

Environmental Goals and Priorities for Princeton University:

Environmental Mission: Princeton University seeks to reduce its Environmental Impact by implementing policies and procedures that create tangible, significant improvements and strike a proper balance between environmental stewardship and economic expense.

Goals:

- 1) Decrease emissions of Greenhouse gases and air pollutants
- 2) Reduce energy consumption
- 3) Reduce water consumption
- 4) Decrease the amount of solid waste sent to landfills
- 5) Practice environmentally responsible purchasing (for construction and daily campus use)
- 6) Decrease storm water runoff and ensure that it is uncontaminated
- 7) Implement a master plan for preserving green space
- 8) Minimize heat island effects
- 9) Increase environmental awareness
- 10) Establish indoor air quality standards

Goal Description:

- 1) **Decrease emissions of Greenhouse gases and air pollutants**
 - A. Purchase wind energy
 - B. Install photovoltaic cells
 - C. Reduce emissions from vehicle fleet
 - Standardize GEM vehicles
 - Switch current diesel fueled vehicles to biodiesel
 - Consider natural gas for new vehicle purchases
 - D. Minimize single occupant commuter traffic

Energy from the sun warms the Earth's surface and excess heat is radiated back into space. However, some gases in the atmosphere function by trapping the outgoing energy and retaining the heat near the surface of the Earth. This "greenhouse effect" allows the Earth to remain a more hospitable temperature for human habitation.¹ Gases that trap heat, termed Greenhouse gases, result from both natural and anthropogenic sources and consist of: water vapor, carbon dioxide, methane, nitrous oxide, ozone, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). Carbon dioxide and nitrous oxide are released during the combustion of fossil fuels such as oil, natural gas, and coal, while methane is produced through their transportation.² Following the industrial revolution, the greater use of fossil fuels in electricity generation caused the amount of greenhouse gas emissions to increase. The Earth's surface temperature has warmed by approximately one degree Fahrenheit over the past century. In the United States approximately 6.6 tons of greenhouse gases are emitted per person annually, and eighty-two percent of this total is produced from burning fossil fuels.³

Scientists suggest that rising temperatures will change climate patterns throughout the world and could cause environmental problems such as increased flooding and famine in certain areas. Decreasing emissions of greenhouse gases will help slow down global climate change and ward off possible environmental disasters. Additionally, air pollution is also a consequence of creating electricity and other energy from the burning of substances such as coal, natural gas, and oil. The most six common air pollutants such as sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, particulate matter, and lead are created as by-products in the combustion of fossil fuels. These particulates contribute to the formation of smog, acid rain, and an unhealthy outdoor environment that damages both human health and natural ecology.⁴

2) Reduce energy consumption

- A. Install motion sensors in dormitory bathrooms
- B. Efficiently schedule room air conditioning
- C. Design and construct buildings to optimize energy performance
- D. Re-commission existing buildings

¹ U.S. Environmental Protection Agency (EPA). "Climate." 2004. Online Resource. Last accessed 08.09.04. URL: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html>

² EPA. "Emissions." 2004. Online resource. Last Accessed 08.09.04. URL: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissions.html>

³ EPA. "Emissions, Individual" 2004. Last accessed 08.09.04. URL: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissionsindividual.html>

⁴ EPA. "Air Pollutants." 2004. Last accessed 08.09.04. URL: <http://www.epa.gov/eftpages/airairpollutants.html>

- E. Eliminate student use of incandescent light bulbs in favor of compact fluorescent light bulbs

Buildings and homes produce more greenhouse gas emissions than cars.⁵ As previously discussed, greenhouse gas emissions contribute to global climate change, and air pollutants affect the health of the public as well as the natural environment through the formation of acid rain and smog. Acid rain damages both aquatic systems as well as building structures. A reduction in the amount of energy used to maintain a building by investing in more sustainable building equipment and energy efficient products can reduce the total amount of energy utilized by a building or dormitory. Consequently, this will affect the amount of greenhouse gas emissions and air pollutants released into the atmosphere as a result of energy production.

3) Reduce water consumption

- A. Standardize front-loading washers
- B. Install waterless urinals in new buildings and renovations
- C. Minimize irrigation of campus lawns
- D. Track annual water use per person

Water is arguable the most important natural resource in the world. However only approximately 1% of water is drinkable and if it is not conserved water can quickly become polluted and overused. Living in an area with an abundance of water, such as New Jersey, provides the resident with a false belief that wasting water carries no consequences. Yet, other people in the America, as well as the rest of the world, do not have this luxury. Water shortages often occur in Middle Eastern countries and droughts happen throughout the United States during the summer months. High demand for water and overuse contributes to non-point source pollution of local waterways by: altering instream flows due to surface withdrawals, saltwater intrusion through excessive water removal, and allowing polluted runoff to enter waterbodies as a result of excess water applied for irrigation and landscape purposes that contain sediments, nutrients, salts, and other pollutants.⁶ Protecting water through the careful use of the resource will help to preserve the valuable, natural resource and aquatic ecosystems.

⁵ EnergyStar. "Energy Star Fact." 2004. Online resource. Last accessed 08.10.04. URL: www.energystar.gov

⁶ EPA. "How Excessive Water Use Affects Water Quality." 2004. Online resource. Last accessed 08.12.04. URL: <http://www.epa.gov/watrhome/you/chap2.html>

4) Decrease the amount of solid waste sent to landfills

- A. Develop a program to recycle construction waste
- B. Establish a composting program for pre-consumer food waste
- C. Implement a plan to reduce paper use
- D. Ensure recycling of University carpet
- E. Institute a program to handle furniture left by students

In 2001, U.S. residents, businesses, and institutions produced more than 229 million tons of municipal solid waste, approximately 4.4 pounds of waste per person per day. The majority of garbage is placed in a landfill rather than being recycled or reused, although a large proportion of the materials placed in landfills can indeed be recycled. The item most commonly found in these engineered dumps is paper at more than forty percent of landfill contents,⁷ while more than sixty-seven percent of total municipal solid waste produced is compostable.⁸ These paper products and other biodegradable and recyclable materials are unable to decompose in the context of a landfill and will instead remain virtually forever. New Jersey is the most densely populated state with decreasing landfill capacity. Therefore, Princeton University sends its garbage to a landfill in Pennsylvania. Reducing the amount of solid waste Princeton sends to the landfill will help preserve natural resources needed to create new material as well as dwindling landfill space.

5) Practice environmentally responsible purchasing (for construction and daily use)

- A. Construction
 - Purchase sustainable building materials
 - Purchase carpet with recycled material
- B. Daily Use
 - Sustainable food purchases
 - Environmentally friendly cleaning products
 - “Green” paper products
 - Biodegradable bags for trash collection

In 1998, the Environmentally Preferable Purchasing policy was established as a federal-wide program through executive order 13101 defined as “...products or services that have a lesser or reduced effect on human health and the environment when compared with competing

⁷ EPA. “Municipal Solid Waste.” 2004 Online Resource. Last accessed 08.09.04. URL: <http://www.epa.gov/epaoswer/non-hw/muncpl/faq.htm#9>

⁸ EPA. “Composting.” 2004. Online Resource. Last accessed 08.17.04. URL: <http://www.epa.gov/epaoswer/non-hw/muncpl/compost.htm#Figures>

products or services that serve the same purpose...”⁹ The production of “green” goods causes the least amount of harm to the natural environment. The creation of new products from virgin material can generate substantially more pollution through the manufacturing and extraction process. Purchasing sustainable products can decrease potential environmental degradation.

