

Sustainability Task Force Report

January 2009

University of Missouri



UNIVERSITY of MISSOURI

SUSTAINABILITY TASK FORCE

January 2009

TO: Jackie Jones, Vice Chancellor for Administrative Services
Cathy Scroggs, Vice Chancellor for Student Affairs

FROM: Sustainability Taskforce

We, the 13 members of the 2007 ALDP class, are pleased to present the attached report. As you will recall, in the summer of 2007, you asked us to develop recommendations for a sustainability plan for the University of Missouri. Following that conversation, we identified seven areas to investigate:

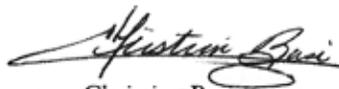
Over the past 17 months, members of the committee have engaged with faculty, staff and students across the campus representing a variety of areas, departments and disciplines. Committee members have traveled across campus and the state to view some of the best practices used in sustainability.

- Building Design
- Environment
- Procurement
- Recycling and Waste Management
- Research & Instruction
- Transportation
- Utilities

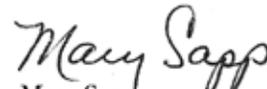
Notably, some of those best practices are already engaged here at Mizzou. While we understand that many of these recommendations made in the attached report might take some time to initiate, we are hopeful that administrators can make good use of the information.

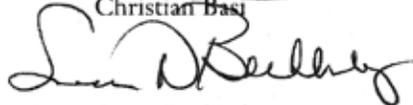
If you have any questions, please feel free to contact us.

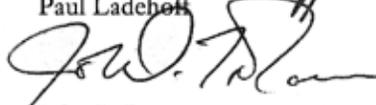
Sincerely,
ALDP Sustainability Task Force

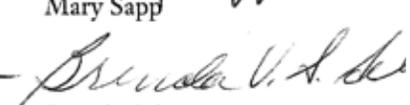

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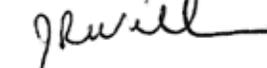

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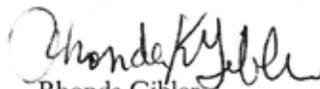

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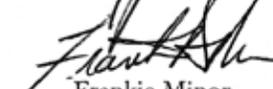

Brenda Selman

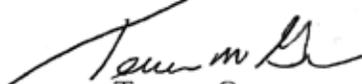

Beth Chancellor

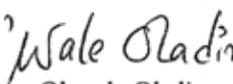

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***We would especially like to thank Karen Gant in the Division of Information Technology who provided the committee with a large amount of office support.*



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Executive Summary

Background

In 2007, members of the Administrative Leadership Development Program were tasked with developing a “sustainability plan” for the University of Missouri. We were asked to define, develop and determine what “sustainability” meant for the University of Missouri. The taskforce identified seven areas at the University that were impacted by sustainable practices: Building Design, Environment, Procurement, Recycling and Waste Management, Research and Instruction, Transportation, and Utilities. Committee members sought input from a wide range of faculty, staff and students on campus. Individuals with expertise in recycling, power generation, instruction, construction, policy making and others were included in the discussion. This report contains an executive summary and seven reports, one on each area, with recommendations for implementation to continue MU’s work in sustainable practices.

Common Recommendations

In addition to the seven areas identified, committee members discussed broad recommendations that should be implemented to coordinate the seven areas. *(It is important to note that these common recommendations are not covered in the individual reports. Rather, the individual reports provide more specific recommendations based on the area that was reviewed.)*

1.) Appoint a sustainability coordinator.

The coordinator would:

- Work with existing programs (recycling, energy management, procurement) to support their sustainability efforts.
- Encourage faculty members to use sustainable practices in their classrooms as well as their research.
- Develop a communications plan to reach all the audiences at the university so all university and staff are knowledgeable about MU’s sustainability practices.

2.) Appoint a sustainability council.

- Students, faculty and staff would be represented on the council.
- The council would be charged with supporting the sustainability coordinator, developing new sustainability programs, identifying new sustainability issues, and assisting with the communication of current sustainability programs.
- Council should report biannually to the Chancellor.

3.) Adopt a sustainability statement

- The Sustainability Task Force developed an administrative support statement (see attached) that should be adopted by the campus as a symbol of MU’s commitment to sustainability.

4.) Review current policies and develop new policies.

- Many of the current policies regarding sustainability are out-of-date and are not supportive of a sustainability plan. For example, the recycling policy only identifies “desktop,” or office paper, recycling. It does not discuss other ways or materials to recycle. (i.e. printer cartridges, building materials, etc.)
- Policymakers should review the seven areas listed in this report and determine if current policies might be a disincentive to offices or faculty members wanting to implement sustainability policies. For example, purchasing an energy-saving piece of equipment does not benefit an individual department, because the department does not recoup the cost-savings, which goes directly to the university.

5.) Create a campus wide communication plan for sustainability

- Through our research, members of the committee were pleasantly surprised to discover the multitude of actions already being taken on campus. However, most committee members were unaware of these actions. It is important that we take advantage of current technology by creating a sustainability website and coordinating a communication plan that will help keep students, faculty and staff knowledgeable about the sustainability actions that the campus is taking. In addition, MU community members should know what actions they can take to help the campus become “greener.”
- MU could use a variety of relatively simple and low-cost methods to draw attention to current recycling opportunities including:
 - Advertise in the weekly “MU Info” mass email.
 - Advertise and/or seek a highlight story/piece in “Mizzou Weekly.”
 - Organize mass email campaigns.
 - Distribute publications, such as the “Mizzou Recycles: A Guide to Recycling at MU” piece, and make these guides available at visitor’s stations, Surplus Property, residence halls and other selected venues. (*See Appendix C for “Mizzou Recycles...” guide.*)
 - Ensure that web sites are linked appropriately (e.g. recycling websites to Surplus Property website).
 - Provide training for key individuals who are involved with purchasing or using equipment related to sustainability
 - Make presentations to key groups including
 - Fiscal Officers
 - Deans, Directors and Department Chairs
 - Student groups such as Sustain Mizzou

- Promote the use of a new Sustainability graphic.



ENVIRONMENTAL STATEMENT				
 <p>The University of Missouri saved these valuable resources by using recycled paper containing a minimum of 60 percent post-consumer waste, processed chlorine free and manufactured with electricity that is offset with Green-e certified renewable energy:</p>				
TREES 25.5 fully grown	WATER 10,899 gallons	ENERGY 18,174,972 million BTU	SOLID WASTE 1,206 pounds	GREENHOUSE GASES 2,374 pounds of CO ₂
PART OF MU'S SUSTAINABILITY EFFORTS				

Calculations based on research by Environmental Defense and other members of the Paper Task Force

6.) Identify funding for sustainability initiatives.

Some examples include:

- Using realized cost savings to pay back initial project or program costs.
- Seeking grant funding from federal, state and private sources for start up costs.
- Establishing an MU “Green Fund” that could be accessed for one-time start up costs of implementing a new sustainability project. The fund would then be replenished over time by the “savings” realized from the project.
- Receiving and managing donations earmarked for sustainability programs.

Note on Current Practices:

It is clear from the research completed by taskforce members that MU is a leader in many areas of sustainability. However, an important force lacking is an office that can help coordinate and serve as a one-stop shop for individuals both on and off campus who want to learn about or engage in the university’s sustainability practices.

Committee members investigating all seven of the areas identified found a significant amount of work currently ongoing. However, due to what the committee believes is a lack of coordination and communication, the only individuals aware of the success are those in a particular field. We believe that implementing these recommendations could put MU on track for a very successful, and public, sustainability program.

The remaining portion of the report contains reports from seven subcommittees giving recommendations for each of their areas. Included in each report is background on the area investigated, recommendations, current practices at MU and a conclusion.

Administrative Statement (draft)

The University of Missouri is dedicated to environmentally sustainable policies and practices that promote responsible stewardship of existing resources and the environment. This includes, but is not limited to, acquiring and using energy-saving, environmentally friendly and renewable/recyclable resources and materials; providing educational programs, resources and incentives for sustainable practices by students, faculty and staff; participating in recycling programs and the safe disposal of materials; researching and testing new sustainable initiatives; and taking proactive steps to preserve and protect natural resources. Each unit or department within the University is encouraged to evaluate current policies and practices on a regular basis with the goal of adopting or improving sustainability.

Building Design, Construction and Renovation

Background

A common assumption about “green practices” in the area of construction and remodeling is that they are more costly. Developments in technology, construction methods and products combined with increased demand have improved the feasibility of adopting sustainable practices in building design, construction and renovation.

The University of Missouri has more than 300 buildings on MU’s main campus with more than 14.6 million gross square feet of space. In 1980, campus planning became a participatory process through the dynamic and ongoing development of the [MU Campus Master Plan](#). This process is managed by Campus Facilities and encompasses institutional priorities and strategies. Campus Facilities manages construction and renovation projects worth \$100 million on average per year.

While planning efforts are based on sound planning and architectural principles, they remain flexible to achieve multiple goals of stakeholders and programs. Many of the current design principles support sustainable practices. While these principles are the underlying foundation for the plan, there are significant opportunities for improvement in how sustainability principles are put into practice and whether the application of those principles is voluntary or mandatory.

While sustainable practices at MU in the area of building design, construction and renovation are implemented on a project by project basis, there is room for more stringent design and construction principles. Campus Facilities is positioned to make significant progress in this area, but challenges with awareness, funding, incentives and policies keep MU from reaping the benefits that sustainable practices can provide.

The following areas can benefit from the implementation of sustainable practices. These benefits are found in a variety of reports referenced later in this document.

- More energy conservation
- Positive environmental impact locally, regionally and world-wide
- Increased productivity and employee retention
- Positive impact on student learning
- Student recruitment and retention
- Long-term operational cost savings (ROI)
- Development / Fund Raising

Campus Facilities has expertise within their ranks - individuals who are not only aware of how to adopt and implement sustainable practices, but who also are extremely enthusiastic about the possibilities. They also are aware of, and have access to, industry

experts and experts at peer institutions. MU needs to establish broad goals in the area of sustainability and then allow our internal experts the latitude to meet those goals.

Recommendations

1.) *Education & Awareness*

- Develop education and awareness materials (videos, presentations, tours, etc.). These materials should be distributed to the campus community from the Chancellor's Office.
- Require all "clients" (individuals who manage and/or control construction project funding) to go through an awareness video or training session prior to starting a construction/renovation project.
- While construction/renovation clients at MU are generally aware and supportive of sustainable practices, there may be opportunities to ensure clients understand the specific sustainable practices that they can adopt as well as the impact of their decisions. *(The sustainability subcommittee toured two facilities, one in Kansas City and one in St. Louis, and came away with a glimpse of the possibilities. For most of the subcommittee members, this was an eye opening experience that showed just how much we didn't know.)*

2.) *Establish permanent swing space*

- Permanent swing space would allow for more thorough planning, design and project execution. With occupants completely "out" of the existing space, planners would have more flexibility to address a variety of issues.
- A variety of sustainable practices cannot be implemented while a building is occupied. Costs are increased if occupants are not relocated due to the required staging, phasing and need to limit changes to minimize impact on occupants during construction. If buildings could be vacated, construction budgets would experience savings (although they would vary from project to project), some of which could be put back into sustainability practices.
- Long-term swing space used for these purposes needs to be flexible and scalable for the variety and duration of occupants. Swing space should have sufficiently modern building system controls to allow for energy conservation when space is not in use. Developing pre-arranged relationships with local property owners in the MU/Downtown district to use unleased space for short durations also could serve as swing space options while keeping occupants in proximity of the campus.

3.) *Establish a self-certification requirement based on the "LEED Certified" designation.*

- The [UM Facilities Management Policies and Procedures Manual](#) stresses the importance of sustainable design and identifies specific concepts that guide design including site management, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. The manual also indicates a need to "incorporate sustainability principles...to the fullest extent possible, while being consistent with budget constraints, appropriate life cycle cost analysis and customer priorities."

- At MU, with the exception of energy conservation and landscaping, there are few construction/renovation mandates in the area of sustainability. Several sustainable practice opportunities exist including:
 - Flooring, work surfaces, furniture and wall surfaces
 - Lighting, lighting controls and day-lighting
 - Water usage, such as the use of rain water or grey water systems
 - Minimizing construction materials in landfills.
- Campus facilities should be given a mandate to meet *LEED Certified standards and should work with their clients to identify the specific areas or methods adopted for a given project to meet that standard.

*This recommendation means that we would meet LEED Certified standards in a self-certification or self-check process, not that we would actually apply for LEED Certification.

4.) *Modify funding model and/or develop incentives for sustainable building design, construction and renovation practices*

- The funding model for construction and renovation projects is centralized for academic projects and decentralized for auxiliaries and service operations. Divisions/colleges often raise their own funds and therefore, to some degree, control how those funds are spent. This model does not necessarily provide incentives for clients to invest in sustainability practices beyond those already mandated by Campus Facilities.
- The campus needs to identify incentives or some other funding approach to encourage (or require) departments to make better decisions for the good of the institution in the long-run.

Recent Past and Current Practices

Planning, Design and Construction

Sustainable practices have been in place in the planning, design and construction processes at MU for decades. These practices have evolved as staff, primarily from Campus Facilities, have worked to improve design and construction processes and maintain good stewardship of MU resources. While effective, these practices can be enhanced, while balancing benefit against cost, to provide more sustainability opportunities.

Sustainability at MU starts with master planning. MU’s ongoing master planning process helps to insure the best and highest use of MU land by encouraging appropriate density of development and proper placement of buildings with special consideration of how they relate to each other, pedestrian circulation and creating a “sense of place.” The MU master plan is continually refined and reevaluated by our nationally recognized master planning consultant, the Campus Planning committee and Campus Facilities staff.

During design, CF - PD&C staff coordinate the process and manage our world class consultants to achieve appropriate design. Our project managers ensure compliance with the Master Plan, MU Design Principles, Consultant Procedures and Design Guidelines, as

well as good architectural and engineering practice. Stewardship of MU resources are always a major consideration as project design is done.

Typical sustainable practices include:

- Analyzing life cycle costs.
- Maintaining central campus utilities.
- Purchasing durable, long term, cost effective, low maintenance materials.
- Developing detailed modeling of energy usage for new space.
- Making efficient use of open space.
- Maintaining appropriate densities for new construction consistent with good planning principles.
- Renovating and reusing existing buildings whenever possible.
- Creating structured parking at periphery of campus, which would save land for green space and buildings while making the campus more pedestrian friendly.

MU CF - PD&C also use several “state of the practice” project delivery systems for projects. These systems, including Design/Build can encourage sustainable design by having a more integrate delivery approach. Many sustainable practices are utilized during construction including removal and reuse of equipment, separation of materials during demolition for recycling and storm water/silt protection measures to name a few.

Interior Design

Campus Facilities PD&C interior designers strive to educate clients and incorporate sustainable design principles when practical and reasonable to meet project goals and budgets. Flooring and wall materials made from recycled or recyclable materials are specified when available and competitively priced. Working with UM Procurement, contacts for used and reconditioned furniture have been developed as a resource for projects to minimize new furniture manufacture and minimize landfill.

Energy Management (this part may fit better in the Energy subcommittee report)

In 1990, Campus Facilities began a formal energy conservation program. Since that time, they have achieved a cumulative energy cost avoidance of \$28 million for campus Education and General (E&G) space. This equates to a reduction in energy use per square foot of 19 percent. In FY08, cost avoidance was \$4 million.

Other areas that have seen significant progress include:

- 99 percent of exterior lights and 90 percent of interior lights are now high-efficiency lighting.
- 23 major buildings have had HVAC upgrades to high efficiency systems.
- Broad use of energy efficient building controls to save energy and improve comfort and service.
- The use of tire-derived fuels to reduce emissions and lower energy cost.
- Research in the area of biomass fuels such as wood wastes, grasses, crop residues and corn cobs.

