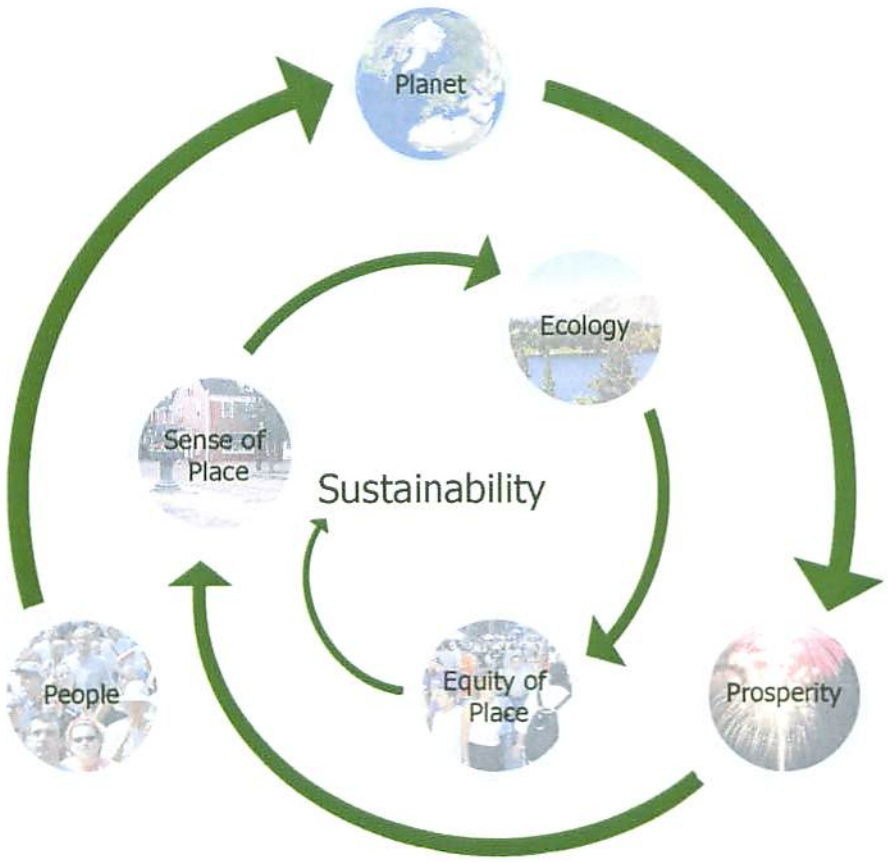
Enhancing Sustainability by spinning green into a grey infrastructure:

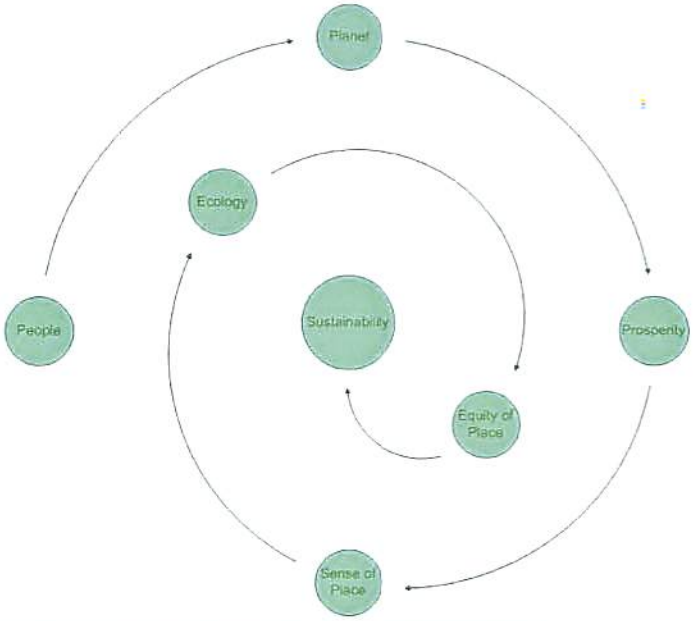
The design of parks and greenways in a community's fabric



Background and Problem Definition

In today's world sustainability is becoming increasingly important. Human development is steadily consuming open space and encroaching upon already scarce wildlife habitat. Increased flooding is occurring in urban areas where permeable surfaces are limited and miles of concrete are the norm. Quality of life issues and the availability of recreational opportunities are becoming increasingly important to people, especially in urban areas where the hectic pace of life is contributing to stress. Traffic jams and freeway congestion are increasingly common, while opportunities for non-motorized transportation such as greenways and bike lanes are rarely provided. Shopping centers that are located adjacent to each other do not have connected parking lots and neighbors who share a back fence cannot get to their neighbor's house without getting in their car and driving out of their gated community and into the other gated community. All of these issues can be attributed to a disconnected, unsustainable development process that focuses on the traditional idea of the most efficient use of space.

In response to these concerns and other environmental degradation problems, the Environmental Protection Agency sponsors a student design competition, P3, which is based upon the principles of People, Prosperity and the Planet. The purpose of the competition, to foster design of sustainable technologies that integrates the three principles and seeks a balance between the three equally important components, can be correlated with the three tenets of sustainability. It is imperative that environmental conditions of the planet be valued and actions be taken to reduce the amount of impact humans have on the environment. At the same time, however, humans' needs are equally as important as environmental health. From as basic as food and shelter to as complex as preservation of cultural practices to quality of life issues, people need to experience prosperity as a human race while sustaining this planet in perpetuity. The notion of sustainability, "to meet the needs of the present without compromising the ability of future generations to meet their own needs", can be addressed through three main characteristics or components; Ecological Characteristics, Sense of Place, and Equity of Place[i].



