Southland Drive Green Infrastructure Feasibility Study
Southland Drive, Lexington, Kentucky
Project Background

Project Overview
In Fall 2012, the Southland Association, a non-profit organization, was awarded a Lexington-Fayette Urban County Government water quality incentive class B grant. The grant focus was to study the practicality of implementing green infrastructure practices on private commercial properties located on or near the Southland Drive corridor.

The Southland Drive corridor is located in the headwaters of the middle branch of the Wolf Run watershed. The top of this watershed is near the intersection of Nicholasville Road and Southland Drive and Regency Center with the Kroger’s store. The discharge of Wolf Run from the area is at the intersection of Southland Drive and Rosemont Garden. The stream continues across Rosemont Garden in an open channel concrete channel between Lafayette Parkway.

Goal for this Study
The purpose of the Southland Drive Green Infrastructure Feasibility Study is to develop a comprehensive understanding and vision for implementing environmentally and financially sustainable stormwater management practices along the corridor. This plan includes a set of tools to guide property and business owners in selecting best management practices to reduce their operational costs while improving the quality of stormwater and reducing runoff. This study’s broad goal is to transform the landscape of Southland by creating a catalyst for change along the avenue. The concepts, ideas and case studies contained within this report respond to the following goals:

- Provide educational baseline information and data on Green Infrastructure practices to business and property owners along Southland Drive.
- Employs GIS analysis to determine the feasibility of implementing Green Infrastructure practices along the Southland corridor within the study boundary.
- Provide site case studies of Green Infrastructure practices for two private property parcels along the corridor.
- Serve as a Green Infrastructure model for other commercial areas in Lexington.

Purpose of Study
Historic storm events, major storms that produce significant and intense rainfalls, have become the norm for Lexington in the past two decades. The impacts of stormwater runoff from impervious surfaces such as building rooftops, parking lots, sidewalks and roadways increasingly threaten Lexington’s properties, lives, financial resources, community resiliency and the environment. This study examines the social, environmental and financial opportunities associated with incorporating Green Infrastructure practices, also commonly known as G.I., within the business corridor along Southland Drive.

Nationally and regionally, municipalities have embraced the concepts and innovative strategies associated with incorporating Green Infrastructure as a means to address challenging stormwater management issues. Regional cities including: Louisville, Nashville, Knoxville, Cincinnati have integrated Green Infrastructure practices into the management strategies for their stormwater program. Lexington has taken the practices of Green Infrastructure one step further than their regional peers, by developing an incentives program to encourage the private sector to implement Green Infrastructure practices on their property.

EPA has specifically recognized Green Infrastructure as a stormwater management approach that can be cost effective and environmentally preferable when used to support or replace gray infrastructure practices.

Acknowledgements
Southland Association Board of Directors
Hilary Baumann, President
Jim Kreiner, Vice President
Melissa Gayheart, Treasurer
Janet Cabaniss, Secretary
Danny Collins
Danielle Dove
Branden Gross
Art Howard
Don Hurt
Rob Milward
Cindy Mulvihill
Stewart Perry
Billy Sherrow
Fred Wohlstein
Phil Wyant
Kristy Yowell

Friends of Wolf Run
Ken Cooke

Lexington-Fayette Urban County Government
Mayor’s Office
Council Office
Division of Water Quality Staff

CDP
Scott Southall, RLA, AICP, LEED AP BD+C, Project Manager
Heather Turner, GIS
Evan McDaniel, Graduate Landscape Architect
Krista Citron, PE
Dave Ucketter, PE
Ashley Johnson, Report/Graphic Manager

Southland Logo Design
Fascination Design, Hilary Baumann
The Southland Drive Corridor is located approximately 2.5 miles southwest from downtown Lexington. The corridor is approximately 1 mile in length running from the northwest to the southeast with the northern terminus at the intersection of Rosemont Garden and the southern terminus at Nicholasville Road. Properties and structures along the corridor follow a pattern similar to downtown Lexington, a long narrow band of retail and commercial properties surrounded by residential.

It was during this same time period of the mid-1980's that FEMA established floodplain elevation for this section of Wolf Run through the Southland Drive Corridor.

**history of southland drive corridor**
Southland Drive was developed as Lexington’s first commercial district outside of the downtown central business district from the early 1950s through the late 1960s as Lexington experienced growth during the post-World War II Era. This commercial district’s growth occurred at a transitional period from a pedestrian-centric urban pattern to an auto-centric suburban design model. As a result, the corridor has a network of right-of-way connectivity to surrounding neighborhoods with missing pedestrian connections. The corridor also lacks contemporary planning and zoning regulations. The corridor was also developed without the benefits of stormwater infrastructure to manage water quality and quantity. As a result of this development pattern, stormwater flooding and sanitary sewer overflows (SSO’s) along the corridor and downstream of the corridor occurs on a frequent basis. To mitigate some of the flooding issues, LFUCG designed and constructed a regional detention basin located behind Good Foods Co-op in the late 1980s. The construction of this basin has aided in reducing downstream flooding but has not eliminated this issue. Further steps to mitigate structural flooding continue to this day. In recent years, the Urban-County Government has offered a buyout program to residential properties located along Lafayette Parkway and Southbend Drive just downstream of Southland Drive to eliminate structural flooding and reduce SSO’s.

**rapid growth for southland**
Post-World War II and post-construction of the connector in 1949, Southland experienced tremendous growth during the1950s as evident by the aerial photographs to the left showing the corridor in 1952 and later in 1958. In the span of just six years, farm fields became roads and houses, Wolf Run Creek became straightened and channelized and the floodplain became commercial buildings.

The 1958 land-use map indicates a small concentrated area of commercial development occurring along Southland Drive near, current day, Southview Drive. Comparing the proposed land use of 1958 to present day, one can understand the impact stormwater runoff has on the corridor as well as downstream.
The infill and redevelopment design standards were adopted in August 28, 2001 with updates adopted on February 13, 2012. The initial scope of the study was focused on the downtown and surrounding neighborhoods. The goal of the infill and redevelopment program has been aimed at increasing urban density through promoting flexible regulations, facilitation, incentives and education. In 2009, LFUCG produced a study to examine the opportunities for non-residential infill and redevelopment. The expanded boundary for the infill and redevelopment overlay stopped just short of Southland Drive, as indicated in the above boundary map. The inclusion of Southland Drive in the infill and redevelopment boundary overlay may offer business and property owners additional development incentives. The infill and re-development incentives provide businesses and developers opportunities to expand retail floor space area, reducing requirements for parking and other beneficial preferences for developers. For additional information regarding the infill and redevelopment policy link to the following website: http://www.lexingtonky.gov/index.aspx?page=1822.