Campus Facilities Communications has also developed and implemented an ongoing public relations campaign to promote and raise the awareness of sustainability as it

pertains to energy conservation and recycling on the MU campus. These efforts include news releases, the Campus Facilities webpage, advertisements in campus newspapers, table tents in dining halls, posters in residence halls and a booth at Earth Day.

Campus Facilities has received national acclaim from the U.S. Environmental Protection Agency and other organizations. Details can be found at http://www.cf.missouri.edu/energy/em_awards/index.html.

Conclusion

The subcommittee believes that MU has the expertise (or has access to the expertise), the understanding and the general interest in making significant progress in this area. Setting mandatory goals, promoting those goals and principles at the highest level, and giving Campus Facilities the latitude to manage how those goals are attained seems to be an equation that will allow MU to make progress in this area.

Sustainability practices in the area of building design, construction and renovation are long-term investments that have real returns and impact in many areas.

Committee members

Beth Chancellor, *chair and associate CIO*
Ben Datema, *student*
Karen Gant, *executive staff assistant*
Brenda Selman, *MU Registrar*

References and Resources

<http://www.cf.missouri.edu/masterplan/>
<http://www.endowmentinstitute.org/sustainability/>
<http://www.aashe.org/index.php>
<http://www.cf.missouri.edu/energy/>
http://www.cf.missouri.edu/energy/em_awards/index.html
<http://www.greencampus.harvard.edu/theresource/guidelines/>
http://greencampus.harvard.edu/news/archives/2008/02/new_leed_certif.php
<http://www.umssystem.edu/ums/departments/fa/management/facilities/policy/Chapter-02.pdf>

Natural Environment and Climate Protection

Background

MU's core missions of teaching, research, service and economic development have a direct and material impact on the University's natural surroundings at multiple levels. At a minimum, it is MU's obligation to identify, establish and maintain regulatory compliance with all federal, state and local mandates and achieve compliance with both the letter and spirit of the law.

In addition, MU endeavors to go above and beyond regulatory compliance. As a University striving for a sustainable orientation to nature, it is our responsibility to continually investigate, develop, implement and disseminate methods to protect and support natural:

- soil, landscape and terrestrial processes;
- water quantity, quality and hydrologic processes;
- atmospheric composition and climate processes;
- wildlife and biodiversity;

at all levels where MU's management decisions may have an impact.

Recommendations

- 1.) ***MU will form and convene a panel that will meet annually to review the effectiveness of the University's efforts in Natural Environment and Climate Protection and recommend changes where appropriate in an annual report.***
 - The annual report may be used to certify to the Board of Curators the progress of the University's efforts as well as to enhance the University's role as a leader in Natural Environment and Climate Protection.
- 2.) ***Establish master planning principles for development phasing, campus densities, land use and conservation patterns that will provide a rigorous framework for determining where, when and how to locate new facilities.***
 - When assessing the merits of any decision that will impact our natural environment, MU will include in those evaluations any indirect long term benefits as well as any direct short term costs.
 - Among the indirect benefits that may be considered is the avoidance of future costs associated with probable regulatory changes, lowering future risk, protecting our reputation as a leader and good steward of resources, and reinforcing our reputation as a sustainable campus.

3.) ***Natural Soil, Landscape and Terrestrial Processes***

- The University will protect and preserve our natural resources, ecosystems and terrestrial processes through the establishment of design structures and use principles that promote good stewardship.
- The University's master planning efforts will include the mitigation of current impacts and the minimization of future impacts on natural resources, ecosystems and terrestrial processes. The preservation of green and open spaces will be a high priority to be achieved through the use of Best Management Practices (BMP).
- MU will develop, validate, utilize and advocate BMPs for the sustainable use of natural resources, ecosystems and terrestrial processes for the state and region. In recognition of the University's educational role, we will use the University as the working laboratory/model to pursue those objectives.

Action Plan for this recommendation:

- In order to document progress toward goals and adherence to policy over time, the review panel will identify and establish baseline inventory and mapping of natural resources, ecosystems and terrestrial processes that are either a) permanent, b) transient or c) may otherwise impact University property.
- Following the establishment of baseline inventory and mapping of natural resources, ecosystems and terrestrial processes of the University, the review panel will recommend and/or conduct studies to determine reasonable goals and benchmarks that can be used to chart progress towards minimizing or mitigating impacts in designated areas.

4.) ***Water Quantity, Quality and Hydrologic Processes***

- Storm water quality will be optimized, and quantity will be managed through the adoption, implementation, revision and enforcement of the Campus' Phase II MS4 (Municipal Separate Storm Sewer System) Permit and Storm Water Management Plan (SWMP) as appropriate.
- The University will invest in validating and implementing sustainable infrastructure and support the efforts of Campus Facilities to implement Best Management Practices.

Action Plan for this recommendation:

- Develop and approve a formal administrative policy, including design guidelines, in support of the MS4 Permit and SWMP to be incorporated into the MU Business Policy and Procedures Manual. By integrating this policy into the vision and operations of the University, Mizzou can uncover efficient, less costly methods and thus receive a reasonable return on investment for pollution prevention efforts. Storm water regulations continue to evolve as do innovative solutions used to meet them. The SWMP includes planning for BMP implementations and maintenance while simultaneously considering storm water runoff and water quality mitigation. It allows for infiltration and groundwater recharge rather than conveying the water directly to waterways. Urban storm water quality is preserved by monitoring illicit discharges, reducing erosion and sediment runoff to acceptable levels during construction

- projects and maintaining pervious area and pre-existing hydrologic processes spanning the pre- and post-construction period. Low Impact Development (LID) measures provide an opportunity to mimic pre-existing hydrologic site conditions as required in our MS4 permit as well as maintain compliance with applicable TMDLs (Total Maximum Daily Load) and WLAs (Waste Load Allocation).
- The Campus Facilities (CF) Design Standards (currently the collection of design standards referred to as the “Green Book” and the “Sustainable Design Policy”) will be updated in-situ according to this policy and will be considered the University’s storm water design manual.
 - Based on an assessment of the fiscal and resource impacts of various patterns of facilities growth, the University is developing and should implement a smart growth strategy. A key planning initiative, the annually updated Campus Master Plan will provide technically and financially responsible guidelines for future campus growth. The intent of the smart growth strategy is to defer and/or reduce additional infrastructure investment by identifying ways of more efficiently utilizing land and infrastructure resources and optimizing development. MU will partner with other stakeholders in meeting the smart growth goals championed by the city of Columbia and other stakeholders in Missouri. Under the auspices of the smart growth strategy, the campus plan will make the stewardship of campus natural resources an integral part of the quality of campus and community life.
 - MU will accelerate the development and applications of science, engineering and administration that provide positive impacts on water quality. The University will adopt a proactive approach to manage water quality at our main campus in partnership with efforts of the city of Columbia, Boone County and the state.
 - The SWMP also requires MU to educate the public (university, city, county, contractors, developers, etc.) on storm water management. MU should complement existing efforts of the city and county through a comprehensive storm water management course such as the one currently under development by MU Water Resources Research Center (WRRC), MU Biological Engineering, University Extension and MU Environmental Health and Safety.
 - Campus Facilities will develop and submit for funding on an annual basis a monetary budget in support of activities pursuant to the aforementioned goals. Budget constraints often limit implementation of Low Impact Development concepts found in the Campus Facilities Design Standards. Instead of evaluating costs from a short term perspective, the best long term value to the campus should be considered. Concepts and values to take into account include building the “brand” of the University of Missouri bearing in mind sustainable design while lowering long term risk by anticipating future regulations. Finally, as the flagship University of Missouri we should continually endeavor to embody the innovative spirit of the Show-Me State.

5.) ***Atmospheric Composition and Climate Processes***

- MU will, where economically feasible, reduce emissions from the campus’ permitted air emission sources and unregulated greenhouse gas emissions. The U.S. Environmental Protection Agency (EPA) has declared that “Energy use in commercial buildings and manufacturing plants account for nearly half of U.S.

greenhouse gas emissions.” The panel will strive to continue MU’s national leadership in reducing campus energy consumption.

- MU will work towards optimizing the natural processes of air quality maintenance from vegetation by preserving and creating additional green spaces in the landscaping of the campus.
- MU will coordinate with stakeholders to accelerate the development and application of education in the natural, physical, social and engineering sciences that provide positive impacts on air quality. These include work in satellite remote sensing and atmospheric science, hydrology, chemical engineering, forestry, horticulture, crop sciences, law and public policy. MU will incorporate these advancements in our teaching as they occur.
- MU will develop and maintain coordination among the various MU stakeholders involved in air quality research and teaching and optimize our services provided to Missouri residents and businesses that are involved with maintaining and improving air quality. These include but are not limited to on-campus courses, continuing education, Campus Facilities, Environmental Health and Safety, MU Extension, and industrial assistance programs.

Action Plan for this recommendation:

- Assemble an inter-departmental air quality committee with an initial assignment to inventory unregulated greenhouse gas emission sources in the University.
- Apply existing emission reduction modeling to identify reductions in regulated and unregulated emissions that have been accomplished through on-going facility management activities.
- Identify additional efforts that could be implemented to yield further reductions of identified gases. Utilizing existing models, estimate further reductions that could occur, and prioritize potential efforts.
- Identify funding sources available to implement additional prioritized air quality improvement efforts. Provide a summary of this information to Campus Facilities.

6.) *Wildlife and Biodiversity*

- Increase native biodiversity and reestablish native species where possible on university property.
- Reduce or mitigate the impact of University resource use and waste export on wildlife and biodiversity at the regional, national and international levels.
- Reduce or mitigate the impact of the University to climate change, wildlife and biodiversity.
- Engage all members of the campus community - faculty, staff and students - with the goal of reducing the University’s impact on wildlife and biodiversity.
- Ensure that policies outlined above are supported long term.

Action Plan for this recommendation:

- Census and map the species on University property and compare the census to a list of species typical of undisturbed ecological communities exhibiting similar characteristics to the University's soil, topography and climate, including oak hickory forest/woodland and tallgrass prairie/savanna. Identify species that are appropriate

- candidates for reintroduction (ex: little bluestem, box turtles, bluebirds) and plan and set annual goals for re-establishing them on campus. Identify species that are invasive (ex: shrub honeysuckle, garlic mustard) and plan and set annual goals for their removal.
- Quantify the natural resources (ex: coal, wood/paper, food, fiber, metals, fuels) imported onto campus and wastes (ex: criteria air pollutants, CO₂, storm water runoff, solid wastes) exported from campus as well as intra- and inter-ecoregion, both national and globally. Identify the geographic source of the resources, the quantity extracted from each location and the local impacts of the extraction on wildlife and biodiversity. Identify the destination of the wastes, the amount transferred and the local and regional impacts of depositing these wastes on wildlife and biodiversity. Set annual goals for the reduction of identified impacts and plan and implement reduction strategies including conservation, alternative sourcing, substitution or mitigation.
 - Estimate the total, per capita and per unit area contribution of University activities by category (ex: burning fossil fuels, land clearance, methane from animals, etc.) to climate change. Set annual goals for the reduction of identified impacts, and plan and implement reduction strategies including conservation, alternative sourcing, substitution, mitigation or other strategies.
 - Create and implement a mechanism that allows and encourages administration, staff and faculty whose responsibilities may not require them to devote compensated time participating in teaching, research or service activities related to environmental stewardship and sustainability. Create and implement programs that encourage students to use resources wisely, participate in sustainability activities (ex: stream monitoring, invasive plant removal, litter collection, etc.) and increase their knowledge and understanding of environmental and sustainability issues through in and/or out of classroom learning opportunities.
 - Ensure that the activities in Action Plan items 1-4 are monitored, recorded and communicated in a timely way to administration, the campus community and the public at large in a format that makes it easy to track progress, make comparisons and set benchmarks for future action. Develop methods to estimate the tangible and intangible (brand protection, avoided regulatory oversight, employee satisfaction, etc.) benefits and costs of implementing practices outlined in this action plan. Accrue these benefits to support continuing these activities and identify ways to reduce costs of activities. Institutionalize support for continuous improvement of these activities.

Recent Past and Current Practices

Mizzou Botanic Garden

The role of the Mizzou Botanic Garden as an adjunct unit of Campus Facilities-Landscape Services is to support the University missions of education, research, extension and economic development. To this end, the Garden is used to demonstrate and promulgate sustainable horticulture that is appropriate for mid-Missouri. The Garden is linked or is a partner to programs such as Plants of Merit and Green Lawns-Blue Waters that serve to educate students, faculty, staff and the public in responsible stewardship of the environment.

Landscape Management Plan

Campus Facilities-Landscape Services utilizes a Landscape Management Plan that allocates the resources used to maintain the campus landscape. This plan supports efforts to efficiently and effectively use the available resources and apply them where needed.

Design Principles for Sustainable Landscapes

Concurrent with the use of the Landscape Management Plan and the Mizzou Botanic Garden initiatives is the application of landscape design principles that recognize the value of efficient landscape maintenance and the demonstration of sustainable landscape as an educational tool. Campus Facilities-Landscape Services applies design principles that preserve campus green space, consider storm water runoff mitigation, and utilize native plant materials.

Integrated Pest Management

Campus Facilities-Landscape Services has practiced Integrated Pest Management for more than 15 years and has made this approach part of the standard operational practices for resolving pest problems on the campus. This has resulted in a significant reduction in the use of pesticides.

Recycling

Campus Facilities-Landscape Services is the lead campus organization for the recycling of paper, cardboard and beverage containers as well as innovative programs such as Tiger Tailgate Recycling and Tiger Treasures. These two programs seek to indoctrinate the practice of recycling within the unique context of University life outside the classroom. In addition, all 'green' waste generated by Campus Facilities-Landscape Services is recycled.

Smart Growth Modeling

Several models of future campus growth, redevelopment and preservation are under study. Models include projections of building density, land use and open space that, from the standpoint of land capacity, are appropriate for areas of campus.

Models indicate an additional future building capacity of approximately 4 million to 6 million gross square feet. The existing campus building area is 14.6 million gross square feet, of which 6.5 million gross square feet has been constructed in the last 25 years.

Density and use projections are designed to strengthen relationships between teaching, research, residential and social functions.

Projections also indicate that new developments will require upgrades and expansion of central heating and cooling plants. Localized constraints in utility distribution networks will require new investment to support facilities development. Similarly, road improvements and parking facilities will be required to serve University population growth and development.

The intent of the Smart Growth Strategy is to defer and/or reduce additional infrastructure investment by identifying ways to more efficiently utilize land and infrastructure resources and optimize development. With objective principles for development phasing, campus densities, land use, preservation and creation of open spaces and conservation patterns, this strategy allows a rigorous framework for determining where, when and how to locate new facilities. With the overlay of the Smart Growth Strategy, the campus plan will make the stewardship of campus resources an integral part of the quality of campus and community life.

Committee Members

Susan Becklenberg, *Co-chair, Director Fiscal Operations, MU School of Medicine*

Rhonda Gibler, *Co-chair, Assistant Vice Provost, Management Services, Extension*

J. Barton Boyle, *MU Retiree*

Robert Broz, *Extension Assistant Professor, Ag Extension – Food Science and Nutrition*

John R. Glenn, *Sr. Landscape Architect, Campus Facilities-Landscape Services*

Todd Houts, *Assistant Director, Environmental Health & Safety*

Jason A. Hubbard, *Assistant Professor of Hydrology and Water Quality, Departments of Forestry, and Soils Environmental and Atmospheric Sciences*

Pete Millier, *Director, Campus Facilities-Landscape Services and Mizzou Botanic Garden*

Robert Reed, *Research Associate Professor, Water Resource Research Center*

Christopher Starbuck, *Associate Professor, Plant Sciences*

Jan C. Weaver, *Director, MU Environmental Studies and Assistant Director for Science, MU Honors College*

Ben Datema, *Student*

Thomas Stokely, *Student*

Procurement

Background

Committee members examined the current use of procurement procedures including the procurement of recycled and sustainable commodities. The University of Missouri purchases more than \$170 million of goods and services each year. While numerous departments have addressed sustainability issues in their procurement processes, additional actions should be taken to improve sustainability efforts throughout the campus. Developing sustainability guidelines for procurement can have a lasting effect across the entire campus since every department must make purchases in order to operate.

