

THE CITY OF NORFOLK
TRANSIT

MULTIMODAL NORFOLK
WALK • RIDE • ROLL

MULTIMODAL TRANSPORTATION MASTER PLAN

Final Plan | May 2022

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MULTIMODAL NORFOLK

A TRANSPORTATION MASTER PLAN

Executive Summary

What is Multimodal Norfolk?

Multimodal Norfolk is the City of Norfolk's first multimodal transportation master plan. It's a plan to improve the City's transportation system for everyone, particularly for walking, bicycling, scooter riding, and transit – modes that have been historically underrepresented in prior planning efforts.

Norfolk envisions a city where walking, riding a bicycle or scooter, and taking transit are safe and easy.

For decades, Norfolk's streets have been designed to move as many automobiles as quickly as possible. Decisions about how to improve transportation in Norfolk have typically considered the efficient movement of vehicles as the highest priority.

Multimodal Norfolk focuses primarily on pedestrians (including those who use mobility devices), bicyclists, scooter riders, and transit passengers. These modes have been historically underrepresented in past transportation planning and decision-making processes, and their users are most likely to be injured or killed in a crash. In 2019, the Norfolk City Council adopted a Vision Zero policy with a goal to eliminate all traffic-related fatalities, with a special emphasis on the most vulnerable road users – pedestrians and bicyclists.

The future of transportation in Norfolk has safe and affordable choices for everyone to meet their daily needs for mental, physical, and financial health and well-being without having to step into their own car.

Multimodal Norfolk represents a shift in priorities

Instead of focusing primarily on moving as many cars as fast as possible, our transportation system should first make sure everyone gets where they're going safely. Our transportation decisions should put our most vulnerable users – pedestrians and bike/scooter users – first. Our transportation system should provide choices and opportunities for everyone, especially those in our disadvantaged communities and communities of color.



The future of transportation in Norfolk has safe and affordable choices for everyone to get around without having to step into their own car.



Multimodal Norfolk is about providing safe options for riding a bicycle or scooter, walking, or taking transit, regardless of age or ability.

Multimodal Norfolk represents a clear direction for the future.

This new plan is built on a substantial platform of public and community input that built a new vision and values for transportation. It contains policies for making decisions in line with that vision and values. It provides maps that show future connected networks for all modes to guide future decisions about transportation investments and to guide coordinated planning with land use changes and policy decisions.

Multimodal Norfolk defines a new process for designing transportation improvements.

It provides detailed frameworks, standards and criteria for designing and evaluating projects to further Norfolk's goals and values.

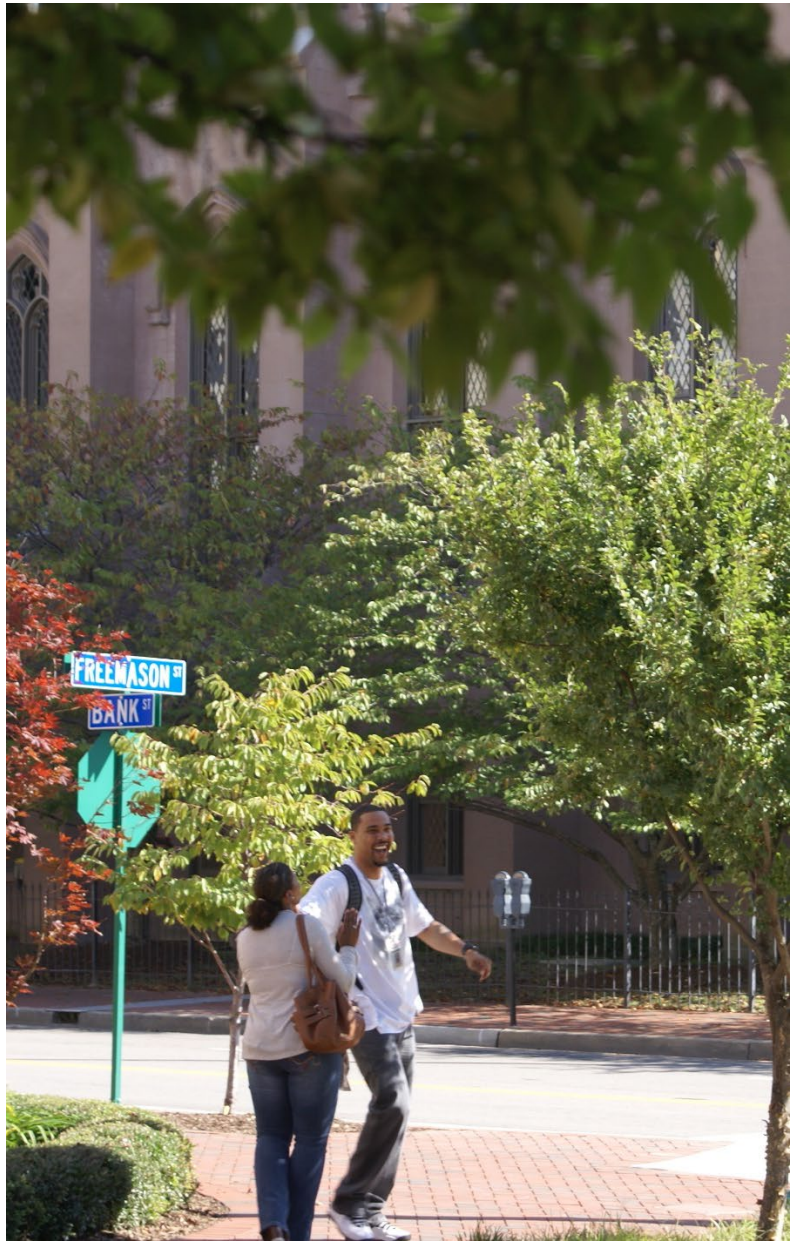
Multimodal Norfolk represents a strategic rethinking of how to best use available resources.

It includes a redesign of the Hampton Roads Transit bus network in Norfolk and identifies the most important multimodal improvement investments needed in the short, medium, and long term to most fully realize the vision within available resources.

What is in the plan?

The Multimodal Norfolk transportation master plan contains 14 chapters and nine appendices. This executive summary provides a high level overview of the plan content, including:

- What the Master Plan is and why it is needed (Chapter 1)
- Guiding vision goals, and objectives (Chapter 2)
- Public and stakeholder engagement (Chapter 3)
- Multimodal System Plan (Chapter 4)
- Bicycle and Pedestrian Master Plan (Chapter 5)
- Designing and Evaluating Multimodal Transportation Projects (Chapters 6, 7, and 8)
- Curb Space Management (Chapter 9)
- Data and Technology (Chapter 10



- Transit System Redesign (Chapter 11)
- Multimodal Needs Assessment (Chapter 12)
- Program of Projects and Resource Allocation Plan (Chapters 13 and 14)

Vision and Values

Multimodal Norfolk is a blueprint for linking all travel modes to support the safety, connectedness, and prosperity of the people of Norfolk and the region.

The above vision statement guided the development of the Multimodal Norfolk transportation master plan. It is based on input from Norfolk's citizens and stakeholders, who affirmed this vision statement through a series of meetings in the public engagement process.

Guiding Values

Three overarching values embodied in the vision statement above have guided the process and have been affirmed throughout each phase of stakeholder and public engagement:

Safety - make sure everybody is safe on Norfolk's streets.

Freedom - give everyone freedom to get where they need to go.

Equitable Prosperity - give equitable and viable choices for getting around and accessing opportunities to work, learn, play, and gather.



Values of safety, freedom, and equitable prosperity guided the development of the Multimodal Norfolk transportation master plan.

Community Engagement

The Multimodal Norfolk Transportation Master Plan is built on a foundation of robust community and stakeholder engagement throughout the two year process.

Residents and other members of the public were engaged through four rounds of input, with a variety of input opportunities, including in-person and virtual meetings, surveys, interactive maps, email and voicemail input. Thousands of flyers were distributed throughout the city. Traditional media and social media posts informed the public of what was happening. Throughout the process, the Multimodal Advisory Committee provided input representing a variety of stakeholder interests.



Community engagement activities included public meetings, surveys, online mapping activities, town hall meetings, presentations local civic league meetings, and others.

General Input Themes

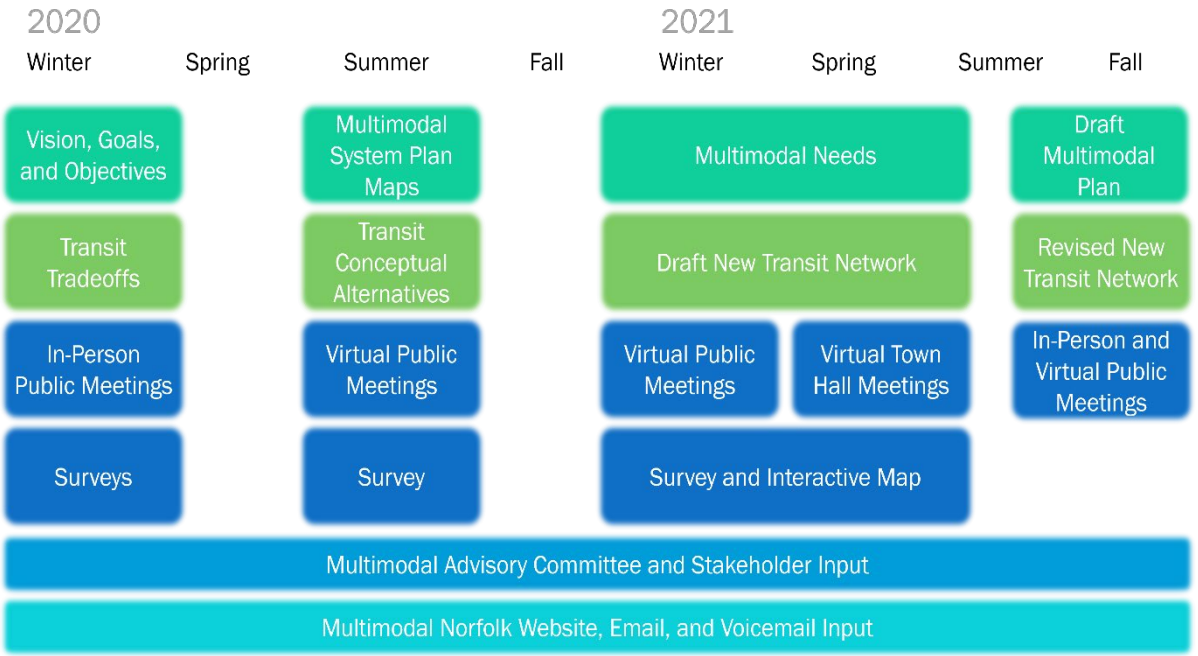
General themes that recurred throughout the public and stakeholder engagement process included:

- Safer connections for bicyclists
- Transit connections to major destinations
- Prioritizing vulnerable street users
- Shorter waits for bus service, even if it meant a longer walk
- Reducing speeding
- Improving safety for people who walk, bike or use a wheelchair

These themes were crucial in guiding the development of the Multimodal Transportation Master Plan.

There were four rounds of public and stakeholder engagement. In each round, the majority of respondents expressed support for the Multimodal Master Plan and the Transit Redesign.

More detailed descriptions of the community engagement activities and results are provided in Chapter 3.



The public and stakeholder process to develop the Multimodal Norfolk Transportation Master Plan and redesign Norfolk's bus system consisted of four major rounds of public and stakeholder input with multiple other meetings and discussions occurring throughout the process as well.



Residents and others participated in virtual public meetings and town hall meetings to give input, voice concerns, and ask questions throughout the development of the plan.

Norfolk's Multimodal System Plan

A Multimodal System Plan is a comprehensive look at the transportation system to ensure all modes have a safe and connected network to get people to where they need to go.

Multimodal Norfolk uses a *multimodal system planning approach* to make sure that each incremental improvement works toward achieving a connected future system. Norfolk's Multimodal System Plan, as described in Chapter 4, shows the location of multimodal centers and the multimodal corridors that connect them. The Multimodal System Plan identifies gaps for each mode and proposes connections to close those gaps.

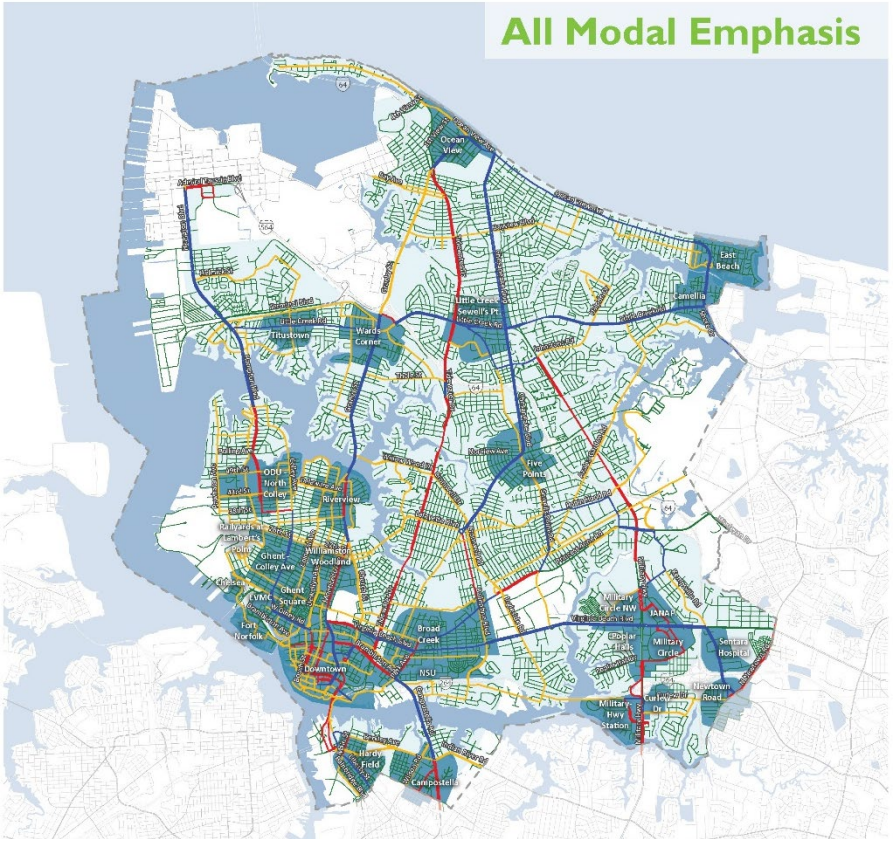
The Multimodal System Plan depicted in the image on the right is the future vision for a comprehensive connected transportation system for all modes across the entire city.

The Multimodal System maps presented in this plan represent a snapshot in time. They are based on the input and analysis conducted over the past two years. However, they are intended to be a living document as well. The maps and recommendations will evolve over time as new information is developed and projects are implemented.

Chapter 4 explains the individual components of the Multimodal System Plan and how they work together.

Bicycle and Pedestrian Master Plan

Chapter 5 represents the Bicycle and Pedestrian Master Plan for the City of Norfolk, built on the foundation of the 12 key corridors from the Bicycle and Pedestrian Strategic Plan that was adopted by City Council in 2015.



The three Modal Emphasis networks, Multimodal Centers, and Multimodal Districts shown here, together with the Transect Zones and Multimodal Corridor types described in Chapter 4 comprise the Multimodal System Plan for Norfolk. Higher resolution and zoomed in versions of this map are available in Appendix A.

Norfolk's Bicycle Network Vision

Norfolk's future transportation system will include a connected network of low-stress facilities for bicyclists of all ages and abilities.

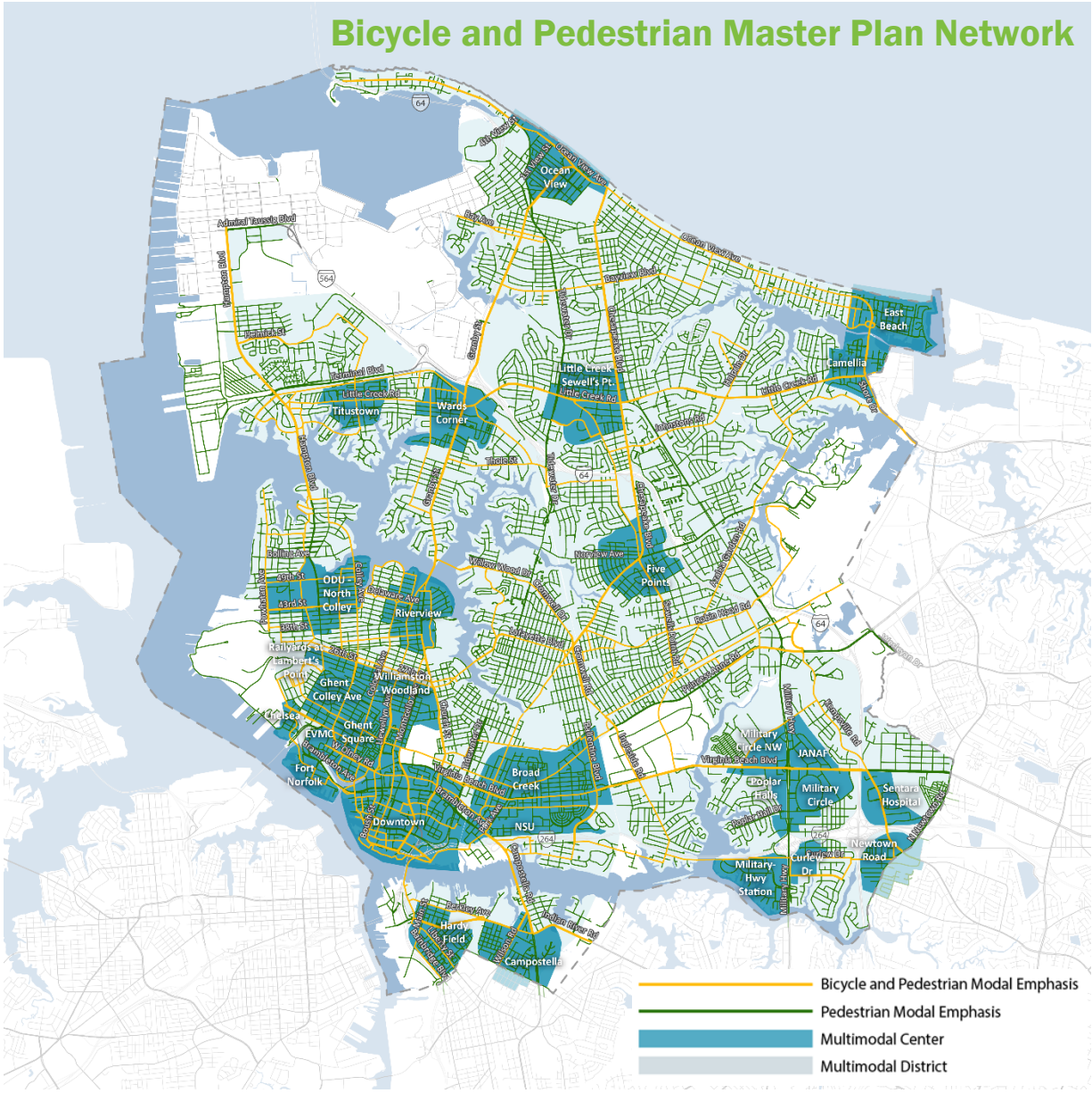
This vision for Norfolk's future bicycle network is consistent with the overarching vision and values of Multimodal Norfolk and the goal of zero traffic deaths embodied in the City's Vision Zero policy.

Bicycle and Pedestrian Master Plan Network

The map to the right represents the Bicycle and Pedestrian Master Plan. It shows a robust long-term network for bicyclists, scooter riders, and pedestrians across the entire city. It connects all of the Multimodal Centers and major destinations throughout Norfolk.

This map should guide design decisions and ensure that the incremental changes to improve Norfolk's transportation system work towards achieving the envisioned network for non-motorized modes.

By referring to this part of the plan as the City implements corridor improvement project, the City of Norfolk can work towards its vision of a future transportation system that has safe and affordable choices for everyone to meet their daily needs without having to rely on a car.



The Bicycle/Scooter Modal Emphasis Network together with the Pedestrian Modal Emphasis Network represents the long-term vision for these modes, providing connections across the entire city and between all Multimodal Centers and major destinations. More detail is provided in Chapter 5.

A New Framework for Designing and Evaluating Multimodal Projects

Chapters 6, 7, and 8 present the Multimodal Project Design Framework - a process for designing and evaluating projects on multimodal corridors so that they work toward the future vision of the Multimodal System Plan.

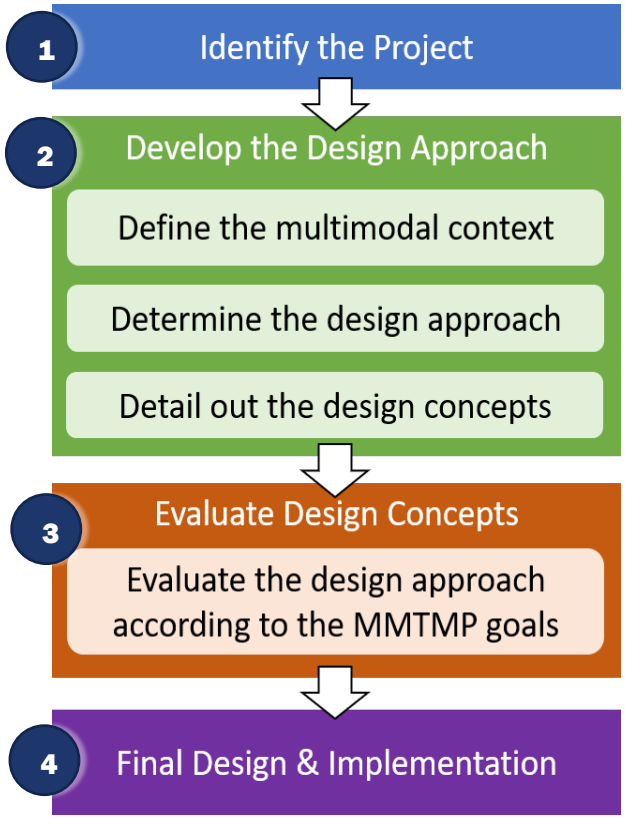
Designing Multimodal Projects

These chapters detail a new process for designing Multimodal projects, organized around a framework called the Design Approach. The *Design Approach* determines how each mode will be accommodated and what type of facility will be provided. The Design Approach depends upon the Modal Emphasis that has been designated for a corridor, as well as a variety of other factors, as further explained in Chapters 6 and 7.

Design Approaches for bicyclists, scooter riders, and buses will vary depending on the modal emphasis and context, and could include:

- General vehicle travel lanes
- Conventional bicycle lanes
- Separated bicycle lanes
- Targeted transit-priority elements
- Dedicated transit lanes
- Combined bus and bicycle lanes
- Separate bus and bicycle lanes

Multimodal Project Design Framework



The Multimodal Project Design Framework is a four-step process for selecting, designing, and implementing a project on a multimodal corridor.



A combined lane for buses and bicyclists, such as this one in Philadelphia, PA, is one possible design approach. Image Source: NACTO



Queue jumps and transit signal priority are two types of targeted transit priority elements that can be implemented at high congestion spots along a corridor. Queens, New York. Image Source: NYCDOT

- Various levels of separating bus and bicyclist/scooter conflicts at bus stops

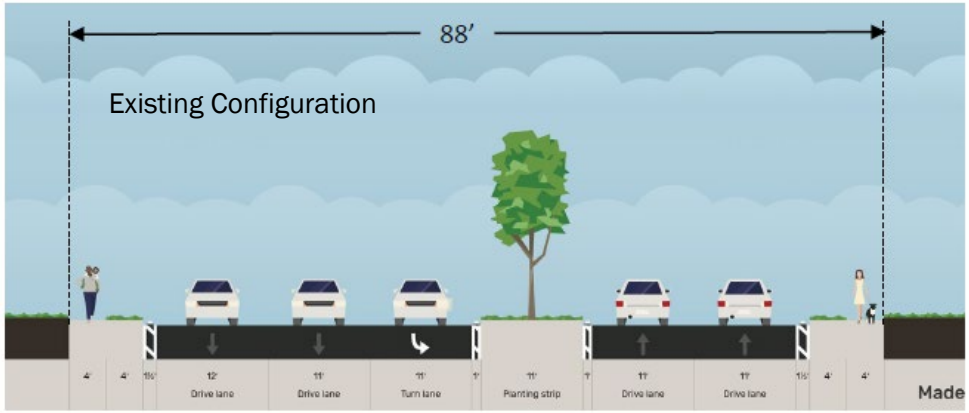
Design considerations for determining the Design Approach include:

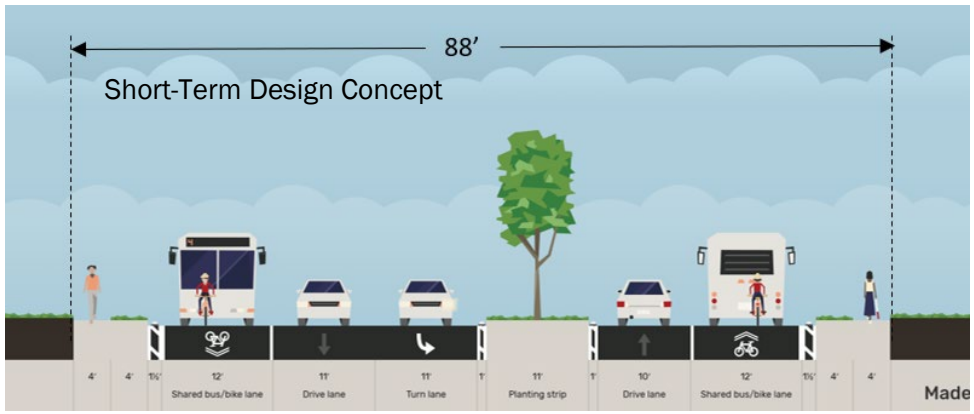
- Traffic speed
- Traffic volume
- Right-of-way and other space constraints
- Availability of alternative low-stress bicycle/scooter routes
- Bus frequency
- Bus reliability and delays

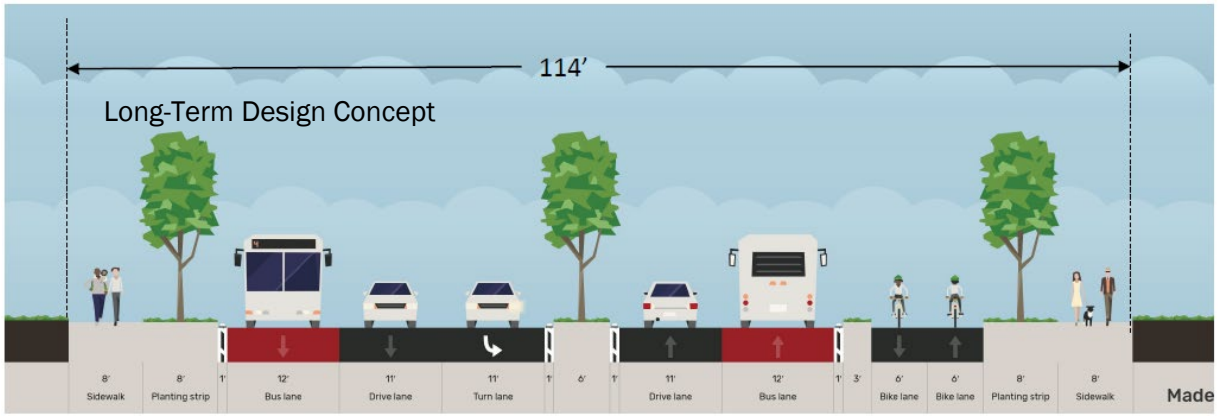
A hypothetical example in Chapter 7 and illustrated here shows how to use the Multimodal Project Design Framework to develop two design concepts:

- A near-term concept that is constrained within the existing curbs
- A long-term concept that expands beyond the existing right-of-way

Multimodal Corridor Design Example – Design Concepts Shown Together







The outcome of the Multimodal Project Design Framework is one or more design concepts with specific dimensions for each element in the corridor cross-section.

Evaluating Multimodal Projects

Chapter 8 describes a new framework for evaluating potential multimodal concepts to reflect the City's goals of safety, connectivity, and prosperity for all. The purpose of this framework is to be able to evaluate new candidate projects and ensure that they address the Multimodal Norfolk goals and objectives. Traditionally, simple mobility metrics such as Level of Service or travel time have been the only metrics used to evaluate transportation projects.

This new framework moves beyond typical vehicular Level of Service metrics, which neither factor in mobility of other modes nor account for other key goals like safety, freedom of travel choice, access to opportunities, overall quality of life, environmental sustainability, and resilience.

The new framework prompts careful examination of how improving safety for one mode may affect the safety and accessibility of other modes, and how this safety balance varies depending on the function of the street, the characteristics of the surrounding land uses, and network connectivity.

Gradually redesigning Norfolk's streets to move more people safely and efficiently will not just improve safety and equity. It will position Norfolk for accommodating more growth and prosperity in the future. The new evaluation framework communicates the benefits and tradeoffs of making changes to improve multimodal transportation.

Multimodal Project Evaluation Framework

	Does the potential design concept:	Yes	No
Connect	Increase overall person-throughput of the street?	☐	☐
	Increase modal options or create dedicated space in the right of way for a new mode?	☐	☐
	Form, enhance, or strengthen a link in a non-automobile modal network?	☐	☐
	Provide non-automobile access to new parts of the city?	☐	☐
	Introduce low-cost mobility options?	☐	☐
	Increase the efficiency of the public right of way?	☐	☐
Protect	Slow down vehicle traffic?	☐	☐
	Provide physical protection to vulnerable road users?	☐	☐
	Shorten pedestrian crossings?	☐	☐
	Decrease curb radii?	☐	☐
	Provide refuge islands?	☐	☐
	Facilitate low or no carbon emission travel?	☐	☐
	Accommodate sea-level rise and flooding events?	☐	☐
	Include green infrastructure to improve resilience?	☐	☐
Prosper	Increase travel choice for residents and workers?	☐	☐
	Add new options for accessing business locations?	☐	☐
	Enhance a local sense of place?	☐	☐
	Contribute to an attractive public realm?	☐	☐
	Support the economic viability of adjacent land uses and the city as a whole?	☐	☐
	Include green infrastructure or recreational opportunities, or improve access to parks or open spaces?	☐	☐

A New Framework for Maximizing Limited Curb Space

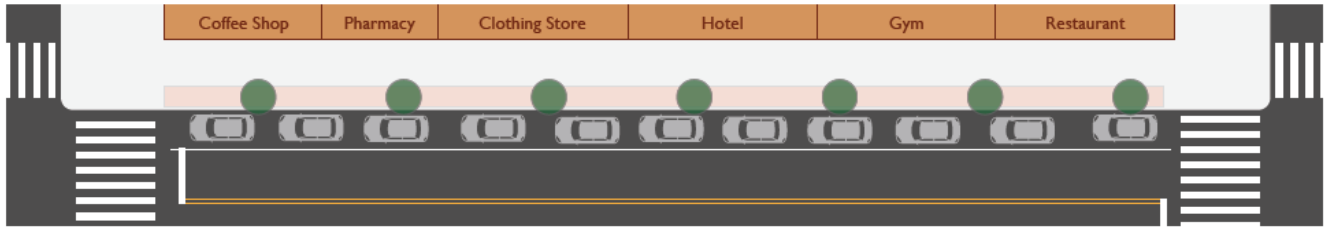
Curb space in Norfolk is a limited asset. Chapter 9 deals with the issue of how we can efficiently manage the multiple demands for use of curb spaces on Norfolk's streets.

As Norfolk continues to grow, the city needs to explore more space-efficient use of its curbsides to maximize the value of this asset and balance multiple, sometimes competing goals.

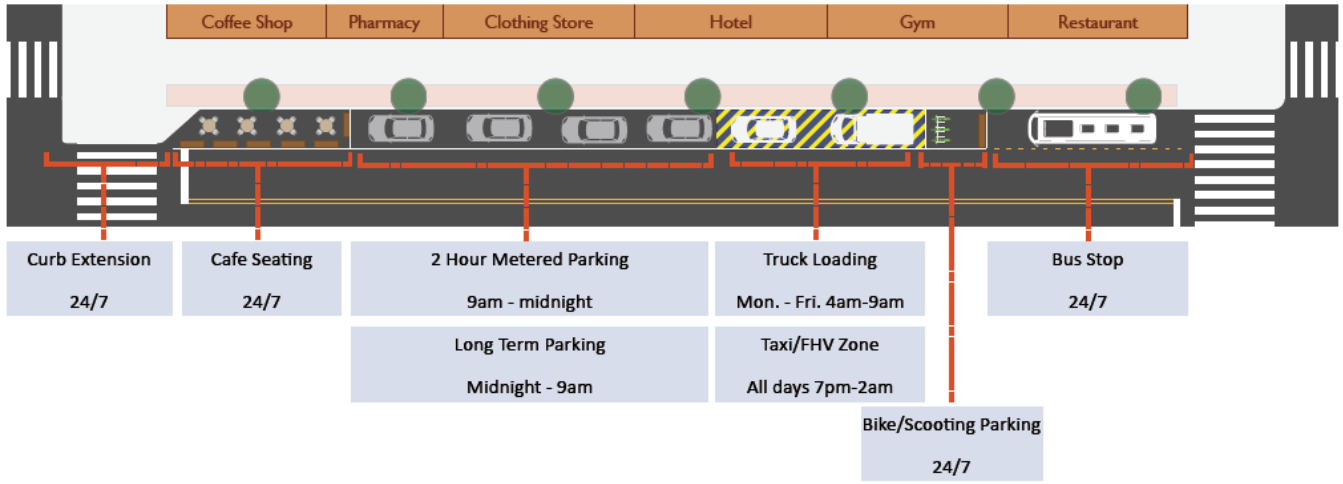
This chapter presents a framework for managing curb space that sets priorities based on land use context. It proposes open and frequent collaboration with business owners, residents, other stakeholders, and amongst various City departments as curb spaces are designated over time.

This approach involves understanding the benefits and drawbacks and balancing competing demands. It proposes a series of flexible elements to accommodate a mix of curb demands that vary by hour. The graphic on this page shows how this approach could be applied to a hypothetical city block, allowing adaptable use of curb spaces to serve the highest priority needs of the block and improve multimodal transportation.

Existing Curb Use of a Hypothetical Block



Redesigned Curb Use of a Hypothetical Block



This hypothetical example, described in Chapter 9, shows how the existing curb uses of daytime metered parking and long-term overnight parking (top) can be transformed to balance various multimodal transportation needs and priorities of different businesses and residents through flexible uses (bottom).

Data and Technology

Chapter 10 provides guidance and insights on potential technological solutions that can help the City of Norfolk address its current and future multimodal transportation system needs. It establishes a framework for evaluating new technologies that is informed by data and can address the concerns of different types of technology adopters. Potential technological solutions and example applications are provided.

Infrastructure Management

Infrastructure management applications can extend the life cycle of existing facilities by using automated monitoring and sensor technology, as well as applying artificial intelligence, machine learning, and business intelligence applications and tools. Potential infrastructure management solutions for Norfolk include:

- Smart Cities
- Electric Vehicle Charging Stations
- SMART GRID Enabled LED Streetlights

System Integration

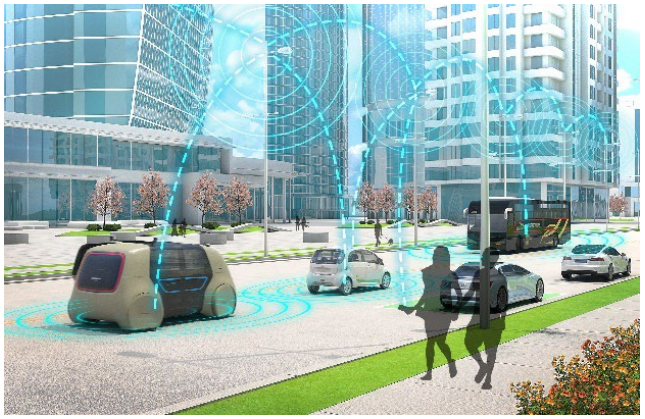
Technology related to system integration can more effectively manage connected infrastructure systems. Potential system integration solutions for Norfolk include:

- Active Traffic and Congestion Management
- Parking and Curb Space Management
- Mobility-as-a-Service

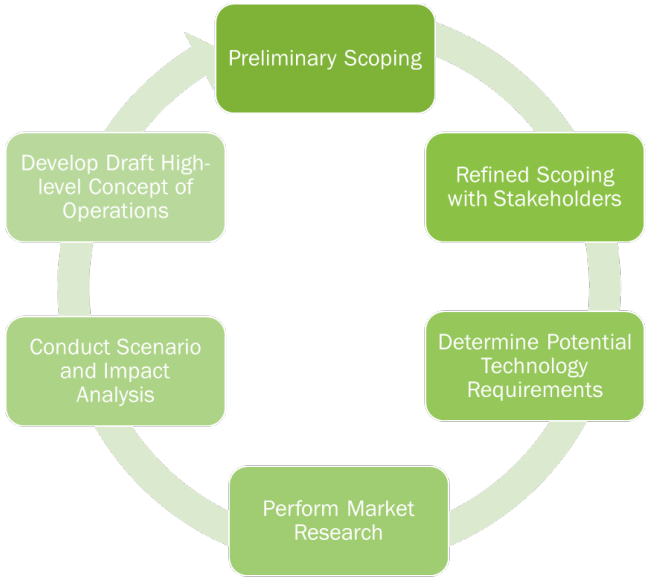
Data Aggregation

Data aggregation allows for the compiling of information from disaggregate databases and combining those databases for processing. Data is the foundational building block supporting infrastructure management and system integration. Potential data aggregation solutions for Norfolk include:

- Data Sources and Collection
- Data Management
- Incident Management



Emerging technologies such as Connected Vehicles and Automated Vehicles (CV/AV) will generate new opportunities to collect and analyze data to optimize transportation infrastructure management.



Chapter 10 outlines a framework for evaluating technology solutions, from preliminary scoping to the development of a Concept of Operations.

Transit System Redesign

Chapter 11 describes the process and recommendations for redesigning Hampton Roads Transit's (HRT) bus service in Norfolk. This transit system redesign represents a major step in implementing the Multimodal Norfolk transportation master plan.

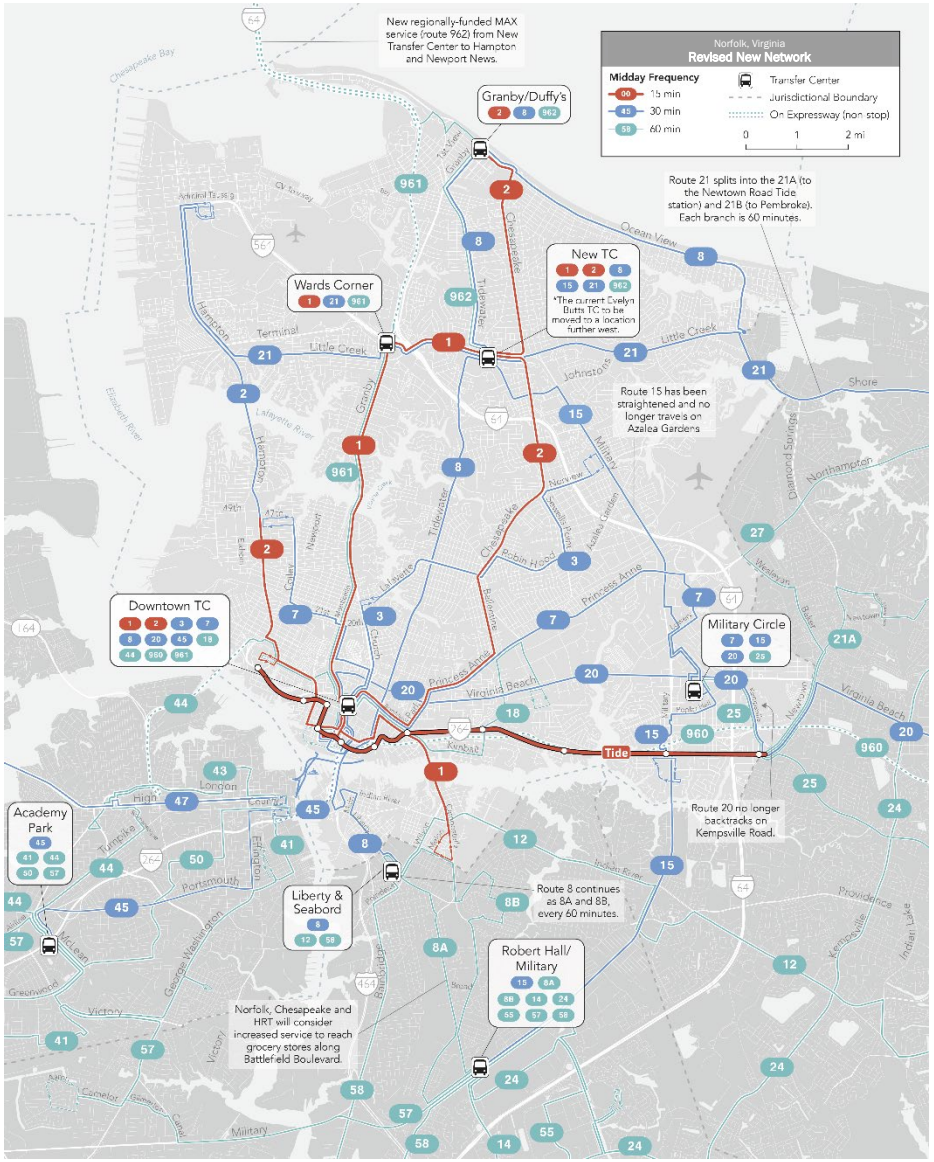
This process used a wealth of public and stakeholder input and, in collaboration with HRT, designed a new bus network to balance the competing goals of coverage and ridership in a way that reflects the City's current goals, priorities, and needs.

The process to design the new network consisted of three rounds of engagement with the public and stakeholders.

- In Round 1, we explored Key Choices such as Ridership versus Coverage and Walking versus Waiting.
- In Round 2, the City and the project team produced two contrasting Transit Network Concepts to highlight the difference between a network designed for Higher Ridership and Access versus a network designed for Higher Coverage.
- In Round 3, the City and the project team released the **Draft New Network** and asked the public, stakeholders, and transit riders for feedback about the new design. That feedback was incorporated into a **Revised New Network** presented in this plan.

The Revised New Network is anticipated to be implemented in 2023.

The City and project team also designed a Long-Term Network that increases service levels by nearly 40 percent over the next 10 years, using funding from the newly created Hampton Roads Regional Transit Fund.



The Revised New Bus Network increases the number of jobs the average Norfolk resident could reach by walking and transit in 45 minutes by 23 percent over the existing network. Access to jobs would increase by 27 percent for the average minority resident, and by 34 percent for the average resident in poverty. A higher resolution image can be viewed on the www.MultimodalNorfolk.com website.

Multimodal Needs Assessment

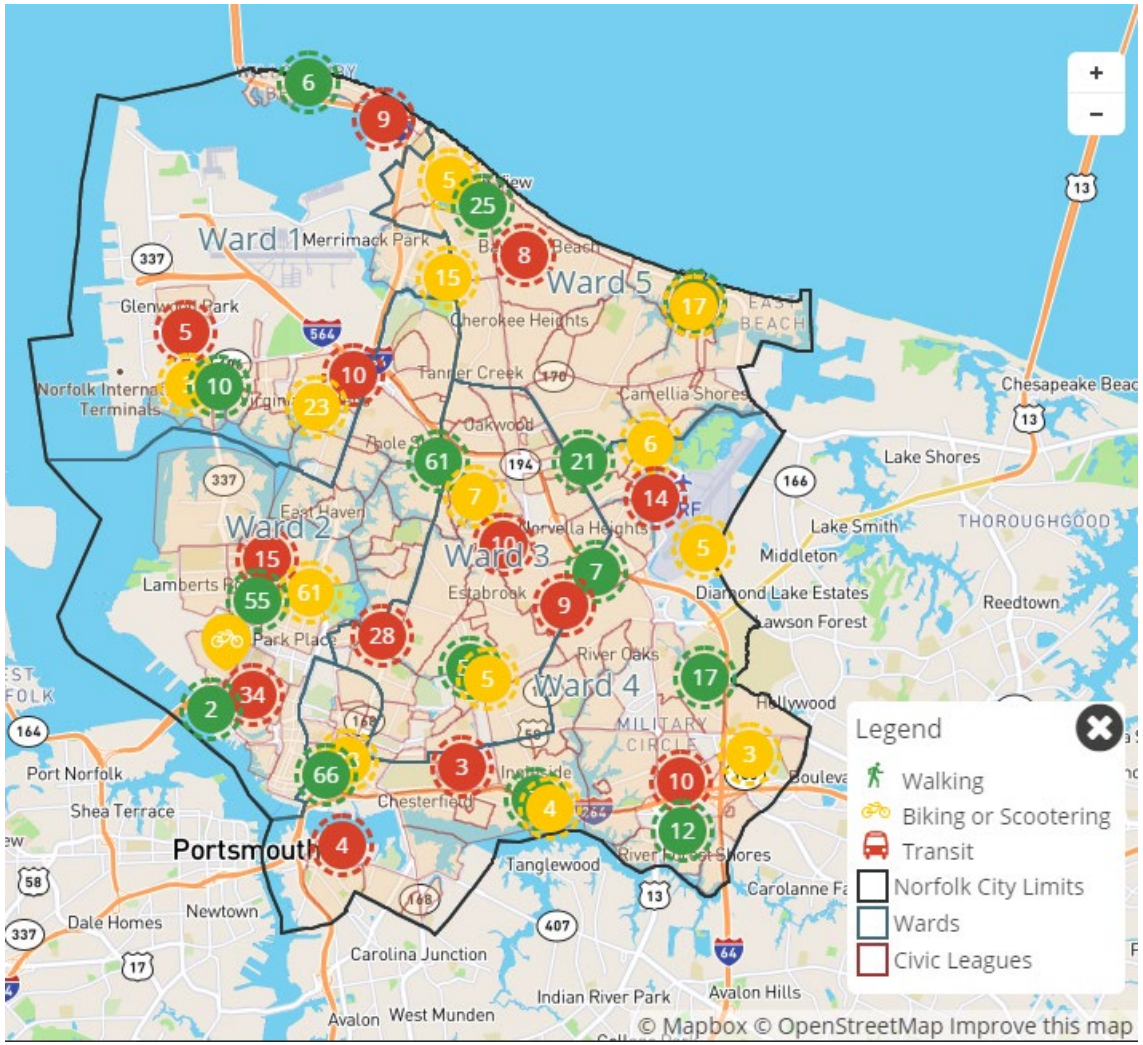
Norfolk's current and future multimodal transportation needs were identified through a combination of data-driven analysis and robust community input.

The data-driven analysis of needs is detailed in Chapter 12 and resulted in two needs maps – one for pedestrian needs, and another for bicycle/scooter needs – as shown on the next page. The data used to identify pedestrian and bicycle/scooter needs relate to the three goals of this plan - Safety, Connectivity, and Equitable Prosperity.

Transit needs were identified based on a combination of public comments and technical assessments. Transit service needs are described in Chapter 11. Needs for transit infrastructure are described in Chapter 12, and include shelters and amenities at bus stops, dedicated bus lanes at key choke points, and improved or relocated transit centers.

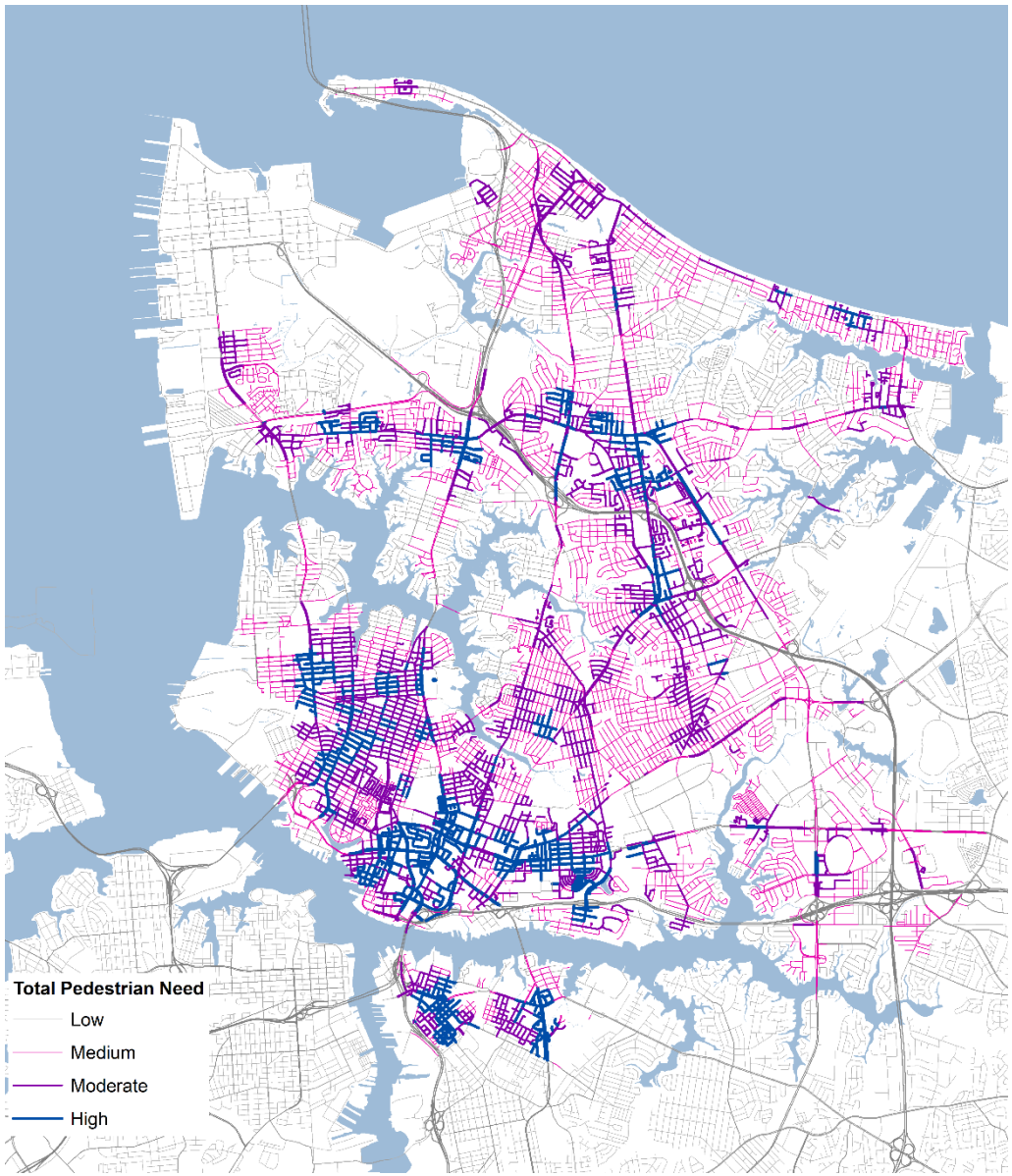
Public input on the multimodal transportation needs was solicited through a variety of in-person and online public meetings, mapping exercises (see image to the right), and input at civic league and task force meetings. Norfolk's residents submitted over 800 map comments identifying multimodal needs.

More information about the multimodal needs assessment is available in Chapter 12.

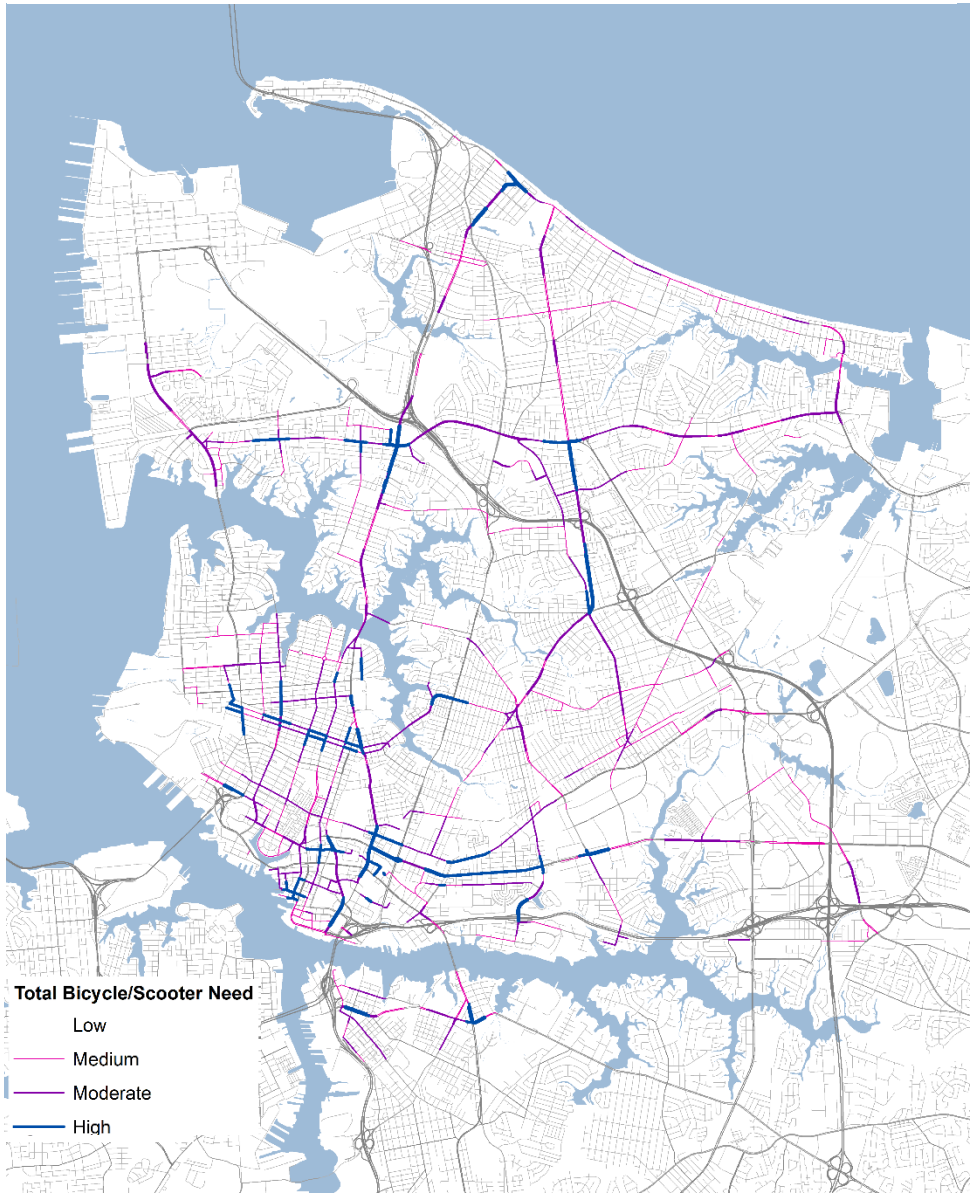


Norfolk's residents identified multimodal transportation needs through an interactive online map. This interactive map was one of several opportunities for residents and other stakeholders to give input and identify needs.

Map of Pedestrian Needs Analysis Results



Map of Bicycle & Scooter Needs Analysis Results



Program of Projects

The more than 800 comments represented a list of potential projects that is much greater than can be constructed with currently available funds. The process to obtain funding for improvement projects is complicated and not all of the identified needs can be met today.

Figuring out which projects can be funded by different funding sources is one key aspect of the process. Another is identifying which projects meet the highest needs.

The program of projects is a list of improvement projects that, if constructed, should meet the highest needs for safer walking, bicycling, scootering, and transit.

The current program of pedestrian, bicycle, scooter, and other infrastructure improvement projects is a map and a list of projects. The current list is available in Appendix G. The online map is currently available at www.MultimodalNorfolk.com.

Appendix G: Program of Projects

The projects listed in this current program of projects are not listed in any particular order, rank, or priority. The map is available at www.MultimodalNorfolk.com.

ID	Project Name	Project Type	Project Source	Funding	Need Level
1	Curlew Drive Multi-Use Path	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
3	Granby Street Bridge Rehabilitation	Other	Committed projects with funding	Funded	Not scored
4	Campostella Bridge Rehabilitation	Other	Committed projects with funding	Funded	Not scored
5	Granby Street Bike Lanes - Willow Wood Drive to Admiral Taussig Bouelvard	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
6	Virginia Beach Boulevard Improvements at Newtown Road.	Sidewalk projects	Committed projects with funding	Funded	Not scored
7	Elizabeth River Trail at Fort Norfolk.	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
8	Granby Bike Bypass at Lafayette Park and Columbus Avenue.	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
9	Princess Anne Road Corridor Improvements between Tidewater Drive and Ballentine Boulevard.	Other	Committed projects with funding	Funded	Not scored
10	Virginia Beach Blvd Widening - George St to Newtown Rd	Other	Committed projects with funding	Funded	Not scored
11	Granby Street - NEON District Streetscape Project	Other	Committed projects with funding	Funded	Not scored
12	Citywide Sidewalk Infrastructure Phase 2 - Little Creek Road (Chesapeake Boulevard to Carlton Street)	Sidewalk projects	Committed projects with funding	Funded	Not scored
13	Citywide Sidewalk Infrastructure Phase 1 - Princess Anne Road (Shelton Avenue to Fleetwood Avenue)	Sidewalk projects	Committed projects with funding	Funded	Not scored
14	Citywide Sidewalk Infrastructure Phase 1 - Easy Street and Tidewater Drive	Sidewalk projects	Committed projects with funding	Funded	Not scored
15	Citywide Sidewalk Infrastructure Phase 2 - Berkley Ave/Indian River Road (Wilson Road to Marsh Street)	Sidewalk projects	Committed projects with funding	Funded	Not scored
16	Citywide Sidewalk Infrastructure Phase 2 - Sewells Point Road (Princess Anne Road to Azalea Garden Road)	Sidewalk projects	Committed projects with funding	Funded	Not scored
17-46	St. Paul's Phase I/II	Other	Committed projects with funding	Funded	Not scored
47	Newtown Road Corridor Study	Other	Committed projects with funding	Funded	Not scored
48	Southside Bicycle Improvements	Bike/scooter facility projects	Committed projects with funding	Partially Funded?	High
49	Church Street Pedestrian Improvements	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
50	Westminster Reconstruction	Other	Committed projects with funding	Funded	Not scored
51	Lake Taylor Sidewalk Improvements	Sidewalk projects	Committed projects with funding	Funded	Not scored
52	Ballentine Blvd Lane Improvements	Other	Committed projects with funding	Funded	Not scored
53	Tidewater Drive Sidewalk at I-64	Sidewalk projects	Committed projects with funding	Funded	Not scored
54	Traffic calming and pedestrian crossing safety treatments on Granby Street between Main Street and Charlotte Street.	Traffic Calming	Candidate projects from 2021 needs assessment	Unfunded	High

The Program of Projects in Appendix G is a comprehensive list of projects that, if constructed, will meet the highest needs for safer walking, bicycling, scootering, and transit. It contains both projects that have committed future funding and projects whose funding has not yet been secured.

Resource Allocation Plan

The Resource Allocation Plan provided in Appendix H is a subset of projects from the Program of Projects that the City could realistically move forward with in the near term, likely over the next five to 10 years.

Given funding, staffing, and other resource constraints, the projects listed in the Resource Allocation Plan are potentially ready to be moved forward into project development and developed further for funding applications.

The Resource Allocation Plan is a shorter list of projects that might be fundable over the next decade. However, funding sources, eligibility criteria, and timeframes frequently change. This list will be updated periodically to adjust to the changing circumstances.

Appendix H: Multimodal Norfolk Resource Allocation Plan

Last Updated 4/14/2022

ID	Project Name/Description	Need Level	Project Readiness	Project Type	Cost Category	Primary Potential Funding Source
246	Install additional safety features at Boush St and Brooke Ave mid-block crossing. Widen the pedestrian refuge island.	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP (ARPA?)
208.1	School Zone Flashing Beacon at Crossroads Elementary School on Tidewater Drive.	High	Ready	Pedestrian signals and crosswalk projects	Medium	ARPA
150	Complete missing sidewalks on Shoop Ave from Chesapeake Blvd to St Mihiel Ave	High	Ready	Sidewalk projects	Low	CIP
211	Pedestrian Signals on Granby St at Adm Taussig Blvd.	Moderate	Ready	Pedestrian signals and crosswalk projects	Medium	CIP/ARPA
174	Provide a facility for bicyclists and scooters that connects the current protected bike lanes along Llewellyn Avenue to the south along Boush Street to connect to Downtown.	High	Ready	Bike/scooter facility projects	High	CIP
237	Sidewalk and curb ramp replacements at Omohundro Ave and W 35th St	High	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
208.6	School Zone Flashing Beacon at Southside STEM Academy	High	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
154	Construct sidewalks on Whitehead Ave from E Berkley Ave to Fauquier St	High	Ready	Sidewalk projects	High	CIP
130	Install vertical barriers or separation on bike lanes on Ocean View Ave from Shore Dr to Inlet Rd	Moderate	Ready	Bike/scooter facility projects	Medium	CIP
206.2	Pedestrian Poles & Signals and ADA ramps on E Ocean View Ave at 13th Bay St.	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP
205.2	Add pedestrian signals on Llewellyn Av at 26th St	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP
120	Complete missing sidewalks on Pleasant Ave from Shore Drive to 5th Bay St	Moderate	Ready	Sidewalk projects	Very High	CIP
222	WB right turn overlap - 5 section signal on Tidewater Dr at Widgeon Rd.	Moderate	Ready	Pedestrian signals and crosswalk projects	High	CIP
125	Complete missing sidewalk on Norview Ave from Sedgefield Dr to Tidewater Dr and improve railroad crossing	Medium	Ready	Sidewalk projects	Very High	CIP
212	Ped only phase on Granby St at Kingsley Ln.	Medium	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
245	Install a scooter corral on the Elizabeth River Trail at Warrington Ave	Medium	Ready	Bike/scooter facility projects	Tactical	CIP

The Resource Allocation Plan in Appendix H is a subset of projects from the Program of Projects that the City can realistically move forward with in the near term, likely over the next five to 10 years.

Facing Forward

The comprehensive Multimodal Transportation Master Plan for Norfolk provides a roadmap for action over time that builds on the input received from citizens, city staff and community leaders over the past two years. These voices have helped build this foundation for reshaping Norfolk's future transportation system. The transportation future of the City of Norfolk will include physical investments, service and operational improvements, and new policies to promote sustainable and equitable transportation.

Norfolk will need to progress on multiple fronts: expanding multimodal travel networks, improving safety, enhancing transit services, and designing streets that support connectivity for all. With a collective effort from leaders, citizens and city agencies working together, we can ensure that the future foundation for transportation projects in Norfolk can be based on transparency, equity, and public engagement towards the betterment of our whole community.



Chapter 1: Introduction

What is Multimodal Transportation?

Multimodal transportation describes the movement of people and goods by a variety of different modes – by car, bus, bike, walking, scooter, wheelchair, truck, train, ferry, airplane, barge, and more. Each mode is an important component of the overall system with unique needs and characteristics.

For decades, Norfolk's streets and transportation system, like most cities across the US, have been designed with a primary focus of moving as many motorized vehicles, namely automobiles, as quickly and efficiently as possible. Decisions about how to improve transportation in Norfolk have typically considered the efficient movement of vehicles the highest priority.

However, not all of Norfolk's residents, workers, and visitors own a personal vehicle, and many people desire options for getting around that don't rely on a car. Instead of moving as many vehicles as fast as possible, Norfolk's City Council adopted a new focus on safety, particularly for pedestrians and bicyclists who are most likely to be injured or killed in a crash.

A well-functioning multimodal transportation system provides safe facilities and balances the needs of all travel modes. Pedestrians, bicyclists, scooter riders, buses, trucks, private automobiles, and ride-share vehicles are all users of the multimodal transportation system.

The goal of a multimodal transportation system is to move people and goods safely where they need to go for all travel modes.

Norfolk is one among many cities across the nation and globe who are working to convert a transportation system that was built primarily for the automobile into one that meets the needs of the future and provides a variety of safe and convenient options for getting around without a car. As cities grow, multimodal mobility is a critical ingredient in solving the most pressing challenges that limit economic potential and increase environmental consequences. By advancing the hard work of making multimodal investments, these cities are preparing to meet the challenges of tomorrow.

This multimodal transportation master plan focuses primarily on pedestrians, bicyclists, scooter riders, and transit passengers. These modes have been historically underrepresented in past transportation planning and decision-making processes, and they are most likely to be injured or killed in a crash.

Other modes, like automobiles and freight movement, serve critical roles in Norfolk's transportation system. Many of Norfolk's residents, employees, and visitors use autos to get around, and freight movement is critical to the City's economic health. The City of Norfolk, Hampton Roads Transportation Planning Organization, Virginia Department of Transportation, Port of Virginia, and other entities study and plan for improvements for autos and freight movement as part of other planning processes.

This multimodal transportation master plan fills in the gaps to envision a balanced multimodal transportation system that safely accommodates all travel modes. This master plan recognizes the key roles that automobiles and freight movement serve. It seeks to provide additional options for getting around so that everyone who lives, works, and visits Norfolk can access all that the City offers by any mode they choose.

The Future of Transportation in Norfolk

Norfolk is a multimodal city. Today, Norfolk is home to the Commonwealth of Virginia's only light rail system. It is the hub of the Hampton Roads Transit bus network. The City has made recent investments in bicycling infrastructure to encourage residents and visitors to ride bicycles and scooters. Its compact neighborhoods and vibrant commercial centers make it possible to walk to nearby destinations. Norfolk has intercity passenger rail and ferry boat service. It is home to the Elizabeth River Trail, as well as the Norfolk International Airport and the Port of Virginia's Norfolk International Terminals.

These assets are a strong foundation upon which the City can build to achieve its vision for transportation from plaNorfolk 2030, the City's adopted comprehensive plan:

Norfolk is a great place to live, work, and play, with a comprehensive transportation system – rare among cities of its size – that offers a wide variety of choices, while also serving as a regional transportation hub.

A comprehensive, truly multimodal transportation system is necessary for the Norfolk to be a resilient, thriving, and equitable city.

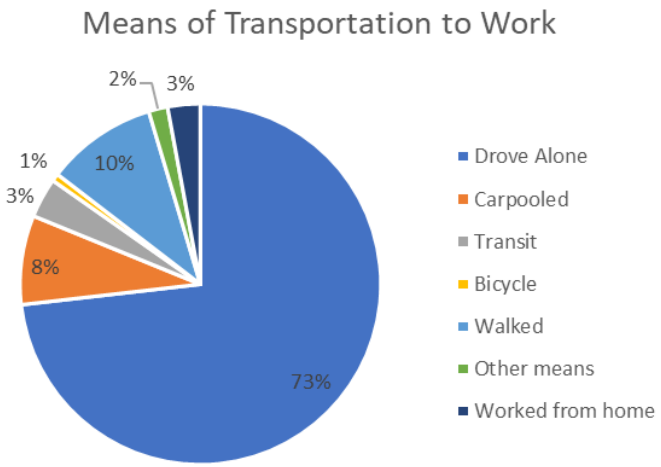
The future of transportation in Norfolk is about more than just moving cars; it is about moving people and supporting quality of life.

The future of transportation in Norfolk is about safety. When Norfolk City Council adopted its Vision Zero policy on November 26, 2019, the City embraced a strategy to:

Eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all because no traffic-related loss of life is acceptable.



Words that embody the vision for Norfolk's future transportation system, from public and stakeholder input.



Today, nearly three quarters of Norfolk's residents drive alone to work. Data source: 2019 American Community Survey 5-Year Estimates for Norfolk city, Virginia

The future of transportation in Norfolk is about resilience. The City is building a long-term strategy, outlined in Norfolk Vision 2100, to address flooding challenges and build a resilient future for the entire city, including areas at risk of sea level rise, areas that can bear the burden of redevelopment, and all the areas in between. Improving transportation connections and choices is a key piece of the puzzle.

Improving transportation connections is a critical part of Norfolk's transition to a resilient coastal community of the future.

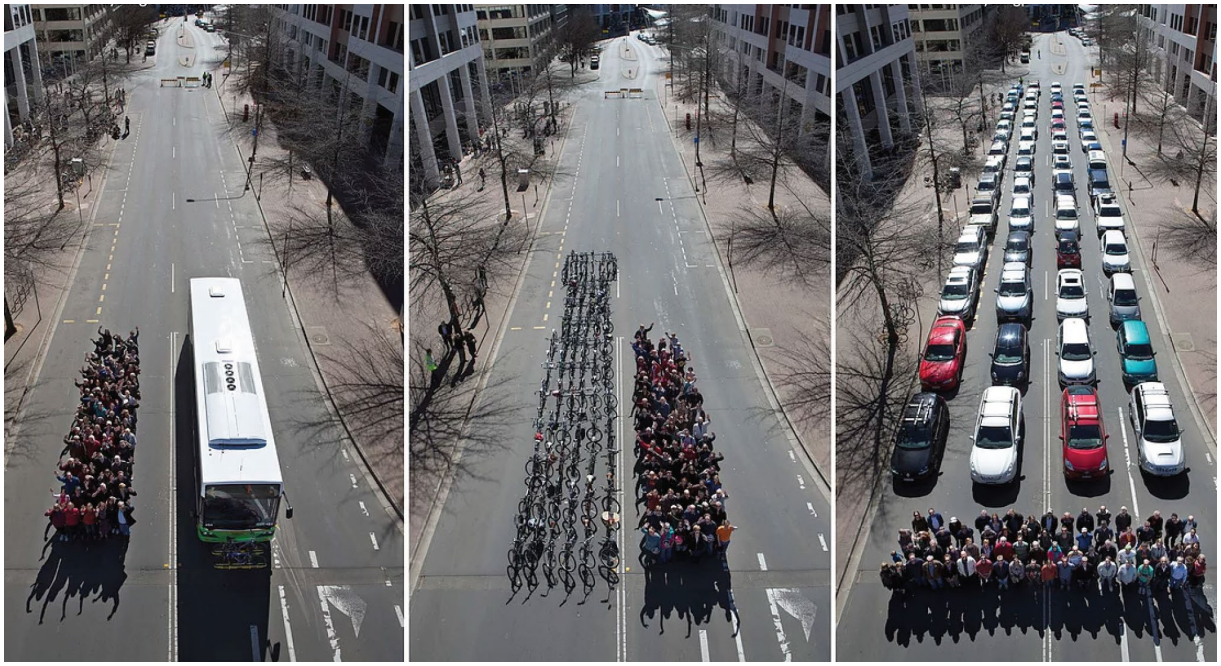
Why Norfolk Needs More Multimodal Choices

While we cannot know for certain what the future looks like, we know that the future will look different from today.

It's about economic development and community vitality

We know the Hampton Roads region is in a favorable position for continued economic growth, which will benefit both Norfolk and the rest of the region.[i] We know that the skilled 21st century workforce desires to live in places with options for getting around.

If we want our city and its neighborhoods to be vibrant active places full of people, not just full of cars, we need to make it easy for everyone to live their daily lives without depending on driving their own cars.



By providing more multimodal options for getting around, more people can move about in less space. Investing in transit service and facilities for walking and riding bicycles and scooters means Norfolk can continue to grow and thrive with a functional transportation system.

Norfolk is projected to grow by 17,000 people and over 4,000 jobs by 2045,[ii] and only three percent of its 28,000 acres of land is vacant.[iii] More people and more jobs will put more pressure on the transportation network.

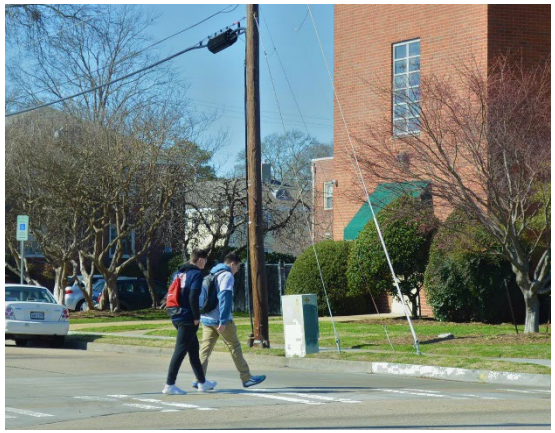


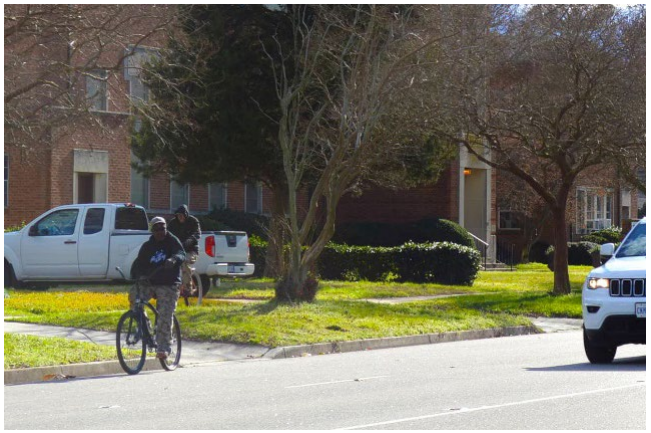
The 21st century skilled workforce prefers to live in places with options for getting around that do not depend on owning your own car. Multimodal options are vital for future economic growth.

It's about safety

In 2020, 25 people were killed in traffic crashes on Norfolk's streets, and on average, six pedestrians and bicyclists are killed every year.[iv] The City adopted a Vision Zero policy with a goal to eliminate all traffic-related fatalities, with a special emphasis on the most vulnerable road users - pedestrians and bicyclists.

To grow and thrive, Norfolk needs improved options for getting around that do not rely on driving a car and are safe, easy, and affordable for everyone.





Multimodal Norfolk is about creating a transportation system for Norfolk that is safe and convenient for everybody. Investments are needed to provide safe facilities for pedestrians, including those who use mobility devices, and people who ride bicycles and scooters.

Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries, while increasing safety, mobility, and equity for all road users. It originated in Sweden in 1994 as an approach to road safety thinking with the mindset that "No loss of life is acceptable".

In November 2019, Norfolk City Council adopted a Vision Zero policy establishing a goal of zero traffic-related fatalities and serious injuries while making the city's streets safer for all, especially for the most vulnerable users – pedestrians, cyclists, scooter users, and bus riders.

Norfolk's Vision Zero Priorities:

- Education – Promote a culture of safe driving, walking, biking, and scootering
- Engineering – Repurpose streets to reduce risk of crashes and to protect vulnerable road users
- Enforcement – Strengthen enforcement practices to reduce and prevent unsafe roadway behavior
- Evaluation – Assess efforts to ensure resources are being used effectively

Norfolk is setting out to be a truly multimodal city offering residents and visitors a variety of ways to travel. It is our goal to ensure all residents are safe when using our streets. Instituting a Vision Zero policy provides an avenue for the city to address safety concerns.

VISION ZERO

ZERO IS THE GOAL

It's about climate action

Norfolk's identity and history are steeped in its coastal assets. Norfolk's shoreline is one of its greatest resources, yet as global temperatures rise, this asset threatens the City with the largest number of people who would be displaced by land subsidence and sea level rise in the United States, only after New Orleans.[v] The transportation sector is the largest contributor to greenhouse gas emissions both in the United States[vi] and in Norfolk. Transportation accounts for 41 percent of the City's community greenhouse gas emissions.[vii]

Reducing vehicle reliance is critical to achieving the City's climate action goals.

To successfully cut carbon emissions and combat climate change, driving a car around Norfolk must change from the norm to the exception. This transformation requires the City to make strategic investments to provide safe and connected networks for getting around without a car.

It's about equity

Norfolk ranked #12 out of 99 cities across the US on the Racial Equity Index in 2019. This high ranking means that compared to other cities, Norfolk has relatively lower racial disparities on indicators such as poverty, disconnected youth, rent burden, and air pollution.[viii]

Yet, there are significant racial inequities in Norfolk, especially in the economic vitality indicators. And while Norfolk scores in the top 5 percent on racial inclusion indicators, it ranks 43rd on overall prosperity measures.[ix]

Creating a more equitable transportation system, where all neighborhoods, especially low-income communities and communities of color have safe and complete sidewalks and bike paths and access to reliable transit service to opportunities for employment, education, daily errands, and social recreation is necessary to overcoming these inequities and the resulting disparities in health outcomes.



Sea level rise projections for 2100 range from 1.6 to 7.5 feet above present-day levels. This map shows the areas that would be in AE flood zone after three feet of sea level rise. Image Credit: Norfolk Vision 2100.

It's about more than reducing traffic congestion

Traffic congestion is an often-cited source of complaint, but decades of investments that solely focus on moving more vehicles more quickly through Norfolk's streets have resulted in an imbalanced transportation system that emphasizes the movement of vehicles over the movement of people and vehicle safety over safety for people in all modes. In the future, we must look to provide safe facilities that balance all modes and allow all people to access opportunities to thrive.

While the COVID-19 pandemic disrupted normal travel patterns, it is unknown how travel behaviors will shift in the long term. Early in the pandemic, people drove less and walked and rode bicycles more. How travel patterns evolve as the immediacy of the pandemic subsides is unknown, but could be a game changer for mobility and transportation within cities.

Speeding vehicles are also a source of concern for residents, and some of the recommendations of this plan are intended to slow down vehicle speeds to create safer streets for motorists and other road users. Other recommendations involve reconfiguring streets and reallocating the space within the right-of-way to balance the space allocated to non-auto modes and other uses. Later chapters in this plan discuss tradeoffs between vehicular capacity and meeting the City's multimodal transportation goals.



Multimodal Norfolk is about making sure Norfolk's transportation system is equitable, so all residents can get where they need to go.

In some instances, projects that improve facilities for walking, bicycling, scooter riding, and taking transit may reduce the vehicle capacity of a street or lower the level of service for vehicles.

This Multimodal Transportation Master Plan represents a new framework for making decisions and balancing tradeoffs of transportation improvements in Norfolk. This framework evaluates how well a project meets the vision and goals for a truly multimodal transportation system. It may involve examining tradeoffs for traffic congestion and other considerations among all travel modes and roadway users.

What is Multimodal Norfolk?

Norfolk's residents and businesses envision a new day for transportation. The old options of being frustrated behind the wheel or taking hours to ride the bus are replaced with freedom of choice on how to get around.

Norfolk envisions a city where walking, riding a bicycle or scooter, and taking transit are safe and easy.

The future of transportation in Norfolk has safe and affordable choices for everyone to meet their daily needs for mental, physical, and financial health and well-being without having to step into their own car.

Multimodal Norfolk is the City's first Multimodal Transportation Master Plan. It is a plan to take that vision from imagination to reality.

Multimodal Norfolk represents a shift in priorities. Instead of focusing primarily on moving as many cars as fast as possible, our transportation system should first make sure everyone gets where they're going safely. Our transportation decisions should put our most vulnerable users – pedestrians – first. Our transportation system will provide choices and opportunities for everyone, especially our low-income communities and communities of color.

Multimodal Norfolk represents a clear direction for the future. It contains policies for making decisions in line with our vision and values. It provides maps that show future connected networks for all modes to guide future decisions about transportation investments and to guide coordinated planning with land use decisions.

Multimodal Norfolk defines a new process for designing transportation improvements. It provides frameworks for designing and evaluating projects to further Norfolk's goals and values.

Multimodal Norfolk represents a strategic rethinking of how to best use available resources. It includes a redesign of the Hampton Roads Transit bus network in Norfolk and identifies the most important investments needed in the short, medium, and long term to most fully realize the vision within available resources.



The future of transportation in Norfolk has safe and affordable choices for everyone to get around without having to step into their own car.



Multimodal Norfolk is about providing safe options for riding a bicycle or scooter, walking, or taking transit, regardless of age or ability.

Plan Purpose

The Multimodal Norfolk Transportation Master Plan represents a set of guidelines and best practices that will help improve the City of Norfolk's ongoing planning and decision-making processes.

The plan represents an objective framework, supported by public and stakeholder input, for future multimodal transportation in the City. The plan is a playbook for how to handle competing priorities for use of Norfolk's streets that minimizes ambiguity and balances competing needs around a publicly supported vision for the City's streets.

The plan is also a living document that will be updated as new issues arise, funding becomes available and technology advances. It is intended to be implemented through the various planning and design initiatives of city departments by providing them with decision-making guidance.

This Multimodal Transportation Master Plan focuses on modes other than the automobile. Planning for the automobile has been the prime focus of transportation planning for several decades, in many cases to the detriment of planning for other travel modes. This plan focuses on the traditionally underrepresented modes of walking (including mobility for people who use mobility devices), bicycling, scootering, and taking public transportation.

This plan recognizes automobiles, including personally owned vehicles, taxis, and ride-share vehicles, as well as trucks, buses, and emergency vehicles as road users, all of whom require space within the right of way. Its focus, however, is on enhancing the city's streets for walking, bicycling, scootering, and transit, to ensure that transportation decisions are centered around moving people, not just vehicles.

Finally, this plan does not provide detailed proposals for redesigning every segment of every street in Norfolk. Nor is it a prescriptive manual without flexibility to adapt to existing conditions. Instead, it gives a new dimension to the way transportation design decisions are made in the city today and ensures that future decisions consider the city's multimodal goals and the vision for a city that is accessible to all travel modes in the future.

The Multimodal Norfolk Transportation Master Plan is one piece in the broader transportation planning process that occurs on many levels and through different entities:

- City of Norfolk Department of Transit
- City of Norfolk Department of Planning
- City of Norfolk Department of Public Works
- City of Norfolk Department of General Services
- Hampton Roads Transportation Planning Organization
- Virginia Department of Transportation
- Port of Virginia
- U.S. Navy
- Hampton Roads Transit

These entities and others not listed here conduct transportation and traffic studies; develop transportation plans: and suggest, plan, and fund transportation improvements, the majority which are focused on moving and improving safety for automobiles and freight vehicles.

Multimodal Norfolk fills a gap in the broader transportation planning process by focusing on pedestrians, bicyclists, scooter riders, and transit passengers. These modes have historically been underrepresented in other planning processes. They are the modes most likely to be injured or killed in crashes, and pedestrian fatalities fall disproportionately on minorities. Addressing these most vulnerable modes and ensuring their safety is a key goal of this multimodal transportation master plan, and the City's adopted Vision Zero policy.

What is in this Report?

This report contains the Multimodal Norfolk Transportation Master Plan. It documents the process of developing the master plan and contains a series of policy recommendations, maps, and recommended projects.

This report contains 14 chapters and nine appendices.

Chapter 1: Introduction describes what the Master Plan is and sets the context for why it is needed.

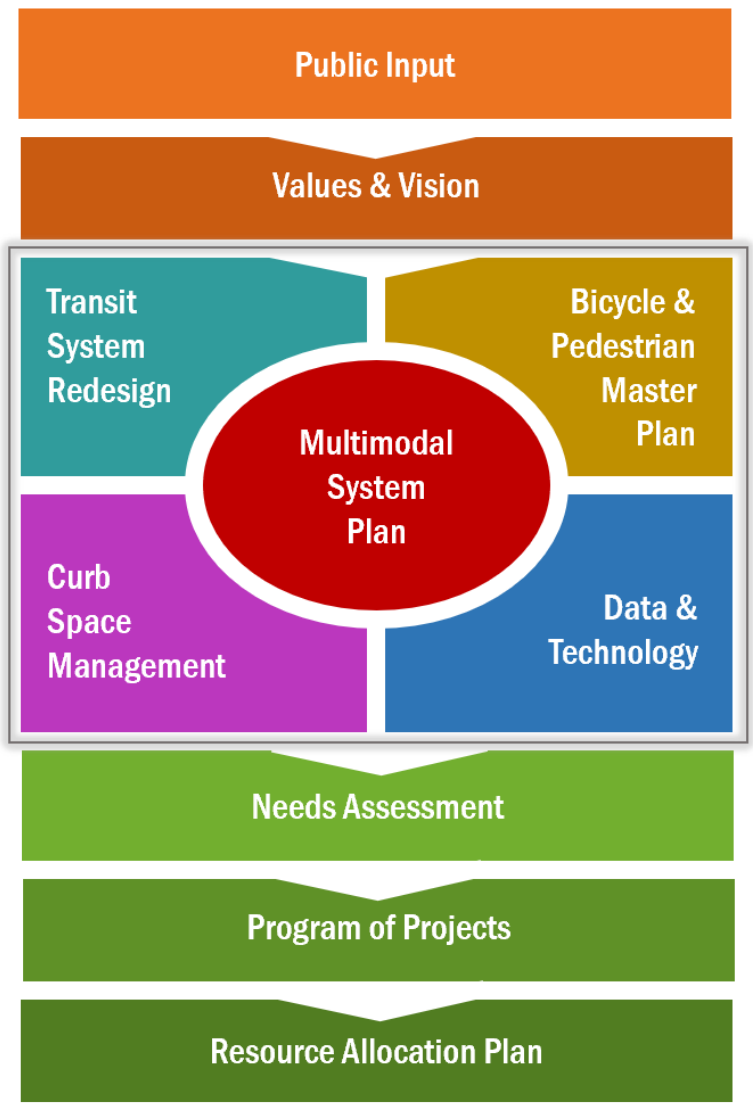
Chapter 2: Vision and Values provides the guiding vision, goals, and objectives for the master plan process.

Chapter 3: Public Engagement describes the robust process to develop the plan with interactive public and stakeholder engagement throughout.

Chapter 4: Multimodal System Plan explains the process for developing the multimodal system plan, which is the basis for the modal networks and shows the geographic vision for an interconnected system for all modes.

Chapter 5: Bicycle and Pedestrian Master Plan describes how this plan builds on the Strategic Bicycle and Pedestrian Plan.

Chapter 6: Multimodal Project Design – Overall Framework presents a new framework for designing multimodal corridors. This framework represents a new process for



This diagram explains the basic organization of this report into three parts.

designing transportation improvement projects to put pedestrians first and to achieve the multimodal system plan from Chapter 4.

Chapter 7: Multimodal Project Design – Approaches for Different Modes expands upon the overall Multimodal Design Framework and provides design approaches and considerations for different modes.

Chapter 8: Multimodal Project Evaluation presents a framework for evaluating potential changes to the transportation system that align with the City's vision and goals. It introduces new metrics that shift away from traditional transportation evaluation metrics.

Chapter 9: Curb Space Management presents a framework for setting priorities for one of Norfolk's most limited assets – curb space – and discusses ways to maximize the usefulness of this limited asset.

Chapter 10: Data and Technology provides recommendations for capitalizing on emerging technology trends and preparing for future innovations in multimodal transportation.

Chapter 11: Transit System Redesign provides an overview of the process and recommendations for redesigning Hampton Roads Transit's bus service in Norfolk. The recommended network is anticipated to be implemented in 2023. This transit system redesign represents the first major step in implementing the Multimodal Norfolk transportation master plan.

Chapter 12: Multimodal Needs Assessment identifies the areas within the City with the greatest needs for pedestrian, bicycle, and scooter improvements, based on a combination of data-driven analysis and public input. Transit needs are also presented based on a combination of public input and technical assessments.

Chapter 13: Program of Projects and Resource Allocation Plan explains the process to develop the Program of Projects – a comprehensive list of all potential projects to address the City's multimodal needs – and the Resource Allocation Plan – a shorter list of priority projects that the City can feasibly move forward with in the near-term.

Chapter 14: Implementation and Next Steps outlines immediate next steps and provides recommendations for revisiting the master plan in the future.

Appendix A: Multimodal System Plan Maps provides a series of high-resolution maps of Norfolk's Multimodal System Plan at the citywide scale and zoomed in to different areas of the city.

Appendix B: Additional Maps provides additional maps that were used during the development of the Multimodal System Plan.

Appendix C: Multimodal Corridor Design Matrix provides the full length and full-scale version of the Corridor Matrix that provides optimal and minimum standards for each corridor element, as explained in Chapters 6 and 7.

Appendix D: Freight Design Considerations contains guidance for designing multimodal corridors in the context of regional freight movement needs.

Appendix E: Pedestrian Crossing Design Considerations provides best practices for designing pedestrian crossings on multimodal corridors at intersections and mid-block locations.

Appendix F: Multimodal Needs Assessment Technical Appendix provides more detail on the data-driven analysis used to produce the needs maps.

Appendix G: Program of Projects provides the full list of projects included in the current Program of Projects.

Appendix H: Resource Allocation Plan provides the current list of projects in the Resource Allocation Plan.

Appendix I: 2015 Norfolk Bicycle and Pedestrian Strategic Plan is the strategic plan adopted by City Council in 2015. The recommendations from the strategic plan remain valid. However, implementation of the project recommendations from the strategic plan will follow the latest industry standard design guidance, which continues to evolve.

[i] Hampton Roads is home to more than 1.7 million residents and is projected to grow to over 2 million by the year 2045. Source: Hampton Roads Transportation Planning Organization, 2019. Hampton Roads 2045 Socioeconomic Forecast and Transportation Analysis Zone Allocation. Retrieved Dec 22, 2020 from https://www.hrtpo.org/uploads/docs/Hampton%20Roads%202045%20Socioeconomic%20Forecast%20and%20TAZ%20Allocation%20Report.pdf.
[ii] Ibid.
[iii] Land vacancy statistic from plaNorfolk 2030
[iv] City of Norfolk, Department of Transit, 2019. *Citywide Crash Analysis (2015-2018)*.
[v] City of Norfolk, Mayor's Advisory Commission on Climate Change Mitigation and Adaptation, 2019. *Climate Action Plan*.
[vi] U.S. Environmental Protection Agency. "Fast Facts on Transportation Greenhouse Gas Emissions." Retrieved Nov 17, 2020 from https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.
[vii] City of Norfolk, Mayor's Advisory Commission on Climate Change Mitigation and Adaptation, 2019. *Climate Action Plan*.
[viii] National Equity Atlas. Racial Equity Index. Data retrieved for the City of Norfolk, VA on May 19, 2022 from https://nationalequityatlas.org/research/racial_equity_index/index#/?geoSectionName=City&geo=06000000000051078
[ix] Ibid.

Chapter 2: Vision and Values

A Guiding Vision for Multimodal Norfolk

Multimodal Norfolk is a blueprint for linking all travel modes to support the safety, connectedness, and prosperity of the people of Norfolk and the region.

This vision statement guided the development of the Multimodal Norfolk transportation master plan. It is based on initial feedback from Norfolk's citizens and stakeholders, who affirmed this vision statement through a series of meetings in the public engagement process.

Guiding Values

Three overarching values embodied in the vision statement above have guided the process and have been affirmed throughout each phase of stakeholder and public engagement:

Safety - make sure everybody is safe on Norfolk's streets.

Freedom - give everyone freedom to get where they need to go.

Equitable Prosperity - give everyone viable choices for getting around and accessing opportunities to work, learn, play, and gather.

More information on the stakeholder and public engagement process is provided in Chapter 3: Public Engagement



Values of safety, freedom, and prosperity guided the development of the Multimodal Norfolk transportation master plan. Stakeholders, residents, businesses, and community advocates reiterated these values throughout the master plan process.

Goals

Using public input and under the guidance of the Multimodal Advisory Committee, goals and objectives for the Multimodal Norfolk transportation master plan were developed to align with the vision and values.

The need for connections was a resounding theme across the public feedback in the first round of engagement. Many participants voiced a need for better bicycle and transit connections across the City and to major destinations.

Improving safety, especially for the most vulnerable street users like pedestrians, bicyclists, and people who use wheelchairs and paratransit, was another common theme, as was the need to slow down cars.

Finally, research shows that geographic mobility is linked to economic mobility.[i,ii] To make sure everyone in Norfolk has access to opportunities for financial prosperity, Norfolk needs a transportation system that gives everyone the ability to get around at an affordable price.



Three goals and six objectives guided the development of the Multimodal Norfolk transportation master plan.

Objectives

Based on these overall goals, objectives were developed under each goal. The objectives provide more concrete clarity on desired outcomes from the master plan process.

Potential Performance Indicators

In addition, to help the City evaluate progress toward the goals and objectives, a set of potential performance indicators with desired performance trends and potential data sources was also developed for each objective. The indicators and potential data sources are listed on the following page under each objective. The intent of these indicators is for the City to gradually incorporate these or similar indicators in their operations and monitoring activities to be able to report progress toward the goals and objectives over time.

TABLE 1: OBJECTIVES AND POTENTIAL INDICATORS

Objectives	Potential Indicators	Desired Performance	Potential Data Sources
Enhance connectivity on all travel networks in the city.	Accessibility to key destinations by mode	Increase	This metric is affected by both network expansions and increases in population and employment. Network data by mode would come from city records. Population and employment data are available from the US Census American Community Survey and LEHD. Key destinations would be defined by the City but could include employment, activity, or education centers, or the multimodal centers in the multimodal system plan.
	Non-auto lane miles by mode	Increase	This metric would capture expansions in transit, bicycle and pedestrian networks over time. Network data by mode would come from city records.
Improve the travel choices for residents, businesses, and visitors.	Transit Ridership	Increase	Average Daily Boardings and Alightings at HRT transit stops within Norfolk; data from HRT. Also, Average Daily Tide Light Rail Boardings and Alightings.
	Pedestrian and Bicyclist Counts	Increase	VDOT has bicycle and pedestrian counters and has offered to install these at locations when requested by localities (including cities). The City of Norfolk has count stations too.
Improve safety and work toward zero fatalities on our streets.	Change in number of pedestrian/bike accidents & fatalities	Decrease	City and VDOT data on accidents and fatalities by mode
	Number of pedestrian safety improvements made	Increase	City data - this will include the number of signal enhancements for pedestrians (such as Leading Pedestrian Indicators) the number of upgraded crosswalks, mid-block crossings and pedestrian overpasses or other facilities installed.
Increase the resilience of the city's transportation networks.	Percent of network miles outside of recurrent flooding zones (by mode)	Increase	City data on network miles and on the preferred method for calculating recurrent flooding zones
	Population by distance to active transportation and transit	Increase	City data on bike/ped and transit networks. U.S. Census data on population locations. This metric would measure the percent of population within specified buffer distances to these networks
Promote economic development through enhanced multimodal connections.	Employment by distance to active transportation and transit	Decrease	City data on bike/ped and transit networks. U.S. Census data on employment locations. This metric would measure the percent of population within specified buffer distances to these networks
	Employment within Multimodal Centers	Increase	City data on Multimodal Centers. U.S. Census data on employment locations. This metric would measure the change over time in the percent of jobs within specified multimodal centers compared to total jobs in the city.
Enhance the comfort and beauty of Norfolk's public street system.	Streetscape improvements	Increase	City data on the linear miles or square feet of enhanced street treatments installed (decorative paving, street furniture, wayfinding signage, etc.), ADA curb ramps and sidewalks wider than 4 feet.
	Street trees installed	Increase	City data on the number of new street trees or low maintenance landscaping installed within the right-of-way that enhances the environment for walking and riding bicycles and scooters.

[i] Chetty, Raj, Nathaniel Hendren, Patrick Kline, and Emmanuel Saez. 2014. "Where is the Land of Opportunity: The Geography of Intergenerational Mobility in the United States." Quarterly Journal of Economics 129 (4): 1553-1623. Retrieved Nov 18, 2020 from https://scholar.harvard.edu/hendren/publications/economic-impacts-tax-expenditures-evidence-spatial-variation-across-us.

[ii] Kaufman, Sarah, Mitchell Moss, Jorge Hernandez, and Justin Tyndall. 2015. "Mobility, Economic Opportunity, and New York City Neighborhoods." Retrieved Nov 18, 2020 from https://wagner.nyu.edu/impact/research/publications/mobility-economic-opportunity-and-new-york-city-neighborhoods.

Chapter 3: Public Engagement

A Robust and Inclusive Process

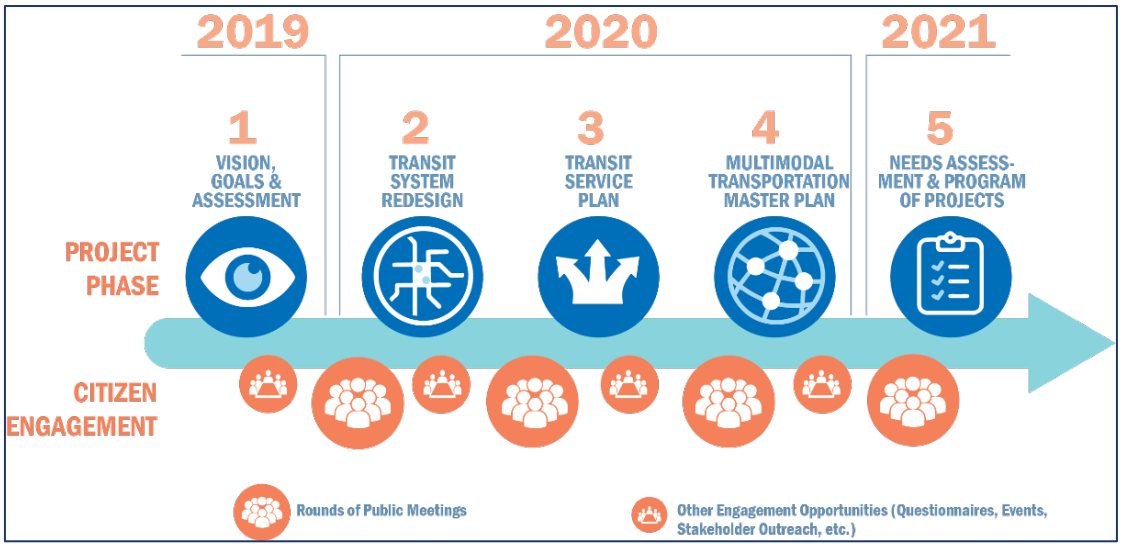
The Multimodal Norfolk transportation master plan was crafted through a robust and inclusive community engagement process throughout all stages of plan development.

Community engagement activities included public meetings, surveys, online mapping activities, town hall meetings, presentations at local civic league and task force meetings, paper and electronic flyer distribution, media blasts, engagement with faith-based communities, and other activities.

Multimodal Advisory Committee

A key step in the community engagement process was the creation of the Multimodal Advisory Committee – representatives of over 30 various stakeholder groups including economic development organizations, transportation agencies, community advocacy groups, educational and military institutions, neighborhood civic leagues, and public health partners.

The Multimodal Advisory Committee met at key milestones throughout the Multimodal Norfolk process to provide critical feedback on concepts and recommendations. The committee was also responsible for disseminating information to and relaying feedback from their colleagues, constituencies, and contacts, to ensure that the process to develop the master plan was as inclusive and far-reaching as possible.



The process to develop the Multimodal Norfolk transportation master plan involved community stakeholders, interested residents, and a variety of other organizations.





In February and early March 2020, stakeholders and interested members of the public attended meetings, identified safety issues and travel patterns, and provided general feedback on the goals and objectives.

Multimodal Norfolk
Multimodal Advisory Committee Representatives

Children's Hospital of the Kings Daughters

City of Norfolk Bicycling and Pedestrian Trails Commission

City of Norfolk Planning Commission

Coalition for Smarter Growth

Downtown Norfolk Council

Eastern Virginia Medical School

Elizabeth River Trail Foundation

Greater Norfolk Corp

Hampton Roads Economic Development Alliance

Hampton Roads Military and Federal Facilities Alliance

Hampton Roads Transit

HRT Paratransit Advisory Committee

HRT Transit Riders Advisory Committee

Hampton Roads Transportation Planning Organization

Hampton Roads Workforce Council

League of Women Voters

NAACP

Naval Station Norfolk

Navy Region Mid-Atlantic

Norfolk Airport Authority

Norfolk Redevelopment and Housing Authority

Norfolk State University

Old Dominion University

Reinvent Hampton Roads

Sentara

Sierra Club

Southern Environmental Law Center

STOP, Inc.

Tidewater Community College

Urban League

VDOT Hampton Roads District

Virginia Conservation Network

Virginia Port Authority

Virginia Wesleyan University

Public Meetings

Four rounds of multiple public meetings were held throughout the Multimodal Norfolk process in concert with the major project milestones as shown in the process chart on the previous page.

The first round consisted of five in-person public meetings throughout the city held in late February and early March 2020. The second and third rounds were held through online public meetings due to gathering restrictions during the COVID-19 pandemic. Online and in-person public meetings are being held in the final round.

Thirteen public meetings were held throughout the four rounds. Additionally, two Superward 7 virtual Town Hall meetings were held in May and June 2021 to target engagement from these communities. The Multimodal Norfolk process benefited greatly from the many citizens and engaged stakeholders from all walks of life and city neighborhoods that provided input, feedback, and critical review of draft plan elements. The wealth of input received ensures that the Plan is built on a solid foundation that reflects public will, input, and support.

Surveys

Three rounds of public surveys accompanied the first three rounds of public meetings. The surveys supplemented the input received in public meetings and ensured that there was a forum for written input (both online and paper surveys) that could be systematically collected, organized and analyzed to ensure equitable representation of input. Various surveys asked



Multimodal Advisory Committee members considered the draft goals and objectives.



Public meetings were held at various locations and online to solicit input and feedback from residents.



Stakeholders participated in workshops during the transit system redesign.



Residents and stakeholders discussed multimodal needs at an in-person public meeting.

specific questions and solicited general feedback on the transit system redesign and the multimodal transportation master plan.

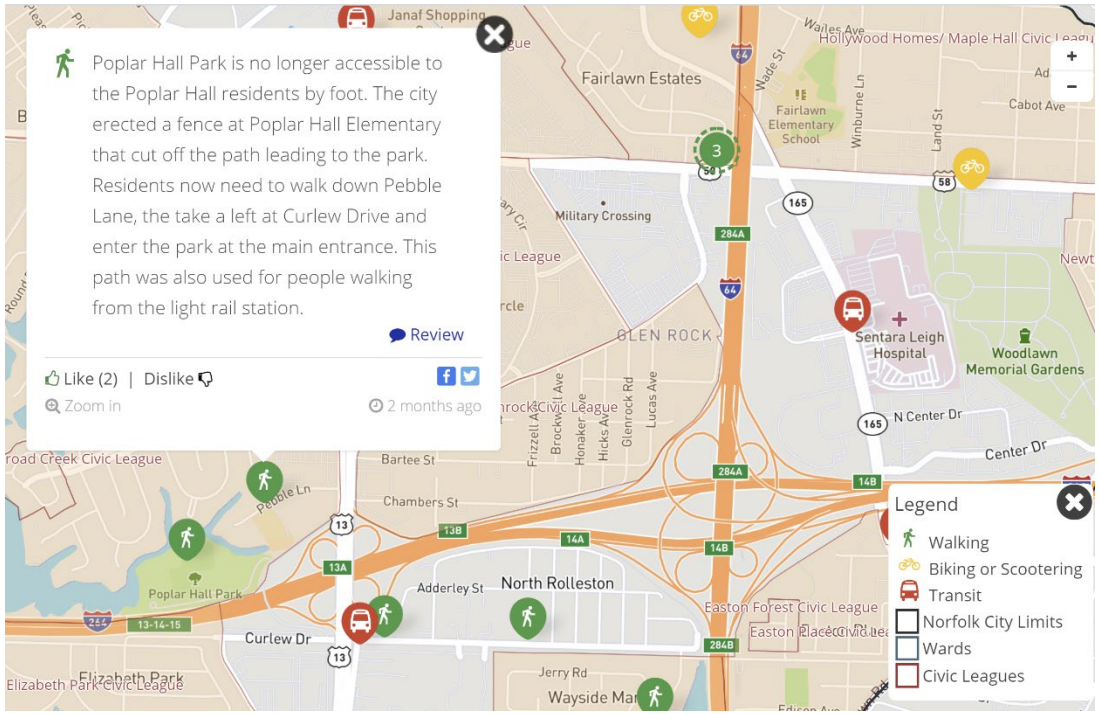
In the first round of surveys, 262 people responded to the transit choices survey. The second round of surveys produced 1,086 responses to the transit concepts survey and 164 responses on the draft multimodal system maps. In the third round of surveys, 1,958 people responded to the survey on the draft recommended transit network.

Other Outreach Activities

Due to limitations on in-person public meetings during the pandemic, a special effort was made to creatively engage citizens in new and safe ways that would increase the reach of public input. Paper surveys were made available at the Downtown Norfolk Transit Center. Citizen volunteers distributed surveys on buses, at transit stops, and in neighborhoods to ensure good coverage, especially among traditionally underrepresented and minority communities.

Nearly 3,000 paper surveys were distributed and returned to supplement the in-person meeting engagement and online surveys that provided a very wide representation of Norfolk citizen input that was used to build this plan.

Throughout the planning process, the www.MultimodalNorfolk.com website provided current information on the development of the plan. An interactive online map was available on the website from January through June 2021. Residents and other members of the public used



Residents and other members of the public identified multimodal transportation needs on an interactive online map available from January through June 2021. Over 800 comments were provided.



Notices about public meetings were displayed on electronic bulletin boards at libraries and recreation centers. Two virtual Town Hall meetings for Superward 7 residents were held to target input from these communities.

this online map as well as email and voicemail messages to submit over 800 comments on multimodal transportation needs.

The Multimodal Norfolk team presented information about the plan at various civic league and task force meetings throughout the city. Paper and online flyers were distributed to solicit input through the interactive map, email, and voicemail at a variety of locations including local restaurants, convenience stores, libraries, senior and public housing communities, and community centers.

Notices about the plan, public and town hall meetings, and how to give input were circulated through traditional media and social media outlets, posted on electronic bulletin boards at libraries and recreation centers, and distributed to faith-based and other community leaders, who shared the information with their constituents and contacts. The Multimodal Norfolk team created a video that was shared at the February 6, 2021 Neighborhood Leadership virtual breakfast meeting.



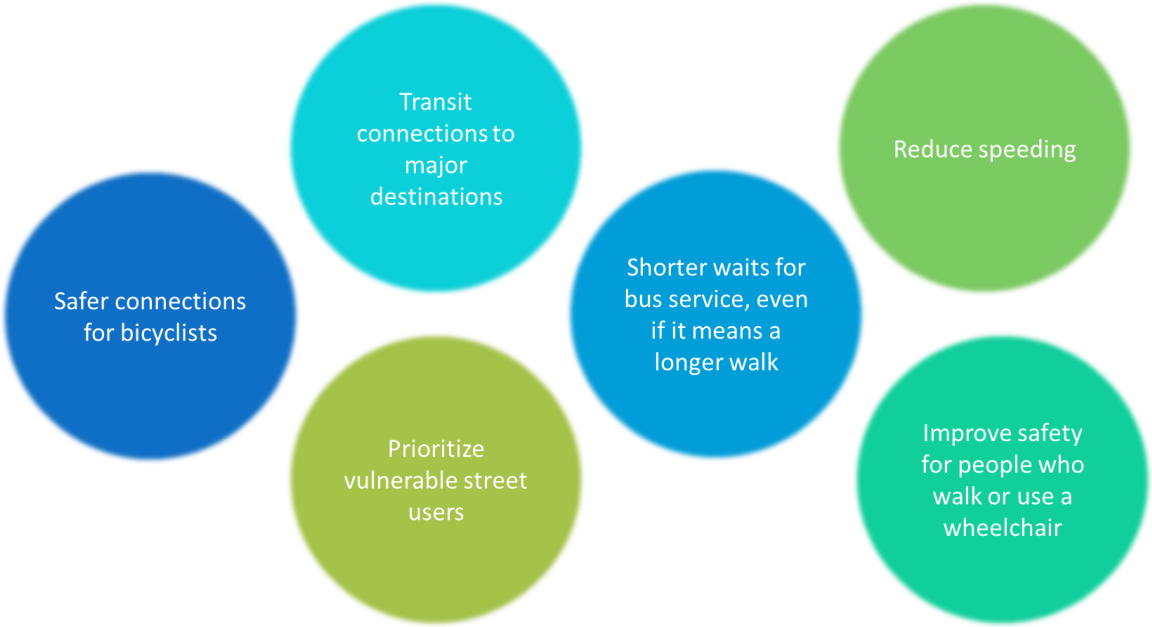
Residents and others participated in virtual public meetings and town hall meetings to give input, voice concerns, and ask questions throughout the development of the plan.

General Input Themes

General themes that recurred throughout the public and stakeholder engagement process are shown in the graphic to the right. These themes were crucial in guiding the development of the Multimodal Transportation Master Plan. In addition, it is important to note that in each round of public and stakeholder engagement, the majority of respondents expressed support for the multimodal master plan and the transit redesign.

Each phase of the development of the multimodal master plan and the transit redesign built upon the feedback received in prior phases, and the plan was molded and modified by the input as the process went on.

More specific feedback and responses are incorporated in subsequent chapters of this plan.



Themes from the public and stakeholder engagement process resonated throughout the development of the Multimodal Norfolk transportation master plan.

Public and Stakeholder Input from Each Round

Figure 3-1 on the next page shows an overview of the four rounds of public and stakeholder engagement.

Round 1: Vision and Values

The first round of public and stakeholder engagement, held in February and March 2020, focused on establishing a guiding vision and defining the goals and objectives for the Multimodal Norfolk process. It also introduced conceptual transit tradeoffs and asked for input on general transit preferences.

This round consisted of one stakeholder meeting and five in-person public meetings.

Participants gave input on the draft vision, goals, and objectives. Generally, the feedback affirmed the need for this study and to focus on safety and connectivity for people who walk, use mobility devices, ride bicycles and scooters, and take public transit. Participants expressed interest in the concept of micro-transit, which was explored in the transit system redesign process, and noted the alignment of the purpose of this plan with goals to reduce carbon emissions and decrease usage of single-occupancy vehicles. Participants noted the goals of this effort are in line with promoting healthy lifestyles through active transportation modes, and indicated wait times and travel times for public transit are too long. Addressing safety and providing more connections were recurring themes throughout public feedback in this round.

Participants were also asked to participate in a mapping activity to indicate where they travel from and to on a regular basis, and what modes they take or would like to take in the future. In this mapping activity, participants also noted location-specific safety and other concerns, which were incorporated into the multimodal system plan maps explained in Chapter 4 and the multimodal needs assessment described in Chapter 12.

Finally, participants in this first round were introduced to four tradeoffs related to the transit service:

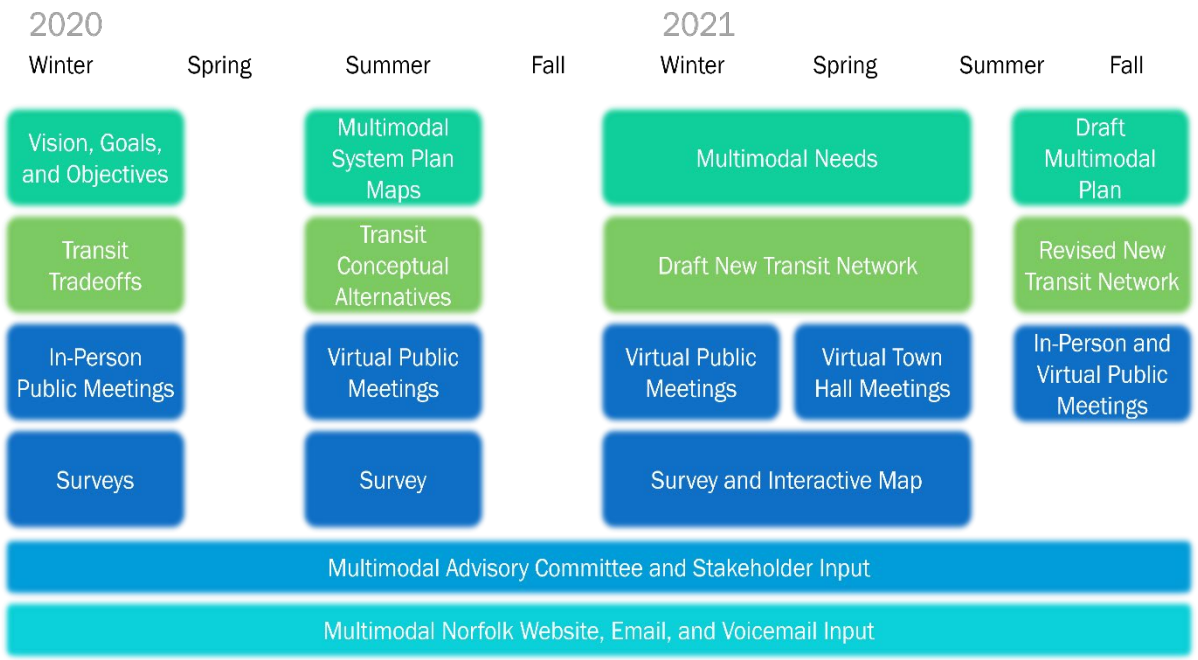
- Walking vs. waiting
- Peak vs. all-day service
- Ridership vs. coverage
- Stop spacing (closer vs. wider)

Participants indicated their preferences on each of the four tradeoffs using sticky dots on a spectrum.

The transit tradeoffs survey asked questions about these same tradeoffs. The majority of respondents indicated they:

- preferred to walk further in order to have a shorter wait for their bus,
- preferred the high frequency scenario over the high coverage one
- preferred providing a useful level of transit service all day, every day over serving higher demand at peak hours.

FIGURE 3-1: FOUR ROUNDS OF PUBLIC AND STAKEHOLDER ENGAGEMENT



The public and stakeholder process to develop the Multimodal Norfolk Transportation Master Plan and redesign Norfolk's bus system consisted of four rounds of public and stakeholder input.

More information on the survey results is provided in Chapter 11: Transit System Redesign.

Round 2: Multimodal System Plan Maps and Transit Conceptual Alternatives

The second round of public and stakeholder engagement occurred in Summer 2020, and consisted of two online stakeholder meetings, two online public meetings, and two surveys that were available online as well as distributed on HRT buses and available in the Downtown Norfolk Transit Center.

In this round, stakeholders and the public were presented with the draft multimodal system plan and asked to give feedback on the draft maps. Feedback on the draft maps was generally supportive of the overall concept. Responses to the multimodal system plan maps indicated overwhelming agreement with most of the maps. Participants provided suggestions for

revising the maps, including adding new multimodal centers and adding bicycle/scooter modal emphasis to specific streets. Participants also reiterated safety concerns, especially for pedestrians and bicyclists, both in general and at specific locations. These comments were incorporated into the revised set of maps, which were shared at the third round of public engagement.

Participants were also shown two different conceptual transit network alternatives of how the bus network in Norfolk could be redesigned – one designed to maximize ridership and another designed to maximize coverage. Survey respondents in this round were largely African-American/Black, mostly transit riders, largely of working age, mostly low-income, and almost entirely from Norfolk.

Nearly two-thirds of the transit concepts survey respondents preferred the Ridership Concept, and about one-quarter preferred the Coverage Concept, with the remaining respondents indicating they were halfway in between or did not answer the question. The transit system redesign team used this feedback to design a draft new transit network.

Round 3: Multimodal Needs and Draft New Transit Network

The third round of engagement occurred from Winter 2020 to Summer 2021. It focused on the draft new transit network, and included a stakeholder meeting, two online public meetings, a survey available online and distributed on HRT buses, two virtual town hall meetings for residents of Superward 7, and an online interactive map.

Stakeholders and the public were presented with the draft new transit network including statistics on the benefits of the new network.

Survey responses in this round reached nearly 2,000, who were primarily regular bus riders, identify as African-American/ Black, have an annual household income below $25,000, and were between 35 and 64 years old.

More than 75 percent of respondents were either positive or neutral about the proposed new transit network, while fewer than 20 percent disagreed that the new network would be better for Norfolk overall.

Many respondents noted they like the draft new network, especially the higher frequency service on key routes and the new one-seat rides on many routes. A regular theme among commentors on the survey was a request for more frequent service on all routes in the city, which would require more funding for more service.

The most commonly cited concerns were the longer walks required to reach some neighborhoods or destinations, a desire for higher frequency on Route 20, and concern



Public citizens listen to a presentation in the Pretlow library.



Public meeting attendees place sticky dots on a map to show places where they live, work, and go to frequently.

about the walking distance to Norfolk General Hospital from Route 2. The feedback from the meetings and surveys was used to refine the new network.

Stakeholders and the public were asked to identify multimodal transportation needs through the interactive online map. Needs

were identified for walking, bicycling, scootering, transit, and auto modes. Chapter 12: Needs Assessment and Chapter 13: Program of Projects provide more details on the needs identified in this round of public engagement.

Also in this round of engagement, participants were shown the revised multimodal system plan maps and given the opportunity to provide final comments and suggestions. Comments received included additional questions on the modal emphasis maps and questions regarding specific facilities.

The project team shared an update on the status of the draft multimodal plan, which would be shared in the fourth round of engagement.

The project team presented updates to various stakeholder groups, including neighborhood leadership civic leagues and task forces, business associations, and commissions including the Bicycle and Pedestrian Trails Commission and the Norfolk Commission for Persons with Disabilities.

Round 4: Draft Multimodal Transportation Master Plan and Revised New Transit Network

The final round of stakeholder and public meetings was held in October 2021 to premiere the draft Multimodal Norfolk Transportation Master Plan and showcase the resulting variety of improvement projects that resulted from this 2-year process.

Two in-person public meetings and two virtual public meetings were held to share the results of this process and what can be expected in the future.

The Multimodal Norfolk team prepared a "toolkit" for community leaders and influencers to share information about Multimodal Norfolk and the public meetings. These community leaders shared the information with their constituents and followers on various social media outlets, news media stations, and on civic league websites and email distribution lists.



Community leaders and influencers promoted the final round of public meetings on Facebook, Twitter, and other media platforms.

The Multimodal Norfolk team organized a street team to disseminate literature promoting the public meetings. The street team distributed 2,000 flyers at over 150 locations over 4 days along Church Street, E. Little Creek Rd, Lamberts Point, Norview, Ocean View, Park Place, Southern Shopping Center, Wards Corner, and others. The street team handed out and posted flyers at community centers, housing complexes, medical facilities, restaurants, retail establishments, and faith-based organizations.



A street team handed out over 2,000 flyers in the fourth and final round of public engagement in October 2021 to advertise the public meetings.

At the public meetings, the Multimodal Norfolk team shared the draft Program of Projects map and list and described the process the City will undertake to determine which projects to seek funding for and how.

Participants provided additional comments on the Program of Projects and were generally supportive of the plan and the engagement process.



The street team handed out and posted flyers at a variety of establishments in targeted areas.

This final round of engagement also included a virtual meeting with the Multimodal Advisory Committee and outreach to Norfolk's Bicycle and Pedestrian Trails Commission.

Chapter Summary

The Multimodal Norfolk Transportation Master Plan is built on a foundation of robust community and stakeholder engagement throughout the 2-year process to develop the plan.

Residents and other members of the public had a variety of input opportunities, including in-person and virtual meetings, surveys, interactive maps, and email and voicemail messages. Thousands of flyers were distributed throughout the city. Traditional media and social media posts informed the public of what was happening. Throughout the process, the Multimodal Advisory Committee provided input representing a variety of stakeholder interests.

The City of Norfolk will continue to engage its citizens, businesses, community leaders, and other public as this plan moves from development into implementation.

Chapter 4: Multimodal System Plan

Why Do We Need to Plan at the System Level?

Why do we make trips? Usually, we make trips to fulfill a daily need or activity, like reaching a job, going to school, buying groceries, and other daily errands. The trip is typically not the purpose; the purpose is reaching the intended activity, except for trips we make for exercise or purely for pleasure. Why does this matter? When we envision Norfolk's future transportation network, we need to think first about where people are going, not just how they are getting there.

The Multimodal Norfolk transportation master plan is Norfolk's first comprehensive look at where people are coming from and going to and how they get there across the entire city by different means. As mentioned in Chapter 2, the Multimodal Norfolk process was guided by three grounding values of **safety, freedom, and prosperity**.

In order to respect these values of giving everyone viable choices for getting around and accessing opportunities to work learn, play, and gather; giving everyone freedom to get where they need to go; and making sure everybody is safe on Norfolk's streets, we need to look at the City's transportation system as just that – a system of interconnected networks that provide safe and seamless ways of making a trip from beginning to end, for any purpose, and by any mode.

Multimodal Norfolk uses a *multimodal system planning approach* to take a comprehensive look at the entire city and identify complete networks for all modes that connect to key destinations and centers of activity. This multimodal system planning approach is important because it helps us understand what role each street needs to serve in the future system as a whole.

Changes will happen incrementally. The multimodal system planning approach makes sure that each incremental change, such as a new bike lane on one street segment or a new crosswalk at one intersection, works toward achieving the broader future system.

Without first developing a Multimodal System Plan, the design of any individual corridor or improvement project may lead to disconnected or underused facilities that fail to provide safe and convenient connections for all modes.



The multimodal system planning approach makes sure that each incremental change to the Norfolk's streets works toward achieving the broader future system.



The Multimodal System Plan envisions a fully connected network of facilities for all modes.

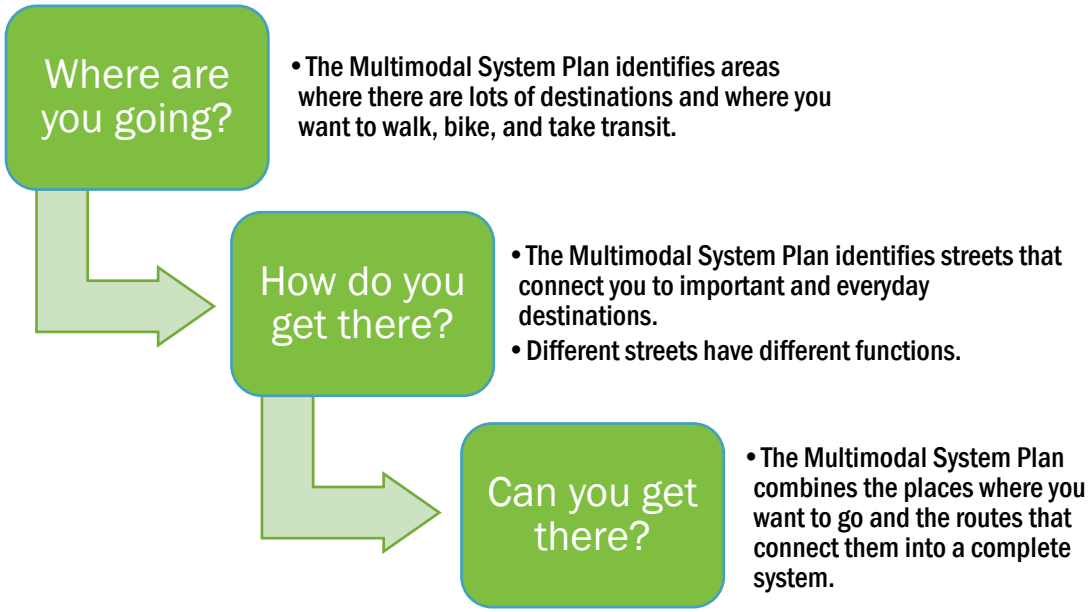
What is a Multimodal System Plan?

A Multimodal System Plan is a comprehensive look at the transportation system to ensure all modes have a safe and connected network to get where you need to go.

A Multimodal System Plan is not a new concept. It has been practiced in several cities around the country and was described in statewide guidelines developed by the Virginia Department of Rail and Public Transportation (DRPT) in 2013.[i] It is essentially a process of creating maps of different travel networks to understand how land uses and transportation facilities and services work together.

A Multimodal System Plan shows the location of the City's *multimodal centers* and the *multimodal corridors* that connect them. These and other terms will be defined in later sections of this chapter.

The multimodal corridors are assigned a special emphasis so that complete networks are provided for every mode, including walking, bicycling, scootering, and transit. Autos are assumed to be accommodated on every street, but as described in later chapters, this does not mean they have priority. Freight movement is also considered, as explained in Appendix D.



A Multimodal System Plan makes sure the City's transportation system works for you, no matter how you choose to travel.

The exercise of developing a Multimodal System Plan identifies gaps for each mode and proposes connections to close those gaps.

The following sections in this chapter define key terms for the Multimodal System Plan and describe how the Multimodal System Plan for Norfolk was developed. This chapter contains a series of maps representing Norfolk's Multimodal System Plan. High resolution versions of the Multimodal System Plan maps zoomed in to different parts of the city are provided in Appendix A. Appendix B provides additional maps that were used during the development of the Multimodal System Plan.

As described in Chapter 3, Norfolk's Multimodal System Plan was developed through a robust process of public and stakeholder engagement, and the maps in this chapter represent a publicly vetted vision for connected transportation across the entire City.

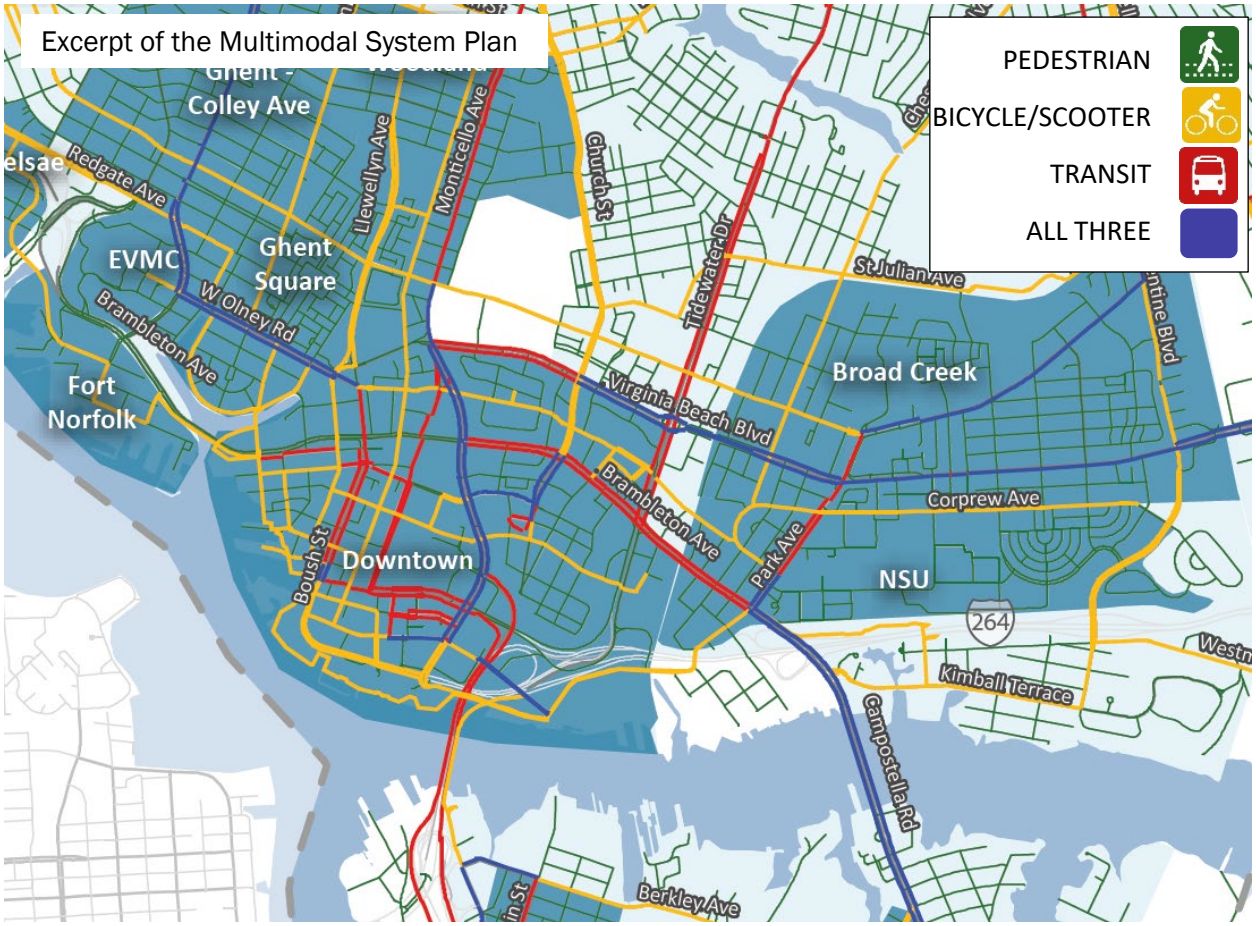
The process to develop the Multimodal System Plan for Norfolk generally followed the process outlined in DRPT's Multimodal System Design Guidelines. The Multimodal System Design Guidelines are a comprehensive

resource for planning and designing multimodal streets and places throughout Virginia. Using Virginia's Multimodal System Design Guidelines as a baseline reference ensured that the Norfolk Multimodal System Plan is based on the latest best practices and the industry standard guidance.

Norfolk's Multimodal System Plan is also an expansion of and an update to the Downtown Norfolk Multimodal System Plan that was prepared in 2020 in conjunction with the Downtown Norfolk Master Plan. The new citywide Multimodal System Plan used the Downtown Norfolk Multimodal System Plan as a starting point and updated it to reflect the newly redesigned bus network and the results of continued discussions with stakeholders and the public.

The Multimodal System maps presented here represents a snapshot in time. It is based on the input and analysis conducted over the past two years, and yet, it is intended to be a living document as well.

The processes described in this and subsequent chapters for designating Multimodal Centers and Modal Emphasis networks and designing and evaluating multimodal projects is intended to be stable over time.



The Multimodal System Plan designates connected networks for each mode throughout the entire city, as shown in this excerpt from the Multimodal System Plan maps.

However, the maps of Multimodal Centers, Multimodal Districts, Transect Zones, and Modal Emphasis, as well as the general recommendations in this plan are intended to evolve overtime with more detailed design.

The next several sections explain the individual components of the Multimodal System Plan. The completed Multimodal System Plan for Norfolk is presented at the end of this chapter.

Multimodal Districts and Multimodal Centers: Where are you going?

The first step in developing a Multimodal System Plan is to define the context and recognize that different areas of the city have different characteristics and different levels of potential for generating walking, bicycling, scootering, and transit trips. Three terms describe types of areas that are important in this step – *Multimodal Districts*, *Multimodal Centers*, and *Transect Zones.*

*A **Multimodal District** is any area of any size that is envisioned to have good multimodal connectivity and be safe for walking, riding a bicycle or scooter, or taking transit, either now or in the future.*

Multimodal connectivity in this definition means the ease of making trips without needing access to a car. The desirable street pattern in Multimodal Districts is a grid network with short block lengths. The density and mix of land uses in Multimodal Districts is not as important as in Multimodal Centers – any neighborhood, commercial area, or institutional campus can be considered to be a Multimodal District, even low-density single use areas. The key is determining which areas are desired to be walkable in the future, even if the current environment does not have these characteristics.

In Norfolk, almost all of the City's land areas are considered to be in a Multimodal District. All civic leagues are included in a Multimodal District. The only areas in Norfolk that are outside of Multimodal Districts are industrial areas, rail yards, marine terminals, and enclosed naval base areas.

*A **Multimodal Center** is an area within a Multimodal District that is envisioned to have a higher density of activity where a variety of destinations are close together, making walking, bicycling, scootering, and taking transit easy and convenient for many types of trips, either now or in the future.*



Multimodal Districts can have a wide variety of land use contexts and characteristics. They can be any area of any size that is envisioned to have good multimodal connectivity either now or in the future.

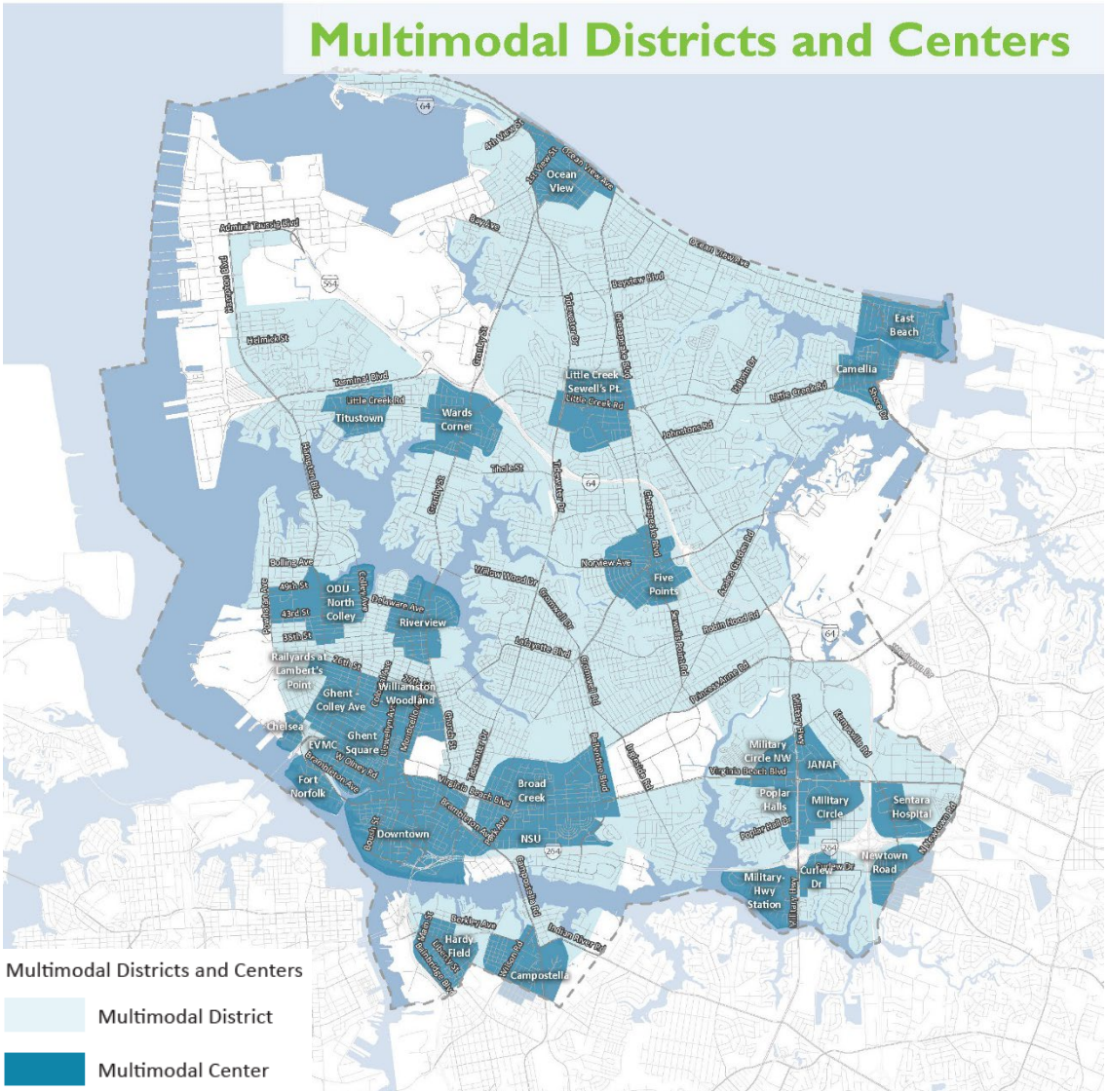


Multimodal Centers are areas that are envisioned to be places where walking, bicycling, scootering, and transit are easy and convenient.

Multimodal Centers typically have, or are envisioned to have in the future, distinctly higher densities of population and jobs than the surrounding Multimodal District. Multimodal Centers are places with the most vibrant street activity and usually have a robust mix of uses. The streets, buildings, and urban form within Multimodal Centers are, or are envisioned to be in the future, designed to promote this vibrant street activity and focused on people, not vehicles.

Multimodal Centers are often based on a half-mile radius area, which corresponds to a 10-minute walk from edge to center, and usually centered on a major destination or anchor point, such as the heart of a commercial district, a popular shopping, dining, or institutional destination, a high-density employment area, or a key transit station or transfer point.

Multimodal Centers in Norfolk were identified using a variety of criteria, including existing and future activity density, future land use, barriers to multimodal connectivity, future planning efforts, and input from the public about where they live, work, and regularly visit. Maps showing these criteria individually are provided in Appendix B.



Multimodal Centers and Multimodal Districts in Norfolk represent the base layer of the Multimodal System Plan. Multimodal Centers are areas envisioned to have the highest levels of activity and mix of uses in the future. Multimodal Districts are surrounding areas that have relatively lower levels of activity but are still envisioned to be safe for getting around without a car. Higher resolution and zoomed in versions of this map are available in Appendix A.

Activity Density and Transect Zones: A Measure of Land Use Intensity

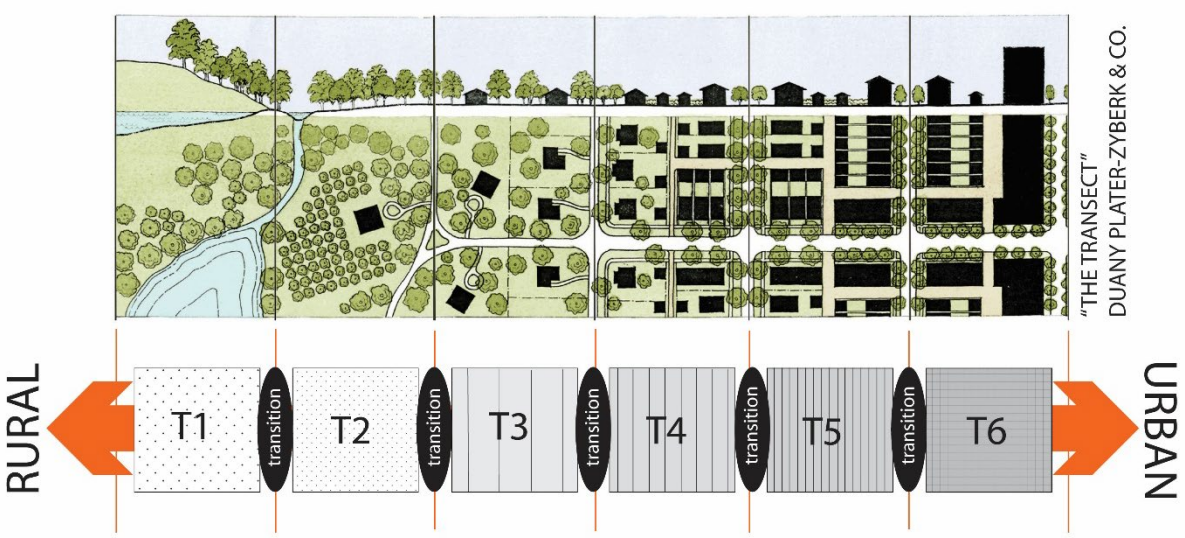
Norfolk is a city of neighborhoods with a wide variety of commercial areas, institutions, regional destinations, and employment centers. Its diversity of land uses makes Norfolk unique. The Multimodal System Plan recognizes the diversity of places within Norfolk and uses a measure of *activity density* to classify the relative intensity of places.

Activity density is a way of combining the density of existing and future population and jobs to classify different types of places in a consistent manner. Activity density is the sum of people and jobs in an area divided by the acreage. Maps of activity density in Norfolk are provided in Appendix B.

The *Transect* is a concept commonly used in the urban planning profession to illustrate the range of natural and built environments. The Transect is divided into six bands of density called *transect zones*.

Transect Zones are categories of land use intensity. Places can be categorized into six transect zones according to the density of population and jobs.

Each transect zone has a defined range of activity density and a whole complement of streets, buildings, and open space that go along with that level of density. DRPT's



The Transect Diagram illustrates the range of natural and built environments across a spectrum of density. Places are classified into six different transect zones depending on the density and intensity of land uses. The Transect is a concept commonly used in the urban planning profession and serves as the basis for categorizing Norfolk's diverse areas into a simple and consistent classification scheme.

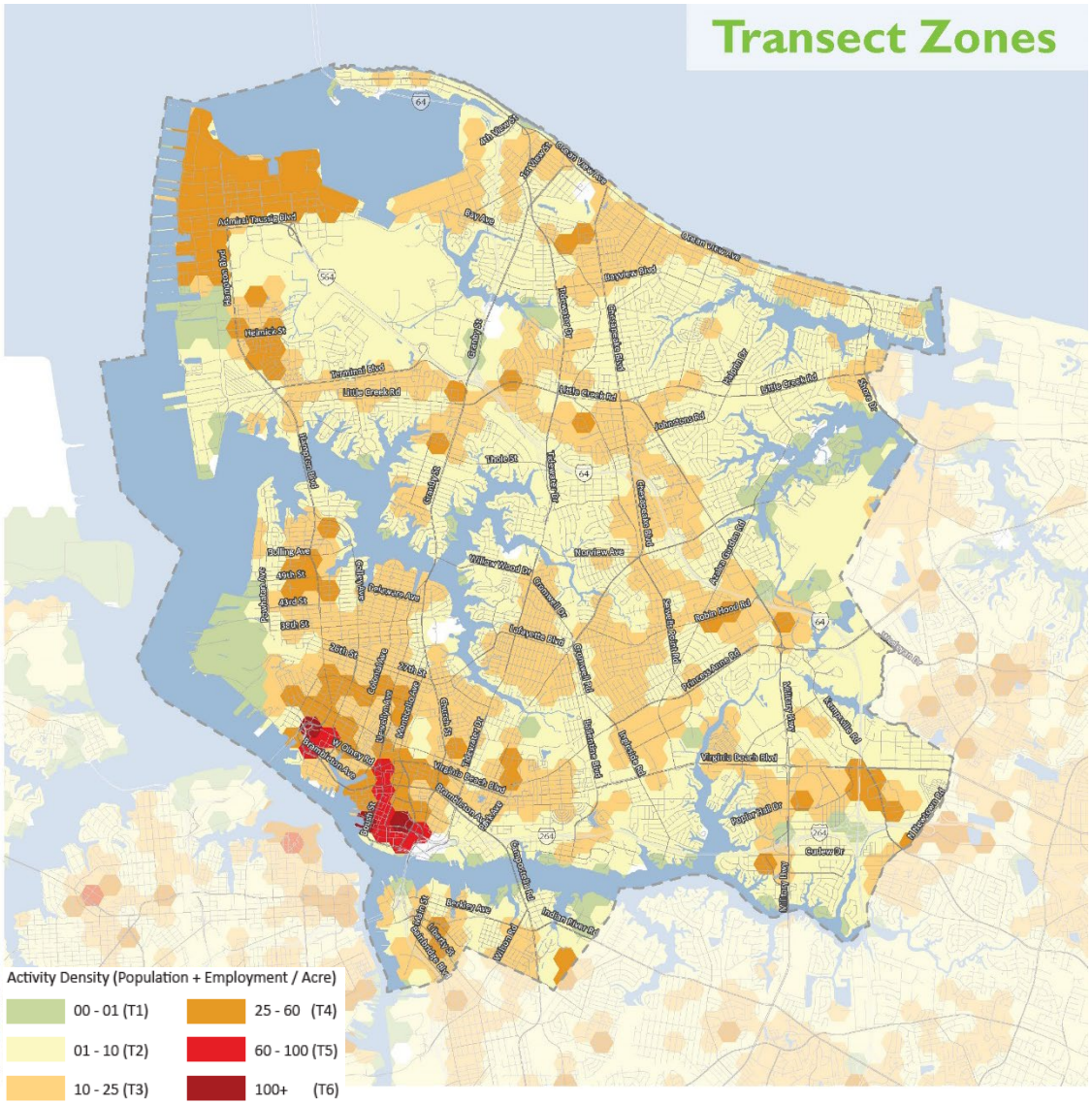
Multimodal System Design Guidelines define a range of activity density for the six transect zones that is calibrated to the spectrum of real places in Virginia.

The transect zones and activity densities define the context of the Multimodal Centers and the Multimodal Corridors in Norfolk.

Transect Zone	Activity Density Range (Population + Employment per acre)
T1	0 to 1
T2	1 to 10
T3	10 to 25
T4	25 to 60
T5	60 to 100
T6	100+

Areas in Norfolk span the full range of transect zone densities, which account for existing and future population and jobs. Most neighborhoods fall within the lower to mid-density T2 and T3 transect zones. Several areas including the naval base, Old Dominion University campus, Military Circle area, neighborhoods north of downtown, and other commercial areas fall into the T4 transect zone. Only the areas around downtown and Eastern Virginia Medical School fall into the more intense T5 or T6 transect zones.

The corridor design framework presented in Chapters 6 and 7 uses the transect zones to tailor the corridor design recommendations to different contexts.



Transect zones describe the spectrum of land use density and intensity in Norfolk. This map shows the existing and future activity density from US Census population and employment data combined with adopted forecasts from the Hampton Roads Planning District Commission. Data is consolidated into a hexagonal grid for consistent representation across the city. Higher resolution and zoomed in versions of this map are available in Appendix A. Appendix B contains additional maps used in this analysis.

Multimodal Corridors: How do you get there?

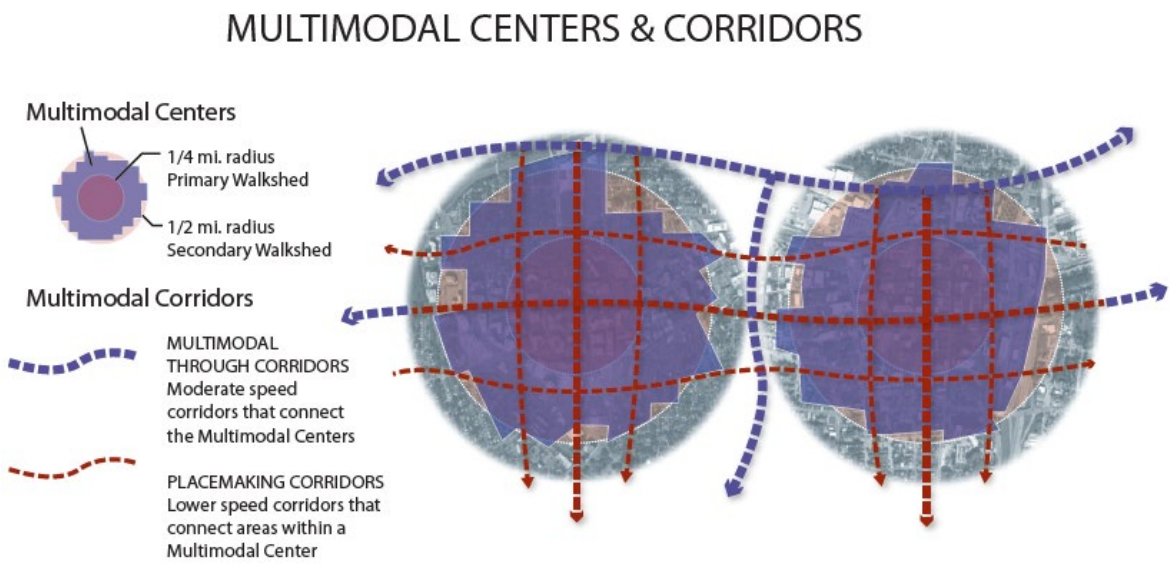
The ultimate goal of the Multimodal System Plan is to designate a connected transportation system for all modes across the entire city. *Multimodal Corridors* are the building blocks for this connected system.

*A **Multimodal Corridor** is any roadway that is envisioned to accommodate multiple modes of transportation, either now or in the future.*

Multimodal Corridors can span a wide range of road types, including vibrant streets with lots of walkable destinations and high pedestrian activity, major arterials that move high volumes of traffic, small neighborhood streets with very few cars, and everything in between.

Only limited-access highways like interstates and other roads that expressly prohibit pedestrians and other non-motorized users are not considered to be Multimodal Corridors.

A road can be designated as a Multimodal Corridor even if it is not considered to be safe or comfortable for all modes today. The Multimodal Corridor designation implies an intention to transform a street into a one that is safe for all modes as opportunities for improvements arise.



There are two general types of Multimodal Corridors – Multimodal Through Corridors and Placemaking Corridors. Multimodal Through Corridors transition to Placemaking Corridors within Multimodal Centers.

Multimodal Corridor Types

There are two general types of Multimodal Corridors – *Multimodal Through Corridors* and *Placemaking Corridors.* Streets are designated as one or the other based on the envisioned future function.

Multimodal Through Corridors are envisioned to move people smoothly and quickly from one area to another.

Multimodal Through Corridors are relatively higher-speed roads that focus on moving lots of people efficiently.

Placemaking Corridors are envisioned to have slower speeds.

Placemaking Corridors are less focused on moving lots of people quickly and more focused on creating a sense of place where pedestrians and bicyclists of all ages and abilities feel safe and comfortable.

Both Multimodal Through Corridors and Placemaking Corridors will be designed to safely accommodate all modes.

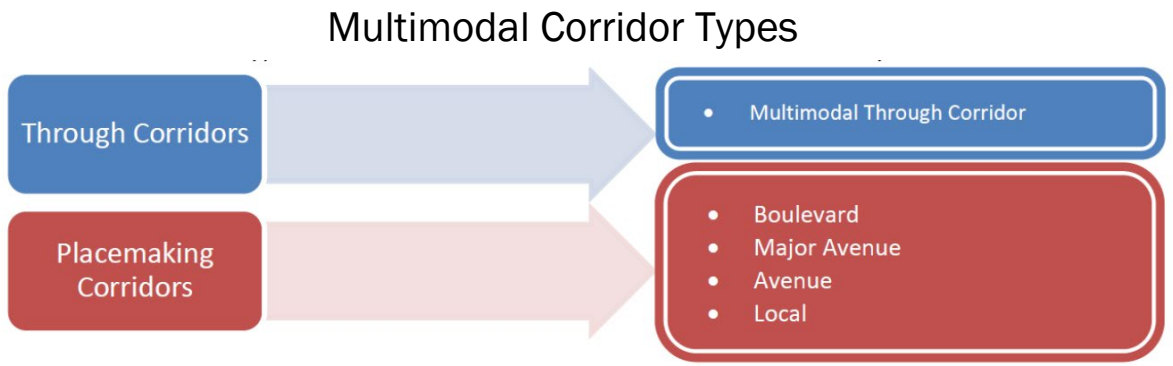
The primary difference between Multimodal Through Corridors and Placemaking Corridors is in the function of the corridor. Placemaking Corridors and Multimodal Through Corridors work together to move people quickly from one area of the city to another and ultimately to activities within a Multimodal District or Multimodal Center.

The type of Multimodal Corridor does not specify or guarantee a specific treatment or type of facility will be provided.

Rather, the Multimodal Corridor type, along with *Modal Emphasis*, which is explained later in this chapter, will influence future decisions regarding corridor design, as explained in Chapters 6 and 7.

Because of the envisioned vibrancy of Multimodal Centers, Multimodal Through Corridors transition to Placemaking Corridors within Multimodal Centers. Placemaking Corridors can be designated anywhere in the city – inside or outside of Multimodal Centers.

Placemaking Corridors are further categorized into four corridor types: *Boulevards*, *Major Avenues*, *Avenues*, and *Local Streets*. The following descriptions indicate the intended future function for each corridor type. Additional descriptions and illustrations for each corridor type can be found in DRPT's Multimodal System Design Guidelines.



Placemaking Corridors are further categorized into four corridor types, based on envisioned future function relative to access, mobility, and multimodal features.

*A **Boulevard** is the corridor type of highest multimodal capacity that accommodates multiple motorized and non-motorized modes.*

Boulevards allow for higher traffic volumes and greater efficiency of vehicular movements than Major Avenues, Avenues, and Local Streets, and typically have four to six lanes of traffic but may grow to eight in particularly dense centers. Boulevards provide safe and convenient pedestrian and bicycle access to adjacent land uses. Boulevards typically feature a median, landscaped amenity elements, street trees, and wider sidewalks. Design speeds for Boulevards typically range from 25 to 35 mph.

Major Avenues contain the highest density of destinations, intensity of activity, and mix of modes.

Because of the close proximity of destinations, pedestrians and street activity are common on Major Avenues. Major Avenues have wide sidewalks to accommodate high numbers of pedestrians and a variety of outdoor activities, including sidewalk cafes, kiosks, vendors, and other street activities. Major Avenues can be areas of high transit ridership for local bus routes. Traffic is low speed and localized. Due to the intensity of destinations, longer regional trips do not use Major Avenues; rather they would typically be on Boulevards or Multimodal Through Corridors. Autos and buses on Major Avenues travel at slow speeds because pedestrian crossings and

on-road bicyclists are frequent. Major Avenues typically have four or fewer lanes for motor vehicle travel while providing adequate facilities for bicycling and typically providing roadway space dedicated to on-street parking. Design speeds for Major Avenues typically range from 25 to 35 mph.

Avenues provide a balance between access to the businesses and residences that front upon them and the collection of vehicular and pedestrian traffic.

While having fewer destinations than Major Avenues, pedestrian and bicycle activity is very common, as Avenues serve as critical links in the non-motorized network. Avenues are low speed roadways that facilitate shorter trips, but still contain a fair amount of destinations. Avenues typically have three travel lanes or fewer, and do not exceed four lanes. Avenues may have roadway space dedicated for on-street parking and provide adequate bicycle facilities. Design speeds for Avenues typically range from 25 to 30 mph.

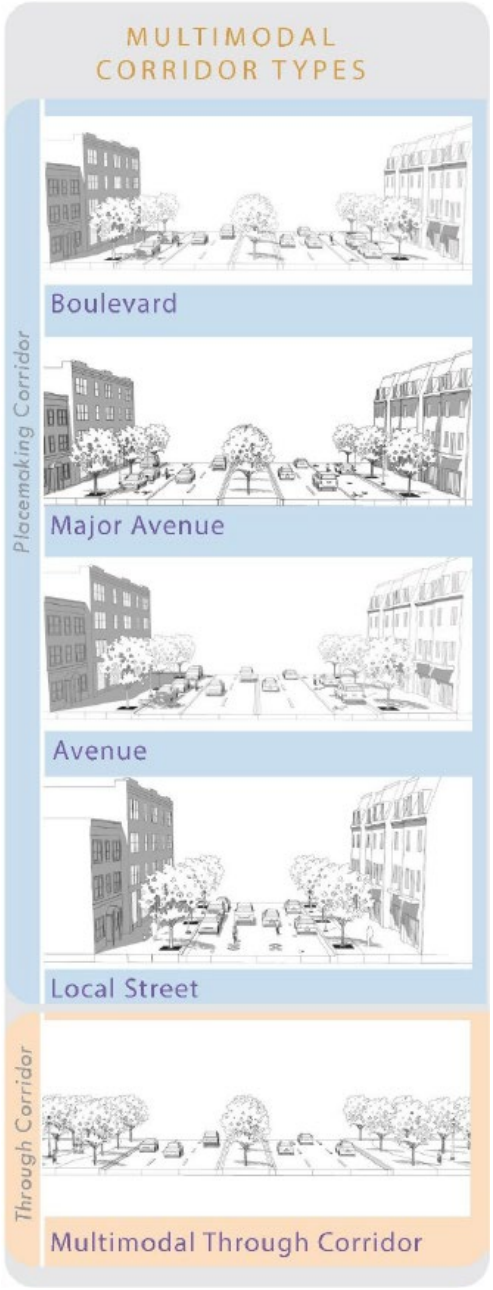
Local Streets see a low amount of activity and have slow speeds and high access.

Bicyclists typically can share the road with autos on Local Streets because speeds are slow and auto traffic is sparse, although Local Streets should typically have separate sidewalks and trails for pedestrian accommodation. Local Streets are primarily located in more residential areas and are intended to serve only trips that originate or end along them. They connect to Avenues, Boulevards or Major Avenues, funneling longer trips to these higher capacity corridor types. Local Streets are characterized by slow design speeds, wider setbacks; they may not have lane striping, and they emphasize on-street parking. Local Streets typically have a 25 mph design speed. Speed limits lower than 25 mph may be appropriate in certain conditions. For example, Granby Street between Main Street and Charlotte Street has a 15 mph posted speed limit.

Multimodal Corridors in Norfolk

The map of Multimodal Corridors in Norfolk shows a connected system of streets that will safely accommodate all modes across the entire city.

There are several key Multimodal Through Corridors, like Military Highway and portions of Virginia Beach Boulevard, Princess Anne Road, Little Creek Road, and a few others. This designation means the primary function of these roads is to move people as quickly and efficiently as possible.



Prototypical cross-section illustrations of the five Multimodal Corridor types from DRPT's Multimodal System Design Guidelines.

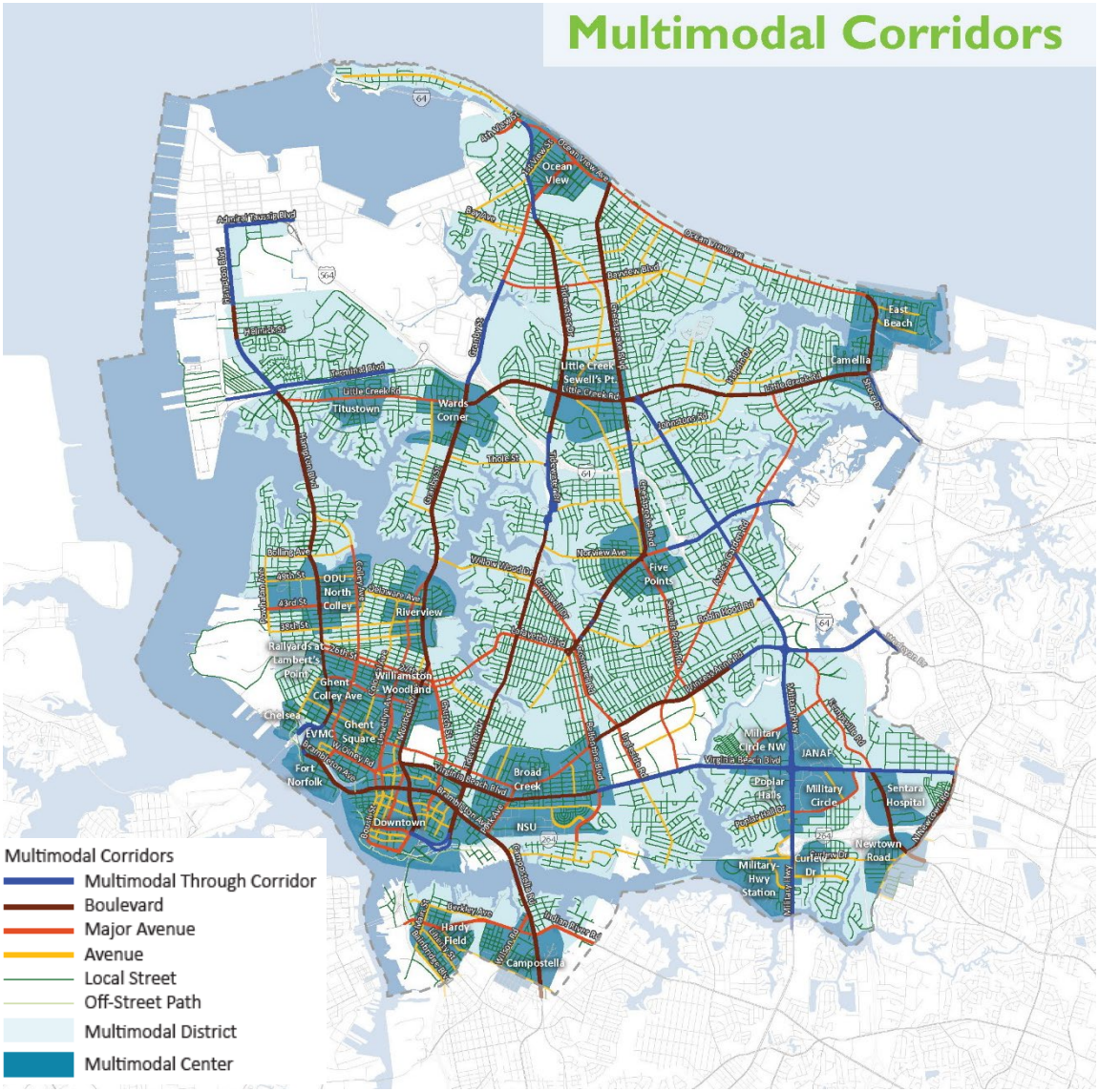
However, most roads within the City of Norfolk are designated as Placemaking Corridors. This means moving people as quickly and efficiently as possible is not the primary function.

The primary function of most of Norfolk's streets is to create a sense of place where pedestrians and bicyclists of all ages and abilities feel safe and comfortable.

