



Naval Station Norfolk Transit Extension Study Norfolk, Virginia

FINAL REPORT

May 2015





Draft Final Report

Naval Station Norfolk Transit Extension Study

Norfolk, Virginia

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May 2015

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- Appendix C Tier 1 Screening Evaluation Technical Memorandum
- Appendix D Station Service Area Analysis Maps
- Appendix E Traffic Analysis Methodology

Section 1
Executive Summary



1.0 EXECUTIVE SUMMARY

Hampton Roads Transit (HRT), the City of Norfolk, and the citizens of Norfolk and Hampton Roads are partnering to study the feasibility of extending fixed guideway transit to Naval Station Norfolk (NSN). This study, the Naval Station Norfolk Transit Extension Study (NSNTES), is looking at the potential opportunities, benefits, and impacts of a fixed guideway transit connection between The Tide, NSN, and other key destinations in the City.

1.1 INTRODUCTION

The efficient movement of military and civilian personnel to NSN is critical for national military readiness as well as for achieving the economic development goals of the City of Norfolk. NSN is the largest naval base in the world and is the region's largest employment center - between 60,000 to 70,000 people may be working at NSN and nearby facilities at any given time. As part of the region's daily commuting patterns, automobile travel demand to the base regularly exceeds the capacity of the surrounding streets and highways, including Hampton Boulevard, Terminal Boulevard, W. Little Creek Road, I-64, and I-564. Delay on these roadways is expected to worsen over time. Efficient, high-capacity transit would provide an alternative to automobile travel and a way for employees to avoid daily congestion around NSN. A transit extension connecting NSN to The Tide would leverage the significant investment the region has made in fixed guideway transit and offer the region's residents multiple mobility options to the largest employment center.

The NSNTES is also examining the transportation needs of other key destinations in Norfolk, including Old Dominion University (ODU), Ghent-area commercial and retail on Colley Avenue and 21st Street, Norfolk International Airport, the Lake Wright Business Park, the Military Highway commercial and retail corridor, and other adjacent local communities. Additional mobility choices can enhance Norfolk's economic potential by improving access to employment and activity centers and by creating transit-oriented development (TOD) opportunities. This effort supports local and regional plans and policies, including Norfolk's general plan, known as plaNorfolk2030, and the Virginia Department of Rail and Public Transportation's Hampton Roads Regional Transit Vision Plan, with both calling for a balanced, multi-modal transportation system.

1.2 STUDY PROCESS

The NSNTES was completed in two phases referred to as Tier 1 and Tier 2. The Tier 1 phase began with an initial set of public meetings in June 2013 to identify issues and opportunities arising from connecting The Tide to NSN. The results of these meetings led to the development of a draft of the NSNTES' *Purpose and Need* statement and a set of seven project themes. The *Purpose and Need* statement is shown in its entirety in Section 2.1.2 on page 2-2, but the core message is that the NSNTES would be:

“An efficient, high-capacity transit connection to Naval Station Norfolk would provide an alternative to driving in congested traffic to access NSN” and that the NSNTES would:

“...Create a more multi-modal transportation system that helps support the region’s economic competitiveness.”

The project themes accompany the *Purpose and Need* statement in defining the goals of the NSNTES by identifying what a transit extension to NSN should accomplish. The project themes are:

1. The transit extension should connect many points within Norfolk, not just the Naval Station.
2. The transit extension should provide an alternative to heavy traffic and congestion.
3. A fixed guideway transit connection between The Tide and NSN should make travel time more reliable.
4. The transit extension should provide parking for transit riders.
5. The transit extension should connect to other transit modes.
6. Planning for the transit extension should ensure it can be expanded in the future.
7. Identify environmental impacts, right-of-way constraints, economic development and neighborhood revitalization, and resiliency.

A second set of public meetings held in September 2013 refined the *Purpose and Need* statement and project themes, ranked the study priorities, located key activity centers, and identified preferred study corridors and 17 preliminary conceptual alignments as shown on the following page in **Figure 1**.

Following the September 2013 meetings, a set of technical evaluation criteria were developed based on public input and the project themes. The Tier 1 screening analyzed the 17 preliminary conceptual alignments using data from HRT, the City of Norfolk, and other sources. The results of the analysis were presented to the public in set of workshops in February/March 2014. Based on public feedback from the February/March 2014 workshops, the technical analysis of the alignments, and input from HRT and the City of Norfolk, a subset of six conceptual alignments (shown in **Figure 3**) were advanced to the Tier 2 screening phase.

The Tier 2 screening of the conceptual alignments included an analysis of potential station service areas and right-of-way along each alignment, preliminary ridership forecasts, potential environmental impacts, and traffic effects of each alignment on selected intersections. After the completion of the Tier 2 technical analysis, the six alignments and accompanying results were presented to the public in a series of workshops in October 2014. Based upon public input at the October 2014 workshops and review by HRT, five options were presented as potential options for advancement to the next stage in the transit study. The five options are shown in **Figure 4** through **Figure 8**.

Figure 1. Alignments for Tier 1 Screening Analysis



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Alignment 1a, 1b, & 1c
- Alignment 2a & 2b
- Alignment 3a, 3b, & 3c
- Alignment 4a, 4b, & 4c
- Alignment 5a & 5b
- Alignment 6
- Alignment 7a & 7b
- Alignment 8
- Shuttle Connection to Airport

0 0.25 0.5 1 1.5 2 Miles

1.3 STUDY MILESTONES

Figure 2 below displays the major study milestones throughout the project’s timeline.

Figure 2. Overall Study Process and Schedule

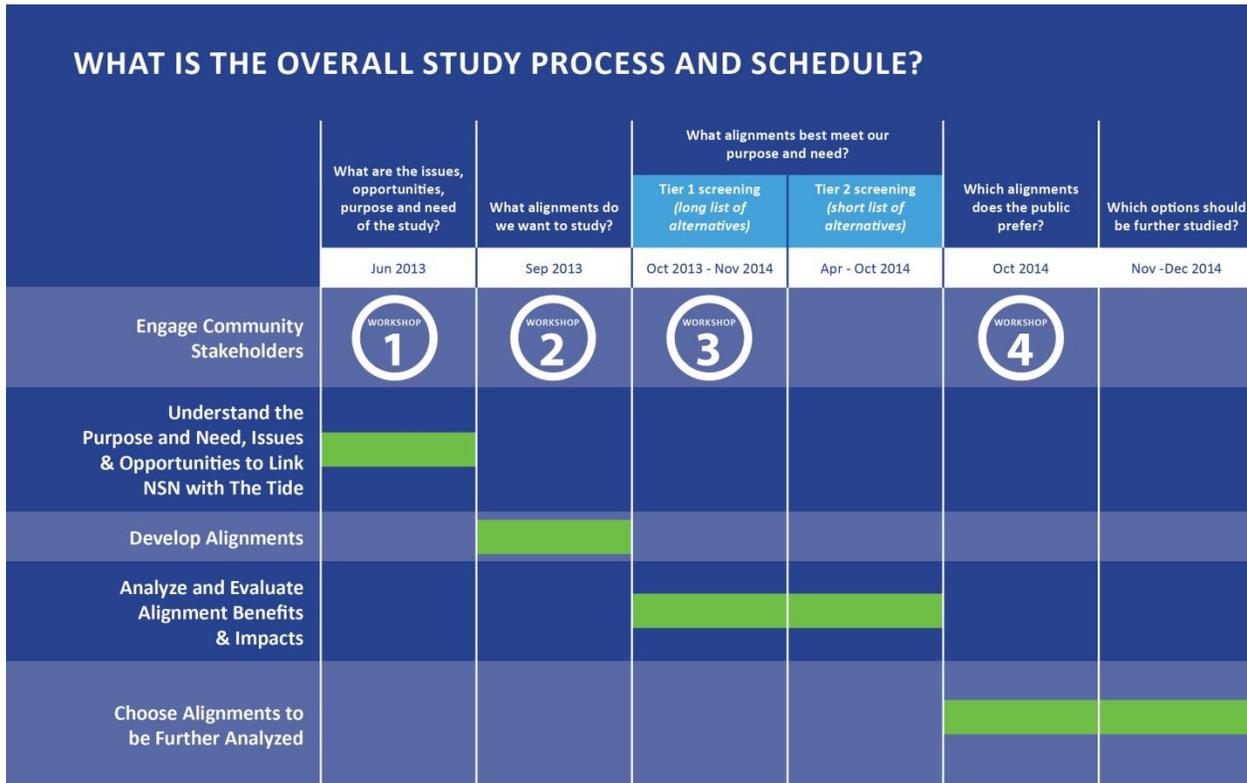


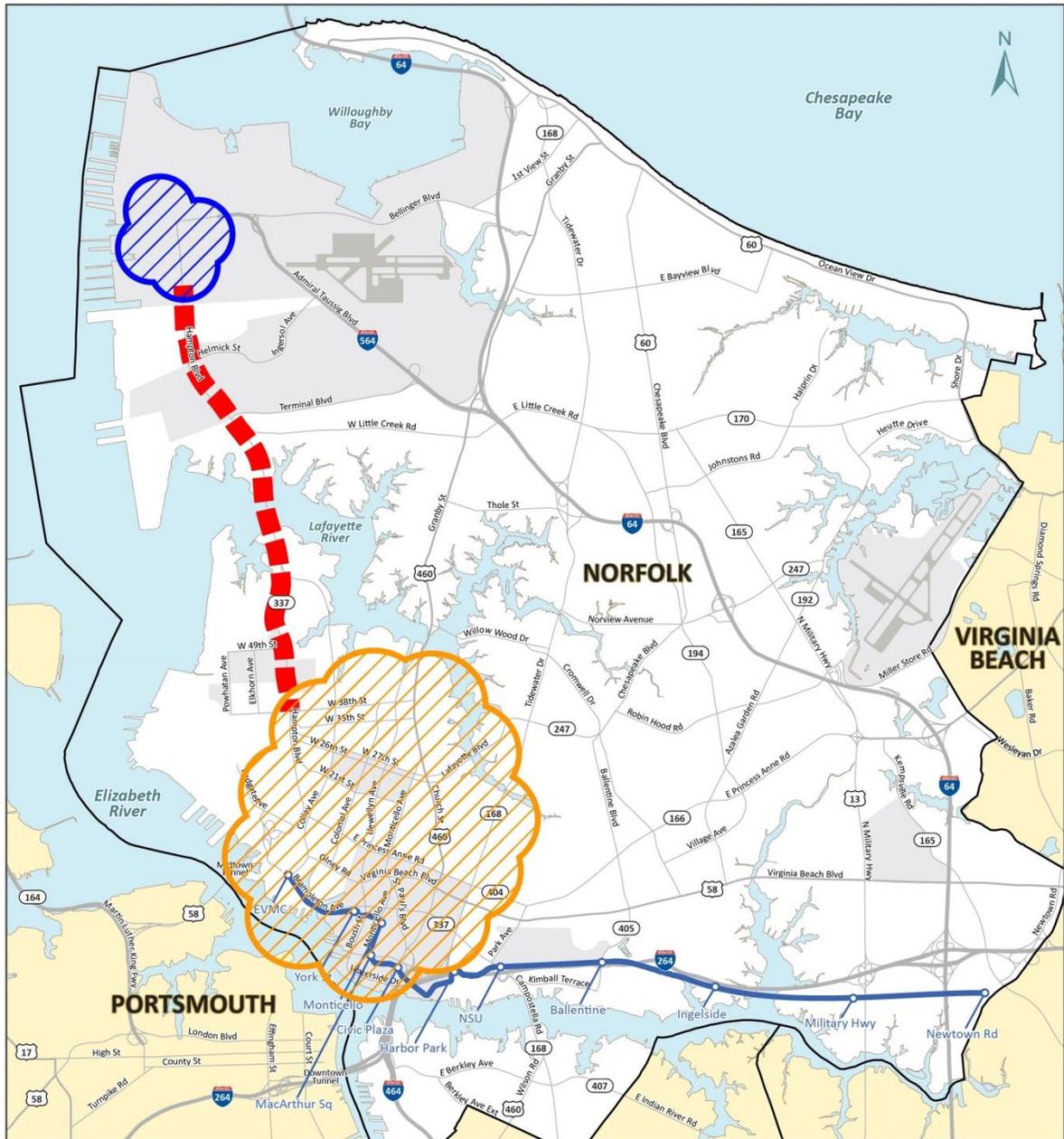
Figure 3. Alignments for Tier 2 Screening Analysis



LEGEND

City Boundary	Western Alignment	Eastern A Alignment
Tide Light Rail	Central A Alignment	Eastern B Alignment
Tide Light Rail Stations	Central B Alignment	
	Central C Alignment	

Figure 4. Option 1

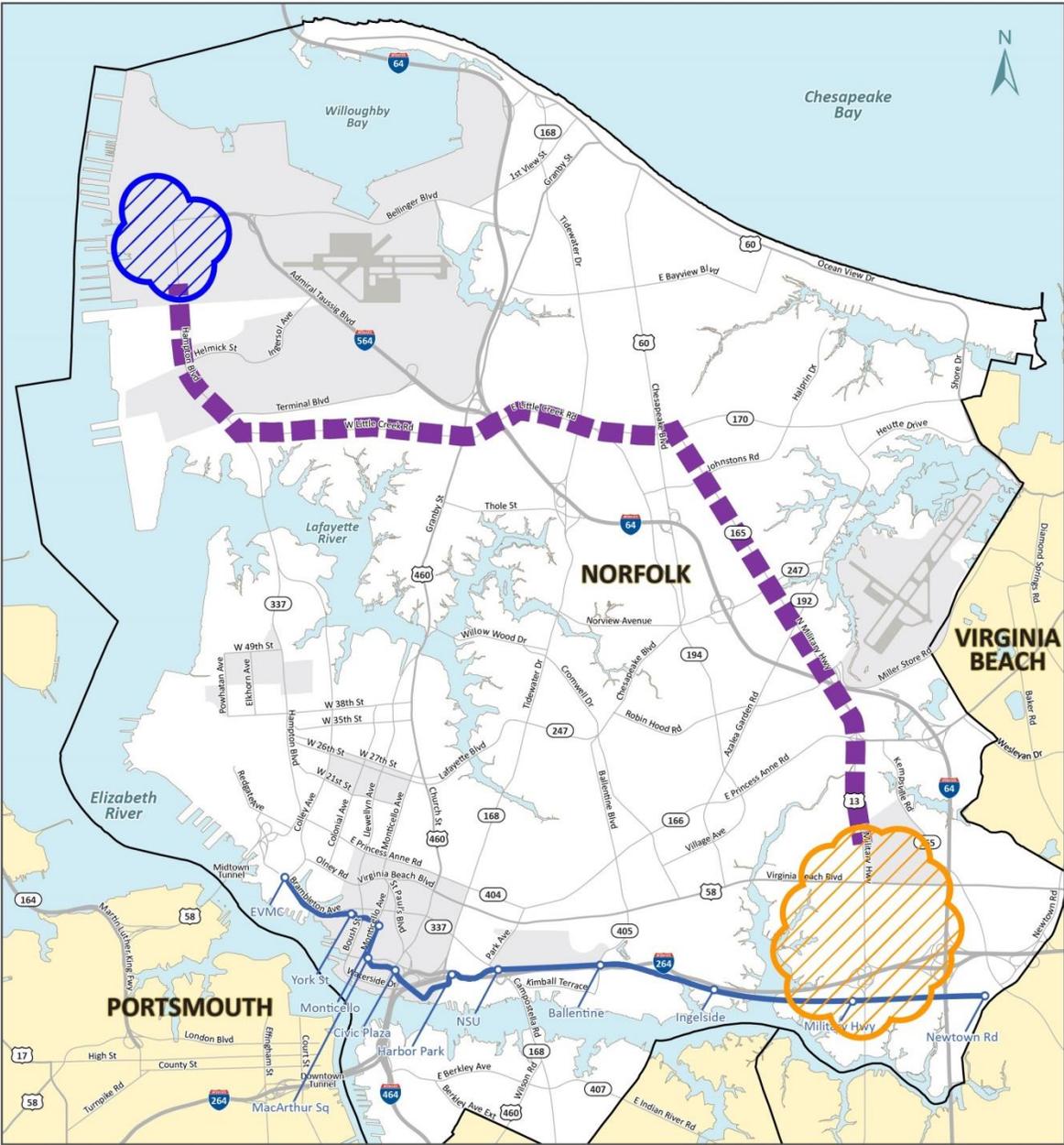


LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Connection to The Tide to be determined
- Connection to NSN to be determined