6) Decrease storm water runoff and ensure that it is uncontaminated

- A. Adhere to new storm water regulations
- B. Conduct survey to determine cross connects between storm and sanitary systems

Rainstorms provide natural systems with water in order to restore the groundwater and help balance what is removed from the system through human and animal consumption. Runoff occurs as discharges from the natural system into nearby lakes, streams, and rivers. This water can often contain pollutants such as oil, grease, and chemicals that are gathered from water traveling across pavement and other impervious surface. Heavy precipitation can overload both waterways and sewer systems possibly causing floods and wastewater contamination.¹⁰

Decreasing storm water runoff and ensuring that the water is uncontaminated will preserve the local bodies of water in the Princeton area through decreasing the possibility for water pollution to occur.

7) Implement a master plan preserving green space

- A. Establish an arboretum

Prior to European occupation, 2 billion acres of land consisted of forests, grasslands, deserts, shrublands, and wetlands. Between 1982 and 1997 approximately seven million acres of agricultural land and ten million acres of forest land were converted to residential, transportation, industrial, urban, and other uses.¹¹ The changing of groundcover has eliminated trees and foliage from their established areas and has reduced green space. The reduction of green space has many significant environmental implications. Ecosystem services provided by trees and vegetation, such as storm water containment, sequestration of carbon dioxide and reduction of air

⁹ EPA. “About EPP.” 2004 Online Resource. Last accessed 08.10.04. URL: <http://www.epa.gov/oppt/epp/about/about.htm>

¹⁰ EPA. “Storm Water.” 04 Online Resource. Last accessed 08.10.04. URL: <http://www.epa.gov/eftpages/watetormwater.html>

¹¹ EPA. “Ecological Condition.” 2004. Online Resource. Last accessed 08.10.04. URL: <http://www.epa.gov/indicators/roe/html/roeEcoLa.htm>

pollutants, are greatly reduced resulting in contamination of waterways and the atmosphere. Preserving green space by establishing an arboretum will help counteract these negative environmental effects.

8) Minimize heat island effects

- A. Standardize white roofs and greenroofs on flat roofs
- B. Increase tree plantings on-campus and in parking lots

The EPA has discovered that during the summer months urban air can become almost 10 degrees hotter than the surrounding suburbs and rural areas. Elevated temperatures increase peak energy demand, air conditioning costs, air pollution levels, and heat-related illness and mortality.¹² “Hot spots” form due to replacement of vegetation with impervious surfaces such as asphalt, concrete, and building structures.¹³ The increased temperature can create substantial environmental problems with regard to air quality thereby posing health concerns to individuals residing in the area. The demand for air conditioning is increased as a rise in building temperature causes greater energy demand and hence emissions from electricity generation. Moreover, chemical reactions resulting in smog are accelerated due to the increase in temperature. Stroke, physiological disruption, organ damage, and death can also occur because of the high temperature. Shading parking lots and buildings with trees and foliage can help to lower the temperature and provide for more efficient building energy use.

9) Increase environmental awareness

- A. Hire an Sustainability Coordinator
- B. Host University sponsored Earth Day events
- C. Establish an EcoRep program
- D. Provide funding for on-campus environmental initiatives
- E. Create a student-run organic garden

Campus environmental awareness occurs when students and staff consider the environment in their everyday decisions and lives and are conscious of the way their actions affect the natural world. Moreover, these individuals seek to reduce the negative impact on

¹² EPA. “Heat Island Effects.” 2004. Online Resource. Last accessed 08.16.04. URL: <http://www.epa.gov/heatisland/index.html>

¹³ EPA “Heat Island Effect.” 2004. Online Resource. Last accessed 08.10.04. URL: <http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ActionsLocalHeatIslandEffect.html>

ecosystems by modifying their behavior. However, environmental awareness does not simply transpire, rather the consciousness is a result of teaching and outreach to the students and staff. Changing the behavior of individuals requires demonstrating the importance of the environment in varying contexts. Raising the profile of the environment on campus will help students and staff become more conservative when utilizing valuable natural resources.

10) Establish indoor air quality standards

A. Maintain LEED standards for indoor air quality

- Follow LEED criteria for emissions of Volatile Organic Compounds (VOC)
- Establish an IAQ management plan for construction period and prior to occupancy
- Ensure new buildings meet ASHRAE 129-1997 ventilation standard

Air quality standards have been established for outdoor areas. However, the majority of the American public spends its time indoors rather than outside. Therefore, the air quality associated with indoor spaces should be of utmost importance. Many different substances and materials found in the home can deteriorate indoor air quality. Cleaning products, paint, as well as adhesives used in carpeting produces fumes that can be harmful to occupants. Health effects such as irritation of the eyes, nose, and throat accompanied by headaches, dizziness, and fatigue, can rapidly occur in humans upon exposure. Furthermore, asthma symptoms can also be greatly aggravated. Long term effects from repeated periods of exposure can include respiratory diseases, heart disease, and cancer.¹⁴ Indoor air quality should meet established standards in order to minimize the possible harmful health effects associated with inhalation.

Goal Implementation

1) Decrease emissions of Greenhouse gases and air pollutants

- A. Purchase wind energy
- B. Install photovoltaic cells

Description: Princeton University should invest in renewable technology for generating a percentage of their electricity demand.

¹⁴ EPA. "An Introduction to Indoor Air Quality." 2004. Online Resource. Last accessed 08.10.04. URL: <http://www.epa.gov/iaq/ia-intro.html>

Environmental Impact: Wind energy is created through harnessing the kinetic energy produced by the movement of air masses in order to propel a turbine to generate energy and electricity. Wind power is renewable and clean with no associated air pollutants and greenhouse gases. Photovoltaic cells use energy from solar heating and radiation to generate electricity. Like wind energy, solar installations are also a clean, renewable source of energy production with no associated greenhouse gases and air emissions produced. Purchasing wind or solar energy would lower the amount of greenhouse gases and air emissions produced by Princeton University. Princeton used approximately 131,583,000 kWh of electricity last year. The table below compares the environmental benefits of procuring five, ten, or fifteen percent of the University's energy from a renewable source by illustrating the reduction in emissions of three pollutants.¹⁵

Electricity Procured	Carbon Dioxide	Sulfur Dioxide	Nitrous Oxides
Five percent: 6,579,150 kWh	86,617,404 pounds	603,965 pounds	196,585 pounds
Ten percent: 13,158,300 kWh	173,234,809 pounds	1,207,931 pounds	393,170 pounds
Fifteen percent: 19,733,450 kWh	259,852,213 pounds	1,811,897 pounds	589,755 pounds

Economic Impact: A program sponsored by New Wind Energy a product of Community Energy Inc. allows the consumer to pay a premium subsidizing the cost of wind energy allowing additional supplies to be added to the grid. The cost is an extra \$2.50 per block of wind energy per month with each block containing one hundred kWh. This is approximately 2.5 cents per kilowatt hour.¹⁶ Last fiscal year, electricity was purchased for approximately 5.6 cents per kilowatt hour. The chart below illustrates the extra cost that would be incurred if Princeton purchases five, ten, or fifteen percent of its energy from the wind energy program:

Electricity Procured	Extra Cost
Five percent: 6,579,150 kWh	\$164,478.75
Ten percent: 13,158,300 kWh	\$328,957.50
Fifteen percent: 19,733,450 kWh	\$493,436.25

¹⁵ New Wind Energy. "Environmental Benefits Calculator." 2004. Online Resource. Last accessed 08.10.04. URL: http://www.newwindenergy.com/buywind/home/mid_atlantic/step3_peco.html

¹⁶ New Wind Energy. "Mid-Atlantic Customers." 2004. Online Resource. Last accessed 08.16.04. URL: http://www.newwindenergy.com/buywind/home/mid_atlantic/step3_midatlantic_other.html

The installation of photovoltaic cells would vary in price depending on the installation size as well as the manufacturer. However, there are numerous monetary incentives to help finance the installation of solar cells. A pilot study of solar panels should be conducted in order to determine whether installing solar panels at the University is a viable option. The cost and building size required should both be minimal.