The Ecological component of sustainability requires a balance between open space and corresponding issues such as wildlife habitat, flood control, and air filtration, and infrastructure such as transportation, buildings and housing. Encouraging behaviors that conserve resources is also an integral factor in the Ecological component of sustainability. Implementing green infrastructure and creating connectivity among green places thus creates and or maintains wildlife habitat and wildlife corridors for species to move along as well as aids in flood control and erosion abatement due to additional permeable surfaces. The addition of green infrastructure to a community also aids in air pollution reduction because of the filtration capabilities of trees as well as providing opportunities for non-motorized transportation, which in effect reduces air pollution.

The second component of sustainability is Sense of Place. Sense of Place can be characterized as the history, culture or meaning of a place to the citizens and visitors who reside or visit there. Historic buildings, public plazas, parks, art pieces and memorials are all factors that contribute to a community's sense of place. The visual quality of communities also contributes to its sense of place and is an important factor to consider when discussing connectivity and green infrastructure. The addition of green infrastructure not only enhances the visual quality of a community, but also enhances the quality of life by providing places for recreational opportunities. In addition, the obesity epidemic in America can be counteracted by providing green infrastructure and connectivity in communities so that people can live healthy, active lifestyles by engaging in recreational activities such as walking or jogging, or perhaps even biking or walking to the local supermarket instead of driving. A focus on connectivity in a community also enhances sense of place by linking people and places together to create a stronger community.

Equity of Place is the third component of sustainability and is focused on including citizens in change and providing equitable access to places. Research has shown that neighborhoods with high minority populations and areas of lower socio-economic statuses have shouldered the brunt of environmental degradation and toxic pollution[ii]. It is imperative that all people have healthy environments to live in and have access to green spaces such as parks and greenways for recreational opportunities as well as for non-motorized transportation opportunities. Opportunities for non-motorized transportation are vitally important, not only in upscale suburban areas, but also in areas characterized by lower socioeconomic status, where biking or walking may be the only way people can get to their place of employment. Including people in change, especially in environmental matters, is especially important for equity of place. Citizens should have a say and be involved in the planning process for parks and other green infrastructure, as well as be actively engaged in the care-taking of the green spaces such as in neighborhood watch groups or volunteer gardening clubs. Through involvement, not only are citizens guaranteed equity of place, but they are also strengthening community ties and enhancing the community's sense of place.

Economics also are an integral component in sustainability and prosperity of people and the planet. Implementing green infrastructure not only beautifies the community aesthetically, but also has a positive economic impact. Many studies have addressed the economic impact of parks and open space on individual property values as well as the economic impact at larger scales such as the community, city and state

levels[iii]. Consistently, these studies confirm that parks, open space and other green infrastructure positively impact property values of homes facing onto, bordering, or near green space. Additionally, the economic impact of something like a state park system, has a profound impact upon the state's economy because of the amount of visitors that visit these areas and spend money in the parks themselves, and in the surrounding local communities.

Connectivity is an additional notion that is a critical component of each of the three characteristics of sustainability. Increasing connectivity and implementing green in the gray infrastructure is an important step towards sustainability that addresses the challenges of the developed world as well as the developing world. Increasing connectivity of vehicular roadway networks, park and open space networks, greenway and bike route networks, and community and cultural networks all contribute to sustainability in that they advance the convergence of people, prosperity and the planet in equitable harmony.

There is a lack of connectivity in modern urban areas, and a general misconception of the value of green infrastructure economically, aesthetically, and ecologically. Development continues to occur haphazardly and unconnected in many areas, even where some policy and development standards exist. Specific policy directing development, promoting connectivity, and incorporating green infrastructure is needed for planners and developers to make appropriate, sustainable decisions. These types of policies can be in the form of streetscape ordinances, park land dedications, greenway dedications, connectivity indices, required connectivity easements and other general policy regulations.

Purpose and Objectives

The purpose of this project was to analyze current public policy dealing with transportation and connectivity issues in College Station, Texas and develop specific policy language and/or tools that would address these challenges through implementation of green infrastructure. To do this, students conducted a case study that examined how stakeholders in this community influence the development of policy and facilities related to parks and greenways at the local level, and learned how citizen use of such places relates to environmental and social quality in the community. Students worked in collaboration with the City of College Station Office of Planning and Development, and the city's existing Greenways Program to understand existing policies related to the development of greenways, and to inform the development of new policies that support sustainability as the city updates its comprehensive plan for development and zoning.