The Multimodal Corridor types were assigned in collaboration with City staff and refined to reflect feedback from stakeholders and the public. Considerations for designating the Multimodal Corridor types included:

- envisioned future corridor land use characteristics
- envisioned future function relative to access and mobility
- VDOT functional classification
- average daily traffic volumes
- striping
- network connectivity
- transit ridership potential

The Multimodal Corridor types, together with the Modal Emphasis designations, should influence future decisions regarding corridor design. Modal Emphasis is described in the following section. The framework for designing Multimodal Corridors is explained in Chapters 6 and 7.



The map of Multimodal Corridors in Norfolk shows a connected system of streets that will safely accommodate all modes across the entire city. Higher resolution and zoomed in versions of this map are available in Appendix A.

Modal Emphasis: Can you get there?

The map of Multimodal Corridors on the previous page starts to define a system of streets envisioned to safely accommodate all travel modes. All Multimodal Corridors should be designed to safely accommodate all modes.

But some streets serve as more important connections for one or more modes than other streets, and there are varying degrees to which a travel mode can be safely accommodated. For example, some streets may be less important for buses but form a critical piece of a bike or pedestrian network. These considerations are addressed through Modal Emphasis.

Modal Emphasis is one of the most important concepts in the Multimodal System Plan.

Modal Emphasis is the designation of one or more travel modes that should be emphasized in the design of a Multimodal Corridor.

Modal Emphasis is independent of the Multimodal Corridor type. Modal emphasis indicates that a street serves as a critical connection for a mode, and that mode should be emphasized, through enhanced design standards, when future design decisions are being made.

The Modal Emphasis of a street, together with the Multimodal Corridor type and the Transect Zone, serves as the basis for corridor design decisions.

There are three Modal Emphases in the Norfolk Multimodal System Plan:

- Pedestrian Modal Emphasis
- Bicycle/Scooter Modal Emphasis
- Transit Modal Emphasis

Each Modal Emphasis has its own features and policy approach, as described in the following sections.

Automobiles are assumed to be accommodated on every Multimodal Corridor, unless a street is currently or will in the future be designated as car-free, either temporarily for events or permanently.

Freight movement and deliveries and curb space uses like parking are other design considerations that are not the same kinds of travel modes and are not considered to be modal emphasis. Freight considerations are addressed in Appendix D, as a follow-on to Chapters 6 and 7. Chapter 9 describes the framework for determining curb use.

The purpose of each Modal Emphasis map is to identify a network of streets and paths that are envisioned to fully connect within and between all Multimodal Centers and other major destinations across the entire city for each emphasized mode.

The Modal Emphasis maps represent a future vision of a connected network. However, many of the streets included in the Modal Emphasis maps lack accommodations for one or more modes today, and it will take many years to achieve a full multimodal vision for the city due to funding needs and constraints.

The process to develop the Modal Emphasis maps included examining the current facilities for each mode, identifying gaps, and identifying needed connections to close those gaps, informed by public review and input.

The Modal Emphasis maps, therefore, represent a combination of streets with existing facilities and streets currently lacking facilities that are critical missing connections for the emphasized mode. Maps of existing facilities are provided in Appendix B.

The Modal Emphasis maps do not guarantee that a specific type of facility will be provided, however. The type of facility should be determined on a case-by-case basis through a more detailed corridor

design process as described in Chapters 6 and 7.

Improvements to build out the Modal Emphasis on each network will be implemented over time as opportunities and funding become available. The Multimodal Needs Assessment in Chapter 12 identifies the highest priority improvements for the near, mid, and long-term, based on funding that is anticipated to be available.

The Modal Emphasis maps shown in the following sections were developed using a variety of data and context considerations, in collaboration with city staff and informed by feedback from stakeholders and the public.

Pedestrian Modal Emphasis

Pedestrians, including able-bodied persons and those who rely on wheelchairs or other mobility devices, are the most vulnerable road users. They are most likely to be fatally or seriously injured if hit by a moving vehicle. The City of Norfolk's Vision Zero policy to reduce traffic-related fatalities to zero gives particular focus to pedestrians.

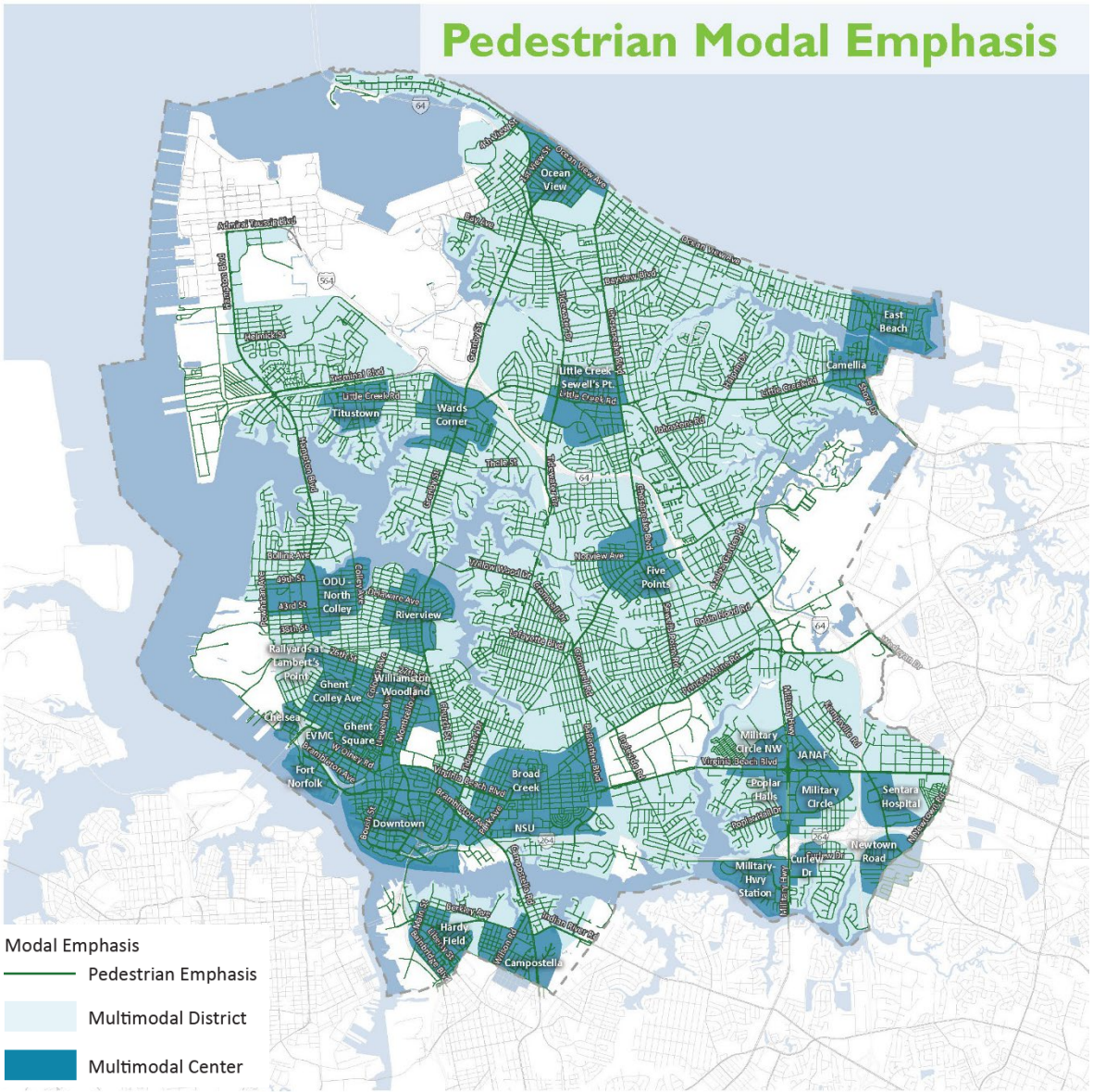
As a general policy, the needs and safety of pedestrians should be considered top priority when decisions about moving people are being made.

Pedestrian safety is the top priority for all Multimodal Corridors.

For this reason, all Multimodal Corridors, both Placemaking Corridors and Multimodal Through Corridors, were designated with Pedestrian Modal Emphasis. This means that future street improvements should consider pedestrian facilities to the greatest extent practicable based on right-of-way constraints and other feasibility factors.

Chapters 6 and 7 explain in more detail how Pedestrian Modal Emphasis influences the design of street improvements.

Many of Norfolk's streets lack accommodations for pedestrians today. The Multimodal Needs Assessment described in Chapter 12 identifies the most critical pedestrian needs, including sidewalk gaps, and needed crosswalks.



Pedestrian Modal Emphasis is designated on all Multimodal Corridors in Norfolk. Higher resolution and zoomed in versions of this map are available in Appendix A.

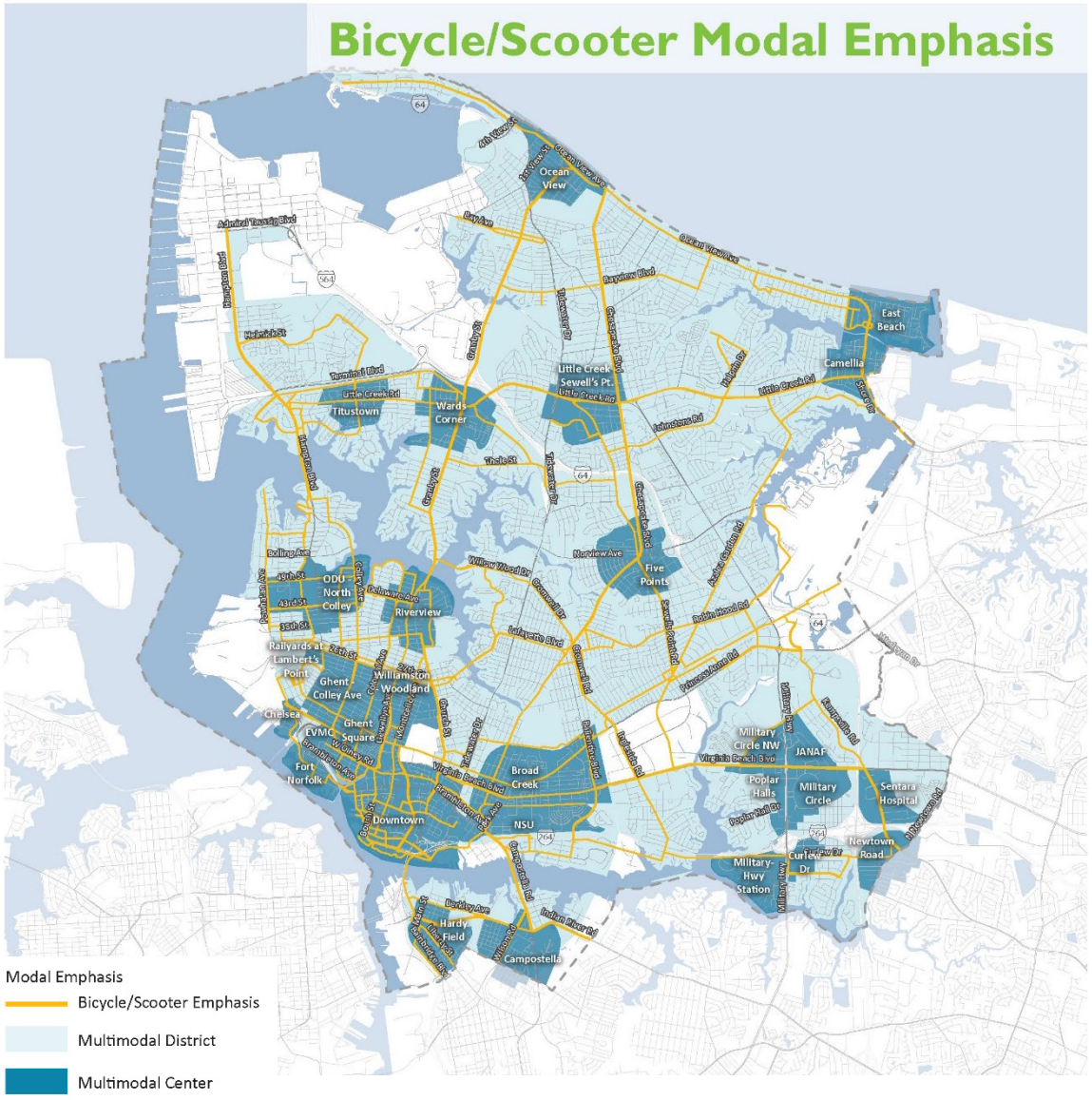
Bicycle/Scooter Modal Emphasis

Bicyclists and scooter riders are also highly vulnerable road users, and the City's Vision Zero policy also focuses on reducing bicycle fatalities. As a general policy, the needs and safety of bicyclists and scooter riders should also be considered top priority when decisions about moving people are being made.

The network of Bicycle/Scooter Modal Emphasis envisions a future connected network of streets and paths that bicyclists and scooter riders can use to travel safely and comfortably within and between all Multimodal Centers and other major destinations across the entire city.

The Bicycle/Scooter Modal Emphasis network includes streets with existing bicycle facilities and streets currently lacking bicycle and scooter accommodations that are critical connections.

All streets with specific improvements identified in the City's Bicycle and Pedestrian Strategic Plan are included in the Bicycle/Scooter Modal Emphasis network. The Bicycle and Pedestrian Master Plan described in Chapter 5 further explains how the Multimodal Norfolk transportation master plan complements and builds on the Bicycle and Pedestrian Strategic Plan.



The Bicycle/Scooter Modal Emphasis network is a future vision of a fully connected network of streets and paths that bicyclists and scooter riders can use to travel safely and comfortably across the entire city. Higher resolution and zoomed in versions of this map are available in Appendix A.

It is important to note that, while this plan combines bicycles and scooters in the same modal emphasis, the two modes have slightly different operating characteristics and regulations.

Generally, bicycles and scooters should be ridden in bicycle lanes and shared-use paths, where provided, and in general vehicle lanes when bicycle lanes or shared-use paths are not available.

Motorized scooters are not allowed to be ridden on any sidewalks in any part of the city, particularly in downtown (unless required for mobility assistance).

Bicycles can be ridden on sidewalks in select areas:

- Sidewalks designated as part of the Elizabeth River Trail
- Sidewalks outside of downtown and outside of the pedestrian/commercial districts.

It is also important to note that the Bicycle/Scooter Modal Emphasis map does not guarantee or imply that a specific type of facility will be provided. The type of facility will be determined in more detailed design phases, as described in Chapters 6 and 7, and will depend on individual factors like posted speeds, traffic volumes, and right-of-way constraints.

In addition, as part of a detailed analysis during design development, it is possible that a street with Bicycle/Scooter Modal Emphasis may be re-designated to a parallel street that better serves bicycle safety and connectivity needs.

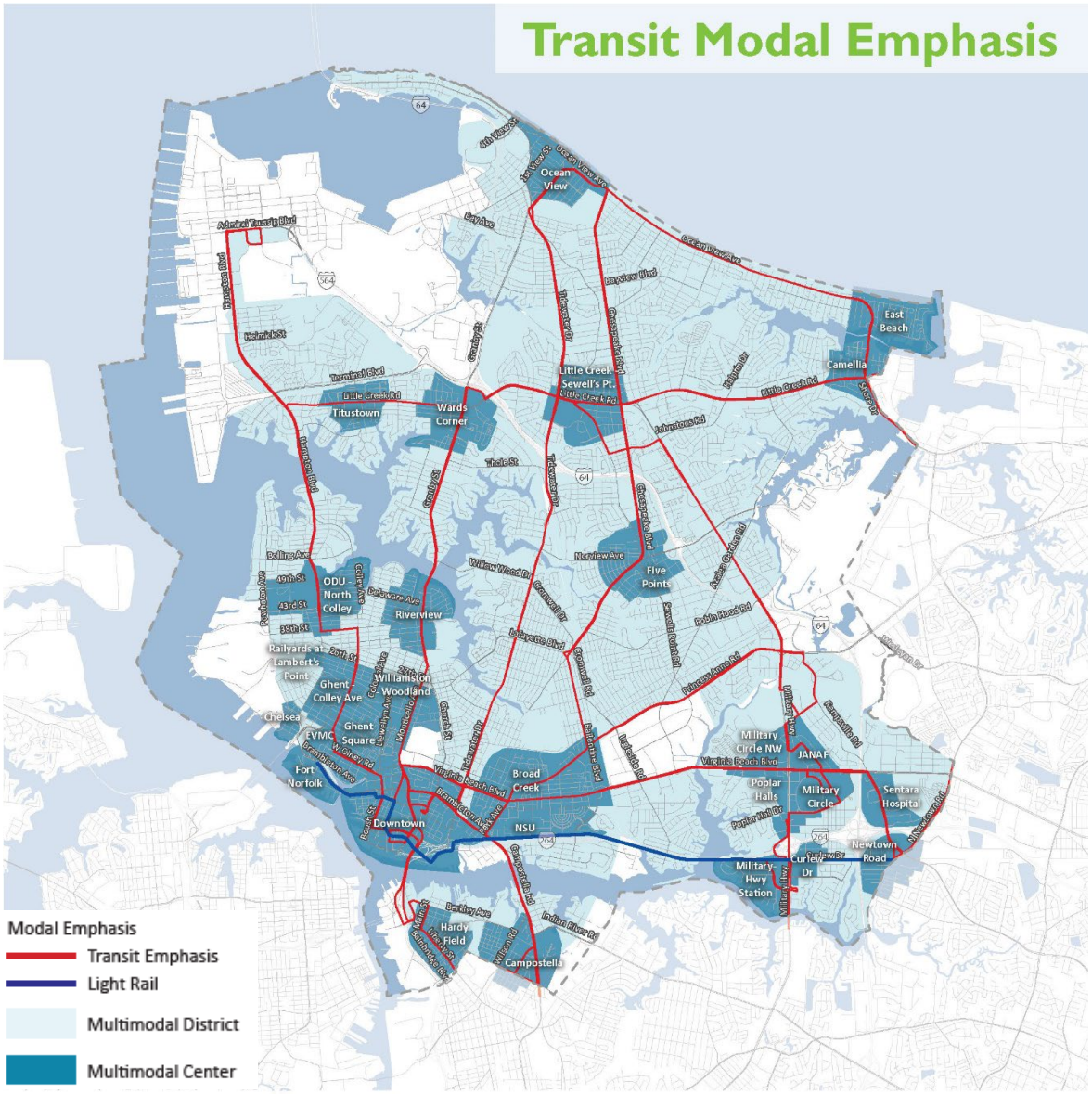
Transit Modal Emphasis

The Transit Modal Emphasis map shows a network of streets that have the highest potential for generating transit trips and connect between all Multimodal Centers and other major destinations across the city.

Although this map looks similar to the new transit network map from the transit system redesign that is anticipated to be implemented in 2023, the Transit Modal Emphasis map serves a different purpose.

The purpose of the Transit Modal Emphasis map is to identify a network of critical transit connections across the city, independent of transit service frequency. It is used to inform the design of corridor improvements. As explained in more detail in Chapter 6, the design of improvements on corridors with Transit Modal Emphasis will involve emphasizing the needs of transit vehicles.

The Transit Modal Emphasis map is also distinct from the Naval Station Norfolk Transit Corridor Project (NSNTCP), currently underway, in which HRT is evaluating various alignments for potential light rail or bus rapid transit service on Norfolk's east side. The Multimodal Norfolk project team coordinated with the NSNTCP team throughout the development of the Multimodal Norfolk transportation master plan. However, the NSNTCP had not yet identified a preferred alternative for light rail or bus rapid transit at the time of the



Transit Modal Emphasis shows a network of streets that have the highest potential for generating transit trips and connect between all Multimodal Centers and other major destinations across the city. Higher resolution and zoomed in versions of this map are available in Appendix A.

development of the Transit Modal Emphasis map. Once the NSNTCP preferred alternative is identified, it is anticipated that the Transit Modal Emphasis map will be updated.

Putting It All Together: Norfolk's Multimodal System Plan

The components introduced and defined throughout this chapter - Multimodal Centers, Multimodal Districts, Transect Zones, Multimodal Corridor types, and the three Modal Emphasis networks - together comprise the Multimodal System Plan for the City of Norfolk.

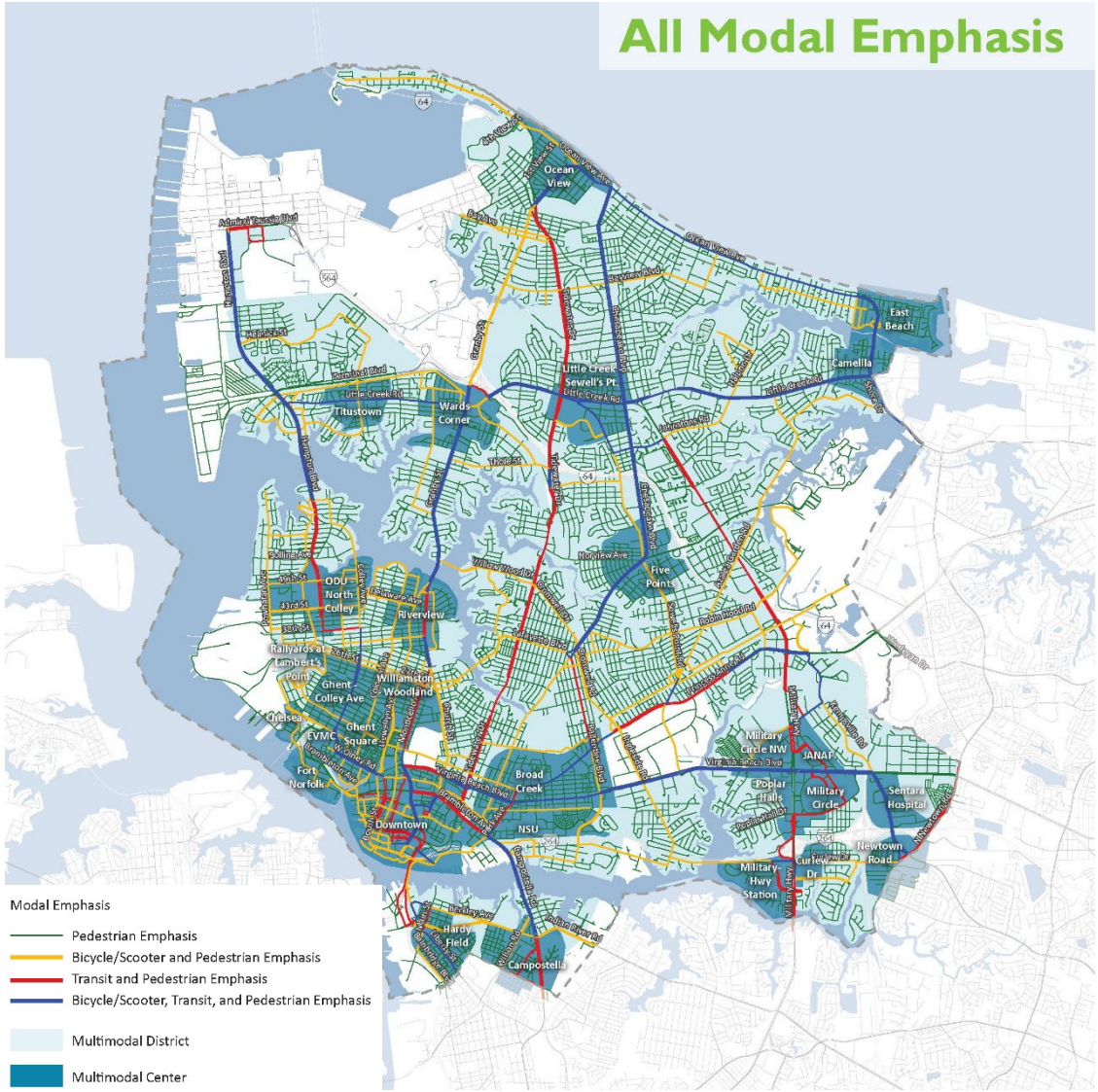
The map on the right shows the three Modal Emphasis networks overlaid on the Multimodal Centers and Multimodal Districts.

This map depicts a future vision of a comprehensive connected transportation system for all modes across the entire city. It includes potential future connections to close existing gaps.

This is ultimately a long-term vision and will be implemented incrementally as funding is available and opportunities arise.

All of the Multimodal System Plan components are factors that influence the design of street improvement projects to ensure that each individual project works toward achieving this connected future system.

The next chapter goes into more depth on the Bicycle and Pedestrian Master Plan, and the following chapter describes how to use the Multimodal System Plan in the design phase.



The three Modal Emphasis networks, Multimodal Centers, and Multimodal Districts shown here, together with the Transect Zones and Multimodal Corridor types comprise the Multimodal System Plan for the City of Norfolk. Higher resolution and zoomed in versions of this map are available in Appendix A.

[i] The Multimodal System Design Guidelines are currently available on the Virginia Department of Rail and Public Transportation's website at: http://www.drpt.virginia.gov/transit/planning/multimodal-guidelines.

Chapter 5: Bicycle and Pedestrian Master Plan

What is a Bicycle and Pedestrian Master Plan?

A Bicycle and Pedestrian Master Plan is a long-range plan for expanding bicycle and pedestrian infrastructure. It establishes a vision for the future bicycle and pedestrian networks, provides a comprehensive assessment of existing bicycle facilities and the pedestrian environment, and establishes a robust long-term network for bicyclists and pedestrians across the entire city, with high level recommendations for improvements.

Norfolk's Bicycle and Pedestrian Master Plan

The Bicycle and Pedestrian Master Plan in this chapter presents a vision for a future bicycle network. It is based on the Bicycle/Scooter Modal Emphasis map established in the previous chapter as the long-term network envisioned to provide safe and comfortable facilities for bicycling and scootering throughout all areas of Norfolk.

It also is based on the Pedestrian Modal Emphasis map, and it builds on the analysis of sidewalk needs that the City conducted previously. The Bicycle and Pedestrian Master Plan informs the multimodal needs assessment in Chapter 12 and program of projects in Chapter 13, which provide specific recommendations for implementation.

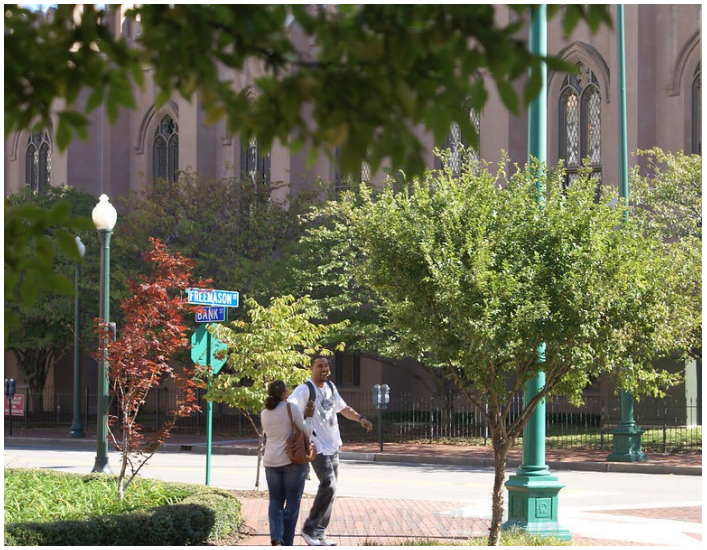
The City of Norfolk prepared a comprehensive bicycle plan in 1981. The current map of Bicycle/Scooter Modal Emphasis is very similar to the 1981 comprehensive bicycle plan.

How is the Bicycle and Pedestrian Master Plan related to the Bicycle and Pedestrian Strategic Plan?

In 2015, the City Council of Norfolk adopted the City's Bicycle and Pedestrian Strategic Plan ("Strategic Plan"), which recommends specific bicycle and pedestrian facilities on 12 key corridors. These 12 key corridors represent the foundation for the broader comprehensive bicycle plan. The goal of the Strategic Plan was to complete the 12 key corridors in the short term. Once the 12 key corridors were completed, the intention was to go back to the other recommendations from the 1981 plan and continue building out the City's network of bicycle facilities.



Scooter riders in Norfolk.



Improving pedestrian safety is a top priority.

The Strategic Plan goes into more detail for each corridor as appropriate to its strategic function than a typical master plan. The Strategic Plan identifies the specific facility type (bike lane, sharrows, priority shared lane, shared use path, buffered bike lane, or separated bike lane) for each block on 12 key corridors. The Strategic Plan defines these recommended improvements in sufficient detail so that they are ready for preliminary engineering and can be placed directly into the City's Capital Improvement Program or funded by other funding sources.

The Bicycle and Pedestrian Master Plan – both the one prepared in 1981 and the one in this chapter - by contrast, expands beyond these 12 key corridors to comprise a true citywide master plan. This Master Plan incorporates the 12 key corridors from the Strategic Plan and the network of existing facilities as a starting point. The Bicycle and Pedestrian Master Plan connects the network of existing facilities and proposed facilities from the Strategic Plan with the Multimodal Centers identified in the previous chapter. This Master Plan shows connections to fill in a finer grained network across the entire City.

The Bicycle and Pedestrian Master Plan also adds a focus to the pedestrian network. It identifies a separate network of Pedestrian Modal Emphasis that is independent of the Bicycle/Scooter Modal Emphasis network.

The Bicycle and Pedestrian Master Plan uses the components of the Multimodal System Plan in the prior chapter to create a long-term network vision for walking and bicycling in the city. The multimodal needs assessment in Chapter 12 and the program of projects in Chapter 13 also provide specific projects for implementation based on anticipated available funding. These recommendations incorporate the specific projects from the Strategic Plan and offer an updated timeframe for implementation.

The 2015 Bicycle and Pedestrian Strategic Plan remains an active and relevant plan, and the City will continue to use the Strategic Plan in its decision-making processes. The Strategic Plan is included in this Multimodal Norfolk Master Plan as Appendix I. The Strategic Plan contains important information including public comments from an interactive mapping exercise and focus group meetings, as well as detailed plans and conceptual cost estimates for each facility type. This information greatly complements the Bicycle and Pedestrian Master Plan in this chapter and should be used in the implementation of the recommendations.

12 Key Corridors from the
Bicycle and Pedestrian Strategic Plan



The City of Norfolk Bicycle and Pedestrian Strategic Plan, adopted in 2015, recommends specific facilities on 12 key corridors. The Strategic Plan serves as a starting point for the Bicycle and Pedestrian Master Plan described in this chapter.

Norfolk's Bicycle Network Vision

The vision, goals, and objectives presented in Chapter 2 speak to the overall intentions of the process to develop the Multimodal Norfolk transportation master plan.

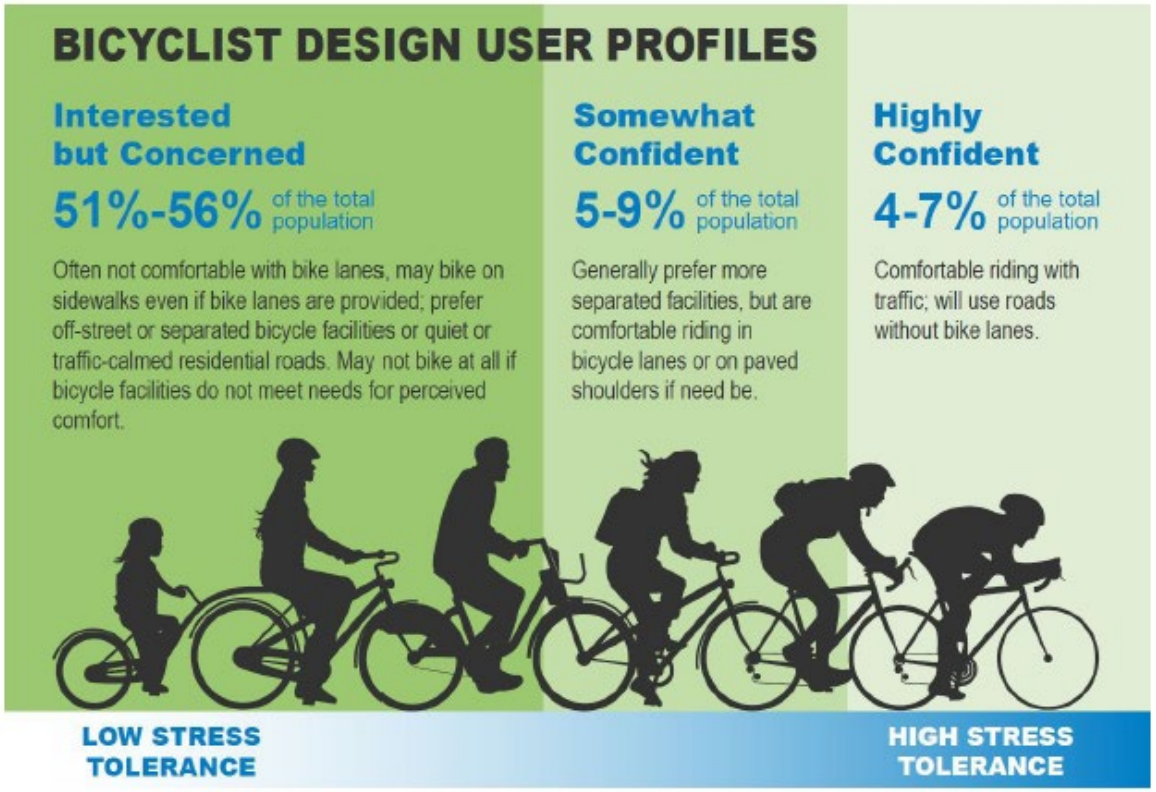
A more specific vision for Norfolk's future bicycle network can be considered as:

Norfolk's future transportation system will include a connected network of low-stress facilities for bicyclists of all ages and abilities.

This vision is consistent with the overarching vision and values of Multimodal Norfolk and the goal of working toward zero traffic deaths in the City's Vision Zero policy.

Norfolk's future bicycle network should not be designed just for highly confident bicyclists who are comfortable riding in mixed traffic. It should also be designed for bicyclists who are interested in bicycling but too concerned about safety to ride in mixed traffic or even in conventional bike lanes except on very low-volume streets.

This design intention to create a low-stress network of bicycle facilities for riders of all ages and abilities is incorporated in the corridor design framework presented in Chapters 6 and 7.



Only a slim minority of adults who have stated an interest in bicycling are considered to be highly confident and are comfortable riding with traffic and using roads without bike lanes. The vast majority are considered to be interested but concerned and will avoid bicycling except on very low-stress bikeways. The vision for Norfolk's bicycle network is to design for the interested but concerned type of bicyclist, which will accommodate the somewhat confident and highly confident types too. Image Source: Federal Highway Administration, 2019. *Bikeway Selection Guide*.

Existing Facilities for Bicycling and Scootering

In 2015, the League of American Bicyclists recognized the City of Norfolk as a Bicycle Friendly Community with a Bronze Award, which was renewed again in 2019. The City has a goal of achieving the Gold Award.

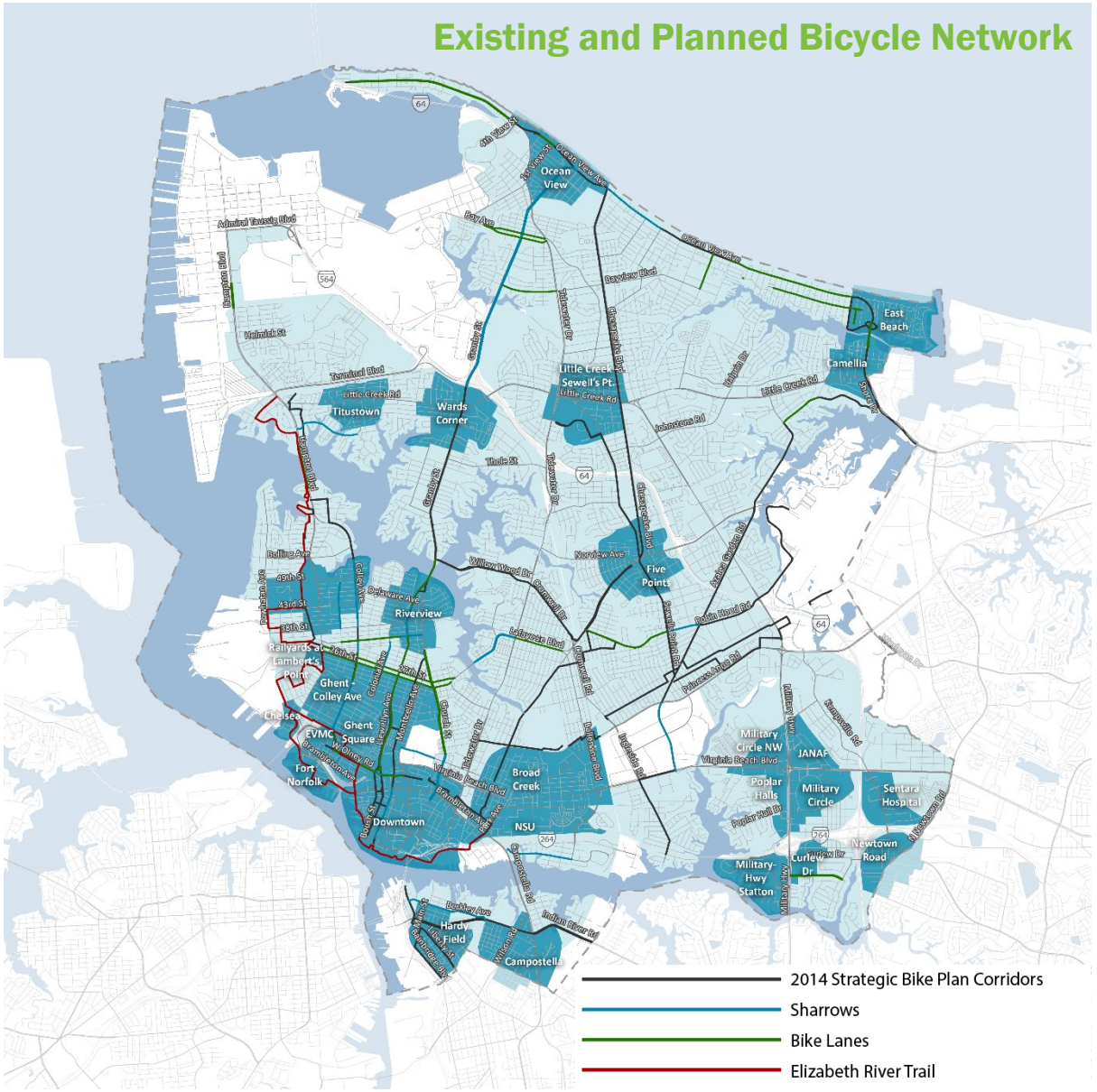
Over the past two decades, the City of Norfolk and other partners have made a number of investments and improvements to expand the network of facilities for bicycling and scootering in the city.[i] The city currently has 35.3 miles of bike lanes and 31.6 miles of shared lane markings (sharrows).

The Elizabeth River Trail, which spans 10.5 miles, was developed in 1994 and has been continually improved with new sections, the most recent of which was completed at Fort Norfolk in Summer 2021.

Prior to the 2015 Bicycle and Pedestrian Strategic Plan, the City added bike lanes and shared lane markings to several streets, including Church Street, W. Ocean View Avenue, and E. Bayview Boulevard among others.

Since 2015, the City has been working to implement the recommendations on several of the key corridors from the Strategic Plan. Recommendations that have already been constructed include:

- Buffered bike lanes on E. Ocean View Avenue,



Over the past two decades, the bicycle network within Norfolk has grown yet remains limited. The 2015 Bicycle and Pedestrian Strategic Plan proposes new connections on key corridors, but the proposed network remains sparse and does not connect to all major destinations across the city.

- Buffered bicycle lanes on Olney Road,
- Shared lane markings on Granby Street,
- Protected bicycle lanes on Llewellyn Avenue,
- Bicycle lanes on portions of Colley Avenue, and
- Bicycle lanes on 26th and 27th Street from Hampton Boulevard to Leo Street.

Recommendations from the Strategic Plan that are currently in progress include:

- Bicycle facilities on E. Ocean View Avenue from 1st View Street to Pretty Lake Avenue,
- Protected bicycle lanes on Granby Street from Willow Wood Road to Admiral Taussig Boulevard, and
- Bicycle lanes and shared lane markings on Robin Hood Road and Miller Store Road.

Other bicycle facilities and markings recently constructed include:

- Mountain bike trails at Northside Park and
- Shared lane markings on Water Street

The City is currently working on other bicycle facility projects including:

- The Granby Street Bike Bypass multi-use path through Lafayette Park,
- Bicycle lanes on Princess Anne Road from Church Street to Armistead Avenue and shared lane markings on Princess Anne Road from Armistead Avenue to Colley Avenue, and
- Shared lane markings on Columbus Avenue to 42nd Street

Bicycle parking has been added downtown and in commercial corridors such as Colley Avenue and Colonial Avenue.

The City has worked with Lime, other City departments, Downtown Norfolk Council, and several civic leagues to install scooter parking corrals at various locations throughout downtown and in other areas. The City is continuing its efforts to expand the corral locations to provide safe and convenient parking for both scooters and bikes. Bike racks have also been installed in the existing corrals downtown.

The City's zoning ordinance, since amended in 1992, requires most new development to provide bicycle parking.

The City's Department of Transit also initiated a Bike-Pedestrian Counter program in March 2021 to provide a reliable method of data collection. This data will be used to advance the goal of making biking and walking more comfortable and more connected in Norfolk by better understanding the trends of pedestrians and cyclists in the city. 15 counters have been installed along existing bike lanes and 6 counters have been installed at various locations along the Elizabeth River Trail.

These efforts all represent a promising start for improving bicycling in Norfolk. These efforts build on the City's assets that have the potential to make bicycling an attractive form of transportation, which include:[ii]

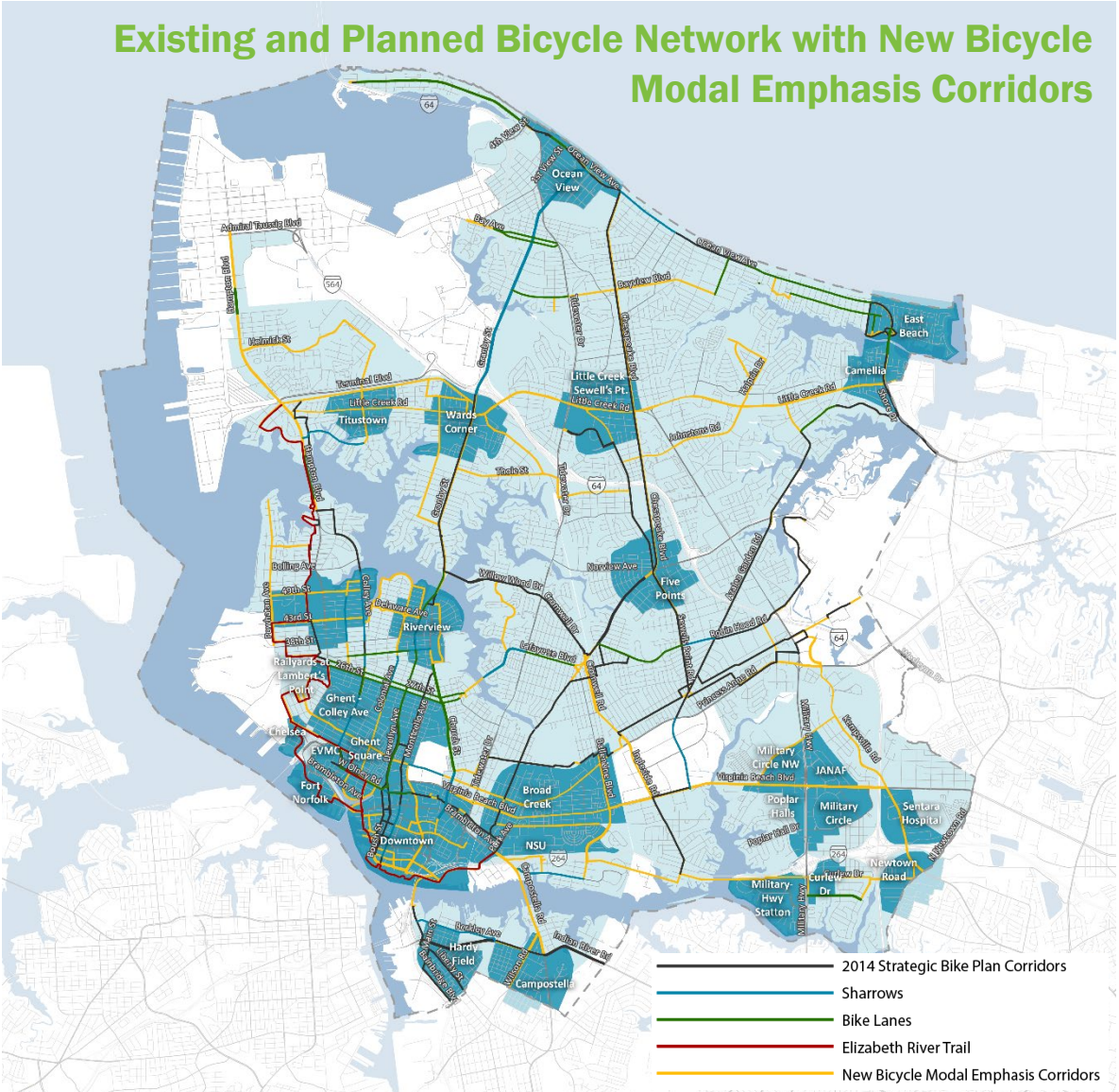
- A compact shape (it is only eight miles east-to-west and north-to-south)
- A fairly well-connected street grid
- Flat terrain
- A strong share of the region's jobs and accessible employment sites
- Commercial land uses that are dispersed throughout the city
- A traditional downtown that is strengthening its mix of commercial and residential land uses
- Recreation and entertainment destinations including the Virginia Zoo, Elizabeth River and Chesapeake Bay waterfronts, Norfolk Botanical Garden, and various performing arts centers and sports venues
- Large universities and other public institutions
- Neighborhood-based school boundaries

Bicycle/Scooter Modal Emphasis Network

As described in Chapter 1, the future vision of transportation in Norfolk is one where everyone has safe and affordable choices for meeting their daily needs without having to drive their own car. In order to make bicycling a viable option for everyday trips, a robust network of facilities that are safe and comfortable for riders of all ages and abilities is needed across the entire city.

The long-term network envisioned in this Bicycle and Pedestrian Master Plan and shown in the map to the right provides safe facilities for anyone to get where they need to go by riding a bicycle or scooter. It expands the network from the 2015 Strategic Plan to include connections between all Multimodal Centers. It provides a finer-grained network of bicycle facilities within the most intense Multimodal Centers, where the density of destinations and mix of uses makes an even finer-grained network critical.

As noted above, the Bicycle/Scooter Modal Emphasis network incorporated the 12 key corridors from the Strategic Plan as a base. It was expanded to include key connections between and within Multimodal Centers. It also incorporates and updates the Downtown Norfolk Multimodal System Plan, which was developed in 2018 in conjunction with the Downtown Master Plan Update. Further, it also reflects input from public and stakeholders,



The Bicycle/Scooter Modal Emphasis network is a future vision of a fully connected network of streets and paths that bicyclists and scooter riders can use to travel safely and comfortably across the entire city. The map above shows the existing and planned bicycle facilities along with the corridors that have bicycle/scooter modal emphasis.

including the City's Bicycle and Pedestrian Trails Commission and other bicyclists and scooter riders throughout the Multimodal Norfolk public engagement process.

The City recognizes that maintenance funding will need to be increased periodically as more bicycle lanes get added to the network to ensure the safe upkeep of the bicycle network.

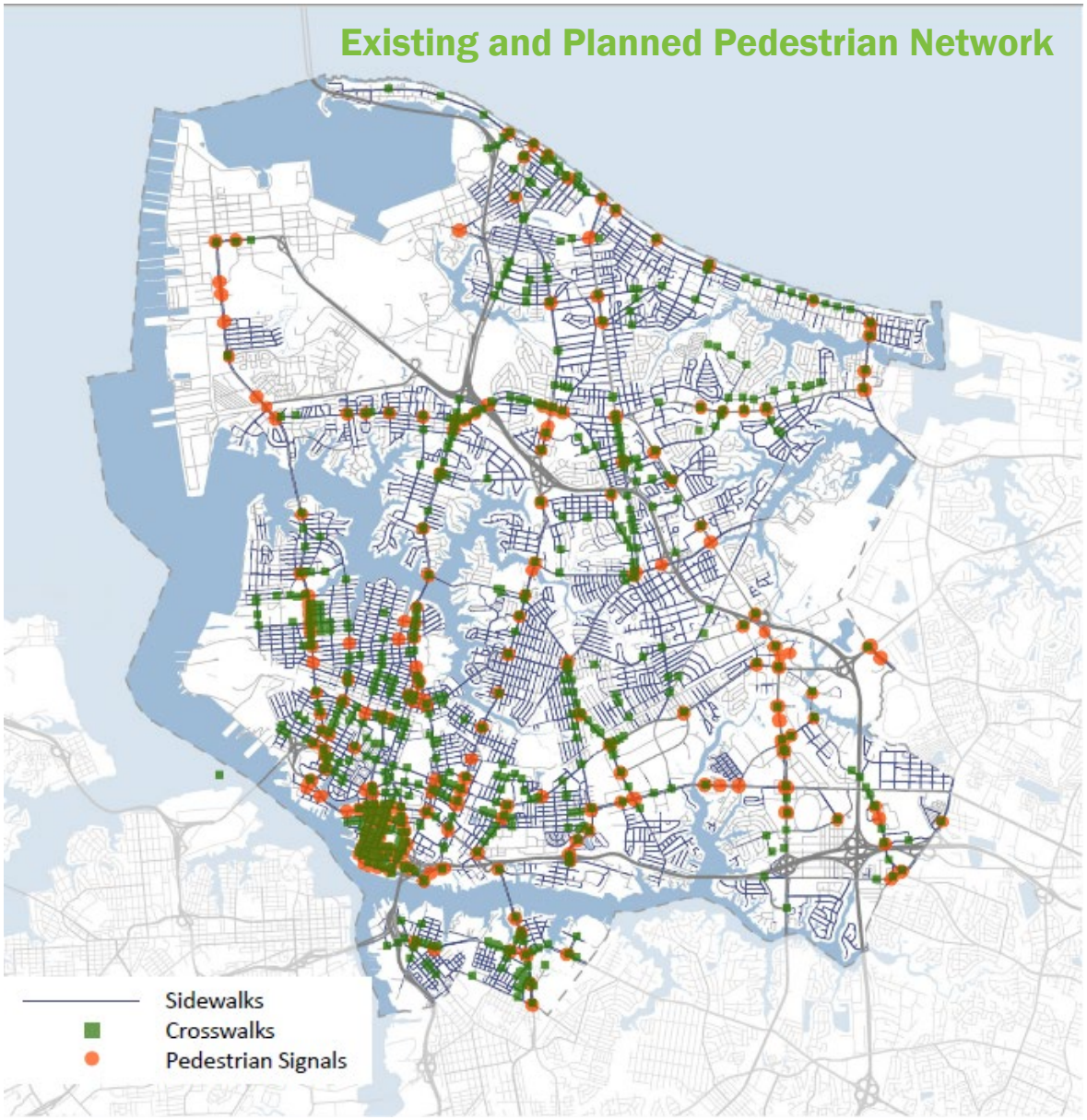
Existing Facilities for Pedestrians

The existing network of facilities for pedestrians in Norfolk today consists of sidewalks, marked crosswalks, pedestrian signals, which are shown in the map to the right, as well as several off-street paths.

Sidewalks exist along many of Norfolk's streets and in many neighborhoods. There are, however, several neighborhoods with very few or no sidewalks, like Camellia Gardens, Roosevelt Area, Hewlitt Farms, South Bayview, East Ocean View, Oakdale Farms, Chesapeake Gardens, Azalea Acres, and others. Most neighborhoods have at least some gaps in the sidewalk network.

There are sidewalk gaps along many of the arterial streets that serve major destinations like Military Highway, Virginia Beach Boulevard, Little Creek Road, Princess Anne Road, and Chesapeake Boulevard. Sidewalk gaps also exist on most arterial streets at the interstate interchange areas.

There are also many streets where marked crosswalks are spaced far apart, forcing pedestrians to cross the street at unmarked locations. Most pedestrian crashes occur at locations where there is no marked pedestrian crossing.[iii]



The City of Norfolk's existing pedestrian facilities include sidewalks on many streets, marked crosswalks, pedestrian signals, and off-street paths. Data source: City of Norfolk. Sidewalk data is current as of 2017. Crosswalk data is current as of 2013.

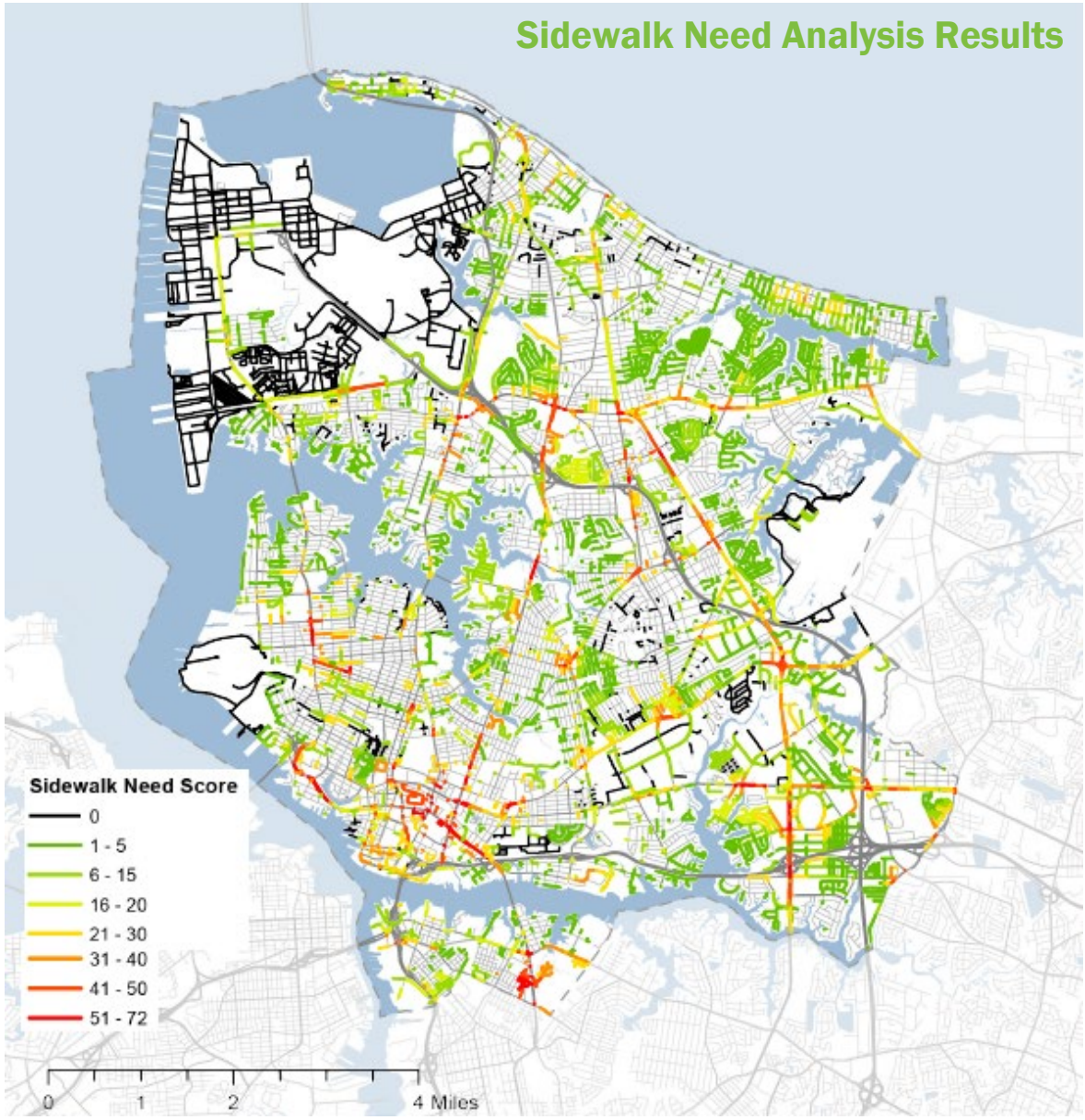
The City is currently undertaking several projects to improve facilities for pedestrians, including:

- Sidewalk improvements on Easy Street, Princess Anne Road, Indian River Road, and Sewell's Point Road
- Adding crosswalks and filling in sidewalk gaps on Little Creek Road between Chesapeake Boulevard and Carlton Street
- Crosswalk and sidewalk improvements at the intersection of Little Creek Road and Shore Drive as part of an intersection improvements project
- Citywide pedestrian accommodations and countdown signals

The City conducted an analysis of sidewalk need in 2017, which identified which streets that lacked sidewalks at the time had the greatest need for sidewalks, based on a variety of factors including:

- Distance to schools, grocery stores, parks, libraries, and other facilities
- Distance to transit stops
- Pedestrian crashes
- Households with zero vehicles
- Households with incomes below the poverty line
- Population below age 18 and over age 60
- Road type

This analysis was used in the development of the multimodal needs assessment in Chapter



In 2017, the City of Norfolk identified sidewalk gaps and determined the level of sidewalk need based on a variety of factors.

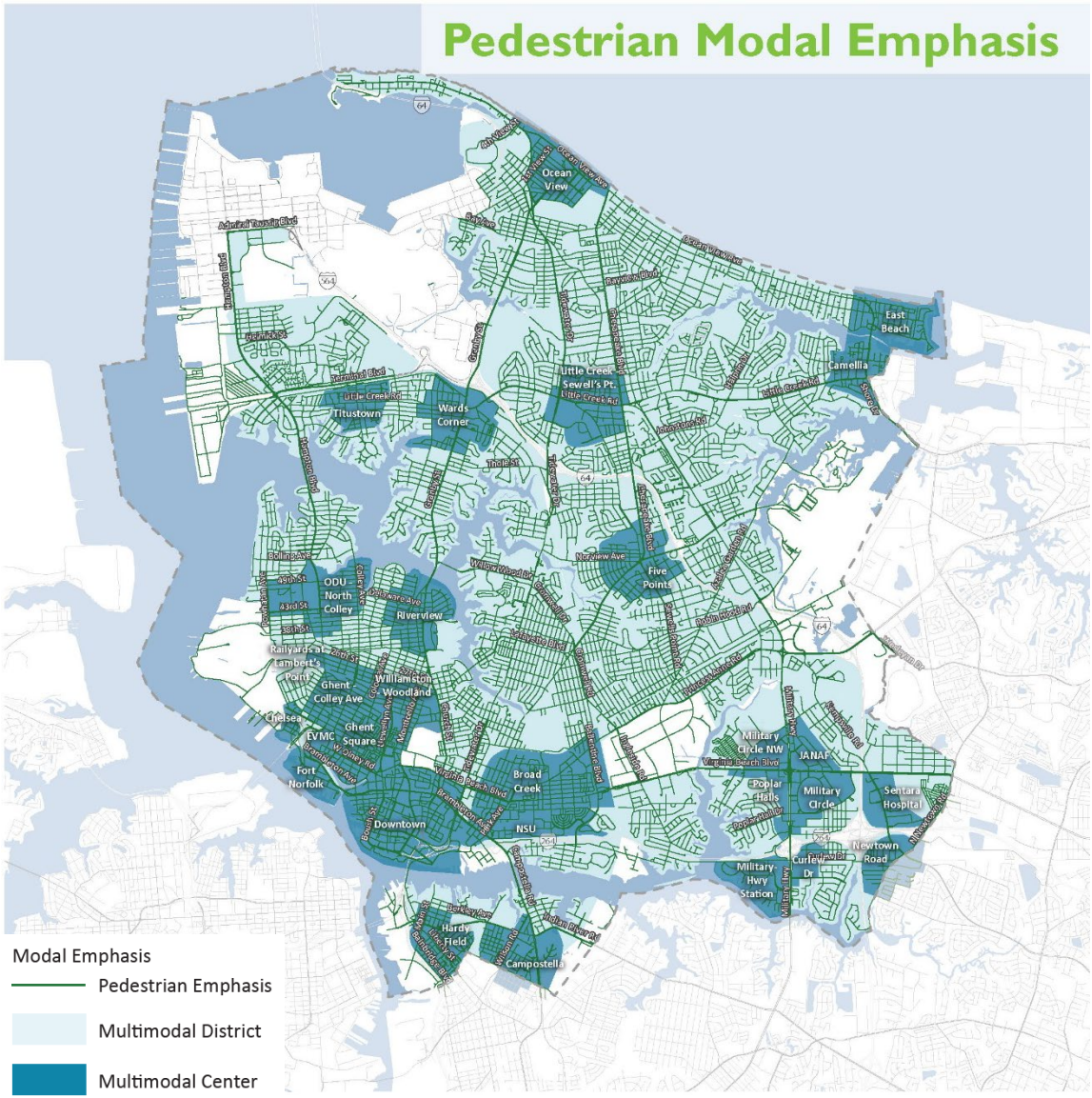
12, which identifies the most critical needs for multimodal improvements throughout the city.

Pedestrian Modal Emphasis Network

As explained in Chapter 4, pedestrian safety is the top priority for all Multimodal Corridors. The Pedestrian Modal Emphasis map designates Pedestrian Modal Emphasis on all Multimodal Corridors. Only the interstates and other limited-access highways are exempt.

This map is important because it clearly shows the intention to emphasize pedestrian facilities to the maximum extent practical and feasible whenever an opportunity for a street improvement arises.

Areas and corridors of highest need for pedestrian improvements are identified in the multimodal needs assessment in Chapter 12. Specific recommendations for new and improved pedestrian facilities are included in the program of projects in Chapter 13.



Pedestrian Modal Emphasis is designated on all Multimodal Corridors, reflecting the focus on pedestrian safety as the top priority.

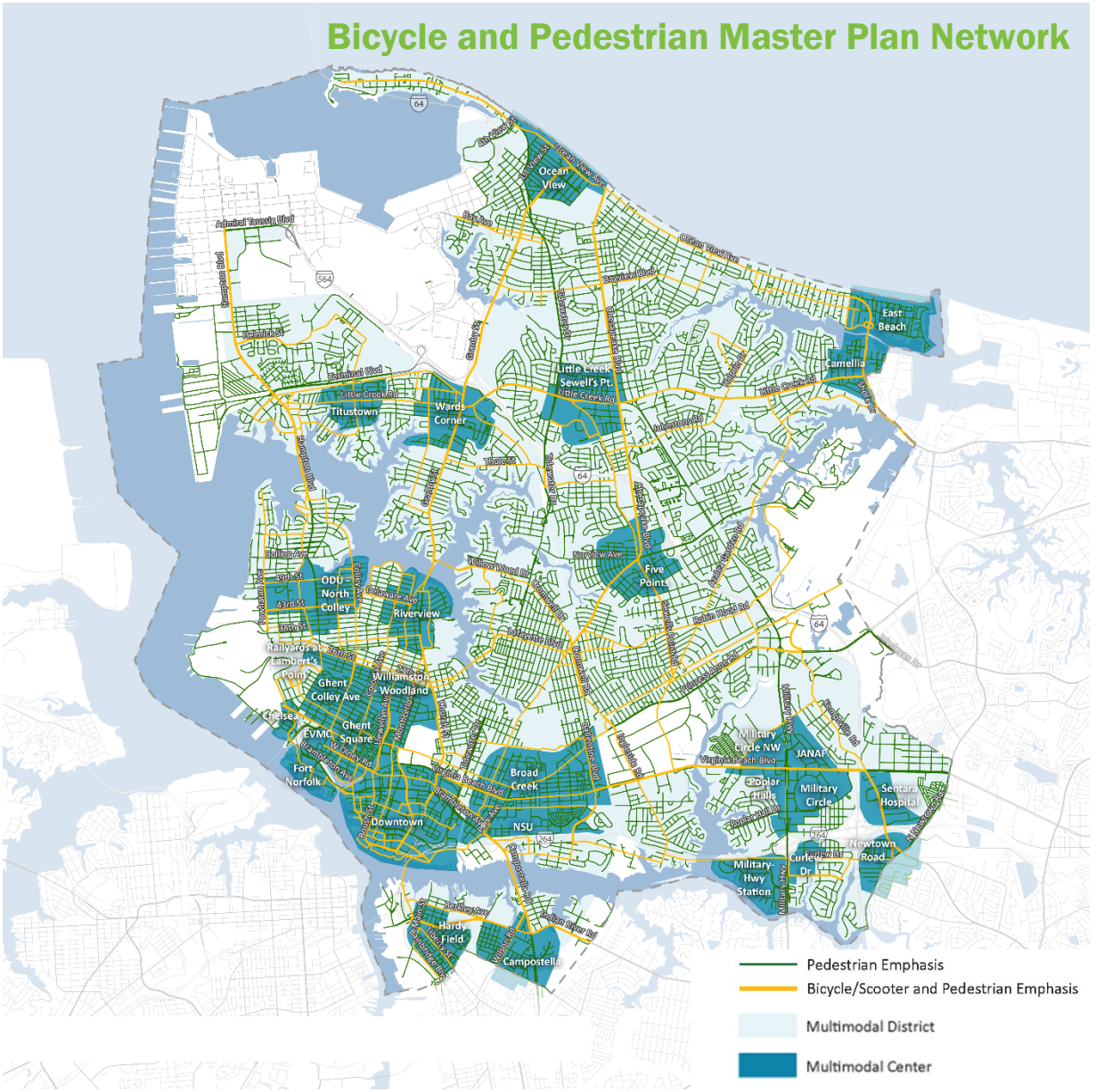
Bicycle and Pedestrian Networks Combined

The map to the right represents the long-term vision for these modes. It shows the Bicycle/Scooter Modal Emphasis network together with the Pedestrian Modal Emphasis network, overlaid on the Multimodal Centers and Multimodal Districts.

This map represents the Bicycle and Pedestrian Master Plan. It shows a robust long-term network for bicyclists, scooter riders, and pedestrians across the entire city. It connects all of the Multimodal Centers and major destinations throughout Norfolk.

This map should guide design decisions and ensure that the incremental changes to improve Norfolk's transportation system work towards achieving the envisioned network for non-motorized modes.

By using this map in the corridor design process, the City of Norfolk should work towards its vision of a future transportation system that has safe and affordable choices for everyone to meet their daily needs without having to rely on their car.



The Bicycle/Scooter Modal Emphasis Network together with the Pedestrian Modal Emphasis Network represents the long-term vision for these modes, providing connections across the entire city and between all Multimodal Centers and major destinations.

[i] The list of facilities and improvements for bicycling and scootering was taken from the City of Norfolk Bicycle and Pedestrian Strategic Plan and updated to include improvements since that plan was adopted in 2015.
[ii] The City of Norfolk Bicycle and Pedestrian Strategic Plan identifies Norfolk's assets that can be key to building strong bicycle and walking mode shares for daily transportation. These assets are reiterated here.
[iii] VDOT Pedestrian Safety Action Plan, 2018.

Chapter 6: Multimodal Project Design – Overall Framework

Designing Multimodal Corridors

The Multimodal System Plan gets implemented through the design of multimodal corridors and individual projects. Changes to Norfolk's transportation system occur in a variety of ways. The City may use funding to completely redesign an entire corridor or reconfigure an intersection, or it may incrementally expand the sidewalk or bike network as funding becomes available. Regular repaving of the roadways also present opportunities for restriping and changing the configuration of the pavement area between the curbs.

Through the development review and approval process, the City can sometimes negotiate with developers to build specific facilities along or adjacent to their property. Small-scale projects might be funded through the City's annual Capital Improvement Program. Larger projects may rely on other sources of federal and state funds for addressing safety issues, mitigating congestion, improving air quality, and enhancing non-motorized transportation. These are just a few examples of the many ways in which an opportunity could arise for a project to make an improvement to the transportation system.

This chapter presents a process for designing a project on a multimodal corridor so that it works towards building out the future vision of the Multimodal System Plan.

The design process outlined in this chapter is called the Multimodal Project Design Framework. It can apply whenever an opportunity for a project arises. This process is most applicable to linear projects on Multimodal Corridor segments, like a pavement restriping to provide bicycle and/or bus lanes, a sidewalk expansion project, or a streetscaping improvement project. But it is also useful when considering spot improvements like striping crosswalks, bus stop improvements, and other intersection reconfiguration projects.

This chapter outlines the Multimodal Project Design Framework overall. The next chapter defines the design approaches and design considerations for each mode.



Roadway striping for a combined bus and bike lane. Image source: Wikimedia Commons



Roadway reconstruction to install wide sidewalks. Image source: Wikimedia Commons

The process for designing projects on multimodal corridors in this chapter works together with the process for evaluating how well those projects align with Norfolk's vision and goals for multimodal transportation in Chapter 8. Determining the best use of curb space is a critical part of the design process, and it is explained in further detail in Chapter 9.

The Multimodal Project Design Framework

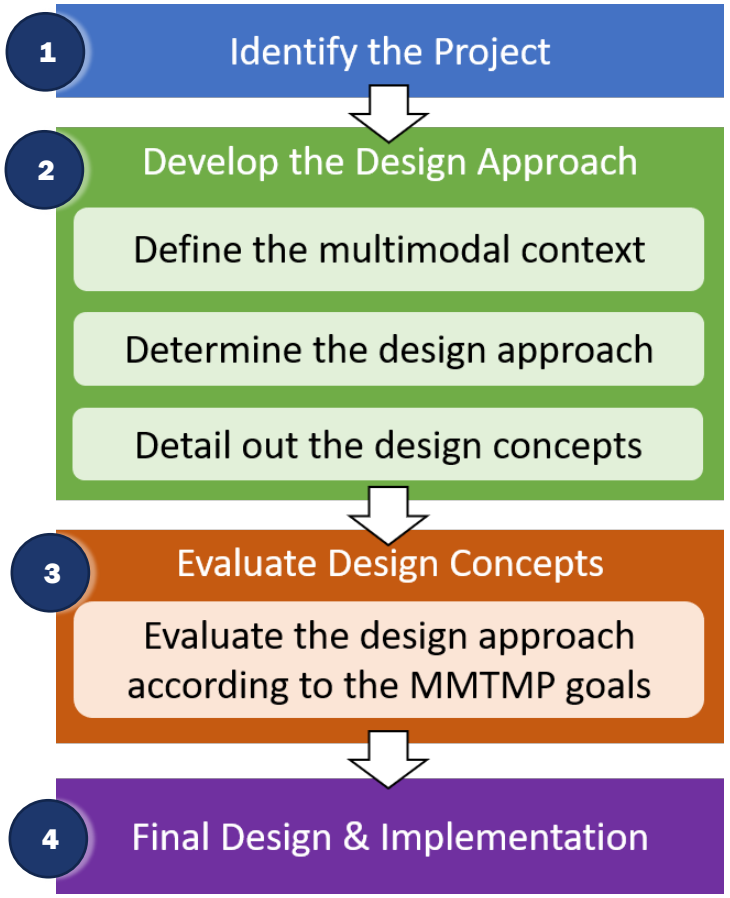
The Multimodal Project Design Framework is illustrated as a four-step flowchart in the graphic to the right.

This section provides an overview of the four steps. Subsequent sections in this chapter and the next chapter focus on the second step – *Developing the Design Approach*. Chapter 8 elaborates on the third step – *Evaluating Design Concepts*. The first and fourth steps are not addressed in greater detail beyond the overview provided in this section, as they simply illustrate the steps that occur before and after the conceptual design phase that is the focus of this framework.

Step 1: Identify the Project

The first step of the Multimodal Project Design Framework is to identify a project. As explained in the introduction of this chapter, the starting point for projects can vary. The program of projects in Chapter 13 list projects that are anticipated to be funded within the near, mid, and long-term timeframes. Opportunities for other projects may arise from unanticipated funding opportunities. The point of this step is to define the purpose and need for the project, the extent of the project , and the degree to which the corridor can be reconfigured (e.g., repaving between the existing curbs, moving curbs within the existing right-of-way, or acquiring additional right-of-way from adjacent properties).

The Multimodal Project Design Framework



The Multimodal Project Design Framework is a four-step process for selecting, designing, and implementing a project on a multimodal corridor.

Step 2: Develop the Design Approach

After a potential project location and need are identified, the next step is to come up with a high-level *design approach* to the corridor.

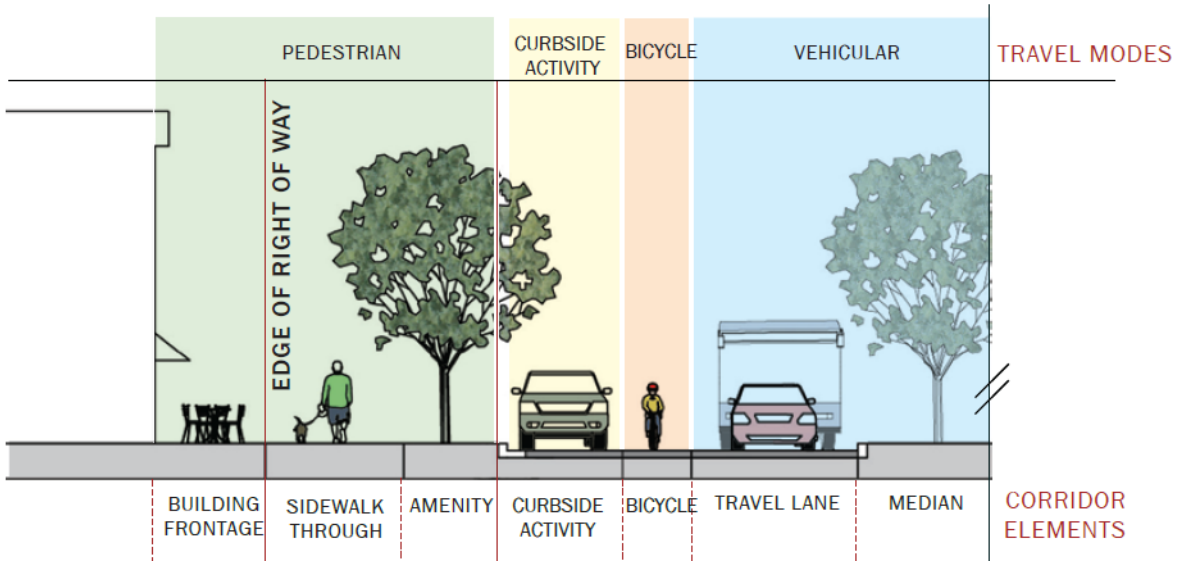
*A **design approach** spells out the way in which each mode will be accommodated within the street.*

In this step, the type of facility that will be provided for each mode is determined. For example, is it desirable to provide a dedicated lane for buses, or is it appropriate for buses to operate in lanes shared with traffic? The design approach may consider if it is feasible to convert a general travel lane into a different type of facility.

Developing the design approach starts with identifying the multimodal context of the corridor, which consists of the Multimodal Corridor type, Modal Emphasis, Transect Zone, and whether the corridor segment is in a Multimodal Center – all components defined in the Multimodal System Plan in Chapter 4.

Next, other factors like traffic volumes, speeds, bus frequencies, desirability for bicycle facilities, potential conflicts with other modes, and other characteristics are identified to determine the desired design approach for each mode.

FIGURE 6-1: MULTIMODAL CORRIDOR CROSS-SECTION ELEMENTS



The design approach determines how each mode will be accommodated and what type of facility will be provided. In this step, you determine which modes receive separate dedicated space within the cross-section and which modes share space with other modes. In the illustration above, this design approach provides a separate facility for bicyclists, while buses and autos share a vehicular travel lane.

Vehicular capacity is one among several considerations to examine when developing a multimodal design approach. Other considerations that reflect the goals of safety, connectivity, and equitable prosperity for pedestrians, bicyclists, scooter riders, and transit passengers should be considered too, and balanced with vehicular capacity, level of service, and overall safety. The acceptable balance among these considerations will depend on the project context, analysis, and public input to determine the appropriate design approach. Examining and assessing these tradeoffs is discussed in more detail in Chapter 7 and 8.

After choosing the desired design approach, the design approach is detailed into a *design concept* with specific dimensions for each *corridor element*.

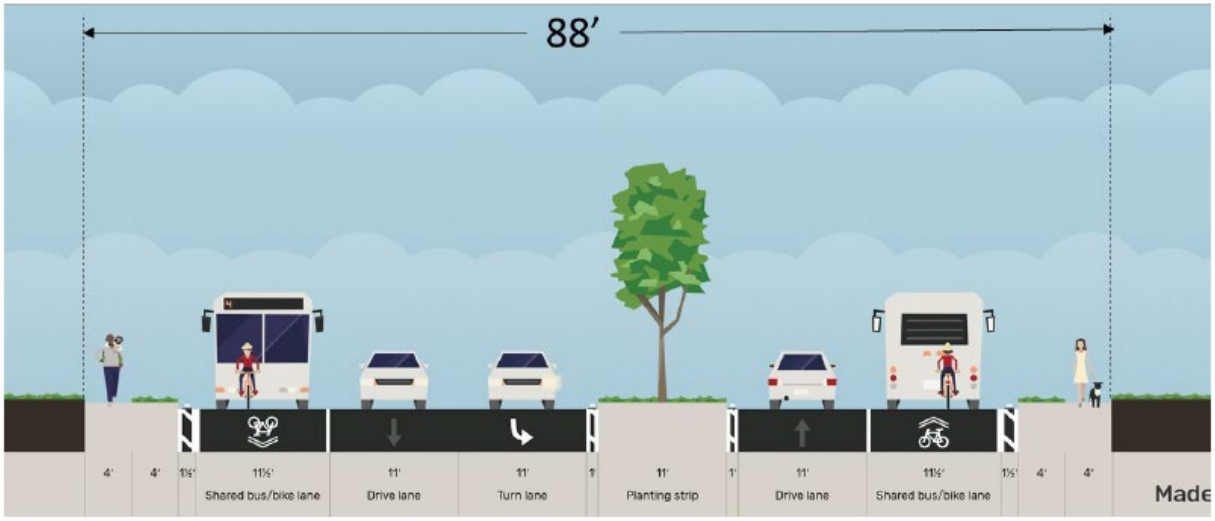
Corridor elements *are the individual "pieces" that are allocated space within the corridor cross-section.*

A ***design concept*** *is an illustration of a corridor cross-section with specific dimensions for each corridor element.*

A design concept may be a typical corridor cross-section illustration with widths for each element within the cross-section, or it may be a plan view concept along a corridor including treatments for each segment and intersection.

The outcome of this second step in the Multimodal Project Design Framework is one or more design concepts that are design approaches detailed out with specific dimensions.

An example of a design concept is shown on the illustration to the right - it takes into account general feasibility and right-of-way constraints. The dimensions determined in the design concept are preliminary planning-level dimensions that will need to go through more detailed engineering-level design. The purpose of this step is to prepare a concept that should be generally feasible and that can be evaluated in the following step.



The outcome of the second step of the Multimodal Project Design Framework is one or more design concepts with specific dimensions for each element in the corridor cross-section.

Step 3: Evaluate Design Concepts

After developing one or more design concepts, the next step involves evaluating the design concept to determine how well it achieves the Norfolk's vision and goals for multimodal transportation.

The purpose of this step is to understand the benefits and tradeoffs of each design concept and choose the best one to carry forward to final design and implementation.

This step is described in greater detail in Chapter 8, which provides several evaluation metrics that illustrate multimodal tradeoffs beyond the traditional metrics associated with vehicular capacity and delay.

The proposed evaluation metrics in Chapter 8 are useful not only for planners and engineers on the project team to understand the tradeoffs associated with different design concepts; they are also useful for communicating the value and benefits of projects to stakeholders, elected officials, and the public.

Step 4: Final Design and Implementation

After choosing the design concept to advance into final design, the process goes into developing engineering drawings and cost estimates and preparing the project for construction.

Developing the Design Approach: A Closer Look at Step 2 of the Multimodal Project Design Framework

As described previously, the second step of the Multimodal Project Design Framework is "Developing the Design Approach." This step consists of three smaller steps:

a. Defining the multimodal context
b. Determining the design approach
c. Detailing out the design concepts

The first of these smaller steps is described in detail in the following section. Chapter 7 continues the discussion and describes the second and third of these smaller steps in detail.

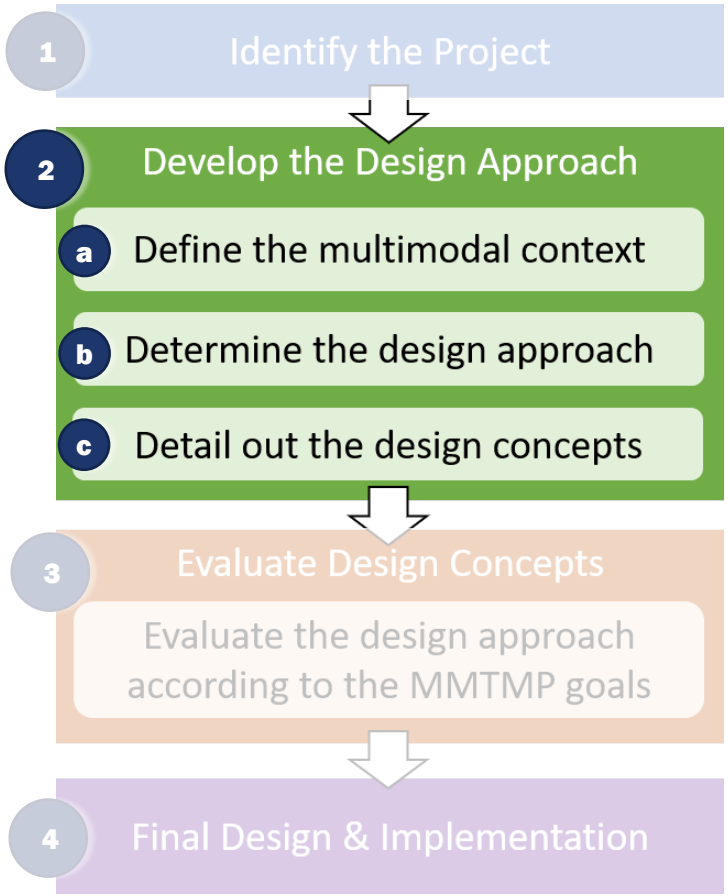
Step 2a: Defining the Multimodal Context

The context of a street, the surrounding land use, and the role it plays in the larger multimodal transportation system all shape the design approach for a multimodal corridor project. The first step to developing a design approach is to understand the context of the project corridor.

The Multimodal System Plan in Chapter 4 defines several important components that describe the multimodal context of a project corridor and influence how that corridor is designed, including whether a corridor is located in a Multimodal Center or a Multimodal District, the Transect Zone, the Multimodal Corridor type, and the Modal Emphasis. Understanding how these components are defined for the project corridor frames the role it plays in the larger multimodal system and sets important context for the design approach. How these components of the Multimodal System Plan influence corridor design are explained in the following sections.

It is also important at this stage to seek stakeholder and public input to identify additional context characteristics or functions that are specific to the project area so the design approach can be tailored to these specific context needs.

The Multimodal Project Design Framework



The second step of the Multimodal Project Design Framework is the focus of this chapter. It consists of three smaller steps.

Multimodal Centers and Multimodal Districts

As described in Chapter 4, a Multimodal Center is an area envisioned to have a high mix and density of uses within walking distance so that everyday destinations can be reached by walking or bicycling. Multimodal Centers are envisioned to be places with vibrant street activity. The environment within Multimodal Centers, including the streets, buildings, and urban form, is designed for people, not for vehicles. Multimodal Districts are areas outside of Multimodal Centers that are envisioned to be safe and comfortable for walking and bicycling. Multimodal Districts have a lesser intensity of destinations and density than Multimodal Centers and are mainly residential neighborhoods and other single-use areas.

Multimodal Corridors in Multimodal Districts will typically see lower demand for non-auto modes than in Multimodal Centers. It is important to provide minimum safe accommodations for all modes on Multimodal Corridors in Multimodal Districts. Multimodal Corridors in Multimodal Centers could see higher demand for non-auto modes, making it important to try to achieve more than just the minimum safe accommodations, depending on other factors like Modal Emphasis.

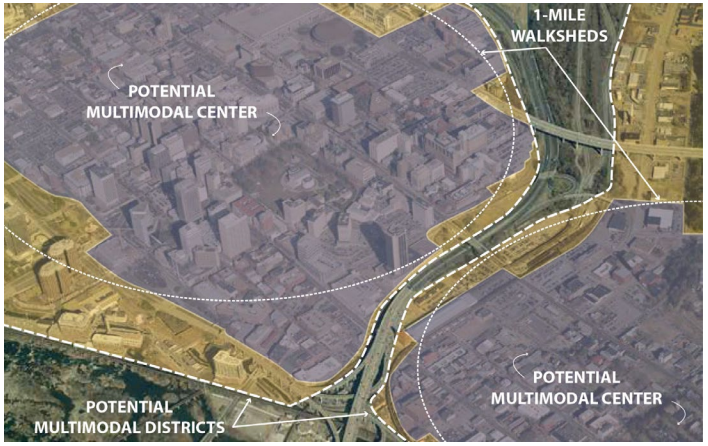
It is important to have a fine-grained network of high-quality facilities for walking and bicycling within Multimodal Centers. Pedestrian crossings should be spaced closer together in Multimodal Centers, and more streets should have bicycle modal emphasis than in areas outside of Multimodal Centers.

Also, all Multimodal Through Corridors should transition to Placemaking Corridors within Multimodal Centers because Multimodal Centers are the areas envisioned to have the highest pedestrian activity. All streets within a Multimodal Center should be designed with slower vehicle speeds and designed to accommodate a variety of activities within the public right-of-way.

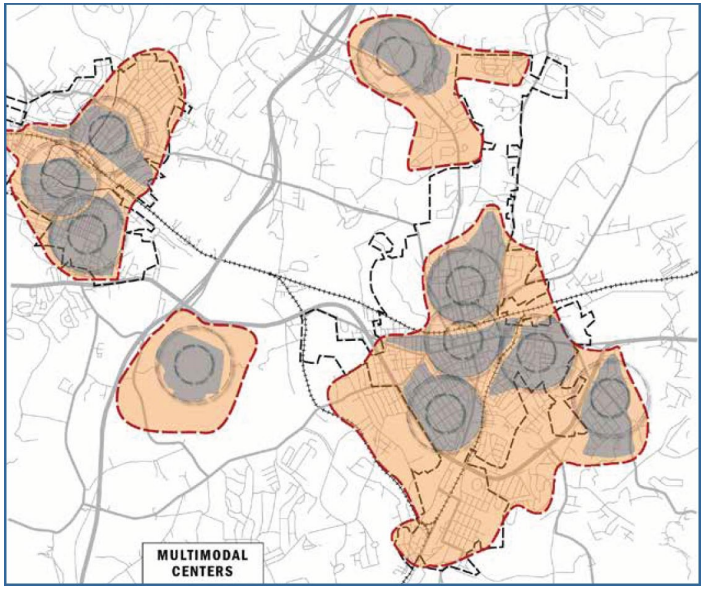
Transect Zones

Transect zones classify the land use intensity of an area into six ranges, as described in Chapter 4, from the least intense T-1 transect zone with zero to one person or job per acre to the most intense T-6 transect zone with 100 or more persons and jobs per acre.

More intense transect zones usually have higher potential for generating walking, bicycling, and scooter trips. In more intense transect zones, it may be more



Multimodal Centers and Districts. Image source: DRPT Multimodal System Design Guidelines



Multimodal Centers are areas of highest multimodal connectivity and have a mix of uses and proximity of destinations such that most trips can be made by walking. Multimodal Centers are designated roughly according to one-mile diameter circles but morphed to fit actual conditions and barriers to connectivity such as rivers or high-speed highways. Image source: DRPT Multimodal System Design Guidelines

important to provide higher-capacity facilities for non-auto modes to accommodate higher volumes of pedestrians, bicyclists, and scooter riders, such as sidewalks and/or bicycle lanes that are wider than the minimum requirements. It may also be important to provide higher quality amenities at bus stops, including more or larger bus shelters to accommodate higher demand.

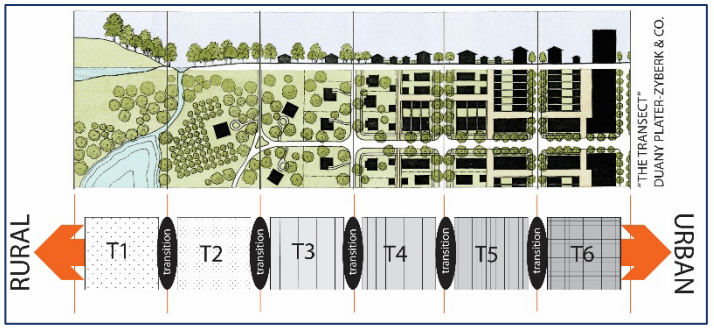
Transect zones also influence design speeds. Design speeds on corridors in more intense transect zones will likely need to be on the lower end of the range of acceptable design speeds because these are areas with the highest amount of pedestrian and non-motorized activity. These areas also have more activity in the curb space, and land uses and access points are more closely spaced together. Design speeds on corridors in less intense transect zones may be in the middle or higher end of the range of acceptable design speeds because land use activity is not as intense and non-motorized users are less frequent.

A project corridor may pass through more than one transect zone along its length. There may be segments of a project corridor where there are two different transect zones on either side of the street. The transect zones identified in the Transect Zone map in Chapter 4 are shown in a hexagonal grid and represent a generalized indication of density for a consistent geometry across the entire city. The Transect Zone map in Chapter 4 should be examined to inform the project team of the general land use intensity. The project team should select one or more Transect Zones for the project corridor using this map as a starting point. The individual break points may be adjusted based on more detailed local knowledge and using professional judgment.

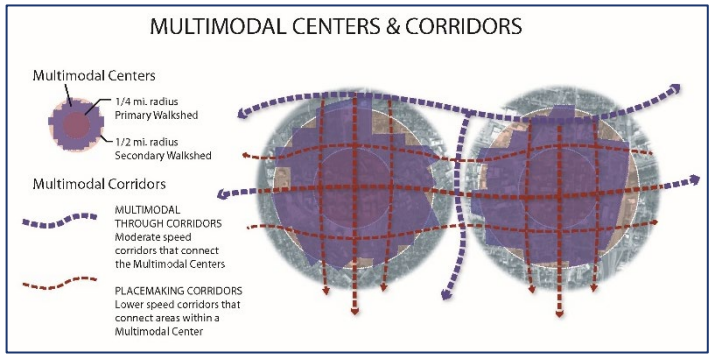
Multimodal Corridor Types

As explained in Chapter 4, there are five types of Multimodal Corridors based on the function and character of a street. Every street in Norfolk, with the exception of interstates and other limited-access highways where non-motorized modes are prohibited, has been assigned a Multimodal Corridor type that reflects the envisioned role of that street within the broader multimodal transportation system.

Chapter 4 defines a specific function for each Multimodal Corridor type. Projects on all Multimodal Corridors should be designed in consideration of that Multimodal corridor type.



Transect Zones. The Transect describes the range of natural and built environments across a spectrum of density. Places can be classified into one of the six different Transect Zones or "T-Zones" depending on the density or intensity of the land uses in an area. Image source: DRPT Multimodal System Design Guidelines



Multimodal Through and Placemaking Corridors. The diagram distinguishes Placemaking Corridors from Multimodal Through Corridors – the two general categories of Multimodal Corridors that together comprise a true multimodal transportation system in a region. Image source: DRPT Multimodal System Design Guidelines

The Multimodal Corridor type can influence many different aspects of design, including total multimodal capacity, design speed, number of travel lanes, medians, on-street parking widths, and sidewalk and amenity zone widths.

The Corridor Matrix, which is explained later in Chapter 7, guides the selection of dimensions for each corridor element, and it is organized by Multimodal Corridor type.

Modal Emphasis

As explained in Chapter 4, Multimodal Corridors can have any combination of the three Modal Emphases – Pedestrian, Bicycle/Scooter, and Transit. General design principles for each Modal Emphasis are provided below. Additional guidance for Bicycle/Scooter Modal Emphasis and Transit Modal Emphasis is provided in Chapter 7. Design considerations for pedestrian crossings are provided in Appendix E.

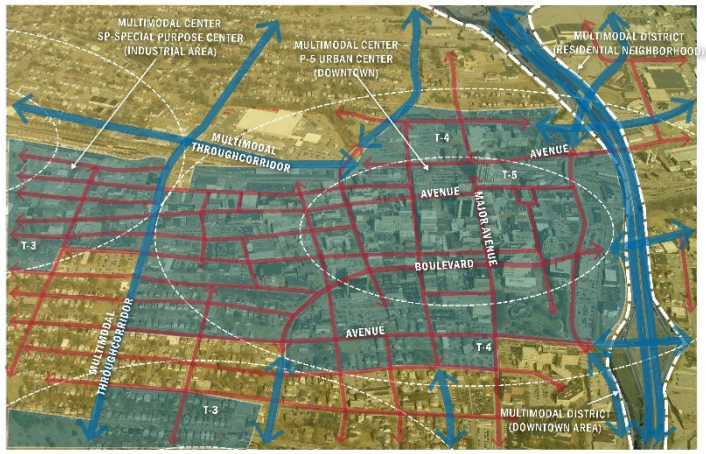
General Design Principles for Pedestrian Modal Emphasis

As described in Chapter 4, the majority of streets in the city have been proposed to have Pedestrian Modal Emphasis. This modal emphasis relates to preferred design standards and dimensions in the Corridor Matrix.

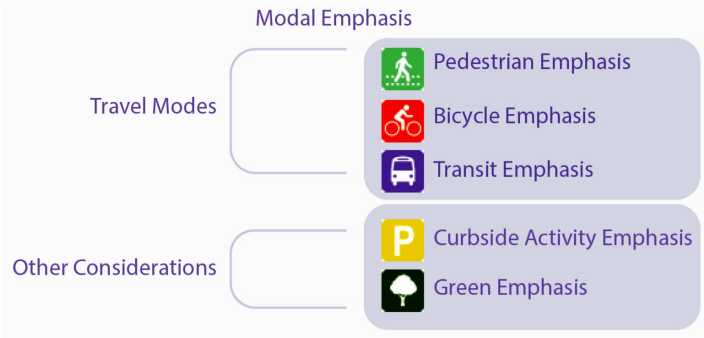
As explained later in Chapter 7, the Corridor Matrix provides optimal and minimum dimensions for each corridor element. The optimal dimensions are used for those modes that are emphasized and the minimal dimensions are used for those modes that are not emphasized.

For Pedestrian Modal Emphasis, the sidewalk through element is the most important one.

The optimal dimensions for the sidewalk through element should be used on streets with Pedestrian Modal Emphasis. Other corridor elements that are related to Pedestrian Modal Emphasis are the amenity element and the building frontage element. On corridors with available right-of-way, these elements should also use optimal dimensions to the degree practicable. The sidewalk through, amenity, and building frontage elements of a multimodal corridor cross-section are illustrated previously in Figure 6-1.



Downtown Roanoke, VA. The superimposed Multimodal Districts, Multimodal Centers and Multimodal Corridors show how a Multimodal System Plan could be applied to this downtown area. Image Source: DRPT Multimodal System Design Guidelines



Travel Modes and Other Considerations for Modal Emphasis in Corridor Cross-Section Design. Image source: DRPT Multimodal System Design Guidelines

General Design Principles for Bicycle/Scooter Modal Emphasis

The selection and design of a facility for bicyclists and scooter riders primarily depends upon traffic volumes, traffic speeds, and available right-of-way. Corridors with Bicycle/Scooter Modal Emphasis are critical connections for bicyclists and scooter riders.

The design considerations for Bicycle/Scooter Modal Emphasis provided later in Chapter 7 provide recommendations for identifying the preferred design approach - based on traffic volume and speed - that is designed for the "Interested but Concerned" type of bicyclist. Norfolk's bicycle network vision in Chapter 5 reinforces the intention to design the city's bicycle network for this type of bicyclist.

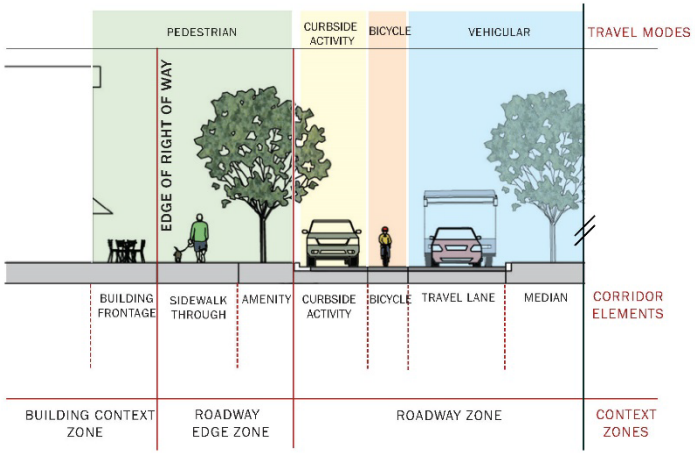
Wherever possible, the preferred design approach for corridors with Bicycle/Scooter Modal Emphasis should follow the guidance for facility selection specified in Step 2b to provide a low-stress facility that serves bicyclists of all ages and abilities.

If it is not possible to provide the preferred design approach due to constraints of site conditions, funding or safety issues, a next best facility should be identified as well as a parallel route that would serve the same trip as much as possible and provide a low-stress option. This parallel route may be less direct but will accommodate the "Interested by Concerned" types of bicyclists who are unlikely to ride a bike if low-stress routes are unavailable.

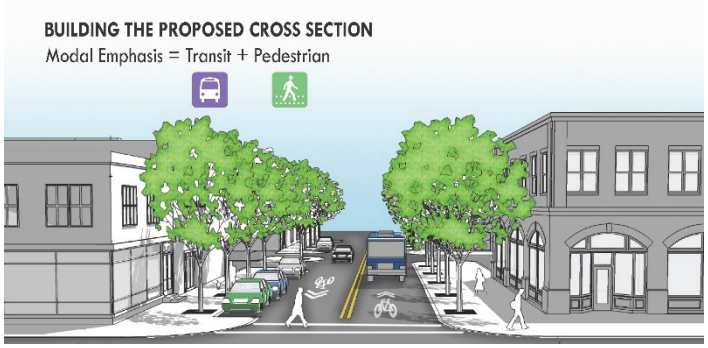
General Design Principles for Transit Modal Emphasis

As explained in Chapter 4, the Transit Modal Emphasis map identifies a network of the most critical transit connections and streets with the highest potential for generating transit trips.

The biggest design decision on corridors with Transit Modal Emphasis is whether a dedicated lane for transit is needed. In general, the design of corridors with Transit Modal Emphasis should follow the design considerations guidance in Chapter 7. If it is determined that a dedicated transit lane is not feasible, the outside travel lane should be optimized to 12 feet wide, to the extent feasible, to provide optimal lane width for bus operations.



Multimodal Corridors are divided into Context Zones. Each element of the corridor relates to a Travel Mode. Image source: DRPT Multimodal System Design Guidelines



Using Modal Emphasis to build a typical roadway cross section. Image source: DRPT Multimodal System Design Guidelines

This chapter has provided an overview of the Multimodal Project Design Framework and explained how the different components of the multimodal system plan define the multimodal context for corridor design. The next chapter focuses in on the design approaches and design considerations for each mode.

Chapter 7: Multimodal Project Design – Approaches for Different Modes

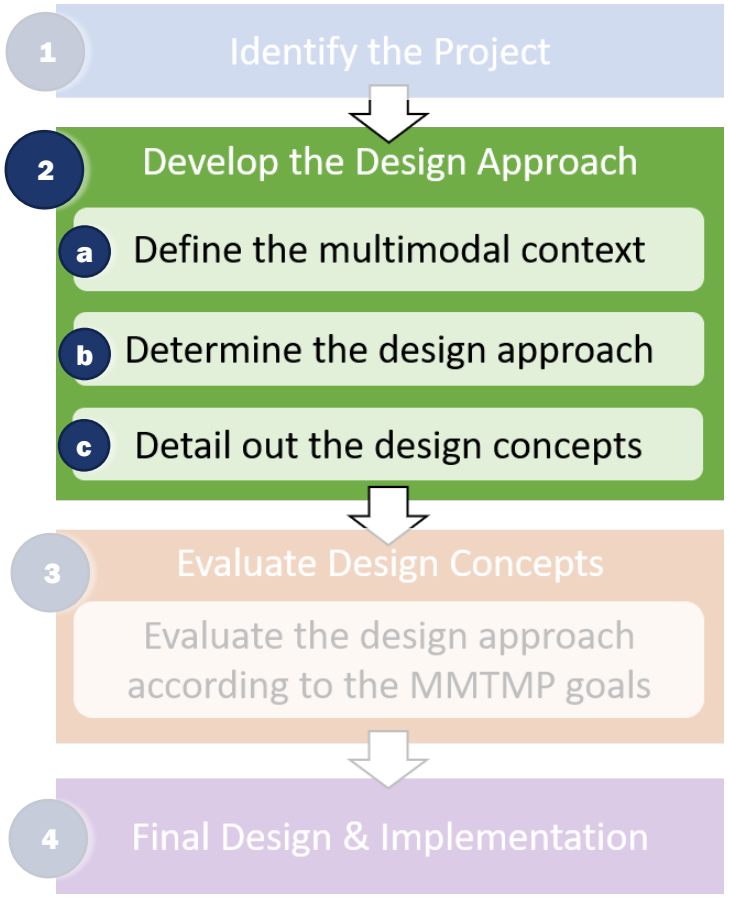
This chapter continues exploring the Multimodal Project Design Framework, focusing specifically on Step 2b: *Determining the Design Approach* and Step 2c: *Detailing Out the Design Concepts*. It provides specific guidance and considerations for bicyclist, scooter, and transit modes. It also provides an example of how to use the Multimodal Project Design Framework on a hypothetical multimodal corridor.

Step 2b: Determining the Design Approach

After the multimodal context has been defined, the next step is to determine the design approach – the way in which each mode will be accommodated within the street. The design approach is heavily dependent upon the Modal Emphasis of the corridor and also depends on a variety of other factors.

This section focuses on types of facilities for bicyclist/scooter and transit modes. It defines the various types of facilities that may be appropriate in different circumstances for potential design approaches. It also provides design considerations for each potential design approach. The following sections are organized by the possible combinations of Bicycle/Scooter Modal Emphasis, Transit Modal Emphasis, and both.

The Multimodal Project Design Framework



Steps 2b and 2c of the Multimodal Project Design Framework are the focus of this chapter.

Design Approaches for Corridors with Bicycle/Scooter Modal Emphasis

The preferred bicycle facility for a corridor with Bicycle/Scooter Modal Emphasis is largely determined by the speed and volume of vehicles on the corridor. As the speed and volume of traffic increases, so does the need for physical separation between bicycle riders and vehicles.

There are three design approaches to accommodating bicycle riders on Norfolk's streets.

- Shared Lanes
- Conventional Bicycle Lanes
- Separated Bicycle Lanes

Shared Lanes

Shared lanes describe a configuration where bicycle riders share a general vehicle travel lane with motorized vehicles. This configuration may be the preferred approach on low-speed, low-volume streets. Some shared lanes can be considered "bicycle boulevards," where treatments such as shared lane pavement markings (aka sharrows), wayfinding signs, and traffic calming features are implemented to prioritize bicycle travel.[i] Generally, shared lanes have the lowest comfort at higher vehicle speeds and volumes, but they require the least amount of space within the corridor cross-section.

Conventional Bicycle Lanes

A conventional bike lane is a dedicated lane separated from the general vehicle travel lane by paint. Sometimes, additional striping provides a buffer between the travel lane and the bike lane. This is called a "buffered bicycle lane" and is considered a conventional bike lane. Conventional bicycle lanes more clearly require motorists to yield to bicyclists and have a higher level of forgiveness than shared lanes, but conflicts may occur anywhere within the facility because of the lack of a vertical separation element.

Separated Bicycle Lanes

A separated bicycle lane is one that is separated from vehicular traffic by a vertical separation element, which may include curbs, planters, bollards, flexible delineators, or parked cars. A separated bike lane can be located on the street or entirely outside of the roadway.



A shared lane design approach is where bicyclists share a lane with motorized vehicles. Shared lanes may have shared lane markings, also called "sharrows." Shared lane markings are not considered to be a bicycle facility; they are a pavement marking. Austin, TX. Image Source: NACTO



A conventional bicycle lane is a bicycle lane that is not vertically separated from vehicle travel lanes. Conventional bicycle lanes may be directly adjacent to the vehicle travel lane or may have a painted buffer. Fairfax, CA. Image Source: NACTO



Separated bicycle lanes are separated from vehicle travel lanes by vertical elements such as curbs, planters, bollards, flexible delineators, or parked cars. New York City, NY. Image Source: NACTO

Separated bicycle lanes reduce the potential for sideswipe, overtaking, and hit-from-behind crash types. They provide higher levels of safety and comfort than conventional bicycle lanes and increase predictability by constraining the location of conflict points.

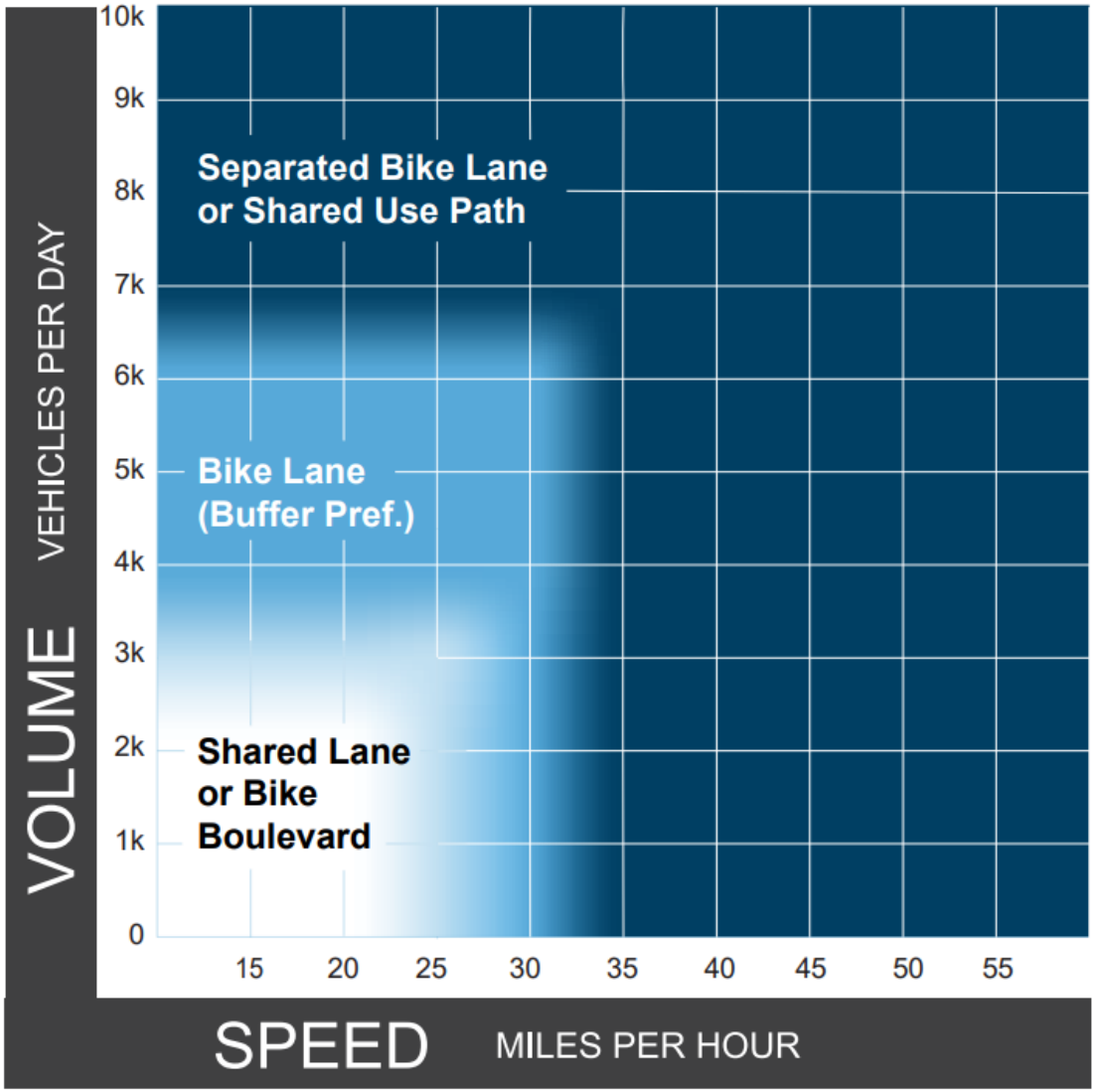
Considerations for Choosing a Design Approach for Bicycle/Scooter Modal Emphasis

The Federal Highway Administration published its *Bikeway Selection Guide* in 2019, and it further defines and compares these types of bicycle design approaches.

The FHWA Bikeway Selection Guide provides guidance for identifying the preferred design approach that meets the safety and comfort needs of the "Interested but Concerned" bicyclist type, as shown **Figure 7-1**. Generally, the higher the speed and volume of a road, the more protective the preferred design approach.

The following paragraphs describe the federal guidance, which is based on a comprehensive literature review and recent safety studies. However, this is guidance for the optimal treatment not considering existing site conditions. It is important to recognize that Norfolk's rights of way are frequently constrained, and implementing this guidance on many of Norfolk's streets will require lane repurposing or road and building reconfigurations to acquire additional right-of-way.

FIGURE 7-1: FHWA GUIDANCE FOR PREFERRED BIKEWAY TYPES FOR URBAN, URBAN CORE, SUBURBAN, AND RURAL TOWN CONTEXTS

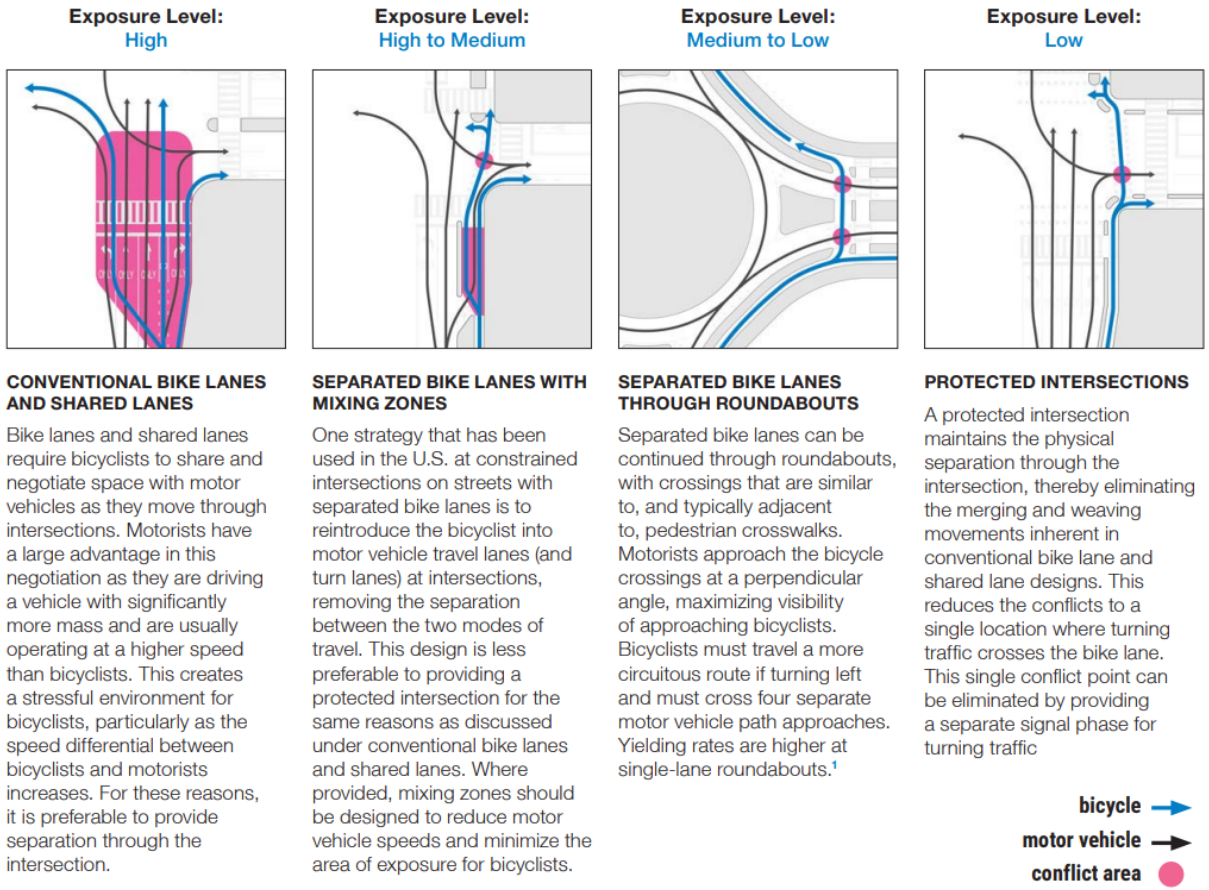


This reference chart from the Federal Highway Administration's 2019 Bikeway Selection Guide shows the optimal design approaches that meet the safety and comfort needs of the "Interested but Concerned" type of bicyclist, depending on traffic speed and volume. Norfolk's constrained rights-of-way and built out conditions will often make achieving these design approaches extremely difficult. However, when new streets are being planned, there may be an opportunity to implement these optimal approaches more fully. Image Source: FHWA

Assessing these types of approaches, particularly for converting travel lanes, is discussed in greater detail in Chapter 8: Multimodal Project Evaluation.

The FHWA guidance reflects the types of facilities that have been shown to best meet the safety and comfort needs of the majority of bicyclists. If the best approach is not feasible due to site conditions, the section below describes how to identify the next best option, which may be a higher-stress facility that serves only the "Highly Confident" bicyclist types or may be an alternate route. These are often tough choices with hard tradeoffs. The following guidance is intended to inform a discussion about these tradeoffs, recognizing that there are often no easy solutions.

Shared lanes can be a positive and affordable solution when designed correctly and used in the correct context.[ii] Shared lanes are most appropriate on roadways where the difference between bicyclist and motorist travel speeds is very low.[iii] Generally, shared lanes are considered the preferred design approach on local streets with operating speeds less than 25 mph and traffic volumes are less than 3,000 vehicles per day. Injury and fatality crash risks rise sharply for vulnerable users when motor vehicle speeds exceed 25 mph.[iv]



Intersections are points in the bicycle network where bicyclists are most vulnerable. Bicycle lanes that convert back to shared lanes at intersections provide little if any safety benefits. Separated bike lanes with mixing zones and through roundabouts provide moderate levels of protection. Fully protected intersections offer the highest level of safety for bicyclists and scooter riders. Image Source: MassDOT Separated Bike Lane Planning & Design Guide

However, shared lanes may be appropriate on streets with speed limits up to and including 35 mph[v] for the "Somewhat Confident" and "Highly Confident" types of bicyclists. The FHWA Bikeway Selection Guide indicates as motorized traffic volumes increase above 6,000 vehicles per day, it becomes increasingly difficult for motorists and bicyclists to share roadway space.

Shared lanes typically require no additional width within the corridor cross-section. In fact, providing wide outside curb lanes are generally not recommended, as research has shown they result in decreased bicyclist

safety and are associated with higher rates of wrong-way bicycling.[vi]

Conventional bicycle lanes, including buffered bicycle lanes, generally improve bicyclist safety, but there are different factors that can influence the degree to which they reduce crashes.[vii] Bicyclists are most vulnerable at intersections. The majority of conflicts and crashes in urban areas between bicyclists and motorists are related to motor vehicle turning at intersections.[viii] Bicycle lanes that transition back to shared lanes at intersections provide little if any safety benefits at these most vulnerable points within the bicycle network. Conventional bicycle lanes with a buffer are the preferred design approach for corridors with Bicycle/Scooter Modal Emphasis whose posted speeds are between 25 and 35 mph and traffic volumes are between 3,000 and 7,000 vehicles per day.

On roadways where traffic volumes exceed 7,000 vehicles per day or where posted speeds exceed 35 mph, the preferred design approach is a vertically separated bicycle lane to accommodate the safety and comfort needs of the "Interested but Concerned" type of bicyclist.

For example, a bicyclist traveling at 10 mph on a roadway with 10,000 vehicles per day will be passed by a motor vehicle during the peak period once every four seconds, which is far too frequent for most bicyclists to feel comfortable.[ix]

Conventional bicycle lanes on streets with traffic volumes above 7,000 vehicles per day or speeds greater than 35 mph will serve the "Highly Confident" and "Somewhat Confident" types of bicyclists, but networks consisting of only non-separated bicycle facilities only have bicycle mode shares of 2 to 3 percent in the United States. Low-stress networks that provide separated facilities on these higher volume and higher speed streets are associated with bicycling rates of 5 to 15 percent in the U.S.[x]

*Federal guidance on an optimal design approach for accommodating bicyclists is outlined in **Figure 7-1**. The preferred design approaches in this chart are designed to meet the safety and comfort needs of most bicyclists and provide facilities for bicyclists of all ages and abilities.*

When the Preferred Design Approach is Infeasible

When the preferred design approach outlined in the chart in **Figure 1** is be infeasible due to right-of-way or other constraints, a *next best facility* should be identified, as well as a parallel route that would serve the same trip and provide a low-stress option.

For example, if a separated bike lane or shared use path is the preferred design approach based on traffic speeds and volumes, but this configuration is not feasible, then buffered bike lanes should be considered the next best option. The next best option may still be an appropriate solution to accommodate the safety and comfort needs of the "Highly Confident" and "Somewhat Confident" bicyclists directly on the project corridor.

As explained later in this chapter, one option for corridors with both Bicycle/Scooter and Transit Modal Emphasis may be to provide a shared multimodal lane where buses, bicyclists, and scooters can operate in the same lane, where car and truck traffic is prohibited.

In some cases. where the preferred design approach is not feasible, it is important to designate a *parallel route* that may be less direct than the accommodation directly on the project corridor but offers a more comfortable and safe facility.

It should be noted that even the provision of a next best option or the designation of a parallel route may prove infeasible in the near- and mid-term. When planning for bicycle improvements in the near- or mid-term, it is important to remember that this Master Plan and associated maps portray the long-term vision of connectivity, and it may take numerous incremental improvements to achieve the long-term vision.

Design Approaches for Corridors with Transit Modal Emphasis

Facility selection for corridors with Transit Modal Emphasis is driven by bus performance and traffic conditions on the corridors. In general, corridors where high traffic congestion or other friction factors cause slow bus speeds or unreliable bus travel times may need dedicated bus facilities. On the other hand, streets where traffic patterns result in low or consistent delays can likely accommodate buses in general travel lanes.

There are three design approaches to accommodating buses on corridors with Transit Modal Emphasis.

- General Travel Lanes
- Targeted Transit-Priority Elements
- Dedicated Transit Lanes

General Travel Lanes

The most common bus facility is a general-purpose travel lane where buses drive in the same lane as other vehicles. On streets where buses operate in the general travel lane, bus performance depends on the traffic conditions of the street.

Targeted Transit-Priority Elements

Under this approach, bus-priority interventions are targeted at points along a corridor to speed up buses. Transit Signal Priority (TSP) is one type of intervention often used in this approach. TSP allows traffic signals to detect approaching buses and change their timing so that buses move through intersections faster. Another type of intervention in this category is bus queue jumps. Queue jumps are installed at intersection approaches and allow buses to bypass the line of cars waiting at the intersection. Targeted transit-priority elements can significantly improve transit performance without making major corridor-long changes to a street.

Dedicated Transit Lanes

Buses can be given their own lane so that they are totally separated from traffic along the entire corridor. This approach gives the biggest boost to bus performance, but it also has the highest impact on other modes. There are several bus lane design options available, including curbside, offset (to the left of the parking lane), center-running (along a median), and a full transit-only street.



Queue jumps and transit signal priority are two types of targeted transit priority elements that can be implemented at high congestion spots along a corridor. Queens, New York. Image Source: NYCDOT



Dedicated transit lanes provide a separate lane for buses throughout an entire corridor. This approach gives the biggest boost to bus performance, but requires the most space within the cross-section. Washington, D.C.. Image Source: NACTO

Considerations for Choosing a Design Approach for Transit Modal Emphasis

Dedicated transit lanes provide for the most reliable transit operations, since buses are completely separate from vehicle traffic. However, they require an entire lane in the cross-section, which may be difficult to achieve. They may not be necessary on roads where there are few bus routes or where bus routes run infrequently.

Conversely, buses in shared lanes with traffic require no or minimal additional space within the cross-section. However, buses in shared lanes will get stuck in traffic, which on roads with heavy congestion can produce unreliable bus travel times.

Bus performance is one key factor to determining the preferred design approach for a corridor with transit modal emphasis. The frequency of buses and the space available within the cross-section are other important factors. **Table 7-1** outlines the design considerations for choosing a preferred design approach for corridors with transit modal emphasis.

There is considerable overlap between the design considerations, and this is intentional. There are often many other factors in circumstances that need to be considered, such as funding constraints, timeframe, and other demands on roadway space that will influence the selection of the preferred design approach.

TABLE 7-1: DESIGN CONSIDERATIONS FOR TRANSIT MODAL EMPHASIS

		Design Considerations		
		Frequency of Buses	Performance of Buses	Impact to Roadway
Design Approach	General Travel Lanes	Appropriate where bus frequency is low (no more than 1 bus every 15 minutes).	Appropriate where buses operate with minimal delays and have reliable travel times.	No additional lanes needed. Buses operate in general travel lane.
	Targeted Transit Priority Elements	Appropriate where bus frequency is moderate or high.	Appropriate to address delays in specific areas.	Additional lane may be needed at intersections.
	Dedicated Transit Lanes	Appropriate where bus frequency is high (at least 1 bus every 15 minutes).	Appropriate where there are corridor-long delays or unreliable travel times.	Additional lane needed for entire length of the corridor.

When choosing a design approach for corridors with transit modal emphasis, it is important to consider the frequency of buses, bus performance, and the impact to the roadway.

Design Approaches for Corridors with Bicycle/Scooter Modal Emphasis and Transit Modal Emphasis

Some corridors in Norfolk are designated with both Bicycle/Scooter and Transit Modal Emphasis. To determine the preferred design approach on these corridors, you would first determine the preferred design approach for each mode separately.

You may determine that the preferred design for the bicycle/scooter modes is a separated bicycle lane and the preferred design for the transit mode is a dedicated transit lane. However, two separate facilities for bicycle/scooter and transit modes may not be necessary, or right-of-way constraints may make providing two separate facilities infeasible.

There are two potential design approaches in this circumstance, each with distinct considerations:

- Combined Bus and Bicycle Lane
- Separate Bus and Bicycle Lanes

Combined Bus and Bicycle Lane

A shared bus-bicycle lane (also called a "multimodal lane") is a single lane that is dedicated to only buses, bicycles, and scooters. Private vehicles like cars and trucks are typically not permitted in this lane, except for right turns at intersections in some configurations. The shared bus-bike lane provides an improvement in bus travel time and separates bicycle and scooter riders from general traf fic. This approach is appropriate where bus frequency is not very high and where there is enough street width available for a wide bus-bicycle lane. If bicycle volumes are very high, bus performance will be reduced. If bus volumes are very high, the facility will not be as comfortable for bicycle riders. Several cities have implemented shared bus-bike lanes across the U.S. Careful design of bus stops and intersections is critical to minimizing conflicts between buses and bicyclists/scooter riders and this is discussed in the following section.

Separate Bus and Bicycle Lanes

This design approach provides two separate lanes - one dedicated to buses and another dedicated to bicyclists and scooter riders. This is the ideal design approach and is preferred where either bus or bicyclist/scooter rider volumes are high.



A combined lane for buses and bicyclists in Philadelphia, PA. Image Source: NACTO



Separate dedicated lanes for buses and bicyclists in New York City, NY. The dedicated bus lane is on the right side of the street. The dedicated bike lane is on the left. Image Source: NACTO

Considerations for Choosing a Design Approach for Bicycle/Scooter and Transit Modal Emphasis

The frequency of buses, speed of buses, and space available within the cross-section are three major considerations for determining which design approach is preferred and feasible. Table 7-2 outlines these considerations for both potential design approaches.

Separate bus and bicycle lanes may be the preferred design approach, but they require the most space within the corridor cross-section.

Generally, combined bus-bike lanes may be appropriate on corridors with few bus routes or where bus routes are infrequent and where bus speeds do not exceed 20 mph. When bus speeds exceed 20 mph or where buses are more frequent than 1 bus every 5 minutes, separate bus and bicycle lanes may be preferred.

The volume and demand of bicyclists and scooter riders is another consideration. Generally, combined bus and bicycle lanes work well when buses are infrequent, and bicyclist and scooter rider volumes are low. If buses become more frequent, the combined lane can begin to feel less comfortable for bicyclists and scooter riders. Conversely, if bicyclist and scooter rider volumes increase, the combined lane can work less efficiently for buses.

TABLE 7-2: DESIGN CONSIDERATIONS FOR CORRIDORS WHERE THE PREFERRED DESIGN APPROACH FOR BICYCLISTS/SCOOTER RIDERS IS A SEPARATED LANE AND THE PREFERRED DESIGN APPROACH FOR TRANSIT IS A DEDICATED TRANSIT LANE

		Design Considerations		
		Frequency of Buses	Speed of Buses	Impact to Roadway
Design Approach	Combined Bus and Bicycle Lane	Ideal where bus frequency is no more than 1 bus every 15 minutes. Potentially feasible where bus frequency is as often as 1 bus every 5 minutes.	Appropriate where bus speed is limited to 20 mph.	16-ft lane desired. Potentially feasible with a 12-ft lane.
	Separate Bus and Bicycle Lanes	Appropriate where bus frequency is more than 1 bus every 5 minutes.	Appropriate where bus speed is higher than 20 mph.	18.5-ft is the minimum width needed to accommodate a dedicated bus lane and a separated bike lane that do not share the same space. More width may be needed.

On corridors where the preferred design approach for bicyclists and scooter riders is a separated bicycle lane and the preferred design approach for transit is a dedicated transit lane, , examine the frequency of buses, speed of buses, and impact to the roadway to determine if bicycle/scooter and bus modes can share the same lane or if separate facilities are needed.

Considerations for Bus Stops Along Bicycle/Scooter Facilities

Regardless of whether dedicated facilities are provided for bicyclists or buses, conflicts between bicyclists and buses most often occur at bus stops and intersections. This is true even on streets where bicyclists, buses, and general traffic all share the same lane.

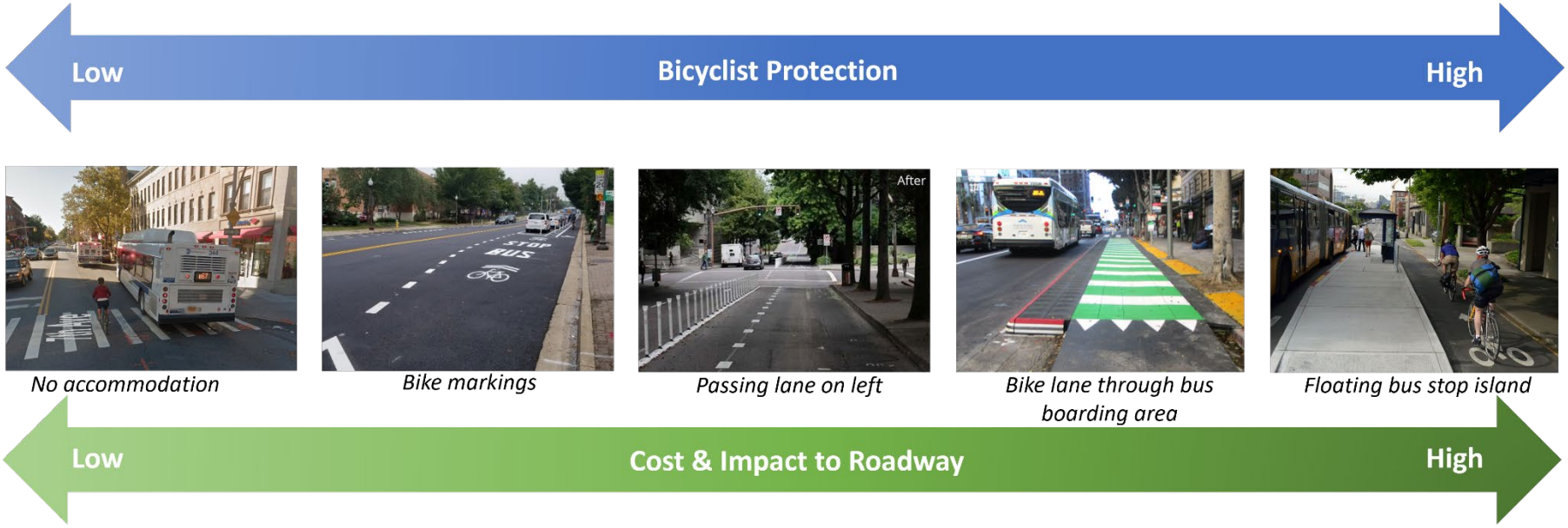
Bus stops can be designed to limit potential conflicts, and there are a variety of treatments available that provide a range of separation and protection, as shown in the figure below. These treatments can be applied to any design approach, whether dedicated facilities for either buses or bicyclists are provided along the length of the corridor.

The design approaches in the figure below range from simple configurations that provide little separation between the modes but require little if any additional space to complex designs that provide significant separation.

Generally, the lower the cost and space needed, the less the separation between bicyclist and bus conflicts.

Designs for intersections to maximize bicyclist protection are discussed under the Design Considerations for Bicyclist/Scooter Modal Emphasis section.

Design Approaches for Bus Stops Along Bicycle/Scooter Facilities



There are a variety of design approaches for bus stops along bicycle/scooter facilities that provide a range of separation between bicyclist and bus conflicts. Generally, the more separation provided, the more space is needed within the right-of-way and the higher the cost to implement.

Table 7-3 outlines several considerations for determining the preferred design approach for a bus stop along a bicycle/scooter facility.

A general rule of thumb is that the busier the bus stop and the higher the bicycle volumes, more separation is needed.

TABLE 7-3: DESIGN CONSIDERATIONS FOR BUS STOPS ALONG BICYCLE/SCOOTER FACILITIES

		Design Considerations			
		Bus Boardings and Alightings	Volume of Bicyclists and Scooter Riders	Impact to Bicyclists and Scooter Riders	Impact to Roadway
Design Approach	No accommodation	Appropriate where bus stop activity is low.	Appropriate where bike volume is low.	Provides minimal protection.	No additional lane width needed.
	Bike markings in bus stop	Appropriate where bus stop activity is low or moderate.	Appropriate where bike volume is low or moderate.	Provides minimal protection.	No additional lane width needed.
	Bike passing lane on the left	Appropriate where bus stop activity is moderate or high.	Appropriate where bike volume is moderate or high.	Provides some protection.	5 ft of additional lane width needed.
	Bike lane through bus boarding area	Appropriate where bus stop activity is moderate or high.	Appropriate where bike volume is moderate or high.	Provides high protection.	Additional width needed in the amenity or sidewalk element.
	Floating bus stop	Appropriate where bus stop activity is high.	Appropriate where bike volume is high.	Provides highest protection.	Additional roadway width needed to provide boarding island and bike lane.

This table outlines the design considerations for the various approaches for bus stop design along bicycle/scooter facilities.

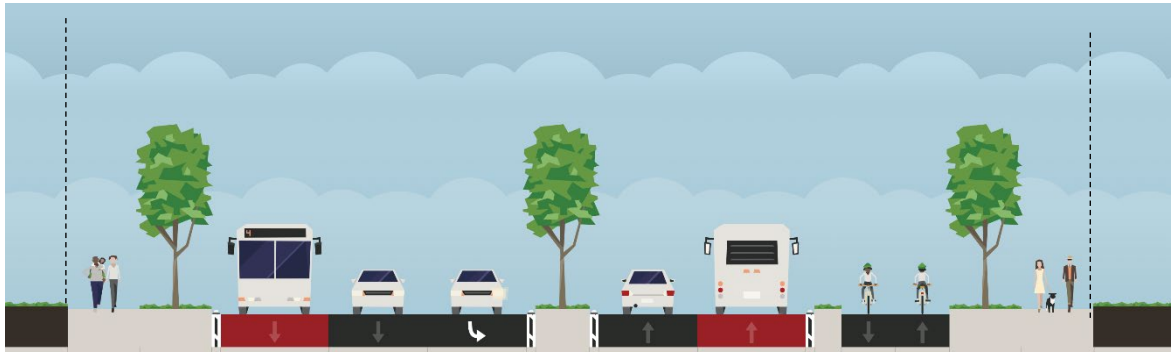
Wrap-Up on Step 2b: Determining the Design Approach

The previous sections have described a variety of design considerations for corridors with Bicycle/Scooter Modal Emphasis, Transit Modal Emphasis, and both that designers should consider in Step 2b: Determine the Design Approach.

The outcome of Step 2b is one or more preferred or desired design approaches for the corridor that spell out how each mode could be accommodated within the corridor cross-section, if feasible.

For example, one preferred design approach may be to provide dedicated transit lanes and a separated bicycle facility. This preferred design approach may require additional right-of-way and may be considered the long-term or vision design approach that could be feasible when an area redevelops. Another preferred design approach may be to provide a combined bus-bike lane without moving curbs by converting one general travel lane to a "multimodal lane." This preferred design approach may be considered a shorter-term design approach. Both preferred design approaches may be advanced into the next step.

This point in the process is a good time for another touchpoint with stakeholders and the public, especially when more than one design approach is being considered.



Several preferred design approaches may result from Step 2b: Determining the Design Approach. This illustration shows an example of a long-term or vision design approach for a multimodal corridor that requires additional right-of-way to provide dedicated bus lanes and separated bicycle facilities.



A less costly near-term preferred design approach may consist of restriping the lanes within the existing curbs to convert a general travel lane to a combined bus-bike lane.

The next step – Step 2c: Detailing Out the Design Approach – further fleshes out the design approaches into a design concept, which is described in the next section.

Step 2c: Detailing Out the Design Concept

After determining the preferred design approach, the next step is to detail out the design approach into a design concept with specific dimensions for each corridor element.

The design concept may be a corridor cross-section illustration with widths for each element within the cross-section, or it may be a plan view concept along a corridor including treatments for each segment and intersection.

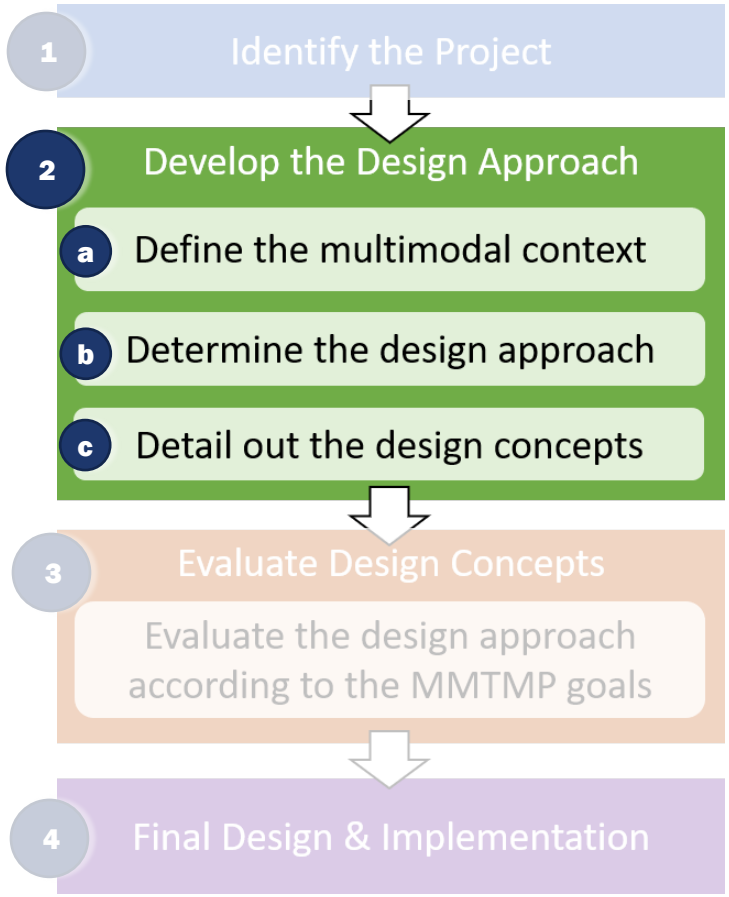
In this step, designers use the *Corridor Matrix* to determine the dimensions of each corridor element.

*The **Corridor Matrix** provides optimal and minimum standards for each Corridor Element.*

The design standards in the Corridor Matrix, provided in Appendix C, are shown as a range between two values – *optimal* and *minimum*. This range allows designers the flexibility to select a dimension for each corridor element anywhere within the range, depending on whether that corridor element should be optimized, minimized, or somewhere in between.

The Corridor Matrix comes from DRPT's Multimodal System Design Guidelines. The optimal and minimum values were developed based on the latest industry standard guidance from the American Association of State Highway Transportation Officials, the Congress for New Urbanism the Federal Highway Administration, the Institute for Transportation Engineers, and the National Association of City Transportation Officials. The Virginia Department of Transportation's (VDOT) Road Design Manual incorporates the Multimodal System Design Guidelines, including the Corridor Matrix and standards therein, by reference.

The Multimodal Project Design Framework



Steps 2b and 2c of the Multimodal Project Design Framework are the focus of this chapter.

The Corridor Matrix provides a range of dimensions for each Multimodal Corridor type and each Transect Zone. The Multimodal Corridor type and Transect Zone for the project corridor will have already been defined in prior steps in the corridor design framework.

The selection of a dimension for each corridor element will use the design considerations previously discussed in this chapter.

On corridors with Pedestrian Modal Emphasis, the sidewalk through element should be optimized as much as is feasible.

On corridors with Bicycle/Scooter Modal Emphasis, the preferred design approach should be consistent with the guidance for facility selection to provide a low-stress facility that serves bicyclists of all ages and abilities, and implemented if feasible. If not, the next best option should be considered, and a parallel route should be designated.

On corridors with Transit Modal Emphasis, the preferred design approach should provide a dedicated transit lane if needed and if feasible. If not, the outside travel lane width should be optimized for bus operations.

On corridors where it is not feasible to obtain the minimum dimension for one or more corridor elements, planners and designers should identify and assess opportunities and tradeoffs. These may include eliminating on-street parking or other curbside use, converting a general travel lane to another purpose, selecting a next best option for one or more

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Boulevard					
	Intensity ⇨	T-5		T-4		T-3	
⇩	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone						
A	BUILDING FRONTAGE ELEMENT	5 ft	3 ft	5 ft	2.5 ft	7 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear
	Typical building entry locations	front	front	front	front	front	front
	Roadway Edge Zone						
B	SIDEWALK THROUGH ELEMENT	10 ft	6 ft	8 ft	6 ft	6 ft	6 ft
C	AMENITY ELEMENT	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells	
	Roadway Zone						
D	CURBSIDE ACTIVITY ELEMENT						
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*						
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT						
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion	

The Corridor Matrix is a series of tables with optimal and minimum dimensions for each element within a corridor cross-section, according to the latest industry guidance. It is used to detail out a design concept with specific dimensions for each corridor element. The full Corridor Matrix is provided in Appendix C.

travel modes, redesignating one or more modal emphases to a less direct alternative route, and/or acknowledging that additional right-of-way is needed which will increase the project cost, likely extend the project timeline, and may encounter pushback from adjacent property owners. All of these options have benefits and disadvantages, and there are rarely any easy solutions.

However, the advantage of using the Multimodal Project Design Framework is that it informs these tough discussions and difficult decisions by putting the tradeoffs into the context of the larger multimodal transportation system.

The following section provides an example of how to use the Multimodal Project Design Framework on a hypothetical multimodal corridor.

Multimodal Corridor Design Example

In this hypothetical example, the project corridor is a four-lane minor arterial in a suburban employment center that serves 15,000 vehicles per day and has a 35-mph posted speed limit.

The existing corridor cross-section is shown in **Figure 7-2**. It consists of 88 feet from the back edge of each sidewalk, with individual corridor elements:

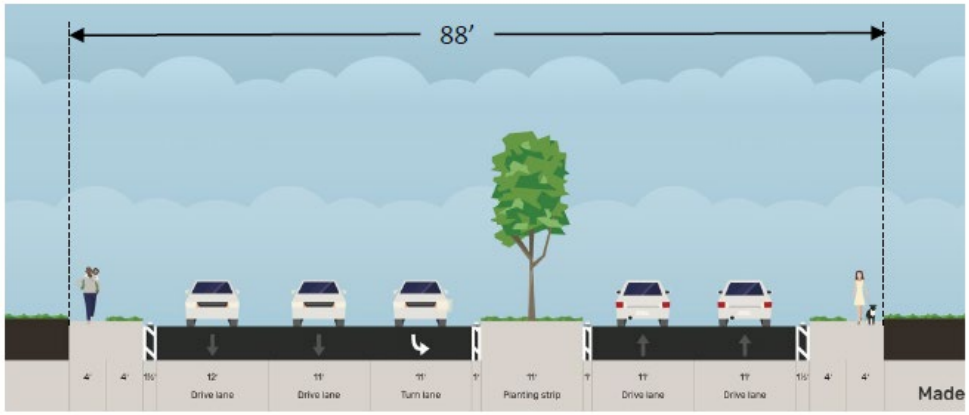
- 4-ft wide sidewalks on both sides
- 4-ft wide buffer/amenity element on both sides
- 1.5-ft wide curb and gutter on both sides
- One 12-ft wide outer southbound travel lane
- One 11-ft wide inner southbound travel lane
- Two 11-ft wide northbound travel lanes
- A 22-ft wide curbed median with 1-ft of pavement on either side that transitions at intersections to an 11-ft wide turn lane with an 11-ft wide median

Step 1: Identify the Project

There are two timeframes envisioned for this project corridor.

The near-term timeframe envisions making changes within the existing edges of curb that would align with the city's repaving schedule.

FIGURE 7-2: MULTIMODAL CORRIDOR DESIGN EXAMPLE – EXISTING CONFIGURATION



The existing configuration of the hypothetical example contains two general travel lanes in each direction, a wide median, and substandard sidewalks on each side.

The long-term timeframe envisions expansions beyond the curb and the possibility of acquiring additional right-of-way on one side where current building are set far back from the edge of the road. The long-term vision for this area involves large scale redevelopment that would increase both residential and non-residential densities.

Step 2: Develop the Design Approach

Step 2a: Define the Multimodal Context

The project corridor is a major spine through a future Multimodal Center, but the area context is generally suburban today. It lacks a connected grid with parallel streets.

In the Multimodal System Plan, the project corridor is identified as a future Boulevard. Boulevards are a type of Placemaking corridor that have the highest multimodal capacity to accommodate multiple motorized and non-motorized modes.

The Multimodal System Plan identifies this corridor as having Pedestrian, Bicycle/Scooter, and Transit Modal Emphasis. The Transect Zone is identified as T-4.

Because this corridor is designated with all three modal emphases, and there is a lack of connected parallel streets, it is a good example of how the limited right-of-way will be a challenge to accommodating all modes. However, we know from the Multimodal System Plan that this is a key corridor for all of these modes, and the tradeoffs will need to be assessed and weighed carefully.

Step 2b: Determine the Design Approach

The design approach spells out the way in which each mode will be accommodated within the street. This portion of the hypothetical example examines each mode individually at first.

Determining the Preferred Design Approach for Pedestrians

As explained in Chapter 4, pedestrian safety is the top priority for all Multimodal Corridors. The project corridor currently has 4-ft wide sidewalks, which are considered to be substandard.

The long-term timeframe envisions expansions beyond the curb. In the long-term timeframe, the preferred design approach will include optimizing the sidewalk width.

However, in the short-term timeframe, the current sidewalk is outside of the pavement between the curbs that would be included in the city's regular repaving schedule. Although the current sidewalk is substandard, it is provided continuously along both sides of the street.

Expanding the sidewalk width will not be considered within the project extents of the short-term timeframe. However, the design of the project will involve ensuring there are marked crosswalks at all signalized intersections, and the project team will perform an analysis of crosswalk frequency to determine if there are any segments where the distance between marked crossings exceeds 600 feet.

Determining the Preferred Design Approach for Bicyclists and Scooter Riders

Because of the project corridor's Bicycle/Scooter Modal Emphasis designation, we know that this corridor is a key connection for bicyclists and scooter riders, and that it is important to identify a preferred design approach that will provide a low-stress facility that serves bicyclists of all ages and abilities.

The project corridor serves 15,000 vehicles per day and has a posted speed limit of 35 mph. 15,000 vehicles per day is well above the 7,000 vehicles per day general threshold above which the preferred design approach is a vertically separated bicycle lane to meet the safety and comfort needs of all bicyclist types. A shared lane design approach on a roadway with this high volume of traffic would only accommodate only the most confident bicyclists.

The preferred design approach for bicyclists and scooter riders at this point in the process is a separated bicycle lane.

Determining the Preferred Design Approach for Transit

The project corridor has Transit Modal Emphasis, meaning it is a critical connection for transit and has a high potential for generating transit trips.

Current bus service on this corridor includes two routes, but at relatively low frequency. In the peak hour, the bus frequency is 1 to 2 buses every 15 minutes. However, it is envisioned that as this area redevelops, more frequent transit service will be provided in the future. It is also anticipated that with redevelopment, future demand will change. This corridor today experiences periods of low reliability in the morning and evening rush hours, which impacts bus on-time performance.

At this point in the process, the preferred design approach for transit is somewhat flexible. The low bus frequency indicates general travel lanes may be appropriate, but the disruption to bus travel time reliability and the anticipated need for high bus frequencies in the future indicate that targeted transit priority elements or dedicated bus lanes could be preferred, especially in the future.

Considering a Combined Bus and Bicycle Lane

Because there is relative flexibility in the preferred design approach for transit, the consideration of a combined bus and bicycle lane occurs in a somewhat iterative process, and it is explained in the following step.

Considerations for bus stops would also be preliminarily considered at this point in the process, but they are not included as part of this hypothetical example.

Step 2c: Detail Out the Design Approach

Although Steps 2b and 2c are explained discretely in this chapter, in practice they are applied in an iterative process of examining the available right-of-way, identifying the

optimal and minimum dimensions for each corridor element, trying out various combinations of corridor element dimensions, and weighing the tradeoffs.

Detailing Out the Design Concept for the Short-Term Timeframe

In this hypothetical example, the constraints of the short-term timeframe present only a few options for reconfiguring the pavement within the existing curbs. Again, note this is a hypothetical example, and the tradeoffs explained here may not apply in all situations.

One option that may have been identified preliminarily would be to narrow each lane to 10-ft wide to provide an on-street bicycle lane. However, this would only provide at most six feet of width – enough for a conventional non-buffered bicycle lane on one side of the street, and that still would require modifications to the median, which is not a part of the short-term project scope.

Removing the turn lane is not considered an option because it alternates throughout the corridor, and the turn lane is critical for avoiding gridlock at the traffic signals, and again, would require modifications to the median.

The project team quickly realizes providing any bicycle accommodation beyond a shared lane will require converting one of the two general travel lanes in each direction to a facility that provides dedicated space for bicyclists without mixing with general traffic.

At this point, a traffic study would typically be conducted, but as explained in Chapter 7, the third step in the Multimodal Project Design Process proposes to modify the traditional traffic engineering evaluation to focus on how well a potential design concept will meet the city's vision and goals for multimodal transportation, not just how much a design concept will increase vehicular delay or worsen vehicular level of service.

After discussing the tradeoffs, the project team may decide in this hypothetical example that because the project corridor serves a critical connection for bicyclists and scooters, it is most important to provide a dedicated facility for bicyclists and scooter riders, and the city may be willing to accept increased vehicular delays, which would occur at select pinch points on the project corridor.

The project team at this point decides to move forward with a preferred design approach of a dedicated bicycle facility, but it is important to note that the resulting design concept and tradeoffs would be shared with stakeholders and the public as part of the public process in the subsequent phases of the Multimodal Project Design Framework.

The project team consults the Corridor Matrix and sees that the optimal width of 10 ft for a one-way separated bike lane is possible to achieve on both sides of the street with the repurposing of the outer general travel lanes.

Because the preferred design approach for the short-term timeframe now consists of only one general travel lane in each direction, the project team revisits the design considerations for the preferred approach for transit. The additional vehicular delay will further worsen bus on-time performance if buses continue to operate in the remaining general travel lane.

The low bus frequency of 1 to 2 buses every 15 minutes in the peak period is consistent with the design considerations for a combine bus and bicycle lane, and bus speeds along the project corridor are below 20 mph because of the frequency of bus stops and intersections.

The project team now examines the feasibility of lane width. Unfortunately, the 16-ft desired lane width is not feasible within the existing curbs. However, the project team determines it is possible to achieve 12-ft widths for the combined bus-bike lanes on both sides of the street. This will require narrowing the remaining northbound general travel lane from 11-ft to 10-ft wide.

The resulting preferred design concept for the short-term timeframe is shown in **Figure 7-3**. It consists of:

- One 12-ft wide combined bus-bike lane on both sides of the street
- One 11-ft wide southbound general travel lane

- One 10-ft wide northbound general travel lane
- The median, turn lane, sidewalks, and buffer/amenity elements remain the same as in the existing configuration.

Detailing Out the Design Concept for the Long-Term Timeframe

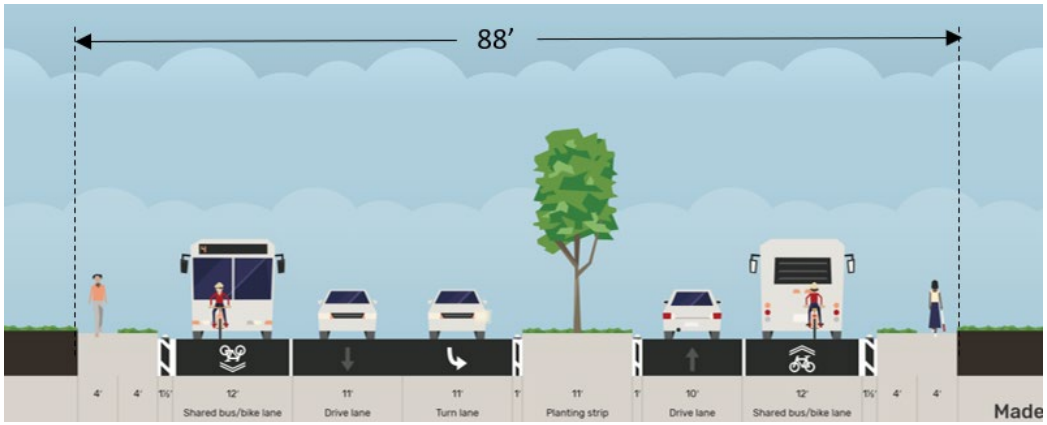
As explained previously, the long-term timeframe anticipates large scale redevelopment of the area and possible expansion of the roadway on the right side where current buildings are set far back from the edge of the road.

With the proposed expansion of the corridor width and the ability to modify the elements beyond just the pavement, the design concept for the long-term timeframe, shown in **Figure 7-4**, expands the sidewalk width to the optimal dimension of 8-ft wide for a T-4 Boulevard. It also expands the amenity element to 8-ft wide, which provides additional opportunities for tree planting or other green amenities.

Some of the width of the median is transferred to a two-way separated bicycle facility on the right side.

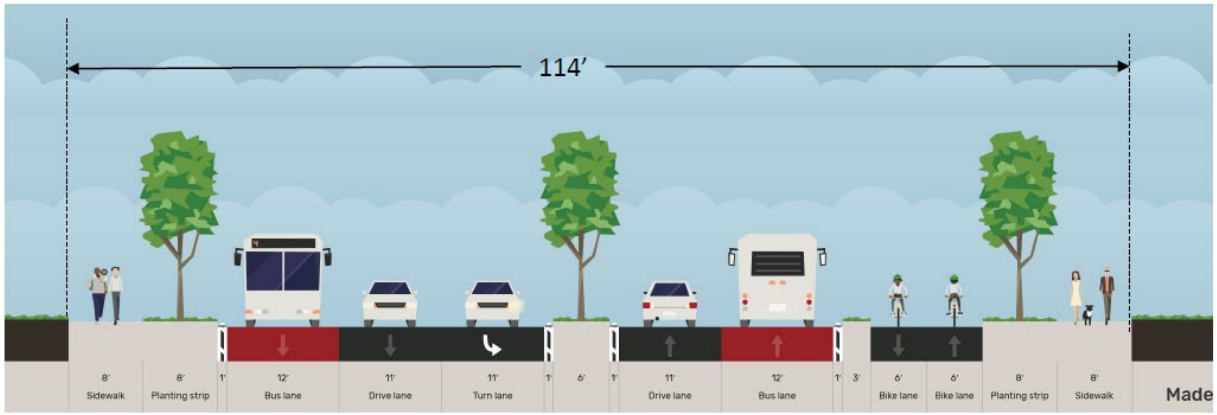
In this design concept, the dedicated bus lane remains on both sides of the street in anticipation of more frequent bus service in the future. This is consistent with the Boulevard's function of providing the highest multimodal capacity. However, flexibility may remain in this long-term design concept, such

FIGURE 7-3: MULTIMODAL CORRIDOR DESIGN EXAMPLE – SHORT-TERM DESIGN CONCEPT



The design concept for the short-term timeframe changes the configuration of the pavement within the existing curbs to provide a combined bus-bike lane on both sides of the street, demonstrating a reconfiguration possible within the general resurfacing and repainting maintenance schedule, without reconstructing curbs..

FIGURE 7-4: MULTIMODAL CORRIDOR DESIGN EXAMPLE – LONG-TERM DESIGN CONCEPT



The design concept for the long-term timeframe assumes large scale redevelopment and expands cross-section beyond the existing curbs to provide separate dedicated transit lanes and a two-way separated bicycle facility. It also expands the sidewalk width to the optimal dimension and expands the width of the amenity zone to allow for tree planting.

that if this configuration were to be constructed, but bus frequency were not yet increased, this design concept could be tweaked to show the bus lane operating as a shared lane for buses and general traffic.

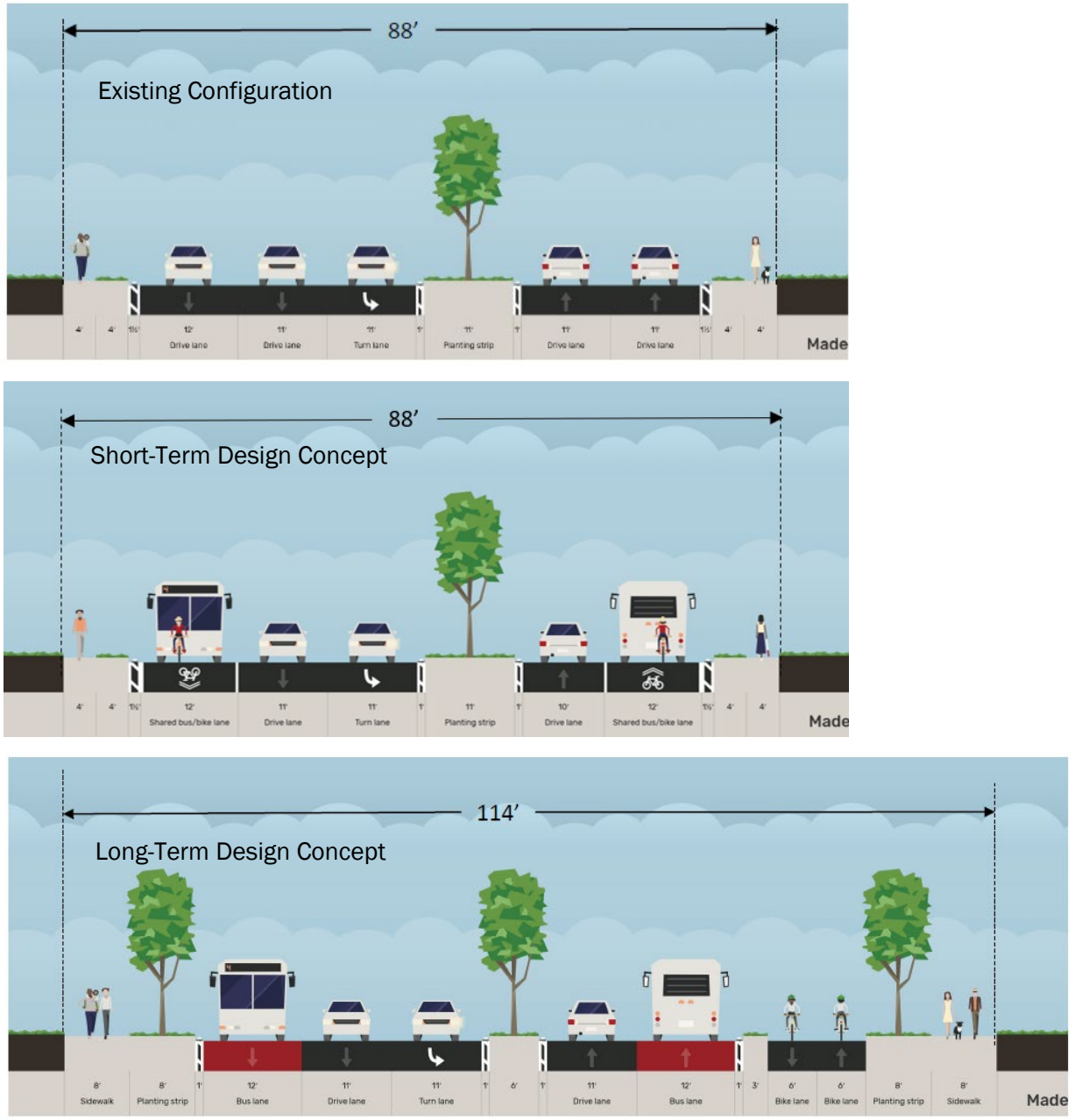
Next Steps

The outcome of this second step in the Multimodal Project Design Framework is shown altogether in **Figure 7-5**.

This second step resulted in two design concepts – one for the near-term timeframe that is constrained within the existing curbs, and another for the long-term timeframe that expands beyond the existing right-of-way.

The two resulting design concepts are now ready to be advanced to Step 3: *Evaluate Design Concepts*. This third step of the Multimodal Project Design Framework is described in Chapter 8.

FIGURE 7-5: MULTIMODAL CORRIDOR DESIGN EXAMPLE – DESIGN CONCEPTS SHOWN TOGETHER



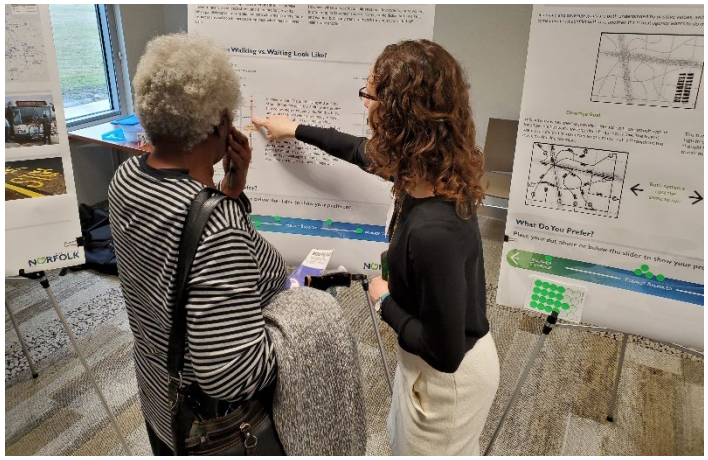
The outcome of the second step of the Multimodal Project Design Framework is one or more design concepts with specific dimensions for each element in the corridor cross-section.