C. Reduce emissions from vehicle fleet

- Standardize GEM vehicles
- Switch current diesel fueled vehicles to biodiesel
- Consider Natural gas vehicles for new vehicle purchases

Description: Princeton University should establish a purchasing policy to: standardize GEM vehicles to phase-out gasoline powered golf carts, procure a biodiesel blend (B20) for use in diesel powered vehicles and machinery, and consider natural gas for new vehicle purchasing.

Environmental Impact: On-campus air pollution from vehicles such as golf carts, shuttles, and garbage trucks, creates an environment that is unhealthy to both the student body and natural campus ecology. Emissions of carbon monoxide, sulfur oxides, nitrous oxides and particulate matter contribute to the formation of smog and affect the aesthetic qualities of the University. Standardizing Global Electric Motor (GEM) vehicles as default purchasing rather than gasoline powered golf carts would reduce harmful emissions. The approximately 92 golf carts currently used on campus emit carbon monoxide, nitrous oxide, hydrocarbons, and carbon dioxide. Approximately, .7 tons of hydrocarbons and nitrous oxide, 27 tons of carbon monoxide, and 66 tons of carbon dioxide are emitted annually from the fleet of golf carts.¹⁷ GEM vehicles have zero emissions from the tailpipe and have no unpleasant odor providing a less polluted campus environment.

Moreover, using biodiesel instead of diesel in garbage trucks and shuttles and increasing the natural gas shuttle fleet would also reduce air emissions. Particulate matter is reduced with B20 by fifteen percent, sulfur emissions by twenty percent and carbon monoxide by ten percent, although there is a two percent increase in nitrogen oxides. Natural gas vehicles are also more environmentally friendly than shuttles powered by diesel fuel. Carbon monoxide is reduced by

¹⁷ PEOC: Fleet Emissions Report. Hallett Johnson. April 15, 2004.

ninety percent, nitrogen oxides by more than fifty percent and carbon dioxide is reduced by thirty percent when compared to gasoline.

Technology is always changing and one of the goals of the University should be remain knowledgeable of new environmentally friendly innovations for purchasing purposes. General Motors has begun marketing a hybrid bus, which operates on diesel fuel and electric power. The vehicle improves fuel economy compared to diesel transit buses by roughly sixty percent. Particulates, hydrocarbons, and carbon monoxide emissions are reduced by up to ninety percent with a Diesel Particulate Filter and nitrous oxide emissions are reduced up to fifty percent.¹⁸ As these buses become more widely available Princeton University should consider their procurement for campus use.

Economic Impact: GEM cars are more expensive than gasoline powered golf carts. The price of a gasoline powered golf cart ranges from \$1300.00 for a used cart to \$13,000.00 for a fully loaded model. The average purchase price of a cart bought in 2003 was \$6,998.70. The price of a GEM cart ranges from \$8,000.00-\$9,500.00.¹⁹ Therefore, the average cost of one cart would be roughly \$2,000.00 more than the golf cart currently used. Replacement of the whole cart fleet would range from \$736,000.00-\$874,000.00. However, phasing-out the existing fleet on a yearly basis would decrease the cost considerably and make the purchase more economically manageable. Since diesel vehicles manufactured after 1994 do not require maintenance to make them compatible with B20, the main economic hindrance to purchasing biodiesel would be the construction of an above ground fueling tank. However, Harvard installed an above ground fueling station at a cost of approximately \$60,000.00, which is not an outrageous expense. Although Biodiesel is also priced higher than diesel fuel by roughly thirty cents a gallon, Harvard found the wholesale cost of biodiesel to be fifteen cents cheaper than the retail price of diesel.²⁰ Natural gas shuttles have a higher purchase price than diesel powered shuttles by approximately thirty percent. Natural gas fuel is also more expensive than diesel. Costs for natural gas are \$.33 a mile while diesel fuel is \$.13 a mile.

¹⁸GM. "Hybrids Fact Sheets." 2004. Online Resource. Last accessed August 26, 2004. URL: http://www.gm.com/company/gmability/adv_tech/300_hybrids/index.html

¹⁹ PEOC: Fleet Emissions Report. Hallett Johnson. April 15, 2004.

²⁰ U.S. Department of Energy: Clean Cities Program. "Harvard University (Biodiesel)." 2004. Online Resource. Last accessed 08.09.04. URL: http://www.eere.energy.gov/cleancities/progs/new_success_ddown.cgi?143

D. Decrease single occupant commuter automobile traffic

Description: A University-wide program with a monetary incentive for those who commute to campus through alternative forms of transportation such as carpooling, train, or bike should be instituted. Additionally, the program should require payment for obtaining a permit to park on-campus and a Guaranteed Ride Home program should be integrated into the plan as well.

Environmental Impact: Commuter traffic creates a campus environment that is both polluted and noisy. The average car releases more than five tons of carbon dioxide a year, which contributes to climate change. Cars also release particulate matter, carbon monoxide, sulfur oxides, and nitrous oxides causing the formation of smog and acid rain.²¹ Moreover, an excessive amount of parking on campus creates a need for more parking spaces and lots. Consequently, a great percentage of impervious cover, such as asphalt, decreases green space on campus and limits mitigation of storm water run-off from vegetation. Greater storm water discharge increases the water flowing into lakes and streams and decreases groundwater restoration thereby creating the potential for floods and water contamination. Decreasing the amount of single occupant commuter traffic will also decrease air pollutants on campus and the amount of parking spaces that are needed.

Economic Impact: A transportation demand management program would initially cost money for the University to implement. However, these costs could be offset by instituting a price on parking permits. Stanford University runs a Clean Air Cash Rewards Program, which provides commuters with a monetary incentive to use a form of alternative transportation to commute to work.²² Employees are rewarded with up to \$160.00 for the school year, although they can participate on a monthly basis. In 2001, 6,260 cars were registered with the parking offices. Five percent of that amount is 313 cars. If that five percent participated in the program and agreed to not park on campus the cost for Princeton would be 50,080.00. However, if those who park on campus, 5947 cars, were charged \$40.00 for the school year, the University would gain \$237,880, which is more than enough to offset the cost of starting this program. Coupling the

²¹ "Pollution Facts." Capital Rideshare. 2004. Online resource. Last accessed 08.10.04. URL: <http://www.capitolrideshare.com/ridefiles/pollution.htm>

²² Stanford University Parking and Transportation Services. "Clean Air Cash Rewards Program." 2004. Online Resource. URL: http://transportation.stanford.edu/alt_transportation/Guaranteed.shtml

monetary incentive with a Guaranteed Ride Home program will make the program more attractive to employees. A Guaranteed Ride Home helps the individual get to their destination if an emergency should occur through guaranteeing the use of a taxi or rental car. This could be integrated into the existing Zipcar rental agency, which began last year. This program could also be extremely beneficial to the commuter as the average monthly cost of commuting is calculated as \$472.80 while the yearly cost is: \$5673.60.