Southland Drive is divided between three council districts. The 3rd district covers the northeast side of Southland from the railroad tracks east towards Nicholasville Road. The 11th district covers the northwest side of the Southland from the railroad tracks west towards Rosemont Garden. The remaining, 10th district, covers the entire south side of Southland Drive from Rosemont Garden to Nicholasville. This three way district division of the corridor provides unique political interest and support for activities along the corridor and proposed by the Southland Association.
Establishing the study boundary: The selection of the Southland Drive feasibility study boundary was predicated on the Business (B-1) and Professional Office (P-1) zones as delineated on the city's zoning map. The zoning map to the left outlines the B-1 and P-1 zones along the corridor and the study boundary above mimics these zones. Since LFUCG's water quality incentive grant class B is designated for non-residential areas, the study focused along the commercial corridor even though the surrounding residential neighborhoods contribute to the stormwater issues in both quality and quantity. Just like the commercial area, the residential areas in this reach of the Wolf Run watershed developed at a time when there little to no stormwater management practices in place.

The study area consists of approximately 115 acres or 0.18 square miles. The vast majority of this commercial area is impervious surfaces including roofs, parking lots, service areas, sidewalks and roadways. Within the entire Wolf Run watershed, the commercial corridor of Southland Drive accounts for 16% of all the commercial and business zoned properties.
This aerial photo shows the Southland Drive area prior to the explosive commercial growth along the connector. Visible in this image is the residential development to the north and the west of Southland. With the exception of the culverts at the intersections, the majority of Wolf Run creek was open channel and connected to its floodplain. The primary land use along the corridor was agricultural production. The next decade would bring rapid change to this district including significant changes to the hydrological dynamics of Wolf Run.
The diagram above is the original 1949 Kentucky Transportation Cabinet’s (KYTC) road plan for Southland Drive overlaid onto the current aerial mapping. The plan illustrates the limited storm water infrastructure constructed in 1949 that remains the primary stormwater conveyance system to this day. The original storm water system was based upon conveying runoff from primarily agricultural/open space land use as shown on page 6. This diagram also shows the stream channel meandering around and through many of the structures on the north side of Southland Drive. Development along the corridor not only encroached upon Wolf Run Creek’s floodplain, but channelized and straightened the stream increasing the erosive forces of the stormwater runoff impacting downstream to this day.

Culvert near Kentucky Chocolate
Culvert at Overpass
As noted earlier in this study, Southland Drive and the commercial development along the corridor paralleled the historic alignment of Wolf Run Creek. The diagram above of the floodplain overlaid on the aerial map illustrates the impact of this development pattern.

In recent years, several floodplain studies have been conducted to update the floodway (blue colored area on map) and floodplain (pink and green areas on map). These updates have adjusted the floodplain elevations and thus the location of the floodplain. Nevertheless, flood waters still inundate structures along the corridor and downstream causing property damage and financial impacts for businesses.
This diagram divides the impervious area into categories by hard surfaces types. Of the 115 acres within the study area, 84 acres or 83% of the land is impervious. With so much impervious area, stormwater runs off properties with great intensity and volume over a very short period of time. Nearly half of the impervious area along the corridor is parking lots, some 40 acres or 30 Lafayette High School football fields. Building coverage is a distant second with only 20 acres of impermeability. While parking lots are a necessary evil for commerce and businesses, creating efficient, attractive and environmentally balanced spaces for vehicles should be a goal for the corridor.
The diagram above is a slope analysis which generalized GIS data to interpret average slope percentages throughout the study area. With few exceptions, the entire study area is suitable to implement Green Infrastructure practices as it relates to slope. The earth toned colors and the greens indicate favorable slopes for implementing green infrastructure practices. The slopes along the railroad tracks and south side of the Nicholasville Road intersection present some limitations for implementation. The gentle slopes reflect the historic floodplain and Wolf Run Creek.
The diagram above indicates groupings of trees within the project area. As indicated by the shaded area there are very few pockets of trees within the commercial corridor. Canopy trees benefit commercial and retail districts by reducing stormwater runoff through the process of evapotranspiration. Urban trees also provide a year after year return on investment (ROI) for property owners with reduction in heat island impacts and increased property value. Based upon a tree study completed in 2013, Lexington’s urban forest has an average tree canopy coverage of 24.56%, with a national average estimated at 35.1% for urban areas. By contrast the Southland corridor average is less than 10%, most of the coverage at the rear of properties. In 2005 and 2006, 140 street trees were planted along the Southland Drive Right-of-Way as one of the first Southland Association projects to improve the commercial corridor. These trees are not included in canopy cover calculation due to the spacing of the trees and the immature canopy of the trees. In time, these street trees will mature in size and contribute to the urban canopy. However, the street trees, currently, provide value in managing stormwater runoff, reducing particulate airborne pollution and reducing the impacts from the heat island effect.
stormwater sanitary sewers with soils map overlay

This diagram shows both the stormwater and sanitary sewer system network on Southland Drive. The green lines indicate the approximate location and size of the stormwater sewer system. The red lines indicate the approximate location and size of the sanitary sewer system. Sanitary sewer overflow’s are a result of insufficient capacity in the sewer system. Sanitary sewers are designed to collect waste water from residential, commercial and industrial facilities. The collection system is sized to capture a relatively small amount of flow compared to a Stormwater sewer which conveys large amounts of flow. Sanitary sewers overflow when stormwater is introduced into by one of two means. Infiltration, ground or storm water infiltrating into the system through cracks in the pipes or manholes or rain water flooding into the system through manholes lids. Inflow, is the other means by which rain or storm water is introduced into the sanitary sewer system. Inflow is water from sump pump or other storm drains directly connected to the sanitary sewer. As a part of the consent decree, this section (Wolf Run Main Trunk Sewer Replacement G) of Wolf Run Watershed is scheduled for sanitary sewer upgrade or improvements to reduce sanitary sewer overflow (SSO's). The current proposed schedule for the sanitary sewer improvements is 2021 for design and 2022 for construction based on LFUCG website. The map in the lower right-hand corner illustrates the major trunk lines within the Wolf Run Watershed and in detail, Section G along Southland.
This composite analysis diagram combines the tree canopy coverage, slope analysis and impervious area into one overlay. The reason for this diagram is to illustrate areas of significant opportunity to implement Green Infrastructure practices. The dark blue indicate areas very favorable to implementing Green Infrastructure practices. The light blue indicates areas that are favorable and the gray zones indicates that are suitable with some minor limitations. In general, the entire corridor is favorable to implement Green Infrastructure practices.

Health First parking lot: under construction with bio-infiltration swales

Typical parking lot with painted paved islands

Parking lot during rainstorm
Green Infrastructure

what is green infrastructure?

Stormwater runoff is a major cause of water pollution in urbanized areas. When rain falls, in open land or wooded undeveloped areas, water is absorbed by the soil and filtered through plants. This natural cycle can be illustrated by the hydrologic cycle which we all learned about in elementary school.