Figure 5. Option 2

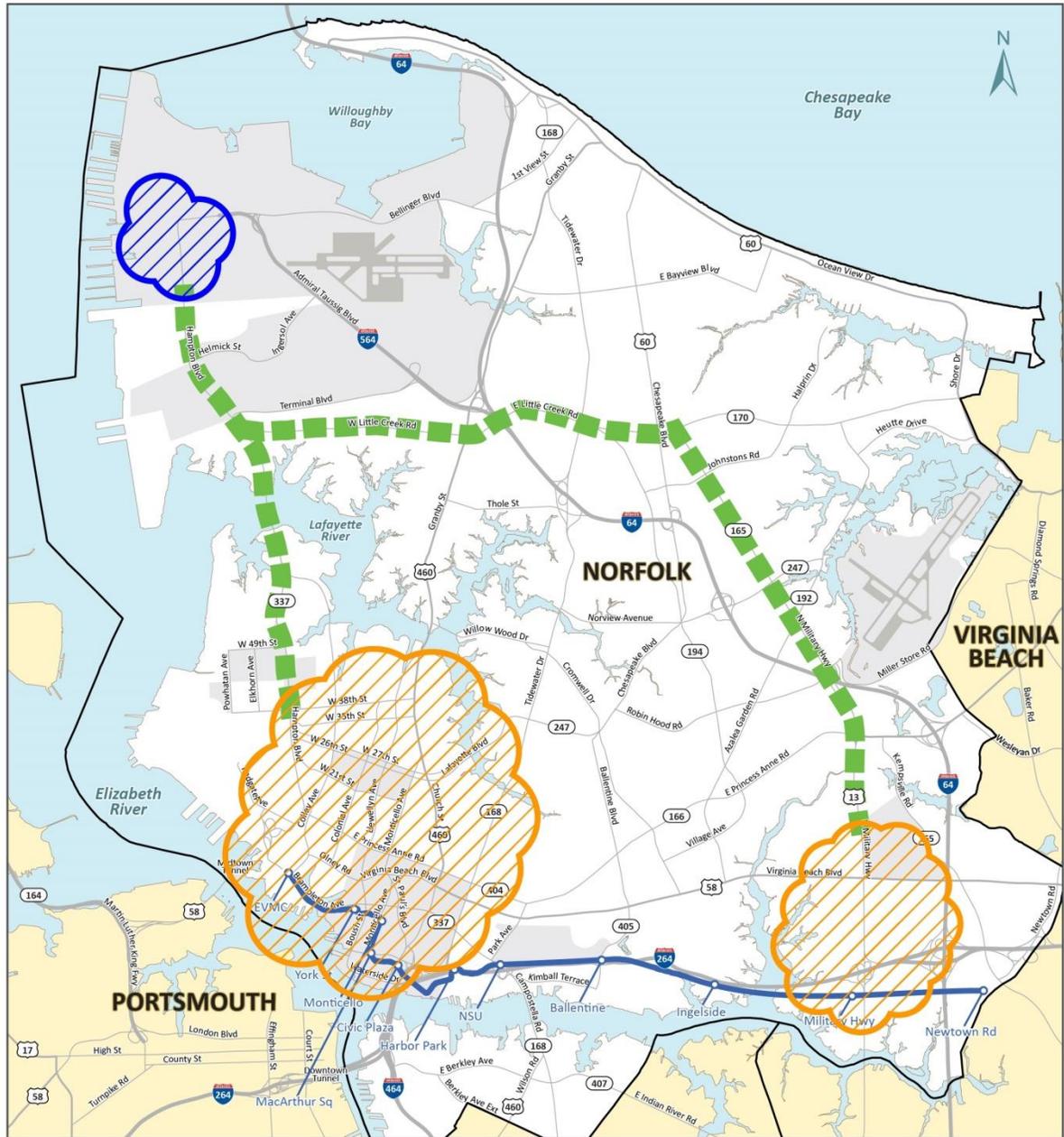


LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Option 2
- Connection to The Tide to be determined
- Connection to NSN to be determined

0 0.25 0.5 1 1.5 2 Miles

Figure 6. Option 3

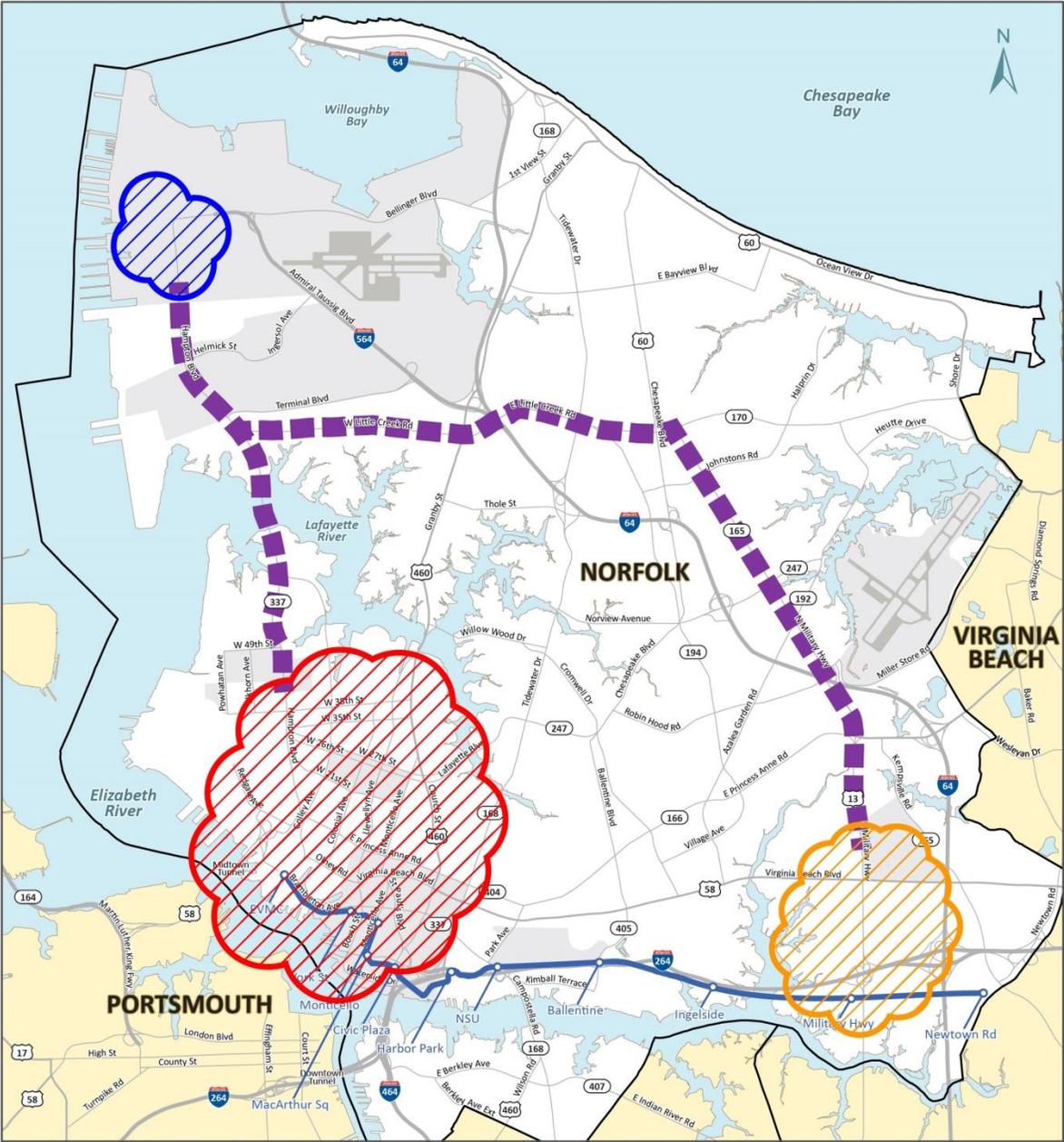


LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Option 3
- Connection to The Tide to be determined
- Connection to NSN to be determined



Figure 7. Option 4

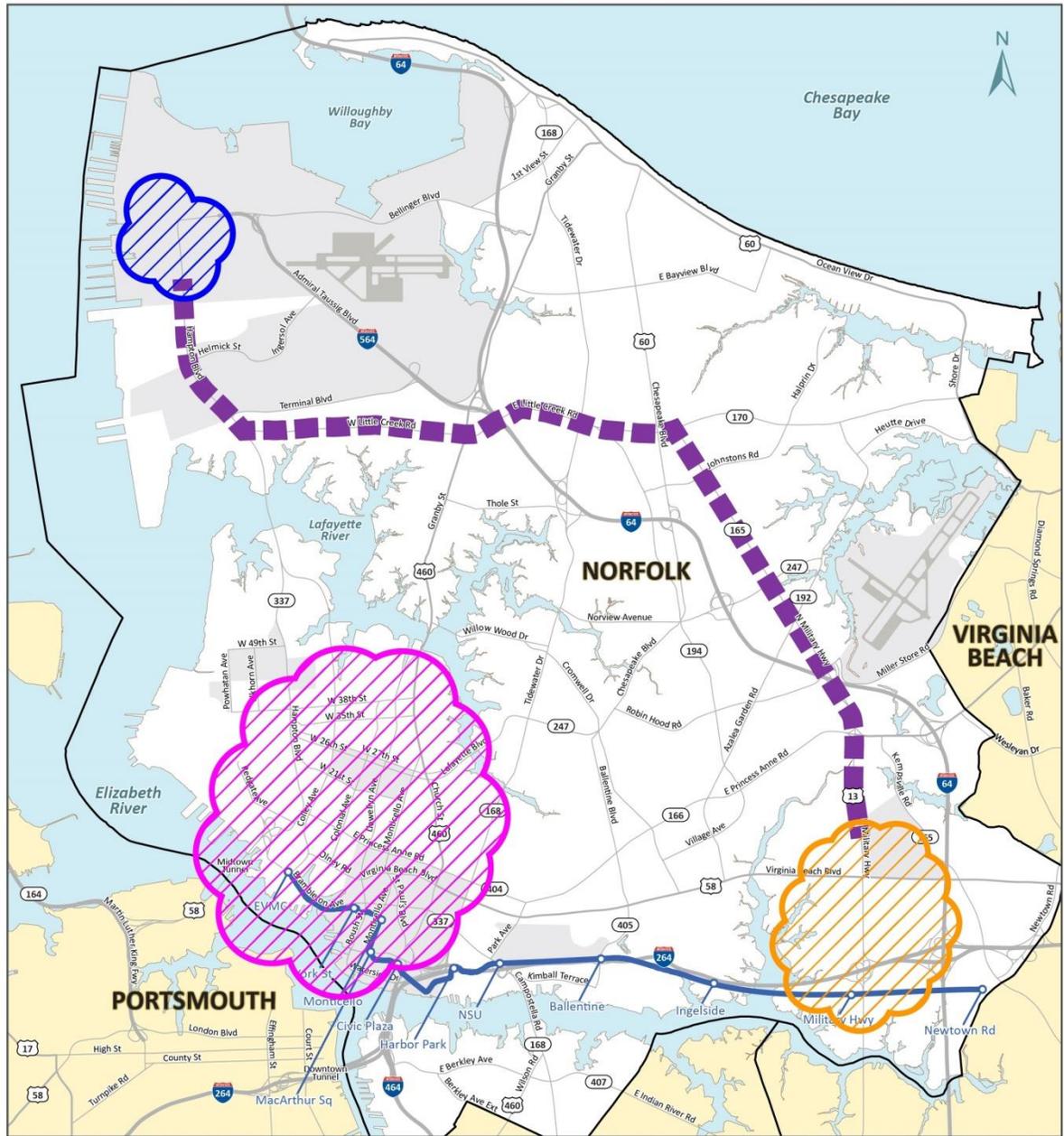


LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Option 4
- Connection to The Tide to be determined
- Connection to NSN to be determined
- Streetcar/bus/shuttle connection to ODU/Ghent to be determined



Figure 8. Option 5



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations



Option 5



Connection to NSN to be determined



Connection to The Tide to be determined



LRT/streetcar connection to ODU/Ghent to be determined



Section 2
Tier 1 Screening of Alignments



2.0 TIER 1 SCREENING OF ALIGNMENTS

The goal of the Tier 1 screening process for the NSNTES was to evaluate the set of unconstrained, conceptual alignments and to establish a short list of the most feasible and community-supported alignments for a more detailed technical evaluation. The Tier 1 screening process included three sets of public meetings that helped define the NSNTES *Purpose and Need* statement, identify the project themes, locate key activity centers, develop an initial set of 17 alignments, create a set of evaluation criteria, analyze the alignments, and select a subset of the most feasible and promising alignments for more detailed analysis as part of the Tier 2 screening process.

2.1 DEVELOPMENT OF THE PURPOSE AND NEED

As defined by the US Department of Transportation, the purpose and need of a project is essential in establishing a basis for the development of the range of reasonable alternatives required in an environmental impact statement and assists with the identification and eventual selection of a preferred alternative¹. The *Purpose and Need* statement helps guide a project through the planning process, serves to provide the basis for the development of alternatives and the eventual selection of a preferred alternative. Soliciting and incorporating public input is a key component in developing a *Purpose and Need* statement, and the NSNTES held a series of meetings in June 2013 that asked the public to comment on a potential transit extension.

2.1.1 June 2013 Public Meetings

The City of Norfolk and HRT conducted the first set of public meetings in June 2013 to solicit public input to help HRT define the project's *Purpose and Need* statement and to identify the project's themes. The *Purpose and Need* public workshops were held on June 12 at Blair Middle School, June 17 at Granby High School, and June 19 at the Hilton Norfolk Airport. The public workshops were held on three different dates and locations in order to provide multiple opportunities for public participation. Approximately 100 community members participated in the June workshops. Workshop attendees watched a PowerPoint presentation given by HRT to learn about the scope, goals, and timeline for the study. Attendees then broke into small groups (see **Figure 9**) to answer two questions:

1. What are the travel needs or problems between The Tide (and any future extension of The Tide) and Naval Station Norfolk?
2. What goals would a successful transit system to NSN need to achieve?

¹ <http://environment.fhwa.dot.gov/projdev/tdmelements.asp>

Each breakout group of 7-10 people was facilitated by a member of the NSNTES team. Each group identified a reporter to record key discussion points on both questions. Groups spent fifteen minutes on each of the two questions, and then were asked to identify their top two priorities for each question. At the close of the meeting, each group reported to all attendees their top two priorities for both questions.

Figure 9. June 2013 Public Meeting Break Out Group



Members of the public were encouraged to record their thoughts, concerns, and suggestions on the comment sheets provided at the registration tables. Those in attendance were informed that comments would be featured on Open City Hall, an online civic engagement tool the City of Norfolk is making available for this study. Members of the public were also informed that they could directly enter their feedback online at the NSNTES website. A complete summary of the June 2013 public meetings and all other public involvement activities for the NSNTES can be found in **Appendix A**.

2.1.2 Purpose and Need Statement

The initial set of public meetings in June 2013 helped HRT produce the NSNTES' *Purpose and Need* statement, which is:

NSN is the largest naval base in the world and is the region's largest employment center. The efficient movement of military and civilian personnel to and from NSN is critical for regional military readiness and for maintaining the ability to meet national military strategic demands. Most days, as many as 60,000 to 70,000 people come to work at NSN, and most access the base by driving. On most days, high automobile traffic volumes create congestion during the peak commuting hours and along the surrounding streets and highways (Interstate 64/564, Hampton Boulevard, Terminal Boulevard, and W. Little Creek Road). This congestion is projected to worsen over time as surrounding areas continue to develop. **An efficient, high-capacity transit connection to Naval Station Norfolk would provide an alternative to driving in congested traffic to access NSN.**

This study supports local and regional visions set out by plaNorfolk2030 (The City of Norfolk's General Plan) and the Virginia Department of Rail and Public Transportation (DRPT) Regional Transit Vision Plan **to create a more multi-modal transportation system that helps support the region's economic competitiveness.** Additional mobility options enhance Norfolk's economic potential by linking more residents to employment and activity centers and by fostering more sustainable (transit-supportive) land development patterns. This proposed project will develop a high-capacity transit connection that will support key regional activity centers, potentially including key destinations as downtown Norfolk, Old Dominion University, Ghent-area commercial uses in the

Colley Avenue and 21st Street corridors, Norfolk International Airport, Lake Wright Business Park, and the Military Highway corridor.

2.1.3 Project Themes

The project themes accompany the *Purpose and Need* statement in defining the goals of the NSNTES by identifying what a transit extension to NSN should accomplish. The project themes were developed based on the answers to the two questions asked during the June 2013 meetings, public feedback received on comment sheets, and through discussions at the meetings. The results of the public input at the June 2013 meetings helped identify and formulate the major themes of the NSNTES:

1. The transit extension should connect many points within Norfolk, not just the Naval Station.
2. The transit extension should provide an alternative to heavy traffic and congestion.
3. A fixed guideway transit connection between The Tide and NSN should make travel time more reliable.
4. The transit extension should provide parking for transit riders.
5. The transit extension should connect to other transit modes.
6. Planning for the transit extension should ensure it can be expanded in the future.
7. Identify environmental impacts, right-of-way constraints, economic development and neighborhood revitalization, and resiliency.

The seventh theme was added by HRT after the June 2013 meetings because of the importance those criteria would have during the alignment evaluation process.

2.2 DEVELOPMENT OF TRANSIT CORRIDORS AND PRELIMINARY CONCEPTUAL ALIGNMENTS

After the June 2013 public meetings, the next step in the project was to develop transit corridors and preliminary conceptual alignments that would meet the NSNTES' *Purpose and Need* statement and themes. These alignments would serve as the set of unconstrained, conceptual ideas that would be assessed in the Tier 1 technical evaluation process.

2.2.1 September 2013 Public Meetings

The second set of public workshops was conducted in September 2013. HRT considered public feedback from the September workshops in the development of potential transit corridors and the refinement of the *Purpose and Need* statement for extending The Tide to NSN. Public workshops were held on September 10 at the Holiday Inn Greenwich Road, September 11 at Norview High School, and September 12 at ODU. Approximately 200 community members participated in the workshops.

Workshop attendees watched a brief PowerPoint presentation given by HRT about the study and the results of the first round of public meetings and then broke into small groups to complete three interactive workshop activities as follows:

1. **Ranking Study Priorities:** Using stickers, attendees ranked the importance of the priorities identified during the June workshops.
2. **Identify Connectivity-Critical Areas/Locations:** Using a large map of Norfolk and push pins, attendees identified areas most in need of premium transit service (green pins), as well as areas to avoid (red pins).
3. **Identify Preferred Corridors:** Using string and without the constraint of existing city roads, attendees connected The Tide to NSN and other key destinations and activity centers.

Members of the NSNTES team facilitated each breakout group of 7-10 people. A reporter was identified in each group and asked to report back on the top corridor preferences at the conclusion of the interactive activities. The results of the September 2014 meetings were a list of areas that the public felt most needed premium transit access, locations to avoid, a set of potential alignments, comments on the draft *Purpose and Need* statement, and a ranking of the project themes. Each of these elements were reviewed by the study team and used to develop the initial set of 17 conceptual alignments.

2.2.2 Description of Preliminary Conceptual Alignments

After removing duplicates, summarizing the results, and incorporating comments from City of Norfolk staff and key stakeholders, a total of 17 discrete conceptual alignments were identified. The alignments were grouped based on their geographic location within Norfolk (western corridor, central corridor, or eastern corridor), as described below. The conceptual alignments assumed that The Tide would be extended to NSN using light rail technology; however, other technologies such as streetcar or bus rapid transit remain under consideration.

