# COMMONWEALTH of VIRGINIA

## DEPARTMENT OF TRANSPORTATION

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September 27, 2024

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The Honorable Karrie K. Delaney
Chair, House Transportation Committee
Virginia General Assembly
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Governor, Secretary and Members of the Virginia General Assembly:

I am submitting this evaluation as required by Item 441 (C) (7) of Chapter 2 of the 2024 Special Session I Acts of Assembly (the "Appropriation Act"). The Appropriation Act directed the Commissioner to evaluate and report to you regarding the cost and feasibility of always permitting high-occupancy vehicle (HOV) access and free-of-charge on the Downtown-Midtown Tunnel and to provide the estimated cost and recommendations for implementation of such HOV access.

Please find attached the report containing the evaluation directed by the Appropriation Act.

If you have any questions regarding this report, please do not hesitate to reach out to me or to Laura Farmer, Chief Financial Officer, at (804) 786-3096.

Sincerely,

Stephen C. Brich, P.E.

Attachment

# DOWNTOWN-MIDTOWN TUNNELS
# HOV2+ FREE IMPLEMENTATION EVALUATION

**REPORT PREPARED PURSUANT TO**
**CHAPTER 2, ITEM 441 C.7, 2024 APPROPRIATION ACT**

**OCTOBER 1, 2024**

VDOT

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## EXECUTIVE SUMMARY

### Purpose

Pursuant to Chapter 2, Item 441 C.7, of the 2024 Appropriation Act, the Virginia Department of Transportation (VDOT) evaluated the cost and feasibility of permitting free high occupancy vehicle (HOV) access at all times on the Downtown Tunnel and Midtown Tunnel (DTT-MTT) facilities. The report describes the project background, modeling/analysis and evaluation, and provides the conclusions and recommendations for consideration by the Governor, the Secretary of Transportation, Chairs of the House Committees on Appropriations, Finance, and Transportation and the Senate Committees on Finance and Appropriations and on Transportation.

The evaluation assumed, toll-free travel beginning in 2026 for passenger vehicles with two or more occupants (HOV2+) in the DTT-MTT facilities; this is consistent with the tolling program on the surrounding Hampton Roads Express Lanes (HREL) network. VDOT developed a series of models to estimate the impact of the change in tolling on traffic congestion, capital expenditures required to support the change, and operational expenditures through the 2070 concession period. VDOT also identified commercial and policy impacts associated with this tolling scenario.

### Study Context

The DTT (I-264) and MTT (U.S. 58) facilities run beneath the Elizabeth River, connecting the cities of Norfolk and Portsmouth. The DTT opened as a toll facility in 1952, and the MTT in 1962. In 2011, VDOT entered into a $2.1 billion, 58-year Comprehensive Agreement (CA) with Elizabeth River Crossings OpCo, LLC (ERC), the concessionaire, to rehabilitate the existing DTT-MTT facilities, construct a new MTT facility to increase capacity, extend Martin Luther King Freeway (MLK Extension), and operate the facilities through 2070.

**Project Location**


Source: Elizabeth River OpCo, LLC. https://www.driveert.com/#/about-facilities

The new DTT-MTT facilities opened in August and October 2016, respectively, and rehabilitation of the existing MTT tube was completed in September 2017. ERC initiated tolling in February 2014 to cover the debt associated with construction, operations and maintenance through the 2070 concession period.

The DTT-MTT facilities are currently tolled for all vehicles, including single-occupancy vehicles (SOV) and high-occupancy vehicles (HOV), with exceptions for categories of exempt vehicles established in Va. Code § 33.2-613 and the CA. Toll rates are the same for both tunnels but vary by time of day, type of vehicle, day of the week, and payment method. As of January 1, 2024, EZPass paid tolls for passenger vehicles, those with two axles and motorcycles, are either $2.26 or $3.06 ($6.77 and $7.57 non-EZPass) and heavy vehicles, those with three or more axles and cars with trailers, are $6.77 or $12.24 ($11.28 and $16.75 non-EZPass) depending on the time of day, non-peak and peak travel, respectively.

**Previous Toll Mitigation and Relief Efforts**

VDOT, in conjunction with ERC, has developed and implemented numerous toll relief strategies to help ease the financial burden of tolls at the facilities. These include establishing categories for exempt vehicles; capping the rate of escalation at the higher of 3.5% or the annual change in Consumer Price Index (CPI); establishing and expanding a Toll Relief Fund (TRF) Program for low to middle income Portsmouth, Norfolk and Hampton Roads commuters which last until 2036; and delaying the annual toll rate increase during the COVID-19 pandemic. ERC has contributed nearly $11.3 million to the TRF Program since 2017 to assist in toll payment for qualified motorists.

**Study Findings Related to Congestion and Safety**

The Highway Capacity Manual uses Level of Service (LOS) to rank roadway facilities based on the density and flow of traffic, ranging from LOS A, completely free flowing, to LOS F, severely congested. Based on an analysis of 2023 traffic conditions, the DTT is currently operating at LOS F during peak periods west bound in the AM and east bound in the PM. The MTT is operating at LOS C and has some capacity remaining, but US 58 east of the tunnel in Norfolk is already experiencing significant congestion.

In 2019, VDOT performed a preliminary analysis to evaluate the potential impacts of a HOV2+ free tolling scenario on the subject facilities by 2025, concluding that the change in tolling would lead to reduced travel speeds. The most substantial impacts were observed in the DTT, with afternoon westbound speeds dropping from 35 MPH to 25 MPH and afternoon eastbound speeds dropping from 33 MPH to 20 MPH. An updated analysis would be required to confirm these 2019 preliminary results. A more comprehensive study of the impacts would also investigate typical trip origins and destination, traveler behavior patterns, regional economic development, local and regional growth plans and other factors.

If a HOV2+ free tolling scenario did increase congestion, it would also be expected to have corresponding safety impacts, such as a higher number of traffic incidents and slower response times for emergency responders. Traffic congestion has been found to contribute to incidents by interrupting traffic flow, reducing the range of vision for vehicle operators, and creating zones of potential conflict between vehicles in the congested location and high-speed drivers approaching these congested areas.

**Study Findings Related to Cost of Removing Tolls for HOV2+**

VDOT evaluated the estimated cost of HOV2+ free tolling by focusing on the capital expenditures (CapEx) and operational expenditures (OpEx) for implementation, specifically the modifications required to the DTT-MTT facilities and tolling systems.

In terms of CapEx, VDOT identified a range of $5 million to $12 million (expressed in 2026 dollars), the most significant cost for a Vehicle-Occupancy-Detection (VOD) system. VOD systems would be used to observe instances where a vehicle with an EZPass transponder set to HOV mode may not have a two-

occupant minimum. The other major cost was for changes to existing signs on the facilities and surrounding network to inform drivers of the tolling policy.

The estimated OpEx through 2070 ranged from $68 million to $96 million (expressed in 2026 dollars) for:

- Additional staff to review VOD images
- Additional troopers from the Virginia State Police (VSP) to support occupancy enforcement
- Routine and major (lifecycle) maintenance of the VOD equipment
- Additional customer support staff to address motorist questions regarding HOV policies and enforcement

In addition to these costs, any Department Change to the facilities and the current toll policy that has a negative impact on the toll revenue collected by ERC, may result in a Compensation Event claim by ERC, pursuant to the CA, where the Commonwealth would be required to pay ERC for lost revenue. Based on a preliminary 2019 traffic and revenue study, a change in policy to HOV2+ free tolling could result in an estimated upfront payment, representing a Compensation Event, from the Commonwealth to ERC in the range of $450 million to $650 million, subject to negotiation with ERC.

If the actual number of HOVs traveling on the DTT-MTT facilities exceeds the level of HOV traffic assumed for the calculation of this upfront payment ERC may have insufficient revenues to maintain and operate the DTT-MTT facilities in accordance with the requirements of the CA. As a result , ERC would likely seek additional compensation from the Commonwealth.