Native plants hold soil and retain water better than turf grass

When water falls on roofs, parking lots, driveways and sidewalks, rain water runs off these services and cannot soak into the ground. As in most urban areas, rain water from Southland Drive is collected in a series of engineered systems and discharged into a channelized Wolf Run. This stormwater runoff carries trash (floatables), bacteria, petroleum byproducts and other pollutants from the urban landscape. Combined with increased water run-off, stormwater degrades the receiving waters, causes erosion and flooding, damages habitat, property and infrastructure.

Urban Green Infrastructure includes local and neighborhood scale planning strategies aimed at reducing urban stormwater runoff in the built environment. The focus of green infrastructure planning in the urban environment extends beyond enhancing, protecting and/or expanding a contiguous network of environmentally sensitive areas, to incorporate landscape-based design controls that restore, protect and mimic natural hydrologic functions within an urban setting.

Green Infrastructure mimics the natural hydraulic cycle by employing vegetation soils and other natural processes to manage rainwater. There are generally two scales of Green Infrastructure. The first scale, city or county level in which Green Infrastructure is a patchwork of natural areas that provides habitat flood protection clean water and clean air such as parks and large buffer zones along stream and rivers. At the second scale neighborhood, districts or site level, Green Infrastructure refers to stormwater management systems that replicate nature by allowing rain water to soak into the ground or evapotranspiration through plants. This study is based upon the later of these two systems, to demonstrate the feasibility of implementing Green Infrastructure practices to benefit not only the overall health and water quality of wolf run watershed but to demonstrate the financial benefits for business and property owners along Southland.

why green infrastructure?

Simply stated, Green Infrastructure is a cost-effective and sustainable approach to the managing Lexington’s stormwater infrastructure needs while providing many tangible social, environmental and economic benefits. Numerous studies have been published, some of which are contained within this report, highlighting the benefits of implementing Green Infrastructure practices in commercial and retail districts.

Green Infrastructure reduces flash runoff

what is low impact development (LID)?

Low impact development (LID) is similar to Green Infrastructure practices in that LID incorporates the same principles of biomimicry to manage and reduce stormwater. LID approach to land development (or re-development) is to work with nature to manage stormwater as close to its source as possible. LID employs planning principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. LID planning principles also include vertical integration of structures, mixed use development, multi-modal transportation opportunities, traffic access management, reciprocal parking arrangements and other smart growth principles to reduce the impact of stormwater runoff.

By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed’s hydrologic and ecological functions. LID has been characterized as a sustainable stormwater practice by the Water Environment Research Foundation and others.

what are the benefits of green infrastructure?

Following is a short list of the benefits of implementing Green Infrastructure practices within a given site or district. The following information was taken from EPA’s website on Green Infrastructure practices.

As of 2008, the total reported water infrastructure needs for the United States included $63.6 billion for combined sewer overflow control and $42.3 billion for stormwater management. Since only 22% of regulated MS4s are included in this estimate, the need for stormwater management is likely much greater. As communities develop and climate patterns shift, these needs can only be expected to grow. While single-purpose gray stormwater infrastructure is largely designed to move urban stormwater away from the built environment, Green Infrastructure reduces and treats stormwater at its source while delivering many other environmental, social, and economic benefits. These benefits not only promote urban livability, but also add to the bottom line.

Nature’s Hydrological Cycle

Green Infrastructure practices are adaptive to urban conditions
**water quality and quantity**

Water Quality: Stormwater from urban areas delivers many pollutants to our streams, lakes, and beaches — including pathogens, nutrients, sediment, and heavy metals. In cities with combined sewer systems, high stormwater flows can also send untreated sewage into our waters. By retaining rainfall from small storms, green infrastructure reduces stormwater discharges. Lower discharge volumes translate into reduced combined sewer overflows and lower pollutant loads. Green infrastructure also treats stormwater that is not retained.

**flooding**

Conventional stormwater infrastructure quickly drains stormwater to rivers and streams, increasing peak flows and flood risk. Green infrastructure can mitigate flood risk by slowing and reducing stormwater discharges.

**water supply**

Rainwater harvesting and infiltration-based practices increase the efficiency of our water supply system. Water collected in rainwater harvesting systems can be used for outdoor irrigation and some indoor uses and can significantly reduce municipal water use. Water infiltrated into the soil can recharge groundwater, an important source of water in the United States.

**private and public cost savings**

When stormwater management systems are based on Green Infrastructure rather than gray infrastructure, developers often experience lower capital costs. These savings derive from lower costs for site grading, paving, and landscaping, and smaller or eliminated piping and detention facilities. In cities with combined sewer systems, Green Infrastructure controls may cost less than conventional controls, and green-gray approaches can reduce public expenditures on stormwater infrastructure.

**air quality**

Ground Level Ozone: Ground level ozone or smog, is created when nitrogen oxides (NOx) and volatile organic compounds (VOCs) interact in the presence of heat and sunlight. Smog conditions are usually worse in the summer and can lead to respiratory health problems. Vegetation can reduce ground level ozone by reducing air temperatures, reducing power plant emissions associated with air conditioning, and removing air pollutants.

**particulate pollution**

Particulate matter refers to the tiny bits of dust, chemicals, and metals suspended in the air we breathe. Because particulate matter is so small, it can enter into the lungs and cause serious health effects. Trees, parks, and other green infrastructure features can reduce particulate pollution by absorbing and filtering particulate matter.

**energy and climate change**

Urban Heat Island: Urban heat islands form as cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Trees, green roofs, and other Green Infrastructure features can cool urban areas by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

**energy use**

By reducing local temperatures and shading building surfaces, Green Infrastructure lessens the cooling and heating demand for buildings, reducing energy needs and decreasing emissions from power plants.

**climate change**

As different parts of the country become drier, wetter, or hotter, Green Infrastructure can help communities improve resiliency and adapt to climate change by increasing the capacity of drainage systems to handle large storms, increasing the resilience of water supply systems in times of drought, and mitigating the urban heat island effect. Urban vegetation can also mitigate climate change by reducing the levels of greenhouse gases in the atmosphere.

