

ST. LOUIS ECO-BOULEVARD

by

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A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

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KANSAS STATE UNIVERSITY
Manhattan, Kansas

2010

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Abstract

Cities and nature are often popularly viewed as polar opposites. Many American cities are seen as “destructive of nature, gray and natureless, distinct and separate from natural systems” (Beatley 2008, 189). Cities lacking in ecological functions can benefit from the application of Green Urbanism theory. Green Urbanism incorporates ecological features as central design elements, cities, and to restore, nurture, and celebrate urban ecology. Unique ecological features can affect a place in positive ways while adding and establishing an identity for the city.

One city that has been stuck in a gray and natureless state is St. Louis, Missouri, in particular, the Central business district. In order to transform St. Louis into a more ecologically rich city, an eco-boulevard will be implemented. An eco-boulevard is a green ribbon that collects stormwater runoff and connects people to surrounding local amenities. In addition to stormwater benefits, the eco-boulevard will serve as a visual and physical connector for pedestrians to public destinations, and connect pedestrians with other pedestrians by serving as its own destination. The eco-boulevard can also provide multiple ecological and social benefits to promote healthy places with a high quality of life.

In order to achieve the implementation of an eco-boulevard, a thorough analysis of watersheds, key low points, transportation hubs, public destinations, and established pedestrian traffic routes were considered. The design of the eco-boulevard is concentrated in areas where low points in elevation, transportation hubs, public destinations, and highly travelled pedestrian traffic routes converge. At the intersection of these elements, unique features capture and store stormwater runoff. As a whole, the entire eco-boulevard improves urban ecology through the use of vegetation, street trees, and the recycling of water.

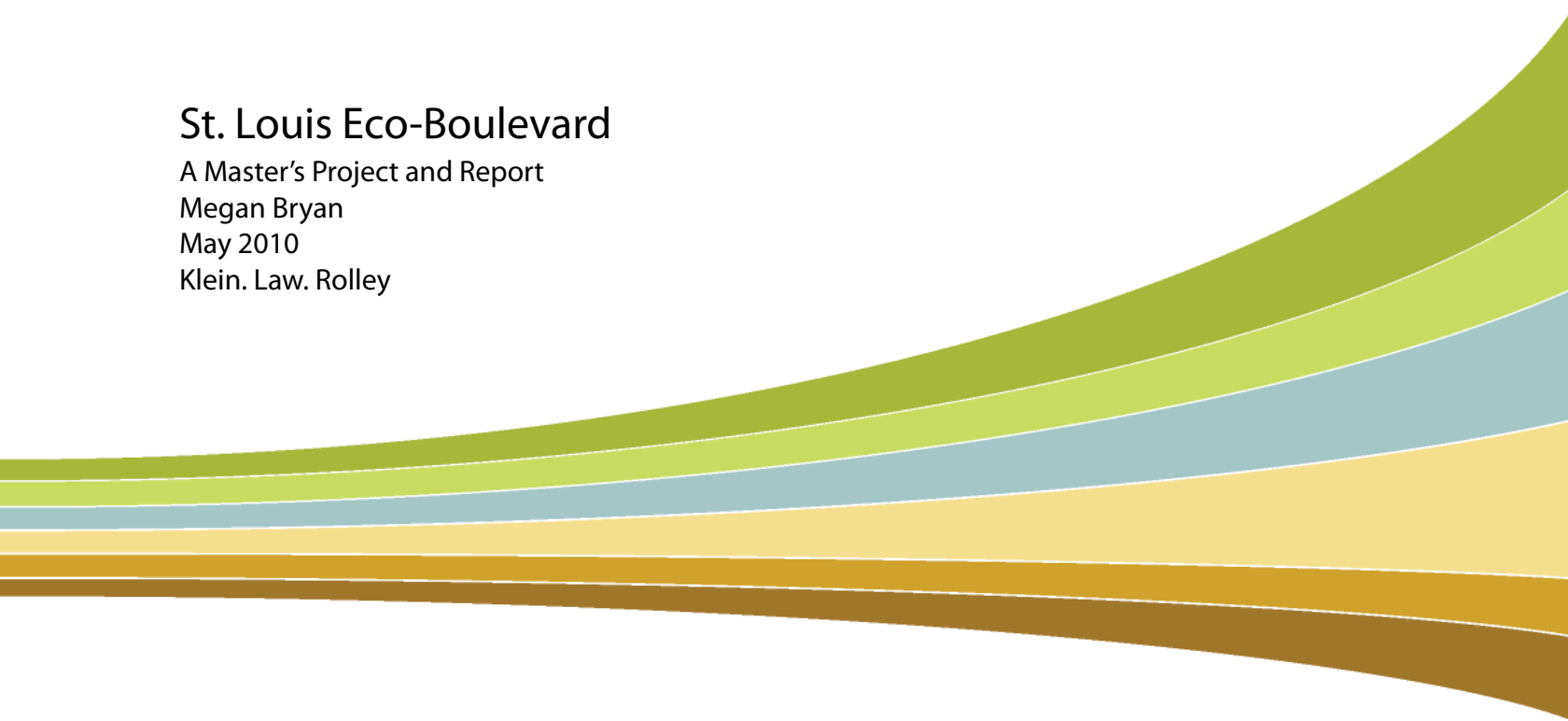
St. Louis Eco-Boulevard

A Master's Project and Report

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May 2010

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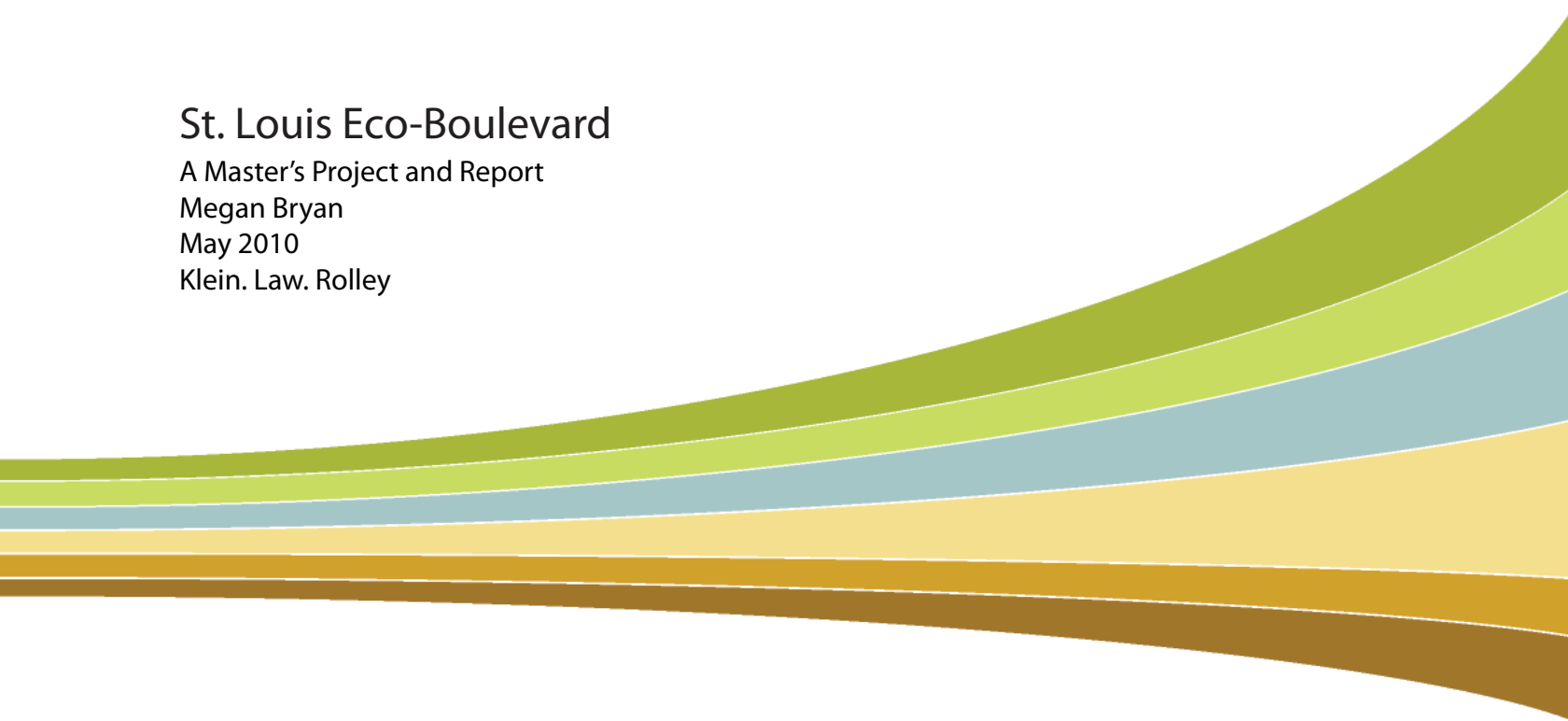
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To all those who have made me laugh when times
have not gone the way they were supposed to.
Thank you.

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Abstract

Cities and nature are often popularly viewed as polar opposites. Many American cities are seen as “destructive of nature, gray and natureless, distinct and separate from natural systems” (Beatley 2008, 189). Cities lacking in ecological functions can benefit from the application of Green Urbanism theory. Green Urbanism incorporates ecological features as central design elements, cities, and to restore, nurture, and celebrate urban ecology. Unique ecological features can affect a place in positive ways while adding and establishing an identity for the city.

One city that has been stuck in a gray and natureless state is St. Louis, Missouri, in particular, the Central business district. In order to transform St. Louis into a more ecologically rich city, an eco-boulevard will be implemented. An eco-boulevard is a green ribbon that collects stormwater runoff and connects people to surrounding local amenities. In addition to stormwater benefits, the eco-boulevard will serve as a visual and physical connector for pedestrians to public destinations, and connect pedestrians with other pedestrians by serving as its own destination. The eco-boulevard can also provide multiple ecological and social benefits to promote healthy places with a high quality of life.

In order to achieve the implementation of an eco-boulevard, a thorough analysis of watersheds, key low points, transportation hubs, public destinations, and established pedestrian traffic routes were considered. The design of the eco-boulevard is concentrated in areas where low points in elevation, transportation hubs, public destinations, and highly travelled pedestrian traffic routes converge. At the intersection of these elements, unique features capture and store stormwater runoff. As a whole, the entire eco-boulevard improves urban ecology through the use of vegetation, street trees, and the recycling of water.

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1

Description and Background

Dilemma

2

"Cities and nature are, it is often believed, polar opposites, and modern cities are popularly viewed as destructive of nature, gray and natureless, distinct and separate from natural systems" (Beatley 2008, 189). The concept of Green Urbanism rejects these perceptions and encourages introducing nature in the urban city. Green Urbanism incorporates ecological features as central design elements, while at the same time "creating just and healthy places with a high quality of life" (Beatley 2008, 189). Green Urbanism argues that cities must "be green," both in the sense of making nature present and in the broader sense of ecological conservation. Combining the terms "green" and "urban" makes the important statement that green design ideas, practices, and technologies can be applied very effectively within cities.

In addition to bringing nature into cities, Green Urbanism restores, nurtures, and celebrates urban ecology. Important green-urban strategies include incorporating street trees, community gardens, restored streams, roof top gardens, vegetated walls and facades, and other natural features. Unique features like these can provide bird and wildlife habitat, sequester carbon and reduce energy consumption, cool the urban environment, contain and treat stormwater, and add a unique identity to the city (Beatley 2008, 190).

One city that has been stuck in a "gray and natureless" state is St. Louis, Missouri. The Central business district (CBD) in downtown St. Louis is lacking ecological features due to oversized roads and large building footprints. The only green space in the St. Louis CBD is the Gateway Mall, which is an effort to create one linear recreation space that links to Jefferson National Expansion Memorial on the riverfront. However, there are no carefully considered transitional spaces between the Gateway Mall and other destinations in the CBD. Carefully considered transitional spaces could provide for some of the lost ecological functions and socially activated spaces.

The ecological problems in the CBD can be improved by implementing changes to the street design of the urban core. One way in which ecological problems can be solved is by introducing an eco-boulevard. An eco-boulevard is a green ribbon that collects stormwater runoff and connects people to surrounding local amenities. In addition to stormwater benefits, the eco-boulevard will serve as a visual and physical connector for pedestrians to public destinations, and connect pedestrians with other pedestrians by serving as its own destination.

Thesis

The Central Business District in St. Louis, Missouri will be transformed into an unique district by the use of an eco-boulevard. The eco-boulevard will serve as a visual and physical connector between people and place, and people and people while focusing on capturing and storing stormwater runoff. The eco-boulevard aesthetics will add to the unique identity of the St. Louis CBD.

Project Goals

- To develop a set of guidelines in which a community can implement their own eco-boulevard
- To understand how to make efficient connections through the use of an eco-boulevard
- To further my knowledge about stormwater management and unique ways to capture stormwater
- Strengthen St. Louis with a unique identity
- Continue to learn about landscape architecture and how it affects the surrounding community
- Design a project from multiple scales: from conceptual master plan to selected site detailed design in order to better understand the impact of the design

Location and Size of Site

The Central Business District (CBD) in downtown St. Louis is located in St. Louis City, Missouri located in Figure 1. The CBD is approximately 445 acres. The site boundaries include Convention Plaza Road to the north, the Mississippi River to the east, Interstate-64 to the south, and 12th Street to the west located in Figure2.

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Figure 1. St. Louis. google.com

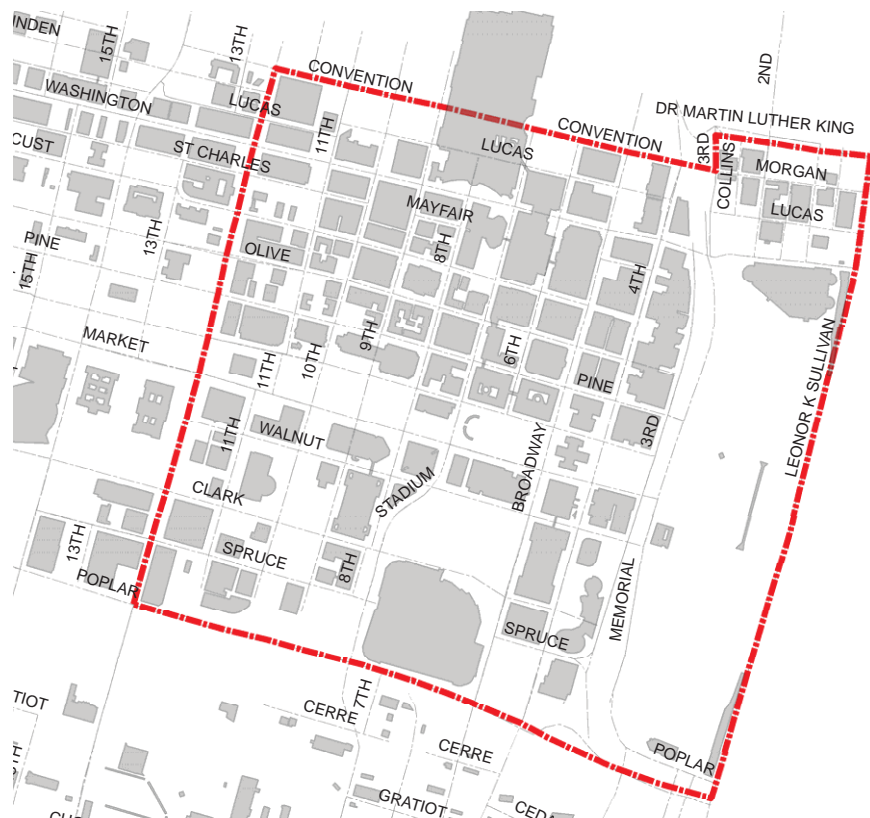


Figure 2. Central Business District. Megan Bryan

Critical Existing Site Conditions

The Central business district (CBD) consists of a variety of land uses, including primarily first floor retail space with commercial and office use of the 2nd stories and above. There are some hotels, government buildings, and very few industrial buildings interspersed. The major entertainment in the area includes the new Busch Stadium, America's Center Convention Complex, Laclede's Landing (restaurant and entertainment district), and the new Gateway Mall redevelopment (a linear outdoor plaza and garden space that opened in 2009) that links the CBD to the Jefferson National Expansion Memorial. There are three districts in the CBD that are named National Historic Districts and four buildings that are named National Historic Landmarks. These can be found in Figure 29. All of these unique sites are important to the project because they add opportunities and restrictions to the design of an eco-boulevard.

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The site is adjacent to the Mississippi River. Most of the site is primarily within two to eight percent slope, making the site easily accessible by everyone.

On average, the warmest month of the year is July, with the highest record temperature at 105 degrees Fahrenheit, in 1999. The average coolest month of the year is January, with the lowest record temperature at -17 degrees Fahrenheit. The maximum average precipitation occurs in November with 4.06 inches.

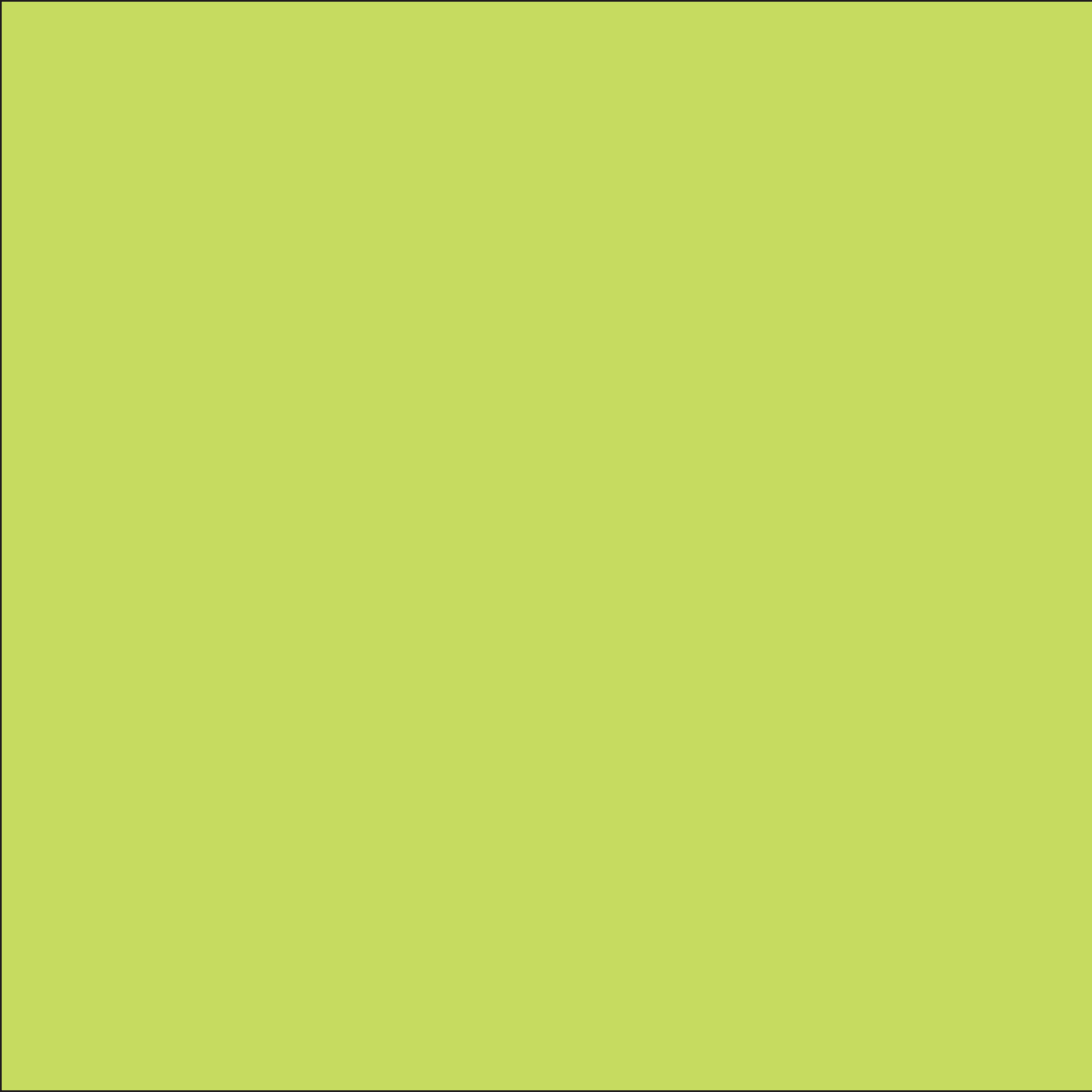
Offices used as Resources

City of St. Louis Planning and Urban Design Agency

(William Bailey)- They have produced a Central business district Downtown Streetscape Design Manual laying out all the components of what they want to change in the District. Everything from detailed site plans to materials used is documented. They have given me some base information in GIS format.

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HOK St. Louis (Andrew Kilmer) – They have given me a SketchUp model of downtown St. Louis. Andrew Kilmer has also provided me with some knowledge about the utilities located in the St. Louis CBD.



2 Process

Time and Task

Figure 3 shows the time and task diagram that is radial form to show where the particular tasks overlap, and for how much time. The dotted lines that extend from the center represent the months of the project, starting with September and ending after May. The tasks are represented with certain colors. The yellow represents initial process pieces, the green represents document pieces, and the pink represents reviews. .

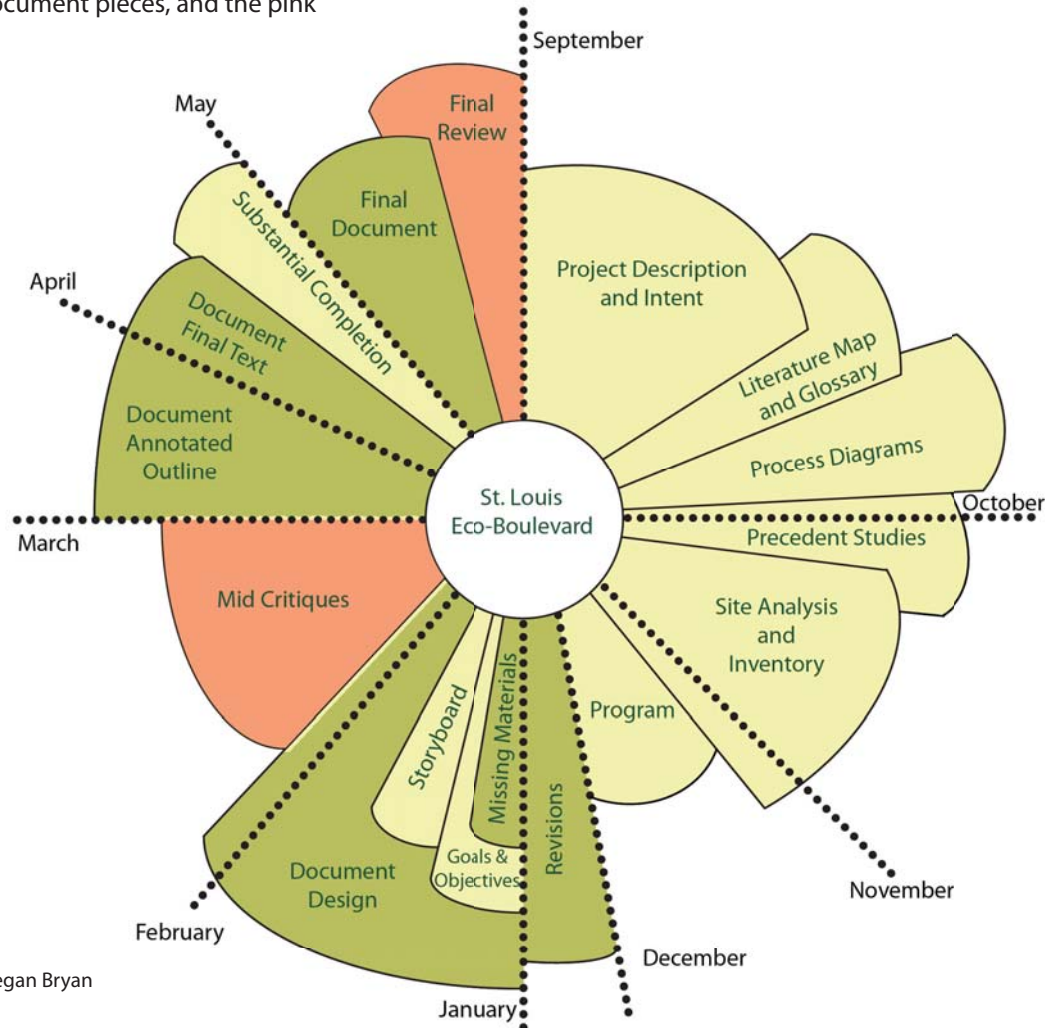


Figure 3. Time and Task. Megan Bryan

Figure 4 is the path diagram that shows a more detailed description of the tasks for the project. It also shows the relationship between tasks and the paths that need to be taken in order to get to the final tasks, which are the final document and substantial completion, in order to have a final review. Starting on the left, the description and intent, literature map and glossary, and precedent study all feed into the inventory and analysis, which then connects with program. After the program is established, the goals and objectives and storyboard begin to develop. From that point, two different paths are taken. One path deals with the document production, and the other deals with design. At the end of the project, both paths terminate at the final review.

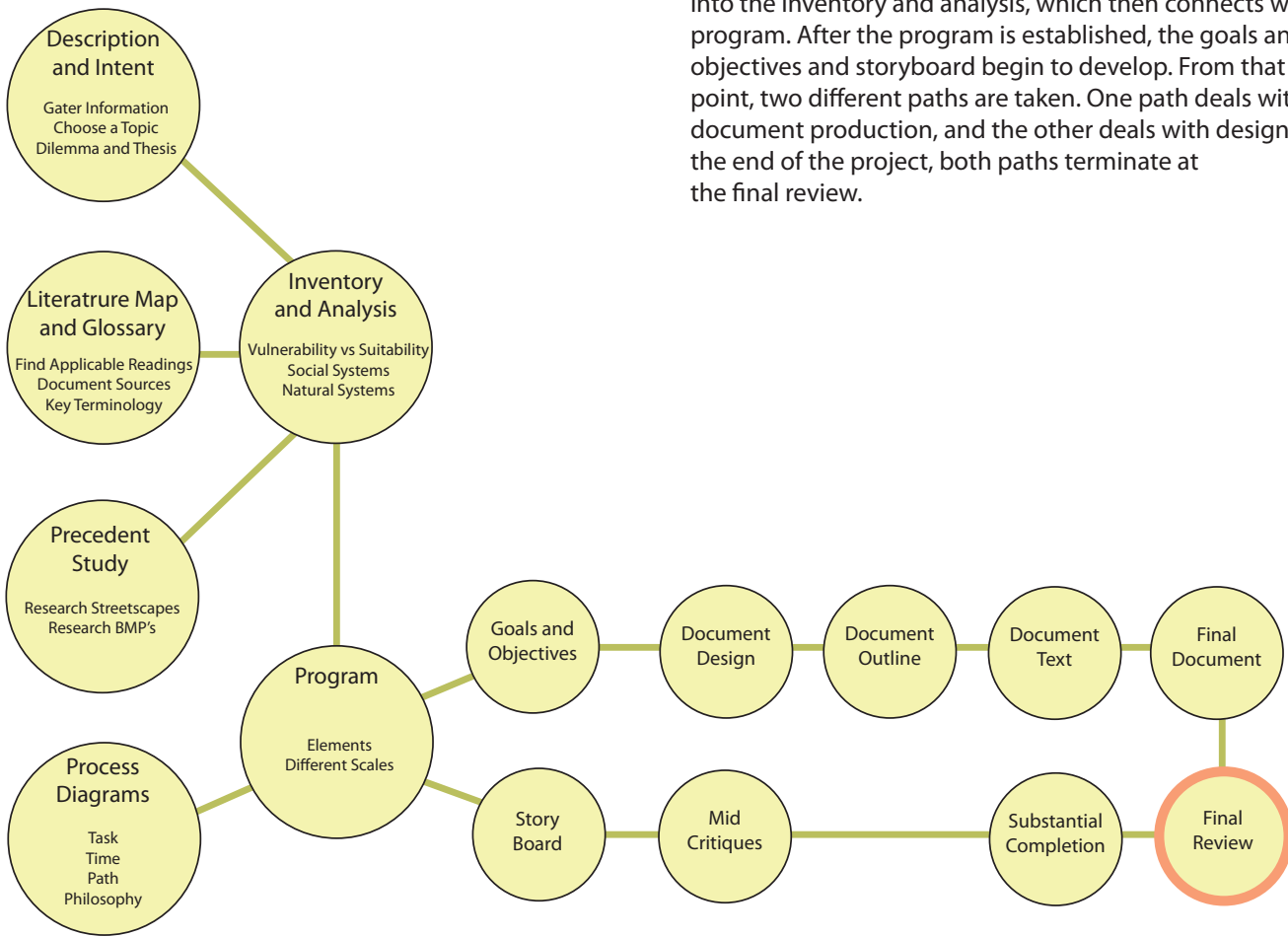


Figure 4. Path. Megan Bryan

Literature Map

Figure 5 is the literature map that helped form the project. To understand the literature that was found, they were split into four different categories: history, theory, stormwater, and site specific. By doing this, overlaps in categories were recognized and documented. Key terms were identified from each piece of literature.