[i] Definitions of bikeway facility types are based on the FHWA 2019 Bikeway Selection Guide.
[ii] FHWA, 2019. *Bikeway Selection Guide.*
[iii] NACTO *Urban Bikeway Design Guide. https://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/shared-lane-markings*
[iv] USDOT Literature Review on Vehicle Travel Speeds and Pedestrian Injuries, 1999.
[v] The Manual on Uniform Traffic Control Devices suggests shared lane markings be restricted to roadways with operating speeds of 35 mph or less. The NACTO Urban Bikeway Design Guide provides similar guidance that shared lane markings are generally not appropriate on streets with a speed limit above 35 mph.
[vi] FHWA, 2019. *Bikeway Selection Guide.*
[vii] FHWA, 2019. *Bikeway Selection Guide.*
[viii] Massachusetts Department of Transportation, 2015. *Separated Bike Lane Planning and Design Guide*. https://www.mass.gov/lists/separated-bike-lane-planning-design-guide.
[ix] FHWA, 2019. *Bikeway Selection Guide.*
[x] FHWA, 2019. *Bikeway Selection Guide.*

Chapter 8: Multimodal Project Evaluation

The previous two chapters introduced and explained the Multimodal Project Design Framework – a process for designing projects on multimodal corridors so that they work collectively towards building out the future vision of the Multimodal System Plan.

The third step in the Multimodal Project Design Framework – Step 3: *Evaluating Design Concepts* – is the focus of this chapter. This chapter describes a process for evaluating projects in the concept phase to reflect the goals of the Multimodal Master Plan. It outlines a process the city can use to evaluate potential concepts to determine how well they work towards the city's goals for multimodal transportation.



Overview

Evaluating potential design concepts on multimodal corridors is an important step in developing a safe, comfortable, multimodal transportation system through a systematic and transparent decision-making process.

Design concepts should be evaluated before a change is made to help decision makers and the public understand the costs and benefits of taking an action before a project is implemented.

The reason for evaluating a design concept before it proceeds to final design is to help answer the question "Should we make this change?"

Projects can also be evaluated after they are implemented to determine if they had the desired benefit. Evaluation is an important tool at various stages of the decision-making process to understand anticipated and actual progress towards the vision and goals.



Evaluation metrics help answer the question "Should we make this change?" and can be used after implementation to determine if a project had the desired benefit.

Why Multimodal Evaluation Metrics Are Needed

The metrics that we use to evaluate a design concept should be consistent with the plan goals and should help explain and communicate the potential outcomes of making a change.

To be effective, consistent, and transparent, the metrics the City of Norfolk uses to evaluate and communicate the potential outcomes of a multimodal corridor design concept should be closely related to its multimodal transportation vision and goals.

Level of Service (LOS) Evaluation Metrics

Vehicular Level of Service (LOS) has become the most commonly accepted and widely used metric used to evaluate vehicular transportation performance in the United States. Its translation to letter grades A through F has made it very intuitive to understand at a cursory level, and the methods for computing it use widely available data.

There is not a single way to compute LOS, and there are various ways to compute vehicular LOS in different situations, including at specific intersections, along different types of roadway segments, and more generally for longer corridor extents based on volume-to-capacity ratios and average assumptions.

Although vehicular LOS is compellingly simple as it produces a simple A to F letter grade, it has some limitations as an evaluation metric. For example, vehicular LOS only accounts for vehicle delay and does not factor in mobility of other modes, such as transit riders, bike riders, and pedestrians. Nor does it account for other key goals that are part of Norfolk's vision for its multimodal transportation system, including safety, freedom of travel choice, access to opportunities, overall quality of life, environmental sustainability, and resilience.

A fundamental principle of this master plan is that design concepts on multimodal corridors should be evaluated based on how they contribute to Norfolk's vision and goals for its multimodal transportation system. Vehicular LOS has a role to play in project evaluation, but additional metrics are needed to guide the implementation of the Multimodal Plan.



This road appears to have good vehicular level of service but lacks facilities for other modes. Image credit: EPR

Common misconceptions about vehicular LOS:

- *LOS A is the most desirable outcome.*
- *LOS F is always considered unacceptable.*

Neither of these statements are exactly accurate.

LOS A can reflect a roadway with excess vehicular capacity. Roadways operating at LOS A and B are typically over-designed, which may not be the best use of limited transportation improvement funds.

LOS F may not represent an unacceptable level of service in all cases. There are varying degrees of LOS F depending on the surrounding context, and vehicle delays that are at the level of LOS F may be acceptable given land use context and availability of multimodal options if other goals are being met.

Multimodal Person Capacity Metrics

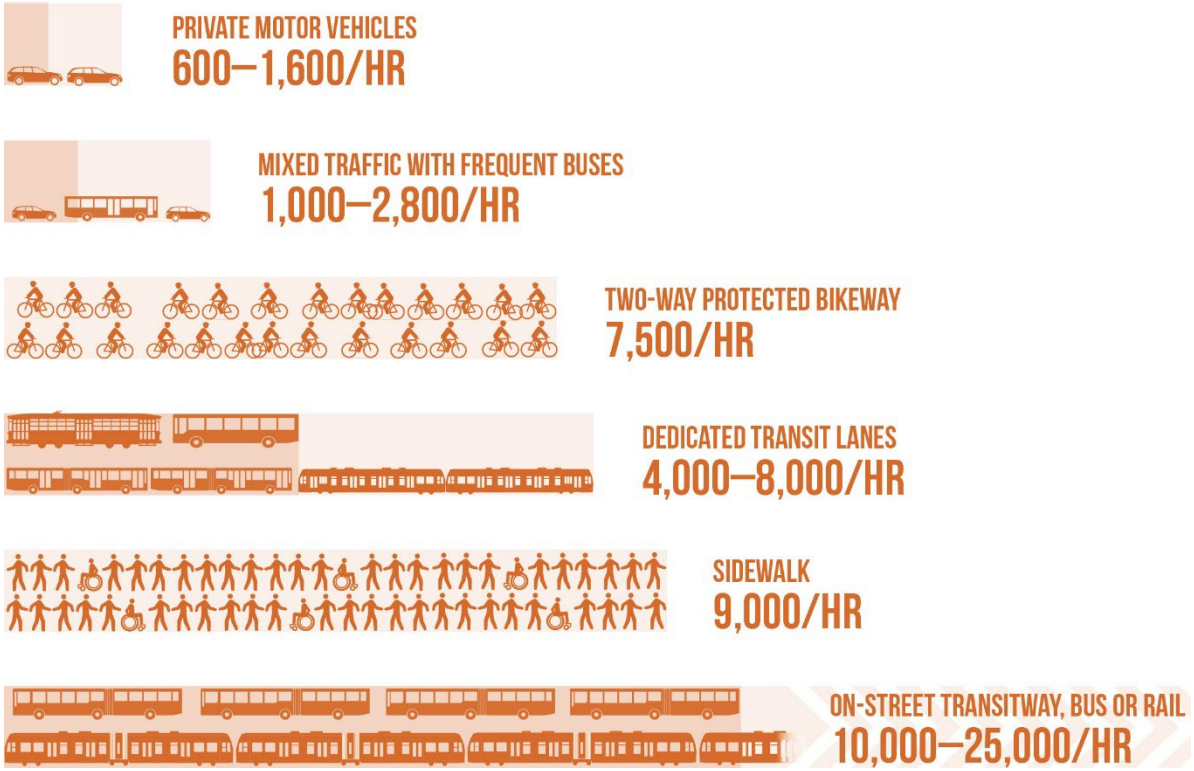
To facilitate a true shift from focusing on moving vehicles to focusing on moving people, metrics beyond vehicular LOS are needed.

The transportation planning profession has grappled for several years with the question of what metrics can supplement vehicular LOS to account for non-auto modes and a broadening array of other economic, social, environmental, and cultural values. As perspectives broaden, so do the possibilities for metrics. Nearly 10 years ago, the Florida Department of Transportation synthesized over 200 metrics to supplement vehicle LOS for growth management and transportation impact analysis to support a transition toward multimodal transportation systems.[i]

One of the more useful metrics that several industry leading organizations have explored is *multimodal person capacity*, as it is closely related to the concept of vehicular LOS but broadened to incorporate a variety of modes. It illustrates that by including more multimodal options, a street can move more people.

Multimodal person capacity is one potential metric that Norfolk can use to evaluate a potential multimodal project to determine the degree to which it will improve the ability to move people.

FIGURE 8-1: NACTO'S MULTIMODAL PERSON CAPACITY ILLUSTRATION



This illustration from NACTO's Transit Street Design Guide shows the multimodal person capacity of a single 10-foot lane (or facility of equivalent width) by mode at peak conditions with normal operations. Image Source: NACTO

This concept is important because Norfolk's long-term vision is to continue to grow. To enable this long-term growth, the transportation system needs to be evaluated on its ability to move people, not just moving cars.

A New Framework for Evaluating Multimodal Design Concepts

As described in Chapter 2: Vision and Values, the Multimodal Norfolk transportation master plan establishes goals and objectives for the City's multimodal transportation system.

The three goals correspond to three vision themes:

- Connect (Freedom and Connectivity)
- Protect (Safety)
- Prosper (Equitable Prosperity)

This chapter describes a basic framework for how to evaluate a design concept for a project on a multimodal corridor based on how it would contribute to the vision themes and goals.

As mentioned previously, one reason to evaluate a design concept is to answer the question "How does this change relate to our overall vision and goals?" Alternatively, a multimodal corridor may have multiple potential design concepts that need to be compared. Evaluating the design concepts can answer the question "How much does each design concept get us closer to achieving our multimodal transportation goals?"

To answer these questions, the framework poses a series of evaluation questions related to the three goals. The framework also includes a list of potential quantitative and qualitative evaluation metrics to be used when considering one or more design concepts. These evaluation metrics are grouped under the categories of the vision themes.

The potential evaluation metrics proposed in this framework may require data collection and analysis to varying degrees of complexity and cost and will depend on available city resources. Bicycle counts are one example of data that can be collected. One of the recommendations from the League of American Bicyclists' key steps to the Silver Award is to develop a bicycle count program that utilizes several methods of data collection including automated bicycle counters to provide long-term data on bicycle use at fixed points and mobile counters. This data could provide periodic before-and-after data related to changes in Norfolk's bicycle network.



Three vision themes represent the three goals of the Multimodal Norfolk transportation master plan.

Connect (Vision Theme #1)

Connect people and places with a choice of affordable and accessible travel options.

This vision theme addresses a variety of affordable travel options connecting people to the things that they need.

Norfolk's population is diverse, and there is no one-size-fits-all solution to mobility within the City that will work for everyone. This vision theme recognizes that a transportation system that provides a range of options is needed to provide equitable access to Norfolk residents, workers, and visitors.

Norfolk is also a mature city with built-out streets. Accommodating travel demand growth and maintaining a range of travel options will require making efficient use of existing street rights of way.



Connections between modes is part of the Connect vision theme.

Evaluation Questions for the "Connect" Vision Theme

Does the potential design concept:	Yes	No
Increase overall person-throughput of the street?	☐	☐
Increase modal options or create dedicated space in the right of way for a new mode?	☐	☐
Form, enhance, or strengthen a link in a non-automobile modal network?	☐	☐
Provide non-automobile access to new parts of the city?	☐	☐
Introduce low-cost mobility options?	☐	☐
Increase the efficiency of the public right of way?	☐	☐

Evaluation Metrics for the "Connect" Vision Theme

The following are potential evaluation metrics for measuring how a potential design concept would contribute to the Connect vision theme and goal.

- Multimodal Person capacity
- Multimodal level of service
- Bicycle, transit, and pedestrian access sheds

Protect (Vision Theme #2)

Protect all who travel on our City's streets.

This vision theme addresses the safety of all citizens who travel on Norfolk's streets. As mentioned in prior chapters, Norfolk's adopted Vision Zero policy sets a goal of zero fatal crashes on the City's streets. Transportation networks that prioritize vehicle speed and capacity over safe and convenient travel for people outside of cars may create conditions where traffic injuries and deaths are more common.

This vision theme envisions a city where the safety of all who travel on Norfolk's streets is prioritized. Achieving this vision will require a shift in priorities for transportation projects and new metrics for considering design concepts.

In recent years, the transportation profession has given increasing emphasis to safety for all road users and not just drivers of vehicles. However, robust quantitative metrics for evaluating the multimodal safety are still somewhat lacking. Recent research using crash data, though, has confirmed that certain street designs reduce traffic injuries and fatalities, and these types of safer street design elements are built into the multimodal design approaches in this Master Plan.

In addition, Norfolk, as one of the most vulnerable cities in the nation with respect to recurrent flooding events, has a special policy focus on resilience. For this reason, evaluation questions and metrics that address resilience have been included in the "Protect" theme.

Evaluation Questions for the "Protect" Vision Theme

Does the potential design concept:	Yes	No
Slow down vehicle traffic?	☐	☐
Provide physical protection to vulnerable road users?	☐	☐
Shorten pedestrian crossings?	☐	☐
Decrease over-designed curb radii?	☐	☐
Provide refuge islands?	☐	☐
Facilitate low or no carbon emission travel?	☐	☐
Accommodate sea-level rise and flooding events?	☐	☐
Include green infrastructure to improve resilience?	☐	☐

Evaluation Metrics for the "Protect" Vision Theme

The following are potential evaluation metrics for measuring how a potential design concept would contribute to the Protect vision theme and goal.

- Number of safety treatments (curb extensions, refuge islands, etc.)
- Number of green infrastructure elements
- Miles of protected bike lanes

Depending on the context, some projects on multimodal corridors may improve safety for all road users including slowing down vehicles and improving facilities for non-auto modes. Some projects may require a careful examination of how improving safety for one mode may affect the safety and accessibility of other modes. This balance varies depending on the function of the street road, the characteristics of the surrounding neighborhood and land uses, and network connectivity. This balance needs to be carefully considered when developing design approaches and refining design concepts.

Prosper (Vision Theme #3)

Create a prosperous multimodal future for all.

This vision theme fosters a future transportation system that supports a resilient, equitable, and strong Norfolk economy. This theme fosters connecting citizens to jobs, education, and other opportunities for personal prosperity regardless of their economic means. It also fosters connecting Norfolk's businesses to a large and diverse talent pool and making the City a more attractive place for businesses and workers to locate. Further, it supports efficient freight deliveries, appropriately accommodating them within the broader multimodal transportation system.

Historically, transportation projects' impacts on a local economy have been evaluated based on reductions in vehicle congestion, travel time, and delay. This approach has been based on the relative ease of calculating vehicular LOS, but it is too limited in accounting for a number of other ways in which a project could impact overall economic prosperity. The following evaluation questions and evaluation metrics provide a broader picture of how a potential project could contribute to overall prosperity.

Evaluation Questions for the "Prosper" Vision Theme

Does the potential design concept:	Yes	No
Increase travel choice for residents and workers?	☐	☐
Add new options for accessing business locations?	☐	☐
Enhance a local sense of place?	☐	☐
Contribute to an attractive public realm?	☐	☐
Support the economic viability of adjacent land uses and the city as a whole?	☐	☐
Include green infrastructure or recreational opportunities, or improve access to parks or open spaces?	☐	☐

Evaluation Metrics for the "Prosper" Vision Theme

The following are potential evaluation metrics for evaluating how a potential design concept could support a resilient, equitable, and prosperous Norfolk:

- Change in the number of jobs accessible by non-automobile modes
- Number of new street trees
- Number of new public amenities added to the street
- Increase in access to parks, recreational opportunities, or open spaces

Assessing and Communicating Tradeoffs

Norfolk is a mature city with well-established street and building frontages. Widening streets is either physically impossible or very expensive in most cases due to the built-up nature of the City's neighborhoods and commercial areas. At the same time, Norfolk envisions new growth and prosperity with increasing travel demands over time. How can these constrained rights of way accommodate increased trips safely and efficiently in the future? The answer is to gradually reconfigure streets to move more people safely and efficiently.

As shown in Figure 8-1 previously, the number of people that can be moved in a street can be greatly increased by including more multimodal options.

Making Norfolk's streets friendlier for bicycles, pedestrians, transit, and future transportation modes is not just an issue of safety and equity but can position the city for accommodating more growth and prosperity in the future.

In the near term, this implies balancing the needs of different modes to achieve the right mix of accommodations for all modes on the street.

The hypothetical example of designing a multimodal project in Chapter 7 illustrates this type of balancing of travel modes. In this example, both the short-term and long-term design concepts involve repurposing one of the two general travel lanes in both directions for use by other modes. While the design concepts in this hypothetical example reduce the vehicular capacity of the corridor, they further all of the city's multimodal transportation goals. Chapter 7 also explains the general process used in this example to identify and assess tradeoffs.

The next section contains a second hypothetical example that illustrates the project evaluation process and how the proposed framework for evaluating multimodal design concepts could be used.

Evaluating a Multimodal Corridor Design Concept – A Hypothetical Example

The following hypothetical example demonstrates how to use the evaluation framework presented in this chapter to assess how a proposed design concept would meet the city's goals for multimodal transportation.

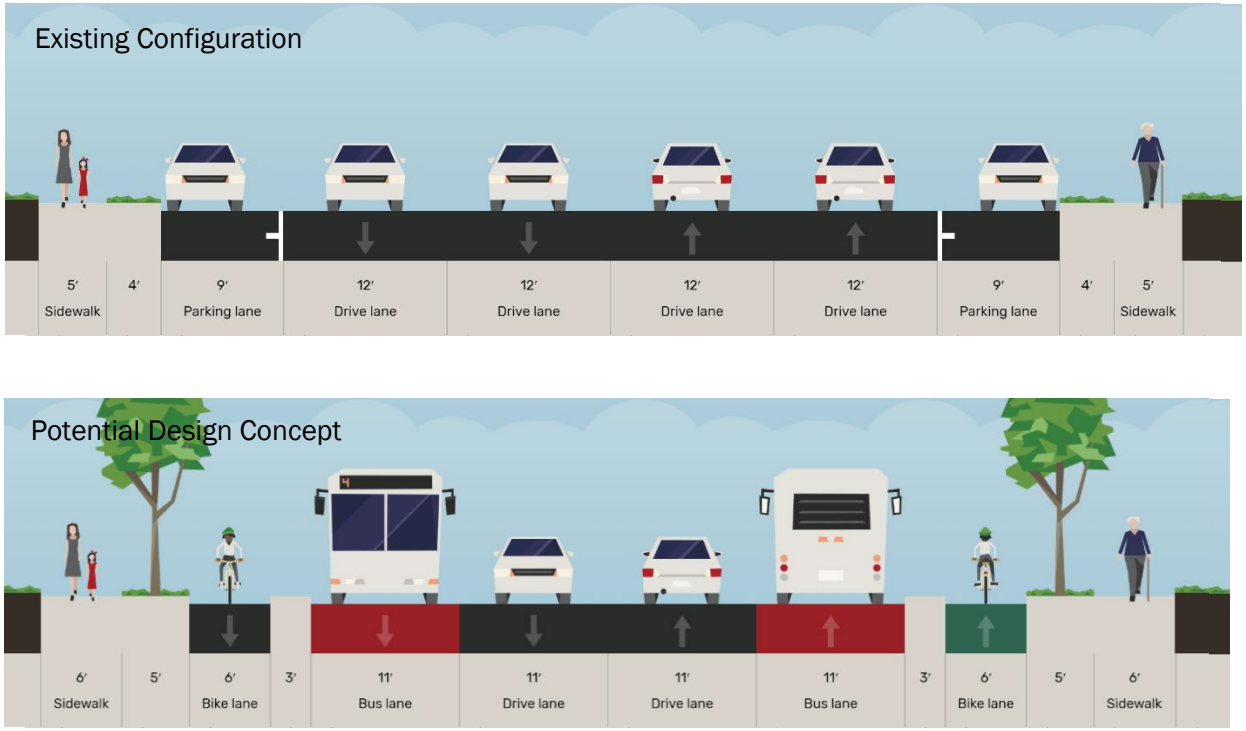
This existing configuration of the hypothetical street (Figure 8-2, top) looks like several corridors in Norfolk that have been designed primarily to optimize circulation for cars. The street has two travel lanes in each direction, curbside parking, and 5-ft wide sidewalks on both sides.

The hypothetical design concept (Figure 8-2, bottom) reimagines the street cross section to better meet the multimodal goals in this Master Plan.

The key additions of this hypothetical design concept are:

- dedicated bus-only lanes in each direction,
- separated bicycle lanes in each direction,
- widening of the planted buffer and addition of street trees, and
- widening of the sidewalks.

FIGURE 8-2: MULTIMODAL CORRIDOR DESIGN CONCEPT EVALUATION EXAMPLE – CROSS-SECTION ILLUSTRATION



This hypothetical example demonstrates how a proposed design concept could be evaluated using the evaluation questions in the proposed framework.

To accommodate these new facilities for bus passengers, bicycle riders, and pedestrians, the project would remove curbside parking and one travel lane in each direction. It is important to note that in this hypothetical example, the overall cross-section width was expanded from 60 feet in the existing configuration to 84 feet in the potential design concept.

The hypothetical design concept was generally evaluated through the lens of the three Multimodal Norfolk vision themes using the evaluation questions, as shown in **Table 8-1** on the next page.

TABLE 8-1: EVALUATION QUESTIONS FOR THE HYPOTHETICAL EXAMPLE

	Does the potential design concept:	Yes	No
Connect	Increase overall person-throughput of the street?	☑	☐
	Increase modal options or create dedicated space in the right of way for a new mode?	☑	☐
	Form, enhance, or strengthen a link in a non-automobile modal network?	☑	☐
	Provide non-automobile access to new parts of the city?	☑	☐
	Introduce low-cost mobility options?	☑	☐
	Increase the efficiency of the public right of way?	☑	☐
Protect	Slow down vehicle traffic?	☑	☐
	Provide physical protection to vulnerable road users?	☑	☐
	Shorten pedestrian crossings?	☐	☑
	Decrease curb radii?	☐	☑
	Provide refuge islands?	☐	☑
	Facilitate low or no carbon emission travel?	☑	☐
	Accommodate sea-level rise and flooding events?	☐	☑
	Include green infrastructure to improve resilience?	☐	☑
Prosper	Increase travel choice for residents and workers?	☑	☐
	Add new options for accessing business locations?	☐	☑
	Enhance a local sense of place?	☑	☐
	Contribute to an attractive public realm?	☑	☐
	Support the economic viability of adjacent land uses and the city as a whole?	☑	☐
	Include green infrastructure or recreational opportunities, or improve access to parks or open spaces?	☑	☐

When evaluating real projects, it would be possible to do more detailed quantitative analysis of some metrics, including multimodal capacity, access, and travel time.

The overall evaluation results are also summarized in **Figure 8-3**, which lists the ways in which the hypothetical design concept contributes to the goals Norfolk established in the Multimodal Plan.

In some instances, the City may prepare multiple design concepts, and each one would undergo an evaluation to illuminate the extent to which it contributes to the City's goals for its streets.

A Note on Tradeoffs and Multimodal Person Capacity
In this example, vehicular capacity is reduced somewhat due to the reduction in travel lanes.

On the other hand, transit, bicycling, and walking can ultimately move more people in the same space than driving in a car. This means street space can be used by more people in the hypothetical example through expanding the capacity for buses, bikes, and pedestrians.

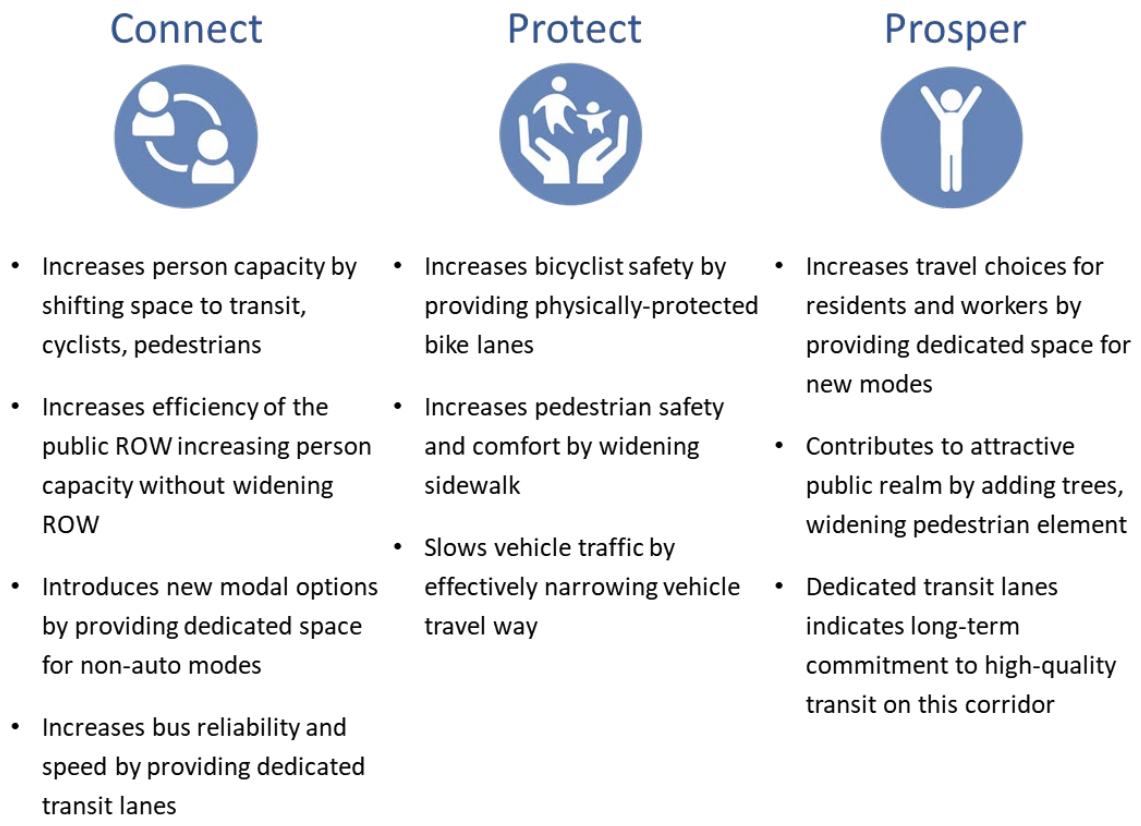
It should be noted that the person-capacity of a bus-only lane is dependent on bus frequency and bicycle lane use is affected by the availability of a complete network of bike facilities. It is difficult to compare the precise person capacity of corridor alternatives, but Norfolk has set a long-term goal of shifting travel to efficient modes so future projects should emphasize non-automobile modes in the public right of way.

Summary of the Evaluation Framework

Multimodal Norfolk establishes a vision and goals for the City's multimodal transportation system. The evaluation framework presented in this chapter allows decision makers, stakeholders, and the public to understand the extent to which a potential project on a multimodal corridor would contribute to the vision and goals before making any changes to the City's streets.

This framework is envisioned to be a tool that city staff, including planners and engineers can use to communicate the benefits and tradeoffs of a multimodal project or design concept to the public and elected officials.

FIGURE 8-3: MULTIMODAL CORRIDOR DESIGN CONCEPT EVALUATION EXAMPLE – EVALUATION RESULTS



This graphic summarizes the results of the qualitative evaluation of the hypothetical example.

[i] Elefteriadou, L., et. al. 2012. *Expanded Transportation Performance Measures to Supplement Level of Service (LOS) for Growth Management and Transportation Impact Analysis.* Retrieved on Jan 20, 2021 from https://trid.trb.org/view/1223021.

Chapter 9: Curb Space Management

Introduction

There's a lot of competition for potential uses of curb space – parking for personal vehicles, parking for bicycles and scooters, bus stops, bike lanes, outdoor dining, truck loading, ride-share drop-off, landscaping and wells for mature shade trees, electric vehicle charging, and more. The list of what happens at the curb continues to grow with new technologies and new opportunities.

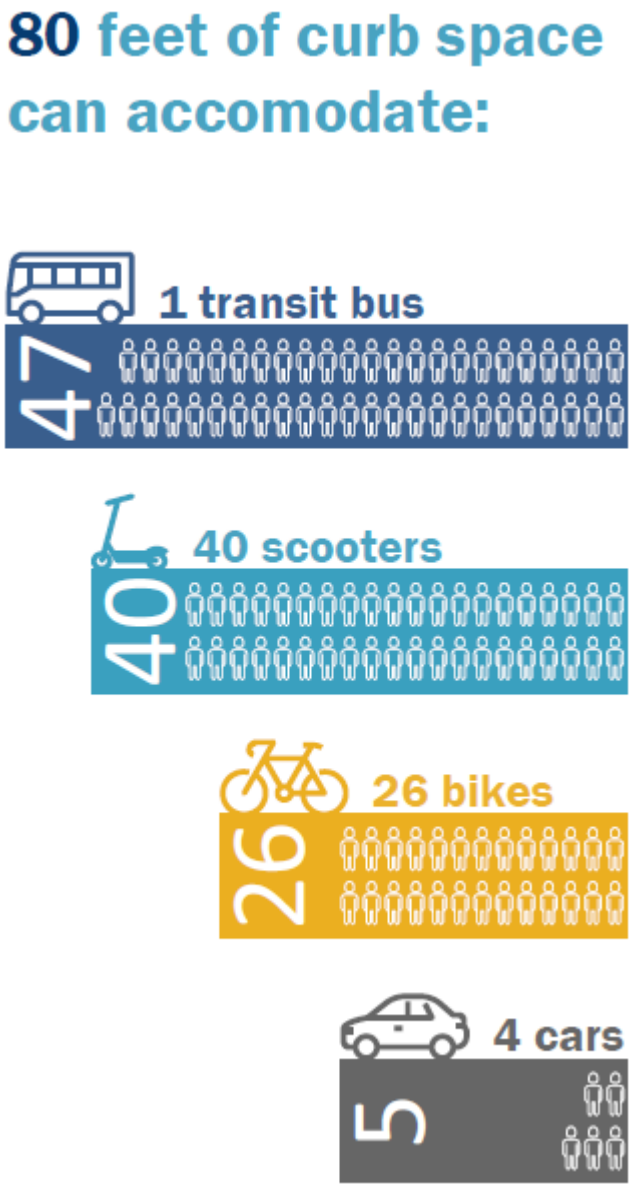
Curb space in Norfolk is a limited asset. Managing this asset will require setting priorities. As Norfolk continues to grow, more space-efficient use of the curbs should be explored to maximize the value of this asset. Curb uses need to be balanced among multiple and sometimes competing goals.

As in most cities, the overwhelming majority of Norfolk's curb space today is used for parking personal vehicles. While on-street parking is crucial in areas with limited off-street parking like some older neighborhoods, an over-allocation of available curb space exclusively to permanent automobile parking in high-activity areas may risk undervaluing this asset. Seeing curb space as the exclusive purview of automobile parking may miss opportunities to use this asset to serve other high-priority curb uses and create a safe and robust network for bicyclists and scooter riders, pedestrians, transit riders, scooters, and other modes.

What is Curb Space?

Curb space is the part of the street that marks the transition from the space where people and vehicles travel to the space where people walk on the sidewalk and enter buildings. Curb space is also the space where both movement and access may conflict, but where both movement and access are needed to serve convenience and commerce.

Curb space traditionally refers to the portion of the street directly adjacent to the curb within the roadway. However, the location and function of curb space has become expanded with the introduction of new uses that span both sides of a curb, such as



parking-protected bike lanes, parklets, on-street restaurant seating, and other new treatments. These treatments sometimes leave the physical curb in place and move curb-side functions further into the roadway away from the curb.

In this plan, curb space is defined as the part of the street next to or near the curb that serves any variety of curb functions, including providing access from the street to buildings , goods delivery, and other uses that will be further defined later in this chapter.

Curb space is flexible. Different uses can be allowed throughout the day and during different days of the week. Curb uses can vary along the length of a block. Curb uses can also be converted using temporary materials as a test or for specific circumstances.



Curb space can be located directly next to the curb or further out into the roadway. Curb space is the part of the street near the curb that serves a variety of curb functions. Image Source: Seattle Department of Transportation.



Managing short term parking in Norfolk's downtown. Image Credit: EPR



Curb space is flexible and can change by time of day. Image Source: Flickr user dumbonyc

Chapter Overview

This chapter presents a framework for establishing curb space priorities and designing curb space to further the City's multimodal goals for safety, freedom, and prosperity.

The curb space management framework is a proactive, flexible, context-based approach to making decisions about what happens at the curb to maximize the benefit of this limited asset.

This chapter begins by defining five different categories of curb uses and identifying the curb uses that fall under each category.

It provides an overview of the curb space management framework and outlines three general steps to designing curb space.

It also includes a matrix that defines general priorities based on land use context and describes the process for selecting curb uses. Design considerations for each curb use are provided.

Finally, this chapter illustrates how to use the framework with a hypothetical example.

Categories of Curb Uses

Most curb activities (or curb uses) can be categorized as serving either a mobility function or an access or other function. For example, a metered parking space allows people in cars to access nearby places for a short period of time (an access function), while a curbside bike lane provides mobility for people riding bikes (a mobility function).

Curb space dedicated to mobility allows people to move through the multimodal transportation network, and curb space dedicated to access provides a place for people to stop, leave the transportation network, and access nearby properties.

Other curb activities, like outdoor dining, serve an amenity function, and still others, like long-term parking, serve a storage function.

In this framework, curb uses are grouped into five different categories:

1. Mobility
2. Access for People
3. Access for Goods
4. Amenities
5. Storage

The following sections describe each category of curb activities and provide examples of curb uses within each category. Each specific curb use is defined later in this chapter.

Multimodal Mobility Curb Uses

Mobility curb uses are those that facilitate multimodal movement of people along a street. Note that automobile mobility uses are not included in this list but are assumed to be part of the existing mobility curb use of many streets without on-street parking.

Curb uses under the Mobility category include:

- Sidewalk extensions
- Curb extensions
- Bicycle lanes
- Bus-only lanes
- Queue jumps

Access for People Curb Uses

Curb space is often the primary interface between the street and buildings – it's where people end their journey and enter a business or their home.

Curb uses within the Access for People category include:

- Bus stops



Shared lane markings on a curbside lane are an example of a curb use under the Multimodal Mobility category.



A bus stop with a shelter and bench is an example of a curb use under the Access for People category.

- Scooter and bicycle parking corrals
- Bike share stations
- Short-term parking spaces
- Taxi and ride-share pick up and drop off zones

Access for Goods Curb Uses

Curbside access for goods delivery is a basic requirement for many businesses that serve urban populations. Some restaurants, stores, and other businesses in mixed-use areas lack off-street loading space and receive deliveries from trucks parked in the curb lane. Residential areas have also seen an increase in goods deliveries with the rise of online shopping.

Curb uses under the Access for Goods category include:

- Loading zones

Amenities Curb Uses

Curb uses in this category provide amenities that improve the livability, resilience, and quality of life of the street and surrounding environment.

Curb uses in the Amenities category include:

- Outdoor dining
- Benches
- Parklets
- Public art
- Wayfinding signage
- Trees
- Bioswales
- Other stormwater management and green infrastructure

Storage Curb Uses

In many parts of Norfolk, curb space provides storage for personal vehicles. Curb space can also provide bus layover storage at end-of-route stops or space for temporary storage of construction materials.

Curb uses in this category include:

- Long-term parking spaces
- Bus layover space
- Construction staging



Loading zones are a curb use in the Access for Goods category. Image Source: Wikimedia Commons.



Parklets and outdoor dining spaces are examples of curb uses in the Amenities category.

Overview of the Curb Space Management Framework

With so many potential curb uses competing for limited space, how can the best use of the limited curb space be determined?

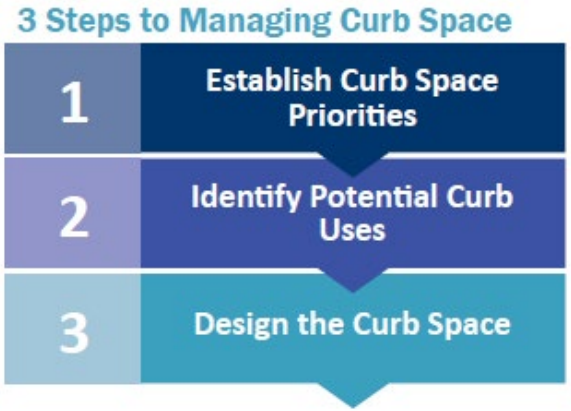
This section describes a three-step framework for establishing curb space priorities and designing curb space to best meet the city's goals for multimodal transportation.

Managing assets requires setting priorities and making decisions in line with those priorities. Each city block has unique needs for curb use and access based on its land uses and role in a transportation network.

The curb space management framework in this chapter provides a process to understand those needs, prioritize them, and determine the optimal configuration to meet those needs within the space available.

It is important to note that curb space management is an inherently dynamic process. As land uses and businesses change on a block, it will be important to ensure that the uses of the curb are well reflective of those changes. In addition, technology changes such as the rise of e-scooters in recent years may cause the reassessment of the curb space management protocols. In general, curb space management should become an ongoing process with regular updates by the city to ensure that it is continuously meeting the overall goals of Multimodal Norfolk.

The curb space framework consists of three general steps.



The following sections describe each of the three steps.

Step 1: Establish Curb Space Priorities

In order to maximize the benefit of the City's curb space assets, it is critical to establish priorities for the use of curb space that align with the Multimodal Transportation Master Plan and best contribute to serving the adjacent land uses.

The first step involves organizing the five curb use categories in order of general priority according to the land use context of a block or segment of street.

Mobility Priorities

Mobility is primarily an issue of a whole transportation network, and priorities for curb uses that fall under the Mobility category are set at the network level. The Modal Emphasis maps in Chapter 4 identify connected networks for each mode – pedestrian, bicycle/scooter, and transit – across the city.

Because mobility needs are determined at the network level, the first priority for curb space in the mobility category is to ensure that the established modal priorities for that street are accommodated appropriately.

FIGURE 9-1: CURB SPACE PRIORITIZATION MATRIX

Priority	Inside a Multimodal Center		Outside a Multimodal Center	
	Mixed Use & Commercial	Residential	Residential	Industrial
1	Mobility: Modal Emphasis		Mobility: Modal Emphasis	
2	Access for People		Access for People	Access for Goods
3	Access for Goods		Storage	Access for People
4	Amenities		Access for Goods	Storage
5	Storage		Amenities	

This table identifies a general list of priorities for curb space depending on the multimodal mobility system needs and the land use context.

Access and Other Priorities

Priorities for curb uses that fall under the other four categories are typically determined by the land use context of each block and the surrounding area. Streets within a Multimodal Center will have different curb space priorities than streets outside of a Multimodal Center. The intensity and type of land uses of the block also shape the prioritization.

Determining General Curb Space Priorities

Determining the general curb space prioritization of a street depends on three questions:

1. What is the modal emphasis of the street?
2. Is the street inside or outside a Multimodal Center?
3. What are the land uses on this block?

To answer the first two questions, refer to the Multimodal System Plan maps in Chapter 4.

To answer the third question, consider the land uses and determine which of the following three broad land use categories best describe the uses along the block:

- mixed use and commercial,
- residential, or
- industrial.

These categories are broad, and choosing the appropriate land use column requires making an assessment of the predominant land use of the block in question.

Based on the answers to these three questions, the Curb Space Prioritization Matrix, shown in **Figure 9-1**, offers a general order of curb space priorities that accounts for the specific land use context.

Step 2: Identify Potential Curb Uses

After defining the general curb space priorities for the street, the next step is to identify potential curb uses that fit within the established priorities. No two blocks are exactly alike and choosing curb uses requires careful consideration of the unique needs of the block.

Curb uses often have a combination of design aspects, including markings and concrete, and usage regulations. Curb regulations define the activity that is permitted to take place, including time of day, duration, and vehicle classification, and are enforceable by the police.

The following sections more fully define the potential curb uses that fall under each category of curb use priority. Curb uses under the mobility category are also broken out by modal emphasis. More detail on design considerations for each curb use is provided in the third and final step.

Curb Uses for Mobility – Transit Modal Emphasis

Bus-Only Lane: A curbside bus lane is one way to prioritize transit mobility in the curb space. A bus-only lane is appropriate where bus speeds are low and travel time is unreliable due to traffic congestion. This treatment is typically applied on a corridor level. Bus lanes can be in effect during certain days of the week and times of day when they provide the greatest improvement to bus performance and allocated to other uses at other times.

Queue Jump: A queue jump is an intersection-approach facility that allows buses to skip past queuing vehicles, reducing intersection delays for buses. This treatment is applied at the intersection level, whereas bus-only lanes are typically applied to corridors. Because queue jumps usually occupy part of the block, it is possible to use the remaining curb space for other priorities. Queue jump lanes can be accompanied by transit-only signals that give buses a head start.

Bus stops are described below under Curb Uses for Access for People because they provide the space where bus riders access nearby properties. Any street with Transit Modal Emphasis should prioritize bus stops as a curb use. If a bus stop is needed on a block, it should be the highest priority curb use.

Curb Uses for Mobility – Bicycle/Scooter Modal Emphasis

Curbside Bike Lane: Bike lanes can be located adjacent to the curb within a block's curb space. Curbside bike lanes can be separated from traffic by a solid white stripe or a larger buffer. Curbside bike lanes are typically in effect 24/7.

Parking-Protected Bike Lane: This type of facility places the bike lane against the curb and places a "floating" parking lane between the bike lane and travel lane(s). When this facility is used, the curb space shifts to the floating parking lane. One benefit of this treatment is that it provides a safe, comfortable bike lane while providing space for other curb functions.

Curb Uses for Mobility - Pedestrian Modal Emphasis

Painted Sidewalk Extension: In places with a high level of pedestrian activity, sidewalks can be extended using paint, bollards, planters, and other non-permanent materials. This treatment leaves the curb in place but shifts curb functions to the space next to the sidewalk extension.

Curb Extension (Neckdown): Curb extensions at crosswalks shorten pedestrian crossing distances and improve safety. Curb extensions work best on streets without curbside moving lanes.

On most streets, pedestrian mobility is adequately provided by sidewalks outside of the curb space. Sidewalk and curb extensions are not needed on every street with pedestrian modal emphasis and are only needed at locations where pedestrian volumes are high or where intersection safety issues can be addressed by adding curb extensions.

Curb Uses for Access for People

Bus Stop: The bus stop is where bus riders begin and end all trips. This is the curb element with the potential for providing the greatest number of people access to a block. Bus stop location is determined by a combination of network and block level factors. Bus stops are typically placed at the end of a block and require careful design to ensure they function well. If it is determined that a bus stop is needed on a block, it should be considered the highest priority curb use regardless of the land use context.

Bike Share Station: Like bus stops, bike share stations are the beginning and ending point of all bike share trips. Bike share stations have the potential to provide a high level of access for people because of the relative space-efficiency of bikes.

Bike & Scooter Parking: Curb space can be used to provide on-street bike and scooter parking. These facilities are often referred to as bike corrals. This element is similar to bike share stations but allow people to park their personal bikes.

Taxi & For-Hire Vehicle Zone: Taxi zones provide a dedicated curb space for taxis and for-hire vehicles to pick up and drop off passengers. This element is highly flexible and can be targeted to specific times of the day when demand is highest, allowing the

space to be used for other priorities at other times.

Short-Term Parking: Short term parking spaces are common in commercial and mixed-use areas. Short-term parking spaces typically limit the duration of parking to one or two hours and charge a small fee for using the space. This element is often used to maximize the number of people who can access a block by encouraging parking turnover.

Curb Uses for Access for Goods

Truck Loading Zone: A truck loading zone is a highly flexible curb element that can be targeted to times of the day when deliveries need to occur. In areas where truck loading zones may be needed, it is helpful to survey businesses on the block to find out how often, when, and how they receive their deliveries. It may be possible for some businesses to choose delivery times that coincide with time-limited truck loading zones.

Curb Uses for Amenities

Street Tree: Trees can be planted in curb space, either in planters or in tree pits. Street trees have many documented benefits, including increased shade for pedestrians, and CO2 capture.

Green Infrastructure: Curb space can be used to install green infrastructure treatments that capture and treat stormwater, improve air quality, and reduce the urban heat island effect.

Parklet: Many cities have experimented with installing small parklets in curb space, both on a temporary and permanent basis. Parklets can increase pedestrian activity and foster a vibrant street life.

Café Dining: In places where the sidewalk is not wide enough for café seating, curb space can be allocated to café seating and tables. Several big American cities have established on-street café seating programs in the past and Norfolk has allowed restaurants to use curb space in response to the COVID-19 pandemic.

Other: Curb space is flexible and can be used for a wide variety of public amenities to improve quality of life and increase the resilience of Norfolk. Other cities have used curb space for public art, wayfinding signs, benches, and many other things.

Curb Uses for Storage

Long-Term Parking: in low-density residential and industrial areas without off-street parking, curb space is often allocated to long-term parking that is free and unrestricted. Curb space is where people store their vehicles for many hours (and potentially days) while they are not needed, such as overnight.

Bus Layover Space: At the beginning and ends of bus routes, layover space is needed for buses while they wait to begin another run. If off-street layover space is unavailable, providing room for layover in the curb space is sometimes necessary.

Construction Staging: Construction projects in dense areas like downtown may require the temporary use of curb space for materials storage and staging if there is no space available on-site. Unlike nearly all the other curb elements described in this plan, construction staging is typically provided on a temporary, as-needed basis, when requested by contractors.

Step 3: Design the Curb Space

After identifying potential curb uses as a general sequence of priorities, the next step is to consider specific design considerations for each potential curb use.

The tables on the following pages describe critical considerations for designing and implementing individual curb uses. These tables are intended to be used after the identification of a prioritized list of potential curb uses to assist in choosing and designing the appropriate curb uses along a specific block.

The tables outline considerations regarding specific land use contexts, implications for interfacing with other curb uses and facilities for other modes, special considerations related to community livability and climate resilience, and whether the curb use has flexibility to be in effect for only a portion of a day and can convert to other uses.

In addition to the design considerations in the following tables, other factors to consider when thinking about converting on-street parking to other uses include *parking turnover* and *parking occupancy*.

The frequency of how often an on-street parking space turns over varies depending on the types of land use and the surrounding context of the area. Parking spaces with high (i.e. frequent) turnover may indicate that people are parking for shorter periods of time, such as to make a quick purchase or run a brief errand. Parking spaces with low (i.e. longer) turnover usually indicate people are parking for longer periods of time. This could be due to the type of trip they are making, regulations that stipulate how long a parked car can remain in one spot, or a combination of both.

Parking occupancy rates – the percentage of time that a parking space has a car parked in it versus being empty – is another factor to consider. Parking spaces with high occupancy typically indicate higher demand for on-street parking uses. However, this too is a function of the regulation of that use. If a space has no time limit, it may have a higher occupancy rate that is due to only one person parking there and leaving their car in the same spot for an extended period of time.

		Design Considerations for 'Mobility' Curb Uses			
		Land Use Context	Interface with Other Modes and Other Curb Uses	Resilience & Livability	Time of Day Flexibility
CURB USE	Queue Jumps	• Appropriate in all land use contexts	• Need to consider bike-bus conflicts	• Improves transit performance • Enhances mobility choices	• Flexible. • Can be in effect during hours when transit performance most impacted by congestion
	Bus Lanes	• Appropriate in all land use contexts	• Need to consider bike-bus conflicts	• Improves transit performance • Enhances mobility choices	• Flexible. • Can be in effect during hours when transit performance most impacted by congestion
	Bike Lanes	• Appropriate in all land use contexts	• Need to consider speed and volume of traffic on street	• Improves safety, comfort of bike riders • Enhances mobility choices	• Not flexible. • In effect 24/7
	Protected Bike Lanes	• Appropriate in all land use contexts	• Provides opportunity for pedestrian refuge islands • Coexists with other curb space uses (short-term parking, loading, etc.)	• Improves safety, comfort of bike riders; enhances mobility choices	• Not flexible. • In effect 24/7

		Design Considerations for 'Access for People' Uses			
		Land Use Context	Interface with Other Modes and Other Curb Uses	Resilience & Livability	Time of Day Flexibility
CURB USE	Bus Stops	• Bus stop location is determined by route-level needs. When a bus stop is needed, it should be high priority compared to other curb uses. • Appropriate in all land use contexts.	• Design to minimize bike-bus conflicts at stops. • Pedestrian access to bus stops is key. Shelters and amenities are desirable. • Typically located at either end of a block.	• Avoid areas that are flood-prone or have drainage issues. • Bus stops increase mobility choice.	• Not flexible. • In effect 24/7.
	Bike, Bike-Share, and Scooter Parking	• Appropriate in mixed-use and commercial areas without on-site parking and in high to moderate density residential areas. • Parking corrals can be located in the street or up on the curb in the amenity zone.	• Can provide buffer between vehicle activity and other uses such as parklets, café seating. • When located adjacent to a transit stop, it facilitates convenient transfer from bike/scooter to transit.	• Encourages sustainable and active transportation modes. • Enhances mobility choice.	• Not flexible. • In effect 24/7.
	Taxi, For-Hire Vehicle, and Private Shuttle Pick-Up & Drop-Off	• Appropriate in dense mixed-use and commercial areas, especially near hotels, theaters, nightclubs, and other land uses that generate for-hire trips.	• Reduces demand for short-term parking. • Facilitates access for people not using personal vehicles. • Can reduce taxi/for-hire vehicle activity in bus stops.	• Improves mobility choices for people not using personal vehicles. • Encourages active street life.	• Flexible. • Can be in effect during high-demand hours, typically evenings and nights.
	Short-term parking	• Appropriate in mixed-use, commercial, and moderately dense areas. • Time restrictions and pricing encourages turnover and increases access	• Parking lanes allow curb extensions at crosswalks • Encouraging curb vacancy reduces double-parking and speeds up transit	• Increases number of people who can use the curb. • Space can be used for other purposes in emergencies	• Flexible. • Can be in effect when other higher-priority curb uses not needed

		Design Considerations for 'Access for Goods' Curb Uses			
		Land Use Context	Interface with other Modes and Other Curb Uses	Resilience & Livability	Time of Day Flexibility
CURB USE	Truck Loading Zones	• Critical for making deliveries in dense mixed-use and commercial areas to avoid double-parking. • Less critical in less dense areas where on-street parking vacancies are common or on low-volume residential streets. • The need for a loading zone depends on the type of adjacent businesses.	• Providing dedicated curb space for loading reduces freight-transit conflicts like double parking and loading in bus stops. • Truck loading can occur in other curb uses such as short-term parking if vacancies are common.	• Goods delivery is essential to commerce and lively activity centers.	• Flexible • Can be in effect during limited hours when deliveries occur. • Business surveys are helpful in determining hours.

		Design Considerations for 'Amenities & Livability' Curb Uses			
		Land Use Context	Interface with other Modes and Other Curb Uses	Resilience & Livability	Time of Day Flexibility
CURB USE	Parklets, Seating, and Dining Spaces	• Appropriate in commercial, mixed-use areas.	• Provides traffic calming benefits. • Useful to people waiting for transit.	• Increases street activity, liveliness, general safety.	• Not flexible • Typically in effect 24/7 due to the need for furniture.
	Trees & Green Infrastructure	• Appropriate in all contexts • Need for green infrastructure driven by topography, city-wide flooding issues.	• Traffic calming benefits all street users. • Trees can provide shade for transit users.	• Green infrastructure provides key resilience benefits • Plantings enhance beauty of the City	• Not flexible • In place 24/7
	Curb Extensions	• Appropriate in all land use contexts, especially areas with high pedestrian activity.	• Can be targeted to areas with high pedestrian crash rate. • Shortens pedestrian crossings; need to consider potential for transit and bikes to use curb space (bus and bike lanes).	• Improves pedestrian safety and comfort • Enhances livability of neighborhoods	• Not flexible • In place 24/7

		Design Considerations for 'Storage' Curb Uses			
		Land Use Context	Interface with other Modes and Other Curb Uses	Resilience & Livability	Time of Day Flexibility
CURB USE	Long term parking	• Appropriate in low-density residential, industrial areas.	• Parking lanes provide opportunity for curb extensions at crosswalks.	• Need to consider flood maps. • Curb parking can reduce need for off-street parking, curb cuts.	• Flexible • Can be in effect off-peak to serve overnight residential parking needs or 24/7
	Bus layover space	• Appropriate in all context. • Need determined by bus routing and staging needs.	• Need to consider bus-bike conflicts.	• Necessary for efficient transit operations.	• Not flexible • Typically in effect 24/7
	Construction staging	• Appropriate in all contexts. • Need determined by availability of on-site construction staging space	• Need to provide safe pedestrian and bike routes through/around construction site. • Need to consider how construction vehicles interact with space.	• Often necessary to construct large, dense buildings that enhance vibrance of City	• Not flexible • Typically in effect 24/7 for the duration of construction.

Input from Businesses and Residents

The framework for determining curb uses also requires proactive communication with the business owners, residents, business associations, civic leagues, and other nearby property owners throughout the decision-making process.

Businesses and residents have unique and various needs for different types of curb uses, and the process to determine the best use of curb space should ensure that these stakeholders have a voice in the process.

Coordination Among City Departments

The process to determine curb uses should also include open and frequent collaborative coordination amongst various City departments. This framework should be integrated into existing departmental planning and decision-making processes.

For example, the Parking Division currently has a process for managing requests for temporarily converting on-street parking for other uses. This process could be expanded to incorporate the proposed curb space management framework described in this chapter.

Assessing Tradeoffs

Changing curb uses involves understanding the benefits and drawbacks. Curb space is limited, and balancing the competing demands means that there will be tradeoffs.

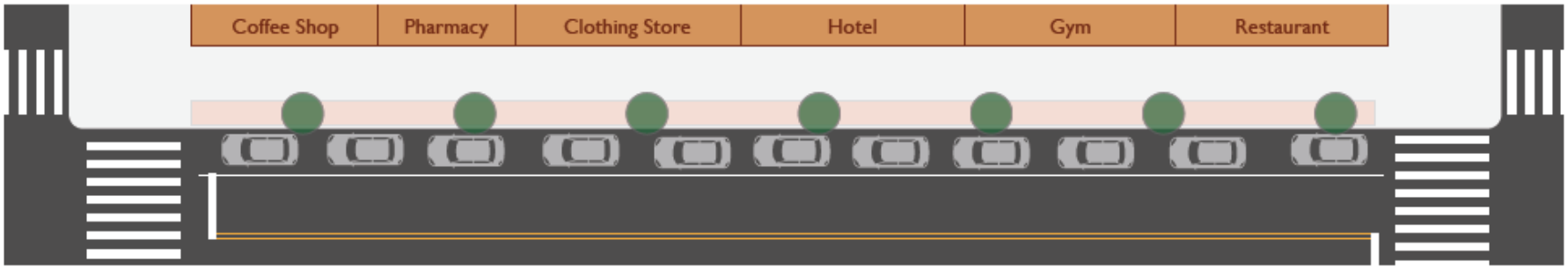
The following list illustrates the variety of potential tradeoffs that should be considered and will vary depending on the unique circumstances of each situation:

- Providing curb space for buses, bicyclists, and scooters increases the capacity of the number of people who can access the land uses within a limited space.
- Diversifying the curb uses along a block may increase the potential for new business patrons.
- Providing curb uses for non-auto modes increases convenience for people to access businesses and residents without relying on driving their own car, increasing choices for how to get around.
- Accommodating non-auto modes within the curb space increases the vibrancy of the community, with more people walking and traveling outside of cars.
- A vibrant community with active street life can attract more businesses and residents, perpetuating the sense of community, place identity, and desirability of the area.
- Metered parking spaces, when available, can facilitate quick and easy access for customers who travel by driving their own vehicle
- Metered parking spaces produce revenue.
- Truck loading/unloading zones provide better access to goods for nearby businesses and can increase business opportunities.
- Taxi and for hire vehicle zones can increase business patron convenience and safety by providing easy alternatives for people to access businesses and residents without having to drive.
- Café seating, parklets, and landscaping encourage people to recreate outdoors, increasing street life and community vibrancy.
- Facilities for bicycling can provide opportunities for active transportation and daily exercise.
- Available and clearly identifiable off-street parking can meet demand for on-street parking spaces.

Using the Curb Space Management Framework – A Hypothetical Example

This section presents an example to demonstrate how to use the curb space management framework to prioritize curb uses and design curb uses along a hypothetical block.

The hypothetical block is in a mixed-use area within a Multimodal Center. The street is home to a variety of businesses and the curb space is currently allocated to metered short-term parking.



This illustration shows the existing curb uses of a hypothetical block, which consists of 11 metered parking spaces during the day and long-term parking overnight. It also shows the land uses along the hypothetical block, which are a mix of various commercial uses on the ground floor, as well as residential uses above.

Step 1: Establish Curb Space Priorities

To identify the appropriate curb use priorities for the hypothetical block, we answer the following questions:

1. What is the modal emphasis?

Transit and Pedestrian.

2. Is it in a Multimodal Center?

Yes.

3. What is the land use context?

Mixed use and commercial.

The answer to these three questions suggests the most appropriate prioritization of curb uses for this block as found in the first column of the prioritization matrix, shown in **Figure 9-2** to the right.

The general priorities for curb space on this block are:

1. Pedestrian and transit mobility
2. Access for people
3. Access for goods
4. Amenities
5. Storage.

FIGURE 9-2: CURB SPACE PRIORITIZATION MATRIX – HYPOTHETICAL EXAMPLE

Priority	Inside a Multimodal Center		Outside a Multimodal Center	
	Mixed Use & Commercial	Residential	Residential	Industrial
1	Mobility: Modal Emphasis		Mobility: Modal Emphasis	
2	Access for People		Access for People	
3	Access for Goods		Storage	Access for Goods
4	Amenities		Access for Goods	Storage
5	Storage		Amenities	

The general order of curb space priorities in this hypothetical example is shown in the first column.

Step 2: Identify Potential Curb Uses

The next step is to identify potential curb uses that fall under each category of curb space priority in the order established.

The list to the right illustrates potential elements that fit within the prioritization for this block. Planners and designers should use professional judgement when selecting elements because not every curb element within the high priority curb use categories will be appropriate or feasible.

The prioritized list of curb elements should be used as a menu of options for building out the curb space of the block.

For example, even though this hypothetical block has pedestrian modal emphasis, sidewalk extensions are not included in the list because the feasibility of sidewalk extensions is driven by factors beyond curb management, and sidewalk extensions are not feasible on this block.

The outcome of this step is a list of potential curb uses in a general order of priority.

Example Curb Priorities and Uses

1. Pedestrian and transit mobility

Curb uses:

Bus stops

Bus lanes

Queue jumps

Curb extensions

2. Access for people

Curb uses:

Taxi/for-hire vehicle zone

Bike/scooter parking

Short-term parking

3. Access for goods

Curb uses:

Truck loading zones

4. Amenities

Curb uses:

Seating/dining

Plantings

Green infrastructure

5. Storage

Curb uses:

Bus layover/staging

Construction staging

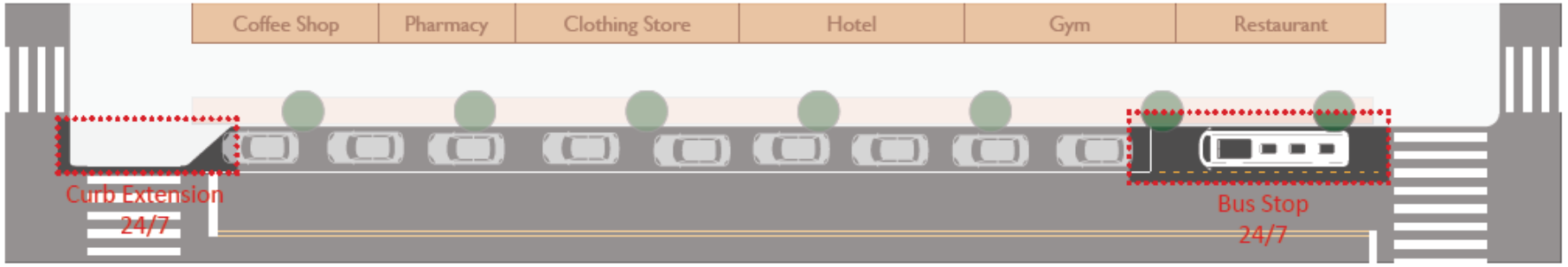
Long-term parking

Step 3: Design the Curb Space

The graphics below show the sequential process to transform the curb uses along the hypothetical block to serve the highest priority needs of the block. Many of the curb uses are applied in a flexible manner to make efficient use of the space during different times of the day.

First considering the Mobility needs, this street segment has both Pedestrian and Transit Modal Emphasis. The parking lane provides an opportunity for a curb extension to shorten the pedestrian crossing distance. In this hypothetical example, the curb radius would be examined to determine if it is sufficient, and in this example, we assume that it is.

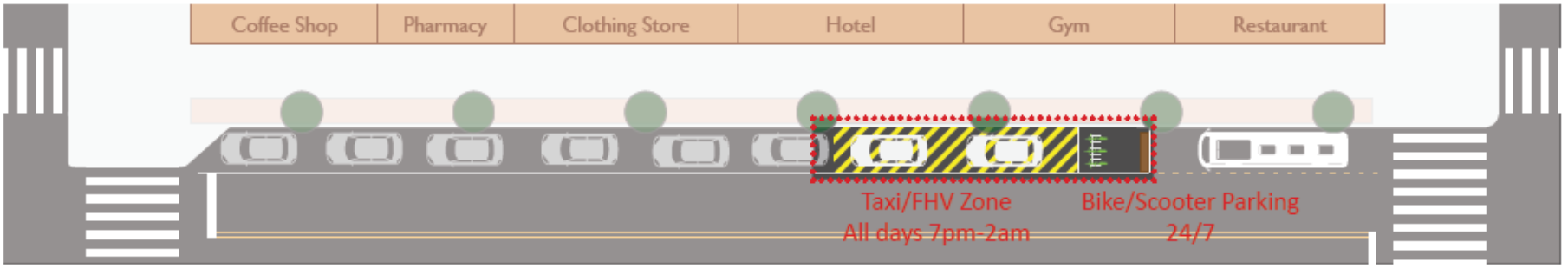
Also, the design of the bus network determines that a bus stop is needed along this block. Two of the existing parking spaces are converted to a bus stop at the end of the block.



A curb extension and a bus stop are added to the curb uses to address the Mobility priority.

Next, considering Access for People needs, the space next to the bus stop was determined, in this hypothetical example, to be ideal to provide bicycle and scooter parking, so that people getting off the bus can easily take a scooter or bicycle to their final destination. One of the parking spaces is converted to bicycle and scooter parking.

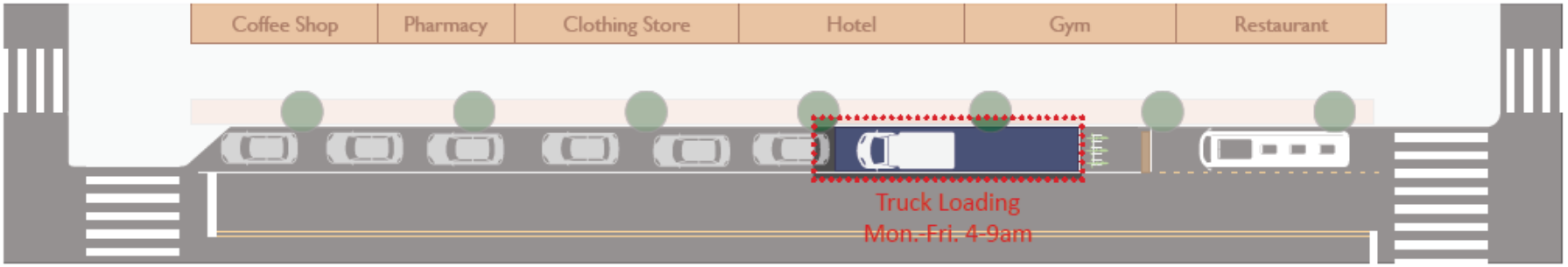
Also, the hotel and restaurant owners in this hypothetical example indicated many of their patrons rely on taxis and for-hire vehicles, and several of the businesses along the other blocks indicated their customers sometimes use for-hire vehicles too. Two of the parking spaces will be used for taxis and for-hire vehicles at the highest demand times, which are in the evening and late night.



Space for bicycle and scooter parking and a taxi and for-hire vehicle zone are added to the curb uses to address the Access for People priority.

At this point, six of the 11 parking spaces remain intact 24/7, which would be metered parking spaces during the day and long-term parking spaces overnight. These short-term parking spaces also contribute to the Access for People needs.

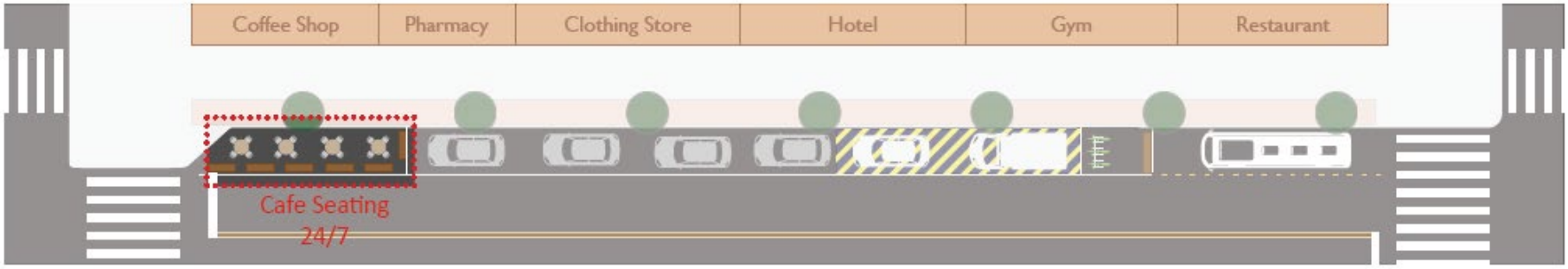
Now, considering the Access for Goods needs, the two spaces that serve as a taxi and for-hire vehicle zone can be used for truck loading in the early morning hours between 4 am and 9 am, which is the business owners indicated was the time of highest demand for deliveries for the uses on this block.



The spaces that are used for taxi and for-hire vehicles in the evening and late night can be used for truck loading and unloading in the early morning, addressing the Access for Goods priority.

To consider the Amenities needs, the businesses and residents indicated that space for outdoor seating would be a great asset. This not only helps add space for the business patrons on this block, but also enlivens the pedestrian realm of the area as a whole. Two parking spaces are converted to café seating.

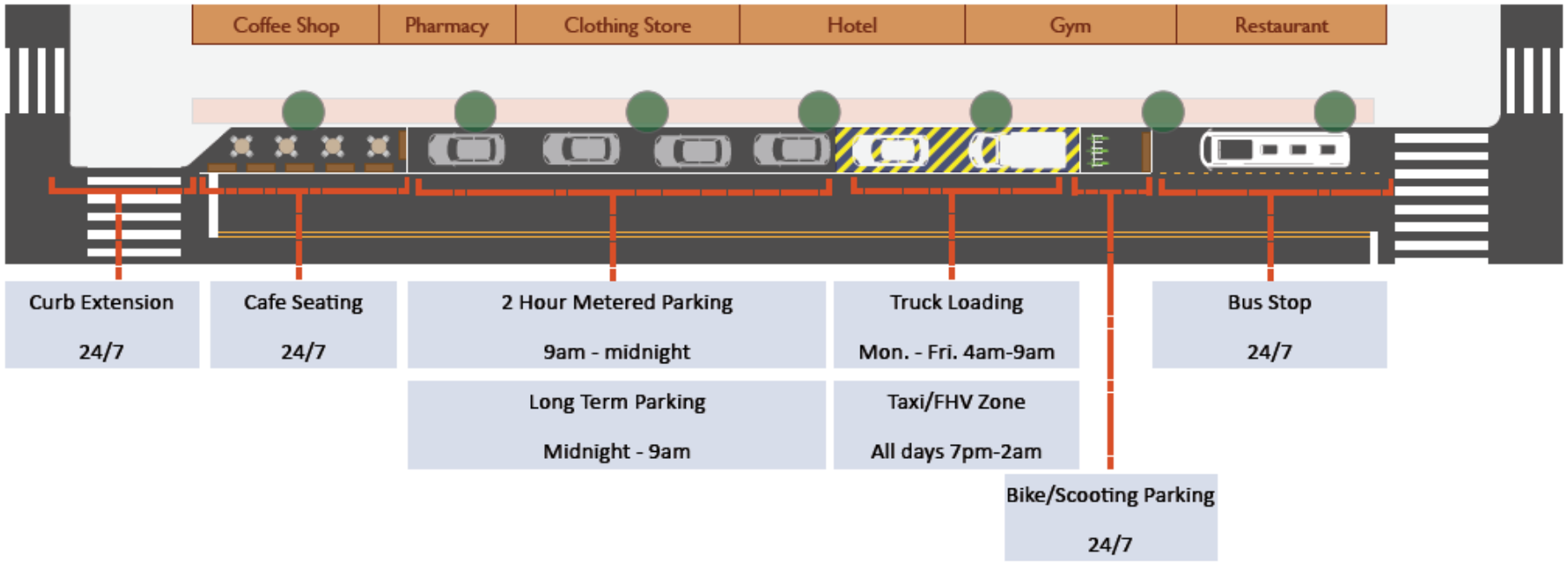
Based on this configuration, four parking spaces now remain for long-term overnight parking, and six parking spaces are available during the daytime for short-term metered parking.



Café seating is added to address the Amenities priority.

Putting It All Together

After designing the curb space for this block, the final design of curb uses is illustrated in the graphic below.



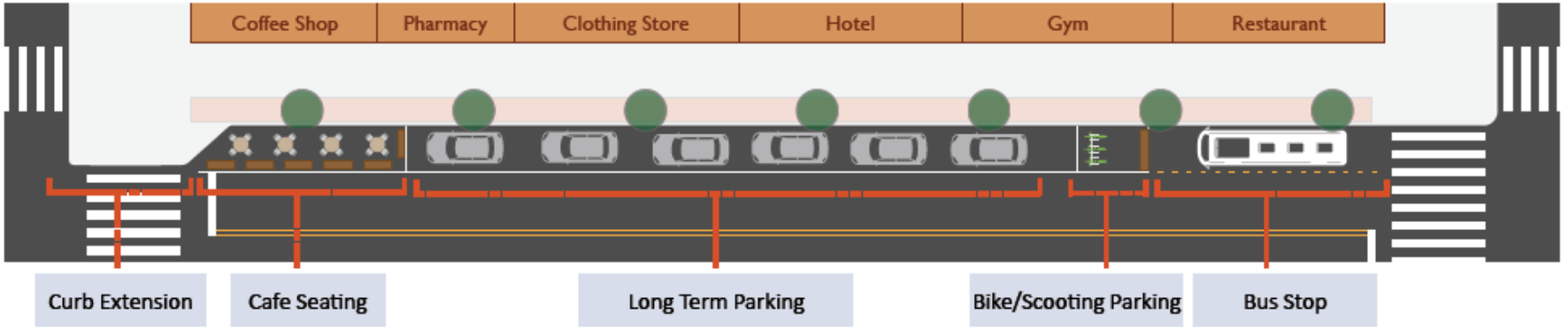
The final design of the curb space in this hypothetical example balances various needs and priorities of different businesses and residents. It addresses all of the various curb use priorities.

Illustrating Time of Day Flexibility

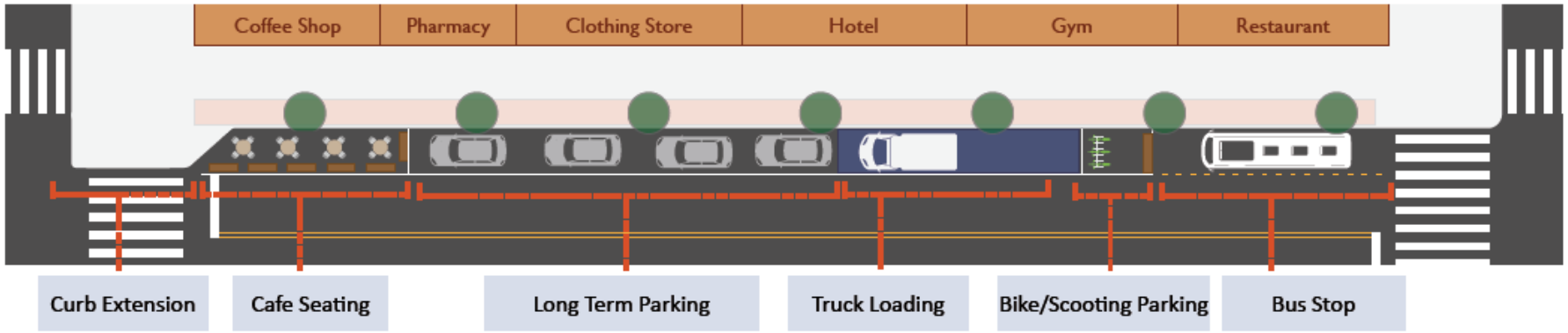
This example illustrates that while curb space is a limited asset, it is also flexible, and uses can change over the course of the day and week. In this example, the composition of the block is different depending on the time of day. Planners can take advantage of flexible elements to accommodate a mix of curb demands that vary by hour.

Enforcement will be key to making this arrangement work and will require additional hours for parking enforcement by either the City's Parking Division staff or a strong partnership with the Norfolk Police Department.

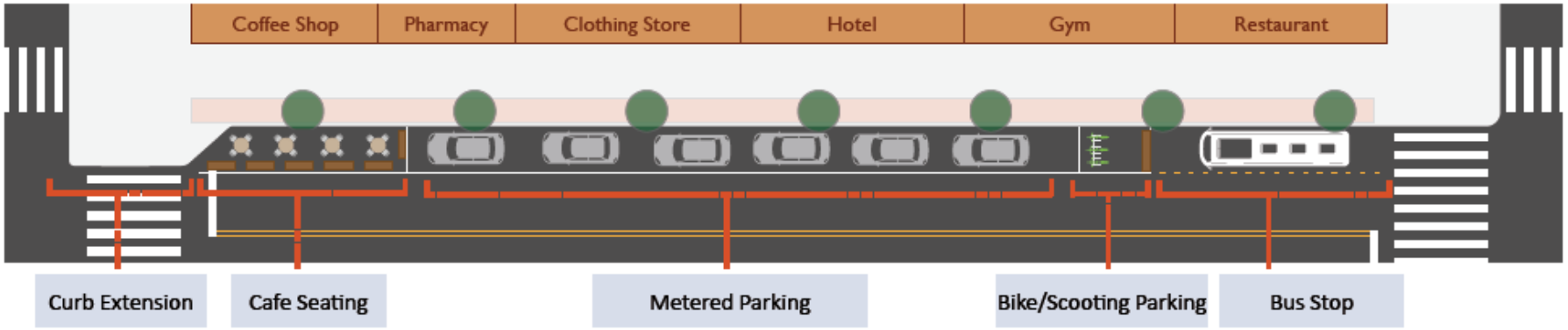
Snapshot: 4am



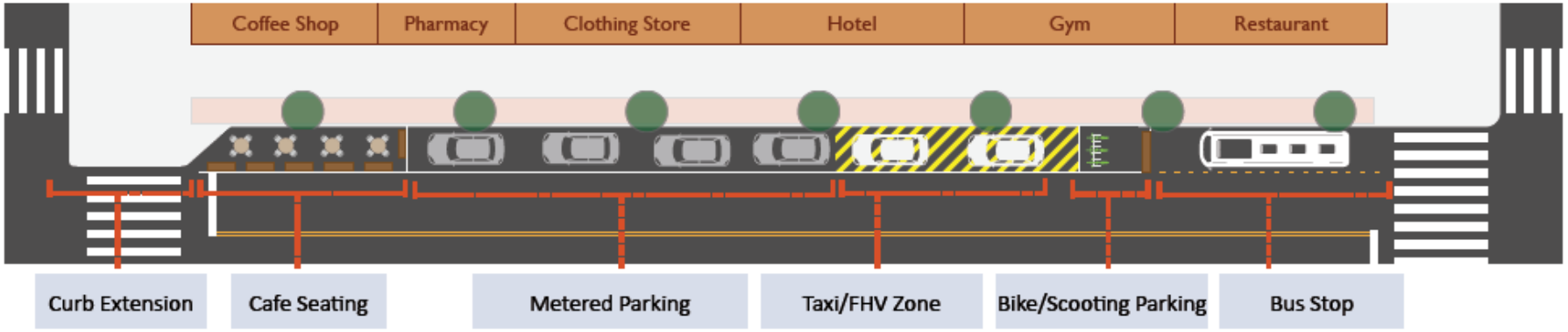
Snapshot: 6am



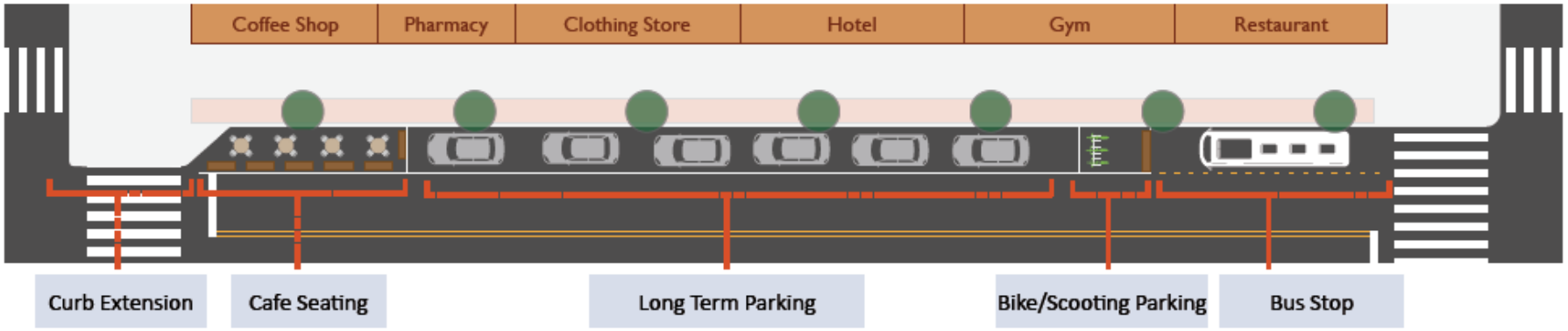
Snapshot: Noon



Snapshot: 8pm



Snapshot: 2am



Chapter Conclusion

Curb space is an often-overlooked part of the street, but it plays a key role in moving people and goods and accessing land uses. There are many different demands competing for the curb, but curb space is flexible and can be managed to accommodate a variety of activities on a block at different times of the day. Because it is not always possible to accommodate every desired curb use on a block, it is critically important to prioritize curb uses and provide a balanced transportation system that advances Norfolk's goals.

Curb space, like the rest of the street right-of-way, can be managed to balance critical needs in space-efficient and beneficial ways and achieve Norfolk's multimodal goals for its transportation system. The above flexible, context-based framework encourages a proactive look at curb space to maximize the number of people and amount of goods that can use curb space to access homes and businesses.

Chapter 10: Data and Technology

Chapter Purpose

Transportation is on the verge of a series of profound changes, many of these changes are being led by technological advancements in the areas of infrastructure management, system integration and data aggregation. As technology continue to evolve, the City of Norfolk aims to be at the forefront of understanding and anticipating the potential impact of new technologies on their transportation systems and the larger urban environment.

A significant part of the development of the Multimodal Norfolk Transportation Master Plan is being able to provide recommendations related to leading-edge innovations and emerging technology trends in the transportation industry.

In regard to recent technological improvement efforts, the City of Norfolk is currently in the process of upgrading its traffic signal system to a centralized Advanced Traffic Management System (ATMS). Using ATMS, traffic signals are connected to a central Traffic Management Center (TMC) by fiber optic and wireless networks. The use of ATMS would allow for improved vehicle detection capabilities, use of thermal imaging cameras and in-road magnetometers to report back to the TMC.

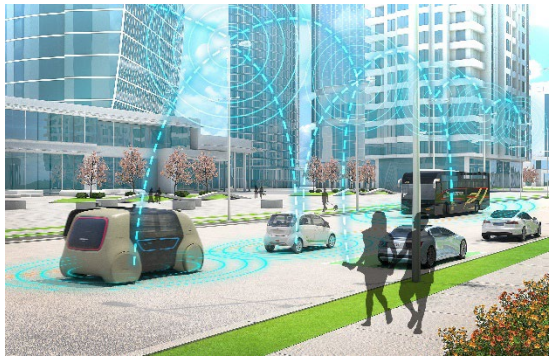
The City of Norfolk is also in the process of installing closed-circuit television (CCTV) cameras, which will allow for the monitoring of traffic conditions in real-time within the TMC. These current investments by the City are paving the way for other potential technological solutions, which can support efforts to continue to create a more efficient, sustainable and safe transportation experience for users.

Due to the constantly changing nature of technology, the purpose of this chapter is to provide general guidance and insights related to applicable types of technological solutions that align with the vision, goals and objectives of Multimodal Norfolk, as well as provide relevant technology use cases and case studies.

The recommendations provided serve as potential technological solutions for the City of Norfolk. They are deemed exploratory and a starting point for further in-depth evaluation and study prior to deciding if, how, when and where these technologies are implemented and integrated with existing systems.

This chapter provides a detailed framework for the evaluation of technology solutions, from preliminary scoping to the development of a Concept of Operations (CONOPS). Industry trends related to infrastructure management, system integration and data aggregation are provided as major considerations that impact the evaluation process. Overviews of each of the three technology areas are given including examples of technology providers in the market, specific use cases for the City of Norfolk, as well as case studies from other jurisdictions.

This chapter then concludes with a summary of major findings for technology solutions, as well as critical next steps once CONOPS for a proposed technology solution has been drafted and approved.



Emerging technologies such as Connected Vehicles and Automated Vehicles (CV/AV) will generate new opportunities to collect and analyze data to optimize transportation

Overview

Technology is an important tool leveraged by cities to address the current and future needs of transportation systems. The use of technology allows for the exponential increase in efficiency when conducting tasks (which without technology would normally take longer to complete), from inventorying assets in the field to analyzing the change in condition of assets overtime. However, the main issue is the associated risks and costs when adopting new technology. The risks vary based on the appetite for technology adoption – from those who are technology innovators (being the first to adopt) to those who are technology laggards (being the last to adopt).

Technology innovators are defined as risk takers with access to resources and the motivation to be first to try something new despite a higher probability of failure. Early adopters are defined as individuals who are excited about possibilities new technology and make decisions based on reducing uncertainty when adopting new technology. Early majority users are defined by making technology adoption decisions on having a thorough understanding of the impact of the technology. Late majority users are defined by making technology adoption decisions based on the increase presence and prevalence of technology. Lastly, technology laggards are defined as being



traditionalists who make decisions based on past experience and positive experience of others. The decision making of laggards is also partially driven by having limited economic resources to experiment or test unproven ideas.

For City of Norfolk decision makers and stakeholders, they will fall across the spectrum for technology adoption. These sensitivities towards technology adoption may also translate to the overall organizational culture. The key is to have an established framework for the evaluation of technology solutions that is informed by evidence. This can help to address the concerns of the different types of technology adopters. The framework proposed emphasizes on the systemic and iterative nature of the technology evaluation process, where new information can reshape each step. For the technology evaluation framework, the steps are as follows:

1. Preliminary Scoping
2. Refined Scoping with Stakeholders
3. Determine Potential Technology Requirements
4. Perform Market Research
5. Conduct Scenario and Impact Analysis
6. Develop Draft High-level Concept of Operations

Preliminary Scoping

The preliminary scoping process is the initial step of the technology evaluation framework and typically led by a small but key group of staff, internal to organization, who will be responsible for the overall management of the process including determining timeline, schedule and milestones for outcomes. This first step of the framework involves defining high-level objectives in considering a new technology solution.

During the initiation phase of technology evaluation framework, the aim is to develop the basis for the business case or justification of technology solution, general description of the elements of technology solution, anticipated outcomes of implementation, as well as assumptions and limitations as it relates to the technology. In addition, the preliminary scoping process includes analyzing existing

processes and workflows within the organization that would be directly impacted by technology solution.

Refined Scoping with Stakeholders

After the preliminary scoping is conducted, it can be presented to a larger group of stakeholders for further refinement. This process includes solicitating feedback and input of individuals internal and external to the organization that will be end-users of technology solution or have a vested interest, influence or importance to the implementation process. These stakeholders can include executive leadership, contracting or procurement staff and operations personnel who can provide insight on constraints and risks related to adoption of new technology from the prospective of their defined roles.

Determine Potential Technology Requirements

With technology solution scoped and business case defined, the next step is to determine potential technology and technical requirements needed for successful implementation. The main focus is transitioning from the general to more specific requirements, such as identifying and listing specialized hardware, software or equipment required. The increased involvement of IT staff and end-users is critical to this step's success.



A critical aspect of technology development and application is scope definition through consultation with key stakeholders to determine the characteristics of the minimum viable product.

Part of this step also includes distinguishing between functional requirements and non-functional requirements. Functional requirements being the elements of the technology solution that result in a minimum viable product (MVP), or version of product with just the sufficient elements to be usable, whereas non-functional requirements are elements of the technology solution that are not immediate or essential to result in a usable product. These non-functional requirements are deemed to be amenity features or capabilities that can be incorporated as part of future iterations.

Perform Market Research

Market research is a key part of the technology evaluation framework. It helps to provide an increased understanding of technology offerings, current and underdevelopment, within the industry. Market research can also aid in garnering insights from other organizations that have explored or adopted similar technology solutions being evaluated. As such, this step involves interacting with technology vendors and their customers via surveys, interviews and focus groups to learn more about the variety service offerings available on the market and associated user experiences.

This process can be as formal or informal as needed, from issuing Request for Information (RFI) through contracting and procurement office to scheduling webinar or requesting demo version(s) of technology. In addition, it is important to note that this can be a complex step and become outdated quickly as vendors frequently enter and exit the market along with vendors continually enhancing their technology solutions.

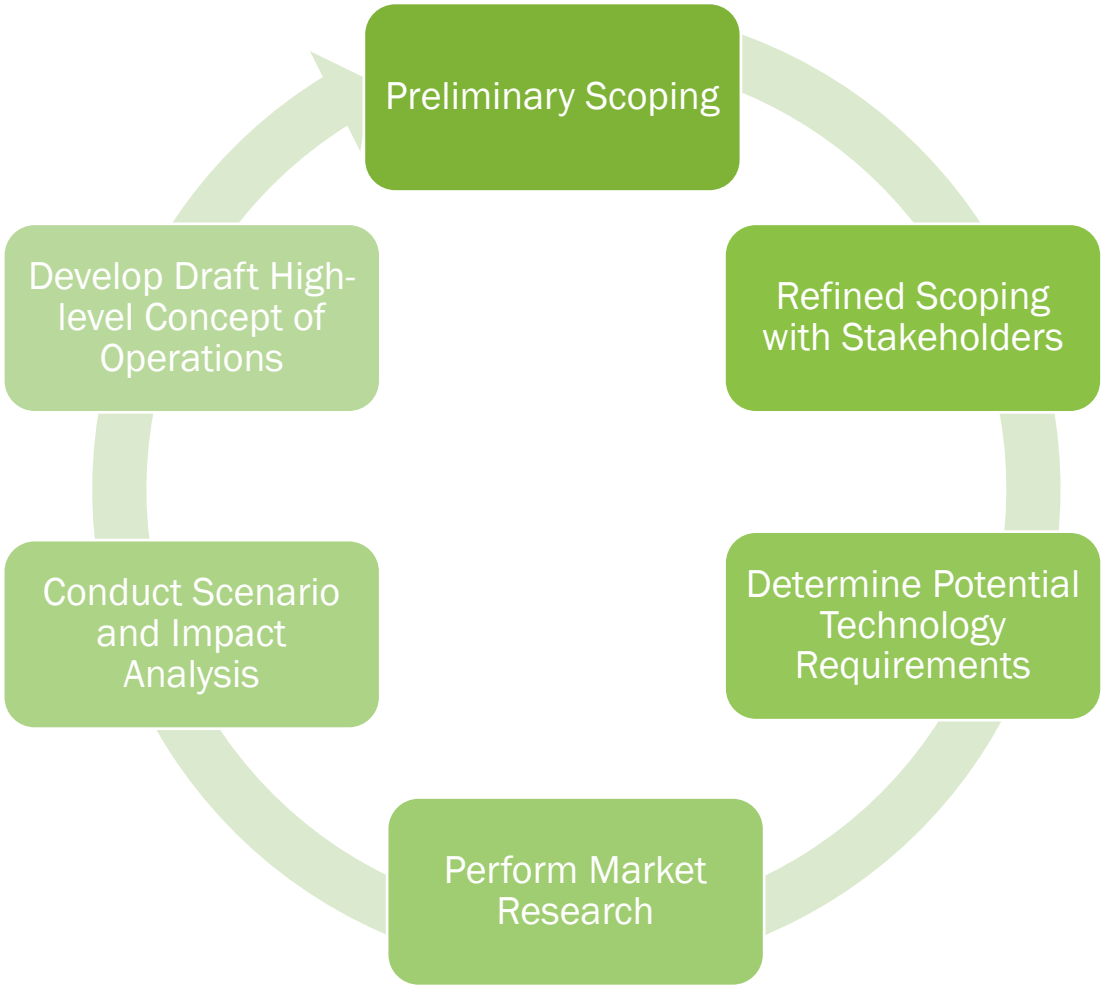
Conduct Scenario Analysis

While market research can inform how technology solutions have been implemented in previous cases or contexts, the observed outcomes from these previous cases may not necessarily

correlate to the potential outcomes for the defined business case under consideration. As such, conducting scenario analysis or using a scenario planning tool to analyze a specific technology adoption can provide a series of potential outcomes to evaluate. These outcomes can help manage risk associated with investing in new technology including likely scenarios and worse-case scenarios. Specifically, outcomes are compared to each other based on impact to resources, finances, operations and other relevant performance measures. Outcomes can include the impact of technology on traffic conditions or decision making as it relates planning construction projects.

Develop Draft High-Level Concept of Operations

Concept of Operations (CONOPS) is the intended end product when applying technology evaluation framework. Based on the work conducted in the previous steps, a CONOPS is developed which can be both a written and graphical document capturing the proposed technology solution's characteristics from the perspective of an end user of the technology solution. The CONOPS considers goals of the technology solution, polices and constraints impacting the implementation of technology solution, associated organizations, and activities of participating stakeholders, and lastly, roles and responsibilities of stakeholders. Overall, the CONOPS describes the intended users, uses and conditions for use of technology solution. It is in turn used as an input for the identification, development and procurement of the technology solution and assessing its ability to meet specified functional requirements.



Overall, the application of the technology evaluation framework is an iterative process. As more information is collected in each of the steps (from engaging with stakeholders to conducting market research), the more refined the CONOPS

and the ability to successfully identify and obtain the desired technology solution.

As part of the City of Norfolk's efforts to explore technological advancements in the areas of infrastructure management, system integration and data aggregation, initial findings that are provided in the subsequent sections can inform further in-depth evaluation of technology solutions.

Privacy Considerations

There is concern about privacy and surveillance with the Smart City applications. For instance, in Toronto a plan to create a highly connected neighborhood was canceled because of lawsuits claiming that the plan violated Canadian citizen's rights.[i] The use of video monitoring, remote sensing, and other data collection efforts to optimize the use and management of the infrastructure can also have unintended consequences if there is no clear plan on how and how long the data will be collected, used, stored and disposed of. Also, the security of the data needs to be considered to protect Norfolk's residents from potential hacks, Robust privacy policies, data use and cyber security policies and data openness will be necessary to overcome them.

Technology Procurement Strategies

For any technology solution related to infrastructure management, system integration or data aggregation, different procurement strategies can be considered along with the steps outlined within the technology evaluation framework. Whether the technology solution is developed in-house, vendor supported via custom solution or commercial off-the-shelf (COTS) product, each option has advantages and disadvantages that must be considered in terms of achieving the desired technical functionality and requirements.

Procurement Strategy	Considerations
In-House Developed Solution	• High degree of flexibility • Requires additional time and resources of City of Norfolk staff; may impact existing workflows • Retain ownership of system and intellectual property rights • High costs and extended timeline • Ability to sell product to other jurisdictions and agencies
Vendor Supported Custom Solution	• High degree of flexibility • Efforts led by vendor with the guidance from City of Norfolk • Ability to retain ownership of system and intellectual property rights • Medium costs and shorter timeline • Ability to sell product to other jurisdictions and agencies
Commercial off-the-shelf (COTS) Solution	• Least degree of flexibility • Limited ownership of system and intellectual property rights • Lower costs and quicker timeline • May not meet technical functionality and requirements for City of Norfolk • Likely high additional cost for any add-on functionality outside of COTS product

In addition, the identification, procurement and implementation of technology solutions should emphasize sustainability and resiliency. Sustainable delivery of the technology refers to the technology resulting in limited economical, ecological and societal impacts. Resilient technology refers to the technology being adaptable to disruptions, as well as changes in business case requirements. The use of open platforms that are able to accommodate third party applications will make this approach resilient and able to adapt to rapidly changing technology.

Industry Trends

While asset management for infrastructure or asset management as a concept has been around for some time, in recent years there has been an increase in leveraging technology to improve asset management operations and procedures. Using technology and data-driven processes, cities with critical transportation infrastructure have been able to develop, operate, maintain, upgrade and dispose of their assets in a more cost-effective way.

Specifically, infrastructure management trends have focused on extending the life cycle of existing facilities by using automated monitoring and sensor technology, as well as applying artificial intelligence (AI), machine learning, and business intelligence applications and tools. Used in combination, these technologies allow for the development of dynamic Decision Support Systems (DSS) and Enterprise Asset Management Systems (EAMS), which provide decision makers with the ability to make informed strategic planning and infrastructure investment choices. With constraints related to limited funding and resources, technology has been used as a stopgap by cities to address issues related to maintaining increasingly degrading infrastructure. It has also allowed for the maintenance of infrastructure while limiting disruptions to service.

In terms of system integration, industry trends emphasize the significance of the interdependences between connected infrastructure systems. To manage assets effectively, it is not only important for the people responsible for infrastructure management to communicate, but also those responsible for the physical systems to communicate with one another as well.

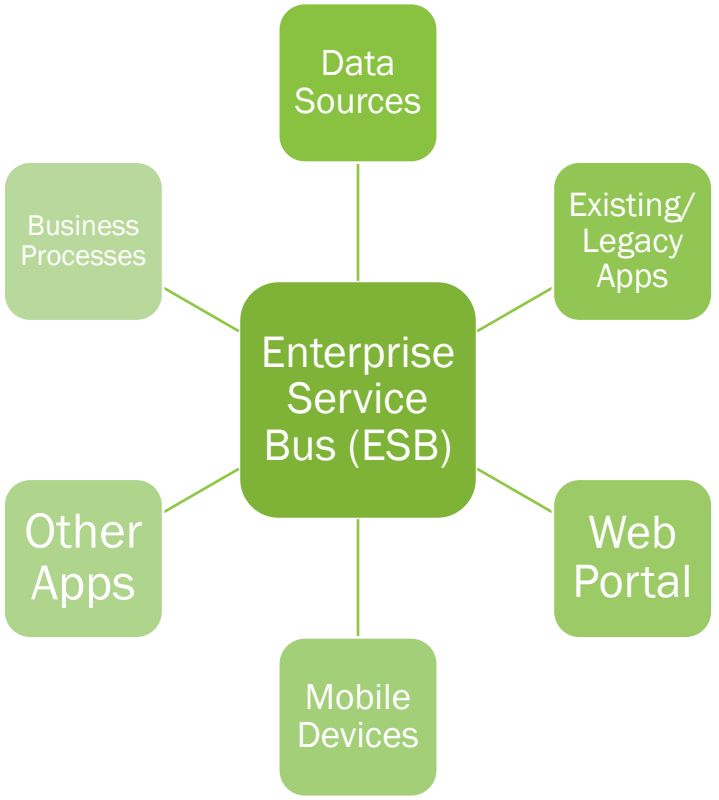
Roadways are a prime example of an asset physically located in the same right-of-way as other infrastructure, such as water mains, stormwater and wastewater systems, telecommunication and electrical lines and natural gas service. A scheduled repair or failure of the roadway can have a cascading effect on these connected systems. As such, being able to communicate impacts to the roadway in near real-time is key to the operation of the larger transportation network as well as these other connected systems. With an increased flow of information, operational costs can be reduced as well as the downtime of systems while they are undergoing maintenance or repair.

Disruptions to the transportation system can be mitigated using active traffic and congestion management tools based on open platforms that ingest various streams of data and take third party application. Integrating existing information and data systems such as the Norfolk Police Department's Computer-Aided Dispatch system and roadway cameras of critical intersections and throughputs allow for the proactive management of local traffic congestion. The mobilization of traffic enforcement officers, deployment of traffic control measures such as barriers and Variable Message Signs (VMS), as well as the broadcasting of alerts on advisory radio channels in response to incidents can be done more efficiently with system integration. During non-emergency situations, increased information sharing also aids in coordinating everyday workflows. For example, system integration can help to avoid the situation where a roadway surface is repaved before the required replacement of a water main underneath.

System integration allows for increased transparency and information sharing. However, effective system integration is dependent on the accuracy of the information shared. Data aggregation allows for the compiling information from disaggregate databases with the intent of combining those databases for processing. The industry trend has been the increased use of data aggregator software and tools to conduct predictive analytics and identify outliers and trends within the data in near real-time. The results of data aggregation can serve as an input for Decision Support Systems, which are used to manage infrastructure systems. However, data aggregation can result in the discarding of

valuable information that may be necessary for other applications. In addition, there are cost and efficiency considerations to account for related to the collection, transmission, storage and retrieval of data, as well as data security and ownership concerns. As such, the specific algorithms or methodology used for aggregating different datasets is based on business case requirements, as well as size, frequency and other characteristics of the datasets.

Infrastructure management can be enhanced by integrating across different systems. Each system communicates with one another or communicates to a central system, such as an Enterprise Service Bus (ESB), to provide a holistic overview of the larger connected network of infrastructure. The integration of each individual system involves the appropriate data aggregation methodology being applied to meet scoped business case.



Infrastructure Management

The City of Norfolk is responsible for the provision of transportation services to its residents. These services rely on infrastructure and include sidewalks, streets, lighting, sewerage, bus stops and shelters, signage, fiber among others.

The Department of Information Technology provides the support framework for customer-focused services. Its three focus areas are providing enterprise-wide technology support and solutions to enhance efficiency, strengthening cybersecurity, and powering data-informed decision-making.

One of the department initiatives is the **Smart City Plan or Smart Norfolk** which seeks to:

1) create a digitally connected public and infrastructure;
2) develop new business opportunities to drive growth;
3) encourage tech-savvy individuals to make Norfolk their home;
4) lead to greater efficiency and productivity; and
5) offer a higher quality of life for residents.

The Department of Transit through its Transportation Engineering division is responsible for the **Traffic Operations Center and Traffic Management Center** that operate and maintain the traffic signal and traffic management systems, maintain all street signs and pavement markings (including 312 traffic signals, 120 school and pedestrian crossing signals, 22 continuous and activated flashers, over 31,000 streetlights, 700 miles of traffic lane lines and 813 crosswalk locations) and assist with special events.

The Parking Division under the General Services Department operates over 19,000 public parking spaces located in 14 garages, 10 lots and more than 500 on-street spaces.[ii] To facilitate parking, the city has launched **ParkNorfolk Mobile Pay** to pay with credit card, extend parking sessions, and access discounted parking. Other organizations that require information on the conditions and status of the infrastructure in Norfolk include the Emergency Preparedness and Response, Office of Resilience, Public Works, Utilities, Norfolk Data and City Planning.

To manage their infrastructure effectively, cities rely on system integration and data aggregation to support infrastructure management. Each infrastructure element has systems that were created to facilitate its operation, monitoring and management. These applications tend to be proprietary and specific to a technology that over time may not be as responsive as needed.

Smart Cities

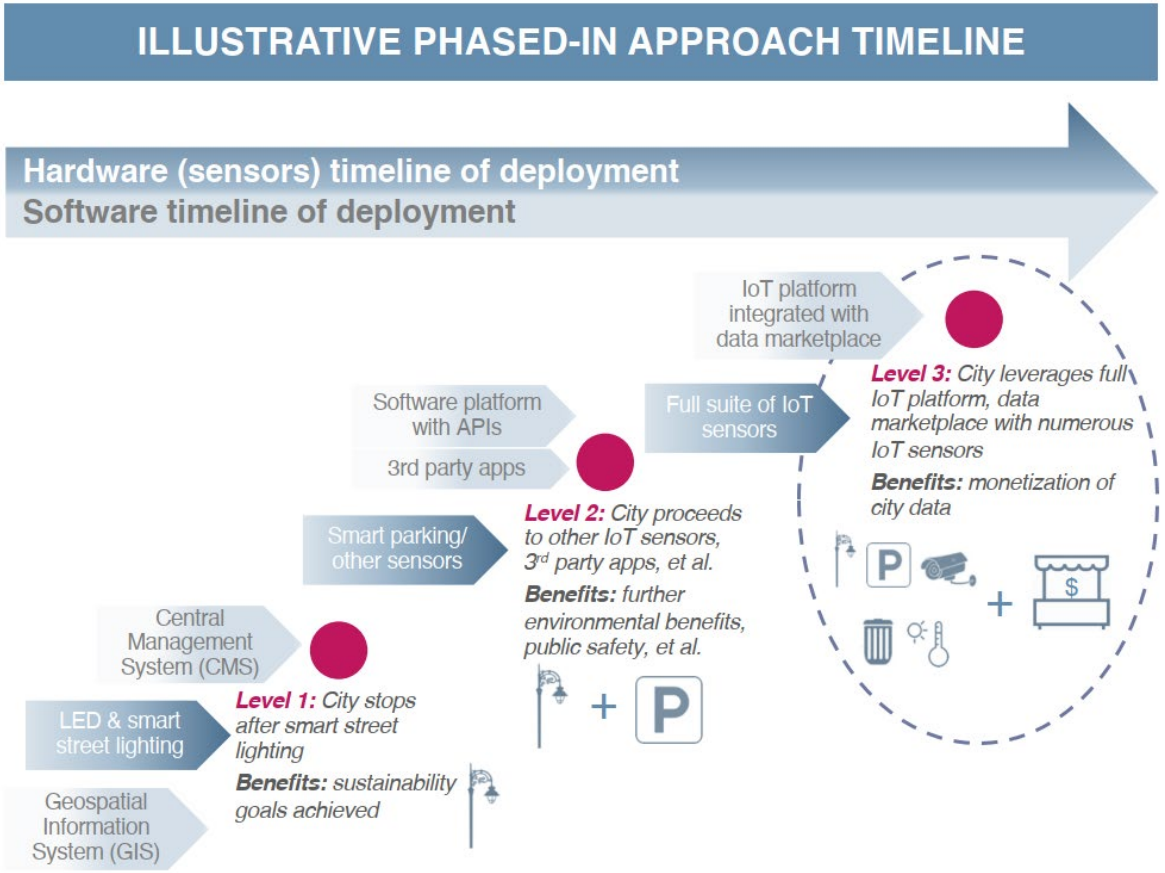
Smart Cities are defined as areas where technology applications (communicating devices and sensors) provide direct benefits to the city and provide data points that can be used in the future. This technology application provides clear financial (cost reduction), environmental (reduce consumption and increase efficiency), and health & safety benefits (real time information, faster response to incidents).

Applications can include:

- Street Lighting,
- Smart Parking,
- Video Monitoring,
- Air Quality Monitoring,
- Public EV Charging,
- Smart Waste Bins, and
- Open Data Apps among others.

Internet of things (IoT) platforms include unified dashboards, open standards for devices, analytics and "as-a-service" models that allow for new devices, services, and applications to be added with minimal additional cost.[iii]

The image to the right is an illustrative phased-in approach to exemplify a potential application implementation.



Source: IoT Software and Platforms (2020). Northeast Group, LLC and Signify

Electric Vehicle Charging Stations and SMART Streetlights

Smart City Solutions for Norfolk can include **Electric vehicle charging stations** for both commercial (fleet and public service) and residential applications (for example - ChargePoint+).

For **residential applications**, an EV Charging Station Program will be needed to guide the permitting and installation of EV chargers in house garages, private parking lots and curb spaces that meet the permitting office and the department of transportation requirements (including determining appropriate location, and if on public space, ensure that there is sufficient parking availability, and permanent underground conduit installation).

There are several companies that offer these chargers for Level 1 (120 volt) or Level 2 (240 volt) applications. Level 2, 240-volt EV charging stations charges any EV up to 9 times faster than normal wall outlet.

For **commercial applications**, there are Level 2 and Level 3 (DC Fast) chargers can be deployed by private companies. These companies offer LCD screen, single or double chargers, support services such as configuration and activation, maintenance, and management services plus ability to see available chargers and pay through a service app.

The City of Norfolk has several contracting options to offer charging:

1) charging-as-a-service (similar to any other utility, with no CAPEX and only pay for its use),
2) purchase the chargers and offer the service itself with management and maintenance service contracts, or
3) develop and deliver all aspects itself.

The implementation of the charging stations would require coordination with the Permitting Department to create a process to guide design and construction, and review applications for commercial purposes.

Company: -ChargePoint+

Established: 2007

Headquarters: California, USA

Technology: Electric Vehicle (EV) charging stations (residential and commercial)

Website: www.chargepoint.com



Residential Electric Vehicle Charger (ChargePoint +)



Commercial Electric Vehicle Charger (ChargePoint +)

SMART GRID enabled LED streetlight applications aim at reducing energy costs and increase efficiency on its service provisions (companies include Interact City (Signify) and OSRAM). The system is anchored by software applications that manage the connected lighting systems and the data these systems collect. The system also conducts asset management through monitoring of function, energy consumption and performance. It also allows the energy optimization through dimming, scheduling (time of day, season, or event) and zoning (plazas, parks) of the lighting based on traffic and pedestrian use. An additional benefit includes the potential of incident detection as the lampposts uses sensors to monitor traffic, sounds and crowd noise. The applications consolidate the operation and information collected on dashboards and offer APIs.

An example of the benefits of implementing Smart Lighting is the City of Guadalajara in Spain where 13,500 connected LED light points and 187 cabinets controlled by Interact City software were installed as part of an upgrade to improve the efficiency in city lighting (see box to the top right). Lighting accounted for nearly 50% of the energy consumption of the city. The smart lighting program was able to reduce energy consumption by 68%, eliminated 4,200 tons of CO2 emissions annually. It has also improved the service to citizens with a reduction in failure complaints to less than 1% per year with its increased to safety. The lighting management software monitors performance, energy consumption and fault detection.[iv]

Another example of the potential of Smart Lighting comes from AMS-OSRAM in Switzerland where the city of Biberstein, as part of an extensive renovation project, replaced their luminaries with LED luminaries equipped with an interface for communication and sensing (see box to the right). The luminaries were placed on roads, paths and places to be illuminated efficiently and economically. One of the benefits of this application is the control over the intensity of the luminaries. To reduce light pollution, the luminaries are dimmed if there are no pedestrians and as soon as a pedestrian enters the path, the lighting comes on completely.[v]

Company: Interact City (Signify)

Established: 1891

Headquarters: Netherlands

Technology: Connected lighting software, lighting, IoT

Website: www.interact-lighting.com/global

Company: AMS-OSRAM

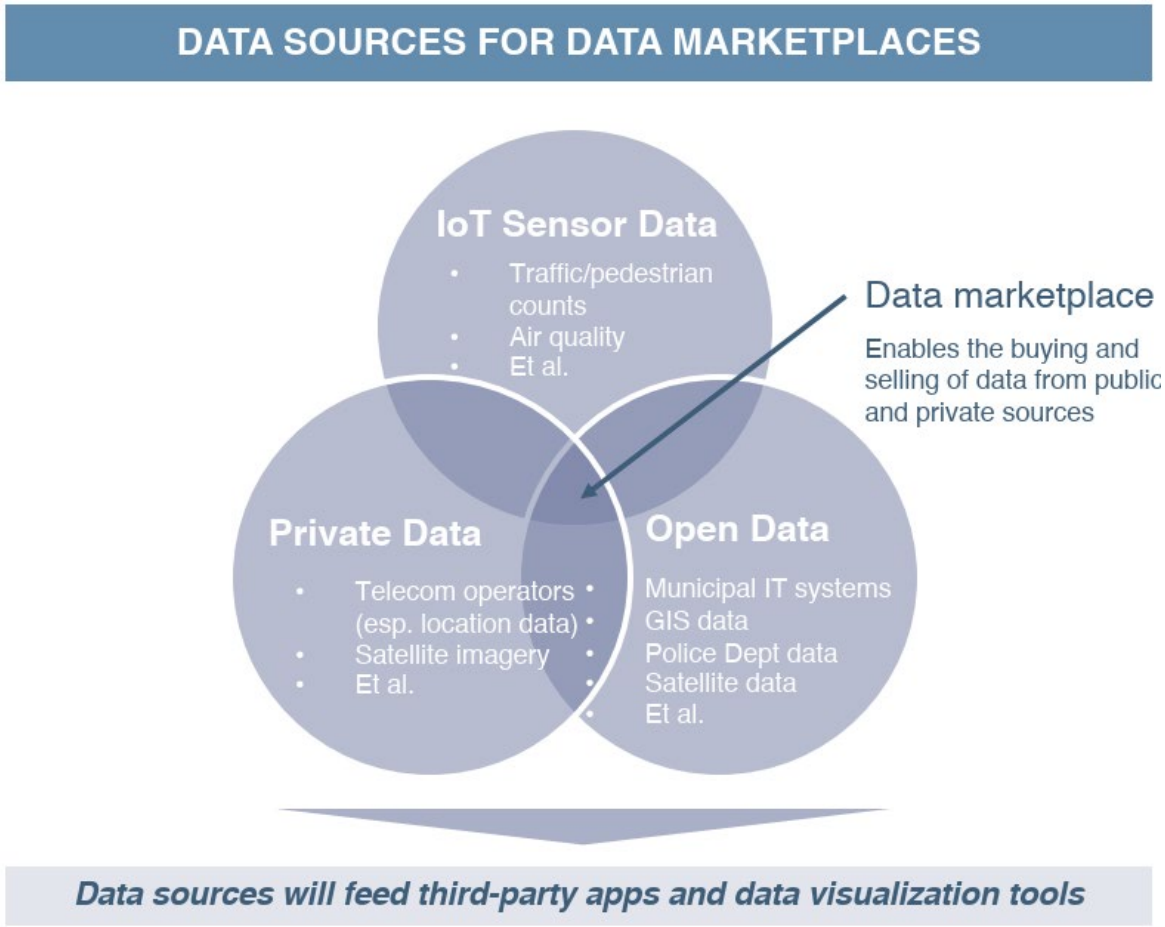
Established: 1906

Headquarters: Munich, Germany

Technology: Sensing, Illumination and Visualization

Website: www.osram.com/cb/

The image below shows the various data sources and potential data marketplaces.



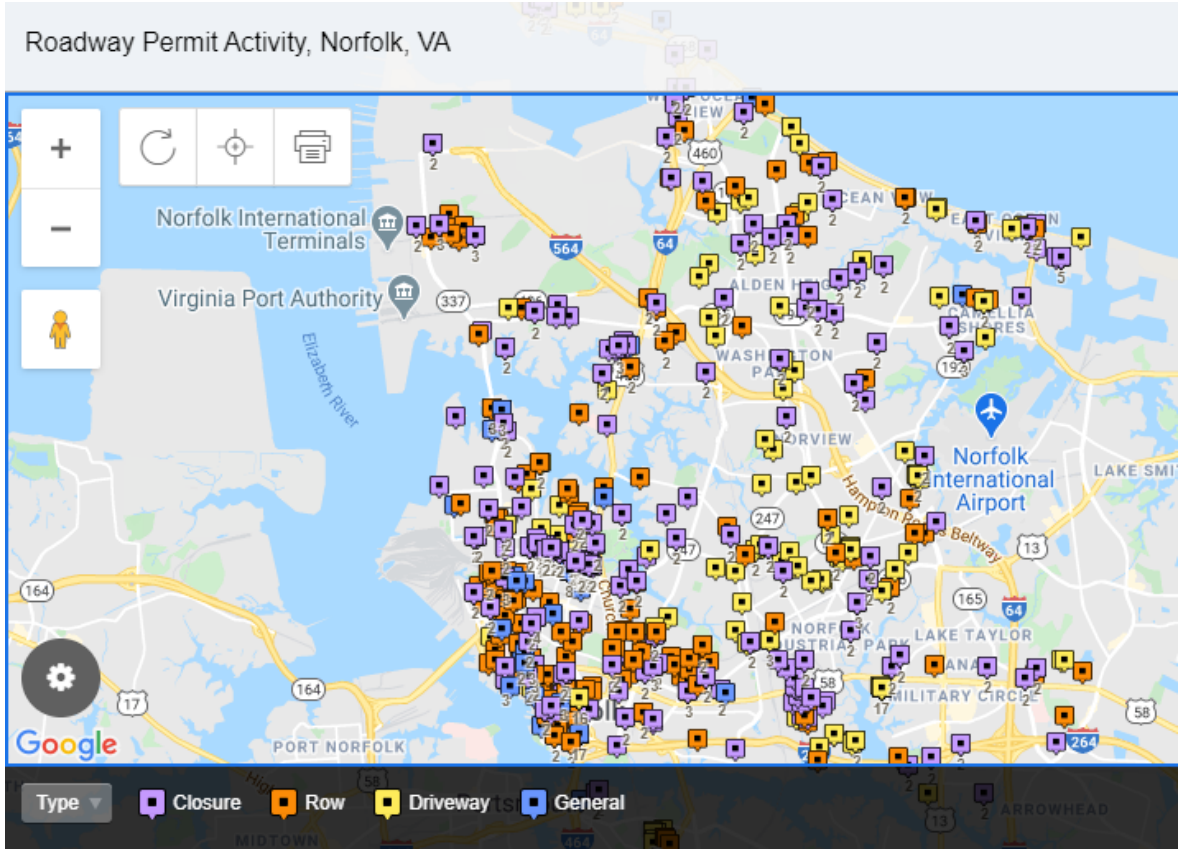
Source: IoT Software and Platforms (2020). Northeast Group, LLC and Signify

System Integration

Technology related to system integration can be leveraged to more effectively manage connected infrastructure systems.

The City of Norfolk Department of Transit is responsible for planning, developing, and maintaining a multi-modal transportation system that supports all modes of transportation. There are inherent interdependences between each of the transportation options made available to users. For instance, many share the same right of way.

The Division of Right of Way Management within the Department of Public Works coordinates, permits, and inspects construction and other activity within the roadways and serves as the liaison to developers, contractors, and private utility companies. It currently provides a GIS-based report of road and lane closures for the City, which includes the street address, X and Y coordinates, applicant, type, and start and end date of permits issued. It is powered by BatchGeo, a technology provider that allows for the copying of data, validating data and setting options for display, and mapping of locations. The information collected and visualized via BatchGeo is critical for coordinating work with other agencies, such as other divisions within the Department of Public Works that maintain physical facilities, and the



Department of Emergency Preparedness and Response when responding to incidents.

In addition, the lane closure application can be leveraged by the City of Norfolk Department of Transit's Traffic Operations Center and TMC systems for managing congestion on the roadway, including integrating with other systems tracking special events and special traffic advisories. BatchGeo is an example of technology that the City of Norfolk can use to support system integration efforts.

As the City continues to identify opportunities for increased integration between infrastructure systems, there are technology solutions related to active traffic and congestion management, parking and curbspace management, and mobility-as-a-

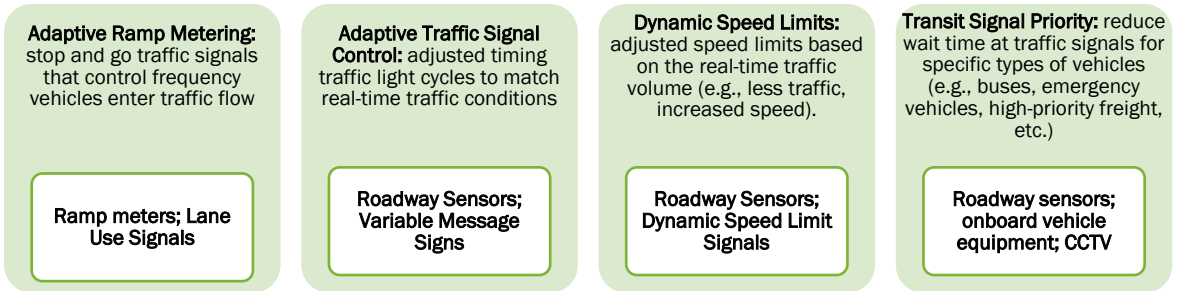
service that can inform these efforts as well as associated case studies.

Active Traffic and Congestion Management

Active traffic management (ATM) refers to the dynamic management of recurrent and non-recurrent congestion based on the underlining and predicted traffic conditions. The intent of ATM is to influence traffic behavior via user choices and operation of transportation facilities. ATM strategies include adaptive ramp metering, adaptive traffic signal control, dynamic speed limits, and transit signal priority (TSP) among others. With the implementation of each of these strategies, there are active technologies that must be deployed, installed and monitored (as shown in the graphic to the right).

With the various technological components utilized for each individual ATM strategy, it is beneficial to have a system that can integrate existing and new technologies within a single platform.

HERE Technologies is a global company that provides platform-based solutions for connected driving, fleet management, supply chain, urban mobility and consumer engagement (see box to the right). Their platforms allow for creation, development and scaling of location-centric data, editing data in real-time, and the licensing and exchange of data. HERE Traffic platform



enables cities to map, analyze, predict, and react to real-time road traffic. It enables for more informed decision making as it relates to road-engineering, traffic flow, road network management, and land use. As such, it has both traffic operations and traffic planning applications.

In terms of operations, HERE Traffic combines reported data and automated data, such as GPS probes points (road sensors and connected vehicles) to enhance operational capabilities. Through the combined data sources and technologies via HERE Traffic Dashboard, up-to-date areas of congestion, travel times on roadway variable message signs, as well as reports on performance measures such as reliability are provided. In terms of planning, HERE Traffic collects data from real events, incidents and congestion, which overtime becomes a sizeable repository of historical traffic data that can be used for predictive travel patterns and to inform infrastructure development.

Company: HERE Technologies

Established: 1985

Headquarters: Netherlands

Technology: Tracking and positioning, traffic, mobility

Website: www.HERE.com

HERE Traffic technology solution has been utilized in the City of Ebersberg, Germany where the majority of the transportation network is located in forested areas which has high incident of vehicular accidents due to animals crossing the road. The issue of safety for drivers and animals was a high priority for the Ebersberger Road Authority (ERA) responsible for road safety. In collaboration with HERE, ERA utilized intelligence traffic technology to enhance road safety by optimizing the location of existing and new animal crossing signs, as

well as communicate via VMS real-time danger of animal crossing to drivers utilizing data streaming catalog of incidents. For the City of Norfolk, a similar approach can be taken in regard to recurring flooding incidents with optimizing the placement of "Road May Flood" signs along specific corridors as well as providing alerts for the potential for flooding via VMS.

Cubic Transportation Systems, Inc is a technology-focused company that provides transportation management technology solutions for public transit operations including but not limited to fare payment and surface transport management (see box to the right). Cubic Surface Transport Management platform solution supports data analytics and visualization across multiple modes of travel for a single operational view or common operating picture. The solution is able to integrate with legacy systems and third-party products, as well as scale based on the need.

Cubic Surface Transport Management serves as the base integration platform that can integrate existing systems into one customizable platform that allows for operators to strategically manage the individual traffic and transportation elements in a holistic manner. Cubic Surface Transportation Management customers include the Highways England, Transport for London (Tfl), Transport Scotland, and Transport for New South Wales. For Tfl, Cubic has been providing traffic control equipment maintenance, capital works and related services since 2014 with focus of work being in South East London. Cubic supports Tfl with the management of traffic control infrastructure including supply, installation, maintenance, modification and monetization of traffic signals and associated equipment, over-height vehicle detectors, and VMS.

For the City of Norfolk, systems integration can be across various operations including light rail and bus via Hampton Roads Transit, road traffic, ferry, traditional taxi cabs via Hampton Roads Transportation, Inc and environmental monitor systems. The solution allows collaborative data analytics as well as business-wide management reporting; all of which can done via cloud-hosting with platform being accessible using desktop, mobile devices as well as a public website for data sharing. The solution would provide map-based access with integrated situational awareness across all systems including implementation of signal plans, dissemination of transportation information, and predicative modeling for identifying potential incidents in advance.

Company: Cubic Transportation Systems, Inc

Established: 1951

Headquarters: San Diego, CA

Technology: Fare collection and revenue management, road user charging, surface transport management

Website: www.CUBIC.com

Parking and Curb Space Management

The increase in shared mobility options, such as e-scooters, e-bikes, and Transportation Network Companies (TNC) like Uber and Lyft, along with traditional taxicab services, has resulted in additional demand on the limited parking and curbside space for the City of Norfolk. Partly due to the COVID-19 pandemic, there has also been increased demand for online commercial and food delivery services. With these competing demands for the curb, there is a need for the City to be able to have a holistic view of the curb space from both an operational and infrastructure perspective.

In terms of operation of the curb space, technology provider, curbFlow has service offerings that enable its customers to determine real-time curb space availability for on-demand and commercial delivery operators to execute delivers in a more efficient and safer manner (see box to the right). Rather than the existing typical practice of vehicles double parking and blocking traffic, curbFlow can support the city in better managing parking spaces through vehicle counting, vehicle dwell-time detection and illegal parking detection technology. These enhancements can be used to determine trends for vehicle movements, reduce congestion by identifying idling vehicles as well as support law enforcement efforts and actions for vehicles double parking and blocking traffic. The technology leverages network of computer vision devices located on private property, machine learning to detect real-time availability and smartphone app and interface that shows inventory of parking. The use of this type of technology benefits both drivers as well as merchants and retail vendors. It can increase productivity of the curb, increase turnover of parking spaces and reduce circling time for drivers seeking parking.

In Washington DC, a curbside research pilot project was implemented by curbFlow in partnership with the District of Columbia Department of Transportation (DDOT). The pilot focused on analyzing the demand at the District's curbside spaces, with particular emphasis on designated pickup dropoff (PUDO) zones; a total of nine PUDO locations were evaluated. For the pilot, "ambassadors" (curbFlow employees) showed drivers and merchants how the system works and counted, classified users and measured benefits (this was done as part of the pilot with DDOT and may not represent their direct-to-market services). During the course of the pilot, which occurred over a period of three months, drivers reserved spaces over 15,000 times. Major findings of the pilot included a 64 percent decrease in double parking and illegal U-turn incidents, as well as an average of two and half minutes per PUDO activity. Using a similar approach, the City of Norfolk can identify streets that experience the most curb space activity and create designated zones. These zones can be then dedicated for drivers to reserve parking spaces, which can be paid in advance through technology platform.

Company: curbFlow

Established: 2018

Headquarters: San Francisco, CA

Technology: Curb space management for loading/unloading

Website: www.curbflow.com

While commercial delivery is one important element of managing the curb space, the demands on the curbside are also a function of time, community needs as well as public policy priorities, so having dynamic or evolving curb space regulations is important capability for City of Norfolk.

Using mapping technology tool provider, Kurb, the City of Norfolk can have a map-driven collaborative approach for designating the use of curb space from physically drawing space boundaries, utilizing virtual collaboration tools (e.g., chat function, file sharing, etc.) for providing and giving feedback between users as well as sharing and reviewing published maps (see box to the right).

It can save time and resources as it relates to allocating curb space for parklets, bus stops, bicycle corrals and more. The tool can be leveraged by the public for advanced reservation of curb space for specific activities as well as the permitting of space by other city agencies (enforcement or compliance is still required; DC effort used “curbFlow Ambassadors” that served as “parking attendants”).

The management of Park and Ride facilities can also be enhanced by analyzing their effectiveness as it relates to usage and their proximity to major employment or residential areas.

AECOM has also developed a concept of operations for dynamic or flexible curb space named FlexZones, which would allow for the adjustment of curb space designations in real-time based on the City’s priorities. The focus is on safety and efficiency and utilizing digital wayfinding signage – displaying usage and associated price – notifying drivers of current availability.

Usage of spaces can change in real-time to meet curb space demand. In combination with roadway sensors, CCTV cameras, dashboarding tool and mobile app, space allocation can be optimized based on availability along with price varying based on demand.

Space usage can also be restricted in the event of emergency incident, ensuring access for first responders. This type of forward-thinking can greatly enhance the management of the curbside space in the future.

Company: Kurb

Established: 2020

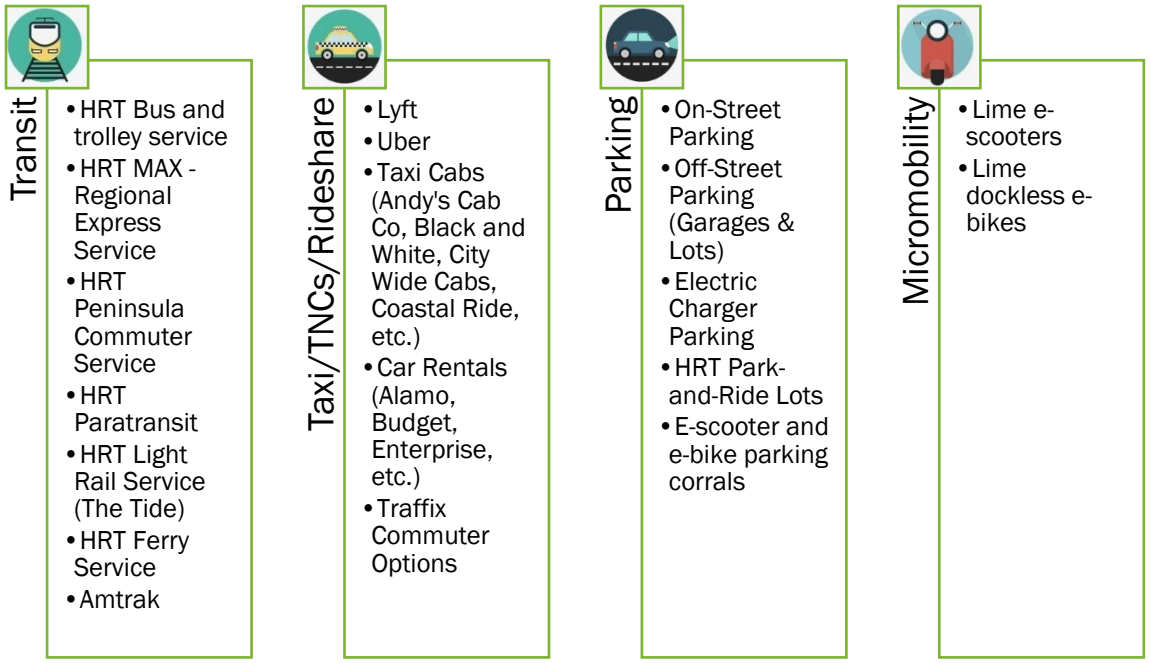
Headquarters: Pittsburgh, PA

Technology: Map-driven collaboration tool for planning outdoor space

Website: www.kurb.io

Mobility-as-a-Service

Integrated mobility efforts have been increasing in cities across the country that leverage the use of technology to enable contactless payment, transfer between different mobility options as well as end-to-end trip planning. Mobility-as-a-Service (MaaS) is the type of service that connects all these various functionalities through a single digital solution that allows for the travel and payment of various mobility service options. With the increase in the variety of mobility options, MaaS can increase efficiency and allow users to more easily navigate the larger transportation network. For the City of Norfolk, the Multimodal Transportation Master Plan includes several key initiatives that can be integrated through a MaaS solution.



With the City installing bike-pedestrian counters, the current electric-assisted dockless bike share program, the current electric scooter share program, the scooter/bike parking corral program, and bike shelter improvements (which can include real-time digital message signs with transit alerts), there is the opportunity to integrate the information and service offerings across these modes onto a single platform.

Beyond these mobility options, there would be the need for interagency collaboration with Hampton Road Transit (HRT) bus, light rail, and ferry service and the private mobility sector such as TNCs and Lime (scooter and e-bike operator) for a truly multimodal platform. The MaaS solution can also include a regional mobility service option such as the Williamsburg Area Transit Authority (WATA) buses integrated with Amtrak service or potential future mobility options such as microtransit. However, the development of an initial platform integrating parking, e-scooters and e-bikes and is under the direct management of the City of Norfolk, would be a step in the right direction and serve as a proof-of-concept.

While mobility-as-a-service has not be fully realized in the US, there are several technology vendors and jurisdictions that have made efforts towards this.

Dallas Area Rapid Transit (DART) Go Pass program allows for the payment and riding of transit service without the need of cash via mobile app or reloadable transit card (see box to the right). The mobile app offers real-time trip planning tools, integrated maps, and the card allows for simple tap boarding on both buses and trains. Fare can be reloaded on both mobile app online or via card at hundreds of retail locations across North Texas. The trip planning capabilities leverages Good Transit features and allows for the creation of personalized trips plans for DART buses, DART Rail, Trinity Railway Express, Tulsa Transit and Denton County Transportation Authority A-train allowing for travel between jurisdictions. DART also allows for the leasing of their app to other jurisdictions to develop their own mobility app solutions which can be leveraged by the City of Norfolk in partnership with HRT.

Another mobility app solution is Cubic Mobile Suite. In addition to the Cubic Surface Transport Management platform solution that supports data analytics and visualization across multiple modes, there is also Cubic Mobile Suite which provides a range of integrated functionality including enabling multimodal transport, multiple payment offices from single account, connection with merchant and retail network to sell tickets as well as ability to support inspectors with validating tickets as well as processing ticket purchases via mobile device. Technology allows for the integration with parking, ride hail, care service, bike share and other third-party vendors with real-time alerts and trip planning via Google Maps. These services are provided through a collection of mobile apps including Merchant App, Inspector App, and Traveler App and allows for individual branding and logo design. Cubic currently provides these services throughout the US including Boston, New York, Washington DC, Chicago, Los Angeles and San Francisco. The City of Norfolk can leverage one or all three applications for their multimodal planning needs.

In terms of other multimodal transportation app solutions, there is Transit App which provides free consumer app for trip planning as well as Transit+ app for cities and transit agencies that allows for mobile payments across bike and scooter share programs as well as ridehailing and carsharing services (see box to the lower right). The platform provides alerts for arrival and departure of transit service based on user GPS location, trip planning and comparison of mobility options all at once, customer communication integration and alert system for service change as well as rider dashboard for data related to ridership and level of service. The data collection can provide insights as it relates to popular destinations and origins, most frequently used of mode of service as well as changes to trip planning choices. Transit app is currently being used by Kansas City Regional Transit (RideKC), Santa Clara Valley Transportation Authority (VTA) and the Montreal Transit Corporation (STM) in Canada

Company: Dallas Area Rapid Transit (DART)

Established: 1983

Headquarters: Dallas, TX

Technology: All-in-one travel tool to buy transit passes

Website: www.gopass.org

Company: Transit

Established: 2012

Headquarters: Montreal, Quebec

Technology: Aggregation and mapping of real-time public transit data

Website: www.transitapp.com

System integration in the form of active traffic congestion management, parking and curb management and mobility-as-a-service solutions can all be used to more effectively manage connected infrastructure systems. There are inherent

interdependences between each of the transportation options made available to users, and the City of Norfolk can leverage technology to eliminate the barriers the exist between these different mobility options.

Data Aggregation

Infrastructure management can be improved through system integration which includes the aggregation of data across the individual systems. As such, data is the foundational building block supporting infrastructure management and system integration.

The City of Norfolk has an adept understanding of the importance of quality data that meets standards of accuracy, completeness, consistency, timeliness, validity and uniqueness. Through Norfolk Open Data portal (powdered by Socrata and Tyler Technologies), the City of Norfolk offers free and easy access to data about Norfolk across the categories of education, environment, government, maps, permits, public safety, real estate, recreation and transit. However, the existing data available is limited to only 43 datasets.

The current transportation related datasets that are available are as follows:

- Fleet
- Mowing Schedule
- Parking Citations
- Parking Permits
- Permits – Right of Way
- Scooters and e-bikes
- STORM | System to Track, Organize, Record, and Map
- Street Lights and Outages Reports
- Towing
- Bike-Pedestrian counters

As such, the portal needs to be reviewed and evaluated for considering the expansion of available datasets as well as improved categorization, increased data types as well as detailed tagging. In addition, the inclusion of links to key datasets not maintained by the City but are available through Virginia state agencies and Federal departments would be beneficial.

Leveraging Socrata capabilities, the Norfolk data portal can be enhanced to provide additional analytic and app development capabilities, as well as data and citizen engagement features (see box to the right). The current version allows for the creation of an account profile and that allows user to track own data sets as well as dataset shared with user. The platform also allows new datasets to be suggested.

While there is room for improvement as it relates to the sharing of publicly accessible datasets, there is the internal process and procedures for the exchange of data between Norfolk departments and external agency partners. Using the Connected Government Cloud feature, data can be shared internal with government partners in a modern, secure, cloud-based infrastructure with self-service access. As such, it eliminates the need of sharing data back and forth via e-mail and ensure a common operation picture of datasets. The streamlined access allows data to be readily available to support government initiatives, polices and decisions. The Socrata Connected Government Cloud provides secure access, internal data-sharing and collaboration for data query and analysis, financial analysis and reporting, performance management, operation analysis as well as open data programs.

Company: Socrata

Established: 2007

Headquarters: Seattle, WA

Technology: Open data, government performance management, government financial insights, data-driven government

Website:
www.tylertech.com/products/socrata

The City of Norfolk current collects, formats, processes and maintains various data

sources according to data standard specifications. As part of Norfolk Multimodal Transportation Master Plan, an inventory of data collection is organized into six categories:

1) Demographics
2) Land Use
3) Transportation Facilities
4) Traffic
5) Transit
6) Safety

These existing conditions data is being used to support a broad and in-depth analysis of Norfolk's transportation system. There are also privately available data and vendor technologies related to data sources and collection, data management and incident management that can be procured to support related efforts.

Data Sources and Collection

Exploring additional data sources and collection in combination with existing data can enhance the City's understanding of their infrastructure. The use of crowdsourced and location-based services (LBS) data specifically can be beneficial. As it relates to crowdsourced data, there is the increased trend for users to report incidents or impacts on the transportation network via social media applications such as Twitter or Facebook. In terms of location-based services data, this relates to data that is retrieved from mobile devices and can provide population movement analytics at trip origins, destinations and points of interest (POI) such as grocery stores, healthcare facilities and others. Both crowdsourced and location-based services data is usually in the form of Big Data, or data that is too large or complex to be dealt with by traditional data-processing. In addition, crowdsourcing data can help City of Norfolk obtain increased data points without requiring additional resources.

In synthesizing crowdsourced data, a tool that can be leveraged is Dataminr, which is a New York-based company that specializes in artificial intelligence to provide real-time information alerts to clients (see box to the right). The company use artificial intelligence and machine learning systems for real-time event detection. These events are synthesized from micro-blogs and social media posts which are accessed based on the credibility of the source, the occurrence of similar online posts and cross-checked with verified sources such as government agencies and news organizations. Dataminr's First Alert product for the public sector alerts first responders to breaking events, enabling the fastest real-time response. This tool can be utilized within a TMC or Emergency Operations Center (EOC) to provide additional data sources for incidents. This is especially useful for areas with large populations or during high-incident events such as hurricanes or winter storms.

Company: Dataminr

Established: 2009

Headquarters: New York, NY

Technology: Artificial intelligence to provide real-time information alerts to client

Website:
www.dataminr.com

Public agency clients of Datminr include the United Nations and the New York City Office of Emergency Management (NYCEM). For NYCEM, Dataminr is used in Watch Command – New York City's incident management monitoring central hub which operates 24 hours a day, seven days a week. It serves as an alert and notification tool for Watch Commanders and agency executives of major events. Once an alert is received, Watch Commanders verify incident with law enforcement agencies and releases public warning message via Notify NYC, which is the City's public source for information about emergency alerts and important city services.

In terms of crowdsourced data that is specific to transportation, Waze, a Google company and GPS navigation software, collects data from users via app related to traffic (moderate, heavy, standstill), crashes (minor, major, other side), hazards (on road, shoulder, weather), road closures among other types of reports (see box to the right). There is also the ability to report incidents with comments as well as pictures. This wealth of information can be ingested by TMCs and EOCs, where it can be verified using law enforcement, CCTV cameras and other verified sources. With the quick reporting of incidents via Waze, responding agencies can quickly formulate mitigation and action plans. Other crowdsourced data-driven application are Spot Angels, which digests public data on public availability, and Gas Buddy, which uses user reports to confirm gas availability at gas stations.

In terms of location-based services data, there are several companies that have business agreements with major telecommunication companies, such as AT&T and Verizon, and aggregate and anonymized data to provide insights on populations movements.

Most popular LBS data providers are Replica, SafeGraph and Streetlight, which is described in the table to the right based on data sources ingested methodology and outputs.

Location-based services data provides both historical trends on population movements as well as real-time analytics that can be used for various analyses from recurring traffic congestion to adherence of stay-at home orders.

Company: Waze

Established: 2006

Headquarters: Palo Alto, CA

Technology: GSP navigation software and trip planning

Website: www.waze.com

Location-Based Services	Data Sources	Methodology	Output
Replica	Publicly available census data; mobile location data, and point-of-interest (POI) transaction data	Advanced modeling and algorithms to create synthetic population that matches the characteristics of a region's real population, and applying travel behavior model to synthetic population	Synthetically generated representation of the activities and movement; data download and dashboard
SafeGraph	Telecommunication device-based data	Analyze GPS location data with POI geofences to determine if a device visited a place, brand, or type of store	Store visitor demographics; data download and dashboard
Streetlight	Data from SafeGraph; major navigation-GPS data supplier, INRIX, and one LBS data supplier provider Cuebiq	Pull de-identified data in bulk batches from data suppliers followed by data cleaning, creating trips and activities, Quality Assurance (QA), storing, aggregating and final QA	Travel pattern metrics; interactive maps and charts within the platform, or downloaded

More conventional data source and collection technology would be the deployment and utilization of field sensors. Roadway sensors for temperature and pressure, strain gauges, Bluetooth devices, and other types of sensors can be used to monitor traffic patterns and the condition of infrastructure.

Sensor companies such as Sensor Solutions and DeepBlue can offer technologies for City of Norfolk to instrument the most critical transportation facilities, intersections and roadways.

DeepBlue provides Bluetooth detection hands-free sets and devices, as well as Wi-Fi based devices that can be mounted on streetlights or electric poles and transmit data wirelessly (see box to the right).

Mobilitynow is DeepBlues' data-as-a-service (DaaS) solution offering temporary data and origin-destination matrix collection for before and after studies, traffic and event planning. TrafficVision and Verizon Network Infrastructure Services are companies that can provide supplementary infrastructure monitoring services in the form or CCTV surveillance systems and upgraded telecommunication networks for the transfer of data.

Company: DeepBlue Sensor

Established: 2002

Headquarters: Barcelona, Spain

Technology: ITS traffic management solutions

Website: www.deepbluesensor.com

Data Management

Data management for accessing, storing, exporting and sharing data is key for public transparency as well as supporting infrastructure management coordination between the City of Norfolk departments and divisions. Through Norfolk Open Data portal, powered by Socrata and Tyler Technologies, the City of Norfolk offers free and easy access to data about Norfolk. By leveraging The Socrata Connected Government Cloud provides secure access, the City of Norfolk can benefit from internal data-sharing and collaboration for data query and analysis, financial analysis and reporting, performance management, operation analysis as well as open data programs.

Another open data portal and data management platform provider is Mapbox Studio. Mapbox's suite of technology solutions can help the City of Norfolk get a better sense of their data through visualization and analysis (see box to the right). Mapbox Quick Launch platform allows for dashboard development, which connects users to internal data sources, supports collaborative annotated mapping tools as well as information sharing between stakeholders. Mapbox's content tagging solution creates a database of location assets that are tagged, stored and retrievable by end users' searches. The NYC Department of Information Technology and Telecommunications' Gov Lab & Studio in partnership with Mapbox designed the NYC Open Data website which stores NYC data by categories (e.g., education, environment, etc.), view types (e.g., datasets, files and documents, maps, etc.), curated data collections of related datasets such as COVID-19 Heath Data, agency and content tags. The data portal allows users to filter, map and export data, with new datasets being published frequently. Other data portal and data management platforms include ESRI ArcGIS Open Data, which software-as-a-service (SaaS) solution allows for the sharing of spatial (i.e., maps) and non-spatial (i.e., tables) data, and Google Maps Platform via Google Cloud, which allows for highly customizable map creation with customer markers, overlays and photos.

Company: Mapbox Studio

Established: 2010

Headquarters: San Francisco, CA

Technology: Custom online maps for websites and applications

Website: www.mapbox.com

Incident Management

The City of Norfolk daily operations, from traffic management to construction work, requires the use of critical transportation and infrastructure data. In the event of an incident or emergency situation, it is even more critical that these datasets are reliable and provided in near real-time. There are various technology solutions within the marketplace that can support incident management coordination and information sharing between the City of Norfolk's departments from law enforcement to utilities. These technologies are deployed to support the identification, analysis, correction and the prevention of emergency incidents.

Waycare Technologies is a map-based incident management solution that provides users with real-time data and information to address roadway and traffic related incidents. Using the Waycare platform, users are able to receive notifications and updates on road and traffic conditions, stalled vehicles, debris, traffic stops, or areas identified as risk zones; obstructions by patrols can be reported and work order requests by maintenance dispatchers can be submitted in the field via mobile devices; first responders can receive the precise location of incidents for route navigation; and on-time performance of transit systems can be monitored to support route planning and schedule adjustments due to incidents. The different incident activity types are tracked and documented to be accessible by other agencies. It also allows for interoperability with agency operation centers' existing incident management systems, such first responder Computer-Aided Dispatch systems. With more interagency partnership and coordination as it relates to the sharing of data, the more accurate and precise the data would be within the Waycare platform. Also, the platform ingests a variety of data sources that are both private and publicly accessible, such as weather conditions and forecast data, CCTV camera feeds, and General Transit Feed Specification (GTFS) via Application Programing Interface (API). This platform can be leveraged by the City of Norfolk to respond to recurring flooding incidents using historical flooding data, current weather reports, as well as field observations.

Data integrated through the Waycare platform can help to decrease response time to incidents as well as notify first responders of the potential for incidents to occur (see box to the right). In 2018, Waycare partnered with the Nevada Highway Patrol (NHP) to improve incident identification, response time and interagency coordination. By leveraging the platform, NHP was able to see an average nine-minute reduction time in incident identification. The platform provides a single common operating picture for NHP with their partner agency the Regional Transportation Commission of Southern Nevada's (RTC) Freeway and Arterial System of Transportation (FAST) allowing for quicker response times. An alternative or complementary incident management platform that can be utilized is WebEOC. It is the preferred emergency management software that is used by the Federal Emergency Management Agency (FEMA). The software is able to support a variety of operations including emergency vehicle tracking, asset and inventory management, incident command and notification, volunteer responder management, as well as mutual aid resource tracking and requesting.

Company: Waycare Technologies

Established: 2016

Headquarters: Palo Alto, CA

Technology: Traffic management systems leveraging predictive analytic

Website: www.waycaretech.com

Chapter Conclusion

The variety of the technology solutions that exist in the marketplace as it relates to infrastructure management, system integration and data aggregation is countless and constantly evolving. Each of the technology solution described offers features that can meet the needs of the City of Norfolk including asset management, smart city solutions, active traffic management, curb space management, data collection and management, as well as incident response. However, there are trade-offs as it relates to cost, scalability and adoptability.

It is important that when developing CONOPS for any technology solution, as part of the proposed evaluation framework, that there are definitive objectives which are scoped with stakeholders, potential technology requirements are clearly defined, and the evaluation is supported by scenario and impact analyses. Scenario planning tools, such as Sustainable Ways to Integrate Future Transportation (SWIFT) platform developed for the Texas Department of Transportation with AECOM, can help to analyze potential impacts of technology adoption prior to implementation. The SWIFT platform developed future build scenarios based on changes in land use, user behavior, technology adoption and transportation policies, which provide broader insights on the implications of specific transportation planning decisions.

With a fully developed draft CONOPS for a technology solution, there are subsequent next steps that can be taken by the City of Norfolk towards successful implementation. These next steps are as follows:

- Conduct testing of technology solution and pilots
- Determine performance measures for evaluation of technology solution
- Execute scaled implementation
- Incorporate proposed technology into existing workflows
- Support ongoing maintenance and upgrades

The testing of technology solution and pilots will provide specific information on the ability of technology to meet defined objectives. It will allow for the documentation of limitations and inform areas of improvements prior to proceeding with the go-live implementation. As part of testing and pilot, there should also be specific performance measures or targets that can be used to evaluate if the technology adequately performed intended functions, conducted any unintended functions, and in general whether the technology can be deemed a success or failure.

Once the testing and acceptance has been completed, with points of failure addressed, plans for scaled implementation can get underway. This scaled implementation can be based on specific user type or geographic areas depending on the type of technology. In addition, as technology is being implemented, the impact on existing workflows can be accessed from roles and responsibilities of staff to the need for additional personnel support. Lastly, the evaluation of the technology solution is a perpetual process, along with maintenance and upgrades to ensure that the solution is sustainable. It is important that the technology is able to adapt with changes in the needs of the City of Norfolk and demands on the larger transportation network.

[i] How to make smart city projects stick. Interact (https://www.interact-lighting.com/en-us/iot-insights/how-to-make-smart-city-projects-stick, consulted 1/20/21)
[ii] Webpage consulted on January 15, 2021 (https://www.norfolk.gov/Faq.aspx?QID=130)
[iii] IoT Software & Platforms: A Phased Approach to Achieving Smart Cities (2020). Northeast Group, LLC, Signify.
[iv] Interact City Cases Study: Guadalajara, Spain (https://www.interact-lighting.com/global/customer-stories/guadalajara)
[v] Smart city becomes reality: outdoor LED driver with DEXAL interface enables networked street lighting (https://www.osram.com/ds/knowledge/street-lighting-biberstein/index.jsp)

Chapter 11: Transit System Redesign

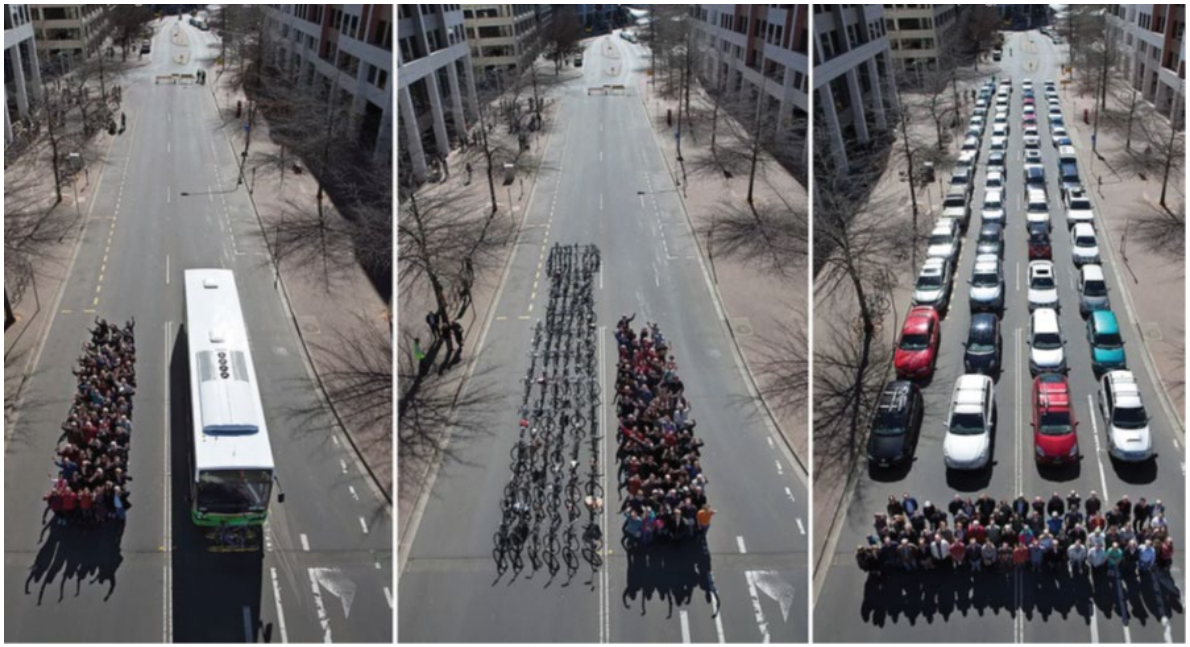
What is the Transit System Redesign?

As part of Multimodal Norfolk, the City has studied a full redesign of the public transit system to evaluate and recommend important policies related to transit funding, and most significantly, recommend how and where transit services should be provided in the city. As part of the redesign many types of transit services have been considered, including traditional fixed route services and on-demand options.

Norfolk is an old city, and overall, a moderately dense city. While not all of Norfolk is dense, large parts of it are, and like all places with high density, Norfolk has limited road space that regularly gets filled and is seeing an increase in the density and intensity of land uses.

These two factors combined mean that more and more people are trying to use a fixed amount of road space. If they are all in cars, they simply will not fit in the space available. The result is congestion, which cuts people off from opportunity and strangles economic growth.

In a growing city that is getting more dense, relying on bikes and transit as major modes of transportation is the only way to have room for everyone.



By providing more multimodal options for getting around, more people can move about in less space. Investing in transit service and facilities for walking and riding bicycles and scooters means Norfolk can continue to grow and thrive with a functional transportation system.

The only alternative to congestion is for a larger share of the population to rely on public transit and other modes that carry many people in few vehicles, or that take far less space per person than cars (i.e. bicycles).

This requires services that most efficiently respond to the city's changing needs, as well as corridor improvements to give buses a level of priority over cars that reflect the vastly larger numbers of people on each bus.

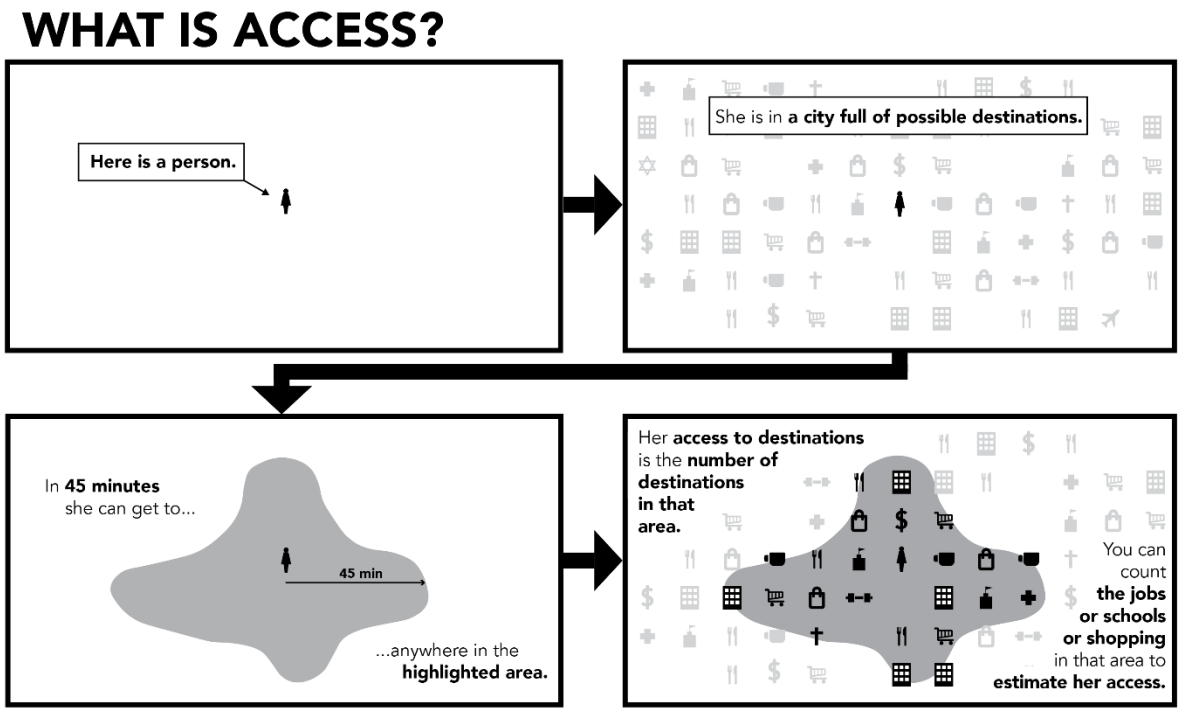
Access, or the Wall Around Your Life

What if we planned public transit with the goal of freedom? Access is your ability to go places so that you can do things. We calculate access, for anyone anywhere, like the diagram at the right.

Whoever you are, and wherever you are, there's an area you could get to in an amount of time that's available in your day. That limit defines ***a wall around your life***. Outside that wall are places you can't work, places you can't shop, schools you can't attend, clubs you can't belong to, people you can't hang out with, and a whole world of things you can't do.

We chose 45 minutes travel time for this example, but of course you can study many travel time budgets suitable for different kinds of trips. A 45 minute travel time one way might be right for commutes. For other kinds of trips, like quick errands or going out to lunch, the travel time budget is less. For a trip you make rarely it might be more.

But the key idea is that we have only so much time. There is a limit to how long we can spend doing anything, and that limit defines a wall. We can draw the map of that wall, and count up the opportunities inside it, and say: *This is what someone could do, if they lived here.*



Measuring access helps us see how much freedom a transit system is providing.

Access is a combined impact of land use planning and transport planning. We can expand your access by moving your wall outward (transport) or by putting more useful stuff inside your current wall (land use). On an individual level, access represents convenience and the ability to do the things you need. As such, the level of access transit provides is part of what determines ridership, but it is also something that many people will see as a worthy goal in itself.

Frequency is Freedom

A transit network is a pattern of lines and services, where each line:

- follows a path,
- at certain days and times (its span),
- at a given average speed, and
- buses come every certain number of minutes. This is known as the headway or frequency.

Frequency is invisible and easy to forget, and yet on transit it is often the most important factor determining where you can get to in a given amount of time.

More frequent service dramatically improves access.

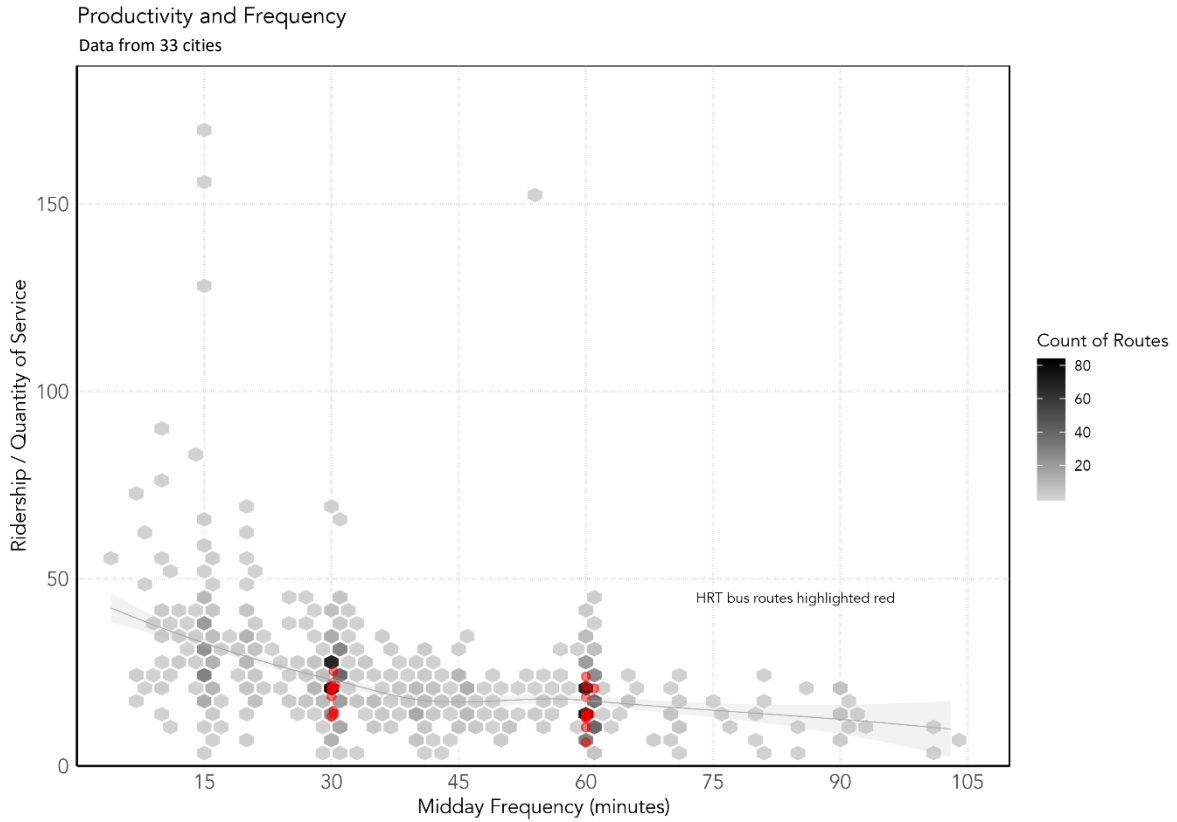
High frequency reduces travel time by providing several linked benefits:

- Shorter waits,
- Faster transfers,
- Easier recovery from disruption, and
- Spontaneity and freedom.

For these reasons, more frequent service is vastly more useful, and is often more highly used, resulting in higher ridership even relative to cost.

The plot to the right shows all the lines operated by 33 different U.S. transit agencies, at various points in the 2010s. Each line is located on the plot based on its frequency and its productivity (boardings per service hour). More frequent service is to the left, and more productive service is higher up. The shade of each hexagon indicates the number of lines in that place on the graph. The plot shows that higher productivity is correlated with higher frequency, even though higher frequencies require more service hours. In other words, ridership appears to rise exponentially as frequency increases.

This is a two-way street: transit agencies rarely run high frequency service in places where they expect low ridership. But conversely, if frequency isn't very high, the amount of ridership transit can attract is fundamentally limited.



More frequent service is often more productive service, as seen in this hex-plot diagram comparing frequency of service and productivity across hundreds of bus routes at 33 transit agencies in North America. HRT bus routes are highlighted in red.

