I-395 at Seminary Road

Interchange Modification Report (Lite)

VDOT Virginia Department of Transportation

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I-395 at Seminary Road Ramp: High Occupancy Vehicle (HOV) to High Occupancy Toll Conversion

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Prepared for

VDOT Virginia Department of Transportation

Prepared by

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I-395 at Seminary Road Ramp: High Occupancy Vehicle (HOV) to High Occupancy Toll Conversion

Commonwealth of Virginia

This Interchange Modification Report Lite submitted to the Virginia Department of Transportation and the Federal Highway Administration to repurpose the Seminary Road HOV ramp of I-395 from High Occupancy Vehicle only to High Occupancy Toll is hereby approved by:

_____	_____	_____
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1. INTRODUCTION

Interstate 395 (I-395) serves as a spur route of Interstate 95 (I-95) that connects the Springfield interchange and continues into Washington, D.C. It is a major corridor for movement of freight and people between Virginia and Washington, D.C. It also serves as a regional route for commuters to and from the Washington, D.C. metropolitan area and areas south.

I-395 contains a reversible, barrier-separated HOV/Express Lanes facility, with its own entrances and exits, provided as a third roadway of I-395 and I-95 between South Eads Street near the Pentagon in Arlington County and south of State Route 610 (Garrisonville Rd.) in Stafford County, Virginia. During rush hour, the reversible lane facility operates in the direction of rush-hour traffic with northbound direction in the AM peak and southbound in the PM peak. The I-395 HOV Lanes are restricted to vehicles containing three or more passengers.

1.1 Project Background

In 2010, the Virginia Department of Transportation (VDOT) initiated a study to construct a south-facing HOV/transit ramp between the I-395 HOV lanes and the third level of the Seminary Road interchange. The purpose of the ramp was to provide new access for HOV and transit vehicles along I-395 to the south of the interchange. The HOV ramp is reversible and permits northbound HOV/transit traffic to exit to Seminary Road in the morning hours and permits traffic from Seminary Road to access the southbound I-395 HOV lanes in the afternoon and evening hours. An Environmental Assessment (EA) was approved in 2011 and a FONSI was issued by Federal Highway Administration (FHWA) in 2012. The ramp was opened to traffic in January 2016.

As part of the coordination with the City of Alexandria (City) during the study of the ramp, a commitment was made to maintain the ramp as HOV/transit-only access in the event the remaining northern section of I-395 was converted to HOT lanes in the future. In 2015, VDOT initiated a study for the I-395 Express Lanes Project (Northern HOT Lanes) to extend the I-95 Express Lanes from Turkeycock Run in Fairfax County to the vicinity of Eads Street near the Pentagon in Arlington County. The reversible ramp at Seminary Road falls within the limits of the I-395 Express Lanes Project and the study maintained the assumption of the earlier commitment that the Seminary Road ramp would remain as HOV/transit-only even with the conversion of the HOV lanes to HOT lanes. An EA was approved in 2016 and a FONSI was issued by FHWA in 2017. The I-395 Express Lanes are currently under construction and are expected to open in Fall 2019, operated by 95 Express Lanes, LLC.

According to the “Amended and Restated Comprehensive Agreement relating to the I95/I395 HOV/HOT Lanes project, executed June 2017”, 95 Express Lanes, LLC retains the right to pursue the conversion of the Seminary Road ramp from HOV to HOT after the I-395 Express Lanes are operational and open to traffic. In order to convert the ramp, a re-evaluation of the EA issued for the I-395 Express Lanes will be required by VDOT and FHWA.

1.2 Purpose and Need of the Study

Under the current I-395 Express Lanes Project, the Seminary Road ramp would remain as HOV/transit-only, which means that any toll paying vehicles which are not HOV3+ or transit will not be allowed to exit or enter using this ramp. This will mean that the toll paying vehicles traveling on the I-395 Express

Lanes will need to use the Turkeycock Run exchange ramp to or from the General Purpose (GP) lanes to then access the GP ramp at Seminary Road, or they would have to exit at some other upstream or downstream access location and use the local arterial network to get to their destination. The Seminary Road ramp is currently underutilized. A review of the available probe data as well as studies conducted by the City of Alexandria (City) determined that there are vehicles that cut through the City's local arterial network which if given a choice could have otherwise stayed on the interstate to access the area around the Seminary Road ramp.

The purpose of the conversion of the Seminary Road ramp from HOV to HOT is to allow greater access and reliable travel options to the vehicles using the corridor. It will utilize the unused capacity on the existing ramp to provide access to vehicles that were previously not eligible. It is expected to reduce the number of vehicles in the GP lanes as well as along the arterial network. It will likely reduce the number of non-HOV violators on this ramp. **Appendix A** includes the Framework Document that was prepared in conjunction with this Interchange Modification Report.

1.3 Study Area

The project study area, as shown in **Figure 1-1,** includes the freeway segments under the influence area of the Seminary Ramp as well as the nearby arterial segments and intersections that will potentially be impacted with the conversion of the Seminary Ramp from an HOV-only ramp to a HOT ramp. The study area limits and intersections were determined in coordination with VDOT, FHWA, and the City.

The following interchanges with associated ramps are included in the study area:

- I-395 and King Street Interchange
- I-395 and Seminary Road Interchange
- I-395 and Duke Street Interchange
- I-395 and Turkeycock Ramps

Table 1-1 shows the 21 intersections included in the study area:

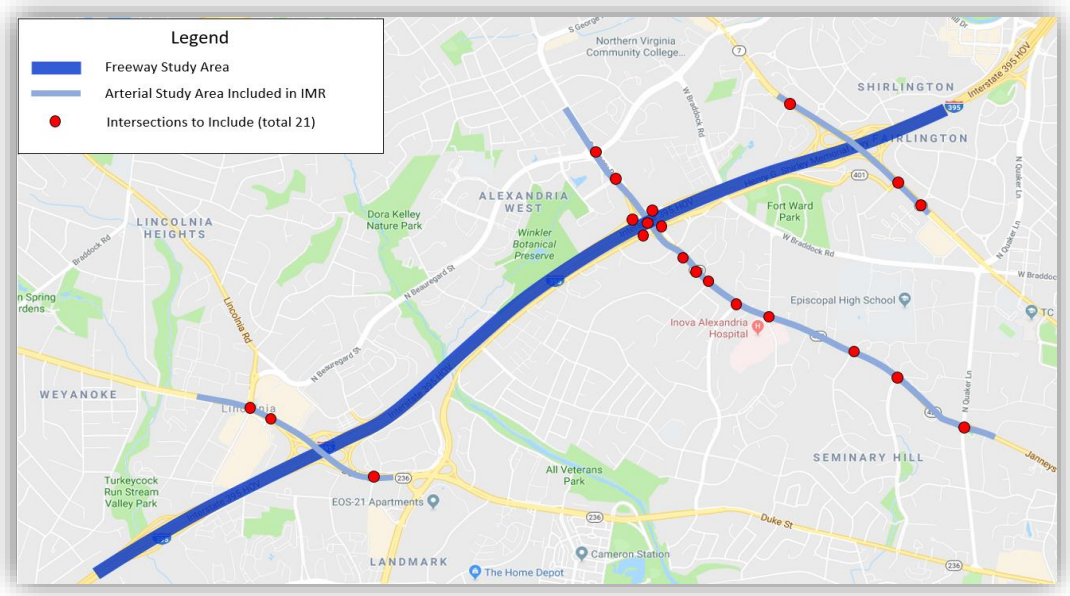


Figure 1-1: Study Area Freeway Segments and Intersections

Table 1-1: Study Intersections

No.	Intersection
1	Duke St and N. Beauregard St
2	Duke St and Oasis Dr and Right-in-Right-out at Shopping Plaza
3	Duke St and S. Walker St (include the ramp to the mall)
4	Seminary Rd and N. Pickett St
5	Seminary Rd and Seminary Rd (The Encore entrance)
6	Seminary Rd and Kenmore Ave/Library Lane
7	Seminary Rd and I-395 Northbound HOV Off-Ramp
8	Seminary Rd and I-395 Northbound Off-Ramp
9	Seminary Rd and I-395 Northbound On-Ramp
10	Seminary Rd and I-395 Southbound Off-Ramp
11	Seminary Rd and I-395 Southbound On-Ramp
12	Seminary Rd and Mark Center Ave
13	Seminary Rd and N. Beauregard St
14	King St (Rt 7) and Menokin Dr
15	King St (Rt 7) and Park Center Dr
16	King St (Rt 7) and N. Dearing St
17	Seminary Rd and N. Jordan St
18	Seminary Rd and N. Howard St
19	Seminary Rd and N. Quaker Lane
20	Seminary Rd and St. Stephens Rd
21	Seminary Rd and Fort Williams Pkwy

2. EXISTING CONDITIONS

2.1 Existing Road Geometry

The existing I-395 HOV/Express Lanes operates within the median of I-395 and consists of a three-lane reversible, limited access express route from South Eads Street near the Pentagon in Arlington County to the Springfield Interchange where it transitions to I-95 Express Lanes. The facility is constructed with 11 to 12-foot wide travel lanes and variable shoulder widths.

Within the study area, there are exchange ramps at Turkeycock Run that provide access to and from the GP lanes. There is a south-facing reversible HOV ramp at Seminary Road interchange.

2.2 Existing Operational and Safety Conditions

Detailed information on existing traffic volumes, traffic operations, and safety characteristics are included in Chapters 4, 5, and 6 respectively. The data in these chapters is shown as a baseline for the purposes of understanding future traffic operations and safety considerations under future scenarios.

3. ALTERNATIVES CONSIDERED

This chapter describes the alternatives that were considered.

3.1 No-Build Alternative

The No-Build alternative provides a baseline of conditions against which to compare the Build alternative. In the No-Build scenario, it is assumed that this ramp continues to operate as an HOV3+ only ramp and only those projects that are already underway, approved, or programmed to be completed by any of the future design years for this project.

3.1.1 Background Projects

The projects that are funded for construction in the Metropolitan Washington Council of Government's constrained long-range transportation plans were included in the study. These were assumed to be in place for the analysis years including opening year (2020) and design year (2040) and were considered in the road network assumed for traffic analysis efforts of the assumed future no-build conditions for this project. Below are the key projects that would influence this project:

- The I-395 Express Lanes northern extension project will extend the I-95/I-395 Express Lanes about eight miles north, from the Turkeycock Run interchange near Edsall Road to the vicinity of Eads Street in Arlington. The two existing High Occupancy Vehicle (HOV) lanes are being converted to express lanes (HOT) and a third lane is being added, providing three reversible express lanes. Vehicles with three or more people can use the express lanes free, while vehicles with fewer than three people can choose to pay a variable toll and use the express lanes. The express lanes are scheduled to open to traffic during Fall of 2019 and are expected to be fully-completed during the summer of 2020.
- The I-395 southbound widening project (CLRP# 3179) which is now a part of the I-395 Express Lanes northern extension project will add a continuous southbound lane on I-395 between the Duke Street interchange and the Edsall Road interchange. This additional lane is expected to

improve safety and traffic operations along this southbound segment of I-395 and will be completed by 2020. Accordingly, the current I-395 southbound to Duke St. eastbound loop ramp will be removed and replaced with a direct off-ramp at a signal-controlled intersection.

- The Seminary Road and Beauregard Street Ellipse project (CLRP# 3175), will reconfigure the current signal to be an "ellipse"— an unconventional at-grade intersection. It would eliminate left turns from both directions along Seminary Road and redirect those movements as right turns, which would subsequently circulate around part of the ellipse to continue in the desired direction. This project is expected to be completed by 2028. The ellipse concept is included in the 2040 No Build and Build models, for both AM and PM peak conditions.
- At the September 2019 City of Alexandria Council meeting, the Seminary Road Complete Streets project to reconfigure the segment of roadway between N Howard St and N Quaker Ln was approved. Although this project was not originally included in the IMR-Lite background conditions, all future conditions analysis for 2020 and 2040 models were updated with the road diet project along Seminary Road as a background condition. The results are included in **Appendix K.**

3.2 Build Alternative

The Build alternative assumes all the No-Build conditions in place and assumes that the Seminary Road HOV ramp will be converted to HOT ramp. This would allow access to the toll paying vehicles that were previously not allowed to use this ramp. No other geometric changes were assumed within the study area for the Build conditions.

Appendix I includes the signing and marking plans for the Build Alternative.

4. TRAFFIC VOLUME PROJECTIONS

This chapter provides an overview of the assumptions and methodologies used in developing traffic volumes for the project. These volumes are the basis for traffic analyses of existing and future conditions.

4.1 Traffic Analysis Years

Traffic operational analyses were evaluated for the existing conditions (2018), opening year (2020) and a design year (2040). The analysis included both the No-Build and Build alternative for the opening and design year scenarios.

4.2 Traffic Data Collection

Mainline and ramp traffic classification counts were collected continuously from Tuesday, October 30, 2018 through Monday, November 5, 2018. Traffic counts representing average weekday traffic consisted of the included Tuesday, Wednesday, and Thursday data. Investigation of the data showed an anomaly on I-395 on Tuesday, October 30, 2018; therefore, the Tuesday counts were removed from analysis and volumes were balanced using the traffic counts from Wednesday and Thursday. Intersection turning movement counts were collected on Thursday, November 1, 2018 from 7:00 AM to 7:00 PM. Traffic counts were not collected for the Turkeycock interchange; therefore, these counts were

supplemented by counts and movement proportions provided by Transurban. Raw traffic count data is provided in **Appendix L**.

4.3 Balancing Methodology

The objective of volume balancing is to eliminate discrepancies between separate count locations to define consistent volumes throughout the network for traffic simulation purposes. The criterion for this procedure is to minimize the adjustments to the original volumes, specifically minimizing the number of vehicles removed from the network. The AM peak hour and PM peak hour traffic volumes for this project were balanced in the sequence shown in **Figure 4-1**. First, in the AM peak period the northbound I-395 HOV mainline and ramps were balanced according to the traffic counts collected and those provided by Transurban. Next, the northbound and southbound I-395 GP mainline and ramp segments were balanced holding the HOV ramp volumes constant. Finally, the study intersections were balanced holding the corresponding balanced ramp volumes from I-395 HOV and GP constant. The balanced volumes were then rounded to the nearest five vehicles. The intersection volumes were balanced by holding constant the approach and departure volumes controlled by freeway on- and off-ramps. The intersection turning movements at these locations were adjusted in accordance with the turning movement proportions defined by the original intersection counts. This procedure was repeated for the PM peak hour, with the only exception being the consideration of southbound vehicle traffic on the HOV lanes. **Figure 4-2** and **Figure 4-3** show the existing conditions balanced volumes for freeway and arterials, respectively. **Appendix B** includes volumes for all the study area intersections.

The traffic count data revealed low pedestrian counts within the study area intersections. Also, based on field observations and review of signal timing and phasing, pedestrians were mostly crossing intersections during concurrent phases during both peak hours. The pedestrian activity was not impacting vehicular delays at any of the study intersections and hence were not included in the models.

Appendix B provides the detailed freeway mainline and ramps balanced volumes for AM and PM peak hour.

