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# Research Paper: Urban Sustainability Initiatives and their Application in a University Setting: Campus Pathways

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# RESEARCH PAPER: URBAN SUSTAINABILITY INITIATIVES AND THEIR APPLICATION IN A UNIVERSITY SETTING: CAMPUS PATHWAYS

by

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RESEARCH PAPER APPROVAL

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# AN ABSTRACT OF THE RESEARCH PAPER OF

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Major Professor: Dr. Leslie A. Duram

Sustainability in urban context is a growing concern that has become popular at the campus level. As cities and college campuses continue to grow the need to adapt to more sustainable development is evident. The purpose of this research is to evaluate current issues with sustainability and solutions in urban settings and how they can be applied at a campus level. Many of the same issues concerning sustainability in urban context are present on college campuses. Through this research, a solution for part of the Brightway path at Southern Illinois University Carbondale will be proposed in order to offer more sustainable solutions for green space along the path, while increasing social interaction of those who use the path.

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# CHAPTER 1

# INTRODUCTION

The increased awareness of sustainability brings forth many new challenges. This requires a new approach to the way cities are designed, infrastructure is built, and new ways of thinking. Sustainability in urban context is a major issue when considering vast populations living in specific areas. This allows opportunity for changes to take place by identifying problems that hinder sustainable lifestyles in urban context.

When discussing sustainability, there are four general propositions that must be considered: 1) Sustainability requires invention, not just discovery. 2) Sustainability is an opportunity rather than a constraint. 3) Sustainability is a process, not an outcome. 4) Sustainability involves a self-conscious choice; it does not just happen (Alberti and Susskind 1996). In an urban setting, this means that all areas of expertise must collaborate in order to reach this goal; the experts of science must work with urban planners and so on in order to reach the goal of sustainable communities. Sustainability should not be thought of as a restriction, but rather a way to expand while keeping the environment in mind. Sustainability is an on-going challenge that, like anything else in an urban context, must be maintained, updated, and evaluated frequently. It is a responsibility that must be taken on by all in order to make decisions that will lead to a more sustainable context within urban areas.

In addition to urban context, college campuses are becoming advocators for sustainability. Universities are starting to make a shift towards becoming more sustainable, both in the classroom and physically, as a whole. "Growing environmental consciousness and corporate social responsibility has seen the emergence of new legislation committed to sustainable growth, such as the case of requiring new public sector buildings and facilities,

including universities and colleges, to be built to LEED standards" (Castleden 2011). Castleden also states that there is a belief that the emergence of a campus landscape that seeks to mimic natural systems inevitably detracts from a traditional campus landscape that is more human and is designed as an open space for social interaction and activity.

Thanks to this new belief that urban and campus settings can be sustainable; applications can be made at a campus level. Sustainable solutions range from systems of manufactured goods and materials to environmental systems. Together, these approaches can help to form a balance between the built and natural environment in urban context, as well as at a campus level.

This balance can be achieved by reviewing specific environmental systems that are appropriate for a campus setting and have already been put into place at Southern Illinois University Carbondale. With this, information regarding exterior lighting can be used to determine if Southern Illinois University would benefit from changing exterior lighting fixtures on campus. A proposal will also be made for a section of the Brightway path to be developed into an outdoor space based on literature review of other universities' students' perceptions of outdoor spaces and sustainability.

The Brightway path is a main means of travel on the campus of Southern Illinois University Carbondale. Here, the main concern for the path is safety. As students and faculty travel throughout the campus at night time hours, they are encouraged to use this path because it is supposed to be well lit. This path has lost attention over the years and the campus has failed to keep it maintained. Chapter 4 of this paper will provide a proposal for a section of the path to be redesigned, incorporating new green spaces that allow for the use of sustainable features and give an overall more pleasing aesthetic to the pathway.

**Research Goals**

1. Urban Sustainability: Describe the key existing issues with sustainable practices in urban environments (literature review).
2. Campus Sustainability: Describe the key existing issues with sustainable practices and solutions being used on college campuses (literature review).
3. Campus Lighting/Pathways: Describe ways of assessing lighting and pathway solutions on college campuses that can ensure safety and sustainability (literature review).
4. SIUC Case Study: Provide a proposal for Southern Illinois University Carbondale's Brightway path with a focus on the economic, social, and environmental impacts of sustainability (Chapter 5).

# CHAPTER 2

## PAPER OVERVIEW

The research within this paper will provide a basis for sustainability issues within urban context as well as at a campus level. Many issues concerning sustainability in urban context are present on campuses. By evaluating issues and solutions for sustainability, steps can be taken in order to progress towards a more sustainable campus at Southern Illinois University Carbondale.

With the topic of sustainability comes the question of efficiency. Countless practices in urban and campus environments today lack efficiency. By researching sustainable solutions for these settings, campuses can begin to incorporate both built and natural sustainable solutions that provide better efficiency for energy use.

Along with efficiency, there is a financial interest on campuses. As always, campuses want to be able to save as much money as possible. By investigating new methods for exterior lighting on campuses, decisions can be made that incorporate sustainable systems of lighting which reduce energy impact on the environment, in turn saving money for the campus.

By making switches to more sustainable lighting, not only can there be financial benefits, but also safety can be increased. Safety is always of concern on campuses for the students and faculty present. Safety can also be applied to pathways on campus and offer for a great opportunity for sustainable features.

From the literature reviewed, a proposal will be made that offers for a change to the Brightway path on Southern Illinois University Carbondale's campus. Along with these changes will be the opportunity to implement sustainable systems on campus. As with other sustainable systems, these can offer an opportunity for education and increased balance between the built and natural environment.

# CHAPTER 3

# LITERATURE REVIEW

## Research Goal 1: Urban Sustainability

When defining sustainability, it is first necessary to define its relationship to ecology. According to (Alberti and Susskind 1996), the term, sustainability, is used in ecology to indicate a condition that can be maintained indefinitely without progressive diminution of the quality. Cities have generally been thought to be a source of environmental problems at a global and regional scale, making them unsustainable in an ecological sense (Alberti and Susskind 1996). Therefore, it is necessary to address problems from their source, which would be that of urban context.

Sustainability can also be defined as the thought of equity, including economic and environmental concerns as to provide a link between biodiversity and ecosystem function, while looking at the role of humans within these ecosystems, connections made within landscapes, and resilience (Andersson 2006). When applied to economic development, the term sustainability implies the maintenance of the capacity of natural ecosystems in order to support the human population over a long term (Alberti and Susskind 1996). The interaction between the economic and social environments gives rise to specific positive and negative external effects, the positive effects stemming from accessibility to social services, such as education, health, social amenities, and jobs, and the negative effects by imposing suburbanization due to high rent, class segregation, new poverties, and inertia in social class division (Camagni and Capello and Nijkamp 1998). It is necessary to evaluate all aspects of human life and interaction. Therefore, it

is necessary to pay close attention to urban landscapes, as landscaping within urban context is equally important as the buildings themselves.

