London, KY: Turning London Green

Conceptual Designs
for the Expansion of
London's Streetscape and Greenspaces

Prepared for London Downtown,
City of London, KY, and London Tree Board

February 2016

community design assistance center
College of Architecture + Urban Studies
Virginia Polytechnic Institute and State University

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*London Tree Board

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The Community Design Assistance Center (CDAC) is an outreach center in the College of Architecture and Urban Studies at Virginia Tech that assists communities, neighborhood groups, and non-profit organizations in improving their natural and built environments. Assistance is provided in the areas of landscape architecture, architecture, planning, and interior design. Working with communities, the conceptual planning and design provides communities with a graphic vision of their project that can then be used for grant applications and fundraising for the next steps toward implementation.

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City Residents

Business Owners

All those who volunteered time for the betterment of the London community

TABLE OF CONTENTS

TABLE OF CONTENTS

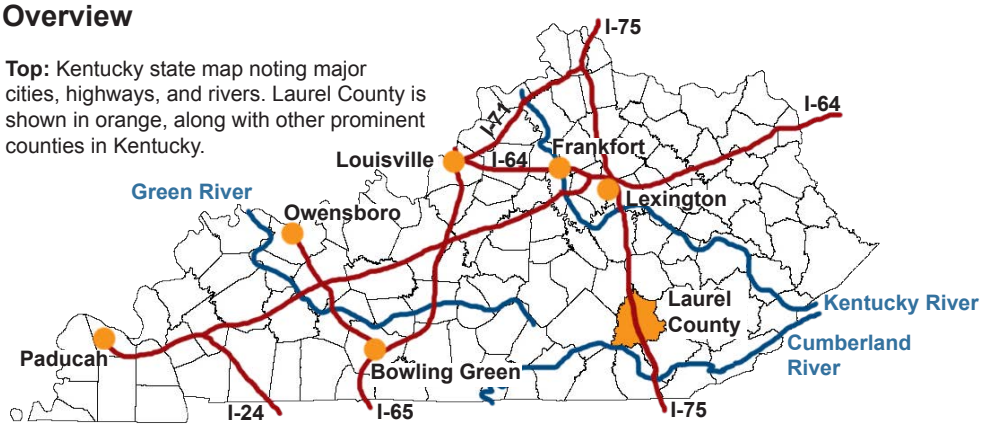
TABLE OF CONTENTS

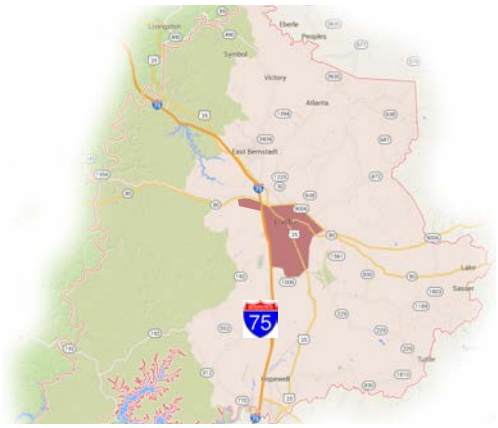
Part III: Appendix

PROJECT DESCRIPTION

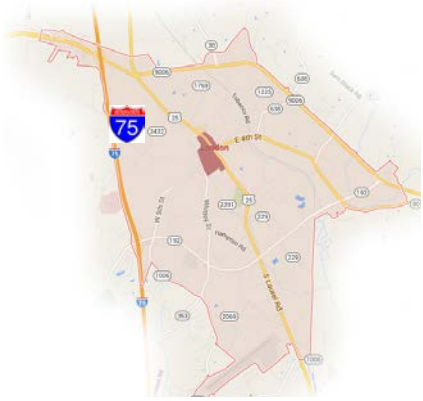
Overview

Top: Kentucky state map noting major cities, highways, and rivers. Laurel County is shown in orange, along with other prominent counties in Kentucky.





Laurel County, noting major highways, and London highlighted in red.



City of London, highlighting the downtown area involved in the design.

Located in Laurel County, Kentucky, the City of London is beginning to look to the future of the town and opportunities that exist for downtown improvements. The downtown area already contains several local restaurants and boutique shops, however the area is lacking in any major green space and is in need of streetscape improvements. Main Street exists as a lovely example of streetscape beautification. Urban trees, perennial shrub plantings, benches, and other pedestrian amenities line the corridor. London hopes to expand upon this aesthetic design by including the Broad Street corridor. London's goal is to create a system of connected greenspace to promote outdoor physical activity such as walking and bicycling. Due to London's recent designation as the Cycling Capitol of Kentucky, the city also looks to renovate and reassess its current cycling infrastructure. Directional and informational signage are also needed to unite the city under one clear aesthetic.

The city hopes to incorporate greenspace, provide safe and comfortable walking routes, celebrate their rich culture, and infuse the streets with local public art. By doing this, London hopes to have a more vibrant, welcoming, and economically viable destination for residents and visitors alike.

The following page depicts the areas of London addressed in this project.

PROJECT DESCRIPTION

Locator Map

DESIGN PROCESS

The design process began with an initial site visit to London in June 2015. The CDAC team met with project stakeholders at the London City Hall and discussed their vision for London as the bicycling capitol of Kentucky, the Broad Street corridor, pocket park, and hospital parking lot. The team then gathered on-site data, documented existing conditions for each of the sites, took soil samples, photographs, and measurements, which helped the team to understand the opportunities and constraints of each area. An inventory and analysis of each site was then created. This background research influenced the preliminary conceptual designs. Preliminary conceptual designs, analysis, and case studies were presented to the stakeholders and community members in a meeting in August 2015.

During the Preliminary Design Presentation, the CDAC team documented community feedback related to the two conceptual design options. The team consolidated the initial concepts into a final concept for each of the project areas. Signage concepts were also created to complement the final concepts. The final master plans, signage concepts, restructured cycle paths, sections, and perspectives were presented to the City of London during in a public community meeting in October, 2015. Comments and suggestions were incorporated into the final designs and are offered in this report as alternative design options.

Following in Part I is a description of each of the final concepts. Part II includes inventory and analysis information, along with initial design concepts.

Community leaders and CDAC team members discuss ideas at the initial stakeholders meeting.

CDAC staff discuss the opportunities and constraints of the project area.

Community members view the final design concepts in October 2015.

Part I:

Final Conceptual Designs

BROAD STREETSCAPE

Description of Analysis

Drainage Issues

During the CDAC team's initial analysis of the current Broad streetscape, drainage issues were very apparent. The CDAC team concluded that in order to properly address these concerns, the Broad Streetscape design includes proposed rain gardens, bioswales, and an underground detention basin to help reduce the chances of London's roads and businesses from flooding during storms. The underground detention basin is a large gravel-filled basin that is calculated to be large enough to store stormwater for up to a 100 year flood. The voids that are created from a gravel pit serves as the negative volume for stormwater storage.

Heat Island Issues

Broad Street currently lacks shade and is plagued with sometimes unbearable heat reflecting off of the paved surfaces. This is a problem that deters residents and visitors from experiencing downtown London, due to high temperatures in the summer months. Street trees, shaded seating, and public water fountains are proposed along Broad Street to reduce heat gain in the downtown area.

Expansive Parking

Currently, expansive asphalt parking lots characterize the Broad Street corridor. Parking lots along Broad Street are often left vacant, as there is more than enough parking to serve the businesses of downtown London. These underutilized parking lots occupy valuable downtown real estate and can be transformed into an interconnected series of green outdoor public spaces.

BROAD STREETSCAPE

Design Description

The proposed conceptual design aims at transforming London into a walkable downtown district. The proposed downtown walking loop would expand upon the current streetscape improvements made along Main Street and include Broad Street, 7th Street, and West Dixie Street. With a walkable downtown, individuals would feel invited to walk downtown and welcomed to explore shops, patronize restaurants, and spend time within green outdoor spaces. The proposed design within this section of the report seeks to create a vision for Broad Street.

Broad Street exists as a wide, paved corridor. This design proposes to include street amenities such as greenspace, shade trees, benches, small pocket parks, trash receptacles, bike racks, and well-maintained, wide sidewalks to help promote a healthy streetscape. Although the city built a large parking structure, visitors to Broad Street conveniently park along the road. The City of London desired to remove parallel parking along Broad Street between 1st and 7th streets to help maximize the use of the existing parking deck and replace the asphalt with pedestrian friendly amenities and greenspace. No longer will Broad Street be dominated by the vehicle, but by multi-modal transportation such as bikers, pedestrians, and cars.

The section comparison on page 14 conveys the proposed changes. The road gives way to a widened pedestrian right-of-way. The street materials and narrowed corridor suggest a change in ownership. Pedestrians, bicyclists, and vehicles have the opportunity to share the corridor. The road's center line meanders to further slow vehicular traffic. This meandering road, called a "woonerf," increases pedestrian safety while providing a visually interesting experience for the driver.

If one were to start walking on Broad Street at Maple Avenue (see master plan on page 14) toward 7th Street, he or she would meander along winding paths through small parks, and past an open, green space. At 7th Street, the pedestrian would arrive in the heart of London. Trailhead Park, a gathering and event space along the path, art, and interpretive signage would celebrate history and culture of the city. Continuing along, lush plantings and dense canopies create a sequence of "outdoor rooms" where one would experience a comfortable walk, unique to London. In addition, each of these new greenspaces along Broad Street would become an extension of business street fronts, further enhancing London's streetscape.

BROAD STREETSCAPE

The proposed design seeks to transform London's Broad Street from an asphalt laden vehicular-centric street into an organically-structured, ecologically-sensitive, and pedestrian-friendly corridor.

Both rain gardens and bio-swales have been proposed in various locations to reduce run-off volume and contaminates. A rain garden typically holds the water in a ponding or highly wet situation while a bio-swale is planted to slow water down, but still allow it to run through.

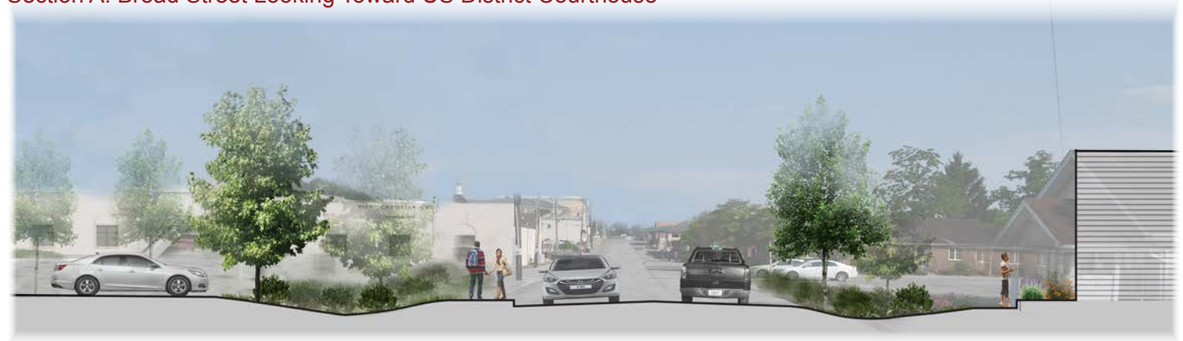
The Garden City and its Garden Street

The following pages include the Broad Street Master Plan, comparison sections of proposed and existing street conditions, an illustration of the proposed street, proposed materials, pedestrian amenities, and a planting palette.

BROAD STREETSCAPE

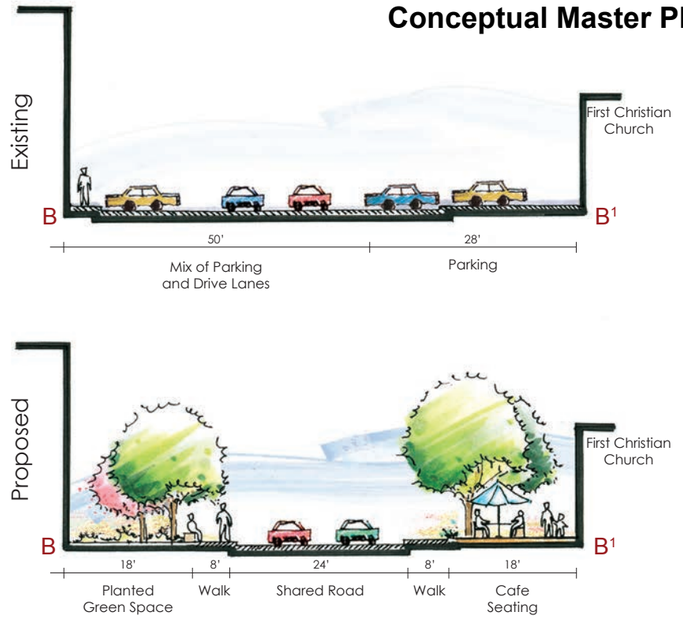
Conceptual Master Plan and Street Sections

Section A: Broad Street Looking Toward US District Courthouse



Section A depicts Broad Street as a green street, with rain gardens on both sides of the road. The rain gardens serve as water catchment and treatment area for the adjacent parking as well as a continuation of the street wall. A continuous street wall draws attention to the periphery of Broad Street, making for a safer pedestrian corridor.

Section B: Broad Street Comparison



The comparative section drawings show the current conditions of Broad Street versus the proposed improvements. Notice an increase in pedestrian-friendly space in the proposed section and imagine this opportunity multiplied along the entire street. Shaded areas to linger, promenades inviting outdoor dining, and a gardenesque streetscape are among the visions for the Broad Street redesign.

The redesign of Broad Street includes a series of parks and places to linger as one walks along the corridor. Bioswales and greenspaces are proposed to reduce the effects of stormwater runoff and erosion. The addition of street trees and larger sidewalks creates a comfortable and shaded experience for visitors as they window shop or enjoy local cuisine.

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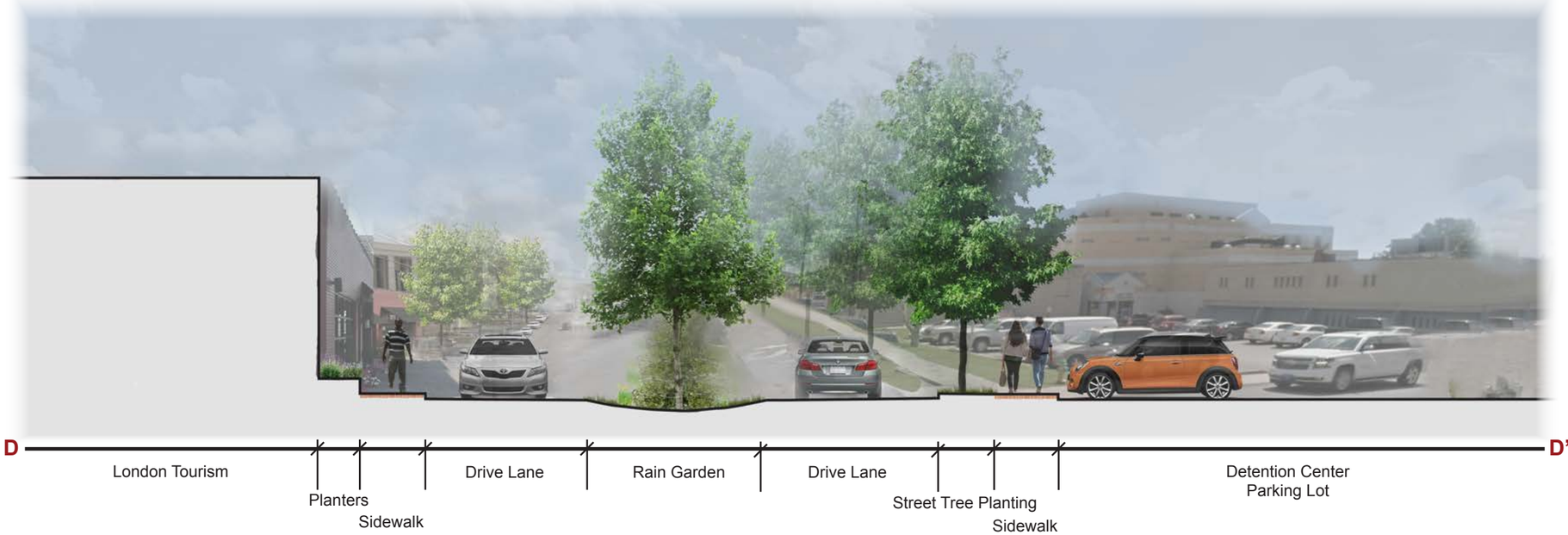
BROAD STREETSCAPE
Street Sections

Section C depicts Broad Street with the proposed bio-swale and pedestrian plaza on either side of the street. Water runoff from Broad Street will be contained in this bio-swale where the water is temporarily stored and filtered by means of natural processes. The pedestrian plaza will increase foot traffic along Broad Street, providing an economic boost to the businesses along Broad Street.

Section C: Broad Street Looking Toward US District Courthouse

Section D: Broad Street



This section of Main Street offers a split road, with a rain garden dividing the two lanes of traffic. Tall street trees line the two lanes of traffic, creating an environment that is pleasing to walk through and functional to drive and park. Micro-climate issues such as the heat island effect during the summer months are resolved due to the high levels of vegetation proposed. The street condition in front of the stores along this section of Broad Street is favorable to pedestrian and bicyclist traffic.

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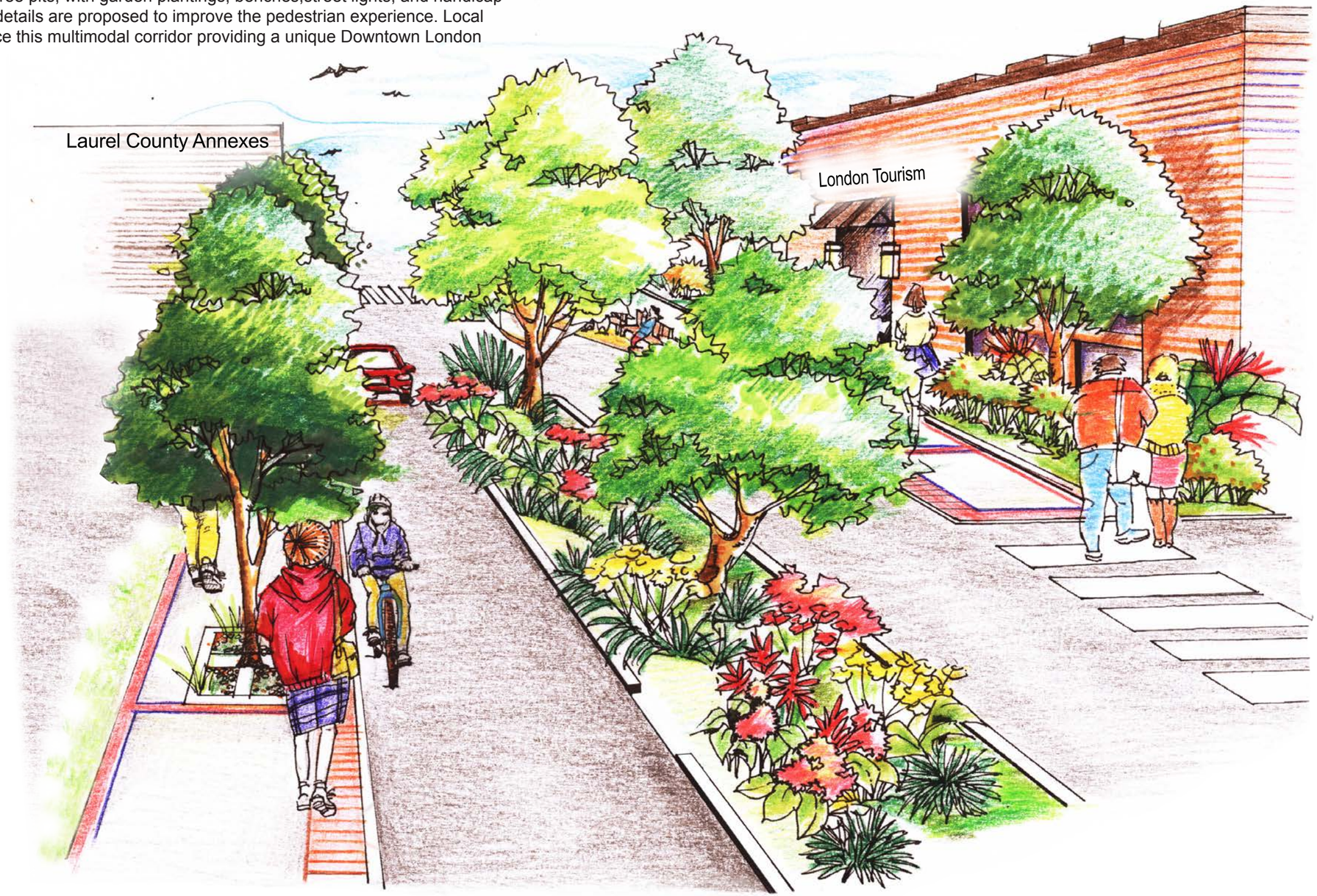
BROAD STREETSCAPE
Perspective Rendering

Perspective A illustrates the vision of Broad Street as a corridor, which compliments London's Main Street gardenesque character. Details such as shade trees, wide tree pits, with garden plantings, benches,street lights, and handicap accesinility details are proposed to improve the pedestrian experience. Local art may grace this multimodal corridor providing a unique Downtown London experience.



BROAD STREETSCAPE

Creative Placemaking

Creative placemaking animates public and private spaces, rejuvenates structures and streetscapes, improves local business viability and public safety, and brings diverse people together to celebrate, inspire, and be inspired. This presentation of public art serves livability, diversity, and economic development goals all the while beautifying the community. Sponsors look beyond physical alterations of space, paying more attention to the animation of places with cultural activity.

London could benefit greatly from this notion by inviting both local and non-local artists to events in downtown, further evoking the branding of the city. Given the passive history of Broad Street, art festivals and public exhibits would be easily conceivable along the route. Such artistry could be permanent installments, such as a mural on the Copper Penny Building, or temporary activities such as a chalk art festival. Examples of permanent and temporary types of creative place making are shown below.

Permanent

Building walls can be reclaimed as blank canvases for local painters.

Recycled glass and tile can be used on retaining walls.

Temporary

Mosaic sculptures can create temporary focal points to showcase local artists.

Benches gain vibrance by means of washable paint or stain.

An otherwise boring chainlink fence is used as a template for artful stained glass.

Chalk art festivals bring residents together in the midst of the streetscape.

Bicycles exhibit color and plant life while reflecting the cycling nature of London.

BROAD STREETSCAPE

Material Palette

The Broad Street corridor offers opportunity for increased commercial and pedestrian viability with its large right-of-way. Proposed materials for streets and sidewalks are chosen to compliment those of the Main Street character, and also to provide an increased sense of awareness to the downtown core.

Stamped concrete sidewalks create visual interest at a lower cost.

Concrete and asphalt alike can be stained or painted to add an artful flair to a space.

Stamped crosswalks make pedestrian maneuverability more recognizable to motorists.

Bio-retention is important along Broad Street considering the current drainage issues. Curb-cuts to natural bioswales allow water to escape the streets and be filtered through plants before re-entering the subsurface water table. Bio-retention areas can be implemented in medians, parking lots, and sidewalk infrastructure and will serve as a catalyst to environmental improvement.

Bio-retention in a parking lot.

Bio-retention along a street corridor.

Bio-retention island within a parking lot.

Pedestrian amenities can augment the biking and art culture of London by adding vibrancy and a character unique to London. Seating, signage, bike racks, and movable planters can contribute to this.

Black furnishings compliment those found on Main Street.

Intricate pots allow for bursts of seasonal color, while bringing a sculpturesque identity to the space.

BROAD STREETSCAPE

Streetscape Plant Palette

Trees

Gleditsia triacanthos f. inermis (Thornless Honeylocust)
A popular street tree, with fine-textured leaves that turn a rich golden yellow in the fall.


Ginkgo biloba (Ginkgo Biloba)
Its oblong leaves have an inspiring light green foliage in the summer and yellow tint in the fall.


Shrubs

Hydrangea quercifolia (Oakleaf Hydrangea)
This medium shrub offers showy cone-like white flowers with large oval leaves. Grows best in part shade conditions.

Hakonechloa macra (Japanese Forest Grass 'All Gold')
This textured grass brings nice light green and yellow tones to the garden. Its mounding circular habit creates structure in the garden.

Perennials

Chrysanthemum x superbum 'Aglaia'
(Aglaia Shasta Daisy)
Puffy white flowers with yellow centers bring showy delight during the summer months. Clumping habit.

Digitalis purpurea 'Apricot' (Apricot Foxglove)
This upright flower compliments the oakleaf hydrangea with its cone-like shape. Light pink and white foliage ties the plant back to nearby canvases.

Amsonia hubrichtil (Arkansas Blue Star)
Blue, spikey flowers tend to mound together to create vibrant color in the garden. Spindle leaves bring a new texture to the typical perennial collection.

Buddleja x 'Asian Moon' (Asian Moon Summer Lilac)
A bit on the smaller side, this purple flower offers fragrance to a space. Attracts butterflies and bees while remaining in a calm atmosphere.

BROAD STREETSCAPE

Bioswale Plant Palette

Trees

Quercus bicolor (Swamp White Oak)
Chosen for its resilience to both dry and moist soils, this species will thrive in the Kentucky climate. It has beautiful fall color and crisp bark.


Ulmus americana (American Elm)
Its tolerance for wet and dry soils makes it a positive choice for bioswales. Leaves turn golden yellow in the fall.


Shrubs

Cornus sericea (Redoiser Dogwood)
This shrub does well in a variety of conditions, including wet soils. Fibrous roots help with erosion control. Its white flowers in the summer and bright red stalks in the winter provide year round interest.


Perennials

Echinacea purpurea (Purple Coneflower)
This tall-stalked flower brings bright color and motion with its upright habit. Great for wet and dry soils alike.

Lilium superbum (Turk's Cap Lily)
The Turk's Cap Lily has an upside-down blooming habit, providing a sense of artfulness to any garden. Its orange bloom contrasts other flowers.

Aster puniceus (Swamp Aster)
The mounding habit of this perennial brings a small shrub-like attribute to the rain garden. It is blue in color.

Iris versicolor/Iris prismatiea (Native Iris)
Easy to grow and multiplies over time. Tolerant to dry and wet soils. Showy summer flowers.

Rudbekia subtomentosa (Blackeyed Susan)
This upright flower provides bright yellow flowers during the summer months. Its thick flowering habit brings powerful color to any area.

BROAD STREETSCAPE

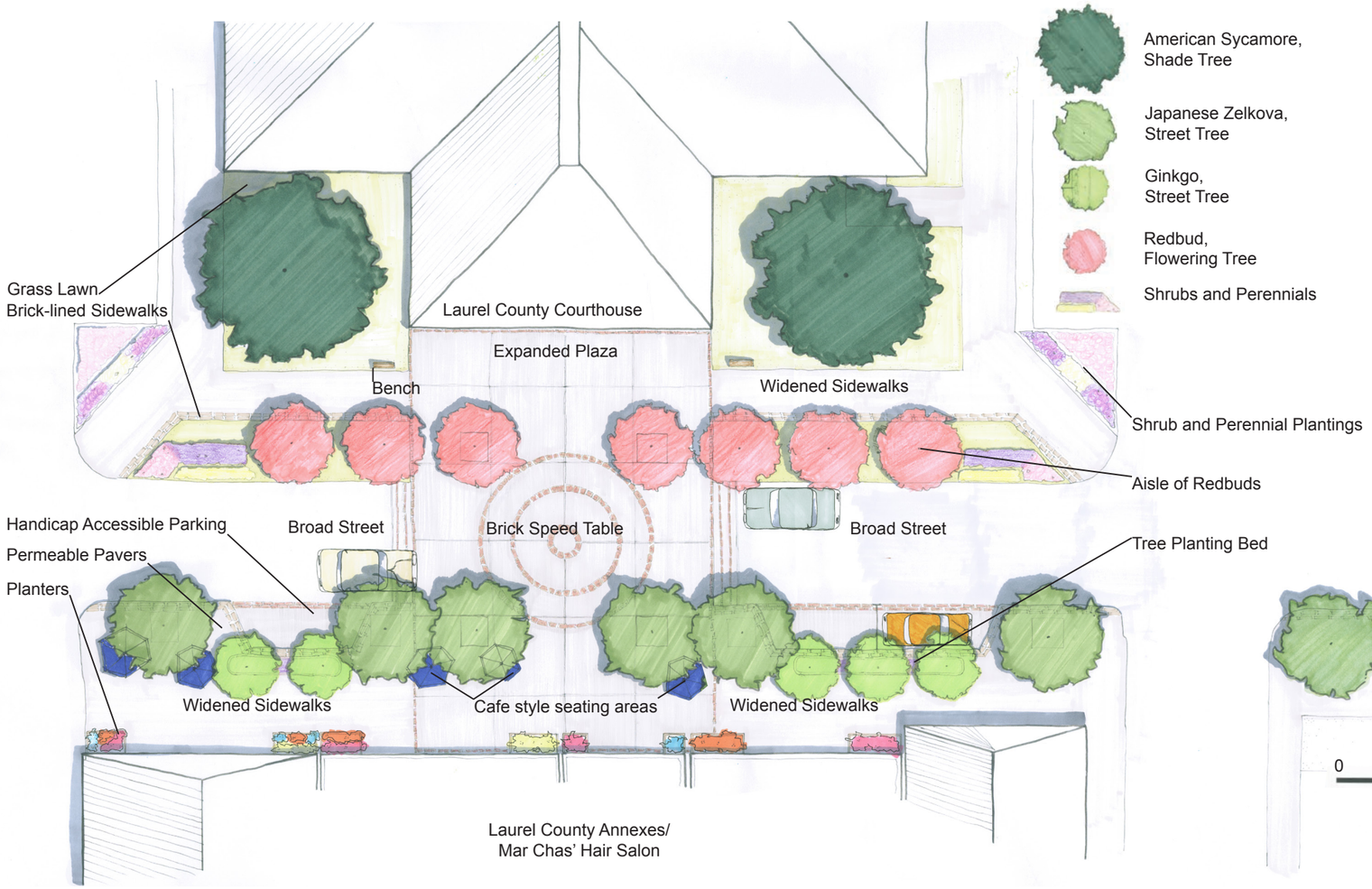
Courthouse Plaza Design Description
Visitors to the London Courthouse typically enter from the rear entrance on Broad Street. However, it is not as inviting as the front facade of the building. The Courthouse plaza concept creates a plaza space between the courthouse and the Laurel County Annexes.

The back of the Courthouse now becomes a place to relax or take lunch on the two brick patios. Dappled shade provides an intimate, yet inviting space during the seasons. Perennial and shrub plantings surround and complement the courthouse, while flowering trees provide bursts of color throughout the year. Widened pedestrian pathways allow ease of access for locals and tourists. In addition, a raised speed table slows traffic and allows pedestrians to safely cross Broad Street to another brick patio located across the street.

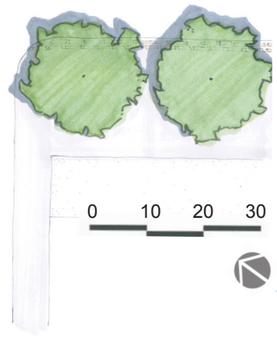
The increased width of the sidewalks is an opportunity to provide cafe seating or promotional space for store owners. The increased vibrancy is sure to draw more people to Broad Street. The addition of eateries would help bring business men and women across the street to enjoy the London locale.

The following pages contain the conceptual master plan and images of possible design elements.

BROAD STREETSCAPE
Courthouse Plaza Conceptual Master Plan

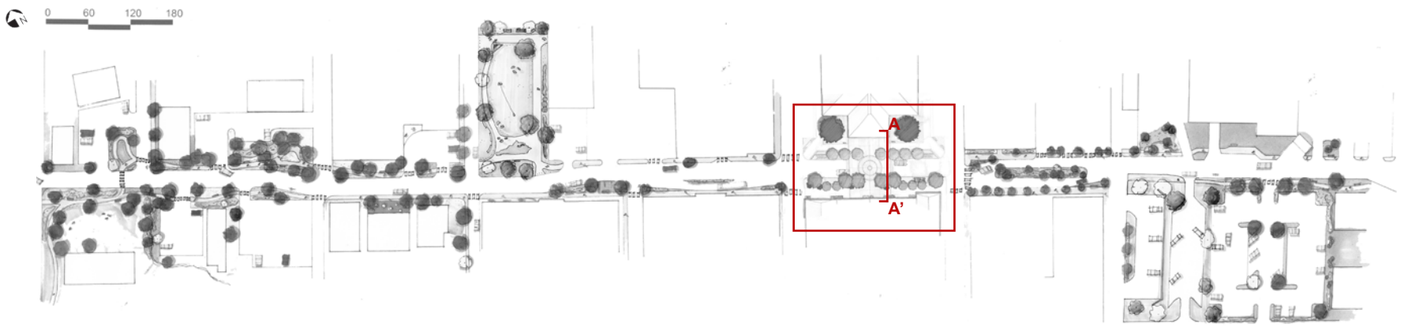


Images of cafe style seating in areas with widened sidewalks and green space opportunities in small urban spaces.



Section A helps to clarify how either side of the street interact with each other. One side is more ornamental and showy with magenta Redbud trees in front of the courthouse, while the opposite site boasts larger shade trees to invite cafe seating and lingering.

Locator Map



Section A

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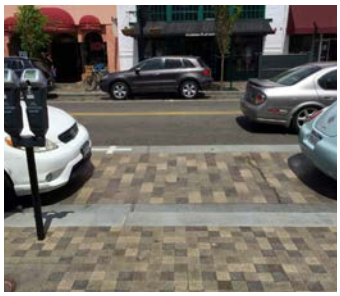
BROAD STREETSCAPE

Courthouse Plaza Material Palette

Special attention is given to the new plaza located behind the London Courthouse to celebrate the coherence of space across Broad Street. Permeable paver parallel parking, stamped concrete or asphalt crosswalks, and brick-lined sidewalks are among these site elements. This design strategy creates moments along the Broad streetscape by identifying desirable places to linger amid the rhythm of the overall scheme.



Permeable paver parallel parking is aesthetically pleasing and creates the illusion of a more narrow street, slowing traffic as it moves through.

Stamped crosswalks make pedestrian maneuverability more recognizable to motorists.

Brick-lined sidewalks reflect the style and material choice of the London Courthouse, generating a cohesive surrounding landscape.

Plant List

To further distinguish the Courthouse plaza from other areas of the Broad streetscape, a refined plant palette increases the biodiversity of Broad Street as well as provides a vertical exaggeration to draw attention to the prominade of the courthouse. Trees, shrubs, and perennials were chosen for their size, hardiness to salt, moisture, cold temperatures, and attractiveness.

Shade Tree

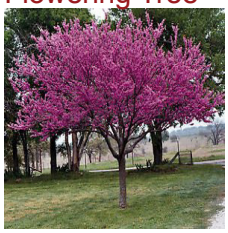
Platanus occidenalis
American Sycamore

Street Trees

Zelkova serrata
Japanese Zelkova

Ginkgo biloba
Ginkgo Biloba

Flowering Tree



Cercis canadensis
Redbud

Shrubs and Perennials

Deutzia x lemoinei
Lemoine Deutzia

Hemerocallis
Common Daylily

Ardisia japonica variegata
Marlberry

Caryopteris x clandonensis
Caryopteris 'Grand bleu'

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Design Description

Entering the more dense urban fabric of London's downtown while driving southeast on Main Street, one is greeted with a vast, asphalt lot. Underutilized and poorly maintained, this is an eyesore and a potential gateway to the downtown corridor. It is situated at the western end of downtown adjacent to the London Elementary School. Seldom is this lot used for parking, except for a couple times a year during large events.

Given its close proximity to London's downtown and nearby residential areas, this site possesses opportunity for an incredible civic space and community asset.

Main Street Community Park was conceptualized from the idea of the awareness ribbon and could be named "Remembrance Park". This system of sweeping paths delineates a variety of spaces, whether open lawn or planted. The park serves as a large gathering space for community events, boasting an open-air event pavilion, splash pad, public holiday tree, and large open lawns for activity. The plant placement creates a sense of enclosure and safety from surrounding roads. The wildflower meadows, close to Main Street, help to separate motorists from park-goers. Adjacent to the pavilion is a rain garden, serving to cleanse and recycle runoff, rain-water from the pavilion roof, and nearby paved areas. Across the lawn from the pavilion stands a Blue Spruce, serving as the city's holiday tree during winter festivities.