2) Reduce energy consumption

- A. Install motion sensors in dormitory bathrooms
- B. Efficiently schedule room air conditioning

Description: The University should replace all exiting light switches in bathrooms on-campus with motion sensors. This should become the norm in all newly constructed or renovated buildings as well. Additionally, more efficient scheduling of air conditioning in office buildings is needed to reduce air conditioning during unoccupied periods in offices.

Environmental Impact: Dormitory bathroom lights remain on throughout both the day and night whether they are occupied or vacant. Therefore, a great deal of energy is consumed without need. Energy and electricity used at Princeton University requires the use of fossil fuels, such as natural gas and oil. Therefore, lowering the amount of energy consumed by a building will also decrease the amount of fossil fuels used in the production thereby eliminating air emissions of sulfur oxides, nitrous oxides, carbon dioxide, and particulate matter from the atmosphere. About 1/6 of the all the electricity generated in the United States is used to air condition buildings and can be responsible for up to 1/3 of the electricity demand during summer months.²³ More efficient programming of air conditioning in office buildings on the campus will result in less energy demands for the campus decreasing the release of air pollutants and greenhouse gases.

Economic Impact: Purchasing the equipment and hiring the electricians to install the sensors are both economic disadvantage to this plan. The cost of installation cannot be truly calculated since the cost will depend on various factors, such as the placement of the sensor. The Watt

²³ Energy Star. "Central Air Conditioners." 2004. Online resource. Last accessed 08.16.04. URL: http://www.energystar.gov/index.cfm?c=cac.pr_central_ac

Stopper Ultrasonic Occupancy sensor can be installed on ceilings to operate in bathroom settings. Ceiling operated occupancy sensors cost approximately \$150.00. However, cost could be recouped through reduced electricity and fuel costs. The 1999 Lighting Energy Analysis conducted by the Engineering department in Facilities estimated that energy savings from installing motion sensors and more efficient lighting in certain buildings on campus would total \$148,205.23 annually with a payback period of 2.64 years.²⁴ Greater efficiency in scheduling air conditioning in academic buildings will help offset the cost of upgrades by reducing energy use. Princeton University should implement a policy to design buildings with smaller zones in order to control the temperature in specific areas more efficiently to provide greater comfort to occupants and reduce energy consumption in offices.

- C. Construct buildings to optimize energy performance
- D. Re-commission existing buildings

Description: Princeton University should set specific goals for the project, design, and construction team to implement in order to comply with creating sustainable, energy efficient structures. Moreover, existing buildings should be re-commissioned to ensure that the structure is functioning at its optimum capacity with respect to efficiency.

Environmental Impact: Leadership in Energy and Environmental Design (LEED) is part of the United States Green Building council, and the program exists to certify building structures based on certain criteria with regard to sustainability. Princeton does not currently specify design standards based on sustainability. Guidelines and goals should be implemented into the design standards manual in order to ensure that the environment is considered in the construction of new buildings and renovations. Considering the environment in construction will allow natural resources such as water and land to be conserved and will decrease the amount of energy used in the building. Moreover, existing structures should be re-commissioned in order to ensure that the structure is operating with the greatest efficiency. Constructing new buildings with energy efficient envelopes and ensuring the proper functioning of existing campus structures will

²⁴ Lighting Energy Analysis For Princeton University: Volume 1 Summary of Opportunities, Calculation Data, Calculations: Issued April 15, 1999

decrease the amount of energy and electricity needed by occupants thereby decreasing air emissions into the atmosphere.

Economic Impact: There are virtually no economic drawbacks to using more sustainable design in buildings. Constructing more sustainable buildings can actually be quite cost effective. LEED requires architects and planners consider environmental issues in their design which often leads to applying techniques such as exterior sun shading and situating the building optimally, which does not cost extra money but could help save on energy costs. The U.S. Green Building Council found that when LEED silver certified buildings are designed and implement energy saving devices and sustainable features, the building is cost comparative to a standard building design. However, those that do can still have the extra cost recouped through reduced energy use. Re-commissioning existing structures should entail virtually no added expense. Paying the people hired to re-commission buildings would be the only true cost. Moreover, throughout the life of the structure energy efficient design will continue to save money for the owners.

E. Eliminate student use of incandescent bulbs in favor of Compact Fluorescent Light (CFL) bulbs

Description: The University should sponsor a CFL exchange and implement a policy banning the use of incandescent bulbs in campus housing in order to reduce energy consumption.

Environmental Impact: Most students bring a floor lamp and incandescent bulb with them to college in order to counteract the poor lighting installed in older dormitory rooms. Unfortunately, incandescent lighting is not very efficient. Only about ten percent of the energy used by the bulb creates light, while the rest is given off as heat. CFLs are far more efficient than incandescent bulbs using $\frac{1}{4}$ of their energy with equal light output and may last up to ten times longer.²⁵ The EPA estimates 25% of energy needs are dedicated to lighting, and approximately 2.5 pounds of carbon dioxide is generated in one kWh of electricity use.²⁶ Less energy consumed on campus creates less air pollution and emissions of greenhouse gases.

²⁵ EnergyStar. "CFLs." 2004. Online resource. Last accessed 08.16.04. URL: http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

²⁶ Green Seal. "CFL Report." Online resource. Last accessed 08.13.04. URL: <http://www.greenseal.org/recommendations/CGR=CFLs.pdf>

Economic Impact: There will be an initial economic impact to procuring and distributing CFLs to students in exchange for an incandescent bulb. Princeton University in the 2002-2003 school year enrolled 4,635 undergraduate students and 1,975 graduate students at the University for a combined total of 6,610 students.²⁷ The price of a CFL can range from approximately \$4.00-\$15.00.²⁸ Therefore, the initial cost could range from \$26,440 to \$99,150. However, this cost is based on all eligible students participating in the exchange, and purchasing a single bulb rather than buying in bulk, which are both unrealistic scenarios. Not all of the students enrolled will participate in the exchange, and a deal could possibly be reached with the same distributor used for purchasing fluorescent lighting in offices thereby substantially reducing the cost. Furthermore, savings will be seen in energy costs. If half of that number of students brought one lamp and one bulb to school that would amount to 3305 lamps and light bulbs. If those students used a 100 watt bulb to supplement the lighting in their room then the chart below illustrates the environmental and economic savings which can occur from the use of CFLs by the student population based simply on the cost of \$0.056 for a kilowatt hour.