Figure 4-1: Volume Balancing Sequence

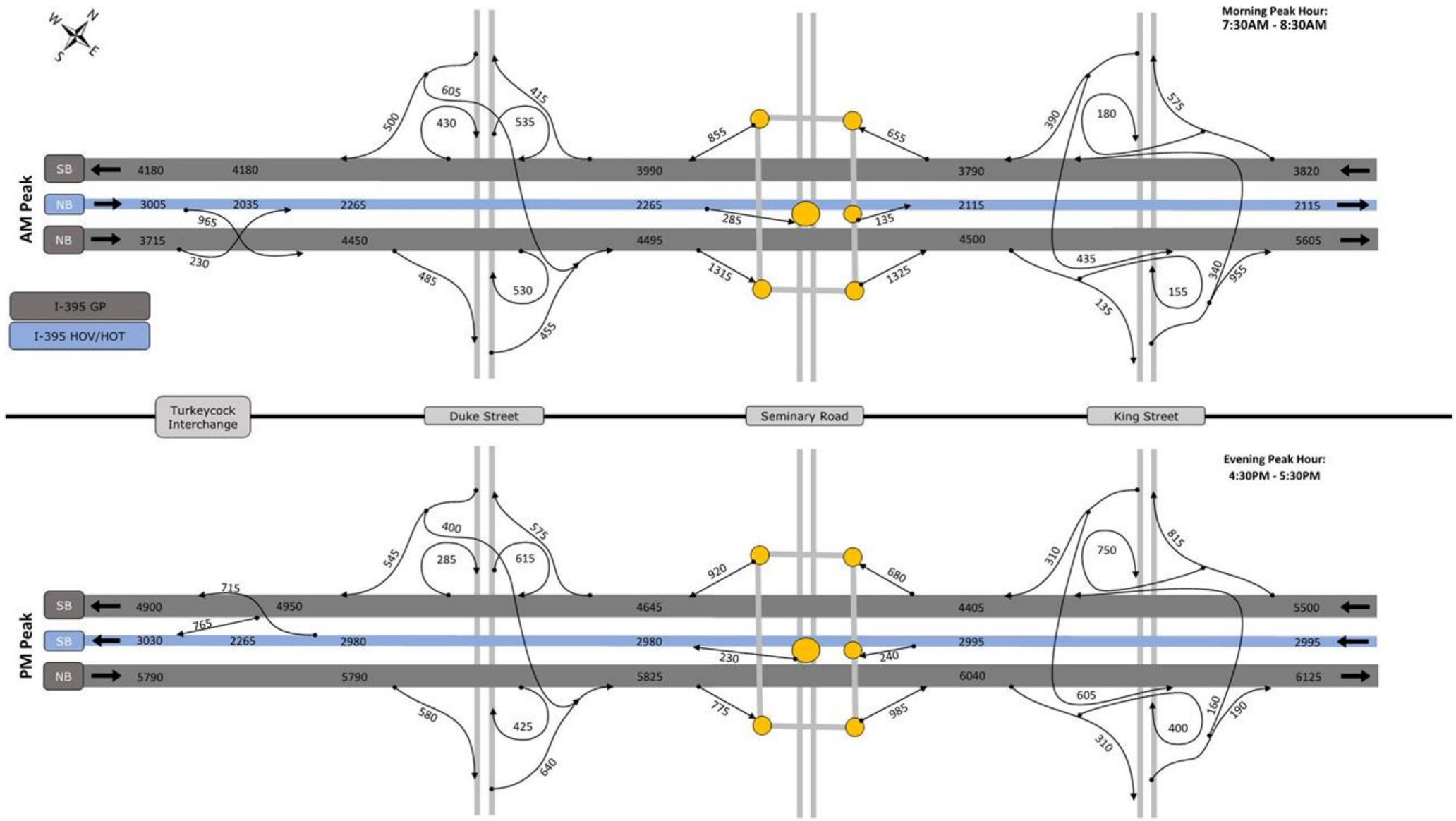


Figure 4-2: Existing Conditions Balanced Freeway Volumes

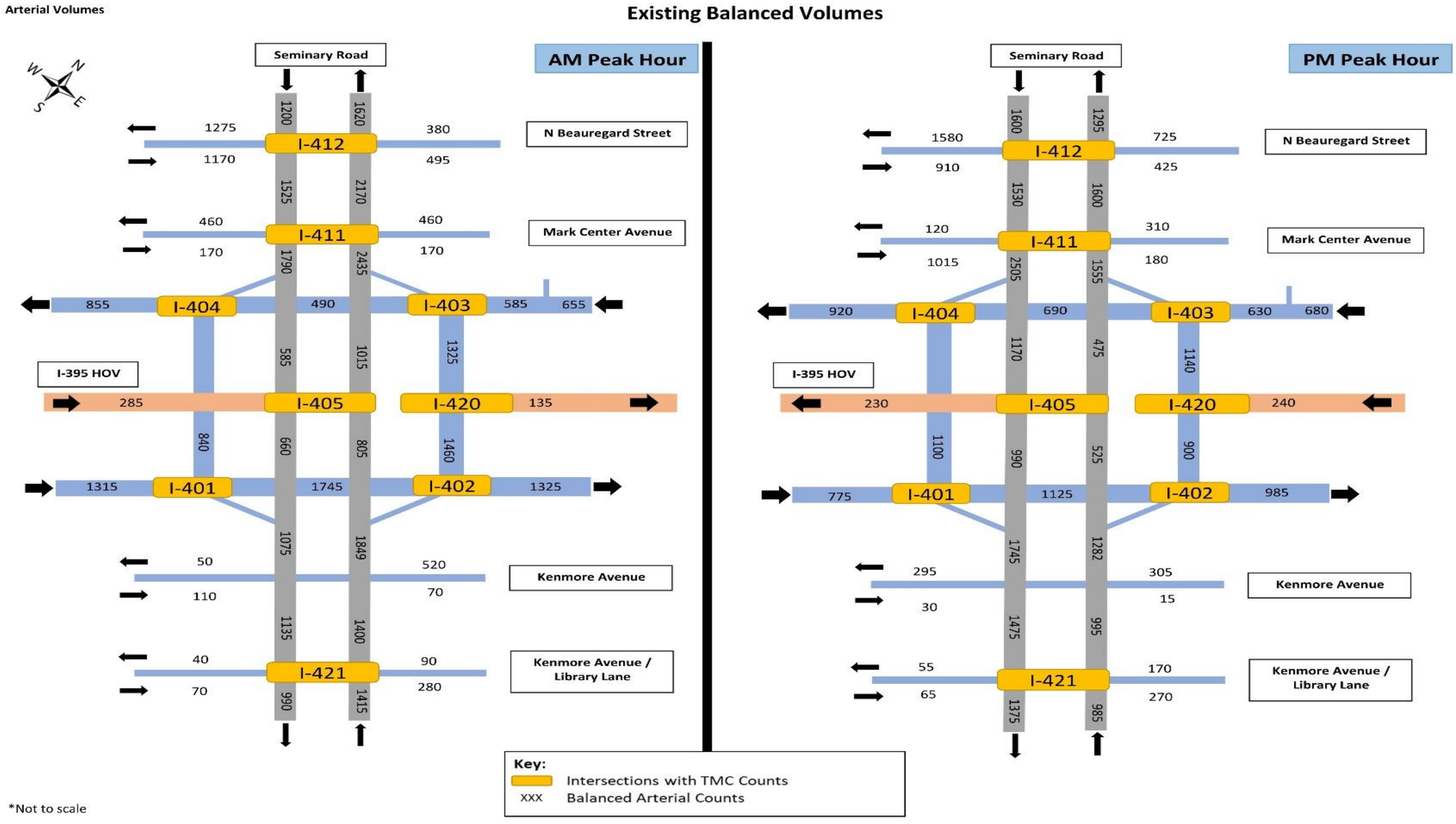


Figure 4-3: Existing Conditions Balanced Arterial Volumes at Seminary Road

4.4 Forecasting Methodology and Assumptions

4.4.1 Forecast Years

After balancing volumes for existing conditions, forecasts were developed for the following scenarios:

- 2020
  - No Build Conditions which includes all projects funded though construction based on the National Capital Region Transportation Planning Board's Constrained Long-Range Plan (CLRP)
  - Build Alternative which includes the CLRP projects and the conversion of the South facing Seminary Road HOV Ramp to HOT Ramp
- 2040
  - No Build Conditions which includes all projects contained in the CLRP
  - Build Alternative which includes the CLRP projects and the conversion of the South facing Seminary Road HOV Ramp to HOT Ramp

4.4.2 Forecasted Traffic Volumes

Future conditions traffic volumes were forecasted using the outputs from the Strategic Travel Demand Model for the Washington region. The Strategic Model is based on Metropolitan Washington Council of Government's (MWCOG) Round 9.0 land use and has a total of 2,191 Transportation Analysis Zones (TAZ's). Outputs from this model were used to estimate growth on study area roadway links using *NCHRP 765* industry-standard practices. Traffic volumes for the 2020/2040 No-Build and 2020/2040 Build scenarios were both grown from the existing 2018 balanced volumes, and future forecast volumes were balanced in a manner consistent with how the existing volumes were developed.

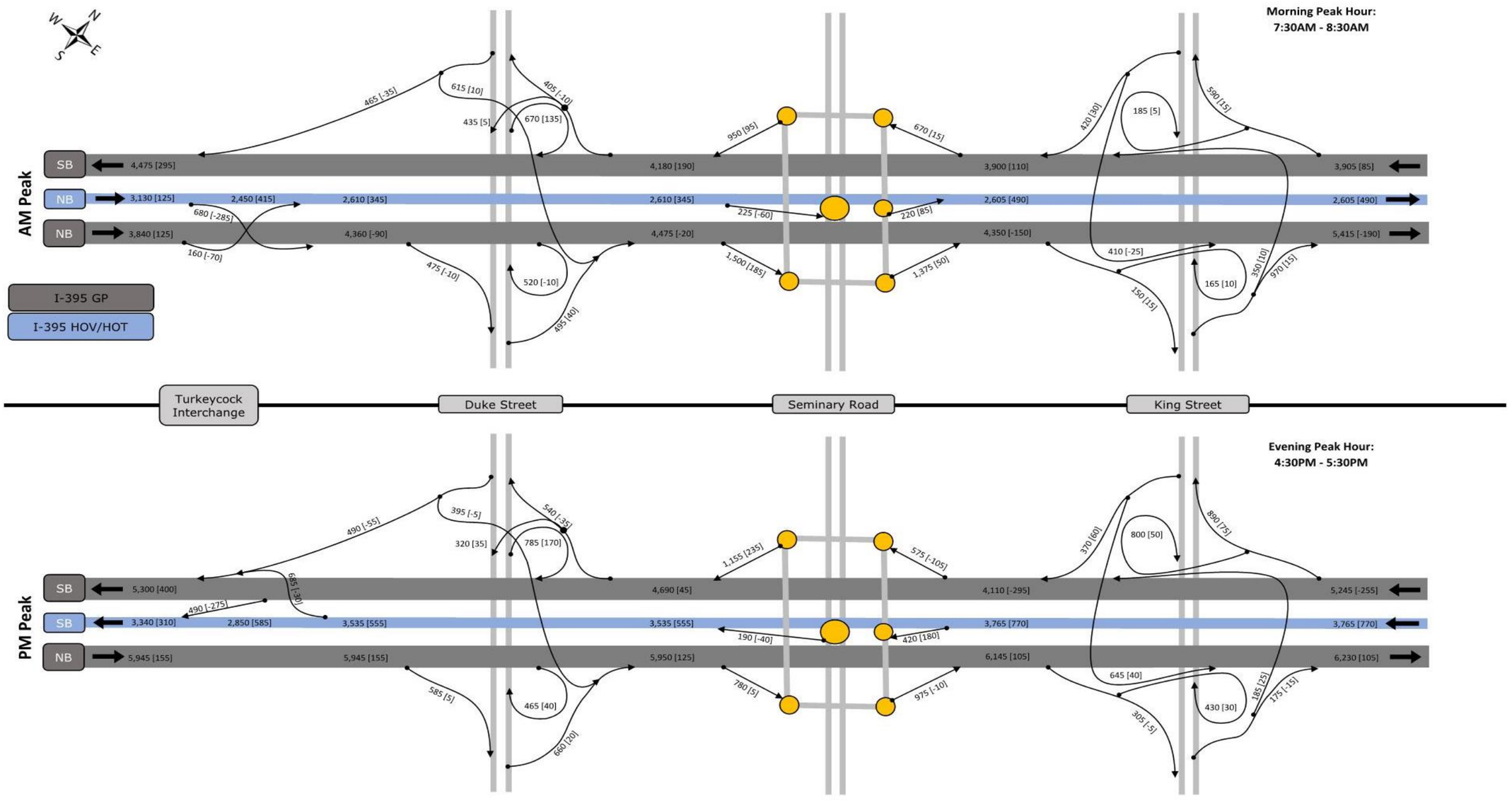
With the I-395 HOV lanes converted to Express Lanes it is expected that portions of GP traffic will shift to Express Lanes in the 2020 No-Build conditions, resulting in a slight decline in volumes on northbound general-purpose lanes in the AM peak and similarly on the southbound general-purpose lanes in the PM peak hour.

In the Build condition, with the south facing Seminary Road ramp conversion from HOV to HOT, there is a slight decrease in northbound volumes on the general-purpose lanes between the Turkeycock Express ramps and the Seminary Road Interchange for the AM peak hour in the 2020 and 2040 scenarios. Similarly, for the PM peak hour there is a decrease in volumes in the southbound general-purpose lanes. With the conversion, some of the northbound drivers are expected to switch from the general-purpose Seminary Road off-ramp to the Express ramp to Seminary during the AM peak hour. Similarly, some of the southbound general purpose on-ramp drivers are expected to shift to the Express on-ramp during the PM peak hour.

The estimation of future volumes along Seminary Road is also based on NCHRP 765 methodology utilizing results from the Strategic Travel Demand Model for 2020/2040 No-Build and Build conditions. The volumes were balanced in a manner consistent with the development of the existing volumes.

- The requirement to use EZ-Pass on the Express Lanes helps reduce the number of HOV violators. Therefore, under the 2020 and 2040 No-Build scenarios, HOV ramp volumes are expected to be less than the existing volumes.
- Under 2020 and 2040 Build scenarios with the south facing Seminary Road ramp converting from HOV to HOT, the following can be expected when compared to No-Build:

- HOT ramp volume will increase as toll-paying vehicles will now have this new access.
- I-395 northbound GP off-ramp and southbound GP on-ramp volumes will decrease during AM and PM peak hours, respectively. The data and analysis also suggest that the HOT ramp volume increase would include the shift of some volumes from the GP ramp and traffic that was cutting through the local arterials because they did not have access to this ramp under the No-Build scenario.
- With the reduction in the GP ramp volume, there will consequently be a reduction in the volumes along the Seminary Road rotary level that provides access to GP ramps.
- During the AM peak, at this interchange, the Seminary Road westbound drivers that use local routes (cut-through traffic) along arterials in the City of Alexandria would now take this HOT ramp, resulting in reduced westbound volumes from the City.
- Similarly, during the PM peak, at this interchange, the Seminary Road eastbound drivers cutting through the City's local arterials would take the HOT ramp, resulting in reduced eastbound volumes going into the city from the interchange.



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* Values in brackets represent the difference from 2020 NB and Existing Balanced Volumes
* Positive values = additional vehicles, Negative values = fewer vehicles

Not to Scale

Figure 4-4: 2020 No-Build Balanced Freeway Volumes

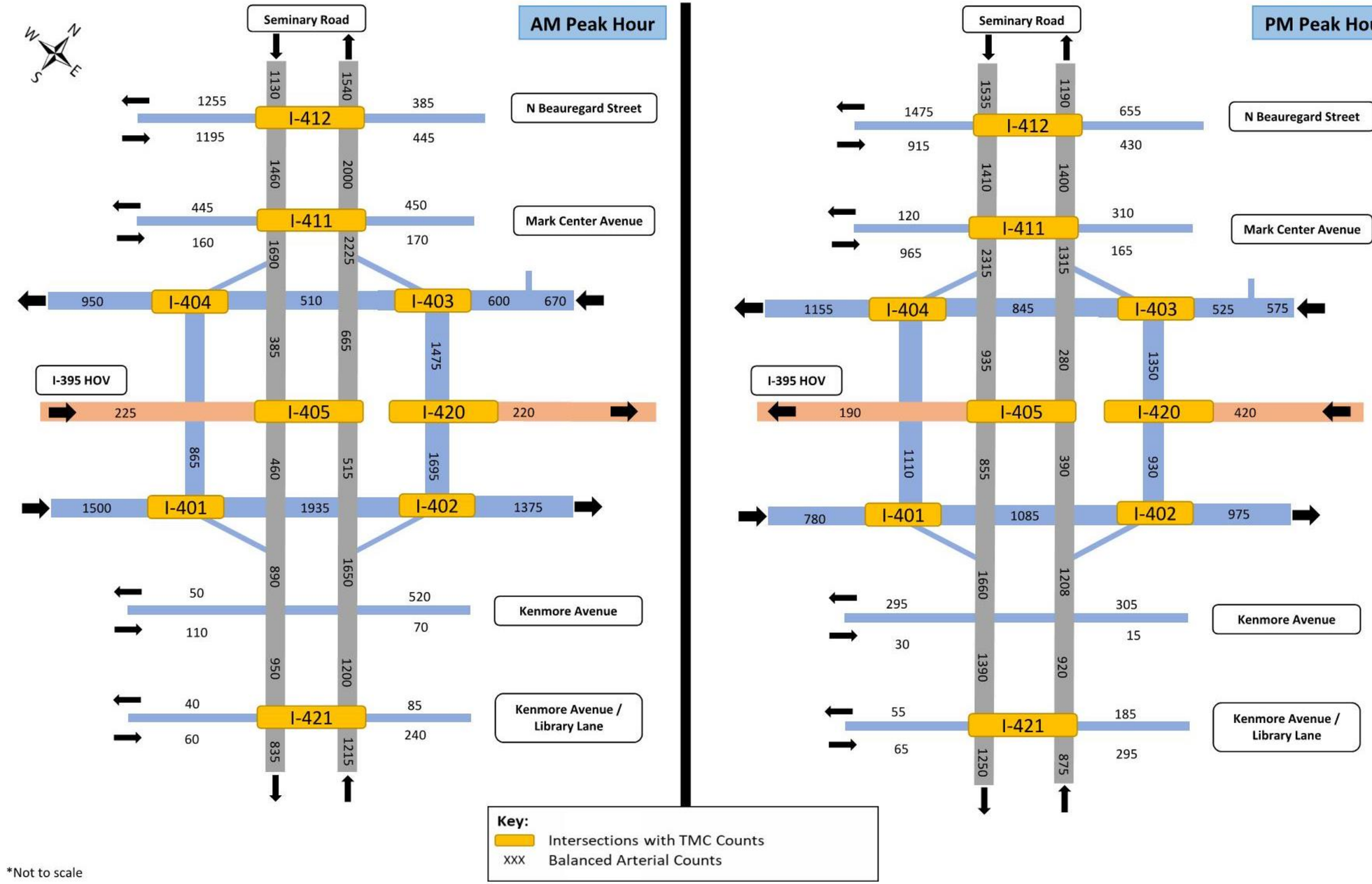
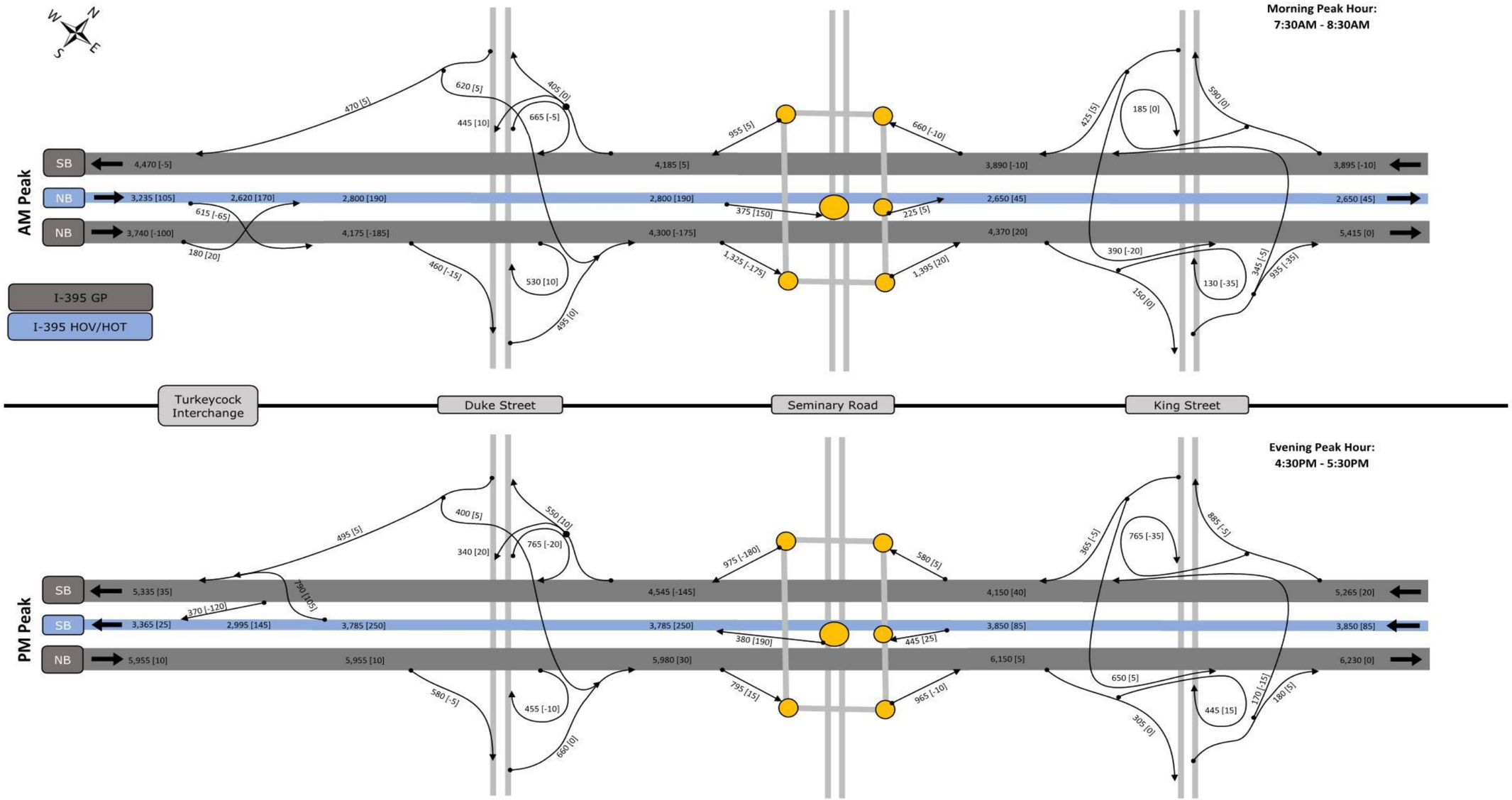


