

A photograph of a University of Virginia campus scene. In the foreground, there is a pond with a small stone waterfall on the left. The water is calm, reflecting the surrounding greenery. To the right of the pond, there is a landscaped area with various plants, including some with bright orange and purple flowers. In the background, a large, multi-story brick building is visible, partially obscured by tall, leafy trees. The sky is overcast.

University of Virginia

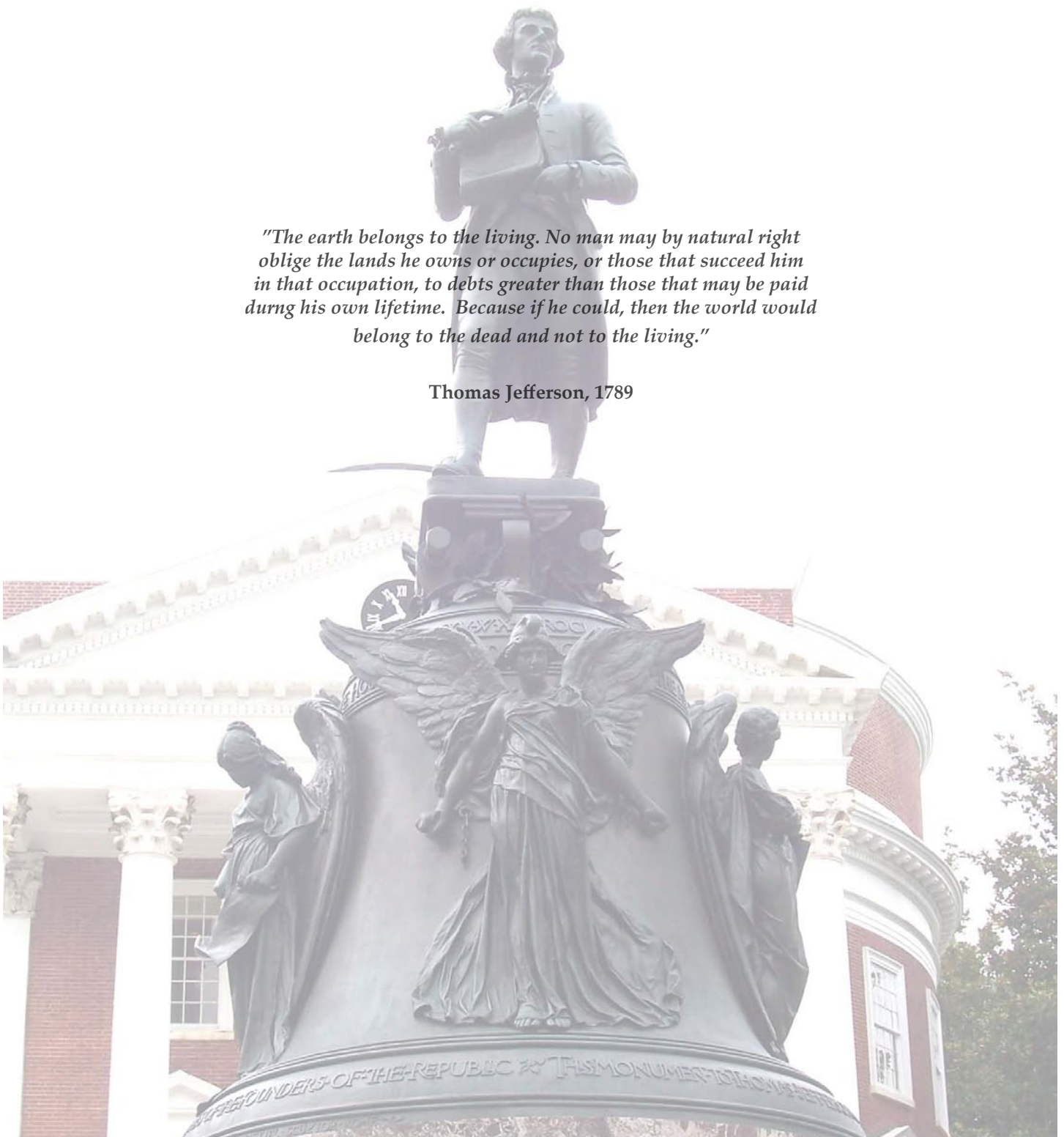
GUIDELINES FOR SUSTAINABLE BUILDINGS AND ENVIRONMENTAL DESIGN



Office of the
Architect
for the University of Virginia

"The earth belongs to the living. No man may by natural right oblige the lands he owns or occupies, or those that succeed him in that occupation, to debts greater than those that may be paid during his own lifetime. Because if he could, then the world would belong to the dead and not to the living."

Thomas Jefferson, 1789



FOREWORD

OFFICE OF THE ARCHITECT

Included in the mission of the Office of the Architect is to provide physical planning and architectural services for the University, which also includes environmental stewardship, community outreach and expert professional services. The Office seeks to ensure an integrated approach toward the long term sustainability and management of UVA's architectural, environmental, cultural and land resources in support of the strategic objectives of the University. A valuable first step towards a sustainable future is the Office's work in developing cooperative relationships with both academic and administrative departments who will share similar approaches to sustainability.

What is Sustainability?

As a planning term, "sustainability" has been in use for many years. Its meaning has evolved over time to become ever more inclusive, even as its application is being discussed and debated. When the term was first used by city planners and environmental scientists in the 1970s it related almost exclusively to ecological concerns. Today, decision makers are increasingly citing sustainability when they address such diverse issues as housing, transportation, employment, food production, water resources and air quality. For the purposes of these guidelines, sustainability will refer to a balanced concern for the long-term planning of three interdependent University areas: equity, economy, and environment. To plan in a sustainable manner, requires treating these three elements as a three-legged stool, in which the importance of each element is equally balanced with the other two.

Equity: Development and operations should be considerate of impacts related to the surrounding community and its social ethics, networks, local history, and neighborhood connectivity.

Economy: High performance buildings, infrastructure and environmental design produce mid- and long-range cost savings yielding maximal benefits in terms of physical development, operational costs, and procurement.

Environment: Sustainable approaches to natural systems and the environment will ensure their protection and continued health for all inhabitants and species.

David J. Neuman, FAIA
Architect for the University
August 2005

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*"Development is sustainable when it meets the needs of the present
without compromising the ability of future generations to meet theirs."*

United Nations World Commission on
Environment and Development, 1987

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ENVIRONMENTAL OVERVIEW

The University of Virginia (UVA) has had a longstanding and rich relationship with the built environment, resulting in a unique architectural and landscape heritage with a distinctive legacy. The Central Grounds are considered to be among America's most important designed places, and as the University moves assuredly into the future it must consider not only its mission as a steward of this cultural heritage, but also of the environment. In the steps of engaging in sustainable activities and related far-reaching decisions, the University will prioritize the well-being of all future students, faculty, staff, and visitors as well as the vitality of the local ecosystem and the global biosphere.

The University's recent focus on pedestrian oriented development has helped create a foundation for a more sustainable future. Housing, classrooms, dining facilities, and other amenities located proximate to each other contribute to a pedestrian friendly environment, thereby reducing dependence on the vehicles. While building on these initiatives, the University must also strive to address sustainability at every scale, from indoor spaces to watersheds. Building construction and materials, for example, may contribute to the pollution and degradation of the biosphere, and ultimately to poor human health. We need to give more thoughtful consideration to the way we design, construct and operate buildings in terms of human and environmental impact.

We are currently faced with pressing environmental concerns such as finite water and energy supplies and land use limitations. Water pollution damages the entire ecosystem, from wildlife habitat to potable water supplies. Traditional stormwater drainage systems contribute to sedimentation and erosion of the local and regional watersheds. Artificial lighting indoors instead of natural daylighting consumes electricity and raises indoor temperatures, requiring increased HVAC operations to moderate the air. As the University grows, the operations and maintenance of its buildings, facilities, and infrastructure become increasingly expensive. While we acknowledge the impact that human activity—such as building construction and energy consumption—has had on the natural environment, we must look for ways to combine cost effectiveness with environmentally friendly operations. In order that the University should further its mission of free inquiry directed to understanding the nature of the universe and the role of mankind within, we must also provide a sustainable learning environment in which to pursue this goal. It is therefore essential to the enduring success of the University to grow in a more sustainable manner.