**health effects**

Breathing ground level ozone and particulate pollution can cause respiratory ailments including chest pain, coughing, aggravation of asthma, and even premature death. In their triple bottom line study on the benefits of Green Infrastructure, the City of Philadelphia found that increased tree canopy would reduce ozone and particulate pollution levels enough to significantly reduce mortality, hospital admissions, and work loss days.
water/energy nexus
Treatting and moving drinking water and wastewater takes a lot of energy. By reducing stormwater inflow into sewer systems, recharging aquifers, and conserving water, green infrastructure can significantly reduce energy use.

habitat and wildlife improvement
Vegetation in the urban environment provides habitat for birds, mammals, amphibians, reptiles, and insects. Even small patches of vegetation such as green roofs can provide habitat for a variety of insects and birds. By reducing erosion and sedimentation, Green Infrastructure also improves habitat in small streams and washes.

habitat connectivity
Large scale Green Infrastructure, such as parks and urban forests, also help to facilitate wildlife movement and connect wildlife populations between habitats.

community
Green Infrastructure can reduce a community’s infrastructure costs, promote economic growth, and create construction and maintenance jobs. As demand for Green Infrastructure skills increases, a range of new training and certification programs has emerged.

health benefits
More green space and parks encourages outdoor physical activity, reducing obesity and preventing associated chronic diseases such as heart disease, high blood pressure, stroke, Type II diabetes, arthritis, and certain kinds of cancer.

recreation space
Green Infrastructure’s vegetation and trees can increase publicly available recreation areas, allowing urban communities to enjoy greenery without leaving the city. Additionally, Green Infrastructure’s vegetation and permeable pavements can reduce noise pollution by damping traffic, train, or plane noise.

property values
By utilizing Green Infrastructure in construction and increasing vegetation and tree cover, property values can increase benefiting both developers and homeowners.

What is the significance of the one inch storm event?
Retaining the first 1.0 inch of rainfall within a site has many advantages in improving the water quality of stormwater runoff. Most of the rainfall events that occur are 1.0 inch or less in magnitude. In Kentucky, the 1.0 inch storm is regarded as the 85th percentile storm event. This means that 90% of the rainfall events in a given year are 1.0 inch or less. By capturing the first inch, the amount of rainfall leaving a site in a given year is significantly reduced. Capturing the 1.0 inch storm provides the following two important stormwater runoff improvements:

- The first inch of stormwater runoff is often referred to as the “first flush” and is generally considered to contain the highest amount of pollutants. Retention of the first flush is an important first step in improving runoff water quality.
- Treating the first inch of rainfall on-site not only reduces the total amount of runoff, but it reduces the speed with which it reaches streams. This reduces the potential for flooding.
Green Infrastructure Practices

types of green infrastructure practices

Green Infrastructure (GI) describes a wide array of practices that use or mimic natural processes to manage urban stormwater runoff. As stated before Green Infrastructure and other natural treatment trains manage rainwater runoff while improving the urban environment. Green Infrastructure controls stormwater runoff by using it as a resource rather than a waste by-product. The following examples represent the general classifications of Green Infrastructure practices. The individual practice combine with other GI practices to form a treatment train system to address water quality.

downspout disconnection

Downspout disconnection refers to the rerouting of roof drain spout pipes to drain rainwater into rain barrels or permeable areas instead of the storm water sewer system. Downspout disconnection can store rain water and or allow stormwater to infiltrate into the ground. The disconnection of downspouts is one of the most cost-effective means implementing GI.

Vertical cisterns collect rainwater & complementing architectural style

Rainwater harvesting systems can be part of an underground storage system as shown in the photograph below.

Existing downspout disconnect drain to pervious concrete

New downspout designed to drain onto pervious concrete

Rain gardens

Rain gardens, also known as bio retention or bio infiltration cells, are shallow vegetative basins that collect and absorb rainwater runoff from rooftops, sidewalks, and parking lots. Rain gardens use native plant material due to the deep root system to mimic the natural hydrology through infiltration and evapotranspiration. Rain gardens are versatile and take a variety of shapes and sizes.

Underground cisterns collect rainwater for reuse or infiltration

Rain Garden: open landscape in swale

Rain Garden: parking lot landscape island

Rain Garden: at end of a parking lot

Rainwater harvesting

Rainwater harvesting systems collect and store rainwater for non-potable use. When designed appropriately, rainwater harvesting slows and reduces runoff while providing a natural and free resource. Rainwater harvesting systems can be integrated into the architectural language of the building as seen in this photograph below.
Planter boxes are urban examples of rain gardens typically with vertical walls and open or closed bottoms that filter or infiltrate rainwater from sidewalks, parking lots and streets. Planter boxes can be an integral part of a streetscape design and can reflect the architecture style of an urban area. This form of a rain garden is ideal for space constrained sites in cities and other compacted areas.

Permeable pavements are paved surfaces that allow rainwater to infiltrate, treat and/or store for harvesting or extended time release. Permeable pavements are typically constructed from pervious concrete, porous asphalt, permeable interlocking pavers and other permeable materials.

Bioswales are vegetated, mulched or stone channels that provide detention and treatment as they convey stormwater from hardscape to downstream. Vegetated swales slow runoff allowing filtration and infiltration. As linear elements, bioswales are ideal for parking lots and streets.

Pervious concrete is similar to conventional concrete pavement in appearance and structural support for light duty pavement. Typically pervious concrete contains between 15 and 25% void space to achieve the permeability of the concrete while maintaining structural integrity. For heavy duty pavement requirements, the creative placement of pervious concrete with conventional concrete provides the additional strength to support increased traffic loads. Finished pervious concrete has the appearance of “rice crispy treats” due to the reduced amount of sand and cement in the design mix.
porous asphalt
Porous asphalt is installed in a similar manner as conventional asphalt. The equipment used to install the porous asphalt is also the same as conventional. The bituminous pavement difference in the material mixture which occurs at the asphalt plant. The finished appearance of the porous asphalt is similar to conventional with the exception of larger void space to allow rainwater to infiltrate.

permeable interlocking pavers
Permeable interlocking pavers are another pavement system suitable for everyday parking and driving activities. Unlike pervious concrete or porous asphalt pavement systems, permeable pavers are manufactured impermeable units with offset knobs creating joints to allow rainwater to flow around the paver units into the porous gravel subbase.

installation of permeable pavers
Installation of permeable pavers is similar to the installation of conventional paver units. The lifecycle of permeable pavers units equals that of conventional units, typically 40-60 years. An additional benefit of permeable paver units allows for removal and resetting of the units if maintenance or utility work is required. Permeable interlocking paver units offer the widest range of style, design and color options for designers, developers and business owners to choose.

vegetative (green) roofs & vegetative walls
A vegetative roof is a thin layer of vegetation grown on rooftops. Green roofs provide shade and UV protection for roofing membrane while capturing and filtering rainwater. Rainwater is then released by evapotranspiration or delayed runoff. Green roofs can be categorized as intensive (6” or more of growing media supporting 80-150 pounds per square foot of vegetation) or extensive (2” - 6” of growing media supporting 10-25 pounds per square foot of vegetation).

vegetative walls
Vegetative walls follow the same practices as green roofs and can be part of a building or freestanding.
Reducing stormwater runoff has mutual benefits for the property owner that receives the initial rainfall and those downstream. One of the requirements of the consent decree with the EPA and Kentucky division of water is reducing the number and frequency of sanitary sewer overflows commonly known as SSO’s. SSO’s are a result of stormwater’s infiltration or inflow into the much smaller sized sanitary sewer pipes. Stormwater or ground water infiltration occurs at cracks in the sanitary pipe, joints or manholes. Since sanitary sewer systems generally parallel streams and other waterways, ground water and rainwater infiltrate the system during heavy rain events. Inflow is the result of rainwater or stormwater being introduced into the sanitary sewer system by direct pipe connection to the system. Downspouts and sump pumps are the prime contributors of stormwater inflow into the system. As stated earlier, the city will be replacing and upgrading the main sanitary sewer trunk line as a part of the Consent Decree order scheduled for the early 2020’s. In the interim, property owners can assist in the reduction of SSO’s thus improving water quality by eliminating downspout or sump pump connections to the sanitary sewer system.