Figure 4-5: 2020 No-Build Balanced Arterial Volumes at Seminary Road



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* Values in brackets represent the difference from 2020 Build and 2020 No-Build Volumes
* Positive values = additional vehicles, Negative values = fewer vehicles

Not to Scale

Figure 4-6: 2020 Build Balanced Freeway Volumes

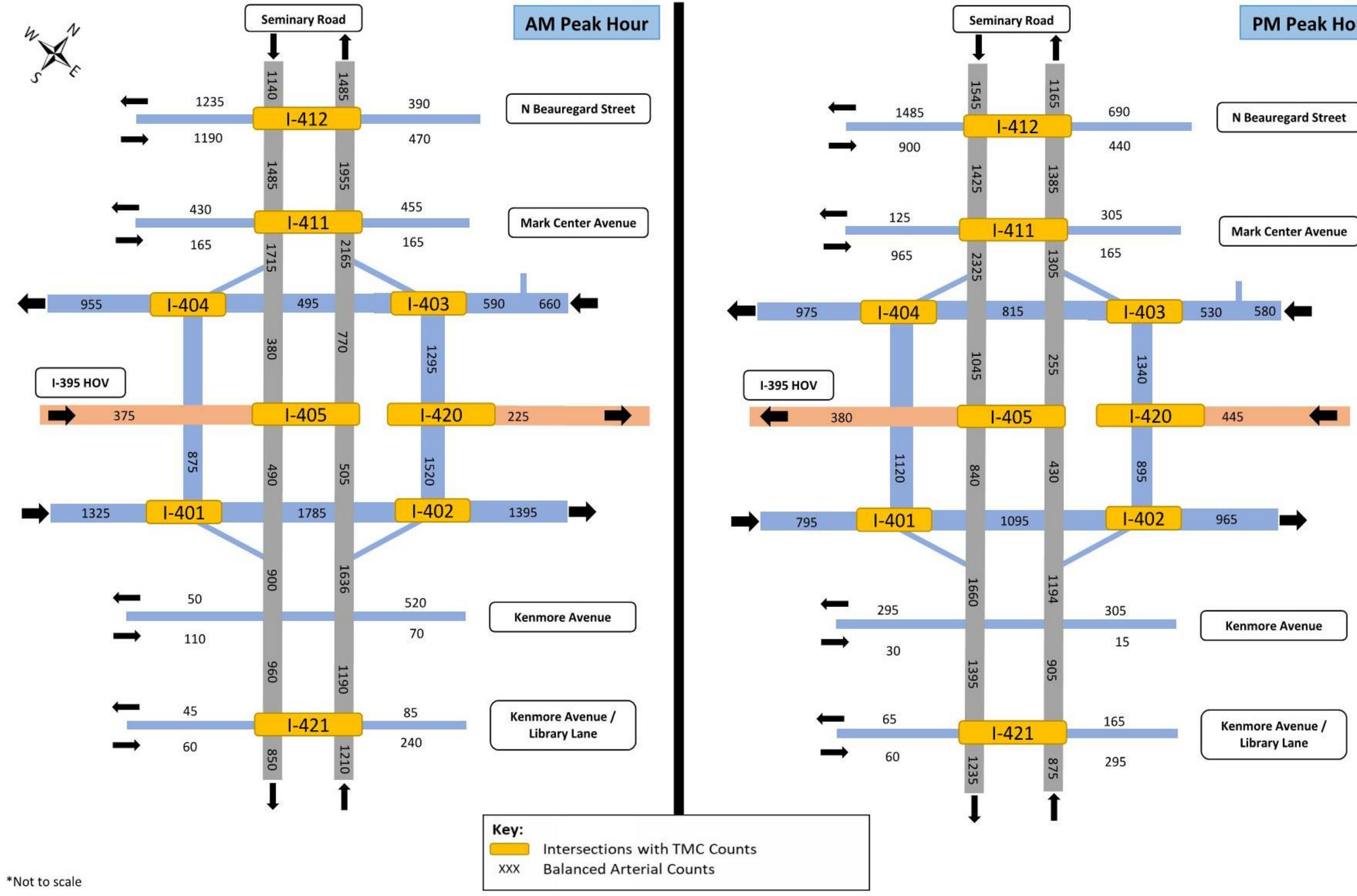
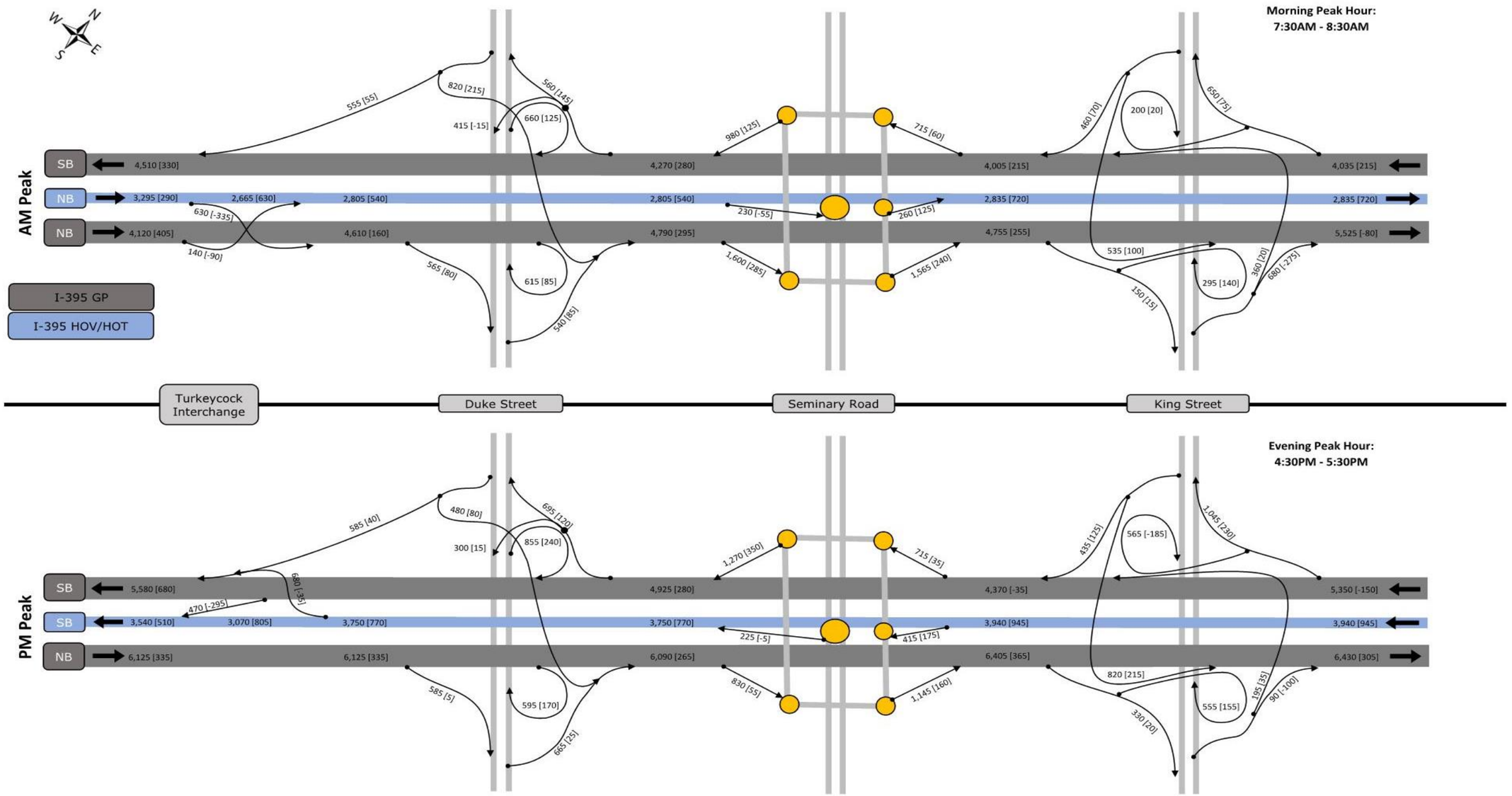


Figure 4-7: 2020 Build Balanced Arterial Volumes at Seminary Road



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* Values in brackets represent the difference from 2040 NB and Existing Balanced Volumes
* Positive values = additional vehicles, Negative values = fewer vehicles

Not to Scale

Figure 4-8: 2040 No-Build Balanced Freeway Volumes

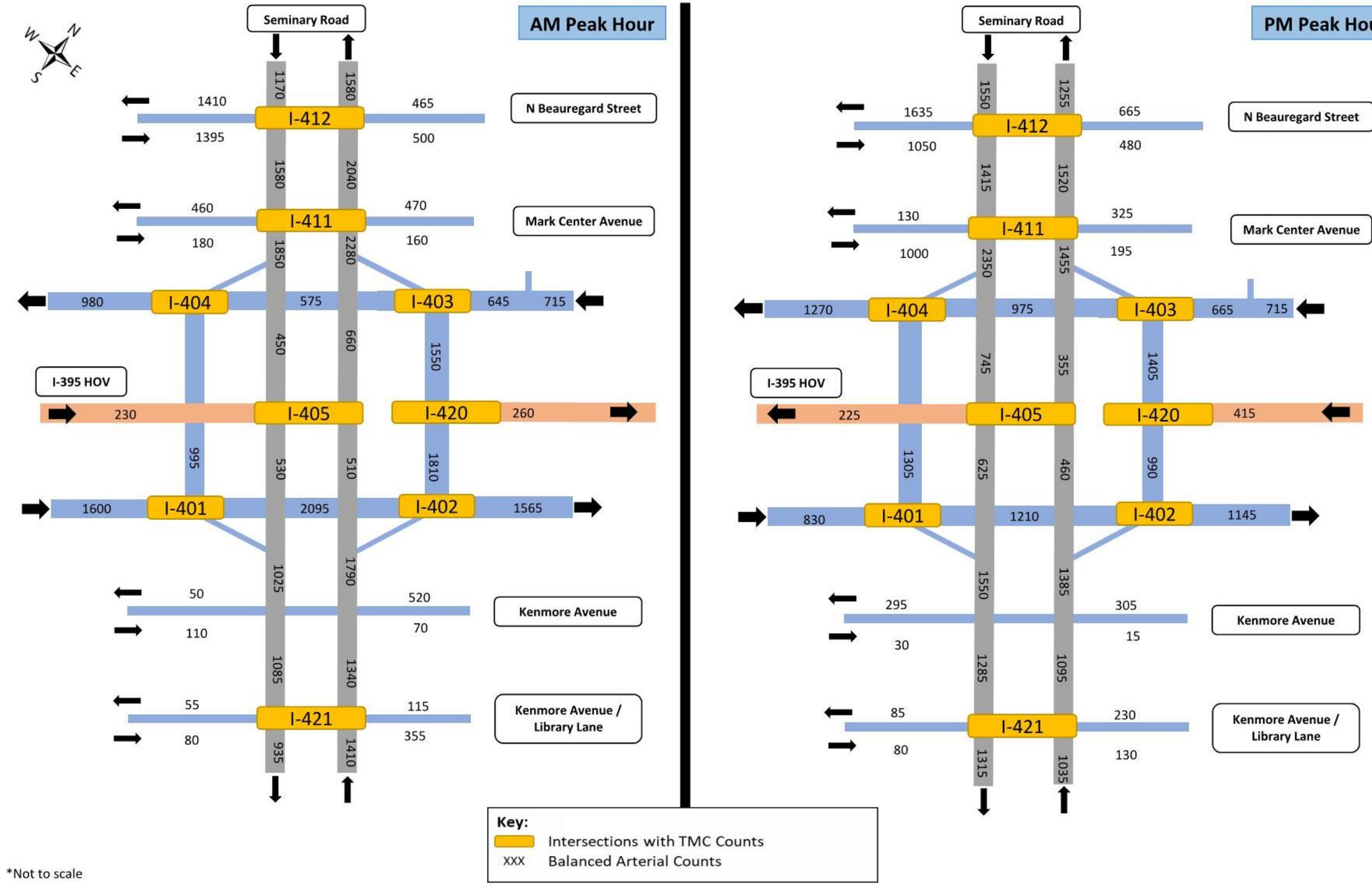
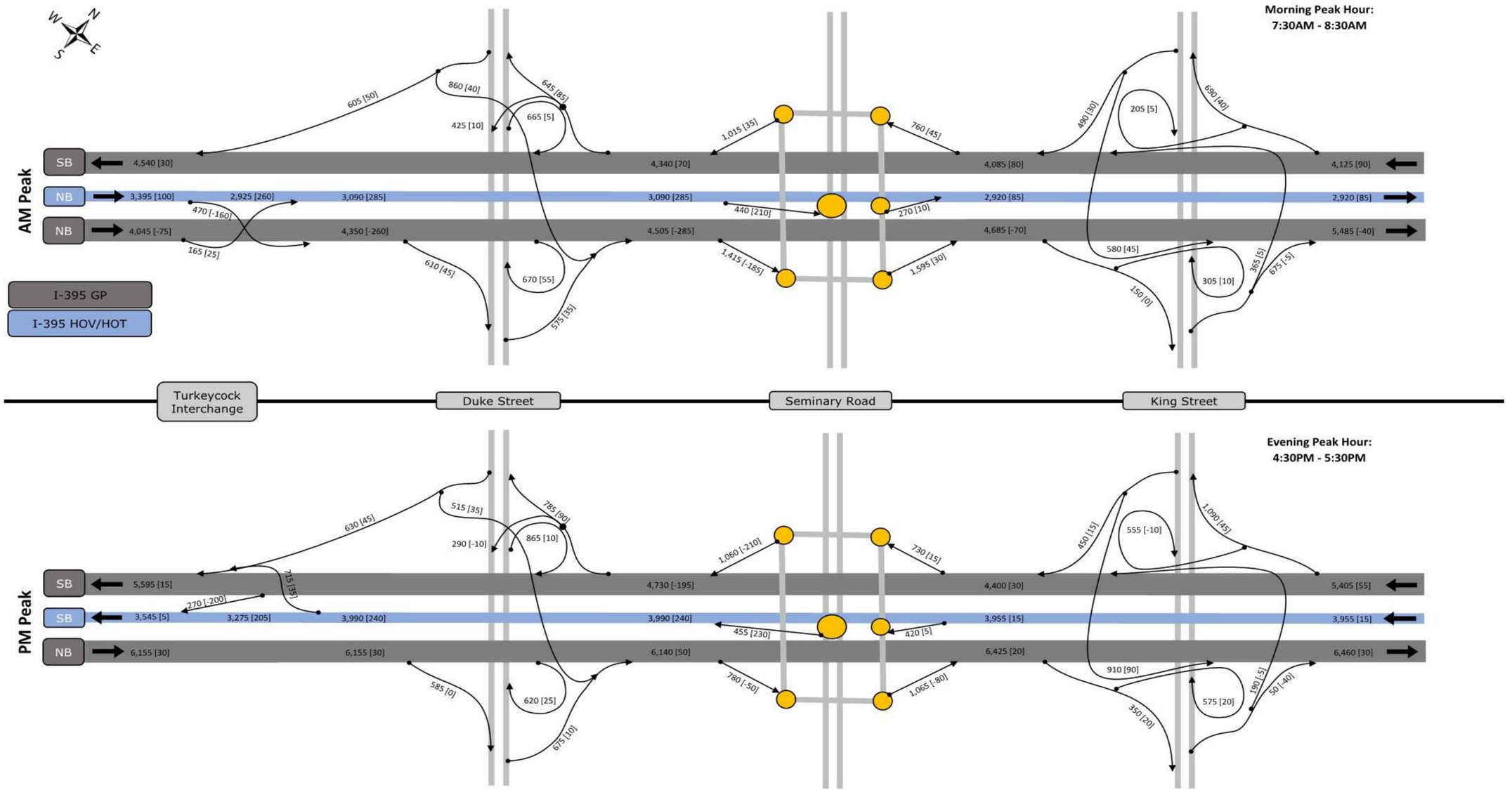


Figure 4-9: 2040 No-Build Balanced Arterial Volumes at Seminary Road



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* Values in brackets represent the difference from 2040 Build and 2040 No-Build Volumes
* Positive values = additional vehicles, Negative values = fewer vehicles

Not to Scale

Figure 4-10: 2040 Build Balanced Freeway Volumes

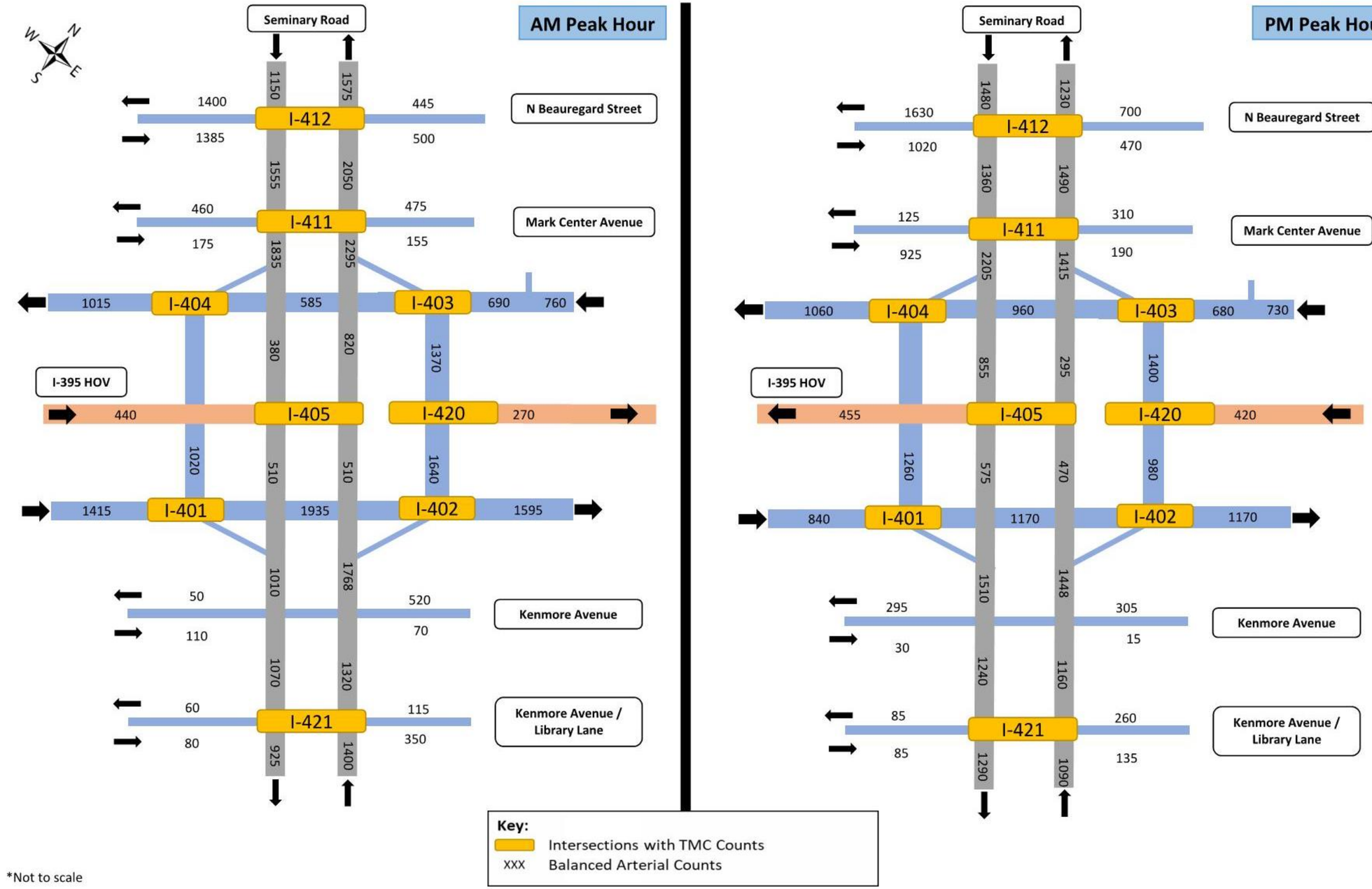


Figure 4-11: 2040 Build Balanced Arterial Volumes at Seminary Road

5. TRAFFIC OPERATIONAL ANALYSIS

This chapter describes the operational analysis performed for existing and forecasted conditions.

5.1 Methodology

5.1.1 Modeling Methodology and Assumptions

VISSIM Version 9.0 was used to perform a comprehensive network traffic analysis within the study area limits. The VISSIM model network includes all freeways and arterials shown in study area map, including arterial signalized intersections. Ten (10) simulation runs using different random number seeds have been conducted for both the AM and PM peak periods. This number of runs was found to be sufficient, using the VDOT Sample Size Determination Tool included in the VDOT TOSAM[1]. The results have been post-processed and averaged to determine the representative state of traffic operations in the study network. Simulation analysis periods and network representative hours are based on the study area speed profiles noted in the **Appendix C**: Existing Conditions Calibration Memo.

- AM simulation analysis period from 6:30 AM to 8:30 AM; network representative hour from 7:30 AM to 8:30 AM. A one-hour seeding period was used for the AM model to accurately represent network-wide congestion.
- PM simulation analysis period from 4:00 PM to 5:30 PM; network representative hour from 4:30 PM to 5:30 PM. A 30-minute seeding period was used for the PM model to accurately represent network-wide congestion.

5.1.2 VISUM and Origin-Destination (O-D) Data Synthesis

An important component of VISSIM modeling is the development of O-D tables. VISUM planning software was used to estimate O-D patterns. One of the key inputs in this process is a seed matrix, which is critical for developing a valid O-D estimate that reflects the regional trip patterns. To do so, a focus model for the project area and subarea cordon travel demand model was developed using the MWCOG's regional travel demand model as a base.

Existing balanced volumes were developed outside of the MWCOG travel demand model using field count data; O-D routing was obtained utilizing StreetLight Data and where necessary the MWCOG model; and the O-D matrix was adjusted using VISUM's TFlowFuzzy methodology to match target balanced volumes along the corridor.

5.1.3 Measures of Effectiveness

The following measures of effectiveness (MOEs) was used for the operational analysis of the roadway network under existing and will be used for future No-Build and Build conditions based upon guidance from the VDOT TOSAM.

5.1.3.1 Freeway Performance Measures

The following MOEs are provided for freeway segments for the network representative hour:

- **Simulated Average Speed** (mph)

[1] *VDOT Traffic Operations and Safety Analysis Manual (Ver 1.0)*

- **Simulated Average Density** (vehicles per lane, color-coded similar to the equivalent Density-Based LOS Thresholds)
- **Simulated Volume** (vehicles per hour)

VISSIM freeway MOEs are reported for each freeway segment. Methodology for the merge/diverge/weave segment analyses is consistent with procedures outlined in the Highway Capacity Manual for the area of influence within the designated segments, and this methodology is consistent with the TOSAM. In addition, the following freeway MOEs have been compiled:

- **Simulated Travel Time** (seconds) — reported for select travel paths corresponding to routes for which travel time data was collected.
- **Congestion Heat Maps** — average speeds (mph) reported for aggregated lanes in one-quarter-mile segments in 15-minute intervals
- **Simulated Ramp Queue Length** — reported average and maximum queue lengths (feet).
- **Percent of Demand Served** — simulated volume (processed volumes) divided by actual volume (input volumes).

5.1.3.2 Arterial/Intersection Performance Measures

The following MOEs are provided for intersection approaches for the network representative hour:

- **Simulated Intersection Level of Service (LOS) and Average Control Delay** — reported by approach and by intersection (seconds per vehicle, color-coded in similar fashion as the equivalent Highway Capacity Manual (HCM) Delay-Based LOS Thresholds). Delay will be reported as “microsimulation delay” per guidance from the VDOT TOSAM.
- **Percent of Demand Served** — simulated volume (processed volumes) divided by demand volume (input volumes).

5.2 Existing Conditions

5.2.1 Model Calibration

The purpose of a simulation model is to investigate the effects of improvement alternatives. Simulation models are an efficient tool for evaluating improvements but are most effective when the base model matches real-world conditions. VISSIM, like all simulation models, was designed to be flexible enough to calibrate the network to match the local conditions at a reasonably accurate level. It is well established that calibration is essential, and VDOT provides guidance in the TOSAM with detailed criteria and acceptance targets for model calibration.

Calibration of the VISSIM model, based on simulated volume processed, travel times, queues, and speed profiles, has been performed against 2018 measured field conditions and traffic data. The guidance provided in the TOSAM was followed in making adjustments to the VISSIM model during the calibration process. These adjustments included modifications to lane change distance for connectors and driver behavior along freeways and arterials. Additionally, few other adjustments listed below had to be made in order to better replicate the conditions –

- **AM peak period** — the downstream congestion on northbound I-395 was represented with reduced speed areas matching the INRIX speeds and induced lane-change movements representing the diverge behavior at Exit 6 to Shirlington.
- **PM peak period** — the downstream congestion on southbound I-395 southbound was represented with reduced speed areas matching the INRIX speeds.

Model calibration according to the criteria and thresholds described in the Project Framework Document has been achieved for both the Existing AM and PM peak periods. Detailed descriptions of the calibration process and comparisons of results with field observations are contained in a VISSIM calibration technical memorandum provided in **Appendix C**.

5.2.2 Existing Conditions Analysis Findings

This section summarizes the operational analysis findings from the calibrated existing conditions VISSIM model.

5.2.2.1 Freeway Density and Speed

5.2.2.1.1 AM Peak Hour

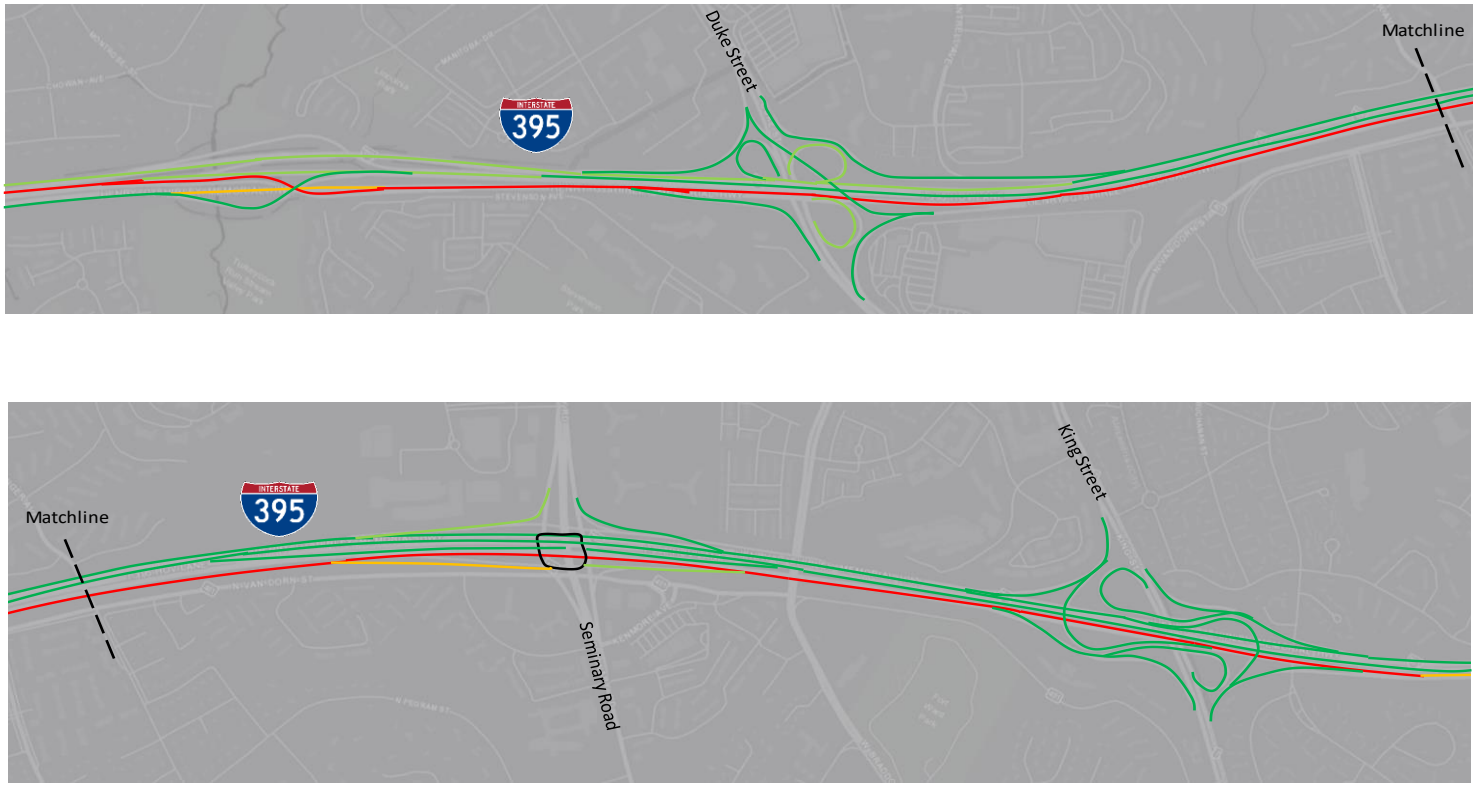
Figure 5-1 and Figure 5-3 illustrate the average density and speed for the mainline segments during the AM peak hour.

Northbound is the peak direction of the I-395 corridor during the AM peak hour. Most of the segments in the northbound direction on the general-purpose lanes operate under heavy to severe congestion with speeds dropping to as low as 13 mph in certain segments. Northbound HOV and southbound general-purpose lanes all segments operate under light to moderate density levels with no congestion. Speeds along the corridor are at free-flow conditions.

5.2.2.1.2 PM Peak Hour

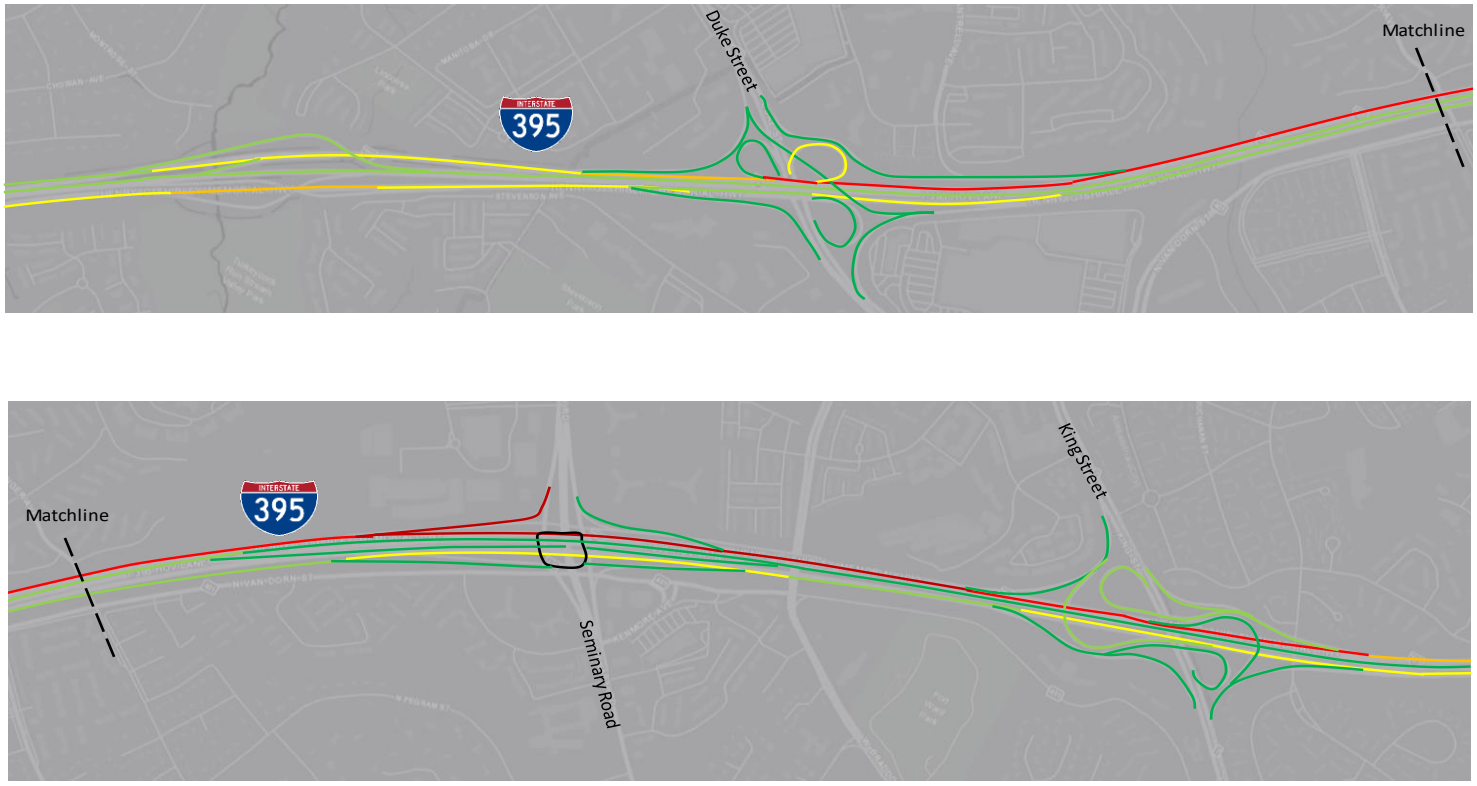
Figure 5-2 and Figure 5-4 illustrate the average density and speed for the mainline segments during the PM peak hour.

Southbound is the peak direction of the I-395 corridor during the PM peak hour. Most of the segments in the southbound direction on the general-purpose lanes between Duke Street and King Street operate under heavy to severe congestion with speeds dropping to as low as 9 mph in certain segments. Southbound HOV and northbound GP lanes all segments operate under light to moderate density levels with no congestion. Speeds along the corridor in the off-peak direction are at free-flow conditions.



Seminary Ramp at I-395 HOV to HOT Conversion		Density (vpmpl) < 18 18-26 26-35 35-45 45-100 > 100	2018 Existing AM Peak Hour Not to Scale	Kimley»Horn

Figure 5-1: Freeway and Ramp Density for Existing Conditions AM



Seminary Ramp at I-395 HOV to HOT Conversion		Density (vpmpl) < 18 18-26 26-35 35-45 45-100 > 100	2018 Existing PM Peak Hour Not to Scale	Kimley»Horn

Figure 5-2: Freeway and Ramp Density for Existing Conditions PM

Figure 5-3: Freeway and Ramp Speed for Existing Conditions AM

Figure 5-4: Freeway and Ramp Speed for Existing Conditions PM

5.2.2.2 Intersection Analysis

As shown in Table 5-1, all signalized intersections within the study area operate at LOS-D or better for both the Existing AM and PM peak hour. Detailed simulated intersection LOS by movement for AM peak hour can be found in **Appendix D** and for PM peak hour can be found in **Appendix E**.

Table 5-1: Level of Service for Network Intersections in Existing Conditions

LOS	Existing AM	Existing PM
LOS A-C	18	17
LOS D	3	4
LOS E	0	0
LOS F	0	0
Total	21	21

5.2.2.3 Summary of Findings

Northbound is the peak direction of the I-395 corridor during the AM peak hour. In the Existing conditions, the northbound GP mainline constantly experiences heavy to severe congestion throughout the entire study area. Heavy inbound travel demand and high interchange density on I-395 are the main contributing factors for congestion during the AM peak hour. The mainline traffic is forced to repeatedly slow down or stop at various locations along the corridor due to merging traffic. Downstream segments on I-395 northbound are also severely congested on a recurring basis during the AM peak hour and queues spill back into the study area.

Similarly, southbound is the peak direction during the PM peak hour and experiences significant congestion between the Duke Street interchange and the Seminary Road interchange. There are two major congestion spots on southbound I-395 during the existing PM peak hour:

- Seminary Road on-ramp merge
- Lane drop near Duke Street interchange

Currently, the I-395 southbound mainline drops from four to three lanes at the Duke Street (Route 236) interchange. This causes a severe bottleneck on the I-395 corridor within the study area during the PM peak hour, southbound traffic is metered due to the capacity reduction, and traffic flows frequently break down at this location during the entire PM peak period. The average travel speed is 10 to 15 mph throughout this section which is also reflected in the INRIX field data.

5.3 2020 Analysis

5.3.1 AM Peak Hour

5.3.1.1 Freeway Density

The traffic operations on I-395 in the 2020 No-Build and Build AM peak hour are illustrated in **Figure 5-5** and **Figure 5-6**. Northbound is the peak travel direction and operates under constrained conditions in the Existing conditions. With the background projects in place, congestion decreases between interchanges at Duke Street, Seminary Road, and King Street both in the No-Build and Build compared to existing. As discussed in the previous section with the conversion of south facing ramp from HOV to HOT, it is anticipated that some demand using the general-purpose off-ramp to Seminary Road shifts to the proposed converted ramp. This alleviates some of the congestion between Turkeycock ramps to Seminary Road off-ramp along the northbound general-purpose lanes. Densities improve significantly in the Build compared to the No-Build at these segments. However, downstream of the Seminary Road interchange congestion is increased due to increase in throughput. Also, downstream congestion beyond the study area still exists.

In the southbound direction, the general-purpose lanes remain uncongested, as seen in the Existing conditions analysis. Similarly, the express lanes in the northbound direction remain at uncongested densities.

Appendix D provides the detailed tabular results with segment-by-segment mainline densities and ramp densities.

5.3.1.2 Speed

Speeds along I-395 in the 2020 No-Build and Build AM peak hour are illustrated in **Figure 5-7** and **Figure 5-8**. Similar to densities, northbound speeds increase considerably in the 2020 No-Build and Build compared to Existing. Travel speeds improve between Turkeycock ramps and Seminary Road interchange in the 2020 Build compared to the 2020 No-Build and drop slightly between Seminary Road interchange and King Street interchange.

In the southbound direction, the GP lanes' speed maintains free-flow conditions, as seen in the Existing conditions analysis. Both in the No Build and Build, the I-395 southbound to Duke St. eastbound loop ramp will be replaced with a direct off-ramp at a signal-controlled intersection. The vehicular speed on the ramp drops to less than 10 mph as all the vehicles stop at the signal and make a left turn. Vehicles clear in each phase and no queues form on the off-ramp. Similarly, the express lanes in the northbound direction remain at free-flow speeds.

Figure 5-5: Freeway and Ramp Density for 2020 No-Build AM

Figure 5-6: Freeway and Ramp Density for 2020 Build AM

Figure 5-7: Freeway and Ramp Speed for 2020 No-Build AM

Figure 5-8: Freeway and Ramp Speed for 2020 Build AM

5.3.1.3 Travel Time

In the AM peak hour, the travel times along the I-395 northbound general-purpose lanes are generally lower in the 2020 No-Build and 2020 Build compared to the existing conditions. The Build travel time compared to No Build improves between Edsall Road and Seminary road and degrades slightly between Seminary Road and Glebe Road. The overall travel time along the corridor improves slightly compared to No-Build.

In the southbound direction, the 2020 travel times are expected to be similar to those of the Existing conditions for both No-Build and Build.

Figure 5-9 below compares the AM peak hour travel time between Existing, 2020 No-Build and 2020 Build conditions.

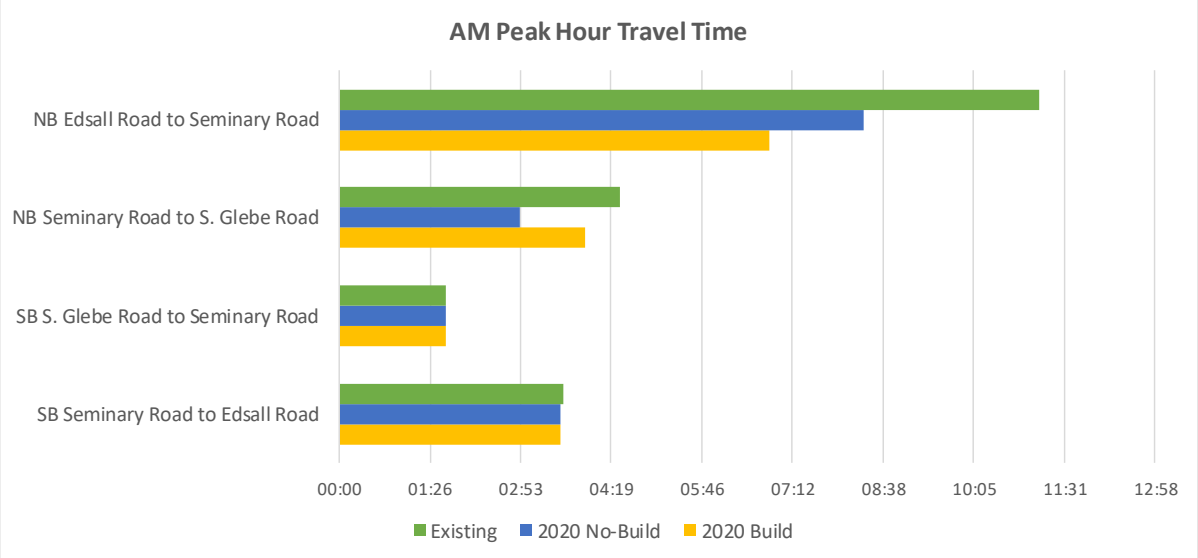


Figure 5-9: I-395 General Purpose Lanes – Travel Time for 2020 AM Scenarios

5.3.1.4 Intersection Delay

The 2020 Build conditions will have no adverse impacts on the crossing arterials and intersections in the AM peak hour. As summarized in the **Table 5-2**, all the intersections within the study area will operate at LOS D or better both in the 2020 No-Build and the Build conditions. The Seminary Road and I-395 Northbound HOT off-ramp, even with additional demand, still operates at LOS B in the 2020 Build condition. See **Appendix D** for detailed intersection results, which includes delay for individual movements.

Table 5-2: Level of Service for Network Intersections in 2020 AM Scenarios

LOS	Existing	2020-NoBuild	2020 Build
LOS A-C	18	19	19
LOS D	3	3	3
LOS E	0	0	0
LOS F	0	0	0
Total	21	22	22

5.3.2 PM Peak Hour

5.3.2.1 Freeway Density

The traffic operations on I-395 in the 2020 No-Build and Build PM peak hour are presented in Figure 5-10 and Figure 5-11. The changes in congestion levels generally match with the changes in traffic demand discussed in the previous section. Southbound is the peak travel direction and operates under very constrained conditions in the Existing conditions. With the background projects in place, southbound demand will no longer be metered. All the segments on the southbound general-purpose lanes operate under light to moderate density level in the 2020 No-Build and Build conditions compared to existing where some of the segments were operating under severe congestion.

In the northbound direction, similar to Existing conditions, most of the northbound GP lanes and southbound express lanes in PM will remain uncongested. **Appendix E** provides the detailed tabular results with segment-by-segment mainline densities and ramp densities.

5.3.2.2 Speed

Figure 5-12 and Figure 5-13 illustrate freeway mainline and ramp segment speeds from the 2020 No-Build and 2020 Build peak hour VISSIM model for I-395 corridor. Detailed tabular results with link-by-link speeds and ramp speeds can be found in **Appendix E.**

Similar to densities, in general traffic flows are expected to be less congested during the PM peak under both the No-Build and Build condition compared to existing. Vehicle speeds increase considerably compared to existing speeds on the southbound GP lanes.

Figure 5-10: Freeway and Ramp Density for 2020 No-Build PM

Figure 5-11: Freeway and Ramp Density for 2020 Build PM

Figure 5-12: Freeway and Ramp Speed for 2020 No-Build PM

Figure 5-13: Freeway and Ramp Speed for 2020 Build PM

5.3.2.3 Travel Time

The travel time along I-395 southbound in the GP lanes improves significantly in both the 2020 No-Build and 2020 Build PM peak hour. Travel times in the southbound GP lanes are projected to decrease from approximately 22 minutes to approximately 6 minutes, a reduction of 74 percent. Like densities and speeds, travel time along the southbound general-purpose lanes show a significant reduction. Between the 2020 No-Build and 2020 Build, the travel time is almost identical.

In the PM peak hour, the travel time along the I-395 northbound general-purpose lanes are similar for both the 2020 No-Build and 2020 Build scenarios compared to the existing conditions.

Figure 5-14 below compares the PM peak hour travel time between Existing, 2020 No-Build and 2020 Build conditions.

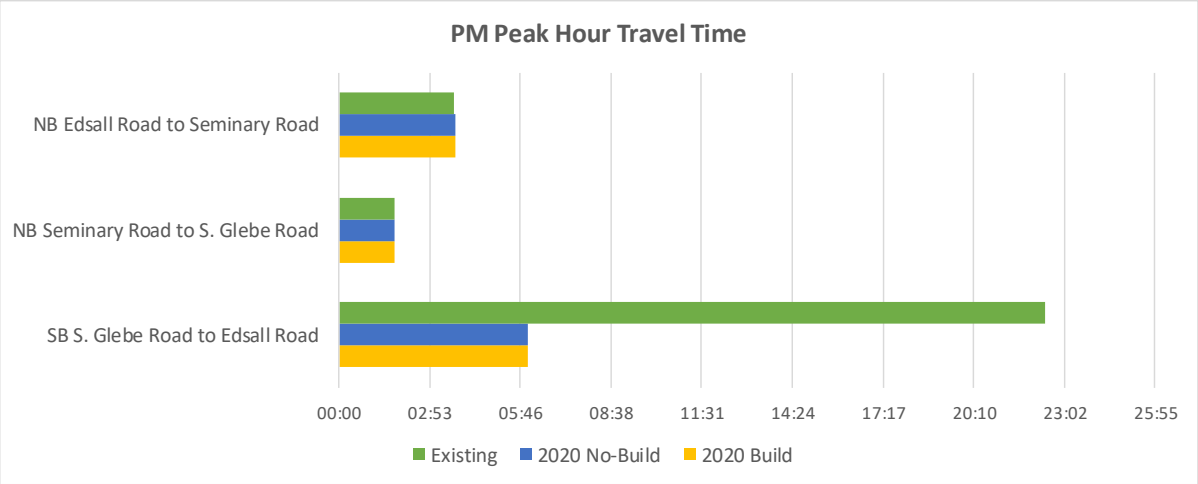


Figure 5-14: I-395 General Purpose Lanes – Travel Time for 2020 PM Scenarios

5.3.2.4 Intersection Delay

The 2020 Build conditions will have no adverse impacts on the crossing arterials and intersections in the PM peak hour. As summarized in the **Table 5-3**, all the intersections within the study area will operate at the same or better LOS in the 2020 Build conditions compared to the No-Build conditions and operate under LOS-D or better. The Seminary Road and I-395 Northbound HOT off-ramp (even with additional demand) still operates at LOS-A in the 2020 Build condition. **Appendix E** provides detailed intersection results which includes delay for individual movements.

Table 5-3: Level of Service for Network Intersections in 2020 PM Scenarios

LOS	Existing	2020-NoBuild	2020 Build
LOS A-C	17	20	21
LOS D	4	2	1
LOS E	0	0	0
LOS F	0	0	0
Total	21	22	22

5.4 2040 Analysis

5.4.1 AM Peak Hour

5.4.1.1 Freeway Density

The traffic operations on I-395 in the 2040 No-Build and Build AM peak hour are illustrated in **Figure 5-15** and **Figure 5-16**. Northbound is the peak travel direction and operates under constrained conditions in the Existing conditions. With the background projects, congestion decreases between interchanges at Duke Street, Seminary Road, and King Street both in the No Build and Build compared to existing. Similar to 2020, with the conversion of south facing ramp from HOV to HOT, it is anticipated that some demand using the general-purpose off-ramp to Seminary Road shifts to newly converted ramp. This alleviates some of the congestion between Turkeycock ramps to Seminary Road off-ramp along the northbound general-purpose lanes. Densities improve in the Build compared to the No-Build between Turkeycock ramps Seminary Road interchange. Downstream of the Seminary Road Interchange the densities increase slightly in 2040 Build compared to 2040 No-Build. The increase in throughput in Build compared to No-Build increases the densities.

In the southbound direction, the general-purpose lanes remain uncongested, as seen in the Existing conditions analysis. Similarly, the express lanes in the northbound direction remain at uncongested densities.

Appendix F provides the detailed tabular results with segment-by-segment mainline densities and ramp densities.

5.4.1.2 Speed

Speeds along I-395 in the 2040 No-Build and Build AM peak hour are illustrated in **Figure 5-17** and **Figure 5-18**. Similar to densities, Northbound speeds increase in the 2040 No-Build and Build compared to Existing. Travel speeds improve significantly between Turkeycock ramps and Seminary Road interchange in the 2040 Build compared to the 2040 No-Build and are comparable between Seminary Road interchange and King Street interchange.

In the southbound direction, the general-purpose lanes speed remains as a free-flow conditions with some slow down near Duke interchange, as seen in the Existing conditions analysis. Similarly, speeds on the express lanes in the northbound direction also remain at free-flow speeds.

The ramp from I-395 southbound to eastbound Duke Street has been reconfigured under a background conditions project. This movement is now a signalized left-turn and hence due to the low turning speeds, it appears in red which is representative of the turn speeds and not of congestion.

Figure 5-15: Freeway and Ramp Density for 2040 No-Build AM

Figure 5-16: Freeway and Ramp Density for 2040 Build AM

Figure 5-17: Freeway and Ramp Speed for 2040 No-Build AM

Figure 5-18: Freeway and Ramp Speed for 2040 Build AM

5.4.1.3 Travel Time

In the AM peak hour, the travel times along the I-395 northbound general-purpose lanes are generally lower in the 2040 No-Build and 2040 Build compared to the existing conditions. The Build travel time compared to No Build improves between Edsall Road and Seminary road and decreases slightly between Seminary Road and Glebe Road. The overall travel time along the corridor still improves slightly compared to No Build.

In the southbound direction, travel times remain consistent in 2040 as they were in Existing conditions for both No-Build and Build.

Figure 5-19 below compares the AM peak hour travel time between Existing, 2040 No-Build and 2040 Build conditions.

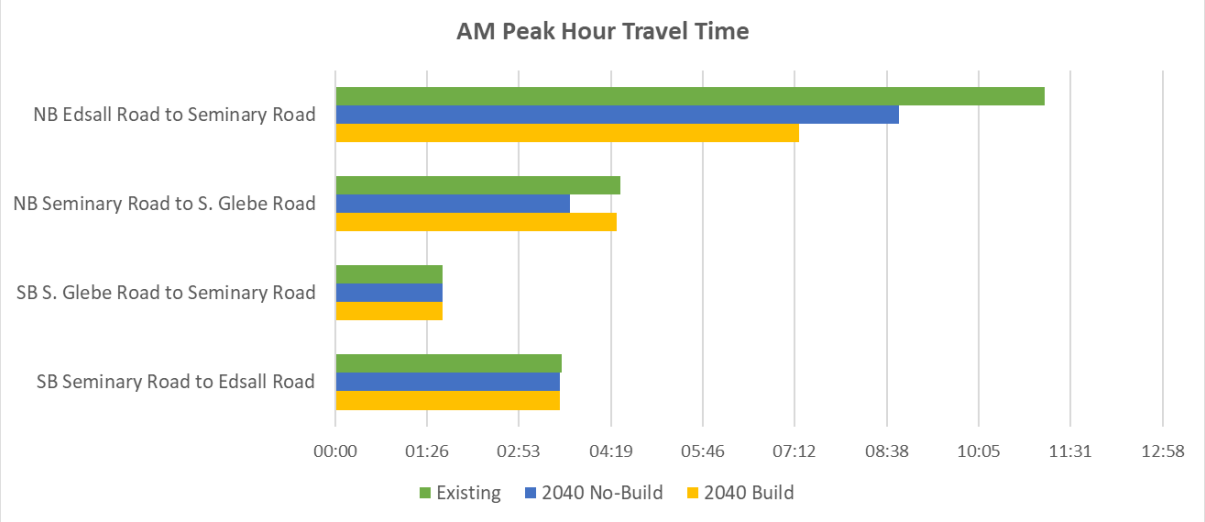


Figure 5-19: I-395 General Purpose Lanes – Travel Time for 2040 AM Scenarios

5.4.1.4 Intersection Delay

The 2040 Build conditions will have no adverse impacts on the crossing arterials and intersections in the AM peak hour. As summarized in the **Table 5-4**, all the intersections within the study area operate at LOS D or better in the 2040 Build conditions where-as in the No-Build one intersection along Duke Street operate at LOS E. The Seminary Road and I-395 Northbound HOT off-ramp even with additional demand still operates at LOS B in the 2040 Build condition. See **Appendix F** for detailed intersection results which includes delay for individual movements.

Table 5-4: Level of Service for Network Intersections in 2040 AM Scenarios

LOS	Existing	2040-NoBuild	2040 Build
LOS A-C	18	21	23
LOS D	3	4	3
LOS E	0	1	0
LOS F	0	0	0
Total	21	26	26

5.4.2 PM Peak Hour

5.4.2.1 Freeway Density

The traffic operations on I-395 in the 2040 No-Build and Build PM peak hour are illustrated in **Figure 5-20** and **Figure 5-21** and detailed segment-by-segment density can be found in **Appendix G**. As seen in the graphics both the 2040 No Build and Build operate under light to moderate congestion levels on all the mainline segments.

5.4.2.2 Speed

Figure 5-22 and **Figure 5-23** illustrate freeway mainline and ramp segment speeds from the 2040 No-Build and 2040 Build peak hour VISSIM model for I-395 corridor. Detailed tabular results with link-by-link speeds and ramp speeds can be found in **Appendix G.**

Similar to densities, in general traffic flows are expected to be less congested during the PM peak under both the No-Build and Build conditions compared to existing. Vehicle speeds increase considerably and travel at free-flow conditions compared to existing on the southbound GP lanes. Similar to the AM peak hour results, since the ramp movement from I-395 southbound to eastbound Duke Street is now a signalized left-turn, due to the low turning speeds, it appears in red which is representative of the turn speeds and not of congestion.

Figure 5-20: Freeway and Ramp Density for 2040 No-Build PM

Figure 5-21: Freeway and Ramp Density for 2040 Build PM

Figure 5-22: Freeway and Ramp Speed for 2040 No-Build PM

Figure 5-23: Freeway and Ramp Speed for 2040 Build PM

5.4.2.3 Travel Time

Figure 5-24 shows the PM peak hour travel time by segments for the 2018 existing, 2040 No-Build and 2040 Build conditions. End-to-end travel time for the southbound GP lanes are projected to be similar for both 2040 No-Build and Build, which is an approximately 73 percent reduction compared to existing conditions. With the background projects in place, the southbound GP lanes show a significant travel time savings.

In the PM peak hour, the travel time along the I-395 northbound GP lanes are almost identical in the 2040 No-Build and 2040 Build compared to the existing conditions. Under the No-Build and Build conditions, vehicles are expected to travel at near free-flow conditions with no major slow-down.

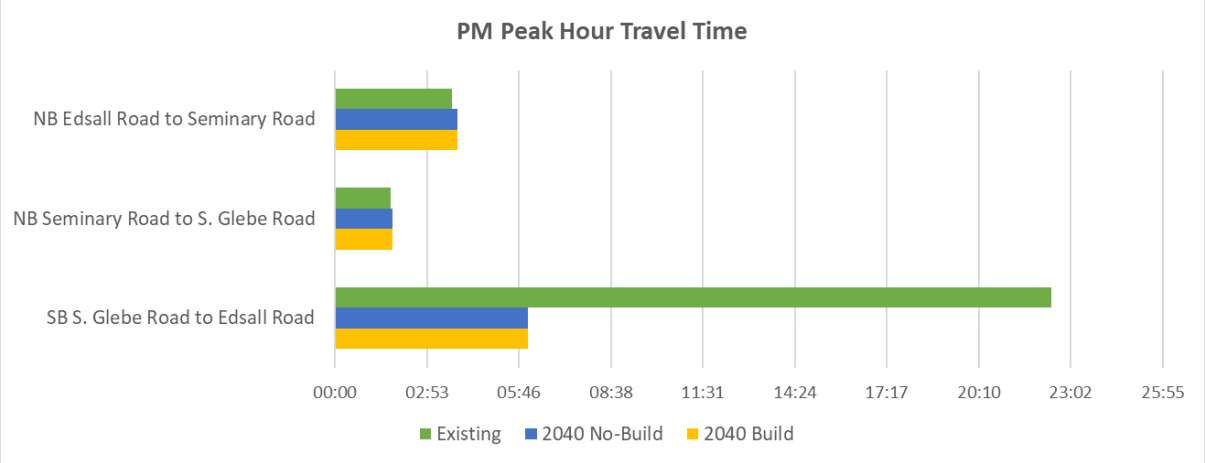


Figure 5-24: I-395 General Purpose Lanes – Travel Time for 2040 PM Scenarios

5.4.2.4 Intersection Delay

Table 5-5 compares the intersection LOS in the Existing, 2040 No-Build and 2040 Build condition. All signalized intersections are projected to operate at the same or better LOS. No degradation in arterial traffic conditions is anticipated. Most of the study intersections are projected to operate at a LOS-D or better with the exception of the intersection listed below, which operate at a LOS-E – Duke St and N. Beauregard St (No-Build and Build)

Appendix G provides a detailed intersection results which include delay for individual movements.

Table 5-5: Level of Service for Network Intersections in 2040 PM Scenarios

LOS	Existing	2040-NoBuild	2040 Build
LOS A-C	17	21	21
LOS D	4	4	4
LOS E	0	1	1
LOS F	0	0	0
Total	21	26	26

5.5 Future Analysis with Road Diet along Seminary Road

The 2020 and 2040 No-Build and Build conditions analysis was also conducted with the proposed road diet project along Seminary Road as a background project. The results of the traffic operations analysis are provided in **Appendix K**. The results show that the findings of the 2020 and 2040 conditions do not change and the Build conditions do not adversely impact the operations within the study area with the road diet in place along Seminary Road.

6. SAFETY ANALYSIS

6.1 Existing crash analysis

Crash data for the I-395 study corridor was used to evaluate corridor safety and identify crash patterns based on location, type, severity, time, and day. Crash data was obtained from the VDOT Tableau-Crash Analysis Tool for the latest available five years of crash data (January 1, 2014 to December 31, 2018). The crash analysis focused on the following regions:

- GP northbound and southbound I-395
- HOV I-395
- Ramps
- Study Intersections (15)

Figure 6-1 illustrates the study area that includes the freeway segments under the influence area of Seminary Road ramps, as well as, nearby intersections that will potentially be impacted with the conversion of the Seminary Road ramp from an HOV-only ramp to a HOT ramp.

Figure 6-1: Crash Influence Area

6.2 I-395 General Purpose Summary

Over the 5-year period for which crash data was collected, there were a total of 1,479 crashes along I-395 northbound and southbound GP lanes.

The mainline GP interstate is analyzed in four segments:

- South of Duke Street: from south of the influence area of Turkeycock Run interchange ramps to the Duke Street overpass
- Duke Street to Seminary Road: from the Duke Street overpass to the Seminary Road overpass
- Seminary Road to Route 7/King Street: from the Seminary Road overpass to the Route 7/King Street overpass
- North of Route 7/King Street: north of the influence area of the Route 7/King Street ramps

Summaries of the corridor crashes are shown in **Table 6-1** with additional details provided in **Appendix H**.

Table 6-1: I-395 General Purpose - Crash Summary per Year

Segment	Direction	2014	2015	2016	2017	2018	Total
South of Duke Street	Southbound	30	38	29	46	53	196
	Northbound	55	38	31	25	47	196
Duke Street to Seminary Road	Southbound	65	67	73	70	124	399
	Northbound	57	68	54	50	80	309
Seminary Road to Route 7/King Street	Southbound	16	25	13	14	28	96
	Northbound	11	25	21	25	37	119
North of Route 7/King Street	Southbound	15	16	14	9	14	68
	Northbound	6	22	20	16	24	88
Total		**255**	**299**	**255**	**255**	**407**	**1471**

The most common types of collisions out of the 1,479 total crashes on the GP lanes were comprised of the following: 978 (66 %) rear end crashes, 178 (12%) sideswipe same direction crashes, 142 (10%) fixed-object, off-road crashes, and 131 (9%) angle crashes. **Figure 6-2** and **Figure 6-3** summarize the crash types on each segment of northbound and southbound I-395, respectively. The segment with the highest crash frequency was between Duke Street and Seminary Road in both the northbound and southbound directions, with the southbound direction having 90 more crashes than the northbound direction.

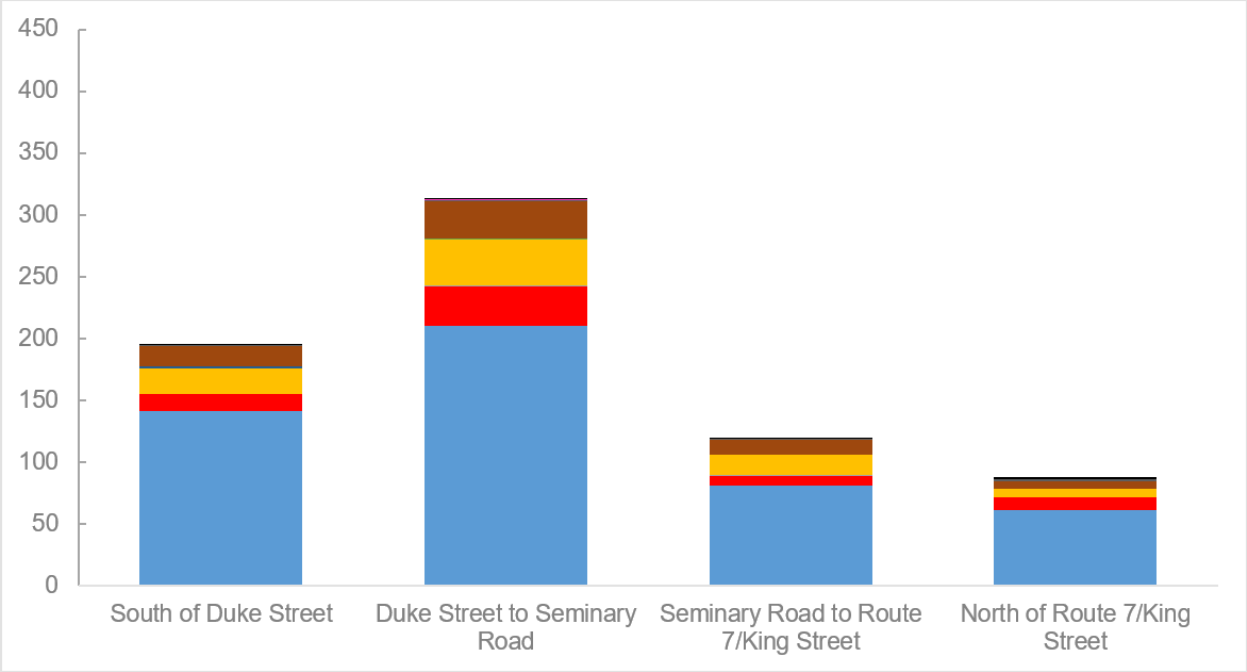


Figure 6-2: I-395 Northbound Collision Types

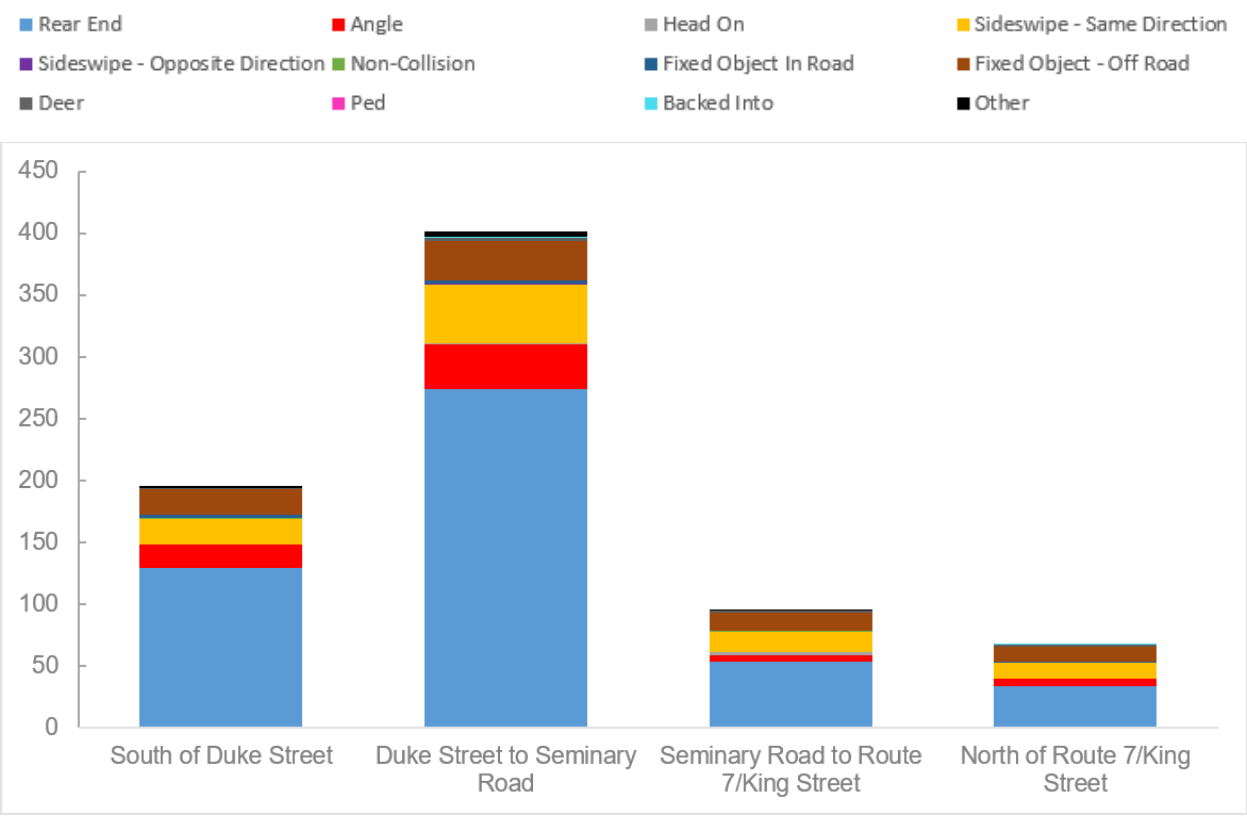


Figure 6-3: I-395 Southbound Collision Types

During the five-year study period, there were no recorded fatalities along the I-395 GP lanes study area. About 25 percent of the total crashes experienced were injury crashes and over 50 percent were during the AM or PM peak periods. **Table 6-2** summarizes the northbound and southbound crashes in relations to crash severity and peak periods.

Table 6-2: I-395 Crash Severity and Time Periods

Segment of I-395	Time Period	Northbound			Southbound		
		Fatal	Injury	PDO	Fatal	Injury	PDO
South of Duke Street	AM	0	16	54	0	5	13
	PM	0	14	37	0	22	58
	Other	0	20	55	0	30	68
Duke Street to Seminary Road	AM	0	24	70	0	7	20
	PM	0	17	54	0	32	146
	Other	0	48	96	0	52	142
Seminary Road to Route 7/King Street	AM	0	13	38	0	0	4
	PM	0	5	16	0	13	26
	Other	0	13	34	0	18	35
North of Route 7/King Street	AM	0	4	30	0	1	3
	PM	0	3	17	0	5	17
	Other	0	7	27	0	9	33

Figure 6-4 graphically illustrates the crash trends throughout an entire 24-hour period. As expected, the I-395 northbound GP lanes have a spike of crashes during the morning peak periods (5:30 AM to 8:30 AM), and the I-395 southbound general-purpose lanes have an increase in crashes during the afternoon peak periods (3 PM to around 7PM). Also shown in the figure are the I-395 HOV trends during similar AM and PM periods. Additional HOV information is summarized in the following section.

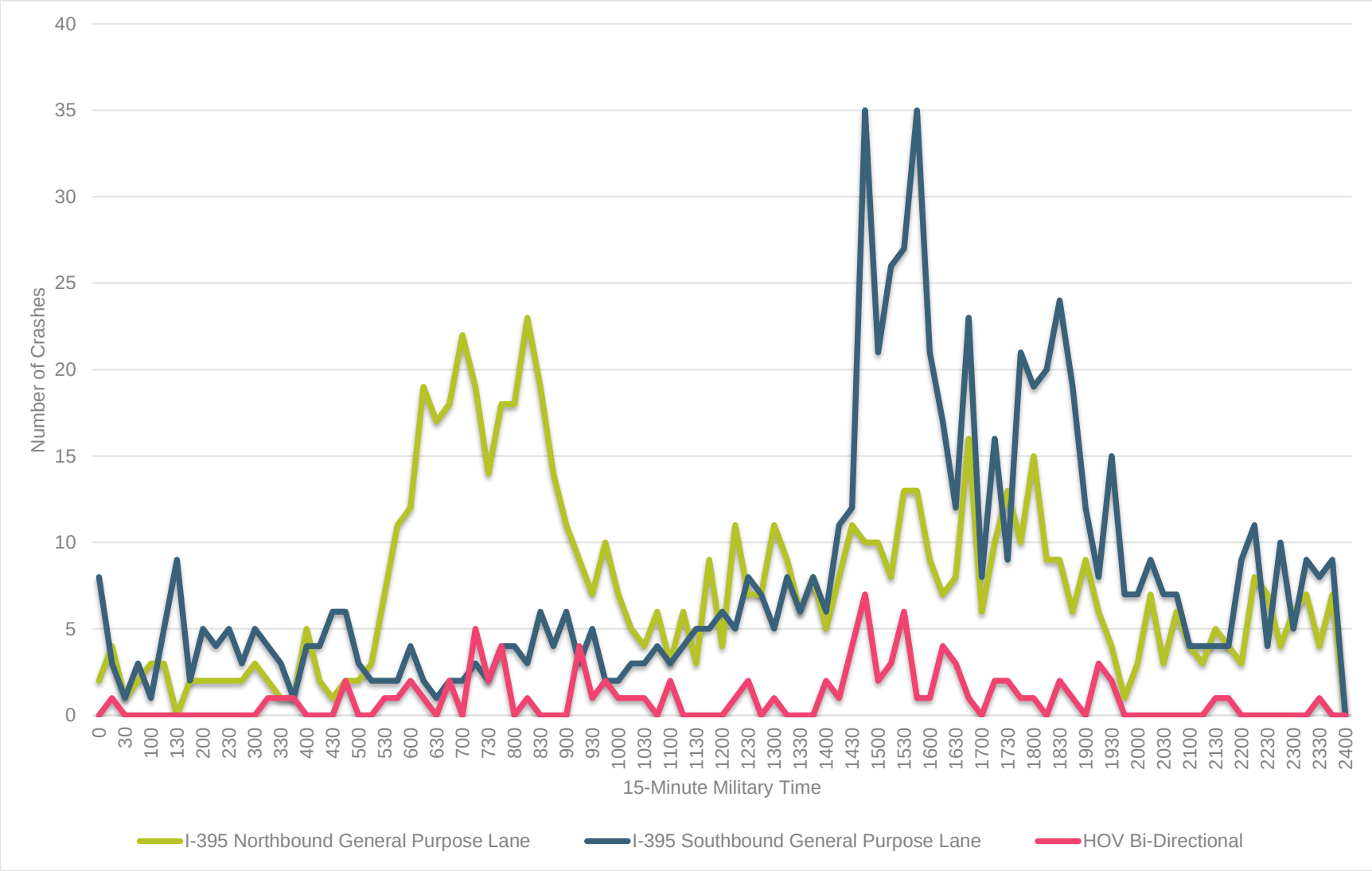


Figure 6-4: Crashes by 15-Minute Intervals

6.3 I-395 HOV Crash Summary

Crashes reported along the reversible HOV I-395 roadways within the study area were not analyzed bi-directionally but instead summarized as one facility. There were a total of 93 crashes along the HOV mainline facility during the study period.

Table 6-3: I-395 HOV - Crash Summary per Year

Segment	Direction	2014	2015	2016	2017	2018	Total
I-395 HOV	Reversible (both directions)	18	13	13	17	32	93

The majority of the crashes were rear-end (56%), followed by fixed-object, off-road (22%), sideswipe same direction (12%), angle crashes (6%), and other collisions encompassing one percent or lower of the total crashes. **Figure 6-5** summarizes the breakdown of collision types of the entire HOV study area.