Western Alignments: These eight alignments would connect NSN to the west side of Norfolk. These alignments would serve downtown, Ghent, West Ghent, ODU, Norfolk International Terminals, and other neighborhoods and business districts.

Central Alignments: These five alignments would connect central Norfolk (primarily areas east of the Lafayette River) to NSN. Areas that would be serviced include downtown, Ghent, Wards Corner, and other neighborhoods and business districts.

Eastern Alignments: Four alignments were identified in the Military Highway/I-64 Corridor on the eastern side of Norfolk. These alignments would serve the Military Highway commercial area, JANAF, Norfolk International Airport, and Wards Corner.

All alignments would have the potential to connect many activity centers in Norfolk, attract new transit riders, and provide an alternate means to and from NSN. Depending on the route, the alignments would provide varying levels of direct access and mobility to/from NSN and downtown Norfolk, and this would affect each alignment's ability to attract riders. The alignments would enable connections that would expand the regional transit network, provide increased interconnectivity between transit modes, and support development of adjacent Park & Ride lots.

Figure 10 displays a map of the 17 Tier 1 alignments. **Appendix B** includes a report that provides additional detail on the conceptual alignments studied.

Figure 10. Alignments for Tier 1 Screening



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Alignment 1a, 1b, & 1c
- Alignment 2a & 2b
- Alignment 3a, 3b, & 3c
- Alignment 4a, 4b, & 4c
- Alignment 5a & 5b
- Alignment 6
- Alignment 7a & 7b
- Alignment 8
- Shuttle Connection to Airport



2.3 TIER 1 TECHNICAL EVALUATION

The goal of the Tier 1 screening process for the NSNTES was to evaluate the set of unconstrained, conceptual alignments shown in **Figure 10** and to establish a short list of the most feasible and community-supported alignments for a more detailed technical evaluation. This was accomplished by using the project themes to create technical evaluation criteria, then analyzing each of the 17 conceptual alignments with local and regional transportation and land use data.

2.3.1 Tier 1 Technical Evaluation Methodology

All alignments were evaluated to understand which would best meet the project's purpose and need and were rated on their potential environmental impacts, economic development benefits, and order-of-magnitude (a planning-based method of determining initial cost estimates) costs.

A number of data sets were used to establish the Tier 1 technical evaluation criteria:

- Regional data
 - Hampton Roads Transportation Planning Organization (HRTPO) Transportation Analysis Zone (TAZ) 2034 socioeconomic data
 - HRTPO analysis of INRIX vehicle data as contained in the 2013 Hampton Roads Regional Travel Time Reliability Study
 - Planned and programmed transportation projects in HRTPO priorities lists
- City of Norfolk data
 - Land use data from plaNorfolk2030
 - Potential environmentally sensitive and historic properties (e.g., parks, historic properties, and wetlands)
- Transit data
 - Existing bus routes in Norfolk
 - Location of existing and potential Park & Ride facilities
- Data identified by the public
 - Location of key regional activity centers identified during the public workshops
 - Preliminary assumptions on length of each alignment in shared right-of-way and in exclusive right-of-way
- Google Traffic historical data

The evaluation criteria reflect the project's *Purpose and Need* statement and the seven themes that were developed through the first two sets of public workshops. Goals such as providing an alternative to heavy traffic and congestion, providing direct access to NSN, meeting the transportation needs within Norfolk, enhancing transit opportunities to activity centers, and reducing travel times to NSN were mentioned by the public.

The project team assigned evaluation criteria to the seven themes as a basis for assessing the alignment options. Part of the process of assigning criteria to themes included choosing a method for evaluating

each criterion and picking the data to use in each evaluation. The themes and evaluation criteria used in the Tier 1 evaluation process are listed in **Table 1**. Detailed discussion of each theme and its criteria follow.

Table 1. Tier 1 Evaluation – Themes and Evaluation Criteria

Theme		Evaluation Criteria
1A	Connect to Many Points within Norfolk	Connect to activity centers
2A	Provide an Alternative to Heavy Traffic and Congestion	Reduce hours of daily roadway congestion
2B		Ability to attract riders
3A	Reduce Travel Time – Make Travel Time More Reliable between Destinations	Opportunity to increase travel time reliability along alignment corridor
3B		Directness of route
4A	Parking – Provide Parking to Accommodate Riders	Proximity to Park & Rides
5A	Interconnectivity of Transit Modes	Ability to connect to other transit services in Norfolk
6A	Future Expansion – Ensure That the System Can Be Expanded in the Future	Ability to leverage other planned regional transportation system projects
7A	Other	Environmental considerations
7B		Right-of-way constraints and project cost
7C		Economic development and neighborhood revitalization
7D		Resiliency

Each conceptual alignment was ranked relative to the rest of the alignments for each criterion in a summary matrix with the following general ratings:

- **“Least Desirable”** - Does not meet the criteria as well as the other alignments – substantial impacts and/or minimal benefits
- **“More Desirable”** - Meets the criteria better than some alignments, but not as well as the highest performing alignments – moderate level of impacts and/or some benefits
- **“Most Desirable”** - Meets the criteria better than most of the alignments – low level of impacts and/or high level of benefits

In general, if an alignment scored below the 25th percentile with respect to a given criterion, it was categorized as "least desirable" and represented with an open circle. If an alignment scored between the 25th and 75th percentiles with respect to a given criterion, it was categorized as "more desirable" and represented with a half-full circle. If an alignment scored above the 75th percentile with respect to a given criterion, it was categorized as "most desirable" and represented with a solid circle. Some of the evaluation criteria (e.g. Park & Rides) were not evaluated using the percentile methods and used natural breakpoints to determine each level of desirability. Overall, solid circles represent alignments that scored better in terms of their desirability than alignments receiving half-full or open circles.

A memorandum that describes the complete technical analysis methodology for each criterion can be found in **Appendix C**.

2.3.2 Tier 1 Technical Evaluation Results

For the Tier 1 technical evaluation, the alignments and corridors shown in **Table 2** were the best performing for each the project themes and evaluation criteria.

Table 2. Tier 1 Evaluation – Results by Evaluation Criteria

	Theme	Evaluation Criteria	Best Performing Alignment(s)	Best Performing Corridor(s)
1A	Connect to Many Points within Norfolk	Connect to activity centers	1a, 1b, 2a, 2b, 3a, 3b	Western
2A	Provide an Alternative to Heavy Traffic and Congestion	Reduce hours of daily roadway congestion	4a, 7a, 8	Eastern
2B		Ability to attract riders	3a, 3b, 4a, 5a, 5b	Central
3A	Reduce Travel Time – Make Travel Time More Reliable between Destinations	Opportunity to increase travel time reliability along alignment corridor	4a, 5a, 7a, 8	Central/Eastern
3B		Directness of route	4b, 5a, 5b, 8	Central
4A	Parking – Provide Parking to Accommodate Riders	Proximity to Park & Rides	6	Eastern
5A	Interconnectivity of Transit Modes	Ability to connect to other transit services in Norfolk	3a, 3b, 4a, 4b, 4c, 5a	Central
6A	Future Expansion – Ensure That the System Can Be Expanded in the Future	Ability to leverage other planned regional transportation system projects	6, 7a, 7b	Eastern
7A	Other	Environmental considerations	1c, 6, 7a, 7b, 8	Eastern
7B		Right-of-way constraints and project cost	1a, 1b, 2a, 2b	Western
7C		Economic development and neighborhood revitalization	1b 4a, 5a, 7b	Central
7D		Resiliency	1c, 8	Eastern

Figure 11 on the following page displays the Tier 1 screening matrix, which includes the results of the criteria evaluation for the 17 conceptual alignments for the NSNTES. The results of the Tier 1 technical evaluation indicated that the following three alignments represent the overall best performing alignments, based on the technical results, from each of the study corridors:

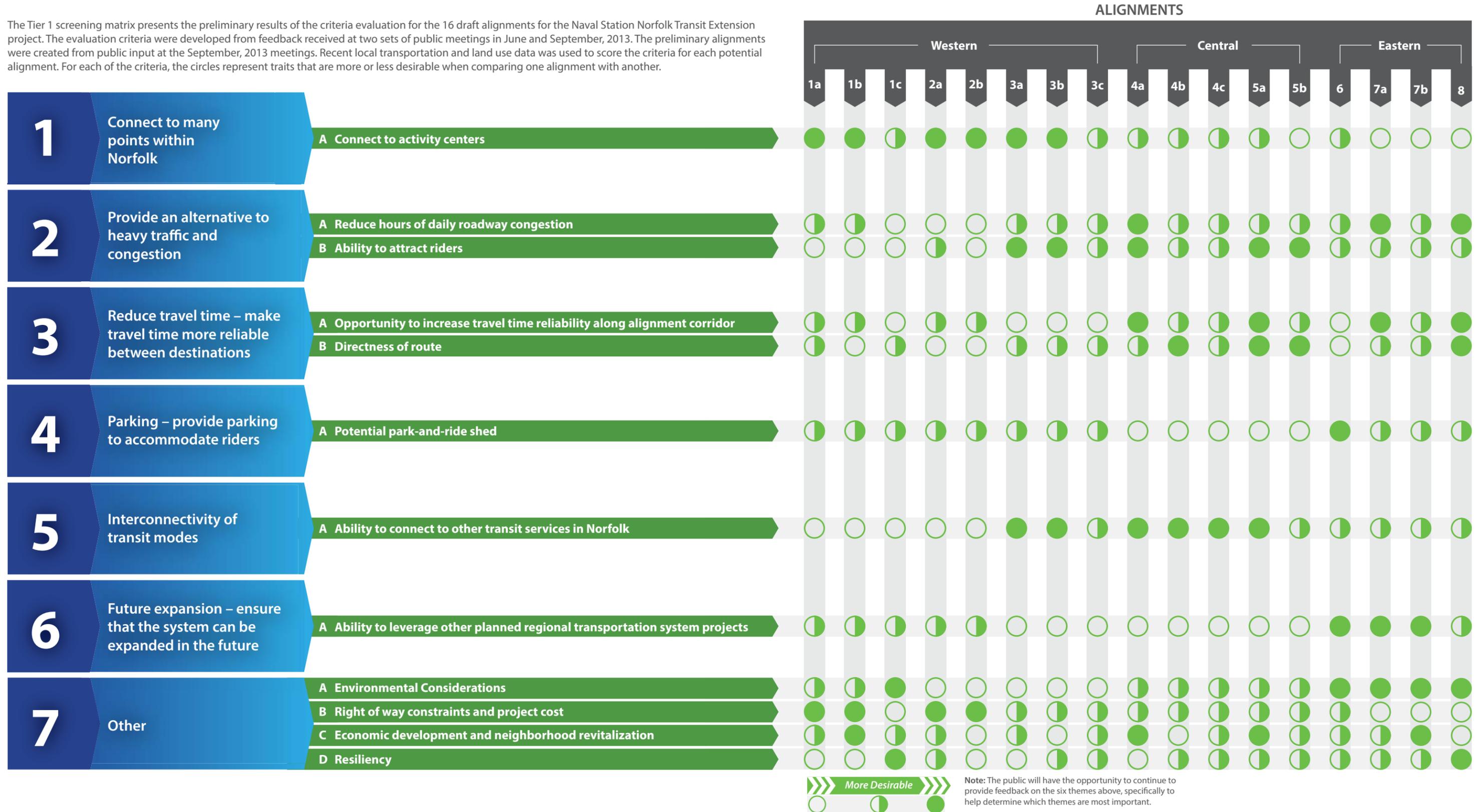
- Western Corridor: Alignment 3b
- Central Corridor: Alignment 5a
- Eastern Corridor: Alignment 7a

Figure 11

Naval Station Norfolk Transit Extension Study Tier 1 Screening Matrix



The Tier 1 screening matrix presents the preliminary results of the criteria evaluation for the 16 draft alignments for the Naval Station Norfolk Transit Extension project. The evaluation criteria were developed from feedback received at two sets of public meetings in June and September, 2013. The preliminary alignments were created from public input at the September, 2013 meetings. Recent local transportation and land use data was used to score the criteria for each potential alignment. For each of the criteria, the circles represent traits that are more or less desirable when comparing one alignment with another.



2.3.3 February/March 2014 Public Review of Tier 1 Technical Evaluation Results

The third set of public workshops was conducted in February/March 2014 after the completion of the Tier 1 technical evaluation. Workshop attendees watched a brief PowerPoint presentation given by HRT that described the results of the Tier 1 technical evaluation. The goal of the meeting was to have the public suggest their preference for an alignment, corridor, or location for future expansion of the system. Attendees then broke into small groups, were provided handouts with the results of the Tier 1 technical evaluation, and were asked to identify the following by placing stickers next to each of their selections of:

1. A preferred alignment (selection of one out of a possible 17 alignments)
2. A preferred corridor (selection of one out of a possible three corridors: western, central or eastern)
3. A preferred location for future expansion (selection of a nearby community such as Virginia Beach or Hampton to expand The Tide to in the future)

The results of the February/March 2014 public meetings indicated a preference for the following alignments from each of the study corridors:

- Western Corridor: Alignment 2a
- Central Corridor: Alignment 4a
- Eastern Corridor: Alignment 6

2.3.4 Selection of Alignments to Advance to Tier 2 Screening Process

Based on the Tier 1 technical evaluation results and input from the February/March 2014 public meetings, six alignments were recommended for advancement to the Tier 2 screening process. These six alignments included the highest-scoring alignments from the technical evaluation and the highest-ranked alignments from the public preference results from each of the three corridors (western, central, and eastern). In addition to those six alignments selected based on technical results or public preference, two additional alignments were advanced forward based on stakeholder input. These two alignments are:

- Alignment 1c
- Alignment 3c

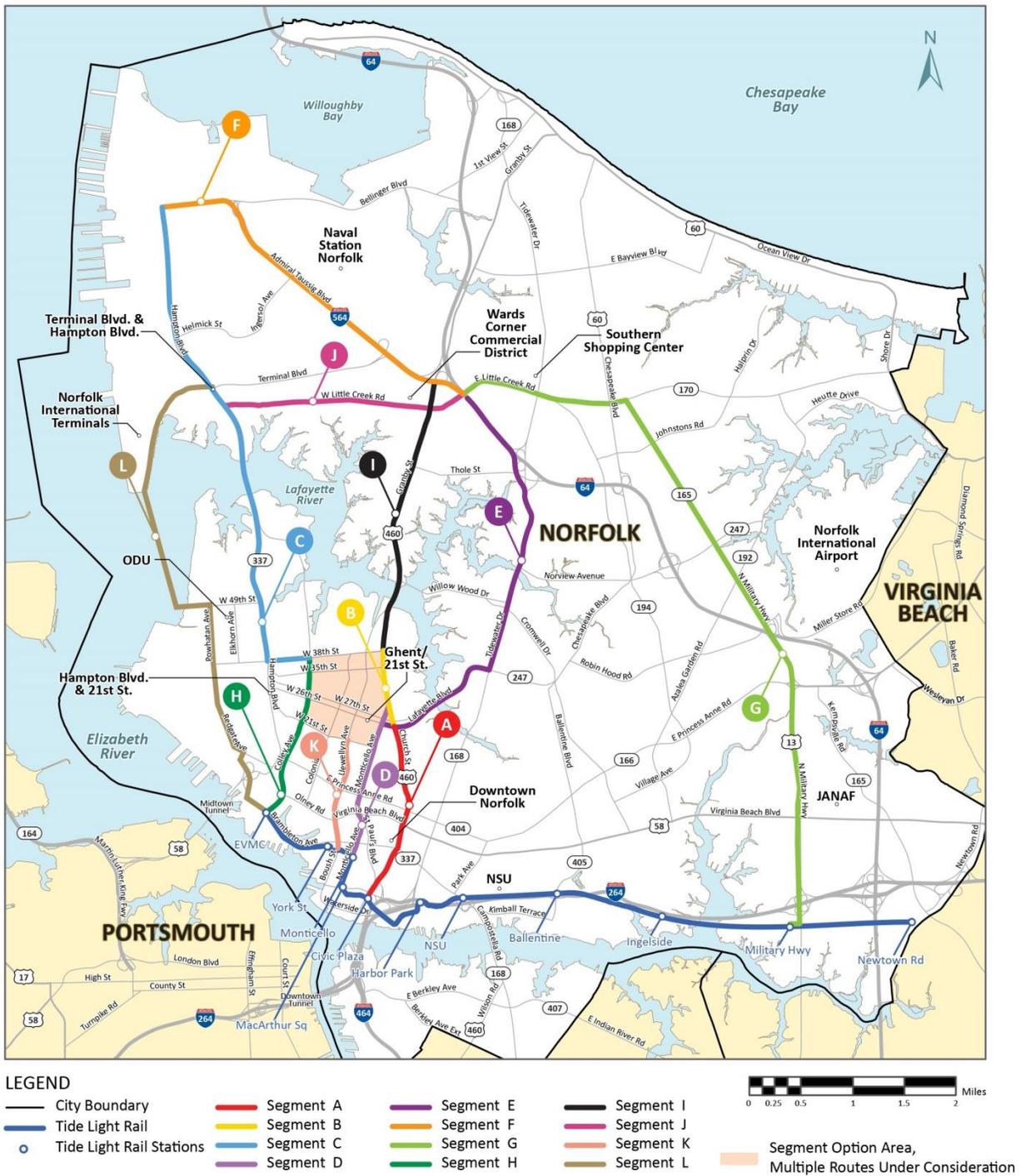
Each of the eight alignments chosen for more detailed analysis in the Tier 2 screening process was divided into individual segments as described below and shown in **Figure 12**.