Efforts should be made to promote campus procurement of recycled and sustainable commodities while minimizing use of other commodities by establishing contracts, increasing availability, and educating users, resulting in a more informed, holistic approach to campus purchases of these products.

Procurement is one segment of a circular sustainability process that also includes use and disposal. If appropriately disposed, products enter the procurement stream as recycled content. The latter portion of the cycle is addressed in the Recycling and Waste Management Report. The following recommendations address the sustainability factors that should be considered during the acquisition process.

Recommendations

1.) *Develop guidelines that define sustainable procurement practices and encourage the campus community to participate.*

Individuals and some departments have made ad hoc efforts to purchase recycled and sustainable products. However, there are currently no guidelines to identify sustainable procurement practices and no coordinated, campus-wide effort to encourage the University community to participate.

Action Plan for this recommendation:

- Designate a group to compile guidelines.
 - Model guidelines on those developed by Duke and other universities.
 - Include methods for tracking and/or reporting sustainable procurement activities.
 - Consider a product's life cycle in determining the overall sustainability.
 - Consider post usage (able to be recycled or reused after initial use).
- Provide guidelines to experts for review.
- Discuss with appropriate commodities buyers.
- Provide guidelines to administration for approval.

- Procurement
- Vice Chancellor for Administration
- Promote to deans, department chairs and other fiscal officers.

2.) *Identify sustainable products in the eProcurement system.*

The eProcurement system was implemented in 2007 and offers University staff an electronic ordering system that provides access to University contracts. The eProcurement system allows vendors to designate sustainable products with a “GREEN” icon. Procurement staff are working with vendors to establish the criteria for this designation and encourage vendors to identify these products. Currently, eProcurement training explains the various icons available in the system, but has not been structured to encourage staff to seek out the GREEN icon. No benchmarking has been done to date.

Action Plan for this recommendation:

- Procurement staff would refine criteria for designating products to be marked as sustainable.
- Encourage vendors to submit items to be designated as sustainable.
- Procurement staff would approve products that meet the criteria.
- Provide information to users about designation system and encourage use when appropriate.
- Track and report on expenditures for these products.

3.) *Purchase energy and resource-efficient equipment.*

In recent years, Energy Management and Campus Facilities have considered life cycle costs to determine the most appropriate equipment to purchase. In calculating life cycle costs, energy efficiency and resource usage (e.g. water) are considered. However, there has been little additional incentive offered to tip the balance further toward equipment offering energy and resource efficiency. This is especially problematic in situations where the department purchasing the equipment does not pay the energy bills to operate the equipment. Departments are reluctant to pay a premium to purchase more efficient equipment when another department (such as Energy Management) obtains the benefits. This is often the case in academic units that operate specialized equipment and in administrative units purchasing equipment such as printers and photocopiers.

Action Plan for this recommendation:

- Develop standards and guidelines to help determine equipment life cycle costs.
- In circumstances where energy efficient equipment is only available at significant additional cost, consider how to offer incentives to departments.
- Establish a list of individuals who can be contacted to provide information regarding energy efficient equipment. Educate Procurement Services staff about the availability of this expertise and Procurement staff will encourage end users to make use of this resource.
- Where possible, establish baselines and track progress.

4.) ***Make recycled content paper products more widely available and encourage people to use them instead of virgin paper products.***

When recycled paper was first introduced, even enthusiastic users experienced problems with it. The dull color, dustiness and inconsistent quality that caused printers to jam discouraged many users. Because a smaller percentage of recycled content helped minimize the negative attributes, 10 percent recycled content became the primary offering among papers with recycled content.

Over the years, quality has improved and the market has expanded – more users are finding not only 10 percent recycled content acceptable, but there is a demand for 30 percent and even 100 percent recycled. Printing Services has been offering 10 percent for quite some time and recently announced it will offer 30 percent as their default paper. Both major University office supply companies offer 30 percent and 100 percent recycled content papers. No tracking has been done by the University of total recycled paper consumption compared to virgin paper. However, data is being gathered from Office Max and Corporate Express to establish a baseline.

Action Plan for this recommendation:

- Establish volume purchase contracts.
- Add products to eProcurement.
- Encourage large-volume users, such as MU Printing Services, to expand the variety of recycled content papers available.
- Where possible, establish baselines and track progress.
- Communicate availability to users.

5.) ***Promote ordering efficiency.***

Desktop delivery is provided by the University's primary office supply vendors. These vendors have said that orders tend to be frequent and often for a small number of items, which increase their fuel usage, transportation and delivery costs. It also increases the costs to the University because multiple small orders consume more staff time for processing (e.g. ordering, receiving, corporate card approvals, account reconciliation and reporting.) Procurement staff anticipate that consolidation of orders could provide savings to vendors and result in greater discounts on University supply contracts. The University has not promoted consolidated ordering or tracked the number of orders. However, Procurement has requested data from office supply vendors to establish baselines.

Action Plan for this recommendation:

- Define ordering efficiency.
 - Order less frequently
 - Consolidate orders within and among departments
 - Set minimum dollar amounts
- Procurement staff would work with vendors to identify departments and educate staff in areas that need improvement.
- Educate users and encourage departments to order more efficiently.
- Where possible, establish baselines and track progress.

6.) ***For RFBs and RFPs, cooperatively identify sustainable specifications, or alternatives and options appropriate for the commodity.***

Only rarely are specifications developed that address sustainability issues. Currently, as mandated by state law, alternative fuel vehicles are specified for new, non-exempt vehicles, and these purchases are tracked and reported to the state. However, no current campus policies encourage University departments to consider including sustainability factors in commodity specifications.

Action Plan for this recommendation:

- User departments should consider including sustainability standards in specifications.
- Procurement staff would assist departments in including specifications that address sustainability needs.
- For some commodities, alternate bids may be prepared that include higher sustainability standards.
- Identify methods for Procurement to track increased sustainable procurement efforts related to RFBs and RFPs.

7.) ***Promote the acquisition of used furniture, case goods and fixtures when appropriate.***

For many years, campus Surplus Property has collected used furniture from departments and made it available to other departments. However, the majority of this furniture is well past its prime and seldom is there a sufficient quantity of similar, quality furniture available for acquisition for major projects.

The University currently has contracts for new furniture lines that offer up to 50 percent discounts from retail.

Now, due to the downturn in the economy, quality “slightly used” furniture is available from suppliers for approximately 24 percent of University prices (12 percent off retail price). This price includes transportation, delivery and setup. University Health Care recently completed a major renovation project using this furniture and estimates it saved \$400,000 compared to the cost of buying new furniture from University contracts. System Procurement and Campus Design staff have been alerted to the availability of this type of furniture and Procurement is preparing specifications to issue a bid for a volume purchase agreement with a used furniture supplier.

Action Plan for this recommendation:

- Promote the use of University Surplus property.
- Establish contracts with used furniture suppliers.
- Promote acquisition of used furniture to user departments and University designers.
- Procurement and design staff will assist user departments in acquiring used furniture.

Committee Members

Mary Sapp, *chair and director of UM Business Services*
Tammy Browning, *supervisor, Instructional Computer Services*
Benjamin Datema, *student*
John David, *associate professor and director of the Division of Biological Sciences*
Brandi Herrman-Rose, *marketing specialist, Residential Life*
Rita Houg, *assistant director, Residential Life*
Matthew Maher, *manager, Custodial Operations*
Patrick Margherio, *student*
Dale Muckerman, *assistant manager, Custodial Operations*
Lawrence Schilke, *managing engineer, Building Maintenance*
David Silvey, *commodity specialist, Procurement*
Rick Wise, *director, Printing Services*

Recycling and Waste Management

Background

Over the years, a number of MU's offices/divisions/departments have developed recycling and waste management strategies in an effort to save money, to adhere to statutory requirements, and/or to be responsible stewards of the environment. Some coordination for these efforts has been provided by the Campus Recycling Committee, the Environmental Affairs Committee, and the Coordinator of Solid Waste and Recycling (Landscape Services), along with other campus entities.

The University has shown progress with regard to recycling, waste management and waste reduction. For example, in 2007, **Records Management** recycled approximately 300,000 pounds of mixed paper and collected and disposed of approximately 1,600 pounds of x-rays and microfilm. **Environmental Health and Safety** safely disposed of more than 25,000 pounds of florescent lamps and collected and recycled more than 24,000 pounds of used motor oil in 2007. **Landscape Services** recycled more than 1,154,000 pounds of paper, 900,000 pounds of cardboard, 94,000 pounds of beverage containers and more than 153,000 pounds of grass clippings in 2007. In all, the University recycled more than 1,869 tons or nearly 4 million pounds of material that would have been sent to a landfill. (*See Appendix A for the complete "2007 Solid Waste and Recycling at MU" report*).

Although the University is making progress, the University lacks a modern "official" campus recycling and waste management policy, as well as a strong, central office/authority to lead and advance the causes of recycling, waste management and waste reduction.

Recommendations

In order to substantially decrease the amount of materials entering the waste stream and to decrease the quantity of resources used at MU, the Committee makes the following recommendations:

- 1.) **Official University adoption of an updated recycling and solid waste management plan.**
 - MU's current official recycling policy was adopted in March, 1999. ("Business Policy and Procedure Manual"; Section 1:150; http://bppm.missouri.edu/chapter1/1_150.html). The plan supports a voluntary desk-side recycling and only addresses the recycling of paper. (*see Appendix B for the complete "Deskside Recycling" policy.*)

- The Recycling and Waste Management subcommittee recommends the adoption of a more substantial recycling policy, based on the principal of “zero-waste” and the inclusion of this policy in the "Business Policy and Procedure Manual."

Proposed Updated MU Recycling Plan

The University recognizes the importance of minimizing solid waste generation by the University community. The University will pursue the goal of zero waste production by establishing policies and processes that will reduce solid waste generation: first through reduction; secondarily through re-use; and through recycling where volume, weight and toxicity can be reduced and value maximized.

At MU, the zero-waste philosophy aims to guide people in the re-design of their resource-use system with the goal of reducing waste to zero. Zero waste maximizes recycling, minimizes waste, reduces consumption and ensures that products are made to be re-used, repaired or recycled back into nature or the marketplace.

- The University commits to waste source reduction, especially at the point of purchase.
- The University supports the re-use of materials to maximize fiscal, environmental and energy efficiency.
- The University supports the development of waste-food composting and bio-mass resource recovery programs.
- The University commits to a comprehensive recycling program as the final step in solid waste reduction and as a means to transform waste into a resource. Information and education programs on campus recycling and other conservation issues should be developed for faculty, staff and students.
- The University supports environmentally responsible reduction, re-use, recycling and disposal of hazardous waste.
- The University supports a student vote to pursue funding from students, faculty and staff for a \$1/per student/per semester fee to fund the means to increase recycling levels. The University will pursue a match of the revenues generated by student fees, when available, through development donations, grants, etc.

2.) *Promote and adopt strategies for re-use of materials on campus.*

- Develop and implement re-use plans at the departmental level.
- Promote Surplus Property’s ability to reduce costs, generate revenue, and communicate material needs and availability.
- Develop and implement a communication plan for building managers to share information on surplus property.
- Advertise and promote the Surplus Property website <http://www.surplus.missouri.edu/>
- Create an internal list-serve or website for programs to market/advertise equipment no longer in use (e.g. Free Cycle).

- Explore the establishment of a building material donation site where normally land-filled, minimally valued materials could be stored and given away to community groups (e.g. Habitat for Humanity).
- 3.) ***Encourage the reporting of solid waste and recycling amounts by campus entities that do not participate in the solid waste contract with the city.***
- Provide report templates for recording the amount/types of materials disposed of and recycled.
 - Offer training sessions on appropriate methods for recording information and assessing carbon footprints.
 - Explore opportunities for providing incentives for programs to voluntarily report this information.
- 4.) ***Include the tracking of solid waste and recyclables generated through service contracts and building projects.***
- Explore the addition of language in all university contracts for demolition, construction and renovation to include the reporting of amounts of waste generated and recycled.
- 5.) ***Increase recycling rates from the current 26 percent to 40 percent by 2012.***
- Fully deploying indoor beverage containers and promoting their usage: a potential increase of 160 tons or 2 percent.
 - Making green recycling paper carts more accessible and easier to use: a potential increase of 500 tons or 6 percent.
 - Encouraging building residents to break down boxes and custodians to take them to recycling containers: a potential increase of 500 tons or 6 percent.
- (Above and beyond the potential 40 percent increase, an additional 25 percent could be recovered by composting dining hall waste, paper towel waste and livestock pen waste.)*
- 6.) ***Include aesthetic and security considerations of secured screening for solid waste and recycling containers for existing and new buildings.***
- Explore the modification of the University's construction manual to include typical designs for waste dumpster and recycling container screening and placement.
- 7.) ***Develop a budget and plan for any monies collected for furthering the recycling and waste reduction efforts.***
- Explore staff and student employment positions to sustain and further advance recycling and waste reduction efforts.
 - Seek to sell recycled materials to offset costs for labor and collection bins in the recycling system.
 - Examine material needs (e.g. equipment, space, etc.) and develop a list of material priorities.
 - Develop and implement pilot programs, such as providing students with re-usable beverage and food containers, to further reduce waste.

Recent Past and Current Practices

As stated, a number of successful recycling and waste management programs have evolved over the years at MU. These programs have relied heavily on volunteer support from student, staff, faculty and the public. The following is an account of the major recycling and waste recovery efforts currently in place at MU:

Paper Recovery

MU has recovered paper for more than 12 years. There are two main types of paper recovery. Several large paper generating divisions, such as Printing Services and Records Management, bale or palletize waste paper. This activity accounts for about half of the paper recovered. The other major type of recovery consists of 500 green roller carts distributed throughout campus buildings. The carts are picked up by Civic Recycling. The focus is on recovering mixed paper consisting of white and colored paper, newsprint, cardstock, envelopes, magazines and telephone books. Collecting mixed paper results in a simple process that collects the most tonnage. Building volunteers move the carts around in the building where they are needed the most. Paper is sorted and baled by Civic Recycling. Paper and fiberboard also are collected in two drop-off sites on campus operated by the city of Columbia. Paper recovery reduces the solid waste amount by nearly 1,000 tons per year.

Cardboard Recovery

Cardboard boxes are recycled at more than 40 locations on campus. Cardboard recycling bins are usually green, two-yard dumpsters marked with “*cardboard only*” and are generally located at the rear of buildings. All packing material must be removed and the boxes must be broken down and flattened. Custodians will recycle normal amounts of flattened cardboard boxes and Campus Movers are available (for hire) to move cardboard.

Indoor Beverage Recycling

Many campus buildings have voluntary beverage container recycling bins. Volunteers empty the bins into wheeled carts, which are then taken outdoors by building custodians for collection. Acceptable materials include aluminum cans and plastic bottles. Steel cans and glass bottles are acceptable in small amounts. Arrangements can be made with the Campus Recycling Coordinator to address larger amounts of materials.

Tiger Tailgate Recycling

Campus Facilities, Intercollegiate Athletics, Sustain Mizzou and the city of Columbia cooperate on a project to recover recyclables from football fans during the tailgate gatherings and inside the stadium after the games. MU encourages football fans to participate in this project.

Tiger Treasures Rummage Sale

MU departments, student groups and the Heart of Missouri United Way coordinate an annual project to recover and sell goods donated by students leaving University housing,

which would otherwise be discarded. Proceeds are donated to the participating United Way agencies.

Other Materials

Other materials such as ink cartridges, toner cartridges, pallets, metals, etc. are recycled as well. More information is available at the recycling web site:

<http://www.cf.missouri.edu/ls/recycle>

Surplus Property

Surplus Property, a division of Procurement Services, is responsible for the disposal, re-distribution and/or sale of used equipment/property that is no longer used. Participating agencies include the University of Missouri, government agencies, and educational institutions. The sale of this equipment is handled through public auctions or sold on eBay.