The University of Virginia is in the process of developing and implementing an Environmental Management System (EMS). The purpose of

an EMS is to help UVA manage its environmental impacts, ensure compliance with all applicable environmental regulations, and encourage sustainability. When fully implemented, the EMS will cover all aspects of the University from building design to facility operations. In keeping with the standards set by UVA's environmental policy, the EMS strives to encourage energy conservation and energy efficient design, prevent and reduce pollution from University property, reduce waste, and increase environmental awareness. The EMS also requires UVA to consider best management practices in the design, construction, and maintenance of its facilities. The standards set by the EMS apply not only to UVA students, faculty, and staff, but also any contractor or consultant hired to complete work for the University. In the first steps of implementing the EMS, UVA's Parking and Transportation facility made the decision to switch from regular diesel fuel to biodiesel in all University busses. The usage of biodiesel reduces the consumption of non-renewable resources and decreases the amount of air pollutants generated by the busses. With the help of the EMS, UVA will continue to evaluate its activities to ensure the University operates in the most environmentally responsible manner practical.

These Guidelines should serve as an introduction to sustainability issues, specifically those that are relevant to the University community. It is also a resource for those who might need an overview of current strategies in order to develop a more comprehensive approach to environmental stewardship for the University.

ENVIRONMENTAL SETTING OF THE UNIVERSITY

The core University Grounds cover 1,300 acres of rolling landscape on the western edge of the Virginia Piedmont, a terrain of small plateaus, hills and valleys. The Grounds are a complex landscape of urban and suburban development, formal open space, steep slopes, forest clusters, and streams. Located primarily on uplands, the Grounds form a transition from steep hillsides to the tributaries of the Rivanna River. Albemarle County and the City of Charlottesville surround the University, with land to the north, south and east being primarily urban and land to the west primarily suburban or rural. The hills of Albemarle County, rising from the Rivanna watershed to the heights of the Blue Ridge Mountains, provide for a varied landscape suitable for a wide range of uses including dairy farms, apple orchards and vineyards. The City of Charlottesville has a network of paved sidewalks, streets and parking lots, with several parks located near the University. Many people who work or study at the University live within the City adjacent to the Grounds.





NATURAL SYSTEMS

In acquiring land for the University, Thomas Jefferson had the foresight to purchase a series of tracts comprising the headwaters of two small streams, thereby ensuring an adequate water supply for his institution. Although these streams no longer serve as the source of the community's water, the University has nevertheless continued to benefit from its commanding hydrologic setting, which has allowed relative autonomy with regard to planning decisions affecting both Moore's and Meadow Creeks. To accommodate its rapid growth over the last fifty years, the University has buried numerous streams, filled low-lying areas, and eliminated wetlands. Furthermore, by observing conventional stormwater practices, the University has dealt with the increased runoff generated by its extensive paving and rooftops by channeling water through pipes and paved culverts. As a result of these practices and related practices in Charlottesville, Meadow and Moore's Creeks have been severely degraded, contributing disproportionately to the pollution and erosion evident throughout the larger watershed. In 1999, the University began a process to reverse this pattern by embarking on a new approach to stormwater management. This new approach began with a planning study, the Strategic Plan for Water Resources Management, which was developed by an expert team of professionals with key input from City and County representatives. Since then, the University has treated stormwater as a resource by emphasizing techniques to reduce run-off, maximize infiltration and restore natural drainage systems.

The streams and rivers in the Rivanna Watershed flow eastward to the Chesapeake Bay, 120 miles across the Piedmont plateau. Locally, three streams—Moore's Creek, Meadow Creek and Ivy Creek. The headwaters of these streams begin as springs and seeps flowing from the hillsides. A minor ridge separates the Meadow and Moore's Creek watersheds, dividing the Grounds roughly into north and south sections at McCormick Road and the northwest portion of Central Grounds. These two creeks are an important part of the texture of the landscape. Moore's Creek, beginning near the Facilities Management site, flows through a natural stream bed and remains above ground until it reaches the pond at the Dell. The movement of the stream over rocks and earth helps aerate the water and remove pollutants, while also providing habitat for various plant and animal species. The pond removes sediment from the water, after which it is culverted into the underground stormwater drainage system.

The Dell project day-lit approximately 1,000 lineal feet of piped stream, installed two large bioretention areas and constructed a pond to improve both stormwater quality and quantity (see page 15 for plan and image). This project, in combination with a major stream restoration project at



the Ivy-Emmet parking garage, greatly improved stormwater capacity within the University's land holdings in the Meadow Creek drainage basin. In fact, these projects improved conditions so effectively upstream of the John Paul Jones Arena, that the Arena project was only required to do minimal on-site stormwater management. This allowed the preservation of a significant wooded area that otherwise would have had to be removed to accommodate a stormwater detention basin. Projects such as the Dell restore the University's natural systems to their original function and should be implemented wherever possible.

The Moore's Creek drainage basin is more a challenging area for the University to implement downstream improvements. The ever-expanding medical center lies within this drainage basin and there are limited areas for above-ground stormwater improvements. The University's approach here is to adopt urban solutions, such as underground storage tanks, rooftop storage and green roof systems to lessen downstream impact.



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IMPLEMENTATION

Buildings create waste during construction and continuous waste output during day-to-day operations. They pollute the biosphere, contributing nearly one-third of carbon dioxide emissions and other harmful emissions that reduce air quality. In addition, buildings may have poor indoor air quality that is harmful to all users. "Whole building," or "holistic" design that considers human and environmental health as well as the impacts on the surrounding community will result in cleaner, healthier and more efficient buildings. Energy use, indoor environmental quality, water resources, materials conservation, historic preservation, site planning, transportation, local climate and bioclimatic design are all interdependent factors that determine the health of the building and campus. Decisions that affect one of these aspects will probably affect performance in another, thus none of these concerns should be viewed in isolation.

The US Green Building Council, a coalition of building industry leaders, seeks to promote "buildings that are environmentally responsible, profitable and healthy places to live and work." The Leadership in Energy and Environmental Design (LEED™) program was created to address a range of environmental, economic and practical implementation issues. As a standard for quantifying environmental design, it is meant to stimulate market-based changes in building practices and the widespread acceptance of sustainability. LEED™ is meant to be voluntarily applied by designers, contractors and building owners to maximize the environmental and economic performance of their buildings and related environs. It has recently been applied by numerous public and private institutions, including the University of California, the University of Michigan, Harvard



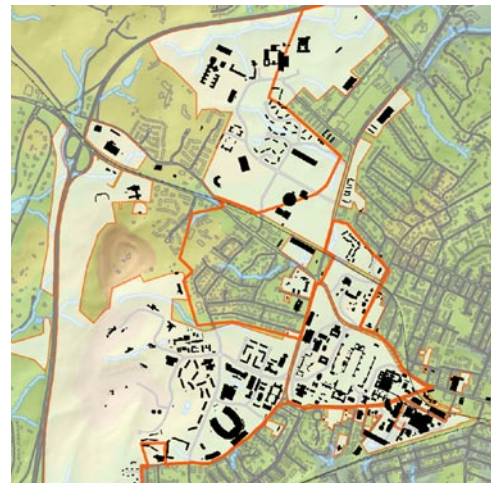
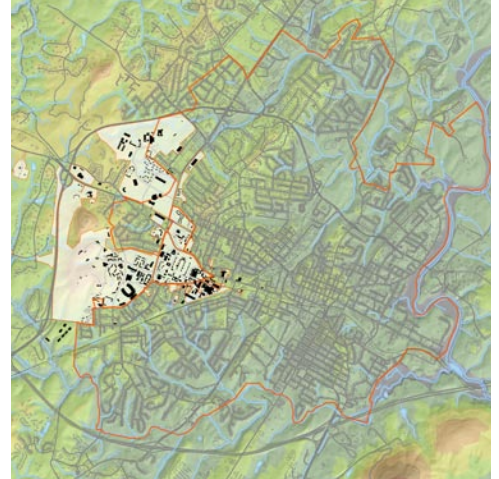
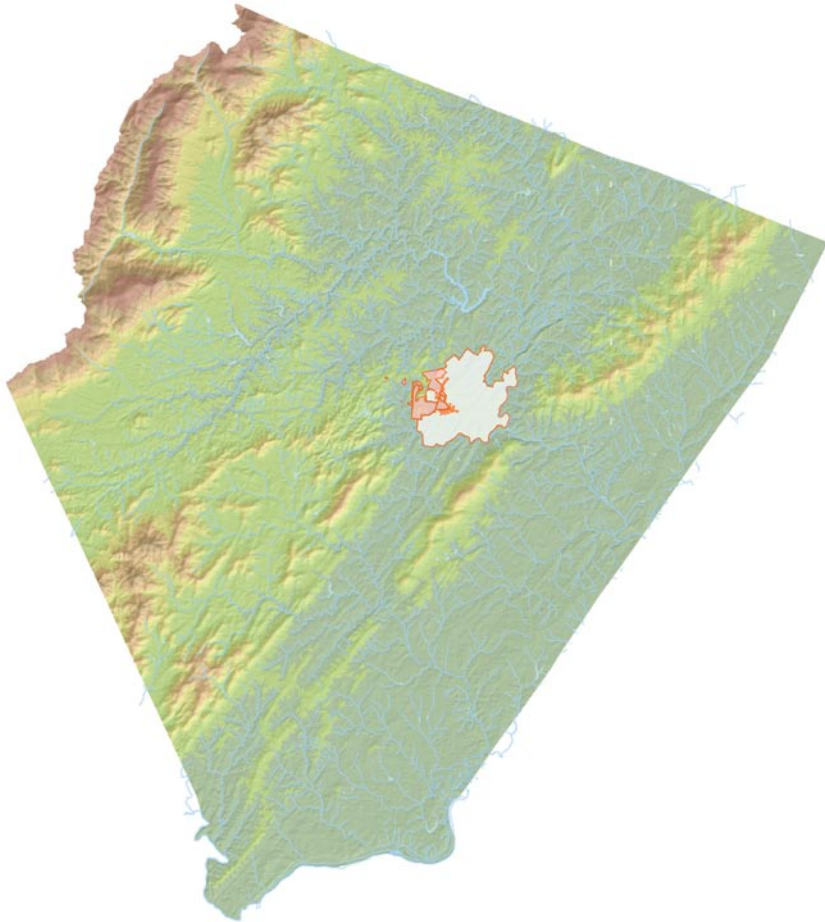
University, and Washington University in St. Louis. Although LEED™ is not an appropriate strategy for every project or institutional setting, it is an excellent reference for integrated building design practices.