- Alignment 1c, composed of segments L and C
- Alignment 2a, composed of segments H and C
- Alignment 3b, composed of segments A, B, and C
- Alignment 3c, composed of segments K and C
- Alignment 4a, composed of segments D, B, I, and F

Naval Station Norfolk Transit Extension Study

- Alignment 5a, composed of segments D, E, and F
- Alignment 6, composed of segments G, J, and C
- Alignment 7a, composed of segments G and F

Figure 12. Potential Alignment Segments Advanced to Tier 2 Screening Analysis



The Segment Option Area (bounded by W. 20th Street, Colley Avenue, W. 38th Street, and Monticello Avenue) has multiple possibilities for east-west and north-south routes that would connect alignments originating in downtown Norfolk with either Hampton Boulevard or Granby Street. The routing possibilities through this area were examined for alignments 2a, 3b, 3c, and 4a.

After the eight alignments were identified, project staff met with engineering and planning staff from HRT and the City of Norfolk to discuss potential fatal flaws of each alignment and segment. The meeting provided project staff with additional planning and engineering information on each alignment segment. The data was used by project staff to refine the eight alignments to avoid potential fatal flaws.

After reviewing the technical data for the eight alignments and their component segments, and taking into account input from engineering and planning staff at HRT and the City of Norfolk, the following segments were dropped from further consideration:

- **Segment E** was dropped because Tidewater Drive has little available right-of-way for a dedicated transit-way and it would be difficult to make a connection to NSN through the Tidewater Drive/I-64 interchange.
- **Segment L** was dropped because of the risk, cost, and engineering challenges in constructing a transit-way on top of a Lafayette River seawall and the need to span the Norfolk Southern railroad tracks near Lambert's Point.
- **Segment H** was removed from further consideration because of the potential difficulty in traversing the Colley Avenue/Brambleton Avenue intersection, the lack of available right-of-way on Colley Avenue north of Brambleton Avenue, and the width of the Norfolk Southern underpass north of W 21st Street.
- **Segment K** was removed from consideration because of the potential for flooding issues on Llewellyn Avenue and the difficulty in mitigating the existing at-grade crossing of the railroad tracks near 23rd Street.

The remaining segments were combined into six alignments that closely followed the routes of the alignments selected through the Tier 1 technical evaluation and public preference. The six alignments were organized by corridor (western, central or eastern) and were advanced to the Tier 2 screening process. The Tier 2 screening process is described in detail in the following section of the report.

Section 3
Tier 2 Screening of Alignments



3.0 TIER 2 SCREENING OF ALIGNMENTS

Based on the results of the Tier 1 screening process, the six alignments comprised of the highest ranking segments were advanced for further evaluation as part of the Tier 2 screening process, which included a technical evaluation and a set of public meetings. The alignments are illustrated in **Figure 13** and are as follows:

- **Western Alignment (Based on Tier 1 Alignment 3b - Segments, A, B, and C):** This alignment would connect the Ghent neighborhood, ODU, and NSN along Hampton Boulevard.
- **Central A Alignment (Based on Tier 1 Alignment 4a - Segments D, B, I, and F):** This alignment would use Monticello Avenue to head north from downtown along Granby Street.
- **Central B Alignment (Based on Tier 1 Alignments 2a and 4a - Segments B, C, D, I, and J):** This alignment would use Monticello Avenue, head north and turn to run along W. Little Creek Road and Hampton Boulevard.
- **Central C Alignment (Based on Tier 1 Alignment 5a - Segments D, E, and F):** This alignment was proposed and refined in discussions with the City of Norfolk. The alignment would run along Lafayette Boulevard and Chesapeake Boulevard before connecting to W. Little Creek Road and NSN.
- **Eastern A Alignment (Based on Previous Alignment 7a - Segments G and F):** This alignment would travel along Military Highway, W. Little Creek Road, and Admiral Taussig Boulevard.
- **Eastern B Alignment (Based on Previous Alignment 6 - Segments G, C, and J):** This alignment would travel along Military Highway, W. Little Creek Road, and Hampton Boulevard.

The Tier 2 technical evaluation and analysis results of the six conceptual alignments are discussed below.

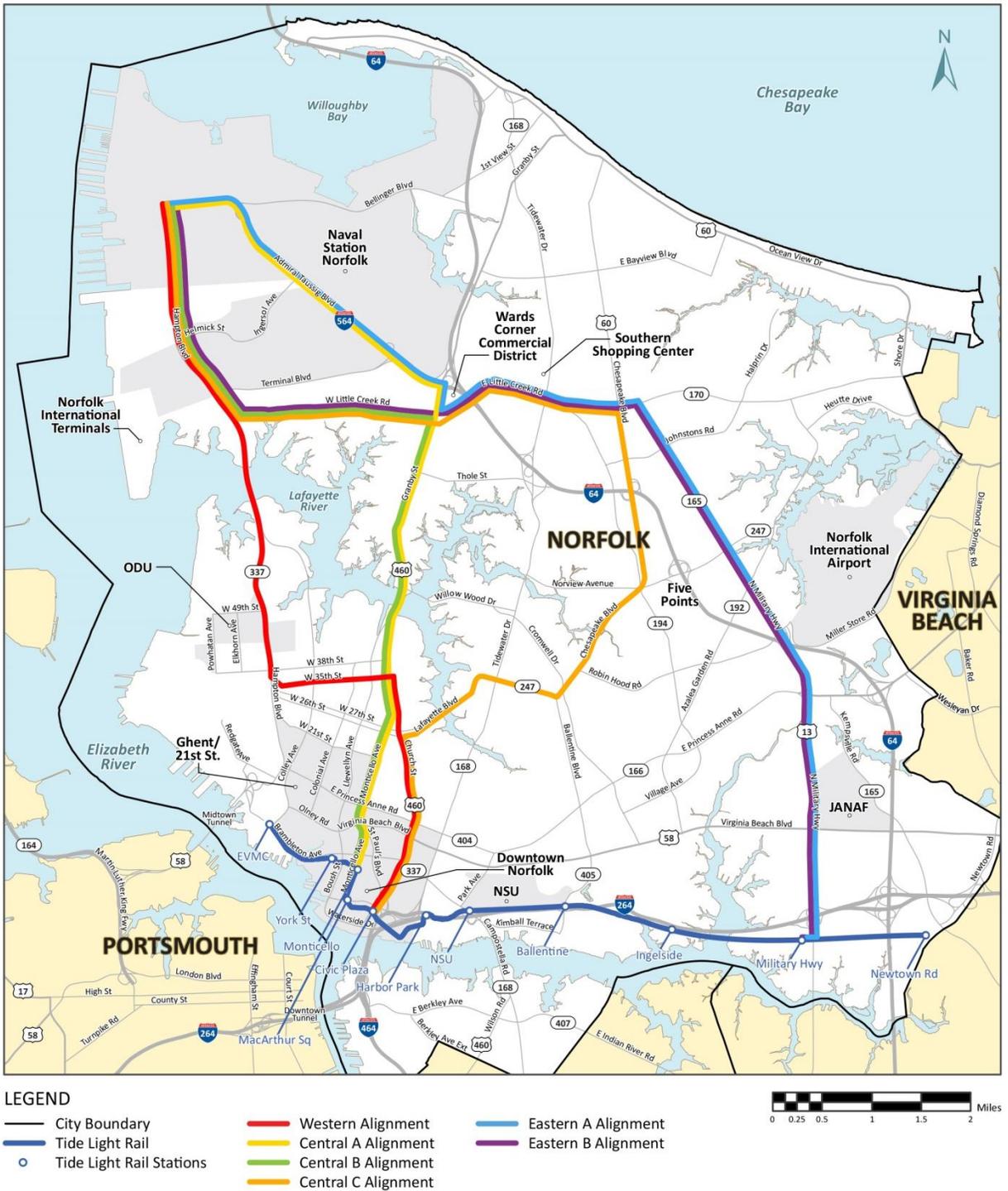
3.1 TIER 2 TECHNICAL EVALUATION

The Tier 2 technical evaluation of the conceptual alignments included an analysis of potential station areas and right-of-way along each alignment, preliminary ridership forecasts, potential environmental impacts, and traffic impacts of each alignment on selected intersections. The results of the Tier 2 technical evaluation were presented to the public at a series of meetings in October 2014.

3.1.1 Station Service Area Analysis

The Tier 2 analysis evaluated each alignment based on the influence and impact of its potential station service areas. By analyzing the catchment areas served by stations, rather than using a ½-mile buffer area as in Tier 1, the Tier 2 evaluation was able to better understand the land use, transportation, socioeconomic, and environmental benefits and impacts. The result of the station area analysis is an understanding of the potential ridership, existing transit supportive land uses, and potential future transit-oriented development (TOD) in the catchment areas of each station.

Figure 13. Alignments for Tier 2 Analysis



3.1.1.1 Methodology

Step 1: Determine Preliminary Station Locations

As part of the station area analysis, potential station locations were identified for each of the six selected alignments. Potential stations were selected based on “rule of thumb” operating criteria for light rail transit (LRT), since LRT is the primary transit technology under consideration. For typical LRT, the average distance between stations ranges from ½ mile to two miles within urban areas and two miles or greater in suburban settings. Potential station locations were selected to support each alignment’s key activity centers as identified by the public during the first series of public meetings. Station location selection also considered existing transit origins or destinations and transit-supportive land uses such as key commercial destinations, employment centers, or high-density residential areas. Major intersections were identified as potential station locations to optimize access by all modes. At this stage of analysis, specific parcels or intersection quadrants were not identified for the station locations. **Figure 14** displays the preliminary station locations identified for each of the conceptual alignments.

Step 2: Determine Station Service Areas

Station service areas were defined as the area that can be reached within a typical half-mile walk, which is generally considered the catchment area in which transit can attract the most riders and encourage the highest level of transit-oriented development. For this study, these areas were determined using the half-mile network distance along existing public streets. The network analysis was based on the City of Norfolk’s existing streets geographic information systems (GIS) dataset. The aggregate service area of all of the stations along each of the alignments was used as the basis for many of the Tier 2 criteria applied to evaluate each alignment.

Table 3, Figure 15, and **Figure 16** summarize and display the aggregate station service areas for each of the alignment options. The density of streets within a station area influences the effective station area size. Station areas with denser and more connected patterns of street networks show more coverage compared to stations with sparser street networks. The Eastern A Alignment and the Eastern B Alignment have stations that appear to have “half a station area” because of Military Highway’s and other public streets access limitations within a half-mile of station locations.

The Central C Alignment would have the greatest potential reach with 3,370 acres of effective service area for 11 stations. The Western Alignment has the second highest total of 2,700 acres of effective service area for 11 stations. The total station area reach is greatly influenced by the number of stations along each alignment. Some alignments have more destinations and reasons to have more stations, while other alignments show fewer stations because of limited access roadways or fewer destinations/activity centers.

Table 3. Station Service Areas and Number of Stations

■ Highest Ranked
■ Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of Stations	11	6	9	11	8	11
Station Service Areas (Acres)	2,700	1,510	2,570	3,370	1,520	2,580

Figure 14. Preliminary Station Locations for Tier 2 Analysis



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations
- Western Alignment
- Central A Alignment
- Central B Alignment
- Central C Alignment
- Eastern A Alignment
- Eastern B Alignment
- Potential Station Area



Figure 15. Station Service Areas for the Western, Central A, and Eastern A Alignments

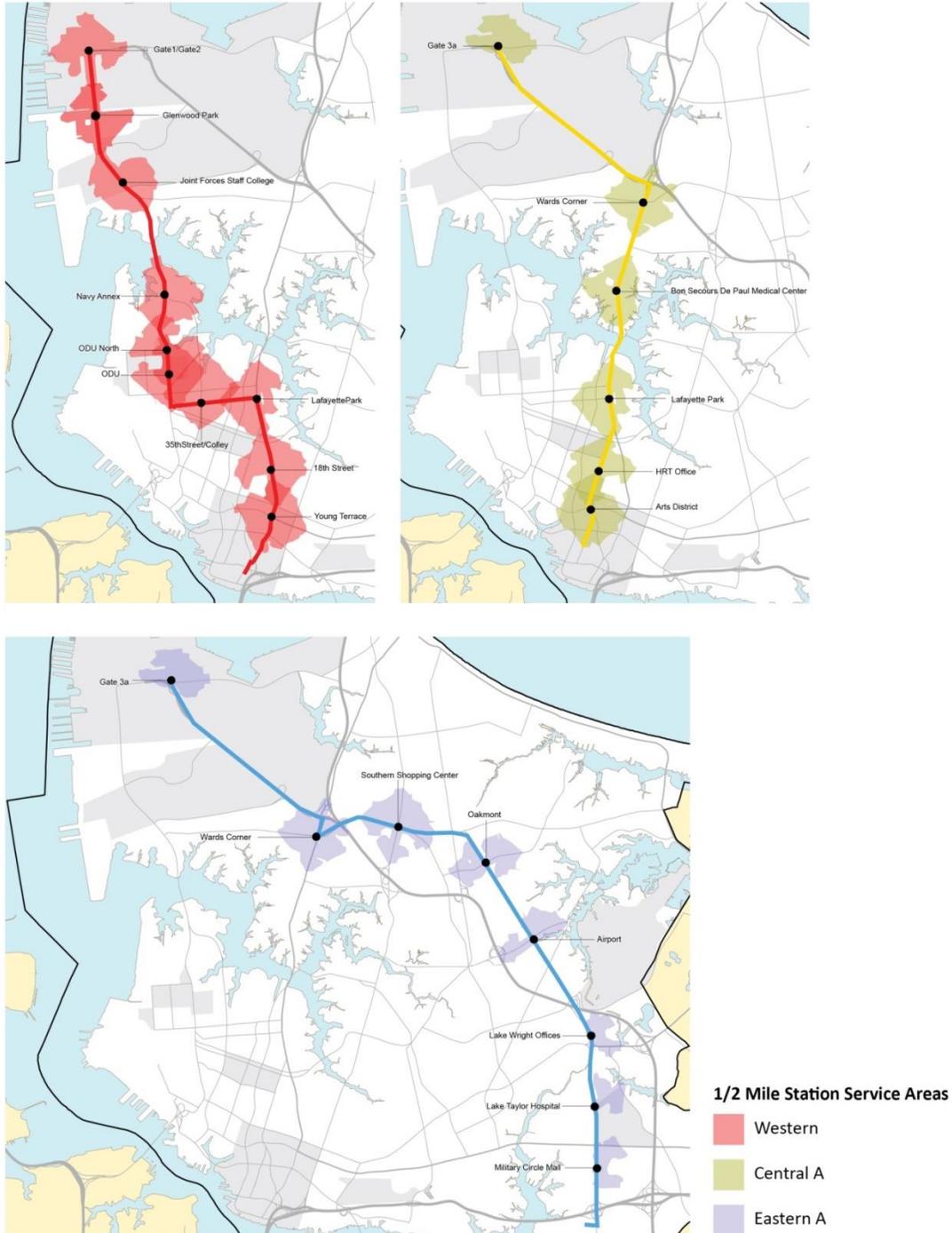
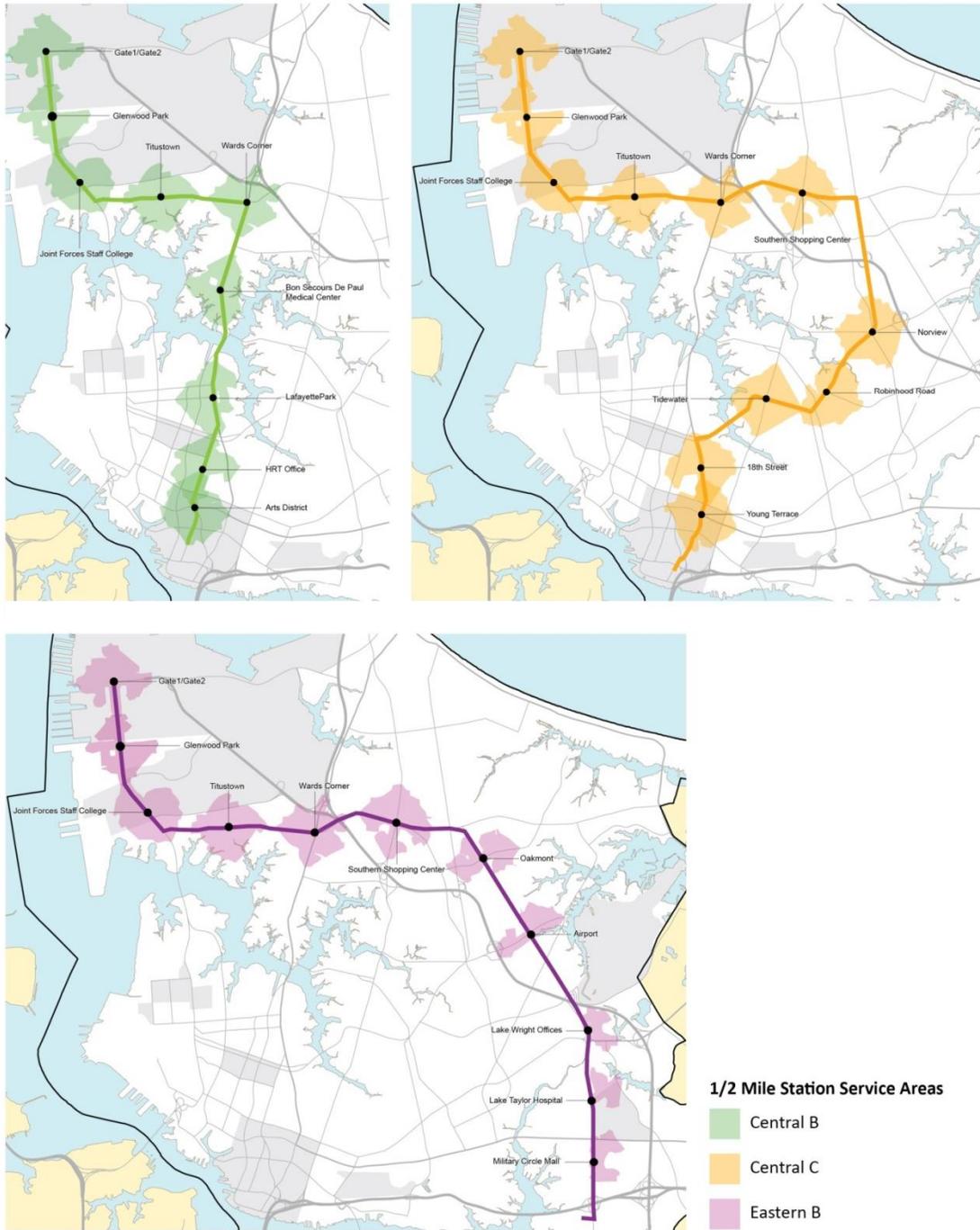


Figure 16. Station Service Areas for the Central B, Central C, and Eastern B Alignments



Step 3: Apply Station Service Areas to each of the Criteria

Based on the aggregate station areas for each alignment, the station area analysis measured the performance of each alignment for each of the following criteria, selected to align with the project themes:

- Connect to Activity Centers: (Relates to Theme 1: Connect to Many Points within Norfolk)
- Existing Transit Supportive Land Uses: (Relates to Theme 1: Connect to Many Points within Norfolk)
- Population within the Station Service Areas: (Relates to Theme 2: Provide an Alternative to Heavy Traffic and Congestion)
- Employees within the Station Service Areas: (Relates to Theme 2: Provide an Alternative to Heavy Traffic and Congestion)
- Total Population within Five-Minute Drive from Station Locations: (Relates to Theme 4: Provide Parking to Accommodate Riders)
- Number of Transit Stops within Station Service Areas: (Relates to Theme 5: Interconnectivity of Transit Modes)
- Sidewalks within Station Service Areas: (Relates to Theme 5: Interconnectivity of Transit Modes)
- Bicycle-friendly Streets: (Relates to Theme 5: Interconnectivity of Transit Modes)
- Future Jobs within Station Service Areas: (Relates to Theme 7: Economic Development and Neighborhood Revitalization)
- Zero-car Households: (Relates to Theme 7: Economic Development and Neighborhood Revitalization)
- Potential for Transit-Oriented Development (TOD) : (Relates to Theme 7: Economic Development and Neighborhood Revitalization)
- Potential to Expand Access to Tide Area Jobs: (Relates to Theme 7: Economic Development and Neighborhood Revitalization)
- Potential to Connect Tide Area Residents to Jobs: (Relates to Theme 7: Economic Development and Neighborhood Revitalization)
- 4(f) Sites and Historic Resources: (Relates to Theme 7: Environmental Considerations)
- 100-year Floodplain: (Related to Theme 7: Resiliency)

3.1.1.2 Station Service Area Analysis Results

Connect to Activity Centers (Relates to Theme 1: Connect to Many Points within Norfolk)

This criterion was evaluated by determining the number of activity centers that are located within the aggregate effective service areas of each alignment. The analysis used the list of key activity centers identified by the community during the set of public workshops in September 2013.