In FY'08, Surplus Property sold approximately 230 tons of material at monthly auctions. This includes 1,423 monitors, 34 automobiles and 10 tons of scrap metal. Profits returned to campus departments totaled \$372,487. All operations were self-supporting and received no General Operating funds. Items sold on eBay and shipped are packed in used boxes using shredded office paper. More information is available at www.surplus.missouri.edu

Conclusion

There are currently a number of recycling and waste management programs in place at MU. Most of the existing programs were developed as efforts to save money, to adhere to statutory requirements, and/or to reduce environmental impact. Through the adoption of a modern recycling plan and by taking advantage of the no or low cost methods of promoting current recycling and waste management opportunities, MU could see a more substantial decrease in the amount of materials entering the waste stream.

Some coordination for current recycling efforts has been provided by the Campus Recycling Committee, the Environmental Affairs Committee, and the Coordinator of Solid Waste and Recycling (Landscape Services), along with other campus entities.

Committee Members

Chair: John LaRocca, *General Manager, University Club and University Catering*

Co-Chair: Terrence Grus, *Director, Graduate Admissions & Records*

Steven Burdic, *Coordinator Solid Waste & Recycling*

Cyndie Parks, *Director, Records Management*

Jo Ann Dennings, *Research Specialist, Center for Family Policy & Research*

John (Bo) Solomon, *Supervisor Surplus Operation-Procurement*

Sandy Gummersheimer, *Continuing Education Coordinator, MU Direct*

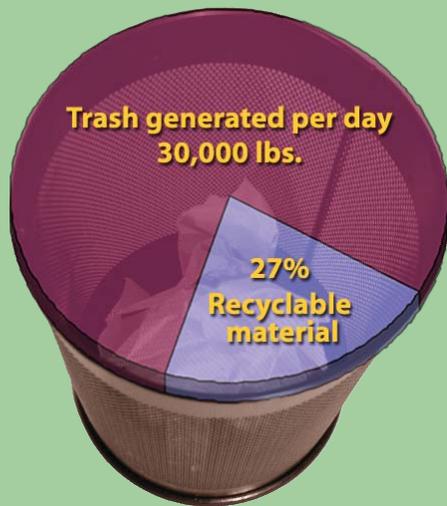
Rebecca Schedler, *Information Specialist, MU Libraries*

Solid Waste Management & Recycling

MU Waste Stream (2007)

Solid waste generated per year: 7431 tons
Solid waste recycled per year: 1869 tons

Each day, MU discards 30,000 pounds of solid waste. More than 8,000 pounds — **over 4 tons** — could easily be recycled!



Recycling saves MU \$95,584 per year in hauling and disposal costs

*Please recycle and help reduce MU's environmental impact!
Thanks for doing your part.*

www.cf.missouri.edu/lr/recycle

Mizzou Recycles is brought to you by the students, faculty and staff of the University of Missouri, including the following supporters:

Administrative Services

- Campus Facilities
- Energy Management
- Facility Operations
- Landscape Services
- Planning, Design & Construction
- Space Planning & Management
- Environmental Health & Safety
- Printing Services

Procurement

- Surplus Property

Records Management

Student Affairs

- Intercollegiate Athletics

Environmental Studies

- Human Environmental Sciences

Sustain Mizzou

With the cooperation of the city of Columbia, Civic Recycling and the Mid-Missouri Solid Waste Management District

To become a supporter of Mizzou Recycles contact:

Steve Burdic
Coordinator, Solid Waste & Recycling
Telephone: 573-882-7287
E-mail: burdics@missouri.edu



Printed on 100% recycled,
50% post-consumer waste paper

MIZZOU



RECYCLES

A guide to recycling at MU

2008

University of Missouri

What to recycle	Acceptable material	Unacceptable material	Where to recycle	Containers
Paper	Copy/computer/office paper; glossy paper; colored paper; envelopes; cardstock; newsprint; magazines, telephone books	Carbon paper; waxy paper; cardboard; manuscript boxes; copy paper wrappers; food trash	Green roller carts: 350 locations in 105 administrative and academic buildings, and residence halls.	 Picked up on Wednesdays
Cardboard	Flattened corrugated cardboard boxes; chipboard (i.e., cereal boxes); paper grocery bags	Styrofoam packaging or peanuts; plastic sheeting; food trash, pizza boxes	Green dumpsters marked Cardboard Only behind many administrative and academic buildings, and residence halls.	 Picked up on Tuesdays
Beverage Containers	Glass bottles; metal food or beverage cans (aluminum or steel); #1 and #2 plastic (look for number on bottom of container)	Aluminum foil, food trash	Cream-colored Sidewalk Recycling Containers on campus and Indoor Beverage Recycling Containers in many MU buildings. Look for outdoor recycling bins and volunteers at home football games. Want to start beverage container recycling in your building? Volunteers are needed for the Indoor Beverage Recycling Program. Contact the Recycling Coordinator at burdics@missouri.edu .	 Picked up on Tuesdays
Other Items: Students	Ink cartridges/batteries/toner cartridges		Sustain Mizzou table Brady Commons: Wednesdays 10 a.m. - 3 p.m. http://www.sustainmizzou.org	If you decide to recycle, PLEASE DO NOT CONTAMINATE RECYCLABLES with food or wet garbage. For example, a pizza box with sauce and cheese on it should be thrown out with regular trash. If in doubt, put the item in the regular trash. Once a container of recyclables is contaminated, all of it has to be discarded as trash.
	Computers/Electronics		Mid-MO Recycling: 573-474-8877 recycle@socket.net	
Other Items: Faculty/Staff	Batteries/Chemicals/Lab Glass		Environmental Health & Safety http://ehs.missouri.edu	
	Computers/Electronics		MU Surplus Property http://www.surplus.missouri.edu/	
	Toner Cartridges		MU General Stores http://www.mugeneralstores.com/	

Residential Life staff are happy to work with students to set up recycling programs in MU's residence halls. Interested?

Residents of **College Ave./McDavid/Dobbs/Mark Twain/Bingham/Southwest Campus:** Contact Larry Culberson, 882-2051, culbersond@missouri.edu

Residents of **Pershing/Johnston/Wolpers/Rollins/Virginia Ave.:** Contact Mary Proctor, 882-7211, proctorms@missouri.edu

Solid Waste and Recycling at MU 2007

4/17/2008

	Tons 2007	Dollars Cost
Solid Waste (includes recyclables)	7,431.6	\$384,000
Recycled Tonnage	<u>1,869</u>	<u>\$25,000</u>
Amount Landfilled	5,563	\$359,000
<hr/>		
Cost / ton landfilled		\$65
Cost / ton recycled		\$13.38
Avoided cost from Recycling		\$95,584
Avoided cost from Chemical Recycling		\$177,440
Percent Recycled	25.14%	

Material Type	Tons	Pounds
Mixed Paper	989.96	1,979,920
Cardboard	464.84	929,680
Newspaper	64.14	128,280
Electronics	41.59	83,180
Steel	149.91	299,820
Aluminum	22.33	44,660
Plastic Bottles	11.45	22,900
Glass	34.24	68,480
Grass Clippings	76.65	153,300
Used Oil	12.19	24,380
Batteries	<u>1.28</u>	<u>2,560</u>
Post Consumer Totals	1,868.58	3,737,160
Waste Utilization		
Boiler Ash	22,446.0	44,892,000
Tire Derived Fuel	3,120.0	6,240,000
Wood Chips/Boiler Fuel	<u>2,042.0</u>	<u>4,084,000</u>
Total for UMC	27,608.0	55,216,000

Projects (Totals Included Above)	2007 Tons
Tiger Tailgate Recycling	24.0
Drop off Recycling	66.0
Sidewalk Recycling	11.1
Paper Recycling (academic, administrative, support)	513.0
Cardboard (academic, administrative, support)	455.0
Newsprint (academic, administrative, support)	<u>64.0</u>
Total	1,133.1

Recycling at MU 2007	Tiger Tailgate	City Side walk	City Drop off	Summary					Type of Materials in Tons- then Pounds and Tons In Totals													
				Number	Pounds	Tons	Post Consumer	Avoided Cost = \$52/ton	Mixed Paper	Cardboard	Newspaper	Electronics and Media	Steel	Aluminum	Plastic Bottles	Glass	Used Oil	Batteries	Totals			
Projects included in Summary totals																						
Records Management																						
Mixed Paper					296,310	148.16	148.16	\$7,704	148.16													
x-rays, microfilm and other electronic media through ACT (Alternative)					1,599	0.80	0.80	\$42				0.80										
Hospital Records								\$0														
Mixed Paper					63,000	31.50	31.50	\$1,638	31.50													
Surplus Property								\$0														
2472 Monitors				2472.00	81,576	40.79	40.79	\$2,121				40.79										
Scrap metal					53,250	26.63	26.63	\$1,385						26.63								
27 Autos				27.00	148,500	74.25	74.25	\$3,861						74.25								
Environmental Health and Safety								\$0														
Fluorescent lamps collected/recycled = 48,160 lamps				44556.00	25,194	12.60	12.60	\$655								12.60						
Batteries collected/recycled					2,559	1.28	1.28	\$67											1.28			
Chemicals recycled = 2450 containers = \$177,440 avoided purchase cost				2450.00			0.00	\$177,440														
Equipment recycled = 566 pieces = \$14,966 avoided purchase cost				566.00			0.00	\$14,966														
Used Motor Oil					24,380	12.19	12.19											12.19				
Energy Management								0.00														
Boiler Ash						22,446.00																
Tire Derived Fuel						3,120.23																
Scrap iron and steel						49.03	49.03							49.03								
Switch Grass						3.00																
Wood Chips						2,042.20																
Printing Services								\$0														
Printer's Mix (high grade paper)					669,824	334.91	334.91	\$17,415	334.91													
Cardboard					19,182	9.59	9.59	\$499		9.59												
Miscellaneous (low grade paper)					53,232	26.62	26.62	\$1,384	26.62													
Aluminum					16,446	8.22	8.22	\$428					8.22									
Landscape Services								\$0														
Aluminum cans				3.12	5.25	5.74	14.11	\$734					14.11									
Glass bottles				19.20	1.17	1.28	21.64	\$1,125							21.64							
Plastic bottles				1.68	4.67	5.10	11.45	\$596						11.45								
Paper (Civic)					791,430	395.72	395.72	\$20,577	395.72													
Paper (City drop off)					106,120	53.06	53.06	\$2,759	53.06													
Cardboard								\$0														
Civic					752,652	376.33	376.33	\$19,569		376.33												
Johnston (City)					37,480	18.74	18.74	\$974														
Rollins (City)					57,880	28.94	28.94	\$1,505														
Dobbs (City)					62,480	31.24	31.24	\$1,624			31.24											
Newspaper (Civic)					128,280	64.14	64.14	\$3,335			64.14											
Organic Recycling								\$0														
Grass Clippings					153,300	76.65	76.65	\$3,986										76.65				
Grand Totals								\$0														
Totals in pounds				48,000	22,173	24,244	0	0	58,960,011	3,737,151	1,979,916	929,674	128,280	83,175	299,810	44,666	22,900	68,474	177,680	2,559	3,737,134	
Totals in Tons				24.00	11.09	12.12			29,480.01	1868.58	\$286,388	989.96	464.84	64.14	41.59	149.91	22.33	11.45	34.24	88.84	1.28	1868.57

Appendix B: MU's Current Recycling Policy

Below is MU's current recycling policy included in the "Business Policy and Procedure Manual" (Section 1:150). (http://bppm.missouri.edu/chapter1/1_150.html)

March 1999

<i>Chapter 1 GENERAL AND ADMINISTRATIVE INFORMATION</i>	<i>Section: 1:150 Deskside Recycling</i>
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Deskside Recycling

University of Missouri-Columbia faculty and staff members may voluntarily participate in deskside recycling, a paper recycling program. The purposes of the program are to decrease the amount of trash, reduce MU's solid waste disposal costs, help add to the longevity of the Columbia landfill and reutilize post-consumer paper.

Materials for The Recycling Bins/Barrels

These materials may be placed in recycling bins:

<i>Bond Paper</i>	<i>Envelopes</i>	<i>Notebook Paper</i>
<i>Cardstock</i>	<i>File Folders</i>	<i>Old Files</i>
<i>Computer Paper</i>	<i>Heavy Papers</i>	<i>Old Records</i>
<i>Copy Paper</i>	<i>Manila Envelopes</i>	<i>Pamphlets (no glue)</i>

NOTE: *Don't worry about staples, rubber bands or paper clips.*

Do not place these materials in recycling bins:

<i>Carbon Paper</i>	<i>Kleenex</i>	<i>Newsprint</i>
<i>Cardboard Boxes</i>	<i>Magazines</i>	<i>Post-ems</i>
<i>Food</i>	<i>Plastic</i>	<i>Waxy Paper</i>
<i>Glass</i>	<i>Manuscript Boxes</i>	<i>Window Envelopes</i>
<i>Glossy Paper</i>	<i>Metal</i>	

For More Information

- *To order more barrels or to resolve problems with the program, contact the manager of Surplus Property (882-5051), Surplus Property Building.*
- *Questions about the pick up schedule may be directed to your building coordinator.*

Research and Instruction

Background

The Environmental Research and Instruction Subcommittee examined the best practices at peer institutions and current practices within the MU community. The research practices that were examined encompassed environmental efforts at the disciplinary and departmental levels. Committee members also reviewed the current state of practice in the MU community and recommend cross-disciplinary approaches to ensure environmental sustainability education occurs across the curriculum.

Recommendations

1.) *Increase Resources for Cross-Disciplinary Approaches*

Currently the only office tasked with the responsibility of cross-disciplinary integration is the Environmental Studies Program

(<http://web.missouri.edu/~umcsnresiwww/index.html>). The program has one half-time faculty member who helps students choose careers, majors and courses; advises students obtaining an environmental studies major or certificate; looks for and integrates environmental education courses and activities from campus and the community into the curriculum; develops and provides courses to fill gaps in the curriculum (specifically courses that integrate across the three disciplinary areas and/or cover modeling problems and causes at an introductory and advanced level, business and the environment, and natural history), and to serve as a resource and link for people and groups inside and outside the institution.

2.) *Create a full-time faculty/ administrative position, with a half- or full-time staff person, and commensurate space and resources.*

Such an arrangement could provide the following benefits:

- **A leadership role in statewide environmental education.** Both the Higher Education Sustainability Act and the No Child Left Inside Act suggest a widespread level of interest and support for across-the-board environmental education. Positioning ourselves as the lead state institution in statewide environmental education will make MU the first place state agencies and businesses, as well as students, will think of when seeking future employees, looking for problem-solving, or deciding on a school.
- **More effective external communication about MU's "Environmental Majors"** These majors might be especially attractive to international students not only seeking an academic degree, but also looking for practical approaches for solving environmental problems. Presented with a "hands-on" approach employed by many departments, this could tip the balance for students seeking real solutions to real problems in their home countries.
- **More effective internal communication about "Environmental Majors"** to ensure that MU students can become involved early in their studies in an environmental

major and give them the opportunity to take advantage of more cross-disciplinary courses and extra curricular activities. Such communication will also stress differences between the various environmental majors to properly place students (i.e., clearly communicate differences between Environmental Science and Environmental Studies Programs).

- **Better identification and support of courses that can serve multiple environmental majors** - GIS and mapping, business management, marketing, writing, strategic communication, web editing, community development, environmental law, group decision making and meeting planning - so that students have the skills to manage organizations and businesses to mitigate or even prevent environmental damage.
- **Better identification and support of student environmental efforts and initiatives** - so that students can hit the ground with real world experience, prepared to confront environmental problems after graduation.

3.) *Encourage environmental research and education in other parts of the university.*

The growing public awareness of the impact of human activities on the environment calls for the development of partnerships between colleges and schools in the university and external partners. The committee sees strong opportunities for partnerships between those colleges that currently include research and education on the environment (Colleges of Agriculture, Food and Natural Resources; Arts and Sciences; Schools of Medicine and Nursing) to partner with nascent programs in Education, Social Work, Truman School of Public Policy, Trulaske College of Business, and School of Law. These partnerships will allow the university to develop research and curriculum role-models for other universities within the region to emulate.

