2022

Cruser Place Green Streets Plan

Neal Friedman

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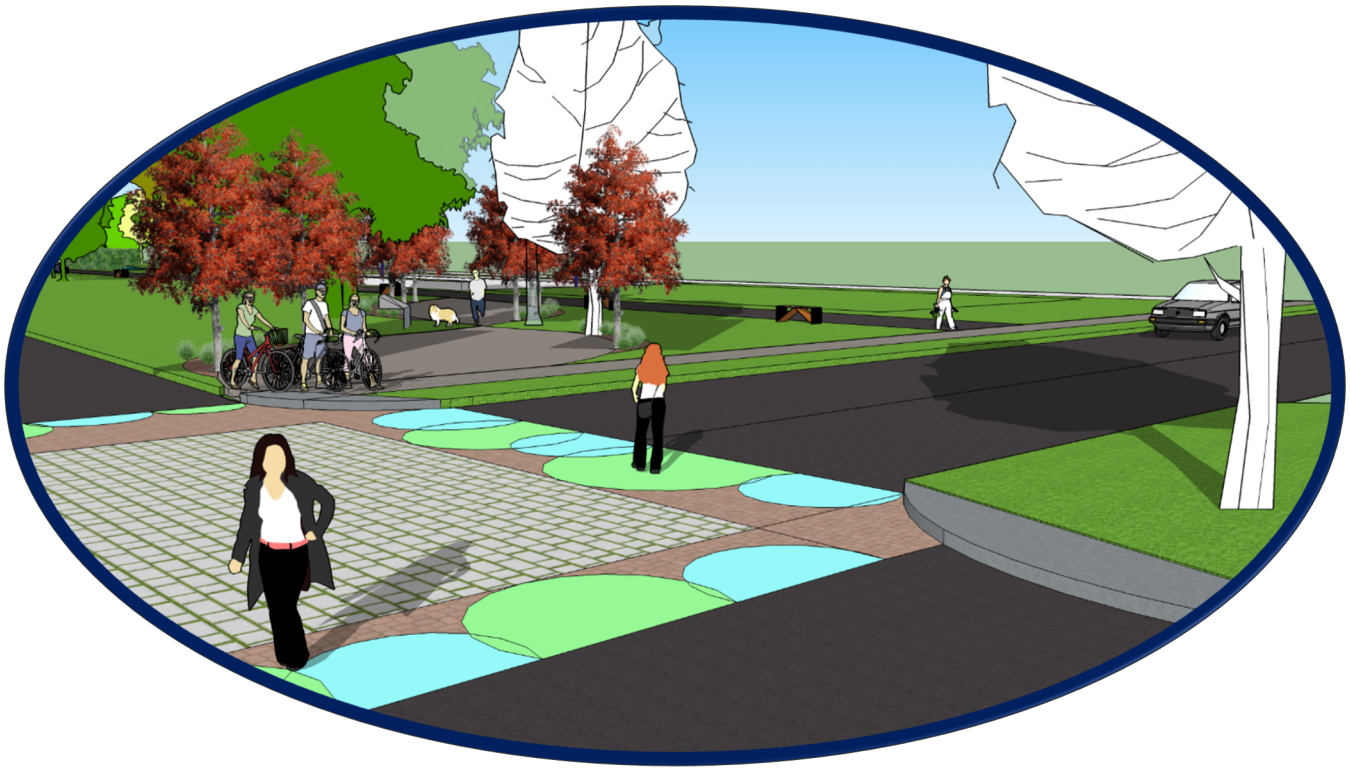

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1. Introduction

1.1 Purpose: Streets have an environmental, social and economic purpose. Planners, engineers, architects and activists study and promote how street design can be used as a tool to better manage water and create more dynamic places (Jordan, 2021; Hui, 2020). The link between street design and water management presents an opportunity to leverage the latter to keep the community focused, particularly as communities begin to adapt to sea level rise. In communities, like Cruser Place, where flooding is common, the opportunity becomes even more salient. The purpose of this project is to provide recommendations for how elements of complete and green street design can be implemented within the study area as part of the overall effort of stormwater-management. Two major goals are therefore to mitigate the effects of stormwater and improve the pedestrian experience.

1.2 Clients: The main client for this plan is the *Colonial Place-Riverview Civic League,* an active civic league representing three adjoining neighborhoods originally planned as streetcar suburbs in the early 20th century. The civic league officially covers Colonial Place and Riverview but also represents residents of Cruser Place. The civic league states its objectives are "to promote the development of our neighborhoods as a better place to live; to unite for cooperation and interchange of ideas; to encourage the participation of all interested individuals in the activities of the League; to further the best interest of these neighborhoods towards beautification, historical appreciation, recreation, the safety and security of its residents, and the protection of their property" (Bylaws, N.D.). The president of the civic league is Michael Langston.

Figure 1. Civic League Logo

The secondary client is the *Norfolk Preservation Collective.* The collective's mission is to "promote the positive impacts of historic preservation in our city, and to bring together a diverse and inclusive network of residents, professionals, and businesses interested in history, architecture, place, and community" (Norfolk Preservation Collective, 2020).

2. Background

Complete and green street design have emerged as popular approaches to create more balanced transportation systems that serve to encourage active transportation.

What is a complete street?

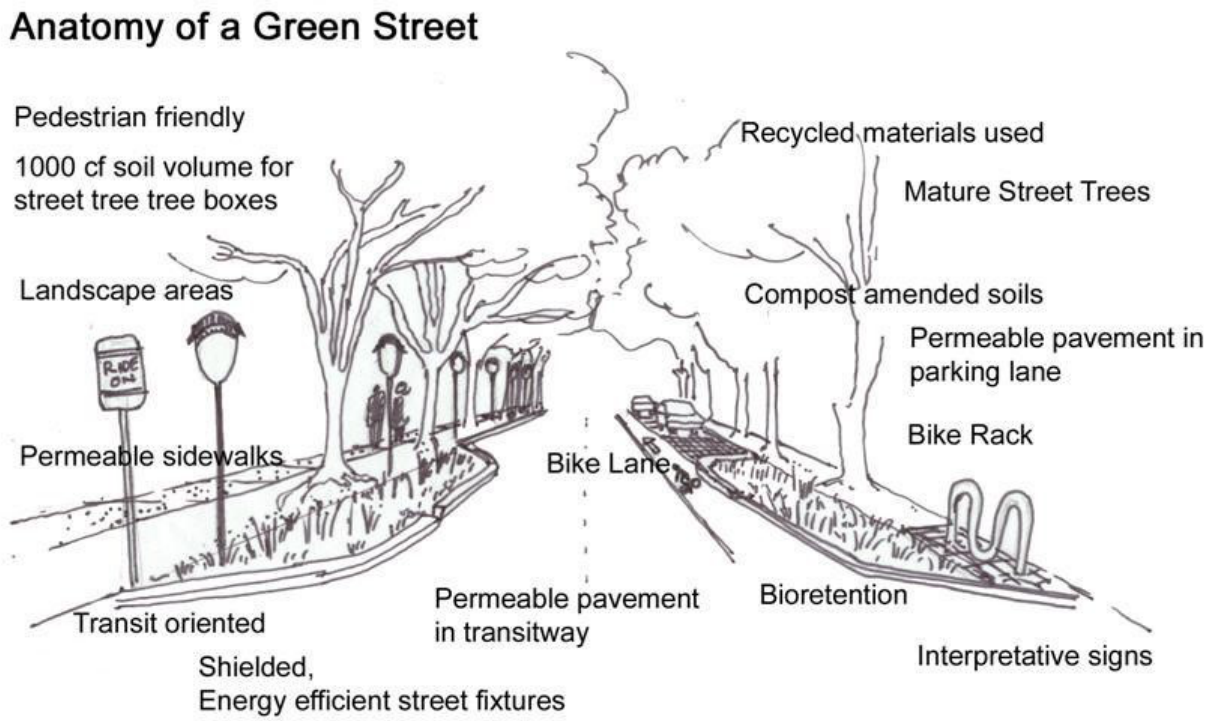
- Complete streets *"are designed—or redesigned*[1]*—and operated to allow safe access to all people, regardless of age, ability, income, ethnicity, or chosen mode of travel, including pedestrians, bicyclists, motorists and transit riders." (Norfolk Complete Streets, 2015).*

What is a green street?

- *"A street that uses natural processes to manage stormwater at its source"* (EPA, 2009)[2]

Concrete, asphalt, most building materials known as permeable surfaces, limit the amount of rainwater that reaches the ground, disrupting natural filtration processes of soil. A green street is "designed" to reverse this dynamic in order to mitigate the environmental effects of urban development. In doing so, green street design can improve a place's aesthetic qualities and shape a safer pedestrian experience.

Figure 2. Anatomy of a Green Street.



[1] Redesign is important, because many complete street initiatives involve reversing older decisions to retrofit roadways.

[2] EPA Green Street Manual

In practice, the many variations of complete and green streets reflect their context. Whether it is a shared street, a neighborhood street, a greenway, a mixed-use street or avenue, an attempt is made to balance the multiple demands placed on a street. Green street design can range from simple landscape additions installed to catch minimal rainfall to comprehensive stormwater management schemes that encourage alternative forms of transportation and blur the line between public and private space (Vermont Green Streets, 2019).

As this document progresses, it will become evident that street design operates in layers. What lies below the surface matters just as much as what lies above it. Thus, the design process is inherently multi discipline and site specific. Some of these design considerations are questions of engineering, climatology and hydrology. Bioswales for example may not be appropriate in an area with a high water table.

Street design is both a physical and conceptual puzzle. Physically, it involves the actual rearranging of space. In this way, the street is built or designed as an "ensemble" of many different pieces making up a "unified whole" (Steuteville, 2012). Conceptually, complete and green streets balance environmental, social, economic and cultural demands, demands that are often in conflict.

2.1 Literature Review: *Complete Streets, Green Streets, Multimodal Planning and Integrated Stormwater Management*

This literature review will explore the common elements, benefits and challenges of street design, multimodal planning and integrated stormwater management, specifically for places confronting increasing pressures of sea level rise. Multimodal planning considers diverse transportation options and the connections between them. The power of complete streets is its championing of both access and safety, represented by Vision Zero, an equity focused transportation movement whose mission is to eliminate traffic fatalities (Austin, 2020). Green streets are often rationalized as water management tools, though they can be much more. Integrated stormwater management schemes utilize green street design as a central feature of redevelopment. Even though complete and green street design is now popular across the design, policy making and academic worlds, assessing their impact is still a case by case, cross disciplinary affair.

2.1a. Complete Streets: "Complete Streets" is more of a slogan for an approach in transportation planning than a specific layout or definition of a street. Physically, complete street design typically involves slowing down car traffic or reallocating road space to pedestrians through a number of design interventions such as bump outs, sidewalk widenings, road and/or lane diets, bike lanes, mixed use paths, robust crossings, lighting, street furniture and more. Complete street design schemes ideally increase walkability, which can be defined as "how suitable" a place is for walking (Im, 2019) or bikeability, "the extent to which an environment is convenient for biking" (Reggiani et. Al. 2021). Most official definitions make clear that a complete street is designed *for all.*

Planners, designers and activists have also had relative success using what is sometimes known as tactical urban design strategies such as painted-on pedestrian improvements, but cost of construction is usually a major factor in building out complete streets (Oahu Plan, 2019). These tactical improvements may lead to capital improvements; they may not; tactical urbanism may act in concert with official improvements; it might not.

Considering the variety of choices made in designing or redesigning streets, Lenker calls complete streets a "collection of decisions" (Lenker, 2016). In coastal areas such as Norfolk, these decisions increasingly involve the consideration of a place's often challenging relationship with water.

2.1b. Green Streets: Green streets can be defined as streets that incorporate landscape features or green infrastructure to better manage water. The street network is intimately connected to sewage and drainage systems. Because stormwater runoff is a major source of water pollution in many urban areas, green street design allows streets to serve an "environmental purpose" through devoting space to green infrastructure or natural surfaces and/or landscaping that lets water reach below the urbanized, paved surface, mimicking natural filtration (EPA, 2014) (Valencia & Ramirez). "Green infrastructure refers to the patchwork of natural areas" (in many shapes and sizes) within an urban area "that provides habitat, flood protection, cleaner air, and cleaner water" (EPA, 2020). "Unlike traditional streets, green streets "retain" as much water as possible "at the source," rather than "discharging run-off off site" (Ferell et al, 2020). The process of storing and filtering water within a street's right of way reduces the amount of pollutants that reach a nearby waterway (Altshuler et. al, 2018). In urban areas dominated by impervious surfaces (it's estimated that roadways and parking lots make up about two thirds of impervious services in urban areas), green street policy and design views the street as a space of unrealized environmental stewardship (ELI, 2019).

Green street design includes landscaping that intentionally breaks up impervious surfaces and increases tree cover, thus managing stormwater, slowing traffic and reducing the urban heat island effect, the tendency for urbanized areas to experience higher temperatures than undeveloped areas (ibid.). A green street can include all or some of these features in more or less "decentralized arrangements," depending on the project (Zhang et al, 2018):

- *Permeable pavement or pavers*: incorporation of porous pavement that allows water infiltration to a soft layer underneath the pavement.
- *Bioretention features*: depressed vegetative areas in which water can filter. This can come in many forms (bioswales, rain gardens, planters) and require varying degrees of maintenance. Depending on space requirements, planters can be contained or floating. Turf block and infiltration basins also increase bioretention by storing and filtering water.
- *Tree filter*: similar to bioretention, but can include structural elements to fit trees into compact urban areas (ibid.).

We can think of these design features (which will be expanded on later in this plan) as a "series of sponges" that soak up water before it reaches centralized sewer systems, temporarily holding and treating water at the source, within the right of way (Haren, 2020). Most importantly, the extra cost of green street features, not considering their social benefits, may be offset if "it is not necessary to install an underground drainage system or curb and gutter drainage system" (Portland, 2018).

Although stormwater management has been called the "workhorse" of green street development, green streets provide other direct and indirect services (Dill et. Al, 2020). Ideally, green streets simultaneously manage water, improve pedestrian safety, fight pollution, decrease energy consumption and decorate urban space through a number of different landscape designs, some simple, some more complex, like rain gardens, bump outs, bioswales, biostrips and planters (ibid.). The primary functions of a green street include water purification and temperature control. Secondary functions include improved pedestrian safety and aesthetics. The benefits of green streets go beyond water management.

2.1c. Combining Complete & Green: Sometimes framed as distinct approaches, complete streets and green streets overlap enough in practice that some argue they "should be thought of as part of a single approach towards building more sustainable streets," especially in areas in which stormwater management is a pressing need (Hui et. Al 2017). Complete streets are typically promoted as boosters of public health. Their claimed benefits include urban revitalization, improved pedestrian safety, reduced vehicle usage and fuel consumption, and improved access to services for older adults, children and people with disabilities (Lenker et. Al, 2016). Primarily through managing runoff, or the flow of water off of impervious surfaces, green streets play a role not only in supporting public health, but also in supporting ecological health. These benefits are intertwined with each other, and evidence supports the intuitiveness of combining complete and green. For example, Hui found that increasing vegetative cover through bio strips and tree plantings increases walkability (Hui et al., 2017). Likewise, there is a causal link between tree planting and biker satisfaction (Valencia Ramirez, 2021). In some cases, green infrastructure like bioswales or rain gardens can double as pedestrian buffers, cutting back on the amount of crosswalk needed for an intersection (ibid.). Or conversely, a threat to public health can also be a threat to ecological health. Sewer overflows threaten humans and marine life alike (Choi, 2016). Greening techniques are essential components of complete streets in many contexts, and complete streets are generally thought of as integral parts of multimodal transportation systems.

2.1d. Multimodal Planning: Multimodal plans recognize that a transportation system is made up of different, complementary, types of trips, like walking, biking, public transit and driving[3]. In valuing flexible conceptions of accessibility (who has access to space), mobility (movement through space) and connectivity (quality and quantity of connections between places) over car centric notions of circulation, be it through an official embrace of concepts like the walkshed, the urban village or the 15-minute city, multimodal planning efforts attempt to produce more equitable transportation systems and outcomes (De Leon, 2020). On a larger scale, multimodal planning tries to use the transportation planning process to sustainably influence land use patterns and fuel consumption habits. At the neighborhood level, complete and green streets can be crucial pieces in fulfilling these goals, sometimes through the inclusion of specific guidelines and dimensions for street types within a multimodal plan. Overall, multimodal transportation planning considers the many different ways people get around a city in order to rebalance transportation systems long dominated by auto oriented investments (Norfolk Multimodal, 2020).

Multimodal planning is being adopted and enacted at various paces around the world, including in Norfolk. Internationally, multimodal planning works, albeit imperfectly, within emerging sustainable development paradigms like the circular city (Hess, 2009). On the West Coast, Seattle[4] and Portland are two more well-known examples of American cities that have undertaken extensive multimodal planning alongside significant investments in transit and zoning changes, while multimodal transportation plays a big role in Charlotte's 2040 comprehensive plan (Charlotte.gov, 2020). Locally, Norfolk began drafting a multimodal plan in 2019, identifying areas throughout the city to serve as multimodal hubs (Norfolk Multimodal, 2020). These are, or are intended to be,

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[3] **...also rollerblading, scootering, skipping, skateboarding, wheel-chairing, and running.**

[4] **About 20 years after first adopting a growth management approach incorporating multimodal hubs designated urban villages, most of Seattle's population growth occurs in urban villages.**

districts that serve as centers of local activity, housing, commerce and transit. Cruser Place has been identified as a multimodal center within the Riverview District in Norfolk's multimodal plan draft.

Although an expansion of Norfolk's sole light rail line is currently being studied, in most of Hampton Roads, choosing to walk or bike instead of driving is impossible for many people, a fact of life illustrated by survey responses for this plan. But multimodal design attempts to build transportation networks in which more people, including groups that are traditionally left out of transportation discussions like children, the elderly or people with disabilities, are able to realistically make that choice. Realistically, this depends on achieving a certain level of density missing in many American cities (Montgomery, 2014).

2.1e. Assessing Street Design: It is well acknowledged now that the reintroduction of even small amounts of what we consider nature into the urban environment has many positive benefits including reducing the urban heat island effect, increasing biodiversity, managing stormwater, soaking up noise, sequestering carbon and even improving mood (Montgomery, 2014). We know, for example, that one square mile of marsh stores the carbon equivalent of 76,000 gallons of gasoline annually (Altshuler et al. 2018). We can also confidently promote the positive impact of an urban tree canopy. How much water can trees soak up? The City of Lynchburg estimated that "during an average high-volume rainfall event" or 10-year storm, "the city's trees take up an average of 65.2 million gallons of water" (about 99 Olympic swimming pools) (GIC, 2019). For reference, the sewer system operated by the Hampton Roads Sewage District is designed to handle 249 million gallons a day (HRSD, 2020)! Additionally, there is a body of research demonstrating the positive pricing effects of pedestrian oriented design on real estate (Nemeth & Rigolon, 2019). These researchers essentially study the effects of the inclusion or the absence of green infrastructure on the broader urban environment.