However, natural landscapes must be kept in mind as well. There are three main properties that separate urban landscapes from natural landscapes: 1) integration among urban habitat patches and communities in them. 2) Succession 3) Invasion by alien species (Niemela 1999). The places where people live and work need to be designed to offer opportunities for them to interact with the natural world (Andersson 2006). Areas of urban context can be detrimental to different species due to the fact that our increased urbanization may isolate certain species. It is therefore necessary to integrate the built environment with the natural environment.

It is important to maintain a connection between the built and natural environment because as cities grow, man-made infrastructure and buildings begin to wipe out vegetation and existing greenery. The idea of the natural world can easily be forgotten when in the center of a large city. This is a problem that needs to be addressed and planned for by increasing ecosystem processes and functions that include: increased biodiversity, habitat, soil formation, ecological memory, seed dispersal, pollination, storage and cycling of nutrients, recreational enhancement of property value, provisioning of food, water, fuel, regulating noise, temperature, pollution, and water quality (Andersson 2006). This can be done by creating connectivity, such as corridors and greenways, which will require consideration of the needs of species sensitive to fragmentation and human disturbance over the needs of introduced and opportunistic species that tolerate or thrive in urban landscapes (Niemela 1999). Along with these greenways or corridors, there should still be areas of cities that are strictly devoted to green space, such as parks. Maintenance of biodiversity from populations to ecosystems is a principle that can be very useful

in urban planning (Niemela 1999). These urban planners need to make connections between green spaces in order to allow species to live in urban context as easily as humans do.

Given how easily humans live in urban context, cities are subjected to strong human influence; and management decisions have profound implications for ecosystem function (Andersson 2006). Cities have a large urban ecological footprint which can be defined as the aggregated area functionally required to support a given city's activities (Alberti and Susskind 1996). Therefore, it is necessary to study human interactions within urban context in order to make the best decisions of how to incorporate the natural environment within the built environment to provide an overall well-balanced community. Humans in these environments have implications on other factors both regionally and globally. The relation between ecological characteristics and ecosystem services is not completely understood, because urban development is directed by human influence, but it is necessary to educate people about ecological requirements for ecosystem services in order to provide increased human well-being (Andersson 2006).

The need to establish a harmonious relationship between the man-made environment and the natural environment is evident. By dismissing the need for encompassing the natural environment within urban areas, extensive growth of the built environment can lead to consequences such as the urban heat island effect. The urban heat island effect is caused by commercial buildings and high rise multi-family units typically being taller and displaying high thermal mass and unique canyons which increase the impact on urban climate within the built environment, including: air flow above and within urban environments, atmospheric turbulence, shading and various radiation parameters such as albedo and emissivity, which are all aspects of global climate change (Golden 2004). Urban environments with high-rise buildings and large

amounts of man-made materials can have an impact on microclimate. This impact can alter temperature in certain areas and affect weather within a city. As a result, roads and rooftops absorb solar energy, causing the surface temperature of urban structures to become 50-70 degrees F higher than ambient air temperatures, which in turn can raise overall temperatures 2-8 degrees F (Golden 2004). Urban heat island effect problems can be found everywhere in urban context due to large amounts of infrastructure, buildings, and other materials that absorb and retain heat.

Combating this problem can be done by increasing the use of vegetation in urban settings. For example, planting trees around areas with large amounts of pavement can help to shade the pavement, which will reduce the amount of heat that is absorbed and released later. In addition, other solutions would include looking at newer materials that have been developed that are more reflective and help to reduce the amount of heat they retain. All of these steps combined, can help to reduce the urban heat island effect in cities and the impact the man-made environment has on ecosystems.

Along with the growth of cities and its impact on ecosystems, increases in population also have a large impact on the environment. With an annual rate of increase estimated at 2.5%, by the year 2025 it is estimated that urban population will reach 5.5 billion (Alberti and Susskind 1996). Undoubtedly, this will lead to more crowding in urban context. Although there may be congestion within urban context, it does have its benefits. According to (Gordon and Richardson 1997), high-rise buildings exist where they do only because the high costs of erecting and maintaining them were considered to be worth the economies realized through increased accessibility, communication and interaction, and the ease of face-to-face transactions. With this increase, suburbanization has become popular as many people are moving outwards from urban

areas to areas that are less dense. This displays a need to find a medium between the space that is desired in suburbs with the ease of access that comes from living within an urban context.

As cities spread outwards towards less densely populated areas such as suburbs, the need to commute into cities increases. Urban traffic in cities within developed countries is expected to grow, following suburbanization patterns, increasing the concern about traffic-generated pollutants such as particulates, nitrogen oxides, and carbon dioxide (Alberti and Susskind 1996). These have long been issues concerning the environment, but are even more prevalent now as people move outwards from cities. As people move outwards from cities, the ideal of mass transit is one that seems to make sense. However, mass transit carries only about 5% of people who commute to work, while the other 95% commute by use of automobile (Gordon and Richardson 1997).

As the trend of suburbanization continues to increase, thus does the use of vehicle traffic, specifically single person vehicles, leading to increased emissions. This is a call for urban planners to address mass transit in a way that makes it available for those in suburbs, but still at a rate that is economically feasible for city budgets.

Sustainable solutions to mass transit are a major factor for problematic infrastructure. This however, has seemingly made a leap in the right direction in many areas of the world, specifically in Bogota, Colombia. Here, local government has made a push in the last decade to make public transportation faster, easier, safer, and along with making the city itself a much safer place to move about. The mayor of Bogota explains how they developed a new method of bus transit that is very similar to a subway system, “there are routes that were developed in order to provide the necessary distribution through the city. These bus stops and bus routes were much cheaper than a subway system due to the fact that they are not below ground, which saves an

enormous amount of infrastructure and does not require nearly as much maintenance" (Urbanized 2011). This makes public transit by citizens very affordable. In addition to affordability, another unique aspect of this new bus system is the ideal of vehicular rights, stating that a bus that can transport one hundred people at a time should be entitled to one hundred times the rights of a car that is carrying one person (Urbanized 2011). Therefore, the bus lanes stand alone as separate roads that are express lanes compared to the constant traffic jams of cars on the roadways. This, along with making these new bus routes the main priority of city budget, has begun to shed light on the citizens of this city and show that public transportation is much more affordable and quicker. By focusing on the public transportation aspect, there has been detraction from streets that are filled with traffic of cars, leading to poor quality roads for single person vehicles. Maintenance of these single car use roads has been made a low priority in order to persuade these single car users to make the switch to public transportation (Urbanized 2011).