The incorporation of greenways into the grey infrastructure of a community is one means of improving that community's environmental, social, economic, and cultural milieu. Greenways have a demonstrated ability to enhance the sustainability of a community by such mechanisms as:

- Connecting neighborhoods
- Easing automobile congestion by providing a venue for alternative transportation

- Providing sites for community gatherings for social and cultural events
- Enhancing property values
- Protecting natural habitats and corridors for safe movement of wildlife
- Generating tourism based on enjoyment of nature

The major goal of this project was to provide a capstone planning experience in community sustainability for undergraduate majors in the Department of Recreation, Park and Tourism Sciences at Texas A&M University. Additionally, one student from the Department of Landscape Architecture and one graduate student from the Department of Recreation, Park and Tourism Sciences were recruited to join the team for their respective technical expertise. Students were asked to implement their ability to:

- Recognize existing and future challenges to community sustainability
- Understand the consequences of those challenges to the environment and society
- Develop innovative policy and design greenway-based solutions to those challenges that will provide environmental, economic, social and cultural benefits
- Understand the impact of these solutions on the sustainability and livability of the community
- Demonstrate the broad applicability of these principles to other communities and locations

This project allowed students to participate in conceptualizing, designing, and demonstrating a greenway-based solution to the problems associated with sprawl and the spread of a grey infrastructure. It offered students meaningful experience in developing public policies that enhance the sustainability of community-scale environment, economy, society and culture.

To meet the goals stated above, the following objectives were identified and are discussed here.

- Gathering Information
- Developing Recommendations
- Developing Example Policies and Green Infrastructure Designs

Gathering Information

In the information gathering stage students researched green infrastructure policy in other cities and sought out examples of model communities that have successfully incorporated green into the grey infrastructure. One key greenway in the city of College Station was identified, the Wolf Pen Creek Greenway, as was the community of The Woodlands, Texas as keystone examples of a greenway and a green community to be studied. Both sites were visited on day field trips, and in the case of The Woodlands community, discussions of connectivity, green infrastructure and policy matters occurred with key employees in the Park Planning Department.

In addition, three members of the P3 design team accompanied the faculty advisor to the 5th Annual New Partners for Smart Growth Conference: Building Safe, Healthy and Livable Communities held in Denver, Colorado in January. The conference attracted local elected officials, city and county staff, landscape architects, developers and builders, planners, transportation professionals and traffic engineers, public health professionals, architects, bankers, crime prevention professionals, realtors, urban designers, parks and recreation professionals, environmentalists, advocates for older adults and youth, bicycle and pedestrian advocates, advocates for social equity and affordable housing, labor representatives and others who care about creating livable communities.[iv] Students attended sessions on topics such as livable communities, promoting active living, integrating the land use and water quality connection, code reform in city government policy, safe routes to school, regional equity and incorporating green infrastructure for smart growth.

In the city of College Station, the P3 Team specifically partnered with the Transportation Planner of the Department of Planning & Development Services and the Greenways Program Manager in the Department of Public Works. Through official meetings and other informal communication, students held key discussions with the respective partners to gain insight into green infrastructure issues. Additionally, students identified key stakeholders in the community planning process and conducted interviews with them to understand their diverse perspectives and get a sense of their understanding of sustainability, connectivity and green infrastructure. Stakeholders interviewed included representatives from the local development community, city planning and transportation staff, Parks & Recreation Advisory Board members, landscape architects and active citizens.

General findings from the interviews demonstrated the polarity of views held by important stakeholders in the community. The development community appears to have the perception that connectivity and sustainability are not important issues to homebuyers and average citizens. Some developers interviewed did not even understand what the concepts meant and therefore did not value these as important ideas to implement when developing. The development community representatives also had strong views about what they thought homebuyers and community members wanted to see in their community, such as more cul-de-sac development, gated communities and no connections such as trails between neighborhoods. These views appeared in direct contradiction to the views expressed by other interviewees such as city staff, Park & Recreation Advisory Board members, and active citizens, as well as survey results compiled in a College Station Park & Recreation Needs Assessment where connectivity between parks through trails and "greening" the city were the top two priorities identified[v].

Other surveys done in previous years on sustainability and connectivity issues in College Station, Texas were also identified and analyzed for their correlation with this project. The city's Office of Transportation Planning had previously conducted an internet-based study on greenways in College Station and identified citizens' perceptions. The results of the study showed that 89.52% of people surveyed had used a greenway trail before as opposed to 10.48% who had not. When asked how they would use a greenway corridor, participants responded that they would use it for: Recreation, 89.21%;

Experience with Nature/Wilderness, 72.06%; and Transportation, 51.11% versus 2.54% who said they would not use one at all. When asked how they would consider close proximity to a greenway trail as a factor when buying a new home, 64.44% responded Very Positive and 27.64% responded Positive. When asked if they believe that connected trail systems add value to the community, 97.46% responded Yes[vi]. These findings support the idea that green infrastructure is valuable and important to people and they will use greenways not only for recreation, but also for transportation.

An additional study focused on connectivity found that when given the choice between living in a highly connected area with access to major roads, public transit stops and greenways to take trips to parks schools and shopping areas, versus living in a cul-de-sac in a neighborhood that is isolated from major access roads and where most trips outside of the neighborhood are by car, citizens would prefer to live in an area that was well connected represented by 60% of survey respondents. Greenways and trails were also overwhelmingly supported by citizens, with 60% of citizens expressing the desire to have this type of infrastructure near their home[vii].

In addition to the interviews conducted and the analysis of previous surveys and needs assessments, students developed a survey and conducted a research project of their own to determine non-motorized transportation choices and perceptions of barriers to non-motorized transportation in College Station, Texas.

