TABLE OF CONTENTS

Executive Summary
Multimodal Norfolk Transportation Master Plan

Chapter 1: Introduction
Chapter 2: Vision and Values
Chapter 3: Public Engagement
Chapter 4: Multimodal System Plan
Chapter 5: Bicycle and Pedestrian Master Plan
Chapter 6: Multimodal Project Design – Overall Framework
Chapter 7: Multimodal Project Design – Approaches for Different Modes
Chapter 8: Multimodal Project Evaluation
Chapter 9: Curb Space Management
Chapter 10: Data and Technology
Chapter 11: Transit System Redesign
Chapter 12: Multimodal Needs Assessment
Chapter 13: Program of Projects
Chapter 14: Implementation and Next Steps

Appendices
Appendix A: Multimodal System Plan Maps
Appendix B: Additional Maps
Appendix C: Multimodal Corridor Design Matrix
Appendix D: Freight Design Considerations
Appendix E: Pedestrian Crossing Design Considerations
Appendix F: Multimodal Needs Assessment Technical Appendix
Appendix G: Program of Projects
Executive Summary

Under development
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 long-term 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.

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, outlined in Norfolk Vision 2100, and 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. 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.

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

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 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 2018, 15 people were killed in traffic crashes on Norfolk’s streets, and on average, six pedestrians and bicyclists are killed every year. 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.

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.
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.\textsuperscript{x} The transportation sector is the largest contributor to greenhouse gas emissions both in the United States\textsuperscript{vi} and in Norfolk. Transportation accounts for 41 percent of the City’s community greenhouse gas emissions.\textsuperscript{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 #13 out of 99 cities across the US on the Racial Equity Index in 2017. 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.\textsuperscript{viii}

Yet, there are significant racial inequities in Norfolk, especially in the economic vitality indicators. And while Norfolk scores in the top 10 percent on racial inclusion indicators, it ranks 40\textsuperscript{th} on overall prosperity measures.\textsuperscript{x}

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.
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.

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.
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 seven 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 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 late 2021. 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 need and presents a prioritized list of multimodal transportation needs.

Chapter 13: Program of Projects explains the process to develop the prioritized list of projects for near-, mid-, and long-term timeframes based on projected available funding.

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 Program of Projects.

Ibid.

iii Land vacancy statistic from plaNorfolk 2030


v City of Norfolk, Mayor’s Advisory Commission on Climate Change Mitigation and Adaptation, 2019. Climate Action Plan.


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 Nov 17, 2020 from https://nationalequityatlas.org/research/racial_equity_index/index#/?geoSectionName=City&geo=060000000000051078

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.
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. 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.

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>
<thead>
<tr>
<th>Objectives</th>
<th>Potential Indicators</th>
<th>Desired Performance</th>
<th>Potential Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance connectivity on all travel networks in the city.</td>
<td>Accessibility to key destinations by mode</td>
<td>Increase</td>
<td>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.</td>
</tr>
<tr>
<td>Improve travel choices for residents, businesses, and visitors.</td>
<td>Non-auto lane miles by mode</td>
<td>Increase</td>
<td></td>
</tr>
<tr>
<td>Improve safety and work toward zero fatalities on our streets.</td>
<td>Transit Ridership</td>
<td>Increase</td>
<td>Average Daily Boardings and Alightings at HRT transit stops within Norfolk; data from HRT. Also, Average Daily Tide Light Rail Boardings and Alightings.</td>
</tr>
<tr>
<td>Improve safety and work toward zero fatalities on our streets.</td>
<td>Pedestrian and Bicyclist Counts</td>
<td>Increase</td>
<td>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.</td>
</tr>
<tr>
<td>Increase the resilience of the city’s transportation networks.</td>
<td>Change in number of pedestrian/bike accidents &amp; fatalities</td>
<td>Decrease</td>
<td>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.</td>
</tr>
<tr>
<td>Increase the resilience of the city’s transportation networks.</td>
<td>Percent of network miles outside of recurrent flooding zones (by mode)</td>
<td>Increase</td>
<td>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.</td>
</tr>
<tr>
<td>Promote economic development through enhanced multimodal connections.</td>
<td>Employment by distance to active transportation and transit</td>
<td>Decrease</td>
<td>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.</td>
</tr>
<tr>
<td>Enhance the comfort and beauty of Norfolk’s public street system.</td>
<td>Streetscape improvements</td>
<td>Increase</td>
<td>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.</td>
</tr>
</tbody>
</table>

Chapter 2: Vision and Values

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.

