I-64 HAMPTON ROADS BRIDGE TUNNEL

HRBT
Hampton Roads Bridge Tunnel EIS

TRAFFIC AND TRANSPORTATION TECHNICAL REPORT

VDOT
Virginia Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

October 12, 2012

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1 SUMMARY

This Traffic and Transportation Technical report documents the data collection, analysis, and traffic forecasting efforts performed to assess potential operational improvements for the I-64 Hampton Roads Bridge Tunnel (HRBT), to support the Environmental Impact Study (EIS) process. This report documents existing traffic conditions, the forecasting process used to develop future-year traffic projections, future-year traffic projections for each alternative under consideration, including tolling alternatives, and future traffic operations with each alternative. A toll diversion study to assess the potential effects of tolling on regional traffic patterns was performed as well.

Today, the Hampton Roads Bridge Tunnel (HRBT) and its approaches along I-64 experience recurring congestion, low speeds for a number of hours each day, and a significant number of rear end crashes on the tunnel approaches. Low overhead clearance in the existing tunnels frequently necessitates the turn-around of overheight trucks, which requires temporary roadway closures in both directions and results in additional delays and unpredictable travel conditions. (In 2010, the last year for which complete data are available, almost 6,200 trucks were turned around, which is an average of 17 trucks each day.) Traffic forecasts for 2040 conditions indicate worsening levels of service across the HRBT and its approaches. Without upgrades to the tunnel and approach bridges, the factors that contribute to the current poor traffic operations (inadequate capacity, risk of overheight trucks, and higher-than-average crash rates) will continue to result in low operating speeds during the peak hours.

To address these deficiencies, a number of alternatives for expanding capacity across the Hampton Roads crossing were evaluated. Three widening scenarios were assessed; in addition, several operational strategies including full toll implementation and other managed lane scenarios were evaluated.

The basic widening scenarios involve expanding the existing 4-lane crossing by two, four, six and eight lanes for a total of six, eight, ten and twelve lanes between the I-664 and I-564 interchanges. These scenarios are referred herein as Build 6, Build 8, Build 10 and Build 12. Weekday daily and peak hour forecasts were developed, which were analyzed using the methodologies from the 2010 Highway Capacity Manual (HCM). Mainline segments as well as ramp junctions were analyzed.

In addition, several managed lane scenarios were analyzed. Using the Build 8 scenario as the starting point, an all-toll scenario, as well as combinations of general purpose (free) and managed lanes were examined. For the all-toll scenario, toll rates of $1, $2 and $3 across the HRBT were evaluated. Other managed lane scenarios that were analyzed include the following:

1. **Two HOT Lanes + Two General Purpose Lanes [2 HOT / HOV-2 "free" + 2 GP]:** This scenario would include two general purpose lanes and two HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.
2. **One HOV Lane + Three General Purpose Lanes [1 HOV-2 "free" + 3 GP]:** This scenario would include three general purpose lanes and one HOV lane in each direction. The HOV lane would be restricted to HOV-2 vehicles that would travel for free.
3. **One HOT Lane + Three General Purpose Lanes [1 HOT / HOV-2 "free" + 3 GP]:** This scenario would include three general purpose lanes and one HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.

Table 1 summarizes the existing and projected daily weekday traffic across the HRBT for all scenarios analyze, as well as the worst level of service during the peak hour. Full analysis results are provided in the remainder of this report.

Table 1. Summary of Traffic Forecasts and Analyses at the HRBT crossing

Scenario	Weekday Daily Traffic Volume	Weekday AM (PM) Peak Hour Volume		AM (PM) Level of Service	
		Eastbound	Westbound	Eastbound	Westbound
2011 (Existing)	88,700	3,655 (3,320)	3,265 (3,380)	**E** (D)	D (D)
2040 No Build	112,350	4,700 (4,150)	4,100 (4,300)	**F (F)**	**E (F)**
2040 Build 6	136,600	5,725 (5,050)	5,000 (5,225)	**E** (D)	D (D)
2040 Build 8	150,300	6,275 (5,550)	5,475 (5,750)	D (D)	C (D)
2040 Build 8 + $1 toll	126,800	5,275 (4,525)	4,600 (4,825)	C (C)	C (C)
2040 Build 8 + $2 toll	111,800	4,650 (4,050)	4,075 (4,250)	C (C)	C (C)
2040 Build 8 + $3 toll	96,000	4,000 (3,500)	3,500 (3,650)	C (B)	B (B)
2040 Build 8 – 2 HOT + 2 GP	132,650 [34,300]	5,525 (4,725) [2,675 (1,125)]	4,825 (5,050) [625 (2,425)]	D (**E**) [C (A)]	**F** (C) [A (C)]
2040 Build 8 – 1 HOV + 3 GP	139,050 [17,500]	5,800 (4,975) [400 (975)]	5,050 (5,300) [425 (775)]	D (C) [A (B)]	D (D) [A (B)]
2040 Build 8 – 1 HOT + 3 GP	141,400 [23,950]	5,900 (5,025) [1,425 (975)]	5,150 (5,375) [450 (1,250)]	D (C) [D (C)]	D (D) [A (C)]
2040 Build 10	155,400	6,500 (5,750)	5,675 (5,950)	C (C)	C (C)
2040 Build 12	159,100	6,625 (5,575)	5,775 (6,050)	C (B)	B (C)

Note: Values in square brackets indicate managed lane

While the **Build 6** alternative adds capacity, level of service E would still prevail at the crossing and on a number other mainline segments.

The traffic analyses indicate that a **Build 8** alternative provides a level of service D or better across the HRBT crossing and most other mainline segments within the study area. This meets the FHWA standard for urban interstate roadways.

The **Build 8 – Managed** alternative was shows that while the toll-free eight-lane crossing may not meet the general FHWA level of service standard for interstate roadways (i.e., LOS D), demand can be managed to achieve better overall levels of service (under all-toll alternatives) or to achieve a high level of service in an HOT or HOV lane by maintaining a level of service in the general purpose lanes that is sufficiently low to provide an incentive for motorists to use the managed lane, either by carpooling or paying a toll.

The **Build 10** alternative provides a level of service C or better at the HRBT crossing and most other mainline segments within the study area. This meets the FHWA standard for interstate roadways in general. This alternative was also retained for detailed study.

The **Build 12** alternative would provide a level of service as high as LOS B at the HRBT crossing and most other mainline segments.

A detailed toll diversion study was performed to assess the effects on regional traffic patterns if one or both Hampton Roads crossings (the HRBT and the Monitor Merrimac Memorial Bridge Tunnel) were to be tolled, using the Build 8 alternative as the baseline.

Tolling the HRBT results in shifting demand to the MMMBT, with an increasing volume of traffic being shifted to the MMMBT as the toll on the HRBT increases. By 2040, without tolls, approximately 64 percent of daily traffic crossing Hampton Roads uses the HRBT. With tolling, this percentage falls to 50 percent with a $3 toll. At the same time, tolling reduces the total volume of traffic on both crossings, with total daily traffic decreasing from 233,600 without a toll to 193,800 with a $3 toll. The reduction in total traffic volume crossing Hampton Roads indicates that implementing tolls results in a shift in traffic patterns, with travelers choosing their destinations so as to avoid crossing the river.

Implementing a toll on both crossing would result in a less pronounced shift in demand between the HRBT and MMMBT, although daily traffic on the HRBT would still decrease from 64 percent to 58 percent with a $3 toll on both crossings. However, total volume crossing Hampton Roads would decrease substantially compared to the Build 8 traffic volume, with total daily traffic decreasing as much as 30 percent with a $3 toll. This indicates that travelers would significantly alter their travel behavior.

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2 INTRODUCTION

The purpose of this report is to document the traffic forecasting and analyses performed to assess operational improvements for the I-64 Hampton Roads Bridge Tunnel, to support the Environmental Impact Study (EIS) process. This report documents existing traffic conditions, the forecasting process used to develop future-year traffic projections, future-year traffic projections for each alternative under consideration, including tolling alternatives, and future traffic operations with each alternative. The study area extends along I-64 from the I-664 interchange on the west, through the Hampton Roads Bridge Tunnel (HRBT) to the I-564 interchange on the east.

Within the Hampton section of the project, I-64 is predominantly three lanes per direction, separated by median barrier, with auxiliary lanes (acceleration and deceleration lanes) at interchanges. Grades are three percent or less. The typical section along eastbound I-64 drops from three lanes to two lanes approximately 300 feet west of the HRBT. Conversely, in the westbound direction, the two lanes exiting the tunnel expand to three lanes at the South Mallory Street interchange. Travel lanes are 12 feet wide; right shoulders also are 12 feet wide; left shoulders are eight feet wide or wider. The posted speed limit is 55 MPH. The following interchanges are located west of the HRBT:

- Exit 264 – I-664
- Exit 265 – Route 167 / Route 134 – LaSalle Avenue, North Armistead Avenue, and Rip Rap Road
- Exit 267 – US 60 / Route 143 – Settlers Landing Road and Woodland Road
- Exit 268 – Route 169 – Mallory Street

The 3.5-mile HRBT connects the Peninsula to the Southside, by spanning Hampton Roads, the mouth of the James River. A variable speed limit system is in use; however, the maximum posted speed limit is 55 MPH.

Within the Norfolk section of the project, I-64 has two lanes per direction. The travel lanes are 12 feet wide; right shoulders are 12 feet wide; left shoulders vary from two to six feet wide. The median is a 36 foot open–graded, grass section. The posted speed limit is 55 mph. The following interchanges are located east of the HRBT:

- Exit 272 – Route 168 – West Ocean View Avenue/Bayville Street
- Exit 273 – US 60 – 4th View Street
- Exit 274 – Entrance ramp from eastbound West Bay Avenue traffic to I-64 east and exit ramp from westbound I-64 westbound West Ocean View Avenue
- Exit 276 – I-564 and Granby Street (Route 460). Southbound Granby Street cannot be accessed from westbound I-64 and northbound Granby Street is not accessible from eastbound I-64.

3 EXISTING CONDITIONS

3.1 Data Collection

An extensive data collection effort was conducted in May and June 2011 to establish baseline traffic conditions for the project area. Automatic ramp counts and manual intersection turning movement counts were conducted, and data from VDOT's permanent count stations was reviewed for both the HRBT and the segment of I-564 between Terminal Avenue and Admiral Taussig Boulevard.

All manual counts were conducted on a Tuesday, Wednesday or Thursday from 6:00 AM – 9:00 AM and from 3:00 PM – 6:00 PM. Automatic counts were conducted for a minimum of 48 consecutive hours on a Tuesday, Wednesday or Thursday. All counts were conducted between May 24 and June 8, 2011. Table 2 and Table 3 provide the locations of the automatic and manual counts conducted for the study.

Table 2. Automatic (Tube) Count Locations

Exit	Mainline/Ramp Movement			
	From		To	
264	I-64	EB	I-664	SB
264	I-64	WB	I-664	SB
264	I-664	NB	I-64	EB
264	I-664	NB	I-64	WB
265	I-64	EB	LaSalle Ave	
265	LaSalle Ave	SB	I-64	EB
265	LaSalle Ave	NB	I-64	EB
265	I-64	WB	Armistead Ave	EB
265	I-64	WB	LaSalle Ave	SB
265	I-64	WB	Armistead Ave	WB
265	I-64	WB	Bay Ave	
274	Bay Ave		I-64	EB
275	Granby St	SB	I-64	WB
275	Granby St	NB	I-64	WB
275	Patrol Rd		I-64	EB
276	I-64	EB	I-564	WB
276	I-64	EB	Granby St	SB
276	Granby St	NB	I-564	WB
276	I-564	EB	I-64	WB
276	I-64	WB	Granby St	NB

Exit	Mainline/Ramp Movement			
	From		To	
276	I-564	EB	I-64	EB
276	I-564	EB	I-64 HOV	EB
276	I-64	WB	I-564	WB
276	I-64 HOV	WB	I-564	WB
N/A	Terminal Blvd	EB	I-564	EB
N/A	I-564	EB	Granby St	
N/A	I-564	WB	Terminal Blvd	WB

Table 3. Manual (Intersection) Count Locations

Exit	Location		
265	Armistead Ave	at	I-64 WB on-ramp
265	Armistead Ave	at	LaSalle Ave
265	Rip Rap Rd	at	I-64 EB off-ramp
267	I-64 EB off-ramp	at	Settlers Landing Rd
267	I-64 EB on-ramp	at	Settlers Landing Rd
267	I-64 WB ramps	at	Settlers Landing Rd
268	I-64 EB ramps	at	Mallory St
268	I-64 WB ramps	at	Mallory St
272	I-64 EB ramps	at	Bayville St
272	I-64 WB ramps	at	W. Ocean View Ave
273	I-64 EB ramps	at	4th View St
273	I-64 WB ramps	at	4th View St
N/A	Granby St	at	Admiral Taussig Blvd
276	I-64 EB on-ramp	at	Little Creek Rd
276	I-64 WB ramps	at	Little Creek Rd

The automatic tube counts and data from VDOT's permanent count stations also provided vehicle classification information; this information was analyzed to determine heavy vehicle percentages, and used in the capacity analyses. INRIX data was used to determine average and 85th percentile speeds along I-64. Finally, crash data from VDOT's GIS database identified crash trends and crash hotspots.

3.2 Development of Balanced Existing Traffic Volumes

To support the assessment of alternatives for the HRBT corridor, Peak Hour and weekday Average Daily Traffic (ADT) volumes were developed for each alternative to provide a comprehensive assessment of operations during both the highest volume conditions, and over the course of a typical weekday.

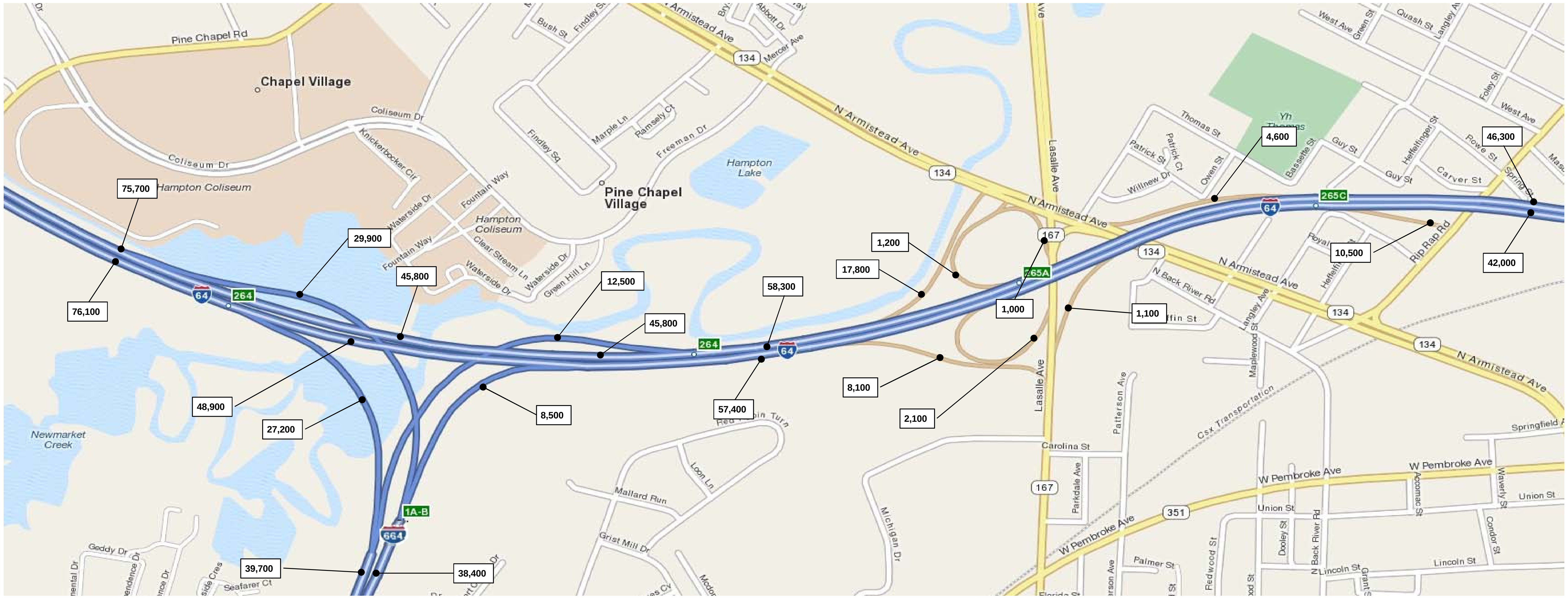
Peak Hour Volumes: Raw traffic counts were reviewed to identify the peak hour at each data collection location (ramps, intersections, and mainline permanent count stations). In locations where the data was collected over multiple days, peak hour data was averaged if those data were collected on a Tuesday, Wednesday or Thursday. After reviewing the peak hours for the individual data collection locations, common peak hours for major sections within the project area were selected. The hourly traffic volumes for the common peak hour were then extracted from the raw count data at each location. The identified peak hours were 7:00 – 8:00 AM and 3:30 – 4:30 PM west of the HRBT; 7:15 – 8:15 AM and 3:00 – 4:00 PM between the HRBT and the I-564 interchange; and 6:30 – 7:30 AM and 3:00 – 4:00 PM through the I-564 interchange and points east.

Daily Volumes: Development of the daily volumes followed the same approach as the development of peak hour volumes, with additional adjustments for seasonal variations. In order to determine seasonally adjusted daily volumes, traffic volumes for the year 2010 on the HRBT were reviewed to determine the month-to-month variation, as well as the daily variations within each month. First, the monthly totals were computed for 2010. Then, the percentage variation for each month compared to the annual average volume was computed. These percentages were applied to the counts conducted in May and June to normalize the data. Adjustment factors for days of the week were computed in an identical manner, and applied to each count.

At some locations only peak hour data was collected. To estimate daily volumes from these peak hour data, k-factors (ratio of peak period versus daily traffic volume) were computed by dividing AM and PM peak hour volumes by the seasonally adjusted daily volume at those locations where both peak and daily data was available. Assuming that the resulting k-factors are similar at nearby locations, these factors were then applied at those locations where only peak hour counts were conducted to estimate a daily volume. Once daily volumes for all the locations were obtained, balancing procedures identical to those followed for the peak hour volumes were used to develop the balanced daily volume network.

Two key reasonable checks were performed on the final balanced peak hour and daily volumes. First, k-factors were re-computed using the balanced daily and peak hour volumes. These factors were then reviewed to ensure that there were no ramps or intersections where the ratio of peak-to-daily volume is beyond typical values. Second, the daily volumes were compared to the latest available (2010) traffic data published by the VDOT to ensure 2011 volumes are in line with the established 2010 volumes (see http://www.virginiadot.org/info/2010_traffic_data.asp). Peak hour and daily volumes along I-564 were also compared with data prepared for the I-564 Interchange Justification Report for consistency.

Year 2011 (Existing) peak hour volumes and Average Daily traffic volumes are provided in Figure 1 and Figure 2 (for ease of reference, they are also included in Appendix A). It should be noted that the volumes in Figure 1 and Figure 2 represent average weekday conditions. Higher weekend and seasonal volumes have been observed on the HRBT with daily volumes exceeding 100,000 vehicles/day; however, the purpose of this study is to address the commuter traffic congestion patterns and not necessarily to provide sufficient capacity for seasonal peaks.



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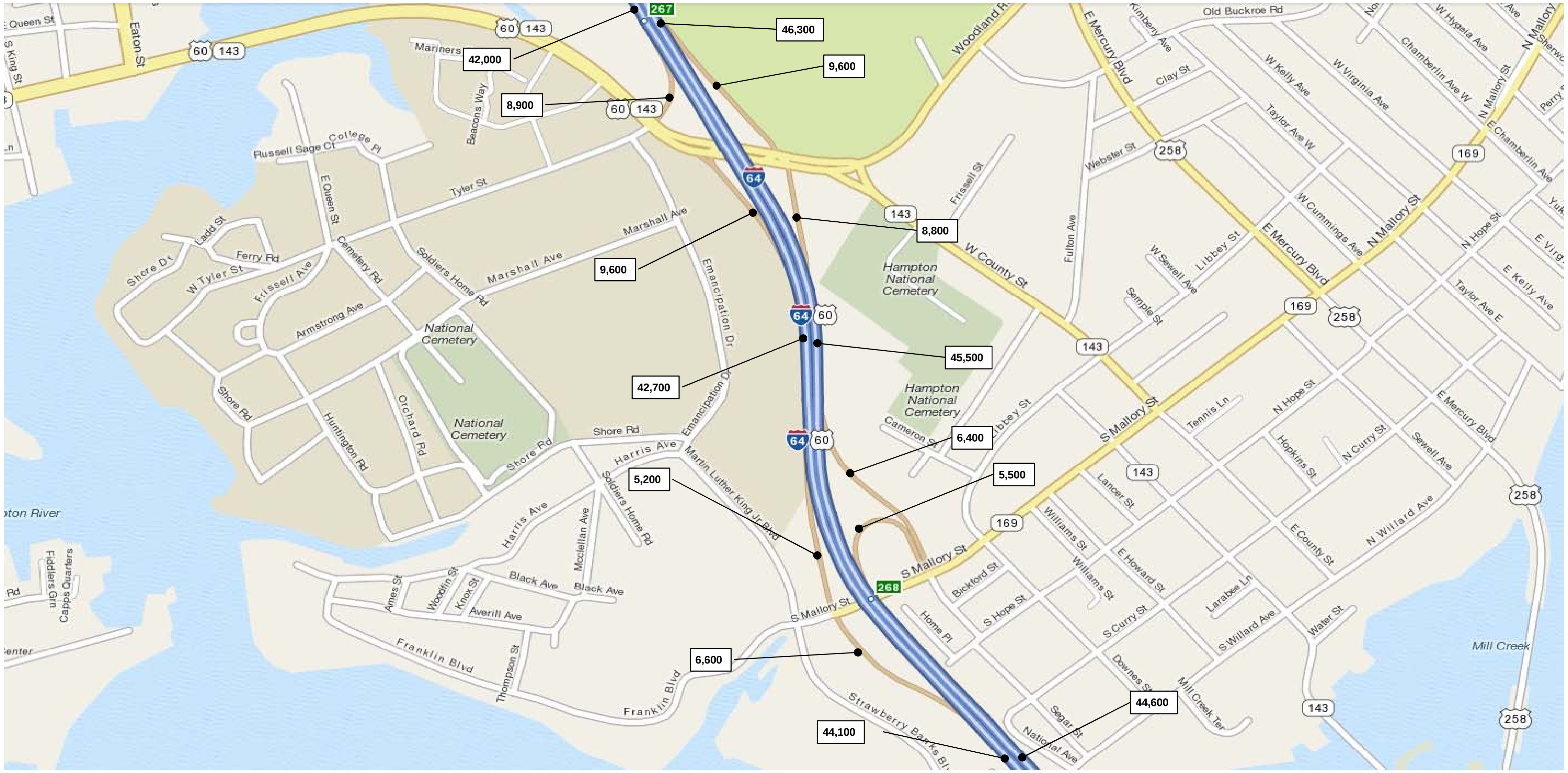
2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 1 of 6

October 12, 2012



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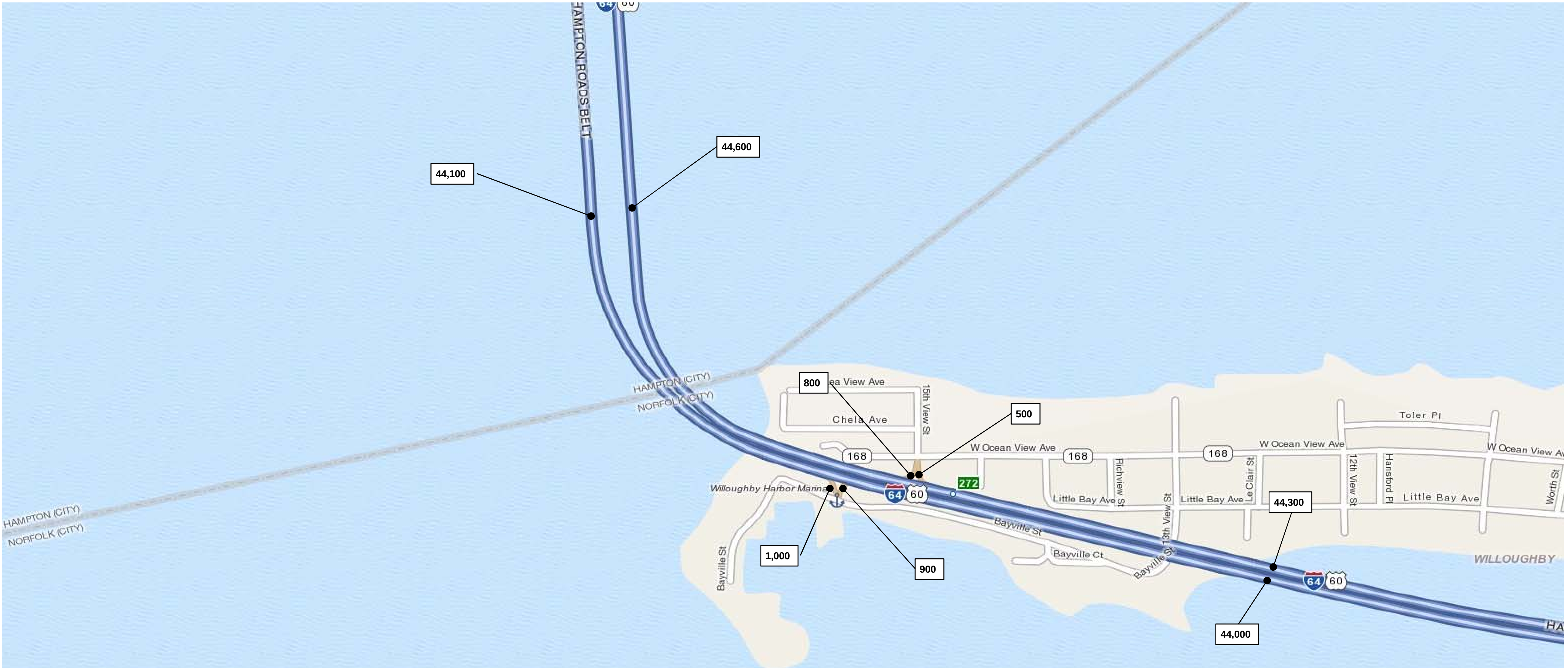
2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 2 of 6

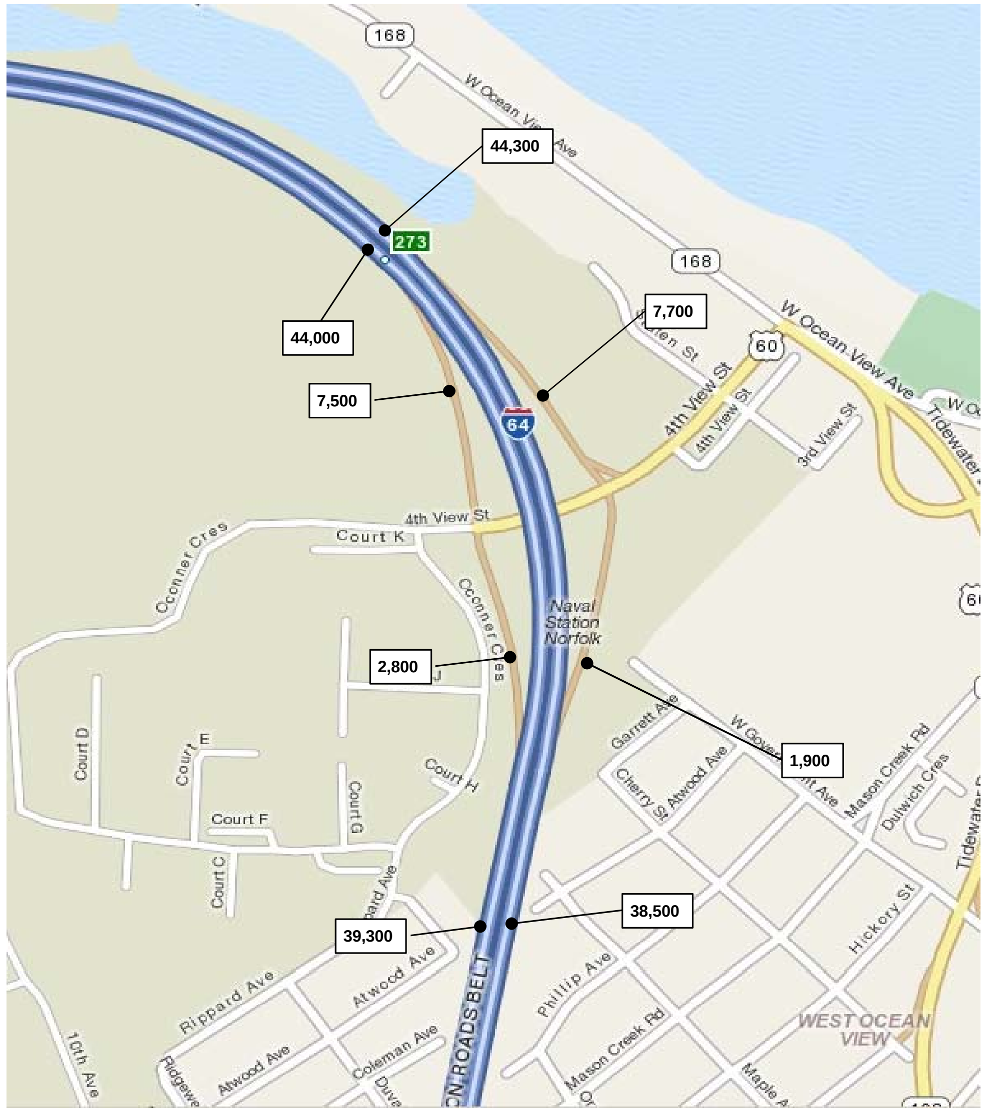
October 12, 2012

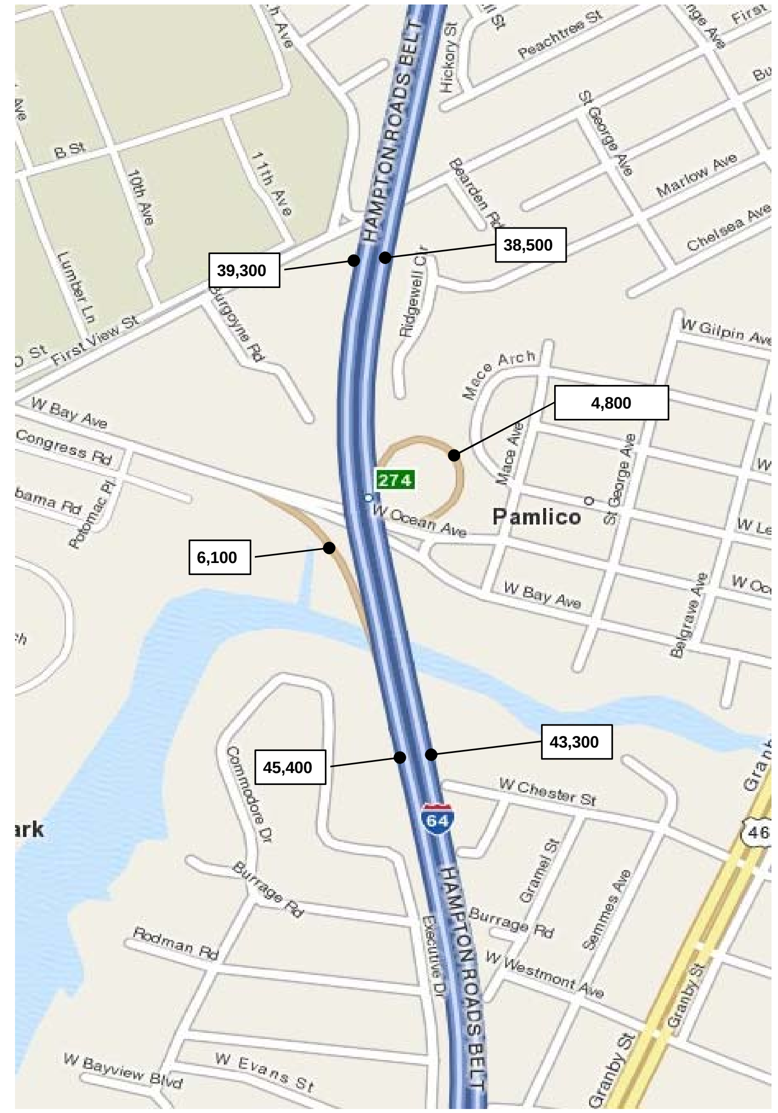


2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 3 of 6

October 12, 2012

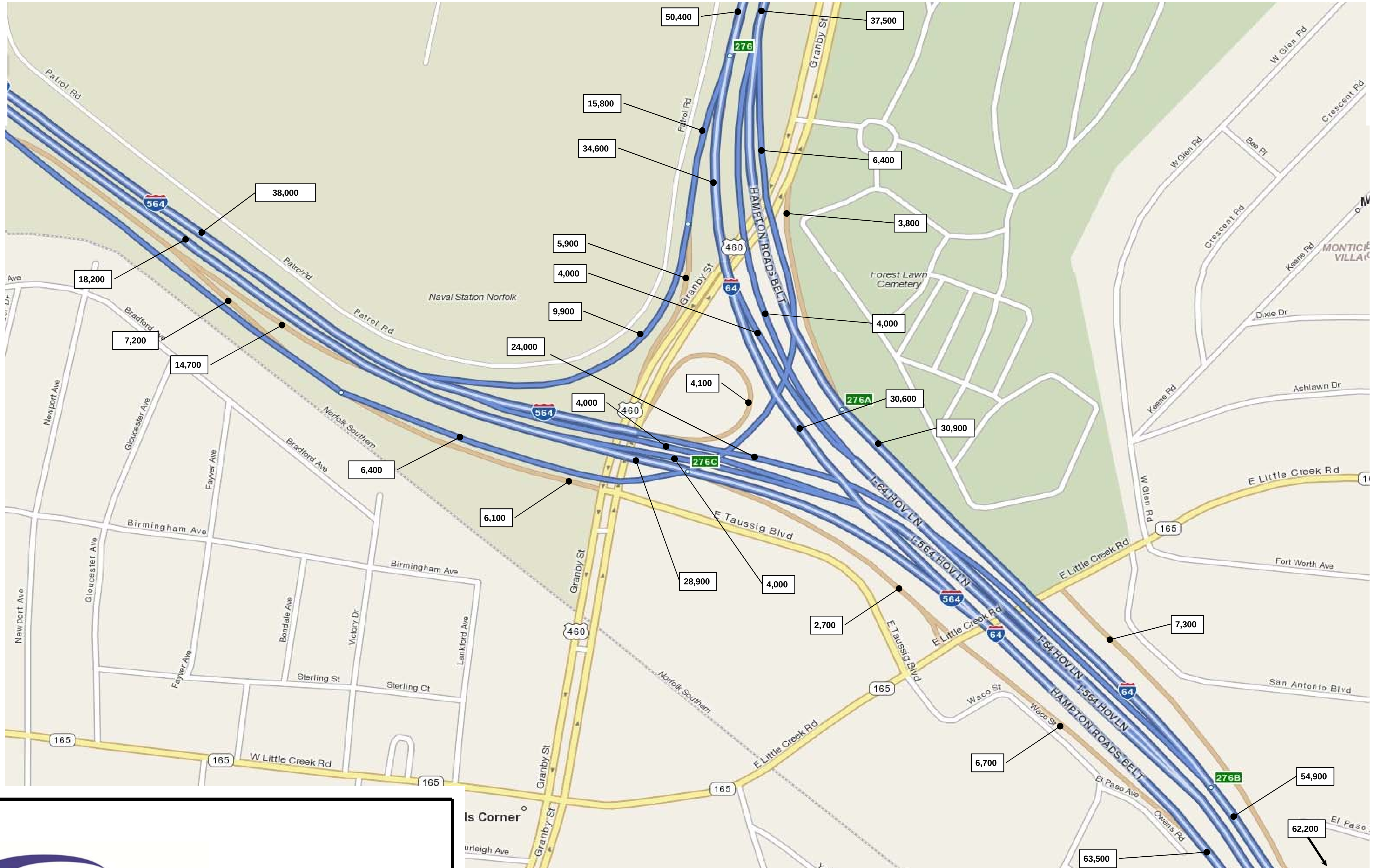




2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 4 of 6

October 12, 2012



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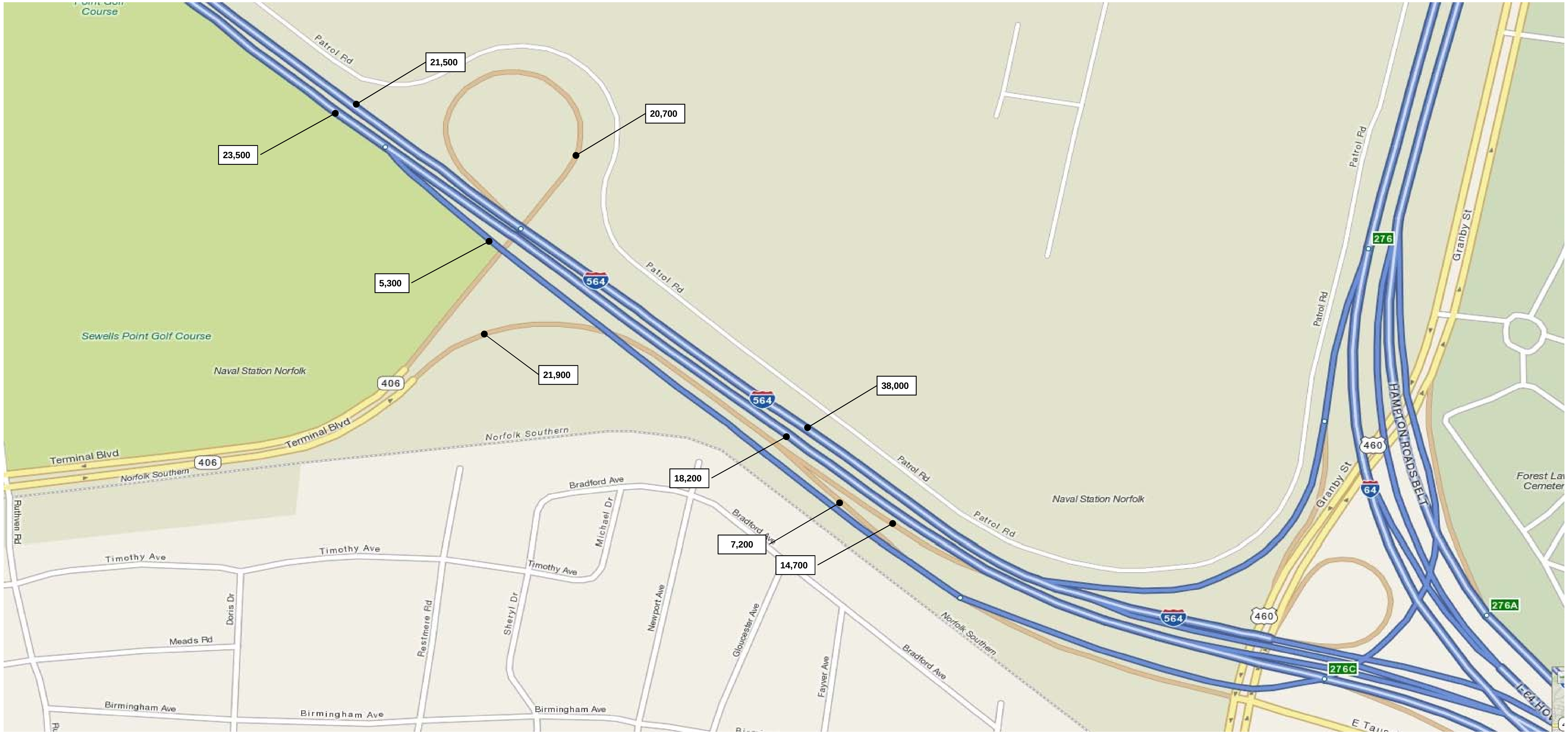
2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 5 of 6

October 12, 2012



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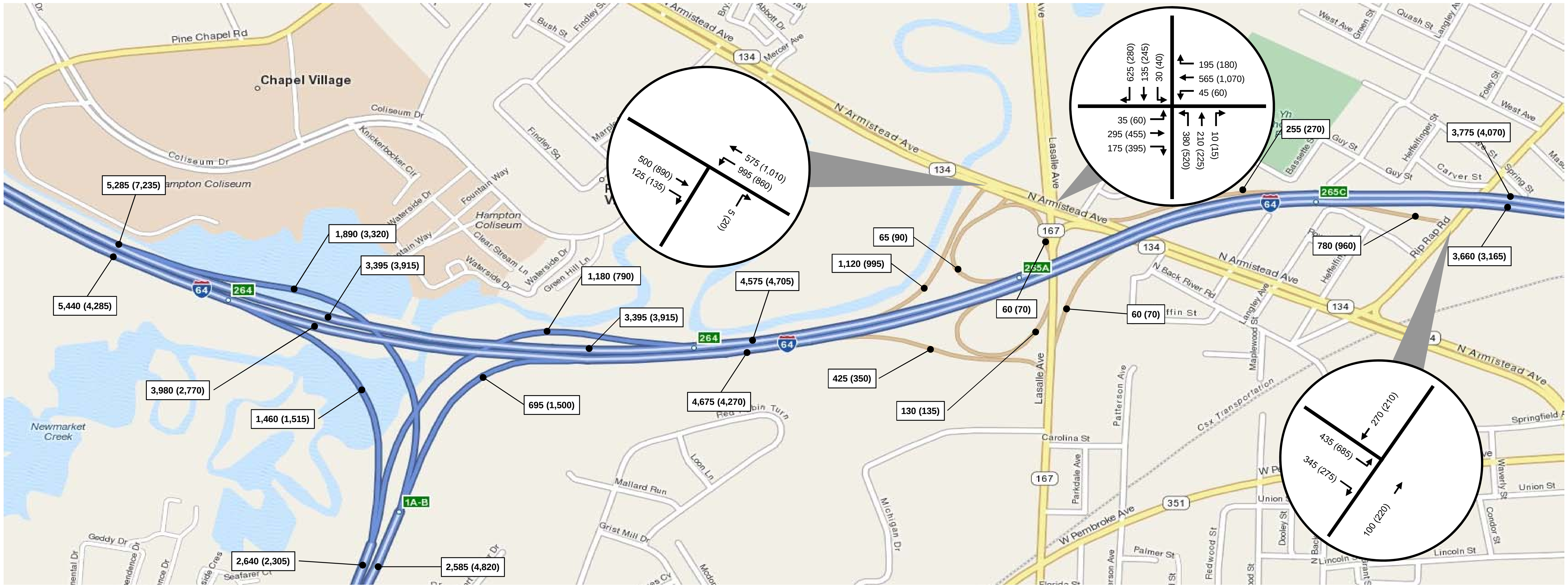
2011 Existing Daily (ADT) Volumes

Figure 1: Sheet 6 of 6

October 12, 2012



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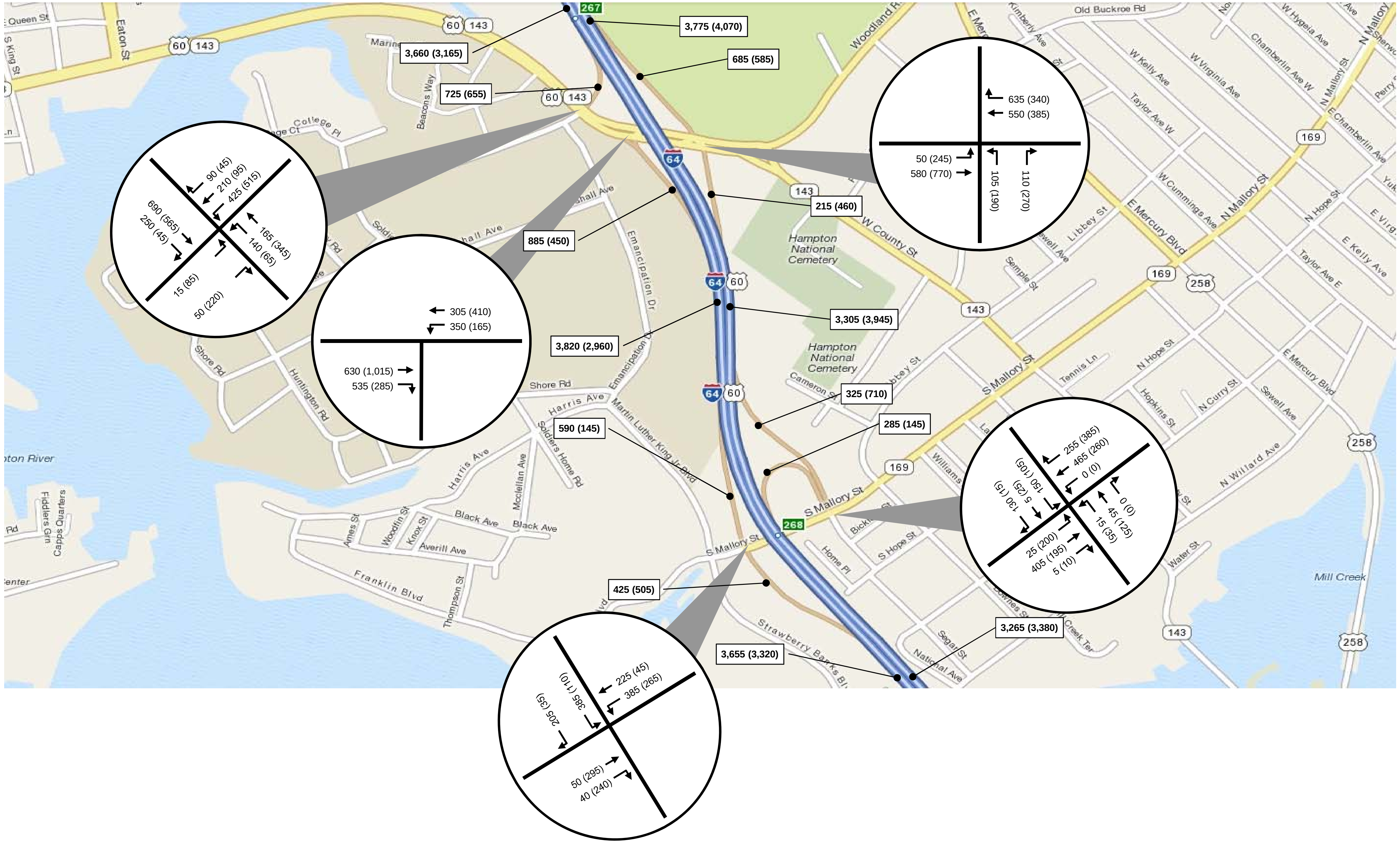
2011 Existing AM (PM) Peak Hour Volumes

Figure 2: Sheet 1 of 6

October 12, 2012



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2011 Existing AM (PM) Peak Hour Volumes

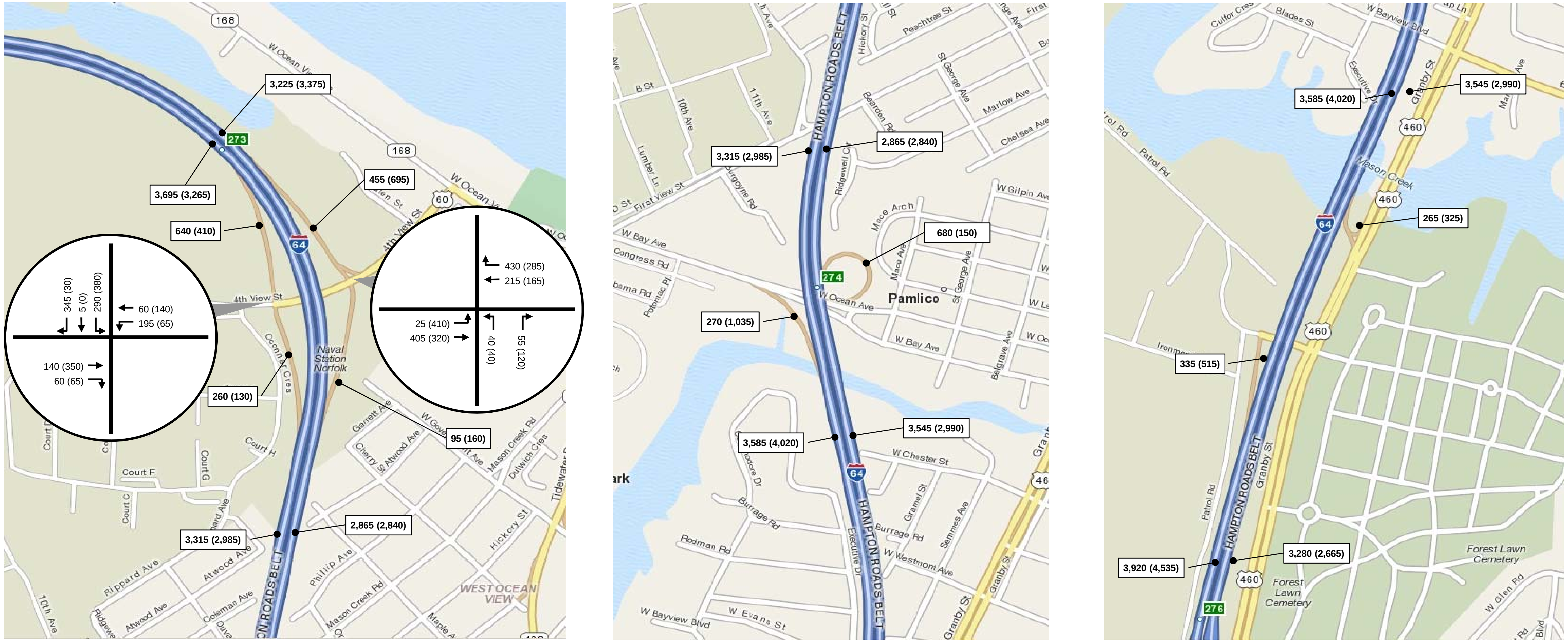
Figure 2: Sheet 2 of 6

October 12, 2012

2011 Existing AM (PM) Peak Hour Volumes

Figure 2: Sheet 3 of 6

October 12, 2012



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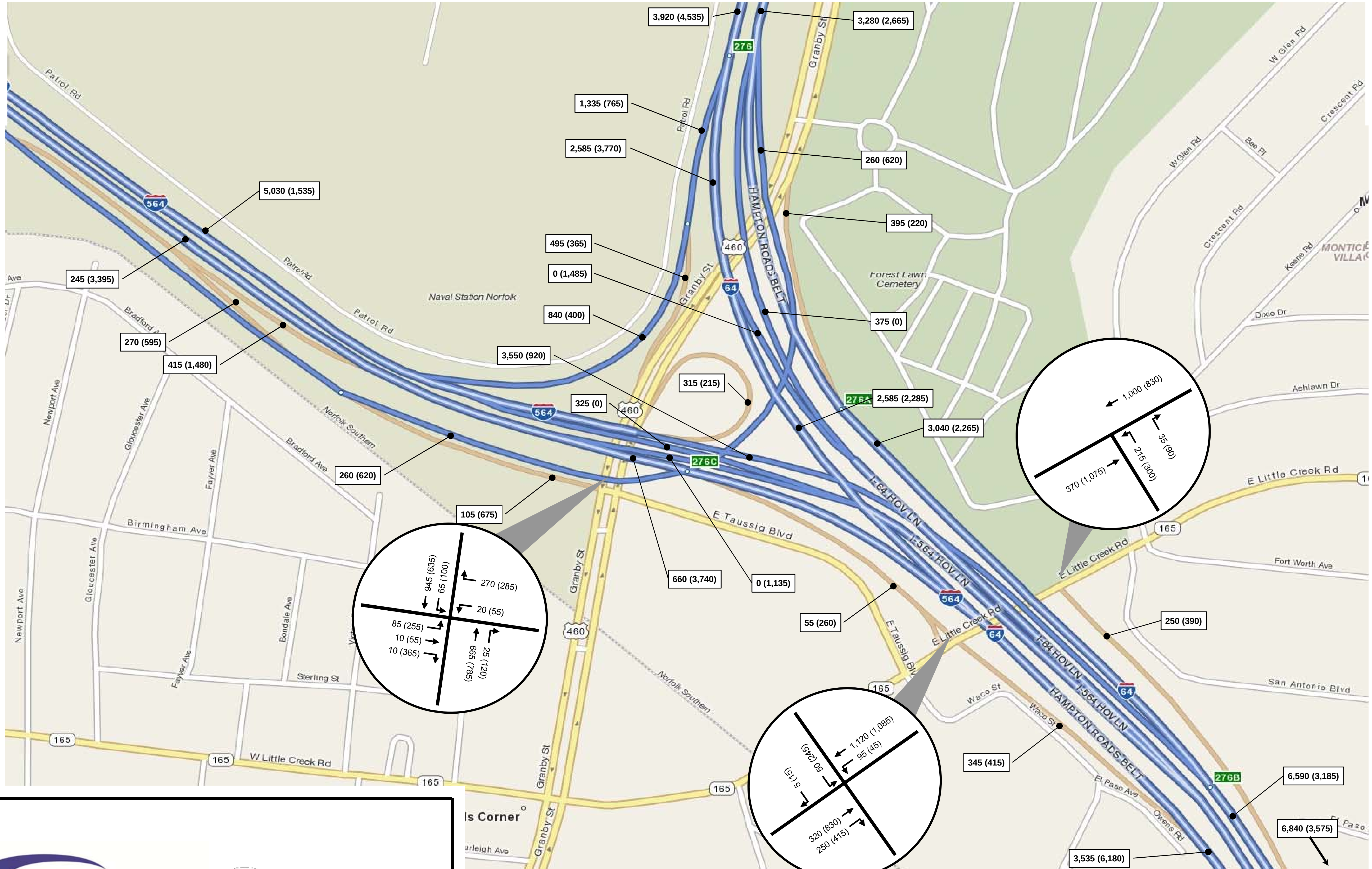
2011 Existing AM (PM) Peak Hour Volumes

Figure 2: Sheet 4 of 6

October 12, 2012



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2011 Existing AM (PM) Peak Hour Volumes

Figure 2: Sheet 5 of 6

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2011 Existing AM (PM) Peak Hour Volumes

Figure 2: Sheet 6 of 6

October 12, 2012

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3.3 Crash Analysis

Recent historical crash data for the study segment of I-64 was analyzed including data for the Hampton Road Bridge Tunnel, I-64 ramps, I-564, and I-664 within the vicinity of the interchanges of those routes with I-64. Geocoded crash data, including milepoints, was reviewed for the years 2006 through 2009.

I-64 Eastbound Crash Analysis: Between January 1, 2006 and December 31, 2009, a total of 1,055 crashes were reported along the 13.5 mile segment of I-64 between I-664 and I-564. Three (3) fatal crashes were reported during this time period. Twenty-seven (27) percent, or 284, of the crashes resulted in 417 injuries. The remaining 73 percent (768) crashes resulted in property damage only. As shown in Figure 3, rear-end collisions were the most common-type along eastbound I-64; these crashes represented 63% of the total observed during the 4-year study period. Fixed-object crashes at 22% and sideswipe collisions at 13% comprised the majority of the remaining crashes along eastbound I-64. Nearly half (502) of the reported crashes occurred during the peak travel periods, between 6:00 and 9:00 AM and 3:00 and 6:00 PM, as shown in Figure 4.

To identify potential hot-spots, the crash rate (per 100 million vehicle miles traveled) was evaluated in quarter-mile segments for the 13.5 mile stretch of eastbound I-64 between I-664 and I-564. Figure 5 displays a plot of the crash rate along eastbound I-64 for this 13.5 mile segment, along with the overall average crash rate of 122 per 100 million vehicles miles traveled for this segment of I-64. A total of nine 0.25-mile segments were identified with crash rates more than twice the average crash rate for the HRBT study corridor. Eight of these critical segments are located between milepoint 267.25 and 270.50, an area which roughly corresponds to the eastbound approach to the HRBT. The remaining critical segment is located between milepoints 276.75 and 277.00, near the I-64 / I-564 interchange. For comparison, in 2008 (the latest year for which complete state-wide data are available), the average crash rate along the entire 267-mile length of I-64 in Virginia was 74 per 100 Million Vehicle Miles Traveled.

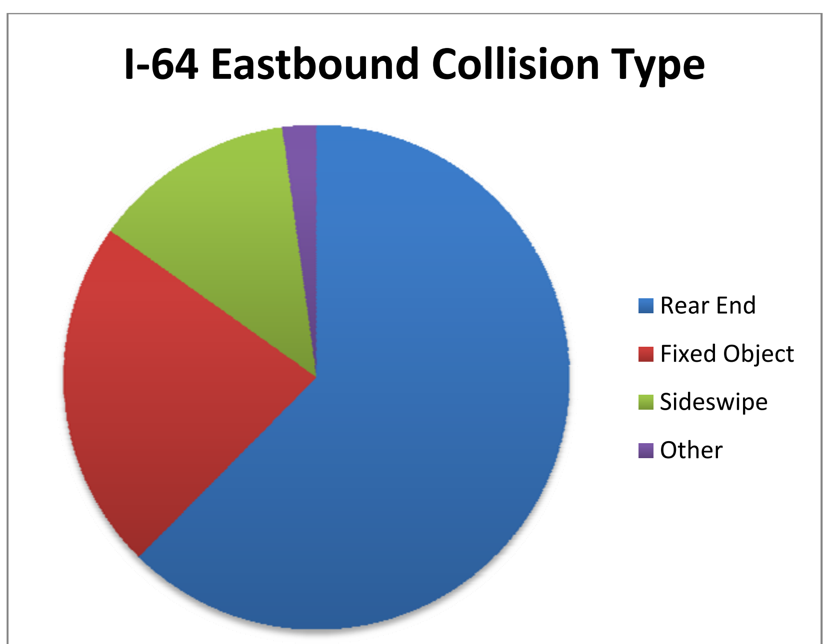

Figure 3. I-64 Eastbound Collision Type

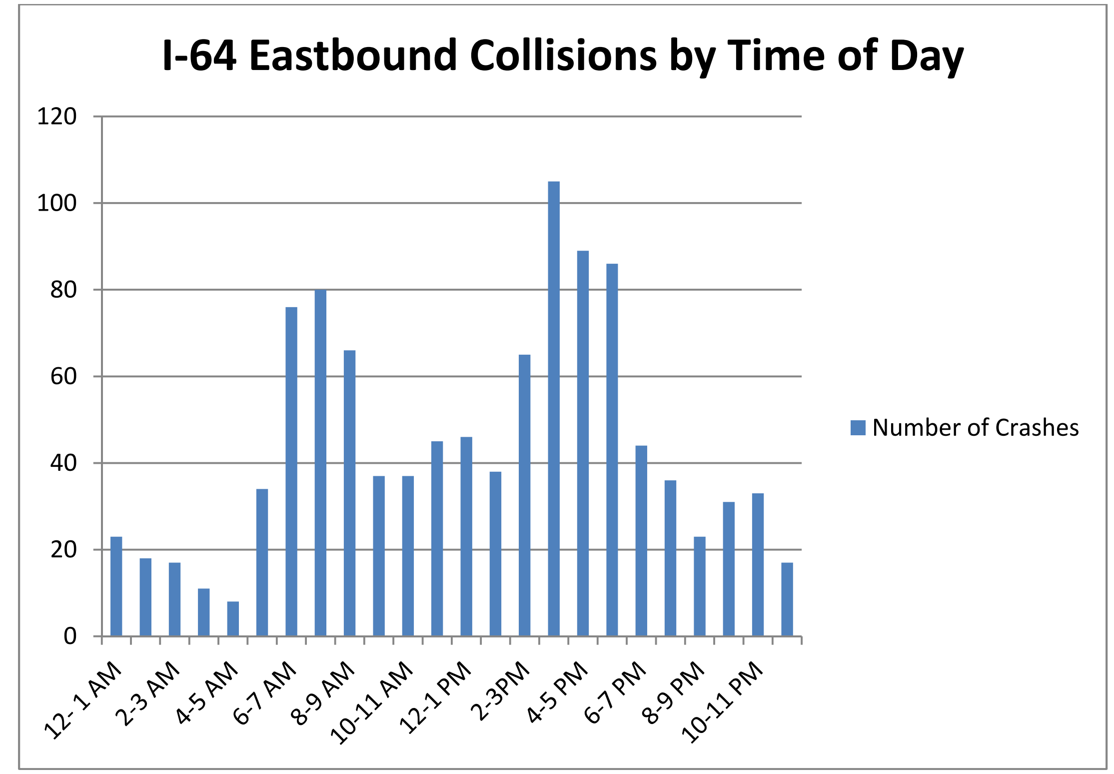

Figure 4. I-64 Eastbound Collisions by Time of Day

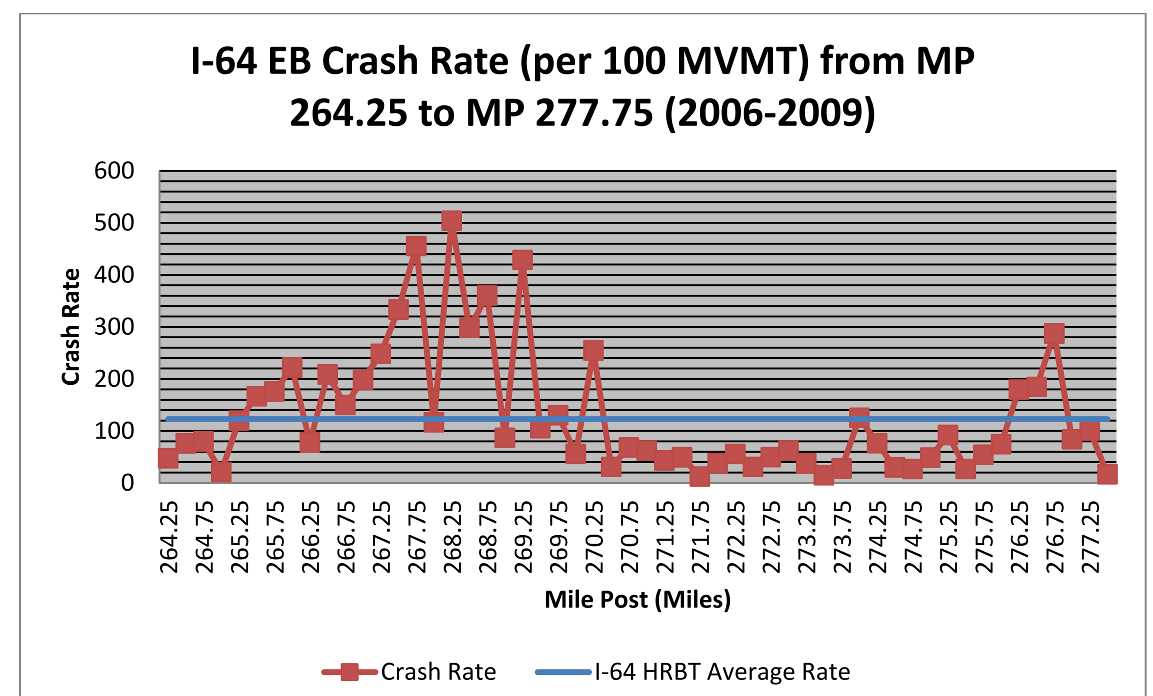

Figure 5. I-64 Eastbound Crash Rate by Milepoint Segment

I-64 Westbound Crash Analysis: Between January 1, 2006 and December 31, 2009, a total of 1,178 crashes were reported along the 13.5-mile segment of westbound I-64 between I-564 and I-664. One (1) fatal crash was reported along this segment of westbound I-64. Twenty-nine (29) percent, or 339, of the crashes resulted in 488 injuries. The remaining 71 percent (838) crashes resulted in property damage only.

As shown in Figure 6, along westbound I-64, rear-end crashes represent 74 percent of the total reported crashes. Fixed object collisions, at 19%, and sideswipe collisions, at 7%, made up the majority of the remaining crashes. Westbound crashes were concentrated between 10 AM and 7 PM; 68 percent of the total reported crashes occurred during this 9-hour period, as shown in Figure 7.

To identify potential hot-spots, the crash rate (per 100 million vehicle miles traveled) was evaluated in quarter-mile segments for the 13.5 mile stretch of westbound I-64 between I-664 and I-564. Figure 8 displays a plot of the crash rate along eastbound I-64 for this 13.5 mile segment, along with the overall average crash rate of 142 per 100 million vehicles miles traveled for this segment of westbound I-64, which is almost doubled the 2008 statewide average for I-64 in Virginia. A total of six (6) 0.25-mile segments were identified with crash rates more than twice the average crash rate for the HRBT study corridor. All six of the critical segments are located between milepoints 272.25 and 275.00, between the I-564 interchanges and the HRBT.

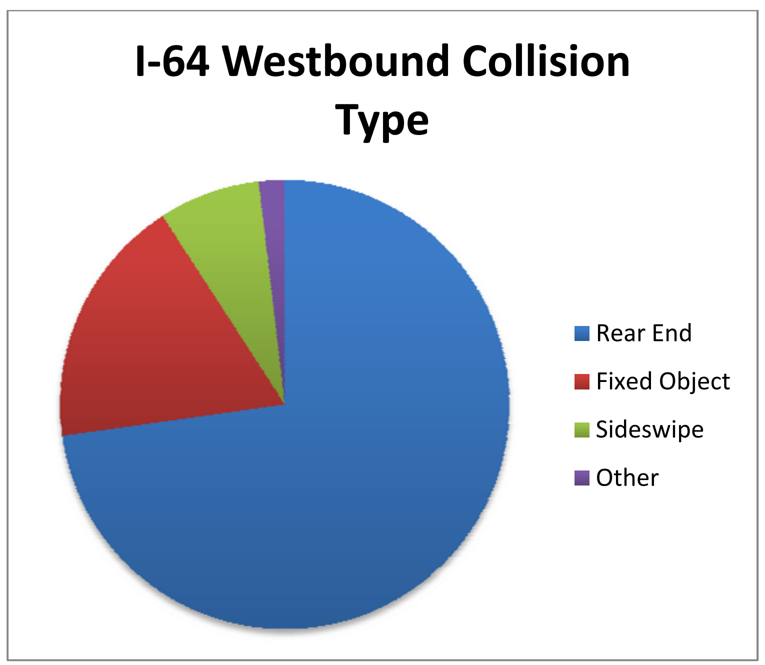

Figure 6. I-64 Westbound Collision Type

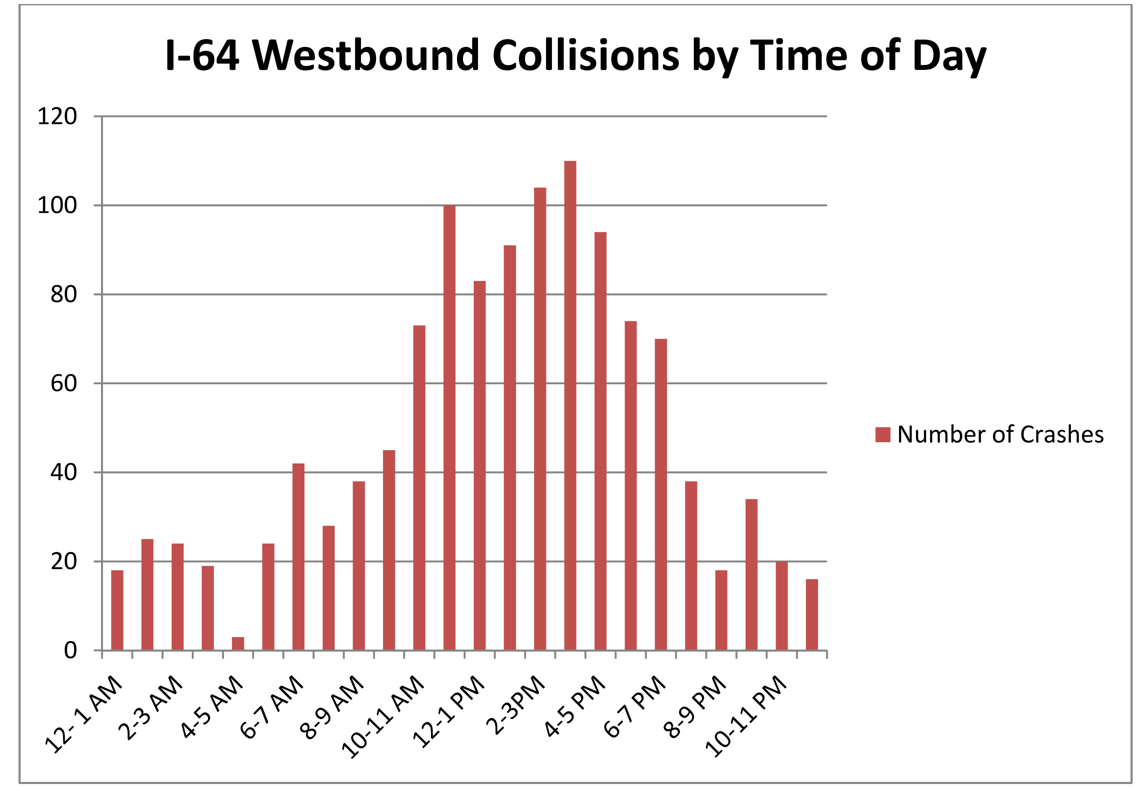

Figure 7. I-64 Westbound Collisions by Time of Day

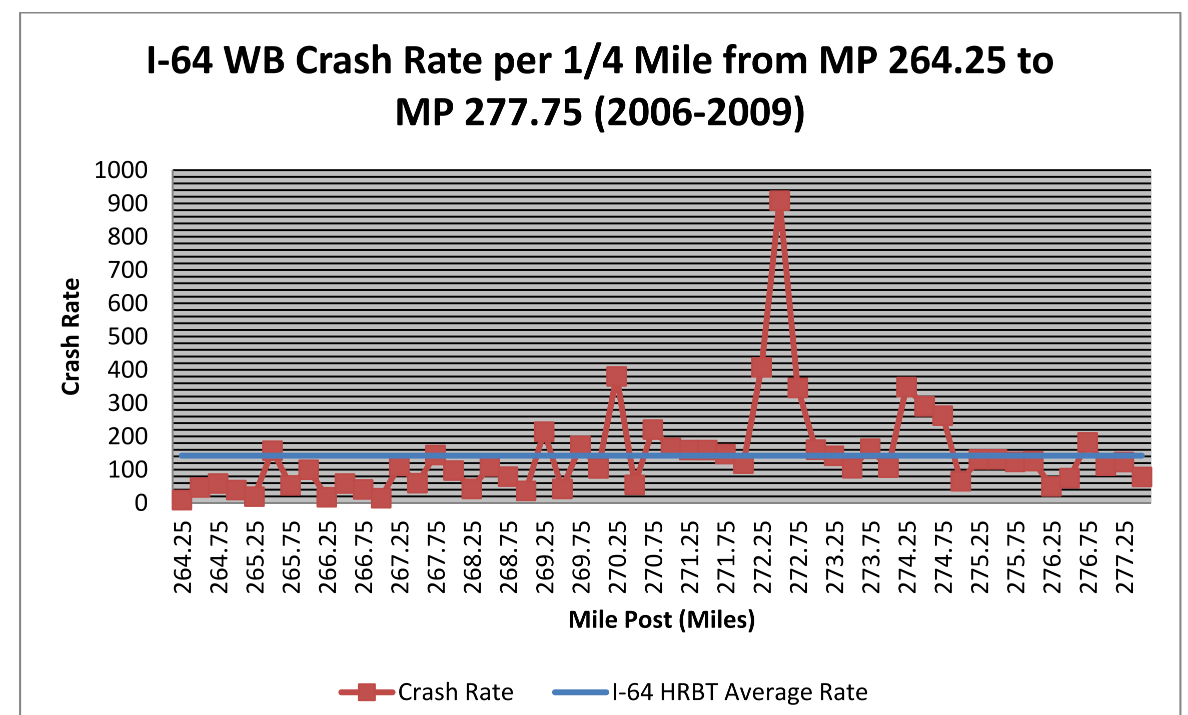

Figure 8. I-64 Westbound Crash Rate by Milepoint Segment

I-64 Ramp Crashes: A total of 29 crashes were reported along eastbound I-64 on / off ramps during the 4-year study period. Additionally, a total of 17 crashes were reported along westbound I-64 on / off ramps during the 4-year study period. There were two (2) fatal crashes reported along westbound I-64 ramps; one fatal crash occurred at the West Ocean View Avenue interchange and the other occurred at the I-664 interchange.

3.4 Assessment of Vehicle Speeds

As part of the HRBT EIS, INRIX speed data for the corridor from the I-664 interchange to the I-564 interchange was analyzed. INRIX provides mean and percentile speed data for individual segments (generally between consecutive ramp terminals) in 15-minute increments. For the HRBT study, corridor data from June 8 – June 10, 2010 were analyzed. Mean and 85th percentile speeds for each segment and each 15-minute period were averaged and cross-tabulated by milepoint and time period. The resulting table is shown as a speed contour plot in Figures 9 and 10. These figures show the average speed along the I-64 corridor throughout the day. In these figures, the milepoints are shown on the vertical axis, and time of day is shown along the horizontal axis. Milepoints correspond to the interchange numbers. Four speed bands are shown: 0 – 20 MPH (dark purple), 20-40 MPH (red), 40-60 MPH (orange) and 60-80 MPH (green).

Eastbound I-64: Figure 9 shows that in the eastbound direction, two pronounced periods with slow traffic occur. During the AM period, speeds fall below 40 MPH as early as 5:15 AM, and they do not exceed 40 MPH again until approximately 10:00 AM. Speeds fall below 40 MPH as far east as milepoint 265 (near the Armistead Avenue Exit) and remain below 40 MPH until the tunnel/bridge entrance. Speeds are at their lowest (below 20 MPH) between 6:00 AM and 8:30 AM.

The duration of the PM peak slowdown is somewhat shorter, starting around 2:30 PM and ending approximately 6:30 PM. These low speeds occur over approximately the same approach length as the AM peak period. Speeds fall below 20 MPH during a significant portion of the PM peak as well. A third period of slow traffic occurred during the mid-evening hours (8:30 PM – 11:00 PM).

Speeds along eastbound I-64 were found to be below 40 MPH for almost 11 hours during the 24-hour day, and below 20 MPH for almost 6 hours, indicating severe congestion and queuing.

Westbound I-64: In the westbound direction (Figure 10), one pronounced period of slow traffic occurs during the PM peak, starting as early as 1:45 PM, and lasting through 6:45 PM. Speeds fall below 20 MPH during significant portion of this peak (2:45 PM to 6:15 PM). Figure 10 shows two areas where speeds are reduced during the PM period: one approaching the HRBT (in advance of milepost 271), and through the I-564 interchange area (milepost 277 – 276). An evening period of slowdown occurs between 8:30 PM and 11:30 PM, with speeds falling below 40 MPH. A check of the incident log at the HRBT revealed that roadway maintenance was ongoing during the period for which the INRIX data were analyzed. In addition, one major incident involving a disabled vehicle occurred on westbound I-64 on June 10. These events likely affected speeds between 8:30 PM and 11:30 PM.

Speeds along westbound I-64 were found to be below 40 MPH for almost 8 hours during the 24-hour day, and below 20 MPH for 3.5 hours, indicating severe congestion and queuing.

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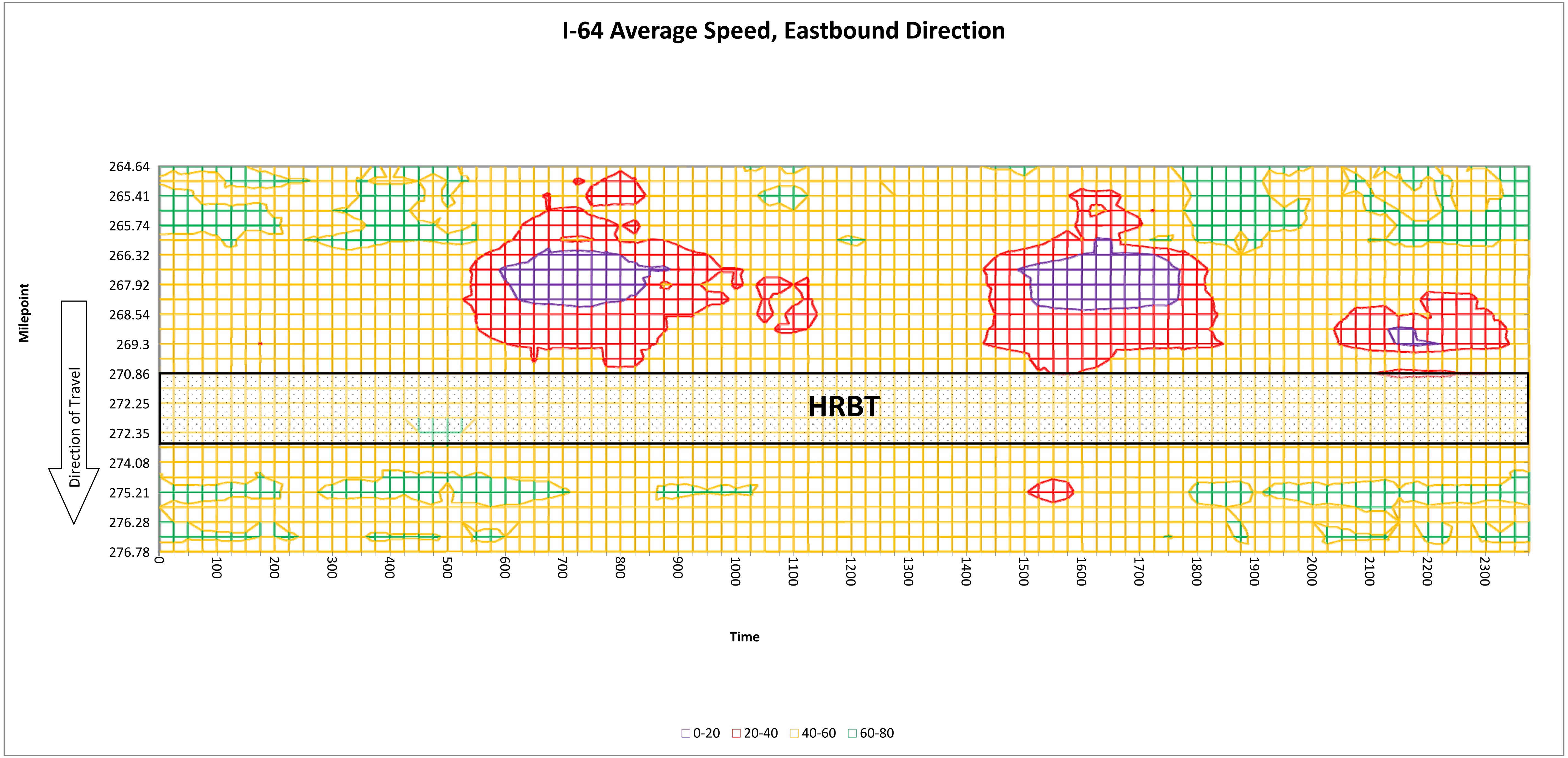

Figure 9. I-64 Eastbound Speed Contours

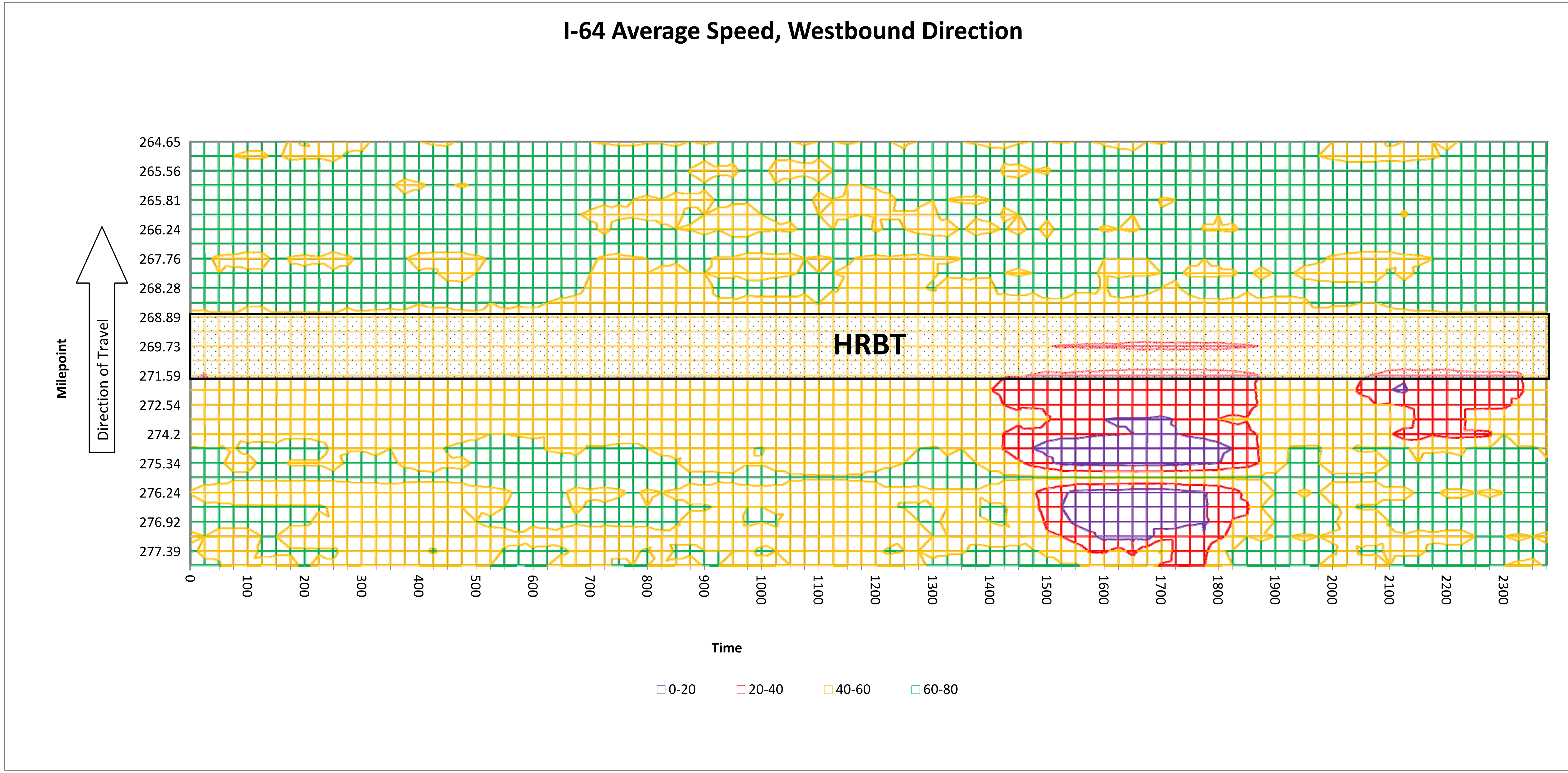

Figure 10. I-64 Westbound Speed Contours

In addition to developing speed contour maps, the INRIX data were used to estimate free-flow speeds along I-64. The free-flow speeds through the study area are shown in Figure 11 and Figure 12. The field-measured free-flow speeds were used in the capacity analyses as discussed in Section 3.5. As indicated in these figures, average free-flow speeds are generally highest on the east side of the HRBT (approximately 60 MPH), drop to approximately 50 MPH on the HRBT, and increase to approximately 55 MPH on the west side of the HRBT and through the I-564 interchange.

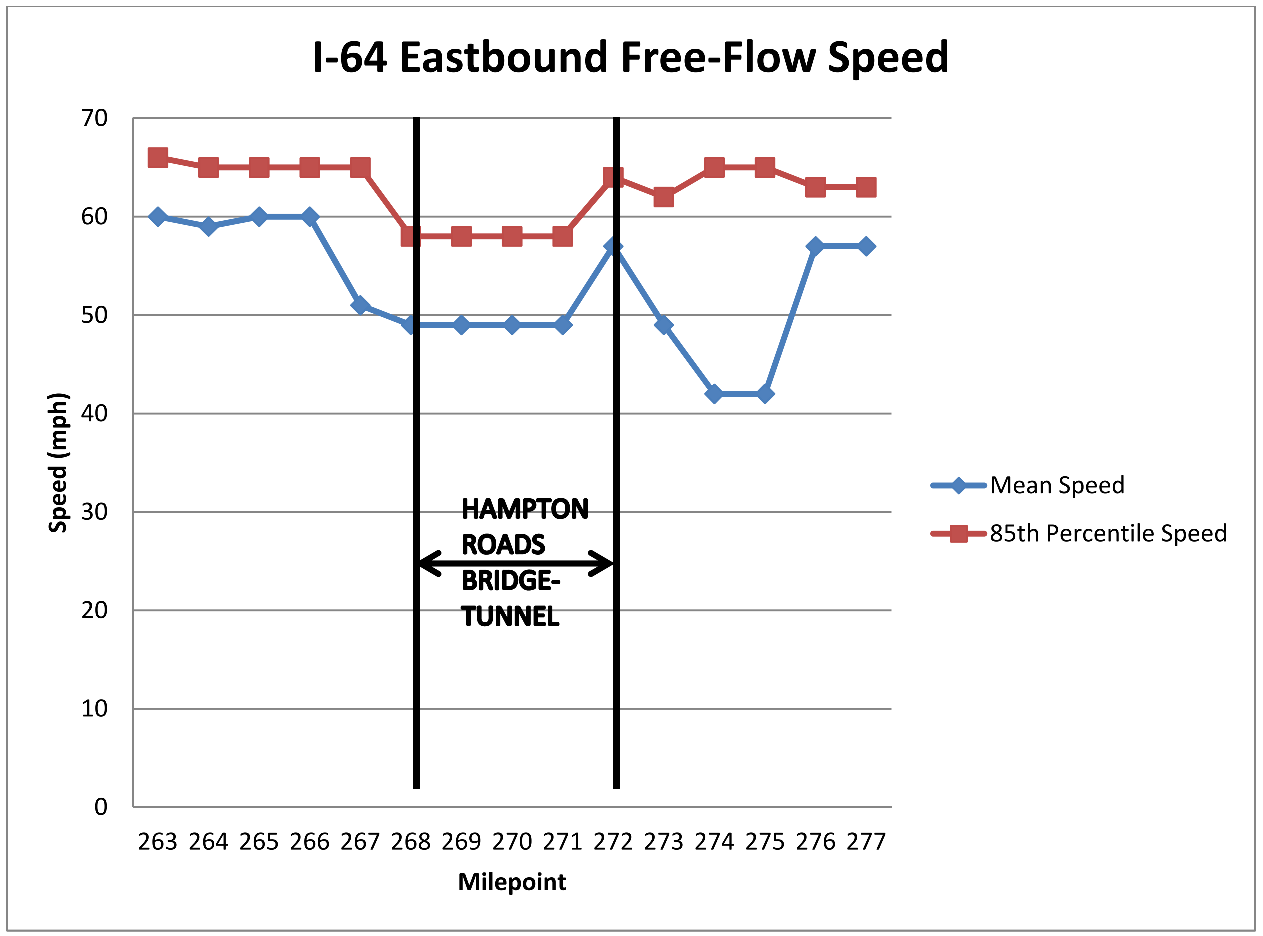

Figure 11. I-64 Eastbound Free-Flow Speed

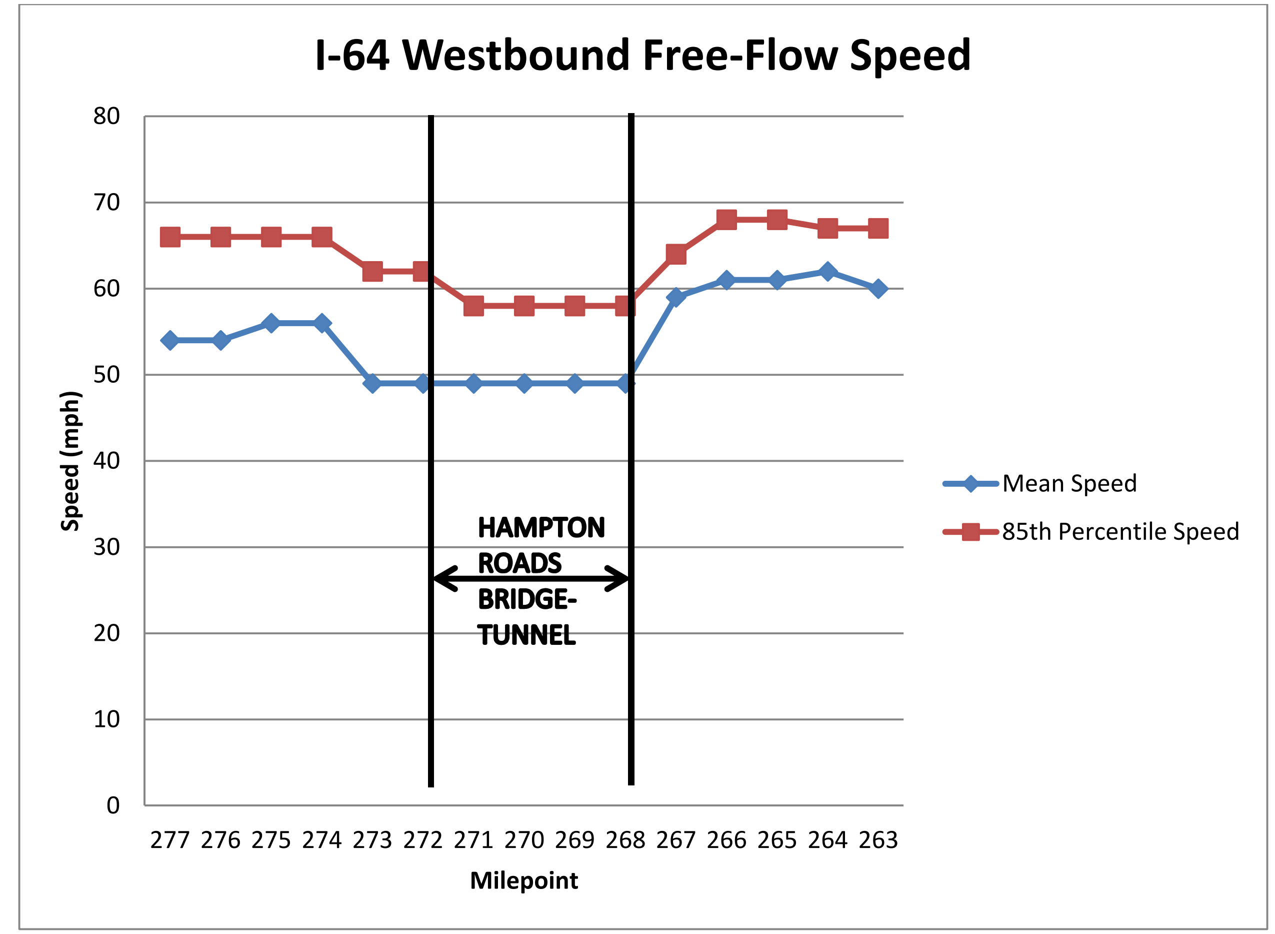

Figure 12. I-64 Westbound Free-Flow Speed

3.5 Existing Traffic Operations

Capacity analyses were conducted for existing weekday AM and PM peak period conditions using the latest version of the Highway Capacity Software (HCS 2010 Version 6.1), which was developed based on the methodologies presented in the 2010 Highway Capacity Manual.

The I-64 and I-564 corridors were each divided into segments, representing either a mainline freeway segment, a weaving segment, or a ramp junction (merge or diverge condition). Each segment was then evaluated to determine the AM and PM peak hour Level of Service (LOS) based on the existing (2011) volumes developed for this study.

Level of Service is a letter-grade description of the quality of traffic flow, ranging from A (best) to F (worst). Level of Service A represents free-flow conditions where vehicles can travel unimpeded, and where incidents can generally be absorbed. Level of Service E represents operations near the roadway's capacity, with very unstable flow in which even minor incidents lead to significant queuing. Level of Service F represent a breakdown in traffic flow with demand exceeding capacity.

In addition to the peak hour volumes, several other key pieces of data were used in the capacity analyses using the Highway Capacity Manual methodologies as follows:

Peak Hour Factor (PHF): Based on a review of mainline I-64 traffic count data collected at the HRBT and the I-664 interchange, a peak hour factor of 0.95 was selected for all mainline I-64 movements. A similar review was conducted for mainline I-564 traffic counts and a peak hour factor of 0.92 was selected for all mainline I-564 movements. The PHFs for the individual ramps were determined based on the field collected data.

Truck Percentages: Based on a review of mainline classification count data, truck percentages were identified for the I-64 and I-564 corridors. The following truck percentages were assumed for the mainline Interstate movements:

- Eastbound I-64: 4%
- Westbound I-64: 3%
- I-564, Northbound and Southbound: 4%

Truck percentages for the individual ramps were determined based on the field collected data.

Free Flow Speed: Free-flow speeds were estimated for each I-64 freeway segment based on the INRIX data. The speed data was evaluated during the midday off-peak period (between 11 AM and 1 PM). Speeds were reviewed and the 85th-percentile speeds identified for each segment. These 85th-percentile speeds were then used as the free-flow speeds for each segment. These speeds ranged from 58 to 67 mph along westbound I-64 and between 58 and 66 mph in the eastbound direction. Since INRIX data was not provided for I-564, a free-flow speed of 65 mph was selected for that corridor, based on the I-64 data. The following free-flow speeds were used for the ramp types found throughout the corridor:

- Directional Ramp (ex. I-64 WB to I-664) = 50 mph
- Diamond Ramp (ex. I-64 EB to Rip Rap Road) = 40 mph
- Loop Ramp (ex. I-64 WB to W Bay Avenue) = 30 mph

The results of the capacity analyses are summarized in Table 4 through Table 8, and shown graphically in Appendix A.

Table 4. Eastbound I-64 Mainline and Ramp Capacity Analysis Results – Existing Conditions

Exit	From	To	Type	AM	PM
265	NB I-664	SB LaSalle Avenue	Weave	C	C
	SB LaSalle Avenue	I-64	Merge	C	C
	NB LaSalle Avenue	I-64	Merge	D	D
	I-64	Rip Rap Road	Diverge	D	C
	Rip Rap Road	Settlers Landing Road	Mainline	C	B
267	I-64	Settlers Landing Road	Diverge	C	C
	Settlers Landing Road	Mallory Road	Weave	D	C
268	Mallory Road	I-64	Merge	D	D
	I-64 (HRBT)		Mainline	**E**	D
272	I-64	Bayview Avenue	Diverge	**E**	D
	Bayview Avenue	I-64	Merge	D	C
	Bayview Avenue	4th View Street	Mainline	D	D
273	I-64	4th View Street	Diverge	D	D
	4th View Street	I-64	Merge	D	C
	4th View Street	Bay Avenue	Mainline	D	C
274	Bay Avenue	I-64	Merge	D	**E**
	Bay Avenue	Patrol Road	Mainline	D	**E**
	Patrol Road	Ramp to I-564/Granby Road	Weave	D	**E**
	Off ramp to I-64 HOV	On ramp from I-564	Mainline	C	C
276	I-564	East Little Creek Road	Mainline	B	C

The mainline and ramp capacity analyses indicate that most locations operate at acceptable levels of services today, with some locations approaching capacity (level of service E) and one location operating at a failing level of service (level of service F). Key locations approaching capacity include the following:

- Eastbound HRBT during the AM period
- Ramps and mainline on eastbound I-64 between Bay Avenue and the ramp to Granby Avenue/I-564
- Merge from Terminal Avenue to southbound I-564
- Weave from ramp from eastbound I-64 to northbound I-564

Table 5. Westbound I-64 Mainline and Ramp Capacity Analysis Results – Existing Conditions

Exit	From	To	Type	AM	PM
276B	I-64	Ramp to I-564	Mainline	D	B
276A	I-64	Granby Street	Diverge	D	C
	I-564	I-64	Merge	C	C
	I-564	Granby Street/Rte 460	Mainline	D	C
	Granby Street/Rte 460	I-64	Merge	D	C
	Granby Street/Rte 460	Ocean Avenue	Mainline	D	C
274	I-64	Ocean Avenue	Diverge	C	C
	Ocean Avenue	4th View Street	Mainline	C	C
273	I-64	4th View Street	Diverge	C	C
	4th View Street	I-64	Merge	D	D
	4th View Street	Ocean View Avenue	Mainline	D	D
272	I-64	Ocean View Avenue	Diverge	C	D
	Ocean View Avenue	I-64	Merge	D	D
	I-64 (HRBT)		Mainline	D	D
268	I-64	Mallory Avenue	Diverge	D	D
267	Mallory Avenue	Settlers Landing Road	Weave	B	C
	Settlers Landing Road	I-64	Merge	C	C
	Settlers Landing Road	Armistead Avenue	Mainline	C	C
265B	I-64	Armistead Avenue	Diverge	C	C
	Armistead Avenue	I-664	Weave	C	C

Table 6. Northbound I-564 Mainline and Ramp Capacity Analysis Results – Existing Conditions

Exit	From	To	Type	AM	PM
	NB Granby	Terminal Avenue	Weave	D	A
	EB I-64	Terminal Avenue	Weave	**F**	A
	Terminal Avenue	Admiral Taussig Boulevard	Mainline	C	A

Table 7. Southbound I-564 Mainline and Ramp Capacity Analysis Results – Existing Conditions

Exit	From	To	Type	AM	PM
	I-564	Admiral Taussig Boulevard	Diverge	A	C
	I-564		Mainline	A	C
	Terminal Avenue	I-564	Merge	A	E
	I-564	E Little Creek Parkway	Lane Drop	A	D

Table 8. Intersection Capacity Analysis Results – Existing Conditions

Intersection	Control Type	AM	Delays (sec/veh)	PM	Delays (sec/veh)
WB I-64 On-Ramp at N Armistead Ave	Signalized	B	18.3	C	20.5
N Armistead Ave at LaSalle Ave	Signalized	B	17.9	C	26.9
I-64 EB Off-Ramp at Rip Rap Rd	Signalized	C	28.8	D	51.1
I-64 EB Off-Ramp at Settlers Landing Rd	Signalized	E	64.0	D	44.5
I-64 WB Ramps at Settlers Landing Rd	Signalized	B	15.0	C	28.6
I-64 EB Ramps at S Mallory St	Signalized	C	22.1	D	49.9
I-64 WB Ramps at S Mallory St	Signalized	B	18.8	C	26.2
Granby St at E Admiral Taussig Blvd	Signalized	B	14.5	B	16.5
I-64 EB Ramps at E Little Creek Rd	Signalized	A	6.2	A	9.8
I-64 WB Off-Ramp at E Little Creek Rd	Signalized	B	13.2	B	12.9
EB I-64 Ramps at Bayville St	Stop*	A	8.8	A	9.6
WB I-64 Ramps at W Ocean View Ave	Stop*	A	6.3	A	5.6
EB I-64 Ramps at 4th View St	Stop*	**F**	194.1	**F**	233.3
WB I-64 Ramps at 4th View St	Stop*	B	14.6	**F**	149.5

*Level of Service for worst approach

3.6 Summary

Contrary to the speed contour maps in Figure 9 and Figure 10, the results of the capacity analyses do not appear to reflect the recurring congestion and poor operating conditions that motorists experience within the project area. This is likely due to the fact that the HCM methodology does not take into account any effects from downstream bottlenecks and spillback of congestion. The HCM methodology also tends to overestimate available capacity on roadway segments where the driving environment significantly affects motorist behavior which is the case on the HRBT, with its combination of narrow lanes and lack of shoulders, abrupt transition from daylight to dark lighting conditions, and low overhead clearance. All these issues are present in the HRBT, which likely resulted in HCM levels of service that are better than the observed conditions and INRIX data indicates.

Analysis of the INRIX speed data shows consistently very low speeds for extended periods throughout the day. Distinct periods of AM and PM congestion occur on eastbound I-64, starting at Armistead Avenue approaching the HRBT. Along westbound I-64, congestion is pronounced only during the PM peak, but the PM congestion extends over a longer distance of I-64 (starting as far west as the I-564 interchange).

Speeds along eastbound I-64 were found to be below 40 MPH for almost 11 hours during the 24-hour day, and below 20 MPH for almost 6 hours. Speeds along westbound I-64 were found to be below 40 MPH for almost 8 hours during the 24-hour day, and below 20 MPH for 3.5 hours, indicating severe congestion and queuing.

Analysis of crash data indicates a significant spike in the number of crashes as well as the crash rate approaching the HRBT in both the eastbound and westbound directions. The majority of reported crashes were rear-end collisions, which are indicative of stop-and-go conditions and correspond to the significant speed decreases near the tunnel approaches.

Therefore, which not entirely indicated by the HCM results, there is evidence of severe congestion issues on the HRBT and approach roadways with existing condition. While HCM may be limited for evaluating the existing conditions (and needs to be supplemented with INRIX and crash data to fully assess the operations), it is still a valuable tool for predicting future conditions where geometric constraints and environmental factors have been corrected for the tunnel and approach roadway as part of the rehabilitation program proposed for all Build alternatives.

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4 ALTERNATIVES CONSIDERED

Alternatives were developed after a review of alternatives from previous studies; consideration of public and agency input received during scoping; and development of alternatives to address the study's purpose and need using the most current design criteria for interstate highways and structures over tidal waters.

A number of criteria were developed to screen the various alternatives on the extent to which they address the project's purpose and need. Both roadway design criteria and roadway capacity criteria were developed. To evaluate traffic operations, the capacity criteria were used. While FHWA prefers at least a Level of Service (LOS) C for interstates, LOS D is considered acceptable for urban interstates such as I-64 at the HRBT and approach roadways. Thus, LOS D is the screening threshold used for the I-64 HRBT alternatives.

This Section describes each of the Alternatives considered and a brief discussion the reason(s) why each alternative was not carried forward, or retained for detailed study. The operational analysis results for the alternatives that involve addition of roadway capacity (as well as the No Build alternative) are discussed in Sections 6 through 10.

4.1 Alternatives Not Carried Forward

4.1.1 Transportation System Management / Transportation Demand Management (TSM/TDM)

TSM/TDM improvements maximize the efficiency of the current transportation system or reduce the demand for travel on the system through the implementation of low-cost improvements. Examples of TSM activities include the addition of turn lanes, optimized signalization at intersections, and Intelligent Transportation Systems (ITS) measures such as active traffic management and enhanced driver information. Examples of TDM activities include ride sharing, van and carpooling, installation of park and ride facilities, and encouragement of telecommuting.

TSM/TDM alternatives, by their nature, do not include the addition of single occupancy vehicle (SOV) lanes and involve only minor work outside the existing right-of-way. Therefore, because of the limited scope of these types of improvements, TSM/TDM improvements alone would not address the capacity or roadway geometric deficiency needs. Thus, as a stand-alone alternative, TSM/TDM has been eliminated from further consideration. Notwithstanding, the retained build alternatives do not preclude TSM/TDM elements, should they be considered in the future.

4.1.2 Rehabilitation or Reconstruction of the Existing HRBT

This alternative would include rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges. The existing tunnels can be used for another 75 to 100 years[1]; therefore, routine maintenance of the tunnels would continue as required.

As a stand-alone alternative, this alternative would not increase roadway capacity to alleviate current or future unacceptable and unreliable levels of traffic service; operating speeds; or travel times. Although the current geometric deficiencies of the existing facilities could be addressed with reconstruction of the approach bridges, it would not be feasible to address them with the rehabilitation because replacement of the superstructure would not allow for the height of the approach bridges to be raised nor shoulders to be widened. Travel lanes would need to be taken out of service or replaced with temporary structures during the rehabilitation or reconstruction effort, thus affecting the travel capacity throughout the construction period which could extend beyond three years. To minimize potential construction-related cost, transportation, and environmental impacts, HRBT traffic could be detoured; however, this detour would convey additional traffic to already congested routes such as the Monitor-Merrimac Memorial Bridge-Tunnel (I-664) or James River Bridge, or continue to utilize the HRBT with a reduced number of lanes. As these facilities are already at or near capacity, the conveyance of additional detoured traffic from HRBT during the construction period would only increase congestion and gridlock at these locations.

Because this alternative would not address the purpose and need of the study, it was eliminated from further consideration as a stand-alone alternative; however, it has been included as a component of the retained build alternatives.

4.1.3 Replacement of the Existing HRBT

This alternative would include any improvements that involve complete removal of an existing bridge-tunnel in conjunction with reconstruction of a new crossing facility in the same location. This alternative would not address the identified capacity needs as it only replaces the existing HRBT, additional capacity is not contemplated with this alternative. Geometric deficient roadway infrastructure would be replaced by a new facility that would meet current design standards for shoulder widths, vertical clearance in tunnels, and vertical clearance above water for approach bridges. If only one of the existing bridge-tunnels is removed, the remaining bridge-tunnel would have the same geometric deficiencies as the current facility.

Removal of two lanes of the existing bridge-tunnels would be necessary prior to constructing the new facility. The number of lanes crossing the HRBT during construction would be reduced by one half from existing conditions from four lanes to two lanes. This would result in increased delays within the I-64 HRBT corridor for drivers that continue to use the HRBT or additional traffic on other regional routes such as I-664 and the James River Bridge.

This alternative is not reasonable and has been eliminated because the existing tunnels have a remaining life span of 75 to 100 years, and it would be less costly to rehabilitate the existing approach bridge structures than to completely replace the bridges and the tunnel. This alternative would result in a minimal achievement of benefits

[1] Per meeting with VDOT HRBT Study Team and VDOT Structure and Bridge Engineer, August 18, 2011.

relative to an unreasonably high level of disruption to regional travel during the construction period which could extend beyond three years.