Results of College Station Non-Motorized Transportation Barriers Survey

A total of 242 surveys were collected at various spots around and at boundaries of the Texas A&M Campus. 150 respondents were male, while 92 respondents were female. 82.6% of the respondents were undergraduate students, 12.8% were graduate students, and 3.7% were staff or faculty. The following tables show statistics on the number of respondents who walk or bike to school, the motivations behind using non-motorized transportation, and respondents' distance willing to walk or bike.

	Frequency	Percent
Walk to School		
Always	17	7
Often	32	13.2
Ride Bike to School		
Always	82	33.9
Often	55	22.7

Use of Non-Motorized Transportation		
	Frequency	Percent
Exercise	71	29.3
Time	40	16.5
Financial	48	19.8
Convenience	35	14.5
No response	46	19
Total	240	99.2

Distance Willing to Bike			Distance Willing to Walk		
	Frequency	Percent		Frequency	Percent
0 mile	4	1.7	0 mile	6	2.5
.25 mile	2	.8	.25 mile	17	7
.5 mile	4	1.7	.5 mile	25	10.3
.75 mile	3	1.2	.75 mile	8	3.3
1 mile	30	12.4	1 mile	90	37.2
Over a mile	197	81.4	Over a mile	96	39.7
Total	240	99.2	Total	242	100

Qualitative results gained from open-ended survey questions show insight into specific barriers to non-motorized transportation. Positive influences on non-motorized transportation to and from the Texas A&M campus were listed as cross walks, bike lanes, grade separations, good weather, opportunity for socialization and enjoyment of nature, and exercise. Negative influences were listed as traffic, no bike lanes, crossing major arterials, poor condition of roads, bad intersections, and lack of trails or buffered path/sidewalks.

Survey respondents were also asked to map the route they followed when using non-motorized transportation. The following average route map was compiled with the data respondents provided and was compared to the current College Station Bike Plan. As evidenced by the route map, the most heavily used routes do not necessarily follow the existing city Bike Plan. Possible implications may be that the plan needs to be revised to reflect barriers to non-motorized transportation and/or low connectivity.

Developing Recommendations and Example Policies

Based upon the primary data obtained from this project's survey and the secondary data analyzed previously, students developed a "green" connectivity index in addition to several policy guidelines that promote sustainable development and can be used by planning officials when developing public policy.

Roadway Network Connectivity Index

The traditional concept of a connectivity index has been used in the transportation field for many years to increase roadway network connectivity for vehicular transportation efficiency. Connectivity is measured by adding together the number of neighborhood street links and then dividing that number by the number of nodes (i.e. intersections, cul-de-sac bulbs, and dead ends)[viii]. A perfect city grid of four North/South streets by four East/West streets has 32 links

and 16 nodes. The connectivity index is therefore calculated to be a 2.0 (32 links divided by 16 nodes) and represents the highest level of connectivity. A "good" connectivity score would be a minimum of 1.4. Figure 1 represents an increasingly common neighborhood development with a connectivity index of 1.25 (20 links divided by 16 nodes). The links are represented by "dots" and the nodes are represented by "stars".

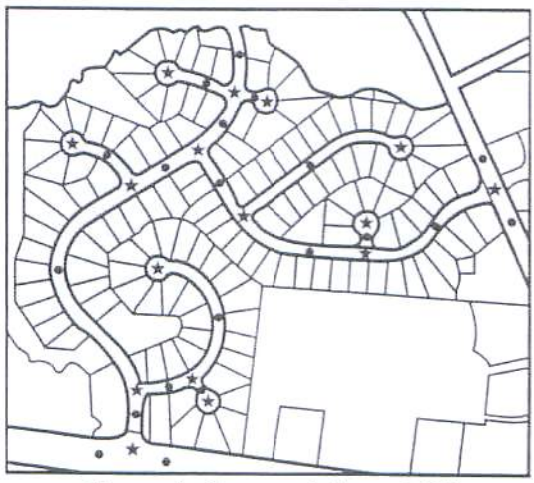


Figure 1. Connectivity = 1.25

Green Connectivity Index

It is the recommendation of this P3 design team that some modifications be made to the traditional roadway network connectivity index to incorporate green infrastructure in planning and development. The addition of administrator-awarded bonus and reduction values that distinguish between alternative types of links as compared to just roadway links, and distinguishes values of different types of connections or nodes, adds a green component that makes for a more comprehensive and inclusive connectivity index.

Administrator-Awarded Index Reductions	**Reduction Values**
Adjacent Major Arterial as Neighborhood Boundary	-0.025
Railroad Crossing Controlled-Access Highway Adjacent Developments with No Street Stub-Outs	-0.05

Adminstrator-Awarded Index Bonuses	**Bonus Values**
Connection between cul-de-sacs	+0.01
Buffered Sidewalk Bike Lane Parkway Arterial (A minimum of 12' wide landscaped median)	+0.025
Greenway (A minimum of a 20' easement with a 8' multiple use trail) Grade Separation Greenway Connections to Schools and/or Shopping Areas	+0.05
Greenway Connections between Parks	+0.075

Justification of Bonus and Reduction Values

The following features will require a reduction to the final index calculation based upon the following:

Major Arterial as Boundary to a Neighborhood

If a neighborhood is bounded by a major arterial, freeway, or expressway where a pedestrian or cyclist will have to cross to exit the neighborhood a reduction will occur.