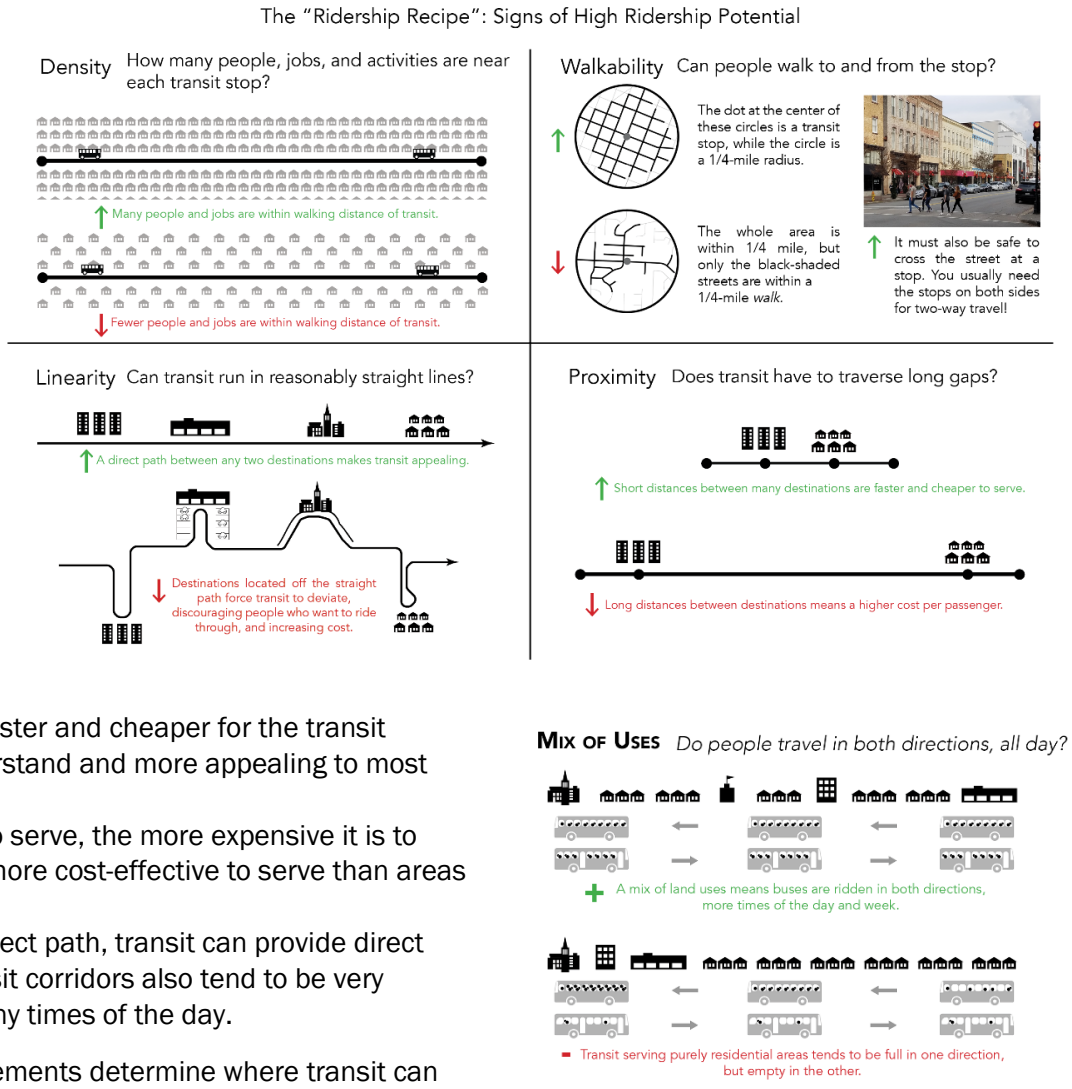
Transit Access Depends on the Built Environment

Creating a high-access transit network isn't just about faster or more frequent service. Many factors – such as land use, development, urban design, street networks – affect transit's usefulness. This is why land use and infrastructure decisions made by the cities and other agencies are an essential part of transit's success.

1. **Density.** Where there are many residents, jobs and activities in an area, there are many places people might want to go.
2. **Walkability.** An area only becomes accessible by transit if most people can safely and comfortably walk to and from the nearest transit stops, since most people reach transit by walking. Improved bike access can also expand the "market area" of transit stops, though only a small portion of riders use bikes to reach transit.
3. **Linearity.** Direct paths between many destinations are faster and cheaper for the transit agency to operate. Straight lines are also easier to understand and more appealing to most potential riders.
4. **Proximity.** The longer the distance between two places to serve, the more expensive it is to connect them. Areas with continuous development are more cost-effective to serve than areas with big gaps.
5. **Mix of Uses.** When there is a mix of land uses along a direct path, transit can provide direct access to a broad range of destinations. Mixed-use transit corridors also tend to be very productive because people ride in both directions at many times of the day.

Regardless of the intricacies of local geography, these five elements determine where transit can be useful for many people, at a relatively low cost.

IF increasing access, freedom, and ridership were the primary goal of Norfolk's transit system, then the City would focus its transit resources on frequent service to those places where these five factors are the strongest. Yet, this is not the only goal that transit is asked to achieve.



These five factors are major predictors of where transit service can achieve high ridership relative to cost.

Goals of Transit

Transit can serve many different goals. But different people and communities value these goals differently. It is not usually possible to serve all of them well all the time.

Possible goals for transit include:



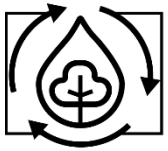
Social Safety Net

Transit can help meeting the needs of people in situations of disadvantage, with access to essential services and jobs, or alliterative social isolation by providing a basic affordable transportation option.



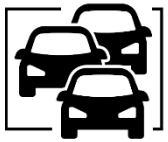
Economic Opportunity

Transit can give workers access to more jobs; businesses access to more workers; and students more access to education and training.



Climate & Environmental Benefits

By reducing car trips, transit use can reduce air pollution and greenhouse gas emissions. Frequent transit can also support compact development and help conserve land.



Congestion Mitigation

Buses carry more people than cars, transit use can mitigate traffic congestion by reducing Vehicle Miles Traveled (VMT). This is especially important in areas with high jobs-housing imbalances and a preponderance of long commutes.



Health

Transit can support physical activity. This is partly because most riders walk to their bus stop, but also because riders will tend to walk more in between their transit trips.



Personal Liberty

By providing people the ability to reach more places than they otherwise would, a transit system can be a tool for personal liberty, empowering people to make choices and fulfill their individual goals.

Some of these goals are served by higher transit access and ridership. For example, the environmental benefits of transit only arise from many people riding the bus rather than driving. The subsidy per rider is lower when ridership is maximized.

*We call such goals **Ridership** goals because they are achieved in part through high ridership, and they also align closely with higher access outcomes.*

Other goals are served by the mere presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if the route is infrequent, not very useful, and few people –ride it. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every political district.

*We call these types of goals **Coverage** goals because they are achieved in part by covering geographic areas with service, regardless of ridership.*

Ridership and Coverage Goals are in Conflict

Ridership and coverage goals conflict. Within a fixed budget, if a transit agency wants to do more of one, it must do less of the other.

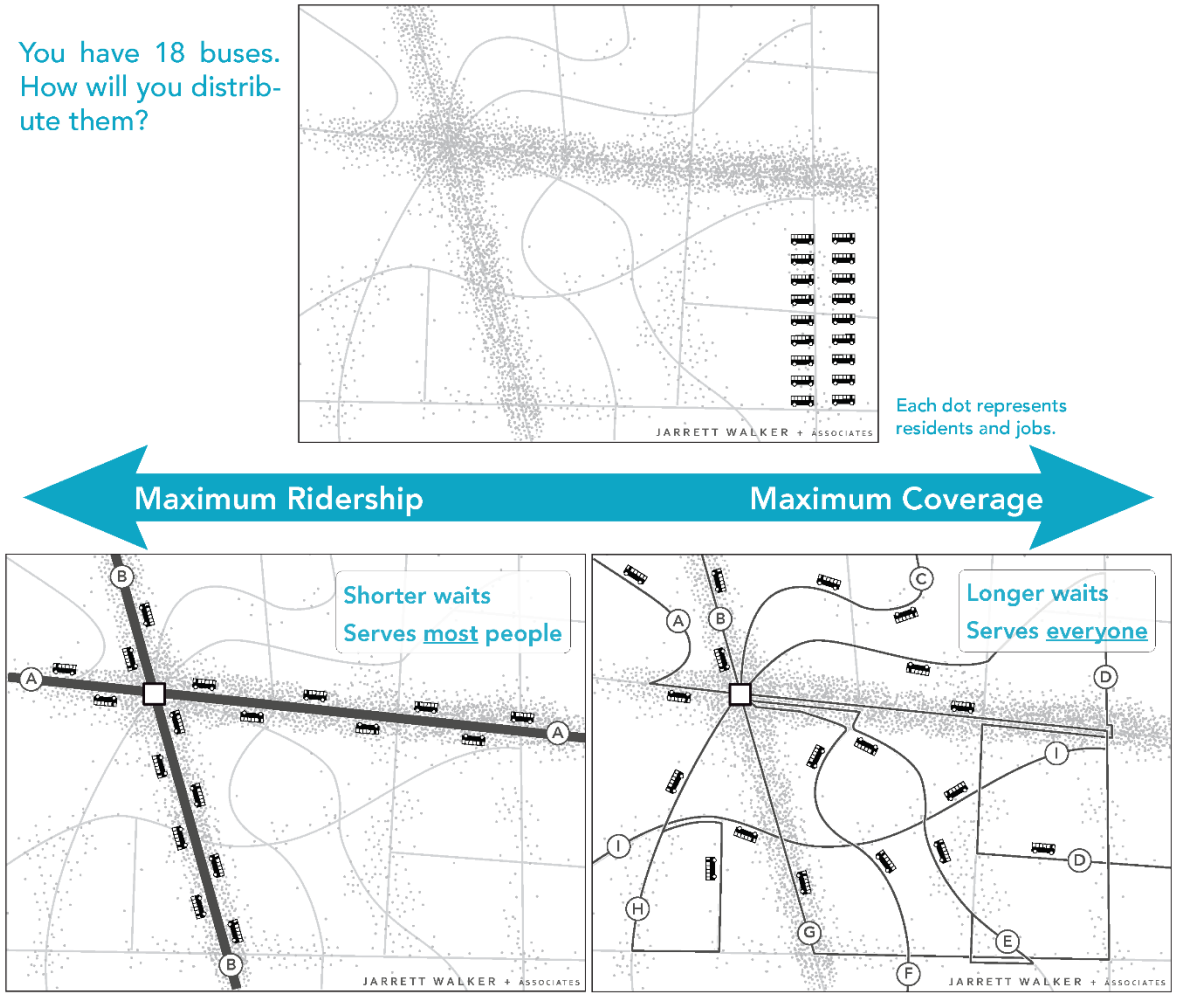
Consider the fictional town to the right. The little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. As in many towns, most activity is concentrated around a few roads.

A transit agency that wants to maximize access for most people would run all its service on the main streets because many people are nearby and buses can run direct routes. A high access network allocates frequent service to areas with favorable urban development patterns, forming a connected network. This would result in a network like the one at bottom-left. This network also maximizes the potential ridership, so we could call it the Ridership Network.

If the transit agency were pursuing only coverage, it would spread out so that every street had some service, as in the network at bottom-right. All routes would then be infrequent, even on the main roads.

These two scenarios require the same number of buses and cost the same amount to operate, but deliver very different outcomes. To run buses at higher frequency on the main roads, neighborhood streets will receive less coverage, and vice versa.

An agency can pursue ridership and provide coverage within the same budget, but not with the same dollar. The more it does of one, the less it does of the other.



The choice between maximizing ridership and maximizing coverage is not binary. All transit agencies spend some portion of their budget pursuing each type of goal. A particularly clear way for cities and transit agencies to set a policy balancing ridership and coverage goals is to decide what percentage of their service budget should be spent in pursuit of each.

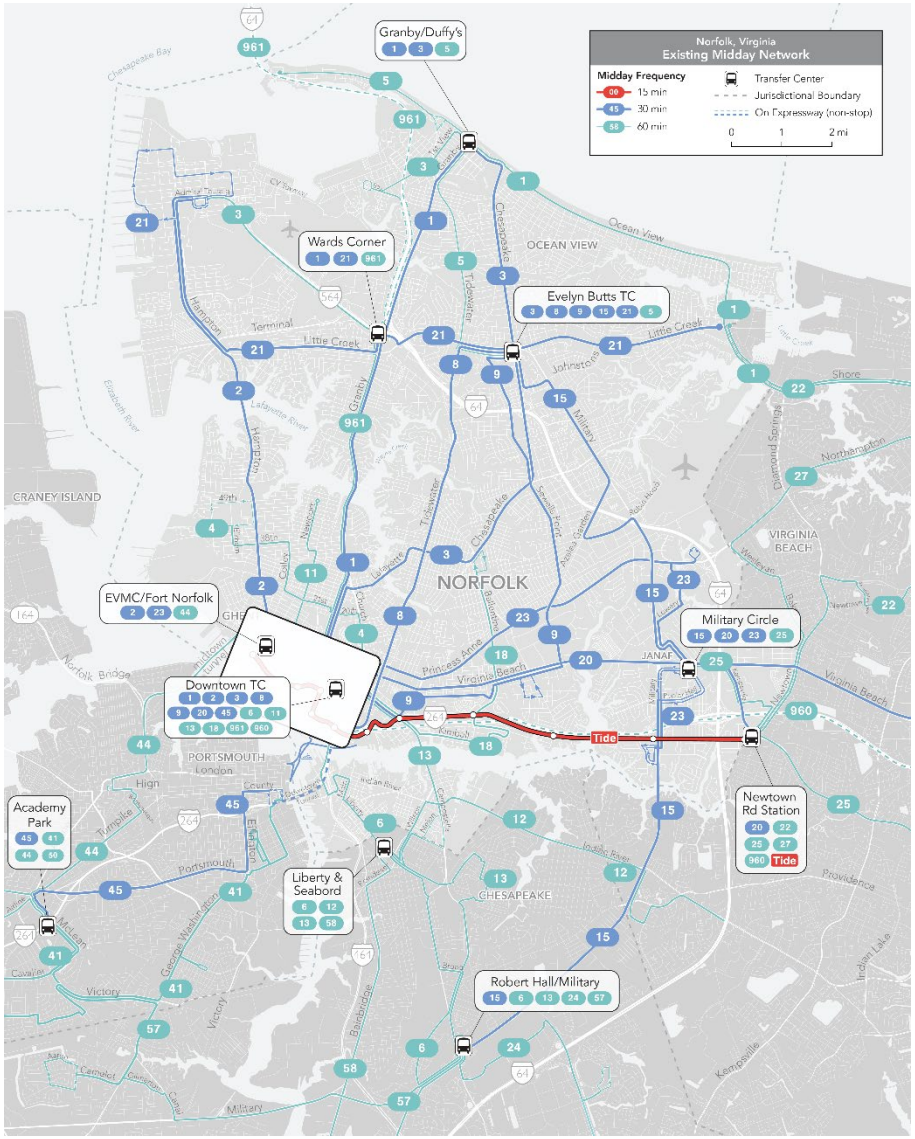
The "right" balance of ridership and coverage goals is different in every community. It can also change over time as the values and ambitions of a community change.

The Transit System Redesign planning process sought to help the City address how to balance these competing goals of Coverage and Ridership, and design a new bus network for the short-term that would better meet the goals, priorities, and needs of today's city.

This has been accomplished through three rounds of engagement with the public and stakeholders:

- In Round 1, we explored Key Choices such as Ridership versus Coverage and Walking versus Waiting.
- In Round 2, the City and the project team produced two contrasting Transit Network Concepts to highlight the difference between a network designed for Higher Ridership and Access versus a network designed for Higher Coverage.
- In Round 3, the City and the project team released the **Draft New Network** and asked the public, stakeholders, and transit riders for feedback about the new design. That feedback resulted in a **Revised New Network** presented in this plan.

Why consider changing the bus network in Norfolk? The map at the right shows the Existing[i] network color-coded by the frequency of service. In this map, the prominent red line is The Tide, the region's only service operating every 15 minutes or better throughout the rush hours and middle of the day. The network is dominated by blue lines, which run every 30 minutes and light blue lines, which run every 60.



The Existing Bus Network in Norfolk has mostly 30-minute or 60-minute routes serving most of the city at midday. A higher resolution image can be viewed in the Choices Report.

The network in Norfolk covers most major streets, so that most of the population and jobs are near some kind of transit service, but the low frequency of service means that most people are waiting a long time for a bus. For the residents, businesses, and leaders of Norfolk, there is a key question:

How much of the City of Norfolk's transit budget should be spent on the most useful, liberating service, in pursuit of higher ridership and better access for most?

How much should be spent providing coverage to ensure some service for nearly everyone?

Round 1 Key Choices

In Round 1 of public engagement, before any new networks for Norfolk were designed, the City and project team asked people to weigh-in on some of the tradeoffs that arise in every transit system and that are described in more detail in the Choices Report and on Key Choices section of the project website. For charts reporting the results of polls and surveys on these questions, please see the Concepts Report. Stakeholders were engaged in a half-day workshop and surveying process and the general public and riders were surveyed through a web and paper surveying process. In total, 255 people responded to the public survey in Round 1.



Stakeholders play a transit planning game to learn the basics of transit network design at the Transit Network Redesign Workshop 1 on February 8, 2020.

Walking vs. Waiting

In any transit network, there is a basic trade-off between walking farther to service, or waiting longer for service. A transit agency can concentrate its service into fewer, more frequent routes... but they will be spaced farther apart. Or it can spread its service out into more routes, that are closer together... but then they run infrequently. Within a fixed budget, the basic math of transit forces a trade-off between offering shorter waits and offering shorter walks.

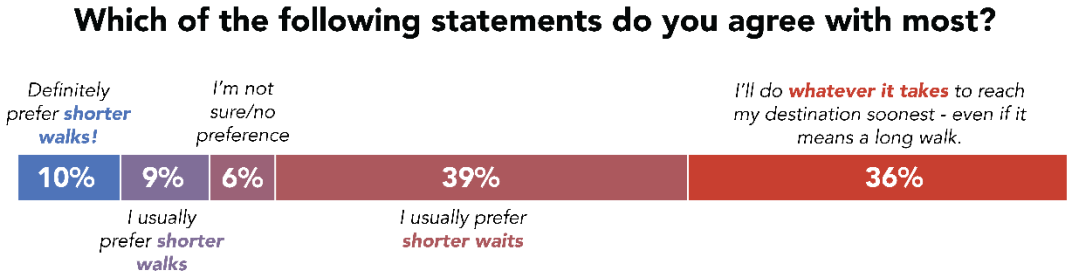
When asked how they would like to see this trade-off made, Norfolk stakeholders and members of the general public tended to support longer walks in exchange for shorter waits. Among web survey respondents, there was a very strong preference for less waiting. And among public meeting attendees (whose sticker-votes are shown at right) there was also a strong preference for less waiting in exchange for more walking.

Stakeholder Feedback



Public Feedback



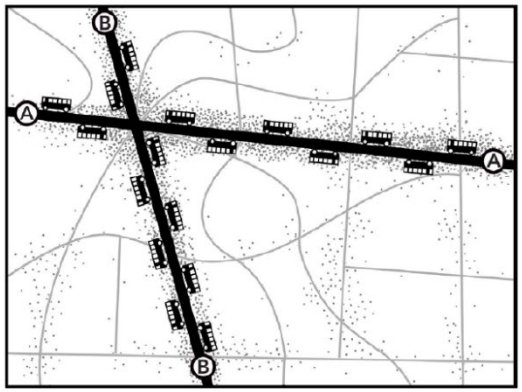


Ridership vs. Coverage

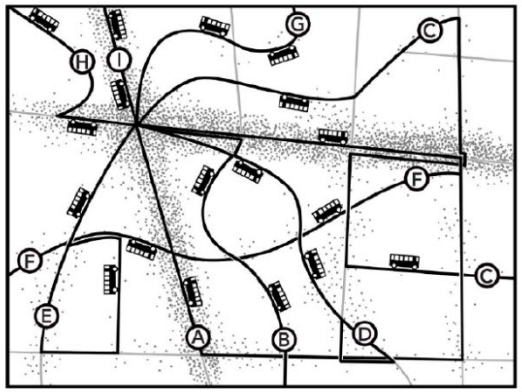
The trade-off between walking and waiting can also be described as a tradeoff between maximizing ridership and maximizing coverage. When transit agencies concentrate their service into fewer, but more frequent, routes, it nearly always leads to higher ridership. Yet, within a fixed budget, this means less service can be spread out to cover everyone.

In response to questions about this tradeoff, most people said that they wanted Norfolk to spend somewhat more of its budget providing frequent, high-ridership service, and somewhat less of its budget on low-ridership coverage services. An interest in this direction of change, among a majority of respondents, was consistently heard from the different groups of people who took the web, or rider survey, or were on the Stakeholder Committee.

Main Goal: Maximize Ridership with a few high-frequency routes along direct corridors with lots of destinations



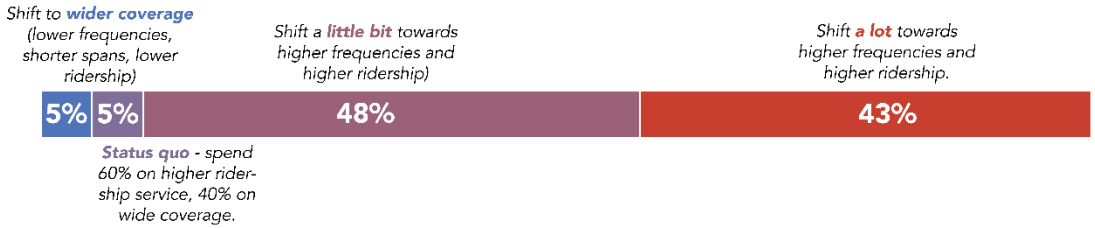
Main Goal: Maximize Coverage with many low-frequency routes on nearly all roads, even those with few destinations



In the Round 1 Public Survey, riders and the general public were asked which goal they preferred to focus on, Ridership or Coverage.

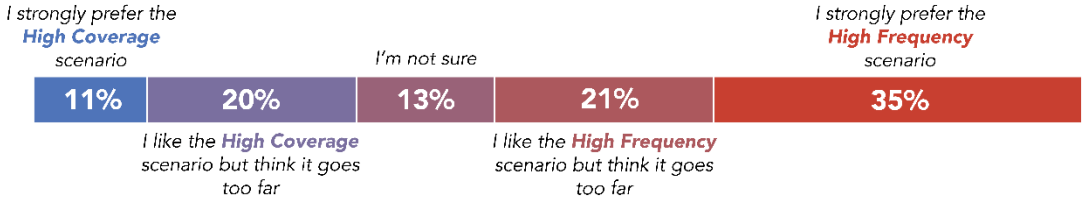
Stakeholder Feedback

Which of the following statements do you agree with most?



Public Feedback

Which Scenario comes closer to serving your values?



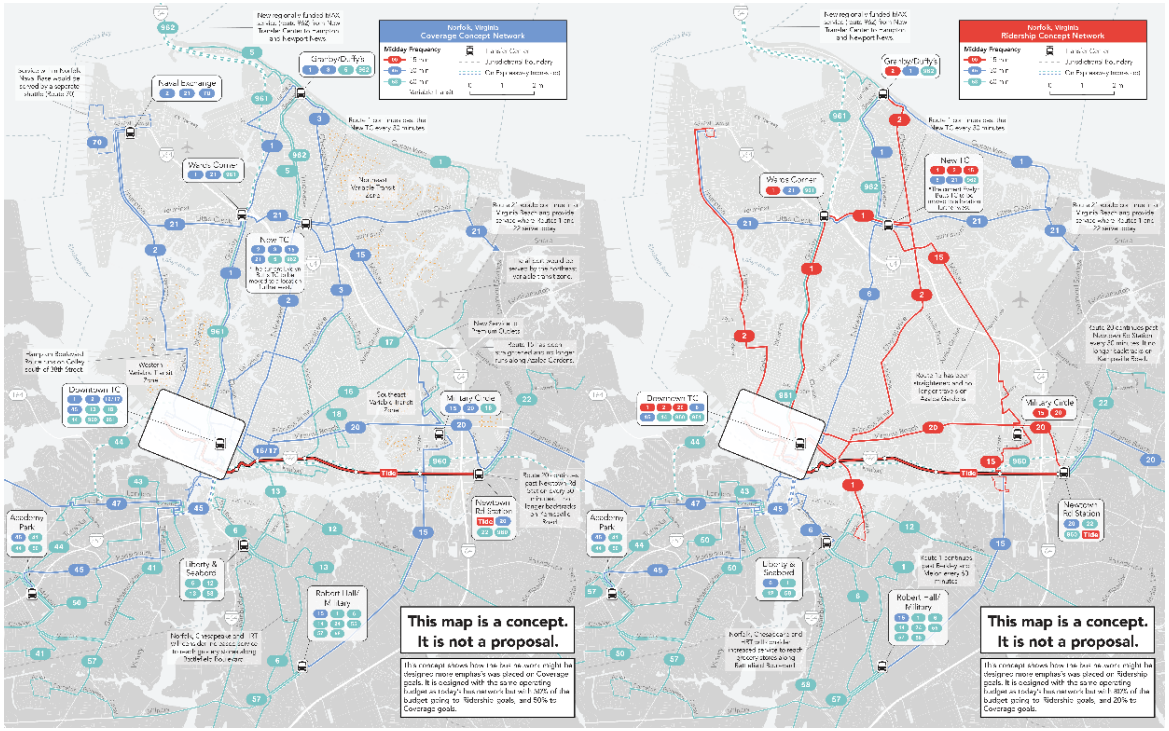
Round 2 Transit Concepts

To help people understand key trade-offs and develop confident opinions, the City and project team created two different "Network Concepts." The concepts differed in the degree to which they emphasize Ridership and Coverage goals.

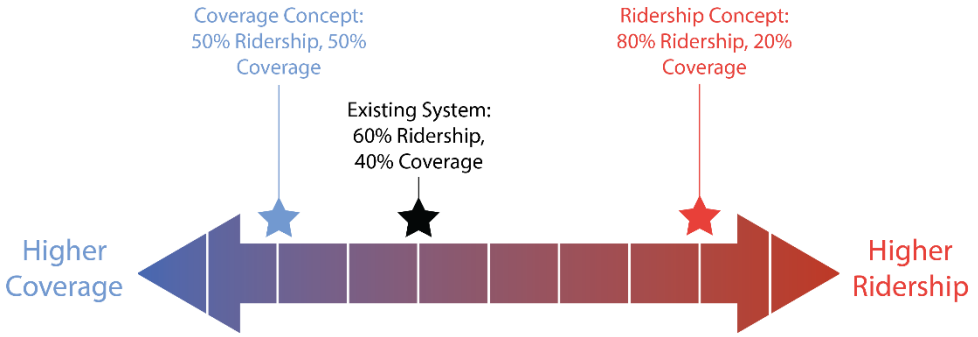
The existing system devotes about 60% of its resources toward Ridership goals and about 40% to Coverage goals and duplication. The Ridership Concept put about 80% of its resources toward Ridership goals and 20% toward Coverage goals. The Coverage Concept put 50% of its resources toward Ridership goals and 50% toward Coverage goals.

The "Coverage" and "Ridership" Concepts were blank slate redesigns of the transit network, completely re-thinking the shape of the transit network, to fit modern-day Norfolk. The Ridership Concept concentrated service into frequent lines, in places where ridership potential is highest. A much greater number of residents and jobs in the City would be close to frequent, direct service than are today.

The Coverage Concept, in contrast, spread service out to cover a large geographic area, but with low-frequency routes. Many fewer residents and jobs would be close to frequent service in the Coverage Concept. However, more residents and jobs would have access to some service, even if it



The Concepts showed a contrast in how to design a transit network for Norfolk across the spectrum between greater emphasis on Coverage goals and Ridership goals. Higher resolution images can be viewed in the Concepts Report.



comes infrequently and therefore isn't very useful.

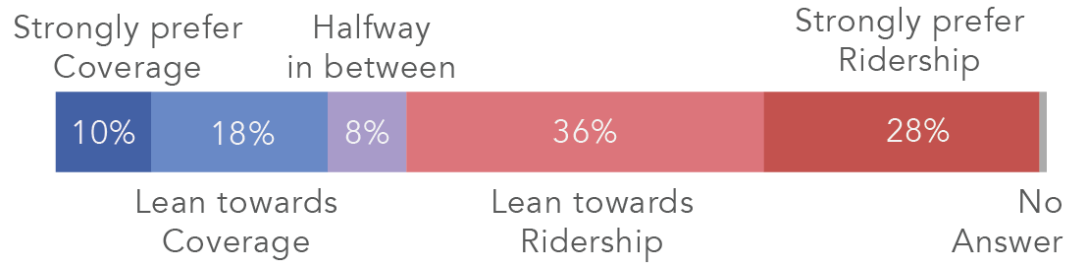
The number of people who would be covered by *any* service, or by *frequent* service and the changes in jobs reachable was summarized in the Concepts Report, available on the project website.

Using the Concepts on the previous page, the City and project team engaged stakeholders and the public in a conversation about which concept they preferred. Stakeholders were engaged in a half-day workshop and surveying process and the general public and riders were surveyed through a web and paper surveying process.

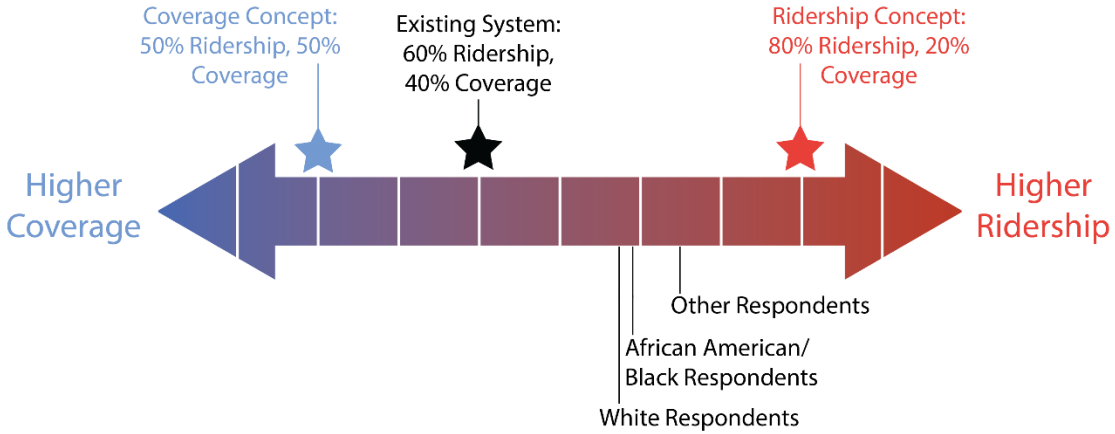
Through the online and paper surveying efforts, 1,085 survey responses were collected between June 25 and September 15, 2020. The largest share of responses (71%) were collected on paper. The remaining portion (29%) of responses were collected online.

Survey respondents were largely African-American/Black, mostly transit riders, largely of working age, mostly low-income, and almost entirely from Norfolk.

Nearly two-thirds (64%) of all respondents preferred the Ridership and about one-quarter (27%) preferred the Coverage Concept. Eight percent of respondents indicated that they were "halfway in between" both options and 1% of



Respondents to the Round 2 Public Survey largely preferred the Ridership Concept.



When mapped against the policy spectrum, the midpoint of public preference was about midpoint between the Existing System and the Ridership Concept.

respondents did not answer the question. Preference for the Ridership Concept was consistent across demographic groups.

Nearly two-thirds of survey respondents preferred the Ridership Concept.

When responses are mapped against the spectrum of possibility between the Coverage and Ridership Concepts, the graphic above shows that the average respondent across racial groups preferred that the Norfolk bus network be closer to the Ridership Concept. Based on this input, the City recommended a policy of designing the new network for Norfolk with 70% of resources focused on Ridership goals and 30% of resource focused on Coverage goals.

Round 3 Draft New Network

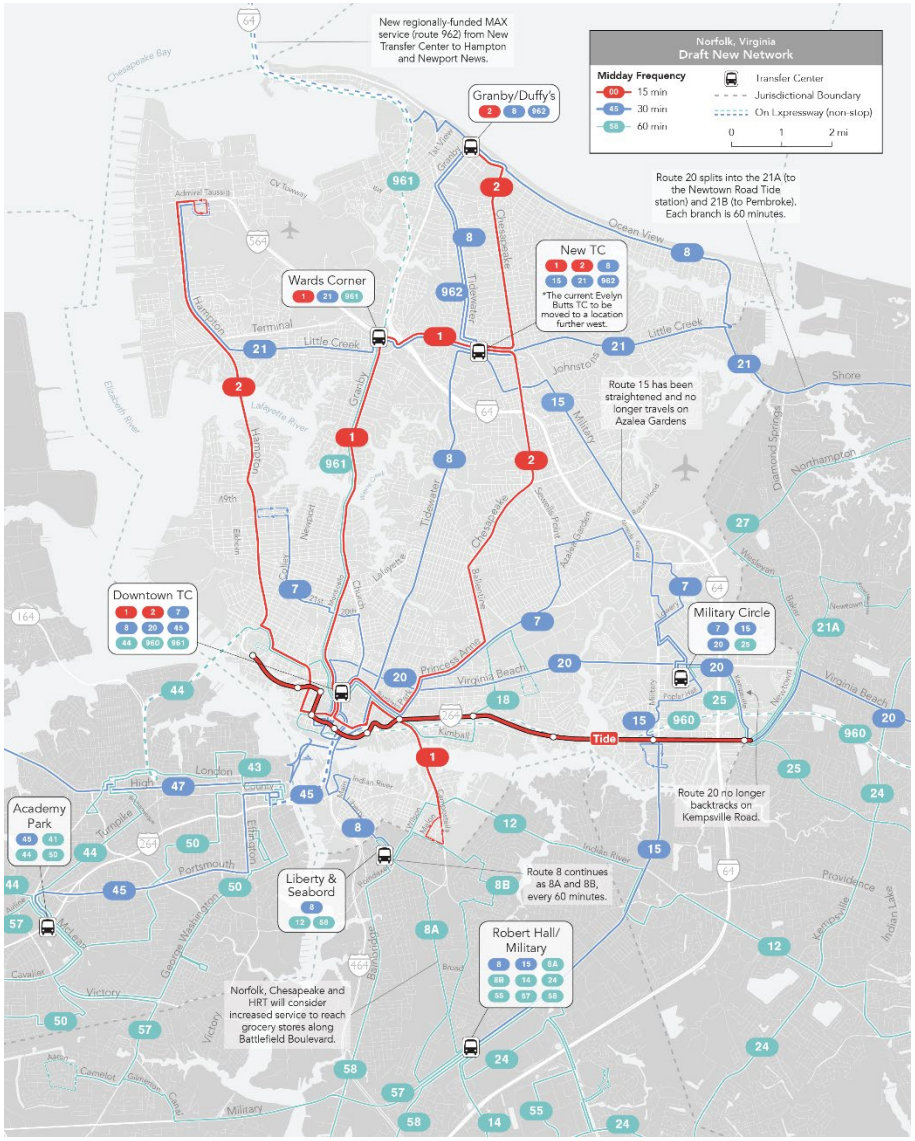
Based on public input collected in Rounds 1 and 2, the City and project team, together with HRT staff, designed a Draft New Network and that network was released for public review and comment in [the Draft New Network Report] in November 2020.

The Draft New Network concentrated service into few, more frequent routes, focused on the places with the most people and jobs. By doing so, the Draft New Network achieved better job access for most, but not all, residents of Norfolk. On job access measures, the Draft New Network:

- Increased the number of jobs that the average person could reach in 45 minutes by nearly 10,000, 31% more than with the existing network.
- Increased the number of jobs that the average person of color could reach in 45 minutes by 10,000, 32% more than with the existing network.
- Increased the number of jobs that the average person in poverty could reach in 45 minutes by 12,500, 39% more than with the existing network.

The increase in access in the Draft New Network is a result of more people and jobs near frequent service, with 140,900 more people and 95,100 more jobs near frequent transit. This increase comes with the cost of reduced coverage for some, as about 6,500 more residents and 13,800 more jobs would be more than ¼ mile from service.

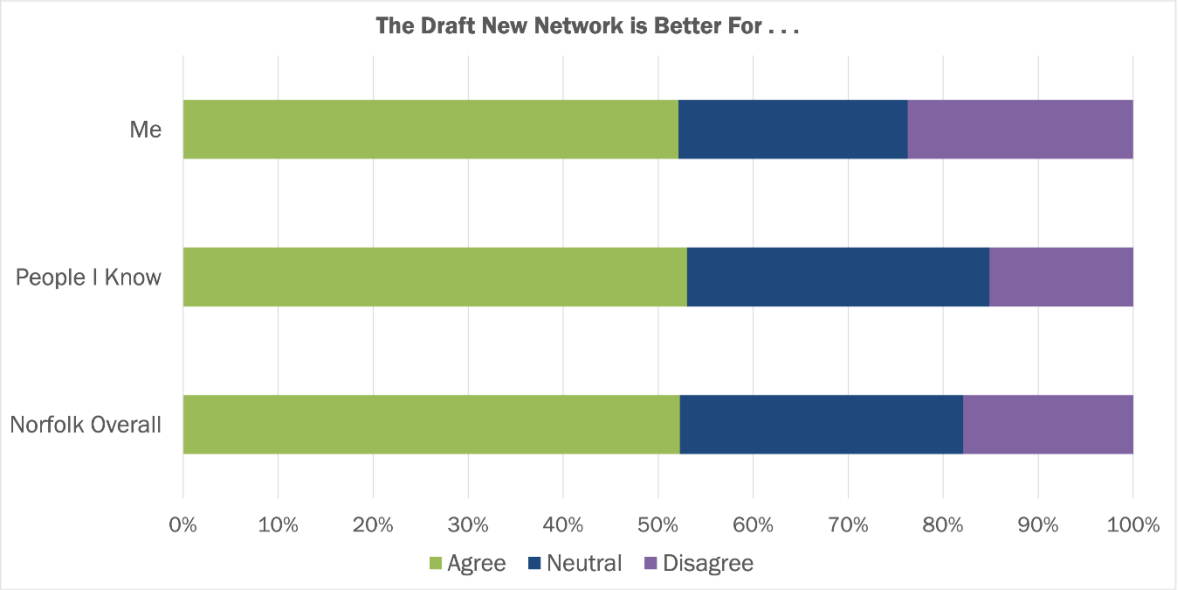
The City and project team engaged the public in two virtual meetings and surveyed bus riders and the public through a web and paper survey that was available from November 30, 2020 through January 8, 2021. Over 1,900 people responded to the survey, 76% were regular transit riders, 81% identified as African-American or Black, and 61% had an annual income below $25,000.



The Draft New Network was released for public review and comment in November 2020. A higher resolution image can be viewed in the Draft New Network Report.

Among these respondents more than three-quarters had a positive or neutral response to the Draft New Network.

The most commonly cited concerns were the walking distance to Sentara General Hospital for Route 2, the lack of service on Lafayette Boulevard west of Chesapeake Boulevard, and lack of service on Princess Anne east of Sewells Point Road.



Round 3 survey results on the Draft New Network

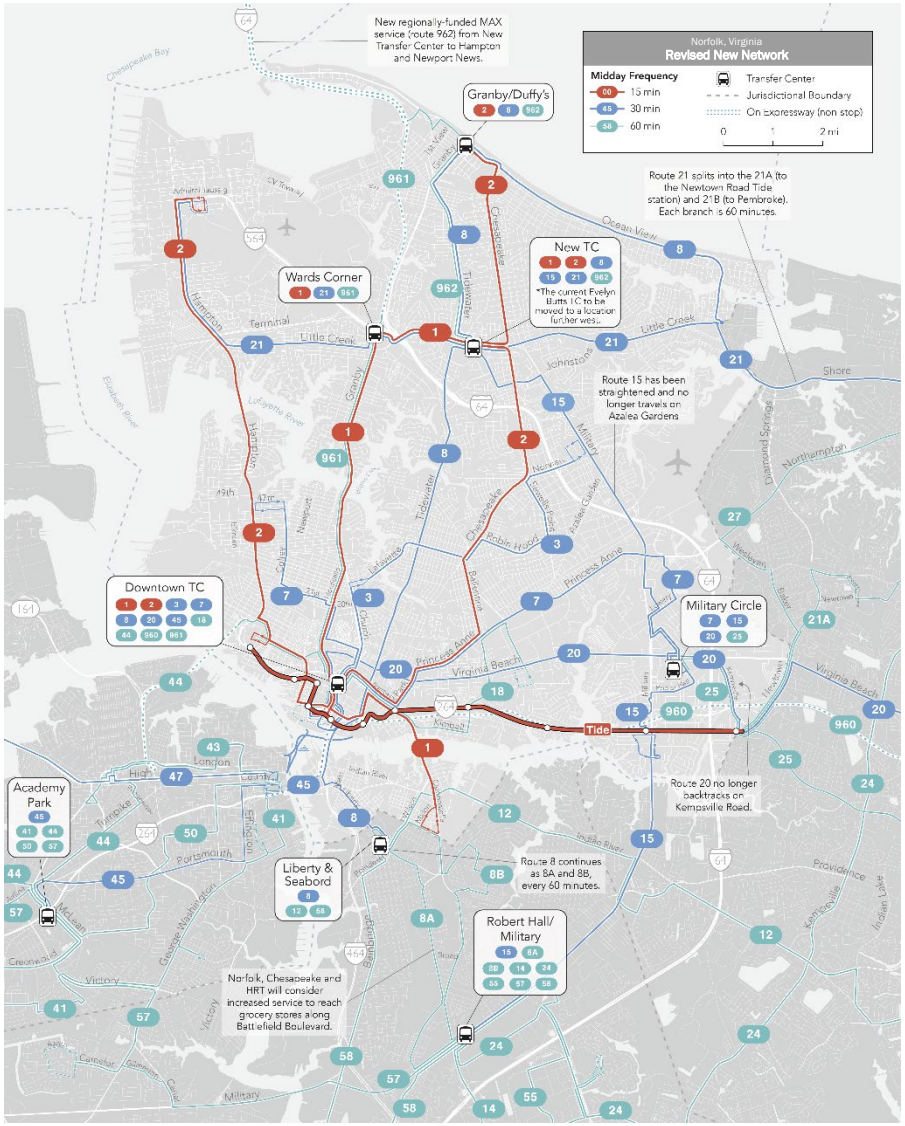
Revised New Network

Based on public input from Round 3 and additional input from HRT and City leaders, the project team revised the New Network and made the following changes:

- Added a new version of Route 3 that runs from DNTC via Church Street to 26th/27th Streets, Lafayette Boulevard, Chesapeake Boulevard, Robin Hood Road, Sewells Point Road, Norview Avenue, and terminating at Military Highway and International Boulevard. This new Route 3 would provide service along the eastern sections of the current Route 3, portions of existing Route 9, and provide a new radial connection from the Norview Avenue and Military Highway commercial areas to downtown.
- With the new Route 3 on potions on Sewells Point Road, Route 7 is shifted to serve Princess Anne Road from Sewells Point Road to Kempsville Road.
- Route 7 is also shifted to serve Princess Anne Road from Church Street to Monicello Avenue.
- The Route 2 loop through Sentara Norfolk General Hospital has been added back, though the loop may be shorter than the existing loop by using Children's Lane.

The net effect of these changes is to slightly increase the cost of the Revised New Network compared to the existing network, so that it is not strictly cost neutral, but is about 1% more costly than the Existing Network. In addition, these change shift the balance of Ridership and Coverage goals slightly toward Coverage.

The recommended changes in this network were the subject of significant public conversation, described above, and discussion with elected officials. Based on the thorough conversations and compromise around competing priorities, Norfolk City Council unanimously adopted a resolution supporting the implementation of this network on November 16, 2021.



The Revised New Network. A higher resolution image can be viewed on the www.MultimodalNorfolk.com website.

The revised new network shown on the previous page would have major benefits for most people in Norfolk. The **average resident could reach 7,400 additional jobs** by walking and transit in 45 minutes, a 23% increase over the Existing Network. The **average minority resident could reach 8,600 additional jobs** in 45 minutes, a 27% increase over the Existing Network. The **average resident in poverty could reach 10,700 more jobs** in 45 minutes, a 34% increase over the Existing Network.

Implementation of the New Network

Making such a significant change the bus network will require careful planning and coordination between the City and HRT to prepare for and implement the new network. In most communities that implement a major network, the actual changing of routes happens on a single day: one day the old routes are running and the next the new routes are running. A great deal of planning and effort goes into that seemingly overnight transition, however. Key steps in the implementation of the new network include

- Development of new schedules: HRT, with support from the City, will need to develop the final schedules for the new and redesigned routes. New public facing schedule booklets and related digital information will need to be produced so that riders can learn about the new routes.
- Designate new stop locations: The City and HRT will need to coordinate to define the exact locations for new stops in places where bus service does not run today, but will in the new network.
- Final Title VI Analysis: HRT, in coordination with the City, will need to conduct the necessary Title VI Service Equity Analysis on the final proposed changes and have the HRT Board review and approve the final changes.
- Update existing stations and stops with new route information: Many existing stops will need updated signage due to new route numbers or names. System maps and other bus route information at transit centers and Tide stations will need to be updated.
- Marketing and Communications: The City and HRT will need to coordinate to inform the public about the major changes through various media outlets, social media, on-bus announcements, and many other avenues so that riders are well-informed in the weeks and months before that a major change to bus routes will happen.

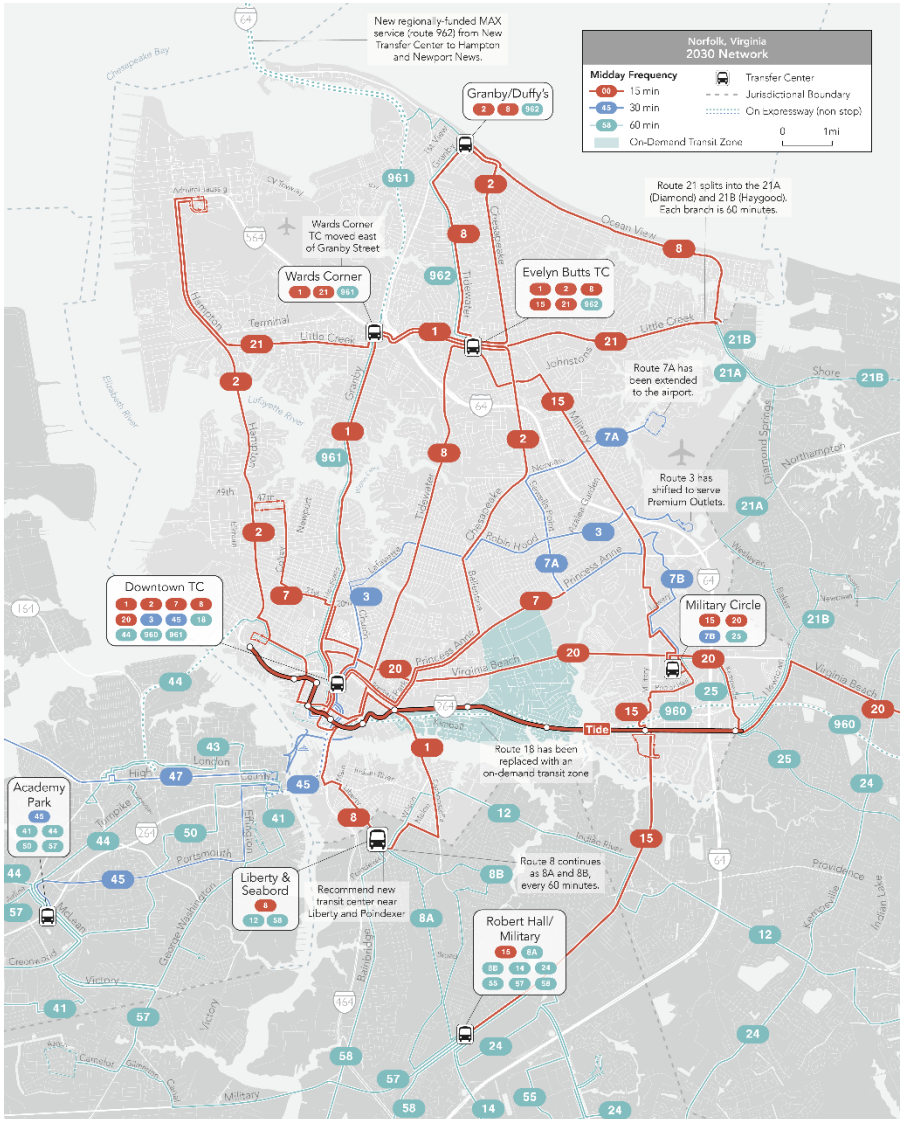
The new bus network is planned for implementation in 2023.

Long-Term Network

In 2020, the Virginia General Assembly passed legislation creating the new Hampton Roads Regional Transit Fund. This new funding source will allow Hampton Road Transit to invest in higher frequency service on its "Regional Backbone" routes which include existing Routes 1, 2, 3, 8, 15, 20, and 21. Under the Revised New Network, Routes 15, 20, and 21 are largely unchanged and the City expects that new or revised Routes 1, 2, and 8 would qualify as "Regional Backbone" routes and qualify for the regional funding to support more frequent service.

Building off the regional funding and continuing City investment, the bus network in Norfolk would drastically improve over the next 10 years, with a total increase in service levels of **nearly 40%**. The map at right shows how the extent of the frequent network could expand drastically by 2030 and shows the following improvements:

- Increased frequency for Route 8 on Tidewater Drive, E. Ocean View Avenue, and Liberty Street to every 15 minutes.
- Increased frequency for Route 20 along Virginia Beach Boulevard to every 15 minutes.
- Increased frequency for Route 15 along Military Highway to every 15 minutes.
- Increased frequency for Route 21 on Little Creek Road to every 15 minutes.
- Increased frequency for Route 7 from ODU to downtown to Princess Anne Road and Sewells Point Road to every 15 minutes.
    - East of Sewells Point Road, Route 7 would branch with each branch having service every 30 minutes. The new northern branch would serve the Airport.
- A revised Route 3 would extend to the Premium Outlets.
- Extend Route 1 from Campostella Road and Berkley Avenue to connect with Route 8 near Liberty Street and Seaboard Avenue.



The Long-Term Network. A higher resolution image can be viewed on the www.MultimodalNorfolk.com website.

This expanded and more frequent transit network would vastly expand access to opportunity for Norfolk residents and support a more vibrant economy for the city.

[i] In this plan, references to the Existing Bus Network refer to the state of the bus network in late 2019 and early 2020, before the Covid-19 pandemic forced major changes in the schedules of HRT services.

Chapter 12: Multimodal Needs Assessment

What are Multimodal Transportation Needs?

Chapter 1 defined "multimodal transportation" and explained why this plan focuses on moving people by modes other than the automobile. Pedestrians (including people who use wheelchairs and other mobility devices), bicyclists, scooter riders, and transit passengers are the primary focus of this plan.

Public input as part of this process has shown that Norfolk's residents want a city where walking, riding a bicycle or scooter, and taking transit are safe and easy. They want safe and affordable choices for everyone to meet their daily needs for mental, physical, and financial well-being without having to rely on a car. Achieving this vision implies many changes. Most of Norfolk's streets were built decades ago, long before people envisioned the travel needs of today.

Multimodal transportation needs in this plan refer to improvements that need to be made to Norfolk's streets to achieve that future vision, such as:

- New sidewalks
- New crosswalks
- New bicycle lanes
- New or more frequent bus routes
- New bus-only lanes or other transit-priority treatments
- New shelters, benches, or trash cans at bus stops
- Extended hours of bus service
- Other changes to Norfolk's streets to make it safer and easier to get around without a car

Physical changes to Norfolk's streets are called "capital" needs, meaning they are adding something new to the transportation infrastructure. There are also "operating and maintenance" needs, which refer to money needed to make sure the roads and facilities we have today are kept in good condition, as well as ongoing costs to run bus and light rail transit service.

Transportation needs are not necessarily projects or solutions. A need states a problem, not a specific solution, and could be solved by multiple possible solutions. A key part of this multimodal plan is to identify transportation needs by mode.



New bicycle lanes, like the ones on 35th Street, are an example of a multimodal transportation need.



New amenities and upgrades to bus stops are examples of multimodal transportation needs.

As described below, this was done through a combination of public input, data, and analysis. Figure 12-1 shows an overview of how the needs assessment was built.

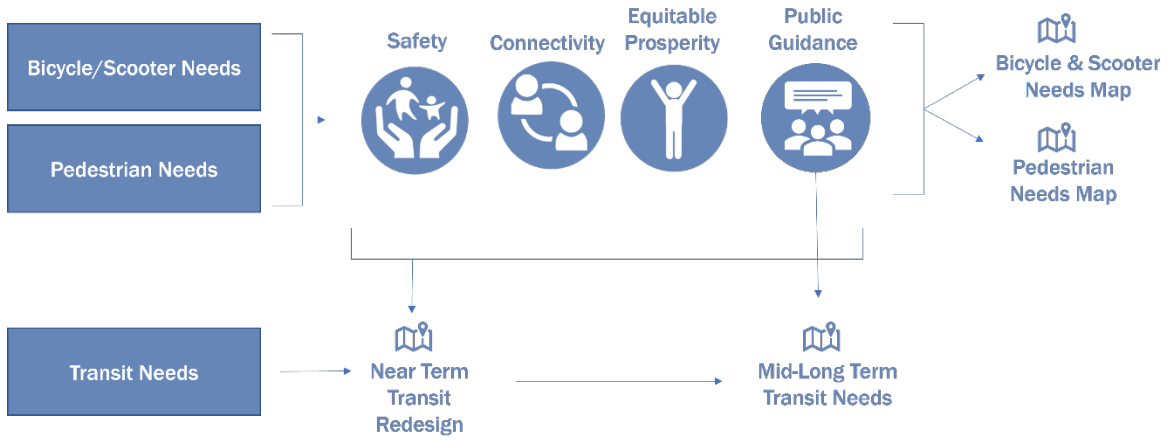
The resulting needs assessment was summarized in the form of maps that show travel need by category for pedestrian, bicycle, and scooter needs. Transit needs were analyzed separately based on the public process and analysis conducted during the Transit System Redesign.

This process yielded a lot of helpful comments, some of which are not a direct part of this multimodal transportation master planning process. As explained previously, this plan is focusing primarily on bicycle, scooter, pedestrian, and transit needs, since many other plans and policies address auto-related issues and needs.

Maintenance and operations comments will be handled by the transit department and public works as part of our ongoing maintenance and operational improvements work. Enforcement comments would be handled by the police department and enforcement departments as part of their ongoing efforts.

Not all needs can be addressed immediately because funding for making improvements is limited and changes to the street can take a long time to design, fund, and construct. This chapter describes the process to identify the most pressing multimodal transportation needs in Norfolk. The program of projects described in Chapter 13 provides a list of projects to address the highest needs and describes funding considerations.

FIGURE 12-1: MULTIMODAL NEEDS ASSESSMENT METHODOLOGY



Pedestrian, bicycle, and scooter needs were determined through public guidance and a data-guided analysis of Safety, Connectivity, and Equitable Prosperity needs. Pedestrian, bicycle, and scooter needs are shown on two sets of needs maps. Transit needs were identified through the transit system redesign process which included public guidance as well.

How were Norfolk's Multimodal Needs identified?

Multimodal needs were identified through a combination of public input and data-driven analysis.

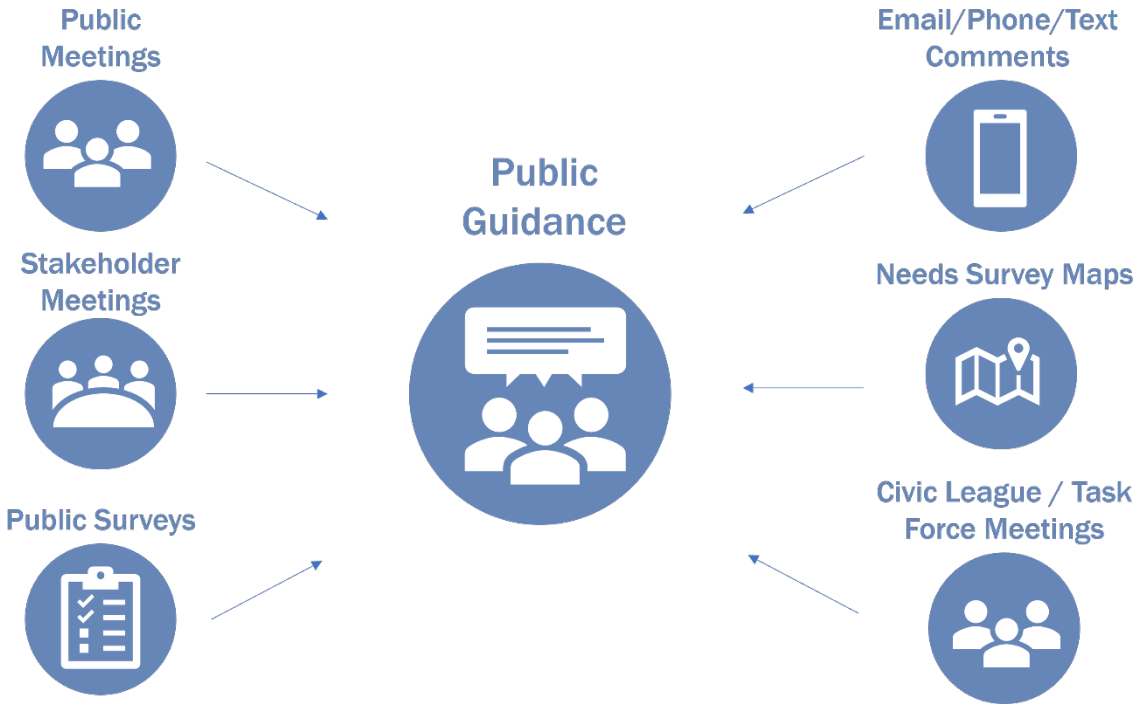
Public Input

As explained in Chapter 3, this Multimodal Norfolk Transportation Master Plan is built on a foundation of public input, and public input was a key component of identifying needs.

Norfolk's residents identified a variety of multimodal transportation needs throughout the development of this plan, including several rounds of outreach. Chapter 3 explains the four rounds of public and stakeholder engagement that occurred throughout the two-year process. Opportunities for input on the multimodal transportation needs included a variety of in-person and online public meetings, mapping exercises, and input at civic league and task force meetings, as shown in **Figure 12-2**.

One of these opportunities included an interactive online map, shown in **Figure 12-3**, through which anyone could drop a pin and identify a need or concern. The map shown in **Figure 12-3** was available for public comment from January through June 2021, in addition to other opportunities to give input throughout the process.

FIGURE 12-2: SOURCES OF INPUT FOR PUBLIC GUIDANCE



Public guidance informing the multimodal needs assessment came from a variety of sources. Norfolk's residents could provide input through civic league meetings, public surveys, written comments, and targeted meetings.

Residents who did not have internet access could identify needs by calling a phone number and leaving a voicemail message.

Public input consisted of specific ideas for improvements as well as general concerns and suggestions. Ideas for improvements included extending existing and providing new on-street bicycle lanes, including repurposing lanes to make them more multimodal on streets like Granby Street and Oceanview Avenue, providing protected crosswalks across multi-lane high speed roads like Hampton Boulevard and Tidewater Drive, installing sidewalks at interstate interchange areas and underpasses, pavement repairs, and more visible and well-lit paths for walking and bicycling.

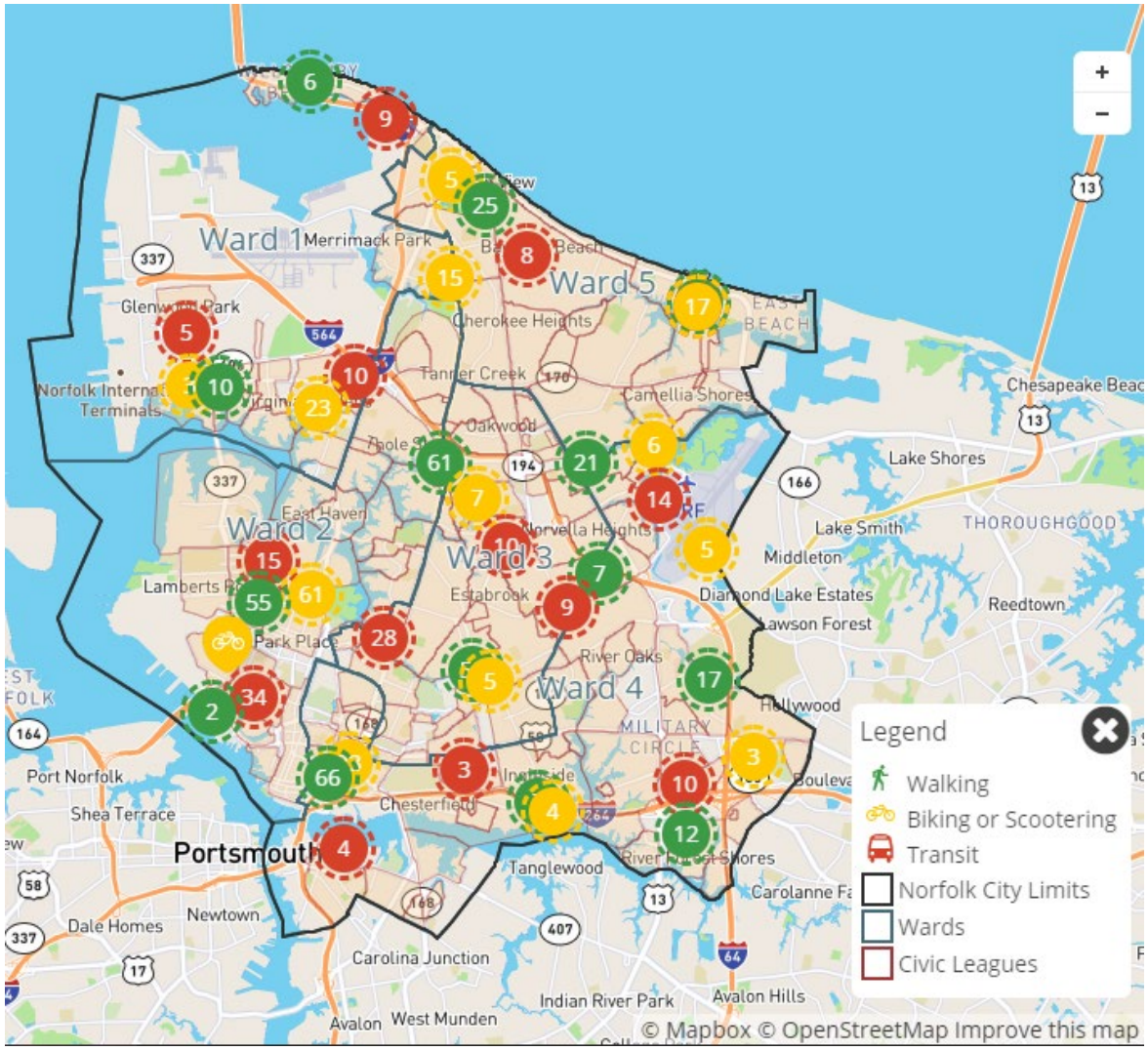
Over 800 comments were received. **Figure 12-4** summarizes the needs comments. All comments were reviewed and categorized into three comment types, as shown in **Figure 12-5**.

New Infrastructure comments on bicycle, scooter, and pedestrian needs were carried forward for incorporation into the program of projects, as described in Chapter 13.

Comments falling under the Maintenance/ Repair/ Operations/ Enhancements and Enforcement/Ordinances categories were reviewed and recorded for future reference and may be addressed through the City of Norfolk's maintenance and enforcement programs.

Comments on transit needs were reviewed and incorporated into the identification of transit needs discussed at the end of this chapter.

FIGURE 12-3: INTERACTIVE ONLINE MAP FOR IDENTIFYING MULTIMODAL TRANSPORTATION NEEDS IN NORFOLK



Norfolk's residents identified multimodal transportation needs through an interactive online map. This interactive map was one of several opportunities for residents and other stakeholders to give input and identify needs.

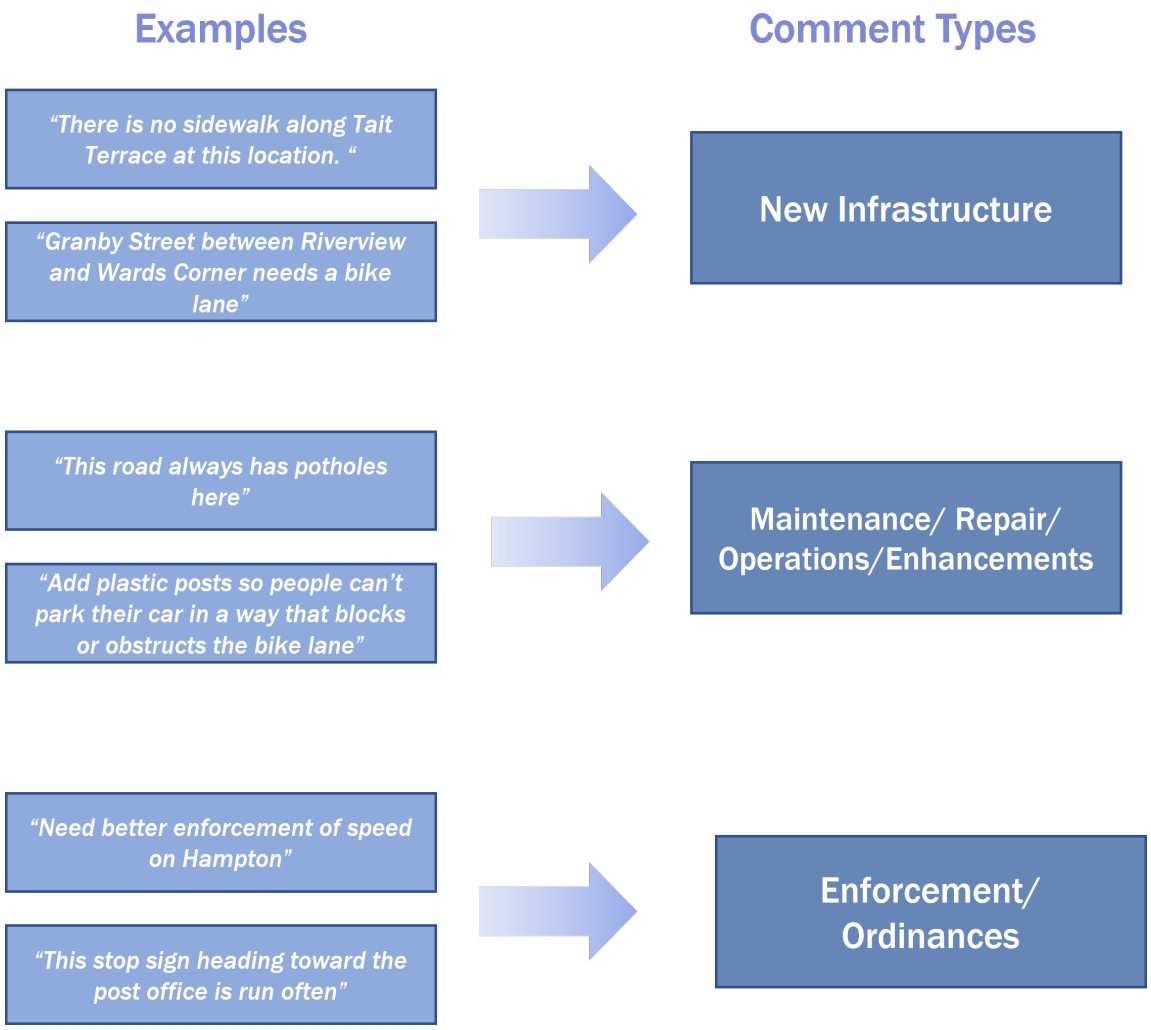
FIGURE 12-4: SUMMARY OF PUBLIC INPUT ON MULTIMODAL NEEDS



The public submitted over 800 comments identifying multimodal needs in Norfolk.

Each comment was also assigned to one or more modes – pedestrian, bicycle/scooter, transit, and auto. As explained in the next section, comments related to pedestrian and bicycle/scooter needs were combined with the pedestrian and bicycle/scooter needs maps that were produced through a data-driven analysis. Comments related to transit needs were incorporated into the transit needs assessment, described later in this chapter. Comments related to autos were recorded and saved for incorporation into future planning efforts.

FIGURE 12-5: PUBLIC INPUT EXAMPLES AND COMMENT TYPES FOR PEDESTRIAN AND BICYCLE/SCOOTER NEEDS



Over 800 comments were received through the online map, meetings, emails, and other input sources. All comments were reviewed and categorized into three comment types.

Data-Guided Analysis

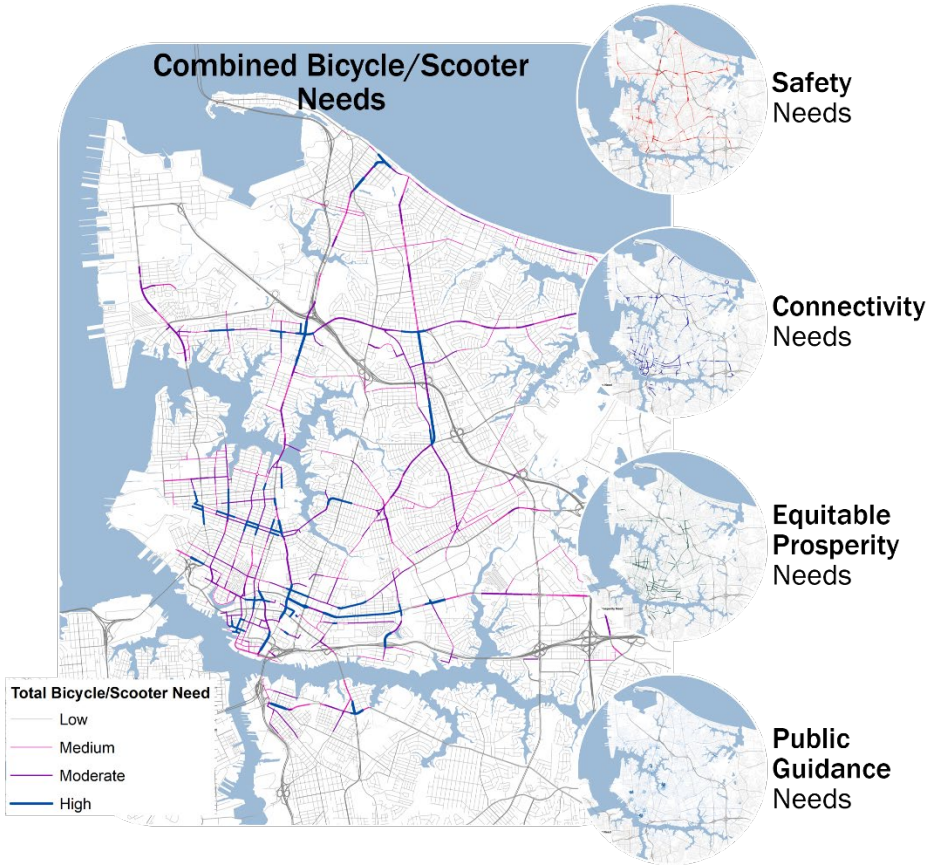
Multimodal transportation needs were also identified through a data-guided analysis. Two different types of analysis were used – one for identifying pedestrian and bicycle/scooter needs, and another for identifying transit needs.

Pedestrian, Bicycle, and Scooter Needs

The data used to identify pedestrian and bicycle/scooter needs relate to the three goals of this plan - Safety, Connectivity, and Equitable Prosperity. The data used to identify pedestrian and bicycle/scooter needs included data on population demographics, activity areas and the impacts of traffic on safety and comfort to users. A full description of the criteria used in the analysis can be found in **Appendix F**.

Each of the needs criteria was overlaid onto a map of Norfolk's streets. As the data from each criterion was overlaid onto the map, a picture began to emerge of the highest need areas in the city for each mode. A composite map was then made showing the sum total of all the needs data for each travel mode. This was shown in the form of a heat map where is the darkest areas had the highest concentrations of needs data. **Appendix F** explains how the needs maps were developed. **Figure 12-6** shows how several different maps were produced and incorporated into the final needs maps.

FIGURE 12-6: HOW THE NEEDS ASSESSMENT MAPS WERE BUILT



The Bicycle/Scooter Needs maps were built from a combination of safety, connectivity, equitable prosperity, and public guidance maps.

The resulting maps of pedestrian and bicycle/scooter needs are shown in **Figure 12-7** and **Figure 12-8**. The maps show individual segments of Norfolk's streets classified into four levels of need – Low, Medium, Moderate, and High – based on the concentrations of needs data from the analysis.

As described in Chapter 13, the pedestrian needs maps and bicycle/scooter needs maps were incorporated into the program of projects.

Figure 12-7: Map of Pedestrian Needs Analysis Results

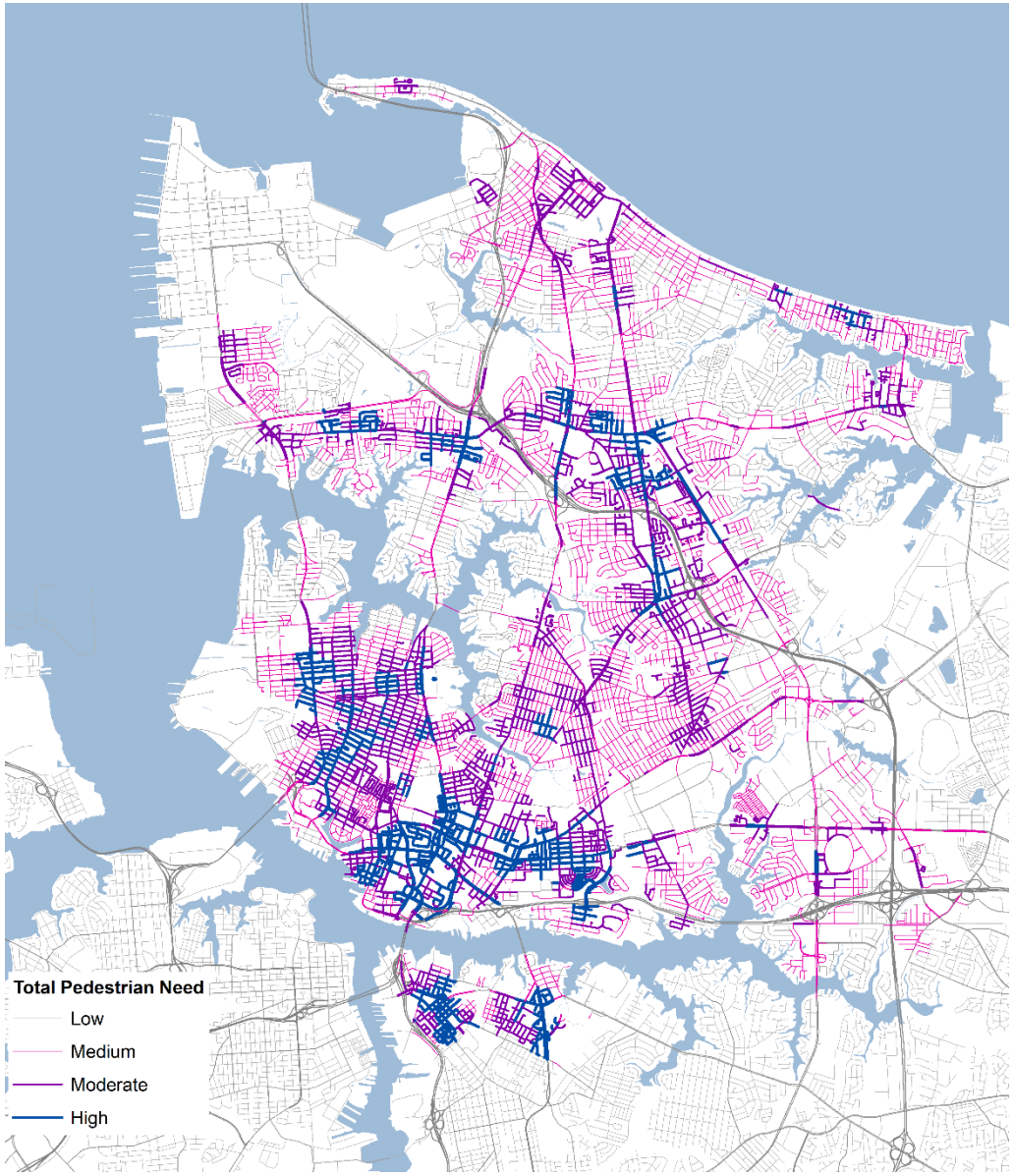
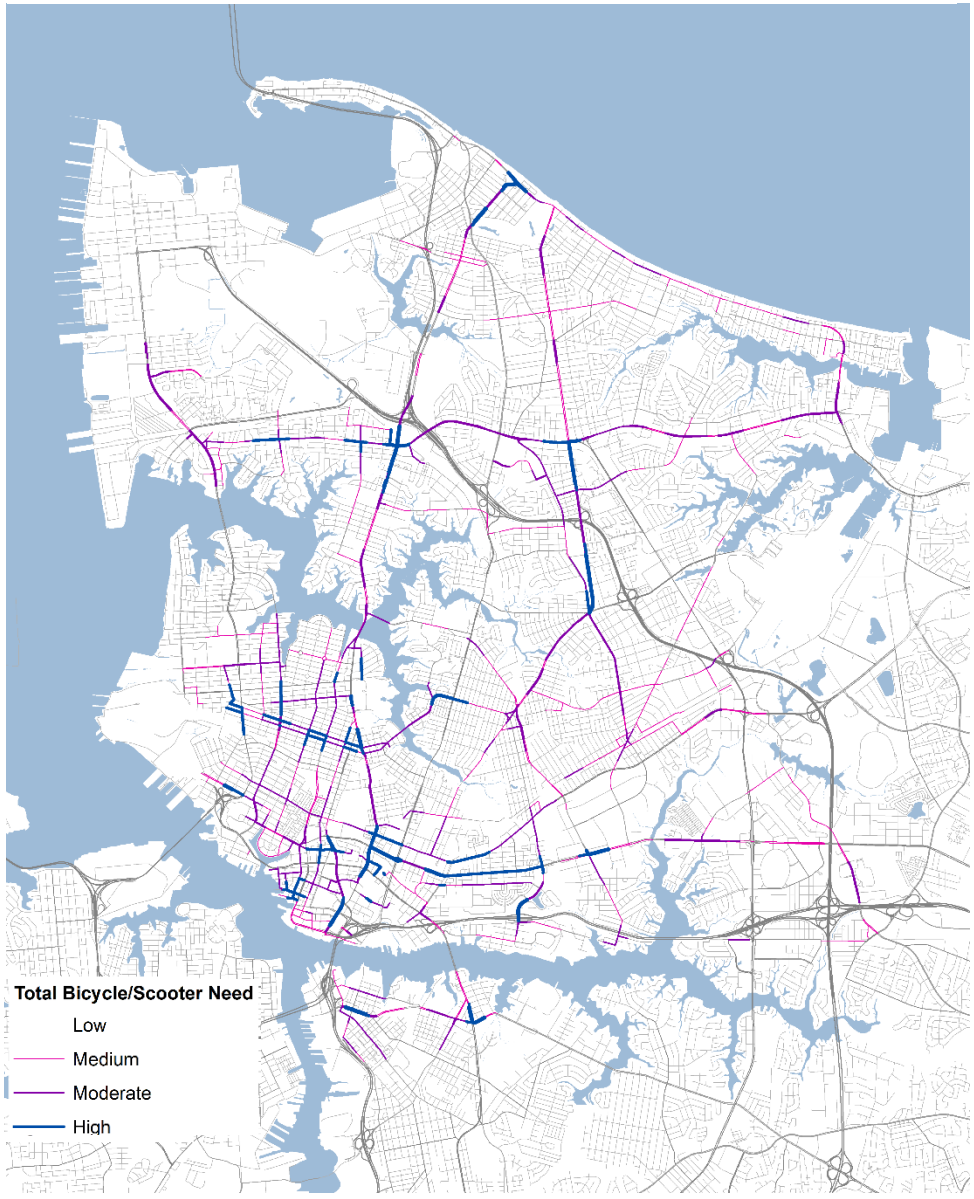


Figure 12-8: Map of Bicycle & Scooter Needs Analysis Results



Transit Needs

Transit needs were identified based on a combination of public comments during the various rounds on engagement during the Multimodal Norfolk process and on technical assessments.

Transit needs can be defined into two broad categories:

1. needs for service, as in where transit service is provided and how, and
2. needs for infrastructure, as in where shelters or transit centers are needed to make it easier to access transit service.

The markets and needs for transit service in Norfolk have been considered throughout the Transit System Redesign process (described in more detail in Chapter 11), and the resulting network maps define where Norfolk will invest in transit service to meet the needs that the City finds sufficiently necessary to serve in the short and long-term.

Through that process key infrastructure needs have been identified to improve the ability to use transit, to improve the speed and reliability of transit, and allow transit to operate more effectively and efficiently within Norfolk.

Key needs identified include:

- Additional shelters and amenities at many existing and planned bus stops.
- Dedicated bus lanes at key choke points where congestion causes delays for bus riders.
- Improved or relocated transit centers to create better connections between bus routes in the city.

STOP AMENITIES

Amenities at stops can be a key part of encouraging higher ridership. Research shows that riders at stops without amenities perceive their wait as more than double the actual time. When riders have shelters and benches at their stops, their perceived wait time drops to only 30% more than actual, and when real-time information is added, the perceived wait time is only 10% more than actual.

A University of Utah study found that stops with shelters, benches, and sidewalk connections had ridership gains compared to stops without such amenities. The same study also found that demand for paratransit service declined where amenities were provided at stops, suggesting that such amenities can shift disabled riders from paratransit to less costly fixed-route service.

As shown in the analysis conducted for the Transit System Redesign Choices Report, many stops in Norfolk that qualify for a shelter or bench under existing HRT policy do not have such amenities. The City is dedicated to ensuring that all stops that meet current HRT policies should have the amenities recommended.

IMPROVED TRANSIT CENTERS

Transit centers are critical places in the transit network: a place where people can make connections between multiple routes, multiplying the usefulness of the network and the freedom and access it provides. Therefore, transit centers need to be located in ways that are easy to get into and out of for buses and safe and comfortable for riders to navigate and use. The improvement of four transit centers in and around Norfolk would significantly improve transit connectivity and the safety and comfort of riders.

The relocation of the current **Evelyn T. Butts Transit Center** is critical to improving access in the northern parts of Norfolk. A new facility located near Little Creek Road and Sewells Point Road would be more central to where transit routes need to connect, closer to commercial and retail outlets in the corridor, larger to handle more buses for more connections, and safer and more comfortable with more amenities to provide shade, benches, information, and other amenities for riders.

The current **Pretlow Library** stop is inadequate to meet the needs of more frequent buses serving this area in the future. A new set of stops in front of the library would be safer and provide easier and faster circulation for buses terminating at this location and for buses passing through.

The current **Wards Corner Transit Center** is awkwardly located between I-564 and the railroad, disconnected from the surrounding neighborhoods and retail areas. It also forces buses going through the facility to make extra turns through a congested area to get into and out of the facility, slowing buses down and delaying riders. In the long-term, this transit center should be relocated to either an on-street facility along a redesigned Admiral Taussig Boulevard site or into the property of the former Farm Fresh grocery store at Admiral Taussig Boulevard and Little Creek Road.

Although the current **Liberty Street and Seaboard Avenue** Transit Center is located in Chesapeake, it is less than ¼ mile south of the City of Norfolk and it is an important connection point for many routes that come from or go to Norfolk and connect to regional destinations. In the long-term, this transit center will be the connection point for two frequent routes that serve South Norfolk. The current location forces long deviations for buses to circulate around and reach the shelters that are only on the northbound side of Liberty Street. Also, in the long-term, the more natural convergence point for bus routes in this area is the intersection of Liberty Street and Poindexter Avenue. While it is not within the City of Norfolk, it is valuable to City residents and businesses to have more effective and efficient transit connections to and from destinations across the region. A relocated transit center closer to Liberty Street and Poindexter Avenue in Chesapeake would be beneficial to the City and the entire region.

DEDICATED LANES FOR TRANSIT

Norfolk has limited road space and it would be highly destructive to expand roadways. More and more people are trying to use a fixed amount of road space. If they are all in cars, they simply will not fit in the space available. The result is congestion, which cuts people off from opportunity and strangles economic growth. *To make the most efficient use of the limited road space, the most space efficient modes (buses, bikes, and walkers) need dedicated space at the most severe choke points to maximize access to opportunity for the most people most efficiently.*

For buses, it is best to have dedicated space where the frequency of service is high and there is a high likelihood that buses would be caught in congestion without a dedicated lane. The following corridor segments are high priorities for dedicated lanes or queue jump lanes to allow buses to avoid congestion:

- Brambleton Avenue from Park Avenue to Church Street (13 buses per hour per direction in 2030)
- Boush Street from Brambleton Avenue to City Hall Avenue (4 buses per hour per direction in 2030)
- St. Pauls Boulevard/Monticello Avenue from Virginia Beach Boulevard to Main Street (approximately 14 buses per hour per direction in peak segment).

Chapter Summary

The needs assessments and resulting needs maps described above give an objective picture of the highest need areas for transportation improvements that can be used to guide future transportation investments and priorities for the city.

Having this analysis ensures that there is an objective framework against which to measure the value and importance of proposed improvement projects. Candidate projects in the future can be compared to these needs maps to see how they line up with areas that both public input and data assessment have shown to be the most significant need areas in the city.

The needs assessments and resulting maps were used to identify higher priority projects for funding assessments in the program of projects, as described in the next chapter.

Chapter 13: Program of Projects and Resource Allocation Plan

What is a Program of Projects?

The previous chapter explained the process to identify the needs for walking, bicycling, scootering, and transit in the City of Norfolk. The more than 800 comments received added up to a list of potential projects that were much greater than could be constructed with currently available funds. Not all needs can be met today, and the process to obtain funding for improvement projects is complicated. The City of Norfolk receives funds from a variety of different sources for improvement projects, each with requirements and constraints.

Figuring out which projects can be funded by different funding sources is one piece of the puzzle. Another is identifying which projects meet the highest needs. Determining which projects meet the highest needs and match with appropriate funding sources is an important process. This chapter explains the process for doing so and introduces the City of Norfolk's current program of multimodal projects.

The Program of Projects in this plan is a comprehensive list of improvement projects that, if constructed, will meet the highest needs for safer walking, bicycling, scootering, and transit.

The Resource Allocation Plan, which is described in greater detail at the end of this chapter, is a smaller list of projects from the Program of Projects that the City can realistically move forward with in the near term.

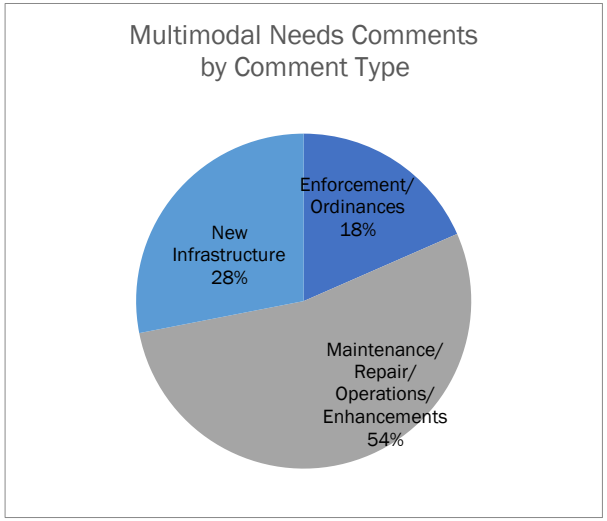
Projects to Meet the Needs

As explained in Chapter 12, Norfolk residents and other members of the public provided over 800 comments describing transportation needs within the City.

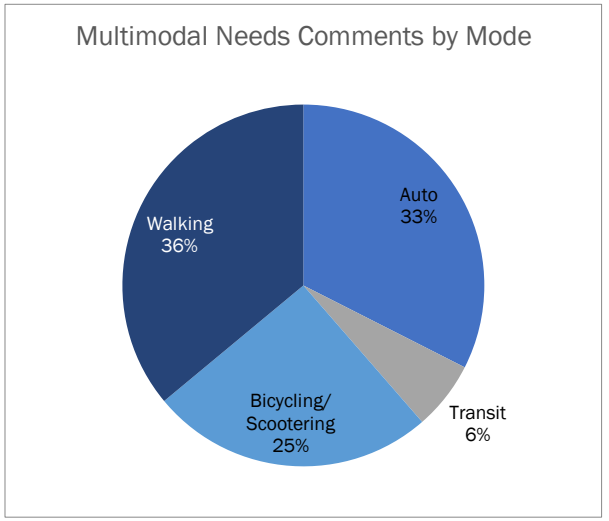
The **Program of Projects** is a comprehensive list of all potential projects to address Norfolk's multimodal transportation needs. The current Program of Projects table is available in **Appendix G**.

The **Resource Allocation Plan** is a shorter list of just the priority projects that the City can feasibly move forward with in the short term. The projects in the Resource Allocation Plan are ready for project development, meet the highest needs, and align best with funding program criteria. The current Resource Allocation Plan table is available in Appendix H.

The interactive map on the City's website shows the location of projects within the current Resource Allocation Plan and Program of Projects.



The more than 800 comments on multimodal needs were categorized into three categories.



The more than 800 comments on multimodal needs referred to walking, bicycling/scootering, transit, and auto modes.

The process for translating these comments into a list of improvement projects is described below.

*The current Program of Projects is a map and a list of projects. The current list is available in **Appendix G.***

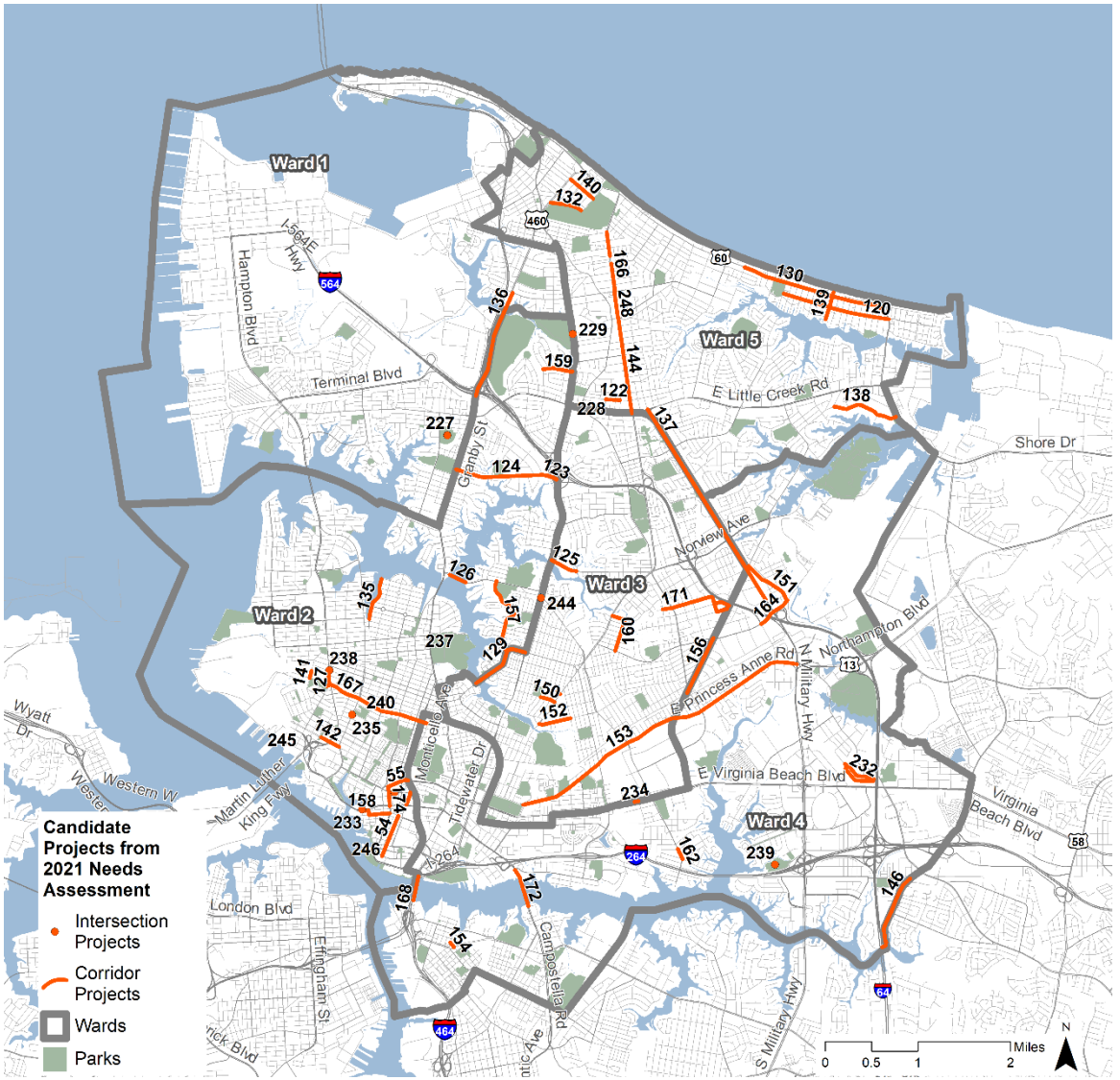
The online map of the Program of Projects is currently available at www.MultimodalNorfolk.com.

As shown in the charts on the previous page, a little more than a quarter of the comments received related to new infrastructure. The new infrastructure comments related to pedestrian, bicycle, and scooter needs were carried forward into a project identification process. Comments related to transit needs were incorporated in the identification of transit needs described previously in Chapter 12.

Maintenance and operations comments will be handled by the City's transit and public works departments as part of their ongoing maintenance and operational improvements work. Enforcement comments will be handled by the City's transit and police departments as part of their ongoing enforcement efforts.

Some comments related to new infrastructure suggested a clearly defined improvement project such as a new mid-block crossing or new sidewalk on a specific street segment. Other comments were less specific, such as a

FIGURE 13-1: CANDIDATE PROJECTS FROM THE 2021 NEEDS ASSESSMENT



75 candidate projects were identified from public input on the 2021 multimodal needs assessment. These 75 projects are listed in Appendix G. The numbers on the map are the project IDs. The numbers are not a ranking of the projects. The projects in this map can be viewed in the online map of the Program of Projects, available at https://bit.ly/3vRrlcE.

walking or biking trail connecting several destinations but without a proposed alignment.

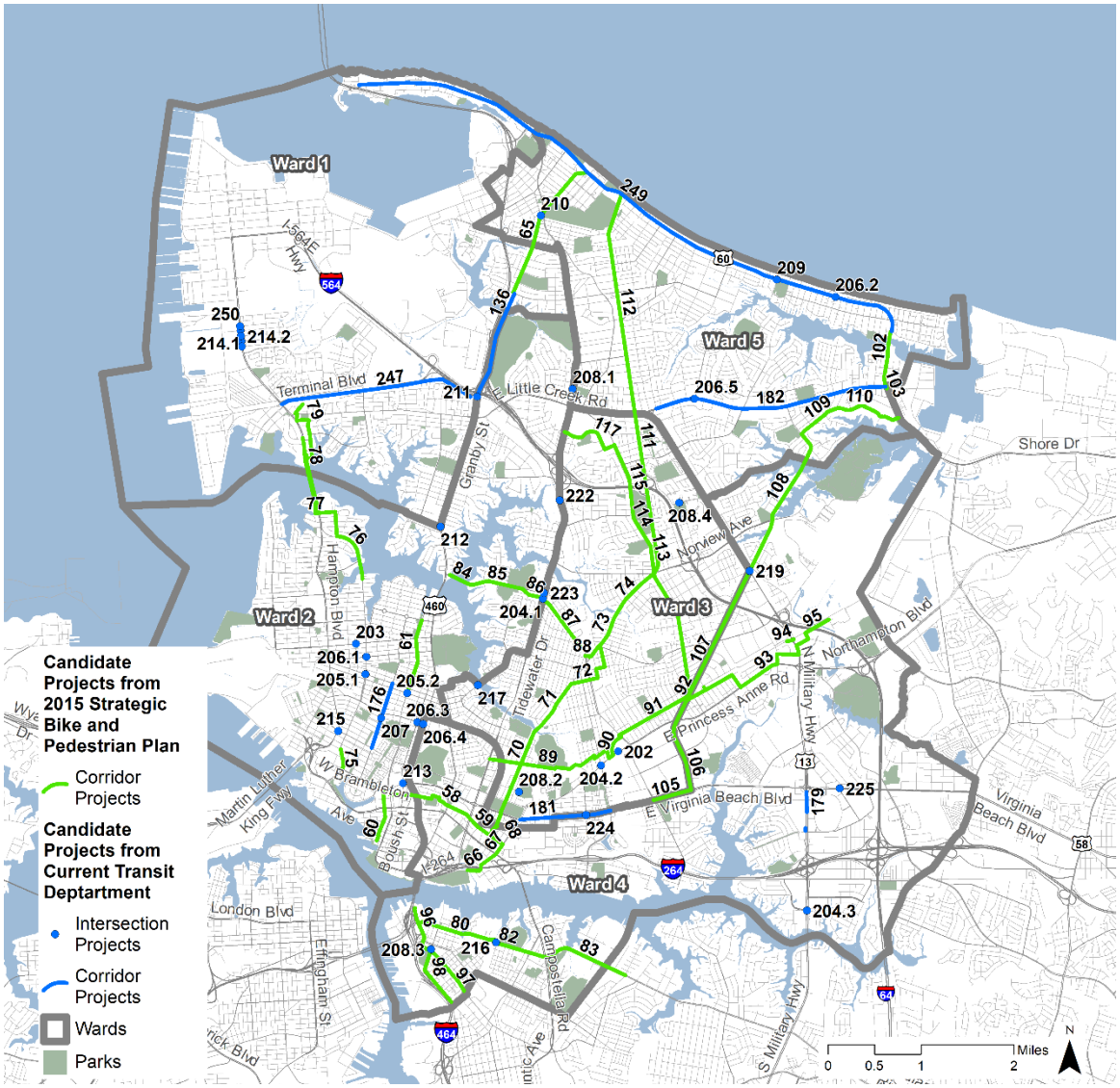
The comments were assessed and translated into a list of potential projects. Some comments were easily translated into specific projects. Others called for further study. **Figure 13-1** shows a map of the easily defined candidate projects. The map shows project ID numbers. Project descriptions are available in **Appendix G.** Comments requiring further study were forwarded to City staff for future efforts.

In addition to the projects identified from public input on the needs assessment, the City of Norfolk Transit Department maintains a list of improvement projects that would meet multimodal transportation needs in the city. These projects were accumulated from public and stakeholder input over several years. **Figure 13-2** shows a map of these candidate projects from the Transit Department's current list and project recommendations from the Norfolk Bicycle and Pedestrian Strategic Plan that was adopted in 2015.

The candidate projects shown in **Figures 13-1 and 13-2** represent projects for which future funding has not been identified.

The candidate projects do not include the projects that the City of Norfolk has acquired funding for and is actively implementing. These "committed" projects are shown on the map in **Figure 13-3**.

FIGURE 13-2: CANDIDATE PROJECTS FROM CURRENT TRANSIT DEPARTMENT LIST



The City of Norfolk Transit Department maintains a list of candidate projects accumulated from public and stakeholder input over several years. The projects shown on this map are listed in Appendix G. The numbers on the map are the project IDs. The numbers are not a ranking of the projects. The projects in this map can be viewed in the online map of the Program of Projects, available at www.MultimodalNorfolk.com.

The projects in **Figures 13-1 through 13-3** can be viewed in an online scalable map on the City of Norfolk's website.[i]

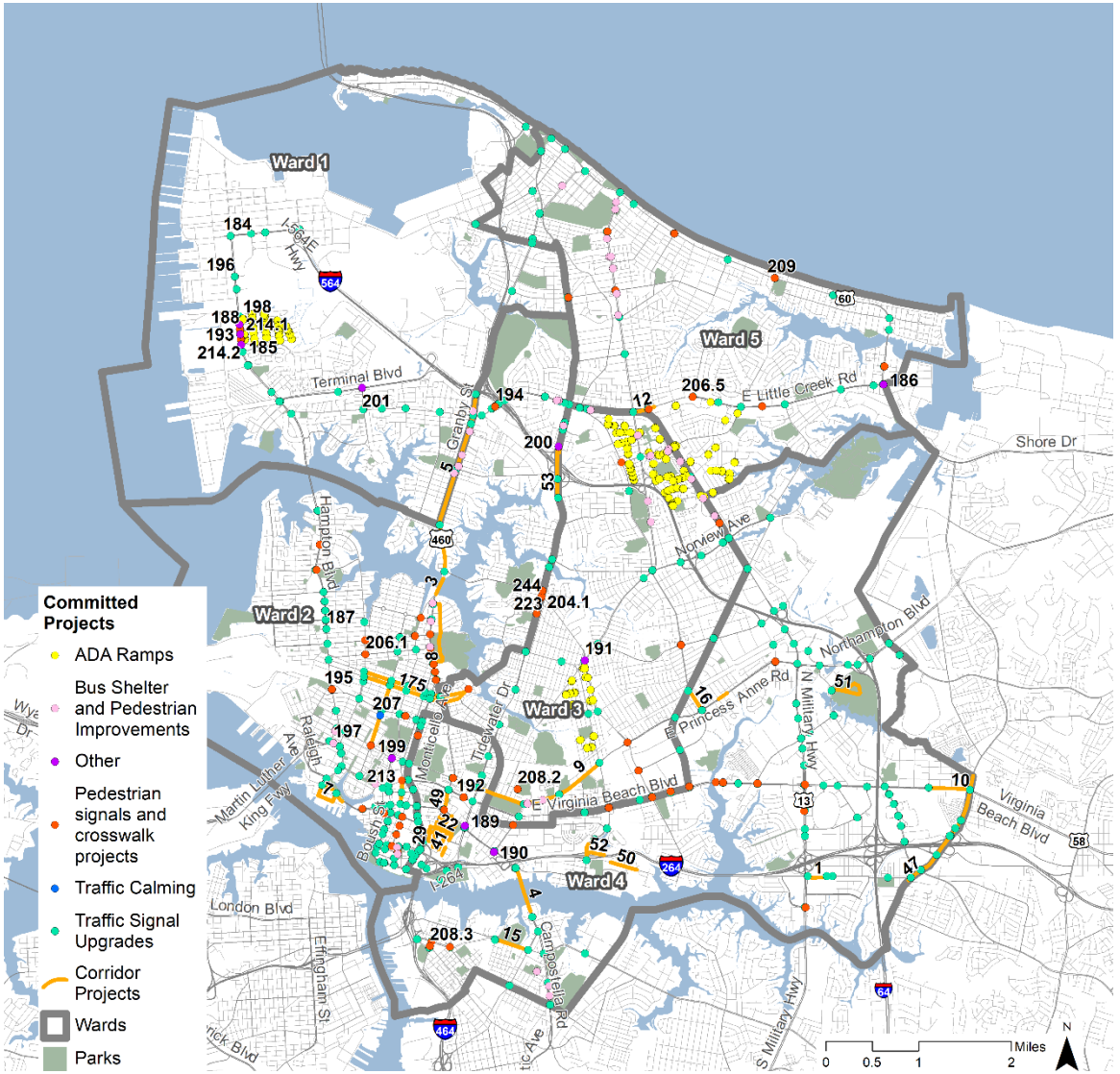
Appendix G shows the current program of projects in a table. Project descriptions are provided, as well as the project type, project source, funding status, and need level. Chapter 12 and Appendix F describe how the need levels were calculated. The projects are **not** listed in any particular order, rank, or priority.

The need levels shown in **Appendix G** provide a reference on the relative level of need based on the goals of safety, connectivity, and equitable prosperity. The projects with the high need levels simply indicate a high need.

However, the level of need is only one factor in determining when and how a project gets funded and implemented. Other factors include funding availability, project development, and scheduling. Matching potential projects to funding sources is a highly complex process due to federal and state funding requirements.

Many of the candidate projects listed in the program of projects in **Appendix G** will require an engineering study to determine feasibility.

FIGURE 13-3: COMMITTED PROJECTS WITH ALLOCATED FUNDING



The projects in this map have been identified for future funding. The projects in this map can be viewed in the online map of the Program of Projects, available at www.MultimodalNorfolk.com.

Funding for Improvement Projects

The diagram in **Figure 13-4** shows a generalized process for reviewing and funding candidate projects for the City. There are several steps involved in getting transportation projects funded, including aligning them with available funding resources and developing the project applications.

NEED REVIEW

The Needs Assessment process as described above represents a carefully vetted and analyzed assessment of where the greatest needs for multimodal transportation improvements in the city are. Projects from the Candidate Project list in the Program of Projects have each been compared to the Needs Assessment map and assigned a need score that shows there relative ranking by ward and citywide. This ranking can be used to prioritize the most important projects to consider in upcoming funding cycles.

New projects that come up that are not in the list of Candidate Projects can also be compared against the Needs Assessment map and given rankings. It is important to note, however, that needs ranking is only one consideration in determining which projects should be funded in the near term. Other considerations may arise, such as overarching neighborhood or safety concerns or the opportunity to leverage additional funds that may be considered in addition to a project's need ranking.

PROJECT ELIGIBILITY

Each funding program it has its own criteria for project eligibility. Each candidate project needs to be assessed with respect to the eligibility criteria across different funding programs. The Funding Compatibility Matrix in **Figure 13-5** shows the various city state and federal transportation funding programs and the general types of projects that are eligible for funding under each. Candidate projects should be compared with each funding program to see not only which projects are eligible under that program but also the timing of the application process and the timing of the final funding to see if that matches the preferred project timeline.

STRATEGIC DEVELOPMENT

After alternative funding programs have been identified for a candidate project, the process of strategic development occurs to find the optimal funding program that fits with each project. This strategic development process includes considerations such as the capacity of the program to fund the project based on its cost, potential synergies with other funding programs and the application requirements and staff resources needed to develop the project sufficiently to be considered for funding. There may also be special considerations with some programs such as a local resource match.

PROJECT DEVELOPMENT

Most funding programs require some level of project development. Project development is the process of developing preliminary designs and cost estimates at a sufficient level of detail to justify the requested funding. Some programs, such as the statewide Smart Scale program, require significant levels of time and effort to develop project designs and costs to be accepted for consideration. It is important to consider this step in the process and to properly allocate resources, whether city staff time or consultant resources to successfully develop projects as needed for funding application requirements.

PROJECT APPLICATION

Once projects have been developed at sufficient detail to meet application requirements, the application needs to be processed and submitted. This may entail coordination with other departments in the city or other state or regional agencies. It may also require coordination with the city budgeting staff if matching funds are required.

The final stage in the process is a review of projects that were successfully funded or were rejected for funding. This step is especially important to derive lessons learned from successful or unsuccessful project applications that can be used to refine the strategic development of future funding applications.

FIGURE 13-4: PROJECT FUNDING CYCLE DIAGRAM

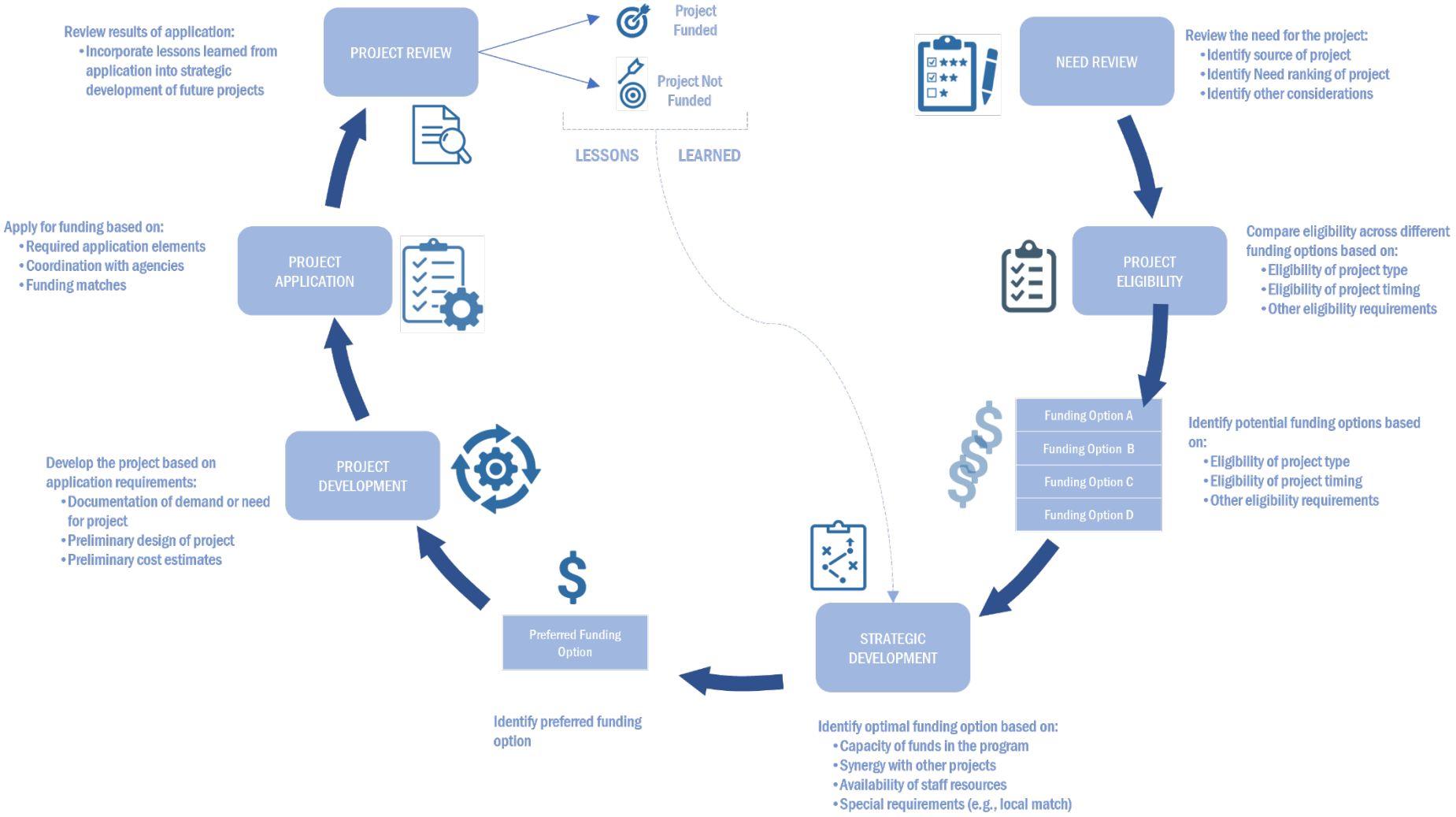


FIGURE 13-5: FUNDING COMPATIBILITY MATRIX

FUNDING COMPATIBILITY MATRIX									
FUNDING PROGRAM	**PROJECT TYPE (Capital improvements Only)**								
LOCAL	**AUTO**	**BIKE**	**PED**	**BIKE/PED**	**TRANSIT**	**BIKE/TRANSIT**	**PED/TRANSIT**	**BIKE/PED/TRANSIT**	**OTHER**
Signals and Intersections	■	□	□	□	□	□	□	□	■
Complete Streets	□	■	■	■	■	□	□	□	
Street Infrastructure	□	□	□	□	□	□	□	□	□
ADA Ramps *									■
Bridge Repair **									■
Neighborhood Streets	□	□	□	□	□	□	□	□	
St. Paul's Road Infrastructure									■
Technology									■
Development Proffers	□	□	□	□	□	□	□	□	□
VDOT/REGIONAL	**AUTO**	**BIKE**	**PED**	**BIKE/PED**	**TRANSIT**	**BIKE/TRANSIT**	**PED/TRANSIT**	**BIKE/PED/TRANSIT**	**OTHER**
Smart Scale	■	■	■	■	■	■	■	■	□
HSIP	□	■	■	■	□	□	□	□	□
Transportation Alternatives		■	■	■	■	■	■	■	
State of Good Repair	□								□
Revenue Sharing	■	■	■	■	■	■	■	■	□
CMAQ	■	■	■	■	■	■	■	■	□
RSTP	■	■	■	■	■	■	■	■	□
MISC. DRPT PROGRAMS					□				
FEDERAL	**AUTO**	**BIKE**	**PED**	**BIKE/PED**	**TRANSIT**	**BIKE/TRANSIT**	**PED/TRANSIT**	**BIKE/PED/TRANSIT**	**OTHER**
BUILD Grants	□				□				
Block Grants		□	□	□	□	□	□	□	□

	Not eligible
□	Eligible only
■	Eligible and preferred

* Eligible under Revenue Sharing Program

** Eligible under RSTP Program

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Resource Allocation Plan

The Resource Allocation Plan provided in Appendix H is a subset of pedestrian, bicycle, scooter, and other new infrastructure projects from the Program of Projects that the City can realistically move forward within the near term, likely over the next five to 10 years.

Given funding, staffing, and resource constraints, the projects listed in the Resource Allocation Plan are generally those that are ready to be moved forward into project development as required for various funding applications.

Projects were prioritized for inclusion in the Resource Allocation Plan based on project readiness, need level, and the City's ability to move them forward into funding applications.

Project readiness and cost category were determined through planning level examination of utility issues, right-of-way constraints, presence of curb and gutter, and other feasibility considerations.

Projects in the Program of Projects that are not within the Resource Allocation Plan generally require further scoping and definition to improve their readiness. This additional scoping and definition will first be applied to high need and high priority projects to advance them into future versions of the Resource Allocation Plan.

The projects listed within the Resource Allocation Plan will change over time as projects are completed, as other projects are developed further to become ready, and as funding program criteria and City staffing resources change.

Chapter Conclusion

This chapter summarizes the development of a list of new candidate projects for the City to pursue in future funding applications. It also represents a new, performance based and public input driven process for identifying and prioritizing transportation projects in the future.

It is hoped that this new objective and transparent process will lead to a better public understanding of how and why transportation projects get proposed and funded. It also represents a greater accountability that links these projects to identified public desires and needs for safety, equity, and connectivity to build a more multimodal future for Norfolk.

[i] A map of all projects in the current Program of Projects, including candidate and committed projects is available at www.MultimodalNorfolk.com.

Chapter 14: Implementation and Next Steps

Where to Now?



Transportation is the lifeblood of any city. However, transportation is about much more than traffic. It is about building connections, it is about keeping people safe, and it is about providing access to opportunities. It is also about bringing new life to communities whose roadways have become barriers instead of safe pathways for the most vulnerable residents.

Multimodal Norfolk represents a new direction for transportation in Norfolk. As the city's first-ever multimodal master plan, it is a blueprint for a safer, more equitable and sustainable transportation network for the future – one for all people to have access to the roads, sidewalks, busways and bike and scooter networks to get where they need to go safely.

This plan is the result of two years of planning, strong public input, and dedicated discussions among leaders to move Norfolk into a new era of multimodal transportation. But the next steps go far beyond planning; they need to involve a redesign and reorganization of the way our city builds and funds its transportation system, including a new need-based approach to funding the most important transportation projects first.

Implementing the Plan

Implementing the framework established by Multimodal Norfolk required several initial steps to translate the broad list of candidate projects (Program of Projects) into built improvements that improve the quality of life of Norfolk's citizens. Broadly this process involved three steps:

1. **Funding Estimates** - Estimating an anticipated level of available funds for transportation projects in the near to mid term

2. **Cost Estimates** - Creating planning level cost estimates of the candidate projects

3. **Priority Project List** - Using the needs ranking of candidate projects to define a shorter list priority of projects for funding in the near- to mid-term timeframe (Resource Allocation Plan.

With a list of priority projects that is scaled to anticipated funding availability and that takes into account staff capacity in the coming years, city staff can proceed with funding applications for projects in a systematic manner, knowing that they are prioritized according to the greatest needs as outlined in this plan.

Each step in this process is described below in more detail:

Funding Estimates

Projecting funding for the future is an imperfect science. Funding programs regularly change their criteria and application requirements, and state, federal and city budgets are always subject to change. however, some rough estimates of future funding can be gleaned from looking at past funding levels of existing programs. Table 14-1 shows an analysis of past funding levels that Norfolk has received from state federal and city funding programs for transportation. it should be noted that this funding includes all modes and not just bicycle, pedestrian, and transit modes and the majority of the funding in prior years has been for automobile- related improvements. However, it is a starting point and an order of magnitude projection to be able to estimate possible future funding levels within which to fit a list of priority projects.

Table 14-1 shows both an annualized estimate of funding levels and a projection of that annualized estimate over 10 years. The timeframe of 10 years was chosen as a planning horizon for near- and mid-term projects. Since some of these funding programs take several years from the time of the application to the time that funds are actually disbursed, it is necessary to go out 10 years in order to capture all but the long term project timeframes.

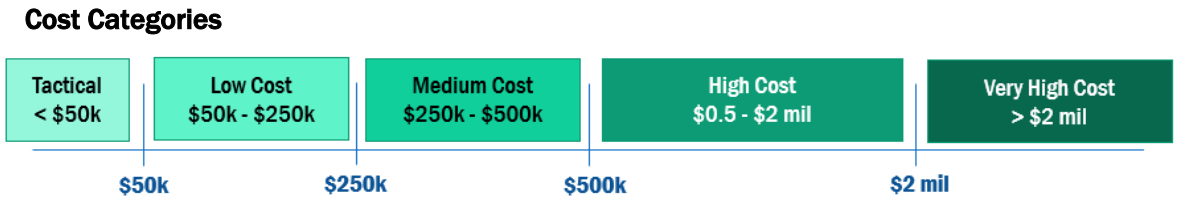
Multimodal Norfolk represents a new direction for transportation in Norfolk. As the city's first-ever multimodal master plan, it is a blueprint for a safer, more equitable and sustainable transportation network for the future – one for all people to have access to the roads, sidewalks, busways and bike and scooter networks to get where they need to go safely.

TABLE 14-1: GENERALIZED ESTIMATES OF FUNDING FROM TRANSPORTATION PROGRAMS

GENERALIZED ESTIMATES OF FUNDING FROM TRANSPORTATION PROGRAMS (1)		
PROGRAM	**Estimate of Annualized Funding from Past Years**	**10 Year Projection Based on Annualized Funding**
Capital Improvement Program (2)	$12.4 m	$124 m
State Funding Programs (3)	$9.7 m	$97 m
Specialized Federal Funding Programs (4)	0.3 m	$3 m
TOTAL	**$22.4 m**	**$224 m**
(1) This analysis was done from available records of City Capital Improvement Program and State Six Year Improvement Program funding. No representation is made as to its accuracy		
(2) From the General Capital Fund allocated to Dept. of Transit for the years 2021 - 2026		
(3) Includes VDOT Highway Safety Improvement Program (HSIP), VDOT Smart Scale, VDOT Transportation Alternatives, and VDOT Revenue Sharing		
(4) Taken from VDOT FY 2021-22 to FY 2026-27 Six Year Improvement Program		

Cost Estimates

Understanding the time horizon, funding, and staff capacity constraints, city staff developed order-of-magnitude cost estimates for each potential project in the Resource Allocation Plan, according to the general cost categories shown to the right.



The project cost estimates at this stage are necessarily rough and did not involve preliminary design or engineering. They involved estimating the linear feet and/or square feet of improvements needed and comparing them to nationally recognized cost estimating tables by type of improvement.

This process of developing planning level cost estimates was done for the entire list of pedestrian, bicycle, scooter, and other new infrastructure candidate priority projects. Potential funding sources for each project were also identified.

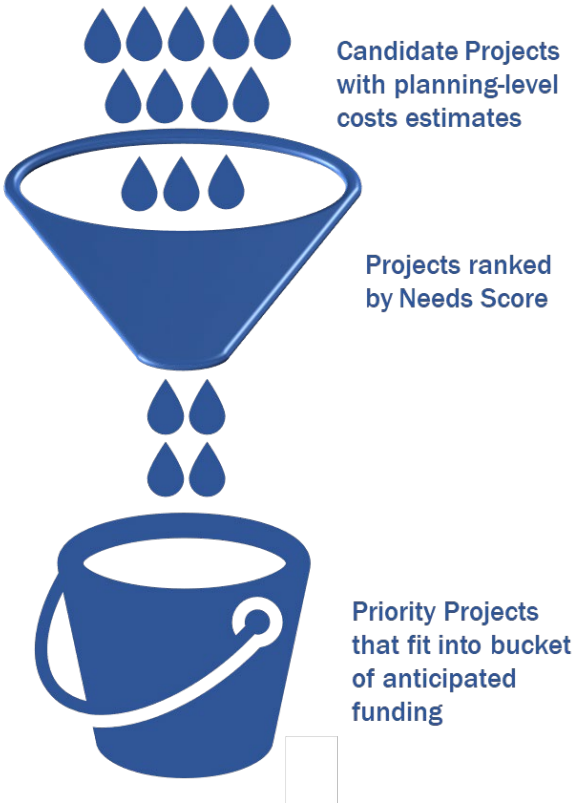
Funding for operations and maintenance comes from different funding sources, usually local City funding. Operations and maintenance funding for new projects will need to be addressed in the City's ongoing maintenance allocation budget.

Priority Project List: The Resource Allocation Plan

Once the planning level cost estimates were developed for each of the candidate priority projects, they were used to develop a list of priority projects for the next five to 10 years. This process involved considering the need rankings of each project, the project costs, and staff capacity for project development.

The process to apply for project funding requires resources to study, define, and develop a scope for a proposed project before funding can be sought. Given staff, funding, and other resource constraints, a shorter list of projects that can realistically be advanced to project development and applied for funding was prepared, based on the needs analysis described in earlier chapte rs. This process included fitting as many projects as realistically possible into an anticipated budget while using their need rankings to filter the top ranked projects.

The Resource Allocation Plan in Appendix H reflects the current list of near term projects for various funding sources that are ready for potential funding applications in upcoming funding cycles. Their



With a collective effort from leaders, citizens and city agencies working together, we can ensure that the future foundation for transportation projects in Norfolk can be based on transparency, equity, and public engagement towards the betterment of our whole community.

advancement in funding applications will also depend on funding source eligibility criteria over the next 10 years.

The graphic to the right shows a simplified version of how this prioritization process worked. Candidate priority projects that have planning level cost estimates attached to them were ranked according to their needs score. Then they were fitted into the bucket of anticipated available funding over the next five to 10 years. The result is a shorter list of projects that might be fundable over the next decade. This is the City's current list of Resource Allocation Plan projects. It should be noted, however, that funding sources, eligibility criteria, and timeframes frequently change. This list of projects to identify funding for will be updated periodically to adjust to the changing circumstances.

Facing Forward

The comprehensive Multimodal Transportation Master Plan for Norfolk provides a roadmap for action over time that builds on the input received from citizens, city staff and community leaders over the past two years. These voices have helped build this foundation for reshaping Norfolk's future transportation system. The transportation future of the City of Norfolk will include physical investments, service and operational improvements, and new policies to promote sustainable and equitable transportation. Norfolk will need to progress on multiple fronts: expanding multimodal travel networks, improving safety, enhancing transit services, and designing streets that support connectivity for all. With a collective effort from leaders, citizens and city agencies working together, we can ensure that the future foundation for transportation projects in Norfolk can be based on transparency, equity, and public engagement towards the betterment of our whole community.



Appendix A: Multimodal System Plan Maps

These maps represent the Multimodal System Plan for Norfolk.

The Multimodal System Plan envisions a new future for the way we travel in and around Norfolk. It's a way of understanding how different transportation networks – bicycle, pedestrian, and transit – could work together and interconnect as a system. This system-wide view of the City is the long-term vision for multimodal transportation in Norfolk.

A Multimodal System Plan is made up of layers of maps that show things like Multimodal Centers, Multimodal Districts, Multimodal Corridor Types, Transect Zones, and Modal Emphasis. These concepts are described and shown in the following maps.

These maps were developed through work sessions with a consultant project team and City staff and were presented to stakeholder and the public for feedback. The project team surveyed the public, held virtual town hall meetings, and received comments and suggestions on the draft maps. These maps have been revised to reflect the comments and suggestions submitted by members of the public.

Citywide Maps

Northwest Maps

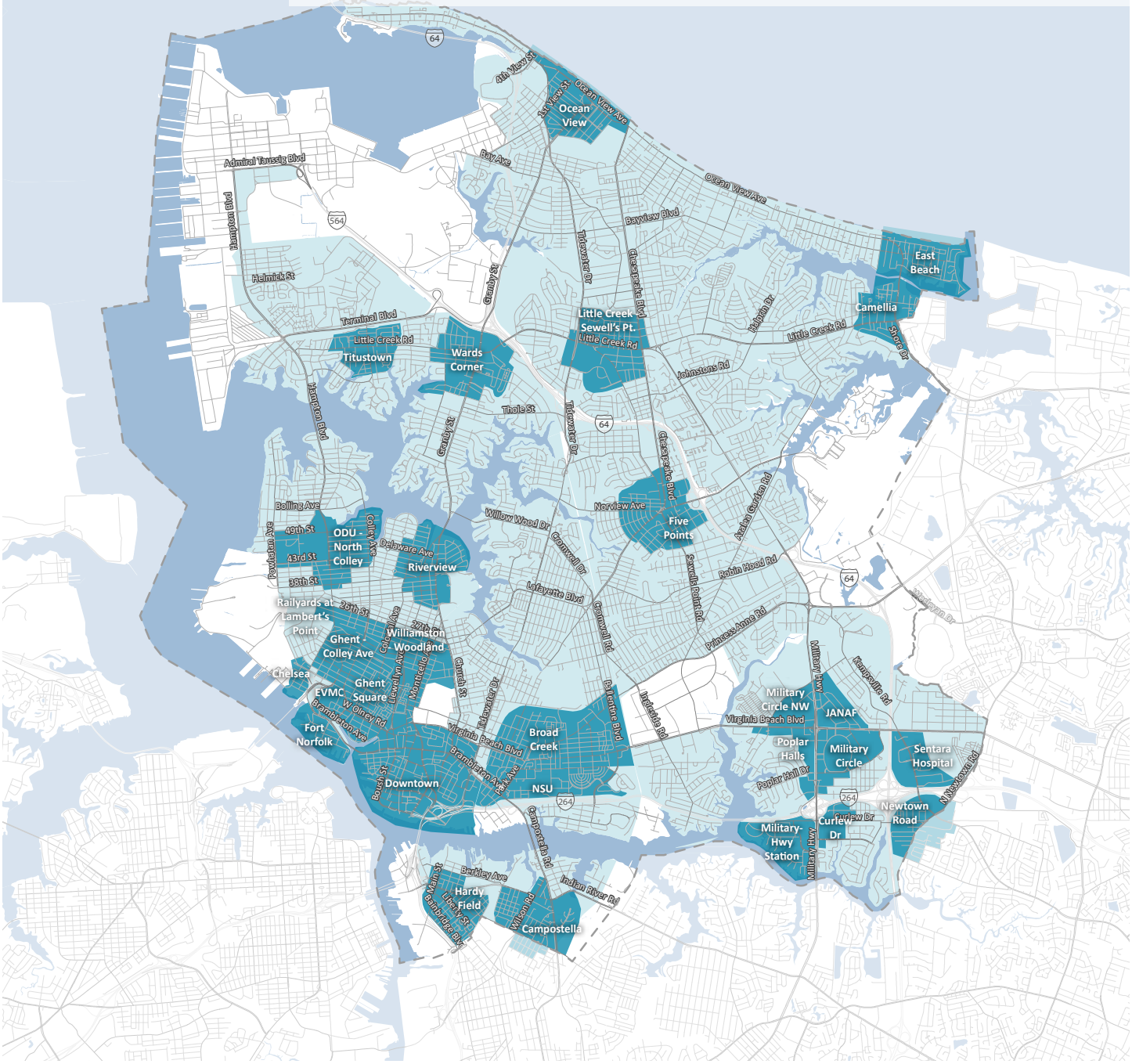
Northeast Maps

Southeast Maps

Southwest Maps

Downtown Maps

Multimodal Districts and Centers



Multimodal Districts and Centers

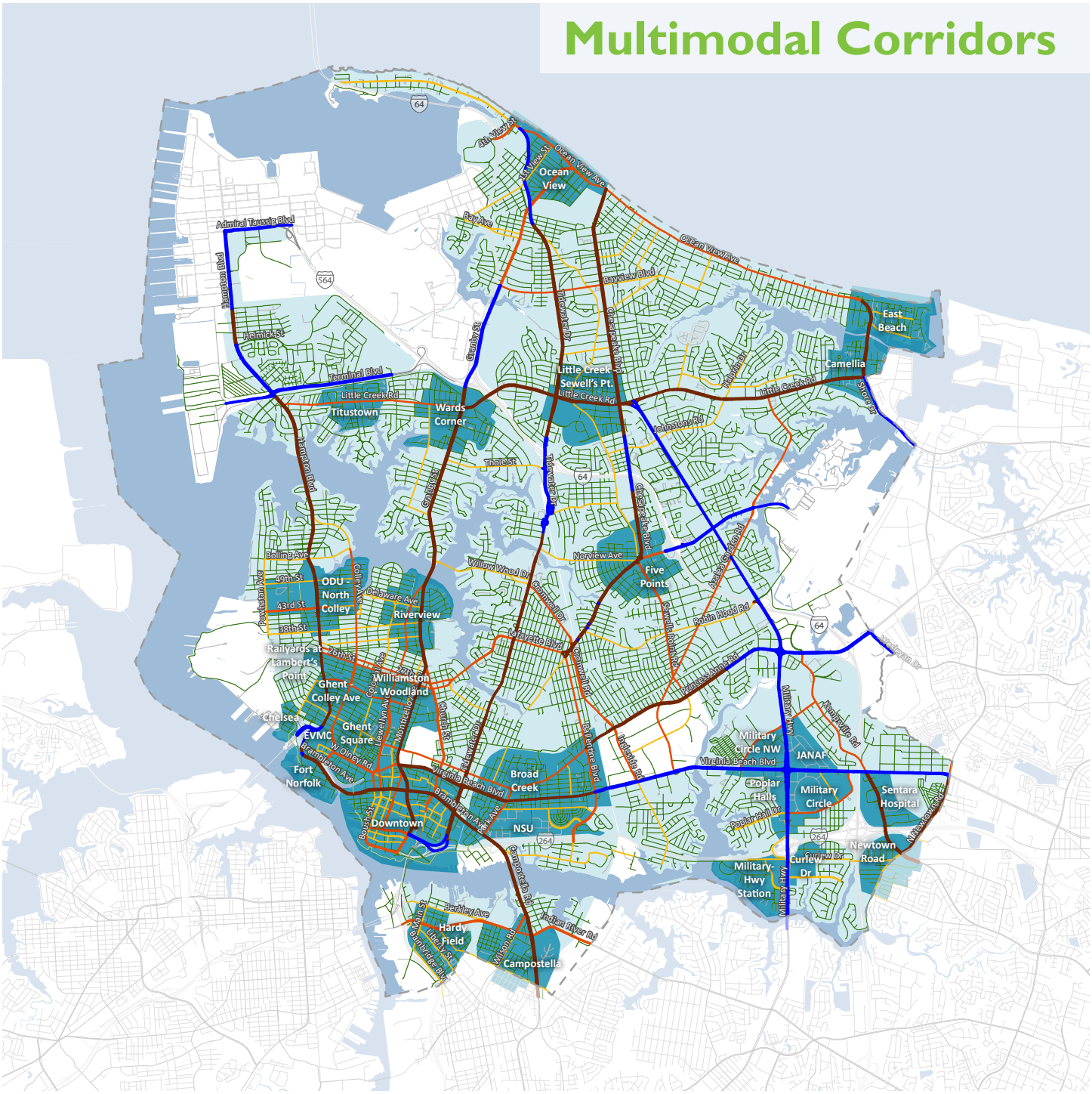
Multimodal District

Multimodal Center

Multimodal Districts are, quite simply, areas that should be safe for walking, riding a bike, or using other modes, either now or in the future. They are usually low density areas like residential neighborhoods and can be any size. They cover most of the City, except for areas like special industrial districts and federal land. All civic leagues are part of a multimodal district.

Multimodal Centers are areas with a higher density of people and jobs than Multimodal Districts. Destinations are closer together and easily reachable by bike or walking. Multimodal Centers should have a fine-grained network of high-quality facilities for walking and bicycling.

Multimodal Corridors



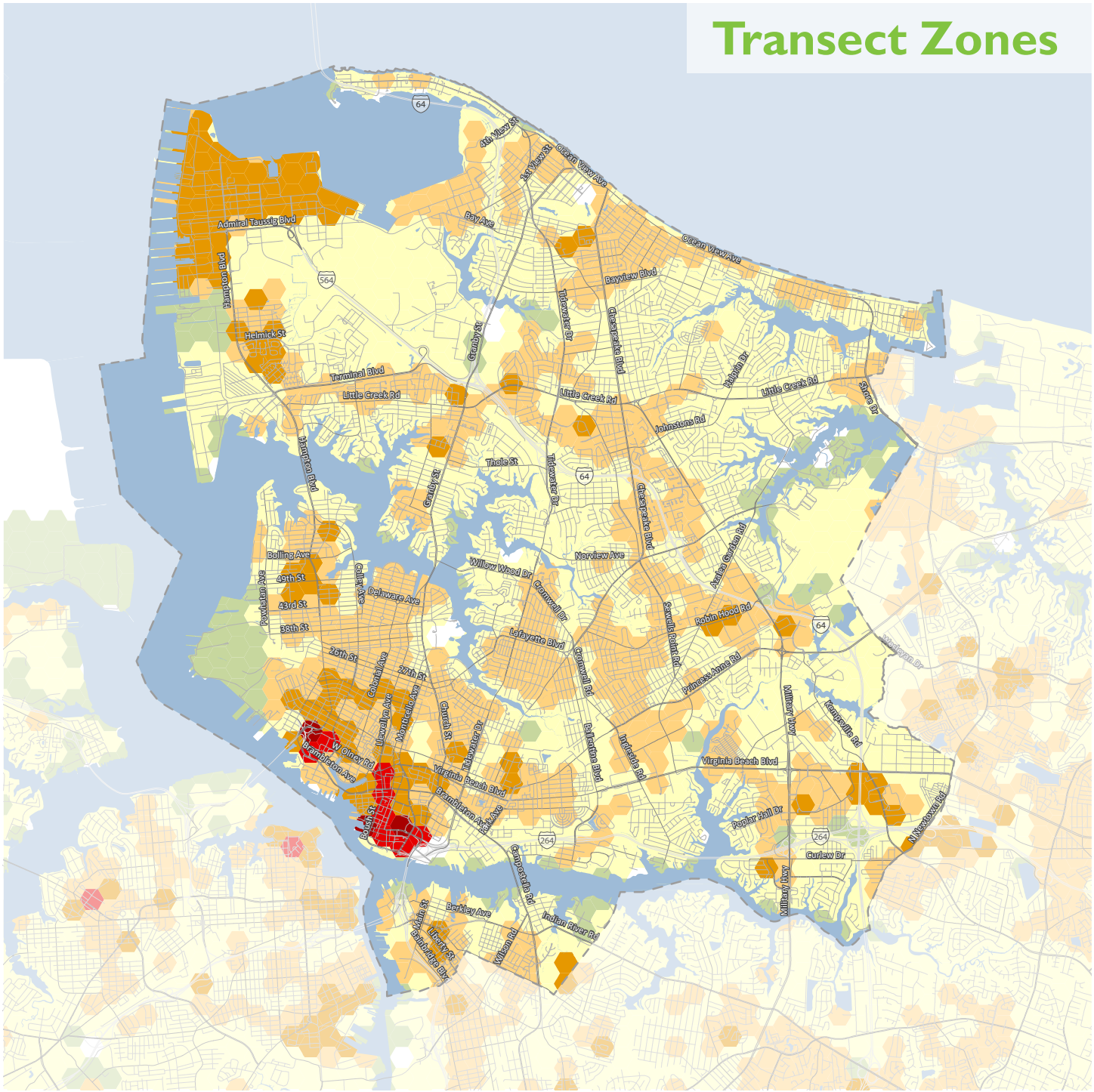
Multimodal Corridors

- Multimodal Through Corridor
- Boulevard
- Major Avenue
- Avenue
- Local Street
- Off-Street Path
- Multimodal District
- Multimodal Center

Multimodal Through Corridors are higher speed streets designed for vehicles to get smoothly and quickly from one area to another, yet still provide safe minimum facilities for non-motorized modes.

Boulevards, Major Avenues, Avenues, and Local Streets (Placemaking Corridors), are streets designed with slower speeds than Multimodal Through Corridors. These Placemaking Corridors will be designed for pedestrian and bicyclists to feel safe and comfortable. **Boulevards** will be designed to move lots of people in buses, on bikes, and on sidewalks. **Local Streets** will be designed to serve only trips that begin or end along them. **Avenues** and **Major Avenues** will be designed to connect Local Streets to Boulevards and Multimodal Through Corridors.

Transect Zones



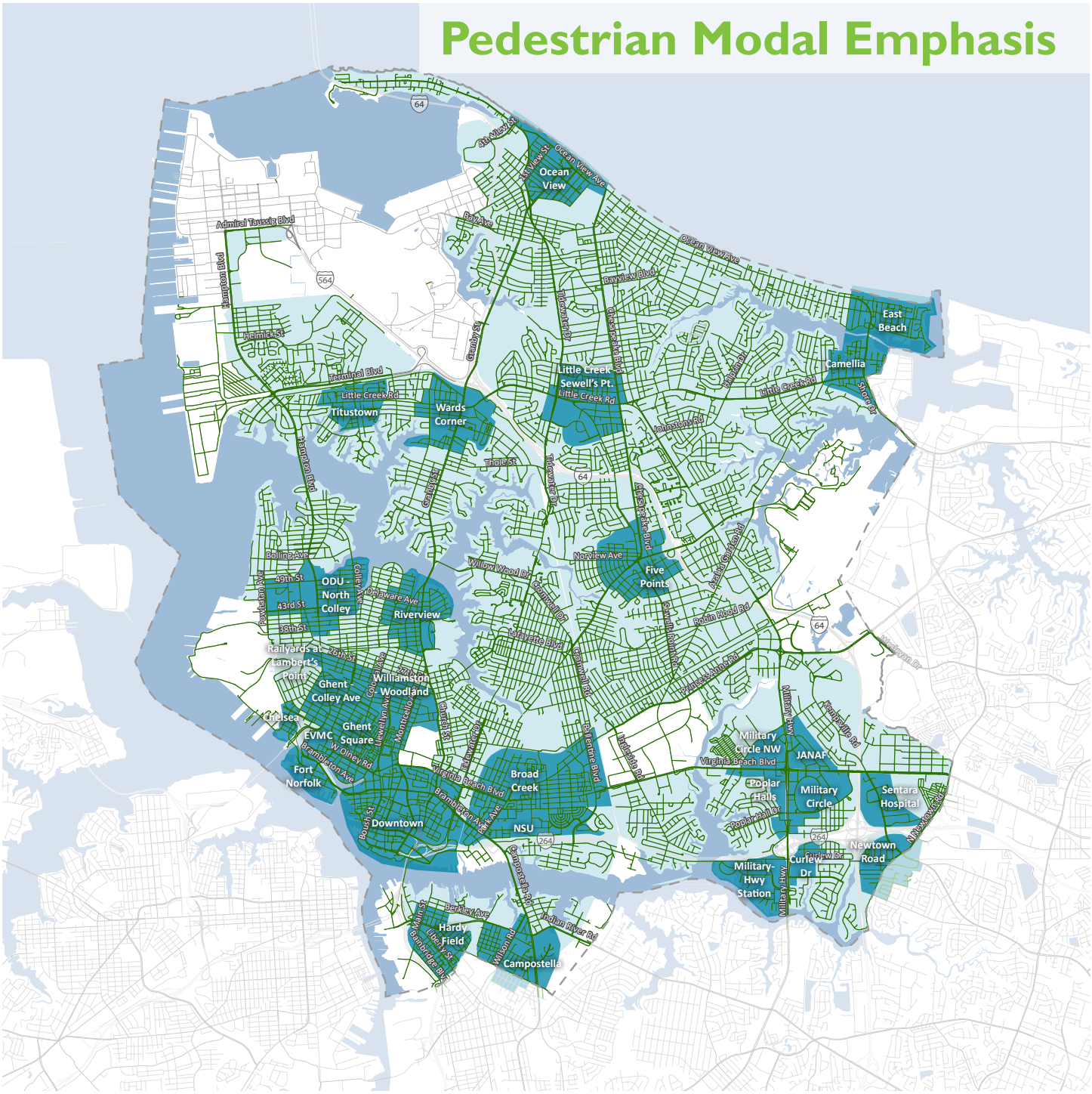
Activity Density (Population + Employment / Acre)

00 - 01 (T1)	25 - 60 (T4)
01 - 10 (T2)	60 - 100 (T5)
10 - 25 (T3)	100+ (T6)

The design of a multimodal corridor is intended to vary depending on the surrounding land use and community context. Streets in areas with high activity levels like downtown are different from streets in areas with lower levels of activity in neighborhoods and should vary in design. **Transect zones** illustrate the general intensity of activity, based on population and job density.

The six categories of transect zones show a generalized gradation of density across the city, based the level of employment and population in each area. These transect zones will be used to fine tune the specific corridor designs in a series of lookup tables for each element of the street, such as sidewalks, bike facilities and vehicle travel lanes.

Pedestrian Modal Emphasis



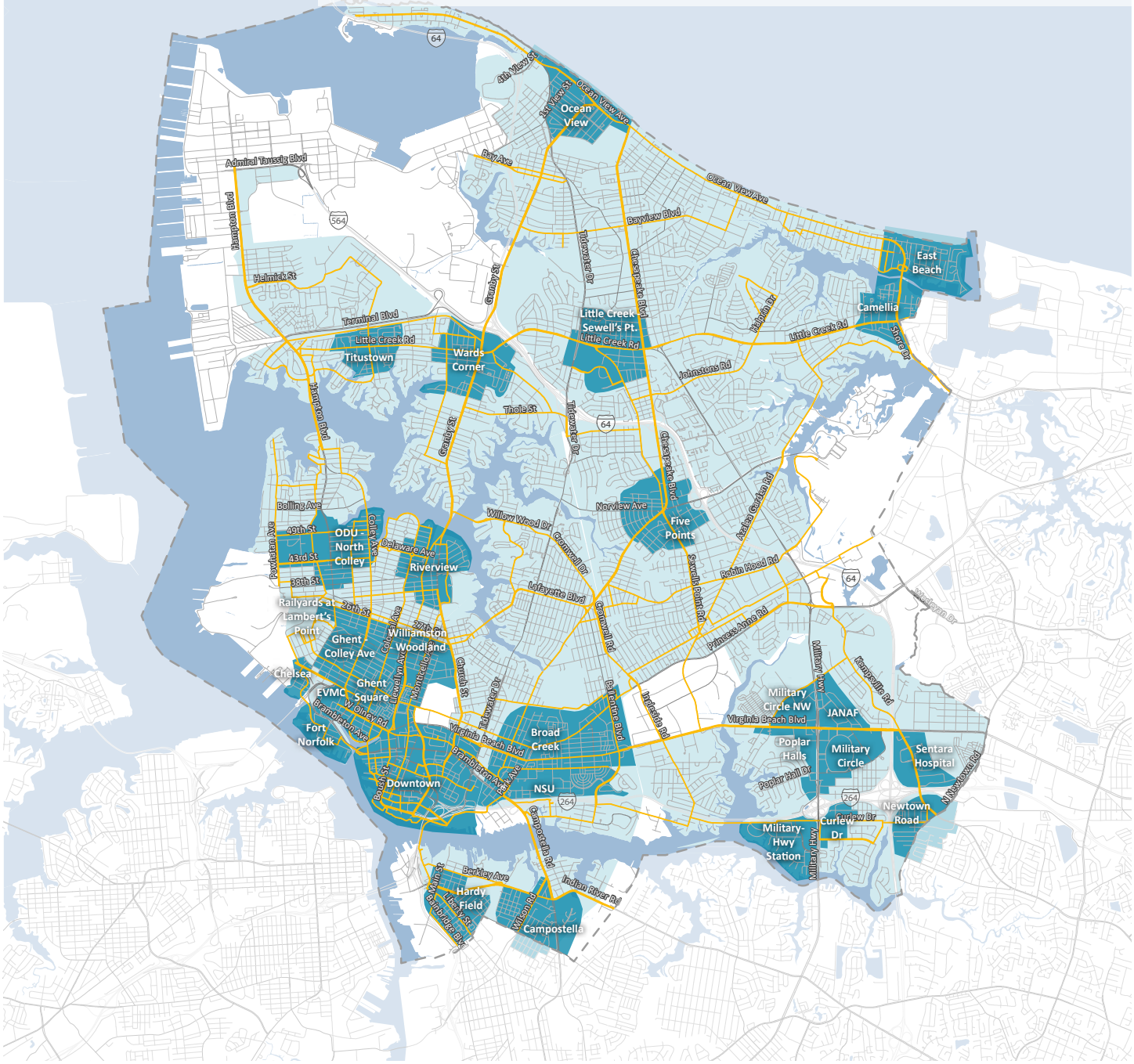
Modal Emphasis

- Pedestrian Emphasis
- Multimodal District
- Multimodal Center

Streets with **Pedestrian Modal Emphasis** will be designed to emphasize pedestrian safety and comfort. Improvements on streets with pedestrian modal emphasis will be designed to provide **optimal** facilities for walking on a case-by-case basis. Improvements may include wider sidewalks and wider buffers between sidewalks and vehicle travel lanes, where feasible.

Improvement projects on streets without pedestrian modal emphasis will meet **minimum** standards for pedestrian facilities.

Bicycle/Scooter Modal Emphasis



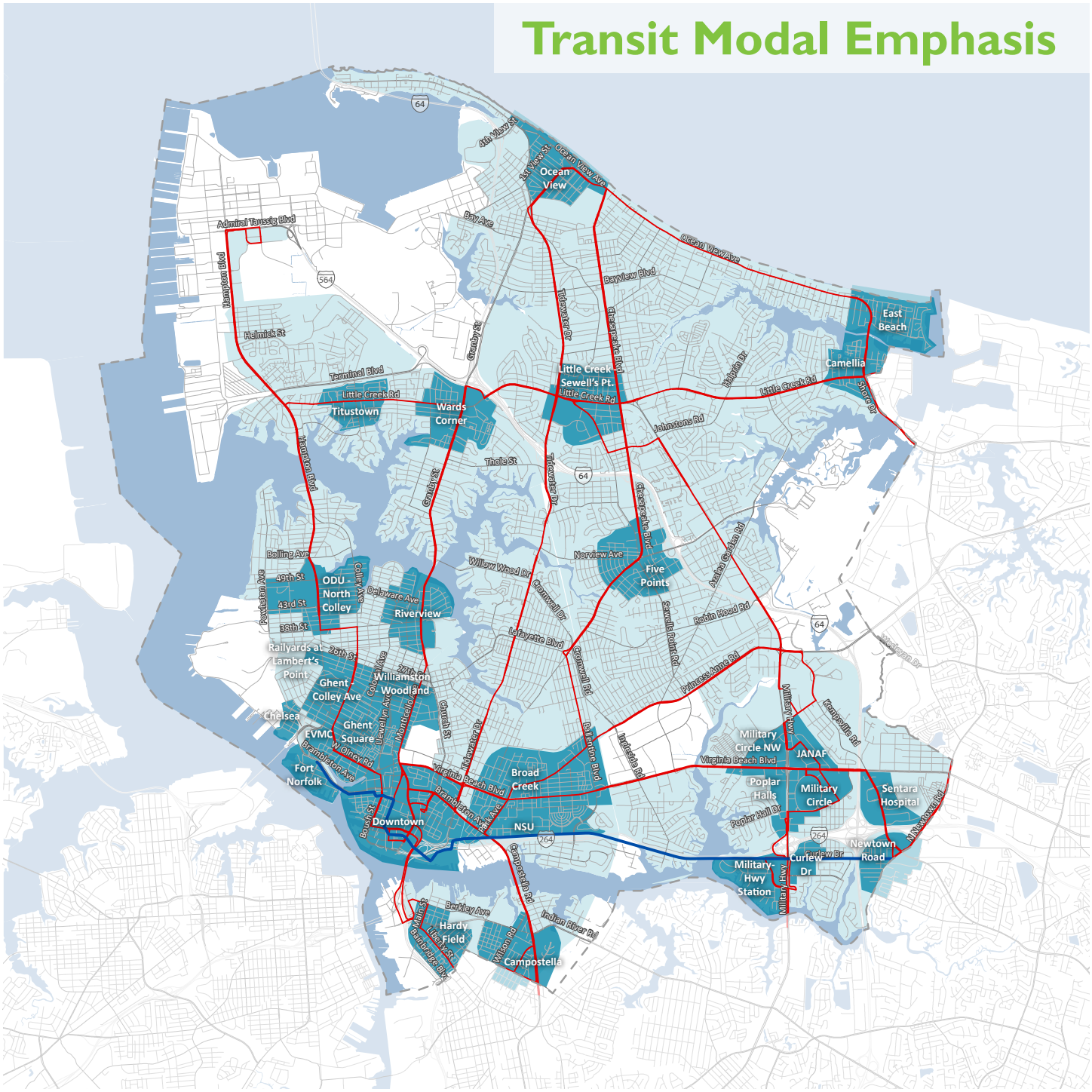
Modal Emphasis

- Bicycle/Scooter Emphasis
- Multimodal District
- Multimodal Center

Streets with **Bicycle/Scooter Modal Emphasis** will be designed to emphasize bicyclist and scooter rider safety and comfort. Improvements on streets with bicycle/scooter modal emphasis will provide optimal facilities for bicycling and scootering, which may include lane repurposing to provide separated bicycle/scooter facilities or collocated bike/bus lanes.

Bicycle/scooter facility design will be determined on a case-by-case basis and follow industry guidance to determine the appropriate type of treatment. Bicycle/scooter modal emphasis may be re-designated during the design phase to parallel corridors that serve the bicycle/scooter safety and connectivity needs better.

Transit Modal Emphasis

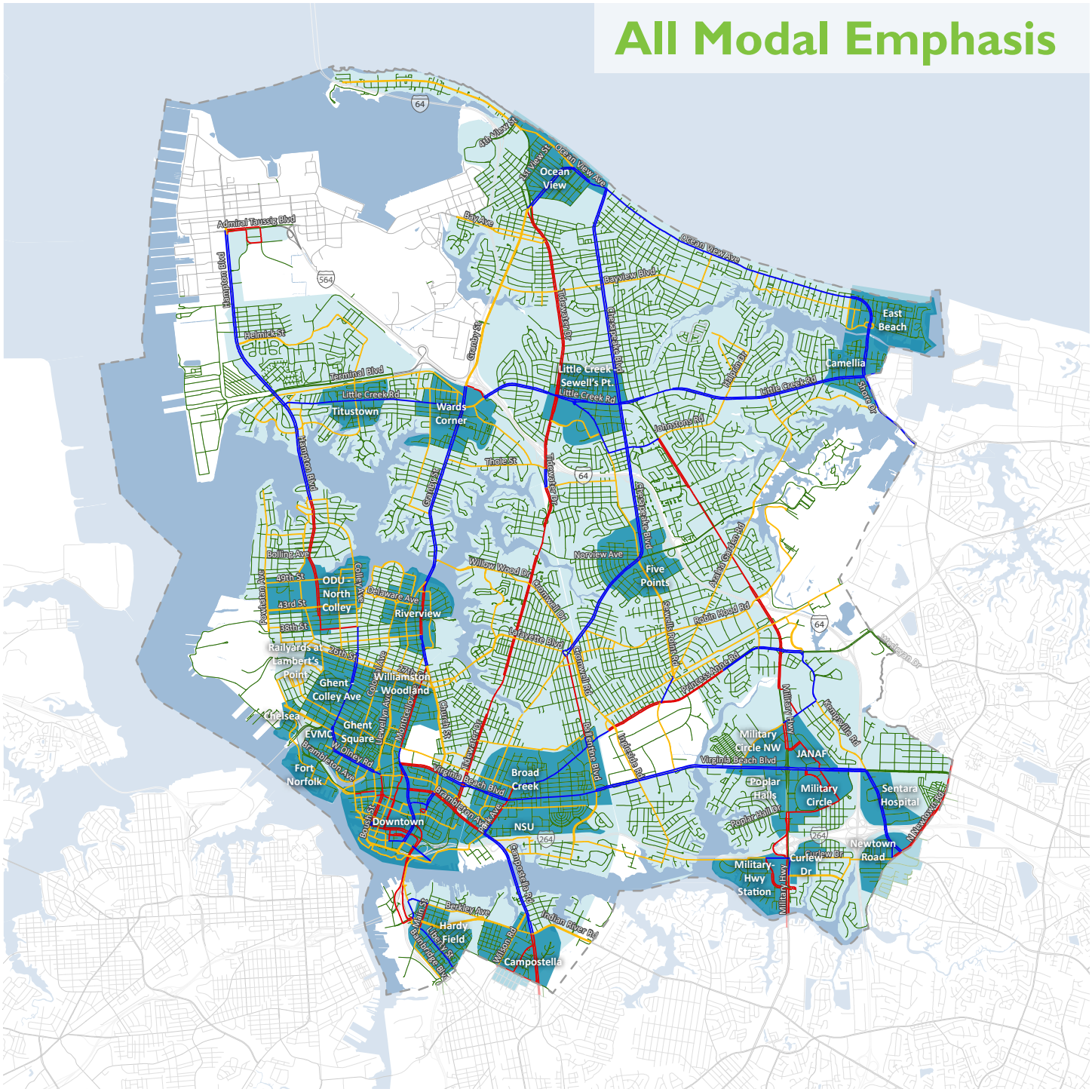


Modal Emphasis

- Transit Emphasis
- Light Rail
- Multimodal District
- Multimodal Center

Streets with **Transit Modal Emphasis** will be designed to provide for efficient transit operations. Improvements on streets with transit modal emphasis will provide adequate lane width for buses and may include dedicated bus-only lanes or combined bike/bus lanes. Improvements may also involve higher quality amenities at bus stops.