4.1.4 Reversible Lanes

This alternative would include adding one or two reversible travel lanes to I-64. At the HRBT crossing, the additional lanes would be constructed west of the existing crossing to prevent disturbance to the existing bridge-tunnels during construction. However, the reversible lanes would operate in the center of the roadway, and eastbound traffic would use the new lanes. The reversible lanes would connect to the mainline of I-64 west of I-664, and connect to the existing reversible lanes on I-64 east of I-564. The lanes would either be completely barrier separated from both directions of traffic, similar to the reversible lanes east of I-564, or a moveable-barrier system could be used to separate opposing traffic.

Construction of reversible lanes would partially address deficiencies at the existing crossing, because the reversible lanes would be on a new bridge-tunnel that would meet current design standards for shoulders, vertical clearance in tunnels, and vertical clearance above water. However, the existing bridge-tunnels would continue to be used without improvements; therefore, geometric deficiencies at these facilities would not be addressed.

The travel patterns along I-64 through this study area do not allow for effective operation of reversible lanes. Based on the traffic volumes for existing conditions and the No-Build Alternative provided in Section 6 (see **Table 11**), there is not a clear directional peak volume. The westbound and eastbound volumes have a defined peak period; however, the volumes in each direction are comparable during those peak periods. Thus, reversible lanes would add capacity in one direction during any given peak period, but the capacity needs in the opposite direction would not be met. Consequently, this alternative has been eliminated from detailed study because it would not meet the minimum LOS requirements for both directions. It is also noted that the *2008 HRBT Expansion Feasibility Study* recommended elimination of the reversible lanes alternative for similar reasons.

4.1.5 Build 6 Alternative

This alternative would include construction of two additional lanes of capacity (one in each direction) on I-64 at the Hampton Roads crossing and within the Norfolk section of the corridor, so that a continuous six-lane facility would extend from I-664 to I-564. The existing bridge tunnels would remain. However, rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges would be completed, and routine maintenance of the tunnels would continue as required. Through the Hampton section of the corridor, no additional through lanes would be constructed because there are currently six lanes. This alternative would include a new two-lane bridge tunnel at the Hampton Roads crossing.

The capacity analyses and results for this Alternative are provided in Section 7.

4.1.6 Build 12 Alternative

The Build 12 Alternative would construct six additional lanes of capacity on I-64 within the Hampton portion of the corridor, and eight additional lanes of capacity on I-64 on the Hampton Roads Bridge-Tunnel and within the Norfolk section of the corridor. This expansion would result in a continuous twelve-lane facility that would extend from I-664 to I-564. The existing bridge-tunnels would remain, however, rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges would be completed, and routine maintenance of the tunnels would continue as required.

Due to the additional roadway capacity, the Build 12 Alternative would improve capacity for current and future traffic within the study corridor, and result in a better LOS as compared to the Build 8 and Build 10 Alternatives. This alternative would address geometric deficiencies of existing facilities by constructing a new bridge-tunnel that would meet current design standards for shoulders, vertical clearance in tunnels, and vertical clearance above water. However, because I-64 is the most direct route between the Peninsula and Southside populations, additional capacity on the HRBT in the form of a Build 12 Alternative would draw traffic from other Hampton Roads crossings, in particular the Monitor-Merrimac Memorial Bridge-Tunnel (I-664), even though the total traffic volume crossing Hampton Roads would not substantially increase. As a result, capacity on parallel facilities would likely become underutilized in the future.

As discussed in Section 10, the Build 10 Alternative would generally provide LOS C throughout the corridor, and therefore meets the LOS standard for interstate roadways. The Build 12 Alternative would provide more capacity than the Build 10 Alternative, and would generally provide LOS B or C throughout the study area. The additional capacity provided by the Build-12 Alternative would result in an LOS that exceeds the LOS standard.

4.1.7 High Bridge

As with the *2008 HRBT Feasibility Study,* a high bridge was evaluated as a potential alternative. For this study, a high bridge would not be a stand-alone alternative, but rather an option to address the crossing type for the Hampton Roads channel. The option would involve either a new cable-stayed or suspension bridge parallel to the existing HRBT. The bridge would be built to carry all lanes of I-64 over Hampton Roads. This option would fully address the geometric deficiencies of existing facilities by constructing a new bridge that would have full shoulders, no vertical clearance issues, and meet or exceed the minimum height above mean high water (MHW). The bridge lanes would be designed to meet the capacity needs for the corridor.

Depending on the bridge type, a high bridge would require a new and/or expanded island to accommodate new bridge piers. These new or expanded islands have a high potential to infringe on the existing channel. A high bridge would introduce a height restriction over the shipping channel that does not exist today. A high bridge could be vulnerable to natural hazards and manmade threats, including ships colliding with bridge piers and high winds affecting bridge operations. A high bridge would require 500-foot to 800-foot tall towers that would be obstructions to FAA controlled air space from nearby Chalmers Field and Langley AFB. This anticipated bridge height would create a visual impact to nearby communities and historic properties.

As discussed with agency representatives during the study scoping effort, a new or expanded island could have a detrimental impact on the hydrodynamic characteristics of Hampton Roads. Therefore, although a high bridge option over Hampton Roads could be a feasible alternative from an engineering perspective and would address the stated transportation needs, the option creates additional challenges that make it unreasonable to carry forward. Additional information on the high bridge option is included in the *HRBT High Bridge Technical Memorandum*.

4.1.8 Light or Heavy Rail Transit

This alternative would include dedicated light or heavy rail transit on a new structure across Hampton Roads. The existing bridge-tunnels would remain; however, rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges would be completed. Routine maintenance of the existing tunnels would continue as required. This alternative would not address geometric deficiencies of existing facilities as no improvements would be made to the existing bridge-tunnel to address current design standards for shoulders, vertical clearance in tunnels, or vertical clearance above water.

There is currently no rail transit service connecting Hampton to Norfolk, nor comprehensive transit service within the larger region. The nearest rail transit service is "The Tide," which is a light rail line located approximately 5.5 miles from the study area and operates on the Southside from Fort Norfolk Station to Newtown Road Station. For a rail transit crossing at the HRBT to be viable, a new rail transit route or system would be necessary on both the Peninsula and the Southside.

The Hampton Roads Transportation Planning Organization (HRTPO) and Virginia Department of Rail and Public Transportation (DRPT) recently completed the *Hampton Roads Regional Transit Vision Plan* (*Vision Plan*). The *Vision Plan* was prepared in two phases. Phase I, the *Transit Vision Plan for Hampton Roads*, was completed in April 2009 by the HRTPO. Phase 2, the *Hampton Roads Regional Transit Vision Plan Final Report*, was completed in February 2011 by DRPT. Together, these two documents provide a strategic approach for the development and implementation of a regional mass transit system. The *Vision Plan* offers short-term recommendations to address current regional transit inadequacies and long-term strategies to achieve the goals of reduced traffic congestion and increased transit use. The *Vision Plan* proposes a dedicated light rail transit connection across Hampton Roads in the long term (beyond 2034), although specific corridor recommendations are not provided. Several alternative locations for this facility are identified, with the preferred potential crossing located approximately four miles west of the HRBT. Potential transit improvements across Hampton Roads are not funded for study, design or construction in the HRTPO's *2034 Long Range Plan*; therefore, they are not reasonably feasible.

Ridership estimates were not included with Phase II of the *Vision Plan*, however, the *Preliminary Cost and Ridership Estimation Report,* prepared as part of Phase I, included estimated 2034 ridership for light rail service across Hampton Roads. These projections provide a reasonable approximation of the potential ridership for the Light or Heavy Rail Passenger Alternative. The projections assume two services: from Naval Station Norfolk to downtown Newport News, and from downtown Hampton to Wards Corner (near the I-64 interchange with I-564). Both services are recommended for implementation after 2035. According to the report, daily ridership is projected to be as much as 4,100 for Naval Station Norfolk to downtown Newport News, and 5,100 for downtown Hampton to Wards Corner.

Currently, approximately 88,000 persons use the HRBT every day; approximately 112,000 are projected to use the HRBT in 2040 under No-Build conditions. Assuming that the potential daily projected ridership for the two proposed rail transit services all uses the HRBT, it would include 9,200 person-trips on the HRBT per day. Thus, rail transit would accommodate approximately ten percent of the existing HRBT users and eight percent of the year 2040 users on the HRBT. Similarly, approximately 22,000 vehicles use each lane of the HRBT today and approximately 28,000 vehicles would use each lane under year 2040 No-Build conditions. Therefore, rail transit would accommodate approximately 42 percent of one existing lane and 33 percent of one of the 2040 lanes.

Based on the discussion above, the Light or Heavy Rail Transit Alternative has been eliminated from further consideration because it would not address the roadway deficiency or capacity needs identified by this study. The alternative would require substantial new rail transit connections on the Peninsula and Southside, and it would have limited ability to accommodate existing and future traffic volumes on the HRBT. Further information regarding consideration of light and heavy rail transit is included in the *HRBT Transit Technical Memorandum*.

4.1.9 Bus Transit

This alternative would include expansion of existing bus transit services within the study corridor and across Hampton Roads. This could be in the form of an increase in bus service or inclusion of a dedicated (express bus or bus rapid transit) facility, as recommended for study in the *Vision Plan*. A Bus Transit Alternative could be considered as a stand-alone build alternative or in conjunction with other retained alternatives. Regardless, the existing bridge-tunnels would remain, however, rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges would be completed, and routine maintenance of the tunnels would continue as required.

As a stand-alone alternative, increased bus service or a dedicated bus facility would not involve roadway or bridge-tunnel improvements; therefore, it would not address the identified capacity and roadway geometric deficiencies of the existing facility. Expansion of the existing bus transit network alone would likely not attract enough riders to substantially address the capacity need within the I-64 HRBT corridor because there is currently a lack of bus ridership across Hampton Roads. This fact is demonstrated by recent recommendations by Hampton Roads Transit (HRT) to eliminate five current weekday trips across HRBT due to low ridership (*Service and Schedule Efficiency Review, HRT, March 2011)*. All bus routes across Hampton Roads accommodated approximately 700 passengers per day in 2011, which is less than one percent of the existing HRBT daily traffic volume. Any increased bus service would also continue to rely on the existing HRBT facility, and its operation would be hampered by current capacity and deficiencies of existing facilities. Therefore, expanded bus transit as a stand-alone alternative has been eliminated from further consideration.

Bus transit could be implemented as part of other retained build alternatives. Expanded service could travel more freely within alternatives that provide additional lane capacity and improve capacity for trips across Hampton Roads. Build alternatives that include managed lanes could include bus transit and/or dedicated bus lane as part of the management strategy. Thus, expanded bus transit has been carried forward for further evaluation as a component of other alternatives.

4.1.10 Ferry Service

During scoping, various public and agency comments suggested consideration of hydrofoil or ferry service as part of the I-64 HRBT Draft EIS. This alternative would provide a service to carry vehicles across Hampton Roads via water transport. The existing bridge-tunnels would remain; however, rehabilitation of the superstructure or reconstruction of the substructure and superstructure of the approach bridges would be completed, and routine maintenance of the tunnels would continue as required.

The Ferry Service Alternative would not address the geometric deficiencies of the existing facilities, because no improvements would be made to the I-64 roadway or existing bridge-tunnel to address current design standards for shoulders, vertical clearance in tunnels, or vertical clearance above water. Ferries would require that vehicles arrive at least 20 minutes prior to departure to load and would travel at maximum speeds less than 40 miles per hour. This speed may not be reasonable across Hampton Roads where ferries would have to traverse shipping lanes and adhere to speed restrictions. The total trip length (including loading and unloading) would be approximately 30 minutes across Hampton Roads only. This represents an average increase in the travel time across Hampton Roads of approximately 30 minutes as compared to the current average peak hour travel time across the bridge-tunnel. Even in 2040 the predicted travel time across Hampton Roads would exceed the predicted travel time for the ferry alternative. In both scenarios the ferry alternative is less effective than traversing Hampton Roads using the bridge-tunnel.

Further, as cited in the *Vision Plan*, total average weekday ferry ridership between downtown Hampton and the Norfolk Naval Station in the year 2034 are expected to range from 600 to 1,100 vehicles, or about one percent of the existing traffic volume and less than one percent of the projected 2040 No-Build volume on the HRBT. The Ferry Service Alternative would not address geometric deficiencies of the existing facilities or capacity needs of the HRBT.

For the reasons cited above, the Ferry Service Alternative would not address geometric deficiencies of the existing facilities or capacity needs of the HRBT, and thus has been eliminated.

4.2 Alternatives Carried Forward

In addition to the No-Build Alternative, which is depicted in Figure 13, three Build alternatives (Build 8, Build 8 Managed, and Build 10) met the study screening criteria and were carried forward for detailed study. These build alternatives are being presented to the public as the current candidate alternatives for a potential proposed action to address the study purpose and need. They received an additional level of evaluation including development of engineering details such as typical sections and detailed traffic analysis. The traffic analysis is presented in Sections 6 through 10.

4.2.1 Build 8 Alternative

The Build-8 Alternative would provide four continuous mainline lanes in each direction of I-64 throughout the limits of the study. Through the Hampton section of the study, this alternative would require one lane of widening in each direction of I-64. Through the Norfolk section, this alternative would require the addition of two lanes in each direction of I-64.

At the western study limits west of the I-664 interchange, the alternative mainline would tie to the existing mainline typical section of twelve lanes at the Pine Chapel Road Bridge. At the eastern study limits east of the I-564 interchange, the mainline would tie into the existing I-64 mainline typical section of four lanes.

A cross-section diagram of this alternative is shown in Figure 14.

The capacity analyses and results for this Alternative are provided in Section 8.

4.2.2 Build 8 Managed Alternative

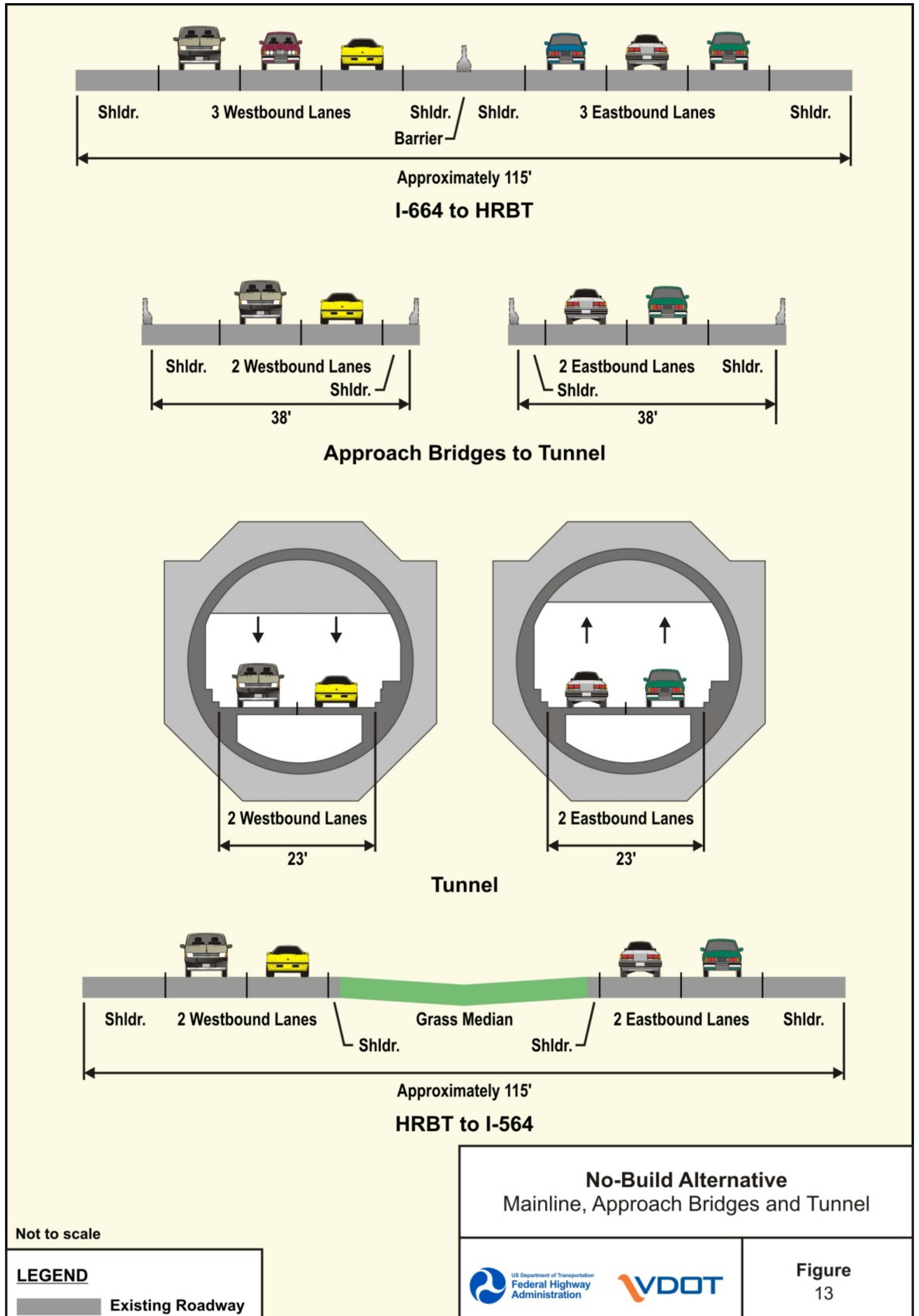
The Build 8 Managed Alternative would be similar to the Build-8 Alternative, providing four continuous mainline lanes in each direction of I-64. However, some or all of the travel lanes would be managed based on tolls and/or vehicle occupancy.

The Build 8 Managed Alternative would have the same mainline alignment through Willoughby Spit as the Build-8 Alternative. The Build 8 Managed Alternative would also have the same tie points to the existing mainline as the Build 8 Alternative.

The Build 8 Managed Alternative could include tolling of all I-64 mainline lanes, or a combination of managed and general purpose lanes, such as high occupancy toll (HOT) lanes where HOV users could use the lanes for free but single occupancy vehicles (SOV) would be required to pay a toll. The alternative includes the following four operational options:

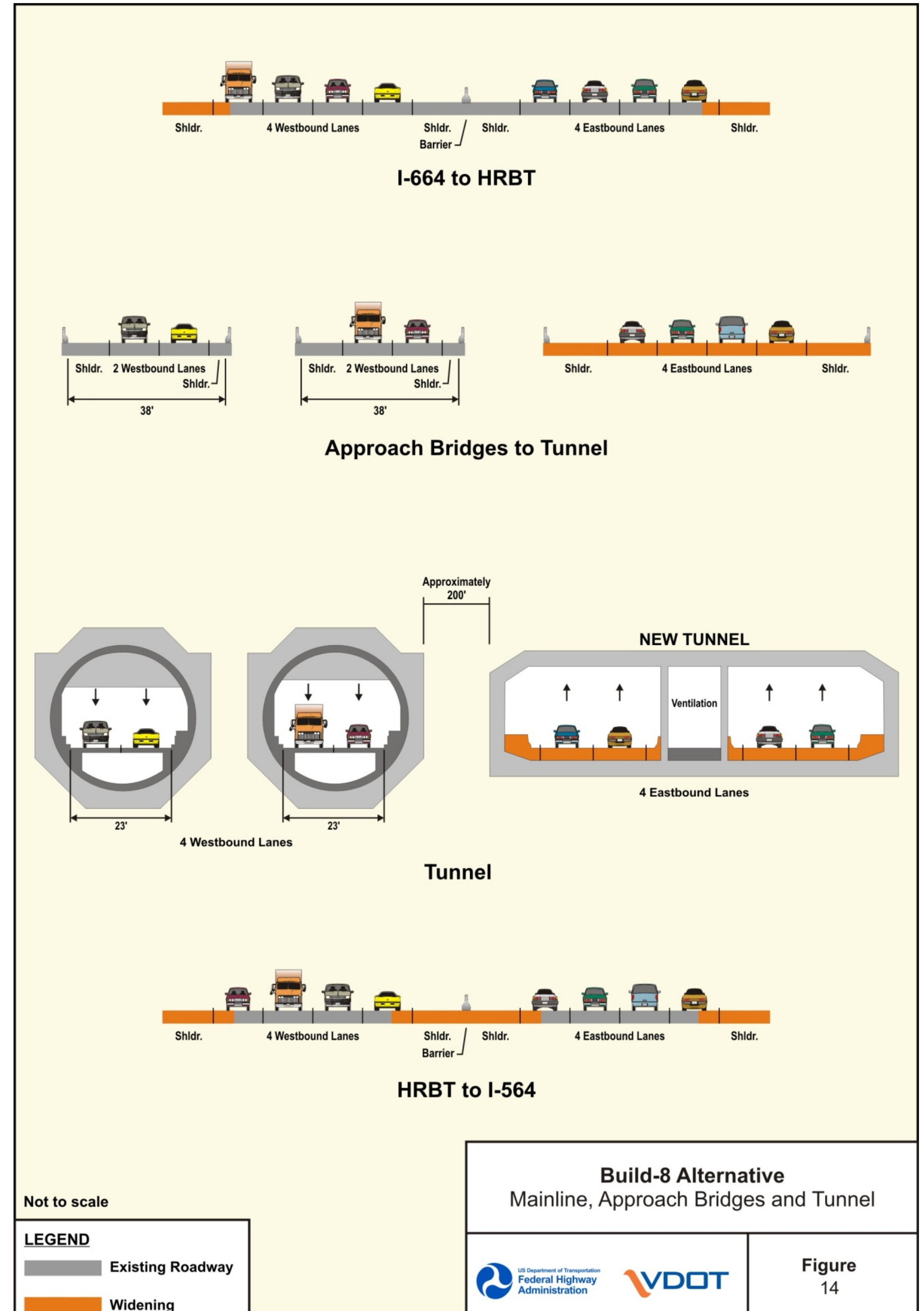
1. **All lanes tolled:** All HRBT users would have to pay a toll. The tolls could be varied to maintain a desired level of service on the HRBT, with higher tolls during periods of higher demand and lower tolls during periods of lower demand.
2. **Two HOT Lanes + Two General Purpose Lanes [2 HOT / HOV-2 “free” + 2 GP]:** This scenario would include two general purpose lanes and two HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.
3. **One HOV Lane + Three General Purpose Lanes [1 HOV-2 “free” + 2 GP]:** This scenario would include three general purpose lanes and one HOV lane in each direction. The HOV lane would be restricted to HOV-2 vehicles that would travel for free.
4. **One HOT Lane + Three General Purpose Lanes [1 HOT / HOV-2 “free” + 3 GP]:** This scenario would include three general purpose lanes and one HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.

A cross-section diagram of these alternatives is shown in Figure 15; the analyses are provided in Section 9.



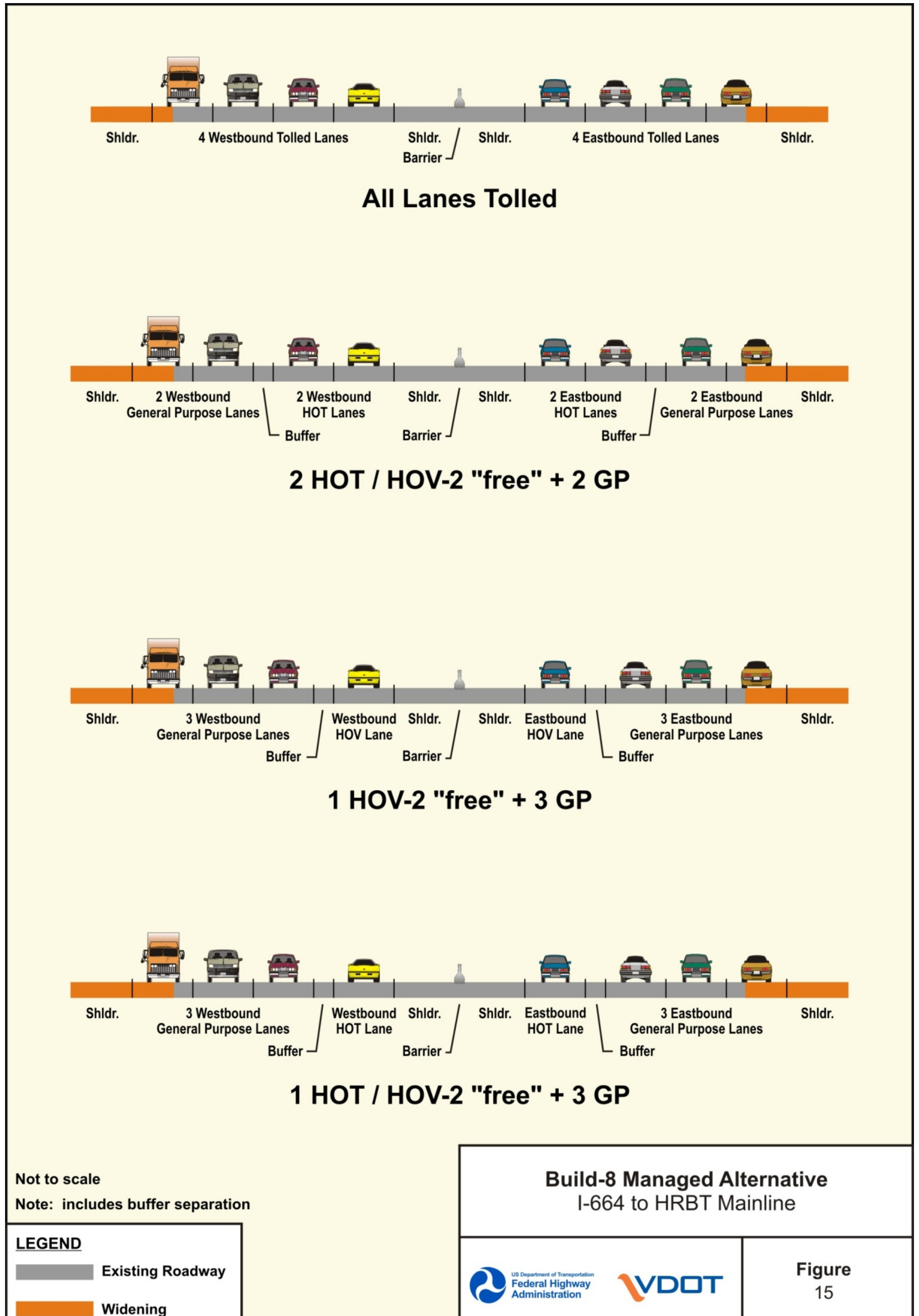
No-Build Alternative
Mainline, Approach Bridges and Tunnel

Figure 13



Build-8 Alternative
Mainline, Approach Bridges and Tunnel

Figure 14

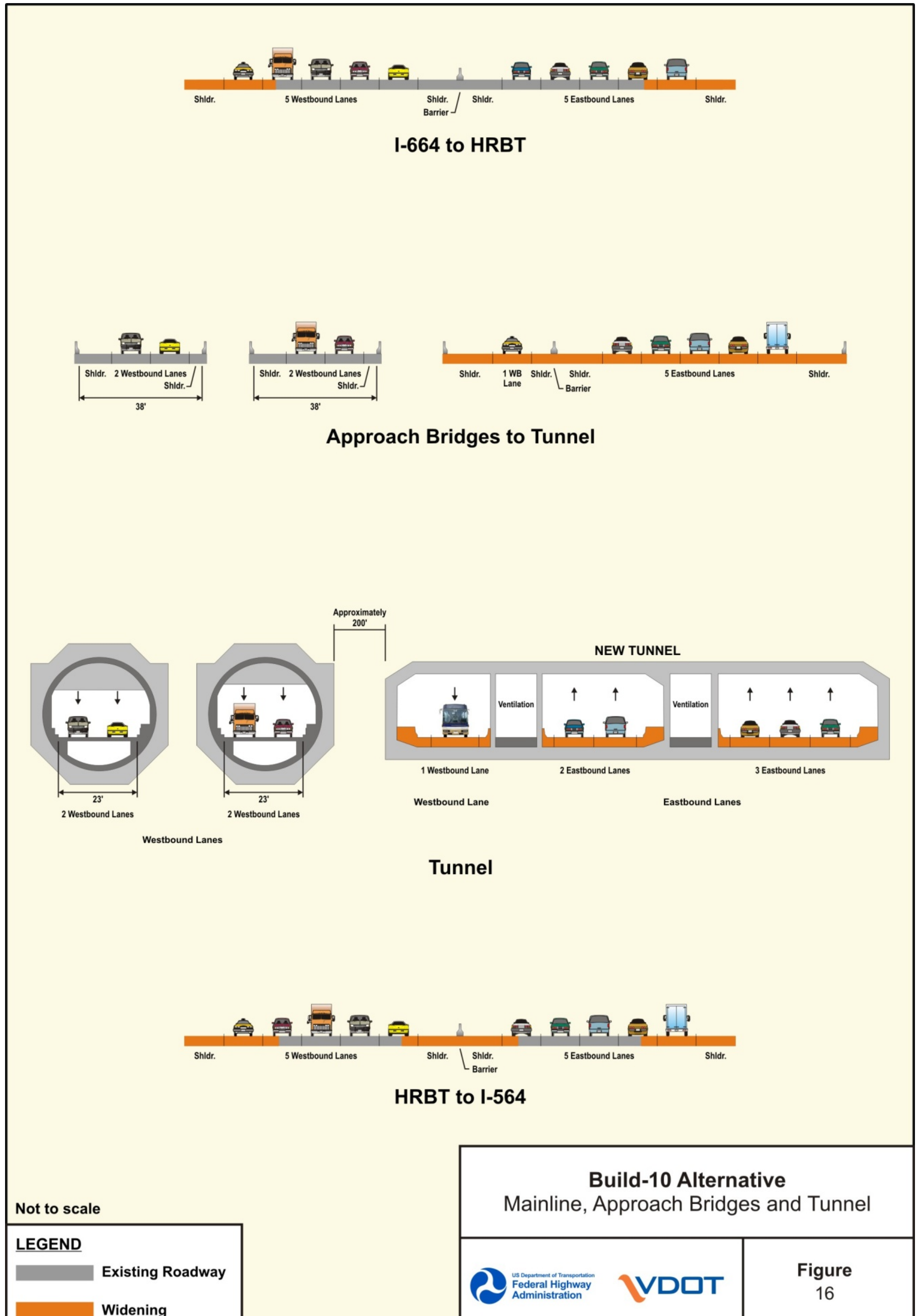


4.2.3 Build 10 Alternative

The Build 10 Alternative would provide five continuous mainline lanes in each direction of I-64 throughout the limits of the study. Throughout the Hampton section of the study, this alternative would require widening both directions of I-64 by two lanes. In the Norfolk section of the study, this alternative would require widening both directions of I-64 by three lanes.

As with the Build 8 Alternative, the mainline would tie into the existing mainline typical section of twelve lanes at the Pine Chapel Road Bridge, and the four lane typical section at the east end of the project limits.

A diagram of this alternative is shown in Figure 16. The capacity analyses and results for this Alternative are provided in Section 10.



Build-10 Alternative
Mainline, Approach Bridges and Tunnel

Figure 16

5 FORECASTING PROCESS

5.1 Travel Demand Model

Year 2040 travel demand forecasts were developed using the Hampton Roads Travel Demand Forecast Model. A travel demand forecast model is a set of computer-based mathematical relationships that attempts to capture the interaction of travel activities and choices made by a population in a specific region given a proposed network (e.g., highway, transit, etc.) and demographic or land use inputs (e.g., population, employment, etc.). The Hampton Roads model was provided by the Virginia Department of Transportation (VDOT) in August of 2011, and included updated truck forecasting methodology. The main inputs to the travel demand model are:

- Demographic and economic changes in the region, specifically the location of employment and housing, and
- Characteristics of the region's transportation system, including proposed changes in transportation facilities and operating policies.

Although VDOT maintains the travel demand forecast model for the Hampton Roads region, land use data is determined at the local level. The Hampton Roads Transportation Planning Organization (HRTPO) provided land use forecast for the year 2034 for use in this study, which is the last year for which HRTPO has forecasted land use data. To develop Year 2040 forecasts, as directed by VDOT, the 2034 traffic forecast was developed and then extrapolated to 2040 with a growth factor. This factor was developed by extrapolating the modest growth anticipated between 2007 and 2034 to 2040. This growth trend, resulting in about 0.7 percent per year, was applied for an additional six year period to 2040, which is consistent with traffic growth in similar areas in Virginia with low growth in the immediate surrounding area and potential higher growth in the outer areas of the region. This results in a total growth of 4.7 percent between 2007 and 2040.

5.2 Validation

A detailed model validation was conducted for the 2008 Hampton Roads model. With concurrence from VDOT TMPD, some model parameters were adjusted for the 2008 and 2034 model runs to obtain improved calibration, which then formed the basis for the 2040 No Build forecast.

Model parameters which were adjusted include time penalties on the Hampton Roads crossings, the Value of Time (VOT) for all trip purposes, and certain coefficients in the mode choice module of the model.

In addition, the model script for the calculation of intra-zonal trips was modified. A full description of the model validation is provided in Cambridge Systematics' October 27, 2011 Technical Memorandum.

5.3 Post-Processing

Post-processing refers to analyses performed after execution of the travel demand forecast model (TDFM) run. Post-processing activities are applied to TDFM model results to compensate for the limitations of the model. The model used for this project produced average daily traffic (ADT) volumes. In order to develop design hour volumes for the peak travel periods, the ADT outputs were refined for the segments of interest along I-64 and the arterial approaches. The freeway system included all mainline links, collector/distributor roads, and ramps. The arterial links included the approaches to the interchanges of interest.

Highway post-processing involves three stages:

- Refinement of the raw link volumes, which is done with the direct output from the model for the ADT volumes;
- Derivation of the peak hour link volumes; and
- Calculation of the turning movements.

For this study, all post-processing activities for refining the highway link ADT volumes and developing turning volumes involved procedures outlined in NCHRP-255 Highway Traffic Data for Urbanized Area Project Planning and Design, published by the Transportation Research Board. This technical report provides a set of procedures for refining “raw” link volumes output directly from the model. Link vehicle flows were smoothed across parallel competing routes. These routes were grouped together and bisected by artificial cutlines, which serve as the basis for refining model output. Each cutline is reviewed to make sure that the total deviation between estimated and observed volumes for the validation year is within an acceptable level of deviation.

Standard NCHRP 255 post-processing procedures were followed to refine cutline volumes and develop target daily link volumes. Daily volumes were assumed to be split equally in each direction. The daily volumes were further analyzed to develop peak hour volumes by using existing k-factors and applying those to the daily volumes. Turning movements were projected based on balancing inflows and outflows at each intersection and interchange and using existing turning movements as a seed to iteratively develop balanced turning volumes.

For design and analysis purposes, peak hour traffic projections are required. These are derived from the refined ADT volumes. The peak hour projections were based on the existing ratio of peak hour traffic to daily traffic. The peak hour inbound and outbound link approach volumes on the interchanges and intersections were derived from the daily volumes and then used in the IPF routine to calculate turning volumes that balanced the interchange and intersection approaches.

The turning movements at the interchanges along I-64 as well as the adjacent intersections of interest were developed using a hybrid method derived from the A-Turns and B-Turns methodology outlined in NCHRP-255. This procedure utilized an iterative proportioning function (IPF) to calculate turning movements. In this process, the refined future forecast approach link volumes, both inbound and outbound, serve as the inputs. The existing turning volumes were used as seed volumes, and the IPF routine iteratively adjusted the turns to balanced the turns given the forecasted approach inbound and outbound link volumes.

5.4 Build Conditions Forecasts

Following completion of the No Build forecasts, several Build scenarios were developed. These scenarios were based on the need for providing sufficient capacity to accommodate future projected demand while minimizing the number of model runs and associated effort to develop daily and peak hour volumes. The initial model runs were intended to be used for screening out alternatives that are likely unfeasible or unable to provide the desired future level of service.

As a starting point, a “Build 8” alternative was modeled. This alternative assumed widening the HRBT crossing to 8 lanes total (2 new lanes in each direction). Following analysis of this alternative, a “Build 6” and “Build 10” alternative were modeled, depending on the initial level of service achieved by the Build 8 alternative. The guiding assumption was that if a Build 8 alternative failed to achieve acceptable levels of service, it would be unnecessary to model an alternative that would provide less capacity.

It is important to note that at this stage of the analysis, the type of crossing (bridge or tunnel) is not considered. The only variable being analyzed is the additional capacity crossing Hampton Roads. The analysis also does not consider configuration of any crossing (for example, if only one lane in each direction is added, it has not been determined how two-way traffic would be managed in one tube).

5.5 Toll/Managed Lane Forecasts

Tolls impact the decisions that travelers make in terms of destinations, mode, and route. The travel demand on toll roads is directly related to motorists’ value of time, which is tied to income. Incorporating income into the travel demand forecasting model was necessary to model toll facilities and understand the toll diversion impacts. The value of time varies for each trip purpose, and different trip purposes occur at different times of the day. For example, morning traffic consists of more commuting trips (i.e., home-based work trip purpose) than shopping or other discretionary trips. Commuting trips also have a different value of time associated with them. The current Hampton Roads Transportation Planning Organization (HRTPO) model does not stratify trips by income, and also does not break down the trips by time of day, but only provides daily trips. To incorporate the tolls into the model process, several enhancements were made to the current model provided by VDOT for this study. These enhancements included:

- Stratification of trips into income quartiles to better represent differences in the value of time during the assignment step;
- Partitioning of the trip table into three time periods (morning peak, evening peak, and off-peak);
- Incorporation of a feedback loop to the trip distribution step; and
- Improved application of the assignment algorithm.

These improvements allow for the impacts of congestion and tolls on travel choices to be modeled more precisely. In making these modifications, an important goal was to keep the model output consistent with the existing model validation.

5.6 Toll Diversion Study

As part of the toll forecasts, the impacts on regional traffic patterns were examined. In particular, the impacts to traffic volumes on the Monitor Merrimac Memorial Bridge (MMMBT) were examined.

Tolling the HRBT results in shifting demand to the MMMBT, with an increasing volume of traffic being shifted to the MMMBT as the toll on the HRBT increases. As illustrated in Figure 17, without tolls, approximately 64 percent of daily traffic crossing Hampton Roads uses the HRBT. With tolling, this percentage falls to 50 percent with a $3 toll. At the same time, tolling reduces the total volume of traffic on both crossings, with total daily traffic decreasing from 233,600 without a toll to 193,800 with a $3 toll. The reduction in total traffic volume crossing Hampton Roads indicates that implementing tolls results in a shift in traffic patterns, with travelers choosing their destinations so as to avoid crossing the river.

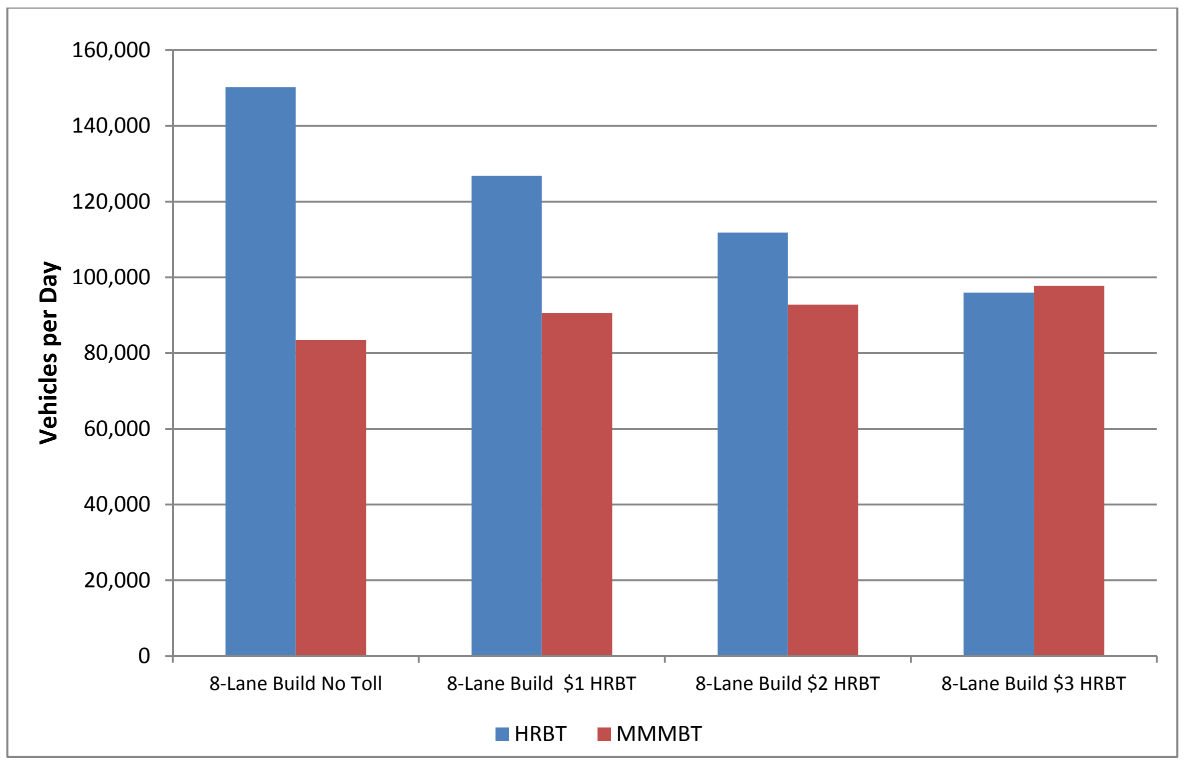


Figure 17. Average Daily Traffic on HRBT and MMMBT, HRBT Toll Only

Implementing a toll on both crossing would result in a less pronounced shift in demand between the HRBT and MMMBT, although daily traffic on the HRBT would still decrease from 64 percent to 58 percent with a $3 toll on both crossings. However, total volume crossing Hampton Roads would decrease substantially compared to the Build 8 traffic volume, with total daily traffic decreasing as much as 30 percent with a $3 toll. This indicates that travelers would significantly alter their travel behavior. The response to tolling both facilities is illustrated in Figure 18. The complete Toll Diversion Study results are provided in Appendix G.

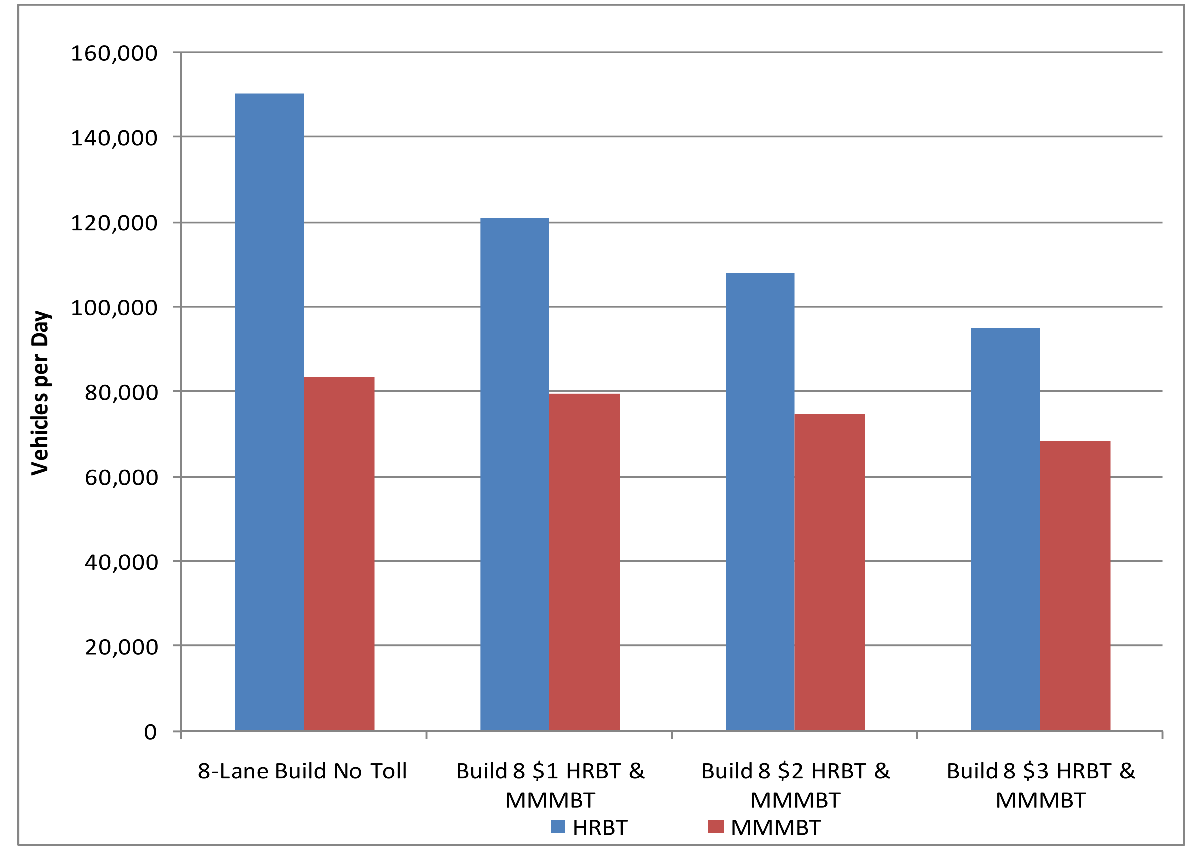


Figure 18. Average Daily Traffic on HRBT and MMMBT, HRBT and MMMBT Toll

5.7 Summary of Forecasts at the HRBT Crossing

The travel demand model volumes show that increasing the capacity on the HRBT crossing attracts traffic to the facility from other crossings, primarily the Monitor-Merrimac Bridge Tunnel (MMMBT). While new capacity is expected to generate some new trips that cause the increase in daily and peak hour volumes on the crossing, an assessment of regional traffic volumes also indicates that expanding capacity on the HRBT will draw traffic from parallel facilities, in particular I-664, the MMMBT.

As shown in Table 9, the total traffic crossing Hampton Roads steadily increases as capacity is added to the HRBT, but the increase in traffic demand levels off once the Build-10 capacity is reached. This trend indicates that the demand for capacity on the I-64 crossing (versus I-664) is met with the provision of 3 additional lanes per direction.

Table 9. Average 2040 Daily Traffic on HRBT and MMMBT by Scenario

Facility	No Build	Build 6	Build 8	Build 10	Build 12
I-64 (HRBT)	112,200	136,600	150,200	155,400	159,100
I-664 (MMMBT)	103,500	90,900	83,400	78,900	75,800
Total Traffic	215,700	227,500	233,600	234,300	234,900

6 VOLUMES AND ANALYSIS FOR THE NO BUILD ALTERNATIVE

The 2040 No Build Alternative represents 2040 traffic conditions under the assumption that all projects currently in the Constrained Long Range Plan are constructed, but no other roadway network improvements are made, other than structural rehabilitation of the crossing as described in Section 4. This study does not assume any improvement related to the Third Crossing.

Following the procedures outlined in Section 5, 2020 and 2040 No Build peak hour and daily traffic volumes were developed for the project area. These volumes are provided in Appendix B. A summary of No Build mainline volumes, and a comparison of these volumes with existing mainlines volumes, is provided in Table 10 and Table 11.

Table 10. Existing and Future No Build Average Weekday Traffic Volumes

Location on I-64	2011 Existing			2020 No Build			2040 No Build		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
West of I-664 (Exit 264)	76,100	75,700	151,800	84,700	84,600	169,300	97,900	97,900	195,800
I-664 to LaSalle Ave (Route 167, Exit 265A)	57,400	58,300	115,700	58,750	58,650	117,400	65,000	65,000	130,000
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	42,000	46,300	88,300	48,850	48,750	97,600	55,000	55,000	110,000
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	42,700	45,500	88,200	46,650	46,550	93,200	53,300	53,300	106,600
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	44,100	44,600	88,700	48,450	48,400	96,850	56,100	56,100	112,200
15th View Street to 4th View Street (Exit 273)	44,000	44,300	88,300	47,750	47,700	95,450	52,400	53,400	105,800
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	39,300	38,500	77,800	39,650	39,600	79,250	44,300	44,300	88,600
West Ocean/West Bay Ave to Granby Street (US 460)	45,400	43,300	88,700	45,050	45,000	90,050	50,200	50,200	100,400
Granby street to I-564 (Exit 276)	50,400	37,500	87,900	49,450	38,550	88,000	55,800	42,700	98,500
Mainline East of I-564	62,200	63,500	125,700	62,200	62,150	124,350	66,700	66,700	133,400
HOV Lanes East of I-564	8,000	8,000	16,000	8,750	8,750	17,500	10,000	10,000	20,000

Table 11. Existing and Future No Build AM (PM) Peak Hour Traffic Volumes

Location on I-64	2011 Existing		2020 No Build		2040 No Build	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
West of I-664 (Exit 264)	5,440 (4,285)	5,285 (7,235)	6,075 (4,775)	5,900 (8,050)	7,025 (5,525)	6,875 (9,225)
I-664 to LaSalle Ave (Route 167, Exit 265A)	4,675 (4,270)	4,575 (4,705)	4,775 (4,300)	4,650 (4,750)	5,250 (4,800)	5,150 (5,275)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	3,660 (3,165)	3,775 (4,070)	4,075 (3,475)	4,175 (4,475)	4,550 (3,950)	4,700 (5,075)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	3,820 (2,960)	3,305 (3,945)	4,050 (3,100)	3,500 (4,150)	4,625 (3,575)	4,000 (4,775)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	3,655 (3,320)	3,265 (3,380)	4,050 (3,550)	3,525 (3,675)	4,700 (4,150)	4,100 (4,300)
15th View Street to 4th View Street (Exit 273)	3,695 (3,265)	3,225 (3,375)	4,075 (3,475)	3,475 (3,650)	4,675 (4,150)	3,975 (4,275)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	3,315 (2,985)	2,865 (2,840)	3,400 (3,025)	2,925 (2,900)	3,775 (3,400)	3,275 (3,225)
West Ocean/West Bay Ave to Granby Street (US 460)	3,585 (4,020)	3,545 (2,990)	3,675 (4,050)	3,600 (3,025)	4,050 (4,550)	4,025 (3,375)
Granby street to I-564 (Exit 276)	3,920 (4,535)	3,280 (2,665)	4,000 (4,575)	3,300 (2,675)	4,325 (5,250)	3,575 (2,750)
Mainline East of I-564	3,535 (6,180)	6,840 (3,575)	3,600 (6,175)	6,600 (3,600)	4,425 (8,300)	8,675 (4,075)
HOV Lanes East of I-564	0 (2,620)	700 (0)	0 (2,600)	575 (0)	0 (2,650)	650 (0)

Examination of Table 10 and Table 11 shows that daily traffic volumes within the project limits are projected to increase between 12 and 26 percent by 2040, with the highest percentage increase occurring on the HRBT (two-way daily volume increase from 88,700 to 112,200, or 26 percent). Peak hour volume increases are generally in the same percentage range. Highest tunnel volumes are projected during the AM peak in the eastbound direction, with a projected volume of 4,700 vehicles in the peak hour.

As with the Existing Conditions assessment, capacity analyses were conducted for both the 2020 and 2040 No Build AM and PM peak hour conditions using the latest version of the Highway Capacity Software (HCS 2010 Version 6.1), which was developed based on the methodologies presented in the 2010 Highway Capacity Manual. All forecasts were analyzed with the same methodologies and assumptions used for the Existing Conditions Analysis.

The results of the 2020 and 2040 No Build capacity analyses are summarized in Table 12 through Table 15, and shown graphically in Appendix B.

Table 12. Eastbound I-64 Mainline and Ramp Capacity Analysis Results – 2020/2040 No Build

Exit	From	To	Type	2020 No Build		2040 No Build	
				AM	PM	AM	PM
265	NB I-664	SB LaSalle Avenue	Weave	C	C	C	C
	SB LaSalle Avenue	I-64	Merge	C	C	D	C
	NB LaSalle Avenue	I-64	Merge	D	D	D	E
	I-64	Rip Rap Road	Diverge	D	D	D	D
	Rip Rap Road	Settlers Landing Road	Mainline	C	C	C	C
267	I-64	Settlers Landing Road	Diverge	C	C	D	C
	Settlers Landing Road	Mallory Road	Weave	**E**	C	E	D
268	Mallory Road	I-64	Merge	**E**	D	F	F
	I-64 (HRBT)		Mainline	**E**	D	F	F
272	I-64	Bayview Avenue	Diverge	**E**	**E**	F	E
	Bayview Avenue	I-64	Merge	D	D	F	D
	Bayview Avenue	4th View Street	Mainline	**E**	D	F	E
273	I-64	4th View Street	Diverge	**E**	D	F	E
	4th View Street	I-64	Merge	D	C	D	D
	4th View Street	Bay Avenue	Mainline	D	C	D	D
274	Bay Avenue	I-64	Merge	D	**E**	E	F
	Bay Avenue	Patrol Road	Mainline	D	**E**	E	F
	Patrol Road	Ramp to I-564/Granby Road	Weave	D	**E**	E	E
	Off ramp to I-64 HOV	On ramp from I-564	Mainline	C	C	C	E
276	I-564	East Little Creek Road	Mainline	B	C	B	D

Table 13. Westbound I-64 Mainline and Ramp Capacity Analysis Results– 2020/2040 No Build

Exit	From	To	Type	2020 No Build		2040 No Build	
				AM	PM	AM	PM
276B	I-64	Ramp to I-564	Mainline	D	B	E	B
276A	I-64	Granby Street	Diverge	D	C	E	D
	I-564	I-64	Merge	C	C	D	C
	I-564	Granby Street/Rte 460	Mainline	D	C	D	C
	Granby Street/Rte 460	I-64	Merge	D	D	E	D
	Granby Street/Rte 460	Ocean Avenue	Mainline	D	C	E	D
274	I-64	Ocean Avenue	Diverge	C	C	D	C
	Ocean Avenue	4th View Street	Mainline	D	C	D	D
273	I-64	4th View Street	Diverge	C	C	D	D
	4th View Street	I-64	Merge	D	D	D	F
	4th View Street	Ocean View Avenue	Mainline	D	D	E	E
272	I-64	Ocean View Avenue	Diverge	D	D	D	E
	Ocean View Avenue	I-64	Merge	D	D	E	E
	I-64 (HRBT)		Mainline	D	**E**	E	F
268	I-64	Mallory Avenue	Diverge	D	D	E	F
267	Mallory Avenue	Settlers Landing Road	Weave	B	C	C	D
	Settlers Landing Road	I-64	Merge	C	C	D	D
	Settlers Landing Road	Armistead Avenue	Mainline	C	C	C	D
265B	I-64	Armistead Avenue	Diverge	C	D	D	D
	Armistead Avenue	I-664	Weave	C	C	D	D

Table 14. I-564 Mainline and Ramp Capacity Analysis Results– 2020/2040 No Build

Exit	From	To	Type	2020 No Build		2040 No Build	
				AM	PM	AM	PM
	NB Granby	Terminal Avenue	Weave	D	A	D	A
	EB I-64	Terminal Avenue	Weave	C	A	C	A
	Terminal Avenue	Admiral Taussig Boulevard	Mainline	C	A	C	A
Exit	**From**	**To**	**Type**			**AM**	**PM**
	I-564	Admiral Taussig Boulevard	Diverge	A	C	A	C
	I-564		Mainline	A	C	A	C
	Terminal Avenue	I-564	Merge	A	D	B	F
	I-564	E Little Creek Parkway	Lane Drop	A	D	A	F

Table 15. Intersection Capacity Analysis Results– 2020/2040 No Build

Intersection	2020 No Build		2040 No Build	
	AM	PM	AM	PM
WB I-64 On-Ramp at N Armistead Ave	C	**E**	B	C
N Armistead Ave at LaSalle Ave	C	**F**	C	F
I-64 EB Off-Ramp at Rip Rap Rd	C	**E**	C	D
I-64 EB Off-Ramp at Settlers Landing Rd	F	D	**E**	D
I-64 WB Ramps at Settlers Landing Rd	B	C	B	C
I-64 EB Ramps at S Mallory St	D	**F**	**F**	**F**
I-64 WB Ramps at S Mallory St	F	C	F	F
Granby St at E Admiral Taussig Blvd	B	B	C	B
I-64 EB Ramps at E Little Creek Rd	B	B	A	B
I-64 WB Off-Ramp at E Little Creek Rd	C	C	B	B
EB I-64 Ramps at Bayville St*	A	A	A	A
WB I-64 Ramps at W Ocean View Ave*	A	A	B	A
EB I-64 Ramps at 4th View St*	**F**	**F**	**F**	**F**
WB I-64 Ramps at 4th View St*	**F**	**F**	**F**	**F**

*Stop-controlled intersection; LOS for worst approach shown

Examination of the capacity analysis results shows that levels of service along the mainline are generally projected to decrease compared to Existing Conditions. By 2040, the HRBT is projected operate at LOS E or F during both peak hours; with the exception of westbound I-64 between I-564 and Granby Streets, all segments south/east of the HRBT to the I-564 interchange are projected operate at LOS D or worse during all peak hours. Segments north/west of the HRBT are generally projected to operate at LOS C or D. The declining levels of service clearly indicate that current congestion and delays will worsen in the future if no mitigation beyond the current CLRP is implemented.

As mentioned earlier, the HCM methodology also tends to overestimate available capacity on roadway segments where the driving environment significantly affects motorist behavior. Therefore, without addressing the existing geometric deficiencies congestion is likely to be worse than these analyses indicate.

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7 VOLUMES AND ANALYSIS FOR THE BUILD 6 ALTERNATIVE

The Build 6 scenario assumes provision of one additional lane in each direction on the crossing. One additional lane in each direction would also be provided on I-64 between the crossing and the I-564 interchange. Because there are already six lanes (three in each direction) between the I-664 interchange and the crossing, this section of I-64 was not modified in the network coding. Under this scenario, there are six continuous lanes through the study area between the I-664 and I-564 interchanges.

The resulting daily and peak hour volumes for the Build 6 scenario are provided in 0. A summary of 2040 mainline volumes is provided in Table 16 and Table 17. It should be noted that only 2040 volumes were developed for the Build 6 scenario, because it was not carried forward for detailed analysis after this assessment, and no interim year forecasts for air and noise analyses were required.

Examination of these tables and figures shows that expanding capacity of the HRBT crossing to six lanes is projected to attract additional traffic to the facility beyond what is forecast under the 2040 No Build scenario, with daily volumes between 10 and 36 percent higher compared to 2040 No Build volumes, and peak hour volumes showing a similar increase.

Table 16. 2040 Build-6 Average Weekday Daily Traffic Volumes

Location on I-64	2040 Build 6		
	Eastbound	Westbound	Total
West of I-664 (Exit 264)	101,200	101,200	202,400
I-664 to LaSalle Ave (Route 167, Exit 265A)	71,900	71,900	143,800
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	63,400	63,400	126,800
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	65,400	65,400	130,800
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	68,300	68,300	136,600
15th View Street to 4th View Street (Exit 273)	66,500	66,200	132,700
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	60,200	60,200	120,400
West Ocean/West Bay Ave to Granby Street (US 460)	68,800	68,800	137,600
Granby street to I-564 (Exit 276)	73,500	61,000	134,500
Mainline East of I-564	73,200	73,200	146,400
HOV Lanes East of I-564	10,000	10,000	20,000

Table 17. 2040 Build 6 AM (PM) Peak Hour Traffic Volumes

Location on I-64	2040 Build 6	
	Eastbound	Westbound
West of I-664 (Exit 264)	7,250 (5,725)	7,075 (9,400)
I-664 to LaSalle Ave (Route 167, Exit 265A)	5,800 (5,300)	5,675 (5,850)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	5,250 (4,550)	5,425 (5,850)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	5,950 (4,600)	5,150 (6,125)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	5,725 (5,050)	5,000 (5,225)
15th View Street to 4th View Street (Exit 273)	5,725 (5,025)	4,950 (5,250)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	5,125 (4,625)	4,425 (4,400)
West Ocean/West Bay Ave to Granby Street (US 460)	5,550 (6,225)	5,500 (4,650)
Granby street to I-564 (Exit 276)	5,775 (6,700)	4,425 (3,250)
Mainline East of I-564	4,150 (7,550)	7,900 (3,750)
HOV Lanes East of I-564	0 (2,775)	650 (0)

Table 18. Eastbound I-64 Mainline and Ramp Capacity Analysis Results –2040 Build 6

Exit	From	To	Type	AM	PM
265	NB I-664	SB LaSalle Avenue	Weave	D	D
	SB LaSalle Avenue	I-64	Merge	D	D
	NB LaSalle Avenue	I-64	Merge	**E**	**E**
	I-64	Rip Rap Road	Diverge	D	D
	Rip Rap Road	Settlers Landing Road	Mainline	D	C
267	I-64	Settlers Landing Road	Diverge	D	D
	Settlers Landing Road	Mallory Road	Weave	E	D
268	Mallory Road	I-64	Merge	D	D
	I-64 (HRBT)		Mainline	**E**	D
272	I-64	Bayview Avenue	Diverge	**E**	D
	Bayview Avenue	I-64	Merge	D	C
	Bayview Avenue	4th View Street	Mainline	**E**	D
273	I-64	4th View Street	Diverge	D	D
	4th View Street	I-64	Merge	D	C
	4th View Street	Bay Avenue	Mainline	D	C
274	Bay Avenue	I-64	Merge	D	**E**
	Bay Avenue	Patrol Road	Mainline	D	**E**
	Patrol Road	Ramp to I-564/Granby Road	Weave	**F**	**F**
	Off ramp to I-64 HOV	On ramp from I-564	Mainline	B	D
276	I-564	East Little Creek Road	Mainline	C	**F**

The Build 6 peak hour volumes were analyzed using HCS, using the same assumptions as were used for the No Build analysis. Lane configurations for mainline section and ramp merge/diverge/weaving sections were modified to reflect the number of mainline lanes in the Build 6 scenario. Results of the capacity analysis are provided in Table 18 through Table 20, as well as in Appendix C. As the mainline capacity analyses on the crossing showed levels of service E, intersection analyses were not performed for this alternative.

Table 19. Westbound I-64 Mainline and Ramp Capacity Analysis Results– 2040 Build 6

Exit	From	To	Type	AM	PM
276B	I-64	Ramp to I-564	Mainline	**F**	B
276A	I-64	Granby Street	Diverge	D	C
	I-564	I-64	Merge	C	C
	I-564	Granby Street/Rte 460	Mainline	C	B
	Granby Street/Rte 460	I-64	Merge	D	D
	Granby Street/Rte 460	Ocean Avenue	Mainline	D	D
274	I-64	Ocean Avenue	Diverge	C	C
	Ocean Avenue	4th View Street	Mainline	C	C
273	I-64	4th View Street	Diverge	C	C
	4th View Street	I-64	Merge	D	D
	4th View Street	Ocean View Avenue	Mainline	D	D
272	I-64	Ocean View Avenue	Diverge	C	C
	Ocean View Avenue	I-64	Merge	C	D
	I-64 (HRBT)		Mainline	D	D
268	I-64	Mallory Avenue	Diverge	D	D
267	Mallory Avenue	Settlers Landing Road	Weave	D	E
	Settlers Landing Road	I-64	Merge	D	D
	Settlers Landing Road	Armistead Avenue	Mainline	D	D
265B	I-64	Armistead Avenue	Diverge	D	**E**
	Armistead Avenue	I-664	Weave	C	D

Table 20. I-564 Mainline and Ramp Capacity Analysis Results– 2040 Build 6

Exit	From	To	Type	AM	PM
	NB Granby	Terminal Avenue	Weave	C	A
	EB I-64	Terminal Avenue	Weave	**E**	B
	Terminal Avenue	Admiral Taussig Boulevard	Mainline	C	A
Exit	**From**	**To**	**Type**	**AM**	**PM**
	I-564	Admiral Taussig Boulevard	Diverge	A	C
	I-564		Mainline	A	C
	Terminal Avenue	I-564	Merge	B	C
	I-564	E Little Creek Parkway	Lane Drop	A	B

8 VOLUMES AND ANALYSIS FOR THE BUILD 8 ALTERNATIVE

The Build 8 scenario assumes provision of two additional lanes in each direction on the HRBT crossing for a total of eight lanes crossing Hampton Roads. Along with the two additional lanes on the crossing, one additional lane in each direction was assumed between the I-664 interchange and the HRBT, and two additional lanes between the HRBT and the I-564 interchange.

The resulting daily and peak hour traffic volumes for the Build 8 scenario are provided in 0. Summaries of 2020 and 2040 mainline volumes are provided in Table 21 and Table 22.

Examination of these tables and figures shows that expanding capacity of the HRBT crossing to eight lanes is projected to attract additional traffic to the facility beyond what is forecast under both the 2040 No Build and Build 6 scenarios, with daily volumes between 29 and 64 percent higher compared to 2040 No Build volumes, and with peak hour volumes showing a similar increase. As expected, the highest volume increases are projected where the largest capacity increases occur on the HRBT and eastward.

The Build 8 peak hour volumes were analyzed using HCS, with the same assumptions used for the 2040 No Build analysis. Lane configurations for mainline section and ramp merge/diverge/weaving sections were modified to reflect the number of mainline lanes in the Build 8 scenario. Results of the capacity analysis are provided in Table 23 through Table 26, as well as in Appendix D. The capacity analyses show that, while levels of service generally improve compared to the No Build scenario, level of service D is still prevalent on most mainline sections. Failing levels of service are found on the weaving section along eastbound I-64 between Granby Street and the I-564 interchange. Although level of service C is preferred, FHWA considers level of service D acceptable for an urban interstate roadway such as I-64 in this corridor.

Table 21. 2020 and 2040 Build-8 Daily Weekday Traffic Volumes

Location on I-64	2020 Build 8			2040 Build 8		
	Eastbound	Westbound	Total	Eastbound	Westbound	Total
West of I-664 (Exit 264)	89,800	89,800	179,600	103,100	103,100	206,200
I-664 to LaSalle Ave (Route 167, Exit 265A)	73,700	73,700	147,400	83,700	83,700	167,400
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	63,500	63,500	127,000	73,200	73,200	146,400
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	64,400	64,400	128,800	75,100	75,100	150,200
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	69,500	69,500	139,000	75,100	75,100	150,200
15th View Street to 4th View Street (Exit 273)	68,850	68,850	137,700	72,800	73,900	146,700
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	60,700	60,750	121,450	70,700	70,700	141,400
West Ocean/West Bay Ave to Granby Street (US 460)	69,500	69,550	139,050	82,200	82,000	164,200
Granby street to I-564 (Exit 276)	75,750	56,050	131,800	86,500	73,000	159,500
Mainline East of I-564	68,900	68,950	137,850	78,400	78,400	156,800
HOV Lanes East of I-564	9,850	9,850	19,700	10,000	10,000	20,000

Table 22. 2020 and 2040 Build-8 AM (PM) Peak Hour Traffic Volumes

Location on I-64	2020 Build 8		2040 Build 8	
	Eastbound	Westbound	Eastbound	Westbound
West of I-664 (Exit 264)	6,425 (5,075)	6,250 (8,325)	7,400 (5,825)	7,225 (9,700)
I-664 to LaSalle Ave (Route 167, Exit 265A)	5,950 (5,250)	5,825 (6,000)	6,775 (6,175)	6,625 (6,800)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	5,275 (4,350)	5,425 (5,875)	6,075 (5,250)	6,250 (6,750)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	5,575 (4,125)	4,825 (5,775)	6,500 (5,050)	5,625 (6,725)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	5,800 (4,925)	5,050 (5,300)	6,275 (5,550)	5,475 (5,750)
15th View Street to 4th View Street (Exit 273)	5,825 (4,875)	5,000 (5,275)	6,300 (5,575)	5,450 (5,775)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	5,175 (4,450)	4,475 (4,425)	6,025 (5,425)	5,200 (5,150)
West Ocean/West Bay Ave to Granby Street (US 460)	5,625 (6,100)	5,550 (4,675)	6,650 (7,450)	6,575 (5,550)
Granby street to I-564 (Exit 276)	6,050 (6,875)	4,850 (3,925)	6,875 (7,900)	5,350 (3,950)
Mainline East of I-564	3,900 (6,450)	7,150 (3,975)	4,375 (7,925)	8,375 (3,975)
HOV Lanes East of I-564	0 (3,075)	675 (0)	0 (3,050)	725 (0)

Table 23. Eastbound I-64 Mainline and Ramp Capacity Analysis Results – 2020 and 2040 Build 8

Exit	From	To	Type	2020 Build 8		2040 Build 8	
				AM	PM	AM	PM
265	NB I-664	SB LaSalle Avenue	Weave	C	C	D [D][1]	**F** [D][1]
	SB LaSalle Avenue	I-64	Merge	C	C	C	C
	NB LaSalle Avenue	I-64	Merge	C	C	C	C
	I-64	Rip Rap Road	Diverge	D	C	D	D
	Rip Rap Road	Settlers Landing Road	Mainline	C	B	C	C
267	I-64	Settlers Landing Road	Diverge	D	C	D	C
	Settlers Landing Road	Mallory Road	Weave	D	C	**E** [D][2]	C [C][2]
268	Mallory Road	I-64	Merge	C	C	D	C
	I-64 (HRBT)		Mainline	D	C	D	D
272	I-64	Bayview Avenue	Diverge	C	C	D	C
	Bayview Avenue	I-64	Merge	B	B	C	B
	Bayview Avenue	4th View Street	Mainline	D	C	D	C
273	I-64	4th View Street	Diverge	C	C	D	C
	4th View Street	I-64	Merge	B	B	C	C
	4th View Street	Bay Avenue	Mainline	C	C	C	C
274	Bay Avenue	I-64	Merge	C	D	D [B][3]	**E** [D][3]
	Bay Avenue	Patrol Road	Mainline	C	C	D	D
	Patrol Road	Ramp to I-564/Granby Road	Weave	**F**	**F**	**F [F]**[4]	**F** [D][4]
	Off ramp to I-64 HOV	On ramp from I-564	Mainline	B	B	B	C
276	I-564	East Little Creek Road	Mainline	B	C	C	D

[1] Requires addition of choice exit lane on ramp to LaSalle Road
[2] Requires addition of choice exit lane on ramp to Mallory Road
[3] Requires addition of second ramp lane from Bay Avenue
[4] Requires addition of choice exit lane on ramp to Granby Street

The capacity analyses indicate that while most mainline freeway segments are projected to operate at acceptable levels of service, a number of weaving segments are projected to operate at level of service E or F. Conceptual improvements were developed for these segments; the resulting levels of service are provided in brackets.

It must be noted that these improvements have not been reviewed for feasibility or constructability; the intent is to show the level of improvement necessary to achieve acceptable levels of service for this Alternative. The analyses show that the weaving section between Patrol Road and the ramp to Granby Road along eastbound I-564 continues to operate at LOS F; additional improvements may be required to provide acceptable levels of service, which will be examined in the next phase of the study.

Table 24. Westbound I-64 Mainline and Ramp Capacity Analysis Results– 2020 and 2040 Build 8

Exit	From	To	Type	2020 Build 8		2040 Build 8	
				AM	PM	AM	PM
276B	I-64	Ramp to I-564	Mainline	D	B	**F**[D][1]	B [B][1]
276A	I-64	Granby Street	Diverge	C	B	D	B
	I-564	I-64	Merge	B	B	B	B
	I-564	Granby Street/Rte 460	Mainline	C	B	C	B
	Granby Street/Rte 460	I-64	Merge	C	C	D	D
	Granby Street/Rte 460	Ocean Avenue	Mainline	C	C	D	C
274	I-64	Ocean Avenue	Diverge	C	B	D	B
	Ocean Avenue	4th View Street	Mainline	C	C	C	C
273	I-64	4th View Street	Diverge	B	B	C	C
	4th View Street	I-64	Merge	C	C	C	C
	4th View Street	Ocean View Avenue	Mainline	C	C	C	C
272	I-64	Ocean View Avenue	Diverge	B	B	B	C
	Ocean View Avenue	I-64	Merge	B	C	C	C
	I-64 (HRBT)		Mainline	C	C	C	D
268	I-64	Mallory Avenue	Diverge	C	C	C	C
267	Mallory Avenue	Settlers Landing Road	Weave	B	C	C	D
	Settlers Landing Road	I-64	Merge	C	C	D	C
	Settlers Landing Road	Armistead Avenue	Mainline	C	C	C	D
265B	I-64	Armistead Avenue	Diverge	C	D	D	D
	Armistead Avenue	I-664	Weave	C	C	D	D

[1] Requires addition of one lane on westbound I-564

Table 25. I-564 Mainline and Ramp Capacity Analysis Results– 2020 and 2040 Build 8

Exit	From	To	Type	2020 Build 8		2040 Build 8	
				AM	PM	AM	PM
	NB Granby	Terminal Avenue	Weave	D	A	F	A
	EB I-64	Terminal Avenue	Weave	**F**	A	**F**	A
	Terminal Avenue	Admiral Taussig Boulevard	Mainline	B	A	B	A
Exit	**From**	**To**	**Type**	AM	PM	**AM**	**PM**
	I-564	Admiral Taussig Boulevard	Diverge	A	C	A	C
	I-564		Mainline	A	C	A	C
	Terminal Avenue	I-564	Merge	A	C	A	D
	I-564	E Little Creek Parkway	Lane Drop	A	D	A	C

Table 26. Intersection Capacity Analysis Results– 2020 and 2040 Build 8

Intersection	2020 Build 8		2040 Build 8	
	AM	PM	AM	PM
WB I-64 On-Ramp at N Armistead Ave	C	**E**	B	B
N Armistead Ave at LaSalle Ave	C	**F**	**E**	**F**
I-64 EB Off-Ramp at Rip Rap Rd	D	**E**	C	C
I-64 EB Off-Ramp at Settlers Landing Rd	**F**	D	**F**	**E**
I-64 WB Ramps at Settlers Landing Rd	C	C	C	C
I-64 EB Ramps at S Mallory St	B	**F**	**F**	**F**
I-64 WB Ramps at S Mallory St	**F**	D	**F**	**F**
Granby St at E Admiral Taussig Blvd	B	B	B	**E**
I-64 EB Ramps at E Little Creek Rd	B	C	B	D
I-64 WB Off-Ramp at E Little Creek Rd	C	D	C	**E**
EB I-64 Ramps at Bayville St*	A	A	A	A
WB I-64 Ramps at W Ocean View Ave*	A	A	B	A
EB I-64 Ramps at 4th View St*	**F**	**F**	**F**	**F**
WB I-64 Ramps at 4th View St*	**E**	**F**	**F**	**F**

*Stop-controlled intersection; LOS for worst approach shown

Since the focus of the study was the mainline operation, intersection improvements were not yet developed at this stage of the study.

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9 VOLUMES AND ANALYSIS FOR THE BUILD 8 – MANAGED ALTERNATIVE

The Build-8 Managed Alternative is similar to the Build-8 Alternative, providing four continuous mainline lanes in each direction of I-64 throughout the limits of the study. However, the Build-8 Managed Alternative also includes tolling options, including tolling of all I-64 mainline lanes or a combination of managed and general purpose lanes, such as high occupancy toll (HOT) lanes (where HOV users use the lanes for free but single occupancy vehicles (SOV) pay a toll to use the HOT lanes).

A number of managed lane forecasts were developed, which analyzed combinations of various toll rates on the Hampton Roads crossing (i.e., toll implementation on the HRBT alone and on both the HRBT and Monitor Merrimac Memorial Bridge); and three different general purpose/managed lane configurations on the HRBT. Forecasts from the all-toll alternatives determined the assumed toll rate the development of the other managed lane alternatives.

9.1 All-Toll Alternatives

Table 27 shows the weekday daily mainline volumes along I-64 for the three all-toll alternatives which were analyzed. For comparison, the Build-8 volumes are shown as well. Table 28 shows the changes in daily traffic volume on the Monitor Merrimac Memorial Bridge Tunnel (MMMBT) as tolls on the HRBT are implemented. Table 29 shows the peak hour traffic volumes for the all-toll alternatives. These volumes are also provided in Appendix E.

Implementing tolls generally results in lower volumes crossing Hampton Roads compared to the no toll Build-8 alternative. With only the HRBT being tolled, daily volumes on the HRBT decrease from 16 to 36 percent. At the limits of the project area (near the I-664 and I-564 interchanges), volume decreases are less pronounced.

As shown in Table 28, under the "Toll HRBT Only" scenarios, some traffic is seen diverting to the MMMBT, although the total volume of traffic crossing Hampton Roads declines as a result of changes in regional travel patterns.

Mainline capacity analyses were performed for the all-toll alternatives; results are shown in Table 30. The analyses show that except for the weaving segment between Granby Street and I-564 on eastbound I-64, LOS D or better is achieved on all segments under all toll scenarios except the "$1, both crossings" scenario. As expected, the highest levels of service along I-64 are experienced when only the HRBT is tolled.

Table 27. 2040 Build 8 – All Toll Weekday Daily Traffic Volumes

Location on I-64	Build 8	Toll on HRBT		
	$0	$1	$2	$3
West of I-664 (Exit 264)	206,200	199,200	194,950	191,800
I-664 to LaSalle Ave (Route 167, Exit 265A)	167,400	155,000	143,750	132,200
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	146,400	133,000	121,800	110,600
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	150,200	132,400	116,400	100,200
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	150,200	126,800	111,800	96,000
15th View Street to 4th View Street (Exit 273)	146,700	128,600	113,500	97,600
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	141,400	123,150	108,600	93,250
West Ocean/West Bay Ave to Granby Street (US 460)	164,200	147,350	134,000	118,850
Granby street to I-564 (Exit 276)	159,500	139,750	127,500	114,450
Mainline East of I-564	156,800	146,300	139,700	137,750
HOV Lanes East of I-564	20,000	20,800	19,800	19,400

Table 28. Average 2040 Daily Weekday Traffic On HRBT and MMMBT with Toll Implementation

Crossing Facility	Build 8	Toll on HRBT		
	$0	$1	$2	$3
I-64 (HRBT)	150,200	126,800	111,800	96,000
I-664 (MMMBT)	83,400	90,500	92,800	97,800
Total Traffic	233,600	217,300	204,600	193,800

Table 29. 2040 Build 8 – All Toll Peak Hour Traffic Volumes

Location on I-64	Build 8		Toll on HRBT					
	$0		$1		$2		$3	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
West of I-664 (Exit 264)	7,400 (5,825)	7,225 (9,700)	7,150 (5,625)	6,950 (9,300)	7,000 (5,500)	6,800 (9,175)	6,875 (5,425)	6,650 (9,100)
I-664 to LaSalle Ave (Route 167, Exit 265A)	6,775 (6,175)	6,625 (6,800)	6,275 (5,575)	6,150 (6,275)	5,800 (5,225)	5,675 (5,825)	5,350 (4,850)	5,200 (5,350)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	6,075 (5,250)	6,250 (6,750)	5,525 (4,625)	5,700 (6,100)	5,050 (4,300)	5,175 (5,625)	4,575 (3,950)	4,700 (5,075)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	6,500 (5,050)	5,625 (6,725)	5,725 (4,300)	4,950 (5,900)	5,050 (3,825)	4,325 (5,200)	4,350 (3,350)	3,725 (4,450)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	6,275 (5,550)	5,475 (5,750)	5,275 (4,525)	4,600 (4,825)	4,650 (4,050)	4,075 (4,250)	4,000 (3,500)	3,500 (3,650)
15th View Street to 4th View Street (Exit 273)	6,300 (5,575)	5,450 (5,775)	5,475 (4,675)	4,600 (4,900)	4,850 (4,175)	4,075 (4,325)	4,175 (3,625)	3,475 (3,700)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	6,025 (5,425)	5,200 (5,150)	5,250 (4,575)	4,525 (4,500)	4,625 (4,100)	3,975 (3,975)	3,975 (3,550)	3,425 (3,400)
West Ocean/West Bay Ave to Granby Street (US 460)	6,650 (7,450)	6,575 (5,550)	5,950 (6,525)	5,900 (4,975)	5,425 (6,000)	5,325 (4,525)	4,800 (5,350)	4,750 (4,000)
Granby street to I-564 (Exit 276)	6,875 (7,900)	5,350 (3,950)	6,400 (7,350)	5,150 (4,175)	5,850 (6,750)	4,675 (3,825)	5,200 (6,025)	4,250 (3,450)
Mainline East of I-564	4,375 (7,925)	8,375 (3,975)	4,150 (6,825)	8,150 (4,250)	3,950 (6,625)	7,775 (4,050)	3,925 (6,625)	7,675 (4,000)
HOV Lanes East of I-564	0 (3,050)	725 (0)	0 (3,275)	700 (0)	0 (3,100)	675 (0)	0 (3,000)	650 (0)

Table 30. 2040 Build 8 – All Toll Mainline Capacity Analysis Results

Location on I-64	Build 8		Toll on HRBT					
	$0		$1		$2		$3	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
I-664 to LaSalle Ave (Route 167, Exit 265A)	D (**F**)	D (D)	C (C)	C (C)	C (B)	C (C)	C (C)	C (C)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	C (C)	C (D)	C (C)	C (C)	C (B)	C (C)	C (B)	C (C)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	**E** (C)	C (D)	D (C)	C (D)	C (B)	B (C)	D (C)	C (D)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	D (D)	C (D)	C (C)	C (C)	C (C)	C (C)	C (B)	B (B)
15th View Street to 4th View Street (Exit 273)	D (C)	C (C)	C (C)	C (C)	C (C)	B (C)	C (B)	B (B)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	C (C)	C (C)	C (C)	C (C)	C (B)	B (B)	B (B)	B (B)
West Ocean/West Bay Ave to Granby Street (US 460)	D (D)	D (C)	C (D)	C (C)	C (C)	C (C)	C (C)	C (B)
Granby street to I-564 (Exit 276)	**F** (**F**)	C (B)	**F** (**F**)	C (B)	**F** (E)	C (B)	**F** (**F**)	B (B)
Mainline East of I-564	C (D)	**F** (B)	B (D)	**E** (B)	B (D)	D (B)	B (D)	D (B)

9.2 High Occupancy Toll (HOT) and High Occupancy Vehicle (HOV) Alternatives

The all-toll alternatives assumes that all trips across the HRBT will be charged. However, three alternative managed lane approaches which comprise a combination of free general purpose and managed lanes. The managed lanes are available free of charge roadway users who meet certain requirements, but will be tolled to all other users.

Three scenarios were examined:

1. **Two HOT Lanes + Two General Purpose Lanes [2 HOT / HOV-2 "free" + 2 GP]:** This scenario would include two general purpose lanes and two HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.
2. **One HOV Lane + Three General Purpose Lanes [1 HOV-2 "free" + 3 GP]:** This scenario would include three general purpose lanes and one HOV lane in each direction. The HOV lane would be restricted to HOV-2 vehicles that would travel for free.
3. **One HOT Lane + Three General Purpose Lanes [1 HOT / HOV-2 "free" + 3 GP]:** This scenario would include three general purpose lanes and one HOT lane in each direction. The HOT lanes would be restricted to HOV-2 vehicles that would travel for free and SOVs that would pay a toll to use the lane.

Based on the results of the initial toll analysis, a fixed toll of $2 was assumed for the HOT scenarios.

All HOT/HOV scenarios have the same general eight-lane configuration as the Build 8 alternative; however, the cross-section varies slightly in order to separate the general purpose and managed lanes.

The resulting total weekday daily volumes are shown in Table 31, as well as in Appendix E. Managed lane volumes for each mainline segment are shown in square brackets. For comparison, the Build 8 volumes are shown as well.

Total peak hour volumes for each alternative are shown in Table 32, and corresponding mainline levels of service are shown in Table 33. Volumes and levels of service for the managed lanes are shown in square brackets. The capacity analysis assumes that all interchange movements currently possible at each interchange are retained for the managed lanes. Levels of service for the managed lanes are not provided for weaving segments, because weaving segments do not allow the separation of managed and general purpose lanes.

The analyses show that volumes under the Build 8 – HOV/HOT scenarios are generally closer to the Build 8 scenario than the Build 8 – Toll scenarios. The 1 HOT + 3 GP scenario sees the highest total daily traffic volume on the HRBT crossing, and while the 2 HOT +2 GP scenario attract the most traffic in the managed lanes, it sees the lowest total traffic volume on the HRBT.

The capacity analyses indicate that only the 1 HOT + 3 GP scenario achieves level of service D or better

Table 31. 2040 Build 8 – HOT/HOV Weekday Daily Traffic Volumes

Location on I-64	Build 8	1 HOT + 3 GP	2 HOT + 2 GP	1 HOV + 3 GP
West of I-664 (Exit 264)	206,200	197,600	196,600	197,350
I-664 to LaSalle Ave (Route 167, Exit 265A)	167,400	160,200 [29,200]	153,900 [52,150]	156,050 [24,300]
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	146,400	139,000 [27,150]	133,100 [48,200]	135,450 [22,400]
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	150,200	142,000 [25,700]	135,050 [46,375]	139,450 [18,500]
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	150,200	141,400 [23,950]	132,650 [34,300]	139,050 [17,500]
15th View Street to 4th View Street (Exit 273)	146,700	142,700 [24,150]	134,150 [34,700]	140,250 [17,650]
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	141,400	134,000 [28,400]	127,650 [41,150]	131,600 [15,700]
West Ocean/West Bay Ave to Granby Street (US 460)	164,200	155,600 [32,950]	149,450 [48,175]	153,400 [18,300]
Granby street to I-564 (Exit 276)	159,500	146,900 [29,150]	142,700 [42,625]	144,850 [16,575]
Mainline East of I-564	156,800	147,100	148,400	144,200
HOV Lanes East of I-564	20,000	21,000	21,300	20,700

Table 32. 2040 Build 8 – HOT/HOV Peak Hour Traffic Volumes

Location on I-64	Build 8		1 HOT + 3 GP				2 HOT + 2 GP				1 HOV + 3 GP			
			AM		PM		AM		PM		AM		PM	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
West of I-664 (Exit 264)	7,400 (5,825)	7,225 (9,700)	7,075	6,850	5,575	9,225	7,050	6,825	5,550	9,200	7,075	6,850	5,575	9,250
I-664 to LaSalle Ave (Route 167, Exit 265A)	6,775 (6,175)	6,625 (6,800)	6,475 [1,550]	6,300 [950]	5,725 [1,375]	6,500 [1,625]	6,225 [2,650]	6,050 [2,050]	5,525 [2,275]	6,250 [3,025]	6,300 [925]	6,150 [775]	5,600 [1,375]	6,350 [1,525]
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	6,075 (5,250)	6,250 (6,750)	5,750 [1,300]	5,925 [1,000]	4,800 [1,100]	6,400 [1,475]	5,525 [2,600]	5,650 [1,925]	4,625 [1,900]	6,125 [2,950]	5,600 [600]	5,775 [750]	4,700 [1,100]	6,250 [1,350]
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	6,500 (5,050)	5,625 (6,725)	6,150 [1,500]	5,325 [575]	4,600 [1,025]	6,350 [1,500]	5,850 [2,900]	5,025 [1,325]	4,375 [1,650]	6,050 [2,925]	6,050 [500]	5,200 [525]	4,525 [975]	6,225 [1,025]
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	6,275 (5,550)	5,475 (5,750)	5,900 [1,425]	5,150 [450]	5,025 [975]	5,375 [1,250]	5,525 [2,675]	4,825 [625]	4,725 [1,125]	5,050 [2,425]	5,800 [400]	5,050 [425]	4,975 [975]	5,300 [775]
15th View Street to 4th View Street (Exit 273)	6,300 (5,575)	5,450 (5,775)	6,075 [1,450]	5,150 [450]	5,150 [1,000]	5,425 [1,275]	5,700 [2,775]	4,825 [625]	4,850 [1,150]	5,125 [2,475]	5,975 [400]	5,025 [425]	5,075 [1,000]	5,325 [775]
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	6,025 (5,425)	5,200 (5,150)	5,700 [1,425]	4,925 [850]	4,975 [1,200]	4,900 [1,175]	5,425 [2,600]	4,700 [1,025]	4,750 [1,625]	4,650 [2,200]	5,600 [550]	4,850 [350]	4,900 [950]	4,800 [875]
West Ocean/West Bay Ave to Granby Street (US 460)	6,650 (7,450)	6,575 (5,550)	6,300 [1,575]	6,225 [1,075]	6,875 [1,675]	5,250 [1,275]	6,050 [2,900]	5,975 [1,300]	6,625 [2,275]	5,025 [2,375]	6,200 [600]	6,125 [450]	6,800 [1,300]	5,175 [950]
Granby street to I-564 (Exit 276)	6,875 (7,900)	5,350 (3,950)	6,775 [1,675]	5,375 [750]	7,750 [1,825]	4,375 [1,050]	6,525 [3,100]	5,250 [950]	7,475 [2,325]	4,275 [2,000]	6,650 [900]	5,300 [300]	7,650 [1,425]	4,300 [950]
Mainline East of I-564	4,375 (7,925)	8,375 (3,975)	4,125	8,175	6,825	4,250	4,225	8,325	6,950	4,300	4,075	8,050	6,725	4,150
HOV Lanes East of I-564	0 (3,050)	725 (0)	0	725	3,350	0	0	700	3,350	0	0	700	3,275	0

Note: values in brackets indicate managed lane volumes

Table 33. 2040 Build 8 – HOT/HOV Mainline Capacity Analysis Results

Location on I-64	Build 8		1 HOT + 3 GP				2 HOT + 2 GP				1 HOV + 3 GP			
			AM		PM		AM		PM		AM		PM	
	Eastbound AM (PM)	Westbound AM (PM)	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
I-664 to LaSalle Ave (Route 167, Exit 265A)	D (**F**)	D (D)	C	C	C	C	C	C	C	C	D	C	C	C
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	C (C)	C (D)	C [C]	D [B]	C [C]	D [C]	C [C]	D [B]	B [C]	C [C]	D [A]	D [B]	B [C]	D [C]
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	**E** (C)	C (D)	D	C	B	D	C	C	C	C	E	C	B	D
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	D (D)	C (D)	D [D]	D [A]	C [C]	D [C]	D [C]	**F** [A]	**E** [A]	C [C]	D [A]	D [A]	C [B]	D [B]
15th View Street to 4th View Street (Exit 273)	D (C)	C (C)	D [C]	D [A]	C [C]	C [C]	C [C]	E [A]	D [A]	C [C]	D [A]	D [A]	C [B]	D [B]
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	C (C)	C (C)	C [C]	C [B]	C [C]	C [C]	C [C]	D [A]	C [B]	C [C]	D [A]	C [A]	C [B]	C [B]
West Ocean/West Bay Ave to Granby Street (US 460)	D (D)	D (C)	D [C]	D [B]	D [D]	C [C]	D [C]	F [A]	E [C]	C [C]	D [A]	D [A]	D [C]	C [B]
Granby street to I-564 (Exit 276)	**F** (**F**)	C (B)	**F**	C	**F**	B	**F**	**E**	**F**	C	**F**	D	**F**	C
Mainline East of I-564	C (D)	**F** (B)	B	E	D	B	B	**E**	D	B	B	D	D	B

Note: values in brackets indicate level of service for managed lane

10 VOLUMES AND ANALYSIS FOR THE BUILD 10 ALTERNATIVE

The Build 10 scenario assumes provision of three additional lanes per direction on the HRBT crossing for a total of ten lanes. Along with the three additional lanes per direction on the crossing, two additional lanes in each direction were assumed between the I-664 interchange and the HRBT, and three additional lanes between the HRBT and the I-564 interchange.

The resulting daily and peak hour traffic volumes for the Build 10 scenario are shown in **Error! Reference source not found.** through **Error! Reference source not found.**. A summary of 2020 and 2040 mainline volumes is provided in Table 34 and Table 35.

Table 34. 2020 and 2040 Build 10 Daily Weekday Traffic Volumes

Location on I-64	2020 Build 10			2040 Build 10		
	Eastbound	Westbound	Total	Eastbound	Westbound	Total
West of I-664 (Exit 264)	91,000	91,100	182,100	104,400	104,400	208,800
I-664 to LaSalle Ave (Route 167, Exit 265A)	79,850	79,950	159,800	92,000	92,000	184,000
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	67,650	67,700	135,350	78,200	78,200	156,400
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	68,550	68,600	137,150	79,400	79,400	158,800
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	73,150	73,200	146,350	77,700	77,700	155,400
15th View Street to 4th View Street (Exit 273)	72,650	72,700	145,350	76,300	76,500	152,800
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	64,950	65,000	129,950	76,400	76,400	152,800
West Ocean/West Bay Ave to Granby Street (US 460)	75,050	75,100	150,150	89,700	89,700	179,400
Granby street to I-564 (Exit 276)	81,700	59,800	141,500	93,600	78,000	171,600
Mainline East of I-564	70,500	70,550	141,050	80,900	80,900	161,800
HOV Lanes East of I-564	10,100	10,100	20,200	10,000	10,000	20,000

Table 35. 2020 and 2040 Build 10 AM (PM) Peak Hour Traffic Volumes

Location on I-64	2020 Build 10		2040 Build 10	
	Eastbound	Westbound	Eastbound	Westbound
West of I-664 (Exit 264)	6,525 (5,125)	6,325 (8,425)	7,475 (5,900)	7,300 (9,625)
I-664 to LaSalle Ave (Route 167, Exit 265A)	6,475 (5,725)	6,325 (6,500)	7,425 (6,800)	7,275 (7,475)
LaSalle Ave to Settlers Landing Road (US 60/Rte 143, Exit 267)	5,625 (4,675)	5,800 (6,250)	6,475 (5,600)	6,675 (7,200)
Settlers Landing Road to South Mallory Street (Route 169, Exit 268)	5,975 (4,425)	5,150 (6,125)	6,875 (5,325)	5,950 (7,100)
South Mallory Street to 15th View Street (Exit 272) – Hampton Roads Bridge Tunnel	6,125 (5,225)	5,325 (5,575)	6,500 (5,750)	5,675 (5,950)
15th View Street to 4th View Street (Exit 273)	6,175 (5,225)	5,275 (5,550)	6,500 (5,800)	5,725 (6,025)
4th View Street to West Ocean Avenue and West Bay Avenue (Exit 274)	5,575 (4,825)	4,775 (4,750)	6,500 (5,875)	5,625 (5,575)
West Ocean/West Bay Ave to Granby Street (US 460)	6,100 (6,625)	6,000 (5,075)	7,250 (8,125)	7,125 (6,050)
Granby street to I-564 (Exit 276)	6,550 (7,450)	5,200 (4,200)	7,475 (8,550)	5,700 (4,100)
Mainline East of I-564	4,075 (6,600)	7,250 (4,075)	4,525 (8,125)	8,575 (4,075)
HOV Lanes East of I-564	0 (3,175)	700 (0)	0 (3,175)	775 (0)

As expected, expanding capacity of the HRBT crossing to ten lanes is projected to attracted additional traffic to the facility beyond what is forecast under all other scenarios, with daily volumes between 39 and 74 percent higher compared to 2040 No Build volumes, and peak hour volumes showing a similar increase. The largest volume increases compared to the No Build alternative are found on the HRBT crossing, rather than on the peninsula and south sides, as noted in the other Build scenarios. Changes in peak hour volumes are comparable to the percentage increases in daily volume.

The Build 10 peak hour traffic volumes were analyzed using HCS, with the same assumptions used for the No Build analysis. Lane configurations for mainline section and ramp merge/diverge/weaving sections were modified to reflect the number of mainline lanes in the Build 10 scenario. One exception is the weaving analysis, which was modified to accommodate more than five lanes in the weaving section, because with five mainline lanes, there are at least six lanes in the weaving area. Results of the capacity analysis are provided in Table 36 through Table 39, as well as Appendix F.

Table 36. Eastbound I-64 Mainline and Ramp Capacity Analysis Results – 2020 and 2040 Build 10

Exit	From	To	Type	2020 Build 10		2040 Build 10	
				AM	PM	AM	PM
265	NB I-664	SB LaSalle Avenue	Weave	C	C	C [C][1]	**F** [C][1]
	SB LaSalle Avenue	I-64	Merge	C	B	C	C
	NB LaSalle Avenue	I-64	Merge	C	C	C	C
	I-64	Rip Rap Road	Diverge	C	C	D	D
	Rip Rap Road	Settlers Landing Road	Mainline	C	B	C	C
267	I-64	Settlers Landing Road	Diverge	C	C	D	C
	Settlers Landing Road	Mallory Road	Weave	C	B	**F** [D][2]	C [C][2]
268	Mallory Road	I-64	Merge	C	C	C	C
	I-64 (HRBT)		Mainline	C	C	C	C
272	I-64	Bayview Avenue	Diverge	C	C	C	C
	Bayview Avenue	I-64	Merge	B	B	B	B
	Bayview Avenue	4th View Street	Mainline	C	C	C	C
273	I-64	4th View Street	Diverge	C	C	C	C
	4th View Street	I-64	Merge	B	B	C	B
	4th View Street	Bay Avenue	Mainline	C	B	C	C
274	Bay Avenue	I-64	Merge	C	D	C [B][3]	**E** [C][3]
	Bay Avenue	Patrol Road	Mainline	C	C	C	D
	Patrol Road	Ramp to I-564/Granby Road	Weave	**F**	**F**	**F [F]**[4]	**F [E]**[4]
	Off ramp to I-64 HOV	On ramp from I-564	Mainline	B	B	B	C
276	I-564	East Little Creek Road	Mainline	B	C	C	D

[1] Requires addition of choice exit lane on ramp to LaSalle Road
[2] Requires addition of choice exit lane on ramp to Mallory Road
[3] Requires addition of second ramp lane from Bay Avenue
[4] Requires addition of choice exit lane on ramp to Granby Street

The capacity analyses show that level of service C would be achieved in most mainline locations under the Build 10 scenario. In two locations, the level of service under the Build 10 scenario is worse than under the Build 8 scenario (eastbound I-64 between Settlers Landing Road and Mallory Street, and westbound I-64 between LaSalle Avenue and the I-664 interchange). This drop in level of service can be attributed to the increase in volume that results from the increased capacity on the crossing and approaches; while the Build 10 scenario does provide additional capacity, it is not sufficient to accommodate the induced demand resulting from this capacity increase on I-64.

Table 37. Westbound I-64 Mainline and Ramp Capacity Analysis Results– 2020 and 2040 Build 10

Exit	From	To	Type	2020 Build 10		2040 Build 10	
				AM	PM		
276B	I-64	Ramp to I-564	Mainline	D	B	**F** [E][1]	B [B][1]
276A	I-64	Granby Street	Diverge	C	B	C	B
	I-564	I-64	Merge	B	B	B	B
	I-564	Granby Street/Rte 460	Mainline	B	B	C	B
	Granby Street/Rte 460	I-64	Merge	C	C	D	D
	Granby Street/Rte 460	Ocean Avenue	Mainline	C	B	C	C
274	I-64	Ocean Avenue	Diverge	C	B	C	B
	Ocean Avenue	4th View Street	Mainline	B	B	C	C
273	I-64	4th View Street	Diverge	B	B	C	C
	4th View Street	I-64	Merge	B	C	B	C
	4th View Street	Ocean View Avenue	Mainline	C	C	C	C
272	I-64	Ocean View Avenue	Diverge	B	B	B	B
	Ocean View Avenue	I-64	Merge	B	B	B	B
	I-64 (HRBT)		Mainline	C	C	C	C
268	I-64	Mallory Avenue	Diverge	C	C	C	C
267	Mallory Avenue	Settlers Landing Road	Weave	B	C	C	D
	Settlers Landing Road	I-64	Merge	C	C	C	C
	Settlers Landing Road	Armistead Avenue	Mainline	B	C	C	C
265B	I-64	Armistead Avenue	Diverge	C	C	C	C
	Armistead Avenue	I-664	Weave	**F**	C	**F** [C][2]	C [C][2]

[1] Requires addition of one lane on westbound I-564
[2] Requires addition of choice exit lane on ramp to southbound I-664

The capacity analyses also indicate that while most mainline freeway segments are projected to operate at acceptable levels of service, a number of weaving segments are projected to operate at level of service E or F. Conceptual improvements were developed for these segments; the resulting levels of service are provided in brackets.

It must be noted that these improvements have not been reviewed for feasibility or constructability; the intent is to show the level of improvement necessary to achieve acceptable levels of service for this Alternative. The analyses show that the weaving section between Patrol Road and the ramp to Granby Road along eastbound I-564 continues to operate at LOS F; additional improvements may be required to provide acceptable levels of service, which will be examined in the next phase of the study.

Table 38. I-564 Mainline and Ramp Capacity Analysis Results– 2020 and 2040 Build 10

Exit	From	To	Type	2020 Build 10		2040 Build 10	
				AM	PM		
	NB Granby	Terminal Avenue	Weave	D	A	F	A
	EB I-64	Terminal Avenue	Weave	**F**	A	**F**	A
	Terminal Avenue	Admiral Taussig Boulevard	Mainline	C	A	C	A
Exit	**From**	**To**	**Type**	**AM**	**PM**	**AM**	**PM**
	I-564	Admiral Taussig Boulevard	Diverge	A	C	A	C
	I-564		Mainline	A	C	A	C
	Terminal Avenue	I-564	Merge	A	C	A	D
	I-564	E Little Creek Parkway	Lane Drop	A	C	A	C

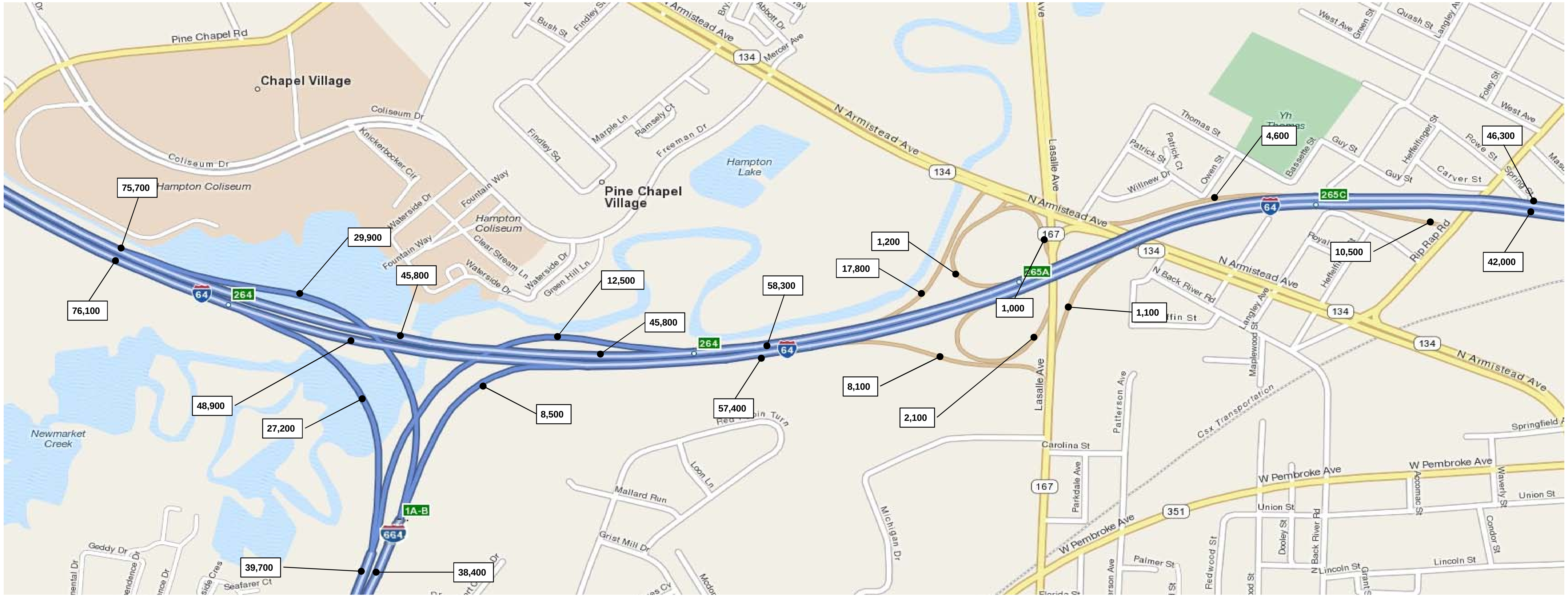
Table 39. Intersection Capacity Analysis Results– 2020 and 2040 Build 10

Intersection	2020 Build 10		2040 Build 10	
	AM	PM	AM	PM
WB I-64 On-Ramp at N Armistead Ave	C	**E**	B	C
N Armistead Ave at LaSalle Ave	C	**F**	C	**F**
I-64 EB Off-Ramp at Rip Rap Rd	D	**F**	C	F
I-64 EB Off-Ramp at Settlers Landing Rd	F	D	F	D
I-64 WB Ramps at Settlers Landing Rd	C	C	C	C
I-64 EB Ramps at S Mallory St	C	**F**	**F**	**F**
I-64 WB Ramps at S Mallory St	**F**	**E**	**F**	**F**
Granby St at E Admiral Taussig Blvd	B	B	C	B
I-64 EB Ramps at E Little Creek Rd	B	C	B	D
I-64 WB Off-Ramp at E Little Creek Rd	C	B	C	B
EB I-64 Ramps at Bayville St*	A	A	A	A
WB I-64 Ramps at W Ocean View Ave*	A	A	A	A
EB I-64 Ramps at 4th View St*	**F**	**F**	**F**	**F**
WB I-64 Ramps at 4th View St*	D	**F**	**F**	**F**

*Stop-controlled intersection; LOS for worst approach shown

Since the focus of the study was the mainline operation, intersection improvements were not yet developed at this stage of the study.