Railroad Crossing

The existence of a railroad crossing in any capacity (i.e. bike lane crossing RR tracks, sidewalk crossing RR tracks) will result in a reduction value due to the hazardous nature of such a crossing.

Controlled-Access Highway

The existence of a controlled-access highway creates significant challenges to non-motorized transportation and results in a reduction value for each controlled-access highway present in a neighborhood, including those controlled-access highways that bound a neighborhood.

Adjacent Developments with No Street Stub-Outs

If a neighborhood is platted with no street stub-outs to existing adjacent developments' streets, or proposed adjacent developments' streets, reduction values will be assigned.

The following features will receive a bonus value added to the final index calculation based upon the following:

Connections between Cul-de-sacs

A minimum of a 20' wide easement with a 6' wide pedestrian trail is required. No greenery requirements are required for this type of connection.

Buffered Sidewalk

A minimum of a 2' vegetation buffer between the sidewalk and the roadway is required. The sidewalk must be a minimum of ¼ of a mile in length and is required to connect two destinations within a neighborhood (i.e. school to a park, one end of block length to another end, etc.).

Bike Lane

Bike lane must be a minimum of ¼ of a mile in length and connect two destinations within a neighborhood (i.e. school to a park, shopping center to a greenway entrance, etc.) The bike lane must be on a major arterial or collector street, the presence of a bike route through neighborhood streets is not included as a bonus value.

Greenway

A minimum of a 20' easement with an 8' multiple use trail constitutes a greenway. A multiple use trail includes providing for pedestrians, bicyclists, runners, etc. The minimum length requirement is 100 feet and must include a greenery component as determined by the administrator.

Grade Separation
Pedestrian and/or bicycle traffic must be grade separated from vehicular traffic at crossings in any manner of several ways. Grade separations can occur where trails and bike lanes follow a natural creek and can follow under street bridges. Various height requirements exist depending upon the type of trail use and the height of the bridge. When planning for a future grade separation these requirements can be designed into the bridge construction, otherwise excavation can occur on the trail level to retrofit the grade separation so that height requirements may be met. Grade separations can also occur in the form of pedestrian access ways under busy streets and/or railroad tracks in heavy-use urban areas.

Greenway Connections to Schools and/or Shopping
A minimum of a 20' easement with an 8' multiple use trail that connects homes in neighborhoods to local schools and/or shopping areas. This bonus is awarded in addition to the bonus for a single greenway, because it recognizes the connection function of the greenway as an important component, and will discourage development of short, isolated, "goes nowhere" greenways.

Greenway Connections between Parks
A minimum of a 20' easement with an 8' multiple use trail that connects homes in neighborhoods to local schools and/or shopping areas. This bonus is awarded in addition to the bonus for a single greenway, because it recognizes the connection function of the greenway as an important component, and will discourage development of short, isolated, "goes nowhere" greenways.

Greenway Dedication and Land Use Zones

In addition to current park land dedication ordinances currently used in many cities, including College Station, Texas, more specific requirements aimed at connectivity need to be in place for park or green space dedication. Requirements should focus on linear parks or linear green spaces (greenways) for their greater contribution to connectivity. Connected greenways keep the floodplain along creeks open and provide a permeable ground surface that reduces flooding, they connect habitat and create wildlife corridors for animals to move through and they connect parks, schools and neighborhoods through trails that people can access. These types of benefits are justification for focusing on linear land dedications as opposed to isolated park land dedications.

Greenways Zoning
In addition to traditional zoning categories such as residential, commercial, agricultural, industrial, special districts, etc., a special zoning category for greenways needs to be established. By establishing greenways as a zoning category, city planners can protect key areas such as floodplains and designate other connections between parks and schools as greenway areas. Changing the way greenways are implemented from simply a land use designation, to an actual zoning category, escalates green infrastructure to the level of importance and value it deserves in a sustainable approach to development. The following is proposed as an outline for inclusion in a subdivision ordinance. This has been developed in conjunction with College Station's Greenways Program Manager, Public Works Director and Development Services staff.

Proposed Greenway Zones

1. Urban Greenway (GU)

Urban greenways will be the most highly developed of the three types of greenways. The primary functions served by these greenways will be to provide for flood control, recreation, transportation, economic development and aesthetics. Wildlife protection and service as a utility corridor are secondary functions.

Urban greenways will provide connections between commercial areas along the greenway and surrounding areas. Highly visible access to the greenways will occur at frequent intervals between the surrounding development and the corridor. The width of the corridor will be determined by the floodway line, plus some additional area, to provide space for maintenance access and planned improvements. The trail, within the corridor, will be designed to handle primarily pedestrian traffic with provisions for maintenance vehicle access. The trail will be a minimum of eight feet (8') wide wherever feasible, having a hard, smooth surface. Urban greenways will be used quite intensely, simply because of where they are located and the surrounding land uses. Improvements to the channel should occur only as needed using the softest technique possible. All proposed improvements must comply with adopted standards and are subject to permitting and requirements of the State and Federal government. Development surrounding urban greenways will occur at the highest intensity, will be in close proximity to the edge of the corridor and should be sensitive to the creek. This development will be primarily institutional, commercial and multi-family residential.

2. Suburban Greenways: (GS)

As with urban greenways, the primary functions served by suburban greenways will be to provide for flood control, recreation, transportation, aesthetics and to serve to enhance the value of adjacent property. Wildlife protection and service as a utility corridor will be secondary functions.