Other provisions of the CA may be impacted by this proposed action and a full review of the CA and assessment of impacts would need to be initiated. Any change to the financial structure of the asset would require the consent of ERC's lenders', including the U.S. Department of Transportation (USDOT). Statutory and regulatory requirements governing state and federal highways (including the operation of HOV/HOT facilities), would also need to be addressed before a change in tolling policy could be implemented.

### Recommendations

VDOT recommends that the HOV2+ free tolling scenario contemplated by Item 441 C.7 ***should not be implemented on the DTT-MTT facilities*** for the reasons summarized below:

- **Traffic Congestion and Safety:** VDOT's traffic analysis showed that a HOV2+ free tolling scenario would negatively impact the DTT-MTT facilities by increasing congestion and further reducing speed. This would require significant capital investments to add capacity. In addition, an increase in congestion would also lead to delays in responding to incidents by emergency personnel.

- **Impact on Capital and Operational Costs:** VDOT estimated that implementation of a HOV2+ free tolling scenario would result in additional OpEx costs estimated between $68 million to $96 million through 2070 and an estimated $5 million to $12 million in additional CapEx.

- **Commercial Impacts:** A change in tolling policy to HOV2+ free would result in a compensation event to ERC, pursuant to the CA, estimated between $450 million to $650 million. The unknown risks around higher than expected HOV2+ use could result in further loss in revenue potentially jeopardizing ERC's ability to operate and maintain the DTT-MTT facilities. This could result in a need for additional public contribution.

**VIRGINIA DEPARTMENT OF TRANSPORTATION**
**DOWNTOWN-MIDTOWN TUNNELS HOV2+ FREE EVALUATION**
**REPORT PREPARED PURSUANT TO**
**CHAPTER 2, ITEM 441 C.7, 2024 APPROPRIATION ACT**

## 1. BACKGROUND

Chapter 2, Item 441 C.7, of the 2024 Appropriation Act, calls for the Commissioner of Highways ("Commissioner") to evaluate the cost and feasibility of permitting free high occupancy vehicle (HOV) access at all times on the Downtown-Midtown Tunnel (DTT-MTT) facilities and to report the estimated cost and recommendations for implementation to the Governor, the Secretary of Transportation, Chairs of the House Committees on Appropriations, Finance, and Transportation and the Senate Committees on Finance and Appropriations and on Transportation no later than October 1, 2024.[1]

### 1.1 Project Team

The Commissioner directed the Virginia Department of Transportation (VDOT), Office of Public-Private Partnerships, to lead the evaluation and reporting, in coordination with its Transportation and Mobility Planning Division, Tolling Division and industry experts. The Office of the Attorney General was consulted on topics relating to applicable laws, regulations and policies.

### 1.2 Base Assumption

The DTT-MTT facilities are currently tolled for all vehicles, including single occupant vehicles (SOV) and HOVs. This evaluation considers a free tolling scenario for two-axle vehicles occupied by two or more passengers (HOV2+) in the DTT-MTT facilities: this is consistent with the tolling program on the surrounding Hampton Roads Express Lanes (HREL) network. The evaluation focuses on the impact of HOV2+ free tolling on traffic throughput, level of service, tolling operations, roadway operations and maintenance, and major maintenance. The evaluation assumes the HOV2+ free implementation to commence in 2026, with traffic impacts modeled through 2045 and capital/operational expenditures (CapEx/OpEx) considered through the 2070 end of the concession.

## 2. STUDY CONTEXT

### 2.1 Project History

The DTT (I-264) and MTT (U.S. 58) facilities run beneath the Elizabeth River, connecting Norfolk and Portsmouth, Virginia. The DTT opened as a toll facility in 1952, and the MTT in 1962. VDOT discontinued tolling in 1986 after paying off the public debt used to fund the original tunnel construction.

In 2011, and pursuant to the Public-Private Transportation Act of 1995, Va. Code § 33.2-1800 *et seq.*, VDOT and the concessionaire, Elizabeth River Crossings OpCo, LLC (ERC), a partnership between Skanska and Macquarie Infrastructure Partners II, executed a $2.1 billion, 58-year Comprehensive Agreement (CA) to rehabilitate the existing Downtown-Midtown Tunnels, construct a new Midtown Tunnel to increase capacity, extend Martin Luther King Freeway (MLK Extension), and operate the facilities through 2070. The project location is shown in **Figure 1.**

[1] For more information, visit https://budget.lis.virginia.gov/item/2024/2/HB6001/Chapter/1/441/

**Figure 1. Project Location**


Source: Elizabeth River OpCo, LLC. https://www.driveert.com/#/about-facilities

The new DTT-MTT facilities opened in August and October 2016, respectively, and rehabilitation of the existing MTT tube was completed in September 2017. ERC initiated tolling in February 2014 to support operations and maintenance of the DTT-MTT facilities through the 2070 concession period . Ownership of ERC changed in November 2020, when a consortium led by Abertis, a global infrastructure firm headquartered in Spain, and Manulife Investment Management, a global investment firm, acquired 100% of the concession entity from the original partners.

The DTT-MTT facilities are currently tolled for all vehicles, including single-occupancy vehicles (SOV) and high-occupancy vehicles (HOV). Exempt Vehicles, as defined in Va. Code § 33.2-613, are allowed free passage through the DTT-MTT. Toll rates are the same for both tunnels but vary by time of day, type of vehicle, day of the week, and payment method. The current toll rate schedule is shown in **Table 1**.

**Table 1. DTT-MTT Toll Rates as of January 1, 2024**

| Time of Day | Passenger Vehicles (Max 2-Axles and 6 Tires) | | Heavy Vehicles (3 or More Axles) | |
|---|---|---|---|---|
| **Monday – Friday** | **EZPass** | **Pay-by-Plate** | **EZPass** | **Pay-by-Plate** |
| 12:00 to 5:30 AM | $2.26 | $6.77 | $6.77 | $11.28 |
| 5:30 to 9:00 AM (Peak) | $3.06 | $7.57 | $12.24 | $16.75 |
| 9:00 AM to 2:30 PM | $2.26 | $6.77 | $6.77 | $11.28 |
| 2:30 to 7:00 PM (Peak) | $3.06 | $7.57 | $12.24 | $16.75 |
| 7:00 PM to 12:00 AM | $2.26 | $6.77 | $6.77 | $11.28 |

Source: https://www.driveert.com/#/about-tollrates

## 2.2 Toll Mitigation and Relief Programs

VDOT, in conjunction with ERC, has developed numerous toll relief strategies to help ease the financial burden of tolls at the facilities. The following forms of toll mitigation and toll relief have been implemented since the beginning of construction. A timeline of these measures is provided in **Figure 2.**[2]

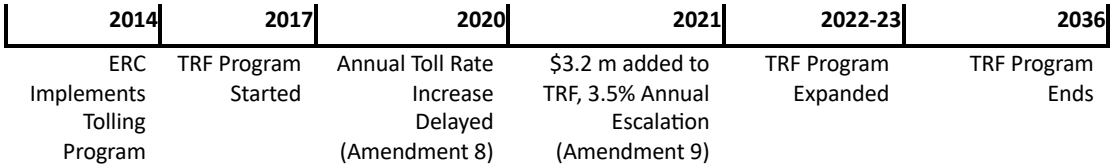
**Toll Mitigation**

- $581.6 million in state transportation funds were spent on toll relief during the rehabilitation (DTT-MTT) and new construction (MTT) between 2012 and 2015
- Toll-rate escalation has been capped at 3.5% or the annual change in the Consumer Price Index (CPI), the primary indicator of inflation, whichever is greater
- In 2020, Amendment 8 to the CA provided toll mitigation by delaying the scheduled 2021 toll rate increase until at least January 2022 in recognition of the COVID-19 economic impact to the region

**Toll Relief Program**

- In 2017 a Toll Relief Fund (TRF) Program was established for lower-income Portsmouth and Norfolk residents (annual income $30,000 or less) who had eight (8) or more two-axle toll transactions in the facilities per month. The annual contribution to the TRF Program was $500,000 per year for a 10-year term
- In 2021, the TRF Program was expanded as follows through the execution of CA Amendment 9:
  - Beginning in 2022, the annual contribution for the TRF Program increased to $3.2 million with a 3.5% annual escalation through 2036.
  - TRF enrollees currently receive a 50% rebate for tunnel tolls, up to 14 per week, for two-axle vehicles using a TRF-designated EZPass Virginia transponder
  - The TRF Program now encourages enrollment of any Hampton Roads resident with $65,000 or less in annual income
  - TRF enrollment has grown from an average of 2,150 participants during the 2017-2021 period to 19,759 participants, as of July 2024
  - For 2024, the TRF Program contribution is set at $3.5 million

**Figure 2. Major Toll Mitigation Milestones**




[2] VDOT limited the scope of this report to the requirements of Chapter 2, Item 441 C.7, 2024 Appropriation Act. The report does not include information pertaining to the other subsections of Item 441.