"Remembrance Park" is designed, too, with the London Elementary School in mind. Large gathering spaces could accommodate a physical education course, recess, or outdoor classrooms could gather under the pavilion structure. Openly programmed lawns allow for spontaneous and creative play among classmates. These spaces could foster closer social relationships and imaginative play activity. A variety of trees and shrubs have been chosen for shade, fragrance, and brilliant fall foliage, drawing people in and making "Remembrance Park" a year-round community destination.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Interpretive signage is proposed throughout Main Street Community Park. This signage is intended to inform the public about the many aspects and layers of the park, such as native plant species identification, cultural and community information about London, as well as the ecological and social benefits of rain water harvesting, habitat preservation, and open green areas. This signage will be a powerful tool in informing members of the London community as well as visitors to London, about the efforts being made by London to become a more socially, environmentally, and economically vibrant place to live.

Welcome to Remembrance Park, London's Main Street Community Park.

The following pages include a conceptual master plan, an axonometric perspective view of the site, images of possible design elements, and a planting palette.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Conceptual Master Plan

Formerly referred to as “The Vacant Hospital Parking Lot,” “Main Street Community Park” lends itself to be the signature view as you enter downtown from the west. A meadow of wildflowers fronts Main Street, acting as a buffer between park-goers and vehicular traffic. These flowers tie in nicely with the existing streetscape and further emphasize London as a ‘Garden City.’ Just beyond the wildflowers stands an evergreen tree, functioning as the city’s holiday tree during the winter months. The surrounding lawn space and open-air picnic pavilion with stage structure serve to invite any number of guests to use the space year round. With London’s Thursday Night Live in need of relocation, the stage area is focused to the larger lawn areas to accommodate for comfortable gathering space.

Locator Map *Not to Scale*

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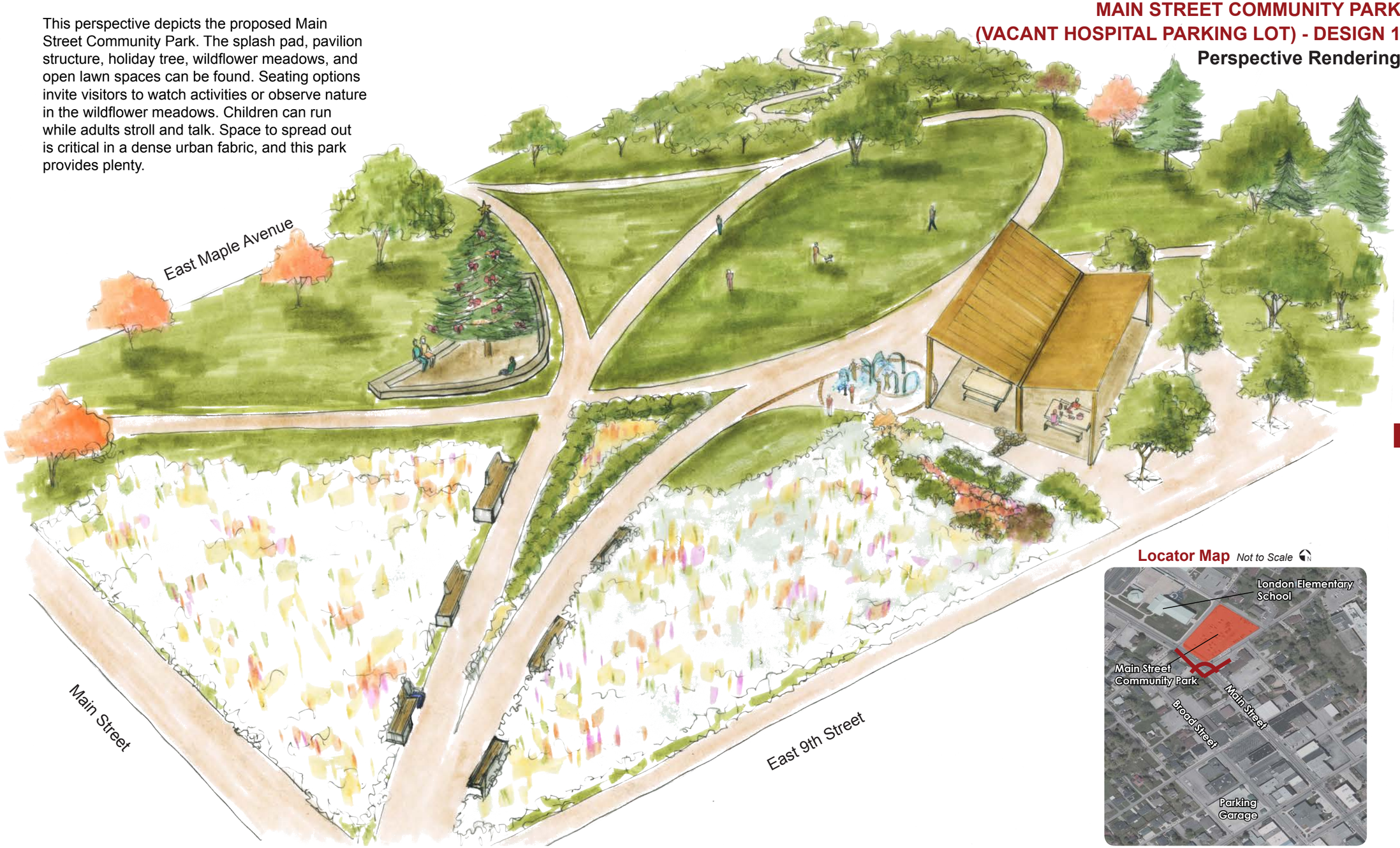
MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Perspective Rendering

This perspective depicts the proposed Main Street Community Park. The splash pad, pavilion structure, holiday tree, wildflower meadows, and open lawn spaces can be found. Seating options invite visitors to watch activities or observe nature in the wildflower meadows. Children can run while adults stroll and talk. Space to spread out is critical in a dense urban fabric, and this park provides plenty.



Locator Map *Not to Scale*

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MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Inspiration and Material Palette

Inspiration

With the exception of London's thoughtfully designed and well-maintained Main Street, London's downtown has a host of design problems, including the lack of a large public gathering space. Main Street Community Park, Design 1 addresses that issue by incorporating programs that bring community members together as one outdoors to gather, play, and relax. The conceptual design proposed is inspired by community parks which offer open gathering spaces, splash pads, and ample seating options. Active play and a tranquil area have been encompassed into this design.

Inspiration for the open-air, picnic pavilion. Notice the outward focus of the structure, offering unrestricted views of the surroundings.

The sculptural splash area is both an inviting attraction for children as well as a complement to the picnic pavilion.

Paths through dense foliage create a peaceful environment within the city.

Material Palette

In an effort to blend traditional with contemporary standards, site furnishings use standard materials in a more refined geometry. More angular design demonstrates a modern, updated aesthetic. Multi-functional seating invites guests to observe the environment in a position comfortable to themselves. Providing trash receptacles made from the same materials as the benches creates a cohesive style among furnishings.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 1

Plant Palette

Cladrastis kentukea (Kentucky Yellowwood)
A small to medium-size deciduous tree, chosen for its fragrant white flowers blooming at the beginning of the summer season. Its smooth gray bark compliments the compound pinnate foliage beautifully.

Cercis canadensis (Redbud)
To compliment the tradition of the annual Redbud Ride in London, *Cercis canadensis* can be found throughout the city. Known for their winding branch structure and stunning magenta flowers from spring through summer, this large shrub or small tree is a superb addition to this gardenesque park.

Amalanchier canadensis (Serviceberry)
This ornamental shrub or small tree offers small white flowers in a less-dense form beginning in early spring. The deep purple fruit, becoming ripe in late summer, is edible to mammals and birds.

Acer saccharum (Sugar Maple)
Large tree offering exceptional shade during hot summer days. Its deep yellow/orange foliage is spectacular during the fall. It maintains a stately stature with its symmetrical growth habits.

Ulmus parvifolia (Lacebark Elm)
A favorite along the Main Street landscape, the Lacebark Elm contrasts other trees with its slender trunk and leather, pointed leaves, bringing a varied texture to any space.

Ginkgo biloba (Ginkgo)
Resistant to snow and wind, the Ginkgo is a resilient tree suited well for the Kentucky climate. It erratic branching structure and bright yellow fall foliage make this tree a sculturesque specimen year-round.

Rain Garden
For more information regarding rain garden plantings, refer to page 52 (Judicial Parking Lot plant palettes)

Example wildflower meadow
The addition of wildflower meadows will attract pollinator bees and butterflies and be a beautiful entry into the park. A mix of spring, summer, and fall blooming flowers ensures a constant variety of colors and fragrance in this area.

Picea pungens (Blue Spruce)
This hearty tree offers sturdy branches, perfect for a holiday tree. Its glaucous color and spiney foliage contrasts surrounding trees.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Design Description

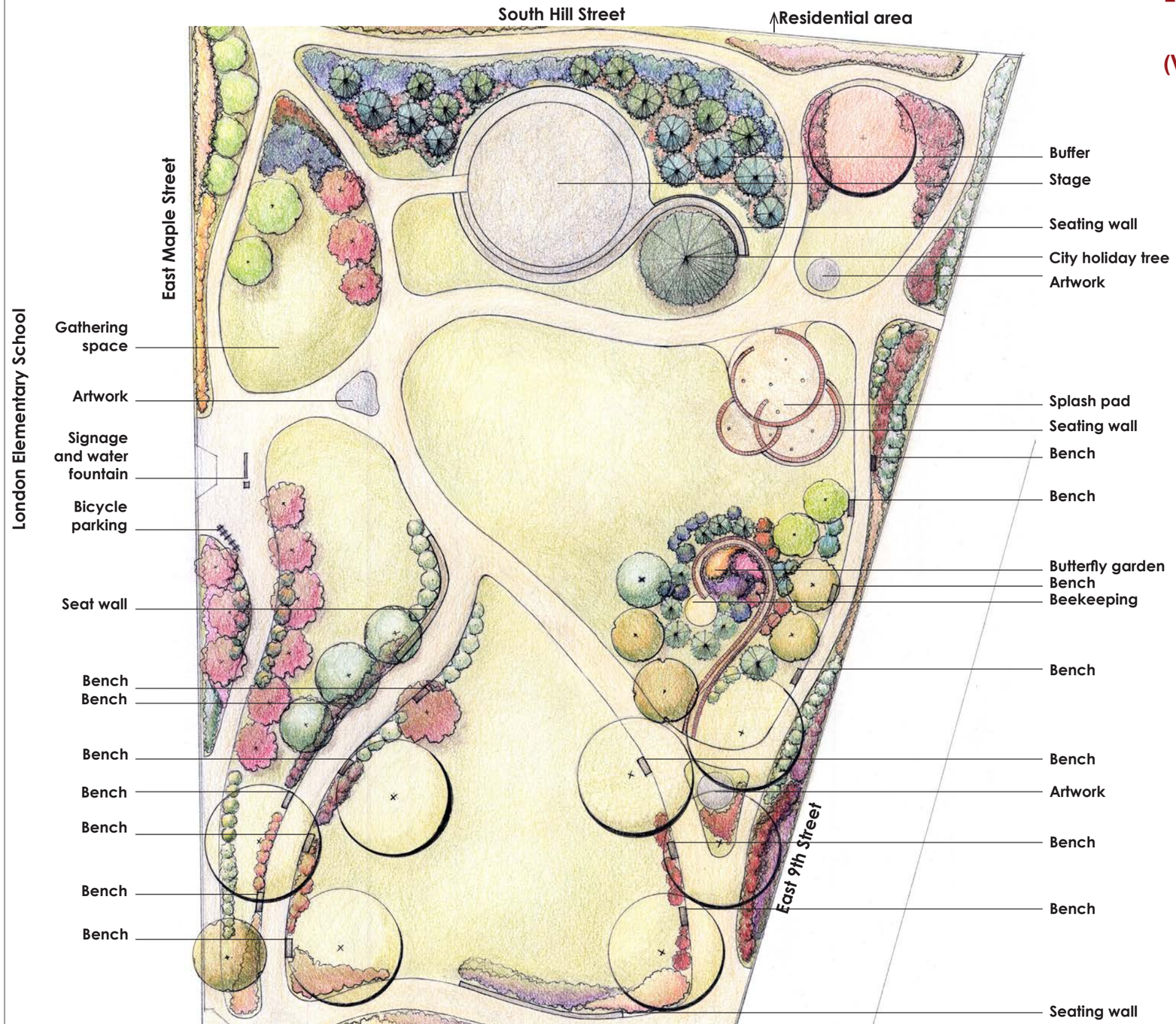
The alternative design emerged as a response to comments made during the Final Conceptual Design Presentation. The aim of this concept is to provide a more gardenesque character than the first alternative. Soft edges and transitions buffer and layer the vegetation by using varying heights and color that provide separation and transition between urban and park spaces, as well areas in the park that need to be open and areas that need to be protected. Framing of the paths and trails with vegetation, works as architectural marks to contribute to the feeling of mystery, interest, and direction to focal points in the park. Intersections of trails provide opportunities for focal points. In these areas, there is space for artwork made by community members, possibly through a contest for sculptures for the park. Selection of plant species that have special meaning for the community, such as redbud trees and Kentucky yellowwood are included in the planting palette. Design decisions were made to incorporate plants, in ways of adding beauty and a gardenesque feeling to the park, reminiscent of the pride the town has about their gardens around London.

Specific aspects of this alternative include:

- A stage, located at the far end of the park: surrounded by open space, community gatherings would focus attention to the stage/event space.
- A holiday tree: located to take advantage of its location near the stage and to reinforce it with decorations for celebrations. It is also a gathering space, with a seat wall around it, ramping through the stage, embracing it.
- Beekeeping and butterfly garden space: This area serves well for an area to linger and observe native insects. Bees and butterflies are great pollinators to enhance the natural pollination of native plants.
- A gathering space near the school: this open space can be used for outdoor classes and learning experiences of observing nature in the park. This space is complemented by signage about the park, a water fountain, and bicycle parking.
- Buffers behind the stage and holiday tree: they help with separations and soft transitions between the park and the urban environment around it by blocking the view to the residential area behind the stage.
- Seat walls and benches located throughout the park.
- A splash pad for entertainment and refreshment on warm days.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Conceptual Master Plan



As part of the gardenesque landscape typology, Design Two for the Main Street Community Park includes multiple meandering walking paths. These walking paths wind through sensual plantings that evoke emotions of peace and tranquility. The walking paths are concentrated around the planting beds along the perimeter of the site, leaving space for open lawn in the central portion of the site. Benches and bicycle racks promote the notion of providing a pedestrian oriented Main Street for London. This Community Park is a place for stopping by on a walk down Main Street, and also a destination, with program elements included such as the stage and children's splash pad.

Locator Map *Not to Scale*

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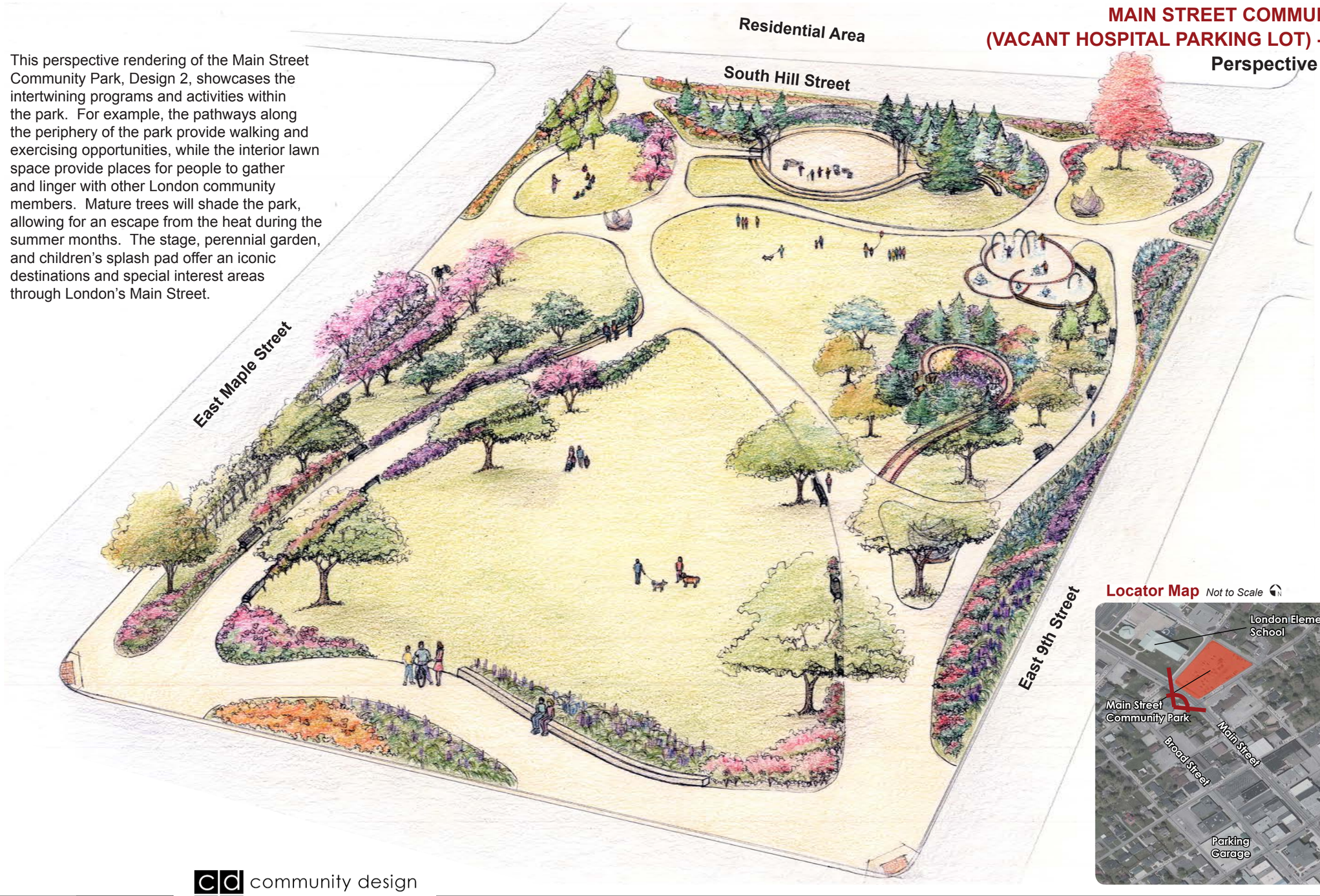
MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Perspective Rendering

This perspective rendering of the Main Street Community Park, Design 2, showcases the intertwining programs and activities within the park. For example, the pathways along the periphery of the park provide walking and exercising opportunities, while the interior lawn space provide places for people to gather and linger with other London community members. Mature trees will shade the park, allowing for an escape from the heat during the summer months. The stage, perennial garden, and children's splash pad offer an iconic destinations and special interest areas through London's Main Street.



Locator Map *Not to Scale*

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MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Inspiration and Material Palette

Inspiration

Design alternative 2 proposed a gardenesque place for public gathering. It incorporates community feedback with the city's desires for a park space. The park would provide space for different groups of people to enjoy different activities harmoniously. It was also designed to accommodate a phased-in construction implementation due to funding or time issues.

Material Palette

A few suggestions and references were incorporated in the design as follows:

Inspiration for the stage: The Toronto Music Garden has a beautiful metal structure in its stage, which allows for climbing plants to grow. It's a suggestion to use the idea as inspiration for a contest between artists in town to make this type of structure in a way that represents the identity and expertise of the community.

Sculptural splash pads: many parks throughout the country have splash pads with structures that are fun and inviting for play, but also aesthetically interesting.

Seating walls.

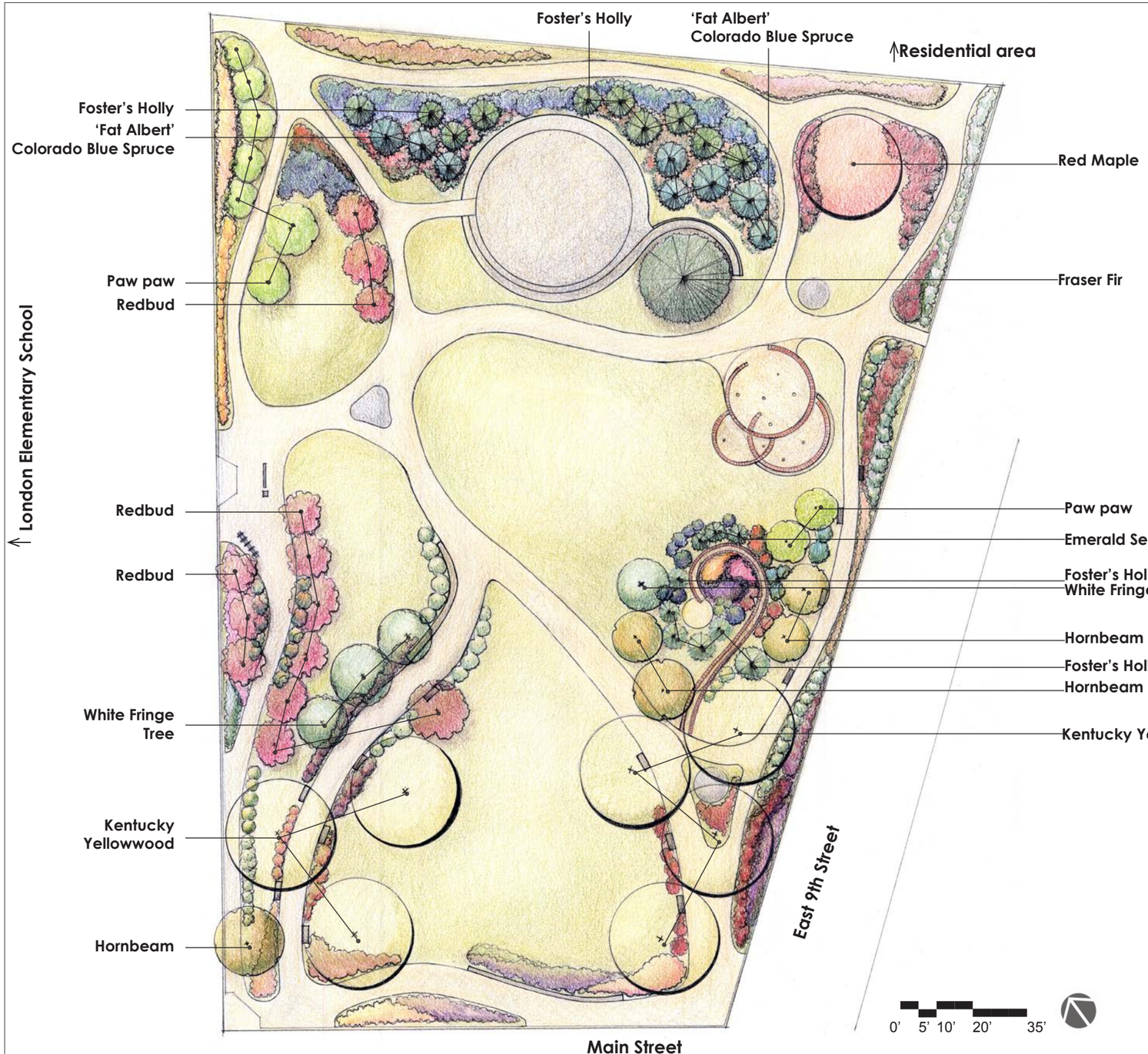
Benches used in London.

Inspirations for bee-keeping structures.

Art for the park: Another opportunity for local artists to display their work is in the artwork spots through the park where there is room for exhibition of either permanent or temporary sculptures.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Planting Plan (Trees)



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MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Plant List (Trees)

Cladrastis kentukea (Kentucky Yellowwood)
Deciduous tree with white flowers in the beginning of summer, showy yellow fall foliage, and gray bark. 30 to 50' tall and wide.

Cercis canadensis (Redbud)
Chosen because it is already a symbol of the City of London during the traditional Annual Redbud Ride in London. Small tree with magenta flowers from spring through summer.

Carpinus caroliniana (American Hornbeam)
New leaves emerge reddish purple, changing to dark green. Turns to shades of orange, yellow, and red make excellent fall colors. 20-30' tall and wide. Rounded habit.

Chionanthus virginicus(White fringe tree)
Multi-stemmed tree with fragrant spring flowers. 12 to 20' tall and wide.

Asimina triloba (Paw paw)
Yellow edible fruit and yellow fall color. 15-20' tall and wide. Rounded or pyramid habit.

Pincea pungens 'Fat Albert' ('Fat Albert' / Colorado Blue Spruce)
Blue green needles. 10-15' tall, 7-10' wide. Chosen for its interesting color and broad pyramid habit to compose buffers.

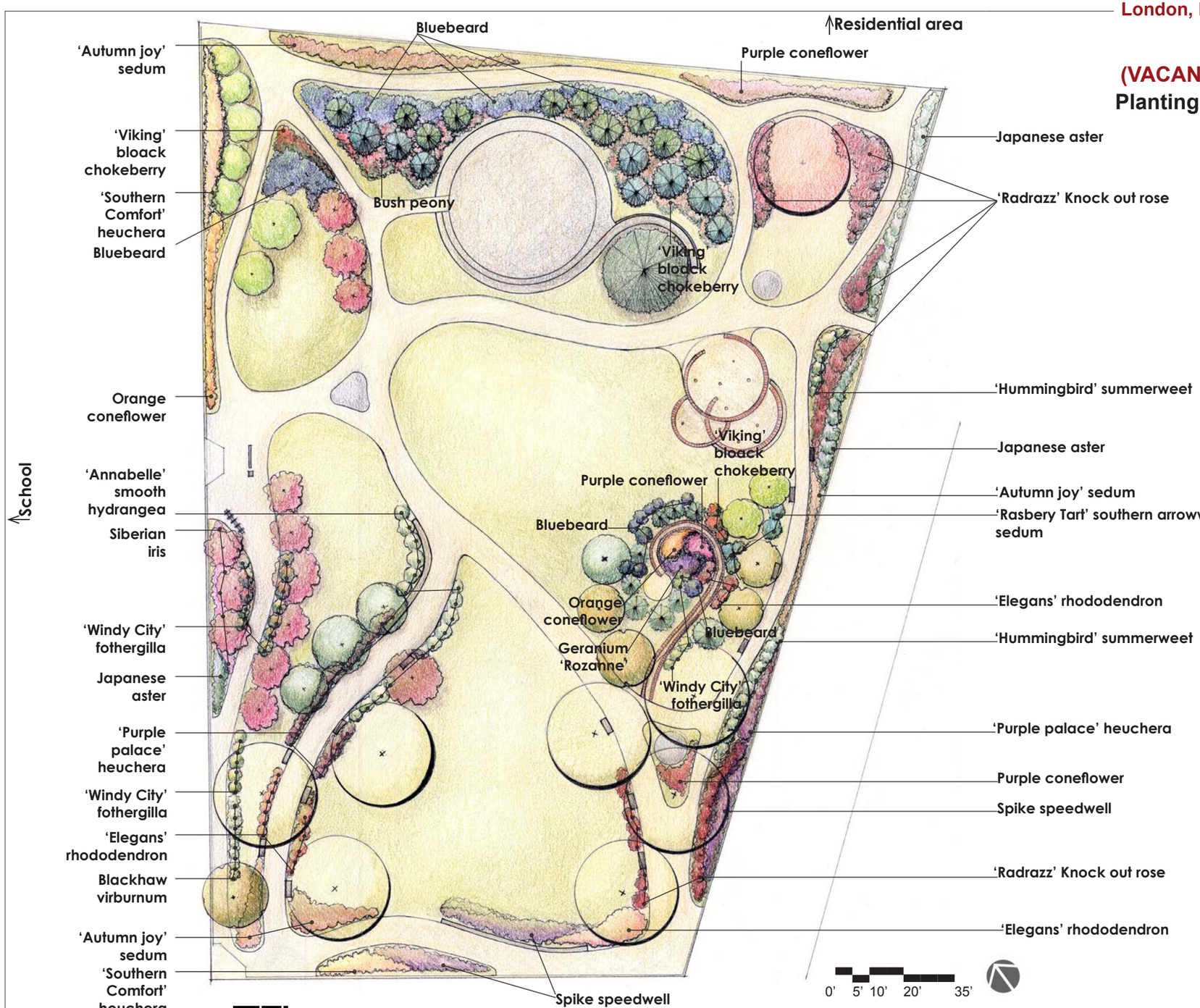
Ilex × attenuata 'Fosteri' (Foster holly)
Evergreen tree with a dense, upright, pyramidal habit. Dark olive green leaves. Small white flowers bloom in late spring, followed in fall by an abundant crop of bright red berry-like drupes which persist throughout the winter. 20-30' tall, 10-15 wide.

Abies fraseri (Fraser fir)
Its up-turned branches and dense form will serve well as a holiday tree. 30-40' tall and 20-25' wide.

Acer rubrum (Red Maple)
Beautiful in all seasons and with gorgeous fall colors. 40-60' tall, 25-35 wide.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Planting Plan (Shrubs, Perennials, and Grasses)



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MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Plant List (Shrubs, Perennials, and Grasses)

Heuchera 'Southern Comfort' ('Southern Comfort' heuchera)
Apricot to soft orange foliage, white flowers late summer, full sun to part shade. 12" tall, 12-18" wide. Mounded habit.

Heuchera 'Plum Pudding' or 'Palace Purple' ('Palace Purple' heuchera)
Chosen for its purple foliage, dainty white flowers early summer, part sun/part shade to full shade. 12" tall, 12-18" wide. Mounded habit.

Sedum 'Autumn joy' ('Autumn joy' sedum)
Dusky salmon pink flowers, part-shade or full sun. 1.5-2' tall and 2-3' wide. Mounding habit.

Veronica spicata (Spike speedwell)
Indigo flowers in the summer and a few in early fall; full sun to part shade. 1-2' tall and wide. Mounded habit.

Rhododendron 'Elegans' ('Elegans' rhododendron)
Vigorous-growing, medium-size evergreen shrub with pink flowers, spring to early summer; shade, part-shade, full sun; 4-5' tall and wide.

Virburnum prunifolium (Blackhaw virburnum)
White flowers, edible black berries; full-sun to part shade. 12-15' tall, 10-12' wide.

Fothergilla minor 'Windy City' ('Windy City' fothergilla)
Showy spikes of fragrant white flowers rising above the foliage in mid spring before the leaves. It has bluish-green foliage throughout the season. Beautiful round orange leaves in the fall, full sun to part shade. 3-4' tall and wide.

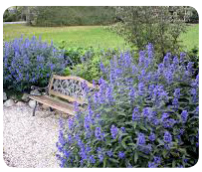
Iris sibirica (Siberian iris)
Purple flowers, full sun to part shade. 2-4' tall, 2' wide.

Hydrangea arborescens 'Annabelle' ('Annabelle' smooth hydrangea)
Large balls of white flowers, full sun to part shade. 3-4' tall.

MAIN STREET COMMUNITY PARK (VACANT HOSPITAL PARKING LOT) - DESIGN 2

Aronia melanocarpa 'Viking' ('Viking' black chokeberry)
Red foliage, white blooms and black fruits, full sun to part shade. 3-6' tall, 6-8' wide.

Caryopteris × clandonensis 'Longwood Blue' (Bluebeard shrub)
Chosen for its purple foliage. 2-4' tall and wide. Deciduous shrub with aromatic foliage and late summer flowers. Chosen because its flowers are very attractive to butterflies, bees, and other beneficial insects, and also for its height and spread; sun.



Rosa 'Radrazz' ('Radrazz' Knock out rose)
Red, yellow, and pink cultivars which bloom summer to frost 3-4' tall and wide. Chosen for its strong red colors and for being disease resistant. Flowers are followed by orange-red hips. Foliage is dark purplish-green in summer, turning purple to burgundy in fall. Full sun to part shade.

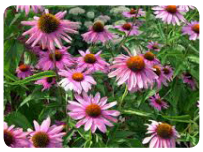
Paeonia sp. (Bush peony)
Color vary from white to pink to dark magenta. 2-3' tall and wide. Mounding habit. Full to part sun.

Clethra alnifolia 'Hummingbird' (Hummingbird summersweet)
Fragrant white blooms; partial to full sun. 3-4' tall, 4-5' wide. Attractive to hummingbirds and butterflies.

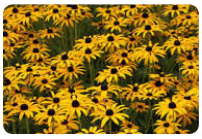
Viburnum dentatum 'Raspberry Tart' ('Raspberry Tart' southern arrowwood)
White spring flowers and blue berries; full shade to full sun. 4-5' tall, 3-4' wide.

Kalimeris pinnatafida 'Hortensis'(Japanese aster)
White flowers in late summer into early fall; part to full sun. 2-3' tall and wide. Mounding habit.

Echinacea purpurea (Purple coneflower)
Pink, purple, orange and red flowers blooming late summer to early fall. 2-3' tall, 2' wide. Chosen for its pink cultivars. Upright habit. Part shade to full sun.



Rudbeckia fulgida var. sullivantii 'Goldsturm' (Orange coneflower)
Yellow blooms in late summer into early fall. 1.5-2' tall and 2-3' wide. Mounding habit. Part to full sun.



Geranium 'Gerwat Rozanne' (Geranium 'Rozanne')
Violet-blue flowers. 12-18" tall and 18-24" wide. Mounding habit. Part to full sun.

MAIN STREET POCKET PARK

Design Description

During a second visit CDAC made in April 2015, the city identified the vacant lot between Mike's Hike and Bike and Bodean's Tattoos as an underutilized space, which could serve as a future park. This small, pocket park is proposed as a green space, which could host community events, art installations, gatherings, and ceremonies.

Benches, a bike rack, bike service station, and seasonal potted plants welcome visitors into the space. One would walk through an artistically designed wrought-iron fence into the site's casual seating area. This fence would have a gate, which could secure the space at night or in the event of an outdoor art exhibit.

Cafe-style tables provide a comfortable place for a quick lunch, a meeting, or a relaxing break. The tables are located under a canopy of honey locust trees, creating an inviting space under dappled shade.

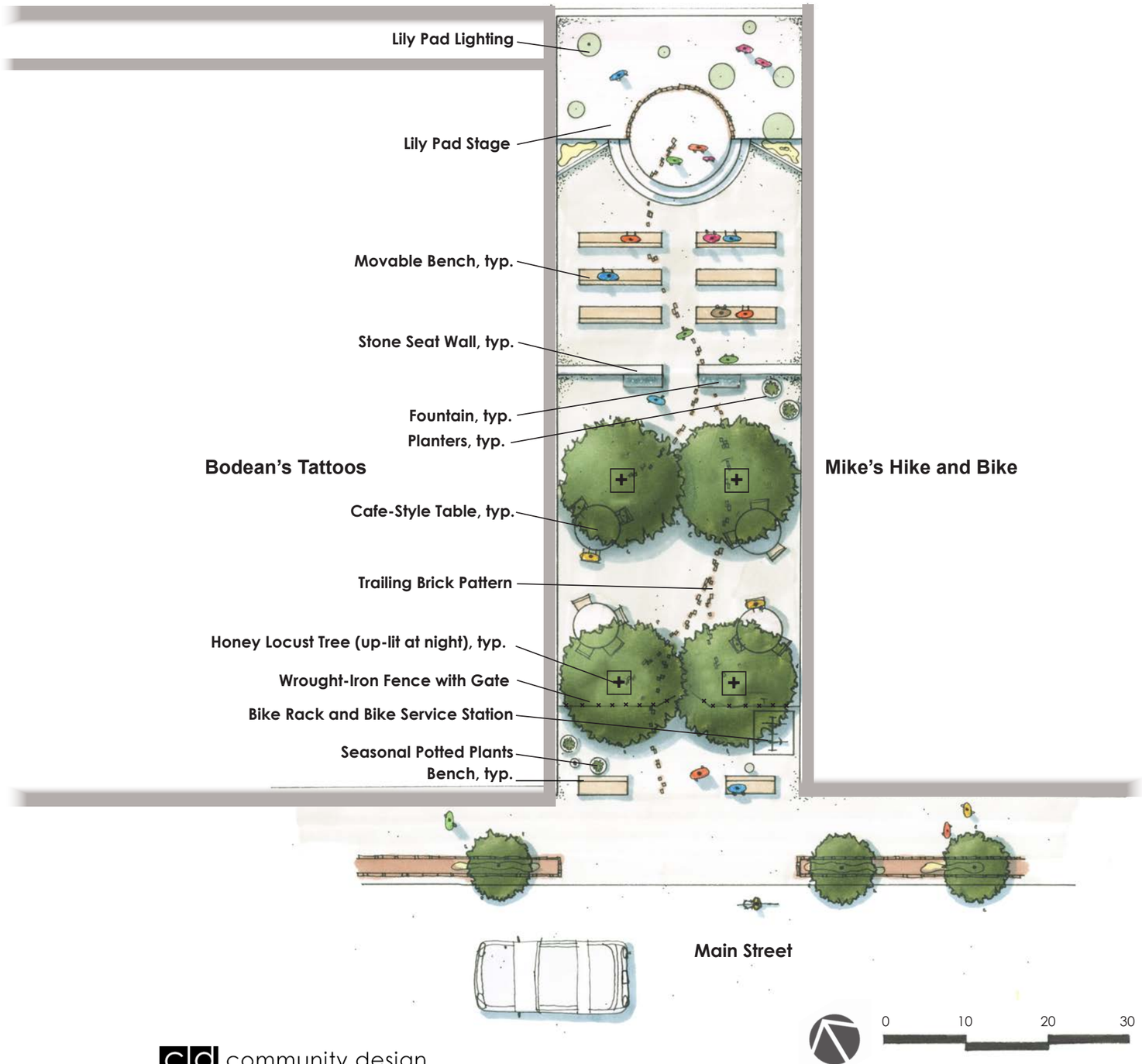
As one moves further into the park, they come to a low seat wall, highlighted by two bubbling fountains, creating a calm and serene atmosphere. The fountains also help mask the sounds of vehicular traffic on Main Street. The stone seat walls serve as the entrance to the final space, a small stage area with ample movable benches where events could take place.

