4% of the national total. However, Michigan has a great deal of untapped wind potential, with 321,936 MW of off-shore potential in the Great Lakes and 16,500 MW on-shore potential[6]. The Center for Sustainable Systems and the Michigan Memorial Phoenix Energy Institute will join Grand Valley State University in a recently funded joint research project that will further analyze Michigan's off-shore wind potential[7]. In keeping with the national goal of

[1] Calculations: 106.5 quads energy generated in 2008 (data from EIA) = 31.2 billion MWh energy generated => divide by 8760 hours in a year => 3.56 million MW average power => 34,863 MW is 0.98% of average power

meeting 5% of the U.S.'s energy with wind power by 2020, the Energy Office of Michigan recommends a statewide goal of 800 MW of installed wind power by 2010 in conjunction with a RPS[8]. Michigan exempts all property devoted to renewable energy development from personal property tax, and recently implemented their first RPS, which mandates that 10% of the state's energy come from renewable sources and that an additional 5.5% of the state's energy needs are met through energy efficiency measures by 2015[9].

3.2.2 Wind Energy: Benchmarking

Almost a hundred other institutions of higher education have wind capacity either installed on campus or purchased through renewable energy credits (RECs) or local utilities. A detailed list is given in the Appendix. Most universities purchase their wind energy through RECs, often regionally. Many universities only have demonstration wind projects on-campus, while others own turbines as large as 1.65MW nameplate capacity[10,11]. For the purposes of this report, university wind energy utilization is categorized as on-site, off-site, and purchased. Some comparable installations are listed in the following table (all purchase their wind power):

Table 1. Wind capacity of benchmark universities.

School	Wind Capacity (MW)
University of Oklahoma	101 (nameplate)
University of Pennsylvania	22
New York University	13.5
University of Phoenix	5.4
Texas A&M University	4.9
Northwestern University	4.6
University of Utah	4.4
Pennsylvania State University	3.9
University of Michigan	? (recent REC acquisition)

Of these schools, the University of Pennsylvania purchases the largest amount of wind electricity. They have a 10-year contract (began in 2003) to annually purchase 40 million kWh from Pennsylvania wind farms through RECs, which meets 10% of the campus's electricity needs[12]. Additionally, in 2008 they increased their annual REC purchase to 193 million kWh of wind energy. Other notable wind energy purchasers include: Northwestern University with 40 million kWh in RECs from Midwestern wind farms;[13] Pennsylvania State University with 17.6 million kWh purchased from Pennsylvania wind farms and 16.5 million kWh from out-of-state;[14] and Oregon State, with 26 million kWh of wind consumed annually to meet approximately 30% of their energy needs[15].

3.2.3 Wind Energy at the University of Michigan

The University of Michigan is taking an important step with its DTE Energy partnership to buy wind power RECs from two turbines in northern Michigan, equivalent to about 2% of the Ann Arbor campus's annual electricity consumption.[16] These two turbines also serve as tangible

examples of renewable energy assets that can be used to increase awareness of the benefits of green energy among students and faculty.

3.2.4 Solar Photovoltaics: Trends and Development

Solar resources are widely available across the United States. On average, one square meter receives about 6 kWh of solar insolation per day. At this level of insolation and assuming 15% efficiency of photovoltaic (PV) panels, 20,000 square miles – or 0.4% of total land area – could provide the same amount of energy consumed by Americans each day[17]. In Detroit, Michigan, annual average solar insolation levels are 4.28 kWh/m^2/day for a south-facing solar panel tilted at 42 degrees[18]. (Ann Arbor can be assumed to have similar insolation levels.) Nevertheless, solar photovoltaics have the potential to contribute to the state of Michigan's RPS. Ann Arbor specifically has established a goal of using 30% renewable energy for municipal operations by 2010 and 20% renewable energy for the entire community by 2015[19]. Although statistics from early 2010 show Ann Arbor only producing 20% of its electricity through renewable energy,[20] the US Department of Energy named Ann Arbor one of 25 Solar America Cities in 2007-08 for its efforts, which included a $200,000 award in federal funding[21]. With the addition of a 33 kW rooftop photovoltaic system to the Samuel T. Dana building in 2005, the University of Michigan is helping lead the way toward more photovoltaic installations.

3.2.5 Solar Photovoltaics: Benchmarking

The University of Michigan is not alone in utilizing solar resources. Of the 332 colleges and universities included in the annual College Sustainability Report Card, 94 (or 28%) had installed photovoltaic panels[22]. Among schools with similar levels of solar radiation to the University of Michigan, the majority of these installations have peak capacity of <25 kW. The leader among schools in this insolation range is Yale University, with 160kW installed across its campus. Yale is followed by SUNY Buffalo with 73.5kW, Harvard University with 58kW, Michigan State University with 40kW, and finally the University of Michigan with 35kW.

Typical uses for these systems include demonstration or research, and providing electricity to campus buildings and dormitories. None of the universities we investigated were found to meet more than 1% of their electricity demand through on-site PV generation. Interestingly, SUNY Buffalo also partnered with its local utility, the New York Power Authority, to rent a portion of university land for installation of a 1.1 MW system that will provide electricity for about 735 apartment buildings housing 2000 students. Table 2 shows the photovoltaic capacity of several other universities in similar solar insolation ranges.

Table 2. Select university photovoltaic installations, by capacity.

School	PV Capacity (kW)
Yale University	160
SUNY Buffalo	73.5
Harvard University	58
Michigan State University	40
University of Michigan	35
All other universities	< 25 each

3.2.6 Solar Photovoltaics at the University of Michigan

A solar PV system is currently installed on the Samuel T. Dana building roof at the University of Michigan. This array was installed in 2005 in conjunction with LEED (Leadership in Energy and Environmental Design) renovation. The array, which provides a maximum of 33 kW power, meets less than 1% of the university's electricity demand and less than 23% of the building's electricity demand during peak production hours[23]. Three types of panels were installed on the Dana rooftop as a demonstration project for alternative technologies and as a research model for comparing panel performance[24]. These panels include 88 KC120 multicrystalline modules manufactured by Kyocera, and two types of thin-film laminates -- 132 PVL136 and 75 PVL62 panels, both manufactured by UniSolar. These panels contribute 32%, 54%, and 14%, respectively, of total power output.

Figure 3. PV array on Dana Building[25]

3.2.7 Biomass Electricity: Trends and Development

Biomass energy sources, not including biofuels such as ethanol and biodiesel, provide 2.5% of total U.S. energy consumption[26]. Total U.S. consumption of biomass[2] derived renewable energy has increased by around 60% over the past two decades[27]. There was a 332 MW increase in capacity primarily using wood and derived fuels from 2006 to 2007[28]. Currently, biomass and wind are the two largest contributors to Michigan's renewable energy production. Biomass resource availability makes electricity production from this source a viable potential contributor to Michigan's RPS (10% renewable for all utilities). The extension of Production Tax Credits (PTC) for biomass to 2013 under the American Recovery and Reinvestment Act of 2009[29] could support this development. Closed-loop biomass facilities are eligible for 2.1 ¢/kWh PTC and open-loop biomass and municipal solid waste facilities are eligible for a 1 ¢/kWh PTC, which is available for ten years from the date the facility is placed in service. In a closed-loop system biomass is grown exclusively as a fuel source while open-loop systems utilize byproducts and other resources, as available. The Act also creates a new 30% investment credit and a 50% "depreciation bonus" for capital expenditures on new equipment placed in service in 2009[30].

3.2.8 Biomass Electricity: Benchmarking

There are several examples of organizations using biomass to generate a portion of their electricity needs. A Maryland Department of Corrections facility has cut its fuel costs by 63% by producing its own power using a wood-chip-fired cogeneration plant. Their boilers consume 50,000 tons of green wood chips a year to power two 1.9 MW turbines. Central Michigan University has retrofitted its natural-gas fired systems with a wood-fired energy system that uses a 1 MW steam turbine and wood chips from local sources, allowing savings in excess of $1

[2] Includes municipal solid waste biogenic, landfill gases, agriculture byproducts/crops, sludge waste, and other biomass solids, liquids and gases. Includes municipal solid waste nonbiogenic and tires for 1989-2000

million per year, and offering benefits to the state economy via wood harvesting and processing operations. Wood fired heating systems have been installed in as many as 25 Vermont schools. The systems use around 8,000 tons of wood chips a year to reduce fuel bills by more than 50%[31]. Traverse City Light & Power utility is planning to install 4 new biomass power plants (fueled by forest residues, farm residues and switchgrass) to produce about 20 MW of power to meet its goals of providing 30% of its energy from renewables. Also in northern MI, Decker International's 37 MW Grayling Station has been using wood chips and residues, all collected within a 50 mile radius, since 1992[32]. Other significant university biomass energy benchmarks include Middlebury College, which produces 10% of its demands by on-site wood chip biomass combustion[33] as well as the University of Vermont, Ohio State and Penn State, which satisfy 42%, 20% and 20%, respectively, of renewable energy consumption by purchasing biomass electricity from utilities. Biomass electricity is not currently produced on-site at UM.

3.3 Renewable Heating and Cooling

3.3.1 Geothermal: Trends and Development

Many educational institutions throughout the United States have implemented, or are in the process of implementing geothermal heat pumps (GHPs) for heating and cooling. From small-scale single building climate control systems to district-scale systems that service an entire campus, geothermal heating and cooling is both eco-efficient and cost-effective for a variety of scales and configurations. Although it still represents a small fraction of the US energy portfolio, the use of energy from GHPs in US has increased by nearly a factor of six between 1990 and 2007, from 0.0054 to 0.0317 quadrillion Btu. This represents 0.031% of the total energy consumed in the U.S. in 2007, and 0.47% of all renewable energy consumed the same year. All geothermal power systems combined, including utility direct use and electricity generation, supplied 5% of the renewable energy consumed in the US in 2007[34].

GHP systems take advantage of the relatively constant and moderate temperature of the ground below the frost line. In the winter the below-ground temperature is warmer than that of the surface, and vice-versa in the summer. Heat exchange with the surface is facilitated by circulating a fluid through underground pipes. Overall, about 70% of the energy used for heating and cooling is drawn from the renewable ground source, making geothermal heat pumps inexpensive to operate and reducing their energy consumption. Moreover, they require significantly less maintenance and monitoring than comparable furnace or boiler systems, and are not subject to the same fuel price fluctuations that affect natural gas boilers.

The two primary types of geothermal heating and cooling systems are open loop and closed loop. Open loop systems draw groundwater directly into a building for heating or cooling, and closed loop systems circulate water or a mix of water and refrigerant through a self-contained series of buried pipes. Examples of closed loop systems, which are more common than open loop systems, are shown in Figure 4. In a vertical loop system, plastic pipes are buried 100-400 feet deep into the earth. A horizontal loop system only requires 4-6 foot deep trenches to lay the pipes, but require more

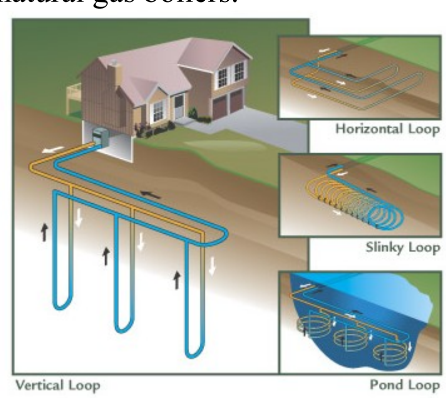

Figure 4. Geothermal ground loop configurations.
Image courtesy Grand Valley State University

area. The slinky loop is a type of horizontal configuration which uses additional piping to maximize the surface area for heat exchange. One other configuration, which can be either open or closed loop, uses a pond or lake as the thermal source or sink. As a rule of thumb, the body of water used in this system must be at least ½ acre in area and about 8 feet deep. The local geography and amount of space available for a geothermal loop are key factors in determining the optimal configuration for a given system[35].

3.3.2 Geothermal: Benchmarking

Many universities, including Harvard, Georgia Tech, UNC Chapel Hill, and Yale have installed geothermal heat pumps to provide heating and cooling to a single building. Nearby Skyline High School in Ann Arbor, MI has one of the largest horizontal loop systems in North America, with 80 miles of pipe providing service to a single 382,000 square foot building.

Ball State University began a $75 million vertical closed loop geothermal project in 2009. The system will replace aging coal-fired boilers and chilled water cooling towers, while taking advantage of much of the campus' existing district-chilled water distribution infrastructure. It will serve 45 buildings covering 660 acres, require 4100 boreholes, and take 5-10 years to construct and integrate into existing infrastructure. It is projected to save about $2 million per year in energy costs. After the project is completed, the University will look into installing on-site solar PV panels and purchasing green power from the grid to supply electricity needed to run the system[36,37].

Cornell University's $55-60 million Lake Source Cooling system has been in operation since 2000, and supplies 18,000-20,000 tons of cooling (no heat) to campus buildings. An open loop draws cold water from the lake up to exchange heat with a closed chilled water loop, which is routed throughout the campus. The water in the open loop is returned to the lake over a large area in order to avoid local heating of the lake.[38] The system uses 86% less electricity, operating on an average of 0.1 kW/ton of cooling (1 ton of cooling = 12,000 Btu/h). It saves 25 million kWh each year, and allowed 40,000 pounds of CFC refrigerants to be phased out[39].

3.3.3 Solar Thermal: Trends and Development

U.S. imports of solar thermal collectors in 2008 increased by 1.5 times the 1999 value[40]. Solar hot water installations have boomed since the increase in the federal investment tax credit in 2006. In the continental 48 states, installations have quadrupled since 2005[41]. Solar thermal capacity has increased by 22%, with a majority of this due to the installation of the Nevada Solar One plant in Boulder City[42]. The U.S. Energy Policy Act implemented a 30% tax credit for consumers who install solar water heating systems. Michigan has a variety of policy incentives in the form of grants, rebates and tax incentives.

3.3.4 Solar Thermal: Benchmarking

Nationally, some of the university leaders in solar thermal are: Harvard[43], Yale[44], Stanford[45] and the University of North Carolina - Chapel Hill[46]. These universities have installed solar water heaters to supplement the hot water demands of residence halls and campus buildings, with some meeting 50% or more of the building's needs. Harvard's solar thermal system provides 500 gallons of hot water each weekday, with an estimated payback period of 13 years due to electricity savings[47]. The newest building of Yale's School of Forestry &

Environmental Studies, Kroon Hall, has incorporated 4 evacuated solar hot water tubes into the building façade to provide domestic hot water. The Phoenix Federal Correctional Institution is one of the forerunners in utilizing this technology, producing 70% of its hot water needs using solar thermal technology. In 2010 Guilford College installed of the nation's largest solar thermal energy system, producing 9,000 gallons of hot water per day[48]. Other universities, such as Governor's State University in Illinois, have solar thermal water systems in place to heat swimming pools.

3.3.5 Solar Thermal at the University of Michigan

The University of Michigan's central power plant currently has a concentrated solar collector installed on the roof, configured to augment the heating of domestic hot water distributed to central campus. The collector consists of a solar array of parabolic trough reflectors that concentrates the sun's energy onto a modular absorber[49]. The collector tracks the sun to improve solar energy capture. The system has cumulatively collected 42,000 kWh since its installation, produces a peak output of 146,000 Btu/hr, and has an annual output of 250,000,000 Btu[50].

3.4 Transportation Fuels

3.4.1 Transportation Fuels: Trends and Development

The U.S. now produces greater than 50% of the world's ethanol; combined with Brazil, the two countries produce nearly 90% of the global supply[51]. In 2008 in the U.S., 3% of total transportation energy was provided by biofuels[52]. Recent federal policies, such as the Renewable Fuels Standard (discussed in the policy section), have established mandates for national biofuel production, and drives the increased production. At the state level, Michigan consumes approximately 3% of the nation's E85 fuel and produces about 5% of national biodiesel[53]. Based on the best available models and analysis, the ethanol produced at efficient facilities has 20% lower life cycle greenhouse gas emissions than petroleum. Advanced fuels derived from cellulosic sources and algae, when commercialized, will have 50% lower life cycle GHG emissions than petroleum[54].

President Obama issued an executive order in October 2009[55] that requires federal government agencies with fleets larger than 20 vehicles to achieve a 30% reduction in petroleum consumption by 2020. The 5,600 least fuel efficient vehicles will be replaced with hybrid electric vehicles (HEVs) during this period and approximately 100 plug-in hybrid electric vehicles (PHEVs) will be purchased in 2011[56]. Consumer purchases of HEVs have also risen over the last five years. From 2005-2009, 1.4 million hybrid electric vehicles were sold in the U.S., with the most popular being the Toyota Prius[57].

3.4.2 Transportation Fuels: Benchmarking

Biodiesel is becoming common in university fleets, and there are several interesting benchmarks to consider. For schools in the Big Ten among the most similar to UM in terms of size and climate, both Ohio State[58] and Wisconsin[59] use B20 fuel in their bus system; both schools had 124 B20 buses in 2008. Iowa and Purdue are now using B10 in their buses; Iowa has 80 B10 buses[60] and Purdue has nine[61]. Iowa also plans to begin using B20 in their buses in

2011[62]. For reference, UM has the largest fleet in the Big Ten (1119 total vehicles), of which 96 buses and trucks use B20 fuel. Table 3 shows a comparison of Big Ten vehicle fleets.

Table 3. Vehicle benchmarks, select Big Ten Universities[63]

School	Fleet Size	Biodiesel Vehicles	E85 Vehicles	Hybrid Vehicles	Electric Vehicles
University of Michigan	1119	96 (B20)	501	14	-
Ohio State University	996	124 (B20)	-	13	12
Michigan State University	406	-	100	21	5
University of Iowa	740	80 (B10)	274	20	8
University of Wisconsin	648	124 (B20)	226	28	19

A small number of universities have begun to operate their buses on B100 fuel as well. The University of California, Irvine runs all ten of its shuttle buses on B100 biodiesel[64]. The University of Colorado, Boulder[65] and the University of South Florida[66] also ran pilot B100 programs. CU Boulder has returned to B20 fuel, and USF has settled on B50 for the moment.

Several universities have also started to produce their own biodiesel from vegetable oil recycled from university cafeterias. Often, the waste oil is collected and processed by a private company, and then resold, either to the university or on the open market. The University of Vermont[67] and Bucknell University[68] both use the latter approach, while Carleton University[69] uses the former approach and powers its landscaping vehicles with the vegetable biodiesel. Some schools also process the vegetable oil (using transesterification) on site; examples include the University of Kansas[70] and Illinois[71]. Processing vegetable oil on campus circumvents the nascent biofuels market, while offering a reliable, affordable, and sustainable source of biodiesel for the university.

Hybrid-electric vehicles (HEVs) are another popular option. Geographically, the closest benchmark is the city of Ann Arbor, which operates 27 HEVs and 51 conventional diesel buses[72]. These HEVs yield a 32% improvement in fuel economy over conventional diesel buses[73]. Several Big Ten schools have added a handful of compact HEVs to their fleets, but none have implemented HEV buses yet[74]. Generally, HEVs seem more popular among municipal transit authorities rather than university fleets. In the long-term, an environmentally more attractive version will be the plug-in hybrid-electric vehicle (PHEV), although the technology is not yet fully mature, followed by the fully electric vehicle. Currently a few dozen PHEVs are in use as school buses in districts around the country[75].

3.4.3 Transportation Fuels at the University of Michigan

The University of Michigan consumes significant amounts of ethanol and biodiesel fuels. There are currently 501 E85 fueled vehicles, 61 B20 buses, and 35 biodiesel trucks. Since 2004 the university's total transportation energy has increased 9%, while the fraction of this energy derived from renewable sources has remained relatively steady, between 18% and 20%. In 2009, the UM fleet and buses consumed 140,000 gallons of E85 fuel, 370,000 gallons of B20 biodiesel, and 360,000 gallons of unleaded gasoline[76]. UM also owns 14 hybrid electric vehicles. Transportation vehicles (buses and fleet vehicles) account for less than 2% of the university's total reported energy consumption and 1-3% of greenhouse gas (GHG) emissions[77].

4.0 CHALLENGES AND OPPORTUNITIES

Each of the following technologies offers a means of reducing UM's fossil fuel consumption and greenhouse gas emissions. If implemented, they would offset electricity purchased from the local utility (currently DTE), natural gas consumed at the central campus power plant to produce electricity and steam through co-generation, or gasoline and diesel. The magnitude of savings achievable through each technology must be determined through further analysis of their costs and performance potential.

As shown in Figure 5, a majority of the currently reported greenhouse gas emissions at UM are from stationary power sources (i.e. electricity and steam production). Although GHGs from mobil tunities for improveme

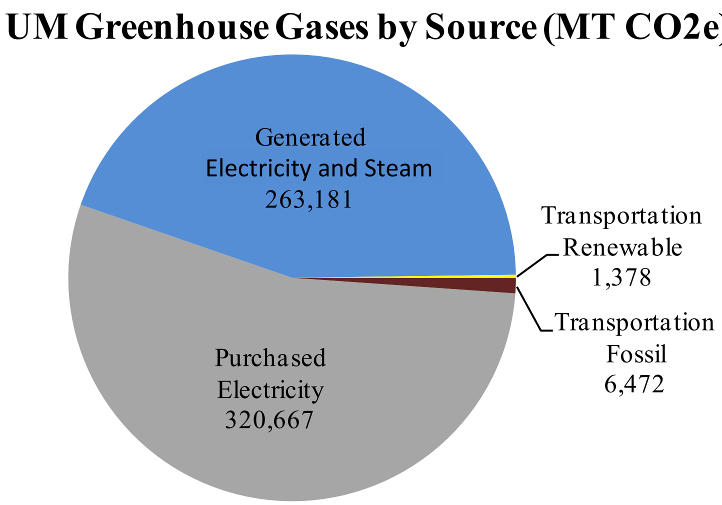

Figure 5. UM reported GHG emissions by source, 2009 (metric tons CO_2-equivalence).

Table 4 shows how UM ranked among academic peers in 2009.

Table 4. Greenhouse gas emissions of peer universities[78,79,80, 81].

School	GHG Emissions (MT CO2e)	GHG Emissions / Capita (MT CO2e)
University of Michigan	591,698	7.5
University of Minnesota	642,735	12.6
Duke University	425,960	32.8
Yale University	242,500	21.32
University of California - Berkley	209,989	6.1

4.0.1 Greenhouse Gas Reduction Goals

The University has already begun documenting greenhouse gas emissions, which will support Integrated Assessment goal setting process by serving as a point of reference. However, developing a more detailed report of emission levels per building or activity would support behavior-targeted change. Additionally, the sustainability report should be expanded to include upstream processes such as commuting to campus, life cycle greenhouse gas emissions for biofuels (in accordance with federal policy trends), and other emission sources such as grounds keeping equipment. This issue is discussed in greater detail in the recommendations section.

University emissions reduction plans should focus on developing a low carbon energy supply combined with energy conservation and efficiency strategies to reduce gross energy demand and energy demand per person. UM OSEH has reported an almost 10% reduction in Btu consumption per person from FY2004-FY2009, as well as an 8.7% reduction in CO_2 emissions per square foot. Table 5 shows the GHG reduction targets put forth by other universities.

Table 5. Select university GHG reduction goals.

School	Sustainability Goal
University of Michigan	None… yet!
Arizona State University	Committed to achieving carbon neutrality, including Scope 2 emissions by 2025 and Scope 3 by 2035.
University of California - Berkley	Committed to reducing greenhouse gas emissions to 1990 levels by 2014.
California Institute of Technology	Pledged to reduce carbon emissions to 1990 levels by 2020.
Columbia University	Committed to reducing carbon emissions to 30% below 2005 levels by 2017.
Pennsylvania State University	Ahead of schedule on commitment to reduce emissions 17.5% below 2006 levels by 2012. Currently sources 20.5 % of energy from renewables.
New York University	Has committed to reducing its emissions 30% by 2017
University of California - Los Angeles	Committed to reducing campus emissions to year 1990 levels by 2020.

4.1 Renewable Electricity

4.1.1 Wind Energy

Although the wind potential is not ideal in Ann Arbor, the University of Michigan has the opportunity to take an early role in partnering with regional utilities and wind companies to develop the nearly 350 GW of wind potential in other parts of Michigan. Purchasing RECs from DTE is an important first step. Opportunities include building community wind collaborations, finding a partner to develop a Center of Energy Excellence wind laboratory, or investing in a wind farm owned by the university.

Another option for the university is to invest in a wind farm. Estimates for costs range from \$1.2-2.6 million per MW of installed nameplate capacity[82]. University ownership offers the benefits of community leadership and positive public relations, in addition to environmental and economic benefits to local communities[83,84,85]. The state and a consortium of universities, including the University of Michigan, are actively exploring development of Michigan's offshore wind potential[86,87].

4.1.2 Solar Photovoltaics

Future opportunities for use of solar energy at the University of Michigan are abundant. There is approximately 4 million square feet of general fund building rooftop area on the Ann Arbor campus[88]. As a rough estimate, assuming that one-third of this area were utilized by rooftop PV systems that are 7% efficient, 143 million kWh of electricity could be produced annually. If it were assumed that PVs covered 75% of this area and were 10% efficient, 460 million kWh could be produced annually. For comparison, current energy usage across campus is 1.9 billion kWh. By selecting optimal campus locations for solar photovoltaics, the University of Michigan could significantly reduce fossil fuel consumption.

One such optimal site is the roof of the newly renovated Big House stadium. With at least 50,000 square feet of roof space, the stadium could potentially produce more than 700,000 kWh per year. This estimate is based on a 2009 engineering Master's degree project by a group of UM Society of Women Engineers students[89], who analyzed the still-under-renovation stadium. Building on this effort, further analysis should be conducted to refine the technical and cost assumptions. Preliminary estimates put this project on the order of $3 million installed costs. We suggest exploring supplemental financing options, once the cost estimate has been refined, such as contributions from former athletes. Although the first estimate of electricity production from this project is less than 0.2% of the fiscal year 2009 purchased electricity, it would be equivalent to 13% of the electricity purchased from renewable sources in that same year – a significant step forward. Additionally, the Solar Stadium project would be a highly visible symbol of UM's leadership, to the community as well as a much broader audience during nationally televised football games.

The University of Michigan should also consider Power Purchase Agreement options with DTE. Many such partnerships have been developed at universities, including SUNY Buffalo and the New York Power Authority, in which the university rents land or rooftop area to the utility for solar PV installations. One benefit of this arrangement is that upfront PV system costs are avoided.

4.1.3 Biomass Electricity

The University should explore integration of biomass fuel into the natural gas central power plant. Doing so would involve evaluating power plant equipment purchase needs and fuel supply options. To begin with, Washtenaw County in Michigan alone produces 25-50 thousand dry tons of Municipal Solid Waste (MSW) a year[90]. MSW combustion is becoming more popular in Europe, but should be carefully considered in the scope of UM's master sustainability plan.

There is a possibility of co-firing wood chips along with natural gas at the central power plant. For example, Central Michigan University retrofitted a natural gas power plant in 1984 and the project paid for itself in 4 years[91]. At UM this would likely require retrofitting of current boilers, addition of steam turbines and finding local sources of biomass fuel. According to the Michigan Biomass Inventory[92], which is a Michigan Department of Energy, Labor, and Economic Growth modeling tool, significant local biomass sources are available in the Ann Arbor area. The local biomass market and the potential for direct purchasing of industry biomass byproducts should also be assessed. For example, the University of Iowa purchases oat hulls directly from Quaker Oats as a fuel source for their power plant[93].

One benefit of using biomass as a fuel source at the central power plant is that it would reduce greenhouse gas emissions, proportional to the amount of natural gas that is displaced. The GHGs released when the biomass is burned are assumed to be recently pulled from the atmosphere, compared to a fossil fuel such as natural gas that was sequestering "old" carbon underground. On net, biomass combustion releases very little or zero new carbon to the atmosphere (when upstream emissions such as transportation and harvesting are not considered), conceptually and in accordance with standard GHG accounting methods (see Figure 6). In the UM Environmental Data Repository, the fraction of electricity generated from biomass could be accounted for just as the renewable fraction of transportation fuels are recorded. To determine the GHG savings potential of biomass fuel use at the central power plant, the availability of resources and costs should be analyzed during Phase III of the Integrated Assessment.

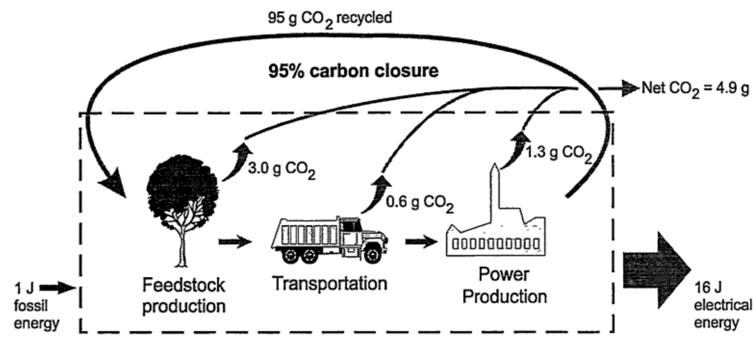

Figure 6. Life cycle greenhouse gases of biomass derived electricity[94].

4.2 Renewable Heating and Cooling

4.2.1 Geothermal

The opportunities for using geothermal heat pumps for building heating and cooling at UM are numerous. The 2008 updated North Campus Master Plan shows substantial building and infrastructure construction projects in the near future[95]. This will necessitate an expansion of existing environmental systems, for which geothermal district heating and cooling is well-suited. The Matthaei Botanical Gardens, as well as the recently-acquired Pfizer properties, with their large expanses of open fields, should also be evaluated. Central Campus may be the most challenging site for geothermal, given the lack of large contiguous areas for borehole fields.

Geothermal systems offer stability unavailable with natural gas or heating oil suppliers, and university planners have acknowledged the financial risk from unstable natural gas prices. "After many years of slow and predictable movements in these prices, we seem to have entered an era where prices can fluctuate rapidly with no historical basis… Escalating and fluctuating energy prices present challenges but also offer opportunities for managing University energy costs. The Energy Economics Master Plan Committee will address those challenges and pursue opportunities for reducing overall utility costs[96]."

Geothermal heat pumps also have the advantage of lower operating costs. A central boiler requires constant monitoring by a team of skilled technicians. The IHM Motherhouse, a residence for retired nuns in Monroe, MI, uses a geothermal heat pump system which requires very little oversight. Previously, a team of trained technicians operated the original heating and cooling plant. Today, their highly automated GHP system is occasionally adjusted by a single nun with a laptop[97].

In order to determine if geothermal heat pumps are feasible for UM, a number of related questions must be addressed. There are three conditions which would enable geothermal heating and cooling to be utilized at UM:

1. The borehole field or lake source loop can be properly sized to meet the heating and cooling requirements of the building or buildings it services.
2. Funding or financing is available to cover the upfront cost of the system.
3. The ROI of the system is acceptable.

The following criteria, if met, will increase the feasibility of using geothermal heating and cooling at UM. 1) Many building furnaces, boilers, chillers, and (in certain cases) air handlers currently in operation are soon due to be replaced anyway.[3] 2) Existing district heating and cooling infrastructure can be utilized with little or no alteration (for district scale geothermal). 3) A borehole field can be drilled in conjunction with construction or renovation work already planned, eliminating the need to tear up new surfaces. 4) For district systems, conditions 1-3 are true for a series of buildings concentrated in the same general area on campus, thus reducing the electricity used for pumping fluid to distant parts of campus. 5) The energy cost savings, operation and maintenance cost savings, and projected future savings of system integration (in the case of district geothermal) should provide sufficient incentive, and warrants further investigation.

In order to evaluate the potential for geothermal systems on UM's North Campus, a model could be developed to find the optimal solution space for various scenarios. Unfortunately, the most recently published Energy Master Planning Report, which could provide much of the needed information, dates to 2007. According to this document, the MSRB chillers (representing 3500 tons of capacity), as well as the chillers in Chemistry, Kraus and Mason (representing 5500 tons of capacity) are scheduled for replacement in 2018. Also, a plan was in place to expand the MLB chiller plant in 2009[96]. Our team currently lacks data on the outcome or current planning related to this project. More information is needed to proceed in this evaluation.

The life-cycle cost of geothermal heating and cooling systems depend entirely on the type of field (open/closed/horizontal/vertical), the number and depth of the boreholes, the capacity of the heat pump, offset fuel and operations costs, recovered building space (due to lower equipment requirements), existing building air handler compatibility, pre-existing distribution infrastructure and other factors. It is not possible to project a return-on-investment for a generalized geothermal system at UM. A more narrow scope must be defined. Fortunately, the student assigned from the IA team to study this issue is continuing his analysis this summer, working directly with Plant Operations in order to assess the feasibility of implementing a geothermal district heating and cooling package for North Campus. Similar studies should be considered for other UM properties. It should be emphasized that, as previously discussed, other universities have shown such systems, at a range of scales and in various configurations, to be cost-effective. There is no reason to believe that UM cannot realize the same benefits.

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[3] Buildings which use circulated steam for heat will require new air handlers, and possibly other equipment, in order to use geothermal heating. It may be possible to use the geothermal loop for cooling purposes only without replacing the air handler.

4.2.2 Solar Thermal Water

One opportunity for solar thermal water heating that has been identified is the campus swimming pools. The north campus recreation building's 180,000 gallon swimming pool is currently being heated by natural gas. The pool is heated by a continuous water circulation system. While moving through this loop, water is filtered then either heated or cooled as needed. Integration of a solar thermal system should be explored. Solar pool heating systems typically operate at a slightly warmer temperature than the surrounding air and normally use unglazed, low temperature collectors made from polymers. Solar heaters can stand alone or work in conjunction with an existing fossil fuel heater to make a "hybrid" system. Most solar pool heating systems include the following:

- Solar collector - the device through which pool water is circulated to be heated by the sun – which has to be installed. Typically the collector size is 50-100% of the pools area, depending on the amount of annual solar insolation and annual usage. Since our swimming pool is used throughout the year, it is expected that we would need collectors to cover an area equal to 100% of our 25 yard, 6 lane pool area.
- Filter - removes debris before water is pumped through the collector – which is already available in the current system.
- Pump - circulates water through the filter and collector and back to the pool – which also already exists in our current system.
- Flow control valve - automatic or manual device that diverts pool water through the solar collector. When the temperatures get too hot, this valve diverts the pool water away from the collector to prevent further heating.

Solar thermal water heating systems should be a viable option for UM as a hot water source for dormitories, kitchens, and recreation centers (pools and showers). Their implementation would reduce UM's natural gas needs. The savings potential of these systems is difficult to estimate at this time. For example, the north campus recreation center pool heating system's natural gas consumption is not metered separately from the rest of the building. Just as with the geothermal systems plan described above, their integration will require further analysis.

4.3 Transportation Fuels

4.3.1 Biofuels

Increasing the biodiesel blend ratio used by the campus buses from B20 to B100, and the potential limits on achieving this, should be explored. For example, widespread adoption of B100 seems to be limited by supply and seasonal performance concerns. ASTM standard biodiesel is rated to cloud between -3 and 15 degrees Celsius (26-59 degrees Fahrenheit)[98] – a lower limit on temperature violated routinely during Ann Arbor winters. Additionally, vendors who supply UM with biodiesel only offer a 5% biodiesel formulation during the winter. The cold weather performance of biodiesel is a complicated issue and depends significantly on the biodiesel feedstock. One report shows a difference of 17 degrees Fahrenheit between the pour points of B20 biodiesels from different feedstocks[99]; the use of additives can reduce the pour pint by another ten degrees as well[100].

UM has already purchased an E85 fleet of light vehicles; all but 72 of the University's 573 non-hybrid light vehicles are E85-compatible. However, only 28% of the fuel consumed by these vehicles is E85[101]. E85 fuel offers a 5% reduction in lifecycle GHG emissions per mile, but the primary limitation is fuel cost[102].[4] While E85 costs about the same as unleaded gasoline per gallon, the fuel economy is lower, such that the total cost per mile can be higher than that of unleaded gasoline. Combined with the limited reduction in total GHG emissions, E85 should only be viewed as a short-term improvement over gasoline.

4.3.2 Electrification

In the longer-term, the feasibility of replacing UM buses with PHEV buses should be explored. The electric-only mode of PHEVs are distance-limited by their battery capacity, and the sustainability of their energy usage depends significantly on the GHG characteristics of the electricity grid used to recharge the battery. However, both of these limitations can be minimized if the PHEVs are used as buses. Buses travel fixed distances each day and so their usage and recharging can be scheduled and optimized for sustainability in a manner that would not be possible for commuter vehicles. A more quantitative analysis of PHEV buses is forthcoming but outside the scope of this report.

Mass-market 2010 HEVs can yield over \$1000/year in fuel savings over the oldest vehicles in the UM fleet (\$2070/year compared to \$3350/year)[103], and the cost savings are likely to increase as fuel prices rise.[5] Modern hybrids also emit 33% less equivalent carbon dioxide compared to older models. Plug-in hybrid electric vehicles are even more promising in terms of their ability to reduce fuel costs and GHG emissions. Calculating their GHG reduction potential, however, is non-trivial and would require more data (such as vehicle use patterns) than was available to the Energy Team during Phase I. A study currently underway at the UM Center for Sustainable Systems on PHEVs may provide insight into the savings potential by Fall 2010.

4.3.3 Waste Grease to Biodiesel

It is estimated that the dormitory cafeterias at UM produce over 10,000 gallons of waste grease each year, and when waste grease from the University Hospitals and local restaurants is included, it has been estimated that a supply of up to 50,000 gallons per year is available[104]. The University of Michigan should consider starting an on-campus waste grease to biodiesel conversion facility, as has been done at other universities. This would provide an extremely valuable learning opportunity to the students, while concurrently reducing the university's waste and increasing the renewable fuel supply. Dr. Sudhakar Reddy (redv@bf.umich.edu) of UM OSEH has stated his interest in being involved with this project, and should be included in planning and evaluation activities.

4.3.4 Other On-site Emission Sources

Based on a fuel usage inventory, whose completeness is unknown, UM grounds keeping equipment used at least 15,000 gallons of diesel in 2009 (at a cost of \$30000/year)[105]. The emissions produced by on-site grounds keeping equipment, such as lawnmowers and construction equipment, should be inventoried (just as the UM buses and fleet inventory). This

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[4] Assumptions from GREET Model v. 2.7 using Light-Duty Trucks, Class 2

[5] Assuming 15000 miles/year per vehicle - 70% city driving and 30% highway driving

would provide a quantitative measure of GHG reductions through reduced grounds maintenance in support of the Integrated Assessment Land & Water team's recommendations.

4.4 Policy and Economics

4.4.1 Renewable Portfolio Standards

Thirty-one states have implemented renewable portfolio standards (RPS) to incentivize renewable energy production – including Michigan's 10% renewable energy by 2015 mandate. Other states hosting Big 10 schools with RPS regulations are shown in Table 6.

Table 6. Midwestern States and Renewable Portfolio Standards.

State	Renewable Portfolio Standard
Michigan	10% renewable energy by 2015 mandate
Ohio	25% by 2025 (1/2 from energy efficiency credits)
Illinois	25% by 2025
Iowa	2015 MW by 2015 (voluntary)
Minnesota	25% by 2025
Wisconsin	10% by 2015
Pennsylvania	18% by 2020 (1/2 from energy efficiency credits)

Although the University lacks the power to dictate utility fuel portfolios, it could demonstrate its environmental leadership by developing its own campus renewable portfolio standard.

4.4.2 Renewable Fuel Standard

The Energy Policy Act of 2005 established section 211(o) of the Clean Air Act, creating the Renewable Fuel Standard (RFS) program[106]. The law prescribed volumetric production requirements for renewable fuels and GHG reduction potential of renewable fuels produced. The following table shows the 2010 renewable fuel production requirements.

Table 7. Renewable Fuel Standard, 2010 requirements[107].

Fuel Category	% of Fuel Required to be Renewable	Volume Renewable Fuel (billion gallons)
Cellulosic biofuel	0.004%	0.0065
Biomass-based diesel	1.10%	1.15
Advanced biofuel	0.61%	0.95
Renewable Fuel	8.25%	12.95

The policy mandates the production of 36 billion gallons of biofuels each year by 2022. This represents a three-fold increase over current production[108]. To ensure that this large scale-up of biofuel production is environmentally sustainable, each fuel source must meet a life cycle

GHG reduction requirement compared to a baseline of petroleum production in 2005. The requirements are shown in Table 8. The EPA estimates that as a result of the RFS, gasoline prices will increase 3¢-11¢/gallon, while diesel prices will only change by 1¢/gallon or less.

Table 8. Life cycle greenhouse gas reduction compared to 2005 petroleum baseline[109].

Fuel Category	GHG Reduction	Example Qualifying Fuels
Cellulosic biofuel	60%	Cellulosic ethanol and cellulosic diesel
Biomass-based diesel	50%	Biodiesel from soy oil, waste oils, greases, etc.
Advanced biofuel	50%	Sugarcane ethanol
Renewable Fuel	20%	Ethanol from corn starch (produced in new, efficient gas-fired plants)

At the state level, California has adopted a low-carbon fuel standard, mandating a 2020 fuel mix that is 10% less intensive than the 2010 baseline. It assumes that the average low carbon fuel will be 50% less intensive, so that a 20% fuel mix will achieve the desired reduction. In December 2009, a compact of eleven Northeastern states agreed to model a low carbon fuel standard after California's framework, to be developed by 2011. Using the EPA's standards, UM buses already meet California's 2020 fuel requirements.

4.4.3 Carbon Prices

Analysis was also conducted to determine the budgetary impacts of a carbon price on the university's operating expenses. According to the data in the EDR[110], the costs shown in Table 9 would be incurred in 2009 if a carbon tax/cap regime existed[111].

Table 9. Costs incurred to UM under various carbon tax prices.

$/Ton CO_2 Emitted	Total Costs Incurred	On-Site Emissions Charges
$5	$2,938,780	$1,485,560
$10	$5,877,560	$2,971,120
$20	$11,755,120	$5,942,240
$30	$17,632,680	$8,913,360

These impacts reflect 587,756 tons of CO_2 emitted in 2009, including stationary sources, mobile sources, and purchased electricity produced off-site. The extent to which a carbon price would be captured in higher electricity rates is unknown, although research suggests coal-dominant utilities such as DTE would experience a 0.7¢/kWh increase under a $10 tax[112].

Table 10. Individual input costs to the university under $10/ton CO_2 emission system.

Fuel Source	Lbs CO_2/unit	Cost/Unit	2009 UM Use	2009 Costs ($10/ton CO_2)
Natural Gas	12.06 lbs/ CCF	$.0603/CCF	48,189,300	$2,905,815
Gasoline	19.6 lbs/gallon	$.098/gallon	138,269	$35,513
E85	16.3 lbs/gallon	$.082/gallon	138,269	$11,247
B20	20.2 lbs /gallon	$.101/gallon	370,702	$37,367
Oil	26.0 lbs/gallon	$.112/gallon	0	0
Electricity	1.64lbs/kWh	$.082/kWh	341,949,118	$5,834,446

4.4.4 Project Funding Mechanisms

Funding new energy projects remains a challenge. Leveraging alumni support for visible projects that boost pride (such as the solar stadium or upgrades specifically for the Law School) presents one possibility. The University of California-Berkeley has undertaken a project to target prospective donors that do not donate to campus. The school offers the opportunity to support sustainability projects – an opportunity for environmentally-minded alumni not interested in supporting other departments (i.e., athletics, the general fund, etc.)[113]. University of Wisconsin-Platteville alumnus Ron Meissen established a fund strictly devoted to 'teaching and expanding sustainability throughout the university.' Funds can only be used to promote renewable energy on-campus or within the curriculum[114].

Examples from other institutions include Harvard's Green Campus Loan Fund[115]. Managed by Harvard's Office for Sustainability, the program has a $12 million revolving fund to finance up-front capital costs of efficiency projects (similar to Michigan's Energy Conservation Measures program). Funded projects must pay for themselves through reduced consumption, waste removal, or operating costs over ten years. One hundred and fifty-three projects have been approved, receiving $11.5 million in loans while accruing $4 million in savings to date. Example projects include motion sensor light fixtures, insulation, and behavior change training.

Another option is to purchase renewable systems constructed by third parties with access to tax credits. Because companies can receive tax credits for renewable energy projects (e.g., solar farms), they are provided a greater incentive than tax-exempt universities. The projects can then be sold for a lower price to universities or simply provide electricity on contract (pursuing the project was made possible because the institution has already agreed to purchase the generated electricity). Taking this idea one step further, Colorado State University entered an agreement to purchase electricity from a company leasing land on CSU's campus[116]. This symbiotic agreement will supply 10% of CSU's electricity demand.

New approaches for financing may be necessary for implementation of many of the renewable energy projects recommended in this report. Some may have long payback times but expected cost increases in conventional fossil fuels and a carbon price can improve their overall economic performance.

5.0 RECOMMENDATIONS

The Energy Team has benchmarked colleges and other institutions and found that UM lags behind with respect to energy sustainability goals and implementation. We have identified a number of key technologies and strategies to enhance UM's energy sustainability, long-term economic performance, and role as a leader in sustainability education and research.

1. Given the impact of climate change and expected carbon regulations and markets, **we recommend that the University develop a comprehensive energy and carbon reduction plan** including goals for reducing carbon emissions and expanding the renewable energy supply. The long-term targets should at a minimum align with IPCC recommendations, such as a 50-85% GHG reduction by 2050. In order to set goals that are achievable but challenging (stretch goals) and develop a strategic plan, further analysis of the integration obstacles, energy production potential, capital costs, and payback times of the technologies listed in recommendations 2-4 is required. We also believe that a strategic plan could be framed in terms of spatial and temporal variables, i.e. where and when each technology can be implemented.

2. Heating and Cooling Systems

a. Geothermal Heating and Cooling

- Create a strategic plan for integrating geothermal systems into existing and new infrastructure on campus
- Continue the technical and economic analysis currently underway, which is identifying appropriate technologies
- Estimate the GHG reduction potential of geothermal on campus as a result of the technical and cost analysis

We recommend creating a strategic plan for integrating geothermal systems into existing infrastructure and new infrastructure as the campus building footprint expands. The high up-front costs associated with geothermal technology are diminished when taken in context of extended system longevity, and reduced equipment requirements. A properly sized and configured ground-source heat pump can replace a building's chiller, steam boiler or furnace, and service hot water heater. The value of such a system can be multiplied many times over when used in a district heating or cooling environment, whereby several larger centrally-located plants replace the need for many smaller distributed systems. In some cases, the less-expensive open-loop option may be viable. The football stadium, which already actively pumps water from its low-lying footprint, deserves special attention. With respect to land availability, the University should consider that many geoexchange fields are now being built using a technology called horizontal directional drilling, which enables fields to be built underneath existing buildings, and allows for future buildings to be built on top of such fields. This method may allow the University to create a geoexchange field in even the most densely-occupied parts of campus.

Lower operations and maintenance costs, avoided capital replacement expenditures, freedom from volatile natural gas prices, reduced equipment requirements, the scalability of district heating and cooling systems, and other benefits of using a low-emissions heating and cooling system each represent a strong argument in favor of adoption of geothermal.

b. Solar Thermal Water Heating

- Partner an Energy Team member with an appropriate mentor in Utilities or OCS to facilitate analysis of technology integration and costs
- Create a strategic plan for integrating solar hot water systems into existing and new infrastructure on campus
- Estimate the GHG reduction potential of solar hot water systems according to the results of the technical and cost analysis

The solar water heating assessment is likely to be similar to that of geothermal systems. An analysis of technical integration issues, cost-effective technologies, and economic payback must be performed in coordination with relevant UM departments (i.e. Utilities). Preliminary analysis began in Phase I but more information is needed before useful conclusions can be drawn. Analysis will support a strategic plan for prioritizing when and where the solar hot water systems should be installed. At this preliminary stage, top candidates include recreation centers and residence halls.

3. Renewable Electricity

a. Solar Photovoltaics

- Revisit the 2009 student Solar PV Football Stadium Plan. Refine the engineering calculations to estimate electricity production and payback period. This would be a high visibility project.
- Explore options for partnering with DTE on other rooftop systems on campus. Compare the payback period of this option to UM direct purchasing. Utilize previous studies (not available to our team during Phase I) of prioritized UM solar PV rooftops.

The University should continue its analysis of solar development opportunities on campus buildings. This includes refining the previous analysis of putting solar photovoltaic panels and other necessary equipment on the roof of the football stadium to produce electricity. Because of the high visibility of this proposed project, it may be possible to leverage alumni assistance not available to generic solar projects.

Priority candidate campus buildings for rooftop PVs should be identified for solar construction based on radiation exposure, rooftop characteristics, and other criteria. A prioritized list should be developed from this analysis that can be made readily available in the event of a decision to build additional solar projects. Finally, options for leasing UM properties for solar panel construction should be pursued. The siting advantages offered by the University (e.g., no property taxes, potentially less restrictive zoning, engineering expertise) could make it an attractive option as DTE diversifies its electricity mix to comply with Michigan's recently enacted RPS.

b. Biomass Electricity

- Identify the best conversion technology (e.g. a specific direct-fire or gasifier system[117]) in terms of cost and efficiency for integration at the central power plant
- Identify the availability and costs of local biomass resources
- Estimate the GHG reduction potential, dependent on how much natural gas can be offset

Biomass electricity generation has the potential to significantly reduce greenhouse gas emissions. GHG accounting standards do not count stack CO_2 emissions from biomass as net GHG emissions; it's assumed that the carbon released through combustion was recently pulled from the atmosphere and does not contribute "new" carbon when re-emitted. Integrating biomass as a fuel source at the central power plant would build on the EPA recognized tradition of efficiency and environmental sustainability, and further reduce UM's greenhouse gas emissions.

c. Wind

- On-campus wind resources may not be economical. REC purchasing may be the most cost-effective way to acquire substantial wind-produced electricity. However, consider smaller-scale systems for research and student learning purposes (such as at NCRC).

Renewable Energy Credits appear to be the best option for supporting wind development in the area. Over the long-term, an evaluation of the potential for wind turbine ownership should be undertaken. The recent partnership with DTE to purchase the electricity produced by two turbines may provide an initial framework for future agreements. The potential to expand such an arrangement into a future offshore project in Michigan should also be considered.

4. Transportation Fuels

a. Biofuels

- Continue and expand biofuel use as a short-term strategy for buses and fleet vehicles
- Evaluate constraints on increasing the biofuel blend ratio (seasonally) for buses, up from the current B20 to B100
- Evaluate UM waste grease to biodiesel conversion as student-run university operation, and consider purchasing locally produced biofuels

b. Vehicle Electrification

- Consider immediate replacement of older vehicles in the truck fleet with hybrid pickup trucks. Replacing a 15 mpg truck with a 20 mpg truck will save more fuel than replacing a 34 mpg car with a 50 mpg car (if the truck and car drive the same number of miles)[118].
- Analyze costs and GHG reductions of hybrid electric vehicle fleet vehicles. This will require data on fuel consumption per vehicle
- Analyze the GHG reduction potential of electric vehicles. Use data from EVs currently being tested at UM, such as use patterns, time of charging, and charging amount
- Explore the potential for hybrid electric buses on campus
- Estimate the GHG savings potential of HEVs and EVs for fleet integration scale-up scenarios. Use data from UM Center for Sustainable Systems PHEV study if available.

Improvement strategies for the university's overall transportation fuel mix can be framed in near- and long-term actions. At this time, the most feasible method of reducing transportation fossil fuel use and greenhouse gas emissions is to increase the biodiesel blend used by campus buses and incorporate more hybrid vehicles into the UM fleet. As better technologies, such as plug-in hybrid electric and fully electric vehicles, become commercially available their incorporation into the UM fleet should be pursued. An analysis of the cost savings and greenhouse gas reductions that could be achieved by integrating these vehicles will be performed in Phase III if sufficient data is available. This analysis will support goal setting for transportation GHG reductions.

A student-run waste grease to biodiesel conversion facility should be established on-campus. This would reduce UM's current waste stream and also provide valuable learning opportunities to students. Dr. Sudhakar Reddy (redv@bf.umich.edu) of UM OSEH has stated his interest in supporting development of this project at UM and should be involved with planning and evaluation activities.

5.1 Other Recommendations

The University of Michigan Environmental Data Repository currently tracks average building energy use by area and campus population, but only on a campus-wide average basis. We believe that **a metric for building specific carbon footprints** (for each campus building in terms of area and also occupancy) could be very useful to faculty, staff, and students that work on campus. The electricity and steam consumption of each building is currently reported, and we recently received, but have not yet reviewed, greenhouse gas characterization factors for UM electricity and steam production. Using this information, building carbon footprints could be calculated. However, building occupancy levels are not currently known. We recommend exploring this metric in Phase III.

Another consideration for the Integrated Assessment project teams, collectively, is how campus sustainability should be tracked and reported. Standard greenhouse gas accounting methods, such as the GHG Protocol developed by World Resources Institute and World Business Council for Sustainable Development, provide an excellent framework[119]. In this framework, greenhouse gas emissions are categorized according to three scopes, as shown in Figure 7.

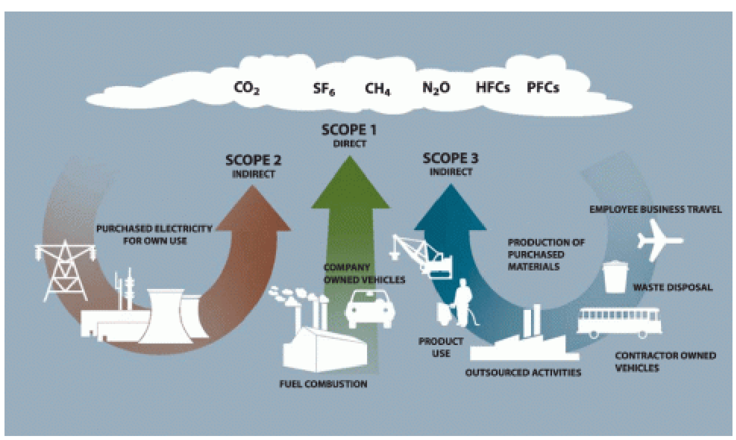

Figure 7. Scope 1, 2, and 3 greenhouse gas emissions[120].

The university currently tracks a majority of Scope 1 and 2 emissions in the Environmental Data Repository. Scope 3 emissions are not inventoried at this time, although the Integrated Assessment Purchasing & Recycling Team is exploring a full life cycle assessment of the university's operations and purchasing. Another large and missing piece of Scope 3 emissions could also be campus commuting miles. The transportation focus in this report was on fuels in university vehicles, but their GHG emissions are most likely only a small fraction of the total transportation-related GHG emissions associated with the University of Michigan. Emissions caused by faculty and staff on business-related air travel are probably comparable to the GHG emissions by the UM bus and vehicle fleet; GHG emissions from students, faculty, and staff who commute to campus every day are probably several times larger. Most universities, including UM, do not yet track off-campus emissions, but a few estimates exist. Penn State University estimates the GHG emissions from campus vehicles, air travel, and commuters are approximately in the ratio 1:1:9[121]. Illinois State University estimates a ratio of 1:4 for emissions from air travel and commuters, respectively[122].

Scope 3 emissions are important to consider because a new proposed rule for the GHG Protocol would require accounting for at least 80% of these emissions[123]. In order to meet the newly suggested GHG Protocol reporting standards, at least 80% of Scope 3 emissions would need to be reported. To comply, commuter miles would likely need to be reported. As a result, we recommend developing an inventory and accounting method for commuter miles and business-related air travel.

Once a consensus has been reached by the Integrated Assessment teams, tools such as the Clean Air-Cool Planet spreadsheet calculator[124] could facilitate standardized accounting and categorization of UM greenhouse gas emissions. However, we believe not enough information (e.g. data on carbon reduction projects or Scope 3 emissions) is available at this time to proceed on this effort.

We also believe the tremendous intellectual resources available at UM should be utilized to generate more suggestions for the Integrated Assessment project. One way to collect ideas from faculty would be to hold brainstorming sessions at the beginning or end of faculty departmental meetings.

Finally, it should be noted that the recommendations developed by the Energy Team are also applicable to other UM campuses (e.g. UM-Flint, UM-Dearborn) and properties (e.g. Camp Michigania, UM Biological Station, Saginaw Forest).

ENERGY TEAM – BIOGRAPHIES

Professor Gregory Keoleian (Faculty Lead) is a Professor in the School of Natural Resources and Environment and in the Department of Civil and Environmental Engineering and serves as co-director of the Center for Sustainable Systems. His research focuses on the development and application of life cycle models and sustainability metrics to guide the design and improvement of products and technology. He has studied automobiles, renewable energy, buildings and infrastructure, consumer products and packaging and food systems and has led over 50 life cycle projects. Greg recently helped launch the Engineering Sustainable Systems dual-Masters degree program and helped develop the UM campus sustainability reporting framework and metrics. He currently serves as President-Elect of the International Society for Industrial Ecology.

Alphonse Anderson (Co-Lead) is a Research Associate at the University of Michigan Center for Sustainable Systems (CSS). He graduated from UM with an M.S.E. Mechanical Engineering in December 2008 and has since focused on research grant proposal development, a chapter for a professional handbook on the life cycle energy and greenhouse gas emissions of biomass energy (co-authored with Professor Keoleian), and other duties at CSS. His primary interests are in developing practical solutions to sustainability challenges, especially related to energy production and GHG emissions, which use quantitative metrics to evaluate performance.

Student Team:
Mike Anderson did his undergraduate work at the University of Michigan, graduating in 2007 with Highest Honors in astronomy/astrophysics and interdisciplinary physics. He earned his Master's degree in astrophysics in 2008 from the California Institute of Technology, and is now working on his PhD in astrophysics at Michigan. Since 2010, he has also been enrolled in the Science, Technology, and Public Policy (STPP) program at Michigan. His primary policy interest is in sustainability policy, particularly energy and environmental issues.

Jarett Diamond is a Mechanical Systems Engineering graduate student at the University of Michigan. He graduated from University of California – Berkeley in 2004 and was subsequently employed with Cook Medical as a consultant of medical products. His work with the Integrated Assessment team has led to a summer internship position exploring opportunities for geothermal development at the University of Michigan.

Patty Liao is an Engineering Sustainable Systems student pursuing a dual degree in Mechanical Engineering and Natural Resources at the University of Michigan. Patty has an undergraduate degree from Williams College in Physics and Asian Studies (2009). She is interested in developing and spreading renewable energy technology.

Claire Santoro is a Master of Science student at the University of Michigan School of Natural Resources & Environment, focusing on environmental economics and energy policy. She received undergraduate degrees in economics and environmental studies from Brown University in May 2009. Previous experience includes two summers as instructor of the Brown Environmental Leadership Lab and publication of her economic analysis - the rebound effect of Energy Star appliances on residential energy consumption - in the 2009 Brown Policy Review.

Dave Thoman completed his Master of Public Policy at the University of Michigan in May 2010. He received his undergraduate degree in Political Science from Washburn University in Topeka, KS in 2008. Prior to his graduate studies, he served the Kansas State Senate for one session and served as Director of the Rotary Youth Leadership Academy. His research and studies have focused on policies to promote domestic energy conservation and renewable energy development.

Ajay Varadharajan is currently pursuing dual-Masters degrees in engineering and natural resources through the Engineering Sustainable Systems program at the University of Michigan. He holds an undergraduate degree in Mechanical Engineering from the National Institute of Technology, Trichy, India and has significant experience in renewable energy research and life cycle analysis. He has presented a paper on life cycle analysis of biodiesel at the World Renewable Energy Congress - 2008 at Glasgow, Scotland and hopes to involve himself in more research related to renewable energy and climate change.

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Transportation Team Liason: Brennan Madden

REFERENCES

[1] Environmental Protection Agency (US). Inventory of U.S. Greenhouse Gas Emissions and Sinks [Internet]. U.S. EPA # 430-R-10-006; April 2010 [cited 2010 June 10]. Available from: http://www.epa.gov/climatechange/emissions/usinventoryreport.html

[2] Energy Information Administration (US). Renewable & Alternative Fuels, Total Consumption [Internet]; July 2009 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table1.html

[3] Lawrence Technological University College of Engineering. Wind Energy Delphi Project [Internet]; 2005 [cited 2010 June 10]. Available from: http://www.ltu.edu/engineering/mechanical/delphi_wind.asp

[4] Energy Information Administration (US). Electric Power Industry 2008: Year in Review [Internet]; 21 January 2010 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html

[5] Department of Energy (US). Wind Powering America [Internet]; 5 May 2010 [cited 2010 June 10]. Available from: http://www.windpoweringamerica.gov/wind_installed_capacity.asp

[6] Department of Energy (US). Michigan's Offshore Wind Potential [Internet]; 20 September 2008 [cited 2010 June 10]. Available from: http://www.windpoweringamerica.gov/filter_detail.asp?itemid=2045

[7] Department of Energy, Labor & Economic Growth (MI). MPSC Approves over $1.6 Million in Michigan Efficiency Grants for Offshore Wind Technology Research [Internet]; 8 February 2010 [cited 2010 June 10]. Available from: http://www.mich.gov/dleg/0,1607,7-154-10573_11472-231263--,00.html

[8] Lawrence Technological University College of Engineering. Wind Energy Delphi Project [Internet]; 2005 [cited 2010 June 10]. Available from: http://www.ltu.edu/engineering/mechanical/delphi_wind.asp

[9] Southeast Michigan Council of Governments (MI). Renewable Portfolio Standard and Energy Efficiency Legislation [Internet]; April 24, 2008 [cited 2010 June 10]. Available from: http://www.semcog.org/uploadedFiles/Services/SEMCOG_University/Environment/IV%20-%20State%20Actions%20-%20RPS_Skip_Pruss.pdf

[10] Department of Energy (US). Wind Energy for Schools – Project Locations [Internet]; 6 April 2010 [cited 2010 June 10]. Available from: http://www.windpoweringamerica.gov/schools/projects.asp

[11] Association for the Advancement of Sustainability in Higher Education. Wind Power on Campus [Internet]; 2010 [cited 2010 June 10]. Available from: http://www.aashe.org/resources/wind_campus.php

[12] University of Pennsylvania. University of Pennsylvania Doubles Its Purchase Of Wind-Generated Power to 10 Percent of Energy Need [Internet]; 23 April 2003 [cited 2010 June 10]. Available from: http://www.upenn.edu/pennnews/article.php?id=210

[13] Northwestern University. Northwestern Running on 'Green' Power [Internet]; 13 April 2006 [cited 2010 June 10]. Available from: http://www.northwestern.edu/observer/issues/2006/04/13/energy.html
[14] Pennsylvania State University. Green Power. Office of Physical Plant [Internet]; 2005 [cited 2010 June 10]. Available from: http://energy.opp.psu.edu/energy-programs/procurement/green-power
[15] Oregon State University. Renewable Energy [Internet]; 2009 [cited 2010 June 10]. Available from: http://oregonstate.edu/sustainability/renewable
[16] University of Michigan. U-M, DTE Energy Announce Alternative Energy Partnership. Office of Campus Sustainability [Internet]; 24 March 2010 [cited 2010 June 10]. Available from: http://www.ur.umich.edu/update/archives/100324/umdte
[17] Department of Energy (US). How much land will PV need to supply our electricity? Energy Efficiency and Renewable Energy Office [Internet]; 2004 [cited 2010 June 10]. Available from: http://docs.google.com/viewer?a=v&q=cache:49awPsCO-DgJ:www1.eere.energy.gov/solar/pdfs/35097.pdf+How+much+land+will+PV+need+to+supply+our+electricity%3F+NRAL&hl=en&gl=us&pid=bl&srcid=ADGEESgI-kXPKmT9tJgQIJ2XY1GYo7_gflEPU4d4Hmj4IZUET6lezD1pqE5Wq1eAtcjtfmwwbSXb3wWu2mG5MmMpHDdwYEKThWP8pl6ib25uXYJCZ_qAXNfp9SoGM0l_Hb7bAv3iJmZ4&sig=AHIEtbRLXYeHN4l8ZVYDe9yYJYTYaqX52w
[18] Department of Energy (US). Performance Calculator for Grid-Connected Systems. National Renewable Electricity Laboratory [Internet]; 29 December 2009 [cited 2010 June 10]. Available from: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/
[19] City of Ann Arbor. What is the Energy Challenge? [Internet]; 2009 [cited 2010 June 10]. Available from: http://www.a2gov.org/government/publicservices/systems_planning/energy/energychallenge/Pages/WhatIsTheEnergyChallenge.aspx
[20] Environmental Protection Agency (US). Top 20 On-Site Generation [Internet]; 6 April 2010 [cited 2010 June 10]. Available from: http://www.epa.gov/grnpower/toplists/top20onsite.htm
[21] U.S. Department of Energy. Solar America Cities [Internet]; 2 June 2010. [cited 2010 June 10]. Available from: http://www.solaramericacities.energy.gov/
[22] Sustainability Endowments Institute. College Sustainability Report Card 2010 [Internet]; c2010 [cited 2010 June 10]. Available from: http://www.greenreportcard.org/
[23] Pacca, Sergio, S. Deepak, and G.A. Keoleian. 2005. Life Cycle Assessment of the Photovoltaic System in Dana Building: Thin Film Laminates, Multi-crystalline Modules and Balance of System Components. University of Michigan: Ann Arbor: 1-106.
[24] Ibid.
[25] Dzombak C. Our Energy Future: Solar. The Michigan Daily. 13 April 2009.
[26] Department of Energy (US). US Energy Consumption by Source. Energy Information Administration [Internet]; 2009 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table1.html
[27] Department of Energy (US). Historical Renewable Energy Consumption by Energy Use Sector and Energy. Energy Information Administration [Internet]; 2009 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table1_5.pdf

[28] Department of Energy (US). Renewable Energy Trends in Consumption and Electricity 2007 Edition. Energy Information Administration [Internet]; April 2010 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/rentrends.html
[29] Frederikson & Byron P.A. American Recovery and Reinvestment Act Provides Billions for Biomass [Internet]; 20 March 2009. [cited 2010 June 10]. Available from: http://www.fredlaw.com/articles/energy/energy_0903_tat_sjd2.html
[30] Ibid.
[31] Federal Energy Management Program (US). Biomass Energy – Focus on Wood Waste [Internet]; July 2004 [cited 2010 June 10]. Available from: http://docs.google.com/viewer?a=v&q=cache:V6v283Lpc2MJ:www1.eere.energy.gov/femp/pdfs/bamf_woodwaste.pdf+EERE+%E2%80%93+Federal+Energy+Management+Program,+Biomass+and+Alternative+Methane+Fuels+vermont&hl=en&gl=us&pid=bl&srcid=ADGEEShkOTeSyNcJJM_13m2T4KUW8TZdH7-mKQt_Tz2Zm1YKaluT2503CGHqkSotU1jECGm1uJYtw8toEgfY_fIBHXM-0YpRgY8M5OVVqIxqxos-8sUARenMjDsr2E4bfWHVs8bQmwjQ&sig=AHIEtbRnG5ous-Y4IHTtlc_MZcqr2fw_cw
[32] Decker Energy International. Grayling Generating Station [Internet]; [cited 2010 May 27]. Available from: http://www.deckerenergy.com/52863/53001.html
[33] College Sustainability Report Card. Middlebury College [Internet]; 23 July 2009 [cited 2010 June 13]. Available from: http://greenreportcard.org/report-card-2010/schools/middlebury-college/surveys/campus-survey
[34] Department of Energy (US). Renewable Energy Annual (2007). Energy Information Agency [Internet]; May 2009 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/rea_sum.html
[35] Energy Commission (CA). Geothermal or Ground Source Heat Pumps [Internet]; 2006 [cited 2010 June 10]. Available from: http://www.consumerenergycenter.org/home/heating_cooling/geothermal.html
[36] Ball State University. Ball State University - Going Geothermal [Internet]; 2010 [cited 2010 June 10]. Available from: http://cms.bsu.edu/About/Geothermal.aspx
[37] Koester R. Association for the Advancement of Sustainability in Higher Education. Planned Geothermal System Will Allow Ball State University to Shut Down Coal Plant [Internet]; 3 May 2009 [cited 2010 June 10]. Available from: http://www.aashe.org/blog/planned-geothermal-system-will-allow-ball-state-university-shut-down-coal-plant
[38] Cornell University. Lake Source Cooling [Internet]; 2006 [cited 2010 June 10]. Available from: http://www.utilities.cornell.edu/utl_ldlsc.html
[39] Cornell University. Lake Source Cooling: Environmental Facts & Benefits [Internet]; October 2008 [cited 2010 June 10]. Available from: http://www.utilities.cornell.edu/doc/the_lsc_broch_impact_timesnr-2.pdf
[40] Department of Energy (US). Annual Solar Thermal Collector Manufacturers Survey. Energy Information Administration [Internet]; July 2007] [cited 2010 June 13]; [Form EIA-63A]. Available from: http://docs.google.com/viewer?a=v&q=cache:P-2c88gYwmwJ:www.eia.doe.gov/cneaf/solar.renewables/page/forms/instr63a.pdf+Form+EIA-63A,+Annual+Solar+Thermal+Collector+Manufacturers+Survey&hl=en&gl=us&pid=bl&srcid=ADGEEShJkrwikbqKjXh1TntKHApRAKGaMyQh3gy_eEWymg-

0lsrybU8h0UACIlN7Mpku7jV6fU_F_pai4ppaRQQlYZriPbvwaMgKu275t53oQZSud_ysEzWJk gJANEj9nLI-EkOLn4W5&sig=AHIEtbQ8evwUWWrWl4GW5KIv78BoKix2MA

[41] International Renewable Energy Council, [cited 2010 June 10]. Available from: http://www.irecusa.org/fileadmin/user_upload/NationalOutreachPubs/IREC%20Solar%20Market%20Trends%20August%202008_2.pdf

[42] Department of Energy (US). Renewable Energy Trends in Consumption and Electricity 2007 Edition. Energy Information Agency [Internet]; April 2009 [cited 2010 June 13]. Available from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/rentrends.html

[43] Green Report Card. Harvard University [Internet]; 24 July 2009 [cited 2010 June 10]. Available from: http://greenreportcard.org/report-card-2010/schools/harvard-university/surveys/campus-survey

[44] Green Report Card. Yale University [Internet]; 21 July 2009 [cited 2010 June 10]. Available from: http://greenreportcard.org/report-card-2010/schools/yale-university/surveys/campus-survey

[45] Green Report Card. Stanford University [Internet]; 24 July 2009 [cited 2010 June 10]. Available from: http://greenreportcard.org/files/Stanford_Surveys.pdf

[46] Green Report Card. University of North Carolina at Chapel Hill [Internet]; 21 July 2009 [cited 2010 June 10]. Available from: http://greenreportcard.org/report-card-2010/schools/university-of-north-carolina-at-chapel-hill/surveys/campus-survey

[47] Harvard University. Blackstone's New Solar System. Office for Sustainability [Internet]; 23 March 2009 [cited 2010 June 10]. Available from: http://green.harvard.edu/node/49

[48] Guilford Green. Guilford College to Install Campus-Wide Solar Hot Water System [Internet]; 25 March 2010 [cited 2010 June 10]. Available from: http://guilfordgreen.wordpress.com/2010/03/25/guilford-college-to-install-campus-wide-solar-hot-water-system/

[49] University of Michigan. Central Power Plant. Plant Operation Division [Internet]; November 2008 [cited 2010 June 13]. Available from http://www.plantops.umich.edu/utilities/CentralPowerPlant/es/Equipment_Summary.html

[50] University of Michigan. Concentrating Thermal Solar Collector. Environmental and Energy Initiative [Internet]; [cited 2010 June 10]. Available from: http://www.planetblue.umich.edu/resources/solar_collector_factsheet.pdf

[51] Renewable Fuels Association. Statistics [Internet]; 2009 [cited 2010 June 10]. Available from: http://www.ethanolrfa.org/pages/statistics#E

[52] Department of Energy (US). Annual Energy Review 2008. Energy Information Administration [Internet]; June 2009 [cited 2010 June 10]. Available from: http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf

[53] Department of Agriculture (MI). Michigan Biodiesel Map [Internet]; January 2008 [cited 2010 April 15]. Available from: http://www.michigan.gov/documents/mda/BiodieselMap_183689_7.pdf

[54] Environmental Protection Agency (US). EPA Lifecycle Analysis of Greenhouse Gas Emissions from Renewable Fuels [Internet]; February 2010 [cited 2010 June 10]. EPA-420-F-10-006. Available from: http://www.epa.gov/otaq/renewablefuels/420f10006.htm

[55] The White House (US). Federal Leadership in Environmental, Energy, and Economic Performance [Internet]; 5 October 2009 [cited 2010 June 10]. Available from: http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf
[56] Department of Energy (US). U.S. Federal Government to Double its Hybrid Fleet; DOE Takes the Lead. EERE Network News [Internet]; 7 April 2010 [cited 2010 June 10]. Available from: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=15913
[57] Department of Energy (US). HEV Sales by Model [Internet]; 24 May 2010 [cited 2010 June 10]. Available from: http://www.afdc.energy.gov/afdc/data/vehicles.html
[58] The College Sustainability Report Card. Ohio State University-Columbus [Internet]; 2010 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010/schools/ohio-state-universitycolumbus/surveys/campus-survey
[59] The College Sustainability Report Card. University of Wisconsin-Madision [Internet]; 21 July 2009 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010/schools/university-of-wisconsin-madison/surveys/campus-survey
[60] The College Sustainability Report Card. Iowa University [Internet]; 2010 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010/schools/university-of-iowa/surveys/campus-survey#transportation
[61] The College Sustainability Report Card. Purdue University [Internet]; 22 July 2009 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010/schools/purdue-university/surveys/campus-survey#transportation
[62] Christiansen, Liz. Personal Communication. 17 May 17 2010. Director of Sustainability, University of Iowa.
[63] The College Sustainability Report Card [Internet]. Cambridge (MA): Sustainable Endowments Institute; c2007-2010 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010
[64] Associated Students of the University of California, Irvine. The B100 Retrofit Process. University of California, Irvine [Internet]; 2007 [cited 2010 February 26]. Available from: http://www.abs.uci.edu/b100retrofitprocess.pdf
[65] Boulder Biodiesel Student Group [Internet]. Boulder (CO): University of Colorado; c2004 [cited 2010 February 26]. Available from: http://www.cubiodiesel.org
[66] University of South Florida. Biodiesel Report [Internet]; [cited 2010 February 26] Available from: http://usfweb2.usf.edu/parking_services/Biodiesel.pps
[67] University of Vermont. Composting, Recycling, and the Environment [Internet]; 2010 [cited 2010 April 2]. Available from: http://uds.uvm.edu/social_composting.html
[68] University Business. Dining Halls of Distinction [Internet]; October 2009 [ciited 2010 June 16]. Available from: http://www.universitybusiness.com/viewarticle.aspx?articleid=1411
[69] Carleton University. Sustainability Initiatives [Internet]; [cited 2010 April 2]. Available from: http://www.campusdish.com/en-US/CA/Carleton/Sustainability/CarletonUniversitySustainability.htm
[70] University of Kansas. Building the Biodiesel Boom [Internet]; 2010 [cited 2010 April 8]. Available from: http://www.features.ku.edu/biodiesel/
[71] University of Illinois. Current ISTC Projects [Internet]; 2010 [cited 2010 April 8]. Available from: http://www.istc.illinois.edu/tech/biodiesel_projects.cfm

[72] Ann Arbor Transportation Authority. 2009 Facts and Figures [Internet]; 24 July 2009 [cited 2010 February 26]. Available from: http://www.theride.org/pdf/AATA%20facts%20and%20figures%202009%20for%20web.pdf
[73] Ann Arbor Transportation Authority. AATA Saves 100,000 gallons, $270,000 Using Hybrid Electric Technology [Internet]; 25 August 2009 [cited February 26]. Available from: http://www.theride.org/PRhybridSaves.asp
[74] The College Sustainability Report Card [Internet]. Cambridge (MA): Sustainable Endowments Institute; c2007-2010 [cited 2010 February 12]. Available from: http://www.greenreportcard.org/report-card-2010
[75] Department of Energy (US). Secretary Chu Announces up to $10 Million to Support Plug-In Hybrid Electric School Buses [Internet]; 17 April 2009 [cited 2010 April 17]. Available from: http://www.energy.gov/news2009/7284.htm
[76] University of Michigan. 2009 Annual Environmental Report, Raw Data Overview. Department of Occupational Safety and Environmental Health [Internet]; 2010 [cited 2010 April 8]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
[77] Ibid.
[78] Ibid.
[79] ACUPCC. GHG Report for University of Minnesota-Twin Cities [Internet]; 22 July 2009 [cited 2010 June 16]. Available from: http://acupcc.aashe.org/ghg/620/
[80] ACUPCC. GHG Report for Duke University [Internet]; 26 November 2008 [cited 2010 June 16]. Available from: http://acupcc.aashe.org/ghg/225/
[81] ACUPCC. GHG Report for University of California, Berkely [Internet]; 20 July 2009 [cited 2010 June 16]. Available from: http://acupcc.aashe.org/ghg/142/
[82] Windustry & Great Plains Windustry Project [Internet]. How Much Do Wind Turbines Cost? Minneapolis (MN): Windustry; c200-2010 [cited 2010 June 10]. Available from: http://www.windustry.org/how-much-do-wind-turbines-cost
[83] Department of Energy (US). Economic Benefits, Carbon Dioxide (CO2) Emissions Reductions, and Water Conservation Benefits from 1,000 Megawatts (MW) of New Wind Power in South Dakota. Energy Efficiency & Renewable Energy Office [Internet]; October 2008 [cited 2010 June 10]. Available from: http://wpadev.nrel.gov/pdfs/economic_development/2008/sd_wind_benefits_factsheet.pdf
[84] Department of Energy (US). Economic Development Benefits from Wind Power in Nebraska: A Report for the Nebraska Energy Office. National Renewable Energy Laboratory [Internet]; June 2009 [cited 2010 June 10]. Available from: http://www.nrel.gov/docs/fy09osti/44344.pdf
[85] Department of Energy (US). Comparing Statewide Economic Impacts of New Generation from Wind, Coal, and Natural Gas in Arizona, Colorado, and Michigan. National Renewable Energy Laboratory [Internet]; May 2006 [cited 2010 June 10]. Available from: http://www.nrel.gov/wind/pdfs/37720.pdf
[86] Michigan Great Lakes Wind Council [Internet]. Lansing (MI): Michigan Great Lakes Wind Council c2010 [cited 2010 June 10]. Available from: http://www.michiganglowcouncil.org/
[87] Michigan Memorial Phoenix Energy Institute. State approves offshore wind farm study [Internet]; 9 February 2010 [cited 2010 June 10]. Available from: http://www.energy.umich.edu/news/news_stories_10/wind_study_grant.html

[88] Krieg D. Personal Communication. University of Michigan. Facilities Maintenance/Roofs, Metal Shops & Elevators; 23 April 2010.
[89] Dorer H, Hibbard J, Paris E, Wang D, Widen E. SWE Boeing Team Tech Final Report [master's thesis]. Ann Arbor: University of Michigan. 2009.
[90] Roberts B. Biomass Resources of the United States. Department of Energy (US). National Renewable Energy Laboratory [Internet]; 23 September 2009 [cited 2010 June 10]. Available from: http://www.nrel.gov/gis/images/map_biomass_urban_wood_residues.jpg
[91] Department of Energy (US). Biomass Energy: Focus on Wood Waste. Energy Efficiency and Renewable Energy Office [Internet]; 2004 [cited 2010 June 10]. Available from: http://www1.eere.energy.gov/femp/pdfs/bamf_woodwaste.pdf
[92] Michigan Waste Biomass Energy Inventory to Support Renewable Energy Development [Internet]. Lansing (MI): Michigan Biomass Inventory [Internet]; c2009 [modified 2010; cited 2010 June 17]. Available from: http://mibiomass.rsgis.msu.edu/Map.aspx
[93] University of Iowa. Sustainability at Iowa – Energy & Climate [Internet]; 2010 [cited 2010 June 10]. Available from: http://sustainability.uiowa.edu/energy-climate/
[94] Mann M, Spath P. Life Cycle Assessment of a Biomass Gasification Combined-Cycle Power System. Department of Energy (US) [Internet]; December 2007 [cited 2010 June 10]. Available from: http://www.nrel.gov/docs/legosti/fy98/23076.pdf
[95] University of Michigan. University of Michigan North Campus Master Plan Update [Internet]; Summer 2008 [cited 2010 June 10]. Available from: http://www.aec.bf.umich.edu/campus.plans/U-M%20North%20Campus%20Master%20Plan%20Update%20-%203.5.09.pdf
[96] University of Michigan. Energy Master Planning – FY07 Annual Status Report. Utilities and Plant Engineering; 16 July 2007. Pp16.
[97] Professor Hoffman A. Personal Interview. University of Michigan. 18 March 2010.
[98] Department of Energy (US). Biodiesel Handling and Use Guide, Fourth Edition. National Renewable Energy Laboratory [Internet]; 2009 [cited 2010 March 26]. Available from: http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/43672.pdf
[99] National Biodiesel Board. Biodiesel Cold Flow Basics [Internet]; Winter 2007/2008 [cited 2010 March 26]. Available from: http://www.biodiesel.org/cold/Cold%20Flow%20-%20Master.ppt
[100] Biodiesel Experts International. Biodiesel Cold Flow Additive [Internet]; c2008 [modified 2010 June 15; cited 2010 March 26]. Available from: http://www.biodieselexpertsintl.com/store/Store/tabid/281/ProductID/14/Default.aspx
[101] University of Michigan. 2009 Annual Environmental Report, Raw Data Overview [Internet]. Department of Occupational Safety and Environmental Health [Internet]; 2010 [cited 2010 April 8]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
[102] Department of Energy (US). GREET Model Version 2.7. Argonne National Laboratory; 30 August 2007. Available from: http://www.transportation.anl.gov/modeling_simulation/GREET/index.html
[103] Department of Energy (US). Fuel Economy Estimates [Internet]; 2010 [cited 2010 June 10]. Available from: http://www.fueleconomy.gov

[104] University of Michigan. UM Students Make a Case for Waste Elimination and Energy Recovery. University of Michigan News Service [Internet]; 19 May 2004 [cited 2010 March 12]. Available from: http://www.ns.umich.edu/index.html?Releases/2004/May04/r051904a
[105] University of Michigan. Private Communication Re: 2009 Data. Occupational Safety Environment and Health; 2010.
[106] Environmental Protection Agency (US). Renewable Fuel Standard Under Section 211(o) of the Clean Air Act as Amended by the Energy Policy Act of 2005 [Internet]; 27 November 2008 [cited 2010 February 11]. Available from: http://www.epa.gov/EPA-AIR/2007/November/Day-27/a23095.htm
[107] Environmental Protection Agency (US). EPA Finalizes Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond [Internet]; February 2010 [cited 2010 February 11]. Available from: http://www.epa.gov/oms/renewablefuels/420f10007.htm
[108] Bravender R, Winter A. Biofuels: 'Difficult' Rules Will Consider GHGs From Land Use. Greenwire/E&E Daily [Internet]; 3 February 2010 [cited 2010 February 9]. Available from: http://www.eenews.net/Greenwire/2010/02/03/archive/1?terms=renewable+fuel+standard
[109] Environmental Protection Agency (US). EPA Finalizes Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond [Internet]; February 2010 [cited 2010 April 2]. Available from: http://www.epa.gov/otaq/renewablefuels/420f10007.htm
[110] University of Michigan. Environmental Data Repository [Internet]. Occupational Safety and Environmental Health [Internet]; 2009 [cited 2010 June 15 2010]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
[111] University of Michigan. 2009 Annual Environmental Report Raw Data Overview [Internet]. Occupational Safety and Environmental Health; 2009 [cited 2010 April 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html#
[112] Audin L. Preparing for Cap and Trade and Its Energy Costs. Building Operating Management [Internet]; December 2009 [cited 2010 February 26]. Available from: http://www.facilitiesnet.com/green/article/Preparing-for-Cap-and-Trade-and-its-Impact-on-Energy-Costs--11360
[113] University of California-Berkeley. Alumni Sustainability Fund-Raising. The Berkeley Institute of the Environment [Internet]; 2007 [cited 2010 June 10]. Available from: http://bie.berkeley.edu/node/1516
[114] Daily Pioneer News. Alumnus Establishes Sustainability Fund for UWP [Internet]; 21 May 2009 [cited 2010 June 10]. Available from: http://www.uwplatt.edu/news/2009/05/alumnus-establishes-sustainability-fund.html
[115] Harvard Unversity. Green Campus Loan Fund [Internet]; 2009 [cited 2010 June 10]. Available from: http://green.harvard.edu/loan-fund
[116] Renewable Ventures. Fotowatio's Renewable Ventures Completes $200 Million Fund to Finance and Develop New Solar Projects in the U.S. [Internet]; 3 August 2009 [cited 2010 June 10]. Available from: http://www.renewableventures.com/news/20090803-pressrelease-solarfundv.html
[117] Environmental Protection Agency (US). Combined Heat and Power Partnership – Biomass CHP Catalog of Technologies [Internet]; 16 February 2010 [cited 2010 June 10]. Available from: http://www.epa.gov/chp/basic/catalog.html
[118] Larrick R, Soll J. The MPG Illusion. Science 2008; 320:1593-1594.