### 2.3 Previous Studies

Traffic conditions in the Hampton Roads region have been studied extensively by VDOT and the Hampton Roads Transportation Planning Organization (HRTPO). The studies noted below have focused primarily on traffic conditions at the DTT-MTT facilities.

In 2021, VDOT conducted a study similar to the current effort, pursuant to Item 433(L) of Chapter 854, 2019 Appropriations Act. This report references the 2021 study, as well as traffic analyses published in 2012 and 2015 by the Hampton Roads Metropolitan Planning Organization, now HRTPO:

- HRTPO 2012: Studied travel times on key routes in the Hampton Roads region. The study found that, with no tolls on the DTT-MTT facilities, the DTT and MTT had some of the highest congestion levels throughout Hampton Roads[3]

- HRTPO 2015: Examined the impact of reintroducing tolls on the DTT-MTT, based on traffic volumes, traffic backups, back-up clearance times and travel times. The study found that reintroducing tolls in 2014 had improved traffic flow and travel times on the DTT-MTT facilities[4]

- VDOT 2021: Focused on the impact of toll mitigation on the DTT-MTT facilities and explored scenarios for future action, including the termination of the CA with the concessionaire. The study found the CA-termination cost for the Commonwealth would be between $2 and $3 billion[5]

[3] HRTPO. 2012. *Hampton Roads Regional Travel Time/Speed Study.* https://www.hrtpo.org/DocumentCenter/View/1969/T12-04-E11---Travel-Time-Study-Final-Reportpdf-PDF?bidId=
[4] HRTPO. 2015. *Analyzing and Mitigating the Impact of Tolls at the Midtown and Downtown Tunnels*. https://www.hrtpo.org/DocumentCenter/View/1914/T15-05-E13F---Impact-of-Tolls-at-MTT-DTT---FINAL-Report-PDF.pdf.
[5] VDOT. 2021. *The Downtown Tunnel and Midtown Tunnel Analysis*. https://rga.lis.virginia.gov/Published/2021/RD888/PDF

## 3. ANALYSIS

VDOT structured the analysis to address the key variables pursuant to the Item 441 C.7 requirements. The section reports the impact of the HOV2+ free tolling scenario on traffic conditions, capital expenditures (CapEx) and operational expenditures (OpEx), commercial implications, and policy impacts.

### 3.1 Traffic Conditions

A high-level traffic analysis was conducted to evaluate impacts of the HOV2+ free tolling scenario for two-axle passenger vehicles in the DTT-MTT facilities; this is consistent with the tolling program on the surrounding Hampton Roads Express Lanes (HREL) network. To conduct this analysis, vehicle occupancy rates in the vicinity of the DTT-MTT facilities, as well as existing capacity on those facilities and forecasted growth, were examined. Analysis of 2023 traffic conditions indicated that the DTT is operating over capacity in the AM and PM peak periods. The MTT has remaining capacity in the peak periods, but segments of US 58 east of the MTT on Hampton Boulevard in the City of Norfolk are experiencing congestion. **Figures 3 and 4** show the current level of traffic congestion at the DTT and MTT, respectively. The available capacity is a factor in evaluating the impacts of potential increased traffic that could occur with HOV2+ free implementation.

#### 3.1.1 Vehicle Occupancy Rates

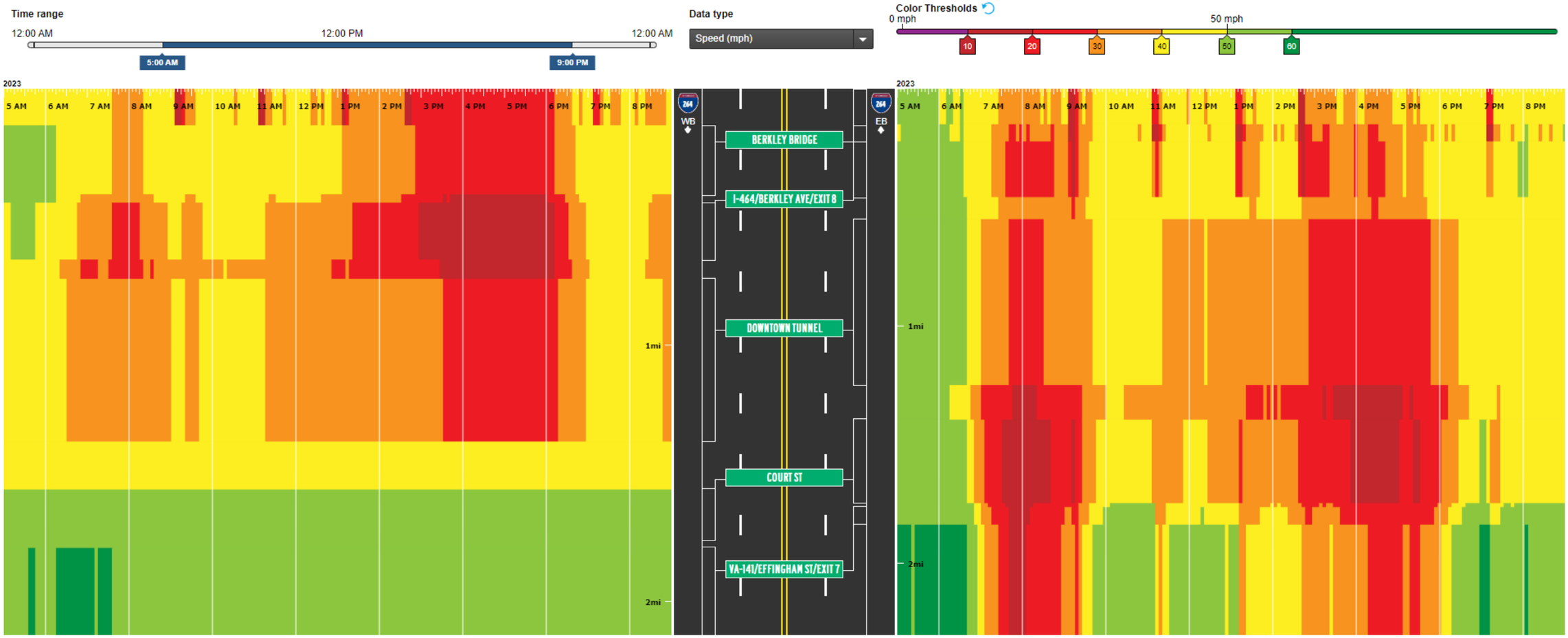
VDOT referred to a 2022 Virginia Transportation Research Council (VTRC) study, that featured a method for estimating vehicle occupancy rates (VOR) based on vehicle crash records.[6] Crash data sources now include the total number of occupants for each crash, regardless of injury status. This allowed VDOT to estimate occupancies by time period, day of the week, and functional class. VDOT considers the values from applying this method to be more representative than historic HOV usage in the Hampton Roads region. The VORs resulting from this analysis for the DTT-MTT facilities are shown in **Table 2**.