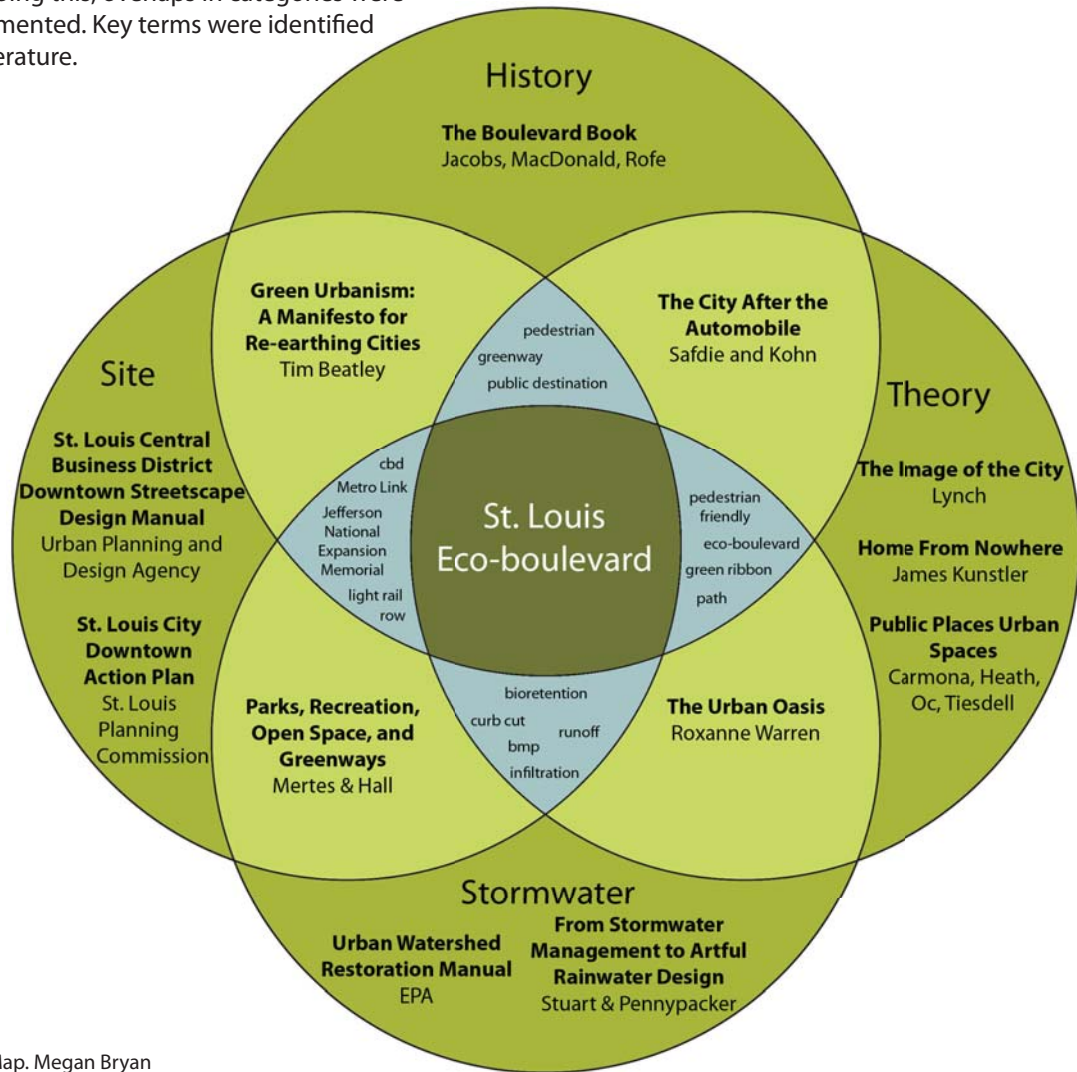


Figure 5. Literature Map. Megan Bryan

Design Philosophy

My personal design philosophy is shown in Figure 6 and is circular in motion. Collaboration between the client and design team begins. After the design team has discussed the goals of the project with the client, the design team then does performs tasks to be able to understand the problem. After the problem is understood, all the ideas that are discussed are filtered through the core values and core goals of the design team. Once the ideas have ran through the filters, there are only a few ideas or concepts that are left and are taken into the different design phases. All the while, collaboration between the client and design team continues to happen.

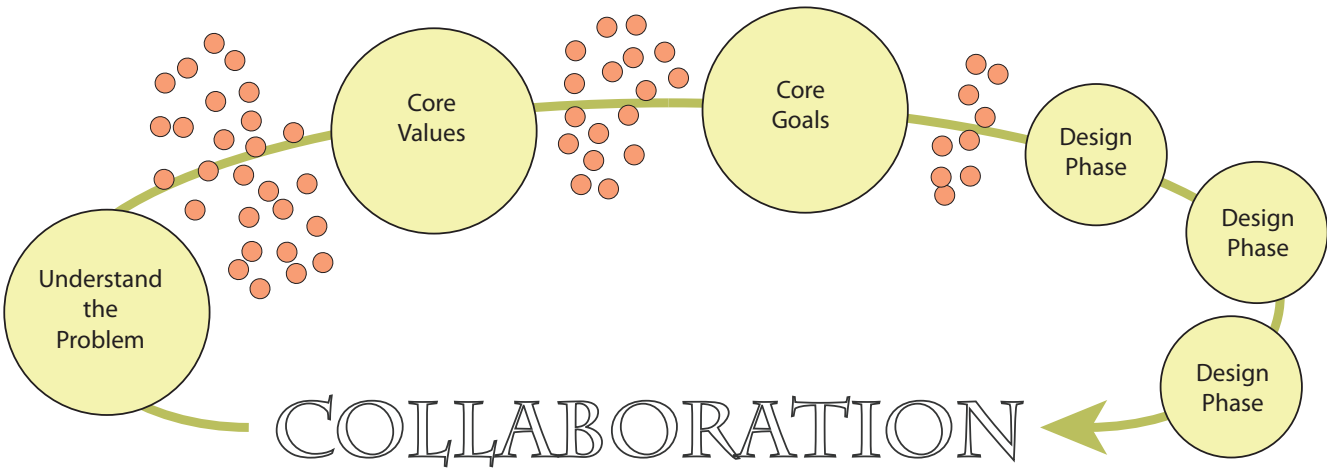


Figure 6. Design Philosophy. Megan Bryan

3 Precedent Studies

Eco-Boulevards (Growing Water Design Competition 2009)

Location: Chicago, Illinois

Date: Design Development October 2008

Size: Urban Downtown Chicago

Designer(s): Urban Lab

Theoretical and Historical Context

In 2106, water will be the world's most valuable resource: the new oil. Urban Lab's project envisions Chicago evolving into a model city for "growing water" by creating a series of Eco-Boulevards spread throughout the city. The Eco-Boulevards will function as a giant "Living Machine" which will treat 100% of Chicago's wastewater and stormwater naturally, using micro-organisms, small invertebrates (such as snails), fish, and plants, as shown in Figure 7. Treated water will be harvested and/or returned to the Great Lakes Basin. Ultimately, the Eco-Boulevards will create a closed water loop within Chicago.

The Growing Water project is inspired by three historic Chicago engineering feats: (1) The "Emerald Necklace" of public parks, boulevards, and waterways, which will be greatly supplemented by the new Eco-Boulevards, (2) The reversal of the Chicago River, which Urban Lab proposes to un-do in order to retain (not drain) Lake Michigan; and, (3) The Deep Tunnel, which Urban Lab proposes to reprogram to house mass-transportation trains.

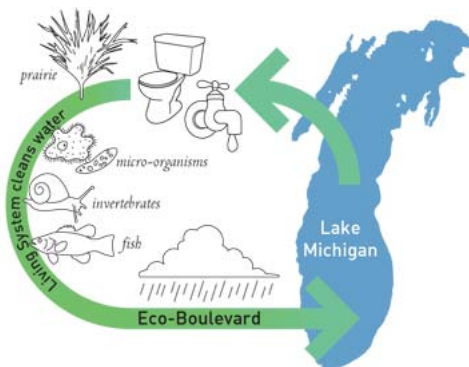


Figure 7. Growing Water. urbanlab.com

Physical Context and Site Analysis

Figure 8 shows the water west of the sub-continental divide flows into the Mississippi Watershed, water east of the sub-continental divide flows into the Great Lakes Watershed.

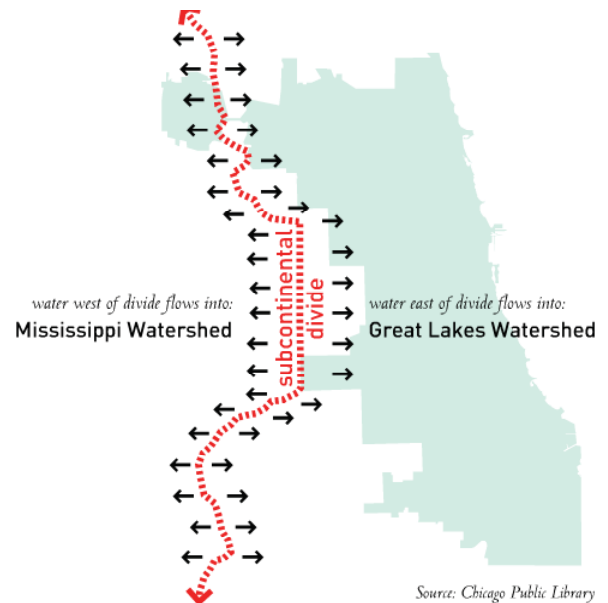


Figure 8. Water Divide. urbanlab.com

History

1899 - An incredible engineering feat of the 19th century reversed the flow of the Chicago River. The Chicago River is the first river in the world to flow away from its mouth. A 28 mile canal connects the Chicago River to the Des Plaines River in Figure 9. The river diverts water from the Great Lakes Watershed to the Mississippi Watershed.



Figure 9. Water Flow. urbanlab.com

1869- Today

Chicago's Motto: Urbs in Horto (City in a garden). Chicago's "Emerald Necklace" connects parks with green boulevards as seen in Figure 10.

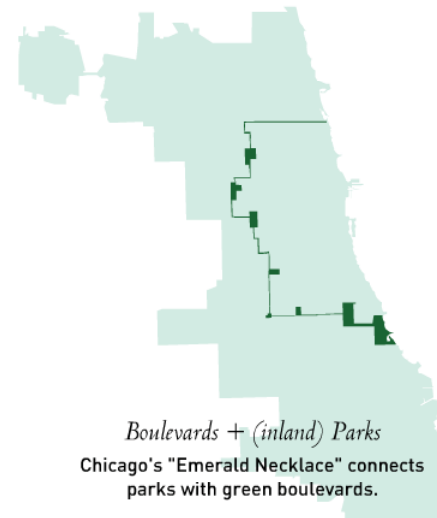


Figure 10. Emerald Necklace. urbanlab.com

2000 - The Deep Tunnel, a 109 mile engineering marvel, "solved" contemporary flooding and water pollution problems by diverting contaminated water to the Mississippi Watershed. In Figure 11 the Deep Tunnel intercepts sewer overflow. It conveys overflow to large storage reservoirs and treatment plants before it is routed to the Mississippi.

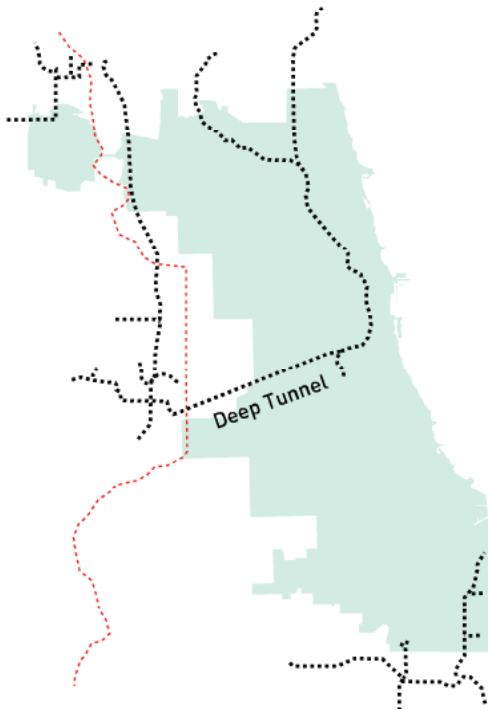


Figure 11. Deep Tunnel. urbanlab.com

2106 – Chicago will be a model city for "Growing Clean Water." The city will become a holistic Living System multiplying intensifying Chicago's "Emerald Necklace" of parks, boulevards, and waterways; and saving, recycling, and "growing" 100% of its own water. Figure 12 shows how these systems are connected.

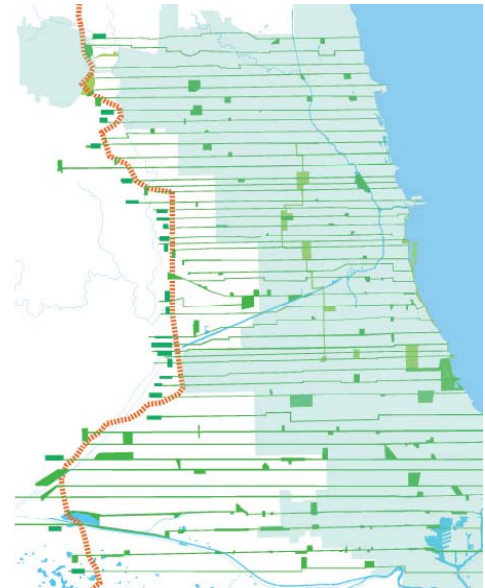


Figure 12. Living System. urbanlab.com

Program Elements

Living System Eco-Boulevards = Green Infrastructure

Examples: Wetlands, prairies, Walk/Bike Trails, Forests, Open Green Space, Savannahs, Marshes, Recreation Space, Preserves, Swells/Swales, Swamps, Vegetation Corridors, Biomes, Botanical Gardens, Fauna Corridors, Organic Farms, Dunes, Aquatic Systems, BlueBelts, Geothermal Wells, Fishing/Swimming Holes, etc.

Eco-Boulevards Anatomy

As seen in Figure 13, the eco-boulevard will begin at Lake Michigan and will extend to a suburban park. Along the eco-boulevard, walk/bike paths will extend from the urban core to the suburbs while incorporating one or more living system practices (listed above). Other eco-boulevards will intersect at given points. Different living systems will add water into the eco-boulevard which will then cleanse and disperse the water back into Lake Michigan.

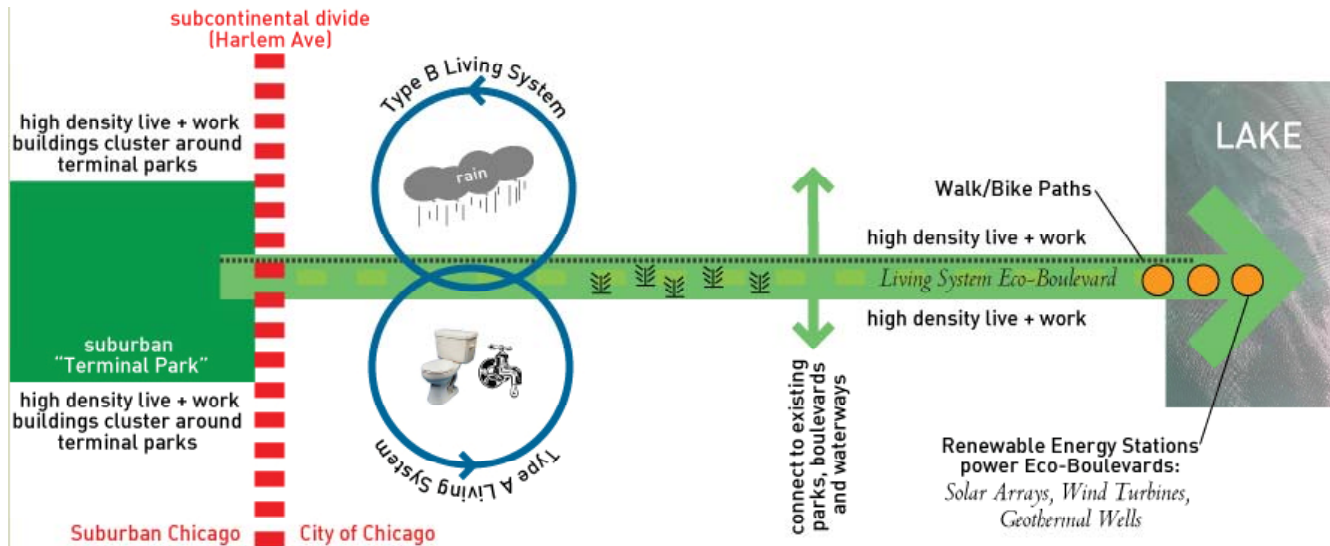


Figure 13. Eco-boulevard. urbanlab.com

Chicago Re-Engineered as a Living System:
100% of the world's most valuable resource saved, recycled, and "grown", Eco-Boulevards intensify social, cultural, and ecological effectiveness of historic Emerald Necklace, and Terminal Parks promote dense living and working clusters, as depicted in Figure 14.

Application of Planning and Design Principles

- Connections to surrounding neighborhoods (City to Suburbs)
- Connections to waterfront (Lake Michigan)
- Strategic planning of the location of transportation hubs
- Improving water quality and quantity

Relevance/Application to St. Louis Eco-boulevard

- Use of Eco-Boulevards to transform a city to have a unique identity
- Connections of places within study area
- Development around transit hubs
- Improving the treatment of water that is returning back into larger bodies of water
- Incorporating the natural landscape into the urban core

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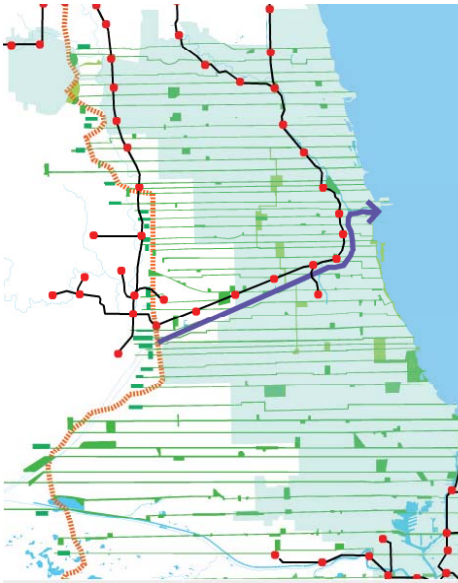


Figure 14. Chicago Re-engineered. urbanlab.com

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Date Accessed: October 09, 2009.

SW 12th and Montgomery Green Street

Location: Portland, Oregon (adjacent to Portland State University)

Date: Built May and June 2005

Size: City of Portland

Designer(s): Portland Development Commission

Client: Portland City Council

Project Background and History

Prior to the project completion in 2005, the stormwater runoff was not properly managed and flowed over impervious surfaces picking up pollutants along the way and washing them into the nearby rivers and streams. The stormwater runoff also caused flooding and erosion, destroyed habitats, and contributed to the combined sewer overflows.

The stormwater management systems that mimic nature by integrating stormwater into building and site development can reduce the damaging effects of urbanization on rivers and streams. Disconnecting the flow from storm sewers and directing runoff to naturalized systems such as landscaped planters, swales, and rain gardens, or implementing an eco-roof reduces and filters stormwater runoff. Figure 15 shows the plan of the SW 12th and Montgomery Green Street.

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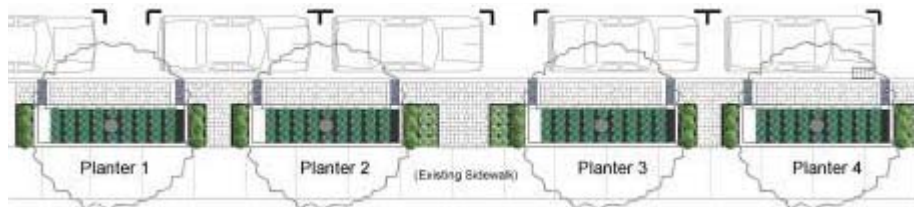


Figure 15. SW 12th Avenue. portlandonline.com

As part of the City of Portland's commitment to promote a more natural approach to urban stormwater management, this "green street" project converts the previously underutilized landscape area between the sidewalk and street curb into a series of landscaped stormwater planters designed to capture, slow, cleanse, and infiltrate street runoff. Built in the summer of 2005, this street retrofit project demonstrates how both new and existing streets in downtown or highly urbanized areas can be designed to provide direct environmental benefits and be aesthetically integrated into the urban streetscape. Though this green street project maintains a strong functional component, it is the ability of the landscaped stormwater planters to be integrated into the urban fabric that has the design community, developers, policy makers, and local citizens excited about the SW 12th Avenue Green Street.

Design Elements

- Elegant and detailed treatment of curb cuts that allow stormwater to enter the planters
- Ornamental trench grates cover each curb cut
- Sand-set tumbled concrete unit pavers were utilized in all of the pathways so that there was a clear physical and aesthetic separation from the sidewalk zone
- A landscape buffer was added on the outside of each planter's sidewalls in order to further "soften" the look of the stormwater planters as well as define where the access paths are located (Figure 16).



Figure 16. BMP Planter. portlandonline.com

Other Info

The approach to choose the most suitable site for the BMP was rigorous. The issues that the Development Commission considered were traffic impacts, stormwater catchment area, utility conflicts, loss of parking spaces, street slope, suitability for monitoring, soil infiltration rates, and available space.

-The planters capture runoff from approximately 7500 square feet of paved surfaces. They treat and infiltrate most of the runoff they receive, providing volume and flow control and water quality benefits.

-Runoff is managed onsite, instead of entering the storm drain system that feeds directly into the Willamette River.

-The planters are designed to safely accommodate pedestrians, on-street parking, and vehicle access

Relevance/Application to St. Louis Eco-boulevard

- Collection of stormwater
- Treatment of stormwater
- Material selection and use
- Urban context that incorporates vehicular parking and pedestrian access
- Plant selection

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www.asla.org/awards/2006/06winners/341.html. Date Accessed: October 2009.

Street Edge Alternatives (SEA Streets)

Location: Seattle, Washington
Date: Built Spring 2001
Size: Four City Blocks
Designer(s): Seattle Public Utilities and Seattle Department of Transportation
Client: City of Seattle, Washington

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Physical Context and Site Analysis

Before improvements were made, 2nd Street was a wide street with parallel parking on one side. The corner of the street was poorly marked and unappealing. There was little pedestrian access to the street and no sidewalks were present. Either side of the street consisted of mowed lawn surrounded by shrubs. The large amount of paving from the wide street produced a lot of stormwater runoff that would gather and flow into the adjacent intersection.

Figure 17 shows the plan of the SEA Street. The numbers one through six correspond with the six different program elements (on page 23).

Results of Design

In the first three years, project monitoring has shown that 98% of wet-season and 100% of dry-season stormwater runoff has been eliminated.

The project reduced impervious surfaces to 11% less than traditional streets.

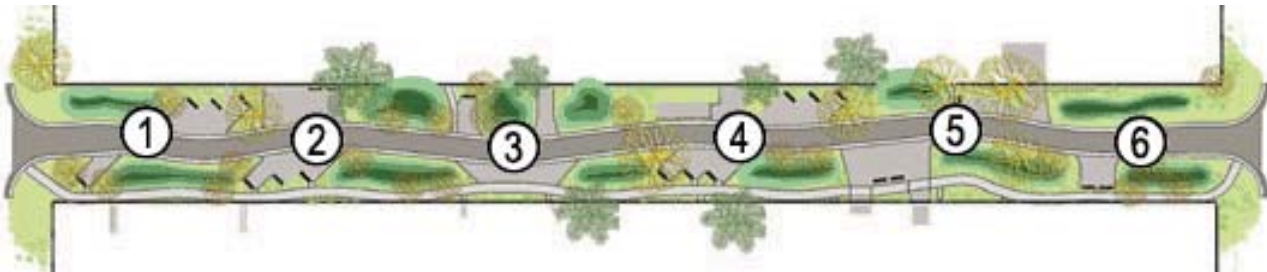


Figure 17. SEA Street. ci.seattle.wa.us

Program Elements

1. Drainage (Figure 18)

- reduce impervious surfaces by narrowing the road
- create more space for plants and soils to absorb rain water
- control flooding and move stormwater away from the road

2. Water Quality

- utilize a combination of soil and plants to filter rain water and to allow it to seep into the ground as it washes off the roadway and parking spaces

3. Landscaping (Figure 19)

- use natural materials – plants and soils – to slow, filter, and infiltrate stormwater runoff all within the space of the public right-of-way

4. Mobility

- calm traffic by narrowing and curving the roadway
- provide adequate parking for residents and guests
- ensure safe access for emergency vehicles, bicyclists, and pedestrians

5. Community

- bring life to the street by constructing sidewalks, gardening with neighbors, and promoting watershed stewardship

6. Education

- set an example for future alternative street projects
- monitor changes in water quality and drainage
- share ideas with watershed neighbors and other cities



Figure 18. Drainage. ci.seattle.wa.us



Figure 19. Landscaping. ci.seattle.wa.us

The main street is 14 feet wide, 18 feet wide at intersections.

- There are no curbs present, only “flat curbs” that provide an extra two feet of width on either side of the street
- Angle and parallel parking stalls are grouped between swales and driveways
- There is only one sidewalk on one side of the street to eliminate impervious surface area

Relevance/Application to St. Louis Eco-boulevard

- Pedestrian safety is a high priority
- Introducing different types of stormwater BMP's
- Create a buffer zone between vehicular and pedestrian traffic
- Accommodate for all modes of transportation: vehicles, bicyclists, pedestrians
- Provide aesthetic qualities at street intersections
- Get the community involved
- Introduce native plants to slow and cleanse stormwater runoff
- Treat stormwater
- Reduce the amount of impervious surface
- Set an example for future street projects

References

Seattle Public Utilities. www.ci.seattle.wa.us. Date accessed: December 3, 2009.

Synthesis

Each project discussed has had a focused documentation on the particular problem at hand. The application to the design of an eco-boulevard in the Central business district of downtown St. Louis has been stated and taken into account.

The precedents will serve as a reference for program development and design strategy that can be applied to the Central Business District of St. Louis.

4

Site Inventory

The methodology in Figure 20 is used to inventory the Central business district in downtown St. Louis. Goals were established: capture and store stormwater runoff near populated areas, maintain and promote the surrounding land use, and develop areas in which long term plant growth and health can be maintained. These goals are important because the eco-boulevard should be placed in an area where locals will be able to appreciate and interact with it on a regular basis. Since the CBD is already established, the surrounding buildings should be maintained and not demolished for the purpose of the eco-boulevard. There are several historic districts and buildings that need to be maintained. Also, since the CBD consists of dense, multi-story buildings, it will be important to develop in areas which receive proper amounts of sunlight where vegetation can exist.

After the goals were established, certain elements were able to be identified to inventory. The pieces to inventory from the first goal, **capture and store stormwater runoff near populated areas**, are location of dwelling units, public transportation, and green and plaza spaces. The elements to inventory for the second goal, **maintain and promote the surrounding land use**, are public destinations, historical landmarks, and pedestrian circulation. For the third goal, **develop areas in which long term plant growth and health can be maintained**, sun availability was important to inventory. After each element was inventoried, important questions were asked, and answered.

GOALS

IDENTIFY

RELATE

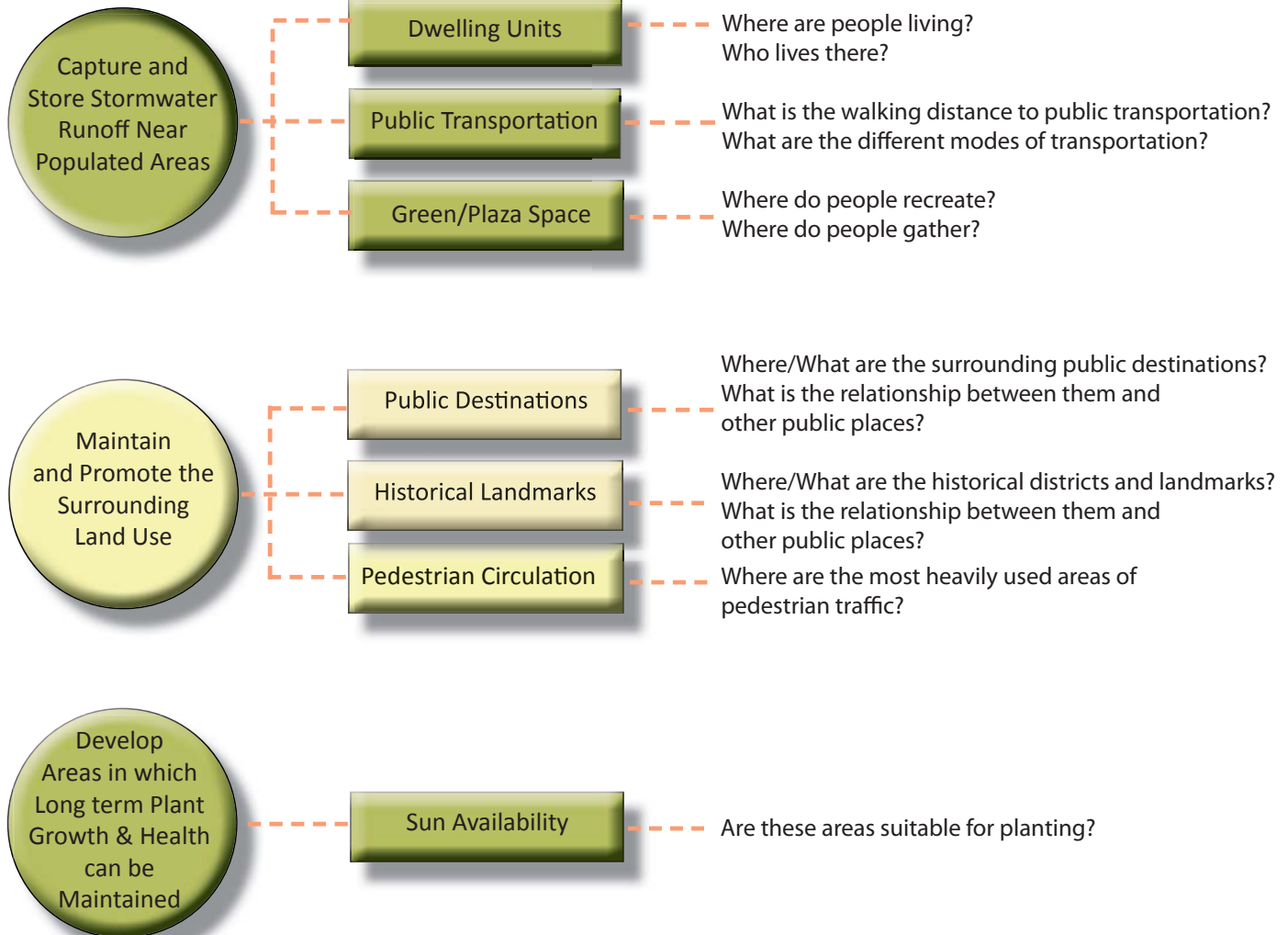


Figure 20. Methodology. Megan Bryan

Where are people living and who lives there?

St. Louis City

Total Population 2007: 355,663

Race: 77.6% White, 18.1% African American, 1.8% Asian, Other 2.5%

Sex: 51.7% Male, 48.3% Female

Age: 0-14 years 20%, 15-24 13.9%, 25-34 12.4%, 35-44 14%, 45-54 15.7%, 55 and up 24.1%

Average Age: 36

Total Households: 138,805

Education: High school 48.7%, Associates 6.5%, Bachelors 15.6%, Graduate 10.5%

Median Household Income: \$33,386

Per Capita Income: \$19,420

Unemployment Rate: 11.8%

Central Business District

Total Population 2007: 1260

Race: White 43.97%, African American 51.03%, Asian 2.38%, Other

Sex: Male 56.83, Female: 43.17%

Age: 25-29 10.56%, 30-34 10.16%, 35-39 10.63%, 40-44 10.00%

Households: 926- 1 person household: 73.99%, 2 or more: 24.08%

Housing Tenure: Owner- .54%, Renter- 99.46%

Median Rent: \$523

Education: High school 19.70%, Associates 5.68%, Bachelors 19.22%, Graduate 20.27%

Household Income: \$35,000- 49,999 29.38%, \$50,000-74,999 12.59%, \$25,000-34,999 12.91%

Median Household Income in 1999: \$34,826

Median Family Income 1999: \$37,500

Per capita income in 1999: \$31,261

Unemployment Rate: 10.79%

Figure 21 shows the location of where the residents live within the St. Louis CBD.

Apartment Buildings



Figure 21. Location Where Residents Live. Megan Bryan

What is the walking distance to public transportation and what are the different modes of transportation?

Different Modes: Vehicle, Pedestrian, Bicycle, and Lightrail

Accessibility: In the CBD, there is only a five minute walk (quarter mile) to get to a light rail station in all of the CBD. As seen in Figure 22, all of the light rail stations in downtown are located underground. Bus stops are frequent on all major streets, and shared bike lanes are located on major streets. There is also the Mississippi River Trail that runs north-south along the Mississippi River, east of the Arch grounds.

Transportation Routes

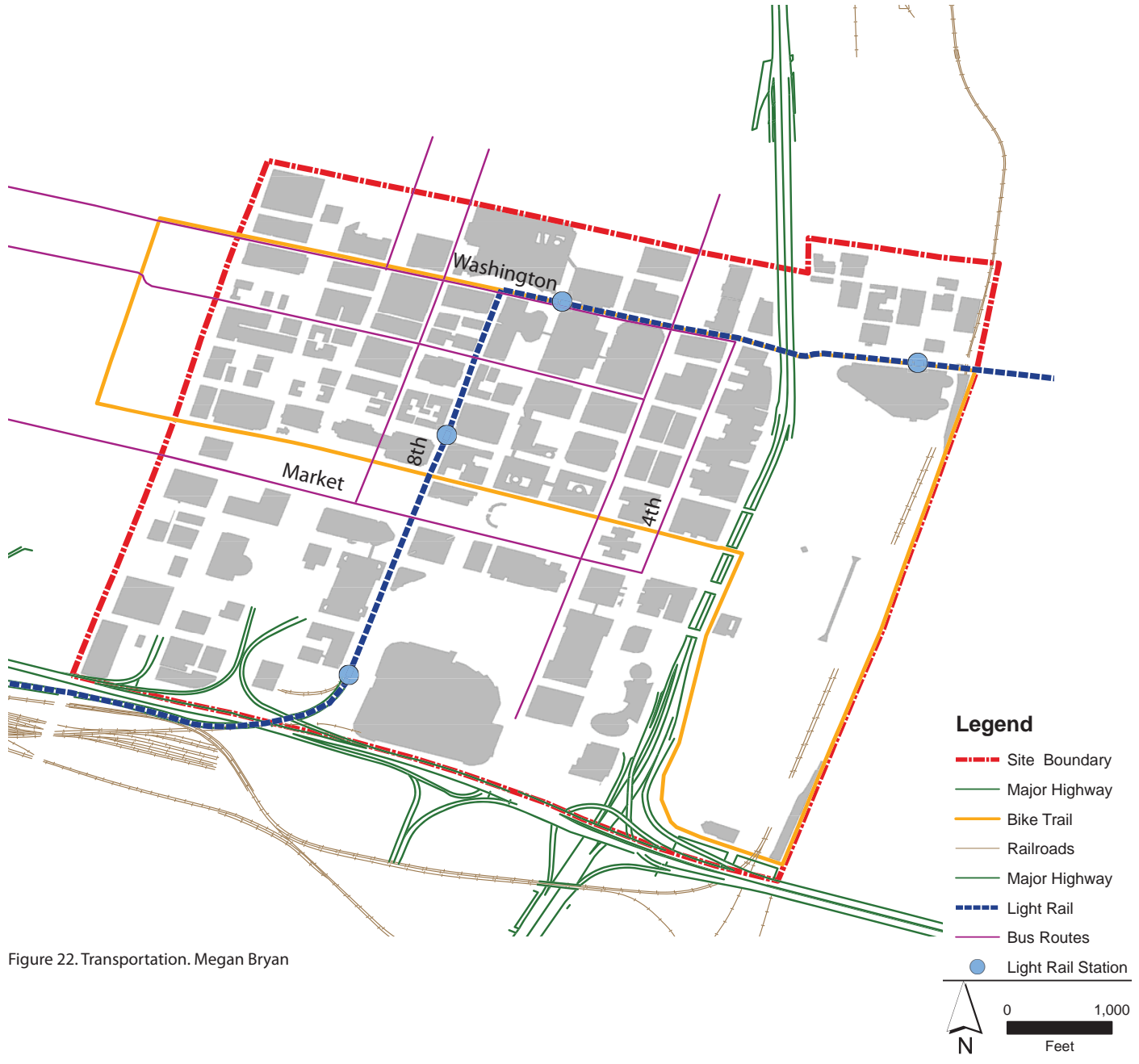


Figure 22. Transportation. Megan Bryan

Where do people recreate and gather?

In the CBD, the large expanses for recreation occur at the arch grounds and in the Gateway Mall. The Gateway Arch grounds are located around the Arch and include two ponds, a series of trails, and access to the riverfront. The Gateway Mall is intersected by the Gateway Arch grounds. The Gateway Mall provides different amenities. The Old Courthouse building, which is a local historic attraction, is located on the east side, Keiner Plaza is a hardscaped plaza that includes a large amphitheater and a few water features.

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A new City Garden, also known as an urban oasis, is also present in the Gateway Mall. The City Garden includes many sculptures from various artists, water features, interactive art, six rain gardens, two surrounding green roofs, and a cafe. In 1999, a nonprofit group developed a master plan for downtown St. Louis. The plan called for a sculpture garden on two blocks of the Gateway Mall. Over the next several years, lofts and apartments were renovated from old warehouses and industrial buildings, dozens of new businesses opened, and the population roughly doubled. By 2006, the city saw a need to develop a public, recreational space. In 2007, The private St. Louis-based Gateway Foundation was going to finance the design and construction of a “world-class sculpture garden” on the Gateway Mall between Eighth and Tenth streets. In addition, it planned to place 24 pieces of nationally and internationally renowned sculpture on the site. Nelson Byrd Woltz Landscape Architects (NBWLA) in Charlottesville, Virginia, was selected as the project’s designers.

From day one, the goal of the Gateway Foundation was to create a hybrid “oasis,” both botanic garden and city park. Although originally described as a sculpture garden, it was instead to be a garden–park that would host a diverse collection of modern and contemporary sculpture.

Reference
www.citygardenstl.org

Emphasis would be put on ensuring City Garden’s openness, a mix of shade and water to accommodate the city’s hot summers, and a range of experiences that would provide something for everyone. It was to be a place for fun, a place to enjoy and interact with (Hazzelrigg 2010).

Kiener Plaza and Morton D. May Amphitheater

Sitting in the heart of downtown, Kiener Plaza and the Morton D. May Amphitheater are located across from the Old Courthouse and not far from the Gateway Arch. Figure 23 shows that the park’s centerpiece is a pool and fountain containing a sculpture in the middle. Kiener Plaza hosts the St. Louis Cardinals, Rams and Blues rallies and victory celebrations. Concerts, festivals, and other events hosted by civic, private, marketing, and nonprofit organizations all use the space. The maximum capacity for Kiener Plaza and the May Amphitheater is about 3,000 people.

Figure 24 shows the location of the green spaces and hardscape plazas in the CBD.



Figure 23. Kiener Plaza 2. flickr.com

Green and Plaza Space



Figure 24. Green and Plaza Space. Megan Bryan

Reference
Urban Planning and Design Agency.

Where and what are the surrounding public destinations?

Some of the major public destinations are the major sport venues: Busch Stadium and the Edward Jones Dome and Convention Center. Busch Stadium is home to the St. Louis Cardinals and located on the south side of the CBD. The new Busch Stadium was opened in April 2006. The new stadium holds 46,000 people. The new Busch Stadium occupies some of the site of the stadium it replaced. Part of the Cardinals' prior ballpark was torn down, as needed, to make room for the new ballpark. Because of the 40 feet of grade change, home plate was placed in the southwest corner of the site and seating and scoreboard heights were lowered in center field to allow for dramatic views of the Gateway Arch and the downtown St. Louis skyline, as seen in Figure 25.



Figure 25. Busch Stadium. flickr.com

The America's Center Convention Complex (Figure 26) features 502,000 contiguous square feet of exhibit space, 80 meeting rooms, 1,411 fixed-seat Ferrar Theater, private meeting rooms and the Edward Jones Dome (home to the St. Louis Rams). In 2009, America's Center hosted fan fest for the MLB All-Star Game.

Figure 27 shows the location of major public destinations including Busch Stadium, America's Center Convention Complex, the Gateway Mall, and the Jefferson National Expansion Memorial.



Figure 26. America's Center. flickr.com

Public Destinations



Figure 27. Public Destinations. Megan Bryan

Where and what are the historical landmarks and districts?

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One of the historical districts located in the CBD, is Laclede's Landing. In 1763, a French fur trapper named Pierre Laclede set out from New Orleans to explore the Illinois Country to establish a trading post. In 1764, he chose the west bank of the Mississippi River. In 1784, the site was cleared and temporary cabins were built. Laclede named the settlement St. Louis in honor of the patron saint of the king of France. Today, Laclede's Landing is a nine block industrial area that once housed companies producing coffee, leather, goods, tobacco, whiskey, and machinery for the barges, features some of the most unique restaurants and sidewalk cafes in St. Louis, as seen in Figure 28. During the day, the historical district is home to people who work at the many offices located on the edge of the Mississippi River. At night, horse drawn carriages and live music add to the atmosphere of one of the premier entertainment areas of St. Louis.

Washington Avenue was a historic warehouse district. Most of the old buildings have been transformed into mixed-use buildings with retail on the bottom floor and dwelling units above.

Other historical districts include Washington Avenue, and Cupples Station. Samuel Cupples saw an opportunity to locate warehouses with ready rail access to the yards. The new warehousing idea saved considerable time in freight handling. The resulting large group of multi-story buildings transformed a previously useless part of the city into a highly productive area. Cupples Station played a major role in maintaining St. Louis as a railroad center in the first half of the twentieth century. Today, several of the original buildings were demolished for construction of Bush Stadium and Highway 40; the remaining buildings have been renovated into lofts.

Figure 29 shows the location of historic buildings in the CBD.



Figure 28. Laclede's Landing Road. flickr.com

Historical Landmarks and Districts

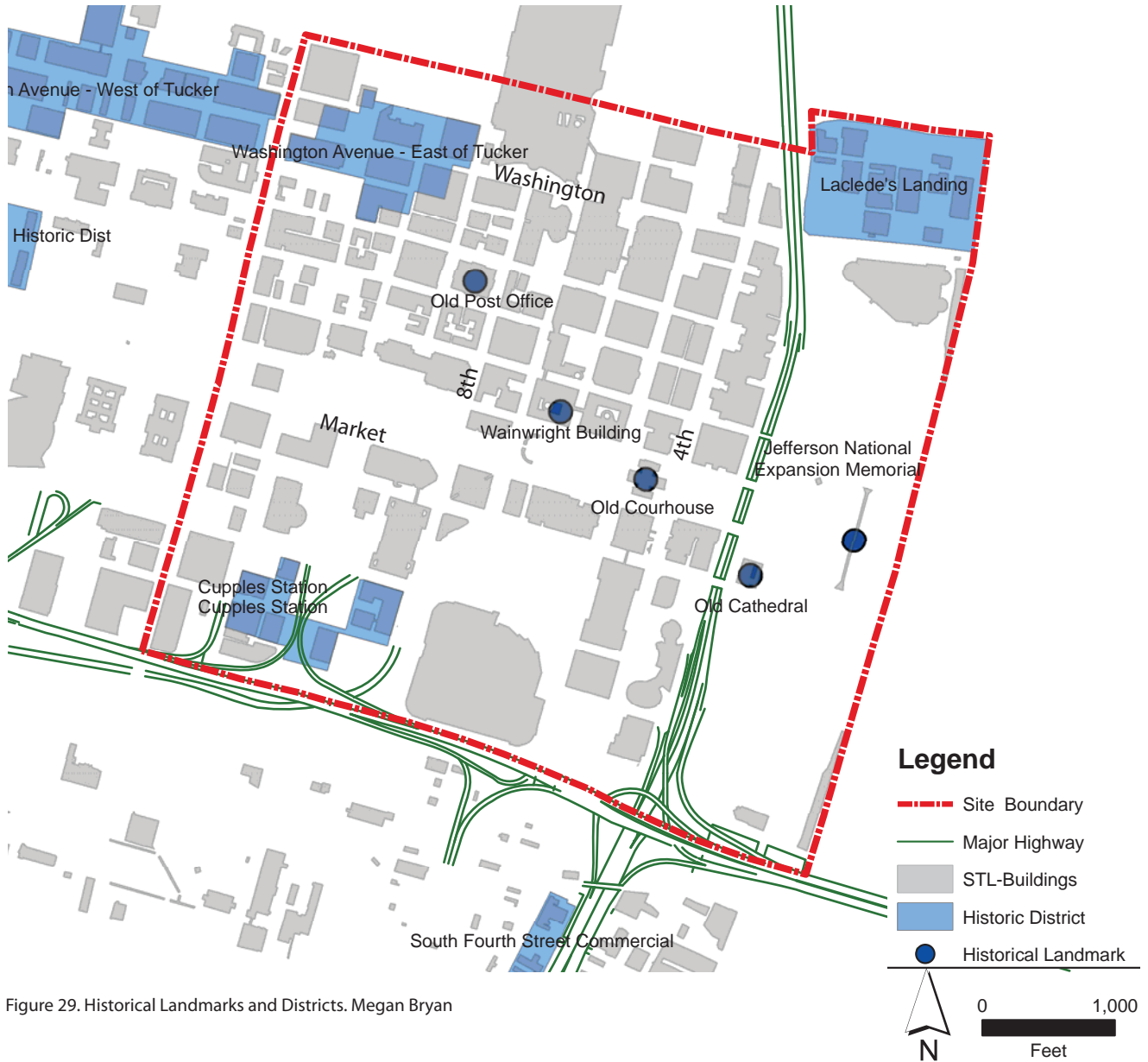


Figure 29. Historical Landmarks and Districts. Megan Bryan

Where is the most heavily used area of pedestrian traffic?

Figure 30 shows where pedestrian traffic is located. The most heavily pedestrian-used areas in the CBD are located near the center. Most of the high pedestrian traffic during the work week (9am – 5pm, Monday through Friday) is due north of the Gateway Mall. Surrounding this area are tall multi-story buildings that house many employers. Also, this is located near the 8th and Pine transit station. Thus, a lot of people are coming and going from this area. The typical work week traffic expands further east and west of the high traffic due to more companies that are located in the area. The weekend and sporting event traffic primarily runs north-south between Busch Stadium and America's Center.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Pedestrian Traffic



Figure 30. Pedestrian Traffic. Megan Bryan

Is there enough sun availability to maintain plant growth and health?

Different plants have different tolerances to soils, shade, heat, and cold. There are many varieties of plants that can grow in full shade. A few of these are:

American Beech (*Fagus grandifolia*), American Hophornbeam or Ironwood (*Ostrya virginiana*), Bigleaf Magnolia (*M. macrophylla*) and the related Fraser Magnolia (*M. fraseri*), American Hornbeam, Ironwood or Musclewood (*Carpinus caroliniana*), Chalkbark or Whitebark Maple (*Acer leucoderme*), Common Pawpaw or Custard Apple (*Asimina triloba*), Evergreen Magnolia or Bull Bay (*M. grandiflora*), *Cornus florida* or Flowering Dogwood, Pagoda Dogwood (*Cornus alternifolia*), Painted Buckeye (*Aesculus sylvatica*), Red Buckeye (*A. pavia*), Rosebay Rhododendron (*R. maximum*), and Southern Witchhazel (*Hamamelis macrophylla*).

Source: www.virtualplanttags.com

Figures 31-34 show the shadows casted from the buildings in March, July, October, and December of 2010.

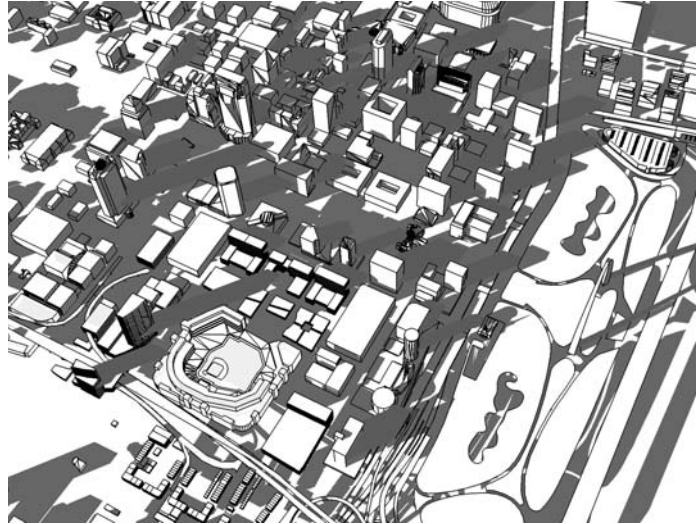


Figure 31. December 2010 Shadows 2pm. HOK St. Louis

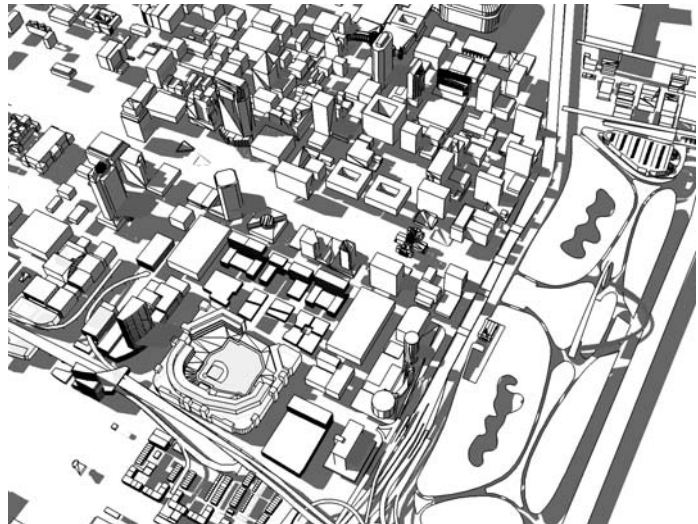


Figure 32. July 2010 Shadows 2pm. HOK St. Louis

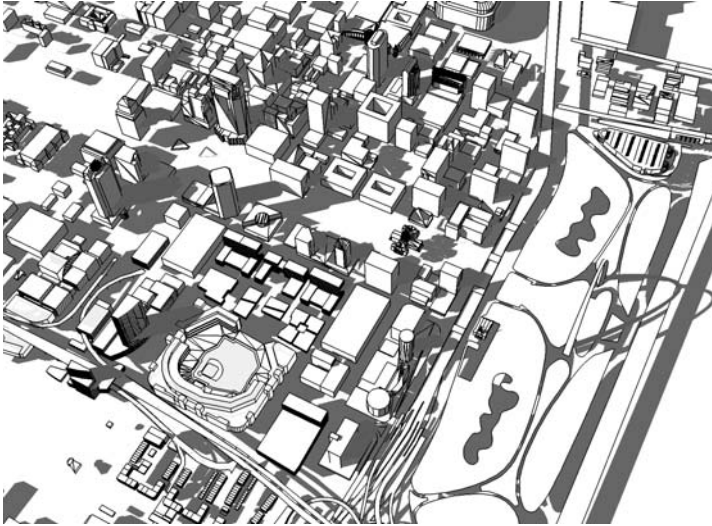


Figure 33. March 2010 Shadows 2pm. HOK St. Louis

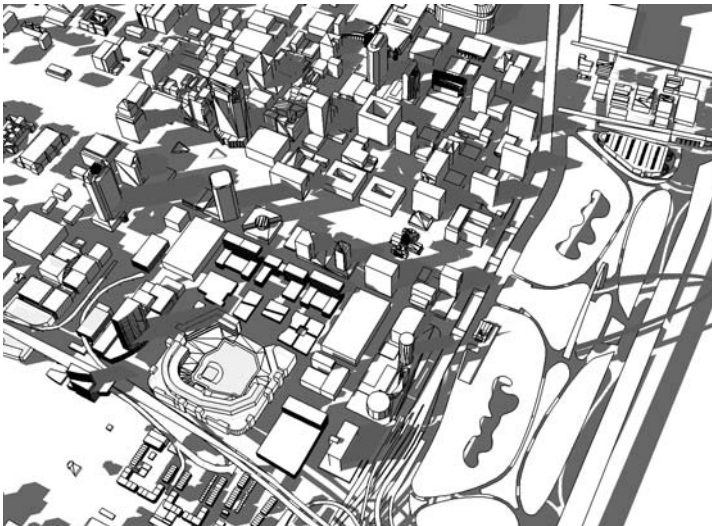


Figure 34. October 2010 Shadows 2pm. HOK St. Louis

5 Site Analysis

Major Employers, Public Destinations, and Pedestrian Traffic

After documenting the inventory, some diagrams have been layered on one another to better define where an eco-boulevard might be placed in the CBD. In Figure 35 the diagram where major employers are located, the public destinations, and the pedestrian traffic. This diagram begins to show where these three elements overlap. The eco-boulevard would ideally be in a location where people pass by on a daily basis, thus, near local businesses and major public destinations.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Major Employers, Public Destinations, and Pedestrian Traffic

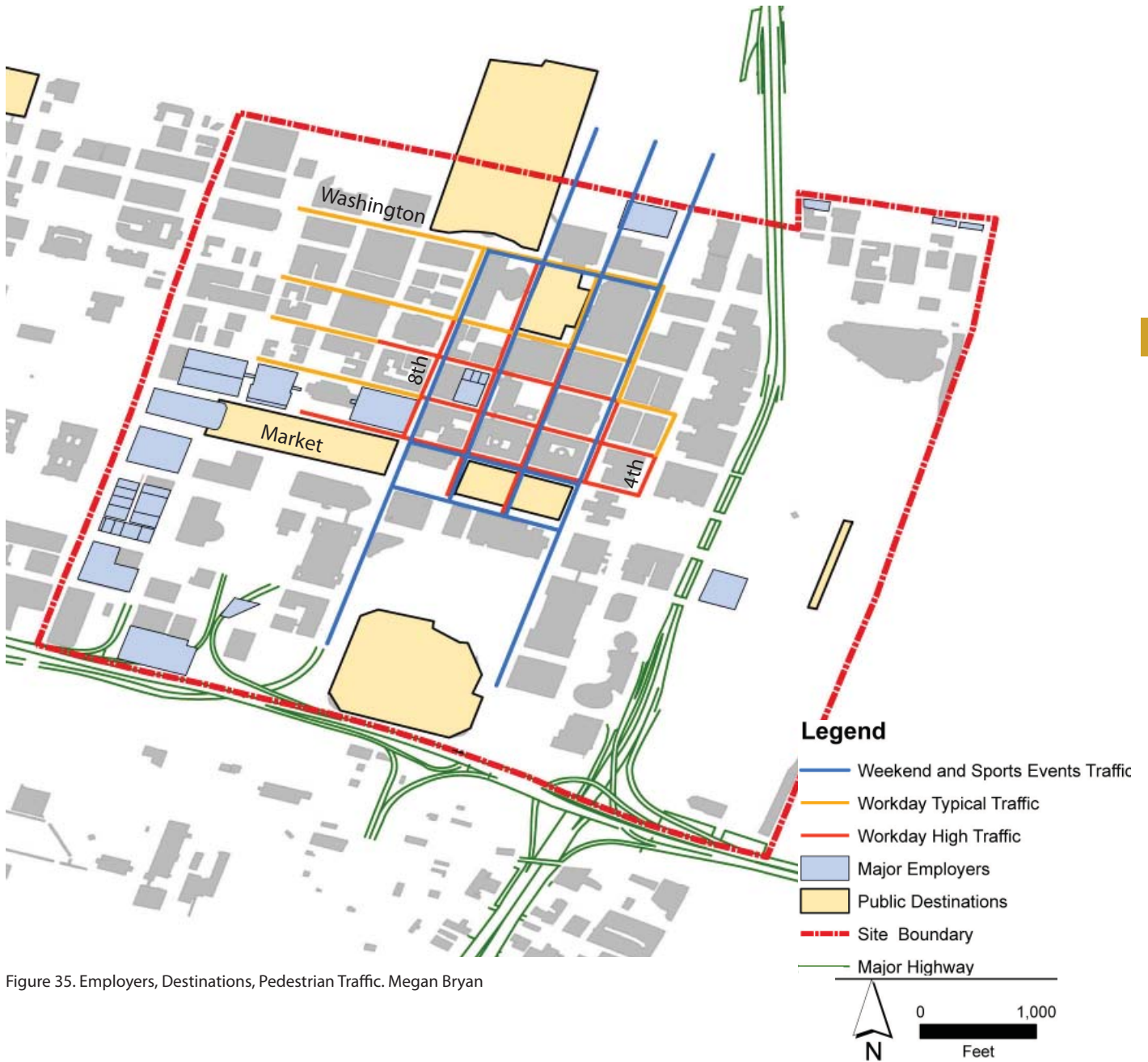


Figure 35. Employers, Destinations, Pedestrian Traffic. Megan Bryan

Major Employers, Public Destinations, and Pedestrian Traffic Synthesis

The layering of major employers, public destinations, and pedestrian traffic has shown some overlaps, as seen in Figure 36. The areas are highlighted where the overlapping has occurred. The highlighted areas have begun to lay out where the eco-boulevard will possibly be located in the CBD. The diagram on the right shows the location of the overlapping elements. Most of the overlapping between major employers, public destinations, and pedestrian traffic occur in the center of the CBD stretching from Bush Stadium to the south to the America's Center Convention Complex to the north.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Major Employers, Public Destinations, and Pedestrian Traffic Synthesis

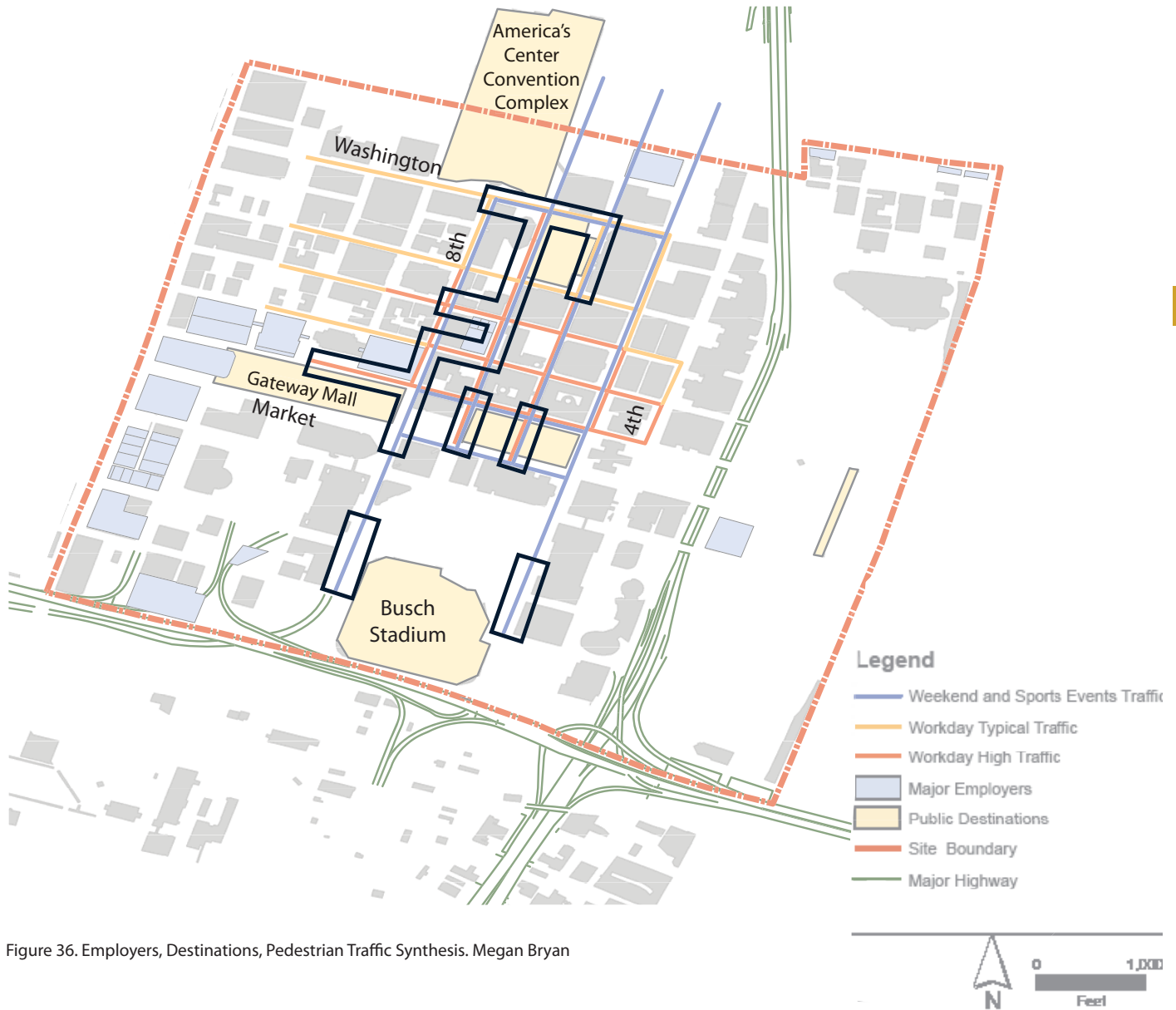


Figure 36. Employers, Destinations, Pedestrian Traffic Synthesis. Megan Bryan

Light Rail and Pedestrian Traffic

In Figure 37 the light rail stops and routes are combined with the areas of heavy pedestrian circulation. The light rail stops are adjacent to the workday high traffic routes and near the weekend and sport event routes. The location of the light rail stops being adjacent to heavily used pedestrian routes is important so the pedestrian can interact with the eco-boulevard as often as possible.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Light Rail and Pedestrian Traffic



Figure 37. Light Rail and Pedestrian Traffic. Megan Bryan

Light Rail and Pedestrian Traffic Synthesis

The overlapping of the light rail route and the pedestrian traffic is highlighted in Figure 38. There are only a few areas where this happens because of the location of the light rail stations. There are three major areas that are highlighted: in the south near Bush Stadium, the center at 8th and Pine, and the north near America's Center Convention Complex.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Light Rail and Pedestrian Traffic Synthesis



Figure 38. Light Rail and Pedestrian Traffic Synthesis. Megan Bryan

Green Space, Plaza Space, and Pedestrian Traffic

The next layers of inventory that were combined were the green and plaza space with the areas of heavy pedestrian circulation. In Figure 39 the relationship between where the pedestrian travels and where the pedestrian recreates can be identified. Near the heavily used areas, there are limited hardscaped plazas.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Green Space, Plaza Space, and Pedestrian Traffic



Figure 39. Green Space, Plaza Space, and Pedestrian Traffic. Megan Bryan

Green Space, Plaza Space, and Pedestrian Traffic Synthesis

Figure 40 shows where the green and hardscape plaza spaces are located in relation with the pedestrian traffic. The overlapping of these elements occurs primarily in the center of the CBD with most overlap occurring south from Busch Stadium reaching north near the Gateway Mall. Some overlap also occurs north near the America's Center Convention Complex.

References

St. Louis CBD Downtown Streetscape: Design Manual. City of St. Louis Planning and Urban Design Agency. September 2004. <http://stlouis.missouri.org/citygov/planning/>. Date Accessed: August 2009.

Green Space, Plaza Space, and Pedestrian Traffic Synthesis



Figure 40. Green Space, Plaza Space, and Pedestrian Traffic Synthesis. Megan Bryan

Eco-Boulevard Location Synthesis

When the previous diagrams had been mapped, the synthesis diagrams have been combined to see where most overlapping had occurred to begin to be able to assess where the eco-boulevard will fit in the landscape. In Figure 41, the overlapping of the three diagrams are combined. The darkest color represents the location where most overlapping occurred. The lightest color represents where the least amount of overlapping occurred, and the medium color blue represents where a few overlappings occurred. The location of these start to show where the location of the eco-boulevard should be located.

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One more piece was important when analyzing the location of the eco-boulevard: elevation and topography. The overlapping pieces are placed on top of the elevation to see where the low points exist.

Eco-Boulevard Location Synthesis

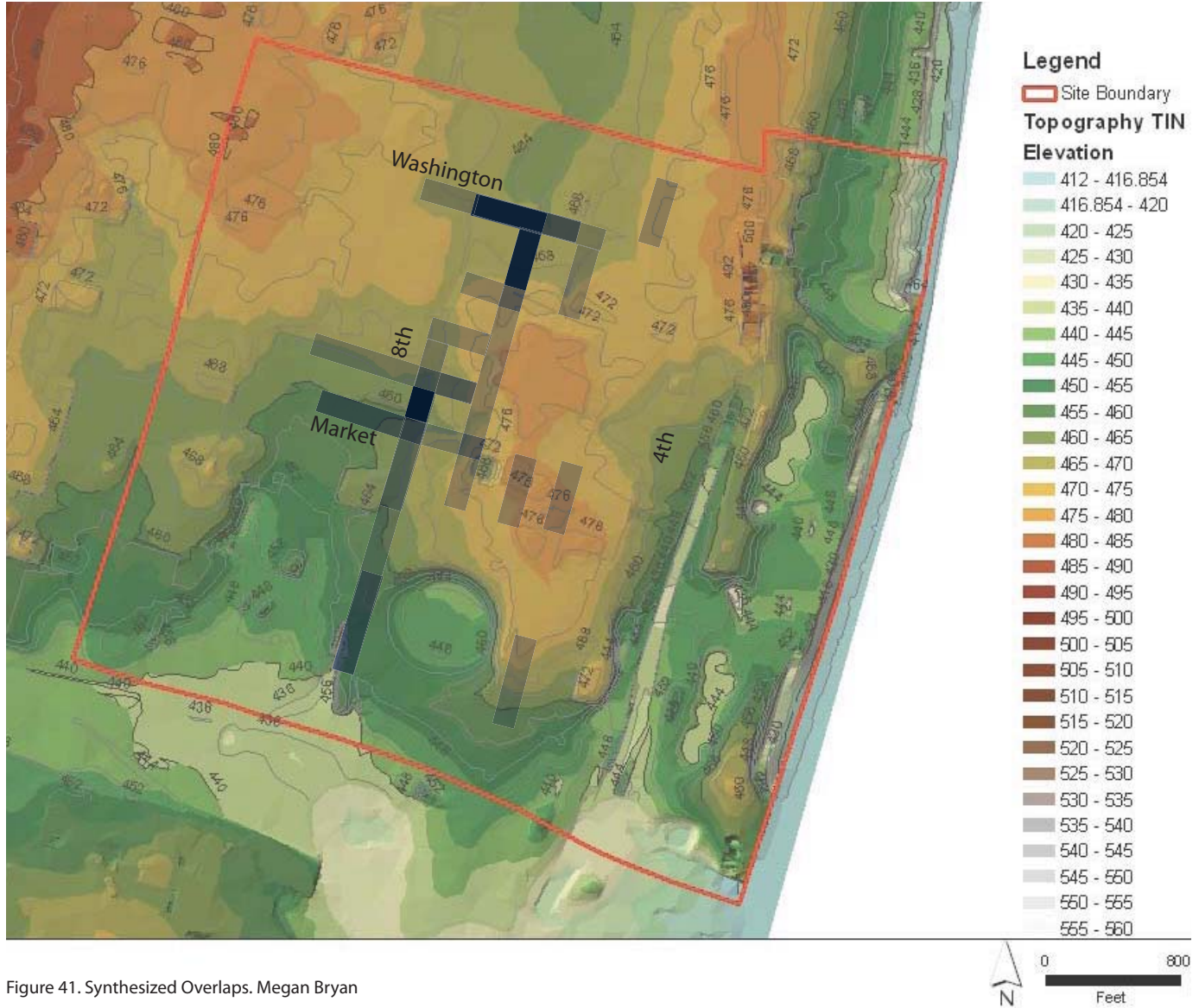


Figure 41. Synthesized Overlaps. Megan Bryan

High and Low Points

Figure 42 shows the elevations of the overlapping layers. There are spot elevations at every corner and where overlapping occurs. After the spot elevations were established, drainage arrows were placed to show where water was flowing. Where arrow heads had come together, a low point was established. Where arrows faced opposite directions, high points were established. The high and low points were established to figure the best location for BMP's along the eco-boulevard. The three low points that were located were at the south near Busch Stadium, in the center near the 8th and Pine light rail station and to the north near the America's Center Convention Center. The high points that were located were northwest of the 8th and Pine light rail station, and in the center near the Gateway Mall.

High and Low Points

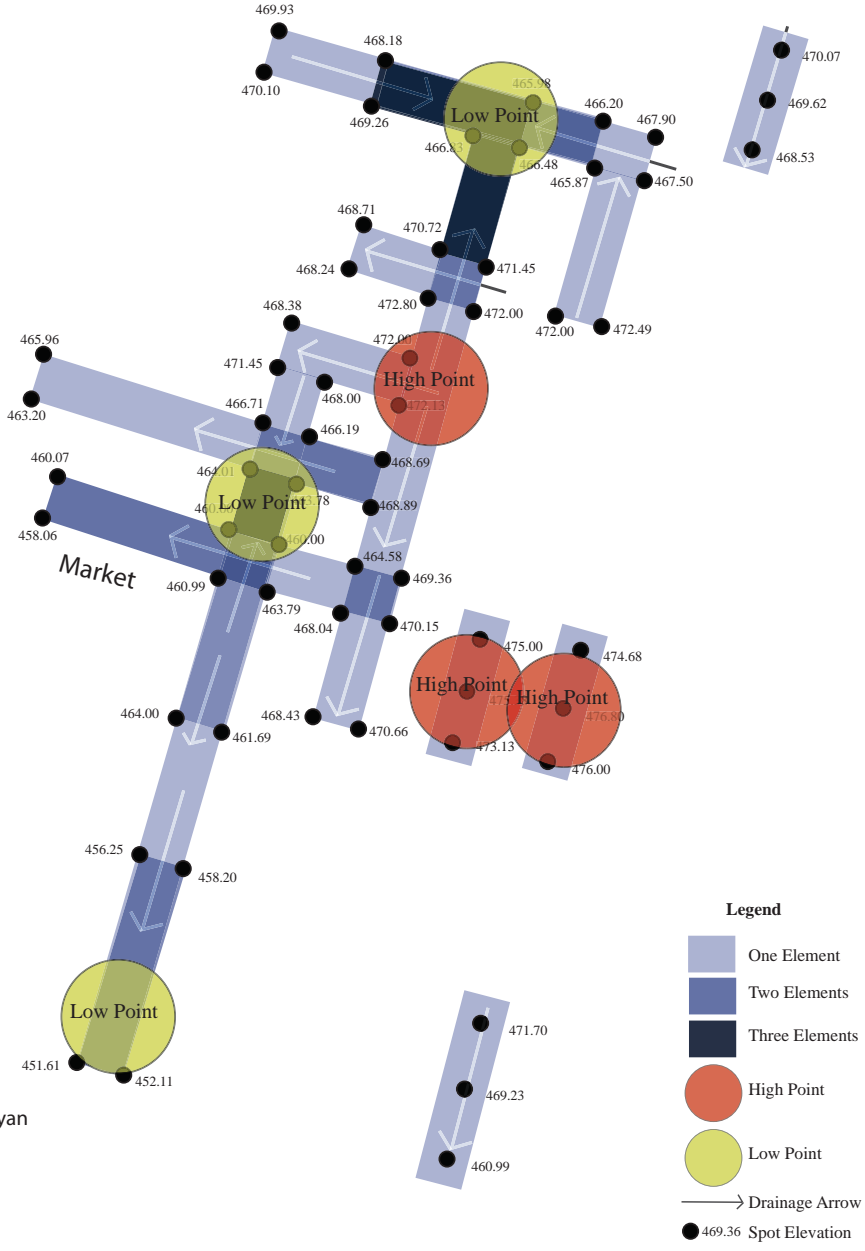


Figure 42. Spot Elevations. Megan Bryan

Synthesis and Drainage

Figure 43 shows the previous diagram with context. One can begin to see where the high points and low points are located, where drainage is occurring, and where the lightrail stations are in relation to the high points, low points and surface drainage. The diagram shows the location of the three low points. The first low point is located directly south of America's Center Convention Complex. The second low point is located in the center of the central business district near the intersection of 8th Street and Pine Street. The third low point is located west of Busch Stadium on 8th Street. These locations become key when choosing the route of the eco-boulevard.

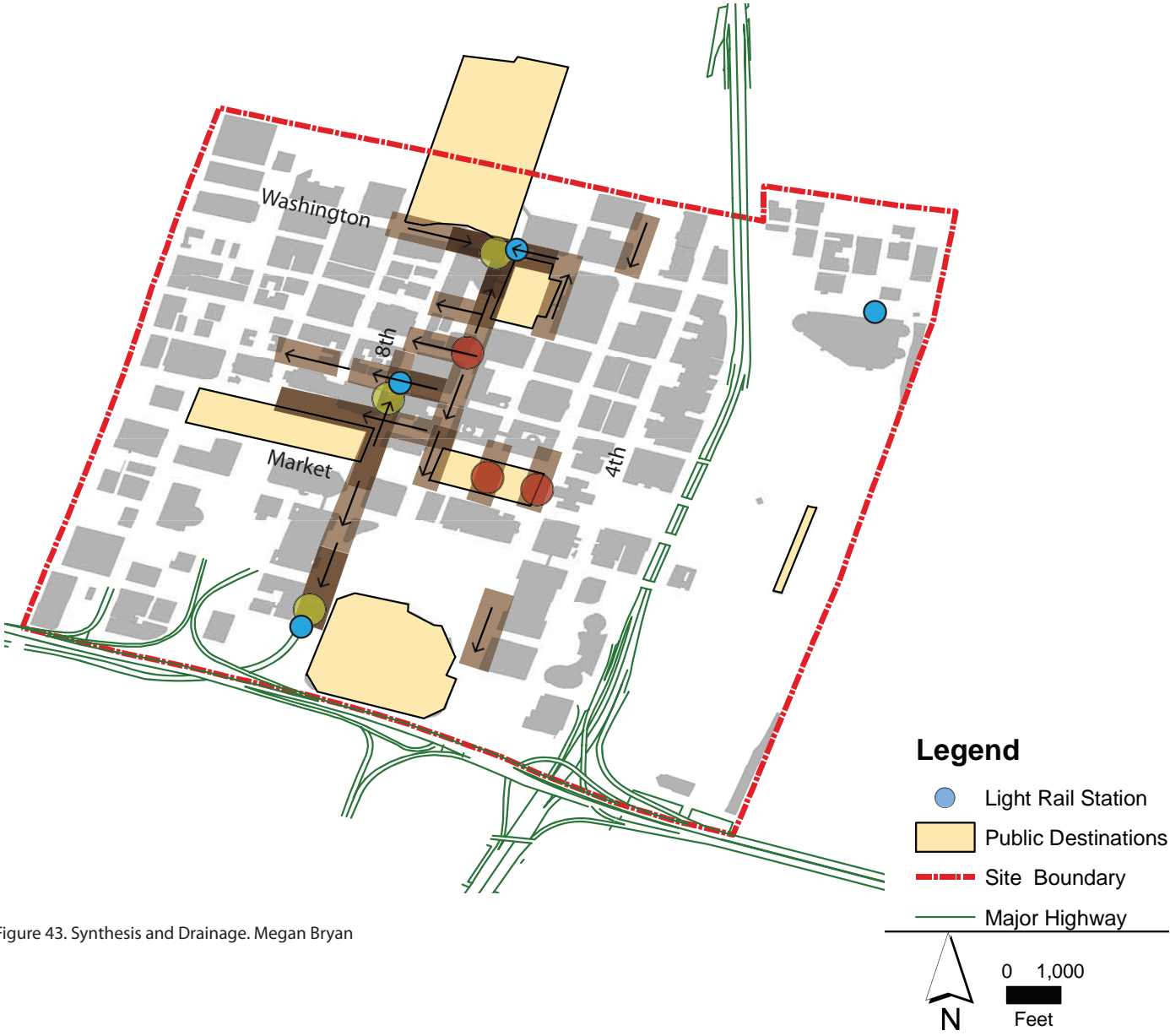


Figure 43. Synthesis and Drainage. Megan Bryan

Eco-Boulevard Location

In order to achieve the goals stated in Figure 20 (capture and store stormwater runoff near populated areas, maintain and promote the surrounding land uses, and develop areas in which long term plant growth and health can be maintained) the location of the eco-boulevard takes a specific route. The location of the eco-boulevard (Figure 44) begins at the north directly south of America's Center Convention Complex on Washington Street. The eco-boulevard heads east two blocks then heads south on 7th Street. At Pine Street, the eco-boulevard heads west one block then heads south on 8th Street. The eco-boulevard terminates at the most southern low point on 8th Street, just west of Busch Stadium. The reason why the eco-boulevard takes this route is because it passes by high pedestrian use areas (three major transit stops), it is intercepted by the three lowest points on site, and it connects the major destination points (America's Center Convention Complex, the Gateway Mall, and Busch Stadium).

Eco-Boulevard Location

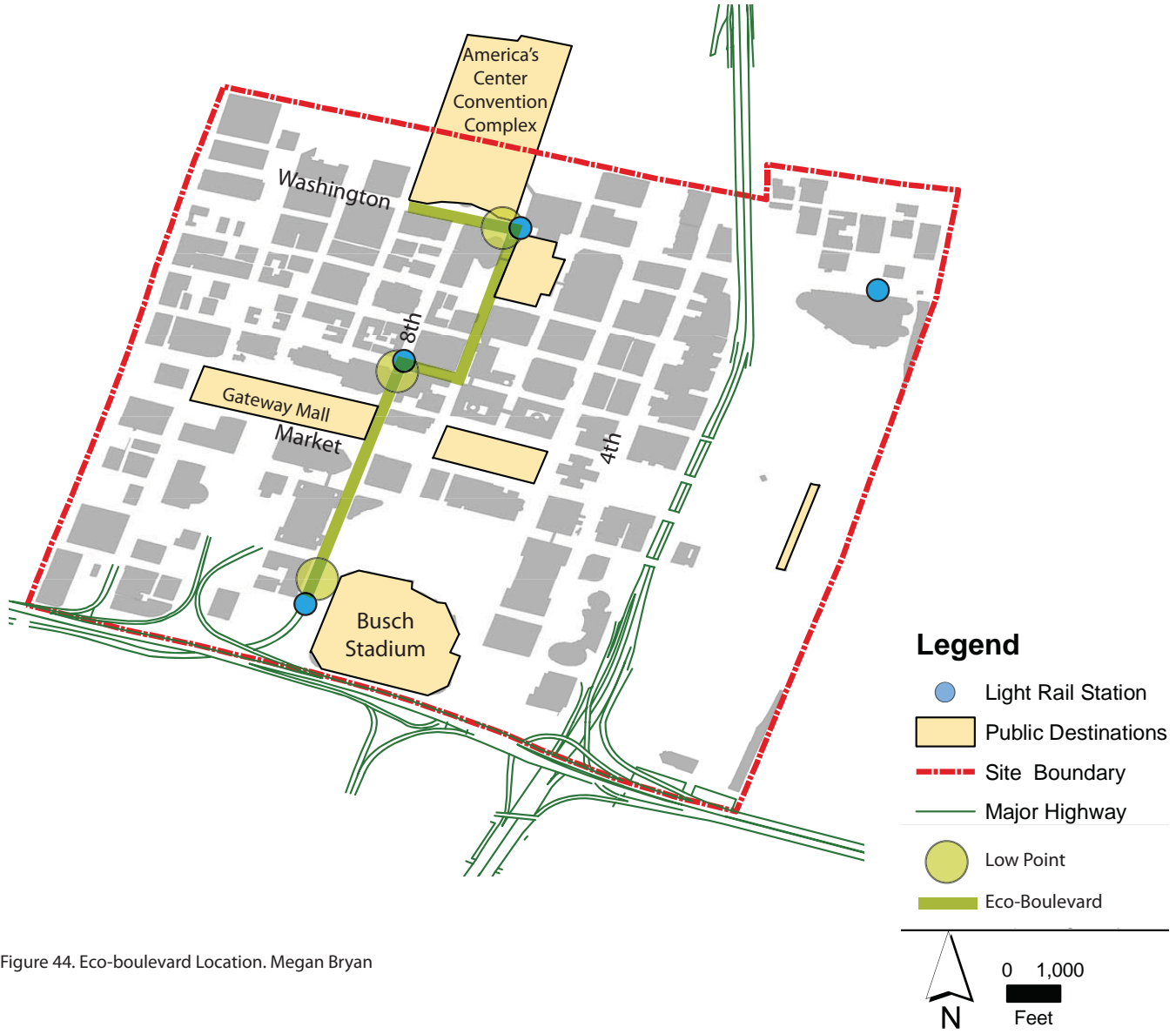


Figure 44. Eco-boulevard Location. Megan Bryan

6 Program

Introduction

The design for an eco-boulevard in the central business district in St. Louis, Missouri is based upon the location of local employers, pedestrian traffic volumes and locations, and the location of public destinations within the area. These factors were all inventoried separately then analyzed to see where suitable places for an eco-boulevard exist. The purpose of this program analysis is to better define what an eco-boulevard is exactly. In order to do this, a few goals and objectives for the eco-boulevard need to be defined. The goals are stated in order of significance. This will be important when deciding which scenario is the most applicable in the Central Business District.

Goals and Objectives

1. Bring a form of ecology back to downtown St. Louis

- Green the streets with vegetation
- Create a series of BMP's to collect and cleanse stormwater
- Provide connections between important transit and destinations

2. Capture and store stormwater runoff near populated areas

- Maximize the number of pedestrians who will interact with the eco-boulevard

3. Connect the community from one destination to another

- Provide visual aesthetic
- Provide for unobstructed linear movement
- Provide pedestrian amenities at key points along the eco-boulevard
- Facilitate transportation: walking, biking, light rail

4. Maintain and promote the importance of the surrounding land use

- Maintain the visual character of iconic buildings

5. Develop areas in which long term plant growth and health can be maintained

- Carefully select plant species that can thrive in urban shaded environments

After the goals and objectives were defined two scenarios for the eco-boulevard were developed. These scenarios are: treat stormwater and a "green ribbon." For both scenario goals, facts, concepts, needs, and the problems that correspond with function, form, economy, and time were listed as seen in Table 1 and 2 on pages 70 and 71.

Scenario 1: Treat Stormwater

	Goals	Facts	Concepts	Needs	Problem
Function	<ul style="list-style-type: none"> capture & treat all stormwater run-off cleanse stormwater & release or infiltrate in ground 	<ul style="list-style-type: none"> Need impermeable vs. permeable surface ratio Amount of rainfall annually/seasonally 	<ul style="list-style-type: none"> Series of BMP's creative idea alternatives to collect stormwater interpretive signage 	<ul style="list-style-type: none"> appropriate location enough space to implement 	<ul style="list-style-type: none"> size of BMP appropriate size for appropriate space
Form	<ul style="list-style-type: none"> Pedestrian safety along street pedestrian amenities to be included 	<ul style="list-style-type: none"> urban soils amount of rainfall surrounding land use (particularly housing) 	<ul style="list-style-type: none"> accessibility - not only ADA, but public vs private 	<ul style="list-style-type: none"> low budget low maintenance 	<ul style="list-style-type: none"> amount of space that is available
Economy	<ul style="list-style-type: none"> reduction of life cycles le. water cycle minimize maintenance 	<ul style="list-style-type: none"> low energy source meet LEED standards 	<ul style="list-style-type: none"> recycling of water 	<ul style="list-style-type: none"> low life cycle cost low maintenance cost 	<ul style="list-style-type: none"> higher price upfront, but no long-term fees
Time	<ul style="list-style-type: none"> plant growth will occur each year historical landmarks will be maintained 	<ul style="list-style-type: none"> space serve as a "unifying" element in downtown 	<ul style="list-style-type: none"> easily expandable & more BMP's can be implemented w/ effective site analysis the more the merrier 	<ul style="list-style-type: none"> depending on BMP, short construction time 	<ul style="list-style-type: none"> everchanging w/ season & plant growth

Table 1. Scenario 1. Megan Bryan

Reference

Pena, William M. and Steven A. Parchall. Problem seeking: an architectural programming primer, fourth edition. 2001. New York: John Wiley and Sones, Inc.

Scenario 2: Green Ribbon

	Goals	Facts	Concepts	Needs	Problem
Function	<ul style="list-style-type: none"> TO CREATE A SMALL THIN GREEN (& PERHAPS BLUE) STRIP TO WEAVE IN & OUT OF STREETS TO CONNECT PEOPLE TO DESTINATIONS 	<ul style="list-style-type: none"> unite community serve as community destination for social gatherings surrounding surrounding land use infill opportunities utilities 	<ul style="list-style-type: none"> unite community serve as destination provide social gatherings provide "activities" pedestrian amenities aesthetic quality 	<ul style="list-style-type: none"> low widths & sidewalk widths pedestrian movement vegetation in narrow path 	<ul style="list-style-type: none"> narrow streets underground utilities pedestrian flows
Form	<ul style="list-style-type: none"> provide as social connector around living areas connect people w/ local & tourist attractions 	<ul style="list-style-type: none"> soils utilities surrounding land use start/end high points low points 	<ul style="list-style-type: none"> pedestrian safety considerations provide aesthetic character 	<ul style="list-style-type: none"> environmental influence 	<ul style="list-style-type: none"> enough space utilities
Economy	<ul style="list-style-type: none"> minimize street cleaning maintenance & cost 	<ul style="list-style-type: none"> bring green bring "green" or ecology to downtown 	<ul style="list-style-type: none"> less cost for maintenance 	<ul style="list-style-type: none"> lower carbon cycle & water cycle 	
Time	<ul style="list-style-type: none"> plant growth will change over time stormwater collection will make "stream" full or not 	<ul style="list-style-type: none"> WILL THERE BE ACTIVITIES "ALONG THE WAY" IN VACANT LOTS? 	<ul style="list-style-type: none"> will adapt in an urban enviro. 		<ul style="list-style-type: none"> people destroying the landscape

Table 2. Scenario 2. Megan Bryan

Reference

Pena, William M. and Steven A. Parchall. Problem seeking: an architectural programming primer, fourth edition. 2001. New York: John Wiley and Sones, Inc.

After analyzing the first scenario, treat stormwater, the important things that were brought to the surface were that the locations of the BMP's are going to be important. The location will need to be in areas that are at or near low points in the terrain to capture the most water possible. The size and type of the BMP will also need thoughtful consideration. The amount of stormwater runoff that is captured will determine the size of the BMP. The location of the BMP may vary due to the amount of space provided within the existing right-of-way.

The second scenario is a green ribbon. In this scenario, visual and physical connections are the most important factors. It will be a linear system that will be physically connected by a series of elements such as vegetation, BMPs, and paving materials. The physical connector means that the green ribbon will connect people with local destinations and discovered attractions. The eco-boulevard can also serve as a connector between people because it will serve as a destination in itself where people can gather and take part in seasonal activities. For both of these scenarios, a list of program elements was developed for the suitability of an eco-boulevard, seen in Figure 3.

Both lists are almost identical with the exception of the last row. The last row holds characteristics of the opposing scenario. The scenarios and lists of possible program elements have shown that both scenarios combined into one scenario can define what an eco-boulevard is. In addition to serving as a visual and physical connector, the eco-boulevard also connects the local residents with other local residents by serving as its own destination. The eco-boulevard will also serve the function of collecting and treating stormwater runoff from the surrounding area. The definition of eco-boulevard is a two-fold: a green ribbon that collects and treats stormwater runoff, while also serving as a pedestrian connection between urban destinations.

Treat Stormwater	Green Ribbon
Public and Private Space	Public and Private Space
Hardscape and Softscape	Hardscape and Softscape
Public Art	Public Art
Safe Paths/Sidewalks	Safe Paths/Sidewalks
Pedestrian Amenities	Pedestrian Amenities
Green Ribbon	Treat Stormwater

Table 3. Program Elements. Megan Bryan

From the program elements listed, more analysis was done in order to define what each element entails.

Public Spaces:

- Right-of-Ways
- Usually located in open areas
- Multiple access points
- Holds many users
- City/county owned
- Emphasizes communication and interaction with people

Source: Public and Private Spaces of the City. Ali Madanipour. 2003. New York: Routledge.

Softscape Features:

- Vegetation
 - Native material-aesthetic and maintenance
 - Mowed turf- recreation
 - Planters
 - Frame views with vertical vegetation

Source: Project for Public Spaces. Pps.org. Date Accessed: December 2009.

Public Art

- Located in various places
- Provide aesthetic quality
- Provide a point of interest
- Different types of media
 - Urban Installation
 - Sculpture
 - Interactive

Safe Paths/Sidewalks

- Buffer between the pedestrian and the vehicle
- Use of different paving material
- Paving surfaces should not exceed more than one quarter inch in height
- Raised and textured crosswalks
- Crosswalk signals
- Pedestrian countdown signals
- Pedestrian signage
- Adequate sidewalk widths (atleast six feet)
- Downward facing lighting fixtures
- ADA accessible
- Ramps should be atleast 4' wide and a slope not to exceed eight percent
- Connect with other paths/sidewalks
- Separated bike path
- Encourage outdoor dining at local restaurants

Source: Better Streets. www.sfbetterstreets.org. Date Accessed: December 2009.

Pedestrian Features:

- Seating Opportunities- benches, wall edges, sloped turf, steps
- Variety of Different Paving Materials
- Shade- trees, umbrella canopies, roof overhang
- Safety- paving, bollards, crosswalks, buffer from vehicles, railings, and signage
- Environment- trash receptacles, recycle bins
- Aesthetics- water feature, art, vegetation variety, signage, paving

Best Management Practices

- Planters four foot in width, at the minimum, to support healthy plant growth
- Eight foot in length, at the minimum
- Twelve inch curb cuts every eight feet, or in between planting beds
- Decorative grates to allow pedestrian access over BMP

Source: ASLA. 2006 Professional Awards. SW 12th Avenue. Green Street in Portland, Oregon.
www.asla.org. Date Accessed: December 2009.

In an urban right-of-way in Portland, OR, these parameters will provide an infiltration rate of four inches per hour, 180,000 gallons of water managed through a series of four of these planters, and the system can reduce a 25-year storm event by 70%. For St. Louis CBD, this system can be modified into an eight foot wide existing sidewalk.

Source: ASLA. 2006 Professional Awards. SW 12th Avenue. Green Street in Portland, Oregon.
www.asla.org. Date Accessed: December 2009.

Urban BMP Retrofitting

Existing CBD urban landscapes, including plazas, waterfronts, urban streetscapes, and pocket parks occupy a small amount of total watershed area, but they represent a great opportunity to demonstrate BMP retrofits in highly visible locations. The basic strategy is to treat stormwater as a landscaping resource and design amenity using innovative practices such as stormwater planters, expanded tree pits, permeable pavers, or curb cuts between planting beds.

Urban BMP retrofits will receive more runoff to the planting area than would otherwise be supplied by rainfall (due to the amount of impervious surface area surrounding the planting area). Designers should compare the impervious surface area delivering runoff to the surface area of the planting bed itself. If the ratio is more than 5:1, the retrofit should have an underdrain so that plants do not become water logged. If the ratio is greater than 10:1, the design should include a surface overflow (EPA Urban Subwatershed Restoration Manual 1997).

Even in heavily paved urban areas, there are design techniques that can slow and reduce the amount of stormwater runoff. For plaza and sidewalk drainage, impermeable surfaces should be sloped toward the landscaped areas. Permeable pavers or porous concrete can further limit runoff generation from hard surfaces.

Reference

Center for Watershed Protection. Urban Stormwater Retrofit Manual. 2008. www.cwp.org. Date Accessed: January 2010.

BMP Toolbox (recommended by the EPA)

The Environmental Protection Agency (EPA) has published an Urban Subwatershed Restoration Manual Series. In total, there are 11 different manuals that range in topics from how to restore a watershed to pollution control to watershed management practices. Manual three is titled Urban Stormwater Retrofit Practices. The manual describes both off-site storages and on-site retrofit techniques that can be used to remove stormwater pollutants, minimize channel erosion, and help restore stream hydrology. Guidance on choosing the best locations for retrofits in a subwatershed is provided in this manual, as well. The manual also presents a method to assess retrofit potential at the subwatershed level, including methods to conduct a retrofit inventory, assess candidate sites, screen for priority projects, and evaluate their expected cumulative benefit. The manual concludes by offering tips on retrofit design, permitting, construction, and maintenance considerations.

The manual series outlines 13 types of locations to retrofit water storage. Each location presents different opportunities and challenges to successfully obtain retrofit storage. In Table 4 a comparison of retrofit locations are listed (according to the EPA).

Subwatershed Location	Simple to Design?	Easy to get Permits	Low Treatment Cost?
Add to existing ponds	N	M	Y
Above roadway culvert	N	N	Y
Below Outfalls	N	M	M
Conveyance System	N	M	M
Transport ROW	N	M	Y
Large Parking Lots	N	M	M
Hotspot Operations	M	Y	N
Small Parking Lots	M	Y	M
Individual Streets	M	Y	N
Individual Rooftops	Y	Y	M
Little Retrofits	Y	Y	Y
Landscape/Hardscape	Y	Y	M
Underground	N	M	N

Key: Y=Yes M=Moderate N=No

The subwatershed location site, noted in Table XX, that is most suited with the eco-boulevard is the “little retrofit.” Little retrofits are simple on-site practices that treat runoff from directly connected impervious areas less than one acre in size. Examples include sidewalks, bike paths, driveways, vacant lots, paved areas, and other surfaces that are impermeable to rainfall. Recommended stormwater treatment options for little retrofits include swales, infiltrations, filter strips, impervious cover conversion, impervious cover disconnection and soil compost amendments. Collectively, small impervious areas comprise less than five percent of total impervious area in a subwatershed.

Little retrofits are ideal because they are low cost and can solve localized drainage and erosion problems. The best conditions for little retrofits are when the retrofit is located on publicly-owned land and can serve as an education or demonstration function.

Retrofitting involves choosing the most appropriate and effective stormwater treatment option at the individual retrofit site that can achieve local objectives. There are eight different stormwater treatment options. Each option differs in its pollutant removal capability, stormwater benefits, and retrofit suitability. Table 5 shows the types of stormwater treatment options used in different subwatershed locations (according to the EPA).

Water Storage Location	Extended Detention	Wet Ponds	Wetlands	Bio-retention	Filters	Infiltration	Swales	Other
Add to existing ponds	P	P	P	F	F	S	S	S
Above roadway culvert	P	F	P	S	S	S	S	S
Below Outfalls	P	P	P	F	F	S	S	S
Conveyance System	F	S	P	P	S	S	P	S
Transport ROW	P	P	P	P	F	S	F	S
Large Parking Lots	P	P	P	F	F	F	S	S
Hotspot Operations	S	S	S	P	P	X	S	S
Small Parking Lots	S	S	S	P	P	P	P	P
Individual Streets	S	S	S	P	F	F	P	S
Individual Rooftops	S	S	S	P	S	F	S	P
Little Retrofits	S	S	S	P	F	P	P	P
Landscape/Hardscape	S	S	F	P	F	F	F	P
Underground	F	S	S	F	S	F	S	S

Key: P=Preferred option F=Feasible option S=Seldom used for the retrofit X=Not recommended

Table 5. Water Storage Location. EPA

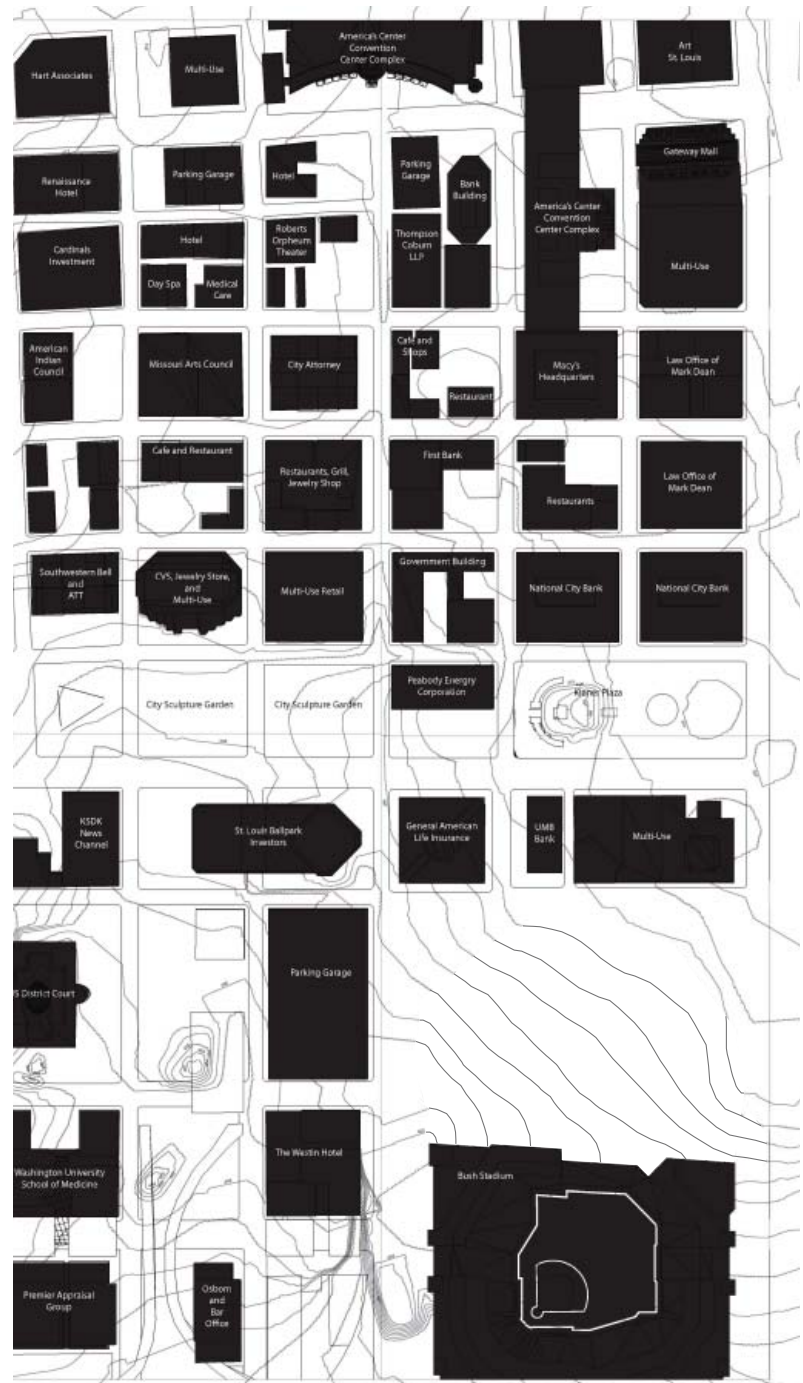
7 Design Communication

The location of the eco-boulevard has been determined in Chapter 5: Site Analysis. However, the locations of BMPs on the eco-boulevard have been determined by a thorough watershed analysis and series of calculations. The calculations in Figure 45 have been noted and have influenced the type of BMP and the location of each individual BMP.

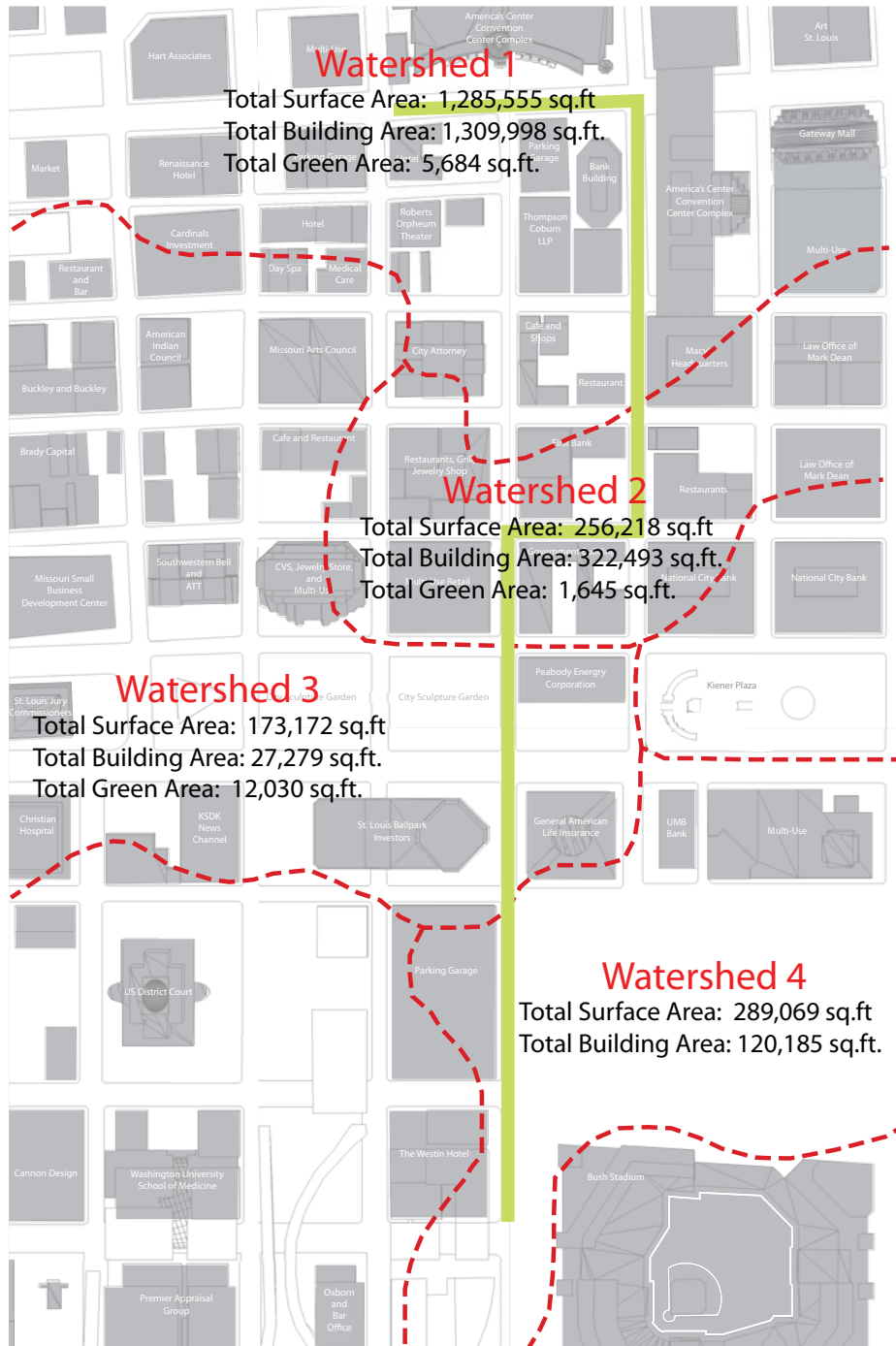
The overall design of the eco-boulevard contains a number of drawings to illustrate the best design solution given the existing opportunities and constraints of the site. These drawings include a master plan locating and naming the BMPs. Each BMP is accompanied by a series of drawings that include plans, sections, perspectives, details, and water routes. The water route diagram shows how the water will flow into, flow through, and exit the BMP. Materials and color palettes are noted, as well.

To determine the best locations of the BMPs, a thorough watershed analysis was performed, as seen in Figure 45. First, the ridge lines and break points in the CBD of St. Louis were located; which allowed for the delineation of individual watersheds. After the delineation of watershed boundaries was performed, drainage arrows were placed on top of the existing topography to determine the flow of water in each watershed. The drainage arrows show the location of the low points on site. To determine how much water is flowing into each low point of each watershed, calculations were performed. The calculations determined the total surface area of each watershed. From the total surface area, the buildings footprints and green space within the individual watershed were subtracted. The surface area of the building footprints and green space were subtracted from the total surface area to determine the amount of building surface area, impermeable surfaces, and permeable surfaces.

Not to Scale



Watershed Analysis



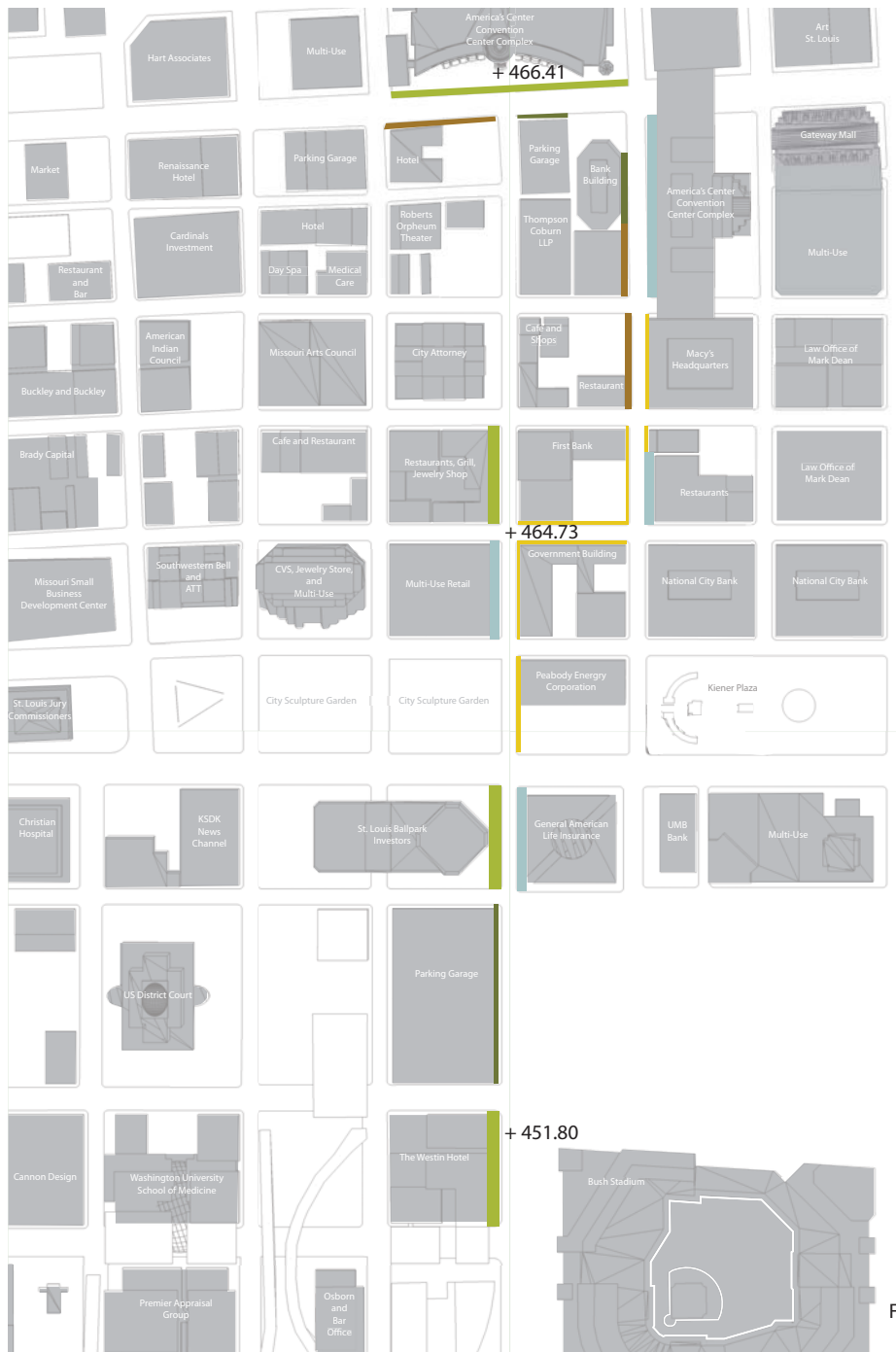
Not to Scale

Figure 45. Analysis Process (left). Megan Bryan
 Watershed Diagram (right). Megan Bryan

The results of the watershed analysis showed that three locations along the eco-boulevard were best suited for BMPs. The appropriate selection of BMP type was dependent on the allotted size needed for the particular BMP and the width of the sidewalk in which the BMP would be located. Figure 46 shows the existing sidewalk widths along the eco-boulevard. The first location that is well suited for a BMP (and highest point in elevation) is on Washington Avenue directly south of America's Center Convention Complex. The existing sidewalk width varies from 32 feet at the narrowest point to 87 feet at the widest point. One constraint that has to be taken into consideration is that there is an existing vehicular drop off point that is located in front of the Convention Center.

The second low point location along the eco-boulevard that is well suited for a BMP is on 8th Street near the intersection of Pine Street. The existing sidewalk width is 26 feet for the length of the city block. The third low point location along the eco-boulevard that is well suited for a BMP is also located on 8th Street but directly west of Busch Stadium. Here the sidewalk width is 32 feet wide. A constraint of this location is that the area is highly used by pedestrians during events at Busch Stadium. Thus, keeping the sidewalk open and not having too many obstacles is important for maintaining the accommodation of heavy pedestrian traffic.

Sidewalk Widths



- 30'-37' Sidewalks
- 25'-26' Sidewalks
- 17' Sidewalks
- 12'-13' Sidewalks
- 10" Sidewalks



Not to Scale

Figure 46. Sidewalk Widths. Megan Bryan

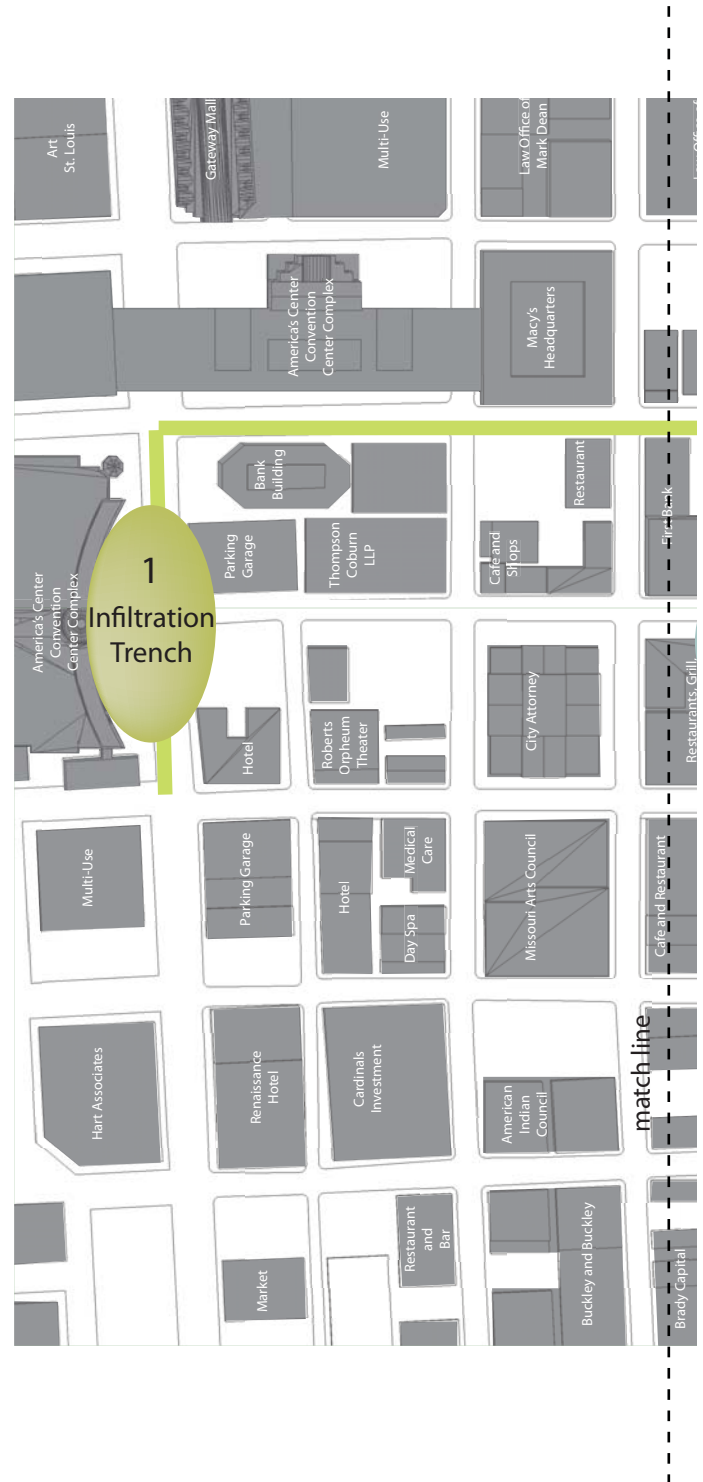
Master Plan of the Eco-Boulevard

The eco-boulevard has taken a specific route in the Central Business District of downtown St. Louis due to the location of low points, location of light rail transit stops, and pedestrian flow and circulation. The proposed design of the eco-boulevard accommodates visual connections through the use of the unifying street trees, sidewalk trench drain, connection of BMPs, and other pedestrian amenities. All of these unifying factors would give the eco-boulevard a unique identity. The eco-boulevard has “layers” of unifying elements. The first and highest layer is the massing of street trees that line the boulevard. The street trees branching pattern and leaf texture provide an overhead element that provides the pedestrian with a sense of protection and shade. The second, or middle layer, is the use of pedestrian amenities. These amenities include: bollards, benches, light fixtures, banner poles, trash receptacles, planters, bike racks, and tree grates. The third layer, on the ground plane, is a meandering trench drain that is within the sidewalk.

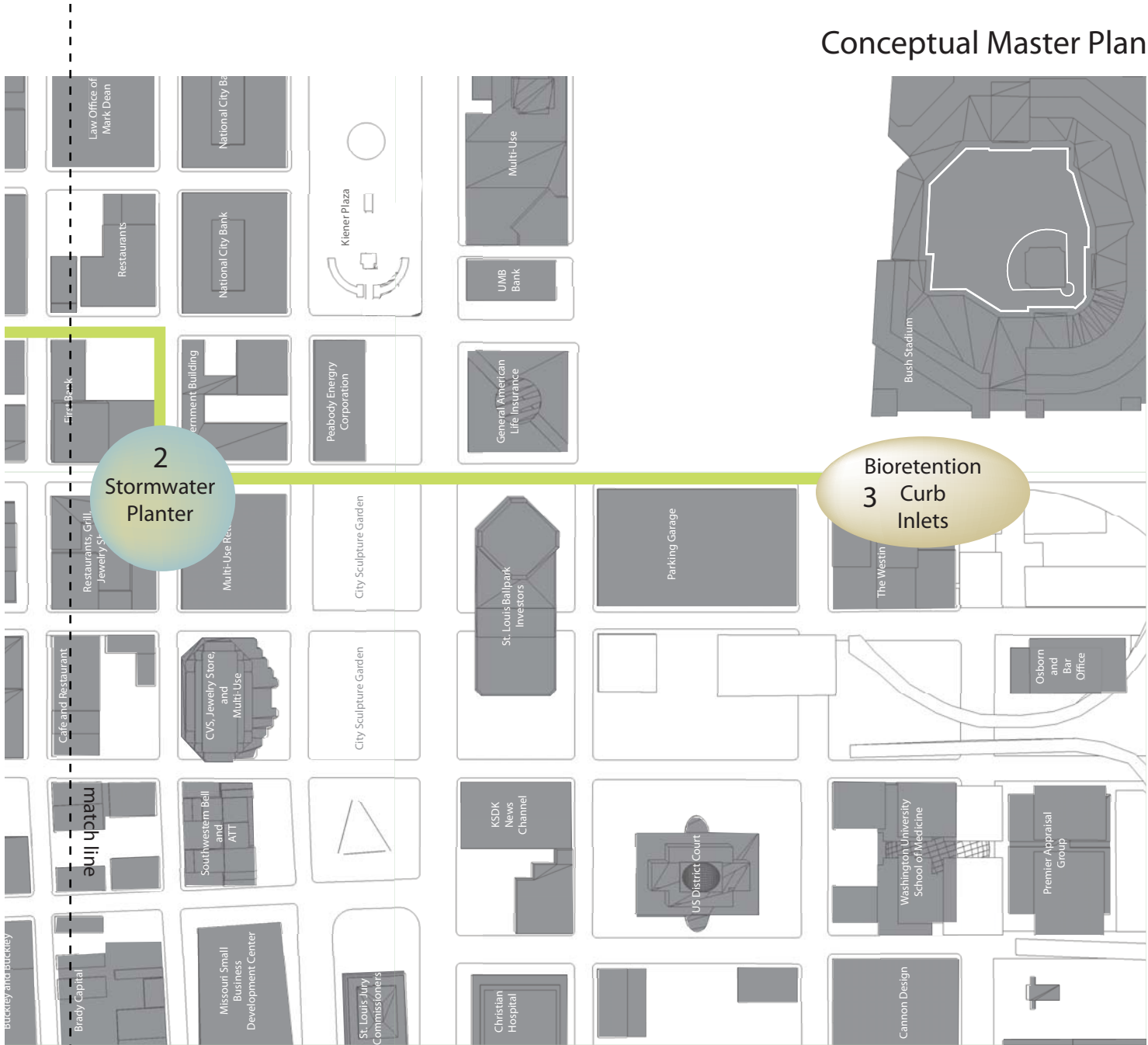
84

There are three BMPs located on site. Figure 47 shows the BMPs starting with the northern most BMP and heading downhill are: 1. Infiltration Trench, located in front of America’s Convention Center; 2. a Stormwater Planter, located at 8th and Pine Street; and 3. Bioretention Curb Inlet system, located on 8th Street just west of Busch Stadium.

Figure 48 (page 86) shows an aerial perspective of the eco-boulevard. The different “layered” elements can be seen.



Conceptual Master Plan



2
Stormwater
Planter

3
Bioretention
Curb
Inlets


 N Not to Scale

Figure 47. Conceptual Master Plan. Megan Bryan

Aerial Perspective

86

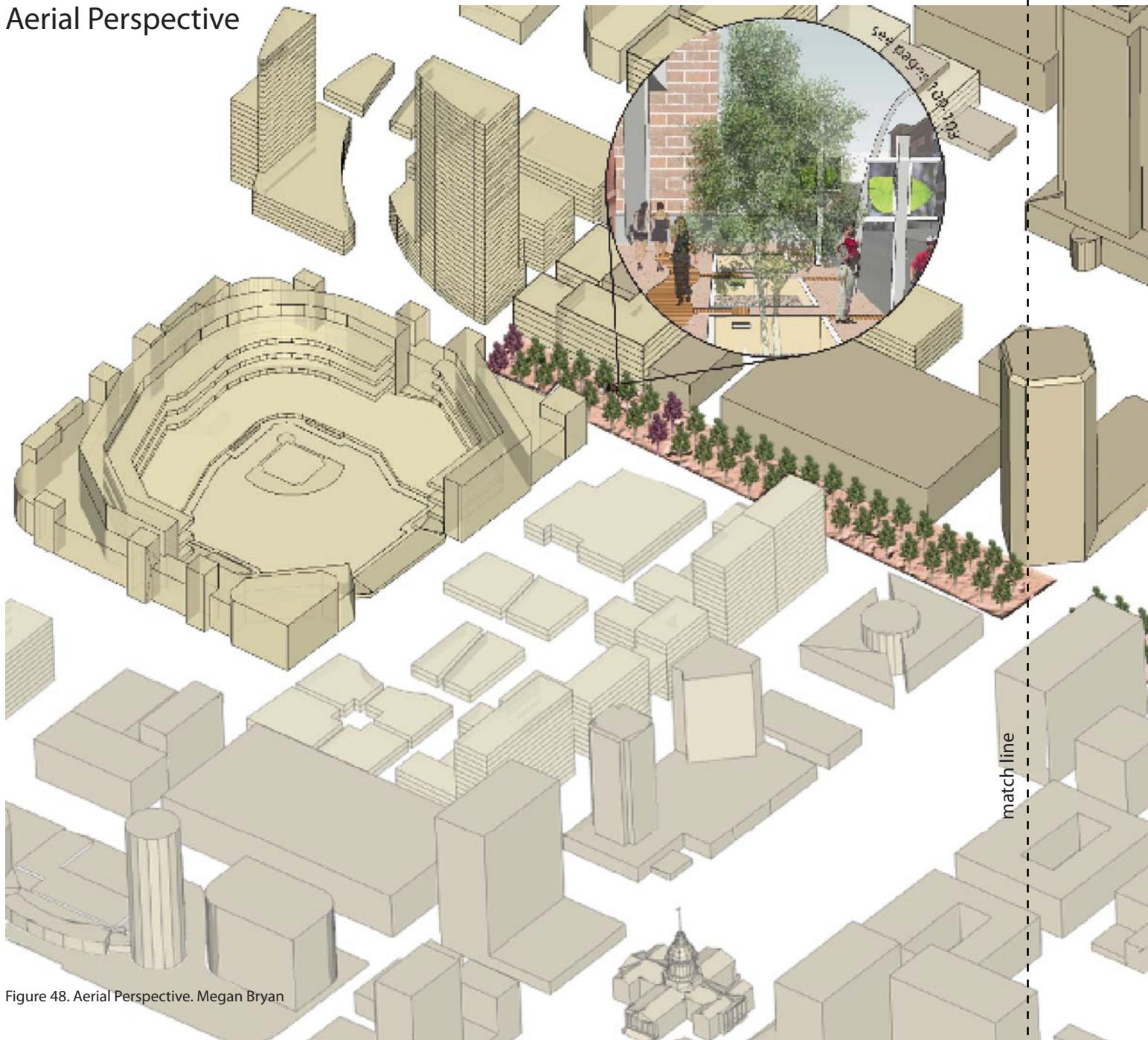
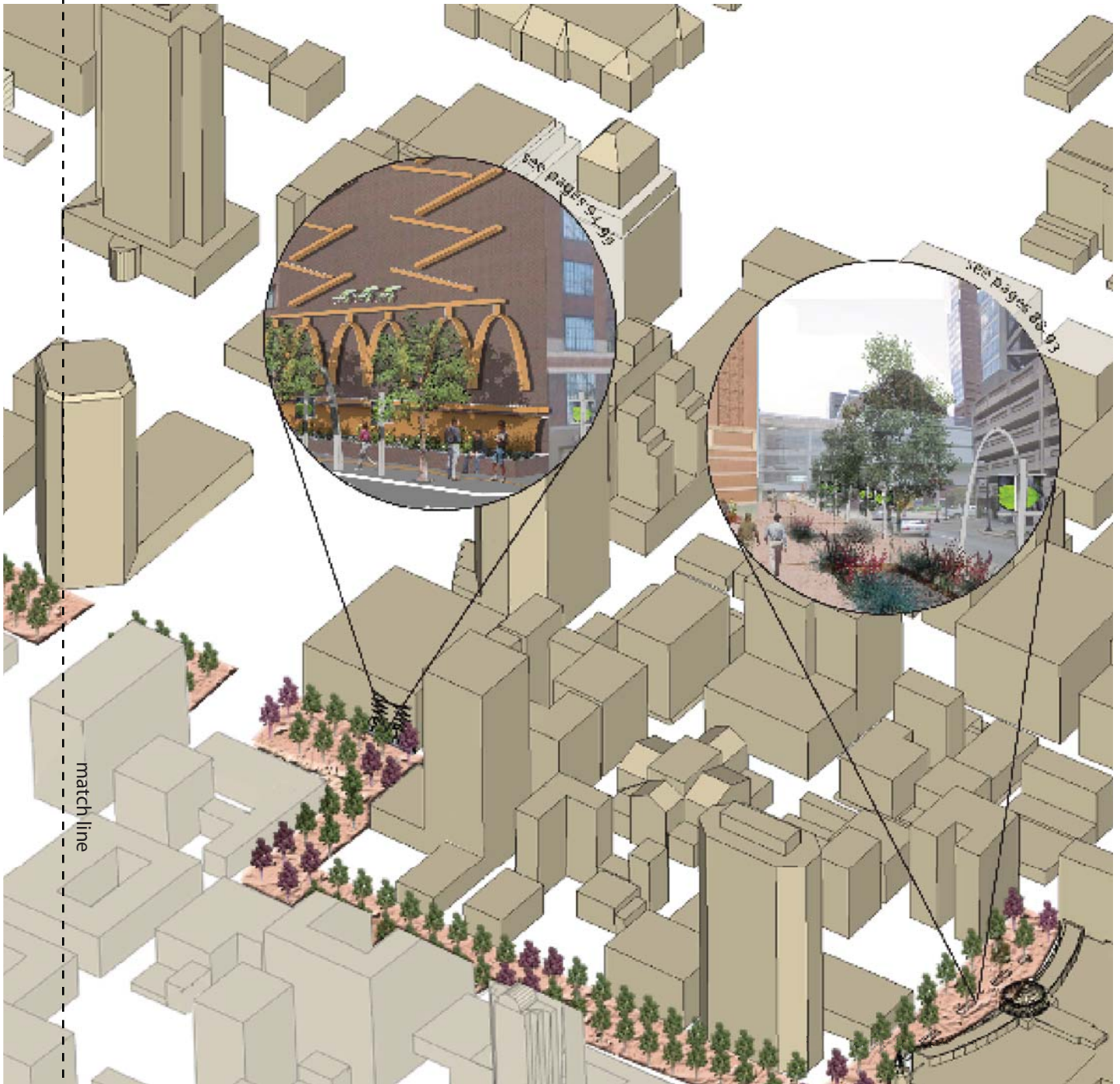


Figure 48. Aerial Perspective. Megan Bryan



1. Infiltration Trench

Urban development is significantly increasing surface runoff and contamination of local watersheds. As a result, infiltration practices, such as infiltration trenches, are being employed to remove suspended solids, particulate pollutants, bacteria, metals, and nutrients from stormwater runoff. An infiltration trench is an excavated trench; usually three to twelve feet deep. A small portion of the runoff is diverted to the infiltration trench, which is located either underground or at grade. Pollutants are filtered out of the runoff as it infiltrates the surrounding soils. Infiltration trenches also provide groundwater recharge and preserve base flow in nearby streams (EPA Stormwater Technology 1999, 2-3).

88 From the watershed analysis conducted, the first low point location is best suited for an infiltration trench. Infiltration trenches are often used in place of other BMPs where limited space is available. Limited space is available in this location due to the vehicular and pedestrian circulation that has to access the entry to the Convention Center.

The design of an infiltration trench has a few advantages and disadvantages. The infiltration trench provides efficient removal of suspended solids, particulate pollutants, bacteria, metals, and nutrients from stormwater runoff. Also, captured runoff infiltrates the surrounding soils and increases groundwater recharge and base flow in nearby streams. Some disadvantages of the infiltration trench are that the potential for groundwater contamination and can be likely to fail early if it is not properly maintained.

Design Description

As seen in Figure 50, the infiltration trench, located directly south of America's Center consists of a linear "strip" of vegetation and a bed of rocks. The trench will be depressed from grade so it can store and move water throughout the system. The trench will be 11 feet wide: a five foot wide rock bed with a three foot wide vegetation bed on either side. The rock bed will be filled with large gravel. On either side of the rock bed will be a three foot wide vegetation bed to provide a softening of edges. The vegetation will feed from the water that will move throughout the rock bed. The entire infiltration trench will be four feet deep. There will be five foot buffer between the street and the infiltration trench to allow for easy pedestrian flow on either side of the trench.

Figure 51 (Page 90) shows a section perspective of the Infiltration Trench). The depth of planting medium (rock bed and soil) will need to be determined by an arborist.

Infiltration Trench Plan

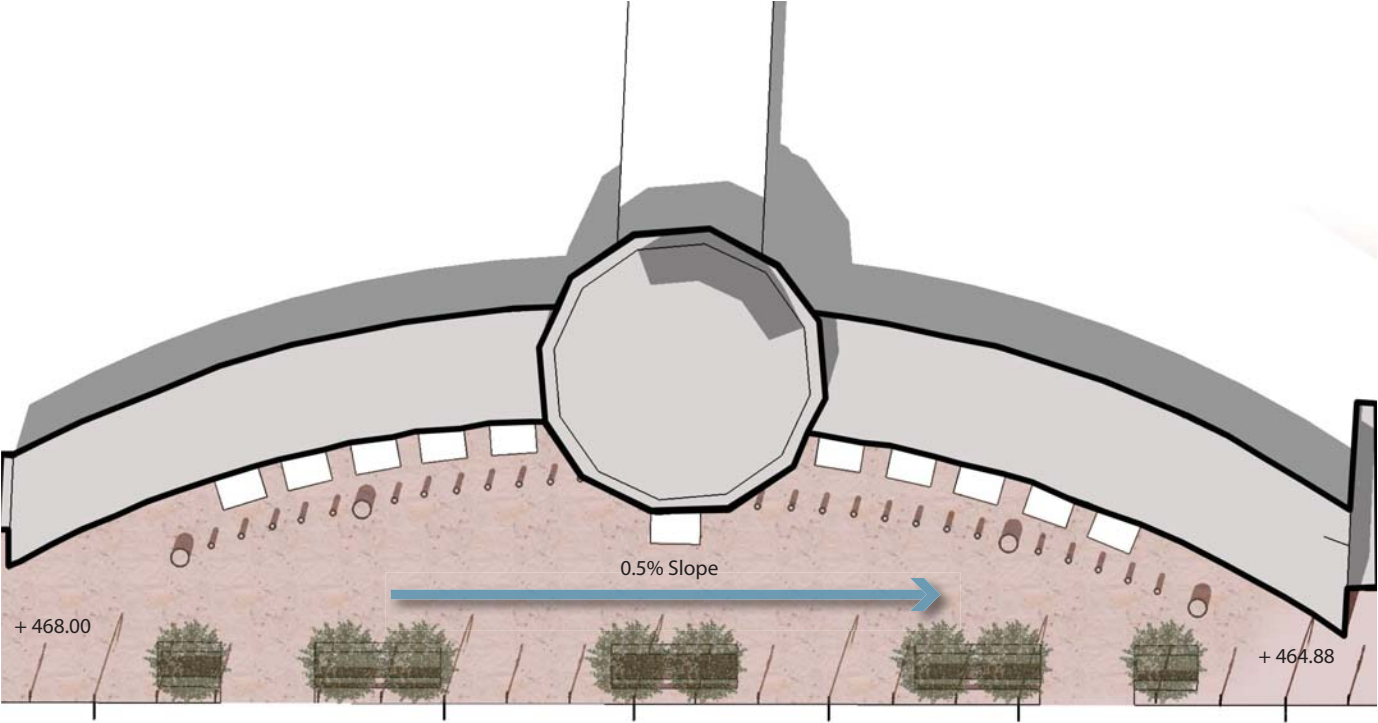


Figure 49. Infiltration Trench Plan with approximate elevations and slope noted. Megan Bryan



Scale 1" = 40'

Infiltration Trench Section Perspective

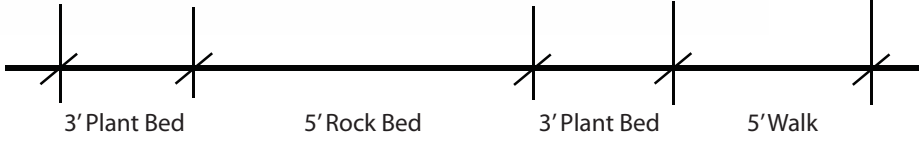
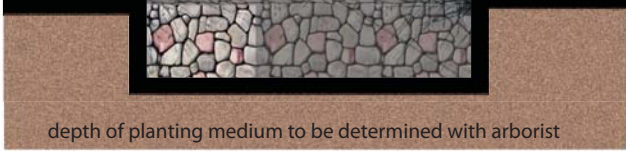
90



Figure 50. Infiltration Trench Section. Megan Bryan



match line



Infiltration Trench Water Route

As seen in Figure 52, the stormwater runoff will be intercepted before it flows into the underground stormwater system by an infiltration trench. The water will be collected and infiltrated through the trench. The water will easily flow from the higher elevated trench to the lower elevated trench because the large rocks will make pore space for the water. Once the water is in the trench and has moved through the pore spaces of the rocks, the water will then be held in an underground storage tank. The tank will feed directly into America's Center Convention Complex and could be used as gray water throughout the buildings.

Infiltration Trench Water Route

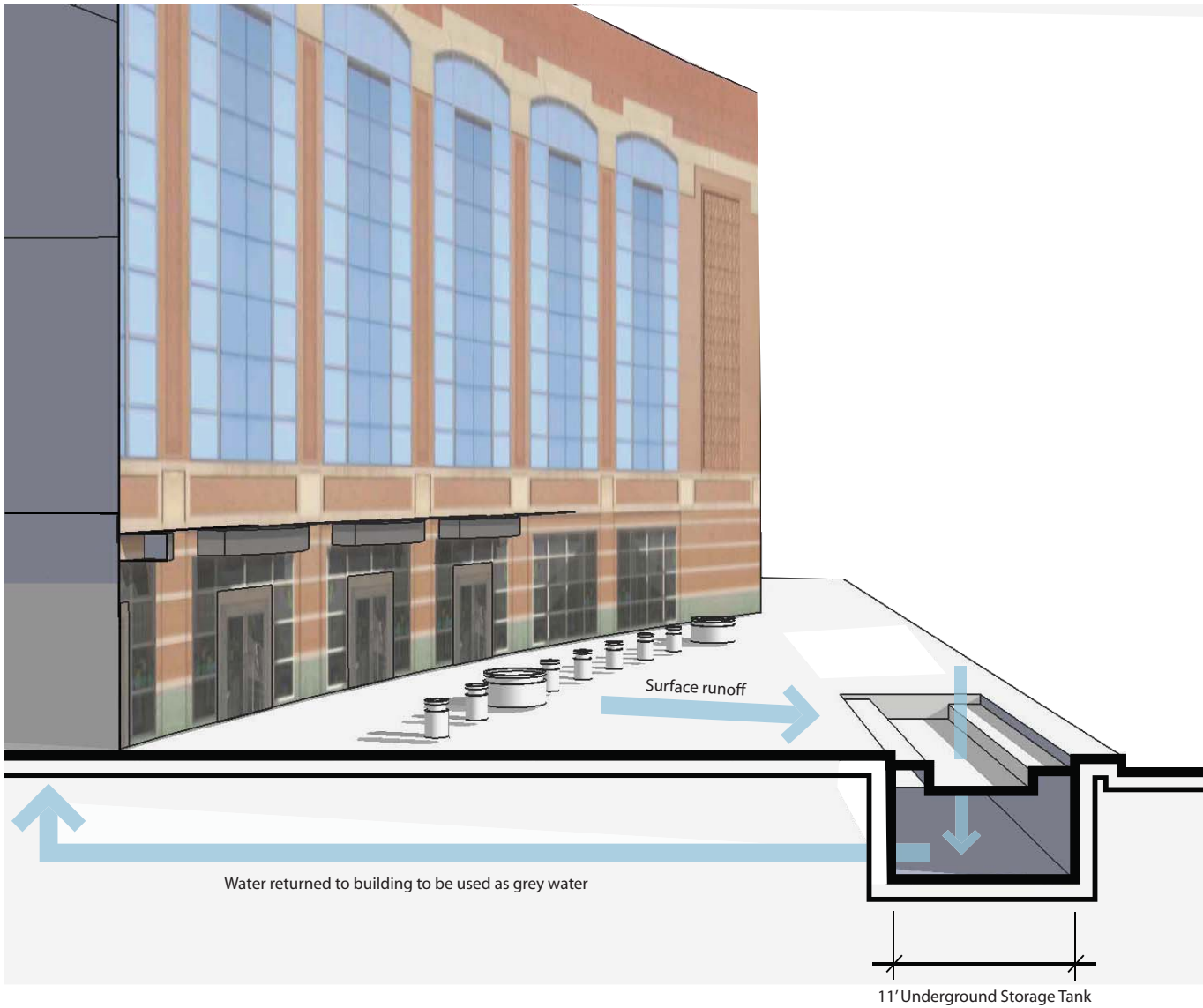


Figure 51. Infiltration Trench Water Route. Megan Bryan

2. Stormwater Planter

From the watershed analysis study, the second low point along the eco-boulevard (located at 8th Street and Pine Street) is best suited for a stormwater planter. One of the opportunities at this site is that one of the existing building facades is only brick, without any windows. This allows the use of the building facade to enhance the stormwater planter BMP.

Stormwater planters are an onsite retrofit practice that can treat rooftop runoff. This retrofit consists of confined planters that store and infiltrate runoff through a soil bed to reduce runoff volumes and pollutant loads. One type of stormwater planter is the infiltration planter. The infiltration planter is designed to allow runoff to pass through a series of filters to cleanse the water before infiltrating through the soils. Stormwater planters are useful in treating rooftop runoff in highly urban areas. They can also be used to establish a pervious area within the landscape of a plaza, courtyard, riverfront, or streetscape (EPA Urban Stormwater Retrofit Practices Appendix F 2007, 64-68).

The design of the stormwater planter has a few advantages and disadvantages. A few advantages include that the stormwater planter can be easily retrofitted into an urban area. Another advantage is that stormwater is collected from the rooftop; instead of allowing the rooftop runoff to go directly into the underground storm sewer system. One disadvantage of the stormwater planter is that the planter can cause basement flooding or seepage damage if appropriate precautions are not considered.

Design Description

Figure 53 shows that the stormwater planter is located at the intersection of 8th Street and Pine Street along one of the building facades. The planter is approximately ten feet wide and seventy feet long. The planter is about two feet high allowing a seat edge around the perimeter. The actual planter is filled with gravel and some plants. The eye popping feature of this planting bed system is what is on the façade of the adjacent building. In order to collect the stormwater from the rooftop, a series of gutters are placed on the façade at different angles to bring the water down to the ground level. The plants in the bed will be fed from the water that is infiltrated from the gutter system.

The gutter system begins near the rooftop. The water enters the gutter system through scuppers. The design of the scuppers is a series of Eastern Redbud (*Cercis Canadensis*) metal leaves. The Eastern Redbud is a common tree found throughout St. Louis. The water is collected in two different scuppers, on either side of the façade. The water runs through the scuppers and into the gutters. There are a series of eight gutters on both sides of the façade. After the water passes through the eight gutters, the water on both sides of the façade are combined into one gutter. This gutter is then connected by a series of six arches. The water is divided among the six arches. When the water passes through the six arches, it is then dispersed into one final gutter. This gutter is perforated and percolates onto a curved water wall. The water wall feeds directly into the stormwater planter bed located two feet above grade. The curved wall allows for the water to slowly infiltrate into the gravel rock bed.

Figure 54 (page 96) shows a section of the stormwater planter. The depth of planting medium (rock bed and soil) will need to be determined by an arborist. Figure 55 (page 97) is a perspective of the entire gutter system and stormwater planter bed.

Stormwater Planter Plan

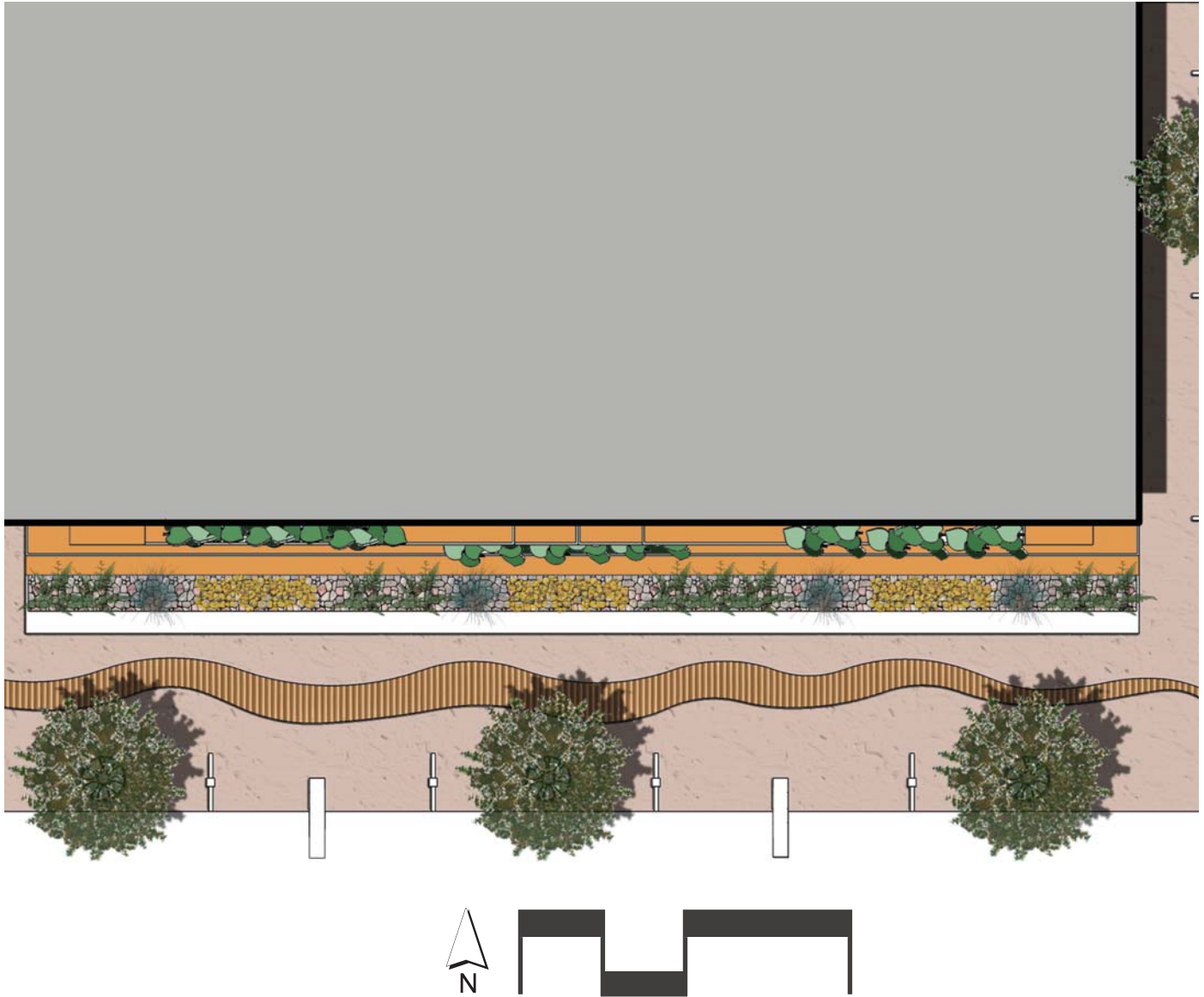


Figure 52. Stormwater Planter Plan. Megan Bryan

Scale 1" = 10'

Stormwater Planter Section

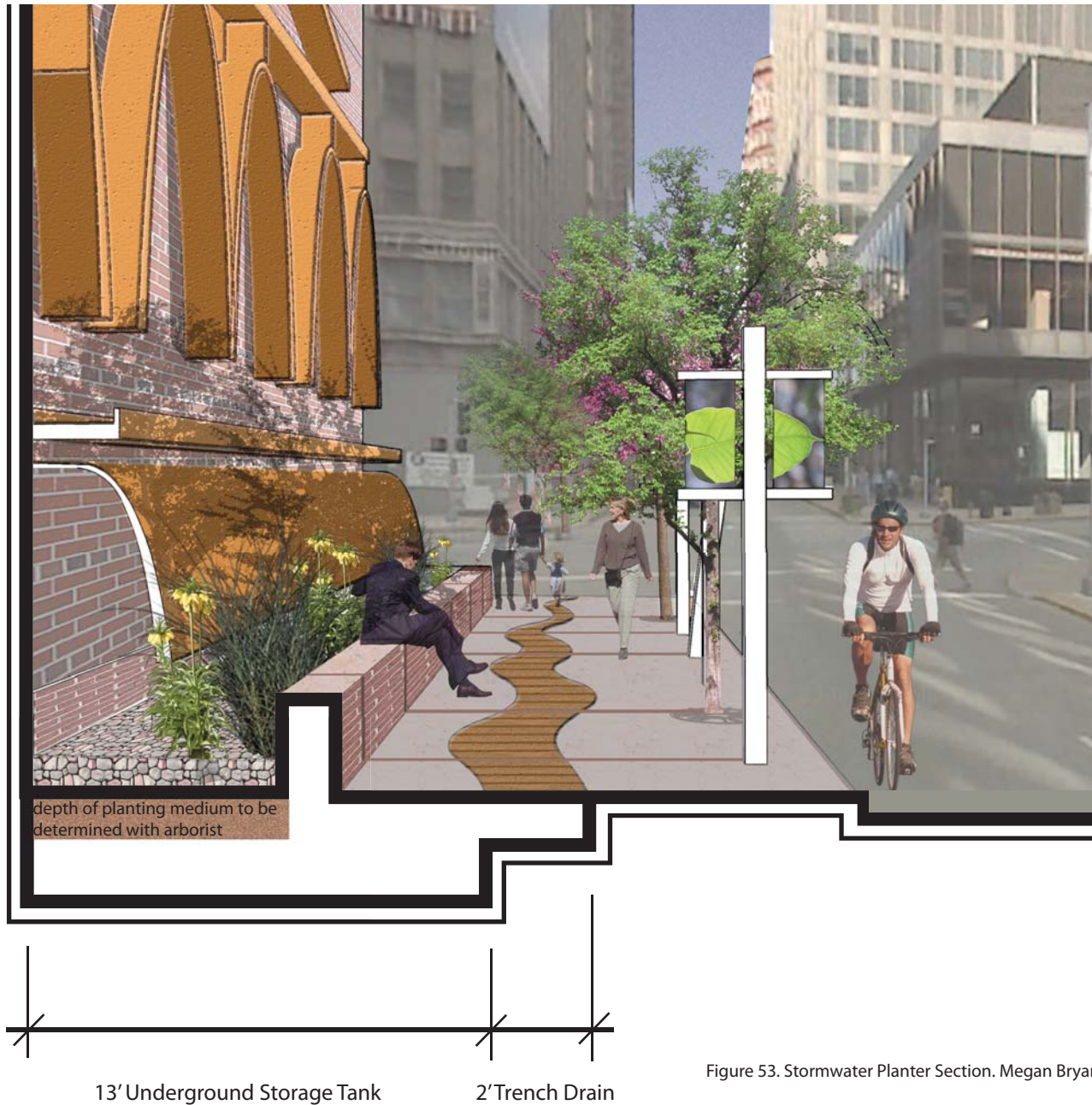


Figure 53. Stormwater Planter Section. Megan Bryan

Stormwater Planter Perspective



Figure 54. Stormwater Planter Perspective. Megan Bryan

Stormwater Planter Water Route

Shown in Figure 56, the water from the rooftop will be collected and drained through a gutter system on the façade of the adjacent building. As the water exits the diagonal gutters, it flows into a horizontal gutter that acts as a large sediment filter. The perforations in the horizontal gutter will disperse the water onto a curved water wall. The water then enters the stormwater planter that is filled with a rock bed. When the water reaches the planter bed, it will infiltrate through the pore space of the rock bed. Once the planter has reached maximum holding capacity, the remaining water will be recycled to the adjacent building and be used as gray water.

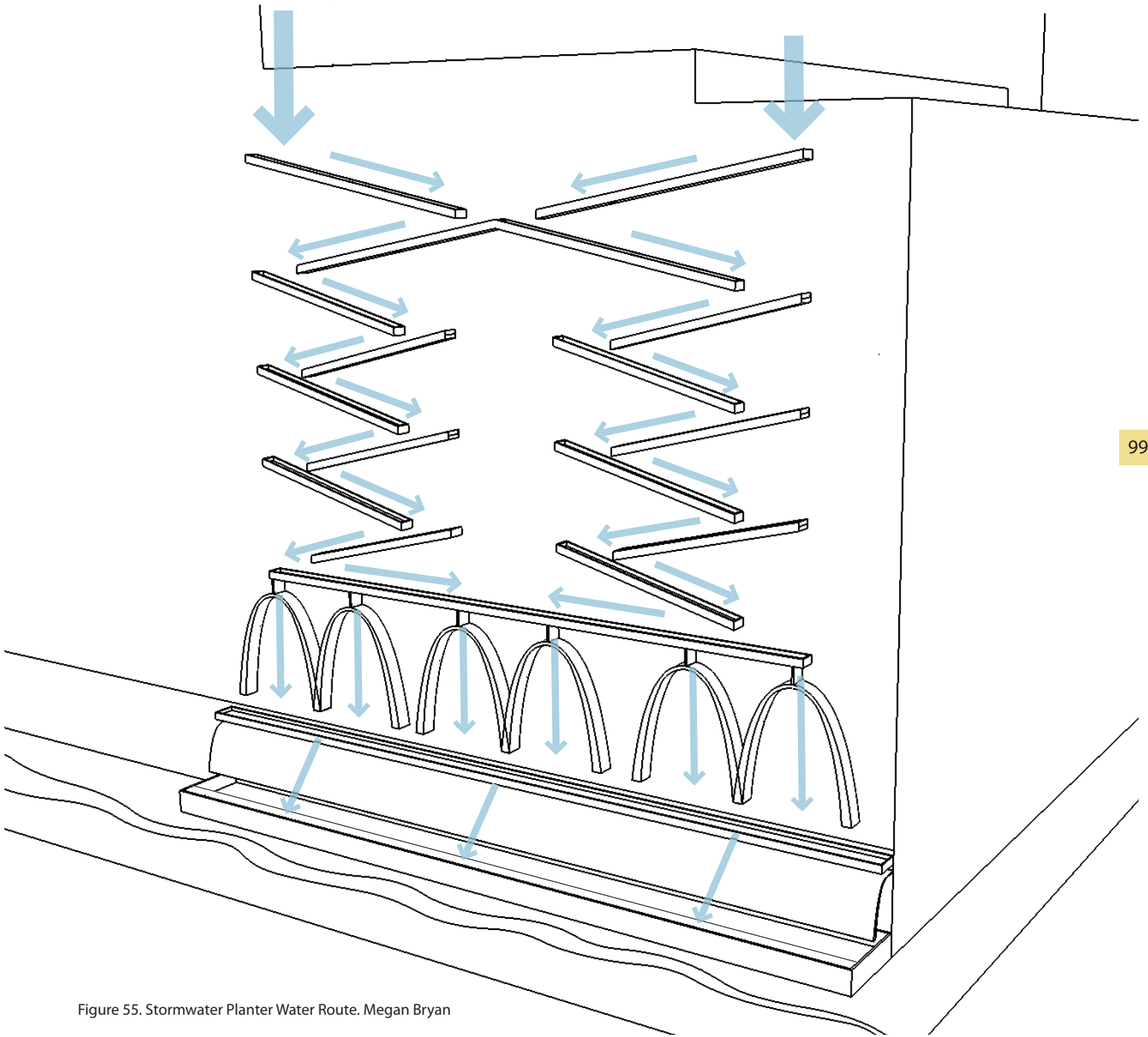


Figure 55. Stormwater Planter Water Route. Megan Bryan

3. Bioretention Curb Inlets

From the watershed analysis conducted, the third low point location along the eco-boulevard is best suited for Bioretention Curb Inlets (located on 8th Street directly west of Busch Stadium). One constraint that is at this site is that the sidewalk is heavily used during weekend and sport events. Thus, leaving the sidewalk open and void of obstacles is important to accommodate heavy pedestrian traffic.

Bioretention is a landscaping feature adapted to treat stormwater runoff at retrofit sites. Individual bioretention areas can serve drainage areas less than an acre in size. Surface runoff is directed into a shallow landscaped depression. The depression is composed of 18 to 48 inches of soil depth with a mulch layer on top. Bioretention creates an ideal environment for filtration, biological uptake, and microbial activity, and provides some pollutant removal. Bioretention can become an attractive landscaping feature with high amenity value and community acceptance.

Curb cuts are used to direct water into a stormwater facility that is associated with streets and parking lots. Curb cuts, within a raised curb condition, allow stormwater to enter a stormwater facility, such as a bioretention area, at specific points, thus concentration runoff is decreased in both in velocity and volume. Careful attention should be paid during design, such as spacing the curb cuts as frequently as possible to distribute the water flow evenly within the stormwater facility. Curb cuts should be designed 18 inches wide to avoid the potential for sediment to clog the entry point (EPA Urban Subwatershed Restoration Manual 1997, 171-174).

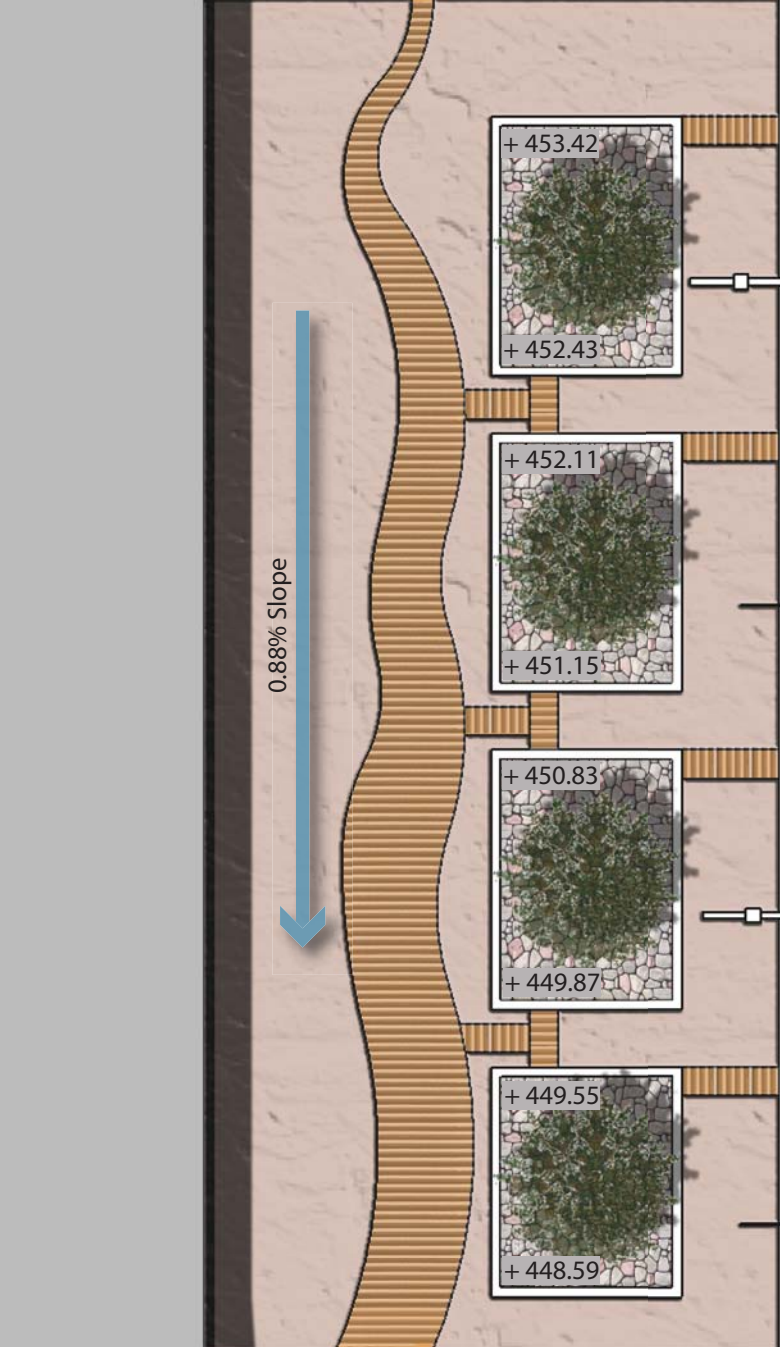
There are some advantages and disadvantages to this type of system. Curb cuts allow stormwater to enter a bioretention area at specific points. Also, curb cuts concentrate runoff in both velocity and volume. However, some disadvantages include that the curb cut can be prone to failure if large sediment and debris cause buildup at the mouth of the curb cut.

Design Description

The bioretention curb inlet system is located on 8th Street west of Busch Stadium. As seen in Figure 47, the system consists of four different planting beds that are all connected by a covered drain trench. Each planting bed is offset from the road by five feet. Near each planting bed there is a curb inlet. The curb inlets are 18 inches wide to allow for maximum volume and velocity. The curb cuts feed the water collected directly into the planting bed. In order for pedestrians to see the system in action, there will be covered drain trenches from the curb inlet to the planting bed and in between each planting bed. The covered drain trenches will have a decorative pattern on them and allow one to see the movement of water. The planting beds are approximately ten feet wide and 15 feet long. The planting beds are depressed three feet in elevation. The soil level within each planting bed will be one foot higher than the lowest point of the planting bed. This allows water to move in and out of the system without dispersion of the soil. The planting beds will also contain plants to hold the soil in place while water moves from one planter to the next. In between each planting bed will be a five foot buffer to allow for ease of pedestrian circulation.

Figure 58 (page 102) is a section perspective of the bioretention curb inlet system. The depth of planting medium (rock bed and soil) will need to be determined by an arborist.

Bioretention Curb Plan



Scale 1" = 10'

Figure 56. Bioretention Curb Inlet Plan with approximate elevations and slope noted. Megan Bryan

Bioretention Curb Inlet Section

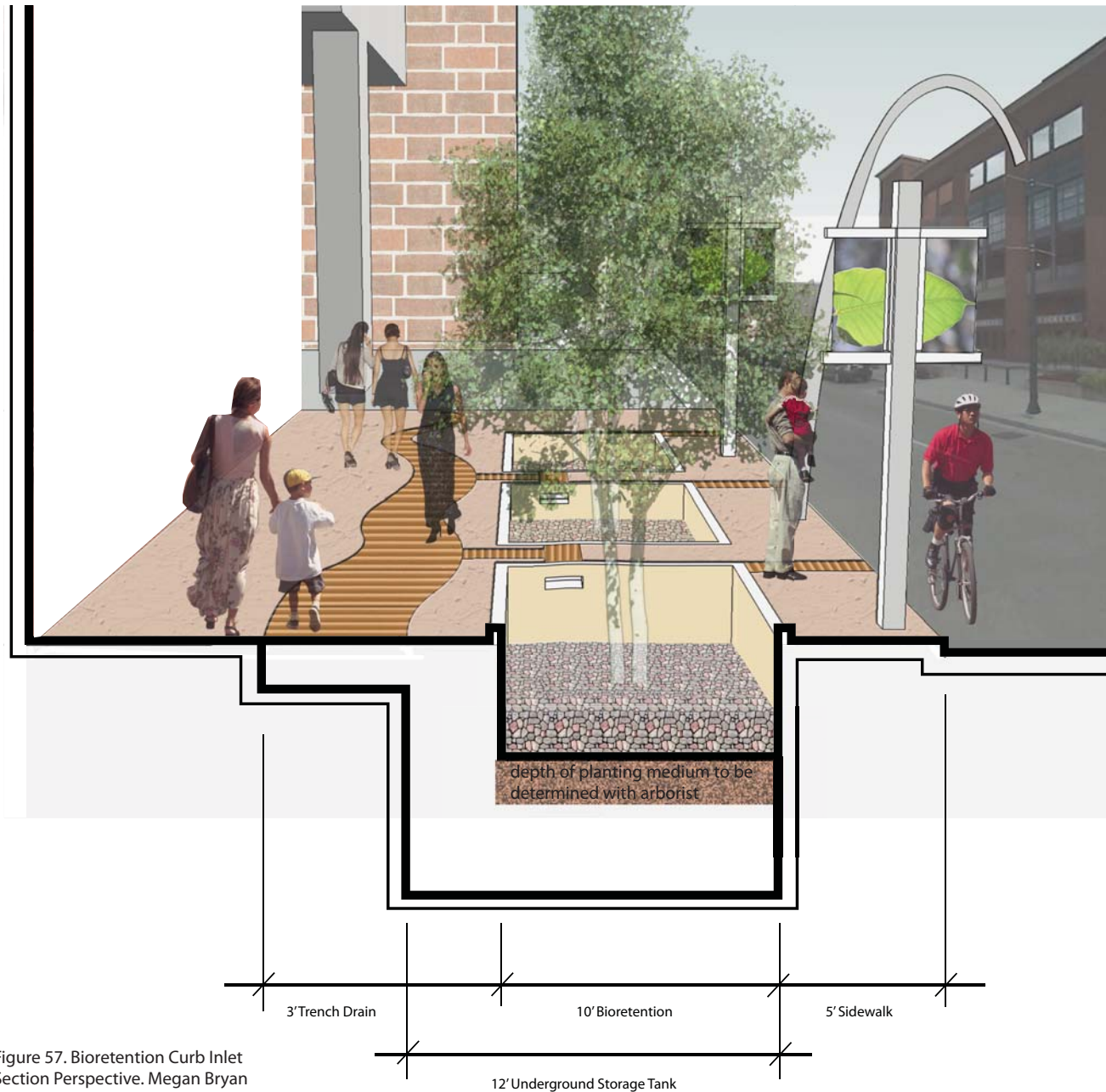


Figure 57. Bioretention Curb Inlet Section Perspective. Megan Bryan

Bioretention Curb Inlets Water Route

As seen in Figure 59, the stormwater runoff will enter the first curb cut on the side with the highest elevation of the bioretention curb inlet system on 8th Street. The water will be sent to the adjacent bioretention planter through a covered trench drain which connects the curb cut to the planter. Once the first planting bed (highest in elevation) is filled with water, the water will then enter the adjacent planter which is connected by another covered trench drain. This process continues until the water enters the fourth and final planting bed. Once the last planting bed has reached its maximum holding capacity, the water will be held in an underground storage tank and feed directly into the adjacent building to be used for gray water purposes.

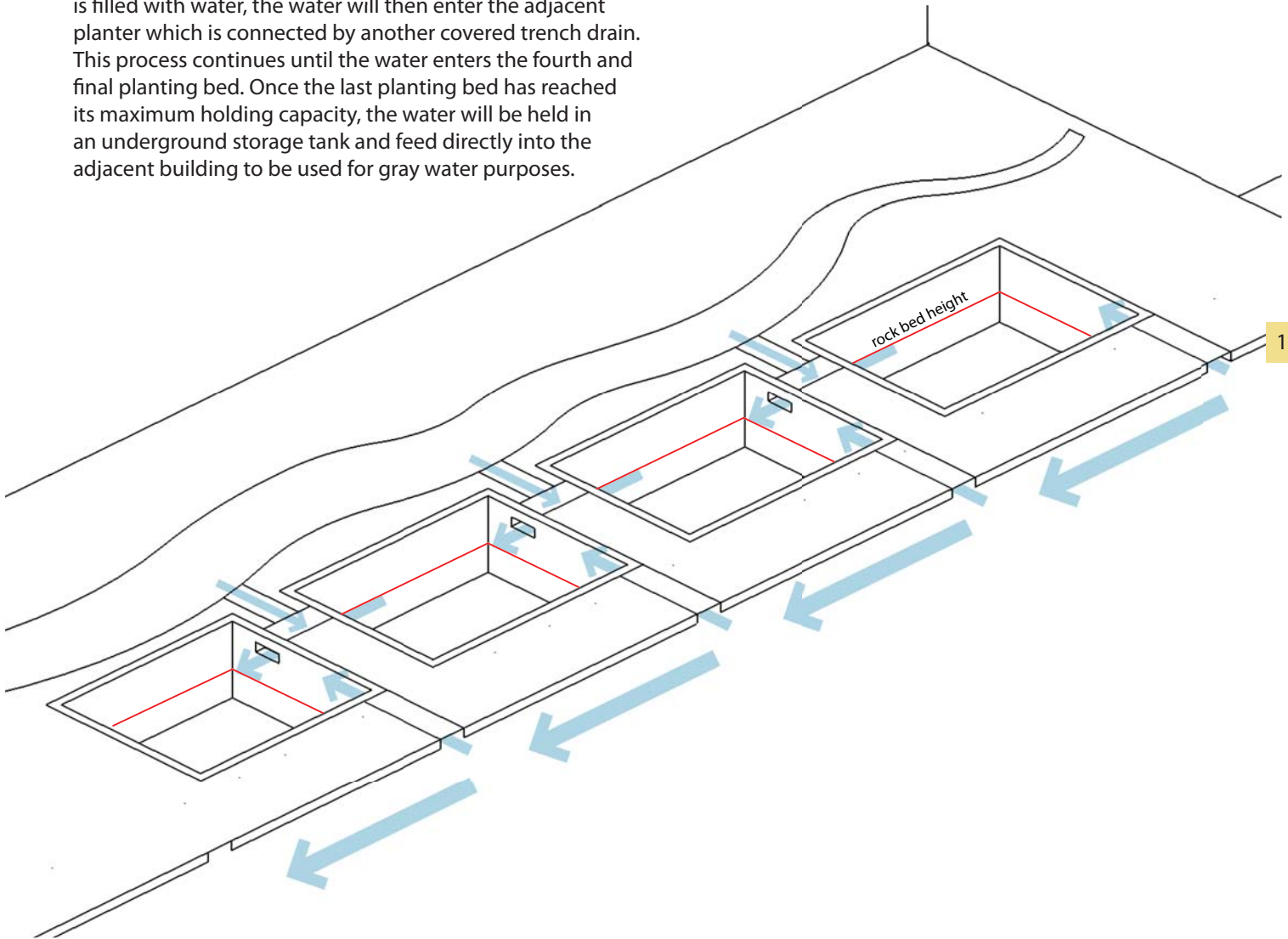


Figure 58. Bioretention Curb Inlet Water Route. Megan Bryan



Aesthetics

Introduction

The eco-boulevard should read as an entire boulevard not individual pieces where the BMPs are located. In order to achieve this, the eco-boulevard adheres to a certain aesthetic. Adherence to prescribed aesthetics lends a visual cohesion to the eco-boulevard, giving the eco-boulevard a unique identity within the Central Business District of St. Louis. Most of the eco-boulevard details contain an underlying arch form. The arch form represents and mimics the arch geometry of the Jefferson National Memorial Expansion.

Bench

All the benches located on the eco-boulevard are simple in design. Figure 60 shows that they consist of two arches on either side of the bench to serve as the support legs. These arch legs are made from stainless galvanized steel. The seat of the bench is made from recycled wood and is weather treated. The benches are six feet in length and three feet wide. There should be at least four benches on every street block along the eco-boulevard.

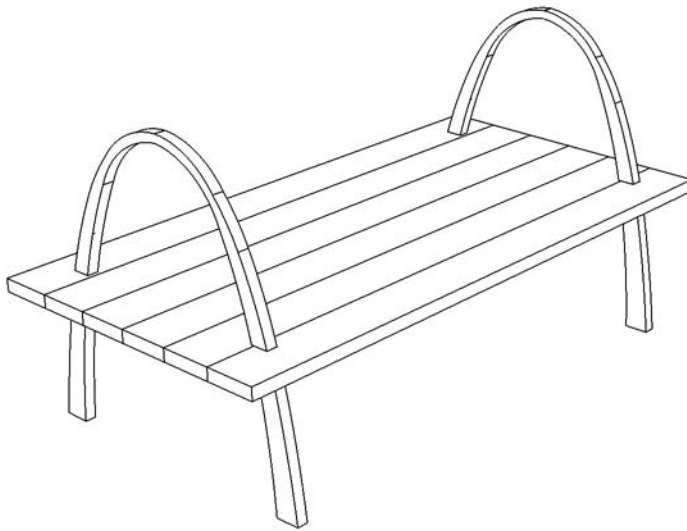


Figure.59. Bench. Megan Bryan

Trash Receptacle

All the trash receptacles located on the eco-boulevard are simple in design. Figure 61 shows that they consist of a square form with artful metal work on the perimeter. The metal work on the outside consists of two arches stacked vertically on two sides of the trash receptacle. The metal is made from stainless colored and galvanized steel. There should be at least two trash receptacles on every street block along the eco-boulevard.

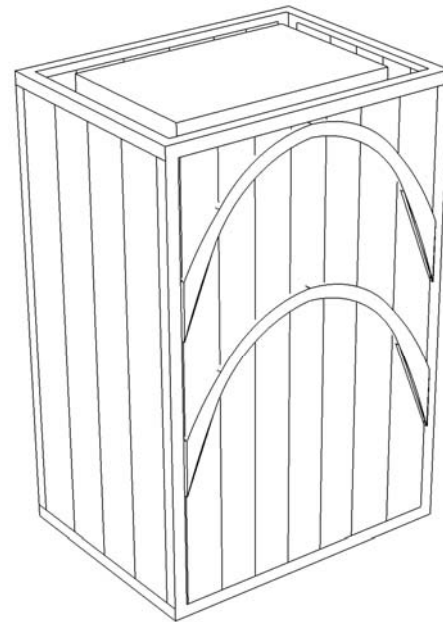


Figure 60. Trash Receptacle. Megan Bryan

Planter

All the planters located on the eco-boulevard are simple in design. Figure 62 shows that they consist of a circular form four feet in diameter and three feet in height. There is a reveal, or small indentation, that is two feet from the bottom of the planter and six inches high. The planters are made from stainless galvanized and colored steel. There should be four planters on every street block along the eco-boulevard.

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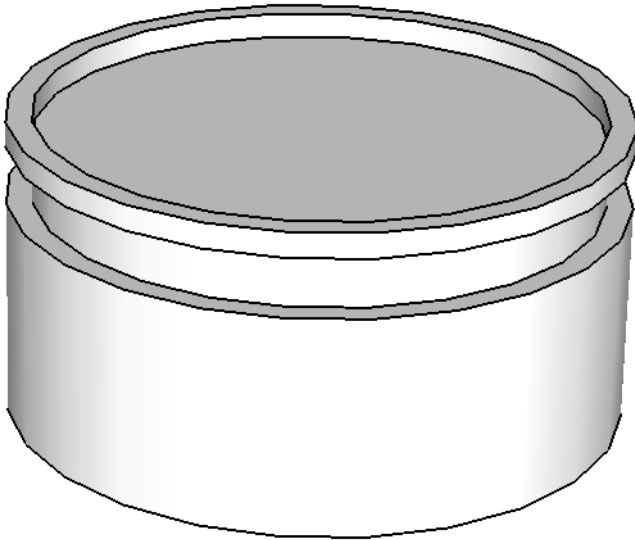


Figure 61. Planter. Megan Bryan

Street Light

All the street lights located on the eco-boulevard are simple in design. Figure 63 shows that they consist of one large partial-arch form. The street side of the arch form terminates with a LED light. The street lights are approximately fifteen feet in height. The fixtures are spaced 50 feet apart from each other. There are three to six street lights located on each street block along the eco-boulevard (depending on block length).

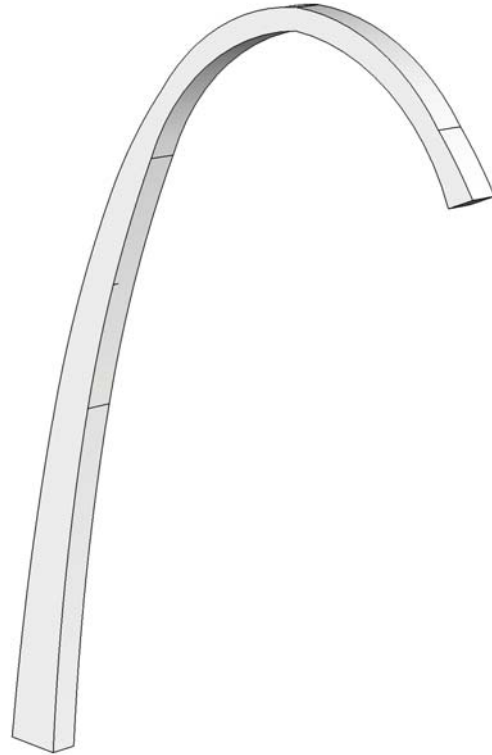


Figure 62. Street Light. Megan Bryan

Banner Pole

All the banner poles located on the eco-boulevard are simple in design. Figure 64 shows that they consist of one main pole with two arms on either side of the pole (near the top). There is a banner on either side of the main pole. Each banner has a series of Eastern Redbud (*Cercis Canadensis*) leaves on it to represent a common species found in St. Louis. The banners are interchangeable and should be changed for each season and for special events. The banner poles are located every twenty feet and on both sides of the eco-boulevard.

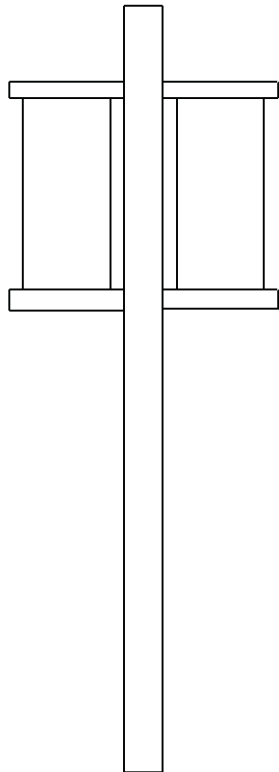


Figure 63. Banner Pole. Megan Bryan

Bike Rack

All bike racks located on the eco-boulevard are simple in design. Figure 66 shows that the bike racks consist of five arches that are all 18 inches high and two feet apart from one another. The racks are made from stainless colored and galvanized steel. Two bike racks are located near each light rail station. Four or more bike racks are located near Busch Stadium and America's Convention Center Complex.

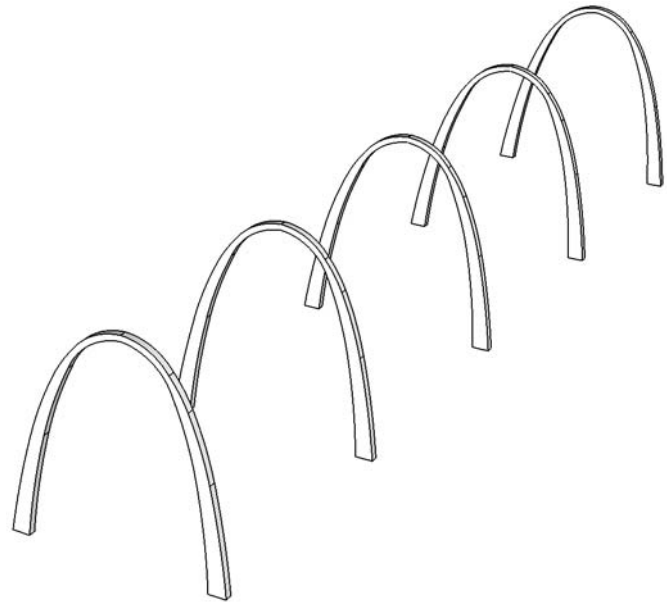


Figure 64. Bike Rack. Megan Bryan

Tree Grate

All tree grates located on the eco-boulevard are simple in design. Figure 66 shows that the tree grates are able to be adjusted in size for healthy tree growth. In between both rings are seven decorative arches. The tree grate is made from stainless colored and galvanized steel. These decorative tree grates are located at the base of every street tree along the eco-boulevard.

Street Trees

All the street trees located on the eco-boulevard are either a Eastern Redbud (*Cercis Canadensis*, Figure 67) or Green Ash (*Fraxinus Pennsylvania*, Figure 68). The Green Ash is one of the most commonly used street trees in all of St. Louis City. The Eastern Redbud is another commonly used tree in St. Louis. The street trees are located every twenty feet along the eco-boulevard. Light maintenance is needed for trimming and cleanup.

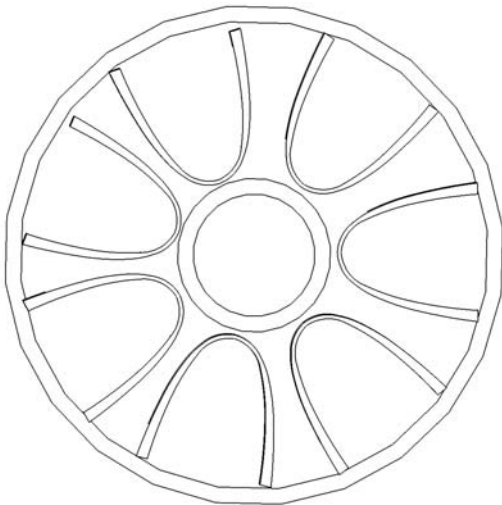


Figure 65. Tree Grate. Megan Bryan



Figure 66. Eastern Redbud. Geoffrey VandeReit Figure 67. Green Ash. Geoffrey VandeReit

Signage

All signage elements located on the eco-boulevard are simple in design. Most of the signage found on the eco-boulevard is educational. As seen in Figure 69, the signage explains the purpose of the eco-boulevard, description of the design of individual BMPs, description of water flows, and the importance of capturing and storing water. At least two educational signs will be located on each street block. More signage is located where individual BMPs are located to help further explain their importance.



Figure 68. Educational Signage. www.communitygarden.org

Covered Trench Grate

Shown in Figure 70, all the covered trench grates located on the eco-boulevard are simple in design. The trench grate covers are a colored metal that is located on grade and expands the entire length of the eco-boulevard. The covered trench grate is a minimum of six inches wide to the maximum of three feet wide to provide visual variety along the street. The covered trench grates collect water and either feed the water directly into a nearby BMP or to the underground storm sewer system.



Figure 69. Covered Trench Drain. www.ironsmith.com



Conclusions and Recommendations

Conclusions

Challenges

Although the process of creating a design proposal for the eco-boulevard had many advantages, there were also some challenges that were faced. The location of existing utilities was difficult to find. There is very little documentation of the underground utilities for downtown St. Louis. HOK had little documentation of the existing utilities in the St. Louis Central Business District but thought the utilities ranged in depth anywhere from 18 inches to 25 feet deep underground. Having a better understanding of the location and depth of utilities on site could have influenced some design decisions like placement of BMPs or depths of BMP planting beds.

Another challenge to this project was trying to retrofit the design into an existing site that is very urbanized. Existing large building footprints and established roads limited the amount of space to implement an eco-boulevard within the right-of-ways. Also, working within the existing sidewalk widths became a struggle at times. Some of the sidewalk widths are only ten feet wide. The narrow width of the sidewalks made it difficult to place street trees and other site furniture.

Lastly, accommodating for the pedestrian became a challenge, especially within the narrow sidewalks. Maintaining the ease of pedestrian flow was an important factor, but, the overall connectivity and unity of the eco-boulevard was also an important factor. Trying to accommodate all factors was difficult. However, the unifying aesthetics of the eco-boulevard were placed in areas that were unobstructed to the pedestrian.

Opportunities

One of the opportunities of implementing an eco-boulevard is that it slows and collects stormwater runoff rather than the runoff flowing directly into the underground storm sewer system and being pumped to a nearby tributary. If implemented as shown in this document, the St. Louis CBD eco-boulevard would collect 8% of stormwater during a two-year storm event. Although this is a small percentage of water being collected, the success of the three BMPs could persuade future development stakeholders. If future CBD developments incorporate a variety of thoughtfully considered BMPs, far more than 8% of stormwater could be slowed, collected, and reused.

The eco-boulevard can serve as a learning tool for the public. The BMPs along the eco-boulevard can educate the public on how stormwater can be captured and recycled. Proper signage informs the public about watersheds, water conservation, stormwater cleansing and storing techniques, and grey water uses. The eco-boulevard also contains benches, trash receptacles, and planters that are made from recycled material to inform the public about reusing old materials.

This eco-boulevard could influence future development. In future development, stakeholders should be aware of how much stormwater runoff from building gutters and the ground surface would be produced and piped underground. If the designers and stakeholders use the eco-boulevard as an inspiration to have more thoughtful design ideas then more stormwater can be collected and reused. Other types of BMPs that can be used and retrofitted into an urban environment are green roofs, cisterns, permeable paving, filtration, rain barrels, and a detention pond (Refer to Appendix A).

Recommendations

The eco-boulevard can serve as a prototype and precedent for other cities to implement in their urban environment. In order to implement the eco-boulevard the following process needs to be followed:

1. **Locate the major transportation hubs and major pedestrian traffic routes in the area.** These two things are important when trying to find the most suitable location for the eco-boulevard. The eco-boulevard should be seen by the highest number of people every day. Placing the eco-boulevard along the major transportation routes and in the highest pedestrian traffic route will force people to notice and have a better understanding of the purpose of the eco-boulevard. Figure 71 shows the location of the light rail stations and heavy used pedestrian traffic.

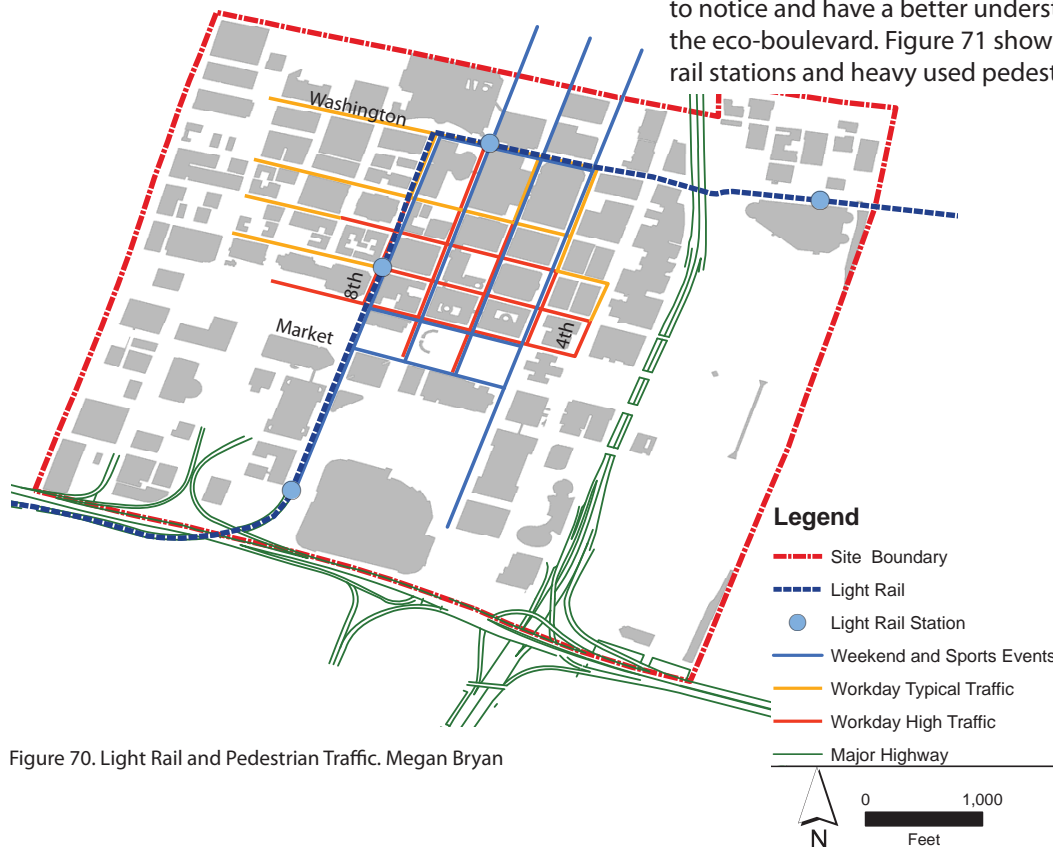
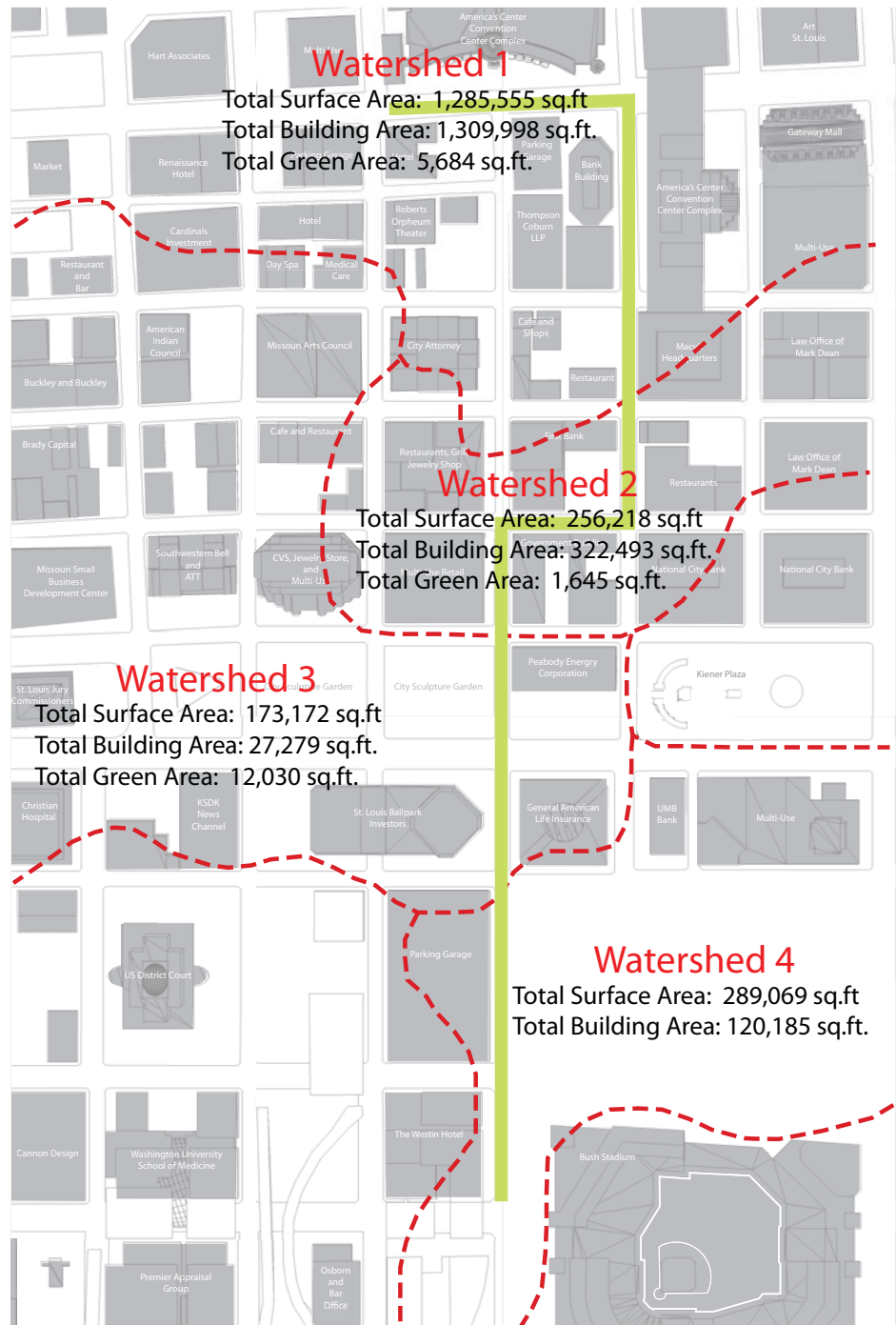


Figure 70. Light Rail and Pedestrian Traffic. Megan Bryan

2. Determine the flow lines and ridge lines to determine the watershed boundaries. Find the high points on site because these determine the breakpoints of a watershed and begin to outline the boundary of the watersheds. The ridge lines determine a break of where the water is flowing. Once all the break points and ridge lines are determined, begin to draw the watershed boundaries to know where water is flowing. Figure 72 shows the watershed boundaries in the St. Louis CBD.



Not to Scale

Figure 71. Watershed Diagram. Megan Bryan



3. **Locate the low points within each watershed.** Figure 73 shows the low points determine where the water in each watershed is flowing. These low points may be the most suitable locations for the placement of BMPs.



Not to Scale

Figure 72.Drainage Diagram. Megan Bryan

4. **Within each given watershed, calculate how much water flows into each existing low point.** The amount of water that flows into each low point will help to determine the size of the BMP or water storing mechanism. If the amount of water flowing into the low point is more than what the BMP can store, other means will have to be determined, or, reroute the water to flow into another BMP or into the existing storm sewer system.
5. **Research what types of BMPs are appropriate in the city's environment and ecoregion.** There are different types of BMPs that can be retrofitted in an urban environment. Find the one that is best suited with your city (refer to Appendix A).
6. **Size the BMP according to how much water will be collected and how much space is within the ROW.** The size of the BMP will be determined by how much water is flowing into the BMP, but will also depend on how much space is existing in the ROW. If the size of the BMP is larger than the ROW, you may need to reduce the size of the BMP and divert some of the water into a different BMP or the existing storm sewer system.
7. **Connect the BMPs with a visual connector such as street trees, paving materials, and covered trench drains.** Provide unifying elements to connect all the BMPs. Make the eco-boulevard a unique feature in the urban area. The eco-boulevard should stand out aesthetically from the other streets of the area.
8. **Provide pedestrian amenities at key locations for the everyday user.** Include pedestrian amenities with unified aesthetics such as benches, planters, trash receptacles, bike racks, street lights, and banner poles (refer to Chapter 8).
9. **Provide educational signage to help the pedestrian understand the need and importance of an eco-boulevard.** The signage will help the pedestrian to understand the purpose of the eco-boulevard. The signs will also describe the water flow into, through, and exiting each BMP. Signs give a reason behind the design and give the pedestrian a reason to care about the eco-boulevard's design.

Contributions to the Landscape Architecture Profession

The concept and design of the St. Louis eco-boulevard contributes to the landscape architecture profession in the following ways:

A value for ecological concern. For as long as I have been studying landscape architecture, ecological studies have not been a huge concern in most project. This eco-boulevard project has made me focus on the urban ecological concern of St. Louis. However, St. Louis is slowly reviving its urban core. More attention to ecological problems have had a higher degree of focus. The recent design of the new City Garden has made steps toward the ecological drought in St. Louis. The implementation of an eco-boulevard can help aid in this concern. Both the City Garden and eco-boulevard capture stormwater in a unique manner. As new development in the area progresses, some different measures of maximizing ecology in an urban environment can help change the identity of St. Louis.

Unique aesthetic quality. The eco-boulevard captures stormwater runoff in several different ways. Some water is collected from the ground surface and some from building rooftops; making a statement to the public about several of the different ways stormwater can be captured and recycled. The artful and unique treatment of a building façade and covered trench drains in the paving along the eco-boulevard begin to give St. Louis an identity that differs from other urban areas.

Resource conservation. The collection of stormwater has seemingly become more popular in all areas of the United States. Stormwater runoff can cause stream impairment in urban areas. Large volumes of water are carried to local streams and lakes that can cause flooding and erosion. The capturing of stormwater runoff can be recycled into a building for grey water purposes. This way, fresh water is being conserved for other purposes.

Opportunities for future development. The eco-boulevard has set an example for how stormwater runoff can be collected, stored, and recycled in urban areas. There are other areas in downtown St. Louis that can implement the myriad of BMP types. For all other future development, planners and designers should consider alternative ways to capture stormwater and incorporate them into the design.

Appendix A: Acknowledgements

First, I would like to thank my family for always being there for me, especially my parents. Without my family I would not have gotten the little extra push I needed to be where I am at today. Thank you for always believing in me. I would also like to thank my nephew Michael. Even though you are such a young and sweet baby, there is not a day that goes by when I do not think about you. You have taught me patience and to have a free spirit.

Thank you to the professors who have helped me through the master's project process. A special thanks to Melanie Klein for dealing with me on a daily basis. Thank you for all of your very helpful input and suggestions. This project would not have been as successful without your help. Thanks to Dennis Law and Stephanie Rolley who have given me great feedback and guidance throughout this process. Thanks to all of my professors I have come across in the past six years from both University of Missouri Kansas City and Kansas State University. You have truly molded me into the best and well prepared landscape architecture student I could become.

A special thank you to Andrew Kilmer from HOK St. Louis and William Bailey from St. Louis Planning and Urban Design Agency for giving me information that was needed to accomplish a specific site inventory and analysis.

Lastly, I would like to thank the three best studio-mates, and friends, I could ask for. Aaron, you have been my big brother for the past four years. Thank you for always being the one who can laugh with me (and at me when times are needed). It will always be a "lonely car ride without you by my side." Jon, thanks for always being the person I can go to for advice or to share a secret with. You are a rare and trustworthy friend to come-by. "Thank you Larry." Andrew, thank you for always showing me how to "chill out" and relax when I get all worked up. Thanks for also always providing the daily music to keep everyone in a light mood. "The eagles are flying."

Appendix B: Alternative
Urban BMPs

Alternative Urban BMPs

There are many different types of BMPs that can be retrofitted into an urban area: green roofs, cisterns, permeable paving, filtration, rain barrels, and a detention pond.

Green Roofs

Green rooftops are used to store and treat rooftop runoff. Also known as a “living roof” or “eco-roof,” they consist of a layer of vegetation and soil installed on top of a conventional roof. A green rooftop can be installed on small garages and larger industrial, commercial and municipal buildings. Green rooftops can be designed as extensive or intensive systems. Extensive systems have a thin layer of soil and a cover of grass or moss, while intensive systems have a thicker soil layer, may contain shrubs, trees and other vegetation, and are designed as a landscape amenity (EPA Urban Stormwater Retrofit Practices Appendix F 2007, 71-74).

Cisterns

Cisterns capture and reuse rooftop runoff from non-residential sites in a subwatershed. They consist of devices that retain runoff storage volume in aboveground or underground storage tanks. Runoff collected in the tank can be used for outdoor watering, gray water needs or in some cases, even drinking water supply. Stored rainwater provides an opportunity to conserve water and reduce water utility bills. Cisterns are generally much larger than rain barrels and typically have a capacity of more than 10,000 gallons. Since outdoor residential irrigation can account for up to 40% of domestic water consumption in the hot summer months, cisterns can conserve water and reduce the demand on the municipal water system. Cisterns are not yet widely used in most regions of the United States but can be incorporated into high-density green buildings (EPA Urban Stormwater Retrofit Practices Appendix F 2007, 69-70).

Permeable Paving

Permeable pavers treat or reduce parking lot runoff using a porous or semi-porous material on driveways, access roads, parking lots and walkways. Permeable pavers can also allow for underground storage or infiltration of runoff, which can reduce stormwater flows compared to traditional non-porous surfaces like concrete or asphalt pavement (EPA Urban Stormwater Retrofit Practices Appendix F 2007, 87-89).

Filtration

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting it in an underdrain and then returning it back to the storm drain system. The filter consists of two chambers; the first is devoted to settling, and the second serves as a filter bed (with sand or an organic filtering media) (EPA Urban Stormwater Retrofit Practices 2007, 187-192).

Rain Barrels

Rain barrels are used to capture, store and reuse residential rooftop runoff. They consist of a simple stormwater collection device that stores rainwater from individual rooftop downspouts. Stored water can be used as a source of outdoor water for car washing or lawn or garden watering. The rooftop runoff stored in a rain barrel would normally flow onto a paved surface and eventually into a storm drain. Rain barrels typically have a capacity of 50 to 100 gallons of water (EPA Urban Stormwater Retrofit Practices Appendix F 2007, 75-77).

Detention Pond

Wet ponds consist of a permanent pool of standing water that promotes a better environment for gravitational settling, biological uptake and microbial activity. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to re-suspension of sediments and other pollutants deposited during prior storms. When sized properly, wet ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate (EPA Urban Stormwater Retrofit Practices 2007, 103-106).

Appendix C: Glossary

Accessibility- the ability to reach destinations, activities, and services. Source: Great Streets Initiative, St. Louis

Bioretention- Bioretention is a landscaping feature adapted to treat stormwater runoff at retrofit sites. Individual bioretention areas can serve drainage areas less than an acre in size. Surface runoff is directed into a shallow landscaped depression. The depression is composed of 18 to 48 inches of soil depth with a mulch layer on top. Bioretention creates an ideal environment for filtration, biological uptake, and microbial activity, and provides some pollutant removal. Bioretention can become an attractive landscaping feature with high amenity value and community acceptance (EPA Urban Subwatershed Restoration Manual 1997)

BMP- A storm water best management practice (BMP) is a technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of storm water runoff in the most cost effective manner. BMPs can be either engineered and constructed systems (“structural BMPs”) that improve the quality and/or control the quantity of runoff such as detention ponds and constructed wetlands, or institutional, education or pollution prevention practices designed to limit the generation of storm water runoff or reduce the amounts of pollutants contained in the runoff (“non-structural BMPs”). No single BMP can address all storm water problems. Each type has certain limitations based on drainage area served, available land space, cost, pollutant removal efficiency, as well as a variety of site-specific factors such as soil types, slopes, depth of groundwater table, etc. Careful consideration of these factors is necessary in order to select the appropriate BMP or group of BMPs for a particular location (EPA Urban Subwatershed Restoration Manual 1997, 171-174).

CBD- Central Business District of downtown St. Louis, Missouri

Corridor- pathway allowing movement between activity centers; may encompass single or multiple transportation routes and facilities, adjacent land uses, and the connecting street network. Source: Great Streets Initiative, St. Louis.

Curb Cut- Curb cuts are used to direct water into a stormwater facility that is associated with streets and parking lots. Curb cuts, within a raised curb condition, allow stormwater to enter a stormwater facility, such as a bioretention area, at specific points, thus concentration runoff is decreased in both in velocity and volume (EPA Urban Subwatershed Restoration Manual 1997)

Eco-boulevard- In addition to serving as a visual and physical connector, the eco-boulevard also connects the local residents with other local residents by serving as its own destination. The eco-boulevard will also serve the function of collecting and treating stormwater runoff from the surrounding area. The definition of eco-boulevard is a two-fold: a green ribbon that collects and treats stormwater runoff, while also serving as a pedestrian connection between urban destinations

Green ribbon- a linear green strip that connects people visually and physically to surrounding uses

Greenway- A protected open space area following a natural or man-made linear feature; greenways are often used for recreation, transportation, and conservation, and to link amenities. Source: Great Streets Initiative, St. Louis.

Infiltration Trench- An infiltration trench is an excavated trench; usually three to twelve feet deep. A small portion of the runoff is diverted to the infiltration trench, which is located either underground or at grade. Pollutants are filtered out of the runoff as it infiltrates the surrounding soils. Infiltration trenches also provide groundwater recharge and preserve base flow in nearby streams (EPA Stormwater Technology 1999, 2-3)

Jefferson National Expansion Memorial- also known as the Gateway Arch

Light Rail- the mass transit train line that runs underground in downtown St. Louis. The line also stretches to surrounding counties above and underground.

MetroLink- the name of the light rail system in St. Louis, Missouri

Path- a concentration of some special use or activity along their margins, a characteristic special quality, a special texture of floor, particular lighting pattern, unique set of smells or sounds, typical detail or mode of planting (Lynch)

Pedestrian- person either on foot, bicycle, skates, or any other means of transportation, other than a vehicle

Pedestrian Friendly- A built environment that emphasizes and is conducive to walking between destinations. A pedestrian friendly environment may include sidewalks, buffers, street trees, benches, fountains, transit stops, pedestrian-oriented signs and lighting, public art, and buildings that are visually interesting with high levels of transparency and articulation. Source: Great Streets Initiative, St. Louis.

Public Destination- a local attraction in which many tourists come to visit

Row- Right-of-way- Public strip of land on which streets, sidewalks, alleys, transit and railroad lines, and public utilities are built. Source: Great Streets Initiative, St. Louis.

Runoff- stormwater runoff is generated when precipitation from rain and snow melt events flow over land or impervious surfaces and does not percolate into the ground. As the water runoff flows over the land or impervious surfaces, it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. The primary method to control stormwater discharges is the use of best management practices (BMP's). Source: U.S. Environmental Protection Agency

Appendix D: Annotated Bibliography

Carmona, Matthew, Tim Heath, Taner Oc, and Steve Tiesdell. 2003. Public Places Urban Spaces. Jordan Hill, Oxford: Architectural Press.

The authors discuss how urban design has been implemented in the past and how urban designers can make a place “better.” They say that “while urban design’s scope may be broad and its boundaries often fuzzy, the heart of its concern is about making places for people” (p.vi). Because of this thought, the authors developed six dimensions of urban design for designers to take into consideration to make a place better for the users. The six dimensions are: morphological- the layout and configuration of urban form and space (p.61), perceptual- the awareness and appreciation of environmental perception and the experience of a place (p.87), social- a continuous two-way process in which people create and modify spaces while at the same time being influenced by them in various ways (p.106), visual- the aesthetics of a place (p.130), functional- how places work and how urban designers can make better places (p.165), and temporal- how time will effect a place (p.193). Finally, at the end of the book, the authors describe how implementation and delivery mechanisms of the six dimensions can be accomplished. The concepts in this book have been applied to the eco-boulevard designed in the CBD of St. Louis based on the six dimensions. The dimensions of morphological, perceptual, social, visual, functional, and temporal have been analyzed and some of them have aided the design of the eco-boulevard.

Echols, Stuart and Eliza Pennypacker. From Stormwater Management to Artful Rainwater Design. Landscape Journal . February 2008 Issue.

The authors discuss new stormwater management techniques to capture rainwater to enhance a specific site’s aesthetic. The concept of artful rainwater design addresses stormwater management in environmentally responsible ways and creates expressive landscapes that celebrate stormwater. The goals and objectives of different projects are presented and focuses on how stormwater management is a focal site amenity. There are five main goals drawn from the series of projects: education, recreation, safety, public relations, and aesthetic richness. Education entails creating conditions to learn about rainwater and stormwater runoff related issues. Recreation entails creating conditions for interacting with the stormwater systems in a way that is relaxing, amusing, and refreshing. Safety promotes safe interaction with stormwater treatment systems by mitigating danger associated with water. Public relations create symbolic stormwater statements about the values and qualities of those who created and own the site. Aesthetics create an interesting experience of beauty or pleasure focused on stormwater. The design of the eco-boulevard has incorporated some of these key concepts. The education and aesthetic concepts have played a major role in the eco-boulevard.

Kunstler, James. 1996. Home from Nowhere. New York: Simon and Schuster.

Kunstler discusses how our cities and suburbs have changed post World War II. Before, places were inviting and demanded interaction between people. The term New Urbanism has been introduced and Kunstler says, "New Urbanism is revolutionary because it starkly contradicts the world of suburban sprawl that has become the real setting for our national life" (p. 19). He believes that the New Urbanism movement has been one of the most hopeful developments because many of the damaged and abandoned institutions of our civic life may follow into restoration (p. 20). This book seeks to restore the standards that have been lost and "revive standards of work and orders of design that might be described as classical" (p.20). The ideas of New Urbanism have developed from how people used to live decades ago. The eco-boulevard fulfills some of the key ideas that have been lost in downtown areas. The eco-boulevard addresses some of the key ideas that have once been present in urban areas, such as, having people interact on a daily basis.

Lynch, Kevin. 1960. The Image of the City. Cambridge, MA: Harvard University Press.

The author, Kevin Lynch, discusses how people may move through an urban landscape. In order to do so successfully, Lynch argues that people make mental maps of paths, edges, districts, nodes, and landmarks. Of these five elements, paths seem to be the most important since these organize movement in the urban environment. From these 5 elements, urban designers should be able to create a clear mental map of their environment, be able to learn how to move throughout the environment, and be able to act upon in the environment. A mental map that is carefully drawn gives people a sense of security as they travel through the city. During the design phase of the eco-boulevard, the five elements that Lynch presents; paths, edges, districts, nodes, and landmarks, have been taken into account. Some of all of the elements are present in the design, thus, resulting in human interaction with other humans and with the landscape.

Safdie, Moshe, and Wendy Kohn. 1997. *The City After the Automobile*. Toronto: Stoddart Publishing Co.

The authors, Safdie and Kohn, discuss the past, present, and future of the city with a focus of the vision of the “town center”. In the past, the evolution of cities was based on the need to exchange goods with one another. During these exchanges, people interacted with one another in a town center environment “which made for a better and richer society” (p. 31). Today, “in almost every city, crucial sections of originally thriving downtowns are dying” (p. 32) and have been occupied by the lower-income population. Older traditional streets of shops and local businesses have been challenged and replaced by large-box commercial centers, parking lots, and indoor malls. In the future, “the new urban center will be linear, structured by a spine of intense activity” (p. 154). At either end, it would be served as a transportation node including a regional rapid train station (p. 155). The eco-boulevard serves as a “spine” in the CBD of St. Louis. The eco-boulevard incorporates transit stations and has areas of activity. By including both transit stations and activity zones, more people will be introduced to the eco-boulevard and more likely to use the spaces provided.

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