




Final Report

Interstate 95

Corridor Improvement Plan

September 2021

VDOT

Office of INTERMODAL Planning and Investment

DRPT
Virginia Department of Rail and Public Transportation

INTERSTATE 95

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Introduction

The results of the I-95 Corridor Improvement Plan will be folded into the Interstate Operations and Enhancement Program (IOEP), which is intended to improve the safety, reliability, and travel flow along interstate highway corridors in the Commonwealth. The IOEP was developed in accordance with Chapters 1230 and 1275 of the 2020 Virginia Acts of Assembly, as codified in §33.2-372 and through amendments to §§ 33.2-232 and 33.2-358 of the Code of Virginia, in which the General Assembly of Virginia directed the Commonwealth Transportation Board (CTB) to prepare interstate corridor improvement plans for those interstate corridors with more that 10 percent of their vehicle miles traveled comprised of Federal Highway Administration (FHWA) Class 6 vehicles and above. These corridors (I-81, I-95 and I-64) receive dedicated funding from the IOEP. The IOEP policy text is provided in **Appendix A**.

I-95 is the primary interstate corridor on the East Coast of the US with more than 1,900 miles between Maine and Florida. This corridor serves a region that contains 38 percent of all US jobs, and considered by itself would represent the second largest economy in the world.[1] According to the I-95 Corridor Coalition, by 2035, 100 percent of the urban segments will be heavily congested, and 55 percent of the non-urban segments will see increased congestion. I-95 serves as a vital conduit for Virginia's urban crescent, connecting the Richmond, Fredericksburg, and Washington, DC, metropolitan regions—a population of almost 3.5 million. In Virginia, I-95 provides north-south movement of people, goods, and freight, with every mode of transportation represented, as shown by the breadth of travel options and amenities in **Figure 1**. Approximately 9 million trucks and almost $200 billion in goods are moved through the corridor per year, second only to the I-81 corridor in Virginia.

Figure 1 Significance of the I-95 Corridor

1 A 2040 Vision for the I-95 Coalition Region, I-95 Corridor Coalition, December 2008, https://tetcoalition.org/wp-content/uploads/2015/03/2040_Vision_for_I-95_Region_Executive_Summary.pdf?x70560
2 2012 Global Insight/ Transearch data
3 Ibid
4 VDOT Crash Data
5 Ibid

Rail transportation is another critical mode currently operating within the I-95 Corridor. On April 30, 2021, the Commonwealth signed an agreement with CSX Transportation (CSXT), Amtrak, and Virginia Railway Express (VRE) formalizing the Transforming Rail in Virginia Program, a $3.7 billion investment expanding capacity for passenger, commuter, and freight rail in the I-95 corridor and throughout the state. This new Virginia-led rail expansion program is expected to remove 5 million cars and 1 million trucks off Virginia's highways each year, while propelling the Port of Virginia towards its goal of moving 40 percent of containers by rail.

CSXT's north-south intermodal freight mainline in Virginia is part of CSXT's multistate National Gateway Initiative, generally paralleling I-95. This route provides service from Washington, DC, to Richmond and then farther south via Petersburg and Emporia. At Weldon, south of the Virginia/North Carolina border, this mainline has an eastward extension to the Port of Virginia facilities in Hampton Roads. The CSXT National Gateway Initiative has improved the efficiency of double stack container movements between the Mid-Atlantic and the Northeast/Midwest, and has improved train operations to and from the Port of Virginia.

Study Request

During the 2019 Virginia General Assembly Session, the Senate and House of Delegates approved similar resolutions (SJR 276 and HJR 581) requesting the CTB study the 52 miles of the I-95 corridor between Exit 118 (Thornburg) in Spotsylvania County and Exit 170 (I-495/I-395) in Fairfax County along with potential financing options for improvements to the corridor. The Secretary of Transportation and the CTB requested that the study area be expanded to include all 179 miles of I-95 in Virginia between the North Carolina state line and the Woodrow Wilson Bridge in Alexandria. The corridor traverses 12 counties, six cities, and four VDOT construction districts: Northern Virginia, Fredericksburg, Richmond, and Hampton Roads.

According to SJR 276 and HJR 581, a 2017 nationwide study conducted by the Texas Transportation Institute ranked southbound I-95 at Exit 133A in Fredericksburg as having the worst traffic congestion in the nation. According to that study, this location is projected to cost drivers $2.3 billion from 2017 through 2026 in time lost, fuel wasted, and carbon emitted. Additionally, northbound I-95 between Exit 126 (US 1/Route 17) in Spotsylvania County and Exit 143 (Route 610) in Stafford County was ranked the seventh worst traffic hot spot in the nation with a projected cost to drivers of $1.1 billion through 2026. According to the National Capital Region Transportation Board, the Northern Virginia portion of the Washington, DC, metropolitan region is projected to grow by 20 percent in population and 25 percent in employment by 2040, placing additional strain on the I-95 corridor and the transportation system in general.

The Office of Intermodal Planning and Investment (OIPI), the Virginia Department of Transportation (VDOT), and the Department of Rail and Public Transportation (DRPT) jointly conducted this study resulting in the I-95 Corridor Improvement Plan (Plan).

Study Purpose

The purpose of this plan is to identify a package of targeted operational, multimodal, and capital improvements that are expected to deliver faster, safer, and more reliable travel on I-95 throughout Virginia. It also includes the evaluation of two key parallel routes to I-95 (US 1 and US 301) and the rail cooridor to identify strategies and improvements to more effectively accommodate diversions of traffic, especially during major incidents on I-95.

Multimodal Corridor Characteristics

The I-95 corridor is one of the most multimodal interstate corridors within Virginia. Multimodal travel options such as bus, rail, carpool, and vanpool contribute greatly to moving people in the I-95 corridor, offering a wide array of alternatives to single-occupancy vehicle (SOV) travel. Rail service along the corridor is provided by Virginia Railway Express (VRE) (commuter rail), Amtrak (intercity and long-distance passenger rail), and Washington Metropolitan Area Transportation Authority (WMATA) (Metrorail/heavy rail). Commuter bus service is a popular commuting choice along the northern section of the I-95 corridor, with several providers offering service to key employment hubs including Tysons, Mark Center, the Pentagon, Crystal City, Rosslyn, Ballston, and Washington, DC.

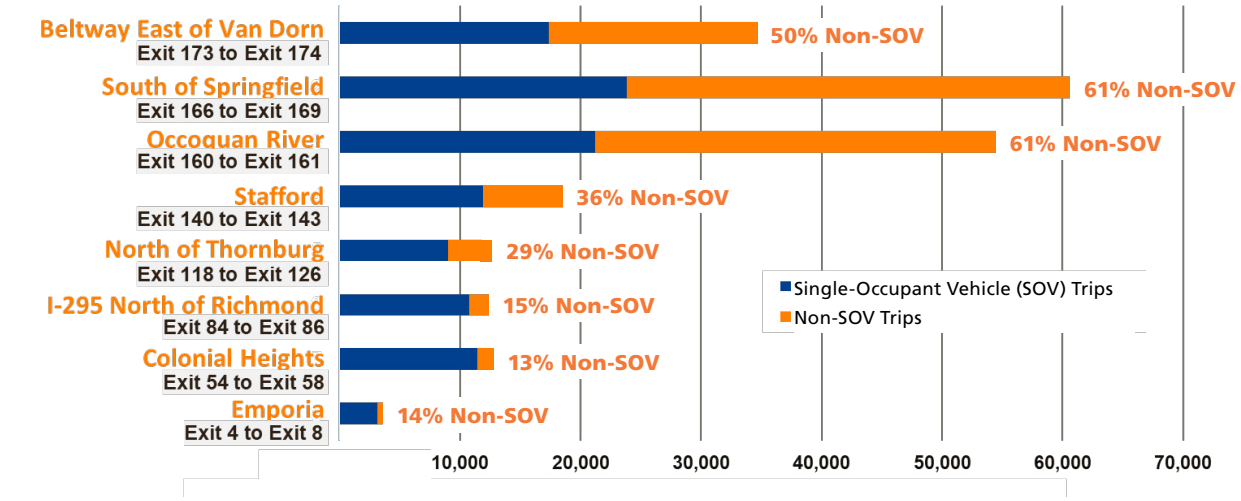
Park-and-ride lots also contribute positively to multimodal travel along the corridor. The availability of commuter parking not only enables even more people to make use of bus and rail systems when co-located with transit hubs but also helps to enable a robust culture of carpooling and vanpooling, including slugging—ad hoc, informal carpools for purposes of commuting. Commuter assistance programs provide residents, employers, and workers along the I-95 corridor with travel options information, trip planning, guaranteed ride home, and multimodal ride matching services.

Additionally, the presence of the I-95 Express Lanes between the Fredericksburg region and the I-495 Beltway around Washington, DC, makes bus travel along the corridor more reliable and incentivizes carpooling and vanpooling as vehicles with three or more people do not pay a toll. Traffic and occupancy counts indicate that during peak periods, the Express Lanes on I-95 are carrying more people than the general purpose lanes.

Throughout the corridor, the availability of these multimodal travel options facilitates tens of thousands of commutes each weekday, as shown in **Figure 2**. Multimodal travel is most prominent in the areas of Northern Virginia and Fredericksburg that are characterized by higher densities of population, employment, and transit service. As an example, between the Occoquan River and I-495, more than 60 percent of all weekday commute trips are made by a combination of rail, bus, vanpool, and carpool trips. The proportion of multimodal trips at the southern end of the corridor is consistent with the more limited amount of commute options available and generally lower density of development.