**Table 2. Current VOR Estimates from Using VTRC Method**

| | SOV | HOV2 | HOV3+ |
|---|---|---|---|
| **DTT** | 88.00% | 8.50% | 3.50% |
| **MTT** | 85.19% | 11.11% | 3.70% |

[6] VTRC. 2022. *Developing Guidance for a Corridor Level Vehicle Occupancy Rate Data Collection Program*. https://vtrc.virginia.gov/archived/projects/developing-guidance-for-a-corridor-level-vehicle-occupancy-rate-data-collection-program-project-no-118055/

**Figure 3. Heat Map: Current DTT Congestion (5 min speeds 5AM to 9PM)**




Source: INRIX 2023. https://pda.ritis.org/suite/cscan/

**Figure 4. Heat Map: Current MTT Congestion (5 min speeds 5AM to 9PM)**


Source: INRIX 2023. https://pda.ritis.org/suite/cscan/

### 3.1.2 Traffic Counts

In the second step in the analysis, VDOT evaluated 2023 traffic count data from its Traffic Monitoring System (TMS). The traffic count data for the subject facilities are shown in **Table 3.**

**Table 3. VDOT Traffic Counts - 2023**

| Facility | Annual Average Daily Trips (AADT) |
|---|---|
| **DTT – Westbound (WB)** | 39,072 |
| **DTT – Eastbound (EB)** | 37,681 |
| **MTT- Westbound (WB)** | 13,820 |
| **MTT_ Eastbound (EB)** | 14,385 |

Consistent with the HRTPO 2015 findings, referenced in **Section 2.3**, VDOT concluded that traffic counts for both DTT and MTT facilities dropped significantly following the implementation of tolling in 2014. This has led to a flattening in historical traffic growth for the MTT. Following a drop in traffic associated with COVID-19 pandemic, the DTT facility 2023 traffic volumes have increased almost to 2019 levels.

### 3.1.3 Traffic Forecasts

VDOT used the HRTPO 2017 traffic demand model to forecast traffic conditions based on the HOV2+ free versus no HOV2+ free scenarios beginning in 2026.[7] The HRTPO model assigned HOV trips to each tunnel, and the rate of growth for a HOV2+ free tolling scenario. This provided a "base" case for comparison of the percentage change in the number of HOV2+ trips that would be assigned to each facility.

The VOR percentages from **Table 2** were then applied to determine the HOV percentages on each facility. This methodology provided results that better aligned with the current level of HOV use in the Hampton Roads region (7.8% carpooling; 0.7% public transit) as indicated in the *HRTPO's The State of Transportation in Hampton Roads- 2023*. The results are shown in **Table 4** and **Table 5**.

**Table 4. HOV2+ Free Estimates – 2026**

| | HOV2+ Free – 2026 | |
|---|---|---|
| | **MTT** | **DTT** |
| **Daily Volume** | 29,050 | 78,100 |
| **SOV** | 84.88% | 87.65% |
| **HOV2** | 11.50% | 8.94% |
| **HOV3** | 3.62% | 3.41% |

[7] HRTPO. 2017. Travel Demand Model & Data. https://www.hrtpo.org/519/Travel-Demand-Model-Data

**Table 5 – HOV2+ Traffic Volumes – 2026**

| HOV2+ Free – 2026 | | | | |
|---|---|---|---|---|
| | MTT | | DTT | |
| | WB | EB | WB | EB |
| **Total Daily Volume** | 14,960 | 14,090 | 40,240 | 37,860 |
| **SOV** | 12,698 | 11,960 | 35,270 | 33,184 |
| **HOV2** | 1,720 | 1,620 | 3,597 | 3,385 |
| **HOV3** | 542 | 510 | 1,372 | 1,291 |

Validation issues were discovered in the HRTPO model as applied to the MTT. Since historic traffic growth at the MTT has been negative or flat, VDOT applied a linear growth rate of 0.5% (*VDOT Traffic Forecasting Guidebook* indicates use of a 0.5% growth rate when historic traffic trends are negative). In addition, VDOT estimated a 0.5% linear growth could be assumed due to the HOV policy change. This combined 1% linear growth and the VTRC methodology was used to forecast HOV trips through the 2045 study modeling period. The results from the VDOT model forecasts are shown in **Table 6** and **Table 7**.[8]

**Table 6. HOV2+ Free Estimates – 2045**

| | HOV2+ Free – 2045 | |
|---|---|---|
| | MTT | DTT |
| **Daily Volume** | 34,400 | 93,600 |
| **SOV** | 77.32% | 82.88% |
| **HOV2** | 17.38% | 11.42% |
| **HOV3** | 5.30% | 5.70% |

[8] HRTPO. 2023. *Annual Roadway Performance Report*. https://www.hrtpo.org/DocumentCenter/View/3578/HRTPO-Annual-Roadway-Performance-Report-PDF
HRTPO. 2024. *Annual State of Transportation Report 2024*. https://www.hrtpo.org/DocumentCenter/View/3579/T24-01-Annual-State-of-Transportation-in-Hampton-Roads-Report-PDF?bidId=
VDOT. 2024. *Traffic Forecasting Guidebook*, v. 1.1. https://www.vdot.virginia.gov/media/vdotvirginiagov/doing-business/technical-guidance-andsupport/technical-guidance-documents/transportation-and-mobility/traffic-forecasting-guidebookv1.1-2024-05_acc.pdf

**Table 7. HOV2+ Traffic Volumes – 2045**

| HOV2+ Free – 2045 | | | | |
|---|---|---|---|---|
| | MTT | | DTT | |
| | WB | EB | WB | EB |
| **Total Daily Volume** | 17,540 | 16,860 | 47,550 | 46,050 |
| **SOV** | 13,562 | 13,036 | 39,409 | 38,166 |
| **HOV2** | 3,048 | 2,930 | 5,430 | 5,259 |
| **HOV3** | 930 | 894 | 2,710 | 2,625 |

Note: The VDOT analysis accounts only for the redistribution of existing HOV trips in the model network to the new HOV facilities at each of the tunnels, and assumes low to moderate growth in traffic associated with the HOV2+ free policy (0.5% linear growth annually). Without additional information, such as a user preference survey, VDOT cannot accurately account for changes in travel behavior by the public or increased transit service that may accompany the potential HOV2+ free scenario.

### 3.1.4 Capacity Analysis

VDOT conducted a basic highway capacity analysis for 2023 to assess existing available capacity at the DTT-MTT facilities. VDOT modeled the traffic capacity for both facilities at 1600 vehicles per hour per lane ("v/h/l"), below typical freeway capacity of 2200 v/h/l. This model constraint was implemented consistent with guidance in the HRTPO 2023 congestion mitigation report, which noted that tunnels typically have a lower capacity value than highway facilities.[9]

Each tunnel facility was classified as a basic freeway segment for the purpose of the analysis, however, the MTT posted speed limit of 35 MPH is below the 45 MPH free flow speed threshold for freeway segments. To adjust, VDOT used a 45 MPH free flow speed for the MTT. For the DTT, the posted speed for the approaches to the tunnel is 35 MPH and the tunnel posted speed is variable. For the analysis, a posted speed of 35 MPH was used, and the free flow speed was assumed as 45 MPH.

The analysis revealed that, during the peak hours, the MTT is operating below capacity, and with the forecast 1% growth, will still be at LOS C in 2045. The MTT would require a 4%+ annual growth (extremely high) to reach an AADT of 54,000 by 2045; which is the volume that would have the tunnel operate at LOS E. Rather than this extreme growth in traffic, a more likely scenario is that with increasing volumes, Route 337 (Hampton Boulevard) and US 58 (Brambleton Avenue) immediately east of the MTT in Norfolk will become congested first, with potential backups extending into the tunnel in the eastbound direction during the AM peak hour.

The DTT operates over capacity (LOS F) in the WB direction in the AM peak and the EB direction in the PM peak. These trends are expected to continue into the near future.

Additional traffic would be generated at both tunnels by implementing a HOV2+ free tolling. This would likely lead to increased congestion at the MTT during peak periods and further degradation of the DTT, resulting in an expansion of the overcapacity peak hour to a peak period 2 hours or more.