At the rear of the site, a three feet change in elevation lends the opportunity for a stage. This stage could be called "The Lilly Pad". It is constructed with inset circular lighting, reminiscent of small lily pads. From this space, the Mayor could address a gathering of citizens, children could run and play on the "Lily Pad" lighting, a local band could perform in the Thursday Night Live! event, or wedding services could take place in this intimate space.

Each of these spaces, united by a trailing brick pattern as if the lily pads were floating down a stream, create a new pocket park in Downtown London.

The following pages contain a conceptual master plan, a perspective of a view into the site, images of possible design elements, and a planting palette.

MAIN STREET POCKET PARK
Conceptual Master Plan



Another addition to Downtown London's green network, the Main Street Pocket Park offers a comfortable environment for pedestrians to lounge in the core of the city. Divided into two segments, the front of the park offers seating under the light shade of thornless honeylocust trees, along with the sounds of a bubble fountain.

Further into the site is the lily pad stage. Equipped with lily pad motif lighting, tables, and movable seating. This space could host a variety of activities and become an intimate event space. Potted planters throughout the entire space would provide seasonal interest. Murals are envisioned to grace the three walls of this site; art installations may contribute to this park. Other place-making activities and programs could bring the community together in celebration of London's culture and heritage.

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MAIN STREET POCKET PARK
Perspective Rendering

This perspective of the Main Street Pocket Park identifies key features found in the pocket park. One can begin to understand the intimate space. In the foreground, notice the thornless honeylocust trees creating a green ceiling for the space. Two bubble fountains are built into the stone seat wall, which creates a welcoming entrance to the stage area. The brick walls offer themselves as a canvas for murals, adding pops of color.

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MAIN STREET POCKET PARK

Material and Plant Inspiration

Material Inspiration

Considering the small size of the pocket park, it is important to make sure that the space does not feel confined. Several different elements were incorporated to help avoid this. From patterns in the paving to the sensory details of crisp leaves and flowing water, the Main Street Pocket Park offers an escape from the hustle and bustle of the city.

Uplit trees greet Londoners as they enter the space and offer a soothing atmosphere for evening events.

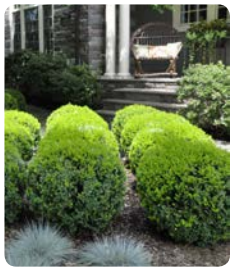
A winding brick pattern reminiscent of flowing water could compliment the theme of a lilly pad and pond motif.

A set of small fountains divide the stage area from the seating/dining area and create a relaxing and peaceful soundscape.

Plant Inspiration

Scale is important when choosing plants for a small area. In order to maximize space and sightlines, few permanent plants were chosen, and seasonal color will be added by potted plants. Thornless honey locusts were chosen for their particular resiliency in this tight space and their less-dense foliage, allowing light to still infiltrate the space. This tree will also provide spectacular fall color. The boxwoods will also thrive with moderate lights throughout the entire year.

Thornless honey locusts will create a ceiling for the cafe space and have brilliant fall color.



Boxwoods for year-round structure and provide evergreen accents during winter holiday events.

Movable pots containing azaleas or small trees.

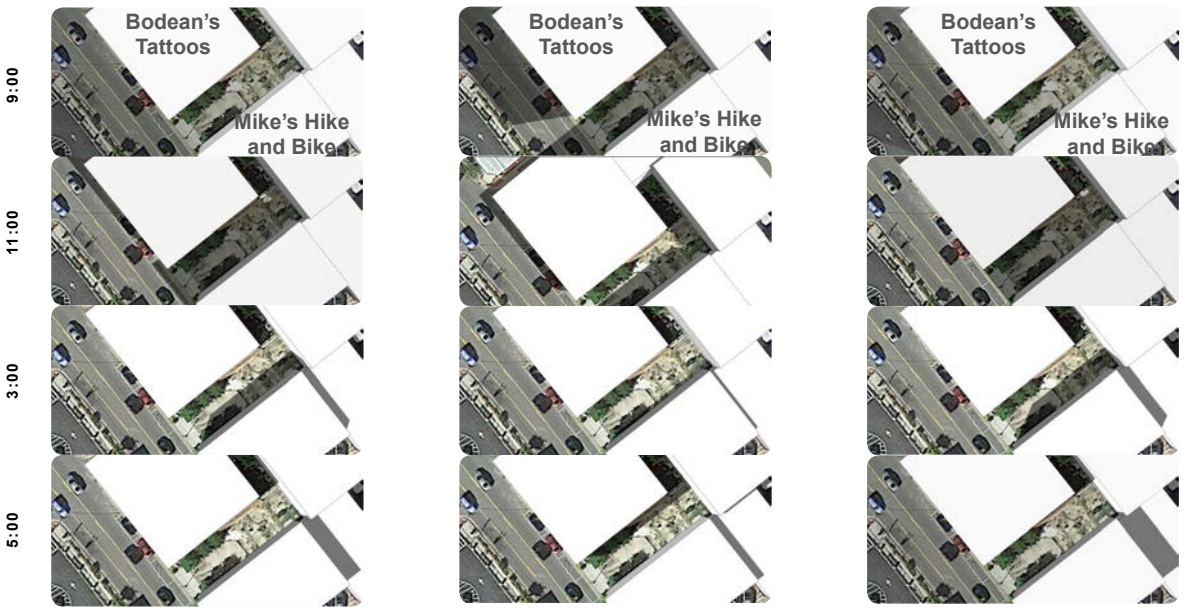
Seasonal rotation of annuals: Coleus for a mix of vibrant color.

Lenten Roses for early Spring brilliance.

MAIN STREET POCKET PARK

Sun and Shade Study

Not to Scale



March July October

To further understand the opportunities and constraints of the pocket park site, the CDAC team conducted a sun/shade study to try to better understand the amount of direct sunlight the space receives daily and throughout the different seasons. The site receives a moderate amount of direct sunlight throughout the afternoon, throughout the year. With this in mind, trees and plants were chosen that would flourish in these specific sun/shade conditions.

7TH STREET TRAILHEAD PARK

Design Description

Currently, London's recreational trailhead can be found at London's Farmers Market. There, signage, maps, brochures, and painted markers direct cyclists and trail enthusiasts. The location of the market, however, is detached from the central city core. The design team proposed moving the trailhead to the heart of London by transforming a large parking lot into a green space. This green space would celebrate bicycles and provide highly desirable pedestrian and bicyclist amenities.

With an influence of bicyclists, the businesses along the Broad Street and Main Street corridors could benefit economically from the bicycling culture.

The parking lot along 7th Street was selected and agreed upon at the Preliminary Design Presentation. This lot had been leased to the city for a considerable number of years and is used for events such as the World Chicken Festival. The addition of a trailhead and supporting amenities such as signage, maps, markers, and informational kiosks would provide a place for the London community to congregate. The design also proposes an event stage as well as an open lawn to accommodate playful activities.

Located at the corner of Broad and West 7th Streets, the trailhead park will become a new place for both Londoners and visitors alike to gather, attend events, and park bikes. This new designated trailhead will serve as a major attraction for cyclists beginning or ending their journey. Contemporary signage will offer visitors and locals information concerning biking trails, attractions, and the culture and history of London. Ample bike racks for bike storage and two bike maintenance stands will also give cyclists peace of mind as they explore the city and Laurel County. In addition, a large open green space could play host to events ranging from a small birthday party to the celebration of the Redbud Ride.

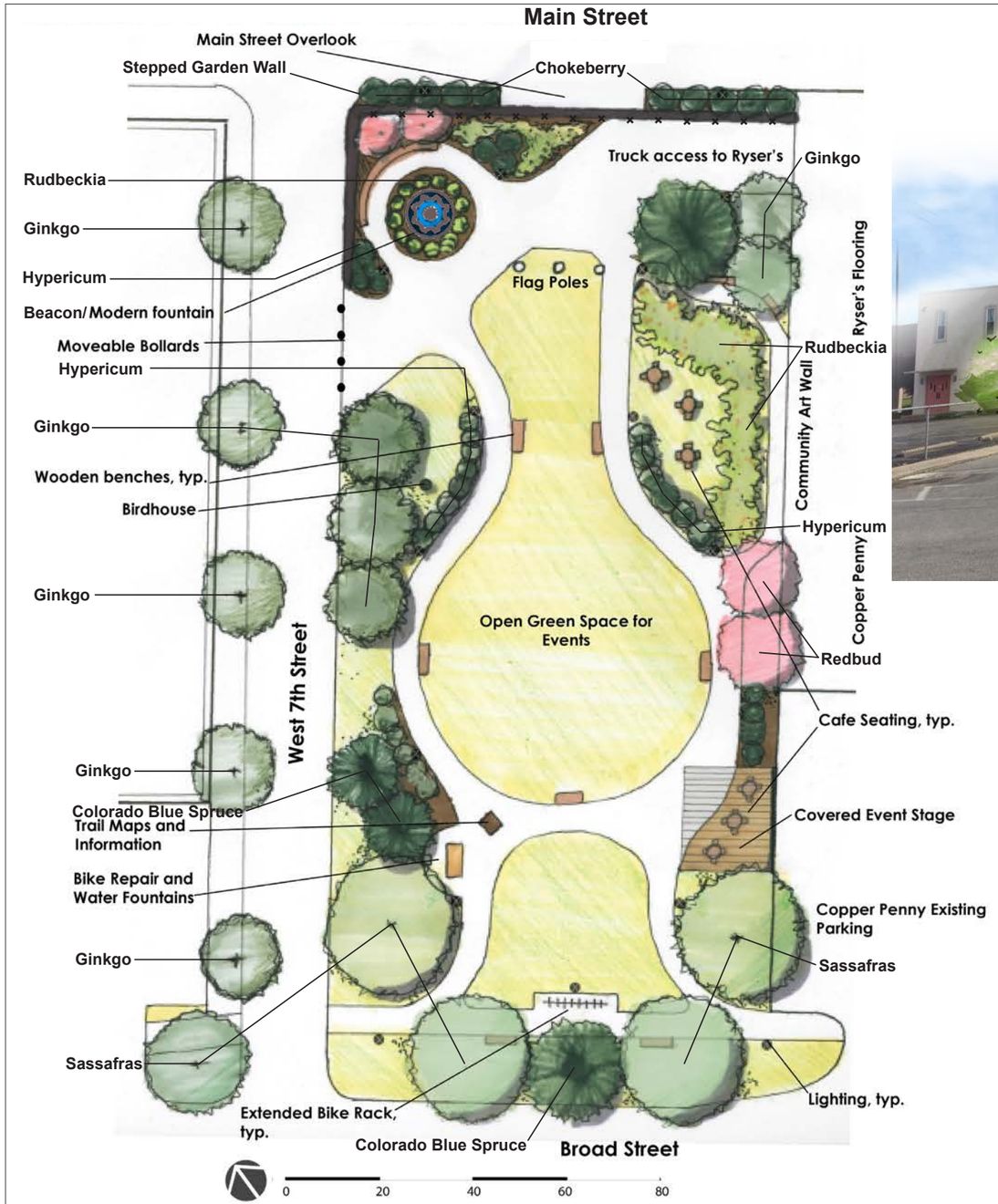
7TH STREET TRAILHEAD PARK

The design aimed to include the site's present programs and activities. Access to Ryser's Flooring is important and is facilitated through a driveway system with movable bollards to allow or restrict vehicular traffic. A modern fountain marks the northwest corner of the site. This modern fountain would be a tall sculptural element; a beacon, at the top of the fountain would signal one's entry into the heart of London. This plaza also contains cafe style seating for a quick break or an afternoon picnic. Finally, those walking along Main Street are given sweeping views of the site from a newly added overlook area, creating additional seating on the Main Street level.

Welcome to London's new trailhead park.

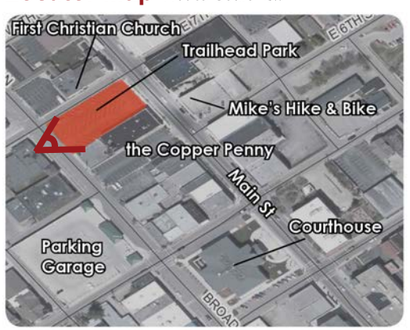
The following pages contain a conceptual master plan, a section through the site, images of possible design elements, and a planting palette.

7TH STREET TRAILHEAD PARK
Conceptual Master Plan



This perspective, viewing the 7th Street Trailhead Park from Broad Street, shows the busy park being utilized by many bicyclists and pedestrians during the day. The stage and seating area are used as places to meet and gather. This trailhead park offers the necessary amenities for passing bicyclists such as a water source, bicycle racks, and a maintenance station for repairs. The opportunity for enjoyable chance meeting with neighbors and fellow community members arises, as this is a central location for gathering in London.

Locator Map *Not to Scale*



The Trailhead Park is in close proximity to restaurants and Mike's Hike and Bike for cycle repairs.

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7TH STREET TRAILHEAD PARK

Inspiration for a Bicycling Themed Park

A map of Kentucky can be inlaid in the pavers so people can trace their route through the state and London.

Contemporary signage will inform cyclists and visitors of trails, attractions, and the history of the City of London.

Artistic sculptures can be designed to highlight culture and serve as an attractive statement piece.

Contemporary and creative adaptations of standard bicycle racks can be both attractive and memorable.

Bicycle maintenance stations can provide people the opportunity to perform small repairs in the park.

Water features and drinking fountains can have a bicycling theme and motif to celebrate cycling culture in London.

Murals on large empty walls of buildings enclosing the park can be painted with bicycling themed mural art.

An attractively constructed performance stage can be a gathering place and serve as the beginning for cycle races.

7TH STREET TRAILHEAD PARK

Plant List

*We recommend soil testing in this site before any plantings are installed, as topsoil may be needed.

Sassafras albidum (Sassafras)
Medium size tree chosen for its resiliency in the Kentucky climate, as well as its size to create shaded areas in the park. Its yellow-red fall color is brilliant.

Ginkgo biloba (Ginkgo)
Medium sized tree and moderatey fastigiate in growth habit. Brilliant fall color and interesting leaf shape. A tree of interest in the landscape. Recommended male sapling selection to avoid unpleasant oder from female fruit.

Pincea pungens 'Fat Albert' ('Fat Albert' / Colorado Blue Spruce)
Blue green needles. 10-15' tall, 7-10' wide. Chosen for its interesting color and broad pyramid habit to compose buffers.

Cercis canadensis (Redbud)
Known for their winding branch structure and stunning magenta flowers from spring through summer, this large shrub or small tree is a superb addition to this gardenesque park.

Aronia melanocarpa (Chokeberry)
This shrub is home to small white flowers and edible berries - a positive addition to landscape to invite birds. In the fall, their leaves turn deep red. Full sun to partial shade.

Rudbeckia fulgida (Rudbeckia)
A plant genus in the sunflower family, the *Rudbeckia fulgida* offers bright yellow flowers, attracting bees and butterflies. Flowers will return year after year. Full sun to light shade.

Hypericum olympicum (Hypericum)
A mounding flower type, hypericum is a lovely addition to any landscape. This perennial with showy flowers is drought tolerant, and will come back every year as long as it has well drained soil to prevent winter rot. Partial sun to partial shade.

JUDICIAL CENTER PARKING LOT

Design Description

The City of London and London Downtown identified the Judicial Center's parking lot as a priority for landscape design. The proposed design reflects their desire to provide shade trees to visitors as well as planting solutions that help to contain and filter stormwater runoff. The trees selected for the Judicial Center Parking Lot design perform well in urban conditions, such as this parking lot. In addition, they will help to alleviate the uncomfortable micro-climate created by the heat island effect.

Rain gardens, on easily eroded banks, are a concave depression in the landscape that will both retain and treat runoff before it seeps into the stormwater drainage. These gardens are designed to tolerate both wet and dry conditions. The design team identified runoff and erosion issues, which currently erode the soil structure and create unsightly conditions within the parking lot. The use of rain gardens will contribute to achieving a garden aesthetic, while solving stormwater issues.

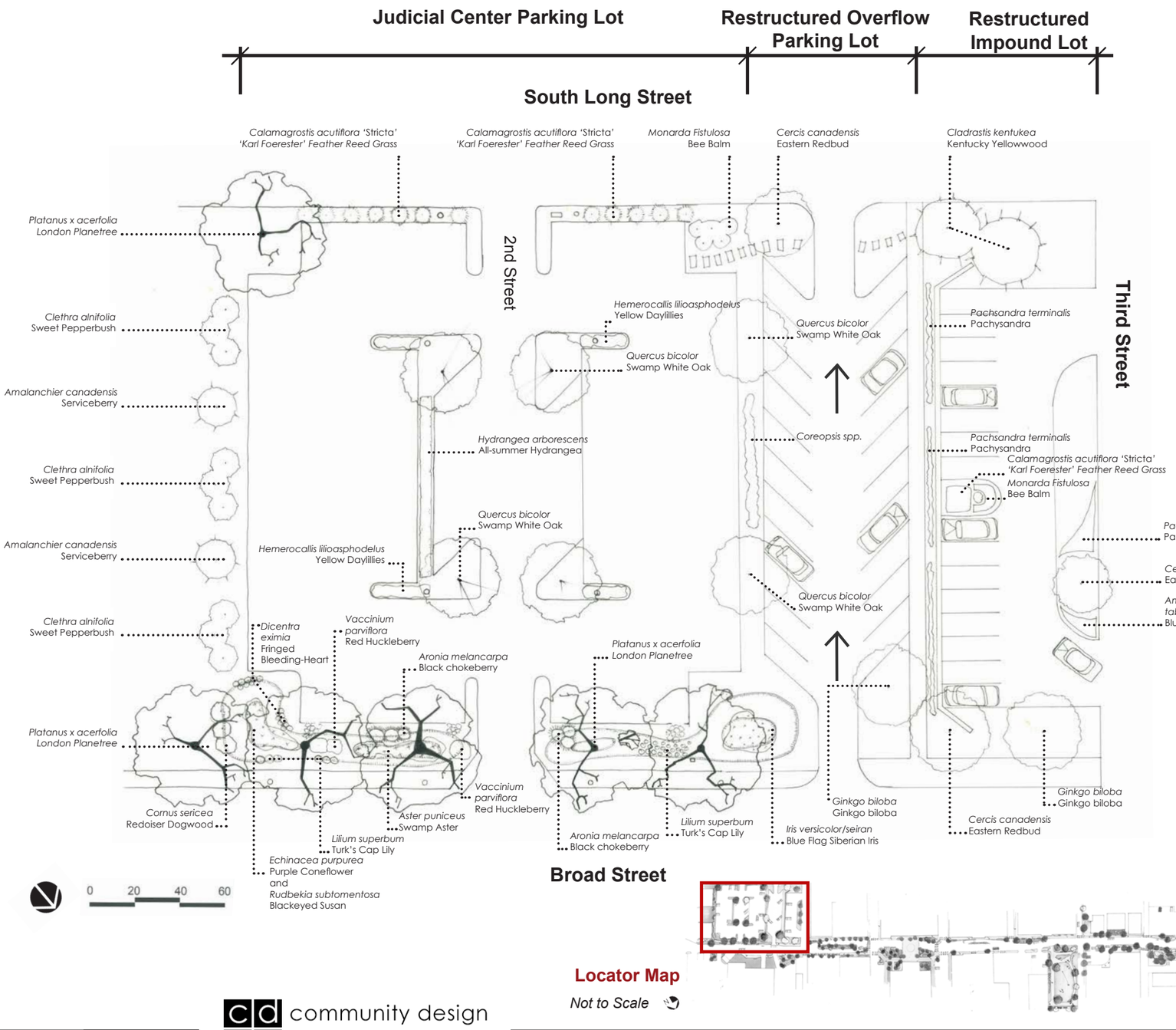
The current impound lot adjacent to the site has been converted to angled parking, adding twenty-one new parking space, with a one way drive through the lot. The ten-foot elevation change between the impound lot and the gravel lot above created a deteriorating slope due to rainwater runoff. A small retaining wall now separates this space from the existing parking lot to mitigate the severe erosion currently seen on the site. The design proposes to restructure the current impound parking lot, making it accessible to the Laurel County Police Force.

The following pages contain a master plan for the parking lot improvements, a section cut through the entire site, images of possible design elements, and a planting palette. For more information on rain gardens and bio-retention, see "Designer's Guide to Bio-Retention Area Implementation", in the Appendix on page 96.

JUDICIAL CENTER PARKING LOT
Conceptual Master Plan

Locator Map

JUDICIAL CENTER PARKING LOT
Planting Plan



Locator Map

Not to Scale

Plants throughout parking lot noted on plan:

Cercis canadensis
Eastern Redbud Tree
Pachysanda terminalis
Pachysandra
Monarda fistulosa
Bee Balm
Calamagrostis acutiflora 'Stricta'
'Karl Foerester' Feather Reed Grass
Cladrastis kentukea
Kentucky Yellowwood
Hemerocallis lilioasphodelus
Yellow daylilies
Hydrangea arborescens
All-summer hydrangea
Liriodendron tulipifera
Tulip poplar
Amelanchier canadensis
Serviceberry
Clethra alnifolia
Sweet Pepperbush
Platanus x acerifolia
London Planetree
Ginkgo biloba
Ginkgo Biloba

Rain garden plant palette:

Echinacea purpurea
Purple Coneflower
Lilium superbum
Turk's Cap Lily
Aster puniceus
Swamp Aster
Iris versicolor/Iris prismatiea
Native Iris
Rudbekia subtomentosa
Blackeyed Susan
Dicentra eximia
Fringed bleeding-heart
Cornus sericea
Redoiser dogwood
Vaccinium parvifolium
Red Huckleberry
Aronia melanocarpa
Black chokeberry
Bluestar Coreopsis
Common Bluestar

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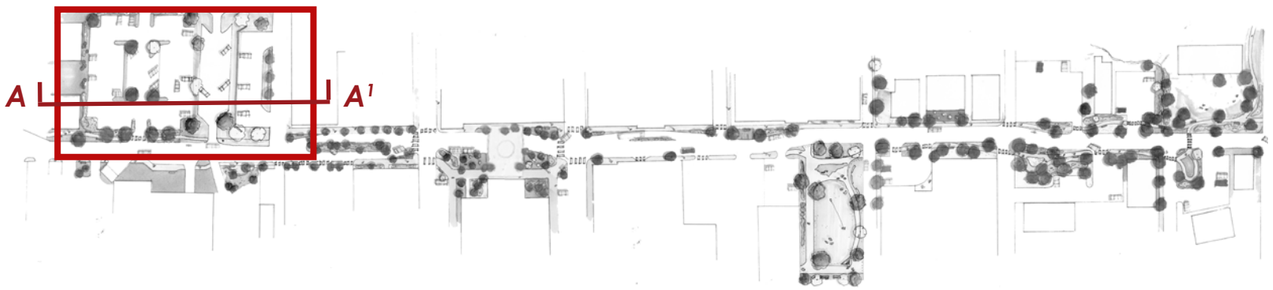
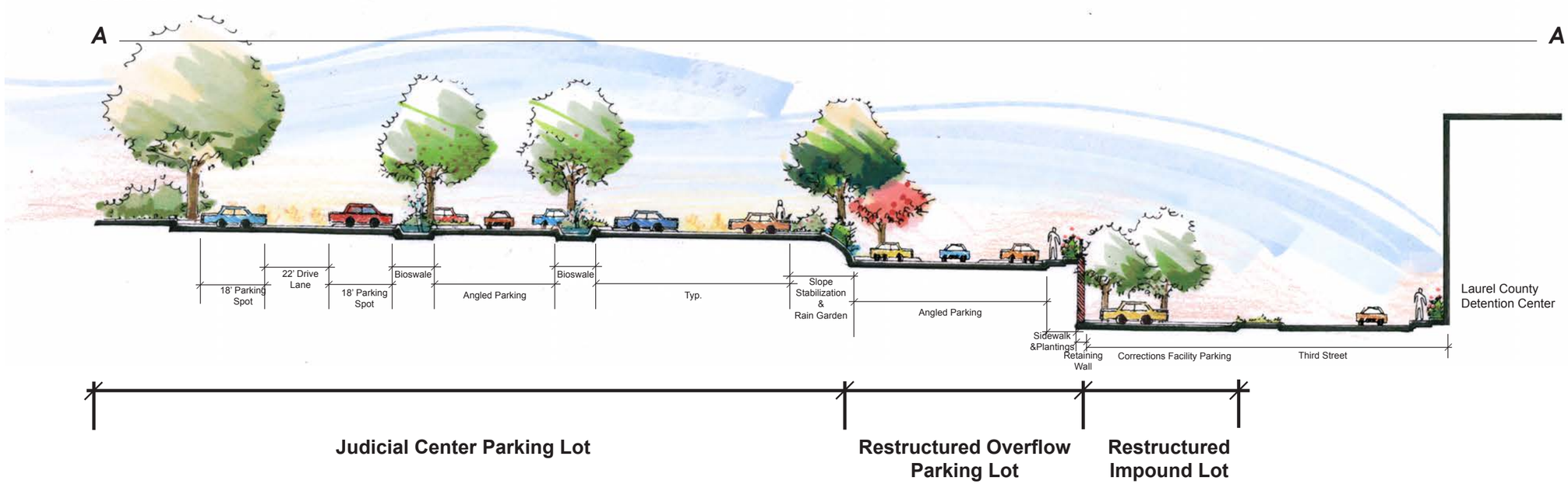
JUDICIAL CENTER PARKING LOT
Section Rendering

Locator Map *Not to Scale*



Section A depicts the relation between the three-tiered parking lots. To the left, the largest parking lot is existing, but without landscaping. A variety of trees, shrubs, groundcovers, and water-tolerant plants help provide shade and filter water runoff from the lot. The middle tier, which is currently a gravel overflow parking lot, is restructured as a one-way parking lot with angled spaces for maximized efficiency. The lower lot, currently an impound yard, is also restructured for city and county police enforcement vehicles. These lots all include safe pedestrian crossing areas and are sloped in a way where rain water is mostly retained and filtered on-site.

Section A



JUDICIAL CENTER PARKING LOT

Bioretention and Rain Gardens Description
A rain garden is a planted depression or a hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed.

The purpose of a rain garden is to improve water quality in nearby bodies of water and to ensure that rainwater becomes available for plants as groundwater rather than being sent through stormwater drains straight out to sea. Rain gardens can cut down on the amount of pollution reaching creeks and streams by up to 30%. In addition, rain gardens help to slow stormwater at the source. Because asphalt is an impervious surface, water accumulates, causing erosion and flooding issues in the city's low points.

This parking lot, Broad Street, and Third Street suffer from high levels of runoff during rain storms. Rain gardens offer an effective solution to reduce stormwater runoff volumes in these areas, filter out pollutants before they reach storm sewers, and ultimately, rivers.

Planted medians absorb waterfall, and trees provide shade to nearby cars.

Rain gardens in parking lot islands can help to slow infiltration and hold water.

Certain plant species can filter pollutants and make soil healthy.

Using permanent and non-permanent structures to create an effective rain garden.

GATEWAY AND WAYFINDING SIGNAGE

The final signage concept blends the rustic material choices with a contemporary graphic, shown on page 68. This design offers itself to the heritage of London as well as the cycling-friendly theme. The Daniel Boone Trace and Wilderness Trail are shown on the gateway signage concept, identifying London as a Wilderness Crossroads. The bicycle medallion found on the place-making and street-lamp signage is a reminder to visitors and residents that London is a bicycle friendly community and the Bicycling Capital of Kentucky. Wood signage with stone veneer lends itself to the natural resources found in this region and compliment the building elements currently found throughout the city.

Streetlamp Banner

Wayfinding Signage

Gateway Signage

CONCLUSION

London Downtown worked with the Community Design Assistance Center (CDAC) to develop a vision for London's downtown green infrastructure, and to complete a walking loop traversing Broad Street and connecting green space locations. With this idea as a catalyst, the CDAC team worked to create conceptual master plans and focal site designs that reflected the character and integrity of the city to help lead it toward that vision of an economically, environmentally, and socially vibrant community.

Broad Street in downtown London currently serves as a passthough avenue and lacks a sense of place. Currently, London offers an excessive amount of parking, leaving little room for green space. Because of the parking expanses and little green space, London suffers from the heat island effect creating uncomfortable and hot micro-climates. London also currently offers few pedestrian amenities necessary for a vibrant downtown life, such as benches, shade, gathering spaces, signage, and lighting.

After visiting London, CDAC designers worked to reconfigure London's Broad Street into what could be the new pedestrian district. Streetscape improvements, parklets, and an all-around inviting environment is sure to serve the residents and visitors of London well.

Several new greenspaces are proposed as gathering spaces and attractive destinations in the downtown district. The vacant hospital parking lot on Main Street creates opportunities for the community to host events and festivals or to enjoy tranquility within downtown London. A Community Park, in place of the vacant hospital parking lot, a Main Street Pocket Park, the 7th Street Trailhead Park, as well as other greenspaces in London will be tied into the larger Broad Streetscape corridor master plan.

The re-envisioned Judicial Center Parking Lot will provide shaded parking while also creating a visual barrier between downtown and nearby residents. The town will also have relief from runoff, as rain gardens and bioswales will capture a large amount of the polluted runoff.

The CDAC design team believes that the City of London is at a pivotal moment in its history; a moment in which the city can become more welcoming, more inviting, and more comfortable for residents and visitors. It is hoped that the designs can bring even more vibrancy to the city and to Laurel County as a whole.

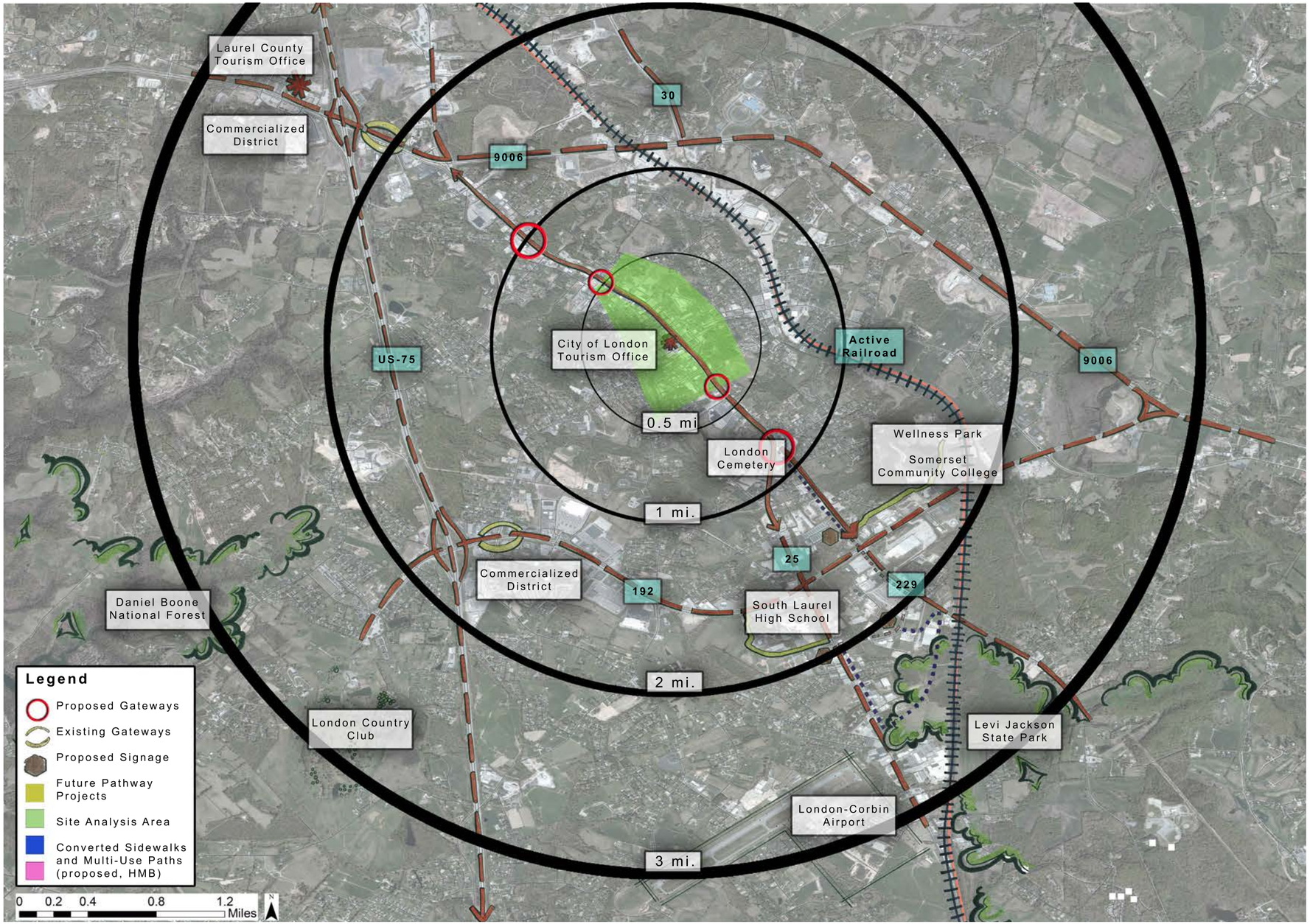
Part II:
Inventory, Analysis, and Design Development

REGIONAL ANALYSIS

Overview
To better understand the City of London, a regional analysis was conducted, focusing on vehicular, bicycle and pedestrian circulation to understand connectivity to the city and surrounding greenspaces. Biking distances and times were also investigated to further understand the cycle culture of the area and of the city.

The following page includes a regional connectivity analysis denoting greenspaces and other major attractions.

REGIONAL ANALYSIS
Regional Analysis Map



INVENTORY AND ANALYSIS

Overview
A site analysis of the downtown London area was conducted to understand the opportunities and constraints. This inventory and analysis phase then led to the preliminary concepts for each of the sites for which designs were developed.