This leads into the topic of infrastructure in an economical sense. By the year 2025 there will be an estimated 486 mega-cities in the world that will all have a population of at least one million people (Choguill 1996). Therefore, it is necessary to look at infrastructure to help maintain sustainability and help the movement of people within cities to be as efficient as possible. As it is now, infrastructural provisions fail to recover the costs of providing that system because accounting systems are inefficient, payment collection systems do not work, the richer more powerful members of society refuse to pay their due through one means or another or the system itself is based on elaborate systems of subsidies from the central treasury or elsewhere and, therefore, in the strictly economic sense, run at a loss (Choguill 1996). This is true, more so, in developing countries but still needs to be evaluated for developed countries in order for all

aspects of infrastructure to run as smoothly and as efficiently as possible, while still providing all necessary services to those who live within a community.

The idea of sustainability in urban areas is a challenge brought forth by the necessity to harmoniously mesh the natural environment with the built environment. This has long been a challenge that, in hindsight, was handled in ways that have proved to not be the most sustainable solutions. Main aspects of the issues concerning the development of urban areas include the management of growing urban areas and poor or lacking successful infrastructure.

Additionally, a main challenge with urban areas is the rate of growth. Cities are growing constantly, and within the next fifty years the world will double in population in urban areas (Reuterswärd 7). As cities continue to grow, there is a constant increase in population which will grow at a much faster rate than the physical environment, causing for a constant battle in order to maintain sustainability in urban context.

**Research Goal 2: Campus Sustainability**

Many of the same issues concerning sustainability in urban settings can be applied to a college campus setting. College campuses are similar to an urban setting given the numerous amounts of people that are present in a defined area. Like an urban setting, college campuses experience the challenge of being sustainable given the large amount of energy required to operate a college campus. In his article, "Impeding Sustainability? The Ecological Footprint of Higher Education" William Rees states that there is a consensus among scientists in various fields that excess energy and material consumption is at the heart of the problem of a path of unsustainable development. Lack of sustainable development has been an ongoing issue; we (as a planet in general) exploit resources way beyond the capacity of their renewal.

The exploitation of resources has brought a turning point, "in which biophysical constraints are forcing a paradigm shift from 'empty-world' to 'full-world' economic thinking" (Rees 2003). Rees states that human demand already exceeds the long-term carrying capacity of the planet by 20 percent or more. Looking ahead, the World Business Council for Sustainable Development states, "Industrial world reductions in material throughput, energy use, and environmental degradation of over 90 percent will be required by 2040 to meet the needs of a growing world population fairly within the planet's ecological means."

Reductions of this magnitude call for a fundamental change. Those opposed to the idea of necessary action being taken to reduce impact "minimize attendant social and ecological problems, exaggerate the costs of prevention, and emphasize the potential of technology to overcome all obstacles and from this perspective, nothing short of certain catastrophe can stand in the way of continuous economic growth" (Rees 2003). As the population continues to rise there is an increasing need for advances in efficiency of materials in order to produce gains in resource productivity. A college campus presents an ideal opportunity for improvement given the constant research that takes place. Here, research can be applied to developing better techniques for making a campus sustainable, along with developing ways to reduce the current exploitation of resources.

With the increase in population and depletion of resources, there is a question of whether humans just have a nature of being unsustainable. Society has taken a path, similar to one throughout history, that involves steady growth and increasing sophistication that will ultimately lead to collapse. "Achieving ecological sustainability with social justice will require a fundamental shift in prevailing cultural – and scientific – values, beliefs, and assumptions" (Rees 2003). Rees attributes that Contemporary higher education nurtures and propagates our

prevailing growth-bound myth and, inevitably, universities and colleges are presently at cause of the sustainability crisis. The idea of being growth-bound is one that can still be present in higher education; but is simply a matter of making a transition to implementing new strategies of how to achieve this in a sustainable manner.

Like many urban settings, the main causes of the eco-footprint on university campuses are indirect energy and material consumption. "Buildings and associated infrastructure (including the physical plant of college campuses) are notoriously energy and material intensive, accounting for 40 percent of the materials and about one-third of the energy consumed by the world economy" (Rees 2003). It seems no surprise that "countries whose citizens impose the greatest per capita ecological load on the planet are the countries that have the highest levels of public and private education" (Rees 2003). As Rees states, the greatest so-called environmental problems confronting the world are the result of production and consumption processes traceable mainly to the highly urbanized, well-educated, high-income populations of developed countries.

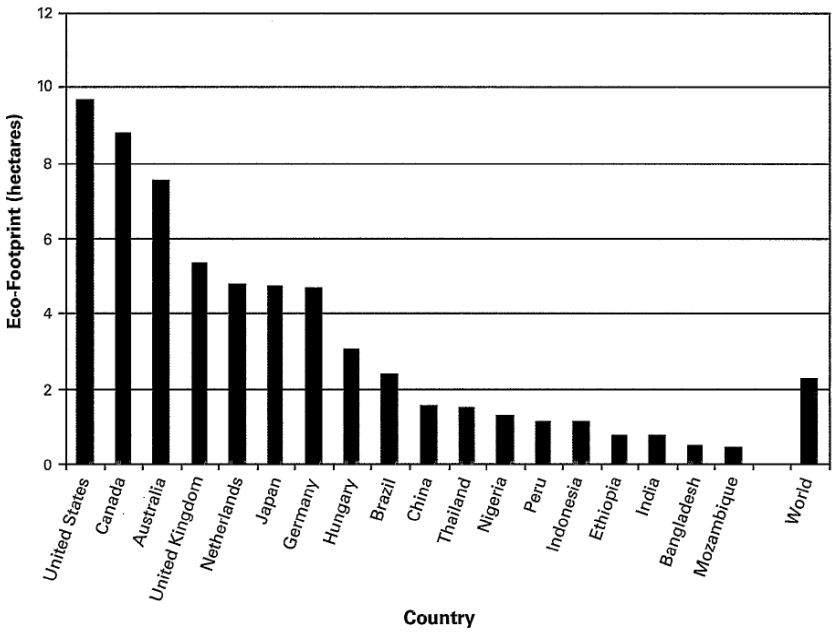


Figure 1. Per Capita Ecological Footprints of Selected Countries
Source: Worldwide Fund for Nature 2002

The problem with higher education is that "many universities seem to define their role not in terms of creating better, more intellectually aware global citizens, but rather as producing a 'product' that will help their respective nations to hone their competitive edges and maintain dynamic growth in an increasingly global market economy, higher education today actually impedes the quest for sustainability" (Rees 2003). If so, education needs to shift its plan to orienting towards creating a society founded on mutual respect, spiritual fulfillment, a cultivated compassion for all others, and a sense of participating consciousness with nature (Rees 2003). Fortunately, higher education has begun to make this shift by involving students in research projects that study sustainable systems that can be applied to college campuses.