[9] HRTPO. 2023. Hampton Roads Congestion Management Process. https://www.hrtpo.org/DocumentCenter/View/3476/Part-III---Congestion-Mitigation-PDF?bidId=

### 3.2 Capital and Operational Expenditures

VDOT evaluated the estimated cost of the HOV2+ free tolling scenario by focusing on the capital expenditures (CapEx) and operational expenditures (OpEx) for implementation, specifically the modifications required to the DTT-MTT facilities and tolling systems. VDOT, working with its consultants, developed a rough-order-of-magnitude (ROM) estimate of the non-recurring expenditures for facility modifications (CapEx) and recurring expenditures for system changes (OpEx) through the 2070 concession period. The assumptions for this analysis are provided in **Appendix A**.

#### 3.2.1 Methods

VDOT's estimation methods for CapEx/OpEx relied on the same base assumptions stated in Section 3. For CapEx, with additional assumptions detailed in Appendix A. VDOT first identified components of the DTT-MTT facilities that would need to be modified to enable the HOV2+ free tolling scenario, then grouped these modifications into categories: roadside and back-office systems, (including design, installation and testing); mobilization; project management; documentation and training.

A primary modification for the roadside tolling infrastructure would be a Vehicle-Occupancy-Detection (VOD) system used to observe instances where a vehicle with an EZPass transponder set to HOV mode may not have a two-occupant minimum. VDOT also reviewed existing signage for the DTT-MTT facilities, factoring signage changes into the ROM estimate. VDOT used a Monte Carlo simulation method to estimate these costs, validating the model by exploring benchmarks from comparable projects. While no example could be found to match exactly the Item 441 C.7 scenario, VDOT did identify a project where an express lane toll system, operating with a HOV-free discount, was approved for implementing VOD.[10]

For OpEx, VDOT identified the primary contributors to the operational cost as follows: additional staff to review VOD images, additional trooper from the Virginia State Police (VSP) to support occupancy enforcement, routine and major (lifecycle) maintenance of the VOD equipment, and additional customer support staff to handle motorist questions regarding HOV policies and enforcement. VDOT then applied simulation methods to develop a range for the OpEx ROM estimate.

#### 3.2.2 ROM Estimates

The high-low range of ROM estimates for CapEx/OpEx is shown in **Table 8**. Breakdowns for these estimates are provided in **Appendix B** (CapEx) and **Appendix C** (OpEx).

VDOT observed that CapEx estimates through the 2070 concession period were between **$5.1 million** and **$12.1 million**. Much of the disparity between the high-low estimates was attributed to the variability in roadside costs, which stems from the fact there are currently few suppliers of VOD equipment, and there are significant differences in equipment dimensions and mounting configurations. Also, the sample project used for validation had fewer locations for VOD equipment installation, so the

[10] See Minutes from Riverside County Transportation Commission (RCTC) meeting, Agenda Item 6E "91 Express Lanes Occupancy Detection System Change Order and Resolution for Occupancy Correction Fee", Occupancy Detection System (ODS) pp. 93 to 95. referenced costs for integrating VOD into the existing toll system including a breakdown of costs to modify the roadside and back office systems. As a result, information regarding a one-time design cost of $4 million and a one-time system modification cost of $392,953 were selectively incorporated into the CapEx estimate and scaled using engineering judgement. https://www.rctc.org/wp-content/uploads/2024/07/July-Commission-Agenda.pdf

roadside cost from the benchmark was scaled to better reflect the DTT-MTT facilities with four toll zones.[11]

OpEx estimates through the 2070 concession period ranged from **$68.5 million** to **$96.0 million**, or an average of $1.25 million to $1.74 million per year. There are five major contributing elements to OpEx for the HOV2+ free tolling scenario:

- VOD image review
- Additional customer service representatives to handle customer inquiries
- Enforcement support from Virginia State Police
- Routine maintenance of the VOD equipment
- Life cycle cost (major maintenance) every 10 years.

The primary sources of uncertainty relating to the OpEx estimate include:

- Finalized cost of roadside equipment
- Percentage of images from the VOD system that require manual review
- Percentage of vehicles having a flex transponder that is properly mounted
- Percentage of SOVs that have their flex transponder incorrectly toggled to HOV status
- Number of images per hour for reviewer processing

**Table 8. CapEx/OpEx ROM Estimates – 2070 (in 2026 $)**

| CapEx ROM | Estimate ($Millions) | OpEx ROM | Estimate ($Millions) |
|---|---|---|---|
| Low | $5.1 | Low | $68.5 |
| High | $12.1 | High | $96.0 |
| Range | $5.1 to $12.1 | Range | $68.5 to $96.0 |

### 3.3 Commercial and Policy Impacts

VDOT identified the following potential commercial and policy impacts associated with the HOV2+ free tolling scenario.

#### 3.3.1 Commercial Impacts

VDOT reviewed the CA governing the DTT-MTT facilities, along with related documentation, to identify the following commercial considerations:

- Department Change to project: The CA between VDOT and ERC calls for the collection of toll revenues from all vehicle classes during peak and off-peak hours. Pursuant to the CA, any change in the existing tolling policy, such as the implementation of HOV2+ free tolling, would constitute a Department Change to the project and would likely be subject to a Compensation Event due to the net revenue impact to ERC. Determining the net revenue impact of the Department Change would require a detailed study by VDOT and ERC, which is beyond the scope of this evaluation and report.

[11] The implementation of VOD on the DTT-MTT facilities would need to comply with Va. Code § 33.2-500 *et seq.* and § 46.2-819.3:1.

- Estimated compensation event amount: VDOT used the results from a 2019 traffic and revenue study to estimate the net revenue impact to ERC in the HOV2+ free tolling scenario. A discount rate was applied to the net revenue impact to estimate the value of future revenues in current-day dollars. The analysis assumed a discount-rate range from 6% to 8%, which reflects the estimated cost of equity based on prior VDOT market assessments of similar assets. The resulting upfront payment, representing the estimated compensation event amount, for HOV2+ free ranged from $450 million to $650 million, subject to negotiation with ERC.[12]

- Potential HOV-use protection: The negotiation between VDOT and ERC on the loss of revenue to calculate the upfront payment of the Compensation Event would be based on assumptions relating to the amount of HOV traffic traveling through the DTT-MTT facilities. However, if the actual number of HOVs traveling on the DTT-MTT facilities exceeds the level of HOV traffic assumed for the calculation of this upfront payment, there may be insufficient revenues for ERC to maintain and operate the DTT-MTT facilities in accordance with the requirements of the CA. As a result, ERC would likely seek additional compensation from the Commonwealth.

Other provisions of the CA may be impacted by this proposed action and a full review of the CA and assessment of impacts would need to be initiated. Furthermore, any change to the financial structure of the asset would require the consent of ERC's lenders', including the U.S. Department of Transportation (USDOT). Statutory and regulatory requirements governing state and federal highways (including the operation of HOV/HOT facilities), would also need to be addressed before a change in tolling policy could be implemented.

[12] The estimate range of the upfront payment amounts represents VDOT's perspective and not that of ERC. In the event of a HOV2+ free tolling scenario, the actual upfront payment amount will be subject to negotiation.

### 3.3.2 Policy Impacts

VDOT identified the following policy and regulatory considerations. These policy impacts may have associated cost impacts, however, VDOT does not presently have sufficient data to prepare an actual cost estimate for the policy and regulatory components.

- Terms and conditions between FHWA and VDOT on Value Pricing Pilot Program: VDOT and the Federal Highway Administration (FHWA) entered into a Cooperative Agreement, dated September 4, 2009, to establish, maintain, and monitor the DTT-MTT/MLK Extension Project as a Value Pricing Pilot Project (VPPP) consistent with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). This FHWA program enabled VDOT and ERC to use tolling and other pricing mechanisms to manage highway congestion in the project facilities. Pursuant to the CA, VDOT must specify certain uses of the toll revenue and agreed to obtain the prior FHWA approval for any significant change related to the approach to tolling the project. Implementation of HOV2+ free tolling may require FHWA approval of the revised tolling structure as well as FHWA consent to amend the Cooperative Agreement.