Appendix A. **Existing Traffic Volumes and Capacity Analysis**



2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 1 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

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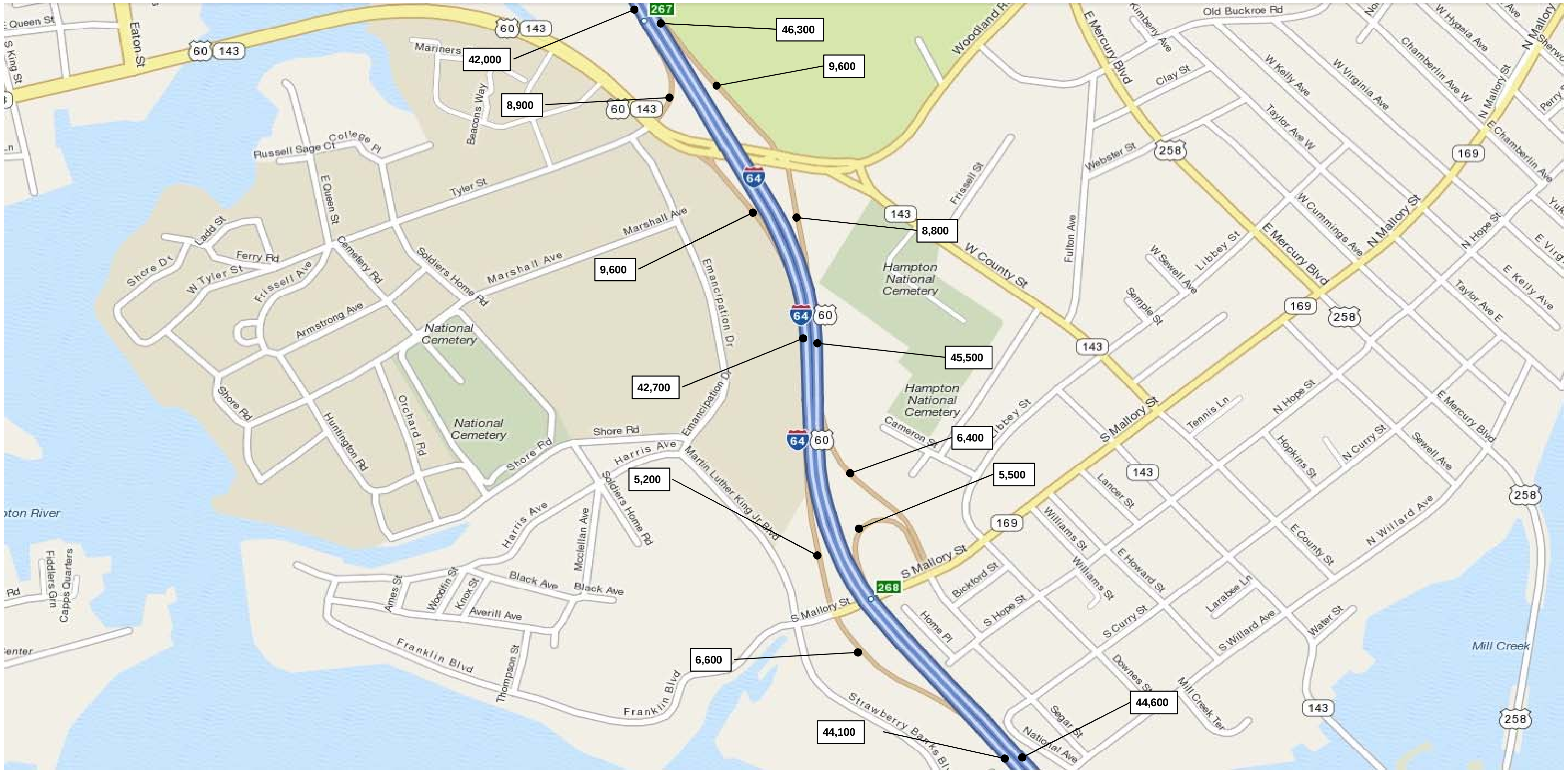
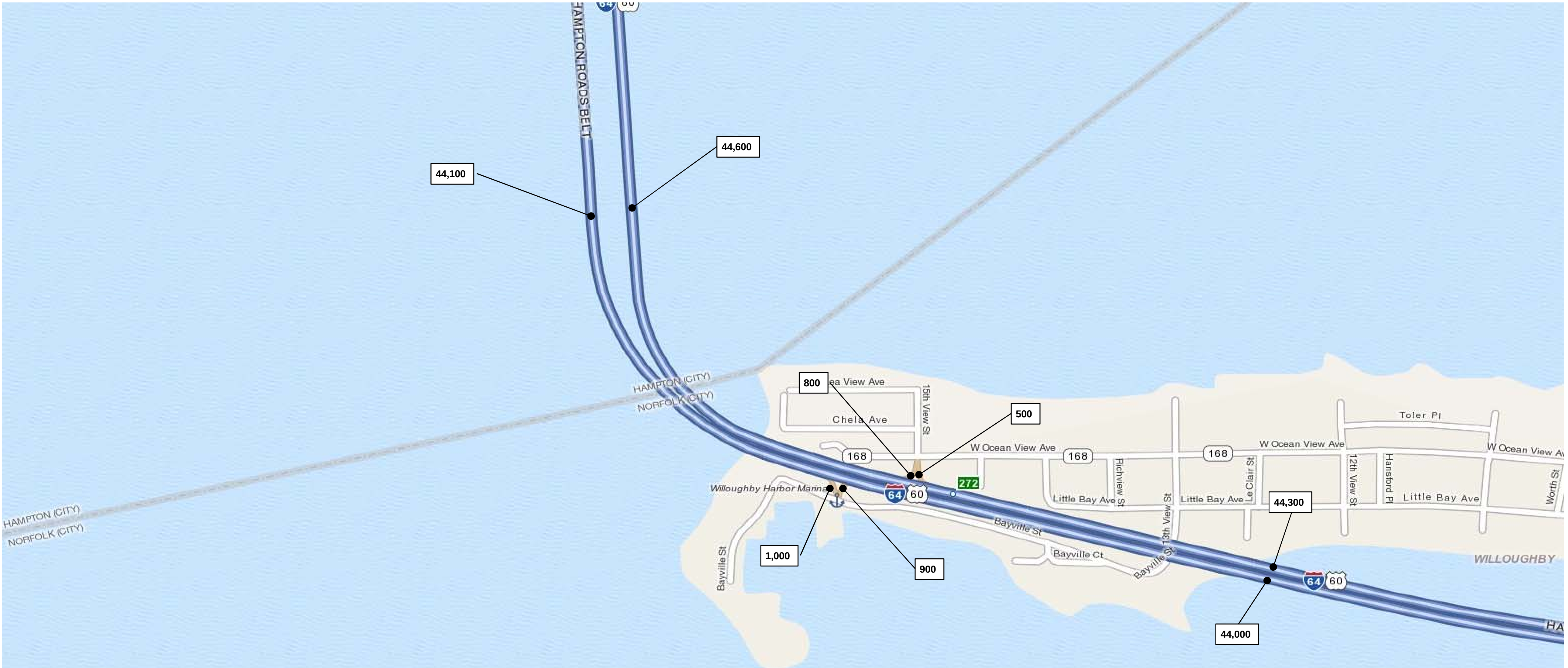


2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 2 of 6

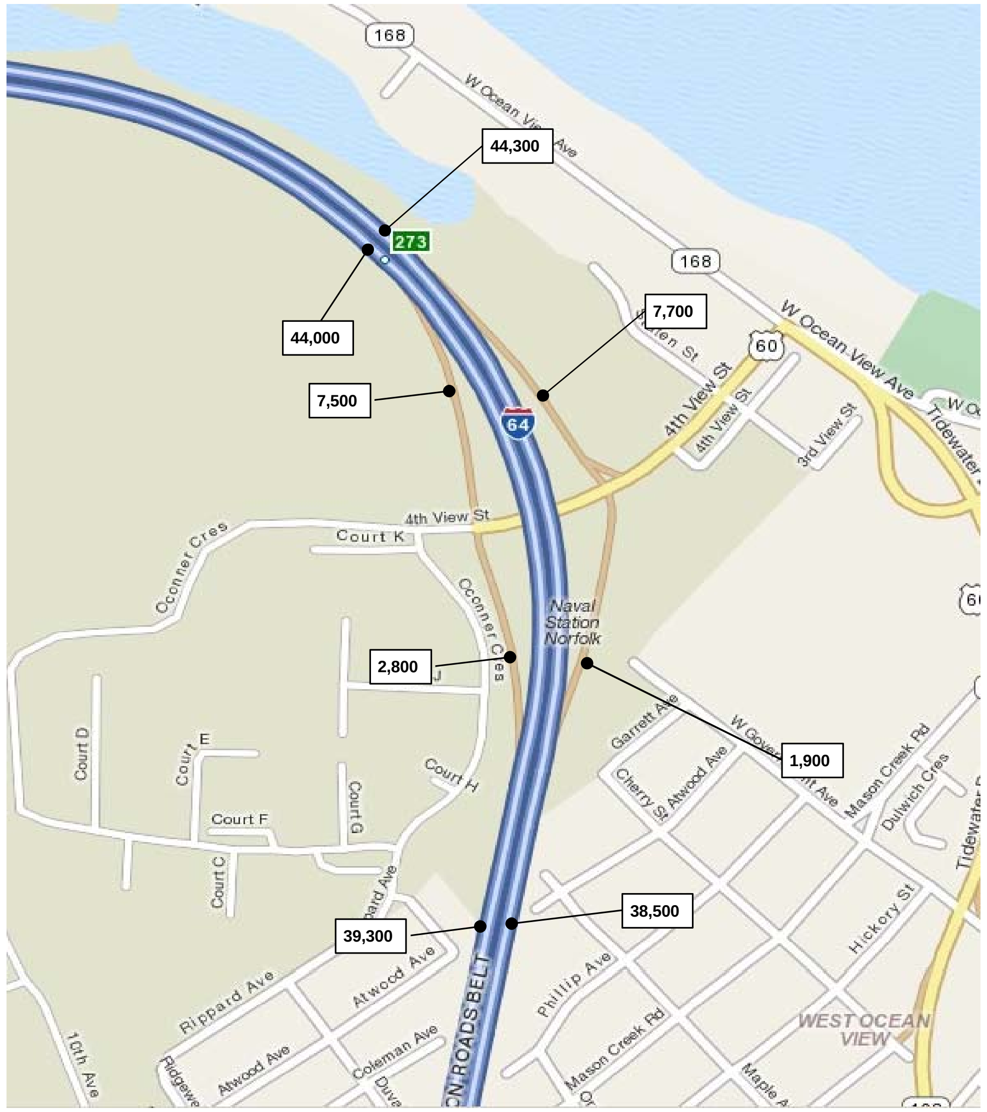
October 12, 2012

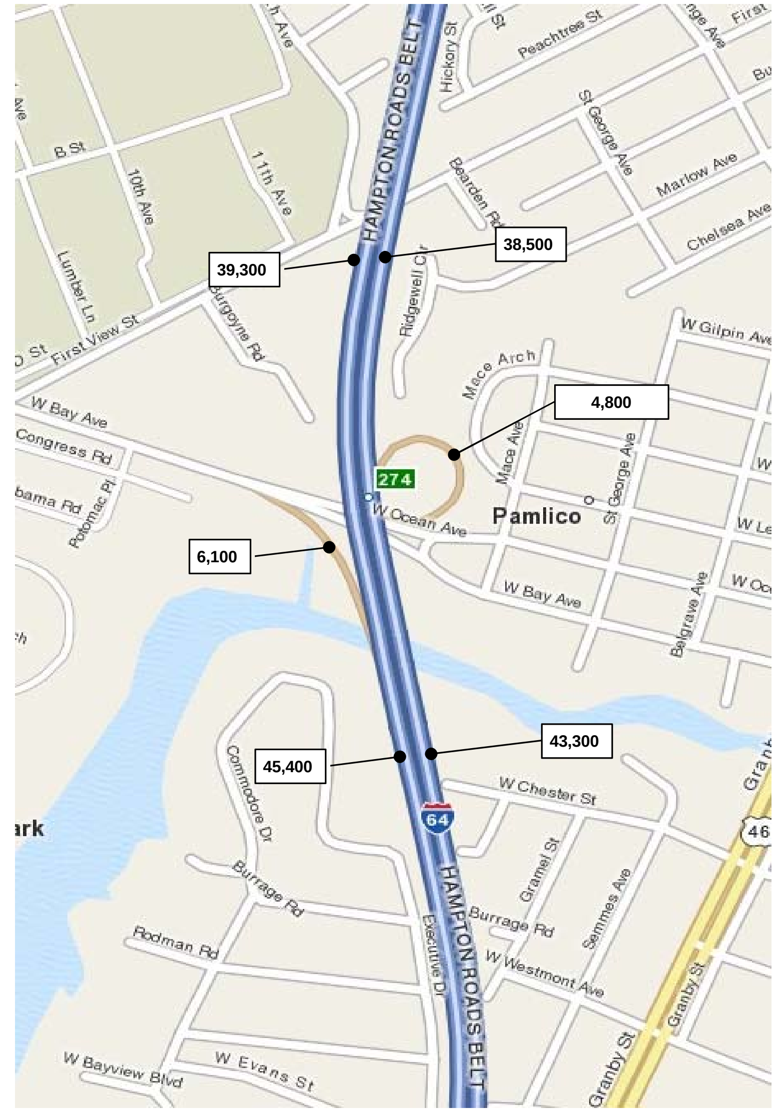


2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 3 of 6

October 12, 2012



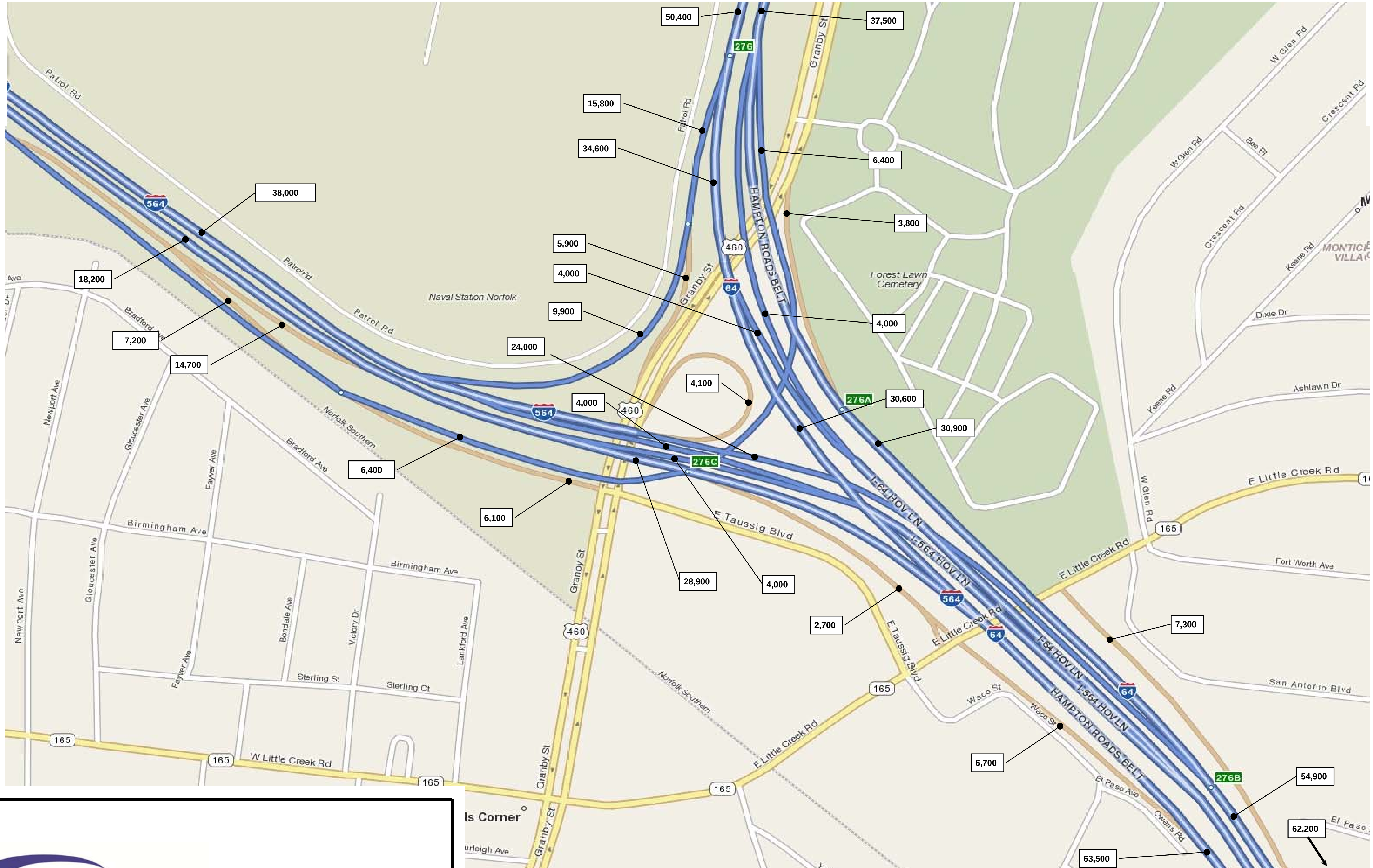


Hampton Roads Bridge Tunnel EIS

2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 4 of 6

October 12, 2012



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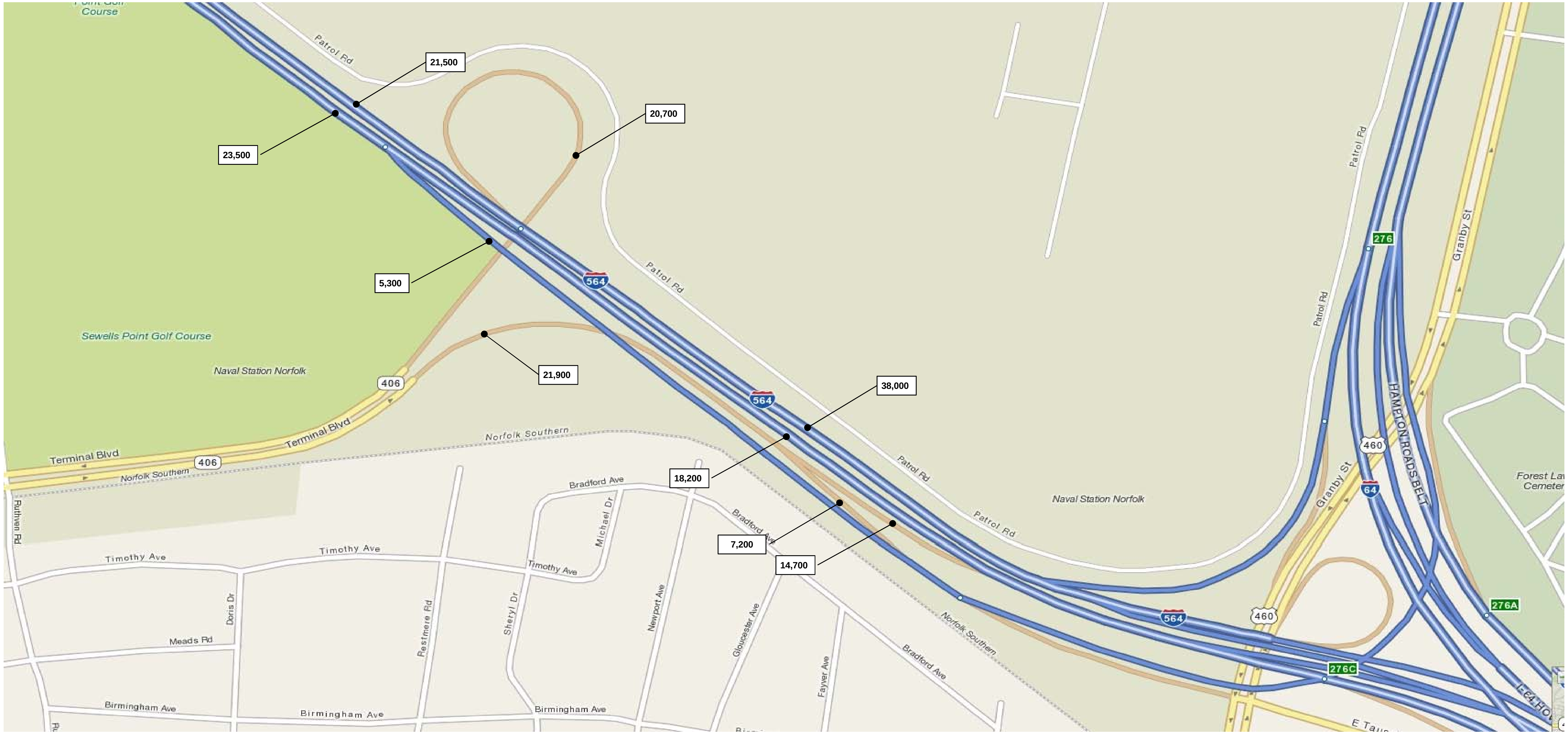
2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 5 of 6

October 12, 2012

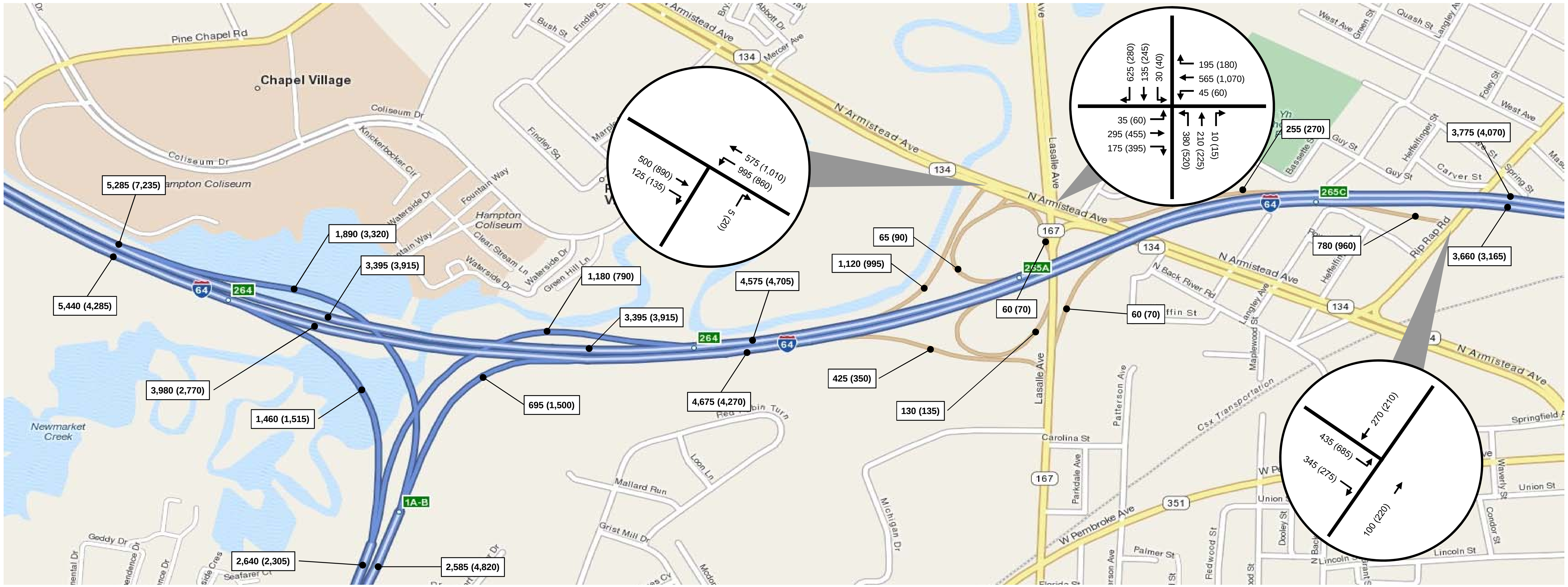


Hampton Roads Bridge Tunnel EIS

2011 Existing Daily (ADT) Volumes

Figure A-1: Sheet 6 of 6

October 12, 2012



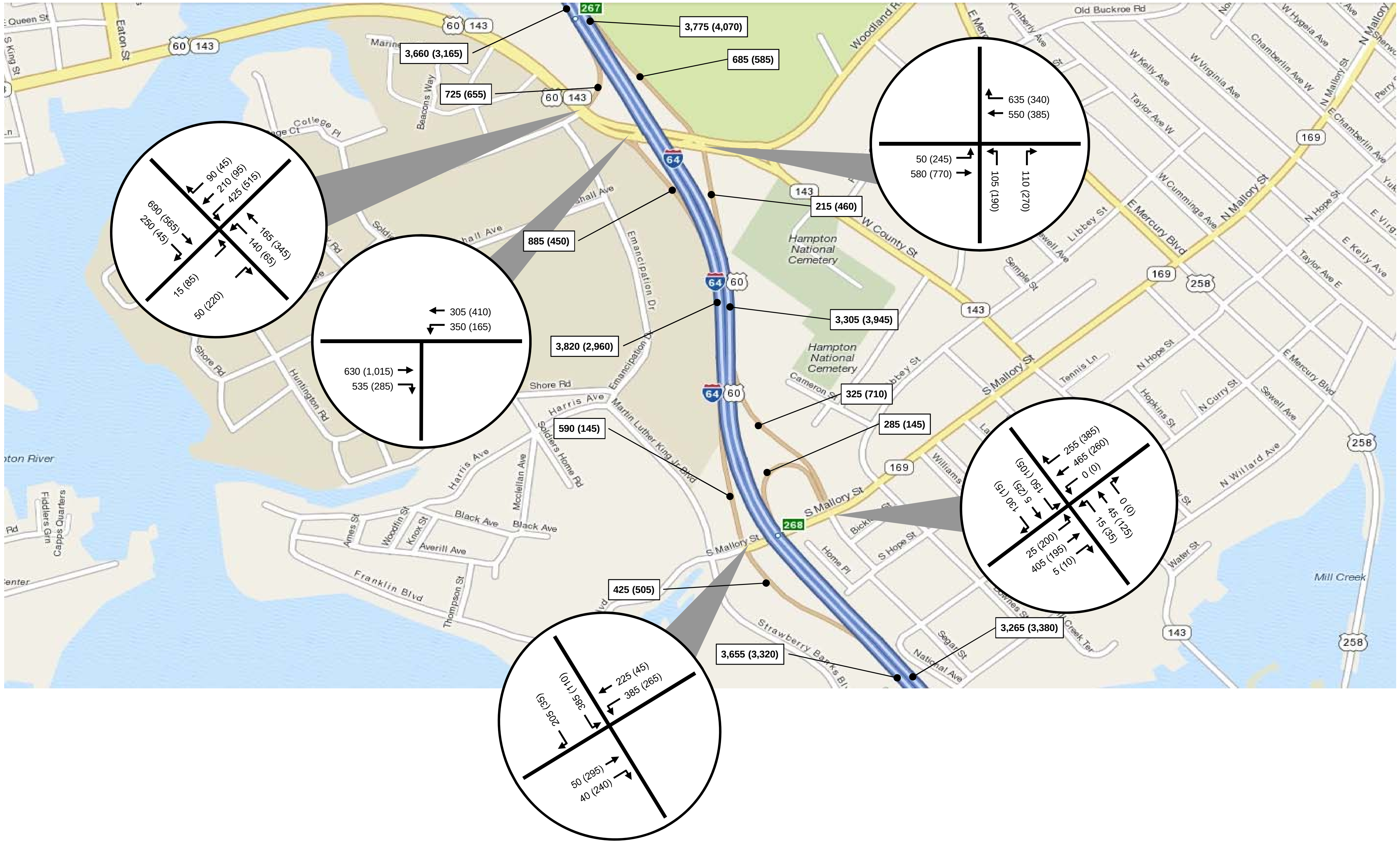
Hampton Roads Bridge Tunnel EIS

VDOT

2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 1 of 6

October 12, 2012



Hampton Roads Bridge Tunnel EIS

2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 2 of 6

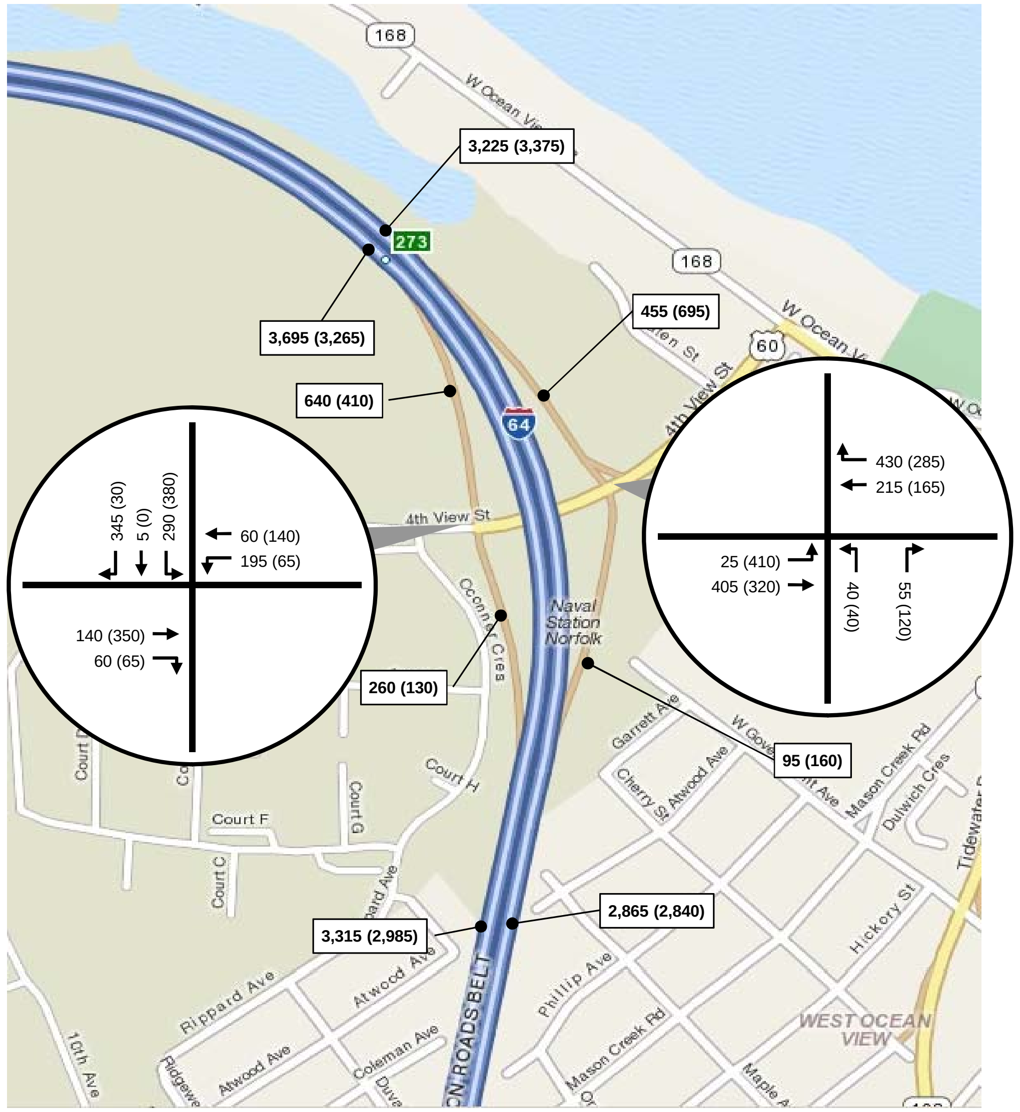
October 12, 2012

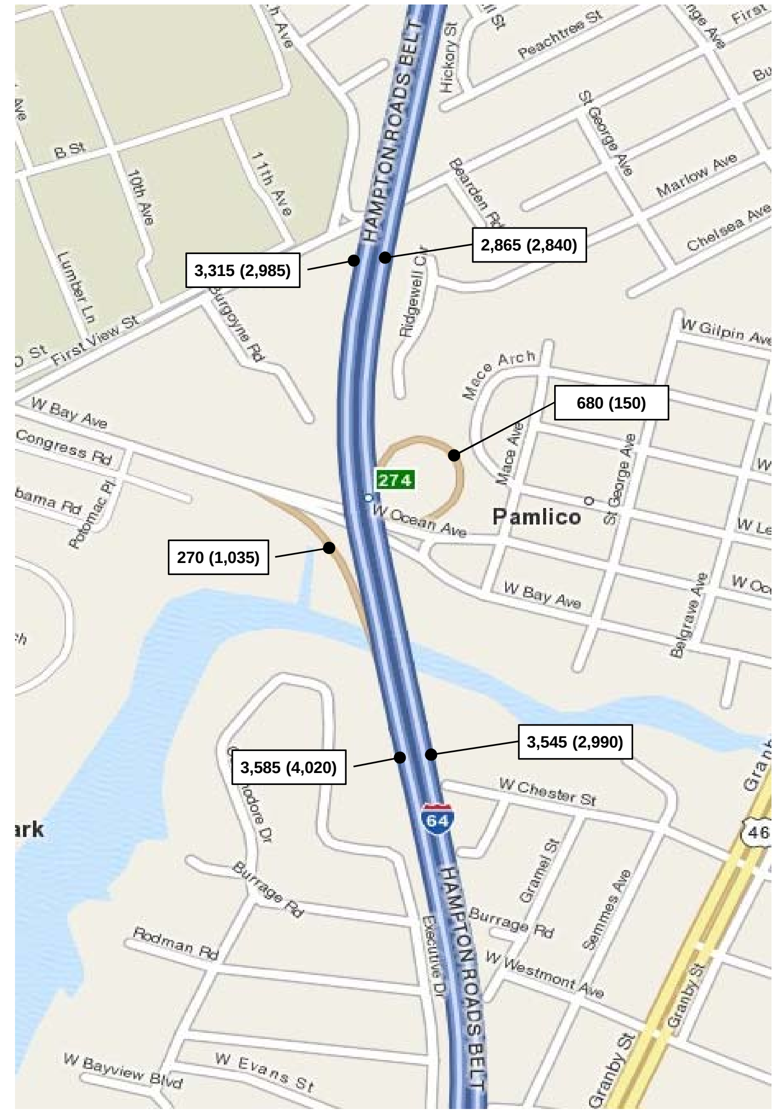
Hampton Roads Bridge Tunnel EIS

2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 3 of 6

October 12, 2012





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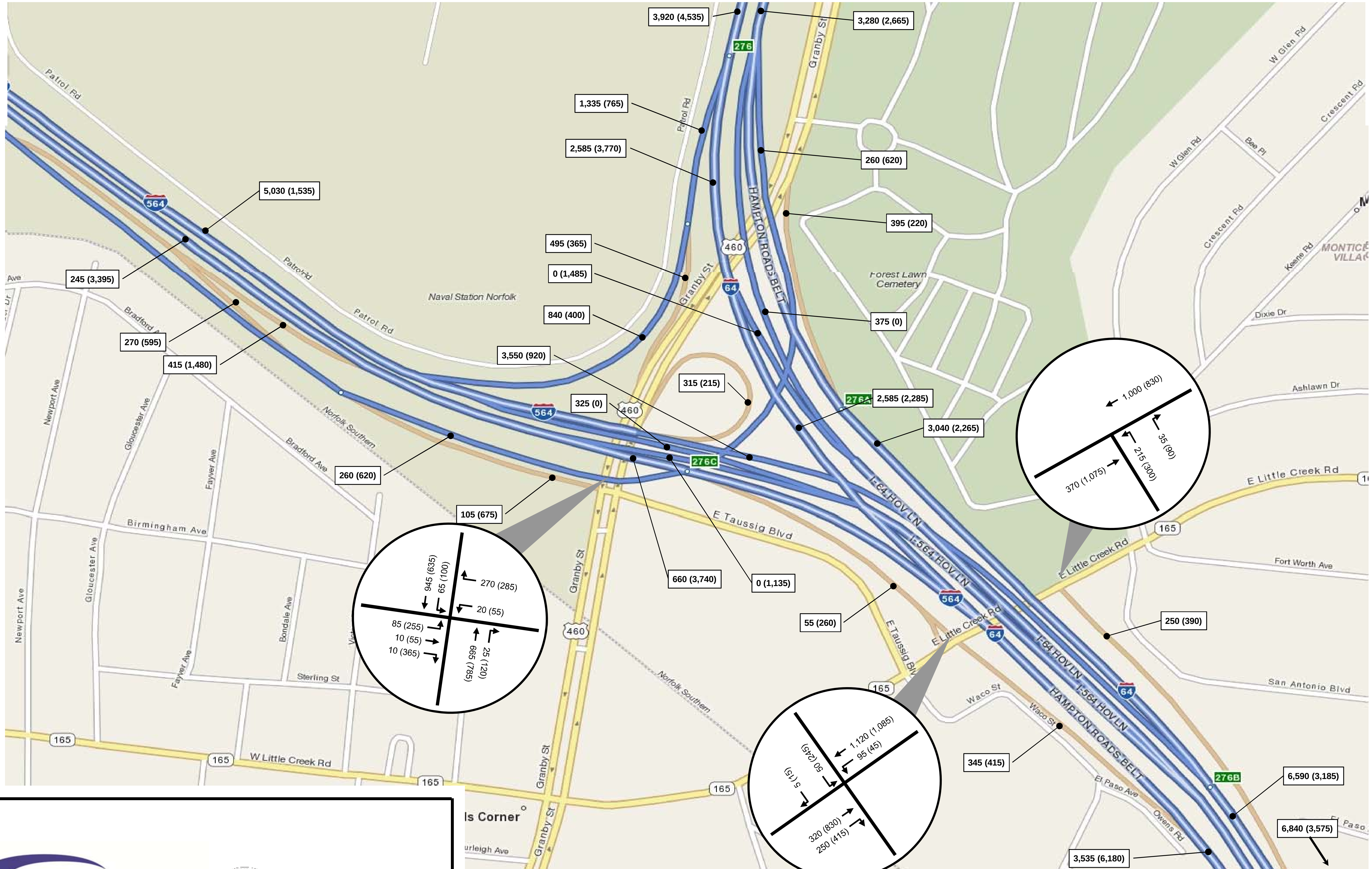
2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 4 of 6

October 12, 2012



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2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 5 of 6

October 12, 2012

2011 Existing AM (PM) Peak Hour Volumes

Figure A-2: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

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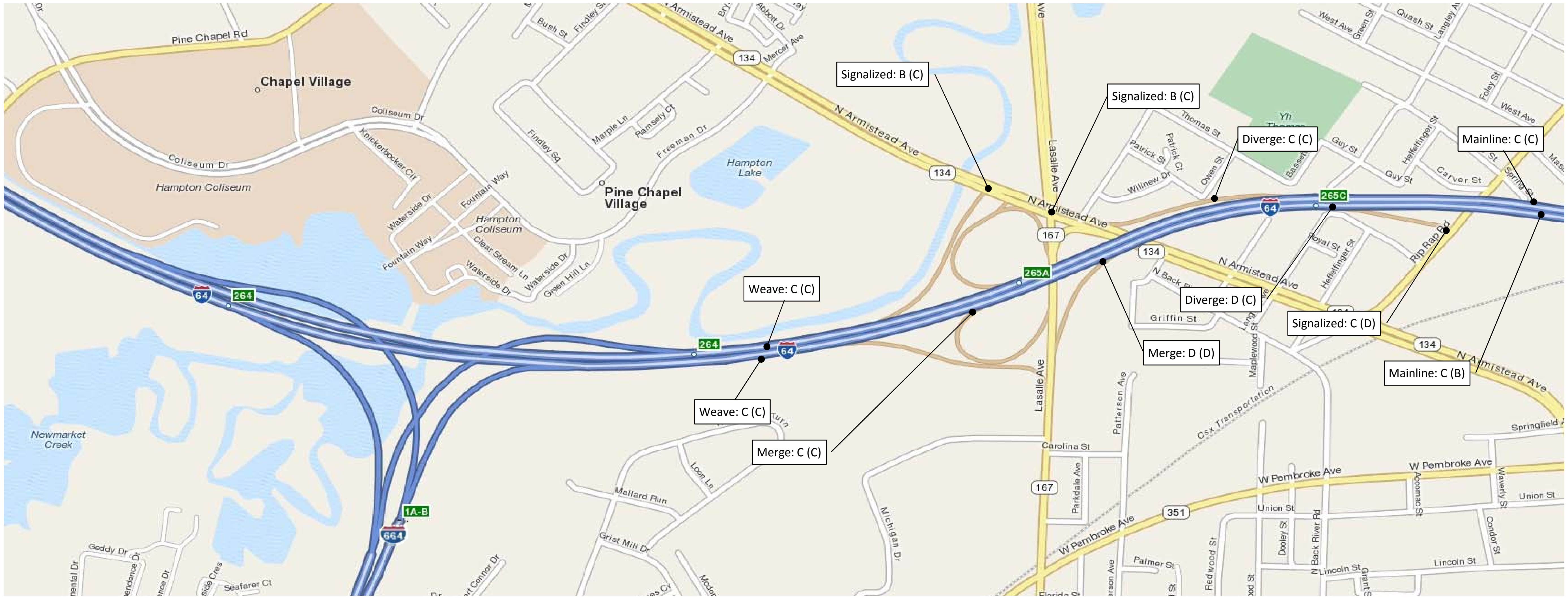
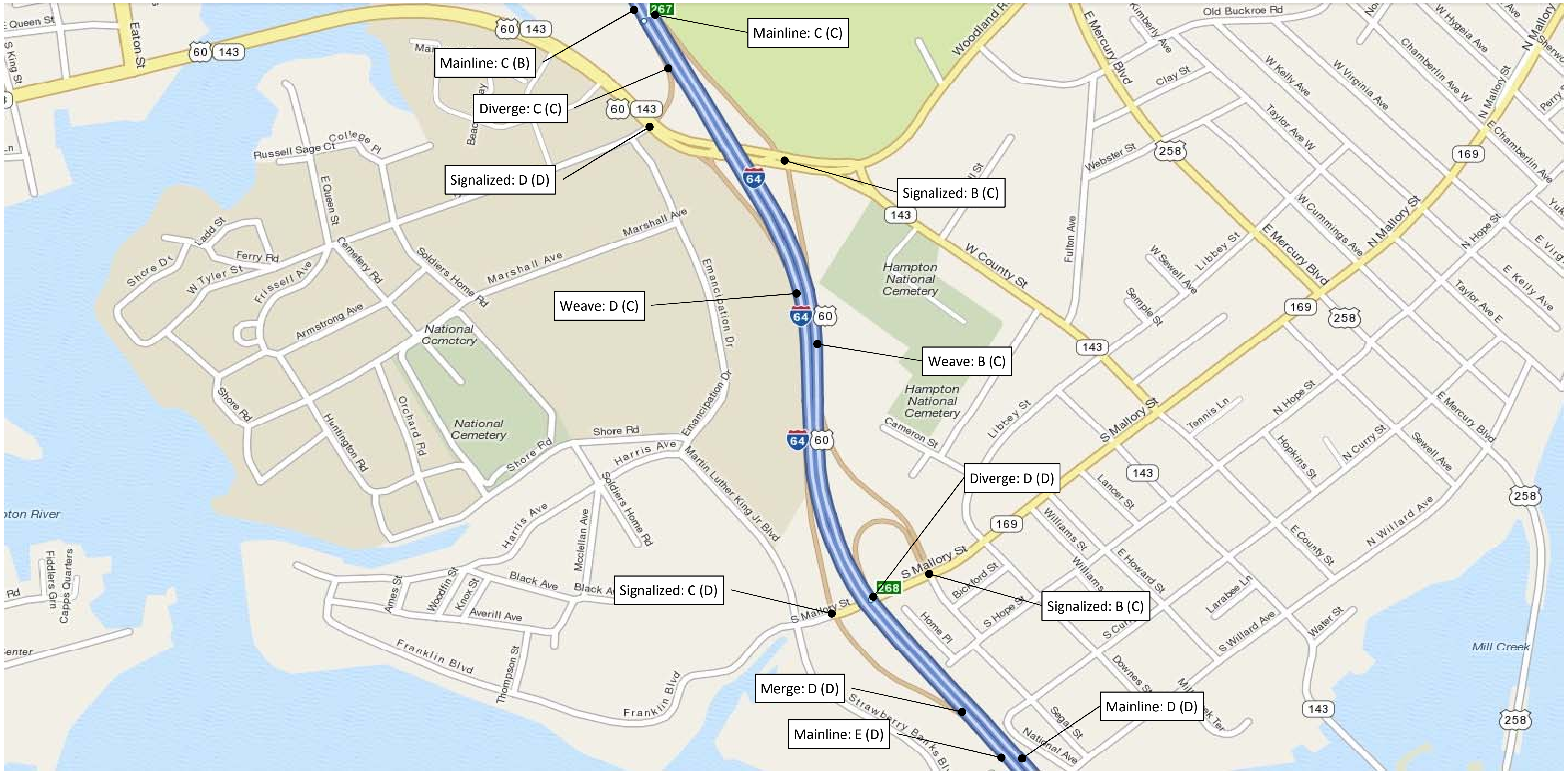


2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 1 of 6

October 12, 2012



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2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 2 of 6

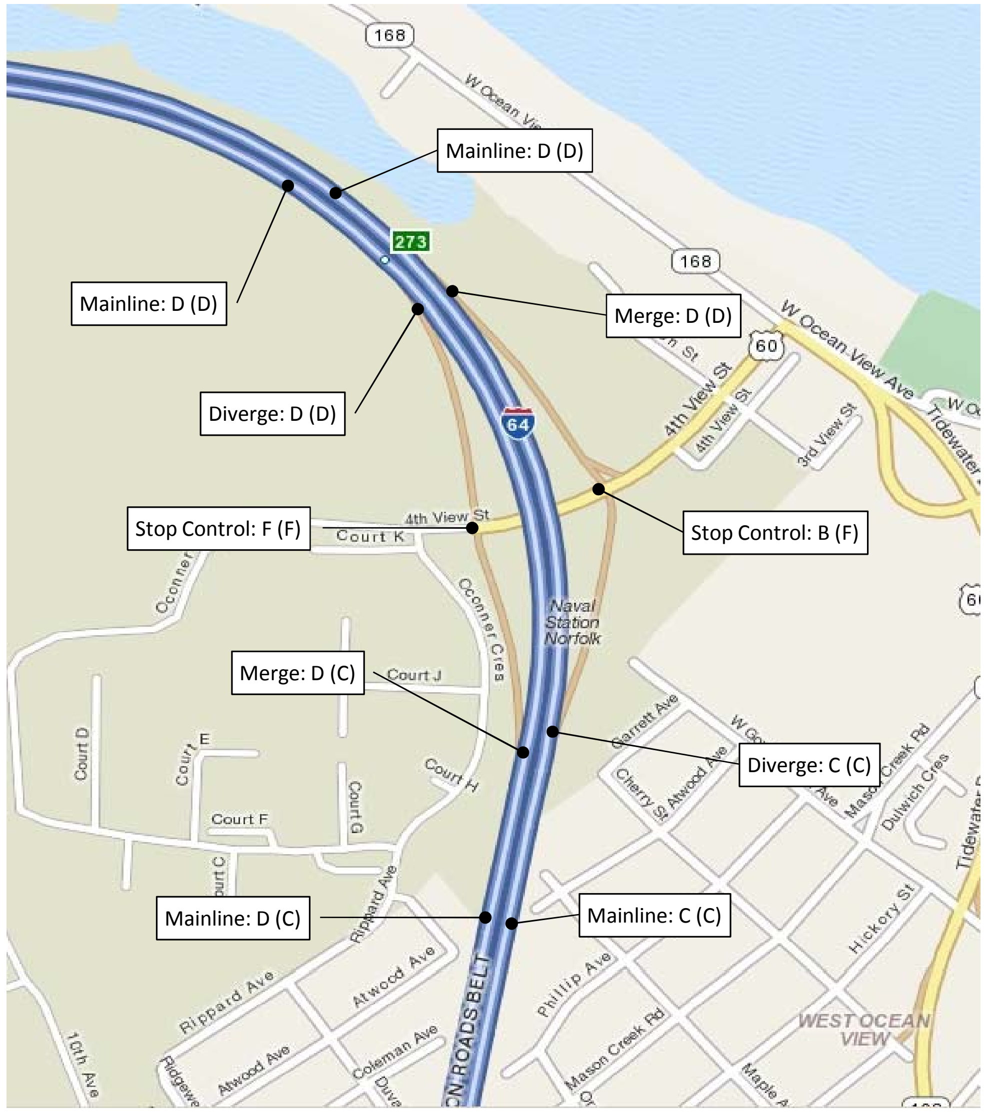
October 12, 2012

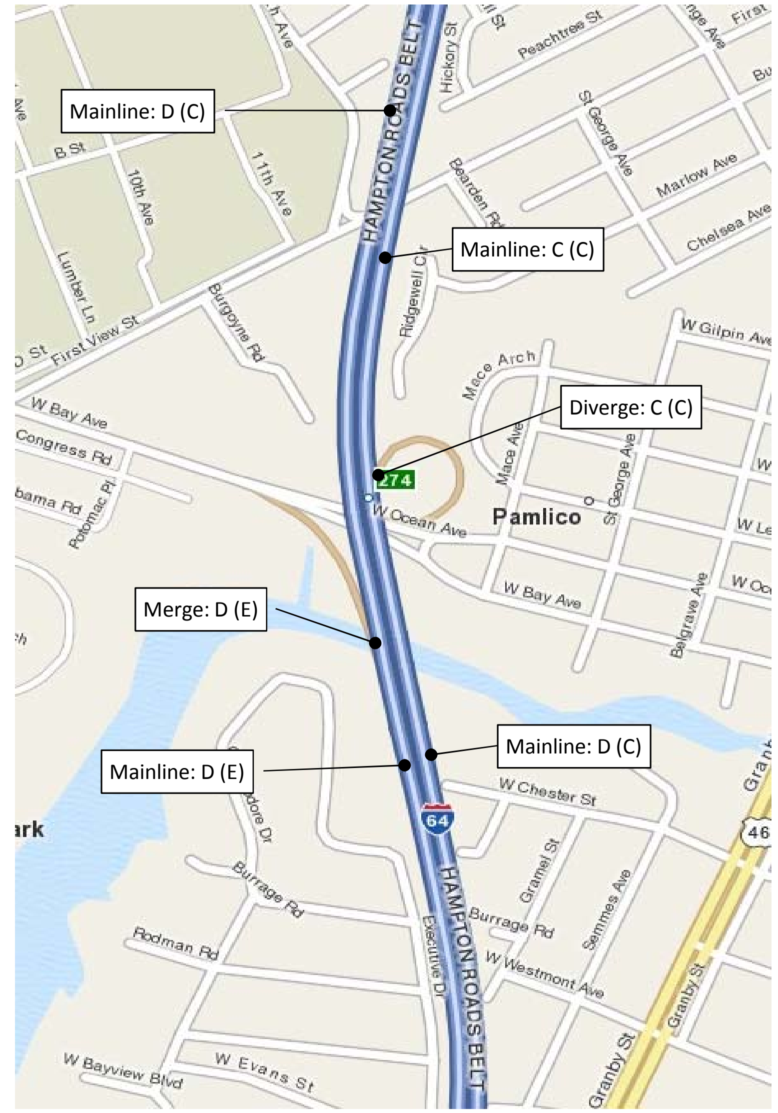
Hampton Roads Bridge Tunnel EIS

2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 3 of 6

October 12, 2012





HRBT Hampton Roads Bridge Tunnel EIS

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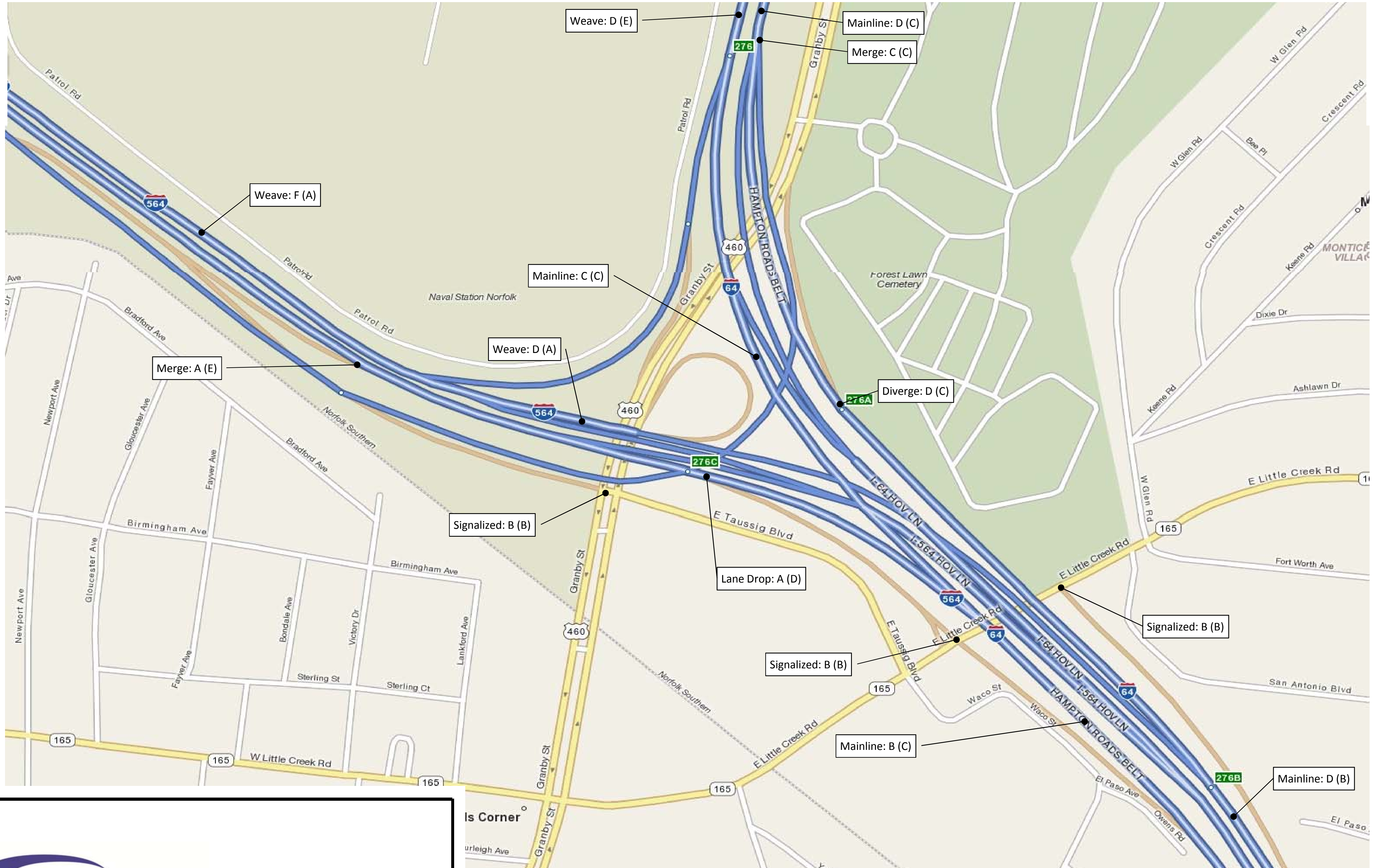
2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 4 of 6

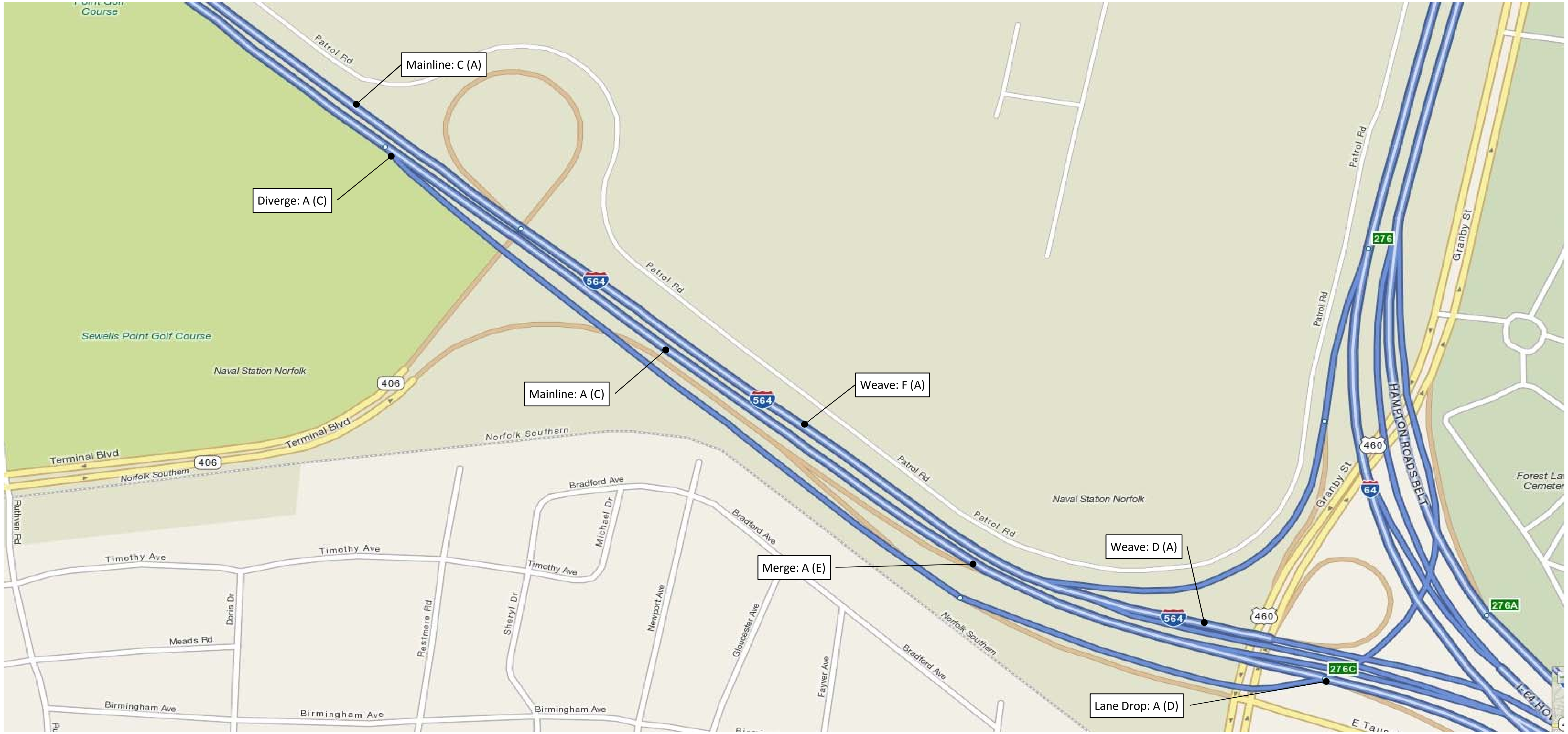
October 12, 2012



2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 5 of 6

October 12, 2012

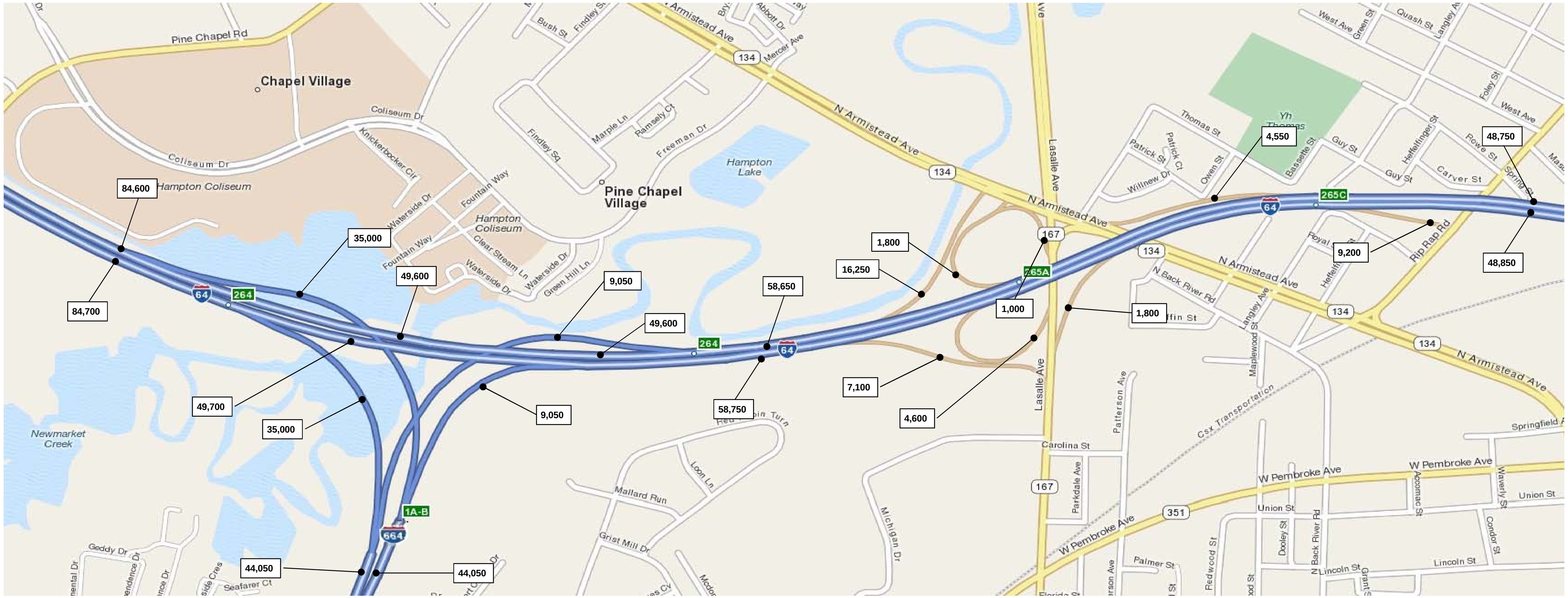


2011 Existing AM (PM) Level of Service

Figure A-3: Sheet 6 of 6

October 12, 2012

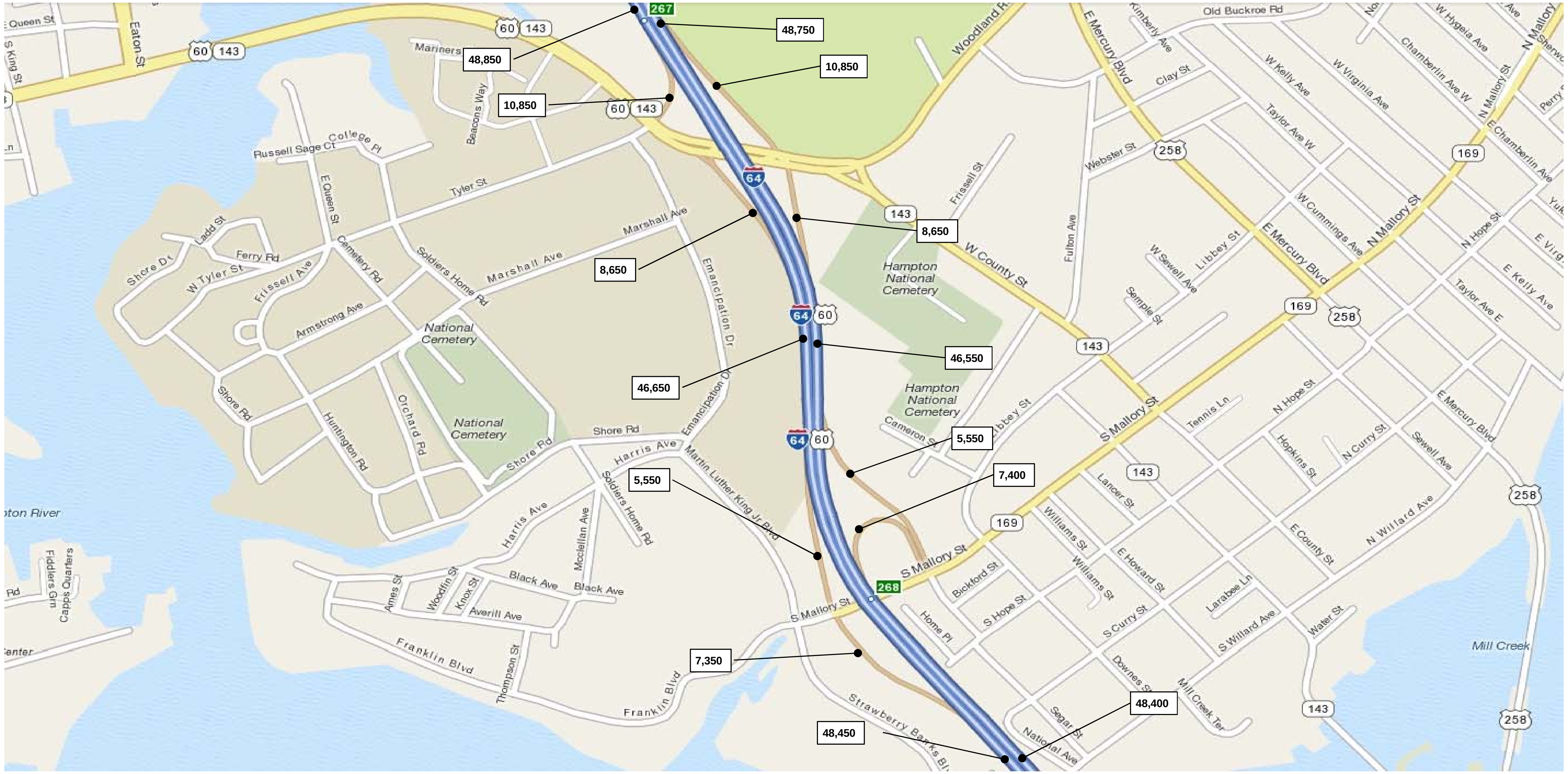
Appendix B. **2020/2040 No Build Traffic Volumes and Capacity Analysis**



2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 1 of 6

October 12, 2012



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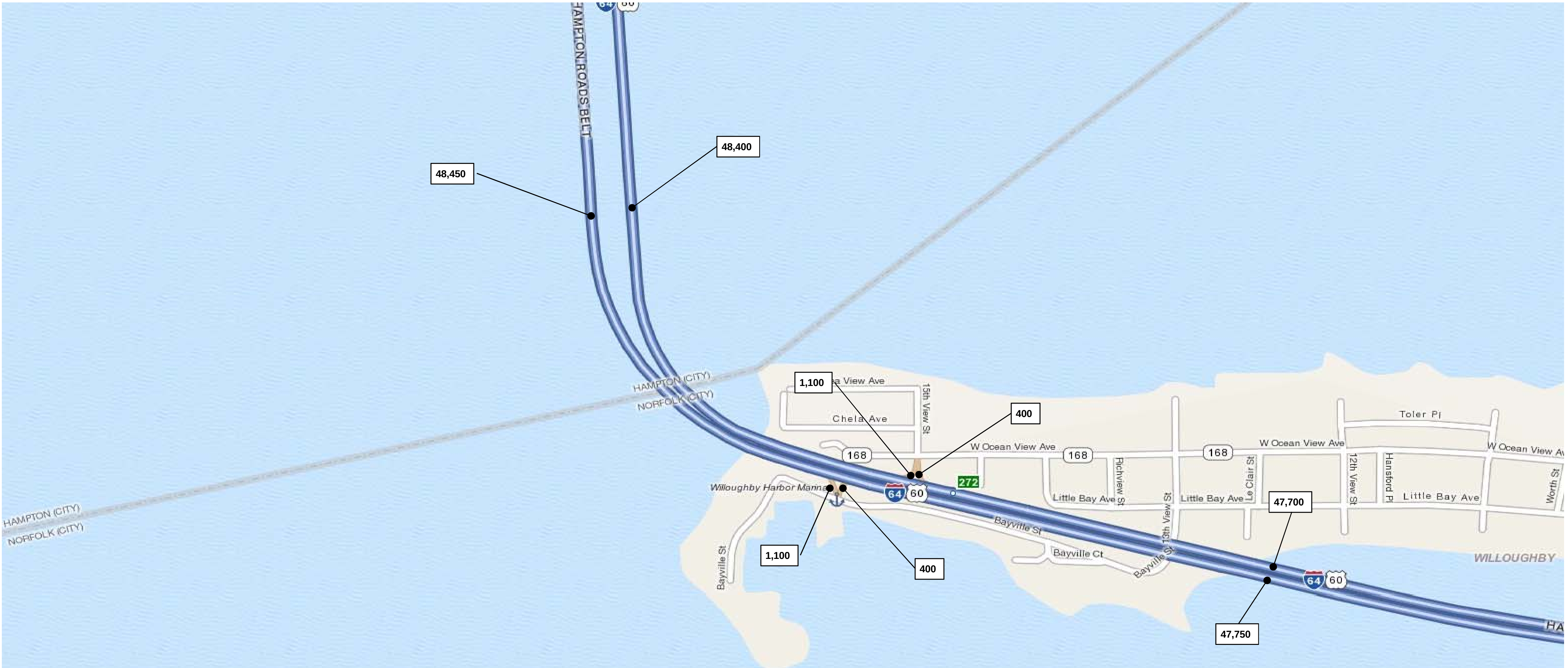
2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 2 of 6

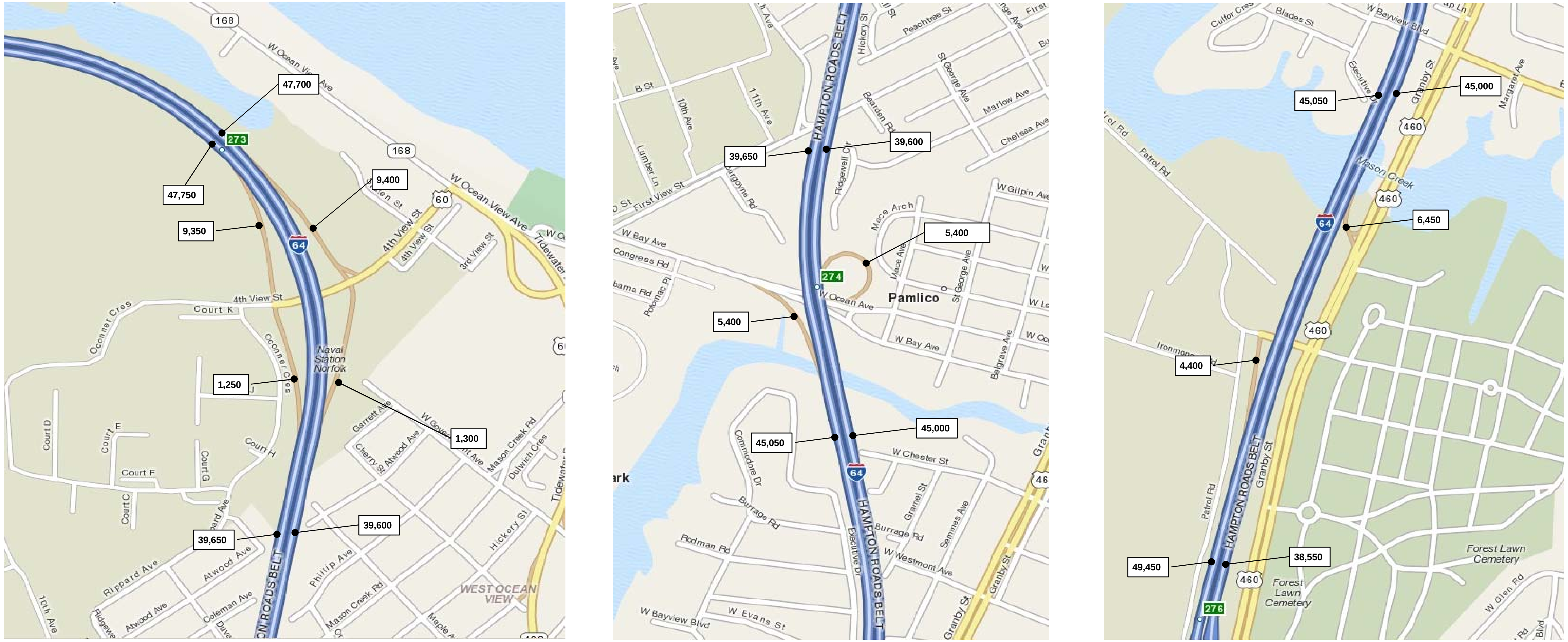
October 12, 2012



2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 3 of 6

October 12, 2012



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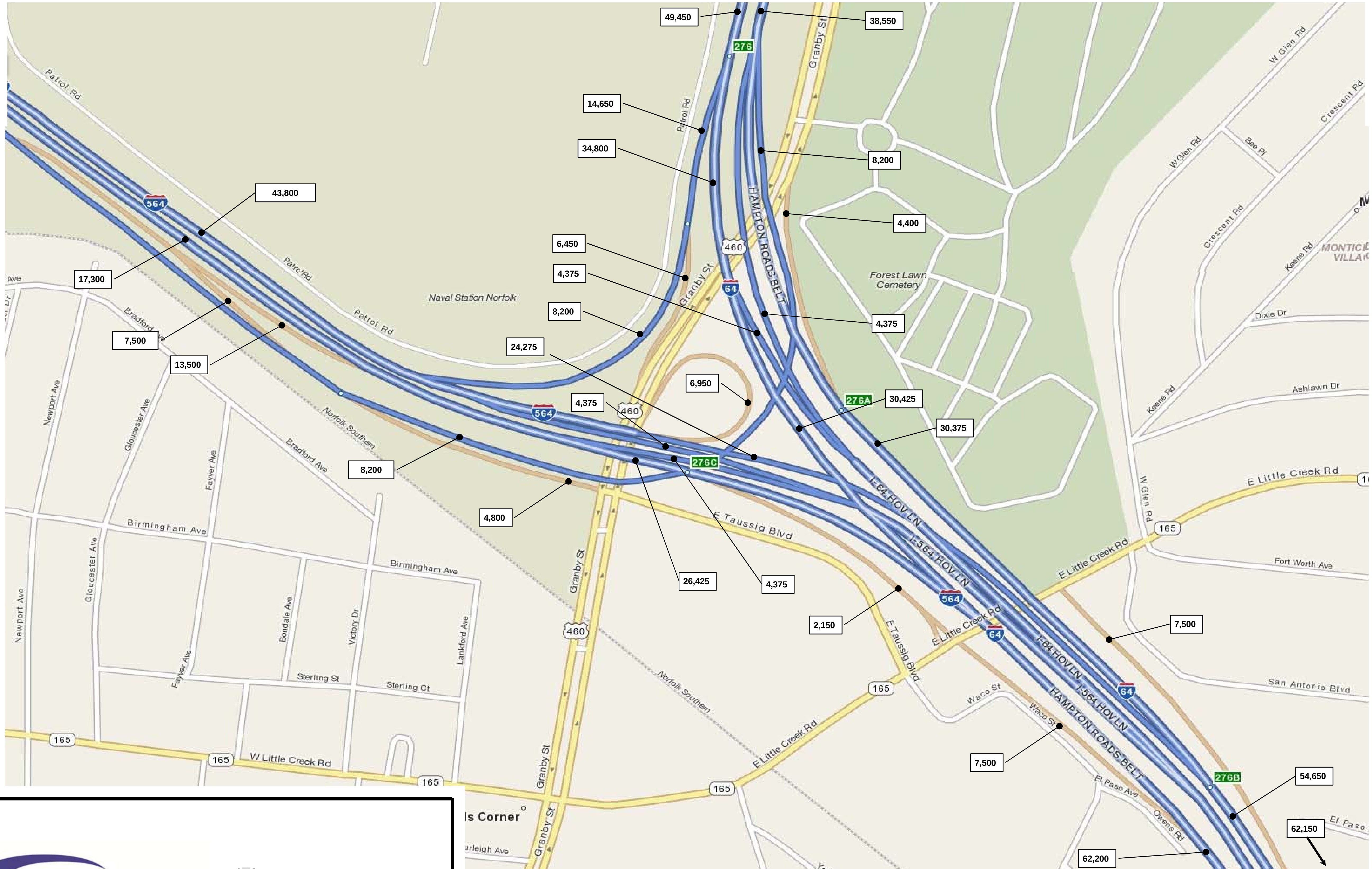
2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 4 of 6

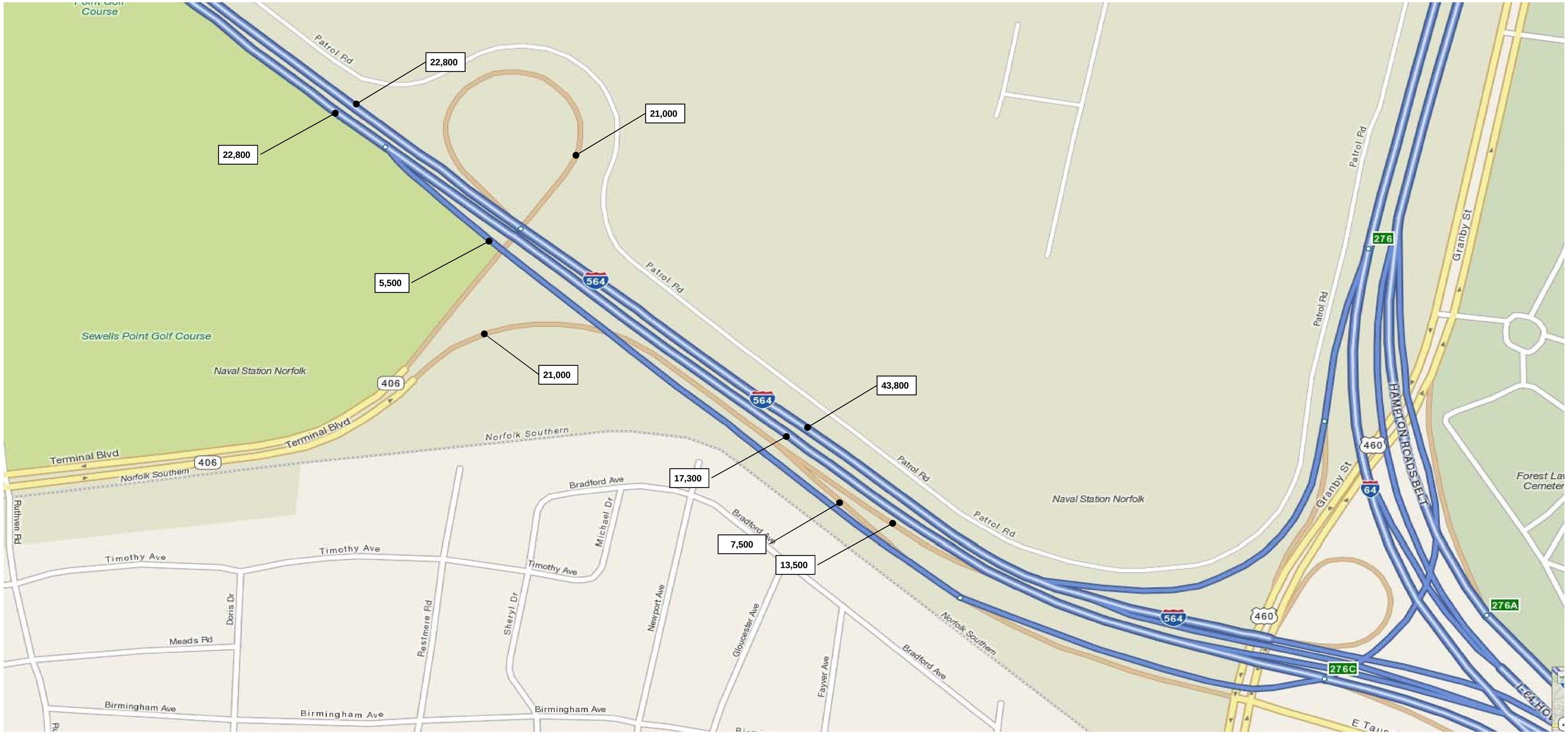
October 12, 2012



2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 5 of 6

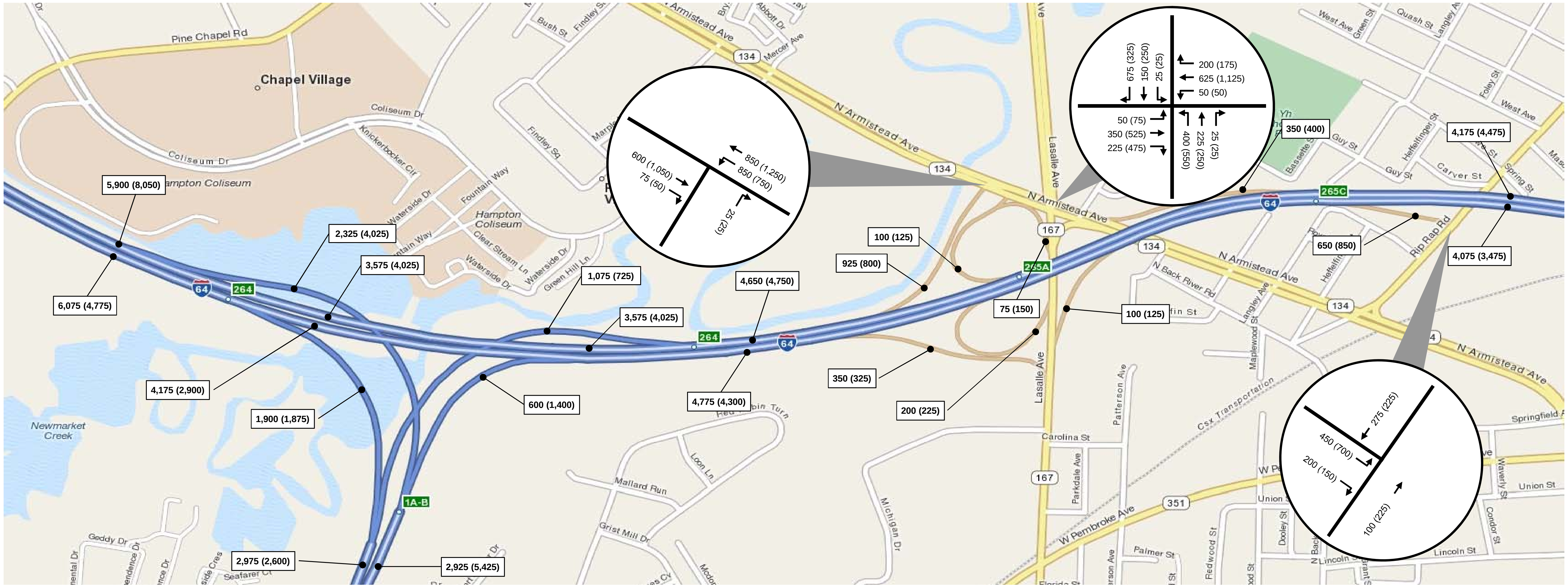
October 12, 2012



2020 No Build Daily (ADT) Volumes

Figure B-1: Sheet 6 of 6

October 12, 2012



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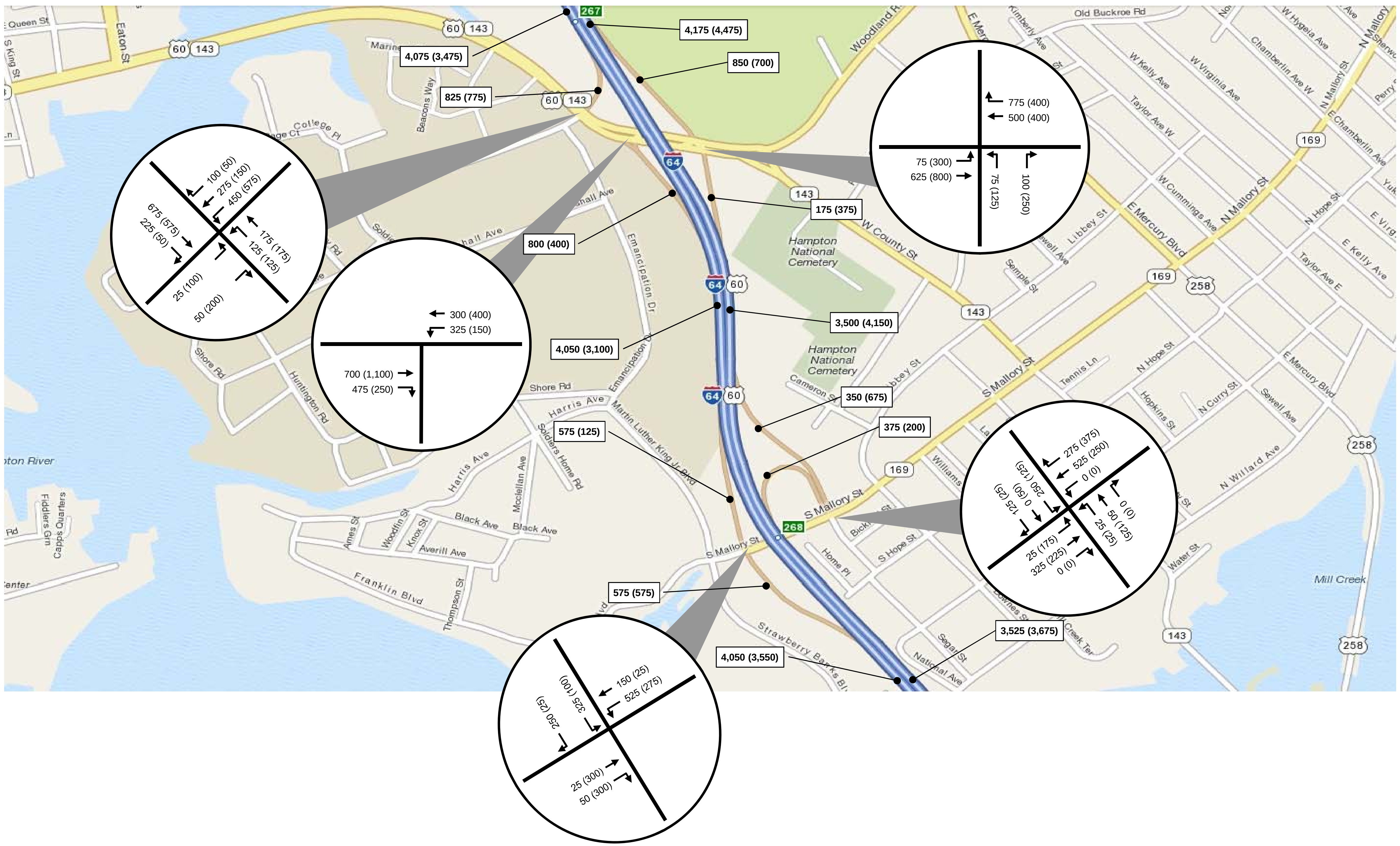
VDOT
Virginia Department of Transportation

2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 1 of 6

October 12, 2012



2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 2 of 6

October 12, 2012

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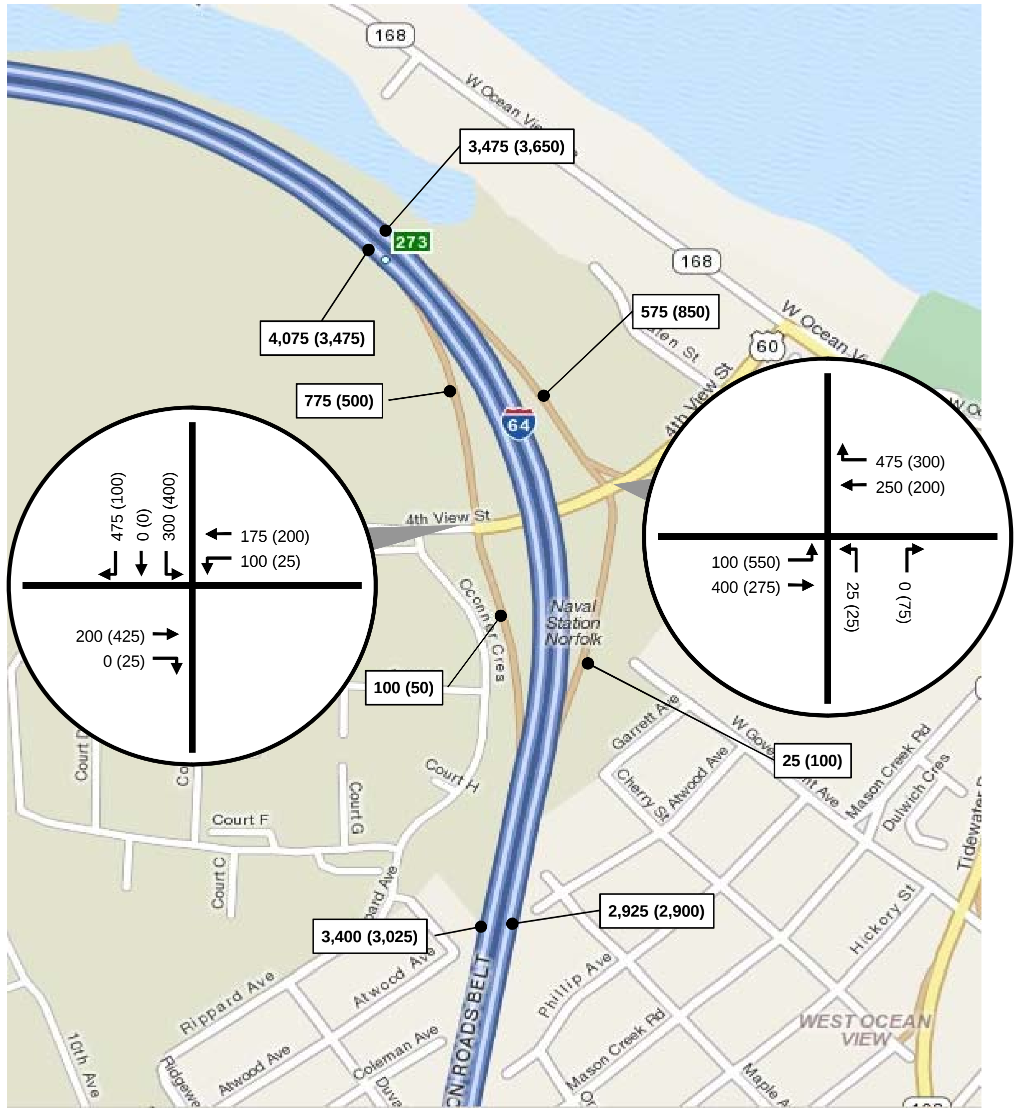
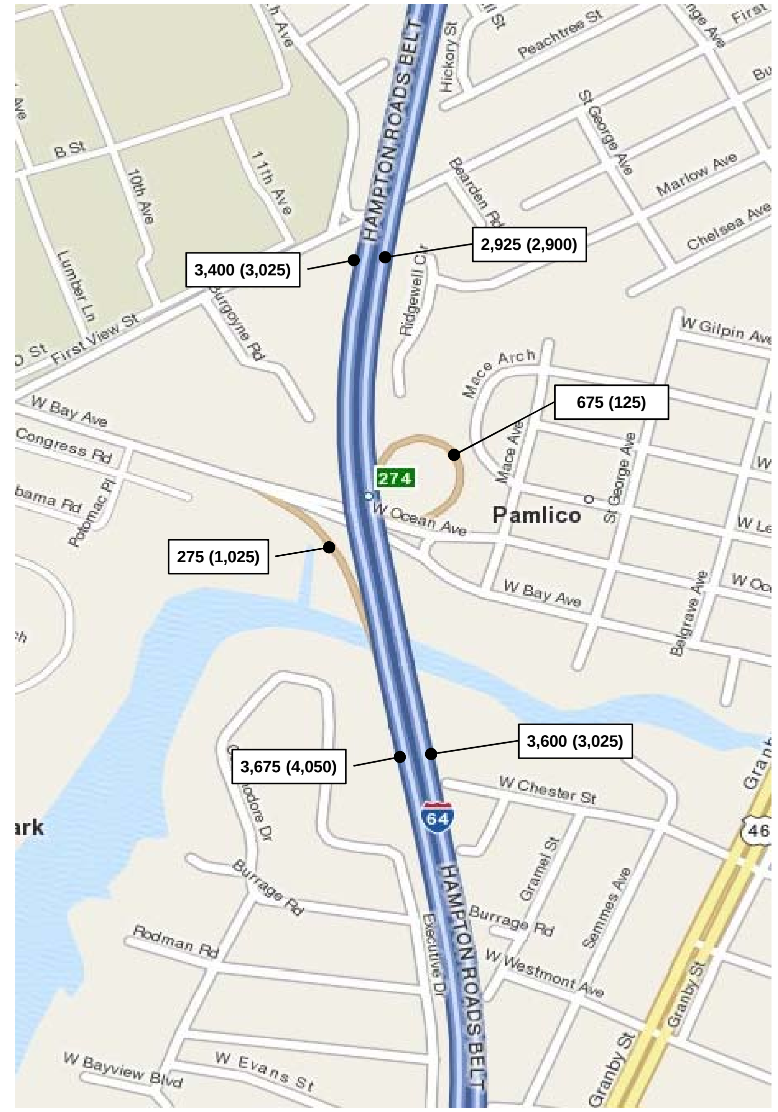
2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 3 of 6

October 12, 2012





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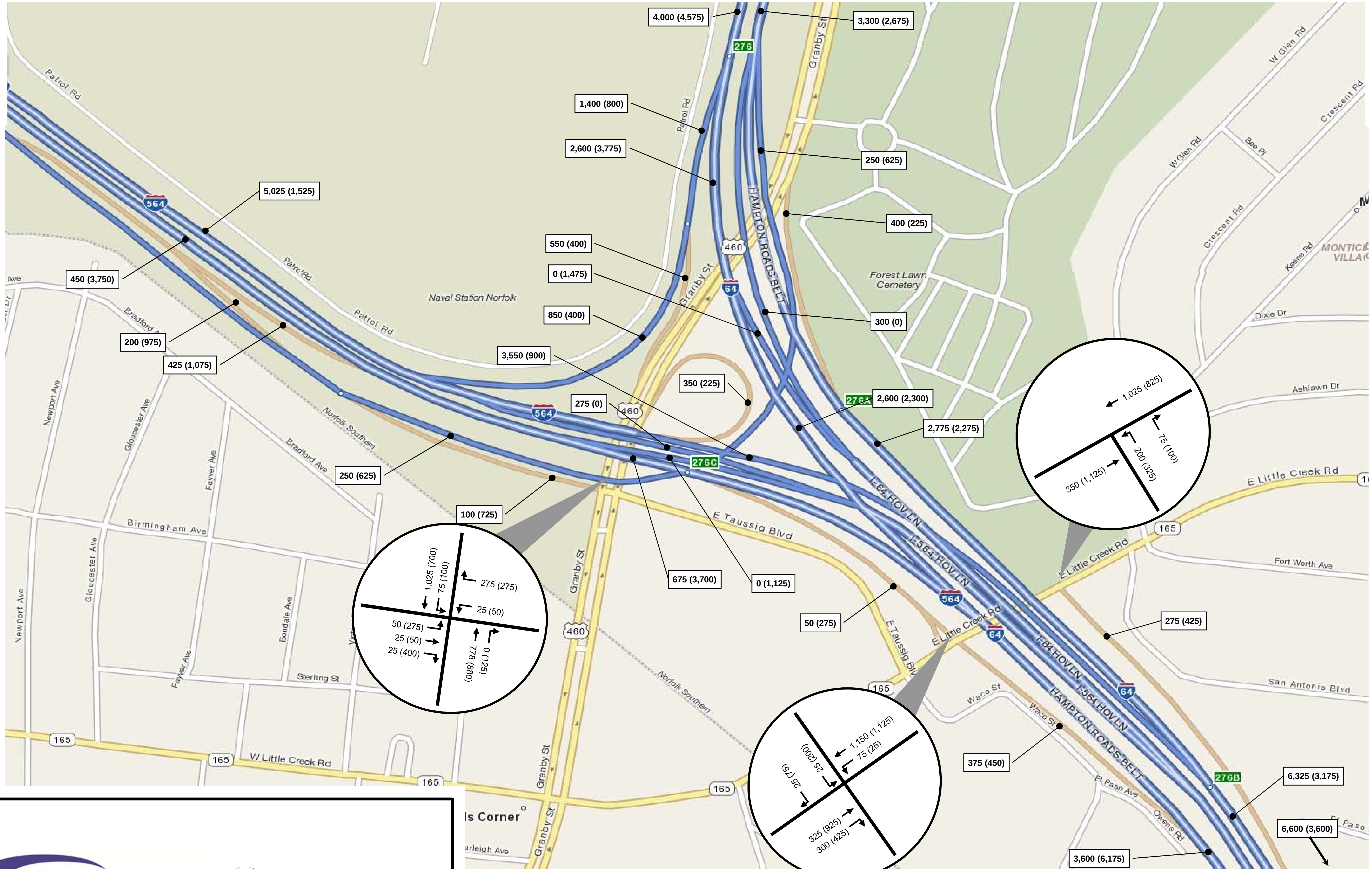
2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 4 of 6

October 12, 2012



2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 5 of 6

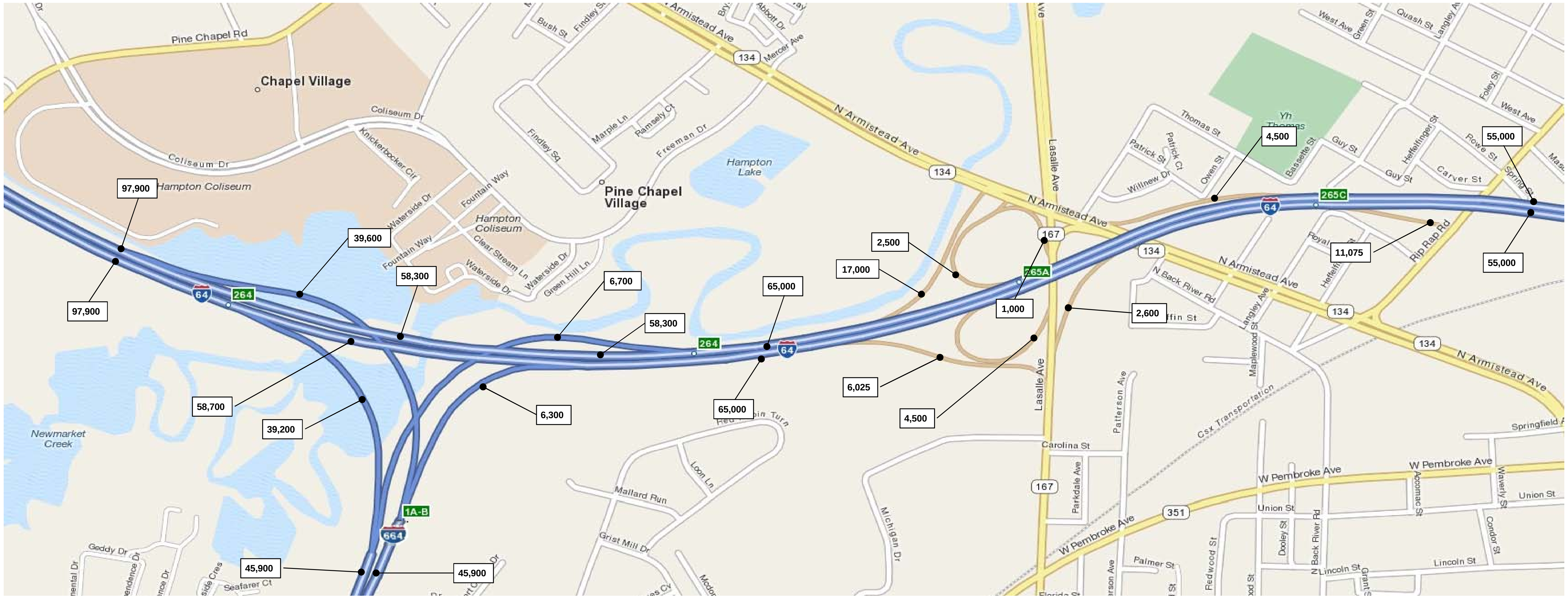
October 12, 2012

2020 No Build AM (PM) Peak Hour Volumes

Figure B-2: Sheet 6 of 6

October 12, 2012

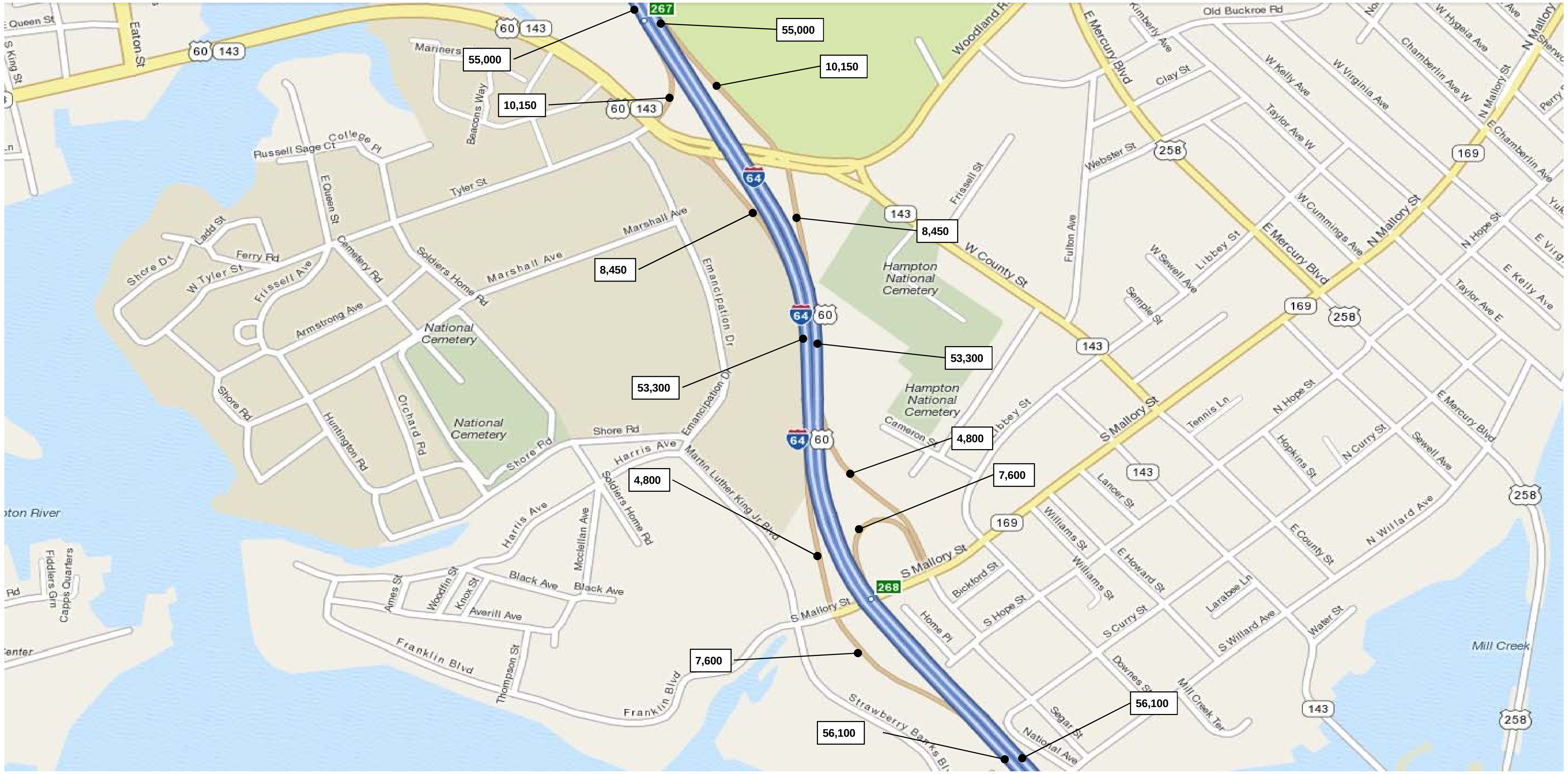
Hampton Roads Bridge Tunnel EIS



2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 1 of 6

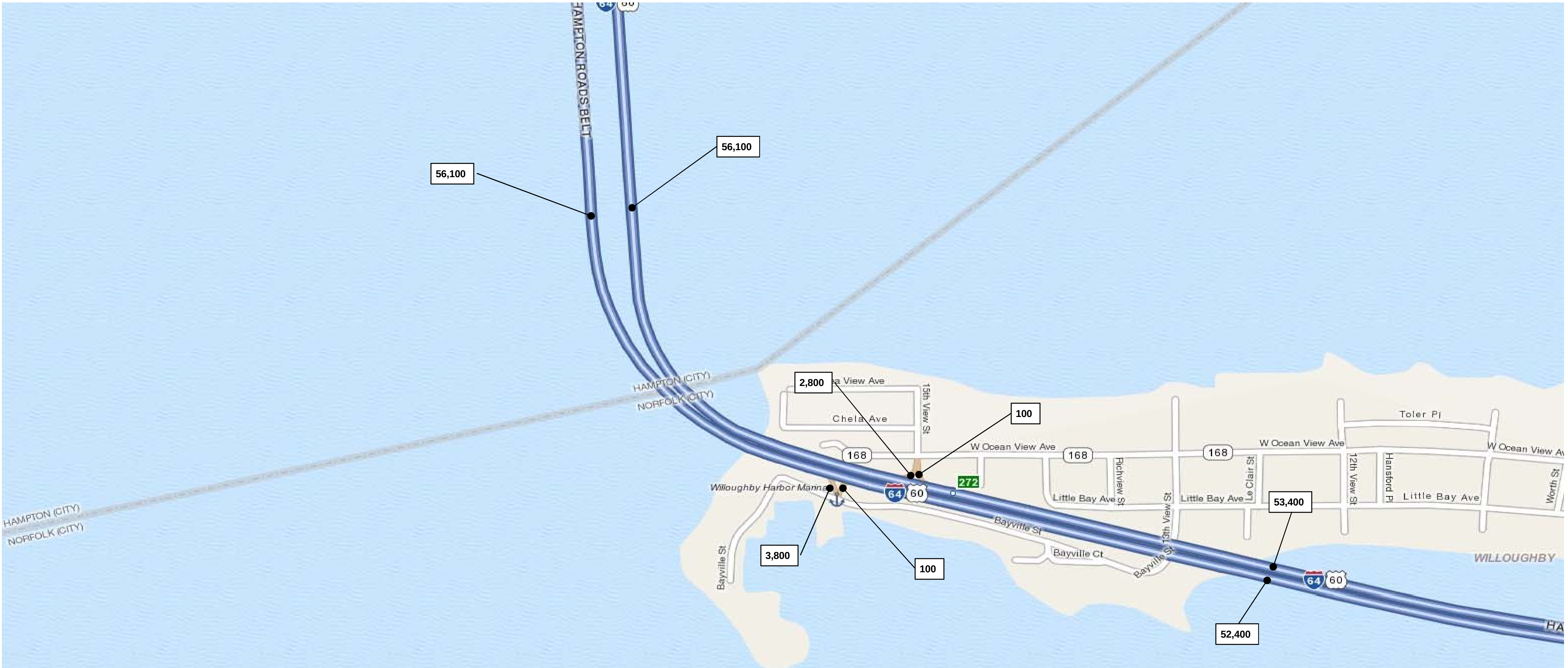
October 12, 2012



2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 2 of 6

October 12, 2012



Hampton Roads Bridge Tunnel EIS

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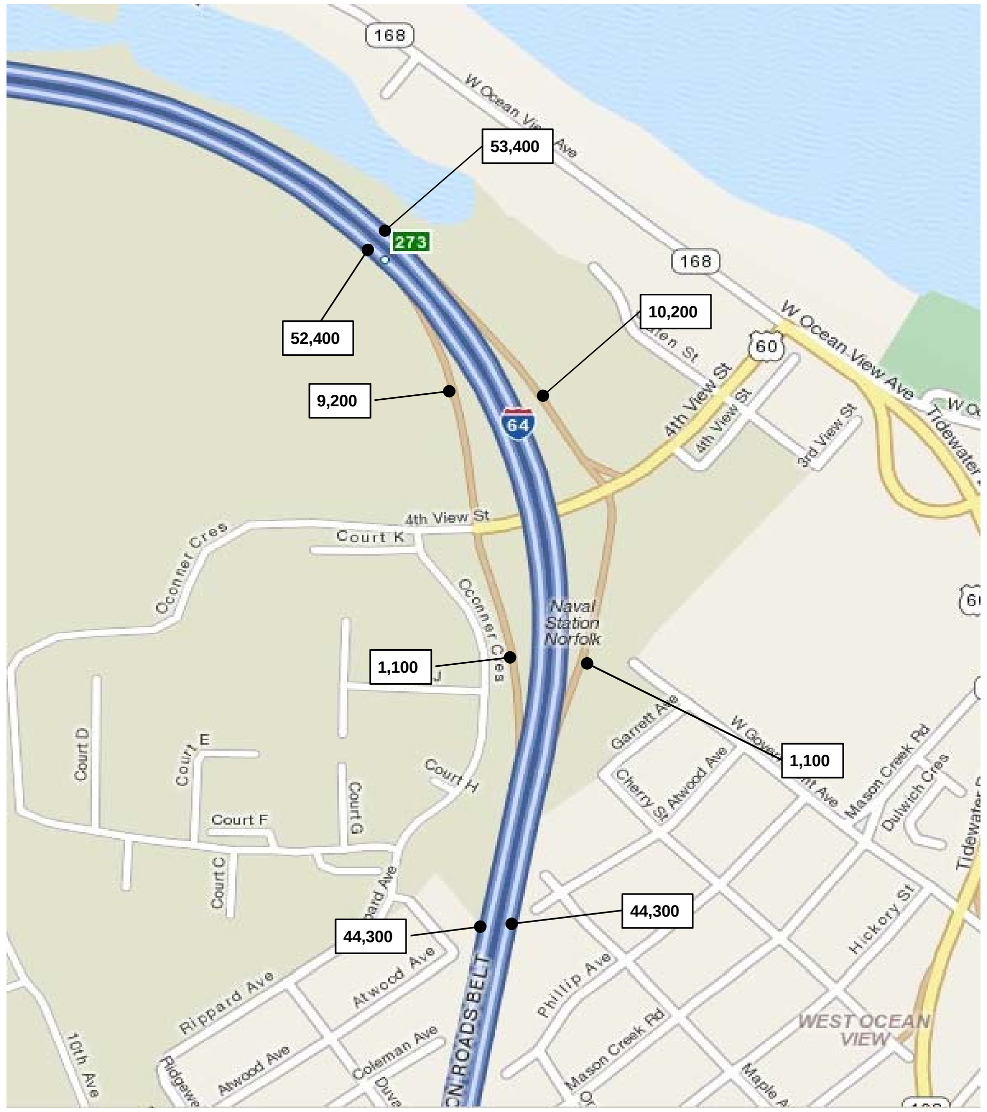
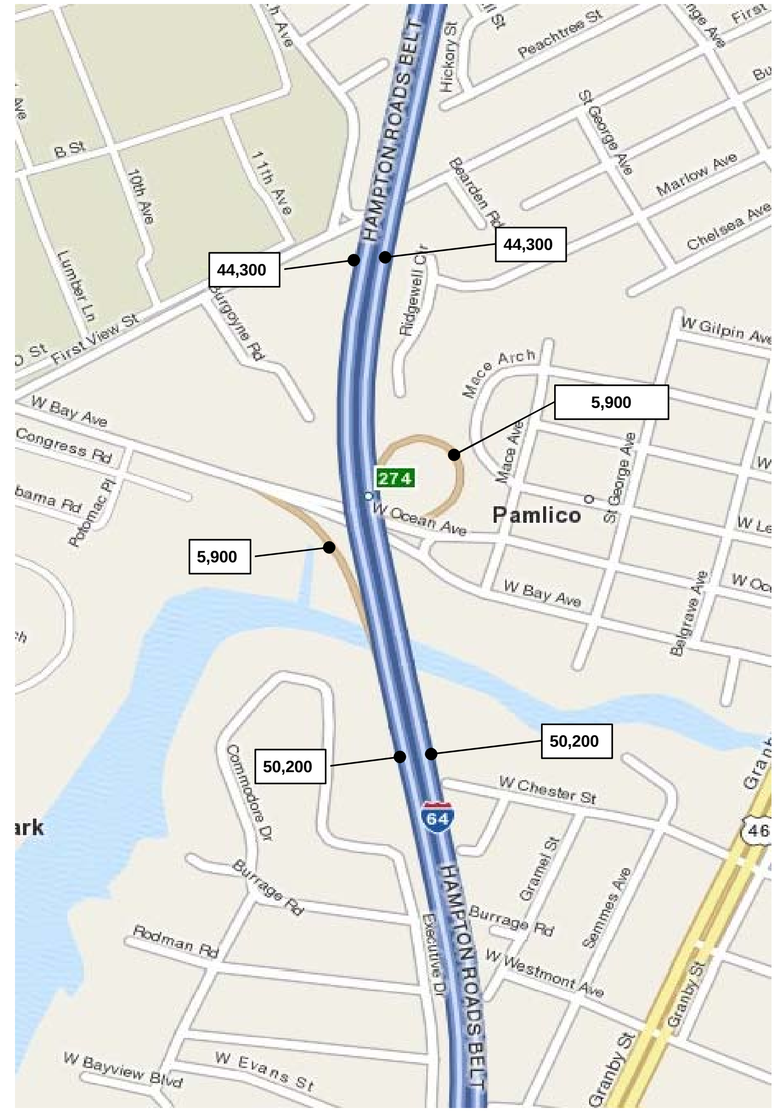
2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 3 of 6