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.

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

The www.MultimodalNorfolk.com website provided current information on the development of the plan. An interactive online map was available from January through June 2021. Residents and other members of the public submitted over 800 comments on multimodal
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.

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.

transportation needs through the online map and through email and voicemail messages.

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.
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.

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.

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 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**

A final round of stakeholder and public meetings will be 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 will be held to share the results of this process and what can be expected in the future. This final round of engagement will also include 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 were engaged through four rounds of input, with 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.
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. 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 identifies areas where there are lots of destinations and where you want to walk, bike, and take transit.

The Multimodal System Plan identifies streets that connect you to important and everyday destinations. Different streets have different functions.

The Multimodal System Plan combines the places where you want to go and the routes that connect them into a complete system.

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 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.

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 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 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.

<table>
<thead>
<tr>
<th>Transect Zone</th>
<th>Activity Density Range (Population + Employment per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0 to 1</td>
</tr>
<tr>
<td>T2</td>
<td>1 to 10</td>
</tr>
<tr>
<td>T3</td>
<td>10 to 25</td>
</tr>
<tr>
<td>T4</td>
<td>25 to 60</td>
</tr>
<tr>
<td>T5</td>
<td>60 to 100</td>
</tr>
<tr>
<td>T6</td>
<td>100+</td>
</tr>
</tbody>
</table>

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.
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.

**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 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.

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.

**Avenues** are the corridor type of moderate multimodal capacity that accommodates multiple motorized and non-motorized modes.

Avenues are typically service arteries for local access to destinations and provide safe and convenient pedestrian and bicycle access to adjacent land uses. Avenues typically feature a median and landscaped amenity elements, street trees, and wider sidewalks. Design speeds for Avenues typically range from 15 to 30 mph.

**Local Streets** are the corridor type of lowest multimodal capacity that accommodates multiple motorized and non-motorized modes.

Local Streets are typically service arteries for local access to destinations and provide safe and convenient pedestrian and bicycle access to adjacent land uses. Local Streets typically feature a median and landscaped amenity elements, street trees, and wider sidewalks. Design speeds for Local Streets typically range from 15 to 30 mph.

---

Chapter 4: Multimodal System Plan

35

Draft Plan - October 25, 2021
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.
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 (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 2021, 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

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.
bus rapid transit at the time of the 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.
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.
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 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.
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.

---

**BICYCLIST DESIGN USER PROFILES**

**Interested but Concerned**

- 51%-56% of the total population
- Often not comfortable with bike lanes, may bike on sidewalks even if bike lanes are provided, prefer off-street or separated bicycle facilities or quiet or traffic-calmed residential roads. May not bike at all if bicycle facilities do not meet needs for perceived comfort.

**Somewhat Confident**

- 5-9% of the total population
- Generally prefer more separated facilities, but are comfortable riding in bike lanes or on paved shoulders if need be.

**Highly Confident**

- 4-7% of the total population
- Comfortable riding with traffic, will use roads without bike lanes.

---

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.

The Elizabeth River Trail was developed in 1994 and has been continually improved with new sections, the most recent of which is currently under construction at Fort Norfolk.

Prior to the 2015 Bicycle and Pedestrian Strategic Plan, the City added bike lanes and shared lane markings to several streets, including Church Street, Willoughby Avenue, and Ocean View Avenue, 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:

- Bicycle lanes on Olney Road,
- Shared lane markings on Granby Street,
- Separated bicycle lanes on Llewellyn Avenue, and

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.
• Bicycle lanes on portions of Colley Avenue.

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

• Bicycle lanes on Ocean View Avenue,
• Buffered bicycle lanes on Granby Street from Willow Wood Road to Admiral Taussig Boulevard,
• Shared lane markings on Granby Street from Virginia Beach Boulevard to 22nd Street,
• Continuing the bicycle lanes on 26th and 27th Streets from Colley Avenue to Leo Street, 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 Bike Bypass asphalt 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

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

The City is currently working with the Downtown Norfolk Council and several civic leagues to install scooter parking at various locations throughout downtown and in other areas.

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

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:

• 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.
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.
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 5.
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.
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 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.