	ENERGY STAR Qualified CFL	Non-ENERGY STAR Incandescent Bulb
Number of CFLs	3305	3305
Wattage (use chart to right)	32	100
Initial Cost per Unit	\$3.50	\$0.50
Rated product life in years	5	0.685
Hours used per day	6	6
Your Electric Rate	5.6	cents per kWh
Discount Rate	4%	
Annual Operating Costs		
Energy Consumption, kWh	231,614	723,795
Energy Cost	\$12,970.41	\$40,532.52
Lifetime Operating Cost	\$57,741.94	\$180,443.58
Total Purchase Price	\$11,568	\$8,263
Additional Investment	\$3,305	
Annual Savings	\$27,562	
Approximate Lifetime Savings	\$122,701.63	

²⁷ Princeton University. "A Princeton Profile 2003-04." 2004. Online resource. Last accessed 08.11.04. URL: <http://www.princeton.edu/pr/facts/profile/03/02.htm>

²⁸ Energy Star. "Bulbs." 2004. Online resource. Last accessed 08.17.04. URL: http://www.energystar.gov/index.cfm?c=buyers_guide.pr_lighting_guide_bulbs

Net Savings	\$119,396.63	
Years to recoup initial investment	0.1	
kWh Saved	2,460,903	
Equivalent Cars Removed from Road	388.0938338	

3) Reduce Water Consumption

A. Standardize front-loading washers

Description: The University should standardize purchasing of front-loading washing machines should be purchased instead of the standard top-loading versions in order to conserve water and energy.

Environmental Impact: The laundry room is a relatively small location that consumes a great deal of water and energy. The University could decrease consumption of both water and energy by investing in more energy and water efficient washing machines. Standard washers use approximately thirty-three gallons of water per load, while a front-loading commercial washer manufactured by Maytag uses only 14 gallons per load. Since less water is used, less energy is needed to heat the water thereby saving energy as well.²⁹ Princeton's water is provided by the Elizabethtown Water Company, which obtains the water from both the ground and surface. Groundwater comes from wells throughout the area. The Raritan and Millstone Rivers as well as the Delaware and Raritan canal supplement the supply.³⁰ Decreased water use in washing machines will help preserve aquatic ecosystems and the groundwater supply in the Princeton area by decreasing the amount of withdrawals reducing the possibility of salinization and contamination of the water supply.

Economic Impact: The price of a commercial washer from Maytag was unavailable. However, the cost of a residential washing machine was available for comparison sake. Front loading washers are more expensive than standard top-loading. A front loading washer from Maytag is priced at \$1,139.00, while the least expensive top-loading machine costs \$439.00. However, as they become more available the price is dropping rapidly. Moreover, energy savings could

²⁹ Maytag. "New Product Innovations." 2004. Online resource. Last accessed 08.17.04. URL: http://www.maytagcommerciallaundry.com/cmths/whatsNew/newProductInnovation/newProductInnovationArticle.jsp?category=WhatsNew&sub_cust=3&nosol=1&contOID=536894325&cs=0&BV_UseBVCookie=Yes

³⁰ New Jersey American Water. "In the Spotlight." 2004. Online resource. Last accessed 08.17.04. URL: http://www.ewtownwater.com/awpr/njaw/featured_content/fc3750.html

actually make the machines cost effective within a certain payback period. The Maytag Neptune Washer can save up to \$150.00 a year in water and energy costs. Therefore, the payback period would be a mere five years. Furthermore, the special arrangement could be made with the company reducing the price even further.³¹

B. Install waterless urinals in new buildings and renovations

Description: Flushless urinals should be installed in newly constructed academic buildings and renovations, and Princeton University's dorm policy should be rewritten to allow urinals in dormitories.

Environmental Impact: As much as 5% of the freshwater currently consumed is used to carry away urine. Flushless urinals help to save approximately 40,000 gallons of water per urinal annually and energy is saved through the elimination of water movement to and from water treatment facilities. Carbon dioxide emissions are also reduced since they are no longer a byproduct of the treatment.³² Urine is a sterile, virtually odor free liquid. The odor in bathrooms is generated through the reaction of stagnant water and urine forming bacteria. Therefore, the waterfree urinals provide a more sanitary, aesthetically pleasing bathroom environment as smell is mitigated through the lack of water.

Economic Impact: New Jersey Uniform Construction Code (NJUCC) requires low-flow urinals in order to reduce water use. Princeton University specifies in its design standards the preferred brand of urinal: wall mounted, American Standard Lynbrook #6601.012 or Washbrook #6501.01 with Sloan #186-1 flush valve and Zurn "EZ Flush" automatic flush operator.³³ The price of the Lynbrook 6601.012 can range from \$544-\$755, while the Washbrook 6501.01 ranges from \$384-\$537 both dependent on color. Falcon WaterFree Technologies manufactures three different models of waterfree urinals: F-1000, F-2000, and F-2000A. All three urinals are price competitive with the current type of urinal purchased by the University. The list price for

³¹ http://www.maytag.com/mths/products/product.jsp?model=MAH5500BWW&cs=0&BV_UseBVCookie=Yes

³² Falcon WaterFree Technologies. "About Us." 2004. Online Resource. Last accessed 08.12.04. URL: <http://www.falconwaterfree.com/about/index.htm>

³³ Princeton University Design Standards 4.11 Toilet Rooms. Online Resource. Last accessed 08.13.04. URL: <http://64.233.161.104/u/princeton?q=cache:DU27txlPrLcJ:facilities.princeton.edu/DesignConstruction/designstandards/pdf/4.11.pdf+urinals&hl=en&ie=UTF-8>

F-1000 is \$399. However, the actual price ranges from \$300-\$360 depending on the number of units bought. List price for F-2000 is \$325.00 while the range is \$244.00-\$293.00. List price for F-2000A is \$346.00 while the range is \$260.00-\$311.00. All prices include the first cartridge, which must be replaced approximately every 7,000 uses or two to four times per year. Cartridges range from \$31.75-\$39.95 per cartridge depending on quantity bought.³⁴ However, that is the only maintenance required on the urinal. Traditional urinals also require maintenance and sewer charges, which are billed by the amount of water purchased. Therefore, both of these costs will be reduced with the installation of waterless urinals. Some examples of successful installation and operation have included: Ithaca College, Indiana University, Penn State University, Pro Player Stadium, Everglades National Park. These urinals have been installed throughout the country with success and economic savings in high traffic areas.

C. Track annual water use per person

Description: Water use at Princeton University should be tracked and compiled per person in order to illustrate campus water consumption for instructional purposes.

Environmental Impact: Currently water consumption data is located in the Business office of Macmillan and is not compiled in any particular order. Arranging and posting the data would allow individuals to be aware of their water consumption practices and how their actions on the campus effect overall consumption. Consequently, this could increase awareness about the importance of water conservation.

Economic Impact: This action does not require additional economic financing. Instead, the task of gathering the data from the business office and formatting the information could be performed by a member of the PEOC committee or student intern once a year.

4) Decrease the amount of solid waste sent to landfills

A. Develop a program to recycle construction waste

³⁴ Falcon WaterFree Technologies. "Price Schedule." 2004. Online Resource. Last accessed 08.17.04. URL: <http://www.falconwaterfree.com/financing/pricing.htm>

Description: Princeton University should draft a policy requiring subcontractors to contact a company and set-up dumpsters in order to separate construction materials to be recycled by a vendor Mercer County.

Environmental Impact: The EPA estimated that 136 million tons of construction and demolition debris was generated in the U.S. in 1996. Recycling construction and demolition waste decreases the amount of material sent to landfills thereby decreasing the amount of methane produced and space consumed by such debris as concrete and asphalt. Moreover, recycling construction waste helps to limit the extraction of natural resources through creating a new product out of old.³⁵

Economic Impact: Recycling of construction waste is more cost effective than paying to landfill the material. Tipping and landfill costs are avoided through recycling. Construction waste in Princeton University is sent to Grows landfill in Pennsylvania, which charges \$94.59 per ton to landfill the material. Vinch recycling is located in Mercer County New Jersey and only charges \$5.50 a ton for recycling Princeton's concrete and asphalt from repaving projects. Therefore, significant economic benefits can be realized through recycling the construction and demolition waste from Princeton University.³⁶

B. Establish a composting program for pre-consumer food waste

Description: Princeton University should eliminate pre-consumer waste sent to the landfill from the Frist Campus center by initiating a composting program.