As a means to heighten awareness, build support and encourage utilization of sustainable principles and policies in the design of projects at the University of Virginia, the Architect for the University (OAU) will:

- Establish environmental sustainability objectives and priorities for all University, UVA Health System and UVA Foundation land and facility planning activities for both buildings and landscapes;
- Provide guidance on siting options utilizing environmental sustainability principles and recommend related program initiatives;
- Establish assessment criteria for sustainable design principles for use by University personnel and professional consultants;
- Cooperate with other departments within the University to encourage cooperation and incorporate sustainability elements into related administrative guidelines and documents;
- Work with community partners to identify and support program elements and initiatives which encourage regional environmental sustainability;
- Use existing University environmental expertise within and outside the Office of the Architect, to promote expansion of resources available to implement sustainable development principles effectively;
- Investigate funding new environmental initiatives through reallocation of funds within programs where sustainability is determined to be a priority;
- Work with University Facilities Management to review contracting procedures with the goal of implementing procurement practices which favor technologies, products, or practices which are environmentally beneficial;
- Encourage development of data management systems to allow data on environmental programs and projects to be readily accessed;
- Foster awareness of environmental issues related to capital development among students, faculty, staff and the local community as well.

IMPLEMENTATION

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Above: The University Grounds in orange, City of Charlottesville in white within the context of Albemarle County.

Top Right: Detail of the City of Charlottesville with the University Grounds.

Middle Right: Detail of the University Grounds.

Bottom Right: Detail of the Central Grounds within the University.



TECHNICAL OBJECTIVES

These Guidelines focus on three central themes in campus design: Planning; Architecture/ Landscape Architecture; and Operations. Based on these themes, the Guidelines are organized into eight topics:

- Energy Use and Conservation
- Water Resources
- Materials and Resource Conservation
- Indoor Environmental Quality
- Site Planning and Design
- Local Climate and Bioclimatic Design
- Historic Preservation
- Transportation

These topics are important individually, but they add up to more than the sum of their parts when considered together. This holistic approach is essential to meeting UVA's sustainability goals. The section for each topic includes a summary of the objectives followed by a list of strategies that will further the achievement of these objectives. The strategies are numbered for clarity and ease of reference, but the order does not denote priority. While the Guidelines provide background information and ideas for implementation, they should also encourage exploration of new ideas with the possibility of developing additional strategies as the University's implementation evolves.

Supplementing the Technical Strategies is a summary list of websites that provide broader information on each of the subject areas. Please refer to these websites for further investigation.

ENERGY USE AND CONSERVATION

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ENERGY USE AND CONSERVATION

OBJECTIVES

Maximize energy efficient design in new facilities to achieve long-term economic benefits and savings.

Reduce total energy consumption for all existing buildings and facilities to lower energy costs.

Reduce air pollution and water consumption, to protect our local environs and habitat.

Strategies

The University publishes Facilities Planning and Construction Design Guidelines which mandate specific building practices including energy efficient design practices and performance. Please refer to the website at <http://fmweb.virginia.edu/fpc/DesignGuidelines.htm>. The Facilities Design Guidelines provide specific information describing how buildings are constructed and operated, and they include energy efficiency guidelines.

1. Integrate Energy Conservation in Site Planning and Schematic Design Phases

Designers of new buildings and facilities should consider energy use at the beginning of the process. Attempting to integrate sustainable design strategies in later stages of development will likely result in less efficient systems and greater cost expenditures. Taking advantage of the physical features of the site, its orientation, and microclimates reduces energy consumption for heating and cooling loads.

2. Integrate Renewable and Alternative Energy Sources

Once passive design and conservation techniques have been applied, consider using renewable energy sources to further reduce the consumption of fossil fuels. While we plan for future alternatives, we can begin to integrate renewable energy—such as photovoltaic (PV) panels, solar heating, geothermal enhancements, and wind power—at a smaller scale. Their application should increase as they become readily available and cost-effective, but even today they can be considered for emergency and outdoor night lighting applications.

- Design the roof and walls to accommodate photovoltaic (PV) panels and solar thermal panels, and integrate these into the electrical system and hot water systems.
- Supplement traditional water heating methods with solar hot water technologies.
- Investigate wind turbines and other alternative sources to





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supplement energy needs.

3. Conserve Energy with Passive Solar Heating and Cooling

Use “whole building” design techniques and simple technologies to provide low-cost heating, cooling, and daylighting. Natural ventilation should be utilized to full advantage, especially in spring and fall. Strategies for passive solar design and reducing reliance on mechanical systems (HVAC) include:

- Moderate interior temperature extremes with thermal mass found in materials such as stone, brick and concrete, which have the natural capacity to store and release heat.
- Design the building envelope to take advantage of prevailing winds and breezes as well as seasonal sunlight variations.
- Use features such as “air-lock” entrances to reduce heating and cooling gain/loss.
- Use roof surfaces that reflect light and reduce cooling loads (for example, green roofs that also moderate stormwater runoff).
- Design exterior wall openings so that natural ventilation is available.
- Consider mechanical systems that are compatible with natural ventilation and can be controlled accordingly.
- Control humidity through openings and ventilation rather than artificial cooling.
- Utilize building HVAC systems with air-side economizers that use outside air for cooling when conditions are dry and cool.
- Retrofit water chillers with water-side economizers that allow cooling towers to produce “chilled” water during cool periods of the year. This reduces dependency on mechanical cooling.

4. Optimize the Efficiency of Mechanical Systems

New systems and strategies should be considered over traditional heating, ventilating and air cooling (HVAC) systems. Apply the appropriate strategies below:

- Where possible, minimize or eliminate air conditioning (for example, with fresh air cycles or natural ventilation).
- Program similar building use types in the same temperature control zone.
- Condition air according to occupancy, activities, and operations.
- Use occupancy sensors (such as carbon dioxide sensors) and variable air volume (VAV) distribution systems that reduce unnecessary cooling and heating.
- Use controls that give more freedom than just two modes of operation (“on” and “off”) and allow more personalized control over indoor climate.
- Use heat recovery systems to minimize heating loads.

PROJECTIVES

ENERGY USE AND CONSERVATION

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- Use direct/indirect evaporative cooling systems and/or pre-cooling for conditioned spaces.
- Continually recommission HVAC systems in buildings by calibrating sensors, control valves and dampers. This can result in 20% reduction in energy use of HVAC systems.
- Building sensors (thermostats and humidistats) must be calibrated at least annually to prevent waste of energy.
- Set back temperatures and air flows at night to significantly reduce energy use without affecting people or compromising the building. Often the highest heating and cooling periods of buildings are during periods when buildings are not occupied.