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.

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.
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).
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.

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-sectional 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 with specific dimensions for each element in the corridor cross-section.

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.
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
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.
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.
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.
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.

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. 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.
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.

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. Shared lanes are most appropriate on roadways where the difference between bicyclist and motorist travel speeds is very low. 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.

However, shared lanes may be appropriate on streets with speed limits up to and including 35 mph 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.
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.

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

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 traffic. 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.
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 well 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**

<table>
<thead>
<tr>
<th>Design Approach</th>
<th>Frequency of Buses</th>
<th>Speed of Buses</th>
<th>Impact to Roadway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Bus and Bicycle Lane</td>
<td>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.</td>
<td>Appropriate where bus speed is limited to 20 mph.</td>
<td>16-ft lane desired. Potentially feasible with a 12-ft lane.</td>
</tr>
<tr>
<td>Separate Bus and Bicycle Lanes</td>
<td>Appropriate where bus frequency is more than 1 bus every 5 minutes.</td>
<td>Appropriate where bus speed is higher than 20 mph.</td>
<td>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.</td>
</tr>
</tbody>
</table>

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.

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

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

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.

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.

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.

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 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

<table>
<thead>
<tr>
<th>Corridor Element Key</th>
<th>Corridor Type</th>
<th>Intensity</th>
<th>Context Zones &amp; Corridor Elements</th>
<th>T-5</th>
<th>Boulevard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Building Context Zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Location of off street parking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typical building entry locations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td>Building Frontage Element</td>
<td>5 ft</td>
<td>3 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Location of off street parking</td>
<td>rear</td>
<td>rear</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typical building entry locations</td>
<td>front</td>
<td>front</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td>Sidewalk Edge Zone</td>
<td>10 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AMENITY ELEMENT</td>
<td>8 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paved with tree wells</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>Curbside Activity Element</td>
<td>8 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paved with tree wells</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td>PARALLEL PARKING ONLY</td>
<td>8 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery</td>
<td>10 ft</td>
<td>8 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td>Bicycle Lane</td>
<td>5.8 ft</td>
<td>4.5 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Non-Separated Bikelane</td>
<td>9.0 ft</td>
<td>6.8 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Separated Bikelane</td>
<td>10.0 ft</td>
<td>8.5 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Non-Separated Bikelane</td>
<td>15.0 ft</td>
<td>11.1 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td>TRANSIT ELEMENT</td>
<td>12 ft</td>
<td>11 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Considerations</td>
<td>Low congestion</td>
<td>Low congestion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dedicated transit lane</td>
<td>12 ft</td>
<td>11 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Considerations</td>
<td>High congestion</td>
<td>High congestion</td>
</tr>
</tbody>
</table>
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.

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 as 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](image)

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](image)

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.
Definitions of bikeway facility types are based on the FHWA 2019 Bikeway Selection Guide.


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.


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.
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.

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. LOSS 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.

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.
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.

Evaluation Questions for the “Connect” Vision Theme

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

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

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

### 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**

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

**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.

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.

**Figure 8-2: Multimodal Corridor Design Concept Evaluation Example – Cross-Section Illustration**
Table 8-1: Evaluation Questions for the Hypothetical Example

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

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

- Connect
  - Increases person capacity by shifting space to transit, cyclists, pedestrians
  - Increases efficiency of the public ROW increasing person capacity without widening ROW
  - Introduces new modal options by providing dedicated space for non-auto modes
  - Increases bus reliability and speed by providing dedicated transit lanes

- Protect
  - Increases bicyclist safety by providing physically-protected bike lanes
  - Increases pedestrian safety and comfort by widening sidewalk
  - Slows vehicle traffic by effectively narrowing vehicle travel way

- Prosper
  - Increases travel choices for residents and workers by providing dedicated space for new modes
  - Contributes to attractive public realm by adding trees, widening pedestrian element
  - Dedicated transit lanes indicates long-term commitment to high-quality transit on this corridor

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

- 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
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.

### 3 Steps to Managing Curb Space

1. Establish Curb Space Priorities
2. Identify Potential Curb Uses
3. Design the Curb Space

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.