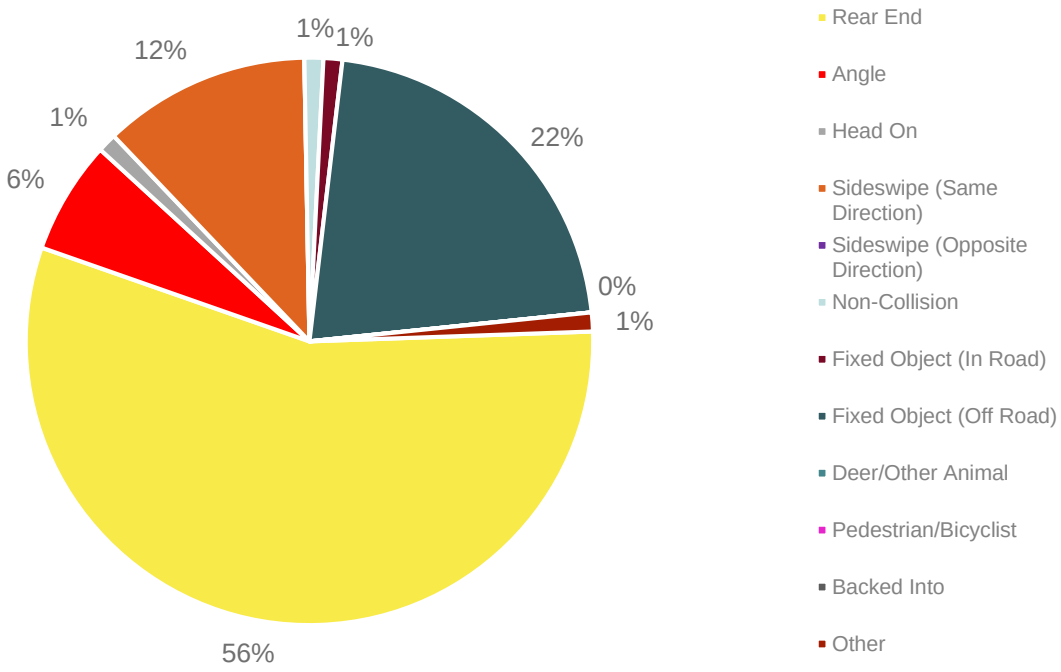


Figure 6-5: I-395 HOV Collision Types

Other crash trends are summarized in **Figure 6-6** through **Figure 6-10** below:

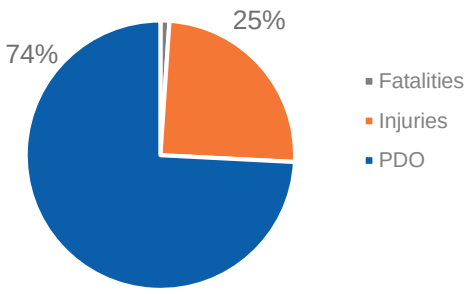


Figure 6-6: I-395 HOV - Crash Severity

- The majority of crashes on I-395 resulted in PDOs (74%), followed by injuries (25%)
- There was one fatality that occurred on April 10th, 2015 during off-peak hours at 9:59 PM between Duke Street and Seminary Road. It was a dark misty day with wet road conditions. Vehicle 1 (truck-SUV) was traveling on the wrong side of the road (northbound on a southbound lane), and struck vehicle 2 (passenger) head on, causing two fatalities

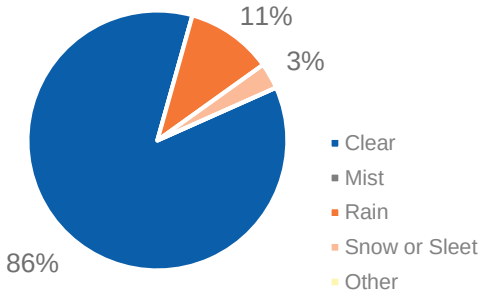


Figure 6-7: I-395 HOV - Weather Conditions

- Most of the crashes occurred during clear weather conditions (86%), followed by rain (11%), and snow/sleet (3%)
- It can be inferred that weather and road surface conditions do not have a significant impact on majority of the crashes

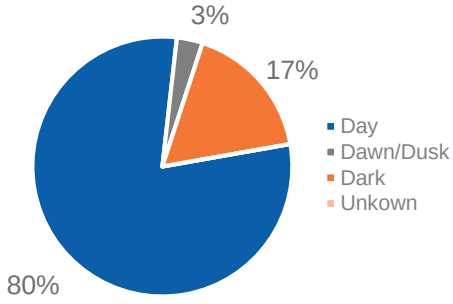


Figure 6-8: I-395 HOV - Light Conditions

- Most of the crashes occurred during the day time (80%), followed by night (17%), and dawn/dusk (3%)

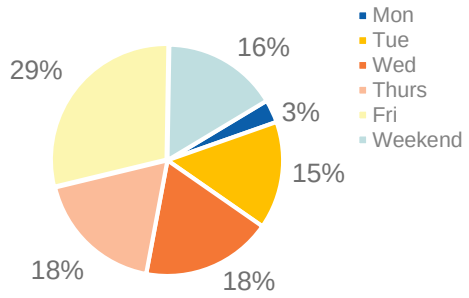


Figure 6-9: I-395 HOV - Day of Week

- Crashes occurred about equally during all of the days of the week, except for on Mondays (consisting of only 3%) of the crashes for all five years
- The average per weekday was around 15% of crashes, most happening on Wednesday and Thursday

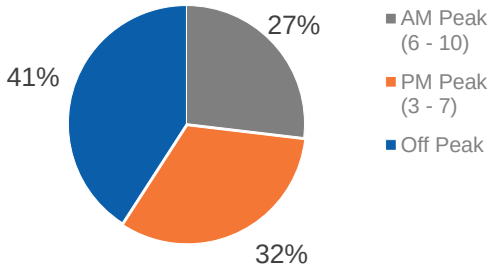


Figure 6-10: I-395 HOV – Time Period

- The majority of the crashes happened during the peak periods (59%), considering the HOV lanes are reversible

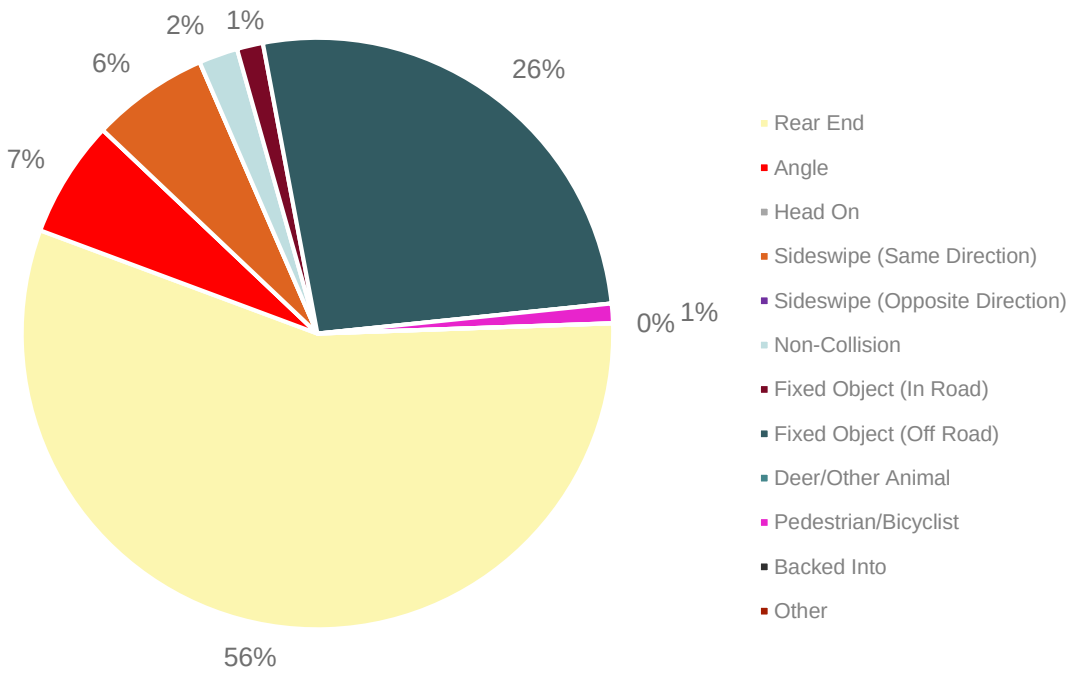
6.4 Ramps Crash Summary

All ramp crashes were analyzed both individually and aggregated. During the five study years, there were 284 total ramp-related crashes. **Table 6-4** summarizes the ramp crashes per year.

Table 6-4: I-395 Ramps - Crash Summary per Year

Segment	2014	2015	2016	2017	2018	Total
I-395 Ramps	50	67	58	42	67	284

The majority of the crashes were rear end crashes (56%), fixed-object, off-road (26%), angle crashes (7%), sideswipe, same direction crashes (6%), and other collisions encompassing one percent or lower of the total crashes.



Other ramp crash trends are summarized in **Figure 6-11** through **Figure 6-15**:

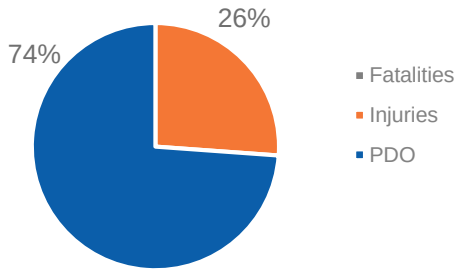


Figure 6-11: I-395 Ramps - Crash Severity

- The majority of the I-395 crashes resulted in PDOs (74%), followed by injuries (26%)
- Though not portrayed in the pie graph, there was one fatality (<1%). The crash occurred on March 20th, 2016 during off-peak hours at 10 AM. It was a clear, dark night with dry roadway conditions. The driver failed to maintain proper control of his motorcycle and ran off road. The fatality happened on the eastbound Duke Street ramp to northbound I-395 ramp

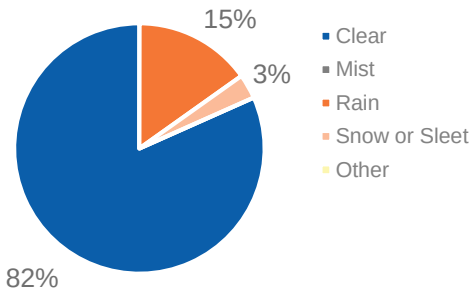


Figure 6-12: I-395 Ramps - Weather Conditions

- Most of the crashes occurred during clear weather conditions (82%), followed by rain (15%), and snow/sleet (3%)
- It can be inferred that weather and road surface conditions do not have a significant impact on majority of the crashes

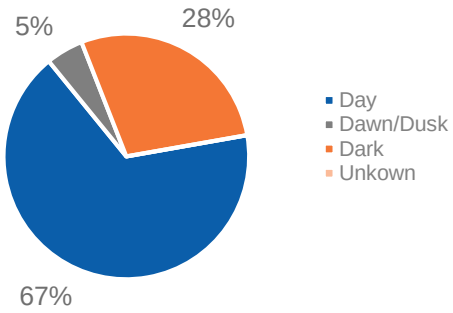


Figure 6-13: I-395 Ramps - Light Conditions

- Most of the crashes occurred during the day time (67%), followed by night (28%), and dawn/dusk (5%)

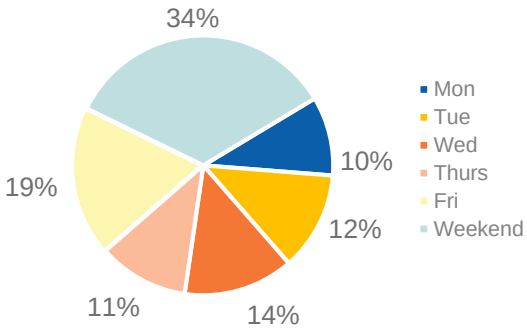


Figure 6-14: I-395 Ramps - Day of Week

- Crashes occurred more frequently during Friday and the weekends, 19% and 34% respectively
- The least amount of crashes occurred during Mondays (10%)

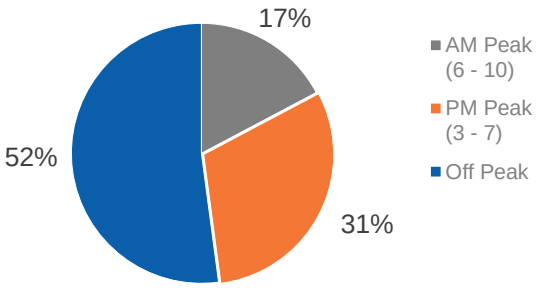


Figure 6-15: I-395 Ramps - Time Period

- Ramp crashes happened evenly during the non-peak (52%) and peak (48%) periods

There are 29 ramps within the study area. The majority of the crashes were along the Duke Street ramps to northbound I-395. This area had the highest number of injury crashes. The next few ramps with high crash frequencies were the northbound Duke Street ramps to northbound I-395 and to southbound I-395. The region with the second-highest injury crashes was at southbound I-395 to eastbound Seminary Road, where about half of the crashes were injuries and half were PDO. The fatality happened on the eastbound Duke Street to northbound I-395 ramp. **Table 6-5** lists the number of crashes and severity types for all the study ramps analyzed.

Table 6-5: Crash Severity for Ramps

Ramps	FATALITY	INJURY	PDO	Total
Northbound I-395 to Westbound Route 7	0	1	6	7
Northbound I-395 to Eastbound Route 7	0	0	2	2
Westbound Route 7 to Southbound I-395	0	0	5	5
Westbound Route 7 to Northbound I-395	0	1	3	4
Southbound I-395 to Westbound Route 7	0	2	4	6
Southbound I-395 to Eastbound Route 7	0	0	1	1
Eastbound Route 7 to Northbound I-395	0	0	5	5
Eastbound Route 7 to Southbound I-395	0	3	4	7
Northbound I-395 to overpass Seminary Road	0	6	3	9
Westbound Seminary Road to Northbound I-395	0	3	2	5
Southbound I-395 to Westbound Seminary Road	0	10	9	19
Eastbound overpass Seminary Road	0	2	6	8
Eastbound overpass Seminary Road to Southbound I-395	0	6	8	14
North facing Seminary Road from HOV	0	0	1	1
South facing Seminary Road to HOV	0	1	1	2
Duke Street ramps to Northbound I-395	0	12	41	53
Northbound I-395 to Westbound Duke Street	0	3	7	10
Northbound I-395 to Eastbound Duke Street	0	4	14	18
Westbound Duke Street to Northbound I-395	0	0	4	4
Westbound Duke Street to Southbound I-395	0	4	23	27
Southbound I-395to Westbound Duke Street	0	6	19	25
Southbound I-395 to Eastbound Duke Street	0	1	8	9
Southbound Duke Street to I-395 ramps	0	3	12	15
Eastbound Duke Street to Northbound I-395	1	0	2	3
Eastbound Duke Street to Southbound I-395	0	5	7	12
HOV to Northbound I-395 GP at Turkeycock Run	0	1	1	2
HOV to Southbound I-395 GP at Turkeycock Run	0	1	6	7
Northbound I-395 GP to HOV at Turkeycock Run	0	0	4	4
Southbound I-395 GP to HOV at Turkeycock Run	0	0	2	2

6.5 Study Intersections Crash Summary

The study area consists of 15 study intersections. These intersections were chosen based on location and proximity to the HOV reversible lanes. The influence area of an intersection comprised any crashes that were within a 250 feet radius of the center of the intersection or within the turning lanes.

The intersections are listed from the highest number of crashes to the least number of crashes in **Table 6-6**.

Table 6-6: Crash Severities - Study Intersection

Intersection	FATALITY	INJURY	PDO	Total
Seminary Road and Mark Center Avenue	0	20	67	87
Duke Street and Walker Street	0	21	65	86
Little River Turnpike and Beauregard Street	0	41	37	78
Seminary Road and Beauregard Street	0	18	47	65
Little River Turnpike and Oasis Drive	0	17	37	54
King Street and Park Center Drive	0	11	33	44
Seminary Road and 395 Southbound Ramp	0	12	24	36
Seminary Road and Library Lane/Kenmore Avenue	0	11	20	31
Seminary Road and 395 Northbound Ramp	0	7	19	26
King Street and Menokin Drive	0	7	16	23
Seminary Road and 395 Northbound Ramp	0	5	10	15
Seminary Road and Pickett Street	0	1	13	14
Seminary Road and Seminary Road	0	4	6	10
Seminary Road and 395 Southbound Ramp	0	2	7	9
Seminary Road and HOV Ramp	0	3	4	7

The top three intersections that experienced the most crashes during the five years were Seminary Road and Mark Center Avenue (87 crashes), Duke Street and Walker Street (86 crashes), and Little River Turnpike and Beauregard Street (78 crashes). There were no fatalities. However, the most injuries occurred at Little River Turnpike and Beauregard Street. This intersection experienced more injury crashes (41 crashes) than PDO crashes (37 crashes).

To better understand the crash trends, the collision types for each study intersection are summarized in **Table 6-7**. The most prominent collision types were rear end (42%), angle (36%), and sideswipe-same direction (10%). Rear end crashes can be attributed to potential rush hour traffic and queues while the angle crashes and sideswipes can be attributed to turns and lane changes.

Individual intersection analysis sheets can be found in the **Appendix H**.

Table 6-7: Collision Types - Study Intersections

Intersection	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into	Other	Total
Seminary Road and Mark Center Avenue	19	45	1	9	1	0	2	2	0	2	1	5	**87**
Duke Street and Walker Street	42	25	0	12	1	0	0	2	0	0	0	4	**86**
Little River Turnpike and Beauregard Street	50	9	3	6	0	1	0	4	0	5	0	0	**78**
Seminary Road and Beauregard Street	31	18	3	4	2	0	0	5	0	1	0	1	**65**
Little River Turnpike and Oasis Drive	28	15	2	4	0	0	0	1	0	2	2	0	**54**
King Street and Park Center Drive	16	23	0	4	0	0	0	1	0	0	0	0	**44**
Seminary Road and 395 Southbound Ramp	5	23	2	5	0	0	0	0	0	0	0	1	**36**
Seminary Road and Library Lane/Kenmore Ave	11	13	2	1	0	0	0	0	0	3	0	1	**31**
Seminary Road and 395 Northbound Ramp	9	15	0	1	0	0	0	0	0	0	0	1	**26**
King Street and Menokin Drive	9	8	0	3	0	0	1	1	0	0	0	1	**23**
Seminary Road and 395 Northbound Ramp	3	7	0	5	0	0	0	0	0	0	0	0	**15**
Seminary Road and Pickett Street	11	0	0	2	0	0	0	0	0	0	0	1	**14**
Seminary Road and Seminary Road	6	3	0	0	0	0	0	1	0	0	0	0	**10**
Seminary Road and 395 Southbound Ramp	5	2	0	2	0	0	0	0	0	0	0	0	**9**
Seminary Road and HOV Ramp	0	4	0	1	0	0	1	1	0	0	0	0	**7**
Total	**245**	**210**	**13**	**59**	**4**	**1**	**4**	**18**	**0**	**13**	**3**	**15**	**585**

6.6 Historical Crash Rates

Crash rates were computed to compare the study I-395 GP segments with statewide rates for similar roadway types established by VDOT. Crash data during the 5-year analysis period, the annual average daily traffic (AADT) volumes, and the length of the study corridor were used to compute the crash rates. I-395 mainline crash rates for 2014 to 2017 are summarized in **Table 6-8**. 2018 data was not available from VDOT; therefore, the 2018 comparison was omitted in the table. The computed rates are compared to the statewide crash rates on I-395 as well as other interstate highways. All the statewide data was available on VDOT's database. Crash rates are expressed in the number of crashes per 100 million vehicle-miles traveled. The study corridor crash rates for fatality, injuries, and total crash rates are lower than the I-395 statewide comparisons. When compared to the urban interstate statewide data, the study area for I-395 has higher crash rates than the average urban interstate crash rates during some years. The study area for I-395 crash rates remain lower than the statewide divided, no control of access crash rates.

Table 6-8: Crash Rate Summary

Segment Description	Crash Rate 2014 (Per 100 Million VMT)			Crash Rate 2015 (Per 100 Million VMT)			Crash Rate 2016 (Per 100 Million VMT)			Crash Rate 2017 (Per 100 Million VMT)		
	Fatal	Injury	All	Fatal	Injury	All	Fatal	Injury	All	Fatal	Injury	All
I-395 Northbound Study Area - Interstate/6 Lanes, Divided	0.0	18.2	87.2	0.0	29.3	113.5	0.0	20.8	80.1	0.0	17.7	70.8
I-395 Southbound Study Area - Interstate/6 Lanes, Divided	0.0	19.7	85.4	0.0	22.4	105.5	0.0	24.0	81.9	0.0	20.6	84.2
I-395 Northbound - Statewide	0.0	23.7	105.1	0.0	32.2	134.5	0.0	34.0	121.3	0.0	35.3	131.9
I-395 Southbound - Statewide	0.0	25.8	105.6	0.0	26.2	118.3	0.3	32.8	120.0	0.0	31.0	114.3
Statewide Urban Interstate	0.3	24.1	85.2	0.2	22.6	82.4	0.3	21.7	76.2	0.3	21.6	78.6
Statewide Divided, no control of access	0.8	53.0	157.5	1.0	53.7	161.5	0.9	52.8	156.4	1.0	50.0	158.5

6.7 Crash Modification Factors

Using the HSM methodology, future crash frequency was predicted under 2040 build conditions. These predictions were limited to the types of improvements for which crash modification factors (CMFs) were developed. CMFs were acquired through the Crash Modification Factors Clearinghouse website.