A growing number of researchers are creatively measuring the impact of green infrastructure within the context of a street. In a "benefits analysis" of green streets in California, Hui was able to reach a few conclusions suggesting best practices, such as there is a "small but significant" monetary benefit to planting street trees, and that the age of trees affects their monetary value (Hui et. Al, 2017). Other scholars have conducted equity analysis of complete and green street distribution (Ahmed et al, 2016). In Toronto, researchers found that green street design works best with "common" rain events as opposed to larger more intense storms (Haren, 2020). In wetter regions like Norfolk, these smaller recurring rain events can make up a majority of a region's precipitation (ibid.). Common rain events are also significant, because a majority of runoff pollution is typically carried in the first ½ inch of precipitation (Marsh, 2005). Furthermore, with the right tools, it is possible to set quantifiable goals of rainwater retention for a proposed intervention. The Norfolk Blue Plan estimated that the plan's proposed green interventions along a stretch of Colley Avenue in the Highland Park neighborhood of Norfolk would capture and filter up to one additional inch of rain water per storm event (Norfolk Blue, 2020).

2.1f. Building Complete Streets; Building Community Support for Complete Streets: Community support (or lack of) is another influential context of multimodal planning and complete and green street design. The conclusions of these authors studying community involvement in genetics research almost ten years ago could easily apply to community engagement in urban planning:

- *"Public input into policy decisions is increasingly being promoted as 'decision makers and other stakeholders recognize the need to generate a wider range of policy options, increase the*

legitimacy of public policies and, more generally, improve the public's understanding of science." (Etchegary et. Al, 2013)"

Robust community input can drive the structure of a planning process, but meaningful participation in urban planning is difficult to achieve within existing power structures (Rosol, 2016). Scholars have identified best practices that may demand a slower pace and a longer time frame of a research project, especially with green street projects that change long accepted street layouts and patterns (Welch, 2016). Environmental justice scholarship explores the relationship between greening initiatives and socioeconomic change (Hui, 2021) (Mabon & Shih, 2018). Because of these well studied implications, transportation planners often cite the need to strike a balance between design guidelines and decision making, or technical expertise and public outreach and support (NJ Streets Guide, 2017).

Some community engaged scholarship utilizes methods of participatory research, in which research is designed to be a more collaborative effort between researcher and research subjects. In two separate studies participatory research methods have been used to gather a wide range of tidal measurements in Norfolk and produce more realistic walking maps of Athens (Mayfield, 2019) (Kapenakis & Chorionapolous, 2017). Collaborative mapping, done with online tools such as Google Maps, can augment a principal researcher's investigation and help correct for the blind spots a researcher or particular method may bring to the table (ibid.). In a survey of participatory mapping literature, researchers from NOAA summarized participatory mapping as "a general term to help communities learn, discuss, build consensus and make decisions about their communities and associated resources" (NOAA, 2020). NOAA includes on-site walks, interviews and collaborative GPS applications like Google Maps in its list of appropriate participatory mapping methods, but admits that potential for bias is high among all three (ibid.). Although it will not fit every situation, participatory mapping can be a powerful resource in which research is done by experts and non-experts (ibid.). Most of us know little about the technicalities of the streets we use every day. The process of building complete streets can operate as an educational and civic capacity building tool:

- *"The transition from the bygone era of promiscuous swamp draining to the contemporary age of comparative wetlands protection has not happened as a result of scientific expertise alone or through litigation alone. It has also required a broader – still ongoing – transformation of public values and commitments, to which end the arts of language and imagining have been indispensable […] (Swearer, 2009).*

2.1g. Adaptation and Historical Preservation: In relatively older cities like Norfolk, adaptation strategies can be used to stall the deterioration of historically or culturally relevant sites. Preservation adaptation strategies can be thought of on a macro and micro scale, by either crafting district wide guidelines or focusing on a specific property or structure (Keeping History Above Water, 2016). The first reflex in preservation is often to elevate structures (or streets). However, architects and engineers are developing ways to let water flow under and float structures in flooded areas (ibid.). Ultimately, these decisions involve the careful weighing of values and are left up to local officials or organizations. Here, like street design, historic preservation can be a community led process. A successful historic preservation movement demands a deep understanding of a place's context. Ironically, when we talk about historic preservation we are also talking about regeneration (Legner, 2010).

2.1h. Putting it all Together; *Integrating urban design, stormwater management and historic preservation:* So far, I have talked about complete and green street design as part of a multimodal transportation planning framework, but street design is also put to use in what is called integrated stormwater management frameworks. While there are many lessons to be learned from Portland and Seattle in the transportation planning arena, cities as diverse as Norfolk, Charleston and Newport, Rhode Island have to approach sustainability differently, because of the heightened risk of sea level rise they confront. These places share an intimacy with their surrounding waterways that form a fundamental part of their identities. Here, city planners, architects, engineers, and historic preservationists have all been thrust into the ring of climate change adaptation, and are crafting a new generation of adaptation policy. We can also include archaeologists in this motley crew of professions racing against the clock in places around the world most affected by rising waters.

Part of the puzzle of sustainable development involves looking more and more towards "non-piped solutions" to stormwater problems (Bohman, Klass & Carlson 2020). Today's emerging stormwater systems often propose, somewhat rhetorically, living with water as opposed to banishing it from the urban realm underground. This means using the right of way and private property to collect and store stormwater, reducing the overall volume and rate at which stormwater enters a sewer system to ultimately limit combined sewage overflow discharges in which wastewater is released into streams and rivers. Modern stormwater management regimes replace what has to be replaced of centralized sewer systems but also design elements to mimic natural filtration processes and bolster the capacity of the hydrological cycle within an urban area (ibid.). Similar to the differences between conventional and green street design, sustainable water management systems decentralize the management of water and incorporate aesthetic considerations whenever applicable. Sustainable methods for dealing with stormwater have become central features of redevelopment plans, but do not replace conventional sewer systems. Rather, they take pressure off of aging systems. Conventional upgrades still claim the biggest amount of funding.

There is a joke about the Netherlands that basically goes: if the Dutch were a more practical people, they would have moved to Germany a long time ago. Urban designers see this blending of form and function the Dutch have developed over centuries as an opportunity to open up new public spaces (Whitaker, 2019). Dutch Dialogues are an intriguing example of how combining urban design and water management practice can transform the urban planning process. We can see this synergy between water management, thoughtful, even "artful," design and urban regeneration in full swing in Norfolk's St. Paul's redevelopment (Vas, 2018). In Charleston, not far from where an aging sea wall, The Battery, is a popular tourist spot, a pedestrianized green street is the defining feature of a medical complex stormwater plan (Charleston, 2019). What makes this different from city beautiful movements that greened America's cities in the early 20th century (Boston's Emerald Necklace, built in 1870, is often touted as a masterpiece of an environmentally conscious park, what today would be called green infrastructure) is a question of environmental justice. Whereas the effects of industrial growth stirred city beautiful movements to action, today the effects of environmental change are the explicit impetus for action. Charleston's stormwater management plan is based on a revision to the city's official sea level rise projections from 1.5 to 2.5 feet to 2 to 3 feet (ibid.). Ideally, under this integrated framework, a city would *design* disaster preparation or prevention, not just response, into its DNA or comprehensive plan (Whitaker, 2019).

In order to figure out what complete and green streets are, it helps to consider what they are not:

- *"Conventional streets are seldom integrated with stormwater treatment systems or connected to open spaces; they are automobile-oriented thoroughfares with a high proportion of impervious surfaces and decreased pedestrian safety [28], and they utilize prescribed street standards that limit the type of multifunctional adaptation considering the pedestrians' use of the street."* (Im, 2019)

Green streets represent a design approach under the conceptual umbrella of complete streets in which streets are attuned especially to their environmental contexts. When this is done well, research demonstrates many positive benefits. Complete and green street approaches complement and sometimes envelope each other, but their implementation depends on the characteristics of the diverse and sensitive contexts that they come out of. In attempting to strengthen connections between multiple forms of transportation, multimodal transportation planning may encourage land use and zoning patterns in which complete and green streets are more appropriate and successful. Sustainable stormwater management integrated with urban design and historic preservation goes far beyond replacing sea walls and can be a spearhead for creatively addressing interrelated wicked urban problems. Success, or completeness, is a delicate balance of quantitative and qualitative assessment and community support.

2.2 Framework: *Communicative Action*

In Norfolk, many different groups, church congregations, public housing developments, and military bases, the city's richest and the city's poorest are experiencing the effects of sea level rise. The city's changing relationship with water is an experience that crosses socioeconomic boundaries. Everyone deals with flooding. This, in the terms of communicative action theory, is a new shared environment.

- *"A key purpose of communicative action is to work out what rules or codes of conduct we can agree we need to allow us to 'live together but differently' in shared environments"* (Healey, 1996)

Like multimodal planning values flexibility of movement, communicative action values flexible understandings, also known as "practical senses," or even "lifeworlds" within a shared urban and political environment (Healey, 1996). Communicative action aims for an ideal form of speech to bridge these worlds. Likewise, quality urban design is seen (especially by designers) as a tool and a method that can stitch together a fragmented urban environment into an ideal space. All of these frameworks (plus other theories of urban planning) employ management strategies for power and special interests. This communicative or collaborative mentality has guided this plan from the start.

The act and idea of placemaking is controversial on the ground and in academic literature around the world. Planning for complete and green street implementation in Cruser Place is not immune to the many conflicts that arise out of the planning process. A plan for green infrastructure in the area will also have to maneuver through opposition and pushback. Dealing with some of the arcane specifics of street design and stormwater management will predictably veer away from communicative action, as will navigating some of the recurring inequitable undercurrents of sustainable development. So communicative action or collaborative planning may work best with technical information that is also highly practical to establish rules of thumb. For example, many urban designers say we should build communities based on the premise that the average human will walk about a ¼ mile before opting for another form of transportation.

As the literature review explains, complete streets can be thought of as a set of principles, a collection of flexible design guidelines and a strategic initiative to influence transportation policy. Green street plans come in many forms, from design handbooks and manuals, concerned mainly with informing, to action plans, focused on implementation. In this way, the communicative planning process shifts away from a cloistered collection of scientific knowledge and towards measured debate, negotiation, action and of course conflict, essentially a democratic project (ibid.).

3. Context

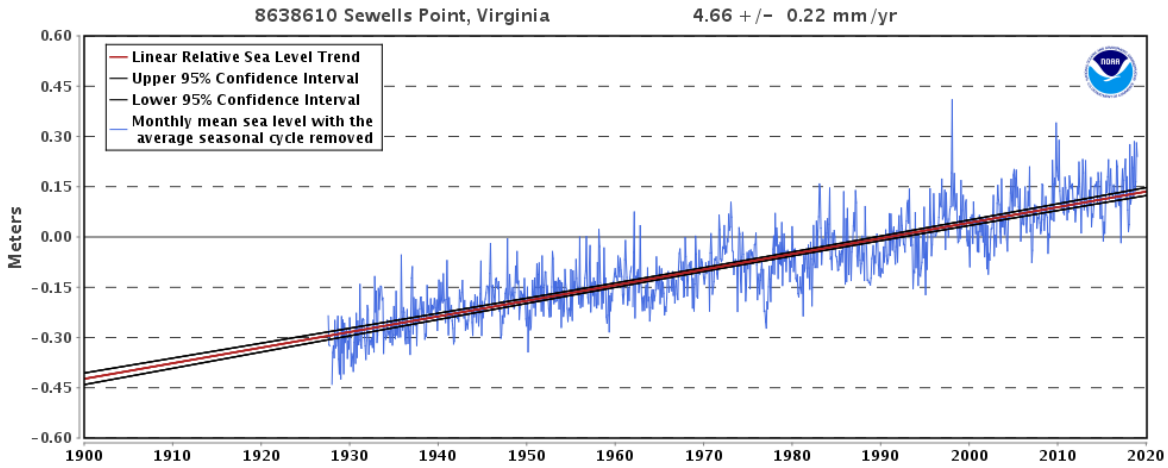
Study Area: The three neighborhoods of Colonial Place, Cruser Place and Riverview make up the larger study area, which also corresponds to Norfolk Census Tract 28. Cruser Place sits in between Colonial Place and Riverview and is characterized by its mix of uses, higher density and lower tree cover than the largely single family residential Colonial Place and Riverview, although Colonial Place and Riverview also retain a mixture of housing types. Cruser Place includes the commercial strip of Granby Street, sometimes called Riverview Village.

Figure 4. Map of Study Area. Source: ARC GIS Layer

- Cruser place in red. Larger study area in green.

3.1 Flooding and Sea Level Rise: Researching the ways in which complete streets and green streets complement each other may help facilitate their development in a neighborhood that routinely feels the effects of two other complementary processes shaping Norfolk: land subsidence and sea level rise (VIMS, 2020). As land sinks and water rises, more frequent flooding occurs (ibid.). In the fall, the research proposal looked at regional sea level rise projections, data and emerging policy. The findings section of this plan looks at these issues within the specific context of Cruser Place.

Figure 5. Sea Level Rise, Norfolk, Va *(Source: VIMS Sea Level Rise Report Card)*



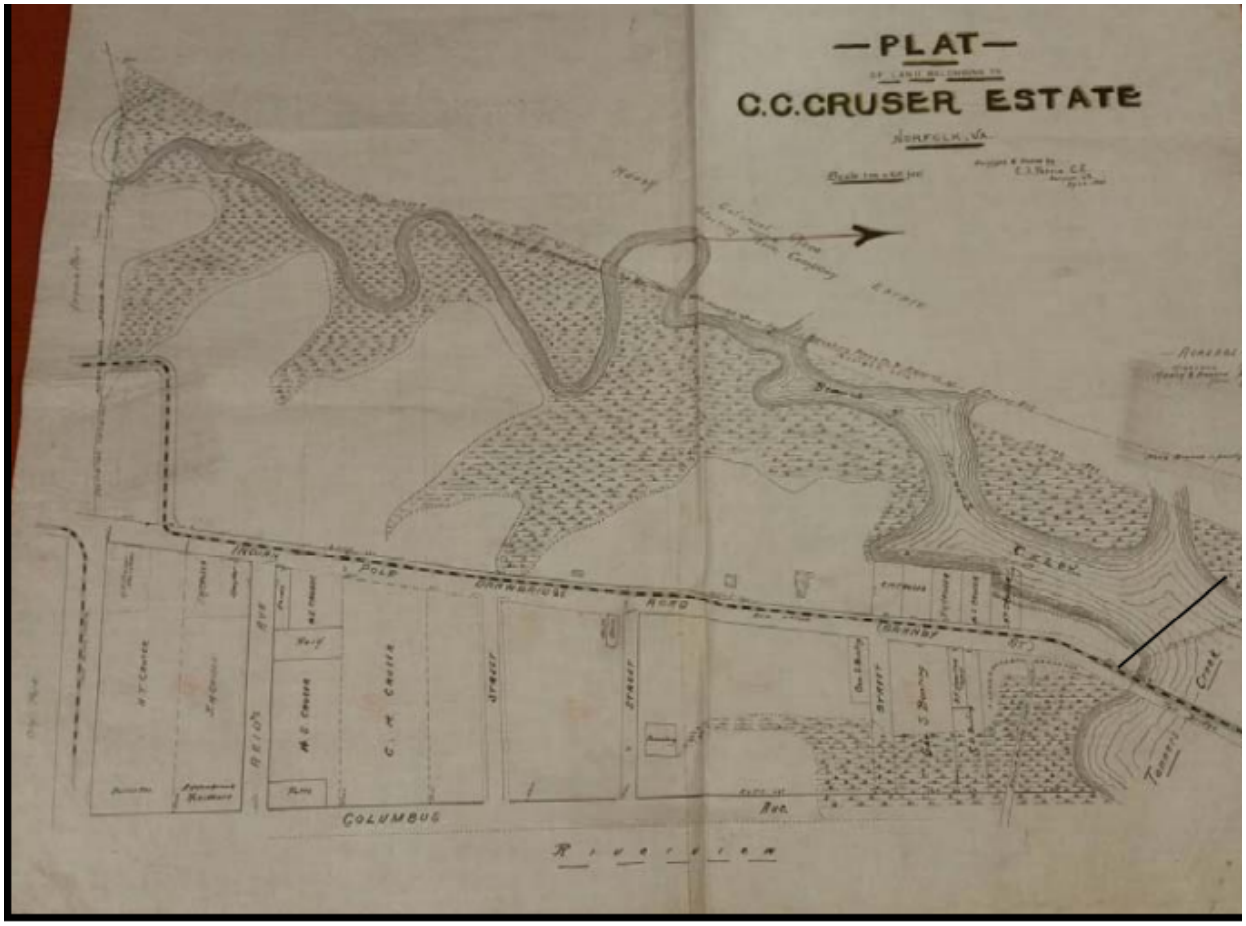
The rate of sea level rise in Norfolk has increased over the last century and is projected to increase more over the next couple of decades. It's hard to reconcile the predictions of climate scientists with everyday experiences, but extensive data hints at a “new shoreline” for much of urbanized Hampton Roads by 2080, even by conservative estimates (NOAA, 2021). According to a tidal gauge that measures the rise and fall of water levels off Norfolk’s Sewell’s Point, about two or three miles southwest of the study area, the “local sea level has risen about a foot and a half” since 1927, as far back as measurements go (Coutu, 2020). In 2018, the Hampton Roads Regional Planning Commission recommended localities begin planning for 1.7 ft of sea level rise by 2050 (VIMS, 2020).

The Lafayette and Elizabeth River shorelines are dynamic and, in some cases, retreating as water continues to rise. Part of this dynamic can be attributed to historic land use decisions as well as natural processes.

3.2 Development of Cruser Place: Originally founded by filling in marshland along a newly formed streetcar line, the physical layout of Cruser Place now reflects its streetcar roots along with decades of auto oriented planning.

Loss of Permeable Surfaces

Figure 6. Original Plat of the Cruser Estate. *Source: Cruser Place National Historic Designation, 2020*



Norfolk is not unique for building itself out of the marsh. Many American cities were expanded by draining marshes and rerouting creeks. Unique or not, we are left to deal with the consequences of land reclamation. The map and aerial photos here clearly show the steady loss of wetland over time throughout the study area. In the 19th century, a creek and substantial marshland extended deep into the study area on the western side of Granby Street. As Norfolk grew, land was infilled to create new parcels for development along a streetcar line. As development spread northward towards the Granby Street Bridge through the 20th century, the neighborhood became more auto oriented, exemplified most by a proliferation of auto repair shops and gas stations on Granby Street. Overall, the study area's historical development has been characterized by a significant loss of permeable surfaces and shift from streetcar suburb to auto oriented thoroughfare. It is only more recently that this trend has started to reverse with the construction of the Colonial Place Greenway, which includes a retention basin and a boardwalk through restored marshes along Haven Creek. Historic land use decisions, over a century old, are still influential in this case.

Figure 7. Source Sargeant Memorial Collection, 1947, creek buried, wetlands filled in. Some remain closer to bridge.