- Implementation of Title 23 of the United States Code (USC) (Highways): While the VPPP enables peak and off-peak tolling on the DTT-MTT facilities, the other tolling operations are governed by Title 23 of the United States Code, specifically Section 129 General Tolling Program (23 USC 129) and Section 166 HOV/HOT Lanes Program (23 USC 166). Both programs have implications for tolled assets. For example, 23 USC 129 includes limitations and minimum requirements for the use of toll revenues and how the tolling program must be conducted. 23 USC 166 sets performance standards for HOV assets including requirements that HOV facilities not become "degraded."[13]

- State statutes, enforcement, and case law: The Code of Virginia establishes requirements for roadways designated as HOV and HOT. For example, Va. Code § 33.2-501 creates a process for the Commonwealth Transportation Board (CTB) to designate roadways as HOV and sets the penalties for violations of the HOV requirement.

- FHWA Oversight: VDOT previously explored a tolling program comparable to the HOV2+ free scenario contemplated under Item 441 C.7. At that time, FHWA, which has oversight authority over the project, identified the following requirements that would be triggered upon initiation of a new tolling program:
  - National Environmental Protection Act (NEPA) re-evaluation: VDOT would need to reassess the potential environmental impacts from the removal of tolling from the subject facilities.
  - FHWA approval of CA amendment: VDOT would need to amend the CA and secure FHWA approval of the amendment prior to implementation of the HOV2+ free tolling scenario

- HOV enforcement: Current language in Va. Code Section 46.2-819.3:1 does not appear to adequately address the facility operator's recourse for those motorists who falsely declare HOV

[13] "A degraded facility is defined as one that does not meet minimum average operating speed of 45 miles per hour (MPH) for 90 percent of the time over a 180-day monitoring period during morning and evening weekday peak hours (or both), in the case of a HOV facility with a speed limit of 50 MPH or greater; or not more than 10 MPH below the speed limit in the case of a facility with a speed limit of less than 50 MPH." 23 USC 166.
https://ops.fhwa.dot.gov/freewaymgmt/hovguidance/chapter3.htm#:~:text=A%20degraded%20facility%20is%20defined,or%20greater%3B%20or%20not%20more

status. Potential Code revision(s) related to HOV enforcement for All Electronic Tolling (AET) facilities, such as DTT-MTT, would likely be needed before implementation of a HOV2+ free tolling policy. In the absence of a legal foundation to recover the lost toll revenue and associated operating costs, ERC would likely seek further compensation from the Commonwealth due to the change in tolling policy.

## 4. CONCLUSION AND RECOMMENDATIONS

Pursuant to Chapter 2, Item 441 C.7, of the 2024 Appropriation Act, VDOT has identified the following conclusions and recommendations associated with the HOV2+ free tolling scenario.

### 4.1 Conclusions

**4.1.1 Traffic Congestion**: VDOT's traffic analysis showed the DTT is currently operating as a degraded facility during peak hours, at a LOS F, and the MTT nearing capacity limits. The HOV2+ free tolling scenario would have negative impacts on traffic flow at these facilities, and in the adjacent roadway network.

**4.1.2 CapEx**: VDOT estimated CapEx costs to be between $5.1 million and $12.1 million. This includes the upfront cost to install and configure the required VOD equipment, as well as signage and related infrastructure.

**4.1.3 OpEx**: VDOT's Monte Carlo simulation models resulted in total OpEx estimates ranging from $68.5 million to $96.0 million through the 2070 concession period. This includes VOD image processing, image review, major maintenance, law enforcement and related operational costs.

**4.1.4 Commercial Impacts**: VDOT concluded that commercial impacts of a HOV2+ free tolling scenario would be significant. While data were not available to evaluate all costs, VDOT estimated the upfront payment to ERC alone would be between $450 million and $650 million, subject to negotiation with ERC.

**4.1.5 Policy Impacts**: VDOT's authority under the VPPP allows ERC to use peak and off-peak tolling to manage congestion. However, performance standards for HOV assets under the Section 166 HOV/HOT lanes program, require that HOV facilities not become degraded. Implementation of a HOV2+ free tolling scenario would cause the DTT-MTT facilities to fail these performance standards.

### 4.2 Recommendations

VDOT recommends that the HOV2+ free tolling scenario contemplated by Item 441 C.7 ***should not be implemented on the DTT-MTT facilities*** for the reasons summarized below:

**4.2.1 Traffic Congestion and Safety:** VDOT's traffic analysis showed that a HOV2+ free tolling scenario would negatively impact the DTT-MTT facilities by increasing congestion. This would require significant capital investments to add capacity. In addition, an increase in congestion would also lead to delays in responding to incidents by emergency personnel.

**4.2.2 Impact on Capital and Operational Costs:** VDOT estimated that implementation of a HOV2+ free tolling scenario would result in additional OpEx costs estimated between $68.5 million to $96 million through 2070 and an estimated $5.1 million to $12.1 million in additional CapEx.

**4.2.3 Commercial Impacts**: A change in tolling policy to HOV2+ free would result in a compensation event to ERC, pursuant to the CA, estimated between $450 million and $650 million. The unknown risks around higher than expected HOV2+ use could result in further revenue loss, potentially jeopardizing ERC's ability to operate and maintain the DTT-MTT facilities. This could result in the need for additional public contribution.

**APPENDIX A. ASSUMPTIONS FOR CAPEX / OPEX ESTIMATION**

| ***CapEx Assumptions*** |
|---|
| A total 4 toll zones comprising a total of 9 lanes would need to be equipped to support VOD |
| Placement of VOD equipment along the roadside will be challenge given the narrow cross-section and location of the current toll zone, which is close to the tunnel portals. Since the VOD equipment works best when mounted on the roadside and at a height equal to the height of windows of a vehicle, modifications would be required including widening the barrier on a taper to provide a foundation for the VOD equipment. This would result in a further reduction of the already narrow shoulder. With a reduction in shoulder width the VOD equipment would be in close proximity to the lanes, increasing the risk of impact from heavy vehicles. Therefore, a higher initial inventory of VOD equipment (cameras, sensors) spares would be required for early and recurring replacement. |
| Only a small number of providers offer the required VOD equipment, with variations in equipment sizes, among differences in equipment configuration. To support a more conservative estimate the vendor whose equipment required a larger configuration and footprint was used. |
| Maintenance of Traffic (MOT) will be needed at the lane level, and installation will occur at the toll zone level. |
| Software modifications, upgrades, integration, and testing must be performed on the existing roadside and back-office systems. |
| New signage would be required in advance of the mainlines and on each entry ramps or roadway entries within 1 mile of the tunnel. |
| Training and workstations are needed to support additional staff required for manual image reviews. |
| Coordination and project management from multiple stakeholders (ERC, VDOT, integrators, consultants) will be essential. |
| Two cost categories were developed to represent the primary high-level system components: (1) System Modification and (2) Standing Up Operations |
| • The System Modification cost category accounts for design and fabrication of the mounting equipment, VOD hardware, servers, cabinets, spare parts, installation efforts, signage, roadside and back office software modifications, integration and testing, documentation, and workstations for new/additional staff. |
| • The Standing Up Operations category incorporates costs related to training, mobilization, and project management efforts. |
| A contingency of 40% was used and is appropriate for the stage of design for the modifications, which at this point is conceptual. |
| A review of the Federal Reserve Bank (FRB) of Cleveland and New York's respective inflation expectations data was performed to determine which rate to use to inflate 2024 $'s to 2026. The FRB of Cleveland's latest 2-year expected inflation is 2.51%.[14] The FRB of New York provides a Survey of Consumer Expectations (SCE) showing median 1-year and 3-year expected inflation rates of 3.02% and |