The number of activity centers within the effective service areas for each alignment ranged from 3 to 11. The Western Alignment and the Central B Alignment would have the greatest number of key activity centers (11 each) within their effective service areas. **Table 4** summarizes the results for this criterion for all of the alignment options. Maps illustrating the analysis results for this criterion are included in **Appendix D**.

Table 4. Number of Activity Centers within Station Service Areas

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of Activity Centers within Station Service Areas	11	8	11	10	3	5

Existing Transit Supportive Land Uses (Relates to Theme 1: Connect to Many Points within Norfolk)

This criterion measures the total existing transit-supportive land uses within the aggregate service area for each alignment option. Alignment service areas with a higher density of transit supportive land uses are forecast to generate more potential transit ridership. Transit-supportive uses include stable single-family and multi-family residential, office, retail, and institutional developments that have densities that support transit use and are likely to generate or attract transit trips. Industrial-zoned properties, vacant parcels, and low-density commercial uses are not considered transit-supportive.

The total building square footage within each parcel was used to determine the amount of existing transit-supportive use. Using building square footage rather than parcel size gives a more accurate reflection of actual development density and prevents the evaluation from being skewed by large parcels with low-density development. Parcel-level land use, building footprints, and building height data from the City of Norfolk were used to analyze this criterion.² This criterion was evaluated by adding total building square footages for all parcels with transit-supportive uses within the station service areas.

² Since existing building floor area data was not available for many of the parcels, the building footprint and building height data were used to arrive at an estimated total building floor area value for each parcel.

The Central C Alignment, with 44,131,000 square feet of building floor area, would have the highest level of transit-supportive uses within the station service areas. The Western Alignment would have the second highest level of transit-supportive uses, with 36,890,000 square feet. **Table 5** summarizes the results for this criterion for all the alignment options. Maps illustrating the parcels with transit-supportive uses for each of the alignments are included in **Appendix D**.

Table 5. Transit Supportive Land Uses within Station Service Areas

Highest Ranked
 Second Highest Ranked

Transit-Supportive Land Use (1,000 ft ²)	Western	Central A	Central B	Central C	Eastern A	Eastern B
Retail	2,344	4,832	5,169	5,246	8,316	8,654
Office	3,581	6,281	6,766	3,884	3,654	4,004
Multi-Family	8,750	6,722	9,028	11,434	4,961	6,429
Single Family	14,962	8,033	11,712	19,744	7,156	10,753
Institutional	7,257	3,086	3,496	3,822	876	1,049
Total	36,894	28,954	36,172	44,131	24,964	30,888

Population and Employees within the Station Service Areas (Relates to Theme 2: Provide an Alternative to Heavy Traffic and Congestion)

These two criteria were evaluated by determining the total population and number of employees within each alignment’s effective station service area based on socioeconomic data from the HRTPO 2034 Transportation Analysis Zones (TAZ). The analysis used GIS to determine the proportional percentage of each TAZ’s population and employment that is located within the station service areas of the alignments.

With a population forecast of 31,520 residents, the Central C Alignment would be able to reach the largest number of residents. The Western Alignment would be able to reach 26,530 residents, second highest of the six alignments. The Central B Alignment, with 32,810 employees, would reach the highest number of employees within the station service areas. The Western Alignment would reach the second highest number of employees, with 25,580 employees working within its station service areas.

Table 6 shows the total population and total number of employees within the station service areas for the various alignments. **Appendix D** includes maps that display how each alignment performs based on these two measures.

Table 6. Total Population and Employment within Station Service Areas

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Total Population within Station Service Areas	26,530	13,770	21,460	31,520	11,940	19,630
Total Employees within Station Service Areas	25,580	24,930	32,810	24,150	13,880	21,770

Total Population within a Five-Minute Drive from Station Locations (Relates to Theme 4: Provide Parking to Accommodate Riders)

At this stage of the study, the parking provisions for each station area have not yet been determined. To understand how well each alignment might be able to accommodate parking for transit riders, the Tier 2 analysis evaluated the forecast population within a five-minute drive of stations if Park & Ride or Kiss & Ride facilities were provided. Five-minute drivesheds from each station location were created using network analysis tools in GIS. Similar to the methodology in determining the half-mile effective service areas, the five-minute drivesheds were calculated using the City of Norfolk’s existing street network data. The five-minute driveshed is based on posted speeds for each street, less 10 miles per hour to account for congestion, traffic signals, and other sources of vehicle delay.

The HRTPO TAZ 2034 socioeconomic data was used as the source of the population data. The analysis used GIS to determine the proportional percentage of each TAZ’s population that would be located within the five-minute drivesheds. The results indicate that the Central C Alignment would serve the highest number of residents (152,980) within a five-minute drive of the transit stations. The Eastern B Alignment, with 109,660 residents within a five-minute driving distance from a station, would serve the second-highest number of residents.

Table 7 summarizes the results for this criterion for all the alignment options. Maps illustrating the population reached within five-minute drive sheds for each alignment are included in **Appendix D**.

Table 7. Total Population Reached within a Five-Minute Drive of Station Service Areas

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Total Population reached within 5-minute Drive of Station Service Areas	95,950	88,200	104,860	152,980	93,010	109,660

Number of Transit Stops within Station Service Areas (Relates to Theme 5: Interconnectivity of Transit Modes)

The Tier 2 analysis considered how potential stations for each alignment would connect to existing transit, walking, and bicycling networks to assess connections with other modes for each alternative. First, evaluation of this criterion determined the number of local bus stops that would be within the half-mile station service areas for each alignment to assess connectivity with the local transit network. Hampton Roads Transit’s bus stop GIS data was used to conduct this analysis.

The Central C Alignment would have the greatest number of bus stops (220) located within its effective station service area, followed by the Western Alignment with 155 bus stops. **Table 8** summarizes the results for this criterion for all the alignment options. Maps illustrating the locations of the bus stops and the service areas for each alignment are included in **Appendix D**.

Table 8. Number of Local Transit Stops within Station Service Areas

 Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of Transit Stops within Station Service Areas	166	119	159	220	67	107

Sidewalks within Station Service Areas (Relates to Theme 5: Interconnectivity of Transit Modes)

To understand how well each alignment performs in terms of pedestrian connectivity, the Tier 2 analysis determined the total linear feet of existing sidewalk within each alignment’s effective station service area. The sidewalk GIS shapefile from the City of Norfolk was used for this analysis.

The Central C Alignment would have the greatest amount of sidewalk within its station service areas with 542,000 linear feet of sidewalk, followed by the Western Alignment with 474,000 linear feet of sidewalk. **Table 9** summarizes the results for this criterion for all the alignment options. Maps illustrating the sidewalks within each alignment’s station service area are included in **Appendix D**.

Table 9. Sidewalks within Station Service Areas

 Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Sidewalks within Station Service Areas (Linear Feet)	474,000	259,000	371,000	542,000	172,000	284,000

Bicycle-friendly Streets (Relates to Theme 5: Interconnectivity of Transit Modes)

To understand how each alignment can be supported by bicycling, the Tier 2 analysis evaluated existing bicycle access to and from the proposed station locations. To measure bicycle access to the stations, streets with less than a 25 mph posted speed limit were considered bicycle-friendly streets. These streets generally allow bicyclists to comfortably share the road with motorists. The analysis used GIS to

determine the total length of streets with posted speed limits of 25 mph or less within each alignment’s effective station service area.

With 545,000 linear feet, the Central C Alignment would have the highest density of bicycle-friendly streets within its service areas, followed by the Western Alignment, with 460,000 linear feet. **Table 10** summarizes the results for this criterion for all the alignment options. Maps illustrating the bicycle-friendly streets within each alignment’s service area are included in **Appendix D**.

Table 10. Bicycle-friendly Streets within Station Service Areas

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Bicycle-friendly Streets within Station Service Areas (Linear Feet)	460,000	257,000	418,000	545,000	202,000	363,000

Highest Ranked
 Second Highest Ranked

Future Jobs within Station Service Areas (Relates to Theme 7: Economic Development and Neighborhood Revitalization)

The total number of future jobs within the effective station service areas of each alignment was used to evaluate the ability of the alignments to serve future job locations. The HRTPO TAZ 2034 socioeconomic data was used as the source for the employment data. GIS was used to determine the proportional percentage of each TAZ’s forecast 2034 jobs within each alignment’s station service areas.

The Central B Alignment would serve the highest number of future employees (26,100) while the Western Alignment would serve the second highest number of employees (25,250). **Table 11** summarizes the total number of future employees within the station service areas for all alignment options. Maps illustrating the future employment within each alignment’s service areas are included in **Appendix D**.

Table 11. Future Jobs within Station Service Areas (2034 Jobs)

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Future Jobs within Station Service Areas (2034 Jobs)	25,250	20,130	26,100	23,890	13,660	19,640

Highest Ranked
 Second Highest Ranked

Zero-car Households (Relates to Theme 7: Economic Development and Neighborhood Revitalization)

Households without cars are more dependent on transit for their overall transportation needs. The zero-car household information used to evaluate this criterion is based on data from the 2010 Census. GIS was used to determine the percentage of each census block within the station service area of the alignments. An area-based proportional calculation was then used to determine the total number of zero-car households that fall within each station service area.

For this criterion, alignments with higher concentrations of zero-car households performed better than those with fewer zero-car households. The Central C Alignment, with 1,980 zero-car households, ranked the highest in this criterion, followed by the Western Alignment, with 1,700 zero-car households. **Table 12** summarizes the total number of zero-car households within the station service areas for all alignment options. Maps illustrating the distribution of zero-car households along each alignment are included in **Appendix D**.

Table 12. Zero-Car Households within Station Service Areas

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Zero-Car Households within Station Service Areas	1,700	1,030	1,250	1,980	480	690

Highest Ranked
 Second Highest Ranked

Potential for Transit-Oriented Development (TOD) (Relates to Theme 7: Economic Development and Neighborhood Revitalization)

This criterion compared the potential for TOD within the service areas for all alignment options. The highest potential for TOD is on currently vacant and underutilized parcels within the station service areas. In addition, parcels larger than one acre were considered to have a higher propensity for TOD because they might not need to be combined with other parcels prior to redevelopment.

Parcel-level tax data from the City of Norfolk containing land and building values was used for this analysis. Parcels with a building value of zero were considered vacant, and parcels with building values less than 40 percent of the total property value (building and land values combined) were considered underutilized³. Since redevelopment of smaller parcels is less likely than larger parcels, only vacant and underutilized parcels one acre and larger were considered in the analysis.

The Eastern B Alignment, with 136 acres of vacant and underutilized land, would have the highest potential for TOD, followed by the Eastern A Alignment with 130 acres of vacant and underutilized land. **Table 13** summarizes the results for this criterion for all alignment options. Maps illustrating the location of parcels with that have the highest potential for TOD along each alignment are included in **Appendix D**.

³ Market economists use this industry standard as an indicator of propensity for an owner to redevelop a property.

Table 13. Potential TOD within Station Service Areas

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Vacant (Acres)	33	28	30	46	61	65
Underutilized (Acres)	33	53	56	71	69	71
Potential TOD within Station Service Areas (Acres)	66	81	86	117	130	136

Potential to Expand Access to Tide Area Jobs (Relates to Theme 7: Economic Development and Neighborhood Revitalization)

It is important that transit investments support economic development, leverage existing infrastructure, and complement ongoing development policies. Because expansion of The Tide would be a substantial investment in the City of Norfolk, this criterion considers how each of the alignments would further the ability of residents in the City to access their existing jobs along The Tide line. The data and analysis for this criterion come from US Bureau of Census and Department of Labor Longitudinal Employment and Housing Dynamics (LEHD), 2012⁴. **Figure 17** shows the home locations of workers who have jobs within half-mile service areas of Tide stations.

Based on the results of the analysis, the Central C Alignment and the Central B Alignment would have the greatest number of people who currently work in The Tide station areas and live in each of the new alignments’ station areas. The Central C Alignment, with 1,560 people, would have the largest number of Tide station area workers living in the new alignment station areas, followed by the Central B Alignment, with 1,170 workers. Based on this analysis, the Central C Alignment would increase the reach of existing Tide stations by more than 240 percent, and the Central B Alignment would increase their reach by 180 percent, based on the number of people who would have the option to take premium transit and both work and live within a station area (Tide or future alignment station area). **Table 14** shows workers along each alignment who would be able to access their current Tide area jobs using The Tide and the potential alignment extensions.

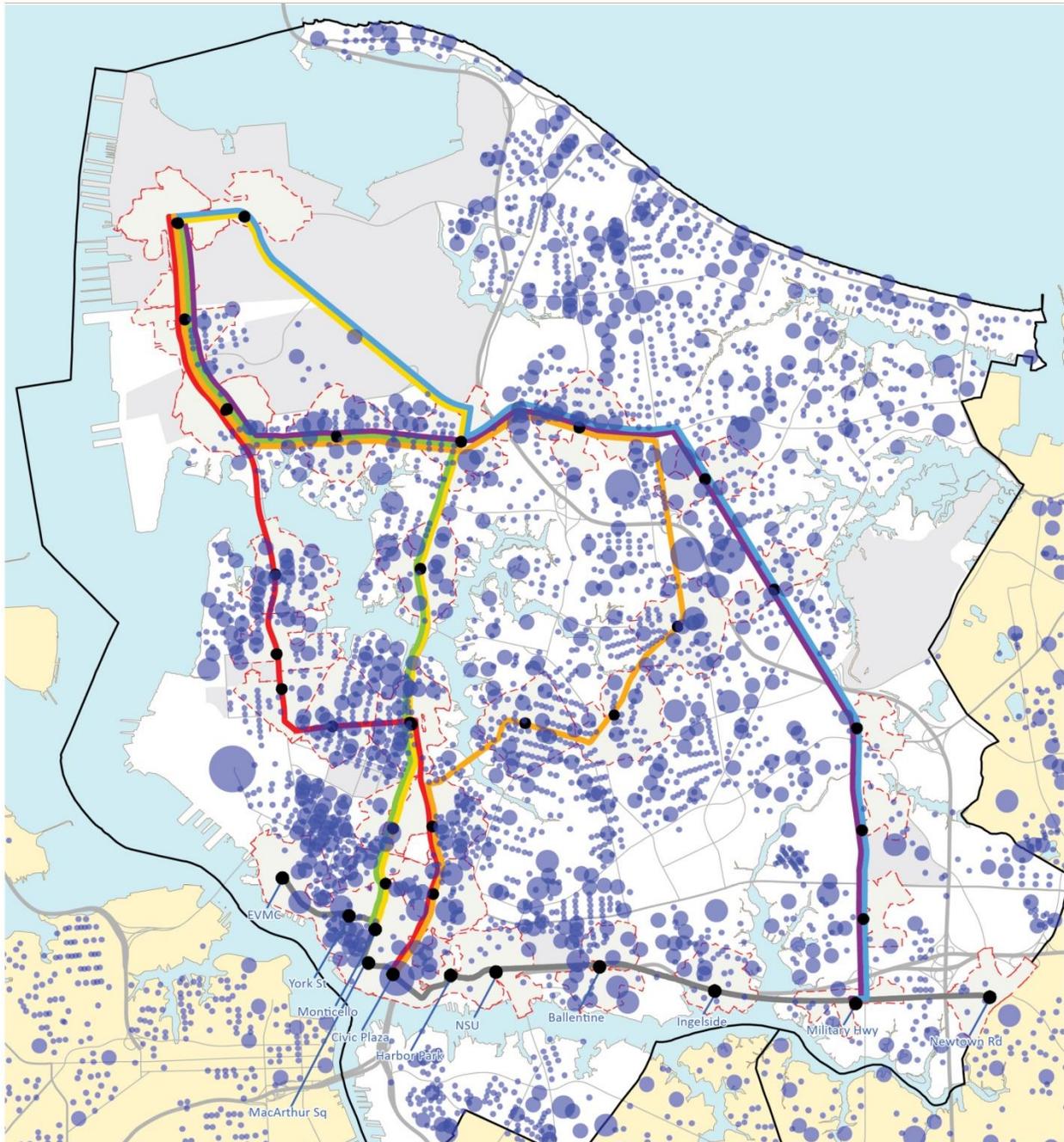
Table 14. Tide Station Area Employees Living within Alignment Station Service Areas

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
TIDE Station Area Employees living in Alignment Station Areas	1,040	880	1,170	1,560	550	840

⁴ These numbers are based on US Census Bureau and Department of Labor surveys, as reported by employers. The data may be limited in how NSN report their employment numbers.