Figure 8. Source: Sergeant Memorial Collection: 1973, construction of Llewellyn Avenue and introduction of parking lots and street grid.

3.2 Demographic Snapshot:

Figure 9. ***Population Change within Norfolk Census Tract 28****, including Racial Demographics 2010-2020:* Population within the census tract has grown slightly from 2010-2020. The percentage of population within the study area identifying as Black has decreased over the same period.

Pop. Change (2010-2020)			
	2020	2010	Change
Total Pop.	4,539	4,151	5%
White	2,839 (65%)	2688 (64.8%)	5.60%
Black	939 (21.5%)	1,161 (28%)	-19.10%
American Indian	20 (.5%)	25 (.6%)	-20%
Asian	99 (2.3%)	87 (2.1%)	13.80%
Pacific Islander	2 (+/-0%)	8 (.2%)	-75%
Other	73 (1.7%)	46 (1.1%)	58.70%
Two or More	387 (8.9%)	136 (3.3%)	184.60%
Hispanic	265 (6.1%)	156 (3.8%)	69.90%

Figure 10. ***Norfolk Census Tract 28 Age Distribution Chart:*** 25 to 39-year olds make up the largest proportion of residents within the census tract.

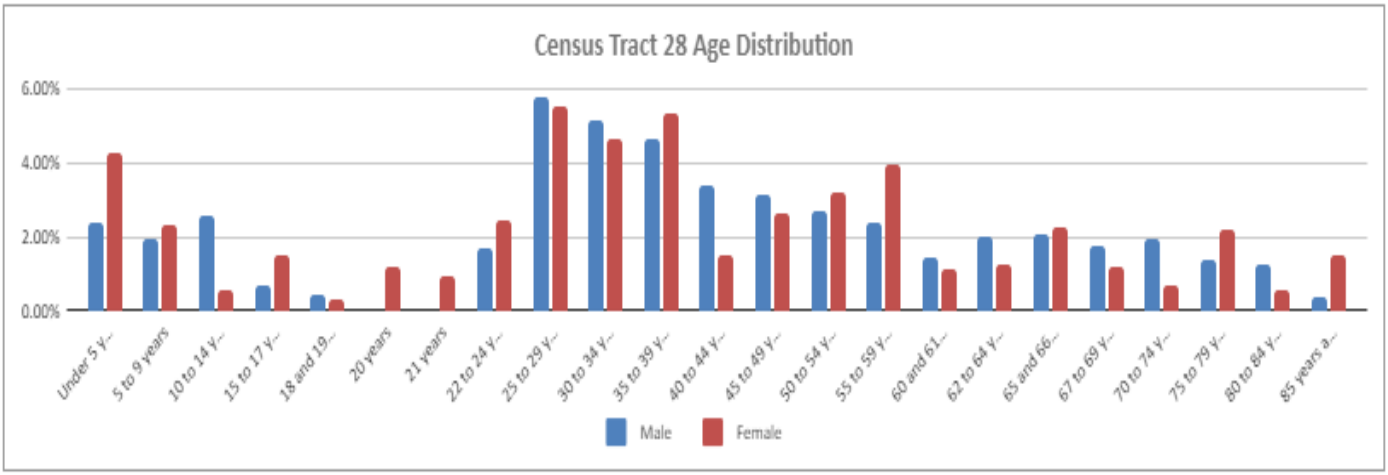
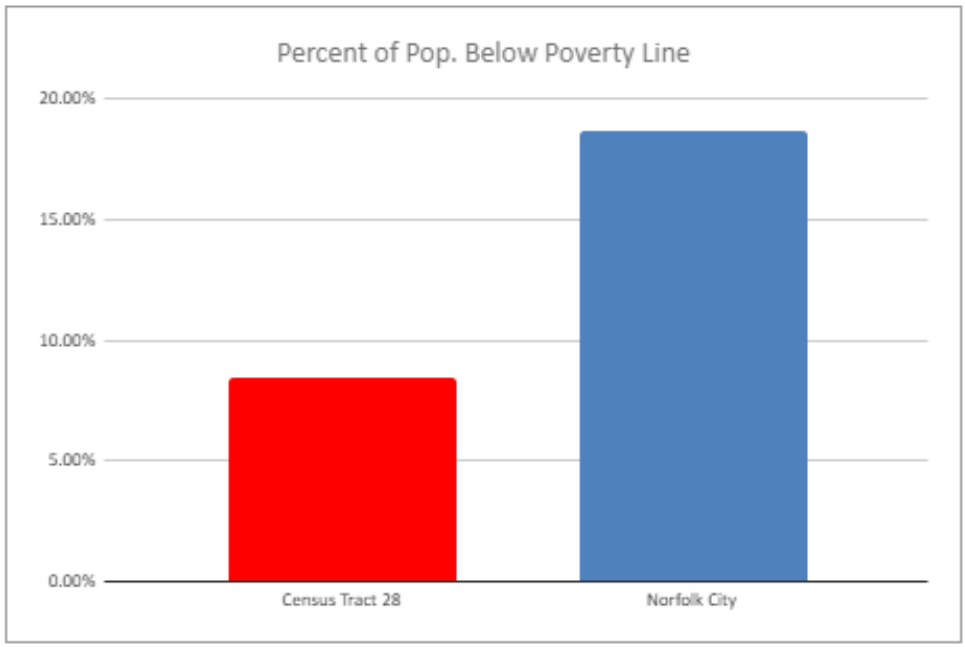


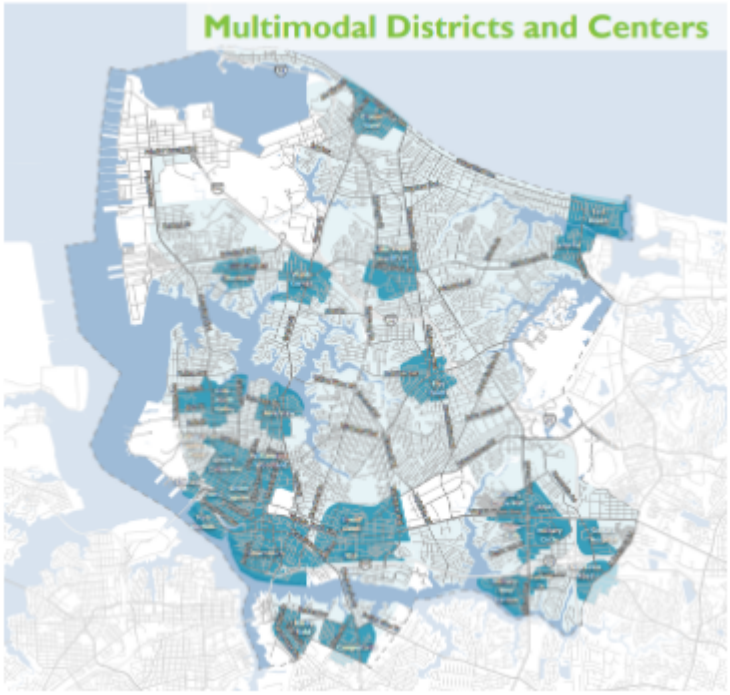
Figure 11. ***Percent of Pop. Below Poverty Line Graph*****:** The study area has a lower proportion of residents living below the poverty line than the city of Norfolk as a whole. Median household income, according to US Census Data, is $73,432, significantly higher than the citywide average of about $50,000.



Census Tract 28 is, on average, wealthier and less diverse than citywide averages. On the whole, Norfolk is roughly 47% white and 43% black, whereas the population of the study area is roughly 65% white and 21% black. Population within the study area has grown by over 5% since 2010. Overall, Norfolk's population declined from an official count of 242,803 persons in 2010 to 238,005 in 2020, a rate of about -.035% a year. Meanwhile, South Hampton Road's suburban localities like Chesapeake and Suffolk continue to see much of the region's population growth. Located near the water, close to many job centers, with a stock of older prewar housing, the neighborhoods of the study area are desirable places to live within the city for many, including students and members of the military, who often take advantage of the mix of housing types and subdivided homes.

3.3 Relevant Plans: Today, the city of Norfolk is undertaking simultaneous planning projects that will affect the development of Cruser Place and the larger study area. The projects included serve as brief case studies or springboards for future exploration to the curious reader interested in investigating green street design.

Figure 12. Norfolk Multimodal Districts and Centers. Source: Norfolk Multimodal Draft



Multimodal Norfolk

"Norfolk's multimodal plan ties together all the ways we travel- by foot, bus, bike, scooter or car- into a single plan to make sure they all work together more safely and comfortably." (Norfolk Multimodal, 2020) The multimodal system plan views an urban area as made up of layered transportation networks, and attempts to develop and use a framework to guide transportation investment and land use decisions. The study area sits within an area identified as a multimodal center, a location or corridor that will be targeted for transportation investments and possible streetscape improvement.

Norfolk's Bike and Pedestrian Plan targets the Cruser Place neighborhood as a hub of pedestrian movement and activity. Recommendations from this plan eventually influenced the creation of a pilot loop of bike lanes, including a gutter lane on Llewellyn Avenue.

Granby Street Bike Lanes

On January 26th, 2022, Norfolk City Council voted to accept funding from VDOT to go towards the design of protected bike lanes on a stretch of Granby Street from Adm. Taussig Boulevard to the Granby Street Bridge.

Resilience Planning

Norfolk has recently developed a Coastal Resilience Strategy. Other cities are now working on resilience plans of their own. For Norfolk and most of Southeastern Virginia's case, it's important to consider relative sea rise, the fact that not only rising water but sinking land and other factors including an ancient meteorite landing contribute to a changing water-land boundary. Even with the smartest people and most up to date computer models, predicting future shorelines, what some of this work comes down to, is not an easy task. Resilience strategy differentiates between flood protection, hard infrastructure like floodwalls or road raisings that may require the help of the federal government, and flood reduction, rain gardens, wetland restoration, tree planting, things that may be carried out using local energy and capacity at smaller scales. Norfolk's resilience strategy calls for 615 million dollars of floodwalls and gates, berms, structural elevations (raising buildings or roads) and drainage improvements throughout the Lafayette River watershed (Resilience Strategy, 2018). "Know your elevation," the resilience plan repeatedly states. In that it is a rethinking of Norfolk's historical

tendency to hug the coast and build close to the river, while also endorsing a range of strategies from massive infrastructure projects to smaller greening methods sometimes called low-impact development intended to protect vulnerable property.

Other Projects and Plans:

Blue Norfolk: The Blue Norfolk Plan for the Highland Park neighborhood proposes a number of pedestrian improvements to Colley Avenue, including a public boardwalk and pier along the waterfront. The plan significantly increases pedestrian space and sets a specific goal of 1-inch water retention for its green infrastructure. In a survey conducted, 67% of the respondents said that water was highly visible in their daily life, however only 44% of residents were satisfied with their level of access to it. Therefore, designing a natural amenity that provided public access to the water within the neighborhood was a goal that came out of the engagement and research processes (Altshuler et. Al, 2018).

Ingleside Greening Project proposes a number of green infrastructure and green street design interventions for the Ingleside neighborhood. A notable aspect of this plan is planning around and through the considerable amount of private space in the neighborhood (Owens et. Al, 2017).

St. Paul's Redevelopment: Norfolk's plan for redeveloping three of its public housing projects downtown is predicated on better managing stormwater and better connecting the adjacent Huntersville neighborhood to greater downtown. The city has adopted a public engagement campaign called People First to facilitate residents' transition from public housing to the private housing market or new mixed-use developments. St. Paul's physical design uses stormwater management to increase pedestrian space, weaving the two together into a network of parks and paths that double as a drainage system in one of the lowest lying and poorest areas of the city (Norfolk, 2018).

23rd Street Corridor: This project envisions a street adjacent to an active rail line as a shared street and green corridor connecting the Ghent and Park Place neighborhoods of Norfolk. An enhanced 23rd street corridor would stitch together neighborhoods fragmented by a heavy rail line, arterial boulevards and industrial uses (WPA, 2021).

Open Norfolk: Open Norfolk is a tactical design initiative started during the Pandemic that has converted underused public space into community spaces across the city (WPA, 2020).

Urban Tree Canopy Report: Including or not including the water within the city's borders affects its percentage of tree coverage. Excluding water, Norfolk's UTC, or the layer of branches, stems and leaves covering the ground, is estimated to be 36%. This study will show how that can vary when looking at the neighborhood scale.

I have included this list of plans as opposed to two or three longer case study descriptions to show the variety of planning currently happening around the city, from funded conservation, parks and stormwater projects to design firm concepts to mostly academic exercises like this one. Elements of multimodal planning and complete and green street design are being proposed and implemented to various degrees and various degrees of combination around the city of Norfolk, increasingly under the banner of resilience. Civic leagues are sometimes active participants. These projects utilize the public right of way, and sometimes private property too when applicable, for multiple social, ecological and economic purposes. Ultimately, an interconnected system of safe pedestrian streets

and spaces designed with an environmental function may be built incrementally, bit by bit. This is an opportunity to expand on valuable research already done at multiple scales, but also a challenge to reconcile sometimes competing visions.

4. Methodology

In order to come up with policy and design recommendations, a mixed methods approach was taken, using qualitative data from a survey and interviews, plus quantitative data from site observations such as street width and other physical measurements. Altogether, these methods conduct research upfront with interested participants like the Civic League.

4.1 Research Questions: Three research questions came out of the proposal in the fall of 2021.

1. ***What elelements of green and complete street design already exist in the study area?***

2. ***What are limitations in the street network that constrain connectivity, mobility and accessibility?***

3. ***What elements of green street design are most suited to the study area?***

4.2 Research Tools: Research was conducted using a survey, interviews and site observations.

Survey: a survey, hosted by Google Forms, was distributed primarily through the civic league's social media network. By early March, 40 responders had filled out the survey. The survey asked responders about their travel patterns and their perceptions of space to attempt to gauge a desire for complete and green street design. Although it's not easily boiled down to a single factor, many bicycle facility studies suggest a lack of sense of safety as the main reason behind the average person's unwillingness to bike more instead of drive (cite Bike Revolution). This was mirrored in my small survey. Moreover, in asking for specific trouble spots (question 4) and leaving room for open ended responses, the survey was able to find travel patterns that my own observations as well as interviews missed. For example, a survey respondent mentioned that many residents of the nursing home on Llewellyn across from the Greenway walk to the 7-11 and McDonalds on Granby Street, using a route that lacks sidewalks and often floods. This is something that my observations missed and that did not come up in interviews. These are valuable pieces of information that suggest limitations in the street network.

Getting a picture of people's travel habits is an important part of this plan. While Hampton Roads is known to be a car centric region, there is not much data of travel patterns at the neighborhood level to go by. This data set is not meant to be comprehensive, but meant to demonstrate one way of how a larger study could be done.

Survey Distribution: The survey was distributed via the civic league's Facebook page, which contains 627 members, mostly residents. The survey went live in January 2022 and stayed open through March. The survey was also sent to business owners in the study area through the Riverview Business Association as well as other identified stakeholders such as the Norfolk Preservation Collective, Wetlands Watch and Bike Norfolk. I directly sent a survey link to these stakeholders. Participation in

the survey is intended for residents of the study area, but also for people that travel to the study area for work.

Interviews: Interviews were conducted with people familiar with green and complete street design, either working for the city of Norfolk, non-profits engaged in street building or advocacy work, and authors of previous plans that incorporate complete and green street design, some mentioned in the existing plans section. I tried to use the interviews (especially the ones about a specific project or plan) to see how the process of street design works and what the role of the planner (as well as the engineer and architect) is, to better understand how these professions work together and to get a feel for how stormwater management is incorporated into the planning and design process.

Site Observations: Observations were conducted in the fall of 2021 and the spring of 2022, typically on foot through the study area. These observations noted characteristics of the study area, then, using GIS software, made measurements like street and sidewalk width of certain sections and crossings. Ironically, observations were sometimes stalled by flooding. I could not access parts of Delaware, Llewellyn, and the Haven Creek Boat Ramp on occasion because they were all underwater.

Community Meetings: I attended three civic league meetings throughout the year, one in September to introduce the project, one in February to update on progress, and one in April to go over a draft of recommendations (and rehearse for the final presentation). Additionally, I met with Norfolk Councilwoman Courtney Doyle and Courtney Hasick from the Norfolk Planning Department to discuss the plan.

Best Practices: Cities, state organizations and federal agencies have put together complete and green street manuals, field books or design guides to promote best practices or procedures generally agreed upon through trial and error to be most effective or successful. These documents were instrumental in choosing which design methods to include as part of the research findings. Research used information from these manuals to evaluate which best practices would be most suitable for the study area alongside the other research tools.

Overall, a mixed methods approach was taken in conducting research using site observations, a survey and interviews. Together, these methods combine qualitative assessment, like perceptions of space, and quantitative assessment, the actual measurements of spaces.

5. Research Findings

Findings Summary: This section will build upon the background information and apply it to the study area. Findings will respond to each research question, pulling insights from applicable research tools. Over the course of the semester, a few key trends emerged from the research:

- A lack of perceived safety was a common response from the survey. This sense of safety was expressed directly ("I don't feel safe" in certain spots) or indirectly ("heavy traffic" or lack of infrastructure).
- The street network lacks basic pedestrian infrastructure in places, especially in connections between Cruser Place and Colonial Place and Riverview. This plan analyzes a few key connecting streets between the neighborhoods.
- Flooding is a common experience throughout the study area. Rising water, but also the nature of development contributes to flooding.
- There are diverse travel patterns and uses within the study area. Like the rest of Hampton Roads, most survey respondents drive a car on their own as their main form of transportation, but walking and biking is still common, especially for recreation.
- Many different types of green infrastructure have been implemented throughout the study area, some that enhance pedestrian space.
- There is a considerable amount of impermeable surfaces within the study area, especially parking lots, not contributing to stormwater management.

5.1 Research Question 1: *What Elements of Green and Complete Street Design Exist in the Study Area?*

In the spring of 2022, site observations assessed and inventoried elements of green and complete street design already in the study area, including pedestrian improvements, street tree coverage and the current stormwater system.

Figure 13. *Current Green Street Design Elements*. Source: Google Earth Layer

1) The Colonial Place Greenway runs like a green spine through the study area, as a boardwalk over restored marshland along Knitting Mill Creek that crosses Delaware, extending into a paved multiuse path that passes green space and retention basins, as well as a popular footpath that follows Mayflower Road along Colonial Place's public bulkhead.
2) Painted bike lanes down Llewellyn connect to a bike lane protected by bollards on the Granby Street Bridge.
3) The stretch of Granby Street from the bridge to Lavellete includes medians, a few bump outs and painted crossings to slow traffic and protect pedestrians. Attempts have been made to improve or restore a main street feel to Riverview Village.

This research question requires a physical surveying of the study area as well as the use of mapping layers. There is a fair amount of green infrastructure in and right outside of the study area.