[119] The Greenhouse Gas Protocol Initiative [Internet]. GHG Protocol [modified 2010; cited 2010 June 10]. Available from: http://www.ghgprotocol.org/
[120] World Resources Institute. GHG Protocol [Internet]; 2002 [cited 2010 June 10]. Available from: http://www.wri.org/files/wri/images/ghg-protocol-scope.preview.gif
[121] Penn State University. Campus Inventories [Internet]; 2009 [cited 2010 February 12]. Greenhouse Gas Reduction Initiative Available from: http://www.ghg.psu.edu/campus_inv/
[122] American College and University Presidents Climate Commitment. 2009 GHG Report for Illinois State University [Internet]; 25 September 2009 [cited 2010 February 12]. Available from: http://acupcc.aashe.org/ghg-report.php?id=1049
[123] World Resources Institute. First Drafts of Product and Scope 3 Standards Released [Internet]; 11 November 2010 [cited 2010 June 10]. Available from: http://www.ghgprotocol.org/first-drafts-of-product-and-scope-3-standards-released
[124] Clean Air-Cool Planet. Conduct an Emissions Inventory [Internet]; 2008 [cited 2010 June 10]. Available from: http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

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For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

Campus Sustainability Integrated Assessment: Phase I

Transportation Team

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EXECUTIVE SUMMARY

Transportation

This assessment of sustainable transportation options for the University of Michigan centers on developing increased choices and revised institutions to reform individual and organizational incentives to rely on solo driving. It focuses both on vehicle-miles traveled (VMT) associated with commuting to the campus and with the University's own operations. The Campus Integrated Assessment consists of three phases. Assessment of Phase 1 centers on five principal areas:

1. **Parking Policy:** A sustainable transportation policy requires that parking be allocated so as to facilitate the use of alternatives to drive-alone commuting to the University of Michigan campus, whether occasionally or regularly.
2. **Land Use:** For many people, commuting via alternatives to driving depends in part on the environment around their workplace. In walkable environments offering easy access to commercial uses, people may not need their automobile mid-day in order to get a meal or perform errands.
3. **Transit:** Ann Arbor currently has two transit operators whose service is largely uncoordinated: the Ann Arbor Transportation Authority and the University of Michigan. The goal of transit policy should be to provide seamless transit mobility both between the Ann Arbor campuses and between campus and the rest of Ann Arbor and Washtenaw County.
4. **Pedestrian and Cycling Environment:** A number of physical and organizational innovations can increase the accessibility of the University of Michigan campuses to pedestrians and cyclists.
5. **Other areas**, including out-of-town travel and goods movement on campus.

Upon completion of Phase I, the assessment team made four key recommendations for the University of Michigan around transportation sustainability:

1. **Eliminate subsidies and incentives for driving in single-occupancy vehicles**
2. **Reduce the need to drive on campus**
3. **Reduce the need to drive to and from campus**
4. **Track transportation habits on campus**

For Phase II, the assessment team will conduct further analysis based on key recommendations from Phase 1. Methods for next steps include:

1. **Land use:** A GIS analysis of walking proximity to campus destinations.
2. **Transit:** A speed analysis of the campus system (dependent on data)
3. **Transit:** Analysis of the impact of city-campus transit integration in East Lansing/MSU
4. **Cycling/pedestrian environment:** Comprehensive set of photos documenting areas needing improvement; areas of inadequate bike parking (or unused potential for covered parking)
5. **Off-campus travel:** Detailed proposal from Michigan Flyer about a potential bulk

purchase covering all UM students, faculty, and staff for airport travel (akin to the AATA M-Ride), together with cost analysis;

6. **Parking:** Analysis of cross-subsidies between structured and surface parking, when land costs are incorporated (dependent on data).

INTRODUCTION

The Transportation Team focused on the University of Michigan's current transportation system by analyzing parking policies, alternative transportation opportunities, public transit, land use, and off-campus travel. Our scope is outlined in **Figure 1.**

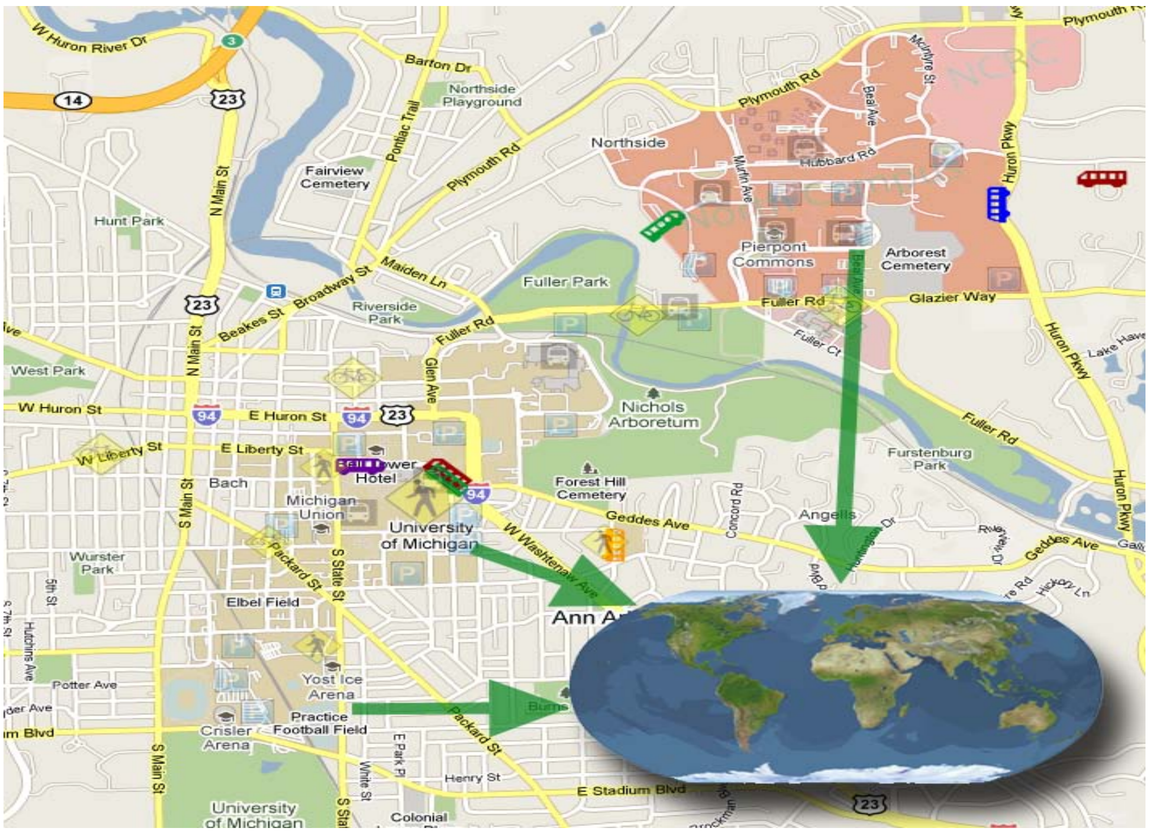

Figure 1. A visual representation of core focus areas: *Parking*, *Land Use*, *Transit*, *Walk and Bike-ability*, and *Off-Campus Travel*.

The Transportation Team is led by Professor Jonathon Levine of the Taubman College of Architecture and Urban Planning and has five members: Anika Fassia, Chris Machielse, Brennan Madden, Sarah Mandlebaum, and Gretchen Miller. Additionally, Jazmine Bennett of the Culture Team attended Transportation Team meetings throughout Phase 1 and made valuable contributions. Aspects of sustainable transportation were broken into five key areas:

- Parking Policy
- Land Use
- Walking and Bicycling Environment
- Public Transit
- Off-Campus Travel and Goods

The Transportation Team researched subsidies and incentives around driving to campus, current biking infrastructure, campus transit times and speeds, utilization of open space and methods of land use, and the impact of off-campus travel and resource sharing. Current practices around transportation were benchmarked against peer institutions, analyses were conducted, and information around community support gathered. As a result of this review, the team developed four prioritized recommendations for UM and our team to pursue through Phase II of this project.

TRANSPORTATION STATUS AND TRENDS

PARKING INFRASTRUCTURE

Description of Issue

The current model of parking payment at UM centers around the long-term payment (i.e., monthly or annual) for a parking pass. Occasional parkers are offered the option of daily permit but at a considerably higher daily rate than that paid by holders of long-term passes. This practice is in conflict with that of other universities who structure parking payment to encourage occasional parking as a necessary complement to pedestrianism, cycling, transit use, and telecommuting. A more sustainable solution to this problem is structure parking payment to make alternatives to driving more feasible, even on an occasional basis.

UM Practices, Policies, and Process

Parking is an important source of revenue for the Parking and Transportation Services (PTS) department and is generated through parking passes. Three models exist for the employee-parking pass: 1) continuous parking passes, which never expire and apply monthly paycheck deductions, 2) annual passes, and 3) pre-paid daily passes. The annual or continuous monthly passes range from $17 to $62 per month, depending on parking tier. Considering daily permits at $5.00 per day and 21 working/parking days per month, the monthly cost is $105. This structure punishes those who park occasionally with parking rates that are 2 to 6 times higher, while providing an incentive for any person who parks more than 13 days per month to purchase even the most expensive parking pass.

By the same token, people who purchase parking annually or continuously lack the incentive to chose other modes to reach campus even occasionally: once the permit has been purchased parking has a marginal cost of zero, and commuters have every reason to seek to get their money's worth out of their investment in a parking pass.

Reform of parking policies could potentially lead to a reduction in the number of cars parking at the UM campuses each day. While this would be seen a desirable outcome—a step toward sustainable transportation—it could also lead to reductions in parking revenues collected. Should this come about, the UM might seek cost savings from decommissioning older structures (thus reclaiming valuable land for academic purposes), or leasing portions of structures to other users.

Relevant Literature and Community Input

One method of reducing commuter miles traveled by car is to alter the *structure* of parking fees. If monthly and annual passes were eliminated, and parking charged on a daily basis instead, those who reduce their number of driving days are rewarded and those who continue to drive everyday are not punished. Elimination of the monthly or annual pass would have the side benefit of leveling the playing field by offering cyclists, pedestrians, and transit users the opportunity to park occasionally at the same rates as everyone else. This can reduce the number that drive every day[1], though this would be at least partly offset by increased parking by occasional parkers. By eliminating the annual pass, the commuter is rewarded for the days not driven to work. This promotes the use of public transit or bicycling with occasional driving rather than habitual driving.

Another way to promote use of alternative transportation is through parking prices. Parking subsidies substantially increase vehicle travel while increased daily parking prices reduce solo driving and promote transit and carpool use.[2] One clear parking subsidy at the University of Michigan is the required unit contribution to an employee's parking pass. This is provided for by Standard Practice Guide 601.21, which states that "[u]niversity units and departments contribute to the cost of staff-paid parking permits." The mandated contribution for blue parking passes for 2010-11 is $142; that is, when employees choose to purchase a blue parking pass, their units are billed $142 on top of what the employees pay. This represents as subsidy to the automobile that is not available to cyclists or pedestrians—a policy worthy of reform in pursuit of more sustainable transportation. (The University also contributes $14 annually per faculty, student, and staff member to provide free universal transit access with the Ann Arbor Transportation Authority.)

Parking at the UM is ostensibly self-supporting through parking fees but other subsidies are present as well. Important among these is a lack of accounting for the cost of land.[3] Land costs, valued between 0.3 and 3.5 million dollars per acre depending on location, are not incorporated into parking charges. With land billed at zero and a blue pass at $63/month, it is likely that the surface parking spaces subsidize those in structures. However, when land is valued appropriately, the cost of surface lot spaces almost doubles, while the cost of structure spaces increase by up to 30%. [4] These subsidies would be expected to increase the number of cars parking at the University of Michigan when compared to an unsubsidized situation.

While considering possible parking policies, it is important to consider those who commute daily and are not served by public transit. Raising the price of an annual or monthly parking pass can unfairly affect those commuters who drive simply because they live further away and have no access to public transit, often because the price of living in Ann Arbor is so high. This can be addressed by charging for parking on a sliding scale based on salary rather than proximity. This approach is already in use at Yale and other universities.

Description of Selected Case Studies

Many universities, such as *UCLA* and *Emory*, have made and upheld "no net new parking" pledges. Under these pledges, the growth in demand for parking will need to be accommodated with alternatives to the automobile. Several universities, such as *Yale*, price parking by salary. Many universities also provide incentives for use of alternative transportation such as rewarding carpoolers with prime reserved parking spots and reduced parking pass prices. At *UC-Berkeley*, the Carpool Program gives preferential parking to carpools: two carpool permits must be displayed in a vehicle to be considered a carpool, and any two or more carpool permit holders traveling together become a carpool with parking access at the highest level of carpool permit displayed. Commuters who cannot carpool on a given day may display your individual carpool permit. *Duke University* and *MIT* reward carpoolers and bikers with free or substantially reduced daily parking passes for those days when they must drive. These stand in stark contrast to UM, where occasional parkers are penalized with higher-cost parking passes, and reserved carpool parking must be purchased.

Trends and Lessons Learned

As seen in Figure 1 below, a compilation of equivalent parking pass prices across universities, the price of parking at UM is below average. Even when Princeton (parking is free) and New York University (parking in a city lot) are removed from the data set, UM's blue pass monthly price ($62) is still below the mean ($67). The fully accounted cost of parking in a structure in downtown Ann Arbor has been estimated at $210 (updated to 2010 dollars)[5 6]; this analysis implies that Michigan's parking remains underpriced and hence subsidized relative to its fully allocated costs.

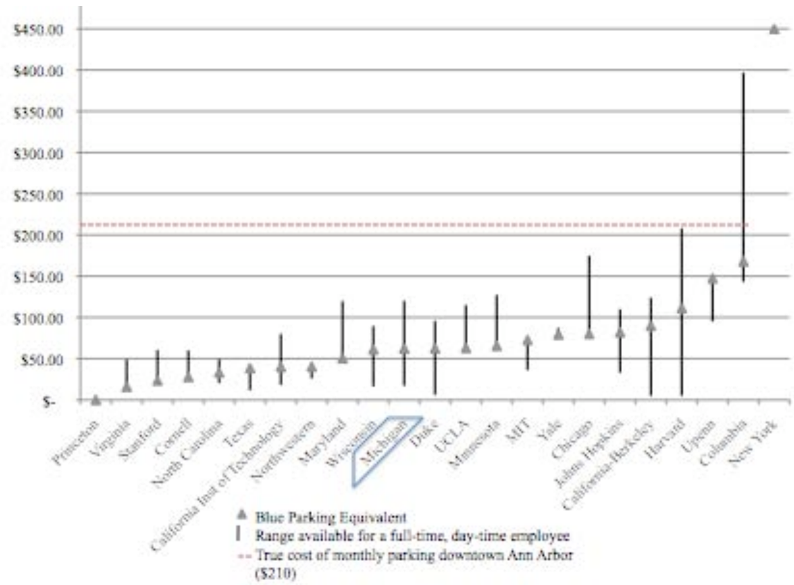

Figure 1. Parking prices of a basic monthly pass across peer universities compared to the true cost of parking in downtown Ann Arbor (red dotted line)

UM offers alternatives to commuting, such as vanpool, carpool, and free AATA services, but current parking prices and pass structure provide insufficient incentive to use them. Moving towards transportation sustainability requires structuring parking charges to as to facilitate the use of transportation alternatives, whether regularly or occasionally, and to reduce identified subsidies to the automobile.

LAND USE

Description of Issue

With the development of UM's four campuses – Central, South, North, and Medical – all happening at different times, one can see and feel the differences in character among the campuses. North Campus, being the youngest campus and now including the North Campus Research Complex (NCRC), is the focus of many planning efforts at the university. Planners hope to transform North Campus into a vibrant and popular destination for students, faculty, and staff, but the planners face challenges because of its physical, functional, and psychological separation from the other campuses. North Campus' large size and suburban character create far distances between destinations, which decreases opportunities for walkers and encourages auto use.

UM Practices, Policies, and Process

Master plans for the UM campus have existed since 1837; however, the focus on land use and urban design began in the 1960s, with the most current comprehensive plan dating from 1998. Plans for North and Medical Campus were updated in 2008 and 2005, respectively. The comprehensive 1998 plan emphasizes that planning is a process and is constantly progressing and adapting to issues as they arise over time.[7] Presently, the main issue is the continuing development of North Campus and the NCRC. When UM's Central and South Campus grew, they grew along with the City of Ann Arbor. Both grew around and within one another, creating integrated and mixed uses. The Central Campus Master Plan of 1963 encouraged the participation of the Ann Arbor community in the development of the university to promote this integration. The study also recommended that small sub-campus areas within Central "be developed as a campus focus around which occur buildings or building complexes of various functions."[8] The plans for North Campus during the same era and up until the 2000s encouraged density and in-fill, but did not suggest adding various uses or discussing its relationship with the surrounding city.[9] The 2008 North Campus Master Plan somewhat rectified this by having four overarching goals of creating strong connections, promoting campus vitality, optimizing development capacity, and respecting and incorporating environmental features.[10]

Relevant Literature and Community Input

While the effect of different land-use policies on travel behavior is still contested, research suggests that residents of dense, mixed-use, and transit-accessible neighborhoods use autos less and walk more.[11] As work environments, these surroundings offer commuters the opportunity to get a meal or run errands without needing a vehicle. In this way, they are an important element of a sustainable transportation policy in that commuters to these areas are more likely to choose transportation alternatives. In as much as the goal is to make North Campus a popular area for students, who already walk to reach many of their destinations, land use mixing and integration will inherently be attractive.

Description of Selected Case Studies

The layout of the University of Michigan stands out from other universities. Many peer institutions have one contiguous piece of land with a central academic core and residential uses around the periphery. Therefore, land use separation has not been a major issue. However, three institutions have practices they follow to ensure land use integration and a vibrant campus. *The*

University of Wisconsin – Madison is beginning to explore public-private partnerships to foster redevelopment on university-owned property.[12] To help revitalize the eastern half of *Cornell University*, the school takes buildings that have reached the end of their usable life and replaces them with mixed-use, higher-density developments. It is intensifying use while staying within its existing footprint.[13] Lastly, *Duke University's* East Campus is about a mile away from the core academic campus, West Campus. To create greater connectivity and to help break up the distance, Duke is trying to infill by building a "New Campus" between East and West Campus on university-owned land. New Campus will be a mix of residential, art, and academic uses.[14]

Trends and Lessons Learned

The master plan for North Campus and the NCRC calls for increased density, mixed uses, and better connectivity among campuses to create a vibrant destination for students. Peer institutions have a tradition of this type of built environment, while North Campus does not. Given its size and suburban surrounding, creation of mixed-use environments on North Campus will likely depend on arrangements under which some campus territory is leased to commercial uses.

TRANSIT

Description of Issue

Campus bus ridership has grown by over 1.3 million in the past 6 years and the successful MRide program in AATA has grown to over 2.4 million riders.[15] (Table 1) But the two systems remain separate and uncoordinated. Currently the problem of shuttling people between the UM campuses is conceived of as separate from the problem of transit connectivity to the rest of Ann Arbor and Washtenaw County. Even current efforts at improving transit in the high-volume corridor running from northeast to southern Ann Arbor are frequently framed largely in terms of the inter-campus shuttle function. For example, a background document for a "Transportation Technology Forum" held in March 2010 states:

> We will structure a forum for companies, community and agency representatives to create potential visions of how we might create a long-term opportunity -- development of better transportation connection between Central, Medical and North Campuses. (http://www.fo.umich.edu/TTF.html)

Yet in order to promote transportation sustainability, transit needs to absorb an increasing share of trip growth both to and between our campuses. This demands a system that offers seamless transit mobility both between campuses and between campus and city. Improved city-campus and intercampus linkages will improve the current level of service for commuting students, faculty, and staff, and can reduce miles traveled (VMT) via automobile commuting.

UM Practices, Policies, and Process

Currently, Parking and Transportation Services operate a six year round and five fall/winter only bus routes run on campus with less running on the weekends than weekdays.[16] The "Blue Bus" and AATA systems are already highly interdependent, as shown in Figure 2. The AATA MRide program decreases transit costs to university members while reducing parking demands. The program shows major increases since its 2005 start, indicating a desire for public transportation as the campus population grows.

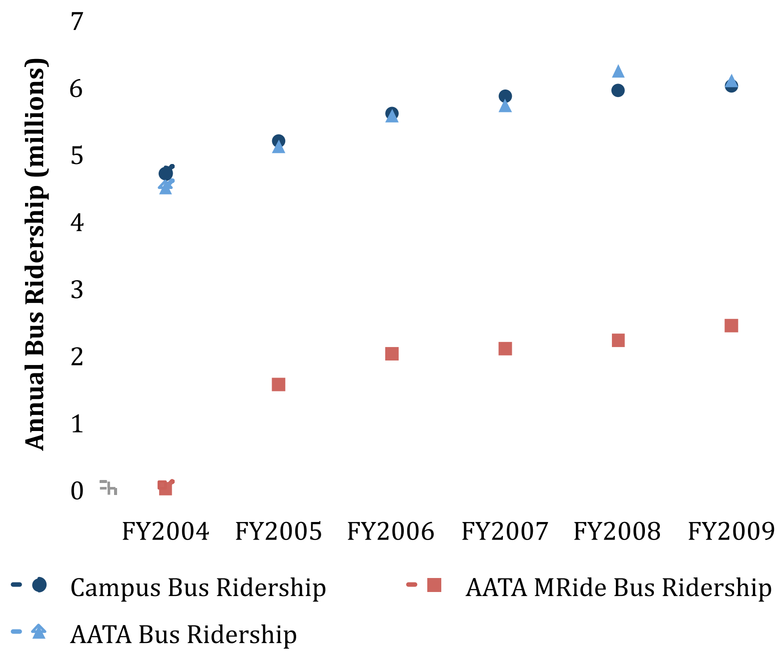

Figure 2 Campus[15], AATA[17] and MRide[15] Annual Bus Ridership

Relevant Literature and Community Input

The UM, jointly with the AATA and the Downtown Development Authority, has commissioned a "Connector Study" to examine the potential of high-quality transit to serve the high-volume corridor extending from East Medical through North and Central Campuses to the administrative buildings on the south side of Ann Arbor. Alternatives were explored in a recent "Transportation Technology Forum" on campus. For example the Personal Rapid Transit (PRT) system consists of small, automated vehicles.[18] Another option, a Bus Rapid Transit (BRT) system, is a higher capacity, bus-based system integrating the cost savings and flexibility of bus transit at the speed and quality of rail transit. Some BRT systems contain dedicated lanes for buses while others reserve bus lanes only at peak hours or intermittently. A study by the University of California-Berkley suggests intermittent lanes, "unlike dedicated ones, do not significantly reduce street capacity. Intermittence, however, increases the average traffic density at which the demand is served, and as a result increases non-bus traffic delay."[19] Some systems analyzed are principally oriented towards shuttling passengers back and forth between campuses. Others, such as Bus Rapid Transit, could be readily integrated with public transit through the rest of Ann Arbor and Washtenaw County—with through-routed town lines making use of the high-capacity corridor—to facilitate seamless transit mobility.

Description of Selected Case Studies

Several universities use public service for campus transit to increase efficiency in administration costs, planning and reducing traffic. In August 1999, the Capital Area Transportation Authority (CATA) in East Lansing, Michigan began a regional partnership with *Michigan State University* (MSU), which integrated MSU bus services with East Lansing and Meridian Township. CATA offers fixed campus route bus service, a 24-hour service during the fall and spring semesters in addition to the greater Lansing area.[20] The agreement provided base transit service at no charge, with the university paying for additional growth. CATA later partnered with the city of Lansing to construct a $10 million downtown intermodal transportation center.[21] CATA ridership has increased from 850,000 (1999) annual rides to over 3.2 million (2006) rides on campus routes[22]. *The University of North Carolina at Chapel Hill* (UNC) uses the Chapel Hill Transit system where it remains the largest contributor at $4.7 million per year. Each student pays $47.50 per year for the service in academic fees while departments pay 0.104% annually on all salary sources.[23] *University of Wisconsin-Madison* (UWM) also uses city buses with five routes circling on campus.[24]

Figure 3 University of North Carolina at Chapel Hill offers bus ETA information at bus stops.

Several strategies have helped promote campus transit system use. MSU uses a "hand holding" technique to introduce students to their transit system through CATA presentations at orientation programs and online.[25] The Chapel Hill Transit system gives up-to-date arrive times for buses at each bus stop and on the Internet to make using the system easier to use.[26]

West Virginia University installed a Personal Rapid Transit system in 1975. The system moves 15,000 people per day (current UM buses carry 33,000 people per day) and can handle 6,700 passengers per hour. During the school year, 73 cars accommodate eight seated and twenty total passengers each. The system features point-to-point service where riders ride non-stop to their destination and wait at most five minutes for a car to arrive. The cars travel up to 30mph and takes 11.5 minutes to travel the length of the 4.5 mile track.[27] Faster, more efficient PRT systems are in development.[28]

The Euclid Corridor Transportation Project in Cleveland, Ohio uses exclusive bus lanes leaving one lane for auto traffic in each direction (a BRT system). To make room, on-street parking was eliminated along the 9.4mile system. The original bus route took forty minutes but with the dedicated lanes in place, the route now takes only twenty-eight minutes. The $168 million includes unique bus stations and customized buses and has promoted significant community development.[29]

Trends and Lessons Learned

Improvements in transportation efficiency in combining campus and city systems have taken hold at MSU, UNC, UWM and Cornell.[30] A major benefit of integration of city and campus transit is in smoothing out the peaks and valleys of hourly volumes. As a transportation planning study points out at the University of Colorado: "students have very different schedules than the working public. Most student trips do not take place during peak hours, so adding students to the system does not force the transit provider to put additional buses on the road. Instead, students fill buses that otherwise are well below capacity during off peak hours. Thus, a substantial number of student riders can be absorbed at no cost to the provider, while helping with transit agencies' biggest PR problem- empty buses during off peak hours."[31] Figures 4 & 5 show the average ridership by hour, indicating that this may also be true in Ann Arbor; the combined volumes are considerably less peaked than those of the AATA alone. UM buses peak at nine and eleven in the morning and continue throughout the day. AATA experiences a peak at eight in the morning and dips in the later morning and early afternoon.

Simple transit information about arrival times at bus stops makes transit systems easier and creates a positive impression. Integration of campus and city transit systems can increase bus ridership and reduce vehicle miles traveled (VMT) by automobile—and can generate operational efficiencies.

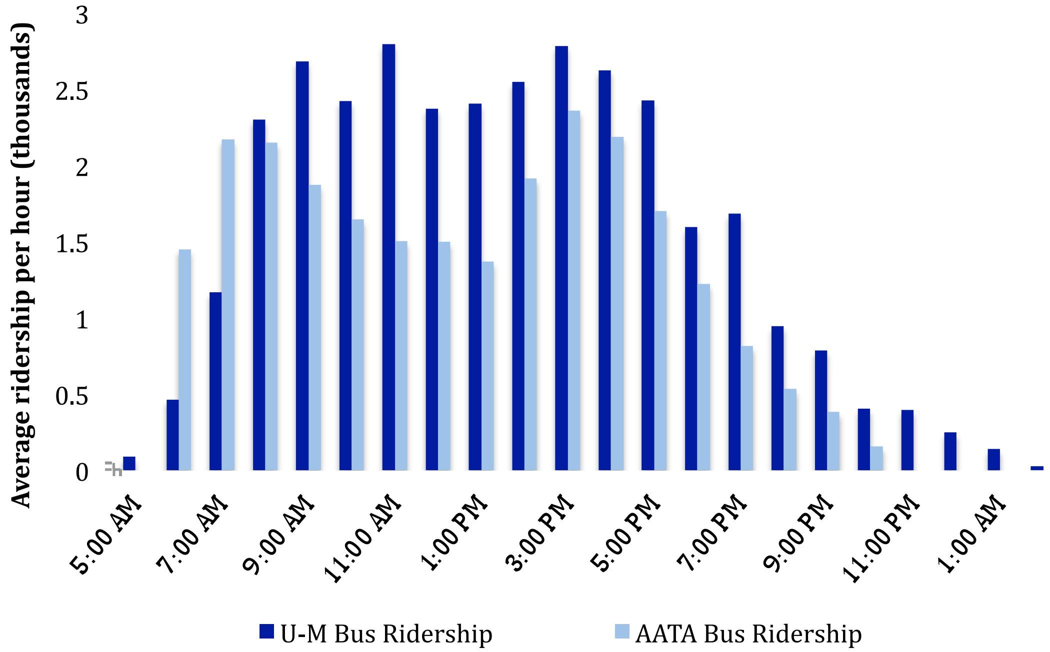

Figure 4 UM bus[32] vs. AATA bus average ridership by hour[33 34]

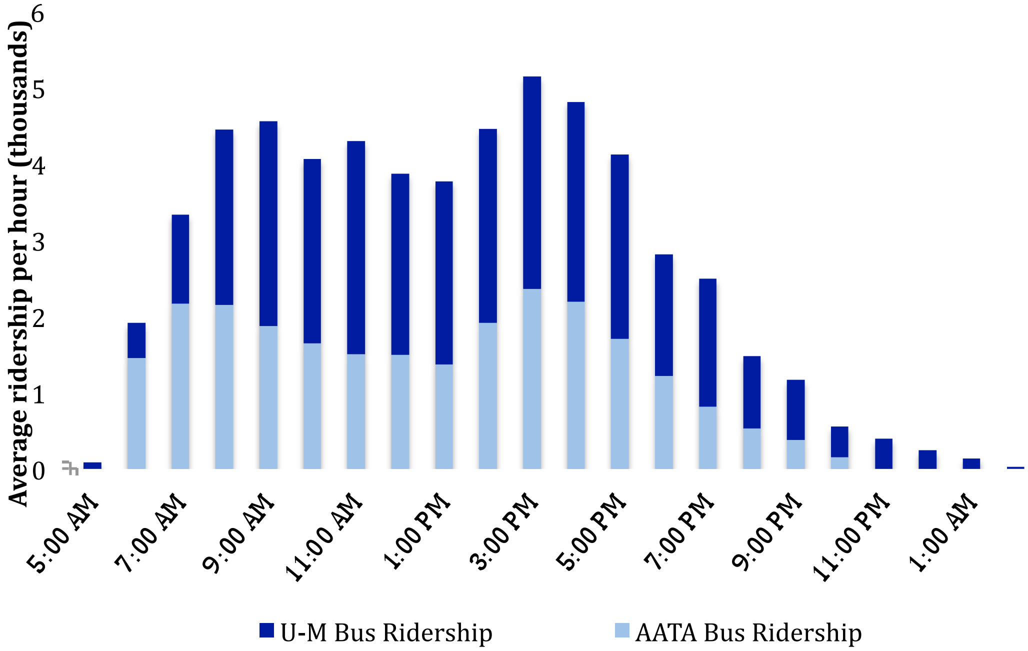

Figure 5 Combined UM bus[35], AATA bus average ridership by hour[36 37]

BICYCLING ENVIRONMENT

Description of Issue

Promoting cycling and walking will diversify its efforts towards a more sustainable campus. These approaches can be extremely efficient in terms of cost, space, and environmental impact.

UM Practices, Policies, and Process

As of FY2009, UM has 4,250 bike racks, several bike lockers, and part-time bike co-op. A covered/secure area will be available in 2010 following the completion of the Thompson St. parking structure renovation. The University does not have a comprehensive bicycle plan or a bike-sharing program; however, available funding has been identified through Parking and Transportation Services.[38]

Relevant Literature & Community Input

Figure 6. Covered area on central campus not utilized near bike racks

Figures 7, 8, and 9. Approaches to Covering Bike Parking

Non-motorized transit promises costs savings as less becomes less available for surface parking lots.[39] Bike parking is extremely affordable, costing less than $100, or less than 1% of the cost for one new automobile parking space.[39] Promoting alternate methods of transit on a campus environment works well because of the high densities of employment and residents on or near campus.[40]

With close to 30% mode share for non auto-based commuting, there is a strong culture of support for non-motorized transit in Ann Arbor, creating an incentive to partner with the city for such efforts.[41] These alternatives can work together with other sustainable initiatives making the campus a safer and dynamic environment for travel options. According to a study of Ann Arbor's cycling environment, one of the barriers on the U-M campus was lack of sheltered and/or covered parking.[42] [38]Most of UM bike racks do not provide shelter from the weather; this leads to rapid deterioration and rusting of bikes. This deficiency can be resolved by by adding bike parking to areas of building overhangs (Figure 6) or covering existing bike parking (see Figures 7, 8, and 9 for examples).

The central campus is an area of intense use by both cyclists and pedestrians, generating considerable points of conflict between the two. It may be that designated bike lanes in heavily trafficked areas of central campus can reduce these conflicts without disadvantaging either transportation mode.

Description of Selected Case Studies

Many universities with successful sustainable transportation initiatives employ a bike-sharing program where bikes are temporary leased to the campus community and/or supply free parking passes for those who need to park on occasion but typically use alternative modes of transit. *Michigan State University* loans out over 700 bikes and has a full-time bike center. The bike center teaches the campus community how to repair their bikes, and basic elements of safety. Bike loaning works by allowing the campus community to temporarily borrow bikes for a deposit or fee for a designated amount of time. *University of California-Berkley* has a comprehensive bike plan that includes current and future initiatives around increasing bicycling use on campus. Current parking and transit incentives offer bicyclists alternatives (free parking passes and emergency rides home) on days when they do not ride/walk. The proposed incentive programs include discounted equipment/service, free giveaways, parking policies, service bikes, shower/lockers, and an on-campus bicycle shop. *Duke University* provides up to 24 daily parking permits when bicycling is their primary commuting mode and also has a bike-loan program.

Trends and Lessons Learned

Increasing bicycle use on campus is an affordable and easily implemented method of sustainable transit. Providing ample covered bike parking is a key initiative; bike sharing and other benefits to cyclists is an important element of cycling programs at other institutions and could be readily implemented at the UM.

OFF-CAMPUS TRANSPORTATION

Description of Issue

The University's transportation needs are not limited to transportation around and between its campuses. As a major employer, educational destination, and research entity, students and faculty routinely travel to and from UM by personal vehicle or commercial aircraft.

UM Practices, Policies, and Process

Business Travel
Procurement Services is responsible for reimbursing faculty for the cost of business travel. Faculty can be reimbursed for miles driven using a personal vehicle on UM business, or can be reimbursed for the price of airfare. If traveling by air, transportation to the airport by bus, taxi, or shuttle is a reimbursable expense. Faculty may opt to travel by rail, but only if the fare is cheaper than air travel. No sustainability criteria are in place to discourage unnecessary or environmentally harmful travel. The Office of Campus Sustainability reports that there is no method by which UM can accurately track annual business travel.[43]

Student Travel
To accommodate the large number of students that fly home during UM breaks, the Michigan Student Assembly (MSA) operates the AirBus to provide transportation to the airport around the holidays and school breaks, but the service only operates four times per year. This service is

more fuel-efficient than a single-passenger taxi, and can achieve up to 150 passenger miles per gallon of fuel.[44]

Travel Reduction Strategies
The University has reported that "a number of UM departments have been experimenting with Telecommuting options for staff,"[45] but promoting the use of teleconferences or digital communications when possible in lieu of physical transportation is not a UM policy. Many departments operate videoconferencing systems, but there is no uniform, campus-wide service.

Relevant Literature and Community Input

Offsets
One approach to mitigating the environmental impact of air travel is the purchase of offsets; funds are used to mitigate emissions elsewhere. Experts and economists note, when "done carefully, offsets can have a positive effect and raise ecological awareness,"[46] reducing carbon emissions in an efficient way.[47] But carbon offsets, as offsets are "new, voluntary, and unregulated," making benefits hard to measure.[48] Some analysts are concerned about the leadership example set by universities that pay others not to pollute rather than reducing their own emissions.

Teleconferencing
Studies have shown that total distance traveled by telecommuters significantly decreased on telecommuting days. In many cases, organizations with teleconferencing technology saw this addition as a complement to business travel rather than a substitute, thus resulting in the generation of new communication rather than the replacement of travel.[49]

Travel to the Airport
Making efforts to partner with Michigan Flyer, the proposed Ann Arbor-Detroit commuter rail, and other regional transportation projects would provide students and faculty with more affordable and efficient means of transportation to Detroit Metro Airport year-round, greatly supplementing the limited service of the MSA Airbus.

Description of Selected Case Studies

The *University of California – Berkley* accepts voluntary donations on an air-travel calculating website from faculty and students support on-campus sustainability projects. The 'Carbon Neutrality Action Plan' from *Arizona State University* calls for departments using air travel to pay fees supporting carbon-related projects on campus.[50] Funds provide loans for campus infrastructure improvements that have a payback due to higher efficiency and provide grants for smaller projects. The 2009 Climate Plan of *Oregon State University* (OSU) reports that university-related air travel emitted the equivalent of 35,000 tons of CO_2 in the 2008 fiscal year. The report advised five strategies to reduce emissions from air travel: promoting alternative transportation modes, restricting air travel when it does not meet certain criteria, encouraging use of teleconferencing and other travel alternatives, reducing the impacts of flights as much as possible, and offsetting remaining air travel emissions. The report also set criteria for the purchase of offsets and renewable energy certificates.[51]

Trends and Lessons Learned

Few schools are taking serious steps to reduce the impact of off-campus travel at this time. By making key policy changes and utilizing improvements to regional transit, UM could significantly reduce the impact of its off-campus transportation practices.

GOODS

Description of Issue

When it is necessary to move time-sensitive materials, many units within the UM use their own courier service, resulting in an operational inefficiency that can add to courier vehicle miles traveled, thus creating an increased environmental impact.

UM Practices, Policies, and Process

Currently, the University has two contracts for courier services: a primary contract with Metro Delivery and a secondary contract with SOS Express.[52] For the delivery of non-time sensitive materials, campus mail offers a standard delivery time of 24 hours.[53] While no data is available for the amount of trips made by third party courier services, campus mail delivers over 10,000 pieces of mail each day.[54]

Relevant Literature and Community Input

The Transport Studies Group found that within examined cities, one express parcel delivery company traveled 14 miles on its daily round, yet moved its vehicle 22 times with "distances ranging from 5 yards to 1 mile" and noted that the necessity to make some deliveries quickly reduces the possibility for cost efficiency or the use of fully loaded vehicles.[55] This would suggest that vehicle miles increase when using courier services instead of less rapid delivery methods, such as campus mail.

Description of Selected Case Studies

Cornell University operates Red Runner, an on-campus courier service that moves documents, materials, and people around campus.[56] Cornell claims that the people-moving component of this service helps reduce time that would otherwise be squandered searching for parking spaces (2010 email to the author; unreferenced).

Trends and Lessons Learned

Centralized and coordinated campus delivery services (presumably provided by Mail Services) could reduce both costs and vehicle use on campus.

TRANSPORTATION OPPORTUNITIES AND CHALLENGES

PARKING INFRASTRUCTURE

Challenges

The best reasons not to change the current parking pass model at UM relate to money. First, parking is an important source of revenue for PTS. In our current parking model, if demand is reduced, then revenue is reduced. Second, the social justice issue related to increasing parking prices poses political problems. It is unfair to increase charges for those who cannot afford to live in Ann Arbor and must rely on commuting to get to work.

Opportunities

Fortunately these problems can be addressed by several complementary solutions: (1) Increase the price of parking in a fair manner by altering our tiered parking rates. We can base parking charges on driver salary rather than proximity of parking space. This eliminates social justice issues and encourages those who can afford to live in Ann Arbor and use public transit to do so. (2) Lease or sell unused spaces to local businesses or to the City of Ann Arbor. (3) Retire a structure once it has reached its end-of-life (rather than paying for maintenance/renovation) and use the land for other purposes.

LAND USE

Challenges

The campuses at UM are very different in character. Central and South Campus are popular destination areas for students, faculty, staff, and visitors because of their high-density and mixed-uses. North Campus (NC) remains mostly academic and has a low-density, auto-dependent design. In order for UM to become more sustainable, it must work to make NC a place where people can not only live and study, but also a place for people to go for entertainment, food, and recreation. The university must utilize any opportunity it has to offer mixed-uses and make NC a destination. This will reduce the numerous cars trips generated because of the small number of options and large, spread-out plan of NC.

Development happens over many years, so this will remain a problem for many years to come. The process can be long and difficult. With the recent economic downturn, the market for commercial building may also be struggling. Therefore, the university must remain devoted to this task and consider each step taken carefully.

Opportunities

One possible way that the university can overcome these challenges is to allow leasing of their land. Many other universities have leased out their land to private developers to create greater density, offer mixed-uses, and ease the financial burden of funding large projects on the university. The university would still own the land, but the private developer would design, build, and manage the building. For example, at the University of Pennsylvania, two new apartment complexes have been built on university property, but are managed by private companies. Other opportunities to overcome these challenges include infill and replacing buildings that have reached the end of their usable life with more intense and mixed-uses.

The Architecture, Engineering, and Construction (AEC) office on campus must take these initiatives. The office must create plans and bring projects to the Board of Regents for approval. Due to the large nature of these projects, the university must fund these projects unless donations can be secured, which was the case with the new Walgreens Drama Center on NC. If leasing becomes an option, then the university would not have to fund the projects since that would part of the developer's job. These projects can be implemented by following the suggestions developed in the 2008 North Campus Master Plan; cooperation among planners, stakeholders, and the Board of Regents; and devotion to this effort for many years to come.

TRANSIT

Challenges

The transit challenge to the university when considering sustainability is to reduce commuter dependence on the car. In order to reduce miles traveled in autos by students, faculty and staff, AATA and UM would do well in better integration of bus stations, information and marketing programs. More immediately, the blue bus system needs information on next bus arrivals at the bus stops to increase the ease and desirability of use.

Opportunities

A more integrated and efficient transit system, due to economies of scale in service and promotion, could reduce automobile dependency by making it easier to coordinate travel on and off campus. In the future, an Ann Arbor bus rapid transit (BRT) system could greatly improve travel times and fuel efficiency in both AATA and UM transit systems. Improvements are achieved through increasing average speeds, reducing congestion and stops between stations while retaining route flexibility for future development. BRT can provide more direct and faster service, since grade separated lanes allow multiple bus routes from various destinations, reducing the need for transfers.[57] Decreases in travel times and increases in inter-modal connections have been shown as a determining factors in increases transit ridership.

Further study into the current speeds and congestion trends of the 'Blue Bus' system is required to accurately assess feasibility of various transit options. General U of M population destinations would yield vital information in assessing AATA-UM Bus system integration. The aforementioned data will also serve to determine the feasibility and effectiveness of an Ann Arbor bus rapid transit system especially in determining expected traffic from develop of the former Pfizer properties

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BICYCLING

Challenges

The UM campus provides little support, programming, and facilities around promoting bicycle use in comparison to peer institutions. Major reasons not to implement more bike-friendly practices at the UM are a lack of funding and staff. There are also cultural challenges to increased bicycling because riders may feel unsafe and drivers who are unwilling share the road.

Opportunities

The UM has already stated a commitment to bicycling and has the support of the greater Ann Arbor community. If money is the largest barrier, funding has been identified through the Parking and Transportation Services (PTS) that could be used to start a bicycle-sharing program, extend East Quad bike co-op hours, raise awareness and education around benefits on bicycle use, and increase areas with covered racks. A bicycle coordinator position could also be created for a current student as a work-study position, assigned to the campus bike co-op, or delegated as a part-time task to a PTS staff member to implement and recommendations.

OFF-CAMPUS TRANSPORTATION

Challenges

As business and student travel makes a significant contribution to the University's environmental footprint, strategies to reduce emissions and reform procurement where possible must be taken. The primary barrier to reforming these practices is political. Changes must be made without drawing ire for restricting travel.

Opportunities

Travel to the Airport
When booking University business travel out of Detroit Metro Airport, rail and bus through fares must be displayed by the University's travel agency. This would provide travelling staff the opportunity to purchase a Michigan Flyer ticket to DTW when booking flights, rather than driving a single-occupancy taxi or personal vehicle to the airport.

Negating Travel Effects
A sustainability assessment charged for each trip on University business could support projects on campus that reduce energy consumption or emissions and have paybacks. Funding could come from departmental overhead costs, but political willpower is necessary.

Teleconferencing
Establishing one or two unified campus teleconferencing systems would end the differing technology and fragmented resources plaguing the University's various departmental systems. Each department could move its current telecommunications funding into a general fund to support one or two campus-wide systems, thus making such services more accessible to the University community.

GOODS

Challenges

Departmental courier services lead to an increase in courier miles travelled, but a University-run service would interfere with two existing courier service contracts.

Opportunities

Any unused fleet vehicle could be used for a consolidated, University-run courier service. If the University were to continue its contracts with Metro Delivery and SOS Express, the University's Procurement Services could set criteria for the companies to meet (e.g. requiring any new meet (e.g. requiring any new vehicles these companies purchase to meet certain mileage or emissions standards).

KEY RECOMMENDATIONS

Eliminate subsidies and incentives for driving in single-occupancy vehicles.
This recommendation can be met by restructuring parking fees from annual or monthly rates to daily ones (ie: convert annual blue pass at $749 to $3-$4 per day). This will require equipping all vehicles and lots on campus with AVI devices. Eliminate required subsidy from departments to the parking passes of their employees. Maintain parking subsidies only to low-paid staff members. Relevant unit: Parking and Transportation Services (PTS).

Reduce the need to drive on campus
This recommendation can be met by altering land use and travel environments on and between the campuses. By introducing mixed land use by leasing space to various businesses on all campuses, the need to drive off campus for errands, etc, can be reduced. For travel between campuses, bicycle travel needs to be easier. Improve bicycle parking with covered and secure options, add bike lanes, and provide bikes to those who need them through a leasing/sharing program. Relevant Units: Architecture, Engineering, and Construction) AEC and PTS. Driving on campus can also be reduced by consolidating courier services across the University. Mail Services might be best positioned to provide this service.

Reduce the need to drive to and from campus
Improving efficiencies in existing alternative transportation is crucial to increased use. Transit planning should focus simultaneously on the problem of moving people between campuses and moving people from town to campus. This implies integrating town-to-campus movements with the high capacity corridor currently under consideration. Technologies that improve movement between town and campus should be preferred over those primarily oriented towards shuttling passengers between campuses. Relevant unit: PTS. Consider cooperative agreement with airport transportation provide such as Michigan Flyer.

Track transportation habits on campus
In order to track progress in meeting our sustainability goals, tracking transportation is key. We need to track off-campus travel for University business, demand for particular transit routes, both on and off campus, and commuting transportation habits. This information can provide insight into what is working and what can be improved.

TRANSPORTATION TEAM

The transportation team is compromised of five graduate students, one undergraduate student and a faculty member of the Taubman College of Architecture and Urban Planning. The team's academic and professional backgrounds consist of social work, urban planning, sustainable systems, and public health.

Faculty Lead:
Jonathon Levine, PhD.

Team Members:
Anika Fassia
Chris Machielse
Brennan Madden
Sarah Mandlebaum
Gretchen Miller

Culture Team Liaison:
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Anika Fassia received a Bachelor of Science in Psychology and Environmental Studies [2007] from the University of Utah, and a Master in Social Work, concentrating in Social Policy and Evaluation [2010] from the University of Michigan. Anika was the chair of the student advisory committee for the Environmental Studies Department at the University of Utah, a graduate intern for the Clean Energy Coalition, and is currently a member of Common Cycle and the Washtenaw Biking and Walking Coalition.

Chris Machielse completed his freshman year as an undergraduate student at the University of Michigan in May 2010. He is currently working towards an undetermined B.A. from the LSA. In the fall he will begin work as a public relations coordinator for the Detroit Partnership and continue working with the Graham Institute's Integrated Assessment.

Brennan Madden received a Bachelor of Science in Psychology and concentrations in Bioethics, Biology, Film and Neuroscience from Loyola University and is currently working on a Master's in Natural Resources and Environment: Sustainable Systems at the University of Michigan. Sustainable research and projects include: Student Team Leader of facility design & grant writing for the US EPA Prosperity and the Planet Student Design Competition for Sustainability entry named 'Innovative biodiesel production: A solution to the scientific, technical and education challenges of sustainability', and BLUElab (Better Living Using Engineering Laboratory) – Sustainable development in Hagley Gap, Jamaica. Brennan is currently working on a Sustainable Development Management Plan for ho avy & New Latitude (conservation non-profits) in Ranobe, Madagascar.

Sarah Mandlebaum has a Master of Public Health in Environmental Health from the University of Michigan. She also received her undergraduate degree in Anthropology-Zoology from the

University. Her experience with life cycle assessment and as a cyclist in Ann Arbor contributed to the *Transportation* team.

Gretchen Miller: will be entering her second year of the Master of Urban and Regional Planning program in the fall of 2010. She received her undergraduate degree in Mechanical Engineering from the University of Michigan [2009]. During her undergraduate career, Gretchen had internships in both research and design, with her main research area being the mechanical properties of micro-scale materials. In the summer of 2007, she worked abroad in Friedrichshafen, Germany and traveled to many of the surrounding areas, which is what piqued her interest in transportation engineering and planning. After getting married in October 2010 and graduation the following May, she will be moving to Boston to pursue a career in transportation.

ACKNOWLEDGEMENTS

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APPENDICES

APPENDIX A- TIME FRAME: TRANSPORTATION TEAM RECOMMENDATIONS

Short Term (1 year)

- ✓ Track transportation habits on campus

Medium Term (1-5 years)

- ✓ Track transportation habits on campus
- ✓ Eliminate subsidies and incentives for driving single-occupancy vehicles
- ✓ Reduce the need to drive on campus
- ✓ Reduce the need to drive to and from campus

Long Term (5-15 years)

- ✓ Track transportation habits on campus
- ✓ Eliminate subsidies and incentives for driving single-occupancy vehicles
- ✓ Reduce the need to drive on campus
- ✓ Reduce the need to drive to and from campus

APPENDIX B – UM CAMPUS BIKING AND WALKABILITY ANALYSIS

Key components to assessing the UM campus cycling environment is to identify barriers to bike parking and safe riding.

Bike Parking

Table 1 represents areas where bikes have been abandoned, preventing current cyclists from parking and areas where covered infrastructure is not being utilized to provide sheltered parking from inclement weather conditions.

Table 1. Covered Parking and Abandoned Bikes

Underutilized Covered Infrastructure	Abandoned Bikes
Chemistry Building East Side	School of Social Work
Chemistry Building West Side	
Hatcher Graduate Library	
Shapiro Undergraduate Library	

Figure 1. School of Social Work Bike Parking

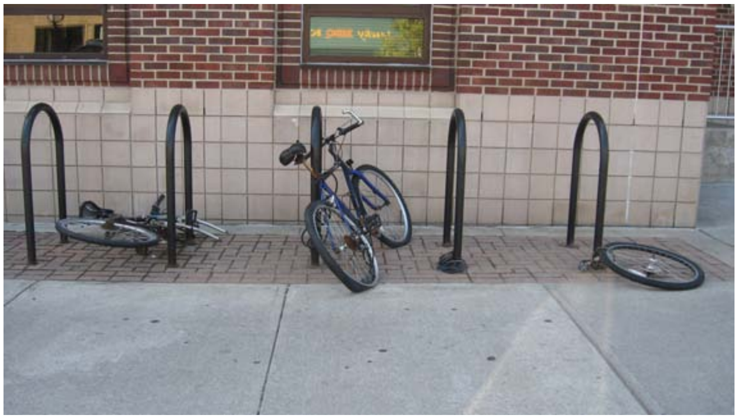

Figure 2. Chemistry Building East Side

Figure 3. Chemistry Building West Side

Figure 4: Hatcher Library Bike Parking

Figure 5. Shapiro Library

Unsafe Cycling Zones for Cyclists and Pedestrians

Many zones throughout campus have been identified to be unsafe zones for both cyclists and pedestrians. Table 2 represents aspects of unsafe areas as it pertains to both cyclists and pedestrians.

Attributes have been given to areas that are unsafe to cyclists such as narrow roads, high traffic, and no bicycle lanes.

A hub for pedestrian activity and mobility is the diag. The diag is where people may move between several academic buildings, between State Street, North University, and South University, engage in campus group and activism activities, and socialize. The South University arch entrance into the diag prohibits cyclists to ride through, but is often not followed. Many cyclists also speed through the diag, creating a dangerous environment for pedestrians.

Table 2. Unsafe Cycling and Pedestrian Zones

Attributes	Unsafe Cycling Zones	Zones Made Unsafe by Cyclists
Narrow Roads	State Street, N. University	
High Automobile Traffic	Fuller, Plymouth	
No Bicycle Lanes	State Street, Glen & E. Huron	
High Speeds	Fuller, Plymouth	
Pedestrian Traffic	Diag	Diag
Small Shoulder	Plymouth	

Figure 6. South University Diag Entrance

Figure 7. Diag

Figure 8. Intersection of North University and State Street

Figure 9. State Street

Figure 10. Intersection of Glen and E. Huron

Figure 11. Fuller

Figure 11. Plymouth

Conclusion

Through the utilization of covered infrastructure for bike parking and the addition of wider shoulders and bike lanes to unsafe cycling zones, we can begin to prevent areas that are both unsafe to cyclists and pedestrians. These efforts will create and instill a bike friendly campus environment that promotes several methods of alternative transportation and environmental sustainability.

APPENDIX C: OFF CAMPUS TRANSPORTATION: What is everyone else doing?

Voluntary Donations:

University of California – Berkeley's Climate Action Fund is made of completely voluntary donations.

Pros:

- Easy to implement politically, no mandate for travelers
- Opportunity for people who care about their carbon footprints to donate to support carbon reduction projects on campus
- The money that is raised stays on campus

Cons:

- Less than 20 donations have been made (voluntary)
- Donations total less than $5000 in this case study
- Not advertised or promoted well
- People aren't responsible for their environmental impacts unless they choose to be

Mandatory Fees:

Arizona State University – Any time a department fills out a form for faculty travel, a fee is assessed that comes from the unit's overhead. The money is divided into three separate funds. One smaller revolving fund provides small grants for projects students or faculty want to do on campus. A larger fund provides matching funds for bigger projects. The largest fund has no cap and funds large-scale projects on campus. These projects need to pay for themselves in energy savings, so the medium and largest funds are considered loans.

Pros:

- Money goes towards campus infrastructure
- Assessed to all University travel
- Projects that save energy can be sold as offsets

Cons:

- Self assessment
- Politically difficult

Carbon Offsets:

Duke University – Does not buy offsets at this time, but produced a report examining the possibility. Funding from RFPs, grants, over-the-counter offsets, CCX membership, procurement, endowment, or optional tuition fees.

Pros:

- Sets criteria for building an offsets portfolio (contributes to compliance, credible, measurable, cost, environmental/community co-benefits, links to education/research/service, low risk through diverse projects)
- Offsets only for local projects (in-state)
    - Forestry (afforestation, forest management, avoided deforestation)
    - Agricultural Lands (soil sequestration, fertilizer/waste application management)
    - Methane Capture (hog waste & landfills)
    - Electricity Energy Efficiency

Cons:

- Offsets that have already been purchased voluntarily might not count as cap reductions if federal climate legislation is passed
- Paying others not to pollute
- Requires Duke to act in an entrepreneurial role
- Expensive

University of Winnipeg – Offers eligible employees a reimbursement at a maximum from $50-100 for “wellness” or sustainability actions. Faculty can use the annual reimbursement to help cover the cost of a gym membership, bus pass, or the purchase of carbon offsets from an approved offset vendor.

Pros:

- Benefit that can serve as a recruiting tool for faculty
- Preserves person choice. Faculty who value sustainability can use this money towards carbon offsets, or purchases of other appliances or goods that promote sustainability.

Cons:

- Staff who only get $50 might not even cover the cost of one qualifying purchase, so unless carbon offsets are the top priority for the faculty member, the reimbursement will likely go to other purposes, or perhaps towards wellness purchases instead of sustainability purchases.
- Only available once per year, which could limit its effectiveness
- To date, no faculty have used the benefit to pay for carbon offsets

Nothing:

University of Michigan – Currently no environmental criteria restrict excess travel, and the University does not offer any way for faculty or staff to support environmental initiatives to reduce environmental impact of travel.

Pros:

- Easiest political solution
- Requires no effort to change
- Eliminates possibility of expenses that could be incurred from environmental projects

Cons:

- Does not ask faculty to consider environmental impact of travel
- Does not provide a way for travelers to mitigate their emissions, even if they would be interested in doing so

- Maximum environmental impact
-

Travel to Airport: U Minnesota and the Minneapolis commuter rail.

- Pro: Students use the same transit pass they have for city buses to ride the rail at no additional charge
- Con: Students need to pay for their UPass to use transit. Use of UPass for travel to airport is not well promoted.

  *Neither Michigan Flyer nor the proposed commuter rail would be run by AATA, so an agreement with those agencies would need to be made.

APPENDIX D: AIRPORT TRAVEL COST ANALYSIS

Assumptions

EDIT ONLY CELLS SHADED IN LIGHT YELLOW

(If red number appears, percentages of travellers are not equal to 100%)

	Demographics
6180	Faculty (People who may travel)
75.0%	Ratio of numbers of trips to number of faculty
4635	Number of Flights Annually
47.5	Percent driving personal vehicle to airport
47.5	Percent taking taxi to airport
5	Percent taking Michigan Flyer (no special contract) to airport
	Reimbursement Rates
$ 10.00	Per day parking
$ 0.50	Per mile of personal vehicle usage
$ 100.00	Taxi Fare (roundtrip)
$ 30.00	Michigan Flyer Tickets
	Behavior
24.00	Average Miles Travelled to Aiport (one-way, personal vehicle trips)
24.00	Average Miles Travelled to Aiport (one-way, taxi trips)
3	Average Trip Length (Days)
	Sustainability
20	Average MPG of Personal Vehicle
1	Number of personal vehicle occupants
18	Average MPG of Taxi
1	Number of passengers sharing taxi
5	Average MPG of Michigan Flyer motorcoach
20	Number of riders sharing Michigan Flyer motocoach
19.4	Pounds of CO2 emitted per gallon of gasoline
22.2	Pounds of CO2 emitted per gallon of diesel

	Number of Travellers
Personal Vehicle	2201.625
Taxi	2201.625
Michigan Flyer	231.75

Passenger MPG	20	Passenger gallons per mile	0.050
Passenger MPG	18	Passenger gallons per mile	0.056
Passenger MPG	100	Passenger gallons per mile	0.010

Cost

	Mileage	Parking	Fares	Avg/Traveller
Personal Vehicle	$ 52,839.00	$ 66,048.75	$ -	$ 54.00
Taxi	$ -	$ -	$ 220,162.50	$ 100.00
Michigan Flyer	$ -	$ -	$ 6,952.50	$ 30.00
Total	$ 52,839.00	$ 66,048.75	$ 227,115.00	$ 74.65
Grand Total	$ 346,002.75			

Emissions

	Passenger Miles	Gallons of fuel	CO2 emissions (lbs)	lbs CO2/passenger
Personal Vehicle	105,678.00	5,283.90	102,507.66	46.56
Taxi	105,678.00	5,871.00	113,897.40	51.73
Michigan Flyer	222,480.00	2,224.80	49,390.56	10.66

Mileage takes into account a roundtrip to and from DTW

Michigan Flyer passenger miles calculated by taking number of faculty trips on the service multiplied by the roundtrip distance between DTW-Ann Arbor and the number of passengers sharing the bus

APPENDIX E: COURIER ANALYSIS

Selected Case Study: Taubman College of Architecture and Urban Planning

Taubman's use of couriers is completely independent of other University units. This decentralized operation may result in redundancies and extraneous vehicle miles travelled (VMT).

Courier services at TCAUP are provided by employees hired directly by the college. Shipments for the college are delivered by an employee using a leased van, unless time sensitive deliveries require that more than one delivery run must be made in a given day. In the event that the van is unavailable, the courier utilizes the U of M bus system. The majority of shipments go to Wolverine Tower, with other common destinations being Rackham and the Fleming Building. In the rare occassion that all of a given day's shipments are for Wolverine Tower, senders are told to use the campus mail dropbox in Pierpont Commons.

Mapping out a route that goes from TCAUP to Rackham, Fleming, and Wolverine Tower yields a trip of roughly 4.9 miles, with an additional 4.7 miles required to return from Wolverine Tower to the TCAUP. Conservatively estimating a courier's journey averages 9 miles in a given business day with an assumption of no time-sensitive deliveries requiring more than one delivery trip per day, TCAUP courier services result in 45 VMT per week. If nearby units such as the School of Engineering, School of Art & Design, or School of Music had similar and independent courier units travelling similar distances, 180 VMT would be travelled per week only from the U of M colleges that are on or near Bonisteel Boulevard. As Wolverine Tower contains much of the University's administrative operations, it is likely that many courier deliveries on campus ultimately end at Wolverine Tower.

If just the Engineering, Art & Design, Music, and Architecture & Urban Planning Schools consolidated their decentralized systems and shared a single courier making a single delivery route to destinations on Central Campus, in the City of Ann Arbor, and ending at Wolverine Tower, VMT could be drastically reduced. Assuming each additional unit sharing the courier would add 5 miles per day to the average TCAUP route because additional buildings throughout campus would become stops while distances travelled between North and Central Campus and between Central Campus and Wolverine Tower would remain constant, a hypothetical shared courier between just the four aforementioned units would travel 25 miles per day, resulting in savings of 15 miles per day or 75 miles per week.

Over the course of a full calendar year, 3900 miles could be saved just from consolidation of these four units. An average University van leased from fleet services could achieve fuel economy of roughly 18 mpg in the city on gas or 14 mpg on E85 ethanol. Using these figures, this consolidation could theoretically save nearly 217 gallons of gas or 279 gallons of E85 per year. At 19.4 pounds of CO_2 emissions per gallon of gasoline, saving this amount of gas would reduce carbon dioxide emissions by approximately 4209 pounds annually. A more thorough analysis of the operations and courier usages of various units would yield a more accurate estimate and also provide the opportunity to identify potential opportunities to consolidate courier services.

REFERENCES

[1] Shoup DC. The politics and economics of parking on campus. In: Ison S, Rye T, editors. The implementation and effectiveness of transport demand measures: An international perspective. Aldershot, UK: Ashgate Publishing; 2008. p. 121-149.

[2] Willson RW, Shoup DC. Parking subsidies and travel choices: Assessing the evidence. Transportation. 1990; 17:141-157.

[3] Shoup DC. The high cost of free parking. Chicago (IL): Planners Press; 2005.

[4] Litman T. Parking Costs, Pricing and Revenue Calculator [Internet]. Victoria Transport Policy Institute; 2007. Available from: www.vtpi.org

[5] Poter, RC. Economics at the wheel: the costs of cars and drivers. San Diego (CA): Academic Press; 1999.

[6] US Department of Labor: Bureau of Labor Statistics. Consumer Price Index. Available from: http://www.bls.gov/cpi/tables.htm.

[7] Venturi, Scott Brown and Associates, Inc. The University of Michigan Campus Plan: Phase 1 Overview. Ann Arbor (MI): April 1998, 2.

[8] Johnson, Johnson, and Roy Inc. Central Campus Planning Study: a concept for continuing physical development. Ann Arbor (MI): June 1963, 18-19.

[9] Johnson, Johnson, and Roy Inc. North Campus Planning Study. Ann Arbor (MI): July 1984.

[10] University of Michigan Architecture, Engineering, and Construction [Internet]. Ann Arbor (MI): c2008. 2008 North Campus Master Plan Update, 7 [cited 2010 Feb 22]; [62 pages]. Available from: http://www.umaec.umich.edu/campus.plans/U-M%20North%20Campus%20Master%20Plan%20Update%20-%203.5.09.pdf.

[11] Kockelman, K.M. Travel Behavior as Function of Accessibility, Land Use Mixing, and Land Use Balance. Transportation Research Record. 1997; 1607: 117-125.

[12] Interview with Gary Brown, Director of the Office of Planning and Landscape Architecture, University of Wisconsin. March 17, 2010.

[13] Interview with Mina Amundsen, University Planner, Cornell University. March 15, 2010.

[14] Interview with Adembesa Gusa, Assistant Director, Planning and Design Staff, Duke University, March 23, 2010.

[15] OSEH University of Michigan, 2009 Annual Environmental Report (Ann Arbor: University of Michigan, 2009).

[16] Parking & Transportation, Bus Routes and Schedules, 2009, 2 March 2009 <http://pts.umich.edu/taking_the_bus/routes/index.php>.

[17] G. Christopher White, Manager of Service Department AATA. AATA Data for Calendar Year Riders. (Ann Arbor, MI, 2010)

[18] BRW, Inc, The University of Michigan Expanded Parking Paradigm Study (Minneapolis: BRW, Inc, 1995).

[19] Michael Eichler and Carlos F Daganzo, Bus Lanes with Intermittent Priority: Screening Formulae and an Evaluation, UC Berkeley (Berkeley, CA, 2005).

[20] University Relations Office. CATA, MSU reach agreement to put CATA in the driver's seat. East Lansing (MI): 1999. Available from: http://news.msu.edu/story/1882/&perPage=100

[21] Bechtel, Amanda. "Universities Conference Explores Strategies for Productive Relationship" American Public Transportation Association (APTA) Transportation & University Communities Conference (East Lansing, MI, 2006).

[22] Capital Area Transportation Authority. 2007 Community Report (Lansing, MI: 2007).

[23] University of North Carolina at Chapel Hill. Sustainability - Transit Options (Chapel Hill, NC, 2010) <http://sustainability.unc.edu/Default.aspx?tabid=138>.

[24] Transportation Services University of Wisconsin-Madison. Transit. (Madison, Wisconsin, 2010) <http://www2.fpm.wisc.edu/trans/alt_transit.asp>

[25] Capital Area Transportation Authority

[26] University of North Carolina at Chapel Hill

[27] Hugh E. Kierig, "Morgantown Personal Rapid Transit," University of Michigan Transportation Technology Forum (Ann Arbor, 2010).

[28] Christopher Perkins, "Personal Rapid Transit - Unimodal systems," University of Michigan Transportation Technology Forum (Ann Arbor, 2010).

[29] Michael York, "Cleveland Euclid Corridor," University of Michigan Transportation Technology Forum (Ann Arbor, 2010).

[30] Cornell University Transportation and Mail Services. TMS: Bus Services (Ithaca, NY, 2010) <http://www.transportation.cornell.edu/tms/parking/commuting/busservices/index.cfm>

[31] Will Toor, "Transportation Planning at the University of Colorado: Finding a New Way," 1998, ULSF University Leaders for a Sustainable Future, 3 March 2010 <http://www.ulsf.org/pub_declaration_opsvol21.html>.

[32] U of M Parking and Transportation Services, "UM Bus Rider Frequency Data," (2009).

[33] Ann Arbor Transportation Authority, "Ridership by Route by Time of Day Data," (2007).

[34] Ann Arbor Transportation Authority, "Average Weekday Riders by Route," (2009).

[35] U of M Parking and Transportation Services, "UM Bus Rider Frequency Data," (2009).

[36] Ann Arbor Transportation Authority, "Ridership by Route by Time of Day Data," (2007).

[37] Ann Arbor Transportation Authority, "Average Weekday Riders by Route," (2009).

[38] Batterman, J.M. Building a Michigan Blueprint: An Outline for the UM Bicycle Master Plan. Parking and Transportation Services, 2009.

[39] Toor, W. & Havlick, S.P. (2004). Transportation & Sustainable Communities: Issues, Examples, And Solutions.

[40] Alliance for Walking and Biking: 2010 Benchmarking Report.

[41] City of Ann Arbor Non-motorized Transportation Plan, 2006

[42] Natsinas, T., Levine, J. & Zellner, M. Successful Bike Planning: Adapting Lessons from Communities with High Bicycle Use to Ann Arbor and Washtenaw County. University of Michigan: Urban and Research Collaborative, September 2001.

[43] Office of Campus Sustainability. Transportation analysis team background information. Report. Ann Arbor (MI). Available from: https://ctools.umich.edu/access/content/group/666109fe-b8ea-4948-b375-9b26e5e571b5/All Team References/OCS Reports/Transportation.docx

[44] The American Bus Association Foundation. 2006 Annual report: impacts of the motorcoach industry on society and the economy. Report. Washington, D.C.: 2007 Jan.

[45] The University of Michigan. Human capital report – 2009: special report – recruitment and retention successes and challenges. Report. Ann Arbor: 2009 July.

[46] Elgin B. Another inconvenient truth: behind the feel-good hype of carbon offsets, some of the deals don't deliver. Business Week 2007 March 26: 96.

[47] Frank R. Carbon offsets: a small price to pay for efficiency. New York Times (New York ed.) 2009 May 31;Sect. BU:4.

[48] Bookhart D. Strategies for carbon neutrality. Sustainability. 2008;1(1):34-40.

[49] Andreev P, Salomon I, Pliskin N. Review: state of teleactivities. Transportation Research Part C. 2010; 3-20

[50] Arizona State University. Carbon neutrality action plan [report on the Internet]. Tempe (AZ); 2010. Available from: http://carbonzero.asu.edu/CarbonPlan022410.pdf

[51] Oregon State University. A strategic plan for institutional climate neutrality. Corvallis (OR); 2009. Available

from: http://oregonstate.edu/sustainability/sites/default/files/docs/osuclimateplan2009.pdf

[52] The University of Michigan. Procurement Services: University Contracts [Internet].Available from: http://www.procurement.umich.edu/ucontracts_list.php

[53] Michigan Print Copy Mail. Campus Mail [Internet]. Available from: http://mbiz.bf.umich.edu/mailsvcs/campusmail.htm

[54] Michigan Print Copy Mail. Campus Mail [Internet]. Available from: http://mbiz.bf.umich.edu/mailsvcs/campusmail.htm

[55] Transport Studies Group. A framework for considering policies to encourage sustainable urban freight traffic and goods/service flows – Report 2: Current goods and service operations in urban areas. Report. London: The University of Westminster; 2000.

[56] Cornell Mail Services. Mail guide. Ithica (NY): Cornell University. Available from: http://www.transportation.cornell.edu/tms/cms/mail/upload/mailguide.pdf

[57] Alan Hoffman (2008), *Advanced Network Planning for Bus Rapid Transit: The "Quickway" Model as a Modal Alternative to "Light Rail Lite,"* National BRT Institute (www.nbrti.org), Federal Transit Administration, USDOT; Available from: <http://www.nbrti.org/docs/pdf/BRT%20Network%20Planning%20Study%20-%20Final%20Report.pdf>

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

Please direct comments or questions to: GrahamInstitute-IA@umich.edu

For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

UNIVERSITY OF MICHIGAN
CAMPUS SUSTAINABILITY ASSESSMENT

PHASE ONE REPORT: LAND AND WATER

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The University of Michigan Office of Campus Sustainability

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In assessing the ecological stewardship of the University of Michigan, the Land and Water Team took a broad, landscape ecology approach rooted in the following key concepts:

1) Landscapes and ecosystems that occur across University of Michigan property, however urban, are nested within a larger, regional landscape composed of watersheds, habitat networks, and other complex natural systems whose health, integrity, diversity, and ability to offer valuable ecosystem services such as clean air, clean water, carbon sequestration to help offset the effects of global warming, etc., is dependent upon maximizing the ecological potential of each part of the whole. The complexity of university planning and design must strive to match the depth and complexity of this larger landscape to which we belong.
2) The ecological health of U-M landscapes must be considered within *both* the immediate and long term time-frames, with special consideration for creating landscapes that will have an increased chance of resiliency in the face of global climate change.
3) All human beings who interact with U-M landscapes are a critical component in the realization of any and all recommendations, and whose role in actively supporting the enhancement of ecological health within and beyond the campus landscape cannot be over-stated. The U-M, therefore, should dedicate itself to not only creating the most sustainable campus that it can, but to also creating a constituency of individuals that deeply understand the role they play in facilitating the ecological health of their regional landscape.

Specific recommendations with measurable goals pertaining to the five main themes of university planning and design, vegetative cover, stormwater management, management and maintenance, and environmental education/eco-revelatory design can be found in main body of this report. The following list is an overview of the goals and action items that are part of the Land and Water Team's specific recommendations. These goals and action items are offered as a vehicle for readers to better understand the range, scope, and interconnectedness of the team's work.

1. **Transform the University of Michigan into an exemplar of sustainable urban design.** Do this by restructuring the campus planning process to : 1) prioritize sustainability and ecological function at a range of scales as a central planning and design principle in all projects; 2) create a consistent policy for meaningful, accessible, and transparent student, staff, and faculty participation in all planning and design; 3) promote landscape connectivity and ecosystem function through sensitive site planning, and through the creation of a tiered system of land conservation zones on campus; and 4) consider the use of eco-revelatory techniques and elements wherever possible to help elevate the visual presence of ecosystem function throughout campus.

2. **Reduce stormwater runoff and increase stormwater quality through the use of best management practices such as bioswales and permeable paving**. In some areas with high pollutant loads, combine traditional tools such as catch basins and oil skimmers with surface drainage techniques such as swales to both improve water quality, reduce peak flows, and increase the time-in-residence of water within the treatment system prior to discharge into local streams, rivers, or municipal stormwater systems. Where possible, utilize 'eco-revelatory' techniques to highlight the issue of stormwater runoff and infiltration, and then make use of these installations to further the understanding of students, faculty, staff and visitors regarding ecosystem health and function in a range of landscape types.

3. **Increase biodiversity through the use of native plants in campus landscapes,** with the goals of: 1) increasing both the quality and quantity of campus habitat for insects, birds, reptiles, amphibians, and small mammals; 2) increasing the resiliency of the landscape in the face of climate change; 3) re-invigorating the campus tree planting program with a focus upon habitat enhancement, and upon a campus-wide understanding of the impact that the campus/urban forest has on microclimate and upon carbon sequestration; 4) establishing stream corridor buffers along campus waterways, including within the riparian ecosystems along the Huron River; and 5) increasing the awareness of students, staff, faculty and visitors to campus regarding the ecological, visual, and cultural impacts that such changes can bring about.

4. **Reduce the amount of 'excess' lawn throughout campus, replacing it with either a more ecologically sustainable substitute such as 'Eco-lawn' or with planting beds**. Manage all areas (lawn, eco-lawn, planting beds) with fewer or no chemical inputs (see #5), paying close attention to the visual/physical health of the vegetation in the landscape as well as to the health of the underlying soils and subsurface water flow present within the campus grounds. Assess all lawn areas in particular and replace turf in low-use, and some medium-use areas, with a lower maintenance-intensive and higher habitat value landcover. Take advantage of on-campus courses, tours, and print/web outreach to educate in both passive and active ways as to how the campus functions as an ecosystem, and how 'site scale' strategies such as the removal of lawn impact both local and more regional landscapes.

5. **Decrease the use of chemical fertilizers, pesticides, herbicides, and fungicides; eliminate their use completely by 2020. Increase the amount of non-mechanized maintenance practices to reduce fuel consumption**. Use this shift in maintenance to encourage more hands-on maintenance, and as a rationale to move away from high-maintenance, manicured non-native landscapes towards a more contextually-based aesthetic that not only reflects the place that we live, but that also requires less overall inputs into the landscape. Utilize the savings in gas and chemical purchasing to instead fund individuals to care for the landscape, which might also increase a sense of ownership and stewardship among the residents of campus. Also, the university should seek to reduce the use of fuel-inefficient, highly polluting (both air and noise) tools that rely on two-stroke engine technology. In winter, consider how chemicals, salts, etc.

applied to the landscape will eventually affect animal, plant, soil and water quality/health when it melts and drains. Reduce the negative impacts of that process.

INTRODUCTION

The landscapes that occur across University of Michigan property are, collectively, what define the university as a unique, beautiful, inspiring, and enjoyable place – a place that should be conducive to learning and research as well as memorable in the hearts of alumni for many years into the future. They are, as a whole, meant to be more than just 'leftover' spaces, architectural accessories, cultural icons, or isolated remnants of natural systems. They have a trajectory, a role in the larger regional landscape, and a need to be considered holistically as a landscape with both ecological and social imperatives that must be considered and addressed if sustainability is to be achieved.

The terrain that U of M is built upon, long ago carved by glaciation, has been shaped by the modern land use demands of university founders, leaders, and community members. Though the fabric of the landscape -- once dominated by hardwood forests, oak savannas, and wetlands -- has been fragmented as the university and the city of Ann Arbor have expanded, the open spaces that remain, however small, still possess ecological value and great potential for enhanced ecological functioning, in addition to their cultural importance. Sustainable land, water, and stormwater management in the 21st century will require a broad sense of stewardship that aims to marry ecological function with both cultural form and economic reality, such that biodiversity can be cultivated, stormwater infiltrated, carbon sequestered, and pollution prevented within the campus ecosystem in ways that align with established cultural aesthetics and values[1], as well as the university's budget.

This assessment of "land and water" at U-M acknowledges that a variety of landscape typologies and landcover types exist across university property, and has considered each through five different (yet overlapping) lenses: university planning and design, vegetative landcover, stormwater management, grounds management and maintenance, and eco-revelatory[2] design. A guiding concept of this assessment is that every landscape that occurs on U-M property -- be it manicured campus, sports field, forest patch, or parking lot – sits within an ecological framework wherein it contributes, positively or negatively, to the overall health of natural systems such as watersheds and habitat networks. The Michigan Department of Natural Resources and Environment (MDNRE) transition coordinator Bruce Rasher has proposed that MDNRE business be organized according to natural systems, as opposed to geographical boundaries[3], in order to incorporate this kind of macro-ecological perspective into environmental decision making in the state of Michigan. We are encouraging the university to consider their position within the Middle Huron Watershed, for example, in all land use-related decision making on campus. In this sense, we are asking university planners, designers, decision and policy makers, and grounds staff to change and adapt not only the fabric of the landscape at U-M, but their fundamental conceptual framework of it.

Another overriding concept in this assessment is the notion that the landscape can be a profound educational tool in and of itself. As such, every recommendation below considered how landscapes could be designed to convey the importance of the ecological functions that they offer, while educating university students, faculty, staff, campus visitors, alumni, and local citizens as to the presence of ecological function in everyday landscapes, using what is termed "eco-revelatory" design[4]. Eco-revelatory design is defined as landscape architecture that intends to showcase, interpret, and/or enhance ecological function at the site-scale and beyond. Its goal is to expand the presence and awareness of visible ecological process, particularly in urbanized and/or developed landscapes. Since this will be a pilot effort in sustainable land use at the University of Michigan, it is important that the recommendations that are implemented are both highly visible and understandable by the widest audience possible. For this reason, most of our attention will be given to the traditional campus landscape; however, it is critical to implement the thinking inherent in this report in all landscape contexts under the control of the U-M.

Finally, sustainable urban ecosystems in the 21st century must possess some degree of resiliency in the face of global climate change. Leading ecologists today posit that human facilitation of ecological resiliency through actions such as assisted species dispersal and migration and simulation of ecological disturbance through controlled burning is not optional, but necessary[5],[6].

The recommendations we are making focus on achieving sustainability at U-M through the adoption of land and stormwater management practices that promote invaluable ecosystem services such as biodiversity, clean air, clean ground and surface water, and more. The new landscape sustainability rating system, the Sustainable Sites Initiative (SSI), has helped inform this assessment, and could prove useful to the university in guiding retrofit and new development projects[7].

Though each recommendation is presented separately in this report, they are highly interrelated, and their individual and cumulative potentials will best be realized if executed in tandem.

Regional Trends

To assess the potential for sustainable land and stormwater management at U-M, the team studied relevant literature, researched precedents at other universities, and studied history and current trends within the university, as well within the broader landscape context that it resides in.

Many environmental organizations and citizens at the state and local levels have labored to inventory natural assets, sensitive areas, ecological threats, and numerous other issues and systems, and have, as a result, instigated efforts to promote watershed, resource, and habitat protection, as well as land conservation. The university community should be aware of local environmental efforts, and view their commitment to the research and implementation of sustainable practices as part of a collaborative regional effort.

Specific local initiatives that were considered in this assessment include those of the Huron River Watershed Council (HRWC), the Southeast Michigan Council of Governments (SEMCOG), the Washtenaw County Water Resources Commissioner relating to watershed and land use planning[8],[9],[10], the Allen Creek Greenway initiative[11], the Mallet's Creek Restoration Plan[12], the Millers Creek Watershed Improvement Plan[13], the Ann Arbor Greenbelt initiative[14], and the Border to Border Trail System[15].