All Modal Emphasis



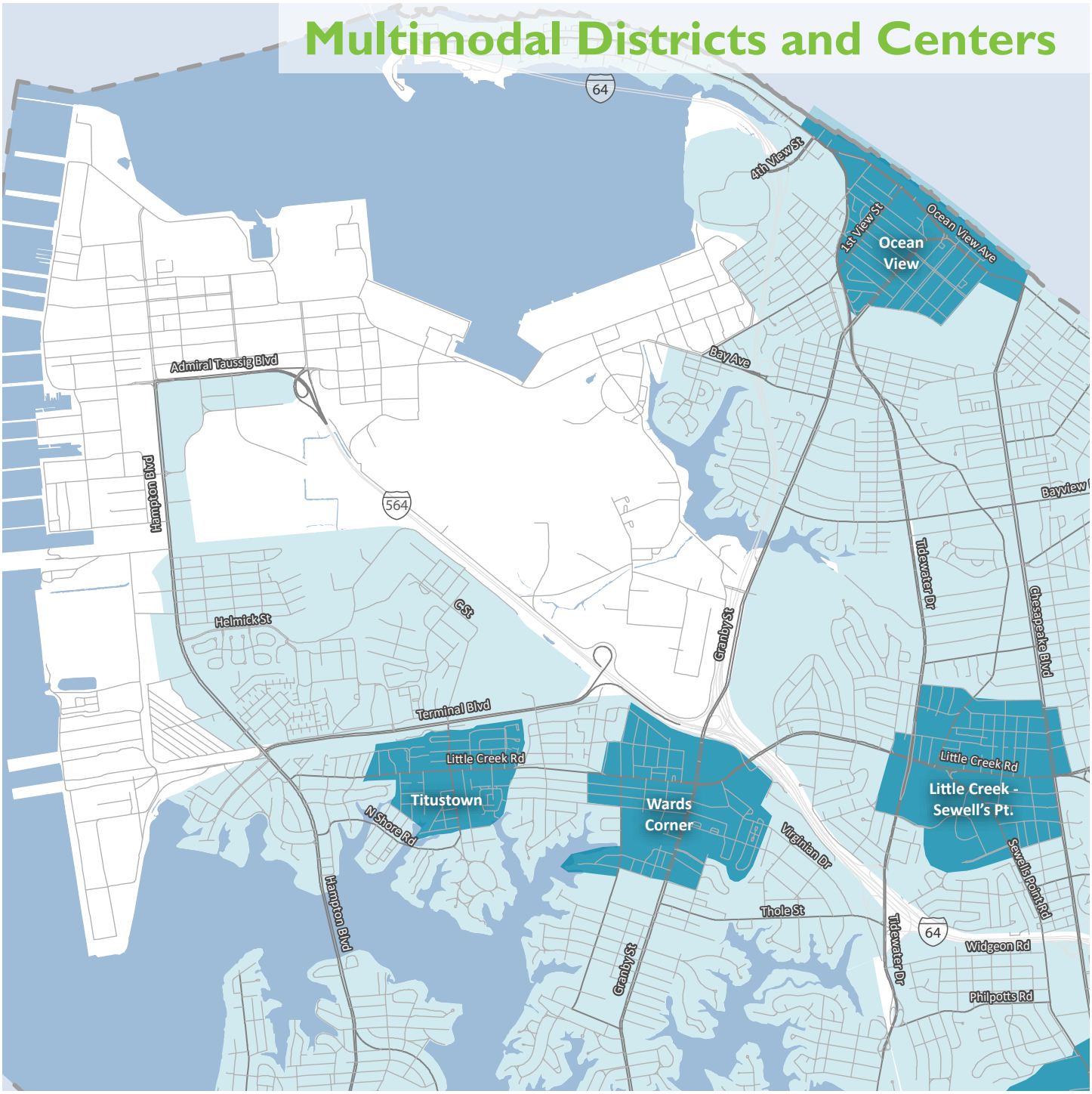
Modal Emphasis

- Pedestrian Emphasis
- Bicycle/Scooter and Pedestrian Emphasis
- Transit and Pedestrian Emphasis
- Bicycle/Scooter, Transit, and Pedestrian Emphasis

- Multimodal District
- Multimodal Center

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Multimodal Districts and Centers



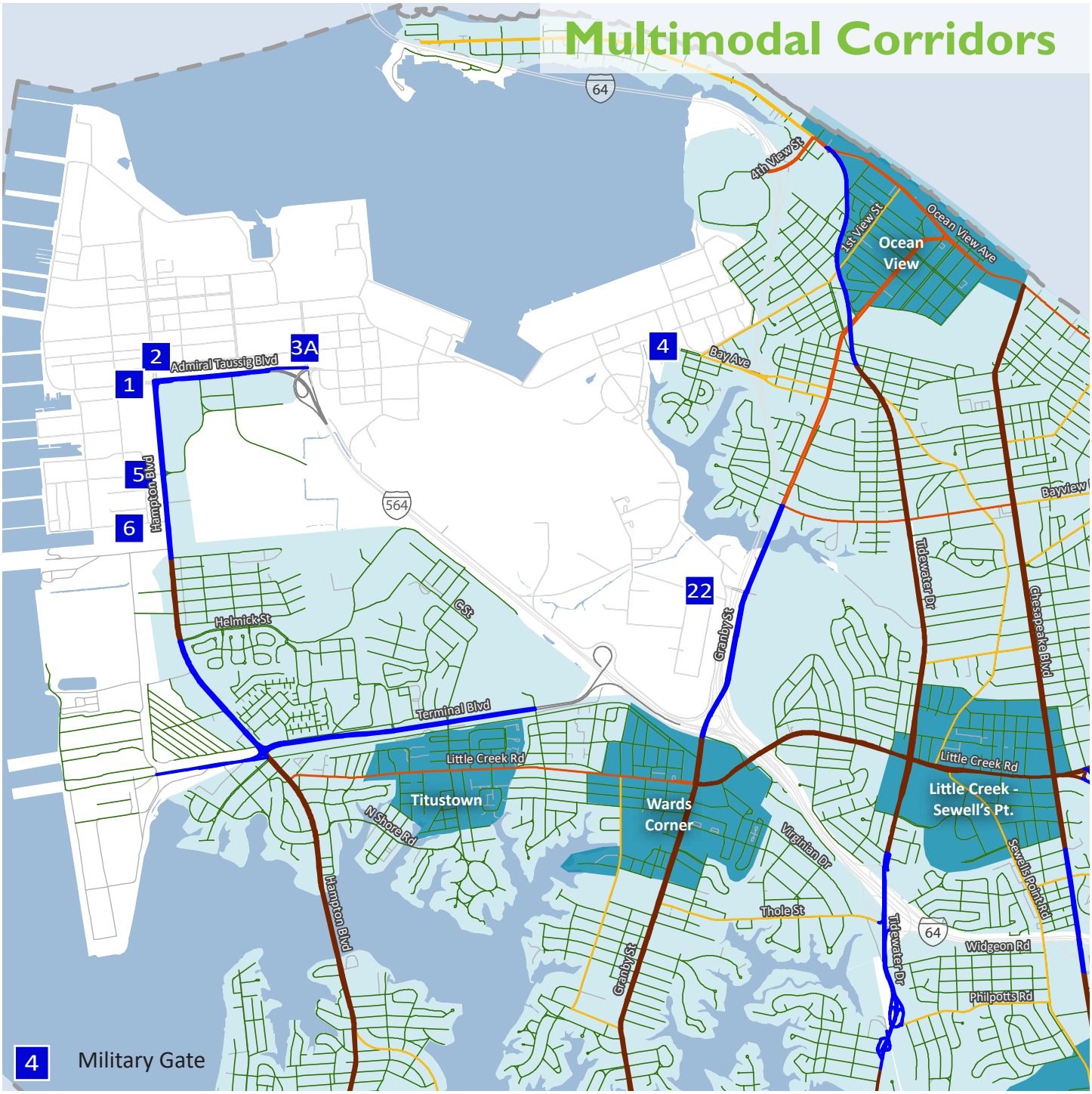
Multimodal Districts and Centers

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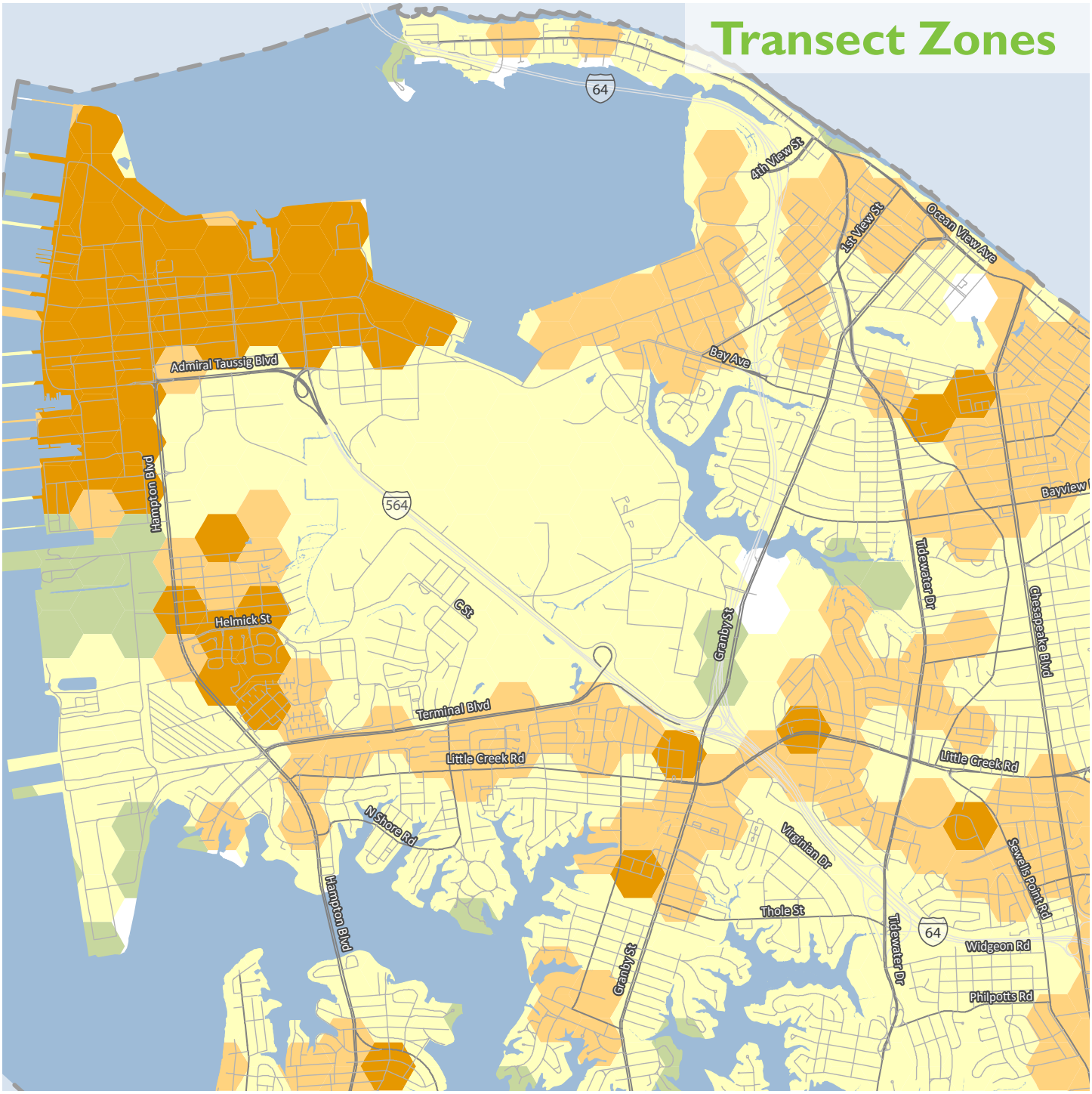
Multimodal Corridors

- Multimodal Through Corridor
- Boulevard
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- Avenue
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Transect Zones

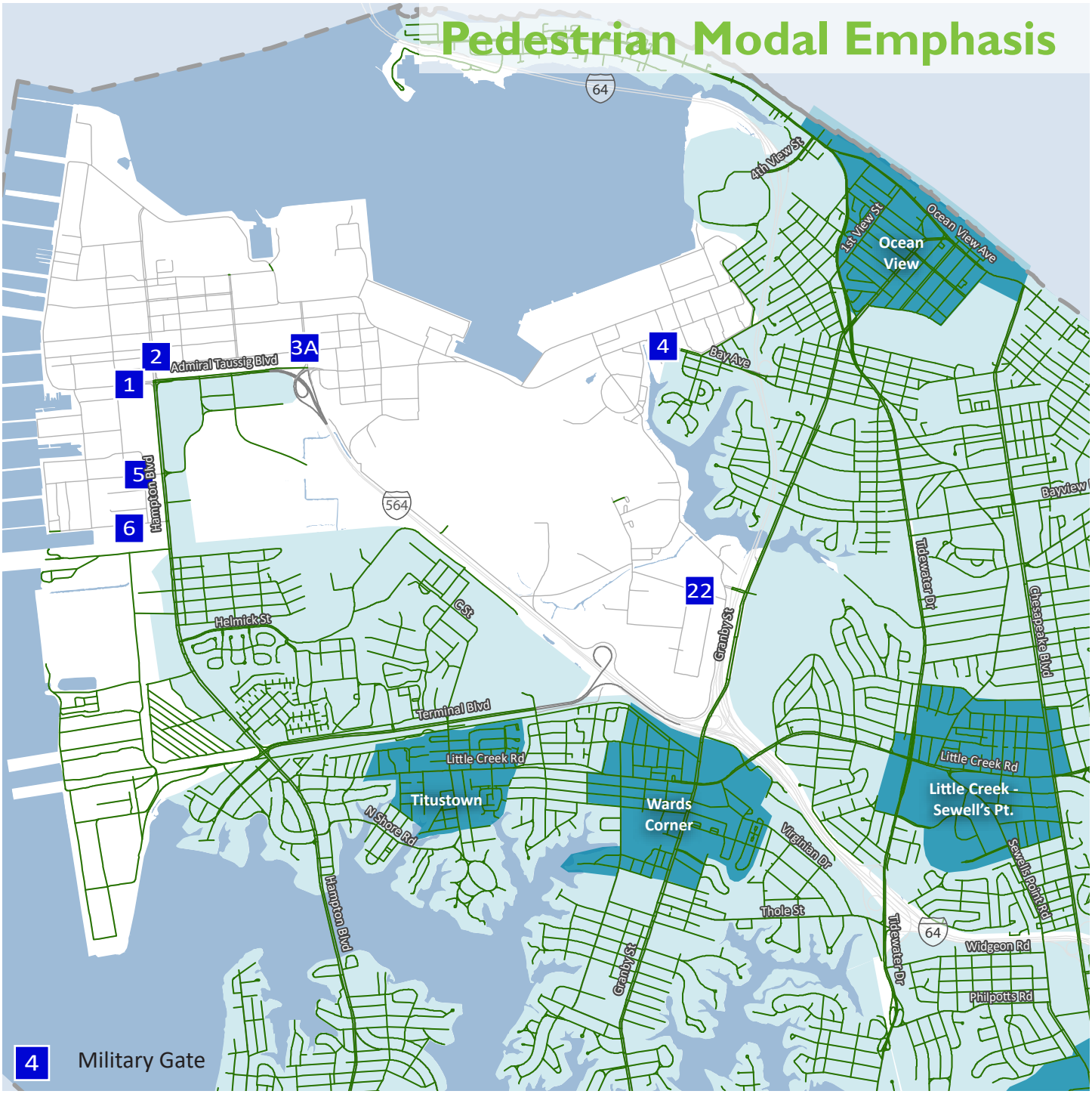


Activity Density (Population + Employment / Acre)

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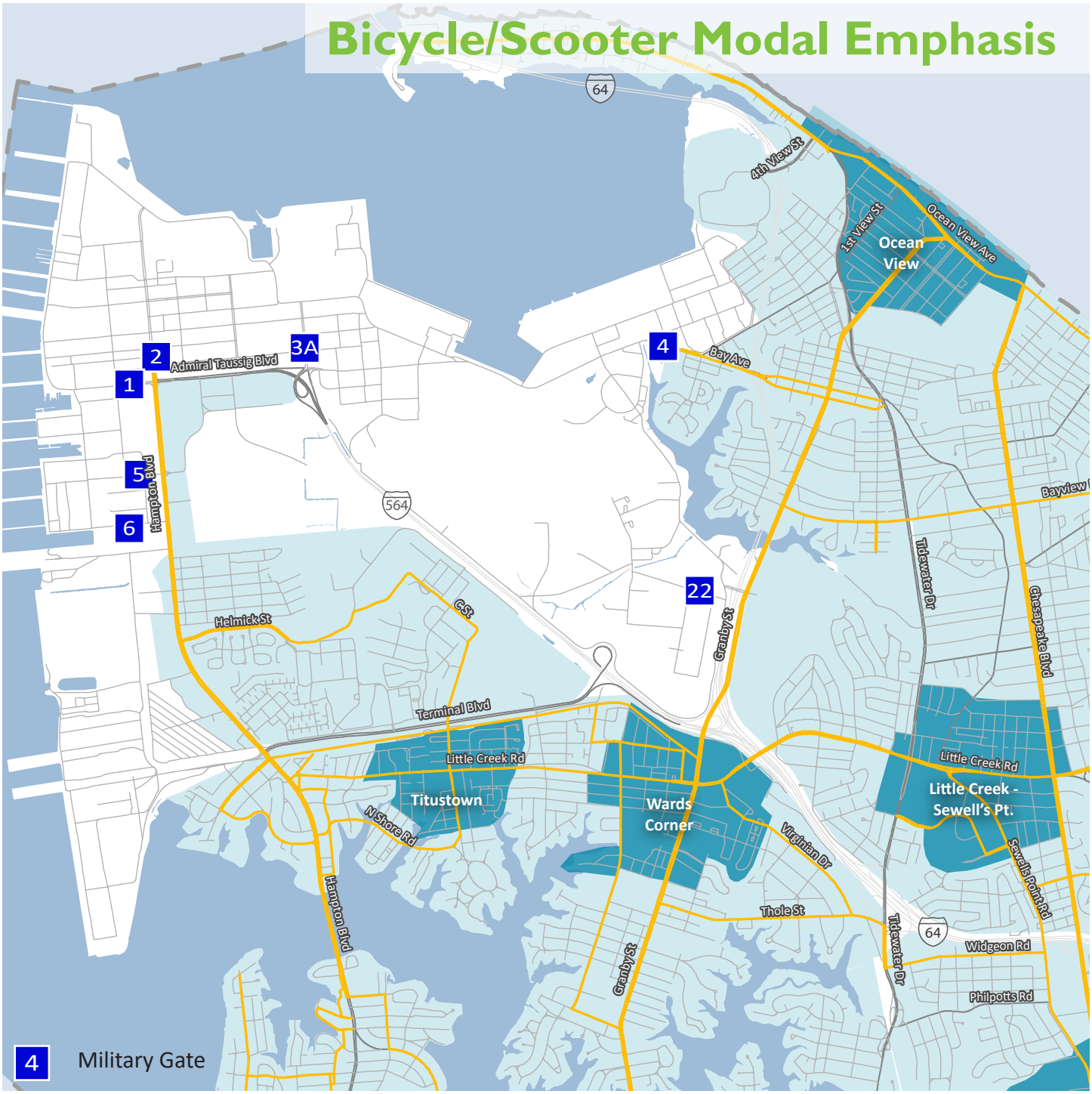
Modal Emphasis

- Pedestrian Emphasis
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Bicycle/Scooter Modal Emphasis



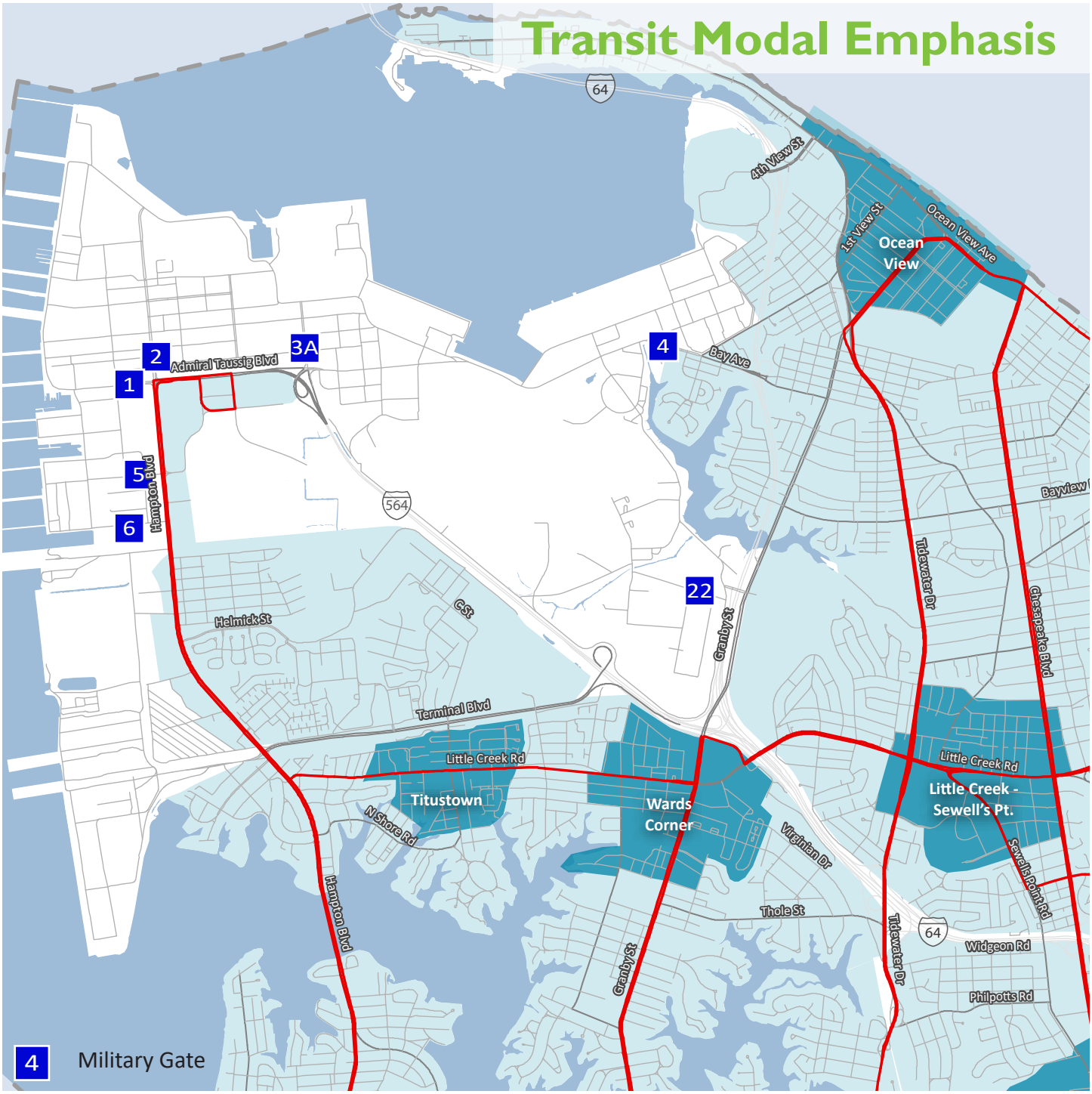
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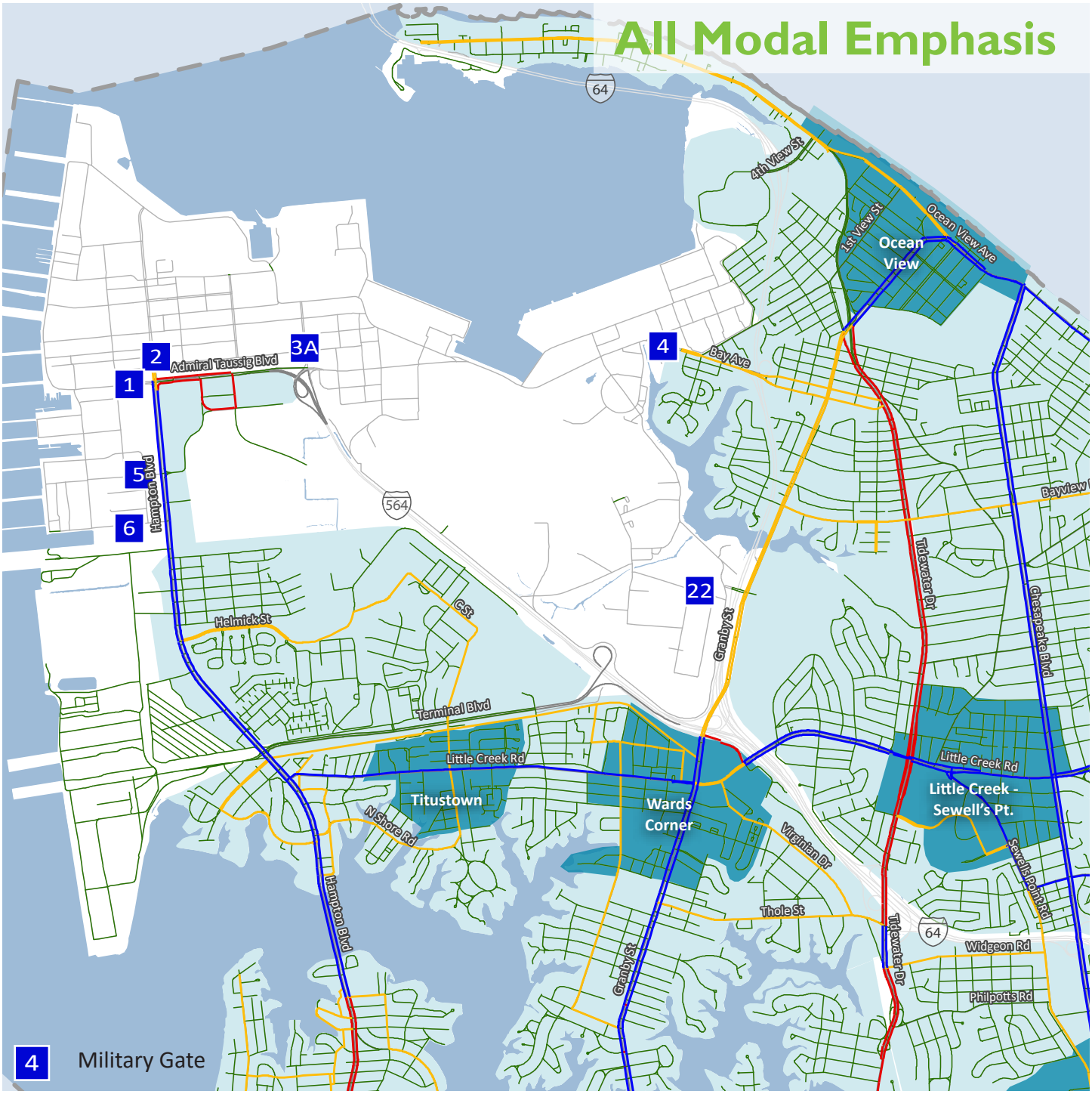
Transit Modal Emphasis



Modal Emphasis

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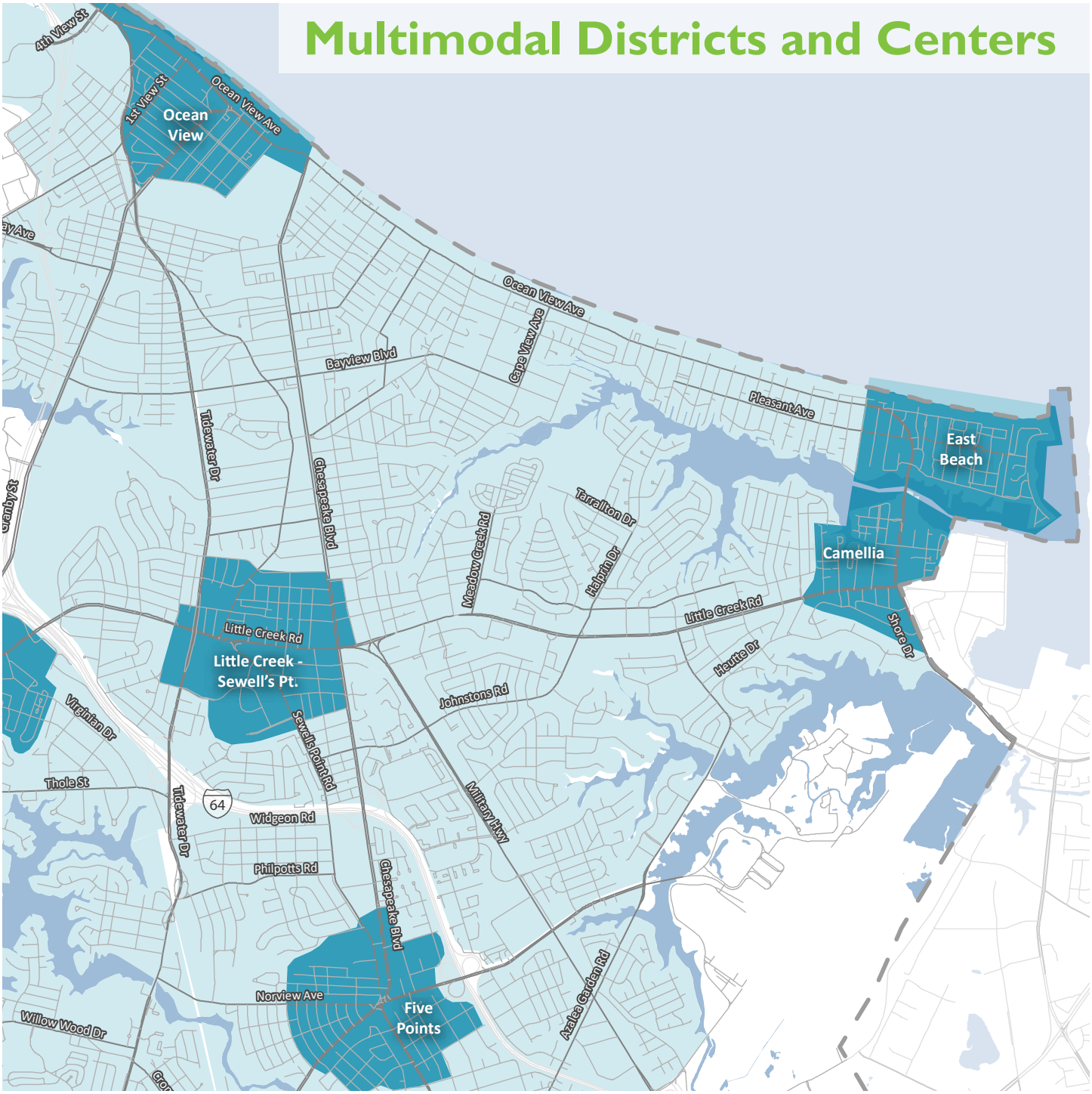
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Multimodal Districts and Centers



Multimodal Districts and Centers

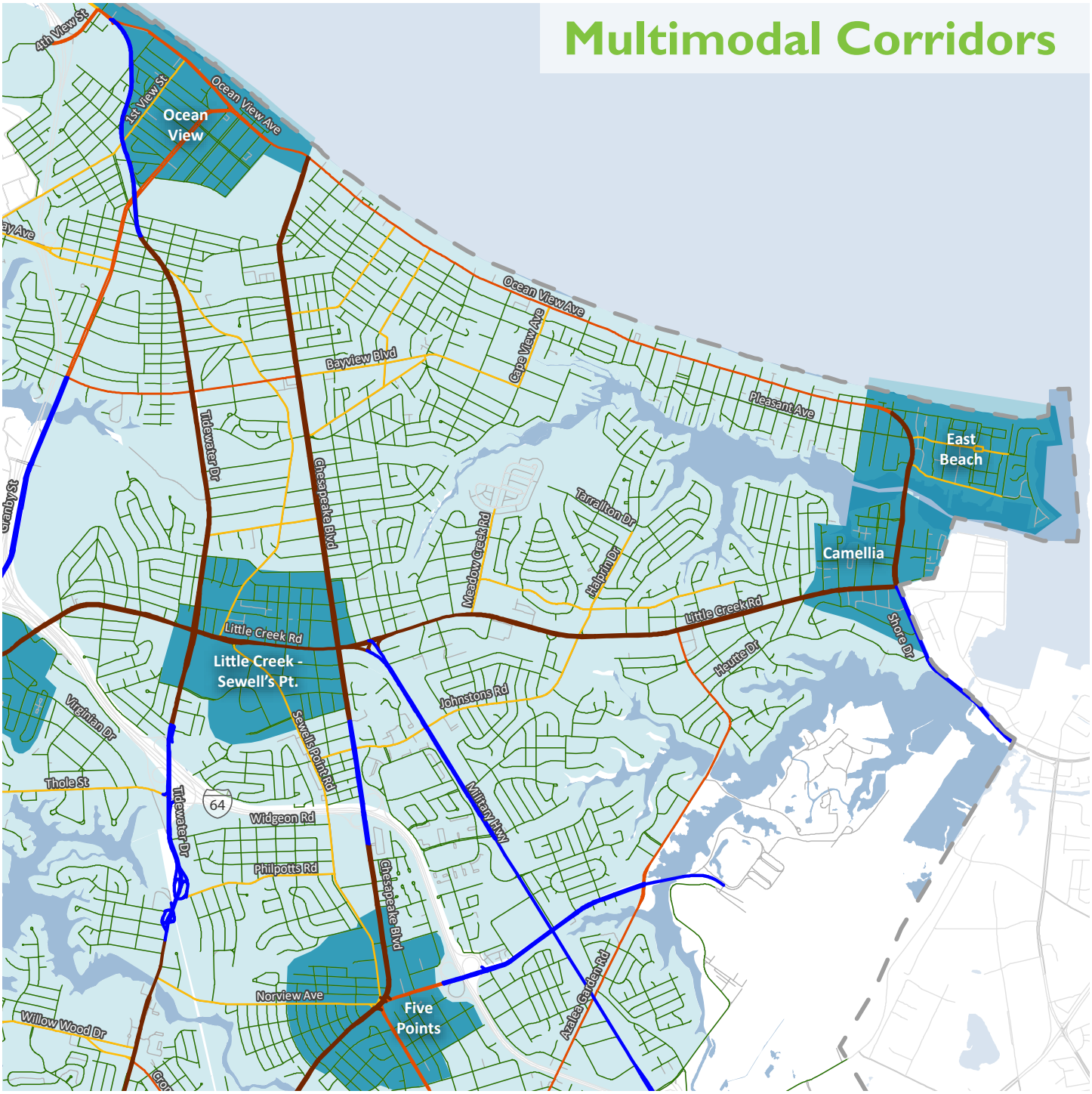
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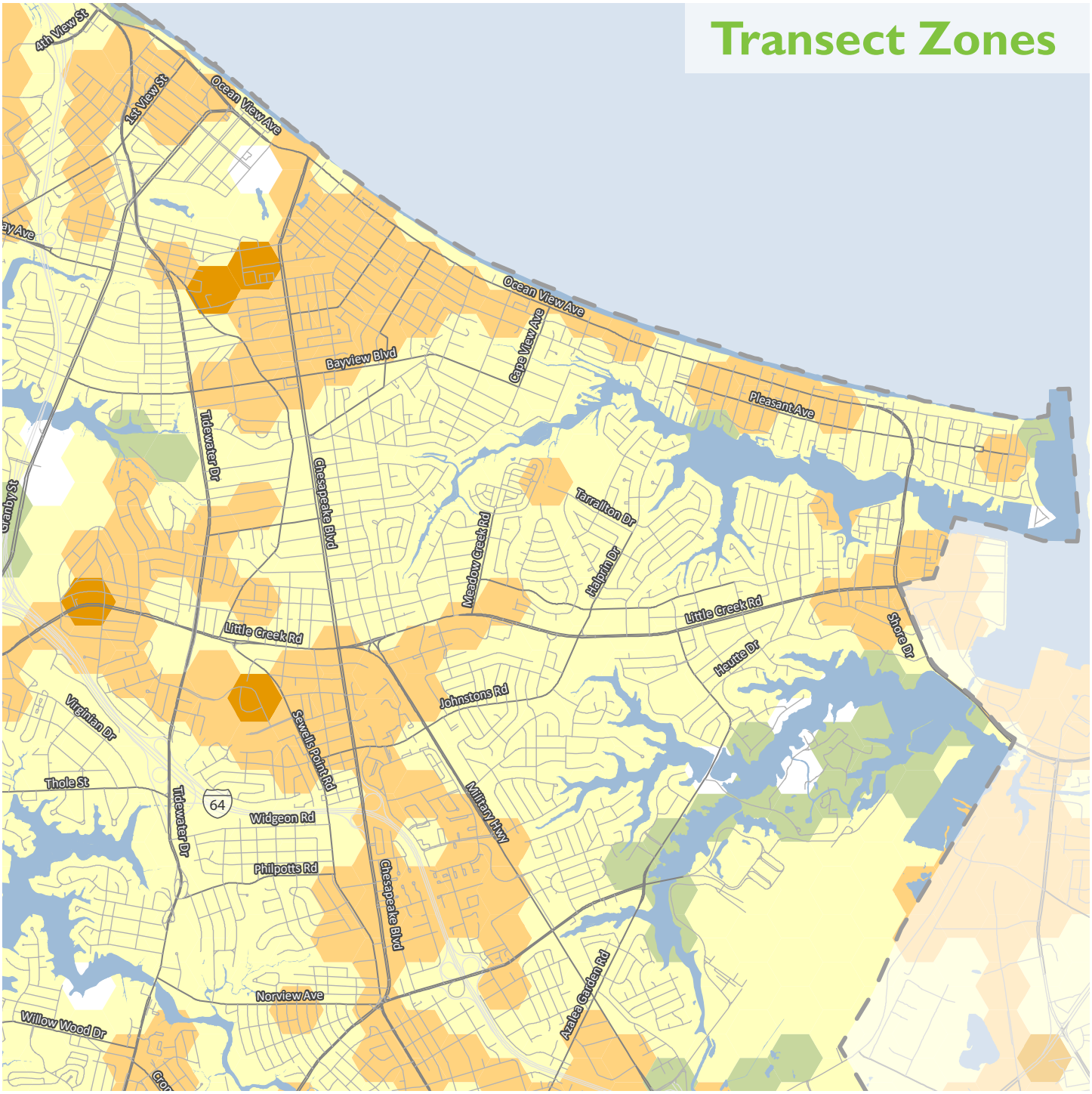
Multimodal Corridors

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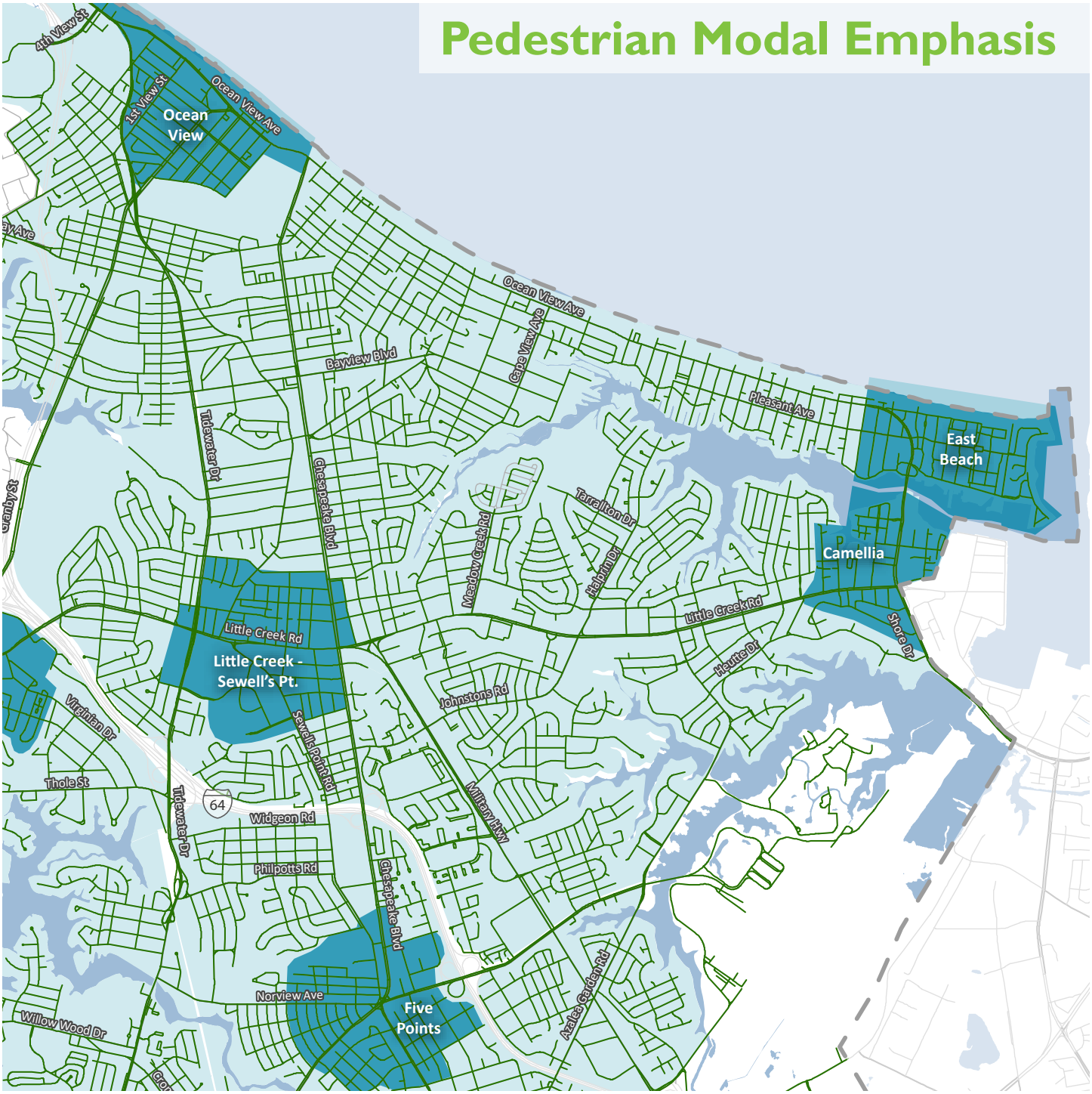
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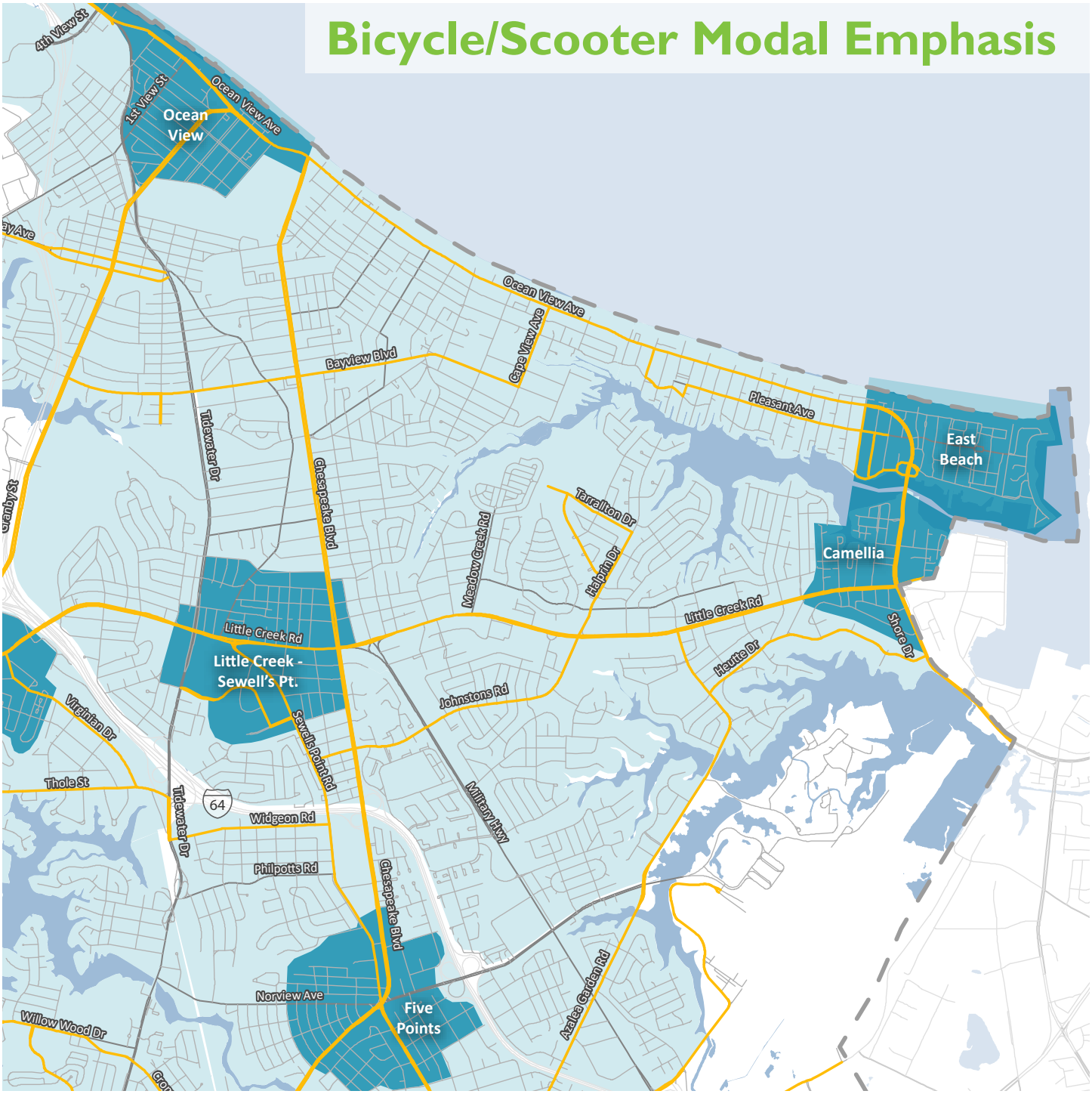
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Bicycle/Scooter Modal Emphasis



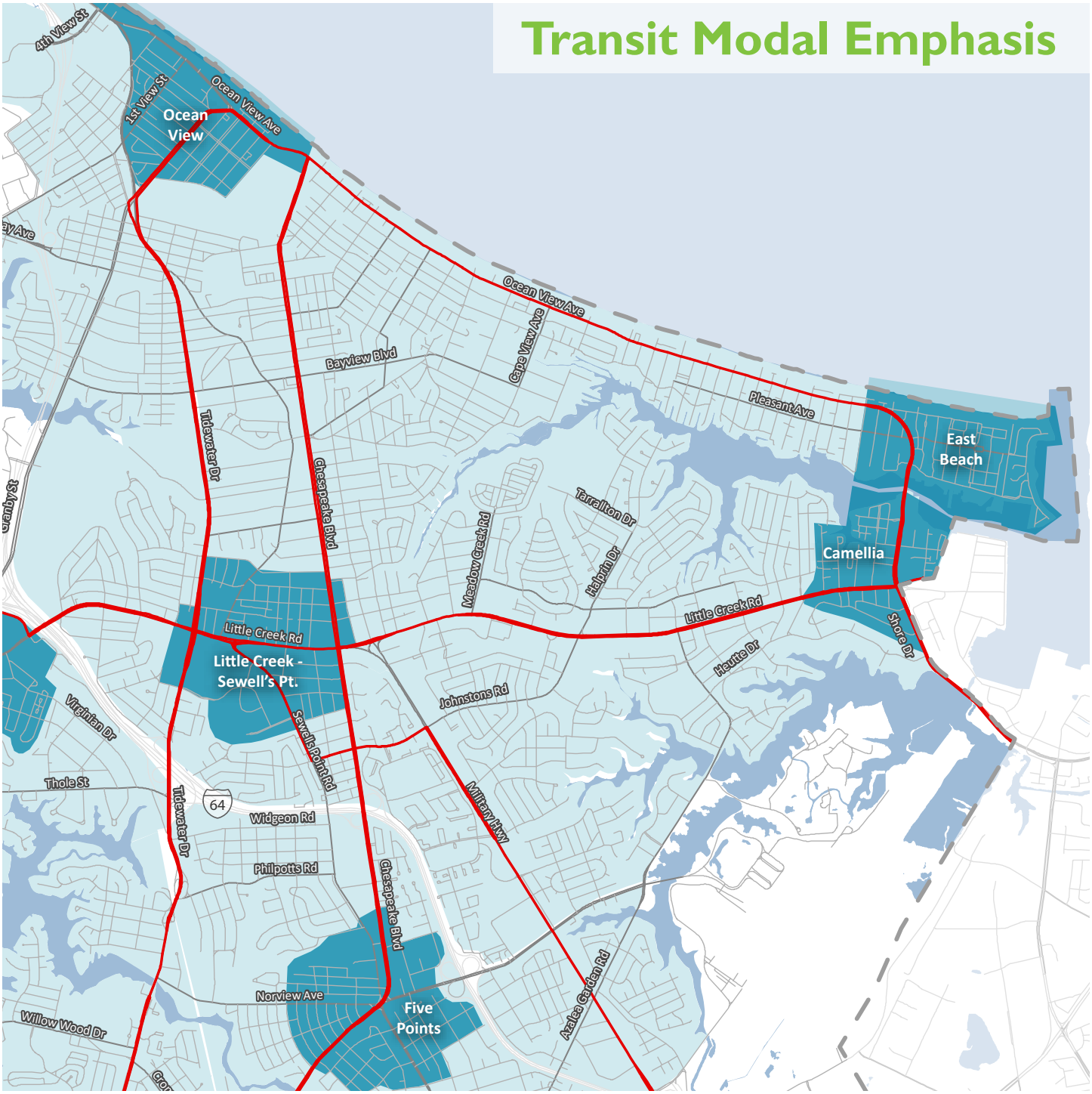
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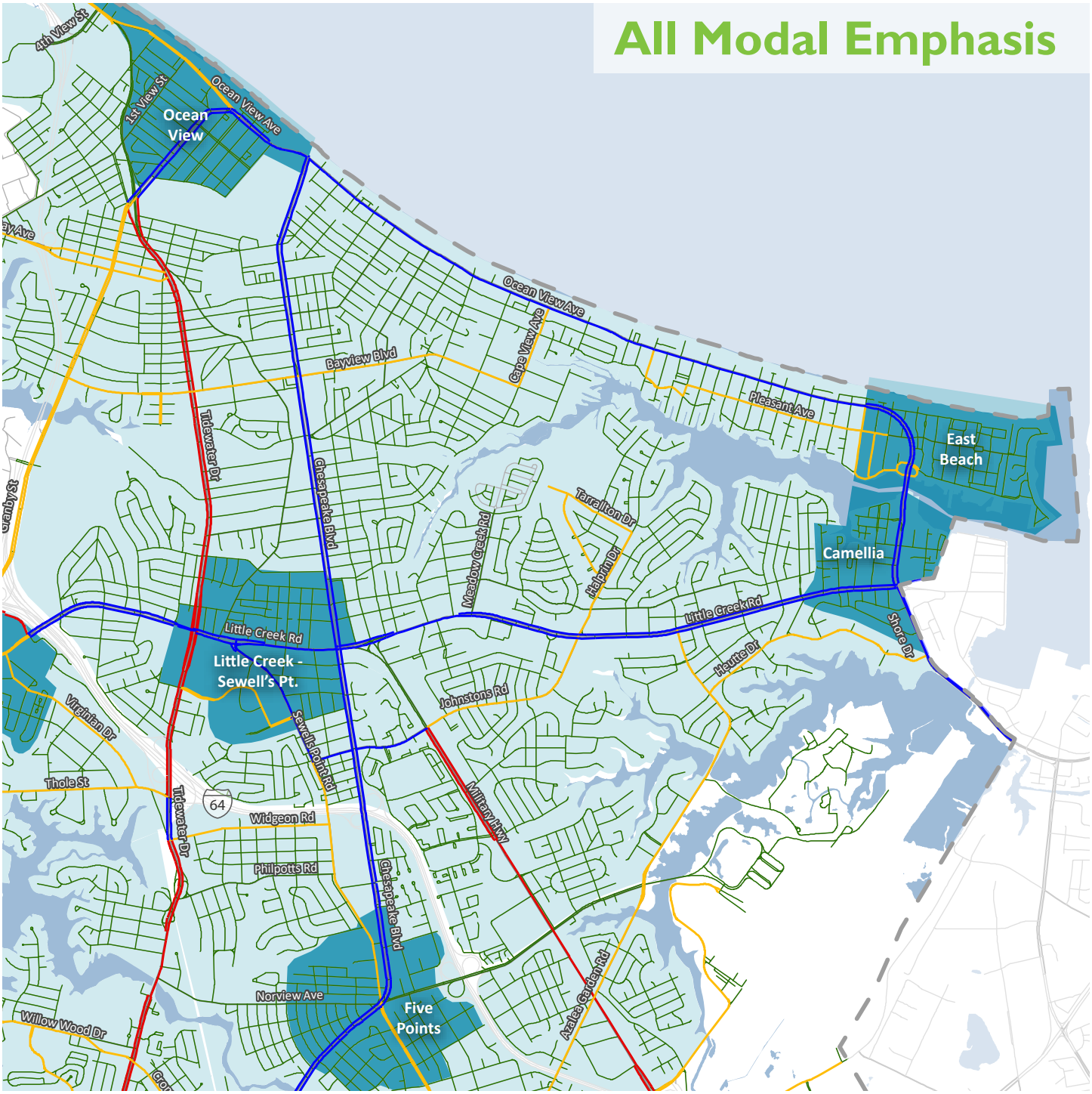


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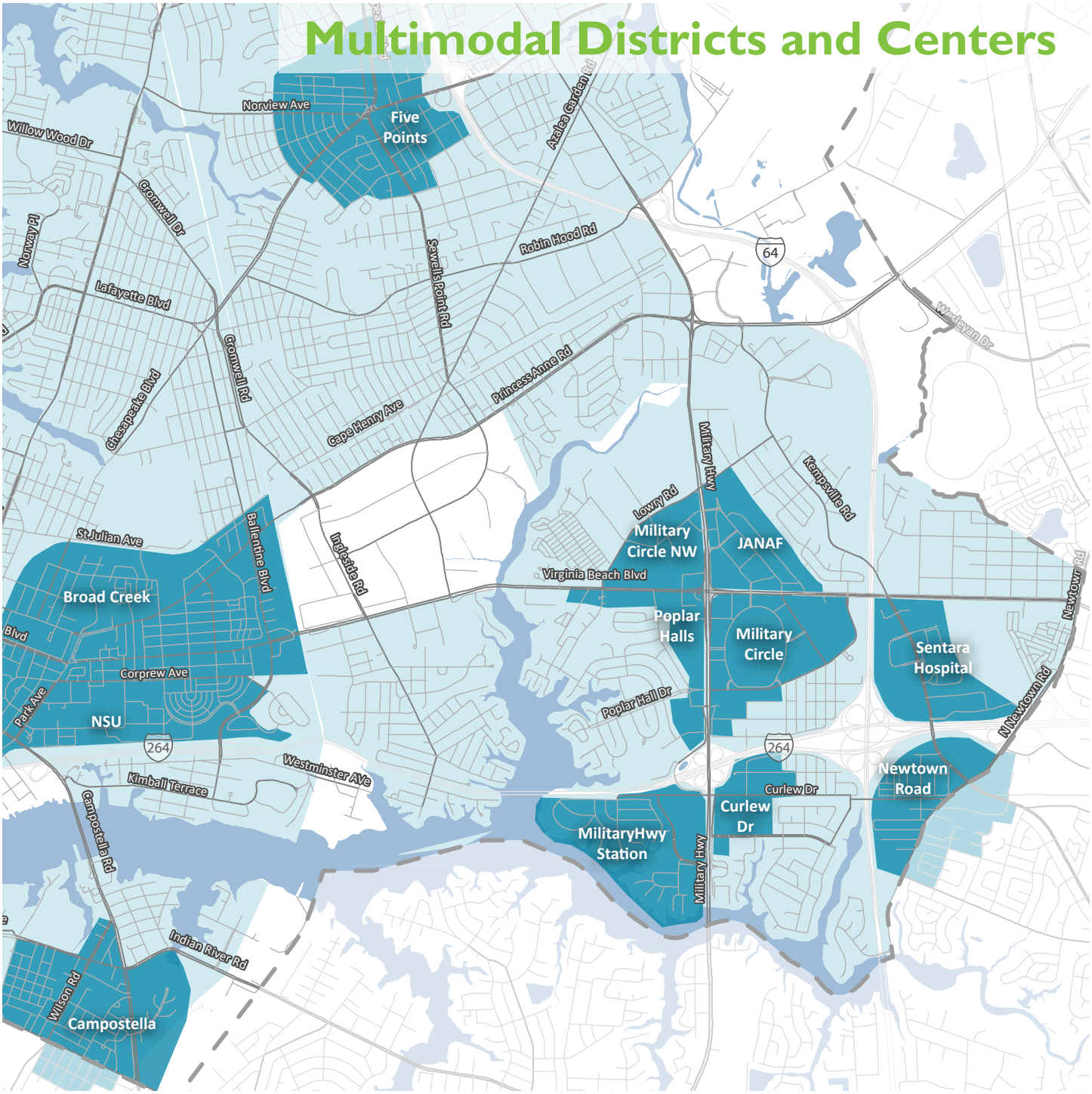
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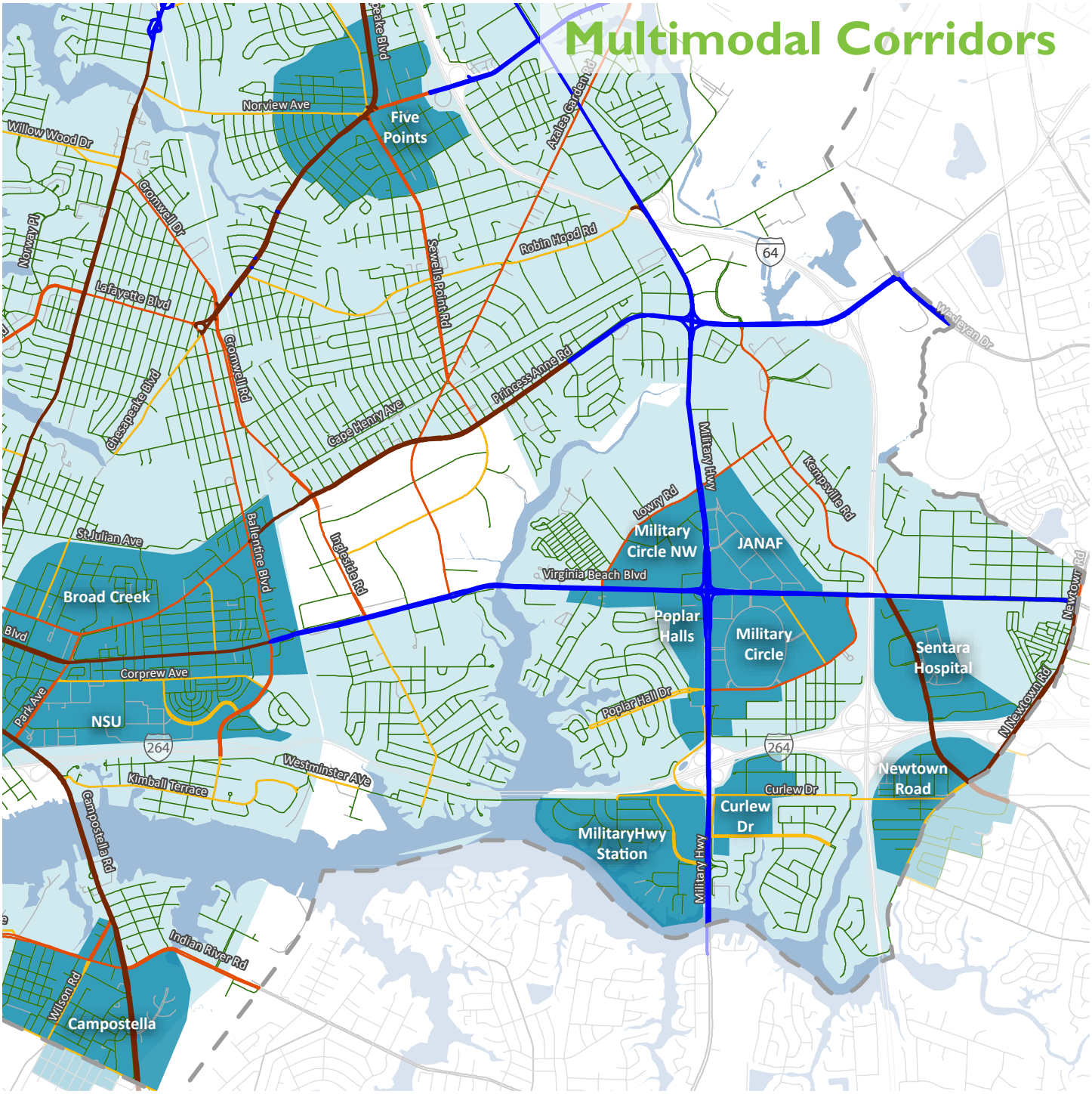
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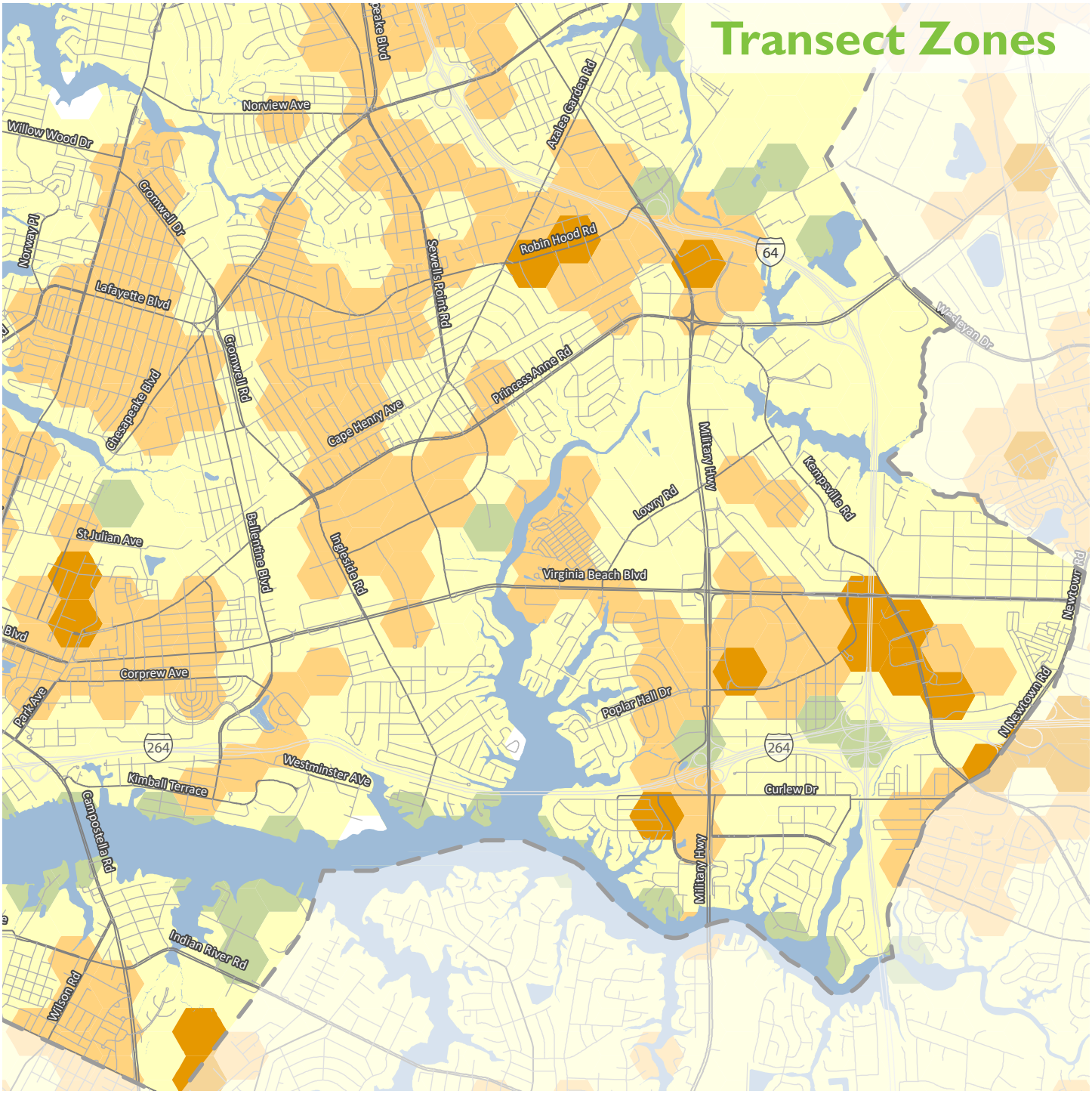


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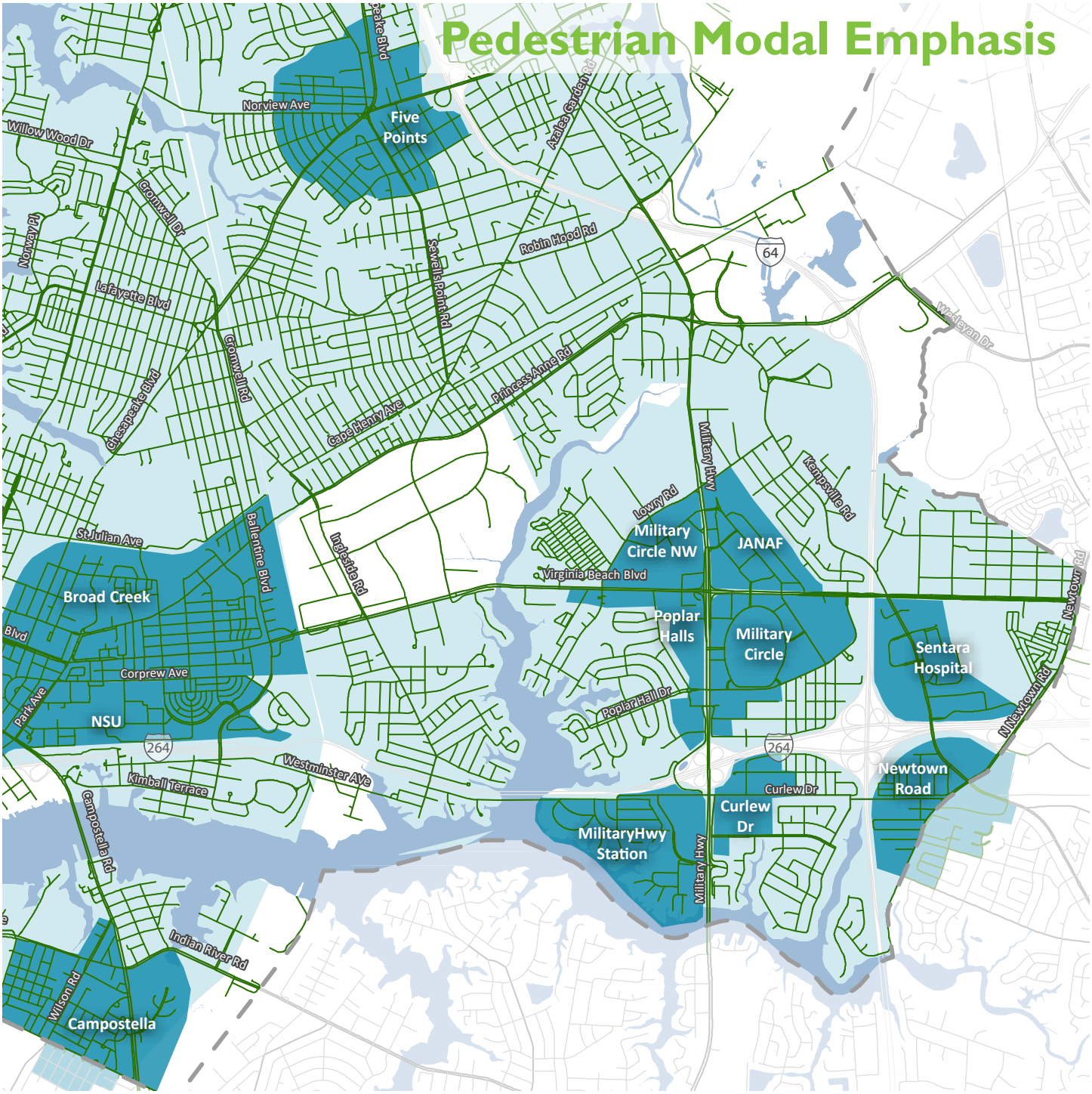
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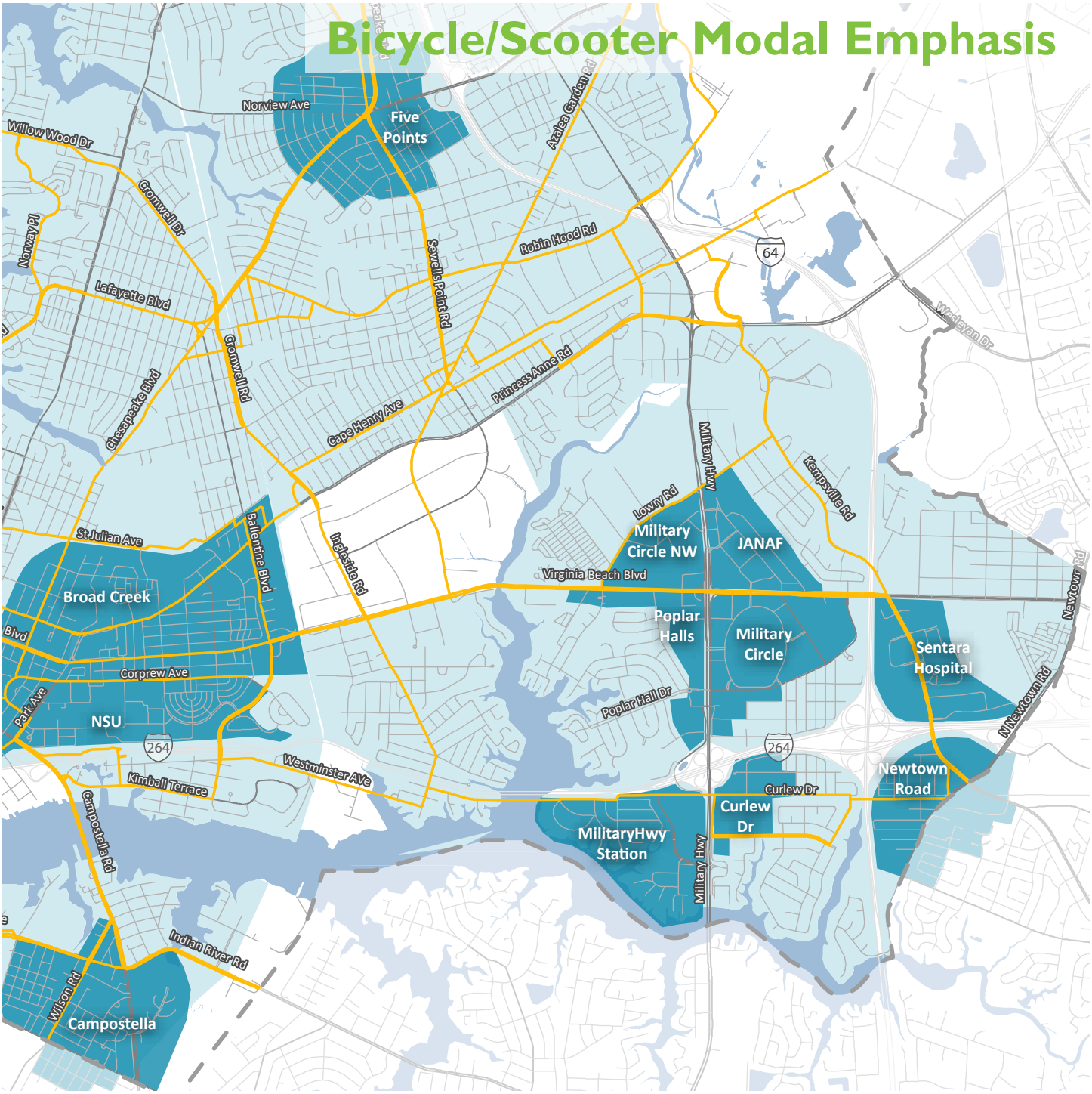
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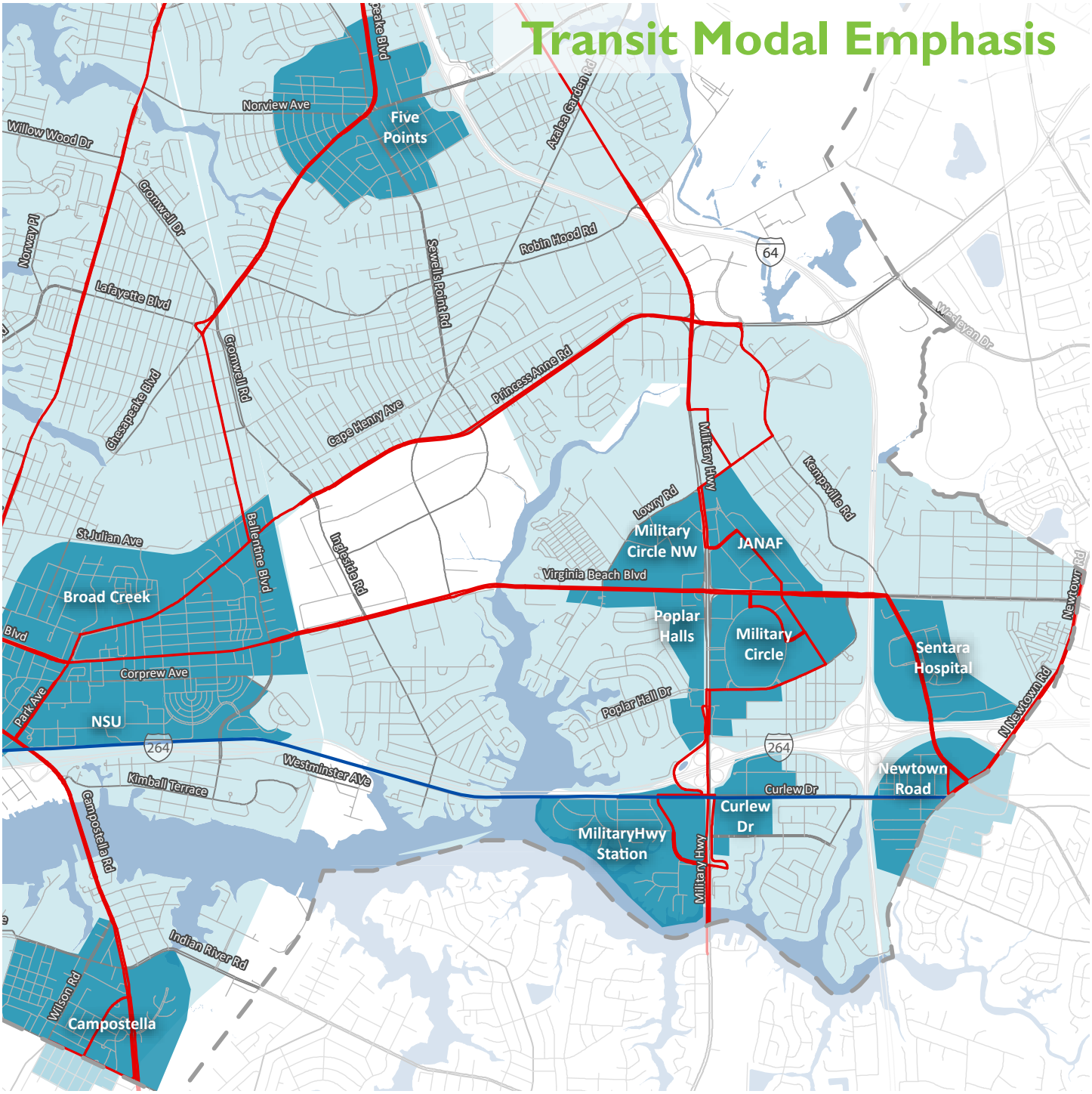
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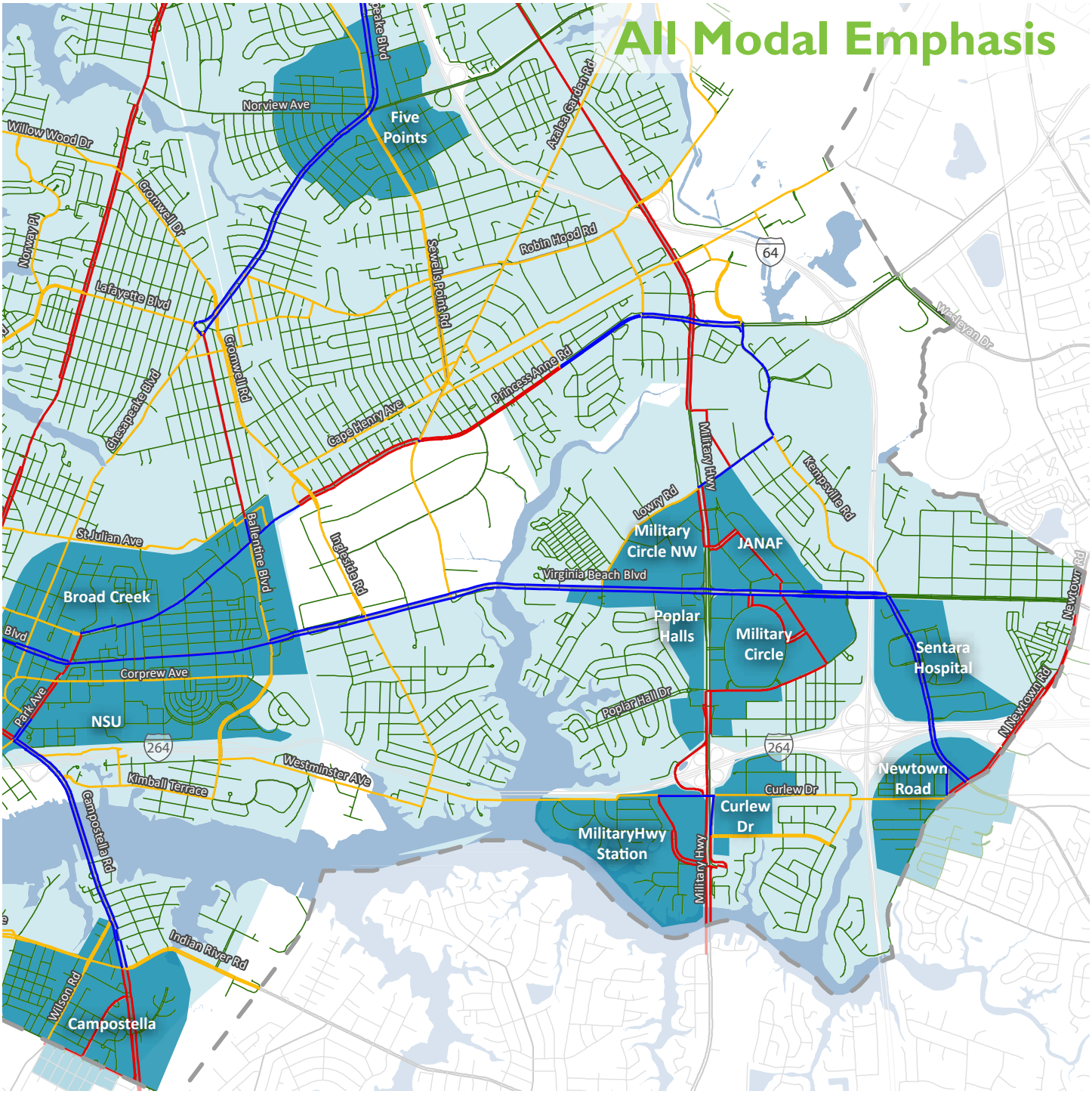


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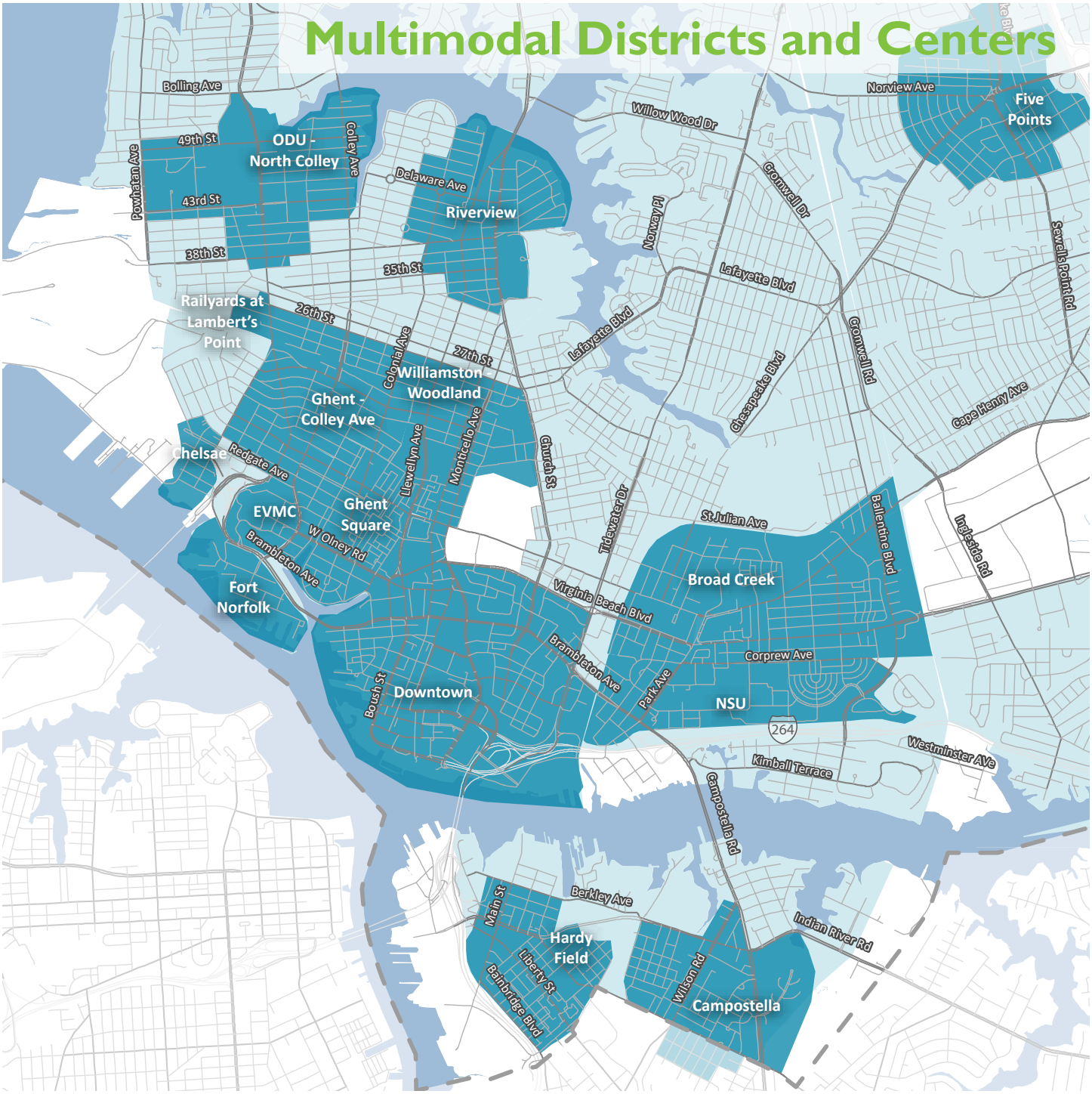
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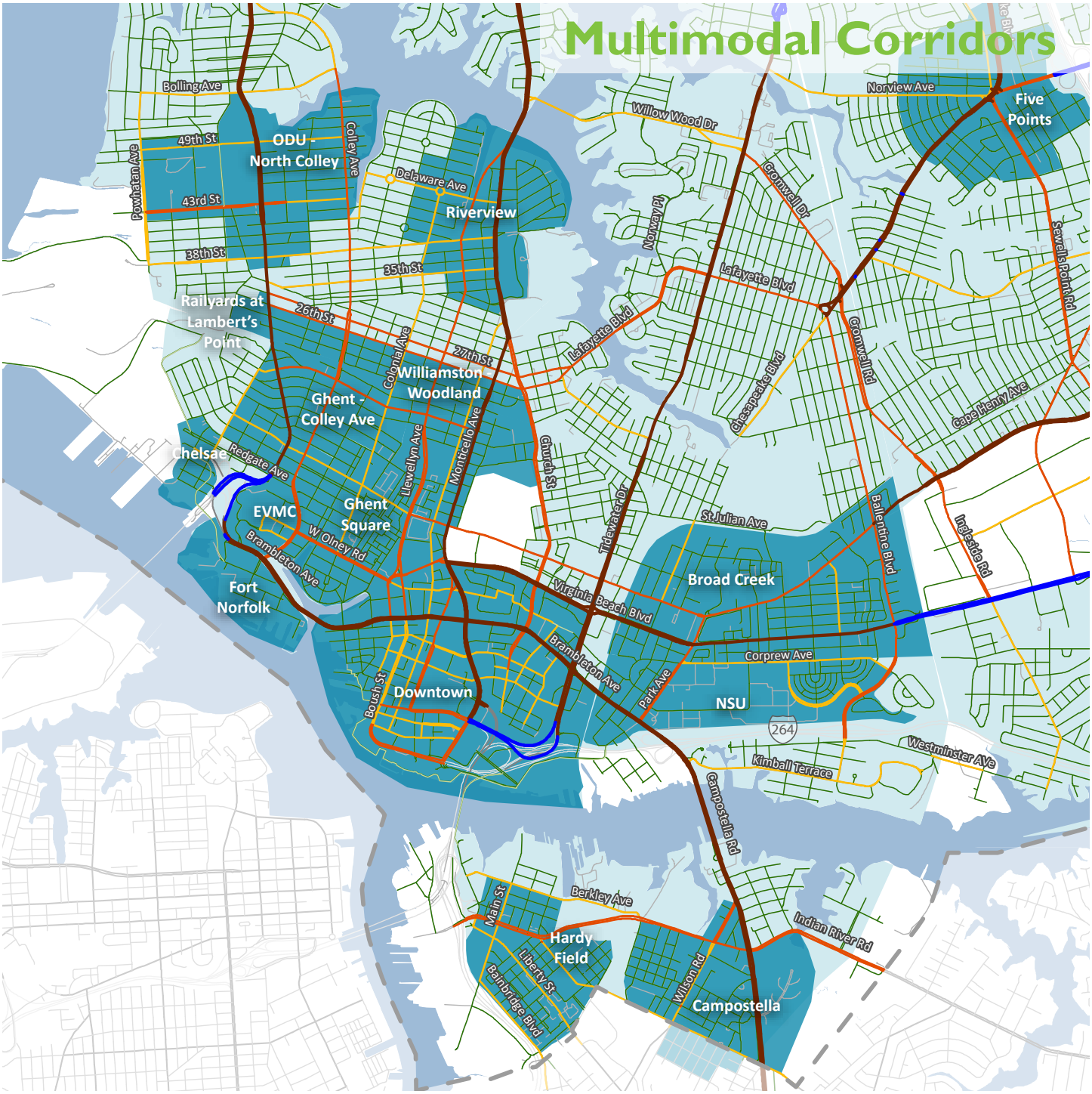
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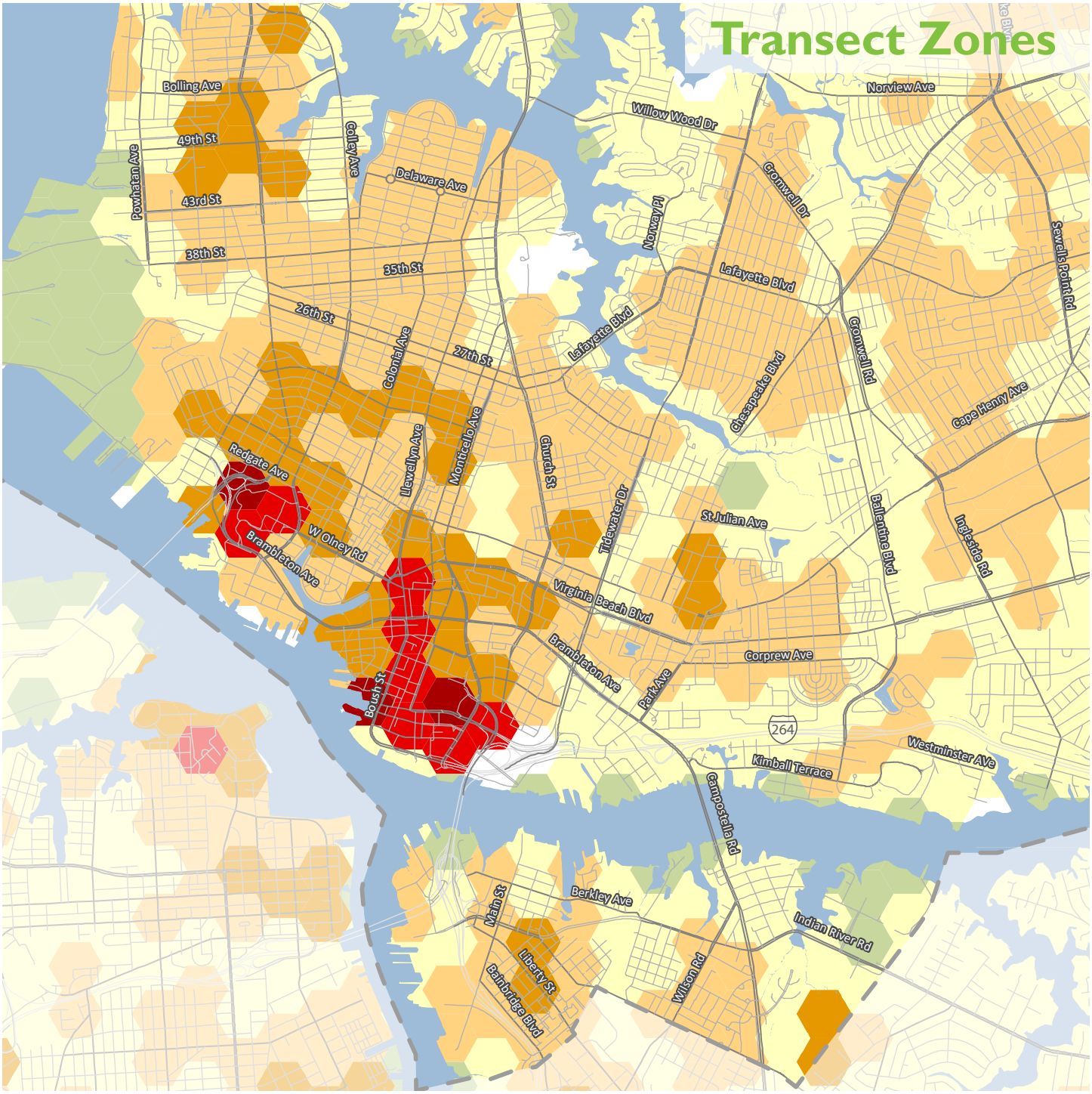


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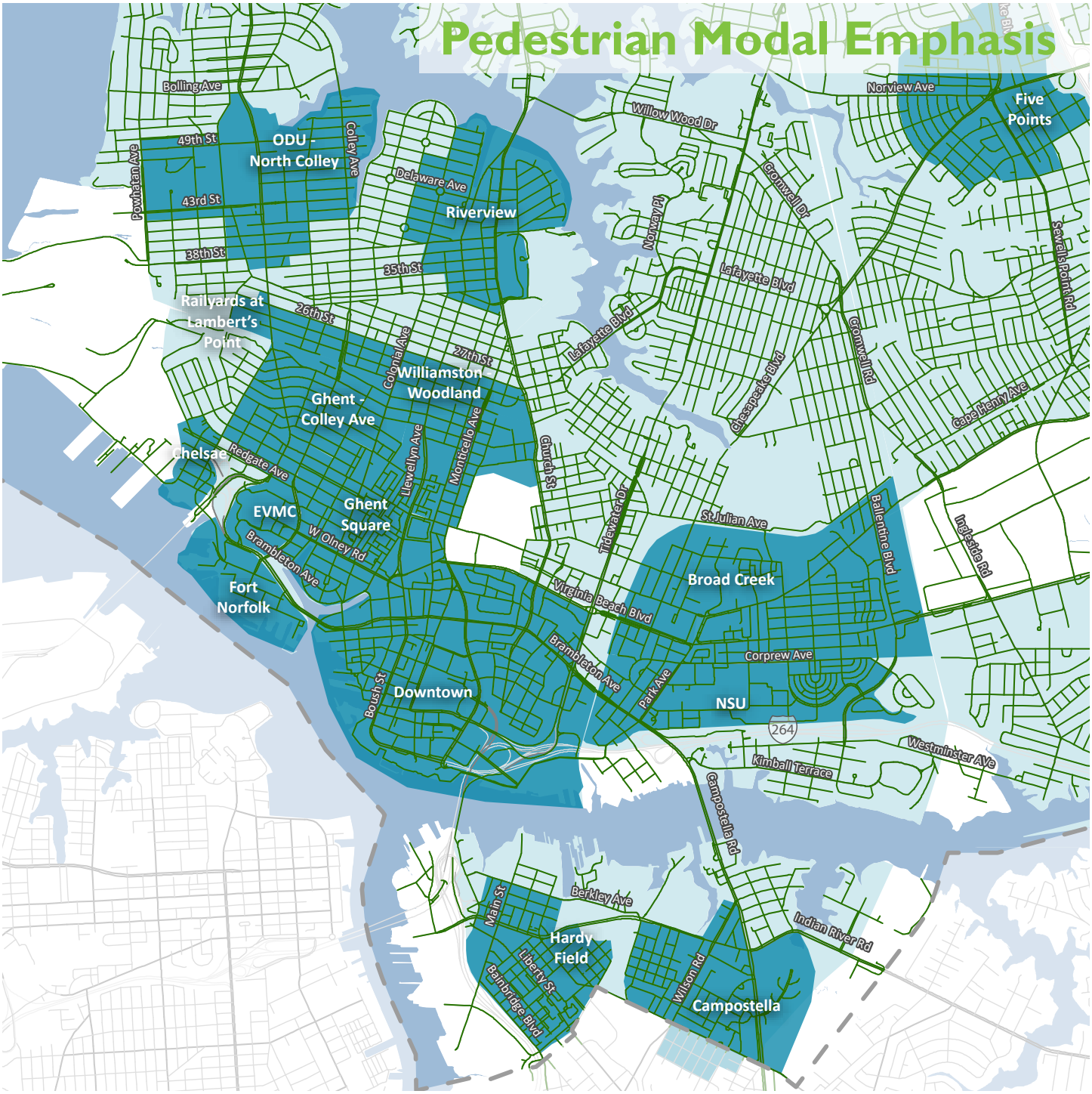
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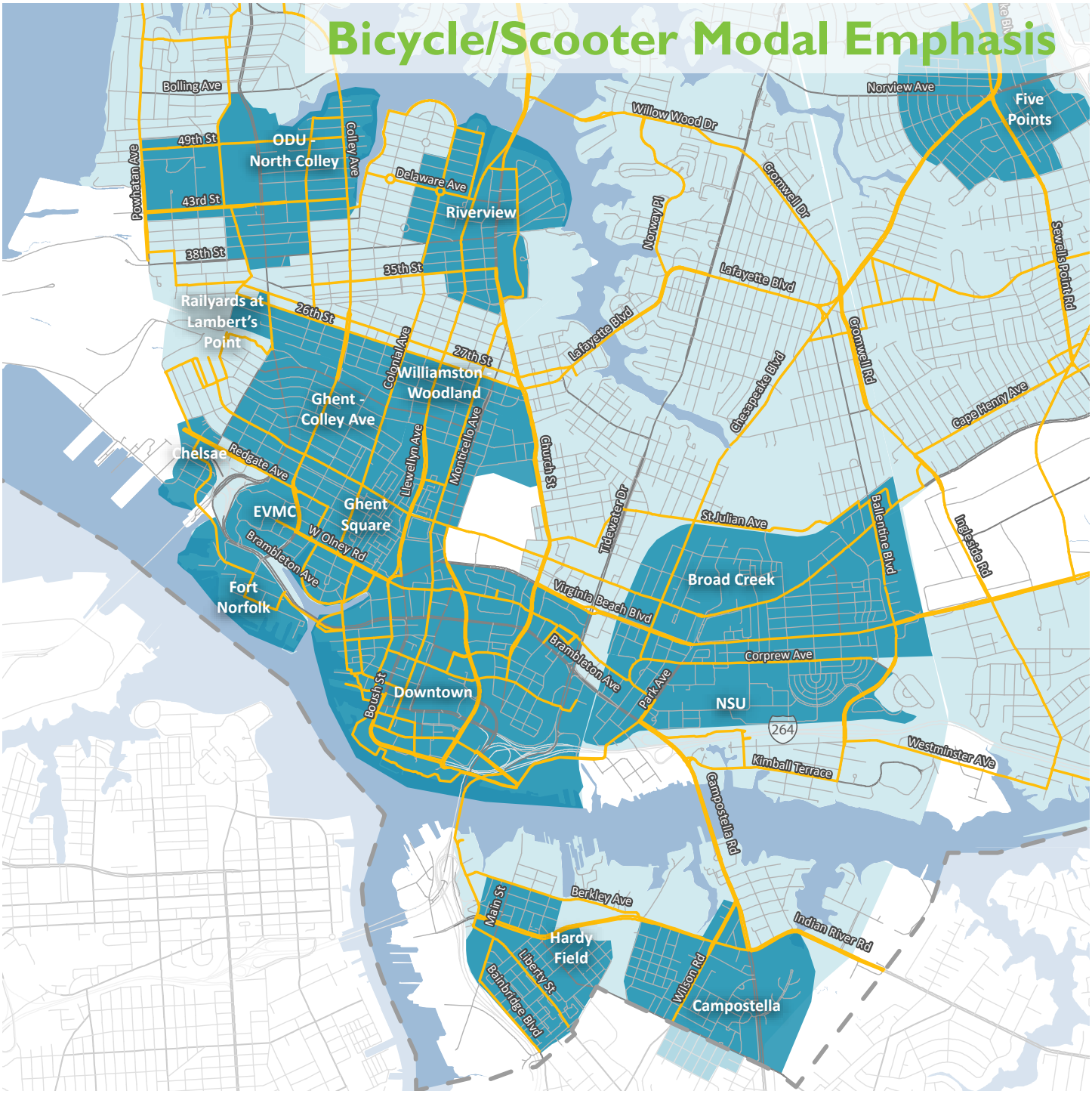
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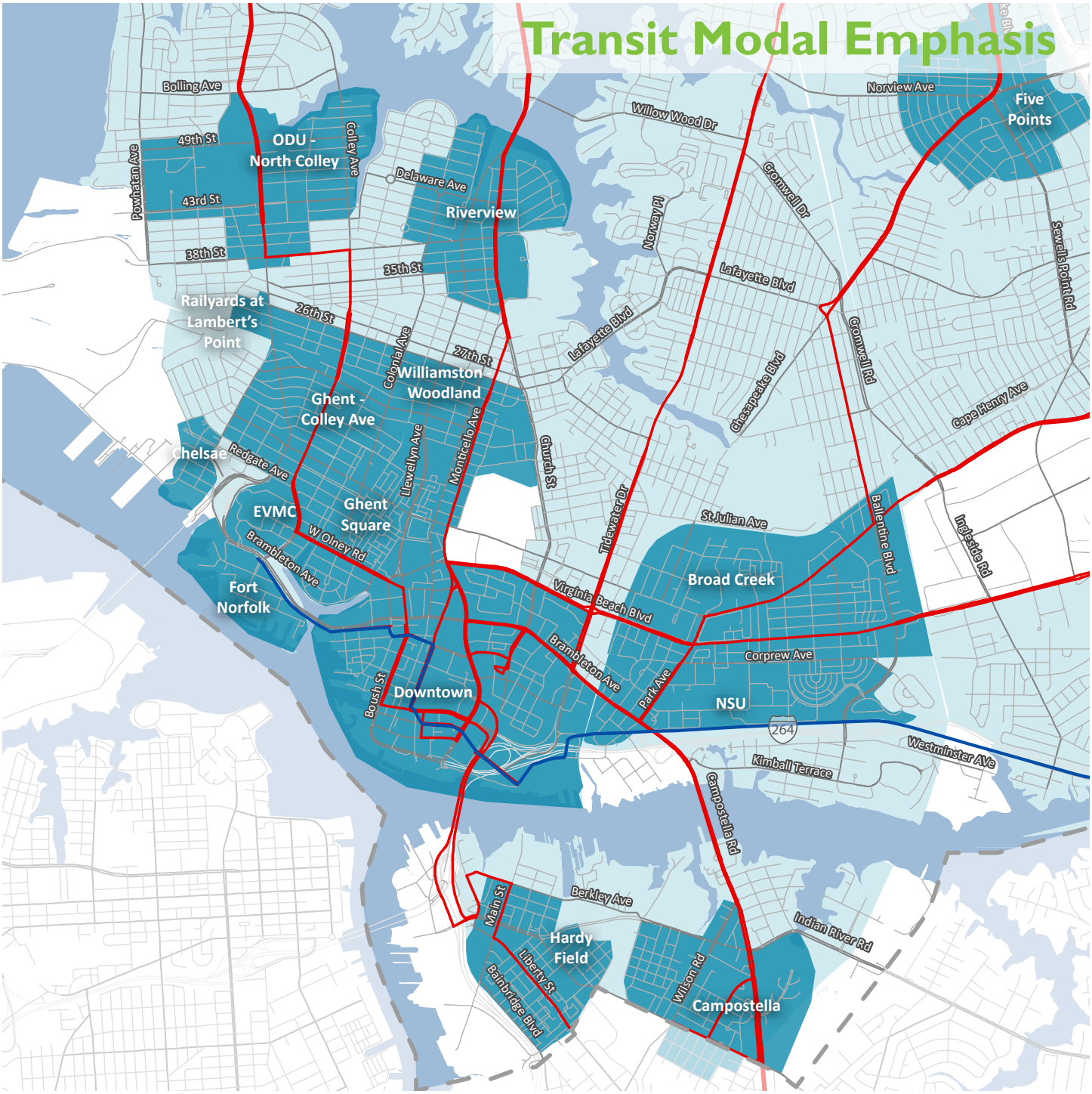
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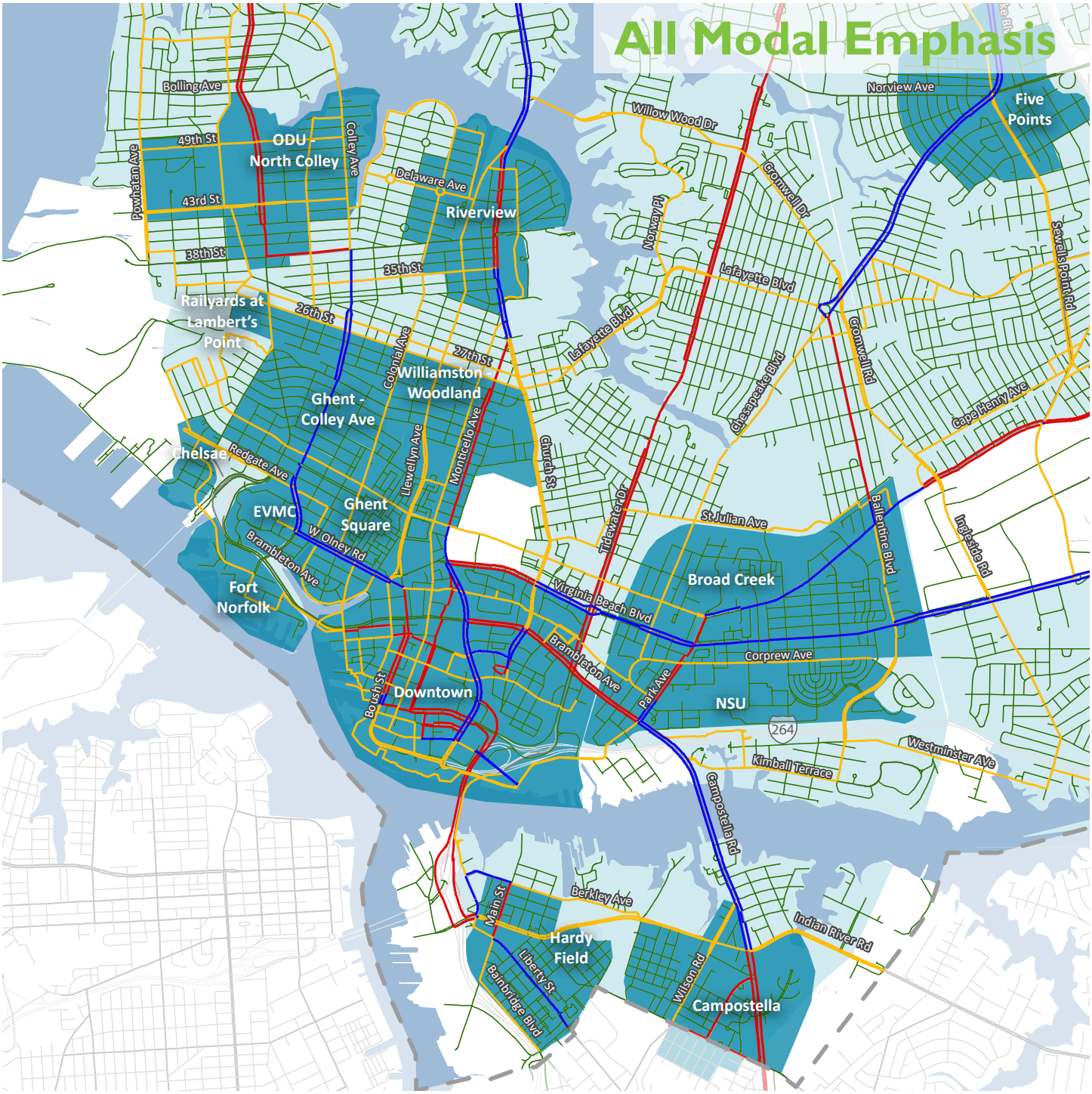
Transit Modal Emphasis



Modal Emphasis

- Transit Emphasis
- Light Rail
- Multimodal District
- Multimodal Center

Streets with **Transit Modal Emphasis** will be designed to provide for efficient transit operations. Improvements on streets with transit modal emphasis will provide adequate lane width for buses and may include dedicated bus-only lanes or combined bike/bus lanes. Improvements may also involve higher quality amenities at bus stops.



Modal Emphasis

- Pedestrian Emphasis
- Bicycle/Scooter and Pedestrian Emphasis
- Transit and Pedestrian Emphasis
- Bicycle/Scooter, Transit, and Pedestrian Emphasis

- Multimodal District
- Multimodal Center

This map represents the Multimodal System Plan for Norfolk. Many streets have more than one modal emphasis. Some have all three. Improvements on Norfolk's streets will be designed according to the street's modal emphasis and multimodal corridor type.

Multimodal Districts and Centers



Multimodal Districts and Centers

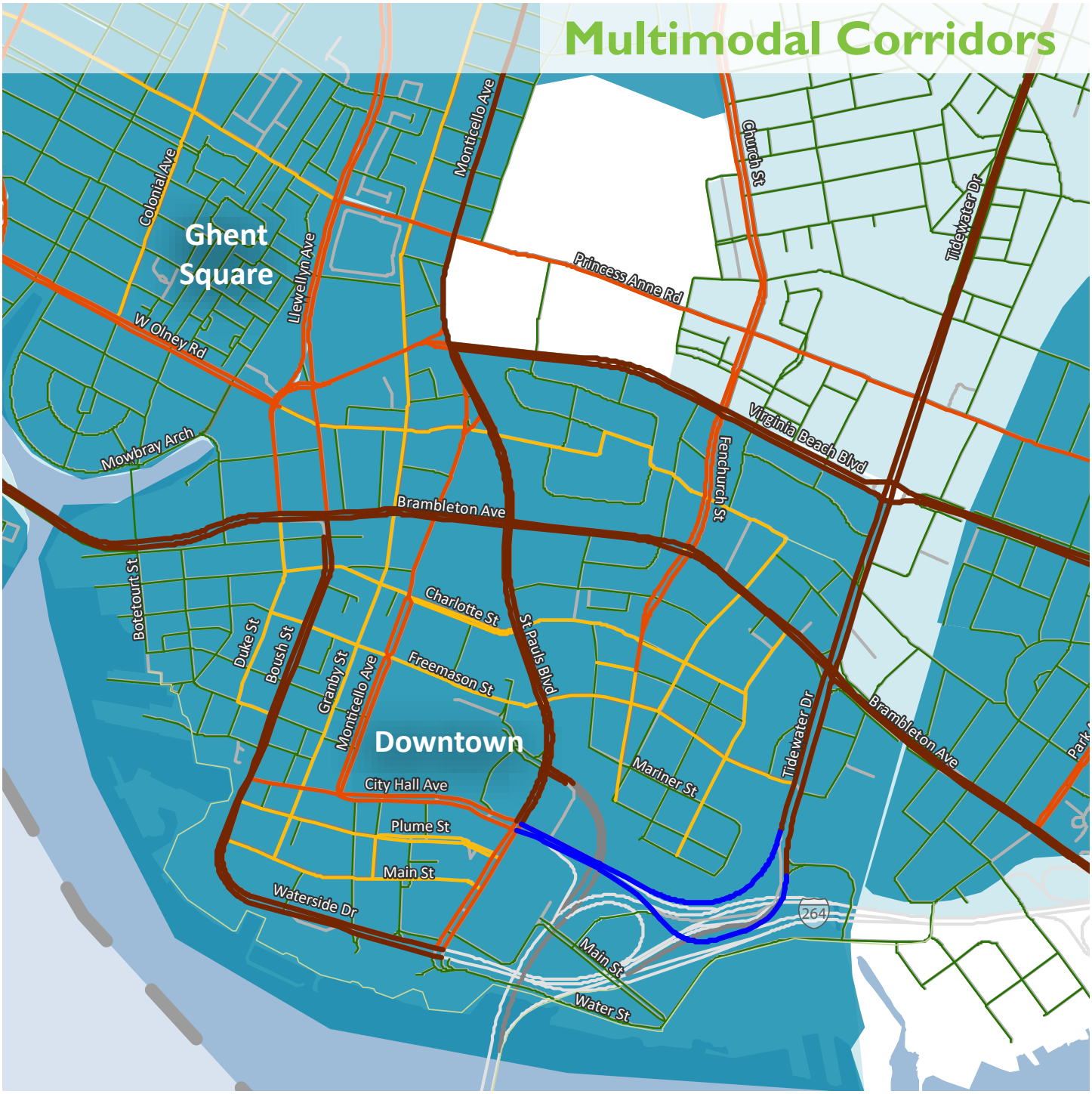
Multimodal District

Multimodal Center

Multimodal Districts are, quite simply, areas that should be safe for walking, riding a bike, or using other modes, either now or in the future. They are usually low density areas like residential neighborhoods and can be any size. They cover most of the City, except for areas like special industrial districts and federal land. All civic leagues are part of a multimodal district.

Multimodal Centers are areas with a higher density of people and jobs than Multimodal Districts. Destinations are closer together and easily reachable by bike or walking. Multimodal Centers should have a fine-grained network of high-quality facilities for walking and bicycling.

Multimodal Corridors



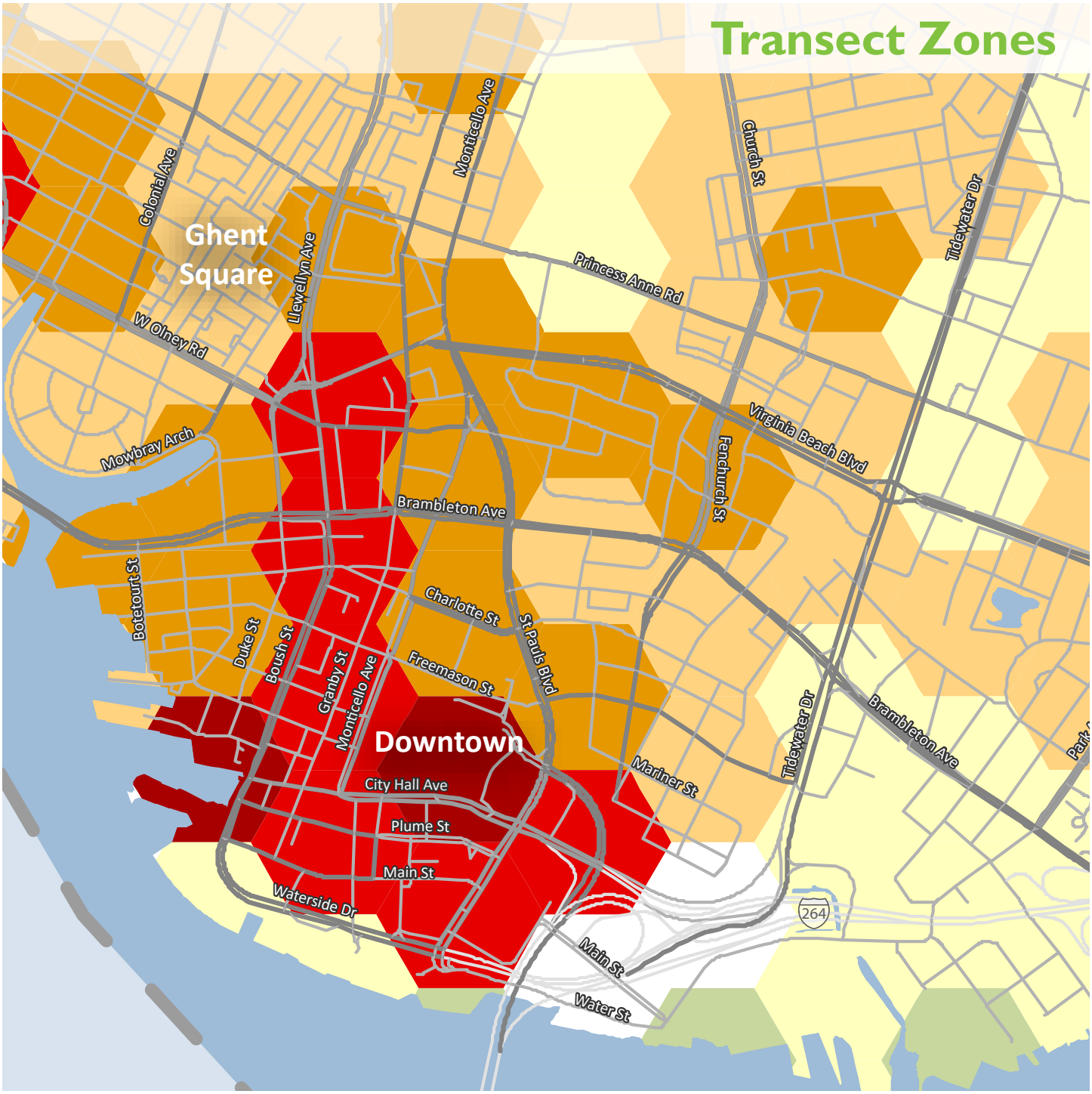
Multimodal Corridors

- Multimodal Through Corridor
- Boulevard
- Major Avenue
- Avenue
- Local Street
- Off-Street Path
- Multimodal District
- Multimodal Center

Multimodal Through Corridors are higher speed streets designed for vehicles to get smoothly and quickly from one area to another, yet still provide safe minimum facilities for non-motorized modes.

Boulevards, Major Avenues, Avenues, and Local Streets (Placemaking Corridors), are streets designed with slower speeds than Multimodal Through Corridors. These Placemaking Corridors will be designed for pedestrian and bicyclists to feel safe and comfortable. **Boulevards** will be designed to move lots of people in buses, on bikes, and on sidewalks. **Local Streets** will be designed to serve only trips that begin or end along them. **Avenues** and **Major Avenues** will be designed to connect Local Streets to Boulevards and Multimodal Through Corridors.

Transect Zones



Activity Density (Population + Employment / Acre)

00 - 01 (T1)	25 - 60 (T4)
01 - 10 (T2)	60 - 100 (T5)
10 - 25 (T3)	100+ (T6)

The design of a multimodal corridor is intended to vary depending on the surrounding land use and community context. Streets in areas with high activity levels like downtown are different from streets in areas with lower levels of activity in neighborhoods and should vary in design. **Transect zones** illustrate the general intensity of activity, based on population and job density.

The six categories of transect zones show a generalized gradation of density across the city, based the level of employment and population in each area. These transect zones will be used to fine tune the specific corridor designs in a series of lookup tables for each element of the street, such as sidewalks, bike facilities and vehicle travel lanes.

Pedestrian Modal Emphasis



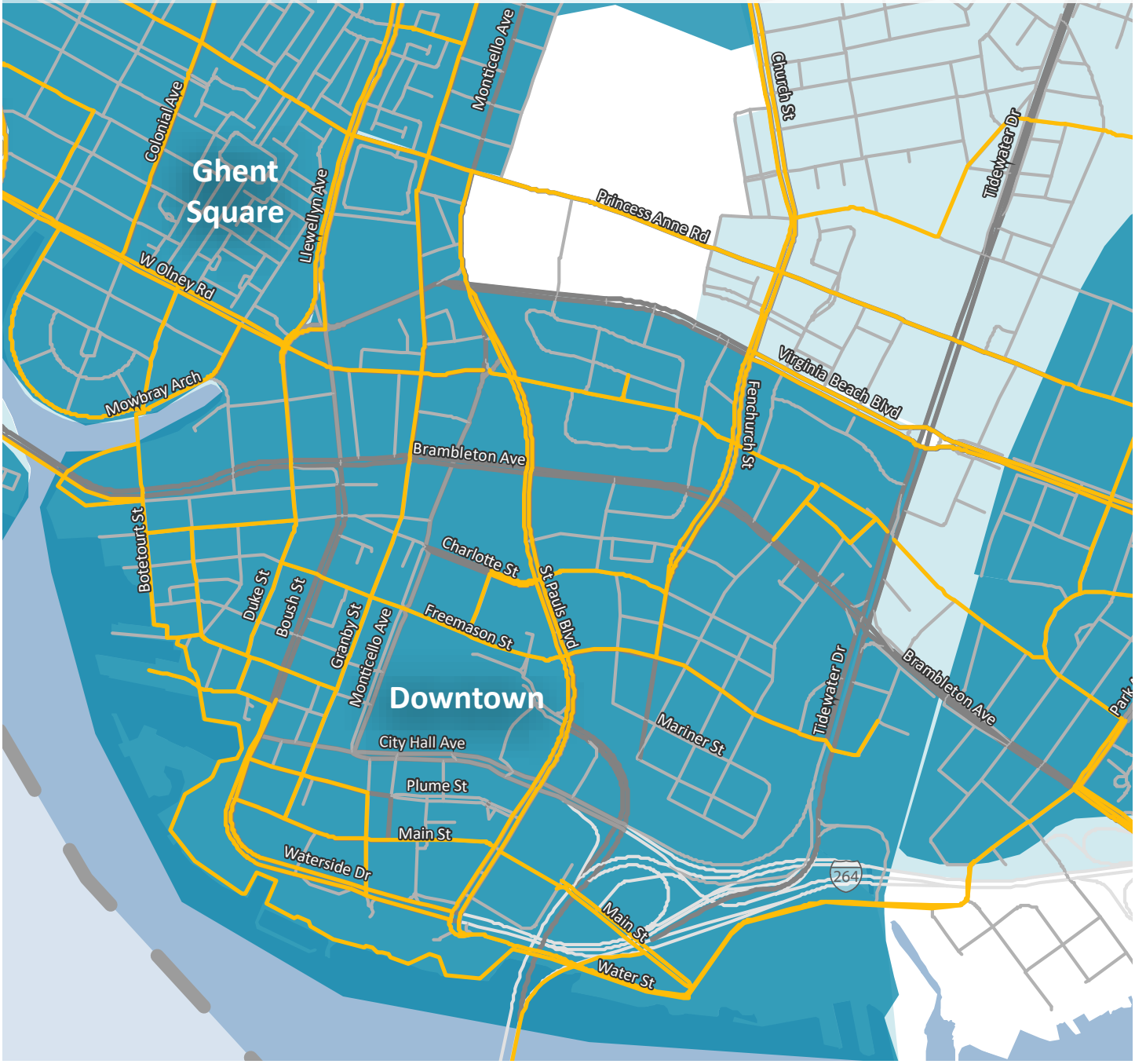
Modal Emphasis

- Pedestrian Emphasis
- Multimodal District
- Multimodal Center

Streets with **Pedestrian Modal Emphasis** will be designed to emphasize pedestrian safety and comfort. Improvements on streets with pedestrian modal emphasis will be designed to provide **optimal** facilities for walking on a case-by-case basis. Improvements may include wider sidewalks and wider buffers between sidewalks and vehicle travel lanes, where feasible.

Improvement projects on streets without pedestrian modal emphasis will meet **minimum** standards for pedestrian facilities.

Bicycle/Scooter Modal Emphasis



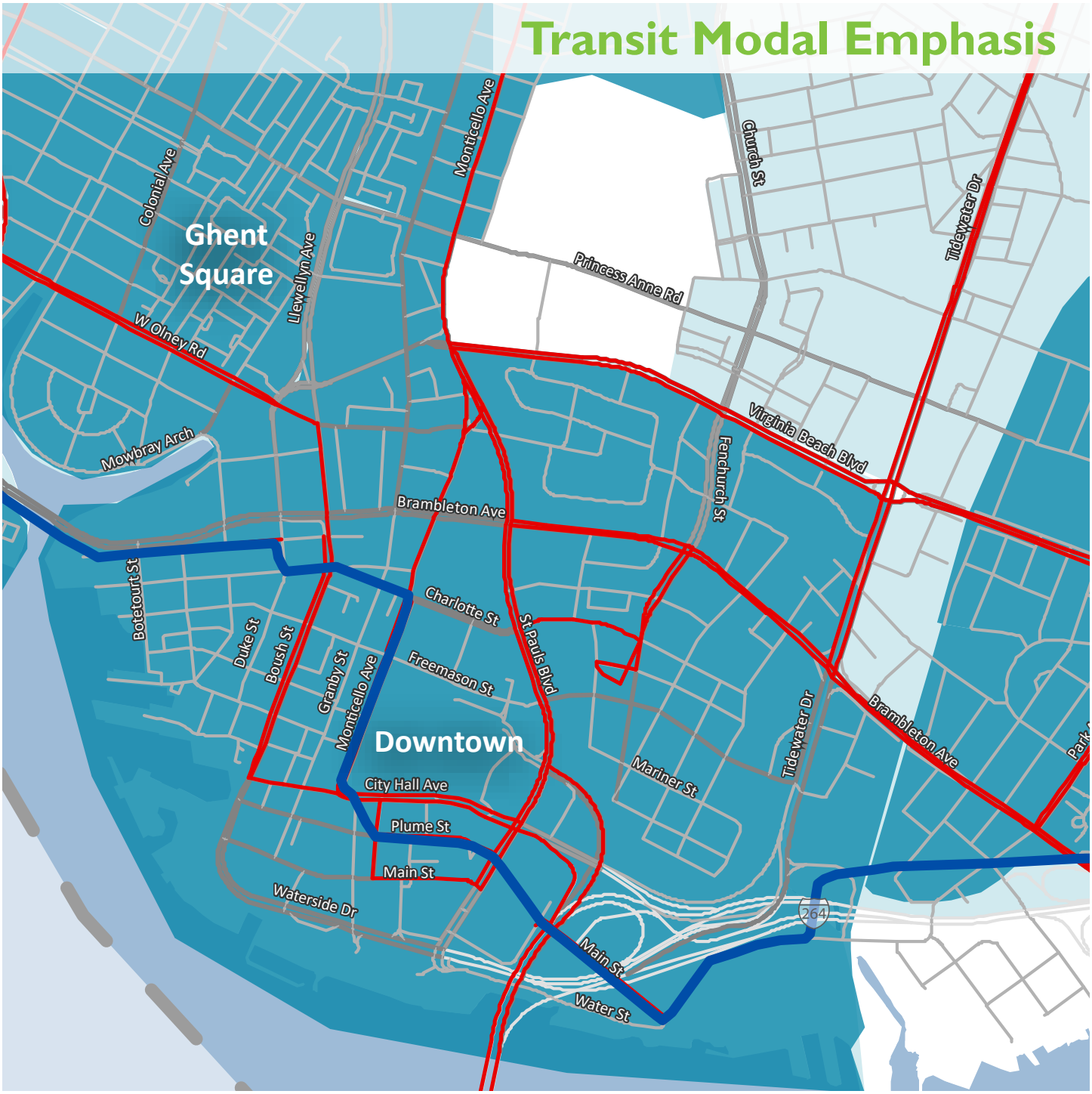
Modal Emphasis

- Bicycle/Scooter Emphasis
- Multimodal District
- Multimodal Center

Streets with **Bicycle/Scooter Modal Emphasis** will be designed to emphasize bicyclist and scooter rider safety and comfort. Improvements on streets with bicycle/scooter modal emphasis will provide optimal facilities for bicycling and scootering, which may include lane repurposing to provide separated bicycle/scooter facilities or collocated bike/bus lanes.

Bicycle/scooter facility design will be determined on a case-by-case basis and follow industry guidance to determine the appropriate type of treatment. Bicycle/scooter modal emphasis may be re-designated during the design phase to parallel corridors that serve the bicycle/scooter safety and connectivity needs better.

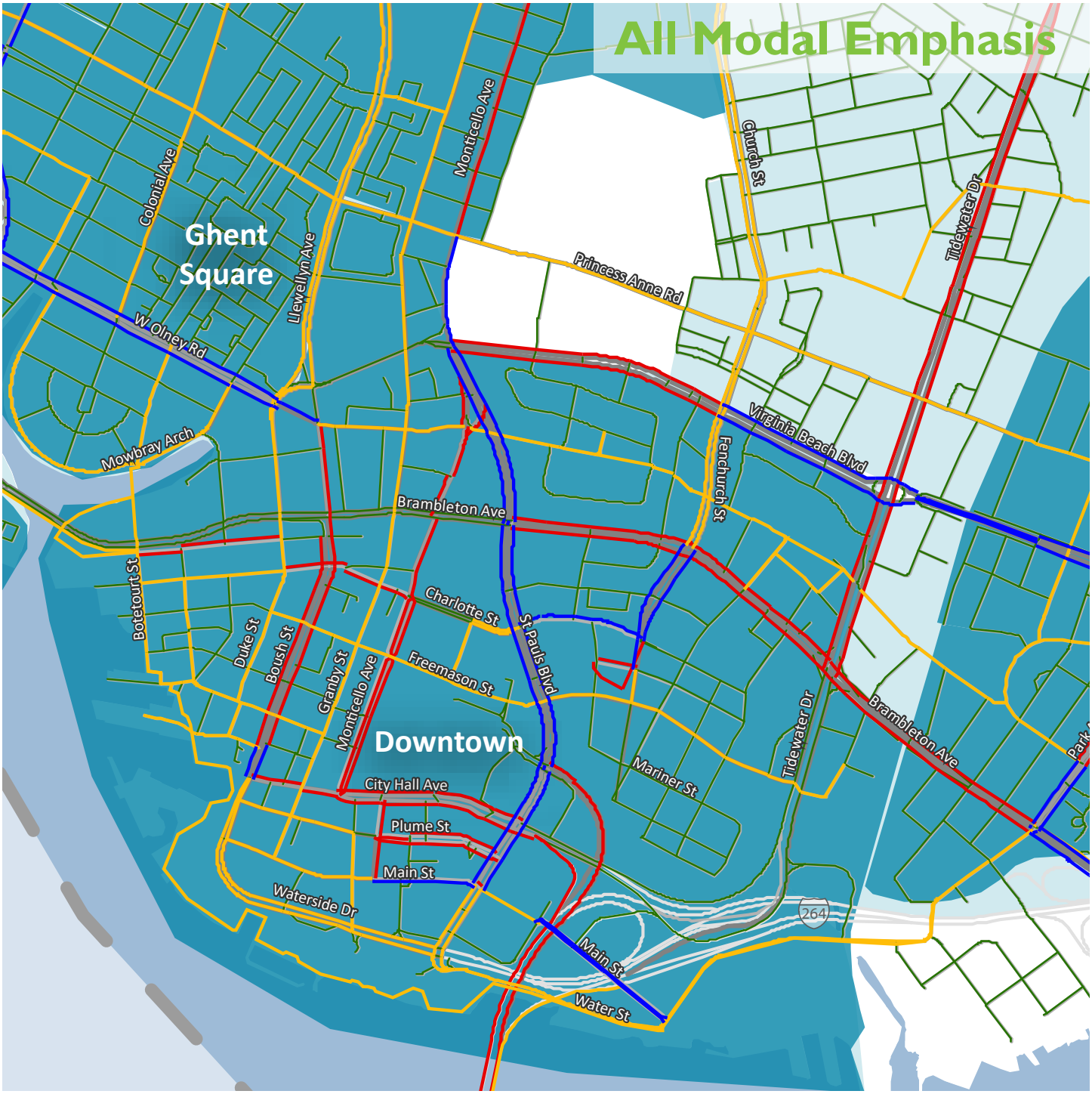
Transit Modal Emphasis



Modal Emphasis

- Transit Emphasis
- Light Rail
- Multimodal District
- Multimodal Center

Streets with **Transit Modal Emphasis** will be designed to provide for efficient transit operations. Improvements on streets with transit modal emphasis will provide adequate lane width for buses and may include dedicated bus-only lanes or combined bike/bus lanes. Improvements may also involve higher quality amenities at bus stops.



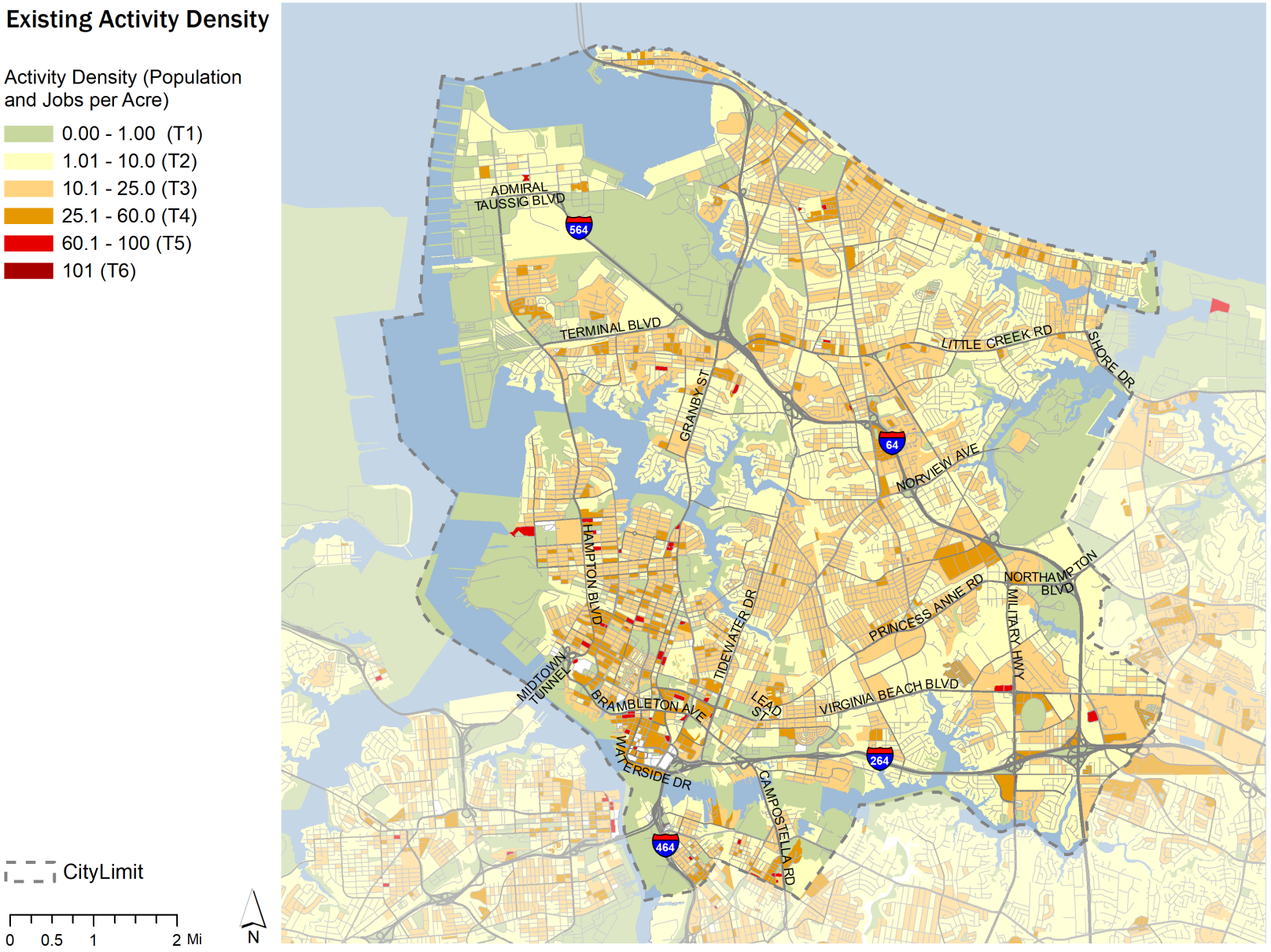
Modal Emphasis

- Pedestrian Emphasis
- Bicycle/Scooter and Pedestrian Emphasis
- Transit and Pedestrian Emphasis
- Bicycle/Scooter, Transit, and Pedestrian Emphasis

- Multimodal District
- Multimodal Center

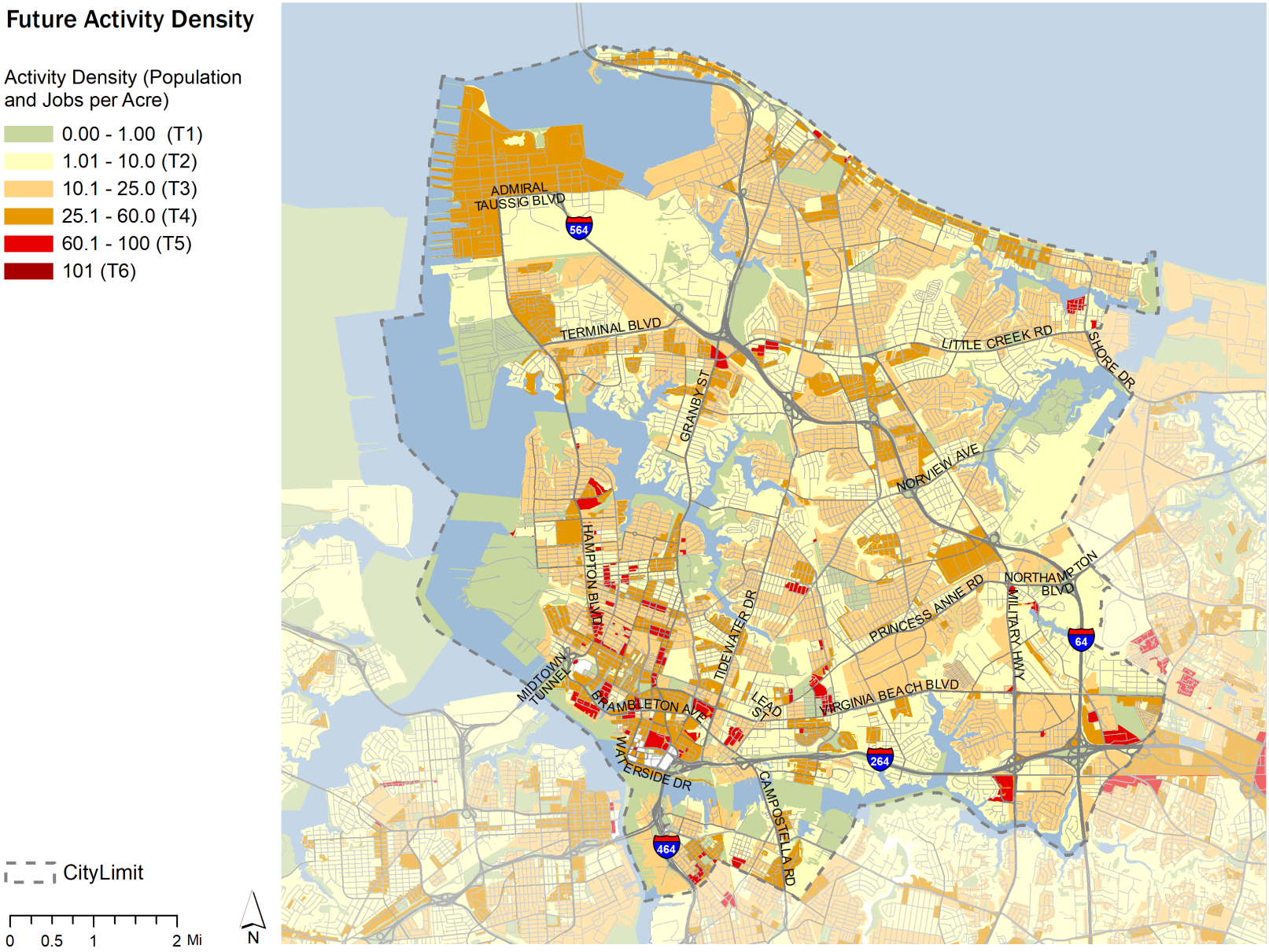
This map represents the Multimodal System Plan for Norfolk. Many streets have more than one modal emphasis. Some have all three. Improvements on Norfolk's streets will be designed according to the street's modal emphasis and multimodal corridor type.

Appendix B: Additional Maps



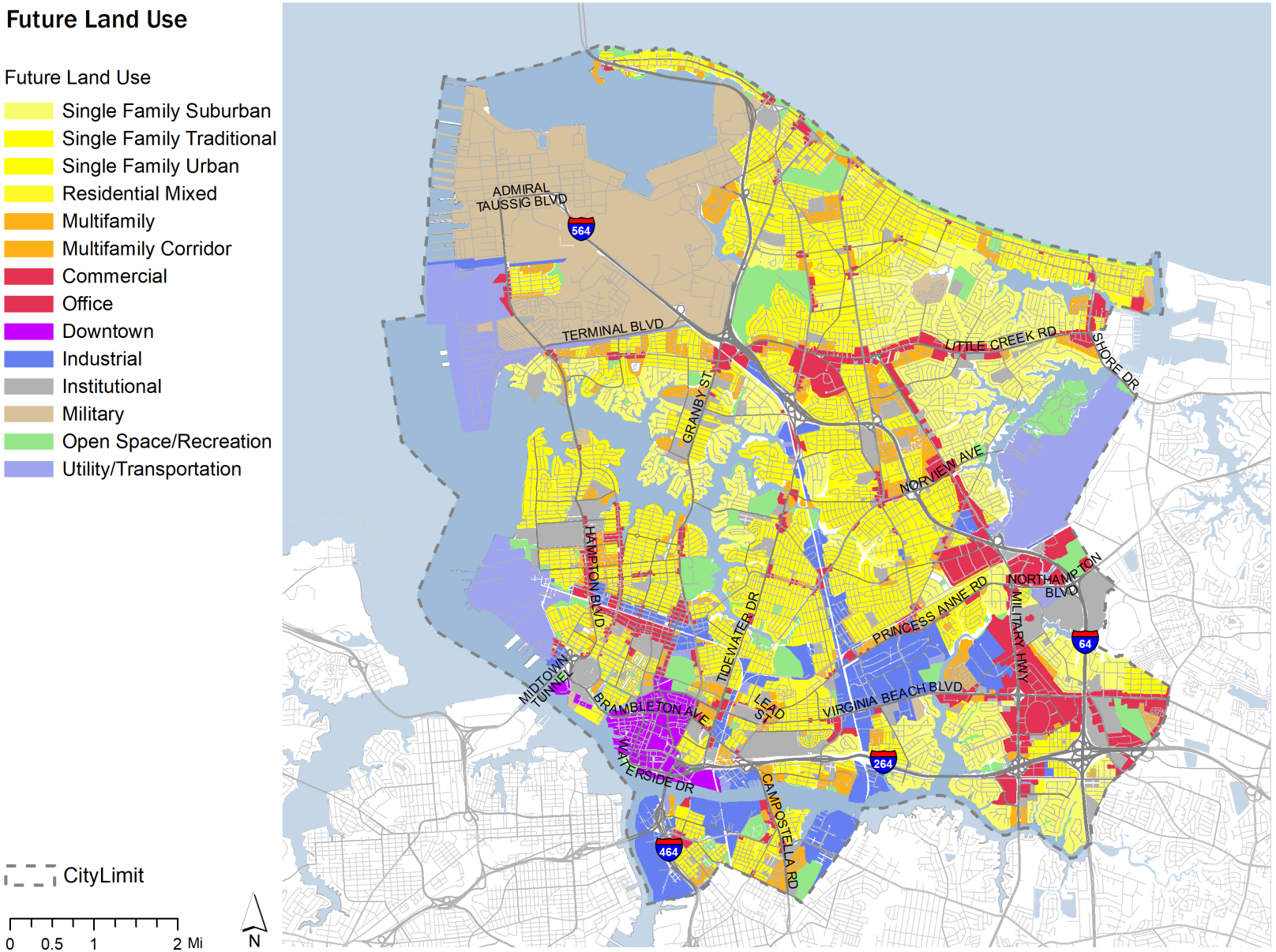
Data Sources: 2010 Census population data and 2010 LEHD employment data by Census block.

Future Activity Density

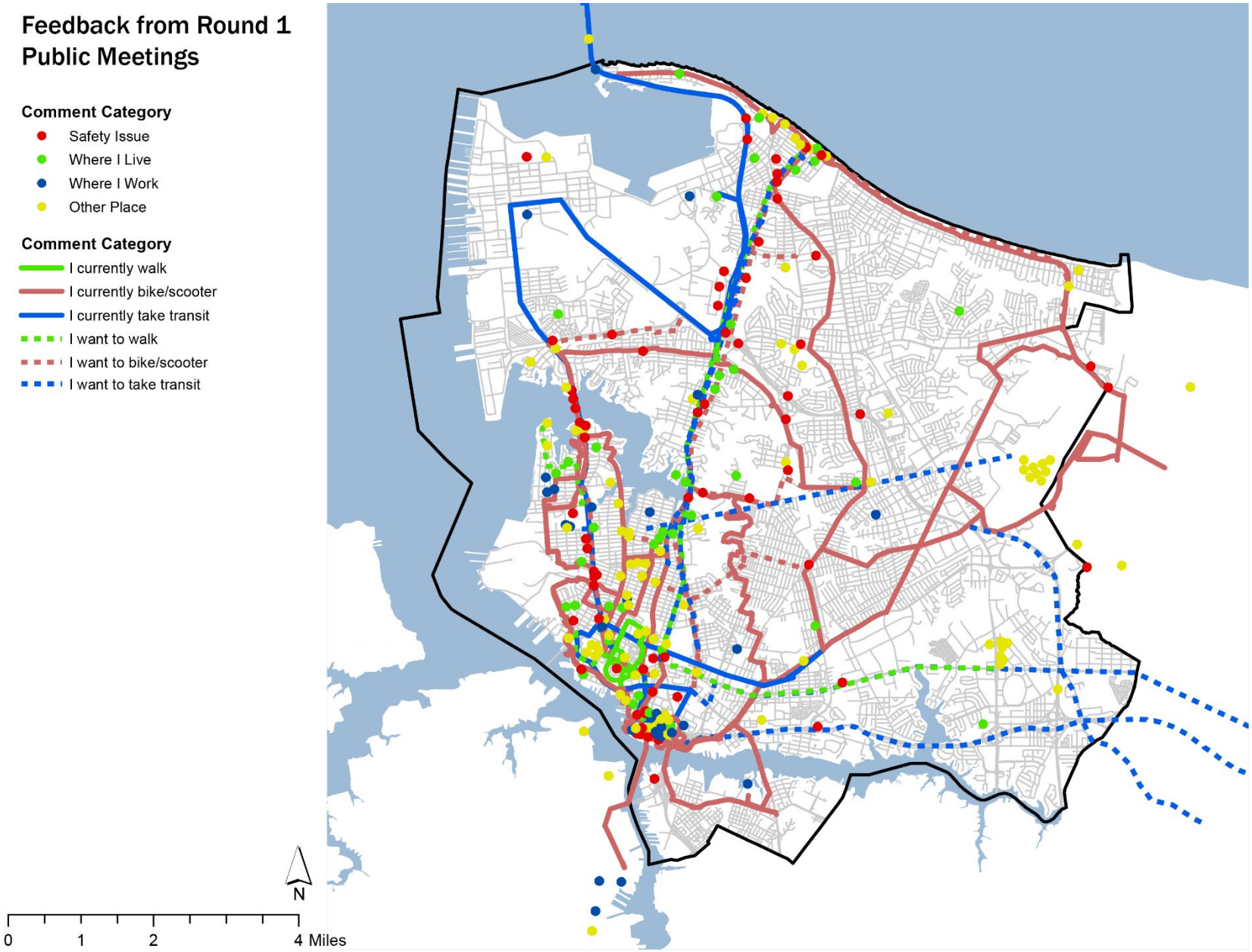


Data Source: 2045 Population and Employment Projections derived from HRTPO Travel Demand Model

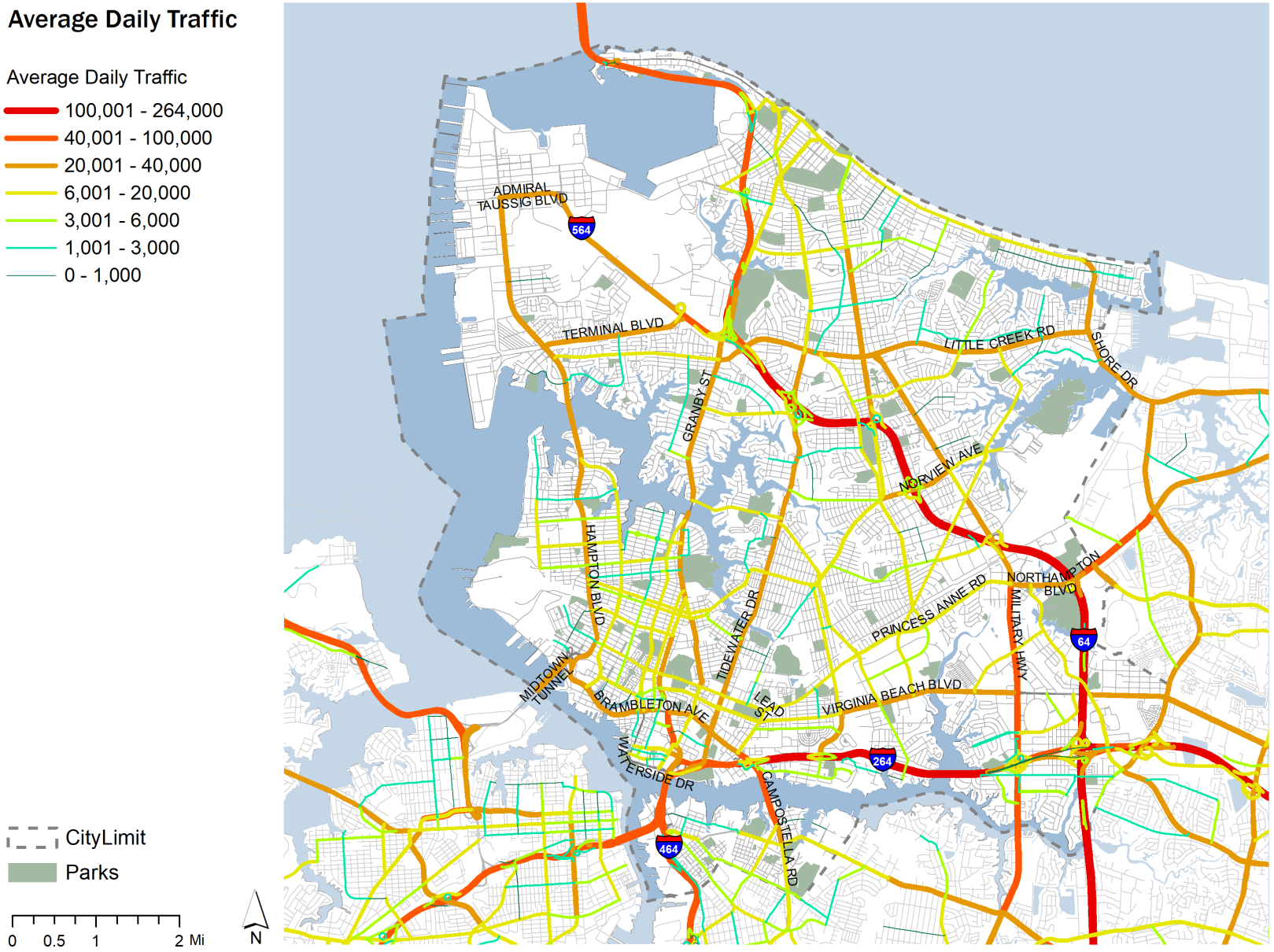
Future Land Use



Data Source: City of Norfolk


Feedback from Round 1
Public Meetings
Comment Category
Safety Issue
Where I Live
Where I Work
Other Place
Comment Category
I currently walk
I currently bike/scooter
I currently take transit
I want to walk
I want to bike/scooter
I want to take transit
N
0
1
2
4 Miles

Average Daily Traffic

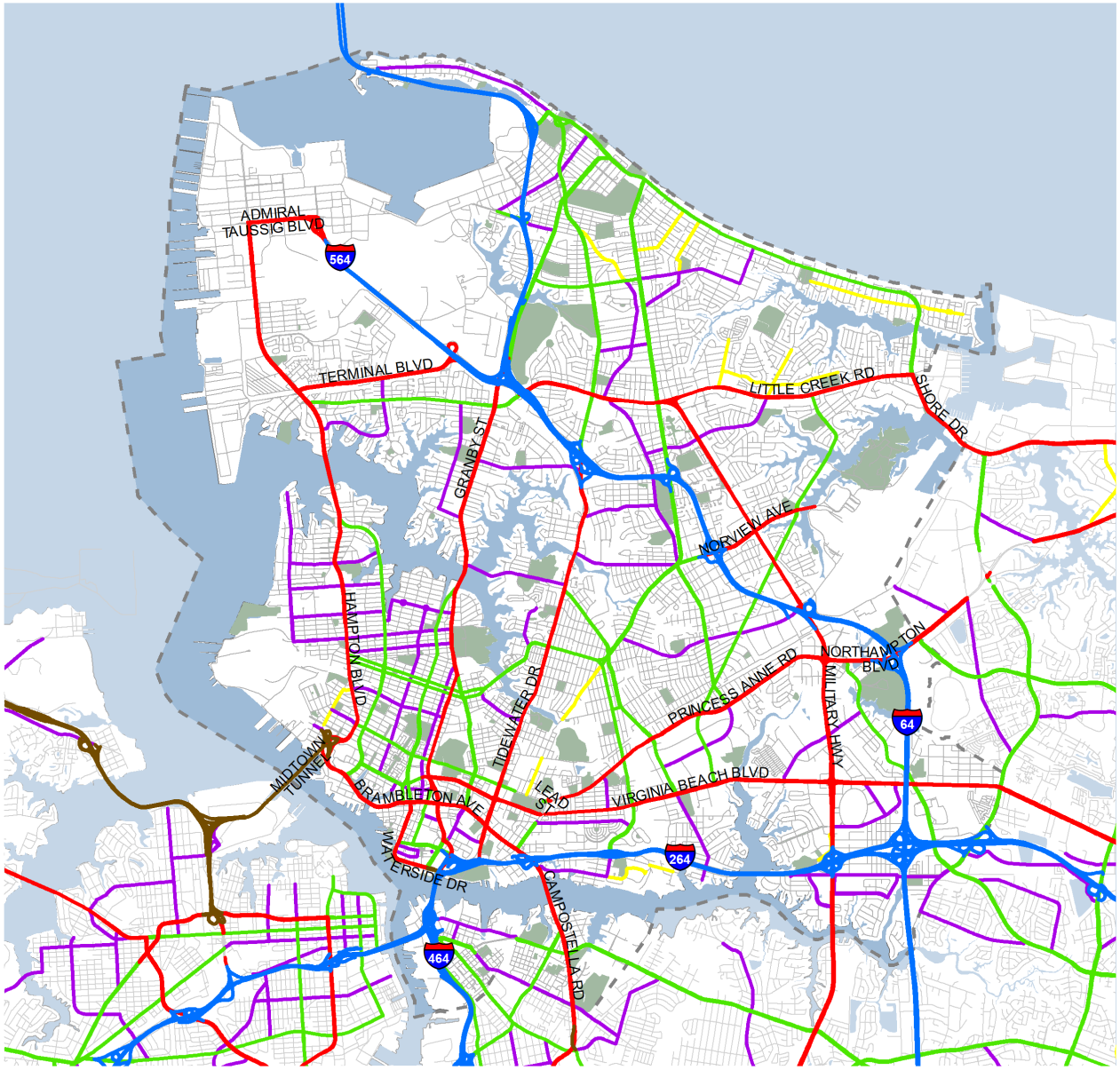


Data Source: Virginia Department of Transportation 2018 Average Daily Traffic Volumes

VDOT Functional Classification

Functional Classification

- Interstate
- Other Freeway or Expressway
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Minor Collector



CityLimit

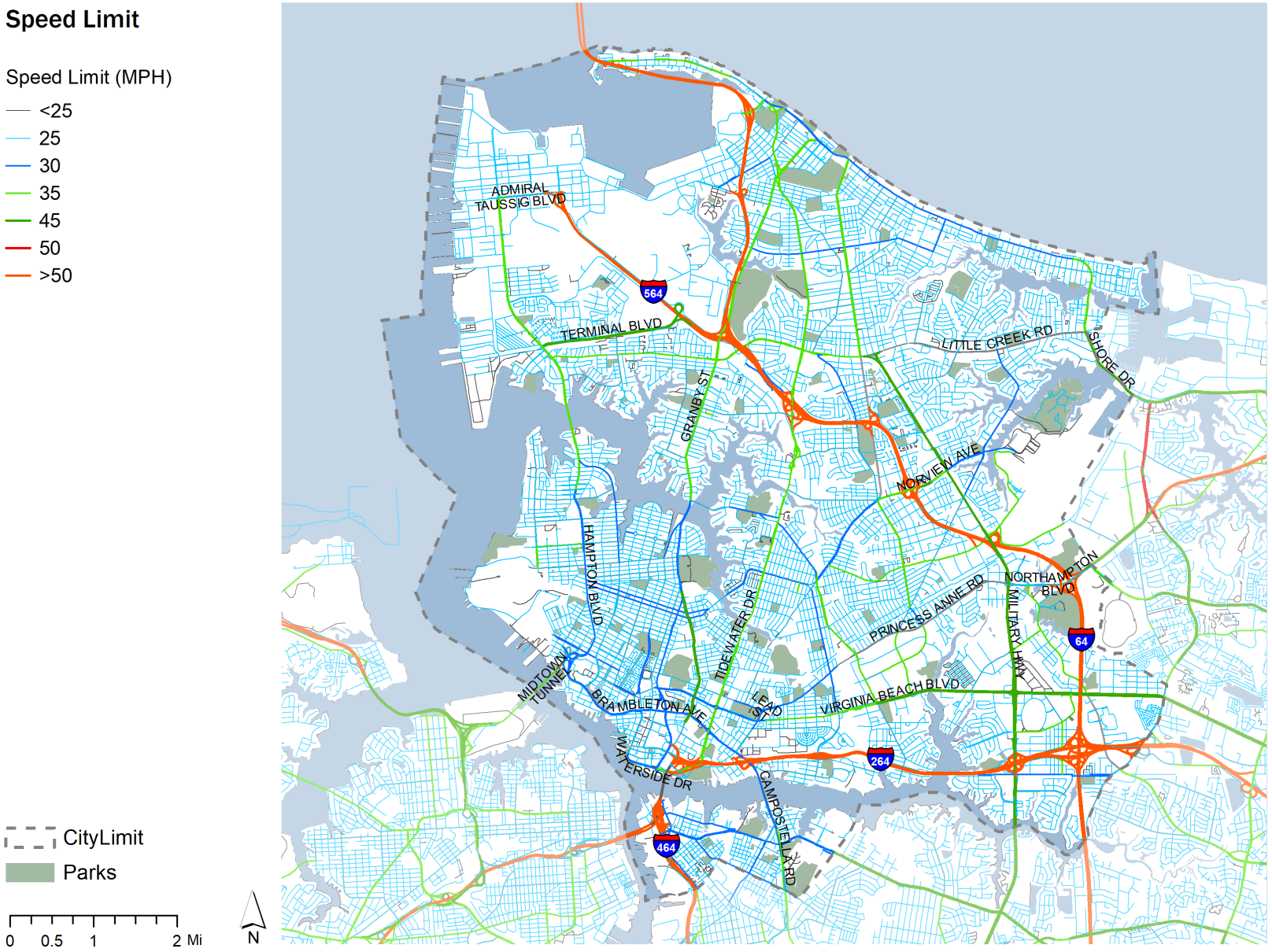
Parks

0 0.5 1 2 Mi

N

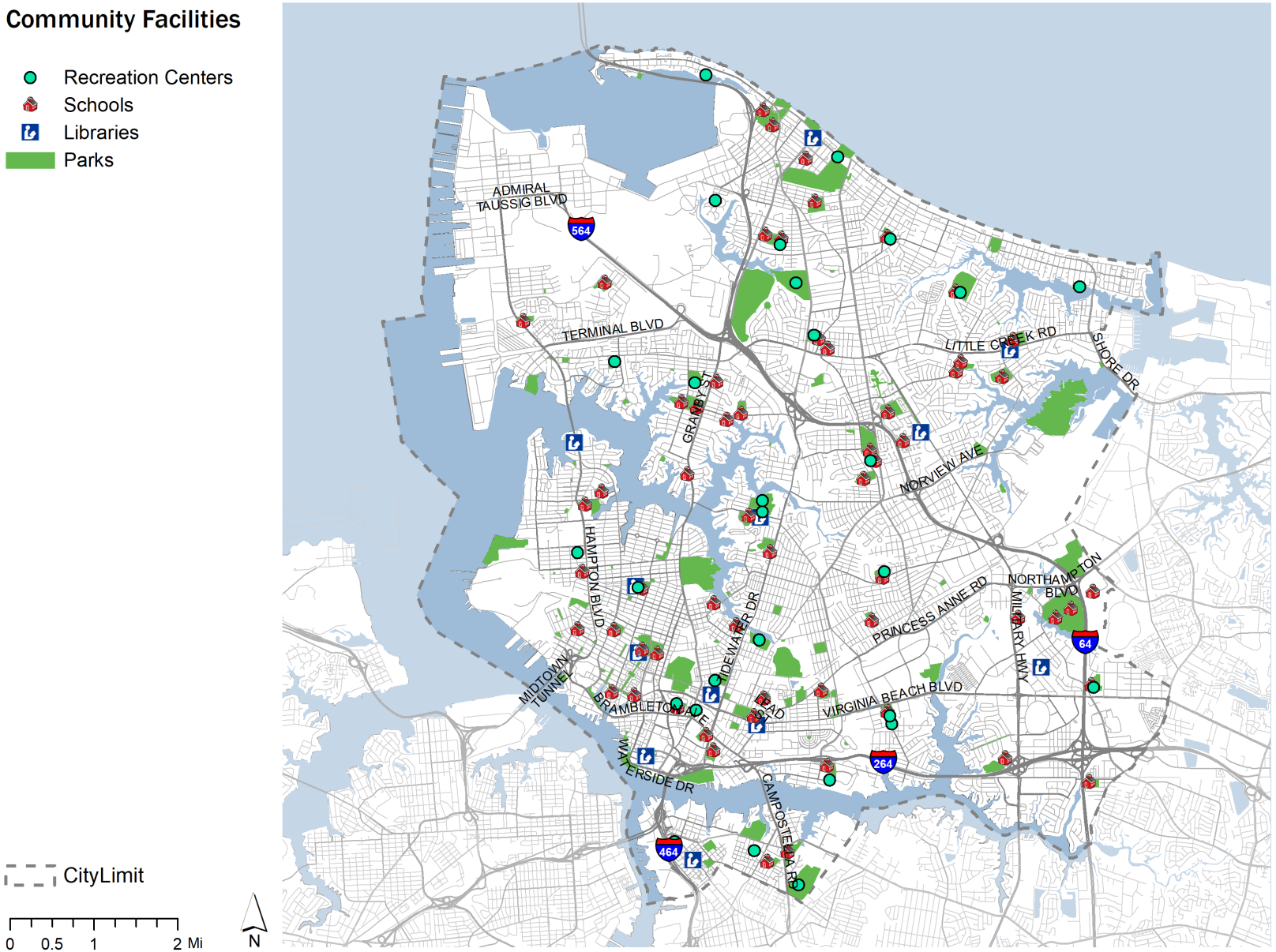
Data Source: Virginia Department of Transportation, Functional Classification approved in 2014.