Constraints:

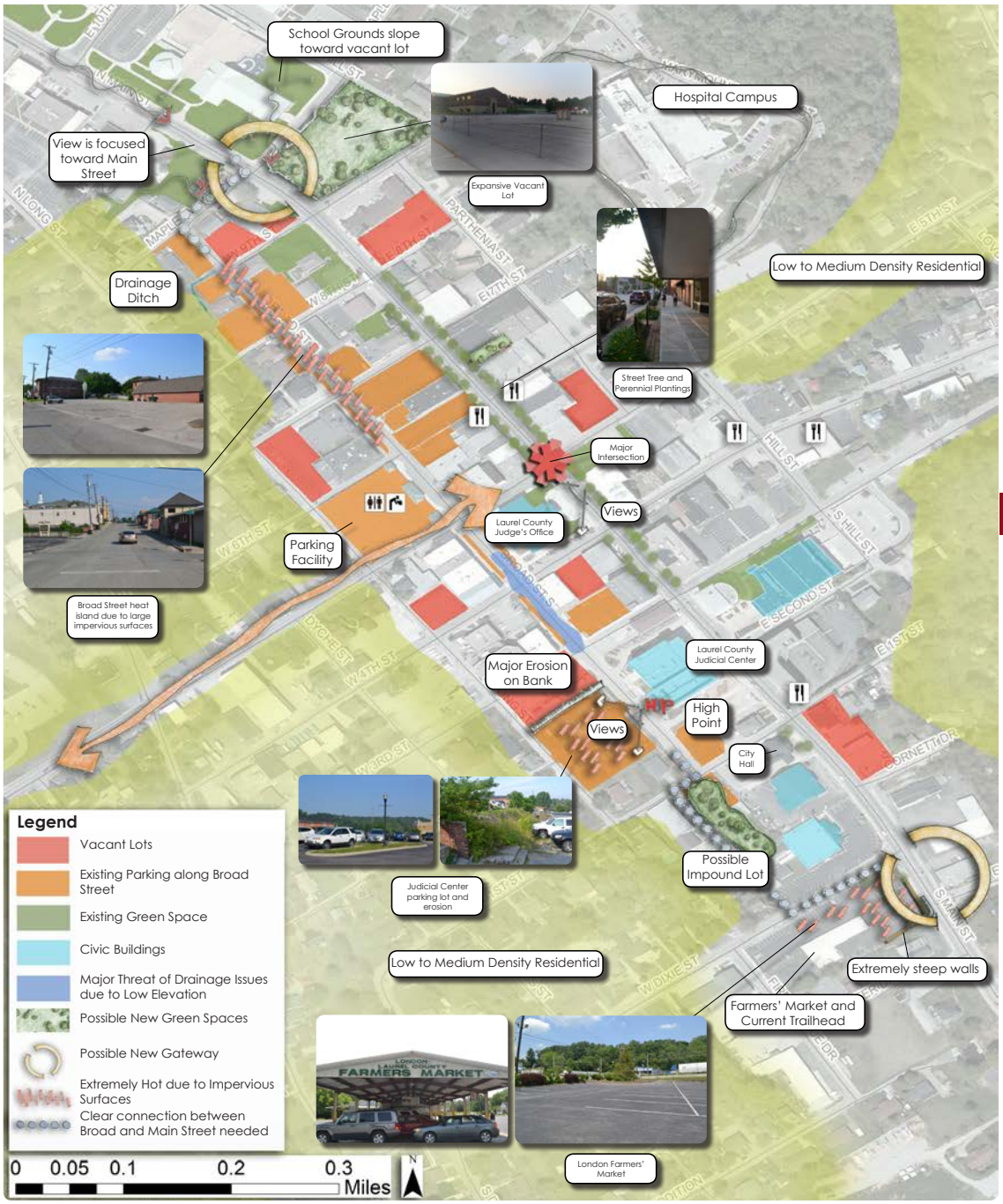
- Drainage is a major issue throughout London as the city is situated on a group of rolling hills. Issues of sedimentation and major erosional processes are evident, especially on Broad Street and in the impound lot behind the Laurel County Judicial Center.
- Main and Broad Streets' traffic patterns both fluctuate greatly throughout the day.
- The downtown has little in the way of outdoor opportunities, i.e. outdoor dining, seating for passersby, or spaces to linger.
- Dining establishments are mainly situated in the center of the town, leaving the western and eastern extremities of Main Street very quiet.
- The only public (to our knowledge) restroom and water fountain facilties are located on the top floor of the parking facility on Broad Street and at the Farmers Market.
- Street trees and plantings, while varied and attractive, are solely located between 8th and 3rd streets.
- As of June 2015, most events and concerts take place in front of the courthouse on the corner of 5th and Main. However due to current state regulations, the future venue will be moved elsewhere to allow for full vehicular access to Main Street.
- The parking lot behind the Judicial Center is the first priority due to a desire for immediate design implemenation. The area is in major need of shade and stormwater remediation.
- The London Farmers Market is currently the de facto trailhead for each of the cycling trails as well as for cycling events. Currently it is surrounded by a large asphalt parking lot that makes the area extremely hot. In addition, a large wall bounds the northeastern section of the site, restricting visual and pedestrian access to the market.
- London is considered the cycling capitol of Kentucky due to its numerous trails and cyclist-centered events, however the lack of cycling infrastructure does not support that designation.

The following page includes an inventory and analysis of the Downtown London area.

INVENTORY AND ANALYSIS

Inventory and Analysis Map

An inventory and analysis of conditions of downtown London allowed the CDAC design team to understand what exists within London and work to fulfill London's desire for a new landscape. The large amount of vacant lots encouraged the development of green parklets and other opportunistic areas.



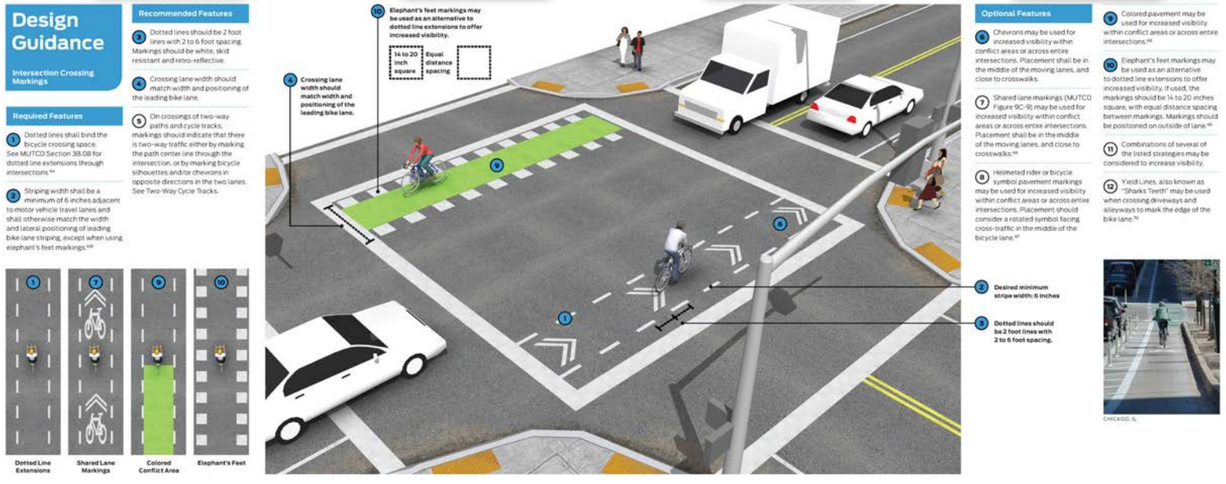
CASE STUDIES AND DESIGN PRECEDENTS

Urban Cycling Towns

Cedar Rapids, Linn County Iowa
Green Bike Lanes

Cedar Rapids was the first city in Iowa to implement "green lanes," a designated bike lane painted green for clearer visibility of cyclists. In addition, these green lanes serve as a means of traffic calming as motorists move parallel to the lanes. Green lanes (5-6' standard) are positioned 50' before all intersections, giving motorists and cyclists time to react to oncoming threats. Motorists may cross these lanes only where the bike lane becomes dashed. Also, these green lanes allow cyclists to position themselves more safely as they prepare to enter an intersection.

Design Implications:
1. Reaction time must be built into the street infrastructure for both motorists and cyclists.
2. Green lanes help delineate cycle lanes more clearly than extra dividing lines or other interventions.
3. Green is the standard color, however dark reds or burgundy have also been implemented.



Woonerf Design

Seattle and Beyond

A **woonerf** is a dutch road that loosely translates to a "living street." They are also called "home zones" in the United Kingdom. Here, cyclists, pedestrians, and motorists share the road. In addition, the width of the road is decreased to slow traffic and increase visibility.

Design Implications:
1. Priority is given back to pedestrians and cyclists.
2. The street is no longer simply a thoroughfare, but a place to stay and linger.
3. Woonerfs can be easily shut down to facilitate large events.
4. Sidewalk spaces are much larger which also allow for more programming opportunities.
5. Larger spaces also allow for community ownership and personalization. Art and cultural elements can be added to these spaces for further personalization.

Traffic Slowing
Diverts traffic through a slightly altered traffic pattern, thus slowing traffic and ensuring safety.

Extending the Neighborhood
By slowing traffic, the street becomes the property of the community once again.

Space for Pedestrians and Cyclists
These roads put pedestrians and cyclists first. Each street user is treated as equal.

More space for the Perimeter
Adjacent businesses with street frontage may now use this added space for dining spaces or displays.

CASE STUDIES AND DESIGN PRECEDENTS

Wayfinding

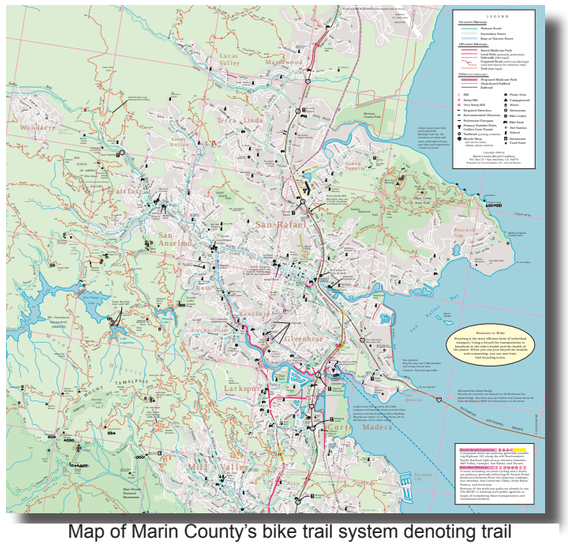
Mill Valley, Marin County, California
Trail Branding and Community Partnerships

Located just outside of San Fransisco, Mill Valley offers a plethora of cycling trails and opportunities. The local cycling retailer, StudioVelo, has partnered with the community in defining the best cycling trails. A logo was created for each trail as well as an informative description describing the cycling experience. Their "Steps, Lanes, and Paths" program has also been used to create more pedestrian and cyclist-friendly circulation throughout the residential areas of Marin County.

Each trail logo reflects specific characteristics of the trail, whether scenic, cultural, or geological.

Design Implications:

1. Branding is key to attracting and informing visitors about the specific trails
2. Trails should incorporate varied scenic settings. Each trail should have its own identity.
3. Clear incorporation of National Forests or Parks (Muir Woods) so that full connectivity is achieved
4. While having an extensive system of trails is advantageous, if there is no central trailhead or start point the system can seem extremely illegible.
5. All branding and mapping is created with cyclists in mind. Bike shops, food shops or markets, campgrounds, and picnic areas are key features to point out.
6. All family-friendly bike paths should be highlighted on maps located in urban areas.



Map of Marin County's bike trail system denoting trail characteristics. A similar style of map could be created to advertise cycling routes and downtown amenities.

Trail Town Composition

Lanesboro, Fillmore County, Minnesota
Incorporation of Trails into the Town Fabric

The Root River Trail incorporates 60 miles of biking trails with a major trail hub in Lanesboro. An information center is located in each of the nine towns the trail moves through. In addition, live trail and river conditions are available through the trail website.
The trail was also created as a link between historic attractions and scenic destinations. In addition, during the winter months, the trail is converted into a 60 mile cross country skiing route.

Maps showing the Root River Trail passing through Lanesboro, MN.

During the winter months, the trail becomes a cross country skiing route.

Lanesboro Visitor Center and Trail Information

The center is located adjacent to the Root River Trail in the center of town and serves as a trail stop as well as a tourism office. The architecture reflects that of the surrounding buildings and is meticulously maintained. Restrooms, water fountains, ample outdoor bike storage (racks), and an interior tourism office are all included in the center. Finally, it is placed on a path that cuts diagonally through town, allowing space for bikers to rest and feel protected from vehicular hazards.

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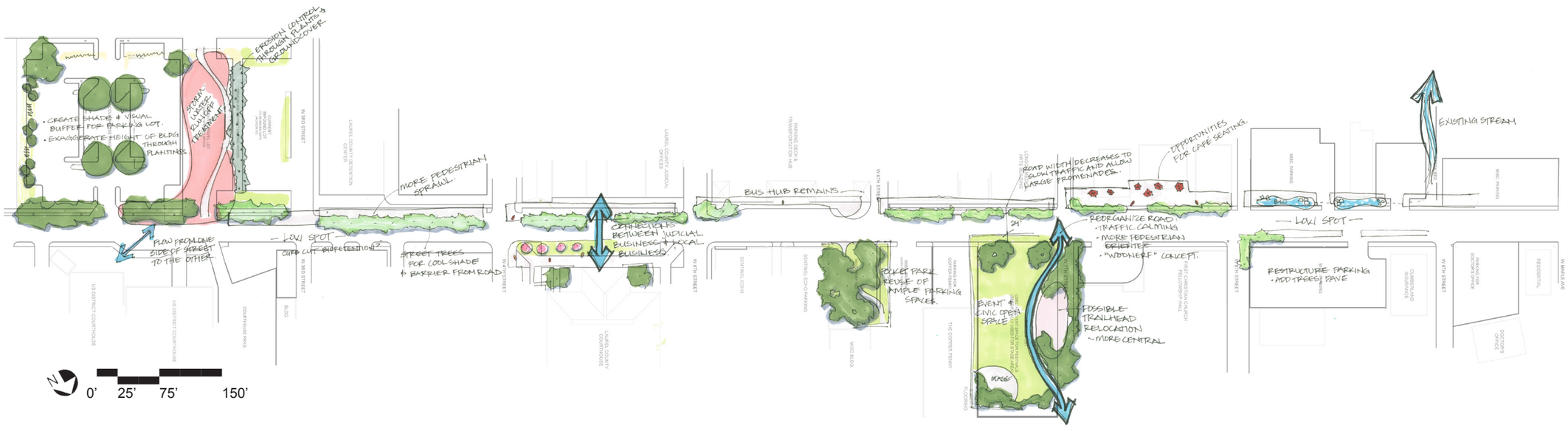
CONCEPTUAL PLANNING
Traditional Broad Streetscape

Design 1 Description
The traditional concept exemplifies the typical city streetscape. It has linear pedestrian and motorist corridor, which help obtain maximum sight lines in an otherwise crowded and congested area. Promenades and sidewalks are buffered from the road's edge by planted islands consisting of trees, low shrubs, and a mix of annuals and perennials. This creates a comfortable and appealing atmosphere for those who wish to escape the heat on a shaded bench or enjoy a coffee at a nearing cafe. In some areas, sidewalks and promenades are compromised with a more narrow path to incorporate on-street and handicap accessible parking. Way-finding signage and place-making tactics are easily viewable to both pedestrians and motorists alike. The tree-lined streets are also welcoming to both parties, as the canopies have the opportunity to span across. The linear typology of the traditional concept creates an equal advantage to all store fronts wishing to show their character to passersby.


Example of a traditionally linear street pattern with landscaped buffer from road.


Linear streetscape with parallel parking and how this meets the promenade.



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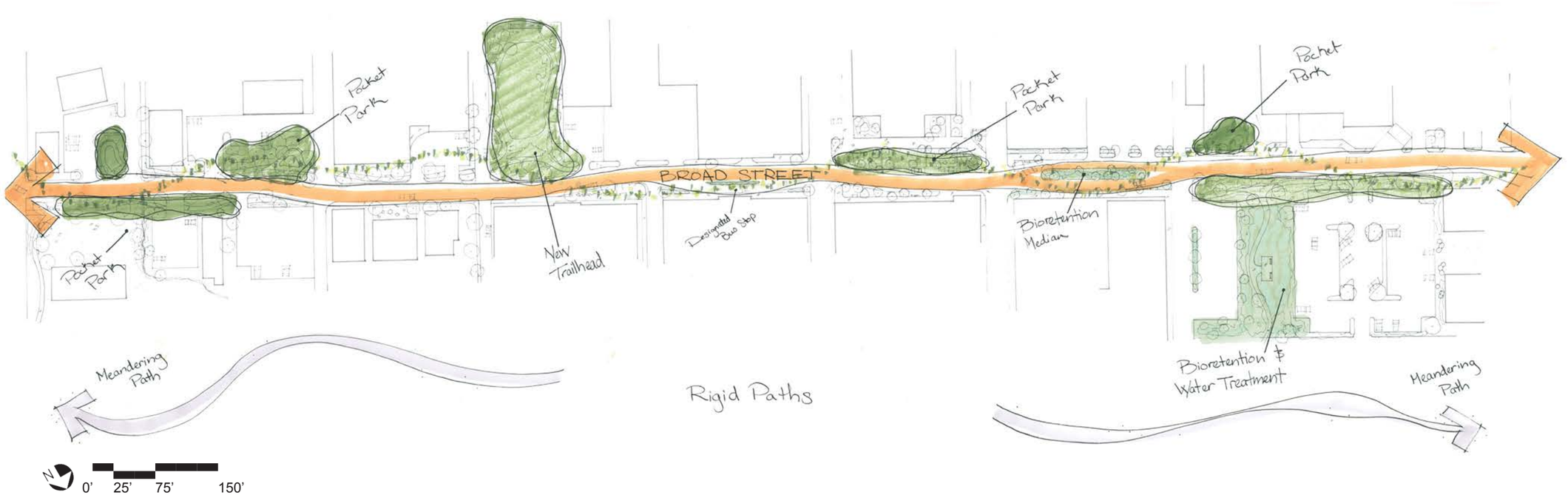
CONCEPTUAL PLANNING
Woonerf Broad Streetscape

Design 2 Description
The woonerf concept demonstrates an understanding of pedestrian prominence in the road design. With origins in the Dutch culture, “woonerf” translates to “living road”. It is typical that these streets intertwine vehicles, cyclists, and pedestrians all together. These streets also tend to be home for more oblique planting patterns and be composed of more organic materials or a different type of material than primary roads. Often times there are no curbs along a woonerf, as these secondary streets can be shut down easily for events that span across the space, perfect for festivals or parades. The narrow lanes and sometimes little-to-no parking creates an environment that calms traffic to prevent motorists from moving too quickly. This concept would work well in London to bring a more natural theme to Broad Street. These create several opportunities for civic spaces to spill out into the street. The streetscape advantages also allow for a garden-style landscape sure to reflect positively throughout the “Garden City.”

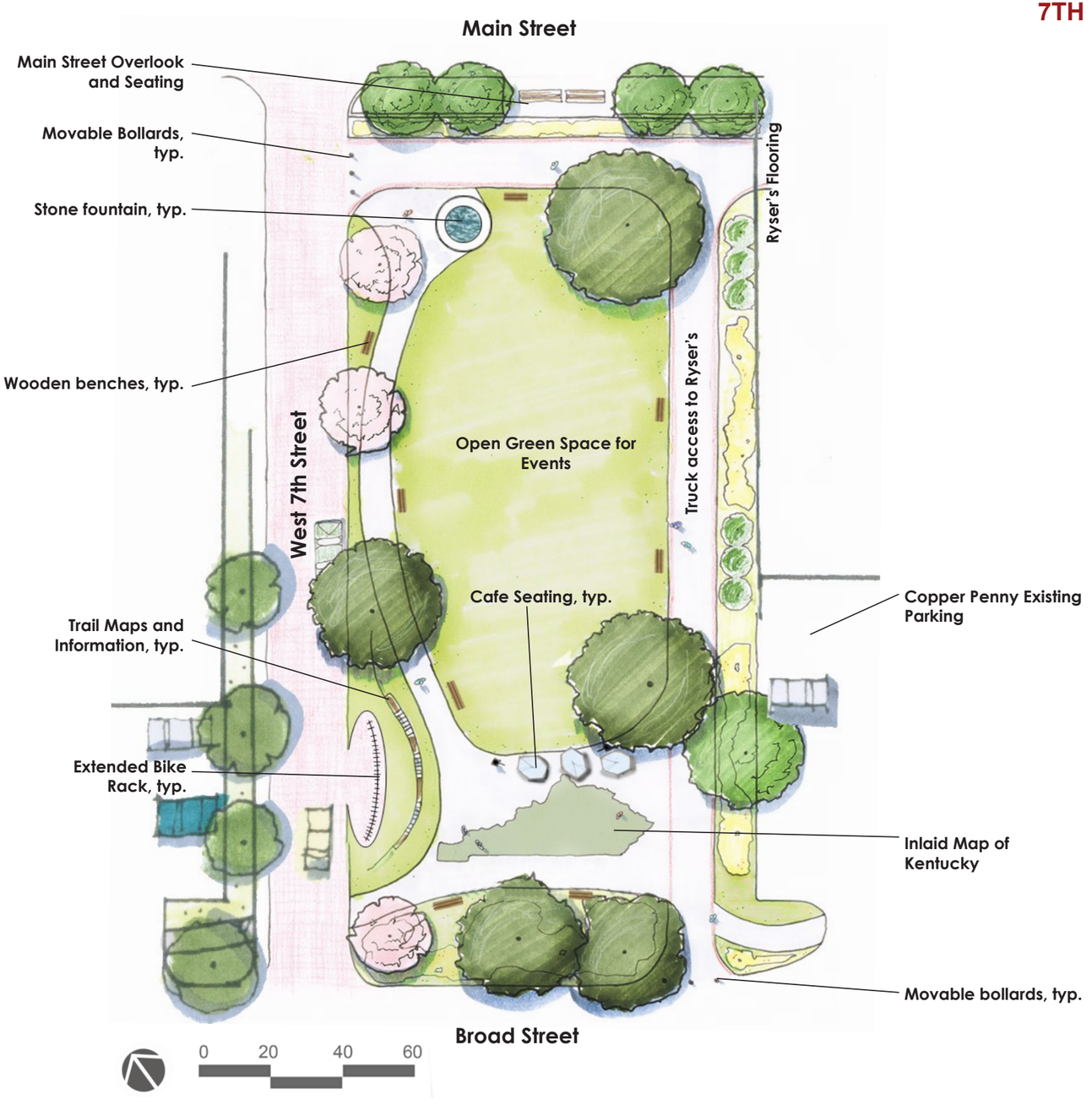

This woonerf shows the lack of curbs, creating more of a plaza than a road.


Oblique paving patterns can help create the meandering effect through the space



7TH STREET TRAILHEAD PARK ALTERNATIVE DESIGN

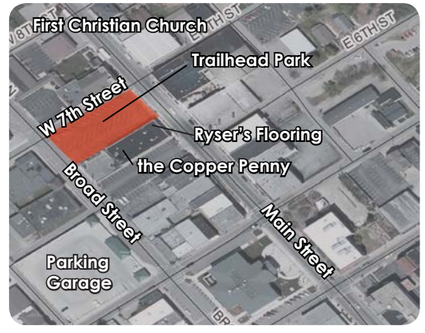
Conceptual Master Plan



Design Description

As pedestrians enter the site from the southeast corner, they are greeted with an inlaid map of Kentucky, depicting the counties throughout the state. It also highlights the locations of Laurel County and the City of London. This plaza holds cafe seating at its perimeter and benches underneath the trees. To the western side of the map are the cycling maps at the designated trailhead. Bicycle racks are located just beyond the maps along the road, so that the space does not become filled with scattered bicycles. As you move through the park to the north, you can look across the lawn at the murals painted on the brickwork that is the side of The Copper Penny. As you approach Main Street, you're engulfed in the serenity of a stone fountain, overlooked by the seating area on Main Street. Access to Ryser's Flooring is kept by the addition of removable bollards to allow the walkway to function as a service road during delivery times.

Locator Map *Not to Scale*



The Trailhead Park is in close proximity to restaurants and Mike's Hike and Bike for cycle repairs.

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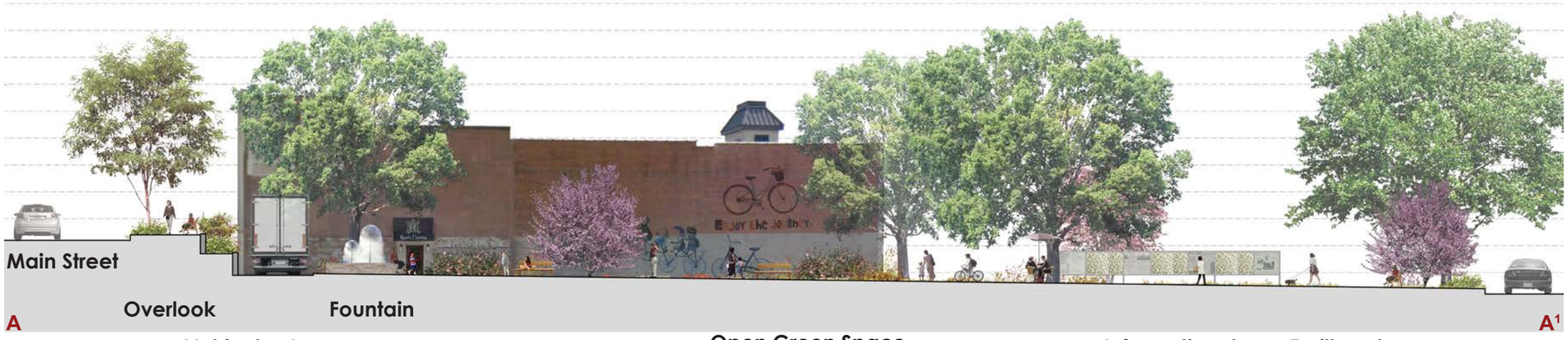
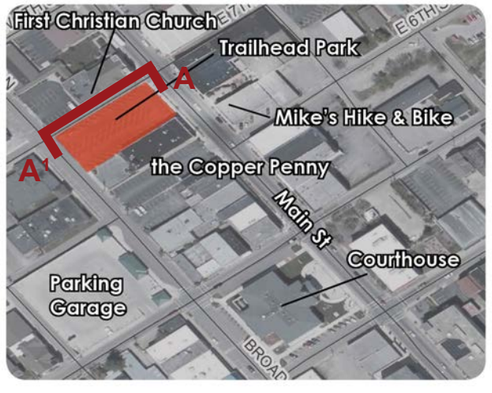
7TH STREET TRAILHEAD PARK ALTERNATIVE DESIGN

Section Rendering

Section A depicts the relation between the Trailhead Park and its surroundings. The addition of trees and shrubs makes this current heat island an inviting space for its visitors. The overlook from Main Street gives pedestrians the opportunity to watch activities in the park and look across to the shops along Broad Street. This park serves as a nice segway space from the judicial core to the business core of downtown. It is hoped that relocating the trailhead from the Farmers Market at the edge of downtown to the core of downtown will bring more pedestrian traffic to both of these avenues and encourage people to linger in London to shop and dine.





Locator Map

Not to Scale

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SIGNAGE DEVELOPMENT

Overview
Two branding concepts were also developed for the City of London to use in the proposed signage. Each concept includes a lamp post banner, a wayfinding post sign, and a large gateway sign option. The two design themes are described below.

Wilderness Crossroads

London was founded at the intersection of the Daniel Boone Trace and Wilderness Trail in the late 1700s. Boone, known as the preeminent figure of America's Westward Movement across its frontier, set the tone in London as the community is forward-thinking and strives to be the leader among contemporary standards in southeast Kentucky. The theme of this signage emphasizes London as a Wilderness Crossroads, which begins the narrative of London's history. This signage can carry through to adjacent attractions, such as the Daniel Boone National Forest. Using similar materials, fonts, and themes across signage helps to create continuity throughout the city.

Cycling Theme

London is the Cycling Capital of Kentucky, making London a place of destination for many travelers. While this theme is evident through other proposed design intentions, the signage aims to continue this motif of cycling and healthy living. Mountains and a Redbud tree are also evident on the street banner, suggesting the Redbud Ride and nearby hiking attractions. A bold color palette brings energy to downtown and relates to the beautiful streetscape plants. At the gateway sign, lush plantings can surround to help emphasize the theme of a garden city.

The following page includes the two concepts and possible signage designs.

SIGNAGE DEVELOPMENT
Signage Concepts

Street Lamp Banner

Wayfinding Signage

Gateway Signage

Design 1
Wilderness Crossroads

Street Lamp Banner

Wayfinding Signage

Gateway Signage

Design 2
Cycling Theme

BROAD STREETSCAPE PARKING

Broad Street Parking Inventory and Analysis
Parking along Broad Street is an issue brought up by several stakeholders and city residents. Currently a great deal of on-street parking and multiple parking lots exist along Broad Street. However, in order to foster a more vibrant community, promote physical activity, and create a more social downtown atmosphere, the city identified the need to eliminate excess parking spaces, especially along Broad Street. The city will reap many benefits by removing parking along Broad Street.

Considering that many parking lots line Broad Street, the Broad Streetscape Design proposes to remove parallel parking along the entire study corridor. Special consideration to handicap parking should remain as a top priority. Local zoning ordinances should be referenced in final plans.

Heat islands are a micro-climate created when the sun reflects off of a dark surface, such as asphalt. This increases the ambient temperature of the space. However, a shaded tree canopy would aide in efforts to reduce ambient temperatures.

Both parallel and angled parking can be re-purposed into civic spaces used by pedestrians in London. Benches, seat walls, café tables, and art would transform the space into a meeting and lingering spaces. Pedestrians would find these meeting spaces more comfortable once heat islands are reduced into a cool and pleasant micro-climate.

There are currently forty-eight on-street parking spaces and an additional fifty-three in the parking lot adjacent to Ryser's and The Copper Penny. These spaces are proposed to be restructured into more common spaces that will benefit both residents and visitors of London. This analysis does not consider parking lots that serve private businesses along Broad Street.

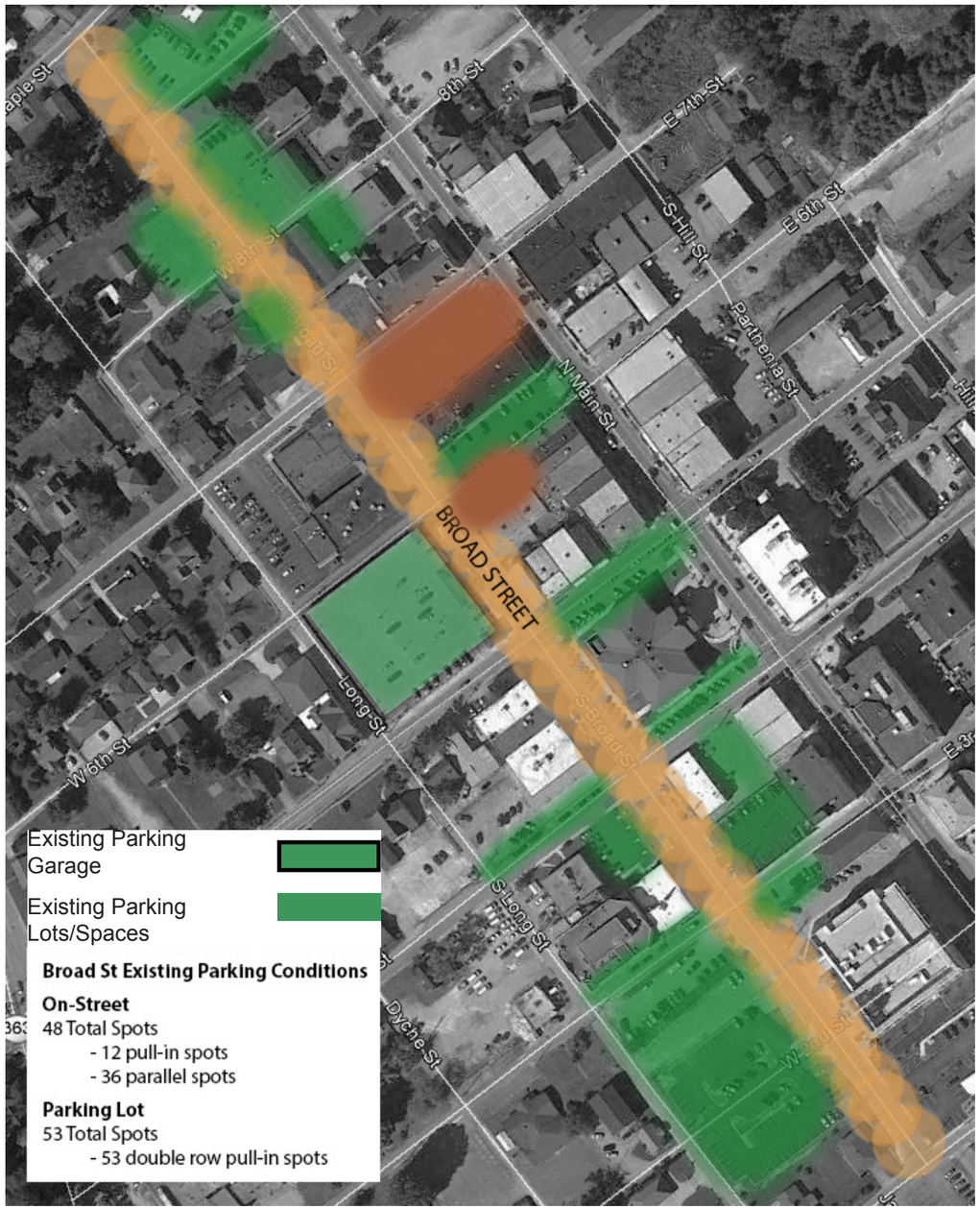
BROAD STREETSCAPE PARKING

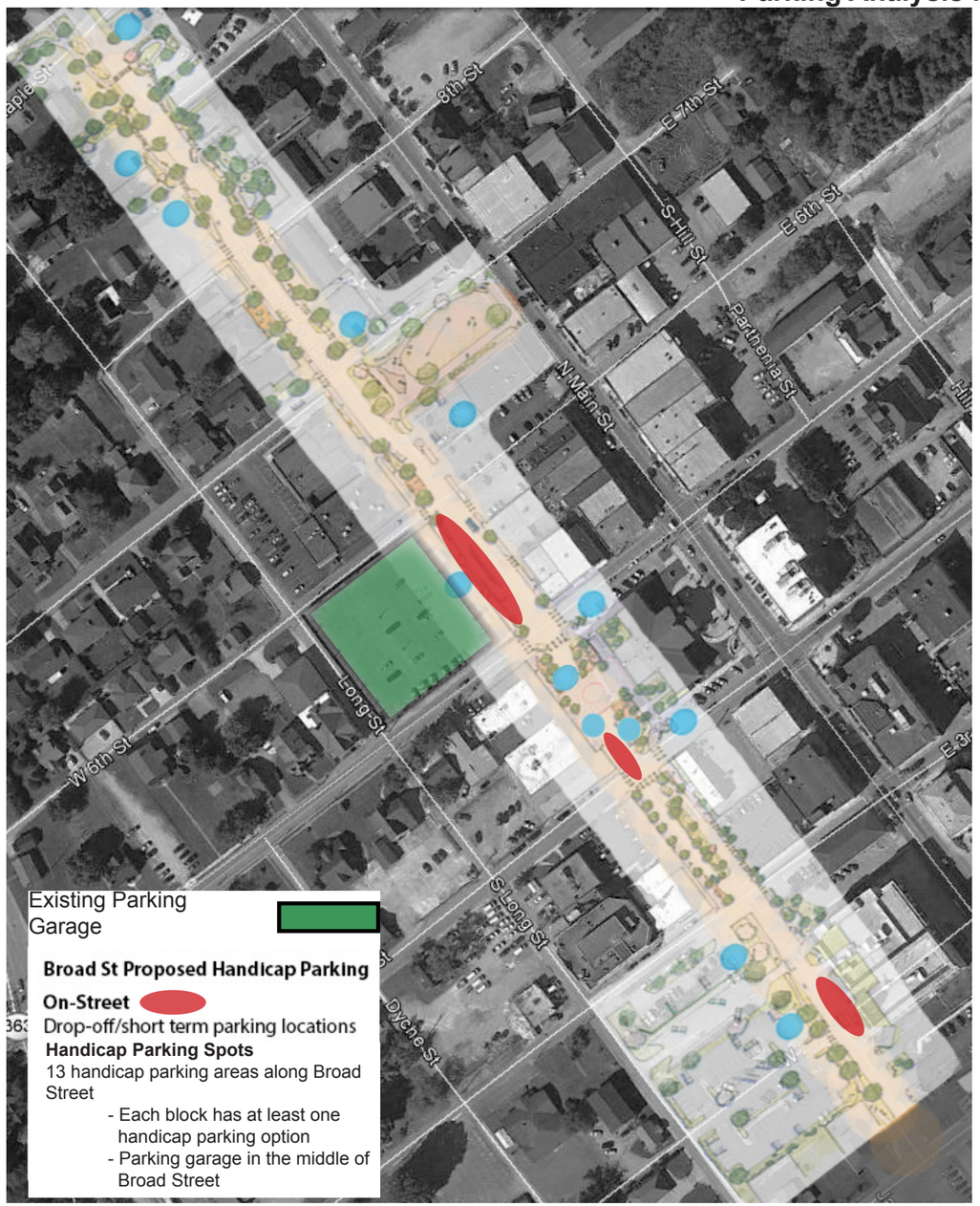
Handicap parking remains along Broad Street as parallel spots, with nearby accessibility onto the promenades and sidewalks. Currently, ten gravel and asphalt parking lots can be found along Broad Street. The design proposal suggests removing only one of these parking lots, which contains 53 parking spaces. The Broad Street parking garage also remains. Though there is a number of parking options, there is still plenty of parking downtown. By forcing people to use the designated lots and garages, there is more pedestrian traffic enjoying the new avenue.