[14] The Federal Reserve Bank of Cleveland reports estimates of the expected rate of inflation over the next 30 years along with the inflation risk premium, the real risk premium, and the real interest rate. The estimates are calculated with a model that uses Treasury yields, inflation data, inflation swaps, and survey-based measures of inflation expectations. https://www.clevelandfed.org/indicators-and-data/inflation-expectations

| |
|---|
| 2.93% respectively.[15] To provide an expected inflation value for 2-years, an average median value of 2.98% was used as a more conservative approach to inflating the 2024 dollars to 2026 dollars. |
| ***OpEx Assumptions*** |
| Traffic data for the period from 2023 through 2045 (in terms of both volumes and SOV/HOV mode splits) are drawn from VDOT's traffic analysis, as documented in Table 1 (2023 SOV/HOV split), Table 3 (2023 traffic volumes), Table 4 (2026 SOV/HOV split), and Table 6 (2045 traffic volumes and SOV/HOV split). Volumes and occupancy splits for all other years were developed via interpolation (2023-2045) and extrapolation (2045-2070). |
| The assumed rate of traffic growth for 2045 through 2070 was drawn from Table ES-3 of the *Elizabeth River Crossings Traffic and Revenue Study Report* (Steer, November 2021). |
| VDOT's traffic volumes were expressed in terms of AADT's. These were multiplied by 365 to convert to annual volumes. |
| To receive free passage through the tunnels via this program, vehicles must have a valid flex transponder. This transponder must be properly mounted in the vehicle, and it must be correctly toggled to designate the vehicle as a HOV. Any vehicle without a flex transponder, or with a flex transponder toggled to SOV, will be assessed the appropriate toll regardless of the actual number of occupants in the vehicle. |
| The only images that will be reviewed for occupancy characteristics will be images generated by vehicles with a flex transponder that is toggled to HOV. |
| Of all vehicles using the tunnels, **60%** will have a flex transponder that is properly mounted. It is assumed that all other vehicles will either (a) use a traditional transponder; (b) fail to properly mount their flex transponder; or (c) post-pay the toll as a Pay by Plate customer. |
| Of all SOVs with a properly mounted flex transponder, **60%** will have the tag correctly toggled to SOV mode. The remaining **40%** of SOVs will have the transponder erroneously toggled to HOV mode. |
| Of all HOVs with a properly mounted flex transponder, **95%** will have the tag correctly toggled to HOV mode. The remaining **5%** of HOVs will have the transponder erroneously toggled to SOV mode, thus incurring a toll. |
| Of all vehicle occupancy detection (VOD) images captured, **70%** are handled automatically at an acceptable level of accuracy, foregoing the need for manual review. The remaining **30%** go through a manual review process. |
| Each image reviewer FTE is assumed to perform as follows:<br>• Review rate of 300 images per hour<br>• Work day of 8 hours, at **90%** efficiency (Review rate of 2,160 images per day per FTE)<br>• Each FTE works 240 days per year (365 days/year, less 104 weekend days, less 11 holidays, and less 10 vacation days). (Review rate of 518,400 images per year per FTE) |
| Customer service representatives (CSRs) will be hired to field questions from drivers regarding the HOV program. The number of CSRs will depend on the number of drivers making calls on an annual basis.<br>• On average, one out of 40 unique drivers through the tunnels will make a phone call at some point during the year.<br>• The average driver makes one trip per week over the course of the year.<br>• The average phone call will take an average of five minutes to resolve.<br>The average CSR FTE works an effective total of 1,728 hours per year. |

[15] The Federal Reserve Bank of New York provides a Survey of Consumer Expectations (SCE) which provides median 1-year and 3-year expected inflation rates. See: https://www.newyorkfed.org/microeconomics/databank.html
"Source: Survey of Consumer Expectations, © 2013-2023 Federal Reserve Bank of New York (FRBNY). The SCE data are available without charge at http://www.newyorkfed.org/microeconomics/sce and may be used subject to license terms posted there. FRBNY disclaims any responsibility or legal liability for this analysis and interpretation of Survey of Consumer Expectations data."

| |
|---|
| A supervisor FTE will be assigned to oversee no more than 8 FTEs (combined image reviewers and CSRs) |
| Image reviewers and CSRs will be paid at an hourly rate of $20 per hour. |
| Supervisors will be paid at an hour rate of $30 per hour. |
| One VSP FTE will be assigned to oversee HOV operations and pursue egregious violators. |
| The cost of a VSP FTE is assumed to be $127k per year. |
| In year 1, and every 5th year thereafter, this cost escalates to $201k to cover the cost of a vehicle and equipment needed to support enforcement efforts. |
| A routine maintenance cost will be incorporated into the analysis; it is an annual cost assumed to be **5%** of the VOD system replacement cost. |
| In 2036, and every 10$^{th}$ year thereafter, the entire VOD system will be replaced (as a “Major Maintenance” cost). |
| All costs are expressed in 2026 dollars. |

## APPENDIX B. CAPEX ROM ESTIMATE COST BREAKDOWN

**Table B-1. Low CapEx ROM Estimate Breakdown**

| | Item | ROM per Item | # of Items | Extended ROM |
|---|---|---|---|---|
| **Roadside** | VOD Hardware | $66,866 | 9 | $601,792 |
| | Servers/Comms/Other Electrical | $25,000 | 4 | $100,000 |
| | Cabinets | $10,000 | 4 | $40,000 |
| | UPS | $20,000 | 4 | $80,000 |
| | Installation | $50,000 | 4 | $200,000 |
| | Design + fabrication of mounting equipment | $500,000 | 1 | $500,000 |
| | MOT | $10,000 | 9 | $90,000 |
| | Spare Parts | $133,732 | 1 | $133,732 |
| | Roadside Software | $175,000 | 1 | $175,000 |
| | Signage | $15,000 | 15 | $225,000 |
| **Back Office** | Back Office Software | $175,000 | 1 | $175,000 |
| | Hardware (servers/comms) | $75,000 | 1 | $75,000 |
| | Installation/Configuration | $75,000 | 1 | $75,000 |
| | Eng./Design/Integration | $200,000 | 1 | $200,000 |
| | Documentation | $50,000 | 1 | $50,000 |
| | Workstations for manual image review | $2,000 | 4 | $8,000 |
| **Testing** | Integration | $175,000 | 1 | $175,000 |
| | Commissioning | $50,000 | 4 | $200,000 |
| | Acceptance | $75,000 | 1 | $75,000 |
| **Other** | Training (CSC, operational, enforcement) | $30,000 | 1 | $30,000 |
| | Mobilization | $50,000 | 1 | $50,000 |
| | Project Management | $300,000 | 1 | $300,000 |

With contingency and inflation applied, the Low CapEx ROM estimate (in millions):

| | |
|---|---|
| **Sub Total (all items)** | **$3.6** |
| Contingency 40% | $1.4 |
| **Estimate Total** | **$5.0** |
| Projected Average Inflation Rate | 2.98% |
| **Total (2026 $)** | **$5.1** |

**Table B-1 – High CapEx ROM Estimate Breakdown**

| | Item | ROM Per Item | # of Items | Extended ROM |
|---|---|---|---|---|
| **Roadside** | VOD system | $7,200,000 | 1 | $7,200,000 |
| | Signage | $15,000 | 15 | $225,000 |
| | Widening barrier wall | $150,000 | 1 | $150,000 |
| **Back Office** | Design, install, test back-office system changes | $392,953 | 1 | $392,953 |
| | Documentation | $50,000 | 1 | $50,000 |
| **Other** | Training (CSC, operational, enforcement, etc.) | $30,000 | 1 | $30,000 |
| | Mobilization | $50,000 | 1 | $50,000 |
| | Project Management | $300,000 | 1 | $300,000 |

With contingency and inflation applied, the high CapEx ROM estimate (in millions):

| | |
|---|---|
| **Sub Total (all items)** | **$8.4** |
| Contingency 40% | $3.4 |
| **Estimate Total** | **$11.8** |
| Projected Average Inflation Rate | 2.98% |
| **Total (2026 $)** | **$12.1** |

**APPENDIX C. OPEX ROM ESTIMATE COST BREAKDOWN**

A Monte Carlo simulation model was developed to estimate a reasonable range of estimates for OpEx costs. The key variables incorporated into the Monte Carlo simulation included the following:

- **Major maintenance**. The analysis assumed that the VOD system would be replaced every 10 years. The analysis built in a cost range of $5.1 million to $12.1 million for this replacement, with a midpoint estimated cost of $8.6 million.
- **Manual image review**. The baseline assumption was that 30% of all VOD images would require manual review. The Monte Carlo simulation considered a range of possible image review requirements, from as low as 15% to as high as 45%.
- **Flex Transponders.** The analysis assumed that the only VOD images to be reviewed would be from vehicles with a properly mounted flex transponder toggled to HOV mode.
    - The simulation considered that between 40% and 80% of vehicles will have a properly mounted flex transponder, with an expected value of 60%.
    - The simulation considered that between 20% and 60% of SOVs will have their vehicle incorrectly toggled to HOV mode, with an expected value of 40%.
    - The simulation considered that between 85% and 100% of HOVs will have their vehicle correctly toggled to HOV mode, with an expected value of 5%.
- **Customer Service and Image processing**.
    - The baseline assumption was that image reviewers would be able to process 300 images per hour. The analysis considered a range of possible processing rates, from as low as 240 images per hour to as high as 400 images per hour.
    - The estimated number of customer service representatives (CSR's) required to field phone calls from drivers who might have questions related to the HOV program was developed with the following assumptions (with appropriate ranges to account for uncertainty):
        - An average driver makes between 26 and 78 trips per year, with an expected value of 52 trips per year (that is, one trip per week).
        - One out of every 40 unique drivers will make a call at some point during the year. This could range from as low as 100:1 to as high as 20:1.
        - Each call is expected to take 5 minutes to resolve, with an expected range of as low as 2 minutes to as high as 8 minutes.

The expected OpEx costs and transaction counts from the model are shown in **Table C-1**. All costs are expressed in millions of dollars.

**Table C-1. OpEx Cost and Transaction ROM Estimates (2026 $)**

| Year | Vehicle Transactions | HOV Images | HOV Images to Review | Annual CSR Calls | *IR & CSR Wages* | *VSP Wages* | Total VOD Wages | Major Maint. | Routine Maint. | **Total OpEx** |
|---|---|---|---|---|---|---|---|---|---|---|
| 2026 | 38,300,000 | 11,100,000 | 3,300,000 | 19,000 | *$0.4* | *$0.2* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2027 | 38,700,000 | 11,300,000 | 3,400,000 | 19,000 | *$0.4* | *$0.1* | $0.5 | $0.0 | $0.4 | $0.9 |
| 2028 | 39,000,000 | 11,400,000 | 3,400,000 | 19,000 | *$0.4* | *$0.1* | $0.5 | $0.0 | $0.4 | $0.9 |
| 2029 | 39,400,000 | 11,600,000 | 3,500,000 | 19,000 | *$0.4* | *$0.1* | $0.5 | $0.0 | $0.4 | $0.9 |
| 2030 | 39,700,000 | 11,700,000 | 3,500,000 | 20,000 | *$0.4* | *$0.1* | $0.5 | $0.0 | $0.4 | $0.9 |
| 2031 | 40,100,000 | 11,900,000 | 3,600,000 | 20,000 | *$0.4* | *$0.2* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2032 | 40,400,000 | 12,000,000 | 3,600,000 | 20,000 | *$0.4* | *$0.1* | $0.5 | $0.0 | $0.4 | $0.9 |
| 2033 | 40,800,000 | 12,200,000 | 3,600,000 | 20,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2034 | 41,200,000 | 12,300,000 | 3,700,000 | 20,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2035 | 41,600,000 | 12,500,000 | 3,700,000 | 21,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2036 | 41,900,000 | 12,600,000 | 3,800,000 | 21,000 | *$0.5* | *$0.2* | $0.7 | $8.6 | $0.4 | $9.7 |
| 2037 | 42,300,000 | 12,800,000 | 3,800,000 | 21,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2038 | 42,700,000 | 12,900,000 | 3,900,000 | 21,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2039 | 43,100,000 | 13,100,000 | 3,900,000 | 21,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2040 | 43,500,000 | 13,200,000 | 4,000,000 | 21,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2041 | 43,900,000 | 13,400,000 | 4,000,000 | 22,000 | *$0.5* | *$0.2* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2042 | 44,300,000 | 13,600,000 | 4,100,000 | 22,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2043 | 44,700,000 | 13,700,000 | 4,100,000 | 22,000 | *$0.5* | *$0.1* | $0.6 | $0.0 | $0.4 | $1.0 |
| 2044 | 45,100,000 | 13,900,000 | 4,200,000 | 22,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2045 | 45,500,000 | 14,100,000 | 4,200,000 | 22,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2046 | 45,900,000 | 14,200,000 | 4,300,000 | 23,000 | *$0.6* | *$0.2* | $0.8 | $8.6 | $0.4 | $9.8 |
| 2047 | 46,300,000 | 14,300,000 | 4,300,000 | 23,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2048 | 46,700,000 | 14,400,000 | 4,300,000 | 23,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2049 | 47,200,000 | 14,500,000 | 4,400,000 | 23,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2050 | 47,600,000 | 14,600,000 | 4,400,000 | 23,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2051 | 47,900,000 | 14,600,000 | 4,400,000 | 23,000 | *$0.6* | *$0.2* | $0.8 | $0.0 | $0.4 | $1.2 |
| 2052 | 48,200,000 | 14,700,000 | 4,400,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2053 | 48,300,000 | 14,900,000 | 4,500,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2054 | 48,600,000 | 15,000,000 | 4,500,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2055 | 48,900,000 | 15,000,000 | 4,500,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2056 | 49,300,000 | 15,100,000 | 4,500,000 | 24,000 | *$0.6* | *$0.2* | $0.8 | $8.6 | $0.4 | $9.8 |
| 2057 | 49,800,000 | 15,200,000 | 4,600,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2058 | 49,900,000 | 15,300,000 | 4,600,000 | 24,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2059 | 50,200,000 | 15,400,000 | 4,600,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2060 | 50,500,000 | 15,400,000 | 4,600,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2061 | 50,800,000 | 15,500,000 | 4,600,000 | 25,000 | *$0.6* | *$0.2* | $0.8 | $0.0 | $0.4 | $1.2 |
| 2062 | 51,000,000 | 15,500,000 | 4,700,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2063 | 51,200,000 | 15,600,000 | 4,700,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2064 | 51,300,000 | 15,700,000 | 4,700,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2065 | 51,500,000 | 15,700,000 | 4,700,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2066 | 51,800,000 | 15,800,000 | 4,700,000 | 25,000 | *$0.6* | *$0.2* | $0.8 | $8.6 | $0.4 | $9.8 |
| 2067 | 52,000,000 | 15,800,000 | 4,700,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2068 | 52,100,000 | 15,800,000 | 4,800,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2069 | 52,300,000 | 15,900,000 | 4,800,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| 2070 | 52,400,000 | 15,900,000 | 4,800,000 | 25,000 | *$0.6* | *$0.1* | $0.7 | $0.0 | $0.4 | $1.1 |
| **Totals** | **2,077,900,000** | **631,100,000** | **189,400,000** | **1,018,000** | ***$24.5*** | ***$5.4*** | **$29.9** | **$34.4** | **$19.4** | **$83.7** |

OpEx costs over the 44-year analysis period (2070) are expected to total $83.7 million. However, the Monte Carlo simulation—which ran 10,000 unique cost simulations, each of which represented a unique estimate based on the range of possible cost parameters identified earlier—suggests that the actual costs will likely lie within a range of **$68.5 million** and **$96.0 million** (expressed in 2026 dollars).

- The lower number represents the 20$^{th}$ percentile cost, meaning that 80% of all cost simulations lay above this value. It equates to an average of 10.9¢ per HOV image captured over the analysis period.

- The higher number represents the 80th percentile cost, meaning that 80% of all cost simulations lay below this value). It equates to an average of 15.2¢ per HOV image captured over the analysis period.

A histogram depicting the outcomes of the Monte Carlo simulation is shown in **Figure C-1**.

**Figure C-1. Histogram of Cost Simulation Outputs (in $ millions)**