The watershed-based initiatives aim to improve and monitor the water quality of the Huron River (the source of drinking water supply for many communities) and its tributaries, which suffer in varying degrees from "urban stream syndrome," with symptoms such as "flashy flows" (rapid, erosive discharges during and after major storm events due to high levels of impervious urban landcover), temperature fluctuations, erosion and sedimentation, high nutrient levels, high bacteria levels, high dissolved oxygen and saline content, etc., all of which degrade water quality and aquatic habitat[8],[16]. The Huron River, in particular, has suffered from high phosphorous and E. coli levels. Detailed research has been conducted for both Millers and Mallets Creeks, two of the more impaired waterways in the county, both of which receive runoff from U-M property. Flooding in the Allen Creek floodplain (despite the fact that the creek has been piped in its entirety) has motivated a number of innovative local stormwater projects, such as the construction of a large underground storage system and raingardens at Pioneer High School[17].

County land conservation initiatives envision a large greenbelt of agricultural and open space around the city of Ann Arbor, a pedestrian/bike path along the route of a once-again day lit Allen Creek,[11] and a bicycle trail that runs the length of the Huron River between Ann Arbor and Ypsilanti, within a protected riparian buffer. The HRWC Bioreserve Project has recently been assessing the ecological value of open space in the county based on a number of critical factors, including proximity to water, biorarity, and connectivity to other open spaces[18]. The team considered HRWC Bioreserve patch value ratings in the assessment of relevant properties both on and adjacent to campus. Furthermore, the city of Ann Arbor has inventoried every street tree that exists within the municipality, just as U-M has a database of all trees on North, South, Central, and Medical Center Campuses, which could prove useful in collaborative biodiversity goal setting.

I. UNIVERSITY LAND USE PLANNING AND DESIGN

STATUS AND TRENDS: UNIVERSITY LAND USE PLANNING AND DESIGN

Trends in Conservation of Natural Areas and Preservation of Ecosystem Function

Conserving natural areas on campus and structuring land use decisions upon the protection of ecosystem function are cost-effective methods of creating a sustainable campus by leveraging the ecosystem services that the land already provides instead of investing in mitigation efforts. Natural areas on campus encourage groundwater recharge, help to filter chemical and nutrient runoff to rivers, provide wildlife habitat, mitigate the heat island effect, and act as carbon sinks for greenhouse gasses[19]. Therefore, the imperative of natural areas conservation on campus and university landholdings is clear. However, there are several methods that can be employed to achieve this objective, and these methods are often determined by the legal, financial, and character settings of a particular university. Following is a brief discussion of trends at universities with respect to the conservation of natural areas and preservation of ecosystem function.

Duke University, a private university, owns many forested acres in an area that is experiencing rapid urbanization. Duke's *2000 Master Plan* sought to preserve the natural landscape identity of the University by stating in its fourth principle that "Duke is a university in the forest."[20] The Duke Forest runs adjacent to the campus, and provides thousands of acres of high quality natural areas for recreation and habitat, as well as for research and environmental education. To conserve this valuable natural asset and to preserve its ecological health, Duke devised a "conservation zone" designation in its *2000 Master Plan*—limiting development in the most "ecologically sensitive and effectively irreplaceable" areas to only light use features such as bike paths, path lighting, and signage.[21] To ensure implementation, Duke has created a Master Plan Oversight Committee that reviews development plans and their adherence to the master plan. Moreover, Duke has entered into a voluntary, nonbinding agreement with the North Carolina Department of Environment and Natural Resources to enroll 1,220 acres of Duke Forest in the Natural Heritage Areas Registry—which commits Duke to preserving these areas in their natural state while prohibiting development indefinitely.[22]

In order to increase the populations of certain threatened and endangered species on the San Francisco Peninsula, and to "support regional efforts to maintain native diversity," ***Stanford University*** has created a US Fish and Wildlife Service approved Habitat Conservation Plan. The Plan establishes conservation easements in perpetuity along all campus riparian corridors that will be held by a land trust specially created by the Stanford Board of Trustees to monitor the Plan's implementation. The Plan also creates 50-year "no build zones" to allow for California tiger salamander habitat to flourish.[23] Although this method does transfer a property interest to a third party, it maintains a high-level of control by the University Trustees, as they ultimately are the creators of this third party body and could feasibly determine those persons who would administer the land trust.

The ***University of Vermont*** (UVM) has a long history of environmental stewardship. UVM is a land grant university that created a system of "natural areas" among its most ecologically valuable and naturally impressive landholdings starting in 1974. The natural areas system, whose lands have been preserved in their natural state for the enjoyment of all Vermonters and for use as ecological/environmental research sites, was placed under the management of the UVM Natural Areas Center after the UVM Board of Trustees created the Center in 1996. As of 2002, the Natural Areas comprised 1,919 acres.[24] The University of Vermont is unique among public institutions in that it must abide by local zoning ordinances and submit to local planning and zoning procedures.[25] In such a situation, the University has an incentive to leverage the value of its large natural areas in municipal jurisdictions whose zoning regulates campus areas, to enter into agreements with these municipalities to allow more dense development in central campus in excess of what previous zoning codes would have allowed. Thus, the University has granted a conservation easement to the City of Burlington in the Centennial Woods area—one of UVM's Natural Areas adjacent to campus. The conservation easement creates a legal property interest in the land that allows the City to oversee and enforce an agreement that the University will conserve the Woods in their undeveloped state in perpetuity.**Error! Bookmark not defined.**

Trends in the Campus Planning Process: Public Participation

An often overlooked, yet essential, component of a planning process that will foster sustainable outcomes is that of public participation from a wide array of stakeholders and users. Quite often, a campus (or city) planning process that includes student, faculty, and employee input from the start fosters a sense of investment among the campus community in its outcomes. End-user investment is a critical factor in the success of sustainability measures because these measures often require widespread education, buy-in, and cooperation. Participatory processes also offer numerous learning opportunities for participants, particularly in venues such as a college campus. In their urban design manifesto responding to decades of top-down modernist planning programs that tended to alienate citizens and produce unintended negative consequences such as sprawl and a decline in vibrant downtowns, Allan Jacobs and Donald Appleyard discuss the relationship between planning participation and citizen responsibility/stewardship. They stress the importance of strong public participation in the development of urban plans that create livable places over which residents and users feel a sense of control as well as a responsibility to become its stewards:

> People should feel that some part of the environment belongs to them, individually and collectively, some part for which they care and are responsible, whether they own it or not…. Like a seminar where everybody has something to contribute to communal discussion, the urban environment should encourage participation…. Environments should therefore be designed for those who use

> them or are affected by them, rather than for those who own them. This should… encourage more care and responsibility for the physical environment…[26]

Landscape architect Randy Hester has further identified the connection between public participation in the planning process and sustainable outcomes by stating unequivocally that "[t]he union of ecology and democracy is essential for making a sustainable future and providing us with greater happiness."[27] Hester eventually identifies fifteen design principles critical to the achievement of his ecological democracy—principles that he claims are "grounded in human values, everyday behavior participatory actions, and ecological processes."

Now more than ever, sustainability has become a central goal of many university campuses, with land use planning and campus master planning entrusted with ensuring that sustainability outcomes are achieved. But such an endeavor requires a particular kind of planning process, since "sustainability requires communities to pursue an evolving and ever-changing program of activities… including an ongoing means of encouraging citizen participation and negotiating conflicts, and an updating of plans."[28] Since such a plan must be built around principles of sustainability that pertain to the campus or community in question, sustainability goals must be clearly articulated prior to the development of a master plan that will succeed in promoting an integrated campus ecology. For communities that have not yet identified sustainability goals and principles in previous planning documents, a goal-setting endeavor will have to be undertaken. To develop the most internally valid set of sustainability goals to include in these plans or documents, Virginia Maclaren, a professor of urban planning at the University of Toronto, notes that community visioning exercises have been "a useful technique for articulating sustainability goals."[29] This increases buy-in to a particular planning project by empowering community members to shape the future vision of their community through a "multi-stakeholder, consensus-based approach to identify how a community should appear at some specified future date in order to be regarded as a sustainable community."

Thus, universities across the United States have begun to incorporate consistent and meaningful processes of student, faculty and campus input in their planning processes. These universities have decided that a good participatory process creates a constituency with a vested interest in seeing the plan realized, and that, more importantly, if sustainability is a central component of these plans, then a constituency with a vested interest in sustainable campus planning outcomes will be created (and students will continue to be vested once they become alumni). Following is a list of highlights from universities that have exceptional methods for campus-wide participation in the planning process that truly enable a University to achieve Hester's vision of ecological democracy. By creating reliable entities for student/faculty review and recommendation of campus plans such as the quite useful "Campus Planning Committee" prototype (CPC), these universities go beyond often-insubstantial forms of input such as results from design charettes or design comments that only give the individuals a preliminary opportunity to impact the course of development. These are "not the kind[s] of participatory democracy that collaborative planning theorists advocate."[30] Instead, under the emerging trend in planning processes at American universities—especially ones that have been successful at engendering sustainable campus outcomes—there has been a re-conceptualization of the role of the planner. In this revised model of campus planning, the users and students are at the center of the planning process, and the planner has been transformed "into a listener and enabler of local needs."[31]

At ***Cornell University***, planning input from a broad range of stakeholders in the campus community is achieved through the recommendations of the Campus Planning Committee. The CPC is charged with reviewing and making recommendations to the Cornell's president "regarding physical planning for the Ithaca campus including landscape planning and design, circulation and parking, and new construction and renovations as they relate to the overall planning and character of the Ithaca campus."[32] This is a permanent committee with its own charter as an association of the University Assembly of Cornell University whose members must always include eight faculty members from the design programs and the environmental programs at Cornell (e.g., City and Regional Planning, Architecture, Natural Resources, etc.), two undergraduate students and one graduate student, and several ex officio members who are included on their committee because of their administrative positions at the University and their expertise in one of the planning, design, or environmental fields. The CPC—permanently chartered in the 1994—reflects the outcome of historical shifts in Cornell's campus planning philosophy away from the use of outside professionals to craft campus master plans, to a later emphasis on environmental and open space concerns in the 1960's, and finally to a desire to establish broad stakeholder participation in a consistent planning review process.[33]

The ***University of Oregon*** structures its campus plan around 12 policies. These policies serve as a guide to all future planning endeavors, with the first policy entitled "Process and Participation." According to this policy, the University's planning process "is designed to ensure that meaningful opportunities exist for participation…."[34] The University of Oregon's participatory process is similar to that of Cornell in that a standing CPC is involved with reviewing and making recommendations on all campus master plans, development plans, and planning policies. However, unlike the CPC at Cornell, anyone that is part of the campus community can volunteer and be considered to participate—a quota does not limit the number of positions on the committee that will be given to students and/or faculty.[35] Participation at Oregon allows for even more intimate collaboration between the campus community and designers in development as the CPC is charged with identifying a user group of students, faculty, staff, community members, and other stakeholders to work with a designer or architect or campus master planner to "work together to solve design problems as they arise." Thus, at Oregon, "group participation differs from most other design processes in which a designer may ask for feedback from users, but the users rarely are involved in the designing or planning itself."

Inclusion of Ecological Concerns in Planning Documents & Policies

Over the last several decades, increasing numbers of local communities and campuses have come to rely on comprehensive planning as a method to advance a sustainability agenda.**Error! Bookmark not defined.** However, Timothy Beatley, professor of urban planning at the

University of Virginia, urges planners to take sustainability efforts a step further by promoting what he has coined as "Green Urbanism." This vision of development and urban design does not only have sustainability as a goal, but believes that all infrastructural and planning decisions should attempt to mimic nature and to replicate ecological function. For Beatley, "nature is a profoundly helpful paradigm" to use as a starting point in planning future development. Specifically, he believes that in order to be sustainable we must plan cities and future development in such a way that strives to make human developments into "places of nature: they should be sheltering, cleansing of air, water, and spirit, and restorative and replenishing of the planet, rather than fundamentally extractive and damaging."[36] This approach also suggests numerous opportunities for not only functional responses to natural process, but also to artistic and/or educational design and planning responses as well.

It is important to note that Green Urbanism and sustainability are not 'fad' terms used as a way to hype planning initiatives. Instead, the concept is substantive, demanding that we let go of a dichotomous view of the natural environment versus the built environment. Instead, a sincere embrace of the policy questions posed by campus sustainability begs all campus users and stakeholders to re-conceptualize the campus as a natural ecosystem in and of itself, whose natural inhabitants—whether human or wild—must learn to interface with their environment in ways that replicate the revitalization potential in natural systems. University communities that understand that campus infrastructure must strive to be an extension of natural systems—and that such a perspective must be central to all planning efforts and documents—will succeed in becoming the leaders of exemplary sustainable design.

There are many aspects of a campus that are affected by using an ecosystem and/or systems perspective as a central concept for campus planning. The following examples showcase planning documents at other universities that strongly focus on ecological principles in devising planning policy and procedure.

At the ***University of Oregon*** (UO), all planning and development documents are extensions of the overall campus master plan as well as the overall campus sustainability plan. This integrated focus on ecological function and sustainability can be seen in UO's Tree Plan: "The Campus Tree Plan describes the intent and implementation of the patterns and policies contained in the 2005 Campus Plan and the Sustainable Development Plan, related to tree management."[37] The integration of campus planning and sustainability principles in all planning documents provides accountability by ensuring that the planning process will always address concerns of ecosystem function and sustainability. Indeed, the Tree Plan is brimming with examples of how UO consistently refers back to principles of sustainability and ecosystem function when crafting its planning policies. When describing the importance of protecting and extending the campus tree canopy, the Tree Plan does more than just pay lip service to the "environmental benefits" provided by trees, but actually lists out the ecosystem functions that a vibrant tree canopy provides for the campus:

> Trees reduce storm water drainage by capturing rainfall in the tree canopy and root system. The root systems also control erosion by stabilizing soil conditions, and reduce water pollution by filtering sediment. Trees are also instrumental in reducing urban pollution. The process of photosynthesis enables trees to filter and store carbon and polluting gases, and filter significant amounts of particulates from the air. In addition, trees provide habitat for urban wildlife supplying food and safe havens, as well as critical nesting sites.

All future development that will either impact the existing tree infrastructure, or that will change the campus landscape must undergo a review that will address the impacts of such development on the above listed ecosystem functions of trees.

A central aspect of the ***University of Vermont*** 2006 Campus Master Plan is that the campus should convey an image and identity of a University that is "a leading institution for research and teaching centered on the environment."[38] The expression of this kind of commitment within the master plan should lead to land use decisions which seriously consider the environmental impacts of development. UVM's focus on ecological integrity can be seen in its approach to land use planning which promotes sustainable outcomes by taking into account overall opportunities to increase density and to protect natural areas/sensitive open space. The Master Plan creates maps that identify "land banks," or areas of open space that have the potential to be used for a variety of future uses based on criteria including viewshed protection, infill and density, connectivity, natural areas protection. Furthermore, the 2006 Campus Master Plan recommends that campus plantings emphasize diversity rather than monoculture, and that planting groups should represent "natural plant associations" as can be seen by "the types of tree and shrub species that tend to be found together in the wild."[39] Having these kind of ecological principles included in major planning documents has a profound effect on the tone of development proposals, by putting project developers and users on notice that ecological function is of the utmost importance to the UVM community.

Absence of Conservation Planning at U-M

Although many of the campus plans and planning documents make reference to the current value of natural assets and ecological health on campus, and though they carefully delineate the ecosystem types that occur across U-M property, there is currently no land use designation in existence that would provide for the conservation and protection of ecologically valuable areas. Indeed, the North Campus Plan Update only provides for five use designations for future development: "1) academic and research; 2) campus life; 3) flexible use; 4) active and passive recreation; and 5) operations and support."[40]

Furthermore, though much data and knowledge has been gathered about the ecological integrity of many of U-M's natural assets, including the North Campus forest patches, Radrick Forest and Radrick Fen at the Matthaei Botanical Gardens, the wetlands, forests, and riparian ecosystems at several of the SNRE Forest Properties, the Dow Prairie and riverbank at the Nichol's Arboretum, Cedar Bend, etc., their preservation is, in the opinion of the Land and Water Team, only given passive attention in actual land-use planning. Although the Sasaki/Venturi report states that the connectivity of the North Campus forest patches is an important part of the ecological functioning of the campus and of the Huron River corridor, two high quality woodlands depicted in the "North Campus Open Space Framework Plan," (in the East Core and the Glazier Road Areas) are later identified as sites for significant development nodes on North Campus.[41]

CHALLENGES AND OPPORTUNITIES: LAND USE PLANNING

The Legal Status of Planning at the University of Michigan

As a State of Michigan constitutional corporation, the University of Michigan is specifically exempt from the master planning and zoning requirements of surrounding municipal governments. It is also exempt from requirements for planning that the State imposes on municipal governments. All planning decisions, site selection, and site plan approvals occur internally. This legal framework makes it very difficult to employ the typical property law tools for ensuring conservation of natural areas, specifically because U-M, as the property owner, would not gain any added development advantage from legally binding itself to conservation agreements.

To overcome this challenge, the conservation of natural areas and the preservation of ecological integrity on University landholdings should be looked at from an outcomes basis. For instance, Duke, Stanford, and UVM first determined what they wished to accomplish through land preservation, and then decided upon the appropriate vehicle for achieving those outcomes (e.g., easements or habitat conservation plans). The University of Michigan should do the same in determining the vehicle that is best suited to achieving its own natural areas conservation outcomes based on its characteristics as a large, public university in the State of Michigan. The following are several options.

Conservation easements are grants made by a property owner to an outside entity, restricting the use of the land to activities that do not alter natural or man-made characteristics of the land. As part of the grant of easement, the property owner often contracts for a benefit such as property tax exemptions or development credits on other properties belonging to the owner. The result of the easement is the creation of a property interest for a third party that would enforce and monitor the agreed upon terms of conservation. Restrictive covenants, on the other hand, would maintain all property interests in the land with the University, but would legally bind the University and any future property owners (for the length of the covenant) from developing the property in any way that runs counter to the terms of the covenant.

Although both conservation easements and covenants might seem inappropriate for the University of Michigan given that the planning framework created by the State already allows the University to plan as it wishes, creative uses of transferable development rights (TDR) could be developed to make such legal property tools worthwhile. For instance, the University and neighboring municipalities could contract for the issuance of TDR credits that the University could sell to private businesses and landowners in the municipalities to build more densely than the zoning code allows. The University would receive the right to award more TDR credits for every acre of land it designates in perpetuity for conservation either through a conservation easement or a restrictive covenant.

Upcoming Development of an Overarching Campus Master Plan

Although the University of Michigan does not currently have a single Master Plan to guide future development and land use decisions on all University property, the Campus Planning Office is currently discussing the development of an overarching plan.[42] This provides an opportunity to enforce the sustainable planning of all future campus development. The upcoming plan should prioritize ecological function and sustainability as overarching principles, and should identify a consistent way for students, faculty, and other stakeholders in the broader campus community to have meaningful opportunities for input in campus planning and design.

With this new plan, the University community would be ensured that questions such as the following would be asked during the process of every site review and selection:

How is sustainability being considered as part of this plan? Can sustainability as a concept provide a framework for the U-M Campus Plan?

How does this site relate to its broader ecological context, and how would its development inhibit or complement regional goals for conservation, watershed protection, and ecological health?

Additionally, the Campus Master Plan that will be created in the next decade should begin to address some of the major land use questions that current plans do not answer with respect to conservation. A dual-tiered system could be created that would include a Conservation Zone 1 designation, which would identify landscapes of superior historical, ecological, or recreational value, where future development would be prohibited or highly discouraged. A Conservation Zone 2 designation could apply to University landscapes with exceptional historical, ecological, or recreational value, dictating that these areas should not be degraded below the level at which they presently function. Statements of environmental impact would accompany any future development in this first tier to ensure that this standard of anti-degradation is adhered to. The Conservation Zone 2 designation would also carry the anti-degradation provisions, but would also prohibit all significant construction or development in such areas; the University would develop binding conservation covenants that would run with the land to these particular landholdings. The Forest Properties, North Campus forest patches, The Arboretum and Botanical Gardens, and all U-M land within a 300 foot buffer of the Huron River should be designated as Conservation Zone 2, given their critical roles in protecting water quality, maintaining biodiversity, infiltrating stormwater, preventing erosion, sequestering carbon, improving air quality, and offering wildlife habitat, landscape connectivity and recreational opportunity.

While placing such covenants on large portions of University property may require University decision makers to make more creative development plans in the future—and may even prevent some projects from moving forward—such a program will showcase the University's commitment to environmental sustainability. Although it might not necessarily enhance economic or political bottom lines, the University—as an institution of integrity—should act according to the urgent principles highlighted in this assessment.

Participatory Planning Potential

The University of Michigan hosts a great deal of expertise in the fields of urban planning, landscape architecture, biological sciences, architecture, and the environment. Unfortunately, public participation in the planning process, though promoted occasionally, is not understood as a regular occurrence at U-M by many constituencies, particularly among students and student groups. Likewise, many faculty, staff, and students possess expertise that is often left untapped or underutilized.

The development of a student and faculty planning Campus Planning Commission that would review, approve, and help develop all campus development projects and planning policies could be a great opportunity to incorporate the expertise in University academic programs and the energy of interested students into the development of a sustainable campus. Moreover, with respect to the ability of campus plans to reflect sustainability concerns important to the campus community, "the most influential, valid, and reliable [sustainability] indicators have been those that were developed with input from a broad range of participants in the policy process…"[43] The creation of this kind of Campus Planning Commission would be in line with recent decisions by the University of Planner's Office to no longer bring in outside consultants or "star" planners to create plans for the University, instead relying on internal resources.[44] This would also offer numerous opportunities to not only engender a sense of ownership of the campus as a whole by its citizens, but to also help to educate those individuals about aspects of their surroundings that them may not have been aware of.

Stewardship of the Middle Huron River Corridor

"The Huron River Valley is both an ecological and recreational corridor linking the University's campuses with the greater community," and as such, the Valley provides one of the most excellent opportunities for the University to enhance its impact on the land-water interface of the region.[45] Planning intended to magnify the vibrancy of the Huron River as a natural resource will also enhance the diversity of habitat for species in Southeast Michigan and encourage the growth of the desired, resilient riparian corridor in central Ann Arbor.

The United States Fish and Wildlife Service and Washtenaw County Government indicate that Washtenaw County and the Huron River are home to several threatened and endangered species. In particular, the summer habitat of the endangered Indiana Bat "includes small to medium river and stream corridors with well developed riparian woods; woodlots within 1 to 3 miles of small to medium rivers and streams."[46] Additionally, the perennial spring wildflower *Trillium sessile-*—a species with threatened designation—can be found all along the Huron River.[47]

RECOMMENDATIONS FOR LAND USE PLANNING:
CAMPUS AS AN EXEMPLAR OF SUSTAINABLE DESIGN

I. Develop an overarching Campus Master Plan that would guide development on all University landholdings, which would:
a) develop a two-tiered land use designation of "conservation zones" to be included in all land use plans that accompany the master plan
b) identify the enhancement and preservation of ecosystem function as one of the major principles guiding all planning documents, decisions, plans, and reviews.

II. Require an environmental sustainability component in all future campus plans and planning policies (i.e., North Campus Plan Updates, Central Campus Plan Updates, Tree Preservation Policy, etc). Such a component should blend with the University's educational mission suggesting eco-revelatory interventions when possible.

III. Create a consistent process for meaningful student and user participation in the creation of future master plans, planning policies, building plans, and site selection. Develop a process—perhaps through the implementation of a multi-stakeholder review, design, and approval body such as a Campus Planning Commission—that will increase transparency and accountability in the campus planning process, while simultaneously creating a constituency of student, faculty, and alumni that will be invested in realizing planned outcomes.

A campus sustainability assessment solely focusing on *ad hoc*, environmentally friendly practices undertaken for their immediate impact would lack a temporal and systems perspective. To address issues of foresight, change, and integration, we have chosen to assess the degree to which the planning and design processes allow human activity and ecosystem services to flourish into the future. The University of Michigan must delineate a campus planning and design process that accounts for concerns about intergenerational sustainability and that views development decisions through the lens of a holistic campus landscape. Most importantly, an effective planning process will ensure that the well thought-out visions, goals, and recommendations developed from campus plans will be translated into action during future site selection and development, and that the constituents of this place will be well informed, even inspired, by the landscape they are a part of.

II. VEGETATIVE LANDCOVER

STATUS AND TRENDS: VEGETATIVE LANDCOVER

The wide spectrum of landcover types that exist at U-M represent a wide spectrum of both sustainable and unsustainable landscapes, the ‘measure of sustainability’ being based upon the amount of habitat, stormwater infiltration, carbon sequestration, climate change resiliency, habitat potential, etc., that they offer. For example, lawn offers more infiltration opportunities than a parking lot, but native perennial plants, with their characteristically large root systems, can offer much more infiltration than turfgrass, in addition to food and cover for native birds, animals, and insects. A glance at the current “lay of the land” at U-M will shed light on how both grey and green fabric are currently functioning within the campus ecosystem[48].

In 2009, The University of Michigan hosted a total of 2,486 acres of green space across all properties considered in this assessment (except the NCRC), which is 81% of the total combined acreage of these properties. Of these acres, 733 or 24% are “maintained,” while 1,754 or 57% are “natural”[49].

Total tree population on these properties, excluding wooded and fringe areas, totaled 14,006 in 2009[49]. U-M has been designated as a Tree Campus by the Arbor Day Foundation[50], and according to University landscape architect Ken Rapp, the campus forest includes many more natives today than it did several decades ago, when there were an abundance of crabapples and other typical ornamental species dominating the campus landscape. Today, all trees and shrubs are inventoried by species in a comprehensive database. Though not well advertised, the university has designed tree tours, available as downloadable pdf maps on the landscape architecture website. The team has yet to receive or generate data totaling canopy cover, on the biodiversity of woody species, or on the ratio of native to non-native species.

Traditional Campus

According to the 2010-2011 Campus Land Use Inventory, a total of 262 acres or 28% of the total landcover on the properties of North, Central, South, Briarwood, and Medical Campuses are planted in turfgrass. There are three priority levels for maintenance of turfgrass and other planted areas on campus. Priority I (PI) areas call for “high intensity landscaping and maintenance” while Priority III (PIII) areas call for low intensity treatment. PI lawns are fertilized 8 times a year (if soil tests deem it necessary) and sprayed for weeds and average of 4 times a year. PIII areas aren’t sprayed or fertilized at all, and mowed much less frequently.

Reducing the amount of lawn at U-M can promote environmental health through a reduction of chemical and water applications, lowered energy and maintenance requirements, and through the prevention of compaction and erosion caused by unwanted foot traffic[51],[52].

In contrast to turfgrass cover, only 4% of the total landcover is in planting beds. However, nearly all of the square footage of beds planted with herbaceous cover is planted with perennial species, as opposed to cost-, fertilizer- and labor-intensive annuals, most of which are non-native. It is uncertain as to what percentage of the existing perennials are native species. More perennials are currently planted on North Campus than other campuses.

A budget cut in 2009 spawned a university policy to eliminate the planting of annual plants and spring bulbs, which were costing the university roughly $150,000 a year[53]. Only the Medical Center and Medical Campus opted to pay for maintaining annuals on their grounds with their own budgets. The university landscape architect, expecting to field complaints this spring about the absence of bulbs and annuals from those who cherish these as part of the manicured campus aesthetic, was relieved and surprised to receive only a few. This policy leaves somewhat of a blank slate for increasing native perennial cover on campus, the benefits of which will be described later in this report.

In the same budget cut, the university's tree replacement policy was abandoned. For $40-60,000 a year, 100-120 trees would be replanted every year - half in the spring and half in the fall – to replenish average losses which typically equal that same amount. According to the university landscape architect, this policy facilitated not only species diversity, but age diversity among trees and shrubs on campus -- qualities which have both ecological and aesthetic benefits.

Current policy prohibits the planting of any invasive species listed on a general catalog used by the university, though this list may not be all-inclusive. The presence of invasive species is not well-documented on the aforementioned campuses (except for the North Campus woodlots in the Sasaki report), as it is at the Matthaei Botanical Gardens[54].

Forested Patches and Natural Areas Properties

The Matthaei Botanical Gardens and Nichols Arboretum, the forest patches on North Campus, the woods and wetlands at the NCRC and East Ann Arbor Properties, and the off-campus School of Natural Resource Forest Properties (Saginaw Forest, Stinchfield Woods, and the Newcomb Tract) are all natural assets of the university, which exhibit varying levels of ecological health. The 2007 Sasaki/Andropogon natural areas assessment has evaluated the biodiversity of forest patches on North Campus, and the HRWC Bioreserve Project has assigned relative value to many U-M natural areas based on their current or potential ecological function, rarity, and/or sensitivity[18]. For example, all U-M properties that border the Huron River are considered critical to regional ecological health by the HRWC for the present or potential role they play in facilitating riparian biodiversity, infiltrating floodwater, and for ameliorating urban steam syndrome in the Huron River. Furthermore, the old-growth, oak-hickory Radrick Forest and the rare Radrick Fen, both located at the botanical gardens, are also rated as highly valuable properties that lie within university ownership and stewardship. The Sasaki report highlighted the fact that the North Campus forest patches act like ecological "stepping stones" of habitat that link directly to the Huron River, the development of which could inhibit species movement between ecosystems, which has been found to be a critical factor in the sustainability of plant and animal populations[55].

Sustainable Landcover Precedents

Many universities across the nation have begun to implement sustainable land use planning, policies, and practices.

Several schools have begun to consider habitat potential on campus, exploring opportunities to enhance biodiversity. ***Arizona State University*** in Tempe, Arizona began executing a Native Habitat Project in 2002, intended to "draw habitat attention to the plight of native wildflowers, pollinators and birds," as well as to "redefine the landscaping character of main campus and inspire the establishment of additional groves of native trees"[56]. Four specific types of habitat, intended to support targeted bird species, were designed to become ecological stepping stones to wildlife habitat along the Salt River. ASU is one of few schools who has considered campus within its landscape ecology framework.

At ***Stetson University*** in Deland, Florida, a campus-wide native plants policy has been officially adopted by the Board of Trustees. This effort involved creating an inventory of all trees and shrubs on campus, in order to quantify the proportion of their existing landscape that is comprised of Florida natives[57].

Indiana University has measured canopy cover on campus by creating a GIS of campus trees, and has calculated the annual net benefit of ecosystem services from these trees. Currently, they've estimated these benefits to amount to $158,000/year, and have set a goal of achieving $200,000 in constant dollars/year until 2017[58].

The ***University of North Carolina at Chapel Hill*** completed an Ecological Assessment Report in 2007, which incorporated a weighted analysis of multiple landscape ecology criteria, including wildlife corridors, tree cover and composition, soil type, slopes, hydrology, stream buffers, etc. Six of the most ecologically sensitive areas (a total of 311 acres which is 32% of the total property) will be protected in perpetuity in conservation easements[59].

Rutgers and the ***University of North Carolina at Chapel Hill*** have goals of strategically reducing lawn on campus, replacing turf with native woody and herbaceous perennials or other groundcovers[60].

CHALLENGES AND OPPORTUNITIES: VEGETATIVE COVER

One of the greatest opportunities for increasing sustainable landcover at U-M lies in the new policy banning the planting of spring bulbs and annuals. This essentially leaves a blank slate upon which a more innovative, environmentally friendly, educational, yet beautiful new landcover type can be instituted across the campus landscape. However, one of the greatest challenges to the implementation of this new fabric will be the cultural attachment to bright, tidy, and constantly changing beds of colorful annuals. The acceptance of landscapes is affected by cultural norms. In order to encourage the acceptance of ecological design, landscapes will need to incorporate "cues to care" to communicate that the landscape aesthetic was intended [1.]

Another opportunity for U-M to increase sustainable vegetative cover on campus lies in the fact that landscapes are already categorized for maintenance inputs based on their use, visibility, historical status, etc. For example, Priority III turf areas and planting beds would be well-suited to be planted in less maintenance intensive native vegetation, eco-lawn, or other alternatives.

Another opportunity for the university, having significant property frontage along the Huron River, can be to serve as a model within the larger community for sustainable riparian (riverfront) land use.

The budget cut eliminating the tree replacement program is currently a major hindrance in the promotion of campus ecosystem sustainability, as trees provide such a wide array of ecosystem functions such as beneficial heating and cooling of buildings, stormwater infiltration, carbon sequestration to help offset global warming, the cleansing of pollutants from air and water, the provision of habitat for native birds, mammals, and insects, and the beautification of the landscape[48].

RECOMMENDATIONS FOR VEGETATIVE COVER: CAMPUS BIODIVERSITY

A multi-tiered recommendation for campus vegetative landcover reform proposes to increase campus ecosystem health through:

I. A reduction in lawn coverage by 35%. This reduction can be achieved through the conversion of the majority of PIII turf areas and conversion of appropriate PII areas within central campus. Historical relevance and recreational usage of turf areas can be assessed to determine ideal locations for lawn reduction in high visibility and use areas.

II. A new native plant policy to promote an increase in both the quantity and diversity of native plant cover over a period of ten years. PIII lawn and former annual beds can be utilized as the first phase of native plant implementation and should be predominantly native vegetation by 2013. Appropriate PII areas should have predominantly native vegetation established by 2016 and appropriate PI areas should have predominantly native vegetation by 2021. This policy will require that campus planting zone biodiversity be measured by monitoring for specific target insect and bird species.

III. A new tree replacement policy that strictly requires inch for inch replacement of woody species on campus, as well as strict goals for urban forest diversity within any given campus planting zone. As a general guide for larger sites, taken from the

Sustainable Sites Initiatives Guidelines and Benchmarks, U-M should plant "no more than 10 percent of any species, no more than 20 percent of any genus, and no more than 30 percent of any family"[7] This goal could perhaps be achieved with the establishment of a tree planting fund.

IV. A policy to give special consideration to U-M property existing within 300' of the Huron River, 25' from a stream or other body of water, such that vegetation promotes optimal water quality protection and enhancement, floodwater infiltration (if possible), prevents erosion, and that aims to functionally connect with other habitat patches.

Increasing the biodiversity of vegetation both on and off campus will enhance overall species diversity at the University of Michigan. Diverse vegetation is more capable of serving as habitat for a wider array of animals and insects, more capable of yielding invaluable ecosystem services such as stormwater infiltration, carbon sequestration, air and water quality amelioration, etc., and more capable of resiliency in the face of climate change[61]. Native perennials require less watering, less maintenance, less toxic inputs, less frequent replacement and therefore less disturbance of soil. They also provide excellent infiltration and/or cleansing of stormwater with their characteristically deep root systems, and offer a regional aesthetic of beauty. Deliberate habitat creation can take place at all stepping stones along the gradient of landcover types, and is best done with specific species in mind[62],[63].

Decreasing the amount of lawn on campus will reduce the carbon footprint generated by mowing, increase vegetative biodiversity, decrease soil compaction, enhance infiltration capacity, and reduce the amount of toxic inputs entering the soil and watershed. Ecologist Douglas Tallamy relates that:

> "Second only to paving in its impact on biodiversity is our love affair with sterile lawns […] If you are concerned about the human impact of climate change, reducing the amount of lawn you mow each week is one of the best things you can do to reduce your carbon dioxide emissions."[64]

Regularly planting trees and maintaining a healthy urban forest are relatively easy efforts through which the university could achieve valuable carbon offsets, among many other ecological benefits. Furthermore, the Sasaki report estimated that the forest patches on North Campus alone store 5,352 tons of carbon every year[68]. A diverse campus forest will better survive pest damage by insects that may gain an upper hand as climate changes. Rapid loss of heavily planted street trees such as the American Elm and ash should warn against monocultural allees and concentrations of tree single tree species.

Re-visioning the campus landscape in this manner also offers numerous opportunities to educate observers on-campus as to the possibilities inherent in a less 'traditional', more ecologically based land use aesthetic, be they regular visitors to campus such as students and faculty, or less-regular visitors such as parents, alumni, or others. Opportunities would abound for campus tours; for courses focusing upon landscape pattern and cover, for urban habitat and ecosystem function; for artistic interpretation and environmental education; and for active engagement in the life, both social and ecological, of the UM.

Linking habitat patches, stepping stones, and corridors can aid in species dispersal and migration, generally promoting biodiversity and healthy ecosystem functioning, and can increase the amount of source habitat relative to sink habitat. Joan Nassauer states, “We can’t rely on the anomaly of large scale land preservation anymore”[1] but must consider the beneficial aggregated effects of incorporating habitat in landscapes across all scales. The university should consciously oversee, maintain, and enhance linkages between U-M property and other local habitat networks, in order to sustain regional connectivity.

III. *STORMWATER PLANNING AND DESIGN*

STATUS AND TRENDS: STORMWATER MANAGEMENT

In 2009, state law in Michigan changed the name of the “Office of the Drain Commissioner” to the “Office of the Water Resources Commissioner”[10]. This change speaks of a fundamental change in our perception of stormwater, once considered a nuisance to be piped away as quickly as possible, now respected as the natural resource that it is. We know today that nonpoint source pollution carried in stormwater runoff is, according to the EPA, the “leading remaining cause of water quality problems” in our country[65], as well as a major ongoing cause of the degradation of urban rivers and streams[16]. Wetlands are very effective at filtering and remediating runoff-born pollution. Unfortunately,” half of Michigan’s inland wetlands and 70% of the coastal wetlands no longer exist,” and an estimated 500 acres of wetlands are lost statewide each year from permitted fills[67]. On-site infiltration of stormwater, facilitated through Low Impact Development (LID) techniques such as green infrastructure and/or structural catchment devices[66], is being promoted world and nationwide, as well as within the city of Ann Arbor, as a site-based solution whose aggregated effects can dramatically improve the health of our watersheds.

University property comprises a good percentage of the Middle Huron Watershed, whose main impairments, according to the HRWC, include high phosphorous and E. coli levels[67]. As stated in the Sasaki report, “[u]nless alternatives to conventional development practices are considered, water quality within the Huron may be expected to decline over the long term.”[68] Within the Middle Huron basin, U-M property is divided between six sub watersheds, as mentioned in the Regional Trends section above, and noted on the map in Figure 1 (see following page). Both Millers and Mallets Creeks suffer from flashy flows and channelization[13], while flooding is often a problem in the Allen Creek floodplain. In addition to the flow and structural health issues mentioned above, Appendix A includes a glossary of water quality concerns affecting water bodies within the larger Middle Huron watershed.

Watershed health can be estimated through calculating the ratio of pervious to impervious landcover in a given catchment area. Resources state that anything above 8-10% of impervious cover indicates an impaired watershed[69]. Beyond this level, “downstream impacts become evident, as stream channels are destabilized and aquatic habitats are degraded.” Furthermore, “[i]mpervious cover over 25% generally results in significant impairment, and watersheds with over 50% impervious cover require extensive and expensive management actions to maintain even modest water and habitat quality.”[9] Insufficient groundwater recharge is also a concern in developed areas.

Figure 1 Sub-watersheds in the U-M/Ann Arbor area

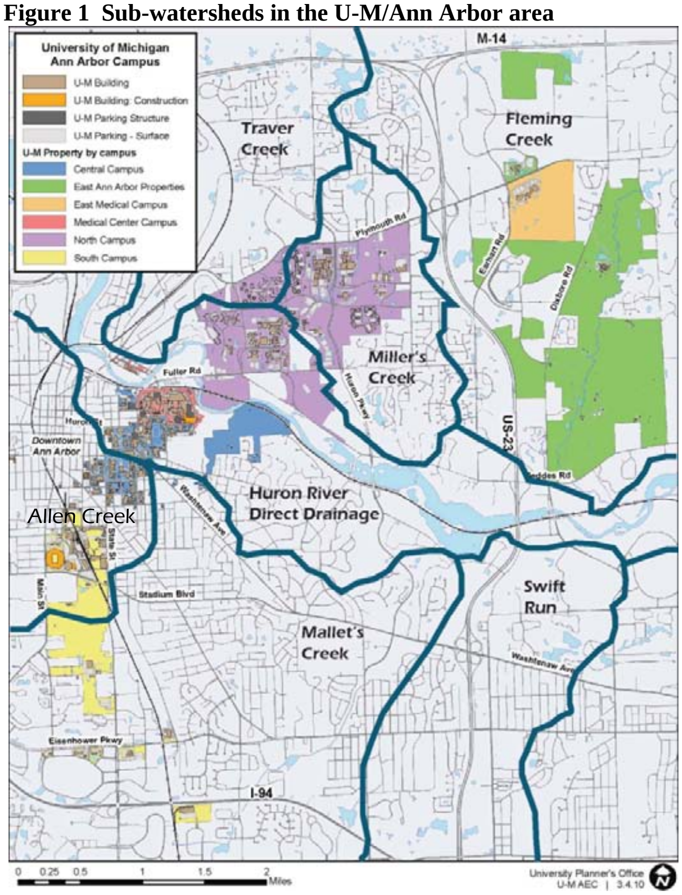
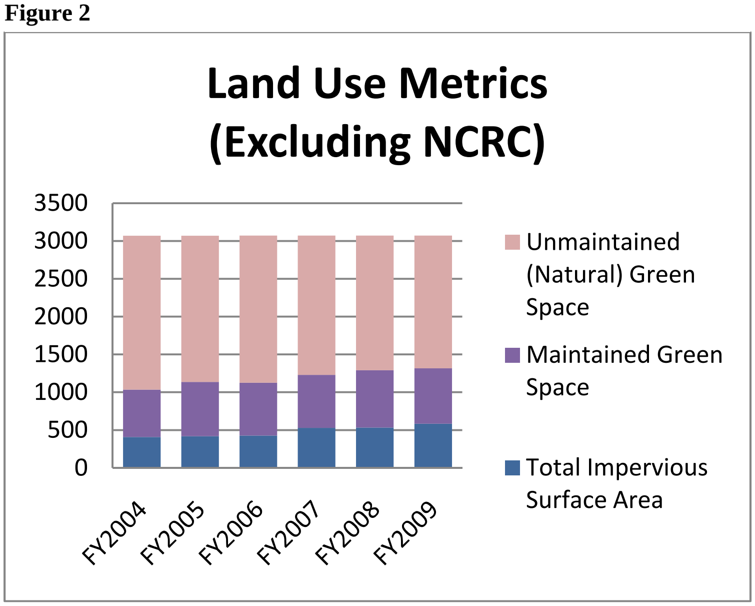
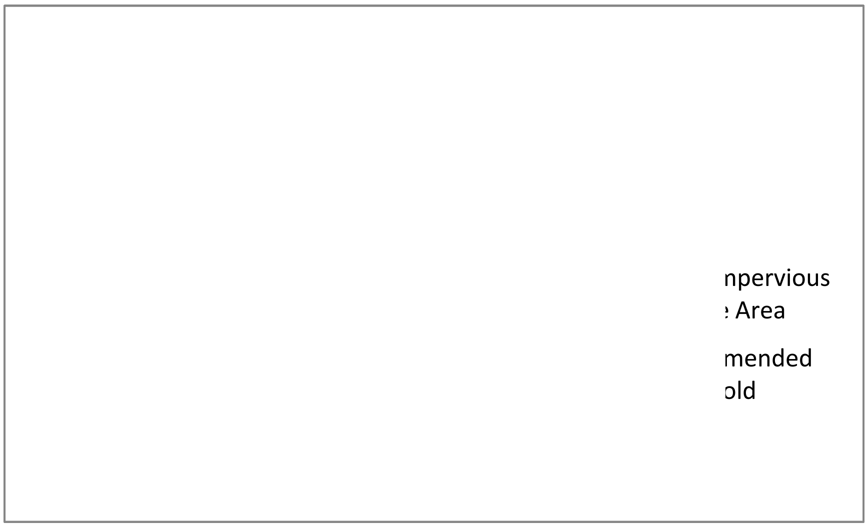


Figure 2 (below) shows that, while the total land area of the Ann Arbor campus has not changed in six years (aside from the acquisition of the NCRC), the impervious surface area has increased. Furthermore, natural, unmaintained greenspace has decreased. Similarly, the Huron River Watershed as a whole is expected to lose 40% of its remaining open space to development in the next 20 years if changes are not made to change these trends[69].

Figure 2



Total impervious cover at the U-M properties under consideration (consisting of rooftops, parking lots, sidewalks, and streets), totals 46%. Figure 3 shows that the University is exceeding, and recently more than doubling, the recommended threshold. The average rate of impervious cover for each University designated planting zone is approximately 49%, which is also very high. The planting zone with the highest ratio of impervious to pervious cover is South Campus, with all of its parking lots to accommodate sporting events. Unfortunately, much of this imperviousness blankets the Allen Creek floodplain.



Impervious cover and associated runoff at U-M are accompanied by pollutant loading as well. The team has not undertaken a comprehensive pollutant loading calculation, but the charts in the Sasaki report, generated with TR-55 software, reflect projections made for pollutant increases if the existing woodlots were developed.

As a National Pollutant Discharge Elimination System (NPDES) permit holder, the University has its own stormwater system and management plan. The University's storm water system is representative of similar systems owned by municipalities." U-M's status as a permit holder requires strict compliance with State regulations.

The University acknowledges the need to protect watershed health. The 2010 Stormwater Management Program Plan (SWMPP) "encourages the development and implementation of measures to control [the effects of urbanization]," and addresses water quality issues such as pollution, illicit discharges, and illicit connections[69]. Control measures listed include the following:

- Directing growth to specifically identified areas
- Protecting sensitive areas such as wetlands and riparian areas
- Maintaining or increasing open space

- Encouraging in-fill development in higher density urban areas and areas with existing infrastructure
- Coordinating release rates for detention basins to minimize flow conditions that may cause stream bank erosion

Under the plan, The Office of Occupational Safety and Environmental Health (OSEH) joined forces with the School of Natural Resources and Environment (SNRE) to make an educational brochure and video. They also participate in the Middle Huron Initiative (MHI), a stakeholder agreement to limit phosphorous discharge to the river to comply with Total Maximum Daily Load (TMDL) requirements. As such, U-M uses phosphorous free fertilizers (unless soil tests indicate that it's needed).

Overall, the SWMPP focuses on promoting BMP's that merely aim to do less harm, rather than on proactively setting any "measurable goals" that would employ low impact design techniques to dramatically reduce impervious cover and increase infiltration on U-M property.

A list of current discharge outlet areas is included the SWMPP. Both the Sasaki report and the Millers Creek management plan list and map very specific locations on U-M property that would benefit from specific suggested interventions. The Land and Water team has created a G.I.S.-based resource which, when finished, should help locate prime areas for stormwater intervention (as well as where to reduce lawn, etc.)

U-M to-date has no bio-infiltration areas (such as raingardens, constructed wetlands, bioswales, etc.) except for the North Campus Detention Ponds. There are green roofs on the Ross School of Business Building and the Mott Women and Children's Hospital, though these only allow evaporation, not infiltration. There are several parking lots that employ pervious paving, and two lots that divert runoff into underground storage tanks.

Sustainable Stormwater Management Precedents

Over the last decade, the ***City of Portland (Oregon)*** and the ***Portland Metro*** regional planning agency have developed and adopted a Green Streets policy. This policy seeks to incorporate sustainable stormwater management innovations into the design of streets, rights of way, paths, as well as off-street sites. The Green Streets policy and design program is part of a "watershed approach to improving the regions' water quality"[70]. Green street projects specifically attempt to replicate natural stormwater systems and cycles that occur in undeveloped land while making "visible a system of 'green' infrastructure," and seek to promote "stormwater treatment, attenuation, and infiltration facilities that are integrated into the open spaces of a community.[70]"

For ***Indiana University***, watershed protection under their sustainability initiative involves the prevention of construction runoff, education, obtaining proper IDEM permits, riparian restoration and buffering (with no pesticide application near the river), the rerouting of sanitary sewers and locking down of manhole covers near the river, turning a wastewater treatment plant at Bradford woods into a wastewater wetland, and the installation of porous pavement. They chose to improve runoff quantity by setting a goal to reduce impervious cover from 16% to 11%

in coming years; and to improve water quality by consistently monitoring against a Pollution Tolerance Index and with Visual Stream Assessments, such that all scores were of an "excellent" rating in a certain number of years to come[58].

San Francisco State University's effort to grasp their stormwater status involved mapping storm drain inlets, drainage networks, and catchment areas, quantifying campus permeability (% roof surface, % impervious, % pervious) in each catchment area, and calculating a percentage of total lawn to be replaced with native landscaping. They quantified runoff amounts and pollutant loading, mapped drainage patterns, and determined appropriate locations for infiltration infrastructure or "treatment trains," determined storage volume needed for a set "design storm," and calculated average water consumption in acre feet for each area to determine if a cistern could meet irrigation needs. Finally, they performed a cost benefit analysis for several different infiltration strategies in several particular areas on campus[71].

CHALLENGES AND OPPORTUNITIES: STORMWATER MANAGEMENT

Opportunities abound for U-M to collaborate with local watershed protection initiatives, and to become a leader in local storm and groundwater stewardship both locally and amongst other prestigious universities. In many cases, the research and foundational work has been done as to what types of interventions should take place where, what metrics and what design solutions to apply. Now it is simply a matter of implementation.

One particular opportunity that should be considered is the construction (and protection of) wetlands. This demonstrates the need and potential for installing new wetlands throughout watersheds.

Low impact stormwater design can be incorporated perhaps most easily into future campus developments. The challenge will lie in retrofitting the existing landscape to be one that receives more water than it sheds. The process of changing the landscape to function, sans pipes, as stormwater infrastructure might be justified as one that will, over time, provide significant cost savings on traditional infrastructure repairs and maintenance.

Opportunities also abound for the creation of stormwater capture, detention, and treatment installations that elevate the visible presence of this activity on campus in such as way as to not only address the functional concern of stormwater management, but to also offer opportunities for both passive and active learning in the form of bioswales that create visual interest, raingardens that enhance the quality of public spaces (Cornelia Oberlander's work at the ***University of British Columbia*** is a prime example of this), and paved surfaces that serve multiple functions, including stormwater storage, biofiltration, and pavement cooling through the presence of vegetated strips/swales incorporated into the design of all surface parking areas.

Some potential target intervention areas have been identified by the team, including those that are mapped in both the Miller's Creek watershed improvement plan and the Sasaki report, as well as parking lots on South Campus that exist within the Allen Creek floodplain.

RECOMMENDATIONS FOR STORMWATER MANAGEMENT: CAMPUS WATERSHED PROTECTION

The Land and Water Team proposes a two-tiered recommendation intended to protect and restore watershed health through:

I. *Reducing runoff quantity* by decreasing impervious surface area on campus properties by approximately 25% in order to achieve a total impervious surface area of 35%. This would require reducing the amount of impervious walkways and parking by about ½ and converting all the impervious game courts to pervious surfaces. Additionally, this goal will be accompanied by a policy in the SWMPP dictating that the level and character of pre-construction/development runoff on a given site must match the post-construction level and character of run off in the area, with the excess collected and retained on site.

II. *Improving water quality* by promoting the biological infiltration of stormwater (i.e. uptake through plants). The construction of raingardens, bioswales, and other vegetated retention/detention areas should be given priority over non-biological infiltration methods. Target areas for biological infiltration should aim to disconnect contiguous impervious surfaces (which speed runoff velocity), and to provide filtration in areas immediately upslope of storm drains and/or waterways.

Impervious surfaces that may be converted to permeable pavement include gaming courts, pedestrian walkways, and parking. If 100% of these existing surfaces were converted to permeable surfaces, there would be approximately 22% of land use remaining impervious, consisting of roads, buildings, and stairs/ramps. Therefore, in decreasing impervious surface area, attention should be given to disconnecting adjacent impervious surfaces to decrease runoff speed and, where possible, to increasing the length of the "time of concentration" (TOC) path that a given drop of stormwater will travel before it reaches an outlet point.

Infiltration efforts should, when possible, incorporate bio-infiltration, as opposed to porous paving, as this will yield greater water-quality improvements. Bio-infiltration zones should employ the proposed native plants policy described above, as native plants typically have large root systems capable of up taking large quantities of water and many are adept at remediating toxins. Also, infiltration can be achieved with more than just one intervention, like a single raingarden. Treatment trains can carry water from one infiltration system to the next. For example, a green roof can transport water down a gutter into a bioswale, which could convey the water further into a raingarden. Water from a large parking lot could also be directed into a series of bioswale medians, with the excess diverted to a large underground cistern for later reuse. There are a variety of structural and non-structural stormwater treatments to use, which are well documented in numerous websites and publications.

The benefits Ann Arbor realizes from the Huron River are significant, and protecting its water quality has direct economic benefits for the State of Michigan. For example, "[i]mproved water quality supports recreational [and economic] opportunities…. [In addition, w]ater treated on site can also lead to reduced expenditures for infrastructure and energy associated with public and private stormwater treatment."[9] On the other hand, "[w]hen a receiving water body does not meet water quality standards (e.g., total maximum daily loads), municipalities incur an additional cost and liability."[9] It is important that the University of Michigan minimize its impact on the river and remaining watershed in order to maintain this resource, especially to minimize any financial burden for restoration and maintenance. "Preventing pollutants from reaching the river is far more cost effective than waiting until restoration is required."[69] While minimizing impervious cover may be a challenging objective, it is necessary to keep in mind that for every percent this threshold is surpassed in a given area, downstream effects are compounded significantly."[69]

IV. MANAGEMENT AND MAINTENANCE

STATUS AND TRENDS: MANAGEMENT AND MAINTENANCE

The University of Michigan has made great strides towards sustainability and has implemented carefully considered policies regarding irrigation, fertilizer and pesticide use, and winter maintenance. However, there is room for improvement, and the University of Michigan can learn from the responsible practices implemented by universities across the country that have faced similar hurdles to sustainability.

A variety of universities have implemented irrigation practices that decrease water use on campus. ***The University of California at Berkeley*** utilizes the Supervisory Control and Data Acquisition (SCADA) system to improve the efficiency of their irrigation system. UC Berkeley has also undertaken simple measures to conserve water used for irrigation by using more efficient sprinklers and evaluating drip irrigation[72]. ***Grand Valley State University*** (GVSU) uses a computerized system to ensure that lawns are watered only when necessary[73]. ***The University of Michigan*** uses an irrigation management system called Maxicom, which utilizes a central computer that communicates with onsite controllers to make necessary adjustments[74]. This irrigation system features a weather station and remote rain gauges that adjust the system based on wind, rain, and evapotranspiration rates[74]. The University of Michigan used 38,246,821 gallons of water for irrigation in 2009[75]. This is approximately two million gallons less than what was used in 2008, but is higher by approximately four million gallons from 2004-2007[75].

Universities across the country have developed unique strategies for using – or not using – fertilizers and pesticides. ***GVSU*** uses slow-release fertilizer that reduces the number of times the lawns need to be fertilized annually and has incorporated organic treatments for pest management, which reduces the need to apply pesticides[73]. GVSU encourages the planting of low maintenance, drought-tolerant plants and uses bark mulch to further reduce water usage[73]. ***Illinois State University*** (ISU) uses an Integrated Pest Management plan and no longer purchases fertilizer that contains phosphorous[75]. ***Williams College*** in Massachusetts also uses IPM, as do many other universities across the country.

The IPM Plan for the ***University of Michigan's*** Grounds and Waste Management Department is based on the following strategies: "inventory of the University's woody and herbaceous plants and identification of pest problems, monitoring of areas and organisms that have been pest problems in the past, remediation using management tactics in the context of the particular pest and plant host"[76]. U-M also complies with local Huron River water quality protection efforts, meaning they use phosphorous-free fertilizer, unless soil tests indicate a severe need. The three priority designations for planting areas determines the quantity of pesticides, herbicides, fertilizer used in a given area, as well as the frequency of other maintenance activities such as mowing, weeding, etc.

As a result of decreased fertilizer use, many universities have turned their focus to using mulch and compost created on or near campus. ***ISU*** turns all of its untreated wood waste into mulch that is used on 27 acres of mulched beds. ***Harvard University*** has a very impressive Organic

Landscaping Program that utilizes campus-made compost to mulch and fertilize lawns, planting areas, and trees. Several varieties of compost are made including a carbon-based, fungal compost used on woody species, and a nitrogen-based, bacterial compost that is used on lawns and herbaceous plants) in the form of a micronutrient-rich compost tea[77].

The ***University of Michigan*** used 68 tons of compost and 6,838 cubic yards of mulch in 2009[75]. Organic material collected from landscape maintenance is composted on North Campus, but some suggest that the system could be improved, as it is not tended in a strategized way, nor is the location large enough for a broad-scale effort[53]. Waste Management Services at the University of Michigan picks up compost from Markley, Betsy Barbour, West Quad, South Quad, East Quad, Hill Dining Center, a campus coffee shop in Pierpont, catering kitchen in Pierpont, and Palmer Commons. Only vegetative prep waste is collected; this material is taken to the City of Ann Arbor's Compost Site[78].

Winter maintenance – a necessity for universities located in temperate regions – can be problematic for universities committed to sustainable maintenance practices. However, a variety of universities have implemented less environmentally harmful winter maintenance practices that do not compromise safety. ***GVSU*** uses a liquid ice melt product that has allowed for a reduction of the amount of bulk salt and sand needed to maintain safe winter conditions[73]. ***Williams College*** primarily uses sodium chloride, but uses magnesium chloride in parking garages and the entryways of buildings[79]. Magnesium chloride is more expensive yet more environmentally friendly option; however, it is still not an ideal solution.

The University of Michigan uses road salt that is treated with a magnesium chloride-based solution, which reduces the temperature at which salt is effective and also minimizes bounce and scatter on the road surface so that salt stays in its intended location[80]. Magnesium chloride is the primary deicer used for walks, steps, plazas, and entryways. Additionally, anti-icing products are applied to paved surfaces when there is a 50% probability of precipitation, or if there are other factors that may lead to slippery conditions. The University of Michigan used 1,927 tons of salt in 2009, which equates to 49 pounds per person[75]. Salt is of concern to watershed health, as it can disrupt aquatic ecosystems[8].

CHALLENGES AND OPPORTUNITIES: MANAGEMENT AND MAINTENANCE

A primary threat to the implementation of sustainable action is the idea that short-term efficiency is of utmost importance. Many of the recommendations suggested by this assessment will take time to implement and may require some degree of trial-and-error. Management of some areas on campus may become more challenging and complex, while the management of other areas may become significantly less intensive and require far less oversight. U-M may experience an increase in costs in relation to certain management strategies, but will find that other recommendations will provide for a significant reduction of costs. The University of Michigan has the opportunity to shift costs from chemical and mechanical inputs to labor inputs, in a shift towards relying more heavily on hands-on maintenance activities such as pulling weeds or making compost. Additionally, the University of Michigan can and should reduce expenditures by using compost and mulch created on campus instead of purchasing fertilizers, pesticides, and other materials from outside sources. Regardless of costs, U-M should consider the implementation of sustainable practices as part of a larger effort at becoming a leading steward of the Middle Huron Watershed.

RECOMMENDATIONS FOR LANDSCAPE MANAGEMENT AND MAINTENANCE: CAMPUS STEWARDSHIP

Maintenance recommendations include the following:

I. Decrease the use of chemical fertilizers, pesticides, herbicides, fungicides, and other toxic inputs by 50% by the year 2015, and eliminate their use altogether by the year 2020.
II. Institute a large-scale campus composting facility to receive all vegetative matter from U-M, including food waste, which can be used in a organic soil management regime which includes the use of compost and compost tea as an alternative to synthetic fertilizers
III. Institute a hand-weeding policy
IV. Decrease water use by 50% in the year 2015. This can be achieved through the implementation of the native plant policy.
V. Develop a new, mandatory training regime for grounds staff to educate them about how to properly maintain the campus ecosystem

When considering sustainability on campus, it is important to pay attention not just to the end result, but to the process. The University of Michigan must implement sustainable management and maintenance practices to care for a sustainable campus landscape. Properly defined management and maintenance practices are essential to ensuring that the recommendations put forward by this assessment carry out a vision of sustainability. Most importantly, these practices should embrace an ethic of environmental stewardship that supports healthy ecosystems. A successful management program based on such an ethic will incorporate long-term strategies that utilize short-term actions[7]. It is essential that these suggestions are taught to and supported by the campus facilities staff who will actually be implementing them, as the staff is the link between policy and practice.

Each different landscape type on or off campus will undoubtedly require a unique management and maintenance regime that is sensitive to the needs of the users of that location. However, this assessment challenges the facilities staff responsible for the management and maintenance of each campus location to meet the goals put forth by these recommendations. These three broad recommendations encompass a number of suggestions that encourage sustainable management and maintenance practices. According to input gathered by the Land and Water team at the Campus Sustainability Town Hall Meeting, many members of the campus community support the following recommendations put forward by this assessment and are excited to see changes to existing practices.

Chemical and mechanical inputs are both economically and energetically costly. Pesticides, fertilizers, and products used for snow removal can damage ecosystems at and away from the initial point of application. There should be an increase in the amount of non-mechanized maintenance practices in order to reduce fuel consumption and a reduction in the use of fuel-inefficient, highly polluting (both air and noise) tools that rely on two-stroke engine technology. In winter, consider how chemicals and salts applied to the landscape will eventually affect animal, plant, soil, and water quality and health when the snow melts.

A decrease in the use of chemical and mechanical inputs can be partnered, as necessary, with an increase in the amount of compost applied to landscapes in need of additional nutrients. Composting of both organic and food waste should be made a priority on campus, and adequate space should be allocated to support such efforts. More staff should be hired to allow the University to create and use its own compost that can be used as fertilizer. Compost is more beneficial to the soil than synthetic fertilizers, and an increase in the use of compost will lead to an increase in soil fertility and soil health. Soil fertility and soil health are essential to a healthy ecosystem. Soil can be evaluated biologically, chemically, and physically; the healthy functioning of all three components is necessary for a sustainable landscape. Soil health affects water movement through the soil and the nutrients available for plant uptake; thus, soil health directly affects both water quality and biodiversity. Opportunities also exist to involve the campus community as a whole in the management of its landscape as well; the ***University of Oregon*** organizes an annual ‘University Day’ event where faculty, students and staff dedicate one or more hours on one day to help clean up and maintain the campus landscape. While the UO’s event is not directly tied to sustainability, the model certainly suggests some intriguing possibilities for hands-on action that could elevate the connection that all residents of the UM campus might feel for their place.

Surface and groundwater sources are used for a variety of purposes by animals and humankind alike. Polluted water can damage ecosystems both on and off the campus. Water quality can be diminished by a variety of maintenance practices (or lack thereof), though can be improved and maintained through the implementation of practices that support healthy ecosystems. Water quality can be enhanced by decreasing the amount of chemicals applied to the landscape. The University of Michigan should strive to decrease water use by using drought-resistant plants that require less water and by continuing to utilize the latest water-saving irrigation technology.

In order to realize any of the aforementioned goals for proper management and maintenance practices, campus facilities staff must not only be properly trained and educated in sustainable management practices, but also need to support and understand the value of such practices. Comprehensive training is essential, and continued monitoring of newly implemented practices is of the utmost importance to maintaining a sustainable campus. Additionally, campus facilities staff should have opportunities to provide feedback regarding changes made to former management and maintenance practices.

V. ENVIRONMENTAL EDUCATION

STATUS AND TRENDS: ENVIRONMENTAL EDUCATION

The University of Michigan's campus environs are among the most diverse and well-loved landscapes not only in the region, but among the many different college campuses extant nationwide. The landscape, however, when examined from a sustainability viewpoint, lacks depth, health, and diversity of purpose in the way it meets the challenges of existing as an exemplar of sustainability. As noted in the many precedents listed earlier in this report, many campuses have taken on significant projects, shifted procedures, and even worked to alter local, regional, or statewide policies to enhance the level of ecological health on their campus. One theme that is often overlooked, however, is the opportunity to purposely develop opportunities for the campus to 'educate' while enhancing ecological health and function. This idea, of combining 'eco-revelatory design' with environmental education, forms the basis for this last, overarching set of recommendations.

CHALLENGES AND OPPORTUNITIES: ENVIRONMENTAL EDUCATION

Environmental education has a long history of utilizing the outdoors as a venue for teaching, learning, and research. Elementary schools across the country routinely utilize 'outdoor school' trips to teach about natural systems; arboretums and botanical gardens utilize outdoor spaces and displays to teach about specific plants, bioregions, and ecosystems; park systems ranging from local parks to national parks utilize interpretive displays and signage to teach people about the landscape they are experiencing. Of these examples, nearly all of them are geared towards a population whose time 'in place' is typically short in duration; unless you consider the employees of park systems, botanical gardens, etc., almost all of the audience spends relatively short time absorbing the lessons offered before moving onto the next place. While return trips may occur, they are generally infrequent when compared to the amount of time those same people spend in their 'everyday' environments of work, home, and/or school.

The University of Michigan's campus offers numerous opportunities for environmental learning, specifically on issues pertaining to sustainability. The campus is also host to thousands of potential 'learners' whose visits to campus are typically daily in number and long in duration. Combining these two facets of the campus suggests that an enormous amount of learning could occur if actively planned for and carried out. How this might happen could vary from place to place, but if one expands upon the examples mentioned in the previous paragraph, it becomes clear that a significant number of lessons about sustainability, natural process and systems within an urban environment, habitat quality, and about the role that human beings play in elevating the overall ecological health of human-occupied environments are there to be taken advantage of.

Doing so would allow for the transfer of lessons learned on campus through direct interaction with its buildings, landscapes and systems to the myriad off-campus environments they inhabit both as 'residents' of the UM, but also as 'past residents' (i.e., alumni) who will take the lessons learned here to their new place of residence.

There are several different categories of responses that could be used on the UM campus, which are: *passive* learning responses; *active* learning responses; and *participatory* responses. *Passive learning opportunities* could include: interpretive signage placed on campus to describe a design, element, or process that is sustainable in nature; an interpretive installation that draws attention to passers-by to an element of interest; a management practice that teaches through its visual presence to campus residents, and more. *Active learning opportunities* could include: course field trips/lectures to sites on campus to talk about precedents, opportunities, or problems extant within the campus landscape; design/build projects that students actively engage to not only solve a design problem, but to also elevate the ecological health of an area while also learning about sustainable design and construction practices; employing students and/or facilitating volunteer opportunities to actively participate in the management and maintenance of specific areas on campus; and encouraging research on urban ecosystem health and other issues, using the campus environment as the site for research. Lastly, *participatory learning opportunities* could include: expanding participatory processes tied to the design and planning of university projects to involve more individuals and to deepen the attachment to place and the sense of ownership that participants have for the campus as a whole; creating opportunities for conversations about the campus landscape, its design, planning and ongoing maintenance to engage an even larger spectrum of the campus population through events like town hall meetings focusing upon the development of the next version of the campus plan; and involving campus 'residents' in ongoing activities centered around the expansion of this sustainability work to an ever expanding arena of focus area, such as event planning, purchasing, and more.

Each of these response-types have many possible forms that they might take, although they do have one thing in common, that being the imparting of knowledge based upon visible elements and/or processes in the landscape. Some of these elements might be landscape elements in a relatively 'common' application such as a garden bed planted with native plants, or they could be something planted in a more 'visual', even controversial manner, such as a bioswale designed to both treat stormwater and to serve as an architectural earthwork that aspires to art installation. The latter intervention falls into the category of eco-revelatory design, which, as mentioned earlier in this paper, is focused upon making natural process and systems visible to both the interested/informed as well as to the casual observer. One such example was constructed at the University of Oregon, that being a sculptural bioswale that handles stormwater from over 10 acres of paved surface (see Figure 4). The swale has been featured on the university's website, and has been the focus of numerous class visits for students in landscape architecture, environmental studies, biology, and other courses. It was also designed to be a venue for research on urban runoff for either faculty or students, be they graduate or undergraduate.

Fig. 4 Bioswale earthwork, University of Oregon

Finally, efforts focusing upon the creation of specific courses pertaining to sustainability both on campus and beyond should be expanded to incorporate opportunities for learning that takes advantage of the campus landscape. Many universities run competitions that sponsor courses that enhance the freshman year experience, or that elevate the discourse on topics such as race and gender, while also offering opportunities to create courses that might meet a specific university's requirements around a multicultural learning goal, or quantitative reasoning. The University of Michigan should consider adding a requirement for all undergraduates that would focus upon sustainability; courses in this 'Sustainability and Community' category would help to elevate the conversation on campus regarding sustainability to a much higher level, and would serve to enhance the ecological literacy of the entire campus population. In addition to this, offering funding for graduate research that focuses upon sustainability in campus environments specifically, and also upon the issue of sustainability in a broader sense, would further the work of this project, and would afford the university an opportunity invest in its commitment to long term ecological health in a manner that not only aids the campus, but that is also rooted in the education mission of the university.

RECOMMENDATIONS FOR ENVIRONMENATAL EDUCATION: ECO-REVELATORY DESIGN

An overarching set of recommendations is proposed that would use the actions and goals set forth in the previous four categories as opportunities to showcase this work in a manner that educates individuals about the range of activates and techniques that exist to elevate ecosystem health and function in all landscapes that are host to human activity.

Recommendations in support of increasing human awareness, understanding, and appreciation for sustainability in landscape planning, design and maintenance include the following:

I. Increase opportunities for both passive and active learning about sustainability through the use of the UM campus as teaching precedent. Create opportunities for direct interaction and learning through the use of the campus landscape as a venue for teaching; increase available information in print and online regarding specific examples/precedents on campus of sustainable practices, processes, and visible strategies; create a coordinated program of educational signage on campus that highlights sustainable practices on campus that has as its audience the students, staff, faculty, alumni, and visitors to the UM campus.

II. Take advantage of new projects, and/or project renovations/retrofits, to create highly visible, ‘eco-revelatory’ installations that elevate the visible presence of sustainable practice, and of ecosystem health and function, on the UM campus. Develop outreach and educational materials that help individuals learn about what it is they are seeing, and encourage faculty and students to utilize these sites in their courses/activities to further the discussion and learning around the issues illuminated by the work.

III. Encourage students and faculty to utilize the campus landscape for research on topics pertaining to sustainability, and then publicize the work, and utilize the work to deepen our own understanding of ‘how we are doing’.

IV. Expand, and make more visible, the UM Planet Blue program to fit into the ‘Campus as Classroom’ theme.

V. Require all undergrad students to meet a *Sustainability and Community* requirement (S&C), similar to the Race and Ethnicity or Quantitative Reasoning requirement. Develop a list of appropriate courses, and encourage faculty to submit new courses, providing ‘seed’ money through a Call for Courses program, where appropriate.

CONCLUSION

As mentioned, and as evidenced by the repetitive nature of this report, many of these recommendations feed off of one another in a mutually beneficial manner. For this reason, it is difficult to prioritize one over the other, as they truly belong together, as parts of a whole. For example, planting native plants in a raingarden that filters pollutants from stormwater would help

U-M meet several of the goals listed above, all as part of the same overarching efforts to improve both biodiversity and water quality.

Each of these recommendations will yield both short-term and long-term effects. The Land and Water Team wishes to impart the critical importance of striving for long-term goals, (such as enhanced carbon sequestration through expanding the urban forest on campus), in addition to those with more immediate and visible results.

The recommendations regarding University planning stand alone, in a sense, in that they aim to establish a framework for thinking about land and water. If this framework is successfully adopted, the inseparability of these goals will become quite clear.

Amongst the recommendations that are more measurable and quantitative, reducing pervious cover is somewhat of a catch-all goal that will require or be assisted by the implementation of other goals listed, such as the native plants policy. Ultimately, however, the act of prioritizing goals would contradict the goals of this assessment.

APPENDIX A: STORMWATER INFORMATION

The information below provides greater insight into watershed management concerns.

Pollutants/Nutrient Loading

Pollutants have "the potential to adversely affect the health of natural water systems."[81] "Pollutants of concern in stormwater from a general standpoint include organic materials which have a high biochemical oxygen demand, suspended solids, metals, nutrients, bacteria, and traces of toxic materials.[81]

TMDL

A Total Maximum Daily Load (TMDL) is the maximum amount of a particular pollutant a water body can assimilate without violating state water quality standards…. If a water body cannot meet the state's water quality criteria with point-source controls alone, the Clean Water Act requires that a TMDL must be established[9].

Stormwater Runoff

Stormwater runoff can negatively impact water resources in many different ways (e.g., decreased water quality, increased temperature, and decreased habitat), and can be described as "rainfall or snowmelt that runs off the land and is released into our rivers and lakes[67].

Impervious Surface

The amount of impervious surface in a watershed affects the amount of stormwater runoff that reaches bodies of water, such as the Huron River. Impervious surfaces, which prevent water from percolating into the ground, cause stormwater to flow directly into rivers via storm sewer systems, along with any detrimental components accumulated along the way, including increased temperature, velocity, and pollutants such as:

- Hydrocarbons and trace metals from vehicles,
- Suspended solids from erosive stream banks and construction sites,
- Chlorides from road salt
- Nutrients from fertilizer and grass clippings and leaves left on streets and sidewalks, and
- Bacteria from pet waste, goose droppings, and other wildlife[67].

Increased impervious surfaces decrease the amount of rainwater that can naturally infiltrate into the soil and increase the volume and rate of stormwater runoff. These changes lead to more frequent and severe flooding and potential damage to public and private property[67].

APPENDIX B: TEAM BIOS

Stanton Jones is an Associate Professor of Landscape Architecture in the School of Natural Resources and Environment. His research and professional work has included: participatory landscape planning projects in the Pacific northwest; development of a greenway plan for the the city of Davis, CA; community development, design and construction of open spaces, parks and gardens in low-income neighborhoods in San Francisco; and numerous site scale design and construction projects throughout California and Oregon. His research has focused primarily upon the issues of environmental equity and justice at a range of scales, and has also addressed the issue of sustainability within the planning, design and construction of equitable, inclusive places and landscapes. Prior to arriving at the University of Michigan, Professor Jones was a member of the faculty in Landscape Architecture at the University of Oregon for fifteen years, holding the post of Department Head for six of those years. His work has been published widely, and he has received numerous rewards from the American Society of Landscape Architects, the American Planning Association, and the Council of Educators in Landscape Architecture.

Virgilio Sklar is a dual degree student at the University of Michigan, where he plans to receive his Juris Doctor at the University of Michigan Law School and his Master of Urban Planning at the University of Michigan Taubman College of Architecture and Urban Planning in December 2011. He earned his undergraduate degree in Public Policy at Princeton University's Woodrow Wilson School of Public Policy and International Affairs in June 2003. Over the last two years, Virgilio has worked as a law clerk at the Environmental Law Institute in Washington, D.C. helping to develop model legal practices on issues ranging from wind energy siting to the inclusion of biodiversity protection in comprehensive master plans; and also as a legal intern at the National Wildlife Federation's Great Lakes Regional Center working on litigation relating to the Clean Water Act. His future career interests lie mainly in the enabling of sustainable urban outcomes through the use of creative legal and planning frameworks, especially in the area of clean energy development and systems-based urban ecology promotion.

Jessica Neafsey obtained her Master's Degree in Landscape Architecture from the University of Michigan School of Natural Resources and Environment in May 2010, where she was the recipient of the Ray Marshall Rowe Memorial Award, the William and Mabel Jackson Fellowship, and the 2009 Spirit of the Studio Award. For her master's project, she analyzed and made recommendations for a 1,200 acre agro-ecosystem in the Shenandoah River Valley, as part of an interdisciplinary team conducting a comprehensive sustainability assessment for a rural monastery in Virginia. She currently works as a landscape architect for the Johnson Hill Land Ethics Studio in Ann Arbor, MI. Her future career interests lie in promoting biodiversity within agricultural ecosystems and in restoring watershed health within the Great Lakes region.

Jennifer Casler is seeking to combine her experience and interest in business with her passion to sustainably develop communities. She will complete two graduate degrees from the University of Michigan in May 2011: a Master's of Business Administration and a Master's of Science in Natural Resources and the Environment. During her studies at U of M Jenny sought out and worked on multiple projects related to natural resource and real estate management while also working on other projects of interest such as K-12 education. Jenny's internships were spent as an Interim CFO for an environmental consulting firm and an Environmental Consultant for the Ingham County Drain Commissioner. Further, Jenny is a Certified Public Accountant, having earned a Bachelor's of Arts with a major in accounting from Michigan State University in 2005. Prior to beginning her graduate studies, Jenny worked as a financial and compliance auditor as well as a tax preparer.

Tina Fix is pursuing her Masters of Landscape Architecture from the University of Michigan. She received her Bachelors degree from the School of Natural Resources and Environment from the University of Michigan in 2003. Prior to her graduate education, Tina worked for wetland consulting and land development firms providing assistance in the preservation, restoration, and creation of wetland systems with native plantings. Her research interests include innovative stormwater management and low impact development.

Amy Fingerle obtained her Bachelor of Science degree in the Program in the Environment from the University of Michigan College of Literature, Science, and the Arts in August 2010, with a focus on aquatic ecology and a Music minor. For her senior thesis project, she analyzed how populations of the amphipod *Diporeia* are changing spatially and temporally within the Great Lakes. During her undergraduate career, she was a marketing intern with the University Musical Society, a member and rank leader of the Michigan Marching Band Drumline, and a peer tutor at the Sweetland Writing Center. In 2009, she traveled to Chile as part of the Graham Scholars Program to study sustainable energy development. She currently works as a research technician at the USGS Great Lakes Science Center in Ann Arbor. Her future career interests lie primarily in the restoration and preservation of the Great Lakes.

APPENDIX C: RECOMMENDATION TIMEFRAME TABLE

Recommendation	Short term (1-2 years)	Medium term (2-10 years)	Long term (10-50 years)
Campus master plan with conservation zoning		1.1	
Incorporate sustainability planning	1.2		
Participatory planning process		1.3	
Reduce lawn by 35%	2.1	2.1	2.1
Native plant policy	2.2	2.2	2.2
Tree replacement policy	2.3		
Riparian zone maintenance policy	2.4	2.4	
Decrease impervious surface area by 25%	3.1	3.1	3.1
Promote bio-infiltration in the landscape	3.2	3.2	3.2
Decrease use of all chemical inputs		4.1	4.1
Institute a campus composting facility		4.2	
Hand weeding policy	4.3	4.3	
Decrease water use		4.4	4.4
Hands-on educational opportunities/signage	5.1		
Eco-revelatory installations		5.2	
Landscape research	5.3	5.3	5.3
Expand Planet Blue to outdoor areas as well	5.4	5.4	
Sustainability and Community requirement	5.5	5.5	

ENDNOTES

[1] Nassauer Joan, Iverson. “Cultural sustainability: aligning aesthetics and ecology,” Nassauer, J.I. editor. In: *Placing Nature: Culture and Landscape Ecology*. Washington, DC: Island Press, 1997. p. 67-83
[2] see Landscape Journal, special addition (exact citation needed)
[3] Daily Press. Kobasic, Jim. “MDNRE Begins Providing Services” January 22, 2010. Accessed May 2010. Available from: http://www.dailypress.net/page/content.detail/id/517090.html?nav=5006
[4] Landscape Journal. Citation to come.
[5] Galatowitsch, Susan, et al. “Regional climate change adaptation strategies for biodiversity conservation in a mid-continental region of North America” *Biological Conservation* 142 (2009): 2012-2022.
[6] Palmer, Margaret, et al., “Ecology for a crowded planet” Science 304: 1251-1252.
[7] American Society of Landscape Architects, Lady Bird Johnson Wildflower Center at the University of Texas, Austin, The United States Botanic Garden, “The Sustainable Sites Initiative: Guidelines and Performance Benchmarks,” Sustainable Site Initiative, http://www.sustainablesites.org/report/
[8] Huron River Watershed Council (HRWC) Accessed April 2010. Available from: http://www.hrwc.org/
[9] Southeast Michigan Council of Governments (SEMCOG). A Design Guide for Implementers and Reviewers: Low Impact Development Manual for Michigan. 2008. Available from: http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf
[10] E-Washtenaw. Water Resources Commissioner. Accessed April 2010. Available from: http://www.ewashtenaw.org/government/drain_commissioner
[11] Allen Creek Greenway Conservancy. Accessed April 2010. Available from: http://www.acgreenwayconservancy.org/
[12] E-Washtenaw. Mallets Creek Restoration. Accessed April 2010. Available at: http://www.ewashtenaw.org/government/drain_commissioner/dc_webWaterQuality/malletts_creek/frontpage
[13] Miller’sCreek Watershed Improvement Plan. Accessed March 2010, Available from: http://wiki.mtri.org/download/attachments/5898358/Chapter1.pdf?version=1
[14] City of Ann Arbor. Greenbelt. Accessed March 2010. Available from: http://www.a2gov.org/greenbelt/Pages/greenbelthome.aspx.
[15] Border to Border Trail Map. Available from: http://www.ewashtenaw.org/government/departments/parks_recreation/forms%20and%20publications/brochure/brochure_b2b.pdf
[16] Walsh, C.J., et al. "The Urban Stream Syndrome: Current Knowledge and the Search for a Cure." *Journal of the American Benthological Society 24 (3)*, 2005: 706-723.
[17] E-Washtenaw. Public Meeting for Pioneer High School Stormwater Project. Available at: http://www.ewashtenaw.org/government/drain_commissioner/dc_webWaterQuality/ac/news/01082009public%20meeting

[18] Huron River Watershed Council (HRWC). Bioreserve Project. Available from: http://www.hrwc.org/our-work/bioreserve/
[19] National Wildlife Federation. (2008). *Higher Education in a Warming World: The business case for climate leadership on campus*, pp. 41-42.
[20] Duke University. (2000). *2000 Master Plan*, II-3, Retrieved from: http://www.architect.duke.edu/planning/master_plan.html.
[21] Duke University. (2000). *2000 Master Plan*, III-7, Retrieved from: http://www.architect.duke.edu/planning/master_plan.html.
[22] Nichols Institute, Duke University. (2005). "Duke University Enrolls 1,220 Acres of Duke Forest in Natural Areas Registry." *Dukenvironment Magazine*, http://www.nicholas.duke.edu/DEarchives/sp05/log-forest.html (*accessed on* May 28, 2010).
[23] Stanford University. (2010) *About the Stanford University Habitat Conservation Plan*. Retrieved from: http://hcp.stanford.edu/HCP_Brochure_04_27.pdf.
[24] University of Vermont Environmental Council. (2002) *Tracking UVM: An environmental report card for the University of Vermont for the years 1990-2000*, p. 8.
[25] University of Vermont. (2006). *Campus Master Plan*, p. 22.
[26] Jacobs, Allan and Appleyard, Donald. (1987). "Toward an Urban Design Manifesto." *Journal of the American Planning Association*, 53: 1, 112 — 120, p. 115.
[27] Hester, R.T. (2006). *Design for ecological democracy*. Cambridge, MA: MIT Press.
[28] Philip R Berke; Maria Manta Conroy. (2000). "Are we planning for sustainable development?" *Journal of the American Planning Association;* 66, 1; p. 23.
[29] Maclaren, Virginia W. (1996). "Urban Sustainability Reporting." *Journal of the American Planning Association;* Spring 1996; 62, 2; p. 188.
[30] Grant, J. (2006). *Planning the Good Community: New Urbanism in theory and practice*. London: Routledge. P. 72.
[31] White, James T.(2008). "An ecological design philosophy: Randolph T. Hester's Design for ecological democracy." *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 1: 2, 187 — 198, p. 189.
[32] Campus Planning Committee Charter, Cornell University. (1994). *ARTICLE 9: The Associate Committees of the University Assembly* (CPCCharter9402_MA.pdf). Retrieved from: http://www.fs.cornell.edu/oppd/departments/planning.cfm.
[33] Baker, Helen. Campus Planning Office, Planning and Project Development, Cornell University. (2005). *History of the Campus Planning Commission.* Retrieved from: http://www.fs.cornell.edu/oppd/departments/planning.cfm.
[34] University of Oregon. (2005). *Campus Plan 2005.* P. 11.
[35] University of Oregon. (November 2005). *Frequently Asked Questions about the University's use of the Pattern Language*. Retrieved from: http://www.uoregon.edu/~uplan/faq/FAQPatternLanquage.html
[36] Timothy Beatley. (2000). "The vision of green urbanism." In: *The City Reader*. LeGates, Richard T. and Stout Frederiv (eds). (2003), p. 401.
[37] University of Oregon. (2008). *Campus Tree Plan*, p. 1.
[38] Campus Planning Services, University of Vermont. (2006). *2006 Campus Master Plan*, 66. Retrieved from: http://www.uvm.edu/~plan/?Page=campusmasterplandraft.html&SM=campusmasterplanmenu.html).
[39] Campus Planning Service at 240.
[40] University of Michigan. (2008) *University of Michigan North Campus: Master Plan Update*. p. 31
[41] University of Michigan. (2008) *University of Michigan North Campus: Master Plan Update*. Figure 5, Open Space Framework, p. 26 vs. Figure 6, Functional Use Framework, p. 30.
[42] Stanton Jones, Interview with Sue Gott, Campus Planner, University of Michigan, (May 2010).
[43] Maclaren, Virginia W. (1996). "Urban Sustainability Reporting." *Journal of the American Planning Association;* Spring 1996; 62, 2; p. 188.
[44] Stanton Jones, Interview with Sue Gott, Campus Planner, University of Michigan, (May 2010).
[45] University of Michigan. (2008) *University of Michigan North Campus: Master Plan Update*. p. 17.
[46] United States Fish and Wildlife Service. (2010). *Endangered Species in Michigan – County distribution*. Retrieved from: http://www.fws.gov/midwest/endangered/lists/michigan-cty.html.