The entire stream section of Wolf Run along Southland Drive has been impacted by development either channelized or under grounded during the past 70 years of growth. Through the study process, opportunities were explored to daylight the stream or reengage the stream with its floodplain. The opportunities associated with these best management practices to improve water quality and reduce the impacts of stormwater runoff are limited due to the cost/benefit ratio and the development patterns in the area.

One area that may offer cost/benefit for daylighting is area from Southport Drive to Rosemont Garden. Currently, multiple structures are in the floodplain in this area and two of the structures are abandoned. If redevelopment of the area was to occur in the future, the removal of the flood prone structures and the daylighting of Wolf Run could offer economic and environmental benefits.

Another best management practice explored during the study was the use of a water quality insert unit to capture trash and sediments within an existing storm drain structure. While these systems provide a positive cost/benefit return, two downsides of the inserts for the Southland Drive corridor are a lack of infrastructure and post installation maintenance. As stated earlier in this study, the corridor has very limited stormwater infrastructure due to the time in which Southland Drive developed. The other requirement of these insert units is scheduled maintenance. The difficulty for private property owners is many insert units require mechanical equipment to remove and clean the inserts. For these two reasons, water quality insert units would have limited benefits for the Southland Corridor.
During the course of this study, a number of opportunities to reduce the impervious surface on private properties were identified. Just as not enough parking spaces can negatively impact commercial and retail establishments, so can too much parking and pavement. The hidden cost of pavement may not be readily known or the financial implications recognized. The initial cost of construction is typically a fraction of the life-cycle cost of a building or facility. Construction costs or “First cost” usually represents about 15% of the total cost of a facility over its lifespan. The remaining 85% of total cost goes to energy, maintenance, replacement operations and miscellaneous expenditures. For the site, routine maintenance, repairs, replacement, services (landscape and snow removal) and fees are just a few of these life-cycle cost associated with a developed property.

**Parking Management Paradigm Shift**

Parking Management represents a paradigm shift, that is a change in the way parking problems are defined and potential solutions evaluated.

**Old paradigm:** Motorists should nearly always be able to easily find convenient, free parking at every destination. Parking planning consists primarily of generous minimum parking requirements, with costs borne indirectly, through taxes and building rents.

**New paradigm:** Parking facilities should be used efficiently, so parking lots at a particular destination may often fill (typically more than once a week), provided that alternative options are available nearby, and travelers have information on these options. This means, for example, that parking lots have a sign describing available, that motorists may often have a choice between paid parking nearby, or free parking a few blocks away. It also requires good walking conditions between parking facilities and the destinations they may serve. Parking planning can therefore include Shared Parking, Parking Pricing and Regulations, Parking User Information, and Walkability improvements.

From Victoria Transport Policy Institute www.vtpi.org

Until recently, parking spaces have been viewed as relatively low-cost infrastructure element to enable business and commerce. The byproducts of pavement, stormwater discharge, has been viewed as a nuisance and the quicker it is removed from the site the better. This thought process regarding stormwater runoff has created enormous and very costly flooding, water quality and property damage problems for communities including Lexington. Reducing excessive parking or replacing impermeable surfaces with permeable Green Infrastructure practices enhance the long term viability of the individual businesses and of the overall corridor.
Reducing stormwater runoff

Reducing stormwater runoff for a number of properties along the Southland Drive can have a direct effect to mitigate the impacts by reducing or eliminating structural flooding, nuance rainwater issues such as downspout overflow or blockage, icing during winter months and land lost due to erosion. While a single project or a single retrofit may not result in significant or measurable improvements for the watershed, the aggregate of these projects along the Southland Drive can have a profound impact for properties along the corridor and those downstream.

The hidden cost of pavement

Let’s start with the hard or fixed cost. Hard costs are those tangible assets property owners need to acquire for construction and for maintenance/ upkeep after construction. These costs are quantifiable and can be determined within a measurable contingency. For site components, these costs may have a wider range of variability due in part to the majority of infrastructure being placed underground. Fixed cost for site construction include; utilities, grading, drainage, pavement, lighting and landscaping. Construction fixed costs is typically referred to as first or initial cost.

So what are the hidden costs of pavement? How can one quantify these costs and compare costs to alternative solutions including Green Infrastructure practices?

A typical commercial or retail parking space for new construction ranges from 8-10 feet in width by 18-20 feet in depth. Adding the drive aisles and other miscellaneous pavement to accommodate a vehicle, the average parking space requires 370 ft² in an efficient parking lot layout. The typical construction cost ranges between $2500-$5000 per space. This cost typically includes grading, drainage, pavement, lighting and landscaping but does not include land cost, which could be an additional $3000-$7000 per space depending upon property value.

Fixed cost for maintenance, repairs, replacement, utilities and fees vary depending upon geographical location and seasonal fluctuations in weather. A recent study by the Victoria Transportation Policy Institute calculated the annual operation and maintenance cost of an urban surface parking space at $575 per year. This cost included routine maintenance, resurfacing on a scheduled basis, routine sweeping, snow removal and other miscellaneous expenses.

Landscape island: lower maintenance cost over paved areas

Additional landscaping area - an increase in parking lot landscaping and perimeter landscaping not only reduces impervious coverage, but also provides other tangible and intangible benefits for property and business owners. Some tangible benefits are reduced overall maintenance cost, reduced heat island impacts and reduced stormwater runoff. Along with tangible benefits, intangible benefits of increased landscape areas can improve property appearance, improve employee morale and productivity and increase positive shopping experience for consumers.

Vegetative bio-infiltration swale: improves aesthetics and reduces runoff

Health First Clinic: new construction

Hampton Inn: new construction

Asphalt parking lot: new construction each parking spot cost $2500-$5000

Asphalt parking lot: resealing surface cost about $0.07 to $0.12 per year
For Lexington businesses there is the additional operating expense of the Water Quality Management Fee. This Stormwater fee is based upon the amount of impervious surfaces on an individual property. To calculate this fee, the impervious surface area is divided by the Residential Equivalent Unit (ERU). In Lexington, the ERU is equal to 2500 ft² of impervious area. As an example, if a commercial property has 50,000 ft² of impervious area including parking lot, driveways, sidewalks and roofs, divided by the ERU of 2500 ft² equals 20 ERU's multiplied by the current fee of $4.63 a month equals a total of $92.60 per month or $1111.20 per year. This fee is in addition to the other maintenance and upkeep required for a property.