When thinking of ways to become more sustainable, one of the biggest issues on campuses is the use of renewable energy. There are numerous sources of renewable energy, with solar energy being one of the more popular. The availability of solar energy in several parts of the United States appears to correlate well with the types of days on which summer peaking utilities experience their highest demand (Nigro 1996). By taking advantage of these days, solar energy can have many benefits for a college campus. The use of solar energy offers several different systems that can be incorporated, all of which can easily be applied to a campus setting. Grid-tied systems are systems in which solar panels are used to produce power and that power is used directly at the time it is collected. This system requires being tied to a grid in order to meet power demands when the panels are not collecting energy, most commonly during night time. However, standalone systems are completely free from any grid. They implement batteries in order to store energy that is collected at peak hours of the day when the sun is at its peak. This excess energy from peak hours is stored in batteries and can be used later. By being completely free from the grid, consumers essentially, have the opportunity to have no power bills; they

would produce all of their own power on their own site. Consumers investing in photovoltaic systems in the United States are eligible for a 10% tax credit for the purchase of these renewable systems (Nigro 1996). As of now, making the switch to renewable energy is still costly and many people choose not to make the switch due to high initial costs. However, as the costs of this mechanical system becomes more affordable, campuses can begin to implement solar power to be used both for energy on campus and as a teaching tool for students.

Along with sustainable mechanical systems, there are many practices that are already in place on college campuses that can be utilized to promote sustainability. Of these practices, many are environmental solutions. These environmental solutions can work to promote a balance between the natural and built environment on a college campus, as is the challenge for environmental sustainability in urban settings. Examples of these environmental systems include: rain gardens, permeable pavers, green walls, and green roofs.

Rain gardens offer a solution for the addition of sustainable features in an urban context, along with a campus setting. The area of Bellingham, Washington is one that is in a constant battle with the natural and built environment. Located in the Pacific Northwest, this is an area filled with huge natural forests that are experiencing erosion and pollution of streams from runoff of buildings and roads (LaCriox 2004). Here, it was necessary to come up with a solution in order to reduce the heavy impact on the natural environment. Bellingham's parking lots are a notorious location for excessive runoff that is a leading cause of this erosion. The parking lots for this project were located in an urban area that has many similar features of a campus setting, given the large amounts of pavement for roadways and sidewalks. In the early planning stages, original thoughts were to install in-ground vaults which retain water during heavy storms, as

water would run across these parking lots. However, the idea to install rain gardens versus these vaults reduced construction costs by 75 – 80 percent (LaCroix 2004).

The installation of this project included two parking lots, one allocating a 550 square foot section for a rain garden; the other allocating three parking spaces of a lot of 60 spaces to be converted (LaCroix 2004). Both sites excavated to a depth of 3-4 feet for the depth of the rain garden. Next, a non-woven geotextile fabric was used at the bottom with 6 inches of drain rock on top (LaCroix 2004). From here, three more layers of drain rock, along with fabric were alternated to account for about half the depth of the rain garden (LaCroix 2004). The final layer of rock was covered with fabric to separate it from the soil along with a 24 inch layer of sand (LaCroix 2004). It was decided that native plants would be planted on top of the garden to help slow the rain moving across the pavement and provide an aesthetic feature to each of the sites. The sites were then analyzed for ways to reduce hydrologic impact. At the conclusion of the hydraulic impact study, one site incorporated a drain pipe connected to a storm sewer in case of a heavy rain that could drain from the garden, reducing the amount of runoff going straight into sewer systems (LaCroix 2004).

Soil analysis was conducted to determine infiltration capability in order to protect groundwater from pollution. The choice for native plants was based on the low maintenance required. Additionally, native plants reduce the amount of weeds that will be present along with the use of mulch on top, again requiring little maintenance. The only issue with using mulch is the possibility of inhibiting the filtration process during a heavy rain. Upon completion, total cost for both rain gardens came in around $19,000 (LaCroix 2004). In conclusion, this project seems to be extremely successful in the fact that it is reducing the runoff pollution into nearby streams which in turn will improve water quality for the streams themselves. Likewise, it also

provides a break in the constant built environment of parking lots, combing the natural environment with the built environment.

Permeable pavers also offer a great solution for sustainability, especially on college campuses. A project by Brown Sardina Landscape Architects and Nitsch Engineering Collaborating at Stonehill College in Easton, Massachusetts makes for a perfect example of how to properly use permeable pavers. The challenge brought forth by this project was to create a public/circulation space for this college campus after the completion of a new science center. Adjacent to the new science center, the quadrangle unified the college's existing landscape but provided a challenge to create a sustainable space that required an expansive plaza area for seasonal events (Foley 2013). Challenges included a plan for event electrical requirements and permanent anchorages for a major tent canopy (Foley 2013). The initial design for this space called for a bituminous-set clay brick over a reinforced concrete slab (Foley 2013). However, this would require area drains to be conveyed to a subsurface recharge system (Foley 2013). Many of these factors put the project way over budget. Upon deciding to use permeable pavers, the savings associated with the project was around 34 percent (Foley 2013). Additionally, the decision to use permeable pavers came from examination of site subgrade infiltration rates and an overall storm water strategy to prevent runoff that would otherwise be generated by such a large expanse of solid pavement (Foley 2013). Multiple additions were also made to the site, including: campus standard light fixtures, metal tables offering unique viewpoints to the beauty of the South Quad, as well as New England field stone seating walls (Foley 2013). The plaza was constructed of approximately 20,000 square feet of Eco-Priora permeable unit pavers manufactured by Unilock (Foley 2013). The units were laid in 5" x 10" and 10" x 10" units made of custom colors (Foley 2013). This project is a great example of how college campuses

can make the switch to going green and save money doing it. This project will provide a great outdoor space for multi-use and, with such a large amount of pavement; it will reduce the amount of runoff and pollution for adjacent green spaces. This was a successful project for the campus at Stonehill College that can set an example for other campuses.

Green walls are a fairly new idea in the sustainability world but are gaining popularity rapidly. A project at the Vancouver International Airport provides a great example of the practical and aesthetic uses of green walls. The goal of this project at the Vancouver International Airport was to offer a visual display of art and architecture. Located at a terminal at the airport, this wall represents the Coastal Mountains, which it faces to the north, with a pixilated pattern used to reflect the image of the mountains through the use of plants as part of this 50 foot high wall (Sharp 2009). Among others, this terminal makes up a collection of terminals that represent the culture heritage, natural beauty, and iconic experiences that embody British Columbia (Sharp 2009). Randy Sharp of Sharp + Diamond Landscape Architects, along with GSky, were responsible for the design of the panels and plants that were used on the wall. In order to ensure their success in the environment, the panels had plants grown into them for several months (Sharp 2009). Additionally, special consideration needed to be taken for the types of plants also due to the fact that this was a north facing wall that experienced heavy wind conditions.