**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 that 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 is 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 or 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 their car in the same spot for an extended period of time.
## Design Considerations for ‘Mobility’ Curb Uses

<table>
<thead>
<tr>
<th>CURBUSE</th>
<th>Land Use Context</th>
<th>Interface with Other Modes and Other Curb Uses</th>
<th>Resilience &amp; Livability</th>
<th>Time of Day Flexibility</th>
</tr>
</thead>
</table>
| 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 |
<table>
<thead>
<tr>
<th>Land Use Context</th>
<th>Interface with Other Modes and Other Curb Use</th>
<th>Resilience &amp; Livability</th>
<th>Time of Day Flexibility</th>
</tr>
</thead>
</table>
| **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

<table>
<thead>
<tr>
<th>CURB USE</th>
<th>Land Use Context</th>
<th>Interface with other Modes and Other Curb Uses</th>
<th>Resilience &amp; Livability</th>
<th>Time of Day Flexibility</th>
</tr>
</thead>
</table>
| 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

<table>
<thead>
<tr>
<th>CURB USE</th>
<th>Land Use Context</th>
<th>Interface with other Modes and Other Curb Uses</th>
<th>Resilience &amp; Livability</th>
<th>Time of Day Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parklets, Seating, and Dining Spaces</td>
<td>• Appropriate in commercial, mixed-use areas.</td>
<td>• Provides traffic calming benefits. • Useful to people waiting for transit.</td>
<td>• Increases street activity, liveliness, general safety.</td>
<td>• Not flexible • Typically in effect 24/7 due to the need for furniture.</td>
</tr>
<tr>
<td>Trees &amp; Green Infrastructure</td>
<td>• Appropriate in all contexts • Need for green infrastructure driven by topography, city-wide flooding issues.</td>
<td>• Traffic calming benefits all street users. • Trees can provide shade for transit users.</td>
<td>• Green infrastructure provides key resilience benefits • Plantings enhance beauty of the City</td>
<td>• Not flexible • In place 24/7</td>
</tr>
<tr>
<td>Curb Extensions</td>
<td>• Appropriate in all land use contexts, especially areas with high pedestrian activity.</td>
<td>• 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).</td>
<td>• Improves pedestrian safety and comfort • Enhances livability of neighborhoods</td>
<td>• Not flexible • In place 24/7</td>
</tr>
</tbody>
</table>
## Design Considerations for ‘Storage’ Curb Uses

<table>
<thead>
<tr>
<th>Curb Use</th>
<th>Land Use Context</th>
<th>Interface with other Modes and Other Curb Uses</th>
<th>Resilience &amp; Livability</th>
<th>Time of Day Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term parking</td>
<td>• Appropriate in low-density residential, industrial areas.</td>
<td>• Parking lanes provide opportunity for curb extensions at crosswalks.</td>
<td>• Need to consider flood maps.</td>
<td>• Flexible&lt;br&gt;• Can be in effect off-peak to serve overnight residential parking needs or 24/7</td>
</tr>
<tr>
<td>Bus layoverspace</td>
<td>• Appropriate in all contexts. • Need determined by bus routing and staging needs.</td>
<td>• Need to consider bus-bike conflicts.</td>
<td>• Necessary for efficient transit operations.</td>
<td>• Not flexible&lt;br&gt;• Typically in effect 24/7</td>
</tr>
<tr>
<td>Construction staging</td>
<td>• Appropriate in all contexts. • Need determined by availability of on-site construction staging space</td>
<td>• Need to provide safe pedestrian and bike routes through/around construction site. • Need to consider how construction vehicles interact with space.</td>
<td>• Often necessary to construct large, dense buildings that enhance vibrance of City</td>
<td>• Not flexible&lt;br&gt;• Typically in effect 24/7 for the duration of construction.</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is the modal emphasis?</td>
<td>Transit and Pedestrian.</td>
</tr>
<tr>
<td>2. Is it in a Multimodal Center?</td>
<td>Yes</td>
</tr>
<tr>
<td>3. What is the land use context?</td>
<td>Mixed use and commercial.</td>
</tr>
</tbody>
</table>

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 order of curb space priorities in this hypothetical example is shown in the first column.

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.
**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.