The city requested a conceptual design that addressed their desire to have a walking loop trail in the downtown district. This loop would connect Main Street with Broad Street, by way of the 7th Street Trailhead Park. The conceptual design removes a large amount of parking along Broad Street. The following page diagrams a comparison between existing and proposed parking counts.

BROAD STREETSCAPE PARKING

Parking Analysis Map





BIKING AND WALKING STUDY

Walking

When parallel parking spaces are removed, then conditions are favorable for more pedestrian-scale design. Cyclists and pedestrian routes are shown within an aerial view of the proposal concepts for London. Walking and biking distances around Broad and Main Streets are diagrammed as a short, 1/4 mile and medium, 1/2 mile distances. In addition to Broad Street, Maple Avenue and Dixie Street are also shown as a shared roadway for cyclists, pedestrians, and vehicles alike. Main Street is proposed to contain a designated bike lane on either side of the street due to its current traffic demands. Road signage options are shown inset.

Walking times in outdoor environments can seem very long, particularly when the outdoor environment is of poor quality. A vehicle dominated landscape makes walking times seem far longer. Improvements to street infrastructure, such as the meandering Broad Street proposal, make for a more pleasant and enjoyable walk.

The Hospital Parking Lot, 7th Street Trailhead Park, and Main Street Pocket Park, as well as the Courthouse Parking Lot are shown with a walking distance of 280 feet, the furthest distance the average Walmart® customer will walk from their parked vehicle to the front doors.

Walking distances may seem greater when walking from a parking spot to a destination, however the proposed walking distances to many destinations are manageable and reasonable within London. Note: handicap parking should be delineated and provided adjacent to commercial buildings.

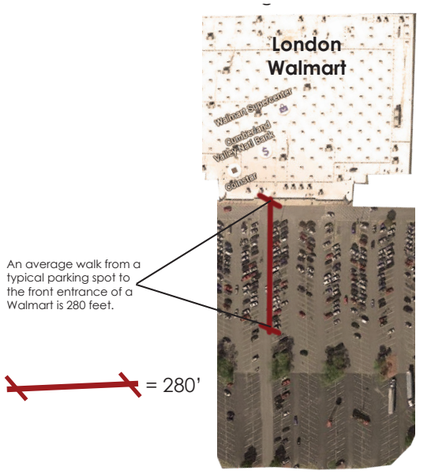
Biking

A study was conducted to better understand how cycling routes networked through town. Current cycling routes are outlined in a solid red line, extending through both Main Street and Broad Street. The current trailhead is at the London Farmers Market, which is shown on the map, but outside of the half-mile radius from the downtown center. Considering the amount of cyclists brought to London for the use of these trails, there is currently little encouragement for them to linger in London before or after their rides. A better understanding of distances could benefit the city in bringing more tourists to the downtown area. As proposed, a relocation of the trailhead to a more central location would be a catalyst for further downtown development as more people fill the streets and sidewalks.

Shown in the map on the following page, The London Courthouse marks the 'center' to downtown London. From this, a quarter-mile radius and half-mile radius has been measured and is shown by a dashed red line. These studies have shown the majority of businesses, residents, and commercial entities that are impacted by possible cyclists and visitors paths while passing through town.

With many trails running through the heart of downtown, London is the Cycling Capital of Kentucky. To better serve cyclists with amenities, the conceptual design proposes bicycle racks, maintenance stations, water stations, and trail maps.

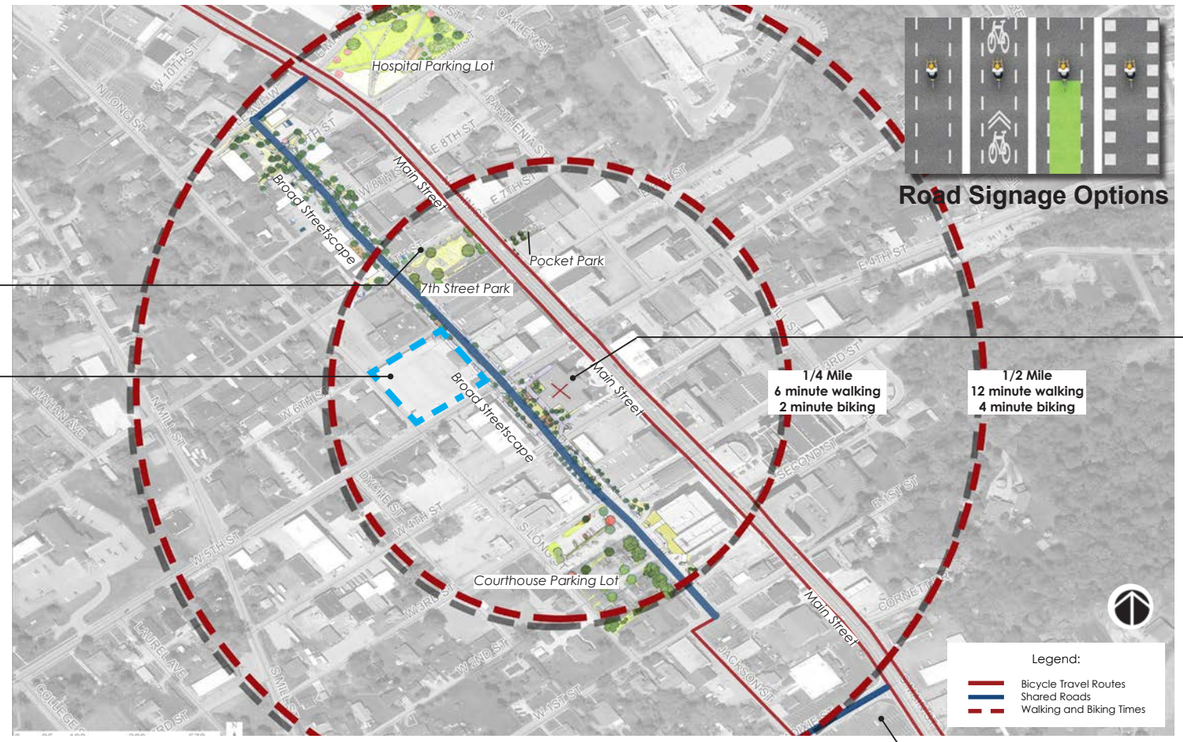
BIKING AND WALKING STUDY
Walking and Biking Maps



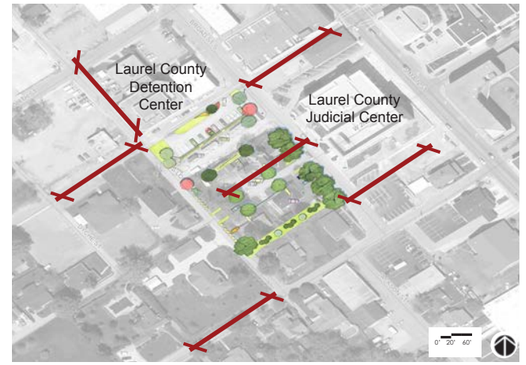
As shown in the aerial image of the Walmart® in London, most people shopping at the Walmart® store park their car within 280 feet of the front entrance. This distance is accepted as a feasible walk that is taken voluntarily.

To illustrate the scale of the proposed designs and their surrounding context, this same red line of 280 feet from the common parking spaces in the Walmart® parking lot have been placed on the proposed designs in London.

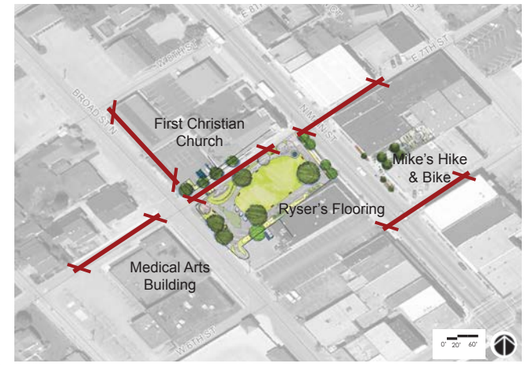
Pedestrian and Bicycling Travel Distances



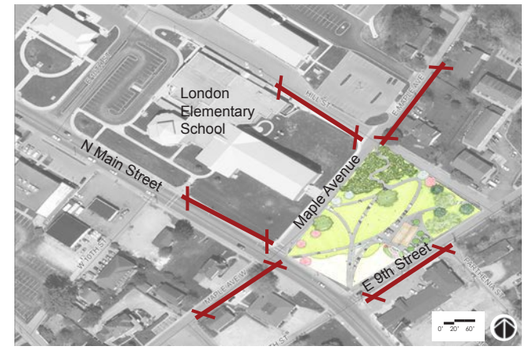
Courthouse Parking Lot Walking Distances



7th Street Park and Pocket Park Walking Distances



Hospital Parking Lot Walking Distances



Part III:

Appendix

STAKEHOLDERS MEETING NOTES

June 11, 2015, 11am-12:30pm

Present
Molly Barnett (Executive Director, London Downtown)
Troy Rudder (Mayor)
Karen Wyan (President of the London Tree Board)
Michael Froelich (Forester, Kentucky Division of Forestry)
John Strojan (Retired US Forest Service, Member of London Tree Board)
Sarah Gracey (Urban Forestry Coordinator, Kentucky Division of Forestry)
Carter Gresham (Virginia Tech Landscape Architecture)
Shane Gray (Virginia Tech Landscape Architecture)
Lara Browning (Former Project Manager, Community Design Assistance Center)
Melissa Philen (Project Manager, Community Design Assistance Center)

Introductions
Sarah Gracey- Introduced project, grant, greenspace development
First community in round of funding, completed six, previous projects
Working with multiple groups from the community

Lara Browning- Introduction, goals for today, understand design focus, green space, trail head, vacant spaces, pocket parks: gingerbread house location, hospital parking lot, gather plan data, GIS information

John asked about project boundaries, answer=flexible

Hospital parking lot: a plan was submitted for a park. KY1, a Catholic initiation
Plan included a path in the shape of a memory ribbon with a fountain in the center of the loop. Designed with the elementary students in mind, education in nature
Design was 3rd Rock's concept (this firm also designed the wetlands project just outside town), Mayor stated that he wants to see a new design.
Discussion about who owns the property, deed in the hands of the Catholic Diocese
Molly will send Hospital parking lot Park Concept Drawings to CDAC

Focus area
Broad Street, Main Street, West Dixie and Downtown district
Mayor asked that we consider a design that allows for underground utilities, a blank canvas underground
Narrow Main Street and mirror image of what has been installed along Main Street (installed 11 years ago)
Way-finding- signage for Farmer's Market and parking (London makes their own signs)

Mayor asked that we consider a one-way concept along Main and Broad Street
1. Concept 1, one-way (new traffic pattern)
2. Concept 2, 2- way (existing traffic pattern)

Character Branding

STAKEHOLDERS MEETING NOTES

Design standards for future locations
Board Street: Desire for it to be tree-lined, no parallel parking, allowance for new business locations

Identity
State designated "Cycling Capitol of KY"
Current statement: "London Live… A Garden City"
Would appreciate design and branding that explores idea: Come and stay for a while
Looks at Damascus, VA (Creeper Trail) as a precedent for London Downtown
Other community strengths noted: History, Value of education, Cycling, Native Plants, and Garden
Laurel County Tourism: Laurel County, "Play, Live, Work" and "Crossroads to Adventure"

Downtown Loop trail
Main Street was a bustling business district
Broad Street was part of the bustling business district, now parking
Jail will be moving
Regional Connections

50,000 acres in Daniel Boone Park
Rockcastle River
Trail heads

People want to live downtown, mixed-use
Trail Designation
July 8th London officially becomes the 5th trail town in KY
Need trailhead and connections of trail head to bike paths, commercial district outside town, Sue Bennett College, Wetlands, Heritage Hills

5th Street the 3rd largest corridor in town

History
2 historic societies in London
Jim Hayes, a contact

Mike's Hike and Bike shop in downtown on Main Street, teaches cycling camps, needs access to trail

Gateways
Locate downtown district gateways

Cultural Locations

Historic Buildings
Trees In Memorandum

STAKEHOLDERS MEETING NOTES

Bike/ Pedestrian Plan

Downtown Events

1. Red Bud Ride: April, gather at farmer's market, currently 914 cyclists participate, plan for 12-1500
2. Cruising on Broad: May-Sept
3. Thursday Night Live: June-August, Courthouse on Main Street, location will move to Broad Street
4. World Chicken Festival: 250,000 people on Main and Broad Street, tents line both sides of street, carnival all along Broad Street and on top of parking deck
5. Arts & Market: Sept-Oct, Fall celebration
6. Boo on Main: Oct, 57 candy vendors, 4,000 children
7. Thriller Ride: 50-60 cycling miles, petting zoo, hay rides, shut down Main Street
8. Christmas on Main: Dec, parade, Santa

Public Interest Groups
Cumberland Valley Cycling Club
Sue Bennett (artists' studios)
Artists' Guild
Tree Board (they would like to complete a tree inventory for saplings their group planted and maintains)
Trail Town Committee
Horticulture and Homemakers Group
Agriculture Departments from North and South Laurel Counties

Round-about construction current, Molly will provide a master plan

Pocket Park in vacant lot adjacent to Mike's Hike and Bike (Mike Hill, owner of Mike's)

Summary
Broad Street pedestrian-friendly green space design
Wayfinding
Landscape design for parking lot behind courtyard, ASAP
Trail/ Trailhead design and location
Pocket Park greenspace
Character/ Branding

- Gardens
- Battle grounds
- Education
- Sweet Buns
- Cycling
- Outdoor recreation, hiking, river and natural resources

STAKEHOLDERS MEETING NOTES

Need Inventory of Community Resources
Wellness Park, Regional Trailhead, Parking lot plan, GIS information, hospital-parking-lot-site design, Downtown master plan (location of round-about), understand the needs of a cyclist, CAD file of parking lot, wetlands, community college, current commercial district, Sue Bennett College

To do

- Soil samples in County Courtyard's parking lot
- Soil samples in Farmers Market,
- Soil samples in pocket park on Main St.
- Measure Farmers Market,
- Measure pocket park
- Measure Broad Street
- Photograph Broad Street, Main Street, Farmers Market, hospital parking lot
- Narrow down locations of downtown gateways
- Opportunities
- Constraints
- Analysis

Future Work
Case Study of Damascus
Board discussing needs of cyclist (water fountains, restroom, outdoor dining)
History
Regional Attractions and Opportunities
Branding: cycling, foods made locally, honey buns, chicken, gardening, artisans

PRELIMINARY CONCEPTUAL DESIGN PRESENTATION NOTES

August 10, 2015, 5:30pm – 7:30pm

Present:
Troy Rudder (Mayor)
Molly Barnett (Executive Director, London Downtown)
Karen Wyan (President, London Tree Board)
John Strojan (Member, London Tree Board)
Peter Stutts (Assistant Urban Forestry Coordinator, Kentucky Division of Forestry)
Carter Gresham (Virginia Tech Landscape Architecture)
Shane Gray (Virginia Tech Landscape Architecture)
Melissa Philen (Project Manager, Community Design Assiateance Center)
Other London Community Members

Topics: Gateways Walking Loop Cyclists
Broad Street (stay/play spaces)
Pedestrian-Friendly Greenspaces Trailhead
Signage: Showcasing plantings, native species, garden city
Erosion Issues
Navigation and Safety
Wayfinding
Branding (Town Assets)

Correction:
Hospital parking lot and “gingerbread” pocket park along Main Street ARE a part of the design proposal. Work on concepts for design and planting (Focal designs).

Gateways:
Likes wayfinding signs to show location of civic amenities like parking
Likes location of proposed gateways

Trailhead:
Farmers Market:
Why was it not trailhead?
Curious because they like current location, but have no opposition against moving it to proposed location.
Liked idea of KY map locating London and locations of biking trails

Proposed Trailhead Location:
Inmates parade near Sheriff’s office (unsightly for businesses and pedestrians)
Where is parking space where will cyclists unload bikes and equipment?

Walking:
Like the vision of wide pedestrian walks, green space, trees, and parks
Show bench locations, tables, places to sit
Need handicap parking! Full accessibility along Broad
Handicap parking NEEDS to stay. – Efficiency is definitely a major priority – maybe make a median – convert a few into minimal parking
Outdoor seating loves
Outdoor walking: businesses follow foot-traffic
Provide interpretive signage to describe art, history, natural sciences, and sustainability

PRELIMINARY CONCEPTUAL DESIGN PRESENTATION NOTES

Cycling:
Cycling in London? Preference: on Main or Broad?
Existing traffic through town is slow on Main; safe for bicyclists, need signage and lanes
Daniel Boone Highway= suicide to bike along
Bike lanes to main street- need parking along main street (one sided parallel parking)

Pocket Park:
Who owns pocket park?
Owners require a gate across for security
Wants: stage, tall shade trees, wi-fi, tables and chairs (possible event space), art

Parking:
Kill restaurant businesses if remove parking lots near Weavers: 40-50 people park there at one time.
No businesses along Broad because of parking, court house, Christian's church parking, jail… only one business

Broad Street Layout:
Likes serpentine layout; Likes speed-table
Likes bump-outs for planting, green space, and shade
Wants a unique pedestrian/ vehicular experience along broad\ Liked promenade/ speed-table across from courthouse

Historic Resources:
Civil war battle field, at elementary school site
African American history in town Reserve existing historic resources
Propose interpretive signage specific to place

Branding:
Colors: red-bud pink, green
Crossroads, destination
Daniel Boone Trace along Broad

Serpentine road: in favor
Behind courthouse, would love outside dining.

Broad needs to become an experience in and of itself.

European idea may be an issue because people are nervous about roundabouts
Serpentine – seems like a yes.

Wayfinding – lamppost as a standard.

Boone Trace (1775) and Wilderness Road (1795) – Sheltowee - Laurel Lake as an attraction, forge, Levi.

PRELIMINARY CONCEPTUAL DESIGN PRESENTATION NOTES

Incorporate heritage and maybe show variation in architectural details. Maybe show more contemporary designs.

Show and teach about sustainability.

Interpretive signage about history, art, heritage, and contemporary practices Hal Rogers Parkway

If 75 is shut down, all traffic comes through London creating tourism and other regional tourism.

Crossroads – buzzword for quite a few people, bluegrass is big here, also Michigan tourists stop here on their way to Florida.

Speed Table as a connection sounds good.

Hendersonville NC or SC for woonerf idea - Built up islands.

Shirley Smith owns the pocket park and the large possible trailhead space – Lilypad for the stage in the small pocket park in honor of her granddaughter - she's open to a park on both and she's seriously considering donating the larger parcel to the city in the near future!

Reda Theater is still a major parking lot and should stay that way.

FINAL CONCEPTUAL DESIGN PRESENTATION NOTES

October 26, 2015, 5:50pm-7:30pm

Attendees:

Molly Barnett	Executive Director, London Downtown
Mayor Troy Rudder	Mayor, London, Kentucky
Karen Wyan	President, London Tree Board

Kentucky Division of Forestry

Sarah C. Gracey	Urban Forestry Program Coordinator
Peter Stutts	Urban Forestry Partnership Coordinator

Community Design Assistance Center

Melissa Philen	Project Manager
Shane Gray	Student Designer
Carter Gresham	Student Designer

Notes:

Broad Street:

- Concern about changing parking around dentist's office. Happy with current design.
- Desire to see café seating across the courthouse. Design does not seem to show enough room for tables and chairs near beauty salon.
- Tree and shrub planting appears to be rendered in creek. Explain that plan does not show planting in the creek bed, but as a riparian stabilization method.
- Major water issues at low-point along Broad Street. In final report, recommend a large underground detention basin with drain field.
- Huffman & Huffman Insurance commented that they can't do full square park, but sidewalk greening.
- Discussion if more of these streetscape additions can address water problems
- Will cyclists be moving down Broad Street more so than Main Street?
- Liked the meandering with gardenesque sense of place
- Good plant palette, seasonal color, and fragrance in areas where seating is available
- Guests liked the increased seating opportunities along the street, especially in the shade
- Concern for adaptability of meandering-type street during large festivals. Areas for booths and vendors usually span across the street

Walking and Cycling in London:

- Would like to understand where bike lanes will go on Main Street
- How would bicyclists move along Broad Street? How do Main Street and Broad Street connect for bicyclists and pedestrians? (Are there improvements on these side streets)
- How will the new location of the trailhead effect downtown motorist movement and parking
- Streetscapes would have more similarity, bringing the entire downtown district together as one

Remembrance Park:

- Park space could be used for London Live! Events.
- Include an outdoor stage and seating for London Live! Events.
- Meadow area could be used for Urban Beekeeping
- Discussion of outdoor hillside amphitheater to be used by London Elementary School
- Request for more buffer between park and residents located on South Hill Street

FINAL CONCEPTUAL DESIGN PRESENTATION NOTES

- Gateway signage at park or opposite side of street? Holiday tree would accent gateway appropriately
- Opportunity for more variety in plant palette
- Concern about parking during events if this becomes park
- No nearby parking for those visiting the park from the other end of town

Pocket Park Design:

- Expression of support for design, using stage for events, weddings, movie showings
- Expression of support for art in park: mural, sculpture, events
- Enjoyed idea of smaller, more intimate gathering space in the core of downtown
- Expressed as another promising opportunity for café seating, and bringing local business back downtown
- Expressed interest in the idea of sensory details to engage user (i.e. bubble fountains, visual interests, possible music opportunity)

7th Street Park and Trailhead:

- Preliminary design included a shelter for bikers at the trailhead. There is a desire to have a shelter in the park. Please include one in the final design.
- Site is currently a parking lot. Hesitation to turn space into a park (loose parking) was vocalized.
- Site is not currently owned by the city, but leased from a city resident
- Service road to Ryser's Flooring was accepted, though owner was not present to comment
- Concern of steep slope for street and access road closest to Main Street (north side) of park – trucks might tip, and there is not enough room to turn onto the service street
- Expressed interest in the different paving type for 7th Street, to showcase as a more pedestrian friendly avenue
- Bike racks and maintenance station are desired to be more central to the park, rather than an add-on of the street

Judicial Center Parking Lot Conceptual Design:

- Expressed support of shaded parking and additional parking for police cruisers and visitors of downtown
- Guests liked the idea of the impound lot moving out of the downtown scope
- Curious as to how this lot might serve future renovation and changes to Laurel County Detention Center building (proposed to be moved within 2 years)
- Bioswales and rain gardens were liked by all – hope to see more of this throughout the city, as water is an issue with small underground storm drains
- Community seemed glad that erosion issues were being addressed with lower lot
- Supported green buffers between parking lot and nearby residence

Wayfinding and Gateway Signage:

FINAL CONCEPTUAL DESIGN PRESENTATION NOTES

- Excitement for signage designs
- Perhaps final design could combine crossroads and cycling themes
- Liked the combination of wood and stone – natural look, materials found in this region
- Legibility seemed strong (white text on darker background)
- Curious of plantings, if any, around gateway signage and if this would effect visibility

Written Comments:
“Outstanding presentation and proposal. Wish we (the city) could implement all of it. Thanks!!” -Anonymous

“NEED TO FILL BUSINESSES ON MAIN STREET
BRING IN MORE BUSINESSES TO DOWN TOWN MAIN ST” -Anonymous

SOIL ANALYSIS

Soil Sampling for the Home Gardener

Joseph R. Hunnings, Extension Specialist, Virginia Tech
Stephen J. Donohue, Extension Specialist, Virginia Tech
Steve Heckendorn, Laboratory Manager, Virginia Tech

A soil test can provide information on the proper amount of lime and fertilizer to apply to your lawn, garden and other areas of your landscape. When gardeners apply only as much lime and fertilizer as is necessary and at the appropriate time, nutrient runoff into surface or ground water is minimized, money is saved, and plant health is optimized. Soil testing can also be used to diagnose common nutrient deficiencies for plants that are growing poorly.

The reliability of the soil test, however, can be no better than the sample you submit. For results you can depend on, it is vitally important that you take samples correctly to accurately represent the soil in your landscape.

This publication explains how to obtain representative soil samples and to submit them for analysis to the Virginia Tech Soil Testing Laboratory. It is an easy-to-learn process that will benefit you, your landscape and the environment.

So Don't Guess, Soil Test!

Soil Sampling Equipment

To collect samples use a stainless steel or chrome-plated soil probe, hand garden trowel, shovel or spade (displayed left to right in the picture above). Do not use brass, bronze, or galvanized tools because they will contaminate samples with copper and/or zinc.

The soil probe is the best tool for collecting soil samples. The soil probe works better than a shovel or trowel because this tool equally collects soil in a continuous core from the surface through the entire sampling depth with minimal disturbance of the soil. It also allows for faster sampling.

Some of the disadvantages of a soil probe are: it cannot be used when the soil is too wet because the soil compresses; it cannot be used when the soil is too dry because it is difficult to penetrate the soil. Soil probes also do not work well in soils that contain gravel.

Soil probes are available through agricultural supply companies or your agriculture Extension agent may be able to help you locate a supplier. Cost is typically $35 or more.

Mix soil samples in a clean, plastic bucket. If the bucket has been used to hold fertilizer or other chemicals, wash and rinse it thoroughly before using it for soil samples. Even a small amount of lime or fertilizer transferred from the sampling tools to the soil can seriously contaminate the sample and produce inaccurate results.

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VirginiaTech Invent the Future

Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2011

SOIL ANALYSIS

In addition to these tools, if you plan to submit your sample to the Virginia Tech Soil Testing Laboratory, you will need a Soil Sample Information Sheet and a Soil Sample Box. The form is available online at *http://www.soiltest.vt.edu/*, while both the box and the form are available from the Virginia Cooperative Extension office in your county or city. Look in the government pages of your phone book or *http://www.ext.vt.edu/offices/* for the address and phone number of your local Extension office.

When And How Often To Sample

When is the best time to take soil samples? Take a soil sample a few months before initiating any new landscaping—whether it be seeding a lawn, starting a vegetable garden, putting in a flower bed, or planting perennials. Sampling well in advance of planting will allow time for applied soil amendments to begin making the desired adjustments in soil pH or nutrient levels.

Sample established areas—lawns, trees, shrubbery, and other perennials- - at any time of year; however, an ideal time to take samples is when the garden season has ended in the late summer to early fall. Sampling in the fall allows time for corrective pH and nutrient management before new growth starts in the spring. Fall sampling also avoids a sometimes busy spring period at the Soil Testing Laboratory, thus avoiding delays in getting your soil test results.

If an established area exhibits abnormal growth or plant discoloration, take a soil sample right away. For areas recently limed or fertilized, delay sampling at least six to eight weeks.

A soil sample is a composite of numerous sub-samples, so a soil that is too wet will be impossible to mix together. As a rule, if the soil is too wet to work (or is good for making mud pies like in the photo!), it is too wet to sample. Another way to judge is to squeeze soil into a ball. If it easily breaks apart, then the soil can be sampled.

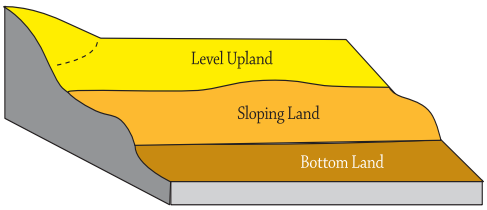
How often should a soil be tested? If you live in the Coastal Plain region and have sandy soils, it is best to test every two to three years. The sandy soils in that region do not hold nutrients as long as soils in the other parts of the state and are more likely to become acid through the addition of nitrogen. The nutrient levels in the silt and clay loam soils of the Piedmont and Mountain regions change less rapidly with lime and fertilizer applications. In these areas, soil testing once every four years is usually sufficient.

Where To Sample

To obtain an accurate soil sample, all that is needed for most gardeners is to divide your landscape into areas of unique use, i.e., a vegetable garden, lawn, perennial flower bed, etc., and to sample those unique areas individually. However, occasionally one of these unique landscape areas will be made up of one or more distinctly different soils. These soil differences may not be evident to the untrained eye, but different soils can have different chemical and physical properties which will result in differences in plant growth. You will need to take your soil sample in a way that will take into account the distinctly different soils that may exist in your landscape.

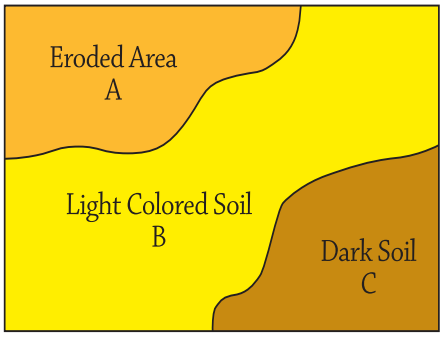
Think of it this way. When a breeder seeks a pure-blooded animal, two animals of the same breed are mated. If you mix two breeds you have a mix-blooded animal, one with characteristics of both breeds. So it is with a sample that contains soil from more than one soil type. The sample will reflect a mixture of the characteristics of each soil and therefore not correctly represent either particular soil. So a soil sample that results from mixing distinctly different soils may result in fertilizer and lime recommendations that might be high for one of the soil types and low for another.

How can you tell if your landscape area has uniform soils? Here are a few clues. First, you can expect differences in soils due to vastly different landscape positions, i.e., hilltops versus steep slopes versus poorly drained bottom areas as in the figure below. Sample each area separately.



SOIL ANALYSIS

A second way that different soils may be evident is by differences in soil color. As in the figure below, a predominantly yellow topsoil will likely have different characteristics than a topsoil that is dark brown in color. The eroded area will have different characteristics than either of the other two soils.



Soil texture is a third factor that may indicate differences in soils. A sandy soil will have different properties than a loam or a clay soil. (Appendix 1 describes a method you can use to determine the texture of your soils). For most small landscapes, it will be unusual to find soils with significantly different soil textures. However, severely eroded areas and soils disturbed during building construction are two examples of how human activities may have left soils with different textures in your landscape.

A fourth factor to consider in your landscape are those areas which have had different treatments, perhaps by you or a previous landowner. For example, different treatments exist if your lawn contains two different turf types such as fescue in the front yard and bermudagrass in the back yard. Different treatments exist if you have a portion of a landscaped bed that has consistently received greater amounts of fertilizer or other soil amendment than another portion of the bed. Different treatments will result in different properties that should be accounted for by sampling the different areas separately.

What's the bottom line? To collect an accurate soil sample that is representative of your landscape, you must, as much as possible, sample from areas that are uniform. So look for changes in soil landscape position, soil color, texture, and treatments to divide areas into separate samples. If there are no evident differences, then sample by unique use areas, i.e., lawn, vegetable garden, orchard, etc.

Where Not To Sample

When collecting samples, avoid small areas where the soil conditions are obviously different from those in the rest of the landscape. For example, in the lawn pictured below, your sample should not include soil from the low, wet spot.

Also, avoid yard or landscape area borders, ditch banks, old brush piles, burn sites, severely eroded areas, old building sites, fence rows, pet dropping and urine spots, etc. Since soil taken from these locations would not be typical of the soil in the rest of the landscape area, including them could produce misleading results.

Soil Sampling As A Diagnostic Tool

If one area of your landscape seems healthy and another area has bare or yellow areas or yields poorly, soil sampling may help to diagnose the problem. Where poor growth exists and this area is large enough to manage separately, then separate composite samples should be taken from both poor and good areas. By comparing the results, the soil test may point out troubles that exist due to a lack of, or an excess of, nutrients and/or an incorrect pH. However, it should be pointed out that other factors may have a greater influence on plant growth that will not be accounted for by a soil test. These include soil drainage, soil compaction, insects, diseases, rainfall, and other factors.

How To Take A Representative Soil Sample

The first thing you must know to collect a proper soil sample is the depth the sub-samples should be taken. The following table gives you recommended sampling depths for common landscape areas.

SOIL ANALYSIS

Recommended Sampling Depths	
Established lawns	2-4 inches
Vegetable and flower gardens	6-8 inches or tillage depth
Trees and shrubs	6 inches

Sample depths are measured from the soil surface downward. For lawns, sample to a depth of 4 inches, excluding any turf thatch. For vegetable and flower gardens, sample to the depth that you plan to incorporate lime or fertilizer, usually 6 to 8 inches. In mulched beds of trees and shrubs, remove any mulch or surface debris, then sample to a depth of 6 inches.

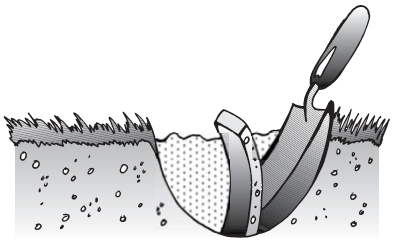
When sampling soil around established trees and shrubs, take sub-samples from an area near the trunk to the outer edges of the branches (the drip line). For a particular landscape area, it is best to use the same sampling depth from year to year so soil test values can be more accurately compared.

How To Take Soil Sub-Samples

We learned earlier that an accurate soil sample must be taken from uniform soil areas. Within that area a soil sample must be made up of multiple sub-samples. These sub-samples are mixed together to make up the composite soil sample for that area. This section describes how to take the soil sub-sample.

STEP 1: Open a hole with a shovel, spade or trowel from the surface to the proper depth for your landscape area. Set that soil aside. (If you are using a soil probe, insert it into the soil to the proper depth and remove the plug from the ground).

STEP 2: With your shovel or trowel remove a 1 inch thick slice from the smooth side of the open hole.



STEP 3: With the slice of soil on the blade of the shovel, remove the sides of the slice with a trowel, knife or your hands to create a ribbon of soil 2 inches wide and 1 inch thick of the proper depth. Place the ribbon (or plug if using a soil probe) into a container.

STEP 4: Remove any surface mat of grass or litter and any rocks. Place the soil in a clean bucket or container. Remember that a clean, plastic container is best.

STEP 5: Continue to take additional soil sub-samples from the uniform landscape area. By mixing these sub-samples together, you create the composite sample that will be sent to the Soil Testing Laboratory. The next section will explain how many sub-samples you should take for the composite sample.

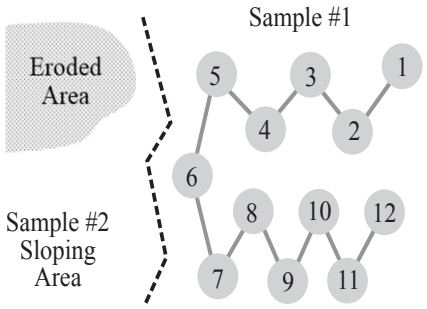
Making The Composite Sample

Take 10 or more sub-samples from different locations within each uniform sampling area to make a composite sample. Take the sub-samples in a random manner, such as with a zigzag pattern to minimize the variability that may be present in your sampling area. This allows you to obtain a reasonably representative soil sample.

In the following figure, composite sample #1 contains 12 sub-samples. Sample 2 should contain at least 10 sub-samples as well. You should avoid the eroded area when making composite samples #1 and #2. If it is large enough in size, a third composite sample could be collected from this area.

The larger the area, the more sub-samples that are needed. The more sub-samples you take, the more representative your sample will be of your landscape area. When you realize that your 1/2 pound composite

SOIL ANALYSIS



sample could represent thousands, or perhaps millions of pounds of soil, you can understand why proper sampling is so important.

When you have taken sufficient sub-samples from a uniform area, thoroughly mix the sub-sample slices or cores, breaking up clumps and removing all foreign matter such as roots, stalks, rocks, etc. Now you are ready to prepare the sample for the Soil Testing Laboratory.

Submitting the Sample to the Lab

Obtain free Soil Sample boxes and Soil Sample Information Sheets from your local Virginia Cooperative Extension office, certain agribusinesses, and garden centers. Use permanent ink or pencil to fill out forms and label boxes.

Fill the sample box completely with soil and label it with your name, address, and sample identifier. Give the sample an identifier of up to five letters and/or numbers. Choose a unique identifier that will help you remember the area it corresponds to, such as FYARD, BYARD, ROSE2, or GARDN. Be sure to keep a record of the areas sampled with their corresponding identifier. This is particularly helpful if you are taking multiple samples.

Complete the Soil Sample Information Sheet

The Virginia Cooperative Extension Soil Sample Information Sheet is an important part of the sample process. The Information Sheet is available online at *http://www.soiltest.vt.edu*, or from your local Virginia Cooperative Extension Office. It also includes a page of sampling instructions.

To get the most value from your soil test, take the time to fill in the blanks on the Information Sheet as completely and accurately as possible. Be sure to list the correct plant code for each sample you submit. Also, check to make sure that the sample identifier you put on the Sheet corresponds to the identifier on the sample box and in your records. Costs for the various soil tests that are offered are listed on the information sheet. If you need assistance with the Information Sheet, contact your local Extension office.