There will be moderate to high levels of use. These corridors will connect users and their destinations such as one neighborhood to other neighborhoods, to businesses, to parks and to schools. Access points will be visible and may include lighting, signage, picnic areas or playgrounds. The width of a suburban greenway should be the entire floodplain, or if surrounding development is present, what can reasonably be obtained. The trails will serve a variety of recreational and transportation uses and will be relatively wide with a medium to hard surface. The trail itself is the focus of the greenway. Channel improvements should only be made if necessary and using the softest techniques feasible. All proposed improvements must comply with adopted standards and are subject to permitting and requirements of the State and Federal government. Bridge structures should provide grade separation for safe passage of users. Surrounding development will consist of low to medium density single family, multi-family, mixed use, retail commercial and uses such as churches and schools.

3. Rural Greenways: (GR)

The primary functions of rural greenways are to control flooding, to protect wildlife and to increase aesthetic value. Recreation, transportation, economics and service as a utility corridor will serve as secondary functions.

This type of greenway would exist in a mostly "natural" state with connections made for wildlife movement. Some trails may be developed for public use. The surrounding land use would be primarily agricultural, undeveloped open space or low density residential. Riparian areas would see very little, if any, modification. Trails would be more primitive, designed for lower levels of use and may connect larger nature oriented parks or preserves. User amenities would be less common and found only at destination points. The corridor width would contain the entire floodplain and possibly more in some areas to include key natural or cultural areas. There would be limited channel improvements allowed.

All proposed improvements must comply with adopted standards and are subject to permitting and requirements of the State and Federal government. Bridge structures would be grade separated to allow safe passage of pedestrians and bicyclists.

Greenway Boundary

Greenway lots lines should be composed of straight line segments that generally conform to the greenway area indicated in the Greenway Master Plan.

Ownership, Access and Maintenance

1. In single-family residential developments the greenway must be shown as a single lot on a final plat dedicated to the City or to an approved homeowner association (HOA). The greenway shall not be contained in a single-family residential lot. The City Council may waive this dedication requirement for replats that were originally platted prior to the adoption of this requirement.
2. For single-family residential developments where the greenway dedication is owned and maintained by an HOA. The HOA's by-laws and covenants, which must be approved by the City and filed of record in the county land records where the property is located, shall provide for any improvements and maintenance of improvements in the greenway.
3. For non-residential and multi-family developments, the greenway must be shown on the final plat as a single lot dedicated to the City or to an approved property management entity. The City Council may waive this dedication requirement for replats that were originally platted prior to the adoption of this requirement.

Improvements

1. Where the Bicycle and Pedestrian Master Plan indicates trails in a greenway, trails or greenway improvements may be made by the City as a capital project or by the developer.
2. A portion of the cost of hike and bike trails constructed in greenway may be eligible for City participation in accordance with Section 9-E.

Density Credits For Landowners

When a greenway consumes more than five percent (5%) of a landowner's developable land, density credits shall be granted to the landowner that allows one additional dwelling unit to be built for every acre of his or her property affected by greenway. These density credits shall be accommodated at the development site by allowing greater flexibility in setbacks, frontage distances, or minimum lot sizes to squeeze in "lost lots." Cluster development may be used for this purpose.

Conclusions

Incorporating green infrastructure into the planning and development process is an appropriate counter to the grey infrastructure and the encroachment of urban sprawl. Green infrastructure enhances connectivity between parks and schools, between wildlife habitats and floodplains, and between neighborhoods and people. The addition of greenways to a traditional grey infrastructure system has tremendous benefits to the environment, to human health and to the economic and social health of communities.

Ecologically, the addition or preservation of existing green space by development regulation will have impacts that reduce flooding, improve air filtration, provide a corridor for wildlife movement, Additionally, greenways are conducive to non-motorized transportation, which will in effect, reduce vehicle emissions and consequent air pollution, reduce the use of and manufacture of environmentally-damaging petroleum-based products. In just a single second, America's cars and trucks travel 60,000 miles, use up 3,000 gallons of petroleum products, and

add 60,000 pounds of carbon dioxide to the atmosphere[ix]. To counteract this, one acre of trees removes up to 2.6 tons (1 ton=2,000 pounds) of carbon dioxide each year. Additionally, in one year, an acre of trees can absorb as much carbon as is produced by a car driven up to 8700 miles[x]. It is clear, that the amount of trees we have aren't able to keep up with the amount of carbon dioxide we are producing, thus further justifying the need for incorporating green infrastructure in a community.

In terms of human health, green infrastructure and subsequent opportunities for recreation and non-motorized transportation will have implications for the obesity problem in this country. According to one pro-cycling website, half of all travel in America is within three miles or less, which is within easy biking distance for most people[xi]. An additional study illustrated that in a neighborhood classified as "high-walkability", people walked 52 more minutes a week, than people who lived in neighborhood classified as "low-walkability"[xii]. According to one website, if a 150 lb. person walks an additional 52 minutes a week at a moderate intensity level, they will burn 207 calories a week, which equates to 10,764 calories burned per year[xiii] Additionally in a study done on the relationship between obesity, community design, physical activity and time spent in cars, results expressed that for each additional hour spent in a car per day, there was an association of a 6% increase in the likelihood of obesity, and for each additional kilometer walked per day there was an association with a 4.8% reduction in the likelihood of obesity[xiv].