<table>
<thead>
<tr>
<th>Example Curb Priorities and Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Pedestrian and transit mobility</strong></td>
</tr>
<tr>
<td>Curb uses: Bus stops Bus lanes Queue jumps Curb extensions</td>
</tr>
<tr>
<td><strong>2. Access for people</strong></td>
</tr>
<tr>
<td>Curb uses: Taxi/for-hire vehicle zone Bike/scooter parking Short-term parking</td>
</tr>
<tr>
<td><strong>3. Access for goods</strong></td>
</tr>
<tr>
<td>Curb uses: Truck loading zones</td>
</tr>
<tr>
<td><strong>4. Amenities</strong></td>
</tr>
<tr>
<td>Curb uses: Seating/dining Plantings Green infrastructure</td>
</tr>
<tr>
<td><strong>5. Storage</strong></td>
</tr>
<tr>
<td>Curb uses: Bus layover/staging Construction staging Long-term parking</td>
</tr>
</tbody>
</table>
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.

A taxi and for-hire vehicle zone is 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.

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.
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**
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 continues 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 infrastructure management.
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 over time. 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 soliciting 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.

**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, policies 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.\(^1\) 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.

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.

<table>
<thead>
<tr>
<th>Procurement Strategy</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-House Developed Solution</td>
<td>• High degree of flexibility</td>
</tr>
<tr>
<td></td>
<td>• Requires additional time and resources of City of Norfolk staff; may impact existing workflows</td>
</tr>
<tr>
<td></td>
<td>• Retain ownership of system and intellectual property rights</td>
</tr>
<tr>
<td></td>
<td>• High costs and extended timeline</td>
</tr>
<tr>
<td></td>
<td>• Ability to sell product to other jurisdictions and agencies</td>
</tr>
<tr>
<td>Vendor Supported Custom Solution</td>
<td>• High degree of flexibility</td>
</tr>
<tr>
<td></td>
<td>• Efforts led by vendor with the guidance from City of Norfolk</td>
</tr>
<tr>
<td></td>
<td>• Ability to retain ownership of system and intellectual property rights</td>
</tr>
<tr>
<td></td>
<td>• Medium costs and shorter timeline</td>
</tr>
<tr>
<td></td>
<td>• Ability to sell product to other jurisdictions and agencies</td>
</tr>
<tr>
<td>Commercial off-the-shelf (COTS) Solution</td>
<td>• Least degree of flexibility</td>
</tr>
<tr>
<td></td>
<td>• Limited ownership of system and intellectual property rights</td>
</tr>
<tr>
<td></td>
<td>• Lower costs and quicker timeline</td>
</tr>
<tr>
<td></td>
<td>• May not meet technical functionality and requirements for City of Norfolk</td>
</tr>
<tr>
<td></td>
<td>• Likely high additional cost for any add-on functionality outside of COTS product</td>
</tr>
</tbody>
</table>
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 lifecycle 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 disparate 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. One its three focus areas, provides enterprise-wide technology support and solutions to enhance efficiency, strengthen cybersecurity and power 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. 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 applications provide 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
SMART GRID enabled LED streetlight applications aim at reducing energy costs and increases 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 lightning management software monitors performance, energy consumption and fault detection.

Another example of the potential of Smart Lightning 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.
The image below shows the various data sources and potential data marketplaces.

*Data sources will feed third-party apps and data visualization tools*

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 Transit 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 the Department of Public Works in maintaining 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 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 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.

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.
Parking and Curb Space Management

The increase in shared mobility options, such as e-scooters 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 deliveries 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 for a maximum of 500 e-bikes, the current electric scooter share program, parking 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 service, The Tide – light rail service, and ferry service as well as engagement with private mobility sector such as TNCs for a truly multimodal platform. The MaaS solution can also include regional mobility service option such as Williamsburg Area Transit Authority (WATA) buses and integration 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.

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.

The City of Norfolk current collects, formats, processes and maintains various data

---

**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
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.

Public agency clients of Dataminr 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.

**Company:** Dataminr  
**Established:** 2009  
**Headquarters:** New York, NY  
**Technology:** Artificial intelligence to provide real-time information alerts to client  
**Website:** [www.dataminr.com](http://www.dataminr.com)
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.