Mail the completed Information Sheet with the sample box and payment in a sturdy shipping box to the Virginia Tech Soil Testing Lab, 145 Smyth Hall (0465), Blacksburg, VA 24061.

Results From the Soil Testing Laboratory

Soil samples at the Virginia Tech Soil Testing Laboratory are usually analyzed within one week of the time they are received. However, in early spring, processing the sample and mailing you your results may take two weeks due to the large number of samples sent in by farmers at this time.

The Soil Testing Laboratory will provide you with information on the availability of nutrients in your soil. The routine soil test costs $10 (cost subject to change). The test measures and makes recommendations for the following major nutrients: P (phospho-

SOIL ANALYSIS

rus); K (potassium); Ca (Calcium); Mg (Magnesium) and five micronutrients. In addition, the routine test determines the soil pH and makes recommendations on how to raise or lower the pH. Less frequently needed tests that are available at an additional cost include organic matter and soluble salts.

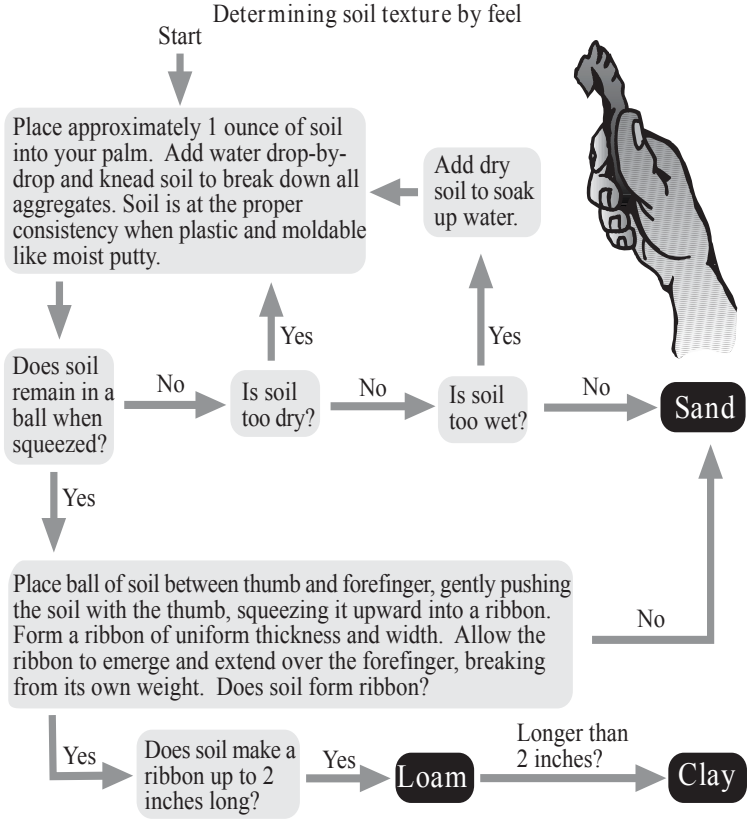
A soil test is not usually performed for the presence of N (nitrogen). Nitrogen can quickly move out of the root zone of the soil by downward movement of water or by plant uptake. Due to nitrogen's potential for rapid changes in availability in the soil, a soil test may show nitrogen levels that no longer exist. Soil Testing Laboratories still provide nitrogen fertilizer recommendations. The recommendations are based on years of research that has determined plant nitrogen needs.

When testing is complete, a report is mailed to you and an electronic copy is available to the Agriculture Extension Agent for your county or city.

Supplemental notes are also sent with the report. The notes explain the technical terms used in the report and provide extra details on fertilizer application schedules and rates for specific kinds of plants. Feel free to contact your Extension Agent for more help on sampling, interpreting soil test results, and understanding how to implement them. The phone number for your local Extension office appears on the upper left of your report.

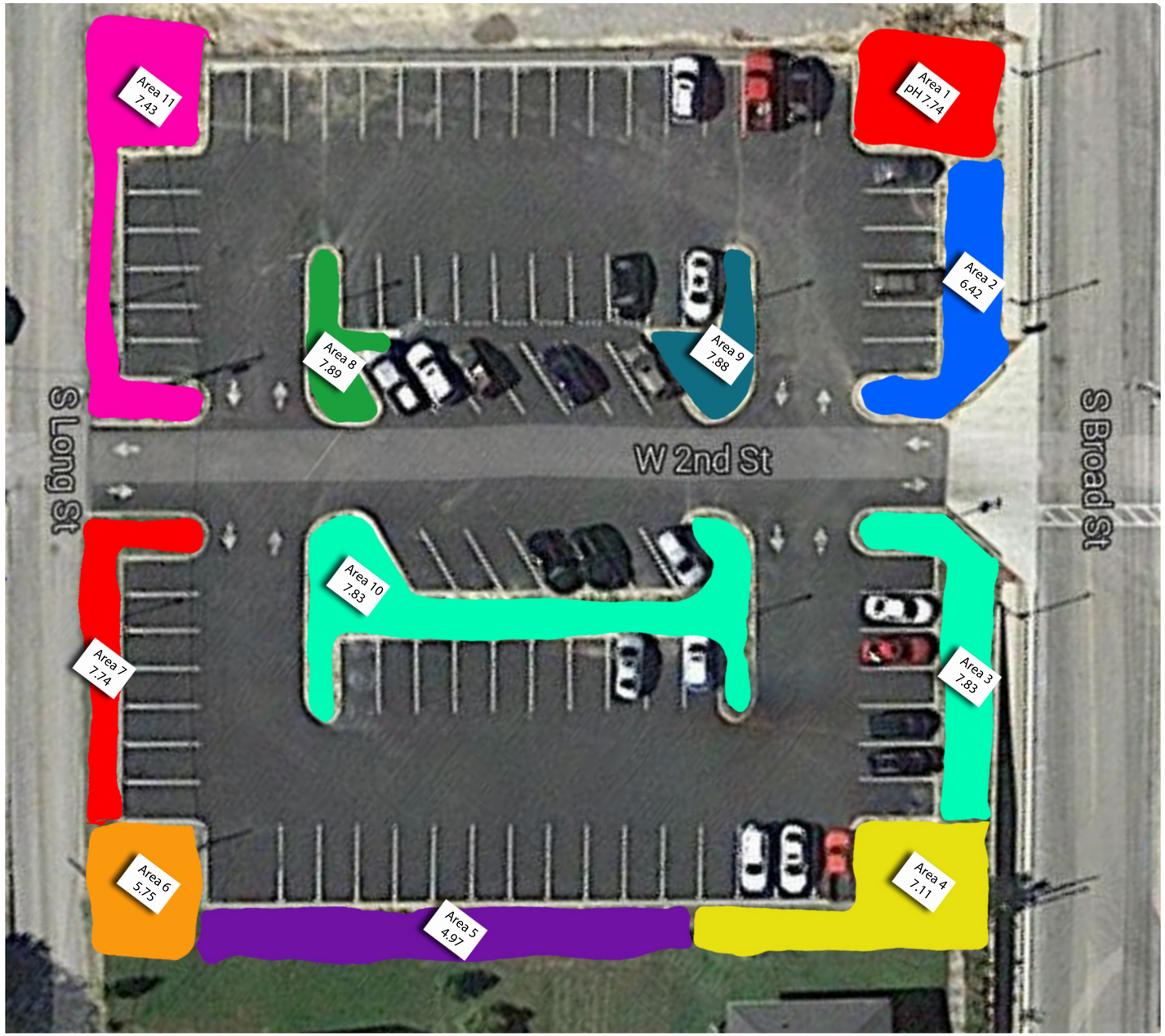
Appendix 1: Soil Sampling For The Home Gardener

Determining soil texture by feel



SOIL ANALYSIS

Soil Sample Locator Map for Courthouse Parking Lot



SOIL ANALYSIS

Explination of Soil Tests

Rory Maguire, Extension Nutrient Management Specialist, Virginia Tech
Steve Heckendorn, Soil Test Laboratory Manager, Virginia Tech

The accompanying Soil Test Report (and supplemental Soil Test Notes, when provided) will help you assess your plant's need for fertilizer and lime.

The "History of Sampled Area" section restates the information you filled in on the Soil Sample Information Sheet you submitted with the soil sample.

The "Lab Test Results" section shows the relative availability of nutrients numerically and if appropriate, as a rating. The rating may be interpreted as follows: L=Low, M=Medium, H=High, VH=Very High, EH=Excessively High (soluble salt test only), DEF=Deficient, or SUFF=Sufficient, and sometimes a "+" or "-." When soils test Low, plants almost always respond to fertilizer. When soils test Medium, plants sometimes respond to fertilizer and a moderate amount of fertilizer is typically recommended to maintain fertility. When soils test High to Very High, plants usually do not respond to fertilizer. If there is no rating for a nutrient, the adequacy of that nutrient in the soil for the plant you specified has not been determined.

The following is an explanation of the symbols and abbreviation used in the report:

Report Symbols and Abbreviations

P = phosphorus	K = potassium
Ca = calcium	Mg = magnesium
Zn = zinc	Mn = manganese
Cu = copper	Fe = iron
B = boron	SS = soluble salts
lb/A = pounds per acre	ppm = parts per million
meq = milliequivalent	g = gram
pH = acidity	Sat. = saturation
N = nitrogen	P_2O_5 = phosphate
K_2O = potash	% = percent

Est-CEC = estimated cation exchange capacity

AG = agricultural limestone (dolomitic or calcitic)

Fertilizer Recommendation

The fertilizer recommendations may be used for the same crop for two to three years. After this time, it is advisable to retest the soil to determine if significant changes have occurred in nutrient levels. When the soil tests Very High for phosphorus or potassium and no fertilizer for these nutrients is recommended, you should retest the following year to determine if fertilizer will be needed. Due to the variability associated with sampling, fertilizer application rates may be varied by a plus or minus 10 percent.

No soil test is performed for **nitrogen** because this element is too mobile in the soil for laboratory results to be useful. Nitrogen fertilizer recommendations are based on the crop/plant to be grown, the previous crop, and when applicable, the soil's yield potential. Comments on the report and other enclosed Notes, if any, will have further information regarding nitrogen.

Lime Recommendation

If needed, a lime recommendation is given to neutralize soil acidity and should last two to three years. After that time, you should have the soil retested. The measured soil test levels of calcium and magnesium are used to determine the appropriate type of limestone to apply. If neither dolomitic nor calcitic lime is mentioned, or "Ag" type or "agricultural" limestone is stated on the report, then it does not matter which type is used. When no information on the Soil Sample Information Sheet was provided regarding the last lime application, the lab assumed you have not applied lime in the past 18 months. If this is not correct, contact your Extension agent for advice on adjusting the lime recommendation to take into consideration recent lime applications. Do not over lime! Too much lime can be as harmful as too little. For best results, apply lime, when possible, several months ahead of the crop/plant to be planted to allow time for more complete soil reaction.

www.ext.vt.edu

VirginiaTech Invent the Future

Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2010

SOIL ANALYSIS

Methods and Meanings

For more detail on the lab procedures used, visit *www.soiltest.vt.edu* and click on "Laboratory Procedures."

Soil pH (or soil reaction) measures the "active" acidity in the soil's water (or hydrogen ion activity in the soil solution), which affects the availability of nutrients to plants. It is determined on a mixed suspension of 1:1, volume to volume ratio of soil material to distilled water.

Virginia soils naturally become acidic, and limestone periodically needs to be applied to neutralize some of this acidity. A slightly acid soil is where the majority of nutrients become the most available to plants, and where soil organisms that decompose organic matter and contribute to the "overall health" of soils are the most active. When a soil is strongly acidic (< 5.0-5.5), many herbicides lose effectiveness and plant growth is limited by aluminum toxicity. When soils are overlimed and become alkaline (> 7.0), micronutrients, such as manganese and zinc, become less available to plants.

For most agronomic crops and landscaping plants, lime recommendations are provided to raise the soil pH to a slightly acid level of between 5.8 and 6.8. Blueberries and acid-loving ornamentals generally prefer a 4.5 to 5.5 pH, and an application of liming material is suggested when the soil pH drops below 5.0. For the majority of other plants, lime may be suggested before the pH gets below 6.0. This is to keep the soil pH from dropping below the ideal range, since lime is slow to react and affects only a fraction of an inch of soil per year when the lime is not incorporated into the soil. If the soil pH is above the plant's target pH, then no lime is recommended. If the pH is well above the ideal range, then sometimes an application of sulfur is recommended to help lower the pH faster; however, most of the time, one can just let the soil pH drop on its own.

A Mehlich buffer solution is used to determine the **Buffer Index** to provide an indication of the soil's total (active + reserve) acidity and ability to resist a change in pH. This buffer measurement is the major factor in determining the amount of lime to apply. The Buffer Index starts at 6.60 and goes lower as the soil's total acidity increases and more lime is needed to raise the soil pH. A sandy soil and a clayey soil can have the same soil pH; however, the clayey soil will have greater reserve acidity (and a lower Buffer Index) as compared to the sandy soil, and the clayey soil will require a greater quantity of lime to be applied in order to raise the soil pH the same amount as the sandy soil. A reported Buffer Index of "N/A" means that it was not measured since the soil (water) pH was either neutral or alkaline and not acidic (soil pH ≥ 7.0) and therefore requires no lime.

Nutrients that are available for plant uptake are extracted from the soil with a Mehlich 1 solution using a 1:5 vol:vol soil to extractant ratio, and are then analyzed on an ICP-AES instrument. An extractable Mehlich 1 level of phosphorus from 12 to 35 pounds per acre (lb/A) is rated as medium or optimum. A medium level of potassium is from 76 to 175 lb/A. Medium levels of calcium and magnesium are 721 to 1440 and 73 to 144 lb/A, respectively. Calcium and magnesium are normally added to the soil through the application of limestone. It is rare for very high fertility levels of P, K, Ca and Mg to cause a reduction in crop yield or plant growth. Levels of micronutrients (Zn, Mn, Cu, Fe and B) are typically present in the soil at adequate levels for plants if the soil pH is in its proper range. See Soil Test Note 4, at *www.soiltest.vt.edu/stnotes*, for documented micronutrient deficiencies in Virginia.

Soluble Salts (**S.Salts**) or fertilizer salts are estimated by measuring the electrical conductivity of a 1:2, vol:vol ratio of soil material to distilled water. Injury to plants may start at a soluble salts level above 844 ppm when grown in natural soil, especially under dry conditions and to germinating seeds and seedlings. Established plants will begin to look wilted and show signs related to drought. This test is used primarily for greenhouse, nursery and home garden soils where very high application rates of fertilizer may have led to an excessive buildup of soluble salts.

Soil **Organic Matter** (SOM) is the percentage by weight of the soil that consist of decomposed plant and animal residues, and is estimated by using either the weight Loss-On-Ignition (LOI method) from 150° to 360°C, or a modified Walkley-Black method. Generally, the greater the organic matter level, the better the overall soil tilth or soil quality, as nutrient and water holding capacities are greater, and improved aeration and soil structure enhance root growth. The percent of organic matter in a soil can affect the application rate of some herbicides. Soil organic matter levels from 0.5% to 2.5% are ordinary for natural, well-drained Virginia soils. A soil organic matter greater than 3% would be considered very high for a cultivated field on a farm, but can be beneficial. Due to relatively large amounts of organic materials being commonly added to gardens, the soil organic matter in garden soils can be raised into the range of 5% to 10%.

SOIL ANALYSIS

The remaining values that are reported under the "Lab Test Results" section are calculated from the previous measured values and are of little use to most growers.

Estimated Cation Exchange Capacity (**Est-CEC**) gives an indication of a soil's ability to hold some nutrients against leaching. Natural soils in Virginia usually range in CEC from 1 to 12 meq/100g. A very sandy soil will normally have a CEC of 1 to 3 meq/100g. The CEC value will increase as the amount of clay and organic matter in the soil increases. This reported CEC is an estimation because it is calculated by summing the Mehlich 1 extractable cations (Ca + Mg + K), and the acidity estimated from the Buffer Index and converting to units commonly used for CEC. This is also an Effective CEC since it is the CEC at the current soil pH. This value can be erroneously high when the soil pH or soluble salts level is high.

The percent **Acidity** is a ratio of the amount of acid-generating cations (as measured by the Buffer Index) that occupy soil cation exchange sites to the total CEC sites. The higher this percentage, the higher the amount of reserve acidity in the soil, and the higher the amount of acidity there will be in the soil solution and the lower the soil pH will be. A reported Acidity% of "N/A" means that a buffer index was not determined, and the acidity is probably less than 1 meq/100g and/or 5%, and the soil pH is alkaline (greater than 7.0).

The percent **Base Sat**uration is the ratio of the quantity of non-acid generating cations (i.e., the exchangeable bases, Ca, Mg, and K) that occupy the cation exchange (CEC) sites.

The percent **Ca, Mg, or K Sat**uration refers to the relative number of CEC sites that are occupied by that particular nutrient and is a way of evaluating for any gross nutrient imbalance.

Additional Information

For questions and more information, contact your local Virginia Cooperative Extension (VCE) office or go to *www.ext.vt.edu*. Contact information for your local Extension office appears on the upper left of your soil test report.

Conversion Factors

(Some Values are Approximate)

1 acre = 43,560 square feet

1 pound of 5-10-5, 5-10-10 or 10-10-10 fertilizer = 2 cups

1 pound of ground limestone or ground dolomitic limestone = 1.5 cups

1 pound of aluminum sulfate or magnesium sulfate = 2.5 cups

1 pound of sulfur = 3.3 cups

1 quart = 2 pints = 4 cups

1 pint = 2 cups = 32 tablespoons

1 tablespoon = 3 teaspoons

1 bushel = 35.24 liters = 1.25 cubic feet

Pounds per 100 square feet x 0.54 = lbs per cubic yard

100 square feet = 5 feet x 20 feet, 10 feet x 10 feet, or 2 feet x 50 feet

1,000 square feet = 50 feet x 20 feet, 10 feet x 100 feet, or 25 feet x 40 feet

Pounds per 100 square feet x 436 = pounds per acre

Pounds per 1,000 square feet x 43.6 = pounds per acre

Pounds per acre x 0.0023 = pounds per 100 square feet

Pounds per acre x 0.023 = pounds per 1,000 square feet

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

A Designer's Guide to Bio-Retention Area Planning, Design, and Implementation

January 2013

Report prepared by Lee R. Skabelund and Dea Brokesh, Kansas State University,
Department of Landscape Architecture / Regional & Community Planning—for the
Kansas Department of Health & Environment and U.S. Environmental Protection Agency.

July 11, 2011 photo by Lee R. Skabelund

The Kansas Department of Health and Environment (KDHE) provided financial assistance to the Sunset Zoo Bio-Retention Area Gardens (K-State Demonstration Project) through USEPA Section 319 Nonpoint Source Pollution Control Grant #C9007405 14 (KDHE Funding Codes 3889 2649598) as part of the KDHE Clean Water Neighbor Program.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

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Introduction & Literature Review

In the book *Water Matters: Why We Need to Act Now to Save Our Most Critical Resource* we are reminded of the urgent need to act to protect our freshwater systems (Lohan 2010). In many articles, documents, reports, and books the value of rain-gardens and bio-retention areas are described as significant tools for reducing stormwater runoff and increasing infiltration rates in urban areas. The USEPA, Center for Watershed Protection, Low Impact Development Center, along with Ferguson (1994), France (2002), Davis & McCuen (2005), Hunt & Lord (2006), Clar (2007), Davis et al. (2009), Li et al. (2009), Calkins (2012), Venhaus (2012), and many others, discuss what we can learn from bio-retention facilities implemented in various parts of the U.S. Additionally, well designed gardens connect people to place/region.

The **recharge potential and functioning of watersheds as integrated systems that temper flooding and cleanse water** are impaired by the removal of native vegetation and permeable plant-soil systems as well as widespread use of impervious surfaces. Water flows swiftly off of most paved surfaces in our urban areas, and many landscapes have poor infiltration due to surface compaction by vehicles and people. Likewise native songbirds are undermined by the loss of native plants, which can offer high aesthetic value (Oudolf & Gerritsen 2003) while supporting essential hydrological and ecological functions (Burrell 2006; Tallamy 2007).

In "Water Matters" Brock Dolman (2010, 130) indicates that we have a great opportunity to change these undesirable conditions by implementing urban infrastructure and stormwater practices that **slow, spread, and sink precipitation into the earth**.

Patchett & Wilhelm (2008), Condon (2010), Dinep & Schwab (2010), and Douglas (2011) all note how **filtering water thorugh soil-and-vegetation systems is vital to the health of watersheds**—providing cleaner and more stable water supplies for downstream ecological systems as well as for people with property, homes, and businesses downstream.

Water conservation—supported by creating rain-gardens and bio-retention areas that need no or very minimal supplemental irrigation once established—**has many positive effects, including energy and economic savings** (Schmidt et al. 2007; Woelfle-Erkskine & Uncapher 2012).

Nassauer (1997), Dreiseitl, et al. (2001), Echols (2007), and the University of Arkansas (2010) highlight the importance of **creating artful stormwater management facilities for enjoyment, engaged education, and perceived value** by residents and stakeholders.

This guidebook shows how designers in the Kansas Flint Hills Eco-region were able to replace approximately 2,000 square-feet of impervious surfaces with a permeable and visually pleasing bio-retention garden that needs very minimal supplemental irrigation once established.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Purpose of this Guidebook

This guidebook aims to benefit both property owners and planners/designers by describing important considerations related to bio-retention planning, design and management.

Two succinct chapters are provided: the first, addressing the planning/design phase of a small-scale urban stormwater management project; the second, offering guidance for the implementation of bio-retention areas in locations similar to the new garden at Sunset Zoo.

Project Accomplishments

One bio-retention area garden was installed in the fall of 2011 to reduce impervious surfaces and increase infiltration of stormwater runoff at Sunset Zoo in Manhattan, Kansas.
The garden lies north of the central amphitheater and "Kansas Plains" displays and west of the Prairie Dog display. An underutilized concrete sidewalk and asphalt parking area were removed and replaced with a series of bio-retention pools that collect a portion of the water running off of upslope pavement and turfgrass. Photos below were taken October & November 2012.

An on-site education session was held on June 21, 2012 and involved interested citizens.
This session (pictured below-right) was co-sponsored by the Wildcat Creek Watershed Council. Additional on-site education and hands-on maintenance events were held September 28, 2012 and involved landscape architecture and planning students from Kansas State University.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Chapter One: Bio-retention Area Planning/Design

The most important idea we can share at the outset is that planners, designers and property owners should **seek to integrate proposed bio-retention areas and rain-gardens into both the larger eco-region** (with thoughtful consideration of the regional climate and plants native or well-adapted to the region) **and to the specific site** (including soils, topography, hydrology, on-site and nearby vegetation, and the bio-physical and socio-cultural context). Budgetary limits (time and financial resources) are almost always an important factor and frequently determine how one proceeds during the planning/design process as well as implementation.

In regards to the **Sunset Zoo Bio-Retention Area Gardens** two broad options were considered by KSU faculty, students, and staff between Fall 2008 and Fall 2011: 1) address the entire area between the residential fence and the roadway, including the removal of the existing large clay pipe and concrete pad leading to this pipe (see photos below); or 2) focus the bio-retention garden more narrowly by removing the underutilized concrete sidewalk and asphalt parking area and retaining the clay pipe and associated concrete pad. Due to both financial and time constraints it became clear that the large pipe should not be removed. Additionally, there was a desire to make sure that the new gardens were able to handle high volume stormwater flows running towards the garden and to also provide a location for plowed snow near the pipe.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Important Planning/Design Considerations:

1) Create a bio-retention garden sized for the specific limitations and opportunities of the selected property, with careful consideration of the impermeable and permeable surfaces associated with the site, present and anticipated (future) watershed conditions, projected stormwater flows into the garden through different seasons, on-site soil and microclimate attributes, and the likely timing of bio-retention area implementation and establishment.

a.) Determine the size of property, structures, and impermeable surfaces. Consider the specific context for the site. Determine if the proposed bio-retention area should be in-line or off-line. In other words, should stormwater runoff be moved directly through the garden *or* should only a portion of upslope stormwater flows be re-directed towards and moved through the garden?

Given the large size of the drainage area above the Sunset Zoo Bio-Retention Area Gardens (approximately 1.5 acres of mostly impermeable paving and semi-permeable turfgrass surfaces) early on it was determined that a majority of the garden would not have all upslope runoff directed into the bio-retention area. Eventually, in large measure due to budgetary constraints and the lack of a legal mandate to immediately remove the pipe or increase stormwater detention, the decision was made to also keep the large pipe and associated concrete pad (immediately above the pipe) in order to handle high-volume flows. At some future time it is certainly possible for the pipe to be removed and thus the bio-retention capacity expanded.

b.) Determine size of watershed and size of bio-retention cells based on surface area. parameters. As needed, seek advice from local landscape architects, USDA-National Resource Conservation Service staff, and city/county engineering departments to obtain needed maps and data and to assist in making accurate calculations. Calculate the total watershed area (specifically the area draining to the proposed bio-retention area). Include a calculation of both permeable and impermeable surface areas within the contributing drainage area.

c.) Obtain the water quality storm value for your site from the local city/county engineer's office. The "water quality storm" is typically one that produces less than or equal to 90 percent volume of all 24-hour storms on an annual basis, per the *Mid-America Regional Council, Best Management Practices Manual* (MARC 2009).
d.) Identify soil types and assess their porosity or permeability.
e.) Identify plant material cover types and determine the coefficient factor(s).

f.) Calculate the water storage needed to capture and treat 90 percent runoff quantities for at least 90 percent of the "one-year storm event." (Reference *Mid-America Regional Council Best Management Practices Manual* for formulas or consult a qualified planner/designer and/or engineer/natural resources specialist. Utilize MARC's "short-cut method" for sites of less than 10 acres. Utilize MARC's "small storm hydrology method" for areas larger than 10 acres.)

Although initial watershed calculations were completed for the Sunset Zoo Bio-Retention Area Gardens it was determined that this demonstration project would retain the concrete gutter pan running alongside the proposed garden, and as a result would not require detailed calculations to determine how much water would flow into and through the garden. In short, the designers planned to skim a small portion of large stormwater runoff flows as it moves along the gutter.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

The designers decided that this adaptive and cautious approach would be helpful to safeguard soils and vegetation, with no cuts being made to the gutter until after bio-retention area vegetation had a chance to establish itself for at least one growing season. Thus, in November 2012, more than one year after 2011 planting days, multiple cuts to the concrete curb were made to encourage some (but not most stormwater runoff) to move into this five-pool garden.

g.) Consider and appropriately address any potential impacts on neighboring properties. Locate and design the bio-retention cells and size the garden pools so that water collection and movement does not adversely impact nearby structures and upland vegetation to remain (either or on or off of a selected property). As needed (and as much as time and budget allow), property owners and planners/designers should consult a civil engineer, soil scientist, natural resources specialist, landscape architect, botanist, horticulturalist, and/or other qualified professional(s) to evaluate existing and proposed soil and topographic conditions, existing and proposed vegetation, and relationships to existing structures and infrastructure (including above and below ground utilities). Recognize that unforeseen issues will always arise when one begins to dig into the earth in urban areas—and be prepared to collaboratively figure out how to best respond to both probabilities and surprises.

At the Sunset Zoo Bio-Retention Area Gardens designers consulted with soil specialists, had the soil tested to determine (estimate) the pH level, discussed removal of some of the nearby Eastern Red Cedar and honeysuckle with zoo staff (which included a staff member with horticultural expertise), and consulted with local fire department staff in regards to providing adequate access to an existing fire hydrant on the site. Underground utilities were also discussed with zoo staff and then marked by City and utility company personnel prior to excavating the bio-retention pools. Buried conduit (encased in concrete and more prominent than expected) had to be considered once the asphalt parking area was removed. It was determined that the access walk to the fire hydrant could help serve to mark the conduit, function as a walkway, and also serve as a terrace between two of the bio-retention pools. Although lots of planning and design takes place on paper, there are always many design decisions to be made in the field, and this was true for the Sunset Zoo project.

h.) Consider sun/shade conditions and other microclimate attributes associated with the proposed site as well as potential invasive species concerns.

Selecting the right plants for the existing and envisioned microclimate is essential. As with most designs, there will generally be no perfect solution, but the fit between a plant species' soil moisture tolerances and on-site conditions is essential. At the Sunset Zoo Bio-Retention Gardens (and most other urban sites) there will inevitably be many invasive or unwanted plants that can influence ultimate plant composition in the garden. Where there are large numbers of invasive or unwanted species (true for Sunset Zoo) then regular, ongoing monitoring and management (weeding) will be required. Eastern red cedar, shrub-form honeysuckle, a range of native and non-native woody plants, and a number of exotic grasses could overwhelm the Sunset Zoo Bio-Retention Gardens if not kept in check. These concerns should be planned and designed for by creating competitive new plant communities, using 2-3 inches of mulch, and allowing for access by volunteers and/or maintenance personnel without causing undue compaction of soils.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

i.) Identify local and state regulations regarding implementation strategies, and siting criteria.

At the Sunset Zoo Bio-Retention Gardens designers were not required to meet specific legal or regulatory stormwater management mandates, thus allowing for a great amount of flexibility in regards to the design and ultimate size and depth of bio-retention pools and cells. From a creative design standpoint, such flexibility is helpful, but is not always possible.

m.) Consider budget parameters. Relocate the proposed bio-retention garden if it is determined that the target site is not the best place for such a facility. Or, re-size the bio-retention pools and garden as needed to effectively address the amount of water that will flow into the garden.

At the Sunset Zoo Bio-Retention Gardens designers found the selected site to be an ideal location for a bio-retention facility even though nearby Eastern Red Cedar would drop fruit into the garden, potentially increasing the need for more regular monitoring and weeding.

2) Know your maintenance needs & capabilities

a.) Contact the property owner to determine maintenance expectations.
b.) Design garden with maintenance capabilities in mind.

At the Sunset Zoo Bio-Retention Gardens dialogue with the zoo director and staff (including maintenance personnel) gave everyone involved a clear picture of expectations and needs. Regular monitoring and weeding was performed by the lead designer, who had intimate understanding of the vision for the garden and all of the species planted. Where this kind of hands-on monitoring and management (including regular watering and weeding) cannot be done by the bio-retention designer, training of staff or volunteers is needed.

3) Determine a proposed soil mix that incorporates existing soils into the mix unless they are hazardous or contaminated in a manner that necessitates their removal.

a.) Does the site require specially designed soil mixes? As needed, consult a soil scientist or soil testing facility to determine the composition and characteristics of the soil. As needed, consult a landscape architect and/or civil engineer to help you determine the appropriate bio-retention soil mix related to your site and bio-retention goals and objectives.

The Mid-America Regional Council's *BMP Manual* (2008, 117) indicates that a bio-retention soil mix (the amended planting soil or "BSM") should be a minimum of 2.5 feet deep and a maximum of four (4) feet deep. The BSM needs to "enhance nutrient uptake" and "have a combination of chemical and physical properties to support a diverse microbial community."

Gregg Eyestone, Riley County, Kansas Horticulture Extension Agent, recommends the use of organic matter that is plant tissue based, with no or very sparing use of manure and the incorporation of a well-balanced organic topsoil and/or organic vegetable compost of two to four feet deep if this is possible (personal conversation, Jan. 2013).

At the Sunset Zoo Bio-Retention Gardens designers dug several test holes and found that the depth to bedrock was quite shallow in a number of locations (expected based on knowledge of the underlying geology shared by zoo staff). Additionally, the intent was to use and amend existing soils as needed rather than to meet some specific engineered soil specification.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

When the concrete sidewalk was removed there was 1-3 inches of sand in the area where the sidewalk had been and this sand was incorporated into the beds via rototilling. Based on a soil test by the K-State Research and Extension Soil Testing Lab (which indicated a soil pH of around 8.6—with phosphorus levels of 7ppm and potassium at 153ppm—for the soils uncovered once the asphalt was removed from the old parking area) it seemed wise to bring in topsoil to the garden. Additionally, several selected woody plant species (namely one Betula nigra 'Heritage' [River Birch], one Ostrya virginiana [American Hophornbeam], and nine Hydrangea quercifolia [Oak-Leaf Hydrangea]) received inputs of cottonburr compost as a way to lower pH levels, per the recommendation of Kyle Koehler, a landscape architecture graduate student with a bachelor's degree in horticulture.

b.) Consider budget parameters as well as availability of local materials.

At the Sunset Zoo Bio-Retention Gardens designers were able to use salvaged materials already available at the zoo (namely limestone rock for the walkways/terraces and a large limestone seat rock). This helped reduce project costs and also minimized expenditures of fuel/energy.

c.) Consider new uses and/or re-use of existing soils. Is it practical to utilize existing site soils to save money when creating new soil mixes? Is it practical to dispose of existing site soils and bring in new? Consider the effect on the "borrow" site when considering off-site soils. The NRCS-SCS Web Soil Survey is a good place to get an overall sense of soil types, but testing by a qualified extension agent or other university or private soil testing lab is a good idea. Recognize that amending existing soils may not be needed to create a rain-garden, and that only modest inputs may be needed depending on the specific site and project goals and legal requirements.

At Sunset Zoo we had no need to dispose of excavated soil from the site, but there was a diligent effort to pick out all of the broken pieces of concrete and asphalt we could find. Approximately eight cubic yards of topsoil came from Pottawatomie County. No pH test or other soil testing was required by the designers for the topsoil as we were simply looking to improve the texture of the highly compacted and high pH soil on the site. In hindsight, however, soil tests from several different locations within the topsoil and cottonburr compost amended bio-retention area would have been wise, as would have more in-depth conversations with County Extension staff about the results and implications of the initial and post-amendment soil tests.

4) Specify non-invasive plant material that is well-adapted to the eco-region and specific soils, microclimate, etc. Specify plant material according to the American Standard for Nursery Stock. Plant pots and balls shall be, at minimum, at least as deep as their circumference.
a.) Specify seed as "pure live seed" and obtain seed and live perennial plants from well-respected nurseries or suppliers within the eco-region.
b.) Use "grade one" woody plant material from a nursery licensed and inspected by local and state authorities.

In the Flint Hills Eco-region we have few specialized native plant nurseries, so we often need to draw upon nurseries in nearby eco-regions when desired native grasses and wildflowers are not available from local sources. As noted below there are a number of good options to consider when specifying plants in central and eastern Kansas.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

5) Choose plants that can handle water and drought and locate specific species in settings that are appropriate to their cultural needs (particularly soil type, texture and moisture).

It is wise to provide some diversity in plant material so that the plant community that is formed can be more adaptive than would likely be possible with use of just two or three species. At the Sunset Zoo Bio-Retention Gardens designers selected 17 species of native wildflowers and nine (9) species of native sedges and grasses. These perennials (planted as small live plants) were supplied by two nurseries within 225 miles of Manhattan, Kansas. Ideally, plants and seed would come from local sources or from nurseries that grow plants within about 100-150 miles of a site, but this is not always feasible.

In Kansas our native prairie species are well-adapted to drought and many perennial plants (as seed or live plants) can be obtained from native plant nurseries such as Kaw River Restoration Nurseries in Lawrence, Kansas (http://www.restorationnurseries.com/index.cfm) *and the Prairie & Wetland Center in Belton, Missouri* (http://www.critsite.com/).

For more native plant information and nursery/supplier options refer to:
http://www.kansasnativeplantsociety.org/plant_seed_sources.php
http://www.wildflower.org/collections/collection.php?collection=KS
http://www.bluebirdnursery.com/Products.asp
http://www.feyhfarmseed.com/index.html
http://dyckarboretum.org/
http://www.kswildflower.org/
http://plants.usda.gov/java/

6) Learn from others, and from your own experiences.
Design a way for water flowing into the garden to safely flow through and out of the garden during a large storm event. Use a range of plants to provide biological diversity and varying rooting densities and depths, specifying those species that will handle expected periods of drought and very wet conditions. Recognize that well-designed and managed bio-retention areas typically infiltrate water within 2-48 hours, depending how dry or wet the soils remain. Once constructed, if bio-retention areas hold water for more than two days perhaps the surface has been compacted and/or sealed by deposited silts and needs to be roughened using a rake. Specifying several inches of clean hardwood mulch (not wood chips as they can float or blow away) on the garden will help to reduce the number of weed seeds that germinate.

Consider the following suggestions as you work through the planning/design process: think long-term and be bold (aim for zero waste and reduced life-cycle costs); consider the details (such as how micro-topographic changes will influence plant survival and health—select plants that match the bio-physical conditions of the place where they are to be planted); know your budget and the institutional capacity of the property owner/client; seek to understand soil, water and plant interrelationships; be practical, ambitious and creative (accounting for aesthetics and human needs and interests as well as ecological concerns); design to conserve water and energy; remember that it planning/design is a process—learn all along the way (especially after you have implemented the project and you document successes and mistakes).

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Selected Sunset Zoo Bio-Retention Area Implementation Images (photos by Dea Brokesh, Fall 2011)

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Selected Sunset Zoo Bio-Retention Area Images (photos by Lee Skabelund, Aug 2011-Oct 2012)

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Chapter Two: Bio-retention Area Implementation & Management

Steps in the Implementation Process

1. Preserve native vegetation
   a. Install temporary construction fencing at least five feet beyond (or outside of) drip-lines of all trees to be preserved.
   b. Do not park or store materials within fenced areas or underneath the drip-line of trees to be preserved. Note that in some locations you may need or choose to work beneath tree canopies and this work should account for the durability or sensitivity of the particular species involved (some species are much more sensitive than others).
2. Preserve native soils to remain by minimizing compaction and disturbance.
   a. Prepare an area for stockpiling and re-use of existing topsoil. Remove undesirable vegetation by hand-pulling or clipping (or when necessary by spot spraying undesirable "weeds" or painting cut stumps with glyphosate 10 days prior to soil stripping or working with the soils; if chemical herbicides are used make sure all directions are followed and employ a trained or certified applicator). Utilize a sod cutter to remove vegetated sod. Reuse sod strips as possible on other parts of project site.
   b. For soils to be re-used strip topsoil and save separately from lower sub-soils.
      i. Place topsoil in area that will not cause disturbance of other natural systems.
      ii. Protect topsoil from contaminants and pollutants:
         1. install water diversion devices to deter erosion;
         2. cover soil, if practical, to protect from air-borne contaminants or place soil in locations away from air-borne contaminants;
         3. keep stockpiled soils shallow (less than four feet depth maximum).
3. Stabilize contributing drainage areas against erosion and sediments prior to construction. As much as possible, route stormflows around the bio-retention area worksite while soils are bare (exposed) and cover with a mulch or non-invasive cover crop if soils are to be exposed for more than a month or two during the growing season.
4. Excavate bio-retention cells to accept bio-retention soil mix
5. Install underdrainage system, if specified by landscape architect and/or engineer
6. Rip, scarify or till at least six (6) inches deep at the bottom of the bio-retention cells to alleviate compaction and help integrate the planting soil into the subsoil and do not run heavy equipment over the planting soils once they are laid down.
7. Place bio-retention soil mix with low ground contact pressure equipment.
8. Plant material (vegetation) handling techniques:
   a. Protect plants during shipment by placing in covered vehicle to avoid wind burn;
   b. Protect live plants on the job site by placing them in the shade (especially during the heat of the summer, covering them as needed to protect from cold or windy weather, and watering them as needed to keep plant roots moist.
9. Install live plant material according to State Extension services guidelines. Excavate plant pits to level of soil found in pot or slightly higher. Make planting holes/pits deep enough to accommodate roots. Backfill plant pits by hand with loose excavated soil. Gently compact soil around each plant by hand during backfill operations so that plants are

snuggly nested into the soils and will not float away if they are within a bio-retention pool. Water the plant roots and soil around each plant soon after planting in order to keep the plant roots moist. Generally projects specifying less than several thousand plants can be readily implemented using small live plants from flats as well as bare-root, container grown, or balled-and-burlap woody plants. Seeding is generally most cost-effective for very large bio-retention areas (several thousand square feet or greater of sedges, grasses and wildflowers) but seeds can be used for smaller projects as well. A biodegradable matrix/slurry, geo-textile fabric, or other suitable erosion control covering should be used wherever there is a good chance for erosion.

10. Seed to the depth recommended by landscape architect, designer, or ecological restoration practitioner based on the selected plant type or mix of species. Annual oats or another non-toxic annual can be used as a temporary cover crop for erosion control.
11. Hand rake soil in the planting bed so that it provides positive drainage away from structures or other areas that water should not be sent to. Variations in micro-topography can be beneficial for native plants and help retain and infiltrate water. Compaction of soils needs to be avoided in order for infiltration to occur. 2x10 or 2x12 boards can be used as bridges over bio-retention pools during both the planting operations and final raking (fine grading) work.
12. If live plants are used the bio-retention garden should be covered with shredded hardwood mulch, landscape rock, or another suitable erosion control material as specified by landscape architect/designer. Wood chips need to be avoided within bio-retention pools as they will likely float and be displaced when pools fill with water.
13. Monitor erosion and sediment control at least once per month or after significant storm events during construction operations and during plant establishment.
    a. Remove silt build up and dispose of silts at an appropriate stockpile location or reuse at low spots of site. Make certain that bio-retention soils are not compacted. Roughen the surface area of bio-retention garden soils to help precipitation and surface water move into the soil profile.
    b. During the establishment period, add mulch to the garden as is necessary to prevent erosion, keep plant roots moist, and discourage the growth of weeds.
    a. Reset and/or replace plants as necessary, making sure that these plants are watered in and roots kept from drying out.
14. Hand water or irrigate as needed during the first year of plant establishment. Monitor the precipitation on-site, or use data from a nearby weather station to know when supplemental watering is needed. Check soil moisture using a trowel and fingers or, if the budget allows and appropriate monitoring equipment can be secured use a soil moisture sensor to help determine when to water the garden. Alternatively, attentive observation of vegetation, weather, and site conditions should provide enough information to guide watering.
    a. During the first two weeks of seed establishment, provide (or see that the garden receives) 1.0 to 1.5 inches of water per week. Afterward decrease irrigation to 1.0 inch of water per week during warmer months and decrease irrigation to 0.5 inches of water per week during cooler months.

b. During the first two weeks after live plants (plug, bare-root, container, or balled-and-burlap material) are installed provide at least 1.0 inch of water per week. Afterward decrease water to 0.5 inches of water per week.

15. Weed undesirable grasses, broadleaf weeds, and woody plants from the garden, being careful to minimize soil disturbance and not compact soils. Refer to the discussion of maintenance practices below for additional guidance.

Maintenance Practices

Any garden requires ongoing and dedicated monitoring and maintenance. Weeding is essential. Fertilizing is not needed if native plants adapted to the location are used and soils have a reasonable amount of nutrients (especially phosphorus and potassium) to begin with. Pruning is rarely needed, though clipping back perennials before spring is important. Watering during the first growing season is vital, and may also be needed during periods of drought for species that do not have a long-term genetic memory of the eco-region where they are planted. Building institutional interest and capacity for ongoing maintenance is essential. Colleges universities, high schools, and other educational institutions can play an important role in assisting local communities monitor sites, and help stakeholders increase their knowledge of sustainable planning, design, and construction practices.

Key ideas to remember regarding maintenance:

1) **Bio-retention gardens need to be maintained. For this type of native plants garden it is wise to plan on 1-2 hours of maintenance** (primarily weeding out unwanted trees and other plants) **every two or three weeks during the first growing season. Visiting the site at least monthly is wise after establishment.** This type of maintenance can be done by grounds staff, a gardener, or a volunteer with a good sense of the native plants used and the design intentions.

2) **Weeding is essential in urban settings**—even though a good hardwood mulch can reduce the number of weeds and make weeding easier. **Pruning is needed time-to-time**—for example to remove dead or damaged materials and to clip back perennials before spring. Maintenance staff, gardeners, and other volunteers may desire to transplant and water in seedlings, and they will definitely want to remove more aggressive perennials if they begin to dominate the garden.

3) **Learn what the "weeds" and invasive species are in the local area and eco-region and prepare to remove them from a bio-retention garden as soon as possible.** Budget at least a few hours a week during the first growing season for monitoring and weeding; it saves lots of time down the road!

4) **Watering during the first growing season is vital** (try to strike a balance between providing too much and too little water). If you **choose plants well-adapted to your eco-region and specific site**, no or very minimal watering should be needed once the plants are established. Check for exposed soil and erosion, and add organic weed-free mulch. **If too much sediment is flowing into the garden find the source and stabilize the area** (if needed, you may need to reduce the volume or intensity of stormwater flowing into the garden).

5) **Draw upon the experience of others**. **Recognize that all good ideas must be adapted to the local site and its context—including client and stakeholder needs and concerns.**

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Cuts into the concrete gutter help move more water into the bio-retention garden while a soil moisture and temperature sensors assist Kansas State University faculty and staff to better understand the interrelationships between soils, vegetative growth, and climatic variables.

These three images were taken by Lee R. Skabelund Jan. 9, 2013 during installation of monitoring devices.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Outreach and Education

The text below was prepared for reference when discussing the rain-garden at formal and informal public education events *and* as the project team developed an interpretive sign for the zoo's new bio-retention area garden. The aim was to connect with 3rd to 6th Grade audiences.

The Sunset Zoo Bio-Retention Area Demonstration Project is a cross between a bio-retention area and a rain-garden. It collects and slows down rainwater with plants, soil, and rock.

What is a Bio-Retention Area?
A bio-retention area collects and slows down stormwater.

Living plants, soils, and organic matter soak up much of the water instead of allowing excess water to flow downhill. Sometimes a bio-retention area has specially engineered soil and an underground pipe and/or inlet.

Bio-retention areas are usually located in upland areas. It is easier to manage stormwater when rain collection starts near the top of a hill.

What is a Rain-Garden?
A rain-garden has a shallow basin that temporarily holds rainwater.
Like a bio-retention area, it uses plants to soak up rainwater.
A rain-garden can be created using existing soil.

Bio-retention areas and rain-gardens allow rainfall and snowmelt to refresh vegetation and soils and can recharge underground water supplies.

This **multi-pool stormwater management garden at Sunset Zoo** includes **native Flint Hills prairie plants** that are well-adapted to the soils, topography, micro-climate, and expected moisture levels within each part of the garden.

The garden, limestone pathways, and terraces were implemented in Fall 2011 with assistance from Kansas State University faculty and students and community volunteers. Many thanks!!!

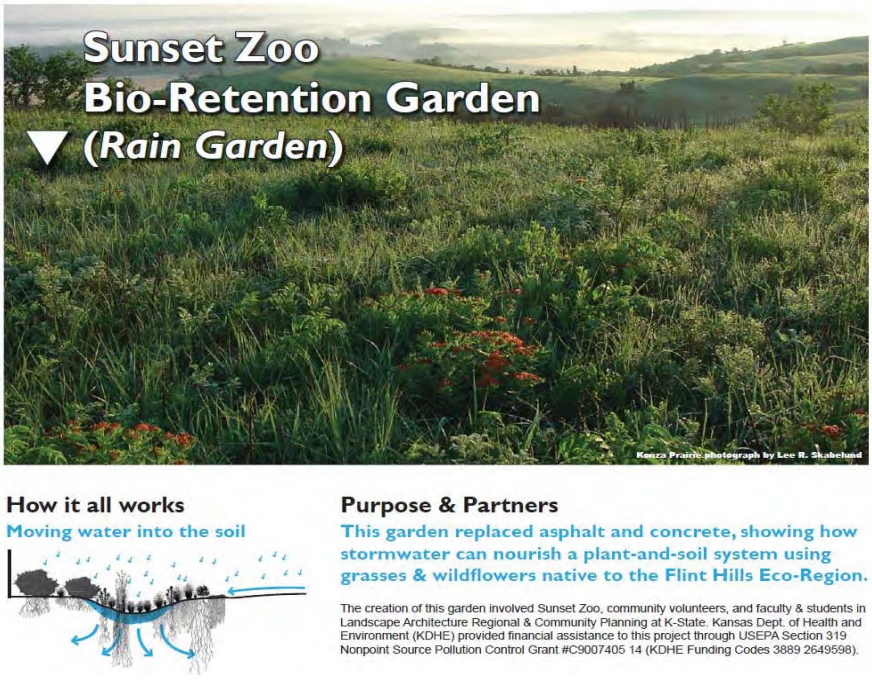
Sunset Zoo staff **removed underutilized asphalt parking and a concrete walk**. Zoo staff next rough-graded **several pools** to **serve as stormwater collection areas**. Volunteers placed rock terraces and walkways, and planted **vegetation** to **fit soils and landform**. Natural processes will ensure that the garden changes over time—while staff and volunteers seek to keep the garden a pleasant place to visit and learn from season to season.

If you wish to volunteer your time to maintain this garden, please contact Sunset Zoo's main office at 587-2737. City and Sunset Zoo staff and K-State's faculty, staff and project managers greatly appreciate all who contributed to this project effort!

The Kansas Department of Health and Environment has provided financial assistance to this project through EPA Section 319 Nonpoint Source Pollution Control Grant #595. This Clean Water Neighbor grant was received by Kansas State University's Department of Landscape Architecture / Regional & Community Planning in Fall 2010. Conceptual design ideas were prepared by KSU Planting Design students and refined by KSU faculty and staff.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Ultimately, Sunset Zoo staff wanted a minimum amount of text displayed on the interpretive sign and so the following signboard was created by K-State faculty and staff for the garden.



Concluding Thoughts

Creativity and persistence is required to create well-designed and effectively implemented stormwater management demonstration projects on a private or public site.

Interest in energy and water savings in a community can open the door for creative, multi-benefit projects that have the opportunity to create more sustainable landscape structure and functions and set a standard for other future projects.

Deep-rooted prairie plants and small-scale bio-retention areas and rain-gardens can make an immediate, noticeable impact on stormwater runoff from a property.

When carried out in an integrated and holistic manner—especially as usable garden spaces—even very small-scale projects can make a very important and positive impact.

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

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Photos by Lee R. Skabelund (October and December 2012)

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

Photos by Lee R. Skabelund (August and December 2012)

"DESIGNERS GUIDE TO BIO-RETENTION AREA IMPLEMENTATION"

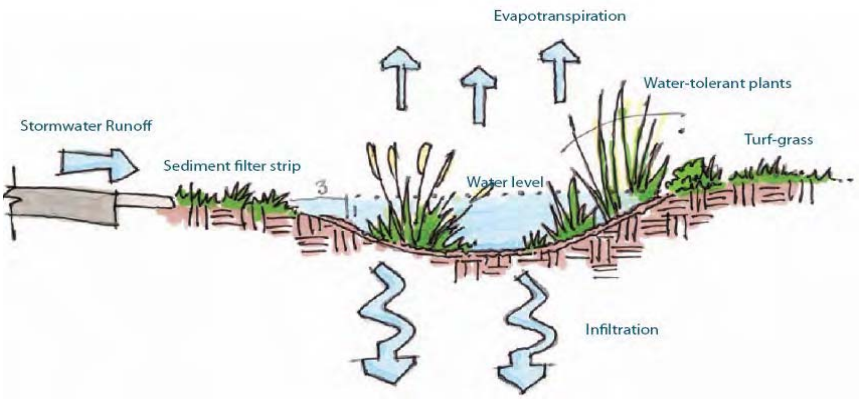
A Parting Thought and Nod to an Earlier K-State Guidebook

"Rain-gardens are a solution that can be readily adapted to capture and infiltrate stormwater on nearly every property, no matter the type of soils or slopes."

(Skabelund 2008, 3)

The quote above comes from the following guidebook, also supported by USEPA & KDHE:

Rain-Garden Design and Implementation for Kansas Property Owners: With a Discussion of Lessons Learned from Kansas State University's International Student Center Rain-Garden Design-Build Demonstration Project in Manhattan, Kansas



Rain-Garden sketch by Tim Merklein (KSU-LARCP 2008)

http://faculty.capd.ksu.edu/lskab/KSU-LARCP_Rain-Garden-Guidebook-lrs.pdf

For a discussion of other Kansas State University LARCP projects refer to:
http://faculty.capd.ksu.edu/lskab/

L E S S O N 1 9

Bicycle Lanes

19.1 Purpose

The AASHTO *Guide for the Development of Bicycle Facilities* defines a bike lane as "a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists." As levels of bicycling have increased in the United States, there has been a growing amount of support for bike lanes on urban and suburban roadways. Bike lanes are a preferred facility type in European countries, and in North America, nearly every major city has made an effort in recent years to install bicycle lanes, either as "pilot projects" (to test their success) or, in many cases, on larger networks of interconnecting roadways. Several small towns have led the way in establishing networks of bicycle lanes, particularly college towns where there are high levels of student bicycle commuters (e.g., University of California at Davis and University of Texas at Austin).

As a relatively new feature in the roadway cross-section, bike lane design has been the topic of much study in recent years. Bike lane design can be quite challenging in situations where the existing urban traffic patterns are complex and cross-sections are already constrained by heavy traffic volumes. Designers throughout the country develop new and better solutions each year. This section includes excerpts from several sources, including Oregon's *1995 Bicycle and Pedestrian Plan* and Philadelphia's *Bicycle Network Plan.*

Note: The Europeans have pioneered innovative bike lane design solutions. Lesson 22 includes a description of European approaches that have been successful.

As with the other bicycle facility design issues covered in this manual, bike lane design is covered in

some detail by the AASHTO *Guide for the Development of Bicycle Facilities.* This text should be referenced for additional information.

19.2 Bicycle Lane Widths and Construction Standards

Bicycle lanes serve the needs of all types of cyclists in urban and suburban areas, providing them with their own travel lane on the street surface. The minimum width of a bike lane should be 1.5 meters (5 feet) against a curb or adjacent to a parking lane. On streets where the bike lane is adjacent to the curb and the curb includes a 1-foot to 2-foot gutter pan, bike lanes should be a minimum of 4 feet wide (width does not include the gutter pan, since bicyclists are typically unable to use this space).

Wider bike lanes are recommended on streets with higher motor vehicle speeds and traffic volumes, or where pedestrian traffic in the bike lane is anticipated. Width measurements are taken from the curb face to the bicycle lane stripe.

Since bicyclists usually tend to ride a distance of 0.8 meters to 1.1 meters (2.5 feet to 3.5 feet) from the curb face, it is very important that the pavement surface in this zone be smooth and free of structures. Drain inlets and manholes that extend into this area cause bicyclists to swerve, having the effect of reducing the usable width of the lane. Where these structures exist and the surface cannot be made smooth, bike lane width should be adjusted accordingly. Regular maintenance is critical for bike lanes (see text in this section).

Bike lanes should be constructed to normal full-depth pavement standards since motor vehicles will occasionally cross them, or may use them as a breakdown area.

19.3 Unmarked Lanes

Where the minimum widths listed above cannot be met, it may be possible to provide an unmarked lane. Studies have shown that the bicyclist's perceived level of comfort is higher when a striped area is provided; therefore, this method can raise the bicycle level of service for the street. An unmarked lane is a striped area of 0.6 m (2 ft) wide or more that contains no markings or signing that would denote it as a bike lane. "Share the Road" signs may be used to caution motorists to be alert for bicyclists.

It is important to recognize that this is a temporary solution. Particularly on busy streets, narrow unmarked lanes will not adequately serve the needs of the majority of bicyclists.

19.4 Location Within the Street Cross-Section

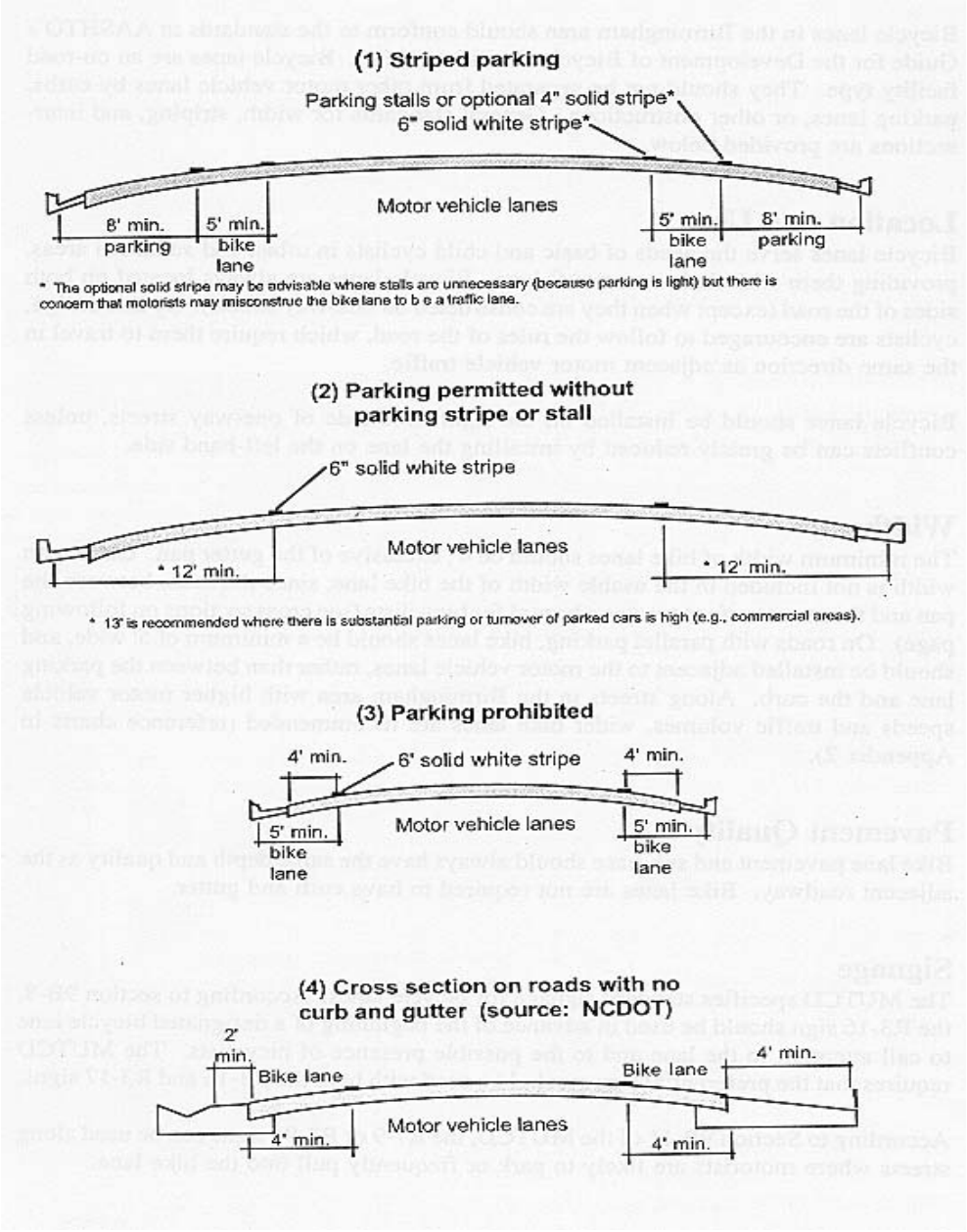
Bicycle lanes are always located on both sides of the road on two-way streets. Since bicyclists must periodically merge with motor vehicle traffic, bike lanes should not be separated from other motor vehicle lanes by curbs, parking lanes, or other obstructions. Two-way bike lanes on one side of two-way streets create hazardous conditions for bicyclists and are not recommended.

On one-way streets, bicycle lanes should be installed on the right-hand side, unless conflicts can be greatly reduced by installing the lane on the left-hand side. Left-side bicycle lanes on one-way streets may also be considered where there are frequent bus or trolley stops, unusually high numbers of right-turning motor vehicles, or if there is a significant number of left-turning bicyclists.

As a temporary solution, striping narrow lanes through intersections may be an option where space is limited.

"BICYCLE LANES"

FHWA COURSE ON BICYCLE
AND PEDESTRIAN TRANSPORTATION



Bicycle lanes provided under different types of conditions. Source: AASHTO Guide for the Development of Bicycle Facilities, 1991.

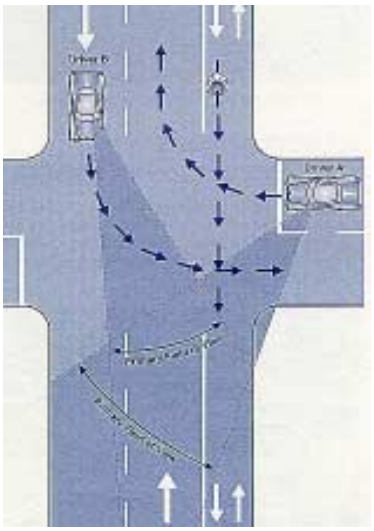
"BICYCLE LANES"

19.5 Practices To Be Avoided

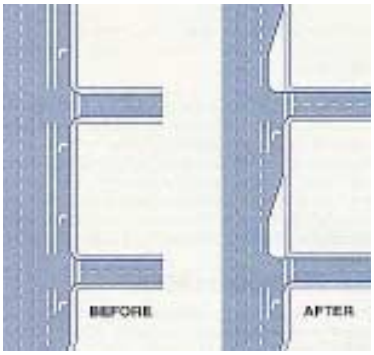
Two-Way Bike Lane
This creates a dangerous condition for bicyclists. It encourages illegal riding against traffic, causing several problems:

- At intersections and driveways, wrong-way riders approach from a direction where they are not visible to motorists.
- Bicyclists closest to the motor vehicle lane have opposing motor vehicle traffic on one side and opposing bicycle traffic on the other.
- Bicyclists are put into awkward positions when transitioning back to standard bikeways.

If constraints allow widening on only one side of the road, the centerline stripe may be shifted to allow for adequate travel lanes and bike lanes:



In both cases above, a wrong-way bicyclist is not in the driver's main field of vision.



Continuous right-turn lane reconfigured to standard approaches.

Continuous Right-Turn Lanes
This configuration is difficult for cyclists: Riding on the right puts them in conflict with right-turning cars, but riding on the left puts them in conflict with cars merging into and out of the right-turn lane. The best solution is to eliminate the continuous right-turn lane, consolidate accesses, and create well-defined intersections.

19.6 Contra-Flow Bike Lanes

Contra-flow bike lanes on a one-way street are not usually recommended. They may encourage cyclists to ride against traffic, which is contrary to the rules of the road and a leading cause of bicycle/motor vehicle crashes.

There are, however, special circumstances when this design may be advantageous:

- A contra-flow bike lane provides a substantial savings in out-of-direction travel.
- The contra-flow bike lane provides direct access to high-use destinations.
- Improved safety be cause of reduced conflicts on the longer route.
- There are few intersecting driveways, alleys, or streets on the side of the contra-flow lane.
- Bicyclists can safely and conveniently re-enter the traffic stream at either end of the section.
- A substantial number of cyclists are already using the street.
- There is sufficient street width to accommodate a bike lane.

A contra-flow bike lane may also be appropriate on a one-way residential street recently converted from a two-way street (especially where this change was made to calm traffic).

For a contra-flow bike lane to function well, these special features should be incorporated into the design:

Contra-flow bike lanes can provide direct access to high-use destinations.

- The contra-flow bike lane must be placed on the right side of the street (to motorists' left) and must be separated from oncoming traffic by a double yellow line. This indicates that the bicyclists are riding on the street legally, in a dedicated travel lane.
- Any intersecting alleys, major driveways, and streets must have signs indicating to motorists that they should expect two-way bicycle traffic.
- Existing traffic signals should be fitted with special signals for bicyclists; this can be achieved with either loop detectors or push buttons (these should be easily reached by bicyclists without having to dismount).

Note: Under no circumstances should a contra-flow bike lane be installed on a two-way street, even where the travel lanes are separated by a raised median.

19.7 Bike Lane Pavement Markings

The *Manual on Uniform Traffic Control Devices* (MUTCD) section 9C addresses standard bike lane markings. The stripe between the bicycle lane and the adjacent motor vehicle lane should be a 100-millimeter (4 inch) wide white line (minimum width). Six- to eight-inch-wide lines provide an even clearer division of space, and are highly recommended.

Where parking is allowed next to a bike lane, the parking area should be defined by parking space markings or a solid 100 millimeter (4 inch) wide stripe.

Care should be taken to use pavement striping that is durable, yet skid-resistant. Reflectors and raised markings in bike lanes can deflect a bicycle wheel, causing a bicyclist to lose control. If reflective pavement markers are needed for motorists, they should be installed on the motorist's side of the stripe, and have a beveled front edge.

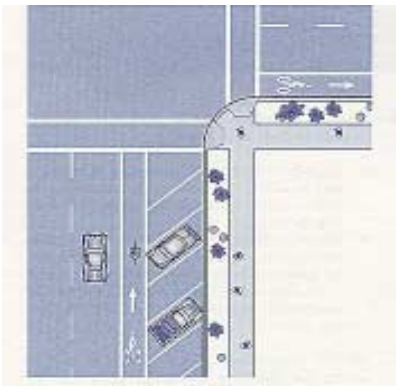
While the 1988 edition of the MUTCD recommends the use of the diamond-shaped preferential lane symbol in conjunction with bike lane signs, this symbol is often confusing for both the bicyclist and motorist. For this reason, subsequent editions of the MUTCD will probably eliminate the use of the diamond in bike lanes. The new standard pavement markings for bicycle lanes are the bicycle symbol (or the words BIKE LANE) and a directional arrow.

19.8 Bike Lane Signing

The *Manual on Uniform Traffic Control Devices* (MUTCD) section 9B addresses standard bike lane signing. According to section 9B-8, the R3-16 sign should be used in advance of the beginning of a

Bike lane signs should be replaced with bike lane stencils, with optional NO PARKING signs where needed.

designated bicycle lane to call attention to the lane and to the possible presence of bicyclists. In locations where bicycle lanes are ending, the same R3-16 sign should be used, with the word ENDS substituting for the word AHEAD. The R7-9 or R7-9a signs should be used along streets where motorists are likely to park or frequently pull into the bike lane.



Bike lane next to diagonal parking, 8-inch stripe should separate the areas.

19.9 Diagonal Parking

Diagonal parking causes conflicts with bicycle travel: Drivers backing out have poor visibility of oncoming cyclists and parked vehicles obscure other vehicles backing out. These factors require cyclists to ride close to the center of a travel lane, which is intimidating to inexperienced riders.

Where possible on one-way streets, diagonal parking should be limited to the left side, even if the street has no bike lane; on one-way streets with bike lanes, the bike lane should be placed adjacent to parallel parking (preferably on the right).

Bike lanes are not usually placed next to diagonal parking. However, should diagonal parking be required on a street planned for bike lanes, the following recommendations can help decrease potential conflicts:

- The parking bays must be long enough to accommodate most vehicles.
- A 200-millimeter- (8-inch-) wide stripe should separate the parking area from the bike lane.
- Enforcement may be needed to cite or remove vehicles encroaching on the bike lane.

19.10 Bike Lane Design at Intersections

Intersections With Bus Stops

If there is a bus stop at the near side of the intersection, a broken line should extend the length of the bus stop (no less than 15 meters [50 feet]), and the solid white line should resume on the far side of the intersection, immediately after the crosswalk. If a bus stop is located on the far side of the intersection, the solid white line on the far side of the intersection should be replaced with a broken line for a distance of at least 24 meters (80 feet) from the crosswalk (at this intersection, a broken line would still be required on the near side if there is right-turning traffic).

Intersections With Right-Turn Lanes

In general, right-turn lanes should be used only where warranted by a traffic study, as they present problems for both bicyclists and pedestrians:

- If right-turning cars and through bicyclists must cross paths.
- If the additional lane width adds to the pedestrian crossing distance.
- If right-turn moves are made easier for motorists, which may cause inattentive drivers to not notice pedestrians on the right.

The through bike lane to the left of a right-turn lane should be striped with two 100-millimeters- (4-in-) wide stripes and connected to the preceding bike lane with 0.9-meter (3-foot) dashes and 2.7-meter (9-foot) spaces. This allows turning motorists to cross the bike lane. A legend must be placed at the beginning of the through bike lane. Sign R4-4, BEGIN RIGHT TURN LANE, YIELD TO BIKES, may be placed at the beginning of the taper in areas where a through bike lane may not be expected.

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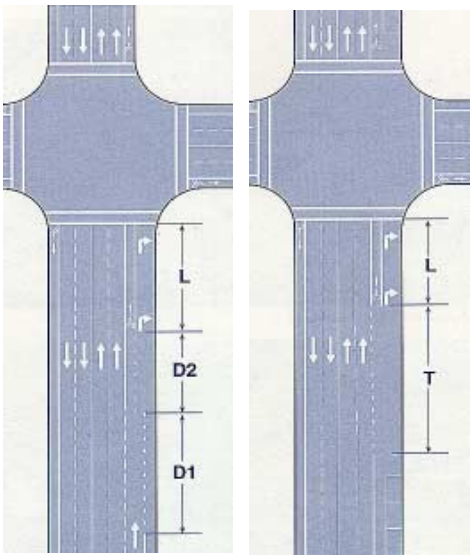
Not all intersections can be widened to provide a right-turn lane. A bike lane to the left of right-turning cars should still be provided. One common configuration occurs where a right-turn lane is developed by dropping parking (see figure at right).

Another configuration occurs where a lane is dropped and turns into a right-turn lane.

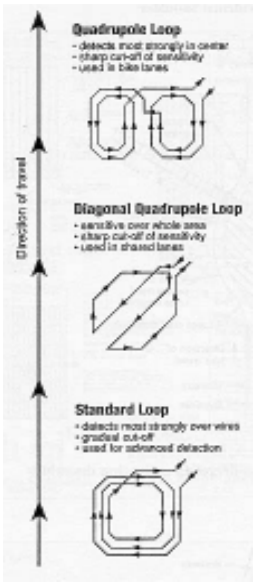
Note: This is a difficult movement for bicyclists as they must merge left and find a gap in the traffic stream:



Above left: Bike lane left of right-turn lane developed by dropping a travel lane. Above right; Bike lane left of right-turn lane developed by dropping parking.

Exception #1: Heavy Right Turns
If the major traffic movement at an intersection is to the right, and the straight through move leads to a minor side street, then the bike lane may be placed on the right and wrapped around the curve, assuming that the majority of cyclists will desire to turn right too. This often occurs where a highway is routed over local streets and the route is indirect.

Exception #2: Tee Intersections
At a Tee intersection, where the traffic split is approximately 50 percent turning right and 50 percent turning left, the bike lane should be dropped prior to the lane split to allow cyclists to position themselves in the correct lane. Where traffic volumes are very high, a left- and right-turning bike lane should be considered.



Different loop configurations: The quadrupole loop is recommended for bike lanes.

Offset Intersections
Care should be taken to ensure that motorists are not inadvertently encouraged to ride in the bike lane because of offset travel lanes. At intersections with offset lanes, dashed offset lane markings should continue through the intersection to direct traffic flow (MUTCD Section 3B-7).

Traffic Signal Actuation
It is highly recommended that new on-road bicycle facilities include traffic signals that detect bicycles for all actuated signal systems. *The Traffic Detector Handbook* (FHWA-IP-90-002) recommends several bicycle-sensitive loop configurations (loops are wires installed beneath the pavement surface that detect the presence of vehicles) that effectively detect bicycles. The quadrupole loop is the preferred solution for bike lanes, and the diagonal quadrupole loop is preferred for use in shared lanes.

One solution for existing intersection signals that do not respond to bicycles is to install a special pavement marking over the exact spot that a bicycle must stand in order to "trip" the signal.

Expressway Interchanges
Expressway interchanges often present barriers to bicycle circulation. Designs that encourage free-flowing motor vehicle traffic movements are the most difficult for pedestrians and bicyclists to negotiate.

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At-Grade Crossings
Interchanges with access ramps connected to local streets at a right angle are easiest for bicyclists to negotiate. The intersection of the ramp and the street should follow established urban intersection designs. The main advantages are:

- The distance that pedestrians and bicyclists must cross at the ramps is minimized.
- Signalized intersections stop traffic.
- Visibility is enhanced.

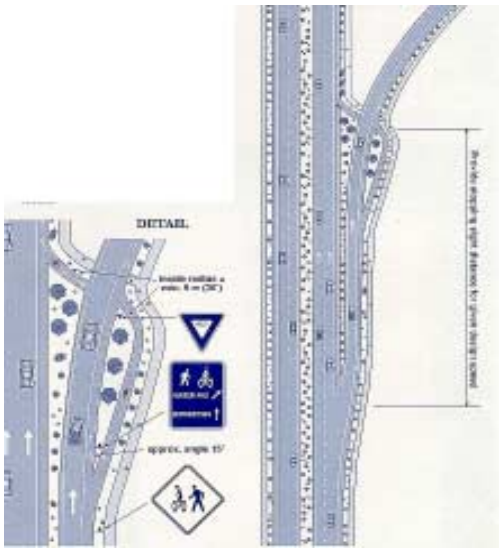
If these configurations are unavoidable, mitigation measures should be sought. Special designs should be considered that allow pedestrians and bicyclists to cross ramps in locations with good visibility and where speeds are low.