[47] Washtenaw County. (2004). *Osborne Mill Final Report*. Retrieved from: http://www.co.washtenaw.mi.us/government/departments/parks_recreation/naturalist/inventories/om/om_report.html.
[48] Girling, Cynthia and Kellet, Ronald. *Skinny Streets and Green Neighborhoods: Design for Environment and Community*. Island Press, Washington D.C.: 2005.
[49] Office of Campus Sustainability (OCS) Land Use Metrics Sheet. January 2010.
[50] Iseler, James "Arbor Day Foundation Names U-M a Tree Campus USA Institution. The Record Update. "http://www.ur.umich.edu/update/archives/100128/trees
[51] Nassauer JI, Wang Z, Dayrell E. What will the neighbors think: Cultural norms and ecological design. Landscape and Urban Planning. 2009;92:282-292.
[52] Douglas W. Tallamy, *Bringing Nature Home: How You Can Sustain Wildlife With Native Plants*. Portland, London: Timber Press, 2007.
[53] Kenneth Rapp, M.L.A., personal communication
[54] David Michener, personal communication
[55] Opdam P, Steingrover E. "Designing metropolitan landscapes for biodiversity: deriving guidelines from metapopulation ecology." *Landscape Journal*. 2008;27:1-08:69-80.
[56] National Wildlife Federation. Arizona State University Campus Profile. Available at: http://www.nwf.org/campusEcology/docs/Arizona_State_University.pdf
[57] National Wildlife Federation. Stetson University Campus Profile. Available at: http://www.nwf.org/campusEcology/docs/Stentson%20landscaping%20FINAL.pdf
[58] Indiana University Office of Sustainability. Sustainability Master Plan. Available at: http://www.indiana.edu/~sustain/
[59] University of North Carolina at Chapel Hill Sustainability Office. Available at: http://sustainability.unc.edu/Initiatives/CampusEnvironment/tabid/408/Default.aspx
[60] Hough, Mark "Graduating to green" Landscape Architecture, Vol. 100 (5), May 2010, p. 66-77.
[61] Hunter, Mary Carol R. "Mitigation, Adaptation, and Uncertainty: Managing a Sense of Place in Transition: Coping with Climate Change," *Places* 20:2 (2008): 20-25.
[62] Paul Opdam and Eveline Steingrover, "Designing Metropolitan Landscapes for Biodiversity: Deriving guidelines from metapopulation ecology," *Landscape Journal* 27 (2008):69-80.
[63] Savard JL, Cleargeau P, Mennechez G. Biodiversity concepts and urban ecosystems. Landscape and Urban Planning. 2000;48:131-142.
[64] Douglas W. Tallamy, *Bringing Nature Home: How You Can Sustain Wildlife With Native Plants* (Portland, London: Timber Press, 2007).
[65] EPA. Basic Information: Non-Point Source Pollution. Available at: http://www.epa.gov/nps/whatis.html
[66] The Low Impact Development Center, Inc.: Sustainable Design and Water Quality Research. Available from: http://www.lowimpactdevelopment.org/
[67] Huron River Watershed Council. Middle Huron River Watershed Management Plan. Avialable at: http://river-huron.org/wp-content/uploads/2009/11/management%20plan/Middle%20Huron%20Managment%20Plan%20w%20Maps.pdf
[68] Sasaki Associates, Andropogon Associates Ltd., Weatherbe, Ellen Elliott. University of Michigan North Campus Woods: Assessing the Value of Natural Areas in the Context of a Growing Campus. August 2007.
[69] University of Michigan Stormwater Management Program Plan. Avaialbe at: http://www.oseh.umich.edu/pdf/SWMPP_Public_Notice.pdf
[70] Portland Metro 2002. Green Streets: Innovative Solutions for Stormwater and Stream Crossings. Available at: www.oregonmetro.gov/index.cfm/go/by.web/id=26335
[71] San Francisco State University. "Respecting Water: Innovative Water Conservation and Management on the San Francisco State University Campus." Powerpoint Presentation, August, 2008. Available at: bss.sfsu.edu/holzman/LakeMerced/water.htm - 72k - 2001-07-17
[72] UC Berkeley. Sustainability – Water [Internet]. Berkeley (CA): UC Berkeley; c2010 [cited 2010 May 17]. Available from: http://sustainability.berkeley.edu/pages/water/overview.shtml
[73] Grand Valley State University. 2008 Sustainability Indicator Report [report on the Internet] Allendale (MI): Grand Valley State University; 2008 [cited 2010 May 17]. Available from:

http://www.gvsu.edu/cms3/assets/1ACDDEF0-A15A-67B1-F268BE06B2416593/documents/2008-sustainability-indicator-report.pdf
[74] University of Michigan Grounds and Waste Management Services. Irrigation Crew [Internet]. Ann Arbor (MI): University of Michigan; 2006 [cited 2010 May 17]. Available from: http://www.plantops.umich.edu/grounds/grounds_svcs/irrigation_crew.html
[75] University of Michigan Occupational Safety and Environmental Health. University of Michigan-2009 Annual Environmental Raw Data Overview [Internet]. Ann Arbor (MI): University of Michigan; 2004-2009 [cited 2010 May 17]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
[76] University of Michigan Grounds and Waste Management Services. Integrated Pest Management Plan [Internet].. Ann Arbor (MI): University of Michigan; 2010 [cited 2010 May 17]. Available from: http://www.plantops.umich.edu/grounds/grounds_svcs/trees_forestry/Integrated_Pest_Management.html
[77] Harvard University. Facilities Maintenance Operations. Organic Landscaping . Avialable at: http://www.uos.harvard.edu/fmo/landscape/organiclandscaping/
[78] A. Richardson, personal communication, May 2010.
[79] Hausman H. Sustainable Landscaping – Williams College [student internship report on the Internet]. Williamstown (MA): Williams College; 2009 [cited 2010 May 17]. Available from: http://www.williams.edu/resources/sustainability/student_projects/hannah_grounds.pdf
[80] University of Michigan Plant Building, and Grounds Services. FY 2010 Snow Removal [Internet]. http://www.plantops.umich.edu/grounds/snow_manual/
[81] Michigan Department of Environmental Quality, Surface Water Quality Division. Guidebook of Best Management Practices for Michigan Watersheds. 1998.

This publication is a result of work sponsored by the Graham Environmental Sustainability Institute and U-M Office of Campus Sustainability.

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

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For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

UNIVERSITY OF MICHIGAN
CAMPUS SUSTAINABILITY INTEGRATED ASSESSMENT

FOOD ANALYSIS – PHASE 1 REPORT
June 1, 2010

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This publication is a result of work sponsored by the Graham Environmental Sustainability Institute and U-M Office of Campus Sustainability.

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EXECUTIVE SUMMARY

Food systems are intrinsic to the wellbeing, wealth, and vibrancy of any community; economic stability, public health, and environmental sustainability are all tied to the movement and availability of food. Within the institutional context, the demand for food can generate a complex system, often dependent on the efficiency, reliability, and consistency of large-scale foodservice providers. As issues relating to informed food choices and sustainability are commanding the attention of communities worldwide, campuses are increasingly considering the effects that their food choices have on the surrounding community, economy, and planet. Although large, decentralized institutions, such as the University of Michigan, have inherent difficulty facilitating change, strong momentum is building through the efforts of numerous campus organizations and individuals. A coordinated effort would unify these dedicated groups, educate and encourage members the community and propel the University of Michigan toward the forefront of institutional food system sustainability.

The Food Team determined the following four goals to pursue during Phase One of the Integrated Assessment:

1. Compile a comprehensive set of data about current institutional practices at U of M relating to food.
2. Garner information regarding innovative food sustainability practices at institutions across North America and, within these, identify the challenges and opportunities that may be relevant to the food system at U of M.
3. Engage with the community to find out what food issues are most important to students, faculty, staff and area residents.
4. Make five policy recommendations that will enhance the sustainability of the U of M campus. Consider environmental, cultural, and economic factors that contribute to sustainability when developing recommendations.

The Food Team began its assessment work by conducting case studies of food sustainability practices at 12 institutions across North America. These were comprised of two different types of institutions: five large universities comparable in student population, annual food spending, and scale and complexity of operations (UC Berkeley, Indiana, Michigan State, Ohio State, and Toronto) and seven

smaller universities (Bates, UC Santa Cruz, Emory, Stanford, Vermont, Washington, and Willamette) notable for their innovative production, purchasing, waste reduction, and educational programs. This research was useful in identifying the progressive trends in campus food practices. It also enabled the team to understand and compare: various definitions used to refer to local food and sustainable food, minimum local food purchasing goals, and different relationships between institutions and large foodservice wholesalers. One sustainability practice, appearing consistently at the progressive institutions, is the on-campus farm/garden (in some places accompanied by an orchard), which serves as a central hub for many student and community engagement activities. Another common trend arising from the case study research is the ability of tray-less dining to dramatically reduce the volume of waste generated in campus dining halls and cafeterias.

Before making recommendations regarding food sustainability at U of M, it was necessary for the Food Team to learn the details as to how the current system operates. This was accomplished through interviews with Residential Dining Services, University Unions and Catering, University Hospitals, and Sysco Detroit (available in the appendix). Some of this information was shocking—a reminder of the staggering scale of foodservice operations at U of M. For example, Residential Dining provides an average of roughly 70,000 meals each week, while the hospitals dispense nearly 50,000 disposable straws and napkins weekly. Additionally striking is the degree of decentralization in food purchasing at the University. Sysco Detroit, the primary food service vendor, currently accepts orders from over 200 separate purchasers within U of M. It became clear that a useful part of the Food Team's task would be to aid the University in developing resources for these 200 entities to both identify and source local, sustainable products in a coordinated way.

Due to time limitations, University Athletics has not yet been included in the food system analysis. As athletics represents a significant portion of the University community, the Food Team hopes to learn about their practices, needs and goals during Phase Two of this integrated assessment.

Essential to the progress of the Food Team's assessment thus far has been the engagement of both the campus and the wider Ann Arbor/SE Michigan community. Team members contacted student sustainability groups, participated in community local food meetings and attended regional food conferences. These experiences provided insights at to how people at U of M and beyond feel about food sustainability, the steps they are taking individually and the direction they would like the

University to move in. Washtenaw County Food Advocates are pushing for a countywide effort to source 10% of all food from within the county; a sharp increase from the less than 1% that they estimate is currently produced within the county. Input garnered from many different campus and community members showed strong concerns regarding the damaging effects of disposable plastic beverage containers on the environment.

All of these sources as well as previous research and personal knowledge led to five recommendations to enhance sustainability on the U of M campus:

1. **Eliminate bottled water from campus**
2. **Source 20% local food by 2020**
3. **Establish a student farm**
4. **Reduce food waste on campus and introduce post-consumption food composting**
5. **Endorse a comprehensive food labeling system for local, sustainable products**

These five recommendations represent a mix of immediately achievable and long-term, stretch goals that, if successfully implemented, will establish the University as a leader in food sustainability among its peer institutions. As the Integrated Assessment Initiative moves forward through the summer and fall of 2010, the Food Team will focus on developing specific plans for implementing these recommendations. In addition, the team will work to identify possible ways to align these recommendations with those of the other six teams involved in the integrated assessment to maximize efficiency and strengthen efforts.

INTRODUCTION

There are several components involved in realizing a complete and sustainable institutional food system, including production, procurement/purchasing, consumption/education and waste. Each member of the team investigated various innovative food practices employed by college and university campuses nationwide in each of these food system areas. This case study research fostered increased awareness as to which sustainable food measures are possible and being piloted, and emphasized just how important people are viewing sustainable food choices. Additionally, current food system practices at U of M were reviewed to determine the types of resources necessary to encourage sustainability, the challenges involved and the successful programs already in place. As a result of this research and community input, the Food Team developed a set of five prioritized recommendations for the University to review, and also to steer and focus the efforts of the Food Team through Phase II of the Campus Integrated Assessment.

The Food Team is led by Professor Larissa Larsen, who contributes a unique perspective on sustainable food systems owing to advanced degrees in both Landscape Architecture and Urban Planning, as well as to her childhood years on a farm in Ontario, Canada. The team is comprised of six student members from diverse backgrounds: Bradley Detjen, Alysia Giatas, Sue Johnson, Margo Ludmer, Kevin McCoy, and Breanna Shell. Additionally, Celia Haven of the Culture Team attended the Food Team meetings throughout Phase 1, contributing valuable insights and information.

STATUS: A Summary of Current University of Michigan Food Practices

The following section provides a brief overview of the University's food system (Please see Appendix I for a detailed report on University of Michigan food practices).

A. FOOD PURCHASING

The University of Michigan has a prime vendor contract with Sysco Detroit. With the exception of athletics, every food vendor run by the university orders food from Sysco. In total, these university food service operations purchase about 85% of all food items from Sysco. This equals approximately $12 Million dollars per year.

Sysco Detroit is striving to purchase more food locally than in the past. Currently, Sysco estimates that between 5 and 6 % of University of Michigan's food is locally produced. Sysco defines "local" products as products that are grown or processed in MI, or in Sysco Detroit's service area, which extends to Findlay, Ohio. In 2009, Sysco Detroit purchased 90,000 cases of produce from 61 different producers and farms in Michigan. Sysco Detroit gives U of M the first bid on new shipments from local suppliers, and presents Michigan suppliers first in its literature whenever one is available for a given product. Sysco also works with small suppliers to improve their ability to sell to large institutions. By working with Sysco, small farms can gain access to greater insurance and access to Sysco's large customer base. Also, small suppliers can save money by tapping into Sysco's distribution systems. Sysco also works closely with institutions to help them meet their local purchasing targets.

Some 200 different on-campus entities independently purchase food from the University's prime vendor, Sysco Detroit. These entities include smaller unlicensed customers, such as academic departments, five child care centers, and the golf course. There is no system in place to coordinate food purchasing among these 200 distinct entities.

B. ON-CAMPUS FOOD OPERATIONS

The University of Michigan employs a decentralized approach to food production, with a few umbrella organizations overseeing the operations of multiple facilities, as well as several smaller independent food service operations.

The numerous food-purchasing entities at U of M each take different approaches to food sourcing, food production, and waste management. Most units fall under the management of Residential Dining

Services (RDS), University Unions (UU), University Catering (UC), University of Michigan Health System (UMHS), and Michigan Athletics.

RESIDENTIAL DINING SERVICES

Residential Dining Services (RDS) operates eight full-service dining halls as well as complementary retail cafes and convenience stores located within undergraduate residence halls. During the fall and winter semesters, the eight dining halls managed by RDS (Hill Dining Center, West Quad, South Quad, East Quad, Markley, Bursley, Betsy Barbour, and Oxford) serve an average of 70,000 meals per week during 18 different mealtimes.

Food services in University Housing are provided by RDS, which oversees dining halls as well as retail cafes and convenience stores in the residence halls. RDS purchases food and food service products from Sysco Detroit and several other smaller vendors. In recent years, RDS has increased the percent of pre-consumer food waste that is composted, shifted to more environmentally friendly materials, and begun labeling foods purchased in Michigan to increase visibility.

The dining hall at East Quad is the leader in food sustainability on the U of M campus. The innovative food practices employed at East Quad demonstrate the feasibility of sourcing local foods for University Dining Halls. Chef Nelson “Buzz” Cummings has formed relationships with several Michigan farmers that enable him to ensure the quality and reliability of products while sourcing more than 50% of East Quad’s produce locally. These farmers have expressed interest in expanding this relationship to service larger/more dining facilities. Significant student involvement has also encouraged the expansion of East Quad’s model practices to other RDS locations on campus.

UNIVERSITY UNIONS & CATERING

University Unions (UU) operates/oversees 23 establishments in the Michigan League, Michigan Union, and Pierpont Commons. University Catering (UC) utilizes facilities and kitchens in each of the three University Unions and serves food at functions throughout campus. University Unions and Catering are auxiliary units within the university, which have their own budgets. For this reason, they consider themselves similar to other small businesses operating in Ann Arbor. Similar to Residential Dining Services, University Unions and Catering rely primarily on a few large vendor contracts, with some smaller contract to source meat, dairy, and beverages from local warehouses. University Unions and Catering say they strive to provide sustainable, local food whenever feasible and are very interested in furthering their ability to source locally.

UNIVERSITY OF MICHIGAN HEALTH SYSTEM

The University of Michigan Health System serves food to patients, produces food for Meals on Wheels, and operates/oversees retail food service within the hospital complex. The University of Michigan Health System's mission regarding food is to provide exemplary food and medical nutrition therapy for patients and the community. The hospital is a different food provider than other institutions on campus because it serves a population that is often immune-compromised, and must accommodate over 100 diets and allergy restrictions. The patient food and nutrition services department serves 54,700 meals per month, as well as 11,200 meals for Meals on Wheels. 100% of the meals served at the hospital are prepared on-site, and kitchens are equipped with several commercial and specialized pieces of equipment to provide appropriate food preparation. The hospital has a unique food provider environment, but aims to continuously review new products and innovations to determine if they are applicable to their operation.

C. FOOD SAFETY

In total, 84 licensed food eateries operate at the University of Michigan. Each of these eateries is regulated by the office of Occupational Safety and Environmental Health (OSEH) to ensure food safety.

D. FOOD WASTE

The university does not track food waste separately from combined building waste. This makes it difficult to gauge the direct impact of food waste on campus sustainability. However, the university does use a comprehensive waste tracking system for pre-consumer food waste composting. In 2009, residential dining halls and unions composted 64 tons of pre-consumption waste at a cost of $40 per ton of waste. Compostable waste is separated on-site during food preparation, then collected by University Waste Management Services and taken to the City of Ann Arbor's compost site. In 1997, East Quad Dining Hall was one of three dining halls selected by the University to pilot this program. Its success led to the current "prep-waste" composting program in place at five residence halls. At this time, the university does not have a post-consumer composting program in place campus wide. The only example of post-consumer food waste composting on campus is operated by The Ross School of

Business, which has contracted its own post-consumer composting provider. Post-consumer composting is more difficult and more expensive due to problems with contamination and sorting.

TRENDS: Summary of Progressive Food Practices at Educational Institutions

As part of our background research, our team conducted twelve detailed case studies of food sustainability practices at a variety of institutions (Matrix on pages 10-12). In our early identification of possible cases, we included different types of large institutions that have significant food service operations and were implementing progressive programs. These included institutions such as prisons and military bases. However when our initial investigations revealed significant differences that made these alternative cases less useful, we narrowed our focus to educational institutions.

We examined two different types of educational institutions: five large universities comparable in student population, annual food spending, and complexity of food service operations (UC Berkeley, Indiana, Michigan State, Ohio State, and Toronto) and seven smaller liberal arts colleges (Bates, UC Santa Cruz, Emory, Stanford, Vermont, Washington, and Willamette). The majority of the following summary focuses on information from the larger university cases with information from the smaller institutions serving as inspiration for innovative production, purchasing, waste reduction/composting, and educational programs.

Definitions of Local – Determination of Area and Inclusion of Processing

For our five larger institutions, the definition of local was geographically expanded compared with the smaller institutions' prevailing 150-mile definition. UC Berkeley identified local food as being produced with the closest 16 California counties. Indiana University defined local food as that produced within the southern portion of Indiana. Michigan State and Ohio State both expanded their definitions of local to include their entire state. Interestingly, both Michigan State and Ohio State also expanded their definitions of local food by including food either **produced and/or processed** within its state. In the case of Michigan State, approximately 12% of its food is produced within the state while an additional 13% of the food is processed within the state. The inclusion of processing helps explain how Michigan State is able to achieve 25% local food and how Ohio State is able to achieve 30% local food.

Differentiating Local Food, Sustainable Food, and Local, Sustainable Food

The terms sustainable and local are not synonymous. Based on our research, only two large universities undertook the challenge of making this distinction. The University of California at Berkeley defines sustainable food as meeting one or more of 18 criteria. Some of these 18 criteria include established criteria (flawed as these criteria may be), such as USDA Organic and Fair Trade Certified. However, food being produced within the 16 county-area around UC Berkeley also qualified for the ‘sustainable’ label without imposing additional criteria specifying the production practices. UC Berkeley requires 10% local purchasing and has established a goal of 20% sustainable food by 2020.

From our research, the University of Toronto is the most progressive institution as it relates to identifying both local and sustainable food. The University of Toronto partnered with a non-profit organization called Local Food Plus (LFP) and identifies food that is both local and sustainable using a “Local Sustainable” labeling system. LFP provides third-party certification at a minimum cost to the producers (LFP costs are subsidized by foundation grants). LFP also assists in strengthening supply chain networks for local producers and provides marketing support for the label throughout the Toronto region. Therefore the Local Sustainable Label extends beyond the University of Toronto campus into the larger community.

Criteria for Local Sustainable Label:

1. Employ sustainable production systems that reduce or eliminate synthetic pesticides and fertilizers; avoid the use of hormones, antibiotics, and genetic engineering, and conserve soil and water
2. Produce safe and fair working conditions for on-farm labor
3. Provide healthy and humane care for livestock
4. Protect and enhance wildlife habitat and biodiversity on working farm landscapes
5. Reduce on-farm energy consumption and greenhouse gas emissions

It is useful to note that while the University of Toronto estimates that 25% of its food is local, that the ‘local, sustainable’ food constitutes only 3.2% of the total food used by the institution. Therefore, distinguishing what is both local and sustainable raises the bar significantly.

Large Food Wholesalers Can Incorporate Local Producers

All of the large universities used food wholesalers to meet the majority of their food supply needs. However, these large food wholesalers made efforts to acquire local food. The significant size of these contracts with food wholesalers makes it possible for the universities to specify local content and thereby enlarge the market size for local food. In the case of UC Berkeley, 3 distributors purchased food directly from 60 local producers. Sysco Grand Rapids, who supplies Michigan State, has created a simplified contract for local producers (this still does not overcome the insurance requirements for local producers).

Some of the smaller universities were able to by-pass large food wholesalers with expanded in-house efforts. In the case of Emory, Stanford, and UC Santa Cruz, a farm liaison position was created to identify potential local sources and provide assistance with purchasing. It is also important to note that UC Santa Cruz addressed the social justice element of sustainability by recently improving food service workers' pay schedule.

On-Campus Food Production

Indiana University has campus gardens associated with three of its residence halls. Michigan State and Ohio State, two of the five large universities we examined, both operated campus farms. Michigan State's campus farm began in 2002 and it is a CSA (CSA = community supported agriculture and this means that community members pre-purchase seasonal shares in exchange for a portion of the harvest) with the majority of labor provided by students. At Michigan State, the farm includes fruit/vegetable production (with season extension through hoop houses and heated greenhouses) and livestock production. Salad greens used in the Michigan State cafeterias are often grown on the student farm. Many of the smaller universities also had active student farms, gardens, or orchards on campus. The majority of these operations were less than 3 acres in size.

Innovative Waste Reduction

Common strategies for waste reduction among our case study schools include reusing cooking oil, donating excess food to local food banks, tray-less dining, and using reusable or compostable service items (cups, containers, napkins, and cutlery). The University of Michigan already has a significant program in place for reusing cooking oil and conscientiously donates excess food to the local Food Gathers organization. Therefore, we won't expand on these two strategies.

The majority of large and small institutions that we studied are adopting tray-less dining as a method to reduce food waste. Tray-less dining decreases the likelihood that students will take more food than they can eat from the cafeteria by limiting their carrying capacity. Estimates of decreased food waste from these institutions vary from 30% to 60%.

Take out food is a significant part of campus life and a significant source of waste. Two waste reduction strategies emerge related to take out food and the necessary containers: one strategy involves reusable items and the other strategy involves compostable items. The University of Toronto started a Lug a Mug program to encourage students to use reusable mugs for drinks and reduce waste from paper cups. Those who use recyclable mugs receive a small discount on their drink purchase. Ohio State offers a small discount for those who reuse shopping bags.

The other common waste reduction strategy is using compostable service items. UC Berkeley now uses containers/boxes made of bagesse (plant fiber) that may be composted. These compostable service items are already available at some University of Michigan venues. However, our team noted that while these compostable containers may be preferable to Styrofoam or plastic, many don't actually get directly composted because they enter the traditional waste stream. This issue of composting leads to our next topic.

Waste Composting

Almost all of our case study institutions have programs for pre-consumption waste composting. This means that all compostable materials yielded in the preparation phase are composted. Some progressive institutions were actually able to compost their own food waste right on campus in their farms or gardens and thereby reduce transportation costs. Washington University in St. Louis is constrained for space on their urban campus. Therefore, they have incorporated in-vessel composters on site at residence halls to speed up the composting process to approximately 14 days in length.

However, the most challenging dimension of composting is implementing post-consumption waste programs. These programs require that consumers separate compostable food waste from other waste products (napkins, paper plates etc.) after eating. Here, the smaller institutions are leading. The University of Vermont is able to compost almost 100% of its pre and post-consumption food waste. The challenge of post-consumption waste is contamination with non-compostable items. Therefore, students must conscientiously separate their wastes. In the case of the Ross School of Business at the University of Michigan, post-consumption waste composting requires hand sorting.

Educational Programs

For the purpose of this review, we have divided educational programs into two categories: awareness and engagement. In the category of awareness, we noted that that University of Toronto, in coordination with Local Food Plus, publishes a map that identifies the sources of local food production. Another common activity that the University of Michigan RDS already participates in is a local meal. At specific times during the school year, the menu is completely derived from local producers and highlights regional faire.

A final educational awareness program approach involves ‘zero waste’ activities. Several universities (beyond our five case study examples) have hosted zero waste football games. University of Michigan students are currently proposing a zero waste basketball game in the near future. These awareness programs draw attention to local food options and highlight how many existing campus activities can be rethought to reduce waste.

The category of engagement requires students to actively engage in the food system. In addition to the highly engaging student farms mentioned above, examples of educational engagement programs include student-run stores, cafes, farmers’ markets. Students at UC Berkeley organize and operate a local, sustainable food store and a weekly farmers’ market. The weekly farmers’ market operates for four hours once a week in the Student Union Building. These engagement tasks help diversify the food offerings on campus and provide students with active learning options and sometimes paid work opportunities.

Community Engagement

In addition to case study institutions that set goals to increase their local food purchasing requirement and increase connections to local producers, several offered innovative community engagement strategies. Many of these community engagement strategies were built around their on-campus farms or gardens. As previously mentioned, Michigan State’s farm engages the local community by selling shares in their harvest (CSA) to off-campus residents. Washington University sells extra produce from their on-campus farm at a local farmers’ market in a lower-income area in St. Louis. Washington University also offers a summer camp for local children, integrating the student garden as a central activity. Indiana University sponsors a “Sprouts” program that communicates information to the community about environmental practices and sustainable gardening practices.

Another potential avenue for community engagement involves highlighting the connection between our local food system and our land use practices. Ohio State's Executive Chef promotes farmland preservation. UC-Santa Cruz offers student tours of local farms. Willamette University has adopted a policy to support food sustainability on a global basis. Highlighting how our food practices connect us to the local landscape and the regional watershed may be a powerful strategy for shaping both student and community engagement activities.

Case Study Matrix (page 1 of 3)

Institutions of Comparable Size	Location	Student Population	Non-Student Population	Annual Food Spending	Definition of Local	% Local Spending of Total Food Budget
UC Berkeley	Berkeley, California	35,000	24,700	$13.1 Million (USD)	Within a 16 County Radius of UC-Berkeley	Yes
Indiana University	Bloomington, Indiana	39,000	8,250	$11 Million (USD)	The southern half of Indiana	5%
Michigan State University	East Lansing, Michigan	47,280	11,320	$ 18 Million (USD)	Michigan	approx. 12% produced in MI approx. 25% produced and/or processed in MI
Ohio State University	Columbus, Ohio	55,000	n/a	$17 Million (USD)	Any item that creates a revenue stream for an Ohioan	30%
University of Toronto	Toronto, Ontario	50,000	n/a	$37 Million (CAD)	Local Food Plus': "Local, Sustainable" label requires satisfying 5 criteria	3%
Smaller Institution With Innovative Program	**Location**	**Student Population**	**Non-Student Population**	**Annual Food Spending**	**Definition of Local**	**% Local Spending of Total Food Budget**
Bates College	Lewiston, Maine	1,752	215	$2 Million (USD)	State of Maine	approx. 30% (goal of 35%)
UC Santa Cruz	Santa Cruz, California	16,000	n/a	$6.9 Million (USD)	Within a 250-mile radius of Santa Cruz	25-30%
Emory University	Atlanta, Georgia	12,740	1,840	$ 5 Million (USD)	n/a	approx. 22%
Stanford University	Palo Alto, California	14,000	1,900	n/a	Within a 150-mile radius of Palo Alto, CA	n/a
University of Vermont	Burlington, Vermont	12,350	1,300	$ 5 Million (USD)	• 1st Priority: within a 150-mile radius of Burlington, VT • 2nd Priority: within the State of Vermont • 3rd Priority: within the bio-region	5%
Washington University	St. Louis, Missouri	13,760	11,400	$6.6 Million (USD)	Within a 150-mile radius of St. Louis, MO	6%
Willamette University	Salem, Oregon	2,600	n/a	$1.8 Million (USD)	150 miles	65%

Case Study Matrix (page 2 of 3)

Institution of Comparable Size	Use of a large food wholesaler	Does Food Wholesaler encourage local food?	Innovative Procurement/ Purchasing	Innovative Production Program(s)	Innovative Waste Reduction/Composting
UC Berkeley	YES	YES	Purchases from 60 local growers thru 3 distributors	n/a	Initated To-Go container, composting initiative using containers/boxes made from bagasse. Post-consumption waste composting equals 50 tons per month. Composted on campus. Recycles cooking oil. Compostable utensils/serving ware.
Indiana University	YES	n/a	n/a	n/a	• All food prep facilities engage in a pre-consumer compost program • Excess food is donated to a local food bank • Vegetable oil is recycled
Michigan State University	YES	YES	• Purchases from 20 local food suppliers through Sysco Grand Rapids • Designed a standard contract specifically for local food producers/suppliers	• CSA-style Student Organic Farm est. In 2002 that has vegetable/fruit fields, livestock and heated greenhouses, which allow year-round production to meet academic year demand	• Excess food dontated to the Red Cross and area food bank • One residence dining hall is tray-less • Used cooking oil is sent to MSU Bio Refinery Training Facility and converted to
Ohio State University	n/a	n/a	• Actively seeks out local vendors by attending state produce growers conference • Brings new vendors to campus for student/staff previews • Sources some salad greens from student farm	• Student Farm	• Trayless dining is standard practice at all dining halls (resulted in 60% reduction in waste) • Bring your own bag program gives students credits for free food • Recycles 20% of all waste
University of Toronto	YES	YES	• Commitment to buy a percentage of food certified by LFP to be "Local, Sustainable" • Buys directly from five local farms • Requires largest food vendor to carry some LFP certified products	• Students run a Vegan Café once a week serving organic local food for very reasonable prices • Publishes a sustainable food map or all sustainable food providers on/near campus • Weekly Farmers Market (Apr-Sept)	•"I Lug A Mug" campaign to reduce waste from disposable containers gives students a 25 cent discount when they use a refillable container. • 7000 tons of food waste composted annually (pre-consumer)

Smaller Institution with Innovative Program	Use of a large food wholesaler	Does Food Wholesaler encourage local food?	Innovative Procurement/ Purchasing	Innovative Production Program(s)	Innovative Waste Reduction/Composting
Bates College	n/a	n/a	• Partners with Farm Fresh Connections, a network that creates relationships between schools and farmers to achieve the bulk of items needed	n/a	• Approx. 85% of waste stream is diverted through composting, recycling, food bank, alternative uses such as pig feed and incineration to produce electricity
UC Santa Cruz	YES	YES	• Severed its contract with a large food service provider in 2004 to move to a unionized work force and an in-house purchasing structure • Contracts with ALBA, a central marketing organization for several local producers	•Organic campus farm, for agricultural research and serving as a CSA for campus community •Appointed a "Farm to College" staff position	•3/5 of dining halls compost 100% of compostable food scraps • Residence hall pulping machine reduces waste volume by 2/3 • Tray-less in all Dining Services facilities since 2008 (32% reduction in food waste) • 100% used cooking oil is converted into biodiesel
Emory University	YES	n/a	• Employed a farmer liaison to expand local and sustainable food procurement	n/a	n/a
Stanford University	n/a	n/a	n/a	•Employs a Sustainable Food Coordinator	• "Love Food, Hate Waste" program, a partnership with a local waste mgmt. company
University of Vermont	YES	YES	• Ongoing efforts include partnerships with the Vermont Dept. of Agriculture and the Vermont Fresh Network	• Sodexho Campus Services has implemented the "Farm to College" program • Student-run campus garden	• 100% of dining facilities have a pre- and post-consumer waste program • Tray-less dining occurs in 3 dining halls (resulting in 40% waste reduction) • Excess food is donated to area food banks by the student-run chapter of Campus Kitchens, a national program created by Sodexho
Washington University	YES	YES	• Choice of food service provider, Bon Appetit	• On-campus, student run, organic garden	• Trayless cafeteria on certain days • Waste cooking oil converted to biodiesel
Willamette University	NO	n/a	• Purchases directly from sixteen local farms • Chefs and students interact directly with farmers on a daily basis • Strong support of several food sustainability labels • Corporate policy is to choose "seasonal, regional, and organic" products as the first option	• Partnership with Bon Appétit' food service management. This company's entire focus is providing sustainable, local foodservice to institutions. • Commitment to reduce GhG emissions by 25% from 2007 to 2010 (Bon Appétit')	• Charges diners for disposable containers and flatware • Composts 30% of kitchen waste on local farm • Experimenting with tray-less dining program (50% waste reduction on tray-less days)

Case Study Matrix (page 3 of 3)

Institution of Comparable Size	Education Program(s) for Students	Engagement with Community	Sustainability Committee	Challenges
UC Berkeley	Student activies are well funded. Students run a cooperative café that provides local, sustainable food options for students. Students also run a farmers' market (once a week for 4 hours in the Student Union).	Local farmers sell at the Student Farmers' Market.	YES	Established RFP criteria for vendors that includes preferences for local, financially sustainable, environmentally friendly, and ethical practices.
Indiana University	• Student-run gardens are being set up at 3 primary residence halls	• Established "SPROUTS" program, a community based education effort that focuses on environmental issues and sustainable gardening	YES	• Volume requirements
Michigan State University	• Student Organic Farm	CSA organic farm	YES	• Purchasing from local producers introduces challenges related to insurance, record keeping, and proper packaging of goods for institutional consumption
Ohio State University	• Student Farm	• Dining Halls food sustainability sparked similar efforts around the OSU campus in other areas • Uses sustainability in marketing materials to get the word out • Executive Chef promotes farmland preservation	n/a	• Size of the institution and state policies makes sourcing from small producers very difficult (only buys directly from five)
University of Toronto	• Publishes a sustainable food map of all sustainable food providers on/near campus • LFP "local, sustainable" label shows students which products are local.	• Support LFP "local, sustainable" label. This label is also used in grocery stores and restaurants in the community • Publishes a sustainable food map of all sustainable food providers on/near campus	YES	• Short growing season limits local purchasing (similar to U of M) • Large, decentralized institution (similar to U of M)

Smaller Institution with Innovative Program	Education Program(s) for Students	Engagement with Community	Sustainability Committee	Challenges
Bates College	• "Nourishing Body and Mind: Bates Contemplates Food" program	• Partners with the Harvard Center for Community Partnerships • Bates Community Service Organization--Community Food Assessment • Coordinates sales of local foods	YES	• Supply of local produce may not meet demand generated by the university • Local produce has different characteristics, such as lack of uniform size • Need for enhanced communication of needs between producers and the university
UC Santa Cruz	• Appoints one student Food Service Advisor per residence hall • Participates in the Real Food Challenge • Regional farm tours offered to students •Holds "zero waste" events to increase awareness	n/a	YES	n/a
Emory University	n/a	• Farmer liaison was active in community meetings and interacted with local producers	YES	• Restrictive food service contracts do not let local farmers distribute directly--they must be connected with a distributor • The greater expense of local and organic food is problematic, which led to the elimination of the farmer liaison position • Campus food menus are often locked into place
Stanford University	• Student-led awareness campaigns for composting	• Sustainable food coordinator interacts with and supports local producers	YES	n/a
University of Vermont	• Maintains a student forum that focuses on supporting sustainable/local and suggests changes to policies and best purchase practices	• Supports over 60 farms in and around the community	YES	• Matching growing season with demand during academic year • Higher expense of organic purchasing • Limited availability of fair-trade products • Composting issues such as the need for more frequent pick-ups during high volume times and adequate storage • The need for better staff training regarding oil collection in preparation for
Washington University	• Creation on the Sustainable Dining Team, a student group that meets with Bon Appetit marketing director to discuss procurement and goals • Real Food Challenge Program implemented on-campus and in dining hall events to increase awareness and visibility of practices/goals	• Student garden offers youth summer camps and activites • Summer harvest is sold at a farmers' market in an underserved neighborhood of St. Louis	YES	• Higher expense of sustainable purchasing • Matching growing season with demand during academic year • Large scale pre- and post-consumer composting hindered by lack of composting facilities in St. Louis area
Willamette University	• "Eat Local Challenge" meal is a highly publicized, 100% local meal once a year • "Circle of Responsibility" website to promote food sustainability • Publishes "Student Garden Guide" to help educate students working on campus farms • Bon Appétit employees give guest lectures	• Circle of Responsibility website • Corporate policy is to promote the cause of food sustainability globally	YES	• University of Michigan is much larger and much more decentralized than Willamette. • Local, sustainable food cost more

COMMUNITY INPUT

Feedback from the local community is fundamental to the improvement of the University of Michigan's food system. There are many individuals from U of M and Washtenaw County that are passionate about sustainable food practices. The knowledge and suggestions of these individuals are valuable assets to the integrated assessment process. This section summarizes input our team received from campus groups, an online suggestion forum, local food conferences, and town hall meetings. The majority of these responses express a desire for increased sourcing of local food, a campus garden or farm, an expanded composting program, and the reduction of disposable water bottles on campus.

A. Cultivating Community

Cultivating Community is a student-run organization associated with the University of Michigan Matthaei Botanical Gardens. Members are dedicated to providing students with an understanding of local food production through hands-on learning experiences. Cultivating Community advocates for closed-loop food systems, and demonstrates these processes at four gardens on or near campus. They suggest a five-part plan for improving food practices on campus (see Appendix 3 for more detail):

- Include more gardens on campus (particularly in Nichols Arboretum as an educational site for food cultivation)
- Increase sustainable produce in University dining halls
- Promote awareness of local, sustainable, fairly traded food
- Expand the composting program on campus
- Clearly distinguish receptacles for recycling

B. Better Living Using Engineering Laboratory (BLUElab)

BLUElab is a group of engineering students that develop and implement innovative engineering projects locally and abroad. BLUElab is currently engaged in a number of food-related projects, including the development of a bio-digester that converts organic waste into biogas and a collaborative renovation project for Growing Hope, a non-profit community gardens organization in Ypsilanti. BLUElab advocates for a number of changes to food practices at UofM (See Appendix 3 for more detail):

- Develop campus gardens
- Minimize disposable water bottles
- Increase composting and zero waste events
- Expand North Campus dining options (with fresh, locally sourced meals)

C. Michigan Sustainable Foods Initiative (MSFI)

MSFI is a student group that formed in response to a growing desire for local foods on campus. Since its formation in 2008, the MSFI has spread awareness of sustainable food options in East Quad Dining Hall and has worked to spread these model practices to other U of M dining facilities. The MSFI has also implemented Meatless Mondays in East Quad Dining Hall to educate diners about the environmental and ethical problems associated with meat consumption. The MSFI would like to see the following addressed on campus (see appendix 3 for more detail):

- More purchases from local farmers
- The implementation of the Meatless Mondays program across campus
- A campus apple orchard
- More organic and natural foods in dining facilities

D. Environmental Support/Facilities Task Force Group

The Environmental Support/Facilities Task Force Group, associated with Mhealthy, is working to promote sustainable and nutritious eating behaviors at U of M.

- **Farmer's Market:** This task force believes in the merit of an on-campus, walkable site for the sale of fresh, local produce. Members are engaged in a dialogue with coordinators of the Kerrytown Farmers' Market, who have expressed support for this initiative and have provided a contact list of farmers. Based on 1300 survey responses from UM faculty, 92% said they would visit a Farmers' Market on the University of Michigan campus highlighting locally grown produce during the Monday-Friday work week.

- **Community-Supported Agriculture:** The group also supports the establishment of a Community-Supported Agriculture program on campus. This might be in the form of an arrangement with a local farm to provide a CSA produce pick-up site at a campus location. A number of local, Michigan farmers have already offered to work with the University.

E. Graham Institute Online Feedback

As a means of receiving individual input during the integrative assessment process, the Graham Environmental Sustainability Institute created a public "Comment and Idea Submission Form" on their webpage. This form asks individuals to provide contact information, a description of their ideas, and a classification of their suggestion based on eight provided topics (one of which is "Food"). The food team received a number of suggestions from University faculty, staff, students and local residents through this system. The following are the most-frequently suggested actions. The full list of responses can be found in Appendix 3.

- **Increased Sourcing of Local Foods:** Many individuals expressed a desire for more local, sustainable foods on campus. One suggestion for sourcing local produce is to establish a Community-Supported Agriculture program. Contributors explained that a CSA will entail less food miles and will support the Michigan economy. Another entry suggested a commons area to sell produce and serve as a student kitchen. This site might sell local fruits and vegetables, in addition to providing a panini maker, toaster, grill, etc to provide a space for home-made meals.

- **Campus Garden or Farm:** The most frequent suggestion for increasing local foods on campus was to establish a campus garden or farm. Many entries requested a garden space or a greenhouse where students and local residents could grow produce. At this site, cultivators might grow herbs and vegetables to supply on-campus dining facilities, and receive campus food waste for composting. One submission form suggested that the farm be around 5 acres (potentially in the recent Pfizer property acquisition). This would serve as an integrative educational tool for U of M multi-disciplinary curriculum and as a demonstration of sustainable technology, engineering and design. Another entry asked for the installation of a hoop-house to supply food year round and encourage innovative, collaborative food cultivation practices. Many highlighted the potential for collaboration with community organizations on the cultivation and education process.

- **Improvements to Waste Management:** The majority of forms also requested the greening of the UM waste stream. Some contributors mentioned the importance of more sustainable packaging in dining locations on campus. This includes a reduction in Styrofoam usage and the supply of more eco-friendly packaging options. This also entails encouraging food vendors to allow students to use their own reusable plates and cutlery. A number of other entries encouraged an expanded composting program on campus. Some proposed that food waste be sold as animal feed or delivered to an on-campus anaerobic digester built by an environmental engineering class. The methane produced from the anaerobic digester might be used to generate electricity.

- **Miscellaneous Suggestions:** Additional suggestions include a centralized dish service for university functions, a more communal north campus dining center, expanded use of the Matthaie Botanical gardens and Nichols Arboretum, and a University website that provides students with coupons to local restaurants that have sustainable practices.

Summary of Online Feedback for Campus IA Food Analysis Team

Proposal ID	Sustainability Topic	Team Comments (include a 2 sentence descriptive statement or simple comment - addressed in Phase 1 report, beyond scope of analysis, focus for Phase 2, etc.)
416, 426, 512, 519, 526, 532, 569, 622, 632	Composting leftover food or sell as animal feed	Addressed in Phase I report--Recommendation #4: Reducing Campus Food Waste
470, 613, 624, 635	Local food purchasing	Addressed in Phase I report--Recommendation #2: 20% Local Food by 2020
410, 470, 484, 493, 502, 567, 609, 618	On-campus farm	Addressed in Phase I report--Recommendation #3: Establish a Farm On-campus
450, 487, 499, 540, 562, 619, 624	Reduction/elimination of bottled water	Addressed in Phase I report--Recommendation #1: Elimination of Bottled Water from Campus
418	Student kitchen for students who pack their own lunches	Noted the importance of this issue and may incorporate within a larger recommendation during Phase II.
468, 475, 483, 489, 518, 535, 537, 538, 596	Use only recycled and biodegradable food packaging, or use washable utensils	Addressed in Phase I report--Recommendation #4: Reducing Campus Food Waste
613, 633	Food labeling systems to show how local/sustainable options on menus are	Addressed in Phase I report--Recommendation #5: Comprehensive Food Labeling System
619	New policy at stadium for water bottles	Noted the importance of this issue and will address further as part of Recommendation #1 during Phase II
634	Reduce meat consumption (meatless Mondays)	Noted the importance of this issue and may embed within Recommendation #4 during Phase II

F. Homegrown Local Food Summit

At the Homegrown Local Food Summit on March 2nd of this year, approximately 250 people met in the Dana Building to evaluate and plan the expansion of a local food system. These individuals included producers, local food processors, food advocates, and representatives from U of M and other institutions. Workshops and break-out sessions focused on a goal of sourcing 10% of food locally in Washtenaw County. Currently, less than one percent of food purchased in the county originates from here. Should the county realize this goal, there would be an estimated direct economic impact of $1 Billion per year to food providers within the county.

G. Town Hall Meeting

The food team participated in the Sustainability Town Hall event that the Graham Institute held on April 12th 2010 at the Rackham Graduate School. We hosted two breakout sessions in which we discussed our progress, presented our initial five policy recommendations, and received feedback from town hall attendees. Among the comments and questions we received, many expressed a desire to see collaborative efforts between U of M and the local community, particularly regarding the development of a campus farm. Additional suggestions included educating diners on the carbon footprint of food and labeling food by the farm of origin. While responses voiced support for an increase in local food purchasing, one attendant highlighted the need to source both locally and sustainably—mentioning that one does not necessarily include the other. Overall, town hall attendees were very positive about our team's five recommendations and about the integrated assessment as a whole.

CHALLENGES and OPPORTUNITIES

We identified several challenges and opportunities that our research indicated would likely influence food sustainability efforts at the University of Michigan.

Challenges include:

- Decentralized purchasing
- Higher costs for local products
- Short Michigan growing season
- Physical infrastructure constraints
- University not set up for small suppliers

Opportunities include:

- Abundance of university owned land
- University purchasing power
- Michigan agricultural diversity
- Existing programs to build on

CHALLENGES

Decentralized purchasing

U of M has over 200 different entities on campus who purchase goods from the prime food vendor: Sysco Detroit. This decentralized purchasing structure will likely make the introduction of local, sustainable food sourcing policies difficult. Purchasing agents may need help to navigate local purchasing networks of smaller farms and suppliers. Another possible strategy to overcome this challenge is to endorse a local and sustainable food label. Labeling can help purchasers easily indentify local, sustainable products. Another important implication of U of M's decentralized structure is the need for multiple locations to accommodate alternative waste removal. It may be a challenge to create the possibility to provide post-consumer waste in all the facilities on campus. Increasing composting on campus to include post-consumer wastes will mean higher costs for waste removal, educating the university community, and sorting food waste.

Higher costs of local products

Another challenge to UM food sustainability is the higher cost of local, sustainable food. Not only are upfront purchasing costs higher, but the sourcing of local, sustainable food requires additional staff resources. Finding enough small to medium scale farms to support needed capacity, managing a larger number of suppliers, and accommodating more frequent drop-offs are just a few examples of challenges that will require additional staff to overcome.

Short Michigan growing season

The most productive months of the Michigan growing season do not match well with the months of highest demand for food on campus. Campus food demands are highest from September through April, while Michigan's most productive agricultural months are May through August.

Physical infrastructure constraints

Physical infrastructure on campus is not configured to support sustainable practices. For example, in order to increase composting and waste management there is the need for more space on loading docks to sort and store waste. There is also a need for more dock capacity to receive deliveries from a higher diversity of suppliers. In general, the dining halls on campus are built to work with the status quo (all-you-can-eat buffets, self-service using trays, and single-stream waste management). Many facilities will need physical reconfiguration/remodeling in order to institute some of the best practices we found in our research such as tray-less dining and post-consumer composting.

University not set up for small suppliers

The university is not equipped to work with small suppliers. Small growers and businesses find the university's $1 million insurance policy requirement impossible to afford. Additionally, many small producers find it difficult to wait for the next billing cycle before receiving payment. These requirements make forming partnerships harder for both the producers and the university food providers.

OPPORTUNITIES

Abundance of university owned land

Opportunities for creating a sustainable UM food system include the abundance of university-owned land and property. There is 3,070 acres[1] of land on the Ann Arbor campus, and some of that space may be available for an on-campus farm or orchard. Also some residential halls have space for loading dock expansions to make local purchasing more attainable.

University purchasing power

The university can harness its large purchasing power to create more opportunities for a community-based food system in the region. The university is Sysco Detroit's largest customer and therefore it is likely that new university policies could push Sysco to seek-out and provide more options in-line with UM sustainability goals. The university can provide a clear signal to producers that there is demand for local, sustainable food and products.

Michigan agricultural diversity and technology

Another unique opportunity for UM is that Michigan is the second most diverse state in agricultural products. Unlike many states, as demand for local products increases, local farmers will be able to adapt and still provide most products from local sources. Through the use of low-cost technologies growers can extend the growing season up to year-round production for some products. Using new growing techniques and technology make bridging the gap between peak growing season and peak campus consumption more realistic. For example growing food in hoop-houses (a plastic roofed shelter over agricultural land) to extend the growing season) can extend the production of certain vegetables throughout the year.

Building on current successes at the university

Another exciting opportunity for UM food sustainability is the already strong movement in this direction in the university and the community. Many organizations and individuals on-campus are already working towards food sustainability. There is a clear signal from campus executives to bring the fragmented student organizations, interested faculty, and staff together to create a

1 Website. Available at: http://mmd.umich.edu/forum/michigan.php#profile

clear university policy towards food sustainability. Furthermore, publicizing the successes the university has already had will bring immediate benefits through increased awareness. It is possible that this publicity could help attract a student body interested in issues of food sustainability.

An engaged community

Another important opportunity is that the surrounding community is engaged in these issues. Several community groups in Washtenaw County and the State of Michigan are working on issues of food sustainability in the community. These groups have set a goal to have Washtenaw County purchase 10% of all food from local sources.[2] These groups want to know what the university is doing and want the university to take the lead to encourage and push this goal. The larger Washtenaw County community is mobilized and ready to contribute to increased food sustainability at U of M.

2 Website. Available at: http://tenpercentwashtenaw.org/index.html

UNIVERSITY FOOD SYSTEM RECOMMENDATIONS

Based on our initial research, data collection, synthesis of best practices and interviews with key individuals, we recommend the following five actions:

1. Eliminate bottled water from campus

Early in our process, we concluded each interview session by asking participants for their recommendations for improving the sustainability of food on the University of Michigan campus. Those engaged in preparing and serving food on the campus never hesitated in their first statement: consistently they said, “stop selling bottled water on campus!”. This sentiment was echoed in the students’ comments.

Environmental Impact of Bottled Water:

Dettore (2009) preformed a comparative life-cycle assessment of bottled versus tap water systems for the Center of Sustainable Systems at the University of Michigan. Based on his research, Dettore concluded that from an environmental perspective, municipal tap water is the preferred drinking water system relative to bottled water. Single-use bottled systems consume 11 to 31 times more energy than municipal tap systems. For bottled water consumed within the region of packaging, 70% of the total energy expended is attributed to the plastic bottle’s creation. For bottled water consumed outside the region or outside the country of packaging, the largest amount of energy-use is attributed toward transportation. Dettore also identified related information that quantifies consumption and recycling behaviors. In 2007, the average person consumed 29 gallons of bottled water. Research from 2006 estimated determined that only 23% of water bottles get recycled.

Eliminating bottled water would make a strong statement about the need to live appropriately within a watershed and remind everyone that locally available potable water is natural resource worthy of concern and protection.

2. 20% Local Food by 2020

Michigan's diversity of food production is second only to the State of California. This presents us with the opportunity to source diverse food offerings. However, any effort to increase local food purchasing and consumption quickly leads to the definition of what is local food. Based on our research we suggest defining local food as 'food either produced or processed in the State of Michigan or within 150 miles of Ann Arbor, Michigan'. This would allow us to purchase food from nearby portions of Indiana, Ohio, and Ontario, Canada. Currently, SYSCO supplies approximately 85% of the University's food. Sysco estimates that 6% of this food is local. (SYSCO defines local as the State of Michigan or within their service area that extends to Findlay, Ohio).

Benefits from increasing the consumption of local food include:

- it is a source of economic development.
- it reduces food miles traveled
- it rebuilds local food infrastructure
- it connect food to the local environment

3. Establish a Farm on Campus

The most progressive universities that we profiled each incorporated an active farm into their campus landscape. Some of these farms also incorporated orchards. Although rarely discussed, the primary reason for operating these farms relates to student and community education. These 'farms' often highlight sustainable practices, course-based educational programs, composting opportunities, and community engagement through either Community Supported Agriculture (CSAs) programs that supply local residents with fresh produce or permit local residents to 'farm' an allocated plot.

4. Reduce Food Waste on Campus and Introduce Post-Consumption Composting

Currently, major food providers on campus (Residential Dining Services, Unions, and the Michigan Health System) compost food waste acquired in the preparation phase (pre-consumption food waste). This pre-consumption food waste compost is sent to the City of Ann Arbor's municipal facility (insert yearly estimate of compost). In the on-line feedback submitted as part of the Integrated Assessment project's community input, many comments addressed the desire to reduce food waste. We recommend exploring tray-less dining as a way to reduce food waste.

It is difficult to address how much food is wasted. Current estimates of the amount of post-consumption are unavailable because post-consumption food waste is combined with other waste system created within buildings. At this time, only the Ross School of Business pays an additional fee to compost post-consumption food-waste at a local farm and to have hand-sorting remove any non-biodegradable waste. Implementing post-consumption food waste composting would require a significant investment in educational programming but we recommend exploring this possibility.

5. Comprehensive Food Labeling System

Many labels exist and many interested consumers are confused by their meaning and uncertain criteria. At the University of Toronto, the label 'Local and Sustainable' was initiated by the institution to overcome this problem of uncertainty. The label's clarity of criteria and combination of local sourcing and sustainable practices has proven successful. We recommend developing (in concert with local food enthusiasts and community-based, non-profit organizations) a 'local, sustainable' food label.

TEAM BIOS

During Phase One of the Campus Integrated Assessment, the Food Analysis Team was comprised of faculty lead, Professor Larissa Larsen, and six students representing a range of disciplines including urban planning, environmental studies, and engineering. The diversity of our team provided us with skills in long-range planning, research, communication and analysis. Many of our team members have long been concerned with sustainable food practices and contributed rich personal experiences to our effort.

Brad Detjen is studying for a B.S.E. in Chemical Engineering, with plans to graduate in December 2010 and pursue work in renewable energy. He is currently working as a summer intern with Shell Oil, and has previously completed an internship with General Electric and an AmeriCorps assignment with the Southwest Detroit Environmental Vision. Brad's family, who live in East Lansing, MI, are active volunteers and shareholders at the Michigan State University Student Organic Farm.

Alysia Giatas received her B.A. from the University of Michigan in 2000, double majoring in Cultural Anthropology and History of Art. She has recently returned to the University to pursue a Master's of Urban Planning, with a concentration in urban design and physical planning. Alysia has spent time volunteering at organic community farms, working at a family-owned market supporting local produce and products, and raising her family to understand the important health, economic and ecological benefits of making informed food choices.

Sue Johnson is a graduate of the University of Michigan where she received a B.S. in environmental science in April of 2008. She also received her Master's of Urban and Regional Planning focusing on urban design and environmental planning from the University of Michigan in May of 2010. Sue has experience in graphic design, environmental education, and community outreach. Sue's is currently the environmental planning intern at the Washtenaw County Water Resources Commissioner's Office where she is involved with community outreach and storm water management.

Margo Ludmer received a bachelor’s degree in Spring 2010 from the University of Michigan, concentrating in the Program in the Environment (PitE) with a minor in Spanish. She has been an active member of the U of M sustainable food community for the past few years. Margo has served on the University Unions Food Advisory Board and is a member of the Michigan Sustainable Foods Initiative. She also co-chaired the Michigan Student Assembly’s Environmental Issues Commission, which focuses on promoting environmental awareness and stewardship on campus.

Kevin McCoy graduated from the University of Michigan School of Music in 2001 with a B.M. in Instrumental Music Education. He spent time working as both a marching band instructor and as the production supervisor of an electronics manufacturing firm before returning to the University of Michigan to pursue the Master of Urban Planning degree. He has recently completed his first year of graduate study, concentrating in transportation, environmental, and land use planning and expects to graduate in May 2011. Kevin is a resident of the city of Detroit, where he is an active participant in his community's urban garden. On the food team, he serves as the student leader.

Breanna Shell graduated from Denison University with a bachelor’s degree in Psychology in 2006. She volunteered with Safe Routes to School programs, neighborhood associations, and community gardens before discovering Planning as a career. Now at the University of Michigan she is working towards a Master of Urban Planning in the Taubman College of Architecture and Urban Planning (TCAUP), expected to graduate in 2011. At TCAUP, she focuses on community development, sustainable land use planning, and the practice of creating local food systems. On the IA food team, Breanna learned about the large and direct impact that the University's food purchasing decisions have on the surrounding community and state. Her favorite discoveries were that Michigan is the second most agriculturally diverse state, that there are over 60 different community organizations or businesses that support the local food movement near Ann Arbor, and that the hard working staff at UM serve on average 70, 000 meals each week.

APPENDIX 1: DETAILED REVIEW OF U OF M FOOD SERVICE PRACTICES

I. INTRODUCTION

The University of Michigan employs a decentralized approach to food production, with a few umbrella organizations overseeing the operations of multiple facilities, as well as several smaller independent food service operations. Residential Dining Services (RDS) operates eight full-service dining halls and complementary retail cafes and convenience stores located within undergraduate residence halls. University Unions (UU) operates 23 establishments in the Michigan League, Michigan Union, and Pierpont Commons. University Catering (UC) utilizes facilities and kitchens in each of the three University Unions and serves food at functions throughout campus. The University of Michigan Health System serves food to patients, produces food for Meals on Wheels, and operates retail food service within the hospital complex. In total, 84 licensed food eateries operate at the University of Michigan. These are overseen by the office of Occupational Safety and Environmental Health (OSEH) to ensure food safety. However, when including smaller unlicensed customers, such as academic departments, the children's center, and the golf course, some 200 different on-campus entities independently purchase food from the University's prime vendor, Sysco Detroit. There is no system in place to coordinate food purchasing among these 200 distinct entities.

The following report first details campus-wide composting efforts and the relationship the University has with its primary food service contractor, Sysco Detroit. Next, an overview is provided for each umbrella food management organization on-campus. Finally, East Quad dining hall is showcased as an example of best practices for local, sustainable food service on campus.

II. UNIVERSITY PRIME FOOD PRODUCTS VENDOR: SYSCO DETROIT

The University of Michigan has a prime vendor contract with Sysco Detroit for food service items. Despite this prime relationship, ordering from U of M is highly decentralized. In total, Sysco Detroit has 200 different customers on-campus. Every food service entity operated by the university orders food items from Sysco. U of M is Sysco Detroit's single largest customer. The contract between the University and Sysco Detroit is estimated to be worth hundreds of millions of dollars.

Quality Assurance

On a corporate level, Sysco has put numerous measures in place to ensure that the produce it purchases is safe, consistent in quality, and sustainable. All vendors that sell produce to Sysco must be in compliance with Sysco's Good Agricultural Practices (GAP) program, which addresses food safety and sanitation for farm production and processing. Many producers also participate in Sysco's Integrated Pest Management program, which has avoided more than 1.5 million pounds of pesticide use over the past four growing seasons.

Local Purchasing

Sysco Detroit, in particular, is striving to purchase more food locally than it traditionally has. In 2009, Sysco Detroit purchased 90,000 cases of produce from 61 different Michigan producers and farms. In the same year, U of M purchased $1 million in food and food products from local suppliers through Sysco. Lisa Reynolds, multi-unit accounts manager at Sysco Detroit, estimates that local product purchasing has grown 75-100% over the last few years. Sysco defines "local" products as products that are grown or processed in MI or in Sysco Detroit's service area which extends to Findlay, Ohio. Some locally owned companies that grow or process food out-of-state, including Kellogg, are excluded from Sysco's definition of "local." Sysco Detroit gives U of M the first bid on new shipments from local suppliers, and strives to present Michigan suppliers first in its literature whenever one is available for a given product.

Sysco works with small suppliers to improve their ability to sell to large institutions. By working with Sysco, small farms can gain access to greater insurance and access to Sysco's large customer base. Additionally, small suppliers can save money by tapping into Sysco's distribution systems. They work closely with institutions to help them meet purchasing targets and have expressed a willingness to help UM groups do research on sustainable food practices. In the past, Sysco helped U of M customers research cage-free eggs, and helped identify a local producer of vegetable oil, Zeeland Farm Soya, Inc (Reynolds).

III. UM FOOD MANAGMENT ORGANIZATIONS

The numerous food-purchasing entities at U of M each take different approaches to food sourcing, food production, and waste management. Most units fall under the management of Residential Dining Services (RDS), University Unions, University Catering, or the University of Michigan Health System (UMHS).

A. Residential Dining Services

Overview

Food services in University Housing are provided by RDS, which oversees dining halls as well as retail cafes and convenience stores in the residence halls. RDS purchases food and food service products from Sysco Detroit and other vendors. RDS currently employs 583 full-time and 72 part-time staff as well as 1,548 temporary student employees. In recent years, RDS has made sustainability improvements in its waste handling, non-food material needs, and labeling.

During the fall and winter semesters, the eight dining halls managed by RDS (Hill Dining Center, West Quad, South Quad, East Quad, Markley, Bursley, Betsy Barbour, and Oxford) serve on the order of 70,000 meals per week during 18 different mealtimes. These are served as buffets: students take a tray, select from a variety of foods, eat, discard their waste (primarily single-stream, but separate bins are available for recyclable bottles and napkins), and place their dishes on a conveyer for washing. Meals are prepared at each individual cafeteria according to rotational menus that a central service coordinates. In addition to the dining halls, RDS manages eight retail and café operations:

- Café ConXion (South Quad)
- Ciao Down Pizzeria (South Quad)
- The East Quad Café (East Quad)
- The Blue Apple (Bursley)
- North Star (Baits)
- Victors (The Hill Dining Center)
- The Markley Hideaway (Markley)
- The Oxford Express (Oxford)

All of these serve prepackaged food, and some are equipped for on-site food preparation. RDS prepares 3800 “Blue-to-Go” meals for these establishments, which include salads, sandwiches, and fruit cups.

Procurement

Each dining hall places an independent food order every day, and food is delivered six days per week. Contracts are established according to a bid process that is managed by University Procurement Services. The primary vendor of food and food service products to RDS is Sysco Detroit, which provides paper products, dry staples, frozen products, dairy, produce, and meat. Sysco provides additional services such as nutrition information and price reductions for volume buying. RDS employees indicate that they like working with Sysco because it works closely with dining units, resolves ordering challenges, responds quickly to orders, and is committed to supporting Michigan growers and manufacturers.

In addition to Sysco, RDS has independent contracts with a few smaller, local vendors. The most significant of these are Mark’s Quality Meats and Prairie Farms Dairy. Mark’s provides the majority of meat and poultry to RDS. Prairie Farms, a farmer-owned cooperative, provides all-liquid dairy, rbst-free milk from local Michigan farms, and dairy products such as ice cream. Coffee is fair trade certified and roasted by Paramount in Lansing. Finally, RDS purchases some produce directly from local farmers, including Grazing Fields, Lesser Farms, Jon Goetz, and Todosciuk Farms. Local farmers must carry $1 Million dollars of insurance in compliance with university policy, and they must sign an agreement with U of M.

Waste

RDS waste that is not composted is combined with building waste, and therefore difficult to track. However, all residence halls except Bursley participate in the Food Waste Composting Program. Since 1997, 500 tons of pre-consumer food waste has been composted by RDS through this program. Used cooking oil is collected by Darling International, cleaned, and recycled.

Surplus food is not typically a problem, but at the end of each semester, any excess food is donated to Food Gatherers.

In terms of materials, RDS makes an effort to purchase low-impact products whenever possible. Several disposable products used by RDS are made of recycled materials or are biodegradable. However, staff from RDS has expressed concern that many “green” packaging products are produced overseas and that the environmental cost of shipping may outweigh the environmental benefit of sustainable materials. Paper tablecloths have been eliminated from the dining halls. Twenty percent of cleaning products used by RDS, including cleaners, detergents, and rinse aid, are “Design for the Environment” certified by the EPA, meaning that they contain no phosphates, color, or fragrance.

Education and Outreach

RDS makes an effort to label certain types of food to promote students’ awareness and ownership of food sources. Current labels include vegetarian (no animal products except dairy), vegan (no animal products), and local. “Local” remains undefined by RDS and has, at various times, meant that food was sourced from within a 100-mile radius from campus, from the state of Michigan, and from the Midwest region. Additionally, each semester, the dining halls serve a “harvest meal” featuring many local foods. The goal of this meal is to raise awareness about the diversity and quality of the agricultural products available in Michigan.

Regulation

Food preparation, storage, and handling methods are codified. The 1999 US Public Health Service Food and Drug Administration Health Code and the 2000 Michigan Food Law govern most processes. The university’s office of Occupational Safety and Environmental Health oversees the dining halls and inspect any local farms that may supply the university. This inspection investigates the presence of hand washing facilities, irrigation and well water testing, harvesting, packaging, and storage methods, and adherence to Good Agricultural Practices (GAP) (Lowry).

B. University Unions and Catering

Overview

University Unions and Catering are auxiliary units within the university, which have their own budgets. They consider themselves similar to other small businesses operating in Ann Arbor. University Unions includes the Michigan Union, the Michigan League, and Pierpont Commons. Each of these locations is home to outside vendors as well as cafes and convenience stores managed by University Unions (e.g. Beansters, U go’s). University Catering operates facilities and kitchens within each of the three University Unions and prepares and serves food for functions throughout campus.

Procurement

Similar to Residential Dining Services, University Unions and Catering rely primarily on a few large vendor contracts, while some smaller contracts are in place to source meat, dairy, and beverages from local warehouses. The prime vendor for both units is Sysco Detroit, supplemented by food purchased from Prairie Farms and Mark's Meats among others. University Catering cites several advantages of the prime vendor relationship with Sysco including reliability of volume, the leverage that the university has against Sysco and that Sysco has against food producers, and Sysco's relationships with other providers such as United Natural.

Unions and Catering negotiate directly with wholesalers for the most competitive prices. Typically, contracts with vendors expire and are reassessed every two to three years, with larger contracts like Sysco's requiring a four-year commitment. The selection criteria for these contracts are predominantly quality—based on audits for industry standards—and cost. However, labor practices, the availability of local food, and the desire to support businesses owned by minorities and women are also considerations.

University Unions and Catering say they provide sustainable, local food, whenever feasible and are very interested in furthering their ability to source locally. Currently, their contract with Sysco states that, when in season, Michigan produce takes precedence. Although both units would like to increase local, sustainable and organic offerings, budget is the limiting factor. Catering is further limited because the type of food served at events is largely determined by patrons' preferences, requests and budgets. Our best estimate is that overall local food sourcing on campus averages 5-6% of total volume.

Waste

Neither the Unions nor Catering have specific policies regarding waste. The waste produced by University Unions is comingled with all waste generated at the Union building or, in the case of Catering, the particular facility where an event takes place. Currently neither unit separates and tracks their individual waste streams. University Unions and University Catering engage in efforts to reduce waste, although they do not appear to have a system in place to measure their success. Disposable products are minimized at in-house catered events by using linens and china, and bulk-packaged condiments have replaced individually-packaged wherever possible. Similar to dining halls and other university buildings, the unions have recycling containers for glass, cans, plastic, mixed office paper, and cardboard. Also, all used cooking oil generated by Unions and Catering is collected by Darling International, converted to bio-fuels and animal feeds.

Financial limitations have sometimes stymied composting efforts. Prior to 2009, University Grounds and Waste Management did not charge non-academic buildings to participate in the pre-consumer food waste program, and Pierpont Commons utilized this service for approximately five years. When the fee was instated in 2009, Unions representatives told us that participation in the program became cost-prohibitive. University Unions and University Catering also expressed consternation over the true environmental benefits of choosing some biodegradable and environmentally friendly paper and disposable products. Concern was voiced their belief that these products could have a higher carbon footprint than domestically produced products. However, no actual carbon footprint statistics were cited. They also expressed concern that some plastic-alternatives are made of food products such as corn or soy and that using these present ethical concerns in light of global hunger. Some environmentally friendly cleaning products are employed. However, the use of others has been discontinued due to ineffectiveness. For example, they found that one eco-friendly dishwasher detergent required multiple wash cycles to fully clean dishes, wasting water, energy and time resources.

Priorities

Representatives from University Catering have identified some priorities that they have for campus food sustainability projects. These include:

- Greater visibility of sustainability efforts and practices already in place
- The ability to compost both pre- and post-consumer waste
- A better database for campus food events and collaboration
- Kitchen and facility re-design to include more space, more energy-efficient appliances, and more sustainable materials
- Increasing education about food issues within the university community

(Roberts, Carr, & Meyer, 2010)

C. University of Michigan Health System (UMHS)

Overview

The University of Michigan Health System's mission regarding food is to provide exemplary food and medical nutrition therapy for patients and the community. The hospital is a different food provider than other institutions on campus because it serves a population that is often immune-compromised, and must accommodate over 100 diets and allergy restrictions. The hospital is bound by health-care industry standards for in-patient meals through Centers for Medicare & Medicaid Services standards, Joint Commission standards, the FDA Food Code, and Michigan State law. On average, UMHS patient food and nutrition services department serves 54,700 meals per month, as well as 11,200 meals for Meals on Wheels. 100% of the meals served at the hospital are prepared on-site, and kitchens are equipped with several commercial and specialized pieces of equipment to provide for appropriate food preparation. The hospital has a unique food provider environment, but aims to continuously review new products and innovations to determine if they are applicable to their operation.

Procurement

The top three vendors the hospital purchases from are Sysco Detroit, Mark's Meats, Tom Davis & Sons Diary. UMHS purchasers cite customer service, pricing, and the established relationships as the primary advantages that these suppliers provide. Fresh produce is ordered from Sysco Detroit and Simon & Leeman. Dairy is ordered from Sysco Detroit and Tom Davis & Sons Dairy. The hospital does consider local purchasing as a factor in sourcing vendors and defines a local product as one that originates within Michigan or within 150 miles of Ann Arbor.

Waste

UMHS does sampling checks on food waste by tracking the number of trays left on each extra tray delivery cart and monitor how much bulk food is disposed of. Approximately 85% to 90% of the waste that is tracked comes from food, and approximately 10-15% comes from packaging or non-food waste. Currently the hospital does not compost any food waste, but does recycle milk crates, cardboard, and metal cans.
Disposable food products are used during emergency or disaster situations, for remote deliveries or when the safety of the patient and staff requires it. This means that UMHS uses an average of 48,958 paper napkins, 26,000 paper cups, 25,000 plastic lids, 4,417 plastic knives, 3,667 plastic forks, 9,750 plastic spoons, and 59,200 paper straws per month. UMHS uses environmentally friendly Biopak Plus take away boxes, which are made of 100% recycled materials.
(Burns, 2010)

IV. EAST QUAD: A "BEST PRACTICES" CASE STUDY

Overview

East Quadrangle is one of seven residence halls located on the University of Michigan's Central Campus, housing approximately 900 residents as well as the Residential College. Dining options include a full-service dining hall and the Halfway Inn café.

RDS Director, Michael Lee, launched a program in 2004 that assigned each dining hall a distinguishing food identity; East Quad was asked to provide a selection of organic food. This focus has expanded to incorporate local food, as its procurement is more cost-effective than purchasing organic products, and these practices support the local economy. East Quad dining hall defines "local" as any food sourced from within Michigan. In addition, Head chef Nelson "Buzz" Cummings and the kitchen staff are dedicated to providing healthy, quality meals to resident diners and meeting the American Culinary Federation standards for the CHEF training program by preparing over 50% of the food they serve from scratch. Owing largely to efforts made by Chef Buzz, East Quad has established relationships with a number of area farmers and producers, enabling more than 50% of East Quad's produce to be sourced locally. The farms include Goetz Farm, Todosciuk Farms, Appleschram Orchard, Lesser Farms, Mama Mo Foods, and Community Based Intervention's Giving Tree Farm.

Challenges

Building relationships with local farmers can be challenging for both the institution and the farmer. After reaching an initial agreement with local farmers, the process of contracting can become extensive. A site visit is required by both the health and purchasing departments. The current dietitian, executive chef, health inspector, and the head of housing and student affairs procurement must visit the farm. If approved, the farm then signs a contract. The legal language of the contract can be unfamiliar and difficult for some farmers to understand, as the same standard contract that is used for major suppliers, such as Sysco, is presented to farmers. Another barrier is the competitive edge that Sysco products have over locally sourced products. Along with higher costs, the quality of local produce has presented problems in the past. It may arrive unwashed or spoiled, since small-scale growers often lack processing and refrigeration resources. For this reason, local produce may require additional labor to sort and prepare. The convenience of Sysco's "one-stop shopping," as well as its ability to deliver daily, may make it a more attractive option than sourcing locally for many purchasing agents. Local sourcing involves choosing from multiple small suppliers who may only be able to deliver once or twice a week. Delivery scheduling becomes an important issue due to limited storage capacity in campus kitchens and on loading docks.

East Quad's Response

East Quad's dining facility employs a trial-and-error approach when sourcing local food. A close relationship between chefs and farmers fosters an atmosphere of trust and reliability. Stringent quality standards are set for local produce, which have consistently been met by farms currently supplying to East Quad. Any farmer unable to meet these standards (based on the quality of similar Sysco products) is released from their contract.

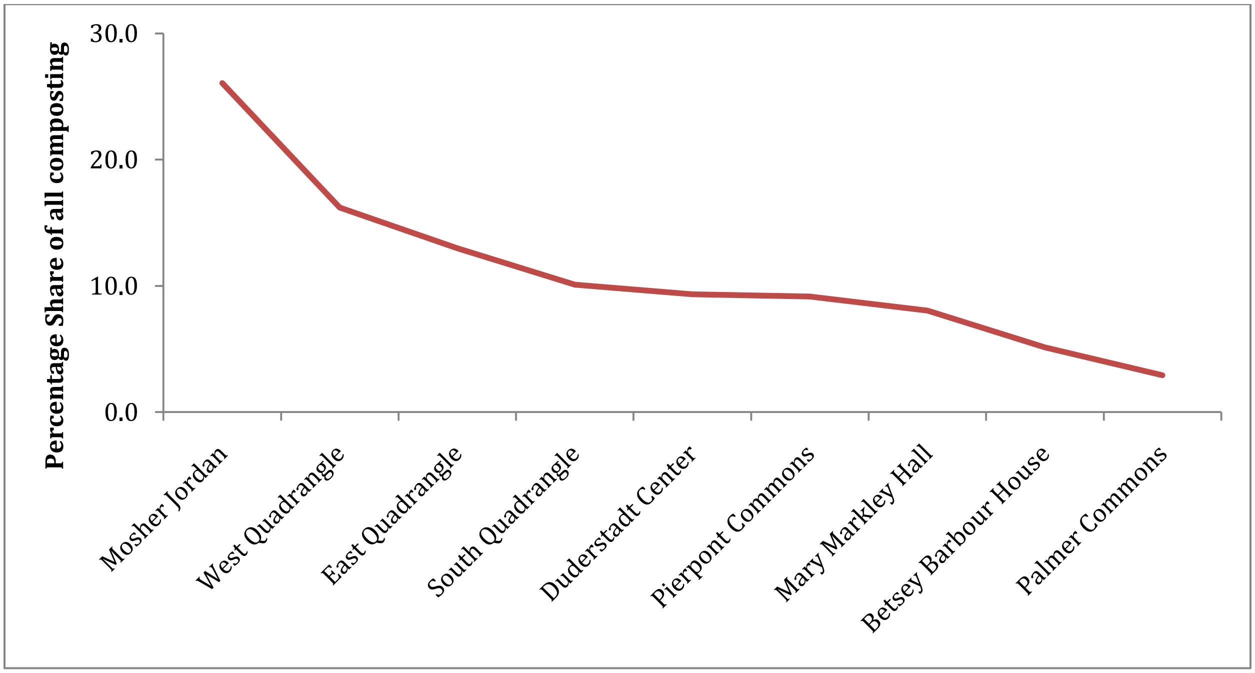
Dedicated student involvement is also integral to the success of local sourcing. East Quad relies on approximately 100 well-trained students working in its kitchens. A student group, the Michigan Sustainable Food Initiative (MSFI), has made large strides in educating students, faculty, and staff on the benefits of eating local. To date, the group has created a local food logo, conducted a local food survey, and convinced administrators to mandate the purchasing of local tomatoes for a period of approximately three weeks. Currently, the MSFI is responsible for hosting Meatless Mondays in East Quad to encourage reduced meat consumption, and is installing art depicting the farms that supply local produce in the cafeteria.

The food practices employed at East Quad demonstrate the feasibility of sourcing local foods for University Dining Halls. The relationships that Chef Buzz has formed with several Michigan farmers ensure the quality and reliability of local produce. These farmers have expressed interest in providing to more dining facilities and larger ones. Significant student involvement has also encouraged the expansion of East Quad's model practices. (Ludmer, 2010)

V. COMPOSTING

The university has a pre-consumer food waste composting program. Collection costs $40 per ton for non-academic buildings such as dining halls and union food service locations. This waste is collected by University Waste Management Services and taken to the City of Ann Arbor's compost site. Wastes accepted through this program include fruit and salad trim, bread and bagels, potatoes, rice, noodles, egg shells, coffee grounds and filters, paper egg cartons and napkins. In 1997, East Quad Dining Hall was selected by the University as one of three dining halls to pilot this program. Its success led to the current "prep-waste" composting program in place at five residence halls. At this time, the university does not have a post-consumer composting program in place campus wide.

Figure 1: U of M Food Waste Composting by Facility



SOURCE: Tracey Artley, University of Michigan Recycling Coordinator

<u>ROSS SCHOOL OF BUISNESS (post-consumer composting model)</u>

The Ross School of Business has its own post-consumer composting program. Food service operations at Ross provide separate bins and instructions for separating leftover food and other compostable materials from non-compostable items. Making this process easier is that food services at Ross use only compostable food packaging, plates, cups, napkins, and cutlery. After compost is collected, it is transported and hand-sorted by a contracted private hauler (sorting is nessecary to remove non-compostable items that were not properly separated by users at Ross). The composting site is Tuthill Farms and Composting in South Lyon, MI (Artley).

APPENDIX 2: COMMUNITY INPUT

Cultivating Community Food Sustainability Recommendations

- **University support for more campus gardens (in addition to the Ginsberg Garden)**
  - Examples of student suggestions for garden spaces include in front of the Chem Building and behind UMMA (among other places, I'm sure)
  - Support for Cultivating Community's proposed "Arb Garden" project, which will provide student gardening space and a site for ecology, biology, and botany classes to do labs, conduct research, and gain hands-on experience.
  - Edible landscaping, (even if only decorative herbs or edible ornamentals)
  - "I was walking across the diag today and saw where they finally opened up that space in front of the chem building that has been under construction for a while. There is a little open space there that is kind of set back from the sidewalk to the building. I think it would be really cool to propose that we make a sample garden there to 1) get publicity for the Arb garden and 2) use as a more accessible teaching tool for random people walking across the diag. I know that there's a lot of politics to push through but that's what the IA teams are all about!"
  - "One thing I have been thinking about lately the tract of land behind UMMA, it looks like they have a few areas that could be beds, but there is nothing in them. I think it would be a great place to put in some "edible art" although I'm not sure how much sun they get back there."
- **As much local, seasonal, sustainably-grown and fairly-traded food as possible in dining halls, University restaurants, in University catering, etc.**
  - Prioritize doing business with local and fair-trade farmers, growers, producers, manufacturers and distributors, cutting out as many middle-men as possible to ensure that University dollars go to communities that need them most.
  - "Our ultimate goal needs to be for almost all our food to come from local sources. We need to be very strict about this. Local food needs to be the central ingredient in all of our cafeterias. Dining needs to move away from trays entirely. Our farmers and our local economy need the support. In addition, what we eat is absolutely essential to the health of our bodies and our minds, and local food tends to be more nutritive and healthy."