In terms of economics and human prosperity, green infrastructure enhances local property values and has important economic impacts. In one study of property values near greenbelts in Boulder, Colorado, housing prices declined an average of $4.20 for each foot of distance from a greenbelt up to 3,200 feet; with one neighborhood having a figure has high as $10.20 for each foot of distance. The same study determined that, other variables being equal, the average value of property adjacent to the greenbelt would be 32 percent higher than those 3,200 feet away[xv].

The incorporation of green infrastructure in the planning and development process, aimed at connectivity and sustainability has tremendous implications for our future. This notion of incorporating greenways, parks and other open space into the grey infrastructure needs to become commonly accepted and widely used across the developed world, as well as in the developing world, so that the future prosperity of people and the planet are not jeopardized and we can live in a world where the natural environment and human communities will be sustained in perpetual harmony.

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Proposal for Phase II

The proposed work for Phase II of this P3 project will sustain environmental protection, economic prosperity and social benefits in the developed and developing world by continuing to examine the ways that green infrastructure - including parks, open space and greenways – can be best integrated into development and how the benefits touted can be quantified in a typical situation. Objectives of Phase II will be 1) to develop a multidisciplinary project that will measure benefits reported to be associated with green infrastructure and 2) to produce a video that addresses the policy challenges, the measurement of benefits and on-the-ground design issues related to designation and development of useful green infrastructure. The project will address the ways that future generations will be influenced by opportunities for more sustainable transportation choices, better health through increased daily activity, more cost effective stormwater management and the increased property values associated with designation, development and protection of green infrastructure.

Relationship to Sustainability

Phase II will be a multidisciplinary effort that will include urban planners, park and recreation professionals, landscape architects, engineers in the realm of public works and wildlife biologists. Students will engage with these professionals to expand on results generated in Phase I.

People: Environmental and economic implications of phase two would benefit society. There is continued need to understand how community design can best include green infrastructure and build on knowledge about how it enhances property values (Crompton, 2004), contributes to the tax base and spurs more environmentally sensitive forms of economic development. Policy that creates a better balance of green and gray infrastructure can help to enhance water quality and storm water management by keeping natural floodplains along greenways intact. Greenway trails provide connectivity for wildlife as well as for humans through bicycle and pedestrian travel, adding more economical and environmentally sensitive transportation options while increasing physical activity in the population (Shafer et al 2000). The way that we design cities (large and small) as we continue to grow has tremendous implications for people's daily quality of life and for environmental integrity in and around urban islands.

Prosperity: Policies being developed in this process are intended to address development primarily at a local scale. That is, commercial and residential development occurring in cities throughout the country are places where policy related to green infrastructure can be employed. The policies include considerations for both capital costs through the use of bonds and private partnerships as well as long term operation and maintenance through funding for public agencies and partnerships with local non-profits and NGOs.

Planet: Identifying, designating and developing green infrastructure in urban areas has great potential to reduce negative impacts on the environment through, for example, increased filtration of surface water runoff, reductions in automobile emissions, increased

carbon sequestration and temperature mitigation. Human health should improve through better access to infrastructure like trails that enhance active living. This project will include the selection of a site at which to specifically measure if, and how, green infrastructure along a floodplain mitigates negative environmental impacts while providing for human transportation and recreational activity. Landscape ecology principles (Dramstad et al, 1996) will be used to guide the selection of potential impacts and mitigation measures.

Relationship to Phase I

Phase I of this project used a college town as a case study to examine issues related to the implementation of green infrastructure as the community develops (e.g., residents, developers, city staff) in an effort to synthesize and propose policy ideas that could help institutionalize a more logical integration of parks, open space and greenways in development patterns. The phase one process has yielded policy ideas related to new greenway land use zones and a green connectivity index that, if adopted, would influence ways that new commercial and residential developments look and function. Phase II offers an opportunity to expand the reach of these ideas and introduce them in other cities to gauge possible acceptance. Phase II also offers an opportunity to document the process on video for later use as a teaching tool. The video tool would address three types of knowledge: 1) the perceptions of city planning staffs, developers, academics and other stakeholder groups, 2) on-the-ground use of green infrastructure by residents to identify which aspects of the design work and which do not and, 3) the ways that green infrastructure influence the urban environment related to habitat, water and air quality, and flood management. The first type of knowledge would be addressed by collecting data through more widely distributed self administered surveys based on interviews conducted in Phase I. The second and third knowledge types would involve a much ore extensive survey, and on-site observations, with residents in areas where green infrastructure exists to examine how it is being used.

Phase I will essentially act as a pilot study for an expanded Phase II that will allow findings to be generalized. Phase II will expand the goals of Phase I to other cities, will help to quantify environmental benefits and will involve the production of a video teaching tool that can be used by groups of future students to better understand what green infrastructure is and how it can be integrated into development.

Innovation

The policy developed in Phase I is innovative. Few examples of policy exist in the United States today that lay the foundations for an integrated green infrastructure that balances the built and natural environments. Greenway land use zones and connectivity requirements that include green components are not well understood by planners, park and recreation professionals, public works engineers or developers. The policies developed have merit and legitimacy given their base formulation. For example, the greenway land use zones proposed in Phase I represent an innovative way of using a traditional planning practice, zoning, to designate floodplain as greenway through the

development process. The connective index proposed advances new ideas for bonus and reduction values based on user input. A connectivity index that incorporates bonus values for green components can be used to leverage infrastructure within and among developments like neighborhoods and commercial centers that will provide more transportation choices, enhance physical activity and more efficiently handle stormwater.