The commuting data shown is reflective of travel behavior prior to the onset of the global COVID-19 pandemic in early 2020. The pandemic, and corresponding shutdowns did impact travel behaviors with marked increases in telecommuting and peak periods. As vaccination rates have risen in Virginia, traffic volumes have shown gradual increases toward pre-pandemic levels. OIPI will continue to monitor these trends and any long-term changes in travel behaviors will be captured in subsequent updates of the interstate corridor improvement plans.

Figure 2 Single and High Occupancy Vehicle Use Along I-95

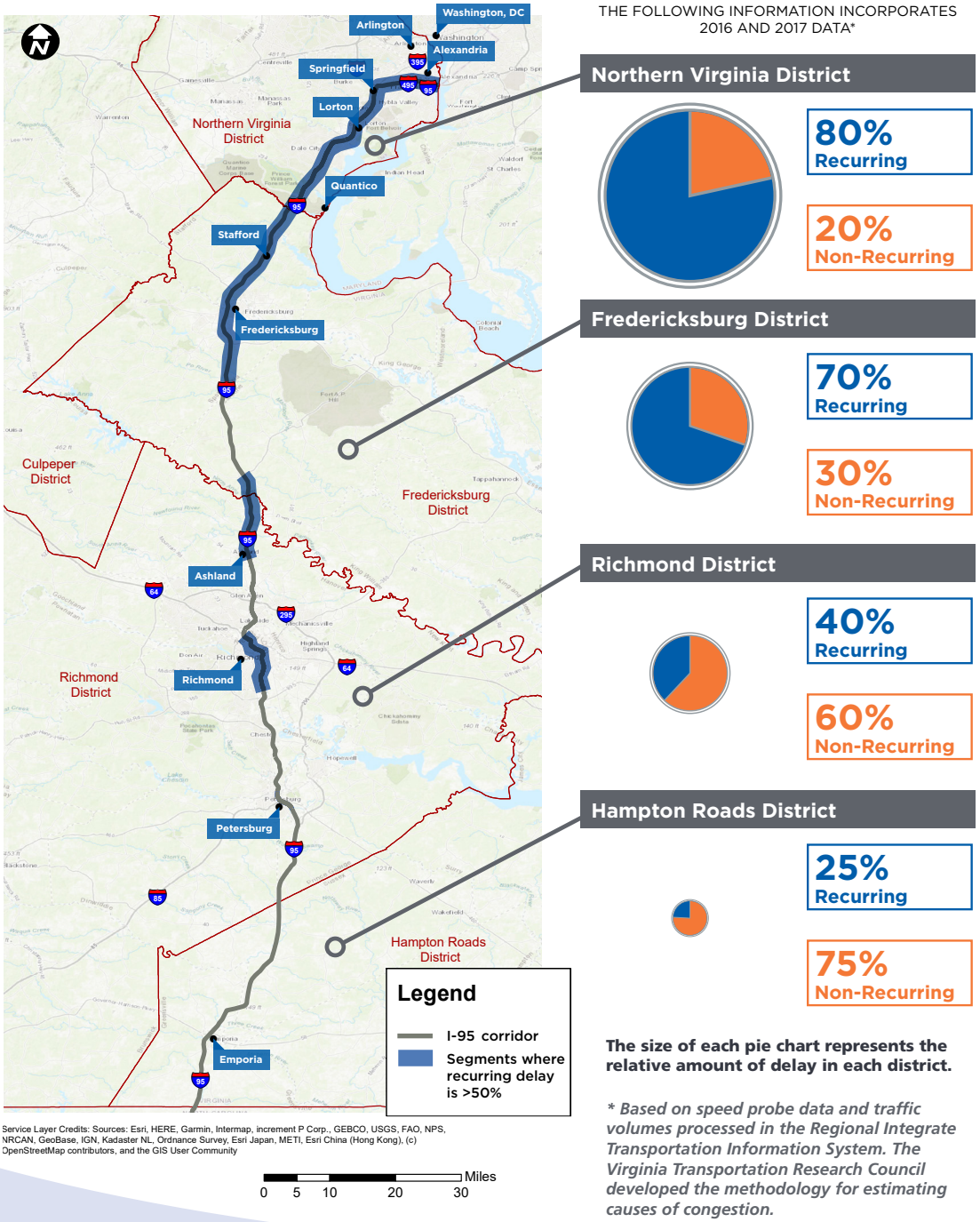


Challenges in the Corridor

While robust and overwhelmingly successful, the existing multimodal system needs improvement to address passenger travel demand along the I-95 corridor. Existing conditions include limited commuter bus service south of Dale City, a lack of off-peak and weekend commuter train service, and, while improvements to the capacity-constrained Long Bridge across the Potomac River are coming, in the interim, it remains a major rail bottleneck limiting immediate passenger rail growth. In addition, many park-and-ride lots with convenient access to I-95 are at or near capacity during weekdays.

Travel and reliability characteristics change drastically as motorists travel from south to north. Travel south of the Fredericksburg area (south of Exit 126) is typically much more reliable than the segments to the north. As shown in **Figure 3**, a greater amount of overall and recurring delays (typically caused by congestion during peak periods) exist in the corridor to the north of Fredericksburg. The area between Fredericksburg and Richmond experiences reliability issues that are expected to worsen as development continues to expand into this area. There are a few areas in the Richmond District where recurring delay exists, specifically in the I-95/I-64 overlap, but the predominant type of delay is non-recurring delay, which is typically caused by incidents, crashes, weather, and/or special events.

Figure 3 Recurring Delay in the Corridor



While the I-95 corridor has definitive segments that experience significant recurring peak hour weekday delays, several portions of the corridor experience weekend and seasonal delays. A key challenge on the I-95 corridor was to identify how travel changed by the time of the day, day of the week, and month of the year. For example, reliability issues that were prevalent on Sunday afternoons in the summer were not issues on Thursday afternoons in the summer.

Another challenge was to identify improvements that could reduce congestion in the corridor to the north of the Fredericksburg area. In addition to the $2.2 million investment in Transforming Rail in Virginia through 2025, Virginia is investing more than $1 billion through 2025 in the capital improvements shown in **Appendix B**. These investments, along with other improvements under construction while the study was being performed, and their expected benefits were taken into consideration when identifying the top 25 percent of locations for congestion, safety, and reliability. As targeted capital improvement recommendations were identified in the areas of greatest need, the study team quickly determined that highway capital improvements alone are unlikely to make a significant enough impact to improve safety and increase speeds in the northern portion of the corridor. Using the travel demand model from the National Capital Region Transportation Planning Board, the study team conducted a hypothetical analysis that added one, two, and three additional general purpose lanes in each direction on I-95 between Exit 118 (Thornburg) and Exit 170 (Springfield Interchange: I-95/I-395/I-495). This analysis showed minor to no speed improvements in 2040 at a planning level cost estimate of more than $12.5 billion for a single additional lane in each direction. Based on the hypothetical widening analysis, the study team anticipates that multimodal recommendations and the promotion of managed lane facilities that incentivize non-single occupant travel will be key components of any solution development along the I-95 corridor in Northern Virginia and Fredericksburg.

To capture performance benefits for non-single occupant travel, the study team adopted an approach that focused on person movement. Additional commuter bus and commuter train service during the peak hours were evaluated. Analyses showed that the number of people moved during those peak hours by bus and rail is projected to be equivalent or greater than the number of persons moved from adding one lane in each direction as described in more detail in the multimodal section of this summary. These types of multimodal solutions must also include the construction of new and/or expanded park-and-ride lots in strategic locations to allow commuters to safely and efficiently access the other modes of transportation.

Approach to Solutions

Realizing that solutions to the challenges in the I-95 corridor involve various modes of travel and different types of expenditures, the study team used a stepped approach to identify improvements. This meant first identifying operational improvements to maximize efficiency of existing infrastructure[6] and then multimodal options, which represent the next lowest cost solution that builds upon the overall goal of moving people. Finally, the team identified highway capital projects where performance issues could not be adequately addressed by either operational or multimodal improvements.

6 Code of Virginia §§33.2-372 requires priority to be given first to operational and transportation demand strategies that improve reliability and safety of travel

Existing Conditions

To more thoroughly understand the current travel conditions in the corridor, the study team gathered data from a variety of sources. This data included travel speeds; numbers and types of crashes; numbers, types, and durations of incidents; origins and destinations of passenger cars and trucks; numbers and types of traffic; multimodal service; and location, number of spaces, and utilization rates at park-and-ride lots.

Depending on the time of day, the day of week, and the month of year, travel in the corridor varies greatly. These differences were important to understand as the study team developed potential improvements.