LexServ bill: Stormwater Quality

The cost to construct and maintain a parking lot is considered the hard cost associated with the property. Soft costs are those perceived intangibles that do not necessarily have a fixed price or line item associated with them, but do impact the bottom line of a business or business district. Soft costs can include such items as the appearance of a property, the ease to access the property, the feeling one has when in a space and social benefits.

Parking lot: landscape islands have lower maintenance cost than pavement especially when using native plants

The combination of initial cost, operation and maintenance cost and soft cost equal lifecycle cost. The old expression of “pay me now or pay me later” often refers to the question of initial cost versus lifecycle cost. For a number of years the initial cost of a project has been the driving force in the decision making process. As stated before initial costs represent only about 15% of the total lifecycle cost for a facility. In recent years, there has been a paradigm shift towards using a lifecycle assessment as a means to inform the decision-making process for initial cost considerations. Green Infrastructure practices take into account the hard and soft costs benefits as it relates to the lifecycle of a facility.

Water Fact:

1000 square feet or 16.6’ X 60’ area equal to four parking spaces. In a 1 inch rain fall event generates 623 gallons of water or enough water to fill over 12 residential hot water tanks.
case study

Opportunities to reduce water quantity run off and improve water quality along Southland Drive. The two sites for the case study were selected based upon the following criteria:

- One site represents a typical large parcel (larger than one acre) along the corridor
- One site represents a typical small parcel (smaller than one acre) within the study area
- Multiple points of ingress/egress or oversized entrances
- Represent similar on-site conditions in the district
- Serve as a visible model for retrofit
- Represent a local property or business owners
- Located within the composite analysis map high suitability category for GI

The two sites selected for the case studies are 306 Southland Drive to represent a large parcel and 2011 Rambler Road to represent a small parcel. These sites were selected based upon the above criteria as models for other locations within the district that could implement the same improvements.

The case study for each site included three scenarios to demonstrate a low, moderate and high level of retrofitting each parcel with Green Infrastructure practices. The overall goal is the reduction of impervious surfaces while maintaining or improving parking lot efficiency, vehicular circulation and improve aesthetic qualities of the property.
306 Southland Drive is an example of a large parcel site with 2.3 acres. The majority of the parcel is covered in pavement, approximately 68%, with four points of ingress/egress onto the site (three on Southland Drive). Currently, parking islands are either painted island or poorly defined with little vegetation and no trees. Based upon the square footage of the building, 96 parking spaces are required based upon LFUCG's zoning ordinance. Currently, this property contains approximately 120 parking spaces or 25% more than required.

Based upon the study by the VTPI, each parking space cost about $535 per year for operation & maintenance. Multiple $535 times the 24 spaces over the required number of spaces equals $12,840 per year. Another way to look at the extra parking spaces is based upon the amount of retail floor area lost to the parking space. Each square foot of retail floor space generates a conservative $100 to $150 per square foot per year. Based upon the 370 square feet of area devoted to parking space, an additional parking space would need to generate between $37,000 to $55,500 per year of retail revenue to justify the additional parking space over retail space. Multiple by the 24 extra parking spaces on the site equals $888,000 to $1,332,000 in revenue.

*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU's. The number or unit for the case study remains constant through each scenario.
case study site 1 - concept scenario 1

- Total Area: 2.3 Acres (100,626 square feet)
- Zoned: Neighborhood Business (B-1)
- Building: 27,500 square feet (27% of site)
- Impermeable Area (parking lot, driveways, sidewalk): 61,241 square feet (60% of site)
- Permeable/Vegetated Area: 11,885 square feet (12% of site) (+8%)
- Required Parking Spaces by Zoning: 96
- Parking Spots: 109 (-7)
- Trees: 0
- ERU’s: $88,741/2500 = 36 \times $4.63/month = $166.68/month (-$9.26/month)

In concept scenario one, paved and painted traffic islands are replaced with grass or landscape islands. In addition to the landscape islands, excess pavement is removed and parking spaces are configured in a more efficient layout. The result of adding the traffic island and eliminating wasted pavement is a reduction of 7350 ft² of asphalt or equivalent to 20 parking spaces. Based upon the VTPI study, the pavement reduction would provide a cost savings of 20 spaces times $535.00 or $10,700.00 per year.

The new configuration increases the vegetative area by 8% and reduces the parking count by seven spaces. The new parking lot still has 13 more parking spaces than required or 13%. The increase landscape maintenance cost would be about $750.00 per year. Thus, the net savings of $10,000 per year for the removal of the extra pavement.

A construction cost analysis for the removal of the pavement and replacement with the landscape islands would range between $58,000 to $105,000 depending upon the configuration of the islands and at the plant material to replace the pavement. Relocation of utilities and other found conditions on site are not included in this analysis. Design cost for this scenario would range between 15% to 20% of the construction cost analysis. This concept would be eligible for a LFUCG water quality incentive grant - class B.

*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU's. The number or unit for the case study remains constant through each scenario.*
**Case Study Site 1 - Concept Scenario 2**

- **Total Area:** 2.3 Acres (100,626 square feet)
- **Zoned:** Neighborhood Business (B-1)
- **Building:** 27,500 square feet (27% of site)
- **Impermeable Area (parking lot, driveways, sidewalk):** 61,241 square feet (60% of site)
- **Permeable/Vegetated Area:** 11,885 square feet (12% of site) (+8%)
- **Required Parking Spaces by Zoning:** 96
- **Parking Spots:** 109 (-7)
- **Trees:** 24
- **Improvements:** BMPs added - Native landscaping, rain gardens, tree canopy.
- **ERU’s:** $88,741/2500 = 36 x $4.63/month = $166.68/month (-$9.26/month)

In concept scenario two, 24 trees have been added to the plan. The addition of trees provides additional water quality benefits but also financial value for the property owner. The trees also shade the asphalt pavement, reducing the heat island effect, saving money on air conditioning while creating a pleasant environment. The additional trees would add approximately $10,000 in cost. A construction cost analysis for the removal of the pavement and replacement with the landscape islands would range between $68,000 to $115,000 depending upon the configuration of the islands and at the plant material to replace the pavement. Relocation of utilities and other found conditions on site are not included in this analysis. Design cost for this scenario would range between 15% to 20% of the construction cost analysis. This concept would be eligible for a LFUCG water quality incentive grant - class B.