October 12, 2012

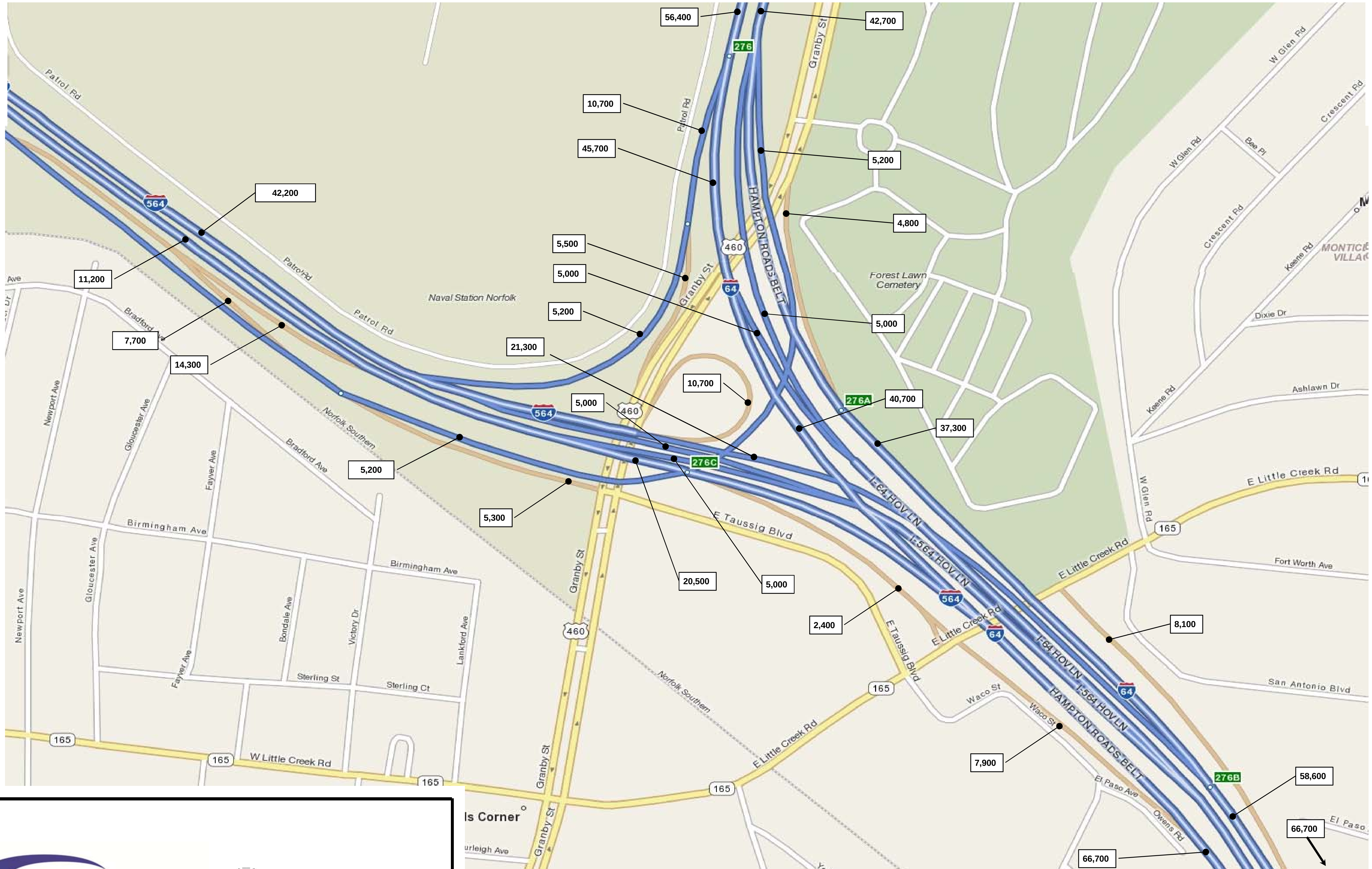




2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 4 of 6

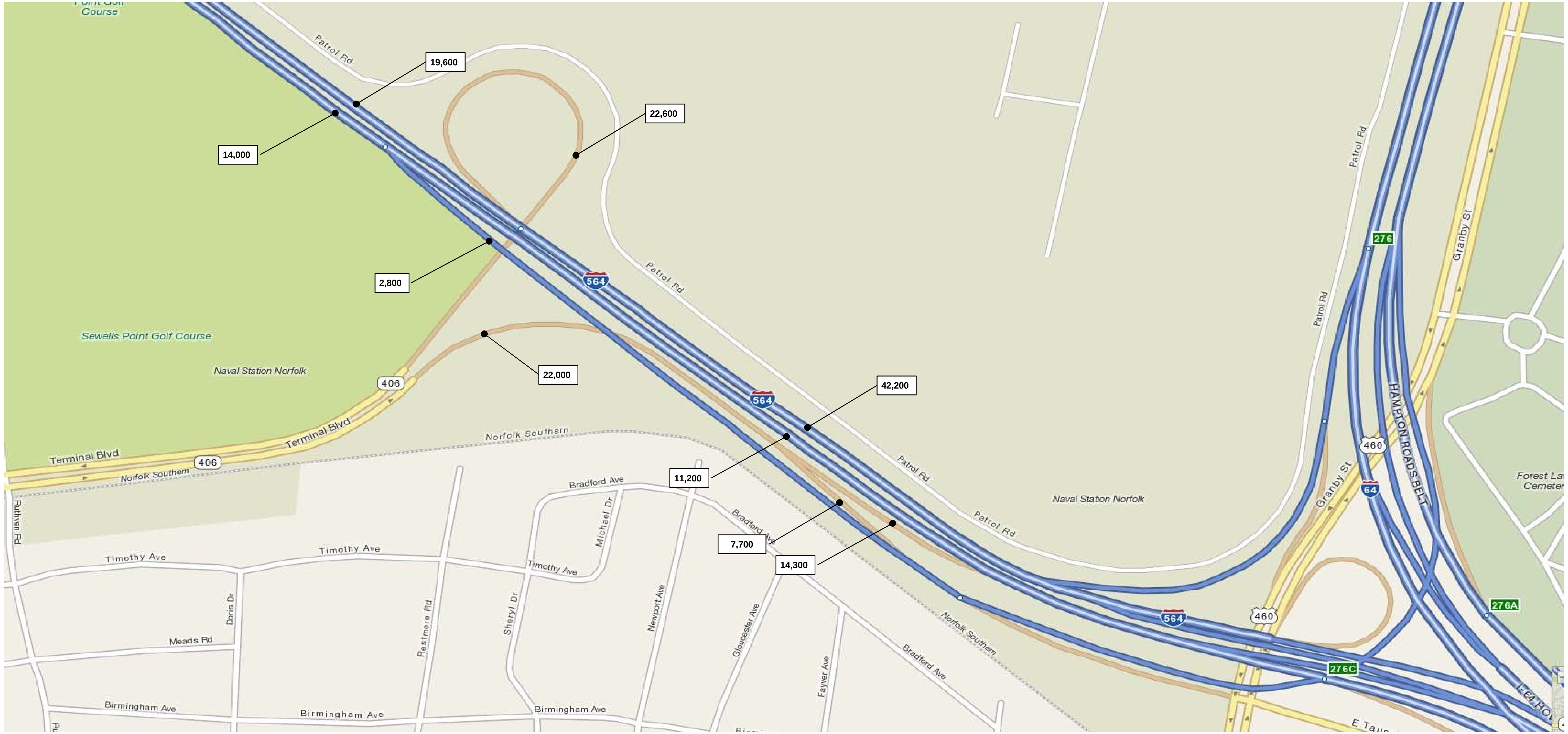
October 12, 2012



2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 5 of 6

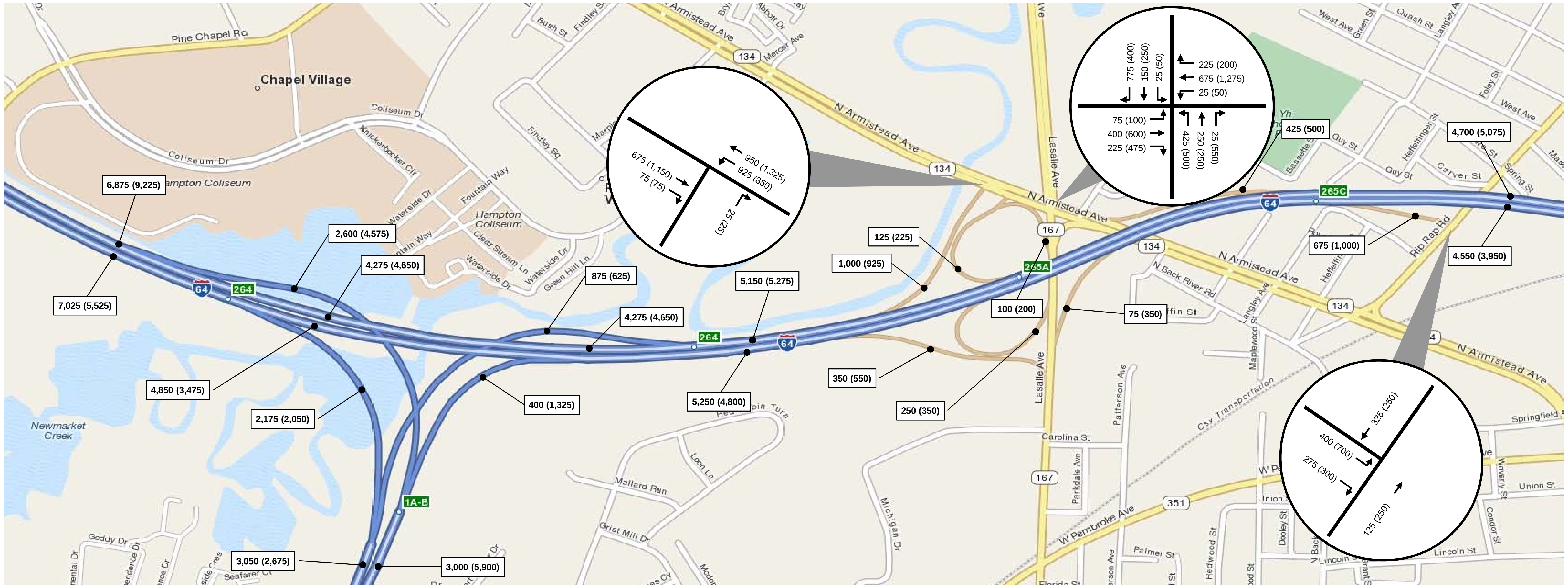
October 12, 2012



2040 No Build Daily (ADT) Volumes

Figure B-3: Sheet 6 of 6

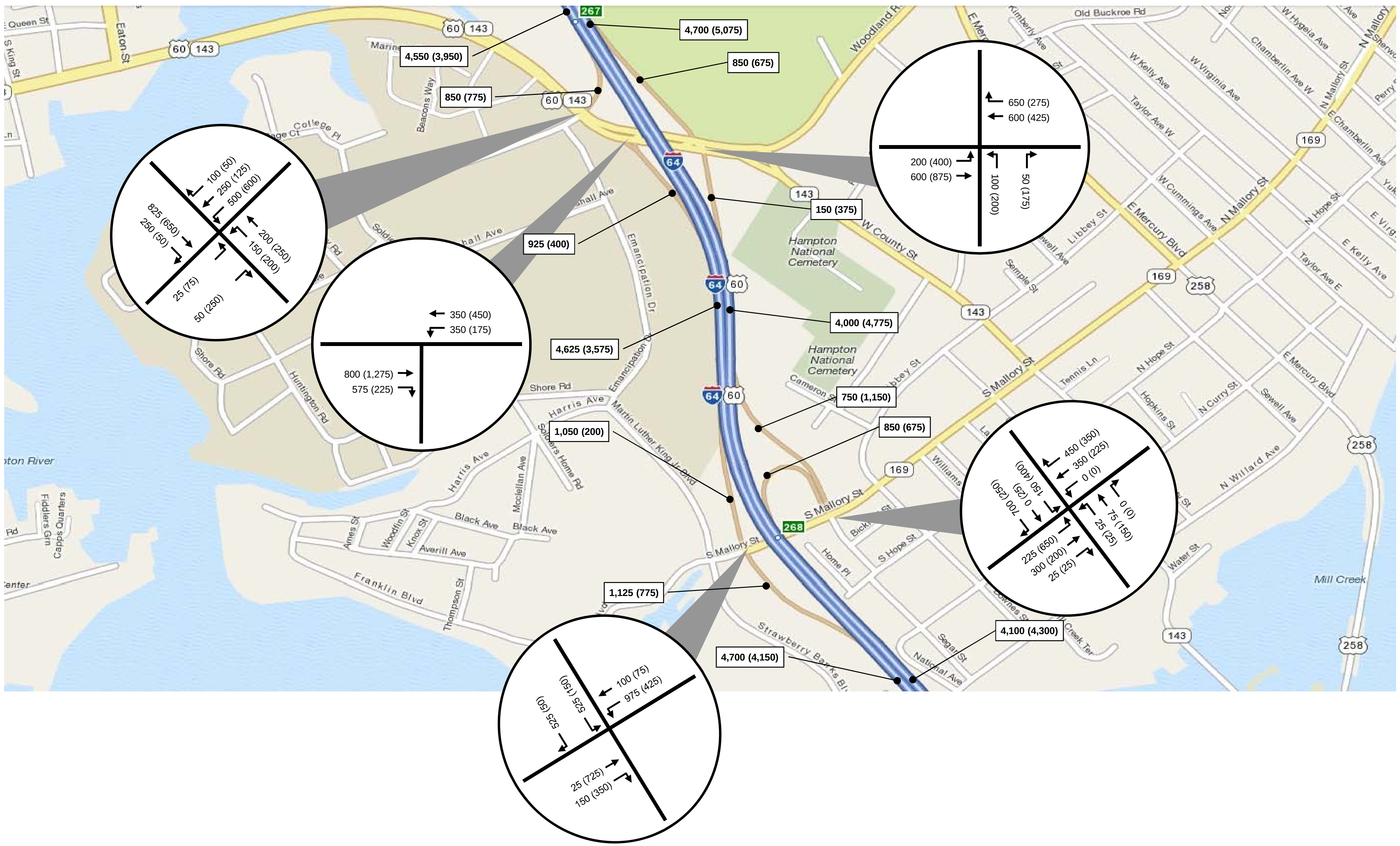
October 12, 2012



2040 No Build AM (PM) Peak Hour Volumes

Figure B-4: Sheet 1 of 6

October 12, 2012



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2040 No Build AM (PM) Peak Hour Volumes

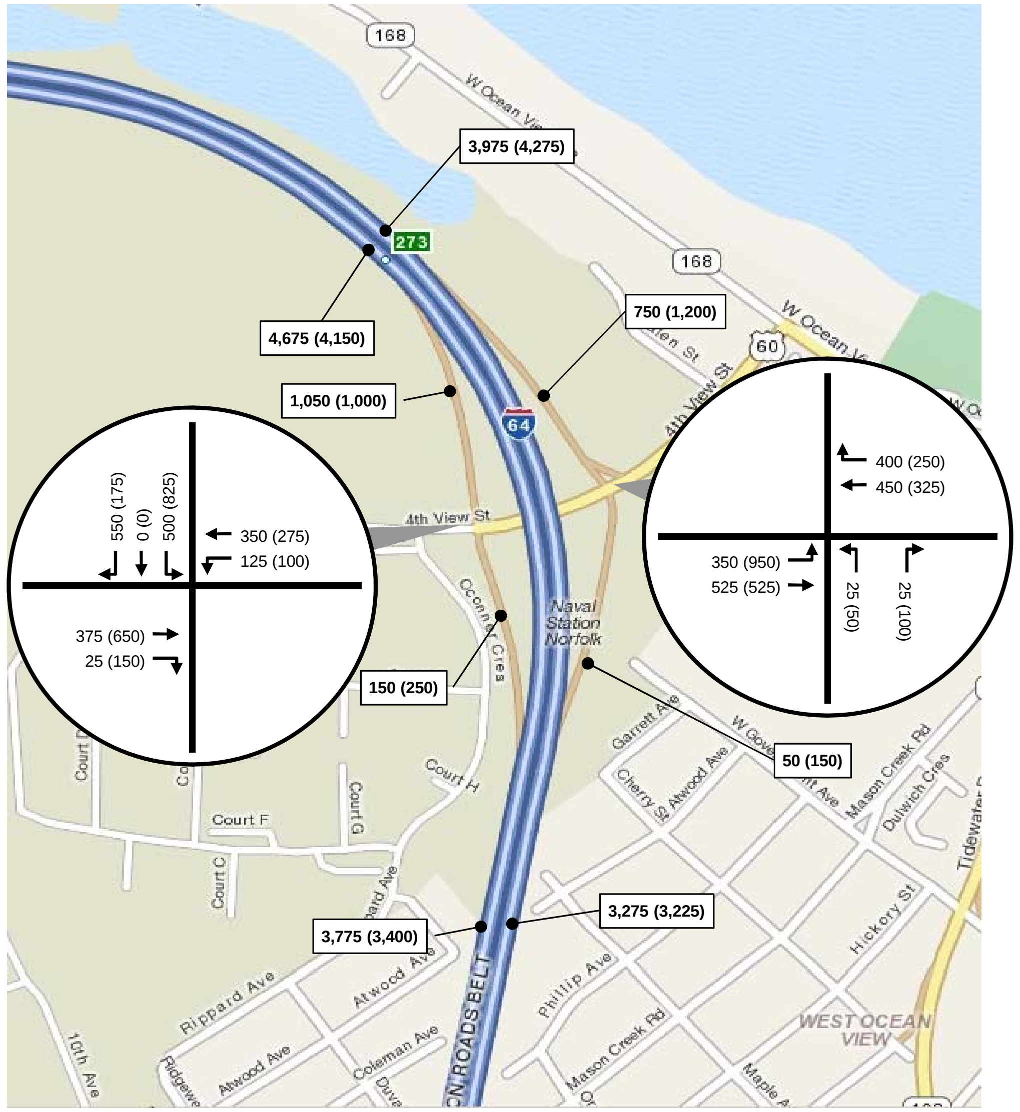
Figure B-4: Sheet 2 of 6

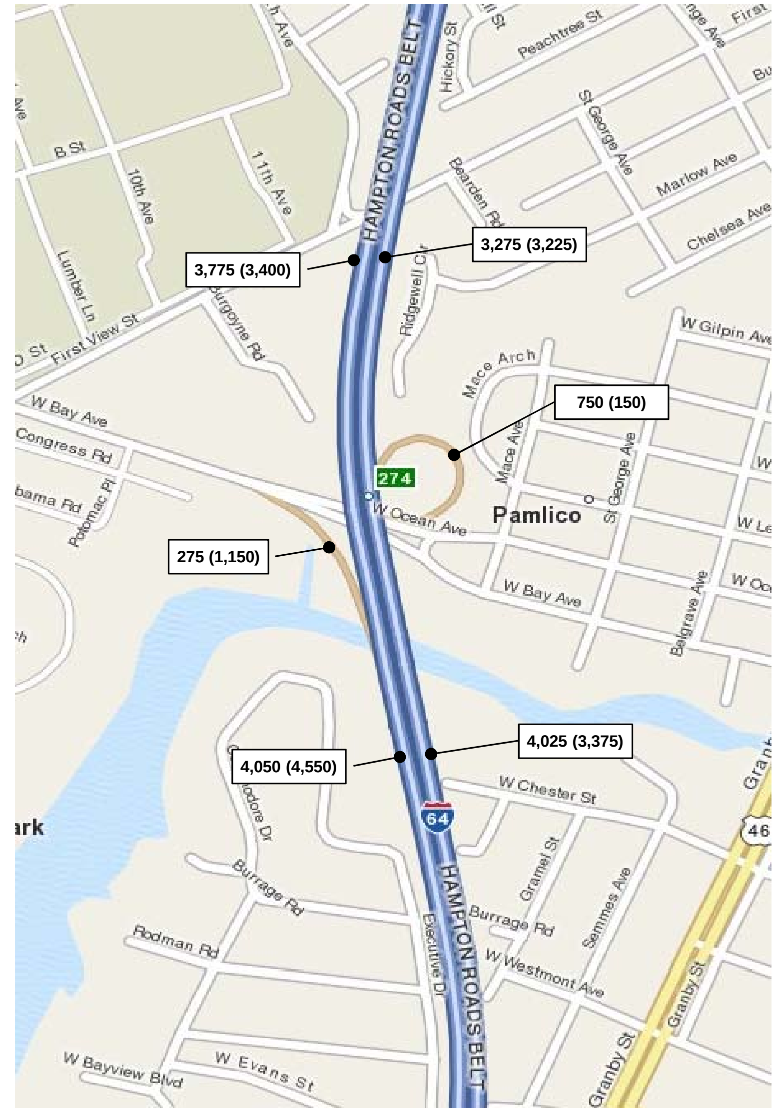
October 12, 2012

2040 No Build AM (PM) Peak Hour Volumes

Figure B-4: Sheet 3 of 6

October 12, 2012





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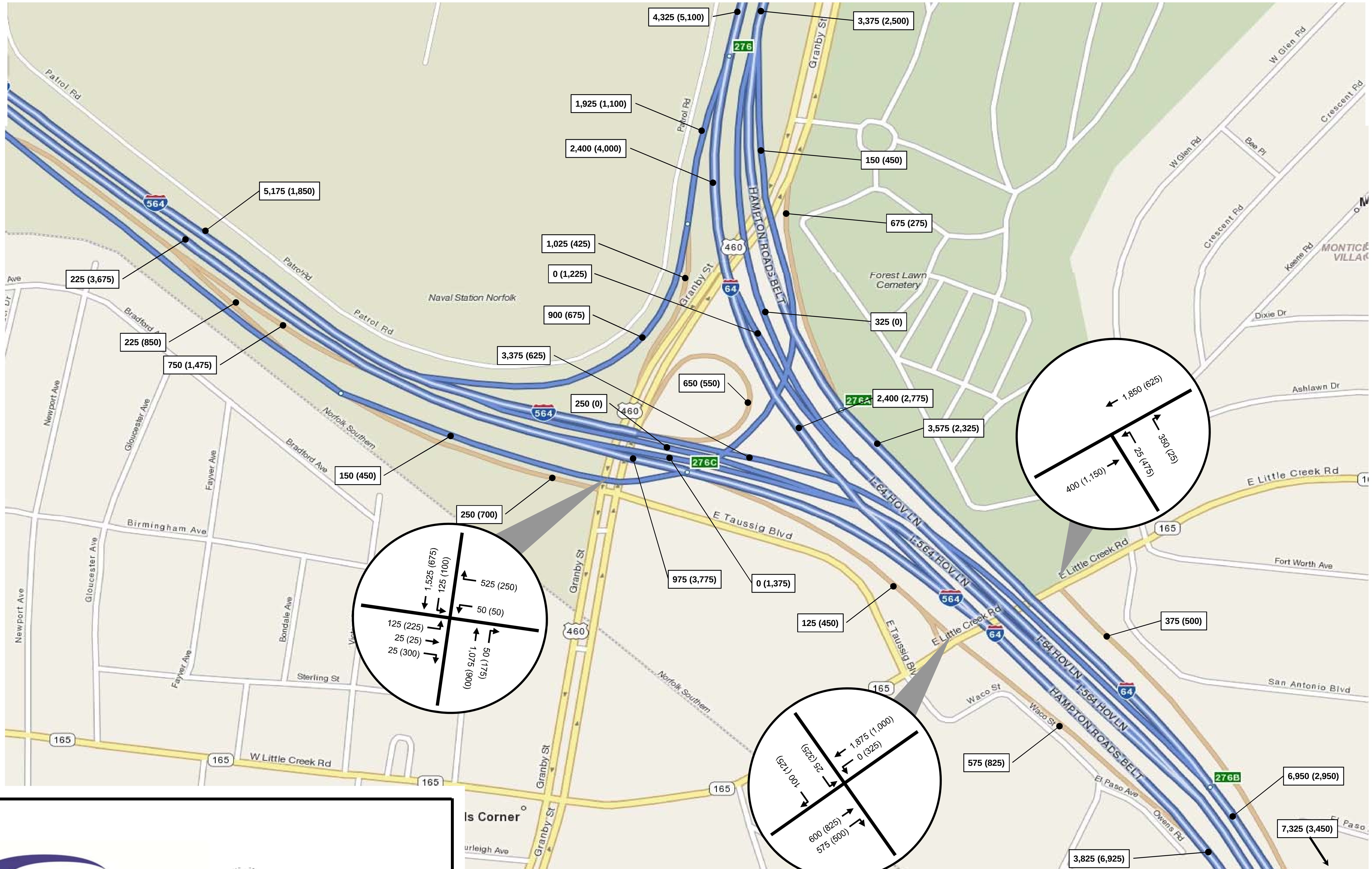
2040 No Build AM (PM) Peak Hour Volumes

Figure B-4: Sheet 4 of 6

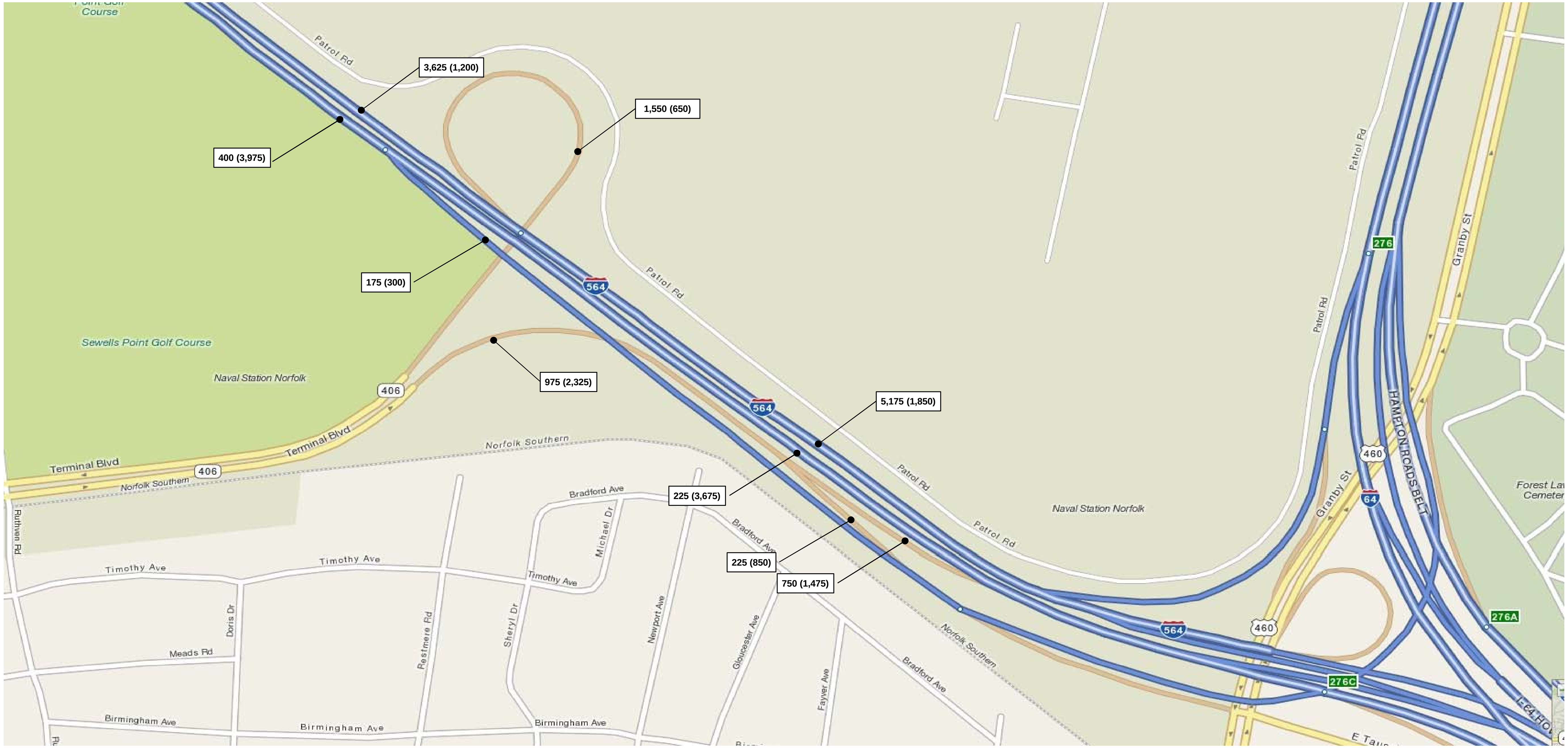
October 12, 2012



2040 No Build AM (PM) Peak Hour Volumes

Figure B-4: Sheet 5 of 6

October 12, 2012



2040 No Build AM (PM) Peak Hour Volumes

Figure B-4: Sheet 6 of 6

October 12, 2012

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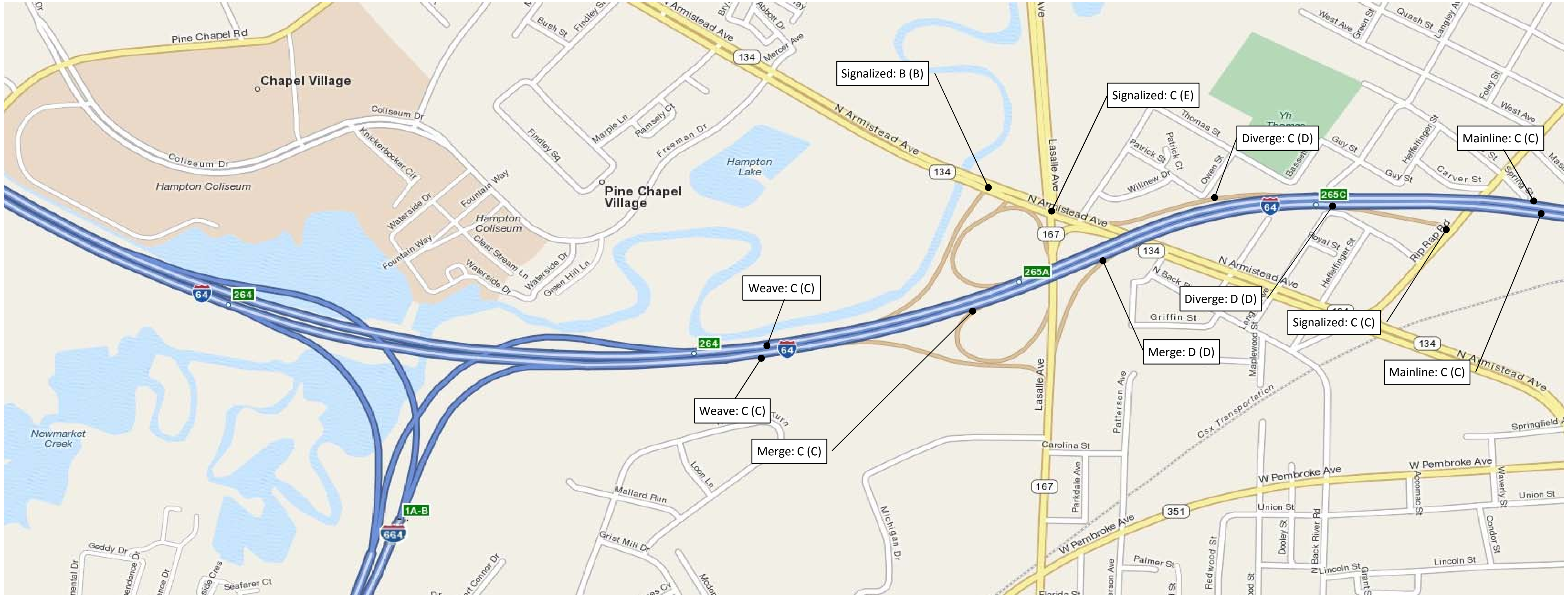

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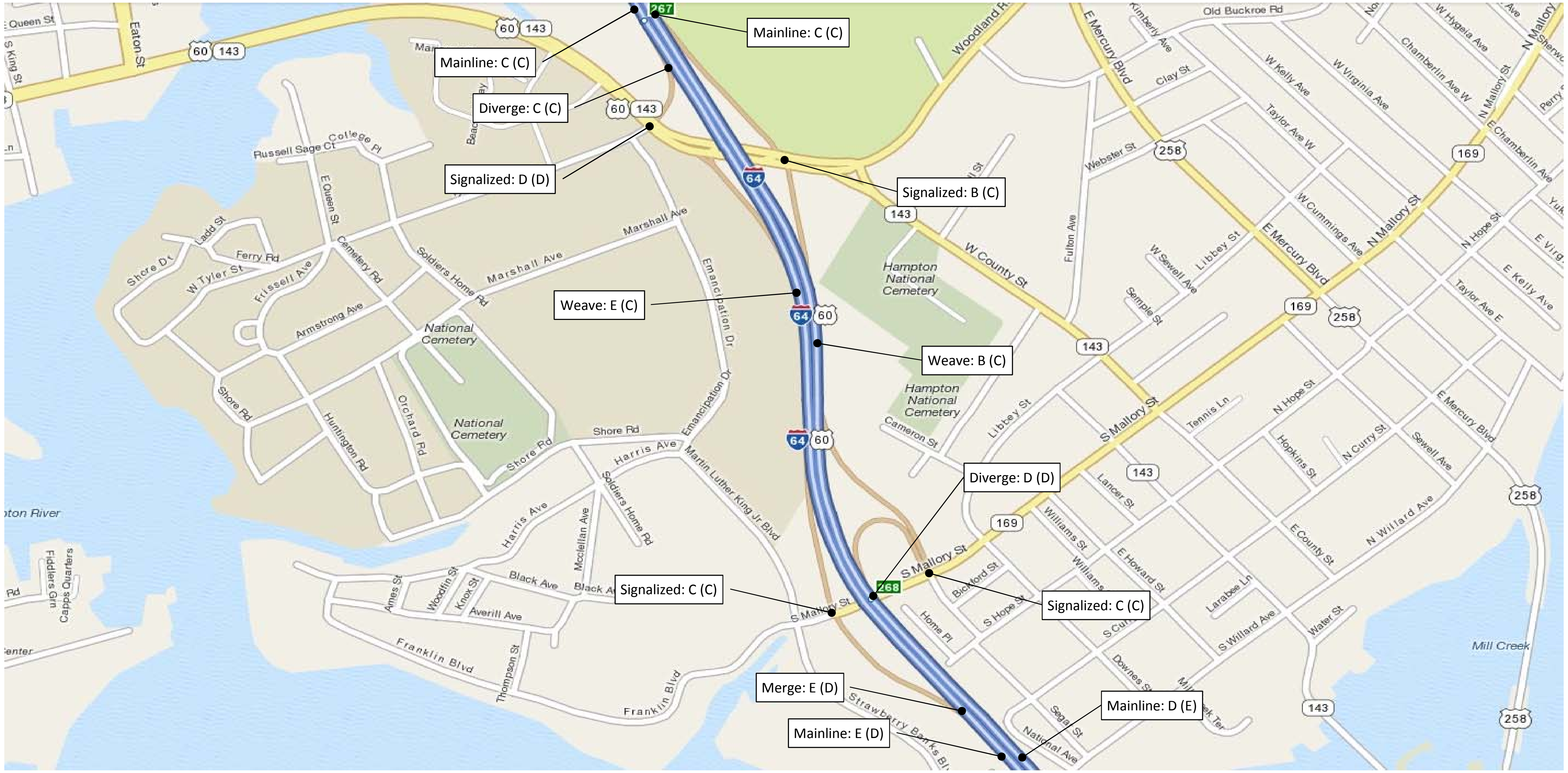
2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 1 of 6

October 12, 2012



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2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 2 of 6

October 12, 2012

2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 3 of 6

October 12, 2012

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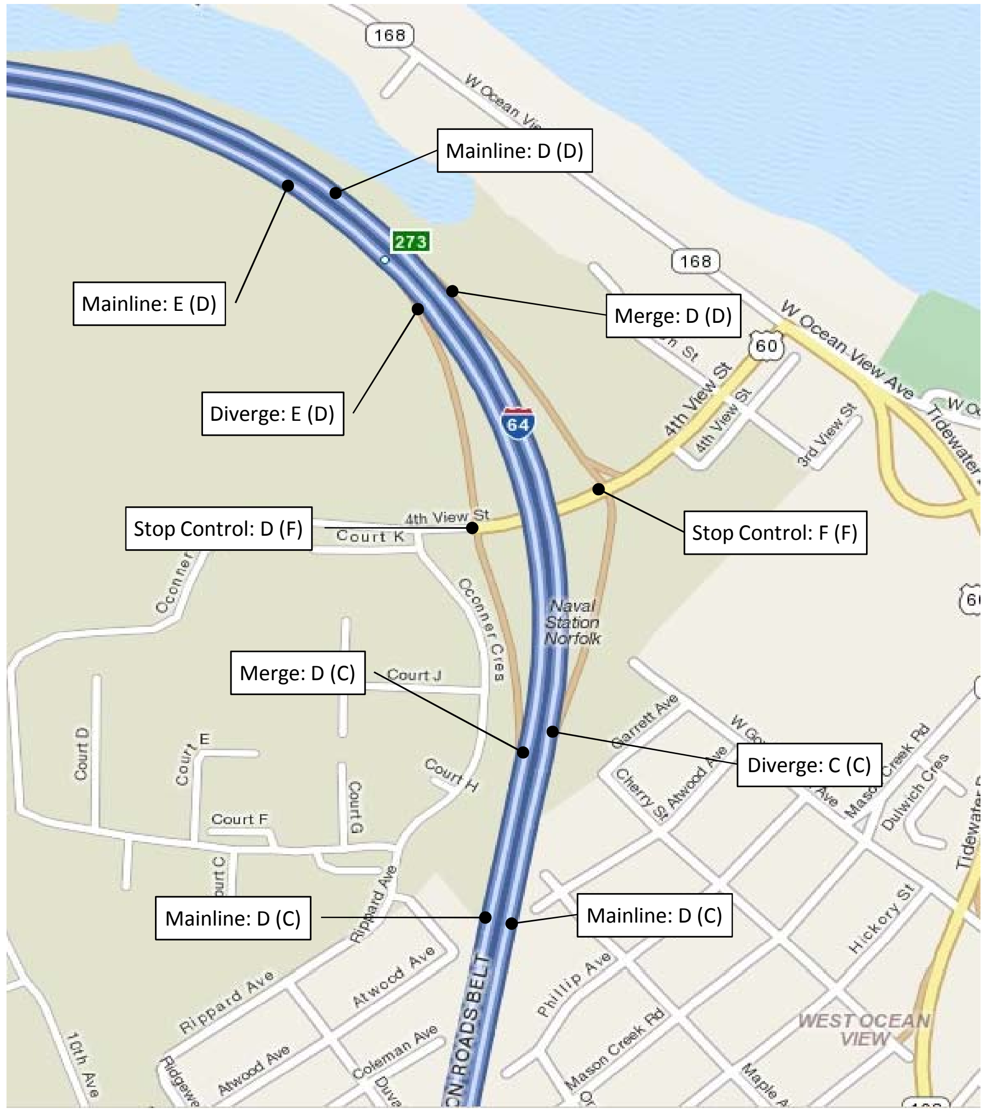

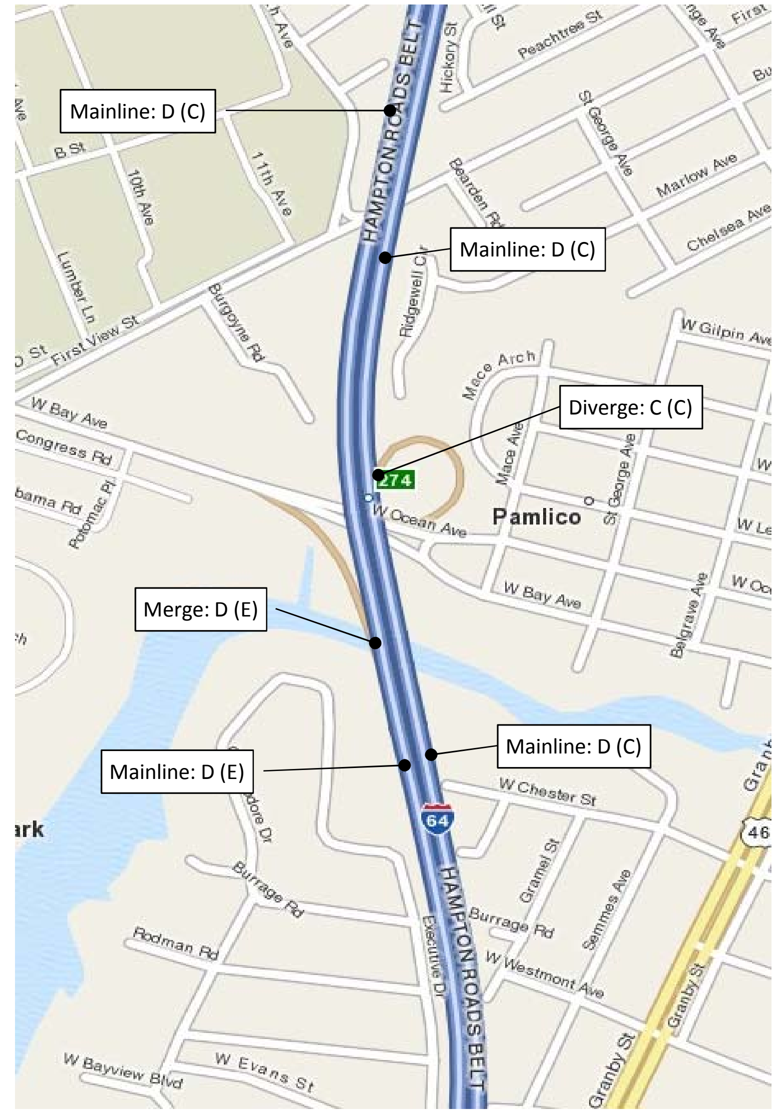

2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 4 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

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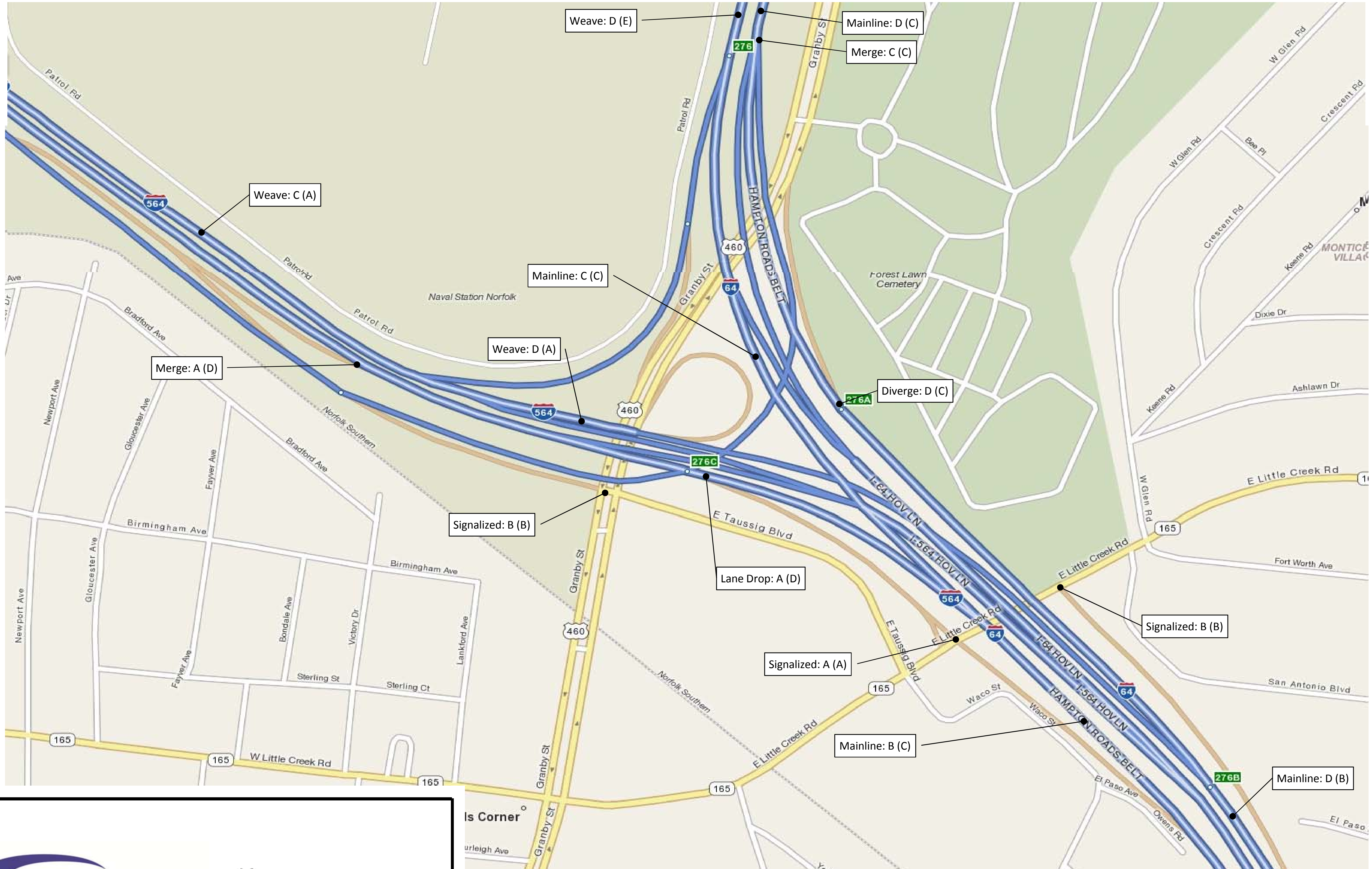
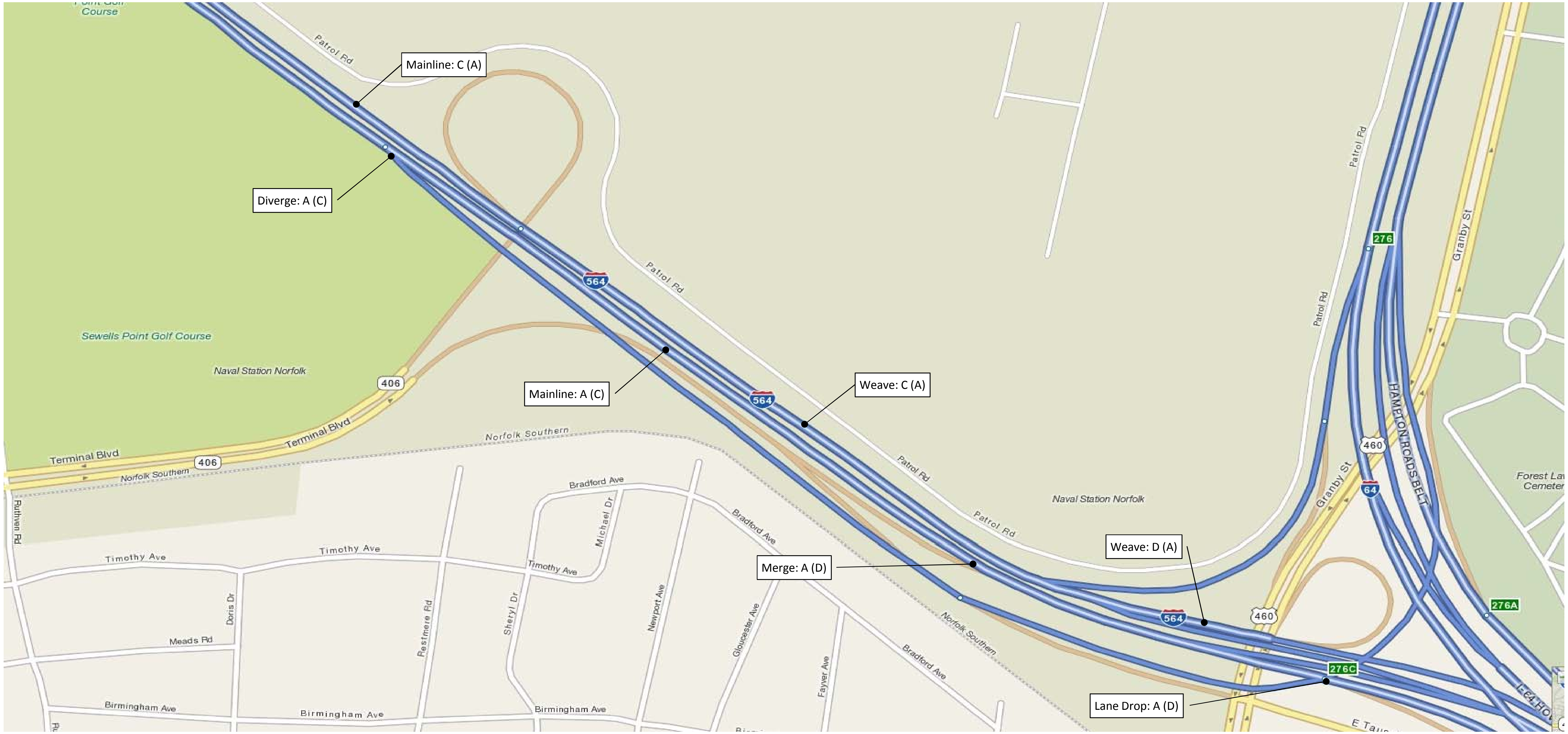


2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 5 of 6

October 12, 2012

Hampton Roads Bridge Tunnel EIS



HRBT Hampton Roads Bridge Tunnel EIS

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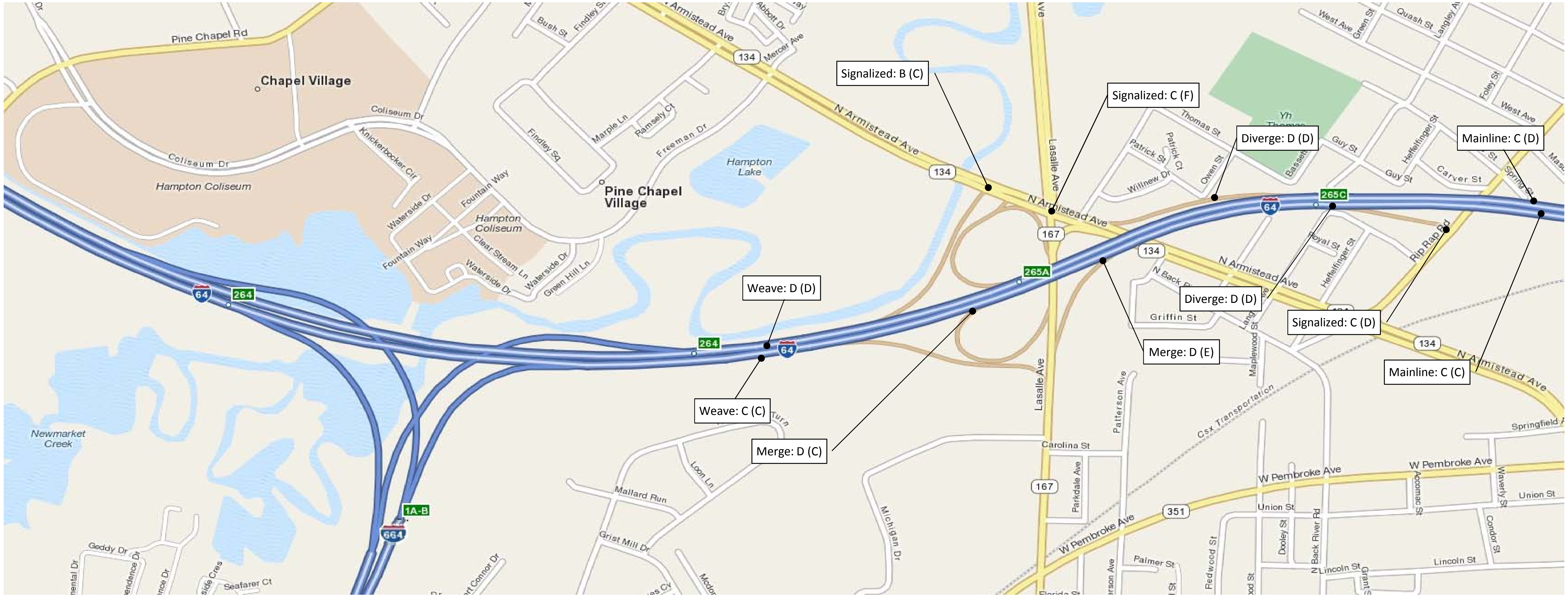
2020 No Build AM (PM) Level of Service

Figure B-5: Sheet 6 of 6

October 12, 2012

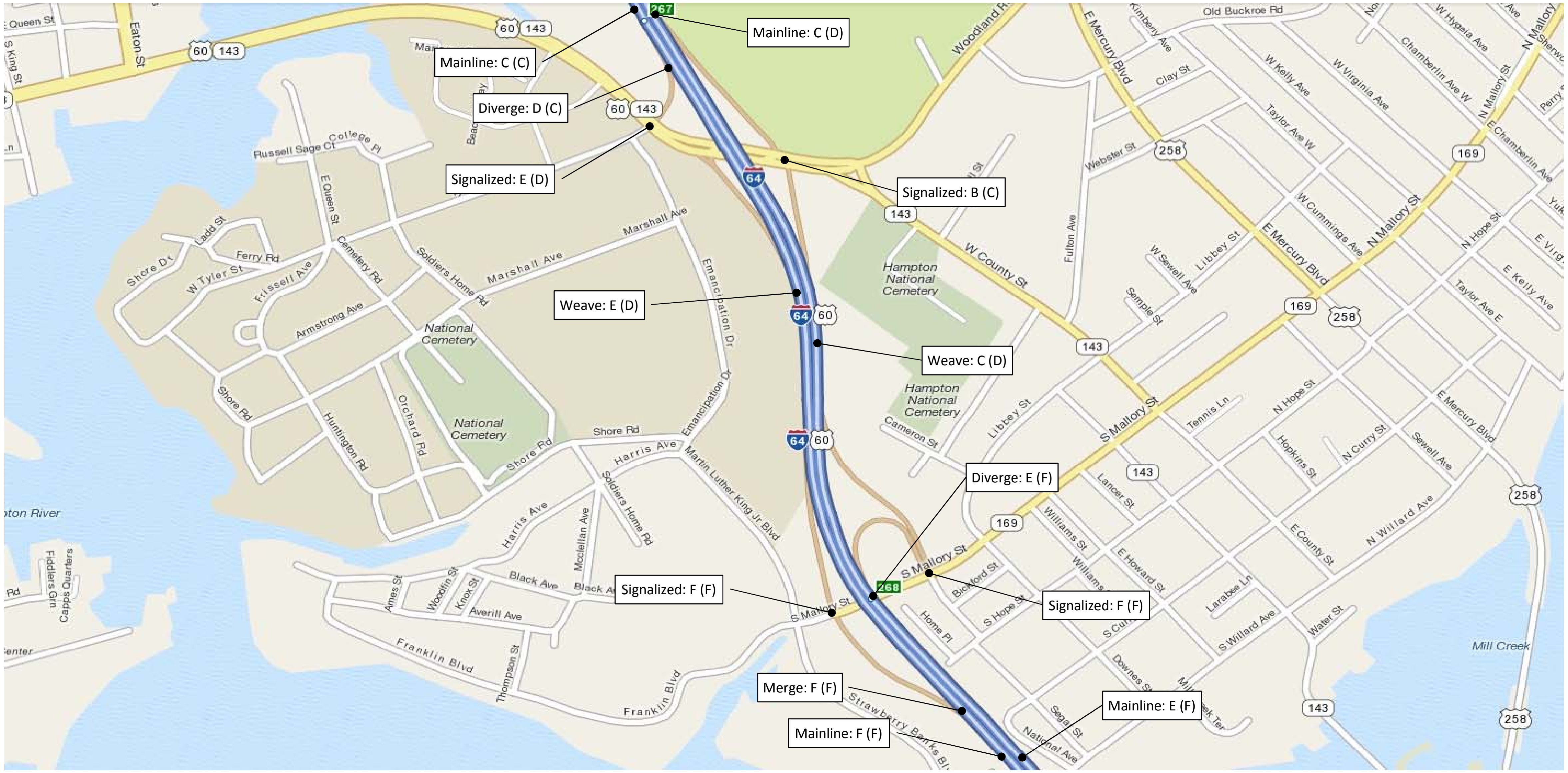


Hampton Roads Bridge Tunnel EIS

2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 1 of 6

October 12, 2012



2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 2 of 6

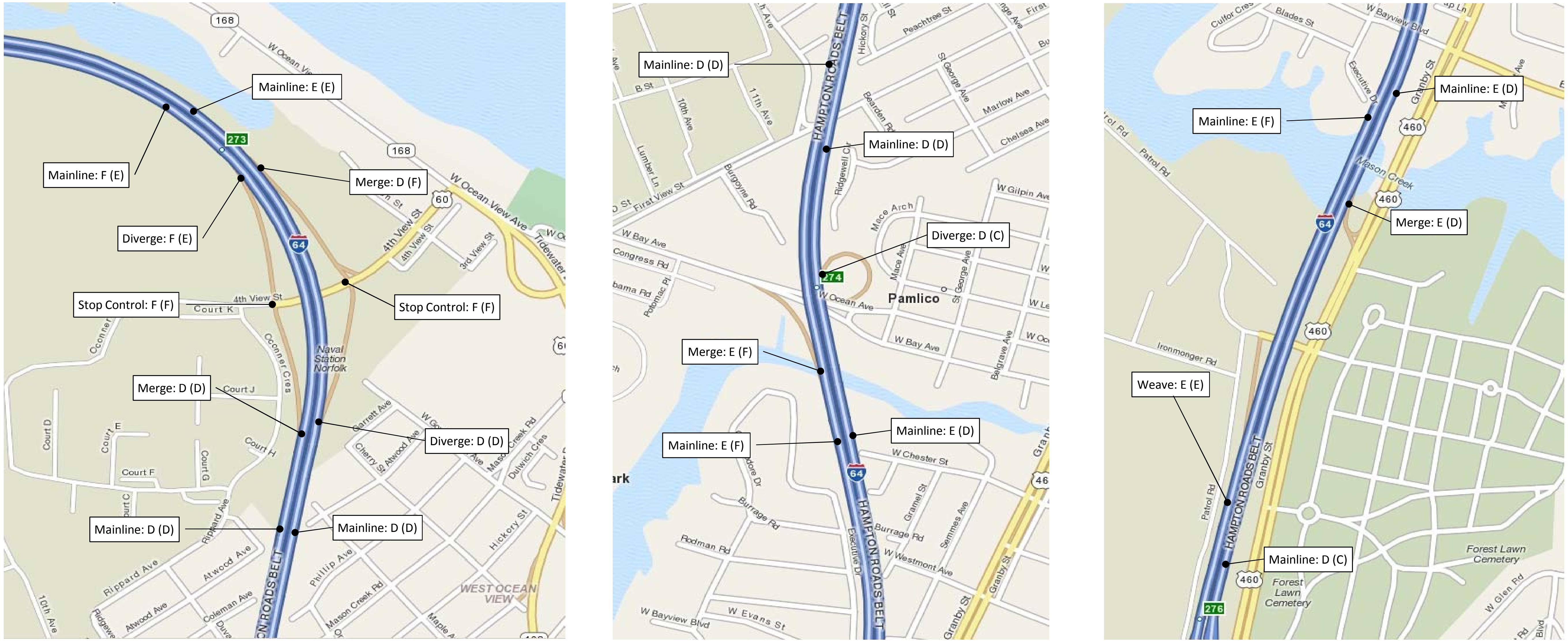
October 12, 2012

Hampton Roads Bridge Tunnel EIS

2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 3 of 6

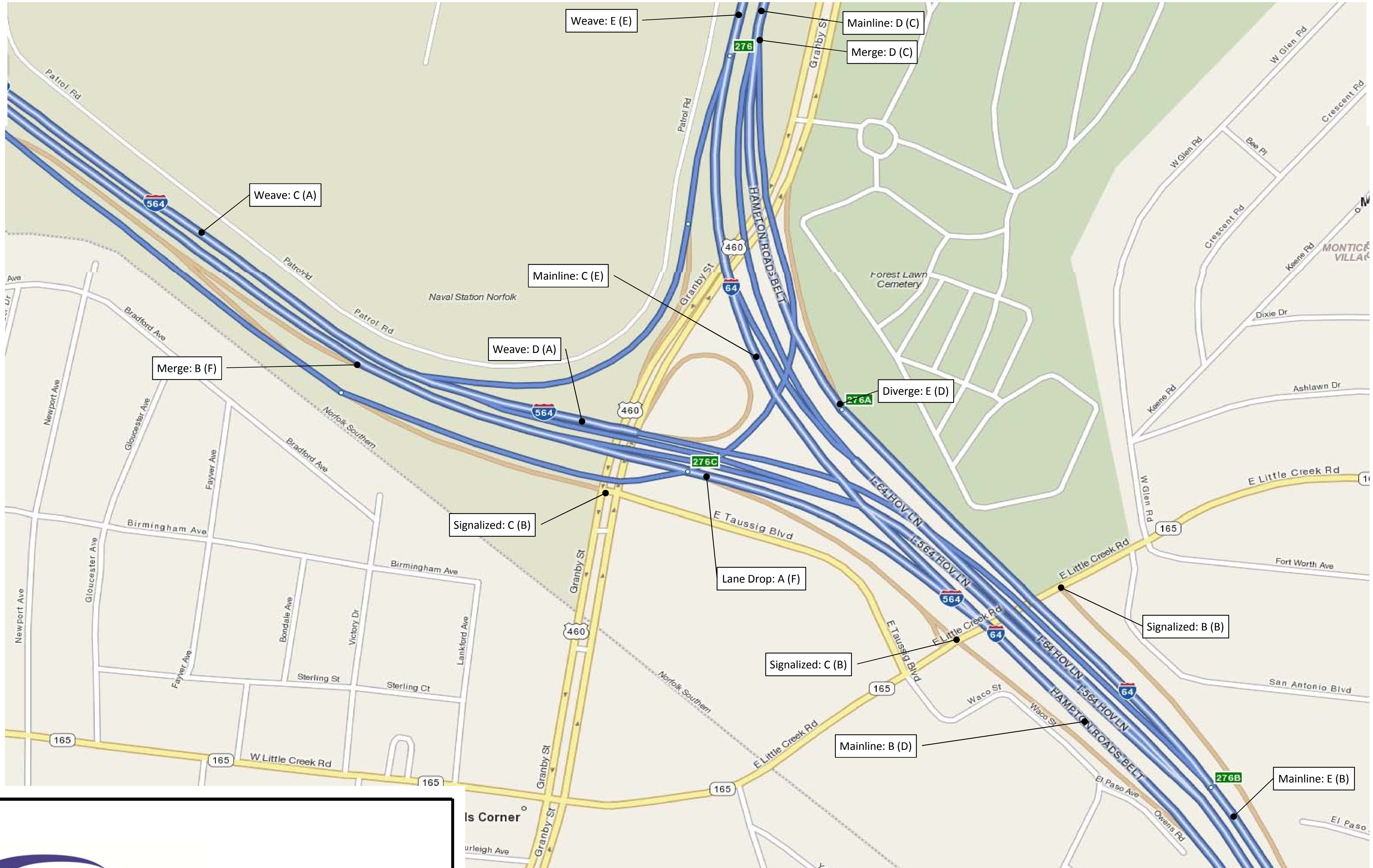
October 12, 2012



2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 4 of 6

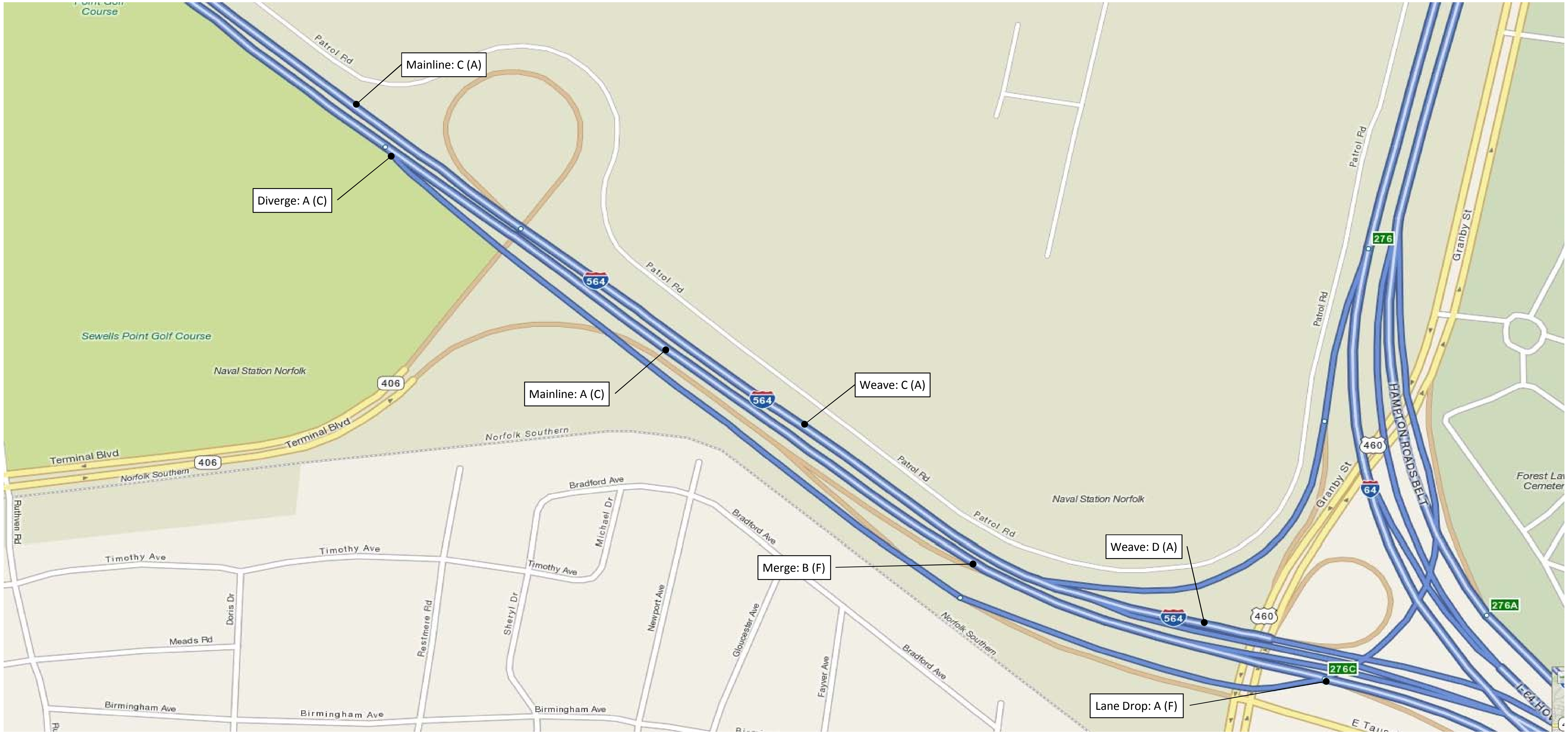
October 12, 2012



2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 5 of 6

October 12, 2012

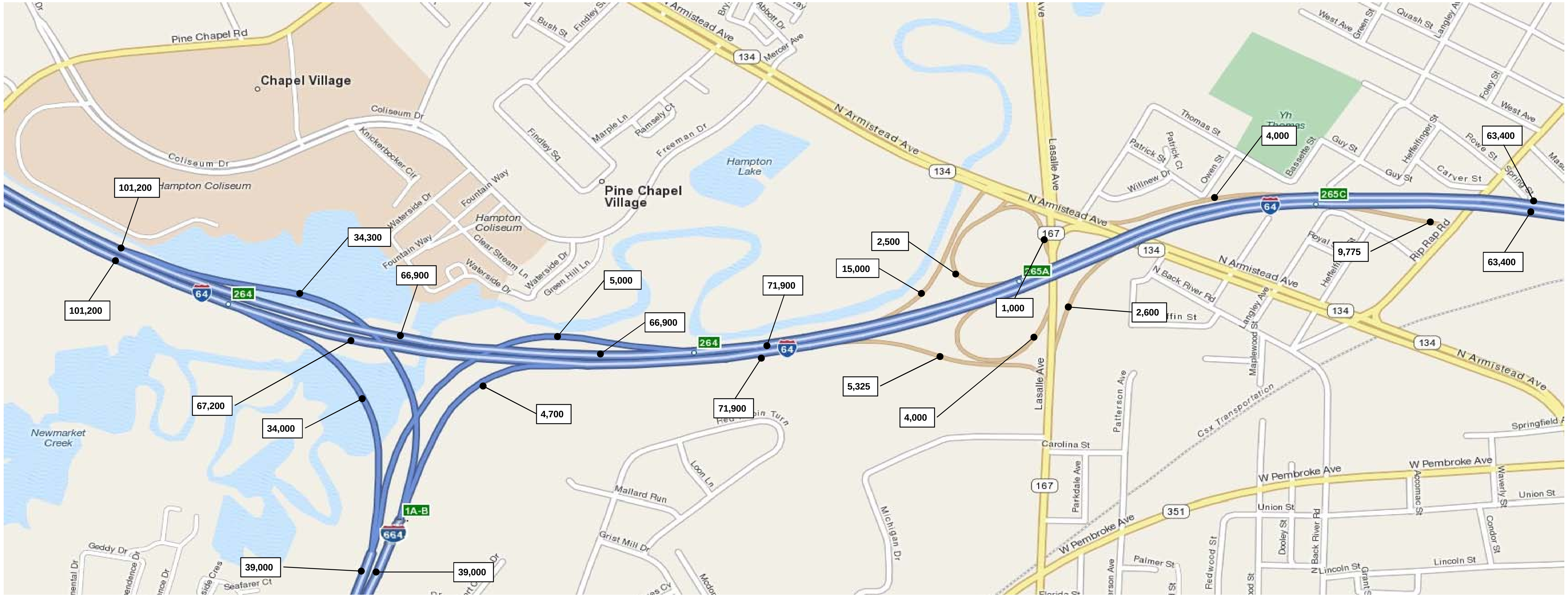


2040 No Build AM (PM) Level of Service

Figure B-6: Sheet 6 of 6

October 12, 2012

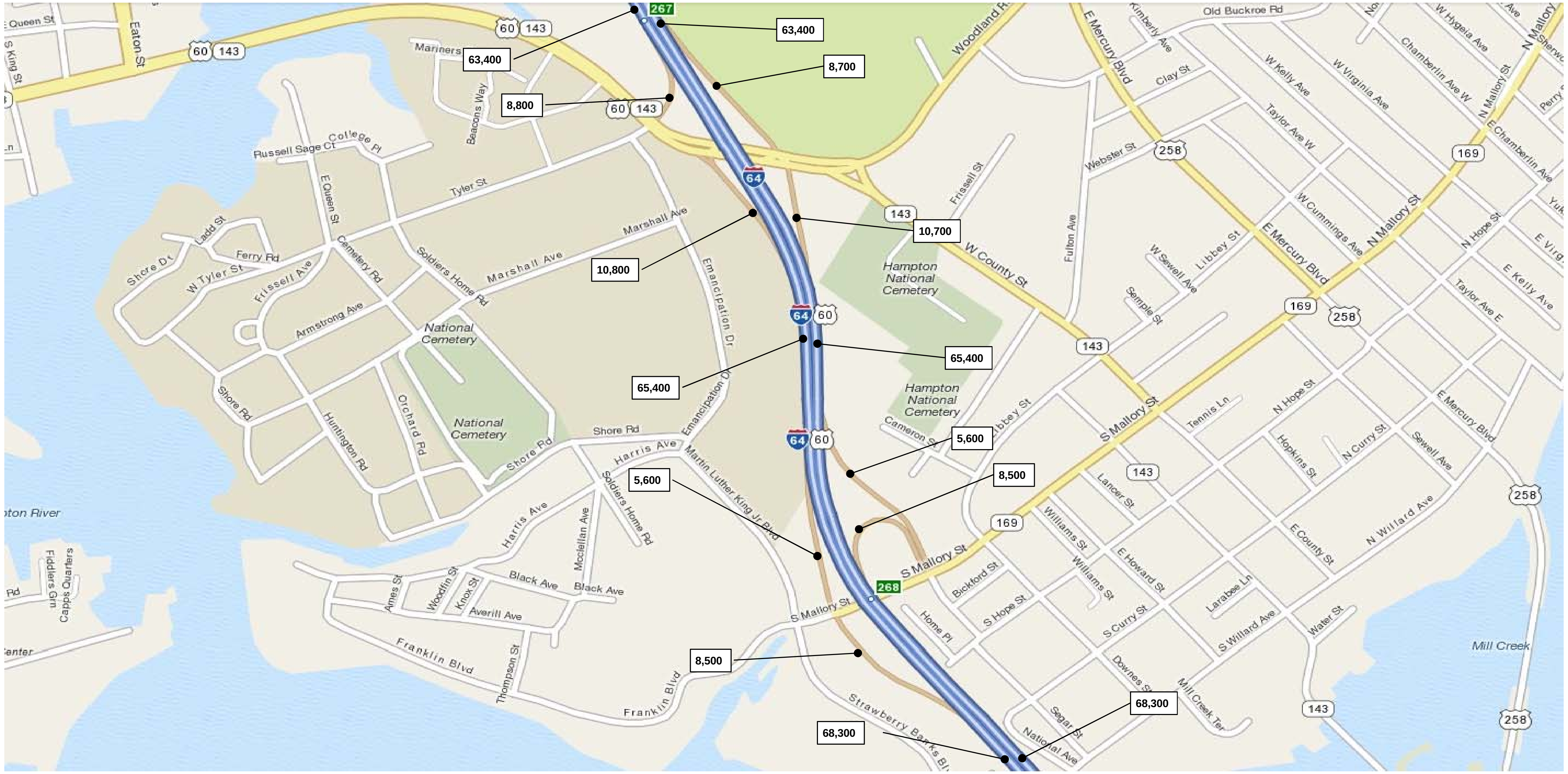
Appendix C. **2040 Build-6 Traffic Volumes and Capacity Analysis**



2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 1 of 6

October 12, 2012



2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 2 of 6

October 12, 2012

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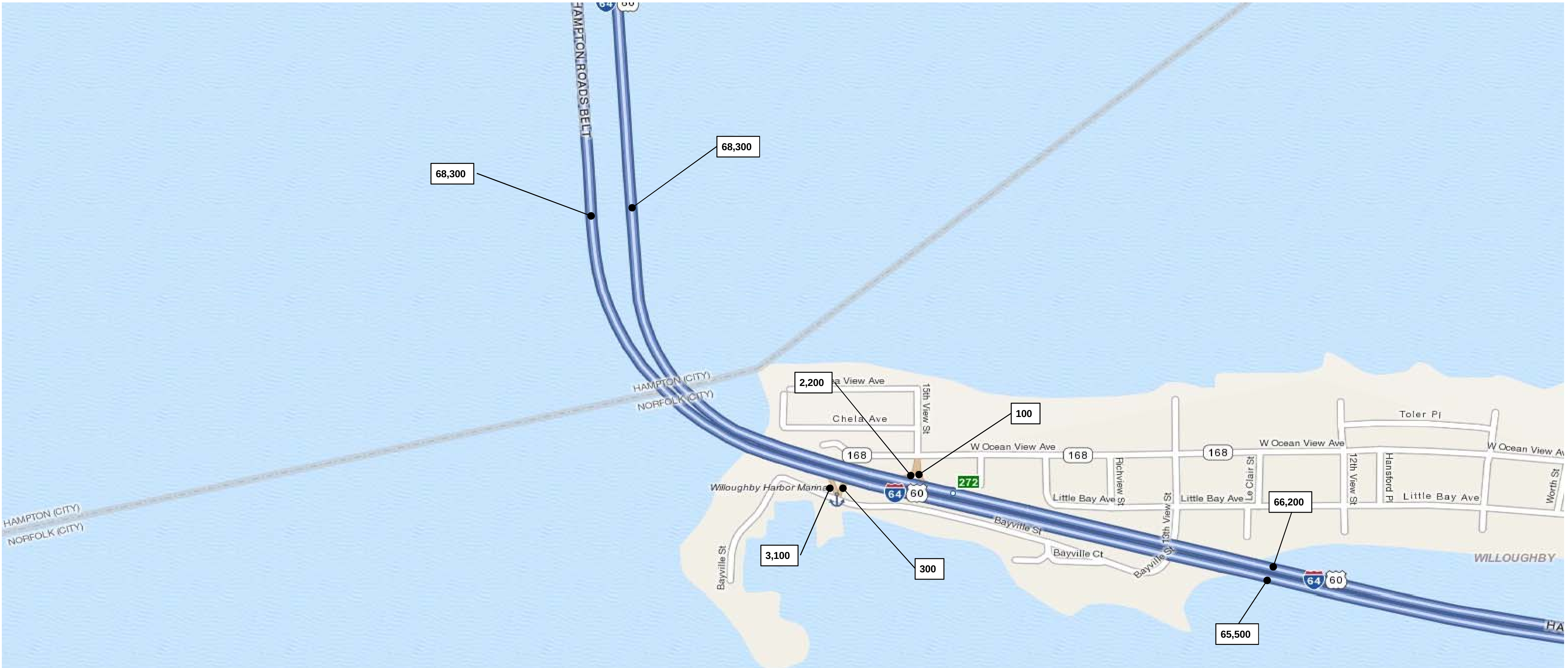
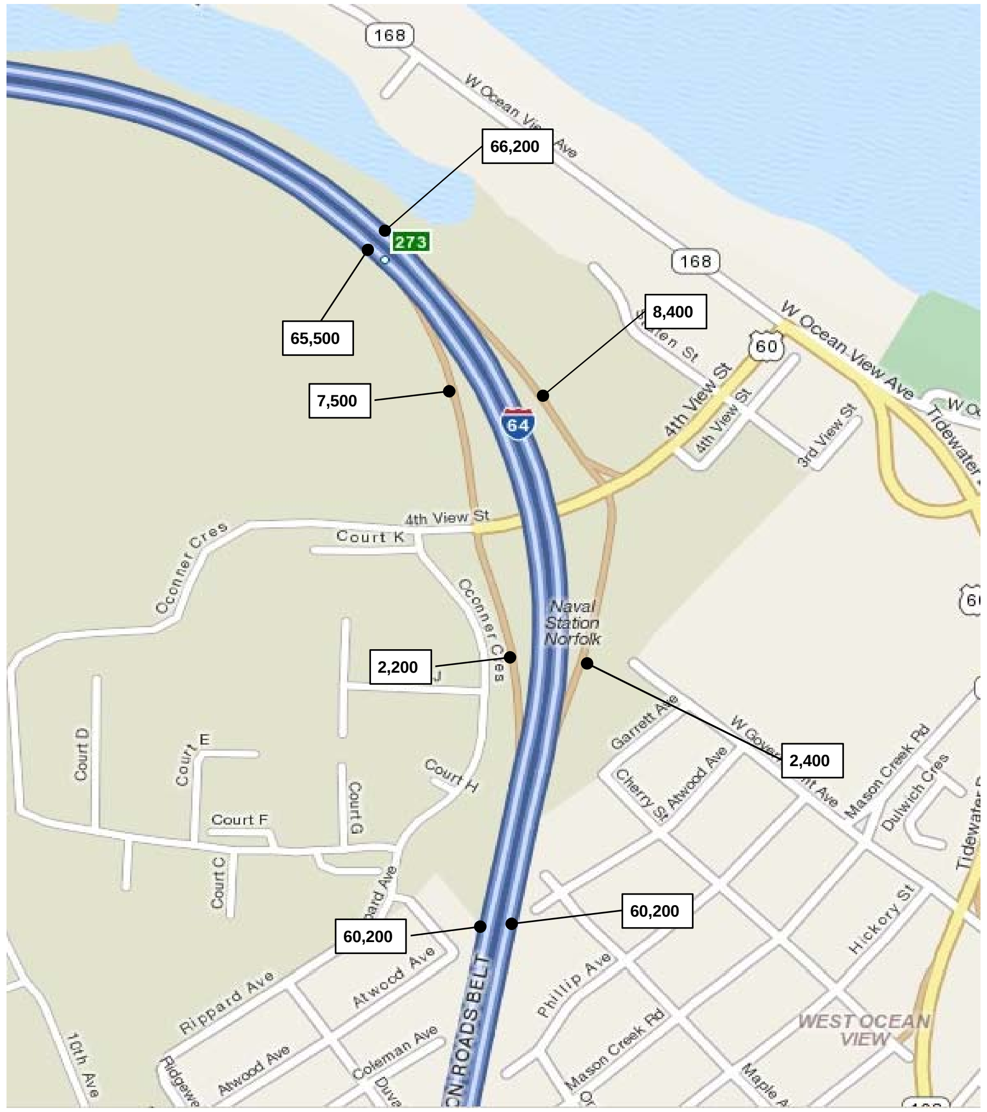
Virginia Department of Transportation

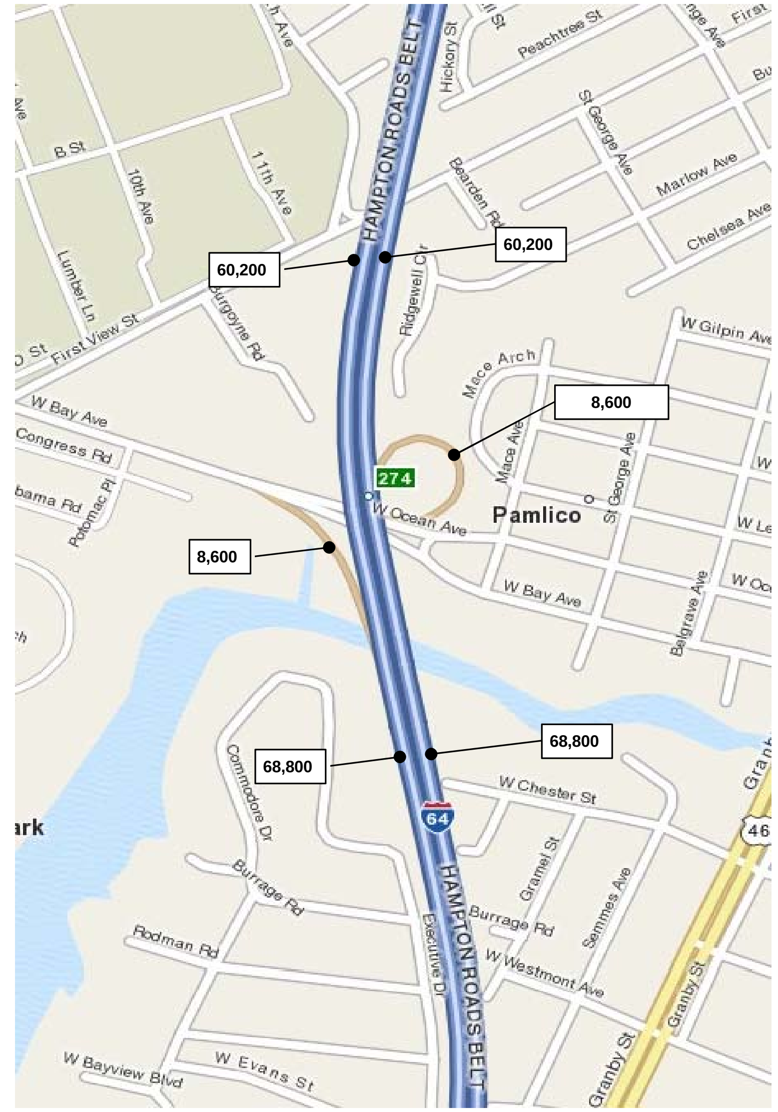


2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 3 of 6

October 12, 2012

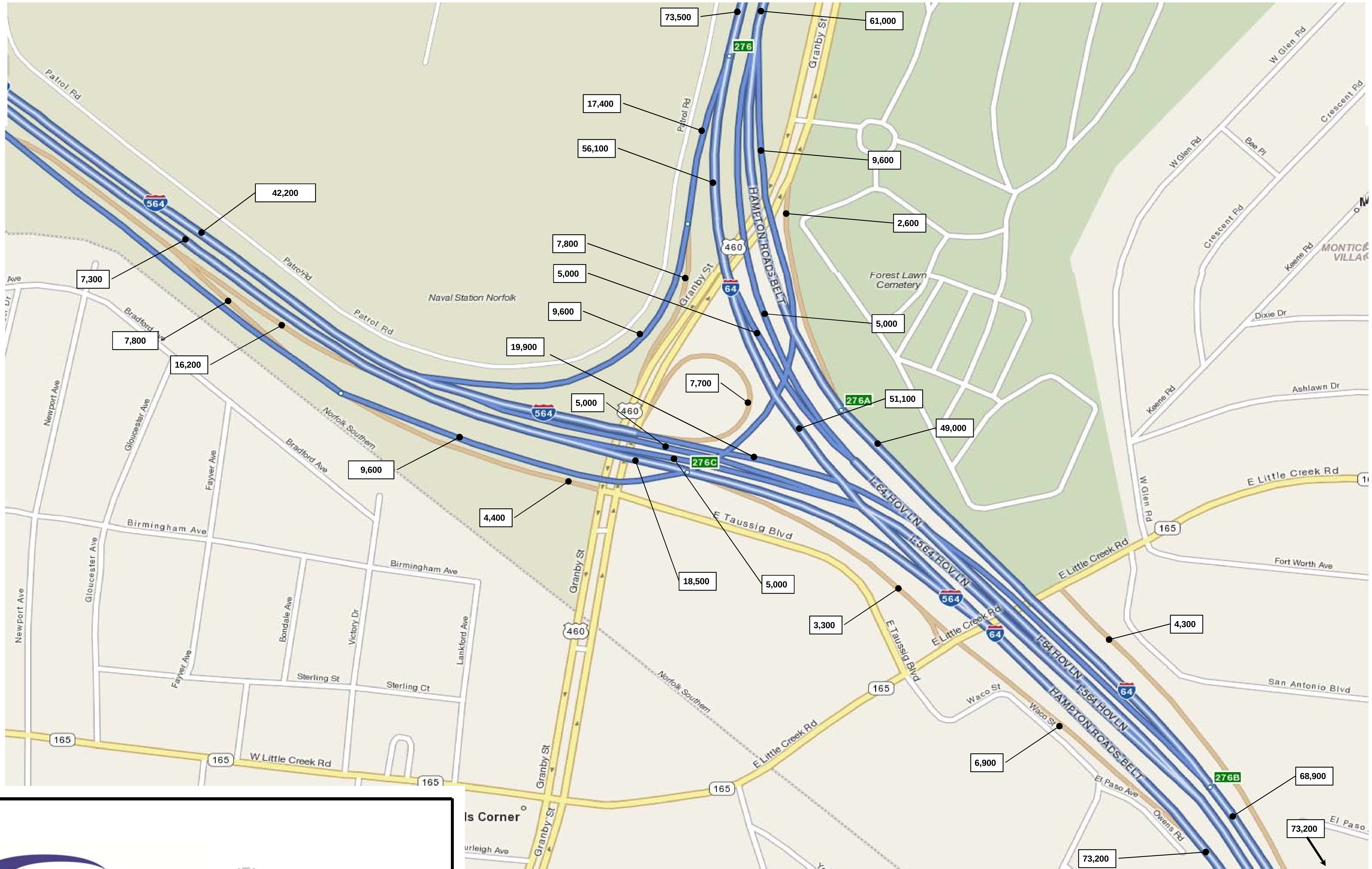




2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 4 of 6

October 12, 2012



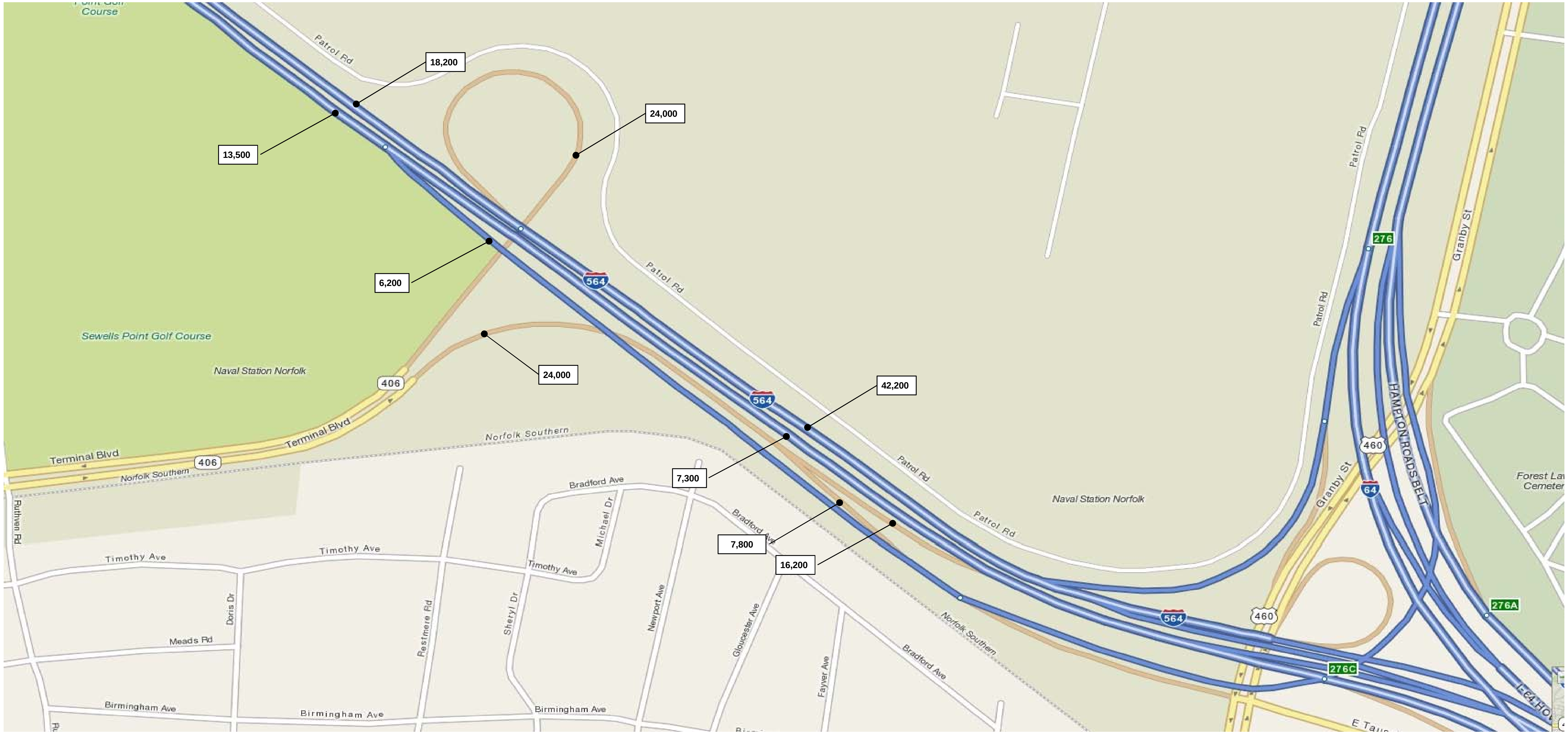
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 5 of 6

October 12, 2012



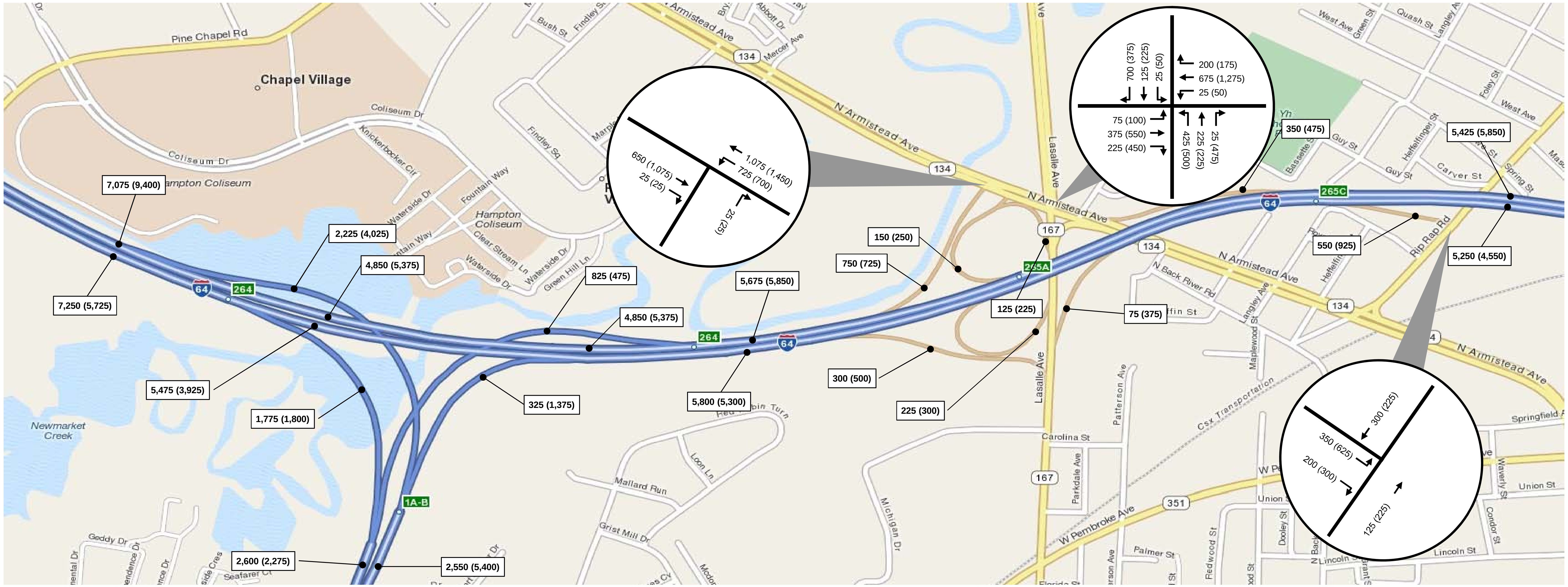
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 6 Daily (ADT) Volumes

Figure C-1: Sheet 6 of 6

October 12, 2012



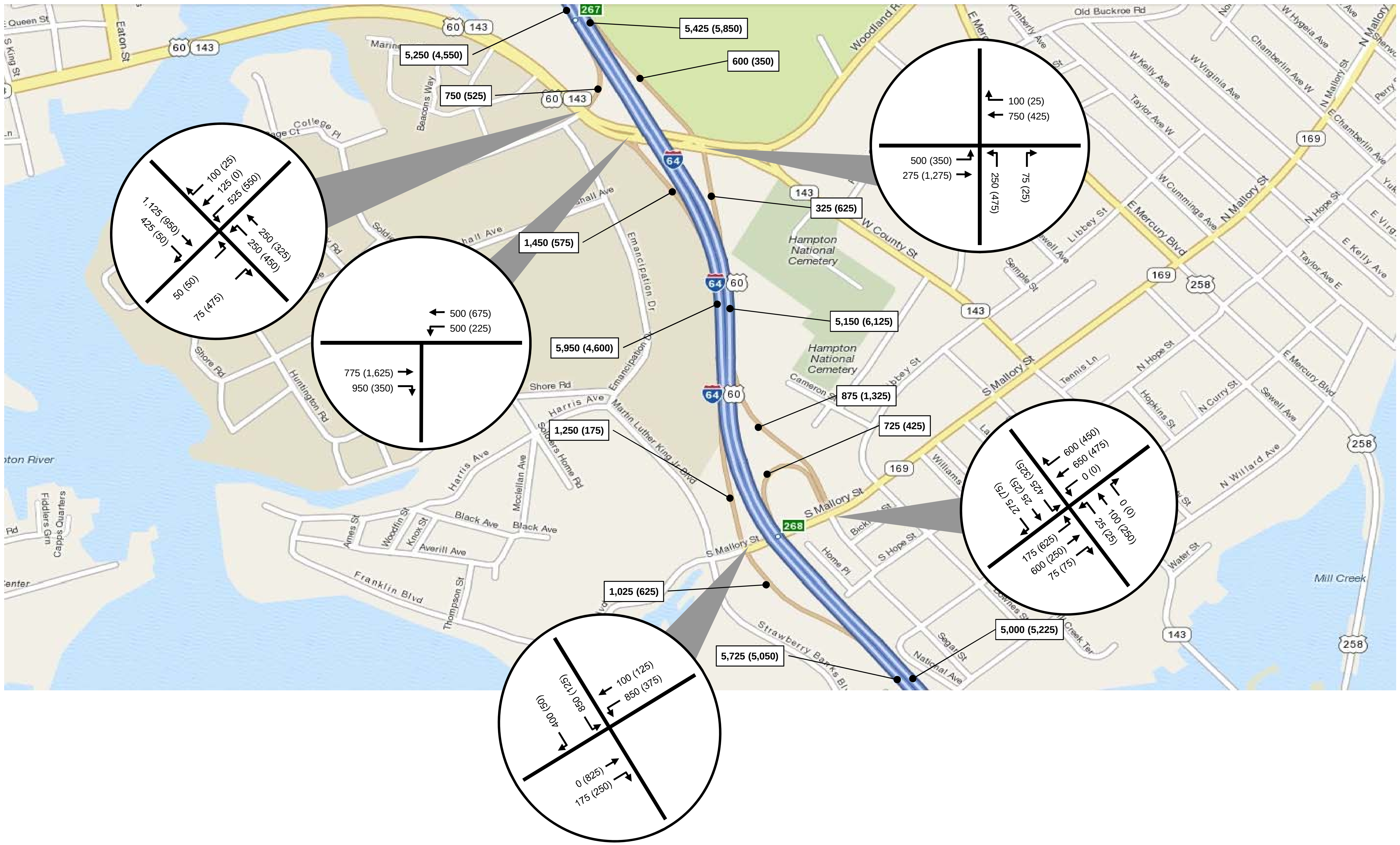
2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 1 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 2 of 6