Measuring Success

A successful Phase II would be represented by 1) the gathering and analysis of more extensive data related to the objectives of Phase I and, 2) the assimilation of materials into a useful information tool (video presentation) that can be used to teach in secondary and tertiary classrooms and used to educate planning and zoning commissions, park boards, city councils and city staff.

Students in several types of classes will be engaged to develop measures and a video that will document data collection and general use (behavior) related to green infrastructure facilities in cities.

Integration as an Educational Tool

Phase I of the P3 project was successfully implemented as an educational tool. The purpose was to create a "cap-stone" learning project for students in park planning and landscape architecture. The project has introduced these students to professionals and citizens concerned with the way the community develops as it relates to sustainability and quality of life. Students have learned about not only green infrastructure but about related concepts related to smart growth, greenways, connectivity, alternative transportation, and in-fill development. The proposed plans for Phase II will maximize the educational value through the development of a video that will be used to further the educational value through future courses. The results and related longitudinal research work will be used in planning classes for many years to come.

	person-months	EPA P3	TAES	Total
A. Salaries and Wages				
Project Director				
Scott Shafer				
1.0 Calendar Month	0.0 1.0	-	7,042	7,042
Total Salaries and Wages	0.0 1.0	$0	$7,042	$7,042
Graduate Assistant				
12 Calendar Months	12.0 12.0	$18,000		
B. Fringe Benefits				
@ 15.6% of salaries		2,800	1,099	3,899
Group Health Insurance		-	380	380
Total Fringes		$2,800	$1,479	$4,279
Total Personnel Costs		$20,800	$8,521	$29,321
C. Travel				
Local rental travel – 3 trips per week to local sites				
60 miles a week @ .38 per mile		1,150		1,150
Transportation to Houston, Austin, Dallas, SanAntonio			-	
2 trips to each location for interviews				
Lodging: 2 days/trip @ $75/day		1,200	-	1,200
Meal Per Diem: 2 days/trip @ $36/day		576	-	576
Total Travel		$2,926	$0	$2,926
D. Equipment				
Hygrometer x 2 @ 100 each		200	$0	200
Infrared thermometer x 2 @ 500 each		1,000		1,000
Gas sampler and tubes x 2 @ 650 each		1,300		1,300
Ph Tester x 2 @ 90.00 each		180		180
Conductivity Tester x 2 @ 95.00 each		190		190
Total Equipment		$2,870	$0	$2,870
E. Materials and Supplies				
Dell Latitude D600 Notebook (2 @ $1250 ea)		2,500	-	2,500
Survey Supplies		300	-	300
Total Materials and Supplies		$2,800	$0	$2,800
F. Contractual		$0	$0	$0
Recording and editing video		$15,000		$15,000
G. Other Direct Costs				
Reproduction/Publication Costs		$250		$250
Total Other Direct Costs		$250	$0	$250
K. Total Direct Costs		$44,646	$8,521	$53,167
L. Indirect costs				
@ 45.5% of modified total direct costs		$20,314	$3,877	$24,191
M. Total Request		$64,960	$12,398	$77,358

Budget Justification

Personnel

Personnel for this project include one doctoral graduate assistant who will run the project during the twelve month period. Faculty and staff effort is being provided as a cost share contribution. Dr. Scott Shafer, the project PI and primary faculty advisor, will devote one month of effort to this project ($7,042). The insurance and fringe benefits associated with that are calculated based on group health insurance rates of $380 per month of effort, and fringe rates of 15.5% of salaries.

Travel

This budget includes a request for funds for travel to four cities in Texas to interview key staff about their policy related to green infrastructure. The budget also reflects local travel to test sites and for on-site survey work an average of three times a week for a total of 3000 miles of travel at $.38 per mile

Equipment

Equipment being requested will be used to measure air and water quality and temperature at sample sites within and adjacent to green infrastructure land uses.

Materials and Supplies

Support is requested to purchase two notebook computers for student use in gathering information, conducting the public survey, analyzing results, and preparing recommendations. Computers were requested in Phase I of the project but were not purchased in favor of allocating the funds to include more students in the travel to Washington DC. Two Dell D600 Notebooks are requested at $1,250 each for a total of $2,500. In addition, supplies for conducting the survey (paper, postage, phone charges) are requested ($300). The Department of Recreation, Park, and Tourism Sciences at Texas A&M University will also contribute use of departmental survey supplies and equipment for this project at no additional cost to EPA.

Other Direct Costs

Reproduction and publication costs are estimated at $250 in this budget request. In addition, the Department of Recreation, Park, and Tourism Sciences will provide (at no additional cost to EPA) access to the existing departmental computer graphics laboratory for development of planning recommendations in graphic form for presentation.

In addition, the City of College Station, as a collaborator in this project, will provide access to students to review all past and present planning, zoning, and community development policies and designs.

Indirect Costs

Indirect costs are calculated based on a negotiated rate of 45.5% of modified total direct costs, and total $3,112 for this project.