### Location-Based Services Data

<table>
<thead>
<tr>
<th>Company</th>
<th>Established</th>
<th>Headquarters</th>
<th>Technology</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waze</td>
<td>2006</td>
<td>Palo Alto, CA</td>
<td>GSP navigation software and trip planning</td>
<td><a href="http://www.waze.com">www.waze.com</a></td>
</tr>
</tbody>
</table>

### Location-Based Services Data Sources

<table>
<thead>
<tr>
<th>Location-Based Services</th>
<th>Data Sources</th>
<th>Methodology</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replica</td>
<td>Publicly available census data; mobile location data, and point-of-interest (POI) transaction data</td>
<td>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</td>
<td>Synthetically generated representation of the activities and movement; data download and dashboard</td>
</tr>
<tr>
<td>SafeGraph</td>
<td>Telecommunication device-based data</td>
<td>Analyze GPS location data with POI geofences to determine if a device visited a place, brand, or type of store</td>
<td>Store visitor demographics; data download and dashboard</td>
</tr>
<tr>
<td>Streetlight</td>
<td>Data from SafeGraph; major navigation-GPS data supplier, INRIX, and one LBS data supplier provider Cuebiq</td>
<td>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</td>
<td>Travel pattern metrics; interactive maps and charts within the platform, or downloaded</td>
</tr>
</tbody>
</table>
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 as 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.
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.

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.
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.
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 top-right. 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 top-left. 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 release the Draft Recommended Network and asked the public, stakeholders, and transit riders for feedback about the new design. That feedback resulted in a Final Revised Network presented in this plan.

Why consider changing the bus network in Norfolk? The map at the right shows the Existing 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.
**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**

**Walking vs. Waiting: Which do you prefer?**

- Prefer a shorter walk to the bus stop but a longer wait: 10%
- I’d do whatever gets me to my destination soonest: 57%
- Prefer a longer walk to the bus stop for a shorter wait: 33%

---

**Public Feedback**

**Walking vs. Waiting: Which do you prefer?**

- Minimize walking: 22%
- Minimize waiting: 78%

**Which of the following statements do you agree with most?**

- Definitely prefer shorter walks! 10%
- I’m not sure/no preference 9%
- I usually prefer shorter walks 6%

- 39%
- I usually prefer shorter waits 36%

- I’ll do whatever it takes to reach my destination soonest - even if it means a long walk.
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.

Stakeholder Feedback

Which of the following statements do you agree with most?

<table>
<thead>
<tr>
<th>Shift to wider coverage (lower frequencies, shorter spans, lower ridership)</th>
<th>Shift a little bit towards higher frequencies and higher ridership</th>
<th>Shift a lot towards higher frequencies and higher ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>48%</td>
<td>43%</td>
</tr>
</tbody>
</table>

Public Feedback

Which Scenario comes closer to serving your values?

<table>
<thead>
<tr>
<th>I strongly prefer the High Coverage scenario</th>
<th>I'm not sure</th>
<th>I strongly prefer the High Frequency scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>11%</td>
<td>20%</td>
<td>21%</td>
</tr>
</tbody>
</table>

I like the High Coverage scenario but think it goes too far

I like the High Frequency scenario but think it goes too far

DRAFT
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 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 Ridership and Coverage Concepts, the graphic to right 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.
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.
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.
- Adding the new Route 3 adds cost. To partially offset that cost, the Revised New Network has a short-turn of the every 15 minute service on Route 2 at Old Dominion University, so that Hampton Boulevard from ODU to the Navy Exchange has 30 minute service. This frequency is the same as today’s service level.
- With the new Route 3 on portions 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 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.
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 along Hampton Boulevard from ODU to Norfolk Naval Station to every 15 minutes.
- Increased frequency for Route 8 on Tidewater Drive, Oceanview West, 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.

1 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.
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.
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.

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.

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.
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. 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.

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.
Chapter 12: Multimodal Needs Assessment

Figure 12-7: Map of Pedestrian Needs Analysis Results

Figure 12-7: Map of Bicycle & Scooter Needs Analysis Results
Transit Needs

Transit needs were identified based on a combination of public comments during the various rounds of 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

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 add up to a list of potential projects that are much greater than can 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 list of improvement projects that, if constructed, will meet the highest needs for safer walking, bicycling, scootering, and transit.

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 process for translating these comments into a list of improvement projects is described below.

The current program of 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 https://bit.ly/3FCPtny. As shown in the charts to the top right, 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 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**.