- **More composting on campus**
    - Composting in residential dining halls and at on-campus restaurants and at campus events
    - Creating a regular route or streamlined system to get as much University compost as possible to the city composting site
    - "We need to educate all employees on the dos and don'ts of composting. Composting needs to be a key component of all university facilities, including the offices (coffee, food from meetings, etc.) We should hook up a regular route from a university location to the A2 composting site."
- **Increased awareness and promotion of local, seasonal, sustainably-grown and fairly-traded foods on campus**
    - Local, seasonal, sustainably-grown and fairly-traded foods need to be marked as such in all University dining facilities, events, etc.
    - Increased funding for student initiatives to promote and educate about local, seasonal, sustainably-grown and fairly-traded foods (including student gardens and educational programs)
- **More recyclable or reusable dinnerware in dining halls, University restaurants, university catering, etc…**
    - More recyclable containers and less plastic silverware for carryout items and items bought with Blue Bucks and Dining Dollars
    - "The items available for purchase with blue bucks and dining dollars really need to be in sustainable containers. My biggest objection is that they are currently sold in plastic not even stamped with a number, and I never know if I can recycle them or not. The containers need to at least be recyclable."
- **Color coded recycling and composting bins for easy use.**

BLUElab Food Sustainability Recommendations

- **Campus Gardens**
  - More support for student-run gardens on campus
  - More classes to learn principles of food security, sustainable gardening/farming, nutrition, etc. Try especially hard to get people not already passionate about these things in these classes. Mini classes aren't scary.
  - More diverse locations for these gardens (north campus has lots of room!)
  - Create a tool lending library for students to check out gardening equipment to use in their own gardens.
  - Use well-established student gardens as both teaching gardens to help students new to gardening (which are most!) learn how to grow and tend a garden. Maybe have "office hours" for people to come in with questions and speak with more experienced students.
  - More ADVERTISING of these things.
- **Bottled Water**
  - No bottled water offered in vending machines.
  - More on campus advertising/education about the myths and evils of bottled water.
  - No bottled allowed water at university events. Large outdoor events could have bottle filling stations like music festivals do. Instead of talking about how great recycling is in Michigan Stadium, why not let people bring in clear, empty bottles for water and offer filling stations around the stadium. This would replace the need to recycle altogether.
  - "I think bottled water should be banned from campus events and stores entirely. The University may not be able to control the stores but it should be able to at least control the events. Frankly, I am always a embarrassed when I go to an event or meeting and bottled water is being offered, when there is usually a drinking fountain right down the hall. Offer cups."

- **Composting & Zero Waste**
    - "The dining halls should keep track of the amount and what kind of food is consumed most. This would help cut back on some leftovers that just go to waste. Also I remember reading in the Daily that another school (don't remember where this was) recently got rid of all trays in the cafeterias. This cut back on dish washing costs, etc. and apparently the inconvenience wasn't too bad."
    - Composting in all dining halls, on-campus restaurants, and events.
    - Make it very easy to get compost to the city's composting site or create a university site
    - Create lots of educational resources and training opportunities about composting and zero waste principles. Especially for staff members but also for students and faculty.
    - There should be a whole webpage devoted to holding zero waste events on campus and university catering should be required to make any event zero waste friendly for no extra charge.
    - Require all university events of a certain size to be zero waste, and make it **very** easy for organizations/departments to do so (ie, access to composting facilities, education, etc).
- **North Campus Dining Options**
    - The dining situation on North Campus (for those who don't use the Bursley dining hall) is quite limited. The only choices for dinner are fast food, convenience store snacks, or leaving. The first two are unsustainable and unhealthy and the last is often an inconvenience. It would be great to see university support for better, fresher local food options on North Campus.
    - Subsidize the organizations that run the dB Café in the EECS Atrium so that they can offer local, sustainably raised fruits, veggies, and dairy products. They already offer some fruits but they probably don't come from Michigan.
    - Encourage stores like U-go's to have better fresh food options from local farmers and food distributors. Better "grab-n-go coolers" from local providers.

- The Commons Café in Pierpont may possibly have low enough volume to be easily able to offer local, seasonal, sustainably-grown foods as entree option several times a week.

MSFI Food Sustainability Recommendations

- Local Businesses in Union, League, Pierpont, make it more like the Glass House, replace fast food with local businesses
- Trying to make ingredients local, expand to other
- University should promote PFC
- Using blue bucks and dining dollars to use on PFC and farmer's marker
- More local and organic food in EQ café, hideaway, Blue Apple, Victors
- Give local foods a preference, keep posting where things are from
- Use the local logo EVERYWHERE!!!
- Getting Meatless Monday into other cafeterias (put dinning in charge of it)
- Offer better vegetarian options on Monday, meatless
- Trayless (food waste)
- Switch up the salad options!!!!
- Increase sustainable meals
- More seasonal (cheaper and more sustainable)
- University catering
- Free food at university events
- Communal refrigerator
- More student kitchens

Comments from Web Form on Graham Institute Website

PROPOSAL TITLE: Campus Sustainability Demonstration Farm
SUBMITTED BY: Mr Shannon Brines
ORGANIZATION: ESA Lab
DEPARTMENT: School of Natural Resources & Environment
SUBMITTED ON: 1/28/10

DESCRIPTION:

University of Michigan should construct a small farm on some of their open space that would integrate into existing and new multi-disciplinary curriculum as well as provide food for special functions and possibly some of the campus food services. There is ample space from which to choose for instance even 5 acres (considering all of the properties and even recent Pfizer property addition). This would be a demonstration of sustainable technology/engineering/design etc. as well as a noteworthy demonstration of the integration of the diverse skills of U of M campus and community.
There is rapidly growing interest in local food, food systems, and their related components and how they relate to public health and nutrition. Throughout the US and Canada, these interests are magnified within university faculty, staff and most importantly, the undergraduate and graduate student body. Academic institutions are seizing the opportunity that this increased interest allows to undertake exciting and intellectually enriching research projects and educational programs. University of Michigan should be one of those institutions. U of M campus student groups like Sustainable Agriculture Working Group, Student Advocates for Nutrition, Michigan Sustainable Food Initiatives, Cultivating Community (planting small gardens) are growing. Chefs like Buzz Cummings and Housing/Food Services folks like Dave Kluck are buying locally or expressing interest in buying locally. Over the years I have spoken with among others folks like Prof. Larissa Larsen and Prof. Bob Grese (director of Matthei Botanical Gardens and Nichols Arb) who are very supportive of the idea. There is a draft proposal from a couple years ago that is relevant here:
http://www-personal.umich.edu/~sjbrines/misc/um_sustainag_20070508.pdf
There are many local non-profits that I am involved with like Slow Food Huron Valley that would be very supportive of such a project which would include things like donated labor.
Thanks!

PROPOSAL TITLE: Dining Hall Food
SUBMITTED BY: Ms. Rebecca Genter
ORGANIZATION: Student
SUBMITTED ON: 1/29/10

DESCRIPTION:

As a [sic] working in the Bursley dining hall I get to see firsthand the amount of food that is wasted on a daily basis in the University. Entire trays of perfectly good food is [sic] put into the trash after one meal, especially at the breakfast times. I would like to see that food either be composted somehow or in the very least I think it would be simple to make food in smaller, more frequent batches. I hope you find this useful.

PROPOSAL TITLE: DL list so interested parties can share ideas/collaborate on initiatives
SUBMITTED BY: Mr Keith Soster
ORGANIZATION: University Unions
DEPARTMENT: Division of Student Affairs
SUBMITTED ON: 1/29/10

DESCRIPTION:

If there is a way for folks to shares thoughts and ideas, initiatives that they are working on, then we might gain more momentum or realize greater cost savings. Composting, buying local, organic, marketing efforts to "tell the story" are just a few topics of interest for me. I believe many on our campus are working toward the same sustainability goals—it would be nice to collaborate.

PROPOSAL TITLE: Food: How to eat sustainably (home prepared food)
SUBMITTED BY: Mr David Witte
ORGANIZATION: Student: Undergraduate Architecture
SUBMITTED ON: 1/29/10

DESCRIPTION:

I wanted to comment about how hard it is (as a student) to eat healthy on campus. I commute to north campus, via bus, more than once a day, and spend most of my time there. The food here is extremely unhealthy and there is little variety (panda express, quiznos ect [sic]). I pack my own lunch every day, which has proved to be healthy and cheaper.
What I see lacking on our campus is a student kitchen. I am not sure what the building codes or health codes restrict when it comes to such a program, but I feel that there could be a better system in place. If there were some sort of commons where people could use a panini maker, toaster, or buy dressings for salads, condiments for sandwiches, maybe even use a grill, then people could eat healthier. The issue is that people find it cumbersome to ear from home, because there is no area to facilitate their home made meals. In the architecture school, some student groups have BBQ's from time to time in our courtyard. If there was [sic] an area for a student to bring meat to be grilled, or where they could purchase fruits and/or vegetables, then the quality of meals would improve dramatically.
At the meeting yesterday, I know that utopian goals are sometimes unable to become actualized, but I see this as a stretch goal. North campus has been seen as a dreadful place to go. There was a competition a few years back of a building or space to liven up the campus. I believe that a student union of this sort would be perfect. A place that students can go to just RELAX and not

be surrounded by a library or terrible food selections (palmer commons). The design of the palmer commons is very linear, and segregating. What is needed is a building that has a central area that is ringed by other food places or seating areas, so it really feels like a student center, not a strip mall separated, and segregated. I was going to apply to the food portion of this assessment, but felt that Architecture fed into buildings more. If the Culture of Food portion would like my input, I would be more then [sic] happy to elaborate further. Thank you for your time and effort to making our campus an [sic] more sustainable environment.

PROPOSAL TITLE: Dining Hall Food Recycling
SUBMITTED BY: Mr Brett Merkel
ORGANIZATION: University of Michigan
SUBMITTED ON: 2/2/10

DESCRIPTION:

To recycle the waste food produced from the dining halls on campus by:

a) selling it as animal feed
b) have an environmental engineering class build an anaerobic digestor [sic] somewhere near campus that will break down the food and use the methane to produce electricity

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PROPOSAL TITLE: Matthei Botanical Gardens and Nichols Arboretum
SUBMITTED BY: Mr Bob Grese
ORGANIZATION: School of Natural Resources and Environment
DEPARTMENT: Matthei Botanical Gardens and Nichols Arboretum
SUBMITTED ON: 2/11/10

DESCRIPTION:

As the campus sustainability analysis teams proceed with their work, they should consider how Matthei Botanical Gardens and Nichols Arboretum can be utilized. There are several demonstration and education projects already in place and others being considered in areas that align with nearly all of the analysis team topics. More at: http://www.lsa.umich.edu/mbg/

PROPOSAL TITLE: Environmental Food Garbage
SUBMITTED BY: Mr Thomas Bellinson
ORGANIZATION: U of M
DEPARTMENT: IRLEE

SUBMITTED ON: 3/22/10

DESCRIPTION:

Use one of the student websites or set up a new on [sic] that allows restaurants to list student discount coupons ONLY if they use all recycled and biodegradable food packaging.

This would have the effect of increasing business to environmentally conscientious companies and causing those that aren't to become so.

PROPOSAL TITLE: Eliminate use of Styrofoam packaging in all food services locations on campus
SUBMITTED BY: Dr Laura Blake Jones
ORGANIZATION: Dean of Students Office
DEPARTMENT: Division of Student Affairs
SUBMITTED ON: 3/22/10

DESCRIPTION:

Instead of packaging to go food in Styrofoam packaging consider using less bulky, more eco-friendly options.

PROPOSAL TITLE: Recycled and recyclable take out containers in the hospital cafeterias.
SUBMITTED BY: Ms Carrie McClintock
ORGANIZATION: Gifts of Art, U-M Health System
SUBMITTED ON: 3/22/10

DESCRIPTION:

There are many green options for take out containers that are not being utilized in the hospital cafeterias. There also need to be more places to recycle in the health system. For instance, all trash cans near cafeteria and in major waiting areas such as the UH main lobby and UH family surgery waiting need to have recycling receptacles next to them.

PROPOSAL TITLE: Central Dishes
SUBMITTED BY: Ms Meredith Miller
ORGANIZATION: U of M
DEPARTMENT: Engineering
SUBMITTED ON: 3/22/10

DESCRIPTION:

There are so many times when food is ordered in for a university function. It would be cool if there were a central dish service that would deliver dishes and silverware, then pick them up at the end of the function, wash them and reuse them. That would eliminate the constant need for paper, plastic, or styrofoam disposables.

PROPOSAL TITLE: University Garden
SUBMITTED BY: Ms Kelly Miller
ORGANIZATION: University of Michigan
DEPARTMENT: Nursing
SUBMITTED ON: 3/22/10

DESCRIPTION:

We should have a large organic garden, or greenhouse because of the weather, where we allow students to maintain the plants. We can grow lots of herbs and vegetable and use them in our dining halls. In return we should compost food from the dining halls and use it to nourish the garden.

PROPOSAL TITLE: University subscribes to a CSA, and offer public gardening spaces
SUBMITED BY: Ms Eileen Quintero
ORGANIZATION: University of Michigan
DEPARTMENT: Dental Informatics
SUBMITTED ON: 3/22/10

DESCRIPTION:

The university should purchase food from local farms. Purchasing local food is more sustainable through:

1. less transportation
2. supporting microeconomies

This would be one way to support the Michigan economy, strengthen university relations with the state population, and support the use of the A2GreenBelt.
I believe there's a movement called "ten percent" around the local food markets that describes HOW the university's food needs could be met locally.
Food wastes should continue to be composted. I think campus gardening space available to locals would be a great way to keep campus beautiful, creative, and healthy. ☺

PROPOSAL TITLE: Farming Campus
SUBMITTED BY: Mr Jeff McCabe
ORGANIZATION: repastspresentandfuture.org (and others)
SUBMITTED ON: 3/23/10

DESCRIPTION:

The University could grow a great deal of the food that is consumed on campus. Hoop-houses can grow food year-round and supply important leafy greens throughout the winter. This system could provide jobs, learning opportunities and recreational and volunteer possibilities. At the same time, the University could greatly reduce its carbon impact and possibly even save some money.
I believe there is a great deal of innovation to be directed at this fledgling farming system and that there is a lot of interdisciplinary potential to imagine many new uses of the basic practice. Aquaculture is but one example.
These structures can also be combined with other facilities to use waste heat and CO2 and to filter water.
I will leave some of this to your imagination, but am available for further ideas and collaborations upon request

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PROPOSAL TITLE: water bottles
SUBMITTED BY: Dr marshall blondy
ORGANIZATION: american academy of pediatrics
SUBMITTED ON: 3/25/10

DESCRIPTION:

begin selling stainless steel water bottles with u of m logo to discourage the use of harmful plastic bottles made from middle east petroleum.

PROPOSAL TITLE: Sustainable Farm and Education Center—models include: Center for Agroecology and Sustainable Food Systems at the University of California (CASFS http://casfs.ucsc.edu/) and MSU Student Organic Farm (http://www.msuorganicfarm.org/home/php/)
SUBMITTED BY: Dr Erica Kempter
ORGANIZATION: Nature and Nurture LLC
SUBMITTED ON: 3/30/10

DESCRIPTION:

The farm could grow food for UM cafeterias, train students in sustainable agriculture, design, and building as well as provide research opportunities for faculty and graduate students.

PROPOSAL TITLE: Make campus food vendors allow customers to bring clean plates
SUBMITTED BY: Ms Jane Whitcomb
ORGANIZATION: COE
DEPARTMENT: EECS

SUBMITTED ON: 4/2/10

DESCRIPTION:

Get Panda and Panda Sushi to allow customers to bring a clean plate instead of forcing them to buy sushi or other food encased within heavy multi-layer plastic as is the case right now. Panda refuses to allow customers to bring a plate right now even though it would be completely painless fro them to keep a small number of unpackaged sushis in the refrigerator and, upon reqest [sic] place eight or ten of them onto a customer's clean plate.
This argument probably applies to other campus food vendors as well, although Panda is probably one of the worst offenders in that its food is so blatantly over-packaged.

PROPOSAL TITLE: Campus wide composting/Building Standards
SUBMITTED BY: Mr Gregory Buzzell
ORGANIZATION: University of Michigan
DEPARTMENT: MBA/MS
SUBMITTED ON: 4/3/10

DESCRIPTION:

It makes economic and environmental sense to expand the composting system currently being undertaken at the Ross School of Business to the whole University community. Economies of scale can be achieved, as a lot of the costs are fixed at Ross. It would provide environmental benefits by reducing waste; and educationally it would provide current students a learning laboratory about the benefits and ease of composting.

PROPOSAL TITLE: Encouraging Recycling
SUBMITTED BY: Ms Andrea Fuhrel-Forbis
ORGANIZATION: UM Internal Medicine
DEPARTMENT: Center for Behavioral & Decision Sciences in Medic
SUBMITTED ON: 4/3/10

DESCRIPTION:

Not only do many of the cafeterias (at least in the Hospital System) use styrofoam cups and trays, but there's no place to recycle these. There isn't really a place to recycle most eating things. It would be ideal to use cornstarch utensils and dishes, or perhaps recycled-paper-content dishes. Also, recycling could be encouraged by having bins easily accessible and visible that are clearly marked for what goes into them. Even better would be to have the utensils and dishes marked for which container they go into so that all people have to do it [sic] match up the markings. Can't the cafeterias use reusable dishes and utensils?

PROPOSAL TITLE: Generate more of our own energy and reduce the overall waste.

SUBMITTED BY: Ms Janet Mitchell
ORGANIZATION: Medical School
DEPARTMENT: Biological Chemistry
SUBMITTED ON: 4/4/10

DESCRIPTION:

• Make wind farm on Pfizer and other North campus property.
• Add solar panels to the roofs of many buildings on campus.
• Review hospital cafeteria food containers and find recycle option and provide recepticles [sic] for food waste and recycle containers.
• Interior packaging recycling such as the plastic tip boxes.
• Provide better posted information for labs on recycling and recyclable materials. Waste cans with printed lists of what people should place in them.
• Provide incentive purchasing to vendors who have recycle options. Give labs incentives for purchasing recyclable goods or recycled goods. Labs are one of the biggest sources of waste outside of the amount of paper generated on campus. Like the hospital is it difficult because of medical/biohazard considerations, but there are many things that can be investigated and improved. Cardboard shipping boxes, styrofoam interior boxes, plastic types of packaging for exterior tip containers. Recycled toner cartridges, ink refills.
• Can more things be autoclaved to be cleaned and recycled?
• Have planned sessions with departments and labs to promote identifiable recycling and the process.
• Install/provide signage and containers along with regular pick up and/or improve janitorial service to make it clear and easy.
• Can we create energy and/or reduce waste with incineration options?

PROPOSAL TITLE: FOOD + FUEL
SUBMITTED BY: Ms Alison Zachritz
ORGANIZATION: University of Michigan Undergraduate Student
SUBMITTED ON: 4/2/10

DESCRIPTION:

A lot of food is wasted in the Dining Halls. Why don't we compost! It's not too difficult or costly to buy some compost bins and put food into them instead of the landfill. Also the compost could be used in the arb for planting or in a memorial garden.
Also there are a lot of students who live on north campus, take classes there or go up to visit friends. Busses should be green!!! We have some seriously intelligent people here, let's convert the engines to run off McDonalds grease! ☺

PROPOSAL TITLE: Waste reduction, new degree program (?) and energy savings.
SUBMITTED BY: Mr Martin Stenzel
ORGANIZATION: Business and Finance

DEPARTMENT: OSEH
SUBMITTED ON: 4/6/10

DESCRIPTION:

Hello,

My first suggestion is to put in light tube light fixtures into [sic] as many University buildings as you can afford. These devices capture sunlight and beam it down a flexible shiny tube (about 12" to 14" in diameter) from the roof into a work or home space. They work best on the floor that is closest to the roof but they probably could go for 10-15 feet or more if you had too [sic]. In the home they cost about $200 if you install them yourself. For the U of M maybe we could get a grant for the cost of them and then have the Plant Department put them in locations where appropriate.

My nest suggestion is to put in more vertical axis wind turbines around campus on some of our tallest buildings, especially near the Huron River where we have the winds whipping down the river banks. The vertical Axis Wind turbine or VWT for short has the best ability to work with turbulent or gusty winds that change directions often as is often found near large buildings. Please see www. Windspireenergy.com and www.Greenwindmill.com. I know the windspire is made in Michigan and installed on many campus locations nationwide.

Another rough idea I have is to investigate the prospect of using algae to grow biofuels on campus. We could in theory use or [sic] Chemical, Civil, Electrical, Aerospace, Mechanical Engineering and Business students to finance, design and maybe build our Bio. Fuels plant. It could be an ongoing project for our student to run the plant ☺ To get mechanical power to run the pumps and other processes we could use the vertical axis wind turbines. Maybe we could even cogenerate heat and steam from the Algae as I believe the process produces fuel and heat, please double check me on this. Who knows maybe we could even set up a new degree program in alternative energy and tie it in with the new battery and solar cells being developed at the North Campus? If we can solve the energy storage/batterie [sic] problem we could make the U of M very rich and then we could do more good Social and volunteer work ☺ Maybe we could even grow organic food near the biofuels plant (use waste heat to warm the greenhouses which could be on the roofs as well) and sell it internally to our own kitchens?

My last suggestion is to find a way to limit or eliminate the unpleasent [sic] mess of plastic cups left all over the place after a home game. I know the property is sometimes privately owned but all this waster still is mostly unessesary [sic]. Maybe the students could be given a small award or something for not trashing the yards where they party? Maybe they could buy a reuseable [sic] mug and get some kind of a discount at the local coffee shops. ie work with our local business people to encourage less pollution from these plastic cups. The students and their children are going to inherit this world, maybe we need to start an ad campaign to remind them of this! At our current rate of environmental degradation we are going to lose the Andean Glacier in about 40 years or less. When this glacier is gone so goes the water supply in this part of the world for irrigation and drinking. As you know the water situation is getter more critical all the time, especially in the Southwest US.

Thank you for asking, please feel free to contact me, I am so excited about sustainability that I will volunteer some of my own time for these projects.

Finest regards,
Martin Paul Stenzel
(17 year U of M employee)

PROPOSAL TITLE: Gardening
SUBMITTED BY: Ms Molly Mardit
ORGANIZATION: LSA (RC)
SUBMITTED ON: 4/7/10

DESCRIPTION:

Involving more students in organic gardening here at U of M, using this produce as food in the dining halls.

PROPOSAL TITLE: Recycling & composting
SUBMITTED BY: Mr Fay Sommer
ORGANIZATION: Bus.
SUBMITTED ON: 4/7/10

DESCRIPTION:

Have more cafeterias at the UM school recycle everything & compost like the ross business school

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PROPOSAL TITLE: Thoughts on food, culture
SUBMITTED BY: Mrs Heather Gardner
ORGANIZATION: University of Michigan
DEPARTMENT: Dept. of Medical Education
SUBMITTED ON: 4/13/10

DESCRIPTION:

I attended the townhall and was excited by the ideas I heard. As a staff member, it made me long to be a student again.
Some thoughts on the farming idea: If there is interest in offering plots for community gardening, talk to Project Grow in Ann Arbor. They already do this type of work. Plus they work in conjunction with WCC and to [sic] offer an Organic Gardening Certificate. Perhaps there could be collaboration between the organizations to increase and encourage the community to get out there and garden. Project Grow and the WCC instructors (Erika Kempter and Mike

Levine from Nature and Nurture, Inc) may be a good source of information on what to consider in terms of setting up a farm/gardens.
Another thought on community outreach would be to offer classes to local farmers in business and marketing to help them promote their farms. Again maybe some collaboration could take place.
In terms of getting staff more involved in sustainability, I wonder if setting up an incentive program would help. Perhaps each building or department could have an annual reduction goal and if met, staff are given a small bonus. In subsequent years, perhaps the goal is to maintain the previous years level (understanding that at some point you cannot reduce further). In any case, I [sic] there needs to be feedback on what changes have been made, how this impacts the department/building and most importantly show how it personally affects people.
Thanks for your work!

PROPOSAL TITLE: Reducing packaging and waste at campus cafeterias
SUBMITTED BY: Mr Binoy Philip
ORGANIZATION: School of Nursing
SUBMITTED ON: 4/14/10

DESCRIPTION:
The campus cafeterias currently serve food almost exclusively in “take-out’ containers and boxes, some of them made from Styrofoam [sic], some from plastic and others from paper based products. Almost all of these containers/packaging have a one time use that ends at the trash can. Often people waste food and that too ends up in the trash can along with the plastics and other waste.
My suggestion focuses on reducing the packaging waste, recycling the food and biodegradable waste and incentivizing the community to change. The suggestion I have is that campus cafeterias come up with a way to serve food in non-disposable containers. The cafeterias could use fairly inexpensive plates that are reusable to serve most of their food. The plates are returned to the cafeteria to be cleaned and re-used. Food waste from returned plates can be collected and then sent to a local composting center on a daily basis.
For those who absolutely need the disposable containers, these can be bought for a slightly higher price (maybe up to 50c). This price will provide sufficient incentive for people to want to use the reusable plates. It will also serve to offset the cost the cafeterias will incur when they buy the reusable plates. Of course, this suggestion is very simplistic in its present formulation and will have to be further developed, but it is a start!

PROPOSAL TITLE: Permaculture campus
SUBMITTED BY: Mr Steve Bean
ORGANIZATION: Ann Arbor Environmental Commission
SUBMITTED ON: 4/21/10

DESCRIPTION:

Capture all resources—sunlight, rainwater, biomass (leaves, food waste)—onsite and use to support a perennial, edible plant community on campus rather than using fossil fuels to maintain lawns and labor to replant annuals each year. Grow plants that can provide materials for use in research, art projects, etc.

PROPOSAL TITLE: Food labeling
SUBMITTED BY: Mr Jeff Tenza
ORGANIZATION: Community Farm of Ann Arbor
SUBMITTED ON: 5/8/10

DESCRIPTION:

At the last town hall meeting, we discussed how to label the food. One of my friends suggested that naturally-grown food be considered normal, and thus not have a label. Pesticide-grown food should be certified, listing all chemicals used. All food should have miles transported listed. Prepared food should be an aggregate of food miles. This would place the burden on corporations that purchase chemicals and GMOs rather than small farms that are simply growing food. This also seems like a more honest approach.
Thanks!

PROPOSAL TITLE: Food Waste
SUBMITTED BY: Dr Olga Lopez-Cotin
ORGANIZATION: LSA
DEPARTMENT: Residential College
SUBMITTED ON: 5/12/10

DESCRIPTION:

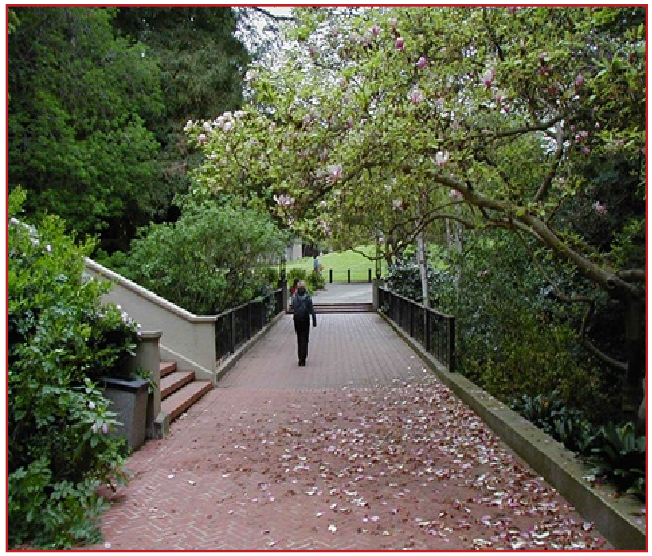
Students should be encouraged to think carefully about food portions and their daily selection of the kind and amount of food they will reasonably eat. I have lunch with students twice a week, and I am shocked at the amount of food that goes to the trash barely touched or not touched at all. Strong environmental and ethical reasons to stop this way of thinking about food would be, I would think, easy to point out to [sic] in the context of increasing self-awareness on sustainability issues. In ethical food practices, local/organic purchasing goes hand in hand with a hard look at long-held consumption habits. We should strive to campaign vigorously for both.

UC Berkeley

By: Margo Ludmer

INSTITUTIONAL BACKGROUND

The University of California was chartered in 1968, with its flagship campus in Berkeley. There are roughly 25,000 undergraduates and 10,000 graduate students enrolled at UC Berkeley, 80% of whom are from California. The University employs 24,700 people, including 1,575 fulltime and 556 part-time faculty members. The campus covers 1,232 acres, which includes a number of green spaces such as the Grinnell Natural Area and the Eucalyptus Grove[1].



source: www.berkeley.edu

INNOVATIVE FOOD PROGRAM

The campus dining facilities at UC Berkeley can be divided into three units: Cal Dining, Associated Students of UC Berkeley (ASUC)-managed food vendors, and independently managed food vendors. Cal Dining is a full-service dining operation that includes residential dining centers and campus restaurants. Cal Dining comprises almost half of all food vending on campus. The seven ASUC-managed restaurants are located in the Bear's Lair Food Court of the Martin Luther King Jr. Student Union. Other independently-run dining locations include cafes and ethnic restaurants scattered throughout campus[2]. The 2010 total annual food budget at UC Berkeley is $13.1 million[3].

Sustainable Food Practices

"Sustainable Food" Purchasing

- Based on UC Office of the President (UCOP) definition of "sustainable food"[4]
    - Food must meet one or more of eighteen criteria
        - Examples of this criteria include: Fair Trade Certified, Locally Grown (within a 16-country radius), USDA Organic, 100% Grassfed, and Certified Humane Raised and Handled
    - Goal to increase sustainable food purchases by campus foodservice providers to at least 20% by 2020
- Minimum standard of 10% local purchases, with a goal of 25%[5]
    - Signed contract with the "Buy Fresh, Buy Local" campaign in 2007
    - **Defines local as within a 16 county radius of UC-Berkeley**
        - Currently sources 60% of in-season produce locally
        - Purchases from 60 local farms/growers through three California distributors: S.F. Specialty, CAFF, and Daylight Produce

UC Berkeley

source: www.york.ac.uk

- Additional "sustainable" foods
  - Cal Dining
    - 100% organic, cage-free eggs
    - Minimum standard of Fair Trade for coffee
    - 30% hormone- and antibiotic-free meat
    - 100% hormone- and antibiotic-free milk

Sustainable Foodservices Working Group
- Created in the Spring of 2009 to meet sustainability goals for food purchasing and operations
  - Works to implement foodservice policies set by the University of California system and policies that are campus-based
  - Promotes coordination amongst food vendors to accomplish sustainability goals
- Selected Aspects of Workplan[6]
  - Perform a feasibility study on the implementation of goals
  - Track and report the sustainable food purchases of foodservice operations
  - Create a standard language for foodservice operator contracts that incorporates sustainable policies

ASUC Request for Proposal Process
- The ASUC Auxiliary and Store Operations Board is composed of students, administrators, and faculty
- Created a Request for Proposal process where businesses must compete with others on the open market to continue operations in ASUC dining locations
- Criteria for vendors, established in the RFP, have included requests for local, financially sustainable, environmentally friendly, and ethical practices[7].
  - Includes becoming Alameda County Green Business Certified, serving some organic items, offering fair trade coffee, offering vegan/ vegetarian options, and using compostable utensils, etc to be composted onsite[1viii].

Other Innovative Programs

Residential Dining Certifications
- All four residential dining centers are Green Business certified by the Bay Area Green Business Program
- All four dining centers are Certified Organic through California Certified Organic

Farmers (CCOF)
- o Each location has a 100% organic salad bar

Waste Stream Diversions at Cal Dining
- Cal Dining sends 50 tons of compostable waste per month to the NORCAL composting facility
  - o 100% of Cal dining facilities have pre-consumer composting programs
  - o Annually composts over 500 tons of post-consumer waste
    - Extensive education, signage, and student involvement was employed to prevent contamination
  - o Initiated a To-Go container composting initiative that sources to-go containers and pizza boxes made from bagasse
- Recycles waste oil with Blue Sky Bio-Fuels
- Recycles aluminum, cardboard, glass, paper, certain plastics, palets, carpet, furniture and equipment, and uniforms[iii]

Berkeley Student Food Collective
- A cooperative, student-run café that promotes "community-building and environmental stewardship"
- Provides local, sustainable food options to students
  - o 100% Real Food, based on the definition set by the Real Food Challenge

The Local
- A student-run farmers' market located in front of the Student Union
- Operating once a week for four hours, it is run entirely by volunteers
- Sources produce from small, local farms

LESSONS LEARNED

1. Clear definition of "sustainable" and "local"
   a. A specific and quantifiable definition for these terms will make it easier to communicate, track, and promote sustainable purchasing consistently among food vendors
2. Feasibility of "greening" independent food vendors
   a. The selection process can be based on environmental and ethical standards
      i. Could be used for food vendors in University Unions facilities
   b. Once selected, independent food operators can be guided by the University to engage in environmentally responsible practices
      i. This can help UofM meet its food sustainability goals in all units of food service on campus
3. Importance of student involvement
   a. Well-funded student projects can develop into valuable assets to

the University
    i. Student groups at UofM have initiatives similar to the student-run coop and farmers' market, that require University support
  b. Motivated students will educate others on the importance of local, sustainable foods
4. Local produce can be effectively sourced through local distributors
  a. UC Berkeley does not purchase directly from farmers, rather three local distributors

ENDNOTES

[1] "Facts at a glance." 2010, UC Regents. http://berkeley.edu/about/fact.shtml

[2] "Sustainable Food Systems at UC Berkeley." 2008, Karen L. Salvini. sustainability.berkeley.edu/.../Karen_L_Salvini.UCB_Sustainable_Food_Systems.pdf

[3] "University of California-Berkeley." Report Card 2010, the College Sustainability Report Card. 2007-2009, Sustainable Endowments Institute. http://www.greenreportcard.org/report-card-2010/schools/university-of-california-berkeley/surveys/dining-survey

[4] "University of California Policy on Sustainable Practices." 2009, University of California Office of the President. www.ucop.edu/ucophome/.../**policy**/**sustainable_practices**2009.pdf

[5] "Environment." Cal Dining. 2010, University of California-Berkeley. http://caldining.berkeley.edu/community.html

[6] "UC Berkeley Sustainable Foodservices Working Group Action Plan, 2009-2010." 2009, The Berkeley Institute of the Environment. bie.**berkeley**.edu/files/Foodservices**group**_actionplan.pdf

[7] "ASUC Search for Vendor on Lower Sproul Awaits Ruling." The Daily Californian. Feb 22nd, 2010, The Daily Californian. http://www.dailycal.org/article/108351/asuc_search_for_vendor_on_lower_sproul_awaits_ruli

[8] "Re: Question from University of Michigan Integrated Assessment Food Team" Message to Margo Ludmer. Apr. 22nd 2010, Christina Oatfield.

Indiana University

By: Margo Ludmer

INSTITUTIONAL BACKGROUND

An analysis of IUB is particularly relevant to our integrated assessment of the University of Michigan, because the two Big Ten universities are analogous in size and geographical location. Indiana University Bloomington is comprised of approximately 39,000 students, 2,900 faculty members, 350 administrative executives, and 5,000 staff members. Like U of M, Indiana University has recently launched a comprehensive sustainability task force, Green Teams, to assess and improve upon various aspects of campus operations and culture. This program was initiated in 2007 by the campus director of sustainability and has made great strides in promoting environmentally friendly practices on campus. The following report will address IUB's present food system and plans for future improvement, as well as lessons the UofM may learn from IUB's efforts.

source: www.indiana.edu

INNOVATIVE FOOD PROGRAM

The dining facilities serve around 22,000 meals per weekday and 10-12,000 meals each Saturday and Sunday. The food service operations on campus are decentralized and are comprised of three primary units. The Residence Hall Dining Services purchase their food from 13 separate suppliers. The Athletics Dining Services and the Indiana Memorial Union (IMU) Dining Services have outsourced operations with Chartwells and Sodexo, respectively.

In 2007, the campus director of sustainability, William M. Brown, created committees for sustainable issues on campus. Each committee was assigned faculty chairs and student interns. Many of these groups established town-gown approaches to improving their particular area of focus and have aimed to work closely with Bloomington. Now supervised by the Campus Sustainability Advisory Board, established in 2009, the Food Working Group aims to provide residents and employees of IUB with high-quality sustainable food options that entail low energy usage and waste generation on behalf of the University. Bruce Jacobs, the Vice Chancellor of Auxiliary Services, and Christine Barbour, a professor of Political Science, are the two co-chairs of this group. There are eleven other active members, including students, faculty members, and staff.

***Sustainable Food Practices at IU*:**

Local food Purchasing:

At a maximum, the University sources about 5% of its food inputs locally. Within the Food Working Group, "local" was originally defined as the full-size county and areas immediately surrounding Bloomington. This definition has since expanded to include the southern half of Indiana in order to meet supply quotas. As a means of adhering to the health codes and guidelines outlined by the University, much of the local food is sourced from the Local Grower's Guild and the local food coop, Moving Foods. Additionally, food is source: www.indiana.edu

sourced from vendors who have contracts with local food distributors, for example The Apple Works and Scholars Inn Bakehouse. Of the eleven million dollar annual food budget for residence halls, only $6,160 was spent on food grown locally and $275,500 was spent on food processed locally.

Waste Streams:

The IUB residence hall dining service diverts about 15% of its waste through recycling. The dining facilities recycle aluminum, cardboard, glass, paper, and plastic. Additionally, cooking oil from the kitchen is purchased by a local forester who converts this material into fuel for biodiesel trucks and tractors.

In the Indiana Memorial Union (IMU), all production facilities have recently begun pre-consumer compost programs in partnership with Hilltop Garden, located on campus. Excess food from this location has been donated since 1986 to the Hoosier Hills Food Bank. The Union also recycles its vegetable oil and has recycling receptacles for aluminum, cardboard, glass, paper, and plastic. Additionally, IMU recycles light bulbs. About 15% of waste is diverted from standard disposal at the Union.

Other Innovative Programs:

Fischer Farms Grille: This food outlet is located in the food court of the Indiana Memorial Union. The Grille serves meals that incorporate meat from Fischer Farms located in Jasper, Indiana. The farm uses all natural feed and no antibiotics.

SPROUTS program: This community-based education effort focuses on environmental education and sustainable gardening. Students have begun to set up a garden in three primary residence halls that have provided produce to dining locations during the Fall months.

Collins Residence Dining Hall (Edmondson Dining Room): This exemplary dining facility within residence hall dining is nationally recognized for providing regularly providing students with vegan and vegetarian meal options. Collins Residence Hall sources local and organic produce. At one point, it featured organic dairy options labeled "local/organic" but few diners showed interest and the efforts was cost prohibitive. The location was also used for a food consumption study in 2008 that examined food sourcing, waste, and environmental impact and suggested local sources of produce.

Monterey Bay Aquarium Seafood Watch guidelines: The Indiana Memorial Union purchases catfish, pacific halibut, mussels, lobster, scallops, striped bass, tilapia, and rainbow trout based on the MBASW guidelines.

Fair Trade Certified: In Residence Hall dining facilities, 20% of coffee is Fair Trade Certified, as is the hot chocolate mix.

LESSONS LEARNED:

As a large institution, with similarly decentralized food operations, Indiana University is an accurate point of comparison for the University of Michigan.

The IU sustainable food effort demonstrates the obstacles of volume requirements and stringent food regulations when purchasing local produce. The dining options of IUB also indicate the feasibility of dedicating specific food outlets to provide more sustainable meal options. This is particularly exemplary for University Union food courts, which provide the option of purchasing from independent food vendors.

ENDNOTES

"Campus Sustainability Report" Indiana University Task Force on Campus Sustainability. 2008, Indiana University Bloomington. http://www.indiana.edu/~sustain/docs/Campus_Sustainability_Report.pdf

"Dining, Indiana Memorial Union" 2008, The Trustees of Indiana University. http://www.imu.indiana.edu/dining/index.shtml

Feb. 10 interview, Bruce Jacobs, Executive Director Indiana Memorial Union, Co-chair Sustainable Food Team. jacobsb@indiana.edu

"Indiana University–Bloomington Dining Survey" Report Card 2010, the College Sustainability Report Card. 2007-2009, Sustainable Endowments Institute. http://www.greenreportcard.org/report-card-2010/schools/indiana-university-bloomington/surveys/dining-survey

"Sustainable Food" 2009, Indiana University Office of Sustainability. http://www.indiana.edu/~sustain/Food/index.html

Michigan State University

By: Brad Detjen

INSTITUTIONAL BACKGROUND

Michigan State University (MSU) is a land-grant public research university in East Lansing, MI. It was the first university in the U.S. to teach scientific agriculture and was called the "Michigan State University of Agriculture and Applied Science" until 1964. As of Fall, 2009, it was home to approximately 36,489 undergraduate students, 10,789 graduate students, 4,985 faculty, and 6,335 staff. MSU's campus in East Lansing spans 5,200 acres and includes 577 buildings; throughout the state of Michigan, 15,000 acres are managed by MSU for agricultural, animal, and forestry research[1].

source: worklife.msu.edu

INNOVATIVE FOOD PROGRAM

MSU's residential dining operations consist of 14 unique dining halls that serve 30,000 meals per day. MSU's total food budget is $18 million per year[2]. Food is purchased centrally by MSU Food Stores, but each dining hall prepares its food on-site. Dining operations are run by one division, MSU Residential and Hospitality Services (RHS). In addition to the dining halls, RHS runs Spartan Signature Catering, the Kellogg Hotel and Conference Center, and Sparty's Coffeeshops[3].

Food Procurement

The majority of MSU's food purchasing is done through Sysco Grand Rapids. Sysco frequently acts as an umbrella organization to local farms who wish to sell agricultural products to MSU. MSU has designed a standard contract for these local food suppliers called "Farm to MSU." This document details numerous requirements that vendors who sell to MSU must fulfill, including food safety, food quality, delivery and payment procedures, sustainability and marketing. In addition, the contract contains a food safety questionnaire, farm and vendor information forms, and a form W-9 substitute[4]. At present, twenty local food suppliers are managed through this contract. Approximately 12-13% of food purchased by MSU comes "off the hoof or out of the ground" in Michigan, while 25-28% is either grown or processed in-state[5].

On its Green Report Card survey, MSU estimated the following, the numbers on poultry, dairy and seafood refer to food served in the dorms by RHS:

- MSU spends $5000 per year on organically grown and produced food

- 15% of poultry and 75% of dairy is hormone- and antibiotic-free

- 30% of seafood meets Monterey Bay Aquarium Seafood Watch guidelines

According to Marta Mittermaier, the manager of MSU Food Stores, purchasing from small, local farms presents several challenges:

source: msuorganicfarm.com

- Insurance. The "Farm to MSU" contract requires each vendor to have worker's compensation insurance, automobile liability insurance, and commercial general liability insurance. Many small farms cannot afford this independently. To deal with this problem, many local farms have obtained insurance under the umbrella of a large distributor such as Sysco Grand Rapids.

-Record-keeping. In the event of a food safety concern, products must be traceable back to the acre of land on which they were grown. Some small farms do not keep thorough records of their crops.

- Packaging. Certain packaging needs, such as refrigeration trucks, are not cost-effective for small, independent growers.

Sustainable Food Positions

RHS has a designated assistant director of sustainability, Diane Barker. The wide variety of initiatives that Diane is working on include:

- Connecting dining halls to MSU's new $13-million recycling complex

- Working with the School of Packaging to identify biodegradable containers that will meet a growing demand for carryout food

- Bringing a compost pulper to Brody Hall's new dining complex

- Connecting dining halls to the anaerobic digester operated by MSU's dairy farm

In addition, RHS is looking into creating the position of Culinary Services Sustainability Manager, who would work exclusively to improve the sustainability of food procurement and food processing. A person in this position would be responsible for identifying new contracts with local food distributors, controlling the safety and quality of food obtained from local distributors, and developing sustainable food processing and food waste strategies.

Finally, each residence hall has an Environmental Stewardship team composed of about 15 students, staff, and faculty. These teams work to develop sustainability initiatives within the residence halls as well as consumption and waste patterns associated with the dining halls[6].

Student Organic Farm

As the nation's oldest school of scientific agriculture, MSU continues to be at the forefront of research in agricultural production and technology. Through the Student Organic Farm (SOF), MSU educates students about sustainable food production practices, manages a Community-Supported Agriculture network (CSA), and produces high-quality local, organic food for MSU's dining services.

The SOF began producing in 2002 and now contains 18,000 ft^2 of heated greenhouses that allow production to continue throughout the winter months, when on-campus demand is highest. The farm also manages vegetable and fruit production fields, 60 laying hens, five beehives, a grove of sugar maples and a mushroom patch.

Through the CSA, local community members (mostly from the University) purchase a share each year that gives them access to a weekly supply of fresh fruit and vegetables as well as occasional shares of eggs and honey[7].

The SOF is trying to bring as much of its volume on-campus as possible. Several dining halls at MSU have differentiated themselves by buying greens and herbs from MSU's Student Organic Farm.. These facilities include the Yakeley dining hall, which serves students, and the Brody Marketplace and the Snyder-Phillips Gallery, which are retail dining facilities on-campus.

Lastly, for six months of the year, the Student Organic Farm sells produce on-campus at a Farm Stand for students.

Other Attributes of Sustainable Food Programs at MSU

- Fair Trade coffee is available in all dining halls

- Disposable containers are made from corn and potato and are biodegradable.

- By customer request, less than 1% of carryout containers are made using Styrofoam

- Excess food is donated to the Red Cross and the Greater Lansing Food Bank

- Yakeley Hall has independently decided to stop using cafeteria trays

- Waste grease is sent to the MSU Bio Refinery Training Facility and Krueger Commodities, who have generated over 900 gallons of biodiesel fuel to date.

- Curtains are used in walk-in coolers

LESSONS LEARNED

Several major lessons can be learned from MSU's sustainability efforts.

- Standard contracts streamline the difficult and complex task of managing heterogeneous food producers
    - Establish procedures for ensuring food safety and food quality
    - Clarify expectations for suppliers

- Established positions or offices of food sustainability are crucial
    - Diverse roles expected of "Food Sustainability" office
        - Food safety officer
        - Local supplier liaison
        - Waste flow manager

    - Cross-campus collaboration deepens and enriches sustainable food programs
        - Bio Refinery processes waste grease
        - School of Packaging designs biodegradable carryout packages
        - Student Organic Farm provides greens and herbs
        - Dairy Farm processes organic waste

In addition, some of MSU's local food sources may be useful for U of M's procurement needs. A few of these are mentioned below.

- Coloma Frozen Foods, Coloma, MI: frozen green beans, asparagus, sliced apples, and blueberries.

- Van Dyk Farms, Imlay, MI: romaine lettuce

- Michigan Turkey Producers, Grand Rapids, MI: turkey

- Kowalski, Detroit, MI: hot dogs

Finally, the MSU employees who contributed information to this study made several recommendations for potential future research.

- Contact David Connor: expert on hoophouses at MSU (connerd@msu.edu)
- Contact Denis Jennisch, produce manager, Sysco-Grand Rapids
- Look into standards set by the following organizations:
    - The National Association of College and University Food Services (NACUFS)
    - The Association for the Advancement of Sustainability in Higher Education
- Investigate the following universities, whom MSU looks to as models:
    - University of Wisconsin-Madison
    - University of Iowa
    - University of Minnesota, Twin Cities

ENDNOTES

[1]"MSU Facts." 2010, Michigan State University Board of Trustees. http://www.msu.edu/thisismsu/facts.html

[2]"Michigan State University Dining Survey." Report Card 2010, the College Sustainability Report Card. 2007-2009, Sustainable Endowments Institute. http://www.greenreportcard.org/report-card-2010/schools/michigan-state-university/surveys/dining-survey

[3] Feb. 23, 2010 Interview, Carla Iansiti, Dining Manager, MSU Residential and Hospitality Services. iansiti@msu.edu

[4] "Farm to MSU: A Collaboration With Local Growers." HFS Support Services, Michigan State University. 2007.

[5] Feb. 26, 2010 interview, Marta Mittermaier, MSU Food Stores manager. mitterma@hfs.mail.msu.edu

[6] Feb. 19, 2010 interview, Diane Barker, Assistant Director for Sustainability, MSU Residential and Hospitality Services. barker@mail.hfs.msu.edu

[7] Feb. 12, 2010 interview, John Bierbaum, MSU Professor of Horticulture and founder, MSU Student Organic Farm. bierbau@msu.edu

Ohio State University

By: Kevin McCoy

INSTITUTIONAL BACKGROUND

OSU's Columbus campus was established in 1870 by the Ohio State Legislature and is home to over 55,000 enrolled students, some 80% of whom are native Ohioans[1]. The university covers nearly 16,000 acres (1,762 acres in Columbus) with more than half of the total area devoted to agricultural research (8,158 acres)[2].

source: www.food.osu.edu

INNOVATIVE FOOD PROGRAM

The program's focus is on using local food sources when possible to benefit the local economy and to reduce the negative impacts that dining services has on the environment. Providing revenue for Ohio farmers and businesses is a major goal. They do not make major distinctions between large corporate producers and small and/or family owned producers in the vendor selection process. The selection process is based on quality, price and personal site visits. The program was started because the personal beliefs of the program directors were in conflict with previous practices.

Program Details[3,4]

Campus Dining Overview
- 150,000 customers served weekly (90% student, 10% staff)
- Annual Budget of $17 Million (34% allocated to food purchasing)
- 12 dining halls that each prepare meals on-site
- 1 commissary that prepares sandwiches for coffee carts in academic areas.
- Employs 2000 students part-time, and 300 full-time employees
- Executive Chef is responsible for interfacing with local food producers

Local/Humane Purchasing
- 30% of all food purchases are local
- $3.6 Million in annual purchasing
- Defines "local" as "any item that creates a revenue stream for an Ohioan."[5]
- Uses 100 miles or within Ohio as a guide
- Includes large corporate producers as well as small independent operators
- Purchases some products directly from five local growers/processors
- Purchases all other local products through 10-20 local distributors
- Specialty greens and lettuces sourced from student farm (12 cases)
- Fair-Trade Products
    - Coffee
    - Bananas
- Does **NOT** use any of the following:
- Cage-free, organic, free-range eggs
- Grass-fed animal products
- Hormone and antibiotic-free meat or dairy products
- Seafood meeting Monterey Bay Aquarium Seafood Watch Guidelines

Ohio State University

source: www.food.osu.edu

Waste Streams

- Composting
    - Investing in pulpers and shredders so that post-consumer waste can be composted to produce methane gas.
- Recycling
    - Recycles all cardboard, paper, glass, aluminum and some plastic
        - Results in diversion of 20% of all waste from landfill
    - Installing cardboard balers to increase payout
    - Used fryer oil sold to local company for use in bio-diesel production
- Reducing
    - Trayless dining policy has reduced total volume of waste by 60%
- Disposables
    - Using all bio-degradable products with the exception of disposable flatware
- Donating
    - Does not donate due to concern over liability issues.
    - Instead, focuses on minimizing waste through use of CBORD software

Other Innovative Programs

- Vendor Selection Process
    - Attends Ohio Produce Growers and Marketing Association Conference (SPGMA) to actively solicit new vendors
    - Brings new potential vendors to campus for sampling sessions designed to get feedback from students/faculty/staff
- *Sprouts Café* specializes in vegetarian, vegan, organic, and gluten-free food
- Trayless dining
    - Standard practice in all dining halls
    - Resulted in 60% reduction in volume of waste
    - Has reduced overall food costs
- Bring your own bag incentive
    - Students receive punches when they bring their own reusable bag for to-go and grocery items. These can later be redeemed for free food

Community Outreach and Impact

- Advances the cause of farmland preservation
    - Executive Chef's motto is "Keep the farmland, farmland."
- Nearly $6 Million in annual economic impact to local producers and distributors
- Student-run farm that contributes some food to dining services
- Was first program on campus to deal with sustainability. Most others have now begun to follow suit.
- Uses food sustainability program in

marketing materials targeting incoming undergraduates.
- Looks to University of California at Davis and at Berkley as a role model.

LESSONS LEARNED

The primary lesson that U of M should learn from this case study is that significant improvements to food sustainability on campus are possible even at a large institution with many dining halls. OSU's program has been put in-place largely by one man: Executive Chef Mark Newton. While progress has been slow relative to some other universities, it is clear that progress can be made even without the devotion of several full-time personnel. However, it stands to reason that if U of M is to put truly innovative, exemplary programs in place it will require the addition of several full-time staff people devoted to sustainable food practices.

Lessons Learned

- Trayless dining a very effective technique
    - U of M can expect to see very large reductions in waste by instituting such a program
    - Food costs can be expected to go down as a result
    - Initial resistance from dining customers will likely fade after a few weeks
- Local sourcing can have a large economic impact
    - OSU is contributing almost $6 Million dollars per year to the economic well-being of the food system in Ohio
    - U of M can expect to have an even larger impact if we set more ambitious goals
    - By focusing on economic impact rather than environmental impact U of M could help preserve farmland in Michigan
- Direct purchasing is difficult for large institutions
    - OSU does very little direct purchasing due to the complexity of getting new vendors through the state contractor approval process
- Site visits and personal communication is effective in sourcing local vendors
    - U of M should incorporate personal site visits and regular communication with local vendors into our program
        - This will enable our program directors to make more informed choices about quality and value.
    - Actively searching for new producers will result in better relationships
- Retrofitting facilities for composting and bio-waste will take time and money
    - Dining halls will likely need new equipment to effectively separate and process food waste for use in composting or bio-fuel production.

ENDNOTES

[1]OSU Today, WEB, accessed 2/8/2010 from: http://www.osu.edu/osutoday.

[2] Ibid.

[3] Newton, Mark A., Executive Chef, Dining Services, Ohio State University, Columbus, OH, Email INTERVIEW, 2/8/2010.

[4] The Green Report Card, Ohio State University Dining Survey, completed by Timothy Keegstra, Director, Campus Dining Services, accessed on 2/14/2010 from: http://www.greenreportcard.org/report-card-2010/schools/ohio-state-universitycolumbus/surveys/dining-survey.

[5] Newton , Mark A. INTERVIEW

University of Toronto

By: Kevin McCoy

INSTITUTIONAL BACKGROUND

source: www.planetware.com

The University of Toronto was founded in 1827 in Toronto, Ontario. The St. George campus (main) is home to over 50,000 enrolled students from around the world engaged in studies and research spanning all academic disciplines.[1] U of T is a potent economic force in Toronto. The university is the region's 15th largest employer and has an estimated $5.4 Billion CAD impact on the regional economy.[2] In 2006, U of T partnered with LFP and committed to purchase a portion of food products used at the St. George campus from producers certified by LFP to be both local and sustainable.

INNOVATIVE FOOD PROGRAM

Local Food Plus Certification Details

LFP has developed an innovative method for certifying food products not as strictly "organic" or "local", but as "local sustainable". This certification process ensures sustainability standards are met in several categories, and represents a more complete standard for certifying sustainably produced products. The LFP website defines the certification program as striving to accomplish five key goals[3]:

- Employ sustainable production systems that reduce or eliminate synthetic pesticides and fertilizers; avoid the use of hormones, antibiotics, and genetic engineering; and conserve soil and water.
- Provide safe and fair working conditions for on-farm labour.
- Provide healthy and humane care for livestock.
- Protect and enhance wildlife habitat and biodiversity on working farm landscapes.
- Reduce on-farm energy consumption and greenhouse gas emissions.

University of Toronto Food Program Details[4]

Campus Dining Overview

- Many dispersed food service operations (both contracted and self-operated)
- $37 Million CAD yearly food spending (estimated)

Local/Humane Purchasing

- $1,215,000 CAD spent on local food annually ($315,000 CAD on LFP-certified products)
- Contract with largest food service provider requires some products to be LFP-certified
- Purchases directly from five local farmers.
- Indirectly through fifteen local distributors
- Uses **NONE** of the following:
    - Cage-free, organic, free-range eggs
    - Grass-fed animal products
    - Hormone and antibiotic-free meat
    - Seafood meeting Monterey Bay Aquarium Seafood Watch Guidelines

University of Toronto

source: www.iep.utoronto.ca

- Uses some of the following:
    - GMO-free milk and other dairy products (100%)
    - Fair-Trade Coffee (some)

Waste Streams

- Composting
    - 95% of facilities divert pre-consumer waste for composting
    - 7000 tons composted annually
- Recycling
    - 100% of fryer oil is recycled into biodiesel
    - Recycles all cardboard, paper, glass, metal, wood, and plastic
    - Results in a 62% diversion of waste from landfills
- Reducing
    - 25 cent discount on beverages when using a refillable cup
    - "I Lug A Mug" marketing campaign
    - Prevents over 75,000 paper cups from landfill annually
- Disposables
    - Uses both reusable china and disposables
    - Has eliminated all but 2% of polystyrene disposables
- Donating
    - Does not donate leftover food

Other Innovative Programs

- Farmers Market[5]
    - Holds weekly farmers market for staff and students (Sept – Apr)
    - Student-Run Vegan Café[7]
    - Once per week
- Hot Yam! Café serves organic, local, vegan food
    - Staffed and Managed by student volunteers
    - Affordable ($4 average lunch price)
    - Publishes recipes on blog

Community Outreach and Impact

- Sustainable Food Map[8]
    - The university publishes a map of all sustainable food providers on and near the St. George campus
    - Extensive list includes restaurants, groceries, U of T eateries, and information sources
- LAP marketing[□]
    - LAP supports certified producers by providing free marketing and promotional materials
    - LAP establishes partnerships with institutions, groceries, and restaurants to sell LAP-certified products
    - LAP maintains a website to provide information on the LAP certification process and where LAP-certified products can be purchased

LESSONS LEARNED

The partnership with LAP is what makes the U of T local food program stand out. LAP has dramatically improved upon the more basic food certification standards to create a comprehensive sustainability certification. Aside from this unique relationship, U of T suffers from many of the same challenges that U of M is likely to encounter in our effort to create a more sustainable food system. Nevertheless, U of T has made a formal commitment to support local sustainable food. Although the program is still small, there is a lot of potential for a large impact in the future as the program grows due to the huge economic power of the university in the region.

Lessons Learned

- Adopting a more comprehensive standard for local sustainable food should be a priority
  - LAP's "local sustainable" certification provides a single measure by which to evaluate local products.
  - This is preferable to the patchwork of ill-defined terms like "local", "organic", "fair-trade", etc…
  - U of M should seek to support the establishment of a similar non-profit organization in Michigan that can provide this type of local food certification service.
- Decentralized food services present significant challenges to more sustainable food programs
  - At U of T, the size of the university and the number of food service operators makes increasing use of local sustainable products challenging.
  - The same can be expected at U of M because the institutions are similar in size and food service organization.
  - U of M should strive to incorporate local sourcing standards into all food service contracts to ensure the greatest possible impact.

ENDNOTES

[1] University of Toronto, Quick Facts

[2] Ibid.

[3] Local Food Plus, Certification For Farmers, Access on 3/7/2010, http://www.localfoodplus.ca

[4] The Green Report Card, University of Toronto Food Survey, completed by Jaco Lokker, Director of Food Services. Accessed on 3/7/2010 from http://www.greenreportcard.org/report-card-2010/schools/university-of-toronto/surveys/dining-survey

[5] University of Toronto, Food and Beverage Services, WEB, Accessed on 3/7/2010 at http://www.food-beverage.utoronto.ca/food/FarmersMarket.htm

[6] Hot Yam! Blog, WEB, Accessed on 3/7/2010 at http://hotyam.blogspot.com/

[7] University of Toronto Sustainable Food Map, WEB, retrieved on 3/7/2010 from http://www.food-beverage.utoronto.ca/Assets/Ancillary+Services+Digital+Assets/Food+Bev/food/mapf.pdf

[8] Local Food Plus, How The Program Works, WEB, Accessed on 3/7/2010 at http://www.localfoodplus.ca

Bates College

By: Breanna Shell

INSTITUTIONAL BACKGROUND

Bates College is a private residential college located in Lewiston, Maine. Bates was founded in 1855, with a current student body of 1,752 students and 215 faculty members. The Bates campus covers 109 acres on the edge of a Lewiston residential neighborhood.[1] Because of the small campus size students live on campus at least through their junior year and are required to use the board plan created by the dining services. Senior year students are allowed to live off campus, and of those students 98% still use the campus meal plan. Because of the campus proximity to the residential Lewiston area, they also serve community members, opening up to casual traffic. Bates Dining Services has been practicing environmental sustainability since 1986, leading to 22% of the annual food budget spent on natural, local and organic food.[2] The scope of the program increased significantly in 2008 when they received a $2.5 million donation to expand upon local food purchases and to create the educational curriculum: "Nourishing Body and Mind: Bates Contemplates Food."[3] This coincided with the building of a new energy efficient dining commons which opened in February 2008.[4]

Bates Dining Services Overview:[5]
2 million dollar food budget, centralized and self operated.

- Operations: One Commons dining hall, 5000 catered events, two cash operations (restaurant and cafe) and vending machines.

- Students: Approximately 1700 on the board plan.

source: Bates College

-One all inclusive plan: "all you care to eat"

- Staff: 98 benefited staff and 73 Full-time equivalent
    - 45 student staff members

INNOVATIVE FOOD PROGRAM

Bates College Dining Services is a leader in the field of sustainable sourcing of food because of its long history incorporating environmental sustainability into its programming. Highlights of their Dining Service programming include local, natural, and organic sourcing, waste stream diversion, and incorporating their local food initiatives into the curriculum and mission of the College. This section gives a snapshot of some of their leading innovative food initiatives in their campus dining services, student body and community collaborations.

Program Highlights:[6]

- Local Sourcing:

Bates College

source: Bates College

- Definition of local is the state of Maine
- Currently at about 30% local products purchased, but goal is 35%

- Waste Streams:
  - Innovations:
    - About 82-85% of waste stream diverted[7,8]:
    - Compost: pre-consumer food waste delivered to a farm in Lisbon, ME.
    - Recycling: cardboard, glass, tin, plastic and mixed paper.
    - Post-consumer waste: diverted to pig food in Poland, ME.
    - Food bank: provided 33, 000 meals last year for two local food banks.
    - The remainder is incinerated to make electricity.

  - Problems: commonly getting something in the wrong bin.
  - Solutions: try to decrease packaging, everything is color coded.
  - Use as much as the product is possible ex: save bread ends to make crumbs.
  - Central grease collection: picked up by a grease company to turn into bio-diesel.

Community Outreach and Impact

- College Level
- Nourishing Body and Mind: Bates Contemplates Foods
- Yearlong and continuing education pairing with healthy, local food issues.
- President on Food Education: "We want to educate our students to act prudently, and to think about sustainability when they eat."[9]
- Communication Techniques with students:
  - Education about programming
  - Napkin board: Virtual and Actual in Dining Hall, open door policy.

- Community Level
- Director of Dining Services: "We have the obligation to give back to the community in which we live, a farming community"[10]

- Partners:
- Harward Center for Community Partnerships: Bates Community Service Organization.[11]
- Community Food Assessment: Investigating Nutrition Needs and Assets[1]
- Farm Fresh Connection: Coordinates Sales of Local Foods[13]

Challenges and Solutions

Bates College Dining Services encountered barriers on all levels in the development of their local food network, from resistance from the farmers, to retraining kitchen staff about the different products, and gathering enough local products to meet need. These examples can be helpful in the development of the UM Food program.

Barriers and Solutions:

- "Town/gown" issues: Farmers did not understand collegiate food services.
- Therefore had to establish relationship to get passed prejudice, communicate effort to buy the best product.
- Pooling of different farms' products can be difficult to get the appropriate volume needed.
- Therefore Bates partners at times with Farm Fresh Connections, a network that creates relationships between schools and farmers to get the bulk of items needed.
- But try to avoid because more expensive, prefers working directly with farmer.
- Also have partnered with farmers: for example have let farmers use the College Greenhouse to start seedlings. Have discussed with farmers about how much food to grow to meet needs.
- Produce is not the same type of uniformity, for example: carrots are not uniform
- Therefore needed to retrain kitchen staff to understand the new product.

LESSONS LEARNED

Bates College is at a much smaller scale than the University of Michigan, but there are still important lessons to be learned from their innovative programming. The primary lessons that Bates College exemplifies is the benchmark amount of 30% local purchasing, a comprehensive waste stream reduction program, and incorporating the local, healthy food movement into the curriculum and mission of the campus. Because Bates College has a long established local food system the University of Michigan can learn from their systematic approach.

Lessons Learned:

- Define local as where the products are available.
- Start close and move regionally out.
- Think waste first.
    - Consider compost, grease, recyclables, and food banks in order to incorporate all areas of waste.
    - Can be a large cost savings.
- Integrate food education into the curriculum, students are interested!
- Consider incorporating into mission statement campus-wide.
- Cross-discipline classes, service learning, gardening education.
- Examples at Bates: "Biology of World Health and Disease," "Taste, Memory, Book: Indigestible Memories of Food" and "Food Culture and Performance."[14]

Other:

- Bates decided not to go trayless, instead decreased size of trays and number, and because of this, students take more plates and silverware, therefore the savings are not really there.
-Going local produces economic benefits: just good business

- Recommend if going carbon neutral as well, limit the number of miles traveled by minimizing deliveries.
- Does not explicitly advertise local on food products,
- "Why should you advertise what you should be doing anyways?"[15]

Bates College

Leads:

- Encourage UM to use the National Association of College and University Food Services Sustainability Guide[16] as a reference tool.

Bates College Dining Services has shown to be a leader in the area of sustainable food and waste management practices. UM can learn a lot about their methods and techniques applying it on a much larger scale in our community in Michigan. The most influential lessons learned are creating a manageable benchmark for local food sourcing, creating an all encompassing waste reduction process, and always encouraging the program to grow by incorporating food sustainability issues into the mission and curriculum across campus.

ENDNOTES

[1]Bates in Brief. http://home.bates.edu/about/in-brief/

[2]2.5 million gift helps inspire food-awareness initiatives at Bates College. Sept 2 2008. Office of Communications and Media Relations. http://www.bates.edu/x182808.xml

[3]2.5 million gift helps inspire food-awareness initiatives at Bates College. Sept 2 2008. Office of Communications and Media Relations. http://www.bates.edu/x182808.xml

[4]More than a month old, Dining Commons still a fresh Bates place. Apr 9 2008. Office of Communications and Media Relations. http://www.bates.edu/x174908.xml

[5]Interview with Dining Services Director Christine Shwartz.(interview 2-15-10 8-845a)

[6]Interview with Dining Services Director Christine Shwartz.(interview 2-15-10 8-845a)

[7]Interview with Dining Services Director Christine Shwartz.(interview 2-15-10 8-845a)

[8]About Us: Bates College Dining Services. http://www.bates.edu/dining-about-us.xml

[9]What's the role of food in the Bates Curriculum. August 2008 conversation with the President Elaine Tuttle Hansen. http://www.bates.edu/x182705.xml

[10]Interview with Dining Services Director Christine Shwartz.(interview 2-15-10 8-845a) Harward Center for Community Partnerships. http://www.bates.edu/x166216.xml

[11]The Harward Center: Collaboratories. Community Food Assessment. http://www.bates.edu/x165552.xml

[12]Food Routes. http://www.foodroutes.org/bl-mofga.jsp

[13]Food in the Bates Curriculum: A tasting menu. http://www.bates.edu/x202915.xml

[14]Interview with Dining Services Director Christine Shwartz.(interview 2-15-10 8-845a)

[15]The National Association of College and University Food Services: Sustainability. Guidance on Going Green

[16]$150 for members, $200 for nonmembers. http://www.nacufs.org/i4a/pages/index.cfm?pageid=4700

University of California, Santa Cruz

By: Brad Detjen

INSTITUTIONAL BACKGROUND

The University of California, Santa Cruz (UCSC) is one of ten universities in the University of California System. Located 75 miles south of San Francisco, its campus comprises 2,001 acres (8.8 km^2). The school was founded in 1965 as ten small residential colleges; each student enters one of these colleges upon matriculating and remains affiliated with it throughout his or her college career. In the 2008-2009 school year, UCSC's enrollment, averaged over 3 quarters, consisted of 14,662 undergraduates and 1,425 graduate students[1].

source: rhorii.com

INNOVATIVE FOOD PROGRAM

UCSC's housing department manages five dining halls, three cafes, a catering department, a restaurant, and several coffee kiosks[2]. Between 6,000 and 7,000 UCSC students typically live on-campus. About 23,000 meals are purchased every day, and the university purchases $6.9 million in food supplies annually[3]. Sixty-five percent of meal-plan holders are freshmen[4]. For thirty years, UCSC had a contract with Sodexho, Inc. through which Sodexho performed all food purchasing and preparation. In 2004 UCSC dropped this contract and shifted to an in-house purchasing and preparation system, including a prime vendor contract with the locally operated Ledyard Company. To supplement food purchased from Ledyard, UCSC buys from its on-campus farm as well a consortium of local farmers managed by the Agricultural and Land-based Training Association (ALBA).

Shifting to in-house food system management

In 2004, campus labor unions and the student organization Students for Labor Solidarity collaborated on a campaign for the university to "dump Sodexho." Though many food service workers had worked for Sodexho for many years, they rarely received the same pay packages and benefits as UCSC staff in other departments. Largely in response to the student and union campaign, the university severed its contract in June 2004 to move to a unionized work force and an in-house purchasing structure. According to Candy Berlin, the Program Coordinator for UCSC dining, this shift cost the university approximately $3 million, mostly in increased pay rates for unionized employees. Partly to pay for this cost, the university began requiring every student who lived in campus residence halls to have a meal plan.

Following this structural shift, a number of significant changes came about in dining administration at UCSC. Significantly, the in-house dining system was more transparent than Sodexho and more responsive to student demands. A Food Systems Working Group (FSWG) was founded, which brought together 17 different student organizations on-campus to develop food purchasing guidelines for dining administrators. FSWG developed a six-part metric indicating desire

source: gilroydispatch.com

for local, organic, humanely produced, directly purchased, Fair Trade, and worker-supportive food products. In the Fall of 2006, approximately 24% of food purchased by UCSC dining services met the FSWG's guidelines[5].

Local food purchasing

At present, approximately 25-30% of produce purchased by UCSC is considered "local," meaning that it comes out of the ground within a 250-mile radius. About 24% of produce is organic, and of that quantity, 61% (15% of all produce) is purchased from local farmers through the Agricultural and Land Based Training Assocation (ALBA)[iv].

Following a meeting of campus chefs and local farmers in 2004, UCSC decided to add ALBA to its vendor agreements. ALBA is a central marketing organization for several local farmers around Santa Cruz. In order to facilitate sales from ALBA to UCSC, the Monterey Bay Organic Farming Consortium (MBOFC) was founded. Through this consortium, several farms sell to UCSC through one weekly invoice. ALBA also helps the farms meet university insurance, ordering, and delivery requirements. ALBA farms have agreed to make their farms available for UCSC's organic farming and food systems research.

In terms of pricing, UCSC works with local farmers as follows. Each year, MBOFC provides a list of their plantings and anticipated production rates to the UCSC purchasing department. All participating farms collaborate to set prices, which include ALBA's delivery and overhead fees. The Purchasing Department negotiates prices with MBOFC twice yearly and then writes a contract based on produce availability and pricing with ALBA. ALBA delivers food to campus 3-4 times per week and submits its own invoices to the university. The university pays ALBA, which then pays the individual member farms of MBOFC.[6]

Once the university had decided to sever its comprehensive food service contract with Sodexho, it began the search for a new primary food vendor. After a competitive bidding process, UCSC chose Ledyard Company, a food and food supplies distributor based in Santa Cruz. Ledyard was able to meet the competitive bidding process while agreeing to meet the university's sustainability requirements. UCSC became Ledyard's largest buyer, giving the university a high degree of leverage in specifying their food demands. In addition, being so close to campus, Ledyard could foster relationships with local food producers and respond quickly to the University's needs. Each dining hall manager orders his or her own food through the computerized FoodPro system, and Ledyard downloads these orders directly.[iv]

Fostering student participation

Many representatives from UCSC cite student participation as a primary driver of sustainable food initiatives. The dining administration works closely with student groups. The primary platform for this collaboration is the Food Systems Working Group (FSWG) coordinated by Tim Galarneau, a former UCSC student and current

Dining Services staff member. Seventeen different student organizations work with FSWG to voice concerns and ideas about food on-campus. These organizations range from the Green Campus program, which makes recommendations to dining services about improving energy-efficiency in facilities, to Banana Slugs to Save Animals, who have helped dining services implement Meatless Mondays and Beefless Tuesdays in the dining halls.

In addition to FSWG, the university obtains feedback from its Food Service Advisors. Each residence hall has one student Food Service Advisor, who is compensated with free housing and a meal plan. These students must also be employees in the dining hall. They seek out feedback from students about their satisfaction with dining system, and report back to dining services.

Statewide sustainability programs

The successes of UCSC's sustainable food program have been influential beyond the campus itself. After a June 2006 committee meeting between Housing Directors from the University of California's ten campuses, a food systems task force was formed to develop statewide food sustainability guidelines. Sue Matthews, UCSC's Executive Housing Director, and Tim Galarneau were selected to lead this task force due to the leading role that UCSC has taken in advancing on-campus food sustainability. This task force recently gathered 5,000 postcards from different UC schools lobbying the UC Regents to adopt sustainable food guidelines[vi].

At present, the California Student Sustainability Coalition is working to develop UC-wide sustainable food goals, which UCSC would try to meet by 2020. In the interim, several UC schools are participating in the Real Food Challenge. This is a nationwide competition that uses a calculator to judge university food systems based on four goals: local/community-based, fair, ecologically sound, and humane.

Other attributes of sustainable food systems at the University of California, Santa Cruz

- Educational and outreach events
    - Three organic dinners with over 1,500 students
    - Tastings and dialogues with farmers and Dining Services staff to promote understanding of seasonal variation
    - Regional farm tours for students
    - Organic taste tests
    - Conferences with student leaders from other UC campuses[vi]
    - "Zero waste" events involve collecting and weighing uneaten food scraps
- Campus farm
    - Administered by Center for Agroecology and Sustainable Food Systems (CASFS)
    - 25-acre farm for organic agriculture research[7]
    - Farm is a member of MBOFC
    - Appointed "Farm-to-College" staff position
        - Handles campus education and outreach
        - Coordinates deliveries of CASFS food to campus food service outlets
        - Runs a freshman class on organic farming[vi]
- Community-Supported Agriculture Shares available for students
    - Can pay with credit from student meal plans
    - Special student membership (Sep-Nov) suits student calendar[8]

- Energy efficiency
  - By replacing exit signs, incandescent lighting, and T12 lighting ballasts, dining services saved 82,901 kW/year, equivalent to $9900 annually, and received a $26,528 rebate from utility PG&E
  - Only EnergyStar appliances are purchased for use in kitchens, now constituting 56 appliances in total
  - Eight electric carts are used for transporting food and employees around campus[iv]
  - "Dining by Daylight" program dims lights in dining halls when sunlight is brighter[ii]

- Waste handling
  - Composting
    - Three of the five dining halls are currently composting 100% of compostable materials and food scraps
    - The other two dining halls will reach this figure in Spring 2010[ii]
    - A pulping machine at the College 8 residence hall reduces waste volume by 2/3[iv]
  - Water
    - Stage 2 water-emergency procedures are used at all times
    - Water thawing has been eliminated, saving up to 250 gallons per hour
    - By going trayless in 2008, UCSC Dining Services reduced food waste by 32% and saved 1 million gallons of water
  - Campus sustainability plan
    - UC office of the President has mandated 0 waste in UC systems by 2020
    - Goal: bring in 100% of items in compostable or recyclable containers
    - 100% of waste oil is converted to biodiesel
- Certification
  - UCSC Dining Services was the first business to be designated a Green Business by the city of Santa Cruz
  - At present, almost 100% of - - - UCSC facilities have received this certification
- Almost 100% of seafood falls under the "green" category of the Seafood Guide published by the Monterey Bay Seafood Watch[ii]

LESSONS LEARNED

Several major lessons can be learned from UCSC's food sustainability efforts.

- Developing the capacity for in-house food service and purchasing has a major impact on food systems
  - Increased participation of students
  - Greater autonomy and control
- Student power over food system can guide it toward sustainability goals
  - Food Systems Working Group – a platform for student groups to provide feedback about on-campus food
  - Food Service Advisors – student employees
- One university's sustainable food policy impacts others in the region
- Collaboration with local farmers is crucial
  - Monterey Bay Organic Farmer's Consortium
  - Streamlines insurance, ordering, delivery, and invoicing
  - Allows small farmers to meet UCSC's food specifications
- Many impressive sustainability goals are achievable by a large university
  - 100% composting of compostable materials and 100% conversion of waste

oil to biodiesel
- 100% trayless
- Green Business certification
- 25-30% of produce purchased locally

ENDNOTES

[1] "About UC Santa Cruz – Statistics." 2009, The Regents of the University of California. http://www.ucsc.edu/about/statistics.asp
[2] March 3, 2010 interview, Clint Jeffries, unit manager for Crown/Merrill dining hall, Green Business Coordinator, UC Santa Cruz Dining. cjeffrie@ucsc.edu
[3] "Foodservice Sustainability." Entry, Hobart Corporation award. UC Santa Cruz Dining.
[4] March 1, 2010 interview, Candy Berlin, Program Coordinator, UC Santa Cruz Dining. cberlin@ucsc.edu
[5] "UC Santa Cruz's Food Systems Working Group Helps Develop Statewide Farm-to-College Initiative." The Cultivar, Vol. 24, No. 2. Fall/Winter 2006. The Center for Agroecology and Sustainable Food Systems. University of California, Santa Cruz.
Helps Develop Statewide Farm-to-College Initiative
[6] "UC Santa Cruz makes the Farm-to-College connection." The Cultivar, Vol. 24, No. 1. Spring/Summer 2006. The Center for Agroecology and Sustainable Food Systems. University of California, Santa Cruz.
[7] Feb 25, 2010 interview, Tyler Pitts, Co-chair, Student Environmental Center, tpitts@ucsc.edu
[8] "Farm offers CSA shares for students." The Cultivar, Vol. 24, No. 2. Fall/Winter 2006. The Center for Agroecology and Sustainable Food Systems. University of California, Santa Cruz.

Emory University

By: Sue Johnson

INSTITUTIONAL BACKGROUND

Emory University is a private research university located in Metropolitan Atlanta. They rank 17th among undergraduate universities in the country and are considered one of the "Top 10 Great Places" to work.[1] Emory University houses an undergraduate and graduate program, as well as the Oxford College campus and Emory Medical Center.

The purpose of this case study is to highlight the Sustainable Initiatives program at Emory University and their unique use of a farmer liaison in achieving sustainable food goals. Emory University defines sustainability as "meeting the needs of the present generation without compromising the needs of future generations."[2] The university has committed to positively transforming the world with sustainability being the top priority.

Emory University has set the ambitious goal of using local or sustainable sources for three-quarters of the food served on campus by 2015.[3] In order to accomplish this goal, the dining and food services at Emory need to change. Currently, Emory University serves 12,000 students on campus, split between approximately 6,000 undergraduates and 6,000 graduates. The Oxford College campus is home to an additional 740 students. On a typical day there are between 25,000 to 35,000 people on campus utilizing food services provided by the university, college, and hospital/doctor's offices. Emory employs 340 people and about 1,500 faculty/staff as well. Sodexo runs the foodservice at Emory and two restaurants are sub-contracted out to a local restaurateur. Currently the university spends $5, 036,000 a year on food, beverages, and other non-tracked items. Of this $5 million, 1.1 million is spent on sustainable products.[4]

source: electroniccampus.com

INNOVATIVE FOOD PROGRAM

The Sustainable Initiatives program through Emory's Office of Sustainability was founded in 2006. Original work began more than a decade before and focused on six different efforts:[5]

- Recycling
- Campus Forest Protection
- Committee on the Environment (COE)
- Alternative Transportation
- Green Purchasing
- Sustainability in the Curriculum

In 1999, the Ad Hoc Committee on Environmental Stewardship was formed. This committee's goal was to foster a deeper engagement with sustainability issues across campus. The focus of the committee began by developing an Environmental Mission Statement for the University, designed to bring environmental issues to the forefront. The committee met with the Emory Dining division on campus, as well as many

Emory University

source: sustainability.emory.edu

other groups to form the statement.[6]

As the movement for sustainability on campus continued and in lieu of the university's goal of 75% local or sustainable grown food by 2015, the sustainable food initiative was created. The Sustainable Food Committee was named in the spring of 2007 to lead this initiative. The committee consists of faculty, staff, graduate, and undergraduate students. The Sustainable Food Initiative established purchasing guidelines, created an educational garden and farmers market, but most innovatively, hired a Farmer Liaison.[7]

The University wanted sustainable food to be a way to stimulate Georgia's southeast and regional economies and in response, the Farmer Liaison position, commonly called a forager, was created to expand the local and sustainable food purchasing in the area. Emory decided that the best way to initiate the position would be to partner with the non-profit, Georgia Organics. A contract allowed Emory University to collaborate with the local non-profit, from 2007-2009, to hire the Farmer Liaison.[8] The Liaison traveled around the state of Georgia talking to diverse agricultural groups and providing information about Emory University, its food systems, and sustainability practices taking place at the school. The Liaison also went to local community meetings and made himself easy contactable to answer any questions from local farmers. He connected local farmers with the proper resources to become food providers with Emory, most importantly, linking them with a local distributor.[10] The main responsibilities of the liaison were to provide guidance to the food service distribution system, new farmer partners, and help growers become certified as sustainable producers. Overall, the liaison position was established to get the word out.[11] The University knew the position would not be permanent, but hoped that in a short period the liaison could inform the state and its residents about sustainable practices at Emory.[12]

The Farmer Liaison position unfortunately only lasted for a two-year stint and fell victim to the tough economic times of today. In its short existence, however it can be seen as a success.[13] Emory Dining sources food from nearby producers whenever possible with highest priority being given to those in Georgia. The dining services currently source from 29 local Georgian farms, which can in part be attributed to the work of the Farmer Liaison.[14] The position was successful because it created awareness and brought numerous local farmers and their resources to Emory's doorstep.[15]

Lessons Learned

Several lessons were learned from the experience with the Farmer Liaison and local sustainable purchasing:

- Emory University does not have flexibility in their food service contracts to let local farmers distribute and have access to loading docks; farmers must be connected with a distributor.