Figure 17. Home Locations of Workers Who Work within Half-mile of Tide Stations



LEGEND

- City Boundary
- Stations
- - - Half-Mile Service Area from Stations

- TIDE
- Western A
- Central A
- Central B
- Eastern A
- Eastern B

Home Locations of Employees in TIDE Station Service Areas

- 101 - 300
- 51 - 100
- 21 - 50
- 6 - 20
- 1 - 5

Potential to Connect Tide Area Residents to Jobs (Relates to Theme 7: Economic Development and Neighborhood Revitalization)

Similar to the previous criterion, this analysis evaluated the ability of each alignment to capitalize on the benefits of the existing Tide line. This criterion considers the ability of Tide area residents to access jobs within station areas along each new alignment. **Figure 18** and **Table 15** show the current job locations of residents who live within a half-mile of The Tide stations. The map shows the concentration of jobs in downtown and along part of Military Highway. The residential areas along The Tide are not as dense when compared to the number of jobs along The Tide, and the extension alignment options do not travel through areas with a large concentration of jobs, except for NSN. As a result, the number of residents served would be lower compared to the prior criterion.

The Western Alignment, with 170 residents, would have the largest number of Tide station area residents working in the alignment station areas, followed by the Central B Alignment, with 150 residents. There would be a 27 percent increase in the number of Tide station area residents who would be able to access jobs without driving if the Western Alignment was built, and a 23 percent increase if the Central B Alignment was built.

Table 15. Tide Station Area Residents Working within Alignment Station Service Areas

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
TIDE Station Area Residents working in Alignment Station Areas	170	130	150	100	60	80

Highest Ranked
 Second Highest Ranked

3.1.1.3 Summary of Station Service Area Analysis

The station area analysis conducted as part of the Tier 2 screening process compared six alignments based on the 13 evaluation criteria. The results show that the Central C Alignment and the Western Alignment performed the best for the majority of the evaluation criteria and across all project themes. The Central B Alignment ranked third on many criteria, and ranked first or second on other criteria. Although the Eastern A Alignment and the Eastern B Alignment did not perform as strongly on most of the measures, these two alignments represent a greater potential for TOD because of the greater number of large vacant and underutilized parcels around the station locations. **Table 16** summarizes the results for each of the evaluation criteria for all of the alignment options.

Figure 18. Job Locations of Residents Living within Half-mile of Tide Stations

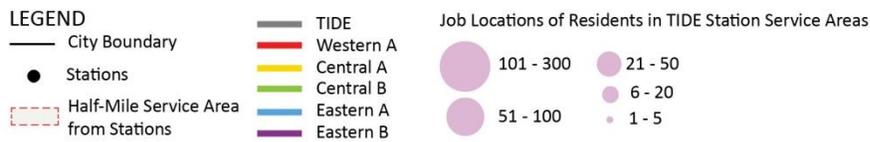
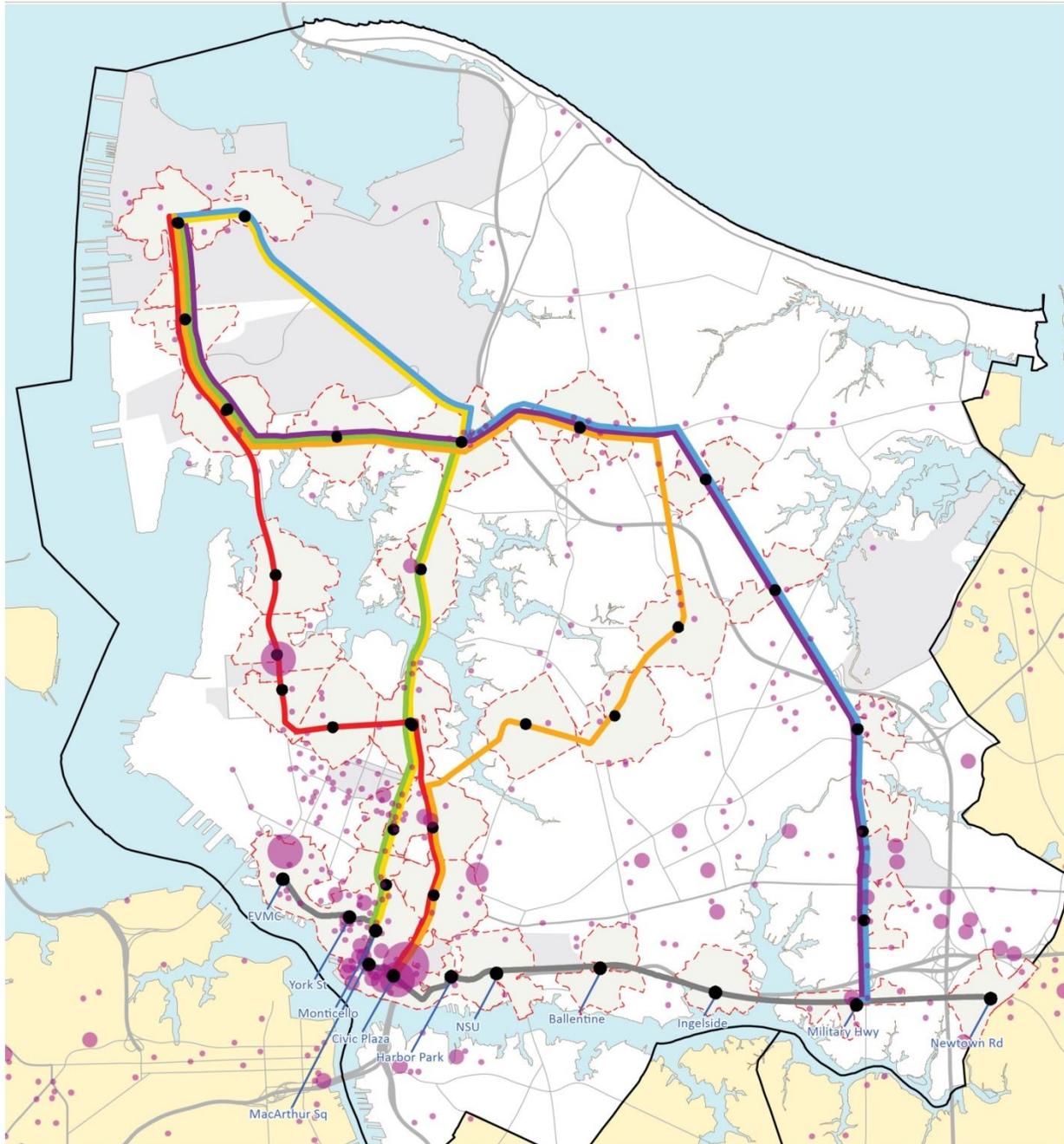


Table 16. Summary of Station Service Area Analysis

Highest Ranked
 Second Highest Ranked

Project Themes		Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Station Service Areas (Acres)			2,700	1,510	2,570	3,370	1,520	2,580
Number of Stations			11	6	9	11	8	11
Connect to Many Points within Norfolk	Number of Activity Centers with Station Service Areas		11	8	11	10	3	5
	Total Transit Supportive Land Uses (1,000 ft ²)		36,894	28,954	36,172	44,131	24,964	30,888
Provide an Alternative to Heavy Traffic and Congestion	Total Population within Station Service Areas		26,530	13,770	21,460	31,520	11,940	19,630
	Total Employees within Station Service Areas		25,580	24,930	32,810	24,150	13,880	21,770
Provide Parking to Accommodate Riders	Total Population within 5-minute Drive of Station Areas		95,950	88,200	104,860	152,980	93,010	109,660
Interconnectivity of Transit Modes	Number of Local Transit Stops within Station Service Areas		166	119	159	220	67	107
	Sidewalks within Station Service Areas (Linear Feet)		474,000	259,000	371,000	542,000	172,000	284,000
	Bicycle-friendly Streets (posted speed of 25mph or less) within Station Service Areas (Linear Feet)		460,000	257,000	418,000	545,000	202,000	363,000
Economic Development and Neighborhood Revitalization	Future Jobs within Station Service Areas (2034 Jobs)		25,250	20,130	26,100	23,890	13,660	19,640
	Potential TOD within Station Service Areas (Acres)		66	81	86	117	130	136
	Number of Zero-car Households Served		1,700	1,030	1,250	1,980	480	690
	Tide Station Area Employees living in Alignment Station Areas		1,040	880	1,170	1,560	550	840
	Tide Station Area Residents working in Alignment Station Areas		170	130	150	100	60	80

3.1.2 Right-of-Way Analysis

The identification of potential right-of-way impacts for the Tier 2 alignments followed a similar process as the analysis performed for the Tier 1 screening. This analysis relates to project Theme 7: Right-of-Way Constraints. The following assumptions were made in determining the extent of the right-of-way impacts:

- All corridors would have exclusive at-grade LRT operations⁵ (except at railroad crossings, crossings of interstate highways, or along portions of Military Highway south of I-64 where the alignment would be grade separated).
- Grade separation structures will be required at all railroad crossings, crossings with interstate highways, and under the runway at I-564.
- Typical sections are based on maintaining the existing number of through travel lanes on each roadway.
- On-street parking would be removed⁴ from streets where the alignment would be located.
- Limits of impact do not include turn lanes or bike lanes.
- Limits of impact do not include station platforms or Park & Ride facilities.
- Limits of impact do not include operations and maintenance facilities (vehicle storage and maintenance facilities, traction power substations, other wayside equipment).
- Dimensions are as shown in typical sections, including 11 feet minimum travel lane width and a minimum of 10 feet for sidewalks, utilities, and other right-of-way needs.
- No landscaped median or buffer would be added where the proposed section is wider than the existing right-of-way.

The typical sections used for this analysis are shown in **Figure 19** through **Figure 23**.

⁵ For the purposes of this study, LRT operations were assumed. If another transit vehicle technology such as streetcar or bus rapid transit were selected, some of assumptions (e.g. exclusive right of way or removal of on-street parking) above would not be applicable to the right-of-way analysis.

Figure 19. Typical Section, One Lane in Each Direction

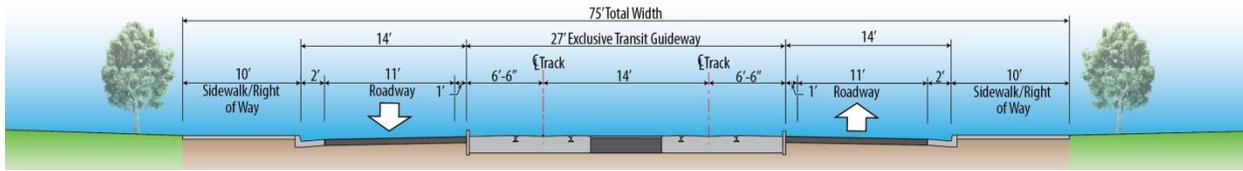


Figure 20. Typical Section, Two Lanes in Each Direction

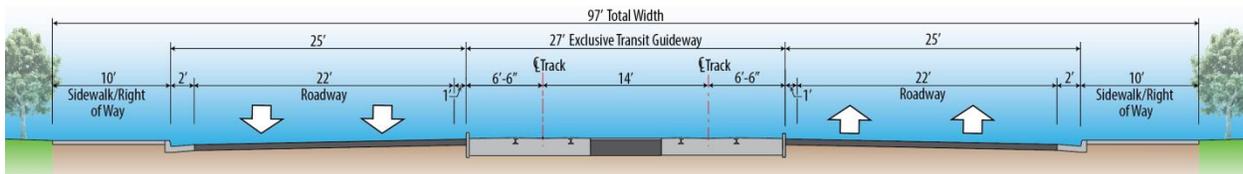


Figure 21. Typical Section, Three Lanes in Each Direction

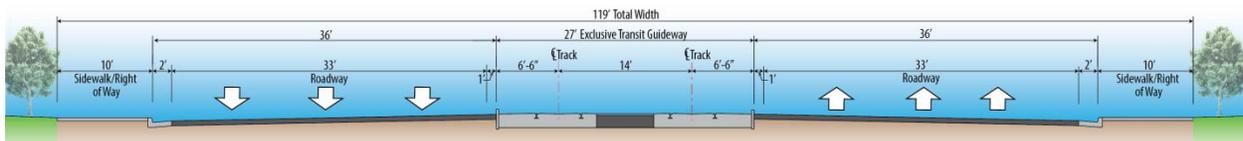
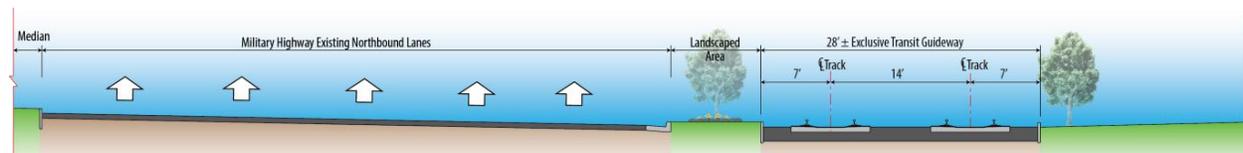


Figure 22. Typical Section with Guideway in Existing Median



Figure 23. Typical Section with Guideway adjacent to Military Highway



The alignments were developed on a basemap consisting of the City of Norfolk’s GIS parcel shapefile and 2013 aerial photography. While the City’s right-of-way limits are not delineated in the shapefile, it was assumed for this analysis that the parcel lines adjacent to roadways formed the right-of-way boundaries in most cases.

The total requirement for the potential right-of-way consists of the combined widths of the transit guideway, adjacent roadways, and sidewalks. For each of the transit alignment segments, conceptual level track alignments were drawn on the basemap so that the complete section was approximately centered on the right-of-way. Placing the section in the center of the existing right-of way produces the most conservative estimate of the number of parcels that would have potential right-of-way impacts.

Where the transit guideway would be in exclusive lanes within roadway rights-of-way, the proposed typical section for each segment was selected based on maintaining the existing number of through lanes. The widths of the transit guideway, adjacent roadway, and sidewalks were drawn on the basemap as offsets from the centerlines using the dimensions shown in the typical sections. Outside existing rights-of-way, a typical transit guideway width of 27 feet was applied and sidewalks or other buffers were added where appropriate.

To determine the potential impacts, the potential right-of-way width was compared to the existing parcel data using GIS. This process identified the total land area of the estimated impacts and the number of parcels that would be impacted based on the assumptions made in developing the alignments. The analysis also identified locations with insufficient right-of way-width to add an exclusive transit guideway while also maintaining existing roadway capacity.

3.1.2.1 Right-of-Way Analysis Results

Table 17 shows the potential total right-of-way requirements for the Tier 2 alignments. The Central C Alignment would impact the greatest number of parcels, while the Central A Alignment would impact the fewest number of parcels. The Eastern B Alignment would potentially impact the greatest land area outside of existing rights-of-way and the Central A Alignment would require the least amount of additional property.

Table 17. Right-of-Way Analysis Results

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Total Area of Right of Way Impacts (acres)	7.2	4.3	11.6	12.9	9.0	16.4
Total Number of Parcels Impacted	491	115	299	611	220	408

3.1.3 Ridership Analysis

Ridership was modeled for the Tier 2 alignments to determine the potential demand and projected number of transit riders that would use the expanded system. Ridership forecasting relates to project Theme 6: Future System Expansion. Ridership was modeled for each of the alignments as a distinct

system separate from the existing Tide alignment. The results demonstrate the estimated daily ridership for each of the Tier 2 alignments.

3.1.3.1 Ridership Analysis Methodology

The ridership model considered various input components that affect transit usage, including residential population and employment density around the proposed stations, highway and roadway congestion levels and associated travel times, costs associated with automobile ownership (for example, parking costs near places of employment), fares for existing transit modes, and transit travel and wait times. The model incorporated each of these factors to estimate the ridership potential for each of the alignments under consideration. Data incorporated into the model was provided by local government agencies and Hampton Roads Transit.

3.1.3.2 Ridership Analysis Results

The projected opening year (2034) daily ridership for the Tier 2 alignments is provided in **Table 18**. The Eastern A Alignment has the highest ridership potential, with 5,150 projected transit riders daily. The Central A Alignment had the lowest projected daily ridership, with 2,500 riders. The variations of the central and eastern alignments that include W. Little Creek Road have higher ridership projections than their counterparts that would use I-564 to get to NSN. The Western Alignment, which would travel through dense residential neighborhoods and Old Dominion University between downtown and NSN, has lower projected ridership levels (4,000 riders) than variations of the central and eastern alignments.

Table 18. Projected Opening Year (2034) Ridership for Tier 2 Alignments

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Ridership on Norfolk extension only (not inclusive of the entire Tide system)	4,000	2,500	4,550	2,850	5,150	4,700

3.1.4 4(f) Sites and Historic Resources Analysis

The environmental analysis included three components to identify the proximity of 4(f) sites to each of the Tier 2 alignments options. Section 4(f) of the Department of Transportation (DOT) Act of 1966 stipulates that the Federal Highway Administration and other DOT agencies cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless the following conditions apply:

- There is no feasible and prudent alternative to the use of land.
- The action includes all possible planning to minimize harm to the property resulting from use⁶.