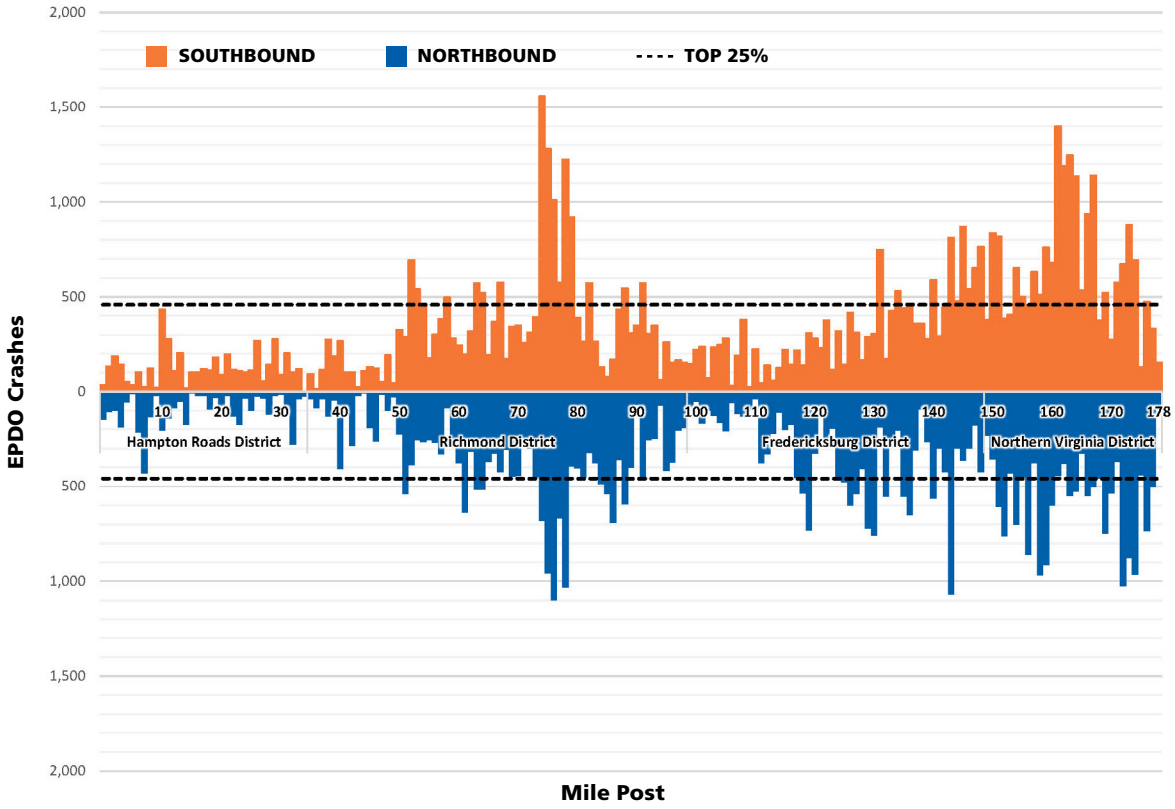
Performance Measures

Based on a review of the available data in corridor, the study team developed four performance measures to evaluate the existing operational and safety issues throughout the corridor. The team collected and summarized crash and delay data for 4 years, 2015 through 2018, in 1-mile segments. The study team then ranked the segments and highlighted the top 25 percent of segments, regardless of direction, to be reviewed for potential improvements. The four performance measures included:

- **Crash frequency and severity:** The total number of crashes, weighted by severity using the equivalent property damage only (EPDO) scale. Source: VDOT Roadway Network System
- **Crash severity rate:** The total rate of crashes, weighted by severity, per 100 million vehicle-miles traveled. Source: VDOT Roadway Network System and VDOT Traffic Monitoring System
- **Total delay:** The total person-hours of delay caused by the impacts of congestion, incidents, and weather events. Source: INRIX
- **Incident delay:** The total person-hours of delay caused by incidents (crashes and disabled vehicles) that lead to at least one lane of the interstate to be closed for an hour or more. Source: INRIX and VA Traffic

An example histogram detailing the EPDO crashes per 1-mile segments is shown in **Figure 4**. The highest crash location along the corridor occurred in the I-95/64 overlap in downtown Richmond, one of the older segments of the corridor constructed prior to the establishment of interstate standards. The next highest crash location occurred on I-95 southbound at the Occoquan River (Exit 160, Route 123). **Appendix C** includes histograms detailing each performance measure for I-95.

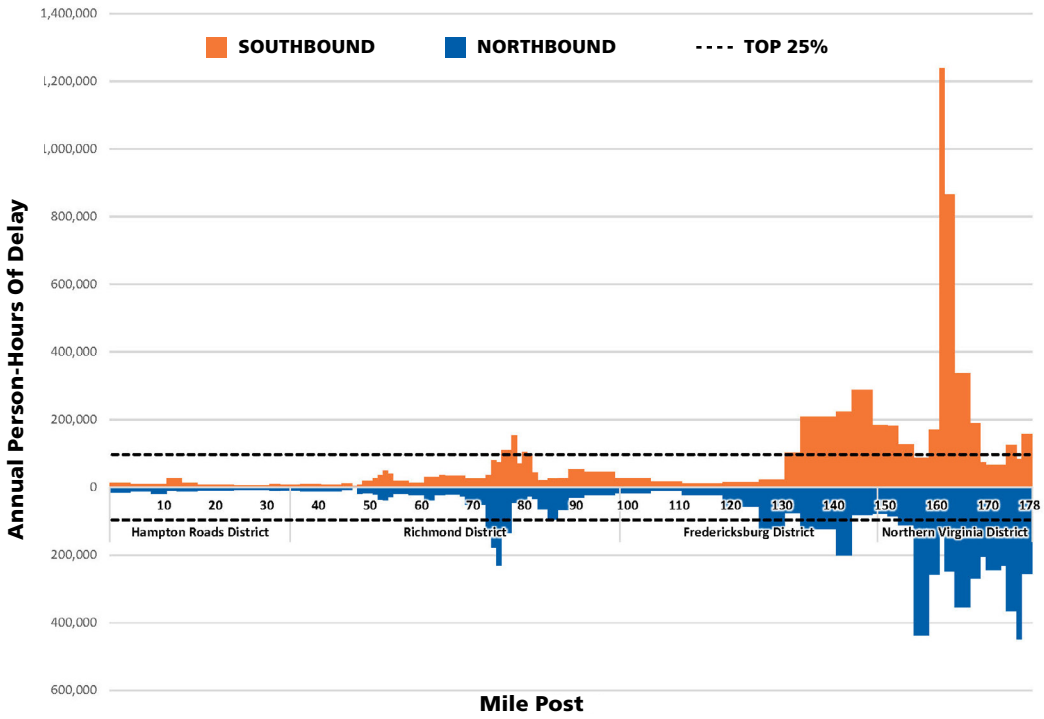
Figure 4 Equivalent Property Damage Only (EPDO) Crashes



In addition to the crash data, person-hours of delay data showed that I-95 southbound at the Occoquan River (Exit 160, Route 123) had the highest person-hours of delay along the entire corridor: more than 1.2 million hours annually as shown in **Figure 5**.

The study team used this information to focus on improvements that would provide the greatest delay reduction for the stretch of I-95 between Exit 158 and Exit 177 in both directions.

Figure 5 Annual Person-Hours of Delay



Supplementary Data

The study team collected and summarized additional data to supplement the four performance measures for the identification of problem areas and project identification. The supplementary data included the following information:

- INRIX speed data to summarize average speed patterns and variability in speeds throughout the corridor by time of day, day of week, and time of year for 2018
- StreetLight origin-destination data to summarize origin-destination patterns on I-95 in 2018 (**Figure 6**)
- VA Traffic Incident data to summarize the number of total or lane-impacting incidents and the average time to clear a lane or scene

This information was used to help identify specific countermeasures at various locations along the corridor. For example, the origin-destination analysis shown in **Figure 7** highlighted that a large percentage of vehicles traveling across the Occoquan River during the p.m. peak period were coming from Fort Belvoir. Given the large workforce at Fort Belvoir and the relatively short distance on I-95 from Fort Belvoir to the popular destinations, DRPT, OIPI and VDOT plan to coordinate with Fort Belvoir in the future to discuss multimodal solutions.