October 12, 2012

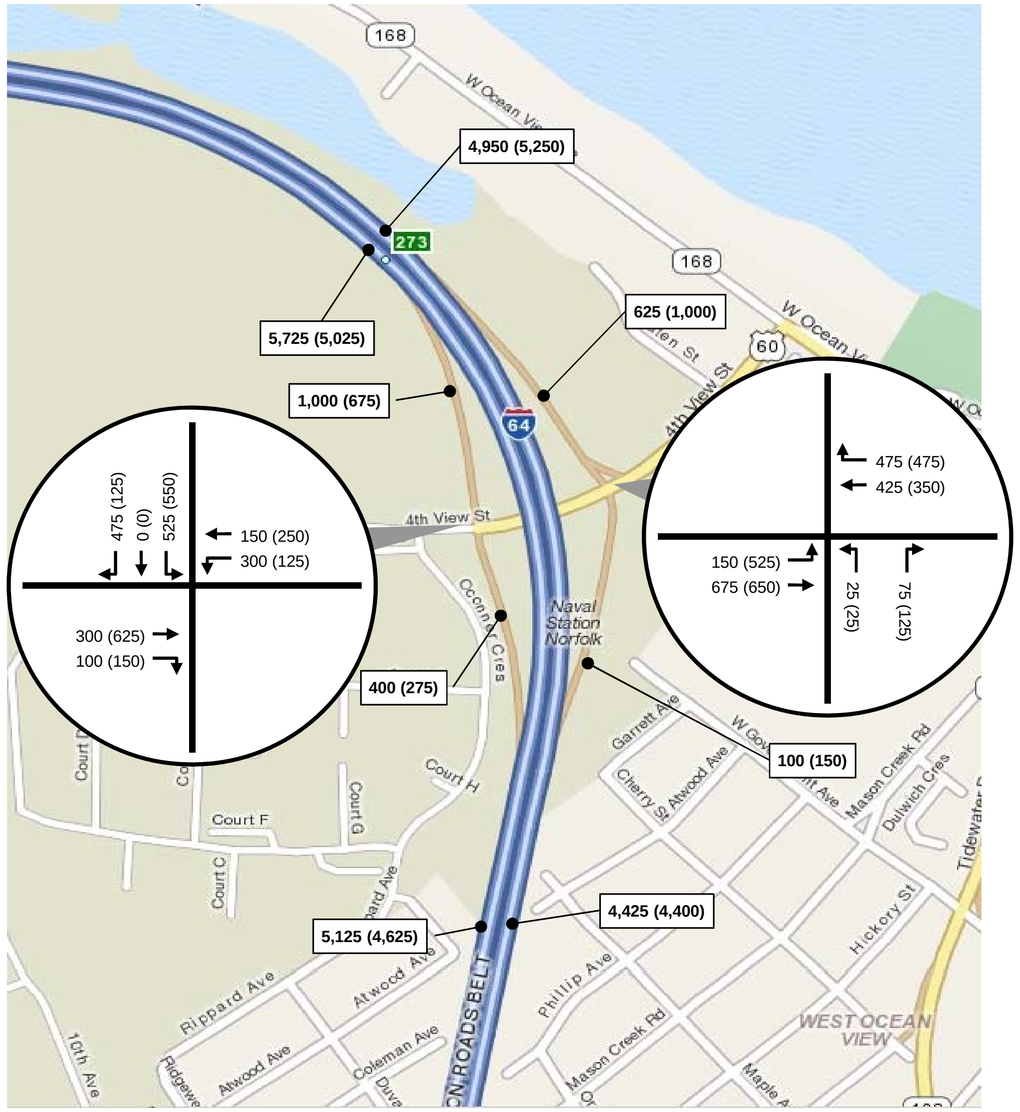
HRBT Hampton Roads Bridge Tunnel EIS

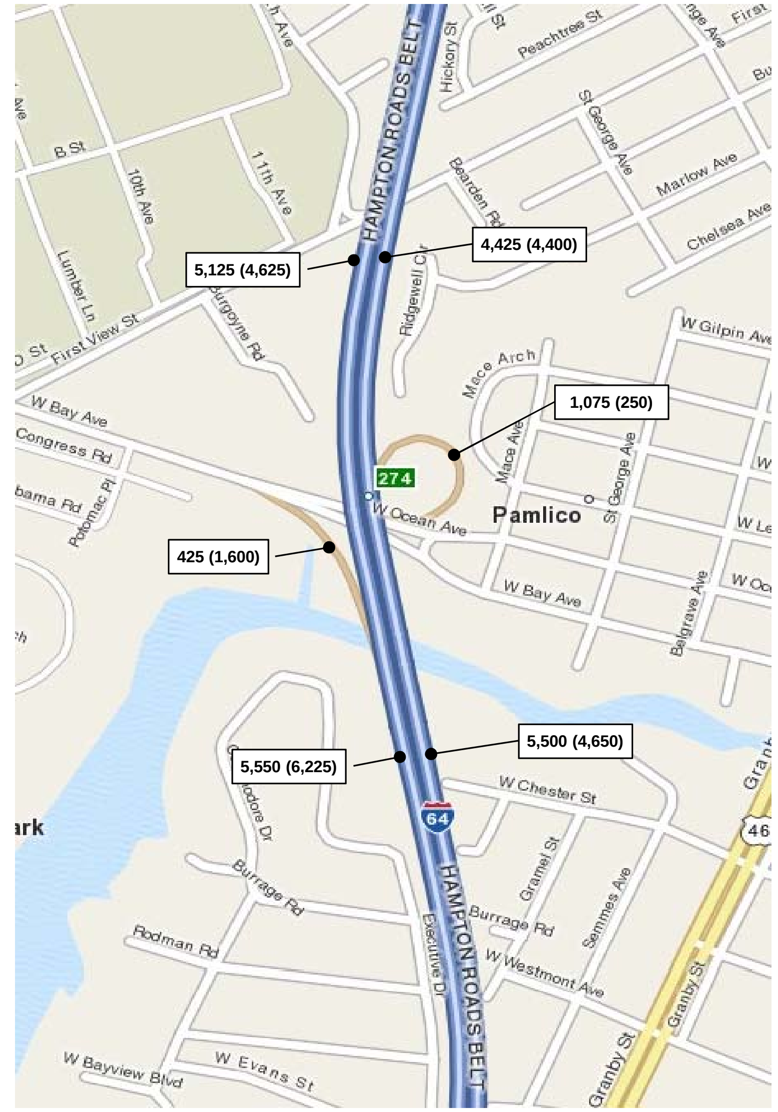
VDOT Virginia Department of Transportation

2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 3 of 6

October 12, 2012





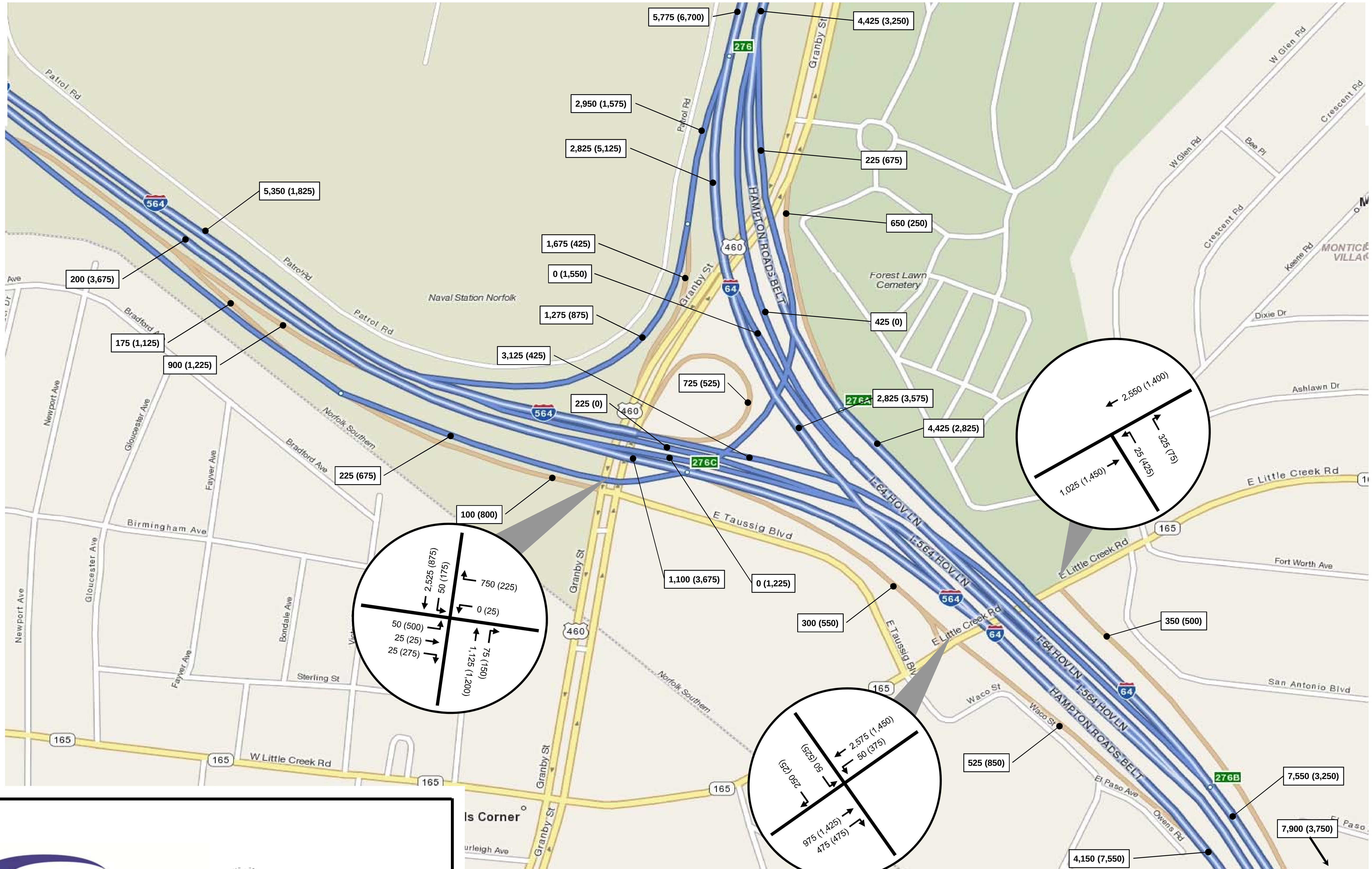
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 4 of 6

October 12, 2012



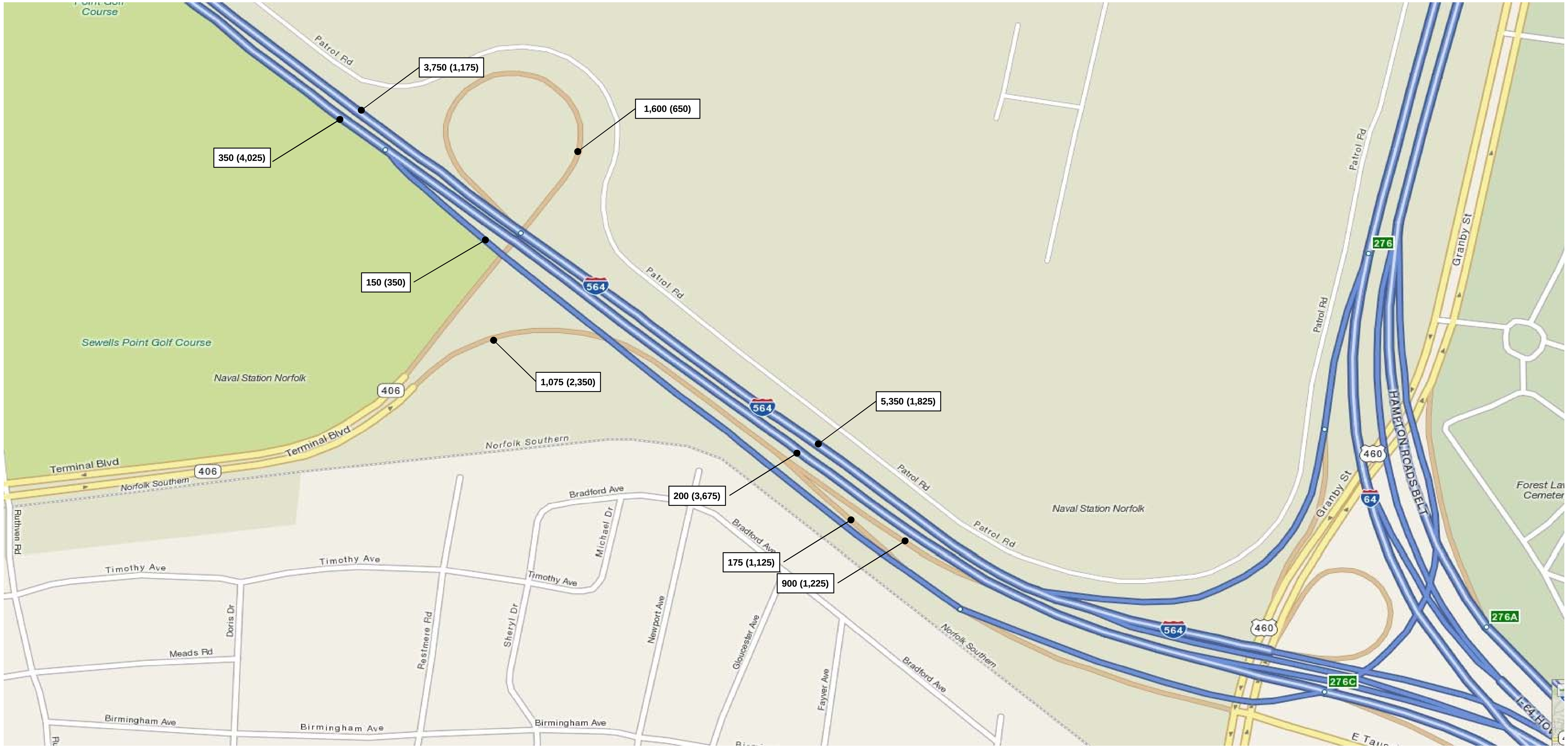
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 5 of 6

October 12, 2012



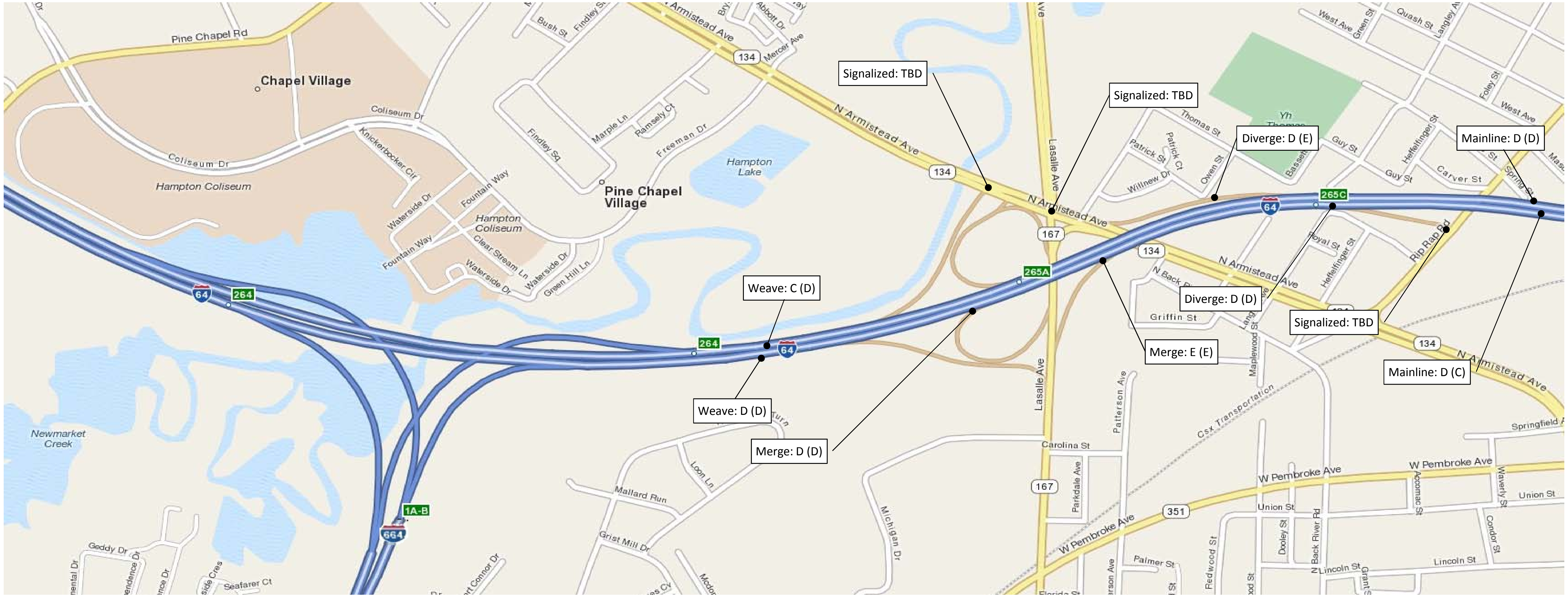
2040 Build 6 AM (PM) Peak Hour Volumes

Figure C-2: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



HRBT Hampton Roads Bridge Tunnel EIS

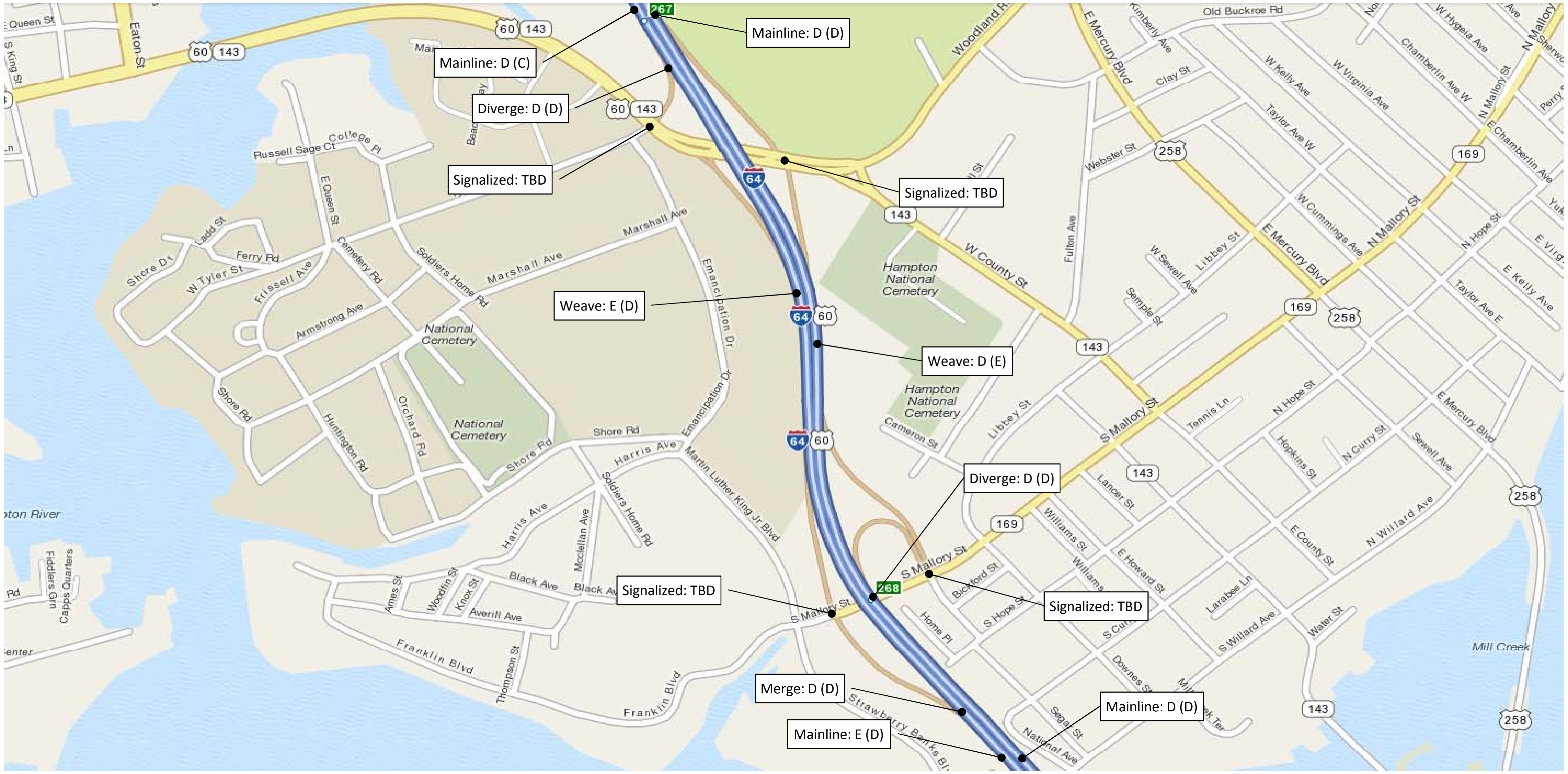
VDOT Virginia Department of Transportation

2040 Build 6 AM (PM) Level of Service

(6 total lanes crossing HRBT)

Figure C-3: Sheet 1 of 6

October 12, 2012



2040 Build 6 AM (PM) Level of Service
(6 total lanes crossing HRBT)

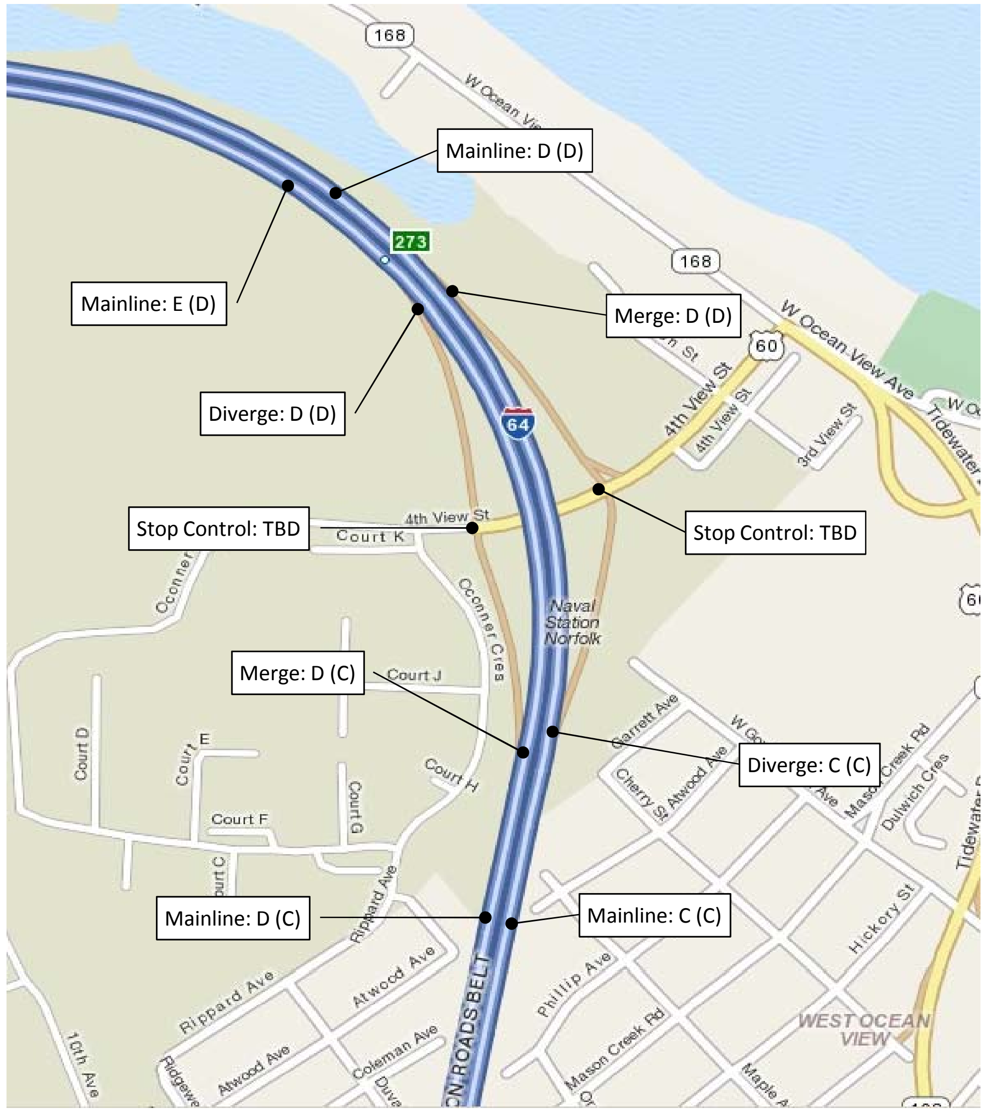
Figure C-3: Sheet 2 of 6

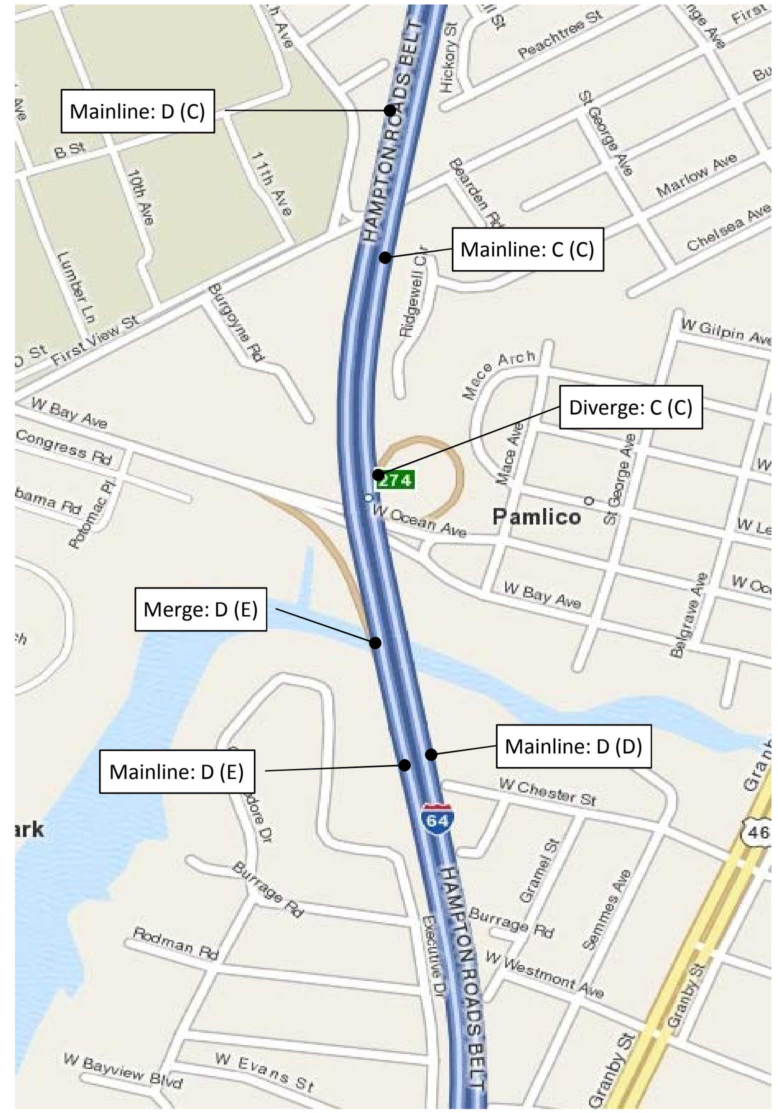
October 12, 2012

2040 Build 6 AM (PM) Level of Service
(6 total lanes crossing HRBT)

Figure C-3: Sheet 3 of 6

October 12, 2012





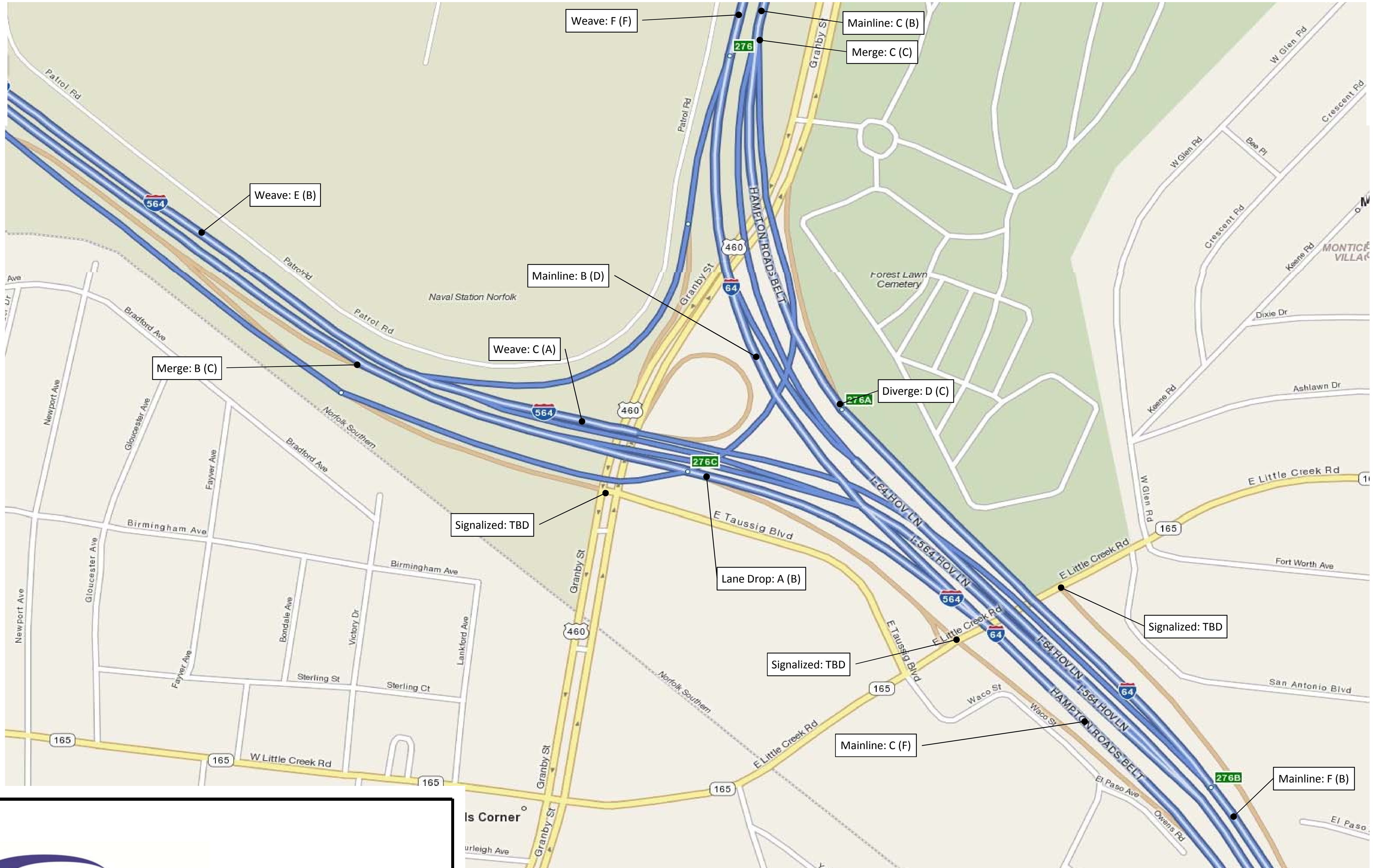
Hampton Roads Bridge Tunnel EIS

2040 Build 6 AM (PM) Level of Service

(6 total lanes crossing HRBT)

Figure C-3: Sheet 4 of 6

October 12, 2012



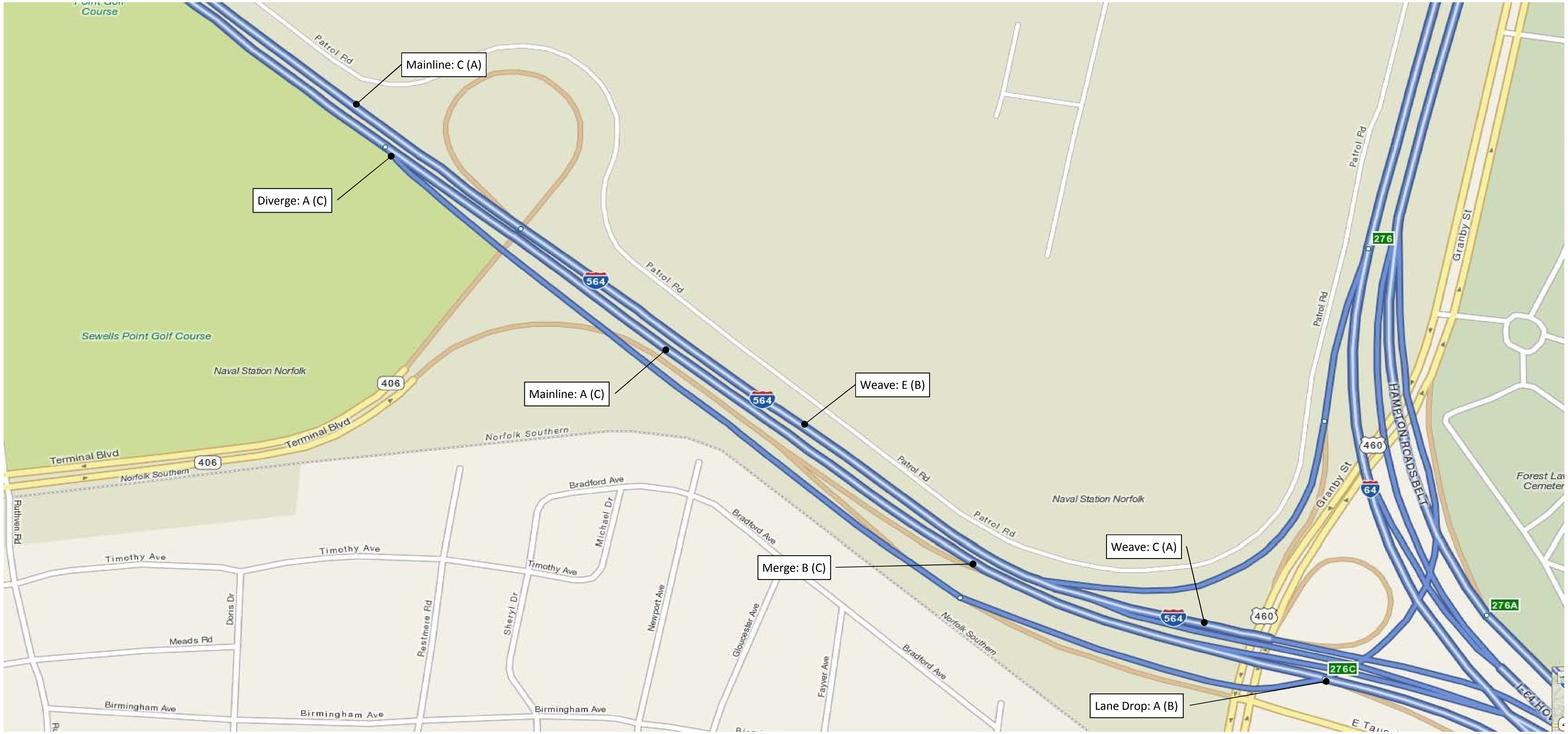
Hampton Roads Bridge Tunnel EIS

VDOT

2020 Build 10 AM (PM) Level of Service
(6 total lanes crossing HRBT)

Figure C-3: Sheet 5 of 6

October 12, 2012



2040 Build 6 AM (PM) Level of Service

(6 total lanes crossing HRBT)

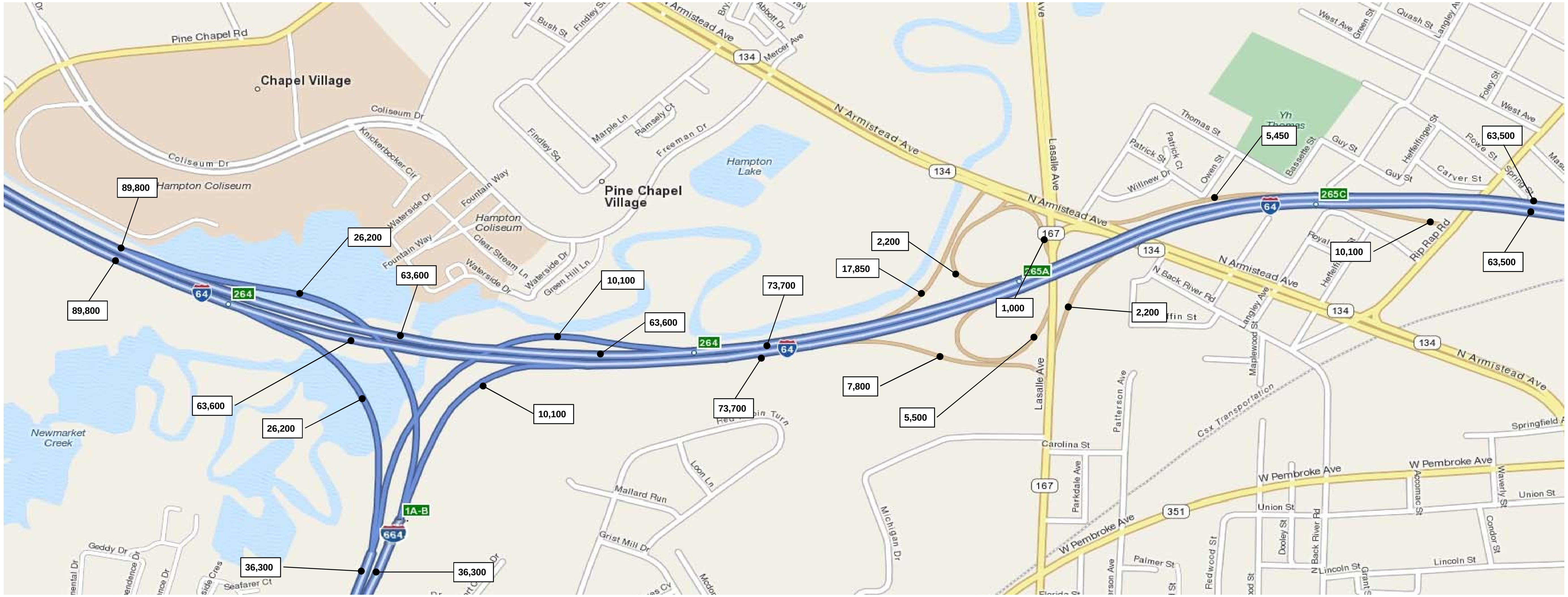
Figure C-3: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

Appendix D. **2020/2040 Build-8 Traffic Volumes and Capacity Analysis**



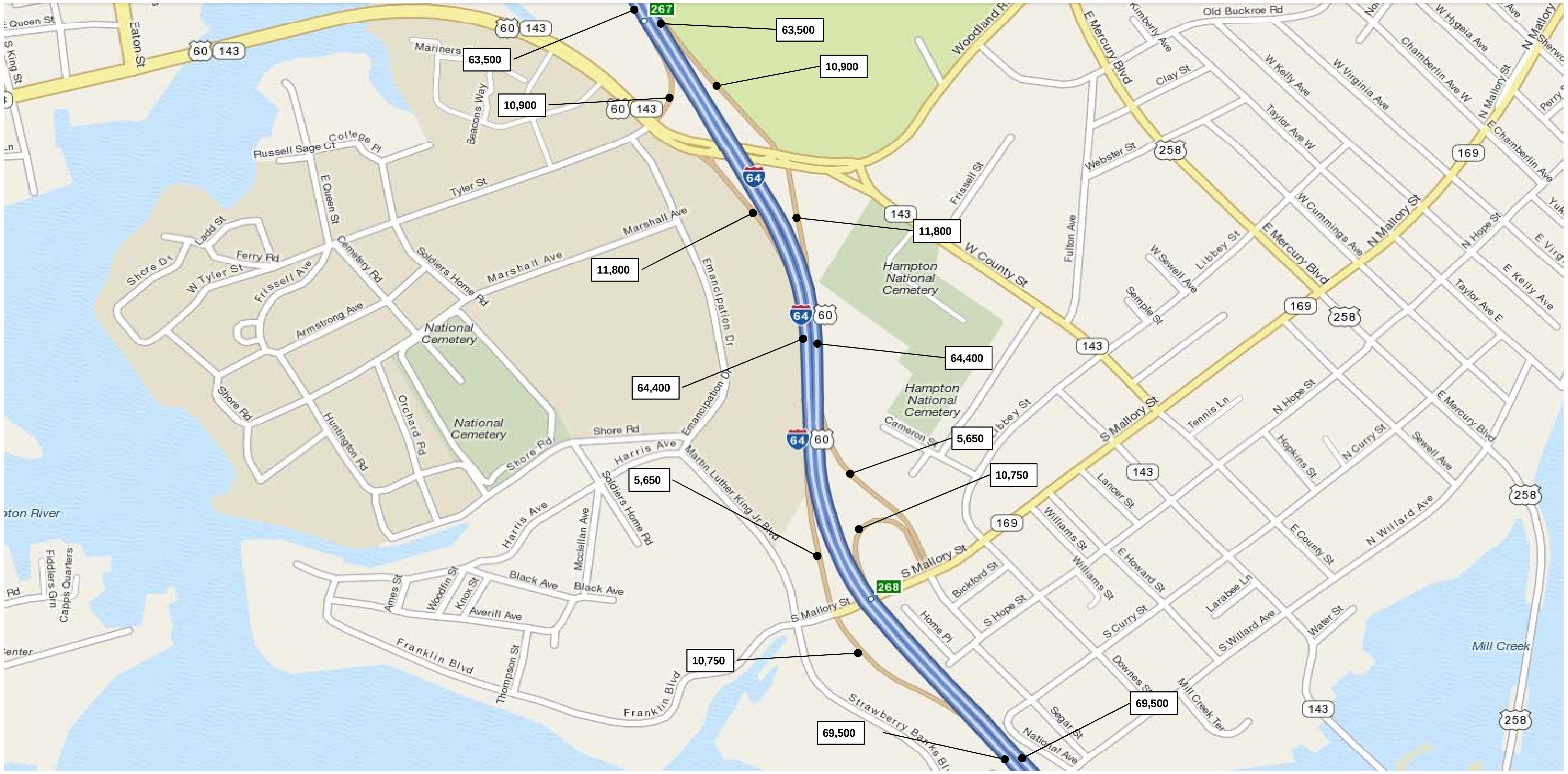
2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 1 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

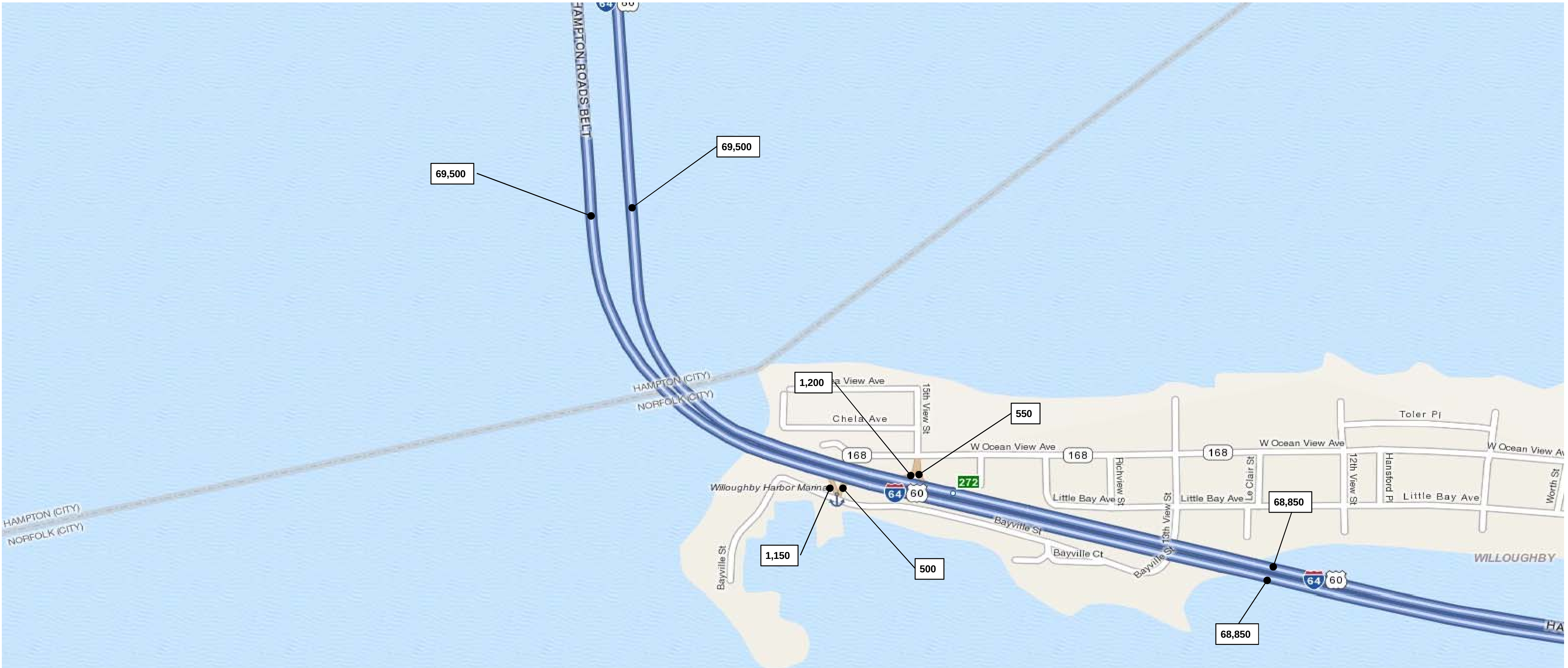
VDOT Virginia Department of Transportation



2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 2 of 6

October 12, 2012

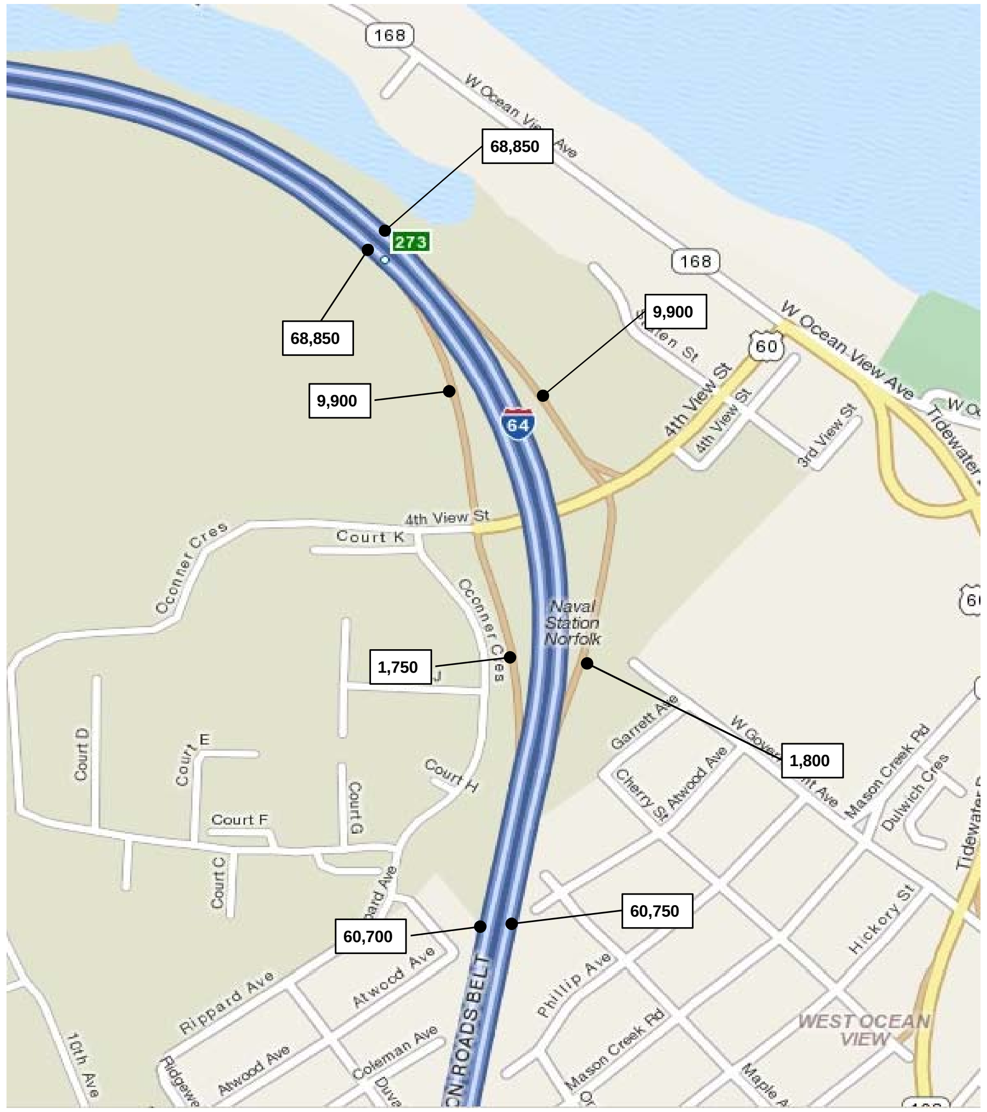


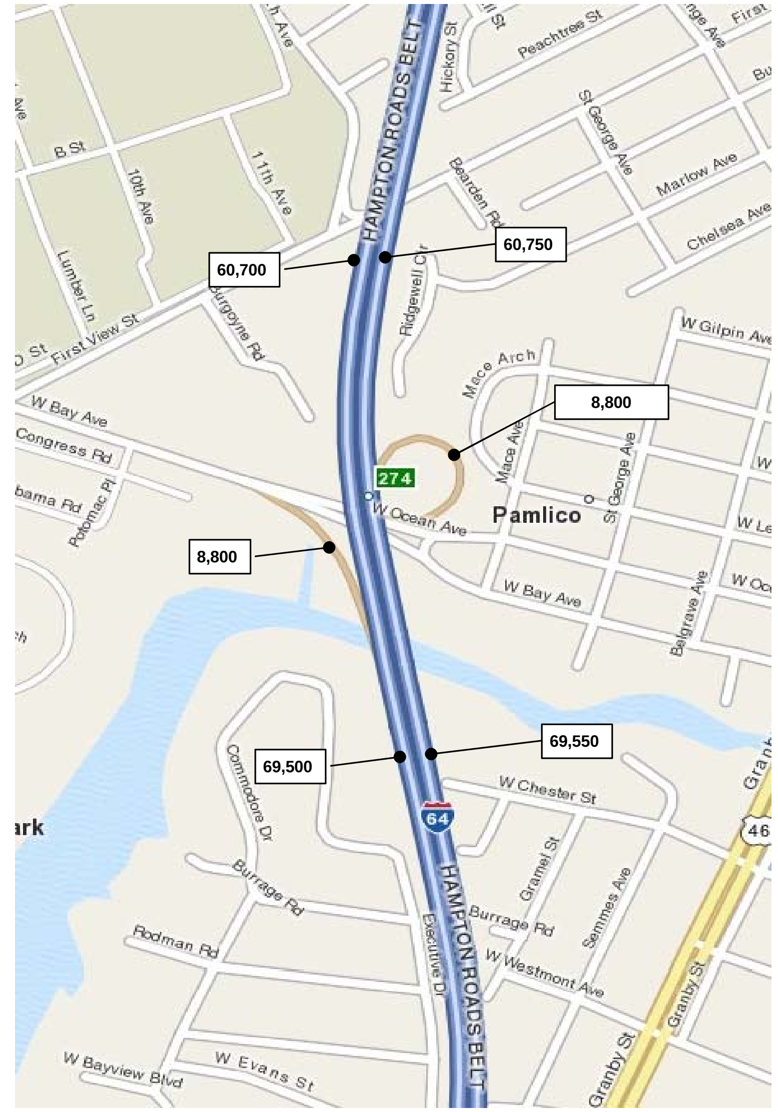
2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 3 of 6

October 12, 2012

Hampton Roads Bridge Tunnel EIS

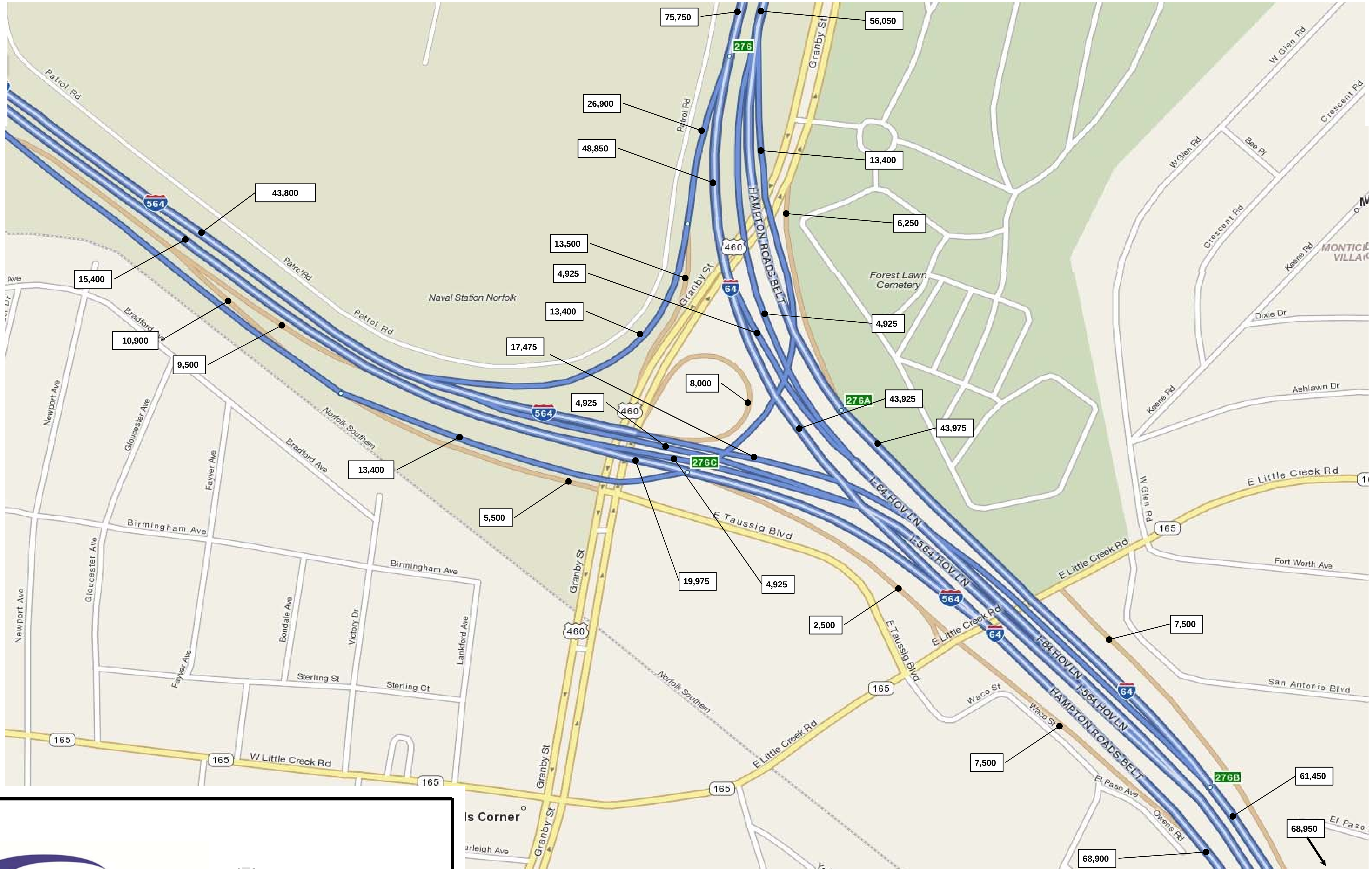




2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 4 of 6

October 12, 2012

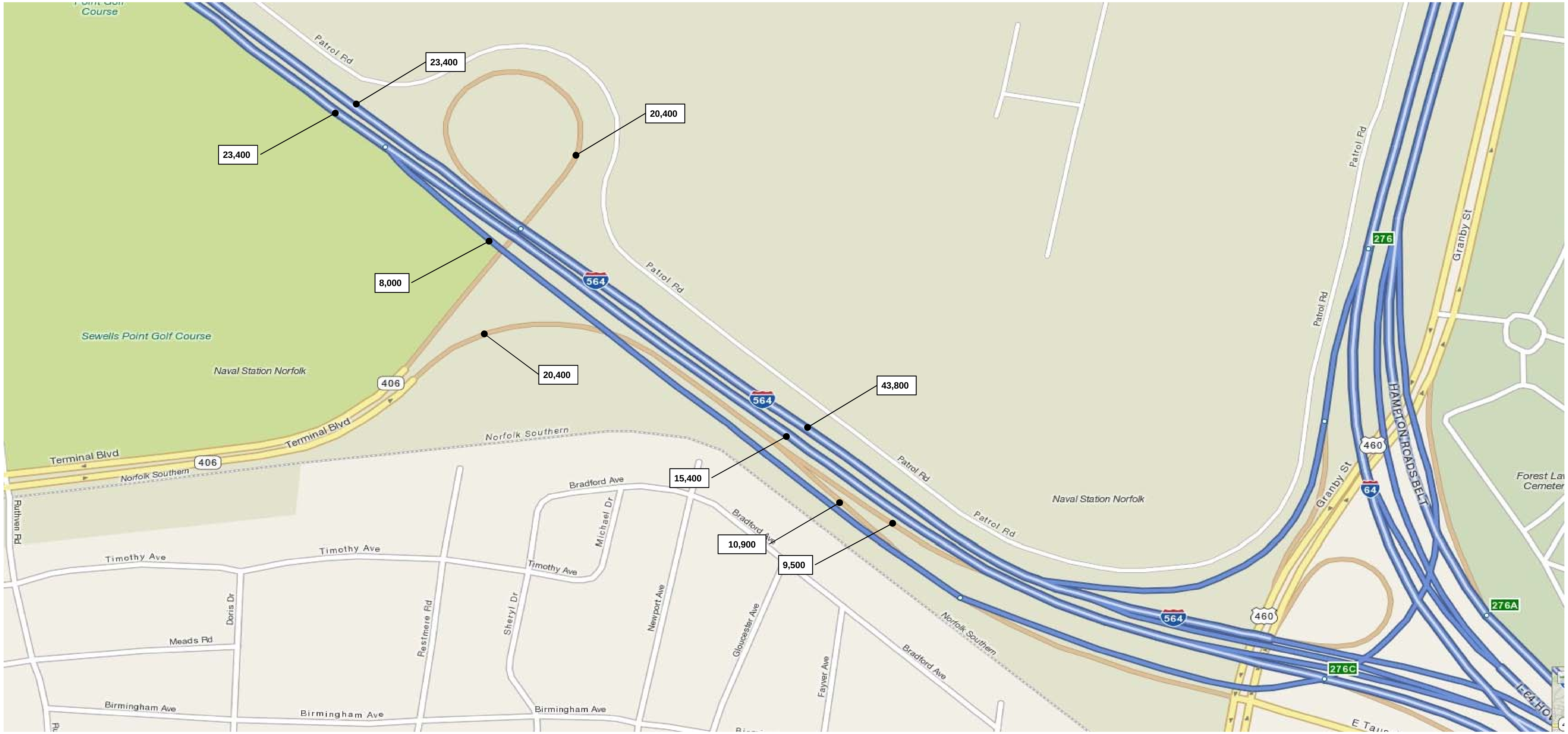


HRBT Hampton Roads Bridge Tunnel EIS | VDOT Virginia Department of Transportation

2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 5 of 6

October 12, 2012

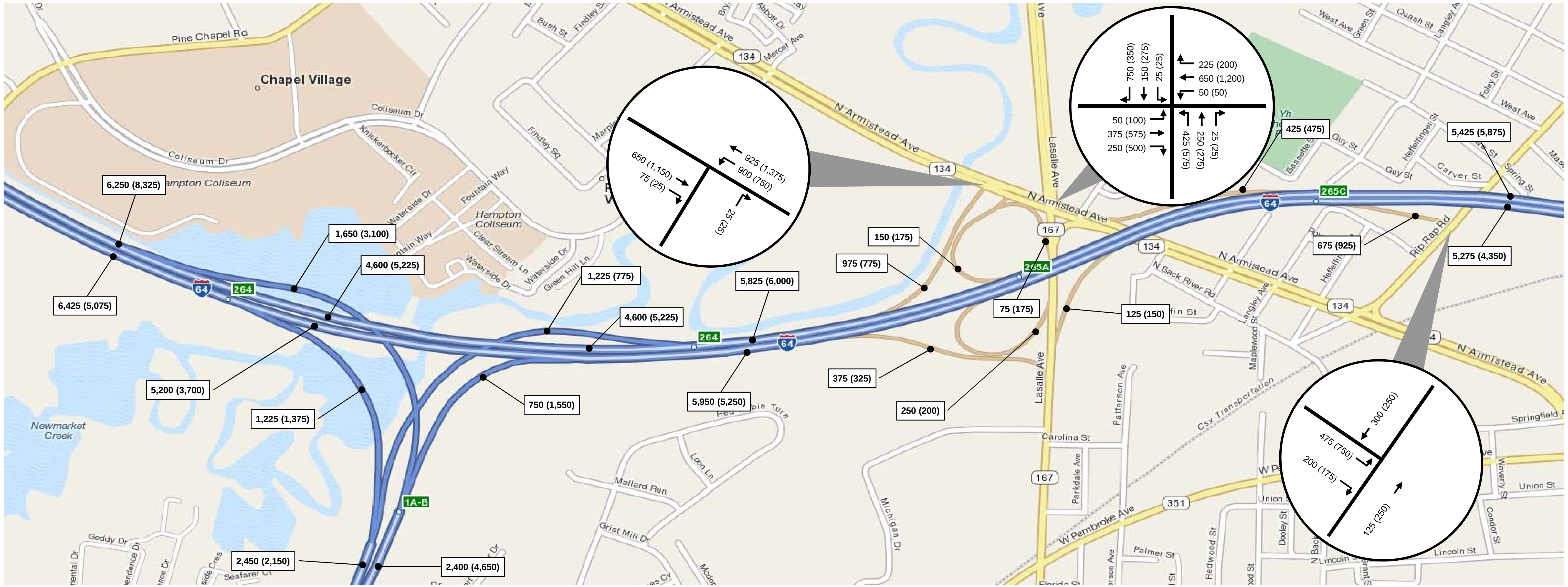


Hampton Roads Bridge Tunnel EIS

2020 Build 8 Daily (ADT) Volumes

Figure D-1: Sheet 6 of 6

October 12, 2012



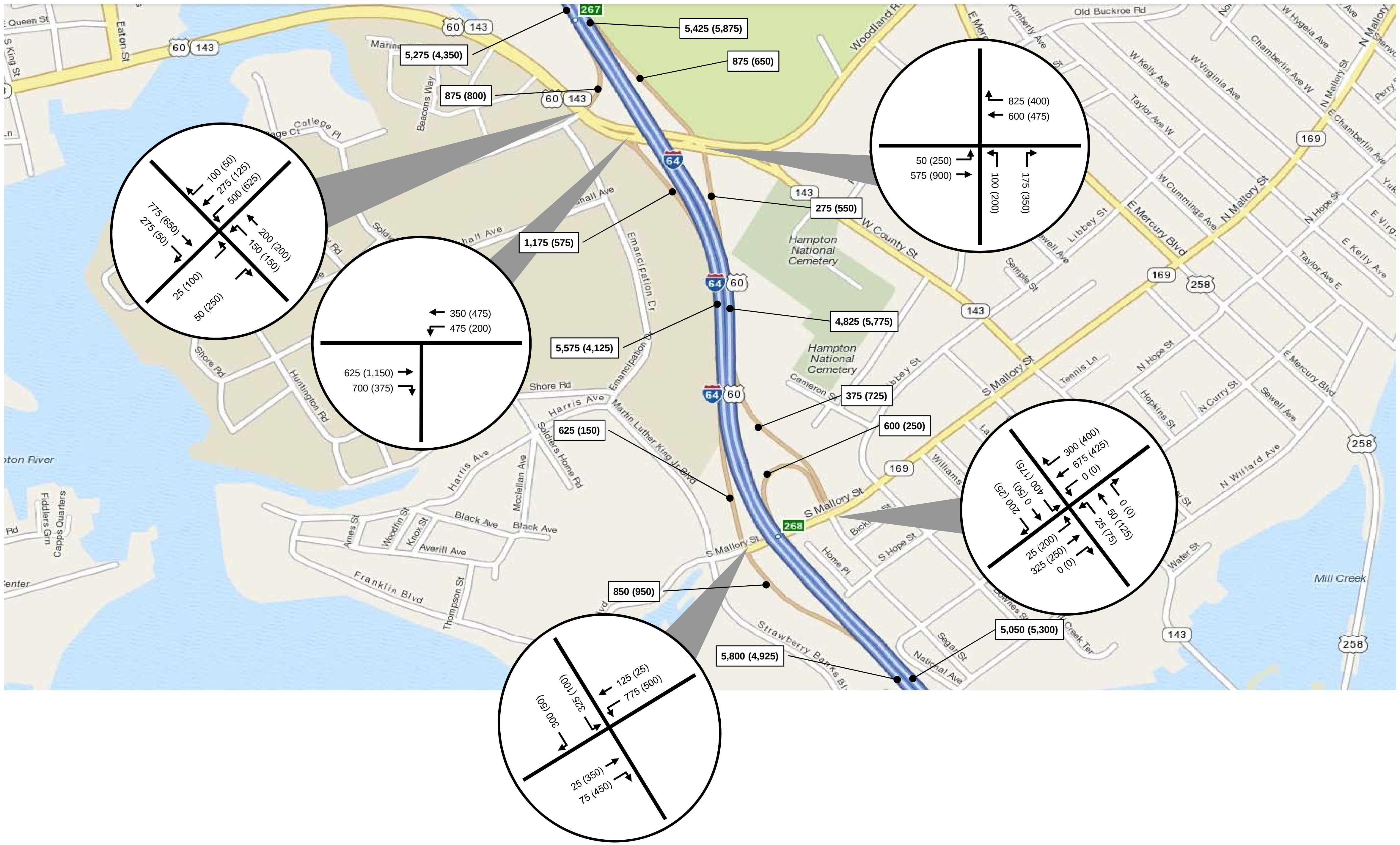
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Peak Hour Volumes

Figure D-2: Sheet 1 of 6

October 12, 2012



22.5
18.75
15
18.75

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Peak Hour Volumes

Figure D-2: Sheet 2 of 6

October 12, 2012

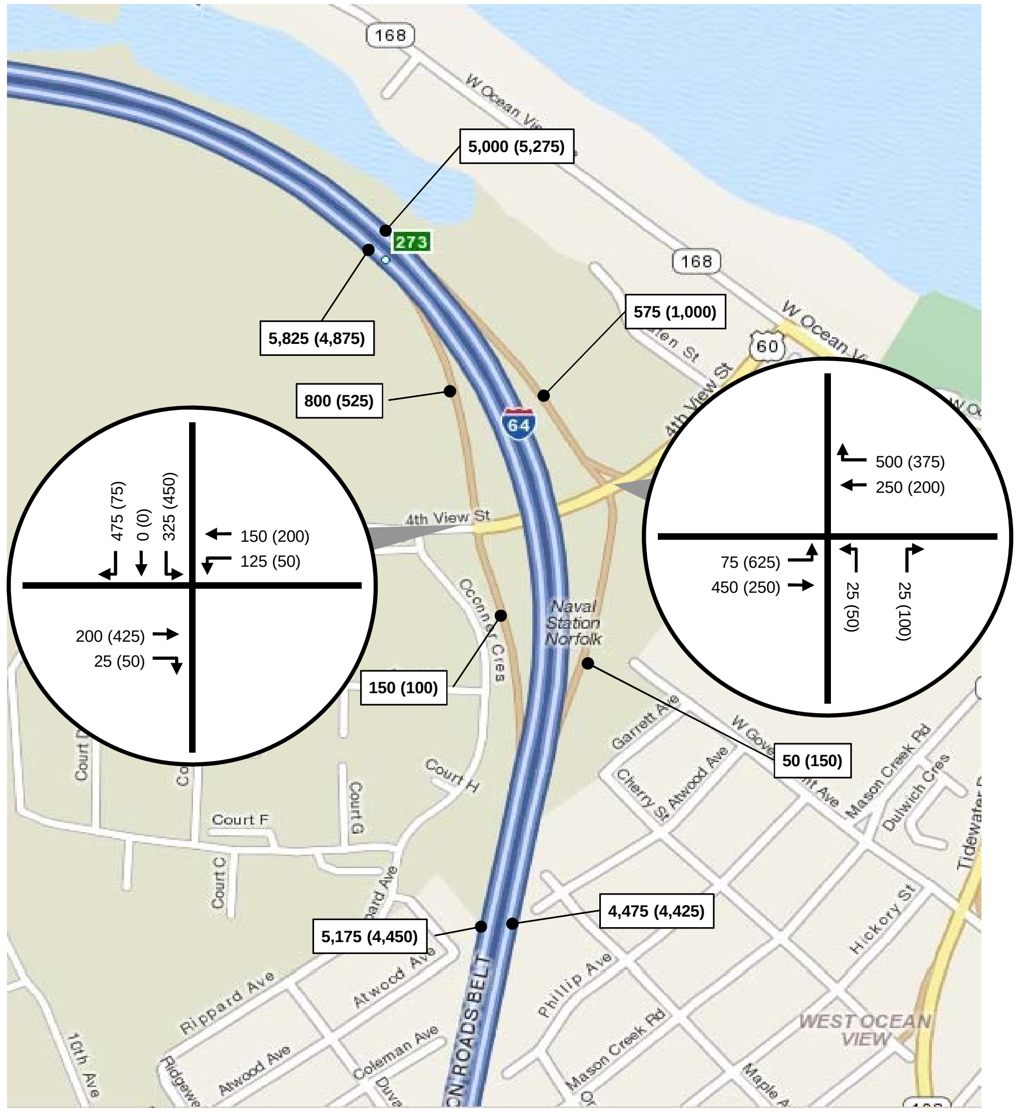
2020 Build 8 AM (PM) Peak Hour Volumes

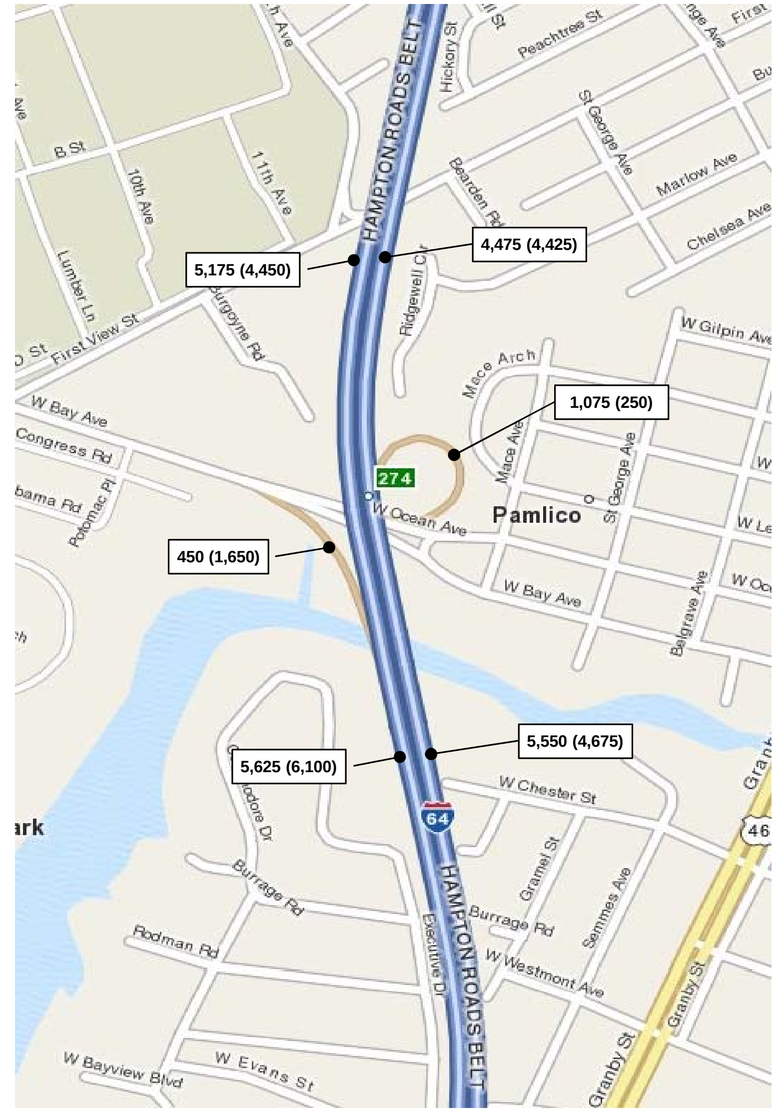
Figure D-2: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation





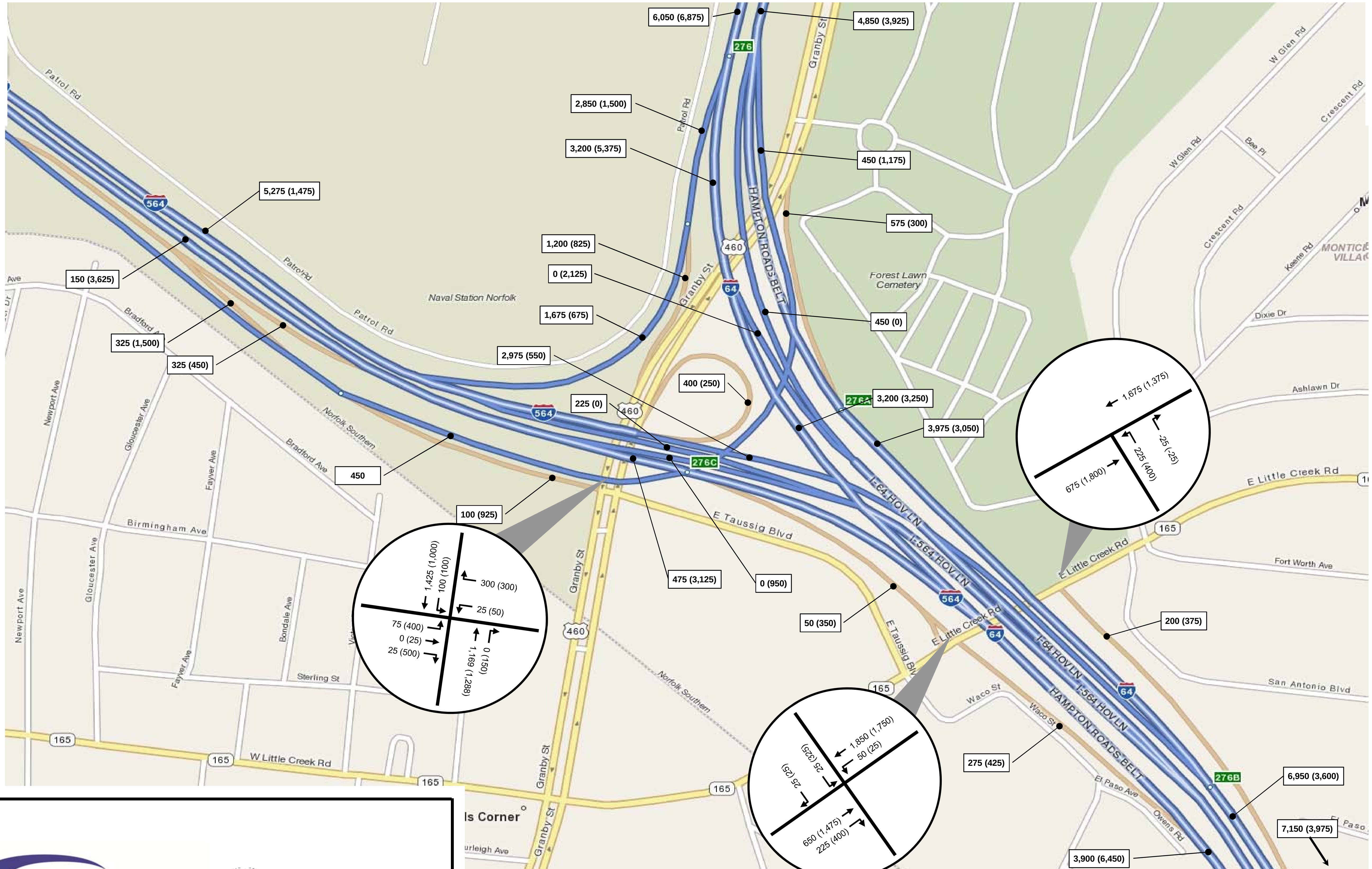
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Peak Hour Volumes

Figure D-2: Sheet 4 of 6

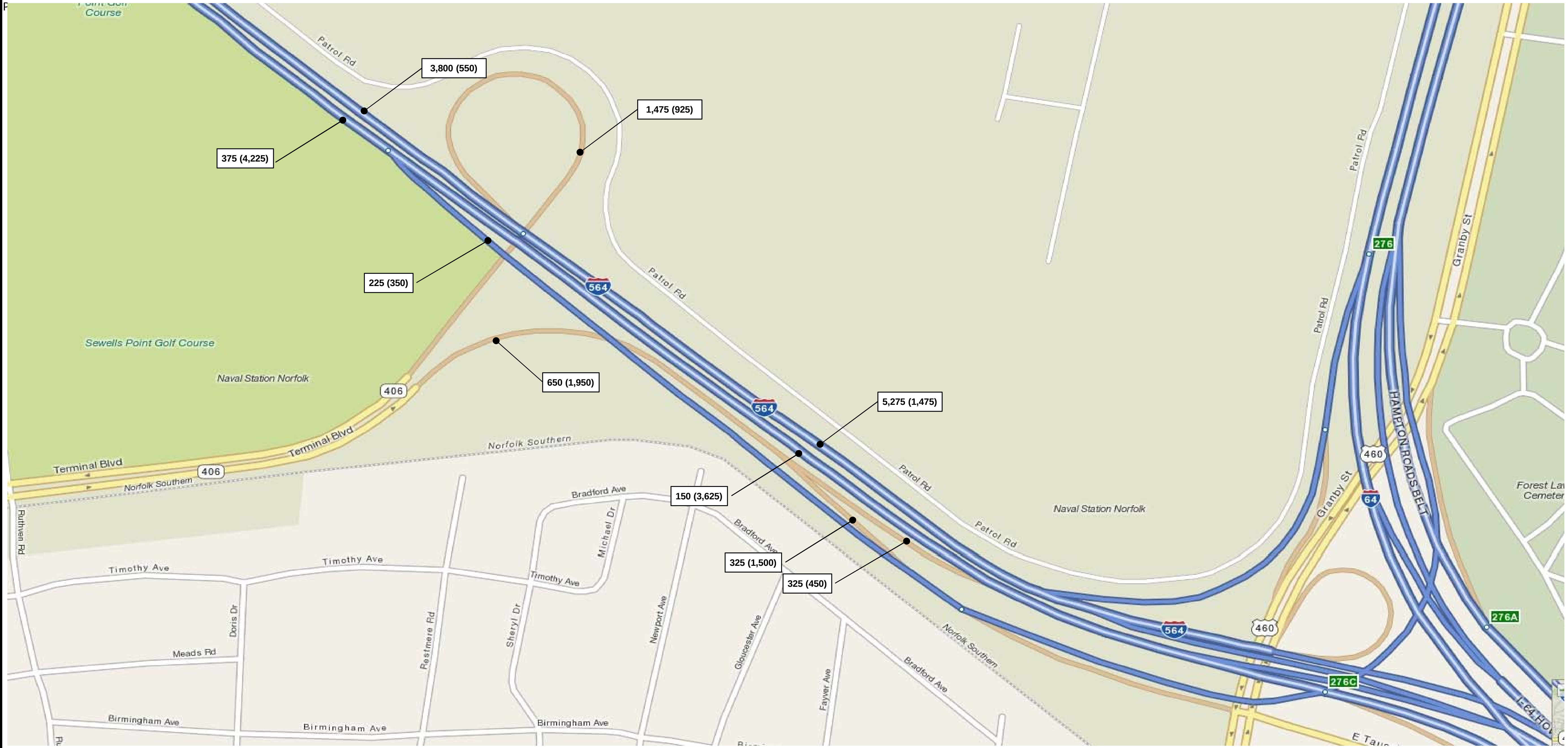
October 12, 2012



2020 Build 8 AM (PM) Peak Hour Volumes

Figure D-2: Sheet 5 of 6

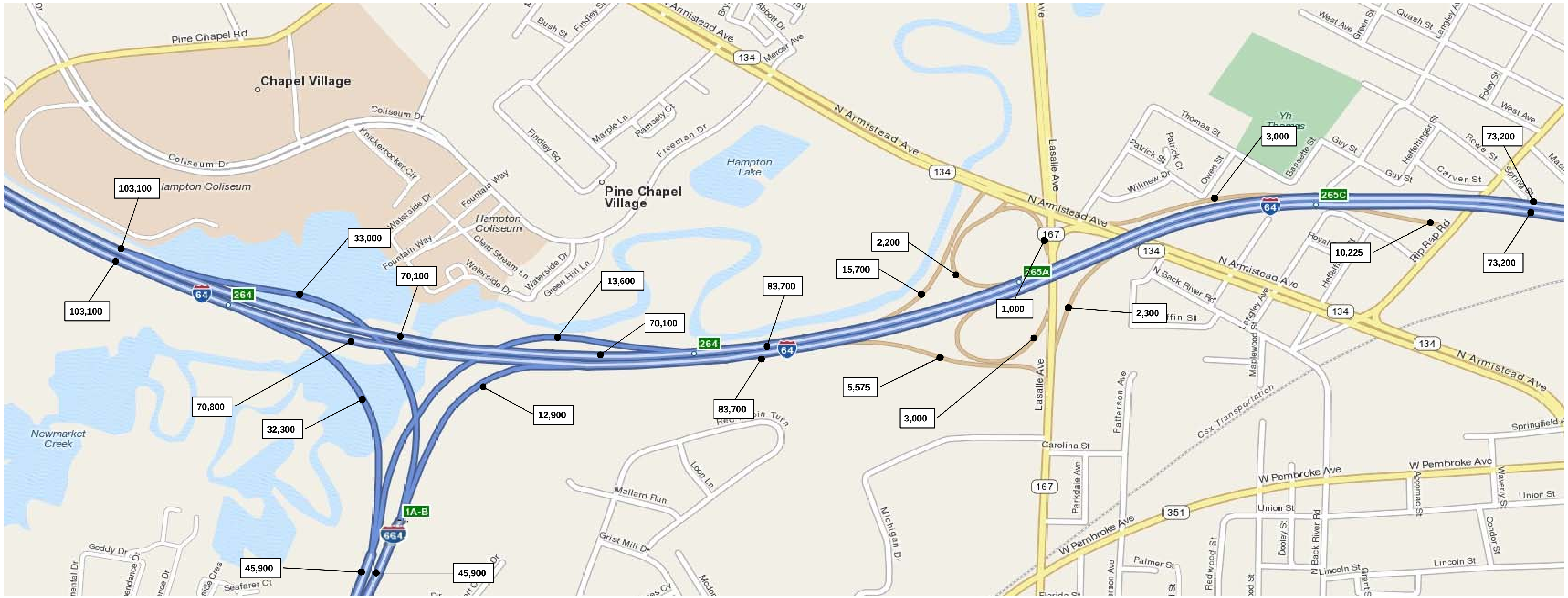
October 12, 2012



2020 Build 8 AM (PM) Peak Hour Volumes

Figure D-2: Sheet 6 of 6

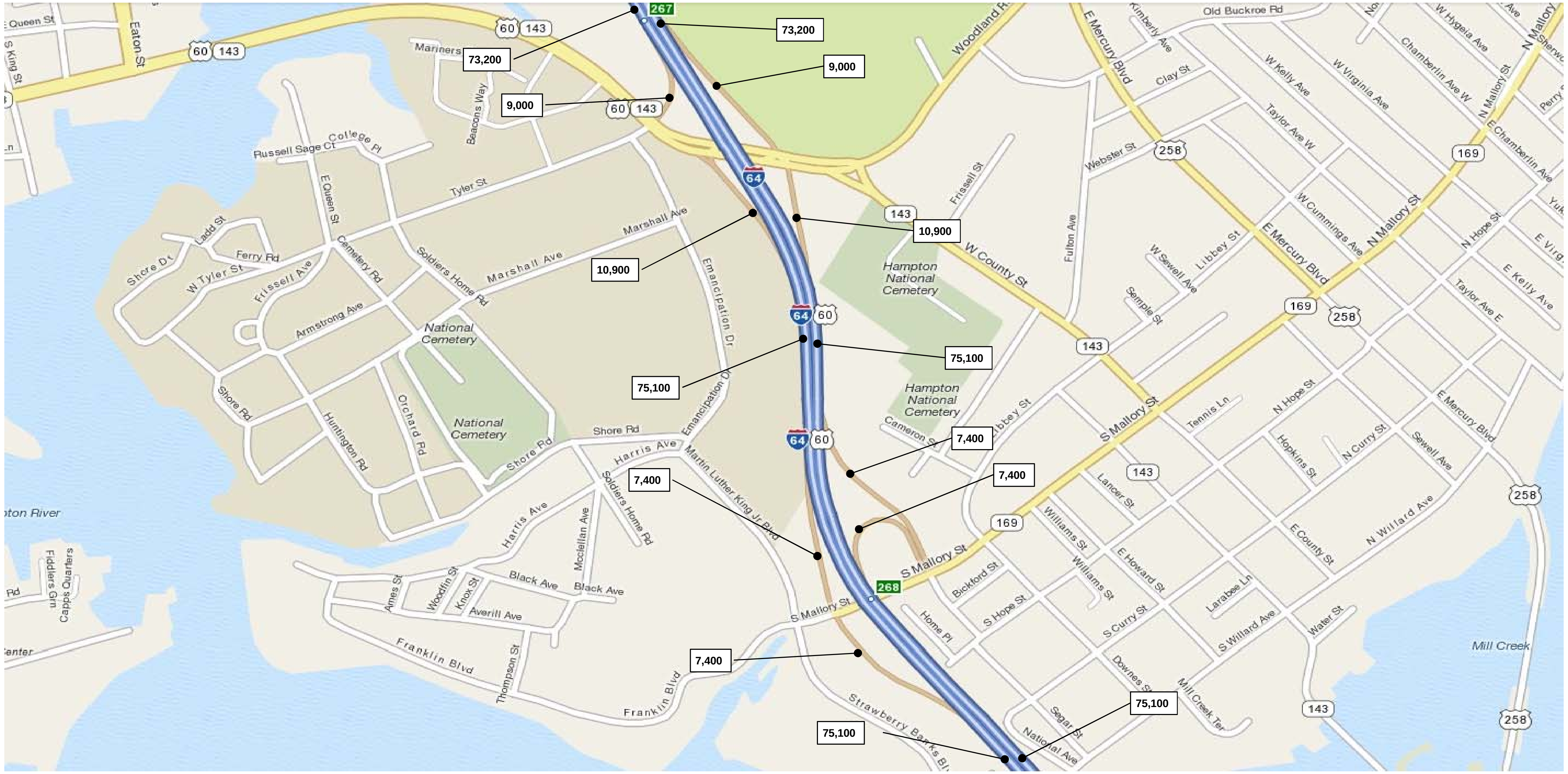
October 12, 2012



2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 1 of 6

October 12, 2012



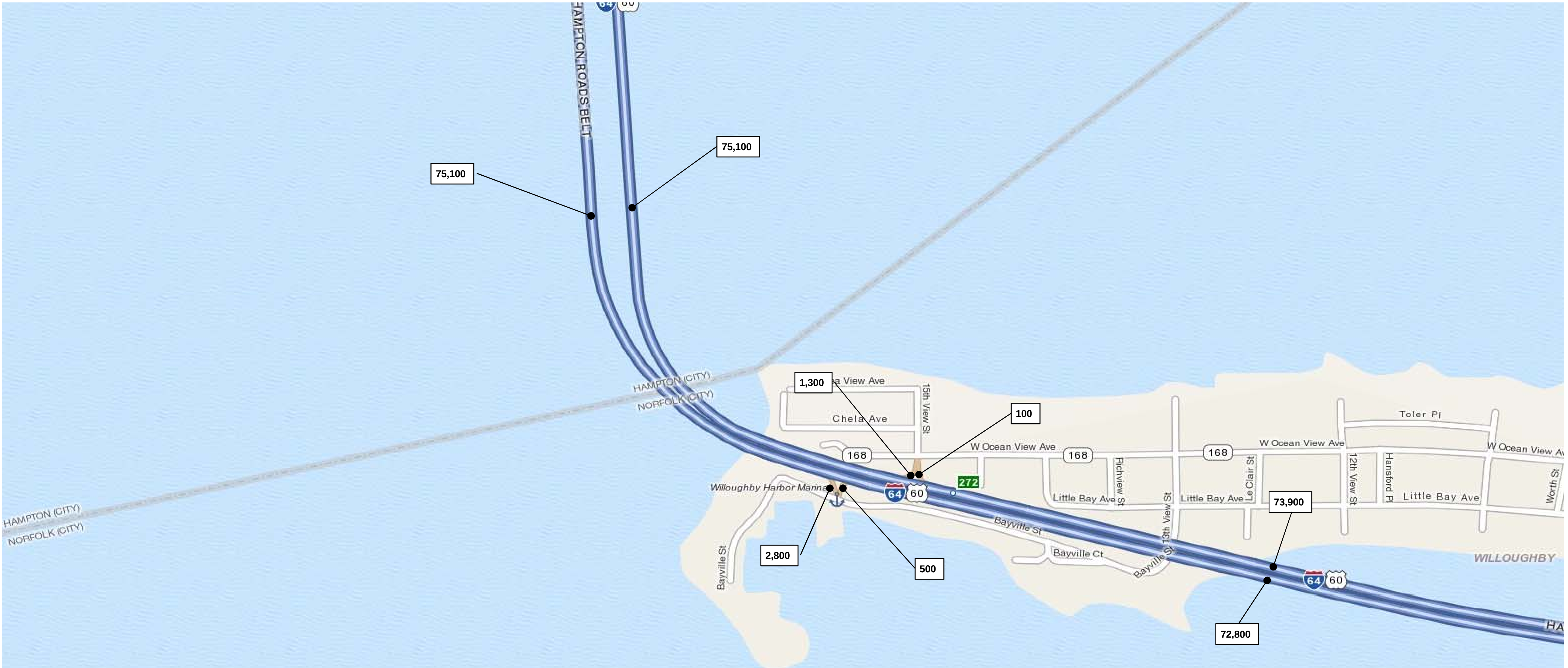
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 2 of 6

October 12, 2012



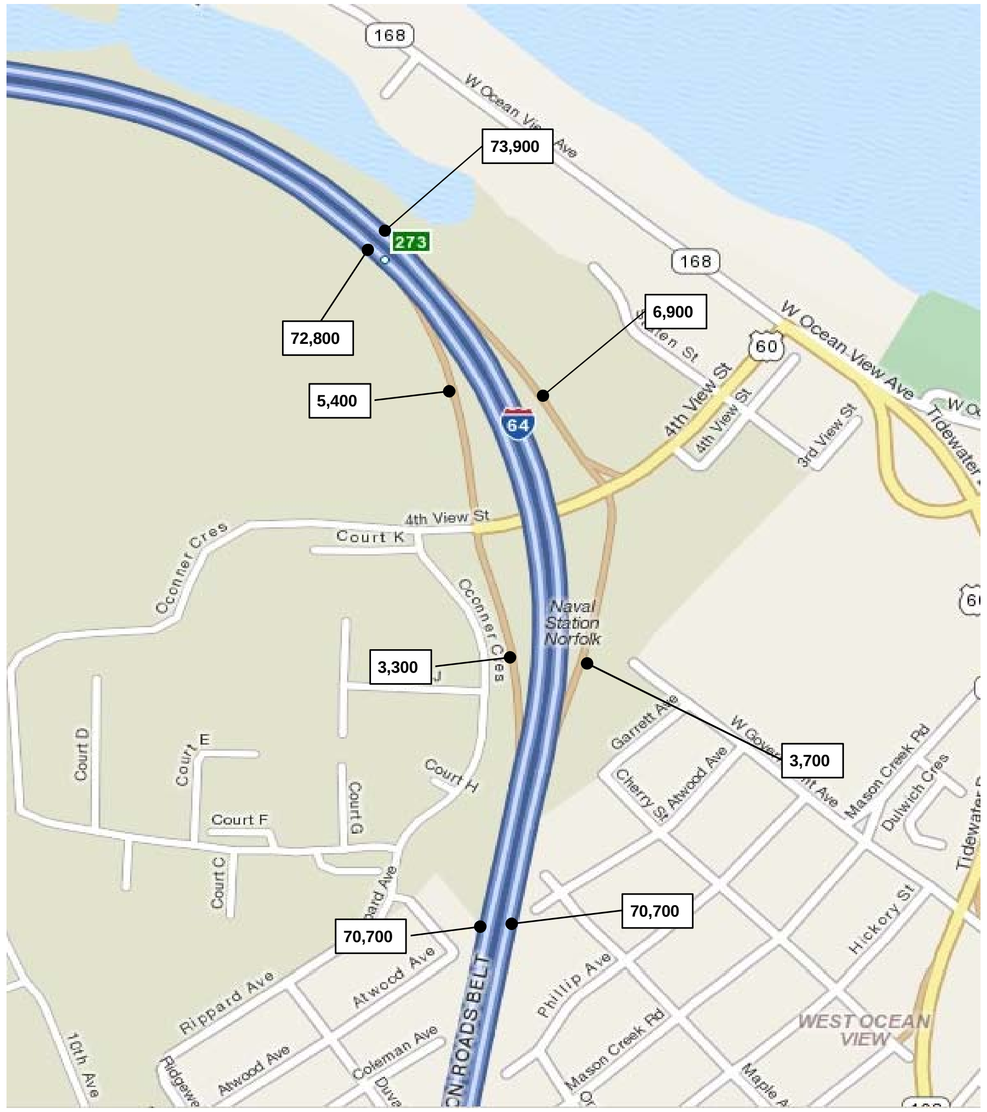
HRBT Hampton Roads Bridge Tunnel EIS

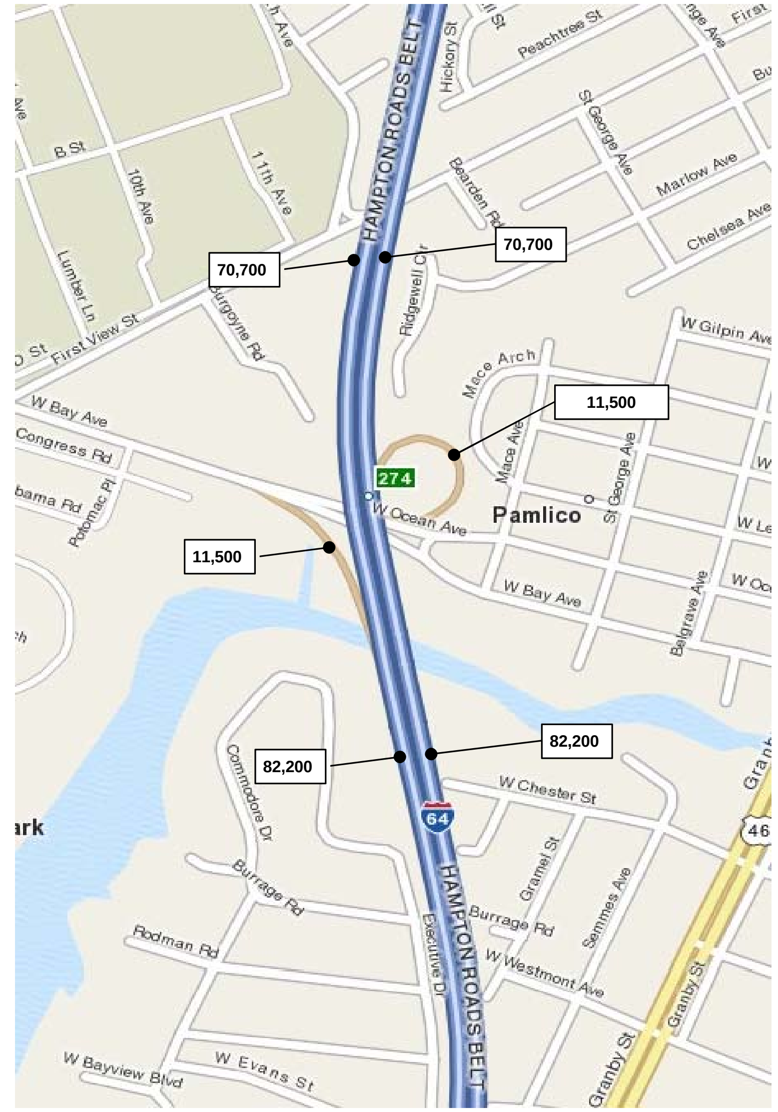
VDOT Virginia Department of Transportation

2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 3 of 6

October 12, 2012

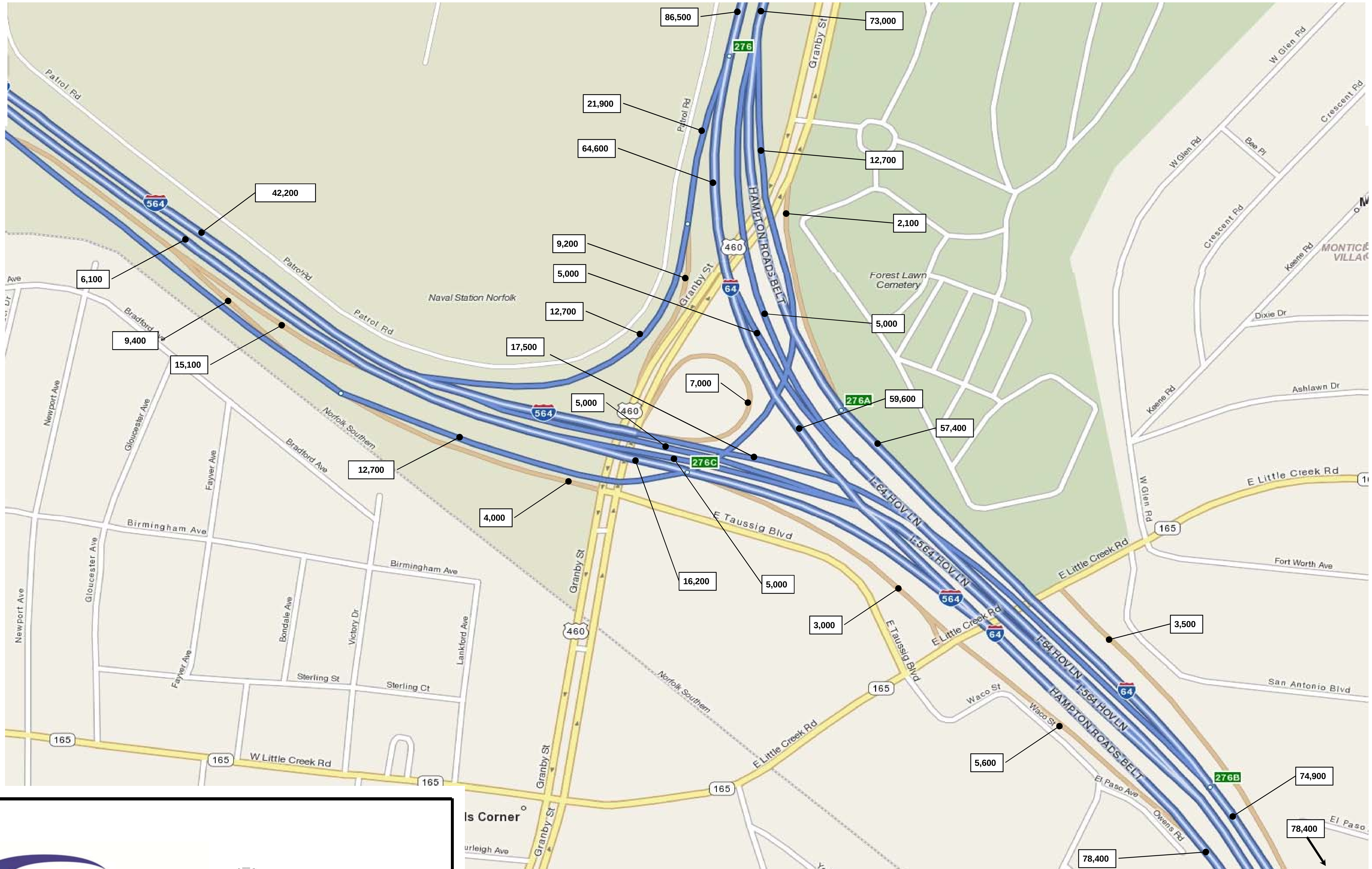




2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 4 of 6

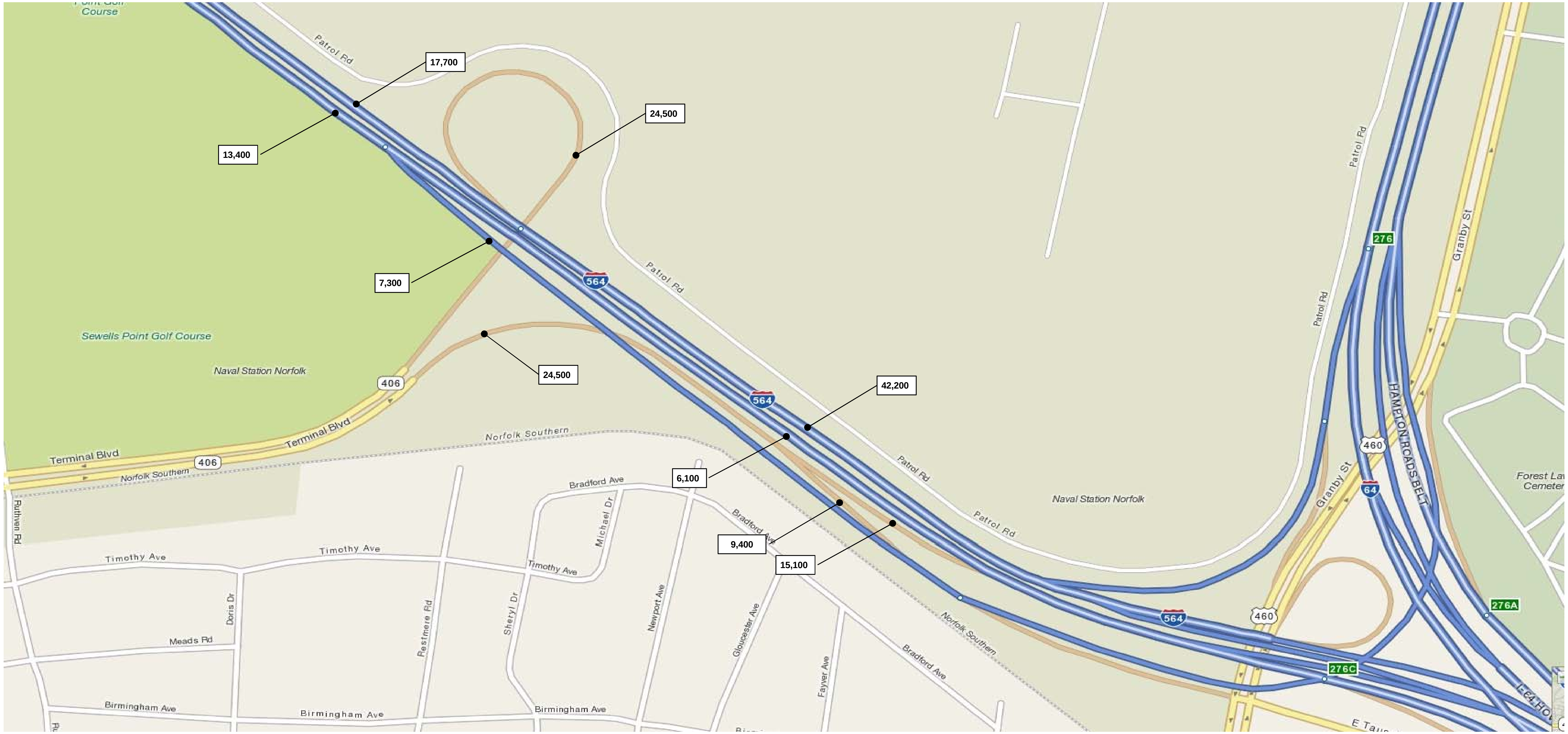
October 12, 2012



2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 5 of 6

October 12, 2012



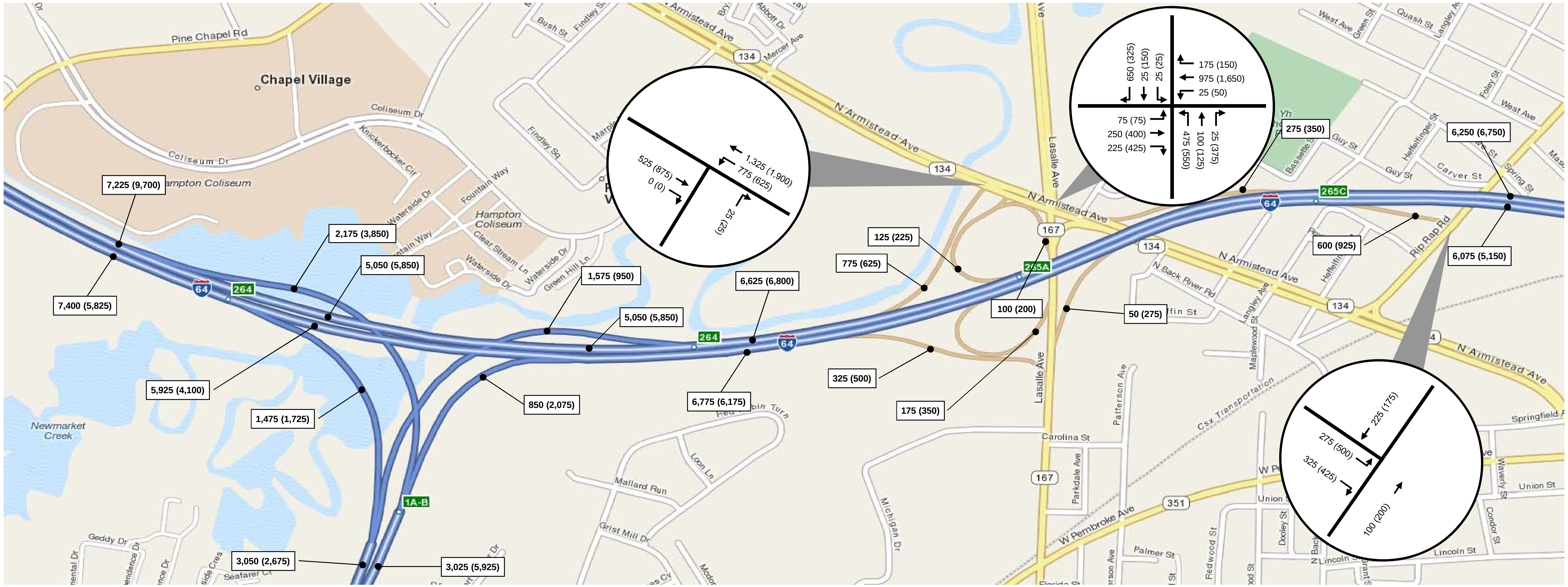
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Daily (ADT) Volumes

Figure D-3: Sheet 6 of 6

October 12, 2012



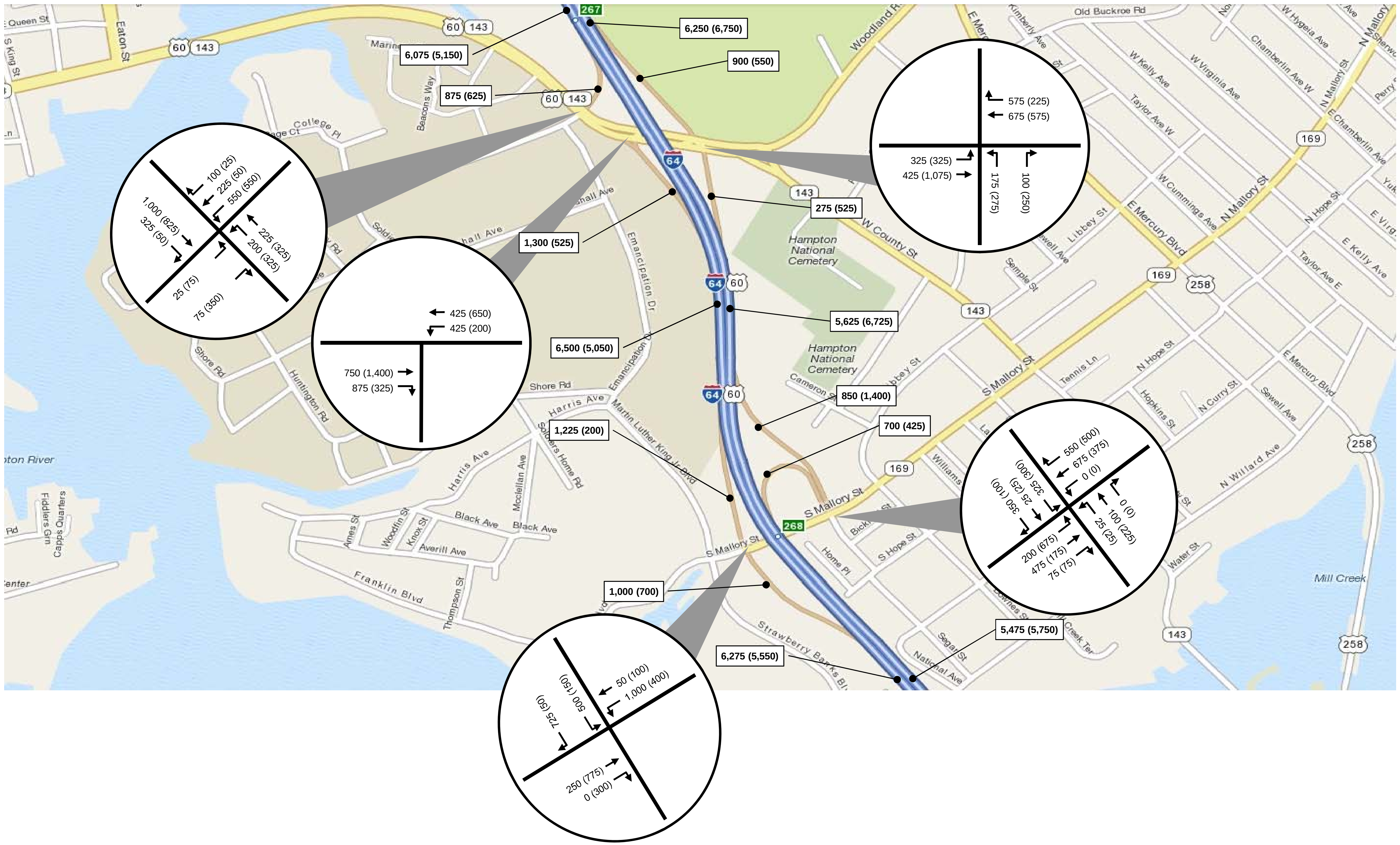
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 AM (PM) Peak Hour Volumes

Figure D-4: Sheet 1 of 6

October 12, 2012



Hampton Roads Bridge Tunnel EIS

2040 Build 8 AM (PM) Peak Hour Volumes

Figure D-4: Sheet 2 of 6

October 12, 2012

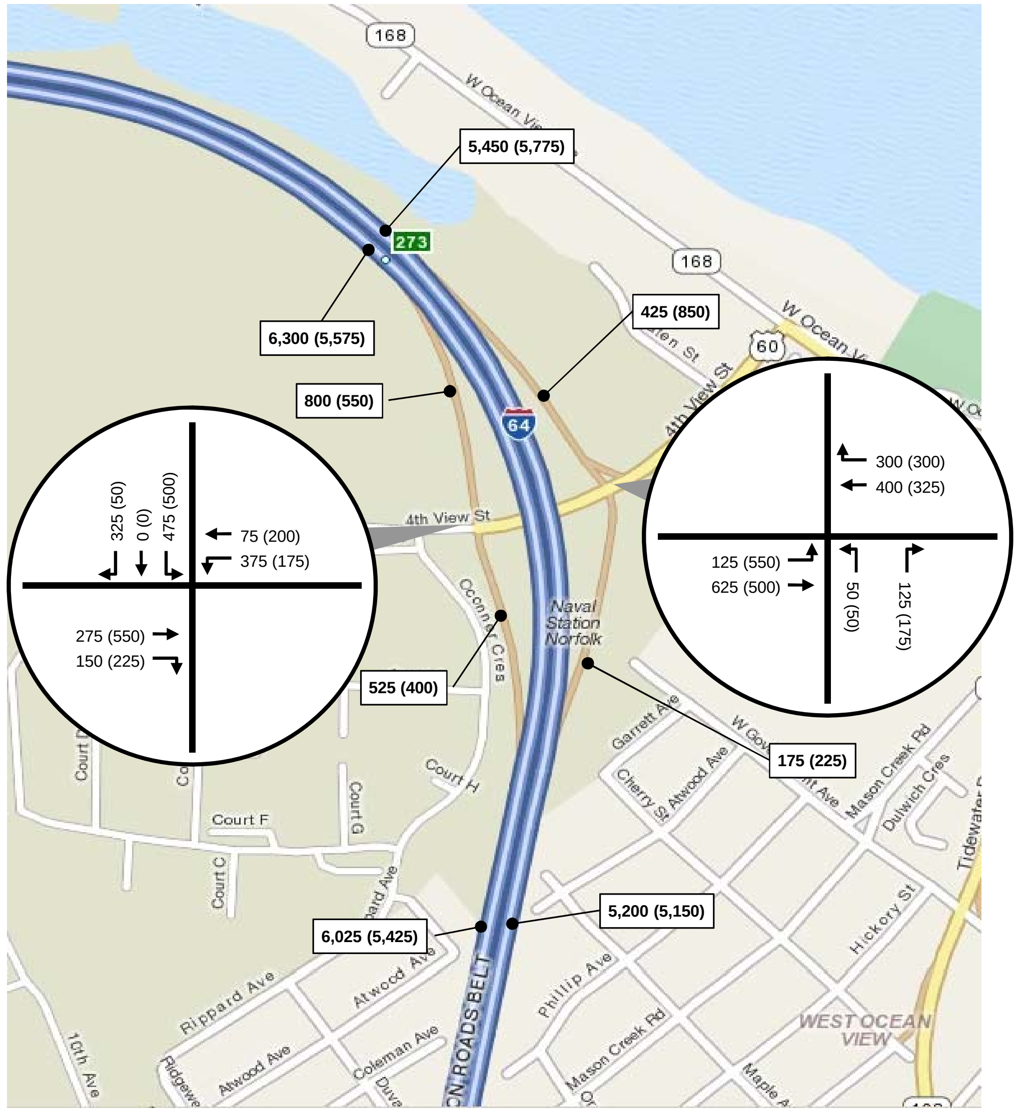
2040 Build 8 AM (PM) Peak Hour Volumes

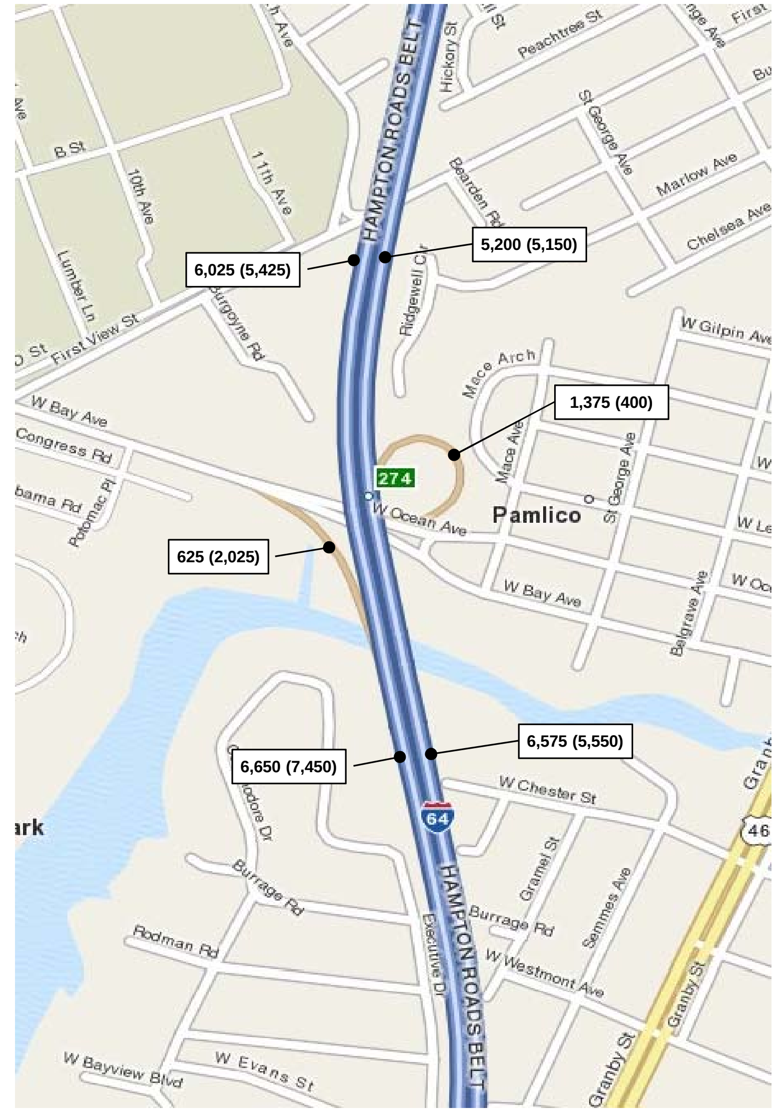
Figure D-4: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation





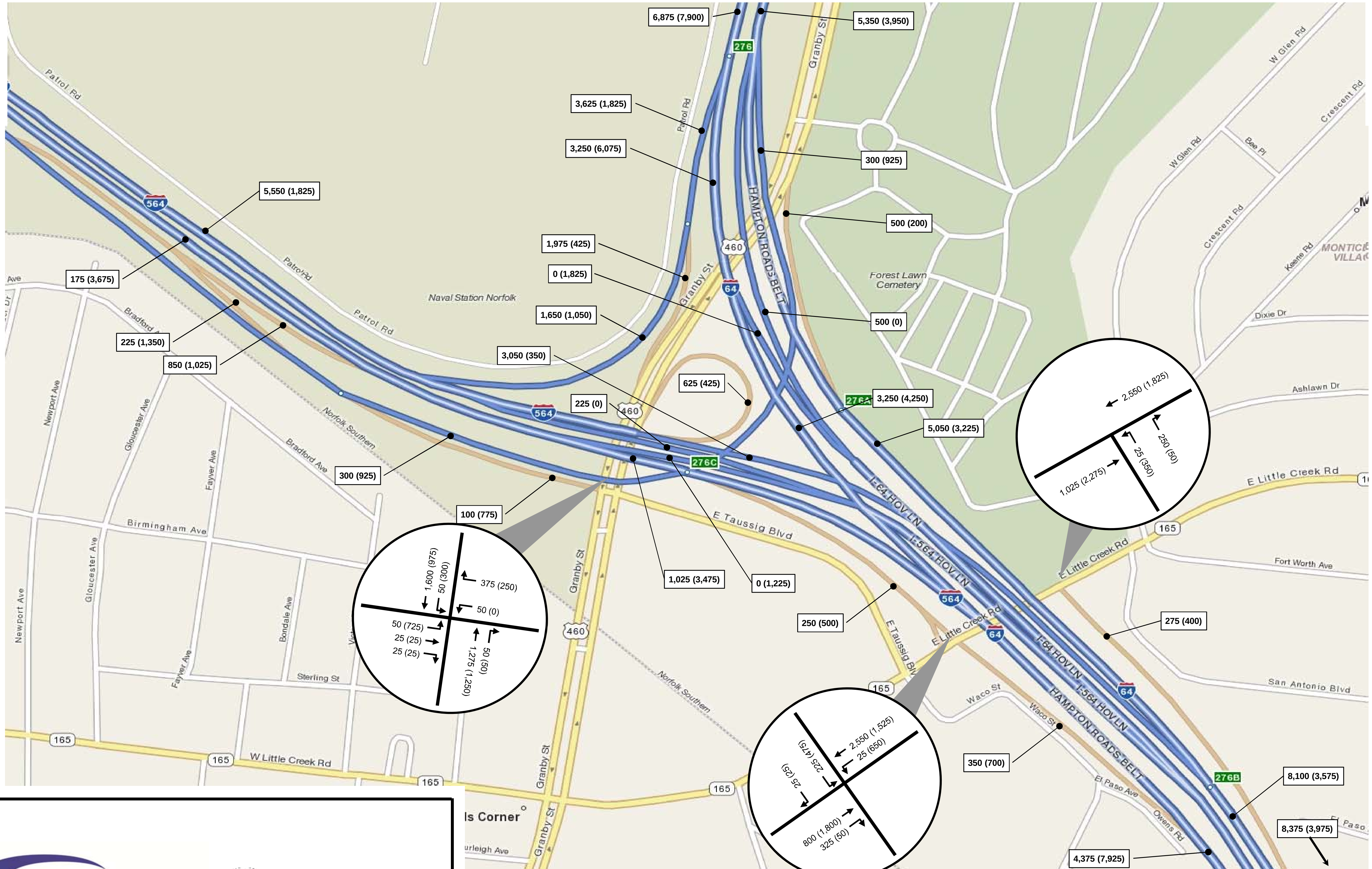
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 AM (PM) Peak Hour Volumes

Figure D-4: Sheet 4 of 6

October 12, 2012

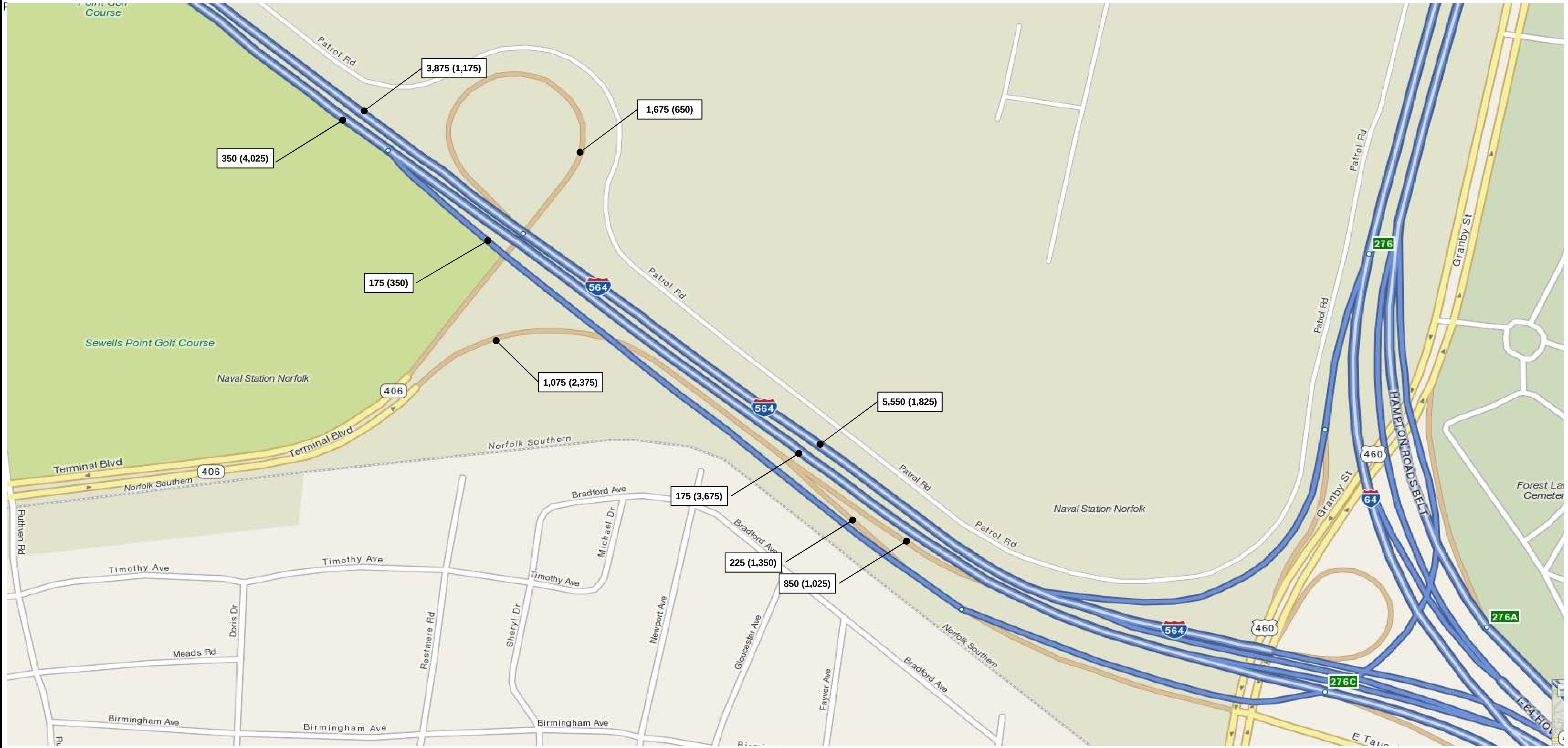


Hampton Roads Bridge Tunnel EIS

2040 Build 8 AM (PM) Peak Hour Volumes

Figure D-4: Sheet 5 of 6

October 12, 2012

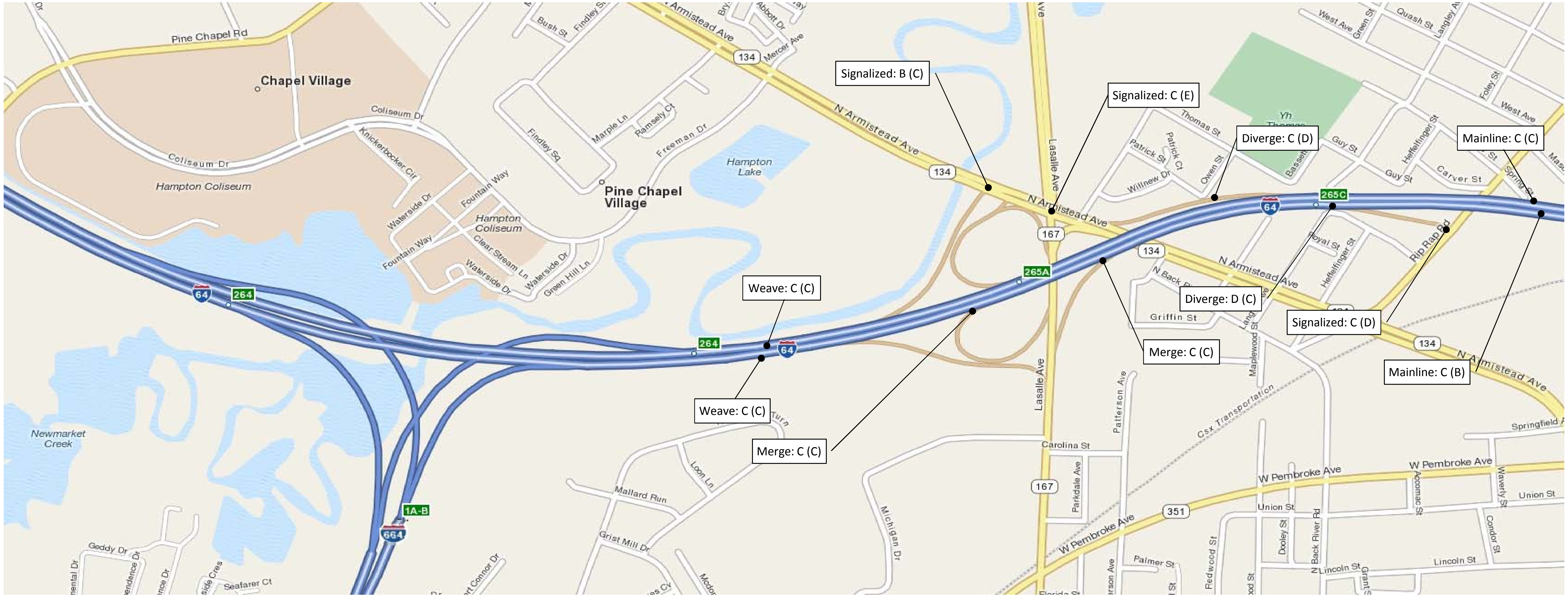


Hampton Roads Bridge Tunnel EIS

2040 Build 8 AM (PM) Peak Hour Volumes

Figure D-4: Sheet 6 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

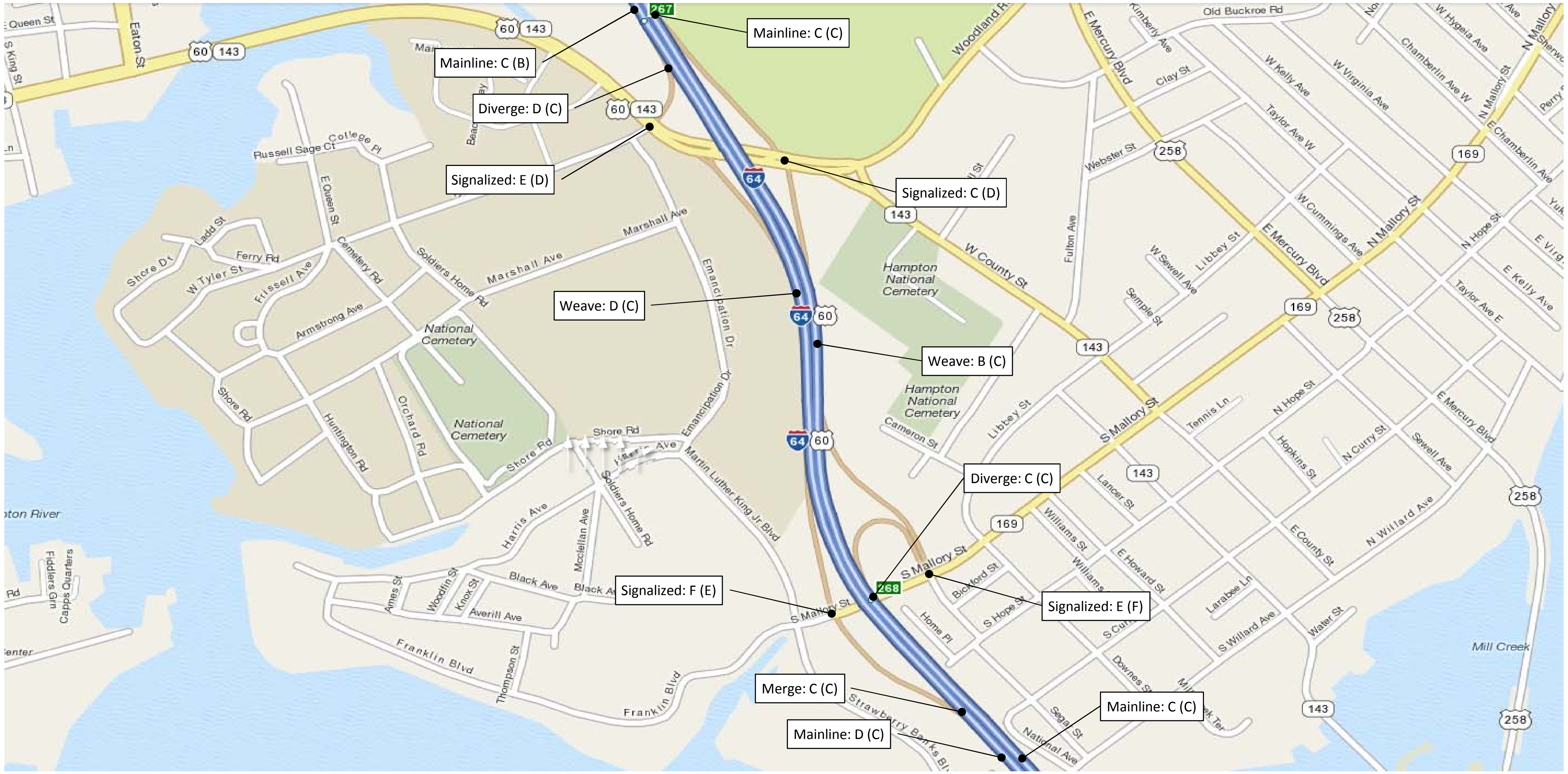
VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-5: Sheet 1 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-5: Sheet 2 of 6

October 12, 2012

2020 Build 8 AM (PM) Level of Service

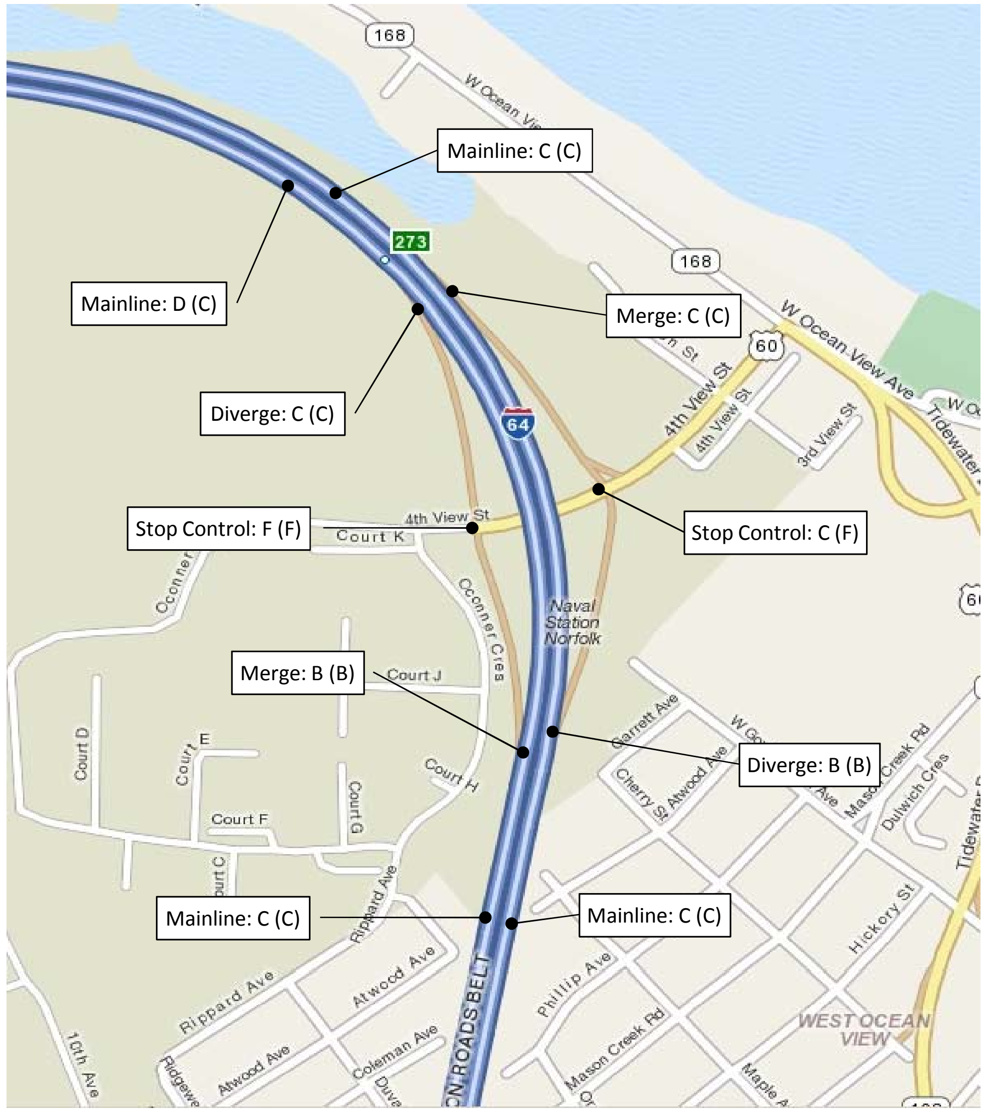
(8 total lanes crossing HRBT)

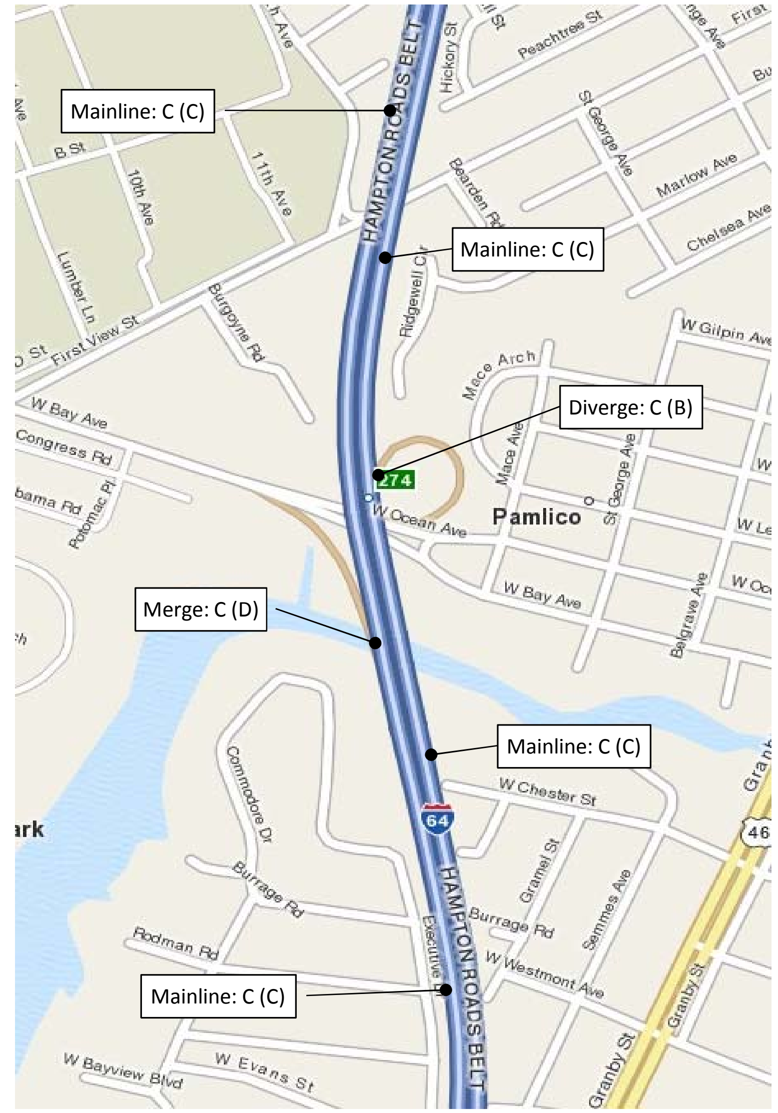
Figure D-5: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation





2020 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-5: Sheet 4 of 6

October 12, 2012

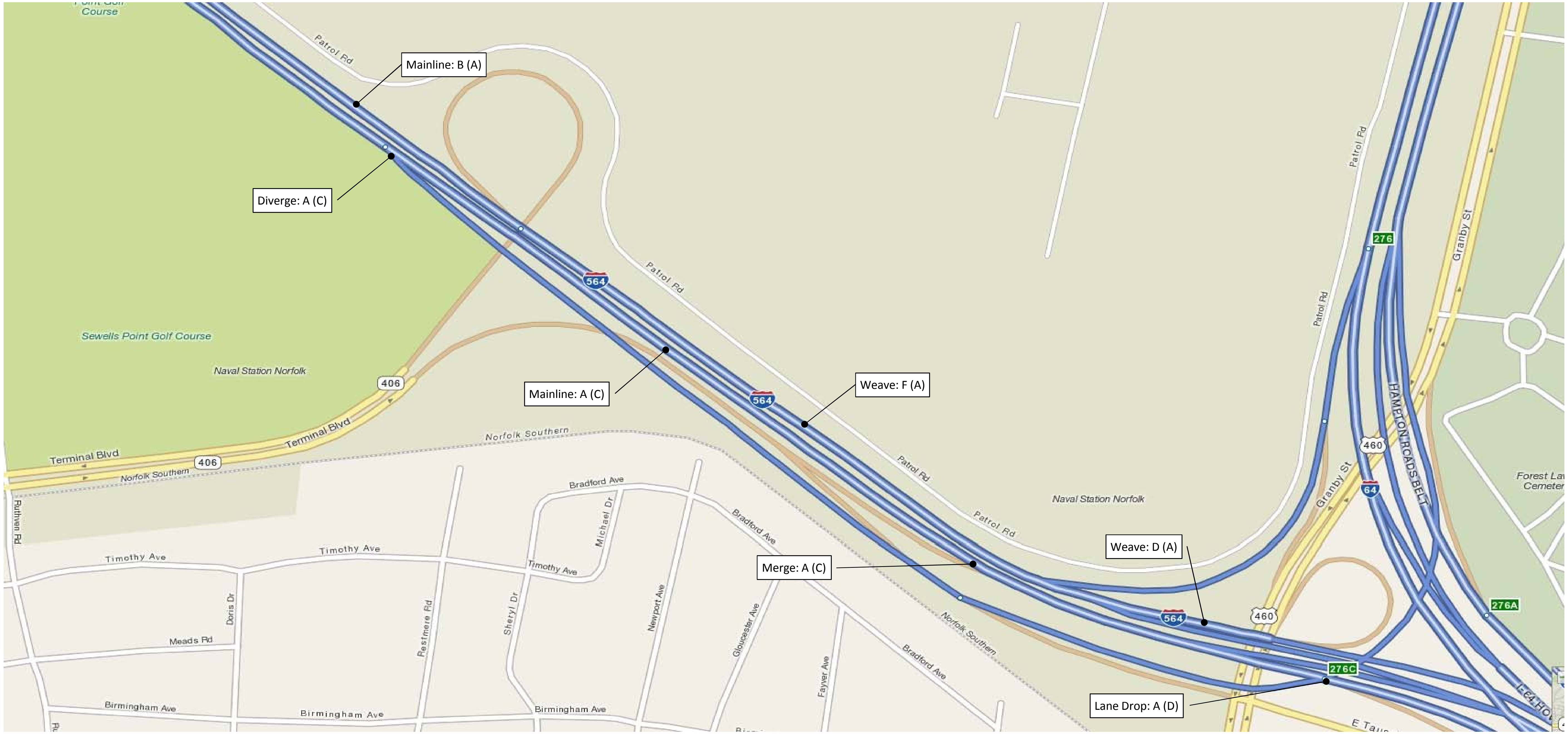
Hampton Roads Bridge Tunnel EIS

2020 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-5: Sheet 5 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

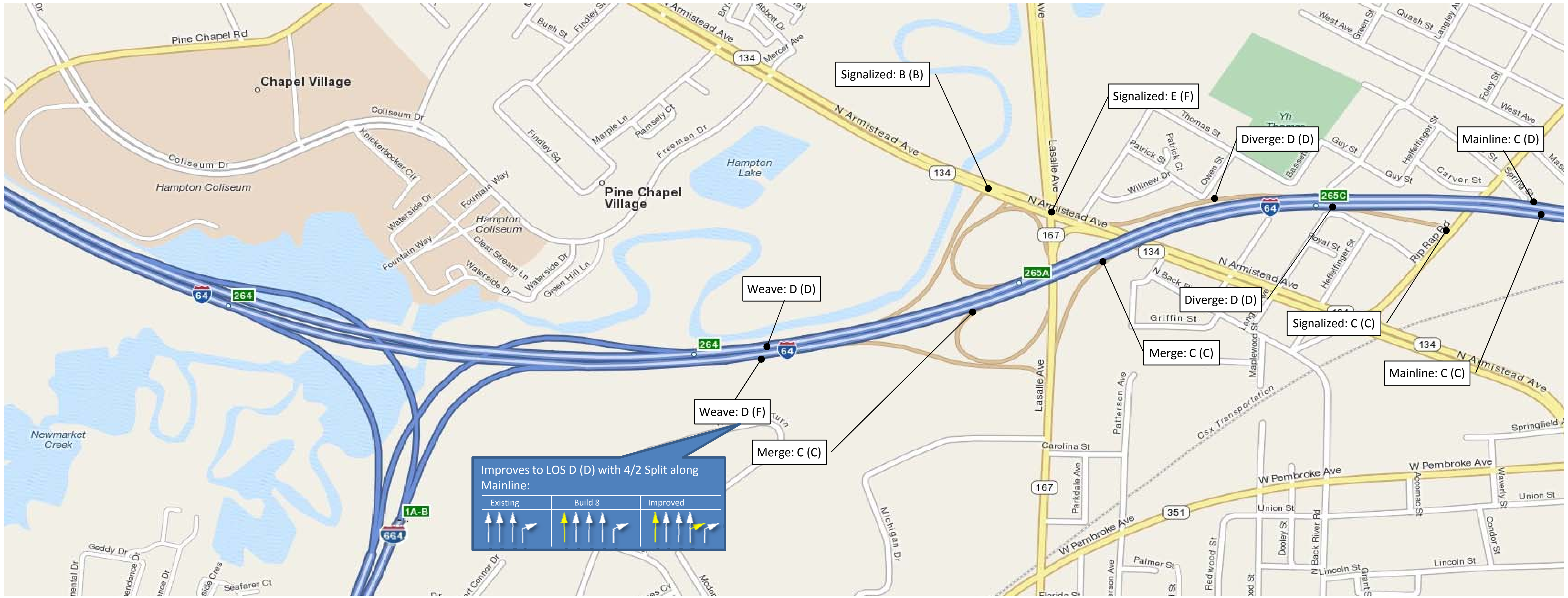
VDOT Virginia Department of Transportation

2020 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-5: Sheet 6 of 6

October 12, 2012

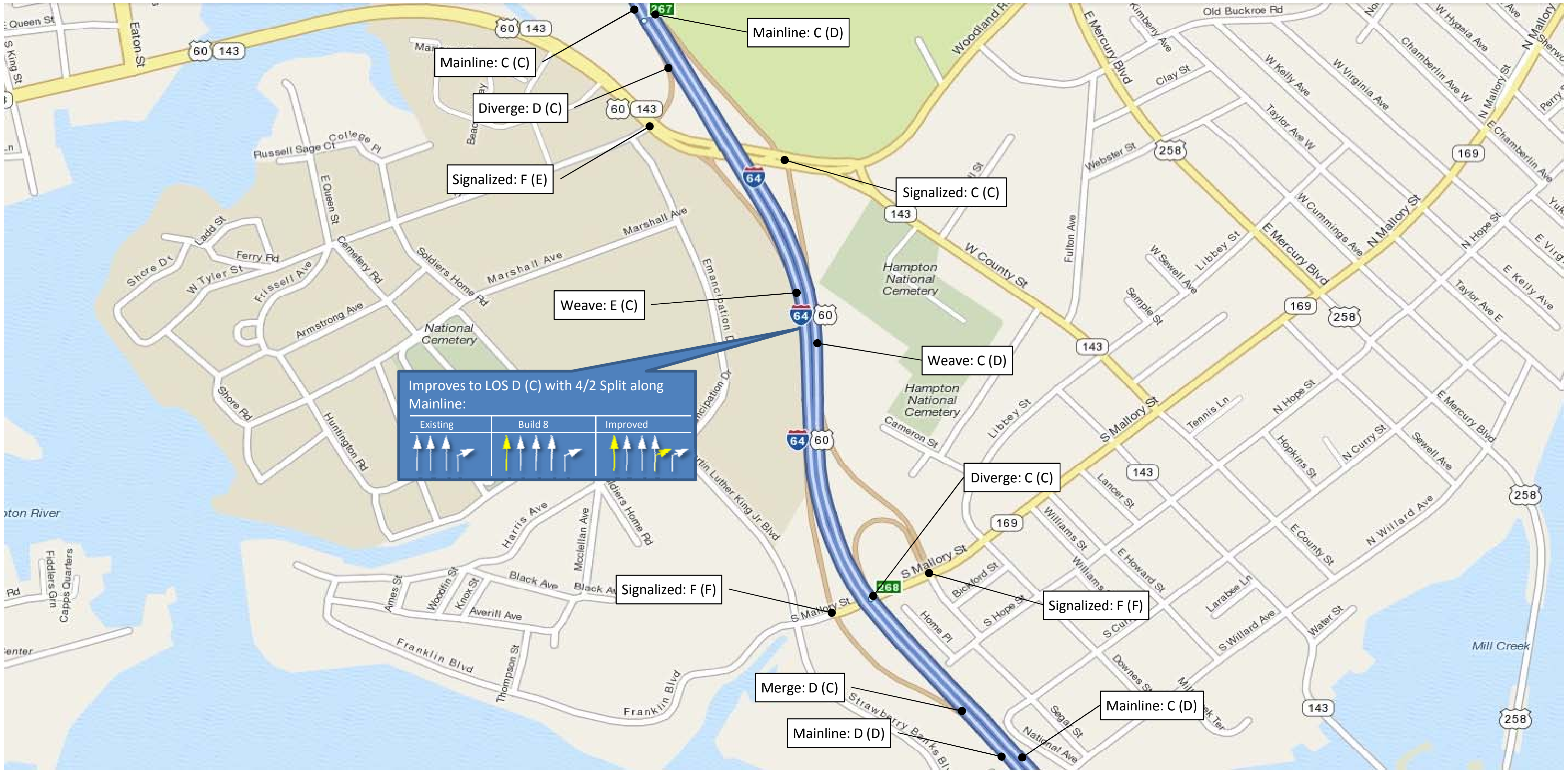


2040 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-6: Sheet 1 of 6

October 12, 2012



HRBT
Hampton Roads Bridge Tunnel EIS

VDOT

2040 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-6: Sheet 2 of 6

October 12, 2012

2040 Build 8 AM (PM) Level of Service

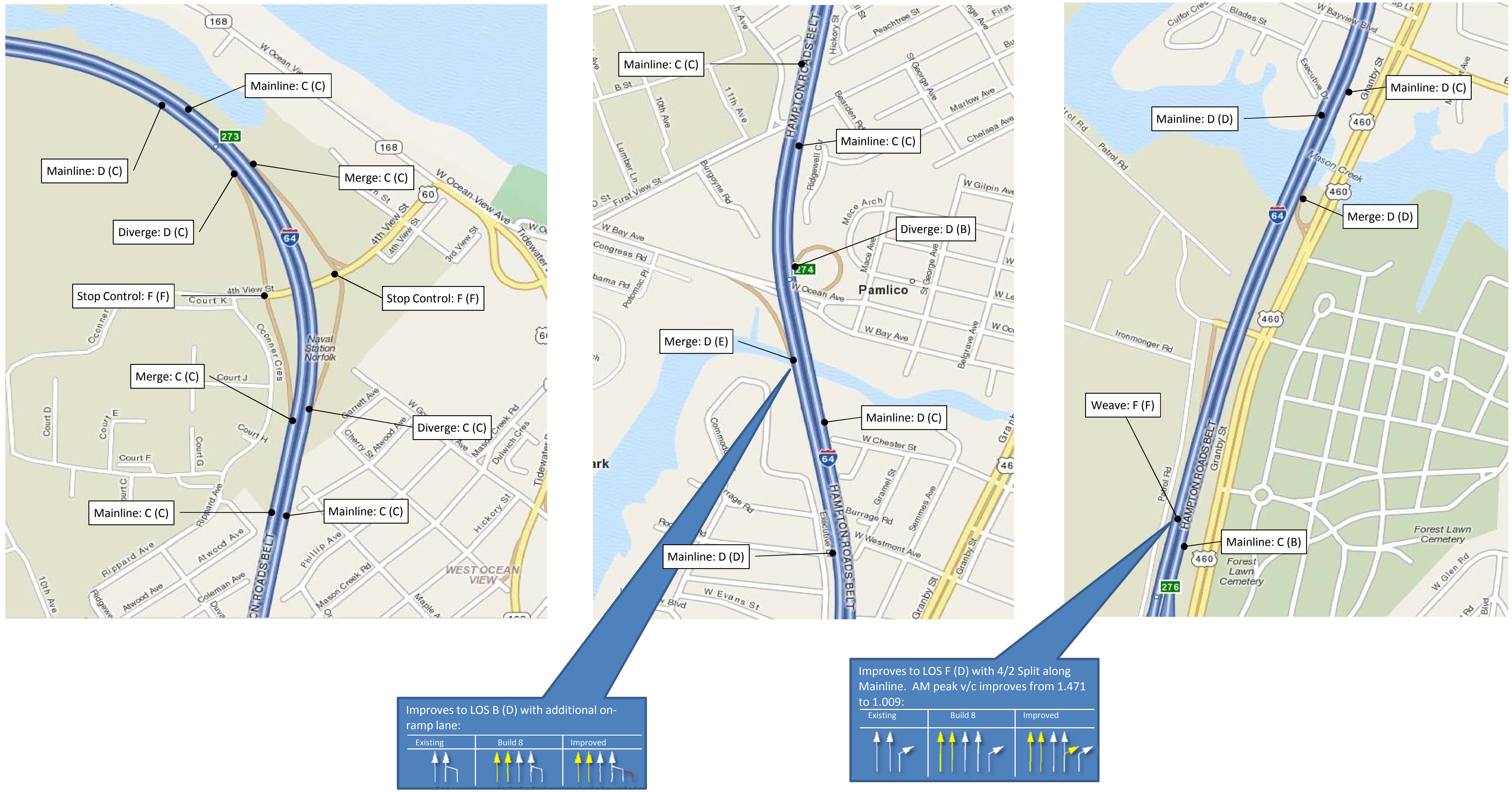
(8 total lanes crossing HRBT)

Figure D-6: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



Note: projected volumes put HCS analysis at limits of methodology. Results should be verified using simulation.

HRBT Hampton Roads Bridge Tunnel EIS

VDOT

2040 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-6: Sheet 4 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

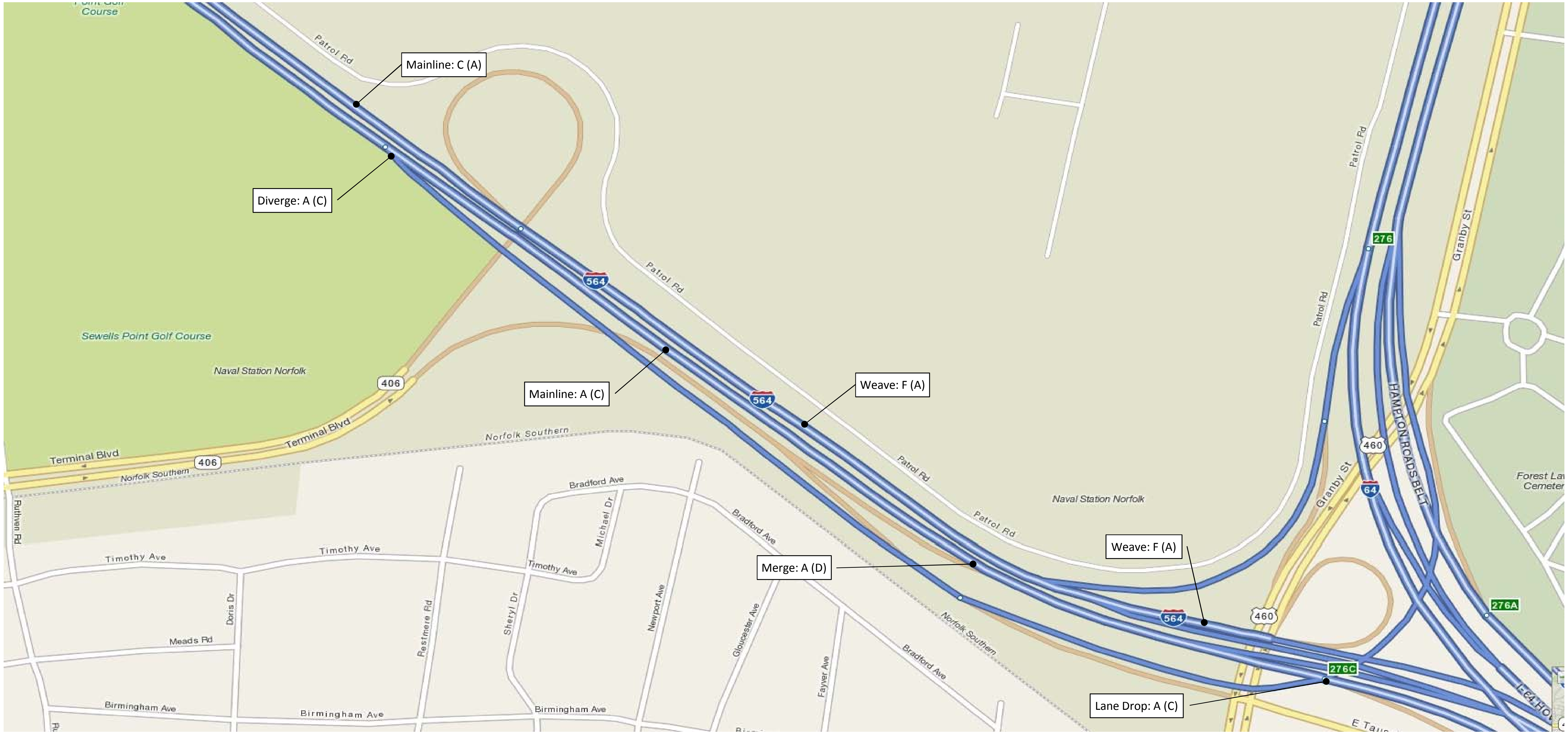
VDOT Virginia Department of Transportation

2040 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-6: Sheet 5 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

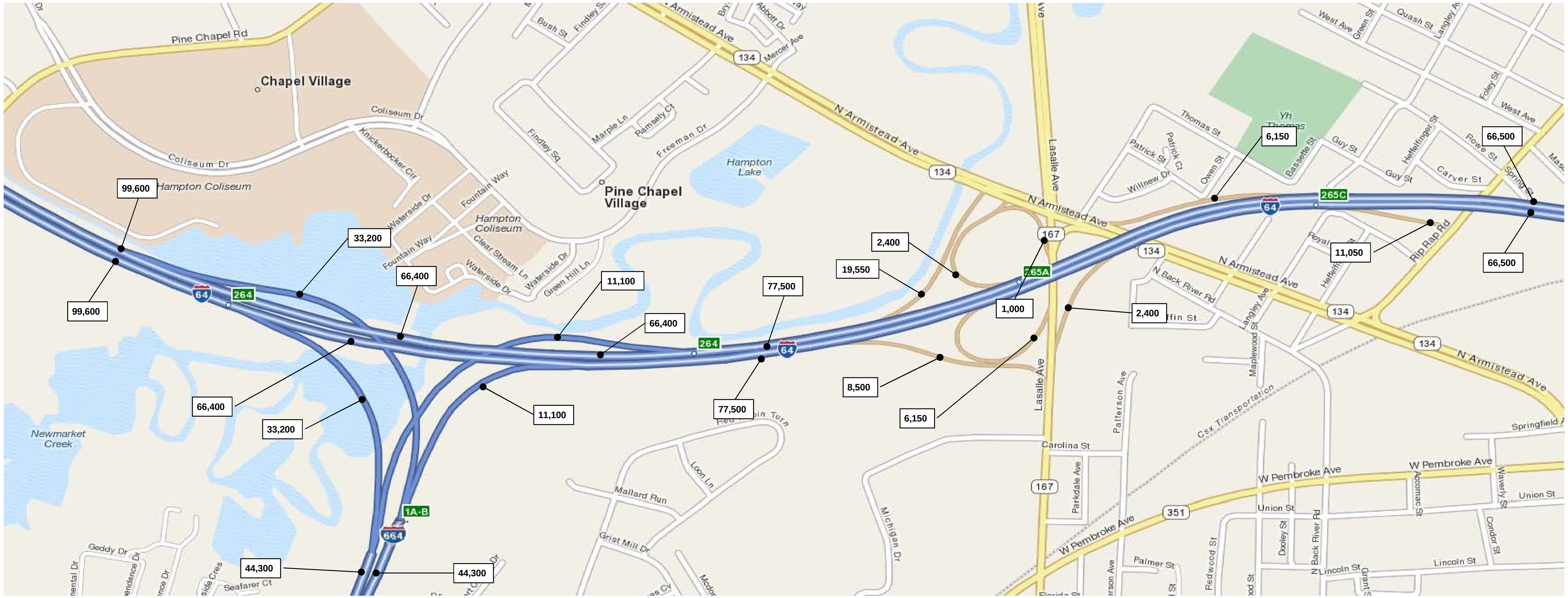
2040 Build 8 AM (PM) Level of Service

(8 total lanes crossing HRBT)

Figure D-6: Sheet 6 of 6

October 12, 2012

Appendix E. **2040 Build-8 Managed Traffic Volumes**

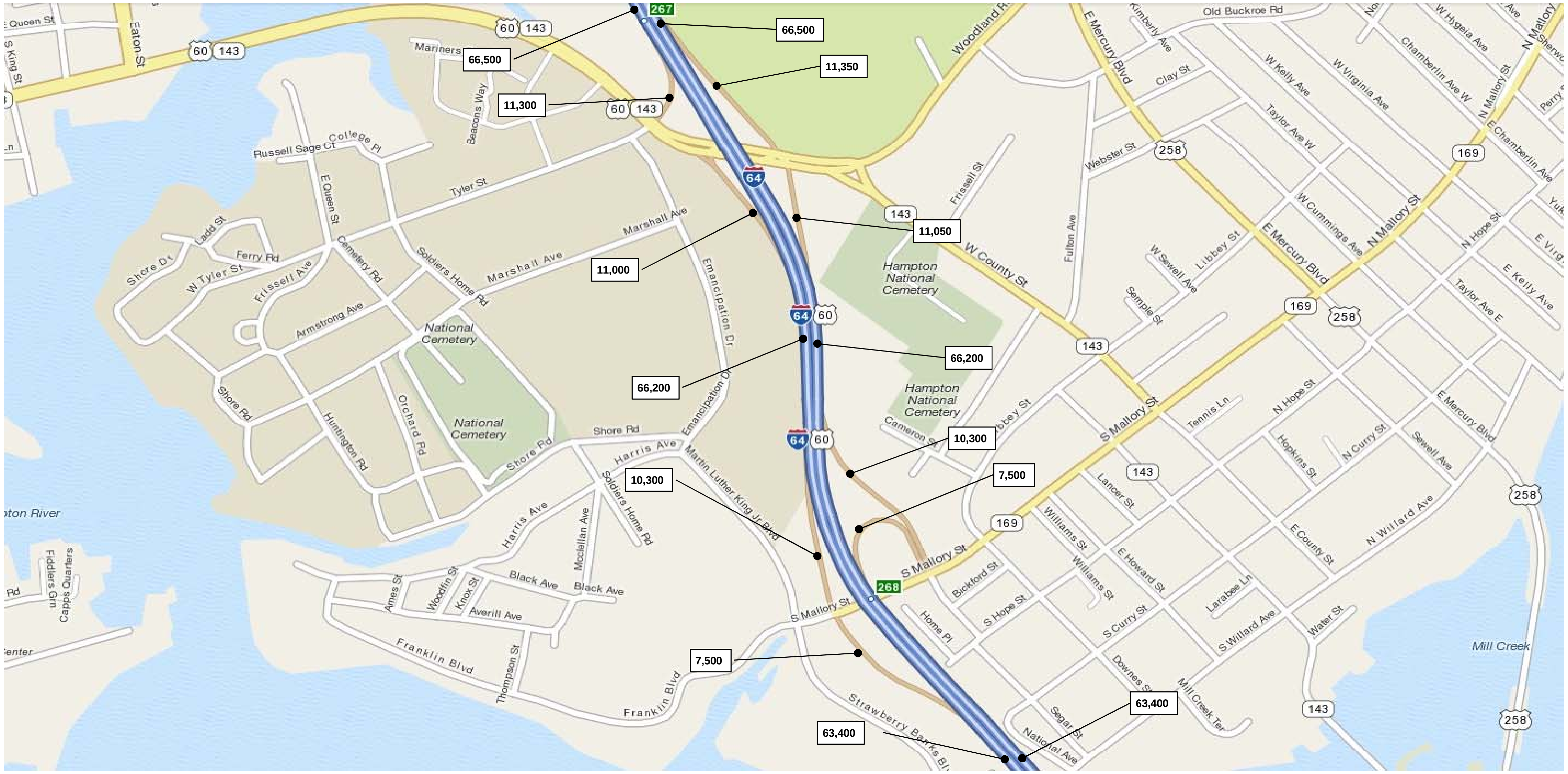


2040 Build 8 - $1 Toll on HRBT

Daily (ADT) Volumes

Figure E-1: Sheet 1 of 6

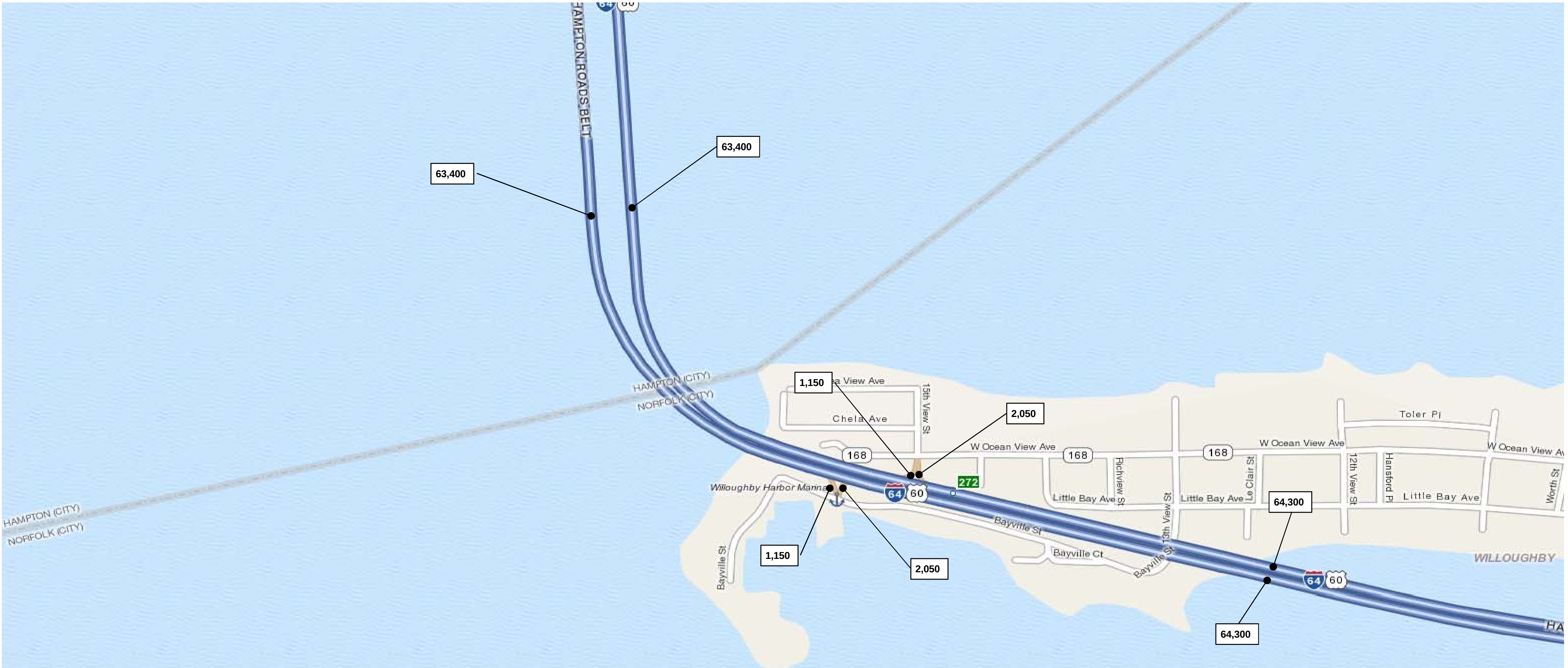
October 12, 2012



2040 Build 8 - $1 Toll on HRBT
Daily (ADT) Volumes

Figure E-1: Sheet 2 of 6

October 12, 2012

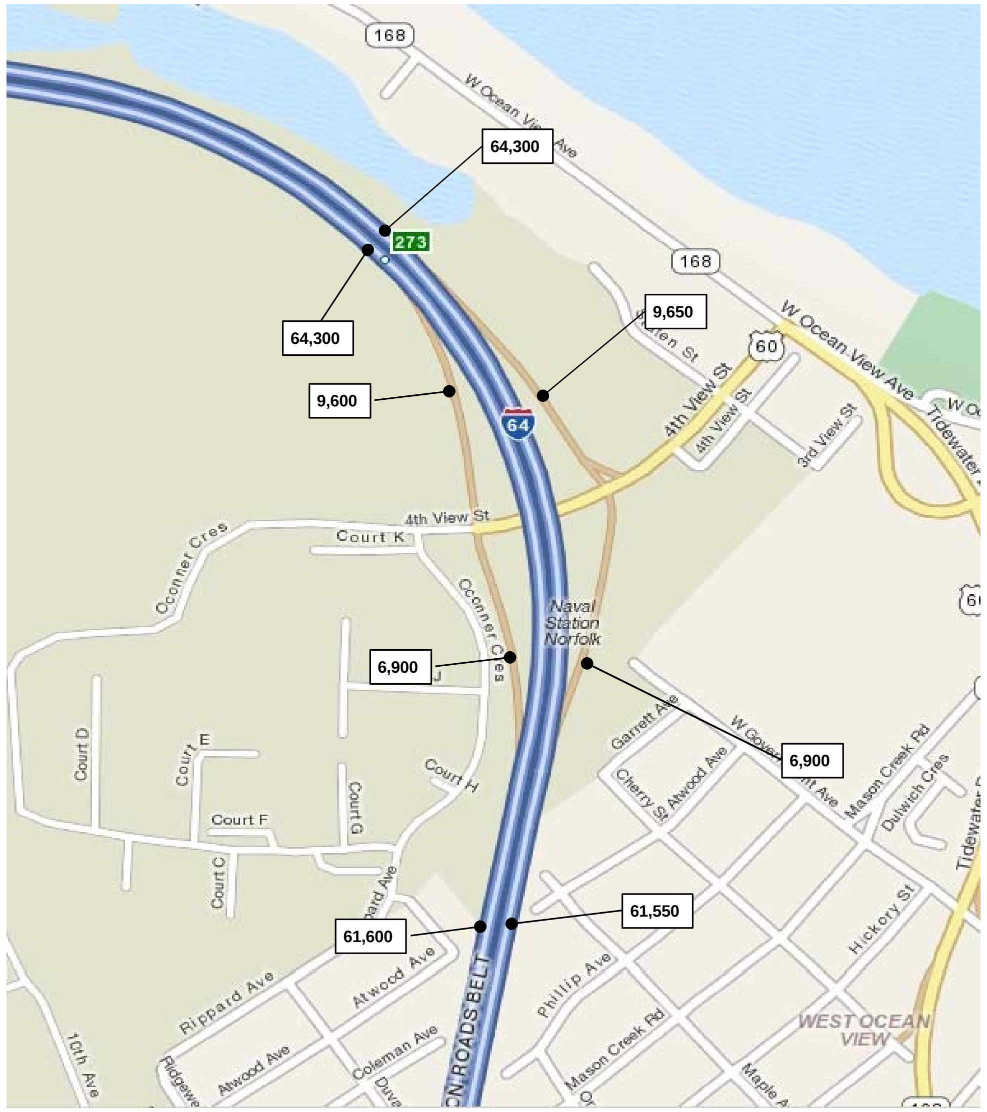


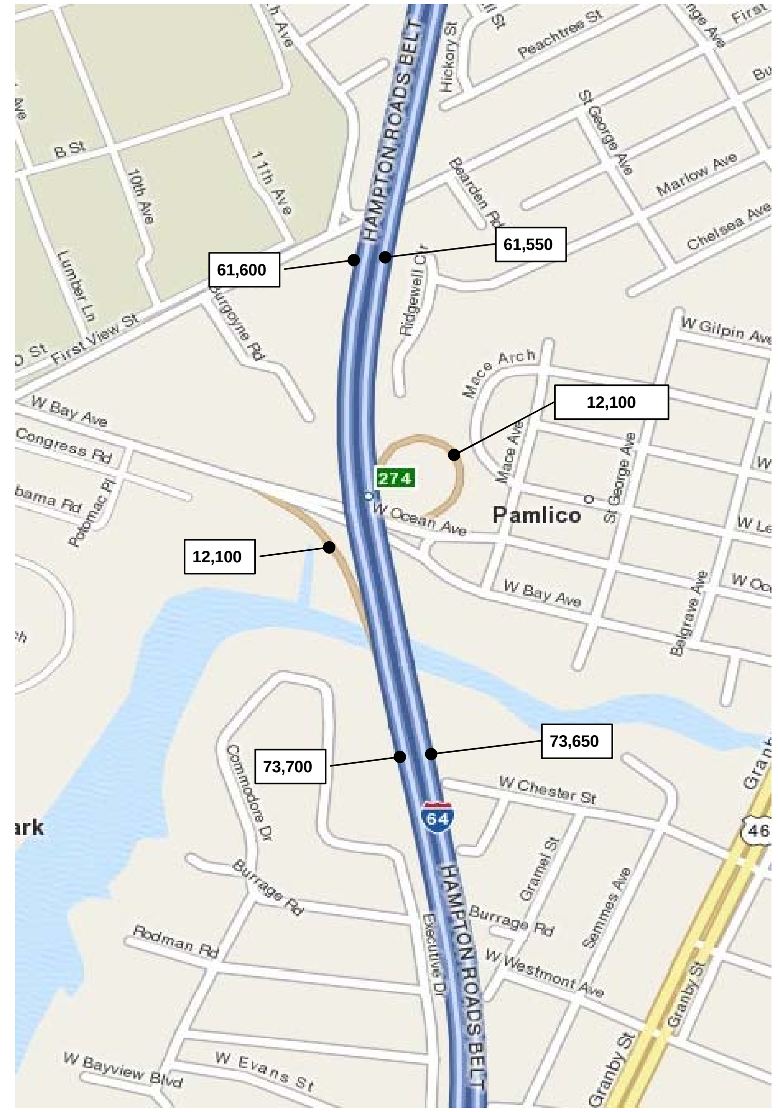
2040 Build 8 - $1 Toll on HRBT

Daily (ADT) Volumes

Figure E-1: Sheet 3 of 6

October 12, 2012

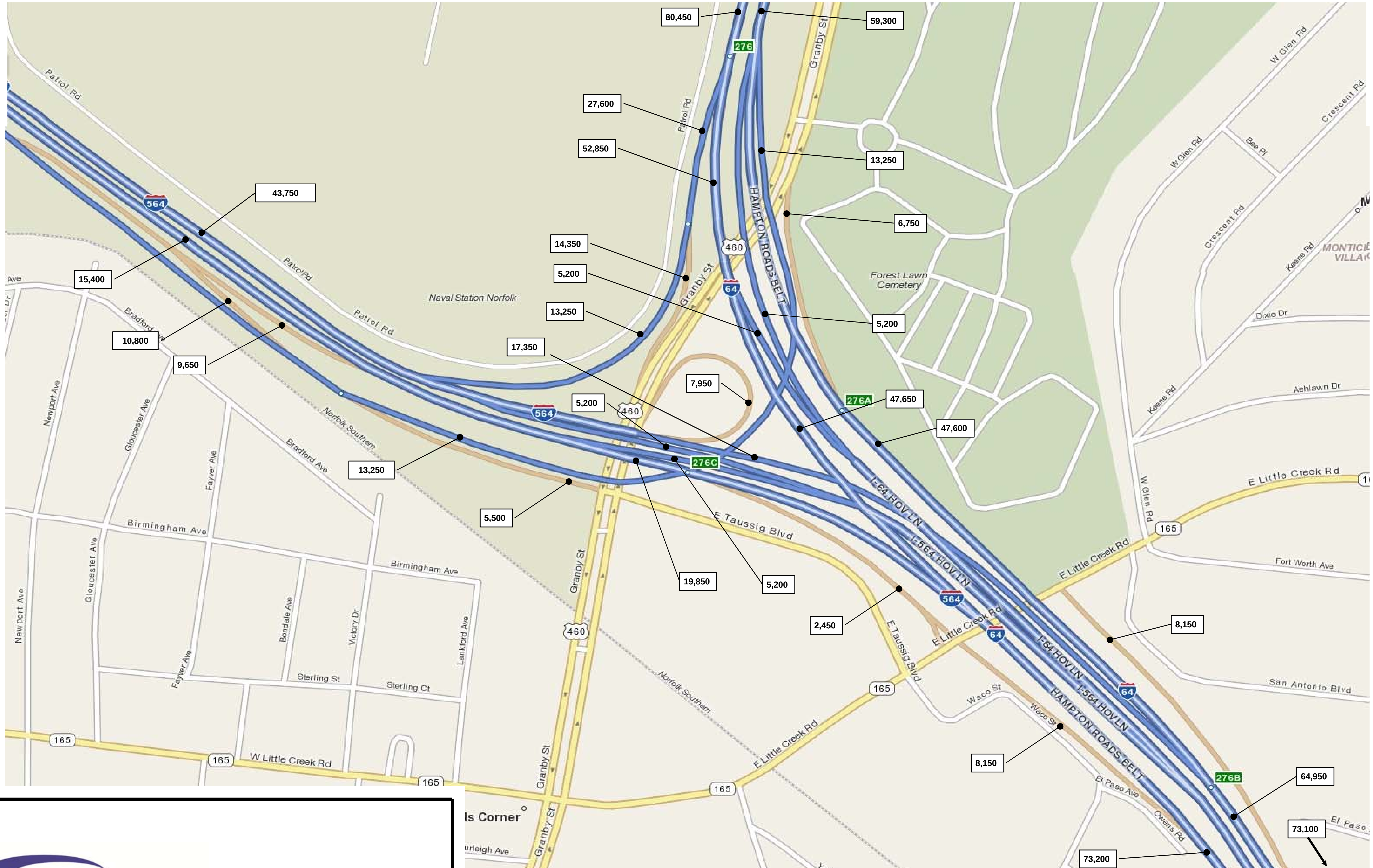




2040 Build 8 - $1 Toll on HRBT
Daily (ADT) Volumes

Figure E-1: Sheet 4 of 6

October 12, 2012

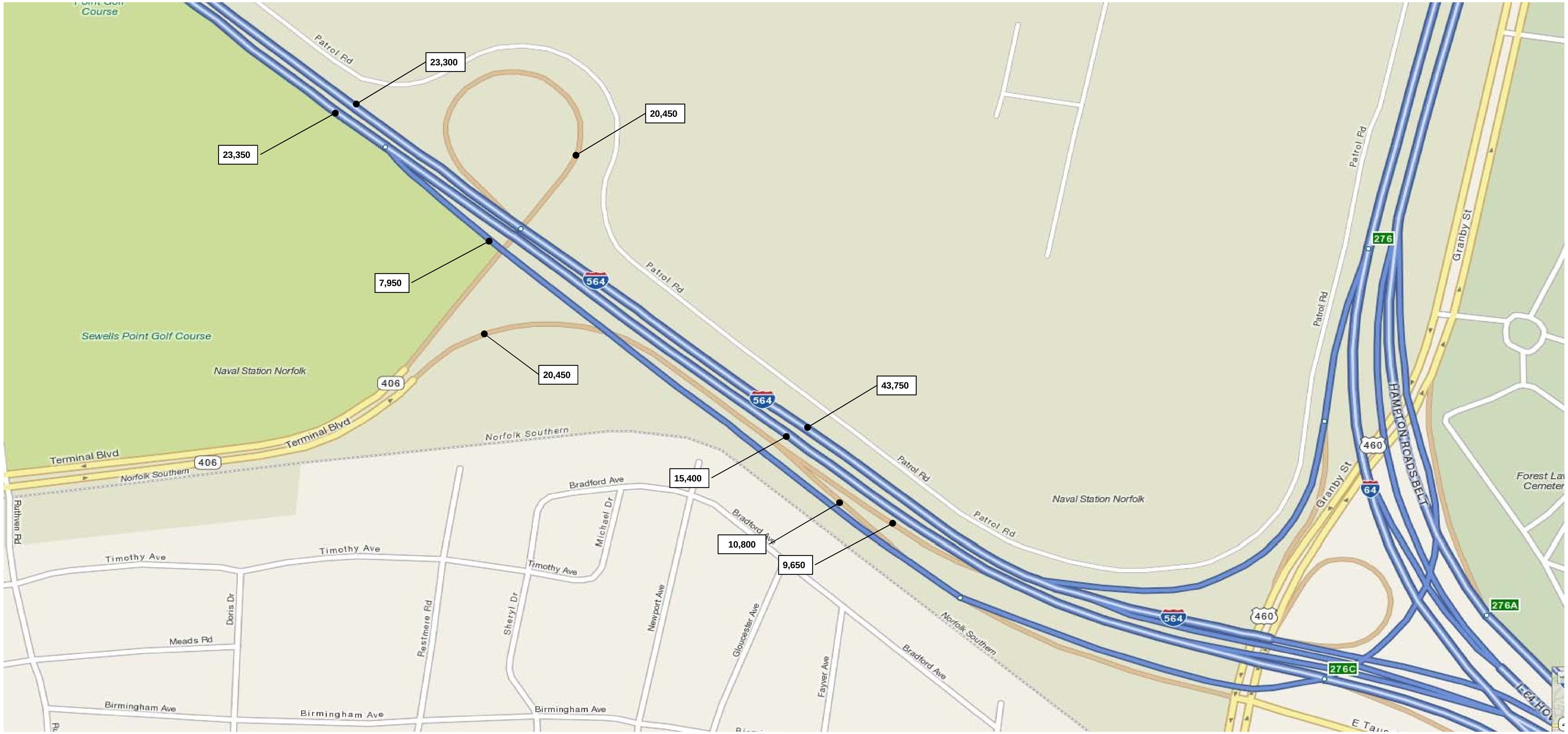


2040 Build 8 - $1 Toll on HRBT

Daily (ADT) Volumes

Figure E-1: Sheet 5 of 6

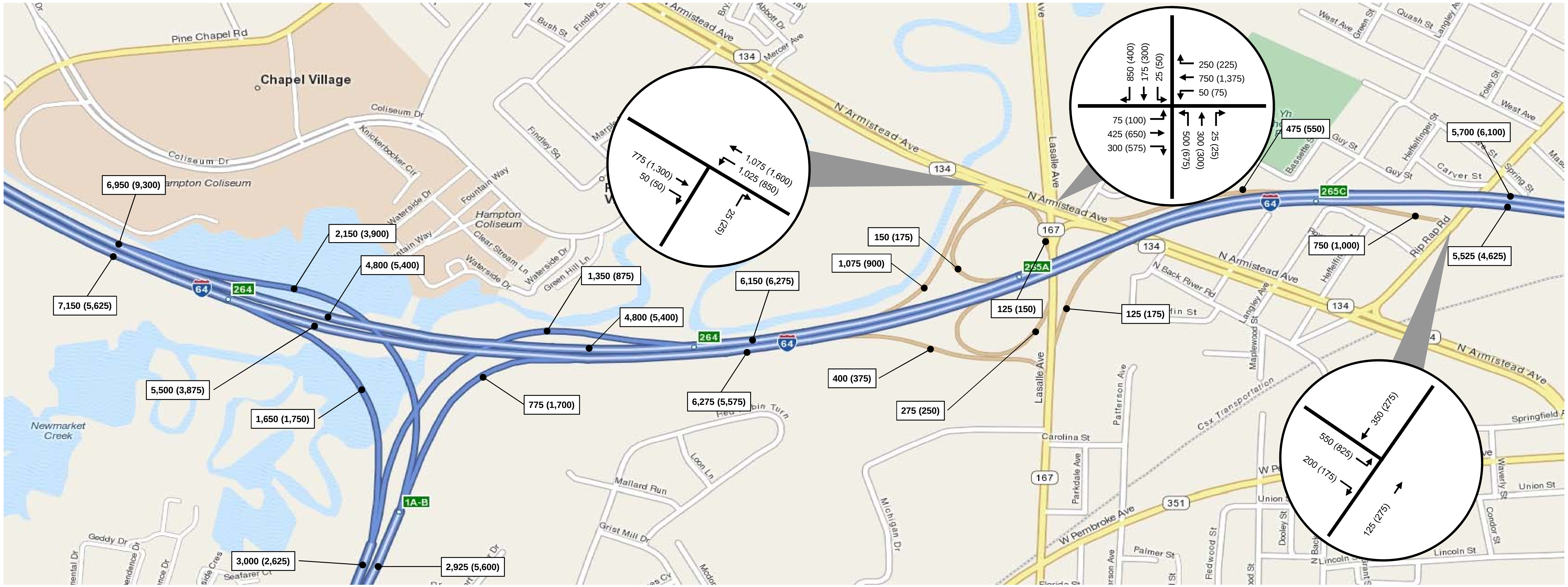
October 12, 2012



2040 Build 8 - $1 Toll on HRBT
Daily (ADT) Volumes

Figure E-1: Sheet 6 of 6

October 12, 2012

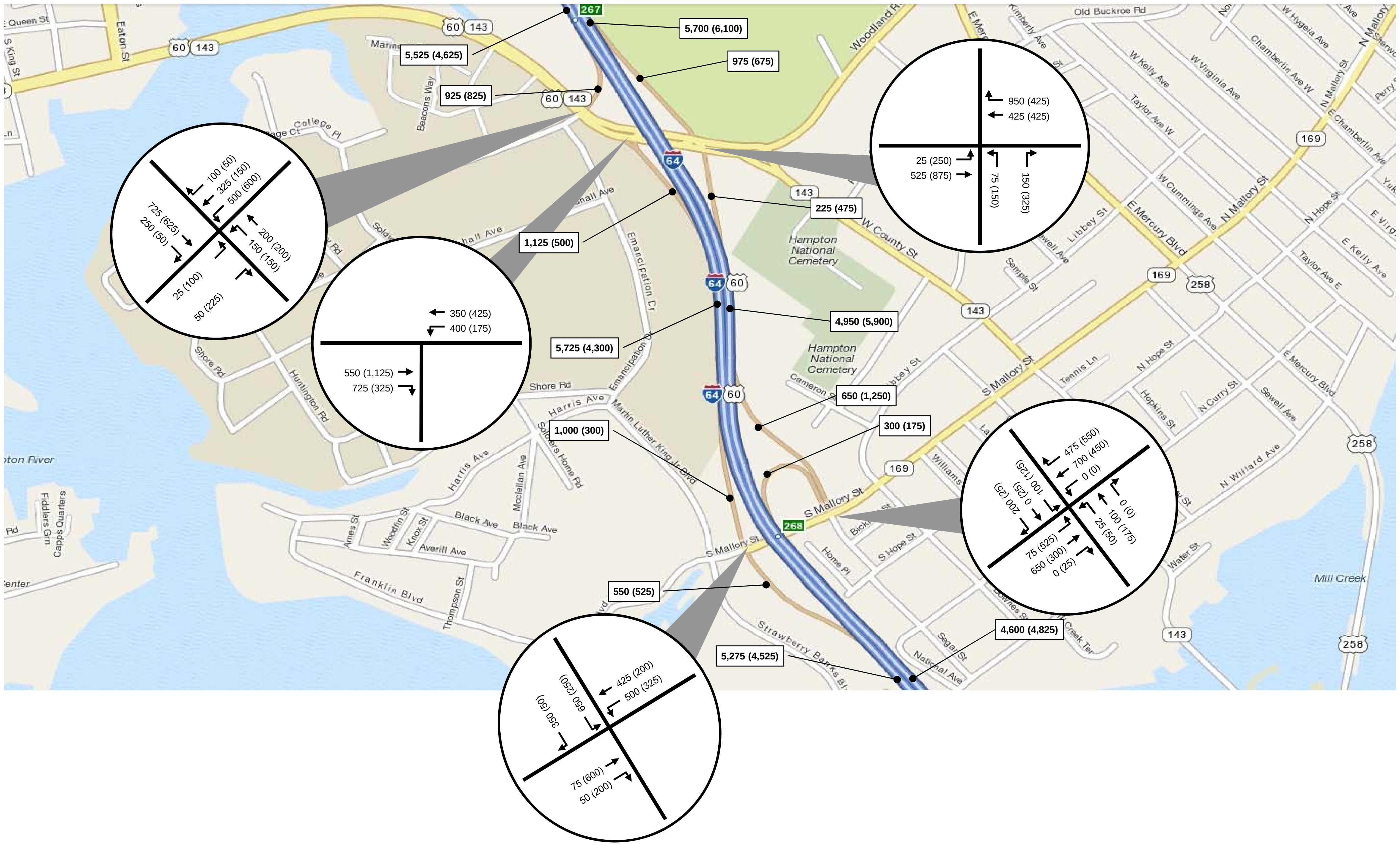


2040 Build 8 - $1 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-2: Sheet 1 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 - $1 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-2: Sheet 2 of 6

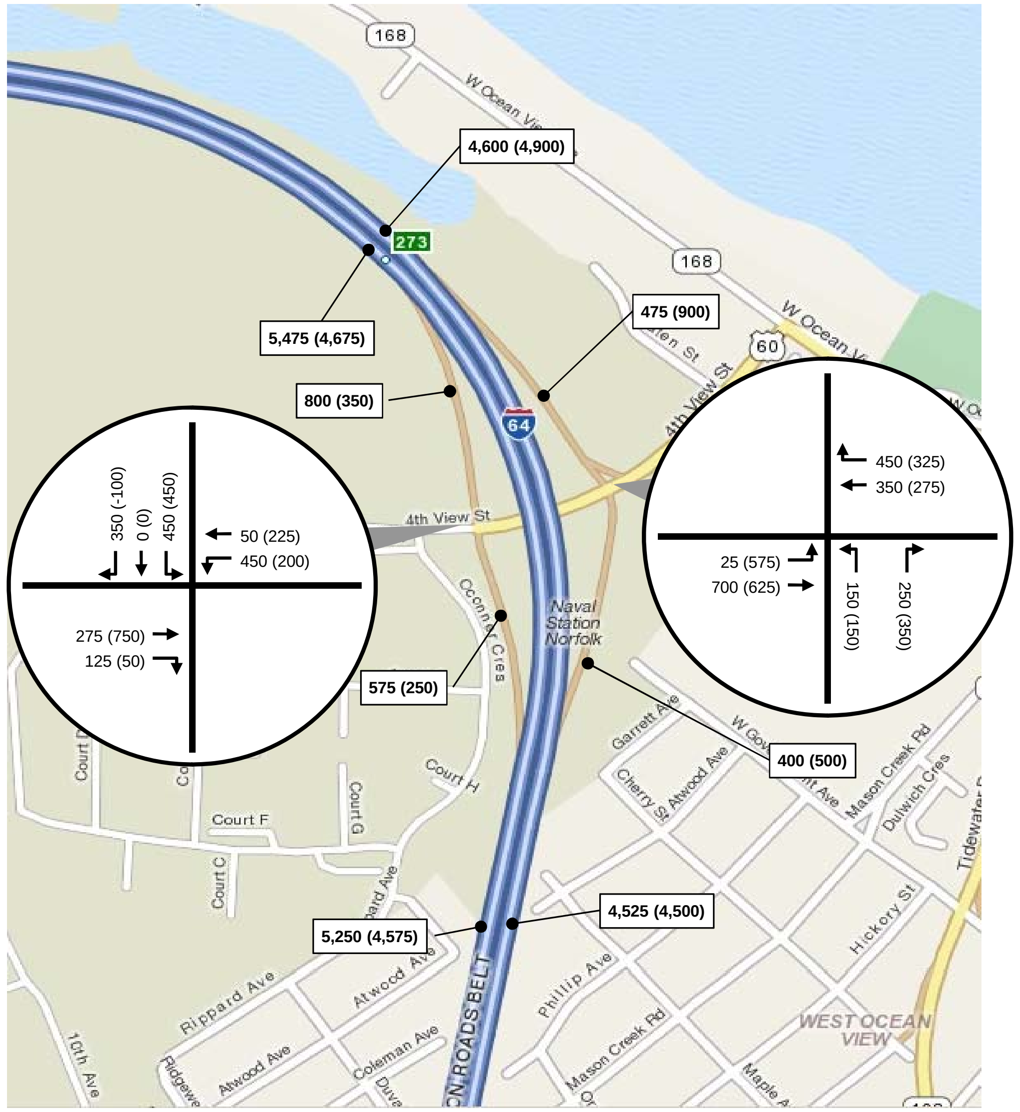
October 12, 2012

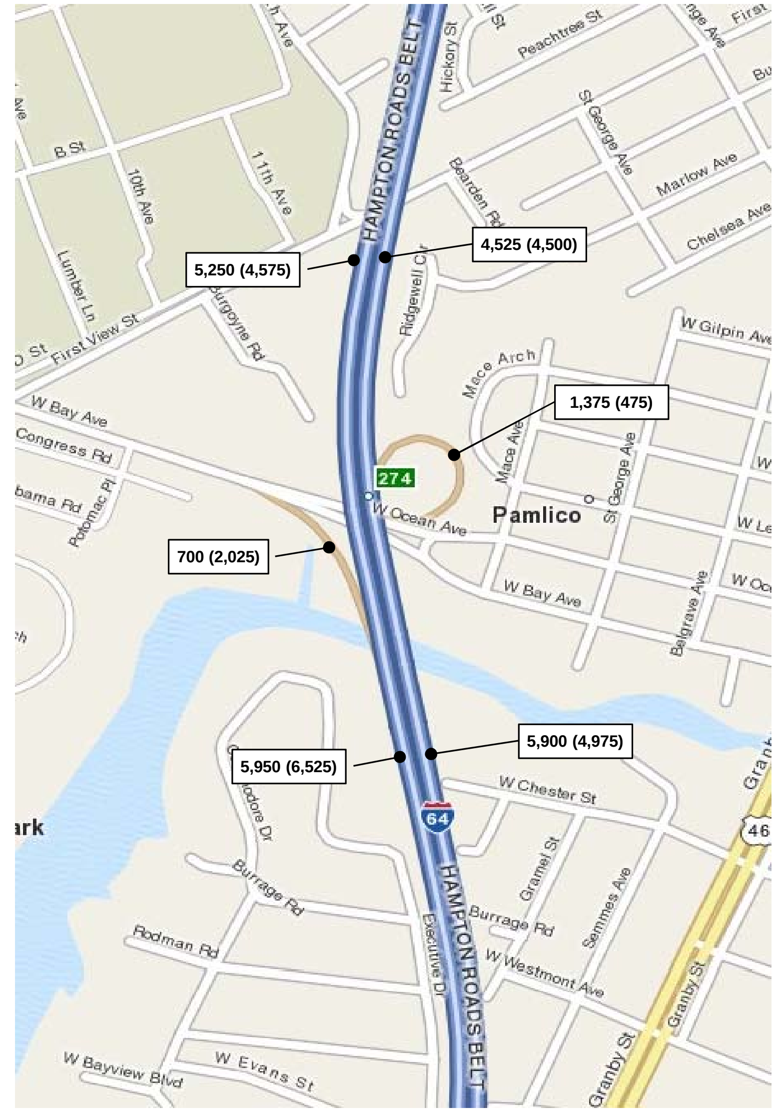
2040 Build 8 - $1 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-2: Sheet 3 of 6

October 12, 2012



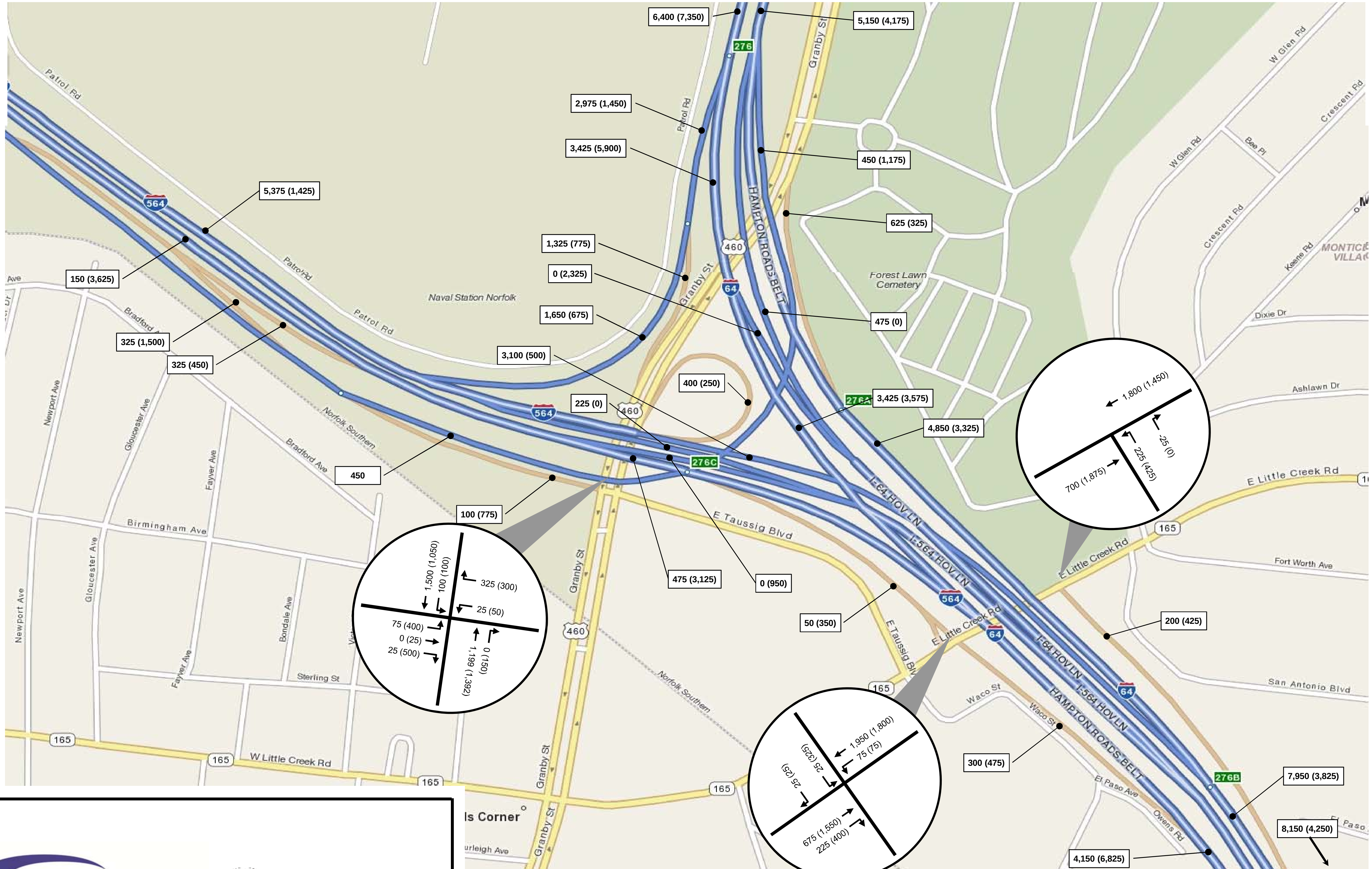


2040 Build 8 - $1 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-2: Sheet 4 of 6

October 12, 2012

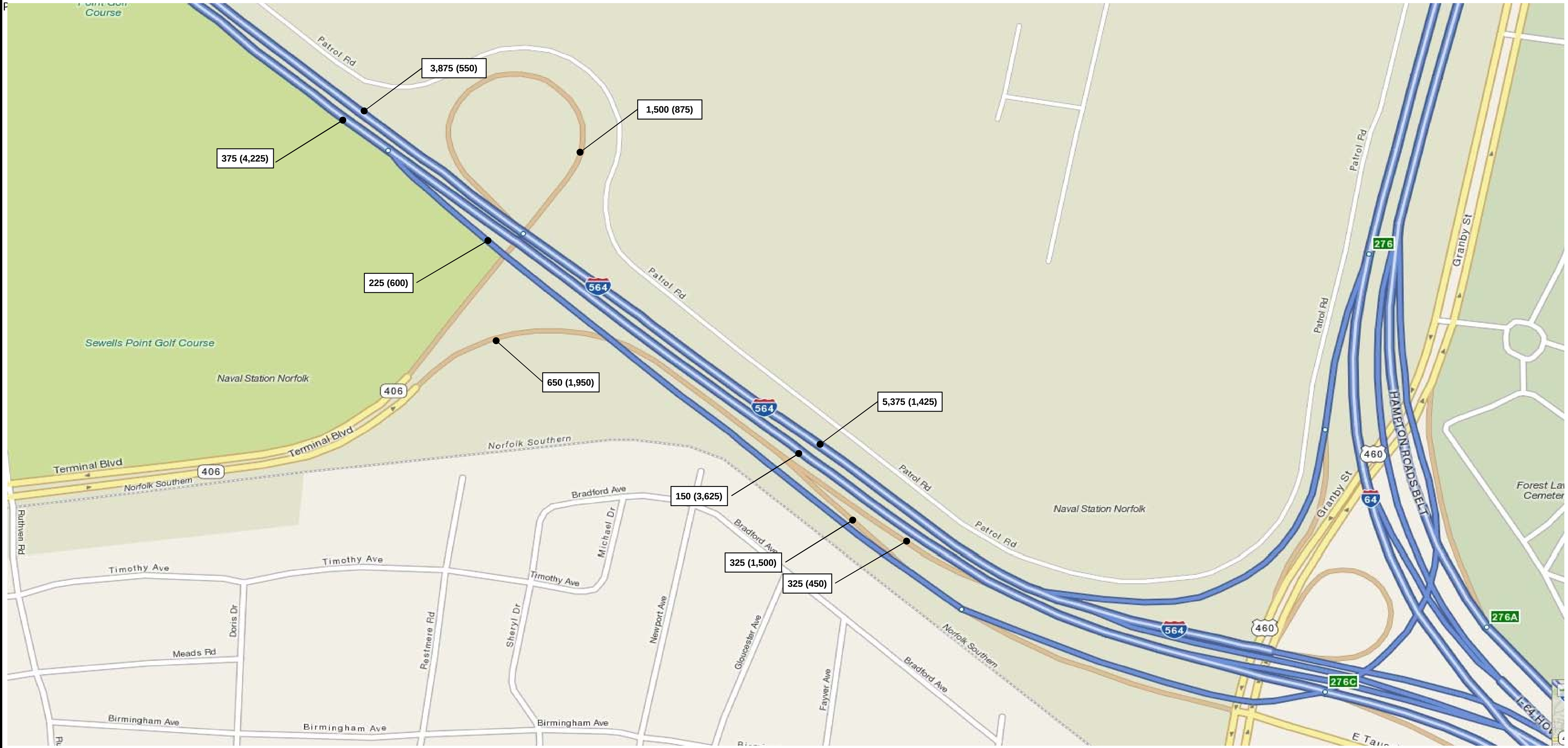


2040 Build 8 - $1 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-2: Sheet 5 of 6

October 12, 2012

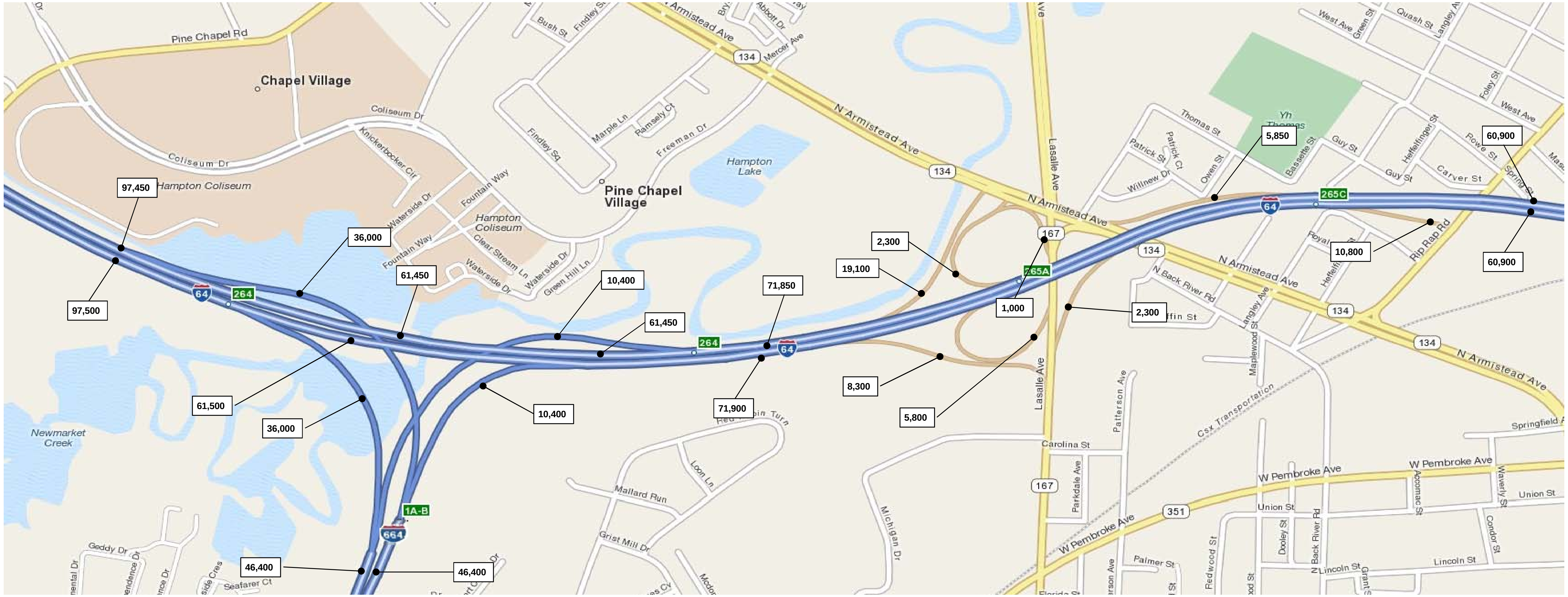


2040 Build 8 - $1 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-2: Sheet 6 of 6

October 12, 2012

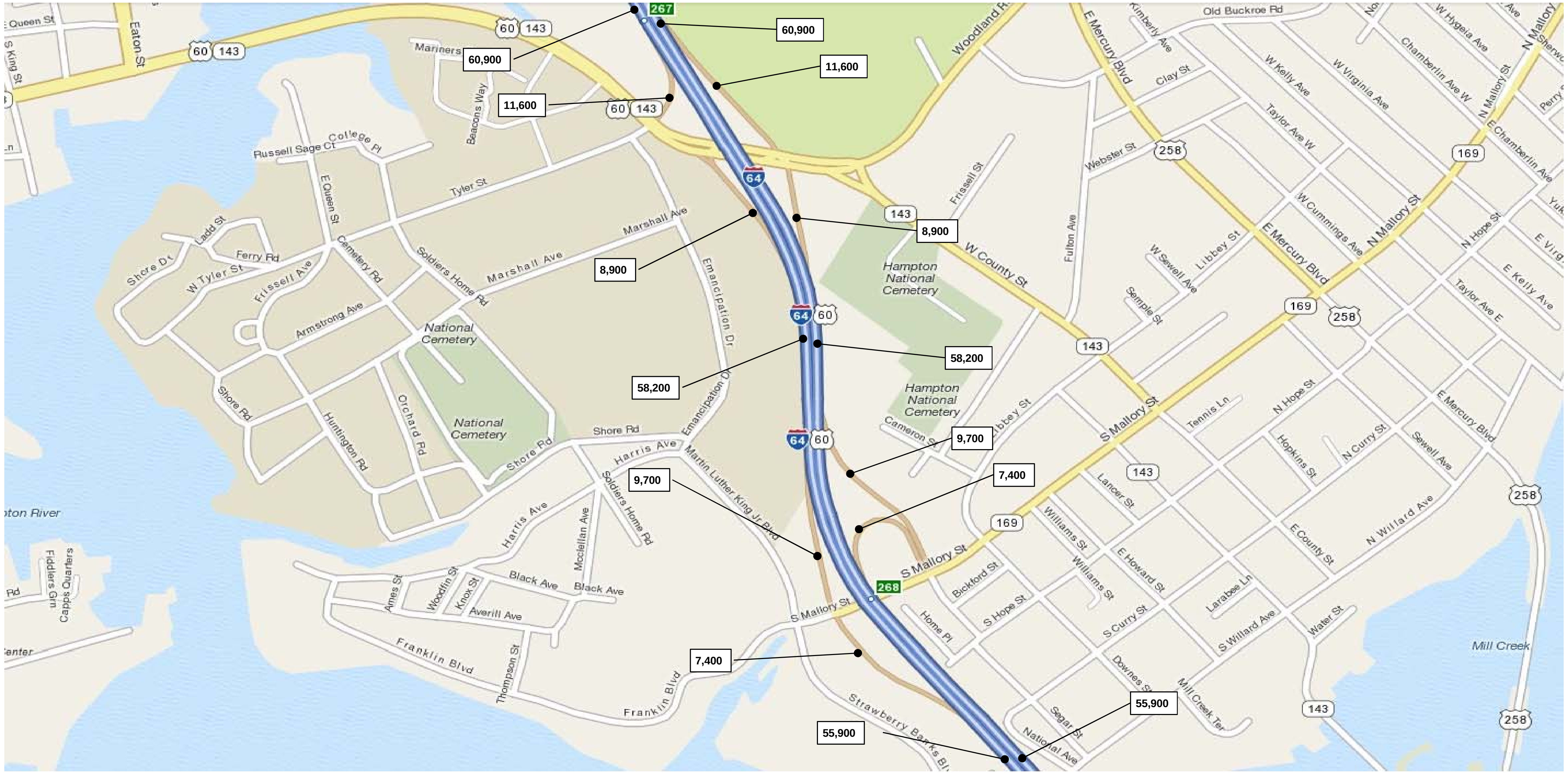


2040 Build 8 - $2 Toll on HRBT

Daily (ADT) Volumes

Figure E-3: Sheet 1 of 6

October 12, 2012



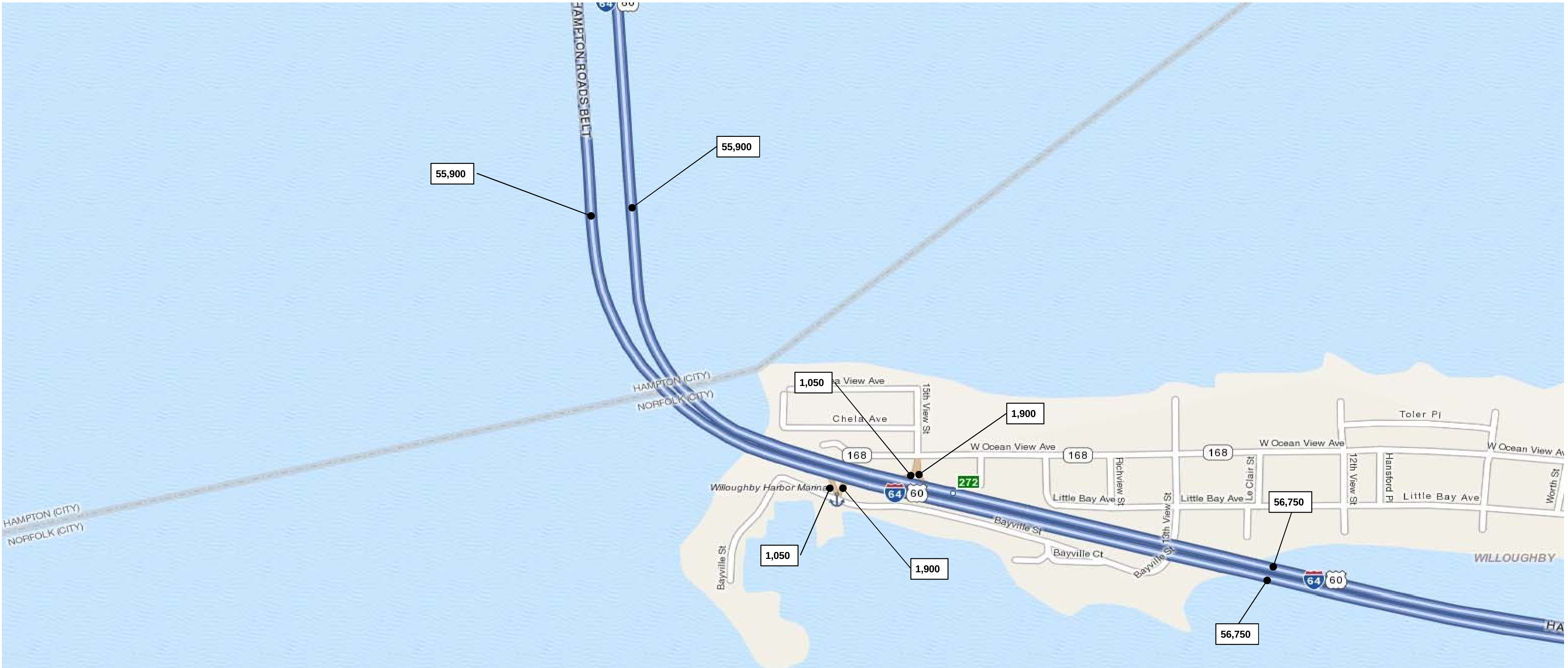
2040 Build 8 - $2 Toll on HRBT
Daily (ADT) Volumes

Figure E-3: Sheet 2 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



2040 Build 8 - $2 Toll on HRBT

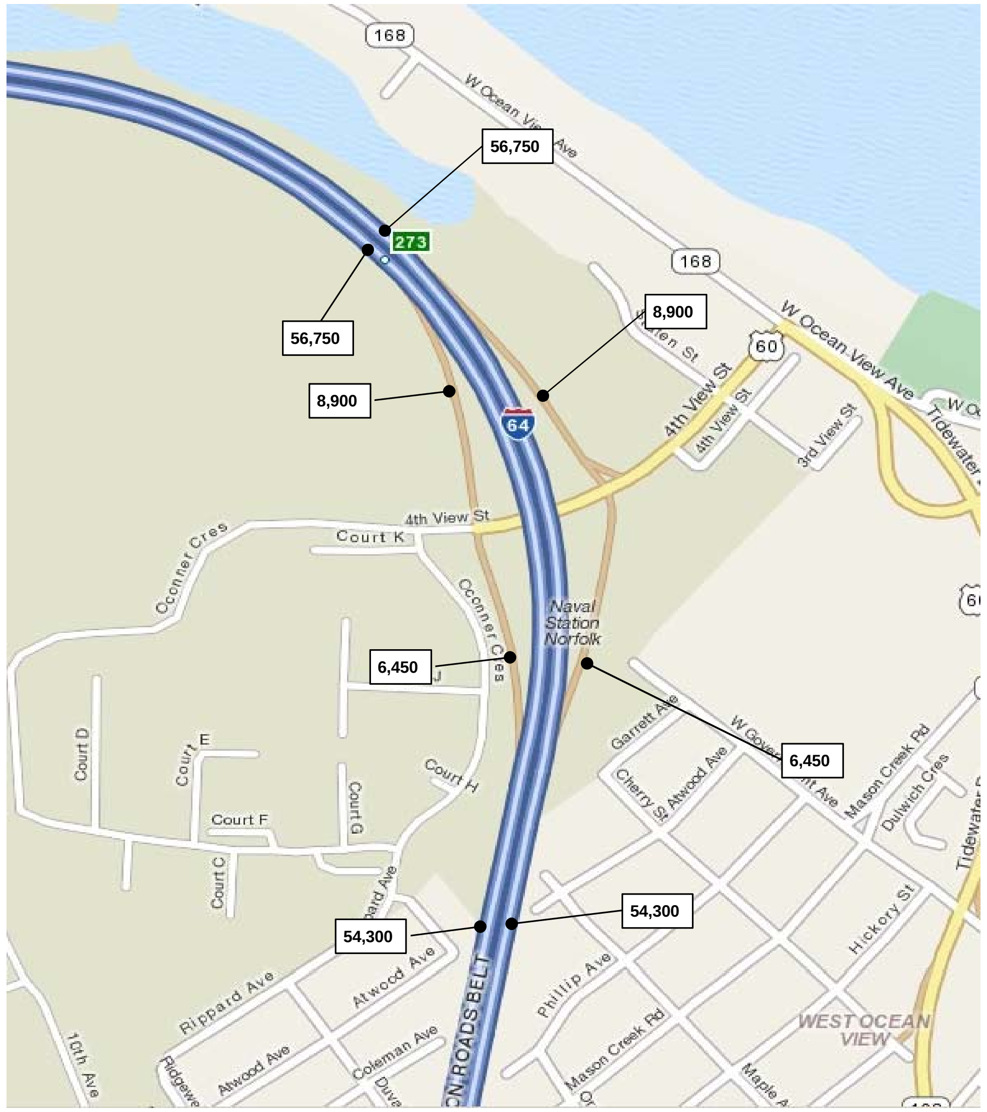
Daily (ADT) Volumes

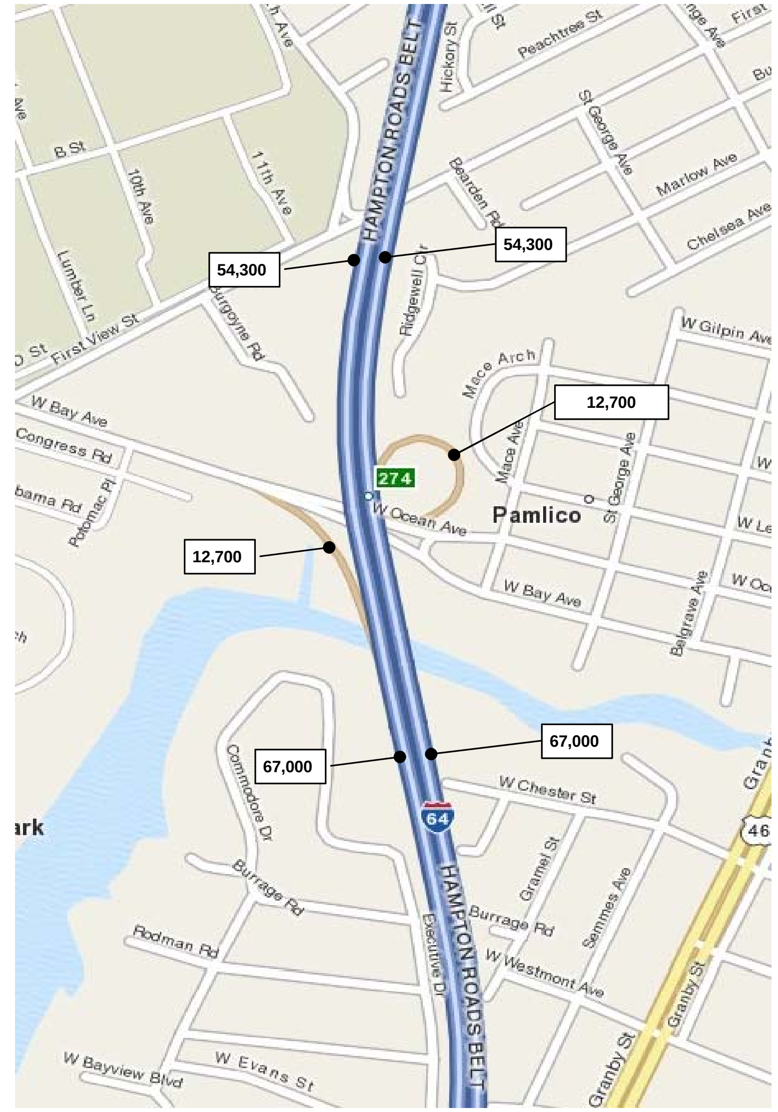
Figure E-3: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation





HRBT Hampton Roads Bridge Tunnel EIS

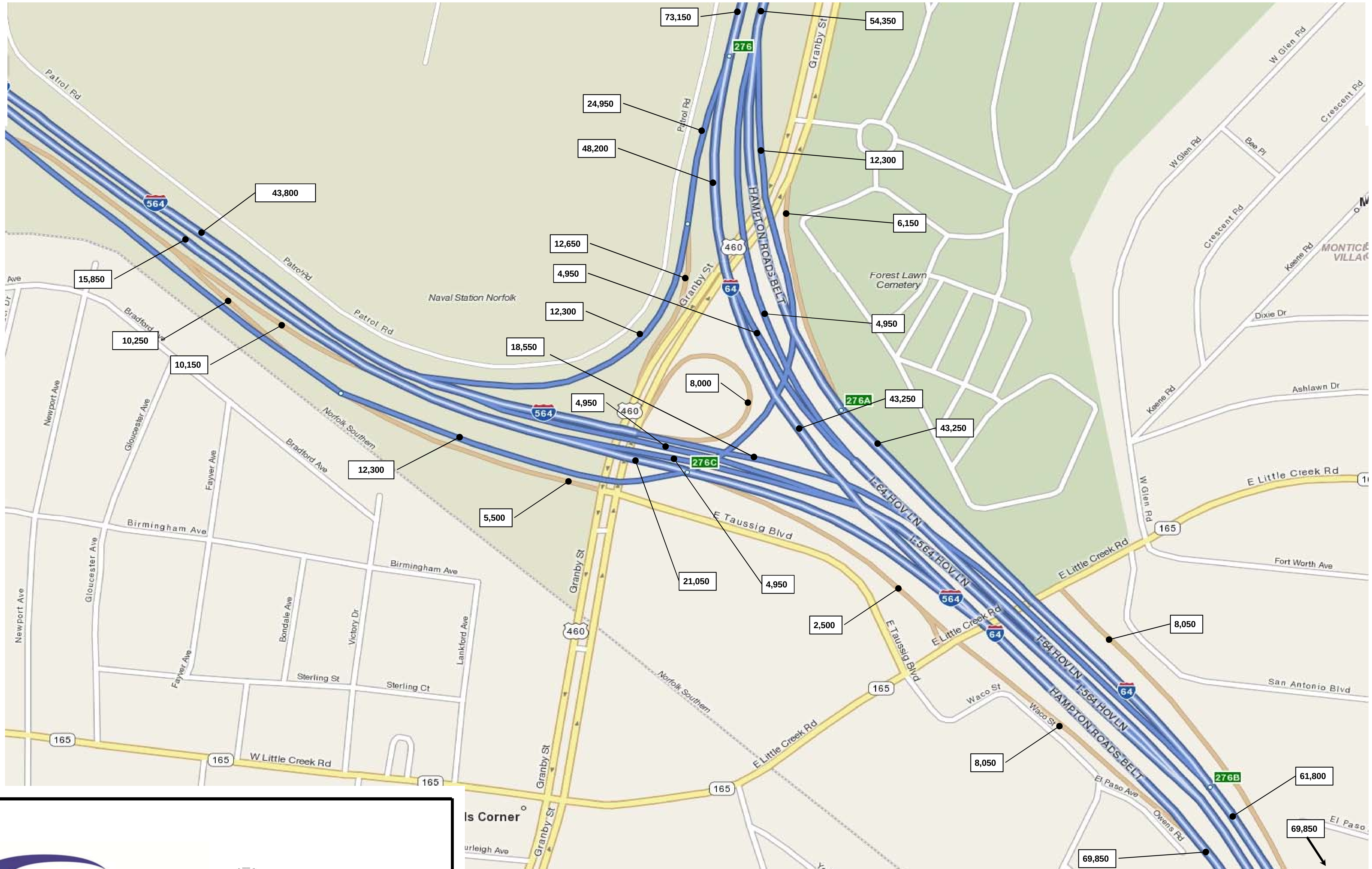
VDOT Virginia Department of Transportation

2040 Build 8 - $2 Toll on HRBT

Daily (ADT) Volumes

Figure E-3: Sheet 4 of 6

October 12, 2012



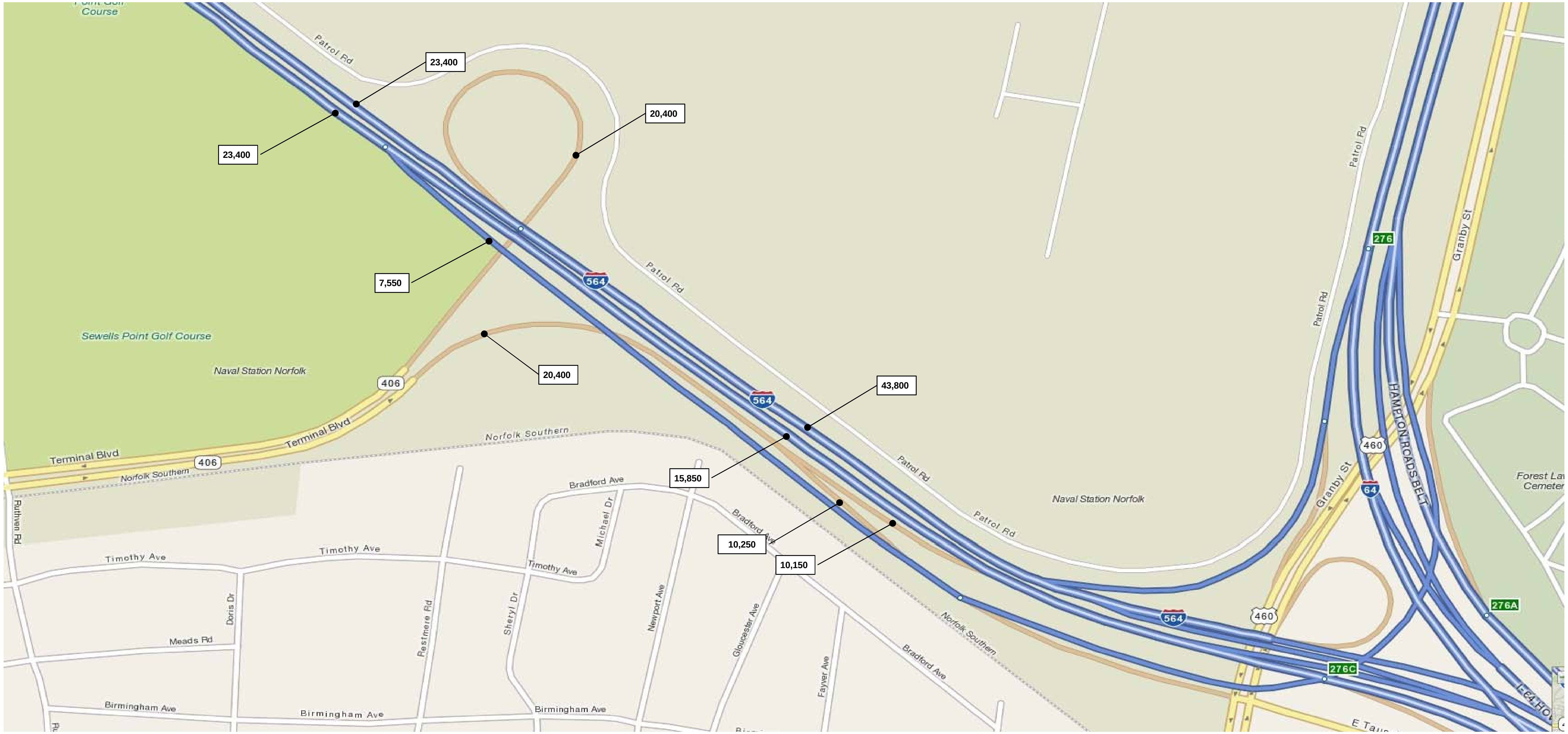
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 - $2 Toll on HRBT
Daily (ADT) Volumes

Figure E-3: Sheet 5 of 6

October 12, 2012



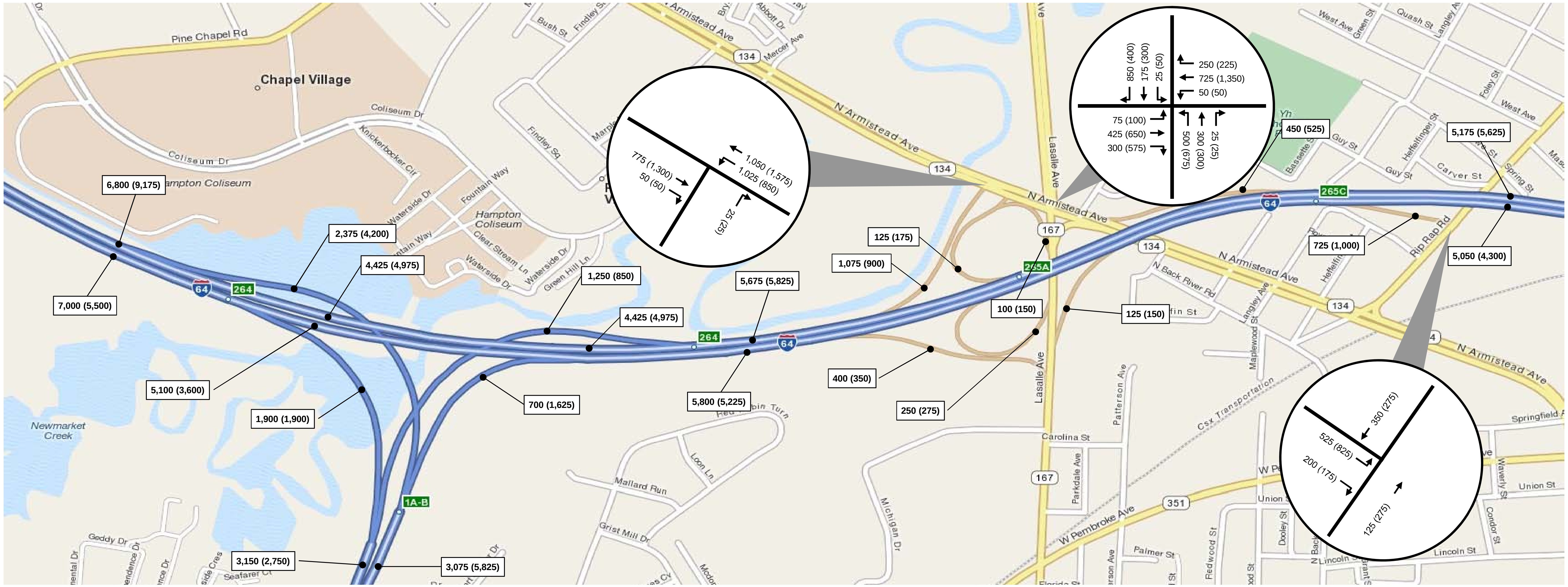
2040 Build 8 - $2 Toll on HRBT
Daily (ADT) Volumes

Figure E-3: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



HRBT Hampton Roads Bridge Tunnel EIS

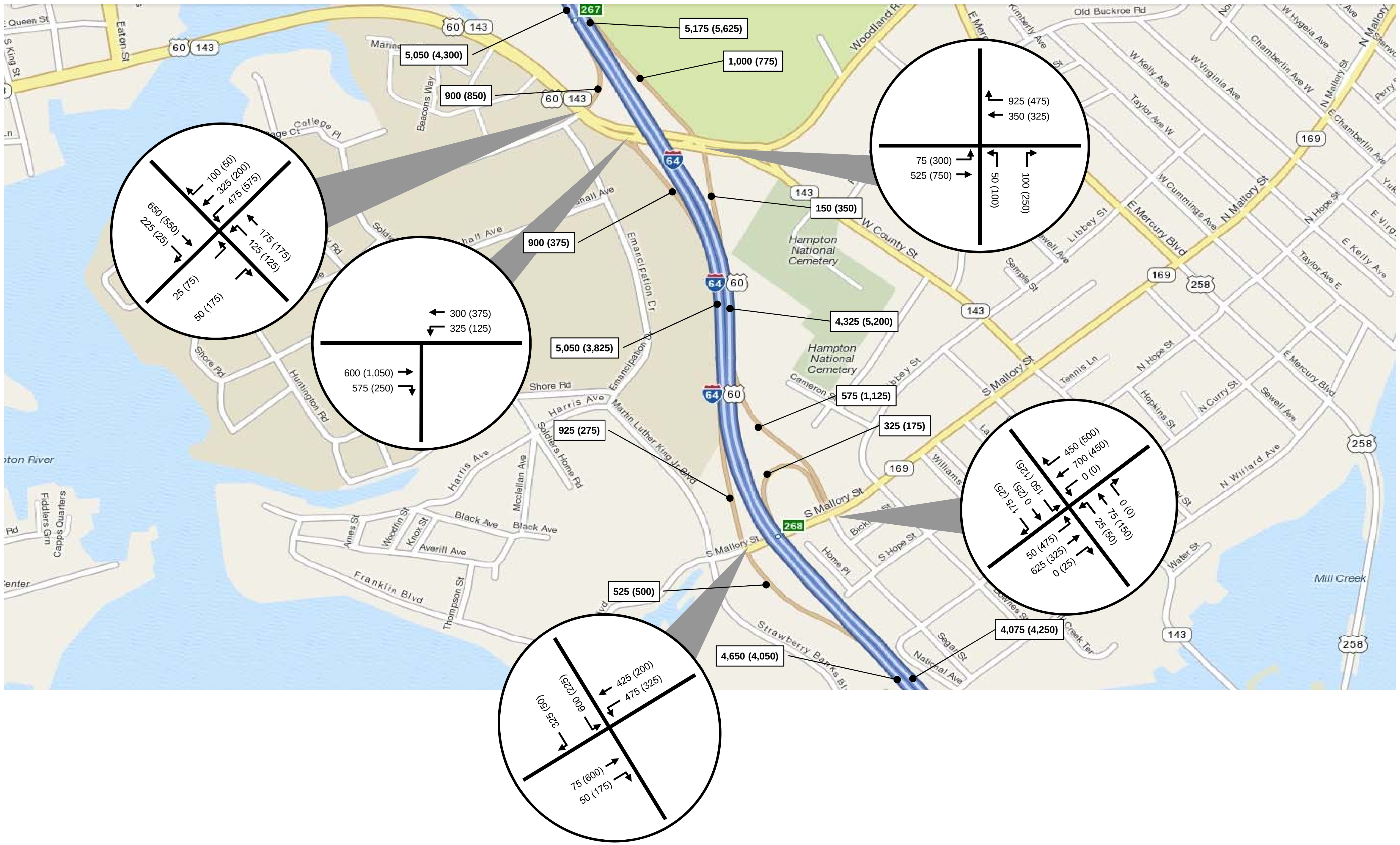
VDOT Virginia Department of Transportation

2040 Build 8 - $2 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-4: Sheet 1 of 6

October 12, 2012



2040 Build 8 - $2 Toll on HRBT

AM (PM) Peak Hour Volumes

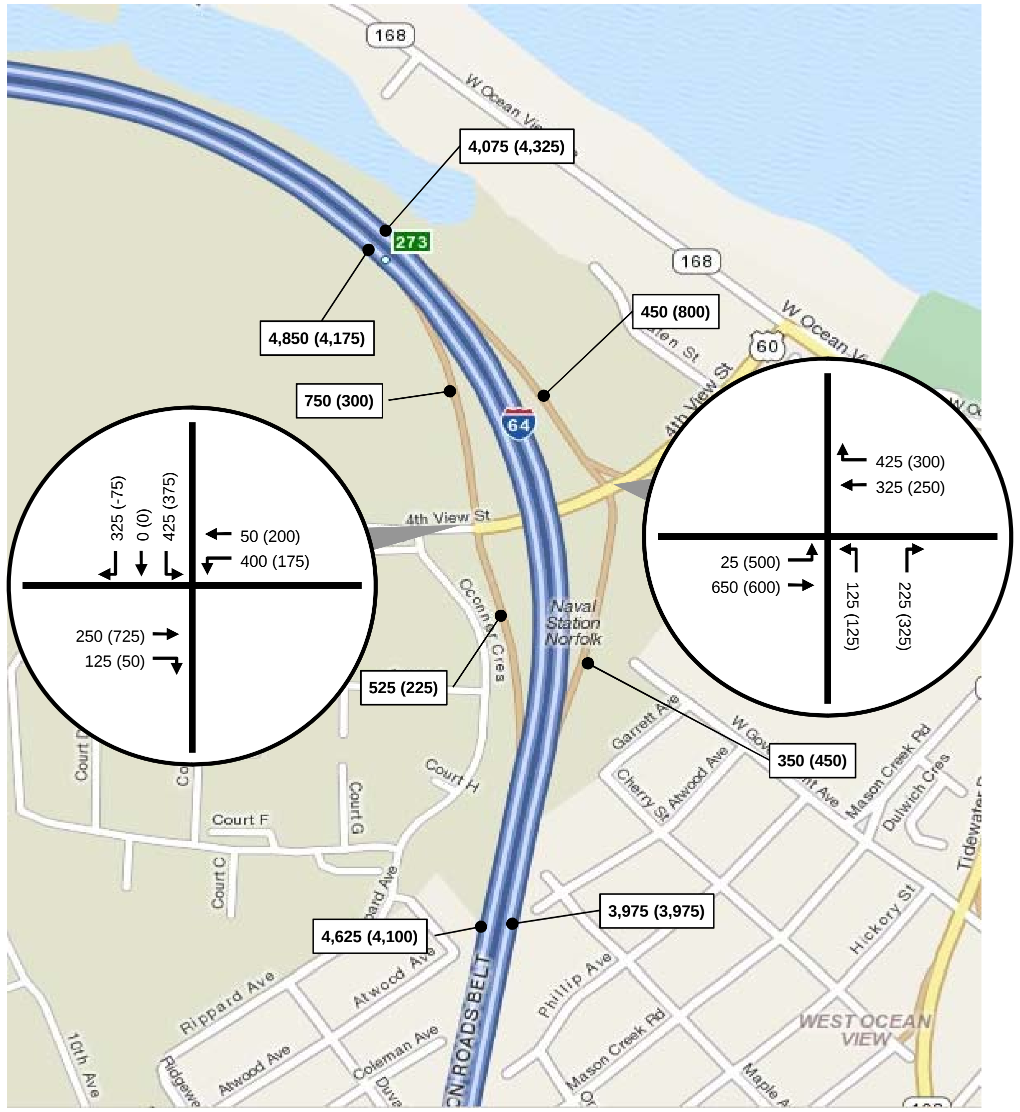
Figure E-4: Sheet 2 of 6

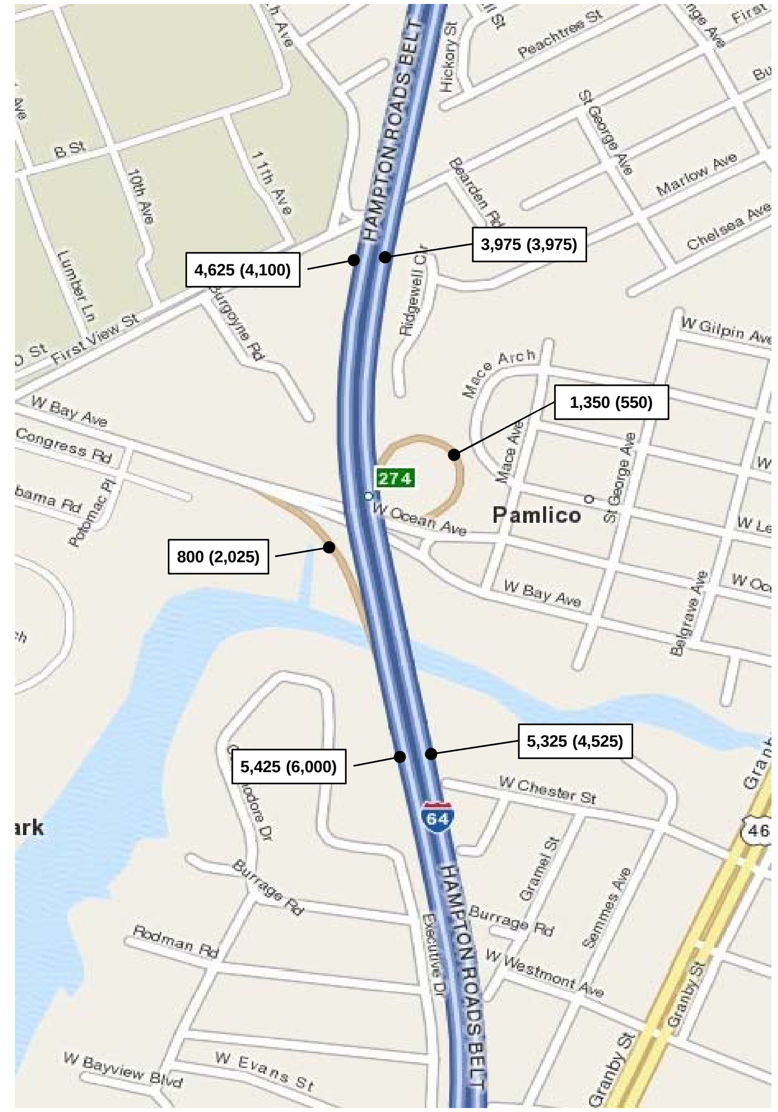
October 12, 2012

2040 Build 8 - $2 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-4: Sheet 3 of 6

October 12, 2012

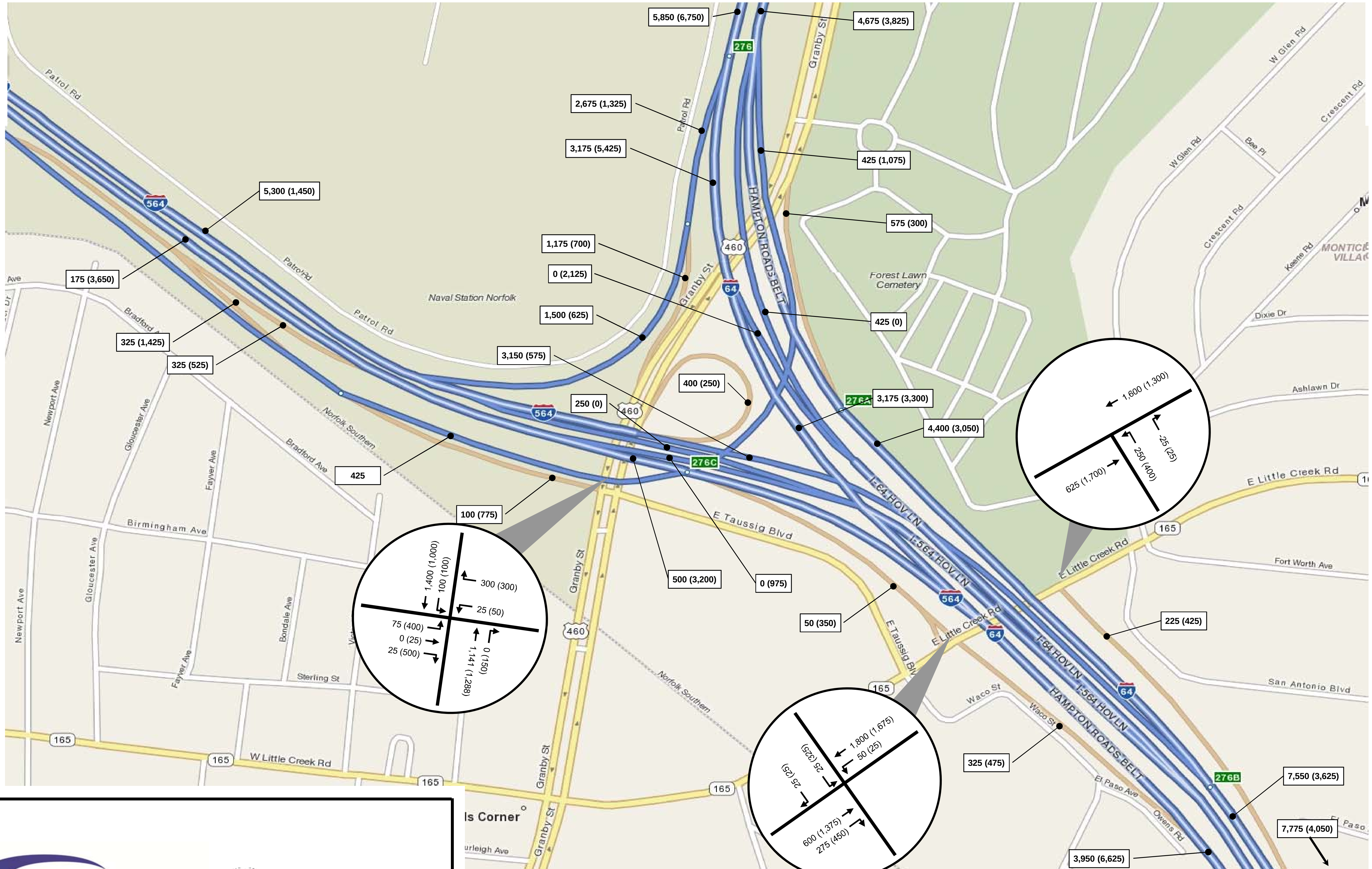




2040 Build 8 - $2 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-4: Sheet 4 of 6

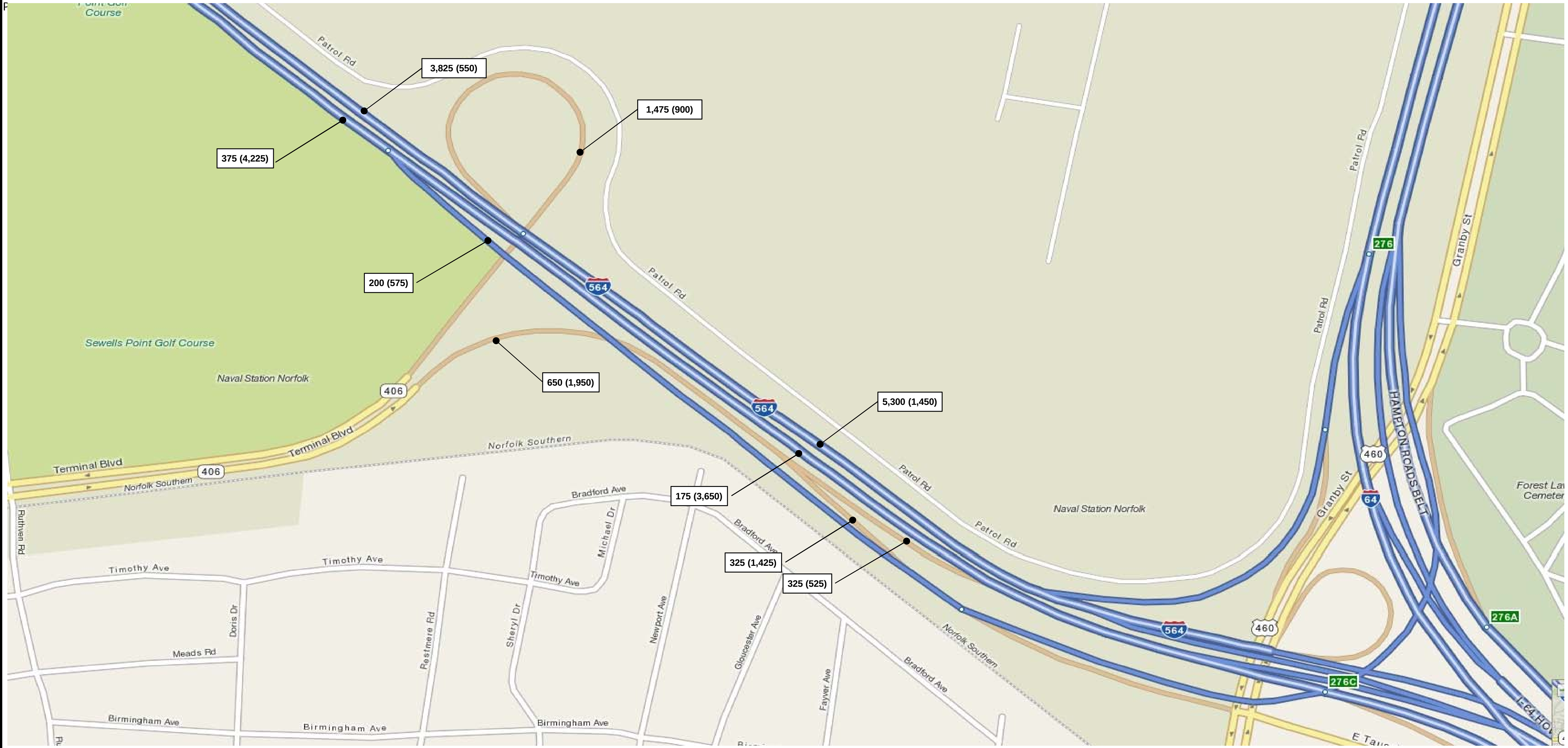
October 12, 2012



2040 Build 8 - $2 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-4: Sheet 5 of 6

October 12, 2012

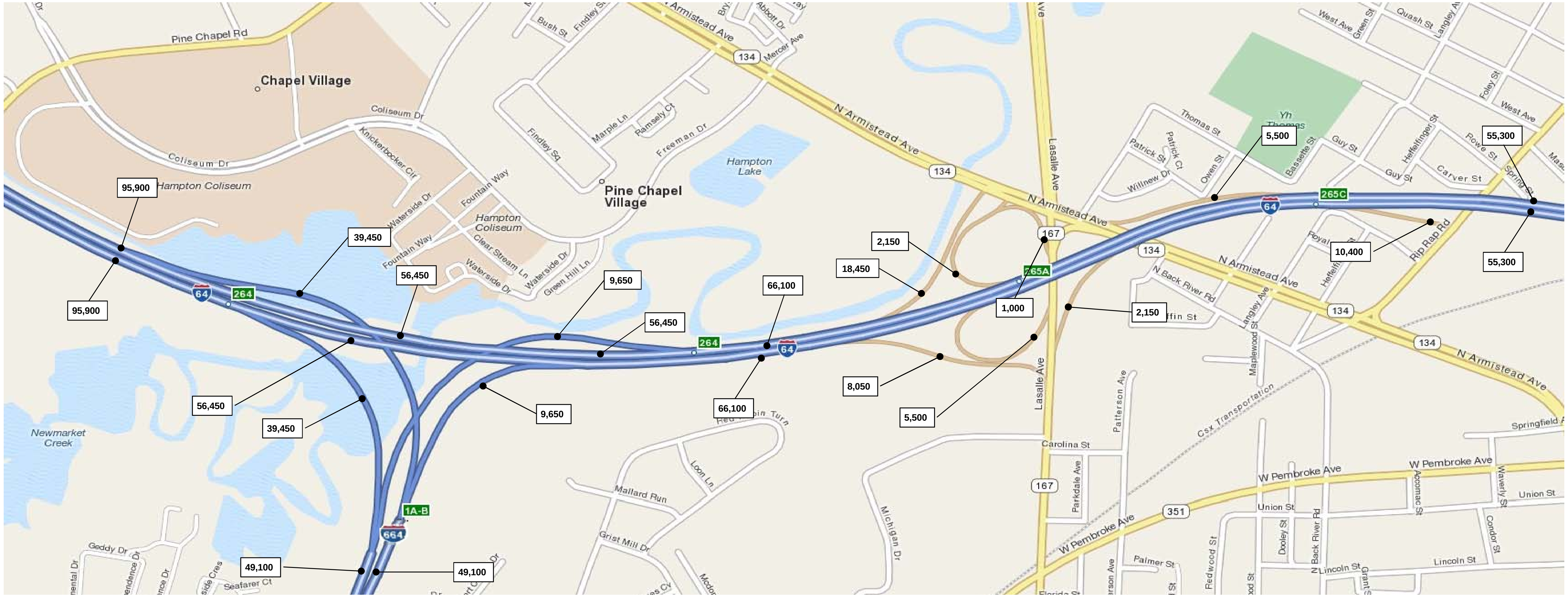


2040 Build 8 - $2 Toll on HRBT

AM (PM) Peak Hour Volumes

Figure E-4: Sheet 6 of 6

October 12, 2012



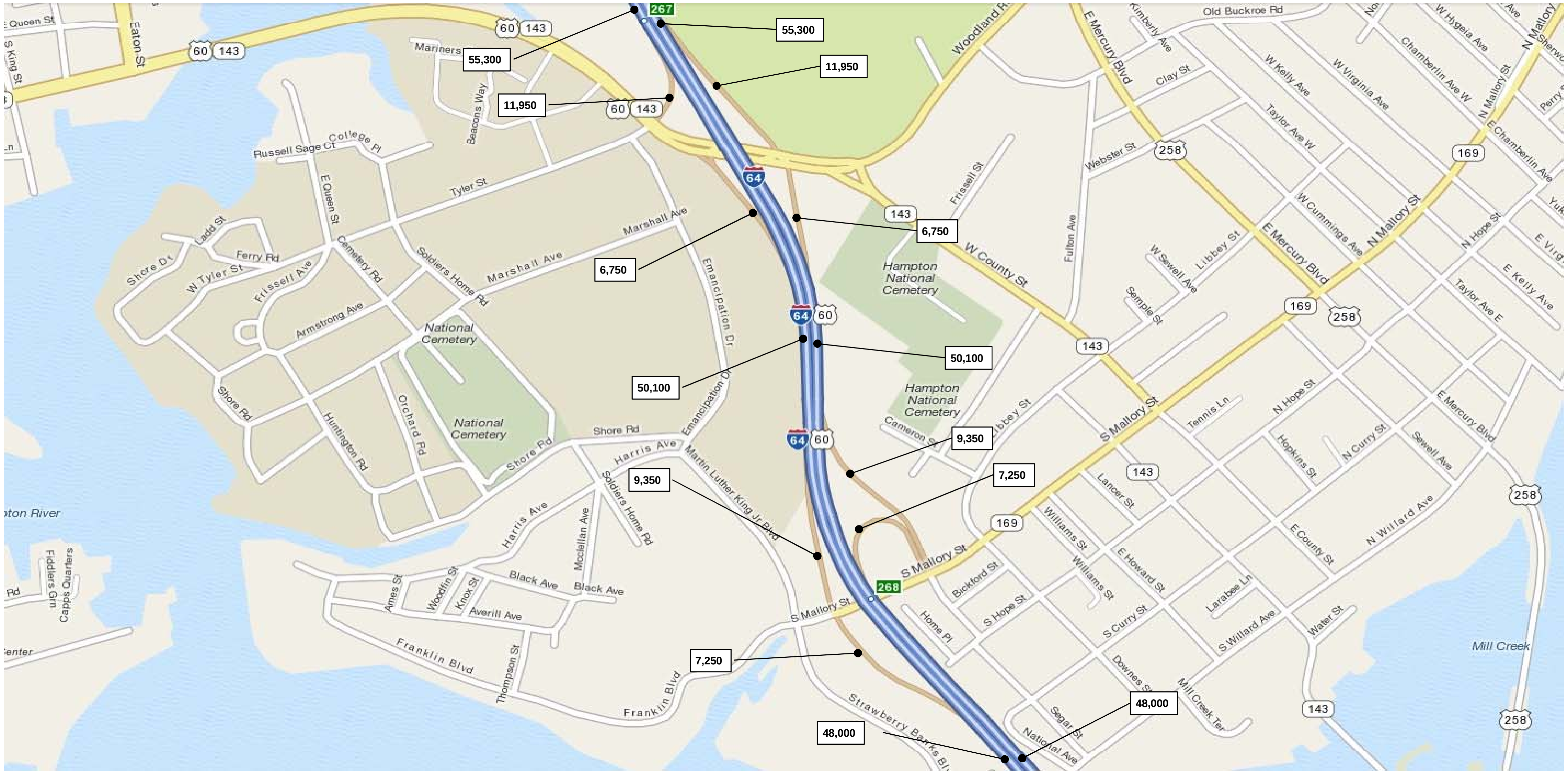
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 - $3 Toll on HRBT
Daily (ADT) Volumes

Figure E-5: Sheet 1 of 6

October 12, 2012

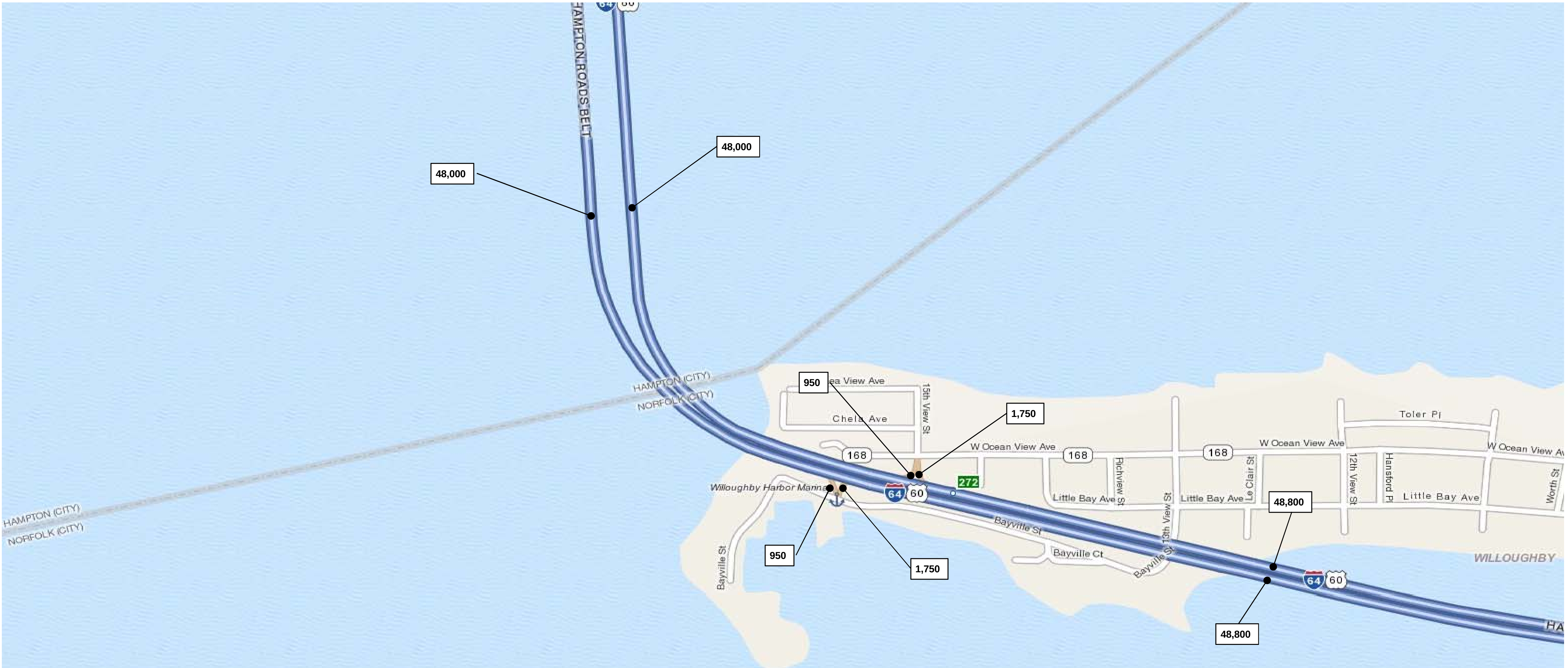


Hampton Roads Bridge Tunnel EIS

2040 Build 8 - $3 Toll on HRBT
Daily (ADT) Volumes

Figure E-5: Sheet 2 of 6

October 12, 2012



2040 Build 8 - $3 Toll on HRBT

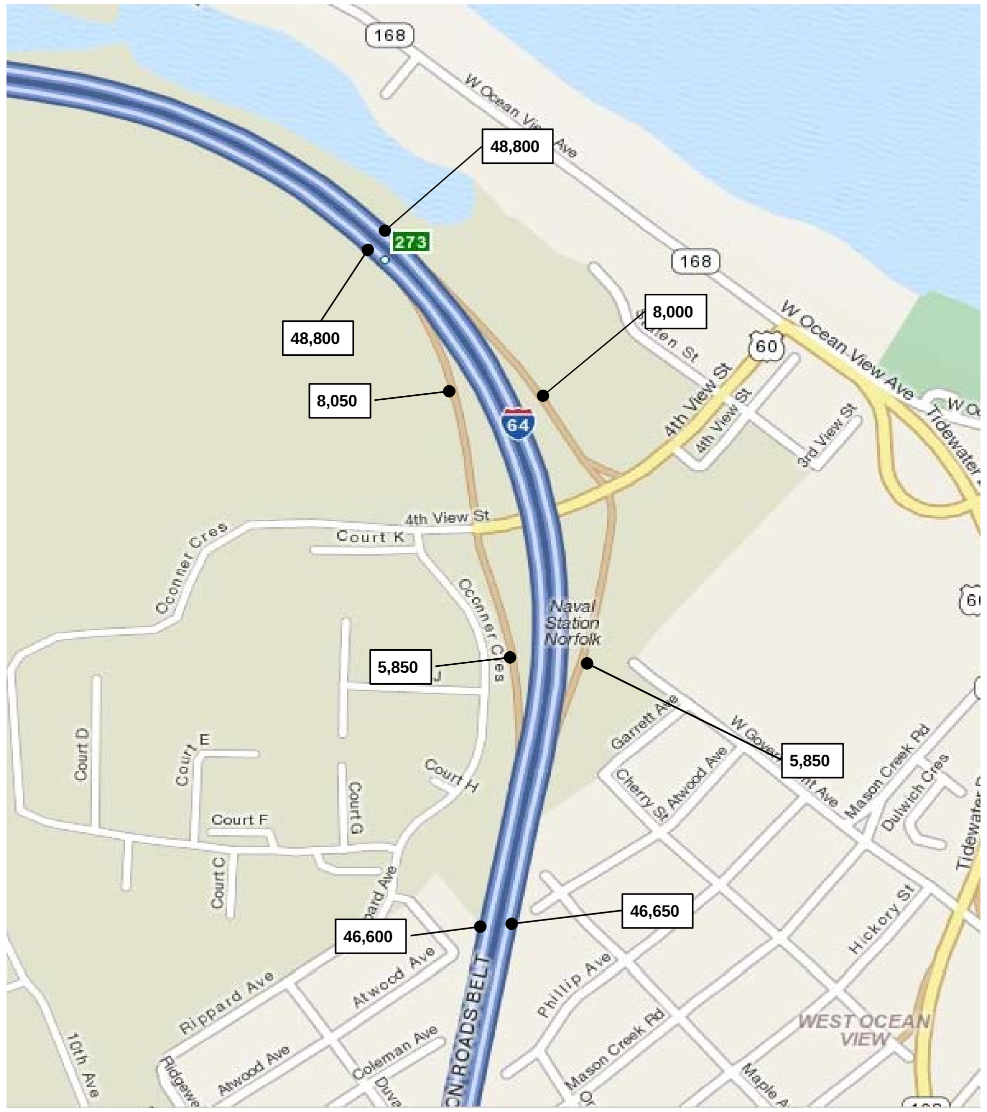
Daily (ADT) Volumes

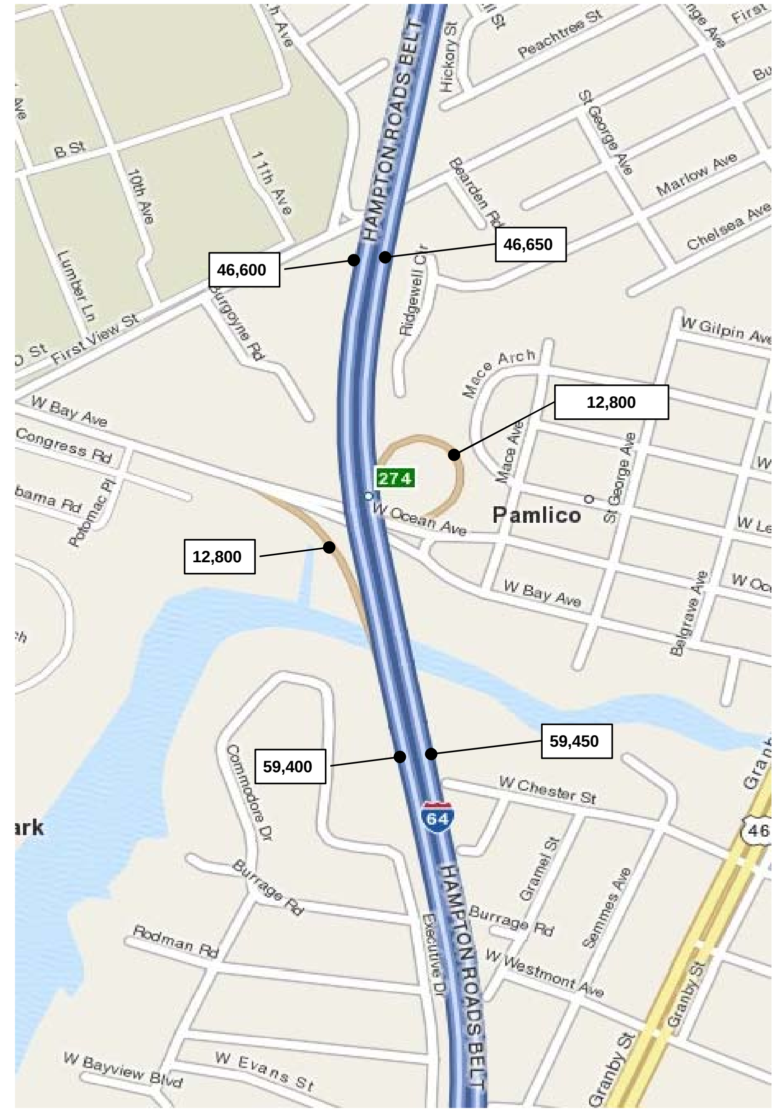
Figure E-5: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

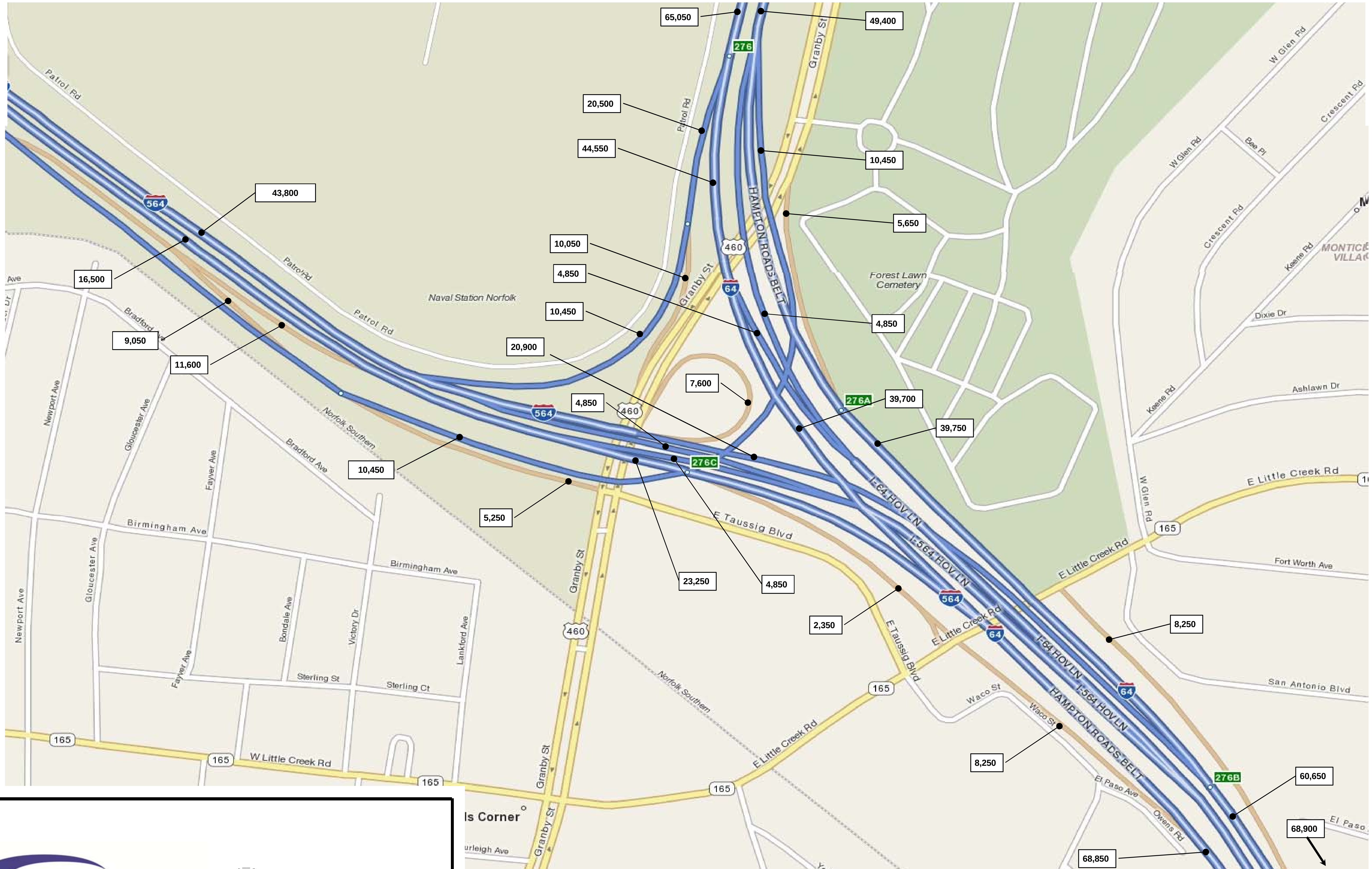




2040 Build 8 - $3 Toll on HRBT
Daily (ADT) Volumes

Figure E-5: Sheet 4 of 6

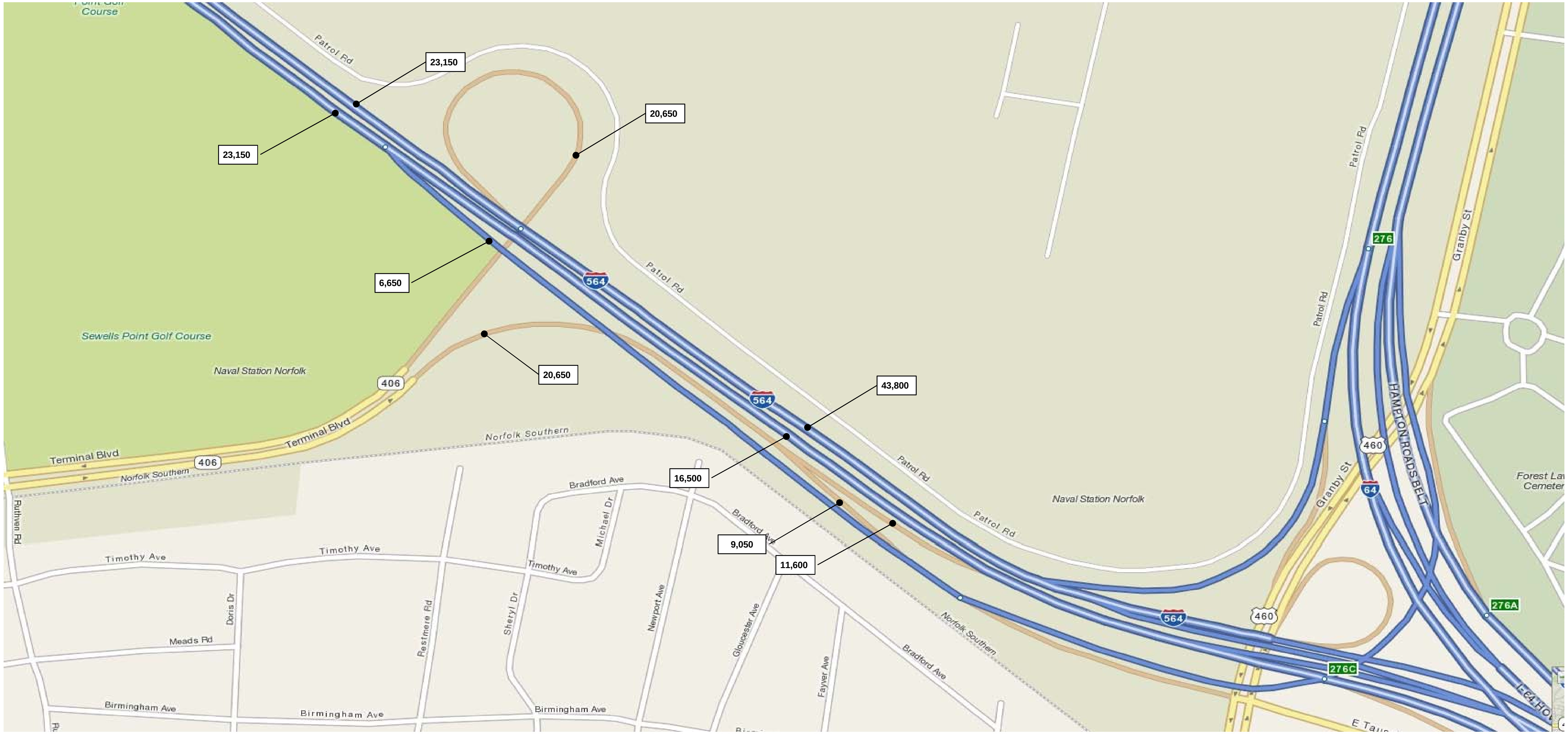
October 12, 2012



2040 Build 8 - $3 Toll on HRBT
Daily (ADT) Volumes

Figure E-5: Sheet 5 of 6

October 12, 2012

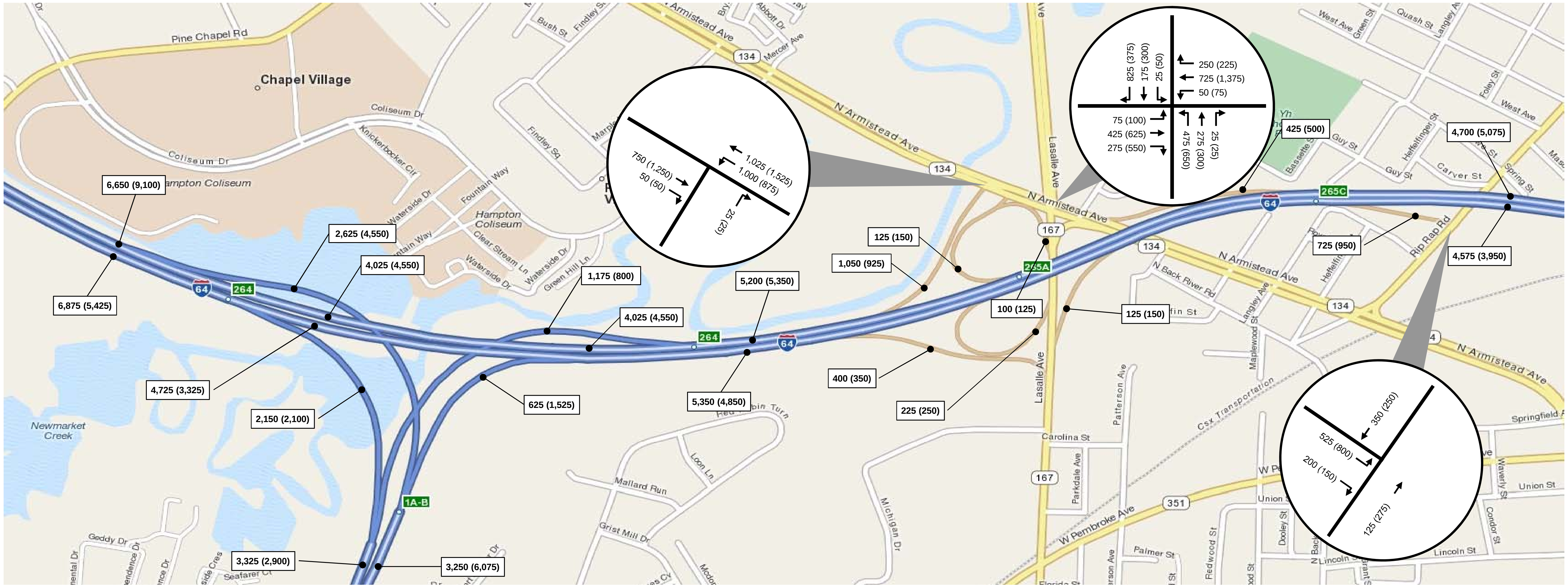


2040 Build 8 - $3 Toll on HRBT

Daily (ADT) Volumes

Figure E-5: Sheet 6 of 6

October 12, 2012



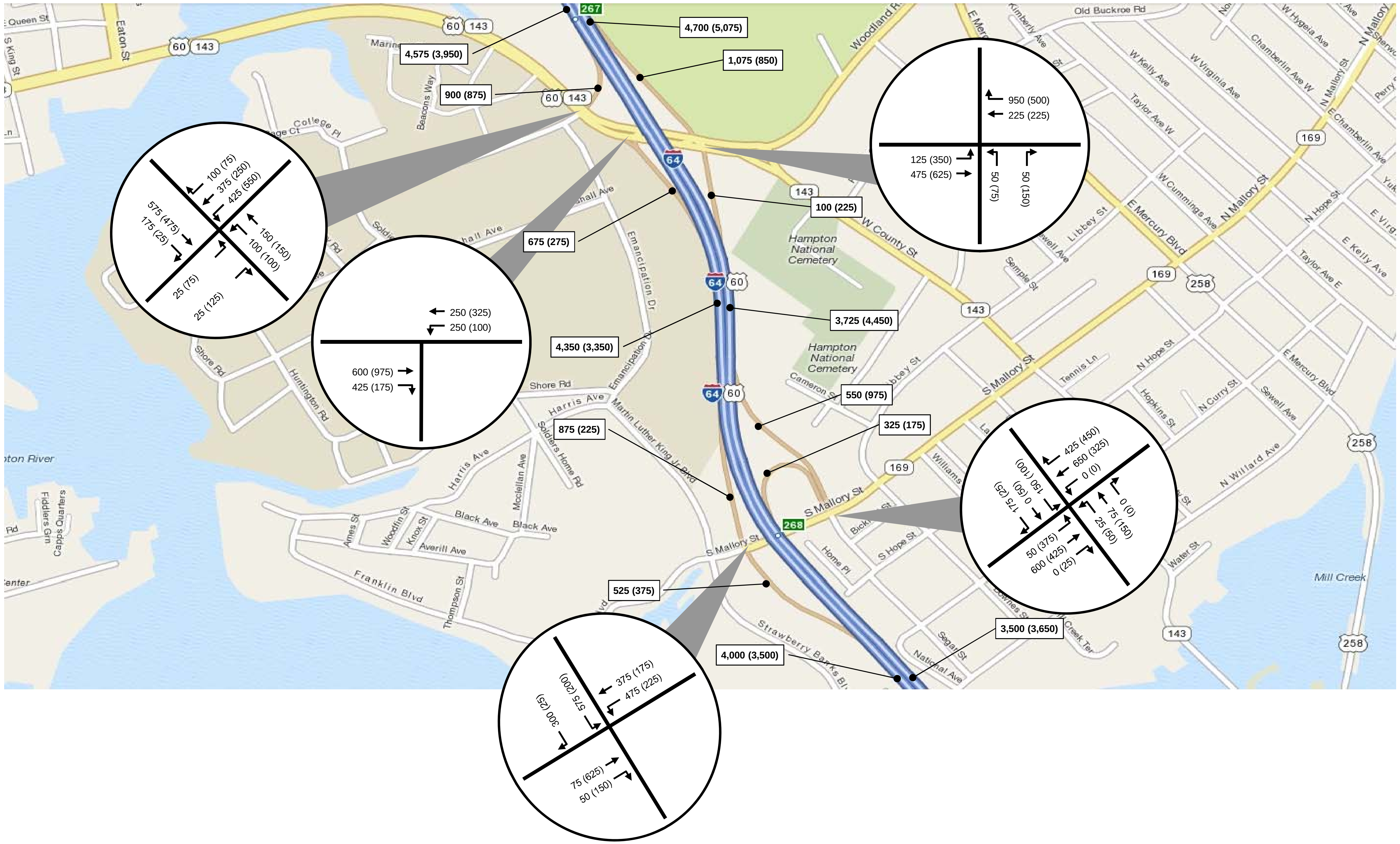
2040 Build 8 - $3 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-6: Sheet 1 of 6

October 12, 2012

HRBT
Hampton Roads Bridge Tunnel EIS

VDOT
Virginia Department of Transportation



HRBT
Hampton Roads Bridge Tunnel EIS

VDOT
Virginia Department of Transportation

2040 Build 8 - $3 Toll on HRBT
AM (PM) Peak Hour Volumes

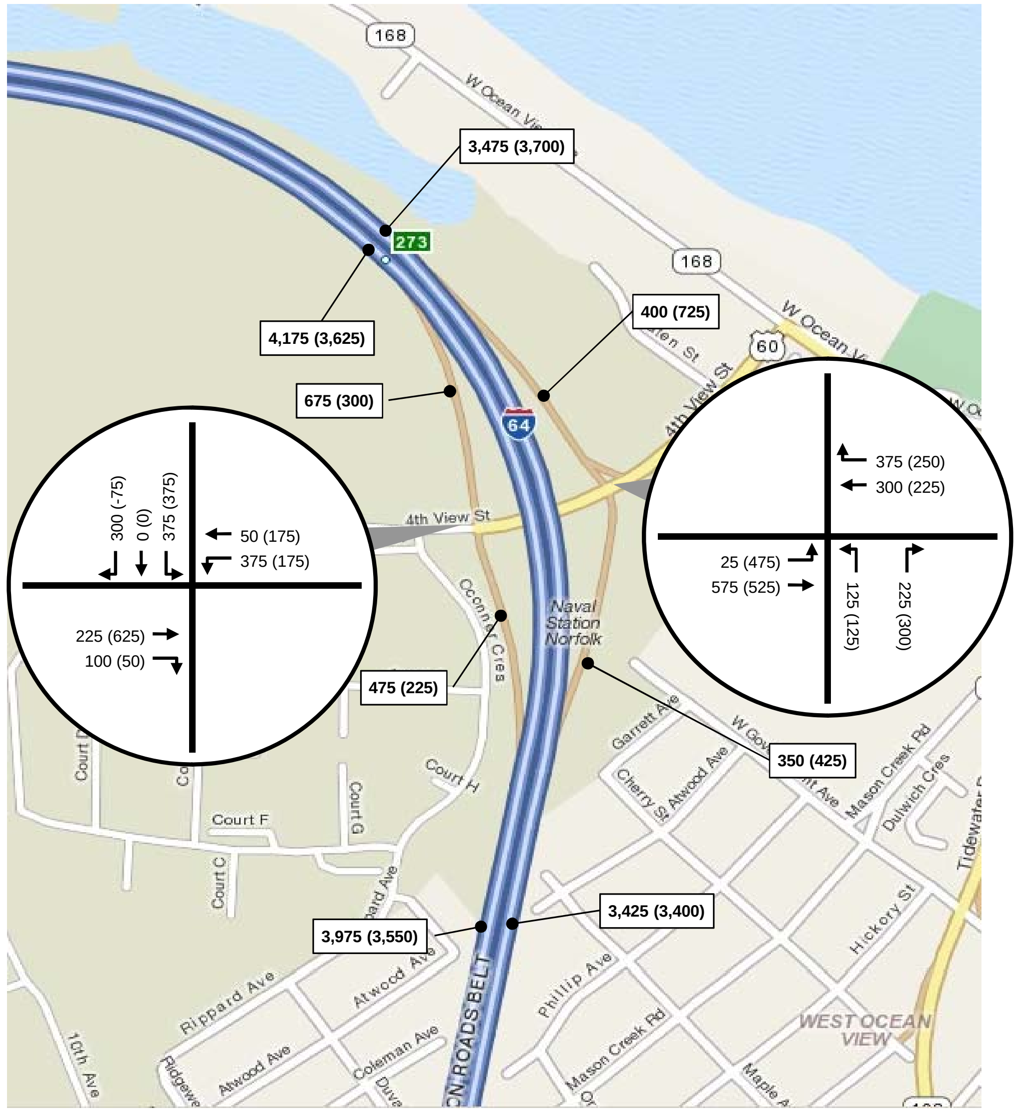
Figure E-6: Sheet 2 of 6

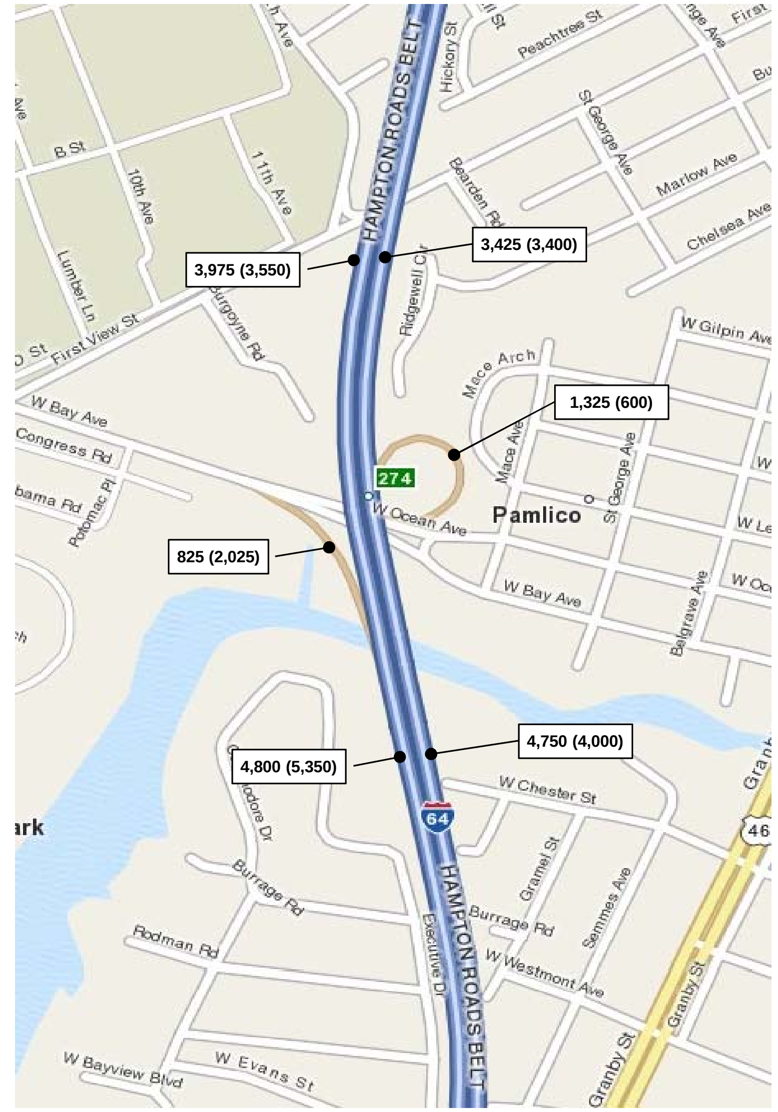
October 12, 2012

2040 Build 8 - $3 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-6: Sheet 3 of 6

October 12, 2012





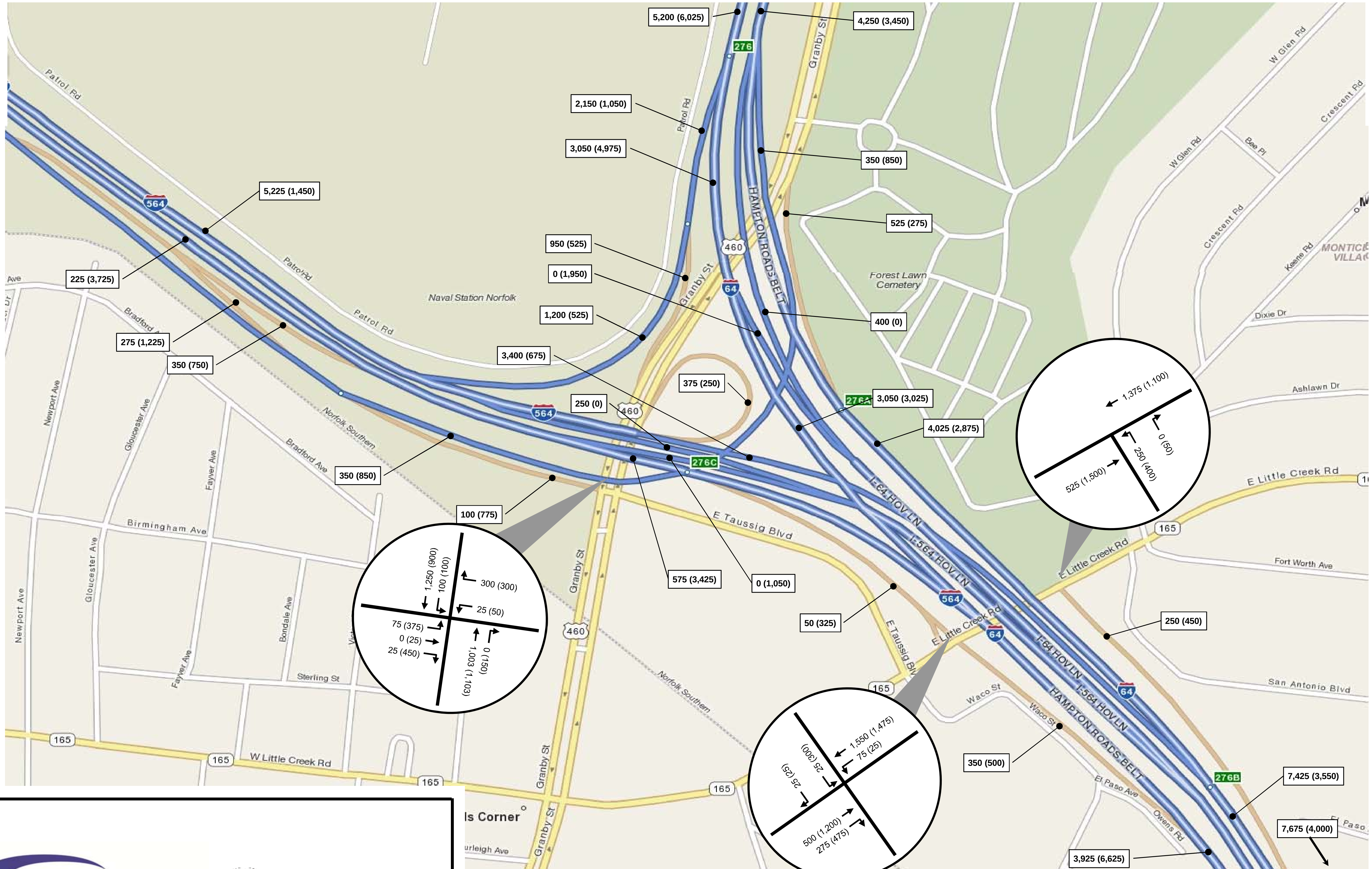
HRBT
Hampton Roads Bridge Tunnel EIS

VDOT

2040 Build 8 - $3 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-6: Sheet 4 of 6

October 12, 2012



2040 Build 8 - $3 Toll on HRBT
AM (PM) Peak Hour Volumes

Figure E-6: Sheet 5 of 6

October 12, 2012

2040 Build 8 - $3 Toll on HRBT

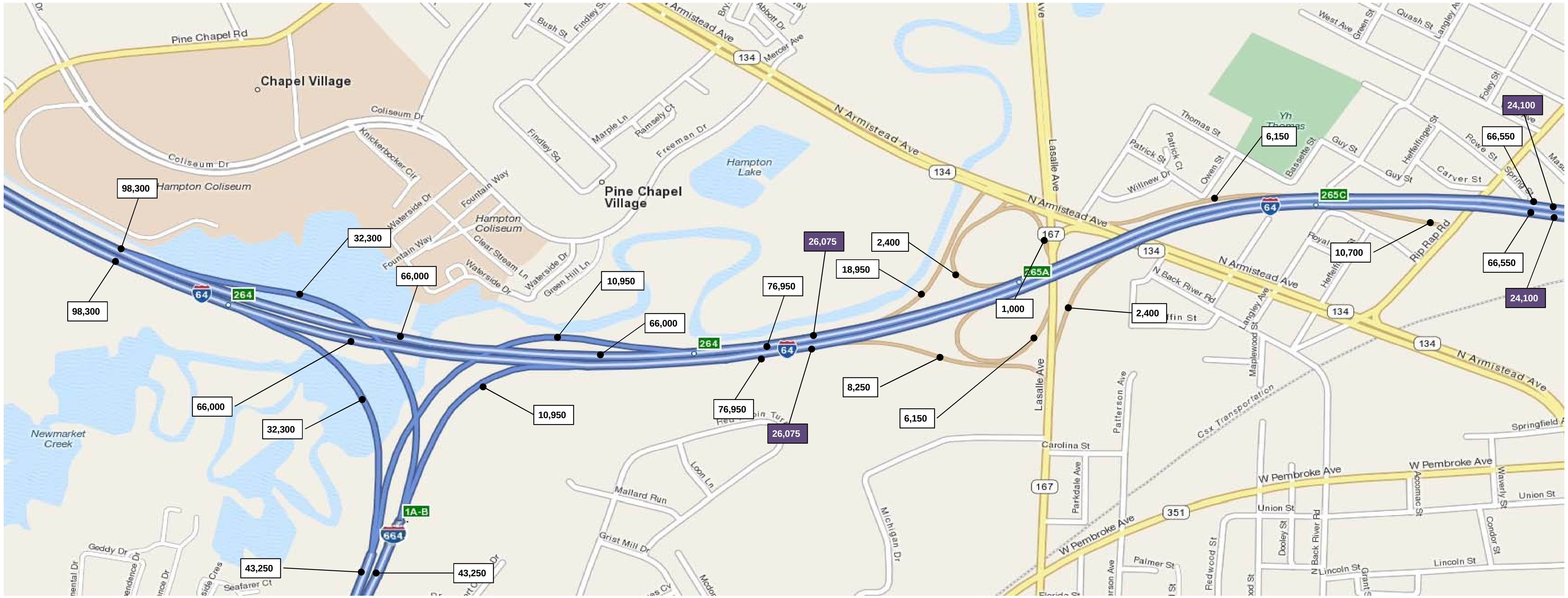
AM (PM) Peak Hour Volumes

Figure E-6: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

2040 Build 8 Managed - 2GP + 2HOV

Daily (ADT) Volumes

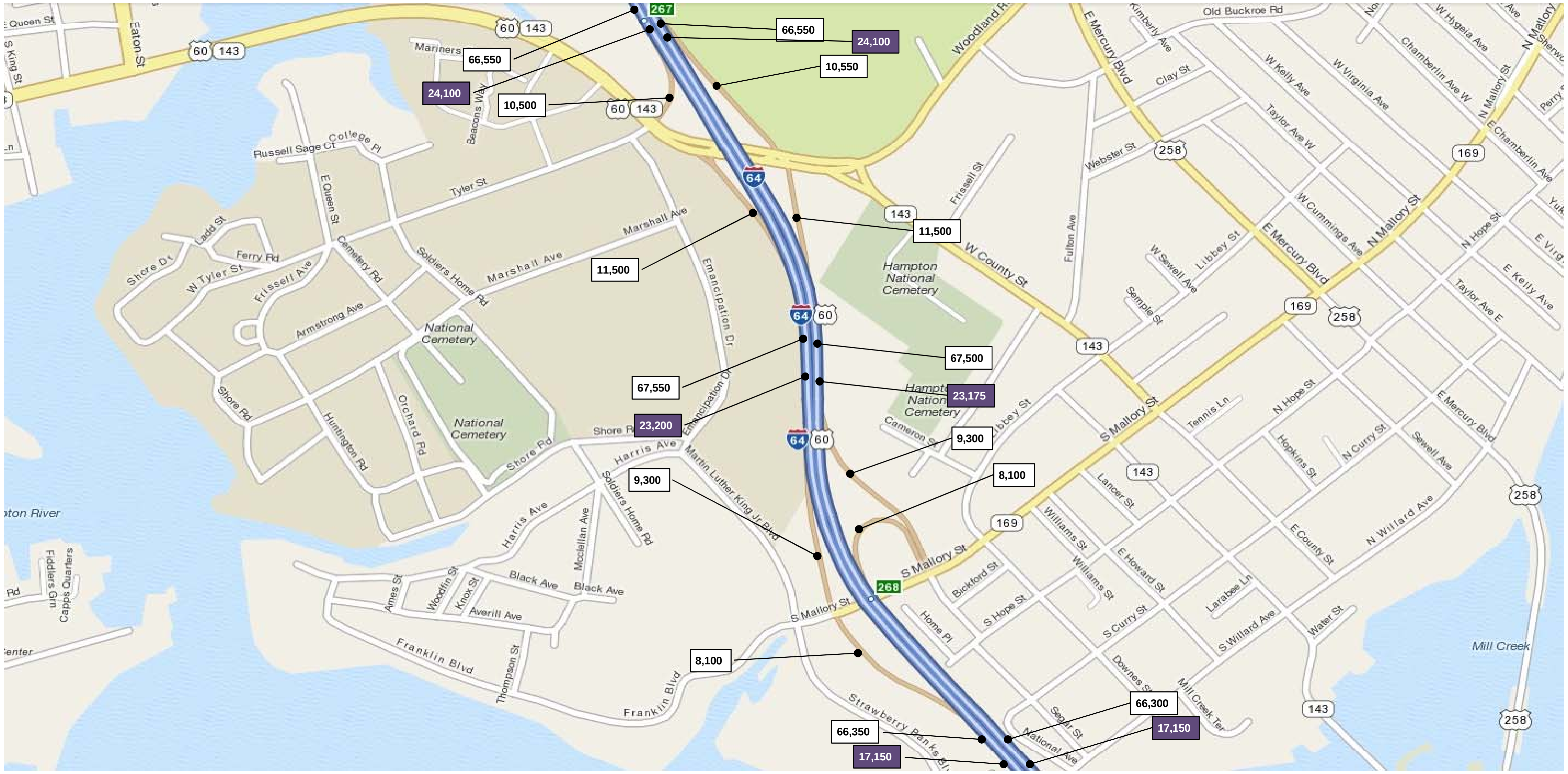
Figure E-7: Sheet 1 of 6

October 12, 2012

Hampton Roads Bridge Tunnel EIS

VDOT

Virginia Department of Transportation



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV
Daily (ADT) Volumes

Figure E-7: Sheet 2 of 6

October 12, 2012

0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

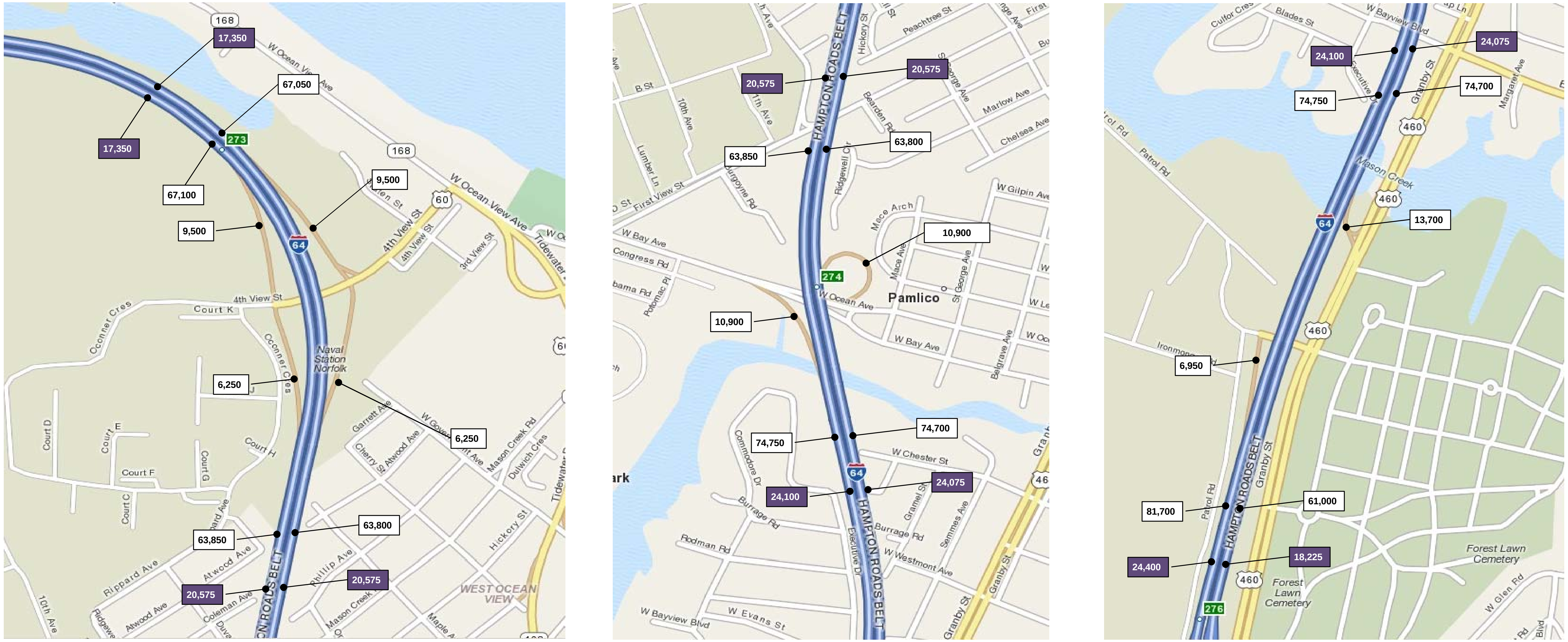
2040 Build 8 Managed - 2GP + 2HOV
Daily (ADT) Volumes

Figure E-7: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

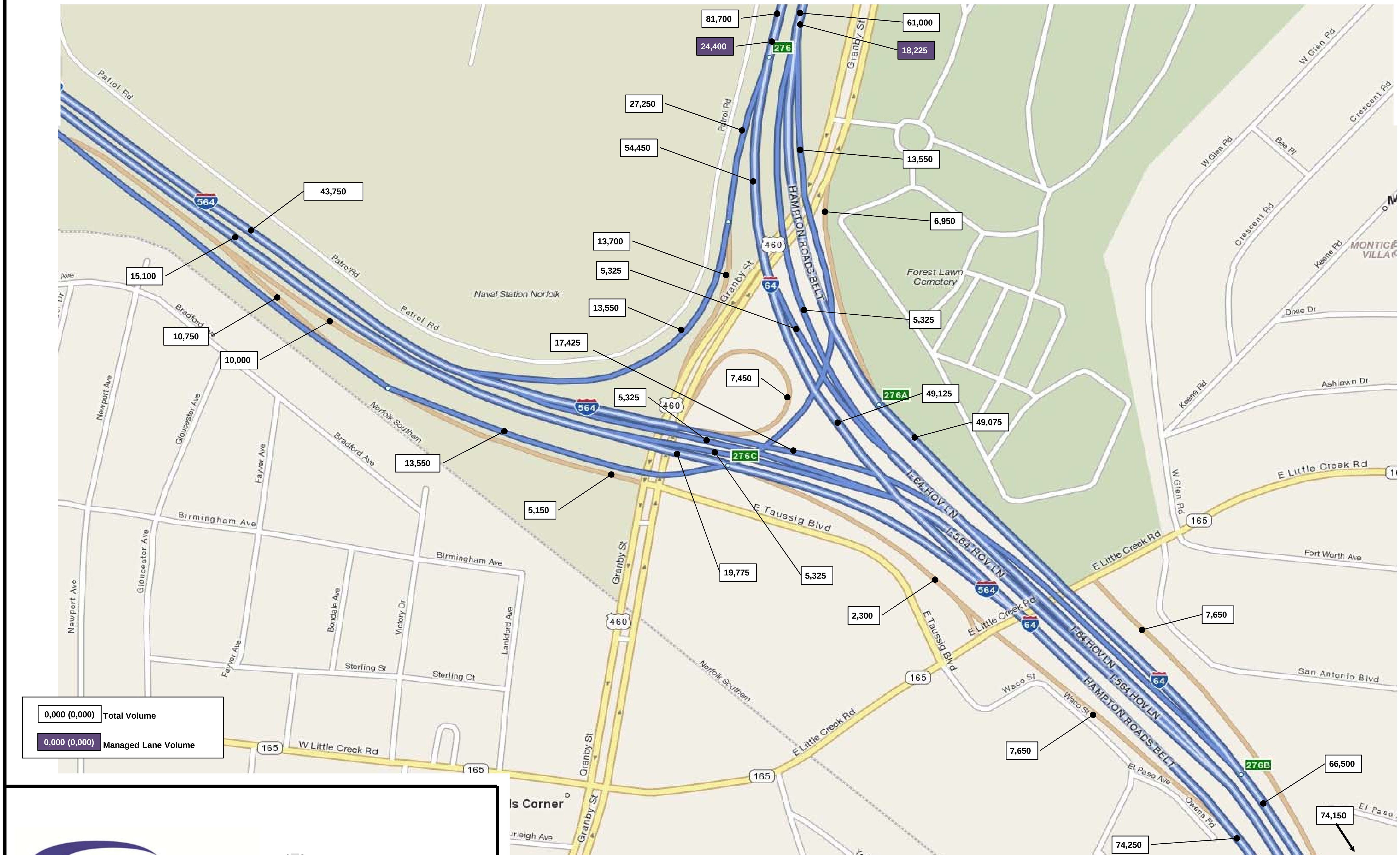
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV
Daily (ADT) Volumes

Figure E-7: Sheet 4 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

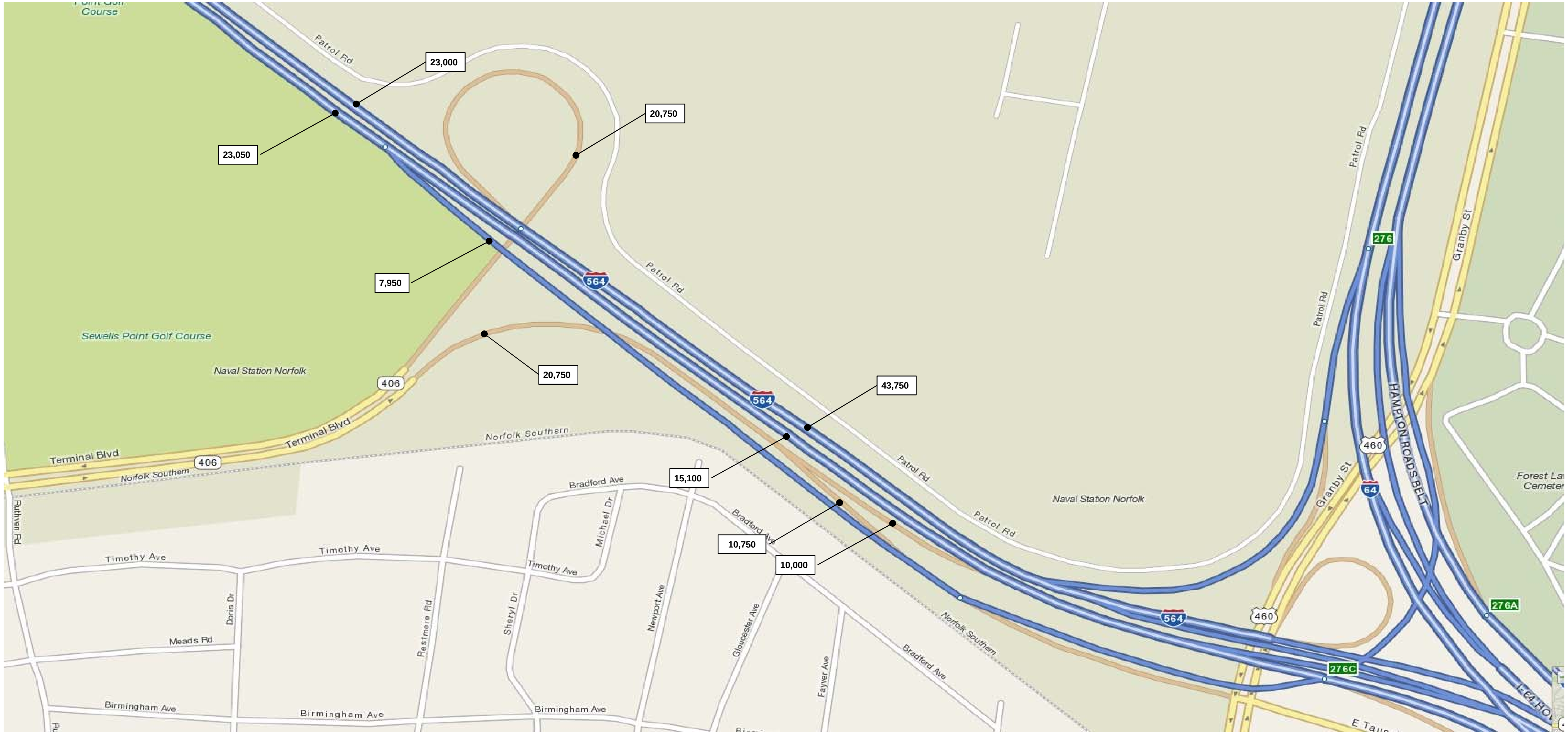
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

Daily (ADT) Volumes

Figure E-7: Sheet 5 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

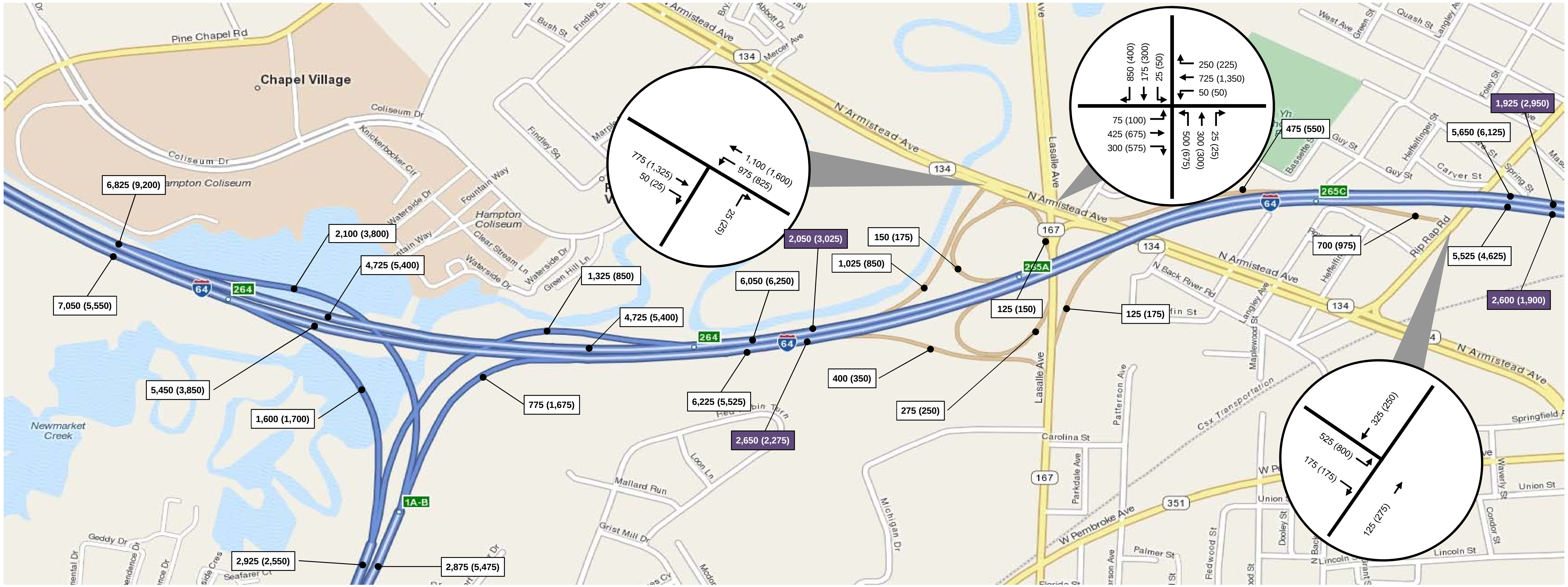
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

Daily (ADT) Volumes

Figure E-7: Sheet 6 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

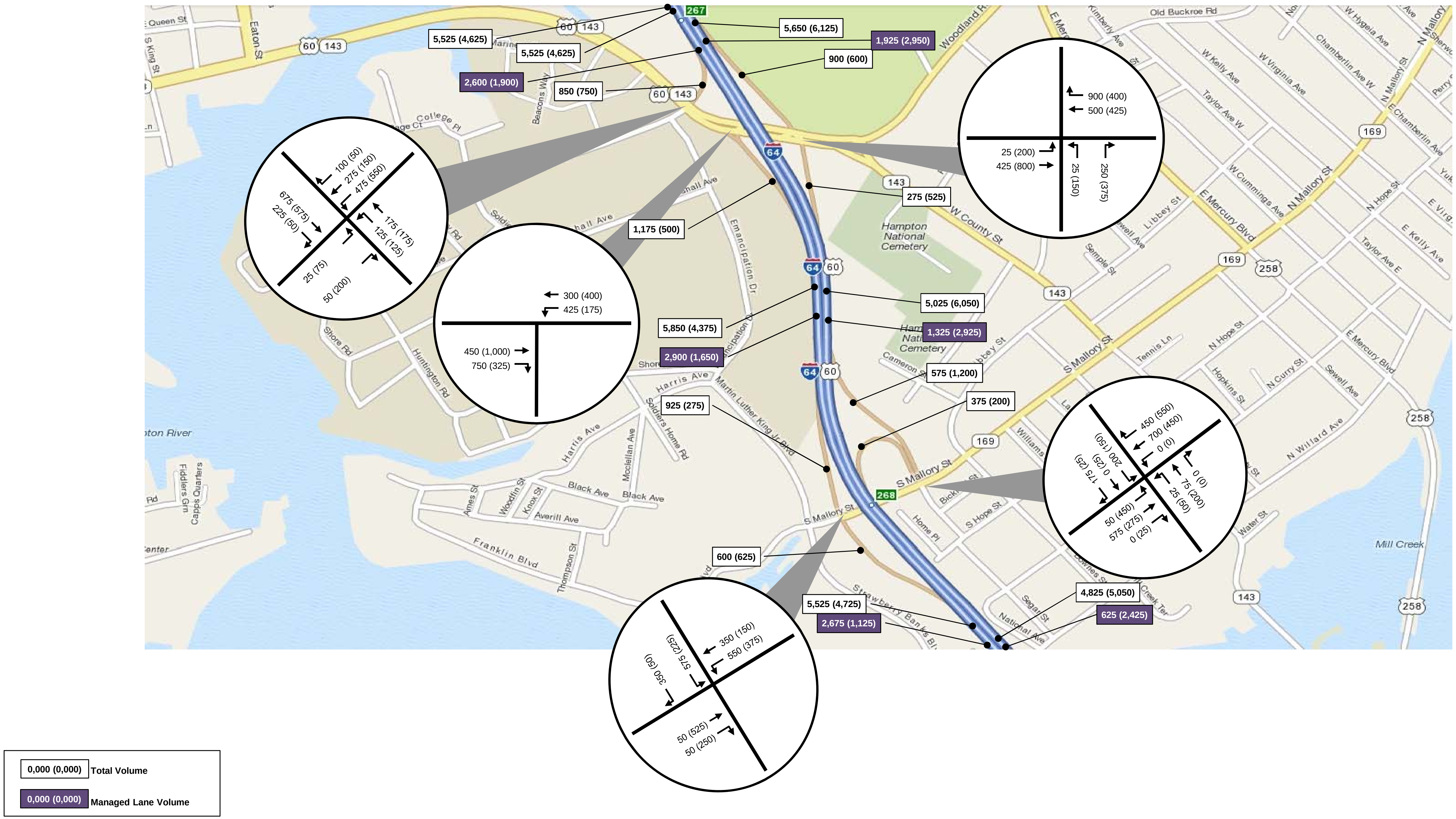
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