Environmental Impact: Frist Campus center does not currently participate in the food recycling program the dining halls have established with Neil McIntyre: Recyclers of Food Waste. Therefore, all the pre-consumer food generated by the eating areas is sent to the landfill. Decreasing the amount of food waste sent to the landfill from Frist Campus Center will lower the amount of material the University landfills annually and decrease methane emissions created through the decomposition of organic matter, which contribute to global climate change.

³⁵ EPA. "C and D Debris." 2004. Online Resource. Last accessed 08.12.04. URL: <http://www.architectureweek.com/cgi-bin/wlk?http://www.epa.gov>

³⁶ For more information on recycling construction waste in New Jersey see the "Recycling of Construction Waste" report compiled by PEOC intern Christina Harris

Moreover, composting allows for the creation of a nutrient rich soil that benefits plants and trees, and on-site composting reduces the air emissions from fossil fueled trucks, which carry the garbage away from the University to holding stations and the landfill.

Economic Impact: The Eastern Organics Resource Woodhue Composting Center is located in Springfield, Burlington County New Jersey on 2469 Saylor's Pond Road. It is currently the only facility in New Jersey accepting food scraps. However, the center is unable to process food waste with meat, fish, or dairy. Instead, it mainly caters to food processors and packers such as supermarkets, although the facility would be able to handle kitchen prep material and paper waste. Moreover, the company will be investing in an in-vessel composting system shortly allowing most food waste to be processed.³⁷ They charge \$25.00 a ton for food waste. As technology becomes available, Princeton University should consider composting its food waste at the facility.

Princeton University could also compost its own pre-consumer food waste from Frist by purchasing a compost bin and placing the staff of dining services in charge of its operation. Rice University has had success with the Earth Tub, a system designed for on-site composting of food waste.³⁸ An area of about twelve square feet is needed to accommodate the unit.³⁹ The retail cost of the composter is approximately \$6,500.00.⁴⁰

C. Implement a plan to reduce paper use

Description: Princeton should reduce the amount of paper that is used by the University through placing information online and discontinuing the policy of providing University employees and students with a hardcopy version of the document as well. Additionally, a training program should be initiated to instruct office staff on editing and reading online documents and communicating through email rather than circulating memos and printing out

³⁷ Phone Interview with representative from Woodhue Composting Center. 08.12.04. Information for contacting the center found at URL: <http://www.state.nj.us/dep/dshw/rtrp/Mercer%20County>

³⁸ Green Mountain Technologies. "Earth Tub." Online resource. Last accessed 08.17.04. URL: <http://www.gmt-organic.com/et-info.html>

³⁹ Rice University. "Earth Tub Frequently Asked Questions." 2004. Online resource. Last accessed 08.17.04. URL: http://www.ruf.rice.edu/~envintrn/composting_FAQ.html#installation

⁴⁰ Commercial Food Waste Composting Research Report 1998-99. Online resource. Last accessed 08.17.04. URL: http://cesonoma.ucdavis.edu/hortic/compost_food_98-99.pdf

reports. Moreover, the default setting on all printers and copiers should be changed to print and copy double-sided.

Environmental Impact: Americans use approximately 31.5 million tons of printing and writing paper each year requiring 535 million trees and more than 12 billion gallons of oil for production. Sixty-five percent of used printing and writing paper ends up in landfills.⁴¹ Energy is needed to create these paper products, and emissions from the production of paper products pollute both air and waterways through the release of emissions. Moreover, chlorine, the bleaching agent used in bleaching paper also releases dioxins. Dioxins are stored in the fats of animals causing bioaccumulation through the food chain and are thought to have a number of adverse health effects. Decreasing the amount of paper used on campus will lessen the environmental impacts of paper production and decrease the amount of paper in landfills.⁴²

Economic Impact: A positive economic impact will occur at the University through decreased paper use. Printing and creating fewer documents will reduce the amount of money spent on paper as well as the amount spent on recycling or placing the paper in a landfill.

D. Ensure recycling of University carpet

Description: Princeton University should institute a policy specifying that carpet installers must recycle the carpet that is removed prior to the installation of new carpet.

Environmental Impact: Most of the carpet discarded in the United States is sent to a landfill with only one percent being recycled. In 1999, approximately 2.44 million tons of old carpet were landfilled.⁴³ However, most carpet materials can either be recycled into new carpet product or downcycled into materials such as auto parts and benches. Since most carpet is not made with biodegradable materials but with nylon and polyester, carpet placed in a landfill will remain

⁴¹ Green Seal Report. "Printing and Writing Papers." November 1999. Online resource. Last accessed 08.17.04. URL: <http://www.greenseal.org/recommendations/CGR=P&W2.pdf>

⁴² More information on the environmental impacts of paper production can be found in the Paper Towel report

⁴³ Green Seal Report. "Carpet." December 2001. Online resource. Last accessed 08.17.04. URL: http://www.greenseal.org/cgrs/Carpet_CGR.pdf

there forever. Recycling University carpet will help reduce the amount of materials the university sends to the landfill.⁴⁴

Economic Impact: Carpet recycling will save the University money. University carpet can be dropped off at one of the DuPont collection sites in the U.S., preferably the one in New York City where the company will downcycle the carpet into other products. Recycling the carpet will avoid landfill costs for the university.

E. Institute a program to handle furniture left by students

Description: The University is responsible for any furniture left by students following move-out. To avoid sending the excess furniture to a landfill Princeton should create a program to sell the furniture at the beginning of the fall semester.

Environmental Impact: Furniture occupies a large amount of space in landfills due to bulk. Moreover, the materials used in the production of furniture are mainly synthetic and non-biodegradable remaining virtually forever. Selling and reusing furniture will help decrease the amount of landfill space occupied by bulky, reusable items and will preserve the land area.

Economic Impact: Landfill costs charged to Princeton will be reduced. Moreover, the University could profit from selling furniture and goods to students at the beginning of the school year. The profits could be used to fund an environmental initiative or be given to a charity. Dump and Run is a program that has been instituted on other campuses that functions by collecting used furniture and goods at the end of the spring semester and selling them to the student body at the beginning of the fall term. The proceeds are donated to a charity of the school's choosing.⁴⁵

5) Practice environmentally responsible purchasing (for construction and daily use)

A. Construction

- Purchase sustainable building materials
- Purchase carpet with recycled material

⁴⁴ For more information on carpet recycling options see the "Carpet" report compiled by Christina Harris July 2004

⁴⁵ Dump and Run. Online resource. Last accessed 07.14.04. URL: www.dumpandrun.org

Description: As part of their construction and demolition policy, Princeton University should purchase and use sustainable building materials, such as bamboo and recycled carpet in new buildings and renovations.

Environmental Impact: The expansion of the campus has created numerous construction and renovation projects. These projects have substantial environmental impacts in all areas: land, water, and air. LEED standards specify material and resource selection as part of the criteria for determining sustainable buildings and structures. The U.S. Green Building council has determined that using products that contain recycled content and rapidly renewable materials can help lessen the environmental strain associated with large construction. Such materials, such as carpet with recycled content and bamboo flooring, present possibilities for procuring “green” building materials.