- Premium prices are a problem. Organic and locally grown food is expensive. The Farmer Liaison position was eliminated because of cut backs and the University realized that sustainable food has to become cheaper before they can really make a difference.

- Food menus on campus are often locked in about 1.5 years in advance. If the goal is to use sustainable and local foods, large scale menu changes would be necessary.

ENDNOTES

[1] http://en.wikipedia.org/wiki/Emory_University

[2] http://sustainability.emory.edu/page/1037/Our-Vision

[3] http://www.emory.edu/home/life/housing-dining.html

[4] Interview with Mollie Walsh, Sustainability Manager and Sodexo Campus Manager for Emory University, February 8, 2010.

[5] http://sustainability.emory.edu/page/1015/History

[6] http://sustainability.emory.edu/page/1015/History

[7] http://sustainability.emory.edu/page/1008/Sustainable-Food

[8] 2-14-2010: Interview with Peggy Bartlett , Sustainability Food Committee Chair, Emory University

[9] Ibid

[10] http://sustainability.emory.edu/page/1008/Sustainable-Food

[11] 2-14-2010: Interview with Peggy Bartlett, Sustainability Food Committee Chair, Emory University

[12] Interview with Peggy Bartlett, February 9, 2000

[13] http://www.emory.edu/dining/local_farms.php

[14] 2-14-2010: Interview with Peggy Bartlett, Sustainability Food Committee Chair, Emory University

[15] 2-14-2010: Interview with Peggy Bartlett, Sustainability Food Committee Chair, Emory University

Stanford University

By: Sue Johnson

INSTITUTIONAL BACKGROUND

source: stanford.edu

Stanford University is a private research university located in Stanford California. It sits on 8,180 acres in the San Francisco Peninsula, approximately 37 miles southeast of San Francisco and 20 miles northwest of San Jose. The university was founded in 1891 and is part of Silicon Valley. Stanford is ranked among the top five universities in the nation and is the 2nd largest university in the world in terms of contiguous area.[1]

The academic mission at Stanford University focuses on being a leader in research, teaching, and the institutional practice of environmental sustainability. They are committed to following sustainability principles in all areas of planning and operations, including dining services. Stanford seeks to lessen its environmental impact, ensure a healthy community, and contribute to global solutions. The sustainability efforts focus on eight broad areas:[2]

- Advancing Sustainability Knowledge
- Reducing Greenhouse Gas Emissions
- Fostering Land Stewardship
- Conserving Water Resources
- Creating Environmentally Sound Buildings
- Encouraging Alternative Transportation
- Minimizing Waste
- Purchasing Sustainably

As part of the campus wide effort for sustainable practices, Stanford Dining strives to make their dining services align. Every meal strives to be healthy, delicious, and beneficial to those who created it. Stanford Dining collaborates with the University, the local community, and the broader sustainable food movement in the following areas:[3]

- Sustainable Purchasing
- The Stanford Produce Stand
- On-Campus Production
- Education and Awareness
- Conservation Efforts

The food services at Stanford serve some 14,000 students divided by 6,800 undergraduates and 8,300 graduates. The University also employs approximately 1,900 faculty and/or staff.[4] Stanford Dining manages about half of the food service for undergraduate residences and 25% of university cafes. The food services on campus serve nearly 4 million meals annually.[5]

INNOVATIVE FOOD PROGRAM

Sustainable Stanford includes the Sustainability Working Group, organized in 2006 and Sustainability Working Teams, formed in 2008. The working group involves representatives from all areas of the university working to design the sustainability

source: sustainablestanford.stanford.edu

policies and programs. The Working Teams develop recommendations, assess progress, and help implement the practices and policies defined by the Working Group. The teams consist of campus experts, community group members, and other facilities and operational representatives. The Green Purchasing and Food team is responsible for food services and dining on campus.[6]

Stanford Dining focuses on sustainable food sources, waste reduction, and composting programs.[7] In terms of sustainable food sources, the Sustainable food coordinator is responsible. This position with Stanford dining was formed by the ideas of a small group of students and later approved as a full-time position by the university. The coordinator is responsible for managing the sustainable food program within the university. He uses purchasing guidelines to work to buy a greater percentage of local organic food (within a 150 mile radius). The coordinator also works with the purchasing group, existing and potential vendors and suppliers, and a collective of farmers. The food coordinator visits farms, views daily operations, and talks with farmers to see if they would be a good fit with Stanford University. In order to ensure distribution, the dining services see which local farms distributors are purchasing from and these are given priority.[8]

Waste management is also extremely important at Stanford. A few years ago the "Love Food, Hate Waste" program was started with food waste being the major focus. All kitchens on campus compost and compost bins are placed in the dining halls and cafeterias accompanied by signage and student who are part of an awareness campaign. Stanford Dining is responsible for 7 of the 30 retail food outlets on campus and has started a pilot program in 2. The outlets offer a 100% compostable serviceware option. Additionally, Stanford Dining partners with their local waste management company. The waste management company provides waste audits. Theses audits consist of opening up bags of trash and quantifying what could have been composted/recycled/etc. The goal of the waste audits are to show how well waste management is working on campus. They have been successful in creating awareness among students and faculty.[9]

Stanford has been successful in many other areas of its sustainable food efforts, listed below:[10]

- Nearly 40% of Stanford Dining produce is organic or grown within 250 miles of the University.

- Stanford Dining partners with the Agriculture and Land-Based Training Association to support 30 small farms in Salinas, CA that supply food to Stanford Dining.

- The campus Community Farm and more than ten community herb-and-vegetable gardens provide herbs and produce to dining halls and row houses.

-74% of Stanford Dining's seafood was in the Best of

Good Category of the Seafood Watch Card.

- Stanford composted over 1,300 tons of food waste in 2008. All dining halls and row houses and 8 cafes participate.

- A student-run produce stand was created and provides local and organic produce from campus and surrounding farms to the community.

- 10,000 gallons of waste oil from the dining halls and cafes is converted to biodiesel each year.

ENDNOTES

[1] http://en.wikipedia.org/wiki/Stanford_University

[2] http://sustainablestanford.stanford.edu/principles

[3] http://www.stanford.edu/dept/rde/dining/food_sys.htm

[4] http://en.wikipedia.org/wiki/Stanford_University

[5] http://sustainablestanford.stanford.edu/food

[6] http://sustainablestanford.stanford.edu/working_group_and_teams

[7] http://sustainablestanford.stanford.edu/food

[8] interview with Matt Rothe, Sustainable Food Coordinator, 2-17-2010

[9] Ibid.

[10] http://sustainablestanford.stanford.edu/food

University of Vermont

By: Breanna Shell

INSTITUTIONAL BACKGROUND

The University of Vermont has 10,371 undergraduates, 1,516 graduate students, 460 medical students and 1,299 full- and part-time faculty.[1] Located in Burlington, Vermont the University began in 1791 and has a strong history of partnership with the community.[2] Recently UVM was ranked in the top ten of America's Greenest Colleges and Universities by Forbes, top four coolest cities by Sierra Magazine, and the top six by the Sustainable Endowments Institute.[3] It is therefore understandable that UVM is an excellent example of sustainable food systems programming.

source: www.uvm.edu

UVM Dining Services Overview:

-Food budget represents approximately 36% of total volume of purchases. Amounting to approximately 5 million dollars annually.

- Contracted with Sodexo Campus Services: Manages 15 on-campus food locations.
- Three residential dining halls, 12 retail food outlets, a full service restaurant, cyber cafes, and three local restaurants that operate kiosks in student center.
- Meal Plans are divided up by categories of members of the university community
- Residential, commuter, faculty and staff, medical and graduate, and summer.
- Maintain a student forum that focuses on changes to policy and best purchase practices evaluating on both local and sustainability ideas.

INNOVATIVE FOOD PROGRAM

University of Vermont Dining Services has a breadth of services that cover several areas of the food production, consumption, and waste cycles at the university. UVM resources include local sourcing from their Farm-to-College program, the Vermont Fresh Network, and the student-run Common Ground Farm. For waste reduction they operate a Campus Kitchen's Project, create bio-diesel fuel, utilize tray free dining, use biodegradable products, compost at the Intervale Center and recycle most products.

Program Highlights[4,5]:

- Local Food Sourcing:
- Local definition: 150 miles of dining, state of Vermont, then bio-regional.
    - Annual Spending on Local Food: $50,000 in 2006 and it has grown through better tracking and increased volume to at least $250,000 in 2009.
    - Working to create a better way to track local purchasing, considering Real Food Calculator[6] or Slow Food Calculator.
- Farm to College Program:
    - Sodexo Campus Services began with the Farm to College program in April 2005 and hosted a Farm Forum event in April 2007.

University of Vermont

source: www.uvm.edu

- On-going efforts include: Partnerships with the Vermont Department of Agriculture and Vermont Fresh Network
- Dining services also employs a student Sustainability Intern who tracks and reports local purchases and investigates additional local food opportunities for our campus.

- Access to over 60 Farms through direct purchases and local suppliers
- Products Grown or Raised Locally: milk, apples, honey, cider, maple syrup, cheese, yogurt, bread, salad greens, some Vermont deli meats, ham, turkey, chicken, beef, pepperoni, hamburgers, soy milk, tofu.
- Products Processed Locally: Approximately 10-15% of total local purchases Bread, granola, baked goods, cheese, yogurt, coffee, tofu, salsas, mustard, jams, jellies, ice cream.
- Campus Garden: CSA shares with the Common Ground Student Run Farm for our summer orientation programs, summer retail and fall start up. Sponsor about $1500.00 each summer.
- Organics: Local produce and yogurt, fresh herbs and salad greens.
- Fair Trade: 90% of coffee is certified fair trade, also some tea, bananas, and chocolate.
- Dairy: regionally contracted 100% antibiotic and hormone (rBGH/rBST) free fluid milk.
Seafood: currently at 50% with a goal of 100% by August 2010, certified by the Marine Stewardship Council and the Monterey Bay Aquarium Seafood Watch guidelines as well as the Aquaculture Certification Council.

Waste Streams:

- Pre-consumer and post-consumer waste: 100% of dining facilities have compost program, total of 225 tons of waste collected annually.
- Campus Kitchens: student run chapter of National Program. Collect and convert food into meals which is donated to the Burlington Food Shelf and the Vermont Food Bank.
- Trayless Dining: One week pilot program occurred in a single dining hall spring semester of 2008. Fall of 2008 opened with all three campus dining halls tray-free. Estimated 40% reduction in food waste.
- Recyclables: Aluminum, Cardboard, Glass, Paper, and Some Plastics
- Bio-diesel: Since 2004 Green Technologies of Winooski processes UVM's used fryer oil into bio-diesel generating 1575 gallons of fuel annually.

LESSONS LEARNED

The University of Vermont Dining Services program is an exemplary food program that is effective on a large scale at a public university, therefore it could be a good example for how to manage a similar program at the University of Michigan. Applying some of these concepts at UM could present different problems, but could also mean a greater impact for the university and the community. Therefore listed are some of the major challenges and lessons learned from UVM:

Challenges[7]

- Matching growing season with demand during academic year
- Higher Price of Organics can be sold in a retail outlet, where the higher price can be recouped to the purchaser
- Composting: Extra pick ups needed at high volume, at times freezes in the bins which makes pick-up more difficult, pest control, odors and contamination from other waste types are common problems.
- Availability of fair trade products other than coffee are inconsistent in volume and quality.
- Bio-diesel: dining services employees need to be trained regarding oil disposal process to remove all sediment.

Lessons Learned[8]***:***

- Give students choices when incorporating new policy and products make the more sustainable choice more attractive and the students will choose.
- Best time to introduce new sustainable food practices and behaviors is during orientation, easier to teach from the beginning than to change.
- Partner with contracted distributors where their practices align with sustainable local sourcing policy. - Larger contractors have the ability to lobby for needed volume while meeting required safety measures.
- Establish a Sustainability Intern student position to assist in the local purchasing navigation process, especially useful in the transition.[9] Also useful to have the student implement peer pressure on student body to create behavioral change.
- Partner with local food producers and suppliers to gain a larger portion of the market of local products in the community.

The University of Vermont Dining Services and Sodexo is a great example of a dining services program partnering with their distributor to create a more sustainable and socially just food production, consumption, and waste reduction program for their community. The University of Michigan could gain a lot from learning from their techniques and challenges as they developed this extensive program.

ENDNOTES

[1] About UVM. http://www.uvm.edu/about_uvm/

[2] About UVM: History and Traditions. http://www.uvm.edu/about_uvm/?Page=history/default.html&SM=historysubmenu.html

[3] National Acclaim for UVM. http://www.uvm.edu/admissions/undergraduate/why/?Page=acclaim.html

[4] The Green Report Card, University of Vermont Dining Services, Food Survey, Completed by: Melissa Zelazny, Director of University Dining Services. Retrieved from: http://www.greenreportcard.org/report-card-2010/schools/university-of-vermont/surveys/dining-survey. On 2/17/2010

[5] Interview with Tom Oliver, Retail Operations Director of UVM Dining Services Sodexo. 2/19/2010

[6] Real Food Calculator, provided by the Real Food Challenge will be available for general use in November. http://realfoodchallenge.org/calculator

[7] University of Dining Services Sustainability Initiatives. Created by Karen Upton, Sodexho Campus Services, March 2007. http://uds.uvm.edu/documents/social/sustainability_07.pdf

[8] Interview with Tom Oliver, Retail Operations Director of UVM Dining Services Sodexo. 2/19/2010.

[9] Sustainability Student Intern Job description is coming from UVM

Washington University in St. Louis

By: Alysia Giatas

INSTITUTIONAL BACKGROUND

Location: St. Louis, MO
Enrollment: 13,761 (as of Fall 09)
Employees: 11,413 (as of 2/09)
Total Annual Food Budget: 6.6 million

source: visitor.wustl.edu

Washington University in St. Louis is a nonsectarian, private research university located in suburban St. Louis, Missouri. Founded in 1853, the university is attended by over 13,500 students and employs over 11,000 faculty/staff. Dining Services provides 20 percent of its food from purveyors within 150 miles through Bon Appetit Food Management, participates in a Farm to Fork program and holds an annual Eat Local Challenge featuring meals made entirely from local ingredients. It also serves some organic produce, only fair trade coffee and bananas and antibiotic-free beef, pork, and poultry products. Additionally, the school has an on-campus student founded and run garden, the Burning Kumquat, which supplies herbs and some produce to Dining Services during the fall and spring months and sells its summer harvests at a farmer's market in an underserved area of St. Louis .

INNOVATIVE FOOD PROGRAM

Washington University is comprised of two campuses: Danforth Campus, serving as the main campus where all of the undergraduate residence and dining halls are located, and the research oriented Medical Campus, a setting primarily for staff. Danforth Campus is supplied predominantly by Bon Appetit Management Company, and supplemented by Aramark. Bon Appetit specializes in supplying sustainable and local foods and all the Washington University's local sourcing is done through Bon Appetit's purchasing decisions. Due to its commitment to sustainability, Bon Appetit's offerings are purchased at a higher price than traditional food service items. The medical campus and hospital are considered a separate entity and contract exclusively with Aramark, a traditional food service supplier, for their food system needs.

Farm to Fork

In 1998 Washington University in St. Louis joined Bon Appétit's Farm to Fork program to support small farmers and local communities. Through this initiative, the university makes purchasing seasonal, regional and organic ingredients from a 150-mile radius of Washington University's cafes and dining halls a top priority. Buying directly from local farmers stimulates the local economy, guarantees fresh and high quality produce for students and staff, as well as gives the university much more control over which types of agribusiness it supports as well guarantees .

source: sustain.wustl.edu

Eat Local Challenge

In 2005 Bon Appetit issued the Eat Local Challenge to their purchasing directors, (referred to as executive chefs). Building off the Farm to Fork initiative, the challenge was to hold an event with a meal made completely from local ingredients—everything used in the preparation of the food must be sourced from within a 150-mile radius of the café, with salt being the only exception allowed. This event has taken place on Washington University's campus each year since and has become a popular tradition. While Bon Appétit serves locally purchased food everyday in the university cafés, this extreme example of 100% local ingredients has stimulated lively discussions amongst students, faculty and staff, increasing food sustainability awareness.

Waste Diversion/Reduction

Currently, Washington University does not engage in large scale composting, although it is moving in that direction. A small scale effort is taking place on the student-operated farm, the Burning Kumquat, however this is almost exclusively their own vegetative/gardening scraps. Hindering large scale progress is the lack of composting providers located in the St. Louis area. Over the last few months, however, a handful of composting companies have received their licenses and the university is looking into them as potential providers.

This past month, the university switched to single stream recycling, in an effort to make recycling more efficient. It has been received favorably by employees, as training was minimal and it has alleviated some previous job responsibilities. The dining halls are almost entirely trayless (with some available by request) reducing the amount of wasted food as well as lowering energy comsumption needs. Dining Service's "All You Can Eat" program has been eliminated, which has contributed to significant wast reduction, but has been met with some resistance, primarily from athletes.

Additionally, Dining Services has partnered with a company owned by an alumni of the university to convert waste cooking oil into biodiesel. Once converted, the fuel is returned to the university to power trucks used by the dining service. The hope is to expand this effort.

The Burning Kumquat

Founded by a group of students in the fall of 2007, the Burning Kumquat is a low-impact, intensive, organic garden located on the university's residential campus. Entirely student-run, the garden is approximately 7840 square feet and includes 17 raised beds, compost piles, a drip irrigation system, and stations to process and refrigerate produce. The farm uses natural fertilizers such as fish emulsion and compost produced on-site. The mission of the garden is to raise consciousness about the links between community, food and environmental issues, to inspire responsible and sustainable food practices and provide local produce not only for students on-campus but for the larger community.

The Burning Kumquat received start-up funds from

Washington University's Campus Enrichment Fund through the Student Union. The farm is recognized as a community garden by Gateway Greening, a St. Louis organization that leads a collaboration of local non-profits, colleges and universities to increase food security in the area. Gateway Greening provided a grant that paid for the majority of the garden's soil and offers resources such as seeds, master gardner expertise and support. Currently, the farm depends solely on student volunteers but hopes in the future to acquire funding to secure a farm manager and possible work study positions.

The Burning Kumquat grows a variety of produce from seed, such as herbs, lettuces, peas, corn, okra, strawberries,tomatoes, peppers and cucumbers. During the academic year, produce from the urban farm is available for purchase at a table within the Student Commons twice a week. Additionally, some of the produce, most notably herbs, is purchased by Bon Appetit. During the summer months, when the student population decreases, Camp Kumquat comes to life. A diverse group of youth, ages 10-12, gather from throughout the city to take part in the free opportunity to grow, harvest and prepare organic fruits and vegetables. Summer farm workers also take their produce to North City Market in St. Louis, which operates in an underserved area of the city. Any leftover produce year-round, is donated to an area food rescue organization.

LESSONS LEARNED

Liz Kramer, of Washington University's Office of the Executive Vice Chancellor of Administration, identified some of the challenges to realizing a sustainable food system on campus. She noted the expense of sustainable purchasing and practices as presenting a significant challenge, especially during an economic climate when universities want to keep costs low for current and prospective students. Catering to student's tastes is an important consideration when preparing menus and purchase orders, but can contribute to hindering the progress towards sustainable goals (think chicken nuggets and tater tots). Ms. Kramer also includes limitations set by the growing season as a challenge. There is little local produce available for purchase from November until March, precisely when the campus' demand is the greatest. As a result, Washington University has refrained from stating a goal of a certain percentage of food products coming from local sources.

Education and student involvment are considered key to the success of a sustainable campus food system. Washington University is dedicated to programing events and partnerships that increase awareness and co-operation and increase the visibility of its sustainability efforts. Fall 2009 saw the creation of the Sustainable Dining Team which consists of students from various campus organizations (as well as individuals with a strong interest) who meet every two weeks with the marketing director of Bon Appetit to discuss purchasing decisions and future visions for campus food options.

The newly drafted Strategic Plan for Environmentally Sustainable Operation is available for community review at the university's website. In January, fifteen public forums were held to solicit input from the campus body and larger community. Additional feedback has been gathered from 150 mailed surveys and 300 online surveys. The goal is to have the final draft completed by the end of this current Winter 2010 semester. Another short term goal for Washington University is to determine how to measure its procurement practices and then set quantitative goals based on these assessment critieria. In the long term, the focus will be on consistently meeting these quantitative goals for improved procurement practices as well as developing a large scale composting program.

Liz Kramer considers the Real Food network (and its Real Food Challenge) an invaluable resource for any institution interested in expanding its sustainable food efforts. Implementing the Challenge on Washington University's campus has been tremendously effective in fostering awareness and student involvement.

ENDNOTES

Washington University in St. Louis, Energy, Environment & Sustainability http://wustl.edu/sustain/

The Green Report Card http://www.greenreportcard.org/report-card-2010/schools/washington-university-in-st-louis

Bon Appetit Management Company—Food Services for a Sustainable Future http://www.bamco.com/

Real Food Challenge http://realfoodchallenge.org/

Phone Interview: Liz Kramer, Fellow in the Office of the Executive Vice Chancellor of Administration) 2-15-10 10amEST.

The Green Report Card: http://www.greenreportcard.org/report-card-2010/schools/washington-university-in-st-louis

Washington University in St. Louis Strategic Plan for Envionmentally Sustainable Operations.

Photo Credit: The Burning Kumquat, http://burningkumquat.wustl.edu/

Willamette University

By: Kevin McCoy

INSTITUTIONAL BACKGROUND

Willamette University was founded in 1842 in Salem, Oregon[1]. It is home to approximately 2,600 enrolled students from around the world.[2] The university motto is "Not unto ourselves alone are we born"[3] and this reflects the tradition of service and sustainability present on campus. Bon Appetit Management is a large food service provider based in Palo Alto, California. Their operational definition of sustainability is "*Food choices that celebrate flavor, affirm regional cultural traditions, and support local communities without compromising air, water or soil now and in the future.*"[4]

source: www.ccsc.org

INNOVATIVE FOOD PROGRAM

Willamette has partnered with Bon Appetit Management for food service operations. Bon Appetit specializes in local and sustainable food practices. This relationship has allowed Willamette to excel in food sustainability, particularly in using local sources for purchasing.

Program Details[5]

Campus Dining Overview

- Two full-service cafés and one breakfast café
- $1.8 Million annual food budget
- 86 people employed by Bon Appetit at Willamette
- There is a full-time manager of this program (works exclusively for Bon Appetit at Willamette University)

Local/Humane Purchasing

- 65% of food budget is spent on local food
    - Translates to 35% of total volume
    - Local is defined as within 150 miles
    - 30% of budget goes to sustainably harvested/produced food
    - Bon Appetit policy is to choose "seasonal, regional and organic ingredients" as the first option
    - "Farm to Fork" program buys direct from local farmers and uses the ingredients within 48 hours of harvest
    - Mostly small, locally-owned farms
- Purchases directly from sixteen local farmers.
    - Indirectly through twenty local distributors
    - $675,000 spent on local food annually
    - Chefs and students interact directly with farmers on a constant basis
- Uses **ALL** of the following:
    - Cage-free, organic, free-range eggs (100%)
    - Grass-fed animal products (100% lamb)
    - Hormone and antibiotic-free dairy products (45% for cheese, 100% for all

Willamette University

source: www.wikipedia.org

others)
- Hormone and antibiotic-free meat (100%)
- Seafood meeting Monterey Bay Aquarium Seafood Watch Guidelines (100%)
- Fair-Trade Products
    - Coffee (50%)
    - Bananas (35%)
    - Chocolate (5%)

Waste Streams

- Composting
    - 30% of kitchen waste composted for use on a local farm
- Recycling
    - 100% of fryer oil is recycled into biodiesel
    - Recycles all cardboard, paper, glass, metal, wood, and plastic
    - Results in a 25% diversion of waste from landfills
- Reducing
    - Charges customers for disposable containers and flatware
    - 10% discount on beverages when using a refillable cup
- Disposables
    - Encourages use of reusable china and silverware
    - When disposables are used they are all biodegradable or compostable and made from renewable sources
- Donating
    - Donates some food to UGM of Salem.
    - However, focus is on not over-producing

Other Innovative Programs

- Farm to Fork
    - Bon Appetit partners with local farms within 150 miles as the first option for ingredient sourcing
- Low Carbon Diet Program
    - Commitment from Bon Appetit to reduce greenhouse gas emissions by 25% by 2010 (from 2007 emission levels)
- Trayless Dining
    - In use occasionally for special events and to highlight waste
    - Considering wider implementation this year
    - 50% waste reduction on tray-less days
- Food Waste Reduction Campaign
    - 10 week campaign to cut food waste by 10%
    - Collected food waste in buckets and put them on display in student commons (to raise awareness)
    - Posted results (11% reduction) and targets for next year
- Eat Local Challenge[6]
    - Company-wide challenge from Bon Appetit for each café to prepare one full day of meals using only local ingredients
    - Highlights local food offerings, seasonal variation, the cause of food

sustainability

Community Outreach and Impact

- Circle of Responsibility[7]
    - Company-wide effort to increase awareness of individual roles in sustainability
    - Website with information on food sustainability
- Student Garden Guide[8]
    - Company-wide effort to engage with student-run farms on college campuses.
    - Website and literature published to help students learn more sustainable practices for use in their farms
- Education
    - Bon Appetit involved in coursework (as guest speakers in classes)
    - Tries to educate the community about the impacts of food choices (carbon footprint, economic impact on area farmers, etc…)

LESSONS LEARNED

The primary lesson U of M can learn from Willamette's food sustainability program is that not all food service management companies are created equal. Bon Appetit appears to be on the cutting edge of many food sustainability issues including local sourcing, waste reduction and outreach. U of M should attempt to emulate many of these practices and may want to consider a relationship with a management company like Bon Appetit, perhaps in a consulting relationship.

Lessons Learned

- Aggressive targets for local sourcing of ingredients can be achieved
    - U of M should not be afraid to set ambitious goals for percentages of food from local/sustainable sources. With proper management and structure they can be achieved
- Outreach is an important component
    - Active engagement of the campus dining community is essential for getting customers to buy-in.
    - Announcing goals and being transparent about the results of programs enhances this goal.
    - Educating diners about how the local growing season effects menu options
- There is value in independent standards
    - Bon Appetit is fully compliant with many independent measures of food sustainability. This provides an objective standard by which customers can judge the effectiveness of their programs.
    - U of M could benefit from this same phenomenon in their efforts to market the university as a leader in sustainability.
- Start small and scale up based on empirical analysis
    - Get some "quick wins" on a small scale (one facility or one type of product)
    - Use data collection and surveys to gauge the effectiveness of the program in gaining increased customer support
    - Use collected data to inform expansion decisions.

ENDNOTES

[1] Willamette University Website, About Willamette, WEB, Accessed 2/14/2010 from: http://www.willamette.edu/about/.

[2] Ibid.

[3] Ibid.

[4] The Green Report Card, Willamette University, Food Survey. Completed by Marc Marelich, General Manager. Accessed 2/14/2010 from: http://www.greenreportcard.org/report-card-2010/schools/willamette-university/surveys/dining-survey.

[5] Ibid

[6] Bon Appetit Management Company Website (http://www.bamco.com/)

[7] Circle of Responsibility, WEB, http://www.circleofresponsibility.com/

[8] Bon Appetit Management Corporation, Student Garden Guide, Retreived on 2/20/2010 from: http://www.circleofresponsibility.com/uploads/documents/student_garden_guide_final_-_food_service.pdf

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

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For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

Purchasing and Recycling

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

Purchasing and recycling is an integral part of campus sustainability and can contribute significantly to the total environmental impact. To better understand this segment, purchasing and recycling were explored as components within the University of Michigan Campus Sustainability Integrated Assessment, which has the goal of advancing sustainability on the U-M campus. The Purchasing & Recycling team explored the life cycle impacts of the purchase, use and disposal of materials on the U-M Ann Arbor campus. The U-M spends nearly $2 billion on goods and services annually.

Current environmental impacts

A screening life cycle analysis (LCA) based on the U-M's spending and energy consumption is shown below in Figure 1A. Spending is divided into four broad categories; purchasing accounts for nearly 60% of expenditures. Figure 1B shows the associated equivalent life cycle CO_2 emissions for the same categories. As expected, the use of electricity and natural gas has a significant impact, but purchasing, within University departments and plant operations, accounts for 1/3 of total impacts for fiscal year 2009 and construction is also significant. Travel and hosting represents 6% but does not account for commuting impacts at this stage.

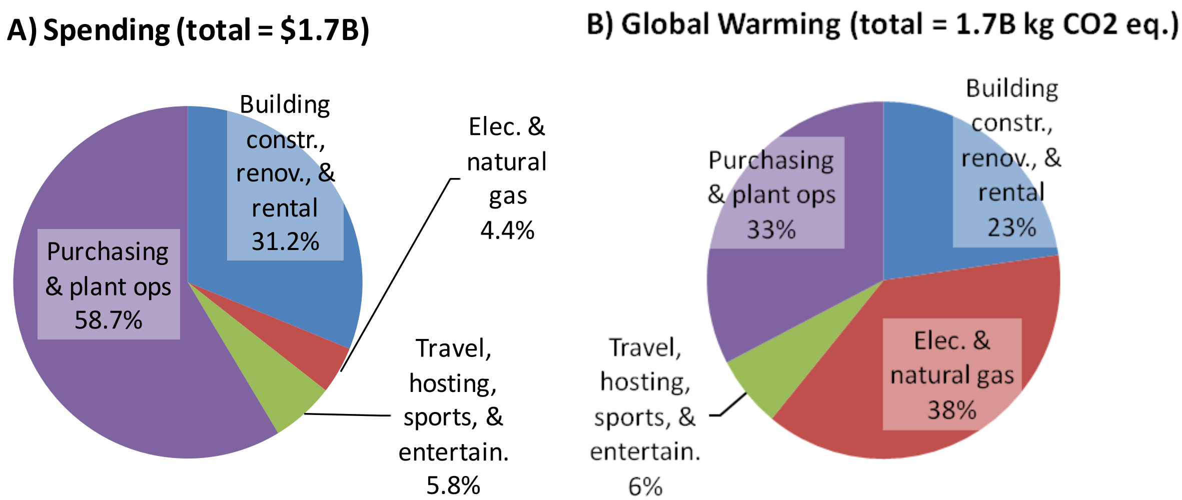

Figure 1: A) Spending and B) Global Warming for U-M in FY2009

Trends in sustainable purchasing and recycling

Schools around the nation are beginning to adopt policies that support sustainable procurement; the U-M has the opportunity to build on its faculty expertise, student engagement, and staff interest, as well as its history of forward-thinking policies by setting sustainability policies and becoming a nationally-recognized leader in this area.

Challenges for sustainability at U-M

Purchasing: Currently, the U-M has disparate efforts aimed at improving portions of the university, e.g., Climate Savers or the voluntary Vendor Code of Conduct. Establishing understandable rating systems for green products, keeping the up-front cost of these products competitive, and providing a platform for users to purchase such products will be a challenge. A cultural change will also be needed as the University encourages purchasers to shift from on-demand, next-day ordering to more infrequent deliveries per week.

Waste minimization: Although the U-M has a respectable recycling rate, there is room for improvement in handling of and minimization of waste. Reducing waste streams can be accomplished both by increasing the recycling rate and also by increasing reuse. Programs such as RecycleMania increase awareness of recycling, but organizational and institutional change is necessary, as well. Currently, waste tracking is incomplete and reuse of goods within U-M is inefficient.

Recommendations

Make sustainable purchasing an institutional priority and policy

- The U-M can only achieve the environmental, social and financial benefits offered by sustainable purchasing if a comprehensive sustainable purchasing policy is adopted. Such a policy should be the product of ongoing review and improvement by a dedicated task force.

Centralize purchasing to reduce costs and improve delivery efficiency

- Requiring use of a system such as M-Marketsite has several benefits: it consolidates ordering so that the Procurement department can negotiate lower costs; it facilitates data tracking; and it is a necessary condition for reduction in redundant deliveries (i.e., by half-full trucks).

Strengthen the Property Disposition system

- If the transfer of useable goods within the U-M can be improved, significant financial and environmental savings can be realized. Current costs for use Property Disposition are prohibitive, and members of the U-M community may not be aware of this service, leading to purchase of new items, incurring high cost and new environmental impacts.

Pursue waste reduction and improved recycling

- Reduction in the material flow going to landfills will require both institutional and individual changes. Individuals must be nudged to make green choices (e.g., compost in the dining hall, double-sided printing), and the U-M can improve the tracking of waste data and the handling of waste streams that are currently not managed (e.g., construction debris).

Phase II recommendations

- *Full LCA:* Building on the present Life Cycle Analysis, conduct in collaboration with the other teams a full LCA of the U-M including commuting, waste and energy production. Such a study will provide a scientifically-grounded and consistent method to evaluate sustainability aspects of proposals to improve the U-M.
- *Equipment sharing:* Investigate opportunities for improvement with respect to equipment sharing. Currently, budgeting may incentivize researchers to purchase redundant equipment. Interviews with the Office of the Vice President for Research and the Division of Research Development and Administration, will help the team identify room for improvement.

2 INTRODUCTION

As part of the Campus Sustainability Integrated Assessment, the Purchasing and Recycling Team has investigated the environmental and social impacts of purchased materials entering the U-M campus, their use on campus, and their fate after leaving campus. Because U-M spends nearly $2 billion on goods and services annually [1], the Purchasing and Recycling domain covers substantial material flows and environmental impacts. This spending, however, also positions the U-M to be a nationally-recognized leader by setting policies that are financially and environmentally beneficial. For the U-M to make progress towards its sustainability goals, it is essential that the impact of Purchasing and Recycling be fully understood.

A paradigm through which to approach Purchasing and Recycling is through the classical 3 R's: "reduce, reuse, and recycle." Some have advocated adding rot and rebuy (i.e., purchase recycled) to the original 3 R's [2]. Taken together, these concepts stress the importance of managing purchasing (reducing waste at the source) and waste management (recycling or composting that which cannot be reused, and only landfilling that which cannot be diverted) [3,4].

Previous work has shown the influence of procurement on the environmental impacts of universities. A 2007 life cycle study of the University of California at Berkeley, a large public research university similar to U-M, found that procurement of goods and services accounted for 28% of the university's total carbon footprint (Figure 2) [5]. Although this study considered only greenhouse gas emissions, it is reasonable expect procurement is a significant contributor to other environmental and social impacts as well. With billions of dollars being spent annually, the possible positive financial, environmental, and social impacts of sustainable procurement are clear.

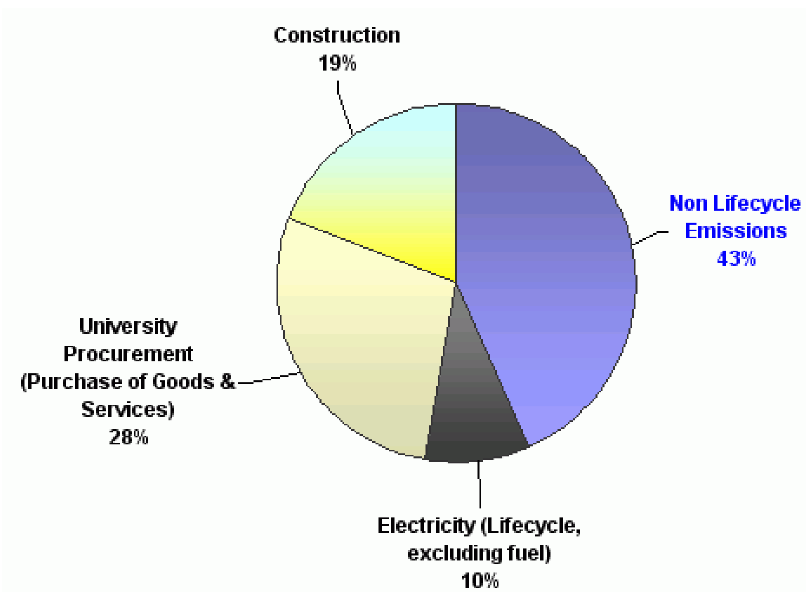

Figure 2: Carbon footprint for UC Berkeley emissions inventory [5].

The large flow of goods into the University leads to a potentially large disposal stream. In this context, institutional and individual actions can have a large impact on the amount of material going to landfills, being recycled, or being reused. Although landfill space is not currently limited, waste disposal can have a large environmental impact through land use change, methane emissions[6] and environmental justice concerns. Financially, there are benefits gained by reducing and properly managing waste through the mitigation of landfilling costs. Miami University in Ohio, for example, saved $180,000 in 2000 by reducing the amount of material sent to landfills [7].

In this study, the purchasing and recycling team has taken the Ann Arbor campus of the U-M, including the hospital, as the system boundaries. U-M expenditures from fiscal year 2009 were used to represent typical procurement habits. Some commodities were excluded from the analysis because they have been covered by other teams participating in this integrated assessment. These categories included food, fuel, and electricity purchases. On the waste stream side, food waste was excluded, as it falls under the domain of the Food team.

3 STATUS AND TRENDS

In order to understand the current state of purchasing and recycling at the U-M, a detailed questionnaire was distributed to selected U-M staff members; this questionnaire is reproduced in Appendix 8.1. The Status and Trends section of this report aggregates findings describing the current state of the U-M with respect to purchasing and recycling.

3.1 Overall environmental impacts of purchasing and waste at University of Michigan

Life Cycle Assessment (LCA) is a useful tool to estimate the overall environmental impact of goods and services; in the evaluation of a good's impacts, production, use, and disposal can be considered. Among different LCA methods, the Input/Output method (I/O method) enables a preliminary calculation of the impacts caused by various materials and services based on total expenditures in over 500 categories [8,9]. Given the spending of the U-M on different goods and services, it is possible to estimate the overall environmental impacts. The objective of this analysis is to understand the overall environmental impacts related to U-M purchasing, as well as to understand how different categories of purchasing are contributing to the total impacts. Limited data for waste associated with Input-Ouput data have precluded quantitative analysis of impacts associated with U-M waste at this stage.

Detailed accounts of spending for the U-M during the fiscal year 2009 (FY2009) were provided by Procurement Services [1]. After removing salaries, financial aid, and accounts not directly related to procurement at U-M, the spending was divided into the following 13 categories according to the purposes of each accounts:

1) building constructions, renovations and rental
2) natural gas
3) electricity
4) plant operation and maintenance
5) furniture & equipment
6) laboratory research supplies
7) IT services and supplies
8) fees and services
9) food and beverage
10) medical expenses
11) sports and entertainment
12) travel, hosting and transport
13) fleet fuel consumption

Since the I/O method does not include the use phase of gas, fuel and electricity, consumption of these commodities (natural gas, electricity, and fleet fuel) was analyzed with a process based LCA method using the Ecoinvent 2.0 database. All other categories were analyzed with the I/O method described previously. The six most robust endpoints for climate change, resources, human health and impact on terrestrial and aquatic ecosystem were selected from the Impact 2002 method [10]: global warming effect (in kg CO_2 eq), non-renewable energy (in MJ), respiratory inorganics (in kg $PM_{2.5}$ eq), terrestrial acidification/nutrition (in kg SO_2 eq), aquatic acidification (in kg SO_2 eq), and aquatic eutrophication (in PO_4 P-lim).

In addition, each category was qualitatively evaluated for 'room for improved sustainability'. Within each of the 13 spending categories above, subcategories were identified and scored across the following dimensions:

- whether the quantity purchased could be reduced, or if the product could be shared
- whether a green alternative is available
- whether UM faculty/staff/students would be willing to change products or their behavior with respect to the item
- how easy it is to reuse the item
- whether the product can be recycled
- whether making a change is cheap, easy to implement, or is a clear winwin.

Based on these categories, the team used best professional judgment to estimate a total score (0-5) for each subcategory. For each main category, a category rating was determined as the spending-weighted average of the subcategory rating.

The results of the I/O analysis are summarized in Figure 3, below. It can be seen that, as expected, the spending on building-related categories (building construction, renovations and rental; natural gas; electricity; and plant operations and maintenance) contributes over half of the total impacts in the global warming and non-renewable energy categories, which combined accounted for 65% of the total impact. This weight also corresponded to their combined large share of fiscal spending (46%). The impacts from fleet fuel consumption were low, which may largely due to the fact that individual commuting is not included, since these data were not available.

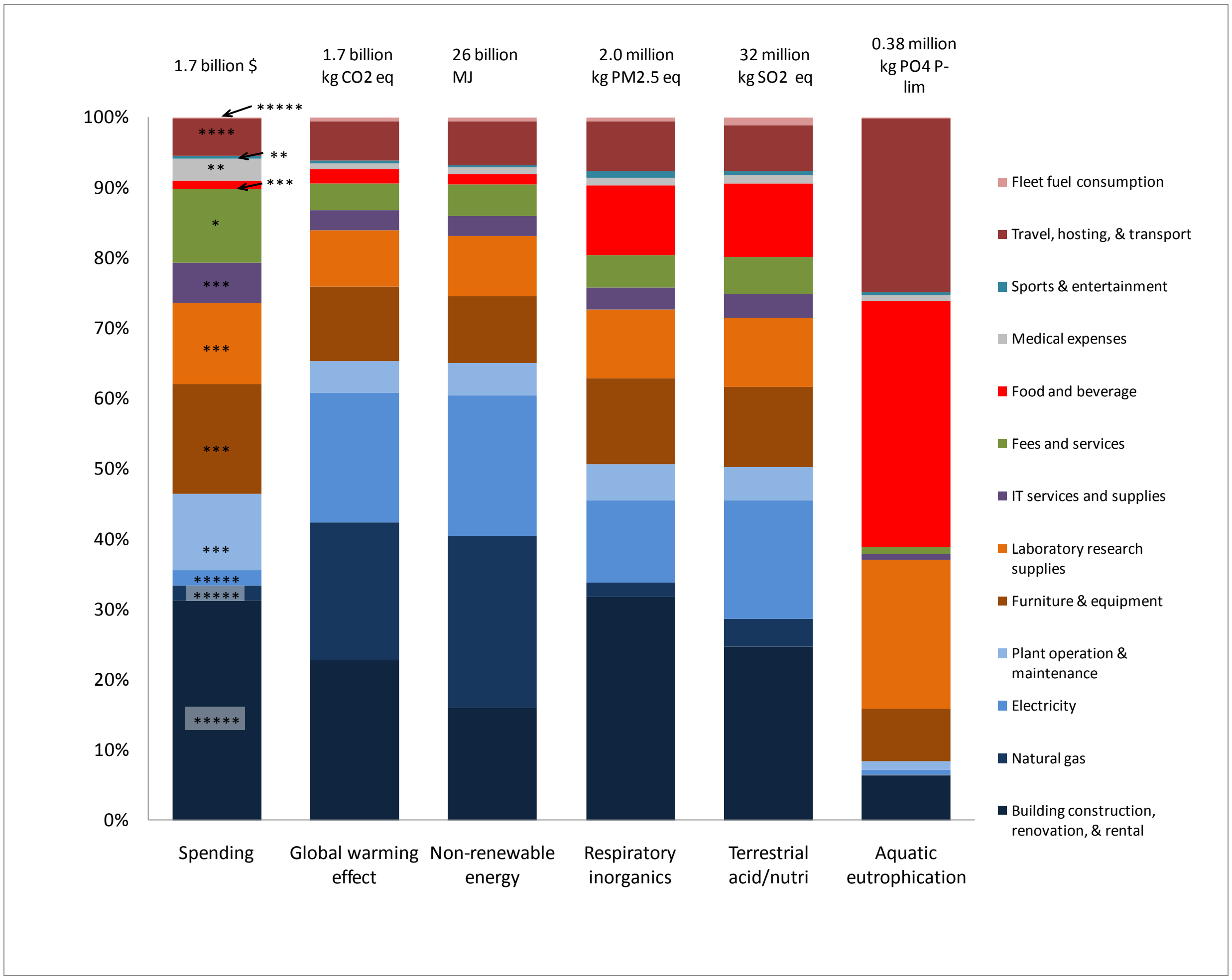

Figure 3: Summary of spending and environmental impacts, by category, for the U-M, FY2009. Ratings for improvement potential for each spending category are indicated by superimposed stars (1-5).

The remaining categories, which fit a narrower interpretation of "procurement," were responsible for a significant share of the total impacts, close to 40% for most categories but up to 92% for aquatic eutrophication. In the aquatic eutrophication category, food and beverage has a high impact, as does travel and hosting, which includes some food preparation. It should be noted that the food and beverage category includes university-run cafeterias but not on-campus food concessions, such as those in the basement of the Union.

From this analysis, we can see that improving the sustainability of procurement at U-M will have a significant change of its overall environmental impact. A more detailed analysis of each category can be found in Appendix 8.2, which also discusses the validity of this analysis. Finally, there is a need for a more detailed and advanced study in Phase II in collaboration with the other teams.

3.2 Background on sustainable purchasing

Sustainable purchasing is fast becoming the norm in higher education and in other sectors of society. Sixty-one percent of 1,068 U.S. campuses surveyed in 2008 said they had programs to encourage environmentally friendly or sustainable purchasing and sixty five percent of respondents said they had plans to do more in this regard [11]. Further, roughly ninety percent of respondents to a 2006 survey of professionals involved in facilities purchasing decisions at 470 institutions of higher education said they "take sustainability into account in deciding upon new products and equipment" [12]. This study concluded that implementing sustainability "will likely become a requirement for institutions desiring to be in the mainstream of higher education" [13].

Attention to in sustainable purchasing is not limited to colleges and universities. The National Association of State Procurement Officials and the Responsible Purchasing Network surveyed directors of central purchasing offices for each of the 50 US states and the District of Columbia and found that 2 out of 3 respondents have some form of a responsible purchasing policy, seventy percent of which are formal policies. Sixty-six percent of the states that do not have any sort of responsible purchasing policy expect to adopt one soon. Survey responses also indicate that eighty-six percent of respondents will engage in more responsible purchasing in the next 2 years [12].

3.2.1 Common sustainable purchasing strategies from other schools

This section summarizes the most common strategies that campuses are taking to advance sustainable purchasing.

<u>Sustainable purchasing policies</u>
Formal sustainability purchasing policies are increasingly common in higher education. A third of the 332 colleges and universities evaluated in the *2010 College Sustainability Report Card* reported having a formal green purchasing policy [14]. Likewise, twenty-four percent of the 101 institutions that responded to a 2009 survey from the National Association of Educational Procurement (NAEP) said they had formal green procurement policies [15].

These policies vary quite widely in their scope and level of detail, but generally they state the institution's goals in relation to sustainable purchasing and provide guidelines or requirements for purchasing environmentally preferable products (Appendix 8.3). Enforcement of such policies can be a challenge given the decentralized nature of purchasing on most campuses

<u>Purchaser education and outreach</u>
Since purchasing decisions are often decentralized at higher education institutions, many campuses are also engaged in efforts to educate purchasers and encourage them to purchase environmentally preferable options. This can take many different forms ranging from offering periodic training workshops for key purchasers such as office managers and administrative assistants to promoting green products and/or the vendors who sell them in online procurement systems to distributing green purchasing guides.

Institutional structures

To strengthen sustainable purchasing efforts and to improve the consistency of such efforts over time, leading institutions have created institutional structures around sustainable purchasing. Some institutions have staff positions dedicated to sustainable purchasing while others form a task force or committee comprised of faculty, students, and staff.

Purchasing Consortiums

In an attempt to secure lower prices for environmentally preferable products, some institutions are pooling their purchasing power with other entities interested in purchasing such products.

3.2.2 Targeted product categories

This section briefly describes the major project categories in which other campuses are focusing their sustainable procurement efforts.

Appliances

Appliances consume energy during their use and are often comprised of toxic and/or rare materials, meaning that their production and disposal can have significant negative environmental consequences. Many sustainable procurement policies require purchase of EnergyStar certified appliances when they are available. Additionally, a small but growing number of institutions require that all computers meet a certain level of performance as measured by the Electronic Product Environmental Assessment Tool (EPEAT).

Cleaning Products

Many cleaning products contain toxic substances and/or contribute to indoor environmental quality problems that inhibit learning and reduce productivity. As a result, many institutions are transitioning to Green Seal or EcoLogo certified products.

Paper

Due to concerns about the loss of forest habitat and the pollution created by paper production, paper consumption is a major area of focus for many campuses. These campuses have set minimum standards for the use of recycled post-consumer waste in their paper purchases and some also give preference to chlorine free and/or tree-free papers. Thirty percent postconsumer waste recycled paper appears to be the most common standard, but a significant number of institutions now require 100 percent postconsumer waste recycled copy paper [16].

3.3 Sustainable procurement initiatives at the University of Michigan

U-M spent over $1.7 billion on supplies and services in fiscal year 2009 [1]. Although it does not have a formal sustainable purchasing policy or an institutional structure devoted to sustainable purchasing, U-M does have several initiatives and programs in place to address the environmental and social implications of the University's purchases.

3.3.1 Labeling of preferred suppliers

U-M has negotiated strategic contracts with approximately 200 preferred suppliers. These suppliers provide discounted pricing and also reduce costs to University through streamlined purchasing procedures [17]. To support sustainable purchasing, Procurement Services includes on its website various labels for preferred suppliers that meet certain sustainability-related criteria:

- 75 support green purchasing products
- 101 are Michigan-based
- 18 offer Energy Star products, including 9 out of 10 suppliers in the field of audio/visual design & equipment and computer hardware, suppliers & peripherals
- 30 have products with recycled content [18].

In addition, minority-owned, woman-owned, and disabled-owned businesses are labeled. Links to a supplier's sustainability initiatives and green products sold by the supplier are also included in many suppliers' profiles.

3.3.2 M-Marketsite

U-M's online procurement system, M-Marketsite, enables University affiliates to make purchases from 43 preferred suppliers [18]. Orders through M-Marketsite can be placed electronically, eliminating paperwork, thus reducing processing costs and facilitating tracking. M-Marketsite incorporates the supplier labeling described above.

3.3.3 Climate Savers

Climate Savers Computing Initiative at UM (CSCI@UM) was a 2-year project that began in March 2008 with the goal of promoting green computing education and awareness to the entire campus [19]. Most of CSCI@UM's efforts were inducements to change behavior rather than mandated policy changes. Its Green IT Achievement Program, for example, recognizes units that have self-reported adherence to CSCI@UM's best practices. Of relevance to purchasing, one of its best practices is purchasing of green IT equipment, including EPEAT-rated computers, 100% recycled paper, and smart power-strips.

3.3.4 Vendor Code of Conduct

U-M has a Vendor Code of Conduct that establishes environmental and social standards for U-M vendors [20]. It was adopted in 2004 at the recommendation of the Task Force on Purchasing Ethics and Policies, a group of faculty, students, and staff appointed by President Coleman to codify U-M's "longstanding commitment to sound, ethical and socially responsible practices" for vendors [21]. The Code requires that vendors comply with applicable laws and also includes preferential standards for the types of vendors with whom the University will strive to do business [20]. These preferential standards, which are aspirational rather than contractual, include environmental protection, human rights, and payment of a living wage [21]. U-M was one of the first universities in the U.S. to adopt environmental and social expectations for its suppliers and is still among a relatively small number of institutions to have such expectations.

3.3.5 Annual reporting on sustainable purchasing

U-M's Annual Environmental Report currently contains data on paper and individual-sized bottled water purchasing [22]. The data on paper purchasing includes a calculation of the overall post consumer recycled content of the University's total paper purchase [22].

3.4 Background on waste minimization

3.4.1 Common waste minimization strategies from other schools

Composting is one method that other universities have successfully employed to minimize the amount of waste that is sent to a landfill. University composting can take a variety of forms, from pervasive pre and post-consumer food composting at the dining facilities of Northeastern University, to successful paper towel and yard waste collection programs at University of California-Berkeley. The waste reduction gains from composting programs can be substantial: UC Berkeley, for example, diverts over 50% as much waste through composting as it does through its more traditional recycling program.

Additionally, increased recycling rates can result from a single campus-wide recycling bin placement plan. Common features at other institutions include comingling recycling receptacles with all trash cans within buildings around campus, placing single use recycling containers in strategic locations (e.g. exclusively having paper recycling bins near printing stations and other high-volume paper use areas), and consistent and obvious branding of recycling containers so that they are easily identifiable.[*]

3.4.2 University of Michigan and peer institutions

While achieving zero waste production is impossible in the current U-M purchasing and recycling regime, reaching a high recycling/diversion rate relative to peer institutions is an obtainable objective. A comparison of U-M's recycling statistics[†] to those of peer institutions, helps identify both recycling growth targets at U-M and high-performing peer schools' best practices to emulate.

U-M currently recycles 33.5% of its solid waste, which is the third highest percentage among peer top-endowment schools with readily available recycling information (Appendix 8.4). In comparison to other Big 10 Universities, U-M's total recycling rate is also third highest.

To accurately assess the data, it is benefitial to compare U-M's recycling and waste production performance to large public research institutions that have strong campus recycling programs, such as University California Berkeley, University of Minnesota – Twin Cities, and Penn State University's University Park campus (chosen in part because of the availability of detailed recycling information). Excluding waste generated by the hospital facilities, U-M's waste volume normalized by student population compares favorably with these other schools at approximately 0.24 tons of waste per student (Appendix 8.4). Using full time faculty and staff data as a normalization device yields a similar result; U-M generates 0.53 tons of waste per full time employee which is comparable to Berkeley, Minnesota, and Penn State's Waste per full time employee rates (Appendix 8.4).

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[*] See, e.g., Penn State's recycling program description: http://www.opp.psu.edu/about-opp/recycling/program-history

[†] Recycling statistics for U-M include waste from Main Campus and the hospital.

One area where U-M may be able to substantially increase its waste diversion rate is through composting. U-M's current annual compost volume is equivalent to Minnesota's, but Penn State with its robust compost program composts about 5 times more material than the other two schools (Appendix 8.4).

In addition to composting, peer schools have achieve strong recycling and diversion rates through a number of other initiatives. Most common are requiring recycling in university construction projects and strategically placing recycling containers around campus. Additionally, schools like Berkeley and Penn State have signaled their commitment to sustainability by creating ambitious long-term diversion goals and by incorporating improved recycling into University strategic plans.

3.4.3 Comparison with national recycling

In 2008, the recovery rate (percentage of total waste recycled or composted) for the United States was 33.2 percent, slightly less than U-M's recovery rate of 33.5 percent [23]. In comparison, the European Union recovery rate in 2006 was 44 percent, and some EU countries accomplished much higher rates [24]. Denmark, Poland, and Belgium all recovered around 80 percent of their waste in 2006 due to their aggressive policies and culture of environmentalism.

3.5 Waste Minimization at the University of Michigan

Multiple efforts are ongoing for waste management at University of Michigan. We present here the main actions and structures involved, grouping them according to the main programs and actors involved.

3.5.1 Waste Management Services and the Recycling Program

U-M's Recycling Program is a collaborative effort with the City of Ann Arbor's Material Recovery Facility. The facility is currently on a dual-stream recycling system, with all paper products recycled in one bin or dumpster and all accepted containers in a separate bin or dumpster. Examples of accepted recyclables consist of:

- Mixed paper, cardboard, and pressboard
- Glass and ceramics
- Cartons, cans, aerosols,
- Scrap metal
- Bottle-shaped #1-2 plastics
- Non-bottle-shaped #1-2 plastics and #3-7 plastics are not recyclable.

The Recycling Program controls the type and quantity of recycling bins located in all buildings on campus by performing evaluations in all large buildings and responding to requests for additional bins from faculty and staff. In the future, the City of Ann Arbor will be switching to single-stream recycling, which will allow all recyclables to be placed in one container. In addition, this will expand the plastics that are acceptable for recycling to #1-7 except for #3. The Recycling Program will also accept the additional recyclables and will replace their bins across the campus to facilitate participation in single-stream recycling.

The U-M Waste Management Services (WMS) has several campus operations which service University departments and dormitories:

- Polystyrene is picked up from laboratories across campus to be recycled through Dart Container Corporation.
- Pipette tip boxes are recycled from laboratories in a partnership with WMS and Fisher Scientific
- Electronic media recycling bins, for products such as CDs, floppy discs and micro-fiche, are located in some buildings and departments.
- Inkjet and toner cartridges can also be recycled through WMS

WMS also facilitates an Office Supply Reuse Program. This program accepts gently-used office supplies from departments and individuals who no longer need them. Other departments can then pick up these supplies without charge as a way to reduce consumption and cost for the University. Although the goal of this project to encourage waste reduction, few departments take advantage of this free merchandise.

To encourage student and faculty recycling and waste reduction, WMS participates in a number of special events on campus. The most prominent activity is RecycleMania. RecycleMania is an international recycling competition between college campuses, based on the amount of recyclables per capita, the amount of total recyclables, the least amount of trash per capita, and highest recycling rate. This competition is directed toward students by placing posters in dormitory recycling closets, banners on campus and flyers in the dining halls. WMS also organizes an intra-university competition called Recycling Champions, which runs concurrently with RecycleMania and pits buildings against each other. This competition targets faculty and staff and encourages “Green Clean Days,” department-wide office cleaning events.

Other events on campus include Student Move-In, where recyclable boxes and Styrofoam are collected, and Student Move-Out, where clothes and household items are donated to local non-profits. Stadium Recycling is also a major activity for WMS, where bottles and cardboard from vendors are collected to be recycled. The average recycling rate for football games last year was 20 % [25]. This percentage is lower than actual level of recycling because many bottles are brought home to retrieve the $0.10 deposit.

3.5.2 Occupational Safety & Environmental Health (OSEH)

OSEH is comprised of ten different departments, ranging from Environmental Protection & Permitting to Diving Safety. OSEH handles the collection and proper disposal of chemical, radioactive, and biological waste, including fluorescent light bulbs, solvents, and paint. OSEH also manages battery disposal and electronic waste recycling. Some offices and buildings on campus have battery, bulb and electronic waste-collection bins located on premises and are picked up regularly by this department, as well as bins on every dormitory dock.

3.5.3 Property Disposition

Property Disposition is the university department that regulates the property that has been purchased by the University and is no longer being used. All items “with value” owned by the University must go to Property Disposition, even if the product is not working. This includes computer monitors, CPU's, TV's, and anything with a circuit board, as well as all items with a digital display. Once determined as broken, these items are given to OSEH. Also, all furniture and equipment must be sent to Property Disposition after an office moves or is remodeled. Property Disposition is then able to sell any items back to a different University Department or to the public. Revenue from these sales totals over one million dollars annually. Any broken electronics are given to OSEH and disposed of properly.

3.5.4 University of Michigan Health Systems (UMHS) Recycling

UMHS recycling is handled separately from that of the rest of the University and is not covered by the WMS Recycling Program. UMHS's waste management has won various awards in recent years for efficient waste management in the hospital setting. Bins for recycling, general waste and hazardous waste are available in offices, hallways and medical rooms. Proper sorting of waste is a big challenges for UMHS. Doctors, nurses and staff sometimes place general waste into the hazardous/biomedical waste bins, which are lined with special bags and processed separately. This increases both costs and energy consumption for UMHS.

The separation of waste management activities between the Health System and the rest of campus does create some inefficiency. For example, employees, especially those who work at the hospital and teach within university buildings, do not always know who to contact when they are in need of addition bins or have questions about recycling.

3.5.5 Student Groups

Several student groups are active in waste minimization efforts:

- Michigan STudents Advocating Recycling (MSTAR) is focused on promoting awareness and the usage of both on and off campus recycling resources through exposure to the city's recycling infrastructure and education about materials that are recyclable.
- Student Book Exchange (SBE) provides students an alternative to shopping for and selling books at bookstores. This provides a valuable service to the campus community by keeping valuable products in circulation and reducing the sale of new books.
- Green Greeks encourages sororities and fraternities on campus to increase their recycling efforts and to decrease energy, water and food waste. One of its goals is a 30% reduction in total trash that ends up in dumpsters.

4 CHALLENGES AND OPPORTUNITIES

This section describes the challenges and opportunities that U-M faces in its sustainable purchasing and recycling efforts.

4.1 Purchasing Challenges

- *Decentralized purchasing* – Thousands of individuals across campus make purchases on behalf of U-M. The decentralized nature of purchasing at U-M limits the University's ability to encourage the purchase of socially or environmentally preferable products. It also reduces U-M's ability to negotiate volume discounts and makes it difficult to track the University's total purchases of preferable products. Furthermore, decentralized purchasing may result in excessive shipments, which could be potentially be avoided by greater coordination.

- *Difficulty in determining which products are preferable* – The market for environmentally and socially preferable products is rapidly growing and evolving, which can make it hard for even the most motivated purchasers to determine which products they should buy. This challenge is compounded by the many competing green claims from product manufacturers. Product certification systems such as EPEAT and Green Seal can help overcome this problem, but it is often difficult to know which certification systems to trust.

- *Higher prices for some green products* – There is a price premium associated with some green products and even products that save money over the long term often have higher initial costs. These price premiums may discourage purchasers from buying green products.

- *Disincentives for sharing* – Our research suggests that internal and external budgeting rules create incentives for spending one's complete budget so as not to be allocated less in future years. This may lead to the purchase of redundant equipment, unnecessarily increasing U-M's environmental impact.

- *Feelings of entitlement* – Some interviewees who spoke with our team suggested that many wasteful purchases may occur on campus due to feelings of entitlement on the part of many campus employees. For example, several people suggested that many campus purchasers have developed a general habit of ordering items to be delivered by next-day air, even for items that are not need immediately. Similarly, others alleged that feelings of entitlement had led some employees to order individual inkjet printers for their offices.

- *Negative past experiences with duplex printing* – While a number of other institutions as well as some U-M units, such as the Law School, at U-M have been able to reduce paper consumption through increased use of duplex printing, U-M's Information and Technology Services (ITS) has had negative experiences with duplex printing. Specifically, ITS has found that duplex printing increases the jam rate by 200-500 percent and takes longer, thus increasing the number of abandoned print jobs.

4.2 Purchasing Opportunities

- *Supportive and knowledgeable students and faculty* – The U-M faculty includes some leading thinkers in fields relevant to sustainable purchasing, such as lifecycle assessment. There is also great deal of knowledge and interest in sustainable purchasing issues among the student body. This deep knowledge base is a valuable resource that U-M can leverage in its efforts to advance sustainable purchasing.

- *Potential cost savings from sustainable purchasing* – Many sustainable purchasing strategies can save money. For example, reducing unnecessary purchases saves money as can purchasing more efficient appliances. In addition, greater centralization of purchasing would enable U-M to negotiate better prices with suppliers. These savings could be used to help cover the higher prices of some greener products.

- *M-Marketsite* – M-Marketsite provides an important foundation for improving the sustainability of the University's purchases. Beyond the current supplier labels, the system could potentially be used to provide more detailed guidance to purchasers. The consolidation of purchasing provided by M-Marketsite provides the University more leverage to secure discounted prices, including on environmentally and socially preferable products, and enables better data tracking. Online ordering also potentially facilitates greater consolidation of deliveries to campus. While M-Marketsite is already fairly well-used for some suppliers, there is substantial opportunity to shift more purchases to this system.

- *Area with high potential for improvement*– Based on the I/O ranking discussed in Section 3.1, the U-M has an initial screening tool that can be used to target policy changes to domains that can yield high return for investment. The subcategories identified in this analysis yield about 30 categories with spending greater than $10 million. Changes in purchasing should be directed towards those categories with high spending, significant environmental impact, and large potential for improvement.

- *Vendor Code of Conduct* – U-M's pioneering Vendor Code of Conduct is a national model for responsible vendor selection and provides a valuable starting point for the development of a comprehensive sustainable purchasing policy that also incorporates product-level standards.

- *External rating systems* – STARS, the Sustainability Tracking Assessment and Rating System, is a new self-reporting framework for gauging relative progress toward sustainability for colleges and universities (see Appendix 8.5 for a sample of such rating systems). Over 130 campuses - including four Big Ten schools and other leading research universities like Duke, ULCA, and UNC - have already registered. Participation in this program would enhance U-M's ability to benchmark with peers and communicate its successes on sustainable purchasing as well as many other dimensions of sustainability.

4.3 Waste Minimization Challenges

- *Difficulty collecting and tracking waste data* – The University does not have centralized monitoring of many waste products. For instance, the current system allows individual departments to independently contract with paper shredders, causing inconsistent data on how much paper is being recycled. Also, the waste from the University of Michigan Health Services and Construction Services are handled separately from general waste management services.

- *Insufficient infrastructure to support reuse* – Limited by budget, storage space, and transportation issues, the Property Disposition Office cannot reach its full potential. Departments are reluctant to buy useable items from the Property Disposition mostly due to the difficulties and cost of transportation. As a result, some items that could still be used end up being recycled or landfilled.

- *Difficulty reducing waste at sporting events* – U-M sporting events typically generate large amounts of waste. Since many of the hundreds of thousands of fans are not formally affiliated with the University and are only on campus for a short period of time, it is difficult to educate them about proper means of waste disposal. This issue is exacerbated by the fact that vendor contracts do not require use of recyclable or minimal packaging.

- *Lack of collaboration between different departments with responsibility for waste management* – The University has three separate departments within Grounds & Waste Management that are charged with handling waste: WMS, OSEH, and Property Disposition. This system sometimes creates confusion among university departments and the U-M community at large about which department handles which recycling and reuse programs. For example, working electronic products are supposed to go to Property Disposition for resale while non-working items to OSEH. Similarly, gently-used office supplies can be found in both WMS and Property Disposition. This confusion leads to inefficiency during the retention and dispersion of reused property. If these groups could collaborate, people would be able find items more readily and take advantage of the University resources.

4.4 Waste Minimization Opportunities

- *Transition from cardboard to plastic shipping boxes* – U-M is participating in a new program with Office Max in which items will be delivered to campus in reusable plastic shipping box instead of cardboard boxes. Office Max will then pick up the boxes for reuse when they make their delivery. This program has the potential to significantly reduce packaging waste. If it is successful, U-M could pursue similar programs with other vendors.

- *Property Disposition* – There seem to be several potential opportunities for improving the efficiency of U-M's property reuse system. One option that seems promising is expanding Property Disposition's scope to support the organization of onsite interdepartmental exchanges. This would reduce transportation to and from Property Disposition's warehouse and could improve convenience for customers. These onsite sales could also make Property Disposition more visible to the campus and community. Additionally, improving the recently started online selling efforts and advertising more widely to the University and Ann Arbor could increase the sales to public.

- *Eco-Reps program and other educational venues* – The new Eco-Reps program, which is intended to promote sustainability in the residence halls, provides a valuable new opportunity for educating residents about recycling. New student and new employee orientations are also good opportunities for educating the campus community about recycling.

- *"Zero waste" sporting events* – Because so many people attend sporting events and sporting events play a large role in shaping campus culture, they provide a highly visible platform for the University to demonstrate its commitment to waste minimization and raise awareness about appropriate sorting of waste. The "zero-waste" tailgate hosted by the U-M Alumni Association in Fall 2009 and the zero-waste basketball game planned for Fall 2010 are important steps in this direction that could potentially be expanded.

- *Integration of the waste stream between WMS, OSEH and Property Disposition* – There is potential to improve the tracking of items, ensure proper disposal, and reduce transportation costs and environmental impacts.

5 PRIORITIZED RECOMMENDATIONS/POLICY OPTIONS

The following section describes the five most important recommendations considered by the Purchasing and Waste team. Each recommendation is accompanied by further detail and suggestions for implementation.

5.1 Institutionalize sustainable purchasing by adopting a sustainable purchasing policy and creating institutional structures to support implementation of this policy.

To realize the potential environmental, social and financial gains from sustainable purchasing, we believe U-M must adopt comprehensive a comprehensive sustainable purchasing policy and create mechanisms to ensure effective implementation of the policy. Based on our analysis of sustainable purchasing policies at other institutions and our meetings with U-M procurement staff, we believe the optimal model would combine a high-level policy statement with more specific and detailed purchasing guidelines that could be updated fairly rapidly in response to new information.

Specifically, the proposed policy would include the following components:

- A statement of U-M's high-level sustainable purchasing goals; e.g. "In an effort to save costs and improve the environmental and social impacts of the University's purchases, U-M aims to eliminate unnecessary purchases and purchase products with the best environmental and social impact (as determined through analysis that examines the entire lifecycle impact of the product).
- A general list of preferred attributes for U-M purchases (e.g. minimally packaged, locally produced, energy efficient, comprised of post-consumer recycled materials, durable, biodegradable, etc) and references the U-M Sustainable Purchasing Guidelines for more specific guidance.
- An explanation of the conditions under which U-M is willing to accept higher initial costs for products that save money over time; e.g. the policy might say that U-M is generally willing to pay more for products with a since payback period of less than 10 years.
- An accepted price premium for more sustainable products; e.g. the policy could say that U-M is generally willing to pay up to a five percent over the cost of conventional products for more sustainable alternatives.
- Preferential standards related to the environmental and social performance of U-M suppliers; the existing Vendor Code of Conduct provides these already and incorporating the Code into a broader policy seems most sensible.
- A requirement to reference the policy in all U-M RFPs and bidding specifications.
- The establishment of multi-stakeholder Sustainable Purchasing Committee to aid in the application and implementation of the policy, as described below.

We believe the proposed Sustainable Purchasing Committee is essential to success of U-M's sustainable purchasing efforts over the long term. The Committee would serve a number of important functions:

- Developing and maintaining the Sustainable Purchasing Guidelines that translate the high-level Policy into more specific requirements for U-M purchases; for example, the Guidelines might specify that all new computer purchases should meet or exceed EPEAT Silver standards or it might even provide a list of "approved" computers.

- Monitoring the sustainable products marketplace and evaluating opportunities to improve the sustainability of U-M's purchases.
- Coordinating trial experiments with relevant departments to determine the most efficient products and/or to assess whether a new product will meet U-M's needs.
- Creating and overseeing implementation of a sustainable purchasing training program and other efforts to educate campus purchasers about the Sustainable Purchasing Policy and Guidelines.
- Developing metrics for measuring and reporting performance on sustainable purchasing and assisting in creation of mechanisms to track such metrics.

The quantitative assessment presented in the first section of this report could inform the Committee's work by enabling it to focus on areas generating large impacts and for which the improvement potential is high.

To be most effective and to capitalize on the knowledge and enthusiasm of faculty and students, the proposed Committee should include faculty, students and staff. This will also help ensure that members of the major stakeholder groups feel represented on the Committee.

This proposed approach to institutionalizing sustainable purchasing combines innovative practices from many other institutions. We believe the structure proposed here, if implemented, would be the most comprehensive and effective approach to sustainable purchasing in higher education and could quickly establish U-M as a leader on this issue.

Implementation
The next step to put the proposed policy in place would be to form a task force to draft the policy. After the policy has been adopted, this Task Force could become the first members of the Sustainable Purchasing Committee.

5.2 Centralize purchasing so as to enhance the U-M's ability to negotiate with suppliers for green products and to coordinate efficient deliveries.

To effectively implement a sustainable purchasing policy, as discussed in recommendation 5.1, we strongly favor the extension of M-Marketsite into a institution-wide centralized purchasing platform. The financial, environmental, and social benefits offered by a system such as M-Marketsite are clear. KPMG Global Sustainability Services argues that sustainable procurement can be accomplished only when changes are made at the strategic, tactical, and operational levels of an organization [26]. All three levels are necessary for effective implementation, and centralization of purchasing is a critical component of the tactical level. As an additional incentive, M-Marketsite will still allows users a wide degree of autonomy, which is crucial in at the U-M, which has traditionally favored a rather decentralized purchasing system.

Centralized purchasing will allow the U-M to purchase green products at competitive prices.

- In the recent past, price premiums for green products have often made it cost-prohibitive to switch to those products. For example, a survey of industrial attendees to a green purchasing summit noted that "[f]ar from realizing any spinoff benefits in terms of reduced operating costs, one of the primary barriers to adoption [of sustainable purchasing policies] is the cost of implementing environmentally friendly purchasing practices" [27].

- To some degree, however, these price differences have become less and less a hindrance to sustainable purchasing, though the perception of price differences persists [28].
- When green products are marginally more expensive, centralization of purchasing can lead to volume discounts, thus eliminating price premiums [28,29].
  - E.g., Princeton University was able to switch to a university-wide policy mandating 100% recycled paper after centralizing purchasing to increase volume, giving Princeton leverage to negotiate with Boise Office Solutions (now Office Max, one of U-M's strategic suppliers) to reduce the cost and improve the quality of recycled paper [30]. As a result of these negotiations, there was a negligible cost – and sometimes a cost savings – to make the switch to 100% recycled paper.
- It should be noted that volume discounts could ratchet down prices for both green and conventional products, thus preserving a price difference. However, this team feels that the benefits of switching to sustainable products outweighs this cost difference, provided there is no cost increase to U-M.

All U-M users should be required to purchase sustainable products when they are available.

- Green products may already be cost-effective, for a sustainable product is often an efficient one. Rather than taking only the initial cost of product purchase into account, considering the total cost of ownership (TCO) can show the economic benefit of purchasing a sustainable product[26]. Although TCO has traditionally been used for purchase of capital goods, it can also be used for other goods (e.g., the disposal cost of a green product may be lower than that of cheaper conventional product).
  - E.g,. this team has estimated that a high-volume, multi-function printer can do the work of many smaller printers at one quarter the cost per page of an inkjet and one third the cost of a laserjet printer.
- At a green purchasing conference, 24% of survey respondents indicated that they did receive some cost reduction as result of green purchasing[27].

A centralized purchasing system will also allow U-M to improve delivery efficiency.

- The easy availability of on-demand ordering and delivery creates an inefficient system, in which delivery trucks are forced to make runs whether or not they are full.
- If deliveries happen less frequently, i.e., with only full or near-full trucks, efficiency is maximized and cost, traffic congestion, CO_2 emissions, as well as other impacts, are minimized.
  - E.g., U-M Procurement has initiated a restricted delivery project with OfficeMax in which deliveries to U-M are made only 4 days per week. It has been estimated that this policy has reduced delivery vehicle miles traveled by nearly 24,000 miles/year, and has also reduced delivery surcharges [31]. Furthermore, if orders were batched (i.e., to prevent placement of orders less than $50, which are currently 44% of all orders), the Procurement office estimates a savings of over 31,000 delivery vehicle miles/year. If this policy were expanded to reduce the number of delivery days further, and mandatory order consolidation were implemented, the U-M could realize substantial cost and environmental impact reduction.

  - Restricted delivery does require a behavioral change, as users must plan ahead to make sure they have necessary supplies on hand. For non-perishable goods, this is not a difficult adjustment.

Centralized purchasing facilitates data collection, a crucial component for sustainability.

- In order to make sure that financial or sustainability goals are being met, progress towards those goals must be tracked [26]. Therefore, data on traceable sustainability metrics (e.g., purchase volume of EPEAT-certified computers) must be collected. Such data collection is vastly easier with a centralized purchasing system, which facilitates transparency [29].

To elect to maintain the current decentralized purchasing system will have the following repercussions:

- Impede institution-wide adoption of policies of the purchasing task force, thus prevent the U-M from taking a national leadership role in sustainability.
- Make it difficult for well-intentioned U-M faculty, staff, and students to reduce the environmental impact of their purchases
- Allow unnecessary daily deliveries to continue.
- Prevent consistent and thorough purchasing data collection.

Implementation

- Faculty, staff, and students with the authority to make U-M purchases must be required to use M-Marketsite (provided that M-Marketsite vendors carry the necessary products). The purchasing team believes loss of some flexibility is well-worth the financial savings and potential sustainability improvements.
- As purchasing volume of certain products increases, the procurement office may begin to negotiate volume discounts on these products.
- If a phased implementation is necessary, products and domains with clear opportunities for improvement (e.g., recycled paper, multi-function copiers) should be selected first.
- As volume permits, the U-M Procurement office should add more suppliers to the restricted delivery day program, as well as expand the number of non-delivery days.

5.3 Improve efficiency and profitability of the Re-use/Property Disposition system by reducing transport and increasing re-sale of goods.

Currently, Property Disposition's ability to efficiently resell goods is limited by transportation costs, limited storage, and budgeting constraints. Increasing the amount of department-department transfers of equipment (e.g., through a web-based interface), increasing resale from Property Disposition (via increased advertising), enabling low-price on-site sale (thus reducing transportation costs), and facilitating donation of goods would be profitable and increase re-use of goods, to the benefit of the University.

Property Disposition is a great venue to encourage reuse and waste reduction within the University system. There is the potential for university offices, departments and buildings to reduce their environmental footprint and save money by using Property Disposition. Unfortunately, this resource does not reach its full potential for a number of reasons.

- The cost to transport the items from Property Disposition to central campus is expensive; often outweighing any cost savings that are attributed to buying a used item. For instance, a filing cabinet can be purchased from Property Disposition for the reasonable price of $40.00. To transport this filing cabinet to a central campus office, it will require the use of the University Moving and Trucking services. An estimate for the price of this move – for one cabinet and only one hour's work – was $90.00. This brings the total purchase cost to $130.00 – a sum that can be beat by our strategic suppliers for a new piece of equipment.
- The relatively high cost of transport causes the costs of reuse to outweigh any benefit for most departments in the University. If this cost can be mitigated, the reuse program within the university has the potential to be much more successful.
- The Property Disposition building itself is also a hindrance to the success of the program. Its location on North Campus, far from most University workers, can be a deterrent to possible customers. Moreover, there is limited storage in the facility. This constraint causes items to be forced to turn over – through scrap metal recycling – more quickly. The limited budget and workforce of the Property Disposition means that the staff does not have the resources to facilitate greater utility of this group.

To increase the effectiveness of Property Disposition, there are a number of improvements that can be made.

- When departments move or close, Property Disposition can facilitate department-department transfers of equipment. This can be performed to web-based interfaces similar to that of Craig’s List or the University of Michigan Health System's mBay. By transferring property from on building directly to another, the interface will reduce the transportation costs and emissions of shipping items from an office, to Property Disposition and to another office or for scrap metal recycling.
- Another outlet to encourage property reuse is to increase advertising targeting both University workers and private sale. Given Property Dispositions limited budget, advertising is difficult, causing many people to be unaware of this service on campus. Advertising can be used to generate higher sales and quicker turnover.
- The current system dictates that all older metal objects (including filing cabinets, etc.) must be recycled as scrap metal because of the limited space within the Property Disposition warehouse and the income that the University earns through scrap metal recycling. Unfortunately, the price to recycle these items is quite low. An alternative would be to work with local non-profit organizations to price the items competitively. For instance, a filing cabinet could sell for $40.00 at Property Disposition and if it has not been sold, it can be recycled for only a few dollars. If Property Disposition worked with non-profits and priced the cabinet at a low price - $15.00 – then both sides would benefit greatly. By working with local non-profit groups, the University will increase its profitability, have greater inventory turnover and assist the community. An option to encourage these programs would be to have monthly auctions, where interested parties can come to buy in larger quantities and at competitive prices, as can be seen at Arizona State University [32].

5.4 Aggressively promote waste reduction and recycling, improve waste management traceability and efficiency, and improve landfill diversion rates.

Reduced landfill diversion rates is the end result of a chain of waste reduction that has financial and environmental benefits. Reduced purchasing, improved reuse of products, and increased recycling should be part of a U-M wide program to create a culture of waste minimization that could become a national model.

Creation of a culture of waste-reduction on campus

- Recognizing that many waste decisions happen on an individual level, it is recognized that these suggestions fall in the domain of the Integrated Assessment Culture team.
- The U-M should increase incentives and activities for students, faculty, and staff (e.g. Green Clean Days) to reduce consumption and increase recycling, leading to enhanced material use throughout the campus. A selection of examples follows:
    - *Printing*:
      rates could incentivize double-sided printing, and printers and photocopiers could be set to default double-sided printing. In view of the challenges noted by ITCS with respect to double-sided printing [33], further study of printing equipment is needed to ensure both reliability and parsimonious use of paper, although some departments, such as the Law School IT team, appear to have been able to satisfactorily resolve this question [34].
    - *Composting:*
      Currently, most University dining programs have functioning "pre-consumer" composting programs for food waste generated during meal preparation. The University should explore the feasibility of a campus-wide "post-consumer" system which would enable composting of leftover food scraps. The Ross School has started its own successful post-consumer composting program. This program, along with successful post-consumer programs at other Universities (e.g. Northeastern), can serve as a model for implementing campus-wide postconsumer food composting.
    - *Strategic placement and advertising of recycling containers:*
      The University's switch to single-stream recycling represents a valuable opportunity to reevaluate the placement of recycling and trash receptacles around campus. Ensuring every trash can is accompanied by a recycling container and identifying possible recycle only areas where trash cans are unavailable (e.g. around student mailboxes and printing areas) would be good steps towards improved recycling container placement. Additionally, the University should advertise features the new single-stream recycling at all recycling locations and around campus generally.

Regular waste audits and improved data collection

- The University should undertake regular audits of its various waste streams (i.e., Waste Management, UMHS, OSEH, and construction waste) in order to identify inefficiencies in the current recycling system and waste types to target for recycling initiatives. Without more detailed recording of the type and volume of waste generate by various University users, it is difficult to identify the areas of the waste reduction and recycling strategies that are most likely to yield the largest decrease in waste the University generates.

Management of additional waste streams

- Data for paper recycling is limited because shredded paper is not tracked well. Althoug the U-M has a contract for paper shredding, many departments use other independent contractors
- Waste generated by University construction projects does not go through Waste Management collection and processing and is typically disposed of by contractors. Consequently, the university's waste and recycling statistics do not reflect waste generated by construction projects. Performing waste audits of current campus construction projects will help the University determine which portions of construction projects generate the most potentially recyclable materials. Integrating robust construction waste reduction and recycling schemes into the initial planning stages of new construction projects is an important step in order to divert waste from these projects away from the landfill.

5.5 Recommendations for Further Study in Phase II

5.5.1 Conduct a full Life Cycle Assessment and footprint of the University of Michigan

This recommendation involves all components of the Integrated Assessment, and thus will require the input of all other Integrated Assessment teams. We recommend extending the purchasing Input/Output Life Cycle Analysis presented here in order to evaluate the overall impacts of University of Michigan in more detail. Areas of special focus are energy, transportation, food, and land use, all to be conducted in collaboration with the respective Integrated Assessment teams.

This approach will yield a sound basis to analyze and evaluate the potential for the environmental benefits of individual actions proposed in the university-wide integrated assessment.

Implementation steps include the following:
Phase II

- Preparation of the life cycle assessment framework, including definition of boundaries and of impact categories (energy, carbon footprint, human health, resources, ecosystems)
- Definition of data needed in particular in collaboration with transportation, energy, building and land use groups
- Data collection (starting from the U of M environmental report when possible)
- Integration of all impacts and analysis of the footprint
- Production of a U of M environmental footprint paper

Phase III

- Evaluation of individual recommendations presented in Phase II, to assess their impact reduction potential. For each analysis, the above steps would be repeated.