- The Environmental Studies program can serve as a bridge between various disciplines and environmental issues. The environment is an inherently interdisciplinary field that can be related to all majors and professions. The environmental studies department can provide fields that are less focused on hard science with the resources and insight necessary to increase environmental education at Mizzou.
- Promote and expand the hands-on service learning classes related to sustainability and the environment.
 - During this fall semester 2008, Sustain Mizzou initiated a new Service Learning opportunity offered through the Environmental Studies Department. This class is called “Sustainable Development in Downtown Columbia, Missouri”. This class was made possible by a grant from the MU Information Technology Innovations Fund and was inspired by ALDP Sustainability Task Force discussions held in the spring of 2008 by the Research and Instruction Sub-committee.
- Provide resources for interdisciplinary component for environmental research
 - Today many grants require interdisciplinary components to be competitive. Resources need to be made available to all departments at Mizzou that would help them to broaden the scope of their projects. Social research studies need help integrating an environmental element and science grants need help integrating a social component.

4.) ***Existing departments should explore how they can further integrate environmental classes into their curriculum.***

- The renowned programs and departments at Mizzou should continue to offer classes that relate their field to the environment. For example, the Harry S Truman School of Public Affairs will offer an Environmental Policy class in the spring of 2009.
- An examination of ways in which other major research universities handle interdisciplinary environmental research and instruction should be undertaken to see other models and methods.

5.) ***Examine and inventory environmental educational and research practices within the national and international spheres.***

- Any effort to make the university a statewide resource on environmental and sustainability practices involves a benchmarking of our current practices with those of peer institutions around the nation and internationally. Such benchmarking efforts will help the university to establish programs similar to other institutions and possibly provide opportunities to partner with those identified institutions to enter into joint research and educational opportunities for our students and faculty.
- Investigate potential relations with the University of the Western Cape, South Africa. For example, researchers at the School of Medicine are investigating alternative treatments, using plants native to South Africa in the treatment of AIDS.

Recent Past and Current Practices

Environmental Education at MU

Environmentally related education at MU is distributed across and within several dozen disciplines, with a modest amount of tracking and integration provided by the Environmental Studies Program.

1. Majors

From a career perspective, MU has approximately 15 majors that would lead to environmental careers in science and technology; protecting air, water and soil quality; managing and protecting forests, fisheries and wildlife; reducing the amounts and mitigating the impacts of hazardous and toxic waste; developing alternative food and fuel crops; and providing and protecting natural environments for public recreation and education. A key step in pursuing any of these majors with the aim of preparing for an environmental career is to integrate environmental courses from across disciplines within and outside the sciences into the general education requirements and electives.

These Majors	Lead to These Environmentally Related Occupations in Science and Technology
Agricultural Systems Management	reduce and mitigate impacts of agricultural water use
Animal Science	manage livestock operations to reduce and mitigate waste, oversee safety and sustainability of food supply
Biochemistry	develop and engineer biological processes for creating alternative foodstocks, reduce

	and mitigate waste production
Biological Engineering	develop and engineer biological processes for creating alternative foodstocks, reduce and mitigate waste production
Biology	field station management, wildlife assessment, conserve endangered species, impacts of pollutants on living organisms
Civil and Environmental Engineering	plan and build traffic, water, waste infrastructure to minimize resource use and waste
Chemical Engineering	air, water quality inspector, develop less toxic alternatives for industrial processes
Chemistry	air, water quality inspector, develop less toxic alternatives for industrial processes
Environmental Science (SEAS)	environmental site assessment, monitor air, water soil quality, land management
Fisheries and Wildlife	field station management, wildlife assessment, conserve endangered species, monitor fisheries practices
Forestry	urban arborist, forest manger, field station manager
Geology	mineral resource assessment, water quality assessment, watershed management, ground water protection, siting of landfills
Horticulture	urban arborist, plan and build/plant/maintain public gardens, outdoor classrooms
Plant Sciences	develop and test crops for food, fiber, fuel alternatives, reduce and mitigate use of pesticides, fertilizers
Soil Resource Management (SEAS)	reduce and mitigate non-point source pollution maintain and enhancesoil quality, watershed management, land use planning

There are approximately five majors that lead to careers in the social and human dimensions of environmental problems: fostering understanding of and connection with nature, developing organizational capacity and tools for rallying public support for solving problems, and providing tools for social change - laws, regulations, rules, business models and economic analyses. As with the programs in science and technology, a key step is integrating environmental courses from across disciplines into the general education requirements and electives for a given major.

These Majors	Lead to Environmentally Related Occupations in the Social and Human Dimensions
Agricultural Economics	cost benefit / risk benefit analysis that incorporates externalities (the environmental impacts), sustainable development
Environmental Studies	draft, advocate for, or lobby for laws or regulations, work for or start organizations or businesses to help the environment, work for businesses aiming to become more sustainable
Geography	map and plan the integration of human societies with nature, do urban planning
Parks Recreation and Tourism	plan and implement outdoor and environmental education
Rural Sociology	community development and planning, sustainable development in the US or internationally

Additional information about majors is available at <http://web.missouri.edu/~umcsnresiwww/careers.html>

2. Courses

There are more than 200 courses in 45 departments and six colleges that cover natural and/or human dimensions of the environment that help students develop skills necessary for addressing environmental problems. Courses range from entry level (1000) - Introduction to Environmental Science, Environmental Economics, and Mapping the Environment - up through advanced courses (3000-4000) - Environmental Land Use Management, Environmental Law and Policy, and Science, Health and Environmental Writing.

3. Cross-Disciplinary Approaches

Because environmental problems are the result of human needs and aspirations exceeding nature's capacity, the solutions have to integrate both the natural and human dimensions of the problem. Therefore the most effective environmental education must connect the natural and applied sciences to the human and behavioral sciences and the humanities.

Only a small number of courses achieve a balance among these areas, though many explicitly or implicitly incorporate components of the other areas within the context of a course focused on one area. Therefore, advising that encourages students to take several environmentally related courses from different areas is critical to ensuring effective environmental education. There are several ways to do this.

Environmental Studies offers a certificate that bundles two lower level courses, a seminar course and two upper level courses in an area outside the student's major. Science majors might take Population and Environment and World Food and You, Ecological Economics, and America's Environmental Experience and Congress and Legislative Policy.

Many departments offer minors in which careful selection of courses may complement a student's training in environmental issues in their major. For example, a forestry minor with an agricultural economics major.

Finally, students may choose to take several environmentally related courses to meet general education or elective requirements. These could include service or internship opportunities with local environmental organizations, for example, organizing invasive plant removal projects or doing home weatherization for low income householders.

Outside of the classroom, students can participate in departmental clubs where departments deal explicitly with environmental concerns, for example forestry or environmental science. Students could join one of the student organizations whose missions are environmental, for example Sustain Mizzou or Greeks Going Green. The leadership development opportunities these clubs offer are very important in helping students develop the people and management skills they will need to be good problem solvers.

Committee Members

Dr. Jeffrey Williams, *co-chair, assistant to the vice provost for enrollment management and adjunct assistant professor of English*

Pablo Mendoza, *co-chair, assistant director of student life and director of the Multicultural Center*

Dr. David H. Trinklein, *associate professor of plant sciences*

Dr. Keith Goyne, *assistant professor of soil, environment, and atmospheric sciences*

Dr. M. Kay Libbus, *professor of nursing and women's studies*

Dr. Jan C Weaver, *director of MU Environmental Studies program*

Adam MacKenzie Saunders, *doctoral student*

Benjamin P. Datema, *student*

Dr. Peter P. Motavalli, *associate professor of soil sciences*
Dr. Rose-Marie Muzika, *associate professor of forest ecology*
Christine O'Brien, *student*
Dr. Mark R. Ryan, *director of the School of Natural Resources and Curator's Professor
of Fisheries and Wildlife*

EXAMPLES OF ENVIRONMENTAL AND SUSTAINABILITY PROGRAMS AT OTHER UNIVERSITIES

Sustainability: The ability to meet the needs of the present while living within the carrying capacity of supporting ecosystems and without compromising the ability of the future generations to meet their own needs.

- Energy Biosciences Institute (EBI) at University of California Berkeley

Their goal is to try to understand, in the broadest sense, the issues, opportunities, and scientific problems associated with biofuels — whether biofuels are a good idea or not. They also investigate specific solutions to technical issues that are associated with biofuels. A full interview with video can be seen at http://www.berkeley.edu/news/media/releases/2008/09/15_biofuels.shtml

- The University of New Hampshire (UNH) is nationally recognized as a *Sustainable Learning Community*

UNH unites the spirit of discovery with the challenge of sustainability across its **Curriculum, Operations, Research and Engagement (CORE)** through initiatives designed around four key systems that underpin the ability to define and pursue quality of life. They are committed to being a *Biodiversity Protection Campus* that promotes ecological and public health through the protection of biodiversity and ecosystem integrity. They are committed to being a *Climate Protection Campus* that pursues a sustainable energy future through emissions reduction policies, practices, research and education. <http://www.sustainableunh.unh.edu/fas/index.html> They are committed to being a *Sustainable Food Community* that promotes healthy food systems from farm to fork to health and nutrition outcomes, and they are committed to being a *Cultural Development Campus* that promotes a culture of sustainability through a dedication to community, diversity, citizen engagement, public arts, and the conservation and sustainable development of cultural and natural resources. Complete information on this program can be found at <http://www.sustainableunh.unh.edu/>

- The goal of Portland State University is to harness the strengths of their urban university toward solving the current environmental, social and economic problems.

In keeping with the Portland State University (PSU) motto *Let Knowledge Serve the City*, Community-University Partnerships marshal support for more than 400 faculty, 7,800 students and 1,000 community partners via community-based learning (CBL) and other civic engagement initiatives to address specific and compelling issues locally, regionally and worldwide. More information is available at <http://www.pdx.edu/sustainability/>

- The **Water Sustainability Program (WSP)** at the University of Arizona provides science-based technical, economic, legal and policy expertise necessary for water development, use and conservation in a rapidly growing urban state.

Nancy Crocker, WSP staff at the Maricopa County Cooperative Extension office in Phoenix, has completed a pilot project to bring water audits into the classroom in Phoenix schools.

During Spring 2008, 366 students at Southwest Elementary School in Phoenix participated in a school water audit project. Students measured water use at their school, created posters and wrote proposals about how to conserve water. One proposal was selected for funding and implementation. The winning proposal noted that the school had a hand washing station with eight faucets that ran continuously during the school's lunch periods, for about two hours each day, whether or not children were present and washing their hands. The proposal suggested retrofitting the station with sensors or push buttons. More information about this university-community project, complete with video, can be seen at <http://www.uawater.arizona.edu/cgi-bin/uawater/news.pl?ID=69>

- Cornell has many established programs to make the campus more sustainable

Recently, Cornell has made a commitment to move towards [Carbon Neutrality](#). This will involve aggressively reducing CO2 emissions and offsetting what is left, to the point here the university's net emissions reach zero. Colleges and universities all across the United States are joining in this commitment, which will help to advance education for sustainability in all sectors of society; complete information on this can be found at <http://www.sustainablecampus.cornell.edu/>

Appendix - Courses with environmentally related content covering the natural dimension (nature) or the human dimension (people), and courses that develop skills (skills) important in addressing environmental problems. Courses were selected from the 2008-2010 Undergraduate Catalog. The list has 261 courses from six colleges and 45 departments. They are sorted by area, then by major. Only a few courses are offered both semesters, and many upper level courses may only be offered in alternate years.

College	Course Designator	#	Course Title	Area
CAFNR - Food Systems and Engineering	Agricultural Systems Management	1020	Introduction to Agricultural Systems Management	nature
CAFNR - Food Systems and Engineering	Agricultural Systems Management	1040	Physical Principles for Agricultural Applications	nature
CAFNR - Food Systems and Engineering	Agricultural Systems Management	4420	Surface Water Management	nature
CAFNR - Food Systems and Engineering	Agricultural Systems Management	4440	Water Quality and Pollution Control	nature
CAFNR - Food Systems and Engineering	Agricultural Systems Management	4460	Irrigation and Drainage	nature
CAFNR	Agriculture	2190	International Agriculture and Natural Resources	nature
CAFNR- Food Systems and Engineering	Animal Sciences	2110	Global Animal Agriculture	nature
Human Environmental Sciences	Architectural Studies	4320	Materials, Methods, Products	nature
CAFNR-SEAS	Atmospheric Sciences	1110	Introduction to Atmospheric Science	nature
CAFNR-SEAS	Atmospheric Sciences / Geography	3600	Climates of the World	nature
CAFNR-SEAS	Atmospheric Sciences / Geography	1050	Introductory Meteorology	nature
CAFNR-SEAS	Atmospheric Sciences / Geography	4520	Meteorology of the Biosphere	nature
CAFNR - Food Systems and Engineering	Biochemistry	2110	Living World	nature
Engineering	Biological Engineering	3050	Environmental Control for Biological Systems	nature
Engineering	Biological Engineering	4150	Soil and Water Conservation Engineering	nature
Engineering	Biological Engineering	4250	Irrigation and Drainage Engineering	nature
Engineering	Biological Engineering	4350	Watershed Modeling Using GIS	nature
Engineering	Biological Engineering	4550	Design of Livestock Waste Management Systems	nature
Arts and Science	Biological Sciences	1060	Basic Environmental Sciences	nature
Arts and Science	Biological Sciences	2100	Infectious Disease	nature
Arts and Science	Biological Sciences	3100	Community Biology	nature
Arts and Science	Biological Sciences	3210	Plant Systematics	nature
Arts and Science	Biological Sciences	3250	Parasitology (Biomed 3250)	nature
Arts and Science	Biological Sciences	3260	Invertebrate Zoology	nature
Arts and Science	Biological Sciences	3360	Herpetology	nature
Arts and Science	Biological Sciences	3650	General Ecology	nature
Arts and Science	Biological Sciences	4328	Introductory Radiation Biology	nature
Arts and Science	Biological Sciences	4660	Plant Population Biology	nature
Arts and Science	Biological Sciences	4670	Avian Ecology	nature
CAFNR - School of Natural Resources	Environmental Sciences	3330	Environmental Land Use Management	nature
Engineering	Chemical Engineering	2118	Introduction to Energy Technology and Sustainability	nature
Engineering	Chemical Engineering	4220	Hazardous Waste Management	nature
Engineering	Chemical Engineering	4312	Air Pollution Control	nature
Engineering	Chemical Engineering	4318	Energy Technology and Sustainability	nature
Arts and Science	Chemistry	4280	Environmental Chemistry	nature
Arts and Science	Chemistry	4290	Environmental -Toxicological Chemistry	nature
Engineering	Civil and Environmental Engineering	3100	Fundamentals of Transportation Engineering	nature
Engineering	Civil and Environmental Engineering	3200	Fundamentals of Environmental Engineering	nature
Engineering	Civil and Environmental Engineering	3220	Water and Wastewater Treatment Processes	nature