Other elements of green infrastructure in the study area include marsh restorations, street trees, oyster reef build outs, open space, a dog park and playground, a community garden, traffic circles in Colonial Place, as well as two public boat launches. Zooming out a bit, Cruser Place is within a relatively short distance of numerous green spaces, parks and river access points, small and large.

Tree Canopy: Street trees are simple but crucial components of green street design and powerful stormwater management tools. Tree canopy coverage is clearly denser in Colonial Place and Riverview than Cruser Place. The commercial strip between Granby and Llewellyn has a significantly lower tree cover than more residential parts of the study area, indicated by the grayer coloring of the middle of the map below.

Figure 14. Tree Canopy Cover. *Source: Esri Layer Tree Canopy Coverage, USA NLCD*

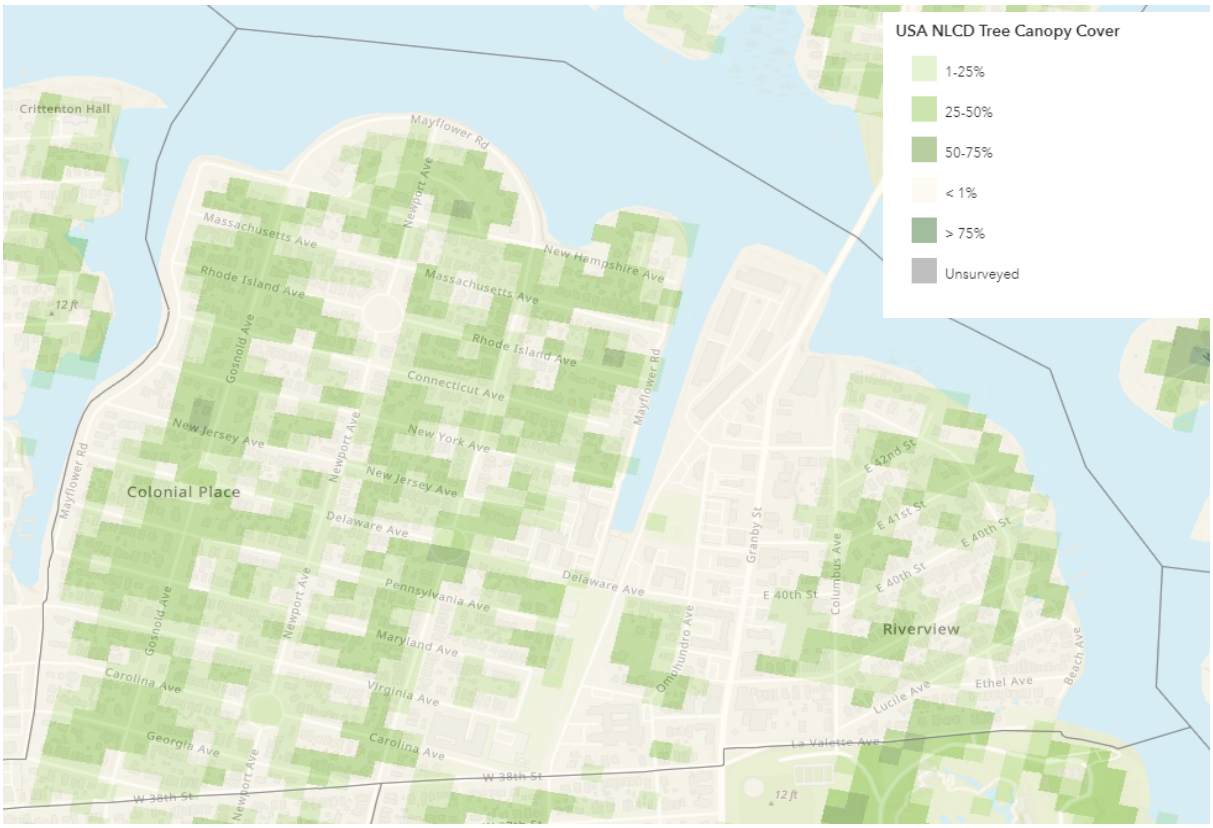
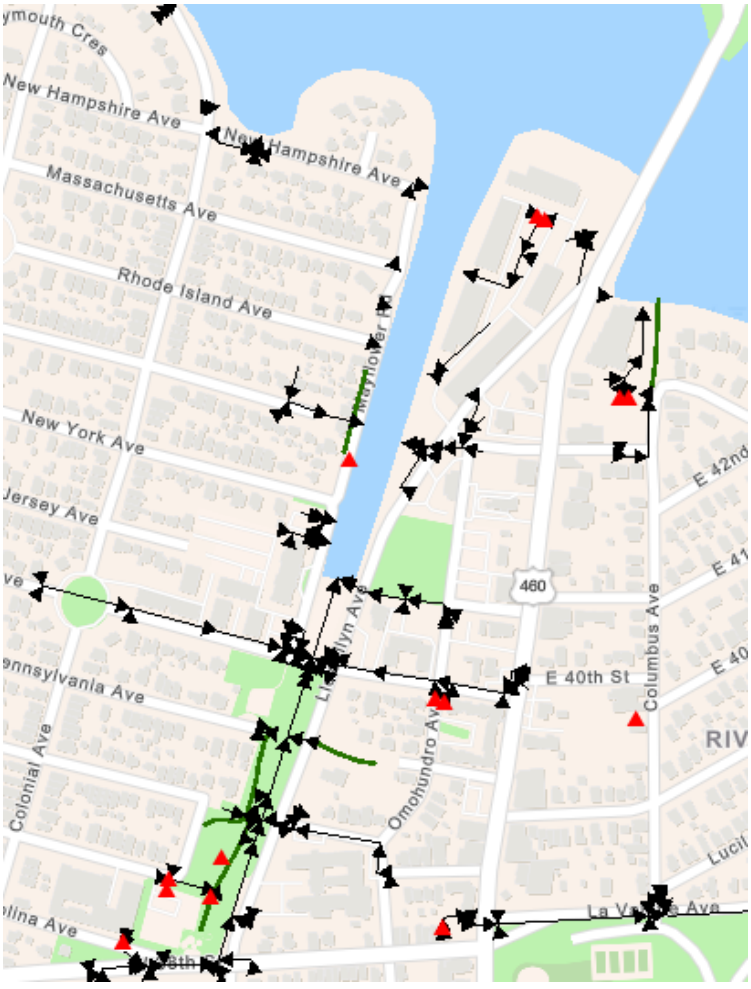


Figure 15. Tree Placement within Study Area: *Source: Esri Tree Placement Layer.*

The accuracy of this map is to be taken with a grain of salt, but each green dot depicts the location of literal tree placement within the study area. Like tree canopy coverage, tree placement is significantly lower in the northern part of Cruser Place and the commercial strip between Granby and Llewellyn compared to Colonial Place and Riverview. There is ample tree coverage in the more residential portions of the study area. A further question that emerged out of observing the tree canopy in relation to the shoreline was: "are there any areas of the study area that could qualify as a stormwater buffer?" Stormwater or riparian buffers are generally horizontal areas between developed areas and waterways. Construction of buffers can sometimes qualify for grant funding.

Stormwater System

Figure 16. Stormwater System, Source Interactive Norfolk.



The stormwater system beneath the streets collects water and directs it via pipe to the river or to constructed retention basins along the Greenway. Black triangles indicate drainage entrances. Some newer construction incorporates elements of low impact development or BMP's (indicated by the red triangles below) as well.

5.2 Research Question 2: *What are limitations in the street network that constrain connectivity, mobility and accessibility?*

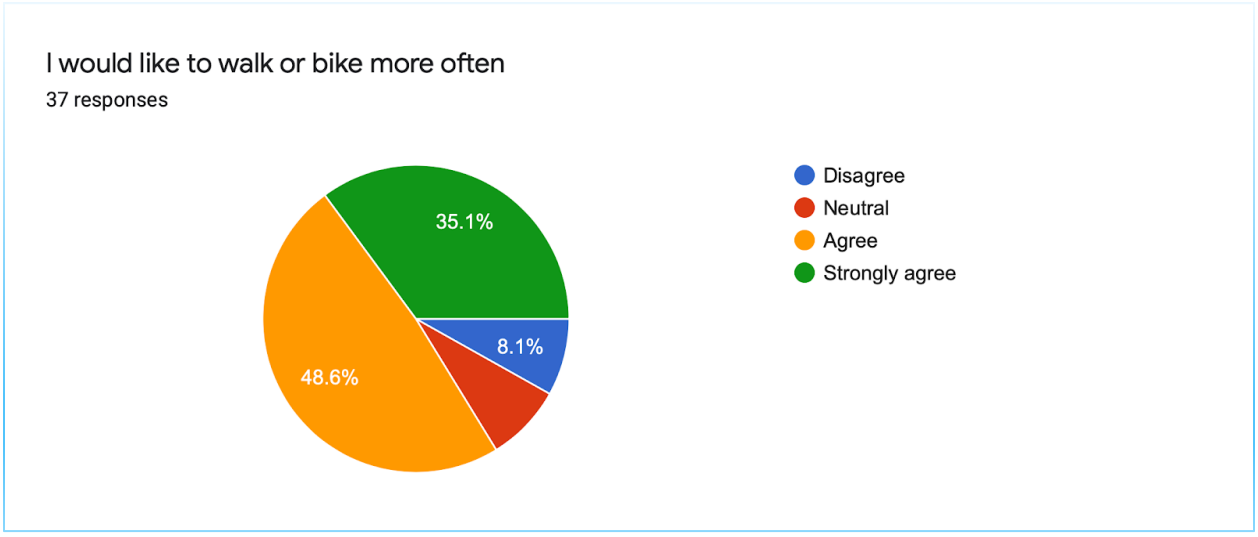
Site observations, survey responses, as well as insight gained from interviews, assessed limitations in the street network related to stormwater capacity and pedestrian connections. Overall, safety is a major concern for pedestrians, flooding is common, and the study area lacks basic pedestrian infrastructure.

Survey Responses: The survey asked respondents for what they perceive to be limitations in the street network. Question 8 asked what typically limits you from walking or biking more and left an open-ended response. A lack of a sense of safety was the biggest cited limitation among respondents. Almost 50% of respondents specifically mentioned concern for their safety as a reason they do not walk or bike more. An additional seven respondents (18%) mentioned a lack of infrastructure like bike lanes, sidewalks and crossings as a main reason for not walking or biking. Other responses mentioned flooding, weather, laziness and lack of destinations as reasons for not embarking on foot or bike.

Question 15 of the survey asked "do you consider the study area a walkable destination?" This question prompted an open-ended response as to what makes or does not make the study area walkable. Notably, a few responses considered the area relatively walkable or bikeable but mentioned a lack of destinations to walk or bike to. Moreover, 81% of respondents said that they typically walk or bike for fun or exercise, as opposed to for work or school, or to access services.

As mentioned earlier, the survey allowed me to augment observations of travel patterns and deficiencies in the pedestrian network of the study area by gathering direct personal experiences. One respondent, representing the residents of a nursing home in Cruser Place on Llewellyn, said that residents who cannot drive use Llewellyn to walk to restaurants and stores on Granby Street. Another mentioned using Omohundro to walk her children to the Montessori school on Granby. Multiple survey responses suggested a tendency for pedestrians to use Omohundro instead of or as well as Granby Street.

Figure 16. Survey Question 7. Source: Cruser Place Green Streets Survey



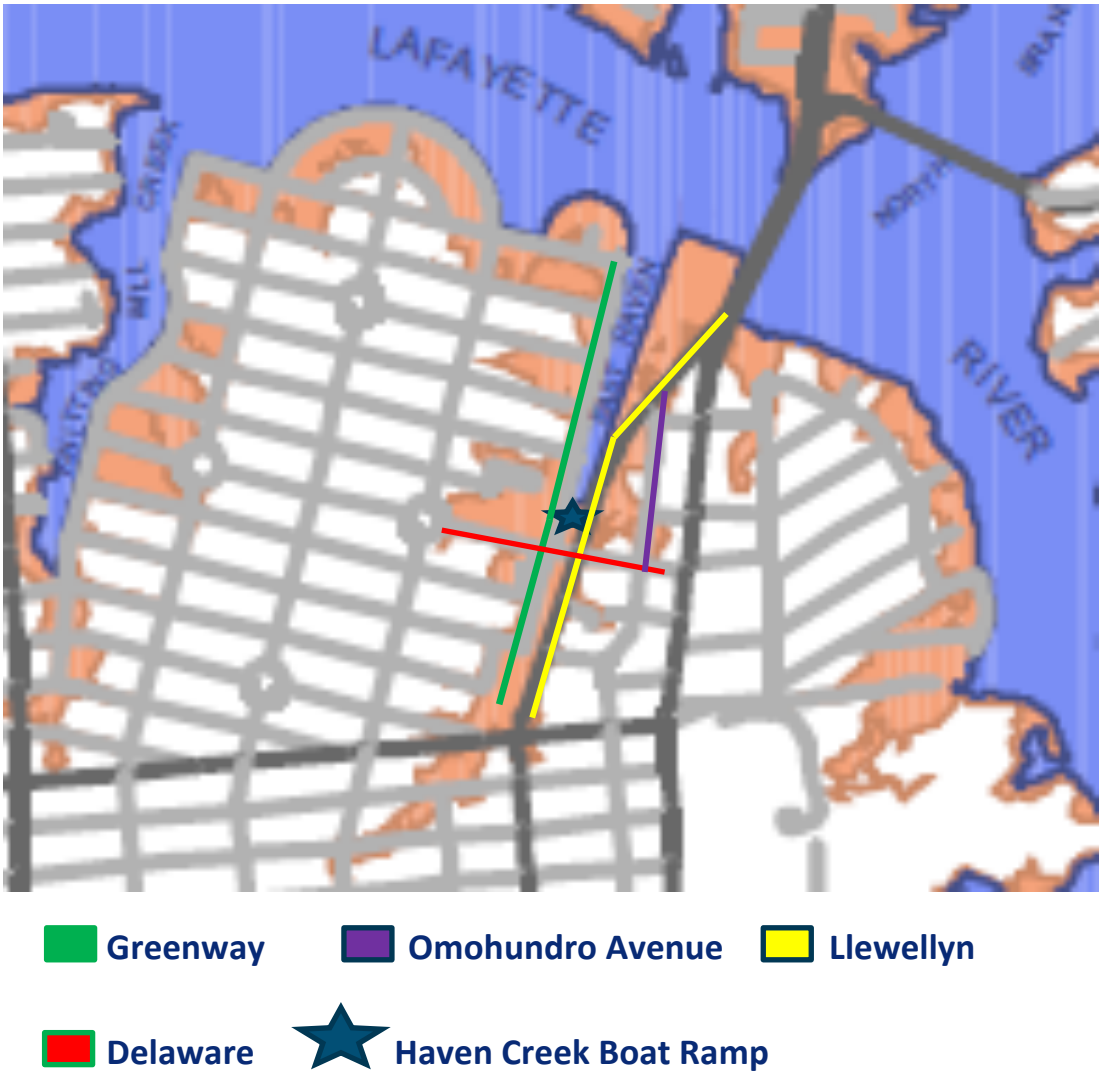
The responses from this survey question suggest that there is a desire among respondents to walk or bike more. 83% of respondents either agreed or strongly agreed with the sentiment.

Flooding within Study Area:

A good portion of the study area lies in a flood plain, including key portions of Llewellyn and Delaware, but land in the study area is low enough that a storm is not needed for flooding to occur. All it takes is a particularly high tide and wind to bring the river into well used routes like Llewellyn, parts of the greenway, the Haven Creek Boat Ramp, and Delaware. Moreover, conventional construction practices do not help this situation. Runoff from rainstorms travels from impermeable building structures like roofs and collects in the low-lying areas of the study area.

Question 11 of the survey found flooding to be a common disruption among respondents. 78% of respondents said flooding affects their travel. When asked where they typically experience flooding, survey responses mentioned many portions of the study area within the flood plain, highlighted in orange in the flood zone map below. Site observations and survey responses found flooding to be a common experience throughout the study area.

Figure 17. Flood Zone Map. Source:
Orange areas flooded at category one hurricane.



Limitations of Key Connections

Figure 18. Limitations of Key Connections. Source: Google Earth

These methods found that a few connecting corridors lack sidewalks and crossings, forcing pedestrians onto paths or into the street. Additionally, there is an abundance of impermeable surfaces and a lack of consistency in green street design techniques, especially along Granby Street. Four streets were chosen to examine limitations in the street network more closely: *Llewellyn, Delaware, Omohundro and Granby.* We can also think of these streets and the immediate space around them as mini watersheds of their own, each having a unique flow or runoff path within the larger watershed. Specific spots and sections of these streets will be discussed below.

1) Llewellyn: Overall, Llewellyn is laid out as an arterial road, cutting the study area's pedestrian network in half. It is the main road between Colonial Place and Cruser Place. Llewellyn Avenue between the Granby Street Bridge and Delaware Avenue lacks sidewalks on both sides, however a multiuse path does run through the greenway parallel to Llewellyn from 38th Street to Delaware on the Colonial Place side. For residents or travelers on the Cruser Place side of Llewellyn, this multiuse path is difficult to access (crossing Llewellen) and in the opposite direction of Cruser Place's commercial strip. The view above is taken from the intersection of Llewellyn and Delaware, looking down Llewelyn towards the Granby Street Bridge. A painted bike lane has been added. The street, which runs parallel to Haven Creek, lacks sidewalks on both sides. Further north towards the Granby Street Bridge, there is a right of way that runs along the degraded bulkhead until the apartment complex visible in the background of the picture below.