5.5.2 Sharing of equipment and resources

The preliminary input/output analysis presented in Section 3.1 shows that many physical goods and equipment, such as furniture and lab supplies are important contributors to the U-M's environmental impacts. One of the most fruitful ways to address this sector is to explore options for sharing of equipment and resources.

In Phase II, we suggest defining methods by which equipment purchase can be reduced through budgeting flexibility and promotion of shared resources.

- Our understanding is that both internal and external budgeting rules may create incentives for spending as much as possible, as users are penalized for unused funds. This may lead, for example, to the purchase of redundant equipment. If there were more flexibility in budgeting, users could save funds over time, or use funds for non-equipment expenses, such as hiring researchers. Our understanding is also that cost sharing support by DRDA is mostly focused on equipment. A policy and incentives for diversified support (salary or equipment) and sharing equipment (e.g. preferential DRDA support) could lead to a reduction in equipment purchase.
- In Phase II, a series of interviews with high-level DRDA staff are planned; this information-gathering will allow the Purchasing team to determine the extent to which funding structure influences user behavior, and whether there is the potential to change the existing structure.

6 PURCHASING AND RECYCLING TEAM

The Purchasing and Recycling Team brings a diversity of academic disciplines and experiences to the University of Michigan Campus Sustainability Integrated Assessment. The team is headed by faculty member Olivier Jolliet and is composed of undergraduate and graduate students with expertise and experience in purchasing and waste management in higher education, economics, natural resources, business, law, and engineering.

Faculty Lead:
Olivier Jolliet, PhD

Team Members:
Amy Braun
Julian Dautremont-Smith
Nicole Flores
Andrew Henderson
Dingsheng Li
Edward Schexnayder
Jessica Ruff

Culture Team Liaison:
Courtney Doman

Amy Braun is currently pursuing her Master of Science in Environmental Policy at the University of Michigan School of Natural Resources and the Environment. In 2008, she received a BS from the University of Michigan in the Program in the Environment, with a minor in Global Change. Amy has interned with the University of Michigan's Waste Management Services, as well as Ford Motor Company and Novelis, an automotive supplier. Her work within the University system has helped the Purchasing and Recycling team better understand the current state of the campus sustainability.

Julian Dautremont-Smith is graduate student in the Erb Institute for Global Sustainable Enterprise's dual MBA/MS in Natural Resources and the Environmental program. Prior to enrolling at University of Michigan, Julian co-founded the Association for the Advancement of Sustainability in Higher Education (AASHE) and served as the organization's Associate Director from November 2004 to August 2009. In that capacity, he played leadership roles in AASHE's major programs, the American College & University Presidents Climate Commitment and the Sustainability Tracking, Assessment & Rating System (STARS). He was also responsible for AASHE's online resource center, partnerships, communications, and publications. Before working at AASHE, he co-founded a social enterprise that produces biodiesel in Barbados while studying there on a Fulbright Scholarship. Julian earned a BA in Environmental Studies from Lewis & Clark College, where he spearheaded a nationally recognized effort to make Lewis & Clark the first American college to declare compliance with greenhouse gas emissions reductions stipulated in the Kyoto Protocol. Julian is also a Harry S. Truman Scholar, a Doris Duke Conservation Fellow, and a USA Today Academic All-Star.

Nicole Flores will be receiving a BA in Economics and Environmental Studies with a focus in Sustainable Development from the University of Michigan in Fall 2010. She is involved with several community service organizations on campus, including the Detroit Partnership, Serve, and Youth Hope Organization. Additionally, Nicole has experience working with a Health and Environmental Justice organization as well as a Community Health center in Detroit.

Andrew Henderson is currently a research fellow in the Impact and Risk Modeling group in the Department of Environmental Health Sciences at the School of Public Health at the University of Michigan. Hreceived a BA in Physics from Williams College in 1999, a M.S. in Environmental Engineering from the University of Texas at Austin in 2003, and a Ph.D. in Environmental Engineering from the University of Michigan in 2010.

Dingsheng Li received his Bachelor of Science degree in Environmental Science from Nanjing University, China in 2009 and is now studying for his PhD degree in Environmental Health Science at the School of Public Health, University of Michigan. His works in Nanjing University focused on laboratory experimental studies on ecotoxicology and now he is studying Life Cycle Assessment. Dingsheng recently received a Summer Fellowship from the Risk Science Center, University of Michigan.

Edward Schexnayder is in his third year of a dual Master of Public Policy and Juris Doctor program at the University of Michigan. In these schools, he is focusing on environmental policy and cooperative federalism regulatory programs. He graduated from Macalester College in 2005 with a Bachelor of Arts in History. Prior to working with the Graham Institute, he founded workplace and student sustainability groups focused on waste reduction.

Jessica Ruff is working towards undergraduate degrees in Spanish and the SNRE Program in the Environment. She is in the leadership of ENACT (Environmental Action), the U-M’s oldest environmental student organization.

7 LITERATURE CITED

[1] Kim, G (U-M Procurement Services). 2010 email to Purchasing and Recycling Team, .

[2] Stanford University Buldings and Grounds Maintenance. The 5R Recycling program [Internet]. Stanford (CA): Stanford University; c2000 [cited 2010 May 20]. Available from:http://recycling.stanford.edu/5r/index.html.

[3] EcoRecycle Victoria. Sustainability and the Waste Management Hierarchy [report on the Internet, by Gertsakis J and Lewis H]. Melbourne, Australia: EcoRecycle Victoria; 2003 [cited 2010 May 20]; [340K bytes]. Available from: http://www.cfd.rmit.edu.au/programs/sustainable_products_and_packaging/sustainability_and_the_waste_management_hierarchy

[4] Yale University Program on Solid Waste. Does the Solid Waste Management Hierarchy Make Sense? A Technical, Economic and Environmental Justification for the Priority of Source Reduction and Recycling; Yale Univ Program on Solid Waste Policy Working Paper No. 1 [report on the Internet, by Schall, J]. New Haven (CT): Yale University 1992 [cited 2010 May 20]. Available from: http://www.yale.edu/pswp/#schall

[5] UC Berkeley Climate Action Partnership. Feasibility Study 2006- 2007: Final Report for UC Berkeley Climate Action Partnership [report on the internet, by Ahmed, F]. Berkeley (CA): University of California – Berkeley; 2009 [cited 2010 May 20]. Available from: http://calcap.berkeley.edu

[6] Ackerman, F. Tufts Recycles [Internet]. Medford (MA): Tufts University; c2009. Waste, Recycling, and Climate Change [cited 2010 May 20]; [about 10 screens]. Available from: http://www.tufts.edu/tuftsrecycles/energy.html

[7] Miami University Physical Facilities [Internet]. Oxford (OH): Miami University; c2008 [cited 2010 Jun 25]. Available from: http://www.pfd.muohio.edu/recycling/atmiami/history.jsp

[8] Miller RE, Blair, PD. Input-Output analysis : foundations and extensions. Englewood Cliffs, New Jersey: Prentice-Hall; 1985.

[9] Suh S, Lenzen M, Treloar G, Hondo H, Horvath A, Huppes G, Jolliet O, Klann U, Krewitt W, Moriguchi Y, Munksgaard J, Norris G. System boundary selection in life-cycle inventories using hybrid approaches. Environ. Sci. Technol. 2004; 38 (3): 657-664.

[10] Jolliet O, Margni M, Charles R, Humbert S, Payet J, Rebitzer G, Rosenbaum R. IMPACT 2002+: A new Life Cycle Impact Assessment methodology. Int. J. Life Cycle Assess. 2003; 8(6): 324-330.

[11] McIntosh M, Gaalswyk K, Keniry LJ, Eagan DJ. Campus environment 2008: A national report card on sustainability in higher education. Reston (VA): National Wildlife Federation; 2008.

[12] Martin Akel & Associates. Institutions of higher education: A study of facilities and environmental considerations. Norwalk (CT): University Business; 2006.

[13] Responsible Purchasing Network. Responsible purchasing trends 2009: The 'state' of sustainable procurement. Takoma Park (MD): Center for a New American Dream; 2009.

[14] Sustainable Endowments Institute. College sustainability report card 2010. Cambridge (MA): Sustainable Endowments Institute; 2009.

[15] National Association of Educational Procurement. 2009 NAEP green purchasing study. Baltimore (MD): National Association of Educational Procurement; 2009.

[16] Association for the Advancement of Sustainability in Higher Education (AASHE). Paper procurement policies. Lexington (KY): Association for the Advancement of Sustainability in Higher Education (AASHE); 2010.

[17] University of Michigan Procurement Services. University contracts [Internet]. Ann Arbor (MI): University of Michigan; c2007 [cited 2010 May 4]. Available from: http://www.procurement.umich.edu/universitycontracts.html

[18] University of Michigan Procurement Services. University contracts listed by product and service categories [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2007 [cited 2010 Mar 31]. Available from: http://www.procurement.umich.edu/ucontracts_list_by_category.php

[19] University of Michigan Climate Savers [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2008 [cited 2010 Apr 15]. Available from: http://www.climatesavers.umich.edu/

[20] Code of Conduct for University of Michigan Vendors [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.vpcomm.umich.edu/pa/key/pdf/VendorCode.pdf

[21] Task Force on Purchasing Ethics and Policies. Report and Recommendations [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2004 [cited 2010 May 4]. Available from: http://www.umich.edu/pres/committees/tf_report.php

[22] Department of Occupational Safety & Environmental Health. University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html

[23] Environmental Protection Agency (US). Municipal solid waste generation, recycling, and disposal in the United States: Facts and figures for 2008. Washington, DC: Environmental Protection Agency (US); 2008 Nov. EPA Report No. EPA-530-F-009-021 [cited 2010 May 4]. Available from: http://www.epa.gov/epawaste/nonhaz/municipal/pubs/msw2008rpt.pdf

[24] European Commission. Waste Statistics [Internet]. Brussels (Belgium): The European Commission; c2010 [cited 2010 May 4]. Available from: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Waste_statistics

[25] University of Michigan Waste Management Services. RecycleMania 2010 [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2010 [cited 2010 May 31]. Available from: http://www.recycle.umich.edu/grounds/recycle/recyclemania.html

[26] KPMG Global Sustainability Services. Buying in to sustainability: Practical framework on how to implement sustainable procurement [report on the Internet, by Hoeksema E, van Bergen B]. Amsterdam (The Netherlands): 2009 [cited 2010 May 21]; [1044K bytes]. Available from http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/sustainable-insight/Documents/Sustainable-Insight-Oct-2009.pdf

[27] Eyeforprocurement. Green purchasing report [report on the Internet, by Janecka I]. San Francisco (CA): Eyeforprocurement; 2008 [cited 2010 May 21]. Available from: http://www.eyeforprocurement.com/green2008

[28] Arthur D Little, Inc. Green purchasing power: Cost reduction and revenue generation through sustainable procurement [report on the Internet]. Boston (MA): Arthur D Little; 2008 [cited 2010 May 21]. Available from: www.adl.com/sustainableprocurement

[29] KPMG Global Sustainability Services. Beyond purchasing: Next steps for the procurement profession [report on the Internet, by Graham J]. Amsterdam (The Netherlands): 2008 [cited 2010 May 21]; [4199K bytes]. Available from: http://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Pages/next-procurement-profession-O-200807.aspx

[30] Princeton's Recycled Paper Campaign [Internet]. Princeton (NJ): Greening Princeton; c2006 [cited 2010 May 20]. Available from: http://www.princeton.edu/greening/paper.html

[31] University of Michigan Procurement Services. OfficeMax Cost Avoidance Initiative [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; [cited 2010 May 22]. Available from: http://www.procurement.umich.edu/Contracts/officemax/officemax_cost_avoidance.pdf

[32] Arizona State University Surplus Property [Internet]. Tempe (AZ): Arizona Board of Regents; c2010 [cited 2010 May 29]. Available from: https://webapp3.asu.edu/spms/public.aspx

[33] University of Michigan Information and Technology Services. Duplex Printing [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2010 [cited 2010 May 2]. Available from: http://www.itd.umich.edu/sites/printing/duplex.php

[34] University of Michigan Law School. Printing Policy [Internet]. Ann Arbor (MI): The University of Michigan Law School [cited 2010 May 2]. Available from: http://www.law.umich.edu/currentstudents/informationtechnology/printing/Pages/printingpolicy.aspx

8 APPENDICES

8.1 Appendix: Questions to U-M personnel from the IA Purchasing and Waste Team

UM CSIA Purchasing and Recycling Team Questions and Data Needs

Waste-Related Questions

**Priority Questions Highlighted*

General questions to top administrative roles:

Past and current progress

In regard to waste management and property disposition, what changes have been made to address sustainability issues? How are they progressing? Where do you see room for improvement?

- What are common inefficiencies that you observe in the systems at the University? Do you have ideas about ways to address these?
- What are the present initiatives for waste reduction, either separately or in parallel with waste management/recycling?
- What is the biggest challenge in your job and/or for the University waste system?
- What does your job entail? Who and what do you have jurisdiction over?
- Have any other groups (e.g., students or outside agencies) performed sustainability assessments of your department?
- If so, which group performed the assessment? When? Were you pleased with the results, and were they feasible? If so, have they been or are they being implemented? Was the implementation successful? Is the data from this report available?
- Are you in communication with or have you conducted research about how people in your position at other Universities are addressing sustainability?
- Have you conducted recent stakeholder surveys? What were the results?

Inflows and outflows - how the current system works

Can you describe or provide us with details about the physical flow of goods in / waste out at the University?

Can one member of our IA team get access to the detailed WMS database?

Are there any key timeframe issues coming up? (E.g., contracts ending/being renewed, new policies, etc.) (We know recycling will be switching to single stream in July)

- UM collects data on some inflows, such as paper purchased. Do you have suggestions on how to obtain data on other inflows?l
- Do you have, and if so, could we have access to the data generated during the 2007 "Waste Sort"?

Budget

How much money does your department generate through sustainable practices? (Selling excess goods, selling recyclables or compost?)

How much room do you have to invest in waste reduction/recycling alternatives in your budget?

What resources would be most helpful for growing these programs?

Communication and social questions

How do faculty and staff know whom to ask about waste-related issues?

How does your department raise public awareness about waste management initiatives and recycling possibilities, and what part do you play in it?

- At what level do you envision that intervention could lead to most effective changes for waste prevention and management? (Your level, management, employees, students, faculty, etc.)

More specific questions for Waste Management:
Technical

- What is your relationship with the hospital and health services? Is this relationship confusing?
- How is construction waste dealt with?
- Are there policies or regulations in place concerning this waste?
- Are there any high-tech or innovative solutions or equipment that you know of to solve waste problems?
- Are there any developments happening right now regarding compost? (E.g., vermicomposting or anaerobic digestion)
- Can you explain the football stadium recycling / no waste initiative? How do you think this program could be improved? (Incentives for student volunteers?)

Social

- Which groups have have been most receptive to and most resistant to changes in waste-related habits (e.g., the public, students, faculty, custodial staff, grounds staff, outside vendors, office workers, other?
- How do you feel about a campus ban on plastic water bottles?
- What do you think about a "trash on the lawn" day for an important building such as the Union?
- How do you think recycling could become more convenient for the public?
- Who is the targeted audience for Recyclemania and Recycling Champions competition?

More specific questions for Property Disposition:
Technical
Could you provide us with a list and amounts of the goods you manage? From which departments are these goods coming? To whom are they going?

- What goods are easy/difficult to resell?
- Do you see a better way to circulate goods between departments at the University?

- How are the goods transported? (E.g., does your department manage vehicles?) Do you see a more efficient way to transport goods?
- What happens to the goods that cannot be resold?

Social

- How is communication with staff or faculty who have excess goods dealt with?
- To what extent is the communication efficient? Where do you see room for improvement?
- What is the process of inventory management? Do you feel that the goods you dispose of could still be used by someone? Are goods ever donated? Could education, awareness, or regulation help this?

Purchasing-related Questions
**Priority questions highlighted*

Questions about Tracking Purchases and Spending

An OCS report puts UM purchasing of supplies and services at $1.2B in FY 2009. What types of expenditures are included in this amount? Is this data collected in a database? If so, could we have access to information about details of goods purchase (e.g., differentiated into e.g., 50 to 300 types of goods/services, that we could use to link to Life Cycle databases?)

How is this information collected and aggregated? Does it exist at the departmental/school/unit level?

- Does the data include electricity costs, fuel costs, construction costs and/or furniture for new buildings?
- Which fraction of purchasing goes through channels such as M-Marketsite. Can we get data from such channels about what has been purchased?
- How are large purchases tracked? Can we tell how much is going towards sustainability-oriented products or vendors?
- Do all departments work through Procurement Services, or are some independent (e.g. do Housing, Medical Center, and Unions go through Procurement Services)?

Questions about green policies and programs

Do we have a sustainable purchasing policy or other formal statement related to sustainability in purchasing? If so, how does this sustainable/green purchasing policy impact purchasing practices?

What are the biggest challenges you face in implementing your "Made in Michigan" and "Green Purchasing" programs? What resources would be most helpful for growing these programs?

- Do we have anyone on staff that is dedicated to sustainable procurement? What is his/her mission, action?
- Is there any way to apply purchasing savings (e.g., from not buying something or purchasing a green option that is less expensive than the conventional option) to green options that are more expensive?

Questions about preferred suppliers and contract decisions

What are the criteria to have a vendor in the green supplier list? How does this affect the UM purchasing in practice?

How is sustainability taken into account in selecting preferred suppliers?

What do we ask companies we purchase from about their sustainability practices? What type of incentive do we give them to offer green products?

- How often are preferred suppliers' contracts renewed? Who are the institutional players involved in the process and final decision making?
- How is lifecycle costing incorporated into purchasing decisions?
- How do we choose among potential suppliers? Who are the institutional players involved in the process and final decision making?
- What is asked about sustainability in the Requests For Proposals or Requests for Quotations?
- Does Procurement Services provide contract templates? Do these incorporate sustainability?
- Do we write environmental specifications into vendor contracts?

Questions about incentives to UM purchasers/ communication & education questions
What are the incentives given to UM purchasers to buy greener products/ Energy Star appliances, etc.?

Do we take any steps to encourage more sustainable choices by individual purchasers? Is there someone to educate buyers about green purchasing (e.g. a Sustainability Coordinator)?

- Are there any opportunities to partner with other schools/departments/units to form a sustainable purchasing consortium?
- How do we currently communicate with the campus community about sustainable purchasing?
- Do we have a sustainability purchasing guide to help purchasers understand the environmental impact of their purchases?
- How much traffic does the Green Purchasing webpage get relative to total traffic to procurement homepage?

Questions About Avoiding Unnecessary Consumption and packaging
What opportunities do you see for reducing consumption?

What steps have we taken to reduce packaging waste?

- Do we have any paper-based forms that could be phased out?
- How do current printing policies affect paper consumption?
- Do we provide packaging guidelines to suppliers?
- Have we negotiated reduced packaging agreements with suppliers? What percentage of total suppliers is this?

Questions about Specific Product Types
- Who purchases furniture? Are sustainability considerations incorporated into furniture purchasing?
- Who purchases appliances? Do we have a policy of purchasing ENERGYSTAR products?
- How are lab chemicals purchased? Do we have a way of promoting least toxic options?

- Who purchases cleaning products? Are we buying GreenSeal products?
- Do we use remanufactured ink cartridges exclusively?
- Who purchases paint? Do we have any environmental standards for paint?
- Who purchases computers, servers, and monitors? Do we have any environmental requirements for these purchases, particularly related to EnergyStar, EPEAT, etc?
- Who purchases lightbulbs? Do we follow any environmental standands for lighting?
- Who purchases washing machines and dryers? Do we have a policy of using use front-loading washing machines or have?
- Who purchases carpet? Do we have any environmental standards related to carpet purchasing?
- Who purchases copy paper? Do we have any environmental standards for copy paper purchasing?
- Who purchases UM letterhead paper? Do we have any environmental standards for this?
- Who purchases paper towels and toilet paper? Are we buying 100 percent recycled, processed chlorine free?
- Who purchases paper for publications and mailings? Do we have any environmental standards for this?
- Who purchases envelopes? Do we have any environmental standards for this?
- (Possible question for Sam Moran?) What type of fuel do your trucks use and where does it come from?

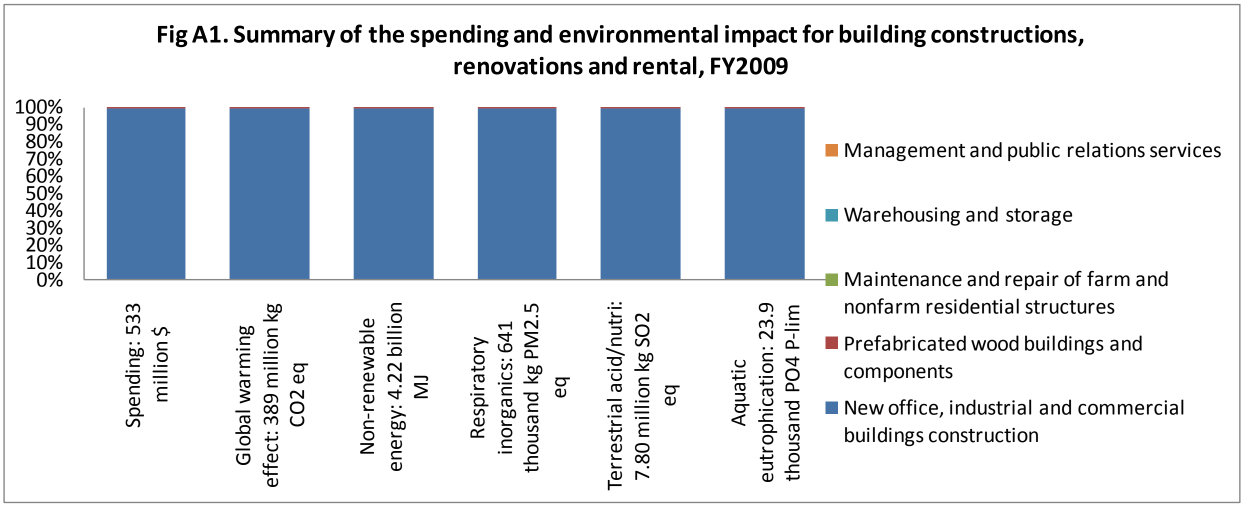
8.2 Appendix: Life Cycle Assessment of spending at U-M

Limitations of this LCA study

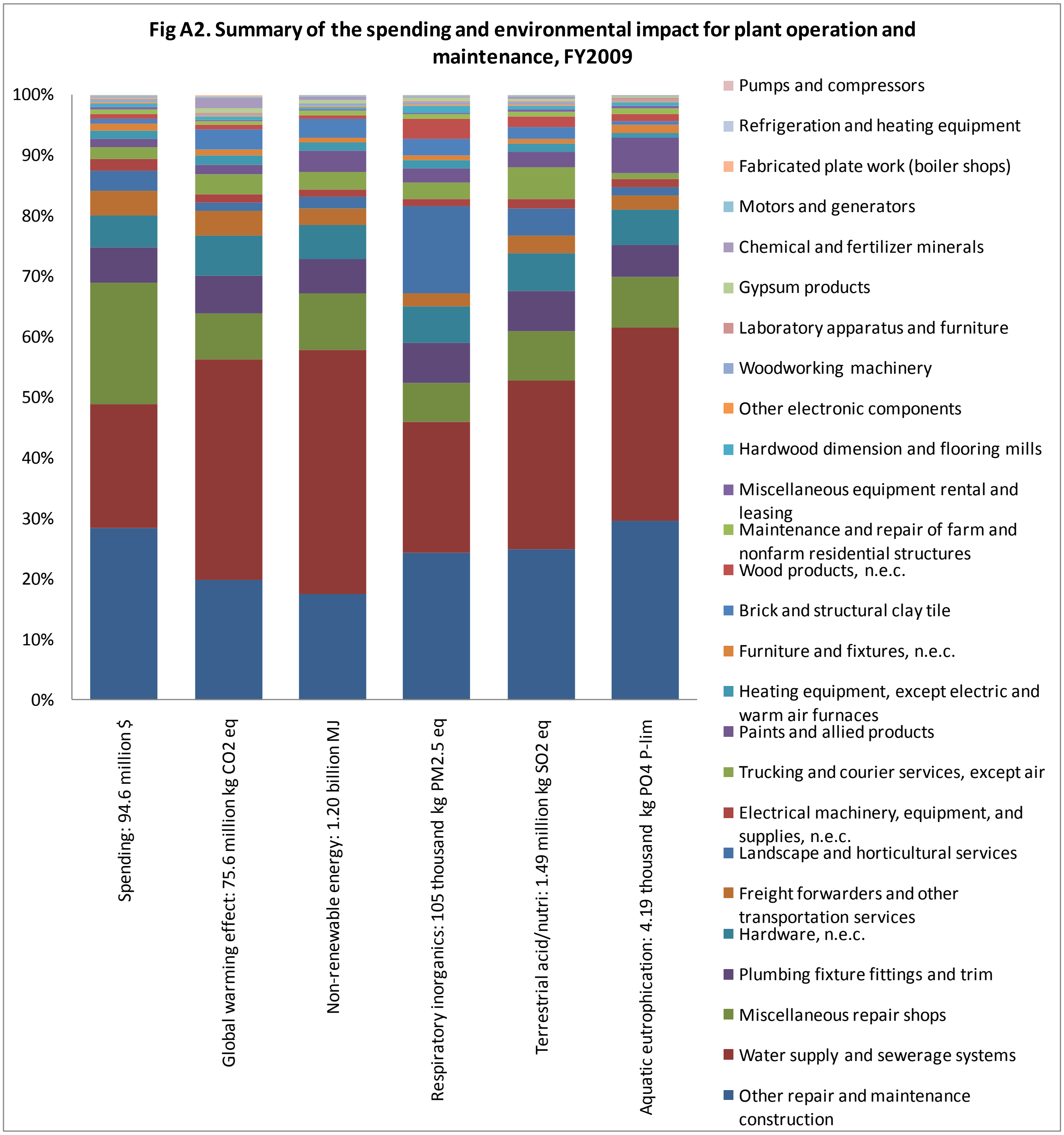
- The I/O method is still in development and may have flaws in its database.
- The records of U-M accounts are complicated and sometimes it is hard to match them with the I/O method.
- The accounts only included the spending on behalf of U-M, all activities due to individual members of campus are excluded. This will substantially underestimate the spending and environmental impacts for certain categories (e.g. food, transportation, etc.).

Detailed analysis of each category

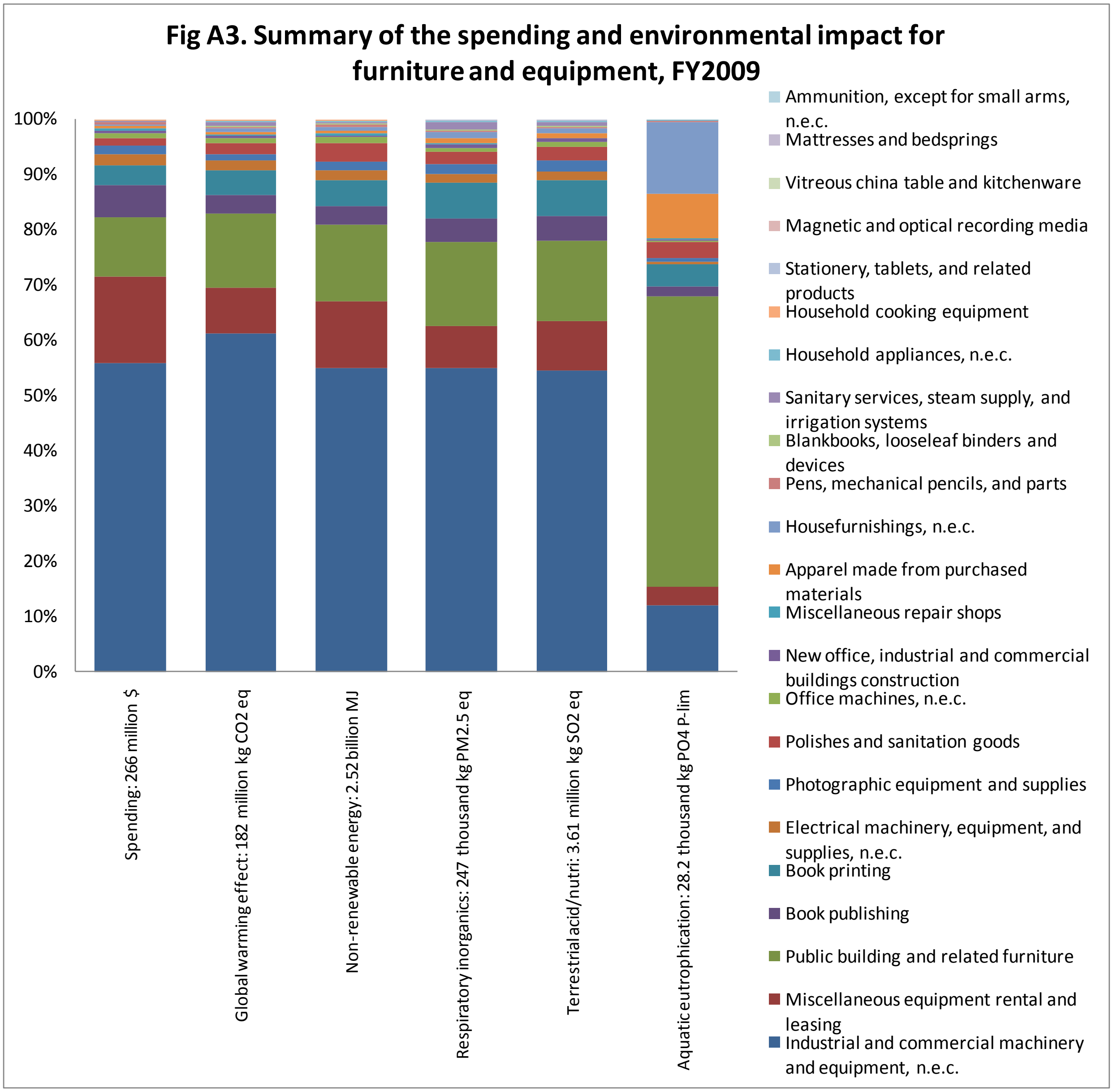
In this section we present the details of the account categories of U-M. Note that natural gas, electricity, fleet fuel consumption are integrated into one category here as “gas, electricity, and fuel oil” for conciseness.



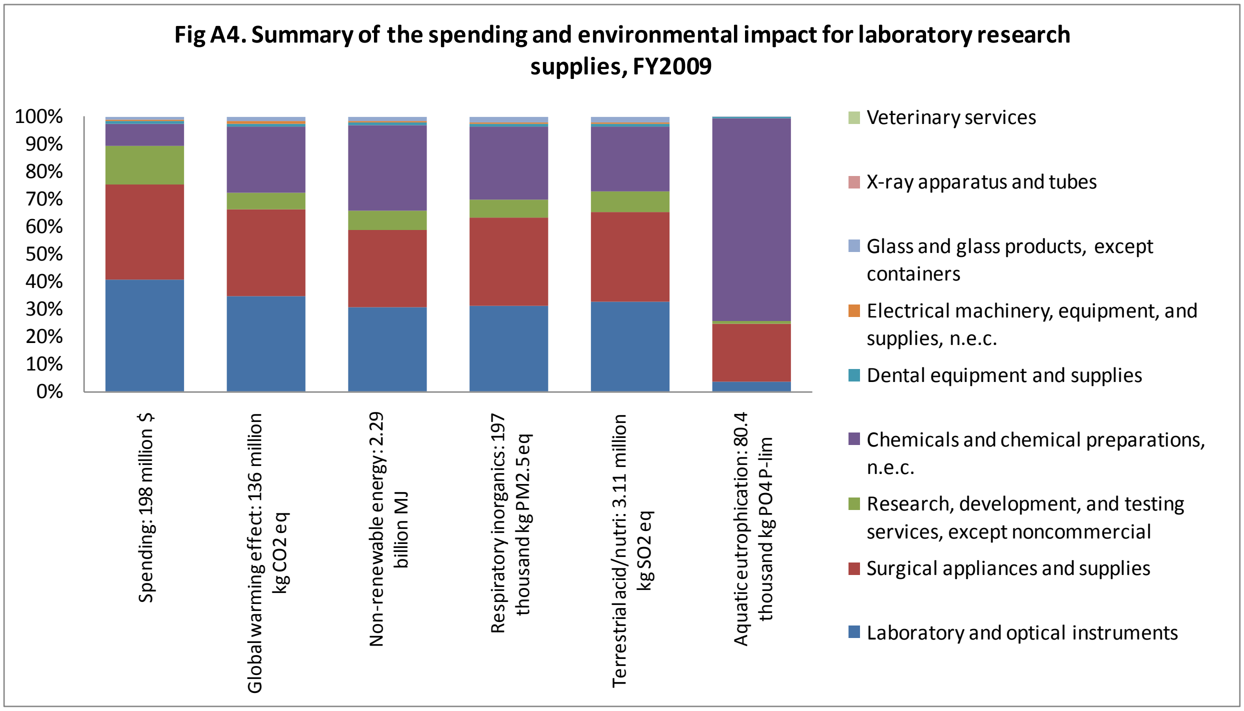
Clearly, the new constructions of building dominated both the spending and environmental impacts of the category of building constructions, renovations and rental. Note that the rental of building spaces was also included as the new constructions since the rent served as the payment of the construction.



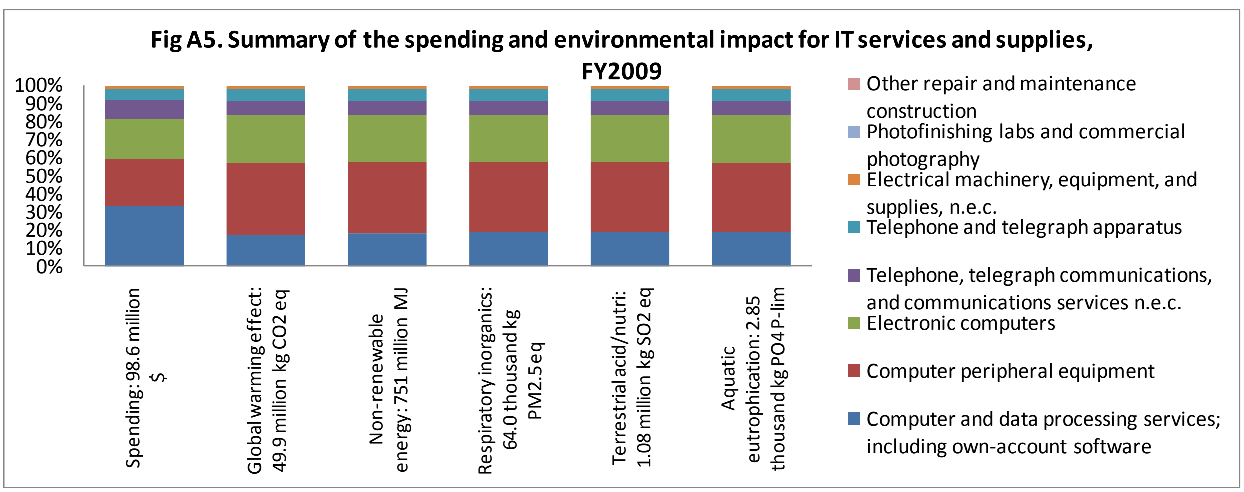
For the category of plant operation and maintenance, the environmental impacts from different types of accounts were proportional to their spending. The "brick and structural clay tile" was giving significantly more impact for respiratory inorganics compared to its spending due to its nature.



In this category, the "office machines, n.e.c.", "apparel made from purchased materials" and "house furnishings, n.e.c." stood out for aquatic eutrophication. The reason was that these three types of products are closely related to agriculture based products (e.g. cotton) which involves the use of fertilizers – one of the major sources of eutrophication.



For the laboratory research supplies, "chemicals and chemical preparations, n.e.c." was giving significant impacts despite its relatively small spending. Again, this is related to its use of crops as basic production materials.



The spending and impacts from different types of accounts were highly consistent for the category of IT services and supplies. This is reasonable since their nature were similar as electronic equipments.

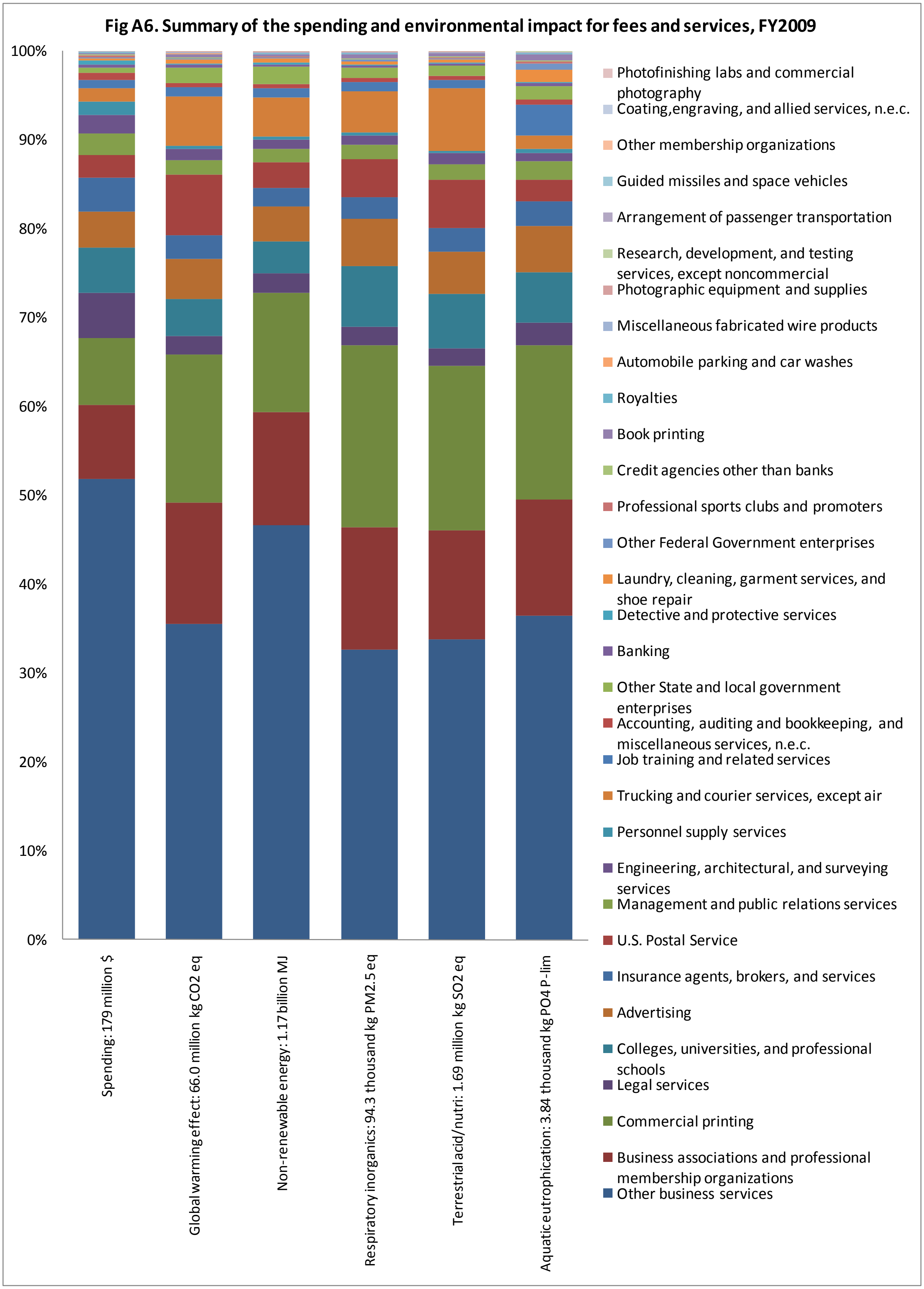
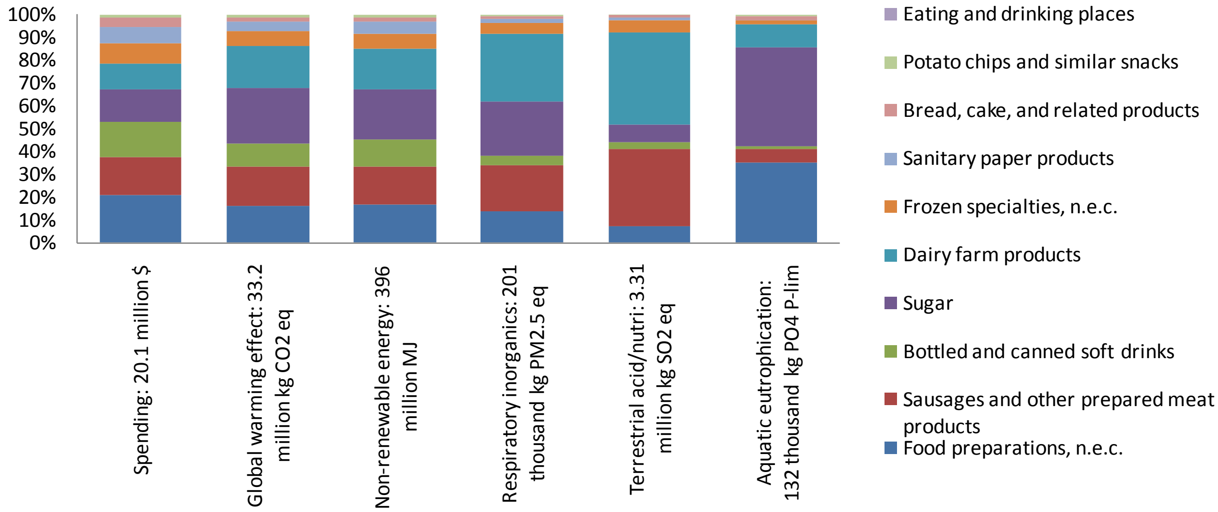


Fig A6. Summary of the spending and environmental impact for fees and services, FY2009
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Spending: 179 million $
Global warming effect: 66.0 million kg CO2 eq
Non-renewable energy: 1.17 billion MJ
Respiratory inorganics: 94.3 thousand kg PM2.5 eq
Terrestrial acid/nutri: 1.69 million kg SO2 eq
Aquatic eutrophication: 3.84 thousand kg PO4 P-lim
Photofinishing labs and commercial photography
Coating,engraving, and allied services, n.e.c.
Other membership organizations
Guided missiles and space vehicles
Arrangement of passenger transportation
Research, development, and testing services, except noncommercial
Photographic equipment and supplies
Miscellaneous fabricated wire products
Automobile parking and car washes
Royalties
Book printing
Credit agencies other than banks
Professional sports clubs and promoters
Other Federal Government enterprises
Laundry, cleaning, garment services, and shoe repair
Detective and protective services
Banking
Other State and local government enterprises
Accounting, auditing and bookkeeping, and miscellaneous services, n.e.c.
Job training and related services
Trucking and courier services, except air
Personnel supply services
Engineering, architectural, and surveying services
Management and public relations services
U.S. Postal Service
Insurance agents, brokers, and services
Advertising
Colleges, universities, and professional schools
Legal services
Commercial printing
Business associations and professional membership organizations
Other business services

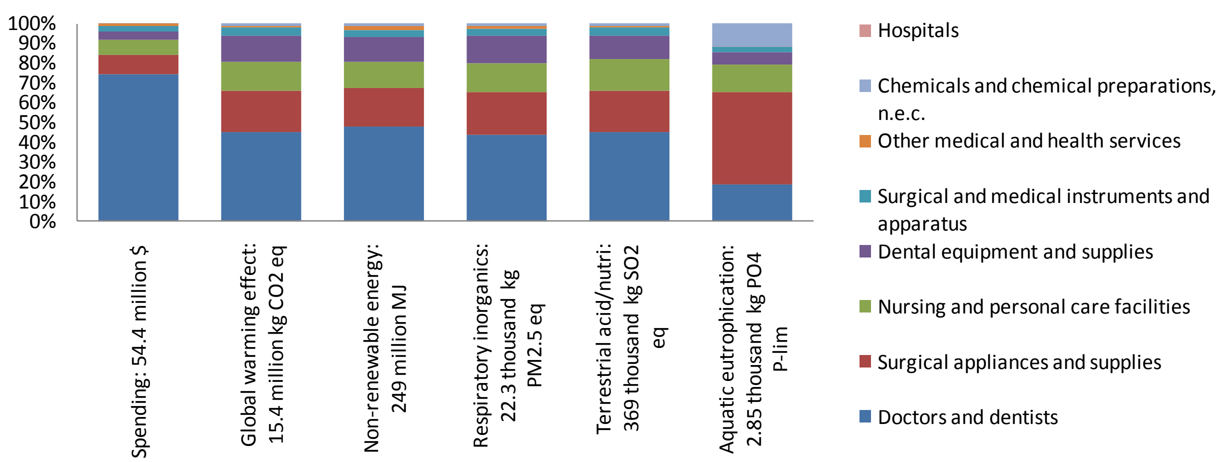
The environmental impacts from different types of accounts were proportional to their spending in the fees and services category. The "U.S. postal services" and "trucking and courier services, except air" were having much higher shares of environmental impacts compared to their shares of spending. This is likely due to the vehicles' consumption of fuel which usually has high impacts with small spending.

Fig A7. Summary of the spending and environmental impact for food, FY2009



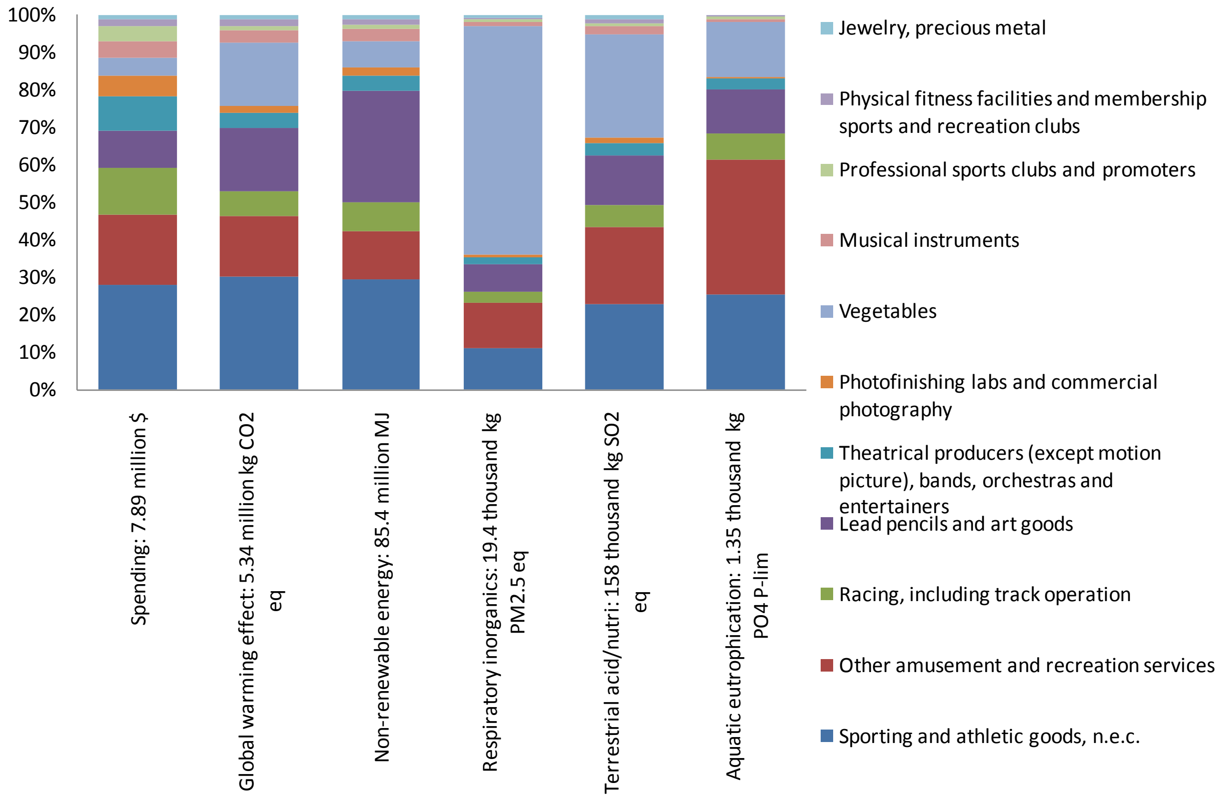
As a part of the total U-M spending, the spending on food and beverage was small (1.2%), the impacts were large (from 1.5% for non-renewable energy to 35% for aquatic eutrophication). It must be realized that this food and beverage only covered the purchases on behalf of the U-M. Individuals' consumptions elsewhere were not included. Given the fact of the high impact from food, it is crucial not only to improve the sustainability of food/beverage procurement within campus but also for each member of U-M during their everyday lives.

Fig A8. Summary of the spending and environmental impact for medical expenses, FY2009

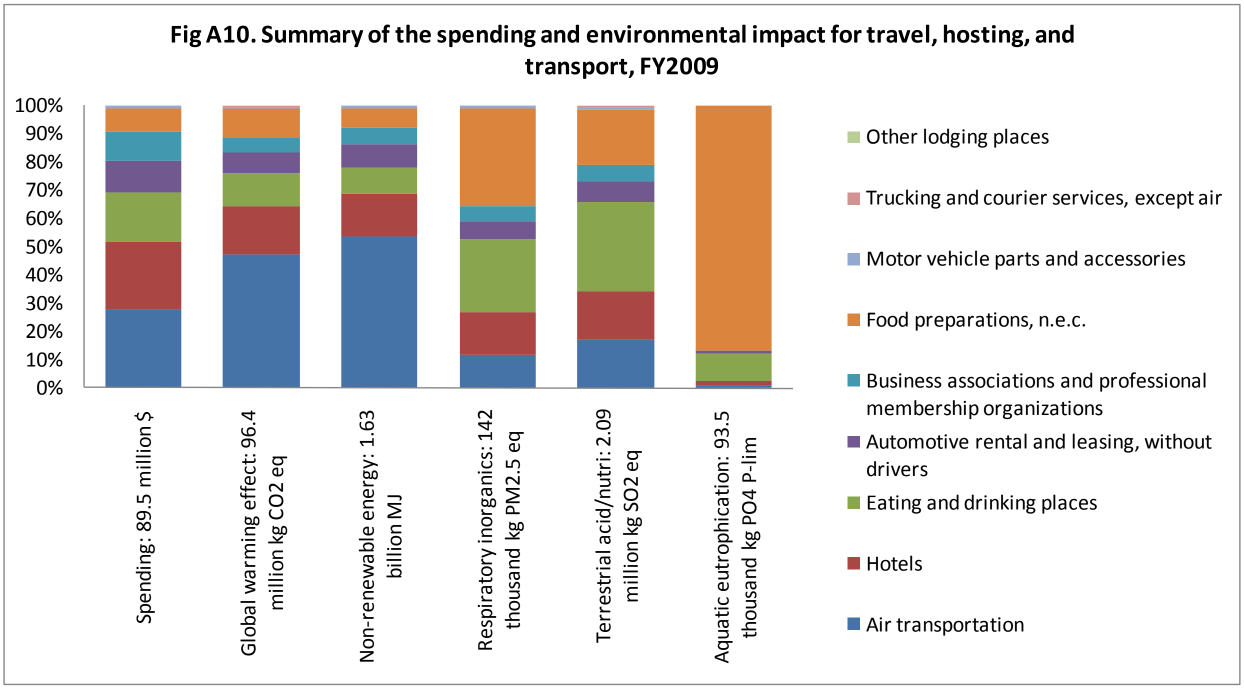


From Fig A8 we can see that the “doctors and dentists” was responsible for most of the spending on medical expenses but had relatively small environmental impacts. It was the equipments and supplies that really of importance.

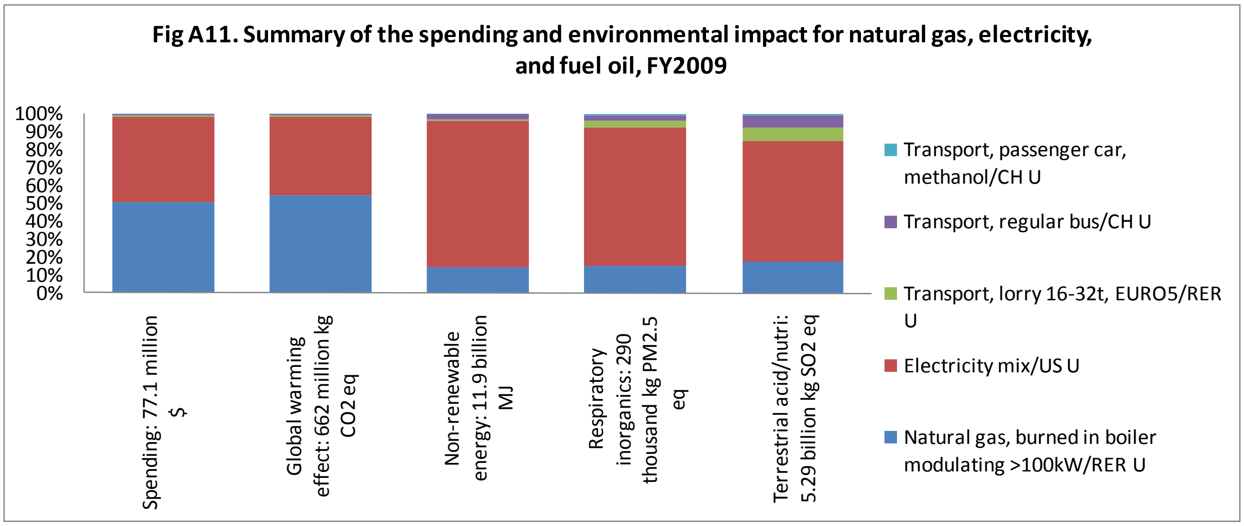
Fig A9. Summary of the spending and environmental impact for sports and entertainment, FY2009



Similar to that of food and beverage, this category of sports and entertainment only included procurements on the U-M side. Individuals’ impacts during sports and entertainment events were not considered. Therefore there could be a much greater impact coming from the sports and entertainment category for the U-M campus.



From the category of travel, hosting, and transport we can again see the significance of food related product procurement on the environmental impact. Although air transportation consisted the major part of global warming effect and non-renewable energy, its impacts on other endpoints were small. In addition, at this stage the air transportation was not differentiated for short distance/long distance travel and which will affect the impacts substantially.



The natural gas, electricity, and fleet fuel consumption were combined as one here. These data were analyzed with the values reported in the University of Michigan – 2009 Annual Environmental Report (citation needed) and the Ecoinvent database. The fleet fuel consumption was divided into three types of vehicle based on the fuel types and constituents of the fleet. The impacts from the fleet fuel consumption are relatively small. This may be due to the limited operation range of the U-M fleet. Furthermore, these results only considered the U-M consumption, the impacts from individuals were not included.

8.3 Appendix: Example Sustainable Purchasing Policies

8.3.1 Arizona State University

http://www.asu.edu/aad/manuals/pur/pur210.html

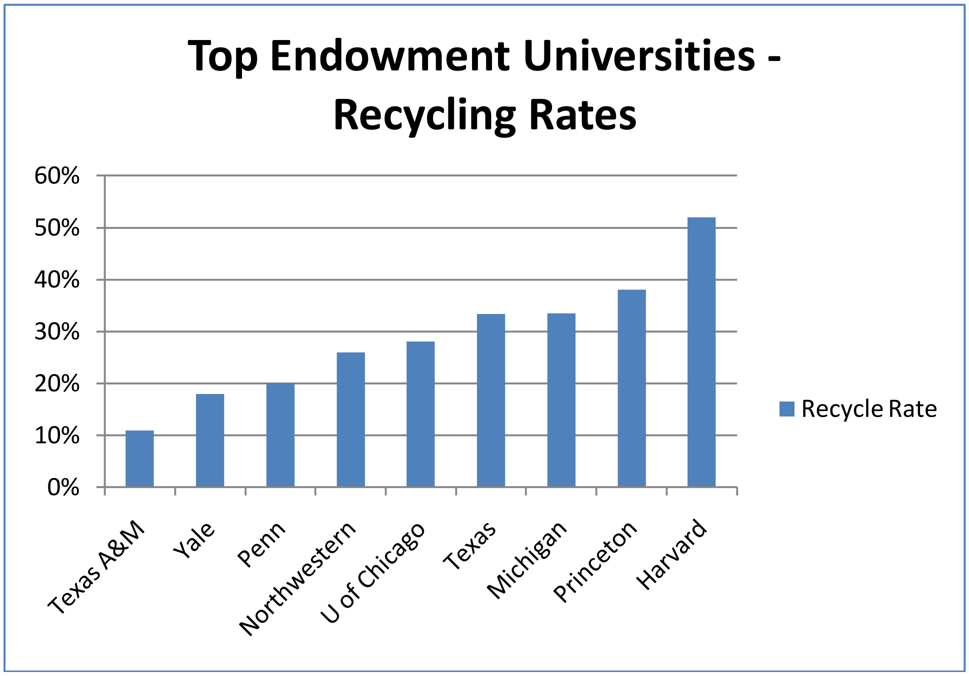
8.3.2 Oberlin College

http://www.oberlin.edu/sustainability/resources/purchasing.html

8.3.3 University of Louisville

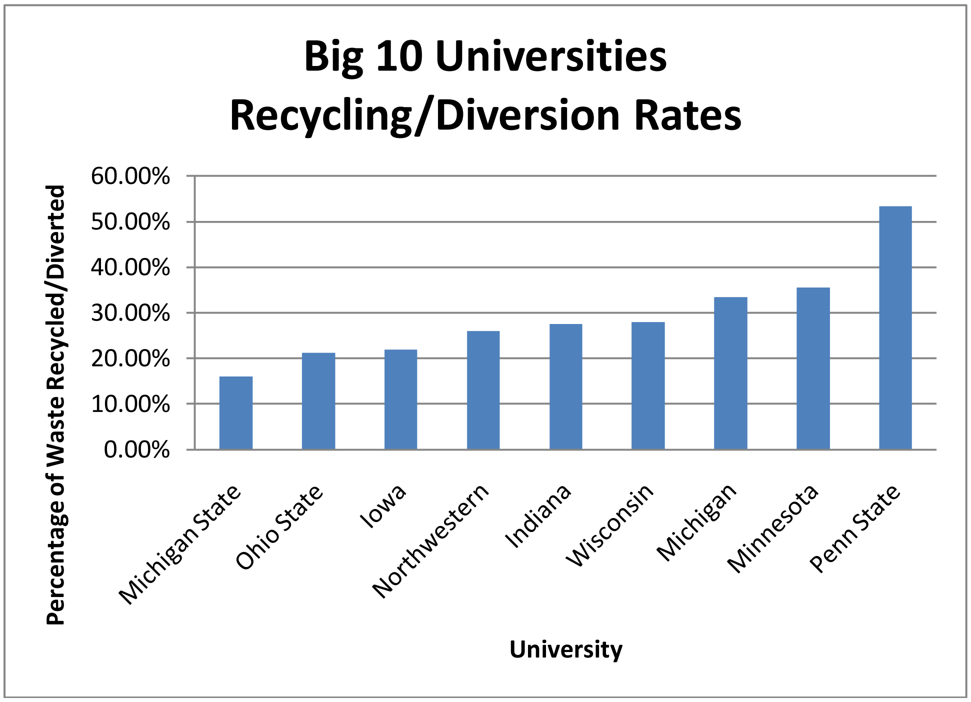
http://louisville.edu/purchasing/sustainability/greenpolicy.html

8.4 Appendix: University Recycling Statistics



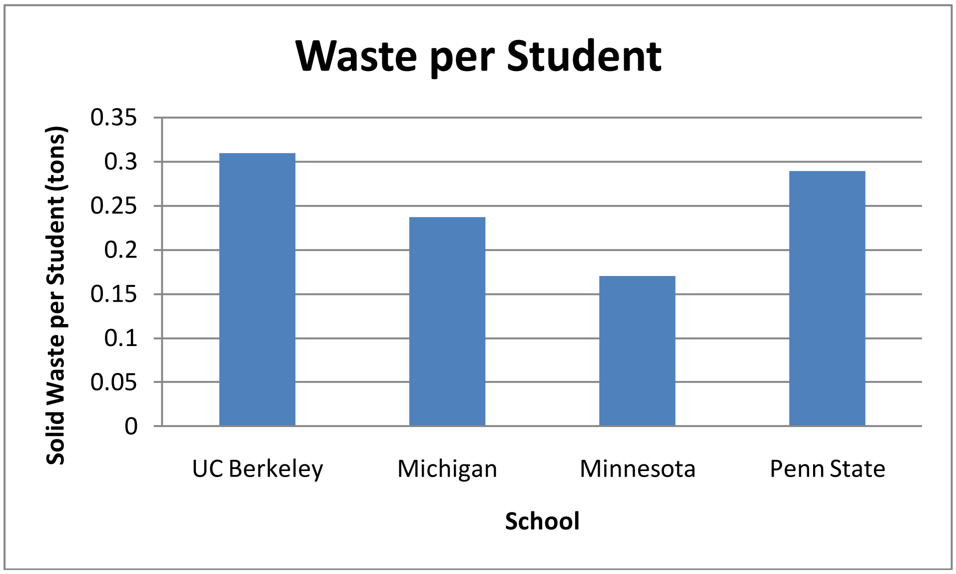
Sources:

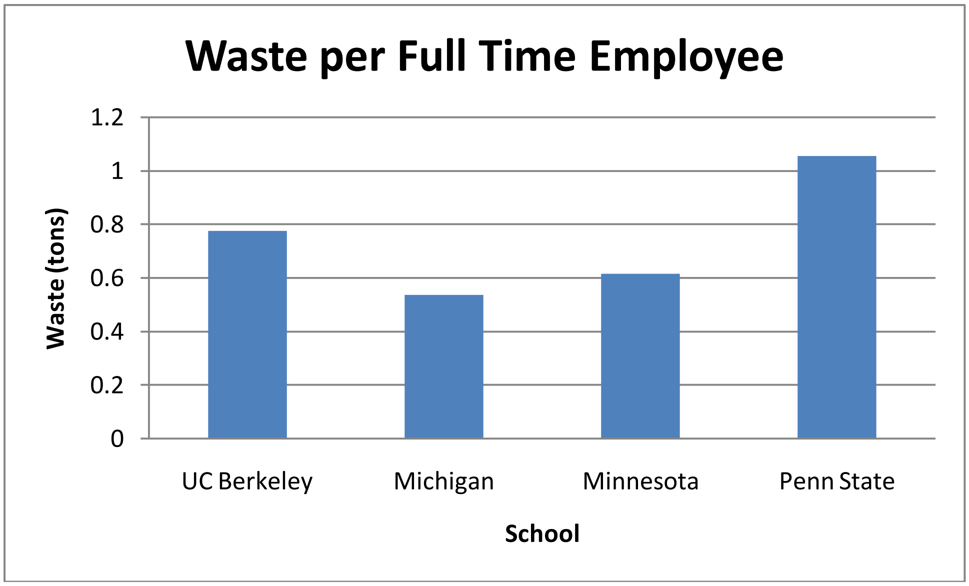
- Department of Occupational Safety & Environmental Health. University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
- Harvard University Operations Services. Recycling [Internet]. Cambridge (MA): Harvard University; c2010 [cited 2010 May 5]. Available from: http://www.uos.harvard.edu/sustainability/recycling/index.shtml
- University of Texas Facilities Services. Recycling Revenues Summary [Internet]. Austin (TX): The University of Texas; c2009 [cited 2010 May 5]. Available from: http://www.utexas.edu/facilities/services/summary.html
- Yale Recycling [Internet]. New Haven (CT): Yale University [cited 2010 May 5]. Available from: http://www.yale.edu/recycling
- Supporting Sustainable Campuses [Internet]. College Station (TX): Texas A&M University; c2010 [cited 2010 May 5]. Available from: http://sustainability.tamu.edu
- Facilities and Real Estate Services: Waste Management and Recycling [Internet]. Philadelphia (PA): University of Pennsylvania; c2010 [cited 2010 May 5]. Available from: http://www.facilities.upenn.edu/sustain_wast.php
- Sustainability: Recycling [Internet]. Chicago (IL): University of Chicago; c2010 [cited 2010 May 5]. Available from: http://sustainability.uchicago.edu/campus/recycling.shtml
- The Princeton University Sustainability Plan [Internet]. Princeton (NJ): Princeton University; c2010 [cited 2010 May 5]. Available from: http://www.princeton.edu/reports/sustainability-plan-20080219
- Facilities Management [Internet]. Evanston (IL): Northwestern University; c2004 [cited 2010 May 5]. Available from: http://www.northwestern.edu/fm/environmental_sustainability.htm



Sources:

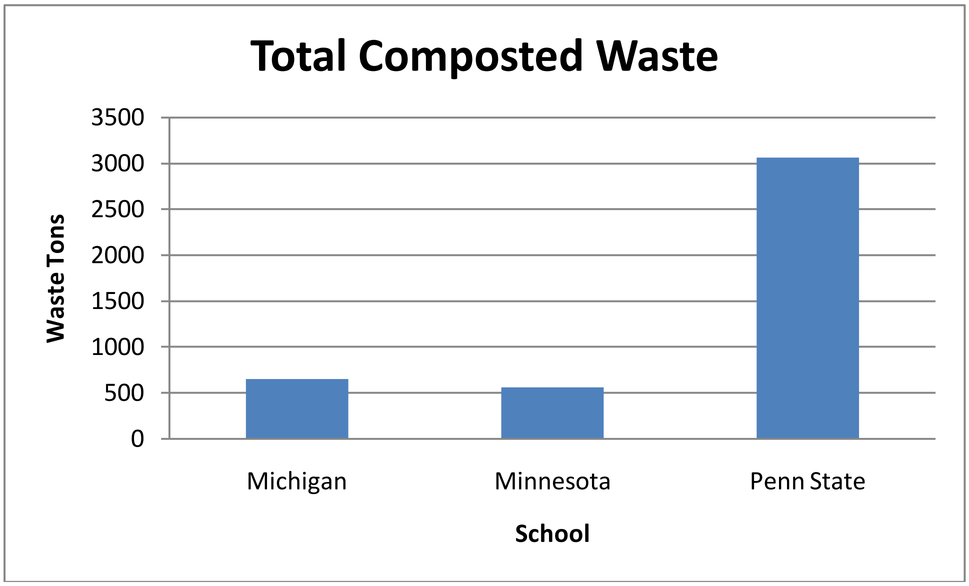
- Department of Occupational Safety & Environmental Health. University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
- Facilities Management [Internet]. Evanston (IL): Northwestern University; c2004 [cited 2010 May 5]. Available from: http://www.northwestern.edu/fm/environmental_sustainability.htm
- Office of the President. President's Council on Sustainability [Internet]. Columbus (OH): The Ohio State University; c2010 [cited 2010 May 5]. Available from: http://president.osu.edu/sustainability
- Recycling Programs: Current Recovery Rates [Internet]. Minneapolis (MN): University of Minnesota; c2004-2007 [cited 2010 May 5]. Available from: http://www1.umn.edu/recycle/statistics.html
- MSU Surplus Store & Recycling Center FAQs [Internet]. East Lansing (MI): Michigan State University [cited 2010 May 5]. Available from: http://www.recycle.msu.edu/new-facility-FAQs.html
- Office of Physical Plant: Recycling Statistics [Internet]. State College (PA): Penn State University; c2010 [cited 2010 May 5]. Available from: http://www.opp.psu.edu/about-opp/recycling/recycling-statistics
- Cleaning Up Our Trash: Improving Recycling at UW-Madison by Reducing Recyclables in the Trash Stream [Internet]. Madison (WI): University of Wisconsin; c2009 [cited 2010 May 5]. Available from: http://lcnl.wisc.edu/people/amato/Cleaning_Up_Our_Trash_Harrod_Amato_2009.pdf
- Indiana University Recycling [Internet]. Bloomington (IN): Indiana University; c2002 [cited 2010 May 5]. Available from: http://www.indiana.edu/~phyplant/recycling.html (accessed 5/5/2010)
- UI Recycling Facts [Internet]. Iowa City (IA): University of Iowa; c2005 [cited 2010 May 5]. Available from: http://www.facilities.uiowa.edu/Recycle/recyclingfacts.htm





Sources:

- Department of Occupational Safety & Environmental Health. University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
- Recycling Programs: Current Recovery Rates [Internet]. Minneapolis (MN): University of Minnesota; c2004-2007 [cited 2010 May 5]. Available from: http://www1.umn.edu/recycle/statistics.html
- Office of Physical Plant: Recycling Statistics [Internet]. State College (PA): Penn State University; c2010 [cited 2010 May 5]. Available from: http://www.opp.psu.edu/about-opp/recycling/recycling-statistics
- UC Berkeley 2009 Campus Sustainability Report [Internet]. Berkeley (CA): University of California Berkeley; c2009 [cited 2010 May 5]. Available from: http://sustainability.berkeley.edu/os/pages/reports/docs/2009_Campus_Sustainability_Report.pdf



Sources:

- Department of Occupational Safety & Environmental Health. University of Michigan-2009 Annual Environmental Report Raw Data Overview [Internet]. Ann Arbor (MI): The Regents of the University of Michigan; c2009 [cited 2010 May 2]. Available from: http://www.oseh.umich.edu/09AERrawdata.html
- Recycling Programs: Current Recovery Rates [Internet]. Minneapolis (MN): University of Minnesota; c2004-2007 [cited 2010 May 5]. Available from: http://www1.umn.edu/recycle/statistics.html
- Office of Physical Plant: Recycling Statistics [Internet]. State College (PA): Penn State University; c2010 [cited 2010 May 5]. Available from: http://www.opp.psu.edu/about-opp/recycling/recycling-statistics

8.5 Appendix: Purchasing and Recycling in Campus Sustainability Rating Systems

In the past several years, a variety of efforts to evaluate campus sustainability have emerged. This appendix describes the coverage of purchasing and recycling in the three most influential of these evaluation programs. These tools provide valuable indications of how the U-M's efforts will be judged by external and internal stakeholders as well as how other many other institutions are evaluating their own performance.

8.5.1 College Sustainability Report Card

Background
The Sustainable Endowments Institute has produced the *College Sustainability Report Card* annually for the last four years. The Report Card assigns letter grades to college and universities in nine sustainability categories: Administration, Climate Change & Energy, Food & Recycling, Green Building, Student Involvement, Transportation, Endowment Transparency, Investment Priorities, Shareholder Engagement. While many in the campus sustainability community have questioned many aspects of the Report Card's methodology and overall approach, [35] it is the longest-standing higher education sustainability rating system and it tends to receive substantial media coverage each year.

The Sustainable Endowments Institute is not entirely transparent about its grading process, but over time they have started to provide greater detail about the indicators they use to assign grades. The most recent grades were based on 48 indicators.

Indicators related to purchasing

- Mandating through a formal policy or informally prioritizing the purchase of reusable or green-certified materials, including, but not limited to, Energy Star products, environmentally preferable paper products, and eco-friendly cleaning products.

Indicators related to recycling

- Administering a recycling program for dining hall recyclables, such as bottles, cans, and cardboard.
- Providing recycling for items such as batteries, cell phones, computers, and printer cartridges.
- Operating programs that facilitate the continued use of items in good condition (instead of disposal), such as end-of-semester furniture or clothing swaps and collections.

8.5.2 Princeton Review's Green Rating

The Princeton Review annually gives colleges and universities a green rating ranging from 60-99. In 2009, it rated 697 higher education institutions [36]. The ratings are derived from institutions' responses to ten questions related to sustainability that are incorporated into Princeton Review's annual survey. Because of the small number of questions that the rating is based upon and the fact that there is minimal guidance to ensure that respondents provide comparable data, the Princeton Review's green rating is not regarded by campus sustainability professionals as being meaningful. Nonetheless, Princeton Review's Green Ratings are well publicized to prospective students and therefore do matter.

Survey questions related to purchasing
None of the ten sustainability-related questions in Princeton Review's survey address purchasing.

Survey questions related to recycling
The survey asks for each institution's overall waste diversion rate.

8.5.3 Sierra's Cool Schools Ranking

Sierra, the magazine of the Sierra Club, has produced an annual list of "Cool Schools" for the last three years [37]. The 2009 list rated 135 colleges and universities from 1-10 on a variety of sustainability criteria to create a numerical ranking [37]. The ranking is based on responses to a survey that Sierra sends out to colleges and officers. If a school does not return the survey, it will not be included in the rankings. *Sierra*'s exact methodology is not fully transparent and a number of observers have raised questions about the integrity of their rankings [38,39,40].

Questions related to purchasing from Sierra's 2010 survey

- Does your school have a sustainable-purchasing policy? If yes, briefly explain.
- What percentage of paper used on campus is made from at least 30% postconsumer recycled content?
- Does your school purchase paper that is Forest Stewardship Council-certified?
- Does your school have a policy to purchase Electronic Product Environmental Assessment Tool (EPEAT)-certified (or similar) electronics? If yes, please describe.
- Do you have packaging agreements with suppliers that minimize waste? If yes, please describe.
- Does your school specify in its purchasing contracts that products with energy-saving features be installed or delivered with these features enabled?

Questions related to recycling from Sierra's 2010 survey

- What is your campus's current waste-diversion rate (i.e., percentage of campus waste being diverted from landfills)?
- Does your campus provide recycling receptacles wherever there are trash cans?
- Are recycling bins readily available at large events such as football games?
- Does your school compost? If yes, are compost receptacles available at all or most on-campus dining locations?
- Is your school committed to waste-reduction goals, such as zero waste? Please explain.
- Does your campus administer a donation program for clothing and other used goods when students are moving out of student housing? If so, are bins located in every dormitory?

8.5.4 Sustainability Tracking Assessment & Rating System (STARS)

Background
Produced by the Association for the Advancement of Sustainability in Higher Education (AASHE), STARS is emerging as the gold standard for campus sustainability assessment [41],[42]. It was developed with substantial engagement of relevant stakeholders, including two public

comment periods. It has the support of many higher education associations, including the National Association of College & University Business Officers (NACUBO). It is also the most transparent and comprehensive campus sustainability rating system available, and the questions upon which the score is based are clearer and better-developed than other systems. Over 130 schools are participating, including many leading research universities [43].

STARS is comprised of over 100 "credits" through which participating institutions earn points for performance on sustainability criteria or through the implementation of various practices that contribute to sustainability [44]. Many of the other sustainability rating systems described in this appendix draw from STARS in developing their own rating systems.

Credits Related to Purchasing
STARS has an entire section devoted to purchasing. Points are available for having institution-wide stated preferences (e.g. in the form of a policy) for purchasing:

- Electronic Product Environmental Assessment Tool (EPEAT) Silver or higher products
- Green Seal or EcoLogo certified cleaning products
- Recycled content office paper

Additional points are available bases on the actual percentage of applicable expenditures that meet these criteria. For example, points would be earned according to the percentage of expenditures on cleaning products that are spent on Green Seal or EcoLogo certified products.

Further points are also available for: having a Vendor Code of Conduct, supporting historically underutilized businesses, minority-owned businesses, and women-owned businesses; and giving preference to local businesses.

Credits Related to Recycling
STARS has an entire section devoted to waste. Points are earned for reducing total waste generation (garbage, recycling, and compost) per campus user compared to a 2005 baseline and based on the institution's recycling rate. Additional points are available for:

- Having programs in place to recycle, reuse, and/or refurbish electronic waste generated by the institution and students
- Having strategies in place to safely dispose of all hazardous, universal, and non-regulated chemical waste
- Having a surplus department or formal office supplies exchange program that facilitates reuse of materials.
- Limiting free printing for students in all computer labs and libraries
- Distributing course catalogs, course schedules, and directories online instead of in hard copy
- Implementing a campus-wide inventory system to facilitate the reuse of laboratory chemicals
- Having program to reduce waste associated with residence hall move-in and move-out

[35] Dautremont-Smith J. College sustainability report card released. Lexington (KY): Association for the Advancement of Sustainability in Higher Education; 2007.

[36] Princeton Review. Green colleges. New York: Princeton Review; 2010.
[37] Binshtock A and Fox M. Cool schools: The third annual list. San Francisco: Sierra; 2009.
[38] Carlson S. Ithaca College opts out of 'cool schools' rankings. Washington, D.C.: Chronicle of Higher Education; 2010.
[39] Carlson S. How does 'Sierra' Magazine come up with its list of greenest colleges? Washington, D.C.: Chronicle of Higher Education. 2008.
[40] Meisner M. Sierra Magazine's grade inflation issue. Syracuse (NY): Environmental Communication Network; 2009.
[41] Carlson S. Frustration with green rankings pushes colleges to develop their own. Washington, D.C.: Chronicle of Higher Education. 2010.
[42] Carlson S. Princeton Review will issue 'green' ratings in coming college guide. Washington, D.C.: Chronicle of Higher Education; 2008.
[43] Association for the Advancement of Sustainability in Higher Education. STARS institutions. Lexington (KY): Association for the Advancement of Sustainability in Higher Education; 2010.
[44] Association for the Advancement of Sustainability in Higher Education. STARS version 1.0 technical manual. Lexington (KY): Association for the Advancement of Sustainability in Higher Education; 2010.

Campus Sustainability Integrated Assessment

The material in this document is one of the seven Phase I Analysis Team reports completed for the Campus Sustainability Integrated Assessment. During Phase I of the project, seven faculty-led and student-staffed Analysis Teams focused on the following topics: **Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture.** These reports summarize the visionary, future thinking of the teams while also establishing a framework for moving forward.

The full team reports include priority ideas for advancing campus sustainability along with additional and related ideas supporting team integration. While all ideas presented by the Analysis Teams in Phase I were extremely thoughtful and insightful, it was not possible to make meaningful progress on all of them during Phase 2 of the Integrated Assessment.

Phase 2 efforts focused on ideas that most closely aligned with institutional priorities (i.e., measurable impacts on desired goal outcomes, and opportunity for the U-M to display leadership), and where it was determined significant progress could be made during Phase 2.

Please direct comments or questions to: GrahamInstitute-IA@umich.edu

For more information on the Campus Sustainability Integrated Assessment, please visit: http://graham.umich.edu/ia/campus-ia.php

Campus Sustainability Integrated Assessment:

Culture Team Phase 1 Report*

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May 2010

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The primary goal of the Culture Team during Phase 1 of the Integrated Assessment has been to develop recommendations that will foster a *culture of sustainability* at the University of Michigan. We define *culture of sustainability* as a culture in which individuals are aware of major environmental challenges, are behaving in sustainable ways, and are committed to a sustainable lifestyle for both the present and future. In order to develop our recommendations, we explored, synthesized, and analyzed information in three key areas: (1) research in environmental psychology and behavior, (2) trends at other colleges and universities throughout the United States, and (3) activities at the University of Michigan.

To gather this information, we conducted literature reviews and met regularly with the other Integrated Assessment teams. Research over the past several decades indicates that many factors can positively influence individuals to undertake pro-environmental behaviors: awareness of environmental challenges, procedural knowledge for addressing these challenges, reminders to conduct these actions, social motives, and material incentives. Campuses around the country, including the University of Michigan, have policies and programs capable of achieving these outcomes, such as comprehensive recycling programs, sustainability-oriented coursework, and environmentally-oriented community groups and projects. However, our research indicated that no colleges or universities had either implemented a broad-based program aimed at developing a culture of sustainability (as defined above) or assessed the cultural impact of their current programs. Our recommendations are designed to do both of these, and by following them we can position the University of Michigan as the *leaders and best* in both research and practice in developing a culture of sustainability.

In order do this, we make three types of recommendations based on three distinct objectives: (1) engagement, (2) education/training, and (3) assessing/monitoring. First, to enhance engagement in sustainability issues, we recommend that the University hire an individual who will be responsible for synthesizing, evaluating, and, if appropriate, implementing programs to enhance sustainability on campus. This individual will actively seek ideas and partners in the University community and will work closely with an advisory council and administrators to explore the feasibility and likely impact of potential new programs. To build engagement throughout campus, we also make several additional recommendations, including the development of sustainability plans for each department or unit.

Secondly, we recommend that the University use various methods to educate members of the campus community about environmental issues and train them in sustainable behaviors. Towards this end, we suggest that students be educated through dormitory-based peer educators and required coursework, and we offer additional recommendations for how staff and faculty can learn about sustainable living, such as through CRLT-based staff and training programs. Finally, we recommend that the University assess and monitor progress towards developing a culture of sustainability on campus by both developing metrics to measure this development and by regularly administering these measures to students, faculty, and staff over an extended period of time.

In total, this report contains five major recommendations and fifteen additional recommendations, all focused on our three core aims: engagement, education, and assessment. By implementing a comprehensive plan to enhance environmental behaviors and to thoughtfully monitor that progress, we can become an international leader and knowledge center for the development of a culture of sustainability.

INTRODUCTION

The challenge for the University of Michigan (UM) is to create a *culture of sustainability* on the Ann Arbor campus. UM is not only its administrators but also its students, faculty and staff members including those in academic, athletic, and medical units as well as those in plant operations and transportation services. By *culture of sustainability*, we mean a campus where people are:

1) Aware of the consequences of not behaving in an environmentally sustainable manner,
2) Acting or behaving in sustainable ways while on and off campus, and
3) Committed to a life-long life-style of sustainable practices and serving as role models for others.

We expect UM to be the "leaders and best" in efforts to reach this goal. In doing so, we want to capitalize our status as a premier research university by tracking and publicizing our progress throughout the UM (students, faculty, staff, alumni) and the world as we move toward a culture of sustainability.

Our Approach. Because of the overarching nature of "culture" in the integrated assessment, efforts of our team relied first on establishing linkages with each of the other assessment teams. That is, a culture team member joined and participated in each of the other team meetings with the intent of: (1) learning of their focus, activities, and informational needs, particularly with reference to the behaviors, perceptions, and intentions of UM students, faculty, and staff; (2) learning about past and current activities at UM aimed at dealing with sustainability and involving students, faculty, and staff; and (3) reminding the team that their work including their recommendations would have behavioral implications. Because of the central role of students in many of the university's sustainability efforts, another team member was assigned to learn about and monitor various student organizations and the role of residence halls in promoting sustainable behaviors.

A second team assignment was to determine what was taking place at other schools and colleges throughout the U. S. in terms of sustainability initiatives involving and/or targeting students, faculty, and/or staff at their respective campuses. Initiatives were initially documented according to building design and use, travel and transportation, energy conservation, purchasing and recycling, land and water, and food. Subsequently, we categorized activities at other schools as administration-led, student & staff initiatives, and community outreach. We also sought to determine if the other schools assessed the effectiveness of their activities/programs and if so, learn about the results of their assessments.