Engineering	Civil and Environmental Engineering	3720	Hydrology	nature
Engineering	Civil and Environmental Engineering	4210	Solid Waste Management	nature
Engineering	Civil and Environmental Engineering	4230	Introduction to Water Quality	nature
Engineering	Civil and Environmental Engineering	4240	Water Quality Analysis	nature
Engineering	Civil and Environmental Engineering	4270	Environmental Engineering Microbiology	nature
Engineering	Civil and Environmental Engineering	4290	Hazardous Waste and Aquatic Chemistry	nature
Engineering	Civil and Environmental Engineering	4406	Geotechnics of Landfill Design	nature
Engineering	Civil and Environmental Engineering	4703	Applied Hydrology	nature
Engineering	Civil and Environmental Engineering	4792	Analysis of Water-Resource Systems	nature
Engineering	Electrical and Computer Engineering	4020	Energy Systems and Resources	nature
CAFNR - School of Natural Resources	Environmental Science	1100	Introduction to Environmental Science	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	2500	Introduction to Genetics and Evolution for Conservation	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3200	Aquaculture	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3300	Wildlife Damage Management	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3350	Wildlife Damage Management Lab	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3400	Water Quality and Natural Resource Management	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3660	Mammalogy	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	3800	Waterfowl Biology and Management	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	4300	Fisheries Management	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	4500	Animal Population Dynamics and Management	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	4600	Wildlife Conservation	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife	4800	Environmental Toxicology	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife / Biological Sciences	2600	Ornithology	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife / Biological Sciences	2700	Ichthyology	nature
CAFNR - School of Natural Resources	Fisheries and Wildlife / Biological Sciences	4100	Limnology	nature
CAFNR - School of Natural Resources	Forestry	2151	Dendrology	nature
CAFNR - School of Natural Resources	Forestry	2540	Forest Hydrology Field Studies	nature
CAFNR - School of Natural Resources	Forestry	2542	Forest Measurement and Inventory	nature
CAFNR - School of Natural Resources	Forestry	2543	Forest Ecology Field Studies	nature
CAFNR - School of Natural Resources	Forestry	2544	Introduction to Silviculture and Management	nature
CAFNR - School of Natural Resources	Forestry	2545	Forest Management Planning	nature
CAFNR - School of Natural Resources	Forestry	3207	Forest Fire Control and Use	nature
CAFNR - School of Natural Resources	Forestry	3212	Forest Health and Protections	nature
CAFNR - School of Natural Resources	Forestry	4320	Forest Ecology	nature
CAFNR - School of Natural Resources	Forestry	4330	Practice of Silviculture	nature

CAFNR - School of Natural Resources	Forestry	4370	Wildland Fire Management	nature
Arts and Science	Geography	2610	Introduction to Physical Geography	nature
Arts and Science	Geography	3610	Physical Geography of the United States	nature
Arts and Science	Geography	3630	Process Geomorphology	nature
Arts and Science	Geography	4620	Biogeography	nature
Arts and Science	Geography	4630	Fluvial Geomorphology	nature
Arts and Science	Geological Sciences	1200	Environmental Geology	nature
Arts and Science	Geological Sciences	1250	World's Oceans	nature
Arts and Science	Geological Sciences	2200	Oceanography	nature
Arts and Science	Geological Sciences	2300	Earth Systems and Global Change	nature
Arts and Science	Geological Sciences	2400	Surficial Earth Processes	nature
Arts and Science	Geological Sciences	2450	Global Water Cycle	nature
Arts and Science	Geological Sciences	2600	Mineral and Energy Resources of the Earth	nature
Arts and Science	Geological Sciences	4100	Groundwater Hydrology	nature
Arts and Science	Geological Sciences	4110	Karst Hydrology	nature
Arts and Science	Geological Sciences	4120	Engineering Geology	nature
Arts and Science	Geological Sciences	4130	Groundwater Modeling	nature
Arts and Science	Geological Sciences	4220	Petroleum Geology	nature
Arts and Science	Geological Sciences	4318	Environmental Soil Chemistry (SEAS 4318)	nature
Arts and Science	Geological Sciences	4400	Geomicrobiology and Microbiological Biogeochemistry	nature
Arts and Science	Geological Sciences	4991	Capstone in Environmental Geology	nature
Arts and Science	Geological Sciences / Soil Science 2107	2110	Introduction to Soil Science	nature
Medicine	Molecular Microbiology and Immunology	4300	Microbial Pathogenesis	nature
CAFNR - School of Natural Resources	Environmental Science/Natural Resources	4320	Hydrologic and Water Quality Modeling	nature
Human Environmental Sciences	Nutritional Sciences	1310	Basic Concepts of World Nutrition	nature
Arts and Science	Physics and Astronomy	4190	Physics and Chemistry of Materials	nature
CAFNR - Plant Sciences	Plant Sciences	2075	Horticultural Ecology	nature
CAFNR - Plant Sciences	Plant Sciences	2110	Plant Growth and Culture	nature
CAFNR - Plant Sciences	Plant Sciences	2710	Insects in the Environment	nature
CAFNR - Plant Sciences	Plant Sciences	3210	Principles of Weed Science	nature
CAFNR - Plant Sciences	Plant Sciences	3213	Genetics of Agricultural Plants and Animals	nature
CAFNR - Plant Sciences	Plant Sciences	3255	Landscape Maintenance	nature
CAFNR - Plant Sciences	Soil Sciences/Plant Sciences	4313	Soil Fertility and Plant Nutrition	skills
CAFNR - Plant Sciences	Soil Sciences/Plant Sciences	4314	Soil Fertility and Plant Nutrition Lab	skills
CAFNR - Plant Sciences	Plant Sciences	4520	Environmental Microbiology	nature
CAFNR - Plant Sciences	Plant Sciences	4720	Aquatic Entomology	nature
CAFNR - Plant Sciences	Plant Sciences	4730	Insect Pest Management for Plant Protection	nature
CAFNR - Plant Sciences	Plant Sciences	4740	Biological Control of Insects	nature
CAFNR - Plant Sciences	Plant Sciences / Biological Sciences	3150	Biology of Fungi	nature
CAFNR - Plant Sciences	Plant Sciences / Biological Sciences	3710	Introductory Entomology	nature
CAFNR - Plant Sciences	Plant Sciences / Biological Sciences	3715	Insect Diversity	nature
CAFNR - SEAS	Soil Science / Environmental Science	3290	Soils and Environment	skills
CAFNR - SEAS	Soil Science / Plant Sciences	2100	Introduction to Soils	nature
Arts and Science	Special Degree Programs - Environmental Studies	3000	Natural History of Missouri	nature
Engineering	Nuclear Engineering	4030	Introduction to Nuclear Reactor Engineering	nature
CAFNR - Applied Social Sciences	Agricultural Economics	2156	Introduction to Environmental Law	people
CAFNR - Applied Social Sciences	Agricultural Economics	3241	Ethical Issues in Agriculture	people
CAFNR - Applied Social Sciences	Agricultural Economics	3256	Agribusiness and Biotechnology Law	people
CAFNR - Applied Social Sciences	Agricultural Economics	3257	Rural and Agricultural Law	people
CAFNR - Applied Social	Agricultural Economics	3270	Conservation and Use of Protected Areas	people

Sciences				
CAFNR - Applied Social Sciences	Agricultural Economics	3271	International Agricultural Development	people
CAFNR - Applied Social Sciences	Agricultural Economics	3272	International Food Trade and Policy	people
CAFNR - Applied Social Sciences	Agricultural Economics	4356	Environmental Law and Polity	people
CAFNR - Applied Social Sciences	Agricultural Economics	2070	Environmental Economics	people
CAFNR - Food Systems and Bioengineering	Agricultural Systems Management	2020	Environmental Ethics in Agriculture	people
CAFNR - Food Systems and Bioengineering	Animal Science	2111	Societal Issues Facing Animal Agriculture	people
Arts and Science	Anthropology	2300	Anthropology of War/Peace Studies	people
Arts and Science	Anthropology	2340	Hunters and Gatherers	people
Arts and Science	Anthropology	3560	Plagues and Peoples	people
Arts and Science	Anthropology	3680	Plants and People in Native America	people
Arts and Science	Anthropology	4200	Environment and Archaeology	people
Arts and Science	Anthropology	4320	Ecological and Environmental Anthropology	people
Arts and Science	Anthropology	4880	Demographic Anthropology	people
Human Environmental Sciences	Architectural Studies	4323	Sustainable Technologies and Systems	people
Human Environmental Sciences	Architectural Studies	4660	Housing Concepts and Issues	people
Arts and Science	Art History and Archaeology	4840	American Architecture	people
Arts and Science	Art History and Archaeology	3720	Cities in the Western Imagination	people
CAFNR - Food Systems and Bioengineering	Biochemistry	2112	Biotechnology in Society	people
Arts and Science	Biological Sciences	3050	Genetics and Society	people
Engineering	Civil and Environmental Engineering	4100	Traffic Engineering	people
Engineering	Civil and Environmental Engineering	4102	Infrastructure Management	people
Engineering	Civil and Environmental Engineering	4106	Intelligent Transportation Systems	people
Engineering	Civil and Environmental Engineering	4108	Bicycle and Pedestrian Transportation	people
Engineering	Civil and Environmental Engineering	4109	Urban Development and Planning	people
Engineering	Civil and Environmental Engineering	4250	Environmental Regulation Compliance	people
Arts and Science	Economics	1013	Economic Analysis of Social Issues	people
Arts and Science	Economics	1111	Environmental Economics	people
Arts and Science	Economics	4335	Economics for Decision Making	people
Arts and Science	Economics	4360	Economic Development (Peace Studies 436)	people
CAFNR - School of Natural Resources	Fisheries and Wildlife	2400	Human Dimensions of Fish and Wildlife Conservation	people
CAFNR - School of Natural Resources	Fisheries and Wildlife	3500	Wildlife Conservation in British Cities	people
CAFNR - School of Natural Resources	Fisheries and Wildlife	3600	Introduction to Conservation Biology	people
CAFNR - School of Natural Resources	Fisheries and Wildlife	4200	Urban Wildlife Management	people
CAFNR - Food Systems and Bioengineering	Food Science/ Plant Sciences	1020	World Food and You	people
CAFNR - School of Natural Resources	Forestry	2541	Forest Utilization	people
CAFNR - School of Natural Resources	Forestry	3217	Fire and Society	people
CAFNR - School of Natural Resources	Forestry	3290	Urban Forestry	people
CAFNR - School of Natural Resources	Forestry	4350	Forest Economics	people
Arts and Science	Geography	2550	Introduction to the Humanized Earth	people
Arts and Science	Geography	2660	Environmental Geography	people
Arts and Science	Geography	2710	Economic Geography	people

Arts and Science	Geography	2720	Urban Geography	people
Arts and Science	Geography	3740	Geography and Planning	people
Arts and Science	Geological Sciences	4200	Economic Geology	people
Arts and Science	History	3420	America's Environmental Experience	people
Arts and Science	History	4420	American Urban History	people
Arts and Science	History	4430	The Great West in American History	people
Arts and Science	History	4440	History of the American Environment	people
Human Environmental Sciences	Human Development and Family Studies	4670	The Politics of Reproduction and Fertility Control	people
Journalism	Journalism	4260	Impact of Advertising on American Culture	people
Business	Management	3200	Business and Society	people
Business	Marketing	4380	Buying and Supply Chain Management	people
Business	Marketing	4750	Marketing, Society and Government	people
CAFNR - School of Natural Resources	Natural Resources	1060	Ecology and Conservation of Natural Resources	people
CAFNR - School of Natural Resources	Natural Resources	1070	Ecology and Renewable Resource Management	people
CAFNR - School of Natural Resources	Natural Resources	4353	Natural Resource Policy/Administration	people
Human Environmental Sciences	Nutritional Sciences	2420	Inactivity and Disease	people
CAFNR - School of Natural Resources	Parks Recreation and Tourism	3215	Program Development in Leisure Services	people
CAFNR - School of Natural Resources	Parks Recreation and Tourism	3230	Introduction to Parks and Outdoor Recreation Services	people
CAFNR - School of Natural Resources	Parks Recreation and Tourism	3231	Principles of Interpretive Outdoor Recreation	people
CAFNR - School of Natural Resources	Parks Recreation and Tourism	4333	Park Management	people
CAFNR - School of Natural Resources	Parks Recreation and Tourism	4340	Advanced Recreation Land Management	people
Human Environmental Sciences	Personal Financial Planning	2185	Consumer as Entrepreneur	people
Human Environmental Sciences	Personal Financial Planning	3287	Consumer and Household Economics I	people
Human Environmental Sciences	Personal Financial Planning	4380	Assessing the American Dream	people
Human Environmental Sciences	Personal Financial Planning	4388	Effective Consumer Decision-Making	people
CAFNR - Plant Sciences	Plant Sciences	2254	Landscape Design	people
Arts and Science	Political Science	4140	Congress and Legislative Policy	people
Arts and Science	Political Science	4160	Interest Groups	people
Arts and Science	Political Science	4330	Policy Analysis	people
Arts and Science	Psychology	3130	Decisions, Values and Choice	people
Arts and Science	Psychology	3820	Environmental Psychology	people
Arts and Science	Psychology	4340	Attitude Change	people
Arts and Science	Psychology	4810	Industrial/organizational Psychology	people
Arts and Science	Psychology	4890	Social Motivation	people
CAFNR - Applied Social Sciences	Rural Sociology	1000	Rural Sociology	people
CAFNR - Applied Social Sciences	Rural Sociology	1120	Population and the Environment	people
CAFNR - Applied Social Sciences	Rural Sociology	2225	Science, Technology and Society	people
CAFNR - Applied Social Sciences	Rural Sociology	3325	Sociology of Food and Nutrition	people
CAFNR - Applied Social Sciences	Rural Sociology	4310	Sociology of Agriculture and Natural Resources	people
CAFNR - Applied Social Sciences	Rural Sociology	4335	Social Change and Trends	people

CAFNR - Applied Social Sciences	Rural Sociology	4370	Environmental Sociology	people
Human Environmental Sciences	Social Work	2000	Exploration in Social and Economic Justice	people
Human Environmental Sciences	Social Work	4710	Social Justice and Social Policy	people
Arts and Science	Sociology	1120	Population and Ecology	people
Arts and Science	Sociology	3000	Urban Sociology	people
Arts and Science	Sociology	4230	Women, Development and Globalization	people
Arts and Science	Sociology	4370	Environment and Society	people
Arts and Science	Special Degree Programs - Environmental Studies	2070	Introduction to Ecological Economics	people
Arts and Science	Special Degree Programs - Environmental Studies	2110	Analysis of Environmental Issues	people
Arts and Science	Special Degree Programs - Environmental Studies	4350	Modeling Environmental Problems	people
Human Environmental Sciences	Textile and Apparel Management	3110	Textiles and Apparel in the Global Economy	people
Human Environmental Sciences	Textile and Apparel Management	4110	Global Sourcing	people
CAFNR - Applied Social Sciences	Agricultural Economics	3283	Fundamentals of Entrepreneurship	skills
CAFNR	Agricultural Education	4320	Designing Curriculum and Instruction in Agriculture	skills
CAFNR	Agricultural Journalism	3210	Fundamentals of Communications	skills
CAFNR	Agricultural Journalism	3240	Communicating on the Web	skills
CAFNR	Agricultural Education	2260	Team and Organizational Leadership	skills
CAFNR	Agricultural Journalism	1160	Introduction to Agricultural and Environmental Journalism	skills
CAFNR-SEAS	Atmospheric Sciences	4510	Remote Sensing for Meteorology and Natural Resources	skills
Engineering	Civil and Environmental Engineering	4200	Remote Sensing of the Environment	skills
Arts and Science	Communication	3460	Organizational Advocacy	skills
Arts and Science	Communication	3572	Argument and Advocacy	skills
Arts and Science	Communication	4474	Theory and Research in Persuasion	skills
CAFNR - School of Natural Resources	Forestry	4360	Forest Information Systems	skills
Arts and Science	Geography	1840	Mapping the Environment	skills
Arts and Science	Geography	2840	Introduction to Mapping Science	skills
Arts and Science	Geography	3840	Computer Assisted Cartography	skills
Arts and Science	Geography	4710	Spatial Analysis in Geography	skills
Arts and Science	Geography	4810	Landscape Ecology and GIS Analysis I	skills
Arts and Science	Geography	4815	Landscape Ecology and GIS Analysis II	skills
Arts and Science	Geography	4830	Remote Sensing	skills
Arts and Science	Geography	4840	Geographic Information Systems I	skills
Arts and Science	Geography	4940	Geographic Information Systems II	skills
CAFNR - Food Systems and Bioengineering	Hotel and Restaurant Management	3410	Conference and Meeting Management	skills
Journalism	Journalism	4200	Principles of Strategic Communication	skills
Journalism	Journalism	4206	Strategic Writing I	skills
Journalism	Journalism	4416	Science, Health and Environmental Writing	skills
Business	Management	3000	Fundamentals of Management	skills
Business	Management	4030	Organizational Behavior	skills
Business	Management	4060	Project Management Fundamentals	skills
Business	Management	4650	Entrepreneurship: Theory and Practice	skills
Business	Marketing	3000	Principles of Marketing	skills
Business	Marketing	4000	Marketing Management	skills
CAFNR - School of Natural Resources	Natural Resources	1090	Beginning GIS for Natural Resources	skills
CAFNR - School of	Natural Resources	3220	Public Relations for Natural Resource	skills