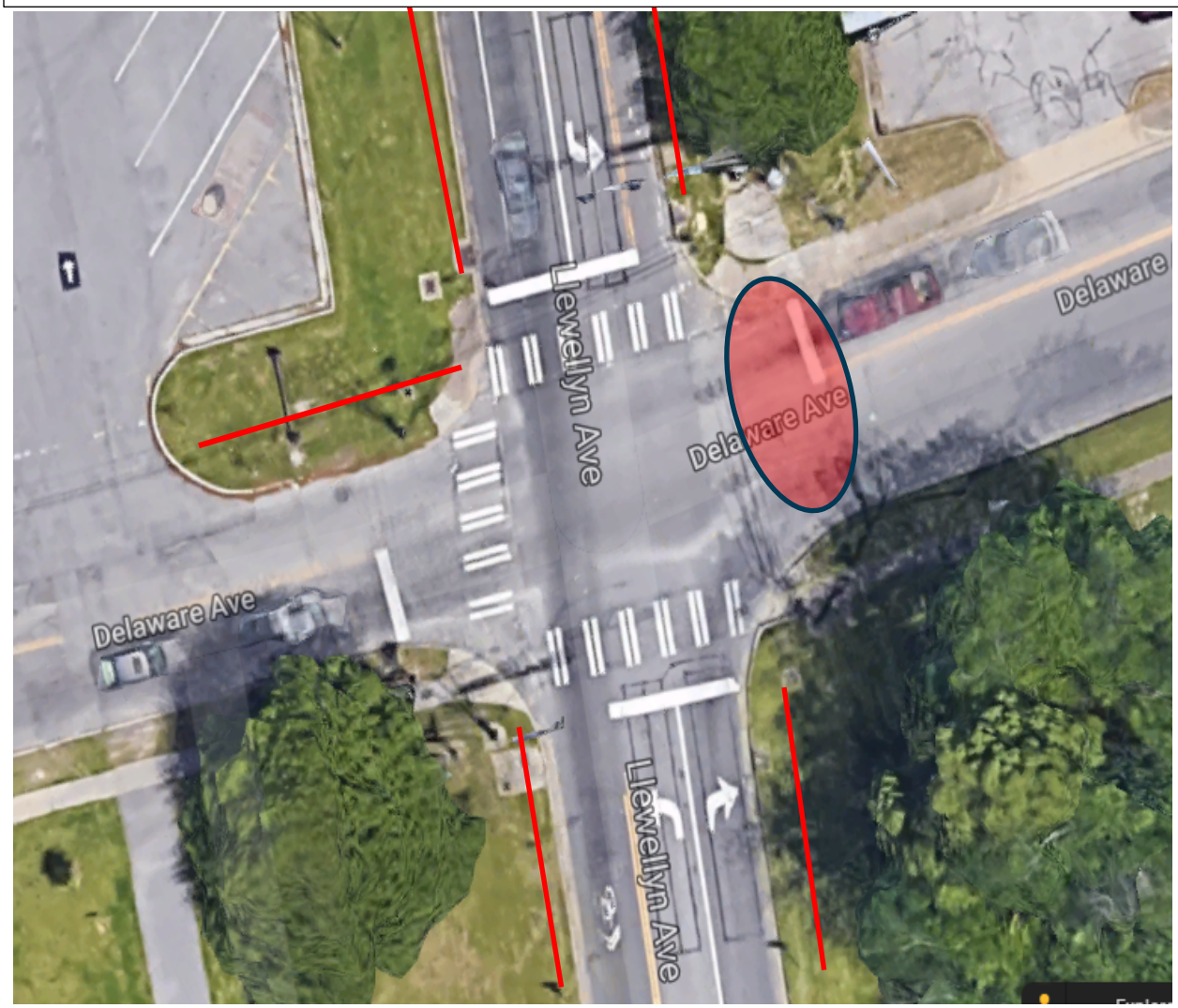
Figure 19. Llewellyn Avenue looking North. Source: Google Maps

2) Delaware: Delaware is a popular route to access the greenway, dog park or boat ramp and is one of the most direct connections between Colonial Place and Cruser Place. However, the route is arguably not a comfortable one for pedestrians. Delaware Avenue between the Colonial Place Circle and Llewellyn lacks a sidewalk on the north side, so pedestrians are forced on to the south side. The north side is home to a gated apartment complex with two entrances on the street. The view below depicts Delaware looking east towards Cruser Place. Notice the lack of sidewalk on the left and lack of formal crossing. In the foreground, out of sight, is one of the large Colonial Place traffic circles, a relatively large green space. Further down Delaware towards Cruser Place, the parking lot of the Haven Creek boat ramp adds a significant amount of impermeable surface to the study area. The intersection of Delaware and Llewellyn lacks sidewalks and lacks a crossing. The swale surrounding the boat ramp lot lacks trees closer to the intersection.

Figure 20. Delaware Avenue, looking towards Llewellyn from Colonial Place Traffic Circle. Source: Google Maps Street Layer

Figure 21. Haven Creek Boat Ramp Impermeable Surfaces. Source: Google Earth

Figure 22. Intersection of Delaware and Llewellyn. Source: Google Maps



3) Omohundro: Omohundro between Delaware and 42nd lacks sidewalks on both sides, and lacks street trees. There is no painted pedestrian crossing here on Delaware or farther west where the road meets up with Llewellyn. Located where land slopes up slightly above the flood plain, Omohundro is the defacto route for many travelers when Llewellyn is flooded. A number of businesses and restaurants on Granby Street have rear parking lots backing onto Omohundro, adding a considerable amount of impermeable surface to the streetscape. Most of these have not been landscaped to enhance stormwater capacity.

Figure 23. Omohundro Avenue, looking north. Source: Google Maps Streets Layer

Omohundro, looking east towards the Granby Street Bridge, runs behind a number of businesses along Granby Street.

4) Granby Street: On a basic level, Granby Street lacks street trees like many of the key connections highlighted in this plan, especially compared to the leafier residential streets that make up the neighborhoods of the civic league. When looked at through the lens of green street design, Granby Street also has a good amount of underutilized space that is currently not contributing to stormwater management and could be exacerbating flooding problems. It's clear that effort has been made to carve out space for landscaping along Granby- planter strips and a few bulb outs have been built- but altogether my observations have found this to be more piecemeal than cohesive. The large amount of space devoted to parking, especially between Granby and Llewellyn, adds a significant amount of impermeable surface that increases runoff close to the river and disrupts the pedestrian flow of the street. Granby Street is 73 feet wide; four lanes, plus a sporadic median, turning lane and parking strip one on the Riverview side, a layout that arguably encourages faster driving.

Figure 17. Granby Street looking towards the bridge, Riverview Village. Source: Google Earth

The triangular space highlighted in red above is typical of space found at the end of parking strips in a couple of places along Granby Street. This is space within the right of way not suitable for parking that is not currently utilized for stormwater management or pedestrian safety.

Challenges: Background research and interviews revealed persistent, fundamental challenges of green street design in compact, already developed urban areas. These challenges are considered here before moving on to recommendations.

- ***Maintenance:*** To paraphrase a couple of project managers I talked to: *begin with maintenance*. How (or if) maintenance is handled will determine the success or failure of a project. In some places in which the city does not have the time or resources to undertake new green street projects, a private or non-profit group may construct a green street project and come to a maintenance agreement with the city in which long term maintenance may be handled by private companies, community groups or a combination of these organizations and the public sector. Interviews with engineers and project managers in Norfolk and Richmond revealed that staffing issues can make maintenance difficult in practice.
- ***Tree growth****:* successful tree growth in urban areas requires deep knowledge. Structural or amended soils are more expensive upfront but require less maintenance going forward. Improper planting can still result in poor or stunted tree growth.
- ***Funding:*** funding often depends on state and federal budgets, which can shift with political priorities.
- ***Basic constraints of space:*** Constraints of space, or in other words, the reality of things on the ground can sway the competing demands described in the literature review that a complete street or green street attempts to balance. Throughout my interviews, I found some features of complete street design, like a bike lane down Delaware, no matter how desirable, to be virtually off the table simply given the lack of space for it. This may be the most challenging aspect of the study area: accommodating multiple transportation and environmental uses within the existing historical fabric.
- ***Community Support and Gentrification****:* Critics of the livable city argue that livability is a double-edged sword, that in surrendering themselves to the "spontaneity of urban life," cities surrender themselves to the spontaneity of the real estate market (Krivy, 2018). The tendency for efforts to improve livability, good intentioned or profit driven or both, to put urban diversity and dynamism "under threat" is also a defining theme of environmental justice scholarship and maybe the most persistent problem of late capitalist urban development (Uribe-Toril et. Al, 2021). In analyzing the relationship between gentrification, displacement and greening initiatives, scholars have found a cultural component to displacement, and maybe a more compelling argument. Gentrification occurs, they argue, not only through rising prices, but also through the introduction of new cultural norms (Goosens, et. Al, 2021). Case studies are again beneficial when considering green streets from an equity perspective. Some call greening initiatives in Detroit "green reparation" (Brooker, 2021).

At a charette for the 23rd street corridor, I struck up a conversation with an architect working on a project in Freemason, one of the oldest neighborhoods in the city. To lay the foundation for her project, her team had inadvertently dug up an unmarked grave pit, presumably from Norfolk's yellow fever epidemic in the early 20th century. I am including this anecdote to emphasize the difficulties, sometimes unexpected, of retrofitting or rebuilding older cities.

5.3 Research Question 3: *What elements of green and complete street design are most suitable to the study area?*

Relevant Complete and Green Street Design Methods

While some elements of green street design can be found in and surrounding Cruser Place, further research has found deficiencies in crucial pedestrian connections between Cruser Place and the larger study area. This is caused by a number of factors, including lack of basic pedestrian infrastructure such as sidewalks or crossings. Survey responses suggest that safety, or the perception of safety, is an influential factor in determining whether people walk, bike or drive. In many places, impermeable surfaces have not been minimized and street tree canopy has not been enhanced to its full potential. Since flooding is an obvious problem in the area, and survey responses suggest that there is a desire among respondents to walk or bike more, these limitations are also opportunities to continue to implement green street design techniques.

Best Practices in Complete and Green Street Design

The following section can be thought of as a small toolkit of potential design methods or best practices in green street design. Best practices are guidelines, procedures or ideas that are generally accepted as most effective within a profession. In this case, suitable methods have been determined by my own observations, survey responses, interviews as well as research into green street design manuals and handbooks. All of these designs are intended to delay or limit the entrance of stormwater into the sewer system and protect pedestrians. This section will split up suitable design methods by intersection and midblock, a typology used by Im (Im, 2020). The following examples can be customized to fit the demands of the study area. They should be thought of as rough concepts of possible solutions for the study area.

Intersection:

Figure 20. Rain gardens within curb at intersection

Rain gardens located within the curb at all four corners treats stormwater without taking up street space

Figure 21. Rain gardens extended from curb at intersection

Extending rain gardens from the curb reduces crossing distance for pedestrians

Figure 22. Pocket rain garden at intersection

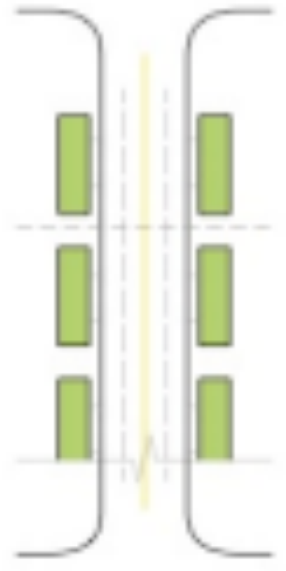
A pocket rain garden at a single corner can also serve as new public space if outfitted with street furniture or bike racks.

Figure 23. Pedestrian island or traffic circle

An island can serve as a green sponge to soak up stormwater or offer pedestrian refuge

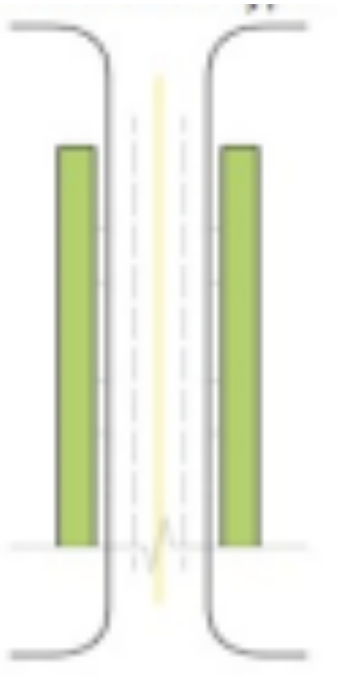
Mid block:

Figure 25. Separated planters within sidewalk



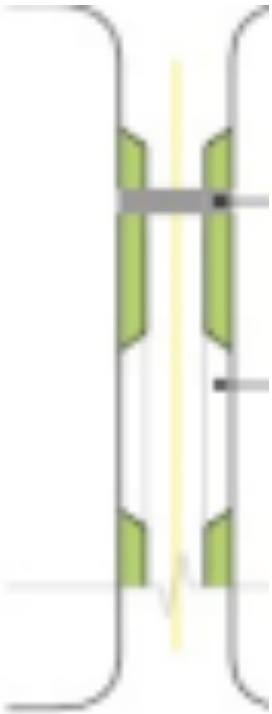
Vegetative planters located within the curb can be independent (flow through) or connected to link up with a larger drainage or retention system. The walls can be made of pavement or more natural materials like stones. Building within the curb, sometimes adding a small strip of pavement between the sidewalk and planter, retains on street parking. Planters can float independently like rain gardens or can be linked together by a small grade and gravity.

Figure 26. Continuous or linear planters or swale within sidewalk



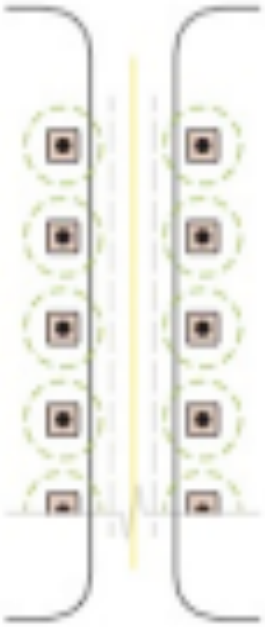
If willing to devote the space, a continuous swale can stretch the length of the block or parking lot. Landscaped with different vegetation than a typical sidewalk buffer, swales, sunken spots that soak up and filter stormwater, can be designed to be interactive and educational as well, encouraging people to climb or walk through built in paths. Check dams or rock formations can be included to slow runoff even further.

Figure 27. Continuous swale extended from curb with crossing



A swale extended from the curb can catch stormwater and serve as a traffic calming device. Swales can also be built into crossings at midblock locations. The curb extensions can be broken up to include parking spaces or placed on one side of the street only.

Figure 28. Tree pits within sidewalk



Tree pits placed within the curb, also known as tree trenches, provide multiple benefits, including the collection of surface runoff and the reduction of the urban heat island effect. Since tree roots are not used to growing within compact urban environments, permeable pavement or amended soils can be used to enhance their growth.

Figure 29. Tree trench diagram. Source:

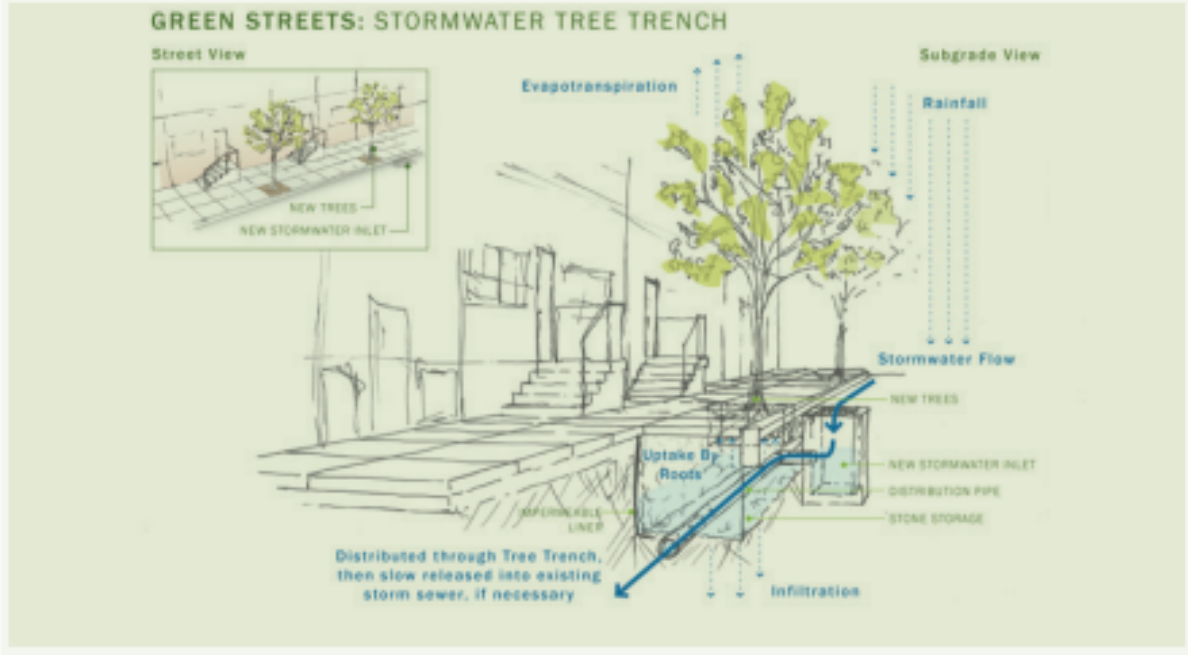


Figure 30. Depressed Median

A depressed median, designed to collect and store stormwater, is engineered to direct the flow of water to basins within the median. Medians can double as pedestrian space if integrated with crossings.

Other interventions:

- *Permeable pavement:* permeable pavement may not always be appropriate in areas with high water tables. If feasible, an impermeable layer can be installed beneath a permeable pavement and connected by pipe to a retention basin or the larger sewer system.
- *Floating planters* placed to catch building runoff or mark gateways.
- *Street furniture:* planters or rain gardens can double as street furniture, including a ledge for sitting.
- *Painted "curbs" or lanes*: quick, tactical fixes can carve out pedestrian space for cheap.
- *Infiltration boardwalk*: a boardwalk placed over a swale, channel or depressed basin.
- *Channels or Runnels:* narrow channels that carry water along the surface.
- *Recessed courts:* depressing basketball courts or recreational surfaces, sometimes called cloudburst planning, allows park space to catch water during high intensity rain events.

These are all potential ways to apply stormwater treatment methods into street design and parking lots, ideally creating more walkable spaces. Of course, space is necessary to begin with, as well as an understanding of underground conditions and native vegetation. Many of these methods can be used on private property as well, especially in places with confounding right of ways.

6. Recommendations

Besides the connections and divisions between stormwater management and street design, the recommendations in this plan can be sorted into tactical projects that could conceivably be completed with a smaller amount of resources, and, on the other hand, larger, capital improvements that require significant outside investment, time and study. Tactical improvements like street tree canopy and crossing enhancements can likely be undertaken by the civic league itself or in partnership with another organization. Other recommendations are directed towards the city or require significant funding, planning and acquisition of private property. By focusing on the connecting corridors identified in the findings section, these recommendations aim to create and enhance a network of green streets, starting with quicker tactical improvements and building up to larger projects over time.

❖ Goal 1: Increase stormwater capacity of study area.

- *Objective 1.1: Increase street tree canopy in Cruser Place.*
  - Action 1.1A: Sponsor a street tree planting program in Riverview Village in coordination with private businesses and land owners
  - Action 1.1B: Test out different tree planting methods and amended soil types
  - Action 1.1C: Determine if an urban forest buffer is applicable within study area along Llewellyn.

- *Objective 1.2: Reduce impermeable surfaces within study area*
  - Action 1.2A: Convert extra parking space in Haven Creek Boat Ramp to swale or rain garden
  - Action 1.2B: Continue bump out and planter construction on Granby Street
  - Action 1.2C: Construct additional depressed median with a crossing on Granby Street
  - Action 1.2D: Expand Living Shoreline along Llewellyn Avenue

- *Objective 1.3: Partner with private businesses and homeowners to incorporate stormwater management and low impact techniques into private development*
  - Action 1.3A: Promote and offer consultation for stormwater fee credit
  - Action 1.3B: Encourage the city to include trees as a BMP

- *Objective 1.4: Collaborate with organizations to raise awareness about integrated stormwater management*
  - Action 1.4A: Create two signs along the Colonial Place Greenway, describing the neighborhood's history of development and its current retention basin system
  - Action 1.4B: Partner with organizations and universities conducting stormwater related research
  - Action 1.4C: Encourage city to undertake a Green Streets Pilot Program
  - Action 1.4D: Encourage the city to undertake a permeable pavement demonstration project.