Speed Limit



Data Source: Virginia Department of Transportation, Posted Speed Limits

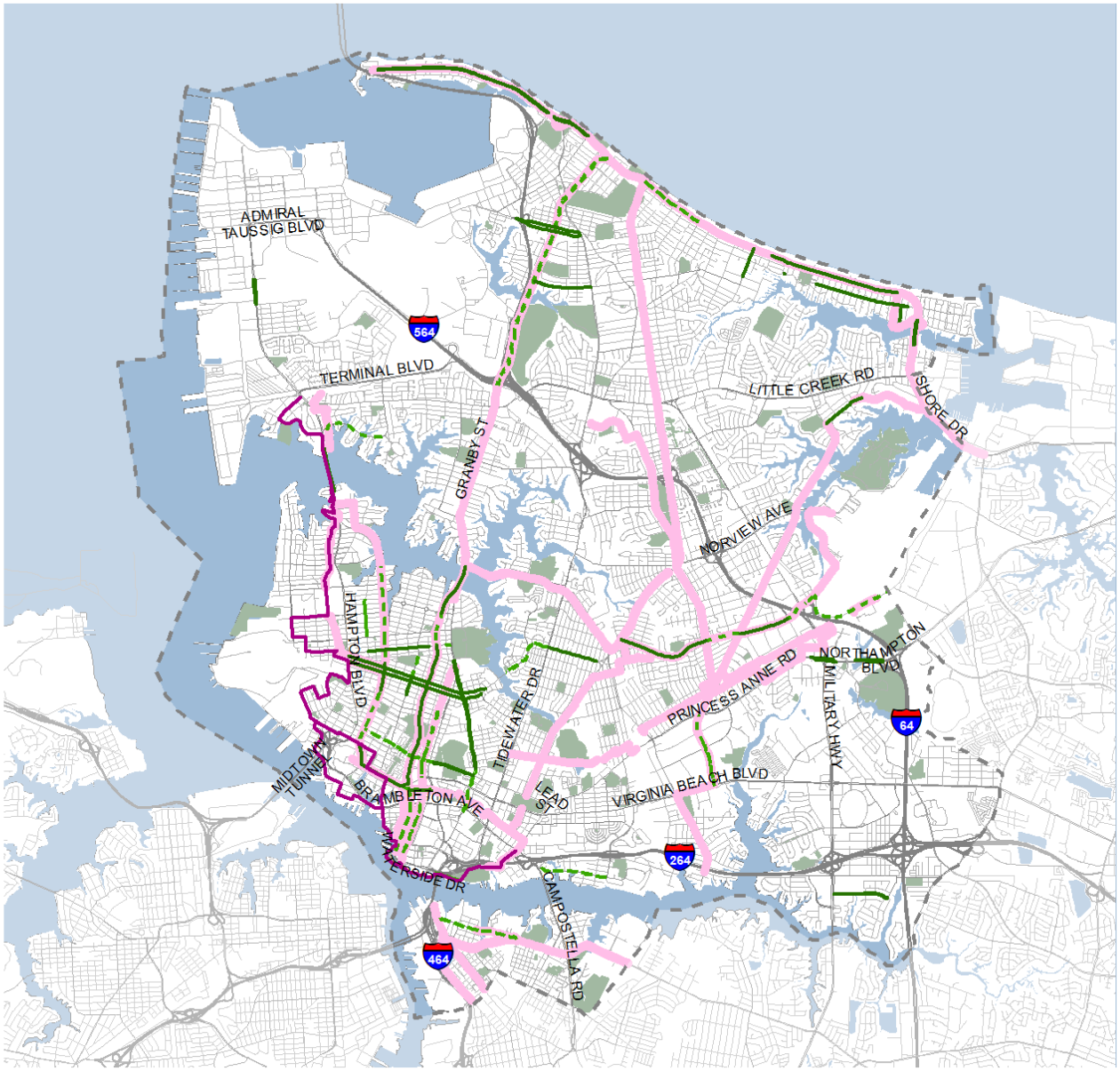
Community Facilities



Data Source: City of Norfolk

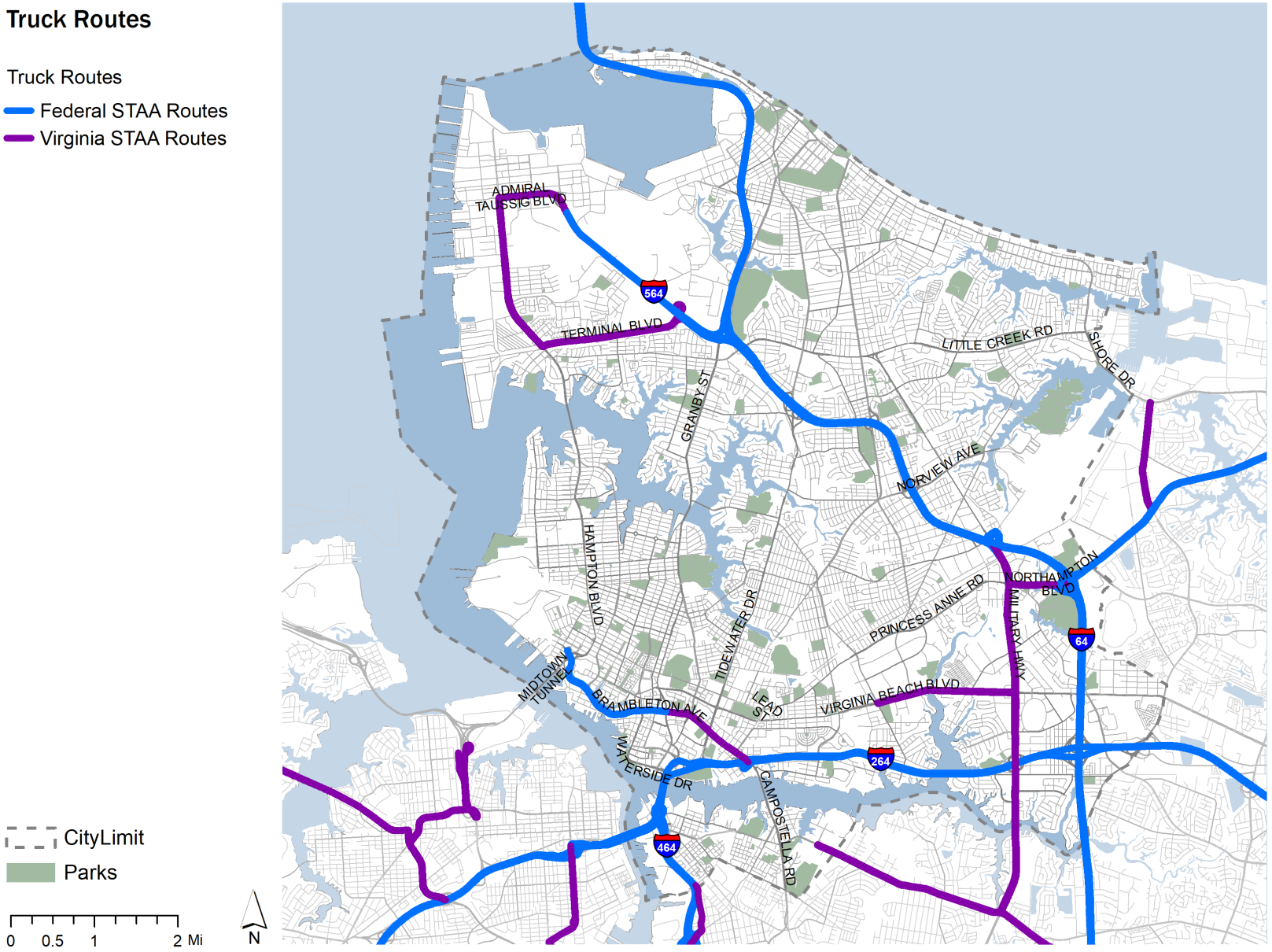
Existing Bicycle Facilities and Strategic Bike Plan Corridors

- Elizabeth River Trail
- Bike Lanes
- Sharrows
- Strategic Bike Plan Corridors



Data Source: City of Norfolk

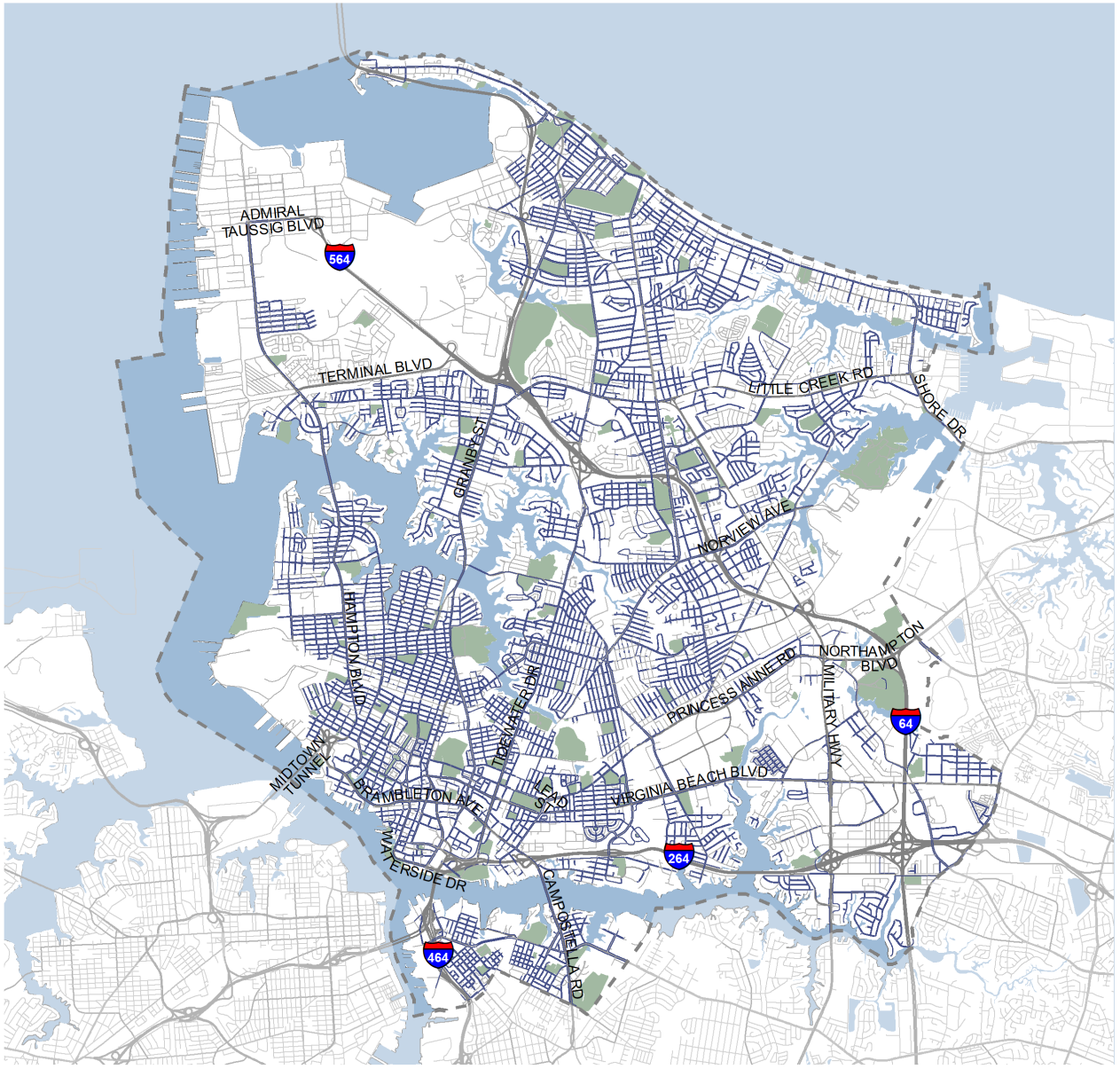
Truck Routes



Data Source: Virginia Department of Transportation

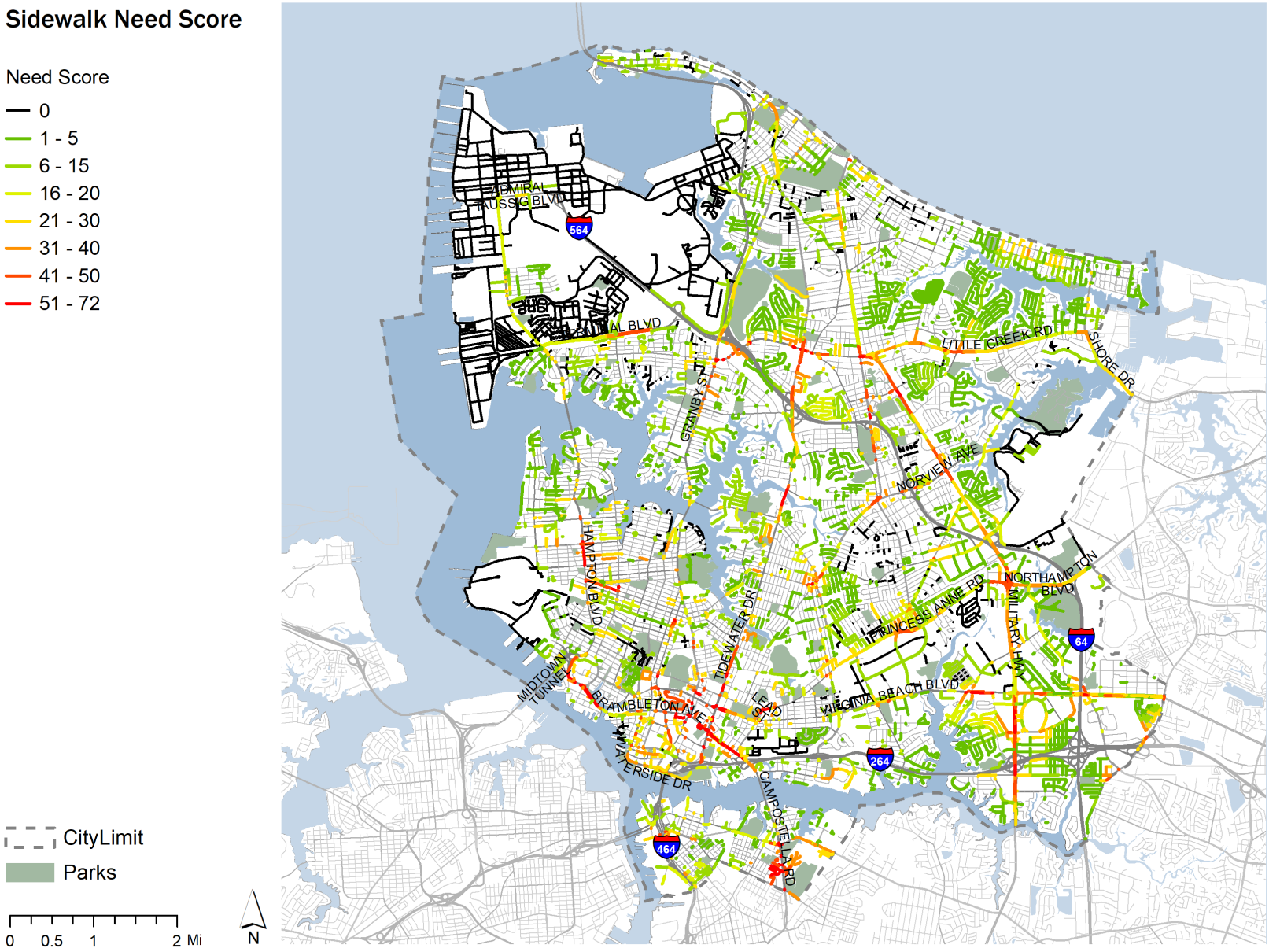
Sidewalks

Sidewalks



Data Source: City of Norfolk

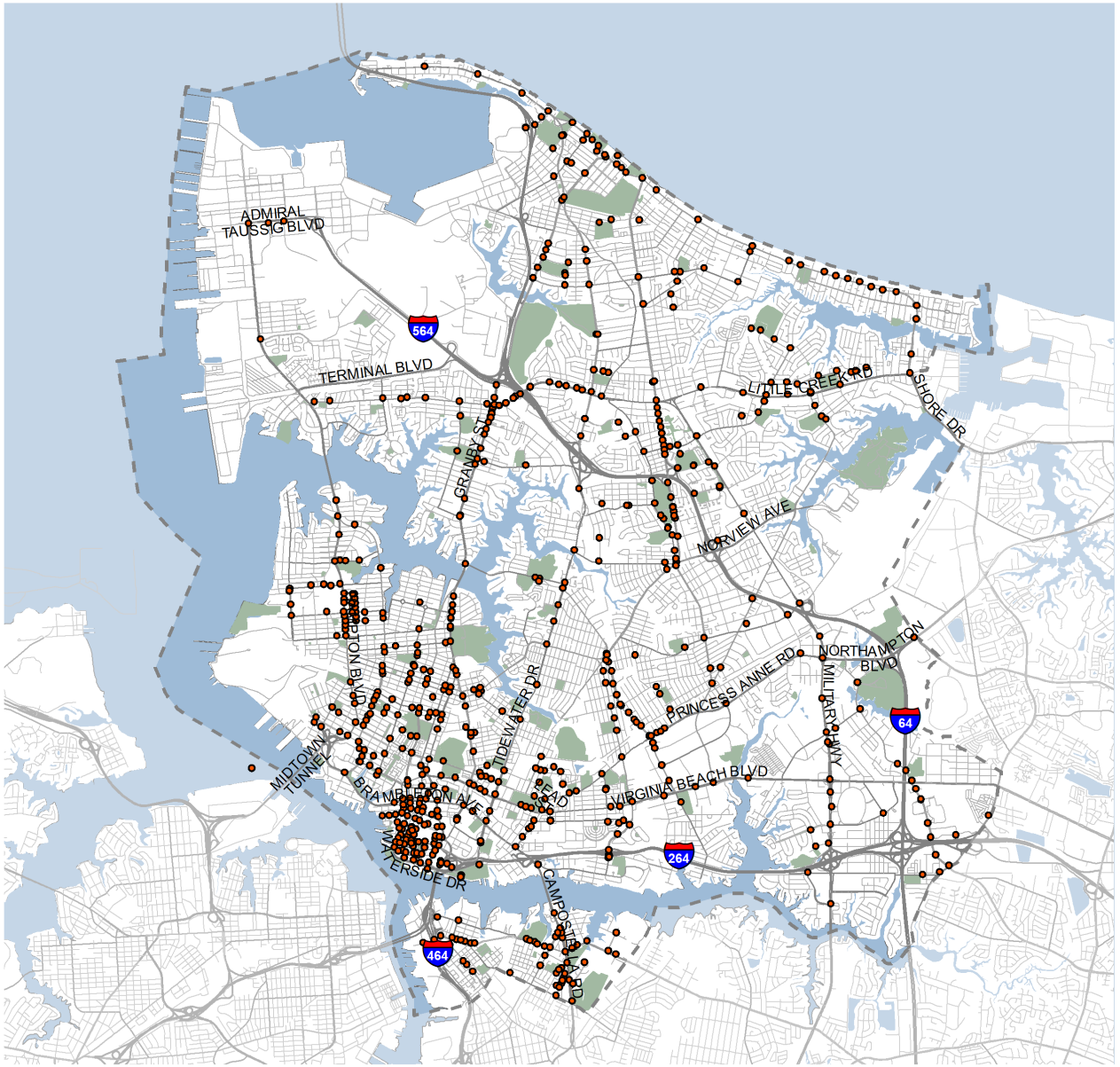
Sidewalk Need Score



Data Source: City of Norfolk

Crosswalks

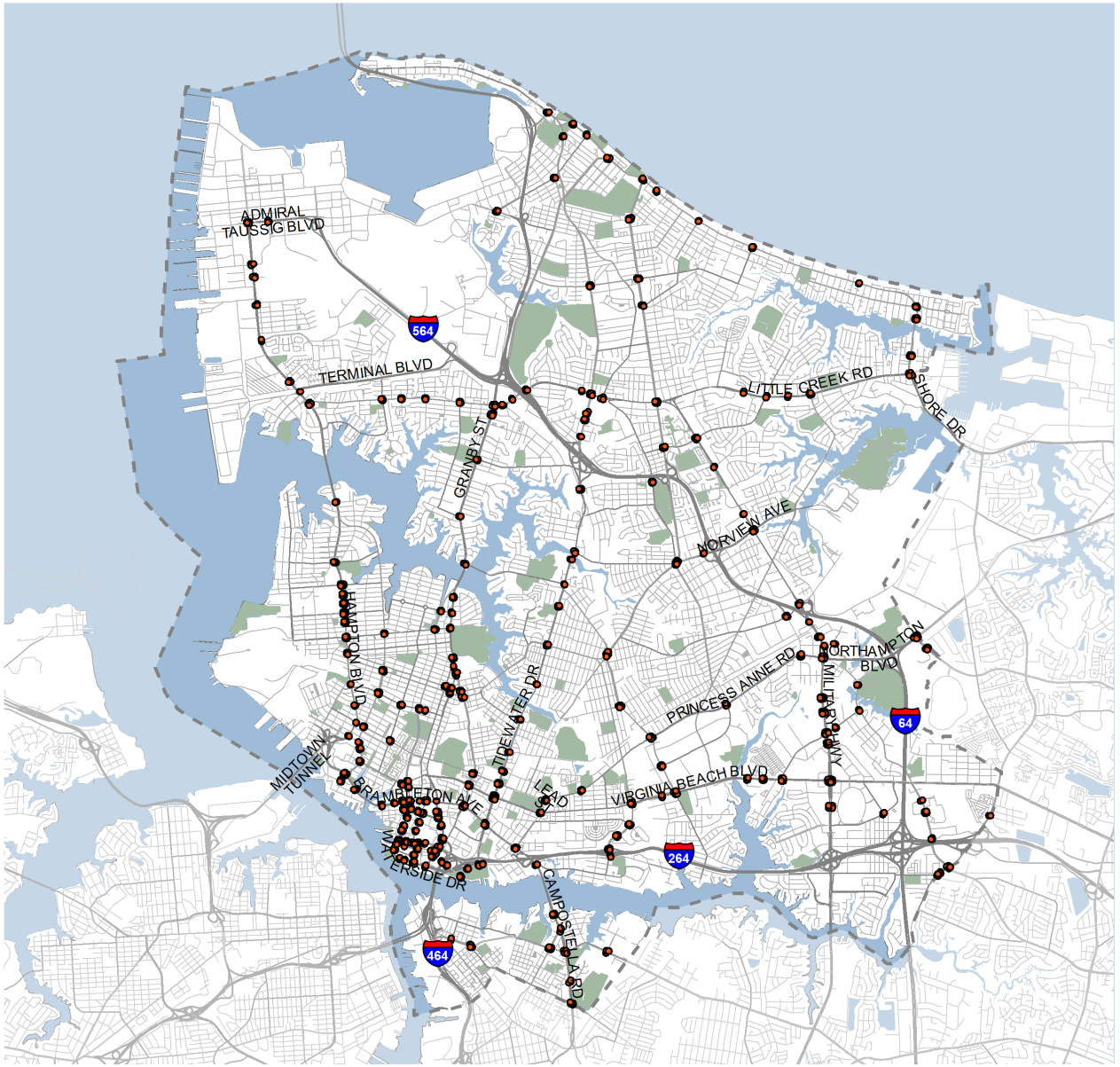
- Crosswalks



Data Source: City of Norfolk

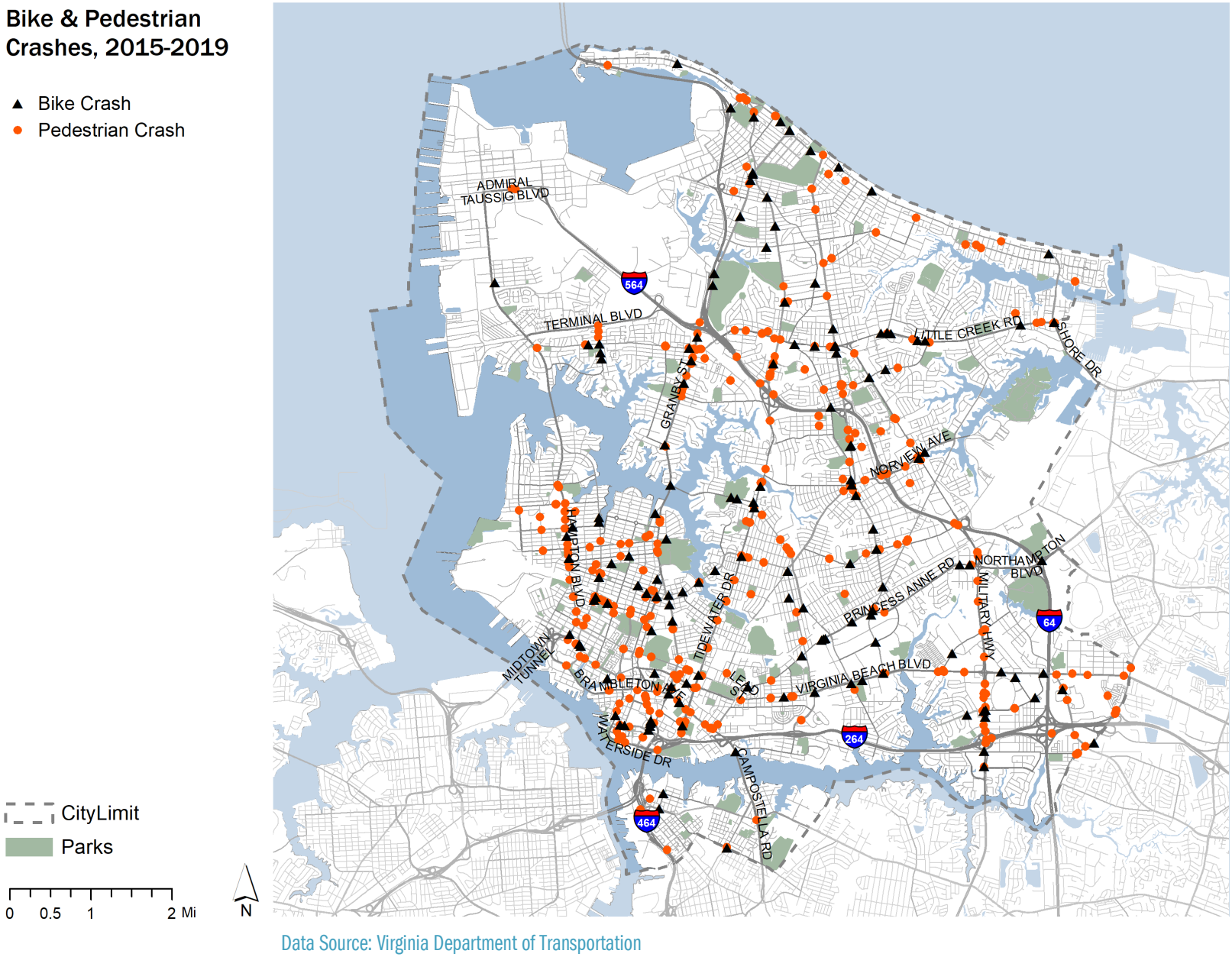
Pedestrian Signals

- Pedestrian Signals



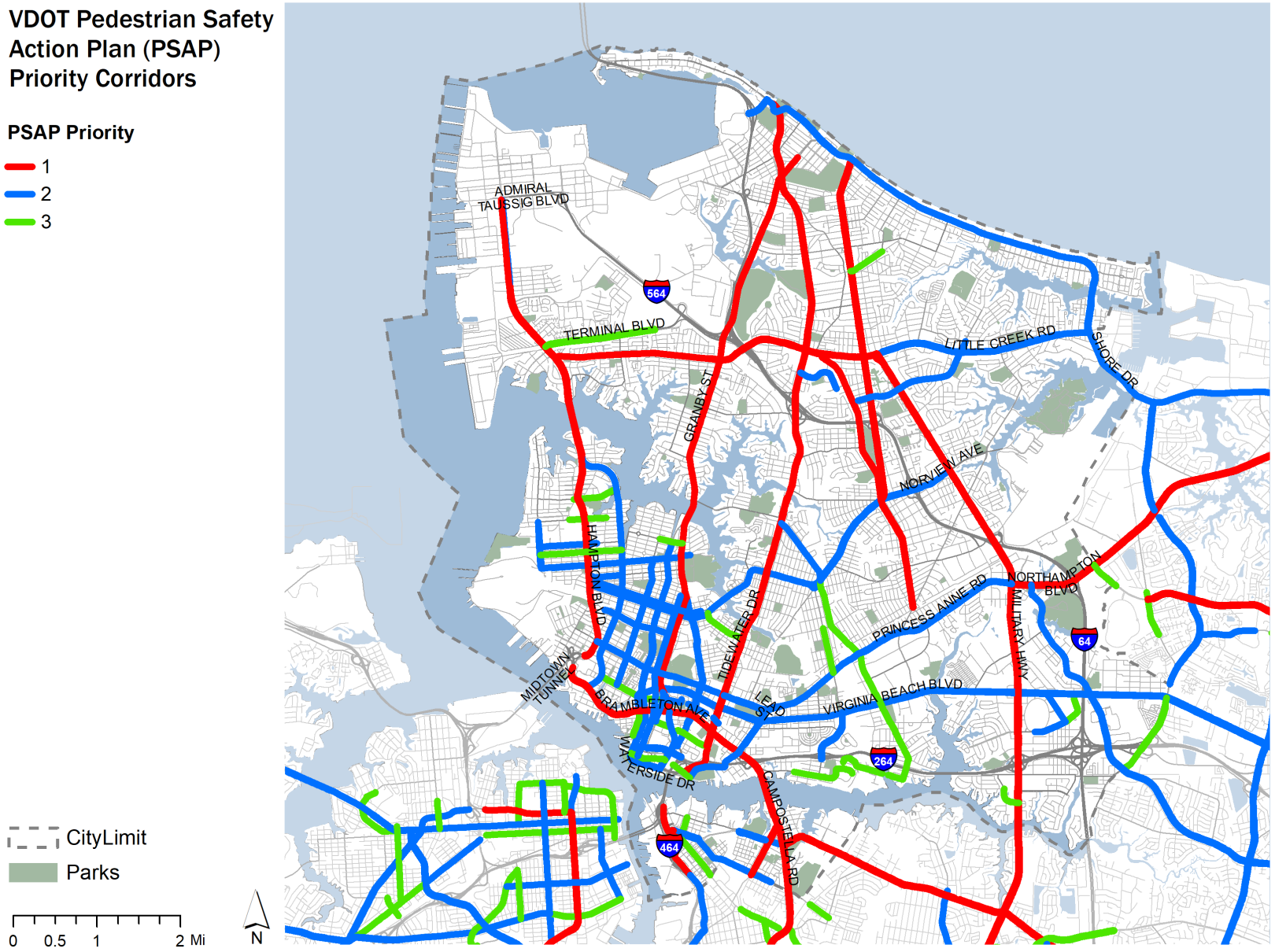
Data Source: City of Norfolk

Bike & Pedestrian Crashes, 2015-2019



Data Source: Virginia Department of Transportation

VDOT Pedestrian Safety Action Plan (PSAP) Priority Corridors



Data Source: Virginia Department of Transportation

Appendix C: Multimodal Corridor Design Matrix

Corridor Element Key		CORRIDOR MATRIX Multimodal System Design Guidelines - 2020 Update									
	Corridor Type ⇨	**Boulevard**									
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**	
⇩	**Context Zones & Corridor Elements ⇩**	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone										
A	BUILDING FRONTAGE ELEMENT	5 ft	3 ft	5 ft	3 ft	5 ft	2.5 ft	7 ft	1.5 ft	12 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear	rear	rear	rear	rear
	Typical building entry locations	front	front	front	front	front	front	front	front	front	front
	Roadway Edge Zone										
B	SIDEWALK THROUGH ELEMENT	10 ft	6 ft	10 ft	6 ft	8 ft	6 ft	6 ft	6 ft	6 ft	6 ft
C	AMENITY ELEMENT	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	9 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees	
	Roadway Zone										
D	CURBSIDE ACTIVITY ELEMENT										
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*										
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT										
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key	Corridor Type ⇨	Boulevard									
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2	
⇩	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
G	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speed	25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	Typical Traffic Volume Range (vehicles per day)	15,000 to 40,000		15,000 to 40,000		10,000 to 50,000		8,000 to 40,000		5,000 to 30,000	
	The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.										
	*2020 VDOT Road Design Manual***										
	Lane Widths	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speeds	30 - 40 mph		30 - 40 mph		30 - 40 mph		40 - 60 mph		40 - 60 mph	
	2018 AASHTO Green Book										
	Lane Widths	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
	Design Speeds	30 mph OR LESS		30 mph OR LESS		25 - 45 mph		25 - 45 mph		20 - 45 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft				
	Design Speeds	35 mph or less		35 mph or less		35 mph or less					
H	MEDIAN ELEMENT	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]

*The bicycle element treatments listed here are discussed in more detail in the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines). Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles**. These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines) for more information on required widths in different circumstances.

[3] Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Boulevards without transit modal emphasis should be minimized. (Refer to the **Corridor Matrix Annotation Document** for discussion.)

[4] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5] Section 7.3.3.2 of the 2018 AASHTO Green Book discusses considerations for lane widths on urban arterials. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Major Avenue											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	7 ft	3 ft	7 ft	3 ft	7 ft	2.5 ft	7 ft	2.5 ft	12 ft	2 ft	12 ft	2 ft
	Location of off street parking	rear	rear	rear	rear	rear	side	rear	side	rear	side	rear	side
	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	9 ft	6 ft	9 ft	6 ft	6 ft	6 ft	6 ft	6 ft	6 ft	5 ft	6 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	9 ft	6 ft	9 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type ⇨	**Major Avenue**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements ⇩**	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	Design Speed	25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph	
G	Number of Through Lanes	2 to 4		2 to 4		2 to 4		2 to 4		2 to 4		2 to 4	
G	Typical Traffic Volume Range (vehicles per day)	10,000 to 30,000		8,000 to 25,000		5,000 to 25,000		5,000 to 20,000		2,000 to 10,000		2,000 to 10,000	
G	*The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.*												
G	*2020 VDOT Road Design Manual***												
G	*Lane Widths*	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	*Design Speeds*	30 - 40 mph		30 - 40 mph		30 - 40 mph		30 - 60 mph		30 - 60 mph		30 - 60 mph	
G	*2018 AASHTO Green Book*												
G	*Lane Widths*	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
G	*Design Speeds*	35 mph OR LESS		35 mph OR LESS		25 - 45 mph		25 - 45 mph		45 mph OR LESS		45 mph OR LESS	
G	*Number of Through Lanes*	4 to 8		4 to 8		2 to 6		2 to 6		2 to 4		2 to 4	
G	*2013 NACTO Urban Street Design Guide*							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
G	*Lane Widths*	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft						
G	*Design Speeds*	35 mph or less		35 mph or less		35 mph or less							
H	MEDIAN ELEMENT	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None

*The bicycle element treatments listed here are discussed in more detail in the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines). Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines) for more information on required widths in different circumstances.

[3] Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Major Avenues without transit modal emphasis should be minimized. (Refer to the **Corridor Matrix Annotation Document** for discussion.)

[4] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5] Sections 6.3.2.1 and 7.3.3.2 of the 2018 AASHTO Green Book discuss considerations for lane widths on urban collectors and urban arterials, respectively. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Avenue											
	Corridor Type ⇨												
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2		T-1	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	8 ft	2.5 ft	8 ft	2.5 ft	8 ft	2.5 ft	10 ft	1.5 ft	15 ft	1.5 ft	15 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	side	rear	side	rear	side	rear	side
	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	8 ft	5 ft	7 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	8 ft	6 ft	7 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type ⇨	**Avenue**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements ⇩**	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	Design Speed	25-30 mph		25-30 mph		25-30 mph		25-30 mph		25-30 mph		25-30 mph	
	Number of Through Lanes	2 to 4		2 to 4		2 to 4		2 to 4		2 to 4		2 to 4	
	Typical Traffic Volume Range (vehicles per day)	2,000 to 20,000		2,000 to 15,000		1,500 to 10,000		1,000 to 10,000		1,000 to 5,000		1,000 to 5,000	
	The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.												
	*2020 VDOT Road Design Manual***												
	Lane Widths	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speeds	20 - 40 mph		20 - 40 mph		20 - 40 mph		20 - 60 mph		20 - 60 mph		20 - 60 mph	
	2018 AASHTO Green Book												
	Lane Widths	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
	Design Speeds	35 mph OR LESS		35 mph OR LESS		20 - 45 mph		20 - 45 mph		45 mph OR LESS		45 mph OR LESS	
	Number of Through Lanes	4 to 8		4 to 8		2 to 6		2 to 6		2 to 4		2 to 4	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft						
	Design Speeds	30 mph or less		30 mph or less		30 mph or less							
H	MEDIAN ELEMENT	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None

*The bicycle element treatments listed here are discussed in more detail in the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines). Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines) for more information on required widths in different circumstances.

[3] Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Avenues without transit modal emphasis should be minimized. (Refer to the **Corridor Matrix Annotation Document** for discussion.)

[4] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5] Sections 6.3.2.1 and 7.3.3.2 of the 2018 AASHTO Green Book discuss considerations for lane widths on urban collectors and urban arterials, respectively. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Local Street											
	Corridor Type ⇨												
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2		T-1	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	8 ft	2.5 ft	8 ft	2.5 ft	8 ft	2.5 ft	15 ft	1.5 ft	20 ft	1.5 ft	30 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear	rear	side	rear	side	rear	side
	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	5 ft	5 ft	5 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	6 ft	6 ft	6 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]
	Non-Separated Buffered Bike Lane	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]
	Separated Bike Lane (two-way)	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	*Not Recommended*		*Not Recommended*	
	Considerations	High congestion		High congestion		High congestion		High congestion					
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type ⇨	**Local Street**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements ⇩**	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]
G	Design Speed	25 mph		25 mph		25 mph		25 mph		25 mph		25 mph	
	Number of Through Lanes	2 to 4		2 to 4		2		2		2		2	
	Typical Traffic Volume Range (vehicles per day)	less than 10,000		less than 10,000		less than 8,000		less than 5,000		less than 2,000		less than 2,000	
	The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.												
	*2020 VDOT Road Design Manual***												
	Lane Widths	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]
	Design Speeds	20-30 mph		20-30 mph		20-30 mph		20-30 mph		20-30 mph		20-30 mph	
	2018 AASHTO Green Book												
	Lane Widths	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]
	Design Speeds	20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph	
	Number of Through Lanes	2 to 4		2 to 4		2		2		2		2	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [4]	10 ft	11 ft [4]	10 ft	11 ft [4]	10 ft						
	Design Speeds	30 mph or less		30 mph or less		30 mph or less							
H	MEDIAN ELEMENT	None	None	None	None	None	None	None	None	None	None	None	None

*The bicycle element treatments listed here are discussed in more detail in the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines). Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines) for more information on required widths in different circumstances.

[2] Travel lane width does not include the shy distance and curb or curb and gutter pan.

[3] Section 5.3.2.1 of the 2018 AASHTO Green Book discusses considerations for lane widths on local streets in urban areas. Lanes should preferably be 10 to 11 ft wide. Where the available or attainable width of right-of-way imposes severe limitations, 9-ft lanes can be used in residential areas.

[4] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Multimodal Through Corridor											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	15 to 25 ft	10 ft	15 to 25 ft	10 ft	20 to 35 ft	15 ft	25 to 35 ft	15 ft	30 to 45 ft	20 ft	30 to 45 ft	20 ft
	Location of off street parking	rear	front	rear	front	rear	front	rear	front	rear	front	rear	front
	Typical building entry locations	front/side	rear	front/side	rear	front/side	rear	front/side	rear	front/side	rear	front/side	rear
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	14 ft shared use path	5 ft sidewalk	14 ft shared use path	5 ft sidewalk	12 ft shared use path	5 ft sidewalk	12 ft shared use path	5 ft sidewalk	10 ft shared use path	5 ft sidewalk	10 ft shared use path	5 ft sidewalk
C	AMENITY ELEMENT	A minimum of 8 feet width is necessary between the face of the curb and the edge of the shared use path. Physical barriers, such as dense shrubbery, railings, or fencing may be placed between travel lanes and shared use path.								Shoulder and drainage ditch recommended instead of curb and gutter. Width between travel lanes and shared use path varies depending on speed. 20 to 28 ft for 60 mph design speed. 14 to 22 ft for 50 mph design speed.			
	Surface Treatment for Amenity Element												
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		On Street Parking Prohibited	
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]
	Non-Separated Buffered Bike Lane	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]
	Separated Bike Lane (two-way)	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key		Multimodal Through Corridor											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]
G	Design Speed	35 - 45 mph		35 - 45 mph		35 - 45 mph		35 - 55 mph		45 - 55 mph		45 - 55 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		2 to 4		2 to 4		2 to 4	
	Typical Traffic Volume Range (vehicles per day)	20,000 to 60,000		20,000 to 50,000		15,000 to 40,000		10,000 to 30,000		5,000 to 20,000		2,000 to 20,000	
	The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.												
	*2020 VDOT Road Design Manual***												
	Lane Widths	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]
	Design Speeds	30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph	
	2018 AASHTO Green Book												
	Lane Widths	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft	12 ft
	Design Speeds	30 mph OR LESS		30 mph OR LESS		25 - 45 mph		25 - 45 mph		30 - 55 mph		40 - 75 mph	
	Number of Through Lanes	4 to 8		4 to 8		4 to 6		4 to 6		2 to 4		2 to 4	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [7]	10 ft	11 ft [7]	10 ft	11 ft [7]	10 ft						
	Design Speeds	35 mph or less		35 mph or less		35 mph or less							
H	MEDIAN ELEMENT	18 ft [3],[4]	17 Ft [3],[4]	18 ft [3],[4]	17 Ft [3],[4]	18 ft [3],[4]	17 Ft [3],[4]	18 ft [3],[4]	None	40 ft[4]	None	40 ft[4]	None

*The bicycle element treatments listed here are discussed in more detail in the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines). Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

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[1] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See the **Corridor Matrix Annotation Document** (Appendix B of DRPT's Multimodal System Design Guidelines) for more information on required widths in different circumstances.

[2] Travel lane width does not include the shy distance and curb or curb and gutter pan.

[3] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[4] Median width does not include accommodation for transit in the median. If transit runs in the median, the width will vary based upon detailed design.

[5] Section 7.3.3.2 of the 2018 AASHTO Green Book discusses considerations for lane widths on arterials in urban areas. Lane widths may vary from 10 to 12 ft. The 12-ft lane widths are desirable, where practical on high-speed, free-flowing, principal arterials. However, Section 7.3.2.1 indicates design speeds for arterials are generally 30 mph or less in the urban core context, 25 to 45 mph in the urban context, and 30 to 55 mph in the suburban context.

[6] 10-ft widths may be used if speeds are less than 35 mph and truck and bus volumes are relatively low. (Section 7.3.3.2 in 2018 AASHTO Green Book)

[7] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

The Multimodal Corridor Design Matrix shown here is from the Multimodal System Design Guidelines, published by the Virginia Department of Rail and Public Transportation.

Appendix D: Freight Design Considerations

Context of Freight Planning in Norfolk

Norfolk is an international shipping hub and home to the Port of Virginia's largest facility, the Norfolk International Terminal, as well as the Norfolk Naval Shipyard. Although much of the freight that moves through Norfolk does so on ships, trains, and trucks on the interstate highways, a significant amount of freight does pass through Norfolk's streets.

The two main categories of freight that affect Norfolk's multimodal transportation system are:

- Regional freight using the City's streets, and
- Local deliveries.

In Norfolk, both categories of freight are growing. Inter- and intraregional freight is growing thanks to Hampton Roads' strategic location where 40 percent of the US population and 128 million consumers are located within one day's drive.[i] Local deliveries are growing thanks to continued growth in e-commerce and a continuing trend of faster deliveries.

The design considerations in this chapter focus on addressing the first category of freight – regional freight movement that consists typically of larger trucks that travel on Norfolk's streets, but do not stop to make local deliveries. The second category of freight – local deliveries – is addressed in Chapter 9.

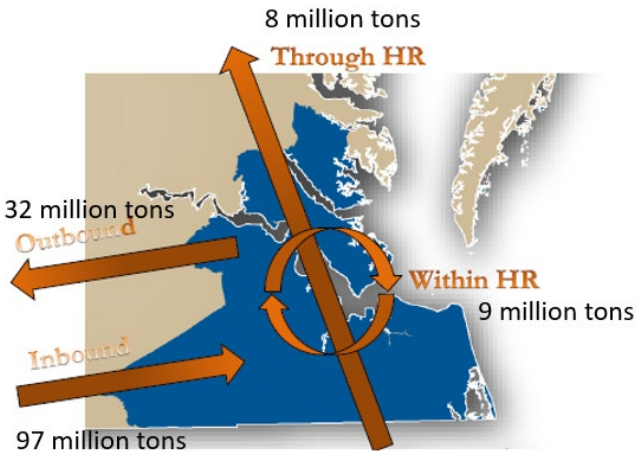
Freight is a huge driver of Norfolk's economy, and there is a complex web of freight planning that happens at the national, state, and regional scale beyond Norfolk's city limits.

Federal Context

At the national level, the U.S. Department of Transportation prepares a National Freight Strategic Plan and designates a National Multimodal Freight Network. The National Multimodal Freight Network is designated to inform freight planning, assist in the prioritization of federal investment, assist states in directing resources toward improved system performance for the efficient movement of freight.

Federal transportation legislation (the FAST Act) lays out requirements for states and MPOs to establish performance targets, including truck travel time reliability on the interstate system.

There is also a National Network of interstate highways and certain primary routes that large trucks like twin-trailers and triple saddlemounts are allowed to operate on per the Surface Transportation Assistance Act of 1982 – this network is also called STAA truck routes.



The Hampton Roads region has a variety of assets and unique characteristics that make it a strategic point of entry and transfer for goods movement. Image Source: HRTPO

State Context

States are required, per the FAST Act, to develop a state freight plan. The Virginia Freight Element of VTrans2040 is Virginia's state freight plan. It identifies freight system trends, needs, and issues; inventories facilities with freight mobility issues; and describes freight policies, strategies, and performance measures that will guide the state's freight-related transportation investment decisions

States also designate Critical Freight Corridors to be included in the National Multimodal Freight Network, where federal resources will be directed for improved freight system performance.

There is also a STAA Network of truck routes at the state level, and DRPT prepares a Statewide Rail Plan that addresses freight movement on privately-owned railways.

Regional Context

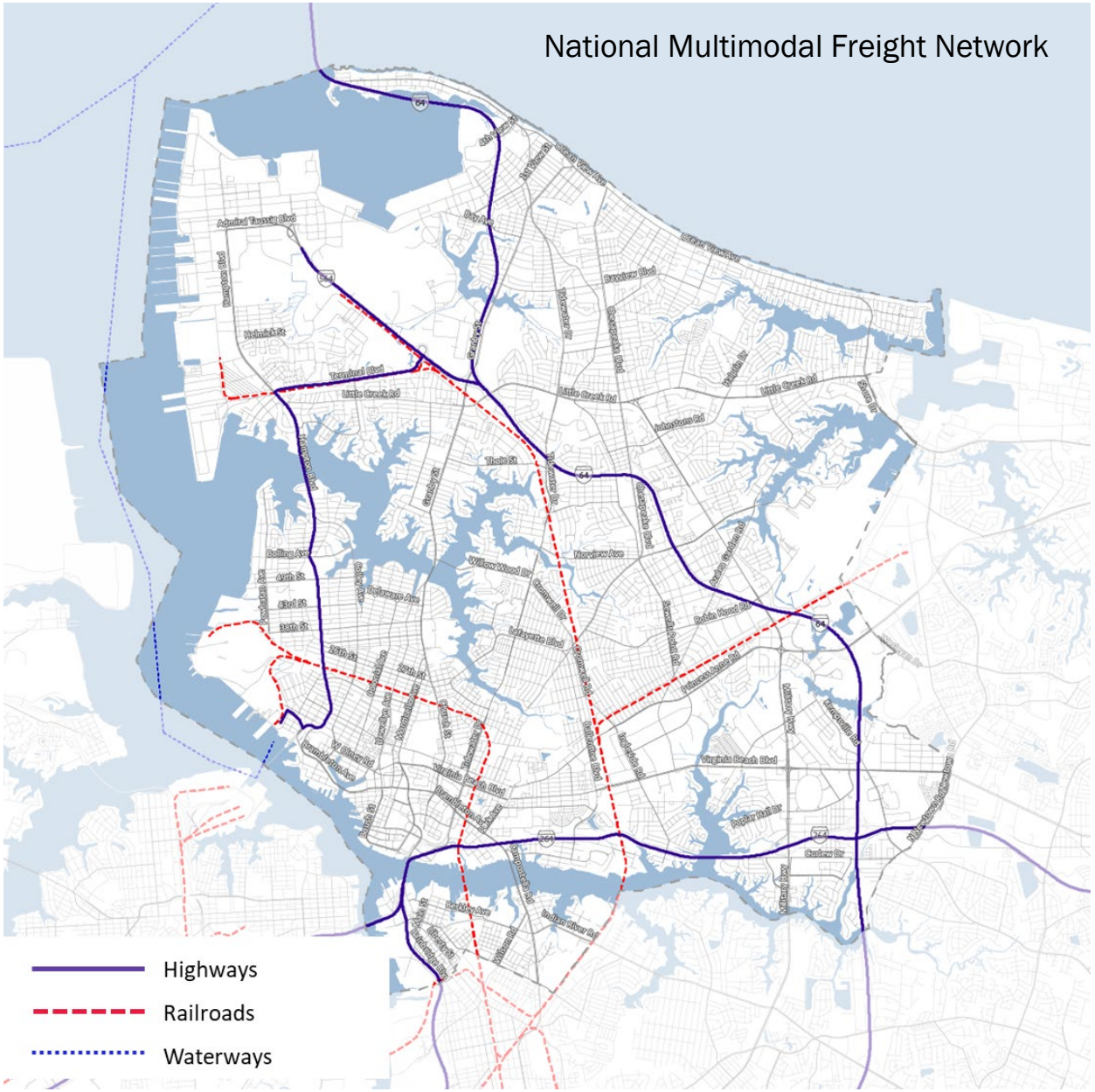
Within the Hampton Roads region, the Hampton Roads Transportation Planning Organization conducts a variety of freight studies, integrates freight into the organization's long- and short-term transportation planning processes, and hosts the Freight Transportation Advisory Committee.

The Port of Virginia and the Navy are private entities whose decisions greatly influence freight patterns and generate freight trips

Local Context

Although the Code of Virginia gives the City of Norfolk authority to prohibit and restrict trucks on roads within its jurisdiction, the feasibility of enacting truck restrictions and prohibitions is complicated.

The City of Norfolk also has authority to design its streets, which can influence the level of accommodation that is provided for large trucks.



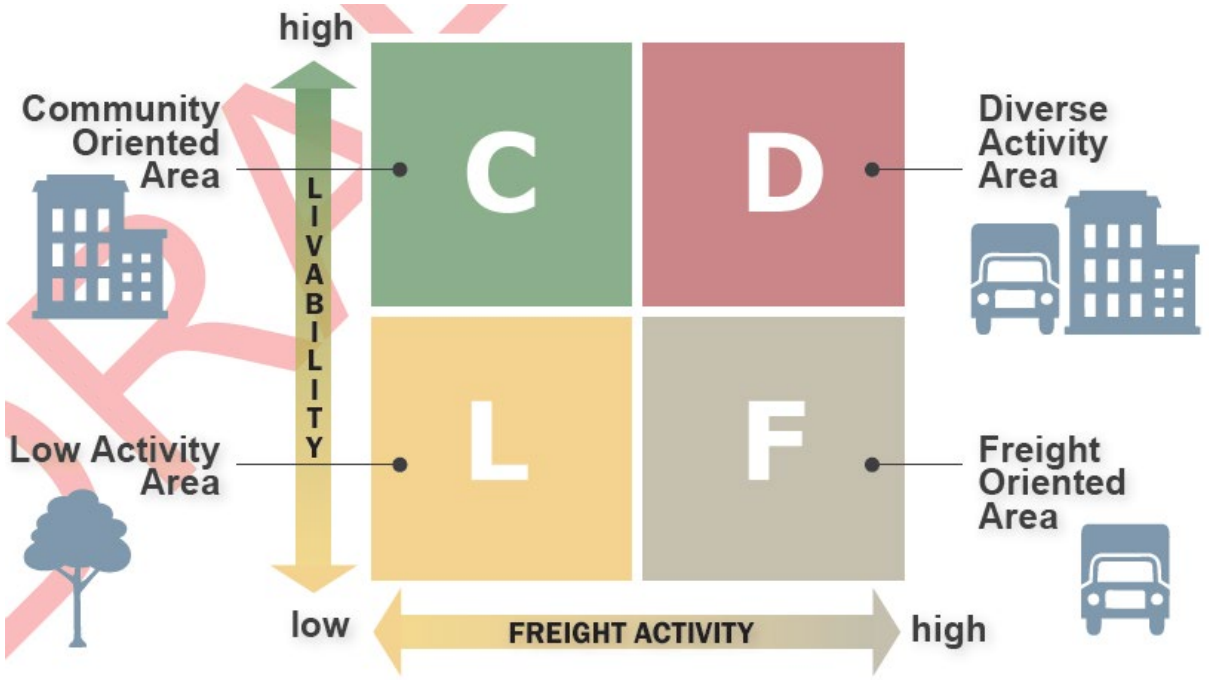
The National Multimodal Freight Network includes highways, railroads, and waterways that are designated by states as critical freight corridors. The National Multimodal Freight Network informs freight planning, assists in the prioritization of federal investment, and assists states in directing resources toward improved system for the efficient movement of freight.

A Framework for Designing for Community Context and Freight Activity

The freight considerations in this chapter use a framework for freight planning and design from a few best practice resources:

- *Tampa Bay Regional Strategic Freight Plan*,[ii] the first plan of its kind to integrate freight activity needs with land use compatibility and community livability
- *Freight Roadway Design Considerations*,[iii] a comprehensive resource for context-sensitive freight design with strategies and guidance for designing corridors and intersections in a variety of land use contexts

Both resources describe a framework for simultaneously considering the intensity of goods movement and the importance of land use patterns and community livability. As shown in the graphic to the right, there is a spectrum of level of freight activity and a perpendicular spectrum of community livability.



Different areas have varying characteristics and functions related to freight activity and community livability. This diagram shows a two-dimensional matrix with freight activity on one axis and community livability on the other. Depending on the combination of freight activity and community livability, areas can be categorized into four different area types. Image Source: *Freight Roadway Design Considerations*, Florida Dept. of Transportation.

Areas can generally fall into four corresponding categories:

- Community-Oriented Areas
- Freight-Oriented Areas
- Diverse Activity Areas
- Low Activity Areas

Community-Oriented Areas are areas where the level of bicycling and pedestrian activity is expected to be relatively high and through truck traffic relatively low. The purpose of these areas is to promote a high level of activity, with a variety of destinations, both residential and non-residential, within walking and bicycling distance.

Freight-Oriented Areas are primarily in industrial areas, including seaports, shipbuilding areas, warehousing, and distribution centers with few if any residential and non-industrial uses where freight activity is high.

Diverse Activity Areas are areas that have an important function for community livability and are also areas where freight movement is important.

Low Activity Areas are generally rural areas whose land use generates low volumes of traffic, including truck traffic.

Design considerations for freight and goods movement on multimodal corridors vary for each area type category.

Correlating Norfolk's Multimodal System Plan to the Freight Activity and Community Livability Area Types

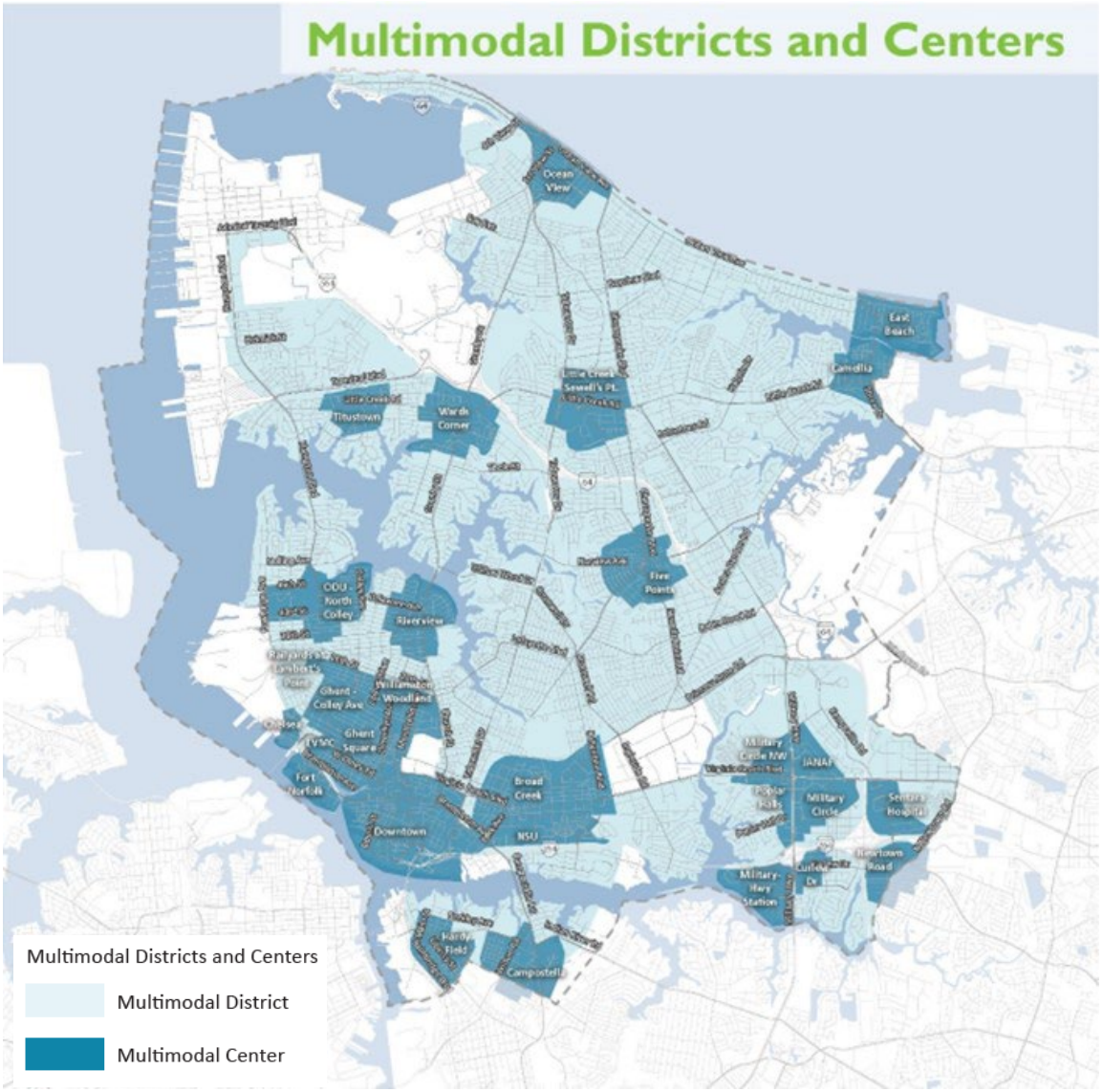
As explained in the Multimodal System Plan in Chapter 4, areas in the City of Norfolk can be generally classified into three broad categories:

- Multimodal Centers
- Multimodal Districts
- Areas outside of Multimodal Districts

For the purposes of freight considerations for multimodal corridor design, these three types of areas from the Multimodal System Plan correspond to three of the four area types in the framework for freight activity and community livability.

- Multimodal Centers generally correspond to Community-Oriented Areas
- Areas outside of Multimodal Districts generally correspond to Freight-Oriented Areas
- Multimodal Districts generally correspond to Diverse Activity Areas

No areas within Norfolk are considered to correspond to Low Activity Areas.



As explained in Chapter 4, areas in the City of Norfolk can generally be classified into three broad categories – Multimodal Centers, Multimodal Districts, and areas outside of Multimodal Districts.

By understanding the various roles a specific multimodal corridor and its surrounding area serve within the Multimodal System Plan, within the network of regional freight activity, and for community livability, designers can select appropriate design strategies that properly balance truck movement needs with the needs of other road users.

The Tampa Bay Regional Strategic Freight Plan provides several intersection design strategies in each area type, which are presented in the following sections. The Freight Roadway Design Considerations document provides a wealth of additional information and design guidance that greatly expands upon these design strategies.

*Designers should reference the **Freight Roadway Design Considerations**, published by the Florida Department of Transportation, for more detailed guidance on the following design strategies for freight considerations.*

Although the *Freight Roadway Design Considerations* was prepared by the Florida Department of Transportation, it is the most comprehensive resource for freight design considerations, and the guidance therein is applicable to all areas within the U.S., not just Florida.

The following pages contain excerpts from the Tampa Bay Regional Strategic Freight Plan, as appropriate for the Norfolk context.

Freight Design Considerations in Freight-Oriented Areas

Intersections in Freight-Oriented Areas should be designed to optimize the operational efficiency of trucks. This is particularly important where two facilities on the freight network meet but applies generally to all intersections.

The following design strategies may be applicable to multimodal corridors with special freight considerations in areas outside of Multimodal Districts.



The graphic above demonstrates recommended strategies for intersection design in Freight-Oriented Areas. Image Credit: *Tampa Bay Regional Strategic Freight Plan.*

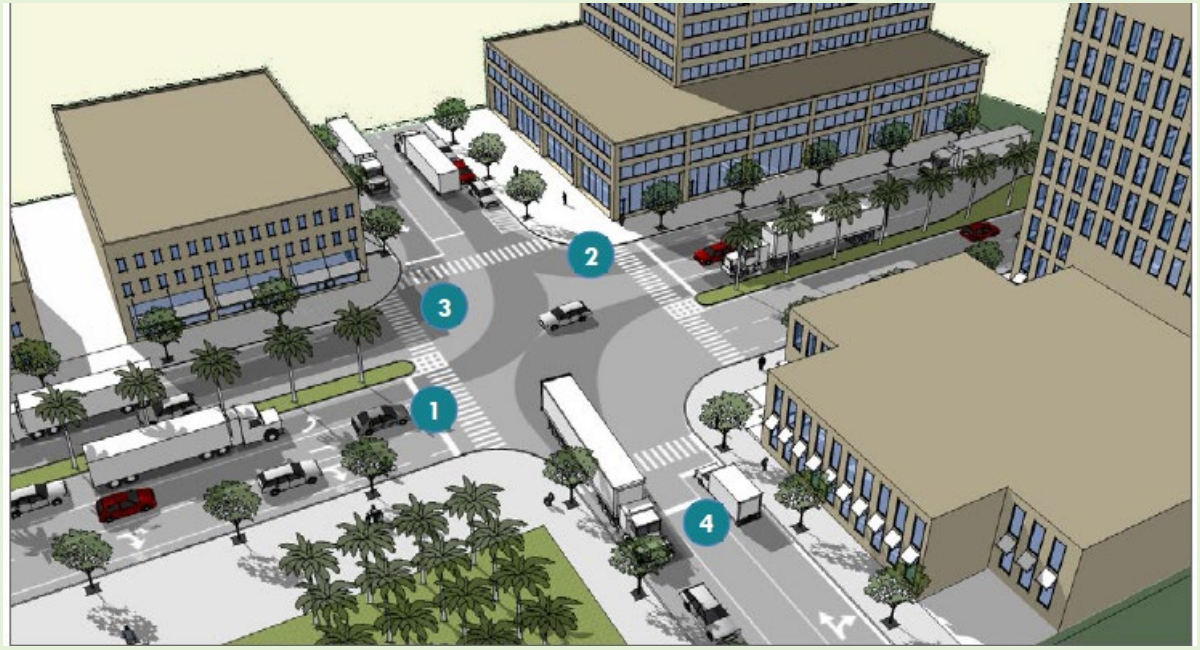
1. **Truck channels** facilitate right turn movements for trucks while providing space for pedestrian refuge and signal poles and equipment. They give the truck storage space that is outside the departing through lane for the yield condition, creating better operating and safety conditions for through traffic.
2. **Median nosings** can be designed to allow additional space for trucks making left turns on or off the mainline facility. They assist trucks in departing left turn lanes and entering receiving lanes. They can be set back from the crosswalk further than normal or striped, depending on the width of the median and the need to guide vehicles into a particular turning pattern.
3. **Left turn lanes** should be designed as single lanes where volumes and the intersection signal phasing and timing strategy support it. Dual lefts can be problematic for traffic in adjacent lanes and opposing traffic in the middle of the intersection where the truck wheel tracking distance is the greatest. Dual lefts can also make it difficult for trucks to enter the receiving lane.
4. **Extended left turn lanes** provide additional storage for trucks and other vehicles. Signal timing and phasing should be designed to allow for processing slower-moving trucks.
5. **Corner radii** should be designed to accommodate trucks turning on and off the mainline facility. In some cases, trucks can use two receiving lanes to complete the turn and each intersection radius can be sized accordingly.

Credit: Tampa Bay Regional Strategic Freight Plan, Florida Dept. of Transportation.

Freight Design Considerations in Community-Oriented Areas

Intersections in Community-Oriented Areas should be designed to accommodate trucks while optimizing the roadway operations for other vehicles and facilitating safe, comfortable and convenient pedestrian access. These areas often have constrained rights-of-way, a limited number of through lanes and shared turn lanes. Roadways should be designed so that smaller trucks can operate. Larger trucks need to be anticipated on the mainline facility but may not be the appropriate design vehicle for side street conditions and turns due to physical limitations or lack of need due to very low large truck volumes.

The following design strategies may be applicable to multimodal corridors with special freight considerations in Multimodal Centers.



The graphic above demonstrates recommended strategies for intersection design in Community-Oriented Areas. Image Credit: *Tampa Bay Regional Strategic Freight Plan.*

1. **Median nosings** can be set back from the crosswalk further than normal on facility where large truck turns are anticipated. Extended median nosings with crosswalks in advance of the nosing do not typically interfere with small truck turning movements.

2. **Curb extensions/bulb outs** and **on-street parking** should be avoided in the portions of receiving lanes that would allow for expanded outside wheel tracking. Providing this space makes it easier for trucks to turn right and left off the mainline facility onto the side street. On street-parking should be avoided on mainline facilities on the Freight Network.

3. **Corner radii** should be designed to accommodate larger trucks on and off the mainline facility at intersections with other facilities on the Freight Network and at major arterials. Radii should be designed to accommodate smaller trucks turning on and off the mainline facility at secondary side streets.

4. **Stop bar setbacks** allow for larger trucks to make left turns from the mainline facility onto the side street by providing more space for inside wheel tracking. Depending on the departure lane and corner condition, they can also help facilitate right turns from the mainline facility onto the side street. The stop bar can be staggered for multiple lane approaches with no median such that only the stop bar on the outside lane is set back from the crosswalk.

Credit: Tampa Bay Regional Strategic Freight Plan, Florida Dept. of Transportation.

Freight Design Considerations in Diverse Activity Areas

Intersections in Diverse Activity Areas should be designed to facilitate truck movements while balancing the needs of other users of the roadway. This often has to occur in constrained rights-of-way where established curb lines, existing infrastructure and equipment and limited right-of-way widths shape truck-friendly solutions.

The following design strategies may be applicable to multimodal corridors with special freight considerations in Multimodal Districts.



The graphic above demonstrates recommended strategies for intersection design in Diverse Activity Areas. Image Credit: *Tampa Bay Regional Strategic Freight Plan.*

1. **Corner radii** should be designed to accommodate trucks turning on and off the mainline facility while maximizing the use of receiving lanes to complete the turn. Tapered curbs and multiple-radius curbs can be used in lieu of increasing a single radius curb to accommodate the truck turn.
2. **Tapered medians** or **expanded receiving lanes** on the side street provide additional turning space where the receiving lanes are inadequate and/or where the corner radius cannot or should not be increased. Tapered medians and expanded receiving lanes do not increase the crossing distance for pedestrians like increased corner radii do. They also do not require additional right-of-way in retrofit conditions.
3. **Tapered curbs** can expand the area for trucks to make left and right turns from the mainline facility to the side street. They do increase the crossing distance for pedestrians. Tapered curbs need to be considered as retrofits in light of a number of conditions, including right-of-way, sidewalk width, drainage and location of equipment.
4. **Bicycle lanes** provide a secondary benefit for trucks beyond their primary function. When trucks are turning right out of a shared through lane, the offset from the curb provides the truck more room to turn by shifting the inside wheel tracking away from the corner radius. When present on the side street, bicycle lanes increase the effective receiving area width.

Credit: Tampa Bay Regional Strategic Freight Plan, Florida Dept. of Transportation.

The design strategies just presented are not a one-size-fits-all set of strategies that must always be employed on every multimodal corridor in each area type.

These design strategies may apply to multimodal corridors with special freight considerations, but careful consideration should be given to the amount of truck traffic on an individual road, the specific land uses on that block, and the role that road plays in the larger regional freight network.

For example, Hampton Boulevard is envisioned to be a Placemaking corridor in the Multimodal System Plan. It traverses several Multimodal Centers with high levels of non-motorized activity, including Downtown and Old Dominion University. And yet, it is one of the most highly used corridors for trucks to connect from Naval Station Norfolk and Norfolk International Terminals to the Portsmouth Marine Terminal, Pinners Point Container Yard, and other major industrial land uses in Portsmouth. Design strategies on Hampton Boulevard may include a range from all three area types presented in this chapter, depending on the unique context and adjacent land use needs.

Design decisions on corridors like Hampton Boulevard are likely to impact a wide array of stakeholders, and in addition to the design considerations presented here, outreach and communication with the variety of stakeholders during the design process will be critical to identifying key tradeoffs and determining the best design solution.

[i] Hampton Roads Alliance, 2016. "About Hampton Roads." *http://www.hreda.com/map-center/?map=majorcities*

[ii] Florida Department of Transportation District Seven, 2018. *Tampa Bay Regional Strategic Freight Plan*. Retrieved Jan 6, 2021 from https://tampabayfreight.com/strategic-freight-plan-web-document.

[iii] Florida Department of Transportation District Seven, 2015. *Freight Roadway Design Considerations*. Retrieved Jan 6, 2021 from https://tampabayfreight.com/frdc.

Appendix E: Pedestrian Crossing Design Considerations

The Bicycle and Pedestrian Master Plan in Chapter 5 identifies the network of existing pedestrian facilities in Norfolk and highlights existing sidewalk gaps and streets where marked pedestrian crossings are spaced far apart. Specific recommendations for new and improved pedestrian facilities are included in the program of projects in Chapter 13.

The following sections provide best practices for designing pedestrian crossings on multimodal corridors at intersections and mid-block locations.

Pedestrian Crossing Design Considerations at Intersections

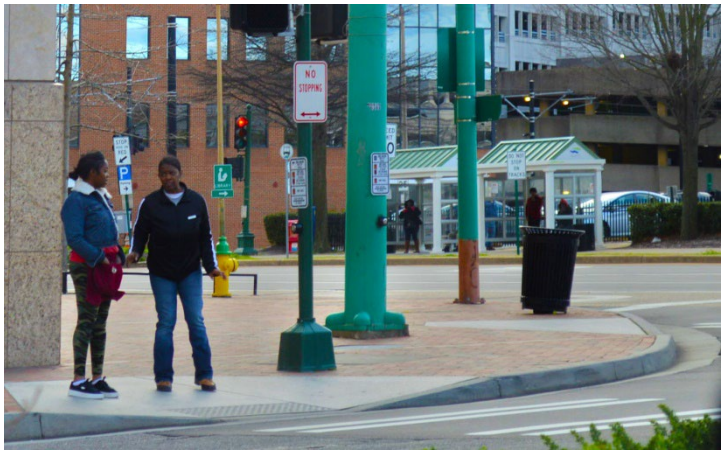
Intersections are areas of complex interaction between different modes and between different movements. When designing pedestrian facilities at intersections, designs should focus on providing clear and safe paths for pedestrians to cross the street and making pedestrians as visible as possible to oncoming vehicles from all directions. Pedestrian safety and visibility should be considered paramount to vehicular throughput.

The following elements are key to designing safe pedestrian crossing facilities at intersections. The design guidance presented here comes from a combination of industry-standard resources, including:

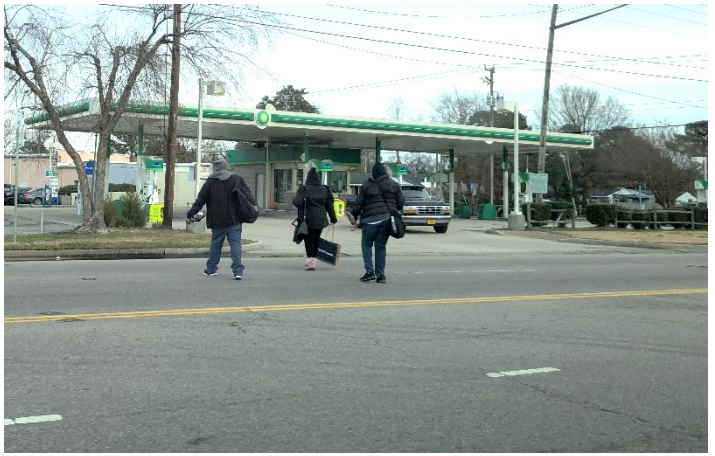
- *Multimodal System Design Guidelines* published by the Virginia Department of Rail and Public Transportation and last updated in 2020.
- *Manual on Uniform Traffic Control Devices* published by the Federal Highway Administration[i]
- *Urban Street Design Guide* published by the National Association of City Transportation Officials

Crosswalks at Signalized Intersections

Marked crosswalks are one of the most critical elements for pedestrian safety. 87 percent of pedestrian crashes that resulted in injury or fatality in Virginia in 2016 occurred at locations where no marked crosswalk was present.[ii]



Designing pedestrian crossing facilities on multimodal corridors requires a focus on providing clear and safe paths for pedestrians to cross the street and making pedestrians as visible as possible to oncoming vehicles from all directions.



Pedestrians cross Military Highway just north of Azalea Garden Road.

Crosswalks should be striped on all approaches at all signalized intersections along all Multimodal Corridors, unless a particular approach leads to a roadway where pedestrians are prohibited.

Accessible pedestrian countdown crossing signals indicate how much time is left during the 'flashing don't walk' phase and provide audible and vibratory cues for pedestrians who are visually impaired or hearing impaired. More information on pedestrian crossing signals is provided in a subsequent section.

Crosswalks at Unsignalized Intersections

Generally, marked crosswalks are recommended at stop-controlled and yield-controlled intersections where traffic volumes exceed 3,000 vehicles per day, speeds exceed 20 mph, or there are more than two vehicle lanes.[iii]

Marked crosswalks may not be necessary on lower volume and lower speed streets with few lanes. However, designers must use professional judgment considering multiple factors including land uses, present and future demand, pedestrian compliance, speed, safety, and crash history.[iv] VDOT's *Pedestrian Crossing Accommodations at Unsignalized Locations* Instructional and Informational Memorandum[v] (VDOT IIM TE-384) provides additional guidance on when to install marked crosswalks across stop-controlled and yield-controlled approaches.

Marked crosswalks alone may not be sufficient at unsignalized intersections with higher speeds, higher traffic volumes, and more than two vehicle lanes. VDOT IIM TE-384 provides recommendations for identifying situations where marked crosswalks alone are insufficient - generally roads with posted speed limits of 40 mph or greater, or with more than 15,000 vehicles per day, although there are variations depending on the number of lanes and the specific combination of speed and volume. When marked crosswalks alone are insufficient, warning signs, warning signals, geometric improvements, traffic calming improvements, safety islands, or some combination thereof may be needed.





An overhead pedestrian warning sign accompanies the traffic signal.

Crosswalk Pavement Markings

The figure to the right shows different types of crosswalk markings that are mentioned in various design guidance resources.

Continental, Bar Pairs, Zebra, and Ladder crosswalk markings are all considered to be "high visibility" crosswalk markings.

Studies have shown that high visibility crosswalk markings improve pedestrian safety because they are more visible to motorists and improve driver yielding behavior.[vi, vii]

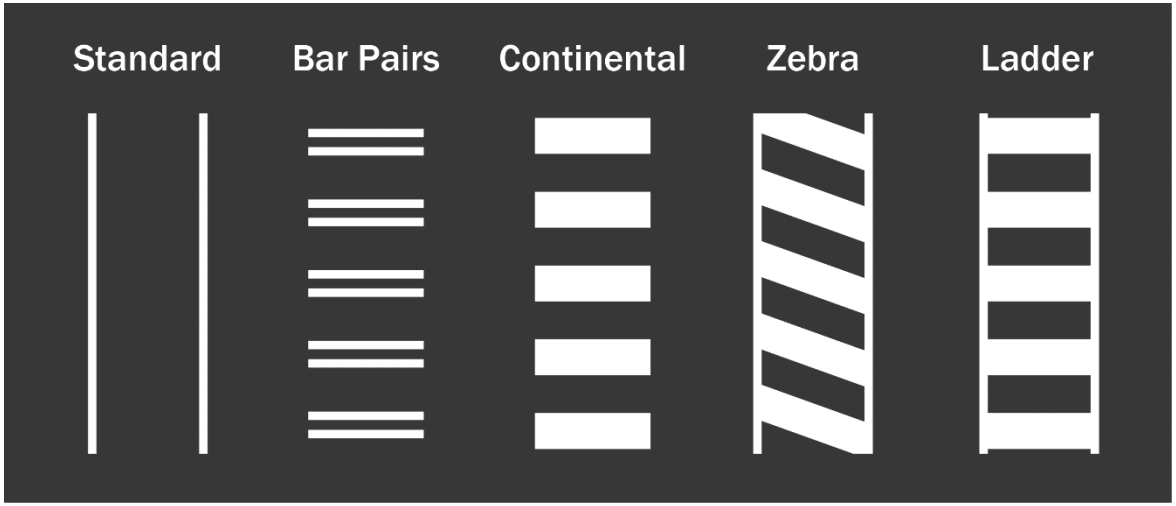
VDOT permits three types of crosswalk markings on VDOT-maintained roadways:

- Standard (aka Transverse Lines)
- Continental (aka Longitudinal Lines)
- Bar Pairs

Zebra and Ladder crosswalk markings have transverse side stripes, which can require increased maintenance. Continental and Bar Pairs lack the side strips, and can be installed such that wheel paths avoid the longitudinal stripes.

Although any type of high visibility crosswalk markings are preferred from a pedestrian safety standpoint, Continental and Bar Pairs may be most preferable because they require lesser main tenance.

Aesthetic treatments, such as StreetPrint pavement texturing that simulates brick lattice and mosaic stone designs through stamped asphalt are another option for crosswalk markings and may be desired to match the surrounding streetscape motif.



Continental and Bar Pairs are the two types of high visibility crosswalk markings that VDOT permits on VDOT-maintained roads. This diagram illustrates other types of crosswalk markings. VDOT permits Standard markings on VDOT-maintained roads, but they are not high-visibility. Zebra and Ladder are two other types of high-visibility crosswalk markings; these have increased maintenance needs since vehicle wheel paths cannot avoid the side stripes.



Bar Pairs are a common crosswalk marking type in Norfolk.



Stamped asphalt treatments with brick designs are common in downtown Norfolk.

A brick or stone alone, however, does not provide enough contrast with the asphalt to draw drivers' attention. The white transverse (i.e. parallel) lines must be

present on the outside of the crosswalk and should be retroreflective.

The design within the transverse lines should be uniform and repetitive patterns, monotone earth tones, and non-retroreflective. FHWA guidance states that designs that have bright or multiple colors, display symbols, or represent artwork should not be used for crosswalk markings because they can present a distraction to drivers and degrade the contrast with the white transverse lines.

Pedestrian Crossing Signals

Pedestrian crossing signals can be either fixed or push-button activated. The Manual on Uniform Traffic Control Devices provides standards and guidance for locating push-buttons for activated pedestrian signals.

Intersections with activated pedestrian phases and median refuges should include push-buttons in the median to prevent pedestrians from becoming stranded in a median refuge with no way to activate the pedestrian phase and finish crossing the street.[viii]

Signal Timing Strategies

Pedestrians are more likely to disregard pedestrian crossing signals when waits are too long. Delays exceeding 40 seconds at signalized crosswalks, especially where countdown signals are not provided, may cause risk-taking behavior.[ix]

Keeping cycle lengths between 60 and 90 seconds are ideal for urban areas. Longer cycle lengths, especially when in succession over multiple intersections, make walking even a short distance frustrating and prohibitive. However, cycle lengths should be long enough for pedestrians to cross the entire street without getting stuck in the median.[x]

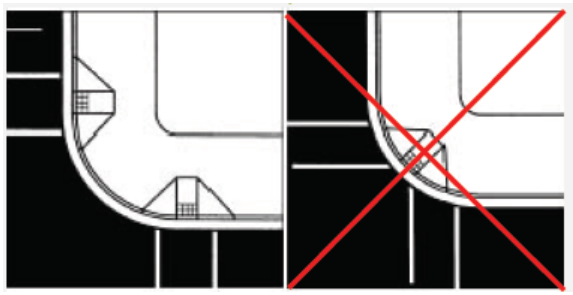
Reducing the minimum green time is another strategy to reduce pedestrian delay, especially for signalized intersections that are not coordinated with other adjacent signalized intersections.[xi]

When signalized intersections are coordinated, strategies to decrease pedestrian delay can include increasing the permissive window, adjusting signal timing for responsiveness at certain times of day, and setting the signal to recall on the pedestrian phase.

A Leading Pedestrian Interval (LPI) is a signal timing strategy that gives pedestrians a 3-7 second head start to cross the intersection while all vehicular approaches are held with a red light. LPIs allow pedestrians to proceed into the intersection where they are more visible to drivers. LPIs have been shown to decrease collisions between vehicles and pedestrians by as much as 60 percent. LPIs can be made more effective with curb extensions at high-conflict intersections.[xii]



Intersections with actuated pedestrian phases and median refuges should have push-buttons in the median to prevent pedestrians from becoming stranded in the median.



The preferred design for curb ramps at intersections is to align two separate curb ramps with each crosswalk. Image Source: Federal Highway Administration.

Curb Ramps

Curb ramps are critical for people who use wheelchairs or other mobility devices, people with strollers, and others who are unable to step down from the curb to cross the street easily and safely. It is best practice and required by VDOT at all new and redesigned intersections to provide two

separate curb ramps at each intersection corner, each aligned across from the curb ramp on the opposite side and aligned directly with the crosswalks.

Curb Extensions

Curb extensions (aka bulb-outs) are recommended as a best practice for the design of multimodal corridors, especially on corridors in Multimodal Centers. Curb extensions shorten the crossing distance for pedestrians and bring pedestrians waiting to cross the street into a more direct view of oncoming motorists. They decrease the effective turning radius and should be considered carefully on corridors with special freight considerations, along with drainage and stormwater considerations.

Raised Intersections

Raised intersections are considered a vertical speed control element that can slow traffic speeds and create a more pedestrian-friendly street environment by encouraging motorists to yield to crossing pedestrians.

Raised intersections are most widely applied on low-speed residential neighborhood streets at minor intersections where freight traffic and cut-through vehicles are discouraged.[xiii]

Streets with speed limits of 30 mph and lower may be candidates for raised intersections, which typically reduce a street's target speed to 20 mph or less,[xiv] although raised intersections may be difficult to implement as a retrofit project.

Pedestrian Crossing Design Considerations at Midblock Locations

People have different tolerances for the extra time it may take to go out of one's way to use a marked crosswalk to cross a street, and this tolerance varies depending on the street width, traffic volume, and traffic speed, as well as other personal and environmental factors. Generally speaking, if using a marked crosswalk will add more than three minutes to a person's walk, he or she may decide to cross along a more direct, but unsafe or unprotected route.[xv]

Midblock pedestrian crossings are important, especially within Multimodal Centers, when marked crosswalks at intersections are spaced far apart, generally when the spacing between adjacent intersections or pedestrian crossings exceeds 660 feet.[xvi] However, motorists generally do not expect midblock crossings, and when installed should be well- signed, well-marked, and clearly visible. Restricting parking or installing curb extensions can help make pedestrians waiting at midblock crossing more visible to oncoming motorists.

When spacing between pedestrian crossings at intersections exceeds 660 feet, midblock pedestrian crossings should be considered to prevent pedestrians from crossing at unmarked locations.

Midblock pedestrian crossings can be particularly useful at midblock transit stops, parks, building entrances, midblock passageways, plazas, other outdoor public spaces, and other locations that may generate pedestrian demand to cross the street.

Pedestrian Safety Islands

Pedestrian safety islands (aka crossing islands) or medians should be considered at marked midblock crossing locations where the crossing distance exceeds 60 feet. They shorten the crossing distance and create a two-stage crossing. Pedestrian safety islands are much shorter than long and continuous medians.[xvii]

Raised Crosswalks

Raised crosswalks are speed tables that also function as marked crosswalks. Raised crosswalks may be appropriate on streets that are not more than 50-feet wide. Raised crosswalks are often designed in conjunction with curb extensions.[xviii] Raised



Midblock pedestrian crossings should be considered when the distance between pedestrian crossings at intersections exceeds 660 feet.

crosswalks may be particularly useful at key access points to parks, schools, and waterfronts.

Pedestrian Warning Signs and Signals

Rectangular rapid flashing beacons (RRFBs) and pedestrian hybrid beacons (PHBs) may be appropriate treatments to accompany marked midblock crosswalks in certain circumstances.

RRFBs are flashing lights typically mounted to a roadside pedestrian-crossing sign that allow pedestrians to press a button and stop traffic while crossing at a mid-block crossing. PHBs are overhead traffic signals with a similar push-button activation to warn drivers that a pedestrian is using the mid-block crossing.

VDOT's Pedestrian Crossing Accommodations at Unsignalized Locations provides guidance on when RRFBs and PHBs are appropriate, which depends on the speed limit, traffic volume, and pedestrian demand.



A rectangular rapid flashing beacon (RRFB).
Image credit: pedbikeimages.org/ Shane Sawyer

[i] At the time of writing, the official current edition of the Manual on Uniform Traffic Control Devices is the 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012.
[ii] VDOT Pedestrian Safety Action Plan, 2018. Presentation by Mark Cole and Lauren Blackburn.
[iii] NACTO Urban Street Design Guide. "Crosswalks and Crossings." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings.
[iv] Ibid.
[v] VDOT IIM TE-384: Pedestrian Crossing Accommodations at Unsignalized Locations was approved in 2016. VDOT is currently working on an update to this resource.
[vi] FHWA, 2010. *Crosswalk Marking Field Visibility Study*. FHWA Publication Number: FHWA-HRT-10-068. Retrieved Jan 7, 2021 from https://www.fhwa.dot.gov/publications/research/safety/pedbike/10068/index.cfm.
[vii] Sonduru Pantangi, et. al, 2020. "Do High Visibility Crosswalks Improve Pedestrian Safety? A Correlated Grouped Random Parameters Approach Using Naturalistic Driving Study Data." *Analytic Methods in Accident Research*. Retrieved Jan 7, 2021 from https://doi.org/10.1016/j.amar.2020.100155.
[viii] DRPT, 2020. Multimodal System Design Guidelines.
[ix] NACTO Urban Street Design Guide. "Crosswalks and Crossings." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings.
[x] NACTO Urban Street Design Guide. "Signal Cycle Lengths." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/signal-cycle-lengths.
[xi] NACTO Urban Street Design Guide. "Fixed vs. Actuated Signalization." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/fixed-vs-actuated-signalization.
[xii] NACTO Urban Street Design Guide. "Leading Pedestrian Interval." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/leading-pedestrian-interval.
[xiii] NACTO Urban Street Design Guide. "Raised Intersections." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersections/minor-intersections/raised-intersections.
[xiv] NACTO Urban Street Design Guide. "Vertical Speed Control Elements." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements.
[xv] NACTO Urban Street Design Guide. "Crosswalks and Crossings." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings.
[xvi] AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004.
[xvii] Ibid.
[xviii] NACTO Urban Street Design Guide. "Speed Table." Retrieved Jan 7, 2021 from https://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements/speed-table.

Appendix F: Multimodal Needs Assessment Technical Appendix

This Appendix explains the methodology and data used in the development of the Needs Assessment for the Multimodal Transportation Master Plan.

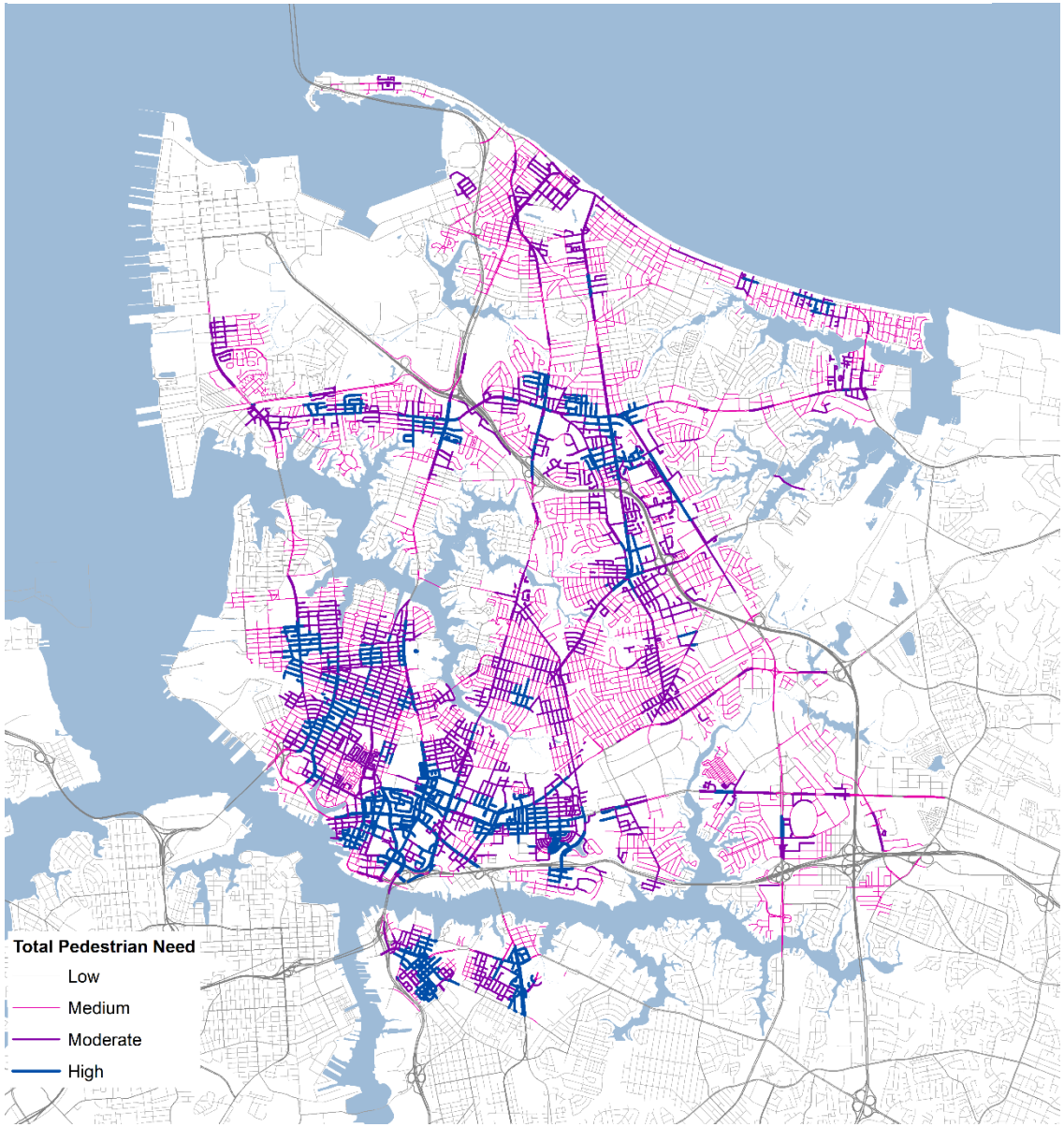
Chapter 12, the Multimodal Needs Assessment includes the map of pedestrian needs for Norfolk (shown again in this Appendix as **Figure F-1**) and the map of bicycle and scooter needs (**Figure F-2** shown on the next page).

The maps show Norfolk's streets classified into four levels of need:

- Low
- Medium
- Moderate
- High

This Appendix first describes the analysis of pedestrian needs and bicycle/scooter needs in more detail. It also describes the approach for the development of the Transit Needs Assessment, which was done as part of the Transit System Redesign portion of this project.

FIGURE F-1: MAP OF PEDESTRIAN NEEDS ANALYSIS RESULTS



Pedestrian and Bicycle/Scooter Needs

The pedestrian and bicycle/scooter needs maps are based on a variety of data sources that reflect Norfolk's three vision themes for multimodal transportation:

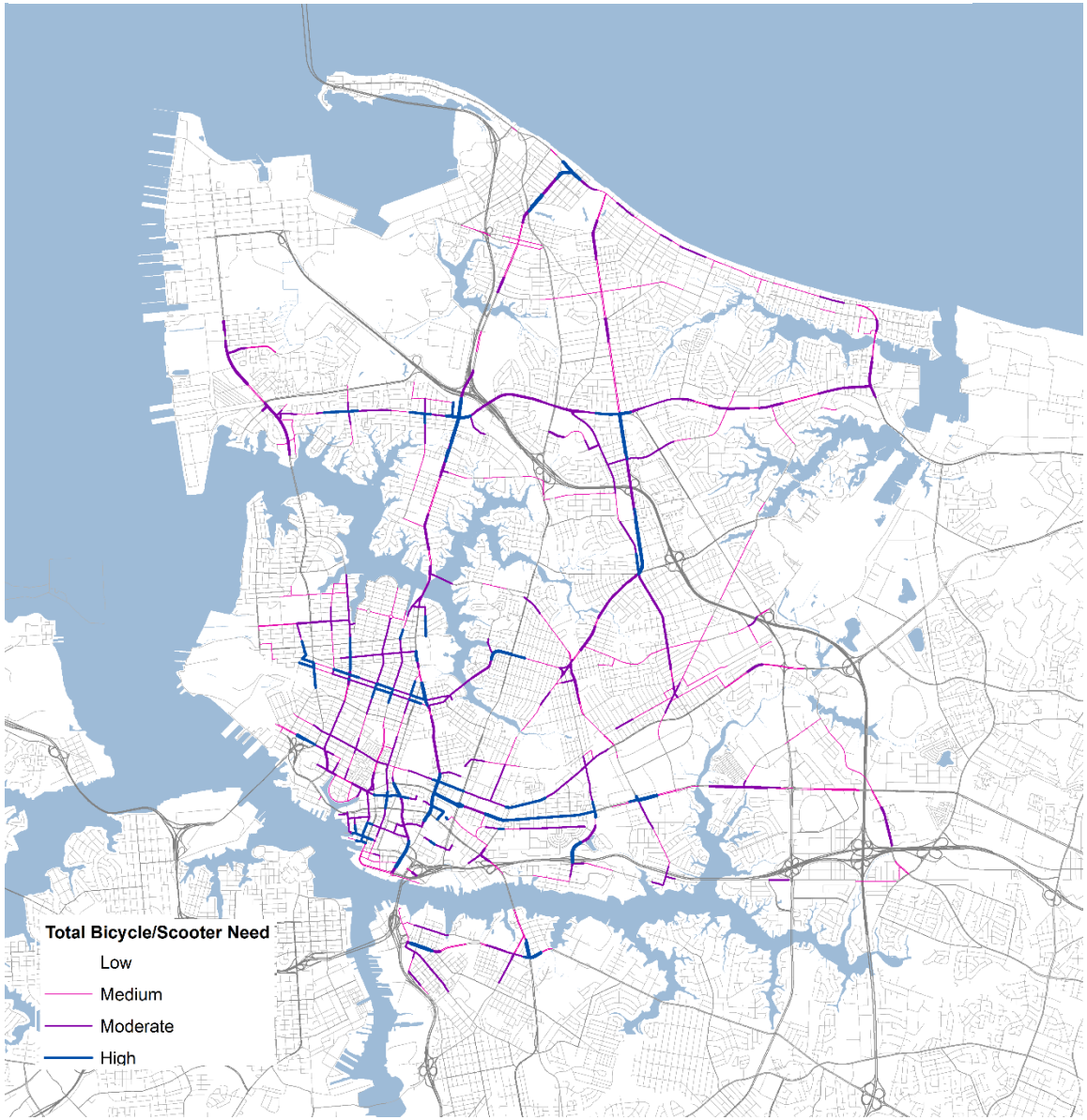
- Safety
- Connectivity
- Equitable Prosperity

The Needs Assessment uses data based on these three vision themes, as well as public input, to calculate a needs score for each street segment in the City.

The final maps based on this analysis are shown in **Figures F-1 and F-2**. The analysis methodology and data that were used to arrive at these final maps are described below. The pedestrian needs were analyzed separately from the bicycle and scooter needs, but both assessments follow a similar analysis method.

The following sections explain the analysis methods for both the pedestrian needs and the bicycle/scooter needs.

FIGURE F-2: MAP OF BICYCLE & SCOOTER NEEDS ANALYSIS RESULTS



Pedestrian and Bicycle/Scooter Needs Data & Analysis

As shown in tables **Table F-1 and F-2,** the three primary vision themes for the project were used as the basis for collecting datasets that were then used to calculate a needs score for that vision theme.

The data used in the Pedestrian Needs Assessment is listed in **Table F-1** and the data used in the Bicycle/Scooter Needs Assessment is listed in **Table F-2**.

The data was compiled, analyzed, and applied to each segment of Norfolk's streets. Maps were then created for each vision theme that summarized all the datasets in that theme.

Figures F-3 and F-4 show the levels of need for the Safety vision theme for pedestrian and bicycle/scooter modes, respectively. **Figures F-5 and F-6** show the levels of need for the Connectivity vision theme. **Figures F-7 and F-8** show the levels of need for the Equitable Prosperity vision theme.

Public input was also incorporated into the needs scores. As explained in Chapter 12, residents and other members of the public identified multimodal transportation needs through a variety of opportunities, including an interactive online map; email, voice, and text messages; civic league and task force meetings, and virtual town hall meetings. Over 800 comments on multimodal transportation needs were received.

TABLE F-1: PEDESTRIAN NEEDS DATA

Safety Vision Theme	Connectivity Vision Theme	Equitable Prosperity Vision Theme	Public Input
• Pedestrian crashes • Pedestrian fatalities • VDOT Pedestrian Safety Action Plan priority corridors • Distance to crosswalks • Sidewalks • Traffic volume • Traffic speed • Interstate ramps • Signalized intersections without pedestrian signals • ADA curb ramps	• Pedestrian trip generators (parks, schools, libraries, etc.) • Transit stops • Transit ridership • Activity (population and jobs) • Multimodal centers	• Zero-vehicle households • Populations of color • Low-income households	• Public comments

TABLE F-2: BICYCLE/SCOOTER NEEDS DATA

Safety Vision Theme	Connectivity Vision Theme	Equitable Prosperity Vision Theme	Public Input
• Bicyclist crashes • Bicyclist fatalities • Bicycle facilities • Traffic volume • Traffic speed • Interstate ramps	• Pedestrian trip generators (parks, schools, libraries, etc.) • Transit stops • Transit ridership • Activity (population and jobs) • Multimodal centers	• Zero-vehicle households • Populations of color • Low-income households	• Public comments

All comments were reviewed and considered. The number of public comments received was a final criterion in the needs mapping. **Figures F-9 and F-10** show the levels of need based on the number of comments received.

As explained in Chapter 4, all streets in the City of Norfolk have pedestrian modal emphasis, except interstates and limited access highways.

However, not all of Norfolk's streets have bicycle/scooter modal emphasis. The streets with bicycle/scooter modal emphasis were based on a separate methodology and represent a potential fully connected network of streets and paths that bicyclists and scooter riders could use to travel safely and comfortably across the entire city. These streets represent the most critical bicycle connections. Many street segments with bicycle/scooter modal emphasis are rated with either medium, moderate or high need levels. Streets without bicycle/scooter modal emphasis are shown as having low needs in the bicycle/scooter needs maps.

FIGURE F-3: PEDESTRIAN SAFETY NEEDS

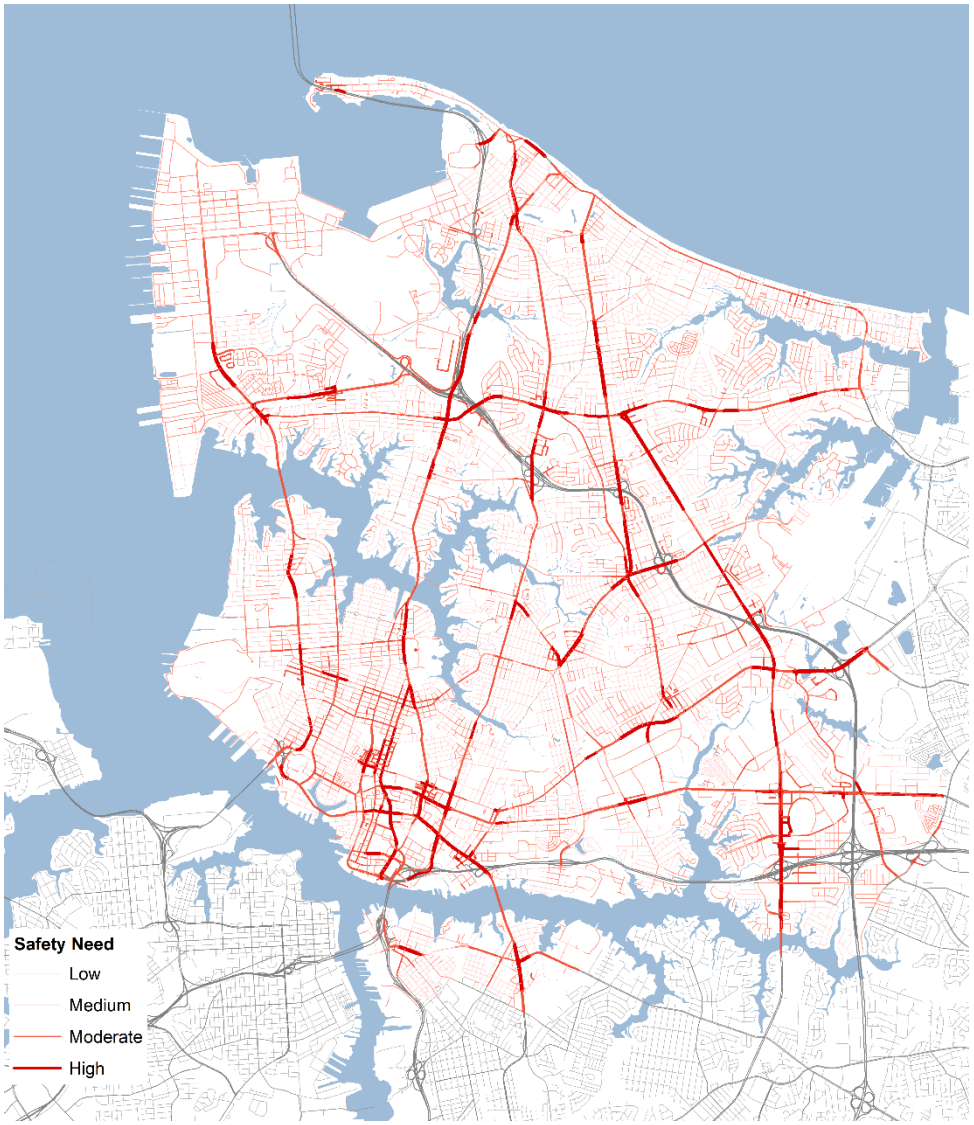


FIGURE F-4: BICYCLE/SCOOTER SAFETY NEEDS



Figure F-5: Pedestrian Connectivity Needs

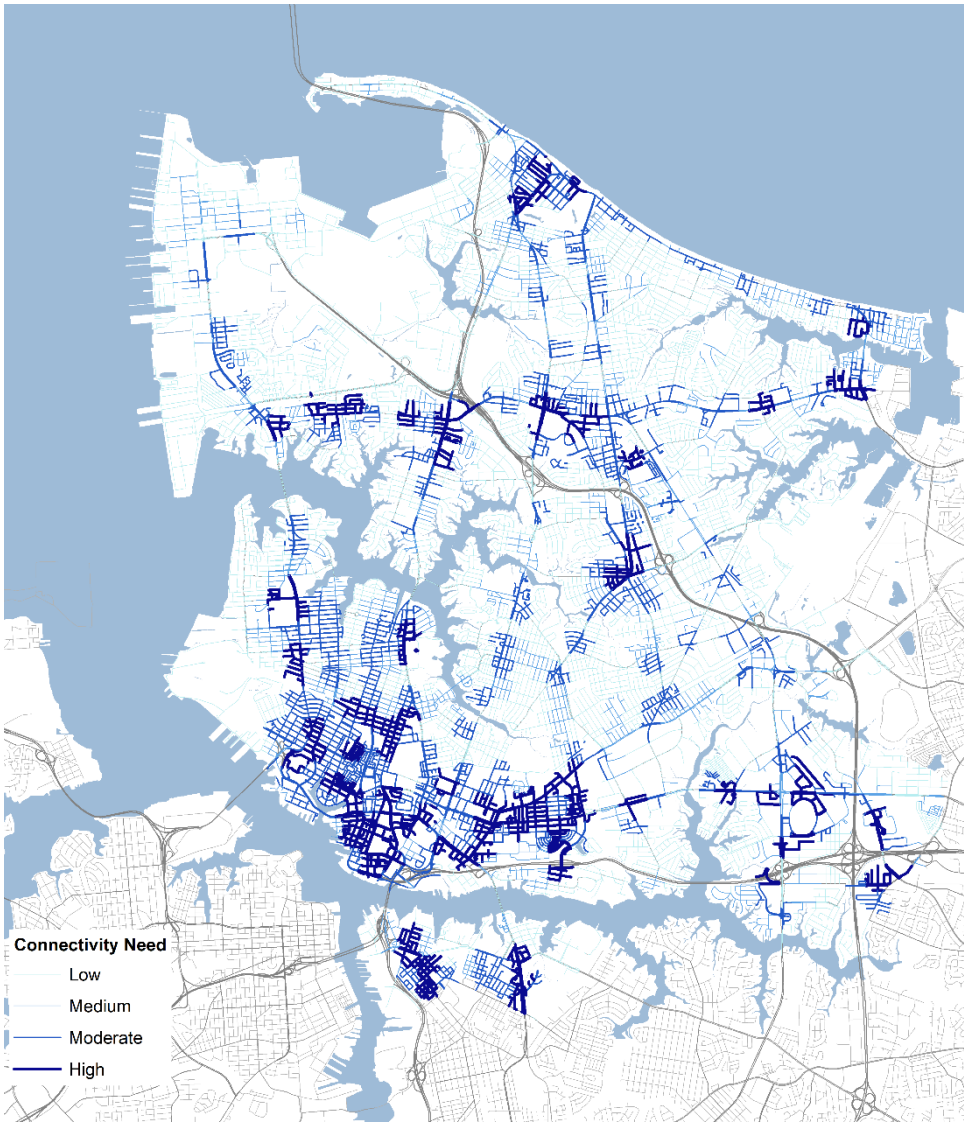


Figure F-6: Bicycle/Scooter Connectivity Needs

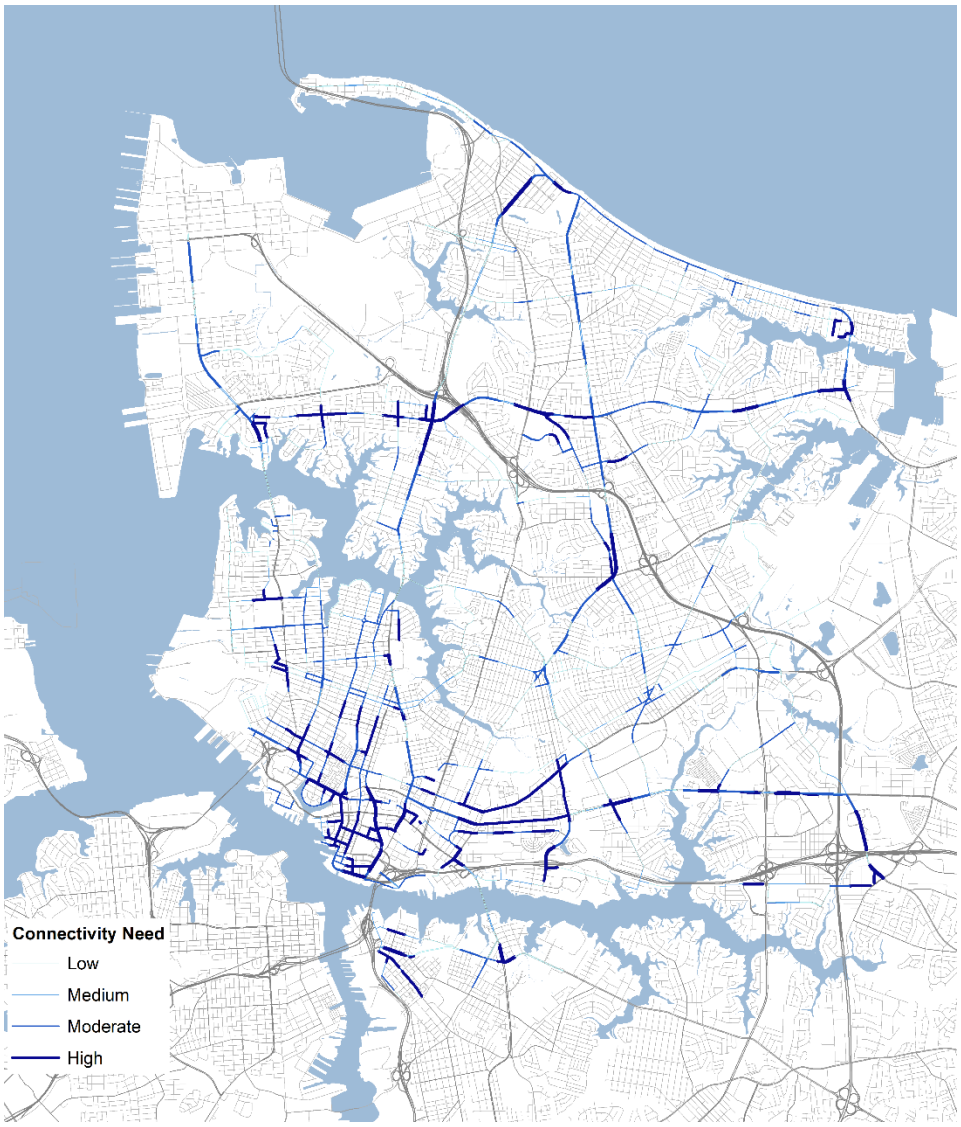


Figure F-7: Pedestrian Equitable Prosperity Needs

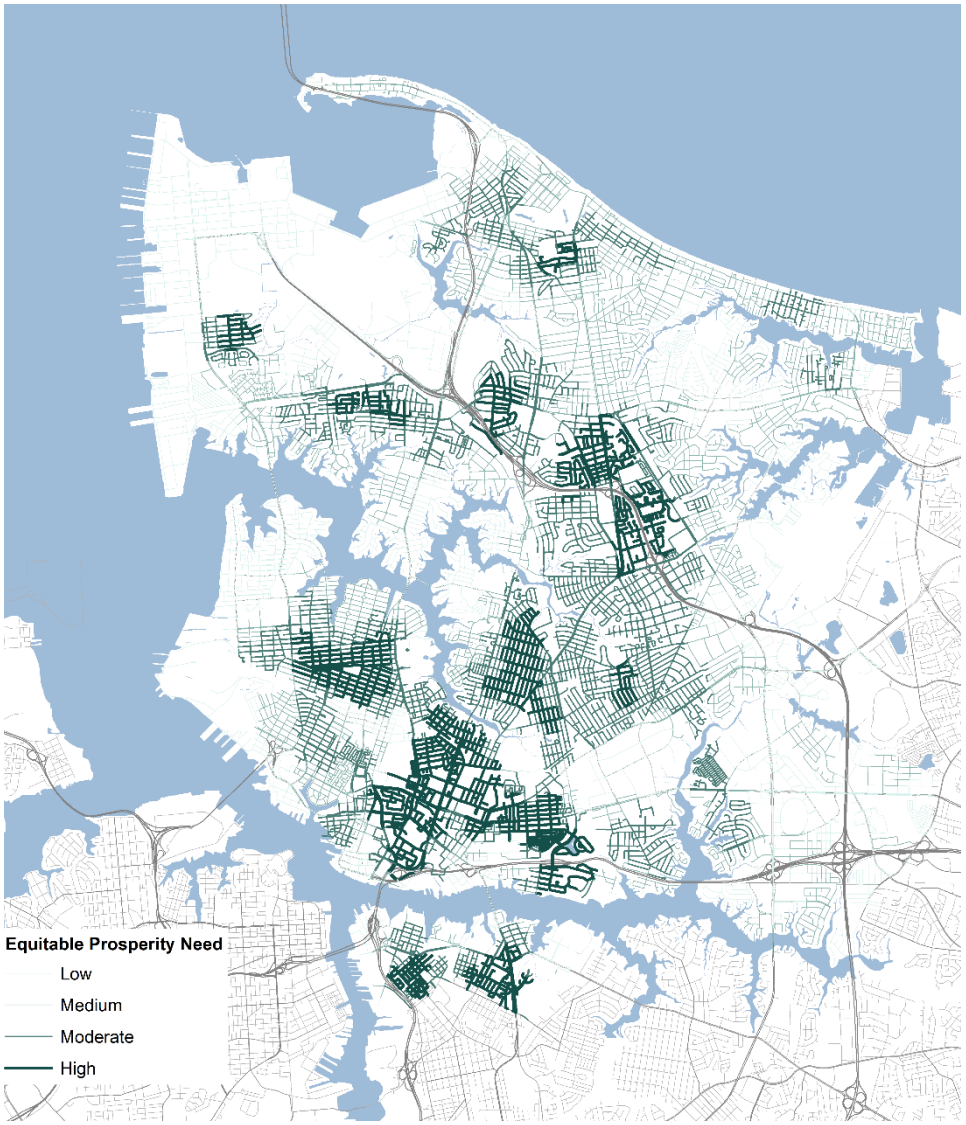


Figure F-8: Bicycle/Scooter Equitable Prosperity Needs

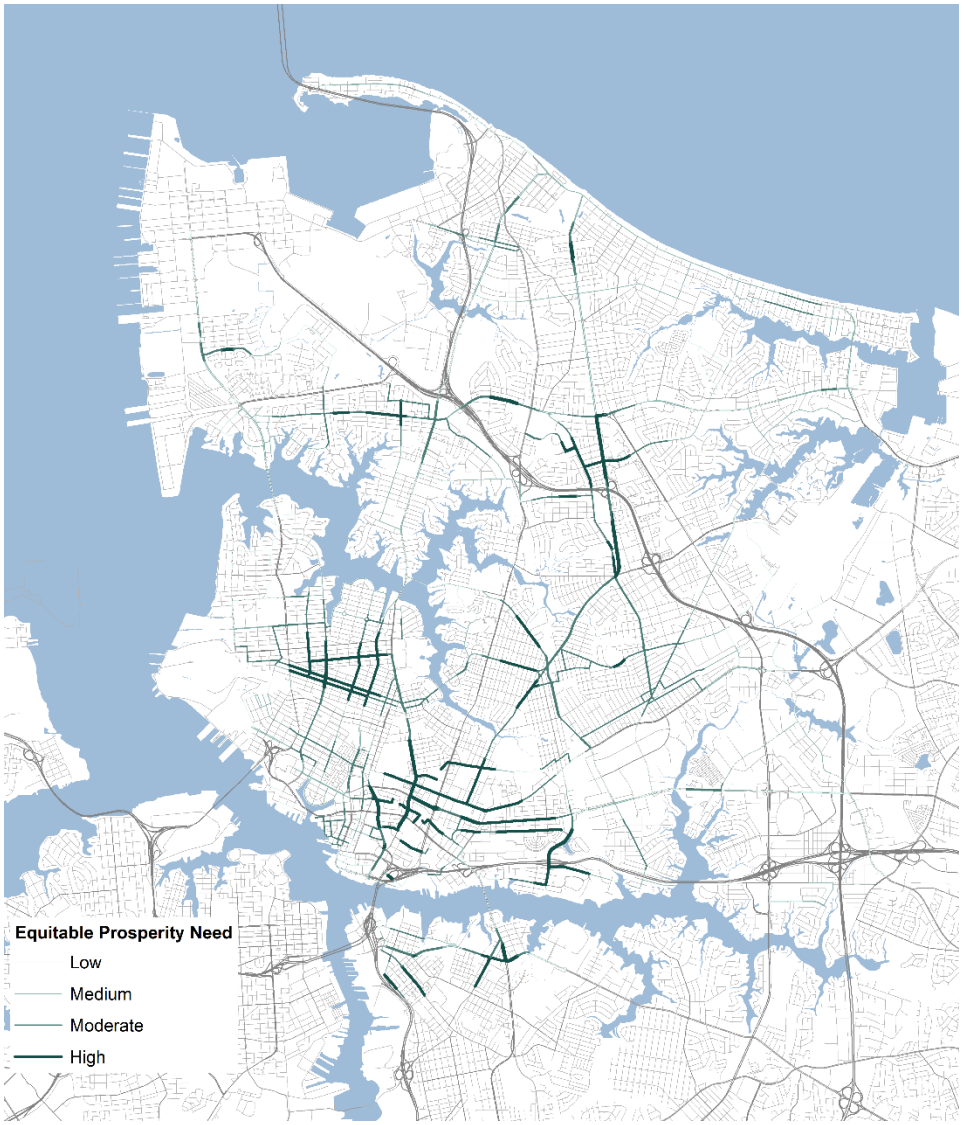


FIGURE F-9: PEDESTRIAN PUBLIC GUIDANCE NEEDS



FIGURE F-10: BICYCLE/SCOOTER PUBLIC GUIDANCE NEEDS



Calculating the Pedestrian and Bicycle/Scooter Needs Scores

Tables F-3 and F-4 provide more information on how the pedestrian needs and bicycle/scooter needs, respectively, were analyzed.

The Metric column in the **Tables F-3 and F-4** describes how each dataset was calculated.

Each street segment was assigned weighting points for each dataset, depending on the value. The Possible Points column in **Tables F-3 and F-4** shows how many points were possible for each dataset. This represents the weight of this dataset towards the needs score. The rightmost four columns show the values for each dataset for each possible point.

Spatial Analysis

The project team performed a series of GIS operations to calculate the values for each of the criteria.

Some datasets were calculated directly for each street segment. These are the "segment" datasets in the Geography column of **Tables F-3 and F-4.**

Other datasets were calculated and aggregated to an area, and that value was then assigned to the street segments. These are the "area" datasets in the Geography column.

To calculate the area-based metrics, a hexagonal grid of half-mile cells was created and overlaid on top of Norfolk's street grid. Scores for the area-based metrics were calculated and assigned to each cell in the grid. For example, the Transit Stops metric was calculated by counting the total number of transit stops in each hex cell.

Segment-based metrics were calculated using a GIS layer of Norfolk's streets where each block is an individual line segment.

The hexagonal grid and segments used to calculate the individual area- and segment-based safety metrics for pedestrian needs are shown as an example in the "Interim Map of Pedestrian Safety Needs" on this page.

The area-based scores were applied to individual street segments using a spatial join operation based on the location of each street segment's centroid. Each street segment received the area-based scores of the grid cell within which its center fell.

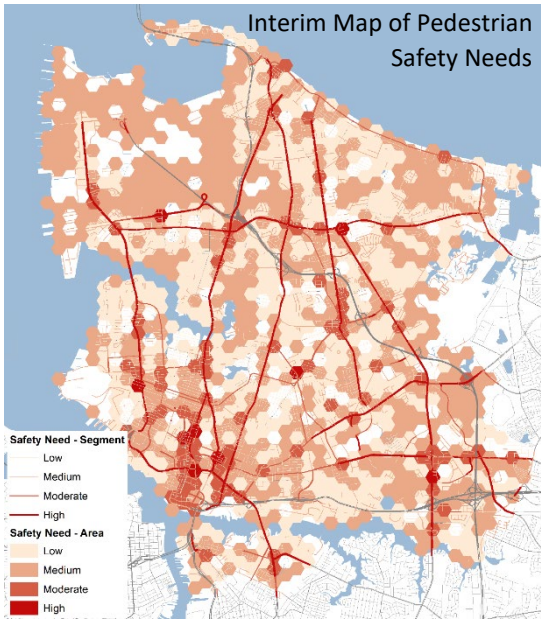
Finally, area-based and segment-based scores were summed up to calculate the total needs score for each street segment.

The modal emphasis networks were then overlaid to derive the total pedestrian needs scores and the total bicycle/scooter needs scores. Pedestrian needs scores were calculated for streets with pedestrian modal emphasis (all streets in Norfolk except interstates and limited access highways).

Bicycle/scooter needs scores were calculated for streets with bicycle modal emphasis. Streets that had not been assigned the relevant modal emphasis are considered low priority for each mode.

Each segment was assigned a modal priority of low, medium, moderate, or high based on its need score.

This analysis resulted in two maps, shown in **Figures F-1 and F-2** at the beginning of this Appendix. These maps represent the combined needs scores for pedestrian needs and bicycle/scooter needs.



This map shows the levels of needs calculated for the area-based datasets for pedestrian safety needs, displayed in the hexagonal grid, as well as the levels of needs calculated for the segment-based datasets.

TABLE F-3: PEDESTRIAN NEEDS DATA, METRICS, AND SCORES

Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Safety	Pedestrian Crashes	# of pedestrian crashes	Area	10%	3	0	1 - 2	3 - 5	6+
	Ped Fatalities	# of pedestrian fatalities	Area	10%	3	0	1	2 - 3	4+
	VDOT PSAP Corridors	Linear ft. of PSAP corridors weighted by rank	Segment	10%	3	Not PSAP	3	2	1
	Distance to Xwalk on PSAP Corridors	Linear distance to Xwalk on PSAP corridors	Area	10%	2	< 600	600 - 1200	1200 +	
	Sidewalk Present?	Is a sidewalk present on at least one side of street	Segment	10%	3	Yes			No
	Traffic Volume	ADT	Segment	10%	3	0 - 1,999	2,000 - 4,999	5,000 - 7,999	8,000 +
	Traffic Speed	Speed Limit	Segment	10%	3	< 25	25	26-35	36+
	Interstate Ramp	Is there an interstate ramp present? (Yes/No)	Area	10%	2	No	Yes		
	Signals without Ped Signals	# of signalized intersections with no ped signals	Area	10%	3	0	1	2	3+
	ADA Curb Ramps	Ratio of curb ramps per intersection within cell	Area	10%	2	3.01 +	0.01 - 3	0	
Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Connectivity	Trip generators	# of parks, schools, libraries, etc. in vicinity	Area	20%	3	0	1	2	3+
	Transit Stops	# of HRT stops in vicinity	Area	20%	3	0	1	2	3+
	Transit Ridership	# of boardings and alightings in vicinity	Area	20%	3	0	1 - 10	11 - 50	51+
	Activity	# of residents + # of jobs in vicinity	Area	20%	3	0	1 - 100	101 - 1,000	1,001+
	Multimodal Center	Yes/No inside or out of MM Center	Area	20%	3	No			Yes
Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Equitable Prosperity	Zero Vehicle Households	# of zero-vehicle households in cell	Area	33%	3	0 - 24	25 - 75	76 - 150	151+
	Populations of Color	# of non-white residents in cell	Area	33%	3	0 - 24	25 - 300	301 - 599	600+
	Low-Income Households	# of low-income households in cell	Area	33%	3	0 - 24	25 - 200	201 - 399	400+
Vision Theme	Criteria	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Public Guidance	Of concern to public or stakeholders	# of comments on the Needs Assessment survey map	Area	100%	3	0	1	2	3-4

TABLE F-4: BICYCLE/SCOOTER NEEDS DATA, METRICS, AND SCORES

Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Safety	Bike Facilities Present	What type of bike facility is present?	Segment	20%	3	Bike Lane		Sharrow	None
	Bicyclist Crashes	# of bicycle crashes	Area	20%	6	0	1 – 2*	3 – 5*	6+*
	Bicyclist Fatalities**	# of bicyclist fatalities	Area	-	-				
	Traffic Volume	ADT	Segment	20%	3	0 - 1,999	2,000 - 4,999	5,000 - 7,999	8,000 +
	Traffic Speed	Speed Limit	Segment	20%	3	< 25	25	26-35	36+
	Interstate Ramp	Is there an interstate ramp present? (Yes/No)	Area	20%	2	No	Yes		
Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Connectivity	Trip generators	# of parks, schools, libraries, etc. in vicinity	Area	20%	3	0	1	2	3+
	Transit Stops	# of HRT stops in vicinity	Area	20%	3	0	1	2	3+
	Transit Ridership	# of boardings and alightings in vicinity	Area	20%	3	0	1 - 10	11 - 50	51+
	Activity	# of residents + # of jobs in vicinity	Area	20%	3	0	1 - 100	101 - 1,000	1,001+
	Multimodal Center	Yes/No inside or out of MM Center	Area	20%	3	No			Yes
Vision Theme	Dataset	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Equitable Prosperity	Zero Vehicle Households	# of zero-vehicle households in cell	Area	33.3%	3	0 - 24	25 - 75	76 - 150	151+
	Populations of Color	# of non-white residents in cell	Area	33.3%	3	0 - 24	25 - 300	301 - 599	600+
	Low-Income Households	# of low-income households in cell	Area	33.3%	3	0 - 24	25 - 200	201 - 399	400+
Vision Theme	Criteria	Metric	Geography	Normalizing Factor	Possible Points	0	1	2	3
Public Guidance	Of concern to public or stakeholders	# of comments on the Needs Assessment survey map	Area	100%	3	0	1	2	3-4

** Bicyclist Crashes provide a total of 6 possible points. Each weighted score bucket is worth double. Cells with 1-2 crashes earn 2 points, 3-5 crashes earn 4 points, and 6 or more crashes earn 6 points.*

*** The Bicycle and scooter rider needs formula includes a metric for bicyclist fatalities but there are no bicyclist fatalities recorded in the current version of Norfolk's crash dataset, which at the time of analysis included crashes from 2015 through 2019.*

Appendix G: Program of Projects

The projects listed in this current program of projects are not listed in any particular order, rank, or priority. The map is available at www.MultimodalNorfolk.com.

ID	Project Name	Project Type	Project Source	Funding	Need Level
1	Curlew Drive Multi-Use Path	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
3	Granby Street Bridge Rehabilitation	Other	Committed projects with funding	Funded	Not scored
4	Campostella Bridge Rehabilitation	Other	Committed projects with funding	Funded	Not scored
5	Granby Street Bike Lanes - Willow Wood Drive to Admiral Taussig Bouelvard	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
6	Virginia Beach Boulevard Improvements at Newtown Road.	Sidewalk projects	Committed projects with funding	Funded	Not scored
7	Elizabeth River Trail at Fort Norfolk.	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
8	Granby Bike Bypass at Lafayette Park and Columbus Avenue.	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
9	Princess Anne Road Corridor Improvements between Tidewater Drive and Ballentine Boulevard.	Other	Committed projects with funding	Funded	Not scored
10	Virginia Beach Blvd Widening - George St to Newtown Rd	Other	Committed projects with funding	Funded	Not scored
11	Granby Street - NEON District Streetscape Project	Other	Committed projects with funding	Funded	Not scored
12	Citywide Sidewalk Infrastructure Phase 2 - Little Creek Road (Chesapeake Boulevard to Carlton Street)	Sidewalk projects	Committed projects with funding	Funded	Not scored
13	Citywide Sidewalk Infrastructure Phase 1 - Princess Anne Road (Shelton Avenue to Fleetwood Avenue)	Sidewalk projects	Committed projects with funding	Funded	Not scored
14	Citywide Sidewalk Infrastructure Phase 1 - Easy Street and Tidewater Drive	Sidewalk projects	Committed projects with funding	Funded	Not scored
15	Citywide Sidewalk Infrastructure Phase 2 - Berkley Ave/Indian River Road (Wilson Road to Marsh Street)	Sidewalk projects	Committed projects with funding	Funded	Not scored
16	Citywide Sidewalk Infrastructure Phase 2 - Sewells Point Road (Princess Anne Road to Azalea Garden Road)	Sidewalk projects	Committed projects with funding	Funded	Not scored
17-46	St. Paul's Phase I/II	Other	Committed projects with funding	Funded	Not scored
47	Newtown Road Corridor Study	Other	Committed projects with funding	Funded	Not scored
48	Southside Bicycle Improvements	Bike/scooter facility projects	Committed projects with funding	Partially Funded?	High
49	Church Street Pedestrian Improvements	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
50	Westminster Reconstruction	Other	Committed projects with funding	Funded	Not scored
51	Lake Taylor Sidewalk Improvements	Sidewalk projects	Committed projects with funding	Funded	Not scored
52	Ballentine Blvd Lane Improvements	Other	Committed projects with funding	Funded	Not scored
53	Tidewater Drive Sidewalk at I-64	Sidewalk projects	Committed projects with funding	Funded	Not scored
54	Traffic calming and pedestrian crossing safety treatments on Granby Street between Main Street and Charlotte Street.	Traffic Calming	Candidate projects from 2021 needs assessment	Unfunded	High

ID	Project Name	Project Type	Project Source	Funding	Need Level
55	Lane repurposing on Virginia Beach Blvd from Boush St to Monticello Ave	Traffic Calming	Candidate projects from 2021 needs assessment	Unfunded	Moderate
56	Lane repurposing on Monticello Ave from Brambleton Ave to Olney Rd	Traffic Calming	Candidate projects from 2021 needs assessment	Unfunded	High
57	Strategic Bike/Ped Plan Corridor 1: Olney Road - Hospitals Complex to Norfolk State University. Segment 3: Olney Road - Boush Street to Monticello Avenue. Remove existing bike lane and restripe with priority shared bike lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
58	Strategic Bike/Ped Plan Corridor 1: Olney Road - Hospitals Complex to Norfolk State University. Segment 4: Olney Road - Monticello Ave to Tidewater Drive. Install shared lane markings and construct shared-use path segments.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
59	Strategic Bike/Ped Plan Corridor 1: Olney Road - Hospitals Complex to Norfolk State University. Segment 5: Olney Road - Tidewater Drive to Maltby Crescent. Install shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
60	Strategic Bike/Ped Plan Corridor 2: Llewellyn Avenue and lower Granby Street, and Boush Street Alternatives. Segment 3: Duke St - Tazewell St to Olney Rd. Lane repurposing with bike lanes and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
61	Strategic Bike/Ped Plan Corridor 2: Llewellyn Avenue and lower Granby Street, and Boush Street Alternatives. Segment 6: Llewellyn Ave - 27th St to Delaware Ave. Lane repurposing with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
65	Strategic Bike/Ped Plan Corridor 3: Granby Street - Willow Wood Road to Ocean View Boulevard. Segment 4: Granby St from Bayview Blvd to Ocean View Ave. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
66	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 1: Park Ave - Holt St to Brambleton Ave. Lane repurposing with two-way cycle track.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
67	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 2: Park Avenue from Brambleton Ave to Olney Rd. Construct a shared use path segment.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
68	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 3: Maltby Crescent - Park Ave to Virginia Beach Blvd. Install shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
69	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 4: Booker T. Washington High School - Virginia Beach Boulevard to Princess Anne Road. Construct a shared-use path on Booker T. Washington High School grounds from V	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
70	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 5: Maltby Ave from Princess Anne Rd to the Lafayette River. Lane repurposing with shared lane markings and bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
71	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 6: Chesapeake Blvd - Lafayette River to Hanbury St. Construct a bike and pedestrian bridge across the Lafayette River and shared lane markings on Chesapeake Blvd to Hanbury St.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
72	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 7: Signed connector route - Chesapeake Blvd to Robin Hood Rd. Install shared lane markings on Hanbury Ave, Arizona Ave, Lafayette Blvd and Kansas Ave from Chesapeake Blvd to Robin Hood Rd.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
73	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 8: Chesapeake Blvd from Robin Hood Rd to Montgomery St. Road widening with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
74	Strategic Bike/Ped Plan Corridor 4: Harbor Park and Tide Station to Five Points. Segment 9: Chesapeake Blvd from Montgomery St to Norview Ave. Lane restriping with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
75	Strategic Bike/Ped Plan Corridor 5: Downtown-Old Dominion University-Naval Station Connector. Segment 1: Colley Ave from Olney Rd to Redgate Ave. Lane restriping with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
76	Strategic Bike/Ped Plan Corridor 5: Downtown-Old Dominion University-Naval Station Connector. Segment 6: Colley Ave/Jamestown Crescent from 52nd St to Hampton Blvd. Install bike lanes and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
77	Strategic Bike/Ped Plan Corridor 5: Downtown-Old Dominion University-Naval Station Connector. Segment 7: Elizabeth River Trail - Lexan Avenue to Hampton Boulevard Bridge. Install shared lane markings on Monroe Pl and Lexan Ave from Jamestown Crescent to Hampton Blvd; intersection improvements at Lexan Ave and Hampton Blvd; construct shared-use path connection to Elizabeth River Trail.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Low
78	Strategic Bike/Ped Plan Corridor 5: Downtown-Old Dominion University-Naval Station Connector. Segment 10: Hampton Bouelvard Bridge. Lane restriping with sidewalk widening and buffered bike lane.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
79	Strategic Bike/Ped Plan Corridor 5: Downtown-Old Dominion University-Naval Station Connector. Segment 11: Hampton Boulevard Alternate - Lafayette River Bridge to Harrison Road. Install shared lane markings on Claud Ln, Shirland Ln, Trouville Ave, Baylor Pl and Harrison Rd.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
80	Strategic Bike/Ped Plan Corridor 6: Indian River Road -- South Norfolk Connector. Segment 1: Indian River Rd from State Rd to Berkeley Ave. Install buffered bike lanes and bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
81	Strategic Bike/Ped Plan Corridor 6: Indian River Road -- South Norfolk Connector. Segment 1a: Berkeley Ave from State St to Indian River Rd. Lane restriping with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan AND Candidate projects from 2021 needs assessment	Unfunded	High
82	Strategic Bike/Ped Plan Corridor 6: Indian River Road -- South Norfolk Connector. Segment 2: Indian River Rd from Berkeley Ave to Campostella Rd. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
83	Strategic Bike/Ped Plan Corridor 6: Indian River Road -- South Norfolk Connector. Segment 3: Indian River Rd from Campostella Rd to City Limits. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High

ID	Project Name	Project Type	Project Source	Funding	Need Level
84	Strategic Bike/Ped Plan Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector. Segment 1: Willow Wood Drive - Bridge. Install signage and shared lane markings on Willow Wood Dr bridge.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
85	Strategic Bike/Ped Plan Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector. Segment 2: Willow Wood Drive - Bridge to Elmore Place. Lane restriping with bike lanes and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
86	Strategic Bike/Ped Plan Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector. Segment 3: Cromwell Dr from Willow Wood Dr to Tidewater Dr. Lane repurposing with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
87	Strategic Bike/Ped Plan Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector. Segment 4: Cromwell Dr from Tidewater Dr to Lyons Ave. Lane repurposing and parking consolidation with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
88	Strategic Bike/Ped Plan Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector. Segment 5: Connector Trail - Cromwell Drive to Robin Hood Road. Close medians and construct trail and enhanced crossings on Chesapeake Blvd from Cromwell Rd to	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
89	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 1: St. Julian Avenue and Cape Henry Avenue from St. Julian Avenue to Princess Anne Road. Shared-use path segments and intersection improvements at various locations on Cape Henry	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
90	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 2: Railroad and Ingleside Road Crossings - Princess Anne Road to Cape Henry Avenue. Sidewalk widenings, signage, shared-use path segments and pedestrian refuge islands on Princess	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
91	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 3: Azalea Garden Road and Railroad Crossings - Juniper Street to Norcova Avenue. Option 1: Widen sidewalks and improve the railroad crossing at Azalea Garden Road.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
92	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 3: Azalea Garden Road and Railroad Crossings - Juniper Street to Norcova Avenue. Option 2: Create a new railroad crossing at Norcova Avenue, improve the unsignalized crossing of Sewells Point Road, provide wayfinding signage, and pave shoulders along Azalea Garden Rd.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
93	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 4: Military Highway Crossing - Princess Anne Road to Rail corridor. Option 1: Connect the end of the Princess Anne Road service drive with the sidewalk, revise signal timing and phasing at the intersection of Military Highway and Elizabeth Road to accommodate cross traffic from bicyclists, and install a two-way sidepath in the wide grass should along the east side of Military Highway.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
94	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 4: Military Highway Crossing - Princess Anne Road to Rail corridor. Option 2: Connect the end of Cape Henry Avenue to a crossing of Military Highway with ramped birdge approaches, and install a new pedestrian/bicycle bridge across Military Highway.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
95	Strategic Bike/Ped Plan Corridor 8: Cape Henry Trail Interim Route. Area 5: NS Rail Corridor - Academy Drive to Pritchard Street. Construct shared-use path along Norfolk Southern rail tracks	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Low
96	Strategic Bike/Ped Plan Corridor 9: Southside Bikeways. Segment 1: State St - I-264 bridge to Liberty St. Install bike lanes and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
97	Strategic Bike/Ped Plan Corridor 9: Southside Bikeways. Segment 2: Liberty St - State St to Halifax St. Lane repurposing with bike lanes and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
98	Strategic Bike/Ped Plan Corridor 9: Southside Bikeways. Segment 3: Main St and Bainbridge Blvd - Liberty Street to Norfolk City Line. Install one-way bike lane and shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
102	Strategic Bike/Ped Plan Corridor 10: Ocean View Avenue and Shore Drive East-West Connector. Segment 7: Shore Drive - Pretty Lake Dr to Little Creek Rd. Lane repurposing and redesign with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
103	Strategic Bike/Ped Plan Corridor 10: Ocean View Avenue and Shore Drive East-West Connector. Segment 8: Shore Drive - Little Creek Road to Diamond Springs Road. Provide regular maintenance on the existing north side sidewalk for two-way bicycling. Improve the intersection at Little Creek Road to accommodate bicyclist transitions to and from the sidewalk. Install, maintain, and repair curb ramps.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
104	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 1: Ingleside Rd - Mississippi Ave to Virginia Beach Blvd. Install shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan AND Candidate projects from 2021 needs assessment	Unfunded	Moderate
105	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 2: Virginia Beach Blvd from Ingleside Rd to Azalea Garden Rd. Construct a shared-use path.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
106	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 3: Azalea Garden Rd from Virginia Beach Blvd to Sewells Point Rd. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
107	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 4: Azalea Garden Rd from Sewells Point Rd to Military Hwy. Road widening with paved shoulder.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
108	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 5: Azalea Garden Rd from Military Hwy to Huette Dr. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
109	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 6: Huette Dr from Azalea Garden Rd to Cameilla Rd. Restripe to widen bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Low

ID	Project Name	Project Type	Project Source	Funding	Need Level
110	Strategic Bike/Ped Plan Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road. Segment 7: Huette Dr from Cameilla Rd to Shore Dr. Install bicycle boulevard.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Medium
111	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 1: Sewells Point Rd and Chesapeake Blvd - Azalea Garden Rd to Little Creek Rd. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
112	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 2: Chesapeake Blvd from Little Creek Rd to Ocean View Ave. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
113	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 3: Sewells Point Rd from Norview Ave to Quail St. Install shared lane markings.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	High
114	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 4: Sewells Point Rd - Quail Street to Philpotts Road. Lane diet with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
115	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 5: Sewells Point Road - Philpotts Road to Denison Avenue. Lane repurposing with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
116	Strategic Bike/Ped Plan Corridor 2: Llewellyn Avenue and lower Granby Street, and Boush Street Alternatives. Segment 8: Granby Street Bridge. Lane repurposing with buffered bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan AND Candidate projects from 2021 needs assessment	Unfunded	Moderate
117	Strategic Bike/Ped Plan Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway. Segment 6: Denison Ave and Central Business Park Dr from Sewells Point Rd to Walmart entrance. Lane diet with bike lanes.	Bike/scooter facility projects	Strategic Bike & Pedestrian Plan	Unfunded	Moderate
120	Complete missing sidewalks on Pleasant Ave from Shore Drive to 5th Bay St	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
122	Dovercourt Rd Pedestrian Improvements (Ardmore Rd to Bancker Rd)	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium

ID	Project Name	Project Type	Project Source	Funding	Need Level
123	Construct sidewalk on Thole St from the railroad tracks east of Virginia Dr to Tidewater Dr	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
124	Install bike lanes on Thole St from Granby St to Tidewater Dr	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
125	Complete missing sidewalk on Norview Ave from Sedgefield Dr to Tidewater Dr and improve railroad crossing	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
126	Construct a bike and pedestrian bridge alongside Willow Wood Dr bridge	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Low
127	Enhance the Elizabeth River Trail from the existing segment at W 25th St to the existing segment at Jeff Robertson Park	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
129	Install bike lanes and other traffic calming treatments on Lafayette Blvd from E 26th St across the bridge to Tidewater Dr	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	High
130	Install vertical barriers or separation on bike lanes on Ocean View Ave from Shore Dr to Inlet Rd	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
132	Install bike lane on Battersea Rd from Norfolk Ave to Granby St	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
135	Construct sidewalk or shared-use path on the water side of Mayflower Rd from Virginia Ave to New Hampshire Ave	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
136	Sidewalks and bike lanes on Granby Street from Bayview Blvd to Admiral Taussig Blvd	Combined Sidewalk & Bike/scooter facility project	Candidate projects from 2021 needs assessment; Candidate project from current Transit Department; and Strategic Bike & Pedestrian Plan	Unfunded	Moderate
137	Construct sidewalks on N Military Hwy from southeast of Croft St to E Little Creek Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
138	Construct sidewalk on Heutte Dr from Camellia Rd to Shore Dr	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
139	Construct sidewalks on 13th Bay St	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium

ID	Project Name	Project Type	Project Source	Funding	Need Level
140	Construct sidewalks on E Seaview Ave from Norfolk Ave to Granby St	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
141	Construct a shared-use path from the end of Armistead Bridge Rd to the end of Bowdens Ferry Rd with a bike and pedestrian bridge over the railroad tracks	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
142	Install bike facility on Redgate Ave from Greenway Ct to Colley Ave	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	High
144	Construct sidewalks on Chesapeake Blvd from E Little Creek Rd to Fishermans Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
146	Construct sidewalks on S Newtown Rd from the I-64 underpass to Curlew Dr	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
150	Complete missing sidewalks on Shoop Ave from Chesapeake Blvd to St Mihiel Ave	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
151	Construct sidewalks on Miller Store Rd from Robin Hood Rd to Azalea Garden Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
152	Construct sidewalks on Tait Terr from Chesapeake Blvd to McKann Ave	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
153	Install bike lane on E Princess Anne Rd from N Military Hwy to Park Ave	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	High
154	Construct sidewalks on Whitehead Ave from E Berkley Ave to Fauquier St	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
156	Construct sidewalks on Azalea Garden Rd from Robin Hood Rd to Sewells Point Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
157	Restripe centerline pavement markings and bicycle facility on Norway Pl from Lafayette Blvd to Willow Wood Dr	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
158	Install an east-west 2-way bicycle facility along York Street or Bute Street from the intersection of Botetourt St at Brambleton Ave to Boush St.	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
159	Construct sidewalks on Burksdale Rd from Simmons Dr to Tidewater Dr	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
160	Construct sidewalks on Jersey Avenue from Robin Hood to Chesapeake Blvd and explore traffic calming techniques to slow down vehicles, especially at the intersection of Jersey Avenue and Radford Street.	Traffic Calming	Candidate projects from 2021 needs assessment	Unfunded	Medium

ID	Project Name	Project Type	Project Source	Funding	Need Level
162	Construct sidewalk on northbound side of Ingleside Rd from Ladd Ave to Riverside Dr	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
164	Continue the bike lanes on Robin Hood Rd east from Almeda Ave under the I-64 overpass to provide facilities for bicycling in both directions through the interchange area.	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
165	Connect the end of Pope Ave to Chesapeake Blvd with a paved path (off-road connection)	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
166	Chesapeake Blvd Pedestrian Improvements (Bayview Blvd to Beach View St and Chester St to Chesapeake St)	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
167	Construct bike facility on W 21st St from Hampton Blvd to Armistead Ave	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	High
168	Widen and/or enhance the sidewalk on the Berkley Bridge (e.g. with lights for safety and easier access for pedestrians and bicyclists)	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
171	Construct sidewalks on Windermere Ave and Thomas St to connect from Sewells Point Rd to Azalea Garden Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
172	Construct bike lanes on Campostella Rd bridge	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Low
174	Provide a facility for bicyclists and scooters that connects the current protected bike lanes along Llewellyn Avenue to the south along Boush Street to connect to Downtown.	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	High
175	26th and 27th Street Reconfiguration between Colley Avenue and Leo Street/Ruffin Way	Bike/scooter facility projects	Committed projects with funding	Funded	Not scored
176	Pedestrian improvements along Colonial Avenue between West 27th Street and Princess Anne Road.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Not scored
179	Median pedestrian fencing along the 800 block of North Military Highway	Other	Candidate projects from current Transit Department	Unfunded	High
181	Safety & traffic calming improvements to be determined on Virginia Beach Boulevard from Park Ave to Ballentine Blvd.	Traffic Calming	Candidate projects from current Transit Department	Unfunded	High
182	Sidewalk, crosswalk, and bicycle facility and improvements on Little Creek Rd from Carlton Street to Shore Dr.	Sidewalk projects	Candidate projects from current Transit Department	Unfunded	High
184	Norfollk Traffic Control System Platform Upgrade	Traffic Signal Upgrades	Committed projects with funding	Funded	Not scored
185	Advanced Traffic Management System Upgrades, Phase 4C	Traffic Signal Upgrades	Committed projects with funding	Funded	Not scored

ID	Project Name	Project Type	Project Source	Funding	Need Level
186	E. Little Creek Road and Shore Drive Intersection Improvements.	Other	Committed projects with funding	Funded	Not scored
187	Flashing Yellow Phase II	Traffic Signal Upgrades	Committed projects with funding	Funded	Not scored
188	Flashing Yellow	Traffic Signal Upgrades	Committed projects with funding	Funded	Not scored
189	Brambleton Ave and Tidewater Dr Intersection Improvements.	Other	Committed projects with funding	Funded	Not scored
190	Brambleton Ave and Park Ave Intersection Improvements.	Other	Committed projects with funding	Funded	No Need Score
191	Chesapeake Blvd and Cromwell Drive Intersection Improvements.	Other	Committed projects with funding	Funded	Not scored
192	Crosswalk pavement markings, pedestrian refuge, and rectangular rapid flashing beacon and signage at Virginia Beach Boulevard and Chapel Street.	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
193	Countdown Ped Phase II	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
194	Little Creek Road & Admiral Taussig Blvd Intersection Improvements.	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
195	Hampton Boulevard/Azalea Court Intersection Improvements.	Pedestrian signals and crosswalk projects	Committed projects with funding	Funded	Not scored
196	Retroreflective Backplate Improvements	Traffic Signal Upgrades	Committed projects with funding	Funded	Not scored
197	Bus Shelters and Ped Improvements	Bus Shelter and Pedestrian Improvements	Committed projects with funding	Funded	Not scored
198	ADA Ramps	ADA Ramps	Committed projects with funding	Funded	Not scored
199	Llewellyn Ave and Princess Anne Road Intersection Improvements	Other	Committed projects with funding	Funded	Not scored
200	Tidewater Drive and Easy Street Safety Improvements	Other	Committed projects with funding	Funded	Not scored
201	Terminal Blvd/Diven St Intersection Improvements	Other	Committed projects with funding	Funded	Not scored
202	Sidewalk and curb ramp connection from bus stop to Walmart on 3300 Princess Anne Rd.	Sidewalk projects	Candidate projects from current Transit Department	Unfunded	Medium
203	Install new mid-block pedestrian crossing on W 38th St across from the 38th Street Playground with flashing beacon and ADA ramps. Remove on-street parking.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
204	Improved crosswalks and ped signals on Tidewater Dr at Cromwell Rd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Moderate
204	Improved crosswalks and ped signals on Ballentine Blvd at Princess Anne Rd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
204	Improved crosswalks and ped signals on Military Hwy at Corporate Blvd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Medium
205	Add pedestrian signals on Colley Ave at 27th St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
205	Add pedestrian signals on Llewellyn Av at 26th St	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
206	Pedestrian Poles & Signals and ADA ramps. on Colley Ave at 35th St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	High
206	Pedestrian Poles & Signals and ADA ramps on E Ocean View Ave at 13th Bay St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
206	Pedestrian Poles & Signals and ADA ramps on Granby St at 21st St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
206	Pedestrian Poles & Signals and ADA ramps on Monticello Ave at 21st St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
207	Pedestrian Poles & Signals and ADA ramps on Little Creek Rd at Meadow Creek Road.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Medium
207	Intersection bulb-outs on Colonial Ave at 20th St.	Traffic Calming	Candidate projects from current Transit Department	Funded	Moderate
208	School Zone Flashing Beacon at Crossroads Elementary School on Tidewater Drive.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
208	School Zone Flashing Beacon at Jacox Elementary School on Marshall Ave.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	High
208	School Zone Flashing Beacon at St Helena Elementary School on S Main Street (Berkley).	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	High
208	School Zone Flashing Beacon at Tanners Creek Elementary School on Longdale Drive (Rosemont)	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
209	School Zone Flashing Beacon at Booker T. Washington High School	Pedestrian signals and crosswalk projects	Comment from Bike/Ped Commission	Unfunded	High
209	School Zone Flashing Beacon at Southside STEM Academy	Pedestrian signals and crosswalk projects	Comment from Bike/Ped Commission	Unfunded	High
209	Improved crosswalk and ped signals on E Ocean View Ave at 3rd Bay St.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Not scored
210	Pedestrian Poles & Signals and ADA ramps on Granby St at Maple Ave. Consider SB left turn lane	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
211	Pedestrian Signals on Granby St at Adm Taussig Blvd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
212	Ped only phase on Granby St at Kingsley Ln.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Medium

ID	Project Name	Project Type	Project Source	Funding	Need Level
213	Pedestrian Poles & Signals and ADA ramps on Granby St at Va Beach Blvd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Moderate
214	ADA ramps on Hampton Blvd at Beechwod Ave.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Not scored
214	ADA ramps on Hampton Blvd at Glendale Ave.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Not scored
215	Signal Replacement Ped Safety at the intersection of Hampton Blvd & Princess Anne Rd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
216	Ped Countdown Signals on Indian River Rd at Berkley Ave.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Medium
217	Install pedestrian signals on Lafayette Blvd at Waverly Way.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
219	Pedestrian signals, marked crosswalk, and short sections of sidewalk to connect to bus stops on Military Hwy at Azalea Garden Rd.	Sidewalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
222	WB right turn overlap - 5 section signal on Tidewater Dr at Widgeon Rd.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
223	Pedestrian crossing improvements at Tidewater Dr at Willow Wood Dr, including closing driveway on northwest corner.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Funded	Moderate
224	Pedestrian Poles & Signals on Va Beach Blvd at Merrimac Ave.	Pedestrian signals and crosswalk projects	Candidate projects from current Transit Department	Unfunded	High
225	Pedestrian signals, sidewalk, and curb ramps on Va Beach Blvd at at Janaf Shopping Center/ Glenrock Road intersection.	Sidewalk projects	Candidate projects from current Transit Department	Unfunded	Moderate
227	Improve walk, bike, scooter, and transit access to the Norfolk Fitness and Wellness Center.	Other	Candidate projects from 2021 needs assessment	Unfunded	High
228	Extend northbound sidewalk on Westcliff Dr to the intersection with Bancker Rd and construct a curb ramp	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
229	Construct crosswalks and curb ramps on Tidewater Dr at Norman Ave	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	Moderate
231	Install a mid-block crossing on W Olney Rd between W Wilson Ave and Magazine Ln	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High

ID	Project Name	Project Type	Project Source	Funding	Need Level
232	Construct sidewalks in the Lake Taylor/Fairlawn neighborhood on Georgetown Rd and Loackamy Ln and all intersecting streets. Consider traffic calming measures to slow down vehicles.	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
233	Pedestrian improvements at W Brambleton Ave and Botetourt St	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
234	Fill in sidewalk gaps, provide ADA compliant curb ramps, and provide signage for turning vehicles to yield to pedestrians in the crosswalk across Scott Street.	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
235	Improve visibility of pedestrians crossing Colley Avenue at Spotswood Ave and at Blair Middle School by removing parking closest to the intersection, installing bulb-outs, considering raised crosswalks or other improvements to increase driver yielding to crossing pedestrians.	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
237	Sidewalk and curb ramp replacements at Omohundro Ave and W 35th St	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
238	Install crosswalks at Hampton Blvd and W 25th St	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
239	Improve walking paths in Poplar Hall Park	Other	Candidate projects from 2021 needs assessment	Unfunded	Medium
240	Provide additional safety treatments for pedestrians crossing W 21st Street at several locations, including (1) the mid-block crossing on W 21st St between Llewllyn Ave and De Bree Ave, (2) at Manteo Street, and (3) between Colley Ave and Manteo Street	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
244	Pedestrian improvements at Tidewater Dr and Cromwell Dr	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Funded	Moderate
245	Install a scooter corral on the Elizabeth River Trail at Warrington Ave	Bike/scooter facility projects	Candidate projects from 2021 needs assessment	Unfunded	Medium
246	Install additional safety features at Boush St and Brooke Ave mid-block crossing. Widen the pedestrian refuge island.	Pedestrian signals and crosswalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
247	Construct a shared-use path along Terminal Blvd from Hampton Blvd to the Ward's Corner HRT Transfer Center	Bike/scooter facility projects	Candidate projects from current Transit Department	Funding application submitted	Moderate

ID	Project Name	Project Type	Project Source	Funding	Need Level
248	Construct sidewalks on Chesapeake Blvd from Fishermans Rd to Bayview Rd	Sidewalk projects	Candidate projects from 2021 needs assessment	Unfunded	High
249	Provide a facility for bicyclists and scooters and improve pedestrian crossings along Ocean View Avenue from Willoughby Spit to Shore Drive	Bike/scooter facility projects	Candidate projects from current Transit Department List, Strategic Bike/Ped Plan, and public comment	Unfunded	High
250	Hampton Blvd traffic safety improvements	Other	Candidate projects from current Transit Department	Funded	High

Appendix H: Multimodal Norfolk Resource Allocation Plan

The map is available at www.MultimodalNorfolk.com.
Last Updated 4/14/2022

ID	Project Name/Description	Need Level [1]	Project Readiness [2]	Project Type	Cost Category [4]	Primary Potential Funding Source [3]
246	Install additional safety features at Boush St and Brooke Ave mid-block crossing. Widen the pedestrian refuge island.	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP (ARPA?)
208.1	School Zone Flashing Beacon at Crossroads Elementary School on Tidewater Drive.	High	Ready	Pedestrian signals and crosswalk projects	Medium	ARPA
150	Complete missing sidewalks on Shoop Ave from Chesapeake Blvd to St Mihiel Ave	High	Ready	Sidewalk projects	Low	CIP
211	Pedestrian Signals on Granby St at Adm Taussig Blvd.	Moderate	Ready	Pedestrian signals and crosswalk projects	Medium	CIP/ARPA
174	Provide a facility for bicyclists and scooters that connects the current protected bike lanes along Llewellyn Avenue to the south along Boush Street to connect to Downtown.	High	Ready	Bike/scooter facility projects	High	CIP
237	Sidewalk and curb ramp replacements at Omohundro Ave and W 35th St	High	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
208.6	School Zone Flashing Beacon at Southside STEM Academy	High	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
154	Construct sidewalks on Whitehead Ave from E Berkley Ave to Fauquier St	High	Ready	Sidewalk projects	High	CIP
130	Install vertical barriers or separation on bike lanes on Ocean View Ave from Shore Dr to Inlet Rd	Moderate	Ready	Bike/scooter facility projects	Medium	CIP
206.2	Pedestrian Poles & Signals and ADA ramps on E Ocean View Ave at 13th Bay St.	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP
205.2	Add pedestrian signals on Llewellyn Av at 26th St	High	Ready	Pedestrian signals and crosswalk projects	Low	CIP
120	Complete missing sidewalks on Pleasant Ave from Shore Drive to 5th Bay St	Moderate	Ready	Sidewalk projects	Very High	CIP
222	WB right turn overlap - 5 section signal on Tidewater Dr at Widgeon Rd.	Moderate	Ready	Pedestrian signals and crosswalk projects	High	CIP
125	Complete missing sidewalk on Norview Ave from Sedgefield Dr to Tidewater Dr and improve railroad crossing	Medium	Ready	Sidewalk projects	Very High	CIP
212	Ped only phase on Granby St at Kingsley Ln.	Medium	Ready	Pedestrian signals and crosswalk projects	Tactical	CIP
245	Install a scooter corral on the Elizabeth River Trail at Warrington Ave	Medium	Ready	Bike/scooter facility projects	Tactical	CIP
146	Construct sidewalks on S Newtown Rd from the I-64 underpass to Curlew Dr	Medium	Ready	Sidewalk projects	Very High	CIP

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Last Updated 4/14/2022

ID	Project Name/Description	Need Level [1]	Project Readiness [2]	Project Type	Cost Category [4]	Primary Potential Funding Source [3]
172	Construct bike lanes on Campostella Rd bridge	Low	Ready	Bike/scooter facility projects	Medium	CIP
215	Signal Replacement Ped Safety at the intersection of Hampton Blvd & Princess Anne Rd.	High	Ready	Pedestrian signals and crosswalk projects	Very High	Revenue Sharing
204.2	Improved crosswalks and ped signals on Ballentine Blvd at Princess Anne Rd.	Moderate	Ready	Pedestrian signals and crosswalk projects	High - Very High	Revenue Sharing
160	Construct sidewalks on Jersey Avenue from Robin Hood to Chesapeake Blvd and explore traffic calming techniques to slow down vehicles, especially at the intersection of Jersey Avenue and Radford Street.	Medium	Ready	Traffic Calming	Very High	Revenue Sharing (could be interchanged with CIP)
152	Construct sidewalks on Tait Terr from Chesapeake Blvd to McKann Ave	Medium	Ready	Sidewalk projects	Very High	Revenue Sharing (could be interchanged with CIP)
56	Lane repurposing on Monticello Ave from Brambleton Ave to Olney Rd	High	Ready	Traffic Calming	Low	CIP
83	Strategic Bike/Ped Plan Corridor 6: Indian River Road -- South Norfolk Connector. Segment 3: Indian River Rd from Campostella Rd to City Limits. Lane repurposing with buffered bike lanes.	High	Ready	Bike/scooter facility projects	Very High	SMART SCALE
249	Provide a facility for bicyclists and scooters and improve pedestrian crossings along Ocean View Avenue from Willoughby Spit to Shore Drive	High	Ready	Bike/scooter facility projects	Very High	**SMART SCALE**
182	Sidewalk, crosswalk, and bicycle facility and improvements on Little Creek Rd from Carlton Street to Shore Dr.	High	Ready	Sidewalk projects	Very High	**SMART SCALE**
179	Median pedestrian fencing along the 800 block of North Military Highway	High	Ready	Other	Medium	**SMART SCALE**
166	Chesapeake Blvd Pedestrian Improvements (Bayview Blvd to Beach View St and Chester St to Chesapeake St)	Moderate	Ready	Sidewalk projects	Very High	**SMART SCALE**
122	Dovercourt Rd Pedestrian Improvements (Ardmore Rd to Bancker Rd)	Medium	Ready	Sidewalk projects	High	**SMART SCALE**
240	Provide additional safety treatments for pedestrians crossing W 21st Street at several locations, including (1) the mid-block crossing on W 21st St between Llewllyn Ave and De Bree Ave, (2) at Manteo Street, and (3) between Colley Ave and Manteo Street	High	Ready	Pedestrian signals and crosswalk projects	Medium-High	HSIP

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Last Updated 4/14/2022

ID	Project Name/Description	Need Level [1]	Project Readiness [2]	Project Type	Cost Category [4]	Primary Potential Funding Source [3]
208.5	School Zone Flashing Beacon at Booker T. Washington High School	High	Ready	Pedestrian signals and crosswalk projects	Medium	HSIP
224	Pedestrian Poles & Signals on Va Beach Blvd at Merrimac Ave.	High	Ready	Pedestrian signals and crosswalk projects	Low	HSIP
205.1	Add pedestrian signals on Colley Ave at 27th St.	High	Ready	Pedestrian signals and crosswalk projects	Low	HSIP
210	Pedestrian Poles & Signals and ADA ramps on Granby St at Maple Ave. Consider SB left turn lane	Moderate	Ready	Pedestrian signals and crosswalk projects	High	HSIP/Revenue Sharing
217	Install pedestrian signals on Lafayette Blvd at Waverly Way.	Moderate	Ready	Pedestrian signals and crosswalk projects	Low	HSIP
206.4	Pedestrian Poles & Signals and ADA ramps on Monticello Ave at 21st St.	Moderate	Ready	Pedestrian signals and crosswalk projects	Medium	HSIP
219	Pedestrian signals, marked crosswalk, and short sections of sidewalk to connect to bus stops on Military Hwy at Azalea Garden Rd.	Moderate	Ready	Sidewalk projects	Low	HSIP
225	Pedestrian signals, sidewalk, and curb ramps on Va Beach Blvd at at Janaf Shopping Center/ Glenrock Road intersection.	Moderate	Ready	Sidewalk projects	Medium	HSIP
206.3	Pedestrian Poles & Signals and ADA ramps on Granby St at 21st St.	Moderate	Ready	Pedestrian signals and crosswalk projects	Low	HSIP
204.3	Improved crosswalks and ped signals on Military Hwy at Corporate Blvd.	Medium	Ready	Pedestrian signals and crosswalk projects	High	HSIP
216	Ped Countdown Signals on Indian River Rd at Berkley Ave.	Medium	Ready	Pedestrian signals and crosswalk projects	Low	HSIP
139	Construct sidewalks on 13th Bay St	Medium	Ready	Sidewalk projects		
129	Install bike lanes and other traffic calming treatments on Lafayette Blvd from E 26th St across the bridge to Tidewater Dr	High	Ready	Bike/scooter facility projects	High	TAP
167	Construct bike facility on W 21st St from Hampton Blvd to Armistead Ave	High	Ready	Bike/scooter facility projects	High	TAP
55	Lane repurposing on Virginia Beach Blvd from Boush St to Monticello Ave	Moderate	Ready	Traffic Calming	Medium	TAP
165	Connect the end of Pope Ave to Chesapeake Blvd with a paved path (off-road connection)	High	Ready	Sidewalk projects	Low	TAP
159	Construct sidewalks on Burksdale Rd from Simmons Dr to Tidewater Dr	High	Ready	Sidewalk projects	High	TAP

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ID	Project Name/Description	Need Level (1)	Project Readiness (2)	Project Type	Cost Category (4)	Primary Potential Funding Source (3)
228	Extend northbound sidewalk on Westcliff Dr to the intersection with Bancker Rd and construct a curb ramp	High	Ready	Sidewalk projects	High	TAP
171	Construct sidewalks on Windermere Ave and Thomas St to connect from Sewells Point Rd to Azalea Garden Rd	Moderate	Ready	Sidewalk projects	High	TAP
140	Construct sidewalks on E Seaview Ave from Norfolk Ave to Granby St	Moderate	Ready	Sidewalk projects	High	TAP
208.4	School Zone Flashing Beacon at Tanners Creek Elementary School on Longdale Drive (Rosemont)	Moderate	Ready	Pedestrian signals and crosswalk projects	Low	TAP
156	Construct sidewalks on Azalea Garden Rd from Robin Hood Rd to Sewells Point Rd	Moderate	Ready	Sidewalk projects	Very High	Smart Scale Round 6
137	Construct sidewalks on N Military Hwy from southeast of Croft St to E Little Creek Rd	High	Ready	Sidewalk projects		
248	Construct sidewalks on Chesapeake Blvd from Fishermans Rd to Bayview Rd	High	Ready	Sidewalk projects	Very High	Smart Scale
138	Construct sidewalk on Heutte Dr from Camellia Rd to Shore Dr	Moderate	Ready	Sidewalk projects		
144	Construct sidewalks on Chesapeake Blvd from E Little Creek Rd to Fishermans Rd	Moderate	Ready	Sidewalk projects	Very High	Smart Scale
162	Construct sidewalk on northbound side of Ingleside Rd from Ladd Ave to Riverside Dr	Moderate	Ready	Sidewalk projects		

High Need, Ready
Moderate Need, Ready
Medium or Low Need, Ready

Table Footnotes:

(1) Need level was determined by a data-driven process that included public input, as detailed in Chapter 12.

(2) Project readiness was determined by city staff based on initial examination of potential utility issues, right-of-way constraints, presence of curb and gutter, and level of public input to date.