Figure 6 Statewide Origin-Destination Patterns by Interchange

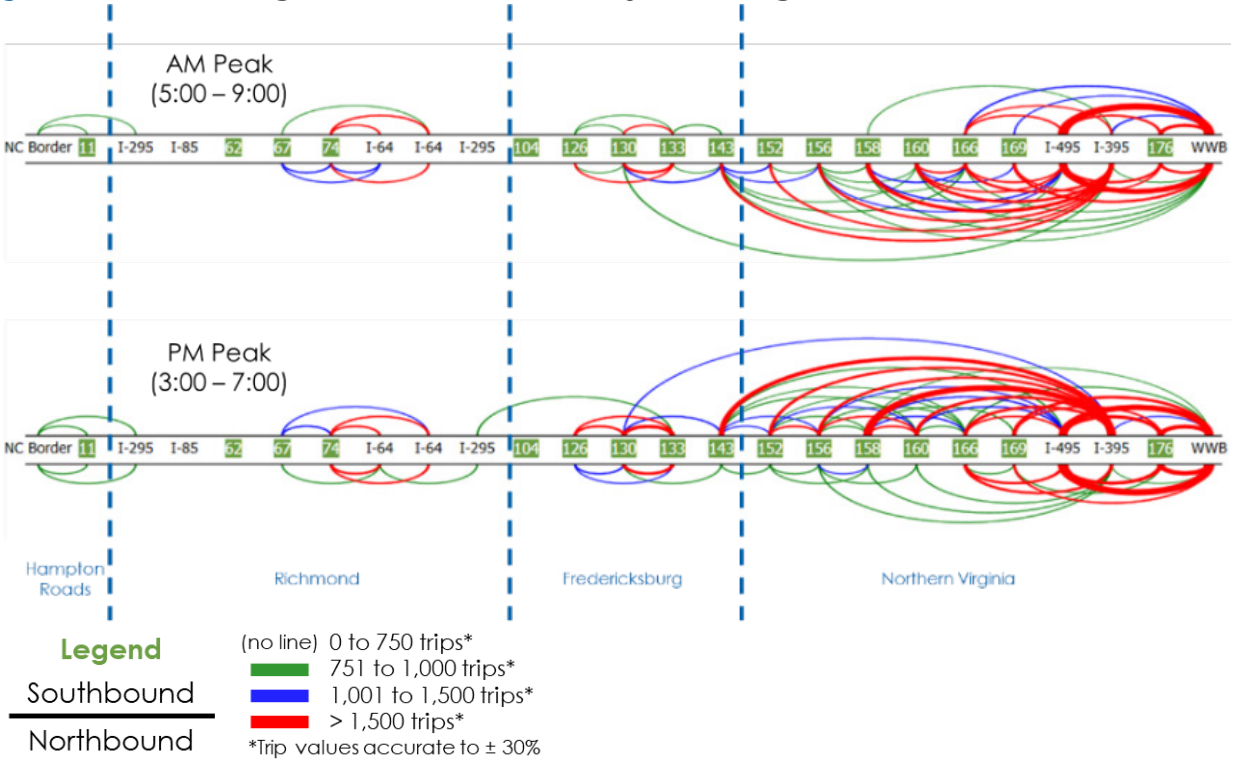
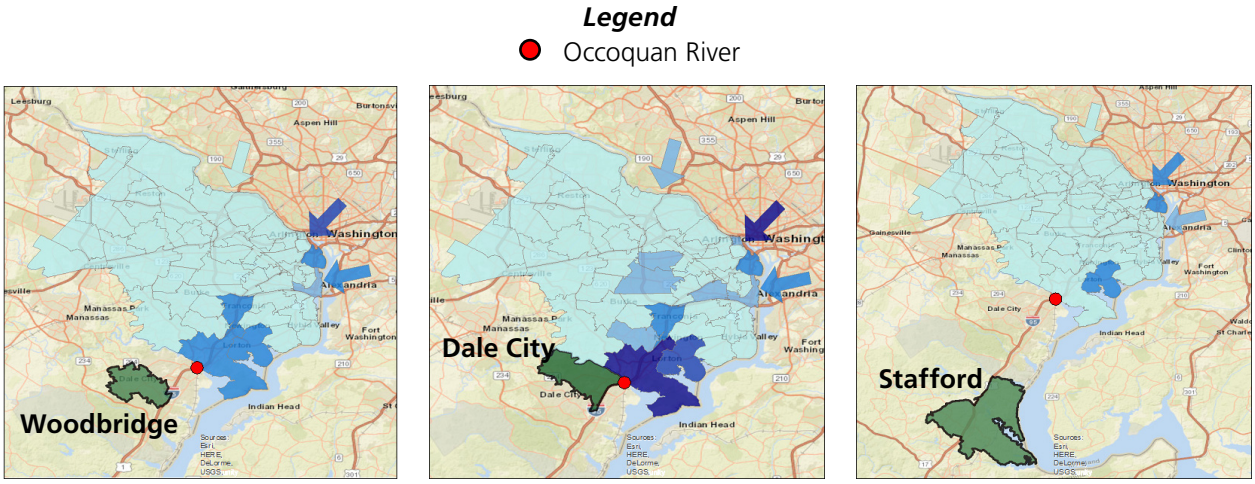


Figure 7 Origin-Destination Patterns at the Occoquan River



Top 3 Origins to WOODBRIDGE

1. Lorton
2. Southbound I-395 from DC
3. **Fort Belvoir**

Top 3 Origins to DALE CITY

1. Southbound 1-395 from DC
2. **Fort Belvoir**
3. Lorton

Top 3 Origins to STAFFORD

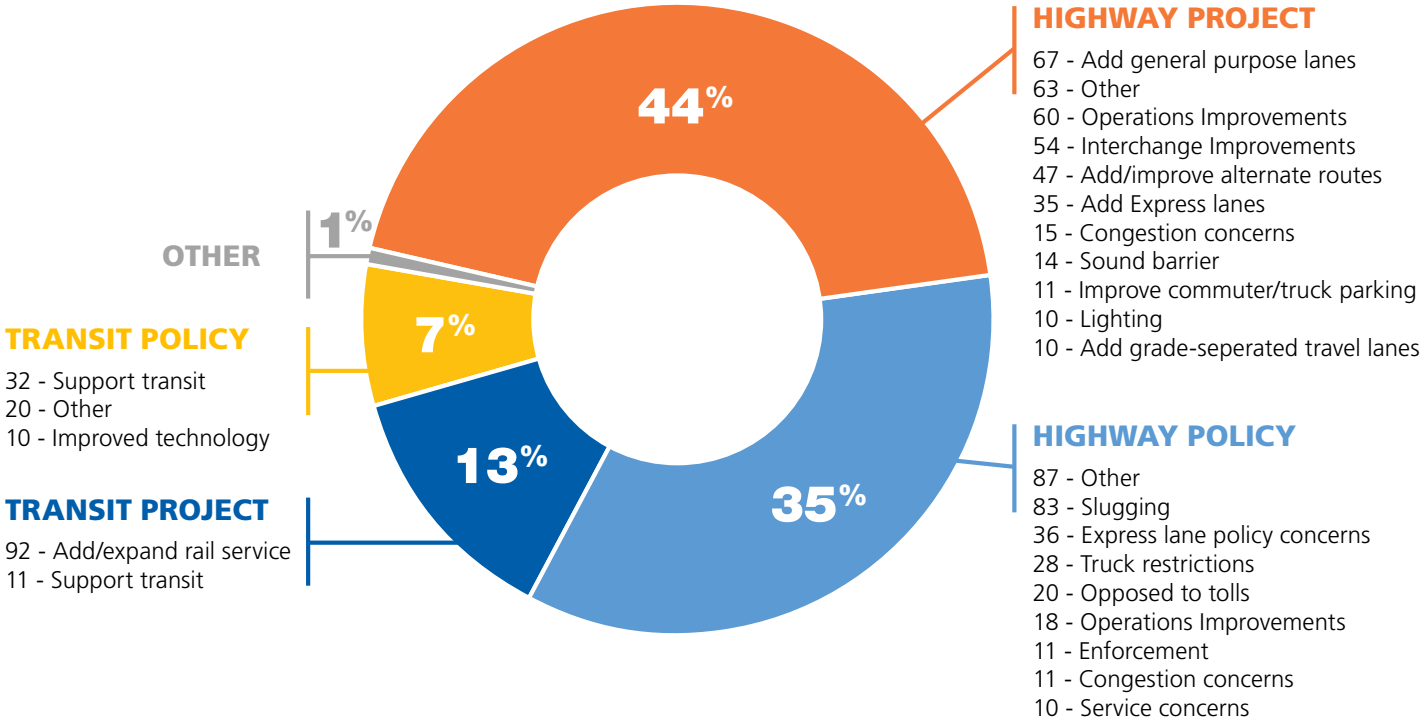
1. Arlington
2. Southbound I-395 from DC
3. **Fort Belvoir**

Public Meetings

Public engagement was encouraged throughout the development of the I-95 Corridor Improvement Plan and served as a critical component of developing the Plan. The study team created a website (**www.va95corridor.org**) to provide information and to gather public input. In addition, an email address was established for receiving comments and a public phone number was made available. The study team also made presentations to local governments and organizations and held public meetings, where attendees were able to view maps of the corridor in their respective area; listen to a presentation about the plan and its progress; identify and validate problem areas; ask questions; and submit comments and suggestions. The display boards and presentations also were made available on the project website.

An online survey tool, MetroQuest, was used to obtain feedback from the public at the July and October meetings. Over 3,000 people provided input to the July MetroQuest survey. The respondents placed nearly 11,750 map markers, with over 75% related to congestion issues. The remainder related to safety, need for alternative routes, multimodal options, technology, and other issues. **Appendix D** contains summary information from the MetroQuest surveys. The study team used comments from this tool to inform the documentation, identification and verification of problem areas in the corridor and develop proposed improvements for consideration. The public was also given the opportunity to identify how they currently use the corridor and document the types of improvements on which they would spend available resources. The public submitted over 850 comments during the course of the study. Those comments are categorized and shown graphically in **Figure 8**.

Figure 8 Public Comment Summary



Operations Improvements Plan

The Plan outlines critical foundational elements for enhancements to operations on the corridor and innovative strategies to improve safety, reduce delay, and enhance customer experience. The operational improvements were identified on both mainline I-95 and on parallel arterials, such as US 1 and US 301.

Using the performance measures for locations within the top 25 percent for incident-related delay on I-95, the study team initially identified more than $200 million in freeway operations and parallel facilities upgrades for the corridor. Using this list as a starting point, the team identified strategies with the greatest need which resulted in a targeted operational upgrade plan totaling $60-$68 million. See **Appendix E** for maps that show the location of operational improvements.