*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU’s. The number or unit for the case study remains constant through each scenario.*
*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU's. The number or unit for the case study remains constant through each scenario.
**existing site statistics**
- Site Area: .72 Acres (31,334 square feet)
- Zoned: Neighborhood Business (B-1)
- Building: 5,800 square feet (19% of site)
- Impermeable Area (parking lot, drive ways, sidewalk): 19,164 square feet (61% of site)
- Permeable/Vegetated Area: 6,370 square feet (20% of site)
- Required Parking Spaces by Zoning: 22
- Parking Spaces: 38
- Trees: 0
- ERU’s: $24,964/2500 = 10 x $4.63/month = $46.30/month

2011 Rambler Road is the location for the small site case study. As with the large parcel, the majority of this parcel is covered in pavement, approximately 61% of the 0.72 acre site with two large ingress/egress points. Currently, there are no parking islands nor interior landscape areas. The parking is arranged in two single bay on the side of the lot and single loaded at the rear of the building. Based upon the square footage of the building, 22 parking spaces are required based upon LFUCG’s zoning ordinance. Currently, this property contains approximately 38 parking spaces or 73% more than required.

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case study site 2 - scenario 1

- Site Area: .72 Acres (31,334 square feet)
- Zoned: Neighborhood Business (B-1)
- Building: 5,800 square feet (19% of site)
- Impermeable Area (parking lot, driveways, sidewalk): 15,474 square feet (49% of site)
- Permeable/Vegetated Area: 10,060 square feet (32% +12%)
- Required Parking Spaces by Zoning: 22
- Parking Spaces: 34 (-4)
- Trees: 0
- ERU's: 21,274/2500 = 9 x $4.63/month = $41.67/month (-$4.63/month)

In concept scenario one, paved and painted traffic islands are replaced with grass or landscape islands. In addition to the landscape island, excess pavement is removed and parking spaces are configured in a more efficient layout. The result of adding the traffic island and eliminating wasted pavement is a reduction of 3690 ft² of asphalt or equivalent to 10 parking spaces. Based upon the VTPI study, the pavement reduction would provide a cost savings of 10 spaces times $535.00 or $5,350.00 per year.

The new configuration increases the vegetative area by 12% and reduces the parking count by four spaces. The new parking lot still has 12 more parking spaces than required or 54% more than required. The increase landscape maintenance cost would be about $500.00 per year.

A construction cost analysis for the removal of the pavement and replacement with the landscape islands would range between $35,000 to $57,200 depending upon the configuration of the islands and at the plant material to replace the pavement. Relocation of utilities and other found conditions on site are not included in this analysis. Design cost for this scenario would range between 15% to 20% of the construction cost analysis. This concept would be eligible for a LFUCG water quality incentive grant - class B.

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case study site 2 - scenario 2

- Site Area: .72 Acres (31,334 square feet)
- Zoned: Neighborhood Business (B-1)
- Building: 5,800 square feet (19% of site)
- Impermeable Area (parking lot, driveways, sidewalk): 15,474 square feet (49% of site)
- Permeable/Vegetated Area: 10,060 square feet (32% (+12%))
- Required Parking Spaces by Zoning: 22
- Parking Spaces: 34 (-4)
- Trees: 16
- ERU’s: 21,274/2500 = 9 x $4.63/month = $41.67/month (-$4.63/month)
- Improvements: BMPs added - Native landscaping, rain gardens, tree canopy.

In concept scenario two, 16 trees have been added to the plan. The addition of trees provides additional water quality benefits but also financial value for the property owner. The trees also shade the asphalt pavement, reducing the heat island effect, saving money on air conditioning while creating a pleasant environment. The additional trees would add approximately $5,000 in construction cost. A construction cost analysis for the removal of the pavement and replacement with the landscape islands would range between $40,000 to $63,200 depending upon the configuration of the islands and at the plant material to replace the pavement. Relocation of utilities and other found conditions on site are not included in this analysis. Design cost for this scenario would range between 15% to 20% of the construction cost analysis. This concept would be eligible for a LFUCG water quality incentive grant - class B.

*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU’s. The number or unit for the case study remains constant through each scenario.
case study site 2 - scenario 3

- Site Area: .72 Acres (31,334 square feet)
- Zoned: Neighborhood Business (B-1)
- Building: 5,800 square feet (19% of site)
- Impermeable Area (parking lot, driveways, sidewalk): 8,694 square feet (28% of site)
- Permeable Pavement: 6,150 square feet (20% of site) (+20%)
- Vegetated Area: 10,690 square feet (34% of site) (+14%)
- Required Parking Spaces by Zoning: 22
- Parking Spaces: 40 (+2)
- Trees: 10
- ERU's: 14,494/2500 = 6 x $4.63/month = $27.78/month (-18.52/month)
- Improvements: BMPs added - porous pavement, native landscaping, rain gardens, tree canopy. The parking lot layout was redesigned with added sidewalks, and the storage building was moved.

In concept scenario three, the parking lot layout is a double stacked perpendicular with permeable pavement in the parking bay area. This layout eliminated one of the ingress/egress points creating a well defined entrance while improving safety. This layout increased the vegetative area by 14% while increasing the potential number of parking spaces by two.

The increase parking spaces may not be required nor desirable for the business, but serves as a demonstration for increased efficiency while reducing overall pavement footprint. In addition to the new layout permeable pavement has been added as shown in the dark red color on the plan. The permeable pavement reduces stormwater runoff by capturing rain water and allowing infiltration.

A construction cost analysis for the removal of the pavement and replacement with the landscape islands would range between $225,000 to $350,000 depending upon the configuration of the islands, amount of permeable pavement, the relocation of the storage unit and type the plant material to replace the pavement. Relocation of utilities and other found conditions on site are not included in this analysis. Design cost for this scenario would range between 10% to 15% of the construction cost analysis. This concept would be eligible for a LFUCG water quality incentive grant - class B.

*The fee is based on the attached aerial mapping and not actual LFUCG LexServ City Services Bill which may result in the actual number of ERU’s. The number or unit for the case study remains constant through each scenario.
The growth of the Southland Drive Corridor occurred as a growing Lexington population moved from the relatively compact downtown neighborhoods to the auto-centric suburban model of development. As the pendulum of development has begun to swing back to the rediscovery of compact walkable neighborhood districts, Southland is poised to engage in its own renewal and rediscovery.

This feasibility study was to assess the viability of implementing Green Infrastructure practices within the corridor. The findings of the study determined, with few exceptions, the corridor is a prime location for Green Infrastructure. Located parallel to Wolf Run, the lack of current stormwater management systems, the abundance of pavement and parking, an aging infrastructure and advantages of incentive programs are all reasons to support the infill and redevelopment employing green infrastructure practices in the district.

As evidence of the economic and social viability of the corridor, a number of new projects have been designed and are currently under construction along the corridor. These projects include the new Health First Clinic building, a new hotel and a new office building. These projects are including water quantity and quality improvements including Green Infrastructure practices.