From a functional aspect, the use of a green wall on a north facing wall provides extra insulation for the terminal which reduces heating costs for the terminal (Sharp 2009). The installation of the project took a total of 20 days and since it is located in a freezing climate zone, it has the GSky Irrigation Automated Winterization and Recharging system installed (Sharp 2009). Any major maintenance is done from the transition from the winter to summer season

(Sharp 2009). However, maintenance is somewhat difficult considering the height of the wall and requires a lift and several hours each time it is maintained (Sharp 2009). Given special consideration, the plants used for the project included: euonymus, japonicus, microphyllus, albovariegatus, polypodium, glycrrhiza, ophiopogon, and japonicus nanus (Sharp 2009). This project provides an example of how environmental sustainable systems can offer both an aesthetic and practical function.

Green roofs are another sustainable system that have gained popularity recently. Butler College, located on Princeton University's campus is now home to a dormitory with a green roof (MacPherson 2009). In addition to their function, green roofs provide an excellent teaching tool by allowing faculty and students to use an integrated monitoring system of sensors within roof layers which was designed to compare energy performance and storm water runoff of the green roof versus conventional roofs (MacPherson 2009). "It also makes the roof complex a living laboratory by feeding data through an Ethernet connection to computers on the ground for processing and storage" (MacPherson 2009). This will help the university monitor how much energy can be conserved using a green roof instead of a conventional roof. "Faculty and students installed instruments to measure heat flux, soil moisture, and temperature" (MacPherson 2009).

By measuring these many factors, many benefits can be provided through the information obtained. "The measurements will provide the basis for research on storm water runoff – how the quantity and quality of the water coming off the green roofs might improve the water quality and ecological balance across the University, in Lake Carnegie and throughout the local watershed" (MacPherson 2009). The data collected will be used with models to track energy efficiency of the green roof and can help for future decisions about green roof retrofitting and construction (Macpherson 2009). "Real-time data, including infrared measurements contrasting

the surface temperatures of the green and conventional roofs, will be transmitted and displayed on a new website that is under development" (Macpherson 2009).

Along with the educational opportunities, there are multiple benefits that come from installing a green roof, including: storm water runoff, energy efficiency, air quality, habitat and biodiversity, temperature, and roof life expectancy (MacPherson 2009). Green roofs help to absorb storm water run-off and filter out nitrates, phosphourous and other rain borne pollutants and excess storm water not used by plants is released more slowly, helping to reduce soil erosion and flooding (MacPherson 2009). Green roof systems are designed to reduce storm water run-off by up to 50-90% and can retain four times the amount of rainfall compared to a more conventional roof" (MacPherson 2009).

Green roofs act to insulate the building, in turn reducing summer cooling and winter heating costs (MacPherson 2009). Additionally, "Green roofs help reduce dust and pollution levels by absorbing air borne contaminates and adding oxygen back into the atmosphere" (MacPherson 2009). Aside from pollution, green roofs reduce the impact heat has on the building. The difference in temperature between city and rural environments is due, in part, to the predominance of concrete, asphalt and other hard surfaces found in cities. These types of hard surfaces act to absorb solar radiation and heat up the surrounding temperature. In helping to reduce the amount of hard surface, green roofs can contribute to a reduction of local air temperatures" (MacPherson 2009). "The plant and soil cover on a green roof acts to protect the underlying waterproofing components from temperature extremes, UV degradation and other damage potentially extending the life of the roof by 10-20 years" (MacPherson 2009).

Any of these environmental solutions to sustainability can benefit an urban or campus setting. With the built environment having such a strong presence in the two, these systems

provide a solution to the problems associated with ecosystems in urban settings, which can then be applied to a campus setting. By choosing environmental systems, they can work hand in hand with sustainable products and materials in order to achieve sustainability in many facets on a college campus.

**Research Goal 3: Campus Lighting/Pathways**

Exterior lighting provides a great opportunity to incorporate sustainability in a built sense that can compliment environmental sustainable features. However, exterior lighting on the campus of Southern Illinois University Carbondale is a large aspect of sustainable development that has not been evaluated. By evaluating the current lighting on the campus of Southern Illinois University Carbondale, the University will be able to lower the impact on the environment by establishing more efficient lighting systems. By doing so, this can provide an opportunity to reduce the amount of electricity needed to run lighting throughout the campus. In turn, this will reduce the amount of capital that is spent on maintenance of these lighting systems and the energy needed. If accomplished, social interaction on campus could be increased on campus during night hours or hours of low natural light by providing a sense of security for students and faculty moving throughout campus.

For comparison, a major study of exterior lighting was performed at Kansas State University and can be used to help make decisions on Southern Illinois University Carbondale's campus. This study evaluates exterior lighting at Kansas State University in all aspects. In regards to exterior lighting, Kansas State has issues with many walkways that need to be properly lit at night time hours. Similarly, Southern Illinois University Carbondale has many of

the same issues, including a number of paths that wind through campus and around wooded areas that are poorly lit at times.

Therefore, it is necessary to address these areas in order to provide a more secure feeling for those travelling on campus. With safety as a main concern, Kansas State made their exterior lighting project such a large scale because of the importance they feel of being able to move throughout campus at any time of the day without the threat of debris or other concerns for the well-being of those moving about campus. Likewise, Southern Illinois University Carbondale is among a large wooded area where debris and the safety of those walking is of concern. Therefore, campus lighting for Southern Illinois University Carbondale needs to be among top priorities, given the fact of the size of the campus and the presence of Thompson Woods. Although students are encouraged to not walk through the woods at night there are still many who do, and the safety of these students needs to be addressed. Due to the fact that Southern Illinois University Carbondale is not in an extremely urban setting hinders the ability to be well lit from surrounding light given off from other buildings and public lighting. Therefore, it is the responsibility of the University to make sure that all areas of campus are properly lit while still maintaining a mind set of sustainable development.

Again, safety is the main concern for those who are on any campus during hours where day light is not present. The main purpose of lighting walkways on college campuses is to provide safety for its occupants as they must be able to identify hazards in order to be able to take action to avoid them (Matlack 2009). As Matlack states, "These hazards can include non-level or sloped parts of the walkway, debris or objects on and around the walkway, and people on or near the walkway." This creates the need for multiple aspects of lighting, both vertical and horizontal, in order to provide a uniformity of light to make paths and surrounding areas visible

to those walking on the path. In order to obtain the same level of comfort and security for students and faculty, these same measures need to be taken and evaluated at Southern Illinois University Carbondale.

In addition to safety, the economic factor associated with exterior lighting analysis will draw attention. Within economic analysis, demolition and installation costs need to be evaluated. Also, cost of new fixtures and the cost to maintain these new systems have to be taken into account as well. Aside from cost, new systems will be more efficient and with the increasingly popularity of LED lighting, will reduce the amount of maintenance necessary for new systems. As of now, one of the major costs currently associated with lighting on Southern Illinois University Carbondale's campus is the maintenance required to keep lights on.

According to Matlack, the best fixture for Kansas State University is a Beta LED round fixture. The following is a table of cost analysis, provided by Matlack for Beta LED lighting round fixtures found to be most appropriate for Kansas State University.