Mainline Operations

Foundational Operations Strategies

Foundational operations strategies are used to address the impacts of non-recurring congestion, such as vehicle crashes and weather events, and respond to those incidents as quickly as possible. These strategies are integral to the function of the freeway and are currently being used throughout Virginia. Foundational operations strategies are infrastructure improvements and/or incident response tools that include following types of improvements:

- Closed-circuit television (CCTV) cameras
- Changeable message signs (CMS)
- Safety service patrol (SSP)
- Towing programs
- Miscellaneous low-cost operations improvements

The study team used a combination of input from the VDOT District Regional Operations Directors (RODs); corridor characteristics; data analysis of traffic volumes and crashes; return on investment analysis; and coordination with other arterial and roadway improvements to determine proposed locations for the foundational strategies.

VDOT determined that CCTV coverage should be expanded to cover 100 percent of the corridor in urban areas, interchanges in rural areas, and locations with high incident rates in the rural areas. To date, the VDOT Regions have begun the preliminary engineering work to design and construct the CCTVs with some CCTVs starting to come online in early 2022. The Regions also identified five new mainline CMS and three replacement CMS to better communicate traffic conditions to the public.

SSP is currently in use along portions of corridor. The study team recommended that select routes be extended and new routes be added to cover existing gaps.

The Towing and Recovery Incentive Program (TRIP) pays incentives to heavy duty recovery companies to clear collisions in less than 90 minutes. The study team identified Greensville, Sussex, Caroline, Spotsylvania, and Stafford Counties as candidates for expanding TRIP. The study team also recommended that instant towing be expanded to the urban areas in the Richmond and Northern Virginia Districts and contract towing be implemented in select locations in Fredericksburg and Northern Virginia.

The study team identified additional low-cost improvements that include Public Safety Answering Point (PSAP) integration, deployment of fiber-optic cabling, and an update to the Active Traffic Management System (ATMS) software.

Innovative Operations Strategies

While the foundational strategies mainly address non-recurring congestion, the innovative strategies address both recurring and non-recurring congestion. The following list includes proposed innovative operations strategies that could be implemented as well as strategies that are already moving forward on the I-95 corridor (those marked with an * are already underway and being implemented).

- Ramp metering*
- Variable speed limits (VSL)*
- Geofenced emergency notifications
- Advanced technologies for work zone management
- Regional Multimodal Mobility Program (RM3P)*

Ramp Metering

Ramp metering involves a signalized meter that regulates the flow of traffic entering a freeway according to current traffic conditions to ease traffic congestion. The study team identified 14 candidate on-ramp locations for ramp metering. Once these ramp metering improvements are implemented, it is recommended that they be operated together within an overall ATMS to be most effective.

Variable Speed Limits (VSL)

VSL is a system that modifies the speed displayed on changeable speed limit signs based on traffic conditions. The VSL system uses traffic detectors and advanced predictive algorithms to identify the ideal speed limit to improve traffic congestion and harmonize traffic flow. To date, a pilot location along the corridor south of Fredericksburg (from Exit 118 to Exit 130) has been identified, along with the preparation of a concept of operations for the system. Preliminary engineering for the pilot has been completed, and a contractor is building the system.

Geofenced Emergency Notification System

The geofenced digital notification system is a tool that alerts drivers stuck in extended periods of congestion. When a large crash occurs and motorists become stranded, the geofenced digital notification system will send information to motorists' mobile phones directly through an alert system.

Advanced Technologies for Work Zone Management

Advanced technologies for work zone management provide the Traffic Operations Center (TOC) the ability to actively manage and inform the public of work zones while also managing work zones along the corridor. The tools for work zone management include additional technology such as the Work Zone Builder application, SmartCone sensors, SmartVests, mobile work zone cameras, dedicated SSP, and mobile message signs.

The Work Zone Builder application should be deployed to the contractor community to facilitate the generation and management of higher resolution work zone data. SmartCones, SmartVests, and the Work Zone Builder application are currently under research in Virginia. Once these technologies are approved for implementation, the study team recommends that they be integrated in work zones throughout the I-95 corridor.

Regional Multimodal Mobility Program (RM3P)

RM3P's mission is to leverage the collaborative use of real-time data to improve travel safety, reliability, and mobility, and to give the public the tools to make more informed travel choices. RM3P consists of five interrelated initiatives designed to reduce corridor congestion and improve multimodal transportation. The study team recommended an area-wide deployment of the following strategies:

- Data-exchange platform (DEP)
- AI-based decision support system (AI-DSS)
- Commuter parking information system (CPIS)
- Multi-Modal analytical planner (MMAP)
- Dynamic incentivization (DI)

The RM3P effort is currently in the planning stages, with the DEP likely to begin later in 2021. Implementation of the remaining areas will follow in 2022 and beyond.

Data-Exchange Platform (DEP)

The DEP is a reliable, continuously updated, cloud-based data storage and exchange system. It will be used by regional partners and third-party providers to capture, process, and exchange information on real-time and historic multimodal travel conditions.

AI-Based Decision Support System (AI-DSS)

The AI-DSS will help predict the impact of disruptions to the transportation network and provide coordinated response options to agencies. The automated tool for operators will use travel data to monitor emerging conditions and recommend plans for coordinated, multiagency responses to congestion, incidents, and events.

Commuter Parking Information System (CPIS)

The CPIS will entail a real-time, app-based parking availability information system that provides reliable information about parking space availability at lots serving bus, vanpool, and carpool commuters.

Multi-Modal Analytical Planner (MMAP)

The MMAP will be a collaboration tool for transportation service providers to pinpoint unmet needs in the transportation network. This highly interactive tool will enable mobility providers to study the impacts of "what-if" scenarios and better plan for travel demand by identifying underserved areas, especially during disruptive events.

Dynamic Incentivization (DI)

DI will be a data-driven system offering the public incentives to modify their travel choices and behaviors in response to real-time travel conditions.

Arterial Operations

During traffic incidents or periods of congestion on the I-95 corridor, motorists choose to use the parallel facilities of US 1 and US 301 to avoid delays. A major incident on the interstate can result in a road closure of the impacted interstate segments and lead to temporary routing of traffic onto these parallel facilities. Because of this, the parallel facilities of US 1 and US 301 were evaluated for improvements that could improve operations during significant traffic incidents or periods of congestion. Highest priority was given to improvements that support the capabilities to mitigate traffic during an incident and at locations where incident frequency is highest. More than 300 locations were studied, and 2,000 improvements identified. The study team worked with the Districts to refine the recommended improvements. See **Appendix F** for a summary listing of the improvements. Arterial improvements consisted of strategies to enhance operations along incident detour routes, including ATSPM, lane reconfigurations, signing and pavement marking, communications upgrades, advanced traffic signal controllers, CCTV cameras, and changeable signage.

Table 1 summarizes the number of parallel facility improvements recommended for funding in each district.

Table 1 Parallel Facility Improvement Implementation Summary

Agency with Jurisdiction	Number of Improvement Locations			
	NOVA	Fredericksburg	Richmond	Total
VDOT	100	25	2	**127**
Locality	3	5	11	**19**
TOTAL	**103**	**30**	**13**	**146**

To date, the regions have made progress in implementing the proposed arterial improvements. The regions have performed initial scoping analysis and planning efforts to expedite the programming and deployment of the arterial improvements.

Figure 12 provides an example of a detour route and potential improvements identified at an intersection In this example, installing a dynamic LED blank-out sign is expected to allow for greater capacity to process turning vehicles along the detour route, reduce queue spillback toward I-95 and improve efficiency of signal operations.

Return on Investment (ROI)

ROI analyses were conducted for each of the operational improvement needs identified using safety, mobility, and environmental measures. Capital costs, as well as the 10-year operations and maintenance (O&M) costs, were calculated for each improvement and weighed against anticipated benefits.

The results of the analysis can be seen in the recommendations in **Table 2** and **Table 3**. The implementation of operational upgrades to the I-95 corridor is in keeping with CTB desires to move forward with operational improvements that offer the highest ROI and fastest potential for implementation along interstate corridors in Virginia.

Figure 12 Example Detour Route (I-95 Between Exit 150 And Exit 152)

**Example detour route is provided for illustrative purposes only and elements of the route may change.*

Table 2 Freeway Operations Improvements ROI

Proposed Operational Improvement	Implementation Cost	O&M Cost (10 Years)	Benefit (10 Years)	ROI (10 Years)
CCTV Cameras	$15.6M	$4.6M	$134.6M	7.0
Changeable Message Signs	$3.2M	$1.9M	$18.6M	3.9
Safety Service Patrols	$4.1M	$27.0M	$88.2M	2.9
TRIP Towing Program	$2.2M	$15.3M	$84.5M	4.9
Towing Program	$1.2M	$9.8M	$141.2M	12.9
Variable Speed Limits	$15.2M	$15.6M	$117.5M	3.9
Ramp Metering	$5.7M	$2.1M	$71.7M	9.7
Geofenced Emergency Notifications	$0.2M	$1.0M	$1.4M	1.3
Advanced Work Zone Technology	$1.0M	$4.1M	$19.2M	3.9
Regional Multimodal Mobility Project (RM3P)	$5.4*	$9.6M	$28.2M	2.9
Misc. Low-Cost Operations Improvements	$4.3M	$14.2M	$98.3M	5.4

* Innovation and Technology Transportation Funds (ITTF) are allocated to cover implementation costs

Table 3 Arterial Operations Improvements ROI

Proposed Operational Improvement	Implementation Cost	O&M Cost (10 Years)	Benefit (10 Years)	ROI (10 Years)
CCTV Cameras - Arterials	$3.2M–$3.5M	$0.9M	$28.6M	7.0
ATSPM*	$10.2M–$11.2M	$2.5M	$65.1M	5.2
Blank-Out Signs	$0.3–$0.4M	$0.7M	$2.5M	8.1

* Includes communications and/or controller upgrades to support the deployment of ATSPM

Multimodal Improvements

I-95: A Multimodal Corridor—Development of Multimodal Improvements

Through a cooperative process involving VDOT, DRPT, OIPI and regional transit providers rooted in existing planning efforts and public feedback, the study team defined and developed the specific multimodal improvements that will be included in the Plan. The process included the following steps to develop the final list of potential improvements:

1. Review existing plans and studies
2. Screen projects using subjective and objective evaluation factors
3. Conduct secondary screening with VDOT, DRPT, OIPI, and regional provider staff based on project focus areas
4. Conduct modified SMART SCALE project scoring
5. Refine and finalize list of potential improvements in coordination with the CTB.