Natural Resources			Managers	
CAFNR - School of Natural Resources	Natural Resources	4325	Introduction to Geographic Information Systems	skills
CAFNR - School of Natural Resources	Natural Resources	4365	GIS Applications	skills
CAFNR - School of Natural Resources	Natural Resources	4385	Landscape Ecology and GIS Analysis	skills
CAFNR - School of Natural Resources	Natural Resources	4395	Landscape Ecology and GIS Analysis II	skills
CAFNR - School of Natural Resources	Parks Recreation and Tourism	2140	Camp Leadership and Management	skills
CAFNR - School of Natural Resources	Parks Recreation and Tourism	4331	Administration of Outdoor Recreation-Education Programs	skills
Human Environmental Sciences	Personal Financial Planning	2180	Personal and Family Management	skills
Human Environmental Sciences	Personal Financial Planning	4188	Community Agencies and Volunteerism	skills
CAFNR - Applied Social Sciences	Rural Sociology	4341	Building Communities from the Grassroots	skills
CAFNR - Applied Social Sciences	Rural Sociology	4342	Empowering Communities for the Future	skills
CAFNR - Applied Social Sciences	Rural Sociology	4343	Creating Capacity for Dynamic Communities	skills
CAFNR - School of Natural Resources	Environmental Science / Soil Science	4305	Environmental Soil Physics	skills
CAFNR - School of Natural Resources	Environmental Science / Soil Science	4306	Environmental Soil Physics Lab	skills
CAFNR - School of Natural Resources	Soil Science	4308	Soil Conservation	skills
CAFNR - School of Natural Resources	Environmental Science / Soil Science	4312	Environmental Soil Microbiology	skills
CAFNR - School of Natural Resources	Environmental Science / Geological Sciences / Soil Science	4318	Environmental Soil Chemistry	skills

Transportation

Background

“The daily movement of people back and forth to campus in automobiles burning fossil fuels is one of the largest impacts a typical educational institution imposes on the life support systems of the planet. In addition, the travel patterns that student learn while in college are likely to influence their future travel choices.” (Toor & Havlik, 2004, p.1)

Transportation related to comprehensive universities like the University of Missouri is multi-faceted with each area representing unique challenges and opportunities. As noted by Toor and Havlik (2004), the movement of more than 34,000 faculty, staff and students to and from campuses like Mizzou consumes a significant amount of fossil fuels each day. However, once on campus, the movement of individuals, materials and services across campus also involves a wide variety of other vehicles and pathways, many of which conflict with each other and waste precious resources. Additionally, large numbers of faculty, staff and students travel to far-flung areas of the continent and around the world for purposes of research, professional conferences, study abroad, symposia and sporting competitions, extending the impact of campus transportation practices and policies worldwide. Mizzou also hosts hundreds of thousands of visitors each year to campus for institutional events (e.g. graduation), sporting events, conferences, tours of programs and facilities as well as to obtain outstanding medical care.

The tremendous role that transportation plays in the life of Mizzou also represents a unique opportunity for it to serve an educational role for its many community members and visitors. As suggested above, the impact of exposure, education and utilization of sustainable transportation may influence life-long habits and practice for those that attend, work or visit the University. While there are many long-standing and recent initiatives that have existed at Mizzou, they have not been actively integrated into a comprehensive sustainable transportation program. Additionally, there are many exciting programs and services that exist at comparable institutions that may be explored or implemented here to help move people and resources in a more environmentally friendly manner.

Recommendations

- 1.) ***Survey the MU community’s transportation behavior and research transportation programs from similar institutions.***
 - Implement a transportation survey to collect feedback and learn how students, faculty and staff view and utilize alternative transportation.

- Measure positive response to suggested ways of incentivizing increased carpooling, bicycling, pedestrian and public modes of transportation (with an open field for suggested incentives).
- Determine distances of commutes/ time allocated to commutes, including differentiation among different groups (i.e. students, staff, faculty)
- Collect feedback on the level of interest in student-run transportation systems and making public transport more student-friendly.
- Identify density areas for developing route extensions for public transportation
- Research comparable universities (e.g. size, density, geography) programs for sustainable transportation, including:
 - Student shuttle services
 - Restricted freshman parking policies
 - Bicycle routes and infrastructure

2.) *Develop a comprehensive transportation strategy and philosophy with aligned policies that supports and encourages alternative forms of transportation.*

- Relevant MU and Columbia units utilize survey and research data to formulate an integrated transportation strategy, and consider if a Transportation Demand Management approach is appropriate for MU.
- Re-examine employees and students parking behavior in light of new strategies/policies and evaluate possible changes to parking infraction consequences – (e.g. change payment methods for parking tickets such as eliminating student charge for parking infractions to increase a sense of personal responsibility for students).
- Explore restricting or eliminating freshman parking privileges to increase awareness of public and other forms of transportation, eliminate crowding in parking structures, and reduce traffic in and around the MU campus.
- Continue MU’s efforts to be a more pedestrian-friendly campus.

3.) *Use MU resources to increase education, awareness and availability of transportation alternatives within the MU community.*

- Provide more covered bicycle parking for students, faculty and staff (for example: Manor House/Hospital covered parking).
- Promote student run bicycle co-operatives initiatives (e.g. service/repair sites developed by student entrepreneurs).
- Increase awareness of the Critical Mass movement designed to highlight greater awareness of bicycles on roadways. http://en.wikipedia.org/wiki/Critical_Mass
- Increase education of students on cost of driving to/from or through campus (e.g. frequent Greek students driving cars to visit east/west clusters of housing). Develop a brochure that stresses the cost of a vehicle and driving frequently/every day.
- Conduct a freshman orientation education campaign directed to students and parents – implement at Summer and/or Fall Welcome on the cost of driving and benefits of alternative transportation methods.
- Develop a “Why drive?” program that emphasizes non-motorized transportation as a way to conserve resources and maintain health.
- Recommend development of a Jeff City to Columbia shuttle, similar to the BiState Commuter Bus.

- Secure and enhance the Columbia/Boonville vanpool program.
- Develop or promote existing lounge spaces for commuter students to better utilize their time (disincentive commuting during mid day breaks by creating desirable campus locations).
- Obtain funding for marketing of these programs and/or utilize students of business/marketing programs in the Trulaske College of Business and the School of Journalism for work as capstone or service learning projects.
- Create incentives for carpoolers – e.g. reduce parking fees, garage spots, some perquisites for carpooling. Provide flexible hours for carpoolers and public transport participants.

4.) *Partner with community resources to increase collaboration between groups and advance programs and methods of alternative transportation available to the MU community.*

- Develop a computerized carpooling referral system within our current data systems (with appropriate privacy protections). A team of students (Ben Datema, Pat Margherio, and Jason Fox) received a Rocky Mountain Institute grant that could facilitate an Oberlin-type program and could be used to refer people to networks of interested carpoolers.
- Work with Parking and Transportation Services to discuss feasibility of increased commuter parking access for students to decrease traffic and increase pedestrian access to campus.
- Continue work with the city of Columbia and Get About Columbia to develop safer bicycle routes (refer to the Get About Columbia priority list).
- Request that the city make zoning codes that mandate sidewalks for pedestrian use and bicycle accommodation shoulders. Increase use of “ped heads”, i.e. pedestrian crossing signals and install actual pedestrian/ADA accommodation devices.
- Promote University participation into City planning and development of transportation needs and improvements.
- Collaborate with Bike, Walk and Wheel Week, Pednet, Get About Columbia and others to increase cooperation between MU and Columbia community (e.g. the University of Montana-Missoula).
- In coordination with campus units (e.g. Student Health, UMHC, Wellness Resource Center) and existing healthy self-care programs (e.g. Healthy for Life Atkins Wellness Program), promote to employees and students the health benefits for walking and biking.
- Encourage pedestrian modes of transportation. Work with the city and MoDOT to make the city more pedestrian-friendly (especially areas surrounding MU – Stadium/ Providence/ College Ave crossings).
- Work with the city to:
 - Give people easy ways to provide public transportation feedback.
 - Make recommendations on public bus stops (based upon employee living locations). Make this worthwhile for the city as well.
 - Provide discounted bus passes for both students and staff.
 - Improve the bus schedule (improve employee promptness).

Recent Past and Current Practices

The University has some success in encouraging or promoting sustainable transportation practices. These include, but are not limited to:

- Incorporating a limited “closed campus” model which limits private vehicle use on major campus roadways during the hours of 8:15 a.m. through 3:45 p.m. on class days. In addition to providing a safer route for pedestrians, it offers a disincentive for drivers to use their personal vehicles for short trips.
- The PAVE committee has sought to increase the awareness and safety of an increasingly pedestrian-friendly campus by educating the campus community on appropriate traffic and pedestrian rights and responsibilities.
- More departments are acquiring or converting to greater use of electric vehicles (e.g. golf carts) for transporting small supplies and personnel around campus. The University is developing standards to appropriately guide and regulate the use of these vehicles in a safe manner.
- MU has established a set of working guidelines and bike pathways that coincide with the city of Columbia’s PedNet/GetAboutColumbia initiatives to create an integrated network of trails for commuting and recreation. The campus Non-Motorized Transport Committee has three representatives on the corresponding city task force.
- A variety of efforts promote the use of bicycles for transportation around campus through programs like the Bike Fair, bike registration sponsored by MUPD, the Tiger Cage (encouraging biking to MU home football games), guidelines for bike rack designs and shared bike programs (e.g. Residential Life has four departmentally-owned bicycles and helmets that any employee can check out for use around campus).
- Collaboration between Parking & Transportation Services, Missouri Students Association and Columbia Transit to establish more “student-oriented” bus routes, which include local businesses/attractions popular with college students. Bus routes were published in the Tiger Guide student handbook given to all new students.
- Campus Dining Services is increasing its “farm to table” program to purchase more locally produced food items to decrease the amount of fossil fuels used for transportation, as well as support for local businesses.
- Collaboration between Parking & Transportation Services, Residential Life and Columbia Transit more than doubled the public transportation service to campus for students living at two apartment complexes.
- Increased acquisition of alternative fuel vehicles in the University fleet, per state guidelines.
- Gasoline at the University Garage has a 10 percent ethanol mixture (but does not yet carry E-85).
- Various research and pilot initiatives are occurring to explore the use of alternative fuels, including biodiesel. For example, The Alliance for Collaborative Research in Alternative Fuel Technology (ALL-CRAFT) is a partnership led by the University of Missouri-Columbia with other partners to develop natural gas (NG, methane) and hydrogen as alternative fuels for advanced transportation. <http://all-craft.missouri.edu/>

Opportunities

Despite the positive steps MU has taken toward more sustainable transportation practices, there remains a wide variety of opportunities for the University to explore and ideally implement in order to support and maintain more sustainable transportation practices.

EMPLOYEE TRAVEL

The University should promote and support alternative means of travel to campus by employees (other than single use of personal vehicles). As some of these methods may involve more time and coordination by employees, flexibility in and modifications to arrival times, work schedules and human resource policies may be needed to avoid disincentives for using these alternative methods. Some options for employee travel include encouraging the use of:

Carpooling - The University could facilitate participation in multiple employees traveling together in a single vehicle by creating a network and/or database of interested employees that correlates information about where they live and work on campus, work schedules and passenger capacity making it easier for employees to identify those who could make up a carpool. Additionally, priority parking privileges might be provided to vehicles designated as carpool vehicles with a ridership of more than two unrelated persons. Other forms of incentives such as prizes, free event tickets or discount coupons might be initiated.

Public transportation – Employees at many institutions, through cooperative agreements or subsidies to local public transit systems, can ride public transportation to and from work at reduced or no cost. A program at the University of Colorado cost a little under \$400,000, but is estimated to free more than 350 parking spaces. The estimated annual debt service for that number of spaces was more than \$960,000, resulting in a net savings of more than \$560,000 (University of Colorado Environmental Center 2002, pp. 18–19). Some institutions are also successfully adding employee access to shared vehicles (see below in student section) as an addition or compliment to public transportation use. Continuation of current policies that allow public transportation vehicles access to areas of the “closed campus” would likely need to be continued for success in this area.

Non-motorized transportation – Columbia’s increasing expansion of the non-motorized travel in and around town supported by a federal grant provides more opportunities for employees to walk or bike to campus more safely and conveniently. Building on the strong, existing collaboration between campus and city planners, various incentive programs might be explored including the creation of bike/walking networks or teams that allow employees to travel with others (for safety or enjoyment), sufficient convenient (possibly sheltered) bike parking areas near major points of destination on campus, access to free or reduced cost shower/changing facilities at the Campus Recreation Center or recognition/award programs as noted above. Included in recent federal legislation pertaining to the \$700 billion “bailout” of the financial industry was a provision to permit a \$20/month reimbursement for each employee who uses a bicycle as their primary form of commuting to work.

[http://thomas.loc.gov/cgi-bin/query/F?c110:1:./temp/~c110wDGRI0:e256472:](http://thomas.loc.gov/cgi-bin/query/F?c110:1:./temp/~c110wDGRI0:e256472)

To facilitate the use/acquisition of bicycles by employees, the University may solicit discounts from local vendors or provide advance notification or priority access for bicycles impounded by the campus throughout the year that are sold to the public at regularly scheduled University auctions.

Policies and Practices – Current personnel and parking policies and practices would need to be evaluated to provide appropriate support and incentives to support sustainable transportation initiatives. Currently, parking management is focused on providing the maximum amount of parking to meet the frequently insatiable demand at the lowest possible price in the most convenient or functional location based on current pedestrian and vehicular traffic patterns. The creation of a revised transportation philosophy and supporting strategies for more sustainable transportation approaches will require a review/revision of policies that support those goals. This may include reduction or restriction of parking spaces to provide additional space for bikes, electronic vehicles or carpool vehicles; differential pricing models; or increased parking fees to support alternative use programs.

STUDENT TRAVEL

Many of the same methods used above could be utilized to promote student use of alternative methods of transportation to and from campus, but given that many more students than employees typically live proximate to campus, the greater the potential impact. One study of 23 research universities found that 64 percent of students lived within one mile of campus, and 84 percent lived within five miles (Daggett and Gutkowski, 2002).

At the University of Missouri, the large populations of private student housing east of the campus and south along Old Highway 63 and Providence Road would suggest that many MU students fall into this category. Given that most student parking is at the perimeter of campus, the provision of more central student parking for carpooling students might provide a significant incentive to participate. The significant increase (more than 200 percent from previous year) in student use of public transportation at the two “extended campus” apartment settings in the fall of 2008 suggest that student interest and willingness to use public transportation is dramatically increasing.

Students on more than 50 campuses, primarily those in urban areas, are making use of shared vehicle programs (e.g. Zipcar, I-Go, Flexcar) that allow them to rent a shared fleet vehicle for an hourly fee using an online reservation system. Some campuses also make this program available to employees who use alternative means of transportation to campus.

TRANSPORTATION AROUND CAMPUS

Once employees and students are on-campus, their movement around campus as they perform their duties, go to class or utilize campus services also can be done in a more sustainable fashion. Some examples include:

Closed/Pedestrian Campus – While MU limits access to certain core areas of campus, the possibility of expanding this either in scope or duration exists. Many roadways that bisect campus are city (vs. campus) streets and would require significant coordination between the campus and city traffic officials. There also is a necessity to accommodate non-emergency deliveries and services provided by the campus (e.g. mail, printing services, maintenance etc.) to all buildings on campus as well as public transportation (e.g. busses). The use of alternative fueled vehicles can be used to address some of these needs, but poses significant challenges to having a pedestrian-only core campus.