Table 1. Light Fixtures Contractor Cost Quote

| Fixture Type | No. | Cost Per Fixture | Total Cost |
|---|---|---|---|
| T5-6 | 2 | $2,075 | $4,150 |
| T5-3 | 1 | $1,535 | $1,535 |
| T5-2 | 4 | $1,375 | $5,500 |
| T4-4 | 2 | $1,720 | $3,440 |
| T3-5 | 1 | $1,920 | $1,920 |
| T3-4 | 2 | $1,720 | $3,440 |
| T3-2 | 10 | $1,375 | $13,750 |
| T2-4 | 1 | $1,720 | $1,720 |
| T2-3 | 1 | $1,535 | $1,535 |
| T2-2 | 4 | $1,375 | $5,500 |
| **Total Cost:** | **28** | **$1,517.50[2]** | **$42,490** |

1. All cost information used in this table was provide by Dan Sanders, Premier Lighting and Controls, Lenexa, KS
2. Average cost of all fixtures.

Source: Matlack 2009.

Although Kansas State University is larger than Southern Illinois University Carbondale this is a useful comparison given that the campus of Southern Illinois University Carbondale has more areas that require exterior lighting, with this university being located in a more rural setting and having large wooded areas that require more lighting.

Additionally, measures can be taken to evaluate current lighting and in order to determine the best type of lighting for an area. "This can be done by identifying the type of luminaire that is used for a specific light fixture and addressing the specifications indicated by a manufacturer. The type of lamp plays a large role in this part, whether it is a vertical lamp, horizontal lamp, etc." (Bakr 2007). In doing so, a major way to measure light is through a photometric survey. Bakr states that this is done through using a luminaire meter which responds to artificial illumination and determines any vertical changes of light illumination. Accordingly, testing

using this method is most effective when readings are conducted both one hour before sunrise and one hour after sunset.

According to Matlack's research, this lighting system, although a somewhat large initial investment, proves to be cost effective in that LED lighting systems do not require a ballast. The presence of a ballast accounts for the largest part of maintenance with lighting systems. Also, LED lights have a lifetime of 50,000 hours, compared to standard ballast lighting which is often less than 10,000 hours (Matlack 2009). Therefore, savings can be accrued through the reduction of maintenance needed, alone. By switching to LED fixtures, maintenance costs will be reduced by up to five times based on light life. For these LED fixtures, 50,000 hours of life has an average lifespan of 10 years of use (Matlack 2009). This already begins to show a large savings that can be obtained simply by changing the types of fixtures used.

Aside from cost, one of the biggest environmental factors associated with lighting is energy consumption. "Lighting systems in the United States account for 1 to 2.5 tons of carbon dioxide emissions annually, depending on the fuel source used to power lighting systems. The most common source of energy used is the burning of coal" (Ming 2009). According to Ming, nine percent of electricity used each year in the United States is from lighting and if all lights in the United States were turned off for one hour during nighttime hours, energy consumption could be cut from nine percent to five percent. This shows an obvious flaw in lighting systems throughout the United States. However, by switching to LED systems, lighting energy use can be greatly reduced which will help with carbon output, and reduce the impact on the environment. Recently, LEDs have become more popular as they can produce the same type of light as other fixtures but require far less energy to do so, making them the obvious choice.

Along with energy consumption, another aspect when considering environmental factors is light pollution. The biggest part of light pollution is called sky glow. Sky glow is caused from light being reflected from the ground and scattering in air molecules, water vapor, dust, and other suspended particles in the air, states Ming. In addition to sky glow, light scatter at low angles is caused by reflection from the ground and can be influenced by the types of materials used on pathways, such as the type of finish on concrete or asphalt (Ming 2009). Light scatter that is cast at a higher angle is caused by pollution or particles in the air (Ming 2009). "Light pollution can be reduced to appropriate levels by lighting only what needs to be lighted and only at times that are required (Ming 2009). As a solution, using luminosity to measure the amount of light emitted from a fixture can be determine what actual amount of light is needed to maintain a presence of safety for a given area (Ming 2009). By calculating what amount of light is necessary for campus, light pollution can be reduced which will reduce haziness on pathways and maintain a crisp, clear, well-lit path.

In addition to lighting, it is necessary to rethink the campus landscape. Here, it is important to understand and integrate student perspectives in campus design and development. For example, within the study context of students surveyed at a Toronto university, water use across the campus landscape is now being completely re-envisioned in ways that mange water application and water flow across the landscape, thanks to the information provided by the students. The information provided by students has led to a new integrated storm water plan "which aims to reduce the amount of water runoff entering municipal storm drains by reducing the amount of non-permeable surfaces on campus, creating green roofs on new buildings, and creating natural and engineered water detention facilities" (Castleden 2011). For this study done by the Toronto university, images were given to students and they were asked to rank current

landscape conditions on campus versus a picture of potential ideas for green areas.

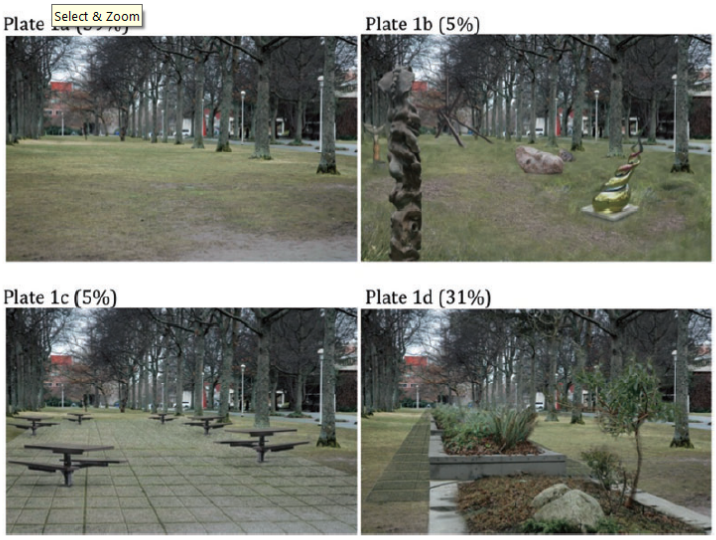


Plate 1 Landscape images from grassy location with irrigation


Plate 2 Landscape images from grassy location with irrigation

Figure 2. Evaluating Outdoor Green Space
Source: Casetleden 2011

The results of this study indicate that the current landscape could be improved by increasing native plant species, vegetation, adding community gardens and green spaces on campus, while decreasing the amount of grass and removing harmful invasive species in order to provide a better outdoor space (Castleden 2011). "Using prospective landscape scenarios to

identify values can be an effective tool for planners to understand how stakeholders currently value and utilize the campus landscape as well as their visions for any change" (Castleden 2011).