The projects in **Figures 13-1 through 13-3** can be viewed in an online scalable map on the City of Norfolk’s website.¹

**Appendix G** shows the projects in the draft 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.

**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.

The steps in this diagram are described in the subsequent sections following Figure 13-4.
**Figure 13-4: Project Funding Cycle Diagram**

- **Project Review**
  - Review results of application:
    - Incorporate lessons learned from application into strategic development of future projects
  - Project Funded
  - Project Not Funded

- **Need Review**
  - Review the need for the project:
    - Identify source of project
    - Identify need ranking of project
    - Identify other considerations
  - Lessons Learned

- **Project Application**
  - Apply for funding based on:
    - Required application elements
    - Coordination with agencies
    - Funding matches
  - Project Development

- **Project Development**
  - Develop the project based on application requirements:
    - Documentation of demand or need for project
    - Preliminary design of project
    - Preliminary cost estimates

- **Strategic Development**
  - Identify potential funding options based on:
    - Eligibility of project type
    - Eligibility of project timing
    - Other eligibility requirements
  - Financial consideration:
    - Preferred funding option
  - Identify optimal funding option based on:
    - Capacity of funds in the program
    - Synergy with other projects
    - Availability of staff resources
    - Special requirements (e.g., local match)
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 13-5: Funding Compatibility Matrix

<table>
<thead>
<tr>
<th>FUNDING PROGRAM</th>
<th>PROJECT TYPE (Capital improvements Only)</th>
<th>LOCAL</th>
<th>AUTO</th>
<th>BIKE</th>
<th>PED</th>
<th>BIKE/PED</th>
<th>TRANSIT</th>
<th>BIKE/TRANSIT</th>
<th>PED/TRANSIT</th>
<th>BIKE/PED/TRANSIT</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals and Intersections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Streets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADA Ramps *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Repair **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighborhood Streets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Paul’s Road Infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Proffers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VDOT/REGIONAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart Scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSIP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation Alternatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State of Good Repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue Sharing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMAQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSTP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MISC. DRPT PROGRAMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FEDERAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUILD Grants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Grants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Not eligible
- Eligible only
- Eligible and preferred

* Eligible under Revenue Sharing Program
** Eligible under RSTP Program
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.
1 The current map of candidate and committed projects is available at https://bit.ly/3FCPtnv.
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 will require several logical steps to translate a list of candidate projects into built improvements that improve the quality of life of Norfolk’s citizens. Broadly this process involves 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 short list priority of projects for funding in the near- to mid-term timeframe.
With a list of priority projects that is scaled to anticipated funding availability in the coming years, the city staff can proceed with funding applications for projects in a systematic manner, knowing that they are based on the greatest needs as outlined in this plan.

This process mirrors what Metropolitan Planning Organizations are required to do under federal guidelines. It is essentially the process of developing a constrained funding program in which projects are prioritized and fit into an anticipated funding projection and time horizon. 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 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 estimates 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

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>Estimate of Annualized Funding from Past Years</th>
<th>10 Year Projection Based on Annualized Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Improvement Program (2)</td>
<td>$12.4 m</td>
<td>$124 m</td>
</tr>
<tr>
<td>State Funding Programs (3)</td>
<td>$9.7 m</td>
<td>$97 m</td>
</tr>
<tr>
<td>Specialized Federal Funding Programs (4)</td>
<td>0.3 m</td>
<td>$3 m</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$22.4 m</strong></td>
<td><strong>$224 m</strong></td>
</tr>
</tbody>
</table>

(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

Once a time horizon and anticipated funding estimate for that horizon have been developed, it is possible to start assigning priority projects to that anticipated funding. However, in order to do this, it is necessary to develop planning-level cost estimates for the candidate projects. These cost estimates are necessarily rough and do not involve preliminary design or engineering. They usually involve 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 will need to be done for the entire list of candidate projects. 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

Once the planning level cost estimates have been developed for each of the candidate projects, they can be used to develop a funding-constrained list of priority projects for the next 10 years. This process involves using the need rankings of each project and adding up the project costs for each of the top ranked projects until the total reaches the 10-year estimates of available funds. It is a basic budgeting process of fitting as many projects as possible into an anticipated budget while using their need rankings to ensure that the list includes the top ranked projects.

The graphic to the right shows how this process works. Candidate projects that have planning level cost estimates attached to them are ranked according to their needs score. Then they are fitted into the bucket of anticipated available funding over the next 10 years. The result is a short list of projects that might be fundable over the next decade.

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.
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.