Still another team assignment was to review literature drawn from environmental psychology and consumer behavior that dealt with conservation and learning. Both theoretical articles and empirical studies were examined; relevant material is summarized in the next section.

Finally, the team met regularly to share information, develop and prioritize recommendations, and discuss challenges the university faces in implementing recommendations.

Theoretical Underpinnings. Our recommendations are grounded in the literature from psychology and, in particular, environmental psychology and consumer behavior. The following highlights some of that literature that has informed our deliberations about possible UM actions.

Over the last few decades, empirical studies have shown that several factors support environmentally responsible behavior such as recycling or energy conservation. Among these are: (1) understanding environmental challenges, (2) procedural knowledge (3) prompts, (4) social motives, and (5) material incentives. Any one of these factors alone may be sufficient to influence some individuals to act in environmentally responsible ways, but for many people, some combination thereof is necessary to support ongoing environmentally responsible behavior.[1]

First, evidence indicates that understanding environmental issues positively influences one's likelihood of undertaking environmentally responsible actions. In their seminal meta-analysis of behavioral research, Hines, Hungerford, & Tomera found 17 studies indicating that when individuals understand environmental problems and/or their potential solutions, those individuals are more likely to act in environmentally responsible ways.[2] These two types of knowledge – declarative (knowledge of the problem) and procedural (how to address the problem) – are both important for effecting behavior change (Ramsey & Rickson, 1977). Although understanding environmental issues and how to address them is a vital step in fostering pro-environmental behaviors, it is insufficient for *sustaining* such behaviors over an extended period of time.

Individuals often need to be reminded to behave in an environmentally responsible manner. Numerous studies have documented the power of providing such reminders or prompts. For example, Katzev & Mishima found that when signs about recycling were posted near waste receptacles in a college mail room, paper recycling increased.[3] Likewise, Aronson & O'Leary[4] found that when signs promoting water conservation were posted in a shower room, individuals decreased their water usage while Ayotte and her colleagues[5] found that small prompts on light switches and computers succeeded in encouraging energy conservation on their college campus. Thus, if individuals possess knowledge but are still not undertaking environmentally responsible behaviors, deploying prompts can help to effect change.

Evidence also indicates that another powerful motivator for behavior change is social motives, including perceived social norms and stated commitments. Studies show that when individuals commit to acting in an environmentally responsible way, they tend to keep their word. For example, Katzev & Pardini found that when community members committed to recycling their newspapers, they were more likely to undertake these activities than those who received material rewards for recycling.[6] Also, in their meta-analysis, Hines et al. found six studies documenting a strong relationship between individuals' written commitments to act environmentally and their actions. This research suggests that people strive to align their actions with their words.[7]

Perceived social norms can also have a large effect on an individual's behavior.[8] In Ajzen's Theory of Planned Behavior, an individual's perception of social norms is one of the strongest predictors of behavior: when someone perceives something as a "normal" way of acting, that individual is more likely to pursue that behavior.[9] Various studies have found that when individuals work together towards environmental goals – thus creating norms of pro-environment behaviors, these individuals begin to behave in more environmentally sustainable ways.[10] For instance, one study found that when people worked with neighbors to discuss ways to reduce their energy consumption and trash generation, they were successful in achieving these goals.[11]

The study by Staats et. al also suggests that when individuals have opportunities to become involved in solving environmental problems, their behaviors can change. Other research has shown similar results. For example, De Young[12] found that when university staff members were given responsibility for monitoring their buildings' energy usage and promoting energy conservation (on a voluntary basis), energy use in their building areas declined substantially. Although social incentives, prompts, and awareness seem to be the most powerful means of promoting sustained environmentally responsible behaviors, there is some evidence that material incentives such as cash or gifts can play a role, as well.[13] These should be employed cautiously, however, because research suggests that behavior changes motivated by material rewards will last only as long as the reward is issued. Katzev & Pardini (1987) for example, found that when households that recycled while receiving a material reward substantially reduced their recycling frequency once that reward was removed. Likewise, Deci & Ryan (2000) found that providing material incentives for individuals' performance of certain tasks can undermine their intrinsic motivation to complete those tasks. However, if the material incentive is modest and carefully targeted at specific behaviors, its use may work well when paired with other strategies to jump-start behavior change in the short-run.

In efforts to build a culture of sustainability on the University of Michigan campus, it is important to consider what we do and do not know about the most effective means of promoting environmentally responsible behaviors and choices. The recommendations presented later in this report reflect many of the principles covered in the above-mentioned literature.

Organization of the Report. In the sections that follow, an overview of what is happening at UM in efforts to move toward a culture of campus sustainability is presented. The report then discusses sustainability activities/programs at other U.S. universities and colleges including specifically identified peer institutions. Rather than presenting a comprehensive overview of all efforts, the focus of our discussion is on the cultural or human dimensions of campus activities related specifically to reductions in energy and resource use and more generally, to sustainable behaviors. Next, we discuss some of the shortcomings of our university's current efforts, the challenges we face in moving toward a culture of sustainability, and opportunities to meet some of the challenges. Finally, we present a number of recommendations aimed at overcoming these limitations and at moving the university forward to achieving our goal. A brief justification for each of our priority recommendations is then presented.

TOWARD A CULTURE OF SUSTAINABILITY

What's Happening at UM? There are a number of activities/programs/initiatives currently underway at UM that are explicitly moving the campus toward creating a culture of sustainability. Many are an outgrowth of the university's past efforts to address environmental issues and to deal with rising energy costs. In the 1980's, Building Performance Teams were created and charged with surveying campus buildings for specific ways to reduce energy costs and conduct tune-ups to reduce energy consumption. These efforts subsequently led to the university's participation in EPA's Energy Star Program beginning in the 1990's which resulted in several Energy Conservation Measures (ECM's) such as replacing outdated HVAC systems, upgrading water-cooled condensing systems, replacing incandescent with compact fluorescent light bulbs, and launching a recycling program. Many of these initiatives resulted in several national awards, including acknowledgement as an Outstanding School by the National Recycling Coalition in both 2001 and 2002 as well as recognition by the EPA as the first public university to be designated as Energy Star Partner-of-the-Year in 2004.

Beginning in the late 1990s, a series of posters were designed and placed in residence halls and other university buildings suggesting to students and staff that energy costs could be reduced by wearing heavier clothing during the winter months, turning off lights, and "using your power wisely" with respect to building lighting and temperature controls. The posters were viewed as a way of informing students, faculty, and staff about responsible behaviors related to energy consumption.

In 2003, President Coleman established an Environmental Task Force to "develop a plan for the University of Michigan to create a more sustainable future." The Task Force recommended that the university establish a reporting mechanism for "tracking it progress on environmental stewardship".[14] Two long-term recommendations called for a sustainability report that incorporates social, economic, cultural, and aesthetic indicators. Similarly, a 2005 report by the Center for Sustainable Systems suggests that aesthetic indicators include "planning, architectural, and environmental design awards received during the selected year."[15]

In 2006, Al Gore's *An Inconvenient Truth* was published and later released as a film documentary raising national awareness of global warming and what individuals could do about it.[16] During the same year, UM officials began to think seriously about the role of building occupants in conserving energy and commissioned ISR to design and conduct a pilot study aimed at understanding the behavioral aspects of energy conservation and sustainability.[17] The purposes of the pilot study were to understand the thoughts and actions of faculty, staff, and students in five UM buildings and to assess current university efforts at reducing energy costs in those buildings. Specifically, the study would address three broad policy questions:

- How effective were current policies and implementation strategies in achieving the goal of cost reduction in buildings?

- Should the same set of policies be applied across campus and target all members of the UM community?

- Should implementation strategies be applied uniformly in units throughout the university?

The pilot study would also test methods and procedures that could be applied to a larger and more representative sample of buildings and building occupants across campus.

The ISR study produced a set of findings covering what occupants of five pilot buildings knew and thought about the university's work in conserving energy, how they behaved with respect to saving energy while on campus and at home, and what energy-using equipment/apparatus they had and used in their university work space or residence hall. It also produced a series of recommendations, several of which were incorporated in the Planet Blue initiative.

Planet Blue was launched in 2008 and was intended to engage building occupants along with technical personnel in energy reduction efforts. To date, Planet Blue has operated in 65 university buildings; it has produced significant reductions in energy consumption and costs and increased levels of recycling in the several of the initial buildings.

Planet Blue is just one element of UM's six-point environmental and energy initiative launched in 2008 by the Office of Environmental Safety and Health.[18] Other points deal with environmental reporting, renewable energy, alternative transportation, green purchasing, and new construction and renovation projects---all of which have cultural or behavioral dimensions.

In fall 2009, President Coleman announced the university's Sustainability Initiative in teaching, research and operations in efforts to "reduce the institution's carbon footprint, set specific targets for reducing environmental impact, create and expand academic courses and research opportunities, and to connect academic and operations activities to make the campus a living laboratory for sustainability." As part of that initiative, Coleman created a *Sustainability Executive Council* which she chairs, restructured the Department of Occupational Safety and Health into an *Office of Campus Sustainability,* and appointed the director of the Graham Sustainability Institute, Don Scavia, as *Special Counsel to the President for Sustainability*. A major initiative involving Graham and the Office of Campus Sustainability is the Campus Sustainability Integrated Assessment which lists among its goals to "involve the full UM community in capturing ideas for a campus sustainability strategy" and "educate the UM community on campus sustainability issues, and identify means to change culture as appropriate".

The following is an overview of other activities/programs/initiatives that have or are currently taking place on campus related to the human or cultural dimensions of sustainability.

Student Activities. Students have been engaged in sustainability issues at UM for several decades.[19] Recently, many freshmen enter UM with a passion for saving the environment while others get exposed to sustainability as residents of student housing. Still others are introduced to sustainability and environmentally responsible behaviors through student organizations and coursework.

Housing. Although University Housing does not have a comprehensive outreach plan to increase awareness in the dorms, there are various individual programs within housing that promote sustainable behaviors. University Housing's recycling program is very efficient and easy for students to understand. The trash rooms in the dorms are clearly labeled and students are generally aware of what they need to. Reminders are posted about turning off the lights before leaving rooms and turning off faucets in bathroom sinks in order to conserve water. In the late 1990s University Housing tried to promote sustainability through an "Ecolympics," which was a competition between dormitories aimed at reducing energy and water consumption and increase recycling. Data were collected monthly for each hall and the one with the best conservation record was awarded with an ice cream party. The Ecolympics was discontinued because housing officials learned that conservation efforts were not sustained following the party.

University Housing also participated in RecycleMania, a national college and university recycling competition pitting UM students against those in other schools. RecycleMania is discussed later in the discussion of UM's recycling activities.

Student Organizations. The Student Sustainability Initiative (SSI) is the major student organization addressing sustainability issues on campus. Sponsored by the Graham Environmental Sustainability Institute, SSI is a conglomerate of many student groups that have sustainability as one of their organizational goals. SSI, which helped to launch President Coleman's Sustainability Initiative, is the link between UM's student body and UM's central administration. Over 20 student organizations are members of SSI, the most active of which are:

- **EIC** (Environmental Issues Commission) is the creation of the Michigan Student Assembly, the University of Michigan's central student government. EIC is focused on helping to make U-M more environmentally conscious by increasing opportunities for students to learn about sustainability. They help to organize events such as the Sustainability Fair and Earth Week.

- **EnAct** (Environmental Action) which is a student group focused on increasing students' ecological literacy. They organize events to achieve this goal, and they also work with children in the community in order to spread knowledge about how to improve the environment. Some of their activities include making environmental art, which is put on display during Earth Week, and Hands on the Planet, which is an event where volunteers help at different sites in Ann Arbor. The volunteers do activities that range from picking up trash to clearing invasive plants.

- **SEED** (Strategies for Ecological Education and Development) which aims to increase knowledge about environmental sustainability to those who cannot make decisions about the conditions of their local ecosystems.

- **MSFI** (Michigan Sustainable Food Initiative) which focuses on increasing the amount of local food made available at the University of Michigan. This group also educates the U-M community about sustainable food practices.

- **BLUElab** (Better Living Using Engineering Laboratory), is based in the College of Engineering and seeks to find sustainable solutions to different problems locally and in underdeveloped countries. They organize project teams to advance sustainable technologies and encourage involvement from students in other parts of the university.[20]

SSI has been instrumental in organizing events to raise levels of environmental awareness. For instance, a Zero Waste Tailgate was organized at one of the fall 2009 football games. The event aimed at having all materials used by spectators reused, recycled, or composted, and from this event, over 500 pounds of waste was diverted from landfills.[21] SSI also holds monthly meetings which are attended primarily by representatives of various student organizations although they are open to the general student body. Attendance during the 2009-10 academic year was low and SSI is planning to reach out to more students during the next academic year.

Other student groups active in sustainability issues on campus include the **Green Greeks** (SSI member), **SOLE** (Students Organizing for Labor and Economic Equity), **MSTAR** (Michigan Students Advocating Recycling), and **SBE** (Student Book Exchange). Green Greeks encourages sororities and fraternities (about one-fifth of all undergraduates) to increase their recycling efforts and to decrease energy, water and food waste. SOLE seeks to enforce the Code of Conduct regarding suppliers of apparel bearing UM's logo, thereby contributing to UM's role in social and economic sustainability locally and globally. MSTAR focuses on promoting awareness and the usage of both on and off campus recycling resources through exposure to the city's recycling infrastructure and education about materials that are recyclable[22]. Campaigns include annual plastic bag recycling drives, and sponsoring recycling at major campus events including Relay for Life, Dance Marathon, K-Grams Kids Fair, and the Big Ten Blood Challenge. Finally, SBE provides students an alternative to shopping for and selling books at bookstores. (See Appendix B for a complete list of student organizations identified by the Office of Campus Sustainability as being involved in sustainability activities.)

Coursework. An expanding number of courses throughout the university also introduce students to sustainability concepts and environmentally responsible behaviors. Within the undergraduate major, the Program in the Environment, 47 courses have been offered in one semester; many of them will change each semester. The Office of Campus Sustainability website[23] gives the following statistics related to the availability of sustainability-related education at the University of Michigan:

- more than 10 undergraduate degrees
- one dozen masters degrees
- 15 doctoral programs
- a wide variety of certificate, minor, and concentration options
- hands-on, field-based courses

One recently introduced and popular introductory course, Environment 391 deals with *Sustainability and the Campus*. Besides lectures and field trips, students undertake projects dealing with campus sustainability issues and work with various UM units. Among the projects

conducted during the first two years are those dealing with *Greening IT practices, the Application of LEED for Existing Buildings, the AASHE's STARS rating program, a Big Ten Sustainability Report, a Bike Share Program Evaluation, and a Student Sustainability Guide* (which could provide a useful starting point for an official Green Guide that could be distributed throughout the campus).
A listing of courses dealing with sustainability is presented in Appendix C.

Staff and Faculty. Among staff members of the university, there are several formal and informal groups that address sustainability issues. **FUN** (Facilities Users Network) is made of facility managers, service providers and other professions and meets monthly to exchange information about environmental initiatives in buildings.[24] Highlights of recent meetings include presentations, updates and discussions on Green IT, campus construction projects, Planet Blue and the Building and Grounds Services, and the OS-1 maintenance program which includes a commitment to reducing the environmental impact of cleaning supplies.

VOICES of the Staff is a volunteer-based program offering UM staff members an opportunity to share ideas and define the campus community issues that matter most to you. The members of the VOICES network groups are chosen from the overall pool of applicants to represent a microcosm of the U-M staff community (demographics including work areas, gender, ethnicity and union representation).[25] "VOICES" has established an *Environmental Stewardship and Advocate* team and is currently seeking support to engage staff with "clear and consistent environmental messages". Their goal is to develop and promote "a greener and cleaner environment across the University community," by finding ways in which the staff can be engaged and integrated into environmental projects across the campus.

OSEH (Occupational Safety and Environmental Health) has numerous programs that promote the "safety and health of all UM employees, and encourage safe practices and strong environmental stewardship and to remain in compliance with state and federal regulations".[26] One of the programs deals with environmental sustainability. As part of UM's sustainability initiative, it reports to the director of Office of Campus Sustainability.

Buildings. A number of UM buildings have been used or have the potential to be used to teach members of the university community about sustainability. The Dana building was the university's first green building and was intended to promote environmental sustainability through innovative building design. The building houses the School of Natural Resources and Environment (SNRE) and is truly a learning environment to its students and others taking SNRE classes. The school offers actual and self-guided tours of the building that explain the many aspects of sustainability incorporated in the design of the build.[27] For several years, UM's Central Power Plant has also offered tours to students demonstrating how energy is managed on campus.

Although the building housing the Ross School of Business is LEED-certified and its energy-conserving features are touted on the school's website, it could also offer tours to students from across campus.[28] Similarly, tours could be arranged once the new green North Quad Residential Hall opens in fall 2010.

An examination of building energy use at UM reveals that energy usage is highest on the Medical and Engineering campuses. (See Appendix D.) This can likely be explained by the laboratory intensive nature of the work taking place in buildings at these sites. Behaviors in medical environments are governed by the protection of human life, while experimental medical and engineering research often requires high amounts of energy to maintain controlled conditions. High energy use is some laboratory buildings may be unavoidable. Nonetheless, there are opportunities to learn about the behavior of occupants in such high-energy density areas.

Land and Water. Community involvement is an integral part of the planning process at UM. For any new project, management teams including representatives of faculty, students, staff and, in some cases, members of the Ann Arbor community are created to find context-sensitive solutions that not only advance environmental sustainability but also consider the functional needs of these groups. For instance, when considering the selection of grass seed for lawn areas, the issue of both appearance and maintenance are addressed. Landscaping in general may be viewed as representing the front door of the campus and can contribute to people's "first impression". Thus, sustainable landscapes are addressed in land and water planning.

The university's planning office strives to be open and clear in working with other parts of the university and its constituents. As an example, it participates in an annual walking tour organized by the Department of Campus Safety for students and others. The tour addresses conflicts between night time safety and light pollution but also includes information about campus landscaping and its relationship to safety and sustainability.

Planning has also made strides to inform faculty, students, and staff about its vision for the campus's future. Besides engaging students, faculty and staff in the process, design concepts are made available on-line and are backed by clear statements on planning principles. For example, the plan for the expansion of North Campus illustrates the UM's commitment to open space preservation and native plant restoration. The report is clear and concise in its text and graphics. Presentations covering the North Campus and other projects are often made to university classes, faculty/staff groups, alumni, and the broader Ann Arbor community.

Transportation. There are multiple options for UM employees and students commuting to campus, including ride-share and carpool programs, commuter lots for private automobiles and free AATA use. Although some walk or ride a bike to campus, many people still drive alone. Within and among the campuses, the university provides a fully subsidized bus system for all campus members as well as the surrounding community. Although there are no data to back the claim, there is the perception that, for many students, faculty, and staff, riding a bus connotes a "second-class" status. There is also the belief among students that it's inconvenient to ride buses – having a personal vehicle available is viewed by many as a necessity. Nonetheless, data show that student ridership on the UM bus system has increased in recent years.

Food. Many people are working individually to make food at UM more sustainable. Personnel involved in food procurement and operations in the residential dining halls, in the Union, and within the hospitals, are for the most part interested in and willing to pursue more local and sustainable foods. Furthermore, there are many students and staff who actively show support for healthier and most sustainable foods on campus. There are efforts from separate individuals such as the head chef at East Quad, Nelson "Buzz" Cummings, who makes local and organic food available in that facility. Also, organizations like the Michigan Sustainable Food Initiative has aimed to establish a campus grocery store and campus farmers market, trayless dining (which can reduce food waste), and sustainable food purchasing.

Sysco Detroit is the largest food distributor serving UM. There are over 200 separate buyers at UM and deliveries are not typically coordinated. It is recognized that greater coordination would be useful in influencing Sysco Detroit's practices regarding the types of foods they carry and delivery procedures.

Procurement. In FY2009, UM spent roughly $2.4 billion on goods and services. This introduces a significant amount of material into the physical waste stream and a high energetic cost in services rendered. Responsible management of material goods from purchase through end-use recycling and disposal are paramount to the UM's ability to act as the leaders and best among sustainable campuses.

UM contracts with 185 strategic suppliers. Of these, 71 suppliers offer "green products," 101 are Michigan based companies, and 18 offer Energy Star products.[29] At present, the purchasing culture is diffuse and there is no overarching policy regarding sustainable purchasing. The university is focusing development of their online procurement website, M-Marketsite, to improve the ease of sustainable purchasing. At present the website features 43 of the university's strategic suppliers and seeks to expand. Benefits of M-Marketsite include eliminating paper orders, prioritizing local suppliers to reduce transportation, and identifying Green Products. The site incorporates suggestions such as a minimum purchase value of $50 to consolidate shipments. At present there is no official policy mandating purchase consolidation or dictating specifications for "Green Products."

CSCI@UM (Climate Savers Computing Initiative at UM)was a 2-year project that began in March 2008 with the main goals of promoting green computing education and awareness to the entire campus with a greater focus on behavior rather than policy change. CSCI@UM efforts included green IT purchasing (EPEAT-rated products and recycled printer paper) and changing energy-saving settings on campus computers. CSCI@UM was a volunteer effort that began after UM Alumnus and Google co-founder, Larry Page, approached President Coleman and encouraged UM to be a founding university member of the larger CSCI organization. The 2-year initiative has ended and it is unclear whether CSCI@UM continues to operate or if certain initiatives were adopted by IT services at large.

Recycling. UM has been a national leader in recycling and as noted earlier, have received national awards for its work. Its recycling program is a collaborative effort with the City of Ann Arbor's Material Recovery Facility. Ann Arbor is currently a dual-stream recycling system which separates paper from accepted mixed containers (glass, #1, 2 bottle shaped plastics, aluminum, and cardboard cartons). The city and, consequently, the University plans to switch to single stream recycling (all materials will be separated at the recycling plant) and expand plastic collection to include #4-7 plastics.

OSEH (see above) handles the collection and proper disposal of chemical, radioactive, and biological waste, including fluorescent light bulbs, solvents, and paint. OSEH works closely with the Graham Environmental Sustainability Institute and the Office of Campus Sustainability to compile and report 150 environmental indicator metrics in the Annual Environmental Report.

Property Disposition is UM’s department that regulates the property that has been purchased by the University and is no longer being used. All property “of value,” regardless of whether it is functioning, must go through property disposition before disposal or recycling.

Finally, **WMS** (Waste Management Services) has separate operations that are unique to the Recycling Program and service University departments and dormitories. These materials include polystyrene, printer cartridges, E-waste, and non-hazardous lab materials such as pipette tips. WMS also sponsors the University’s participation in RecycleMania, the 10 week competition among colleges and universities across the U.S. to see which school can collect the largest amount of recyclables per capita, the largest amount of total recyclables, the least amount of trash per capita, or have the highest recycling rate over the course of the competition.[30] This was the University’s fifth year of participation and they finished 90th out of 267 schools based on a recycling rate of 29.95%.

As mentioned, earlier, student involvement in recycling activities on campus has played a critical role in waste reduction and re-use and had been instrumental in sensitizing students to broader sustainability issues.

What’s Happening at Other Schools Re: Culture of Sustainability? UM is certainly not unique in its efforts to promote a culture of sustainability. Other colleges and universities throughout the U.S. have undertaken various efforts to engage their students, faculty, and staff in creating a more sustainable campus. Whereas some institutions have employed top-down or administrative approaches, others have actively engaged students, staff, and community members in deciding how best to strengthen efforts towards environmental sustainability. The actions of other colleges and universities to conserve energy and reduce waste through effecting human behavior provided useful guidance as we developed our recommendations.

Administration-led Initiatives. First, several universities have promoted sustainable behavior by making simple but meaningful changes that influence the amount of resources that are consumed by students and others. For example, research has long indicated that students waste less food in dining halls when cafeterias do not provide food trays, so numerous institutions have initiated trayless dining hall programs. Among them are North Carolina State, the University of Pennsylvania, the University of Illinois – Chicago, Barnard, and Grand Valley State, which has reduced its food waste by 950 pounds per week.

Other schools have undertaken initiatives aimed at encouraging sustainable food consumption. Harvard Medical School’s dining halls have fair trade, free range, and local foods, and there are signs to inform students about their food choices. The University of Nevada – Reno has a marketing campaign aimed at informing students about sustainable food. To reduce the use of bottled water, the University of Maryland has placed "triple filtered" water stations to supplement bottled water sales on campus. UC-Berkeley has set a goal of making 20% of its food purchases sustainable by 2020 and has created a Foodservices Working Group to facilitate this goal. Thus, numerous universities have begun to take direct steps towards greater sustainability in their food consumption.

Several school administrations have tried to build norms of recycling and procurement on their campuses. A 2008 evaluation of the 300 colleges and universities in the U.S. and Canada with the largest endowments found that sixty one percent of schools had some form of a green purchasing policy.[31] However, only a few universities have set hard line green procurement policies. In 2008, UC Berkeley funded a Green Purchasing Associate to compile and recommend policies and guidelines for a Green Purchasing Action Plan through T.G.I.F. (The Green Initiative Fund).[32] Also in 2008, Notre Dame partnered with Office Depot to fund two student sustainable procurement internships. Both students worked with the Office of Sustainability and Procurement Services at ND and with Office Depot to explore and encourage sustainable purchasing on campus.[33] To encourage reuse of supplies, the University of Virginia and University of Oregon offer the Reusable Office Supply Exchange Program (ROSE) and makes campus members aware of this resource through promotions. At U. of Oregon, ROSE is operated by one student employee and costs approximately $40 per week to operate.[34]

Campus administrations have also undertaken initiatives to influence individuals' travel habits. The University of Nevada at Reno (UNR) is a leader in this area. Students and faculty are given information about alternative forms of transportation throughout their time on campus – at advising sessions, new student/new hire orientation, open houses, and on websites, newspapers, flyers, informational tables at move-in and signs around campus. UNR also has an annual "Bike to Work Day," which targets sorority and fraternity houses with specialized marketing materials that promote walking to campus, and gives five free daily parking permits (for use on bad weather days) to bicyclists and walkers that are registered with the parking office. To help cyclists maintain their bicycles, UNR organized the Reno Bike Project, which carries bike supplies and repair instructions and holds bike repair days on campus.

To reduce energy consumption, universities have undertaken a number of top-down initiatives, but many of these have been mechanical rather than cultural. One exception has been the determination of university-wide greenhouse gas (GHG) emissions targets which encourage practical and research initiatives to reduce a university's overall environmental impact. Columbia University, for example, has committed to reducing carbon emissions to below 2005 levels by 2017, Michigan State University has committed to reducing GHG emissions to 15% below 2005-2006 levels by 2015, and Penn State University has committed to reduce emissions to 17.5% below 2006 levels by 2012. Unfortunately, there is no indication that behavioral initiatives have taken place to achieve these goals.

Students and Staff Engagement. Numerous colleges and universities have undertaken major efforts to engage students and staff in building cultures of sustainability. One common activity,

which is related to food, land use, aesthetics, and curriculum, is the development and maintenance of campus farms or gardens. At the University of Oregon, for example, the campus farm provides sustainably-produced food for students, and it is also used for demonstrations and experiential learning. UC-Berkeley's centrally-located Victory Garden contains signs and educational materials and aims to raise awareness about sustainable food. These initiatives rely largely on student and faculty participation.
Likewise, many recycling efforts have involved students and staff. Several universities have held competitions and challenges amongst its schools, offices, and dormitories to encourage recycling and reduce energy usage. The results during the events are generally positive, but the long-term impact is unclear. Both Barnard and Bucknell have recycling monitor programs where resident advisors (in dormitories) or volunteers encourage and enforce proper recycling behavior. At the California Institute of Technology, the *Recycling Champions Initiative* is an employee-driven effort that focuses on increasing the convenience of recycling; their successful model is open-source and ready to spread throughout the university and elsewhere.[35]

There have also been efforts aimed at influencing how individuals choose to consume energy. For example, the University of Wisconsin's *We Conserve* program gives students the opportunity to pledge their commitment to energy saving goals. Harvard has a *Green Labs Program*, which promotes sustainable efforts amongst its laboratories, and UCLA has created an internship through which students develop behavior-based strategies for reducing energy consumption. At Western Kentucky University, a system has been developed to display real-time energy use in residence halls; giving students instant information about their energy usage and is a frequent reminder (or prompt) that energy consumption matters. In order to influence individuals' travel behaviors, the University of North Carolina has a *Commuter Alternatives Program* that has members pledge to arrive on campus via a means other than a single occupant vehicle.

In addition to these targeted programs, several schools have initiated programs that allow students to develop original solutions to campus sustainability challenges. Providing financial grants for student projects has been one common trend. For instance, the Sustainability Task Force at New York University funds project proposals that "spark the imaginations of the NYU community and advance our long-term future as a sustainable university." Examples of completed projects include a study of sustainable rooftop perimeter barriers, pilot campus bike-sharing program, and an environmental public art competition. UC-Berkeley funds sustainability projects through a $5 per semester student fee, which will allow for approximately $250,000 per year to be awarded to students, faculty, and/or staff projects on campus. One recent project was a $58,600 grant to support water metering in eight campus buildings to increase awareness and educate building users. Another common trend at leading universities is to have student "eco-representatives" who promote sustainable behaviors in dorms, departments, or other parts of campus. At Dartmouth, for instance, eco-reps promote recycling, composting, energy conservation and more.

Community Outreach. Several colleges and universities have also undertaken efforts in their local communities to promote sustainability. For example, many schools showcase their environmentally sustainable buildings. For example, at UC-Irvine, visitors from the campus community and beyond can visit the "The Green Room," which includes environmentally friendly furnishings, Energy Star certified products, and purchasing information for these products. Several other schools, like UCLA and Furman, have model green dormitories, and Notre Dame utilizes a virtual room on its housing website to reach students before they arrive. At Furman College, the LEED Gold-Certified Cliffs Cottage Project is the first sustainable Showcase Home for Southern Living magazine, one of the project's major partners. The Cottage includes geothermal and solar thermal technology, xeriscaping (landscaping designed for water conservation), low-flow water fixtures, rainwater collection cisterns and organic gardens.

Several schools have developed unique outreach programs. For examples, UNC-Chapel Hill coordinates the National Safe Routes to School program, which enables and encourages children to safely walk and bike to school. Arizona State University educates community members about sustainable development with its Decision Theater, which draws on numerous disciplines to create an interactive, immersive, learning environment. Through computational and visualization technologies, visitors learn about major environmental issues in urban growth, public health, education, and environment. Like other universities, ASU also has K-12 programs and a Sustainable Cities Network involving ASU, city, county and tribal leaders.

Finally, several universities regularly host conferences where they educate and discuss sustainability in various fields. For example, UNC-Chapel Hill's Office of Waste Reduction and Recycling (with NC Recycling Business Assistance Center and the Orange County Solid Waste Department) sponsors a free, half-day educational event for local builders. UNC also sponsored a conference on how climate change is influencing their coastline. Likewise, universities in Kentucky host sustainability conferences on a rotating basis through the Campus Community Partnerships for Sustainability.

Throughout our review of initiatives to promote a culture of sustainability on other campuses, we were unable to find documentation indicating the extent to which changes in recycled materials, energy use, transportation costs, and/or organic food consumption were attributable to changes in the behaviors of students, staff, or faculty. Nor was there any evidence showing that the actions taken at the schools had shifted the mindset of members of the university community. We believe that UM has the opportunity to capitalize on the experiences/initiatives of these other schools and at the same time move to the forefront of creating a culture of campus sustainability. Several of our recommendations, if acted upon, will enable us to do so.

SHORTCOMINGS, CHALLENGES, AND OPPORTUNITIES

In the process of identifying what is happening at UM in its sustainability efforts, we identified a number of shortcomings related to our cultural agenda. Several are discussed below. Many relate to a lack of awareness of what is happening on campus. We also believe that UM faces challenges in dealing with these shortcomings and in creating and maintaining a culture of campus sustainability.

Shortcomings. With respect to the roundtables organized by SSI, attendance at the monthly events this past year has been low and disappointing to the organizers. Many attribute poor attendance to apathy on the part of students while others indicate that the general student body is unaware of SSI, its mission, or the salience of the issues surrounding UM's sustainability initiative. Communications within and between student organizations has been weak and events are not as well publicized as they could be.

The introduction of recycling to first year students in the residence halls is considered by many as sketchy and often treated superficially. In fact, some believe that students do not retain all the information given to them during orientation. Others believe that past behaviors are hard to change. In fact, the Ecolympics was discontinued by housing officials when they learned that pro-environmental conservation practices which led to winning the competition were discontinued after the award was made. At present, it appears that there is no overall outreach plan in the residence halls to increase the level of awareness about sustainability efforts.

Still another shortcoming relates to travel and transportation issues. The Transportation Team believes that while UM offers a range of travel options for students, faculty, and staff, these options are not well publicized and understood. For example, it was noted that the benefits offered by AATA to members of the university community and the way the bus system works (routing, scheduling) are not well known to many students.

With respect to buildings, it was suggested that Planet Blue, while professing to target all building occupants in their interventions, is primarily reaching those people who spend most of their time in the building, namely the staff. Students and faculty may participate in a Planet Blue open house if they happen to be in the building at the time the event is scheduled. Otherwise, it is questionable whether or how much they know about the program's intent or operations.

As mentioned earlier, there is little coordination among those ordering food in different parts of the university. Food procurement is highly decentralized. At the same time, the degree to which there is interest in organic food procurement and consumption is unknown.

Challenges. Commitment, time, and financial resources will be required in order to implement recommendations outlined in the following section. These represent challenges that through creativity and numerous collaborative efforts, can be overcome. With regard to commitment, administrators, staff, faculty and students throughout the university need to "buy in" to the goal of creating a culture of sustainability at UM. There are indications that this is beginning to happen.

In fall 2008 the Theme Semester for the LS&A's *Program in the Environment* was Energy Futures which sparked considerable interest across campus from administrators, students, staff, and faculty. As previously discussed, President Coleman announced the university's *Sustainability Initiative* in fall 2009. In making the announcement, President Coleman acknowledged the role of the Student Sustainability Initiative (SSI) whose efforts were instrumental in establishing the initiative. While SSI is a dedicated and important group on campus, there is concern that the vast majority of the students may not be committed to a sustainable lifestyle nor to creating a culture of sustainability on campus. A number of recommendations discussed below are designed to increase that commitment.

Commitment has also been demonstrated by the provost's office and the faculty through the recent Provost's Seminar on Teaching. The 2010 topic was *Dialogues on Teaching Sustainability* and attracted more than 150 faculty members from across campus. Although the turnout was one of the largest for a Provost's Seminar on Teaching and generated animated discussion on ways of research UM students, the question is open on the commitment of the 6000 or so faculty who were not in attendance.

Commitment as well as external regulations may be a challenge in dealing with our recommendation regarding equipment sharing (as described in additional recommendation 3 in Appendix A). For numerous reasons (convenience, control, financial), researchers may be unwilling or unable to share equipment or other types of resources with others in their department or elsewhere on campus. At the same time, federal regulations may present difficulties if research proposals indicate that funds for new equipment will be shared as a conservation effort.

Getting a commitment from most students, faculty and staff to creating a culture of campus sustainability represents one challenge for UM. The backlash or resistance to some of our recommendations if implemented poorly presents another challenge.

Still another challenge to building a culture of sustainability is *time*. UM students, faculty, and staff are busy people engaged in a multitude of activities. Besides attending classes and studying, most students have a social life and are engaged in other activities such as field work/internships/ outreach projects, sports, the arts, etc. Moreover, many are employed within or outside the university. For some, knowledge about sustainability issues and interest in learning about them are low and may not be important agenda items at this stage in their lives.
Time is also a precious commodity for faculty members who have teaching, advising, research, and departmental responsibilities. While they have considerable discretion as to how they allocate their time, many may not be committed to devoting time toward achieving a culture of sustainability on campus or feel ill-equipped to deal with sustainability issues in their teaching or research.

Indications are that there is considerable staff interest in some parts of the university in playing a role in creating a culture of campus sustainability. Many in fact have organized themselves around sustainability issues. The Environmental Stewardship Team of the *VOICES of the Staff* has proposed a coordinated program involving the creation of M-Stewards. The M-Stewards would engage UM staff members "with information about environmental issues and UM sustainability initiatives." Because of time pressures in carrying out their day-to-day responsibilities, staff members may not have time or be willing to become engaged in this initiative.

Finally, financial resources necessary to implement many of the recommendations outline below can be viewed as a challenge. For instance, Recommendation 1 (see below) about hiring a cultural liaison staff person in the Office of Campus Sustainability will require funding for the new staff position. It will also take funds to develop the appropriate training materials for resident hall advisors, teaching assistants, and other students employed in by the university.

Additionally, funding will be needed to design and execute many of the recommendations involving data collection and research. .

Opportunities. Attendance at the recent *Dialogues on Teaching Sustainability* is a clear indication that there are UM faculty members who are interested in and are positioned to play a role in moving forward with some of the recommendations discussed below. Courses within different parts of the university could be created so that "Implementation Strategies for Recommendation X" becomes a class project. For instance, the development of training tools, tutorials, testing modes etc. which would be needed for Recommendation 2, Additional Recommendation 7 (AR7) and AR8 could be class projects in the School of Education and/or the School of Natural Resources and Environment. Similarly, research recommendations or those involving the collection and analysis of data about people (Recommendation 4, Recommendation 5, AR4, AR9, AR10, AR11, AR14, AR15) could be projects for graduate courses in the social sciences or professional schools.(i.e. sociology, psychology, business, urban planning, architecture, natural resources, etc.). A model for the latter might be the Detroit Area Study (DAS) administered through the sociology department for more than 50 years.[36]

DAS was a 3-semester course sequence that was designed to 1) train graduate students from many fields in quantitative (and sometimes qualitative) social science research techniques, 2) facilitate faculty research, and 3) inform public policy. It proved to be a rewarding learning experience for students and important resource for faculty interested in policy-oriented research.

While similar courses could be designed to run for less than 3-semesters, the idea of course practicums presents opportunities for initiating work on a number of recommendations.

RECOMMENDATIONS

The priority recommendations and those covered in **Appendix A** represent a package and are intended to move UM toward the goal of establishing a culture of sustainability by enhancing awareness and promoting environmentally responsible behaviors among of UM administrators, students, faculty, and staff. Furthermore, a number are intended to measure and demonstrate how well the university does in achieving this goal. The set of recommendations stem from an examination of (1) relevant research from environmental psychology and consumer behavior, (2) sustainability initiatives on other campuses, (3) suggestions/comments gleaned from the IA CTools site, town hall meetings, & meetings with UM officials, and (4) current practices at the University of Michigan. Based on this information, we offer recommendations that fulfill three purposes: engagement, educating/training, and assessment/monitoring sustainability initiatives.

***Recommendation 1* (Engagement).** *A full-time cultural liaison position should be created in the Office of Campus Sustainability (OCS) to engage students, faculty, and staff, harness and evaluate their conservation minded efforts and ideas, help bring those ideas to fruitions, and understand the experimental nature and process of moving toward a culture of campus sustainability. This staff member would be responsible for coordinating all initiatives aimed at building a culture of sustainability and work closely with the OCS director, other OCS staff, and a cultural advisory panel. Among the responsibilities, he/she would be charged with soliciting and uncovering existing ideas from* *middle management throughout UM. These ideas would then be brought before an ad hoc working group of administrators who would discuss & assess them and develop strategies for implementing the most promising ideas. He/she should be skilled in networking, have a thorough understanding of the university and its research capabilities, and should be available as a mentor and resource to students seeking involvement in sustainability initiatives. Still another function would be organizing 1-2 sustainability town hall meetings per semester. Finally, the individual would be the point person for developing cultural metrics (indicators) on sustainability and for tracking them over time.*

Recommendation 2 (Education/Training). *In order to create a strong cadre of upper classmen who are committed to sustainability practices and could serve as mentors, and role models for freshmen,* **University Housing** *in connection with* ***OCS*** *and possibly the* **Center for Research on Learning and Teaching (CRLT) and the School of Education,** *should design and implement a sustainability training program for resident hall advisors (RA) and Eco-Reps on each floor of residence halls.*

Recommendation 3(Education/Training). *The* **Office of the Provost** *in consultation with deans of academic units should explore the feasibility of a "global awareness" or "ecological literacy" requirement for all undergraduate students, similar to the current race and ethnicity requirement in LS&A. A sustainability requirement would not be limited to SNRE classes but could draw from existing and new course offerings in different parts of the university. Faculty from all units should be encouraged & rewarded for developing new courses in their respective fields or incorporating sustainability topics in current courses.*

Recommendation 4 (**Assessing/Monitoring).** ***OCS*** *should establish a program of cultural metrics (indicators) to supplement their program covering environmental metrics. The program should be designed to measure and assess progress in creating a culture of sustainability at UM. While OCS has been good at tracking changes in energy use, green house gas emissions, water use, and recycling over time using hard measures, it needs additional measures or indicators that reflect various social dimensions of the university's culture with respect to sustainability. Such cultural metrics can come from periodic surveys aimed at tapping levels of awareness and understanding, degrees of commitment and involvement, values, world-views, and sustainable behaviors. Similarly, other types of cultural metrics should be considered such as stories in the Record or Daily, green purchases in stores near campus, growth in the number of sustainability classes, changes in titles of sustainability theses/dissertations, etc.*

Recommendation 5 (**Assessing/Monitoring).** *As part of the work in developing cultural metrics,* ***OCS*** *should launch a study designed to tap faculty, staff, and student perceptions of our campus including views on its sustainability efforts with regard to its landscape character, buildings, waste management, food offerings, etc. Findings from such a study would help in determining what cultural metrics are most appropriate. They could reveal the extent to which people's views on UM's sustainability efforts influenced decisions to come to UM (as students or employees) and remain here. As a first step toward implementing this recommendation, a series of focus groups should be initiated.*

JUSTIFICATION

The following is a brief justification for our 5 priority recommendations.

Recommendation 1 (Engagement). Although we recognize that the Office of Campus Sustainability (OCS) has primary responsibility for implementing recommendations stemming from the Integrated Assessment, it will need to coordinate its efforts with the Graham Sustainability Institute, the Sustainability Executive Council, academic units, other campus departments, and student, faculty, and staff groups. Nonetheless, the Culture Team believes that there needs to be a point person *within* OCS whose overall responsibility is to initiate, guide, and coordinate the activities necessary to build a culture of sustainability on campus. There is clearly a strong desire to implement environmentally sustainable practices among staff and students throughout the university. At the same time, staff and students don't know where to go with their environmental concerns or ideas. The individual would be identified as the go-to person who would address these issues and concerns and work toward achieving other recommendations emanating from the Culture Team.

Recommendation 2 (Education/Training). Past research has shown that the actions and influence of peers is likely to be more effective at influencing behavior than top-down directives. While past efforts to promote sustainable practices in student housing have had modest success and produced immediate rewards for students and the environment, not all students participated. Nor did everyone understand the programs (i.e. RecyleMania, Ecolympics) and communication within the residence halls was limited. Since 97 percent of all entering freshmen live in resident halls and their Resident Advisors and Eco Reps are the first upper classmen they meet, these potential student leaders serve as mentors and role models for first -year students. The expectation is that the knowledge gained and the environmentally responsible behaviors of these students while living in dorms will carry forward during their remaining time at UM and beyond. Moreover, it is anticipated that students will continue to be a driving force in bringing new ideas to the campus and in creating a culture of sustainability on campus.

Recommendation 3 (Education/Training). This recommendation should be relatively easy to implement and ensures that all students are formally exposed to the broader problems of climate change, resource use, and their human dimensions. Furthermore, it supports the interest shown by faculty at the recent provost-sponsored Dialogues on Teaching Sustainability.

Recommendation 4 (Assessing/Monitoring). Other schools have developed environmental or sustainability reports similar to what UM has produced recent years. While many provide data on recycling growth, energy use, water consumption, changes in land use patterns, etc., none provide metrics indicating changes in culture of sustainability on campus. UM could be a leader in establishing and reporting such metrics. Not only would we be able to show that all are efforts are bearing fruit, but it would provide on-going information that would help OCS and university officials modify existing programs and create new ones where necessary.

Recommendation 5 (Assessing/Monitoring). As a first step toward developing cultural metrics which would be included in UM's annual report, information in needed now on how we are currently doing in the eyes of the students, faculty and staff. Many of UM's activities at reducing energy use, growing our recyclables, etc. are successful. But we do not know how much of this in known, understood, or valued by students, faculty, and staff. Nor do we know what role those of us in the university community have played in contributing to success. Many of UM's programs such as Planet Blue can be viewed as experimental and as such, they need to be regularly evaluated or monitored so as to determine the degree to which they are successful. This information can inform OCS in their deliberations & in their decision to continue the program as is, continue but fine-tune them, or eliminate them. The information may also be useful in the university's recruitment and retention strategies.

Culture Team

The Culture Team comprises five graduate students, three undergraduates, and one faculty member. Our collective experiences and expertise are extremely wide-ranging and include architecture, education, urban planning, engineering, natural resources, and organizational leadership. Below are details on various team members' backgrounds.

The team consists of the following members:
Dr. Robert Marans, Faculty Lead

Team Members:
Jazmine Bennett
Kevin Bush
Courtney Doman
Celia Haven
Beatrice Holdstein
Julie Janiski
Brett Levy (Student Lead)
Ryan Smith

Jazmine Bennett just completed her first year of studies in the University of Michigan School of Natural Resources & Environment Master of Science program, concentrating in Sustainable Systems. She received her B.A. from Bowling Green State University in 2009 graduating magna cum laude in Environmental Policy and Analysis, specializing in Sustainable Management. Jazmine's master's project is helping a local brewery to evaluate their energy use and recommend possibilities for onsite renewable energy generation, improvements for energy efficiency in the brewing process and building structure and increasing awareness of sustainable practices to their customers.

Kevin Bush, LEED AP, has a BA in Marketing [2007] from Michigan State University and is currently working on a Master of Urban Planning from the University of Michigan. While at the University of Michigan he has served as an AmeriCorps volunteer on Detroit's east side, worked at the Michigan State Housing Development Authority, and coordinated data-collection for the Detroit Residential Parcel Survey. He currently works in the City of Chicago Mayor's Office as a Mayoral Fellow.

Courtney Doman completed her B.S. in the Program in the Environment [2010] at the University of Michigan. While at Michigan, she studied sustainable hydropower development in South America as a member of the Graham Environmental Sustainability Institute Scholars Program and studied food ethics as an undergraduate fellow through the University of Michigan Center for Ethics in Public Life. As a member of the culture team, Courtney served as liaison to the purchasing and recycling team. Courtney hopes to continue working within the food system to address human and environmental health and cultural preservation.

Celia Haven received her BA from the University of Michigan in the Program in the Environment in 2010, where she specialized in Michigan ecosystems. Besides her work for the Integrated Assessment, she has completed an internship at the Matthaei Botanical Gardens, where she received the Nanette R. LaCross award for exemplary commitment to environmental concerns, and worked as a project manager for a nonprofit ecological restoration project. Celia will begin an internship with the Great Lakes Commission in summer 2010.

Beatrice Holdstein is from Worcester, Massachusetts and just completed her freshman year at the University of Michigan. Writing her research paper, "Sustainability at UM: Students Take Initiative" gave her a unique understanding of student involvement with sustainability on campus. This prepared her to serve as the student liaison for the culture team. She is a Program in the Environment major and is looking forward to delving furtherinto her studies.

Julie Janiski is currently pursuing a Master of Architecture degree at University of Michigan. She received her undergraduate degree in Urban Design/Architecture Studies and French at New York University in 2004. Prior to arriving at UM, Julie worked for Platt Byard Dovell White Architects (PBDW) in New York, taking one year away to complete a graduate degree in Sustainable Design at the University of Sydney (2008). At PBDW Julie championed a number of green design initiatives and workshops for the firm and oversaw the environmental aspects of numerous projects ranging from schools and museums to historic landmark buildings and high-rise towers. This summer, Julie is working with the Environment group at Buro Happold Consulting Engineers in New York.

Brett Levy is a doctoral candidate at the University of Michigan's School of Education, where he has also served as a Graduate Student Instructor since 2006. Before coming to UM, Brett earned his BA in history from Princeton and taught history and English for four years in California. In Ann Arbor, he has been involved in numerous campus environmental groups, including Focus the Nation, which fosters understanding and civic engagement on climate change issues, and the Student Sustainability Initiative, which promotes collective purposes and actions among UM's diverse environmental community. In 2008, Brett earned a Master of Arts in Educational Studies, and in 2010, he completed a Master of Science in Natural Resources and Environment. His doctoral research explores educational methods for fostering civic engagement among high school students.

Robert W. Marans is a research professor at the Institute for Social Research and a professor emeritus of architecture and urban planning in the Taubman College of Architecture and Urban Planning at the University of Michigan. During the past 30 years, Dr. Marans has conducted evaluative studies and research dealing with various aspects of communities, neighborhoods, housing, and parks and recreation and recreational facilities. His research has focused on user requirements and the manner in which attributes of the physical and sociocultural environments influence individual and group behavior and the quality of community life. Much of Dr. Marans' research has been in the context of urban areas. His current research considers the impact of the built and natural environments on quality of life, the role of neighborhood in the health of Detroit residents, and issues of sustainability and energy conservation in institutional settings.

Ryan Smith is pursuing a Master of Science in Mechanical Engineering with a concentration in Environmental Sustainability at the University of Michigan. He comes to the University after 2 years working as a Project Engineer for the Detroit nonprofit organization NextEnergy Center. Ryan received his Bachelor of Science in Mechanical Engineering from Lawrence Technological University in May 2007. He has managed several U.S. DOE and DOD technology projects while at NextEnergy and is now advocating sustainability at UM as a leader of the Student Sustainability Initiative. His research interests are in life cycle analysis of emerging energy storage technologies, as well as the factors that influence human interaction and behavior toward sustainable action

Appendix A

ADDITIONAL RECOMMENDATIONS (AR) FOR CONSIDERATION

AR1 (Engagement). The **Office of the Provost** working with **Human Resources (HR)** should require each academic unit to develop a sustainability plan for its operations, including measurement objectives for reducing and managing natural resource use. Each faculty and staff member would assume responsibilities (individually or collaboratively) for implementing the plan. Annual performance evaluations for faculty and staff would include an assessment of efforts in moving toward implementing the plan. Performance evaluations would be public within the units.

AR6 (Engagement). **OCS** should initiate discussions with the **Medical School, Engineering, Dentistry**, **Chemistry**, and other units with laboratories about organizing a *Sustainable Laboratory Consortium*, similar to what exists at Harvard. . The consortium could serve as a roundtable for laboratory administrators and researchers to share information & methods used to reduce energy usage.

AR12 (Engagement). Consideration should be given by the **Office of Student Services** working in cooperation with **OCS** to creating competitions designed to provide "fun" solutions to the challenge of increasing sustainability practices on campus. This could be similar to the Volkswagen initiative, Thefuntheory.com, a "site [which] is dedicated to the thought that something as simple as fun is the easiest way to change people's behaviour for the better." Funding from Volkswagen (or some other willing sponsor) could be sought to implement the competition including prize money for the winning entry. One submission was "The World's Deepest Bin," a garbage can retrofitted with motion sensors to play an audio clip of a "long fall" noise followed by a "thunk." This incentivized passersby to throw garbage away in the bin instead of littering[1]. In addition to targeting UM students in residence hall and elsewhere on campus, **OCS i**n conjunction with
VOICES, SACUA, and groups should consider similar programs that target staff and faculty.

AR13 (Engagement). As an expansion of key recommendation 1, **OCS** in collaboration with the **Graham Institute** should host regular hall meetings and consistently question the students, faculty, and staff on how to tackle sustainability-related problems. They should also facilitate smaller meetings or focus group sessions in each of the schools and colleges within UM

[1] http://www.youtube.com/watch?v=cbEKAwCoCKw&feature=player_embedded

AR2 (Education/Training). As a condition of employment, faculty and staff should be required to become *Sustainability Certified* within the first year of employment and be periodically re-certified. Sustainability certification would be patterned after the PEERRS[2] certification required of all UM researchers and consists of on-line "educational modules and short tests covering basic rules, procedures and professional norms for the responsible conduct of research by anyone involved in research and scholarship at the University of Michigan." The **Office of the Provost** should work with **HR**, **OCS** and **IRB** to explore the feasibility of establishing this requirement.

AR5 (Education/Training). In collaboration with **OCS, Procurement Services** should develop a program for training administrative staff members who are responsible for purchasing and have the potential to disseminate sustainable behaviors throughout their unit. As the University of Michigan works to expand use of *MMarket* site, the university's online catalog ordering system, efforts should be made to educate the more than 4000 UM buyers on the best practices to reduce UM's environmental impact such as bulk ordering to reduce shipping, locating and purchasing from "green" suppliers, etc. Administrative staff people are also an excellent pool of individuals from which to draw "sustainability representatives" within units. One positive example of this is "Recycling Champions" Initiative[3] which was created within CalTech's Financial Services. This employee driven effort focuses on increasing the convenience of recycling and their successful model is open-source, ready to spread throughout the university and elsewhere. Their slogan, "100% Easy, 100% Voluntary, and 100% Appreciated" captures the essence of a community-driven, cultural intervention to increase sustainability on campus.

AR7 (Education/Training). In order to create a strong cadre of graduate students who are committed to sustainable practices and who will become teaching assistants (TA), the **Office of the Provost** working with **CRLT** should develop training programs incorporating ecological literacy and sustainability concepts into their teaching skills Participation in the program should be a prerequisite to taking the TA assignment.

AR8 (Education/Training). Entering UM students should be encouraged to complete an online sustainability tutorial before coming to campus in the fall. Students completing the tutorial would be rewarded (e.g. one credit-hour, certification, etc.). The tutorial could be patterned after AlcoholEdu and could include interactive videos and short exercises. It could also be modeled after the PEERRS certification required of researchers by UM's IRB (see **AR 2**). The **Admissions Office** should explore this idea in consultation with UM's **Program in the Environment** and the **OCS**.

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[2] PEERRS is UM's Program for Education and Evaluation in Responsible Research and Scholarship and consists of consists of educational modules and short tests covering basic rules, procedures and professional norms for the responsible conduct of research by anyone involved in research and scholarship at the University of Michigan

[3] **http://sustainability.caltech.edu/materials/waste_recycling/office_project**

AR10 (Assessing/Monitoring). Perceptions of the campus including views on its sustainability efforts with regard to its landscape character, buildings, waste management, food offerings, etc. may influence *prospective students and their parents* in their decisions to attend or not to attend UM. **Admission officials** working closely with **OCS** should consider a study to test this proposition. If perceptions of the campus are a factor in student and parental decisions, the positive aspect regarding campus sustainability should be included in UM marketing efforts.

AR11 (Assessing/Monitoring). A similar study should be launched to tap the perceptions of alumni about UM's sustainability initiative and issues related to the campus's landscape character, buildings, waste management, food offerings, etc. If these efforts are viewed as important to *alumni*, it could influence their financial and emotional commitments to UM. **The Alumni Association** working closely with **OCS** should consider a study aimed a testing this proposition.

AR14 (Assessing/Monitoring). In efforts to move toward a more sustainable transportation system within the university, several proposals to reduce reliance on the automobile and increase bicycle use are being proposed by the IA Transportation Team. As a way of tracking UM's progress in moving toward a more sustainable transportation system and generating data to substantiate their proposals, the Transportation Team has suggested that data on travel behavior and attitudes of members of the university community should be collected. While some of these data may be available, others kinds of data should be obtained through periodic surveys of samples of students, faculty, and staff. The **Office of Parking and Transportation Services** should coordinate efforts with **OCS** to design and implement studies that provide answers to some of the following questions: What are the perceived obstacles to alternative forms of travel to and from campus? What might get automobile commuters to ride bicycles or use public transit? What incentives could be offered to get people to change their mode of travel to/from campus?

AR15 (Assessing/Monitoring). As the number of green buildings on the UM campus increases, there are opportunities to learn about their energy performance which can influence the design of future building projects. At the same time, there are opportunities to learn about how these buildings are used by their occupants and the extent to which the buildings themselves inform people about sustainability. The **University Architect's Office (UAO)** together with **Plant Operations** and the **University Planner's Office** should develop a program for carrying out Post-Occupancy Evaluations (POE) of new and renovated buildings designated as green. A POE is an established process in architectural research that can be used to determine the degree to which the design objectives have been met. Furthermore, it can be used to determine how occupants respond to the building, use it, and learn from it. It can also determine how building conditions impact occupant performance of health. The state of New Jersey now has a program aimed at evaluating green buildings. UM should build on that initiative.

AR3 (Assessing/Monitoring). There is a tendency for research faculty to include the purchase of new equipment in their proposal budgets. Incentives to do this include the opportunity for sole ownership and use (non-sharing), bringing in additional funds which are allowable on federal grants and contracts, which if not used to purchase equipment, is often used for other purposes (i.e. student support, travel, etc.), and the potential to take equipment with them when leaving campus. **OCS** should work with **OVPR, ITS**, & other relevant units to determine the extent to which researchers will share equipment such as printers, copiers, etc. and if incentives might be valued by researchers to encourage them to share equipment.

AR4 (Assessing/Monitoring). Data show that a number of Planet Blue buildings have reduced their energy costs in recent years. Yet there are no data available indicating the degree to which behavioral interventions have contributed to cost savings and reductions in energy use. It is speculated that while some cost savings is attributable to behavior change among building occupants, most of the savings are the result of building modification or retrofit. **OCS,** working closely with the **Plant Operations Department** should initiate an evaluation study to systematically determine how much of the savings is attributable to changes in behavior and to assess the effectiveness of Planet Blue from the perspective of the building occupants. Study findings could demonstrate throughout the university the importance of environmentally responsible behaviors. Findings would also reveal what Planet Blue is doing well and what aspects of the program require modification.

AR9 (Assessing/Monitoring). The **Division of Student Affairs (University Housing)** in collaboration with **OCS** should launch research that investigates existing intervention models to raise levels of awareness and alter behaviors among residents of student housing. There exist pros and cons of various interventions, e.g. a presentation during orientation, a leaflet within the housing packet, participatory programs, continuous intervention by an educated Resident Hall Advisor (RA) and approaches used at other schools (i.e. Barnard, Bucknell) to engage students in sustainable practices. Alternative approaches should be viewed as experiments which need to be evaluated to determine their costs and benefits and long term impacts.

Appendix B

SUSTAINABILITY-RELATED STUDENT ORGANIZATIONS

Bass Fishing Team
BLUElab
Challenge X Hybrid Vehicle Team (CX)
College Democrats Environmental Committee
Cultivating Community
The Detroit Partnership
Earth Week (Informational e-mail address)
Ecology Center Students in Action (informational e-mail address)
Environmental Action (EnAct)
Environmental Enthusiasts (informational e-mail address)
Environmental Health Student Association (EHSA)
Environmental Policy Organization
Environmental Issues Commission (EIC)
Environmental Law Society
Erb Institute Student Advisory Board
Focus the Nation (informational e-mail address)
Freedom from Hunger (informational e-mail address)
GlobeMed
Go Blue Discover Green (informational e-mail address)
Green Greeks
GrEENPEAS
Hayerukim
Industrial Hygiene Students Association
International Law Society
Michigan Animal Rights Society
MSTAR (Michigan STudents Advocating Recycling)
Michigan Student Sustainability Coalition
Net Impact Undergrad
New World Agricultural and Ecology Group
Nourish International
Planners Network
RecycleManiacs
Roosevelt Institution: Policy Center for the Environment
Ross Energy Club
Ross Net Impact
School of Natural Resources and Environmental Student Government
SEEDS (Strategies for Ecology Education, Development, and Sustainability)
Solar Car Team
Student Animal Legal Defense Fund
Student Environmental Action Coalition
Students for PIRGIM (Public Interest Research Group in Michigan)
Sustainable Agriculture Work Group (SAGI)
Sustainable Alternative Energy Student Council (SAESC)
Student Sustainability Initiative
Society of Les Voyageurs
Squirrel Club
Undergraduate Political Science Association
Wilderness Skills Club (informational e-mail address)
Wolverine Geocachers (informational e-mail address)

Appendix C

SUSTAINABILITY COURSE INDEX*

Architecture
ARCH 425 - Environmental Technology II
ARCH 503 - Sustainable Urbanism and Architecture

Business Administration
BA 525 - Erb Institute Seminar

Business Economics
BE 527 - Energy Markets and Energy Politics

Business: Law, History, and Communication
LHC 309 - Business Ethics and Accountability

Business: Strategy
STRATEGY 564 - Strategies for Sustainable Development I: Competitive Environmental Strategy
STRATEGY 565 - Strategies for Sustainable Development II: Managing Social Issues

Atmospheric, Oceanic and Space Sciences
AOSS 321 - Earth Systems Dynamics
AOSS 323 - Earth System Analysis
AOSS 414 - Weather Systems
AOSS 467 - Biogeochemical Cycles
AOSS 476 - Ocean Dynamics and Climate
AOSS 480 - Climate Change: The Move to Action
AOSS 501 - Seminars in Limnology and Oceanography
AOSS 563 - Air Pollution Dispersion Modeling
AOSS 575 - Air Pollution Modeling
AOSS 576 - Air Quality Field Project
AOSS 578 - Air Pollution Chemistry
AOSS 605 - Current Topics in Atmospheric, Oceanic and Space Sciences
AOSS 701 - Special Problems in Meteorology and Oceanography

Biology
BIOLOGY 101 - Energy, Food, and the Environment
BIOLOGY 171 - Introductory Biology: Ecology and Evolution
BIOLOGY 288 - Animal Diversity

Civil and Environmental Engineering
CEE 260 - Environmental and Sustainable Engineering Principles
CEE 345 - Geotechnical Engineering
CEE 360 - Env Process Eng
CEE 500 - Environmental Systems and Processes
CEE 520 - Hydrological Models
CEE 522. Sediment Transport
CEE 526 - Des Hydraulic System
CEE 546 - Slopes, Dams and Retaining Structures
CEE 581 - Aquatic Chemistry
CEE 582 - Environmental Microbiology

CEE 583 - Surfaces and Interfaces in Aquatic Systems
CEE 584 - Hazardous Waste Processes
CEE 585 - Solid Waste Management
CEE 586 - Indus Ecol
CEE 587 - Watr Res Pol
CEE 590 - Stream, Lake, and Estuary Analysis
CEE 592 - Bio Proc Envir Engr
CEE 594 - Environmental Soil Chemistry
CEE 595 - Field Methods in Hydrogeochemistry
CEE 624 - Restoration Fundamentals and Practice in Aquatic Systems
CEE 682 - Special Problems in Environmental Engineering
CEE 686 - Case Studies in Environmental Sustainability
CEE 687 - Special Problems in Solid Waste Engineering
CEE 692 - Biological and Chemical Degradation of Pollutants
CEE 840 - Geotechnical Engineering Seminar

Ecology and Evolutionary Biology
EEB 380 - Oceanography: Marine Ecology
EEB 424 - Behavioral Ecology and Conservation Biology
EEB 489 - Soil Ecology
EEB 498 - The Ecology of Agroecosystems

Environmental Sciences Engineering
ENSCEN 211 - Intro to Nucl Eng
ENSCEN 420 - Env Ocean Dyn
ENSCEN 428 - Introduction to Groundwater Hydrology
ENSCEN 479 - Atmos Chemistry
ENSCEN 484 - RHE Fundamentals
ENSCEN 534 - Strategy for Environmental Management
ENSCEN 535 - Strategy for Sustainable Development
ENSCEN 588 - Life Cycle Assessment: Human Health and Environmental Impact

Energy Systems Engineering
ESENG 501 - Seminars on Energy Systems, Technology and Policy
ESENG 505 - Energy Generation and Storage Using Modern Materials

Program in the Environment
ENVIRON 102 - Extreme Weather
ENVIRON 105 - Our Changing Atmosphere
ENVIRON 110 - Introduction of Global Change: Physical Processes
ENVIRON 111 - Introduction to Global Change: Human Impacts
ENVIRON 118 - Introductory Geology Laboratory
ENVIRON 119 - Introductory Geology Lectures
ENVIRON 120 - Geology of National Parks and Monuments
ENVIRON 139 - First-Year Seminar in the Environment
ENVIRON 175 - The Microbial World: How Unseen Organisms Shape our Planet
ENVIRON 201 - Ecological Issues
ENVIRON 203 - Introductory Ethnobotany
ENVIRON 206 - How the Earth Works: The Water Cycle and Environment
ENVIRON 209 - Introduction to Physical Geography: The Earth System
ENVIRON 211 - Social Sciences and Environmental Problems
ENVIRON 222 - Introduction to Environmental Justice
ENVIRON 232 - Introductory Oceanography
ENVIRON 233 - Introductory Oceanography, Laboratory
ENVIRON 256 - Culture, Adaptation, and Environment

ENVIRON 270 - Our Common Future: Ecology, Economics and Ethics of Sustainable Development
ENVIRON 281 - General Ecology
ENVIRON 282 - General Ecology Laboratory
ENVIRON 284 - Environmental Geology
ENVIRON 300 - Special Problems and Research
ENVIRON 302 - Topics in Environmental Social Science
ENVIRON 303 - Topics in Environmental Natural Science
ENVIRON 304 - Topics in Culture and Environment
ENVIRON 306 - Global Water
ENVIRON 309 - GIS Explorations of the Past, Present, and Future
ENVIRON 310 - Toxicology: The Study of Environmental Chemicals and Disease
ENVIRON 311 - Rivers, Lakes, and Wetlands: Introduction to Aquatic Ecosystems
ENVIRON 312 - Environmental Politics and Policy
ENVIRON 315 - The Ecology and Evolution of Infectious Diseases
ENVIRON 317 - Conservation of Biological Diversity
ENVIRON 318 - Food, Land, and Society
ENVIRON 319 - Food, Land and Society Field Study
ENVIRON 320 - Environmental Journalism: Reporting About Science, Policy, and Public Health
ENVIRON 325 - Environmental Geochemistry
ENVIRON 345 - Environmental Public Opinion Analysis
ENVIRON 350 - The Built Environment: Introduction to Landscape Change
ENVIRON 360 - Behavior and Environment
ENVIRON 361 - The Psychology of Environmental Stewardship
ENVIRON 370 - Introduction to Urban and Environmental Planning
ENVIRON 375 - Environmental and Resource Economics
ENVIRON 376 - Environmental Ethics
ENVIRON 380 - Mineral Resources, Economics, and the Environment
ENVIRON 391 - Sustainability and the Campus
ENVIRON 398 - Environment Internship Program
ENVIRON 399 - Junior Honors Seminar
ENVIRON 404 - Cars, Energy, and Chemistry
ENVIRON 407 - Sustainable Cities
ENVIRON 409 - Ecology of Fishes
ENVIRON 410 - American Environmentalism and the Frontier West
ENVIRON 412 - Environmental Values in Public Policy
ENVIRON 415 - Behavioral Ecology and Conservation Biology
ENVIRON 422 - Biology of Fishes
ENVIRON 423 - The Biology of Fishes Laboratory
ENVIRON 430 - Soil Ecology
ENVIRON 436 - Woody Plants: Biology and Identification
ENVIRON 437 - Environmental and Technological Applications of Mineralogy
ENVIRON 442 - Earth Surface Processes and Soils
ENVIRON 449 - Organizational Theory and Change
ENVIRON 467 - Biogeochemical Cycles
ENVIRON 475 - Environmental Law
ENVIRON 476 - Ecosystem Ecology
ENVIRON 490 - War and the Environment: A Lethal Reciprocity
ENVIRON 499 - Senior Honors Thesis

Geography
GEOG 406 - Introduction to Geographic Information Systems
GEOG 472 - Transportation and Land Use Planning

Geological Sciences
GEOSCI 100 - Coral Reefs

GEOSCI 102 - Energy from the Earth
GEOSCI 106 - Fossils, Primates, and Human Evolution
GEOSCI 114 - Global Warming
GEOSCI 125 - Evolution and Extinction
GEOSCI 154 - Ocean Resources
GEOSCI 208 - Hot Topics in the Earth Sciences
GEOSCI 320 - Earth Systems Evolution

Mechanical Engineering
MECHENG 433 - Advanced Energy Solutions

School of Natural Resources and Environment
NRE 416 – Field Skills in Wildlife Behavior
NRE 430 – Soil Properties and Process
NRE 451 – Biology of Mammals
NRE 455 – Laboratory in Field Ecology
NRE 475 – Environmental Law
NRE 476 – Ecosystem Ecology
NRE 571 - Environmental Economics
NRE 574 - Sustainable Energy Systems
NRE 593 - Environmental Justice: Research and Policy Developments
NRE 501.01 - Analysis and Modeling of Ecological Data
NRE 501.010/011 - Forest Ecology in a Changing World
NRE 501.022/023 - Constructed Wetlands
NRE 501.031 - Sustainable Site Design
NRE 501.032 - Transportation Energy & Climate Policy
NRE 501.034 - Biodiversity Informatics
NRE 501.055 - Environmental Justice: Theoretical Approaches
NRE501.055 - Nature Based Tourism, Conservation and Sustainable Development in the Caribbean
NRE 501.086 - Topics and Tools in Environmental Economics
NRE 501.089 - Conservation Justice
NRE 501.092 - Environmental Systems Analysis
NRE501.098 - Ecological Design of Human-Dominated Landscapes
NRE501.11 - Biofuels and Bio-Based Carbon Mitigation
NRE 501.117 - Institutions and Resources: IFRI Theory and Methods Research Seminar
NRE 501.119 - Messing with Messy Data
NRE 503 - Imprints and Archetypes: History and Theory of Landscape Design
NRE 505 - Human Resource Ecology
NRE 508 - Wetland Ecology
NRE 509 - Ecology: Science of Context and Interaction
NRE 510 - Environmental Decision Making and Governance
NRE 512 - Ethics of Corporate Management
NRE 513 - Strategies for Sustainable Development
NRE 514 - Environmental Impact Assessment
NRE 516 - Aquatic Entomology
NRE 520 - Fluvial Ecosystems
NRE 521 - Field Methods in Fluvial Ecosystems
NRE 523 - Ecological Risk Assessment
NRE 526 - Erb Institute Seminar
NRE 527 - Energy Markets and Energy Politics
NRE 531 - Principles of GIS
NRE 532 - Natural Resource Conflict Management
NRE 533 - Negotiating Skills In Environmental Dispute Resolution
NRE 534 - GIS and Landscape Modeling
NRE 536 - Module on Environmental Mediation

NRE 538 - Natural Resource Statistics
NRE 540 - GIS and Natural Resource Applications
NRE 541 - Remote Sensing of Environment
NRE 543 - Environmental Spatial Data Analysis
NRE 550 - Systems Thinking for Sustainable Enterprise
NRE 551 - Non-Market Strategy
NRE 555 - Climate and Development: Impacts, Mitigation and Adaptation in Less Developed Countries
NRE 557 - Industrial Ecology
NRE 558 - Water Resource Policy
NRE 559 - International Environmental Policy and Law
NRE 560 - Behavior and Environment: The Psychology of Human-Environment Interaction
NRE 561 - The Psychology Of Environmental Stewardship
NRE 562 - Environmental Policy, Politics and Organizations
NRE 563 - International Environmental Policy
NRE 565 - Principles of Sustainability
NRE 566 - Public Opinion and the Environment
NRE 569 - Introduction to Geostatistics
NRE 570 - Microeconomics With Natural Resource Applications
NRE 571 - Environmental Economics
NRE 573 - Urban and Regional Theory
NRE 574 - Sustainable Energy Systems
NRE 575 - Thinking Analytically for Policy and Decisions
NRE 576 - Ecological Design Approaches to Brownfield Redevelopment
NRE 580 - Environmental Assessment
NRE 581 - Advanced Environmental Education
NRE 582 - Conceptions, Practical Issues and Dilemmas in Environmental Justice
NRE 583 - Intermediate Natural Resource Economics
NRE 585 - Seminar on CAD
NRE 586 - Visualizing the Environment
NRE 587 - Landscape as Environmental Media
NRE 588 - Site Engineering
NRE 589 - Ecological Restoration
NRE 590 - Landscape Ecology Design
NRE 591 - Materials and Methods
NRE 592 - Environmental Planning: Issues & Concepts
NRE 593 - Environmental Justice: Research and Policy Developments
NRE 595 - Risk Benefit Analysis in Environmental Engineering
NRE 596 - History of Environmental Thought and Activism
NRE 598 - Natural Resource Internship - Graduate
NRE 600 - Directed Research and Special Problems
NRE 605 - Green Development
NRE 631 - Land Use and Physical Planning Studio
NRE 639 - Advanced Seminar in Resource Ecology
NRE 639.039 - Land Use: The Other Global Change
NRE 641 - Research Methods in Environment and Behavior
NRE 661 - Conservation Behavior Seminar
NRE 662 - Seminar in Resource Policy and Administration
NRE 662 - Localization: Adaptations for the 80% Downshift
NRE 664 - Food & Water: Research Questions at the Base of the Economy
NRE 668 - Advanced Natural Resource Economics
NRE 669 - Advanced Environmental Economics
NRE 677 - RPB Research Seminar
NRE 677.042 - Environmental Quality, Schools, and Health
NRE 684 - Science Illustration: Field Sketching
NRE 686 - Environmental Policy

NRE 687 - Landscape Planning and Analysis
NRE 688 - Site Planning and Design
NRE 691 - Plants and Their Use in the Designed Landscape
NRE 741 - Research Paradigms
NRE 787 - Metropolitan Studio
NRE 791 - Topical Interdisciplinary Studio
NRE 791 - Constructed Wetlands and Subdivision Development

Urban Planning
URP 502 - Environmental Planning: Issues and Concepts
URP 576 - Ecological Design Approaches to Brownfield Redevelopment
URP 696 - Sustainable Urbanism and Architecture

***** All courses taken from the Wiinter 2010 and Fall 2010 course catalogs. Many courses are cross-listed within more than one department but are only mentioned once

Appendix D

TOP 10 ELECTRICITY-CONSUMING UM BUILDINGS PER SQ. FT.

Building	Type:	sq. footage	Total Electricity Energy Use in 2009 (kWh)	kWh/sq. ft
East Ann Arbor Health Ctr	Medical	97158	10228540	**105.28**
Radio Broadcasting Station	Arts	3778	344371	**91.15**
Engin. Research Building 1	Engineering	36033	2238950	**62.14**
Cancer Ctr - Geriatric Ctr	Medical	277795	15859204	**57.09**
Medical Sci. Research Bldg III	Medical	218034	11173248	**51.25**
University Hospitals	Medical	1805077	86151160	**47.73**
EECS Building	Engineering	304929	13537933	**44.40**
Medical Sci. Research Bldg II	Medical	163954	6847957	**41.77**
Fisher Ray Baseball Stadium	Athletics	11556	480896	**41.61**
Gerstacker Building	Engineering	61692	2444679	**39.63**

Appendix E

Suggested Timeframes for Beginning Recommendation Implementation

Recommendation	**0-1 year**	**2-3 years**	**4-5 years**
1	X		
2	X		
3		X	
4	X		
5	X		
AR1	X		
AR2		X	
AR3		X	
AR4	X		
AR5	X		
AR6	X		
AR7			X
AR8	X		
AR9	X		
AR10	X		
AR11	X		
AR12		X	
AR13	X		
AR14	X		
AR15	X		

REFERENCES

[1] Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. A review of intervention studies aimed at household energy conservation. J Env Psy. 2005; 25, 273-291.
[2] Hines, Hungerford, & Tomera. Analysis and synthesis of research on environmental behavior: A meta-analysis. J Env Ed. 1986-7; 18: 1-8.
[3] Katzev, R. and Mishima, H. The use of posted feedback to promote recycling. Psy Reports, 1992, 71, 259-264.
[4] Aronson, E. & O'Leary, M. The relative effectiveness of models and prompts on energy conservation: A field experiment in a shower room. J. Env Syst. 1982-3; 12(3): 219-224.
[5] Ayotte, I., Charette, C., Cordone, J., Cote, K., Gallant, J., Hayes, W., Kornstadt, D., & Nappi, K. [campus project] Flip it, switch it, turn it off: USM marketing students launch social marketing pilot campaign to reduce campus electricity use and carbon emissions. Portland (ME): University of Southern Maine, 2006.
[6] Katzev, R. D., & Pardini, A. U. The comparative effectiveness of reward and commitment approaches in motivating community recycling. J Env Syst. 1987; 17(2): 93-110.
[7] Parnell, R. & Larsen, O.P. Informing the development of domestic energy efficiency initiatives: An everyday householder-centered framework. Env and Behavior 2005; 37: 787-807.
[8] Cialdini, R. Crafting normative messages to protect the environment. Cur Dir in Psy Sci. 2003; 12: 105-109.
[9] Ajzen, I. The theory of planned behavior. Org Behavior and Hum Decision Processes, 1991; 50, 179-211.
[10] Hopper, J.R., & Nielsen, J.M. Recycling as altruistic behavior: Normative and behavioral strategies to expand participation in a community recycling program. Env and Behavior 1991; 23(2): 195-220.
[11] Staats, H., Harland, P., & Wilke, H. Effecting durable change: A team approach to improve environmental behavior in the household. Env and Behavior 2004; 36(3): 341-367.
[12] DeYoung, R. Promoting conservation behavior in shared spaces: the role of energy monitors. J Env Syst. 1989-90; 19 (3): 265-273.
[13] Geller, E.S. Applied behavior analysis and social marketing: An integration for environmental preservation. J Social Iss. 1989; 45(1), 17-36.
[14]University of Michigan Environmental Task Force. Advisory report to President Mary Sue Coleman. [report on the Internet]. Ann Arbor (MI): UM; 2004 [cited 20 April 2010]; Available from: www.umich.edu/pres/committees/envrpt/index.html
[15] Deslauriers, S., McMillan, C., & Spitzley, D. Environmental reporting for the University of Michigan Ann Arbor Campus: the U-M environmental data repository. [report on the Internet]. Ann Arbor (MI): UM Center for Sustainable Systems; 2005 [cited 10 May 2010]; Available from: www.oseh.umich.edu/pdf/Environmental%20Reporting%20%28CSS05-11%29.pdf
[16] Gore. A. An inconvenient truth: The planetary emergency of global warming and what you can do about it. Emmaus (PA): Rodale, 2006.
[17] Marans, R. Behavioral aspects of energy conservation & sustainability: A pilot study. [report on the Internet]. Ann Arbor (MI): Institute for Social Research; 2007 [cited 28 March 2010]; Available from: www.isr.umich.edu/energypilot; Marans, R. W. & J. Edelstein (2010) Human

dimensions of energy conservation and sustainability: A case study of the University of Michigan's energy conservation program. Int J Sustainability in Higher Ed. 2010; 11(1): 6-18.

[18] University of Michigan. 2008 Annual environmental report. [report on the Internet]. Ann Arbor (MI): UM; 20 April 2008 [cited 10 May 2010]. Available from: http://www.oseh.umich.edu/reporting.html

[19] University of Michigan. Earth day: Celebrating 40 years at Michigan. [Internet]. Ann Arbor (MI): UM; 2010 [cited 12 May 2010]; Available from: http://vpcomm.umich.edu/earthday/.

[20] Bluelab. Better living using engineering laboratory. [Internet]. Ann Arbor (MI): University of Michigan; 2010 [cited 12 May, 2010]; Available from: http://www.engin.umich.edu/societies/BLUElab/.

[21] Askins, D. Michigan tailgate tries for zero waste. [Internet]. Ann Arbor (MI): Ann Arbor Chronicle; 27 Sept 2009 [cited 15 April 2010]; Available from: http://alumni.umich.edu/node/830

[22] Michigan Students Advocating Recycling. Are you an MSTAR? [Internet]. Ann Arbor (MI): University of Michigan, 2010 [cited 12 May 2010]; Available from: http://sitemaker.umich.edu/mstar/home

[23] University of Michigan. Sustainability education and research. [Internet]. Ann Arobr (MI): UM; 2010 [cited 12 May 2010]; Available from: http://sustainability.umich.edu/education

[24] University of Michigan Plant Operations Director, Office of the Executive Director. Facilities users' network. [Internet]. Ann Arbor (MI): UM; 2010 [cited 12 May 2010]; Available from: http://www.plantops.umich.edu/director/info/FUN/.

[25] Voices of the Staff. Environmental stewardship team. [Internet]. Ann Arbor (MI): UM; 2010 [cited 14 May 2010]; Available from: http://www.voices.umich.edu/teams/environmental/index.html

[26] University of Michigan Occupational Safety & Environmental Health. A vital link in the enhancement of a healthy and safe university environment. [Internet]. Ann Arbor (MI): UM; 2010 [cited 14 May 2010]; Available from: http://www.oseh.umich.edu/introduction.html

[27] School of Natural Resources and Environment. The greening of dana. [report on the Internet]. Ann Arbor (MI): UM; 2008 [cited 14 May 2010]; Available from: http://www.snre.umich.edu/sites/webservices.itcs.umich.edu.drupal.snre/files/self-guideddanatour.pdf

[28] Ross School of Business. Our learning community. [report on the Internet]. Ann Arbor (MI): UM; 2010 [cited 14 May 2010]; Available from:.http://www.bus.umich.edu/learningcommunity/sustainable.htm#energy

[29] Procurement Services. University contracts listed by product and service categories. [Internet]. Ann Arbor (MI): University of Michigan, 2010 [cited 16 May 2010]; Available from: http://www.procurement.umich.edu/ucontracts_list_by_category.php.

[30] Waste Management Services. Recyclemania 2010! [Internet]. Ann Arbor (MI): University of Michigan; 2010 [cited 15 May 2010]; Available from: http://www.plantops.umich.edu/grounds/recycle/recyclemania.html.

[31] Sustainable Endowments Institute. College sustainability report card 2009. Cambridge, MA: Sustainable Endowments Institute; 2008.

[32] UC Berkeley. The Green initiative fund website. [Internet]. Berkeley (CA): UC, Berkeley; 2007-2010 [cited 16 May 2010]; Available from: http://tgif.berkeley.edu/drupal-6.4/?q=node/18

[33] Sustainability at Notre Dame 2008-2009. Office of Sustainability. [Internet]. Notre Dame (IN): UND; 2010 [cited 16 May 2010]; Available from: Green.nd.edu

[34] Reuse Exchange. Reusable office supply exchange. [Internet]. Eugene (OR): U. of Oregon, 2010 [cited 17 May 2010]; Available from: http://www.uoregon.edu/~recycle/rose.htm

[35] Sustainability at CalTech. Office recycling project. [Internet]. Pasadena (CA): California Institute of Technology; 2010 [cited 17 May 2010]; Available from: http://sustainability.caltech.edu/materials/waste_recycling/office_project

[36] University of Michigan. Detroit area study 2001. [report on the Internet]. Ann Arbor (MI): UM; 2001 [cited 20 May 2010]; Available from: http://www.tcaup.umich.edu/workfolio/DAS2001/stdescript.html