Alternative Transportation – As noted earlier, the use of electric vehicles over fossil-fueled vehicles to deliver materials and provide services continues to rise and should be encouraged. Standards for the appropriate use of these vehicles, but also including parking, re-charging and limitations in inclement weather must also be developed. For movement of personnel, bicycles remain a very viable and affordable option. Private ownership of bicycles can be supported through aforementioned discounts or purchasing options. However, many campuses and communities have a shared bike program where a fleet of designated bikes (painting them yellow with appropriate decals/markings seems to be the most common approach) are readily available for casual or reserved use on campus. An example of this is the Triton Bikes program at the University of California – San Diego. <http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,18392,00.html>

“Some campuses have invested in additional features such as covered bicycle parking, grade-separated crossings for bike paths (see figure 2), bicycle signal heads at signalized intersections, full-service “bike stations” with secure parking and repair service available, free bicycle checkout for students and employees, and even zero-interest loans for bicycle purchases by students (Poinsatte and Toor 1999; Associated Students of the University of Montana 2002). The impact can be significant. The University of California, Santa Barbara campus has achieved a student bicycle mode share of greater than 50 percent.” (Toor and Havlik, 2004)

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References & Resources

Association for the Advancement of Sustainability in Higher Education (AASHE) website –
Transportation <http://www.aashe.org/resources/transportation.php>

Daggett, J., and R. Gutkowski. 2002. *University Transportation Survey: Transportation in University Communities*. Fort Collins, Colo.: City of Fort Collins and Colorado State University.

Poinsatte, F., and W. Toor. 1999. *Finding a New Way: Campus Transportation for the 21st Century*. Retrieved December 14, 2002, from the World Wide Web: www.colorado.edu/ecenter/.

Toor, W., 2008. *The Road Less Traveled: Sustainable Transportation on Campus*. In The Green Campus: Meeting the Challenge of Environmental Sustainability, Association of Physical Plant Administrators

Toor, W., and Havlik, Spenser W., 2004. *Transportation & Sustainable Campus Communities: Issues, Examples, Solutions*. Island Press

Utilities Production and Utilization

Background

The University relies on utilities (electricity, steam, chilled water and water) for virtually every aspect of its daily operation. This subcommittee identified recommendations for ongoing efficiency improvements related to the production and use of utilities as well as maintenance practices that support utility efficiency. The goal is to look continually for new ideas and evaluate them for cost effectiveness, sustainability, practicality and other factors, and to wisely choose improvements.

Recommendations

- 1.) ***Continue practices that promote energy sustainability and investigate/seek new ideas from the various levels of the University, e.g. faculty, students and staff, to improve sustainability.***

This includes taking measures to increase efficiency and use renewable resources as much as it is economically feasible, and to decrease production of waste and hazardous material as much as is practical and cost effective.

For example, the Campus Facilities-Energy Management department currently has a goal to reduce energy consumption in Educational & General (E&G) space by 1 percent per year. This can be achieved by:

- Continuing energy audits across campus and identifying, prioritizing and implementing energy audit recommendations, as resources and funding allow.
- Continue to retrofit or replace fume hood systems with more energy efficient design, whenever possible, during renovation projects
- Continue with various lighting efficiency upgrades
- Continue with heating and cooling system upgrades, including updated efficient heating and cooling control systems, as resources and funding allow.
- Burning renewable and alternate fuels in the MU Power Plant as state operating permits allow and while it is economical.

- 2.) ***Continue to promote healthy learning environment through efficient maintenance and repairs of buildings and other infrastructures.***

For example, Campus Facilities performs building maintenance and repairs efficiently by:

- Maintaining building fenestrations in a manner that reduces unnecessary air infiltration, such as replacing broken window/door glass and repairing windows/doors that do not operate properly.
- Maintaining the heating, ventilating, air conditioning and exhaust systems in a manner that insures they are operating efficiently, by replacing air filters and cleaning coils as needed, repairing/replacing temperature controls that are

malfunctioning, performing annual tests and balancing fume hood exhaust systems.

- Fully implementing green and sustainable cleaning. Continue to evaluate new products, equipment and procedures and implement those items that prove to be efficient and cost effective.
- Maintaining a toxic material source reduction program to reduce the amount of mercury brought into campus buildings as contained in fluorescent lamps. With prices being comparable, staff should choose the lamp with the lowest mercury content.
- Encouraging procurement of energy efficient equipment and appliances across campus.

3.) *Develop practices that promote good water management and sustainability*

This includes developing and promoting technical and policy expertise necessary for water development, use and conservation across the campus to help ensure and maintain a continuous sustainable, high-quality water supply.

For example, for water conservation, Campus Facilities plans to:

- Eliminate waste water cooling wherever possible
- Continue to replace antiquated high usage plumbing fixtures with the new low-flow fixtures as repair and replacement projects are completed.
- Identify and repair leaking faucets and pipes in 24 hours or less to reduce waste water and building damage.
- Continue with the water use reduction program and complete current projects in design to reduce water use at the MU power plant.

4.) *Involve students, faculty and staff in sustainability efforts especially with respect to efficient utilization of utilities.*

- Develop additional communication methods to efficiently reach the campus community and increase their involvement in utilities conservation practices.
- Identify and minimize barriers and create incentives for individuals and departments to practice efficient energy saving methods. For example energy efficient equipment may cost more than non energy efficient equipment, but departments may not directly realize the savings from purchasing the energy efficient equipment. Incentives could be provided to departments to encourage their full participation in the energy savings program.

5.) *Develop indicators and measures for utility (energy and water) sustainability that will enable monitoring, reporting and continuous improvement.*

- Each college, school and department could develop measures and indicators for energy and water conservation methods including strategies and plans for implementation.

6.) *Provide effective communication and education to the Mizzou community*

An effective plan should be developed to educate, promote and engage the MU community (students, faculty and staff) about MU's plan for utility conservation efforts toward sustainability. The MU community should be engaged in various opportunities for

energy and water conservation, and also be made aware of the successes that have been achieved by the current ongoing conservation efforts. Listed below are some tasks that can be used for this promotion:

- Real-time dynamic resource usage display. When exposed to real-time visual feedback, dormitory residents may reduce their utilities consumption. Such display can include space cooling, heating, domestic water usage, building electricity and gas consumption. This also can serve as a means of publicizing savings as something tangible for everybody. A \$25,000 grant was awarded to a student group to facilitate this effort.
- Residential Facilities competition on energy usage and savings.
- Establish Green Campus Program for students by engaging students in opportunities for water and energy saving (10 ways to save water at MU and 10 ways to save energy at MU).
- Educational ad campaign to increase energy conservation awareness across campus.
- Encourage all departments to develop energy and water savings methods.
- Develop incentives or tangible rewards for reaching measurable energy savings goals-separate for students and separate for staff, as part of staff recognition week activities.
- Provide mechanisms for people to make energy saving suggestions (hotline, website, phone #, etc).
- Coordinate building sustainability plans with various building coordinators.
- Develop student capstone projects related to energy conservation.
- Provide academic short courses or seminars on energy conservation.

Recent Past and Current Practices

MU has aggressively pursued improvements and efficiency of both the production and use of campus utilities in order to minimize costs. MU is recognized as a national leader because of the success of these efforts. Campus Facilities has been actively pursuing energy conservation cost-saving opportunities since the mid 1970's. In 1990, a formal energy conservation program was created within the Campus Facilities-Energy Management department. As a result, the campus-wide educational and general (E&G) space energy use per GSF has decreased by 12 percent since 1990, and water use per GSF has decreased by 57 percent in the same period. These energy efficiency improvements have had many environmental benefits that are contributing to campus sustainability. *For detailed descriptions of these past successes by the Campus Facilities-Energy Management and Operations and the Residential Life see the appendix to this subcommittee report and/or the report of the MU Energy Conservation Task Force released January 2007.*

Subcommittee Members

Paul Ladehoff, *co-chair and program coordinator*
Wale Oladiran, *co-chair and associate director of MURR*
Greg Watts, *director of facility operations-general services*
Paul Hoemann, *director of energy management*
Jason Fox, *student*
Stan Freeman, *superintendent of residential life*

Appendix

Recent Past and Current Practices

Energy

In 1990, a formal energy conservation program was created within the Energy Management department of Campus Facilities. The Campus Facilities Energy Management department funds energy conservation projects using proven energy conservation technologies. Energy savings are used to pay back the initial project investment. The purpose of the program is to:

- Perform building energy audits to identify potential energy saving opportunities.
- Perform studies of potential energy projects including economics.
- Initiate and complete energy conservation projects with simple paybacks of five years or less.
- Design, install and operate a campus-wide energy management control system.
- Encourage building energy users to participate in energy conservation.
- Review renovation and new construction plans and specifications for energy efficiency.
- Track energy consumption in all campus buildings.
- Identify projects with acceptable paybacks through energy audits or through analysis of utility billing information.

Since the program began, project paybacks of five years or less have been achieved, after which the campus receives the ongoing savings realized through reduced utility costs. The program has averaged an annual reduction of 1.6 percent in utility costs since its inception.

About \$15 million was spent on energy conservation projects with savings of about \$32 million since 1990. Currently, approximately \$1 million is reinvested each year on new energy conservation projects.

Initiatives complete or underway include upgrades to campus lighting and HVAC systems, building controls, and tire-derived and biomass fuels.

It is anticipated that Energy Management will continue to be able to identify energy conservation projects with paybacks of about five years for at least two to three more years. This should enable achieving the ongoing goal of 1 percent energy reduction per year. Beyond three years, there might be a need to extend the acceptable payback for energy conservation projects beyond five years. However, with rising energy prices, this should be easily justified.

Energy Conservation by the numbers

- Since the Campus Facilities energy conservation program formally began in 1990, a cumulative energy cost avoidance of \$32 million for campus education and general (E&G) space has been achieved.
- In FY08, the energy conservation savings reached an annual cost avoidance of \$4.3 million. This is equivalent to any of the following:
 - The budget for three degree programs

- Tuition reduction of \$170 per student
- Salary of 68 full-time employees
- Since 1990, energy use per square foot in E&G space has been reduced by 12 percent.
- The energy conservation efforts have:
 - Reduced peak steam use by 26,000 pounds/hour
 - Reduced peak electric use by 3 megawatts

Environmental benefits from Energy Conservation

- Decreased green house gas emissions per square foot by 11 percent.
- Reduced carbon dioxide emissions annually equivalent to removing 18,087 cars from the roadways or planting 28,369 acres of trees.
- Decreased emissions and waste products by efficient energy production using a combined heat and power process at the MU Power Plant

Other Initiatives complete or under way

Campus Lighting Upgrades: 99 percent of exterior lights and 90 percent of interior lights now are high-efficiency. This program is continuing.

HVAC-system Upgrades: Campus Facilities installs high efficiency motors with variable-speed drives on fans and pumps, converts constant-volume systems to variable-air volume, and uses motion sensors to turn off lights and set back thermostats. HVAC system efficiency upgrades have been completed in 23 buildings.

Building Controls: Campus Facilities provides efficient operation of HVAC systems that not only saves energy, but also improves customer comfort and service. Electronic controls are installed and networked for air handlers, lighting systems, chillers, cooling towers and metering (steam, condensate, chilled water and water).

Campus-wide Energy Conservation Awareness – Campus faculty, staff and students are encouraged to conserve energy through the use of advertisements and presentations. In addition, engineers in the Campus Facilities Energy Management Department assist professors with tours and presentations in engineering classes. Energy management also participates in events, such as Earth Day, to educate the public on our energy conservation efforts at MU.

Vehicles - The University requires that 70 percent of vehicles purchased must be Alternative Fuel Vehicles (AFV).

Trees – The University plants approximately 200 trees annually on the MU campus.

Tire-Derived Fuel: The MU Power Plant supplements its fuel with tire derived fuel (TDF) made from chipped waste tires. MU partners with the Missouri Department of Natural Resources and Missouri Department of Corrections in a state-wide, tire-dump cleanup campaign. Burning TDF with coal reduces emissions, lowers MU’s energy costs, and offers additional environmental benefits. MU burns 300,000—500,000 tires annually. The MU’s TDF program has received national attention and earned several awards reflecting the overall

efforts to prevent pollution and improve the quality of life for Missouri citizens.

Biomass Fuels: Development and use of “green fuels” is an exciting new initiative. Campus Facilities is working with researchers to identify and develop viable biomass fuels in our region. These alternative fuels include wood waste, grasses and crop residues such as corn cobs.

This program is resulting in a win-win-win situation for the university, the environment and the state of Missouri. Benefits include the reduction of emissions including reduction of greenhouse gases, reduction of fuel costs, local investment in Missouri business and agribusiness, and continued research and development of renewable crop fuels. A test burn of about 6 tons of switchgrass from a USDA test plot near Centralia was recently conducted. The MU Power Plant's ability to use a variety of fuels was expanded in 2007 with the addition of waste wood chips to the fuel mix. The chips are replacing up to 5 percent of the plant's annual coal supply. Currently, MU is burning 7,000 tons of wood chips per year. Burning 7,000 tons of waste wood chips this year will:

- Reduce emissions from the MU Power Plant (like sulfur dioxide) by approximately 4 percent.
- Reduce more than 220 tons of ash for removal.
- Lower the campus fuel bill by about \$50,000.
- Lower greenhouse gas emissions (carbon dioxide) by more than 7,000 tons.
- Reduce the formation of methane, a very harmful greenhouse gas, by not allowing the waste wood to naturally decompose.
- Reduce more than 90,000 trucking miles by using a local fuel supplier. This will reduce the amount of diesel fuel used by more than 16,000 gallons.

Campus Facilities Operations continues to:

- Maintain the building fenestrations in a manner that reduces unnecessary air infiltration, such as replacing broken window/door glass and repairing windows/doors that do not operate properly.
- Maintain the heating, ventilating, air conditioning and exhaust systems in a manner that insures they are operating efficiently.
 - Replace air filters and cleaning coils as needed.
 - Repair/replace temperature controls that are malfunctioning.
 - Annually test and balance fume hood exhaust systems.

Residential Life Maintenance has contributed to energy saving in the following ways:

- Changing incandescent lamps to LED bulbs in all Exit signs in buildings - 50 watts to 25 watts. All emergency lighting was replaced with a more energy efficient model.
- Approximately 8 years ago, started purchasing/installing T-8 fixtures instead of T-12.
- Over the last 10 years, installing motion sensor lighting controls in many of the common areas (occupancy sensors).
- Installing lockable light switches for hallway lighting in Residence Halls. By switching every other light off when possible, electrical usage was reduced.
- Replacing lighting in mechanical rooms and crawl spaces from 100-watt incandescent bulbs to 25-watt fluorescent replacement packs.

- During breaks (Spring, Thanksgiving, Winter), turning off lighting and turning heat/cooling settings to the minimum.
- Reducing heating costs by replacing hot water storage tanks in mechanical rooms with instantaneous heating systems.
- Replacing room units (steam) with more efficient fan coil units as spaces were remodeled.
- Continuing to add to the campus chilled-water loop to many of the halls. This will replace the window a/c units now in place, which should lower the electrical use.
- Doubling up with staff in vehicles to and from jobsites to reduce gasoline consumption to increase fuel price savings.
- Adding four golf carts to the vehicle fleet for Building Services Supervisors, thus reducing gasoline consumption and increasing fuel savings.

Water

MU has reduced water use by eliminating once-through cooling processes on campus. The process cooling loads have been connected to the chilled water loop to eliminate the waste. Efforts continue in looking for ways to reduce water use on campus, and there are two projects in design that will significantly reduce water use at the MU power plant. Since 1990, even though space has increased by 28 percent, water use has decreased by 45 percent. On a total gallon/GSF basis, water use has been reduced 57 percent.

Facilities Operations continues to replace antiquated high usage plumbing fixtures with the new low-flow fixtures as repair and replacement projects are completed and leaking faucets and pipes are identified and repaired in 24 hours or less to reduce wasted water and building damage.