Another example of infill has been the out-lot buildings on the Collins Bowling property. Over the past years, Bank of the Bluegrass, Car Quest Auto Parts store and an office building (under construction) increased the building density of the property without the addition of parking spaces. This demonstrates the overall abundance of parking spaces and repurposing of the parking spaces. Reciprocal parking agreements not only make common sense, they can also make dollars and cents.

With the cost of parking increasing each year, it makes sense to correctly size and allocate the appropriate number of parking spaces needed and share spaces whenever possible. Reducing pavement offers many tangible benefits for property and business owners including reduced maintenance cost, increased property value, increased efficiencies parking and host of other benefits defined in this study.

Private investment in the corridor is not the only dollars being spent. In recent years the Southland Association in partnership with the City have completed Infrastructure improvements including street trees, demonstration rain gardens, intersection improvements at Southland and Rosemont Garden and bike lanes and pedestrian improvements on Southland. The City is scheduled to replace and up size the sanitary sewer trunk line system by 2022, eliminating sanitary sewer overflows that have become common place during heavy rain events.
The following recommendations are broken into three categories addressing action items that can be taken by Southland Association property owners and business owners.

**Action items for the Southland Association:**

- Set a goal or target for reducing pavement and other impervious surfaces along the corridor while improving accessibility for vehicles, non-motorized vehicles, and pedestrian traffic to local businesses. Incorporate a Green Infrastructure Portfolio Standard model for setting goals for green infrastructure. See resources for details.
- Continue to increase the tree canopy within the Southland Drive district. Currently, Lexington’s tree canopy coverage for Southland Drive is 24.5% based upon a study conducted in 2013. The tree canopy coverage is about 9% based on the GIS data. This is less than half Lexington’s average. Urban tree canopy not only reduces stormwater runoff by interception, infiltration and storage, trees also reduce air pollutants, reduce the heat island effect, and enhance aesthetics.
- Petition LFUCG Planning Commission and City Council for the Southland Drive corridor inclusion in the infill and redevelopment overlay boundary.
- Coordinate with LFUCG Division of Planning and Division of Engineering to develop plans for improved pedestrian connectivity throughout the Corridor and surrounding neighborhoods.
- Embrace the greening of Southland Drive as a marketing/branding opportunity for businesses. “Go Green, Shop Southland”

**Recommendations**

**action items for business owners**

- Explore the possibility of implementing Green Infrastructure practices with property owners. Highlighting the economic benefits of Green Infrastructure practices for business as well as property owners.
- Offer employees incentives (financial or other) to use alternative forms of transportation or parking in underutilized parking spaces.
- Offer incentives such as discounts, rewards program or for customers to use alternative forms of transportation.
- Embrace alternative landscape materials and appearances as a means to reduce runoff while diversifying the appearance of the corridor. Use this opportunity to distinguish the corridor from other commercial business districts in Lexington.

**Action items for property owners**

- Talk with business owners and adjoining property owners about implementing Green Infrastructure practices and opportunities associated with LFUCG water quality incentive grants and the multiple benefits with the program.
- Encourage reciprocal parking agreements with adjoining property owners to reduce overall parking requirements and excess pavement. Each parking space cost an average of $535 per year to maintain. Consider the number of parking spaces required for each business and savings associated with the reduction of pavement.
- Consider applying for a Lexington-Fayette Urban County Government water quality incentive grant for design and construction of Green Infrastructure Practices.
During the course of the study, a number of resources has been gathered to assist business and property owners in their assessment of the cost benefits and appropriateness of implementing Green Infrastructure practices. This list provides a sampling of the materials available for business and property owners.

**Manuals**
Lexington-Fayette Urban County Government (LFUCG) Stormwater Manual - The manual purpose is to provide an overview of the standards for stormwater management in Fayette County. Three concepts, the public drainage system, the waters of Fayette County, and post-development floodplains are important to the management of stormwater and are discussed in this manual.

Lexington-Fayette Urban County Government (LFUCG) Stormwater Management Low Impact Development Guidelines for New Development and Redevelopment provides engineers, architects, planners, developers, builders, and interested public groups with guidance on how to incorporate LID into development projects occurring in Fayette County.

Lexington-Fayette Urban County Government (LFUCG) Urban Tree Canopy Assessment and Planting Plan. The trees of Lexington’s Urban Service Area are a major component of the infrastructure and provide more than the traditional values of aesthetics and shade. They also provide numerous quantifiable environmental benefits, including stormwater management, watershed protection, water quality improvements, temperature moderation and cooling, reduction of air pollutants, energy conservation, and overall increases in property values. The amount of urban tree canopy (UTC) and its location determines the amount and types of economic, environmental, and social benefits provided by trees to the government and the citizen.

**EPA Paying for Green Infrastructure.** Better stormwater management through green infrastructure can have many benefits. Many different studies have documented multiple and quantifiable costs and benefits across a range of social, economic, and environmental improvements see most recently “Enhancing Sustainable Communities With Green Infrastructure” http://www.epa.gov/smartgrowth/pdf/gi-guidebook/gi-guidebook.pdf and an entire webpage of approaches for cost-benefit analysis at http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm

**Green Infrastructure Models and Calculators**
The EPA Stormwater Calculator is an online tool to assist property owners in estimating annual amount of rainfall and frequency of runoff from a specific site. The calculator allows individuals to use Green Infrastructure practices to estimate rainwater runoff reductions.
http://www2.epa.gov/water-research/national-stormwater-calculator

Itree Calculator is a state-of-the-art, software application from the USDA Forest Service and that provides individuals with analyses and benefits assessment tool.
http://www.itreetools.org

National tree benefit calculator allows individuals to make a quick and simple estimates of the benefits of individual trees for commercial application.
http://treebenefits.com/calculator/

**Resource Guides**
The Center for Neighborhood Technology is a nonprofit organization dedicated to promoting livable and sustainable communities. They provide a number of resources pertaining to Green Infrastructure including: “The Value of Green Infrastructure: A guide to recognizing its economic environmental and social benefits”, “Upgrade your infrastructure: A guide to the Green Infrastructure portfolio standard and building stormwater retrofits” and “The economic benefits of Green Infrastructure: A case study of Lancaster, Pennsylvania”
http://www.cnt.org

**Green Infrastructure Models and Calculators**

**Resource Guides**

**EPA Paying for Green Infrastructure.** Better stormwater management through green infrastructure can have many benefits. Many different studies have documented multiple and quantifiable costs and benefits across a range of social, economic, and environmental improvements see most recently “Enhancing Sustainable Communities With Green Infrastructure” http://www.epa.gov/smartgrowth/pdf/gi-guidebook/gi-guidebook.pdf and an entire webpage of approaches for cost-benefit analysis at http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm