II. MAINLINE FREEWAY ANALYSIS

As stated in the Introduction, one purpose of this study is to provide an overall framework for developing future improvements to the corridor, and from this it would be reasonable to infer that the operation of individual segments of the I-264 freeway would be independently analyzed. However, the close spacing of interchanges along most of the freeway – and most particularly along the heavily traveled western segments – does not accommodate independent freeway segment analysis because of overlapping influence areas of ramp merge and diverge movements. Focusing on the full-movement interchanges west of Independence Boulevard, the distance between interchanges does not exceed 2,700 feet. One exception is the distance between the Witchduck Road and Independence Boulevard ramp areas on eastbound I-264 at approximately 4,000 feet. Moving east, the distance between the Independence Boulevard and Rosemont Road interchange ramp areas is much longer - approximately 7,800 feet.

Continuing to the east of Rosemont Road, while some freeway segments between interchange ramp areas provide distances greater than 2,700 feet, they were not found to exhibit capacity deficiencies (as will be documented later in this section). Consequently, the only freeway segment for which stand-alone improvements have been proposed (that is not part of an overall interchange improvement) lies between the Independence Boulevard and Rosemont Road interchanges.

II.1 Study Methodology

II.1.1 Traffic Data

Traffic counts were conducted within the study area to help define the existing conditions in December 2014. Mainline traffic counts were conducted using non-intrusive count technologies. Mainline traffic counts were conducted for 48 hours during the week (Tuesday-Thursday), were aggregated by 15-minute periods, and generally classified vehicles (heavy or non-heavy). Mainline traffic counts were conducted at the following locations:

- I-264 EB Mainline (between I-64 and Newtown Rd interchanges)
- I-264 EB CD Lanes (between I-64 and Newtown Rd interchanges)
- I-264 WB Mainline (between I-64 and Newtown Rd interchanges)
- I-264 WB CD Lanes (between I-64 and Newtown Rd interchanges)
- I-264 EB Mainline (between Witchduck Rd and Independence Blvd interchanges)
- I-264 WB Mainline (between Witchduck Rd and Independence Blvd interchanges)
- I-264 EB Mainline (between Rosemont Rd and Lynnhaven Pkwy interchanges)
- I-264 WB Mainline (between Rosemont Rd and Lynnhaven Pkwy interchanges)
- I-64 EB Mainline (north of I-264)
- I-64 WB Mainline (north of I-264)
- I-64 EB Mainline (south of I-264)
- I-64 WB Mainline (south of I-264)

48-hour automated classification counts were conducted during weekdays (Tuesday-Thursday) at all the interchange ramps unless a turning movement count was conducted at the ramp terminus to replace the need for the automated count.

Six-hour turning movement counts were conducted at ramp termini that include multiple turning movements, and at intersections immediately adjacent to ramps that have significant influence on interchange operations. The counts were conducted during the weekday (Tuesday-Thursday) and included general classification of vehicles (heavy or non-heavy).

II.1.2 Balancing Existing Volumes

The 3-day traffic count raw data was consolidated and averaged to provide an estimated 24-hour average weekday daily traffic (AWDT) count. Heavy vehicle percentages were also tabulated for a daily basis. I-264 and I-64 mainline corridor counts were analyzed to determine system-wide AM and PM peak hours; it was determined that the AM peak hour occurred between 7:30 – 8:30 AM, and the PM peak hour occurred between 4:30 – 5:30 PM. The peak hour volumes were then tabulated from the 15-minute periods that constituted each peak hour, respectively.

Where inconsistencies among the counts were found, the I-264 corridor counts were prioritized as the basis for balancing. Ramp movements to and from I-264 carried the next level of priority, and finally arterial volumes and turning movement counts at arterial intersections were the lowest priority level.

Since the focus of the study is on the I-264 freeway, where I-64 volume inconsistencies were found at the I-64/I-264 interchange they were adjusted to match I-264 mainline and ramp volumes. Where imbalances existed, the difference was applied to each ramp volume in a ratio equal to its addition or subtraction from the system. By adjusting each ramp by its respective ratio, each ramp's overall contribution changed, but the percent difference was held constant.

Where no interstate counts were collected, two balancing options were applied:

- For those segments on which freeway volumes were not collected, the ramp volumes were used to adjust freeway volumes across the interchange area.
- For those segments adjacent to a count (i.e., at Parks Avenue), the turning movement counts were used to compute mainline volumes and any intermediate interchanges were adjusted using the same method previously described.

Where ramps terminated or originated from an arterial intersection, ramp volumes were not counted; ramp volumes were instead calculated from the intersection turning movement count.

Estimates of HOV volumes were developed from the results of the VDOT High Occupancy Vehicle counts. For the purposes of this study, westbound AM HOV percentage of total volumes was estimated using the counts at Independence Boulevard; the eastbound PM HOV percentage of total volumes was determined using the counts at Witchduck Road. For both directions, the percentage of carpools and HOV-lane violators from the individual interchanges were applied to the entire corridor, where applicable. Westbound AM carpools were found to be 1% of the total volume, with 5% of the total volume as HOV violators, and eastbound PM carpools were found to be 5% of the total volume, with 5% of the total volume as HOV violators.

Once all mainline and ramp counts were tabulated, arterials were analyzed. At the locations at which ramp volumes interacted with intersections, the volumes associated with ramp movements were held constant, and the remaining turning movement counts in each direction of the arterials were adjusted to achieve balanced volumes. While ramps volumes could be adjusted using ratios, the intersection turning movement count balancing could not be adjusted based on ratios of volumes; therefore, engineering judgment was also applied in this process.

Finally, once all mainline, ramp and turning movement volumes were balanced, a seasonal adjustment factor was applied to the system. The adjustment factor was calculated by comparing counts throughout the year at a VDOT count station where such counts were available. A VDOT count station with continuous data was found between the Witchduck Road and Independence Boulevard interchanges. This count station was used to develop a seasonal adjustment factor of 1.03 (December to annual ratio) which was applied to all volumes in the network, providing a balanced and adjusted network that was fully representative of an average annual weekday.

The existing balanced volumes at each interchange are shown in the respective interchange sections beginning in the next section of this report.

II.1.3 Development of Forecasted Year 2040 Average Weekday Volumes

Development of forecasted volumes employed procedures documented in the *National Cooperative Highway Research Program Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design*. The Hampton Roads Travel Demand Model (Year 2034) was used as the primary tool for developing growth factors to apply to existing volumes to forecast future-year traffic volumes.

The design year for this project is 2040, so the 2034-2040 growth rates were developed by applying a straight-line extrapolated from existing volumes and forecasted 2034 volumes. A growth factor was applied to each freeway segment of I-264 between interchanges, on each segment of I-264 adjacent to I-264, as well as arterials at interchanges on either side of I-264.

The Hampton Roads travel demand model networks used in developing the year 2034 forecasts were modified as follows:

No Build Network

1. I-64 was widened from 4 to 6 lanes from Jefferson Avenue west to Lightfoot (Exit 234):
2. Eastbound I-264 was improved from westbound I-64 to the Witchduck Road interchange to 7 lanes (Greenwich Road flyover to Cleveland street was included); and,
3. The extension of Constitution Drive from Columbus Loop to Bonney Road was added as a 4-lane facility.

Build Network

In addition to the modifications in the No Build Network, the Build Network included:

1. The extension of Sentara Way across I-264 to intersect with Bonney Road at the Rosemont Road interchange (Recommendation in Virginia Beach Strategic Growth Area (SGA) Plan;
2. The extension of Lavender Lane south to Virginia Beach Boulevard and beyond across I-264 to Bonney Road (Recommendation in Virginia Beach SGA Plan); and
3. Widening of I-264 as follows:
    a. To 6 lanes between Rosemont Road and Independence Boulevard
    b. To 7 lanes between Independence Boulevard and Witchduck Road
    c. To 7 lanes on westbound I-264 from Witchduck Road to CD approaching the Newtown Road interchange.

The forecasted weekday daily volumes on I-264 and I-64 are summarized in **Table 2.1.** Detailed forecasts of both freeway and arterial daily volumes have been included in the Technical Appendix.

It should be noted that the forecasted daily volume results from the travel demand model were not used in the analysis process. Instead, the model forecasts were used to compute growth factors that were applied to existing peak hour volumes, and the peak hour volumes were used in the operational analysis.

The travel demand model results were used to compute growth factors that were applied to weekday peak hour volumes for analysis of forecasted operational conditions.

Table 2.1
Summary of Existing and Forecast Weekday Daily Volumes
I-264 and I-64

Freeway Segment	2014 Existing Conditions	2040 No Build Alternative	2040 Build Alternatives
I-264			
West of Military Highway	126,000	130,000	132,000
Military Highway – I-64	167,000	148,000	154,000
I-64 – Newtown Road	229,000	293,000	297,000
Newtown Road – Witchduck Road	191,000	236,000	260,000
Witchduck Rd – Independence Blvd	196,000	223,000	254,000
Independence Blvd – Rosemont Rd	156,000	176,000	204,000
Rosemont Rd – Lynnhaven Pkwy	150,000	170,000	163,000
Lynnhaven Pkwy – Laskin Road	108,000	124,000	128,000
Laskin Road – First Colonial Road	70,000	85,000	83,000
First Colonial Road – Birdneck Road	52,000	67,000	67,000
Birdneck Road – Parks Avenue	23,000	33,000	33,000
I-64			
Northampton Boulevard – I-264	184,000	210,000	210,000
I-264 – Indian River Road	149,000	211,000	220,000

Table 2.1 shows one segment of I-264 (Military Highway – I-64) exhibits a drop in volumes when comparing 2014 Existing Conditions with either the forecasted 2040 No Build or 2040 Build alternatives volumes. This reduction is related to the redistribution of volumes resulting from the application of tolls on the I-264 downtown tunnel, which causes forecasted volumes to be re-routed to I-64 and Military Highway. **Table 2.1** shows forecasted volumes on the I-64 segment between I-264 and Indian River Road to be substantially higher than existing volumes.

On one other segment of I-264 (Rosemont Road – Lynnhaven Parkway) the forecasted 2040 No Build Alternative volume is 7,000 vehicles greater than the corresponding Build Alternative volume. The reduction is a product of the added capacity provided at the Independence Boulevard interchange for motorists moving from northbound Independence Boulevard to westbound I-264 – a movement for which the number of on-ramp lanes are doubled from 1 to 2 with the Build alternative.

II.1.4 Development of Forecasted Year 2040 Peak Hour Volumes

To forecast year 2040 balanced peak hour volumes, forecasted directional freeway volumes on either side of the respective interchange were multiplied by the appropriate growth rate. Next, the TurnsW32 program was used to compute balanced interchange volumes. TurnsW32 uses existing turning movement counts and future year approach and departure volumes in an iterative process to compute future turning movement volumes. Each interchange was analyzed and preliminary baseline future year ramp and mainline volumes were established.

The preliminary volume computations, however, produced freeway approach and departure volumes that varied between interchanges. To finalize the forecasted peak hour freeway volumes on I-264, the mainline approach and departure results of two adjacent interchanges were averaged. Then, once mainline volumes had been set, the ramp movements from the initial run of TurnsW32 were rebalanced to compute final future ramp volumes. In a few locations to accommodate varying growth rates, computed ramp volumes actually decreased from the existing volume. In response and to apply a conservative approach, all ramp volumes were held to no less than their respective current volume.

Next, arterial turning movements were all multiplied per their respective growth rates, and arterial corridors were then balanced using the same balancing process applied at interchanges.

More detailed descriptions of the computation of peak hour volumes have been included in the Technical Appendix.

II.2 Analysis Tools

II.2.1 Highway Capacity Manual Software 2010 (HCS)

Limited access ramp movements and mainline segments were analyzed with HCS 2010 software. All freeway, merge, diverge, and weave segments were analyzed. The pertinent data that was incorporated included hourly volumes, peak hour factors, percent heavy vehicles, number of lanes, and acceleration/deceleration lane lengths. Additionally, free-flow speed was incorporated using the guidelines from *VDOT's Traffic Operations Analysis Tool Guidebook* (TOATG), freeway free-flow speed was taken as the posted speed limit plus 7 MPH, while ramp free-flow speed was posted advisory speed limit plus 10 MPH.

HCS 2010 freeway analysis methodology has some limitations that do not allow it to properly analyze certain geometric conditions. Typical examples of these situations include add lanes (where an on-ramp creates a continuous additional lane to the freeway) and drop lanes (where a continuous freeway lane drops to an off-ramp). The I-264 corridor has numerous locations where the geometry is atypical and is not capable of being properly analyzed in HCS 2010. Analysis was conducted with the basic freeway segment methodology in these geometric cases. This issue is further discussed in the sections focusing on individual interchanges later in this report.

II.2.2 CORSIM 6.3

CORSIM 6.3 (TSIS 6.3) was used to provide microscopic simulation analysis of the interstate system. The study area for the CORSIM analysis spans from Military Highway through Rosemont Road, and it also includes the Birdneck Road interchange as an isolated analysis. The analysis included the mainline freeway system specifically analyzing the merge, diverge, and weave areas at interchanges. The CORSIM analysis did not include the signalized intersections (they were analyzed separately using Synchro and SimTraffic).

CORSIM analysis was used to supplement the HCS 2010 analysis. The purpose of using CORSIM was to capture the cumulative impacts of congestion in both space and time. This capability overcomes the HCS 2010 limitation in which only static analysis is provided. Additionally, HCS 2010 does not consider the cumulative impacts of upstream and downstream traffic operations. CORSIM analysis was applied to the AM and PM peak periods for the existing conditions and the design year conditions when substantial congestion was found to occur.

The AM system peak hour, 7:30-8:30 AM, spanned the westbound I-264 HOV restriction hours – 6:00-8:00 AM. CORSIM modeling of the AM peak hour did not include the shoulder lane, and only conventional lanes were included in the existing and No Build analysis of the AM peak hour. This decision was made to reflect a conservative approach to the changing geometry in the AM peak hour.

Traffic volumes for each peak hour analysis were broken into 15-minute periods matching the distribution of traffic over the hour found in the traffic counts. Seeding was conducted for 20 minutes before the start of the recorded peak hour.

Initial steps used in building the two existing conditions base models (AM and PM) involved the use of a scaled map to accurately lay out links and nodes at critical locations throughout the network. Using available aerial mapping (VGIN), lane geometry and auxiliary lane lengths (acceleration lanes, deceleration lanes, weave lanes, etc.) were matched to existing conditions. Ramp origin and termini locations were recorded from their approximate connections with the freeways.

The proportion of vehicles using HOV lanes was coded to match VDOT HOV use data.

A detailed description of the CORSIM calibration process has been included in the Technical Appendix.

CORSIM was used to determine the density of vehicles within the merge, diverge, weave, and mainline segments. CORSIM output was processed using *VDOT's Traffic Operations and Safety Analysis Manual* (TOSAM) Excel-based Macro Version 1.0. This methodology produces density at the segment level which is the density across the entire cross-section. This methodology differs from the HCS methodology of analyzing merge and diverge locations because the HCS methodology focuses on the auxiliary lanes (acceleration and deceleration lanes) and the two adjacent through lanes.

The CORSIM results typically produce lower densities than the HCS analysis because of the difference in methodologies. The TOSAM Excel macro produces graphical output displays of the volume, speed, and density results on a per segment basis and on a lane by lane basis (this information can be found in the Technical Appendix). CORSIM density results are generated in terms of veh/ln/hr as opposed to the standard pc/ln/hr used to calculate LOS from density. The calculated densities were reported in the CORSIM analysis tables along with a corresponding level of service based on HCS 2010 thresholds for each particular freeway movement type.

II.2.3 Synchro 9.0

The operation of signalized intersections was optimized in Synchro 9 in preparation for analysis in SimTraffic. Signal timings were provided by the Cities of Virginia Beach and Norfolk. Appropriate volumes, peak hour factors, heavy vehicle percentages, and existing geometries were incorporated into the analysis. In the Build and No-Build alternatives analysis, traffic signal timings were modified and optimized to minimize the impact of traffic growth through 2040.

II.2.4 SimTraffic 9

Arterial intersection delay and queuing analysis was analyzed with SimTraffic 9. Ten runs of SimTraffic were conducted for each scenario (per the scope of work), and the average of the results was used. Each analysis time period spanned 60 minutes, with 15 minutes of network seeding. SimTraffic calibration was limited to using the following information: volumes, geometry (lane designations, storage lengths, speeds, grade, etc.), and traffic signal timing information (cycle length, split, offset, etc.). Link speeds were set to the speed limit plus 7 MPH for the arterial network and the ramp links were set to the speed limit plus 10 MPH in accordance with the TOATG. Origin-Destination information was coded to prevent vehicles from exiting the freeway and immediately reentering the freeway via an on-ramp.

II.3 Analysis of Freeway Segments

II.3.1 Existing and Forecasted No Build Alternative

Using the mainline freeway existing and No Build Alternative volumes, capacity analysis was performed on the corridor's mainline freeway segments using both HCS and CORSIM. For brevity, the HCS results are shown in this section, while both the HCS and CORSIM results are shown in the respective interchange analysis sections. Summarized in **Table 2.2,** the results show that – with one exception – the deficient freeway segments (shown in **bold** font) are exhibited west of the Rosemont Road interchange.

Table 2.2
Summary of HCS Analysis of 2014 Existing Conditions
I-264 Freeway Segments Level of Service

I-264 Freeway Segment	Direction	AM Peak Hour		PM Peak Hour	
		Existing	No Build	Existing	No Build
West of Military Highway	EB	C	C	**E**	**E**
	WB	**E**	D	B	B
Military Highway – I-64 (Mainline)	EB	B	D	C	**E**
	WB	D	D	B	B
I-64 – Newtown Road (Mainline)	EB	C	C	D	**E**
	WB	**F**	**F**	C	C
Newtown Road – Witchduck Road	EB	C	C	**E**	C
	WB	**F**	**E**	C	D
Witchduck Rd – Independence Blvd	EB	D	D	D	**E**
	WB	**E**	**F**	D	**E**
Independence Blvd – Rosemont Rd	EB	C	C	D	D
	WB	D	**E**	D	D
Rosemont Rd – Lynnhaven Pkwy	EB	C	C	D	D
	WB	D	**E**	D	D
Lynnhaven Pkwy – Laskin Road	EB	B	B	C	C
	WB	B	C	B	C
Laskin Road – First Colonial Road	EB	A	A	B	B
	WB	B	B	B	B
First Colonial Road – Birdneck Road	EB	A	A	B	B
	WB	B	B	B	B
Birdneck Road – Parks Avenue	EB	A	A	A	A
	WB	A	A	A	A

The exception is the westbound freeway segment between Lynnhaven Parkway and Rosemont Road where the westbound AM peak hour service level is E for the No Build Alternative. However, as shown previously on **Table 2.1**, the forecasted volume on this segment for the Build Alternatives is lower than that in the No Build Alternative. As a result, in the analysis of the Build Alternatives, the existing freeway lane geometry (4 lanes) produces a forecasted service level of D, which does not justify freeway widening.

As discussed in the opening of this section, the narrow spacing between interchanges west of Rosemont Road limits the reliability of the freeway segment analysis component of HCS to produce valid results. The only segment of sufficient length lies between Rosemont Road and Independence Boulevard. Consequently, west of this segment the analysis of freeway segments and the development of improvements to address deficiencies on them has been incorporated into the overall analysis of the individual interchanges, and the results of the analysis has been documented in the respective interchange report section.

II.3.2 Improvements to I-264 (Rosemont Road – Independence Boulevard)

To address the deficiencies in the mainline freeway segment between Rosemont Road and Independence Boulevard, a widening of the roadway section has been analyzed. In considering the improvement, it should be noted that this segment provides two pavement sections. Approximately 2,000 feet west of Rosemont Road, HOV restrictions, which extend to the I-64 interchange, are applied to the median lane, with westbound restriction applied in the AM peak period (6:00 – 8:00 AM) and eastbound restriction applied in the PM peak period (4:00 - 6:00 PM). To the east of the HOV lane restrictions, I-264 provides four lanes in each direction. Where HOV restrictions are applied, the shoulder lane is open to all traffic, so that during the restricted period, I-264 provides a five lane section.

For the widening improvements along this entire segment (Rosemont Road to Independence Boulevard), the shoulder lane is proposed to be converted into a freeway lane and a second freeway lane is added to provide a six lane section - **See Figure II.1: 2040 Build Alternative.**

The results of the HCS and CORSIM analysis are shown in **Table 2.3**, which shows that with the proposed improvements, the freeway segment will provide adequate service during forecasted year 2040 peak periods.

II.3.3 Costs

A planning level cost estimate was developed for the improvement alternative for widening of the freeway segment. Detailed calculations have been included in the Technical Appendix. It should be noted that the estimates do not include costs associated with complete removal of existing I-264 through lanes and inflation/escalation. A 4" overlay was assumed over portions of I-264 that are not being completely removed. The cost estimates in year 2015 dollars are:

Build Alternative - Cost (in $million)

Widening (Rosemont to Independence) - $276.8

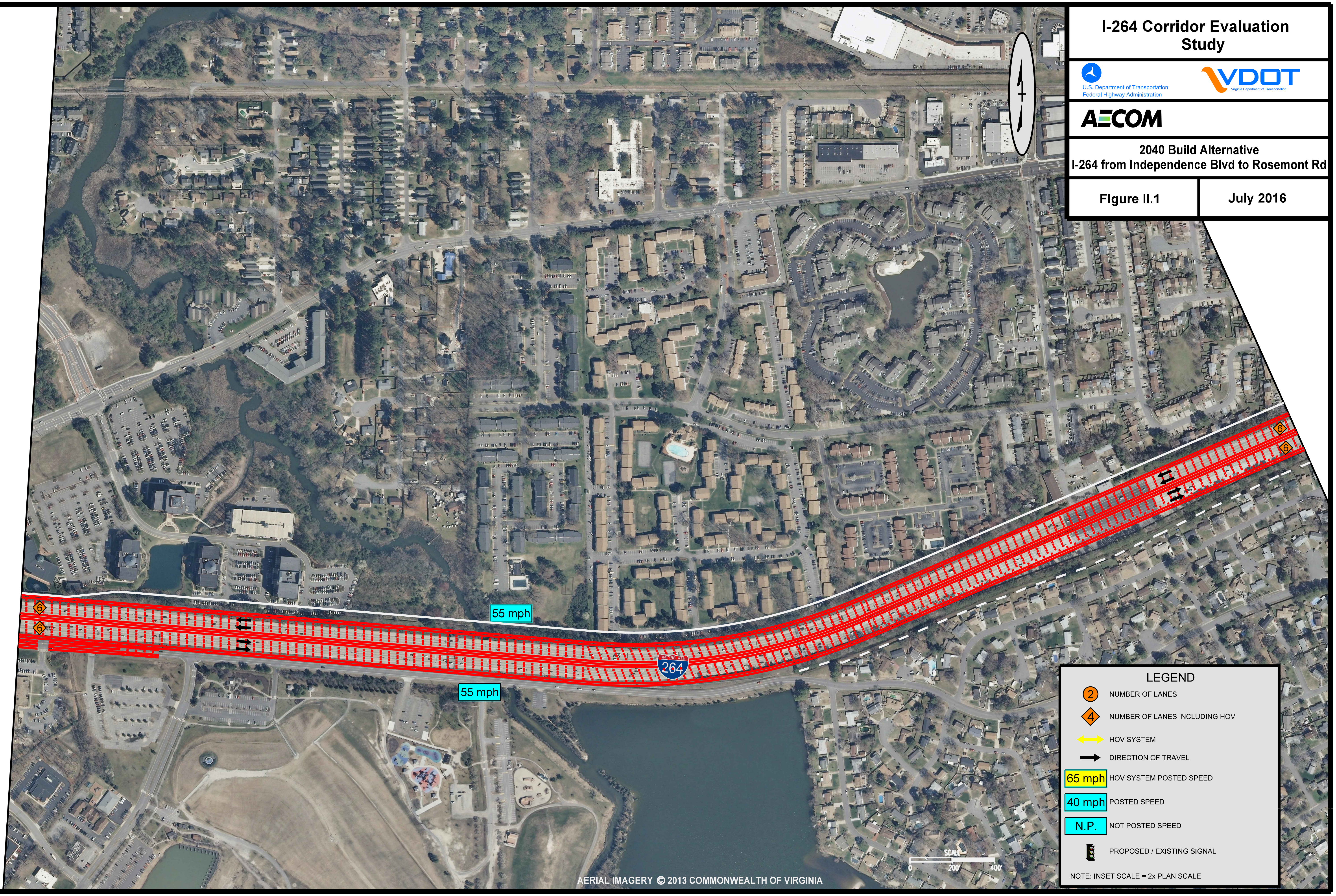

I-264 Corridor Evaluation Study
U.S. Department of Transportation
Federal Highway Administration
VDOT
Virginia Department of Transportation
AECOM
2040 Build Alternative
I-264 from Independence Blvd to Rosemont Rd
Figure II.1
July 2016
55 mph
55 mph
264
6
6
6
6
LEGEND
2 NUMBER OF LANES
4 NUMBER OF LANES INCLUDING HOV
HOV SYSTEM
DIRECTION OF TRAVEL
65 mph HOV SYSTEM POSTED SPEED
40 mph POSTED SPEED
N.P. NOT POSTED SPEED
PROPOSED / EXISTING SIGNAL
NOTE: INSET SCALE = 2x PLAN SCALE
SCALE
0 200 400'
AERIAL IMAGERY © 2013 COMMONWEALTH OF VIRGINIA

Table 2.3 Summary of HCS Analysis and CORSIM Analysis I-264 Freeway Segment: Rosemont Road to Independence Boulevard Year 2040 No Build and Build Alternatives					
I-264 Freeway Segment	Direction	AM Peak Hour		PM Peak Hour	
		No Build	Build	No Build	Build
HCS Analysis	EB	C	C	D	C
	WB	**E**	D	D	C
CORSIM Analysis	EB	C	C	C	C
	WB	**F**	D	D	C

II.3.4 Stakeholder Coordination

Coordination meetings were held with staff from the City of Norfolk, the City of Virginia Beach, Hampton Roads Transportation Planning Organization (HRTPO) and Hampton Roads Transit (HRT). In general, representatives from the agencies were supportive of the evaluation process and the recommended freeway widening.

II.3.5 Impacts

Identification of potential impacts on key resources from construction of the improvement alternative was evaluated using desktop GIS mapping analysis. Detailed exhibits are included in the Technical Appendix. The results are summarized in **Table 2.4**.

Table 2.4 Widening of I-264 between Rosemont Road and Independence Boulevard Impacts				
Improvement Alternative	WATER	BUILDINGS	RESIDENTIAL	POTENTIAL SECTION 4F
Widen Freeway Segment	Y	1	0	N

II.3.6 Recommendation

Based on the findings of the analysis of forecasted operations (including the operations analysis detailed in the sections on the Rosemont Road and Independence Boulevard interchanges presented later in this report) the widening of I-264 between Rosemont Road and Independence Boulevard is recommended as the Preferred Alternative.

II.4 Managed Lanes Impact Evaluations

II.4.1 Purpose and Approach

The objective of this task was to develop a tool within the Hampton Roads Regional travel demand model framework to model and analyze the traffic characteristics of the proposed Managed Lanes (ML) in Hampton Road area. A time saving based toll diversion algorithm was designed to estimate the traffic split between the Managed Lanes and General Purpose Lanes (GP).

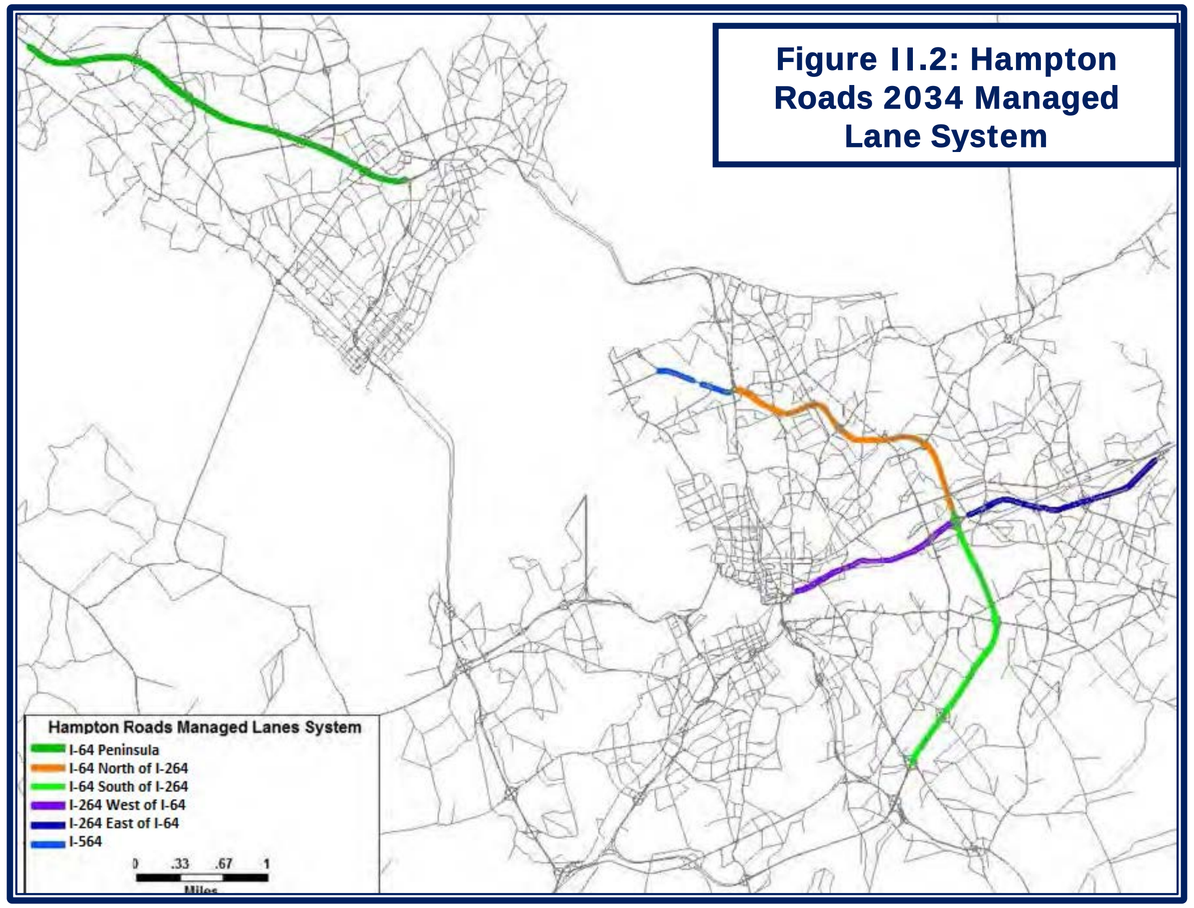
A sub application was developed to set the managed lane toll rates with the objective to maintain the speed on managed lanes to 45 miles per hour or greater. The toll diversion algorithm and the toll setting sub application were incorporated into the Hampton Roads Regional travel demand model. Traffic Analysis Zone (TAZ) based value-of-time (VoT) was estimated from the 2010 Census data and is applied to convert the tolls on managed lanes to equivalent travel time. 2034 Managed Lanes were coded based on the HOV lanes defined in the original network. Model results with the new algorithm were summarized and analyzed and compared with that from the original Hampton Roads Regional travel demand model.

II.4.2 Basic Assumptions

Network Coding

2034 Managed Lanes were coded based on the HOV lanes defined in the original Hampton Roads regional model. The HOV lane on and off ramp locations and configurations were maintained to be consistent with the original assumptions. **Figure II.2: Hampton Roads 2034 Managed Lanes System** presents the proposed managed lanes in Hampton Roads area in 2034.

Figure II.2: Hampton Roads 2034 Managed Lane System



Toll Policy

SOV and HOV2 vehicles were allowed to use the Managed Lanes for a toll and the HOV3+ traffic could use the facility for free. Trucks were banned from using the Managed Lanes.

The Managed Lanes policy was only applied during the peak periods (i.e., 6 AM to 9 AM and 3 PM to 6 PM). During the off peak periods, the original HOV policy was applied.

Managed lane toll rates were set through an iterative process with the objective that managed lane speeds should be maintained at 45 miles per hour or greater.

Model Integration

The toll rates on the managed lanes were set through a feedback loop with the objective of maintaining the speeds on the managed lanes at 45 mph or greater. A sub application was developed to implement the toll setting process

II.4.3 Model Results

Overall, the converting of HOV lanes to managed lanes increases the express lane road utilization and reduces the congestion on general purpose lanes. The total demand along the corridor was slightly lower after imposing tolls to SOV and HOV2+ traffic to use the express lanes.

In the AM peak period, managed lane speeds stay above 45 mph under the minimum toll rate of 10 cent per mile for most segments, except on eastbound I-64 north and westbound I-264 east of I-64. In the PM peak period, maximum toll rates of 35, 65, and 115 cent per mile were needed to keep the managed lane speeds over 45 miles per hour on eastbound I-64 north, westbound I-64 north, and eastbound I-264 east of I-64.

It is worth noting that the managed lanes traffic estimates were made based on the parameters borrowed from other studies and that used in the regional model. For a higher level study, more traffic and travel behavior data are needed to verify the input parameters, including the total demand and mode split along the corridors, the regional traveler's willingness to pay toll, and the traffic peak period characteristics and others.

The results in the detailed report (included in the Technical Appendix) show that in the AM peak period, the use of managed lanes along westbound I-264 (west of I-64) will at times draw vehicles from the unrestricted lanes.

Summarized in **Table 2.5**, the results show that use of managed lanes restrictions would have marginal utility along the HOV restricted segments on I-264 east of I-64. When compared with the forecasted HOV lane use (a continuation of current HOV restriction policies), in the AM peak period the volumes using the westbound managed lane would increase and a higher V/C ratio would result. However, it should be noted that the overall average speed in the restricted managed lane is below the average speed in the general purpose (GP) lanes. In contrast, the minimum speed in the restricted managed lane is higher than the minimum speed in the GP lanes. This discrepancy is explained by the assignment process over the peak period.

The level of congestion in the GP lanes varies over the 2-hour restricted period, and the impact of the availability of the managed lanes on the volumes in the GP also varies. At its most intense, congestion in the westbound GP lanes slows vehicles to a speed of 40.3 mph, but the length of the congested period is short, and average speeds increase. In the managed lanes during the most congested periods volumes tend to be higher, more heavily weighting the speeds, and the lower volumes during the periods of higher speeds result in a lower average speed – 51.1 mph.

Table 2.5
Summary of Managed Lanes Analysis
I-264 Freeway East of I-64
Year 2040 No Build and Build Alternatives

Direction Peak Period	Restriction Scenario (Lane)	Average		Congested Speed	
		Volume	V/C	Minimum	Average
Westbound AM Peak Period	HOV (HOV Lane)	2,900	0.53	53.9	55.9
	HOV (GP Lane)	16,864	0.69	39.0	46.0
	Managed (HOV Lane)	3,486	0.67	45.5	51.1
	Managed (GP Lanes)	14,810	0.61	40.3	56.1
Eastbound PM Peak Period	HOV (HOV Lane)	3,756	0.64	38.9	54.3
	HOV (GP Lanes)	19,474	0.71	38.0	46.1
	Managed (HOV Lane)	3,857	0.66	45.1	52.0
	Managed (GP Lanes)	17,506	0.64	40.0	53.9

In the eastbound direction during the PM peak period, the differences forecasted between the HOV and Managed Lanes restriction scenario are more straightforward. When compared with GP lanes in the HOV restriction scenario, the GP lanes under the managed lanes scenario exhibit higher minimum and average speeds.

II.4.4 Impacts on Operations

To evaluate the impact of converting to managed lanes on I-264, the forecasted "market share" of vehicles using the managed lanes was compared with the forecasted percentage of total directional freeway volume using the HOV lanes. The term "market share" refers to the percentage of total directional traffic volume using the restricted managed lane during the restricted period.

Both current and forecasted **HOV lane** use is estimated at:

AM Peak Hour (westbound) – 6% HOV Lane

PM Peak Hour (eastbound) – 10% HOV Lane

Based on the **managed lane** analysis, the forecasted managed lane is estimated at:

AM Peak Hour (westbound) – 10% Managed Lane

PM Peak Hour (eastbound) – 18% Managed Lane

The marginal percentage increase in the managed lane percentage was applied to the forecasted 2040 peak hour volume developed in this study, and the volume was subtracted from the GP lane volumes used in the HCS capacity analysis. The lower GP volume was then analyzed using the HCS mainline freeway analysis procedures and compared with the HOV restriction scenario results.

The results of the HCS capacity analysis of the two restriction scenarios are summarized in **Table 2.6.** Note that Density (measured in passenger cars per mile per lane - pc/mi/ln) is presented. This measure is the basis used in HCS to determine service level. The results show that with the preferred improvements to the corridor and the change in HOV restrictions to managed lanes restrictions, the impacts on the operation of the freeway segments is marginal. On several segments, the service levels are not changed but the densities are reduced indicating fewer vehicles in the GP lanes. In general, the results in **Table 2.6** show that along an improved corridor, the application of managed lanes restrictions would have marginal impacts on the I-264 corridor's operation.

Table 2.6
Summary of HCS Analysis of I-264: Rosemont to Newtown
HOV and Managed Lanes Restriction Scenarios

I-264 Freeway Segment	Scenario	AM Peak Hour Westbound		PM Peak Hour Eastbound	
		Density*	Service Level	Density*	Service Level
Rosemont Road - Independence Blvd.	HOV	32.5	D	26.1	D
	Managed	27.6	D	23.8	C
Independence Blvd. – Witchduck Road	HOV	31.9	D	27.2	D
	Managed	27.2	D	24.8	C
Witchduck Road – Newtown Road	HOV	27.8	D	27.9	D
	Managed	24.2	C	21.7	C

II.4.5 Recommendations

Based on the results of the managed lanes analysis, implementation of managed lanes within the context of improving the corridor would produce marginal benefits in the peak period operation of the I-264 corridor. However, if improvements to the corridor developed in this study are not to be implemented an analysis of managed lane restrictions should be conducted to determine their utility under more congested general purpose lanes conditions. During the course of this study, VDOT initiated a study relating to the conversion of the I-64 HOV lanes to HOT lanes. The scope and resources for the VDOT study are more in depth and extensive relating to the feasibility and benefits of conversion as well as cost estimates.