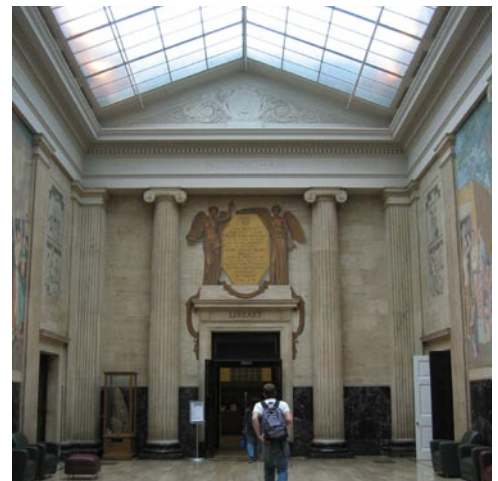
5. Coordinate and Integrate Daylighting with Electric Lighting

Install efficient lighting systems and controls. Energy use can be minimized through advanced lighting systems. Maximizing the amount of space that has access to useful daylighting will reduce the need for electric lighting. Consider using some of the following strategies:

- Use roof monitors and high clerestory windows to complement skylights. Consider skylight models that react to seasonal changes in the sun's altitude.
- Use shading devices to reduce glare of the full sun (overhangs at south windows, vertical fins on east and west windows, or trees and vegetation at any window or opening).
- Specify glazing that allows the maximum amount of light while reducing harmful UV rays and heat transfer. Glazing that darkens the room too much requires more electric lighting, which in turn outputs heat requiring more cooling. Glazing on north-facing walls will require lower shading coefficients and can allow higher daylight transmittance.
- Use photocell-dimming sensors that adjust electric lighting in accord with the amount of natural light.
- Use systems that allow more sensitive control (occupancy sensors, dimmers, and timers).
- Use advanced lighting devices where appropriate (mirror-based systems with single light sources, fiber optic systems that provide daylight).
- Use lamps and luminaries with electronic ballasts.
- Use lighting fixtures that illuminate ceilings and walls for low ambient lighting levels, where appropriate (for example, in computer labs to reduce glare).
- Use full color spectrum lighting sources with a color temperature of 5,000K.

6. Use Efficient Equipment and Appliances in New and Existing Buildings and Facilities

The use of energy efficient equipment and appliances almost always re-



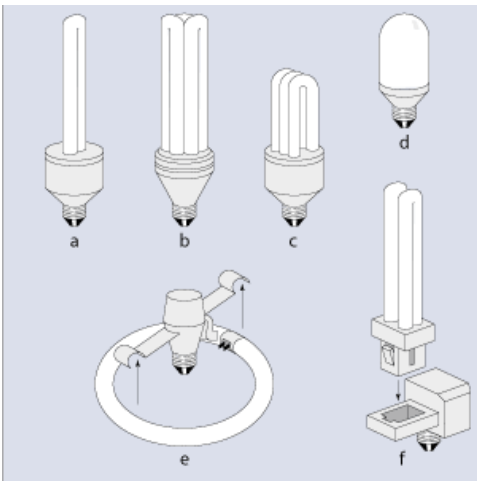


sults in reduced operating costs for the building. Often these technologies cost more initially, but will pay for themselves in 2 to 5 years. Some example of energy efficient equipment:

- Reduce the use of incandescent light bulbs.
- Specify the use of high efficiency electric motors.
- Specify high efficiency lighting such as T8 or T5 fluorescent.
- Prohibit the use of electric water heaters.
- Select equipment and appliances that meet EPA ENERGY STAR® criteria.
- Use efficient heat and water equipment to service buildings, such as solar heaters and tankless water heaters.
- Use heat-pump water heaters.

7. Consider Geothermal Energy

Conventional HVAC equipment is inefficient when conditioning high cooling/heating loads. Ground source heat pump systems use the moderating effect of the ground temperature and require fewer kilowatt hours to make the air hotter or colder. Underground coils replace outdoor air conditioning units, thus all equipment is kept indoors. Horizontal wells can house the coils underneath parking lots, which act as a “thermal battery.” On tighter infill sites and where appropriate, vertical wells can be placed directly underneath the building.



WATER RESOURCES

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WATER RESOURCES

OBJECTIVES

- Respect and restore the local Rivanna River watershed.
- Conserve and recharge groundwater supplies.
- Reduce or eliminate use of potable water for non-drinking uses.
- Reduce and/or reuse stormwater runoff to prevent stream bank and soil erosion.
- Increase pervious surfaces and use porous paving materials; minimize impervious surfaces.
- Reduce off-site treatment of wastewater.

Strategies

1. Manage Site Water

Adopt stormwater management practices according to the University's Strategic Plan for Water Resources Management (1999). Consider the following strategies:

- Do not build on land areas critical to maintaining water balance, especially upland slopes where headwaters originate.
- Select building sites that require minimal alterations and have no ecological impacts on the watershed.
- Retain or improve vegetation and pervious areas on any building site.

2. Restore the Hydrological Process to its Natural Function

The creation of visible water systems will enhance the University's appearance while improving the water supply. Integrate these systems into the University's "green infrastructure."

- Daylight streams by taking them out of pipes and restoring them to open, free-flowing channels with floodplains to purify water runoff to rivers and to the Chesapeake Bay.
- Recreate wetlands in floodplains for flood storage and groundwater recharge.
- Enhance existing streams and wetlands by planting native, water-tolerant species.
- Create a riparian buffer zone (at least 100' across) and minimize development adjacent to the buffer zone.



Rivanna Watershed





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3. Improve Management Practices

Promote alternative technologies and conservation strategies that recharge groundwater and reduce runoff. Stormwater management should function effectively, preventing flooding, erosion and non-point source pollution. Consider the following strategies where appropriate:

- Minimize impervious paved areas and create stormwater recharge beds under porous areas of pavement where possible.
- Create vegetated swales or convert concrete channels to such.
- Retrofit streams and wetlands with biofiltration beds to recharge groundwater.
- Make use of retention, detention, and other capture systems for use in irrigating lawns, gardens, and athletic fields, or in dry wells to recharge groundwater.
- Collect condensation from air conditioning equipment and reuse in cooling towers.
- Disperse stormwater across vegetated areas with well-drained soils.
- Limit erosion disturbance by minimizing grading and the removal of natural vegetation.

4. Integrate Green Roof Systems

Rooftop plantings combined with waterproof membranes and sophisticated drainage systems offer environmental and cost-savings benefits. First, a green roof greatly reduces the heat island effect, which occurs when building and pavement surfaces absorb heat and cause higher ambient temperatures in developed areas. Second, the plants capture particles of air pollution, which are absorbed by the soil and broken down. Finally, the stormwater that falls on the greenroof will be absorbed and purified by the plants and soil. Water that is not absorbed can be released slowly back into the plantings during dry periods. Economic benefits include extending the life of the roof two or more times because the membrane is not directly exposed to the elements. Green roofs also provide savings in the form of increased insulation, which reduces heating and cooling loads inside the building. An unquantifiable benefit is their attractive appearance from higher floor elevations, which may provide significant psychological advantages for those that will see them in their daily activities.



5. Minimize Indoor Water Use

Select plumbing fixtures and systems that are built to conserve water, especially those technologies that outperform federal, state and local standards. Consider using the following:

- Automatic shut-off controls on faucets, toilets, and urinals.
- Waterless urinals in high-use restrooms.

WATER RESOURCES

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- Lavatory faucets with flow restrictors and low flow showerheads and faucets.
- Pressure-assist toilets and composting toilets.
- Ozonation in laundering systems.
- Water-efficient dishwashers.