Another example of using student input for evaluation was done at Claremont College, where students were asked to rate the landscapes of their campus. In doing this, there are a variety of ways to measure perceptions about the aesthetic and functional qualities of the landscape, as well as ecological ones (Marcus 2008). Within this study, students were given a two item rating system of the aesthetic and ecological character of the campus, several items measuring desire to see more or less various landscaping features, and a measure asking participants to grade the sustainability of current landscaping practices (Marcus 2008).

From the results, there were suggestions to have less large grassy areas and to replace them with: more environmentally friendly vegetation, more native, drought resistant trees and plants, focus heavily on using less water, (replacing grass was a wonderful way to save water) (Marcus 2008). Respondents also believed that sustainable landscapes were attractive and the most pleasing landscapes would include a lot of other low water vegetation like succulents (Marcus 2008). Additionally, "xeriscaping could be used to shape and form the landscape such that any water used can be redirected and recollected" (Marcus 2008). Along with these, there were also many suggestions for additional spaces to be added: more outdoor areas for study, relaxation, socialization, planned areas with lots of shade, native vegetation, places to sit, a need to be more pedestrian friendly, less focus on pavement and concrete, and more fountains to improve the peaceful and serene quality of a landscape (Marcus 2008).

Table 2. Desires to see more or less landscaping features on campus

| | Less/Fewer | Leave As Is | More/Greater |
|---|---|---|---|
| 1. Trees that are native to the local area | 0.6% | 12.1% | 57.1% |
| 2. All trees (including native and non-native) | 2.9% | 31.1% | 34.9% |
| 3. Plants and shrubs that are native to the local area | 0.3% | 12.1% | 58.7% |
| 4. All plants and shrubs (including native and non-native) | 4.4% | 34.3% | 29.2% |
| 5. Drought resistant vegetation | 0.6% | 11.4% | 57.1% |
| 6. Open grassy-areas (excluding sports fields) | 19.0% | 30.2% | 22.2% |
| 7. Sports and fitness fields | 9.2% | 45.1% | 14.6% |
| 8. Recreation areas like picnic sites | 3.2% | 33.3% | 34.3% |
| 9. Outdoor entertainment areas where I can see theatre and concerts | 2.2% | 28.9% | 38.1% |
| 10. Pavement | 34.9% | 33.3% | 1.9% |
| 11. Outdoor classrooms | 4.1% | 22.5% | 41.6% |
| 12. Specialized outdoor areas like the organic farm and the arboretum | 2.5% | 21.0% | 45.7% |
| 13. Buildings | 5.7% | 49.8% | 12.1% |

Note: Sample sizes (n) range from 213 to 225. Row totals will not equal 100% due to a missing response rate of 28.6% to 32.4% of each item.

Source: Marcus 2008.

Similarly, these thoughts can be used when thinking of Southern Illinois University Carbondale's Brightway path and the open and green spaces along the path. Areas along the path provide an opportunity for incorporating many of these features. The proposal for Southern Illinois University in Chapter 4 is based on this part of the literature focusing on student perspectives of outdoor spaces. Given there are many similarities of students on different college campuses, these ideas have been incorporated into the design proposal for green space along the Brightway path.

Additionally, a perfect example of addressing outdoor spaces, specifically walkways on campus is taking place at Evergreen University. Here, Evergreen University is implementing a forest canopy on its campus. "This walkway would line existing structures with an aboreal pod that would create opportunities for education, research, conservation collaboration, and community involvement. The purpose of the canopy walkway would be to benefit not only

students, staff, and faculty, but also to serve as an educational resource for area schools and community groups. The walkways would create active teaching and learning about the sustainability of the forest and its contributions to health and future generations. Research conducted would provide scientific data and encourage conservation of our forests to promote change in attitudes and inspire appreciation for the forest and its sustainability. Planning efforts are already underway, receiving support from forest groups, youth groups, senior citizen organizations, public schools, and Evergreen students. Currently, the project is seeking funds to support design, construction, and maintenance costs" (Evergreen State College 2005).

Many of these considerations and features can be taken into account for Southern Illinois University Carbondale. Given the extensive amounts of green space along the Brightway path, there are endless opportunities for developing these spaces. By doing so, these green spaces would benefit all who travel throughout campus in many was similar to what other campuses have done.

# CHAPTER 4

## SOUTHERN ILLINOIS UNIVERSITY CARBONDALE PROPOSAL

From the literature review, a proposal can be made for green space along the Brightway path at Southern Illinois University Carbondale. Research within the literature review has given an overview of sustainable systems and how they are implemented. From here, the main focus can be to develop better practices for exterior lighting and pathways on college campuses, specifically Southern Illinois University Carbondale.

Research done within the literature review can be used to help analyze data of current lighting systems and other sustainable systems used on campuses. Through this research, Southern Illinois University Carbondale can begin to address the needs of exterior lighting on campus, along with attention needed for pathways.

With pathways being an opportunity for sustainable development at Southern Illinois University Carbondale, it would make sense to evaluate the Brightway path on campus. As a main path through campus for students who live in dormitories, there is a need to maintain a level of safety. By revitalizing this path it will provide for a safe means of foot travel throughout campus, increasing safety. Also, it makes for a great opportunity to incorporate sustainable systems on campus that can increase awareness of human impact and sustainability as a whole and make a push for others to take action on campus.

With the Brightway path in mind, information from the literature review can help to form a proposal for Southern Illinois University Carbondale and changes that can be made to an area of the Brightway path. These changes will incorporate sustainable systems and provide an aesthetic value to the campus. Given the information about student perspectives of outdoor spaces and their desire to see more sustainable features incorporated into campus green spaces, I

made the following design proposal for a section of the Brightway path. This design proposal incorporates sustainable features, along with green features that many students from different Universities wish to see on their campus.

## Design Concepts

Table 3. Design Concepts

**Goal:**

To offer a safe pathway through campus for foot traffic as well as an outdoor area for study and leisure between classes.

**Objectives:**

- Make connection between new sports facilities and the rest of campus
- Offer outdoor study areas for students
- Provide seating for students and faculty between classes
- Provide views to new sports facilities to help draw student population to sporting events
- Provide more attractive means of access between different areas of campus in general vicinity
- Provide a space that makes distance between buildings in this area seem closer together as there is a large distance between them
- Implement water feature to help drown out sounds of traffic on adjacent road

**Design Statement:**

The goal of this design is to develop a portion of the Brightway path throughout Southern Illinois University's campus that provides safe and enjoyable movement through campus. This pathway/outdoor space will help to make a connection between Saluki Way, a recent project started in athletics that is intended to connect the new sport facilities to the rest of the campus. This space, southeast of Neckers would provide a wonderful connection between these new sports facilities to the rest of campus as well as providing a staple artery through campus that students can use for foot traffic and a place for students gather between classes. The addition of a water feature on this site would provide not only aesthetic value but would help to eliminate

the sounds of car traffic along with the constant sounds of the Saluki Express as there is a main bus stop nearby.