The following improvements were identified as roadway modifications that that will be in place under future conditions:

- I-395 southbound is widened to four lanes from Duke Street off-ramp to the Turkeycock Run on-ramp (5 lanes for diverge/merge lanes from Duke Street westbound on-ramp). Remains five lanes from Turkeycock Run/Duke Street eastbound to Edsall Road
- Widening of Duke Street westbound approaching the interchange from two to three lanes, then three to four lanes over the interstate
- Widening of Duke Street eastbound departing interchange from two lanes to three lanes, and three lanes to four lanes to meet with the eastbound approach to intersection at South Walker
- I-395 off-ramp to westbound Duke Street changes from one lane to two lanes
- Relocation of on-ramp I-395 access point from eastbound Duke Street to further south of I-395, making the short ramp a longer ramp
- Replacing the HOV lanes with HOT Express lanes from the Turkeycock Run interchange to the vicinity of Eads Street in Arlington
- Off-ramp from I-395 southbound to Duke Street eastbound changes from a cloverleaf to being combined with the southbound I-395 off-ramp and a signalized intersection on Duke Street
- Replacing directional HOV off-ramp to HOT off-ramp from future HOT Express lanes onto Seminary Road

Related crashes within the influence area were analyzed for each improvement. Related crashes are those expected to be reduced by the proposed improvements. Each CMF has a specific type of crash severity and crash type that the factor can apply to. For this study, crashes were separated based on severity (fatal (K), injury (A/B/C), and PDO and divided by five to determine the average yearly historic crash rate for each severity type. CMFs were multiplied to the average yearly historical crash rate to estimate the expected number of crashes after improvements are implemented. The lower the CMF value, the more safety benefits the improvement is predicted to have along the study area. **Table 6-9** summarizes the CMFs used to calculate some of the proposed improvements listed above.

Table 6-9: Crash Modification Factors

Improvements*	CMF	Severity Type
Additional Lane Locations: • Southbound I-395 from Duke Street off-ramp to Turkeycock Run on-ramp • Eastbound and westbound Duke Street • I-395 off-ramp to westbound Duke Street	0.76	Fatal (K) and Injury (A, B, C)
Replacing directional HOV to direction Express lane Locations: • The existing HOV lanes to HOT Express lanes from the Turkeycock Run interchange to the vicinity of Eads Street in Arlington	0.95	All
Providing long ramp instead of short ramp Location: • On-ramp I-395 access point from eastbound Duke Street to further south of I-395	0.62	All
Providing straight ramp instead of cloverleaf ramp Location: • Off-ramp from I-395 southbound to eastbound Duke Street	0.55	All
Install traffic signal Location: • Off-ramp from I-395 southbound to eastbound Duke Street	0.83	All

*Improvement CMFs were acquired from the CMF clearinghouse

Table 6-10 summarizes the predicted crash frequency for the proposed improvements. The influence areas for the project locations are as follows:

- **I-395 Southbound GP:** from the Duke Street off-ramp to the Turkeycock Run on-ramp
- **Duke Street Westbound:** all mainline crashes, excluding any that relate to ramps and intersections
- **Duke Street Eastbound:** all mainline crashes, excluding any that relate to ramps and intersections
- **I-395 Off-Ramp to Westbound Duke Street:** from the start of the taper for the off-ramp to the end of the cloverleaf loop around Duke Street
- **Relocation of On-Ramp I-395 Access Point:** all crashes along the on-ramp starting from the gore of the ramp from eastbound Duke Street to the merge taper onto I-395
- **Replacing Directional HOV to Directional Express Lane:** the full extent of the HOV lanes of the crash analysis study area; south of Turkeycock Run to north of Route 7/King Street

All improvements where historic crashes could be gathered were analyzed. No future crash predictions were calculated for one improvement due to lack of crash data: the off-ramp from I-395 southbound to Duke Street eastbound changing from a cloverleaf to being combined with the southbound I-395 off-ramp and a signalized intersection on Duke Street. However, based on the CMF values (0.55 and 0.83), removing the

cloverleaf ramp and straightening out the ramp to intersect Duke Street with a traffic signal would provide safety benefits.

Table 6-10: CMF Summary for Improvement

Project Location	CMF	Average Historic Crashes per Year	Average Historic (PDO) Crashes per Year	Average Historic (Fatal and Injury) Crashes per Year	Future Predicted Crashes per Year	Crash Reduction Due to Improvements per Year
I-395 Southbound General Purpose – Additional Lane	0.76	77	58	20	73	4
Duke Street Westbound – Additional Lane	0.76	5	4	1	5	0
Duke Street Eastbound – Additional Lane	0.76	3	2	1	3	0
I-395 Off-Ramp to Westbound Duke Street – Additional Lane	0.76	2	1	1	1	1
Relocation of On-Ramp I-395 Access Point - Providing long ramp	0.62	2	1	1	2	0
Replacing Directional HOV to Direction Express Lane	0.95	19	14	5	18	1

CMF values were not available to predict the crash effects of replacing the directional HOV off-ramp to a directional HOT off-ramp (from the future HOT Express lanes onto Seminary Road). Because there is no geometric change for this improvement, only qualitative predictions could be made for this change. The directional HOV off-ramp to Seminary Road was opened early 2016 and was restricted to HOV and transit traffic. Since the opening of the ramp, there have been only two recorded crashes within the south facing ramp. An injury crash occurred during the AM peak hours on January 31, 2017 due to icy conditions that resulted in an angle crash by the signal light on Seminary Road. A rear end PDO crash happened during PM peak hours on May 27th, 2018 at the signal light on Seminary Road. Both crashes occurred by the signal light on Seminary Road.

As stated in previous sections, both in 2020 and 2040, converting the ramp from HOV to HOT leads to a slight decrease in volumes on the general-purpose lanes between Turkeycock Express ramps and Seminary Road Interchange in the general-purpose lanes for the AM peak hour and PM peak hour. Some of the vehicles which use the general-purpose Seminary Road off-ramp in AM are expected to now use the

newly converted Express ramp to Seminary Road. Similarly, in the PM some of the southbound general purpose on-ramp demand gets shifted to the newly converted southbound Express on-ramp. **Table 6-11** summarizes the volume changes between Existing, 2020 Build, and 2040 Build due to the HOV to HOT Seminary Road ramp change.

Table 6-11: Volume Comparison

AM	Ramp	SB Seminary Rd	NB Seminary Rd	Northbound GP	HOT Express Lane
Existing	285	585	805	4495	2265
2020 Build	375	380	505	4300	2800
2040 Build	440	380	510	4505	3090
PM	**Ramp**	**SB Seminary Rd**	**NB Seminary Rd**	**Southbound GP**	**HOT Express Lane**
Existing	230	1170	525	4645	2980
2020 Build	380	1045	430	4545	3785
2040 Build	455	855	470	4730	3990

Based on the historical crash trends, there is an estimation of less than one crash a year along the current south facing HOV ramp. By changing the HOV ramp to HOT, more traffic will flow through the ramp and less traffic will be using Seminary Road and the GP lanes. This shift in traffic will increase the likelihood of crashes along the new HOT ramp. However, it's important to note that the crash rates on this ramp are very low and the crash rates along the GP and Seminary Road are much higher. Therefore, there may be a tradeoff for shifting traffic from one facility to another.

It is important to note that these values should only be used for high-level planning purposes to understand the relationship between certain roadway geometric improvements and safety. The crash reductions per year are only estimated values.

7. ENVIRONMENTAL COMPLIANCE AND STAKEHOLDER COORDINATION

Pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended, and in accordance with FHWA regulations, a NEPA reevaluation of the I-395 Express Lanes Environmental Assessment (EA), published in September 2016, is being completed for this project as prescribed in 23 CFR § 771. This reevaluation will document changes related to the conversion of the Seminary Road ramp from HOV to HOT but will not present new information or circumstances relative to environmental concerns that would result in significant environmental impacts not already evaluated in the previously approved EA.

In addition to this, there have been several coordination meetings held with the stakeholders of the City of Alexandria to update them on the proposed changes. **Appendix J** includes the input that was received from the City.

8. SUMMARY OF FINDINGS

8.1 Traffic Volumes

Existing conditions traffic volumes were developed from the field collected counts during a representative average weekday traffic. The field count data for the AM peak hour and PM peak hour for this project were balanced in the sequence starting from the I-395 HOV lanes, followed by I-395 GP lanes and then the arterial intersections. The volume on the HOV ramp from I-395 at Seminary Road was observed to be only 285 in the AM peak hour and 230 in the PM peak hour. This is significantly lower compared to the adjacent GP ramps operating in the same direction. This means that under existing conditions the HOV-only ramp at Seminary Road is under-utilized. It is also necessary to note that this is the total volume on this ramp including any possible HOV violators.

The future (2020 and 2040) conditions volumes were developed for the No Build and Build conditions using the Strategic Travel Demand Model for the Washington region. Outputs from this model were used to estimate growth on study area roadway links using *NCHRP 765* industry-standard practices. Traffic volumes for the 2020/2040 No-Build and 2020/2040 Build scenarios were both grown from the existing 2018 balanced volumes, and future forecast volumes were balanced in a manner consistent with how the existing volumes were developed. Some key observations of the forecast volumes include:

Under 2020 and 2040 No-Build scenarios, HOV ramp volumes were expected to be less than the existing volumes due to the I-395 Express Lanes would remove HOV violators and drivers are required to have EZ-Pass.

Under 2020 and 2040 Build scenarios with the south facing Seminary Road ramp converting from HOV to HOT, the following can be expected when compared to No-Build:

Seminary Road HOT ramp volume will increase as toll-paying vehicles will now have this new access.

I-395 northbound GP off-ramp to Seminary Road and southbound GP on-ramp volumes from Seminary Road will decrease during AM and PM, respectively. The data and analysis also suggest that the HOT ramp volume increase would include the shift of some volumes from the GP ramp and traffic that was cutting through the local arterials because they did not have access to this ramp under the No-Build scenario.

With the reduction in the GP ramp volume, there will consequently be a reduction in the volumes along the Seminary Road rotary level that provides access to GP ramps.

During the AM peak, at this interchange, the Seminary Road westbound drivers that use local routes (cut-through traffic) along arterials in the City of Alexandria could take the Seminary Road HOT ramp, resulting in reduced westbound volumes from the City.

Similarly, during the PM peak, at this interchange, the Seminary Road eastbound drivers cutting through the City's local arterials can take the HOT ramp, resulting in reduced eastbound volumes going into the city from the interchange.

8.2 Traffic Operations Analysis Findings

Traffic operations analysis was carried out using the VISSIM microsimulation software to perform a comprehensive network traffic analysis for the study area for 2020 (intermediate/opening year) and for 2040 (design year). The VISSIM model network included all freeways and arterials within the study area, including arterial signalized intersections. The analysis was carried out based on the guidance in the VDOT TOSAM for the AM peak from 6:30 AM to 8:30 AM, and for the PM peak from 4:00 PM to 5:30 PM. VISUM planning software was used to estimate O-D patterns. O-D routing was obtained utilizing StreetLight Data and where necessary the MWCOG model; and the O-D matrix was adjusted using VISUM's TFlowFuzzy methodology to match target balanced volumes along the corridor.

Under existing conditions, northbound is the peak direction of travel along the I-395 corridor during the AM peak. Most of the segments in the northbound direction on the general-purpose lanes operate under heavy to severe congestion with speeds dropping to as low as 13 mph in certain segments. Heavy inbound travel demand and high interchange density on I-395 are the main contributing factors for congestion during the AM peak hour. The mainline traffic is forced to repeatedly slow down or stop at various locations along the corridor due to merging traffic. Downstream segments on I-395 northbound are also severely congested on a recurring basis during the AM peak hour and queues spill back into the study area.

Similarly, southbound is the peak direction during the PM peak and experiences significant congestion between the Duke Street interchange and the Seminary Road interchange. There are two major congestion spots on southbound I-395 during the existing PM peak hour:

- Seminary Road on-ramp merge
- Lane drop near Duke Street interchange

Currently, the I-395 southbound mainline drops from four to three lanes at the Duke Street (Route 236) interchange. This causes a severe bottleneck on the I-395 corridor within the study area during the PM peak hour, southbound traffic is metered due to the capacity reduction, and traffic flows frequently break

down at this location during the entire PM peak period. The average travel speed is 10 to 15 mph throughout this section.

All intersections within the study area operate at LOS D or better for both AM and PM peak under existing conditions.

Under 2020 scenario, in both AM and PM peak, with the background projects in place, congestion does decreases along I-395 general-purpose lanes between interchanges at Duke Street, Seminary Road, and King Street both in the No-Build and Build compared to existing. With the conversion of south facing ramp from HOV to HOT, it is anticipated that some demand using the general-purpose off-ramp to Seminary Road shifts to newly converted ramp. Under the 2020 Build conditions, the overall travel time along I-395 northbound in the AM peak improves by almost half a minute. Also, the 2020 Build conditions do not have any adverse impacts on the crossing arterials and intersections in the AM and PM peak hour. All the intersections within the study area continue to operate at the same or better LOS in 2020 Build compared to the No-Build conditions.

Similarly, under the 2040 scenario, even with more traffic growth and background projects, congestion decreases between interchanges at Duke Street, Seminary Road, and King Street both in the No Build and Build compared to existing. Similar to 2020, with the conversion of south facing ramp from HOV to HOT, it is anticipated that in 2040, some demand using the general-purpose off-ramp to Seminary Road shifts to newly converted ramp. This alleviates some of the congestion between Turkeycock ramps to Seminary Road off-ramp along the northbound general-purpose lanes. Densities decrease in the Build compared to the No-Build between Turkeycock ramps and the Seminary Road interchange. Downstream of the Seminary Road interchange the densities are comparable between 2040 No-Build and 2040 Build. Under the 2040 Build conditions, the overall travel time along I-395 northbound in the AM peak improves by more than 50 seconds. All the intersections within the study area will operate at equal or better LOS in the 2040 Build conditions compared to the 2040 No-Build conditions. All intersections operate under LOS D or better in the AM peak, while in the PM peak the Duke St and N. Beauregard St intersection will operate at LOS E. The intersection of Seminary Road and I-395 northbound HOT off-ramp even with additional demand, operates at LOS B in the 2040 Build condition.

The Build Alternative will enhance the traffic flow along I-395 GP lanes. Overall, the 2020 and 2040 peak hour Build conditions operate slightly better than the No-Build conditions relative to the following metrics:

1. Increase in speed and decrease in overall travel time.
2. Improved vehicle throughput and percent of demand served along I-395 (Total of HOT and GP)
3. Lower traffic flow density and less congestion along most freeway segments
4. No adverse impacts to arterials and intersections

These findings confirm that conversion of the HOV ramp at Seminary road will provide additional travel options to the drivers in the region while not being detrimental to the freeway or arterial operations. It maintains the existing access options and utilizes the unused capacity on this ramp to provide new access to the toll-paying vehicles.

The 2020 and 2040 No-Build and Build conditions analysis was also conducted with the proposed road diet project along Seminary Road as a background project. The results show that the findings of the

2020 and 2040 conditions do not change and the Build conditions do not adversely impact the operations within the study area with the road diet in place along Seminary Road.

8.3 Safety Analysis Findings

Analysis of the last five years crash data obtained from the VDOT Tableau shows that the segment with the highest crash frequency was between Duke Street and Seminary Road in both the southbound and northbound directions, with the southbound direction having 90 more crashes than the northbound direction. Over the 5-year period for which crash data was collected, there were a total of 1,479 crashes along I-395 northbound and southbound GP lanes. During this period, there were no recorded fatalities along the I-395 GP lanes study area. About 25 percent of the total crashes experienced were injury crashes and over 50 percent were during the AM or PM peak periods

There were a total of 93 crashes along the HOV mainline facility during the study period with majority of them being rear-end (56%). There was one fatality that occurred in 2015 during the off-peak hours between Duke Street and Seminary Road which was due to a vehicle driving in the wrong direction of travel along the reversible lanes.

There were 29 total ramps that were within the study area. All ramp crashes were analyzed both individually and aggregated. During the five study years, there were 284 total ramp-related crashes with majority of them (56%) being rear end crashes. Majority of the crashes were along the Duke Street ramps to northbound I-395. This area also had the highest number of injury crashes. There was one fatality in 2016 of a motorcycle rider losing control and running off the road. The fatality happened on the eastbound Duke Street to northbound I-395 GP ramp.

The study area consisted of 15 study intersections. The top three intersections that experienced the most crashes during the five years were Seminary Road and Mark Center Avenue (87 crashes), Duke Street and Walker Street (86 crashes), and Little River Turnpike and Beauregard Street (78 crashes). There were no fatalities. The most prominent collision types were rear end (42%), angle (36%), and sideswipe-same direction (10%). Rear end crashes can be attributed to potential rush hour traffic and queues while the angle crashes and sideswipes can be attributed to turns and lane changes.

Crash rates were computed to compare the study I-395 GP segments with statewide rates for similar roadway types established by VDOT. The computed rates are compared to the statewide crash rates on I-395 as well as other interstate highways. The study corridor crash rates for fatality, injuries, and total crash rates are lower than statewide comparisons.

Using the HSM methodology, future crash frequency was predicted under 2040 Build conditions. These predictions were limited to the types of improvements for which crash modification factors (CMFs) were developed. CMF values were not available to predict the crash effects of replacing the directional HOV off-ramp to a directional HOT off-ramp (from the future HOT Express lanes onto Seminary Road). Because there is no geometric change for this improvement, only qualitative predictions could be made for this change. All background roadway modifications were assumed to be in place under the future conditions. Related crashes within the influence area were analyzed for each improvement. Related crashes are those expected to be reduced by the proposed improvements. All improvements where historic crashes could be gathered were analyzed. The lower the CMF value, the more safety benefits the improvement is predicted to have along the study area.

In both 2020 and 2040, converting the ramp from HOV to HOT leads to a slight decrease in volumes on the general-purpose lanes between Turkeycock Express ramps and Seminary Road Interchange in the general-purpose lanes for the AM peak hour and PM peak hour. Based on the historical crash trends, there is an estimation of less than one crash a year along the current south facing HOV ramp. By changing the HOV ramp to HOT, more traffic will flow through the ramp and less traffic will be using Seminary Road and the GP lanes. This shift in traffic will increase the likelihood of crashes along the new HOT ramp. However, it's important to note that the crash rates on this ramp are very low and the crash rates along the GP and Seminary Road are much higher. Therefore, there may be a tradeoff for shifting traffic from one facility to another.

Overall, the proposed improvements will not only provide more capacity and reduce congestion along the study corridor, but also result in safety benefits.