❖ Goal 2: Implement complete street design to enhance connections between Cruser Place and surrounding neighborhoods

- *Objective 2.1: Improve pedestrian experience of key connections*
  - Action 2.1A: Redesign crossings on key connections and intersections identified in plan, including Delaware and Llewellyn, to increase pedestrian safety and calm traffic. Involve the community and civic league through a design competition for a specific crossing.
  - Action 2.1B: Convert Omohundro Avenue, from Delaware to 42nd Street, into a green alley, incorporating tactical design methods. Consider holding a street closing event on Omohundro to open up the street for pedestrians for a day.
  - Action 2.1C: Redesign Llewellyn Avenue from 38th to the Granby Street Bridge as a complete street with greenway elements. This a longer-term action that would involve considerable funding and negotiations with private land owners to convert unused property to a public ROW.
  - Action 2.1D: Create an ad hoc Lafayette River Trail Committee, bringing together multiple groups to study greenway extension across the Granby Street Bridge.
  - Action 2.1E: extend protected bike lane down Granby Street to Delaware

- *Objective 2.2: Use the ROW to enhance public space*
  - Action 2.2A: Include seating in underutilized space of Haven Creek Boat Ramp.
  - Action 2.2B: Incorporate placemaking and complete street design methods into the Granby Street Bridge
  - Action 2.2C: Acquire land for a new pocket park within Cruser Place
  - Action 2.2D: Redesign entrances to Colonial Place Greenway using placemaking and integrated stormwater management strategies

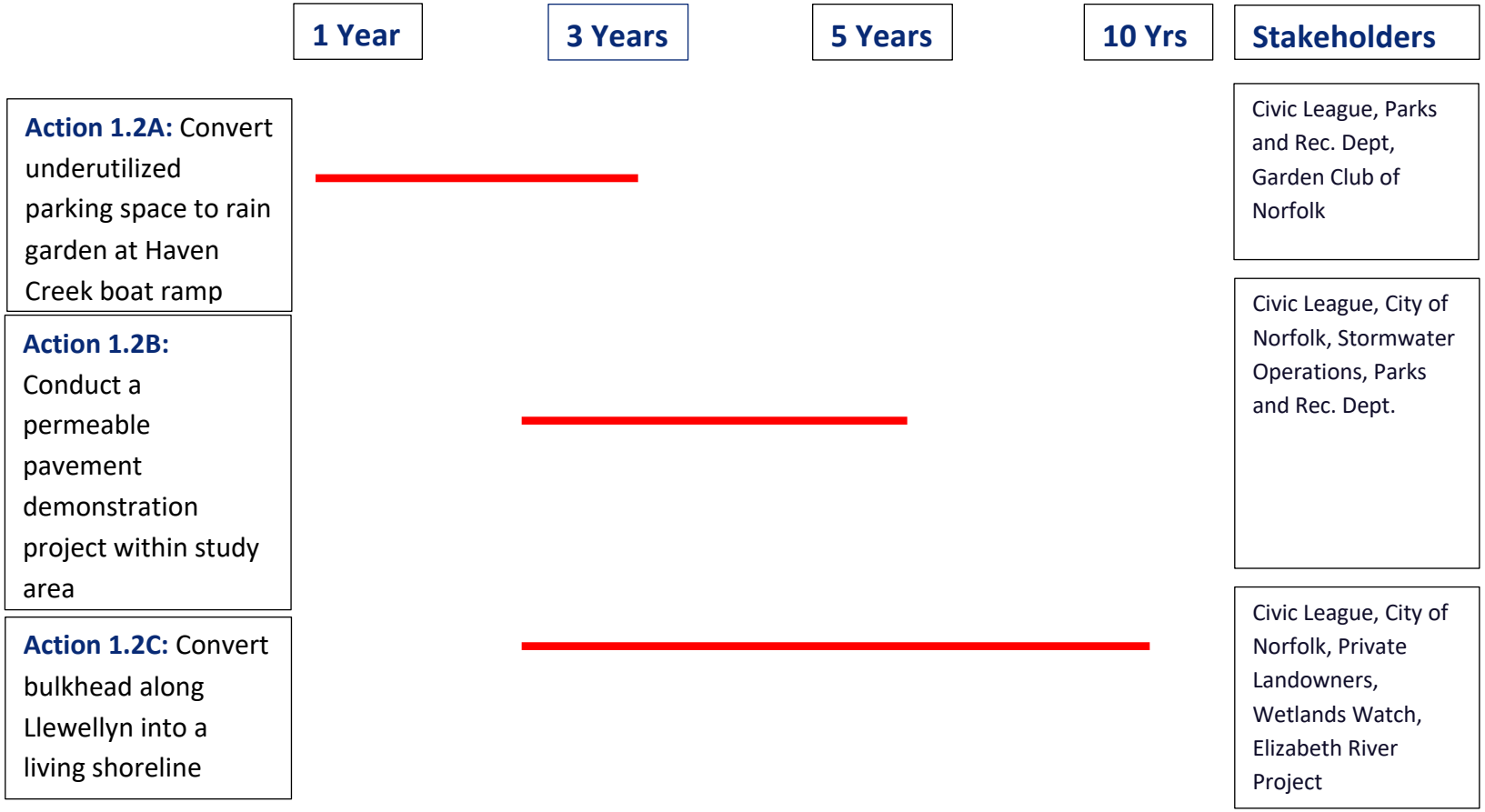
- *Objective 2.3: Collaborate with organizations to raise awareness about bike safety and maintenance*
  - Action 2.3A: Participate in a bike safety awareness campaign in coordination with construction of the Granby Street bike lanes.
  - Action 2.3B: Conduct a follow up travel patterns survey after construction of bike lanes, using methods developed in this plan.

7. Implementation Timeline

Goal 1, Objective 1: Increase Street Tree Canopy in Cruser Place

Funding: EPA Small Waters Grant, Virginia Environmental Endowment, Practice Landscaping Grant

Goal 1, Objective 2: Reduce Impermeable Surfaces Within Study Area



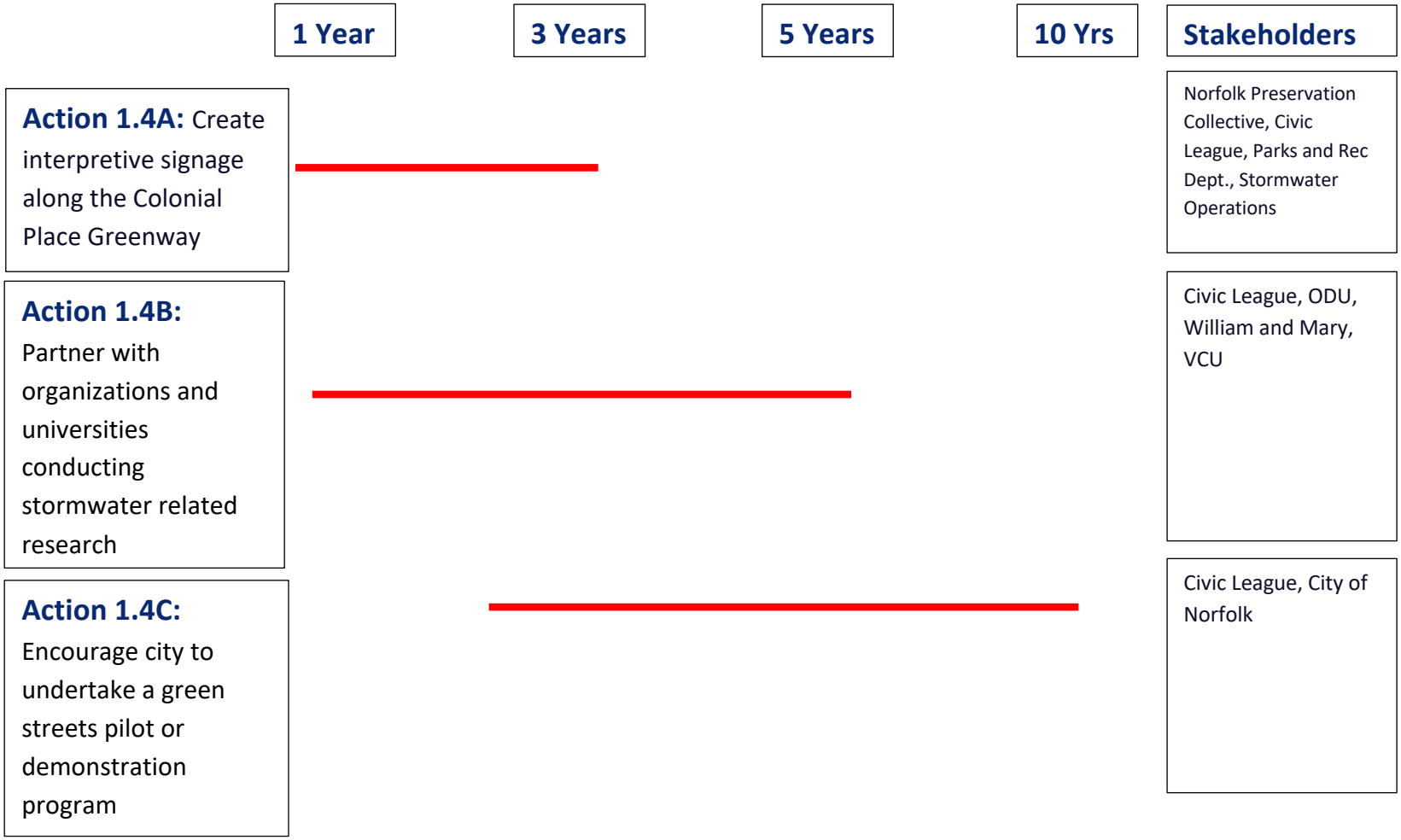
Funding: EPA Small Waters Grant, Virginia Environmental Endowment**,** James River Water Quality Improvement Grant, FEMA Hazard Mitigation Grant Program, Transportation Alternatives Program

Goal 1, Objective 3: Promote stormwater management best practices and low impact development techniques to private businesses and landowners

	1 Year	3 Years	5 Years	10 Yrs	Stakeholders
Action 1.3A: Promote and offer consultation for stormwater credit fee					Civic League, private business and landowners, City of Norfolk
Action 1.3B: Encourage the city to include trees as a BMP					Civic League, private businesses and landowners, City of Norfolk

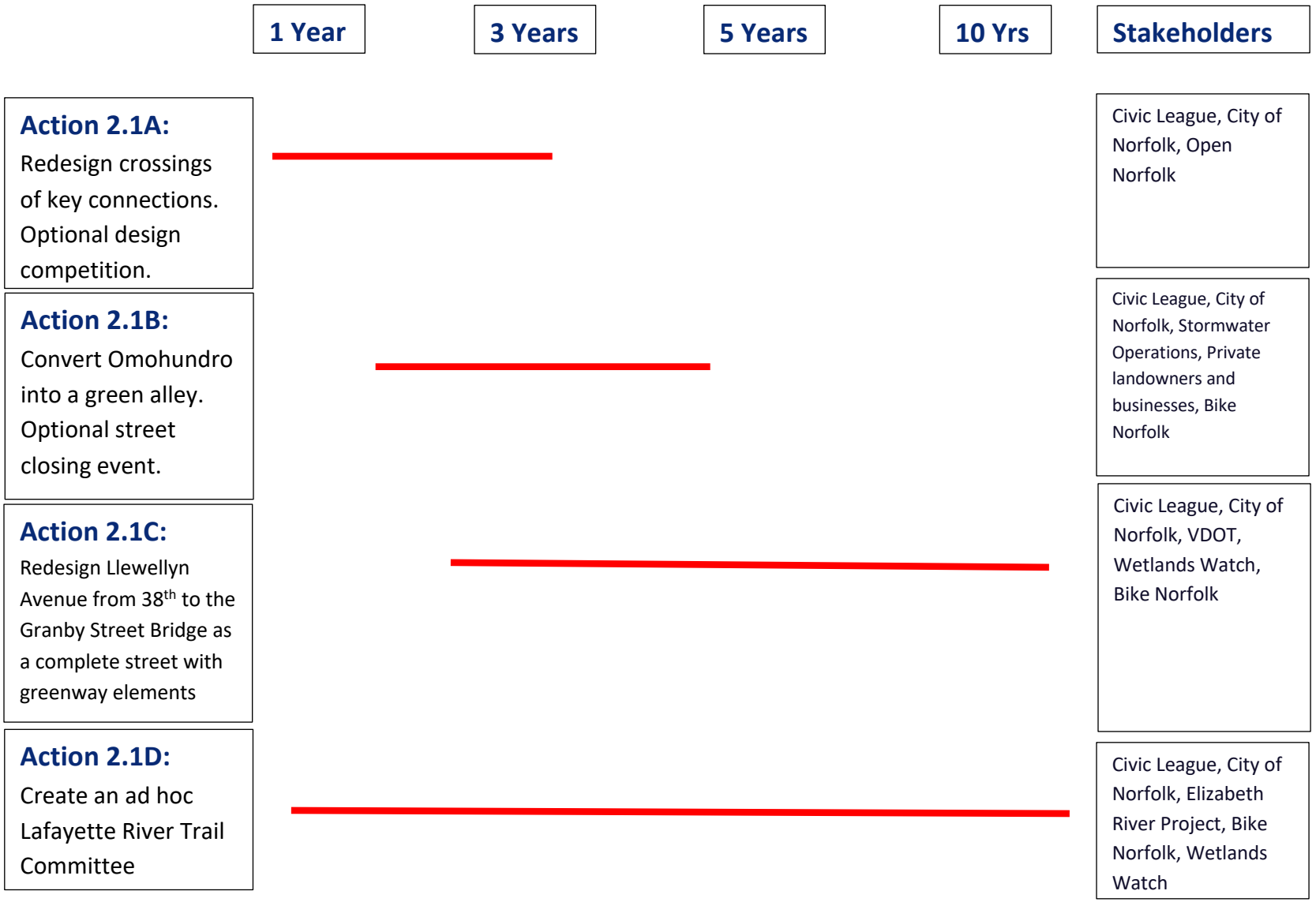
Funding: Virginia Conservation Assistance Program, DEQ Stormwater Local Assistance Fund

Goal 1, Objective 4: Raise awareness about integrated stormwater management.



Funding: National Trust Preservation Funds, Community Development Block Grant

Goal 2, Objective 1: Implement complete street design to enhance connections between Cruser Place and surrounding neighborhoods



Goal 2, Objective 1: Implement complete street design to enhance connections between Cruser Place and surrounding neighborhoods cont'd

	1 Year	3 Years	5 Years	10 Yrs	Stakeholders
Action 2.1E: Extend protected bike lane down Granby through Cruser Place					Civic League, City of Norfolk, Elizabeth River Project, Bike Norfolk, Riverview Business Association

Funding: Practice Landscape Grant, Capital Improvements, Bloomberg Philanthropies Asphalt Art Initiative, National Recreational Trails Fund, Rails to Trails Trail Grant Program

Goal 2, Objective 2: Use the public ROW to enhance public space

	1 Year	3 Years	5 Years	10 Yrs	Stakeholders	Funding
Action 2.2A: Include seating in underutilized space of Haven Creek Boat Ramp					Civic League, Parks and Rec Dept. , Hund's Bicycles	
Action 2.2B: Incorporate placemaking methods into Granby Street Bridge					Civic League, City of Norfolk, Riverview Business Association	
Action 2.2C: Convert space along Omohundro into a temporary pocket park					Civic League, Riverview Business Association	
Action 2.2D: Redesign entrance to Colonial Place Greenway					City of Norfolk, Parks and Rec, Stormwater Operations, Civic League	

Funding: Practice Landscape Grant, Capital Improvements, Bloomberg Philanthropies Asphalt Art Initiative, Southwest Airlines Heart of the Community Grant, National Association of Realtors Placemaking Grant, National Endowment for the Arts Our Town,

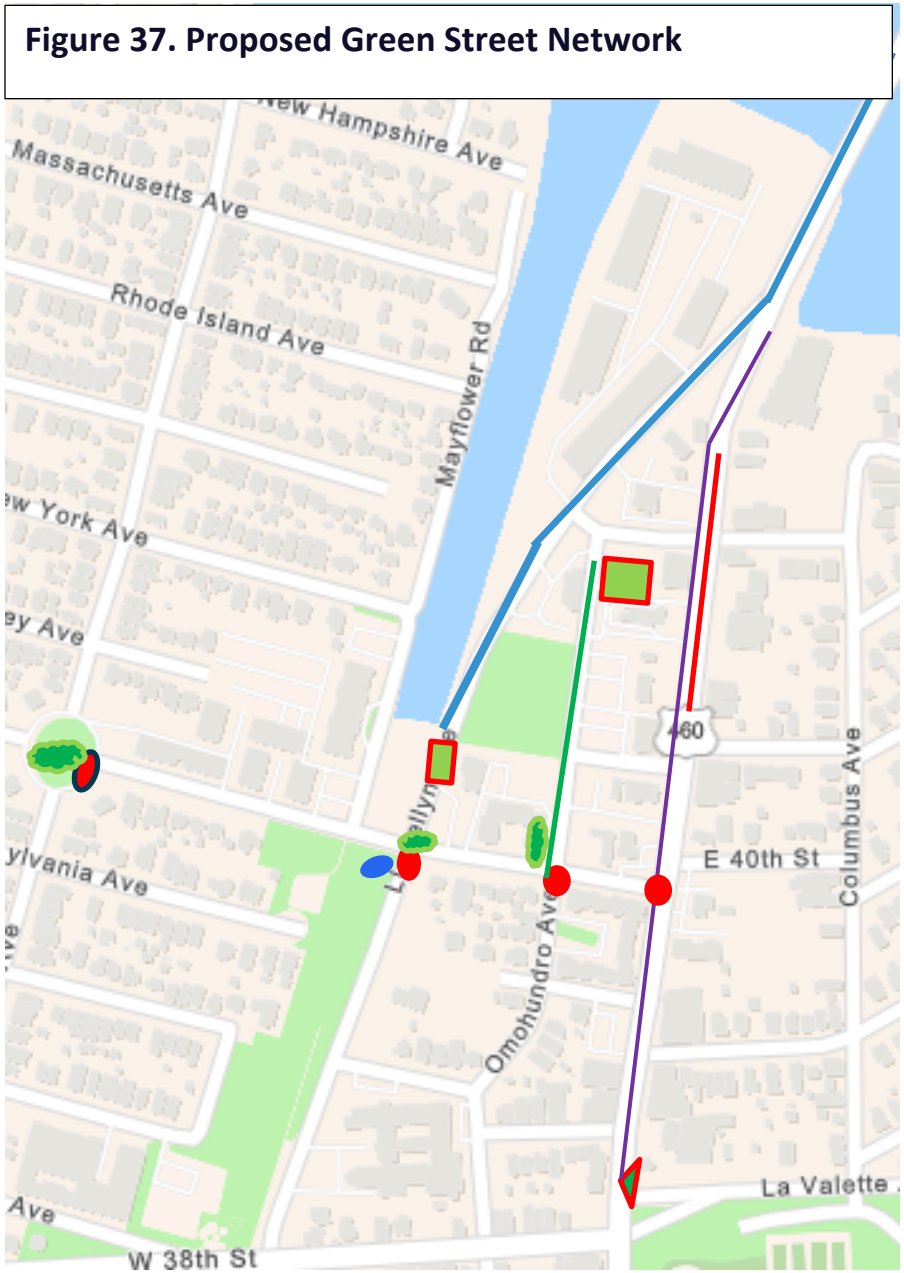
Goal 2, Objective 3: Collaborate with organizations to raise awareness about bike ridership, safety and maintenance

	1 Year	3 Years	5 Years	10 Yrs	Stakeholders
Action 2.3A: Participate in a bike safety awareness campaign in coordination with construction of Granby Street bike lanes					Bike Norfolk, Civic League
Action 2.3B: Conduct a follow up travel patterns study, after construction of bike lanes					Researchers, Civic League, Bike Norfolk

Funding: Service Learning Grants, PeopleForBikes Community Grant, Safe Routes to School

8. Proposed Interventions Map:

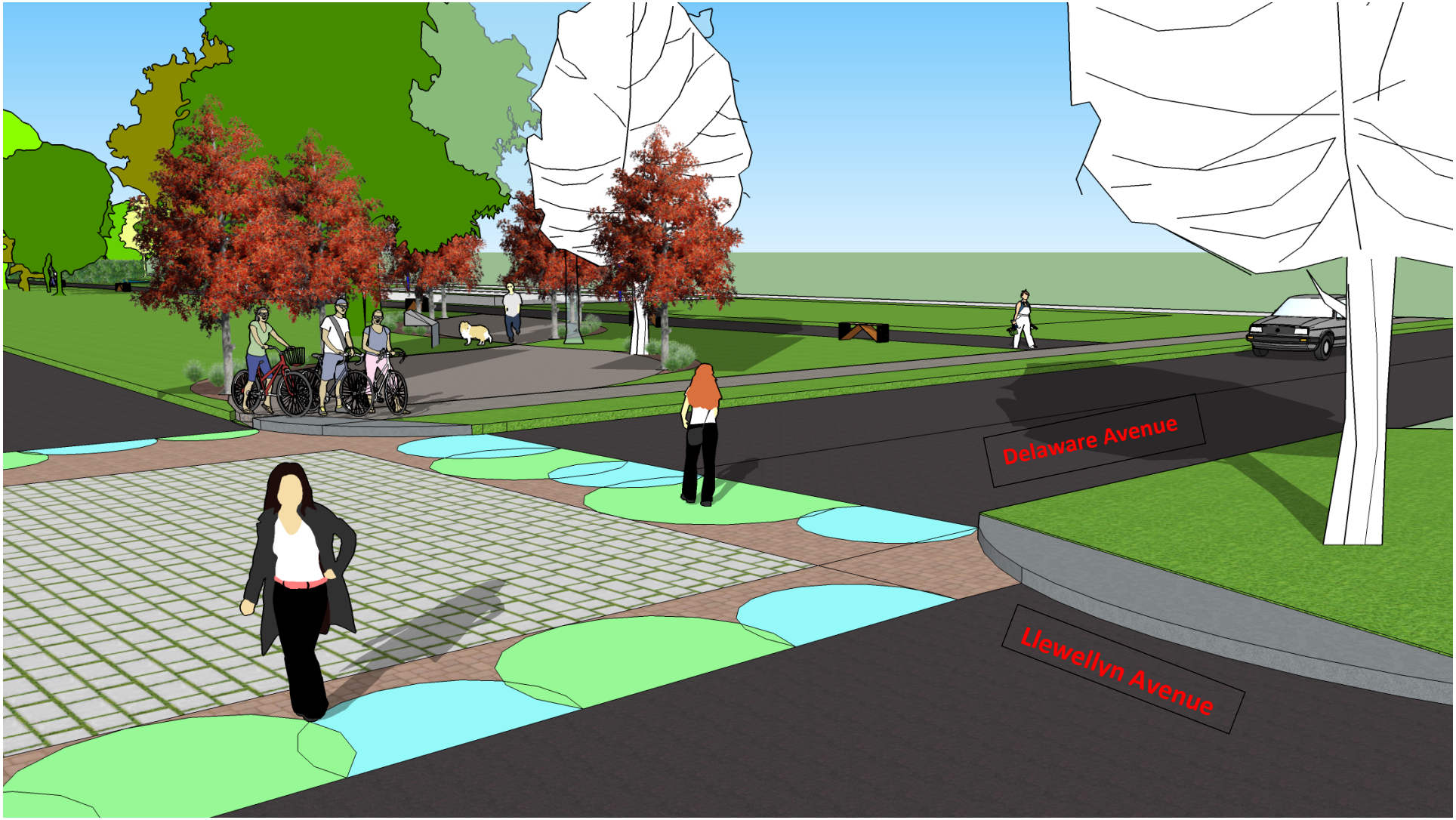
Figure 37. Proposed Green Street Network



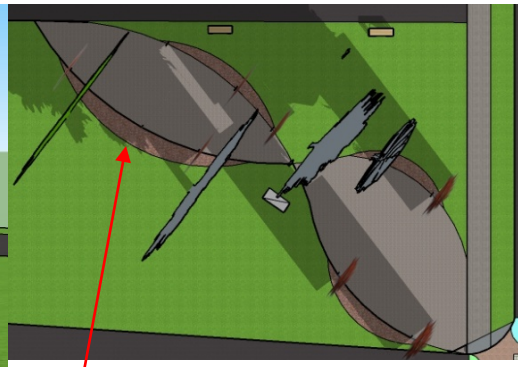
- Rain garden or planter
- Painted crossing
- Vegetated curb extension
- Colonial Place Greenway extension: Lafayette River Trail and living shoreline
- Depressed median with crossing
- Omohundro Green Alley
- Potential pocket park site
- Protected bike lane
- Bioretention Cell

8.1. Site Design Concepts:

Colonial Place Greenway entrance at corner of Delaware Avenue and Llewellyn Avenue



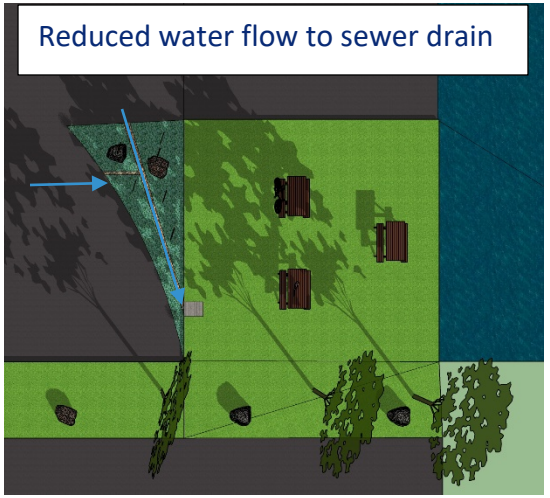
Greenway Entrance Bioretention Cells

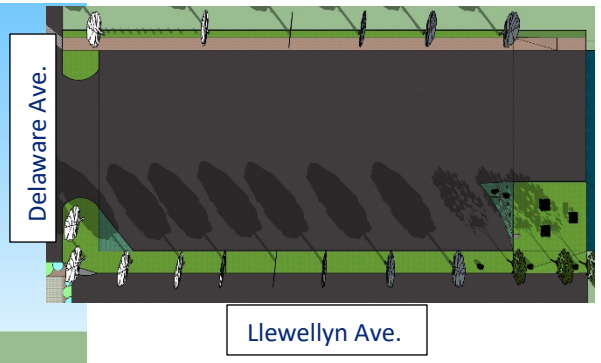


Amended soil and native vegetation in crescent beds

Interpretative sign and permeable pavers

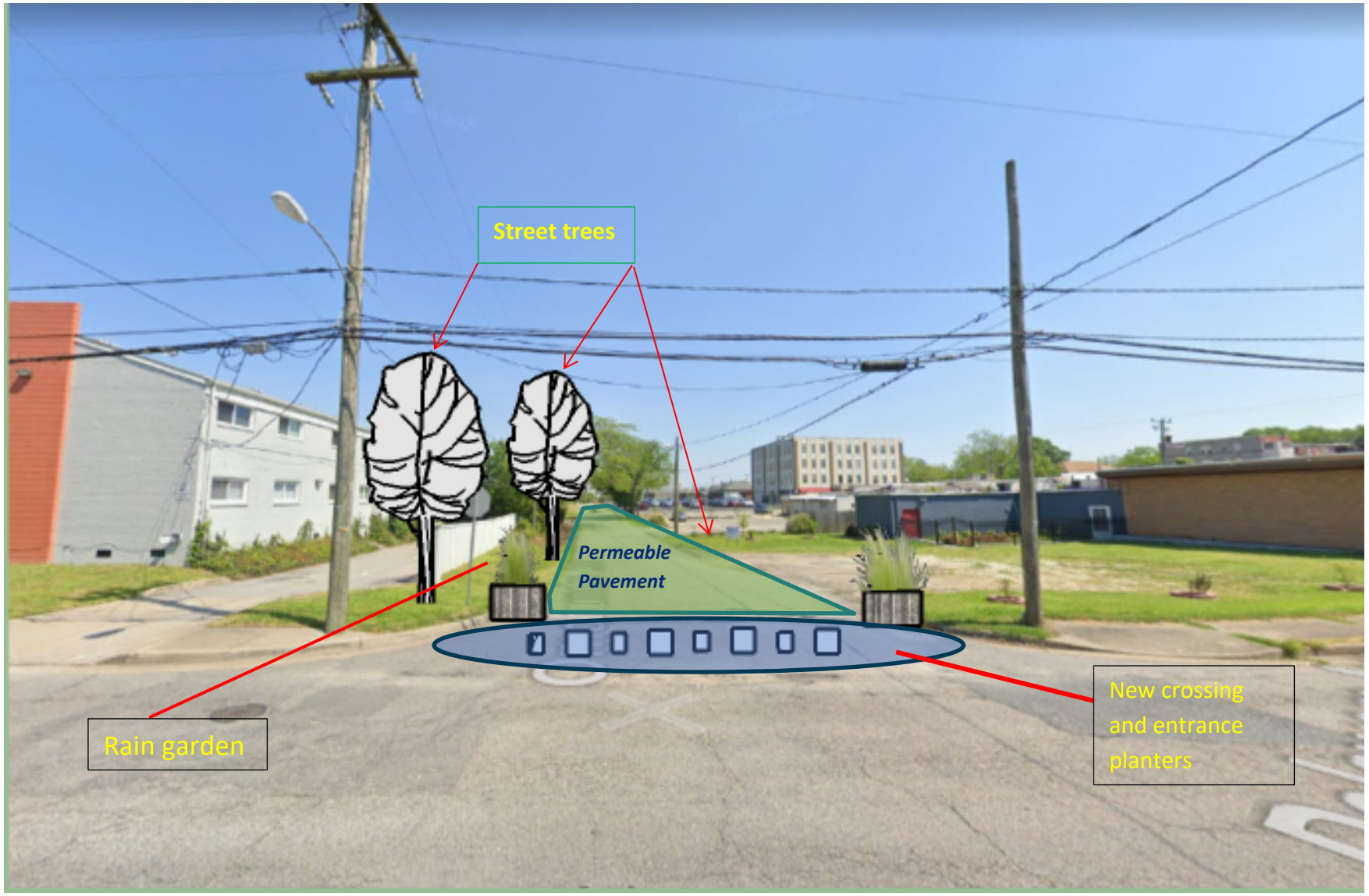
Haven Creek Boat Ramp Rain Garden Pocket Park



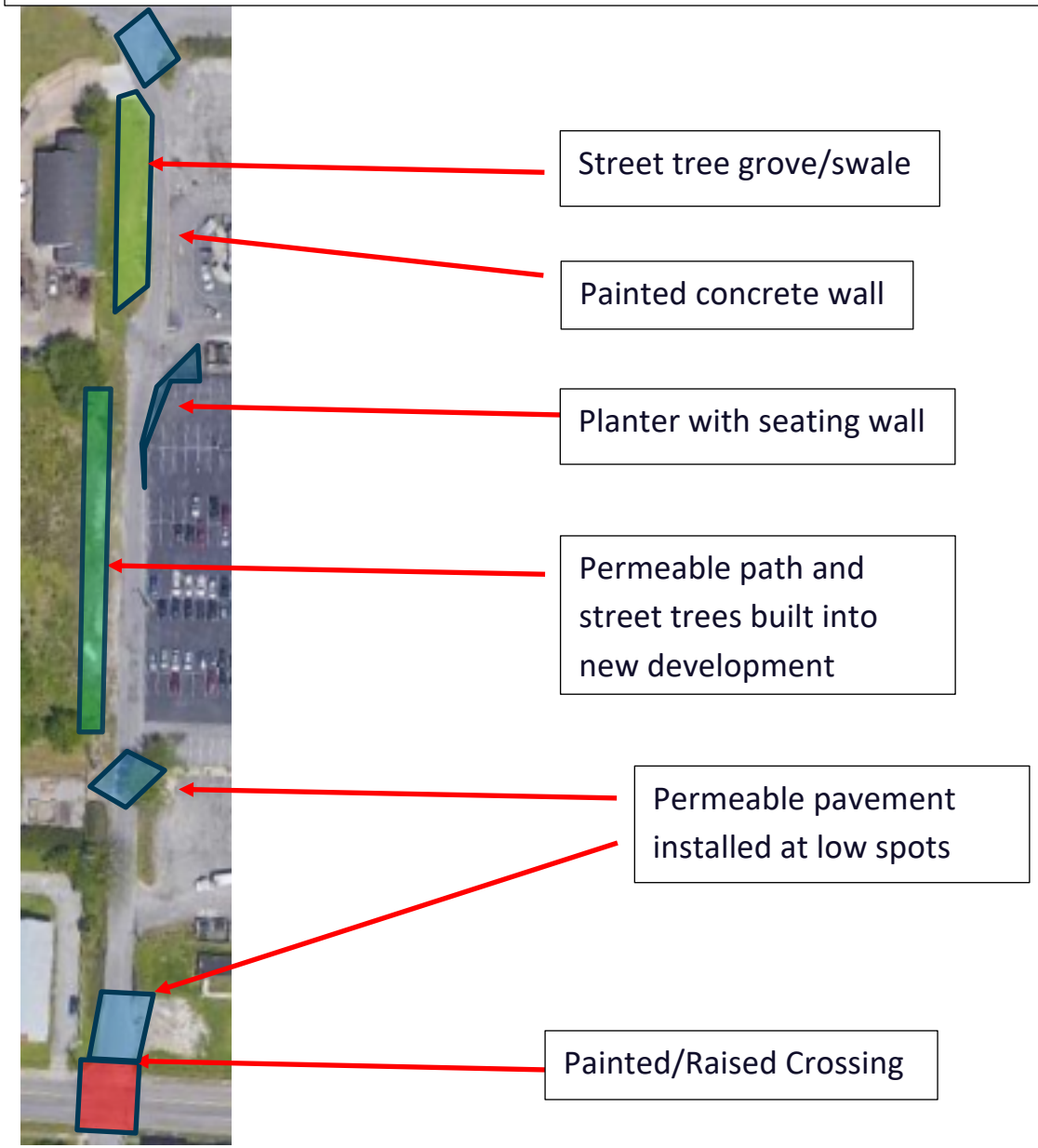


- Picnic table seating
- New trees for sense of enclosure
- Rain garden with boulder seating
- Barrier boulders on Llewellyn buffer

Omohundro Green Alley Entrance on Delaware Avenue



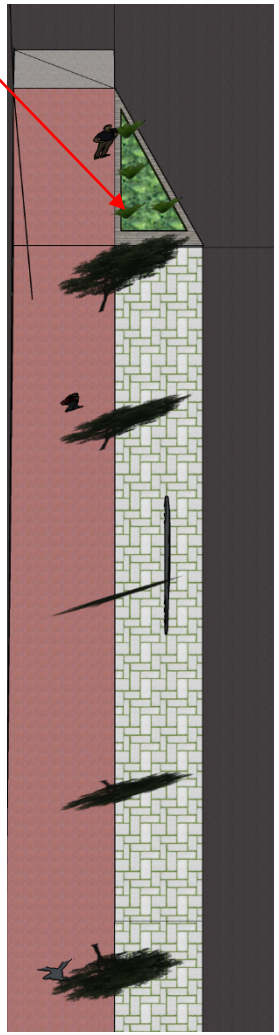
Omohundro Green Alley Concept: Omohundro is mostly curbless and already has a curve in it that slows down traffic near its midpoint. These proposed interventions would accentuate the street as a shared street, using permeable pavement to create a decorative surface.



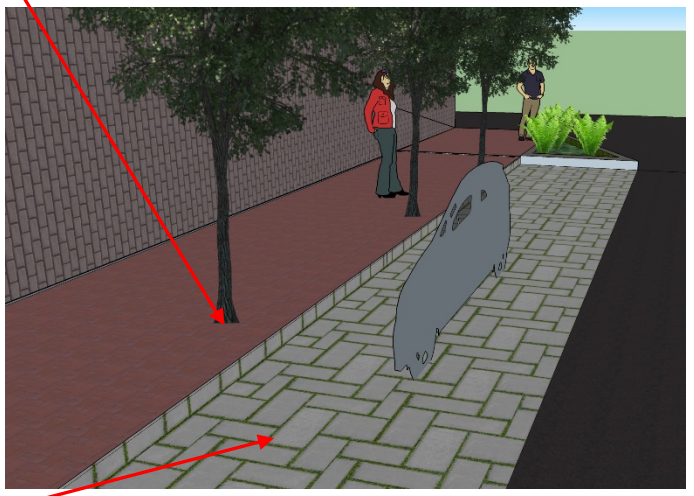
Delaware Circle Enhanced Intersection: Three new crossings and two planters around the circle emphasize pedestrian connections to and from the circle.

Granby Street Green Street Concept: 38th to Delaware

Curb extension planters placed continuously at end of street parking strips



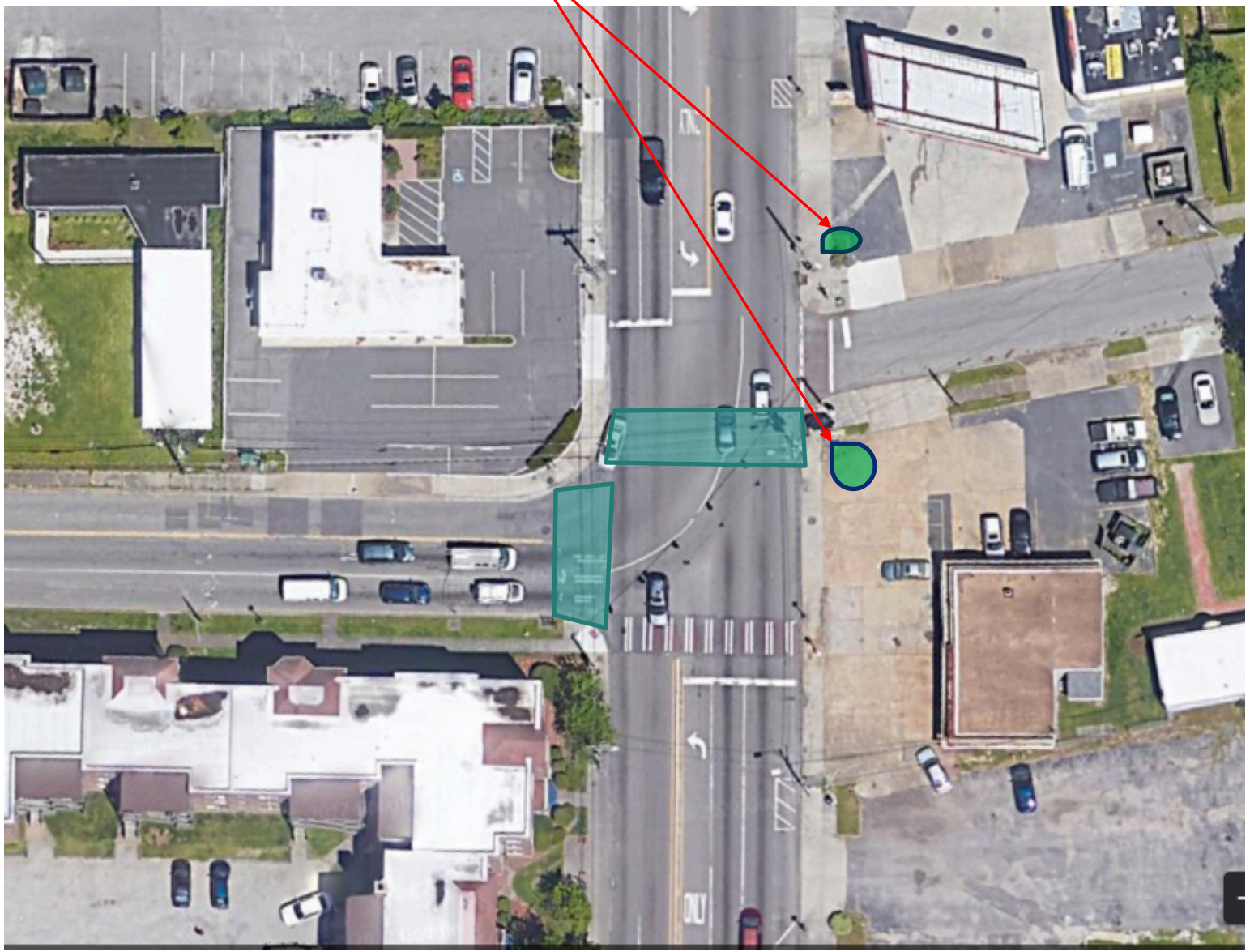
Street trees in curb



Permeable parking strip

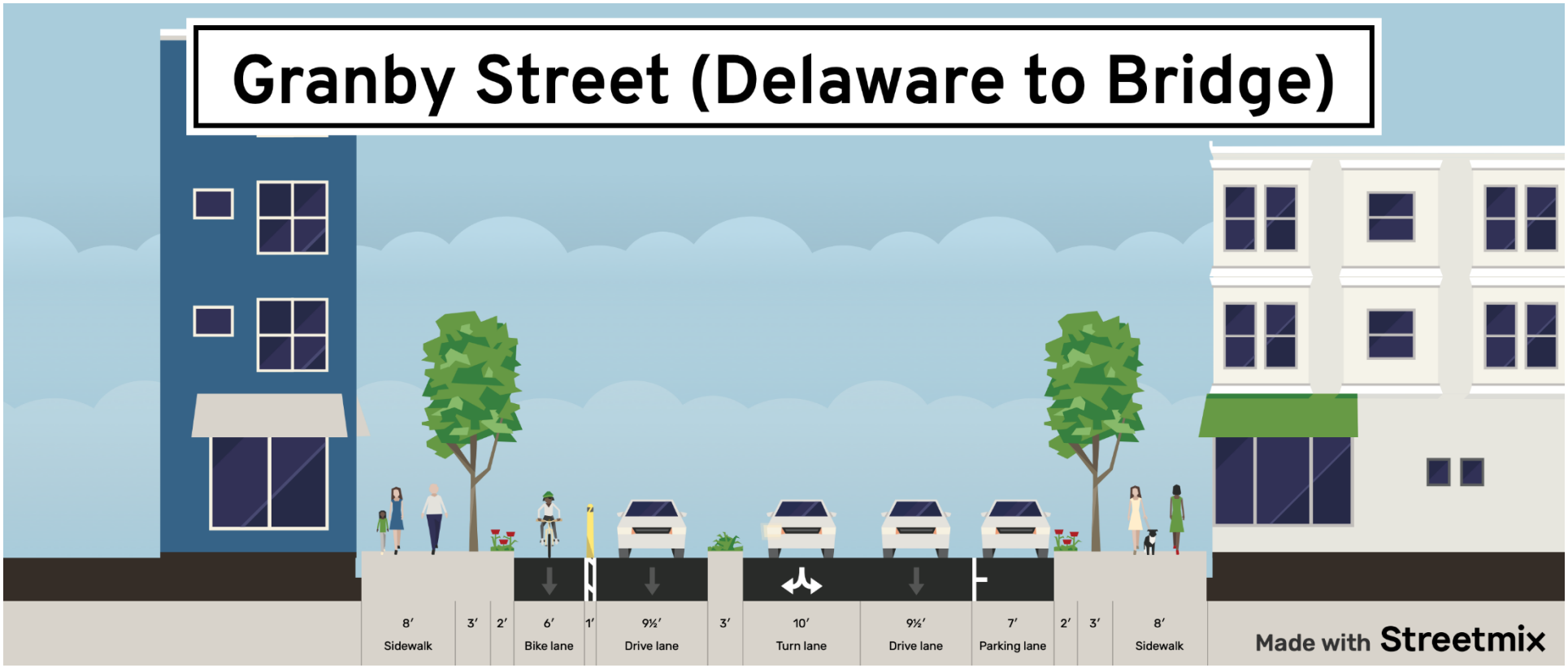
Granby Street and Delaware Avenue Intersection:

Rain gardens or tree trenches within curb and new crossings



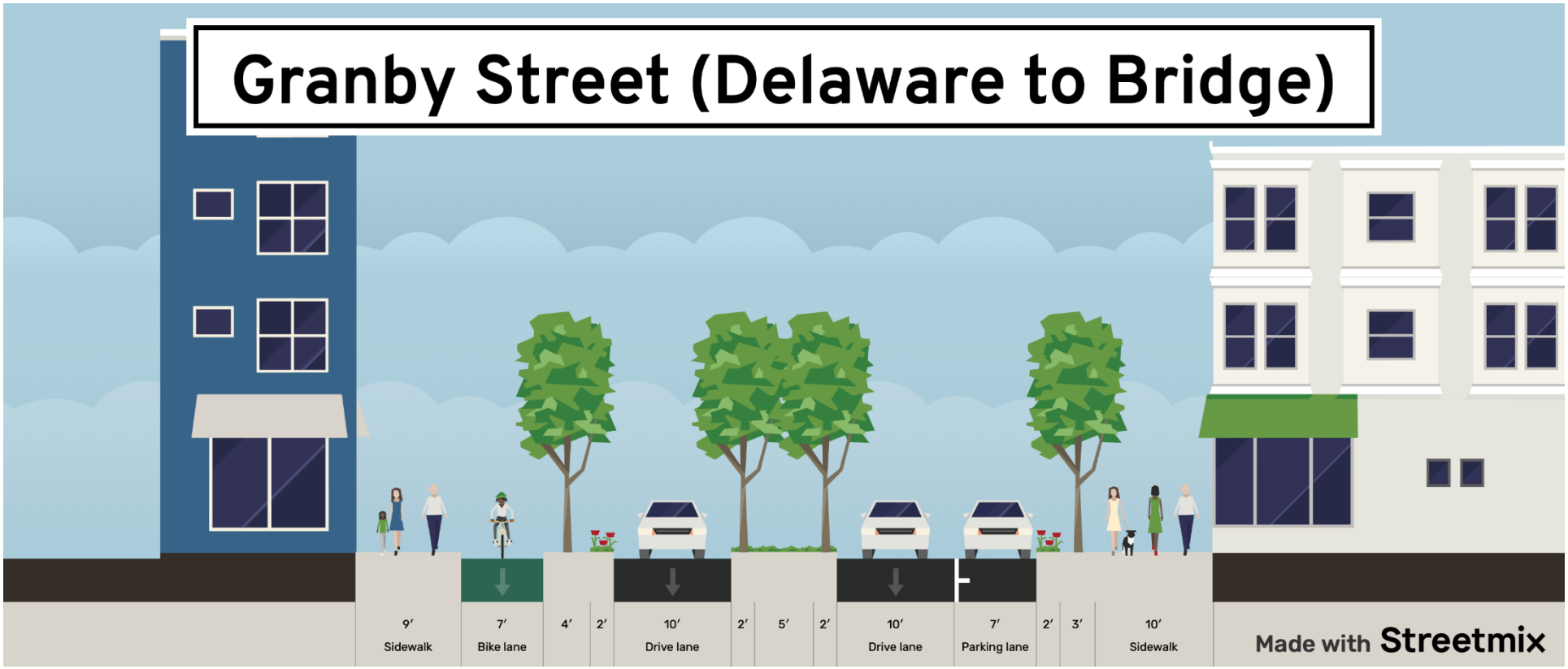
Granby Street Alternate Streetscapes

Concept 1:



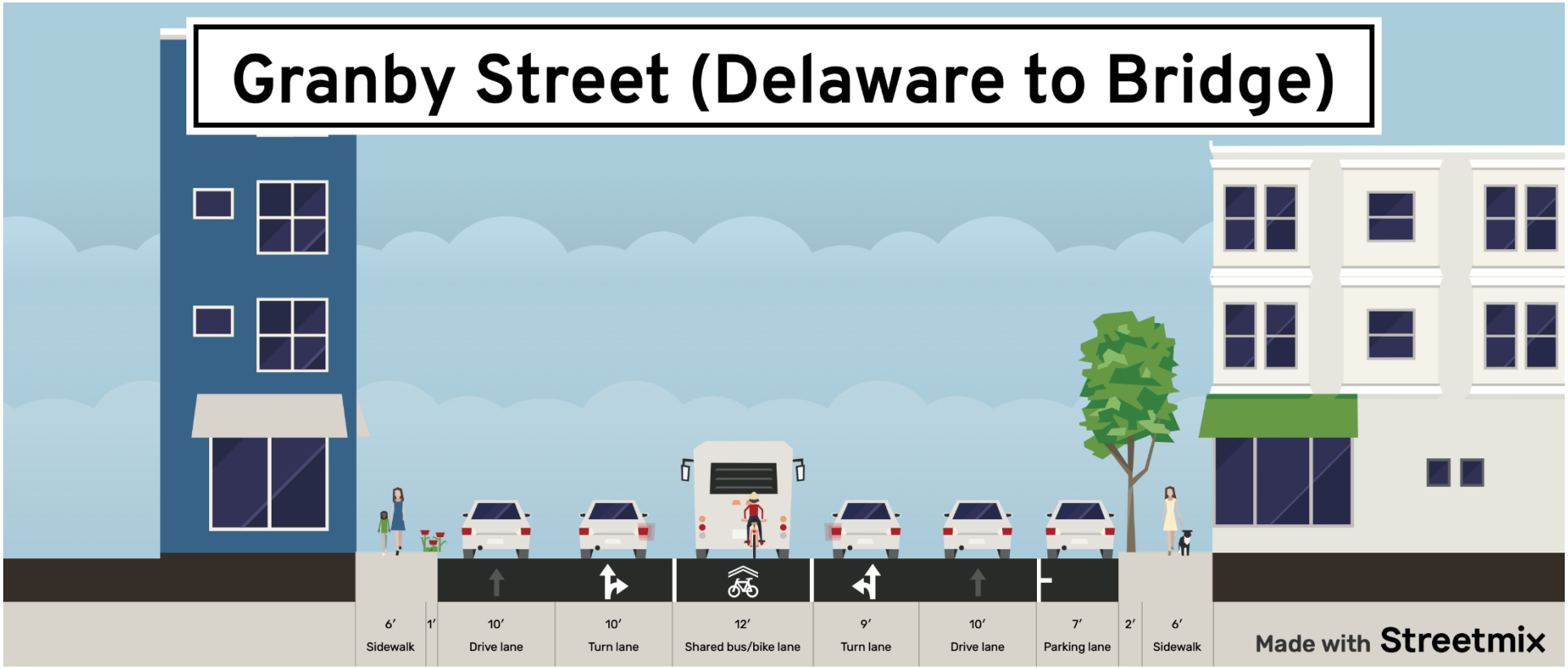
- One lane both ways
- Turn lane
- Protected bike lane below curb
- Widened sidewalks and sidewalk planter buffer

Concept 2:



- Expanded median/turn lane
- One driving lane both ways
- Bike lane above curb
- Expanded sidewalks and vegetated buffer

Concept 3:



- Dedicated central bus lane with sharrow instead of turn lane
- 2 car lanes both ways

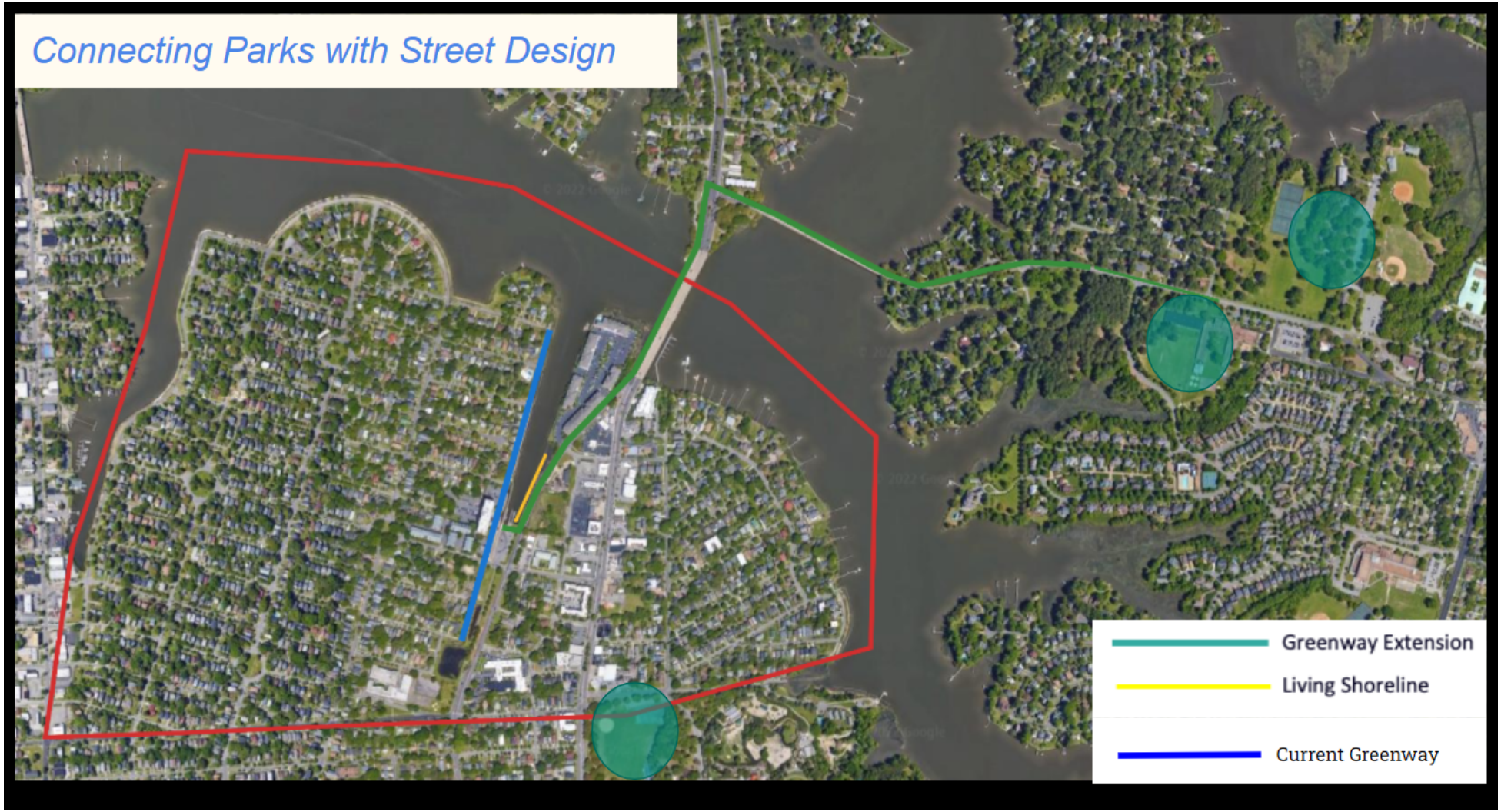
Llewellyn Greenway Extension Concept

Llewellyn's floodplain could be converted into an extension of the Colonial Place Greenway, linking the Greenway to the Granby Street Bridge, opening up new river access and reintroducing a living shoreline. Extending the greenway to the Granby Street Bridge would also open up an opportunity to redesign the Haven Creek Boat Ramp, using some of its extra parking capacity as park space or a small trailhead.

Greenway Extension

Living Shoreline

Potential Greenway Extension and Lafayette River Trail Route



9. Conclusion:

Why all this trouble over a few sidewalks and trees? Norfolk is old enough to have continually built on top of itself over generations, and many of the city's current natural boundaries are anything but natural. The question for Norfolk is not only how do you plan for the future, but how do you plan for a place that may not exist in the future? What should be saved, what should be shored up and what should be left to the course of nature to determine? Land use decisions can have long lasting impact, and green streets are only part of a much larger sustainable design approach to building cities. It is a challenge, but careful and creative design methods can find ways to optimize streets for stormwater management and pedestrian use, packing significant impact into a small footprint. This plan tries to give a sense of what the application of green street design methods could look like for Cruser Place, so that it can successfully transition from tactical to larger scale projects.

Acknowledgements: Thank you to the Wilder School professors that guided me through the Capstone process, my classmates who also navigated the virtual MURP program, the many people who granted me an interview and patiently answered my questions, my family, who listened to me ramble on about stormwater, trees and sidewalks for a couple months, and the members of the Colonial Place Riverview Civic League and Norfolk Preservation Collective, who directly or indirectly participated in this research and design. Additional thanks goes out to Amanda Hall, Meghan Gough, Laura Inghram, Jim Smither, Justin Doyle, and Caroline Creasey.

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