⁶ Taken from: <http://www.environment.fhwa.dot.gov/4f/>

The environmental analysis helped determine the impact each alignment could have on: historic structures, historic districts, and parklands. These criteria are related to project Theme 7: Environmental Consideration and Resiliency.

3.1.4.1 4(f) Sites and Historic Resources Analysis Methodology

The City of Norfolk is primarily built-out and any future transit extension would travel through already developed areas. Therefore, the process for evaluating 4(f) sites and historic resources recognized the locations of City-owned parklands, historic structures, and historic districts and their proximity to the Tier 2 alignments. Identifying the locations of historic resources and parklands relative to the Tier 2 station areas facilitates an understanding of the relative sensitivity to future transit development within certain areas of the City.

This analysis quantified the presence of historic resources and parklands within the station service areas. The process for determining the quantity and proximity of historic resources to a potential transit extension involved isolating the locations of historic sites and historic districts within a half-mile of the station areas. Data provided by the City of Norfolk of locations listed on the National Register of Historic Places, which include historic structures and historic districts, was integrated with GIS mapping to determine the proximity of historic resources within a half-mile of the station areas. Parklands within a half-mile of the station areas were identified using data provided by the City in GIS format, which allowed existing parklands to be mapped and the potential acreage affected to be quantified.

3.1.4.2 4(f) Sites and Historic Resources Analysis Results

Table 19 summarizes the outcomes of the 4(f) and historic resources analysis. The Western Alignment would impact the greatest number of historic structures (eight) and the highest acreage of parklands (149 acres). Both the Central A Alignment and Central B Alignment affect the most historic districts (eight), while the eastern alignments affect no historic districts. The Central B Alignment would impact the second highest acreage of parklands (147 acres) among the Tier 2 alignments. The eastern alignments would impact the lowest acreage of parklands. The lack of historic structures and historic districts, as well as parklands, along the eastern alignments can be explained by the auto-centric development pattern along the corridor and the timing of the development. The western and central alignments travel through historic residential neighborhoods, while the eastern alignments follow roadways with development occurring post World War II. Maps illustrating the locations of 4(f) sites and historical resources relative to the Tier 2 station areas are included in **Appendix D**.

Table 19. 4(f) Sites and Historic Resources within Station Service Areas

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Historic Structures	8	6	6	7	0	0
Historic Districts	5	8	8	6	0	0
Parklands (acres)	149	132	147	109	36	51

Highest Ranked
 Second Highest Ranked

3.1.5 100-year Floodplain Analysis

In addition to the 4(f) sites and historic resources, the environmental analysis included an assessment of the potential impacts of flooding. This criterion is related to project Theme 7: Environmental Consideration and Resiliency. This criterion evaluated potential flood impacts for each alternative by determining the sections of each alignment within the 100-year floodplain. Analyzing the potential impacts of flooding also acknowledges the City’s emphasis on addressing resiliency through future efforts focused on flood mitigation and preparedness measures.

3.1.5.1 100-year Floodplain Analysis Methodology and Data

The purpose of the analysis was to determine the sections of each alignment that would pass through the 100-year floodplain and the total linear miles of each alignment within the 100-year floodplain. The 100-year floodplain, as developed by the Federal Emergency Management Agency (FEMA), is the land that is predicted to flood during a 100-year storm and has a one percent chance of occurring in any given year. The alignments were evaluated using GIS mapping that isolated and added the sections of each alignment within the 100-year floodplain. Data indicating the extent of the 100-year floodplain was provided by the City of Norfolk and FEMA. **Table 20** provides the total length of each alignment that is within the 100 year floodplain. Maps identifying the portions of each alignment that pass through the 100-year floodplain are included in **Appendix D**.

Table 20. Length of Tier 2 Alignments within 100-year Floodplain

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Length of Alignment within 100-year Flood Plain (miles)	1.22	1.10	1.06	0.21	0.13	0.24

Highest Ranked
 Second Highest Ranked

3.1.5.2 100-year Floodplain Analysis Results

The Western Alignment has the largest number of linear miles passing through the 100-year floodplain, with 1.22 miles, while the Eastern A Alignment has the least, with 0.13 miles. This is because the most flood-prone areas in the City of Norfolk are in western area neighborhoods such as Ghent and Larchmont. The existing roadways the eastern alignments follow avoid flood prone areas and are not located adjacent to existing water bodies. The Central A Alignment has the second greatest number of linear miles in the 100-year floodplain at 1.10 miles.

3.1.6 Traffic Analysis

This section describes the traffic analysis methodology used to evaluate the intersections along the possible transit alignment routes for a Tide extension to Naval Station Norfolk. The traffic analysis methodology consists of a critical movement analysis of selected intersections. The objective of this planning-level analysis is to identify potential capacity issues at intersections. This analysis relates to Theme 3: A fixed guideway connection between The Tide and NSN should make travel time more reliable.

3.1.6.1 Intersection Analysis Methodology

The intersection analysis was conducted for important signalized intersections on the possible transit alignment routes. The focus of this planning-level methodology is to examine the signalized intersections that control the capacity of each segment that would form a potential transit alignment. The approach is as follows:

1. **Obtain traffic volumes for the a.m. and p.m. peak hours.** Turning movement counts were collected during June 2014 at signalized intersections within the alignment segments.
2. **Perform a critical movement analysis for each intersection.** The critical movement analysis technique is a *simplified* approach to estimate the capacity utilization at each intersection and identifies the maximum number of vehicles that need to be served during each signal phase.
3. **Estimate the volume to capacity (v/c) ratio for each intersection.** Based on the estimated number of signal phases and using the sum of critical movement volumes, the volume-to-capacity ratio was computed for each intersection.

Critical movement analysis is a simplified technique that allows for an estimate of whether an intersection is operating below, at, or above capacity based upon specific critical traffic movements. The typical threshold used in critical movement analysis for determining whether intersections are under capacity/near capacity is a v/c ratio of 0.85⁷. However, as this methodology does not take into account many real-world conditions including pedestrian movements, consistent values of capacity across all travel lanes, and complex signal phasing, a lower threshold of 0.80 was used to identify intersections that are or would be near capacity. The results of the critical movement analysis are approximations and may overestimate the amount of remaining capacity available at an intersection. Before any decisions regarding possible transit alignments are made, a more detailed operational analysis must be conducted.

The intersection analysis was performed separately for the a.m. and p.m. peak hours. The larger of the a.m. and p.m. peak hour intersection v/c ratios was used to compare operations. Further details about the intersection analysis methodology can be found in **Appendix E**.

3.1.6.2 Year 2034 No-Build Scenario

The next step of the analysis computed future v/c ratios for each intersection after accounting for traffic volume increases. This approximates a “No-Build” scenario analysis, where volume is increased and the lane configuration at each intersection would remain the same as in existing conditions. One of the main advantages of using the v/c ratio to represent the traffic operations of each existing intersection is that the analysis of future intersection traffic operations can be computed once the existing v/c ratios are determined. For purposes of future conditions, the study assumed a 0.5 percent annual growth rate

⁷ <http://ops.fhwa.dot.gov/publications/fhwahop08024/chapter3.htm#3.3> (see Table 3-2 in Section 3.3.6)

over 20 years, which would result in a growth factor of approximately 10.5 percent. The existing v/c ratios were multiplied by a factor of 1.105 to obtain the future v/c ratios. While this adjustment does not consider localized growth or decline due to changes in land use and demographics, it is a reasonable assumption for a high-level analysis.

3.1.6.3 Year 2034 Lane Removal Scenario

The last component of the intersection analysis was to perform a planning-level analysis of a future lane removal scenario where through travel lanes would be removed to provide space for transit operations. For each intersection, a critical movement analysis was performed with the intersection lane configurations altered by removing one travel lane in either direction. At intersections where two or more segments would meet, the critical movement analysis examined the cases where lanes were removed in the east-west direction or the north-south direction. The larger calculated v/c ratio between the two analyses was used as the representative v/c ratio.

The decision to remove lanes did not consider whether a median or other potentially available right-of-way was present along the roadway. Although several roadways within the study area contain a median (e.g. Hampton Boulevard, Church Street, Granby Street, and Llewellyn Avenue) lanes were still removed to support a “worst-case” level of analysis.

Alignments were evaluated by counting the number of intersections with a v/c ratio at or greater than 0.80 under the Year 2034 Lane Removal Scenario.

3.1.6.4 Existing Conditions Results

The existing conditions critical movement analysis indicates that higher v/c ratios generally occur during the p.m. peak hour than the a.m. peak hour. Four intersections (Military Highway/Poplar Hall Road, Military Highway/Princess Anne Road, Military Highway/Norview Avenue, and Chesapeake Boulevard/W. Little Creek Road) along the Eastern A Alignment and the Eastern B Alignment have a v/c ratio higher than 0.80. According to the critical movement analysis, four intersections (Tidewater Drive/Lafayette Boulevard, Chesapeake Boulevard/W. Little Creek Road, Chesapeake Boulevard/Johnstons Road, and Sewell’s Point Road/Chesapeake Boulevard/Norview Avenue) along the Central C Alignment have a v/c ratio higher than 0.80.

Based on the results of the critical movement analysis, the Western Alignment, Central A Alignment, and Central B Alignment do not have any intersections that currently operate with a v/c ratio greater than 0.80. The results of the intersection analysis can be seen in

Table 21. A map displaying the existing conditions intersection results can be found in **Appendix E, Figure E.1.** The complete results for the intersection analysis are contained in tabular form in **Appendix E, Table E.1.**

Table 21. Summary of Existing Conditions Results

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of intersections operating at v/c > 0.80	0	0	0	4	4	4

 Highest Ranked

3.1.6.5 Year 2034 No-Build Scenario Results

Traffic volumes were increased from existing conditions by 10.5 percent in the Year 2034 No-Build Scenario while the number and configuration of lanes remained the same at intersections. According to the critical movement analysis, three intersections (Military Highway/Poplar Hall Road, Military Highway/Norview Avenue, and Chesapeake Boulevard/W. Little Creek Road) along the Eastern A Alignment and the Eastern B Alignment would have a v/c ratio higher than 0.80. The Military Highway/Princess Anne Road intersection would be grade-separated in the future so this intersection was removed from the results. According to the critical movement analysis, four intersections (Tidewater Drive/Lafayette Boulevard, Chesapeake Boulevard/W. Little Creek Road, Chesapeake Boulevard/Johnstons Road, and Sewell’s Point Road/Chesapeake Boulevard/Norview Avenue) along the Central C Alignment would have a v/c ratio higher than 0.80.

According to the critical movement analysis, the Western Alignment, Central A Alignment, and Central B Alignment would not have any intersections with a v/c ratio greater than 0.80. The results of the analysis can be seen in **Table 22**. A map displaying the Year 2034 No-Build intersections results can be found in **Appendix E, Figure E.2**. The complete results for the intersection analysis are contained in tabular form in **Appendix E, Table E.1**.

Table 22. Summary of Year 2034 No-Build Scenario Results

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of intersections operating at v/c > 0.80	0	0	0	4	3	3

 Highest Ranked
 Second Highest Ranked

3.1.6.6 Year 2034 Lane Removal Scenario Results

Traffic volumes were increased from existing conditions by 10.5 percent in the Year 2034 Lane Removal Scenario while one lane in each direction was removed from each intersection along an alignment.

According to the critical movement analysis, the Western Alignment would have three intersections with a v/c ratio greater than 0.80:

- Hampton Boulevard/W. 38th Street
- Hampton Boulevard/W. 43rd Street

- Granby Street/W. 38th Street

This would be an increase of three intersections from the Year 2034 No-Build Scenario. **Table 23** lists the number of intersections with v/c greater than 0.80 along each alignment.

According to the critical movement analysis, both the Central A Alignment and the Central B Alignment would have four intersections with a v/c ratio greater than 0.80:

- Granby Street/W. Little Creek Road
- Granby Street/Willow Wood Drive
- Granby Street/W. 38th Street
- Monticello Street/Virginia Beach Boulevard

This would be an increase of four intersections from the Year 2034 No-Build Scenario.

According to the critical movement analysis, the Central C Alignment would have six intersections with a v/c ratio greater than 0.80:

- Granby Street/W. Little Creek Road
- I-64 Eastbound Ramps/W. Little Creek Road
- Chesapeake Boulevard/W. Little Creek Road
- Chesapeake Boulevard/Johnstons Road
- Sewell's Point Road/Chesapeake Boulevard/Norview Avenue
- Tidewater Drive/Lafayette Boulevard

This would be an increase of two intersections from the Year 2034 No-Build Scenario.

According to the critical movement analysis, both the Eastern A Alignment and the Eastern B Alignment would have six intersections with a v/c ratio greater than 0.80:

- Granby Street/W. Little Creek Road
- I-64 Eastbound Ramps/W. Little Creek Road
- Chesapeake Boulevard/W. Little Creek Road
- Military Highway/W. Little Creek Road
- Military Highway/Norview Avenue
- Military Highway/Poplar Hall Road

This would be an increase of three intersections from the Year 2034 No-Build Scenario. The Military Highway/Princess Anne Road intersection would be grade-separated in the future so this intersection was removed from the results.

Table 23. Summary of Year 2034 Lane Removal Scenario Results

Highest Ranked
 Second Highest Ranked

Evaluation Criteria	Western	Central A	Central B	Central C	Eastern A	Eastern B
Number of intersections operating at v/c > 0.80	3	4	4	6	6	6
Increase in the number of intersections operating at v/c > 0.80 compared to No-Build	3	4	4	2	3	3

According to the critical movement analysis, the eastern alignments and the Central C Alignment would have the most intersections with a v/c ratio greater than 0.80 in the Year 2034 Lane Removal Scenario. The Central A Alignment and the Central B Alignment would have the largest increase in the number of intersections with a v/c greater than 0.80. The Western Alignment would have the fewest number of intersections with a v/c greater than 0.80. From an intersection capacity perspective, the results indicate that each of the alignments would have some intersections that could potentially act as a bottleneck to traffic flow along the possible transit alignments. The critical movement analysis does not indicate any substantial differences in potential impacts between the alignments.

A map displaying the Year 2034 Lane Removal scenario intersections results can be found in **Appendix E, Figure E.3**. The complete results for the intersection analysis are contained in tabular form in **Appendix E, Table E.1**.

3.2 OCTOBER 2014 PUBLIC REVIEW OF TIER 2 TECHNICAL EVALUATION RESULTS

The final set of public workshops was conducted in October 2014. They were held on October 20 at ODU, October 23 at the Mary D. Pretlow Anchor Branch Library, October 27 at the Ray and Joan Kroc Corps Community Center, and October 30 at Tidewater Community College. Approximately 140 community members participated in the workshops. The goal of the workshops was to have the public review the results of the Tier 2 technical evaluation and to identify their preferred alignments and corridors from the Tier 2 subset of six alignments.

Workshop attendees watched a PowerPoint presentation given by HRT to learn about the study and review the preliminary results of the Tier 2 technical analysis. An explanation of the preferred corridor selection activity was given before attendees broke into small groups of 7-10 people to vote on their preferred alignment of the six alignments studied in the Tier 2 technical evaluation process. **Table 24** on the following displays the results for each public meeting and the totals for each alignment.

Table 24. October 2014 Public Meeting Results

Public Meeting	Western	Central A	Central B	Central C	Eastern	Highest Ranked	Second Highest Ranked
October 20, 2014	39	0	4	2	4	7	7
October 23, 2014	5	0	5	4	4	3	3
October 27, 2014	4	1	4	1	8	7	7
October 30, 2014	16	3	2	0	2	9	9
Totals	64	4	15	7	18	26	26

Section 4
Conclusions and Options for Further Study



4.0 CONCLUSIONS AND OPTIONS FOR FURTHER STUDY

The Tier 2 technical analysis evaluated the six alignments that advanced from the Tier 1 screening process across a range of criteria intended to understand which alignments would best meet the study's *Purpose and Need* and project themes. The Tier 2 screening process consisted of analyses of potential station areas along each alignment; potential impacts to right-of-way, historical properties and parklands; resiliency; ridership; and a planning-level traffic analysis of intersections. At the conclusion of the technical analyses, members of the public were invited to four workshops in October 2014 to weigh in and vote on their preferred alignment to connect The Tide with NSN.

Based upon the results of the Tier 2 screening process, five options have been selected to be advanced for further discussion. The five options are based primarily on refinement of the Western Alignment and the Eastern B Alignment, which were the two alignments that performed best across the range of Tier 2 technical analyses and had the broadest public support.

The Western Alignment would connect many key activity centers in the City of Norfolk, serve a wide range of residents and employment locations, integrate well and complement HRT's bus system, travel through areas of Norfolk that have a dense network of sidewalks and bicycle-friendly streets, and would have ridership numbers on the new alignment similar to the existing Tide. However, the Western Alignment would have the greatest potential impact to historic properties, parklands, right-of-way, and would be primarily located in low-lying areas that are prone to flooding.

The Eastern B Alignment would not connect as many key activity centers in Norfolk as the Western Alignment, but it would provide a more direct trip from the existing Tide to NSN and potentially serve the Norfolk International Airport via a shuttle from a nearby transit station. While the Eastern B Alignment would not travel through existing dense residential or employment areas, it would have the second-highest ridership forecast because of its ability to provide a direct trip to NSN. The properties near the likely station areas of the Eastern B Alignment may have the highest potential for future TOD sites because those properties have larger parcel sizes than those around other alignment station areas. The Eastern B Alignment has the benefit of being located in areas with relatively high elevation in the City of Norfolk, and therefore would have the lowest propensity for flooding during major storm events. This alignment would have fewer impacts to historic sites and parklands compared with the other alignments.

While the Western Alignment and the Eastern B Alignment performed best across the range of technical analyses and public input, all five options would meet NSNTES' *Purpose and Need* and project themes. The five options are shown in **Figure 24** through **Figure 28**.

Option 1

Option 1 would use the Western Alignment as studied in the Tier 2 technical analysis. This option would connect the Ghent neighborhood, ODU, and NSN along Hampton Boulevard as shown in **Figure 24**. The

connection to NSN at the north end of the alignment, the route through Ghent, and the connection to The Tide are to be determined.

Option 2

Option 2 would use the Eastern B Alignment as studied in the Tier 2 technical analysis. This option would travel along Military Highway, W. Little Creek Road, and Hampton Boulevard to NSN as shown in **Figure 25**. The connection to NSN at the north end of the alignment and the connection to The Tide are to be determined.

Option 3

Option 3 would use both the Western Alignment and Eastern B Alignment as studied in the Tier 2 technical analysis. This option would connect the Ghent neighborhood, ODU, and NSN along Hampton Boulevard on the west side of Norfolk and would travel along Military Highway and W. Little Creek Road on the east side of Norfolk before linking with the Western Alignment at a station near the Joint Forces Staff College on Hampton Boulevard. The connection to NSN at the north end of the alignment, the route through Ghent, and the two connections to The Tide are to be determined. Option 3 is illustrated in **Figure 26**.

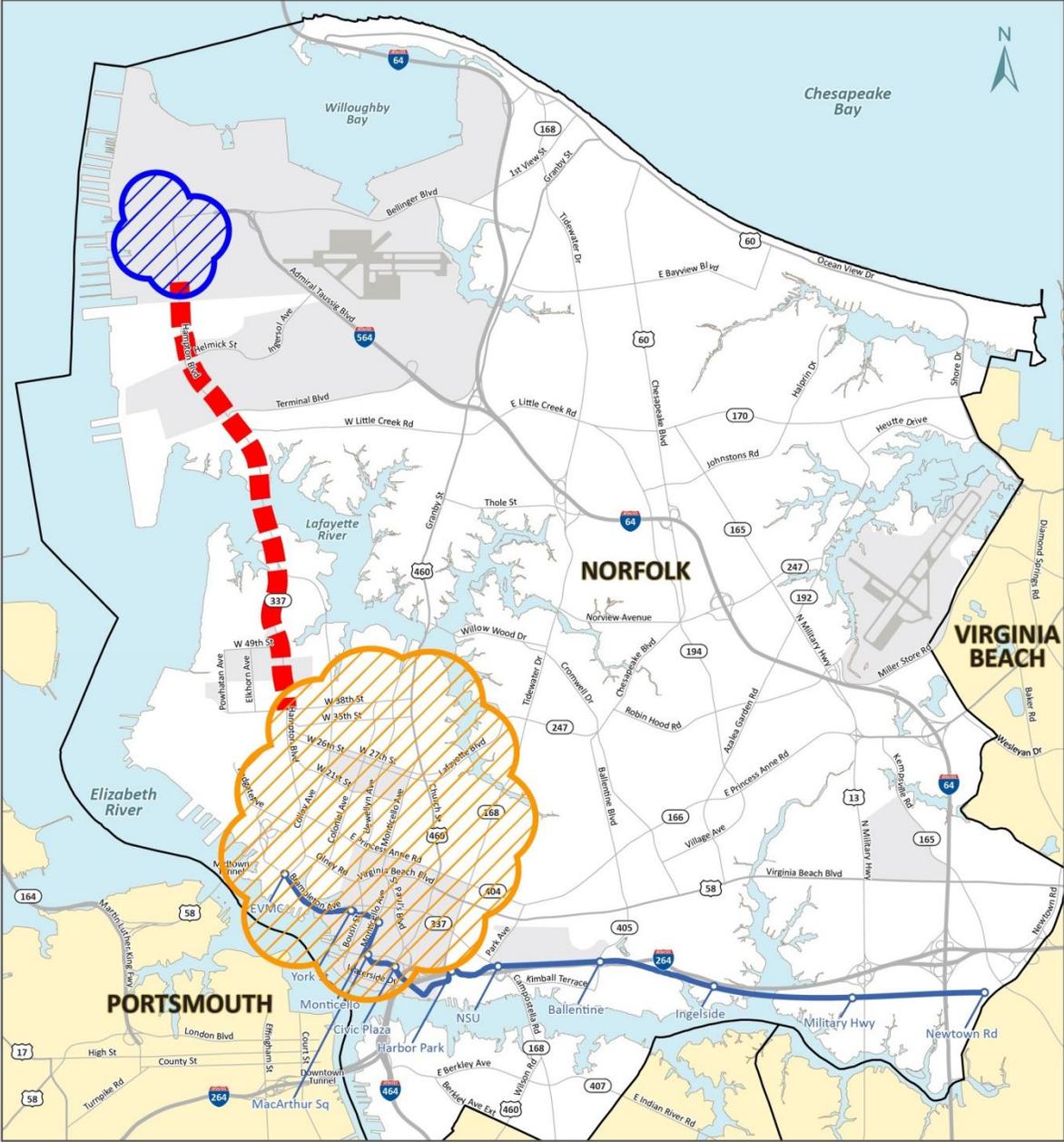
Option 4

Similar to Option 3, Option 4 would use both the Western Alignment and Eastern B Alignment as studied in the Tier 2 technical analysis and connect the Ghent neighborhood, ODU, and NSN along Hampton Boulevard on the west side of Norfolk and would travel along Military Highway and W. Little Creek Road on the east side of Norfolk before linking with the Western Alignment at a station near the Joint Forces Staff College on Hampton Boulevard. The connections to NSN and to the eastern end of The Tide are to be determined. A route from the western end of The Tide through the Ghent neighborhood could include a streetcar, bus, or shuttle connection and is to be determined. Option 4 is illustrated in **Figure 27**.

Option 5

Option 5 would use the Eastern B Alignment as studied in the Tier 2 technical analysis. This option would travel along Military Highway, W. Little Creek Road, and Hampton Boulevard to NSN as shown in **Figure 28**. The connections to NSN and to the eastern end of The Tide are to be determined. A route from the western end of The Tide to the Ghent neighborhood and ODU could include an LRT or streetcar connection and is to be determined.

Figure 24. Option 1



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations

Option 1

Connection to The Tide to be determined

Connection to NSN to be determined

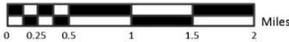


Figure 25. Option 2

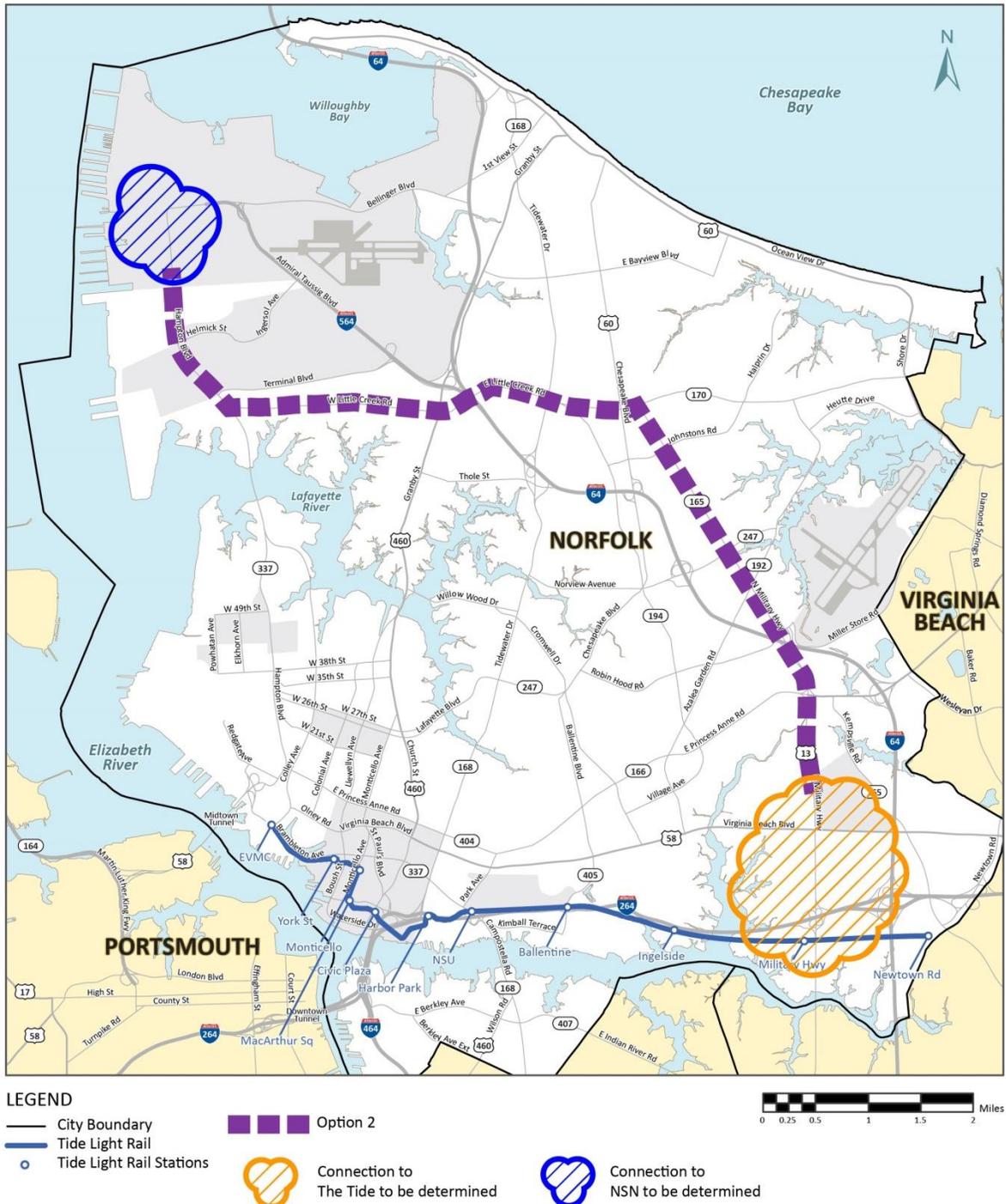
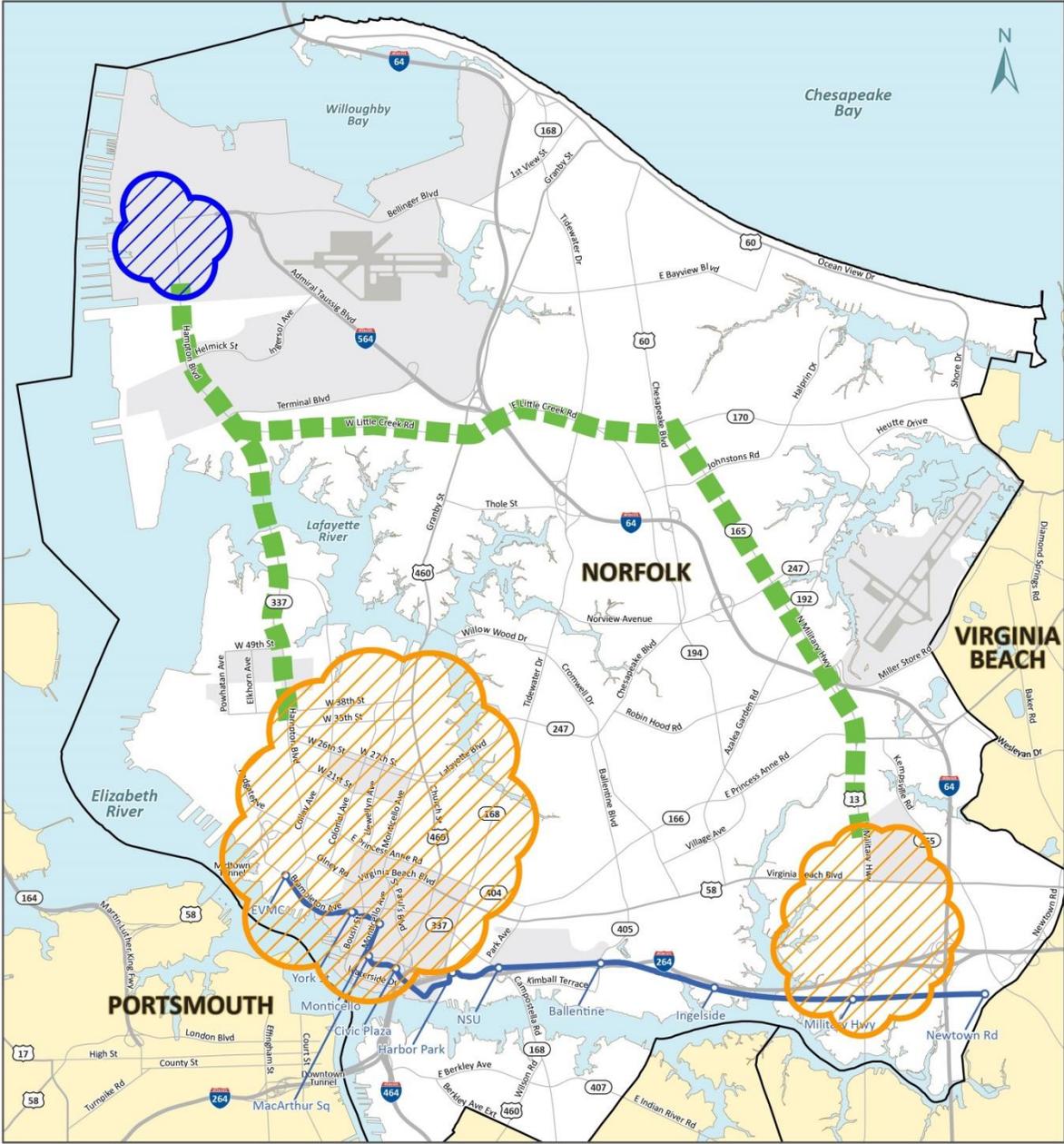


Figure 26. Option 3



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations

Option 3

Connection to The Tide to be determined

Connection to NSN to be determined

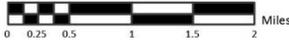
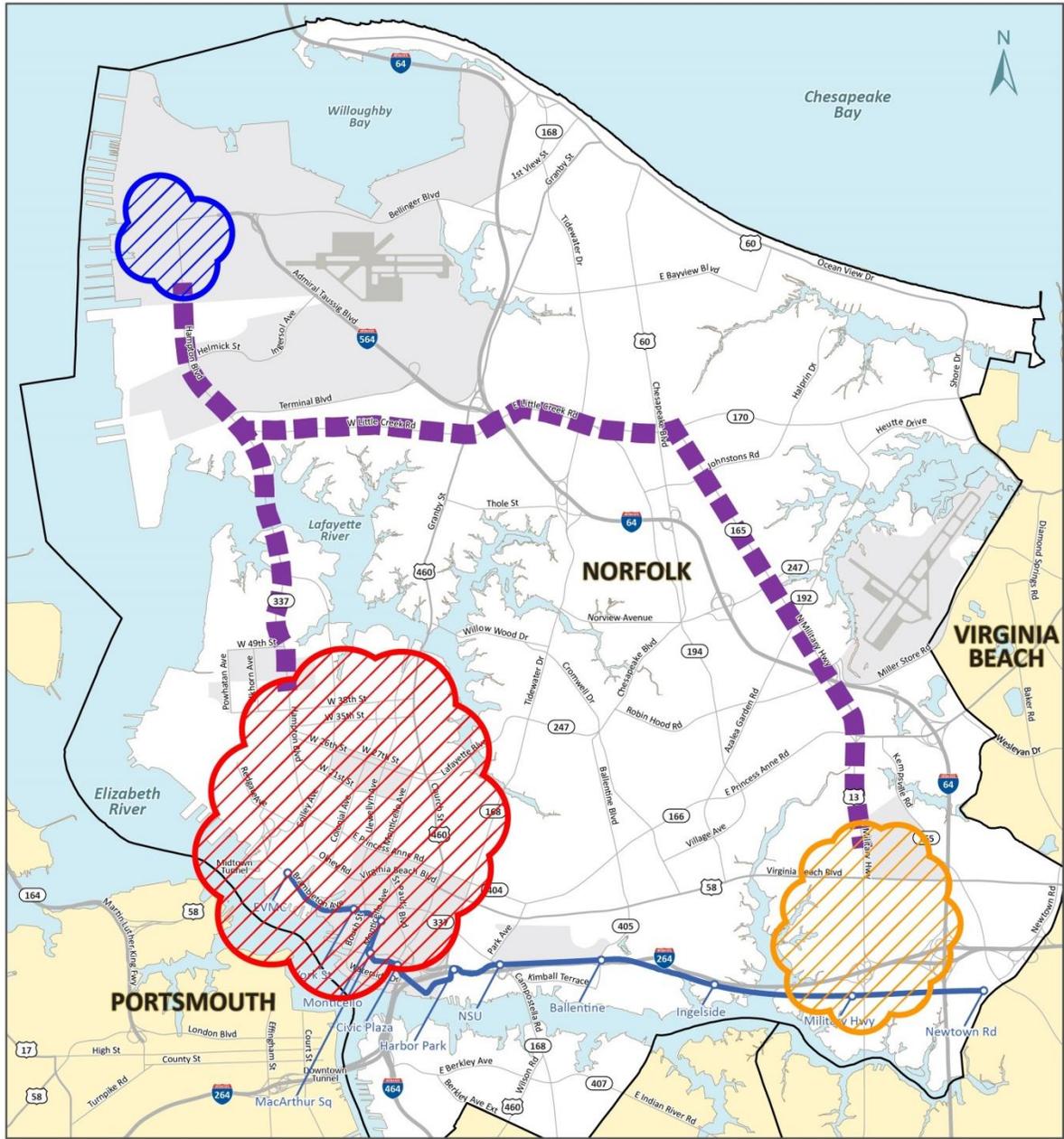


Figure 27. Option 4



LEGEND

- City Boundary
- Tide Light Rail
- Tide Light Rail Stations

Option 4

Connection to The Tide to be determined

Connection to NSN to be determined

Streetcar/bus/shuttle connection to ODU/Ghent to be determined

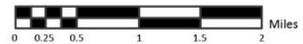


Figure 28. Option 5