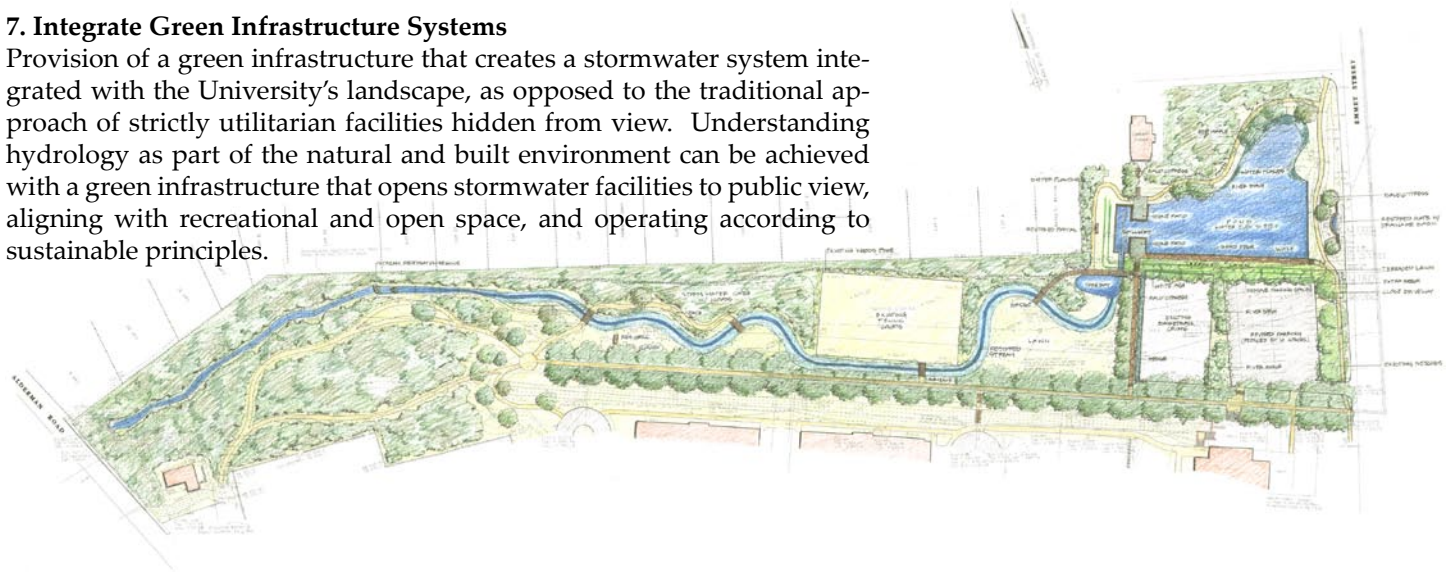
6. Use Gray Water Systems

Establish infrastructure for the future use of water recycling systems, which reduce consumption of potable water. On-site water reclamation and reuse should be encouraged and facilitated wherever possible. Sources include stormwater runoff from roofs and other impervious surfaces; uses include irrigation, toilet flushing and central cooling facilities.

The Dell project day-lit approximately 1,000 linear feet of piped stream, installed two large bioretention areas and constructed a pond to improve both stormwater quality and quantity

7. Integrate Green Infrastructure Systems

Provision of a green infrastructure that creates a stormwater system integrated with the University's landscape, as opposed to the traditional approach of strictly utilitarian facilities hidden from view. Understanding hydrology as part of the natural and built environment can be achieved with a green infrastructure that opens stormwater facilities to public view, aligning with recreational and open space, and operating according to sustainable principles.



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MATERIALS AND RESOURCE CONSERVATION

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MATERIALS AND RESOURCE CONSERVATION

OBJECTIVES

- Increase resource efficiency.
- Reduce consumption of natural capital, especially nonrenewable resources.
- Minimize waste generated by construction, renovation, and demolition of buildings and other projects.
- Minimize waste generated by building occupancy and use.
- Encourage effective and comprehensive recycling programs.

Strategies

1. Design Buildings for Adaptability

When designing and planning a building, consider its adaptability for future uses.

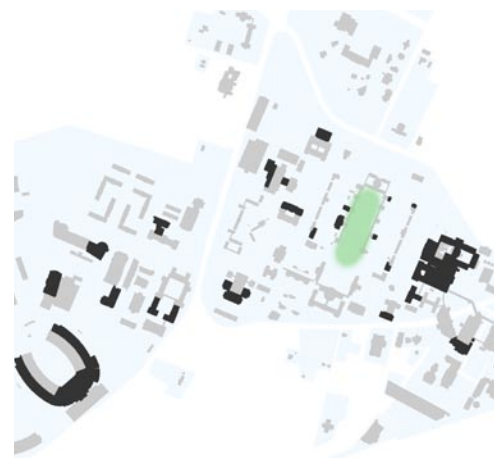
- Consider site planning and building configuration to accommodate later additions and alterations.
- Design spatial configurations as well as structural, electrical and mechanical options for future adaptability.
- Allow spaces to be more easily altered by using interstitial spaces and raised floor systems to house the building infrastructure.
- Use modular spaces and adjustable partitions and furnishings where possible.
- Design core areas (elevator, restrooms, etc.) for ease of retrofit.

2. Select Materials with Low Life-Cycle Cost

"Life-cycle cost" refers to the amortized annual cost of a product. This includes capital expenditures, installation, operation, maintenance, and disposal costs discounted over the lifetime of the material. Use materials that have the lowest environmental impact, particularly those that are used in greatest quantities during construction. Assessment tools such as ATHENA, BEES and LEED provide life-cycle methodologies.

3. Reduce the Consumption of Natural Resources

Materials such as masonry, steel, and some wood products have life-cycles of at least 50 years. These durable materials can ideally last longer than the lifetime of a single building (i.e., through remodeling, adaptive reuse, and reuse of materials in other buildings). Wherever possible, salvage reusable materials from existing buildings that are to be demolished or remodeled. Encourage on-site reuse of scrap and surplus materials. Also



Additions to Buildings on Grounds



Change of Primary Building Use



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consider construction assemblies that allow for ease of disassembly and reuse when the building is no longer useful. This will encourage reuse of valuable materials and may simplify repairs and renovations. Consider and use the following:

- Salvaged materials.
- Remanufactured materials.
- Recycled-content materials and products (post-consumer is preferable to materials with pre-consumer content).
- Reusable, recyclable, and biodegradable materials.
- Reuse of brick and concrete as crushed aggregate for new concrete and asphalt.
- Materials made from renewable sources (such as wheat, cotton, cork, bamboo and other materials that replenish themselves faster than demand for their extraction).
- Wood from well managed forests certified in accordance with the rules of the Forest Stewardship Council.

4. Use Locally Manufactured Materials with Low Embodied Energy Content

Purchasing materials produced within the Commonwealth of Virginia and neighboring states minimizes energy waste and pollution related to transporting materials over great distances, while supporting the regional economy. Also consider the Embodied Energy Content when selecting materials. The “embodied energy” of a material refers to the energy expended in its production. This includes extracting the raw material or materials used to make the final product, manufacturing of the material, and transportation of the final product to its destination.

INDOOR ENVIRONMENTAL QUALITY

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INDOOR ENVIRONMENTAL QUALITY

OBJECTIVES

Provide and maintain healthy indoor air in University buildings. Healthy air is defined by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) as “Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people do not express dissatisfaction.”

Allow building occupants operational control of HVAC and lighting to maintain comfortable temperatures and adequate illumination.

Monitor air quality during renovation and demolition to avoid carcinogenic contamination from asbestos, lead, mold, or other known health hazards.

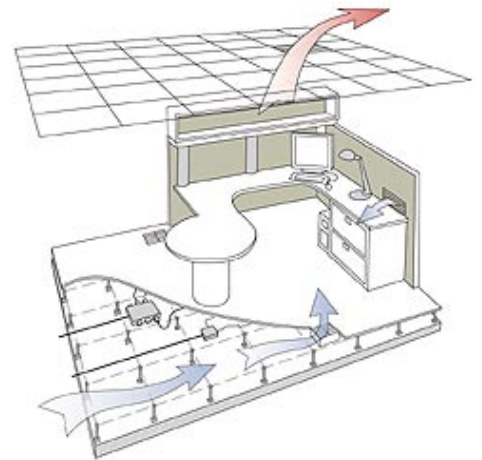
Enhance learning opportunities and productivity by providing healthful and daylit indoor environments.

Strategies

1. Recognize that total building contents and local use conditions contribute to environmental quality

Closed buildings with reduction of air intake from natural sources and reliance on artificial lighting cause poor air quality that affects human health, productivity, and learning. Use strategies to control air pollutants and maximize thermal comfort by complying with current ASHRAE standards and implementing alternative ventilation strategies. Indoor air quality is greatly affected by maintenance activities of HVAC equipment, e.g. proper functioning of for example, automatic dampers that control outdoor air makeup should be verified periodically to insure that they work properly. Screens that cover outdoor air intake and discharge should be verified periodically to make sure that they have not become blocked with dust or debris. Consider alternatives to traditional HVAC systems by using natural ventilation wherever possible.

- Isolate sources of pollution to zones where contaminants are generated.
- Change air filters on a regular basis.
- Verify proper functioning of automatic dampers that control outdoor air makeup.
- Consider using distribution systems such as underfloor ducting that encourages displacement ventilation (where the floor-to-ceiling airflow pattern can be used to reduce concentrations of pollutants).