(3) Potential funding sources are subject to change as state and federal legislation on funding changes frequently. The primary potential funding source was determined at the time of the report writing but may change in the future.

(4) Cost categories:



Appendix I: 2015 Norfolk Bicycle and Pedestrian Strategic Plan

As described in Chapter 5, the City Council of Norfolk adopted the Norfolk Bicycle and Pedestrian Strategic Plan ("Strategic Plan") in 2015. The Strategic Plan recommends specific bicycle and pedestrian facilities on 12 key corridors.

The Bicycle and Pedestrian Master Plan provided in Chapter 5 by contrast, expands beyond these 12 key corridors to comprise a true citywide master plan. This Master Plan incorporates the 12 key corridors from the Strategic Plan and the network of existing facilities as a starting point. The Bicycle and Pedestrian Master Plan connects the network of existing facilities and proposed facilities from the Strategic Plan with the Multimodal Centers identified in Chapter 4. This Master Plan shows connections to fill in a finer grained network across the entire City.

The 2015 Bicycle and Pedestrian Strategic Plan remains an active and relevant plan, and the City will continue to use the Strategic Plan in its decision-making processes. The Strategic Plan is provided in this Appendix. It should be noted that the recommendations in the Strategic Plan will be implemented in accordance with the latest industry design guidance for bicycle facilities, which has changed since 2015 and continues to evolve.



City of Norfolk Bicycle and Pedestrian Strategic Plan

September 2014

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Chapter 1: Introduction

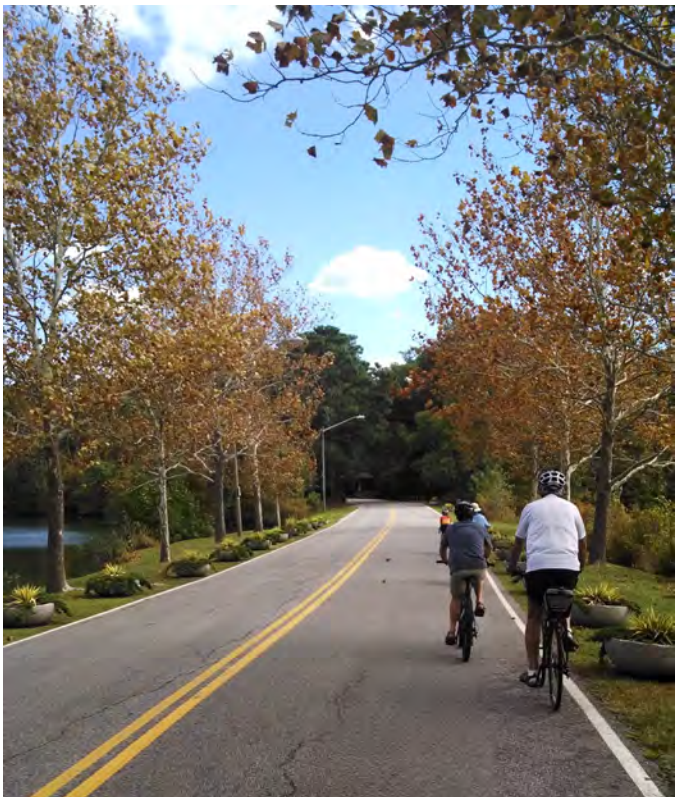
City leaders and residents are seeking to make Norfolk a great place for bicycling and walking. Many residents and visitors already ride bicycles in the city, both for recreation and transportation, and all residents and visitors are pedestrians at one time or another, even if they make most of their trip via transit, automobile or bicycle. This Strategic Plan equips the City with recommendations to improve 12 key corridors identified by stakeholders as critical to kick-starting a comprehensive and connected bicycle network. Recommended improvements also benefit pedestrians through improved crossings at major streets and provision of bicycle facilities that will help residents avoid sidewalk riding. Implementation of the Plan recommendations will result in a solid foundation upon which Norfolk can continue building the premier bicycle and pedestrian friendly city in Virginia.

Bicycling and Walking in Norfolk

Overall, most trips in Norfolk today are taken by automobile. While commute trips only account for a portion of overall trip types in the city, over 80 percent of commutes are taken in passenger cars and trucks. Just four percent are taken using public transit; slightly more than five percent by walking, and less than one percent is taken by bicycle.[1]

These figures do not account for the many non-work trips that occur on a daily basis: errands, social or family visits, school drop-off and pick-up, and others. It is possible that a greater percentage of these trips are taken by bicycling and walking as Norfolk is a compact city and commercial land uses are dispersed throughout. In addition to dispersed commercial land uses, Norfolk has a number of other important assets that can be key to building strong bicycle and walking mode shares for daily transportation, including the following:

- A strong share of the regions jobs and accessible employment sites
- A traditional downtown that is strengthening its mix of commercial and residential land uses
- Recreation and entertainment destinations such as the Virginia Zoo, Elizabeth River and Chesapeake Bay waterfronts, Norfolk Botanical Gardens, performing arts centers and sports venues
- A compact shape (it is only eight miles east to west and north to south)
- A fairly well connected street grid
- Large universities and other public institutions



The Norfolk Botanical Garden is a popular destination for bicyclists.

1 American Community Survey 5-Year Estimates, 2014.

- Flat terrain
- Neighborhood based school boundaries

While Norfolk may not currently have large volumes of commuting cyclists, it does have thousands of bicycle enthusiasts that like to recreate regularly. Many of these cyclists use major city streets for morning or afternoon rides when traffic volumes are low. Norfolk also has many walkers, including those that stroll the waterfronts, walk their dogs in local parks and city-owned cemeteries, exercise on the Elizabeth River Trail and non-drivers and people without access to vehicles,

Norfolk, like cities across the U.S., is experiencing an influx of young residents who want to live in a city, but not spend exorbitant time in their car. Due to the strong mix of employment, commercial activities, public institutions and residential population, the downtown, greater Ghent and Old Dominion University (ODU) areas of the city are experiencing a dramatic increase in people bicycling and walking. Other parts of the city generate bicycle and pedestrian activity as an affordable means of daily transportation, to jobs, school and shopping. While hard numbers are currently not available, it is easily noticed when observing street life in these areas.

Current conditions for bicycling and walking are not poor, but they are not exemplary either. This was underscored by the comments residents provided in the public outreach meetings conducted during the planning process. Though destinations are nearby, conditions make it difficult to walk or bike there. As a result, many bicyclists are observed riding on sidewalks, and walking trips are made less safe by necessary crossing of large auto-oriented streets. Additionally, bicyclists are often found riding in the street against traffic or in other unpredictable ways, which are not uncommon in communities with minimal bicycle infrastructure.

There are a number of groups within Norfolk, in addition to the City, who are working to make it a better place for bicycling and walking. The Tidewater Bicycle Association (TBA) is a regional advocacy group with members in Norfolk, Chesapeake, Portsmouth, Newport News and Virginia Beach. Many members of TBA were involved in this Planning process, and TBA will continue to work to improve the region's bicycle environment The Bicycling and Pedestrian Trails Commission, a citizen representative body appointed by City Council, serves to advise the City on pedestrian and bicycle matters .

The Downtown Norfolk Council (DNC) was also an involved stakeholder in developing this Plan. The DNC has promoted and funded bicycle improvements in



Some intersection locations in the city present challenges to through movements because of large, complex design and high traffic volumes.

the downtown area, including shared lane markings on Granby Street and installation of bike racks. The DNC also seeks an improved pedestrian environment for downtown residents and business owners. Old Dominion University is a major presence in the city that is also making improvements for pedestrians and bicyclists. The university installed pedestrian crossing safety improvements along its periphery in the last few years, and the Outdoor Adventure Program office has started a bike share program for students, faculty and staff affiliated with the university. Other Norfolk colleges and universities are recognizing a growing interest among staff and students in bicycling as well.

Recent Changes in Bicycling and Walking

A number of infrastructure improvements for bicycling and walking have been implemented by the City in the last decade. The Elizabeth River Trail was developed in 1994 and has been continually improved with new sections, including one under construction currently (summer 2015) along Weyanoke Street. Bike lanes and shared lane markings have been added to a number of streets throughout the city – Church Street, Willoughby Avenue and Ocean View Avenue among others. These facilities create space for bicyclists on the street and make all roadway users aware of bicycle traffic. Bicycle parking has been added downtown and in commercial corridors such as Colley Avenue and Colonial Avenue. Additionally, the Parking Chapter of the City of Norfolk Zoning Ordinance, 1992 as amended, now requires most new development to provide bicycle parking.

Investments have also been made in pedestrian infrastructure, most notably in redeveloping parts of the city. For instance, a portion of the 21st Street commercial strip received new sidewalks in 2009 that feature a planter strip, and planted curb extensions were installed on the portion near Llewellyn Avenue. Sidewalk and crossing improvements have also been installed near Tide stations to improve access to and from the light rail.

All of these efforts form a promising start for improved bicycling and walking in Norfolk.

Plan Organization

The Norfolk Bicycle and Pedestrian Strategic Plan contains the following elements:

Chapter 2: Plan Development Process

Summarizes the process used to develop the Plan's infrastructure, policy and program recommendations, including public and stakeholder outreach

Chapter 3: Implementation

Presents overarching strategies, cost estimates, funding mechanisms and policy recommendations for implementation of the Plan

Chapter 4: Corridor Facility Recommendations

Details the recommended facility improvements and existing conditions for each of the 12 Plan corridors, including facility types, implementation actions and cost estimates

Appendices

A: Public Involvement Process

B: Level of Traffic Stress Analysis and Maps

C: Cost Estimate Details

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Chapter 2: Plan Development Process

This development of this Plan was a collaborative effort among City staff, stakeholders, interested citizens and the consultant team. This chapter outlines the process that led to recommendations presented for 12 corridors in Chapter 4.

Stakeholder Goals

A set of goals laid out by City staff and stakeholders early in the planning process drove the development of this Plan.

Goal: Improve the environment for bicycling and walking in Norfolk

City staff and stakeholders recognize that while elements are lacking in the pedestrian environment currently, the experience for bicyclists is in greater need of improvement. Residents are bicycling throughout Norfolk today, but they are doing so on infrastructure constructed solely for automobile and pedestrian travel.

In environments like this, bicyclists create their own spaces and ways of adapting to the infrastructure, which often leads to bicyclist behavior that is inconsistent or in conflict with expected vehicular movements on the street network. This Plan provides recommendations that will give bicyclists their own space on many streets, creating safer routes and encouraging more predictable riding habits which are directed by signage, markings and other elements. These marked bikeways will also alert drivers to bicyclists' presence on streets and help explain where they need to share the travel lane with bicyclists.

The recommendations in this Plan will also create better pedestrian environments, and do so in a variety of ways. First, by providing defined on-street facilities for bicyclists that increase comfort and safety, they will be less likely to use sidewalks, lessening potential conflicts with pedestrians. Secondly, most of the on-street bikeways will be accomplished by moving the traffic further from the curb and sidewalk; the bike lanes, buffered bike lanes and protected bike lanes will create more space between pedestrians and fast-moving traffic. Finally, many of the proposed bicycling upgrades involve creation of safer crossings of major streets. These improvements—crosswalks, rectangular rapid flashing beacons, medians, High-Intensity Activated Crosswalk (HAWK) signals—will also make it safer and more comfortable for pedestrians to cross busy roads.



Safe interactions between bicyclists and pedestrians are part of the goal to improve the bicycling and walking environment in Norfolk.

Goal: Move quickly toward implementation

Rather than identifying a comprehensive network that might take 20 to 30 years to develop, this Plan focused on developing a detailed list of implementable projects.. To achieve this goal, the project team identified bikeway improvements for a select set of corridors that were selected based on the following relevant criteria:

Corridor Selection Criteria

- *Provide at least one corridor in every part of the city*
- *Ensure all corridors connect to each other*
- *Avoid arterials with the largest amounts of traffic and those requiring major reconstruction and land use changes to be made bicycle and pedestrian friendly*
- *Include alternatives to the arterial corridors that are avoided for reasons stated above*
- *Include corridors where staff knowledge suggests improvements can be made with relatively little impact to motor vehicle traffic*
- *Include corridors where people already ride and that connect destinations which bicyclists want to access*
- *Connect to key destinations including downtown, beaches, rivers, the Elizabeth River Trail, employment and activity centers, and other cities*

Goal: Ensure corridor selection reflects public interest

A map and draft list of potential study corridors was developed by the Bicycling and Pedestrian Trails Commission and the project working group. Stakeholder and general public input were sought and used to refine the initial list and identify any important connections that were missing. Stakeholder meetings were held in October 2014, with the following targeted groups:

- Universities
- Bicycling and Pedestrian Trails Commission
- Downtown Norfolk Council

Three public meetings were held in different locations throughout the city to provide the opportunity for varied groups of residents to give input. Attendees were asked to identify important destinations and areas of concern for walking and bicycling. A full account of these meetings and their results is provided in Appendix A.

Residents also had the opportunity to give input online via an interactive map, called a WikiMap. The destinations, barriers and routes identified on this map helped inform the selection of study corridors. The results of this tool are also summarized in Appendix A.

The project team used input gathered from all of these sources to select the final set of 13 study corridors. They conducted field visits to the corridors during three trips in October and December 2014 and February 2015. The final corridors selected are show in the map on the following page.

Comparison Study: Granby Street and Llewellyn Avenue

Based upon public input from bicyclists and an analysis of the city's street grid south of the Lafayette River, it became apparent that a comparison study of two key north-south routes into downtown should be conducted as a part of the overall bikeway planning and corridor selection effort.

From the bridge over the Lafayette River to Downtown, Llewellyn Avenue and Granby Street are a few blocks a part, and run parallel to each other. However, at the north and south ends of these streets, their character and connectivity with other streets vary. In downtown espeically they serve different destinations where Granby becomes the traditional retail commercial center of Norfolk and Lewellyn becomes Duke Street in the waterfront residential section of downtown known as Freemason.

Because of challenging existing conditions on Granby Street north of the Zoo, it was determined that at



Final Study Corridors Map

the north end both routes would use Llewellyn from 30th Street to the Lafayette River. Granby from 30th Street/Church Street to the north, despite the existence of a short stretch of bicycle lanes near the zoo, did not present much opportunity for a bikeway that could be protected from motor vehicle traffic. Also, Llewellyn had safer transitions from the bridge to the surface streets in both the northbound and southbound directions. Additionally, south of Olney Road, where Llewellyn transitions to Boush and Duke Streets, Granby was preferred as the priority bikeway street through downtown, because of its centrality, proximity to many popular destinations, existing traffic calming (15 mph speed limit) and direct access to the waterfront at Town Point Park.

Given the assumption of using Llewellyn in the North and Granby in the south, the study sought to identify one or two linkages between the two north-south corridors, using east-west streets in the grid somewhere between Olney Road and approximately 30th Street. It was assumed that Olney Road would function as a good southbound cut-over to Granby, but that northbound cyclists on Granby may be inclined to remain on Granby and desire to cut-over to Llewellyn at some point further north (the new YMCA at 29th Street was thought to a potential bicycle destination as well). As a result, the study examined the potential for east-west linkages using the following cross streets: West 28th, 29th, 30th or 31st Streets; West 20th Street; and Shirley Avenue.

The table below illustrates a number of the differences between the two primary corridors.

Recommendations

Due to the nature and design of the land uses along Llewellyn Avenue, the low traffic volumes, the high aesthetic qualities of the median and shade trees, and low cost of providing a protected bicycle lane, Llewellyn from Olney to 21st Street is recommended

ATTRIBUTES	ROUTE OPTION 1	ROUTE OPTION 2
	Llewellyn (30th Street to Olney)	Granby (30th Street to Olney)
Range of Average Daily Traffic	2,100 to 23,000	2,100 to 9,000
Range of Speed Limits	15 to 30	25 to 30
Range of Overall Street Width	34’ to 66’	
Number of Travel Lanes	4 lanes divided south of 20th Street. 3 lanes north of 21st Street (2 northbound)	2 travel lanes with on-street parking on both sides in most blocks
Median	25-foot vegetated medial with mature shade trees, south of 20th Street	None
Residential Areas	Olney Road to Shirley; 25th Street to 38th Street	No exclusive residential areas
Mixed Use Areas	Shirley to 25th Street; 38th Street to Granby Street	Virginia Beach Blvd. to 30th Street
Retail/Commercial Areas	Near intersection of 21st Street	Main Street to Virginia Beach Blvd.
Unique Destinations Served	Residential areas of Ghent near Botetourt Gardens; Freemason	Mixed use areas north of Shirley Avenue
Potential for and impacts of introducing dedicated bicycle facilities	Great potential, including almost a mile of separated bike lanes	Bicycle lanes only possible by eliminating parking on one side

Table 1: Comparison of Two Primary Corridors

as the preferred route. In the same stretch, the curb-to-curb width of Granby, higher traffic volumes and need to eliminate on street parking made achieving an equally high quality facility more challenging. Underlying this recommendation is the recognition that by providing protected bicycle lanes for almost a mile on Llewellyn Avenue, the City can best serve the population of novice or tentative bicyclists for whom lack of safety in traffic is a notable barrier to bicycling. Because priority shared lane markings are the best improvement possible on Granby, under current conditions, this route was found to be a less desirable option to get more people bicycling in Norfolk, especially for short trips around town.

Olney Road and Shirley Avenue were found to be the best "cut-over" streets for both north and southbound bicycle traffic, and both should be signed and marked accordingly. Because 28th and 30th are one way eastbound, they would have to be regulated to allow contra flow cyclists to accommodate the northbound link to Llewellyn. 29th Street does not go through to Granby, due to the new YMCA. Making a northbound left turn on 31st Street would be challenging without special treatments due to its close proximity to the Church Street intersection. Making a southbound left turn on 20th Street was also found to be a potentially unsafe location.

The intersections at Shirley and Llewellyn and Shirley and Granby can receive additional treatments to facilitate the left turn movements required. It is also assumed that the complex intersection of Llewellyn/Olney/Duke/Boush/Virginia Beach Blvd. will be addressed as part of the overall project on Llewellyn to make turning and transition movements at that location, efficient, clear and safe.

North of 21st Street, Llewellyn narrows significantly, but can support bicycle lanes by eliminating one of the three existing travel lanes (two northbound and one southbound). The extra motor vehicle capacity is not needed in the northbound direction, and pedestrians and residents along this segment will benefit from the traffic calming effect that will accompany the road diet and addition of bicycle lanes. There are some modest but important design challenges in this section, including the following:

- A few blocks of concrete roadway, upon which the thermoplastic lane striping and bicycle symbols tend to wear-off much faster
- The need for turn lanes at 38th Street
- The fact that the section from 38th Street to the north was recently repaved and marked with shared lane markings and all of this roadway striping and marking would need to be redone.
- The need to address the potential for bicycle detection at the signal at Connecticut and Granby for northbound cyclists.
- Additional eradication of existing striping in order to change/add bicycle lane striping on the transitions to and from the bridge between the bridge and Connecticut (there are no space limitations in this area)
- Design consideration needed on the block north and south of 21st Street to address right turning motor vehicle movements.

The second recommendation is to implement priority shared lane markings on Granby between Olney Road and Shirley in conjunction with the Llewellyn corridor improvements.

The third recommendation of this study is that Granby, between Shirley and the Zoo should be improved as well with priority shared lane markings, but in a later phase of work. While Llewellyn is the preferred route to improve to serve origins and destinations north of the Lafayette River, Granby north of Shirley is becoming its own origin and destination as a mixed use neighborhood that is a bikeable distance from many key destinations throughout the city. Due to revitalization of the properties in this corridor (the YMCA as an example) and its neighbor street, Monticello Avenue (which is much less bicycle friendly and more difficult to make so), Granby is likely to begin generating a significant number of bicycle trips sooner rather than later.

The final recommendation: due to the existence of bicycle lanes on Church Street south of the zoo, and the importance of the zoo as a bicycle destination, a future study should look at Granby adjacent to and north of the Zoo, as well as Columbus Avenue. This study should determine if improvements can be made to link to the Lafayette River bridge. If feasible, a bikeway along this portion of Granby might improve bicycle safety and be a cost effective addition to the City's overall bikeway network.

Recommendations Development

Data was gathered about the streets in each corridor from a variety of sources, including field work. Data used in the study process included Virginia Department of Transportation (VDOT) Average Daily Traffic counts, the width and configuration of travel lanes, shoulders and other road space, the presence of bicycle facilities, the speed limit, the presence of crossing treatments and intersection signalization. Team members also noted locations that would present particular challenges to bicyclists or pedestrians, many of which were large, complex intersections or high-volume, high-speed cross streets at unsignalized locations. The team also studied off-street alignments for the potential to improve directness, decrease exposure to heavy traffic, or circumvent a barrier.

Through this process, one corridor was eliminated from consideration because a reasonable solution was deemed infeasible at this time. This corridor would create an important connection between Wards Corner and Hampton Boulevard. Study of the area reveals a disconnected street network, water barriers and lack of opportunity along Little Creek Road for an on- or off-street bicycle facility. This led the project team to confirm the importance of an alternative route which City staff are currently developing to provide an off-street trail parallel to Terminal Boulevard on the south side of the adjacent railroad line. Due to the large amount of open and unused space parallel to the railroad, it appears to be the best and possibly least costly option.

For the remaining 12 corridors, baseline data was used to develop facility recommendations. Facility types and their bicycling attributes are explained in the following section. In general, recommended facilities fit within the existing curb-to-curb width and are accommodated through road diets and lane diets.[2] Some recommendations require widening of road pavements, but these only occur in locations without curb and gutter. There are also a handful of recommendations for shared use paths that will be constructed outside of the street right-of-way.

In addition to physical constraints, speed limit and traffic volumes were considered in identifying the appropriate facility type. Where streets have higher speeds and volumes, greater separation from automobile traffic is provided. Many of the largest streets in the network have low enough traffic volumes that road diets are likely to be feasible with minimal impact to motor vehicle traffic. On Granby Street and Chesapeake Boulevard, for instance, removal of a travel lane in each direction is recommended for much of their length, and this provides space for wide buffered bike lanes with horizontal separation between bicyclists and adjacent automobiles.

Cost estimates were developed for each corridor based upon the set of recommended improvements needed to make it an effective bikeway, including the features such as crossing signals that would serve both pedestrians and bicyclists. Costs for additional pedestrian-specific improvements (e.g., high-visibility crosswalks) were not included in the cost estimates because a complete assessment of pedestrian needs was not conducted. However, a table of costs for typical pedestrian features is included in the cost estimate appendix.

Strategic Plan v. Master Plan

As a strategic bicycle and pedestrian plan, this Plan identifies improvements for a limited number of corridors. Yet these corridors touch the entire city and create a framework upon which an even more robust long-term bicycle network can be built. This Plan provides a greater level of detail for each corridor than a typical master plan would, and it includes specific facility components that will benefit both bicyclists and pedestrians, such as location specific crossing improvements.

As a whole, the 12 corridors connect important destinations throughout the city and connect to one another, existing facilities, or already planned improvements. This focused set of recommendations provides the City with a defined list of improvement projects that can be placed directly into a Capital Improvement Program, annual City budgets, and be used for funding applications from non-City sources.

At some point in the future, the City may need to develop a master bicycle plan that would consider possible bicycle facility treatments for the many arterial and collector streets that were not

2 A road diet eliminates one or more travel lanes to free up roadway space for other uses. A lane diet narrows lanes but maintains the same number of lanes.

studied in this Plan. A master plan could identify a comphrehensive citywide grid of quality bicycle facilities and address bicycle safety education, encouragement programs, and traffic law enforcement issues.

Similarly, a pedestrian master plan would provide a more comprehensive assessment of the pedestrian environment in the city and offer recommendations related to sidewalk rehabilitation policy, ADA accessibility needs and a set of geographically-specific infrastructure recommendations in high-volume pedestrian areas.

Facility Toolkit

The bicycle and pedestrian recommendations in this Strategic Plan will not only further connect different neighborhoods and areas of Norfolk together, but will also improve the quality of active transportation by using facilities that increase the safety, comfort, and convenience for pedestrians and bicyclists.

This toolkit provides a description of the different elements that are part of the corridor recommendations and classifies them into three categories: bicycle facilities, pedestrian facilities, and spot improvements. All recommendations should adhere to the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as well as other standards such as the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide, as appropriate.

Most, if not all of the proposed bicycle and pedestrian improvements in this Plan will have minimal or no negative impacts on motor vehicle travel. However, many of the on-street bicycle facilities described on the following pages will require a reallocation of space from automobile travel lanes to bicycle lanes. In these cases, the following on-street implementation actions will be needed.

On-Street Implementation Actions

Road Diet

- Removal of one or more travel lanes to repurpose roadway space for other uses
- Rules of thumb applied in Norfolk included the following traffic volumes for final cross sections:
  - Four-to-three lane conversion: 15,000 or fewer vehicles per day
  - Four-to-three lane conversion: 20,000 vehicles per day, traffic study suggested
  - Six-to-five lane conversion: 35,000 vehicles per day possible, traffic study suggested

Lane Diet

- Narrowing of one or more travel lanes to repurpose roadway space for other uses
- Rule of thumb for recommendations in Norfolk was a minimum lane width of 10 feet with an 11-

Bicycle Facilities



Shared-Use Path

- Fully separated, two-way path
- Open to pedestrians, bicyclists and most other non-motorized users
- Typically paved and marked with a center line
- May be parallel to a roadway or along a separate alignment
- Best used on streets with high motor vehicle traffic speeds or volumes



Separated Bike Lane

- On-road, bicyclist-only facility, physically separated from automobile travel lane and sidewalk by curbs, bollards, parked cars, or other vertical elements
- May be one-way on both sides of the street, or two-way on one side of the street
- May be located at roadway level or raised to, or just below sidewalk level
- Best used on streets with medium and high traffic volumes and fewer intersections or driveways



Bike Lane

- On-road bicyclist facility with roadway space dedicated to bicyclists designated by bike lane pavement markings
- Generally located to the right of and in the same direction of the motor vehicle travel lane
- May be placed on one-way streets
- Best used on streets with low to medium motor vehicle traffic volumes



Buffered Bike Lane

- On-road bicyclist-only facility with roadway space dedicated to bicyclists
- Hashed pavement markings create additional space between bicyclists and motor vehicle traffic
    - Buffer may be located between bike lane and automobile travel lane, between bike lane and parking lane, or both
    - Both sides are buffered when total lane width exceeds nine feet
- Best used on streets with medium to high motor vehicle traffic volumes



Shared Lane Marking

- On-road pavement marking indicating that bicyclists and motorists must share the roadway
- Indicates where bicyclists should position themselves to avoid open car doors when on-street parking is present
- Reinforces motorist caution and expectation that bicyclists are present
- Best used on roads with low motor vehicle traffic volumes and speeds limits under 35 mph



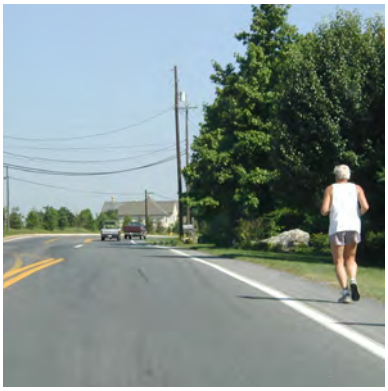
Priority Shared Lane Marking

- Similar to Shared Lane Markings but underlayed with a bright green painted (or thermoplastic) box
- Spaced more frequently than Shared Lane Markings
- Typically used in locations with higher volumes of traffic and/or complex traffic patterns such as those with higher turnover on-street parking
- Best used on roads with low motor vehicle traffic volumes and speeds limits under 35 mph



Contraflow Bike Lane or Shared Lane

- On-road pavement marking on a street that is one-way for automobile traffic
- Indicates bicyclists ride in opposite direction of automobile traffic either in bike lane separated from adjacent lane by a double yellow line or shared lane marking if enough space for bike lane is not available
- Accompanied by signage indicating two-way bicycle traffic for drivers on and crossing the street



Paved Shoulder

- Paved roadway outside of the edge line available for bicyclist or pedestrian travel
- Lack of bicycle markings differentiates it from a bike lane
- Best used on roads with medium motor vehicle traffic volumes where sidewalks are not present

Pedestrian Facilities



High-Visibility Crosswalk

- On-road pavement marking to indicate appropriate location to cross a street
- Connects to sidewalks at intersection or mid-block locations
- Bold, reflective striping improves visibility of crosswalk for pedestrians and drivers



Raised Crosswalk

- High visibility crosswalk raised from street level to sidewalk level
- Increases visibility of pedestrians crossing street
- Raised crossing acts as speed table to reduce vehicle speeds
- May be placed mid-block or at an intersection



Curb Ramps

- ADA-compliant curb ramps provide ramped access to sidewalks
- Detectable warning surface on curb ramp provides warning for physically impaired
- Should be located to place users in line with crosswalk across intersection leg



Curb Extension

- Sidewalk and curb space extended into roadway to reduce roadway width
- Slows motor vehicle turning speed
- Visually narrows roadway to help reduce vehicle speeds
- Reduces crossing distance for pedestrians
- Provides more space for pedestrians waiting to cross the street



Median Island

- Curb separated space for pedestrians in center of roadway
- Allows pedestrians to cross wide streets in two stages
- Visually narrows roadway to help reduce vehicle speeds
- Best used on multi-lane roadways with high motor vehicle traffic volumes



Pedestrian-Scale Lighting

- Street lighting that use shorter lampposts and is directed toward the sidewalk instead of the roadway
- Improves pedestrian visibility and safety
- Special lighting treatments can be used to improve specific locations such as underpasses

Spot Improvements



Leading Pedestrian Interval (LPI)

- Intersection signalization programmed to provide pedestrians additional time to cross the intersection before the "green" signal for motor vehicles
- Pedestrians crossing at an intersection have a head start and are more visible to turning motorists



Rectangular Rapid Flashing Beacon (RRFB)

- On demand pedestrian or bicyclist activated signal with push button
- Bright LED flashing beacons increase motorist awareness of pedestrians or bicyclists crossing
- May be used in conjunction with median islands or high visibility crossings
- May be used at mid-block crossings or intersections



HAWK Signal

- On demand pedestrian or bicyclist activated signal with push button
- Red signal requires motor vehicles to stop while pedestrian crosses the road
- Generally used at mid-block crossings
- Best used on multi-lane roadways or roads with higher motor vehicle traffic speeds



Bike Box

- Space for bicyclists to wait at intersection in front of waiting motor vehicles
- Designated bike box space indicated with pavement markings
- Give bicyclists a head start by positioning them in front of motor vehicles



Intersection Striping

- Bicycle lane striping continues through intersection
- Improves visibility of bicyclist
- May include green pavement, shared lane markings and/or bicycle lane lines



Bicycle Parking

- Bicycle parking provides bicyclists with secure location to store a bicycle
- Conveniently located, covered, and well-designed bike parking can increase bicycle security
- Abundant bicycle parking will reduce instances of bicycles being locked to sign posts, gates, and trees
- Variety of types include sidewalk racks, on-street bike corrals, and bicycle lockers

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Chapter 3: Implementation

foot minimum width where transit vehicles would be present

Strategies

Norfolk has one advantage over communities that began implementing their bicycle and pedestrian improvements in the 1990s and 2000s: Lessons can be learned from the the past experiences and implementation challenges experienced in other places. While most, if not all of the bicycle and pedestrian improvements proposed for these corridors will have minimal or no negative impacts on motor vehicle travel, in the public review process, during construction and after implementation, some motorists or adjacent residents may have concerns or raise objections. Some residents may challenge the necessity of projects when they do not see an existing high volume of pedestrians and bicyclists, and some projects may be challenging for other reasons. In this regard there are four things that Norfolk can learn from those who have gone before:

Conduct demonstration and open streets events.

Norfolk is already familiar with these community events that create a temporary demonstration of what may seem to be dramatic proposals for change in the design and use of public space or streets. Norfolk has successfully conducted a number of these events with the organizers from Better Block, Inc. which have helped residents realize the advantages of these designs. There are any number of components of this Plan that can be implemented temporarily as a way to show the community how proposed changes would work, look and feel.

Taking this a step further, the city may find success from instituting a "Cyclovia"-type open streets event, which is a weekend dedication of lanes and/or whole streets for mass use by people on foot or bike rather than those in cars. Begun in Bogota, Colombia, these events not only demonstrate the joy people feel by having streets free of automobile traffic, but provide social cohesion, health education opportunities and any number of other community-wide benefits. Norfolk's flat topography makes it a perfect city for open streets; people of all ages and abilities can travel more easily, under their own power.

Develop and nurture key partnerships.

Cooperation and support from partners and coordinating agencies is often essential for successful project development. Each of the corridors in this Plan typically has three to five key partners that need to be engaged in implementation (see table on the following page for details).

This table will be useful for City staff, elected officials, Bicycling and Pedestrian Trails Commission members, and other bicycle and pedestrian advocates. Typically, the City has established contacts with these partners, with whom they work regularly, however, at times advocates or elected officials can play an important role developing key contacts, educating representatives or orchestrating engagement.

Implement high-quality designs.

Bicycle and pedestrian improvements should be well designed and carefully considered. When done right, cities find that bicycle and pedestrian improvements often result in improved travel for motorists and sometimes a reduction in motor vehicle crashes. Bicycle facilities that include a reduction of travel lane widths typically help calm traffic which residents and pedestrians appreciate. In some cases, slower moving traffic will flow more easily, resulting in less overall delay.

Get the word out about roadway changes.

It is important to inform local residents and commuters of planned changes to a roadway including the purpose and desired outcomes of the project. This can include signs along the corridor

Corridor												
PARTNERS:	1	2	3	4	5	6	7	8	9	10	11	12
Developers		●						●	●	●		
Downtown Norfolk Council	●	●										
ERT Group				●	●							
Hampton Roads Transit			●									●
Civic Leagues	●	●	●	●	●	●	●	●	●	●	●	●
Norfolk Public Schools	●	●		●			●					
Norfolk Southern RR							●	●				
ODU, NSU, TCC	●			●	●							
Norfolk Redevelopment and Housing Authority	●			●								
US Navy			●		●					●		
VDOT			●	●	●	●	●	●	●	●	●	●
Virginia Beach, Chesapeake, or Portsmouth						●		●	●	●		

Table 2: Key Partners, by Study Corridor

prior to construction, informational meetings for neighborhood groups, media attention in print, on the radio (traffic report stations) and television, and a social media campaign. On-the-ground outreach to pedestrians and bicyclists can also help orient them to a new facility once it is implemented.

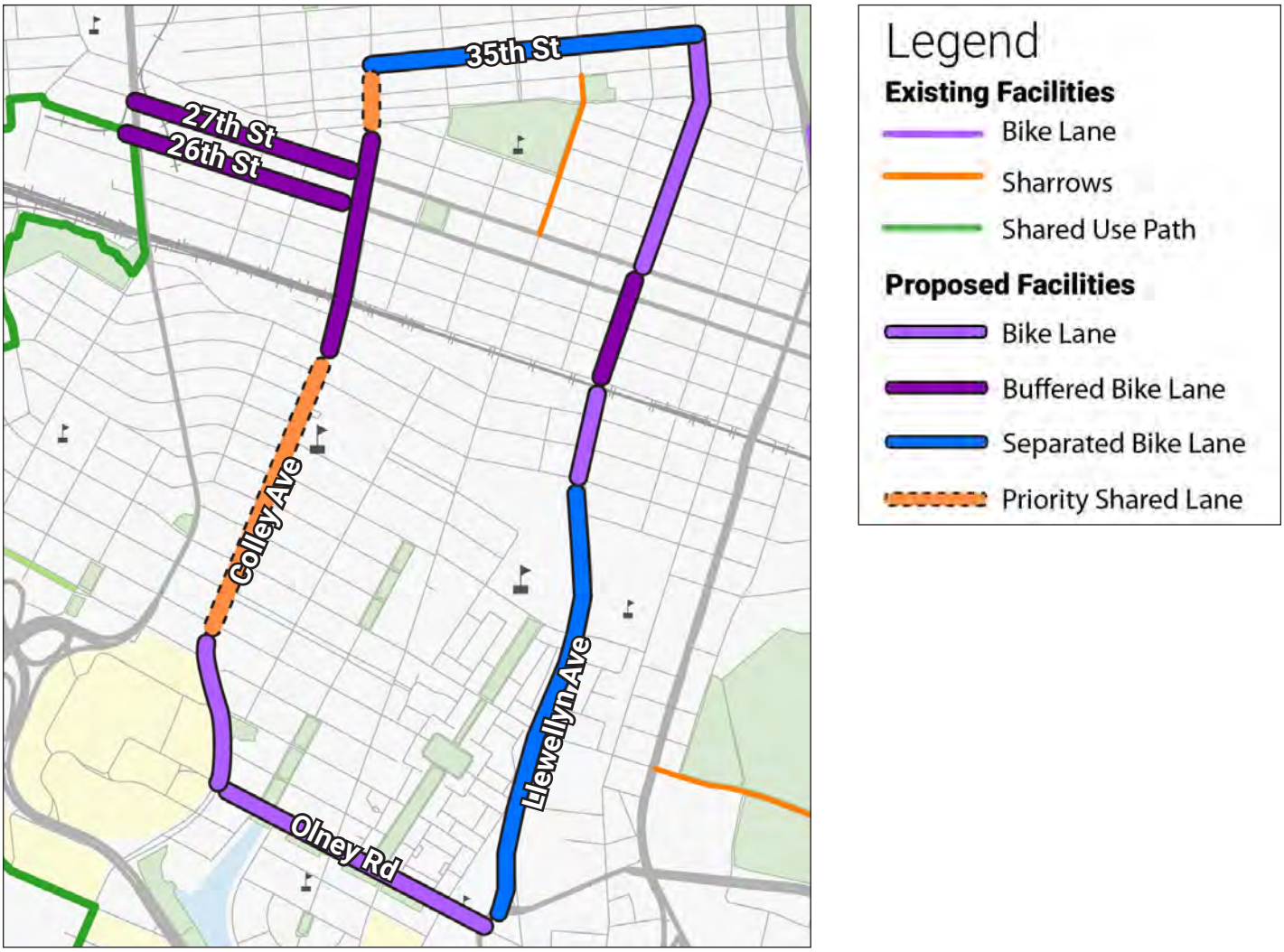
Utilize pilot projects.

The initial set of improvements emerging out of this Plan will take Norfolk to the next level. This Plan recommends infrastructure changes throughout the city, but the projects with the quickest impact are likely to be those located where bicyclists already ride for both transportation and recreation. Creating a short loop that can be ridden for recreation is also likely to attract more riders. Placing these new facilities in a mixed-use area may enable more residents to take short trips by bike. Identifying these projects as a pilot may make the changes seem less intimidating to skeptical residents.

Considering these factors, it is recommended that the City pursue early implementation of the facilities identified in the map on the following page. This loop links major facilities on Colley Avenue and Llewellyn Avenue to one another and to the Elizabeth River Trail to the west. There is already a higher volume of bicyclists in this area of the city. The projects serve a major employment destination at the hospitals complex and reaches the growing destination of the Arts District. Colley Avenue is a destination in itself for shopping and dining as well. The facility recommendations for this loop are outlined in the descriptions of Corridors 1, 2 and 5. A bike lane project is already planned and funded on 35th Street.

High-impact project implementation.

In corridors where traffic studies or other factors suggest that implementation of recommended facilities may have a negative impact on motor vehicle traffic, it may be wise to begin with a low cost investment that can be modified or removed if the project is not a success. For example, if a road diet is needed to provide a protected bicycle lane, changing



Proposed Pilot Projects

a four-lane median divided road to a two-lane median divided road, by converting the right hand lane into the protected bicycle lane, the following approach may be taken:

- Step 1: Stripe the right hand lane as a buffered bicycle lane, which is accomplished by restriping the existing pavement, only using paint (the lowest cost investment). Study the impacts to traffic and the levels of bicycle use that it attracts. Monitor the feedback from motorists, bicyclists, local residents and businesses and other stakeholders.
- Step 2: Install flexible post bollards in the buffer area, to provide a vertical element of protection, and reapply paint where needed.
- Step 3: If all has gone well and the road surface needs repaving, then resurface the lane, or whole road, apply long lasting highly-reflective thermoplastic striping and bollards, add planters, portions of curb or other permanent vertical features, signage and crosswalks to provide a full-featured separated bicycle lane.
- If for some reason the project needs to be reversed after Step 1 or Step 2, the paint or paint and bollards can easily be removed (at relatively low cost) and a priority shared lane marking installed, which restores the right lane for motor vehicle traffic and provides a modest improvement for cyclists to share the space with cars.

Once the city has significant experience assessing the potential for road diets, designing and implementing them, and confirming that they lead to more bicycling, this step by step process may not be needed.

There are other creative ways to phase in new designs that can be used depending on the existing status of the road. For example, a road with six 12-foot lanes (36'/36') could be adjusted first to have an 11-foot inner lane, 10-foot middle and right lanes and a five-foot bike lane, in each direction. The lane diet can be tested first for safety and traffic impacts, and then a full road diet (reducing six lanes to four) with protected bicycle lanes can be implemented as a second step at a later date, as the level of bicycle usage rises.

Designate citywide recreational loop.

Development of a citywide recreational loop is a key concept that emerged from the public meetings and received continued support throughout the planning process. The loop could be formed by the following corridors, beginning in Downtown and moving clockwise:

- North on Corridor 2: Lower Granby, Llewellyn, Granby
- North on Corridor 3: Upper Granby
- East on Corridor 10: Ocean View
- South on Corridor 11: Azalea Garden
- West on Corridor 8: Cape Henry
- South on Corridor 4: Maltby and Park
- Elizabeth River Trail along the waterfront to Granby

With the improvements recommended by this Plan, these linked corridor segments will create an attractive recreational loop ride that can become a signature facility for the City. It can provide a relatively high level of protection from traffic throughout, and thus serve both experienced and less experienced cyclists. It will be popular among Norfolk residents as a way to traverse a variety of city-neighborhoods and visit a number of attractive locations including the downtown waterfront, two Lafayette River crossings, the beach, the Botanical Gardens and revitalizing neighborhoods near Norfolk State University. It will also be attractive for cyclists from neighboring Hampton Roads communities and visitors from outside the region.

Implementing the improvements along the entire loop will take some time and a substantial investment. As a whole, it may not be the most important component of this Plan on which to focus all efforts in the near term since the City already provides some recreational bicycling opportunity via the Elizabeth River Trail, and experienced recreational bicyclists already ride these streets. However, there are certainly components of this loop that are likely to emerge as near-term, high-priority projects. As a 7 to 10 year goal, completion of improvements along the entire loop may provide the City and its residents a singular unifying vision, achievement of which would be a strong motivating force to sustain steady implementation of this Plan.

Funding Strategies

Making Norfolk Competitive

The City of Norfolk is beginning to transform itself to attract the educated, skilled entrepreneurs and workforce that are the key drivers of innovation and economic growth. As described in the Greater Norfolk Corporation's (GNC) 2014 annual report, a new urban model is now emerging: the "innovation district," a compact geographic area where leading-edge anchor institutions and growing companies cluster and connect with each other. Bruce Katz from the Brookings Institution has described innovation districts as the "ultimate mash-up of entrepreneurs and educational institutions, start-ups and schools." They are walkable, bikeable and connected by transit. They are urban, mixed-use and authentic. Norfolk seeks to take advantage of this timely convergence of what communities want and what corporations are now seeking – quality places that are competitive, cool and connected.

City leaders, Downtown Norfolk, GNC and many others understand that making Norfolk more walking and biking friendly will greatly advance efforts to create a quality place. Implementation of the Bicycle and Pedestrian Strategic Plan will establish the framework for this change. To move the corridor recommendations forward faster the City should aggressively engage the private sector. There is growing interest with corporations like Google, Coca-Cola Co., and Walmart who have funded projects ranging from bike shares to multi-use trails. National health funders like Kaiser Permanente and the Robert Wood Johnson Foundation are investing in research and activation programs. Other private



A possible future citywide loop comprising sections of six Plan corridors and the Elizabeth River Trail would provide a 22.5-mile option for bicyclists to link many parts of the city on a recreational ride.

sources include developers who may be required to contribute to infrastructure development as a permitting condition or hospitals and universities who increasingly see the connection between their mission and creating healthier places. A home-grown relationship could be cultivated with Norfolk Southern, who has financial and physical assets that would be of great benefit to an emerging trail and greenway system.

The opportunities outlined above are recognized by government and community leaders. The city should now use this Plan to leverage a wide-range of partnerships including the funding sources listed below to help build this important piece of their competitive future.

Funding Sources

To implement all of the improvements recommended in this Plan, the City will need to allocate funds on an annual basis over a multi-year period. In addition to City funds, there are a variety of other sources that the City can leverage, utilizing both traditional and innovative funding sources. The City should pursue multiple strategies to secure funds not only for a complete and comprehensive walking and bicycling network, but also for active transportation policies and programs that may require an ongoing commitment of resources. Strategies can include:

- Dovetailing with VDOT and City planned roadway improvements or other major capital projects. It is important to inform the lead agency on such projects very early on of the City's desire to incorporate relevant and proximate bicycle and pedestrian improvements in the larger project. In many cases, the cost of adding bicycle and pedestrian facilities to a road reconstruction or repaving project will be a small share of the overall project budget.

- Identifying competitive projects for the State and Federal grant funds discussed below.

- Partnering with major employers and Norfolk-based businesses, the U.S. Navy, large corporations and hospitals in the health care industry, the Norfolk Redevelopment and Housing Authority, Norfolk's universities, and private developers, to fund and support bicycle and pedestrian projects and programs.

There are a variety of potential funding sources at various levels for active transportation projects and programs. It is recommended that the City apply for several of these sources to implement the Bicycle-Pedestrian Strategic Plan. Possible funding sources include:

Federal

- **Transportation Alternatives Program (TAP)** This program was authorized under "Moving Ahead for Progress in the 21st Century" (MAP-21), which combines several programs that were previously stand-alone programs, including Transportation Enhancement (TE), Recreational Trails, and Safe Routes to School (SRTS) programs.[3] In Virginia, projects that also qualify as Safe Routes to School Projects can receive TAP funds.

  Funds are disbursed through VDOT and the Hampton Roads Metropolitan Planning Organization (MPO). The funding is designated for non-motorized transportation projects, such as trails, bicycle facilities, sidewalks, and other pedestrian improvements. Recreational Trails Program funding gets taken off the top, then remaining TAP funding is divided into two equal pots: VDOT distributes 50 percent of TAP funds statewide through a competitive grant process, and the other 50 percent is allocated to metropolitan areas based on population.[4] TAP requires a 20 percent local match. The VDOT website on the TAP program (http://www.virginiadot.org/business/prenhancegrants.asp) is a great source for additional information about this program.

  The Hampton Roads MPO was allocated $3.14 million of TAP funds for FY 2016, and Norfolk was allocated $352k of that for the Elizabeth River Trail.[5] The MPO will allocate somewhere between $1.7 and $2.7 million for FY 2017.[6]

3 Funding for these previous stand-alone programs expire three years after they were apportioned—2015 is the last possible year that these funds could be utilized—with the exception of Safe Routes to School.

4 http://www.advocacyadvance.org/site_images/content/Navigating_MAP-21_Workshop_Funding_Profile_Chesapeake.pdf

5 http://www.virginiadot.org/business/resources/transportation_enhancement/FY16_Transportation_Alternatives_Program_Allocations.pdf

6 Personal communication with George Homewood, Director

- **Surface Transportation Program (STP)**
  The Hampton Roads MPO can use its sub-allocated portion of this flexible funding for roads, bridges, and transit projects. Funds can go towards construction of bicycle and pedestrian facilities, or non-construction projects (such as maps, brochures, and public service announcements) related to bicycling and walking.[7] The program's flexibility makes it a popular funding source, so it is very competitive. The Hampton Roads MPO is currently allocated $160.54 million in this program (amount includes Federal and local match) (FY 2015-2020).[8]

- **Congestion Mitigation and Air Quality (CMAQ)**
  This program supports projects in non-attainment areas that improve air quality and reduce traffic congestion. The City of Norfolk is a non-attainment area. The Hampton Roads MPO is currently allocated $84.88 million of Federal and matching funds (FY 2015-2020).9 In the past, 1993-2018, only 8 percent of all CMAQ funds for the Hampton Roads MPO went towards active transportation projects.[10]

- **Highway Safety Improvement Program (HSIP)**
  HSIP funds may be used for safety projects aiming to reduce traffic fatalities and serious injuries. Bicycle and pedestrian safety projects on public roads are eligible for HSIP funding. Bike lanes, roadway shoulders, crosswalks, other intersection improvements, and signage are some examples of eligible projects. The State of Virginia requires that HSIP funds be allocated to bicycle and pedestrian safety in proportion to fatalities. In other words, roughly 10 percent of HSIP funds should go towards bicycle and pedestrian safety since there are roughly 10 to 12 percent bicycle/pedestrian deaths each year.[11] Funds are distributed through VDOT.

  For additional information on this program, see the VDOT website (http://www.virginiadot.org/business/ted_app_pro.asp) and the *Framework for Selection and Evaluation of Bicycle and Pedestrian Safety Projects in Virginia* report (http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r8.pdf).

  Projects that might be best suited for this program include the following:

  - Those that improve underpasses of the Interstate-Highways that pass through the City (such as Granby/Interstate 64 and Newtown Road)
  - Those that are located along corridors with a concentration of bicycle and/or pedestrian crashes
  - Those that improve bicycle and pedestrian crossing safety at complex intersections
  - Those that provide off-road accommodations along high speed roadways where bicyclists and pedestrians have no other travel route options

- **Section 402, State and Community Highway Safety Grants Program**
  This program funds education, enforcement, and research programs intended to reduce traffic crashes, deaths, injuries, and property damage.

- **National Highway Performance Program (NHPP)**
  This program funds pedestrian projects that benefit National Highway System corridors. Funds are disbursed through VDOT and MPOs and have previously been used to fund construction of new and retrofit crosswalks. In order to qualify for NHPP funds, projects must be identified in a Statewide or MPO long range plan.

- **Community Development Block Grant Program (CDBG)**
  This U.S. Department of Housing and Urban Development (HUD) program, under the "Entitlement Communities" program area, provides annual grants to larger cities and urban counties to develop viable communities

of City Planning for the City of Norfolk

7 http://www.advocacyadvance.org/site_images/content/Navigating_MAP-21_Workshop_Funding_Profile_Chesapeake.pdf

8 http://www.virginiadot.org/projects/resources/SYIP/05_MPO_Coordination_Meeting_March_2014_CMAQ-RSTP_Final2.3.pdf

9 http://www.virginiadot.org/projects/resources/SYIP/05_MPO_Coordination_Meeting_March_2014_CMAQ-RSTP_Final2.3.pdf

10 http://www.advocacyadvance.org/site_images/content/Navigating_MAP-21_Workshop_Funding_Profile_Chesapeake.pdf

11 http://www.advocacyadvance.org/site_images/content/Navigating_MAP-21_Workshop_Funding_Profile_Chesapeake.pdf

by providing decent housing, a suitable living environment, and opportunities to expand economic opportunities, primarily for low- and moderate-income people. Examples include commercial district streetscape improvements, sidewalk improvements, safe routes to school, and neighborhood-based bicycling and walking facilities that improve local transportation options or help revitalize neighborhoods.[12]

The City of Norfolk receives CDBG money; a portion of it could be allocated to bicycle and pedestrian updates in lower income areas and revitalization zones. This would include improvements along portions of corridors 4, 12, 11, and 8, such as the segment near Walmart in Corridor 8. That said, historically CDBG funding has been allocated to social service-oriented nonprofits, such as daycare and elderly providers, and in recent years, funding has decreased.

- **Transportation Investment Generating Economic Recovery Discretionary Grant Program (TIGER)**
  TIGER grants fund a broad array of road, rail, transit, and bicycle and pedestrian projects that have a significant impact on the nation, a region, or a metropolitan area. The program focuses on capital projects that generate economic development and improve access to reliable, safe, and affordable transportation. These competitive grants fund multi-modal, multi-jurisdictional projects that may be more difficult to fund through traditional DOT programs.[13]

  The program is a good fit for bicycle and pedestrian projects given its emphasis on non-automotive modes of transportation and the availability of small grants. TIGER is one of the only avenues for cities, metro regions, and transit agencies to directly apply for federal funds, bypassing state DOTs.[14] That said, the demand for TIGER grants far surpasses supply, and the program is extremely competitive. None-the-less, it may be worthwhile to go through the TIGER application process, as it could help generate a package of corridors that could be pitched to other funding sources.

- **U.S. Department of Defense (DoD)** – The Department of Defense funds transportation projects to improve access to its bases and mitigate impacts from oversized or overweight military vehicles, increased personnel, or other defense activities. Further, Navy facility planners were given new mandates in a May 2013 Memorandum to include transportation alternatives in Installation Master Plans and "provide for pedestrian, bicycle, and transit-friendly communities that allow residents opportunities for regular physical activity and, consequently healthier lifestyles while decreasing dependence on automobiles." However, it is at the Commander's discretion whether or not to comply with this mandate.
  The City of Norfolk can coordinate with the Norfolk Naval Station to incorporate bicycle and pedestrian improvements into any project proposals to better enable military employees to walk and bike.

For more information on the application and selection process for Hampton Roads, Virginia, the following document is a helpful resource: http://www.advocacyadvance.org/site_images/content/Navigating_MAP-21_Workshop_Funding_Profile_Chesapeake.pdf.

State and Regional

- **State or Regional Programs**
  The State of Virginia and Hampton Roads MPO have different pots of money for a variety of transportation programs, such as the Statewide Transportation Improvement Program (STIP). The City of Norfolk can tie projects outlined in this Plan to these funding sources and apply for funding: 12.7 percent of all STIP projects included bicycle and pedestrian facilities, and 10.2 percent were bicycle and/or pedestrian-only projects (a total of 278 projects) with an average project cost of $1 million.[15]

- **Revenue Sharing**
  This state-funded program allows localities (Counties, Cities, or Towns) to earmark state gas-tax revenue to specific projects. This funding can be applied to a wide variety of projects, including new roadways, expansion/widening of existing

12 Pedestrian & Bicycle Information Center

13 US Department of Transportation

14 http://usa.streetsblog.org/2014/09/12/us-dot-awards-72-tiger-grants-but-the-program-remains-in-jeopardy/

15 http://www.advocacyadvance.org/docs/LiftingTheVeil_Virginia.pdf

roadways, improvements to existing pedestrian/bicycle facilities, or construction of new bicycling/walking facilities. Revenue Sharing projects typically require "local match", with the locality providing up to 50 percent of the project costs and the state providing the remainder.

- **Additional Revenue Sources**
  Other State revenue sources that have funded bicycling and walking projects in the State of Virginia include bond proceeds, general fund, license plates, severance fees, toll roads, vehicle and truck tax, vehicle registration fees, and vehicle transfer fees.[16] The City of Norfolk can lobby for funding from these sources to finance projects.

- **House Bill 2 (HB-2)**
  House Bill 2 was signed into law in 2014 and directs the Commonwealth Transportation Board (CTB) to use a new scoring process, which is currently being developed and will be finalized by July 2016, to objectively select projects for funding statewide. Currently, projects will be evaluated and scored based on "congestion mitigation, economic development, accessibility, safety, environmental quality and land use, and transportation coordination (in areas over 200,000 in population). Projects that reduce congestion would rise to the top in traffic-clogged regions like Northern Virginia and Hampton Roads."[17] The City of Norfolk could apply for funding for large bicycle/pedestrian projects (e.g. over $2 million) if they meet this criteria, though bicycle and pedestrian projects may be too small by comparison to compete.

Local

- **Bicycle/Pedestrian Accommodations Dovetailed with Other Projects**
  The most cost-effective way to build bicycle and pedestrian infrastructure is to adopt a policy of including bicycle and pedestrian accommodations into other planned roadway improvements projects. This could include capital projects, other major roadway projects, and potentially military projects, as well as incorporating bicycle lanes and road diets, where appropriate, when restriping/repaving projects are scheduled. This approach is most successful if discussed in the very early stages of a project.

- **General Fund/Capital Improvement Programs**
  Since the City of Norfolk maintains its own roads[18], projects can be funded with money from the City's Capital Improvements budget. Pedestrian and bicycle infrastructure can be constructed and maintained annually via municipal CIPs. For the 2017-2020 CIP, $750,000 has been set aside to "Develop Bicycle, Pedestrian Greenways, Sharrows, and Complete Streets."

- **Developer proffers[19]**
  The State of Virginia uses a system of cash-proffer payments to finance roads since it is illegal to finance roads and other public facilities with impact fees in the State. However, the City of Norfolk has different regulations than the rest of Virginia—any proffers that are offered must be on-site and non-cash proffers, and they are more tightly regulated than those in other cities. Examples of proffers in Norfolk include agreements on landscaping, parking, driveways, hours of operation, and allowable uses.

- **Bond Referendums**
  Many cities use general obligation bonds to pay for their capital improvements, such as roadway and bridge projects. These are approved by a vote of citizens within the municipality.

Other

- **Healthy Community Action Team (HCAT) Grants**
  HCAT grants are offered by the Virginia Foundation for a Healthy Youth and are used to hire a HCAT coordinator who works to promote healthy living for children. Safe Routes to School activities are an eligible activity for HCAT coordinators.

16 http://www.advocacyadvance.org/statefunding/

17 http://virginiahb2.com/docs/HB2_FactSheet_041315.pdf

18 http://www.virginiadot.org/about/districts.asp#4

19 "A 'proffer' is a voluntary offer by a developer to abide by certain development conditions. The best-known type of proffer is a 'cash proffer'. Cash proffers are funds offered by developers at the time of rezoning to help defray capital facilities costs associated with the development." http://www.chesterfield.gov/smartdata.aspx?id=9911

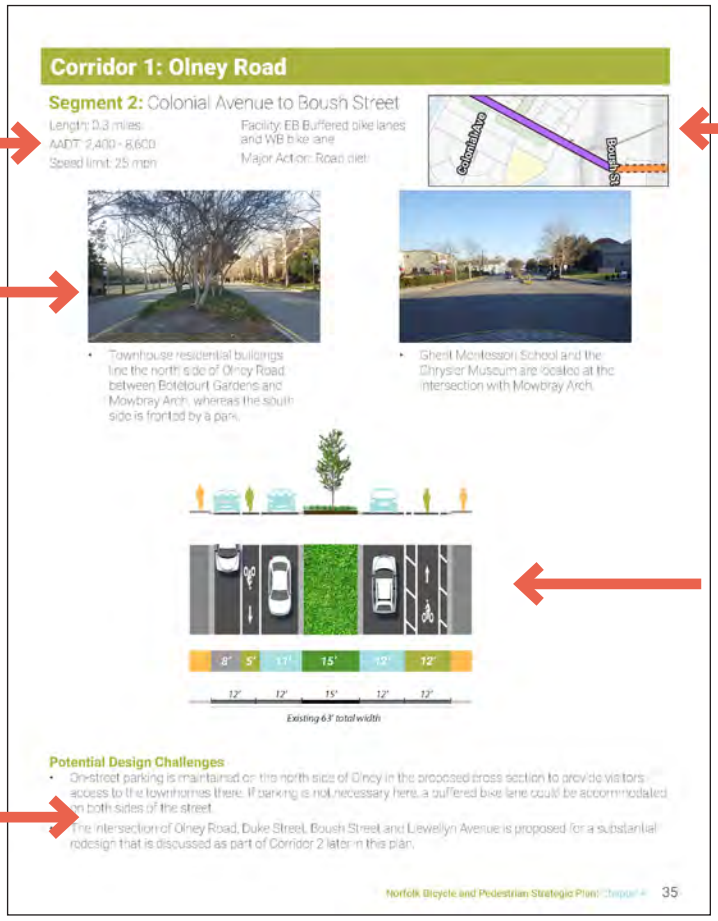
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Chapter 4: Corridor Recommendations

This chapter presents facility recommendations for the 12 selected corridors. An overview of each corridor is provided including a facility map on the first two pages of each corridor section. This overview provides:

- Corridor statistics
- Purpose of improvements
- Key challenges
- Estimated total corridor cost
- Summary public input received

Following the overview, each corridor is broken into multiple segments based upon changes in roadway characteristics (width, lane configuration, etc.) and recommended facility type. A sample page is provided below for orientation to this section.



Segment statistics

Existing conditions photo documentation

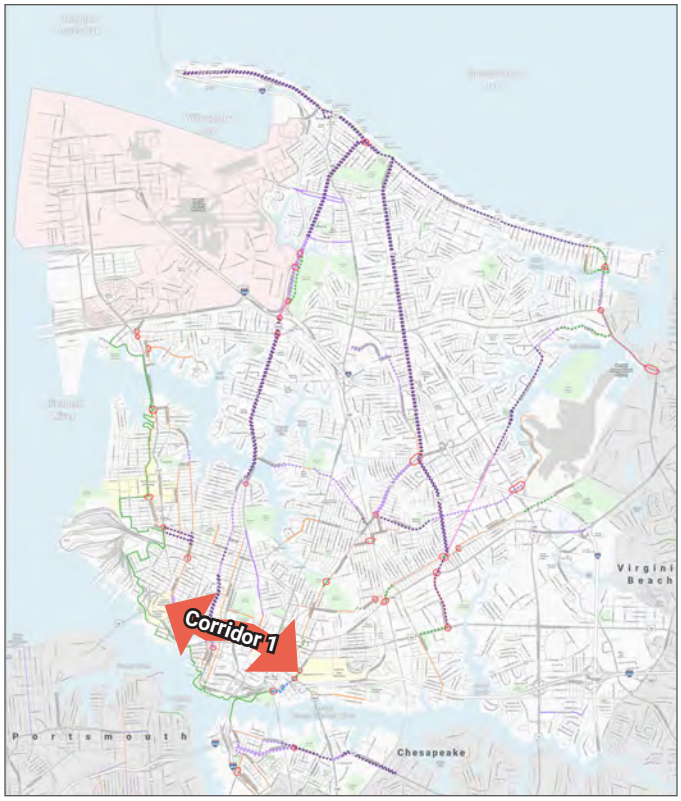
Potential design challenges highlight intersections that will need greater design detail

Segment key map

Cross sections included for segments with more complex roadway configuration changes

Aerial diagrams included for segments with complex routing

Corridor 1: Olney Road - Hospitals Complex to Norfolk State University



Length: 2.1 miles
Speed Limit: 15-25 mph
Curb-to-Curb Width: 30 to 62'
AADT: <2,400 - 8,600

Land Use: Hospitals at eastern end; medium density residential; Downtown Arts and Design District

Key Bicycle Facilities:
Bike lanes, priority shared lane markings, shared lane markings

Key Pedestrian Improvements:
Improved crossings at Monticello Avenue, Tidewater Drive, and Church Street

Estimated Project Cost

$400,110

Purpose of Improvements

- Provides a priority bicycle corridor that will function as an effective alternative to the major automobile corridors of Virginia Beach Boulevard and Brambleton Avenue.
- Connects, via crosstown route, two other key north-south corridors in this plan: Colley Avenue and Granby Street / Llewellyn Avenue.
- Improves bicycle conditions through the Arts District, a high-priority area undergoing revitalization.
- Provides access to/from major employment sites including the hospital complex, NSU and downtown.

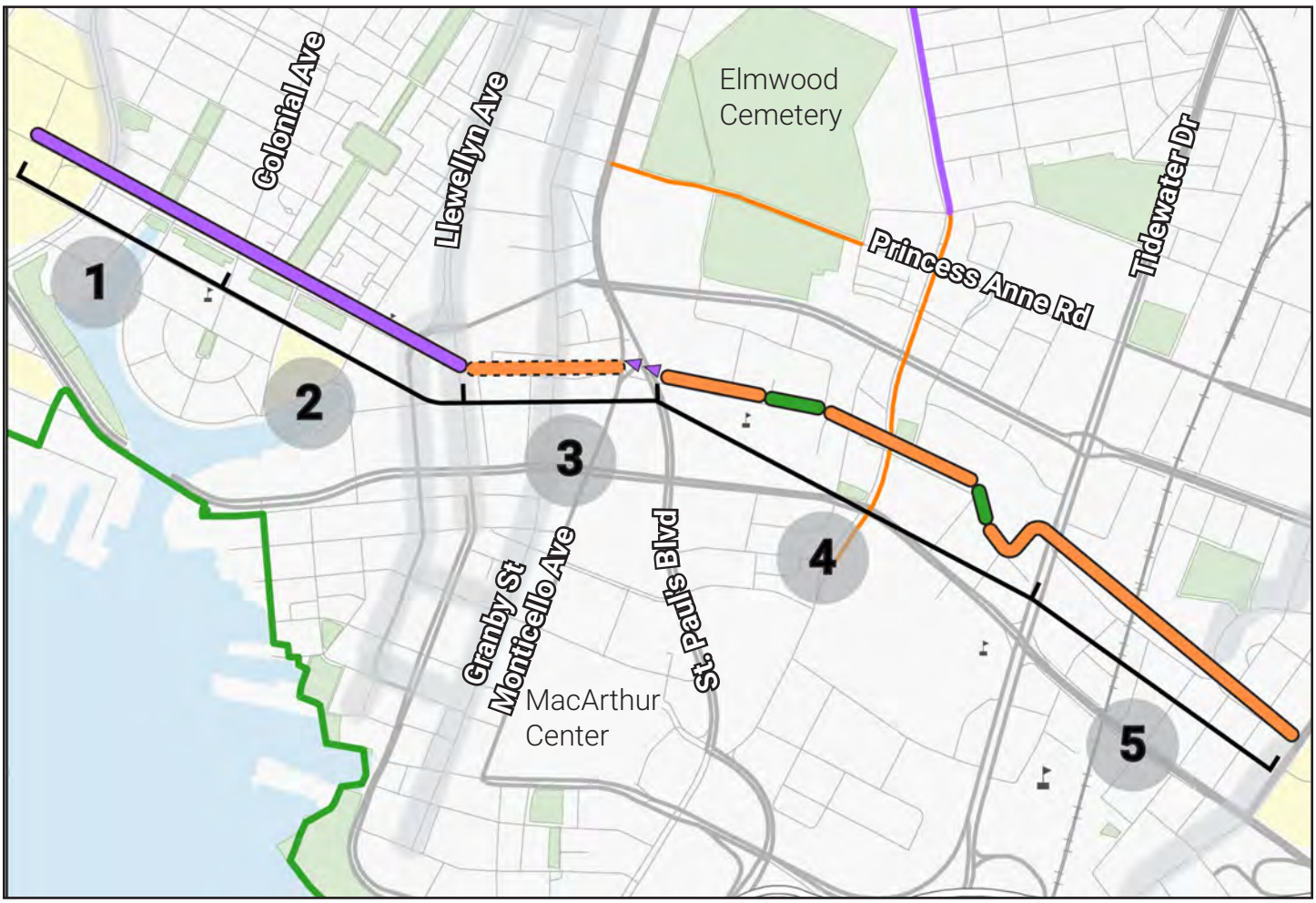
Key Challenges

- The intersection at Monticello Avenue, St. Pauls Boulevard and Olney Road will require its own design effort to deal with crossings of major arterials and complex traffic movements.
- Crossings of Church Street and Tidewater Drive will require geometric and striping improvements to be made safe and comfortable.
- The St. Paul's area is slated for redevelopment, so the facilities recommended there must be designed in coordination with that effort.

Public Input

- Improved bicycle access and general streetscape improvements were called for in the Arts and Design District Revitalization Strategy.
- Many WikiMap users indicated that Olney Road is part of their regular biking route; many use it between Colley Avenue to Granby Street.

Corridor 1: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Bike Lane
- Sharrows
- Shared Use Path

Proposed Facilities

- Bike Lane
- Sharrows
- Priority Shared Lane
- Shared Use Path
- Contraflow Bike Lane

Corridor 1: Olney Road

Segment 1: Children's Lane to Colonial Avenue

Length: 0.3 miles
AADT: 8,600
Speed limit: 15 to 25 mph

Facility: Bike lanes
Major Action: Lane diet

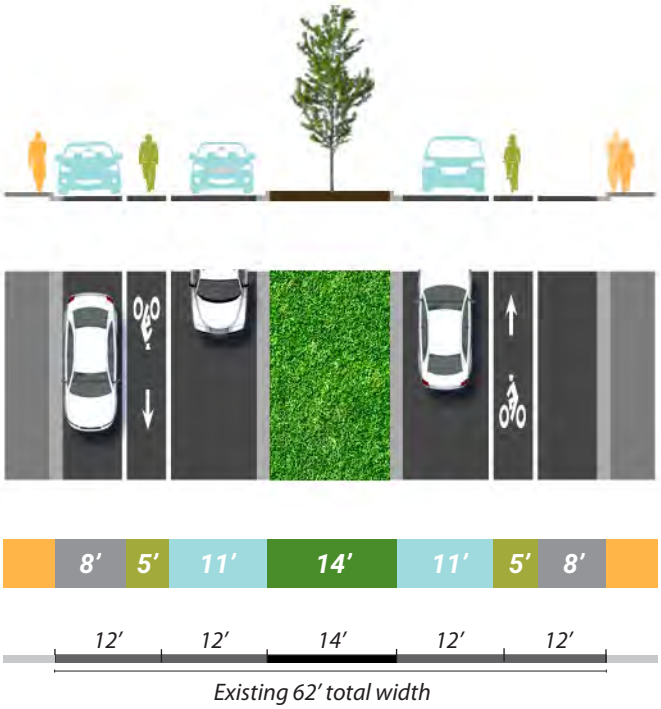




- Olney Road through the hospital area is a two lane street with wide, 15-foot lanes



- Wide lanes continue to the east of Colley Avenue where a planted median separates travel lanes



Existing 62' total width

Potential Design Challenges

- Accommodating turn lanes and bike lanes on the block from Wagner Road to Colley Avenue will require reconfiguring the striping and may warrant a traffic study to determine whether turning queues can be accommodated with a new design that better accommodates bicyclists.

Corridor 1: Olney Road

Segment 2: Colonial Avenue to Boush Street

Length: 0.3 miles
AADT: 2,400 - 8,600
Speed limit: 25 mph

Facility: EB Buffered bike lanes and WB bike lane
Major Action: Road diet

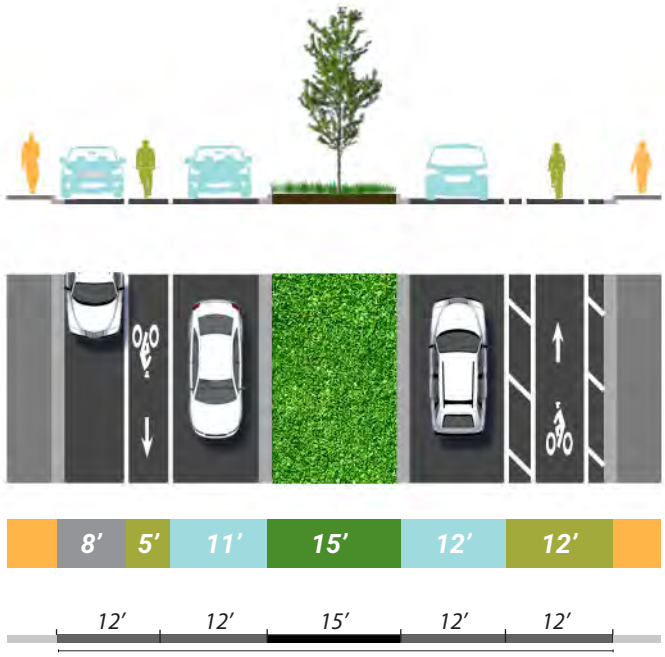




- Townhouse residential buildings line the north side of Olney Road between Botetourt Gardens and Mowbray Arch, whereas the south side is fronted by a park.



- Ghent Montessori School and the Chrysler Museum are located at the intersection with Mowbray Arch.



Existing 63' total width

Potential Design Challenges

- On-street parking is maintained on the north side of Olney in the proposed cross section to provide visitors access to the townhomes there. If parking is not necessary here, a buffered bike lane could be accommodated on both sides of the street.
- The intersection of Olney Road, Duke Street, Boush Street and Llewellyn Avenue is proposed for a substantial redesign that is discussed as part of Corridor 2 later in this plan.

Corridor 1: Olney Road

Segment 3: Boush Street to Monticello Avenue

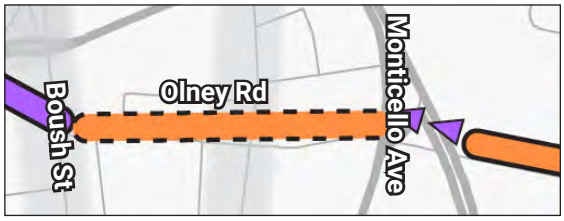
Length: 0.2 miles

AADT: 2,400

Speed limit: 25 mph

Facility: Priority shared lane markings

Major Action: Eradicate and restripe

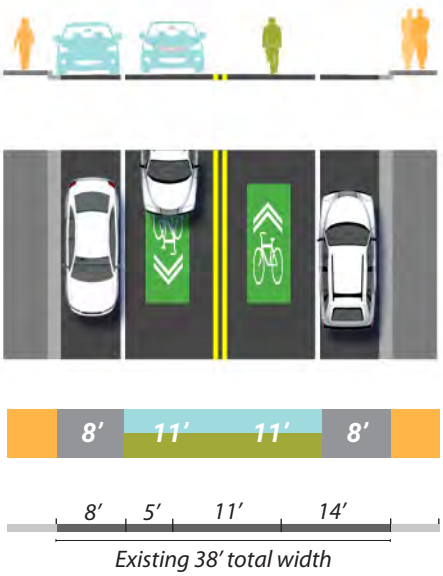




- A bike lane currently exists in the eastbound direction in this segment, with a shared lane marking in the westbound travel lane.



- A number of businesses front on Olney Road in this segment, and more are expected to locate here as the Arts District develops further.



Potential Design Challenges

- Removal of the existing eastbound bike lane may be perceived as a downgrade in facility type through this segment.
- Priority shared lane markings will be a new facility type for the City here, but they are an optimal facility type in a commercial area with high parking turnover and relatively low traffic speeds.

Corridor 1: Olney Road

Segment 4: Monticello Ave to Tidewater Drive

Length: 0.7 miles

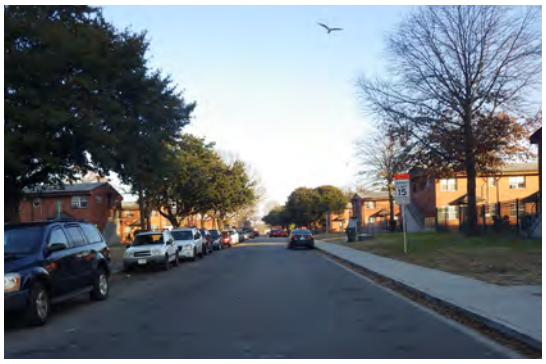
AADT: unknown

Speed limit: 15 to 25 mph

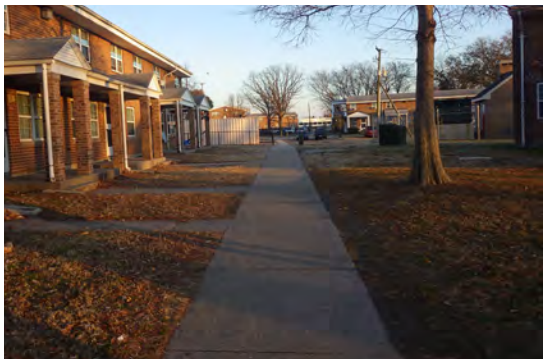
Facility: Shared lane markings and shared use path

Major Action: Install; Construct





- Olney Road through this area is a low-volume local street that includes a 15 mph school zone.



- This sidewalk through Norfolk Housing Authority property provides a connection between two cul de sac portions of Olney Road.



Potential Design Challenges

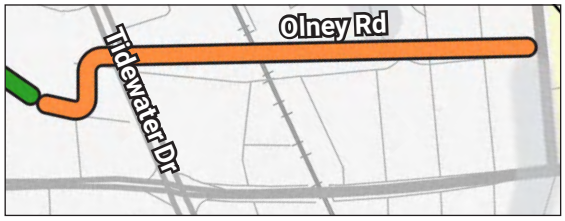
- Intersections at Monticello Ave/St. Paul's Boulevard, Church Street and Tidewater Drive will all need particular design attention to safely and comfortably accommodate bicycle travel.
- Construction of an off-street trail through the park next to PB Young Elementary School is more desirable than routing around the park to the north but will be more costly.
- Routing bicyclists across Norfolk Redevelopment Housing Authority property by widening the sidewalk at the east end of the corridor marked with "NRHA" may spark adjacent tenants to raise concerns.
- Path 2 would require new construction whereas Path 1 has an existing narrow pathway adjacent to the street that would need to be resurfaced and widened.

Corridor 1: Olney Road

Segment 5: Tidewater Drive to Maltby Crescent

Length: 0.5 miles
AADT: >2,400
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install





- The crossing at Tidewater Drive is nearly 150' wide with six lanes of traffic. One marked crosswalk exists today.

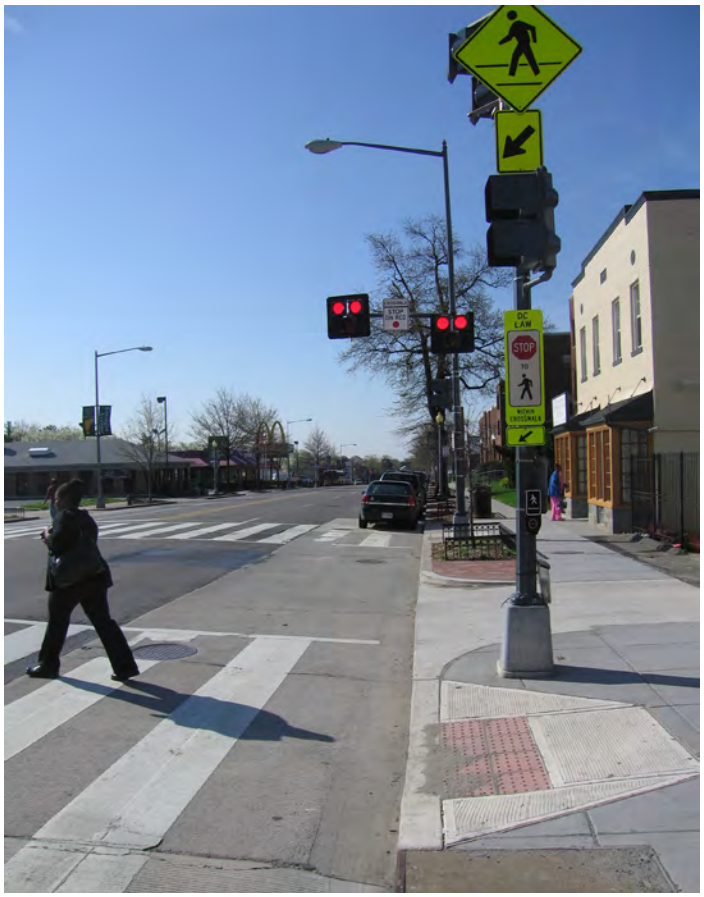


- Streets through this segment are low-volume with residential and industrial uses.



Potential Design Challenges

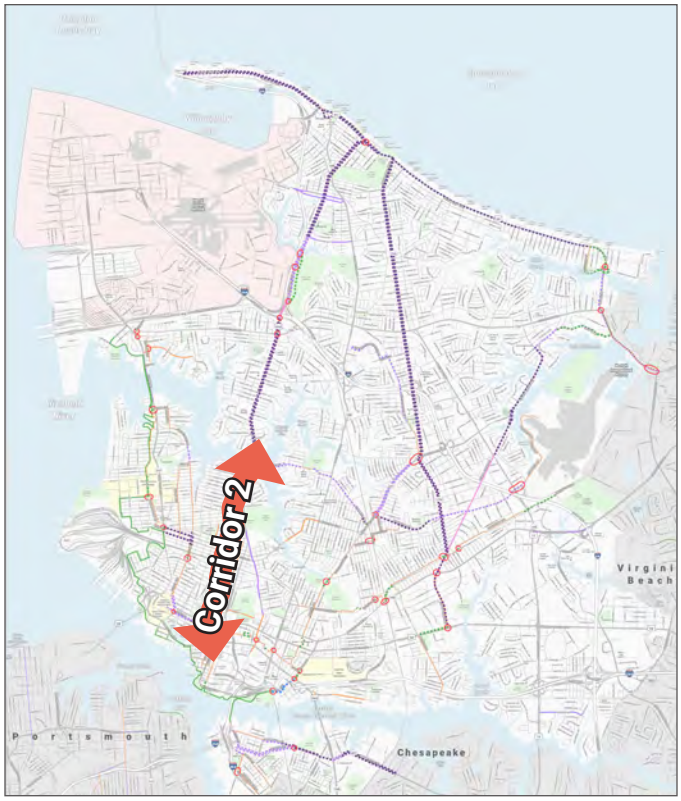
- The Tidewater Drive intersection shown above presents a challenge to moving along this segment of Olney Road.
- Industrial businesses along this segment will need to be notified of an increase in bicycle traffic and make truck drivers aware of safe practices for travel around bicyclists.



- A HAWK (High-Intensity Activated CrossWalK beacon) would facilitate pedestrian and bicyclist crossing with minimal automobile traffic interruption on Tidewater Drive.

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Corridor 2: Llewellyn Avenue and lower Granby Street, and Boush Street Alternatives



Length: 2.9 miles
Speed Limit: 15-30 mph
Curb-to-Curb Width: 34 to 66'
AADT: 2,100 - 23,000

Land Use: Downtown core commercial at south end; neighborhood commercial and medium density residential through mid-section

Key Bicycle Facilities: Separated bike lane on Llewellyn Avenue; priority shared lane markings on Granby Street

Key Pedestrian Improvements: Traffic calming and crossing improvements along Llewellyn Avenue through implementation of separated bike lanes

Estimated Project Cost

$600,000

Purpose of Improvements

- A strong bicycle connection from downtown to the Arts District and Ghent, Park Place and Colonial Place is needed.
- Traffic calming on Llewellyn Avenue through a road diet would make this street more pedestrian friendly in residential segments.
- Bicycle improvements on mid-Granby (Brambleton Avenue to 30th Street) will further support a revitalizing commercial area.

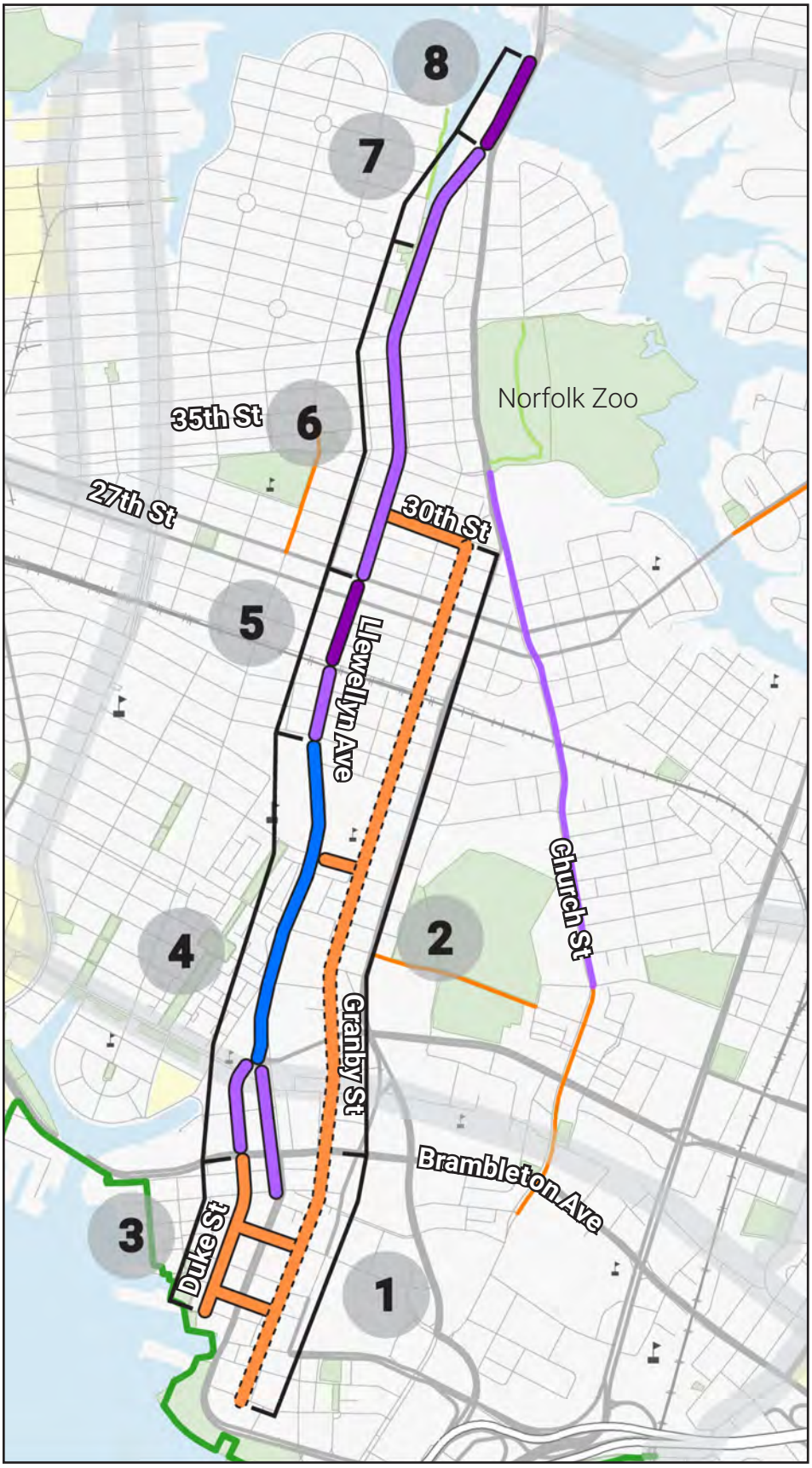
Key Challenges

- Phasing will be critical to their success as the parallel parts of the corridor interact with one another.
- The road diet on Llewellyn Avenue appears feasible based on its low traffic counts.
- Wayfinding signage south of Brambleton Avenue on Duke and Granby Streets will be key to helping bicyclists navigate to their destinations while avoiding travel on high-stress Boush Street.
- The complex intersection at Virginia Beach Boulevard, Olney Road, Duke Street and Llewellyn Avenue will be a design challenge.

Public Input

- Improved bicycle accommodation south of Brambleton Avenue in the core of downtown is a priority for residents and the Downtown Norfolk Council.

Corridor 2: Recommendations Overview Map



Legend

Existing Facilities

- Corridor Segment
- Bike Lane
- Sharrows
- Shared Use Path

Proposed Facilities

- Bike Lane
- Buffered Bike Lane
- Separated Bike Lane
- Priority Shared Lane
- Sharrows

Corridor 2: Granby Street

Segment 1: Waterside Drive to Brambleton Avenue

Length: 0.7 miles

AADT: 4,500

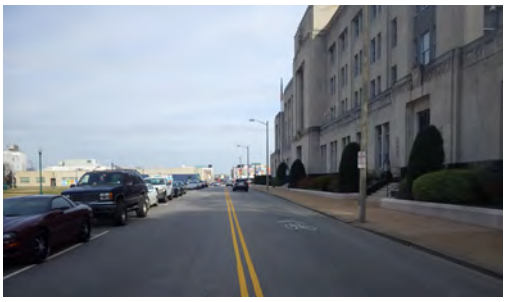
Speed limit: 15 mph

Facility: Trail; Priority shared lane markings and street parking

Major Action: Install and sign



- This segment has existing shared lane markings in narrow travel lanes south of Charlotte Street.



- Travel lanes widen north of Charlotte Street. Parking should be added on east side to narrow lanes.



Potential Design Challenges

- Better wayfinding signage is needed to identify the walkway at the southern end of this segment.
- Operations of the street here will not change, but educational outreach efforts to drivers should take place with installation of the new priority shared lane markings.

Segment 2: Granby Street -- Brambleton Avenue to 30th Street

Length: 1.4 miles

AADT: 4,500 - 8,800

Speed limit: 25 mph

Facility: Priority shared lane markings and traffic calming

Major Action: Install and construct





Granby Street facing south at Olney Road

Why Granby

Granby Street is the main corridor through Norfolk's growing Arts and Design District. The Revitalization Strategy for this area identified a preferred shared lane bicycle treatment between Brambleton Avenue and Virginia Beach Boulevard as depicted in the rendering above. Maintaining on-street spaces will make parking easier and create space for in-street parklet construction.

Corridor 2: Granby Street

Segment 2: Brambleton Avenue to 30th Street



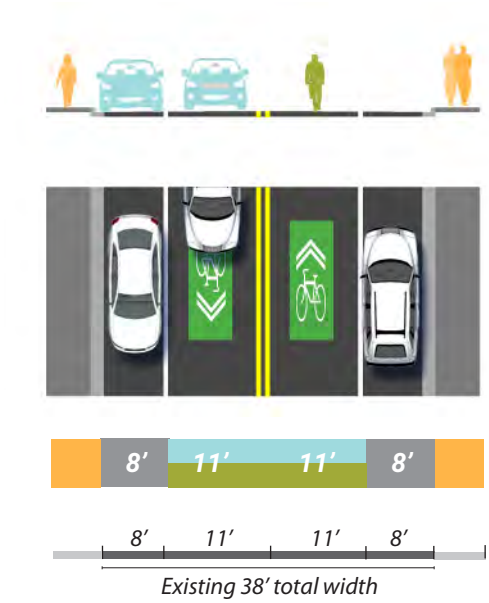
- Near Princess Anne Road, the street is 38' wide with parking on both sides including one commercial loading zone.



- The area near Ghent School elementary school and new residential development would benefit from traffic calming.



Cross section for Olney to Shirley sub-segment



Potential Design Challenges

- The necessity of maintaining parking on both sides of the street through this segment prevents installation of a higher protected bike lane. On-street parking is heavily used in the commercial areas of the Arts District and north of 15th Street.
- In areas of lower utilization, curb extensions should be considered at intersections to prevent drivers from using the parking lane as a passing lane around bicyclists. Curb extensions will also benefit pedestrians by shortening crossing distances.

Corridor 2: Duke Street

Segment 3: Tazewell Street to Olney Road

Length: 0.3 miles

AADT: 2,100 - 9,000

Speed limit: 25 mph

Facility: Bike lanes and shared lane markings

Major Action: Road diet and install



- South of Brambleton Avenue, Duke is a low-volume, low-traffic residential street parallel to the heavily traveled Boush Street.



- The four-lane area of Duke Street is recommended for a road diet based on its low traffic volume of 9,000 AADT.





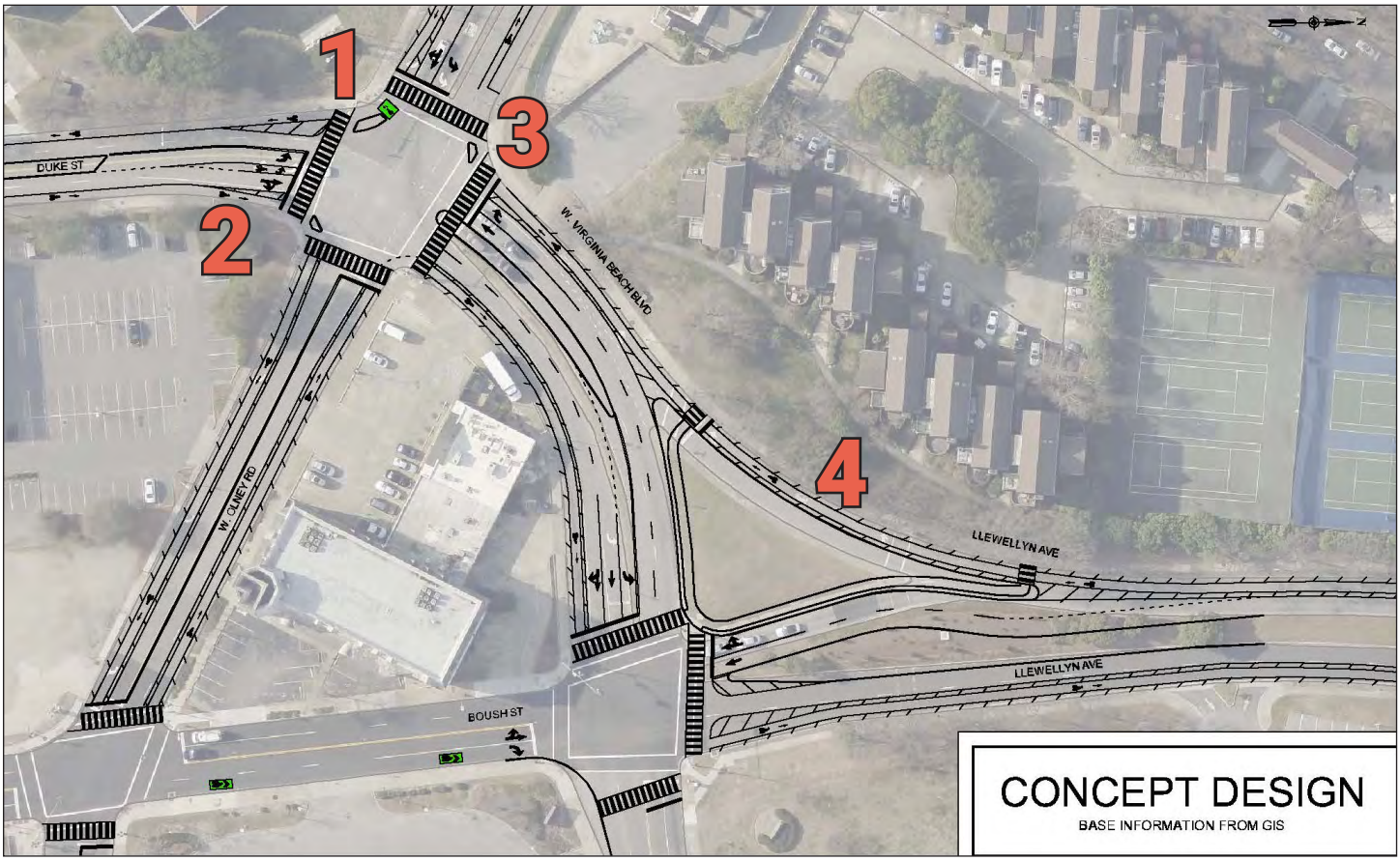
Potential Design Challenges

- Special pavement markings should be used to direct bicyclists cross the light rail tracks at a 90-degree angle at Charlotte Street.
- Wayfinding will be necessary to direct bicyclists to routes on Tazewell Street and Freemason Street to access downtown.
- Bike lanes on Boush Street may be implemented in the long term to add another option for riders with a destination along this street. Today, with no option for accommodating bicyclists south of Charlotte Street, these bike lanes would be a disconnected part of the network.
- In the future, the City should explore implementation of bike lanes on Boush Street from Virginia Beach Boulevard south to Charlotte Street.

Corridor 2: Key Intersection

Intersection: Duke Street at Virginia Beach Boulevard

This intersection is a key location for both Corridor 2 and Corridor 1 which crosses through on an east-west alignment along Olney Road. The intersection was called out for a full reconstruction in the Arts and Design District Plan. That plan and the proposed configuration below call for closing the southbound right turn slip lane from Llewellyn Avenue onto Olney Road. Additional bicycle facility striping and curb alignment changes are shown in the graphic below.



1 Difficult left turns through this intersection are accommodated with curb islands that provide bicyclists space to wait while making a two-stage left turn.

2 The left turn from Duke Street onto Olney Street is accommodated with a pocket bike lane to the left of the through and right turn lane.

3 Right turns on red should be restricted with this design. Bicycle-specific signals or phasing will also be necessary to allow riders to enter the intersection before right-turning automobiles.

4 Southbound bicyclists are routed to the west of this island along the alignment of the former right turn slip lane.

Potential Design Challenges

- Implementation of this design will require major reconstruction of the Llewllyn Ave and Virginia Beach Blvd intersection including changes to automobile traffic patterns. A traffic study is recommended to be conducted before finalization of this design. It is possible that some turn lanes preserved in this concept design will not be necessary and may allow for greater space devoted to bicyclists or pedestrians.

Corridor 2: Llewellyn Avenue

Segment 4: Virginia Beach Boulevard to 20th Street

Length: 0.7 miles
AADT: 8,300
Speed limit: 25 mph

Facility: Separated bike lane
Major Action: Road diet

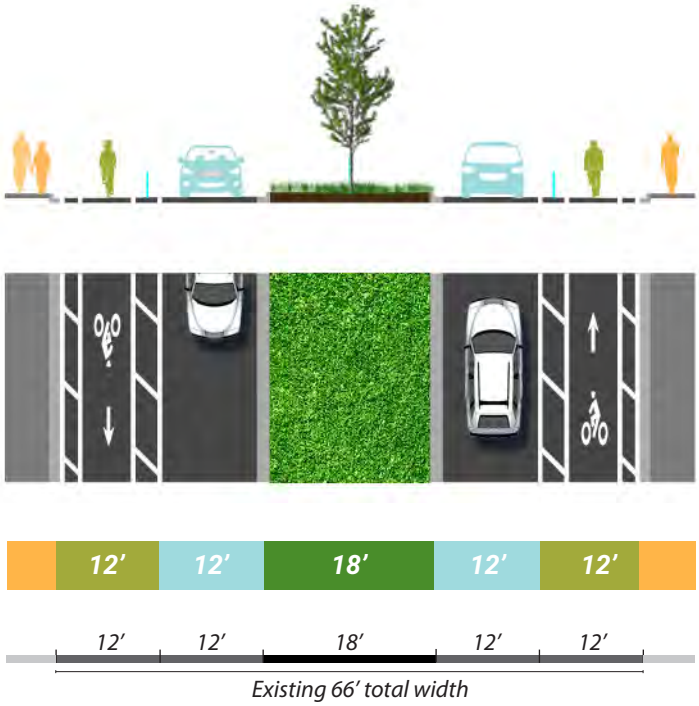


- Dual travel lanes and a 2-foot bermed median encourages higher speeds here.



- A road diet would shorten pedestrian crossing distances in this area near an elementary school and library.





Potential Design Challenges

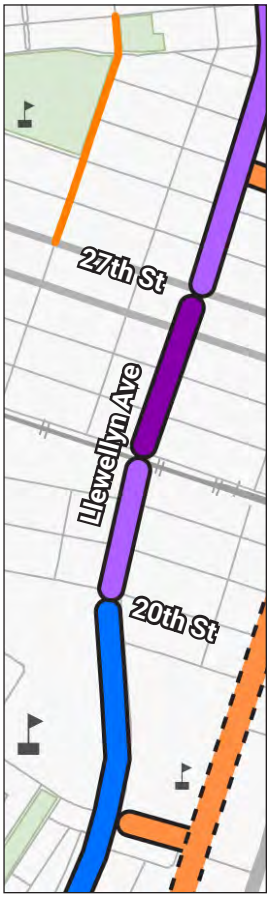
- The four-to-two lane road diet may be seen as reducing levels of services for automobiles, but turn lanes are present for four of seven left turn movements.
- Initial installation of this facility can be done with plastic flex posts. Long term, reconstruction of the road edge is preferable.

Corridor 2: Llewellyn Avenue

Segment 5: 20th Street to 27th Street

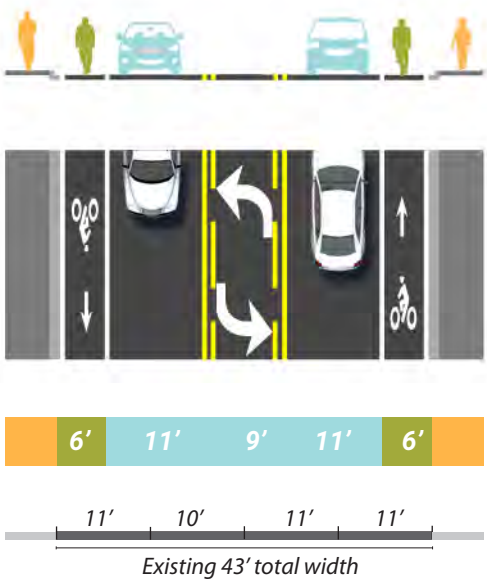
Length: 0.4 miles
AADT: 6,900 - 8,000
Speed limit: 25 to 30 mph

Facility: Bike lanes and buffered bike lanes
Major Action: Road diet





- This segment currently has four travel lanes.



Potential Design Challenges

- The four-to-two lane road diet may be seen as reducing levels of services for automobiles, but turn lanes are present for many left turn movements.

Corridor 2: Llewellyn Avenue

Segment 6: 27th Street to Delaware Avenue

Length: 0.8 miles
AADT: 6,000 - 11,000
Speed limit: 25 to 30 mph

Facility: Bike lanes
Major Action: Road diet

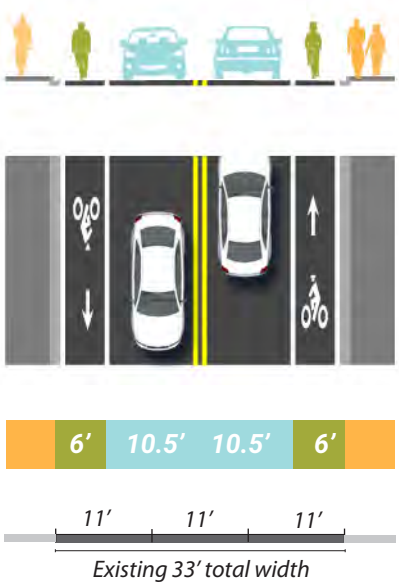


- The three-lane section has shared lane markings today.



- There are gaps in the sidewalk network along this segment of Llewellyn that should be filled.





Potential Design Challenges

- Eradication of existing recently-installed pavement markings may not be desirable.
- Additional study of daily trips to ensure compatibility with designated bike facility may be necessary.

Corridor 2: Llewellyn Avenue

Segment 7: Delaware Avenue to Granby Street

Length: 0.1 miles
AADT: 7,200
Speed limit: 25 to 30 mph

Facility: Buffered bike lane; bike lane
Major Action: Install



- The existing northbound contraflow bike lane allows two-way bicycle travel and should be retained.



- The wide travel lane exiting the Granby Street Bridge encourages high speeds. A buffered bike lane may be a better way to narrow width.



Potential Design Challenges

- Routing northbound bicyclists onto Connecticut Avenue to access the Granby Street Bridge will require bicycle detection and potentially other improvements at Connecticut and Granby to facilitate the bicyclists' left turn.

Segment 8: Granby Street Bridge

Length: 0.3 miles
AADT: 37,000
Speed limit: 30 mph

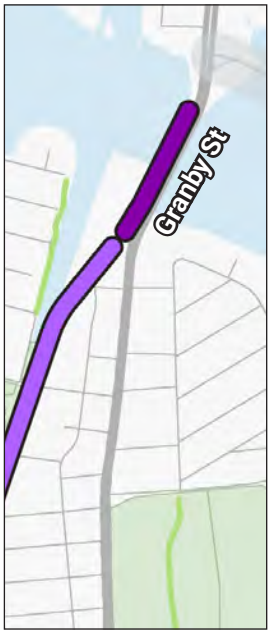
Facility: Buffered bike lanes
Major Action: Lane diet



- This is one of only three bridges over the Lafayette River, connecting the north and south sides of the city.



- Bicyclists ride on the sidewalk today for comfort and safety even though it is only 5 feet wide.



Potential Design Challenges

- Though buffered bike lanes will be a more comfortable facility than sharing the road with automobile traffic, bicyclists will still be near high-volume, higher-speed traffic. Long term, it would be ideal to provide either vertical or horizontal separation for the bicycle facility here.

Corridor 3: Granby Street - Willow Wood Road to Ocean View Boulevard



Length: 4.8 miles
Speed Limit: 35 mph
Curb-to-Curb Width: 80 - 98'
AADT: 12,000 - 34,000

Land Use: Single and multi-family residential; Religious institutions; Major retail center at Wards Corner; Naval Station Norfolk

Key Bicycle Facilities:
Buffered bike lanes

Key Pedestrian Improvement:
Paved shoulder through I-64 interchange

Purpose of Improvements

- Provide a major improved bikeway that connects the north end of Ghent to Ocean View, and improves access to Wards Corner shopping centers and Hampton Roads Transit transfer center.
- Addresses unsafe conditions faced by bicyclists and pedestrians who travel through the I-64 interchange.

Estimated Project Cost

$2,060,000

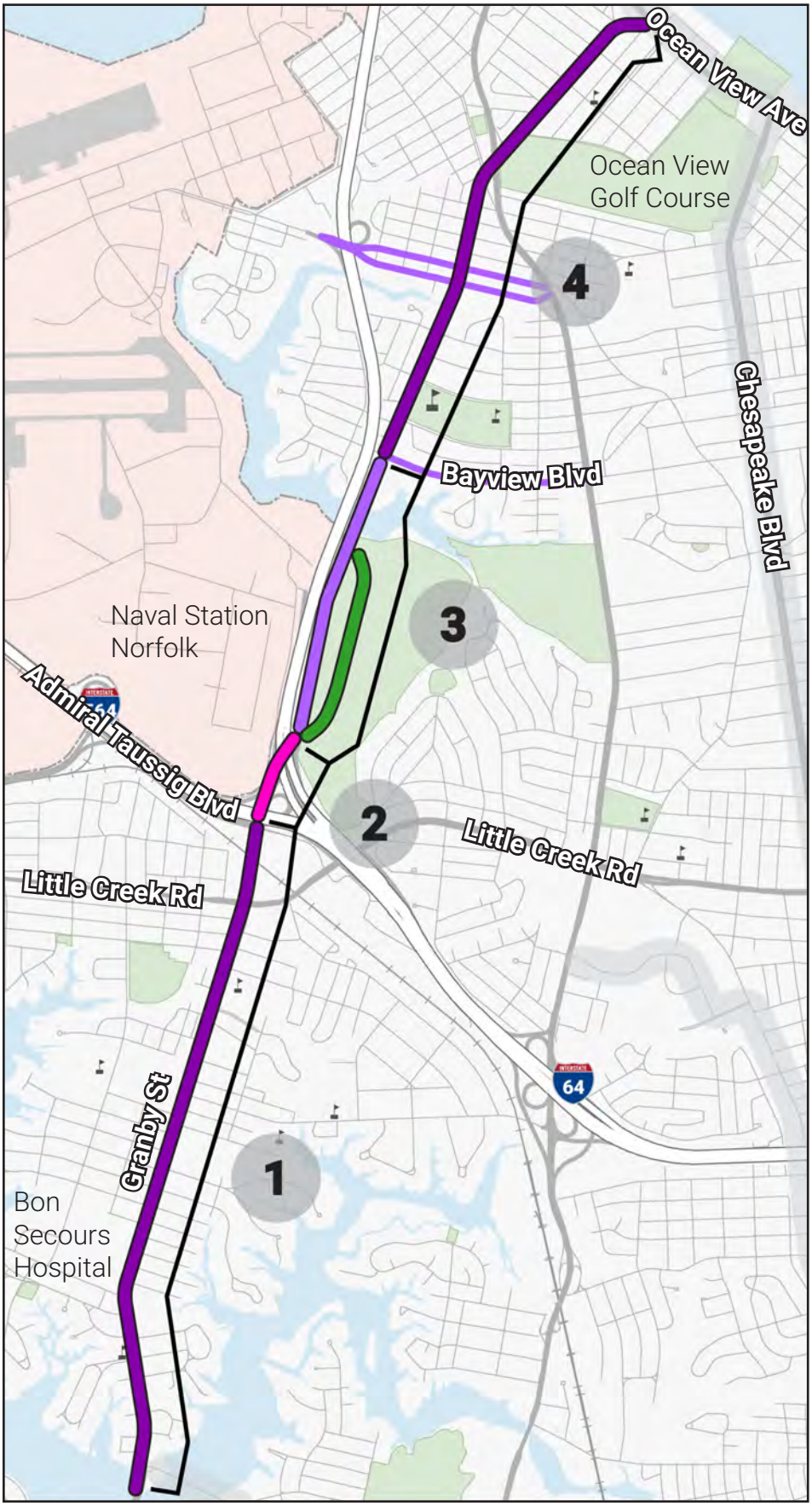
Key Challenges

- I-64 Interchange: Safe navigation of the on- and off-ramps for bicyclists and pedestrians will require a detailed design exercise. City staff and VDOT are currently collaborating on this effort.
- Two-thirds of this corridor requires a six lanes to four lanes road diet. Traffic volumes indicate that this is feasible.
- The interaction of Hampton Roads Transit buses and the bicycle facility will need to be considered.

Public Input

- Corridor was the number one request for improvements at all three community meetings held for this Plan
- Naval Station Norfolk Gate 22 was a priority destination along the corridor
- While many users indicated on the WikiMap they already use this corridor, comments noted that the high volume of traffic goes faster than is comfortable for most bicyclists

Corridor 3: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Bike Lane
- Sharrows

Proposed Facilities

- Bike Lane
- Buffered Bike Lane
- Paved Shoulder
- Shared Use Path

Corridor 3: Granby Street

Segment 1: Willow Wood Road to Admiral Taussig Boulevard

Length: 2.0 miles
AADT: 32,000 - 34,000
Speed limit: 35 mph

Facility: Buffered bike lanes
Major Action: Road diet

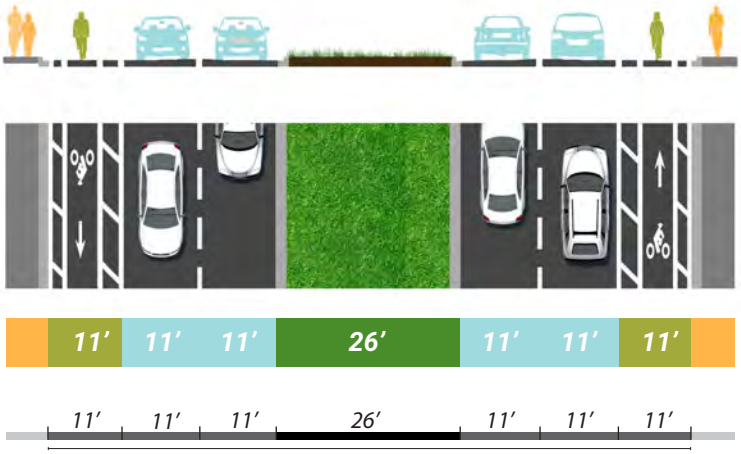


- The outside lane of this segment is concrete and has three bus lines that operate with headways between 10 and 30 minutes over the course of the day.



- A wide planted median divides the north and southbound travel lanes.





Potential Design Challenges

- Enforcement of buffered bike lane for exclusive bicycle use will be important after initial implementation.
- Interaction of Hampton Roads Transit buses and the buffered bike lane will need to be taken into consideration in final design of facility.
- The intersection at Kingsley Lane may require some left turn accommodation for northbound bicyclists to access the Bon Secours hospital.
- Special permitted parking on Granby Street for Temple Israel services may need to be adjusted to accommodate a continuous facility throughout this entire segment.

Corridor 3: Key Intersection

Intersection: Granby Street at Little Creek Road

Length: N/A

AADT: 32,000

Speed limit: 35 mph

Facility: Buffered bike lanes

Major Action: Traffic study and intersection redesign





- This intersection includes five lanes in both the north and southbound directions.
- Two dedicated right turn lanes move traffic onto Little Creek Road. Bicyclists currently travel through the intersection sharing a lane with automobiles.



- Bicyclists currently travel through the intersection sharing a lane with automobiles.

Potential Design Challenges

- Continuing the buffered bike lanes through this intersection will require removal of some lanes, continuing the road diet that occurs north and south of the intersection. Removal could be of through travel lanes or turn lanes.
- A traffic study of the impact of lane removal and full right turn on red restriction should be completed before implementing these design changes.

Corridor 3: Granby Street

Segment 2: Interstate 64/564 Interchange Underpass



Length: 0.3 miles

AADT: 22,000

Speed limit: 35 mph

Facility: Paved shoulder, shared by bicyclists and pedestrians

Major Action: Lane diet and barrier construction



- Pedestrians travel along a dirt path on the inside of the guardrail through this segment.



- Sight lines at the on- and off-ramps are challenging, especially at the southbound off-ramp from I-64.



- Shared lane markings currently exist in this segment, but sharing the lanes in this high-speed area is uncomfortable for all and a deterrent to most bicyclists.



- Currently a protected pedestrian pathway does not exist on the west side of the street Pedestrians are forced to walk in the minimal on-road shoulder.

Potential Design Challenges

- Reducing speed of vehicles exiting I-64 and I-564 will be challenging. Geometric changes to the off-ramps would be the most effective means of decreasing speed but is likely cost-prohibitive. Removal of the southbound lane for traffic exiting I-64 toward Admiral Taussig Boulevard would force traffic to yield and help slow speeds.
- Construction of the paved shoulder will require replacing the existing guard rail with a one-sided Jersey barrier.
- Lighting should be added to the underpass to increase pedestrian and bicyclist safety and comfort.

Corridor 3: Granby Street

Segment 2: Interstate 64/564 Interchange Underpass



Corridor 3: Granby Street

Segment 3: I-64 Interchange to Bayview Boulevard

Length: 0.9 miles
AADT: 24,000
Speed limit: 35 mph

Facility: Bike lanes
Major Action: Road widening



- Current shared lane markings do not provide separate space for bicyclists on this high-volume segment.



- Using the edge of the wide median to shift the northbound lanes will create enough space for bike lanes on the west side of the street.





Potential Design Challenges

- Accommodations for bicyclist left turns at NSN Gate 22 will need to be made.
- Potential conflicts between drivers entering I-64 and southbound bicyclists will need to be considered in the design of this segment.
- Forest Lawn Cemetery is closed for access from 7pm to 6am daily, so if a route through the cemetery is desired, it should also be supplemented by an improved on-street facility.



Corridor 3: Granby Street

Segment 4: Bayview Boulevard to Ocean View Avenue

Length: 1.6 miles
AADT: 12,000
Speed limit: 35 mph

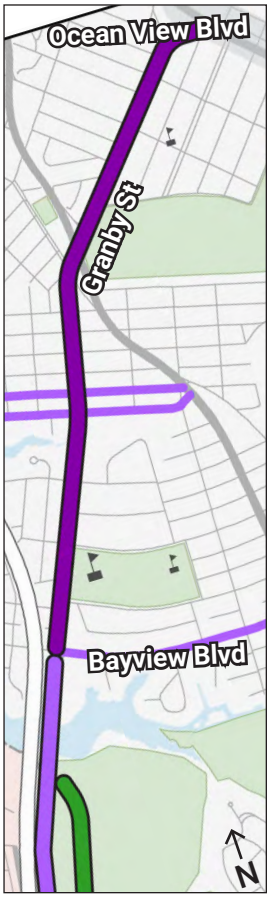
Facility: Buffered bike lanes
Major Action: Road diet - 4 lanes to 2 lanes

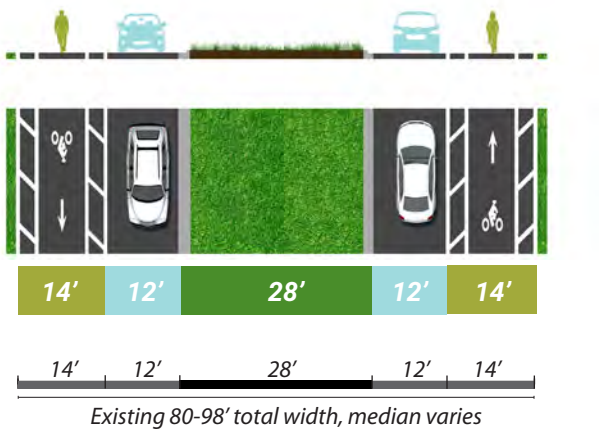


- This segment currently has shared lane markings, but traffic volumes are low enough to enable a road diet.



- A portion of this segment has already been operating with one lane southbound in 2015 due to major stormwater infrastructure work.





Existing 80-98′ total width, median varies

Potential Design Challenges

- A reduction in number of travel lanes may be viewed as decreasing motor vehicle level of service.
- The grade separated intersection with Tidewater Drive would need to highlight the conflict area between through bicycle traffic and automobile traffic accessing the on- and off-ramps to Tidewater Drive.
- The intersection at Ocean View Drive will need to be designed in coordination with the implementation of recommendations for Corridor 10 along Ocean View.
- Enforcement of buffered bike lane for exclusive bicycle use will be important after initial implementation.
- Parking restrictions will need to be enforced along this segment to ensure parked cars do not block the bike lane. Little parking was observed on street as all homes have driveways.

Corridor 4: Harbor Park and Tide Station to Five Points



Length: 4.2 miles
Speed Limit: 25-0 mph
Curb-to-Curb Width: 21 - 86'
AADT: 1,300 - 17,000

Land Use: Mix of residential and industrial land uses including older and new neighborhoods; NSU

Key Bicycle Facilities: Buffered bike lanes

Key Pedestrian Improvement: Improved intersection design at Five Points

Estimated Project Cost

$4,080,000

Purpose of Improvements

- Connects the Five Points Area with major destinations such as the Harbor Park, Norfolk State University, Amtrak Station and the Elizabeth River Trail.
- Linking existing low-volume, low-speed local streets will help bicyclists avoid difficult and dangerous intersections that could be encountered along a different alignment that makes the same connection.
- Combined with Corridor 12, this route provides a north-south link between Ocean View and downtown that is an alternative to Tidewater Drive.

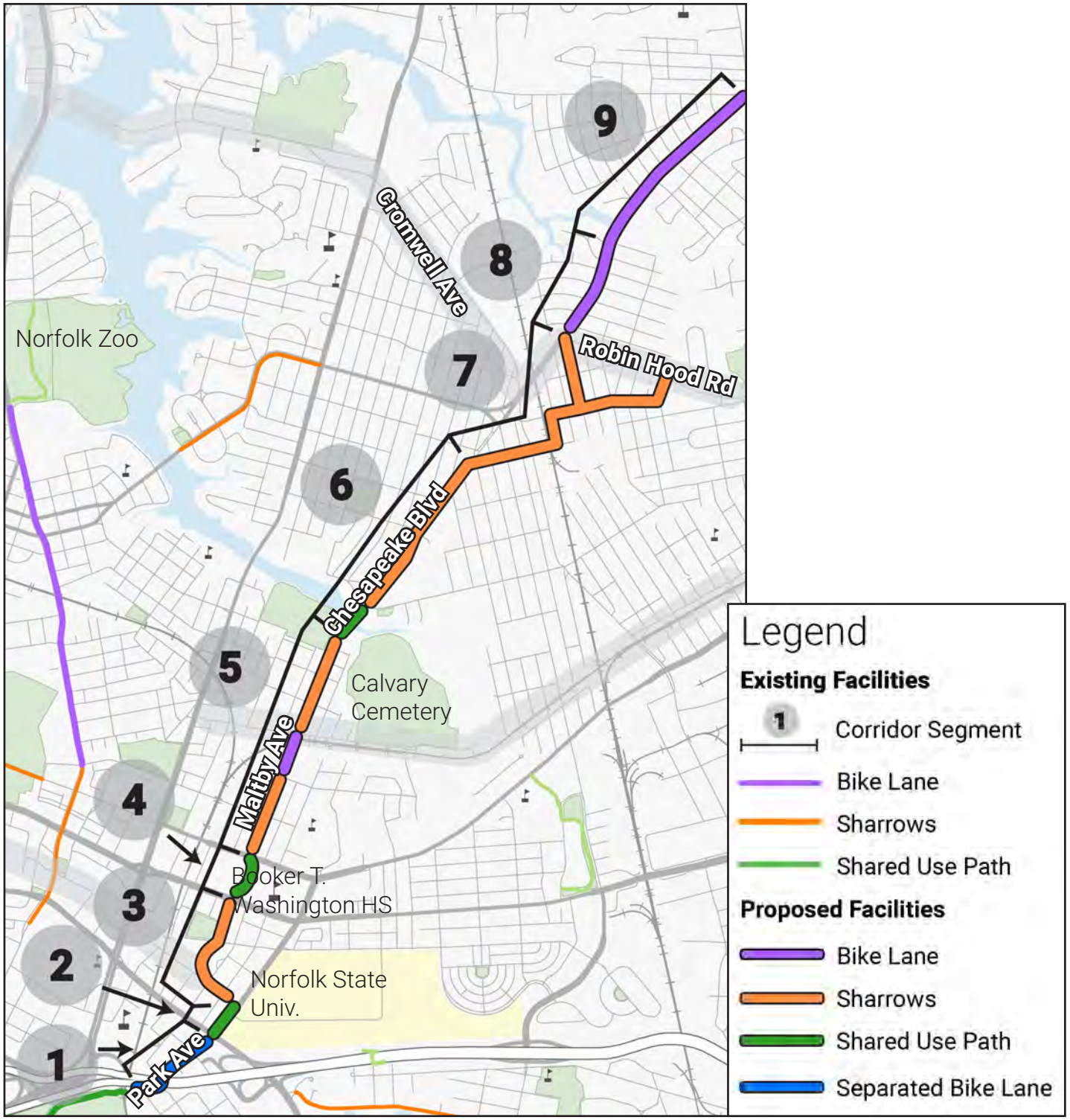
Key Challenges

- A bicycle/pedestrian bridge over the Lafayette River at the location of a former trolley bridge is necessary to complete this corridor.
- Cooperation from Norfolk State University will be needed to complete the shared use path in Segment 2 on their property along Park Avenue.
- The northern end of this corridor is dependent upon the design of the Five Points intersection. This corridor's interaction with Corridor 12 will need to be facilitated through this design.

Public Input

- Many commenters on the online WikiMap noted that the Lafayette River is a barrier to the otherwise comfortable and convenient bike route along Maltby Avenue and Chesapeake Boulevard.
- Some residents raised concerns about personal security in the neighborhoods between the ballpark and Lafayette River, including the Booker T. Washington High School campus.

Corridor 4: Recommendations Overview Map



Corridor 4: Park Avenue

Segment 1: Holt Street to Brambleton Avenue

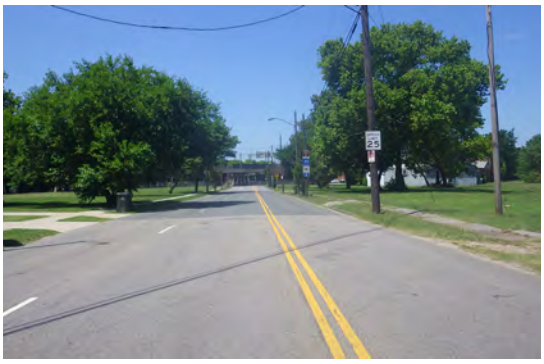
Length: 0.4 miles
AADT: unknown
Speed limit: 25 mph

Facility: Two-way separated bike lane
Major Action: 3 to 2 Road diet

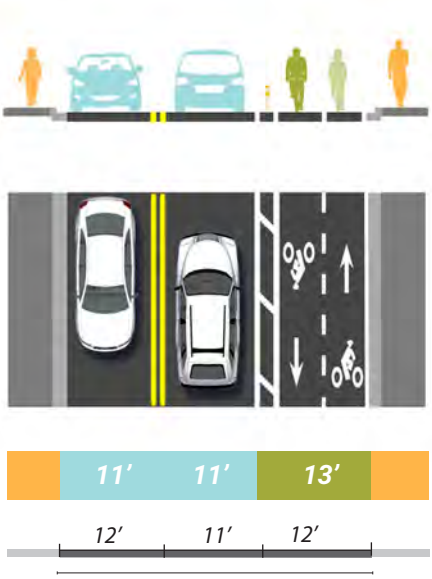




- The Elizabeth River Trail is on the south side of the street here and ends at Holt Street.



- Park Avenue has three lanes in this segment.



Potential Design Challenges

- The interaction of bicycle traffic with motor vehicle traffic at Brambleton Avenue may be complicated by formalizing two-way bicycle traffic on one leg of the intersection. Special attention to crossing design will be needed because of the overall large volumes of traffic, dual turning lanes and multiple turning movements that have been integrated into the signal phasing.

Corridor 4: Park Avenue and Maltby Crescent

Segment 2: Park Avenue from Brambleton Avenue to Olney Road

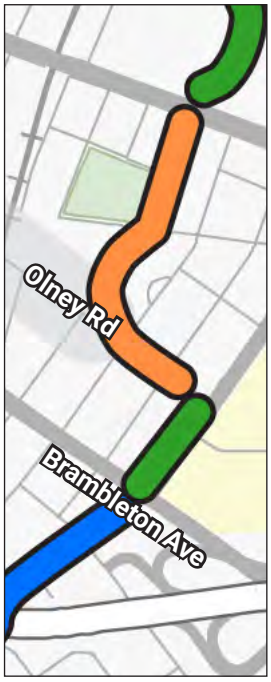
Length: 0.1 miles
AADT: 15,000
Speed limit: 25 mph

Facility: Shared use path
Major Action: Construct



Potential Design Challenges

- Unless a travel lane can be removed from Park Avenue, construction of a 1-block path from Brambleton to Olney Road will require use of Norfolk State University property in addition to the sidewalk.
- Some small trees will need to be removed to widen the existing sidewalk to at least 10'.
- The crossing at Olney Road will need special signage and markings to indicate two-way bicycle travel.



Segment 3: Park Avenue to Virginia Beach Boulevard

Length: 0.4 miles
AADT: unknown
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install



- Maltby Crescent and other streets in this segment are low-volume local streets.



- Parking is allowed on both sides of the street in front of single-family residential development.



Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Corridor 4: Booker T. Washington High School

Segment 4: Virginia Beach Boulevard to Princess Anne Road

Length: 0.1 miles
AADT: N/A
Speed limit: N/A

Facility: Shared use path
Major Action: Construct



- The existing crosswalk on this alignment is not high visibility, and the northern end lacks a curb ramp.



- The northern end of the path should align with Maltby Avenue which currently has no marked crosswalk.





Potential Design Challenges

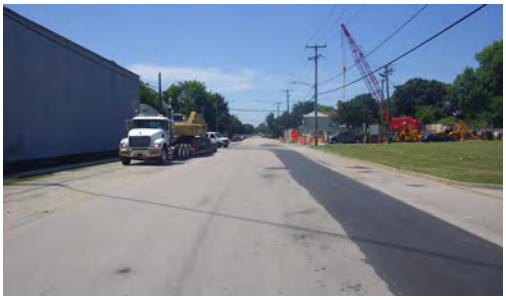
- Creation of a path through the athletic fields of Booker T.. Washington High School will require cooperation from the Norfolk Public Schools. It appears that a relatively direct path can be created by aligning it between existing fields. An alternative, less direct routing can be aligned along existing sidewalks.
- The crosswalks at Virginia Beach Boulevard and Princess Anne Road will need to be upgraded to include curb ramps, high visibility crosswalks, median islands and potentially HAWK, or another signal type, if crossing safety becomes an issue.

Corridor 4: Maltby Avenue and Chesapeake Boulevard

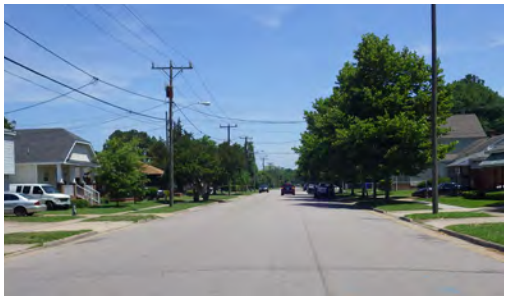
Segment 5: Princess Anne Road to Lafayette River

Length: 0.7 miles
AADT: 903 - 3,600
Speed limit: 25 mph

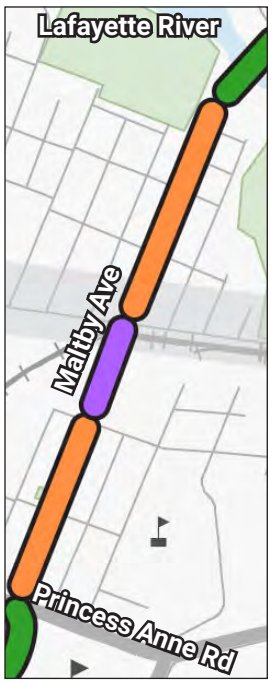
Facility: Shared lane markings; bike lanes
Major Action: Install; Lane diet



- The block of Maltby Avenue between Cary Avenue and Street Julian Avenue is wide enough to accommodate bike lanes



- The majority of this segment is a very low-volume local street that dead ends at the Lafayette River.



Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Segment 6: Lafayette River to Hanbury Street

Length: 0.6 miles
AADT: 1,300
Speed limit: 25 mph

Facility: Bike/ped bridge; Shared lane markings
Major Action: Construct; Install



- Embankments from the former trolley bridge connecting Maltby Avenue to Chesapeake Boulevard still exist.



- This segment of Chesapeake Boulevard is a very low-volume local street.



Potential Design Challenges

- The crossing of the Lafayette River may be too wide for a prefabricated pedestrian and bicycle bridge, so it will need to be custom designed and constructed.

Corridor 4: Signed connector route

Segment 7: Chesapeake Boulevard to Robin Hood Road

Length: 0.7 miles
AADT: unknown
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install



- Hanbury Avenue, Lafayette Boulevard, Arizona Avenue, and Kansas Avenue are low-volume, comfortable local streets.



- The crossing on Hanbury Avenue of Cromwell Avenue today is wide and uncontrolled.





- This routing helps bicyclists avoid the complex, dangerous and potentially confusing quasi-circle intersection of Chesapeake Boulevard and Lafayette Boulevard, and the major intersection of Chesapeake Boulevard and Cromwell Avenue.

Potential Design Challenges

- The intersection at Cromwell Avenue would benefit from improved crossing treatments like high-visibility crosswalks and likely a HAWK signal to stop cross traffic on demand for bicyclists and pedestrians. New median refuge islands or adjustment of existing islands would also benefit pedestrians and bicyclists but may be difficult to place and accommodate left turn movements.

Corridor 4: Chesapeake Boulevard

Segment 8: Robin Hood Road to Montgomery Street

Length: 0.3 miles
AADT: 17,000
Speed limit: 30 mph

Facility: Bike lanes
Major Action: Widen road

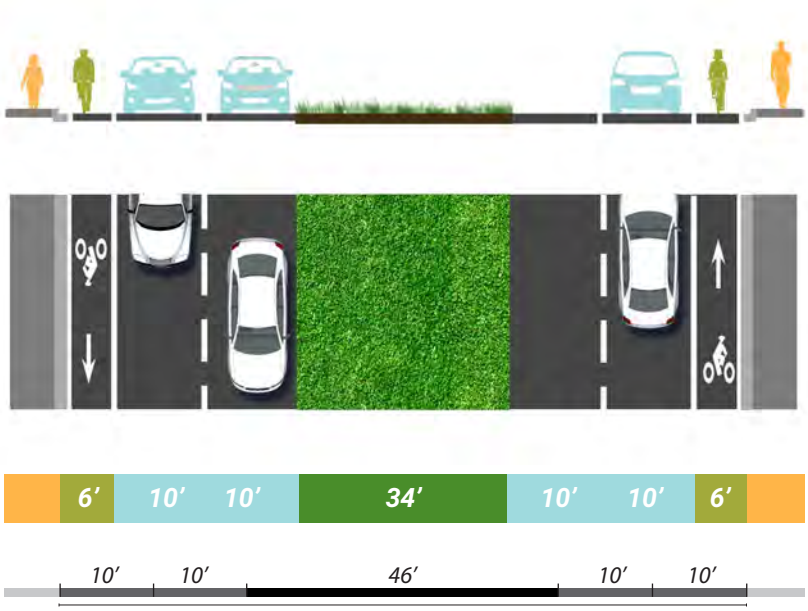


- There is a wide 46' planted median in this segment with no curbs.



- Plantings are far enough to the interior to not be disturbed by widening the roadway into the median.





Potential Design Challenges

- The intersection at Robin Hood Road and Chesapeake Boulevard will need some additional crossing treatment for southwestbound bicyclists to make the left turn onto Robin Hood Road.

Corridor 4: Chesapeake Boulevard

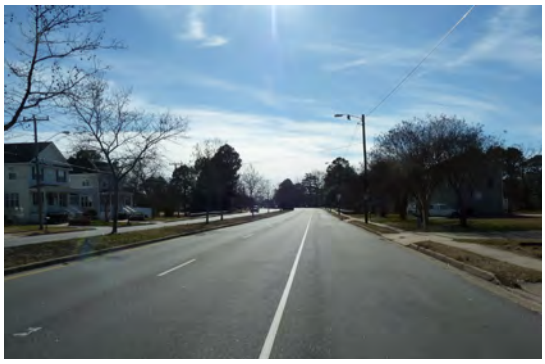
Segment 9: Montgomery Street to Norview Avenue

Length: 0.6 miles
AADT: 17,000
Speed limit: 30 mph

Facility: Bike lanes
Major Action: Lane diet

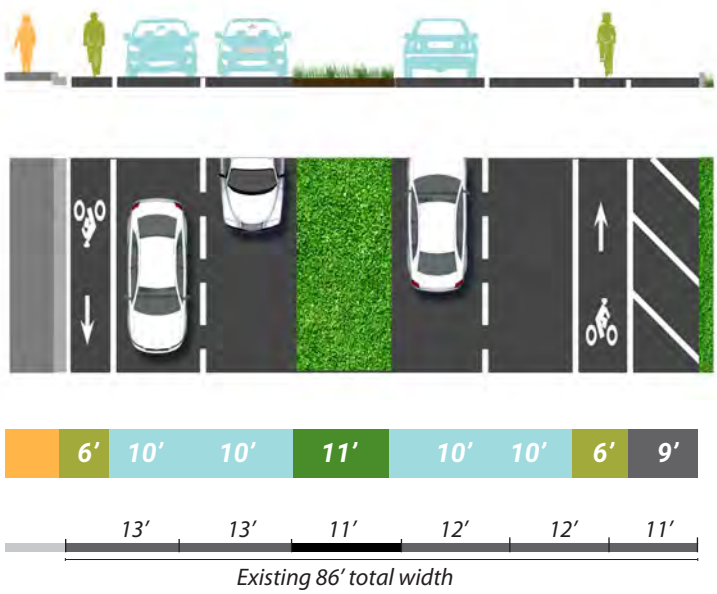


- There is a planted median in this segment that has curbs.



- A 11' to 14' shoulder exists on both sides of the street from Montgomery Street to Wayne Circle and continues on the east side of the street north of Wayne.





Recommended cross section for lane diet section, Wayne Circle to Hyde Circle

Potential Design Challenges

- The design of the northern end of this segment from Hyde Circle to Norview Avenue will need to be coordinated with the redesign of the Five Points intersection. There are constraints to routing bicyclists onto a wide sidewalk in this area (utility poles and boxes), so an on-street facility may be the best choice. Accommodating the northbound bicyclists' movement onto Chesapeake Boulevard (Corridor 12) will be challenging given the double right turn lanes present on the south leg of Chesapeake Boulevard.

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Corridor 5: Downtown-Old Dominion University-Naval Station Connector



Length: 4.2 miles
Speed Limit: 25-35 mph
Curb-to-Curb Width: 20 - 88'
AADT: low - 34,000

Land Use: Majority neighborhood commercial; Old Dominion University; medium-density residential

Key Bicycle Facilities: Priority shared lane markings on Colley Ave; Widened sidewalk for Elizabeth River Trail on Hampton Boulevard Bridge

Key Pedestrian Improvement: Widened sidewalk for Elizabeth River Trail on Hampton Boulevard Bridge

Estimated Project Cost

$660,000

Purpose of Improvements

- This corridor connects a number of major destinations within Norfolk and provides an alternative to bicycle travel on most of Hampton Boulevard.
- Key upgrades to the Elizabeth River Trail are recommended in this corridor.
- There is a significant amount of existing bicycle traffic on Colley Avenue to access neighborhood commercial establishments.
- Retaining existing and increasing future bicycle travel on the north end of Colley Avenue will support neighborhood revitalization.

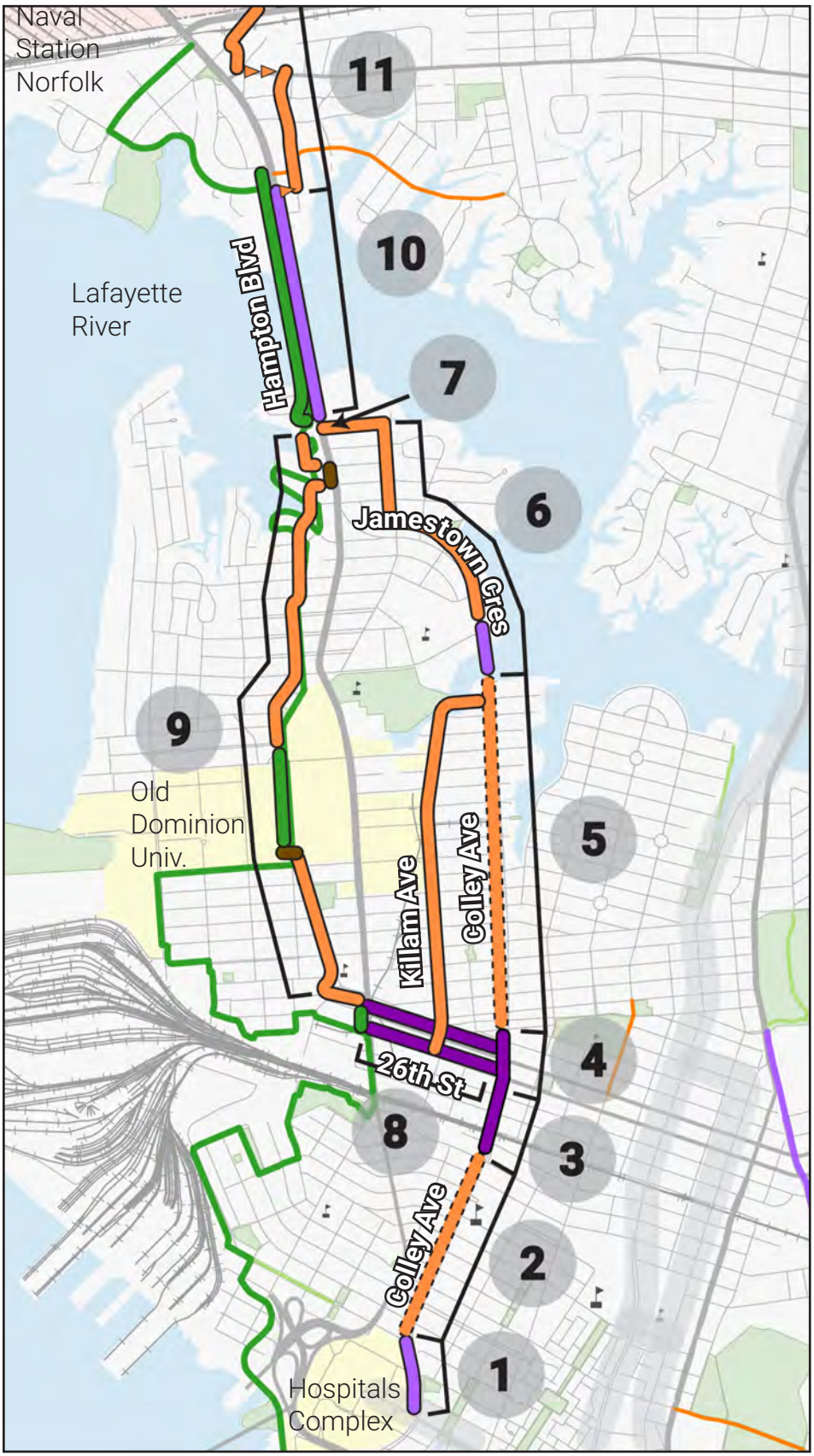
Key Challenges

- The sidewalk on the west side of the Hampton Boulevard Bridge across the Lafayette River is designated as the Elizabeth River Trail. As a shared use path, this sidewalk is severely sub-standard.
- The City will need to prioritize phasing of the east and west routes presented here that parallel Hampton Boulevard. Both are needed and serve different purposes.
- The underpass on Colley Avenue will need to be reconstructed at some future point to provide a better bicycle accommodation than routing on the narrow sidewalk.

Public Input

- Student and staff stakeholders from Old Dominion University expressed a desire for a route to connect to downtown more directly than the Elizabeth River Trail.
- The Colley Avenue commercial zones were noted as important bicycle destinations for people who live in the area.

Corridor 5: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Bike Lane
- Sharrows
- Shared Use Path

Proposed Facilities

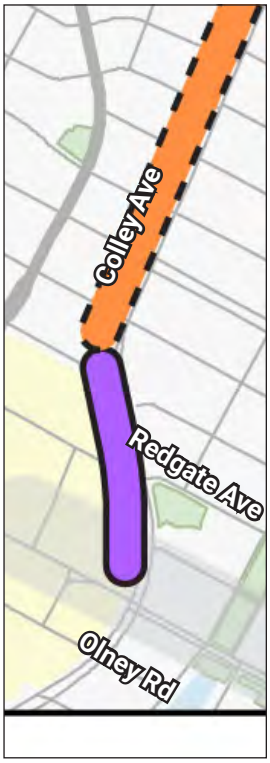
- Bike Lane
- Buffered Bike Lane
- Shared Use Path
- Priority Shared Lane
- Sharrows
- Contraflow Shared Lane Marking

Corridor 5: Colley Avenue

Segment 1: Olney Road to Redgate Avenue

Length: 0.2 miles
AADT: 14,000
Speed limit: 25 mph

Facility: Bike lanes
Major Action: Lane diet

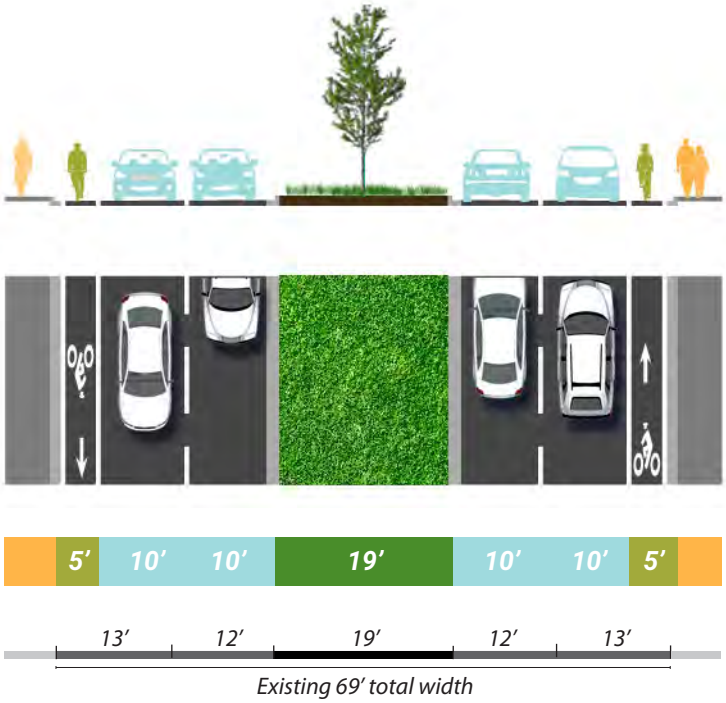




- Left turn pockets exist at all of the intersections along this segment.



- This segment serves the hospitals complex which is a major traffic generator.



Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Corridor 5: Colley Avenue

Segment 2: Redgate Avenue to 21st Street

Length: 0.5 miles
AADT: 15,000
Speed limit: 15 to 25 mph

Facility: Priority shared lane markings
Major Action: Install



- Small retail and restaurant destinations line this segment of Colley Avenue and patrons keep on-street parking heavily occupied.



- James Blair Middle School is located in this segment of Colley Avenue and creates a 15 mph school zone.





- Priority shared lane markings include a green backing and are spaced more closely than traditional shared lane markings to reinforce the message that bicyclists will be sharing the road with drivers.

Potential Design Challenges

- This will be one of the first installations of priority shared lane markings in Norfolk, so outreach to adjacent businesses, residents and visitors to the corridor is recommended.

Corridor 5: Colley Avenue

Segment 3: 21st Street to 25th Street

Length: 0.2 miles
AADT: 16,000
Speed limit: 25 mph

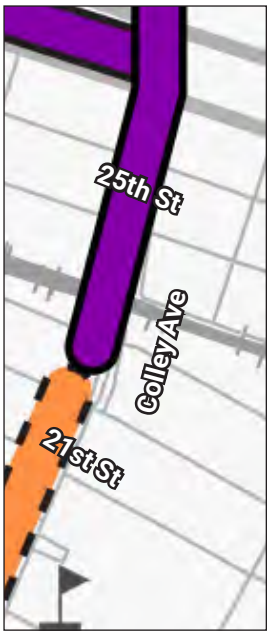
Facility: Buffered bike lane
Major Action: 4 to 2 road diet



- The sidewalk is narrow through the underpass and obstructed.



- The street widens to four lanes at 21st Street. This segment is the only four-lane one for the length of Colley Avenue.



Potential Design Challenges

- Traffic volumes appear to accommodate a road diet in this segment, but an additional traffic study may be desirable to confirm.

Segment 4: 25th Street to 28th Street

Length: 0.1 miles
AADT: 16,000
Speed limit: 25 mph

Facility: Buffered bike lanes
Major Action: 4 to 2 Road diet



- The street width and configuration changes a number of times throughout this segment.



- Left turn movements onto 27th Street will need to be accommodated.



Potential Design Challenges

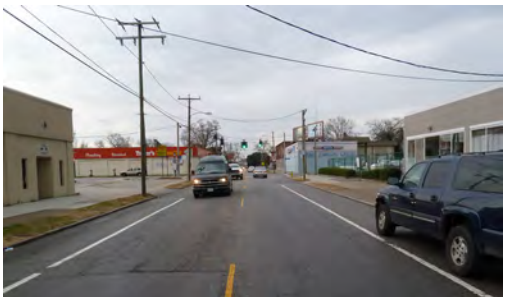
- The shifting roadway dimensions and configurations will necessitate a detailed and careful striping plan.

Corridor 5: Colley Avenue and Jamestown Crescent

Segment 5: 28th Street to 52nd Street

Length: 1.0 miles
AADT: 14,000
Speed limit: 25 mph

Facility: Priority shared lane markings
Major Action: Install



- Parking lanes are striped on both sides of the street in this segment.



- Shared lane markings exist from 38th Street to 51st Street.



Potential Design Challenges

- There are no major challenges to implementing this recommendation.

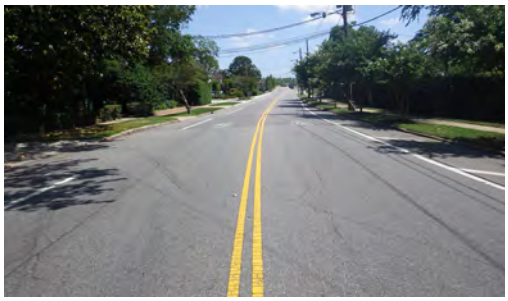
Segment 6: 52nd Street to Hampton Boulevard

Length: 1.0 miles
AADT: low to 7,200
Speed limit: 25 to 30 mph

Facility: Bike lanes; Shared lane markings
Major Action: Install



- Shared lane markings exist from 52nd Street to Magnolia Avenue.



- Streets in this segment are narrow with parking allowed on both sides.



Potential Design Challenges

- Recently striped parking just north of the bridge could be removed to continue the bike lanes from the southern end of the segment through Magnolia Avenue.

Corridor 5: Elizabeth River Trail

Segment 7: Lexan Avenue to Hampton Boulevard Bridge

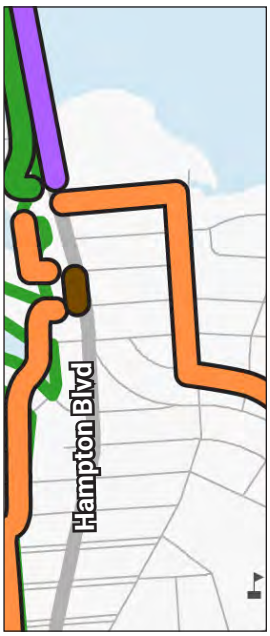
Length: 0.2 miles

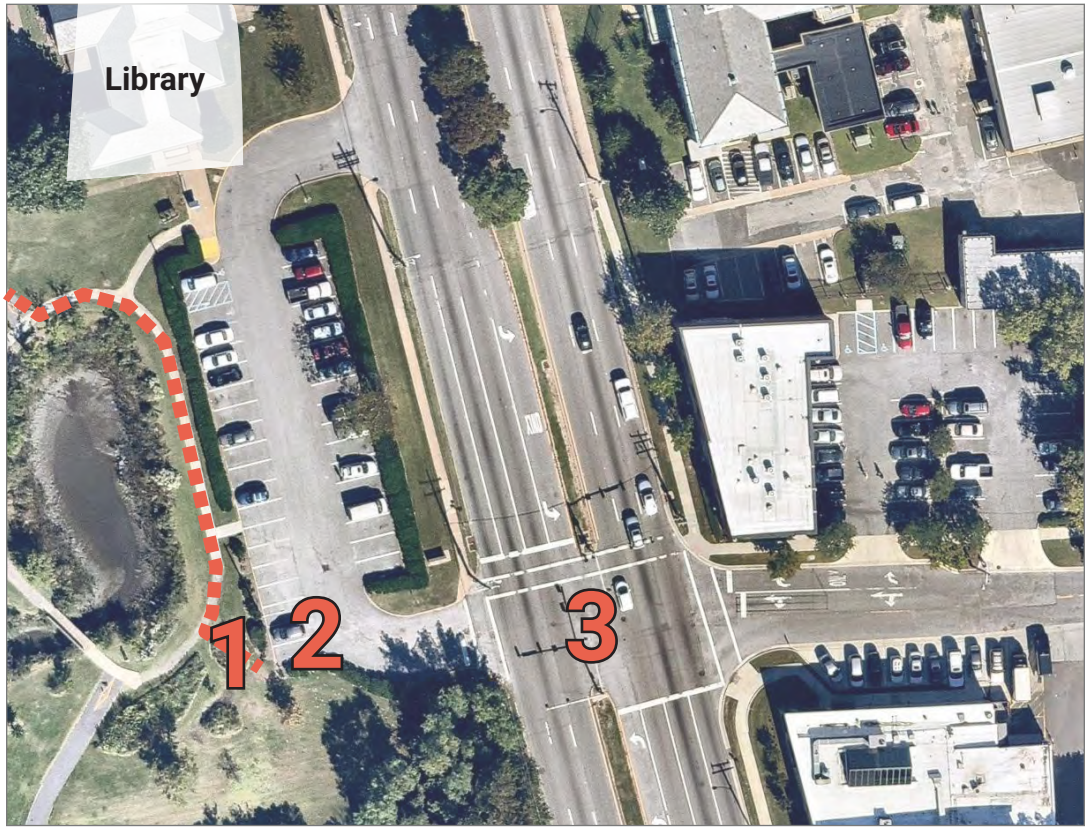
AADT: N/A

Speed limit: N/A

Facility: Intersection improvements; Shared use path spur

Major Action: Install





1 A short spur of shared use path will need to be constructed to connect to the library parking lot in this location

2 The southernmost parking space should be removed to provide access to the new trail spur.

3 A crosswalk and green bike crossing across should be added to the south leg and a green bike crossing to north leg. Pedestrian signal heads and actuators should be upgraded to alert bicyclists to crossing time

Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Corridor 5: 26th Street and 27th Street

Segment 8: Colley Avenue to Hampton Blvd

Length: 0.4 miles
AADT: 4,200 - 8,300
Speed limit: 30 mph

Facility: Buffered bike lanes; Shared use path
Major Action: Road diet; Construct







A one-way pair of buffered bike lanes should be constructed on 27th and 26th Streets. A dialog with adjacent land and business owners along the segment should be initiated to discuss the necessity of on-street parking. Parking is currently allowed on one side of each of these streets, and to maintain two travel lanes at all times, it will need to be removed.

A short segment of shared use path should be constructed along Hampton Boulevard between 26th and 27th Streets (at asterisk) to allow for eastbound access to 26th Street from the crossing at 27th Street.

Potential Design Challenges

- Parking or lane removal on both streets may be met with resistance from neighboring land owners and tenants.

Corridor 5: Hampton Boulevard western alternate

Segment 9: Hampton Boulevard to Elizabeth River Trail

Length: 1.9 miles
AADT: unknown
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install



- There is currently no curb ramp at the corner of Richmond Crescent and Hampton Boulevard to access the sidewalk bikeway.



- Bluestone Avenue and other streets in this segment are low-volume local streets.



Potential Design Challenges

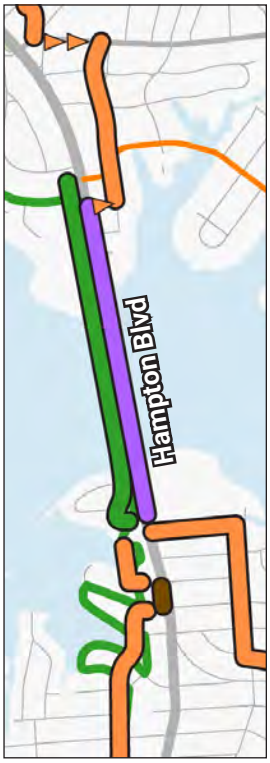
- This route, for the most part, follows the existing Elizabeth River Trail on-road route which requires more obvious wayfinding signage.

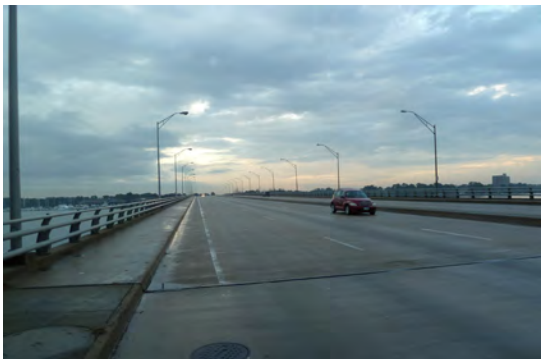
Corridor 5: Hampton Boulevard

Segment 10: Hampton Boulevard Bridge

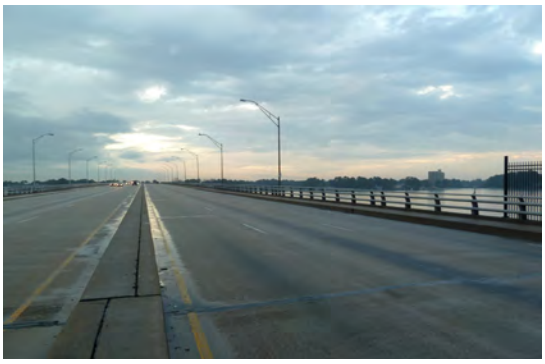
Length: 0.3 miles
AADT: 34,000
Speed limit: 35 mph

Facility: Wide sidewalk; bike lane
Major Action: Reconstruct; lane diet

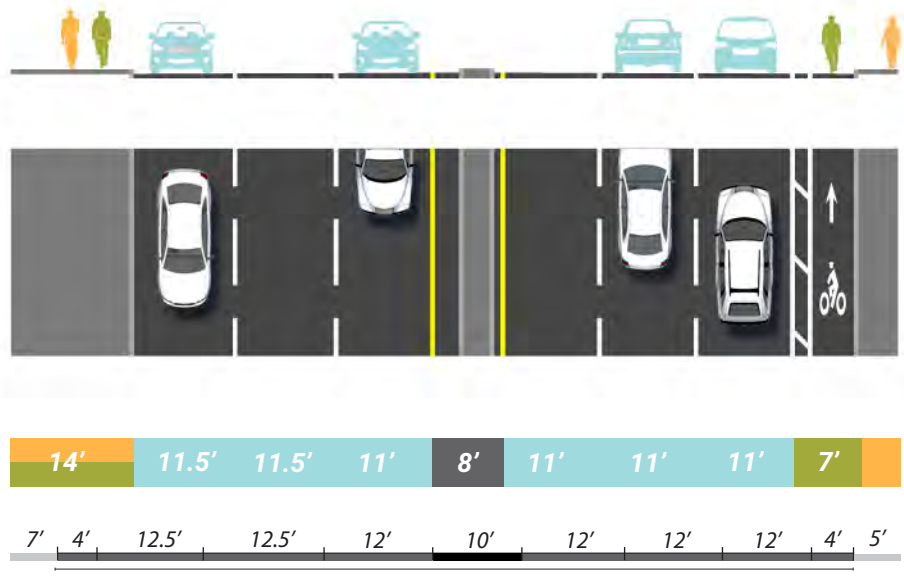




- The current sidewalk is 7' wide which is not wide enough for two bicyclists to pass one another on this facility that is intended as a two-way trail.



- The existing lanes on the northbound side of the bridge are 12' wide, and a 4' shoulder is present.



Potential Design Challenges

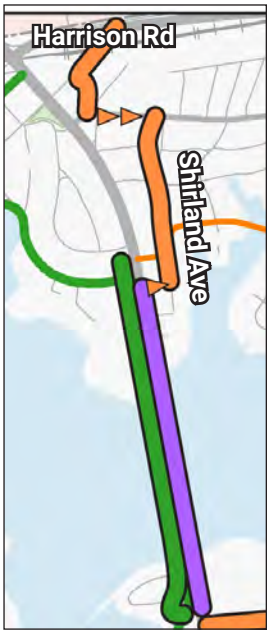
- Widening the sidewalk will be a significant investment.

Corridor 5: Hampton Boulevard Alternate

Segment 11: Lafayette River Bridge to Harrison Road

Length: 0.7 miles
AADT: unknown
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install







- The diverter island at Baylor Place and Hampton Boulevard prevents automobile traffic from turning left onto Hampton Boulevard.

1 Crossing Little Creek Road to access Harrison Road will require some detailed design attention

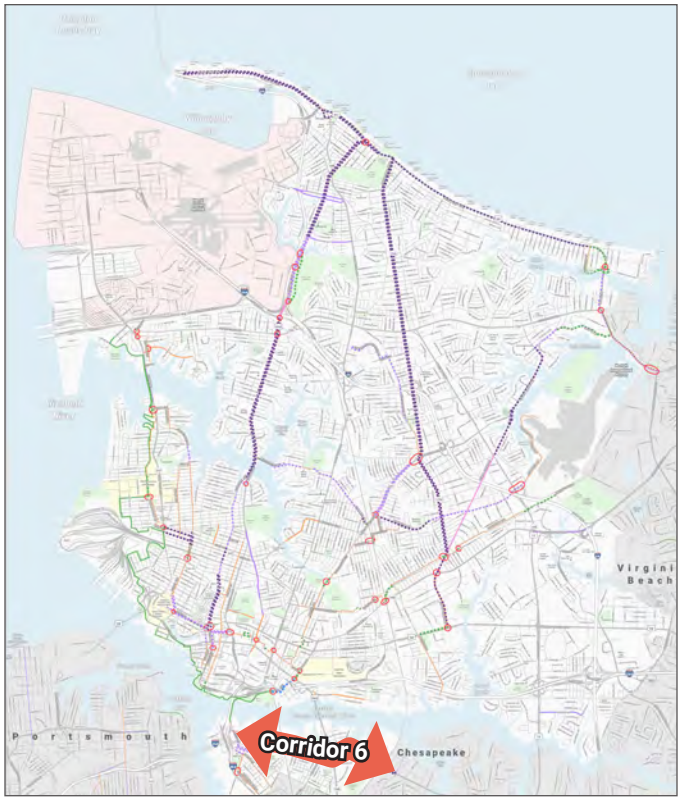
2 The transition between Baylor Place and Trouville Avenue will need special design and passage for southbound bikes through a diverter island.

Potential Design Challenges

- This segment only serves a purpose when the potential trail south of the rail corridor along the Naval Station boundary is constructed.
- For the contraflow sections, signage will be necessary to alert drivers to two-way bicycle travel, especially at intersections.