Grade-Separated Crossings
Where it is not possible to accommodate pedestrians and bicyclists with at-grade crossings, grade separation should be considered. Grade-separated facilities are expensive; they add out-of-direction travel and will not be used if the added distance is too great. This can create problems if pedestrians and bicyclists ignore the facility and try to negotiate the interchange at grade with no sidewalks, bike lanes, or crosswalks.

In some instances, a separate path can be provided on only one side of the interchange, which leads to awkward crossing movements. Some bicyclists will be riding on a path facing traffic, creating difficulties when they must cross back to a bike lane or shoulder (clear and easy-to-follow directions must be given to guide bicyclists' movements that are inconsistent with standard bicycle operation).

To ensure proper use by bicyclists, structures must be open, with good visibility (especially underpasses).

Other Innovative Designs
These concepts are presented as examples of innovative solutions to bike lane design at freeway interchanges and intersections.

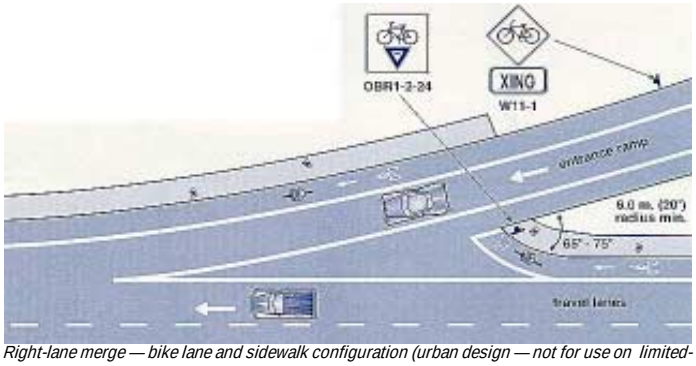


Exit ramp configuration for bike lane and sidewalks (urban design — not for use on limited-access freeways).

Traffic entering or exiting a roadway at high speeds creates difficulties for slower moving bicyclists. The following designs help alleviate these difficulties:

Right-Lane Merge
It is difficult for bicyclists to traverse the undefined area created by right-lane merge movements, because:

- The acute angle of the approach creates visibility problems.



Right-lane merge — bike lane and sidewalk configuration (urban design — not for use on limited-access freeways).

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- Motor vehicles are often accelerating to merge into traffic.
- The speed differential between cyclists and motorists is high.

The following design guides bicyclists in a manner that provides:

- A short distance across the ramp at close to a right angle.
- Improved sight distances in an area where traffic speeds are slower than farther downstream.
- A crossing in an area where drivers' attention is not entirely focused on merging with traffic.

Exit Ramps
Exit ramps present difficulties for bicyclists because:

- Motor vehicles exit at fairly high speeds.
- The acute angle creates visibility problems.
- Exiting drivers often do not use their right-turn signal, confusing pedestrians and bicyclists seeking a gap in the traffic.

The exit ramp design on the previous page guides bicyclists in a manner that provides:

- A short distance across the ramp, at close to a right angle.
- Improved sight distances in an area where traffic speeds are slower than farther upstream.
- A crossing in an area where the driver's attention is not distracted by other motor vehicles.

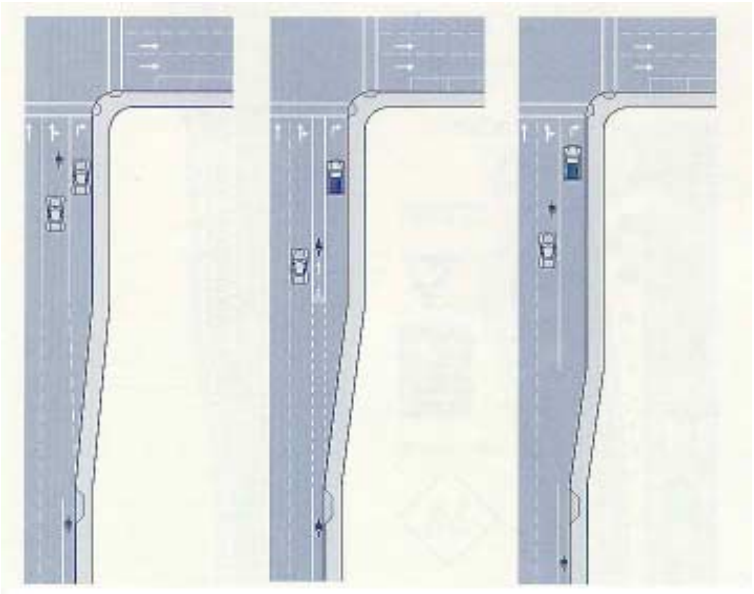
Dual Right-Turn Lanes
This situation is particularly difficult for bicyclists. Warrants for dual turn lanes should be used to ensure that they are provided only if absolutely necessary.

The design for single right-turn lanes allows bicyclists and motorists to cross paths in a predictable manner, but the addition of a lane from which cars may also turn adds complexity: Some drivers make a last minute decision to turn right from the center lane without signaling, catching bicyclists and pedestrians unaware.

Bicyclists and motorists should be guided to areas where movements are more predictable, so bicyclists and motorists can handle one conflict at a time, in a predictable manner. A curb cut provides bicyclists with access to the sidewalk, for those who prefer to proceed as pedestrians.

- Design A (see Figure 19-13) encourages cyclists to share the optional through-right-turn lane with motorists.
- Design B guides cyclists up to the intersection in a dedicated bike lane.
- Design C allows cyclists to choose a path themselves (this design is the AASHTO recommendation–simply dropping the bike lane prior to the intersection).

A. B. C.

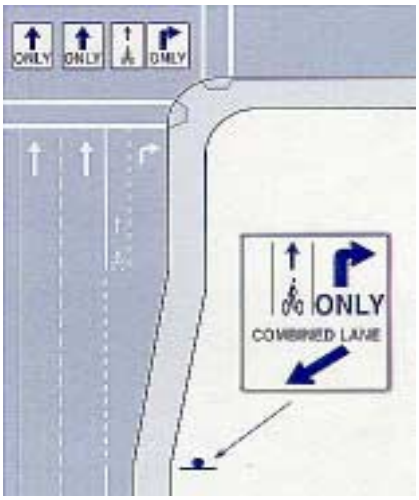


Bike lane through dual right-turn lanes.

A fourth design places an island between the right-turn lane and the optional through-right turn lane. This creates a more conventional intersection, separating the conflicts. This design is also better for pedestrians, as the island provides a refuge.

Engineering judgment should be used to determine which design is most appropriate for the situation.

Right-Turn Lane Without Room for a Bike Lane
On bike lane retrofit projects where there is insufficient room to mark a minimum 1.2-meter (4-foot) bike lane to the left of the right-turn lane, a right-turn lane may be marked and signed as a shared-use lane to encourage through-cyclists to occupy the left portion of the turn lane. This is most successful on slow-speed streets.



Joint use of a right-turn lane for through-bicyclist.

19.11 Exercise

Redesign a local intersection to include bike lanes. Choose an intersection with a moderate level of complexity, and assume that curb lines can be moved at will in order to achieve your design. Prepare a report and graphics that show existing conditions and recommended modifications. Signalization changes (if necessary) should also be explained, as well as any advance striping and signing needed on the intersection approaches.

19.12 References

Text and graphics in this lesson were derived from the following sources:

Oregon Department of Transportation, *Oregon Bicycle and Pedestrian Plan*, 1995.

Philadelphia Department of Streets, *Philadelphia Bicycle Facility Design Guidelines*, 1998.

For more information on this topic, refer to:

AASHTO, *Guide for the Development of Bicycle Facilities*, latest edition.

ITE Technical Committee 6A-55, *Review of Planning and Design Standards for Bicycle Facilities*, 1997.

USDOT, *Manual on Uniform Traffic Control Devices*, Section 9, latest edition.

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

THE BENEFITS OF STREET-SCALE FEATURES FOR WALKING AND BIKING

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"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

AMERICAN PLANNING ASSOCIATION | Planning and Community Health Center

September 2015

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"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

INTRODUCTION

As the car became the dominant mode of transportation throughout the 20th century, the priority for cities and towns to support safe walking and biking—for either transportation or recreation—diminished. Designing our communities to efficiently move cars impacted the scale and form of our streetscapes and the connectivity of bicycle and pedestrian networks. Today, for example, walking represents less than three percent of commuting trips and, while its mode share is increasing, biking represents less than one percent of commuting activity.[A]

As the costs of physical inactivity become increasingly evident, and as planners, public health professionals, and others working in the field of active transportation strive to promote walking and biking, the necessity of retrofitting and updating street facilities and sidewalk features is apparent. The benefits of incorporating infrastructure that supports active transportation into our streetscapes are many. While efforts to encourage walking and biking often focus on physical activity benefits, it is important to recognize that investments in these travel modes offer a wider set of potential co-benefits for communities.

This literature review focuses on the benefits that may arise from investment in different types of street-scale features, either independently or in combination. The review considers not only potential impacts related to physical activity—which have been treated extensively in the literature to date—but also a variety of co-benefits including social cohesion, crime prevention and public safety, multimodal traffic safety, mental health, and economic effects. The review links these co-benefits to various types of street-scale features that encourage walking and biking, such as sidewalks, bicycle lanes, traffic calming, crossing aids, aesthetics and placemaking, public space, street trees, green infrastructure, and street furniture.

This analysis provides background information and supportive data for **planners, transportation professionals, advocates,** and **policy makers** working to encourage community design that promotes active transportation. Through this report, individuals working locally will be able to highlight the co-benefits of street-scale interventions that support walking and biking.

Methodology

Definitions of features and co-benefits

This analysis focuses on nine street-scale features and related co-benefits. The features, defined in Table 1, are those that can be deployed at the street scale, rather than requiring deployment on a broader network scale. In addition to feature definitions, Table 1 also indicates the number of resources included in the literature review that address each feature.

Table 1. Street-Scale Features and Definitions[B]

Feature	Definition	Number of resources
Sidewalks	Maintained areas in the public right-of-way dedicated to pedestrian use, ideally at least five feet wide	57
Bicycle Facilities	Bike lanes, separated bike lanes (cycle tracks), shared lane markings (sharrows), off-road paths, and other facilities such as bike racks	49
Traffic Calming	Physical interventions in street design, including traffic circles and roundabouts, neck downs, center island narrowings, chicanes, speed bumps, and textured surfaces, among others, that can reduce speeds and traffic volumes, improving the experience and safety of users of nonmotorized transportation	53
Crossing Aids	Marked and unmarked crosswalks, pedestrian signals	32
Aesthetics and Placemaking	Public art, fountains, splash pads, decorative features, and other streetscape interventions that create human scale and sense of place	20
Public Space	Parks, plazas, and other spaces accessible to and usable by the public	16
Street Trees	Trees planted along the street or sidewalk to provide shade or for aesthetic purposes	38
Green Infrastructure	Green infrastructure features at the neighborhood or site scale, including greenways, rain gardens, riparian buffers, bioswales, pervious pavement, and green streets	10
Street Furniture	Small-scale features – generally in a fixed location – including bike racks, benches, bus shelters, and signs, which are both functional and create a sense of place	18

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

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The co-benefits examined in this review are identified and defined in Table 2. This table also includes the number of resources in the review that address each co-benefit.

Table 2. Co-benefits and Definitions[c]

Co-benefit	Definition	Number of resources
Physical Activity	Increased levels of physical activity, including walking and biking, for transportation or leisure purposes	65
Social Cohesion	Increased levels of social interaction, social support, collective monitoring, social trust, sense of community, shared cultural identity	36
Crime Prevention and Public Safety	Reductions in actual property and violent crime and perceptions of crime; improvements in public safety	17
Multimodal Traffic Safety	Reductions in frequency and/or severity of crashes or injury to pedestrians, bicyclists, and motorists; increased compliance with traffic regulations	34
Mental Health	Improvements in stress, anxiety, depression, energy levels, sleep quality, and fear of crime	22
Economic	Increased consumer spending, return on investment, job creation, tourism/visitors, and pedestrian and bicycle traffic for local businesses	31

Literature review

This literature review summarizes current evidence on the relationships between the street-scale features and co-benefits defined in Tables 1 and 2. To gain a broad understanding of these relationships, we considered a variety of resources both within and beyond the academic literature. A total of 152 resources were reviewed. The types of resources include:

- Academic journal articles
- Published books
- Reports by transportation and public health agencies, policy makers, and other groups
- Case studies of existing policies and projects

We used the street-scale features and co-benefits in Tables 1 and 2 as search terms in a variety of research databases. We also reviewed the reference lists of existing literature reviews on related topics—such as physical activity promotion, the built environment, and urban design—to identify resources that relate to the topic of interest for this review. Our review included resources that met the following criteria:

- Addressed the direct link between at least one street-scale feature and one co-benefit
- Presented either background information or empirical evidence for this link

We generally excluded resources that focused on broad measures of the built environment (e.g., larger street network connectivity, urban sprawl, metropolitan area density and land-use patterns) or on broad community benefits that cannot easily be attributed to specific street-scale interventions (e.g., larger environmental impacts, overall livability and sustainability, mobility). However, as we reviewed the background materials cited in many of our resources, we identified several studies that measured one or more street-scale features as part of an overall measure of the built environment (e.g., a walkability index). We included these resources as they were identified, provided that they met the other inclusion criteria.

Strengths and limitations of the review

As previously noted, this review captures only a subset of the co-benefits of active transportation investments: those that can be tied to a specific street-scale feature. Active transportation investments may have broader benefits beyond those considered in this review. Additionally, many of the case study resources focus on large cities that have invested extensively in multimodal transportation, such as New York City or Portland, Oregon, or on international locations, such as the Netherlands, whose experiences may not be broadly applicable to all areas of the United States.

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

Despite these limitations, the literature review is based on a diverse set of resources—beyond the academic literature—that are relevant to broad audiences, including policy makers, planners, academics, and advocates. While some community benefits are not addressed, the review is focused in scope and summarizes a subset of the evidence that can be used to further support and justify active transportation investments.

Summary of Findings

Physical activity

Street-scale features can promote walking and biking, leading to increases in physical activity. While cultural and social influences play a role and while active transportation is not highly prevalent in the United States (25, 80), individuals are more likely to walk and bike when the built environment is more supportive of physical activity and provides more opportunities for active transportation to and from local destinations.

- **Dedicated pedestrian facilities and related street-scale features increase walking.** Most pedestrians choose to use sidewalks when they are available (36), and sidewalk availability in a neighborhood is positively associated with total amounts of walking (58). Residents of areas with features such as streetlights, pedestrian crossings, and traffic calming are likely to walk more (13). In a study of the Twin Cities in Minnesota, positive correlations were found between miles walked per day and the presence of sidewalks, as well as other street-scale features such as street lighting and traffic-calming measures. Additionally, transportation-related walking (i.e., walking to reach destinations) was positively associated with these street-scale features (25).
- **Aesthetic and placemaking features are important elements of environments that encourage pedestrian activity.** Features that create "streetscape texture"—including public art, street furniture, and buildings of different types, styles, and colors—help to maintain pedestrian interest (80). For example, a New York City study found that the presence of sidewalk cafes is positively associated with both walking and biking (53).
- **Dedicated bicycle facilities increase biking.** Dedicated bicycle facilities have been found to lead to an increase in bike trips (1, 75, 77). In a study of cycling and the built environment in King County, Washington, cyclists and noncyclists indicated that improvements to the cycling environment—including bike lanes and trails, and features such as lighting at night and bicycle racks—would encourage them to bike more (60). A study conducted in the East Village neighborhood in New York City found that protected bike lanes led to an increase in cycling, and study participants stated that they were more likely to bike with the addition of protected lanes (77).
- **New bicycle facilities are likely to increase the overall amount of biking.** Because sidewalks are more widespread than bike lanes or other bicycle facilities, investing in new bicycle facilities is more likely to have an impact on the *total* amount of cycling, whereas investing in new sidewalks will more likely affect *where* people walk (43).
- **There are equity concerns related to where active transportation facilities are located.** A study conducted in the central Puget Sound region found that, despite the lack of pedestrian infrastructure, between 400 and 800 people walked to suburban commercial centers during the workday. The study also found that pedestrians at these sites were disproportionately young and pedestrians of color, when compared to the corresponding census populations (36). A study in Michigan found that communities with walkable environments tend to have several characteristics: educated and homogenous populations, as well as available funding to support street-scale interventions (80). These demographic and socioeconomic differences may have implications for where and how active transportation facilities are built, promoted, and supported for diverse population subgroups.

Residential self-selection and physical activity

Residential self-selection—the idea that people who *want* to walk and bike may *choose* to live in neighborhoods that support walking and biking—has been examined extensively in the literature. This subset of the literature examines residential self-selection as a confounding variable in order to determine whether features of the built environment still have an impact on transportation behavior after controlling for neighborhood choice. Several studies have found that, when residential self-selection is accounted for, built environment factors remain significant predictors of active transportation (14, 15, 17). Studies that do not account for residential self-selection may overstate the benefits of built environment features.

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Social cohesion

Street-scale features can influence social cohesion by fostering social interaction, building community trust, supporting social equity, and creating a shared sense of identity.

- **Walkable streets provide opportunities for social interaction.** Street-scale features that encourage walking in the public realm can lead to opportunities for social interaction—planned or unplanned, one-time or repeated—with other members of a neighborhood or community (2, 16, 29, 42, 29, 50, 66, 72, 83). These types of interactions, especially when repeated over time, can build community cohesion and trust. A case study of three neighborhoods in Boston found that the following features had the greatest influence on social interaction: seating (both formal and informal), sidewalk width, building facades (e.g., nooks, small setbacks), shade/shelter (e.g., trees, awnings), and unique storefronts (59).
- **Street-scale features promote "eyes on the street."** Street-scale features can offer "natural surveillance" or "eyes on the street" (12, 29, 40), which supports community trust and deters both *actual* crime and *fear* of crime (72). The effects of neighborhood disorder can be buffered by strong, informal social ties (67). While walkable streets may also increase the number of "outsiders" (visitors) and present problems for social monitoring, this effect is generally outweighed by the effects of natural surveillance and residents of walkable neighborhoods tend to feel safer than residents of less walkable neighborhoods (26,29, 82).
- **Walkable streets can enhance sense of community.** Public spaces and attractive environments in which many people walk and cycle can create a unique sense of place and shared social identity (27, 42, 54, 83). A study of the Kentlands development in Maryland found street-scale features including block size, street landscaping, arrangement of buildings, pedestrian amenities, architecture, and street frontage (e.g., garage location) to be correlated with sense of community (42). Another study in Portland, Oregon, found walkable pedestrian environmental features to be associated with stronger sense of community, even after controlling for attitudes (54). Specific features such as public art (34, 71) and historic preservation (50) can build a shared sense of culture and history.
- **Street-scale features can influence social support, and social support can encourage physical activity.** Environments that encourage walking and cycling can increase social interaction and support. One study in the Netherlands found low quantities of green space to be associated with loneliness and perceived lack of social support (57), while another study in Miami found architectural features that promote visual contact (e.g., porches, windows, setbacks) to be correlated with higher social support among elderly residents (12). This relationship can also work in the opposite direction: Several studies have found social support to be an important predictor of walking, cycling, and overall physical activity (5, 7, 68). The relationship between environment, physical activity, and social support can therefore be a self-reinforcing cycle, albeit complex.
- **Planning for walking and cycling supports social equity.** Investing in street-scale features that support active transportation are particularly important for those who depend on alternatives to the automobile. These groups may include socioeconomically disadvantaged populations, disabled individuals, older adults, and children (20, 29, 30, 50, 72, 76, 78). Investments in active transportation can improve equity and access to economic opportunities (30, 50). Additionally, walkable streets can foster social interaction among individuals with diverse backgrounds (49), and thereby increase social trust.
- **The act of creating community spaces can support social cohesion.** While evidence shows that green spaces can support social cohesion once they are in place, the act of creating these spaces may also be important. Community-based creation of green spaces and community gardens (e.g., public involvement in planning, tree planting and garden-building events) can build social capital and empower community members to improve their neighborhoods (4, 81).

Crime prevention and public safety

Community members engaging in active transportation create street-level activity. This activity can have effects on *actual* crime and safety, as well as *perceptions* of crime and safety.

- **Greenery can increase actual and perceived safety.** While several studies note the perception that vegetation leads to higher crime rates by providing places for criminals to hide and crime to take place (44, 46), research has found that the greener a building's surroundings, the lower are both violent and property crime rates (46). Research has also found that tree density and grass maintenance increase the sense of safety in inner-city neighborhoods (44).
- **Other street-scale features can increase actual and perceived safety**. As noted in the social cohesion section above, both actual safety and perceptions of safety influence the decision to walk (72). This may occur due to "eyes on the street" and a greater sense of social trust, both of which can be supported by features that encourage street-level activity.

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

- **Interventions that do not lead to lower crime rates may have other safety-related benefits.** A study of community gardens in Houston found that areas with community gardens have comparable crime rates to areas with similar demographic profiles; however, they are perceived by community members to be safer, and they may result in other positive outcomes such as less illegal dumping, less noticeable drug activity, and higher property values (31).
- **Safety is not just an important co-benefit of active transportation—it is important to *supporting* active transportation.** A study in New York City found that safety concerns can discourage active transportation in neighborhoods that otherwise have walkable urban form. For example, neighborhoods with high homicide rates have lower rates of active transportation (53).

Multimodal traffic safety

Street-scale interventions that create dedicated facilities for pedestrians and bicyclists, as well as those that are intended to calm traffic, can have safety benefits for all street users. Bicycle and pedestrian facilities can raise awareness and visibility of these travel modes within the transportation network and traffic calming measures can slow traffic speeds, thereby reducing the number of crashes that result in injury.

- **Pedestrian-specific infrastructure interventions improve safety.** Street-scale interventions that support walking lead to improvements in pedestrian safety (23, 35, 64). Specific interventions found to be highly effective include sidewalks, pedestrian refuge islands, exclusive pedestrian signal phasing, more intense roadway lighting, and single-lane roundabouts (64). Well-marked crosswalks also lead to a higher observance rate (i.e., compliance with crossing regulations) by both pedestrians and drivers (35).
- **Cyclist-specific infrastructure interventions improve safety.** Just as pedestrian-specific interventions improve safety, street-scale interventions designed for biking have positive safety implications for cyclists and other road users (6, 23, 65). Safety improvements have been observed following the implementation of sharrows (a shared lane marking that indicates to drivers that bicyclists are allowed to use the full lane), including increased driver awareness of cyclists, safer passing by drivers, and increased lane observation by cyclists (10, 23, 39, 69, 70). There is a lower rate of injury for bicyclists on cycle-tracks (physically separated bike lanes) than on roadways (55, 56, 75). Other street-scale interventions, including street lighting and proper maintenance of bicycle routes, have safety benefits for cyclists (65).
- **Traffic calming measures improve safety.** Traffic calming measures affect the speed and volume of traffic, which can improve safety for all street users by reducing the frequency and severity of crashes (22, 37, 51, 84). A meta-analysis of area-wide traffic calming-measures in eight countries found the overall rate of injury crashes to be 15 percent lower in these areas, with an average reduction of 25 percent on residential streets and 10 percent on main roads (22). This finding illustrates the benefit of implementing broad street-scale interventions, rather than installing traffic calming in just a small number of locations.
- **The number of pedestrian and bicycle incidents may initially increase even as the *risk* of active transportation decreases.** It is important to note that improvements to pedestrian and bicycle infrastructure may not immediately reduce the *total number* of collisions and injuries; indeed, if these improvements lead to an increase in walking and biking, they will also increase opportunities for collisions with automobiles (53). However, even if the total number of collisions remains stable or increases, the greater number of pedestrians and bicyclists means that the collision *rate* or *risk* per individual traveler is lower. This may occur due to a "safety in numbers" effect, in which drivers become more aware of pedestrians and bicyclists and these modes become a more integrated part of the transportation network. This effect may take time to appear, and bicycle facilities—particularly those that cross intersections—may be subject to an increased risk of "looked-but-failed-to-see" collisions between bicyclists and cars, which occur when drivers look for other vehicular traffic, but fail to see bicycle traffic (65).
- **Perceptions of safety from traffic are important to increasing active transportation.** Safety-related concerns are a commonly cited reason for deciding not to bike (65). A review of the literature on cycling in six European cities found perceptions of safety, along with comfort and continuity of the network, to be the key factors determining whether people will bike (38).
- **There are equity concerns related to where street-scale features are installed.** Neighborhoods with high percentages of low- or middle-income populations are less likely to have street-scale features, including sidewalks and traffic safety measures, which make walking safe and appealing. A study that examined more than 10,000 streets in 154 communities across the United States found that a variety of street-scale pedestrian and traffic safety features—including streetlights, sidewalks, marked crosswalks, and traffic-calming features—were more likely to be found in high-income areas than in their low- and middle-income counterparts (11).

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

AMERICAN PLANNING ASSOCIATION | Planning and Community Health Center

Mental health

Walking and cycling can have multiple benefits for both physical and mental health (72). Many characteristics of the neighborhood environment—particularly street trees and green spaces—are also associated with positive mental health.

- **Walking promotes mental health.** Walking is associated with reduced anxiety symptoms, better sleep quality, more positive affect (e.g., happiness, enthusiasm, contentment), and better cognitive performance (e.g., for children at school, for older adults) (13). These benefits may be greater when walking takes place in proximity to certain environmental features, such as greenery and water (13, 41). The benefits may also be greater among those who already have relatively poor mental health status (13).
- **Social cohesion promotes mental health.** As previously described, street-scale features can foster social cohesion and other forms of social capital. Higher social capital, in turn, is associated with improved mental health outcomes (29).
- **Various aspects of walkability and neighborhood quality are associated with mental health.** A study in King County, Washington, found higher neighborhood walkability—based on distance to and number of amenities, block size, dwelling unit density, and other factors—to be associated with reduced depressive symptoms in older men; this relationship was not found for women or for younger populations (8). Another study in South Wales found higher neighborhood quality—based on indicators such as litter, graffiti, vandalism, green areas, and aesthetics—to be correlated with greater mental health (3). Specific components of neighborhood satisfaction (safety and walkability, social network, and traffic noise) were positively associated with mental health in a study in Australia (48), and other researchers found perceived green space, noise, and safety to be correlated with mental health in Greenwich, London (33).
- **Green spaces and street trees play an important role in mental health.** Research shows that forest views have a more positive impact on mental health than urban views (47, 79), suggesting the value of incorporating green space into urban environments. Green spaces may have "restorative effects" on mental health, and in a nationwide survey in the United States, a "calming effect" was rated as the second most important benefit of street trees (behind shade/cooling) (52). Studies in the United States, Denmark, Australia, and Sweden have found neighborhood green spaces and street trees to be associated with lower symptoms of depression, anxiety, and stress (9, 21, 32, 61, 73, 74). In fact, one study in London found that for every one-unit increase in the density of street trees per kilometer of street, the antidepressant prescription rate decreased by 1.18 prescriptions per 1,000 residents (74). In a study in Chicago, levels of aggression, violence, and mental fatigue were higher among urban public housing residents living in "relatively barren" areas, compared to those living in areas with nearby trees and grass (45).
- **Quality and distance are important considerations.** The *quality* of green spaces (e.g., variation, maintenance, orderly arrangement, absence of litter, and general impression) may be more important to mental health than their *quantity* (21). Finally, because research shows that people may not go out of their way to access green spaces (32), incorporating green space into the urban fabric (and thus everyday life) is an important mental health objective. This relationship may be particularly important for socioeconomically disadvantaged populations. Lower-income neighborhoods tend to have lower levels of access to street-scale features that are positively associated with mental health, which further burdens these communities.

Economic

Economic benefits are also associated with street-scale features for walking and biking. These benefits include higher property values, an increase in visitors, an increase in pedestrian and bicycle traffic near businesses, and job creation for construction and maintenance of bicycle and pedestrian facilities. Pedestrians and bicyclists may be more likely than motorists to stop at local establishments, as they are moving at a slower pace and may be more likely to notice shops or restaurants.

- **Street-scale interventions have a positive impact on property values.** Location in a walkable neighborhood has a positive impact on housing values, as does proximity to bike facilities; traffic calming measures can also improve property values (13, 24, 63, 43, 50, 51, 72). A Vermont Agency of Transportation study found that property values of homes in walkable neighborhoods were $6,500 higher than those of homes in less walkable or more car-dependent neighborhoods (63), while homes within a half-mile of Indianapolis's Monon trail were found to sell for 11 percent more than comparable homes not near the trail (24).
- **People who walk or bike to retail establishments spend more over time than people who drive to the same places.** A Portland study found that when trips are examined by mode choice, people who drive spend the most per visit, but cyclists spend the most per month and make more frequent visits to different types of establishments, including bars, convenience stores, and restaurants (19). A survey of East Village shoppers in New York City similarly found that bicyclists spend the most per capita per week, followed by pedestrians, and that both bicyclists and pedestrians spend more than drivers or subway

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

users. Bicyclists and pedestrians also visit the neighborhood more frequently than people arriving by cab, subway, or car (77). A survey of Toronto's Bloor Street found that pedestrians spent the most over the course of a month (and visited the area the most often), followed by bicyclists (24).

- **Street-scale interventions create jobs.** Investment in and maintenance of bicycle and pedestrian facilities creates both direct and indirect jobs (24, 28, 62, 63). A study of bicycle, pedestrian, and road infrastructure in Baltimore found that spending on bicycle and pedestrian facilities creates more jobs per $1 million spent than road infrastructure, due to the percentage of expenditures spent on labor relative to materials and the relationship between construction and engineering costs (28). A study of North Carolina's Northern Outer Banks found that spending by bicyclists is responsible for creating or supporting 1,400 annual jobs (62), while Boulder, Colorado's bicycle economy is estimated to support 330 full-time jobs in manufacturing; education, advocacy, and outreach; and retail, rental, and repair (24).
- **Access to bicycle facilities is a tool for recruiting workers.** Proximity to bicycle facilities provides workers with the option of bicycle commuting and can be an important tool for attracting employees. As a result, some businesses are intentionally choosing locations near bicycle lanes and other bicycle facilities (1).

Conclusions

Street-scale features of the built environment can positively impact not only physical activity, but also a variety of other co-benefits that enhance community health and livability. As outlined in the sections that follow, these benefits have implications for policy and planning practice, as well as for future research.

Policy and planning implications

The key conclusions of this review are summarized below, with further consideration of their implications for policy and planning practice:

- **Benefits for the Local Economy.** Strategic investments in street-scale features can have benefits for the local economy. Pedestrians and bicyclists are more frequent visitors to a range of business types and, as a result, may spend more over time. These facilities can add value to surrounding properties, and investment in pedestrian and bicycle infrastructure can create both direct and indirect jobs. Benefits to the local economy should be incorporated into cost-benefit analyses and other decision-making processes for active transportation investments.
- **Equity Concerns.** Low-income neighborhoods are less likely to have environments where walking is safe and appealing. It is important for planners, policy makers, advocates, and others to consider equity of location and access when prioritizing locations for street-scale interventions. Focused interventions in disadvantaged neighborhoods and communities may help reduce disparities in safety, use of active transportation modes, and corresponding health outcomes such as obesity and mental health.
- **Facility Maintenance.** Just like roads, street-scale features that support walking and biking require ongoing maintenance. Benefits from street-scale interventions may also take time to appear, and it is therefore important that bicycle and pedestrian facilities and other street-scale features are maintained over time to ensure that their full potential is realized.
- **Education and Awareness.** While street-scale features can lead to an increase in walking and biking, as well as other co-benefits, there is a need for education and awareness efforts for the full benefits of these interventions to be realized. Currently, active transportation is not the norm in most communities in the United States, and education and awareness campaigns to promote a cultural shift are needed as a complement to infrastructure investments. Education and awareness campaigns are also important for safety, teaching users of all modes to interact safely as pedestrian and bicycle travel becomes more commonplace.
- **Increased Safety.** Street-scale interventions can have important safety benefits, both in terms of traffic safety (e.g., reduced crashes, increased driver awareness) and in terms of crime prevention and public safety. Both types of safety are important considerations in the decision to walk or bike, and have broader benefits for the surrounding community.
- **Perceptions of Safety.** While actual safety is an important co-benefit of street-scale features, *perceptions* of both multimodal traffic safety and crime prevention and public safety are also important. Individuals are more likely to engage in active transportation when they perceive the environment to be safe, and street-scale features that support perceptions of safety—such as streetlighting, street furniture, and aesthetic amenities—can go a long way towards increasing rates of physical activity for transportation or recreation.
- **Where People Live.** Individuals who prefer to walk or bike may be more likely to choose to live in neighborhoods that have features that support this preference. However, research has shown that the built environment and street-scale interventions can lead to more walking and biking even when residential self-selection is accounted for. As a result, and—even more

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

AMERICAN PLANNING ASSOCIATION | Planning and Community Health Center

importantly—for reasons related to equity, investments should not be limited to areas or neighborhoods that are likely to have the most vocal advocates for active transportation. Instead, investing in a broad range of communities can maximize the direct and indirect benefits of street-scale features and lead to more equitable planning and outcomes.

- **Part of the Larger Network.** While this review has focused on the street scale, no project exists in isolation. Rather, the success of individual projects depends largely on their integration into the larger network of pedestrian and bicycle infrastructure. For example, a bike lane in isolation will have few benefits if not connected to a larger network of bicycle facilities allowing for seamless travel. It is therefore important to consider street-scale features as part of the larger network and to pursue coordinated plans and projects that lead to connected facilities. Similarly, while this review focused exclusively on benefits that could be tied to specific street-scale interventions, individual projects and coordinated planning efforts may also be justified based on larger network scale benefits, such as reduced health care costs, reduced traffic, and improved air quality.

Future research

In addition to the policy and planning implications discussed above, the findings of this review suggest several opportunities for future research.

- **Additional Research on Street-Scale Features.** While a wealth of research has addressed larger aspects of the built environment—such as road network connectivity, population density, jobs-housing balance, and urban sprawl—research at the finer scale of the streetscape has been more limited to date. Further research should be conducted to assess the impacts of specific street-scale interventions on walking, biking, and related co-benefits. This effort may be best undertaken through partnerships between researchers in the fields of planning, urban design, landscape architecture, economic development, and other social sciences.
- **Longitudinal, Intervention-Based Research.** The majority of studies reviewed for this report used cross-sectional research designs that examine different locations at the same point in time. Future research should examine data in the same places over time, particularly in areas that receive a streetscape or other environmental intervention. A crucial direction for future research is to examine the impacts of street-scale interventions that combine infrastructure investments with education and awareness campaigns intended to change behavior.
- **Quantifying the Benefits.** Many of the studies in this review were designed to determine whether an impact was present, but not to measure the magnitude of that impact. Further work to quantify the co-benefits of active transportation investments would be valuable for project evaluation efforts, cost-benefit analyses, and other aspects of the decision-making process.
- **More Case Studies and Broader Contexts.** There is a need for additional case studies on the co-benefits of street-scale interventions. The majority of resources included in this review were academic studies or agency reports, while relatively few were detailed case studies of interventions, policies, or programs in specific communities. Case studies may be helpful to highlight the planning processes and nuances that lead to project success. Additionally, many of the studies in this review focused on cities in other countries; on larger U.S. cities such as New York City or San Francisco; or on cities with strong walking and biking cultures, such as Portland and Seattle. Future work should examine broader and potentially more representative settings that will increase the applicability of findings.
- **Equity Considerations.** As noted throughout this report, the location of street-scale interventions raises important challenges and opportunities for social equity. On the one hand, interventions that generate local revenue and increase property values may raise concerns related to displacement and gentrification. On the other hand, street-scale interventions may also result in equity-related benefits such as expanded transportation options for those who rely on alternatives to car travel. These trade-offs have not been examined extensively with reference to street-scale features. Future research should examine the equity-related impacts of street-scale interventions and consider how equity challenges and opportunities can be most effectively addressed in practice.

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

ENDNOTES

A McKenzie, Brian. "Modes Less Traveled—Bicycling and Walking to Work in the United States: 2008–2012." U.S. Census Bureau, May 2014. https://www.census.gov/prod/2014pubs/acs-25.pdf.

B Definitions of street-scale features are drawn from the literature as well as from American Planning Association . 2006. *Planning and Urban Design Standards*. Hoboken, New Jersey: John C. Wiley & Sons.

C Definitions of co-benefits are broadly drawn from the resources included in the literature review.

"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

AMERICAN PLANNING ASSOCIATION | Planning and Community Health Center

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"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

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"THE BENEFITS OF STREET SCALE FEATURES FOR WALKING AND BIKING"

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