2. Ensure Good Visual Quality

Provide as much natural daylighting to as many occupants as possible, with the use of window systems, transoms and skylights. Daylighting is controlled by building openings and glazing, and offers a rich spectrum of illumination that enhances visual acuity. Dynamic and subtle shifts in lighting throughout the day provide visual stimulation that cannot be replicated by artificial lighting. Daylight is an effective way to keep occupants connected to the outside world and is known to increase work and classroom productivity. Artificial light should be carefully selected according to programmatic and user needs.

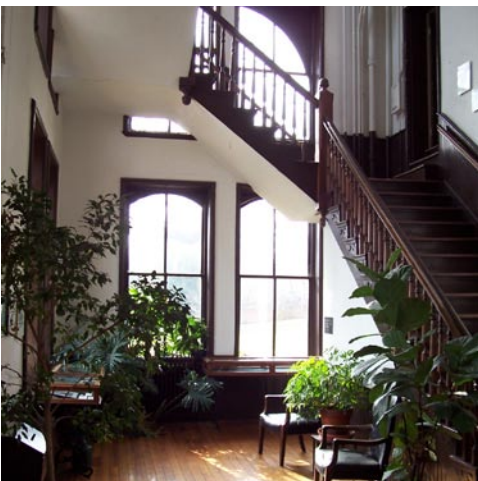
- Integrate daylighting into building design and prioritize artificial lighting for evening luminance or to supplement natural light.
- Electrical lighting systems should be designed to complement natural light.
- Ensure that illuminance levels and luminance ratios are appropriate for users and tasks.
- Select lighting fixtures and controls that avoid glare and support user purposes and preferences.
- Provide visual and physical connections to the natural environment.
- Allow for outside view access from all regularly occupied spaces and combine interior and exterior view spaces.

3. Avoid off-gassing and VOC-emitting Materials

Select low to no off-gassing or VOC (Volatile Organic Compound)-emitting materials, such as furniture systems, office/classroom equipment, upholstery, ceiling tiles, paints, flooring and adhesives. VOC's are chemicals that evaporate easily at room temperature. The term "organic" refers to the carbon content of the compounds. There are thousands of different VOC's that are produced by common materials and used in our daily lives. (Product directories and rating systems, such as Green Seal and GreenSpec, provide current listings of environmentally-friendly materials and their manufacturers.)

4. Reduce and Control Moisture to Prevent Microbial Growth

Water between and behind walls may cause excessive mildew and mold. Select materials and construction strategies that discourage moisture build up and microbial growth. Steam leaks and steam vent lines should not be allowed to leak into building spaces, including mechanical rooms. High humidity levels can directly or indirectly affect air quality by promoting the growth of mold. In addition, steam that leaks increase combustion of fossil fuels contributing to air quality degradation.



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INDOOR ENVIRONMENTAL QUALITY

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5. Ensure Proper Acoustical and Vibration Conditions

Limit noise to the level appropriate for the environment. Good acoustics are free from intrusive and distracting noise. Architecturally there are three components related to acoustics: sound isolation, room acoustics, and building services noise and vibration control. Consider the following strategies when planning for acoustical and vibration conditions:

- Control sources of noise arising from building services (mechanical and electrical equipment, HVAC systems) and from exterior sources.
- Design buildings to control, reduce, or eliminate vibration induced by vehicular or interior traffic and circulation, HVAC systems, machinery, and wind loads.
- Select and design building systems to eliminate unnecessary noise, or isolate it within appropriate acoustic zones.
- Create soundscapes that address background noise levels, sound reverberation levels, and speech interference levels. Ensure appropriate noise levels for classroom, research, medical care, or work programs.



SITE PLANNING AND DESIGN

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SITE PLANNING AND DESIGN

OBJECTIVES

Promote development that conserves and is compatible with natural systems and existing infrastructure. Enhance and/or restore existing conditions of natural systems.

Relate future development with existing campus circulation systems.

Select adaptive reuse/renewal of existing facilities over demolition and new development, whenever economically feasible.

Planning and design of buildings should respond to microclimatic conditions and natural landscapes.

Reduce energy consumption, including external transportation to the site and site maintenance.

Strategies

1. Guide Development to Appropriate Sites

Where possible, select a site that:

- Has been previously developed.
- Utilizes a floor-area ratio (FAR) of .35 and above.
- Minimizes the need for significant grading of natural conditions.
- Minimizes runoff and erosion on steep slopes (maximum slope of 3:1 for grassy slopes, or 2:1 slopes without turf or ground cover).

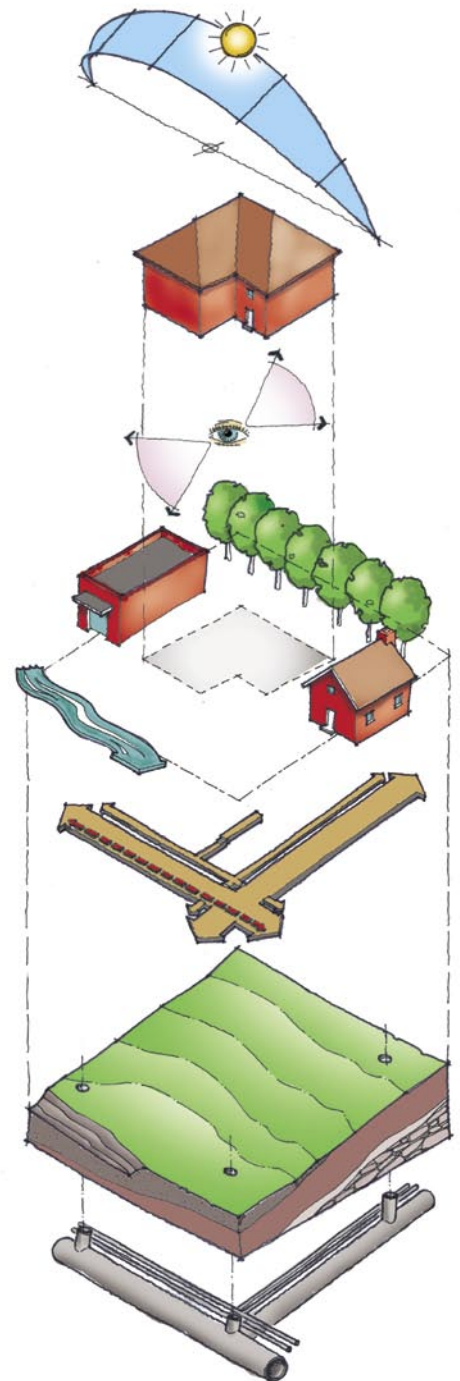
2. Optimize Building Placement for Energy Performance

The building should be oriented to take advantage of daylighting, solar energy, natural ventilation, and shading from surrounding vegetation and buildings. Architectural design should begin with the site and how to work with it, using the following strategies:

- Orient the building so that it takes full advantage of natural light (generally the long axis of the building should be oriented east/west).
- Take advantage of prevailing winds and breezes.
- Consider surrounding context and how it might impact wind and sunlight.

3. Enhance and Maintain Biodiversity

Buildings should be integrated with the site in ways that respect existing



natural conditions. By applying the strategies below, development will enhance the biodiversity of a site while establishing connectivity with the ecological context.

- Remove ecological disturbance from the site where possible.
- Create site-preparation protocols that respect biodiversity and ecological systems.
- Does not create impacts upon habitat and natural systems on Grounds. Design the site with BMP's to protect site context, including wildlife habitat and riparian corridors.
- Identify existing corridors for minimal disturbance during construction, and enhance habitat post-construction.
- Avoid the removal of mature trees and other alterations of sensitive topography and vegetation.

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4. Conserve Water for Irrigation Use

Consider the following strategies where appropriate:

- Plant local and drought tolerant trees and other plant species.
- Re-circulate water supply in fountains and water displays; reuse condensate from cooling towers.
- Use efficient irrigation systems with features such as drip irrigation, moisture sensors, and weather-sensitive (GPS) controllers.
- Maintain appropriate nozzles on irrigation heads.
- Minimize use of potable water for irrigation by incorporating gray-water reuse systems and low-water use systems.

5. Incorporate Climatic and Environmental Design Strategies

Take advantage of or respond to existing microclimate and environmental conditions (see also Local Climate and Bioclimatic Design).

- Use the landscape where appropriate to reduce direct sunlight on the building, and to create cooling and natural ventilation corridors in outdoor spaces.
- Take advantage of solar orientation throughout the site, including outdoor spaces such as courtyards, so that seasonal solar access is maximized.
- Avoid "heat island" effects by controlling external solar gain and temperature increases on flat and/or dark surfaces.

6. Create Desirable Adjacencies

Reduce external transportation to sites within the University by planning for higher housing densities and clusters of dining, academic, administrative, and student life centers. Avoid surface parking wherever possible in favor of parking structures adjacent to the areas of highest density and activity and transit availability.

LOCAL CLIMATE AND CLIMATIC DESIGN

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LOCAL CLIMATE AND CLIMATIC DESIGN

OBJECTIVES

Develop sites and design buildings to take advantage of regional and micro-climatic conditions.

Utilize available wind patterns, sunlight and landscape elements to reduce dependence on artificial environmental control systems and electric lighting.

Create favorable microclimate conditions in and around buildings and outdoor spaces, providing occupant comfort while reducing heating and cooling loads.

Strategies

1. Bioclimatic Design in Site Planning and Buildings

Strategies for moderating temperatures in buildings relate to seasonal requirements. Site planning objectives in the winter are to protect buildings, walkways, entrances, and outdoor spaces from wind and to promote solar heat gain. Summer objectives are to prevent heat gain, and to encourage the cross circulation of breezes and evapotranspiration.

2. Wind Breaks

Adjacent structures, land forms, and vegetation serve as wind protection in the winter (prevailing winter winds are from the northwest, summer winds from the southwest). Plan a site using existing buildings, tree stands, hedgerows, or other landforms.

- Avoid building in open areas.
- Create barriers around a building or outdoor space to control wind. Trees and shrubs are commonly used, but berms and walls can also be effective. The higher the barrier, the larger the “wind shadow”. Note that turbulence is created if the barrier is impenetrable.
- Site buildings on leeward (northwestern) slopes where possible. Because colder air flows downhill, valley locations are not ideal in the winter. The best protected sites from the wind are usually on leeward slopes.
- Consider the summer effect of wind breaks on surrounding buildings and outdoor spaces, as barriers may impede desirable cooling breezes in warmer months.

3. Sun Shading

Opportunities for sun control should be addressed at the beginning of site planning when shading with existing vegetation is considered, or when new trees, shrubs, and hedges can be planted. Sun angles in the summer



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are less acute than winter, and it is therefore feasible to shade spaces and building openings during the summer to minimize solar heat gain while allowing winter solar gain.

- Plant tall deciduous trees on the south side of buildings to block sunlight in the summer and allow it to enter the building in the winter.
- Absorb afternoon sunlight by planting low trees and tall, dense shrubs on the west side of buildings. Vegetation may be evergreen, and can serve double duty as wind breaks in the winter.
- Provide shading using overhead structures and plantings wherever possible, such as a trellis with ivy.

4. Natural Ventilation

Provide cooling for buildings and outdoor spaces using adjacent structures and vegetation to increase exposure to summer breezes. Lower outdoor air temperatures by reducing or eliminating paved surfaces adjacent to buildings, and by planting trees, shrubs and ground cover. Note that the direction of breezes is influenced by surrounding forms, and could differ from the prevailing wind pattern. Treat each site as a microclimate with its own unique set of conditions.

- Guide air flow into building or outdoor space using “wind funnels”, such as rows of trees, hedges or parallel fences.
- Wherever possible, site buildings on slopes to take advantage of cooler air flowing downhill. Also, breezes that cross over water or vegetation are cooler than those that flow across pavement.
- Create “air dams” that increase pressure for inflow to a building. Desirable inflow pulls cooler air into a building using surrounding land forms and structures.

5. Create Microclimates Using Water and Plants

Provide natural cooling with plants and water near building surfaces and outdoor spaces. Evaporative cooling increases outdoor comfort and reduces indoor cooling loads, thus reducing energy consumption. Combined with shading and natural ventilation, plants and water create favorable microclimatic conditions that vary from site to site.

- Use turf and other ground cover to provide site cooling. (Differences between surface temperatures for evaporative surfaces, such as grass, and non-evaporative surfaces, such as asphalt, can be greater than 25°F.)
- Maximize vegetation where possible, and shade non-evaporative surfaces, such as streets, parking lots and rooftops, with trees and green roofs.
- Use fountains and spray jets in courtyards and outdoor spaces to



PROJECTIVES

LOCAL CLIMATE AND CLIMATIC DESIGN

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lower temperatures (applying grey water recycling techniques, where appropriate).

- Provide adequate irrigation for vegetation to maximize evapotranspiration (applying water recycling techniques).



HISTORIC PRESERVATION

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HISTORIC PRESERVATION AND ADAPTIVE REUSE

OBJECTIVES

Conserve and reuse existing buildings on Grounds wherever possible.

Retrofit historic buildings with energy efficient and environmental design features as appropriate to the use and the structure.

Conserve and reinvigorate historic landscapes throughout the Grounds.

Strategies

1. Preserve to Protect Historical Resources

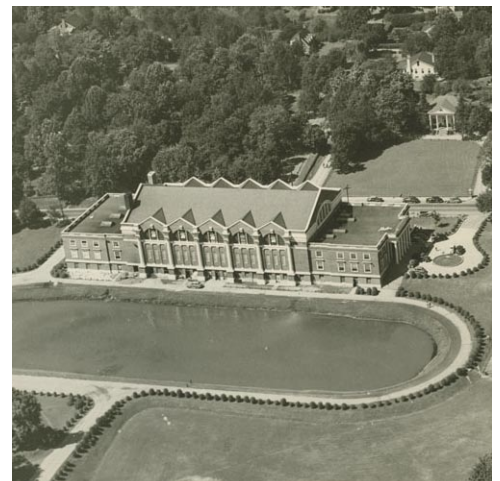
The University's built environment is its most visible asset. Preservation of Jefferson era buildings has long been of primary importance. As we move towards more sustainable development on Grounds, we must also consider preservation of our more recent architectural history. While preserving buildings protects the history and culture of the Grounds, it also retains building materials and their "embodied energy". The embodied energy refers to the production and transportation of materials and the labor required put them into place. Many historic structures on Grounds are inherently sustainable in their design as well.

2. Maximize Sustainable Qualities and Learn from Existing Buildings

Structures built in the first half of the 19th century functioned without the conveniences of modern building systems. They were designed and carefully sited to work with their location, landscape and climate, and to take advantage of breezes and solar energy. For example, microclimates created by the pavilion gardens moderated temperatures both indoors and out. The Lawn cools the air while its wind-channeling effect draws breezes across outdoor spaces and into interiors of adjacent buildings. The Colonnades provide shade for cooling the Pavilions and student rooms, as well as for those walking within them. The dominant building material on Grounds—brick—was chosen for its availability and durability, but its thermal performance is also a valuable characteristic. Brick or stone that is at least 8 – 12" thick acts as a natural insulator, remaining cool in the summer and preventing heat loss in the winter. Older bricks tend to be softer and more porous, and as such they are able to "sweat" and "breathe" on humid days while absorbing small amounts of water when it rains. The role of historic features, such as porches, awnings, skylights, roof ventilators, and large windows should remain in the vocabulary of contemporary designers of the University. Buildings that share these and other sustainable characteristics should be preserved, while their "technologies" should be applied to future structures.



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3. Enhance Historic Landscapes

Landscapes at the University are inextricably linked with the buildings. The built environment includes the landscape of manufactured sites and systems, including all buildings and open spaces. Historic landscapes are defined as any landscape designed and created intentionally by man and which have, over time, acquired cultural significance. These landscapes are often associated with important academic buildings, such as the Lawn and Pavilion gardens in relation to the Rotunda, the Pavilions, the Lawn rooms, and the Range. Historic landscapes, like architecture, typically embrace sustainable design because they are part of the University's "green infrastructure" and they provide habitat for a variety of plants and animals, and are often a preserve of native species.

The University's Observatory Hill is one such historic landscape. Not only is it a preserve of native plants and a haven for small animals, but it serves to protect one of the major headwaters of the Meadow creek drainage basin. Observatory Hill is the first part of an almost contiguous green corridor that includes the University's cemetery (also a historic landscape) and the Dell. Even if a historic landscape does not contain notable habitat or native species, its role in preserving green space is significant. For example, the Brooks Hall Lawn is part of the original land acquisition for the University and contains significant historic features. Because it is protected as a historic landscape, this open lawn with scattered shade trees will not be built upon, preserving it for posterity as a green space with minimal impervious surface.



TRANSPORTATION

OBJECTIVES

Provide a variety of transportation options across Grounds, including public transit, pedestrian ways, and bicycle lanes.

Integrate transportation with existing circulation systems.

Reduce surface parking.

Use renewable or clean energy to power public transit systems.

Strategies

1. Create Bicycle Amenities

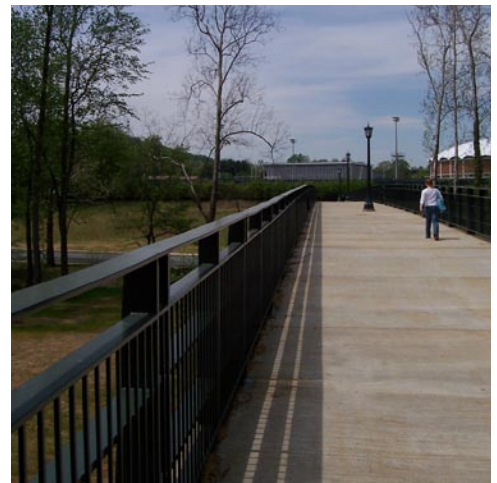
Encourage use of bicycles by providing dedicated bicycle paths, aligned with vehicular or pedestrian traffic where appropriate. Select a bicycle rack system and install it in areas convenient for bicycle commuters (e.g., outside of dorms, classroom buildings and other centers student activity). Also consider the following:

- Install bicycle storage facilities on buses and other public transportation.
- Include bicycle stations with locks and shelters at high use locations.
- Provide enhanced signage for bicycle routes and facilities.

2. Enhance the Pedestrian-Oriented Environment

Pedestrians comprise the majority of commuters on Grounds. Wayfinding facilities and streetscape elements should reflect this majority use. Create pedestrian-friendly corridors using the following strategies:

- Widen sidewalks and install verges or medians between sidewalks and vehicular surfaces.
- Provide adequate signalization and refuge islands at all major crosswalks and intersections.
- Enhance signage to provide accurate directional information for pedestrians.
- Illuminate sidewalks using appropriate lighted bollards or street lighting.
- Create pedestrian overpasses or underpasses, such as the Emmet Street pedestrian bridge, to link across busy traffic thoroughfares.
- Enhance pedestrian-friendly corridors to provide a pleasant experience for users.





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3. Provide Incentives for Non-driving Commuters

Most automobile commuters choose to drive to the Grounds because it is cheaper and more efficient than other modes of transportation. Consider disincentives for driving, such as increasing the cost of parking permits and/or remote parking. Create incentives for those who choose not to drive, such as free bus passes for use on the Charlottesville Transit System, guaranteed ride home and other support programs.

4. Reduce Conventionally-Paved Surface Parking

Surface parking facilities use too much land and create inefficiencies in land use. They usually require large amounts of impervious surface which contribute to stormwater runoff and poor water quality. Consolidate parking in multi-floor structures to free more land for infill development or use as open space. Whenever possible use pervious paving materials where surface parking is necessary.

5. Operate Sustainable Transit Fleet

Reduce fossil fuel consumption, greenhouse gas emissions and air pollution with an alternatively fueled bus fleet. Select an appropriate technology from the following list of available alternatives:

- Hybrid electric vehicles: Conventional internal combustion engine with the motor and battery of an electric vehicle. Increases fuel efficiency and greatly reduces emissions.
- Natural gas: Motors use methane or other compressed and liquefied natural gasses. Costs less than gasoline but requires more refueling. Methane is a harmful greenhouse gas.
- Propane: By-product of natural gas or oil, propane, liquefied petroleum gas and autogas serve the largest market for alternative fuels. Propane and related gasses. Has lowest vehicle conversion costs, and fuel price is comparable to gasoline.
- Methanol: Reduces emissions and can replace conventional diesel.
- Ethanol: Produced from corn. Reduces most emissions, but may increase others. Has lower energy content than gasoline but costs less per gallon.
- Biodiesel: Produced from agricultural feedstocks such as soybeans, or from food wastes such as vegetable oil or cooking grease. Greatly reduces most emissions. Costs more than gasoline but requires minimal or no cost for engine modification.
- Hydrogen: Produced with natural gas, oil or coal. Fuel cell do not create tailpipe emissions, but production emissions (generating hydrogen with fossil fuels) must be considered.

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TRANSPORTATION

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SOURCES

INTERNET RESOURCES

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ASSOCIATIONS AND COALITIONS

Associated Colleges of the South – Sustainability Initiative
<http://www.colleges.org/~enviro/>

Association of Higher Education Facilities Officers
<http://www.appa.org/>

Campus Sustainability Assessment Project
<http://csap.envs.wmich.edu/>

Higher Education Network for Sustainability and the Environment
<http://www.ulsf.org/hense/>

National Wildlife Federation – Campus Ecology Program
<http://www.nwf.org/campusecology/index.cfm>

University Leaders for a Sustainable Future
<http://www.ulsf.org/>

Second Nature – Education for Sustainability
<http://www.secondnature.org/efs/efs.html>

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GREEN BUILDING AND DESIGN

American Indoor Air Quality Council
<http://www.iaqcouncil.org/>

American Solar Energy Society
<http://www.ases.org/>

Building for Environmental and Economic Sustainability (BEES)
<http://www.bfrl.nist.gov/oae/software/bees.html>

Center for Resourceful Building Technology
<http://www.crbt.org/>

Certified Forest Products Council
<http://www.metafore.org/?s=147>

Community Greenhouse Foundation
<http://www.communitygreenhouse.org/>

Concrete Network
<http://www.concretenetwork.com/>

Construction Materials Recycling Association
<http://www.cdrecycling.org/>

Ecological Design Institute
<http://www.ecodesign.org/edi/>

Environmental Design and Construction Magazine
<http://www.edcmag.com/>

Greener Buildings
<http://www.greenerbuildings.com/>

Green Guard
<http://www.greenguard.org/DesktopDefault.aspx>

Green Roofs
<http://www.greenroofs.com/>

Green Seal
<http://www.greenseal.org/>

Green Spec
<http://www.buildinggreen.com/>

OIKOS – Green Building Source
<http://oikos.com/>

Sustainable Forest Products Resource
<http://www.forestworld.com/>

Sustainable Products Corporation
<http://www.sustainableproducts.com/>

U.S. Dept. of Energy
<http://www.eere.energy.gov/>

United States Green Building Council
<http://www.usgbc.org/>

Whole Building Design Guide
<http://www.wbdg.org/>

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INTERNET RESOURCES

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OTHER UNIVERSITIES

Brown University Campus Environmental Stewardship
www.brown.edu/Departments/Brown_Is_Green

Columbia University Conserves
www.columbia.edu/cu/green/

Cornell Center for the Environment
www.cfe.cornell.edu/cfe/greening.cfm

Cornell Sustainable Campus
www.sustainablecampus.cornell.edu

Dartmouth University Resource Working Group
<http://www.dartmouth.edu/~rwg/>

Duke Environmental Sustainability
www.duke.edu/sustainability/

Duke University Greening Initiative
www.duke.edu/greening/index.html

Emory University Ad Hoc Committee on Sustainability
<http://www.environment.emory.edu/>

Greening of Johns Hopkins
<http://www.jhu.edu/~recycle/greening.htm>

Princeton Environmental Reform Committee
www.princeton.edu/~perc/

South Carolina Sustainable Universities Initiative
<http://www.sc.edu/sustainableu/>

Stanford Sustainable Buildings
<http://sustainablebuildings.stanford.edu/>

The Sustainable University of Michigan Initiative
<http://www.umich.edu/~usustain/>

Sustainability at the University of California, Berkeley
<http://sustainability.berkeley.edu/>

University of North Carolina's Sustainability Coalition
<http://sustainability.unc.edu/>

University of Pennsylvania Environmental Group
<http://dolphin.upenn.edu/~pennenv>

University of Texas at Austin - Campus Environmental Center
<http://www.UTenvironment.org>

University of Wisconsin – Campus Ecology
<http://www.fpm.wisc.edu/campusecology>

PROFESSIONAL ORGANIZATIONS

American Institute of Architects
<http://www.aia.org/>

American Planning Association
<http://www.planning.org>

American Society for Testing and Materials
<http://www.astm.org/>

American Society of Civil Engineers
<http://www.asce.org/>

American Society of Heating, Refrigeration,
and Air-conditioning Engineers
<http://www.ashrae.org/>

American Society of Landscape Architects
<http://www.asla.org>

International Society of Arboriculture
<http://www.isa-arbor.com/home.aspx>

SOURCES

PHOTO SOURCES

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PHOTO SOURCES

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<http://www.chesapeakestudy.org/significance.htm>
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