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Corridor 6: Indian River Road -- South Norfolk Connector



Length: 2.2 miles
Speed Limit: 30 mph
Curb-to-Curb Width: 20 - 92'
AADT: 1,200 - 19,000

Land Use: Single-family residential at east end and center; majority industrial uses

Key Bicycle Facilities: Bike lanes and buffered bike lanes

Key Pedestrian Improvement: Traffic calming on Indian River Road with road diet through residential areas

Purpose of Improvements

- Provide a continuous bikeway linking South Norfolk to downtown, using the existing I-264 bicycle/ pedestrian bridge crossing of the Elizabeth River.
- Provide a continuous bikeway link from Norfolk to Chesapeake.

Estimated Project Cost

$360,000

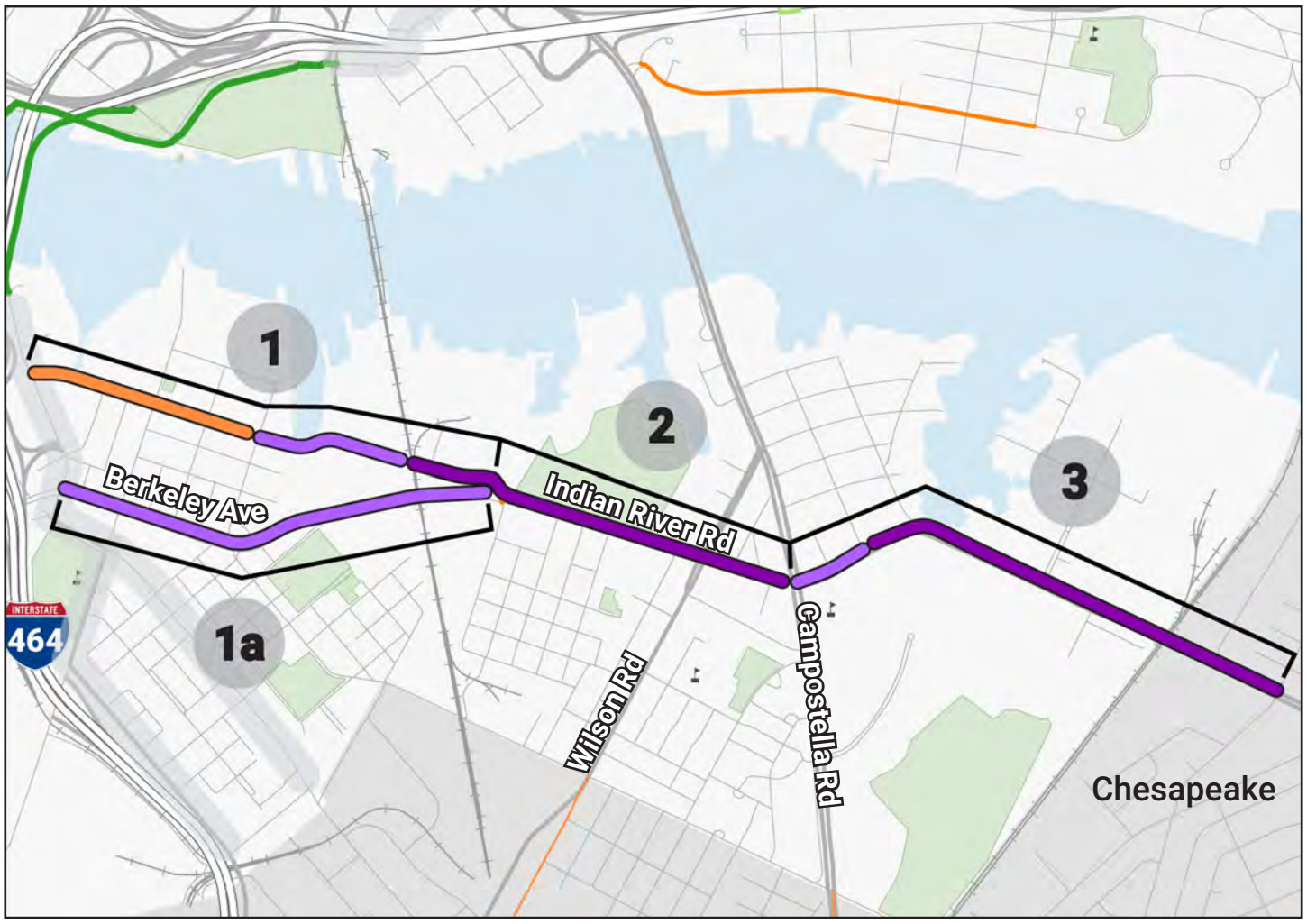
Key Challenges

- Indian River Road transitions to a 45 mph speed limit in Chesapeake to the east of this corridor.
- Accommodating bike lanes through the complex turn lane configurations at Compostella Road will necessitate some detailed design work.

Public Input

- An east-west connector through South Norfolk that reaches Chesapeake was noted as important by residents in this neighborhood.

Corridor 6: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Sharrows
- Shared Use Path

Proposed Facilities

- Bike Lane
- Sharrows
- Buffered Bike Lane

Corridor 6: Indian River Road

Segment 1: State Road to Berkeley Avenue

Length: 0.9 miles
AADT: 1,200 to 2,700
Speed limit: 30 mph

Facility: Buffered bike lane and bike lanes
Major Action: Remove parking

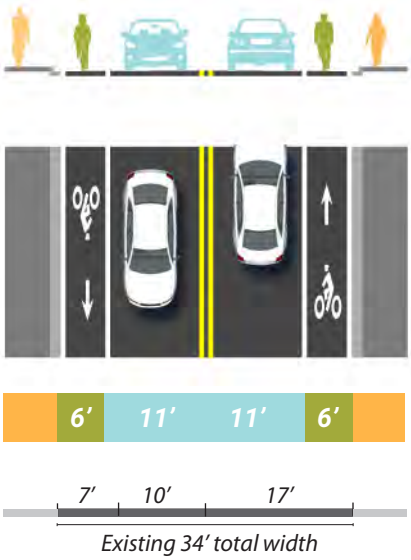




- Existing shared lane markings should be maintained.



- On-street parking is little used in this area as businesses provide parking for their employees.



Recommended cross section for parking removal section, Fauquier Street to Railroad tracks

Potential Design Challenges

- Adjacent businesses may object to prohibiting on-street parking, but there is parking provided at these establishments already.

Corridor 6: Berkeley Avenue

Segment 1a: State Street to Indian River Road

Length: 0.9 miles
AADT: 12,000
Speed limit: 35 mph

Facility: Bike lanes
Major Action: Lane diet

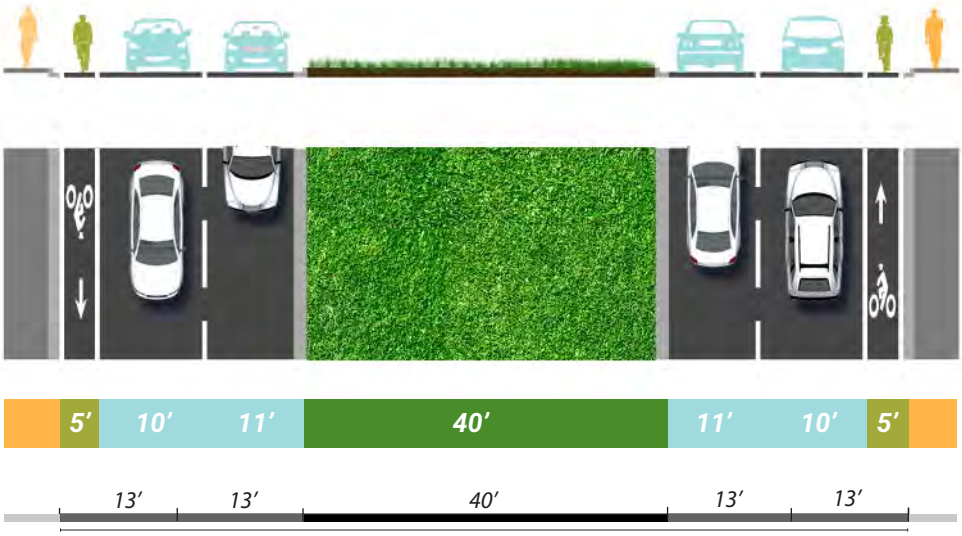




- Existing travel lanes are wide (12-13') on Berkeley Avenue.



- Adjacent residential properties would benefit from traffic calming effect of narrower lanes.



Potential Design Challenges

- Making left turns across the two lanes of traffic may be difficult for less experienced bicyclists. It may be desirable to facilitate some left turns off Berkeley Avenue into the neighborhood to the north and the business district to the south with two-stage turn boxes.

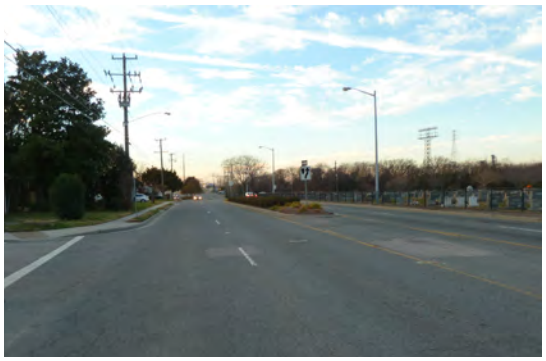
Corridor 6: Indian River Road

Segment 2: Berkeley Ave to Campostella Road

Length: 0.6 miles
AADT: 13,000
Speed limit: 30 mph

Facility: Buffered bike lanes
Major Action: 5 to 3 Road diet

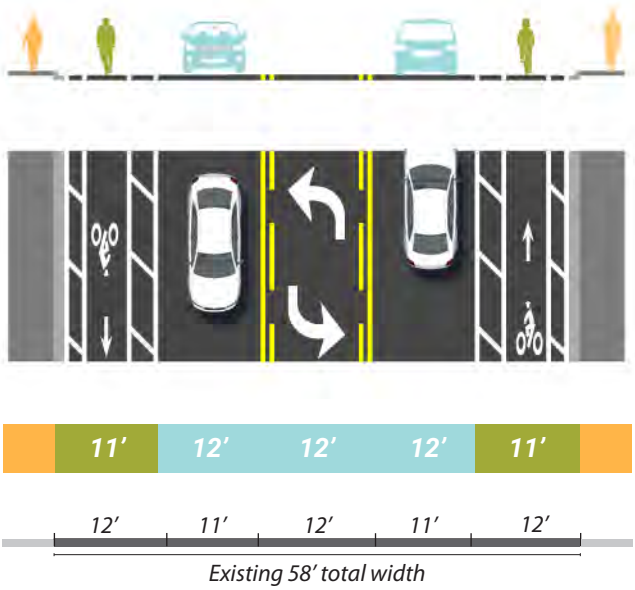




- The 23' curb-to-curb width on either side of the median requires a road diet to accommodate bicycles.



- Left turn pockets are available at major locations such as Riverside Memorial Park cemetery.



Existing 58' total width

Potential Design Challenges

- The intersection at the east end of this segment with Campostella Road will need detailed design work to address the conflict zone created by right-turning vehicles accessing the right turn lane across the buffered bike lane.

Corridor 6: Indian River Road

Segment 3: Campostella Road to City Limits

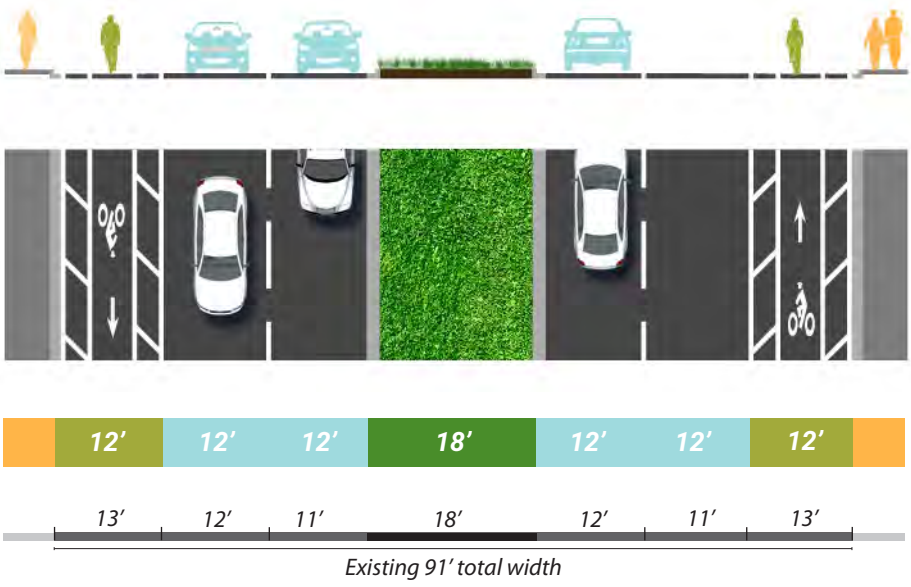
Length: 0.7 miles
AADT: 16,000 - 19,000
Speed limit: 30 mph

Facility: Buffered bike lanes
Major Action: 6 to 4 Road diet



- The existing six-lane section is larger than needed for traffic volumes and promotes higher speeds than the posted limit of 30 mph.



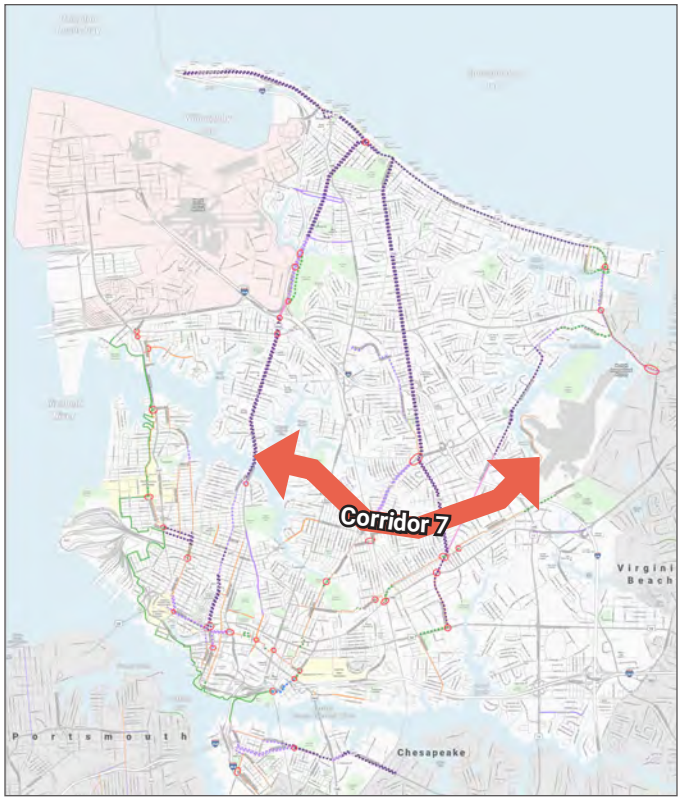


Existing 91′ total width

Potential Design Challenges

- There are no major challenges to implementing this recommendation.
- In the future, adding flexible bollards to the buffer area would provide a greater degree of separation for bicyclists on this segment that tends to be fairly high speed in spite of the 30 mph speed limit.

Corridor 7: Cromwell Drive and Robin Hood Road Cross-City Connector



Length: 4.7 miles
Speed Limit: 25-35 mph
Curb-to-Curb Width: 24-50'
AADT: 4,200 - 11,000

Land Use: Majority single family residential; two elementary schools; some light industrial

Key Bicycle Facilities:
Bike lanes, buffered bike lanes and connector trail

Key Pedestrian Improvement:
Connector trail and crossings from Cromwell Avenue to Robin Hood Road

Purpose of Improvements

- An east-west corridor is needed to connect across the city,.This corridor links three of the north-south corridors recommended in this plan on Granby, Chesapeake and Azalea Garden.
- Providing a connection from the city to a popular recreational bicycling route that uses Miller Store Road.

Estimated Project Cost

$840,000

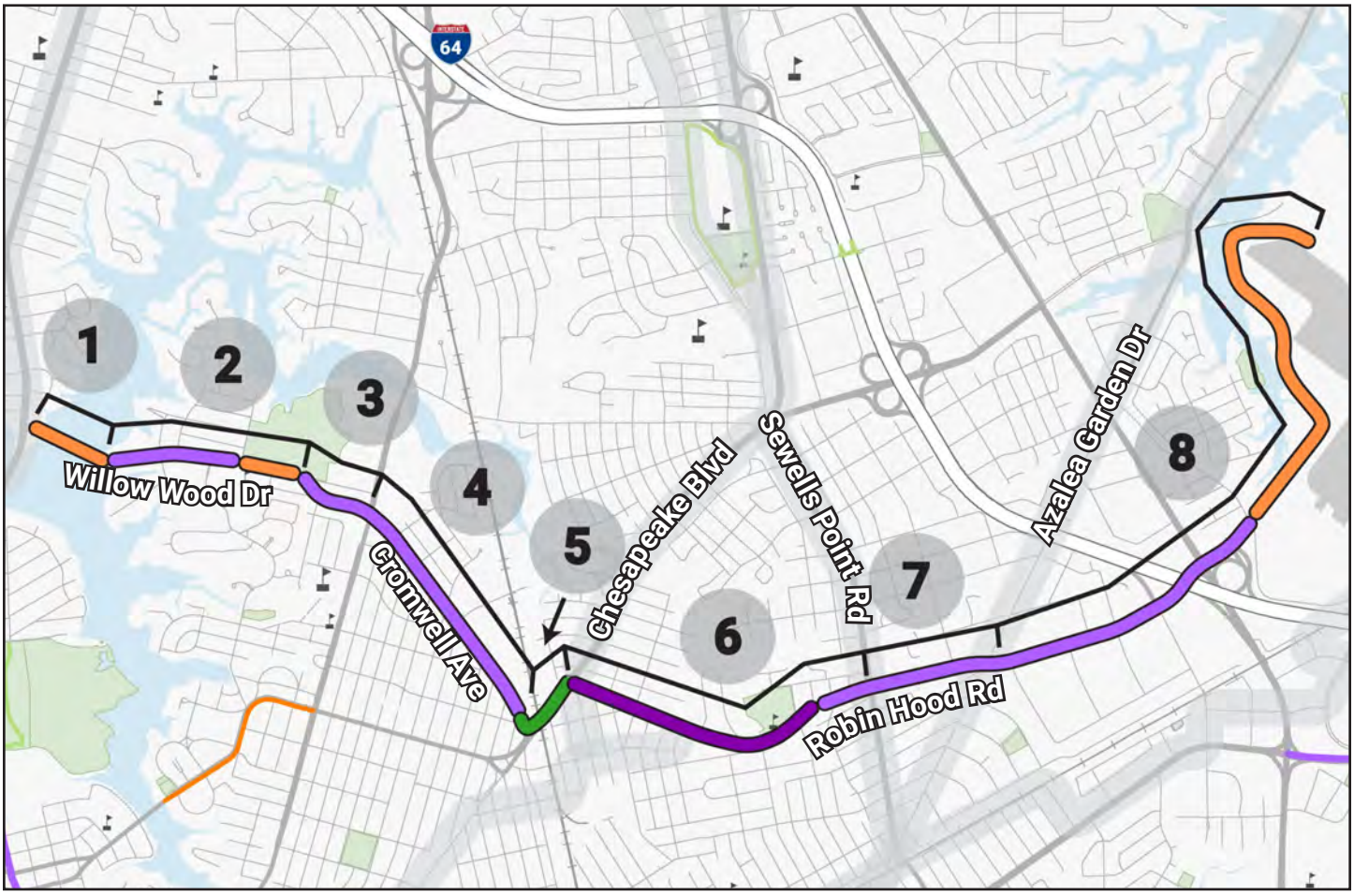
Key Challenges

- Navigating the intersection of Cromwell Drive and Chesapeake Boulevard will require construction of a short trail section that avoids this complex and dangerous intersection. However, this is a key connection between the east and west ends of this corridor.
- This is a long corridor with many different facility types, and implementing the entire set of projects at once may be challenging.

Public Input

- Many bicyclists already ride the western end of this corridor to connect from Granby Street into neighborhoods and to employment destinations at Norfolk Commerce Park.
- Robin Hood Road was noted as a location that is already fairly good for bicycling but has great opportunity for a dedicated bikeway due to wide lanes.

Corridor 7: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Sharrows
- Bike Lane

Proposed Facilities

- Bike Lane
- Sharrows
- Buffered Bike Lane
- Shared Use Path

Corridor 7: Willow Wood Drive

Segment 1: Bridge

Length: 0.3 miles
AADT: 11,000
Speed limit: 25 mph

Facility: Shared lane markings and signage
Major Action: Install





- Bicyclists today ride on the sidewalk on the bridge, even though it is uncomfortably narrow.



- Sightlines for drivers are compromised by the grade of the bridge.



- The MUTCD R 4-11 sign "BIKES MAY USE FULL LANE" should be incorporated on the bridge to alert drivers to the fact that bicyclists will be in the lane ahead though they may not see them.

Potential Design Challenges

- There are no major design challenges to implementing these recommendations.

Corridor 7: Willow Wood Drive

Segment 2: Bridge to Elmore Place

Length: 0.6 miles

AADT: 11,000

Speed limit: 25 to 30 mph

Facility: Bike lanes; shared lane markings

Major Action: Lane diet; install

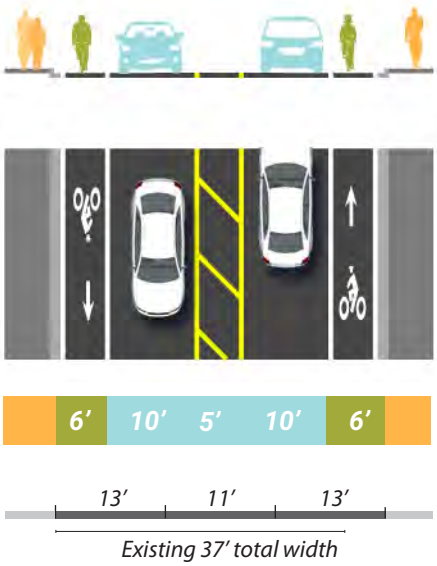




- The western end of this segment has a large planted median with cartways wide enough to accommodate bike lanes.



- There is a 10' striped median throughout this segment except where left turn lanes exist.



Potential Design Challenges

- Maintaining the left turn lane into the school property precludes keeping a continuous bike lane facility through this segment.
- The left turn lanes at Norway Place and Huntington Place will need to be removed to accommodate bike lanes, but these are low-volume residential streets.
- Lowering the speed limit to 25 mph through this entire segment is recommended. The residential character and presence of a park and elementary school justify slower speeds for bicyclist and pedestrian safety.

Corridor 7: Cromwell Drive

Segment 3: Willow Wood Dr to Tidewater Dr

Length: 0.3 miles
AADT: 11,000
Speed limit: 30 mph

Facility: Bike lanes
Major Action: Lane diet

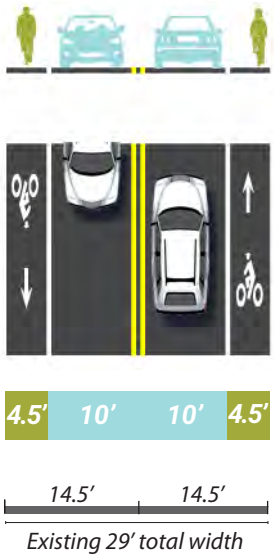




- Elmore Place currently has two wide travel lanes where parking is allowed next to two destinations that have their own parking lots



- This portion of Cromwell Drive is 29' wide where parking is not prohibited, though it is narrow.



Potential Design Challenges

- For bicycle lanes to be installed in the 29-foot section pictured (or described) above, a) the two bicycle lanes will be slightly substandard (4.5' instead of 5'), or b) the two travel lanes will be substandard (9.5' instead of 10').
- Parking will need to be prohibited on Cromwell Drive in this segment, and on the south side of Elmore Place.
- The westbound bike lane should be striped through the intersection of Willow Wood Drive and Elmore Place to alert westbound drivers on Willow Wood Drive that they are crossing bicyclists' path of travel.

Corridor 7: Cromwell Drive

Segment 4: Tidewater Drive to Lyons Avenue

Length: 0.7 miles

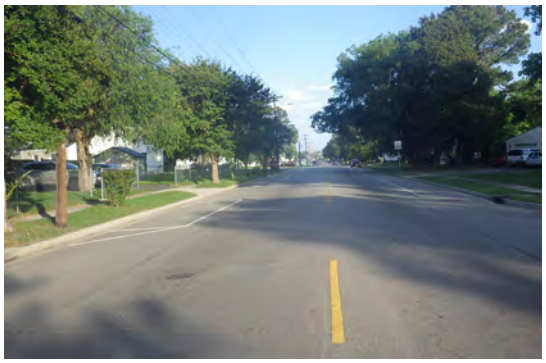
AADT: 12,000

Speed limit: 30 mph

Facility: Bike lanes

Major Action: Parking consolidation; lane diet

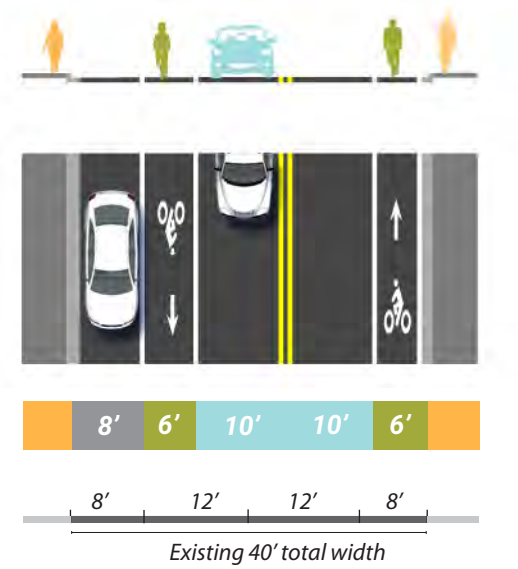




- Between Tidewater Drive and Brest Avenue, parking is little-used. It could be striped on alternating sides of the street to provide traffic calming.



- The center turn lane and travel lanes in this segment are wider than needed.



Potential Design Challenges

- Consolidation of parking on one side of the street may be viewed unfavorably by some residents, however, a chicane configuration will further calm/slow traffic, which typically finds strong local support.

Corridor 7: Connector Trail

Segment 5: Cromwell Drive to Robin Hood Road

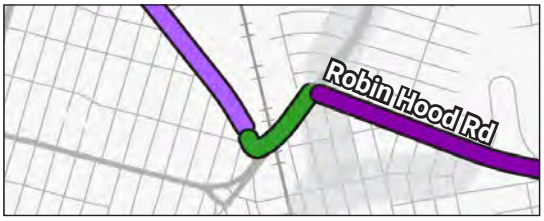
Length: 0.2 miles

AADT: N/A

Speed limit: N/A

Facility: Trail and enhanced crossings

Major Action: Construct; close medians





Due to the unusual geometry, the intersection of Cromwell Road and Chesapeake Boulevard would be difficult and costly to retrofit for safe bicycle travel. Segment 5 recommends an alternative routing that would appear to be feasible. In heavy traffic it will enable cyclists to cross each street in two stages if necessary, rather than waiting for a gap in traffic from both directions.

1 Bicyclist queueing space will be located at the southwest corner of Cromwell Road and Flanders Avenue. Curb will be extended to provide waiting space and narrow this wide crossing.

2 Crosswalks will be striped at both crossings to and from the median on Cromwell Road to facilitate the movement of southeastbound bicyclists. The southern crosswalk aligns with an existing, unused driveway cut that accesses the 7-11 parcel.

3 An easement from the owner of the 7-11 parcel will be needed to route a trail behind the store. Grading issues need to be addressed at the southeastern side where there is a steep ditch next to the railroad tracks.

4 This two-way crossing will have a marked crosswalk, signage and an activated RRFB to facilitate crossing to a trail located in the median along Chesapeake Boulevard.

5 The median openings can be narrowed or closed to reduce or eliminate potential conflicts with motor vehicles.

Potential Design Challenges

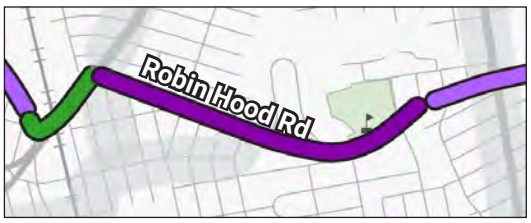
- Designing the two stage crossing of Cromwell to adequately address high speed traffic on that street. Speed enforcement may be needed.
- Determining if any of the median breaks on Chesapeake can be closed, and/or designing crossings that protect bicyclists and pedestrians but still accommodate truck turning movements, if needed.

Corridor 7: Robin Hood Road

Segment 6: Chesapeake Blvd to Sewells Point Rd

Length: 1.0 miles
AADT: 5,600
Speed limit: 25 to 30 mph

Facility: Buffered bike lanes; bike lanes
Major Action: Lane diet

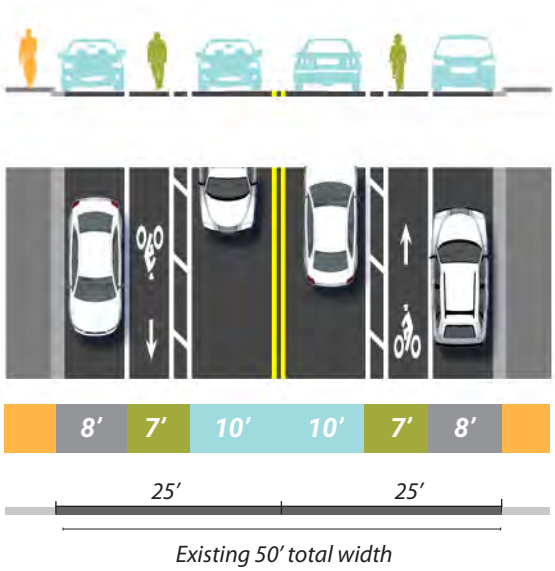




- The street is 44 to 50' wide at the western end with little utilized parking on both sides of the street.



- The street narrows to 30' at Tillman Road, and parking is prohibited on both sides of the street.



Existing 50' total width

Potential Design Challenges

- There is an existing problem with drivers passing on the right in the unoccupied parking lane near the western end of this segment. Striping buffered bike lanes will not prevent this, but the City could consider adding curb extensions at some intersections and switching the parking lane from one side to the other midway through the segment.
- The street narrows incrementally from Chesapeake Boulevard to Tillman Road. Design of bike lane striping will need to take that into account. It is recommended to drop parking from one side of the street and subtract 1' from the bike lanes when the street narrows to 44'.

Corridor 7: Robin Hood Road

Segment 7: Sewells Point Road to Azalea Garden Drive

Length: 0.4 miles
AADT: 4,200
Speed limit: 25 mph

Facility: Bike lanes
Major Action: Parking removal

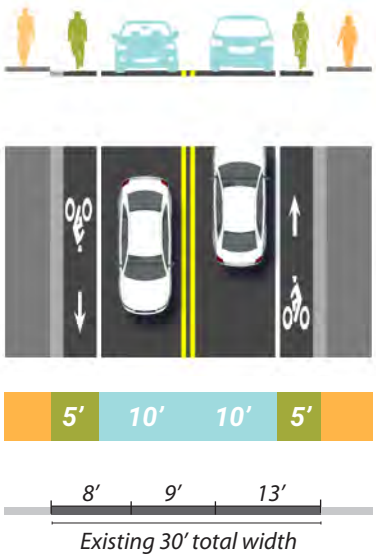




- Speed humps are present in this segment for traffic calming.



- Parking is striped on the north side of the street and prohibited on the south side.



Potential Design Challenges

- On-street parking will have to be completely prohibited in order to provide bicycle lanes on this 30-foot wide road; however replacing parking with two bike lanes and a narrower eastbound travel lanes will support traffic calming efforts instituted in the form of speed humps.
- If residents prefer retention of parking on one side, it can be flipped half way down the street by installing a chicane for the travel lanes. Priority shared lane markings can be installed instead of bike lanes, however this treatment may result in increased motorist frustration as they will be forced to use the opposing travel lane to pass slower cyclists.

Corridor 7: Robin Hood Road

Segment 8: Azalea Garden Drive to Airport Entrance

Length: 2.2 miles

AADT: 9,300

Speed limit: 30 to 35 mph

Facility: Bike lanes; Shared lane markings

Major Action: Road diet; Install

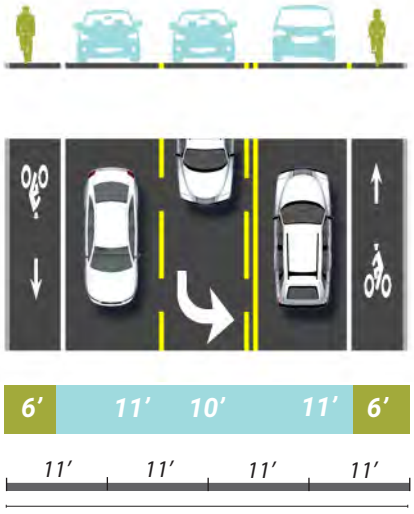




- This section through the Norfolk Commerce Park has four travel lanes and lacks sidewalks on both sides of the street.



- This two-lane section east of Miller Store Road has narrow shoulders.



Existing 44' total width

Potential Design Challenges

- Providing safe bicycle and pedestrian accommodations under the I-64 bridge will require thoughtful design. It is likely that bicyclists and pedestrians will need to be accommodated off of the roadway as a sidepath or "wide sidewalk." Issues that need to be addressed in the design include: a) providing shared bicycle and pedestrian space on both sides of the road, b) providing a wide enough facility to safely accommodate both bicyclists and pedestrians, c) designing safe and easy transitions for the bicyclists to enter the sidepath and re-enter the road at appropriate locations; d) providing lighting that addresses glare during the day and darkness at night, and e) addressing crossing conflicts with motor vehicles at the right turn slip lanes.
- The priority shared lane marking, or a green bike lane, is recommended for the road segment immediately east of Military Highway where a pair of entrance and exit ramps intersect the road on its south edge; through bicyclists must contend with four separate motor vehicle movements potentially crossing their path.

Corridor 8: Cape Henry Trail Interim Route



Length: 5.1 miles
Speed Limit: 25-35 mph
Curb-to-Curb Width: 20 - 64'
AADT: Low

Land Use: Majority medium density residential; Walmart Neighborhood Market; Small commercial; Business park at east end

Key Bicycle Facilities: Shared lane markings; improved crossings; connector trails

Key Pedestrian Improvement: Improved crossings at Ingleside Road, Azalea Garden Road, Chesapeake Boulevard, and Military Highway

Unique Corridor Opportunity

- The Cape Henry Trail can serve as Norfolk's portion of the cross-state Beaches to BluegrassTrail.
- Recommendations proposed here provide on-road improvements and short path linkages to create an interim alternative to the ultimate shared use path construction.
- In the interim, the corridor should be improved and opened to pedestrian and bicycle travel while planning for a rail to trail conversion continues.

Estimated Project Cost

$880,000

Key Challenges

- Coordination with Norfolk Southern and VDOT to address needed at-grade railroad crossing and arterial road crossings.
- Development of a segment of trail adjacent to a minimally active rail line at the I-64 underpass.
- Acquisition of easements or right-of-way across a small number of private properties.

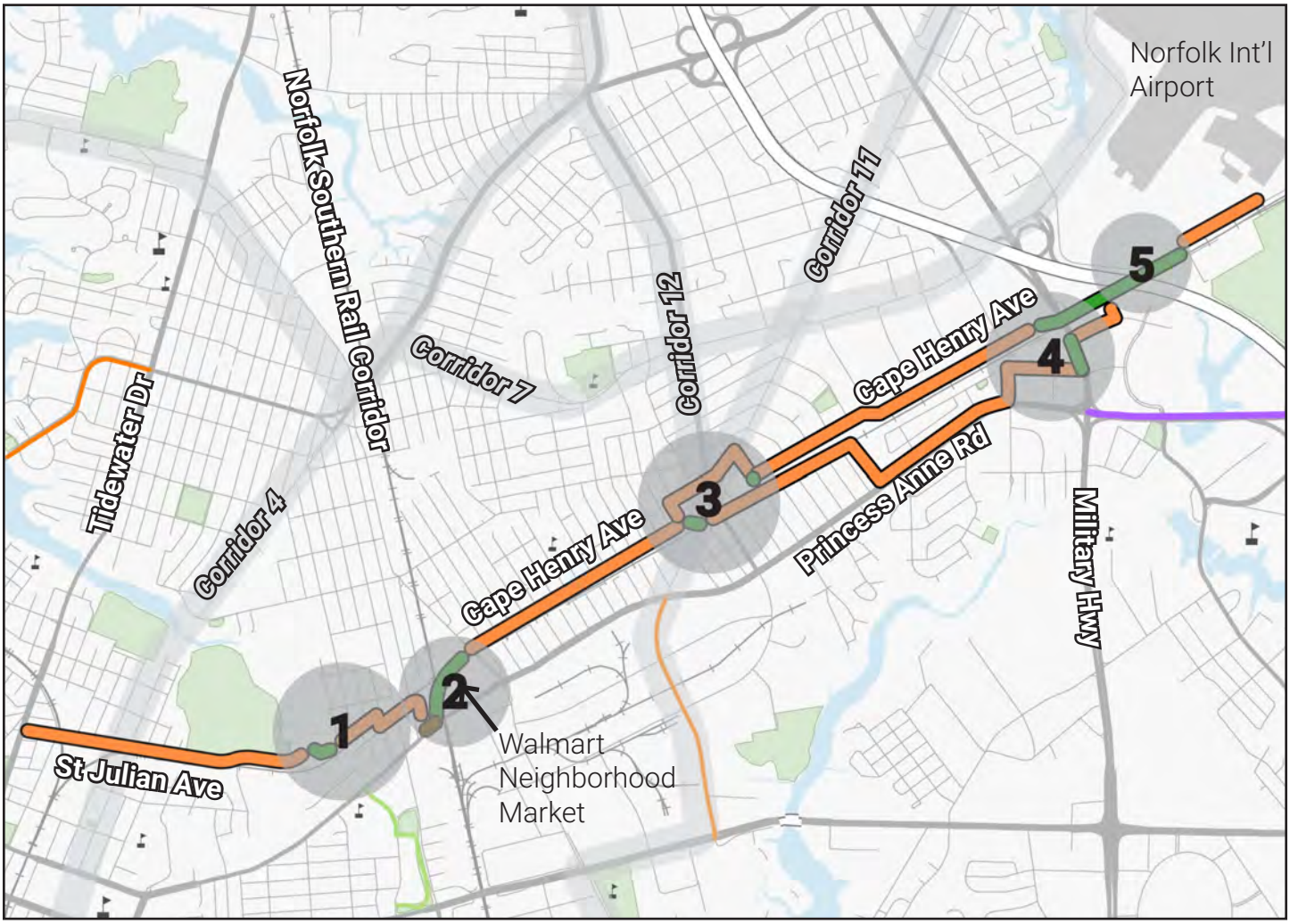
Purpose of Improvements

- Provide a low-stress route in east Norfolk that links to downtown via Corridor 4, as well as employment centers near the airport.
- Connect Norfolk to planned bicycle infratructure in Virginia Beach.

Public Input

- An east-west connection across the middle of the city was desired by numerous stakeholders.
- Improved connection to Virginia Beach via a low-stress route was called for.

Corridor 8: Recommendations Overview Map



Legend

Existing Facilities

- 1 Improvement Area
- Shared Lane Markings
- Bike Lane

Proposed Facilities

- Shared Lane Markings
- Sidewalk Bikeway
- Shared Use Path

Corridor Approach

Due to the unique nature of this corridor, the format used to present it in this report has been modified. The following pages address the numbered areas defined in the map above.

The improvement areas are centered around critical crossings or short segments of shared use path that are needed to link the existing low-stress local streets that form the majority of the corridor's route.

Shared lane markings are recommended for all of the low-vlolume local roads included in this corridor.

On the east end of this corridor, two alignment options are shown, one north of the Norfolk Southern rail line, and one south of it.

Corridor 8: St. Julian Avenue and Cape Henry Avenue

Area 1: St. Julian Avenue to Princess Anne Road

Facilities: Shared use path; Crosswalks; Rectangular rapid flashing beacon

Major Issues: Private property; crossing minor arterial



From Tidewater Drive to its dead end near the Public Works Department property, St. Julian is a very low volume neighborhood street. The lack of connection between the end of St. Julian Avenue and Cape Henry Avenue is a barrier to creating a route though this area. The intersection at Ballentine Boulevard, a higher volume street, also needs additional improvements to make crossing safe and convenient.



1 St. Julian Avenue dead ends near City of Norfolk DPW/Streets property. A shared use path should be constructed from the end of the street utilizing City property to connect to Cape Henry Avenue.

Depending on the location of property boundaries, the City may need to acquire an easement across the edge of private land to connect from the end of St. Julian Avenue to City-owned property.

2 The crossing of Ballentine Avenue should have high-visibility crosswalks and an actuated rectangular rapid flashing beacon to alert drivers to increased volumes of bicyclists and pedestrians crossing.

The route will need wayfinding to direct bicyclists through the zig-zag turns at Vincent Avenue and South Cape Henry Avenue.

Corridor 8: Railroad and Ingleside Road Crossings

Area 2: Princess Anne Road to Cape Henry Ave

Facilities: Wide sidewalk; Shared use path; Crosswalk; Median island

Major Issues: Crossing NS Railroad track and Ingleside Road



Norfolk Southern's north-south rail corridor forms a barrier to a continuous facility through this area. An alternative routing is needed that crosses the rail line at an existing crossing located at Princess Anne Road.



1 The existing sidewalk is used by bicyclists and pedestrians today. Pavement across the railroad tracks will need to be widened.

2 Wayfinding signage and a route delineated in the Longshoreman's Association parking lot can direct bicyclists.

3 Routing bicyclists on existing parking lot and service road is a low-cost alternative to constructing a shared use path. It will require cooperation from the property owner and Walmart operations.

4 Bicyclists will be routed onto the sidewalk along Ingleside Road. This sidewalk requires maintenance and additional paving next to the railroad tracks.

5 The crossing of Ingleside Road should have a median island for bicyclists and pedestrians to cross in two stages. A curb ramp will need to be added on the west side of Ingleside.

Corridor 8: Azalea Garden Road and Railroad Crossings

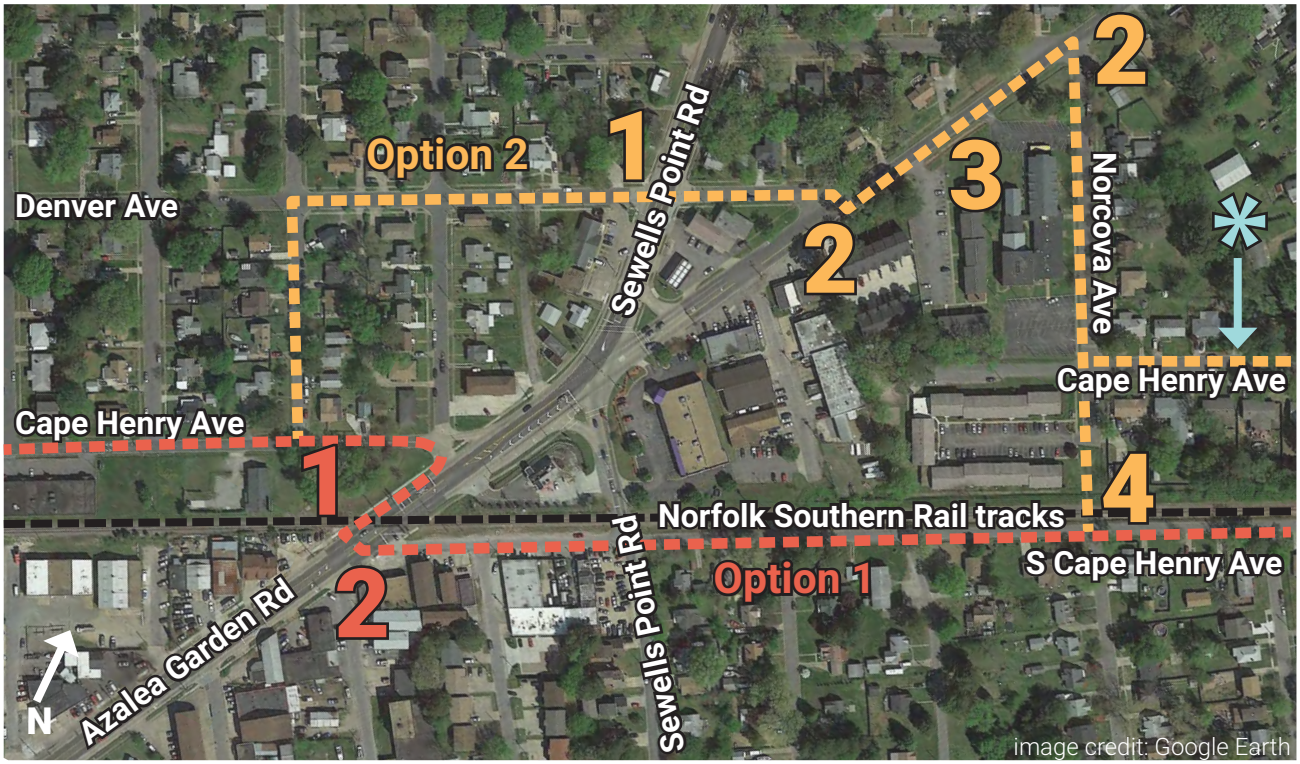
Area 3: Juniper Street to Norcova Avenue

Facilities: Shared use path; Crossing treatments;

Major Issues: Crossings of Azalea Garden Road and rail corridor; Routing choices



The complex intersection of Azalea Garden Road, Sewells Point Road, Cape Henry and S Cape Henry Avenues presents a barrier to bicycle travel through this area. The need to cross the rail line further complicates routing. Two railroad crossing options should be studied: Option 1, use the existing at-grade crossing at Azalea Garden Road, or Option 2, created a new crossing at Norcova Avenue.



1 The sidewalk along the south side of this parcel needs to be widened to accommodate two-way bicycle travel.

2 Crossing improvements are needed at Azalea Garden Road here. A median island is recommended to provide a refuge area and enable two-stage crossing, but this may impact access to adjacent businesses.

* The alternative routing along Cape Henry Avenue avoids the rail crossing described in Option 2. Use of this route is dependent on the items described in Area 4, Option 2 on the following page.

1 Improvements are needed at this unsignalized crossing of Sewells Point Road.

2 Wayfinding signage is needed at these intersections.

3 The recommendation for this segment of Azalea Garden Road in Corridor 11 is paved shoulders. This segment will need to be improved to create this route.

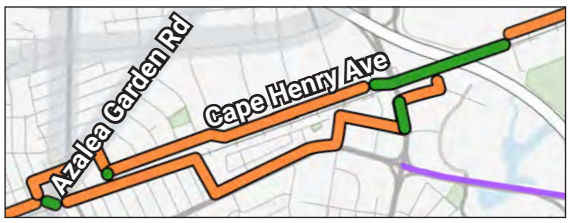
4 Extensive use of this informal crossing of the rail tracks at the end of Norcova Avenue is evident. Pedestrian safety and convenience will be enhanced by formalizing this crossing of the little-used rail line.

Corridor 8: Military Highway Crossing

Area 4: Princess Anne Road to Rail corridor

Facilities: New signal timing and signal heads; Shared use path; Bike/pedestrian bridge

Major Issues: Crossing major artieral; Private property



Military Highway is a major barrier to connecting to the eastern end of this corridor. Two options for crossing are presented below. Option 1 continues from the S Cape Henry Avenue alignment, whereas Option 2 stays north of the railroad tracks and uses Cape Henry Avenue indicated in the Alternative Route in Area 3 on the facing page.



1 A connection is needed between the end of the Princess Anne Road service drive and the sidewalk.

2 The intersection at Elizabeth Road and Military Highway currently does not allow cross traffic. Signal timing and phasing will need to be revised to accommodate cross traffic from bicyclists. Bicyclists and pedestrians should cross the north leg of Military Highway.

3 A two-way sidepath is needed in the wide grass shoulder along the east side of Military Highway to help bicyclists avoid the many turn conflicts at the intersection with Elizabeth Road.

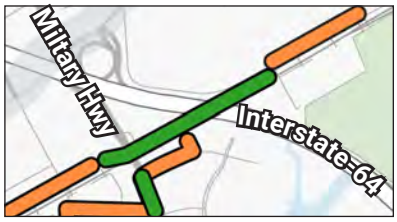
1 City of Norfolk land is available on both sides of Military Highway to use for ramped birdge approaches to connect the end of Cape Henry Avenue to a crossing of Military Highway.

2 Military Highway is a major arterial with an ADT of 43,000 at this location. A new pedestrian/bicycle bridge is recommended to provide a safe crossing.

An at-grade crossing would require a new actuated signal such as a HAWK. An existing controlled at-grade rail crossing periodically stops traffic in this location already with a rail crossing warning system.

Corridor 8: NS Rail Corridor

Area 5: Academy Drive to Pritchard Street



Facility: Shared use path

Major Issue: Construction of trail in little-used but active rail corridor

This is the only segment of the Cape Henry Trail alternative where it is necessary to use the rail corridor in the short term. Other nearby options for crossing under Interstate-64 will require major infrastructure changes to be made comfortable for bicyclists.

This shared use path along the rail corridor will provide a critical link between a proposed new development at Lake Wright and the City of Norfolk. Without this trail, pedestrian and bicyclist access to the development will not be possible.



- The existing rail bed and corridor are wide enough to accommodate a trail on the north side of the tracks.



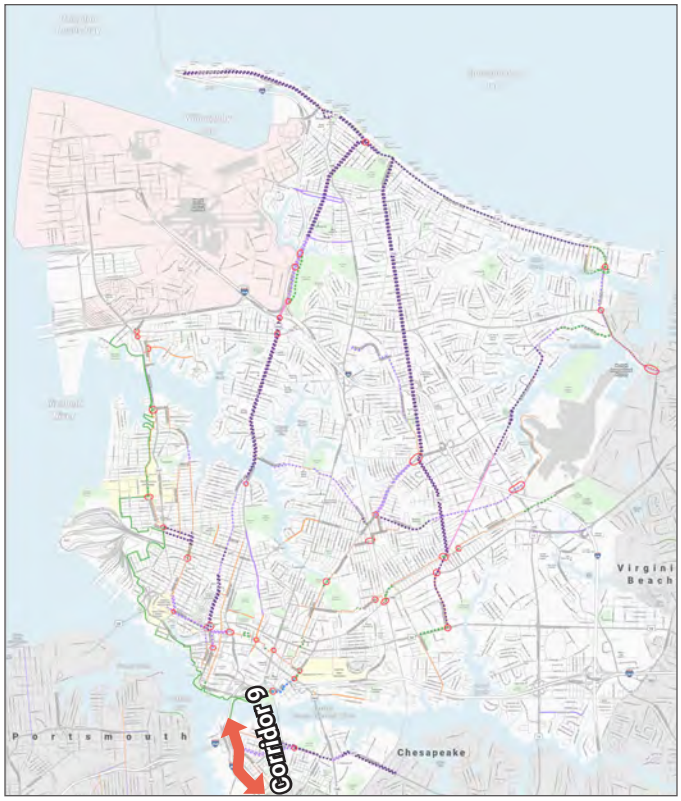
- There is ample space between the tracks and bridge abutments to accommodate a trail.

Potential Design Challenges

- The major challenge of this segment will be working with Norfolk Southern to receive approval to design and construct a trail along this minimally active rail corridor.

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Corridor 9: Southside Bikeways



Length: 1.2 miles
Speed Limit: 25-30 mph
Curb-to-Curb Width: 24 - 48'
AADT: 1,400 - 8,300

Land Use: Multifamily residential; elementary school; industrial

Key Bicycle Facilities:
Bike lanes, buffered bike lanes and connector trail

Key Pedestrian Improvement:
Connector trail and crossings from Cromwell Avenue to Robin Hood Road

Purpose of Improvements

- Provide a continuous bikeway connection between Southside, Chesapeake and downtown.
- Improve access to the Jordan Bridge for recreational cyclists who use it to cross the Southern Branch of the Elizabeth River.

Estimated Project Cost

$110,000

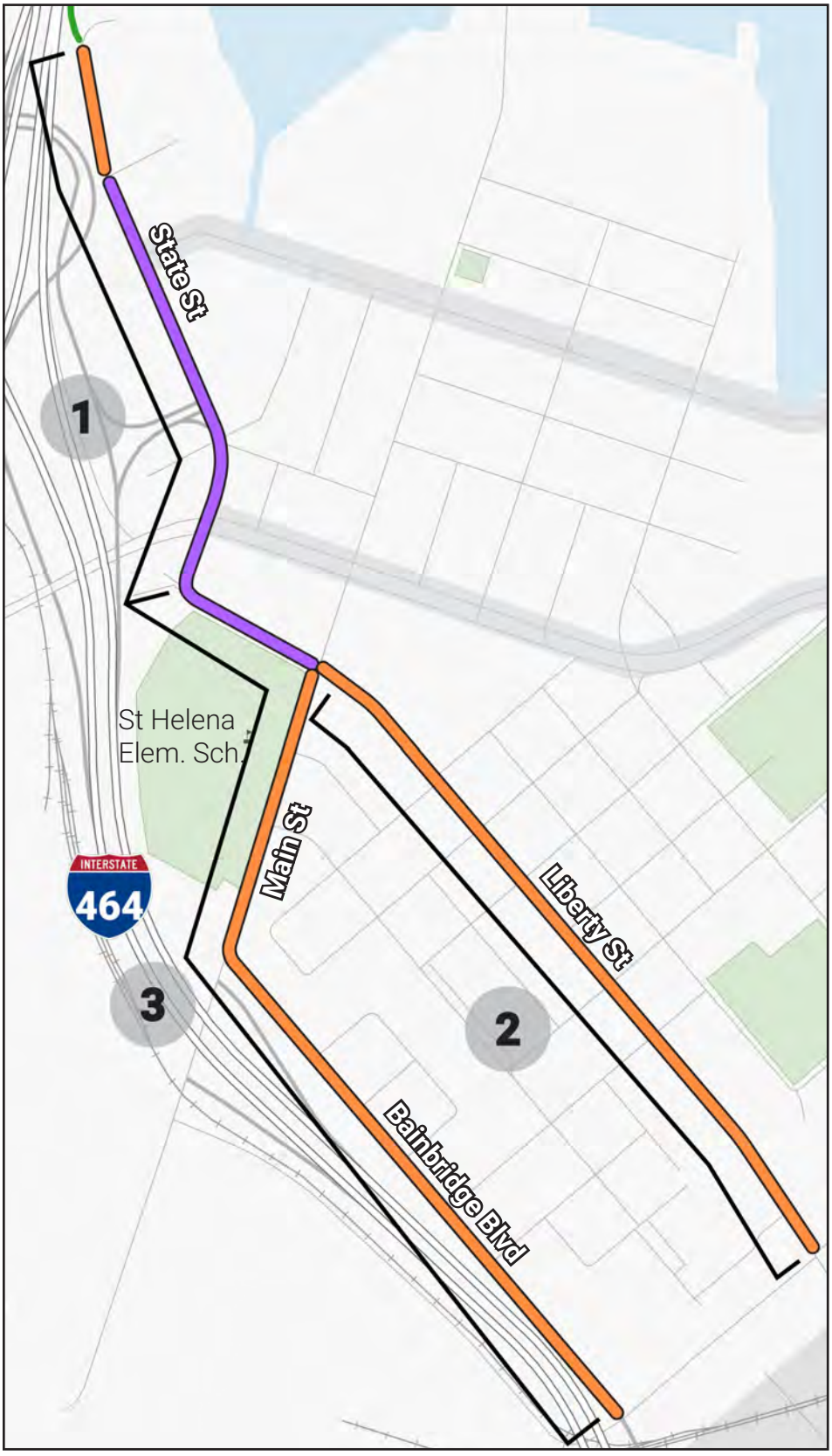
Key Challenges

- The intersection of Main Street and Bainbridge Boulevard has a vast expanse of pavement uninterrupted by median islands or striping. Signage and markings will be needed to alert drivers to bicyclists' presence as it is 125' from an exit ramp off Interstate 464.
- Southbound bicyclists on Main Street making a left turn onto Bainbridge have to watch for traffic coming from three different directions and it is easy for the drivers to miss seeing a cyclist making this maneuver.

Public Input

- Many recreational riders noted that the Jordan Bridge is a major destination.

Corridor 9: Recommendations Overview Map



Legend

Existing Facilities

1 Corridor Segment

Shared Use Path

Proposed Facilities

Sharrows

Bike Lane

Corridor 9: State Street

Segment 1: I-264 Bridge to Liberty Street

Length: 0.5 miles
AADT: < 2,400
Speed limit: 25 mph

Facility: Shared lane markings; bike lanes
Major Action: Install

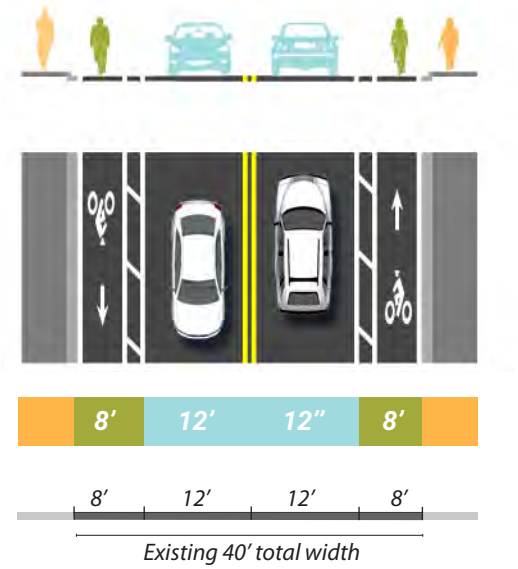




- The shared use path on the I-264 bridge exits onto the narrow end of State Street.



- State Street widens to 48' with parking on both sides.



Potential Design Challenges

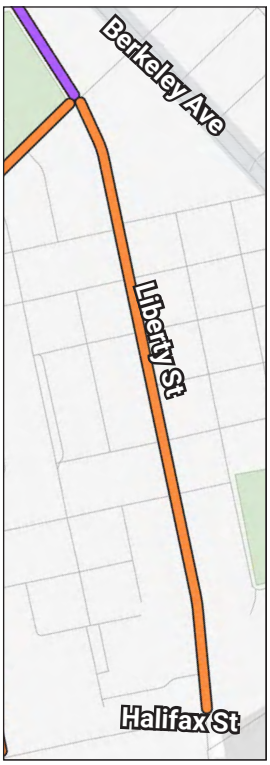
- There are no major design challenges to implementation of this recommendation.

Corridor 9: Liberty Street

Segment 2: State Street to Halifax Street

Length: 0.1 miles
AADT: 3,800
Speed limit: 25 mph

Facility: Bike lanes; shared lane markings
Major Action: Lane diet; Install

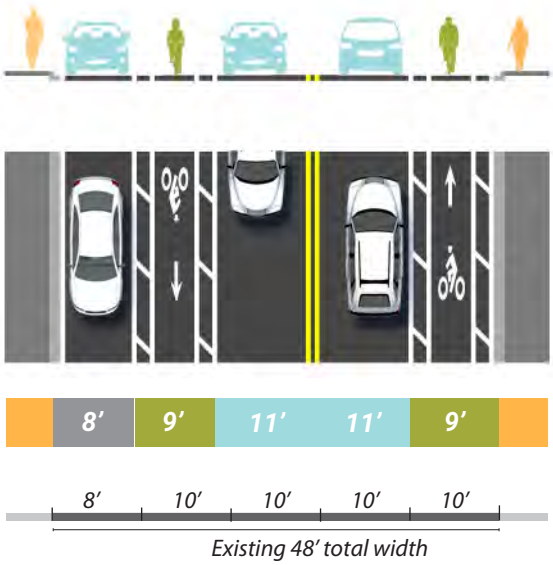




- A new development on the north side of Liberty Street may desire on-street parking.



- Liberty Street from Main Street to Halifax Street is a low-volume residential street with a few small retail businesses.



Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Corridor 9: Main Street and Bainbridge Boulevard

Segment 3: Liberty Street to Norfolk City Line

Length: 0.7 miles

AADT: 8,.300 (Main); 1,400 (Bainbridge)

Speed limit: 25 to 30 mph

Facility: One-way bike lane; shared lane markings

Major Action: Parking removal; install

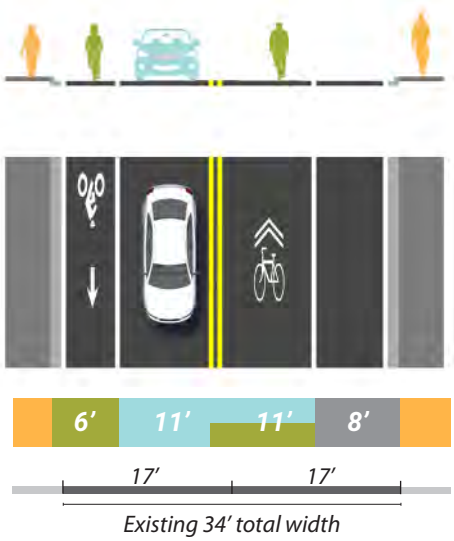




- Main Street has parking allowed on both sides of the street, but it appears to be predominantly used by school employees and for drop off/pick up.



- A bicycle jughandle could provide a waiting space for riders making the lefthand turn onto Bainbridge Boulevard.



Potential Design Challenges

- If parking and/or a drop-off zone is not really needed in front of St. Helena Elementary School, a bicycle lane can be installed in the southbound direction of Main Street, and a priority shared lane marking in the northbound lane. If parking/drop-off/pick-up is needed, priority shared lane markings should be used in both travel lanes.
- The intersection of Bainbridge Boulevard/Main Street/and the northbound off ramp from I-264 needs to have striping and signing applied to clarify stop controls, lanes for turning movements, merge areas and areas of pavement that should not be used by motorists. Cyclists making a southbound left from Main to Bainbridge should have a highly visible, but protected area in which to wait for a gap to make the left turn.

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Corridor 10: Ocean View Avenue and Shore Drive East-West Connector



Length: 8.4 miles
Speed Limit: 30-45 mph
Curb-to-Curb Width: 48 - 78'
AADT: 6,200 - 32,000

Land Use: Oceanfront residential with pockets of restaurant and retail; JEB Little Creek-Fort Story at eastern end

Key Bicycle Facilities: Buffered bike lanes; East Ocean View shared use paths

Key Pedestrian Improvement: Traffic calming through road diet; Improved sidewalk maintenance on Shore Drive

Estimated Project Cost

$4,440,000

Key Challenges

- The road diet that is recommended for much of this corridor is based upon available traffic volume data, however additional counts or a traffic study may be needed to confirm feasibility and guide final design.
- The unique split traffic pattern where Tidewater Drive merges with Ocean View will require special design considerations.
- Shore Drive from Little Creek to the city boundary does not have a consistent cross section, with varying ROW and constraints present. Special attention will be needed to address transitions between facility types, and bicyclist safety in a high speed roadway environment.

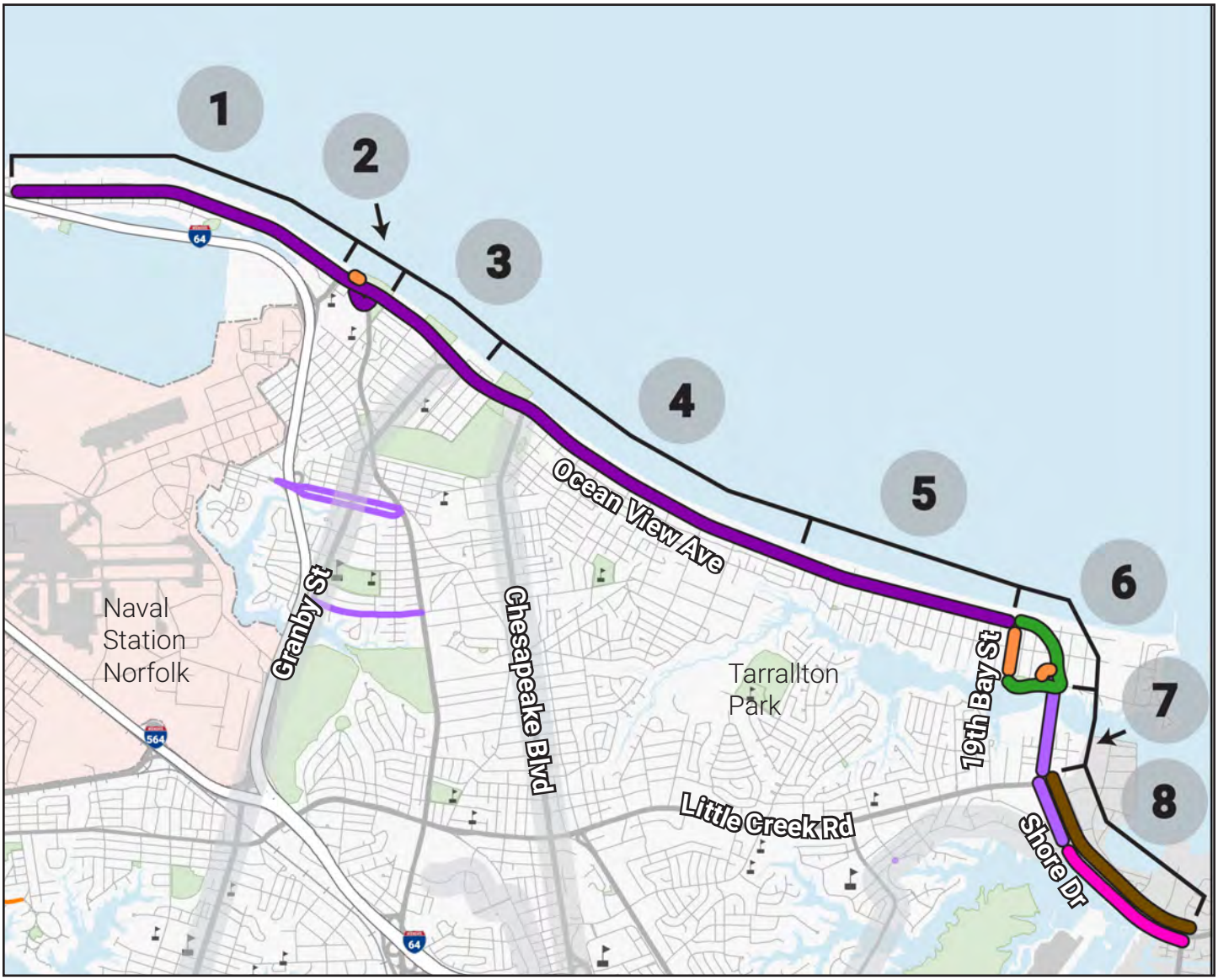
Purpose of Improvements

- Maximize the level of comfort for this beachfront route, which is a popular recreational ride for cyclists of all abilities, and expand the market for commercial bike rental businesses that serve beach visitors and tourists.
- Provide a continuous Ocean View bikeway improvement that will enable local residents and seasonal visitors to make short local trips by bicycle, instead of motor vehicle.
- Provide a connection for Ocean View area residents to access the Granby, Chesapeake and Azalea Garden routes that connect northern Norfolk to the core and south sides of the city.
- Upgrade a high priority segment of a proposed citywide recreational bicycle loop that also includes Azalea Garden and Granby.

Public Input

- The bike lanes on Willoughby Spit were noted as one of the nicest places to ride in Norfolk at public meetings, even though they are a substandard width. This route will extend that enjoyable, oceanfront riding experience.
- Experienced bicyclists already use this corridor to access Virginia Beach, but safer, more comfortable facilities are needed.

Corridor 10: Recommendations Overview Map



Legend

Existing Facilities

- Corridor Segment
- Bike Lane
- Sharrows

Proposed Facilities

- Bike Lane
- Buffered Bike Lane
- Paved Shoulder
- Sidewalk Bikeway
- Sharrows
- Shared Use Path

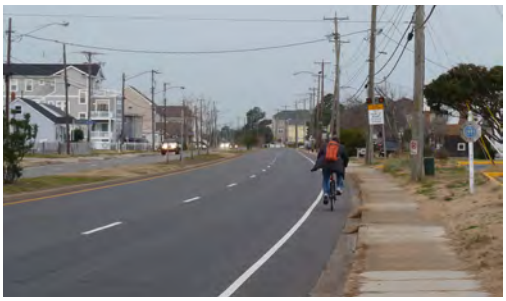
Corridor 10: Ocean View Avenue

Segment 1: I-64 Access to 4th View Street

Length: 1.9 miles
AADT: 6,200
Speed limit: 30 mph

Facility: Buffered bike lanes
Major Action: 4 to 2 Road diet





- Existing bike lanes are substandard width at 4' wide.



- The bike lane ends on the approach to 4th View Street without shared lane markings in the right turn lane.

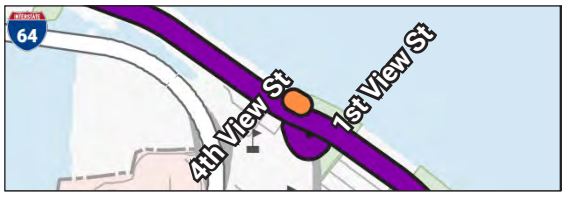
Potential Design Challenges

- Though the existing bike lanes are substandard, implementation of this segment may be a lower priority, given the low traffic volumes and comfortable riding environment.
- The western end of this segment provides access to the I-64 bridge/tunnel which may cause periods of traffic volume higher than counts indicate. This may present a challenge to the road diet recommendation.

Segment 2: 4th View Street to 1st View Street

Length: 0.5 miles
AADT: 13,000
Speed limit: 30 to 35 mph

Facility: Buffered Bike Lanes
Major Action: Road diet; Install





- The single westbound lane (on left of photo) will need to be shared by bicycle and automobile traffic at the 4th View intersection.



- The existing shoulder on the eastbound flyover ramp is sufficient for bicycle travel but needs to be extended to the end of the ramp.

Potential Design Challenges

- The recommendations presented here should be viewed as interim solutions. To truly address the issues presented by complex traffic pattern in this area of the Tidewater Drive interchange, a full intersection redesign is recommended

Corridor 10: Ocean View Avenue

Segment 2: 4th View Street to 1st View Street



1 Bicyclists will share the westbound lane with automobile traffic here. Shared lane markings and signage should be added to alert drivers.

2 The eastbound section from 4th View Street to the off ramp should be restriped to add a bike lane. The 14' left turn lane will need to be narrowed as will both of the 12' travel lanes.

3 The existing wide shoulder on the eastbound ramp should be striped and marked as a buffered bike lane.

4 The striped median in the westbound direction should be narrowed to accommodate a 7' buffered bike lane through this section.

5 Consider eliminating the left turn lane to allow the wide shoulder/buffered bike lane to continue on the right side of the travel lane through to Mason Creek Road.

6 Shared lane markings and signage should be added to the westbound lane between the grass median and curb. In the future, the median should be narrowed to accommodate a bike lane.

Corridor 10: Ocean View Avenue

Segment 3: 1st View Street to Sherwood Place

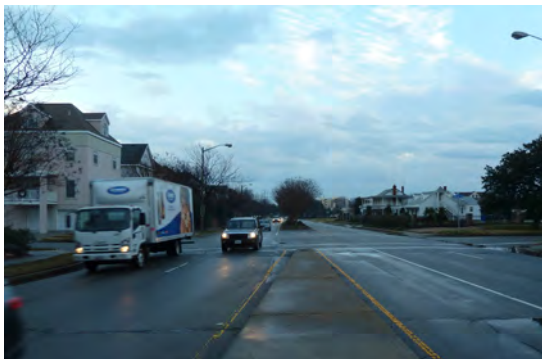
Length: 0.7 miles
AADT: 17,000
Speed limit: 35 mph

Facility: Buffered bike lanes
Major Action: 4 to 2 Road diet

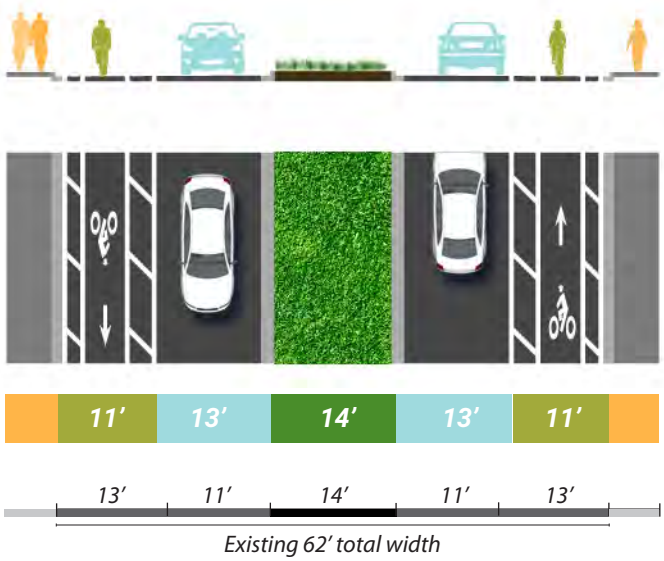




- The City has made improvements in this area of high pedestrian traffic area near Ocean View Beach Park.



- Left turn pockets are available for most intersections throughout this segment, making a road diet less likely to cause traffic congestion.



Existing 62' total width

Potential Design Challenges

- A traffic study will be necessary to assess the feasibility of a 4-lane to 2-lane road diet through this segment. The given estimate is 17,000 vehicles per day which is likely feasible but needs to be confirmed.
- A sidepath on the north side through this segment would be desirable, especially to access the waterfront, but there does not appear to be enough right-of-way to accommodate widening the existing sidewalk.
- The intersection at Ocean View Avenue and Granby Street is complex and will need further study in the design process.

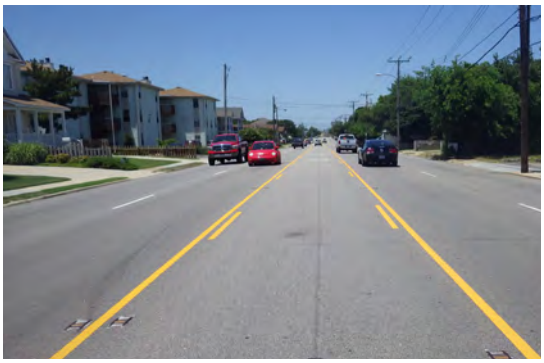
Corridor 10: Ocean View Avenue

Segment 4: Sherwood Place to 1st Bay Street

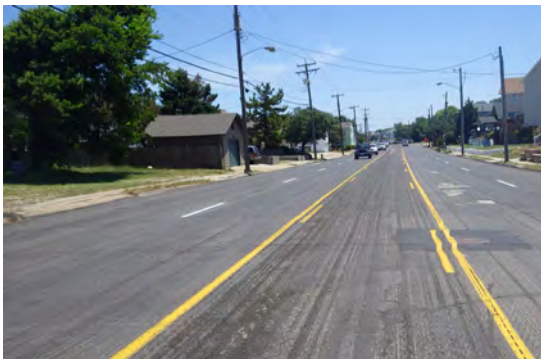
Length: 2.1 miles
AADT: 14,000
Speed limit: 35 mph

Facility: Buffered bike lanes
Major Action: 5 to 3 Road diet





- Shared lane markings exist today from Chesapeake Boulevard to Willow Terrace but do not provide a comfortable bicycling experience.

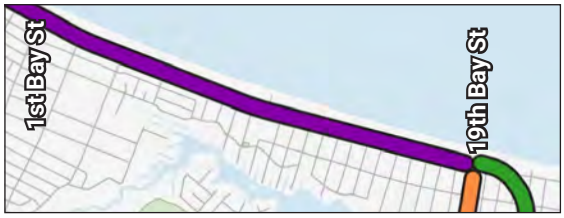


- East of Beaumont Street, parking boxes are striped on the south side of the street. They shift to the north side after Cape View Avenue.

Segment 5: 1st Bay Street to 19th Bay Street

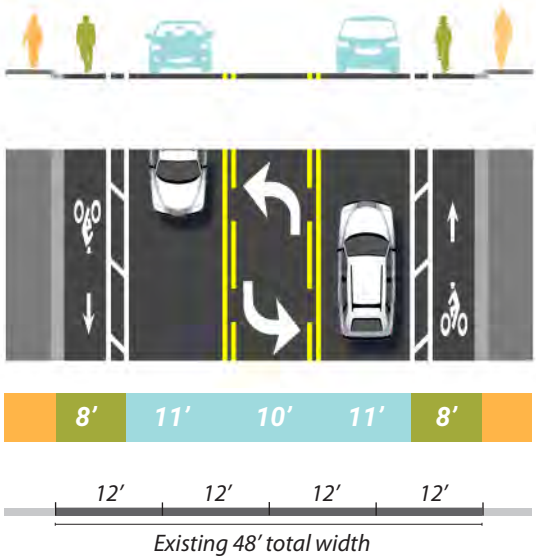
Length: 1.2 miles
AADT: 16,000
Speed limit: 35 mph

Facility: Buffered bike lanes
Major Action: 4 to 3 Road diet





- The many turning movements into residential and commercial driveways are not accommodated in the four-lane section today.



Existing 48' total width

Potential Design Challenges

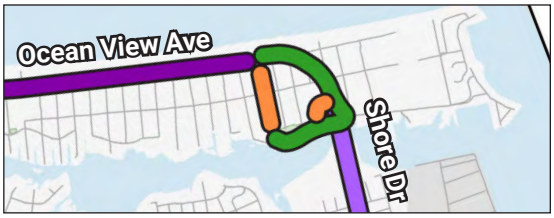
- There are no major challenges to implementation of this recommendation.

Corridor 10: Ocean View Avenue Alternate Route

Segment 6: Ocean View Avenue to Shore Drive

Length: 0.6 miles
AADT: < 2,400
Speed limit: 25 mph

Facility: Shared lane markings; trail
Major Action: Install; construct





An alternate route is needed in this section because traffic volumes may be too high on Ocean View Avenue to accommodate a road diet.

The alternative routing also connects to a community park and will provide a pedestrian and bicycle route from East Beach to the park that avoids the large intersection at Ocean View Avenue and Pretty Lake Avenue.

1 The intersection at 19th Bay Street and Ocean View Avenue needs an improved crossing to facilitate left turns by north/westbound bicyclists. A high visibility crosswalk and actuated rectangular rapid flashing beacon are recommended.

2 A shared use path should be constructed along the existing public right-of-way (paper street) through East Ocean View Community Park to connect 19th Bay Street to 21st Bay Street.

3 Eastbound bicyclists will be directed to turn right onto Shore Drive from Pretty Lake Drive. Westbound bicyclists will make a right turn from Shore Drive onto Pretty Lake Drive.

4 A shared use path should be constructed along the existing paper street that would go underneath the Shore Drive bridge and connect to Pretty Lake Drive west of the bridge.

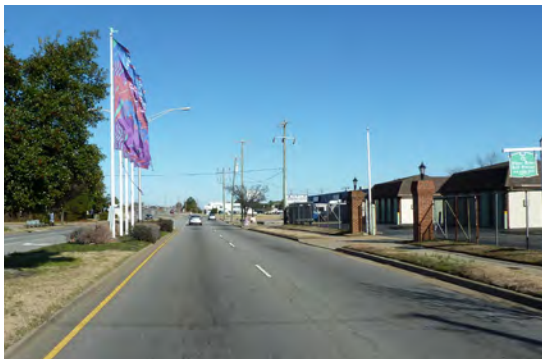
Corridor 10: Shore Drive

Segment 7: Pretty Lake Dr to Little Creek Rd

Length: 0.6 miles
AADT: 22,000 - 32,000
Speed limit: 35 mph

Facility: Bike lanes
Major Action: Lane diet; redesign

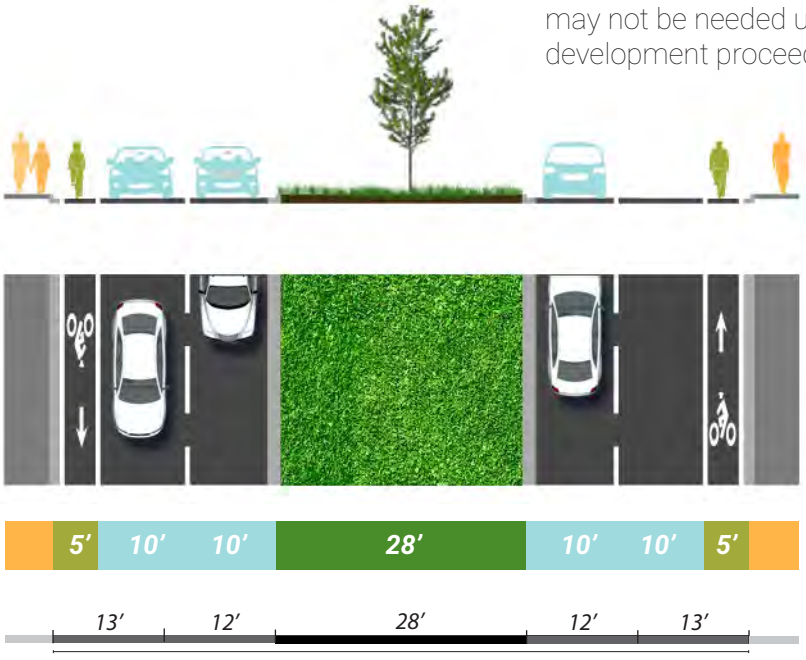




- The existing lanes are 12' and 13' wide in this segment.



- The southbound bike lane currently ends to accommodate a left turn lane just south of the bridge that may not be needed unless future development proceeds.



Potential Design Challenges

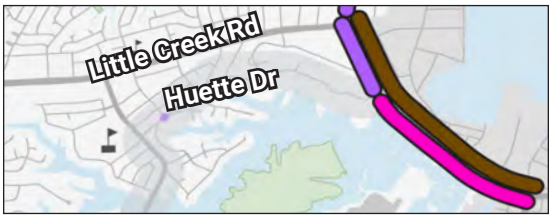
- The left turn lane pictured above will need to be removed to provide enough space to add a bike lane in this area. It appears to be in preparation for planned development. If and when this development continues on the east side of Shore Drive and a left turn lane is actually needed, the developer should be required to move the west curb line to continue to provide enough space for the bike facility.
- The intersection at Little Creek Road is complex with a long right turn lane which will present an extended conflict zone for bicyclists and drivers. Design treatments will need to be added to alert both modes to this conflict.

Corridor 10

Segment 8: Little Creek Road to Diamond Springs Road

Length: 1.2 miles
AADT: 32,000
Speed limit: 45 mph

Facility: Sidewalk bikeway; shoulders
Major Action: Maintain; pave

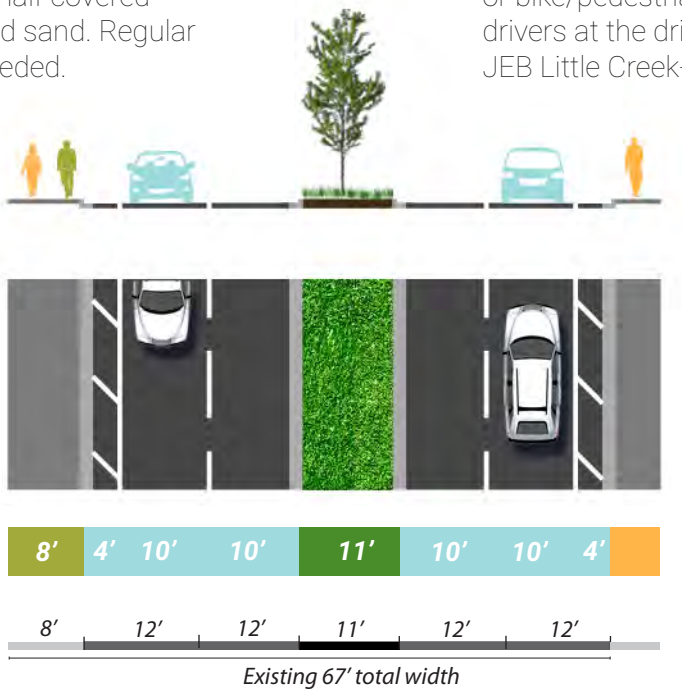




- The existing sidewalk on the north side is 8' wide but half covered with tree debris and sand. Regular maintenance is needed.



- There are no curb ramps, crosswalks or bike/pedestrian warning signs for drivers at the driveway access to JEB Little Creek-Fort Story.



Existing 67' total width

Potential Design Challenges

- While not ideal for all bicyclists, making the existing 8' sidewalk fully functional for two-way bicycling will provide a linkage to Virginia Beach that serves "interested but concerned" riders.
- The intersection at Little Creek Road needs to accommodate bicyclist transitions to and from the sidewalk, likely with a two-stage left turn for southbound bicyclists. Wayfinding will be needed.
- For the sidewalk bikeway, curb ramps should be installed where they do not exist and existing ramps will need to be maintained and repaired.
- It may be necessary to move the guard rail along the south side of the street east of Heutte Drive to pave a contiguous 4' shoulder to accommodate those bicyclists who prefer not to use the sidewalk route.

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Corridor 11: Ingleside Road Tide Station to Airport via Azalea Garden Road



Length: 6.7 miles
Speed Limit: 25-35 mph
Curb-to-Curb Width: 24 - 55'
AADT: 2,400 - 30,000

Land Use: Mostly low-density residential; Tide station and industrial district at southern end; Botanical Garden at northern end

Key Bicycle Facilities: Shared use path along Virginia Beach Bouldevard; Buffered bike lanes

Key Pedestrian Improvement: Shared use path along Virginia Beach Boulevard; Paved shoulder along Azalea Garden Road

Estimated Project Cost

$1,990,000

Purpose of Improvements

- Provide the eastern segment of a citywide recreational loop route.
- Connect east side neighborhoods to popular destinations on the east side of Norfolk, including the ocean beaches, Botanical Gardens, the Airport and the Ingleside Road Tide station.
- Connect east side neighborhoods to east-west routes on Corridors 7 and 8 which lead the heart of the city and to Virginia Beach.
- Improve a route that crosses I-264 at a location without an interchange, thus avoiding the conflicts created by at-grade on- and off-ramp crossings.

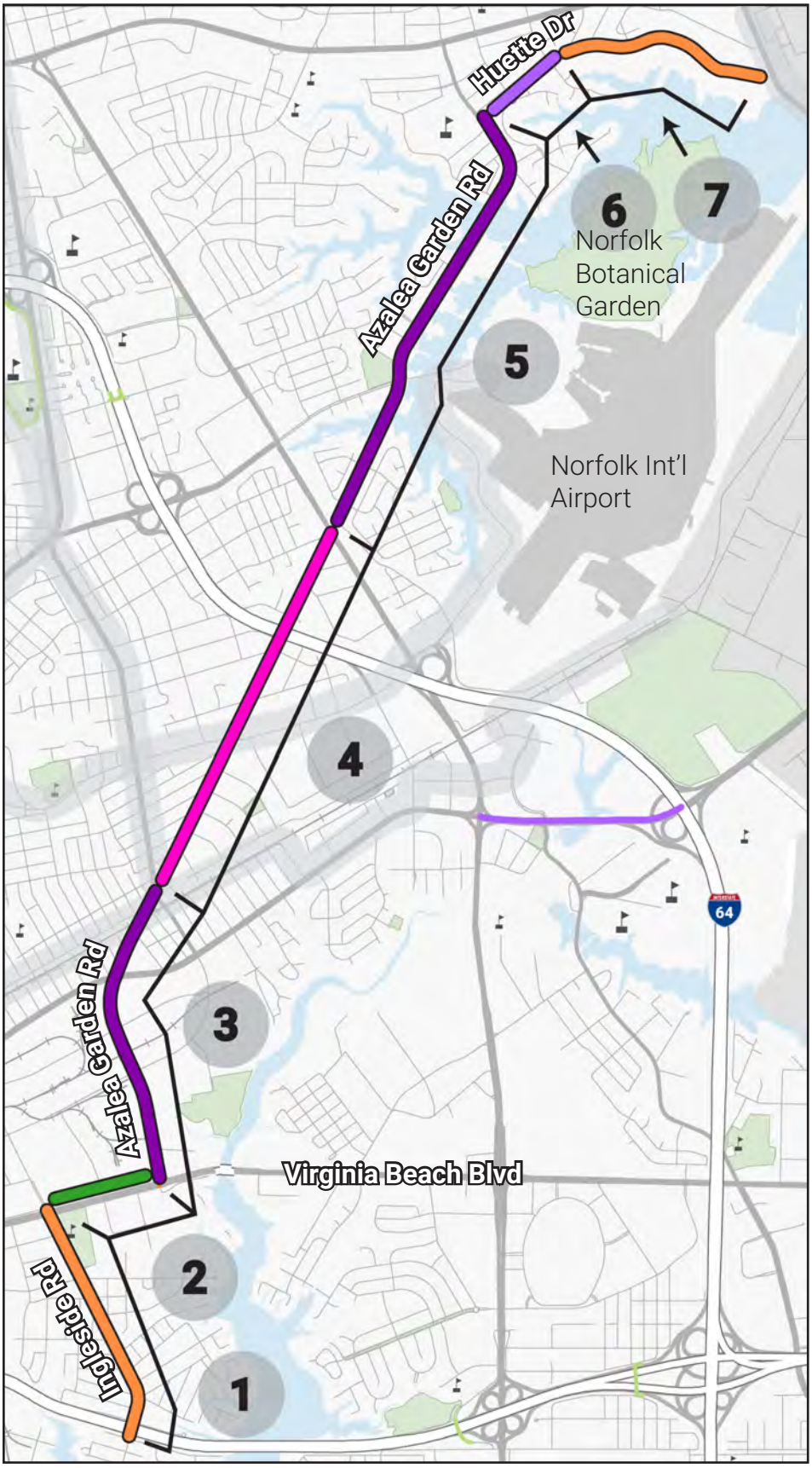
Key Challenges

- Bicyclist movements onto and off of the trail along Virginia Beach Boulevard will require a high level of design attention. There will be complex movements across busy arterial streets.
- Additional complex intersections with traffic volumes, truck traffic, large volumes of turning traffic and high speeds will present design challenges. These also include Huette Drive at Shore Drive and Azalea Garden Road at Military Highway and at Princess Anne Road.

Public Input

- Residents noted that a portion of this corridor is part of a popular recreational riding loop.
- The Botanical Gardens received the highest number of mentions on the WikiMap as an important bicycle destination.

Corridor 11: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Bike Lane
- Sharrows

Proposed Facilities

- Bike Lane
- Buffered Bike Lane
- Paved Shoulder
- Sharrows
- Shared Use Path

Corridor 11: Ingleside Road and Virginia Beach Boulevard

Segment 1: Mississippi Avenue to Virginia Beach Boulevard

Length: 0.9 miles
AADT: 3,100
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install





- Lighting of the I-264 underpass is minimal and should be improved.



- Ingleside is a narrow neighborhood street that will provide a comfortable riding environment

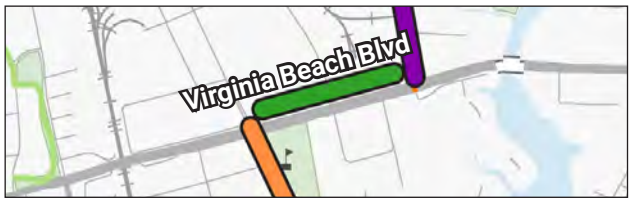
Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Segment 2: Ingleside Road to Azalea Garden Road

Length: 0.4 miles
AADT: 30,000
Speed limit: 35 mph

Facility: Shared use path
Major Action: Construct





Potential Design Challenges

- At Ingleside and Virginia Beach Boulevard (VBB), bicyclists should be accommodated using a two-stage crossing of the east leg of VBB and the south leg of Ingleside. Signing, striping and potentially signal modifications at these crossings should make it clear to motorists making northbound right turns from Ingleside and eastbound rights from VBB that they are crossing a two-way bikeway and a pedestrian crosswalk.
- The same approach should be taken at Azalea Garden Road and VBB, where northbound cyclists using the route will need to cross the northern leg of Azalea Garden Road prior to turning left up AGR and potentially subject to conflicts with a variety of motor vehicle turning movements, depending on how signalization is designed.

Corridor 11: Azalea Garden Road

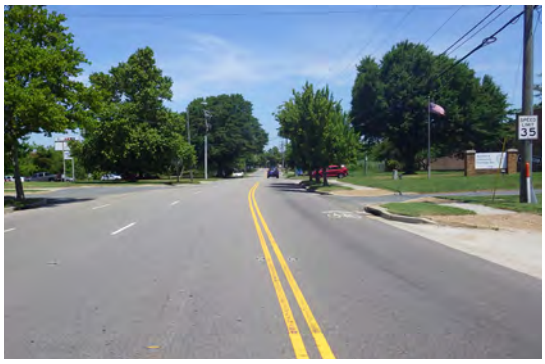
Segment 3: Virginia Beach Boulevard to Sewells Point Road

Length: 1.1 miles
AADT: 9,300 - 13,000
Speed limit: 35 mph

Facility: Buffered bike lane
Major Action: Lane diet; 5 to 3 Road diet

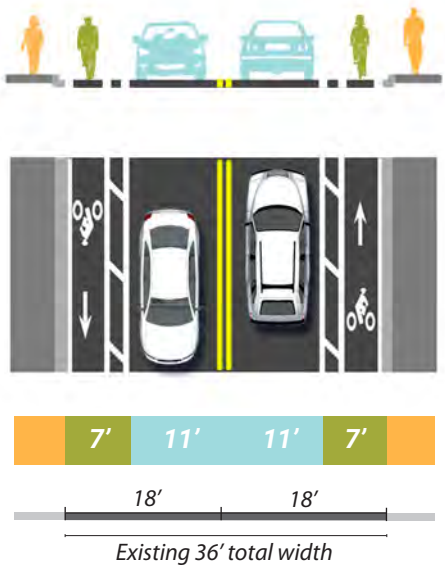


- A 150' two-way left turn lane anomaly exists north of Patent Road for movements onto Patent and into one of the commercial properties.



- From Princess Anne Road to Sewells Point Road, there are currently four travel lanes and a center turn lane. Buffered bike lanes will be accommodated through a road diet.





Recommended cross section for lane diet section, Virginia Beach Boulevard to Princess Anne Road

Potential Design Challenges

- This design does not accommodate the existing pocket two-way left turn lane north of Patent Road.
- The intersection at Princess Anne Avenue will need to be evaluated for the potential removal of one or more turn lanes to accommodate a continuous bicycle facility.
- The northbound right turn slip lane at Sewells Point Road will create a conflict with the buffered bike lane facility and should be removed.
- Making the northbound left turn connection to Corridor 12 at Sewells Point Road is difficult today and will require some special design.

Corridor 11: Azalea Garden Road

Segment 4: Sewells Point Road to Military Highway

Length: 1.4 miles
AADT: 7,900 - 8,200
Speed limit: 35 mph

Facility: Paved shoulder
Major Action: Widen road

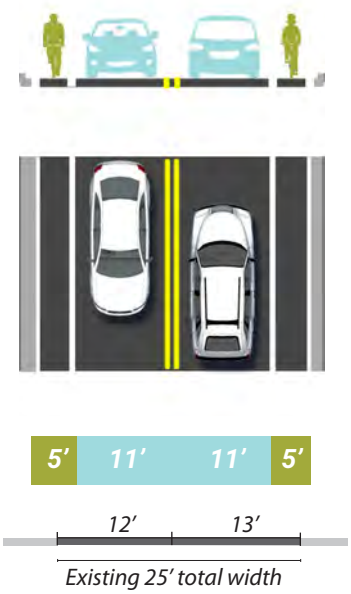




- The current gravel shoulder appears well-built and is suitable for paving to provide a 5' to 6' paved shoulder.



- There are no sidewalks on either side of the street for the majority of this segment.



Potential Design Challenges

- The intersection at Robin Hood Road may require some re-striping to accommodate a new bicycle facility in the roadway.
- There is a 1000' section north of Robin Hood Road that has curb and gutter on the east side of the street. This area may need reconstruction of the roadway edge to provide a continuous shoulder.
- Crosswalks will need to be added to sidestreets indicating the pedestrian path of travel.
- Additional lighting is needed under the I-64 overpass.

Corridor 11: Azalea Garden Road & Huette Drive

Segment 5: Military Highway to Huette Drive

Length: 1.7 miles
AADT: 11,000
Speed limit: 30 mph

Facility: Buffered bike lanes
Major Action: 4 to 2 Road diet





- The existing four-lane roadway and low traffic volumes lead to higher than posted travel speeds.
- This segment contains access to the Norfolk Botanical Gardens.



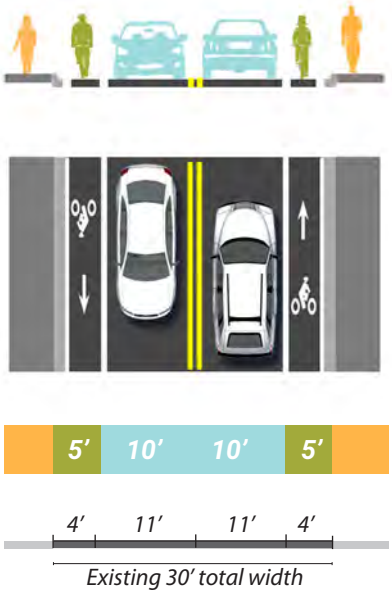
Potential Design Challenges

- The intersections at Military Highway and Norview Avenue will need some detailed design efforts to deal with turn lane configurations.

Segment 6: Azalea Garden Road to Cameilla Drive

Length: 0.5 miles
AADT: 2,400
Speed limit: 25 mph

Facility: Bike lanes
Major Action:
Restripe to widen
bike lane





Implementation Issue

- There are no particular design challenges to implementation of this segment, however this is a low-priority improvement as bike lanes already exist on this low-volume street.

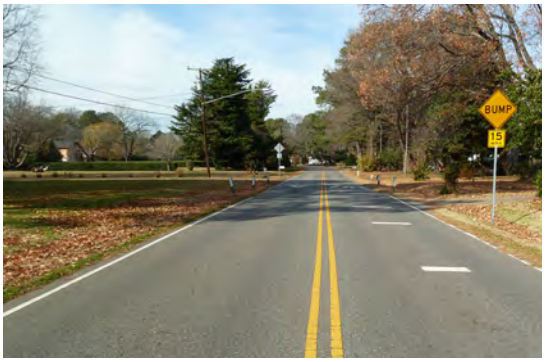
Corridor 11: Huette Drive

Segment 7: Cameilla Road to Shore Drive

Length: 0.7 miles
AADT: 2,400
Speed limit: 25 mph

Facility: Bicycle Boulevard
Major Action: Install





- Some traffic calming already exists in this segment in the form of speed humps.



- This segment has a narrow 22' roadway



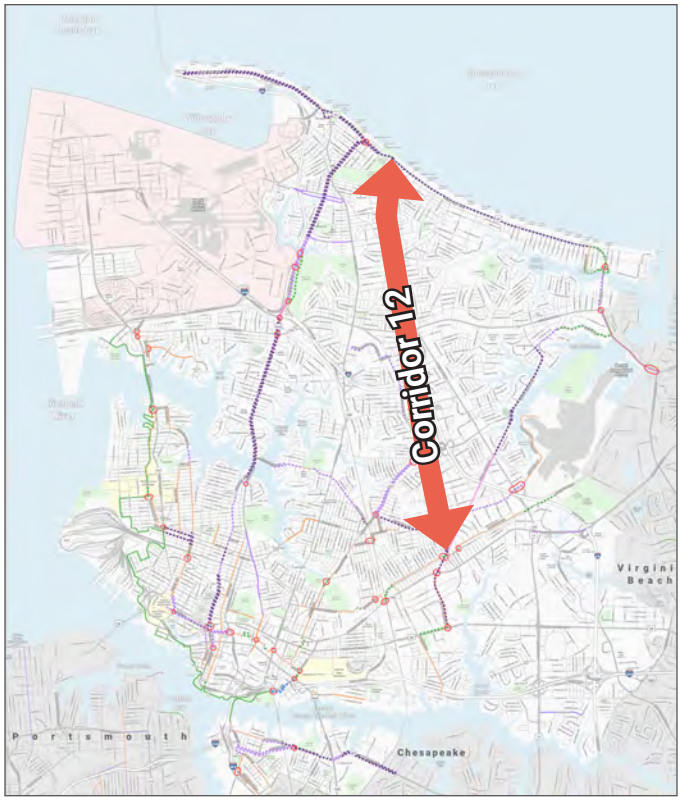
- A BIKES MAY USE FULL LANE sign would alert drivers to expect bicyclists in the roadway especially at the blind curve locations along this Huette Drive.

Potential Design Challenges

- It will be necessary to do outreach to adjacent residents about implementation of additional traffic calming measures which will further slow traffic on the street.
- Facilitating the left turn to travel northbound on Shore Drive (Corridor 10) at the end of this corridor will require some detailed design work.

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Corridor 12: Sewells Point Road and Chesapeake Boulevard Bikeway



Length: 5.5 miles
Speed Limit: 25-40 mph
Curb-to-Curb Width: 21 - 90'
AADT: 7,600 - 26,000

Land Use: Single and multi-family residential; Major commercial center at Five Points; Norview High School

Key Bicycle Facilities: Buffered bike lanes

Key Pedestrian Improvement: Improved intersection design at Five Points

Purpose of Improvements

- Connect the core of eastern Norfolk to Ocean View
- Improve bicyclist access to Five Points and Norview High School
- A spur route along Sewells Point Road connects to the Walmart Supercenter near Little Creek Road and Tidewater Drive

Estimated Project Cost

$660,000

Alternatives Evaluation

- From Five Points north, Chesapeake Boulevard and an alternative route along Sewells Point Road and Old Ocean View Road were investigated. The alternative was found to be less direct and require more crossing improvements than desirable. The road diet option on Chesapeake Boulevard will provide additional benefits of traffic calming that extend to other road users aside from bicyclists.

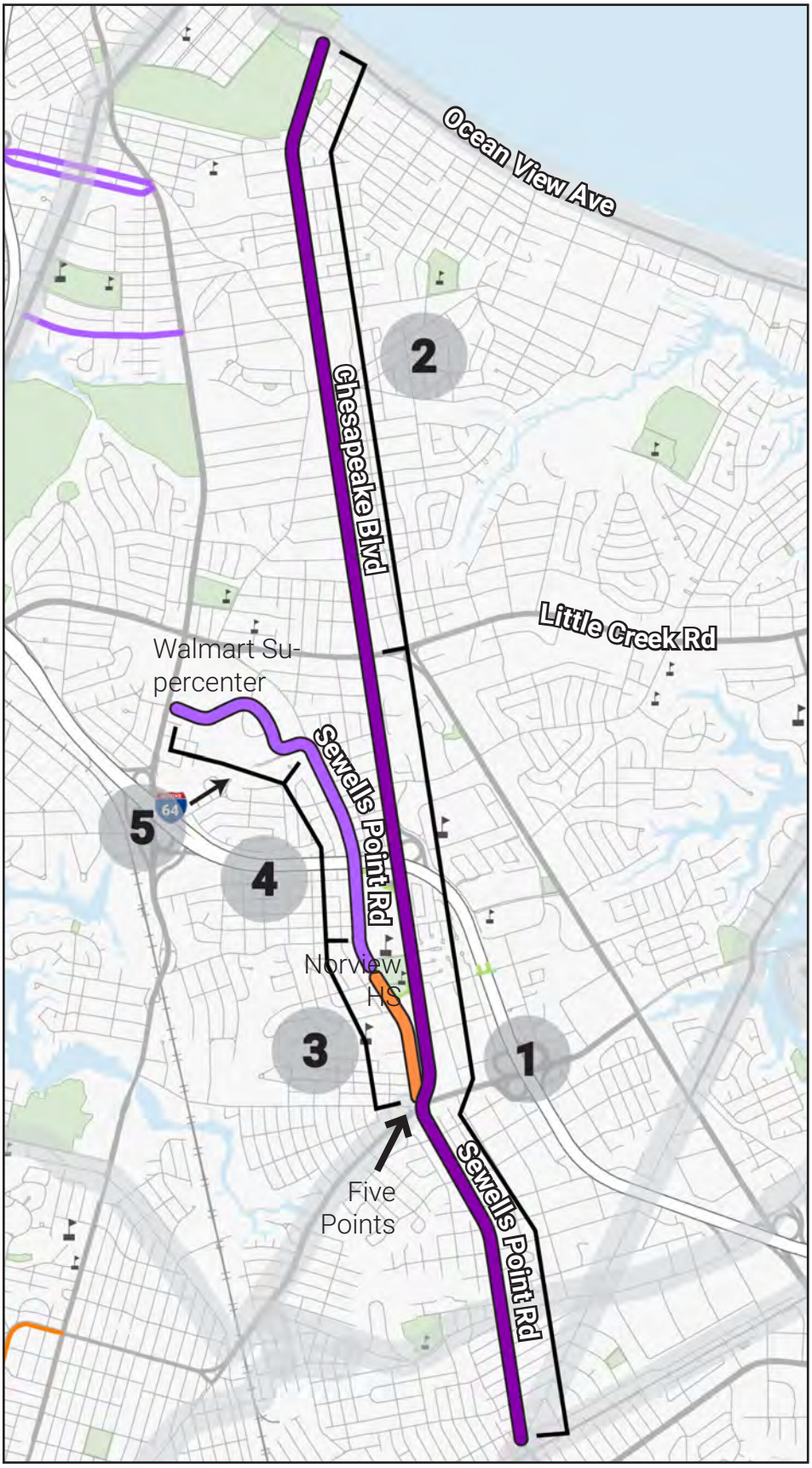
Key Challenges

- Development of safe bikeway crossings of the on- and off-ramps at the I-64 interchange.
- Design of bicycle accommodations at Five Points, a complex intersection
- Potential need for a traffic study to confirm feasibility of recommendations and support the facility design process

Public Input

- Chesapeake Boulevard was identified as an opportunity to provide a longer distance north-south connection.
- The Walmart was identified as a major destination.

Corridor 12: Recommendations Overview Map



Legend

Existing Facilities

- 1 Corridor Segment
- Bike Lane
- Sharrows

Proposed Facilities

- Bike Lane
- Buffered Bike Lane
- Sharrows

Corridor 12: Sewells Point Road and Chesapeake Boulevard

Segment 1: Azalea Garden Road to Little Creek Road

Length: 3.1 miles

AADT: 12,000 - 26,000

Speed limit: 35 to 40 mph

Facility: Buffered bike lanes

Major Action: 5 to 3 Road diet; 6 to 4 Road diet

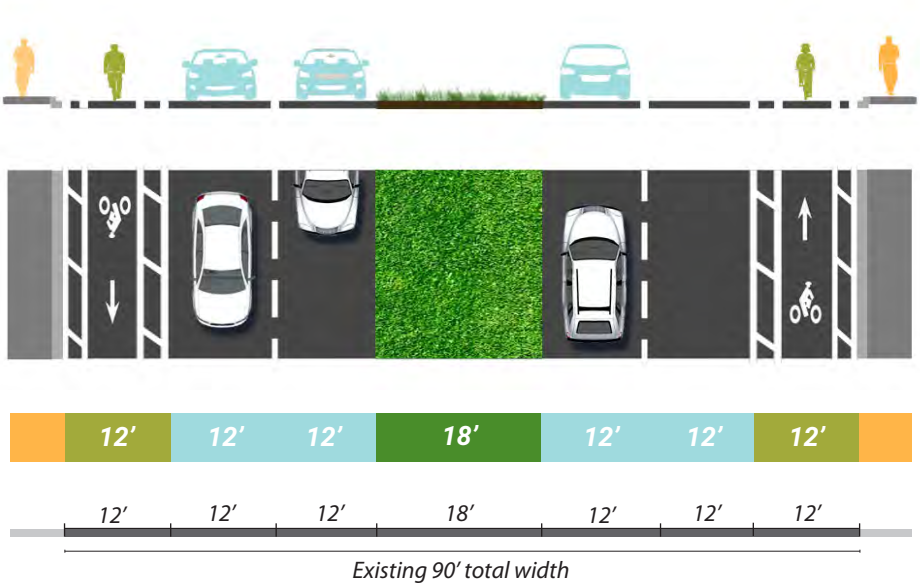


- The five-lane section of Sewells Point Road stretches from Azalea Garden Road to Norview Avenue.



- The six-lane divided section of Chesapeake Boulevard stretches from Norview Avenue to Little Creek Road.





Recommended cross section for Chesapeake Boulevard from Norview Avenue to Little Creek Road.

Potential Design Challenges

- Similar to Corridor 3 on Granby Street, the design of buffered bike lanes will need to accommodate mixing/crossing zones where bus stops are located. Bus routes occur on both Sewells Point Road and Chesapeake Boulevard.

Corridor 12: Key Intersection

Segment 1-INT: Chesapeake Boulevard and I-64 Interchange



1 The rightmost lane converts to a right-turn only lane onto I-64 at these locations and continues through the underpass. It may be advisable to route bicyclists onto a wide sidewalk through these segments.

2 On-ramp crossings present conflicts with high-speed motor vehicle movements. Highly visible crossing treatments will be needed.

3 A lane is added at the end of both off-ramps, so drivers are not forced to yield to traffic on Chesapeake Boulevard and may maintain higher speeds as they enter the city street. This conflict area requires detailed design to ensure bicyclists' safe crossing.

Corridor 12: Chesapeake Boulevard

Segment 2: Little Creek Road to Ocean View Avenue

Length: 2.4 miles
AADT: 7,600 - 12,000
Speed limit: 35 mph

Facility: Buffered bike lanes
Major Action: 4 to 2 Road diet

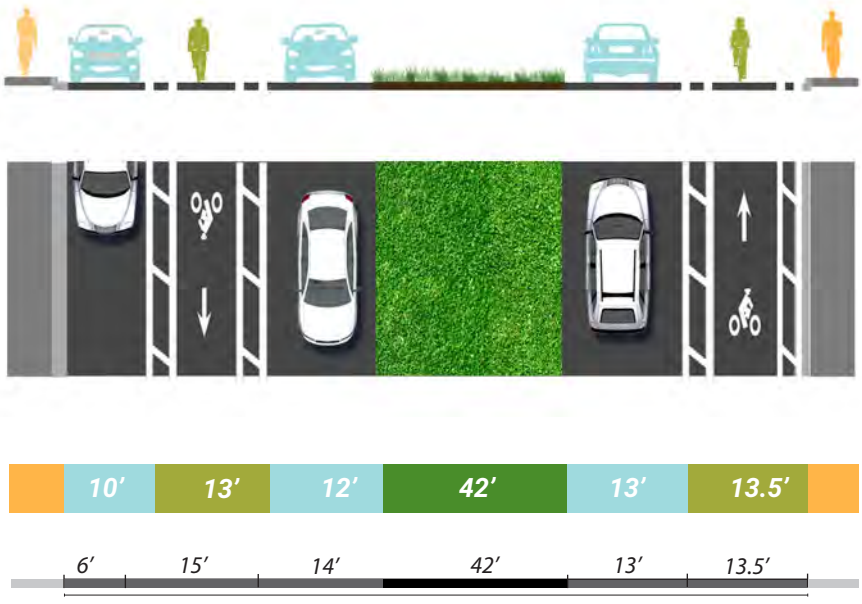


- The entire length of this segment has a wide grass median with no curbs.



- Portions of this segment near the northern end around Liecester Avenue have a wide shoulder that is used for parking.





Recommended cross section for Euwanee Place to Leicester Avenue

Potential Design Challenges

- The southernmost portion of this segment may have higher AADT than indicated by current counts. An updated count and possible traffic study may be necessary to implement this road diet recommendation.

Corridor 12: Sewells Point Road

Segment 3: Norview Avenue to Quail Street

Length: 0.5 miles
AADT: 7,600
Speed limit: 25 mph

Facility: Shared lane markings
Major Action: Install



- Parking is allowed on the east side of the street from Norview Avenue to Strand Street.



- The street narrows to 21' north of Strand Street and parking is removed.



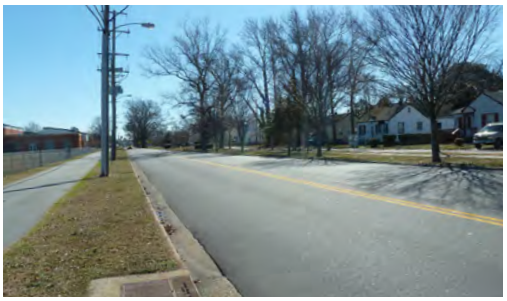
Potential Design Challenges

- Shared lane markings will indicate that drivers are likely to encounter bicyclists, but some drivers were observed exceeding the 25 mph speed limit. Unless traffic calming measures or enforcement activity changes, the facility will not be comfortable for the full range of bicyclists.

Segment 4: Quail Street to Philpotts Road

Length: 0.1 miles
AADT: 7,600
Speed limit: 25 mph

Facility: Bike lanes
Major Action: Lane diet



- An off-street asphalt path is located on the east side of the street.



- Wide lanes (15' to 18.5') can encourage illegal passing in this area and higher speeds adjacent to a school site.



Potential Design Challenges

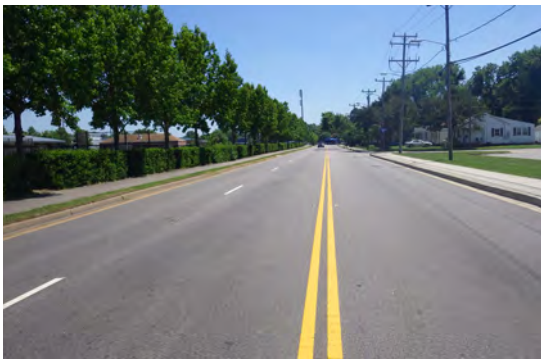
- There are no major design challenges to implementation of this recommendation.

Corridor 12: Sewells Point Road

Segment 5: Philpotts Road to Denison Avenue

Length: 0.8 miles
AADT: 7,600
Speed limit: 25 to 30 mph

Facility: Bike lanes
Major Action: 3 to 2 Road diet; 4 to 3 Road diet

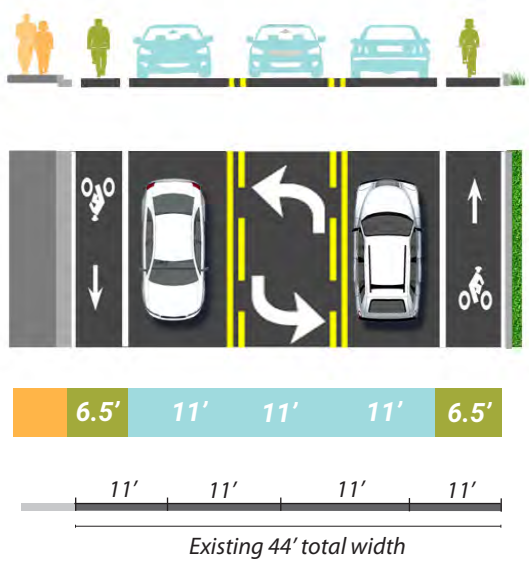


- There are currently two northbound lanes and one southbound in the first half of this segment.



- The northern section of this segment has four lanes with turn lanes designated at Philpotts Road and Johnstons Road.





Recommended cross section for road diet segment from Widgeon Road to Denison Avenue.

Potential Design Challenges

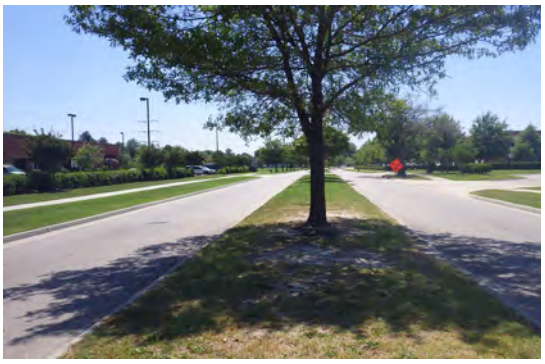
- The northbound turn lane distinctions at Widgeon Road will need to be eliminated to accommodate bike lanes through the entire segment. It is unlikely that they are necessary. A left turn lane in the southbound direction can be maintained.

Corridor 12: Denison Ave and Central Business Park Dr

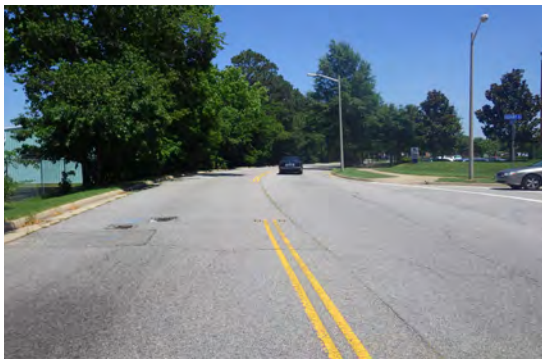
Segment 6: Sewells Point Road to Walmart entrance

Length: 0.5 miles
AADT: < 2,400
Speed limit: 25 mph

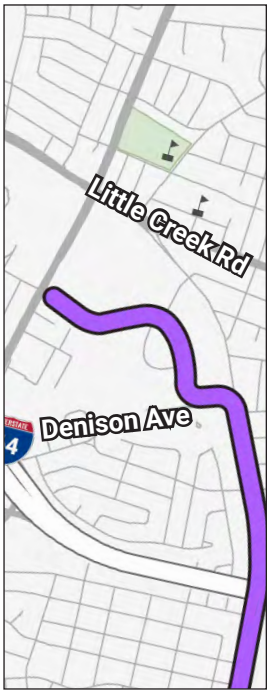
Facility: Bike lanes
Major Action: Lane diet



- Denison Avenue currently has wide, 15' lanes on either side of a grass median.



- Central Business Park Drive provides access to the side entrance of the Walmart Supercenter shopping plaza.



Potential Design Challenges

- There are no major design challenges to implementation of this recommendation.

Appendix A: Public Engagement

The 2015 Norfolk Bicycle & Pedestrian Strategic Plan (Plan) project included high-level collaboration with the public and stakeholder engagement focused on the following groups:

- Technical Committee: Representatives from key City agencies. The committee met six times during the course of the Plan. Additionally, members of the technical committee and citizen activists hosted two guided bicycle tours for the project team.
- Stakeholders/Focus Groups: Advocates, other City departments, universities, and the business community. Interest areas for the focus groups included economics, safety, health, and education.
- Norfolk Bicycling and Pedestrian Trails Commission: Citizen advocates interested in making Norfolk more bike and walk friendly.
- City Council: Regular updates and information were provided to the council via the project manager and Deputy City Manager.
- General Public: Emphasizing outreach to non-traditional constituents through news articles; open house meetings, online engagement and survey.

The project engaged the aforementioned groups in a variety of ways throughout the course of the project: project web site, formal and informal meetings, focused stakeholder meetings, public open houses, and participation in key citywide events. Since the Plan process officially began, the City has reached out to the public in a variety of ways, which are summarized in this memorandum. The City staff has also participated in regular Bicycle and Pedestrian Advisory Committee meetings, ADA Advisory Committee meetings, neighborhood meetings, and attended citywide events with information about the Plan Update.

Technical Committee Meetings

The Technical Committee was made up of key City staff from departments integral to bicycle and pedestrian planning, design and implementation. The group provided valuable feedback and ideas for planning documents, analyses, and outreach activities. The technical committee coordinated information dissemination and facilitated feedback from the non-profit, public and private sectors. The meetings indicated below represent key touch points throughout the planning process. Several other organized meetings took place related to corridor selection, facility recommendations review and draft plan development.

Committee meetings occurred in June 2014 (Kick-off); September 2014 (Corridor selection/public meeting preparation, bike tour); October 2014 (public meetings and corridor selection, bike tour); December 2014 (Fieldwork); and April 2015 (Plan review).

Project Technical Committee	
Susan Pollock	Department of Planning
Paul Forehand	Department of Parks & Recreation
Ben Kane	Department of Parks & Recreation
Paul Filion	Department of Public Works
John Ward	Department of Public Works
Lori Crouch	Public Relations Manager
Greg Reck	Downtown Norfolk Council
John Stevenson	Department of Public Works
Travis Davidson	Tidewater Bicycle Association
Rob Brown	Department of Public Works
Jason Baines	Department of Parks and Recreation
Rachel McCall	Downtown Norfolk Council
Jeff Raliski	Department of Planning
Matt Hales	City Planning Commission
Markus Wegener	Norfolk Bicycling and Pedestrian Trails Commission

Technical Committee Kick-Off

Date: June 5, 2014

This meeting oriented technical committee members to the planning process and relevant expectations in supporting the project. The major components of the meeting included:

- Project Overview: scope, schedule, and management
- Project Issues: Opportunities and challenges, study priorities, formation and role of committee
- Project Tasks: review Formal plan approval, format of Final Plan Report
- Action items and next steps
- Milestones, deliverables and management meetings

Committee priorities identified at the meeting included: regional trail connections, innovative facility recommendations, naval base coordination, options for rail corridor use, corridor connectivity, ERT wayfinding, development requirements, tourism, CEPTED, implementation.

Norfolk Bicycling and Pedestrian Trails Commission Kick-Off

Date: June 5, 2014

This meeting had a similar purpose as the technical committee meeting and was intended to engage the Commission as ambassadors of the planning process and final Plan.

Commission priorities identified at the meeting included: connectivity throughout the city, regional connections, Shore Drive facilities, usable loops for bike transportation, Blue Grass to Beaches, ODU and NSU, Norfolk Police Academy, access to bridges.

Technical Committee — Corridor Selection and Preparation for Public Outreach

Date: September 11, 2014

The focus of this meeting was to begin identifying priority corridors and to prepare for upcoming public outreach and focus group meetings.

Highlights: Discuss data collection for base map and corridor analysis, prepare for public and stakeholder involvement, review proposed corridor maps in preparation for final selection.

Technical Committee Meeting – Field Work

Date: December 15, 2014

This TC meeting occurred at the beginning of our week long site visit and served to inform the committee of the field work process and priorities. Additionally, the project team reviewed the approach and objectives for several focus group meetings that took place that week.

Highlights: Described map books, field forms, and approach to field work. Coordinated with committee on approach to facility recommendations during site visit. Coordinated with committee on focus group meetings.

Technical Committee Meeting – Corridor Recommendations Review

Date: April 24, 2015

Highlights: In-depth review of facility recommendations spreadsheet. The group discussed the consultant team's recommendation process, methodology and analysis. The team received and documented committee comments and questions.

Bicycle Tours

The technical committee with assistance from the Bicycling and Pedestrian Trails Commission hosted two bicycle tours of the city. Members of the consultant team visited key corridors throughout the city becoming familiar with challenges and barriers to making the city more biking and walking friendly. The tours focused on key bicycle/pedestrian corridors and identified desirable characteristics of future bicycle/pedestrian facilities.

During both tours the groups made several programmed stops to discuss the pros and cons of different street environments. Photographs and notes were taken at specific locations to document concerns of the members. Some key findings from

the rides include:

- Developed a keen sense of the physical barriers (highways, bridges, railroads and waterways) in Norfolk.
- Learned about the wayfinding challenges of the Elizabeth River Trail.
- Gained insight into the "local" routes that bicyclists take to navigate the city.
- Observed local biking and walking behaviors.
- Built excellent rapport with the technical committee and members of the Bicycling and Pedestrian Trails Commission as we entered into the recommendations phase of the project.



Committee members toured a number of parts of the city to assess bicycling conditions first-hand.

Public Outreach

Public Open Houses – Project Kick-Off

Dates: October 15th, 16th and 22nd, 2014

In coordination with City staff, Technical Committee members, and the Bicycle, Pedestrian and Trails Coalition, the TDG Team with City staff facilitated three public open houses to provide information and gather input from any and all interested area citizens. The format for the first set of meetings was a combination "open house" and public workshop to introduce the project, capture input on existing needs and motivate future involvement in the planning process

The meetings featured activities and interactive tools that provided a variety of ways for attendees to provide comments and ideas. The TDG Team and City staff employed various techniques to encourage participation from groups that are typically not active participants in bicycle plans such as University Students, non-bicyclists, low-income residents, and visitors to the city.

Each meeting included "stations" for public review and comment to identify barriers to biking and walking, as well as desired routes. Participants provided input through comments at designated map stations and they were invited to use an online interactive map. Comments from participants were documented and incorporated into the corridor analysis phase of the planning process.

Public Open House – Final Plan

Scheduled date: October 6, 2015

The final meeting will be an open house and presentation to report on the final corridor network, recommended facilities, and strategies for implementation. The meeting is intended to offer citizens an opportunity see and hear about the final plan and to garner public support for plan adoption by City officials.

Public Meeting Survey

A series of questions were handed out at each public meeting. These questions enabled the project team to better understand current walking and bicycling behaviors and guide where improvements should be located to have the biggest impact on improving biking and walking in Norfolk. The questions and responses are outlined on the following pages from 44 completed surveys.

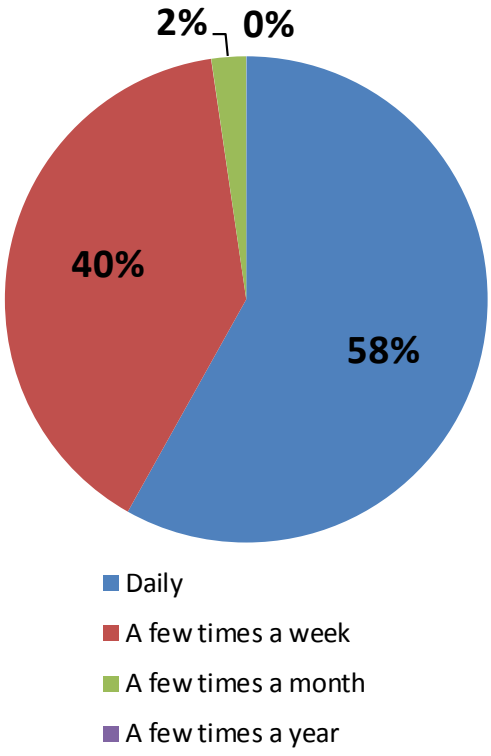
What is your home zip code?

ZIP Code	# of attendees
23508	18
23507	9
23503	2
23504	1
23529	1
23505	4
23517	1
23518	1
23510	2
23509	2
23505	1
23502	1
23322	1

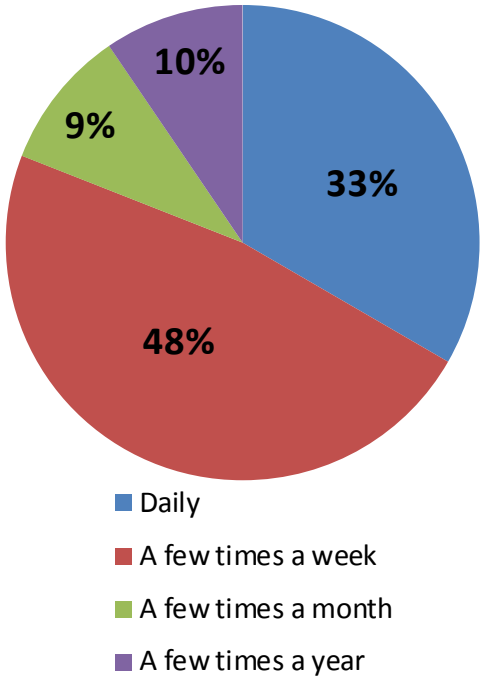
What is your school/work zip code?

ZIP Code	# of attendees
23504	3
23455	1
23507	4
23503	2
23510	11
23460	1
23511	1
23508	6
23320	2
23517	1
23502	1
23529	2
23703	1
23456	1
23513	1
23185	1
Navy Base	1

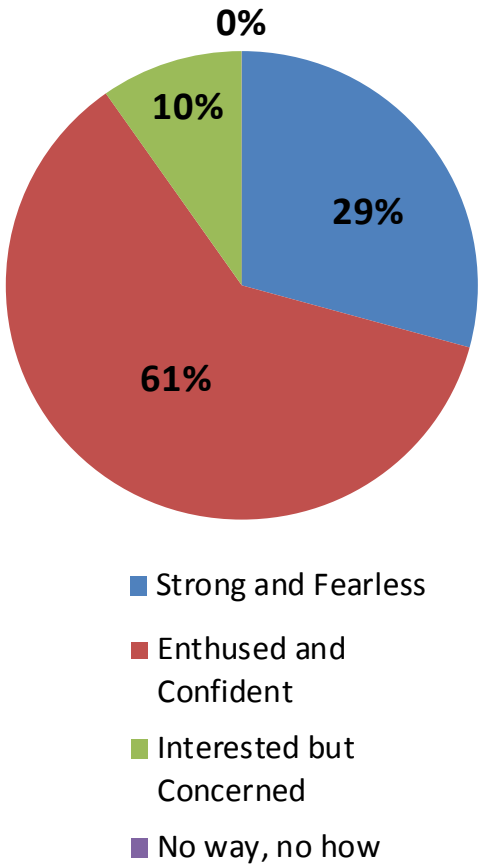
How often do you walk for 10 minutes or more in Norfolk?



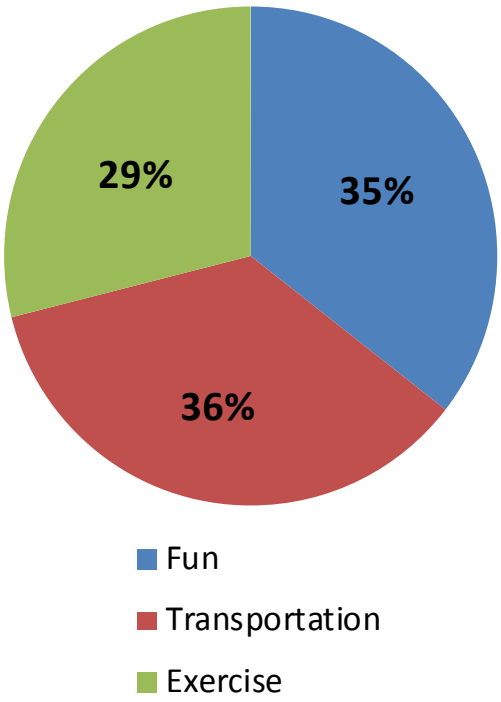
How often do you bike for 10 minutes or more in Norfolk?



How would you classify yourself as a bike rider?



Why do you ride a bike? (Instructed to check all that apply.)



Focus Group Meetings

In addition to public outreach through citizen committees, public meetings, surveys and the on-line interactive map the project team conducted two focus group meetings. These meetings served to enhance the information and perspectives gained through the various outreach venues.

The purpose of the stakeholder focus groups was two-fold: one, to receive practical feedback and guidance from various user perspectives; and two, to foster buy-in and consensus among partners and organizations that play an active role in implementing the plan policies and recommendations.

The meetings conducted are indicated below. An additional meeting was organized for Naval Station Norfolk but was not attended.

Focus Group - Universities
October 15, 2014 from 2:00 PM – 3:00 PM
Attendance: 11

Focus Group - Downtown Commplete Streets Committee
October 16, 2014 from 8:00 AM – 9:00 AM
Attendance: 15

On-line interactive map / WikiMap

A WikiMap was developed to help identify which corridors in Norfolk would be included in the City's strategic bicycle and pedestrian plan. A WikiMap is an online interactive map that interested residents can use to make comments and suggestions that help inform the final plan. In Norfolk, the WikiMap was open to the public from 10/30/2014 to 12/4/2014 and was available as a link from the City's bikeways and trails website. The public was encouraged to go online and contribute to the WikiMap during community meetings, through social media blasts, and through the local news. Over 750 individual comments were made by 142 different users. The results of this public effort helped determine the corridors included in this Strategic Plan. The tables below show a breakdown of WikiMap contributors by age, gender, motor vehicle ownership, and their self-described bicycling habits and level of comfort riding a bicycle.

Age	
Under 19	3
20-29	28
30-39	35
40-49	23
50-59	35
60 and older	17
Prefer not to say	1

Gender	
Female	46
Male	94
Prefer not to say	2

Motor Vehicle Ownership	
Own a motor vehicle	137
Do not own a motor vehicle	5

Self-described level of comfort riding a bicycle	
I am willing to ride in mixed traffic with automobiles on almost any type of street.	39
I am willing to ride in traffic, but I prefer dedicated bicycle lanes and routes.	67
I would like to bicycle more, but I prefer not to ride in traffic.	34
I do not ride a bicycle and am unlikely to ever do so.	2

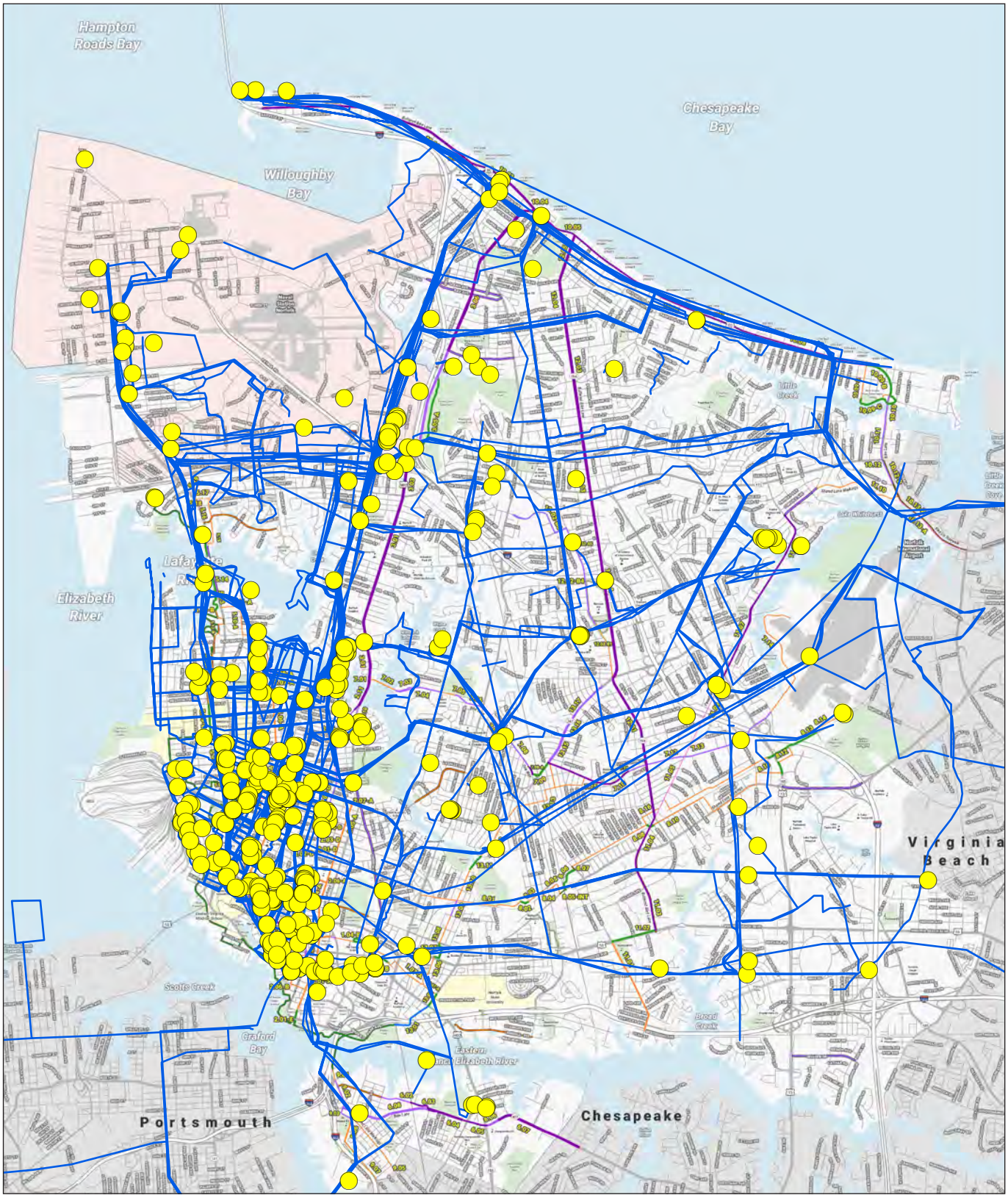
The WikiMap requested users to identify bicycle and pedestrian routes they currently use and would like to use, road segments that need improvement, barriers to bicycling and walking, and destinations they reach by walking or bicycling. The following table summarizes the number of contributed comments:

Point/Line Type Added	# Comments
Barriers to walking and bicycling	154
Road segments that need improvement	81
Needed trails	143
Walking destinations	29
Bicycling destinations	180
Currently used bicycling routes	170

WikiMap contributors were requested to identify the routes that they currently use for bicycling, those that need improvement, and locations that need trails to improve bicycle and pedestrian connectivity. Many of the bicycling routes used today are along Ocean Avenue, and in the downtown area near the Elizabeth River. WikiMap users also identified needed trails that also follow along Ocean Avenue and downtown, suggesting that many existing routes can be improved with additional facilities. Also, WikiMap contributors identified needed trails that provide additional east-west connectivity into the city.

In addition to providing the location of walking and bicycling destinations, WikiMap contributors also identified the type of destination: a link to adjacent communities (Virginia Beach, Chesapeake), dining or entertainment, park, recreation, school, shop, trail access, transportation link, work, or other destination. WikiMap users identified dining or entertainment destinations more often than any other destination type. Shops were the second most common destination added by WikiMap contributors. The following tables summarize the types of walking and bicycling destinations added to the WikiMap.

Bicycling Destination	# Comments
Link to adjacent community	9
Dining or entertainment	52
Recreation	33
School	4
Shop	40
Transportation link	8
Work	14
Other or no response	20



WikiMap comments clustered along a number of streets and informed the selection of Plan corridors.

Walking Destination	# Comments
Dining or entertainment	13
Park	2
Shop	6
Trail access	4
Transportation link	2
Other	2

The WikiMap users identified where barriers to walking and bicycling exist within the City of Norfolk as well as the type of barrier. Options for barriers included physical barriers such as highways, water, or railroad tracks; infrastructure issues such as missing sidewalks, missing connections, no bicycle detection, or poor lighting; and traffic barriers such as difficult intersection crossings or road segments having traffic that is too busy. WikiMap users could also list the barrier as "other" if it did not fit into a specific category. Difficult intersections, followed by traffic that is too busy were identified as the most common barriers to walking and bicycling by the WikiMap respondents.

Barrier to Walking or Bicycling	# Comments
Difficult intersections	66
Highway	15
Lighting	29
No connection	30
No detection	16
No sidewalks	18
Railroad	4
Too busy	44
Other	46

Lastly, the WikiMap users provided the location of individual road segments that could be improved for pedestrian and bicycle transportation as well as what could be improved. The options included traffic issues such as high speed or high volumes of traffic; road issues such as roads that are too narrow or roads without any bicycling facilities; and bicycling facilities that are too narrow for comfortable use.

Users also had the opportunity to choose "other," if the issue was not addressed by the listed options. The most common reason for a road segment to need improvement was because it was lacking facilities, followed by high speed traffic.

Road Segment Needs Improvement	# Comments
Bike lane too narrow	20
High speed traffic	39
High volume traffic	34
No facility	44
Narrow road segment	26
Other	32

The information collected through the public WikiMap was used to select corridors that are included in the Plan network. The study corridors represent a convergence of the data collected. They cover both barriers to walking and bicycling and road segments that need to be improved as an approach to increase the amount, safety, and convenience of walking and bicycling. The corridors also represent opportunities to further connect Norfolk along routes people are currently using and trails that they would like to use in order to reach walking and bicycling destinations within the city. Use of WikiMap input benefits the final Plan by incorporating local knowledge and insight in order to ensure that the Plan's final recommendations address the public's concerns and garner their support.

Appendix B: Level of Traffic Stress Analysis

A Bicycle Level of Traffic Stress (LTS) analysis evaluates the conditions of the roadway network in regard to the relative level of comfort a bicyclist experiences while riding on a specific road segment. Data about automobile speeds and volume, as well as the cross section of the roadway and type of bicycle facility are evaluated to determine a final stress level assessment.

The low stress bicycling concept is premised on the experience of the Dutch who have focused on building a connected bicycle network that minimize bicyclists interaction with motorized traffic. The approach targets mainstream adult bicyclists (Interested but Concerned population) by providing the following types of facilities:

- Shared lanes on low-volume, low-speed, local streets
- Bicycle lanes on moderate-volume, moderate-speed streets
- Cycle tracks (protected bike lanes) on high-volume or high-speed streets

The Bicycle LTS analysis classifies the segments of each priority corridor into four levels of traffic stress, with "LTS 1" being the least stressful and "LTS 4" being the most stressful. The classifications correspond to the upper limit of a type of bicyclist's comfort zone:

- LTS 1 – Suitable for nearly all riders: trails, separated bike lanes, low-volume streets
- LTS 2 – Interested but concerned adults: moderate-volume streets at 30 mph or less with shared lane or minimum width bike lanes
- LTS 3 – Enthused and confident adults: higher-volume streets at 30 mph with a minimum width bike lane
- LTS 4 – Strong and fearless adults: high-volume streets at 35 mph or more with a minimum width bike lane

In the simplified LTS analysis method used for Norfolk, streets were assigned a level of traffic stress 1 through 4 using the following data:

- Streets where bicyclists share the road with automobiles are assessed based on speed limit and traffic volume
- Streets with bike lanes of buffered bike lanes are evaluated based upon the width of the bike lane and speed limit
- Bicycle facilities fully separated from automobile traffic such as separated bike lanes, sidepaths and trails are deemed low-stress facilities

Shared lane and bike lane evaluations work on a "weakest link" principle whereby the element rated the most stressful trumps any other. For instance, Chesapeake Avenue is a street with a wide buffered bike lane recommended, but the speed limit is 40 mph. The speed of traffic gives Chesapeake an LTS rating of 4, the most stressful, in spite of the new wide bicycle facility. Similarly, the northern section of Colley Avenue has a speed limit of 25 mph which would create a low-stress riding environment, but current traffic counts indicate approximately 14,000 vehicles per day. That traffic volume means that a bicyclist would be passed by at least three automobiles a minute during the peak hours of the day. That leads to a more stressful riding environment, and Colley Avenue is rated LTS 4.

While some sections of the proposed facility network do not result in a low-stress riding environment, it is still important to start to implement facilities. As noted in Chapter 3, some buffered bike lanes may be retrofitted in the future to include vertical separation. This would change the stress level of Chesapeake Avenue from LTS 4 to LTS 1. Other factors such as speed limits may also be changed to lower the stress level of other streets, though those recommendations are not made in this Plan.

The following map shows the results of the Level of Traffic Stress analysis for recommended facilities on all 12 corridors in Norfolk.



Appendix C: Cost Estimate Details

Planning-level cost estimates for construction of recommendations were developed to complement the Plan. They were developed by identifying pay items and establishing approximate per-mile quantities. Unit costs are based on 2015 dollars and were assigned based on historical cost data from Virginia Department of Transportation average prices and the estimator's experience and judgement. The costs shown reflect only the cost associated with construction of the particular bicycle facility indicated and do not reflect other costs that may be associated with a larger project such as right-of-way acquisition, signal timing assessment and design. Costs include pavement markings and standard signage for the facility type. Where applicable for implementation of a facility, costs also include eradication of existing pavement markings. The costs are intended to be general and used for planning purposes. A 10 to 30 percent contingency is applied to the cost for each item based on the type of project. The component unit costs for each facility type are detailed in the first set of tables in this appendix.

Per-mile costs for each type of bicycle facility were developed and applied to each segment of a corridor. These segment costs were totaled to come up with the corridor costs included in Chapter 4. Individual segment costs are available in a separate spreadsheet provided to the City.

Some corridors include recommendations for intersection improvements, and these costs were not included in the cost estimates. Recommendations such as crosswalks and High-Intensity Activated Crosswalk Beacons (HAWKs) are priced in Table 4 in this appendix. Additional pedestrian improvement types are also included in that table for the City's reference.

Norfolk Bike Plan - Conceptual Cost Estimates

Prepared: Friday, June 26, 2015
By: Jeremy Chrzan, PE, PTOE, LEED AP

Signed Route

Includes: sign and post.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Sign Panel (Class I)	EA	13	$250.00	$3,300	1 Sign every 800 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	13	$200.00	$2,640	
Subtotal				**$5,940**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$594.00	$594	
			Subtotal	**$6,534**	
			10% Contingency	$653	
			Total Estimated Cost	**$7,200**	→ **$1.36** **Per Linear Foot**

Bike Lanes - Low End

Includes: bicycle lane markings in both directions with bicycle lane signs. No markings on existing roadway require removal.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	10,560	$3.00	$31,680	2 solid lines entire length
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,200	1 Symbol every 200 feet, each side of road
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Bicycle Safe Grate	EA	18	$680.00	$11,968	Every 600', each side of road
Subtotal				**$65,848**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$6,585.00	$6,585	10% of Subtotal
			Subtotal	**$72,433**	
			20% Contingency	$14,487	
			Total Estimated Cost	**$87,000**	→ **$16.48** **Per Linear Foot**

Bike Lanes - High End

Includes: bicycle lane markings in both directions with bicycle lane signs. Up to 2 traffic lane lines removed.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	21,120	$3.00	$63,360	4 solid lines entire length
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,200	1 Symbol every 200 feet, each side of road
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Eradication (Skip Lines)	LF	2,640	$0.50	$1,320	eradicate 2 skip lines
Replace Skip Lines	LF	2,640	$2.60	$6,864	
Bicycle Safe Grate	EA	18	$680.00	$11,968	Every 600', each side of road
Subtotal				**$105,712**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$10,571.00	$10,571	
			Subtotal	**$116,283**	
			20% Contingency	$23,257	
			Total Estimated Cost	**$139,600**	→ **$26.44** **Per Linear Foot**

Table 3: Bicycle facility costs

Norfolk Bike Plan - Conceptual Cost Estimates

Prepared: Friday, June 26, 2015

Bike Lanes - Requires Roadway Widening (Outside of Existing Footprint)

Includes: bicycle lane markings in both directions with bicycle lane signs. Requires road widening up to 7' each side, 14' total, with 22' pavement overlay of existing roadway.Major grading required with curb and gutter. Drainage impacts.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork, Excavation, Grading	CY	5,476	$30.00	$164,267	7 feet width and 2 feet depth, each side of road
Aggregate Base Course	CY	2,738	$42.00	$114,987	7 feet width and 1 feet depth, each side of road
Milling	SY	11,733	$7.00	$82,133	22 feet width
Asphalt Base Course	TON	2,779	$91.00	$252,884	14 feet width and 0.5 feet depth, 13.3 CF in a TON
Asphalt Surface Course	TON	2,387	$80.00	$190,938	36 feet width and 0.125 feet depth, 13.3 CF in a TON
Thermoplastic Pavement Marking Lines (4")	LF	10,560	$3.00	$31,680	2 solid lines entire length
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,250	1 Symbol every 200 feet each side of road (bike lane)
Crosswalk	EA	4	$5,580.00	$22,320	4 Crosswalks per mile, 36 Feet x 10 Feet, High Visibility, curb ramps
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Curb & Gutter	LF	9,504	$25.00	$237,600	5280' x 2 - 10%
Bicycle Safe Grate	EA	18	$680.00	$11,968	Every 600', each side of road
Subtotal				**$1,131,026**	
Lump Sum Items					
Landscaping (10%)	LS	1.00	$113,103.00	$113,103	
Drainage and E&S (15%)	LS	1.00	$169,654.00	$169,654	
Maintenance of Traffic (10%)	LS	1.00	$113,103.00	$113,103	
Utility Adjustments (10%)	LS	1.00	$113,103.00	$113,103	
			Subtotal	**$1,639,989**	
			30% Contingency	$491,997	
			Total Estimated Cost	**$2,132,000**	→ **$403.79** **Per Foot**

Buffered Bike Lane

Includes: add buffer markings to existing roadway in both directions with bicycle lane signs. Eradicate and reinstall lane lines on road.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	25,608	$3.00	$76,824	2 solid lines entire length, each side of road, and gore for buffer
Thermoplastic Pavement Marking Buffer Lines (6")	LF	1,056	$3.50	$3,696	1 solid line, 4 feet long, every 40 feet
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,200	1 Symbol every 200 feet, each side of road
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Eradication (Skip Lines)	LF	2,640	$0.50	$1,320	eradicate 2 skip lines
Replace Skip Lines	LF	2,640	$2.60	$6,864	
Bicycle Safe Grate	EA	18	$680.00	$11,968	Every 600', each side of road
Subtotal				**$122,872**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$12,287.00	$12,287	
			Subtotal	**$135,159**	
			20% Contingency	$27,032	
			Total Estimated Cost	**$162,200**	→ **$30.72** **Per Foot**

Priority Shared Lane Marking Treatment

Includes: shared lane pavement marking at 125 foot spacing with green color bracketing symbol. No markings on existing roadway require removal.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Symbol	EA	84	$250.00	$21,120	1 Symbol every 125 feet per side of the road
Green Bike Lane Paint	SF	5,069	$4.00	$20,275	6'x10' color at $325 per gal./100sf per gal. rounded to $4/sf
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Subtotal				**$50,395**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$5,040.00	$5,040	
			Subtotal	**$55,435**	
			20% Contingency	$11,087	
			Total Estimated Cost	**$66,600**	→ **$12.61** **Per Foot**

Cycle Track - Retrofit with Flexible Delineators

Includes: Cycle Track with no widening.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	25,608	$3.00	$76,824	2 solid lines entire length, each side of road, and gore for buffer
Thermoplastic Pavement Marking Buffer Lines (6")	LF	1,056	$3.50	$3,696	1 solid line, 4 feet long, every 40 feet
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,200	1 Symbol every 200 feet, each side of road
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Eradication (Skip Lines)	LF	2,640	$0.50	$1,320	eradicate 2 skip lines
Replace Skip Lines	LF	2,640	$2.60	$6,864	
Bicycle Safe Grate	EA	18	$680.00	$11,968	Every 600', each side of road
Flexible Delineators	EA	528	$100.00	$52,800	1 every 20' each side
Subtotal				**$175,672**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$17,567.00	$17,567	
			Subtotal	**$193,239**	
			30% Contingency	$57,972	
			Total Estimated Cost	**$251,300**	→ **$47.59** **Per Foot**

Shared Lane Markings

Includes: shared lane pavement marking at 250 foot spacing. No markings on existing roadway require removal.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Symbol	EA	42	$250.00	$10,560	1 Symbol every 250 feet per side of the road
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Subtotal				**$19,560**	
Lump Sum Items					
Maintenance of Traffic (10%)	LS	1.00	$1,956.00	$1,956	
			Subtotal	**$21,516**	
			10% Contingency	$2,152	
			Total Estimated Cost	**$23,700**	→ **$4.49** **Per Foot**

Shared Use Path

Includes: New path with markings and signage

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	1,320	$3.00	$3,960	1 dashed lines entire length
Sign Panel (Class I)	EA	10	$250.00	$2,500	1 Sign every 1000 feet, each side of path
Steel Sign Post (2x2 Inch Tubing)	EA	10	$200.00	$2,000	
Earthwork, Excavation, Grading, Fill	CY	7,822	$35.00	$273,778	20 wide disturbance / 2 feet depth
Aggregate Base Course	CY	2,347	$42.00	$98,560	12 feet width, 1 feet depth
Asphalt Surface Course	TON	704	$80.00	$56,320	12 feet width and 2" depth, 1.8 Ton/CY
Asphalt Base Course	TON	2,112	$91.00	$192,192	12 feet width and 0.5 feet depth, 1.8 Ton/CY
Geotextile Filter Cloth	SY	7040	$3.00	$21,120	
Intersection Treatments	EA	3	$1,250.00	$3,750	Assumed 3 every 1-mile segment. Curb ramps & crosswalk markings
Subtotal				**$654,180**	
Lump Sum Items					
Landscaping (5%)	LS	1.00	$32,709.00	$32,709	
Drainage and E&S (10%)	LS	1.00	$65,418.00	$65,418	
Maintenance of Traffic (5%)	LS	1.00	$32,709.00	$32,709	
Utility Adjustments (10%)	LS	1.00	$65,418.00	$65,418	
			Subtotal	**$850,434**	
			30% Contingency	$255,130	
			Total Estimated Cost	**$1,105,600**	→ **$209.39** **Per Foot**

Shared Use Path along roadway

Includes: Removal of existing sidewalk for a 10' wide curb-side path with markings, signage, and intersection crosswalk/curb ramp improvements.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	1,320	$3.00	$3,960	1 dashed lines entire length
Sign Panel (Class I)	EA	18	$250.00	$4,400	2 Sign every 600 feet (back-to-back on one post)
Steel Sign Post (2x2 Inch Tubing)	EA	9	$200.00	$1,800	
Earthwork, Excavation	CY	3,911	$25.00	$97,778	10 wide disturbance / 2 feet depth (incl. sidewalk removal)
Aggregate Base Course	CY	1,956	$42.00	$82,133	10 feet width, 1 feet depth
Asphalt Surface Course	TON	587	$80.00	$46,933	10 feet width and 2" depth, 1.8 Ton/CY
Asphalt Base Course	TON	1,760	$91.00	$160,160	10 feet width and 0.5 feet depth, 1.8 Ton/CY
Geotextile Filter Cloth	SY	5867	$3.00	$17,600	
Intersection Treatments	EA	9	$4,000.00	$36,000	Assumed every 600' w/ curb ramps, raised crossings, & crosswalk markings
Driveway Adjustments	EA	10	$2,200.00	$22,000	Assumed every 500' w/ raised driveway crossings
Subtotal				**$472,764**	Note: Does not include signal upgrades
Lump Sum Items					
Landscaping (5%)	LS	1.00	$23,638.00	$23,638	
Drainage and E&S (10%)	LS	1.00	$47,276.00	$47,276	
Maintenance of Traffic (10%)	LS	1.00	$47,276.00	$47,276	
Utility Adjustments (10%)	LS	1.00	$47,276.00	$47,276	
			Subtotal	**$638,230**	
			30% Contingency	$191,469	
			Total Estimated Cost	**$829,700**	→ **$157.14** **Per Foot**

Shared Use Path with Lane Diet

Includes: Removal of roadway width, new curbline, and replacing existing sidewalk for a 10' wide curb-side path with markings, signage, and intersection crosswalk/curb ramp improvements.

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Thermoplastic Pavement Marking Lines (4")	LF	1,320	$3.00	$3,960	1 dashed lines entire length
Sign Panel (Class I)	EA	18	$250.00	$4,400	2 Sign every 600 feet (back-to-back on one post)
Steel Sign Post (2x2 Inch Tubing)	EA	9	$200.00	$1,800	
Earthwork, Excavation	CY	3,911	$25.00	$97,778	10 wide disturbance / 2 feet depth (incl. sidewalk removal)
Aggregate Base Course	CY	1,956	$42.00	$82,133	10 feet width, 1 feet depth
Asphalt Surface Course	TON	587	$80.00	$46,933	10 feet width and 2" depth, 1.8 Ton/CY
Asphalt Base Course	TON	1,760	$91.00	$160,160	10 feet width and 0.5 feet depth, 1.8 Ton/CY
Geotextile Filter Cloth	SY	5867	$3.00	$17,600	
Curb & Gutter	LF	4,752	$25.00	$118,800	5280' - 10%
Intersection Treatments	EA	9	$4,000.00	$36,000	Assumed every 600' w/ curb ramps, raised crossings, & crosswalk markings
Driveway Adjustments	EA	10	$2,200.00	$22,000	Assumed every 500' w/ raised driveway crossings
Subtotal				**$591,564**	Note: Does not include signal upgrades
Lump Sum Items					
Landscaping (5%)	LS	1.00	$29,578.00	$29,578	
Drainage and E&S (15%)	LS	1.00	$88,735.00	$88,735	
Maintenance of Traffic (10%)	LS	1.00	$59,156.00	$59,156	
Utility Adjustments (10%)	LS	1.00	$59,156.00	$59,156	
			Subtotal	**$828,189**	
			30% Contingency	$248,457	
			Total Estimated Cost	**$1,076,700**	→ **$203.92** **Per Foot**

Removal of Shared Use Path

Includes removal of existing Shared Use Path and landscaping restoration

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork, Excavation	CY	4,693	$25.00	$117,333	12 wide disturbance / 2 feet depth
Select Backfill	CY	4,693	$40.00	$187,733	12 feet width, 2 feet depth
Subtotal				**$305,067**	
Lump Sum Items					
Landscaping (5%)	LS	1.00	$15,253.00	$15,253	
Maintenance of Traffic (10%)	LS	1.00	$30,507.00	$30,507	
			Subtotal	**$350,827**	
			20% Contingency	$70,165	
			Total Estimated Cost	**$421,000**	→ **$79.73** **Per Foot**

Paved Shoulder

Includes: bicycle lane markings in both directions with bicycle lane signs. Requires road widening

Item	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork, Excavation, Grading	CY	5,476	$30.00	$164,267	7 feet width and 2 feet depth, each side of road
Aggregate Base Course	CY	2,738	$42.00	$114,987	7 feet width and 1 feet depth, each side of road
Milling	SY	0	$7.00	$0	22 feet width
Asphalt Base Course	TON	2,779	$91.00	$252,889	14 feet width and 0.5 feet depth, 13.3 CF in a TON
Asphalt Surface Course	TON	928	$80.00	$74,240	36 feet width and 0.125 feet depth, 13.3 CF in a TON
Thermoplastic Pavement Marking Lines (4")	LF	10,560	$3.00	$31,680	2 solid lines entire length
Thermoplastic Pavement Marking Symbol	EA	53	$250.00	$13,250	1 Symbol every 200 feet each side of road (bike lane)
Crosswalk	EA		$5,580.00	$0	4 Crosswalks per mile, 36 Feet x 10 Feet, High Visibility, curb ramps
Sign Panel (Class I)	EA	20	$250.00	$5,000	1 Sign every 500 feet, each side of road
Steel Sign Post (2x2 Inch Tubing)	EA	20	$200.00	$4,000	
Curb & Gutter	LF		$25.00	$0	5280' x 2 - 10%
Bicycle Safe Grate	EA		$680.00	$0	Every 600', each side of road
Subtotal				**$660,312**	
Lump Sum Items					
Landscaping (10%)	LS	1.00	$66,031.00	$66,031	
Drainage and E&S (15%)	LS	1.00	$99,047.00	$99,047	
Maintenance of Traffic (10%)	LS	1.00	$66,031.00	$66,031	
Utility Adjustments (10%)	LS	1.00	$66,031.00	$66,031	
			Subtotal	**$957,452**	
			30% Contingency	$287,236	
			Total Estimated Cost	**$1,244,700**	**$235.74** **Per Foot**

Pedestrian Improvement	Unit Cost	Assumptions	Total Cost
Curb Ramps	$1,000	Assumes 8 ramps per intersection, or $8,000 per intersection	$8,000
High Visibility Crosswalks	$1,500	Assumes 60' long, 10' wide – should assume 4 crosswalks per intersection, or $6,000 per intersection	$6,000
Median Refuge Island	$15,000	Assumes 50' long x 6' wide. Does not include design costs	$15,000
Upgrade of existing signal	$13,500	Per intersection cost. Assumes new pedestrian signals and push buttons are added (8 per intersection)	$13,500
New HAWK signal	$105,000	Per installation. Assumes two mast arms, controller cabinet, push buttons, etc. Including design costs	$105,000
New Standard signal	$300,000	Per intersection. Assumes four mast arms, controller cabinet, push buttons, etc. Including design costs	$300,000
Signage	$250	$250 per sign installation	$250
Curb Extensions	$18,000	Assumed to be 50' long, 8' wide. Includes curb ramps. Does not include design costs	$18,000
Raised Crosswalks	$4,500	Assumed to be 30' long, 10' wide. Does not include possible design costs	$4,500
**Note: Maintenance of traffic is not included in these estimates and could be 5%-10% of the indicated improvement cost.*			

Table 4: Selected pedestrian facility costs


CITY OF NORFOLK VIRGINIA
TOWN 1682 • BOROUGH 1736 • CITY 1845