Economic Impact: Building materials with recycled content and rapidly renewable materials are largely cost-competitive with their counterparts. Princeton University has already shown initiative in procuring certain sustainable building material. Some of the carpet purchased by the University contains recycled content and bamboo flooring was used in the new Ellipse dormitory.⁴⁶

B. Daily Use

- Sustainable food purchases
- Environmentally friendly cleaning products
- “Green” Paper products
- Biodegradable bags for trash collection

Description: Dining Services should continue to increase their options for organic food as well as provide more vegetarian options. Building Services should seek to use only environmentally friendly cleaning products and incorporate biodegradable bags into trash collection.

Environmental Impact: Princeton already provides a number of “green” products for daily use. Dining Services has worked very hard to provide organic, locally grown seasonal produce as

⁴⁶ For more information on carpet see the Carpet Report by Christina Harris

well as Fairtrade coffee and sustainable seafood. Building Services is running a pilot program to test the use of predominately unbleached paper towels with a higher post-consumer waste content in one of the dormitories on campus.⁴⁷ However, both departments could increase the amount of “green” products they purchase. Buying organic food reduces the amount of pesticides used in agriculture and promotes sustainable farming practices. Purchasing local, seasonal produce decreases the transportation distance the food must travel reducing fuel and energy consumption. Eating sustainably produced seafood helps to ensure that fish stocks are not continuously depleted. Ingredients in cleaning products can produce eye and skin irritation and can affect aquatic ecosystems if released into waterways. Environmentally friendly cleaning products are largely less toxic and less harmful to both humans and the environment.⁴⁸

Plastic is thought to make up 18 percent of the waste stream by volume. Plastic bags are manufactured from petroleum and are non-biodegradable. The products create barriers in landfills disallowing other material to decompose.⁴⁹ Compostable trash bags are manufactured from corn resin and are biodegradable thereby eliminating the barrier present with plastic bags. Procuring “green” supplies, such as biodegradable trash bags and environmentally-friendly cleaning products, will help reduce the environmental impact of the University.

Economic Impact: Organic food is more expensive than conventionally produced products. The Greening Dining report from 2003 predicts that converting to organic pasta would cost \$44,000.00, switching to organic tomato products would cost \$32,000, and changing to organic eggs would incur an extra expense of \$32,000.00. Removing the remaining high impact seafood options from the Dining Services menu will increase the cost of seafood procurement by \$31,000.00.⁵⁰ “Green” paper products are usually cost-competitive or less expensive than bleached paper products with lower post-consumer content. Paper towels are approximately

⁴⁷ For information on environmental effects of paper towel and toilet paper production see Paper towel report by Christina Harris

⁴⁸ EPA. “Environmentally Preferable Purchasing.” 2004. Online resource. Last accessed 08.19.04. URL: <http://www.epa.gov/oppt/epp/documents/clean/cleaning.htm>

⁴⁹ Greenfeet. “Paper vs. Plastic-The Shopping Bag Debate.” Online resource. Last accessed 08.19.04. URL: <http://www.greenfeet.net/newsletter/debate.shtml>

⁵⁰ Greening Dining: Recommendations for changes to Princeton University Food Purchasing 2003. Prepared by Greening Princeton

\$7.00 less per case. Nat-Ur, formerly Biocorp sells a line of biodegradable plastic bags, which could be investigated for use at Princeton.⁵¹

6) Decrease uncontaminated storm water runoff

A. Adhere to new storm water regulations

Description: Princeton University should meet or exceed new storm regulations set forth by NJDEP regarding groundwater recharge, stormwater quality, erosion and flood control, and nonstructural stormwater standards.

Environmental Impact: Stormwater discharges are created by runoff from land and impervious surfaces generated during rainfall, which carries pollutants into nearby waterways. Pollutants contaminate the water source creating an unhealthy aquatic environment. The new stormwater regulations seek to decrease the amount of water discharged into local bodies of water, and instead provide greater groundwater recharge to discourage erosion and flooding.

Economic Impact: The economic impact of complying with storm water regulations will depend upon the actions pursued to comply with the measure. A maintenance plan will have to be established determining the best course of action in complying with the new standards. One method to decrease runoff water from the University would be to increase the amount of vegetation on campus and reduce impervious surfaces. The plants help retain more water in the natural system reducing runoff into lakes and streams.

B. Conduct survey to determine cross connects between storm and sanitary systems

Description: The University should evaluate new building structures to determine cross connects between storm and sanitary systems following their completion.

Environmental Impact: Two years ago Princeton University conducted a survey to determine whether the sewage line was connecting with the sanitary system in University buildings. Since an initial evaluation has occurred, this system should be maintained for all newly constructed

⁵¹ Nat-Ur. "Products." Online Resource. Last accessed 09.03.04. URL: <https://w5inter2.hivelocity.net/biocorp/products.htm>

buildings on campus in order to ensure that the lines do not cross and sewage is not flushed into nearby rivers and lakes. Dispersing sewage into bodies of water creates a toxic situation for aquatic species and an unclean environment for the human population, especially those who use the waterway for fishing and recreation. Princeton University has numerous lakes and rivers nearby. Therefore, preserving the natural ecosystem should be considered extremely important.

Economic Impact: The main economic impact would be in ensuring that a University employee annually conducts a survey of new buildings. There could also be associated maintenance fees associated with fixing the problem. Otherwise, no real economic impact will occur with the University.

7) **Implement a master plan for preserving green space**

A. Establish an unofficial arboretum

Description: The University should establish an arboretum in order to preserve green space and nurture environmental curiosity.

Environmental Impact: Dedicating a specific amount of space to trees will ensure that there remains “green” space on campus that will not be encroached on by campus construction projects. Moreover, trees provide ecosystem services such as filtering groundwater, sequestering carbon dioxide, and cooling and shading campus grounds.

Economic Impact: A registered arboretum could create a problem on campus because of tours and impending construction projects. Creating an unofficial arboretum would allow green space to be preserved without national recognition and responsibility. The economic impact of this endeavor to Princeton University would depend on the cost of the trees purchased as well as the amount of foliage desired.

8) **Minimize heat island effects**

A. Standardize white roofs and greenroofs or photovoltaic cells on flat roofs

Description: A University policy should be established to minimize heat island effects by standardizing white roofs on building structures and installing greenroofs where applicable.

Environmental Impact: Heat islands raise the campus temperature and allows for greater formation of on-campus pollution. Therefore, minimizing the effects of heat islands will cause the temperature on campus to be cooler in the summer and the atmosphere less polluted through reduction in energy consumption and generation. Temperature readings taken on August 27, 2004 illustrated that the white stone installed on top of the Ellipse Dorm has a lower temperature than colored stones. The day was sunny and humid with a temperature of approximately 86 degrees Fahrenheit.⁵²

Roof Color	Temperature (Fahrenheit)
Ellipse Dorm: White stone	112-115
Macmillan: Dark Reddish stone	141-144
Macmillan: Light Grayish stone	128-131
Macmillan: Dark Grayish stone	134-137

Therefore, installing white roofs will lower the energy consumption of the building by allowing the space to remain cooler in the summer reducing the need for air conditioning. Moreover, greenroofs also lower building temperature as well as provide management of stormwater. A greenroof was already installed on Marquand library by the company Skanska, and the plans for Whitman College include a greenroof installation by Torcon.