Table 4. Inventory & Analysis of Site

| Inventory & Analysis of Site | |
|---|---|
| **Inventory** | **Analysis** |
| **Location - Brightway Path** | |
| 1. College Campus | Many users throughout day |
| 2. High traffic between classes | High use and down time |
| 3. Frequent Use | Seating and common areas |
| **Natural Features** | |
| 1. Topography | |
| a. Slightly sloped | Good for seating/gathering areas |
| b. Slopes to Southeast | Water will drain to main road |
| 2. Soil | |
| a. Native and backfill | Undistrurbed |
| 3. Existing Vegetation | |
| a. Variety of trees | Mild shading of site |
| b. Evergreens to NW of site | Help to block winter winds |
| c. Existing grass | |
| d. Shrubs along sidewalks | |
| 4. Climate | |
| a. Filled with sun throughout | Low watering for plants |
| b. Well established trees | Provide shade to site |
| 5. Unique Features | |
| a. Existing sidewalks | Provide movement |
| b. Adjacent Roads | Visual Intrigue |
| c. Sports facilities | Make connection to campus |
| d. Open areas | Views to and from sports facilities |
| **Architectural Features** | |
| 1. Buildings | |
| a. Existing | Classrooms/views to site |
| b. Office buildings | Sports facilities/ views to site |
| 2. Use | |
| a. Neckers | |
| b. Area of high movement | Provide safe means of travel |
| c. Use by univ. and community | |
| **Intended use of space** | |
| 1. College students/community | Provide studious culture |
| 2. Public space | Pedestrian friendly |

**Design Proposal**

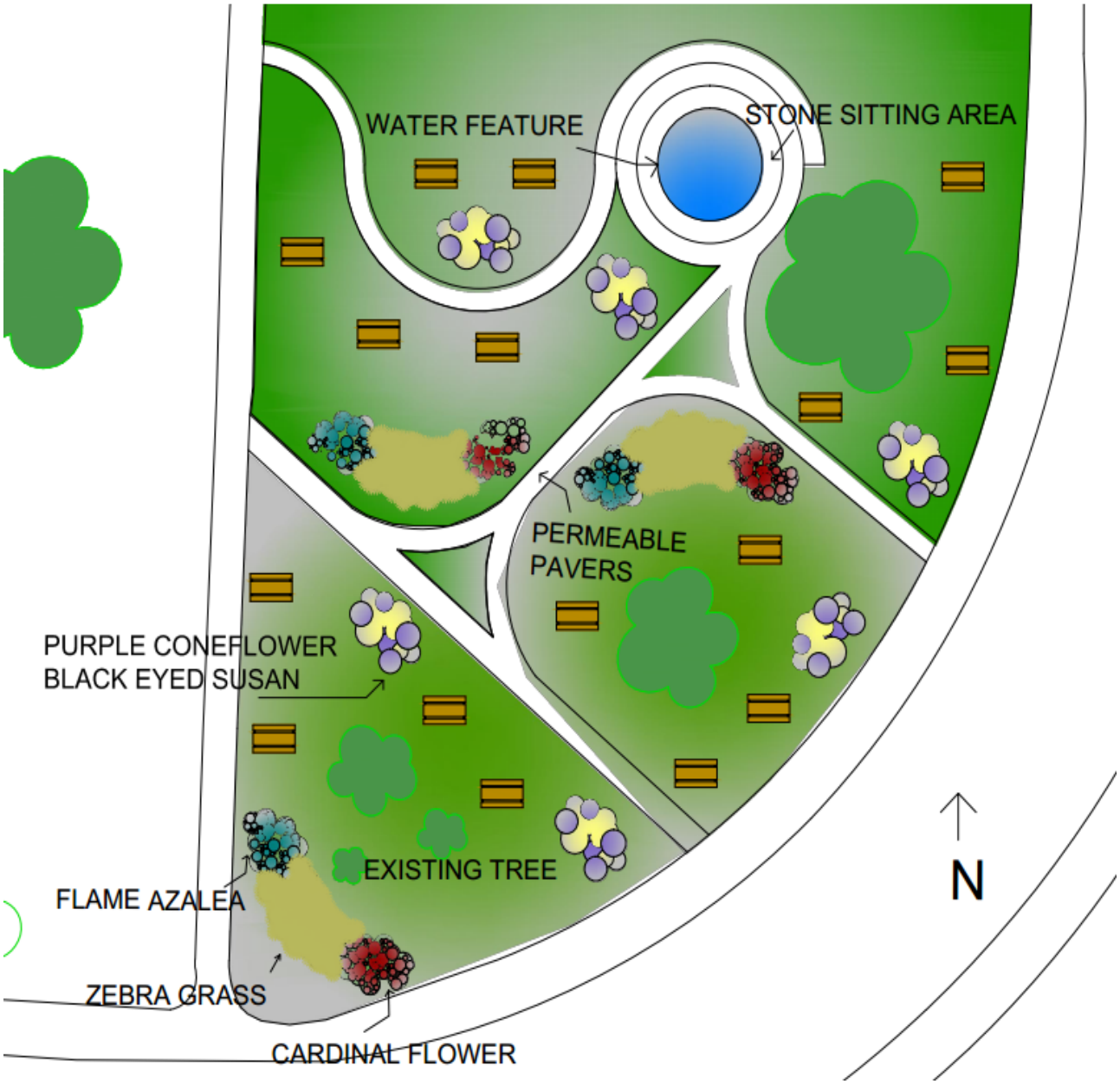


Figure 3. Design Proposal: This proposed design is for a section along the Brightway path that will offer sustainable outdoor features along with green space that is desired by many students. The use of native plants provides a sustainable alternative to green space versus simply using grass. The water feature and sitting areas help to increase social interaction, the desires of many students from several campuses in the literature review in Chapter 3.
Source: Design by Michael Holst, PSAS 480.

# CHAPTER 5

# CONCLUSION

Sustainability in the built environment is an issue that will take stronghold during the future. Sustainable systems make for an ongoing solution that can make the relationship between the built and natural environment manageable. Humans have a large impact on the earth in many ways and finding solutions to better live in harmony with the built and natural environment is essential.

As the built environment continues to grow, sustainable solutions are necessary in order to maintain the natural environment. Sustainable solutions can and are being put into place in urban environments that make for a more sustainable environment. Of the solutions discussed in the literature review, almost all can be applied to a college campus setting. College campuses are very similar to urban context and provide a great starting point for sustainable development through systems and education.

Through the literature review, it can be seen that there are great beginning steps towards making campuses more sustainable. However, a large part of sustainability comes from human participation. Along with education, Southern Illinois University Carbondale's campus can begin to make a more tangible step towards sustainability. A large part of this can be achieved through the Brightway path on campus. This path is a great opportunity for built and environmental sustainable features as well as the opportunity to provide a safer means of travel for all on campus. This is not a onetime solution, but an ongoing process that must be instilled throughout the campus in order to achieve a sustainable campus.

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Major Professor: Dr. Leslie Duram