Multimodal Improvements

After the project screening process, a total of 10 multimodal projects have been proposed to be prioritized for funding for a total of $59.5 million. These 10 projects represent the priorities out of the 130 total multimodal projects initially identified for consideration. The plan includes potential multimodal improvements as laid out in each of the areas below—commuter bus service and park-and-ride lots. The multimodal improvements are part of the suite of proposed improvements along I-95 including operational improvements on I-95, improvements on parallel facilities (such as US 1 and US 301), and capital projects on I-95. These multimodal improvements are complemented by existing transportation demand management (TDM) or commuter assistance programs (CAP) in the corridor such as multimodal ride matching, rewards for non-SOV travel, and strategic marketing and promotion of multimodal travel options and services, with emphasis on the most congested segments of I-95.

Type of Multimodal Improvement
Commuter Bus: Improvements such as new express bus routes from Stafford and Prince William Counties to destinations north of the Occoquan River.
Park-and-Ride: Improvements such as expansion of existing lots and construction of new lots.

Commuter Bus

Today, commuter buses move about 3,000 people across the Occoquan River—a key corridor crossing—in the peak period. The provision of commuter bus service is an important part of the congestion solution along the I-95 corridor, especially in the Fredericksburg region, where until recently public commuter bus service had not been available (In 2019 the I-395 Commuter Choice program recommended funding commuter bus service between Stafford and Washington, DC, and Stafford and the Pentagon, both of which are now operational).

Previous studies conducted by DRPT and the Fredericksburg Area Metropolitan Planning Organization (FAMPO) have shown demand for and recommended commuter bus service originating in Spotsylvania and Stafford Counties to key destinations in Northern Virginia such as the Pentagon, Alexandria, and Rosslyn as well as Downtown Washington, DC. This study advances four new commuter routes that originate in Stafford County, Caroline County, Prince William County, and Fredericksburg, connecting to key employment destinations including the Pentagon, Rosslyn, Crystal City, Alexandria, and Downtown Washington, DC. These recommendations include service that is expected to carry more than 150 riders from Spotsylvania and Stafford to points north each morning. **Table 4** shows the existing and proposed commuter bus service in the I-95 corridor. Compared to other mobility options, the provision of commuter bus is relatively inexpensive and nimbler to adjust based on changing travel patterns and needs.

Table 4 Existing and Proposed Commuter Bus in the I-95 Corridor

Origin		DESTINATION					
		Tysons (via I-495)	Mark Center	Old Town Alexandria (via I-95/I-495)	Pentagon/ Crystal City	Rosslyn/ Ballston	Washington DC
Fairfax County	Springfield	○	○		○		○
Occoquan River							
Prince William County	Lake Ridge	○	○	●	○		○
	Dale City		○		○	○	○
	Montclair/ Dumfries				○		○
Stafford County	Aquia Harbor		●		●		●
	Stafford		●		●		○ ●
Fredericksburg	Fredericksburg				●		●
Spotslyvania	Massaponax				●	●	●

Commuter Bus Key	
Existing (Baseline) Service	○
Proposed New Service	●
Proposed Additional Service	○ ●

Transforming Rail in Virginia Program

In the I-95 Corridor Improvement Plan Interim report, additional rail service options were evaluated including the potential addition of increased peak hour VRE service. During the refinement of the I-95 Corridor Improvement Plan, Governor Northam announced a landmark rail agreement between the commonwealth and CSXT, Amtrak, and VRE, known as the Transforming Rail in Virginia Program. While separate from the I-95 Corridor Improvement Plan, the program will provide considerable benefits to the I-95 corridor with infrastructure improvements that will enable doubled Amtrak round-trip service between Washington, DC and Richmond and expanded Virginia Railway Express (VRE) service with 15-minute intervals during peak periods and added night/weekend service, among other improvements across the commonwealth over the next several decades. Additionally, as part of the 2020 Virginia General Assembly, funding was also dedicated to improving

commuter rail service on the VRE Manassas Line, which parallels I-95 along its northern segments. These improvements will collectively address the rail needs originally identified as potential improvements in the Interim Report. More information can be found at the project website.[7]

Park-and-Ride Lots

Park-and-ride lots are a common transportation feature along the I-95 corridor and include state-owned, privately-owned, and informal lots. Under the oversight of VDOT, these facilities allow commuters—particularly long-distance commuters—to park their vehicles at a convenient location and then finish their commute using alternative transportation modes including carpool, vanpool, bus, train, bike, or walking.

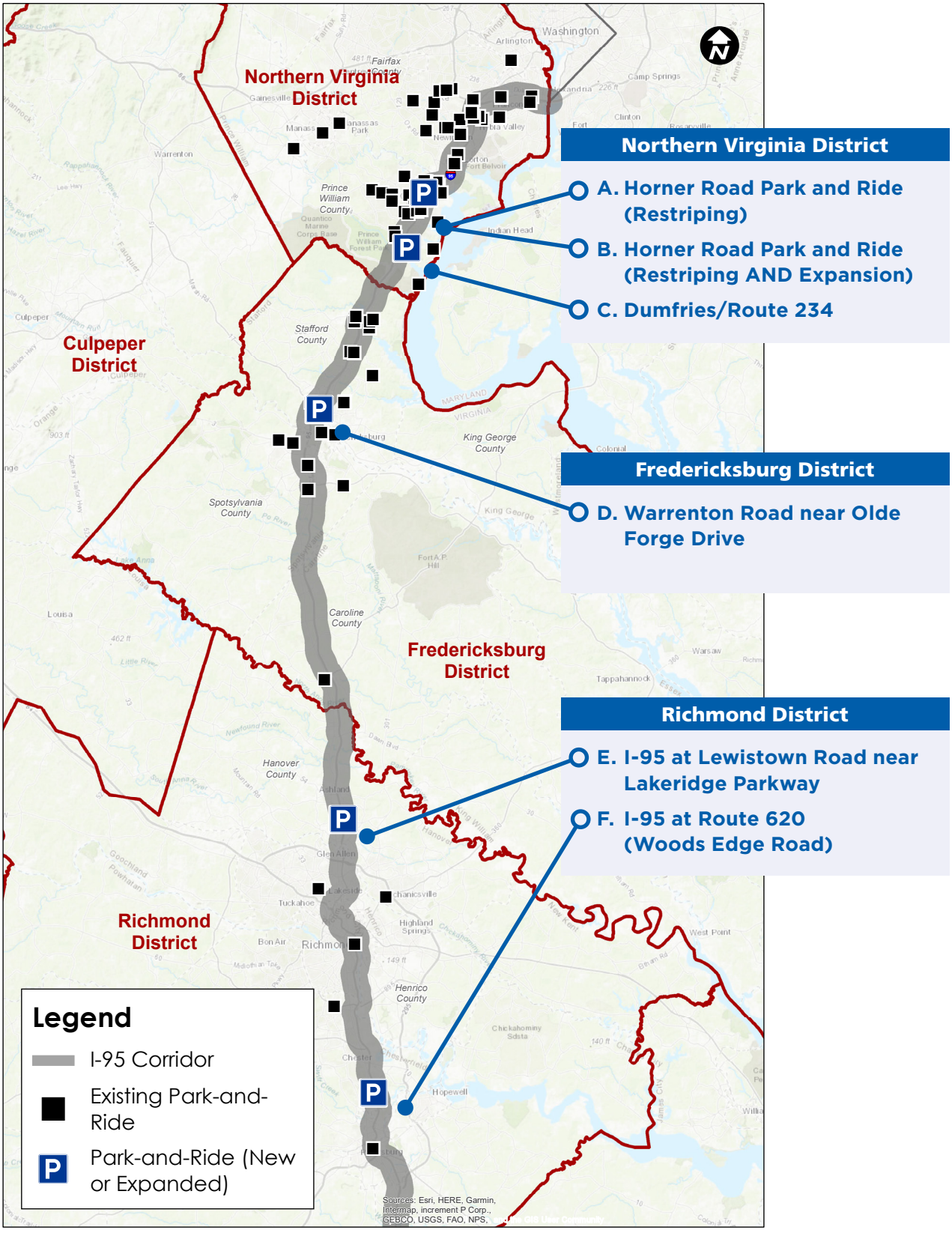
This Plan recommends enhancement, expansion, or new construction of six park-and-ride lots at key points along the I-95 corridor as shown on **Table 5** and in **Figure 9**. When combined, these recommendations would contribute more than 1,450 new parking spaces to the existing 18,000 spaces in the corridor—a seven percent increase. Many park-and-ride lots provide connections to existing and future commuter bus service, and all newly-constructed lots will be designed to accommodate and optimize carpool, vanpool, and slugging operations.

Table 5 Proposed Park and Ride Improvements

Map ID	Park-and-Ride Lot	Exit	Interchange	Description	Space Increase
A	Horner Road Park and Ride	158	Route 294 (Prince William Parkway)	Restriping of existing lot.	80
B	Horner Road Park and Ride	158	Route 294 (Prince William Parkway)	Restriping and expansion of existing lot.	304
C	Dumfries/Route 234	152	Route 234 (Dumfries Road)	Restriping of existing lot.	65
D	Warrenton Road near Olde Forge Drive	133	Route 17 (Warrenton Road)	New park and ride lot.	537
E	I-95 at Lewistown Road near Lakeridge Parkway	89	Route 802 (Lewistown Road)	New park and ride lot.	241
F	I-95 at Route 620 (Woods Edge Road);	58	Route 620 (Woods Edge Road)	New park and ride lot.	224
				Total	1,451

7 https://transformingrailva.com/

Figure 9 Proposed Park-And-Ride Improvements



Northern Virginia District

- A. Horner Road Park and Ride (Restriping)
- B. Horner Road Park and Ride (Restriping AND Expansion)
- C. Dumfries/Route 234

Fredericksburg District

- D. Warrenton Road near Olde Forge Drive

Richmond District

- E. I-95 at Lewistown Road near Lakeridge Parkway
- F. I-95 at Route 620 (Woods Edge Road)

Leveraging Commuter Assistance Programs to Move More People

Building new and widening existing roads alone is not enough to meet Virginia's current and future transportation needs. Congestion was identified by the public survey as the most important issue to address. Modeling efforts completed as part of the study concluded that adding a general purpose lane to I-95 in both directions between Exit 118 and Exit 170 would only temporarily relieve congestion issues and cost $12.5 billion. To effectively improve mobility, provide more travel options, move more people, and promote and sustain economic growth, there is a necessity to move more people with fewer vehicles by sharing rides and using high-capacity modes such as bus or rail. Commuter assistance programs are part of the solution to ensure people know about and are supported in using non-SOV modes of travel. Commuter assistance programs provide transportation choices, make Virginia's transportation more efficient, and help improve air quality. This is accomplished by moving more people in fewer vehicles, reducing vehicle miles traveled, reducing vehicle trips, and moving peak period trips to off-peak times.

Many statewide, regional, and local TDM initiatives are present today that cover the I-95 corridor. To maximize the effectiveness of capital and transit operational improvements as part of the Corridor Improvement Plan, DRPT, through its existing programs and coordinaiton will continue to work with local and regional entities and further target the I-95 corridor with strategic marketing and promotion of travel options, including:

- Targeted marketing that is targeted to corridor travelers with an emphasis on the most congested segments of I-95
- Coordinated marketing messaging with local commuter assistance programs
- Targeted communication with employers with a high concentration of employees that commute on I-95
- Use of the Commute!VA website and mobile app for multimodal travel options and ridematching
- Options for carpool, vanpool, transit, rail, and telework
- Use of Commute!VA rewards for carpool, vanpool, transit, and commuter rail
- Incentives for existing carpool and vanpool as well as assistance forming new ones
- Use of the express lanes free with EZ-Pass Flex and a carpool/vanpool of 3+ (including driver)

Corridor Costs and Potential Benefits

Summary of Costs

The projects listed in the sections above are summarized in **Table 6**. In total, there are 10 multimodal projects that total $59.5 million.

Table 6 Summary of Costs

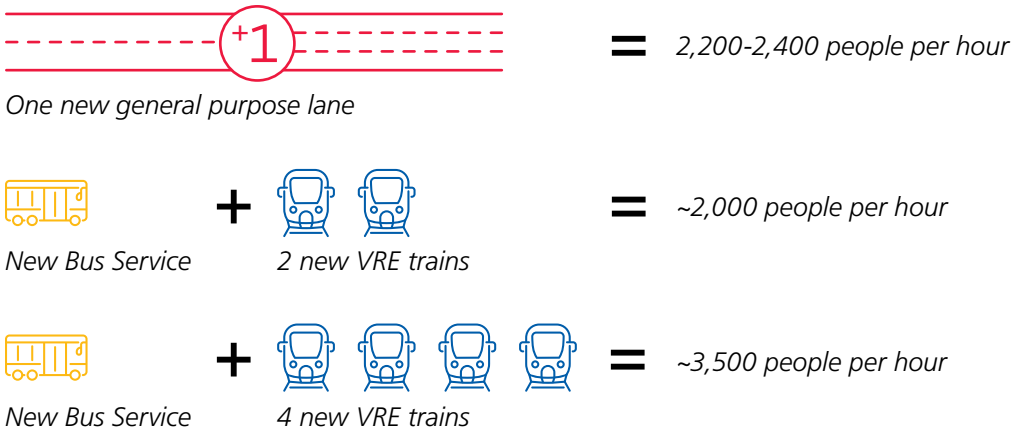
Type of Project	Number of Projects	Project Costs (2020)[8]
Commuter Bus	4	$24,390,000
Park-and-Ride	6	$35,110,000
TOTAL	**10**	**$59,500,000**

Benefits

Today, more than 60 percent of commuters between the Occoquan River and I-495 are moved by modes other than driving alone. Targeted improvements to transit, rail, and carpooling offer the greatest opportunities to not only improve performance on I-95 itself, but to provide fast and reliable trips along more parts of the corridor to more people.

The suite of multimodal improvements included in this study plus the ongoing Transforming Rail in Virginia program offer unique opportunities to address peak period traffic conditions that can be implemented with far lower cost, a much greater ability to safely move people, and more flexibility to adapt to changing travel patterns and needs than that of a large-scale widening of I-95 as shown in **Figure 10**.

Figure 10 People Moving Capacity

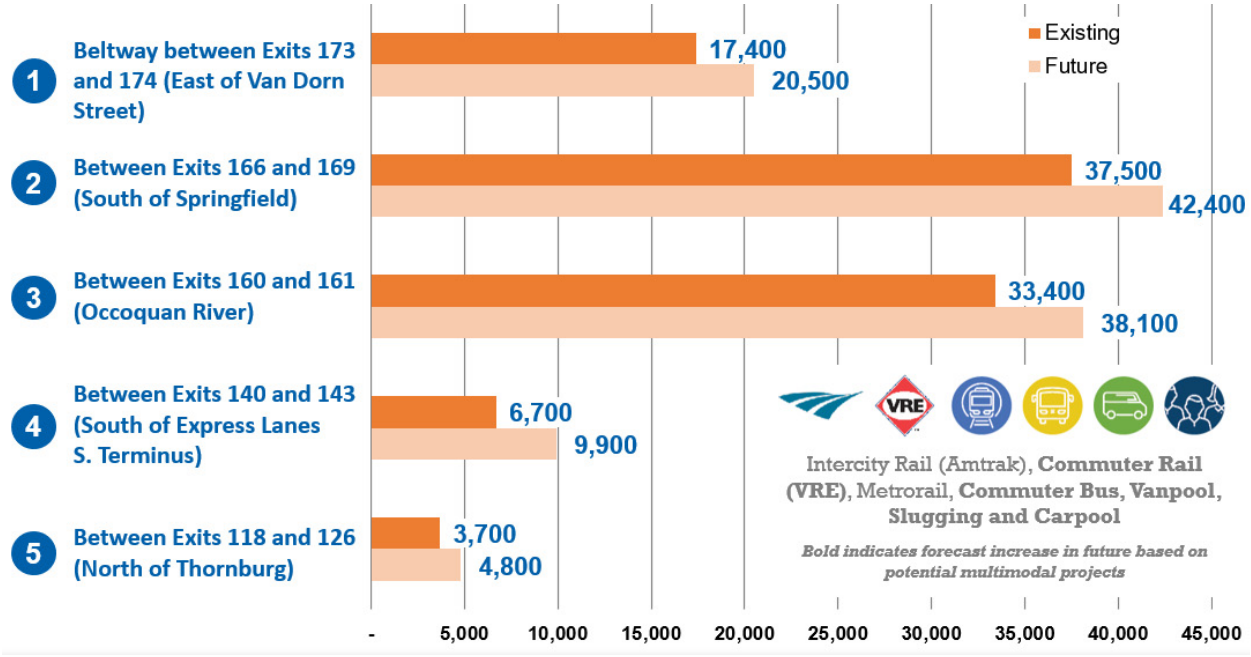


The proposed multimodal improvements in the Northern Virginia and Fredericksburg Districts cost considerably less ($59.5 million[9]) than building an additional lane of capacity ($12.5 billion). These improvements, when bundled with the Transforming Rail Initiative, result in a total benefit with significant cost savings. As part of the previously-mentioned hypothetical analysis of adding a lane in each direction on I-95 between Exits 118 and 170, the proposed multimodal improvements were evaluated. The multimodal improvements are projected to increase the number of persons moved in the corridor by non-SOV modes. As a direct result of the projects, increases are projected in the number of people carpooling (including slugging), vanpooling, and taking commuter bus during the morning peak period (**Figure 11**) in the five northernmost portions of the corridor. Other increases

8 Includes capital costs and operating costs in 2020 dollars.
9 Only includes I-95 Corridor Improvement Plan projects (commuter bus and park and ride lots)

in other modes may be possible but were not forecasted as part of this effort. The commuter rail total includes an assumed future four additional trains per peak period on the VRE Fredericksburg Line, but does not include any additional assumed improvements to the VRE Manassas Line, which received funding in the General Assembly action. At the Occoquan River, a major bottleneck along the corridor, the study team projects an increase of approximately 4,700 multimodal persons moved during the morning peak period. Other increases throughout the corridor vary depending on location.

Figure 11 Future Persons Moved (A.M. Peak Period)



Mainline Roadway Improvements Plan

The study team considered performance measures, supplementary data, existing roadway geometry, recently completed studies, and public input to develop potential capital improvements. The team also reviewed recently constructed projects and projects already funded in the Six-Year Improvement Program (SYIP) to determine how those projects may resolve issues in the corridor relating to the performance measures. The study team also examined recently constructed projects to determine how those projects may resolve issues in the corridor and whether crashes and delays in those areas may have been due to work zones.

The study team recommended the following types of capital improvements in the corridor based on the contributing factors (e.g. traffic volume, geometrics, and ramp spacing) for evaluation.

- **Auxiliary lanes:** An extra lane constructed to connect on- and off-ramps between closely spaced interchanges to reduce the impacts of traffic entering and exiting the interstate
- **Widening by one lane:** an extra lane constructed for multiple miles to increase the capacity of the interstate
- **Acceleration and deceleration lane extensions:** Longer lengths to accelerate when entering the interstate and decelerate when exiting the interstate
- **Hard Shoulder Running:** operating a managed lane on the existing shoulder during one or more peak periods
- **Interchange improvement:** A variety of improvements that improve safety and reduce delay at interchanges by modifying the existing interchange configuration

Table 7 shows the number of proposed mainline improvements by type and by district.

Table 7 Proposed Mainline Roadway Improvements By Type By District

Improvement Type	Hampton Roads	Richmond	Fredericksburg	Northern Virginia	Total
Auxiliary Lane	0	0	0	1	1
Widening by One Lane	0	0	2	0	2
Acceleration or Deceleration Lane Extension	2	6	2	2	12
Hard Shoulder Running*	0	0	0	1	1
Interchange Improvement	0	3	0	3	6
Total	2	9	5	7	22
Projected Cost (Millions)	$17.3	$213.2	$194.3	$604.5	$1,029.3

* The two hard shoulder running alternatives span parts of the Fredericksburg and Northern Virginia Districts but are included only in the Northern Virginia District numbers and cost projections.

Improvements and Locations Requiring Further Study

The study team also identified several improvements with the potential to resolve issues in the corridor relating to the performance measures that had not been recommended in a previously-completed study. These improvements would not be advanced to project prioritization because there is insufficient information to evaluate the projects. **Appendix G** contains a list of individual improvements and locations identified by the study team that were recommended for further study.

Available Funding

Table 8 outlines the estimated distribution of IOEP funding for I-95 in the coming years.

Table 8 Distribution of IOEP Funding For I-95 (In Millions)

Description	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	TOTAL
I-95	$13.2	$25.8	$25.8	$27.0	$28.4	$26.9	**$194.2**

In addition to those funds, additional IOEP funding is available to allocate to additional operations and capital projects as shown in **Table 9**. These funds reflect remaining balance after commitments for operational improvements on I-95.

Table 9 Additional Funding For Operations and Capital Projects For I-95 (In Millions)

Description	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	TOTAL
I-95	$0.0	$12.6	$13.2	$19.4	$28.2	$26.9	**$119.8**

Upon development of planning level cost estimates for recommended projects, the study team determined that the needs identified far exceeded available revenues. In addition, the needs do not account for planning level cost estimates associated with "improvements and or locations identified for further study." As a result, there was a need to prioritize improvements in order to stay within the projected funding levels.

Prioritization of Improvements

The prioritization process for I-95 followed the process outlined in the IOEP. The I-95 Corridor Improvement Plan identified the top 25 percent problem areas for congestion, safety, and reliability and the identified operational strategies, TDM strategies, and roadway capital improvements to address those issues in the corridor. All of these strategies improve reliability and safety of travel. The operational strategies were evaluated using an ROI methodology. The transportation demand management strategies and roadway capital improvements were evaluated using a SMART SCALE-like methodology using the following scoring weights:

- 40% for person-hours of delay reduction
- 40% for reduction of fatal and severe injury crashes
- 20% for accessibility to jobs

These measures are a subset of those used in SMART SCALE and represent those measures that provide the greatest differentiation between segments and correlate with the IOEP goal defined in §33.2-372 of improving the safety, reliability, and travel flow along interstate corridors.

This scoring methodology resulted in the list of transportation demand management and capital projects recommended for funding as part of the I-95 Corridor Improvement Plan shown in **Table 10**[10]. According to the IOEP, available funding will be allocated to the projects based on the prioritization ranking, and scheduled according to constructability, risk, and the Board's discretion. At this time, 10 projects are recommended for funding, as indicated. Additionally, projects labeled as tentative may be considered for funding at the Board's discretion should there be available remaining funding. Detailed improvement prioritization scoring results are included in **Appendix H**.

Table 10 I-95 Corridor Improvement Plan Scoring And FY 2020 Project Costs

Mile Marker	Project Description	SMART SCALE Score	Project Cost	Recommended for Funding
Exit 166	Construct Flyover from I95 NB to Fairfax County Parkway NB	0.08	$ 94,418,000	No
Exit 163	Extend Southbound Acceleration Lane	0.32	$ 7,697,000	No
Exit 163	Extend Northbound Acceleration Lane	0.20	$ 9,982,000	No
Exit 160	Southbound Interchange Improvements	1.45	$ 76,000,000	Yes (IOEP)
Exit 160A	Northbound Interchange Improvements	0.53	$ 28,900,000	No
Exit 158 to Exit 160	Construct Northbound Auxiliary Lane	0.51	$ 40,785,000	No
Exit 158	Park-And-Ride Lot Enhancement, Restriping, and Expansion	2.29	$ 16,200,000	Yes
Exit 158	Park-and-Ride Lot Enhancement and Restriping	13.21	$ 840,000	Yes
Exit 152	Park-and-Ride Lot Enhancement and Restriping	20.10	$ 660,000	Yes
Exit 136	Extend Northbound Acceleration Lane	0.63	$ 3,543,000	No
Exit 133	New Park-and-Ride Lot	3.66	$ 14,900,000	Yes
Exit 133	Construct a Managed Lane (HSR) On Existing Left Shoulders	0.97	$ 387,784,000	No
Exit 126	Widen Northbound to Four Lanes	0.38	$ 87,723,000	No
Exit 126B	Extend Northbound Deceleration Lane	0.09	$ 33,747,000	No
Exit 126	Widen Southbound to Four Lanes	0.17	$ 69,261,000	No
Exit 89	New Park-And-Ride Lot	1.14	$ 11,400,000	Tentative (IOEP)
Exit 81	Extend Northbound Deceleration Lane	0.02	$ 29,624,000	No
Exit 76	Northbound PARCLO Interchange Improvements	0.79	$ 50,000,000	No
Exits 74 and 75 NB	Consolidate Access Points and Replace With C-D System	0.76	$ 70,000,000	No

10 Costs for projects recommended or tentatively recommended for funding have been inflated to year of expenditure and have undergone a preliminary refinement based on a process similar to SMART SCALE. Costs for the remaining projects are planning level costs that were used for initial project prioritization.

Mile Marker	Project Description	SMART SCALE Score	Project Cost	Recommended for Funding
Exit 73	Extend Northbound Deceleration Lane	0.21	$ 2,497,000	No
Exit 62	Extend Northbound Acceleration Lane	0.76	$ 3,504,000	No
Exit 61	Interchange Improvements and Park-and-Ride Lot Phase II	1.07	$ 26,898,000	No
Exit 58	New Park-and-Ride Lot	3.72	$ 7,100,000	Yes
Exit 53	Extend SB Acceleration Lane	2.44	$ 4,500,000	Yes
Exit 51	Construct Flyover Ramp from I95 NB to I85 SB	0.15	$ 30,754,000	No
Exit 50	Southbound Interchange Improvements	0.19	$ 128,974,772	No
Exit 41	Extend Southbound Acceleration Lane	0.29	$ 3,142,000	No
Exit 13	Extend Southbound Acceleration Lane	0.02	$ 10,539,000	No
Exit 11	Extend Southbound Deceleration Lane	0.17	$ 2,152,000	No
Exit 4	Extend Northbound Deceleration Lane	0.04	$ 2,491,000	No
Bus Routes (includes 3 years of operating cost)				
Fredericksburg to the Pentagon and Crystal City		1.69	$ 9,155,000	Yes
West Stafford County to Capitol Hill (Route 4)		9.76	$ 4,456,941	Yes
North Caroline County to DC Core (Route 1)		5.44	$ 6,934,144	Yes
Central Prince William County to Downtown Alexandria		2.22	$ 6,169,000	Yes

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