Economic Impact: Since the price of white roofing material is cost-neutral to dark roofing material no added cost should be incurred through procurement. A greenroof is usually installed as either extensive or intensive and price varies depending on the installation company as well as the type of roof.

⁵² Information provided in an email from Tom Nyquist: August 27, 2004.

B. Increase tree plantings on-campus and in parking lots

Description: A University policy should be established to increase the amount of trees in and around parking lots.

Environmental Impact: Trees provide cooling in heavily paved areas such as parking lots and building structures. At Princeton University there must be one tree for every 3.5 parking spaces and one tree break for every ten spaces. The shade and cooling supplied by trees on campus lowers the temperature and provide ecosystem services such as sequestering carbon dioxide, retaining water, and filtering pollutants from the air.

Economic Impact: The economic cost of installing additional trees in parking lots and other campus areas will depend upon the type of foliage chosen and the destination.

9) Increase environmental awareness

A. Hire a Sustainability Coordinator or Recycling Coordinator

Description: A position should be created within the department of Facilities to oversee and coordinate environmental initiatives and/or recycling initiatives on campus. The job should include the implementation of projects and provide outreach to act as a liaison between students and faculty/staff.

Environmental Impact: A recycling or sustainability coordinator would facilitate the sharing of information across departments in Facilities and coordinate different environmental initiatives on campus. A central person is essential to establishing an understanding of the different “greening” projects occurring on campus. He/She would allow the University to better comprehend its effect on the environment as well as what goals Princeton should pursue in order to be as efficient and “green” as economically feasible.

Economic Impact: The main economic impact would occur in establishing a salary for the recycling/sustainability coordinator. Otherwise, the position could oversee projects and initiatives that do not require funding. Moreover, the increased environmental awareness created

on campus through the funding of this position could potentially cause a decrease in energy consumption on campus providing a monetary gain for the University. Harvard University estimated savings of \$250,000.00 per year if faculty, staff and students practiced environmentally-friendly behavior.⁵³

B. Host University sponsored Earth Day events

Description: The University should host an Earth Day celebration in order to increase campus support of environmental initiatives and demonstrate that the University considers the state of the campus environment important.

Environmental Impact: The recycling/sustainability coordinator would be responsible for hosting and planning an Earth Day celebration to help raise environmental awareness on campus. Currently, no university sponsored event occurs, which lowers the profile of the environment on campus. A University sponsored event would showcase the value of the environment to the Princeton community helping both students and faculty to become more conscious of their impact.

Economic Impact: The economic cost of hosting an Earth day celebration would be dependent on the type of events and activities planned by the coordinator.

C. Establish an EcoRep program

Description: Princeton should establish an EcoRep program in order to foster environmental awareness within the students on campus and facilitate the goals of the Princeton Environmental Oversight C committee (PEOC).

Environmental Impact: Many colleges and universities throughout the U.S. have found that student run awareness programs have helped to decrease the amount of water and energy consumed on campus. Schools such as Harvard, Yale, Dartmouth, and Middlebury have all established EcoRep programs to promote energy and water conservation in dormitories. Energy conservation and recycling competitions have helped to decrease energy consumption in dorms

⁵³ http://www.greencampus.harvard.edu/news_calendar/index.shtml

and increase the amount of paper, bottles, and cans that are recycled. Currently, Princeton University is working towards establishing an EcoRep programs. John Baer is leading this project, and a job description will be posted this fall.

Economic Impact: Initiation of the program entails an expense through providing a stipend or payment for the students. However, the program could also save money through increased student environmental awareness on campus. Actions such as turning the computer off at night, and turning off the bathroom lights will save the campus in energy cost, while recycling trash rather than sending it to a landfill will also reduce operating costs of the University.

D. Provide funding for on-campus environmental initiatives

Description: The University should establish a fund to be used for environmental projects in which students and staff write proposals to apply for the money during the school year.

Environmental Impact: Colleges such as Harvard, Yale, and Duke have already established a fund that concentrate on “green” initiatives and projects that students and faculty wish to pursue. Creating a monetary “green” fund at Princeton would impact both the campus environment in a positive way through increasing student and faculty morale. The fund would allow students and employees to pursue their interests and positively affect the campus providing individuals with a sense of accomplishment.

Economic Impact: An established fund of \$50,000.00 would negatively impact the University initially. However, this may not occur. The funding could be provided by environmentally minded “green” alums and held in an account accruing interest so virtually the same amount could be used annually. Moreover, the projects for which the money is granted could save the University money if the proposals reduce the cost of energy and water. A good, structured example of a green fund can be found at Duke University. The school requires people to apply for the funds and the money must be used on an environmental project, resulting in a decrease in the University’s environmental footprint.⁵⁴

⁵⁴ Duke University Greening Initiative. “Green Grant Fund.” 2004. Online Resource. Last accessed 08.06.04. URL: http://www.duke.edu/greening/grant_fund.html

E. Create a student-run organic garden

Description: The University should sponsor a student-run organic garden at 2 Dickinson.

Environmental Impact: An organic garden can be a valuable learning tool for the students on campus. It allows them to gain skills and learn outside the classroom environment. Furthermore, gardens provide fresh produce and serve to enhance green space on campus. The University has already provided several gardens at various graduate and staff housing. Butler and Lawrence apartments are both have gardens. Moreover, the University also established one at 2 Dickinson following the request of student inhabitants. However, the garden failed when students left for the summer. The garden could be resurrected, though, if students were able and prepared to work there during the summer, and it was better advertised.

Economic Impact: Discussions with Grounds and Maintenance proved that the start-up cost for a garden at 2D would be minimal, approximately a couple hundred dollars. Those who lived and eat at 2D as well as other undergraduate students could work in the garden and share in the produce.

11) Establish indoor air quality standards

- A. Maintain LEED standards for indoor air quality
- Follow LEED criteria for emissions of Volatile Organic Compounds (VOC)
 - Establish an IAQ management plan for construction period and prior to occupancy
 - Ensure new buildings meet ASHRAE 129-1997 ventilation standard

Description: Princeton University should set criteria in their construction policy for emissions of VOC, establish a plan for IAQ management following the construction period, and ensure that new buildings meet the ASHRAE 129-1997 as established in LEED.

Environmental Impact: Indoor Environmental Quality is one of the categories specified by LEED under which points are obtained. LEED certified buildings must meet a minimum indoor air quality performance level prior to certification. LEED points are granted when low-emitting

materials are used in the construction and renovations of new buildings. The requirements state that the VOC content of adhesives and sealants must be low and that VOC emissions from coatings must not exceed VOC and chemical component limits of Green Seal's Standard GS-11 requirements. Carpet must also meet or exceed the requirements of the Carpet and Rug Institute Green Label Indoor Air Quality Test program. Moreover, LEED points are provided for ensuring that there is an IAQ management plan during construction and prior to occupation to prevent indoor air quality problems and guarantee the health and comfort of the workers and occupants. Ventilation standards that effectively allow the mixing of fresh air will also help support a healthy, safe indoor work space.⁵⁵

Economic Impact: These standards should be integrated into the design and construction phase of building and renovation. Therefore, negative economic impacts should be virtually eliminated if these criteria are specified in the planning stage. Low VOC products are labeled and are cost-competitive with high VOC emitting materials.

⁵⁵ LEED Green Building Rating System: For New Construction and Major Renovations. Version 2.1. November 2002