AM (PM) Peak Hour Volumes

Figure E-8: Sheet 1 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

AM (PM) Peak Hour Volumes

Figure E-8: Sheet 2 of 6

October 12, 2012

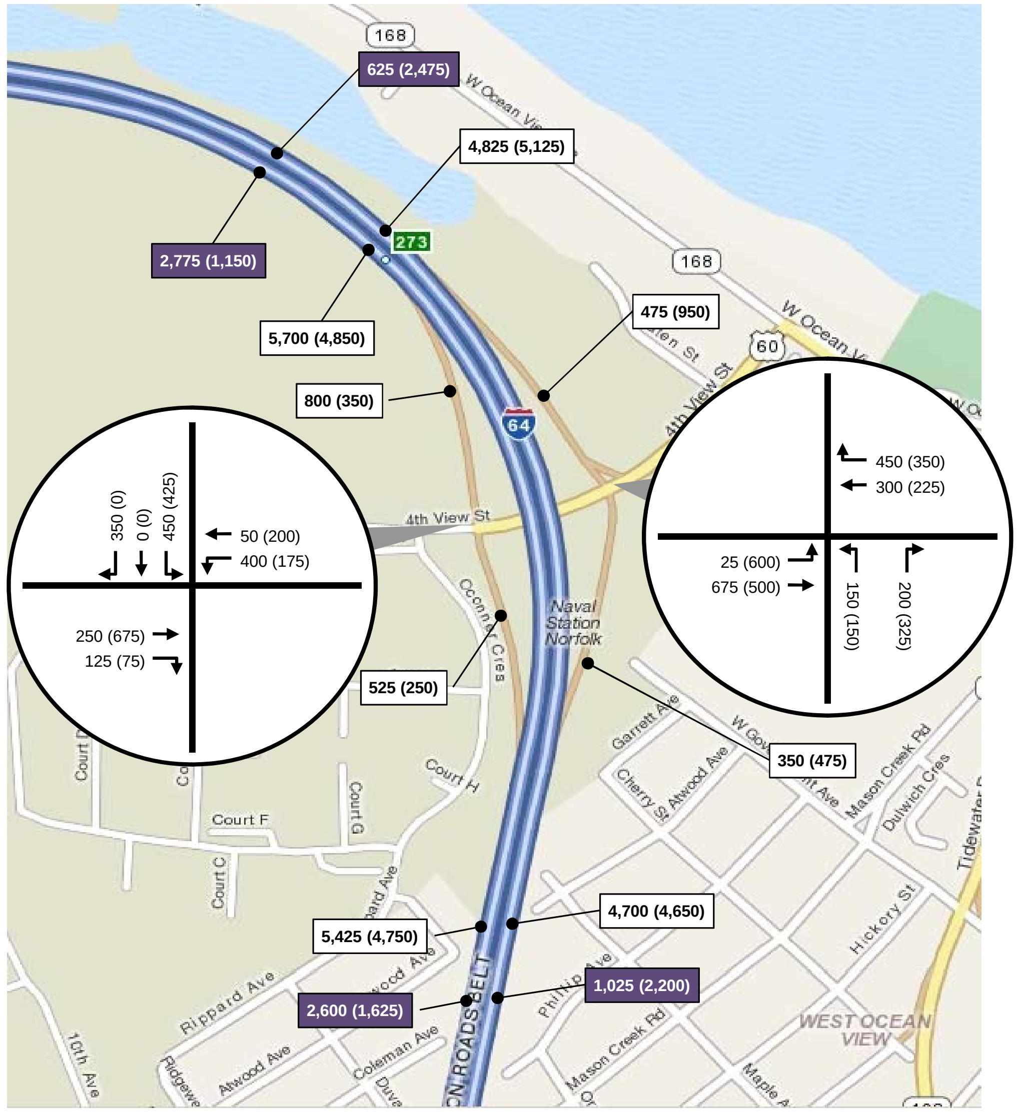
0,000 (0,000) Total Volume

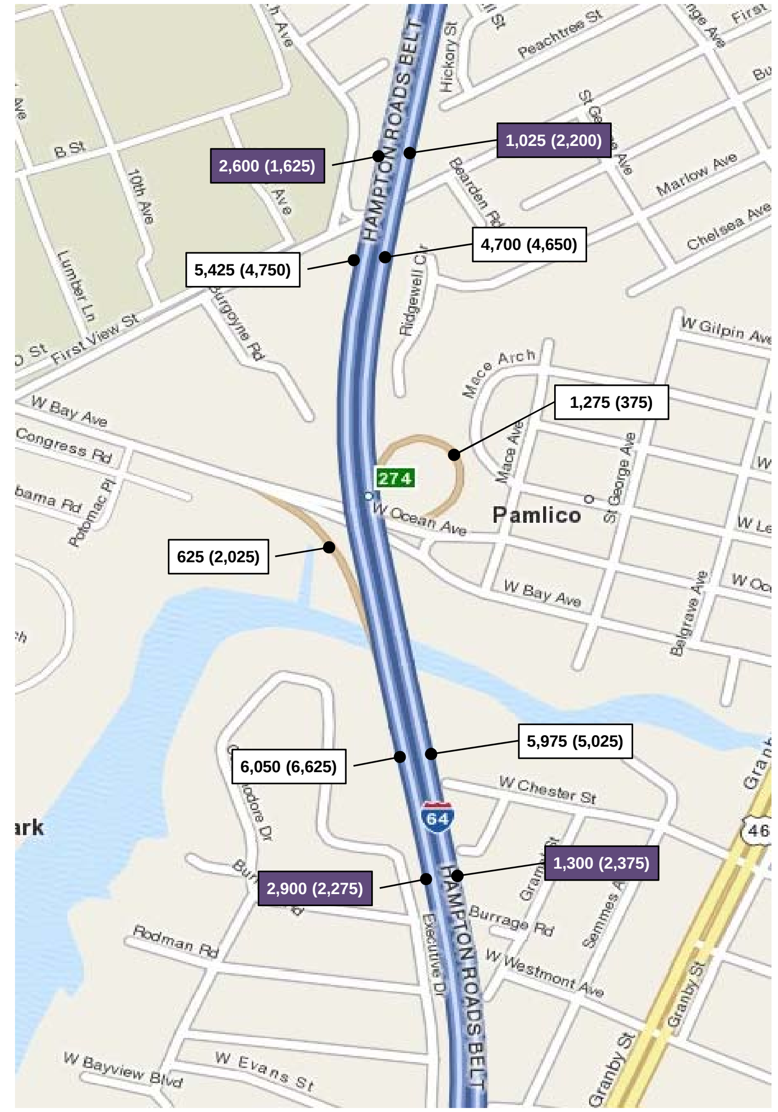
0,000 (0,000) Managed Lane Volume

2040 Build 8 Managed - 2GP + 2HOV
AM (PM) Peak Hour Volumes

Figure E-8: Sheet 3 of 6

October 12, 2012





0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

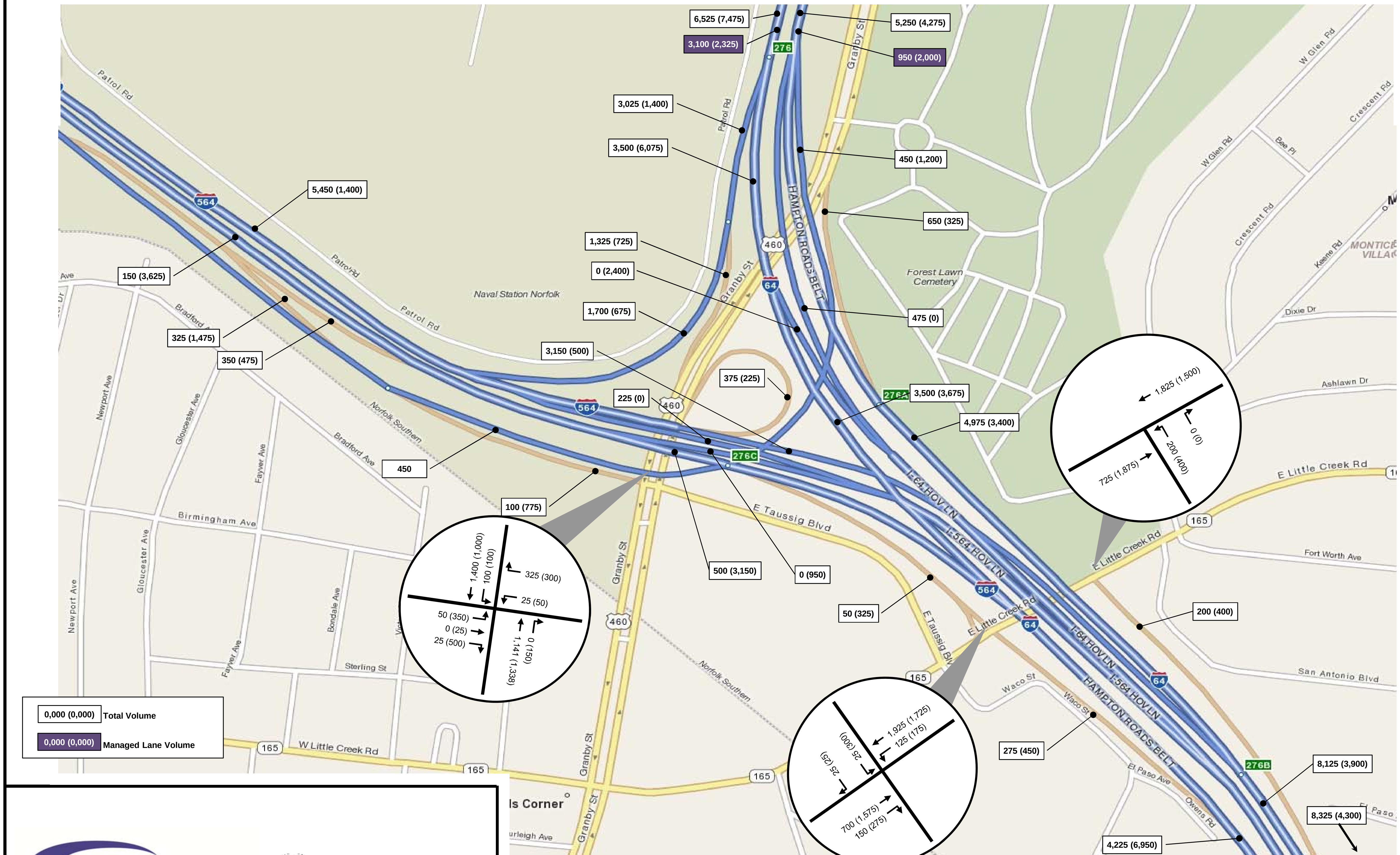
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

AM (PM) Peak Hour Volumes

Figure E-8: Sheet 4 of 6

October 12, 2012



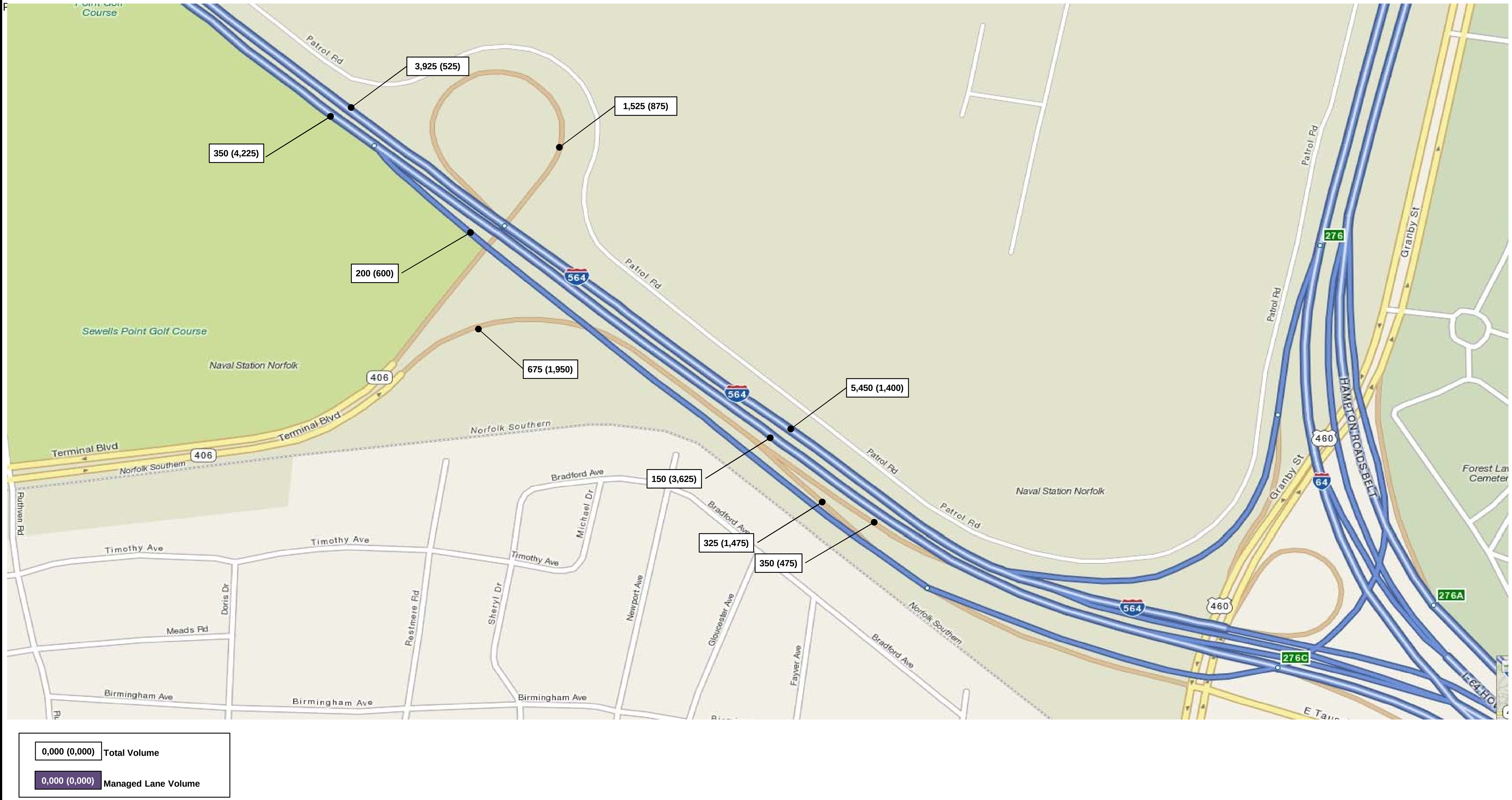
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV
AM (PM) Peak Hour Volumes

Figure E-8: Sheet 5 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

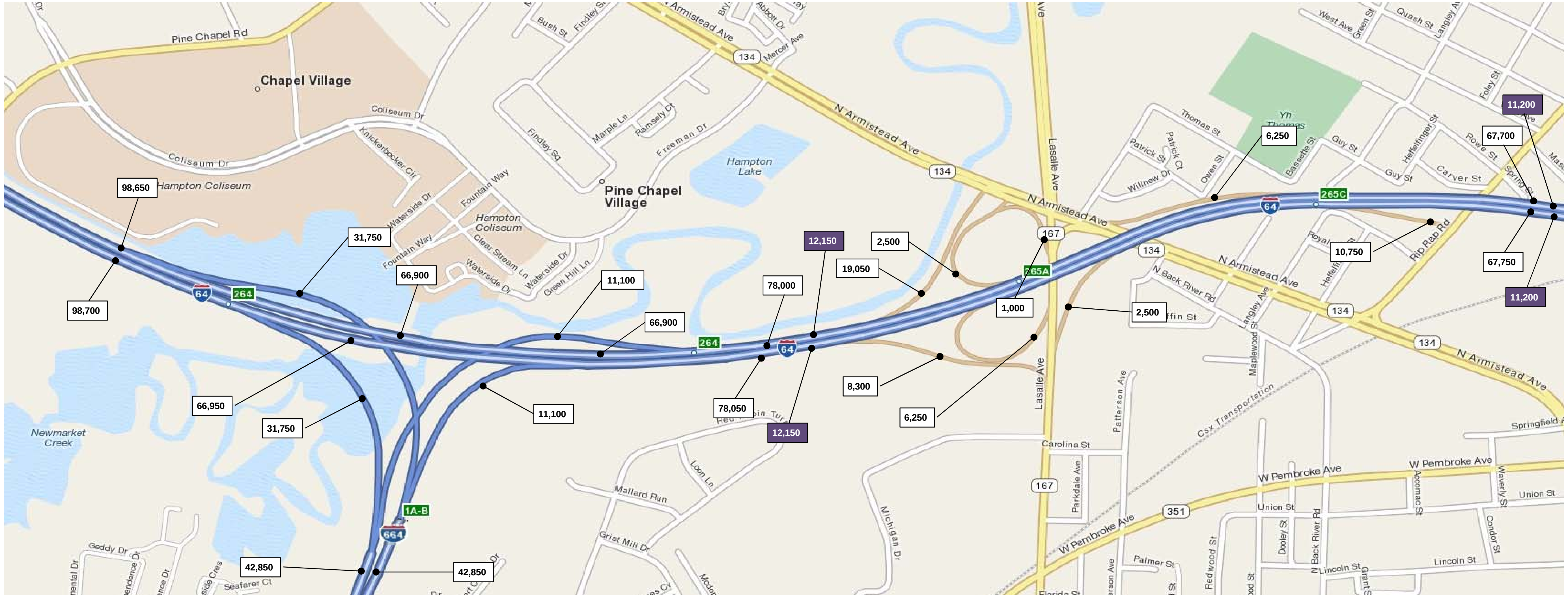
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 2GP + 2HOV

AM (PM) Peak Hour Volumes

Figure E-8: Sheet 6 of 6

October 12, 2012



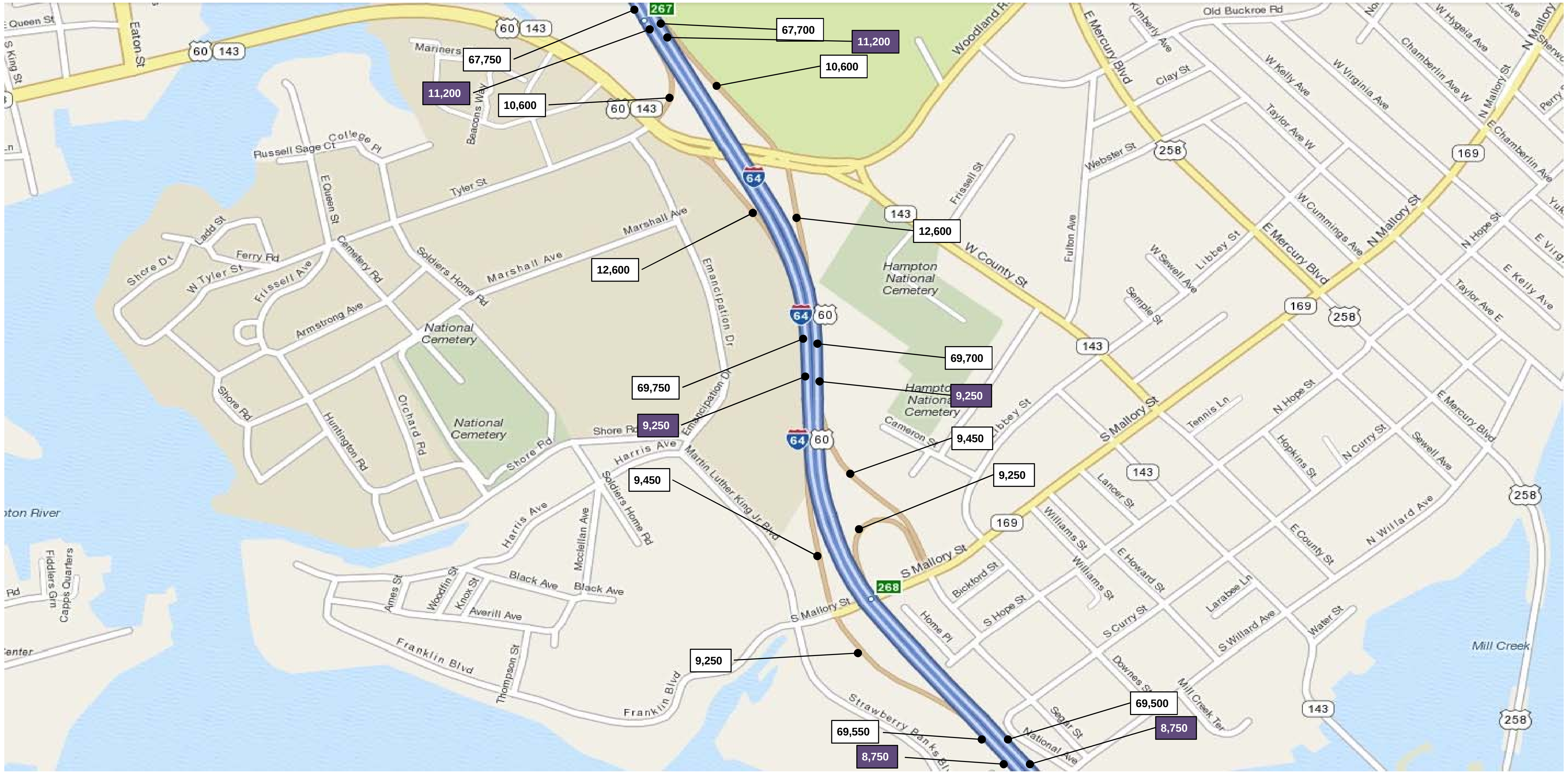
0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

2040 Build 8 Managed - 3GP + 1HOV

Daily (ADT) Volumes

Figure E-9: Sheet 1 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

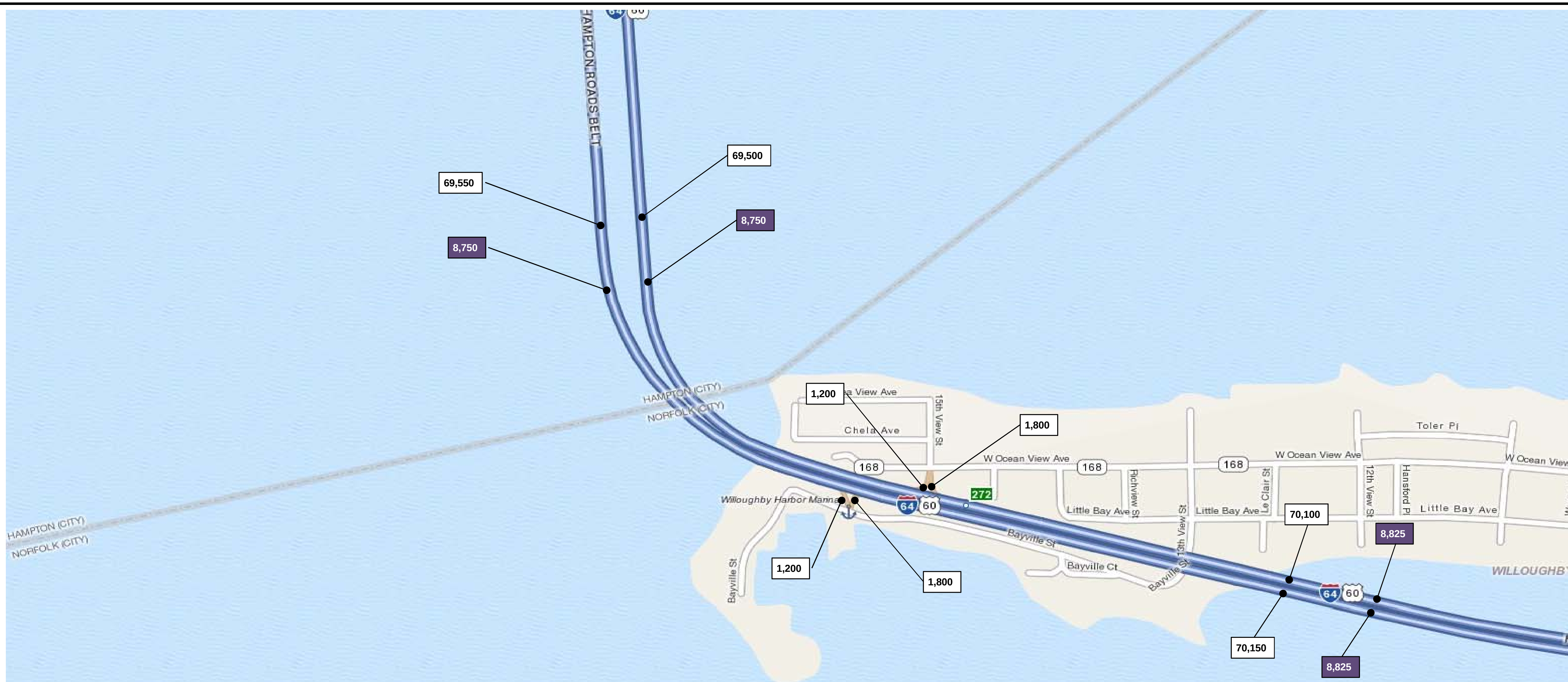
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
Daily (ADT) Volumes

Figure E-9: Sheet 2 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

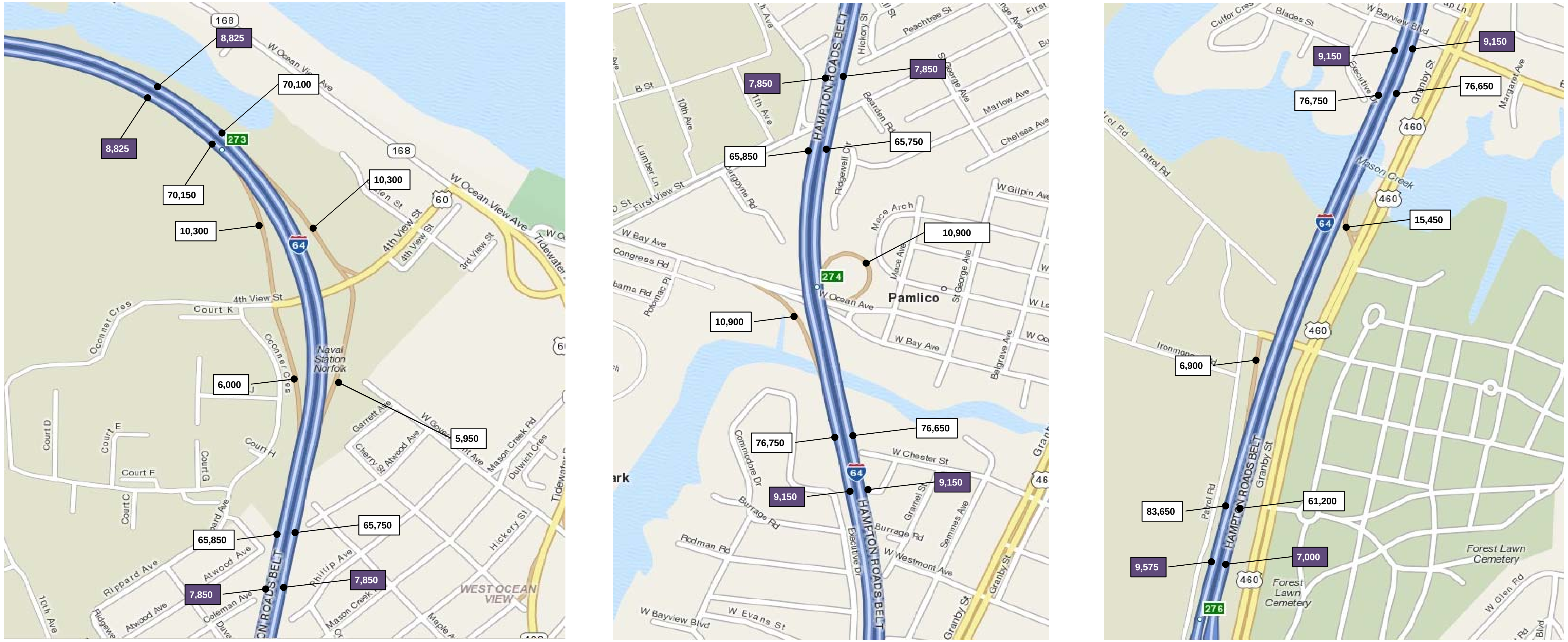
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
Daily (ADT) Volumes

Figure E-9: Sheet 3 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
Daily (ADT) Volumes

Figure E-9: Sheet 4 of 6

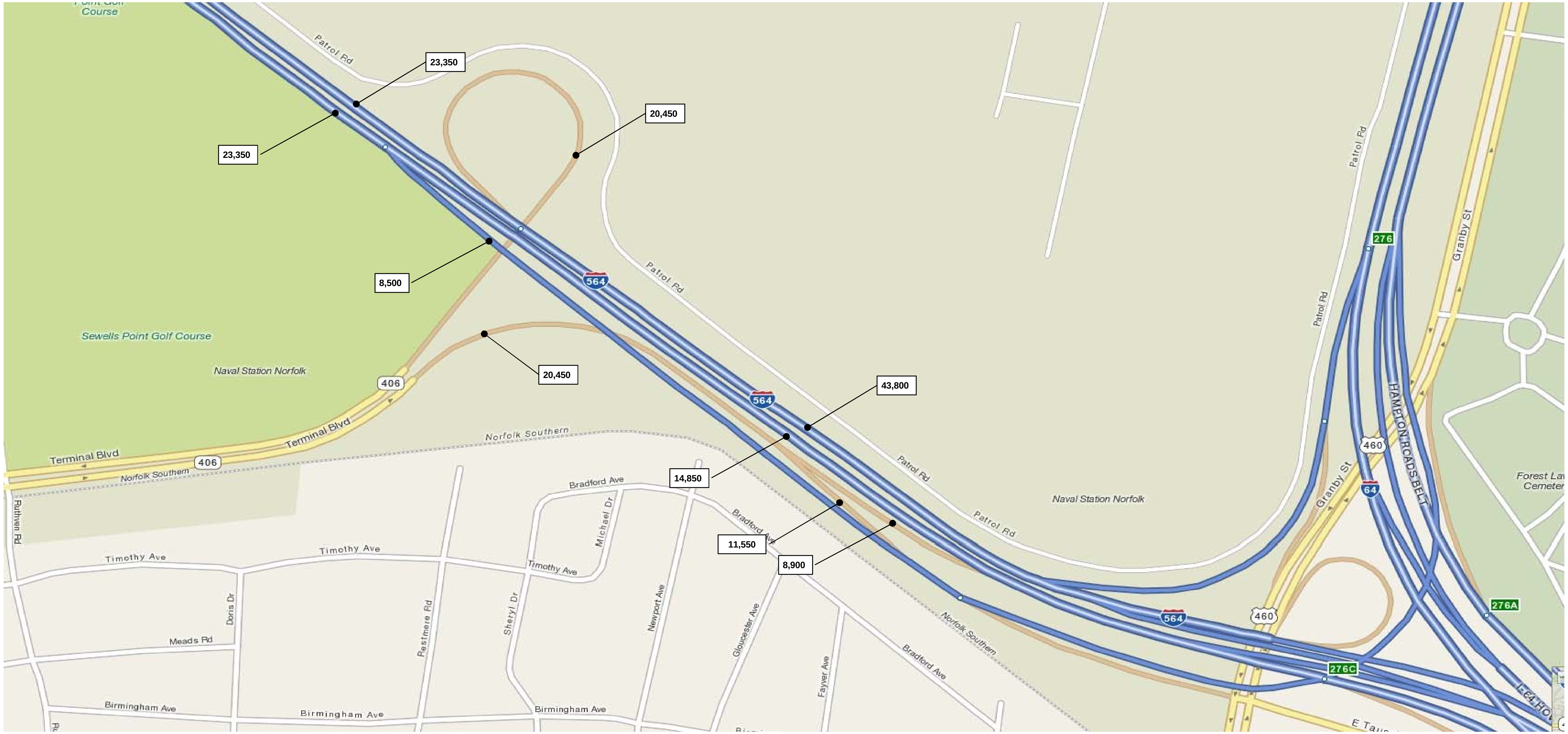
October 12, 2012

2040 Build 8 Managed - 3GP + 1HOV

Daily (ADT) Volumes

Figure E-9: Sheet 5 of 6

October 12, 2012

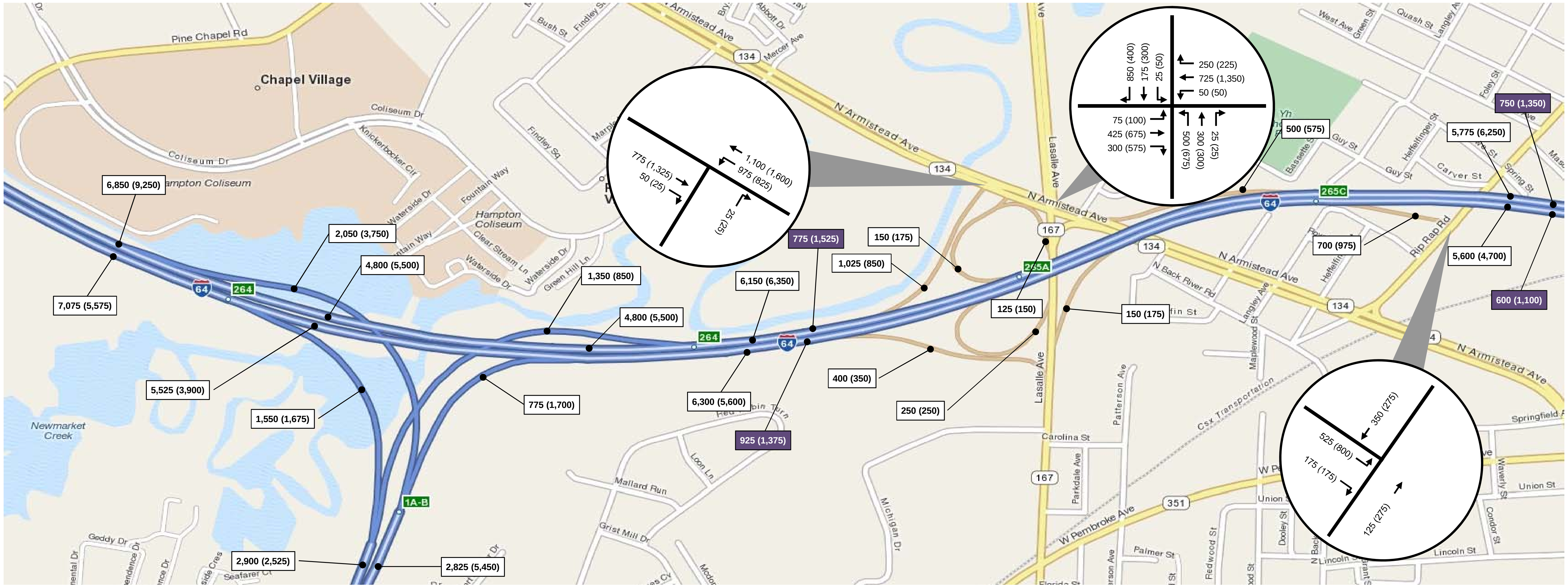


0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

2040 Build 8 Managed - 3GP + 1HOV
Daily (ADT) Volumes

Figure E-9: Sheet 6 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

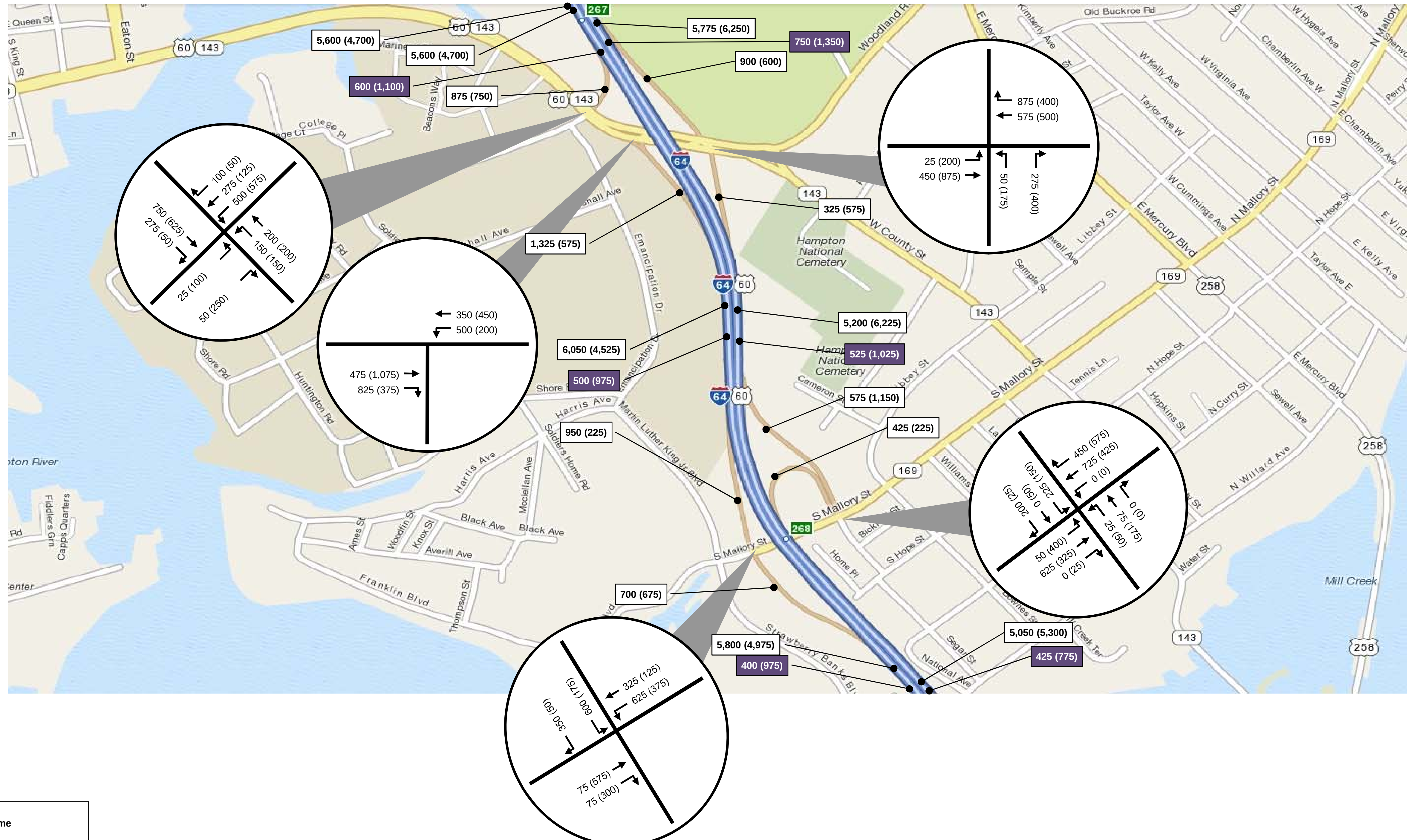
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
AM (PM) Peak Hour Volumes

Figure E-10: Sheet 1 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
AM (PM) Peak Hour Volumes

Figure E-10: Sheet 2 of 6

October 12, 2012

0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

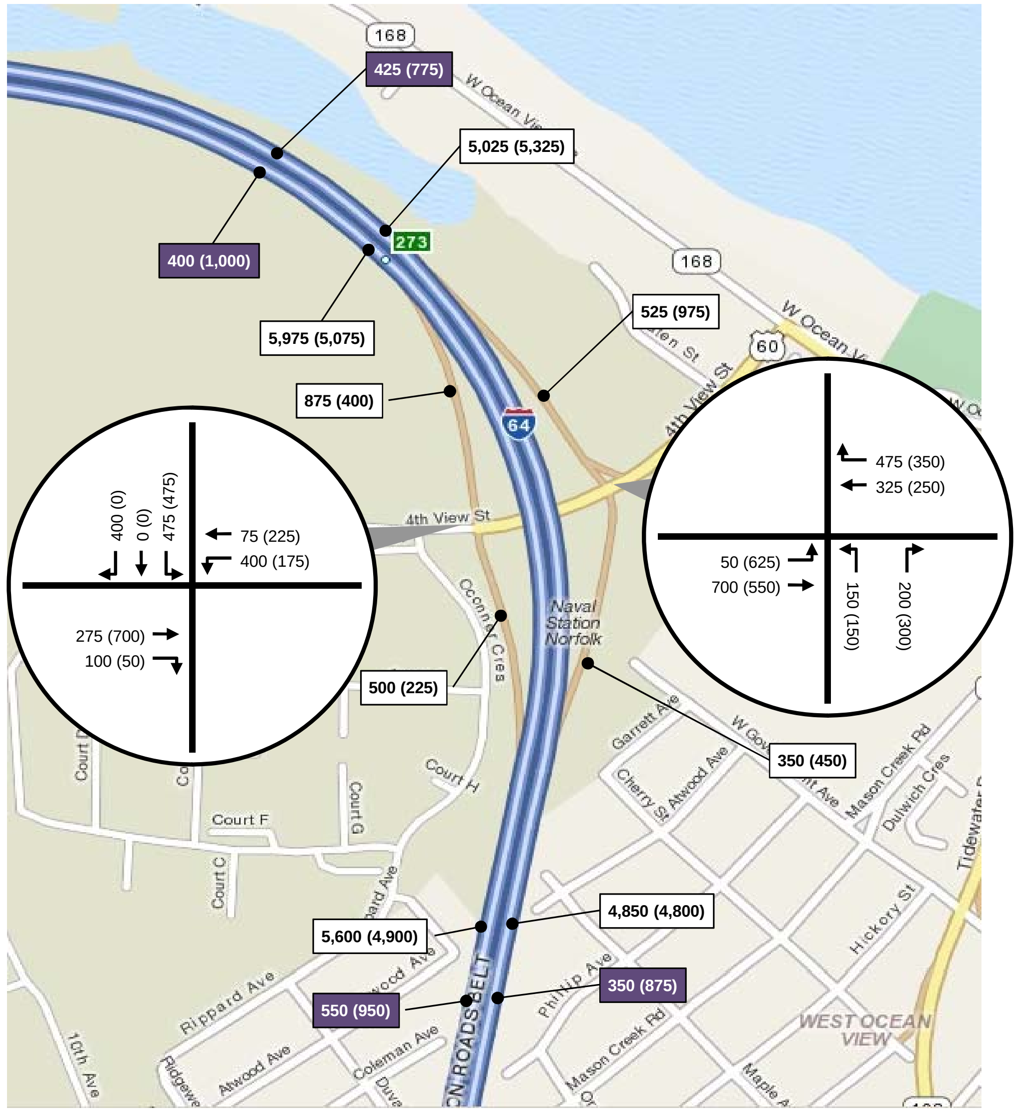
HRBT Hampton Roads Bridge Tunnel EIS

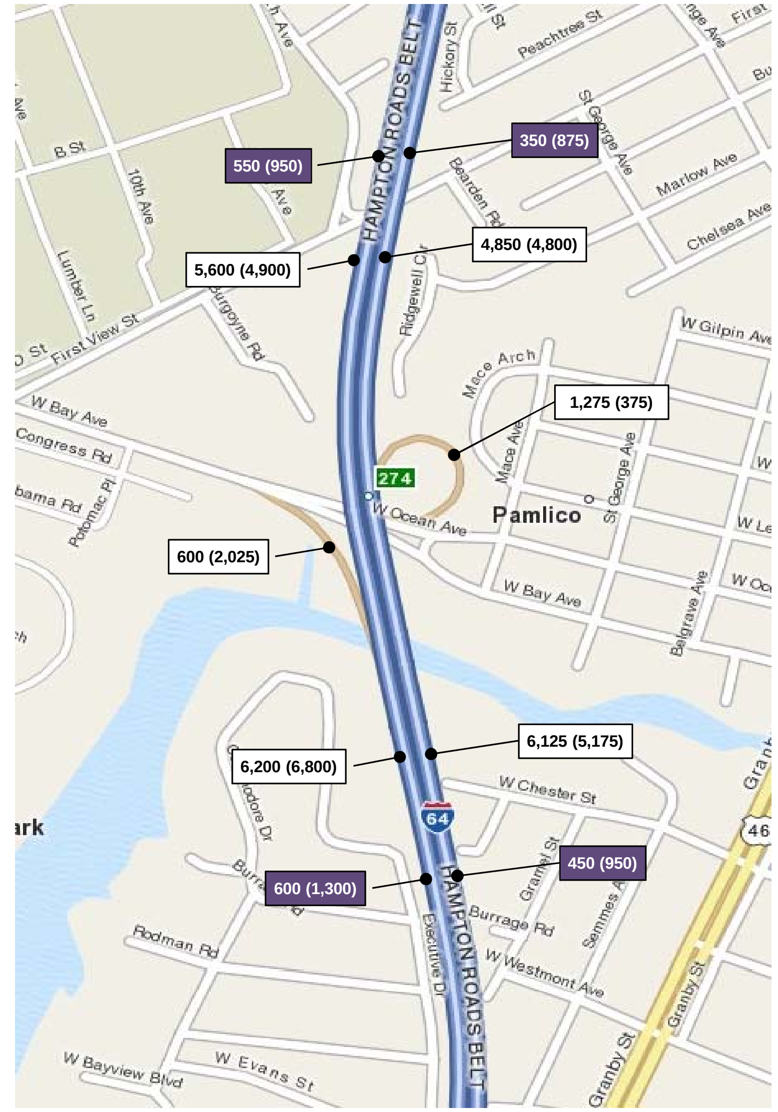
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
AM (PM) Peak Hour Volumes

Figure E-10: Sheet 3 of 6

October 12, 2012





0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

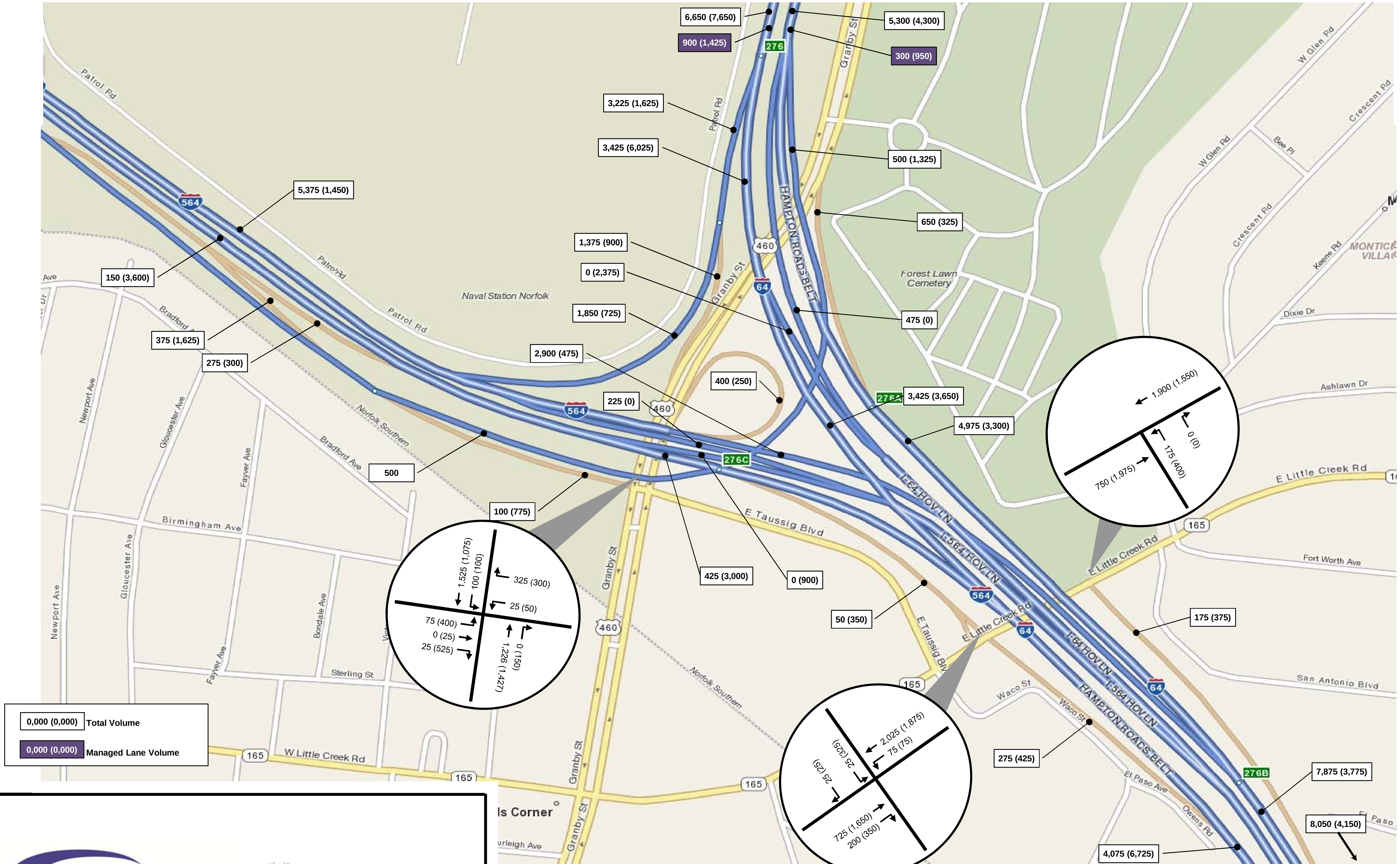
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV
AM (PM) Peak Hour Volumes

Figure E-10: Sheet 4 of 6

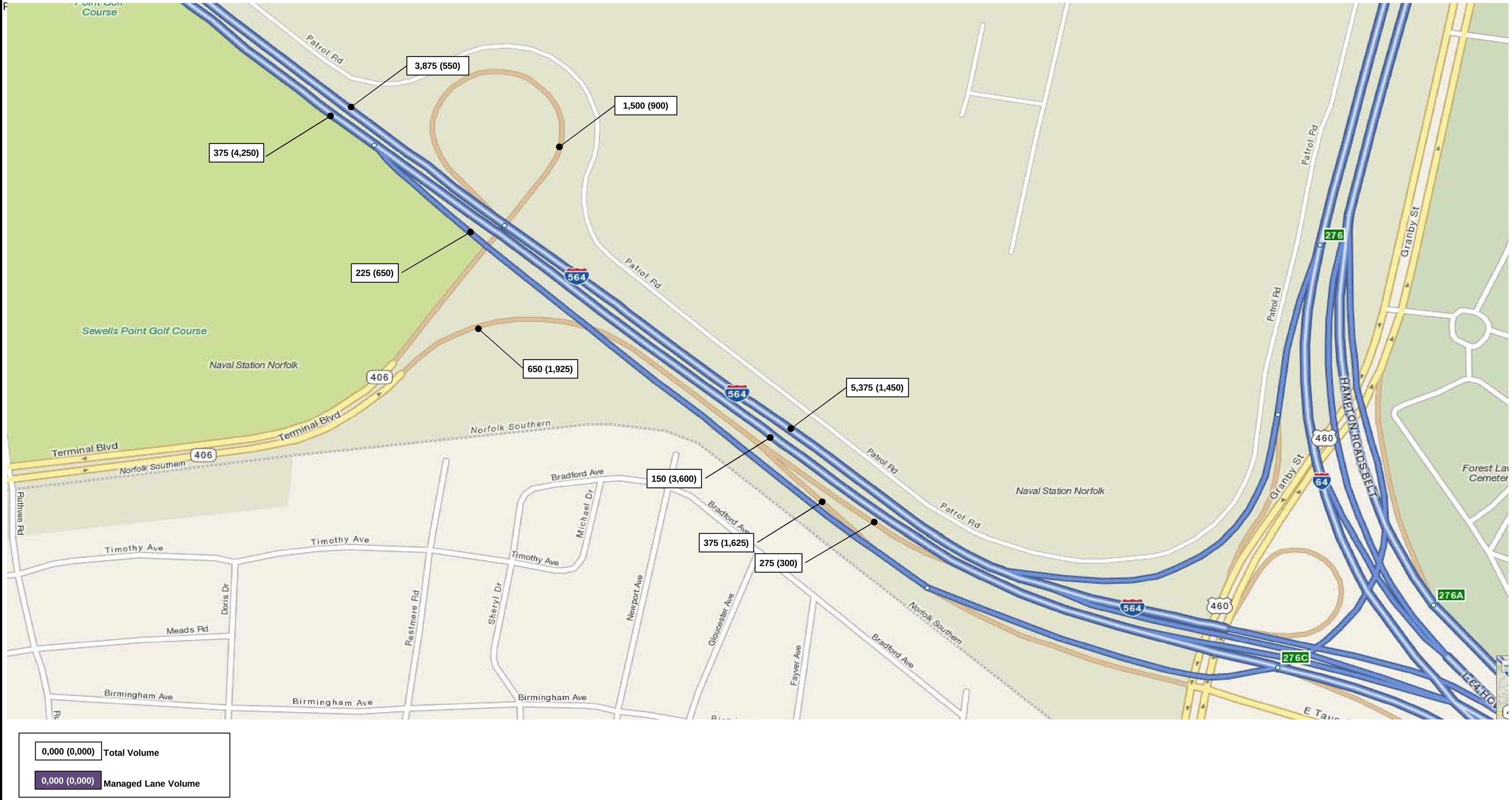
October 12, 2012



2040 Build 8 Managed - 3GP + 1HOV
AM (PM) Peak Hour Volumes

Figure E-10: Sheet 5 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

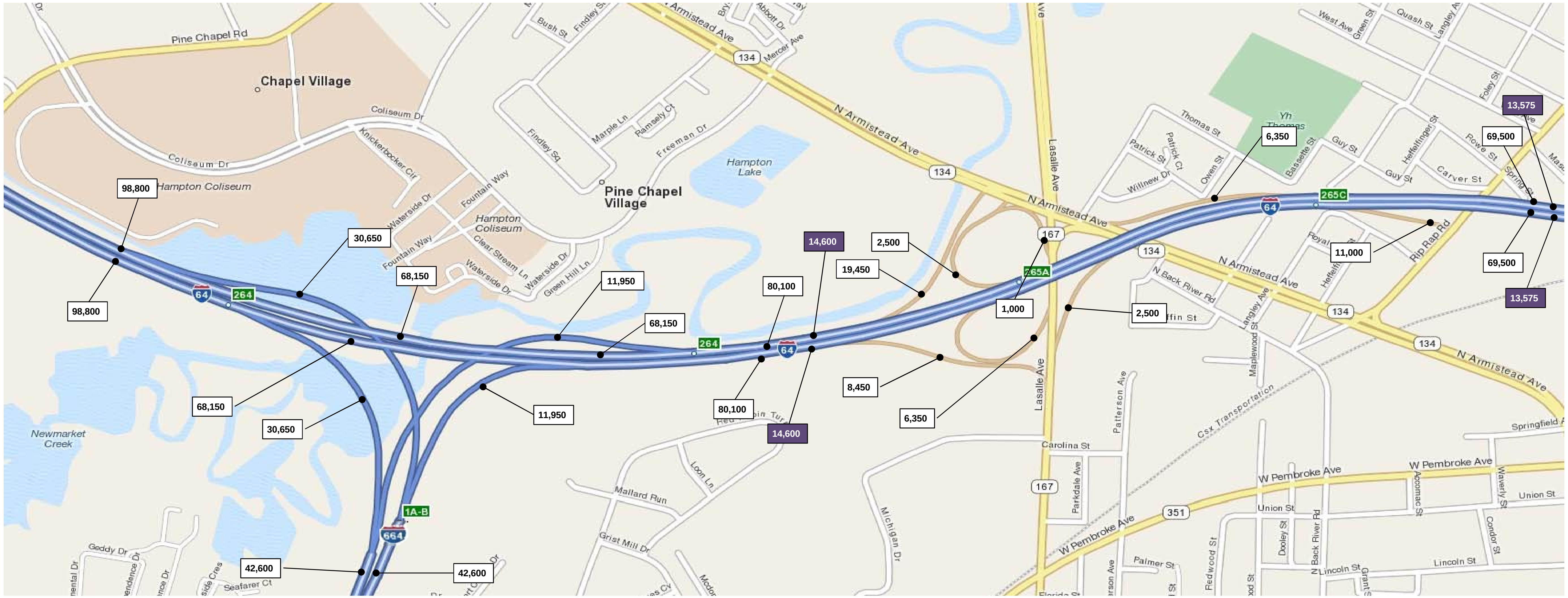
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOV

AM (PM) Peak Hour Volumes

Figure E-10: Sheet 6 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

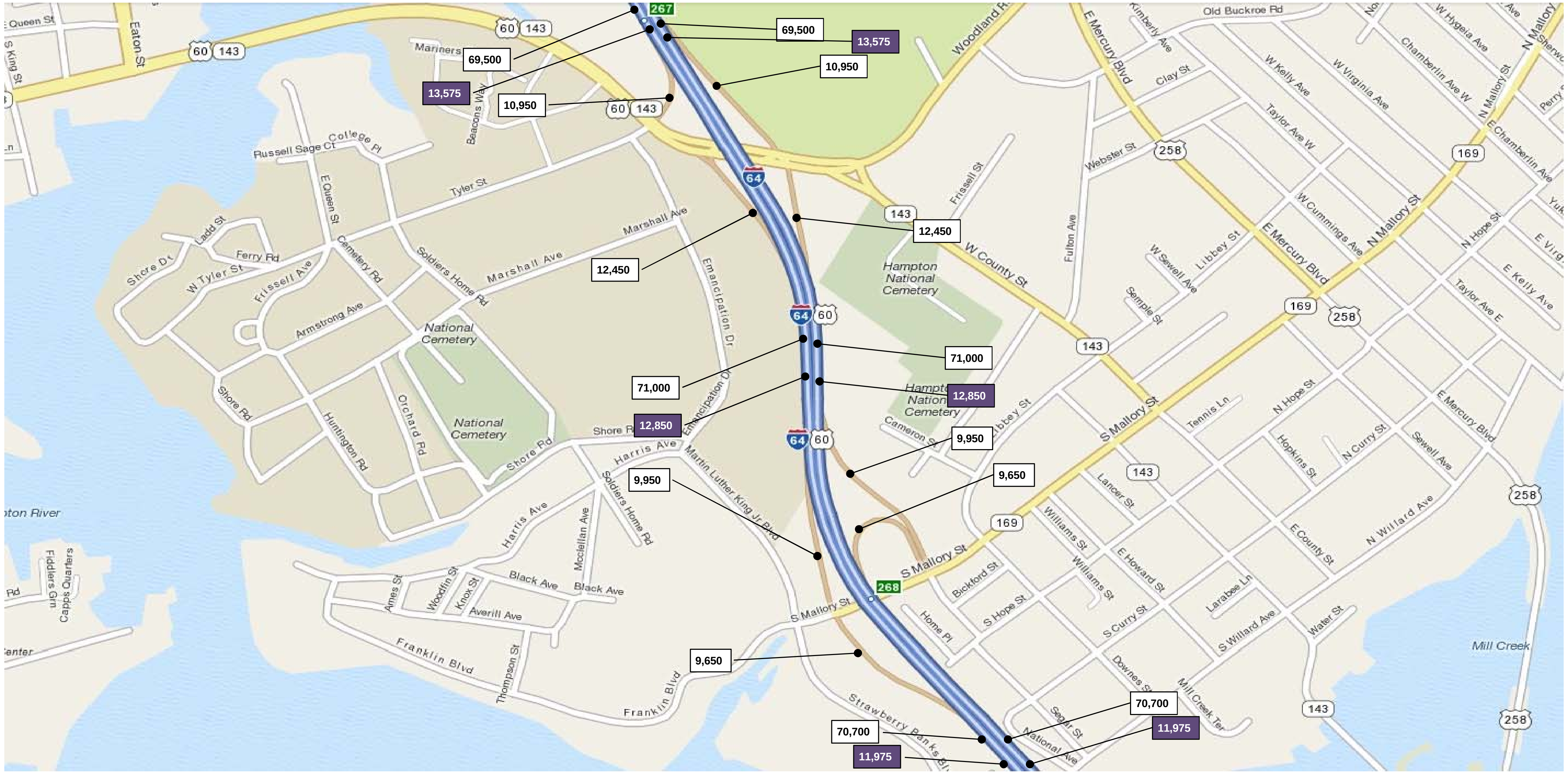
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT

Daily (ADT) Volumes

Figure E-11: Sheet 1 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

2040 Build 8 Managed - 3GP + 1HOT

Daily (ADT) Volumes

Figure E-11: Sheet 2 of 6

October 12, 2012

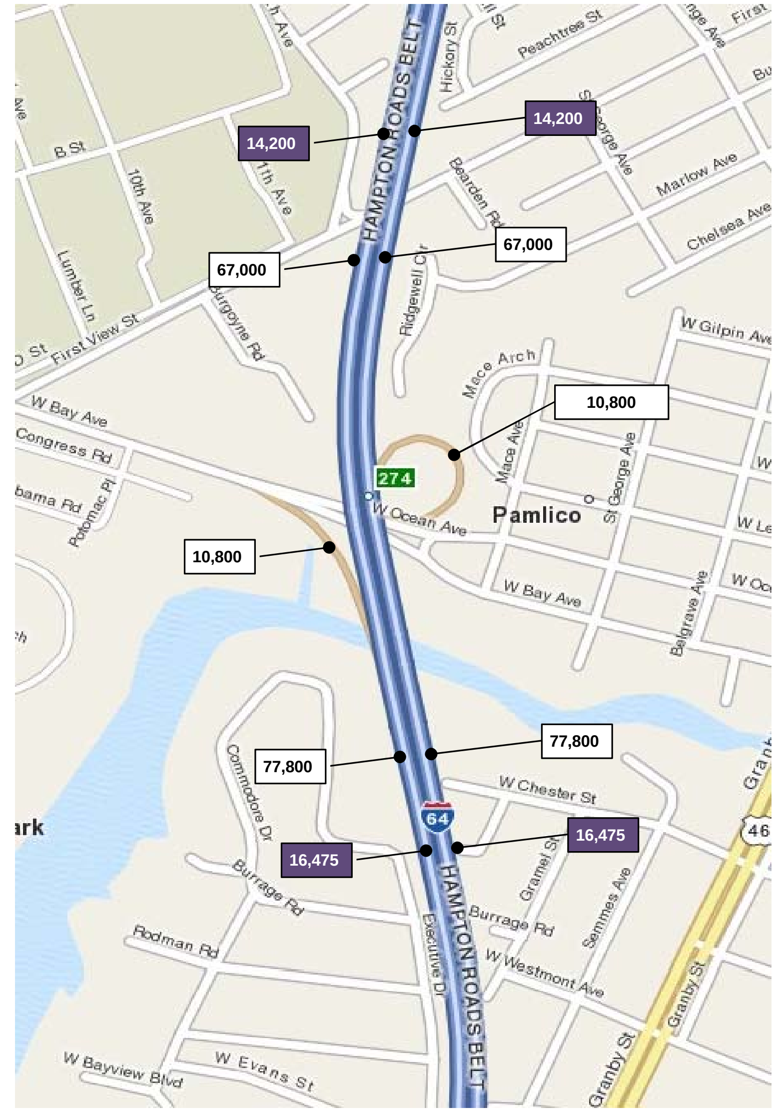
0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

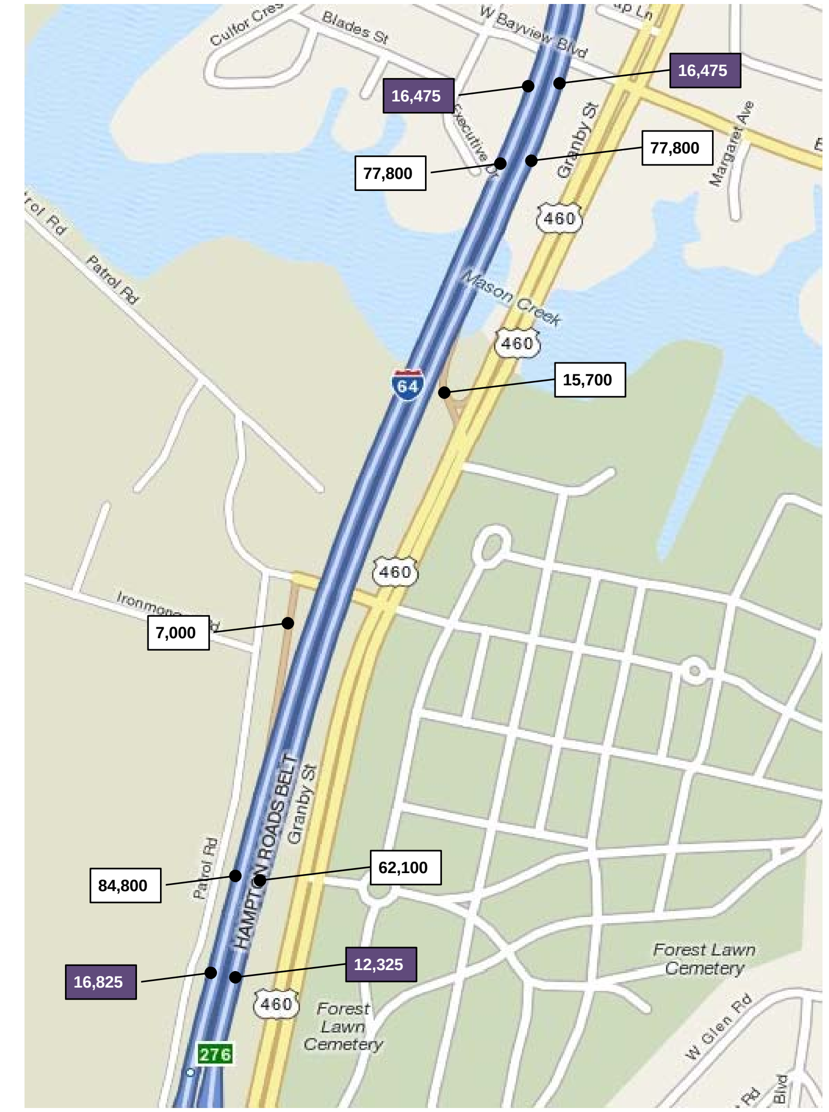
Hampton Roads Bridge Tunnel EIS

2040 Build 8 Managed - 3GP + 1HOT
Daily (ADT) Volumes

Figure E-11: Sheet 3 of 6

October 12, 2012





0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT
Daily (ADT) Volumes

Figure E-11: Sheet 4 of 6

October 12, 2012

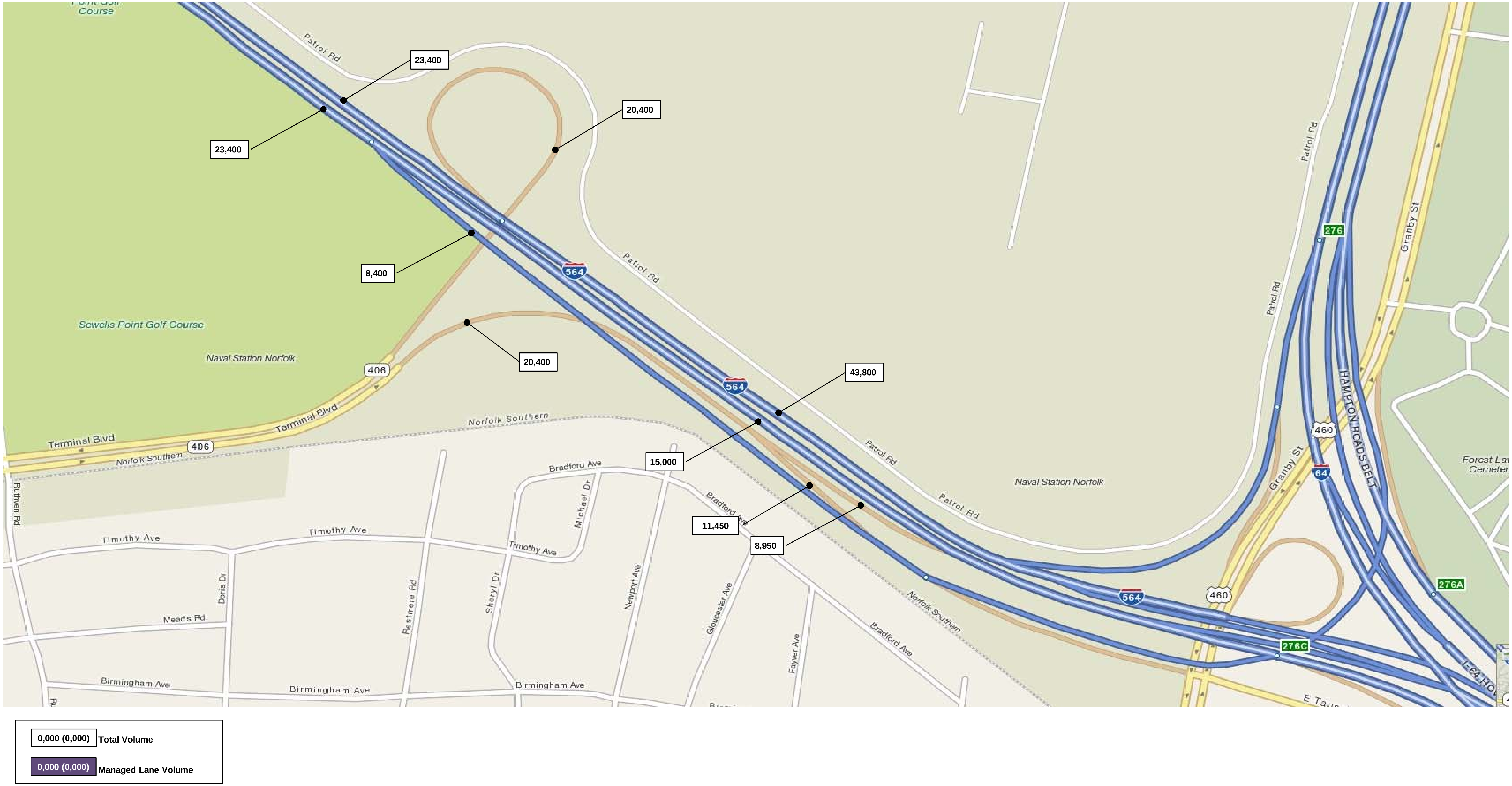
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT
Daily (ADT) Volumes

Figure E-11: Sheet 5 of 6

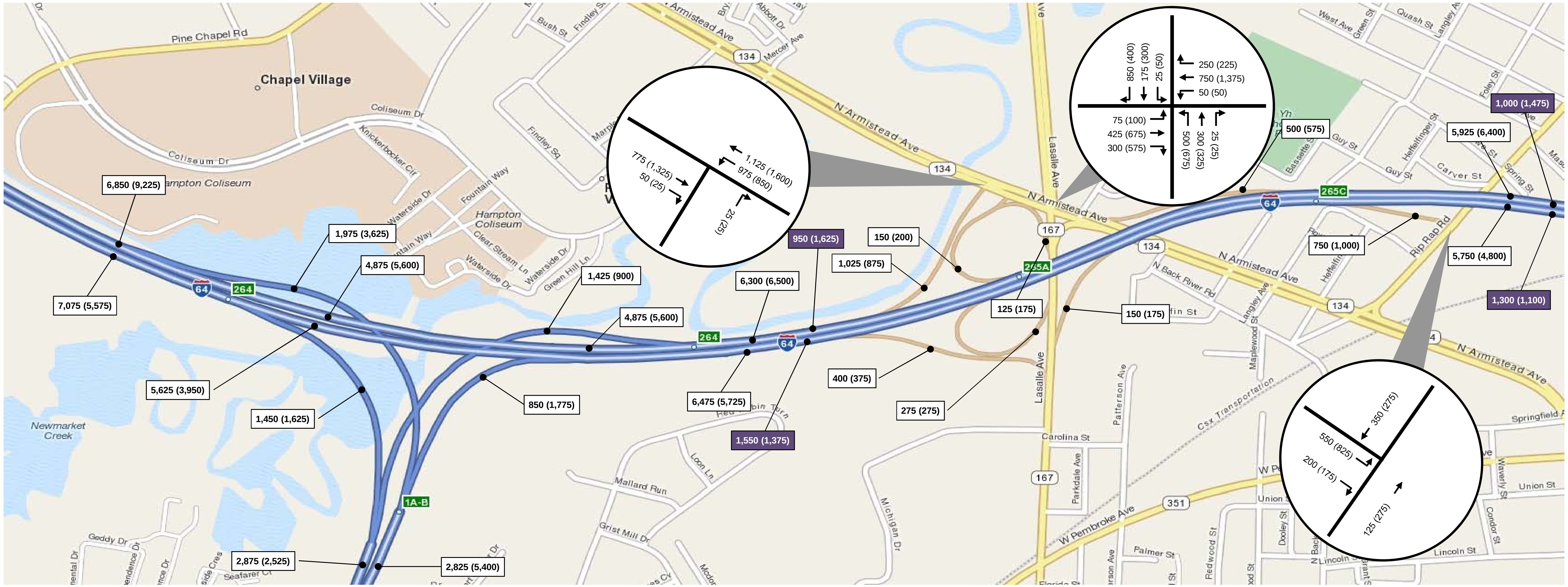
October 12, 2012



2040 Build 8 Managed - 3GP + 1HOT
Daily (ADT) Volumes

Figure E-11: Sheet 6 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

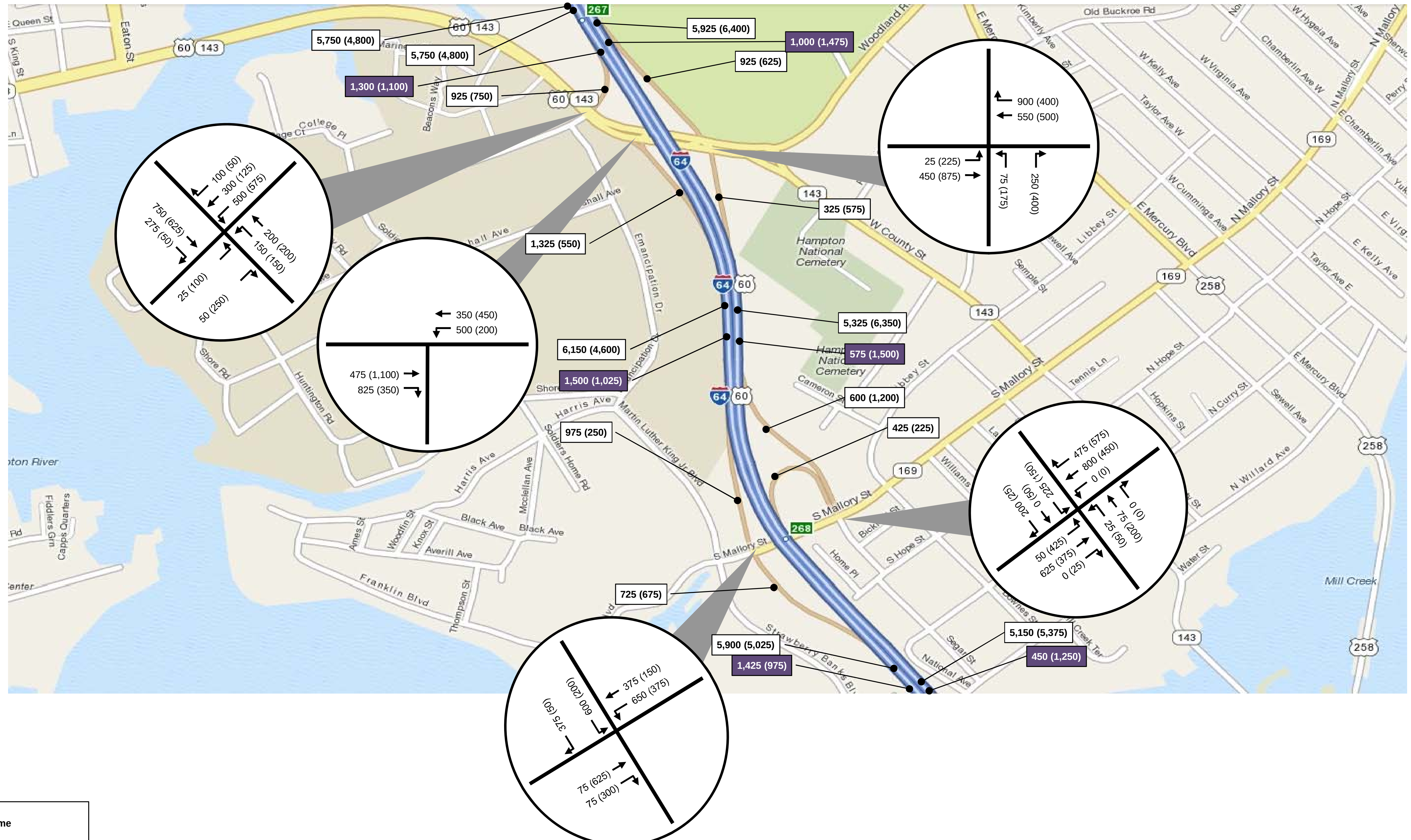
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT
AM (PM) Peak Hour Volumes

Figure E-12: Sheet 1 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT

AM (PM) Peak Hour Volumes

Figure E-12: Sheet 2 of 6

October 12, 2012

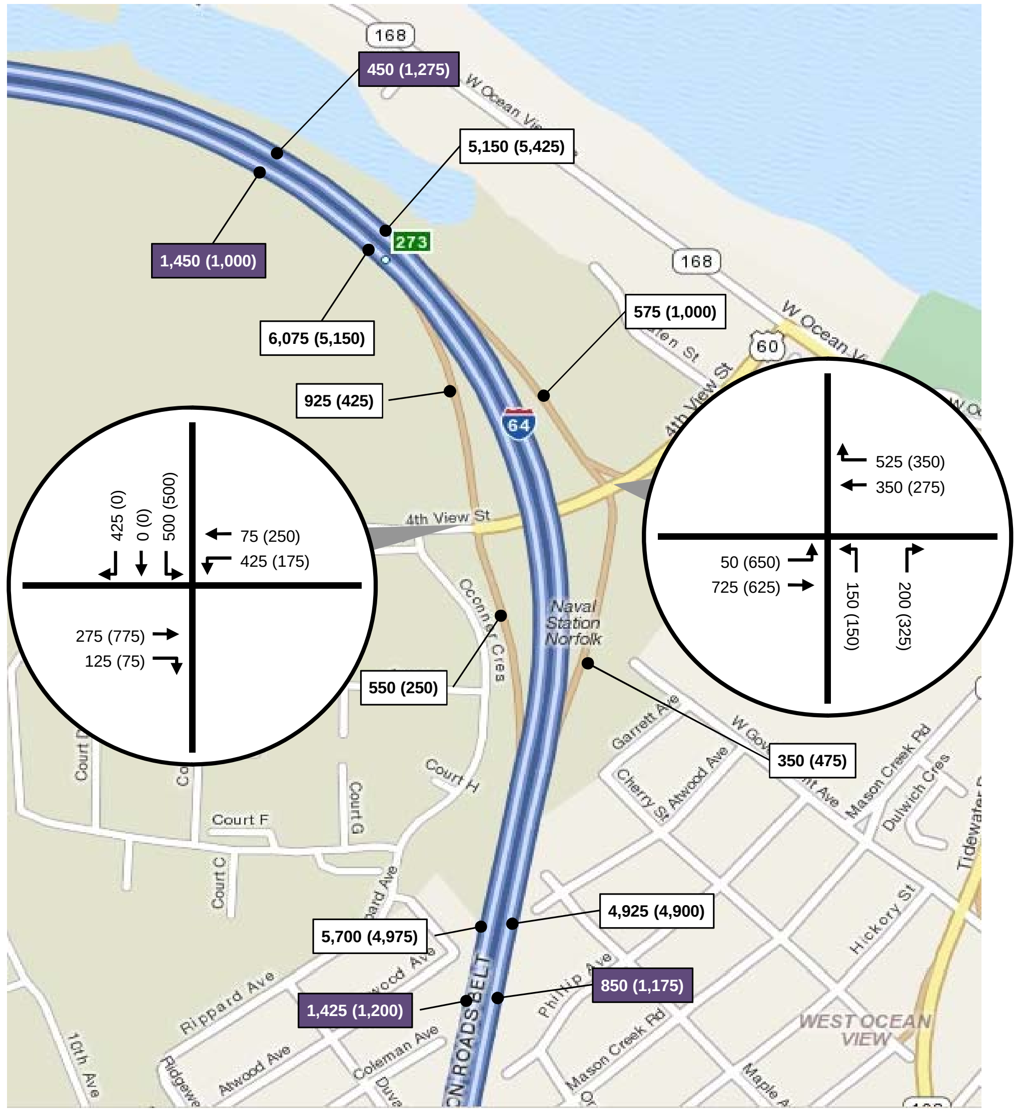
0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

2040 Build 8 Managed - 3GP + 1HOT

AM (PM) Peak Hour Volumes

Figure E-12: Sheet 3 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

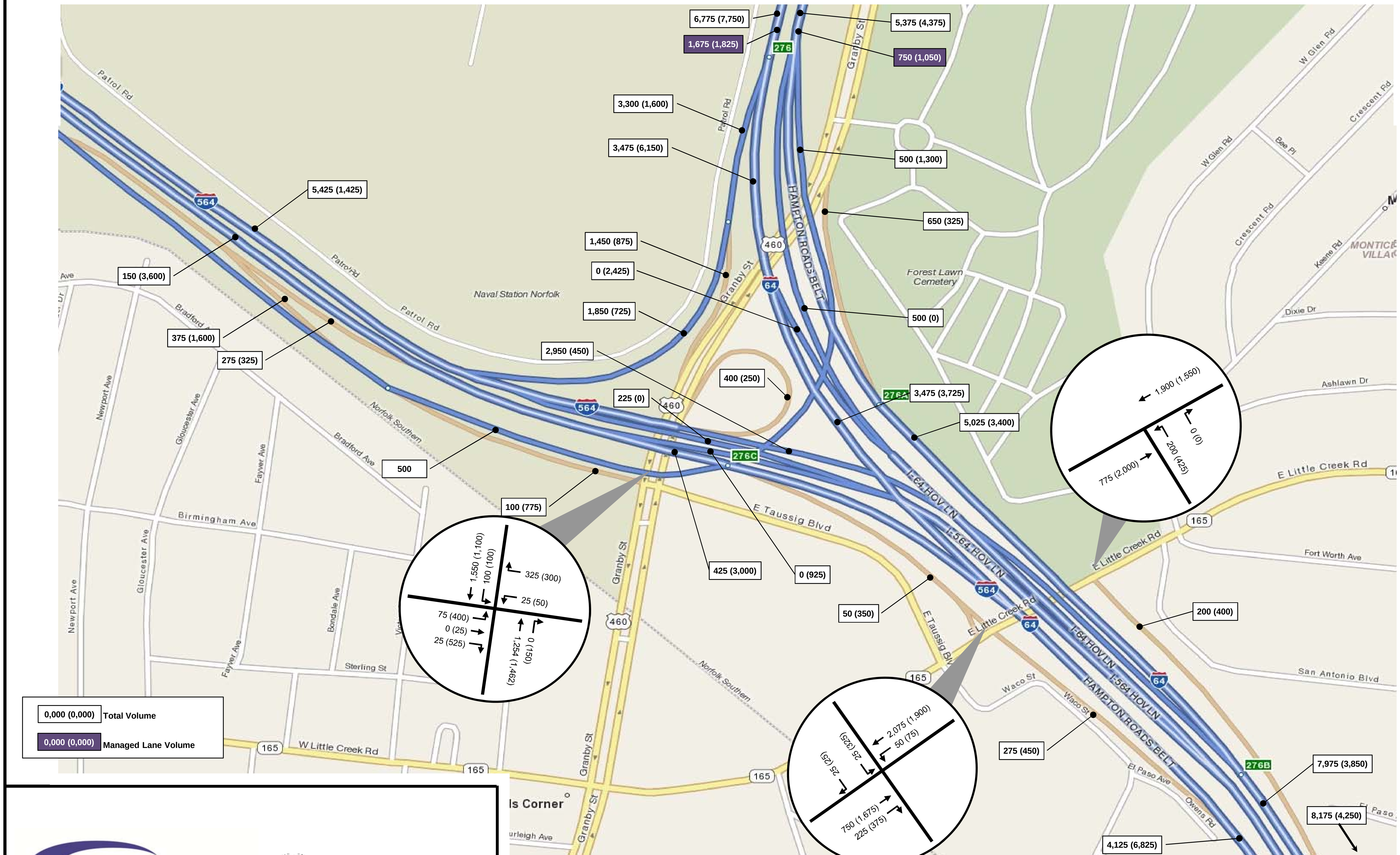
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT
AM (PM) Peak Hour Volumes

Figure E-12: Sheet 4 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

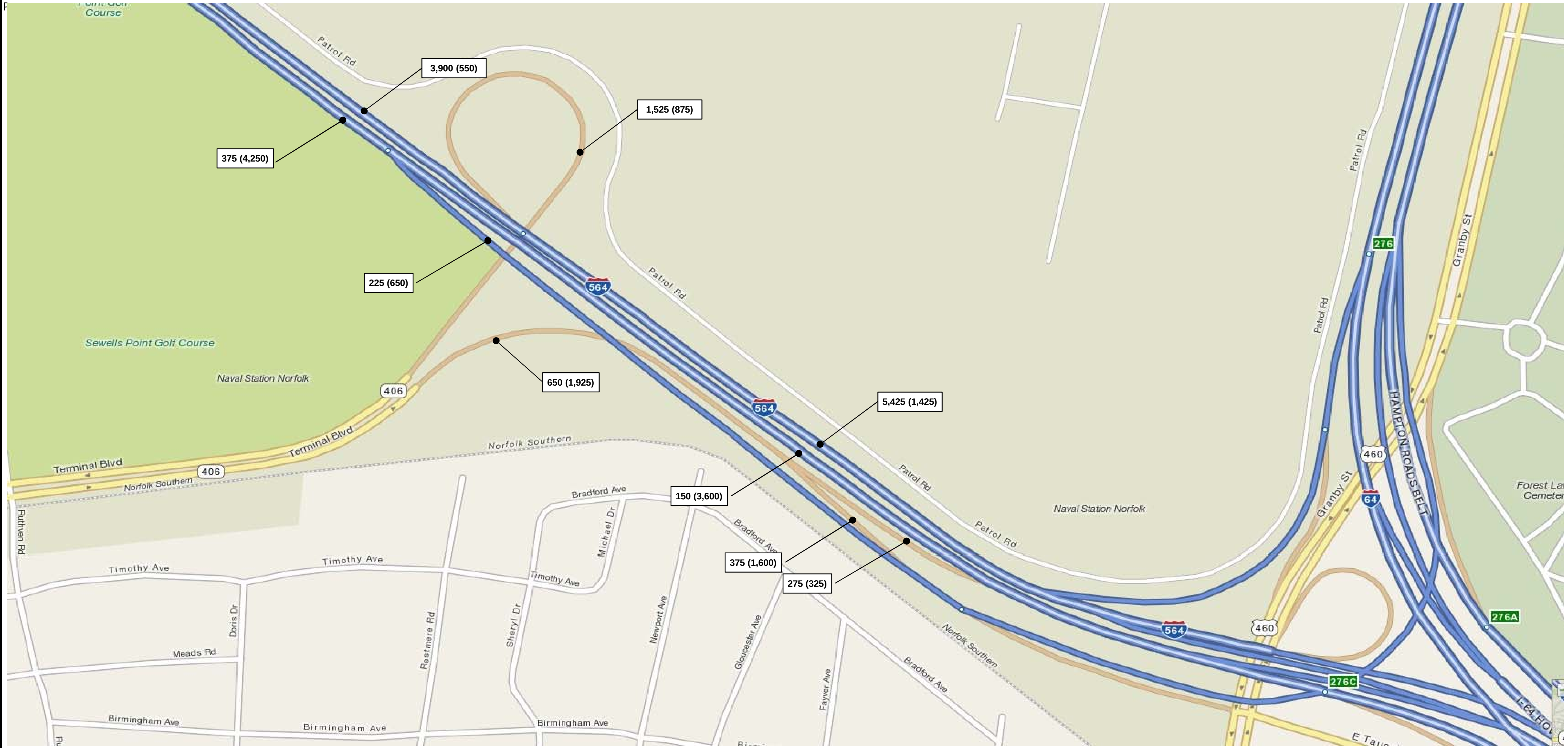
VDOT Virginia Department of Transportation

2040 Build 8 Managed - 3GP + 1HOT

AM (PM) Peak Hour Volumes

Figure E-12: Sheet 5 of 6

October 12, 2012



0,000 (0,000)	Total Volume
0,000 (0,000)	Managed Lane Volume

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

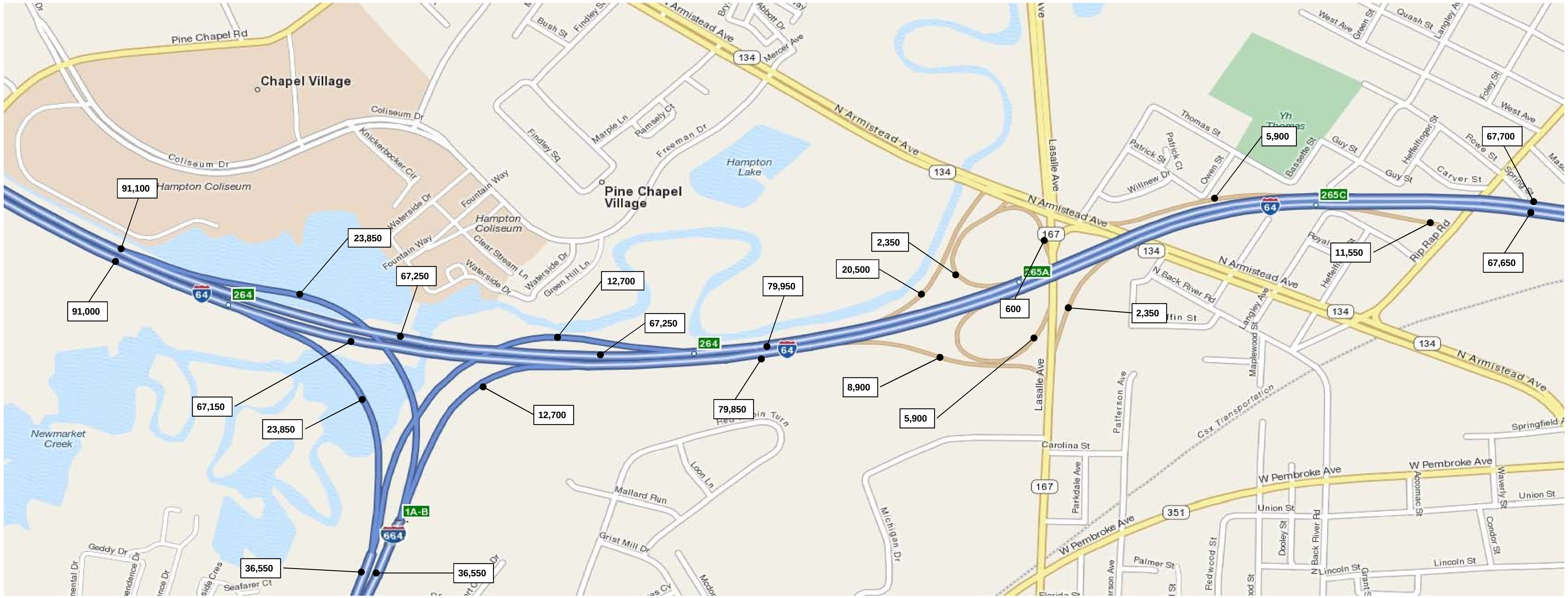
2040 Build 8 Managed - 3GP + 1HOT

AM (PM) Peak Hour Volumes

Figure E-12: Sheet 6 of 6

October 12, 2012

Appendix F. **2020/2040 Build-10 Traffic Volumes and Capacity Analysis**



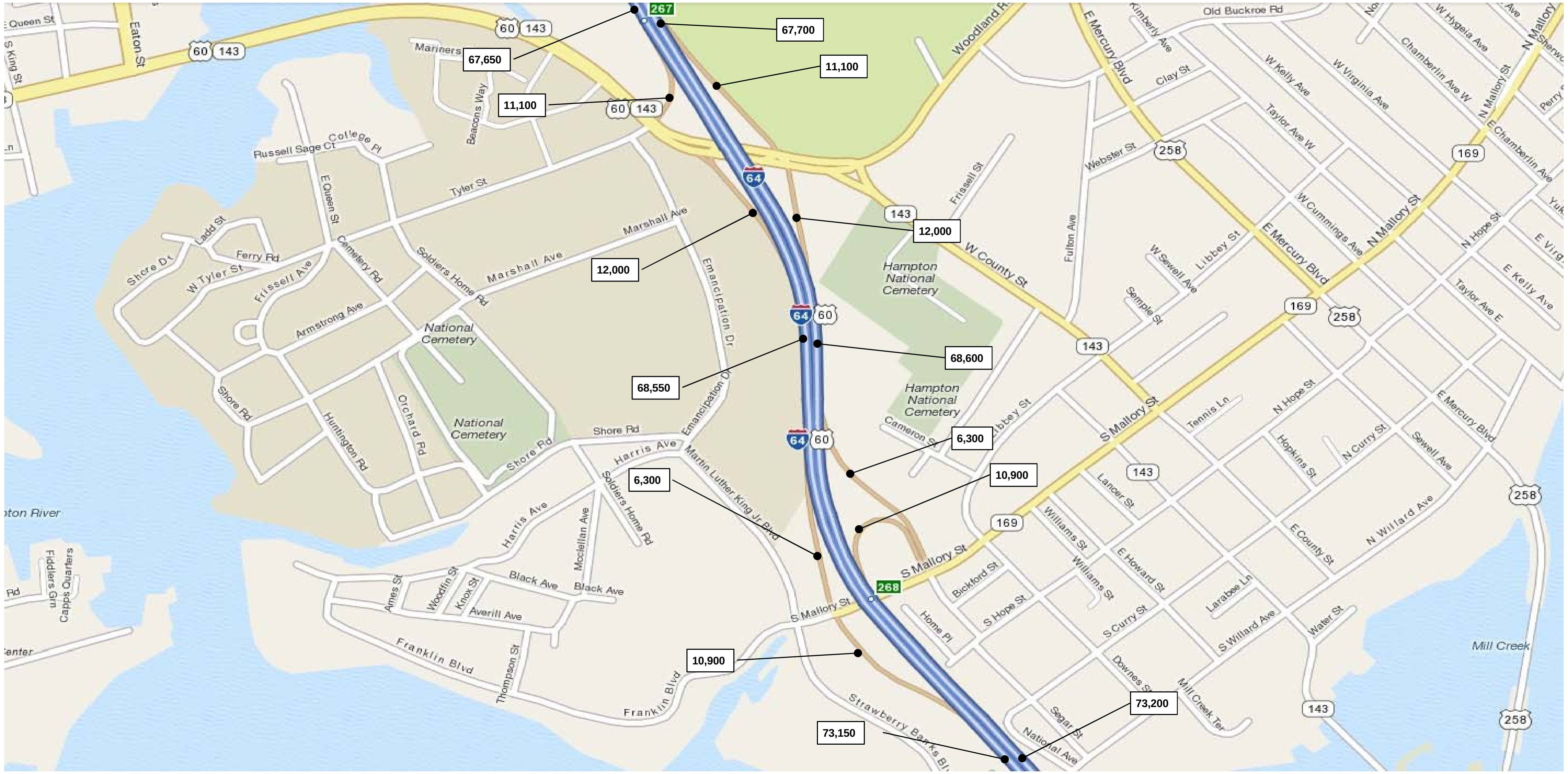
HRBT Hampton Roads Bridge Tunnel EIS

VDOT

2020 Build 10 Daily (ADT) Volumes

Figure F-1: Sheet 1 of 6

October 12, 2012

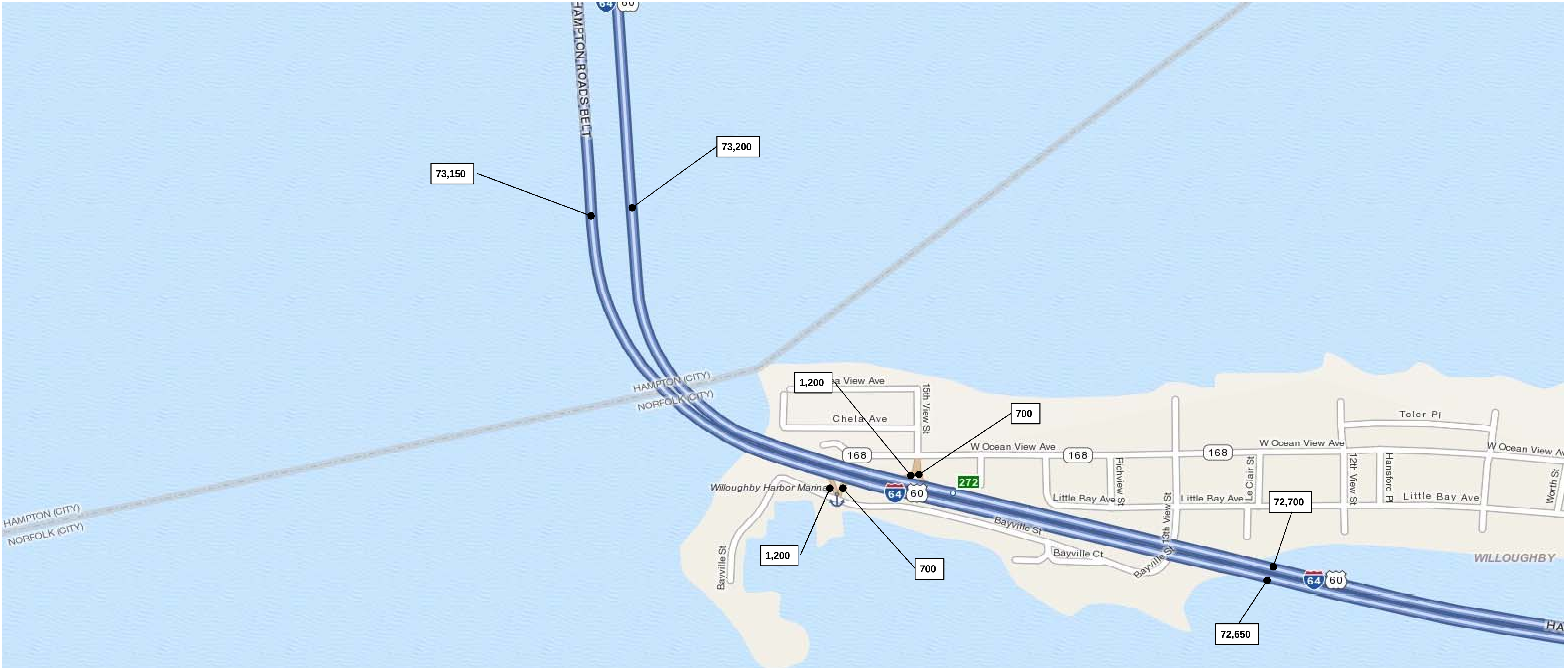


Hampton Roads Bridge Tunnel EIS

2020 Build 10 Daily (ADT) Volumes

Figure F-1: Sheet 2 of 6

October 12, 2012



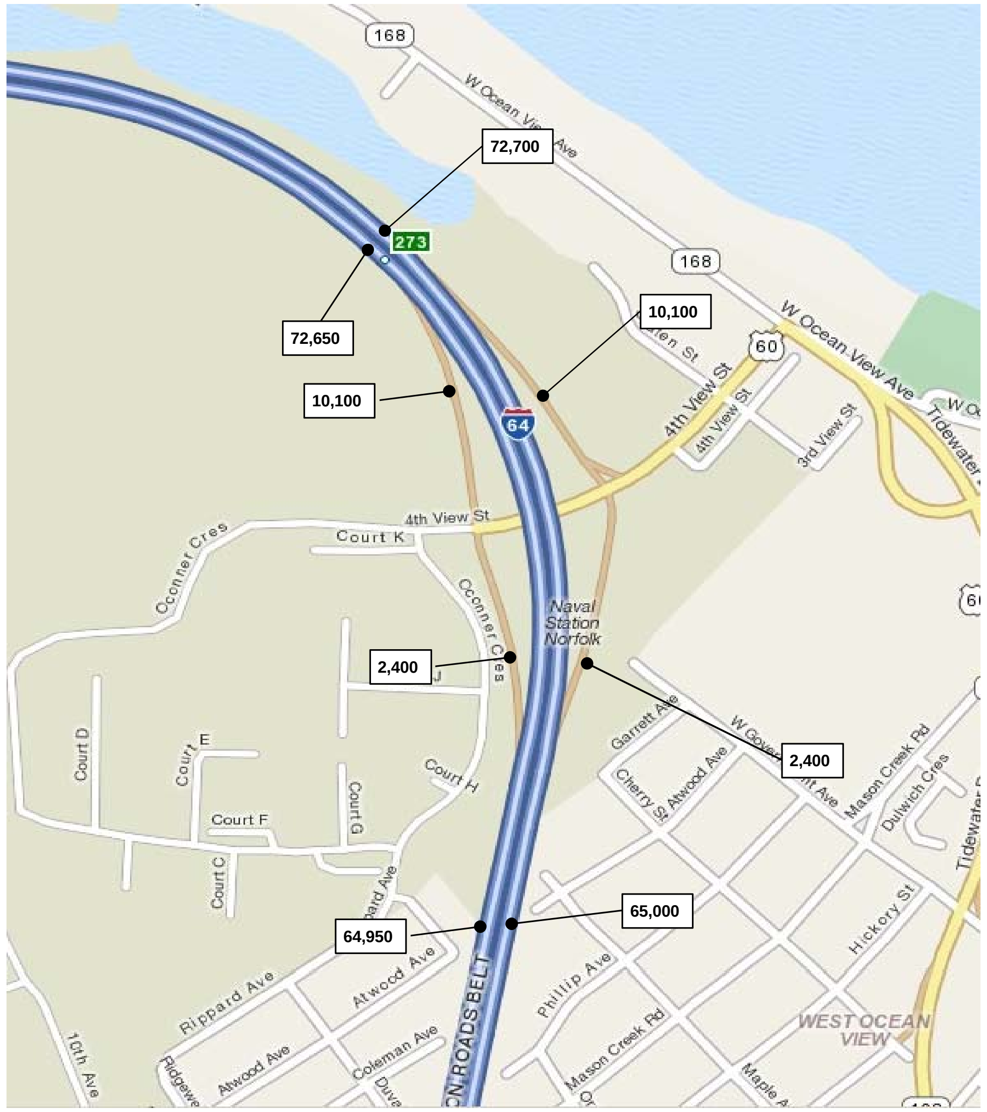
2020 Build 10 Daily (ADT) Volumes

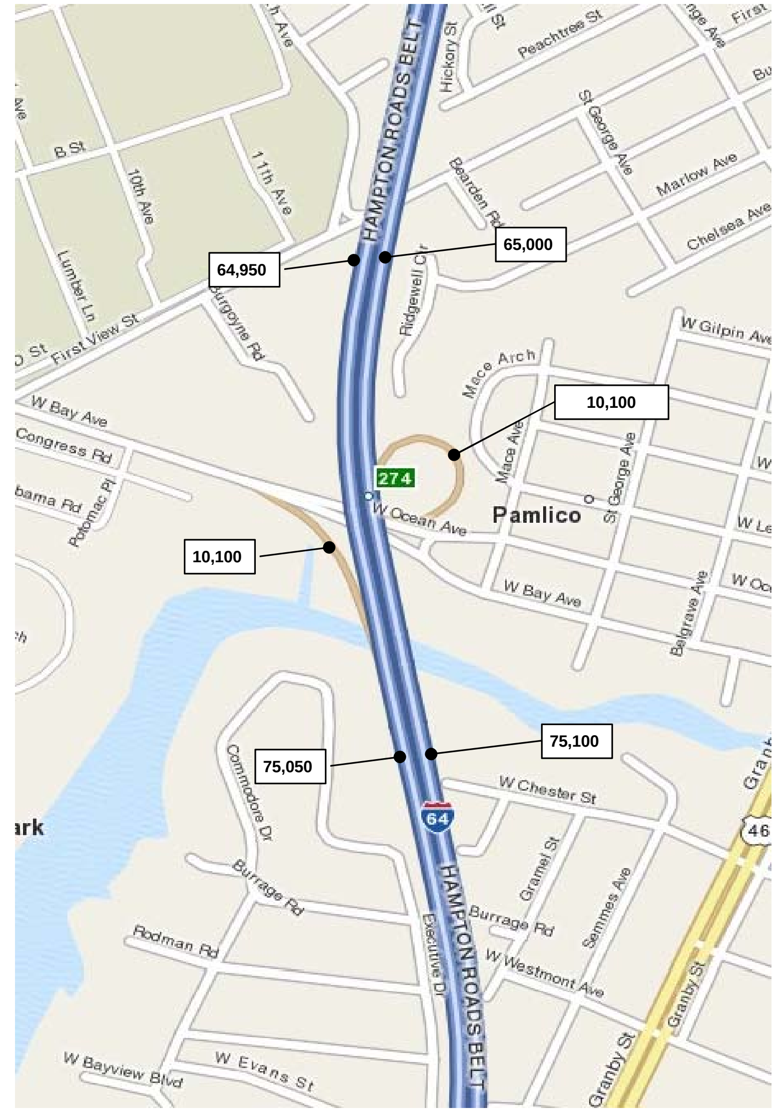
Figure F-1: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

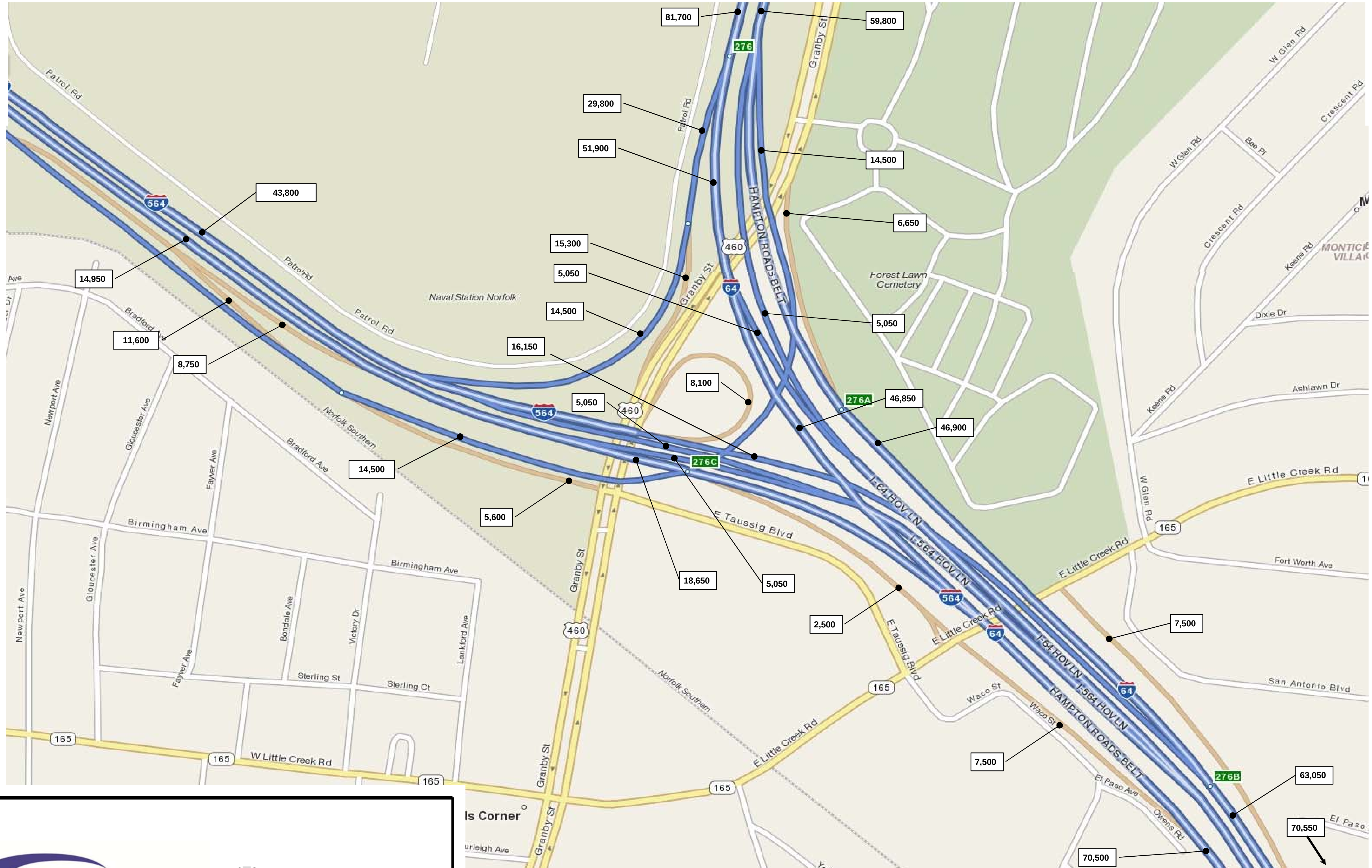




2020 Build 10 Daily (ADT) Volumes

Figure F-1: Sheet 4 of 6

October 12, 2012



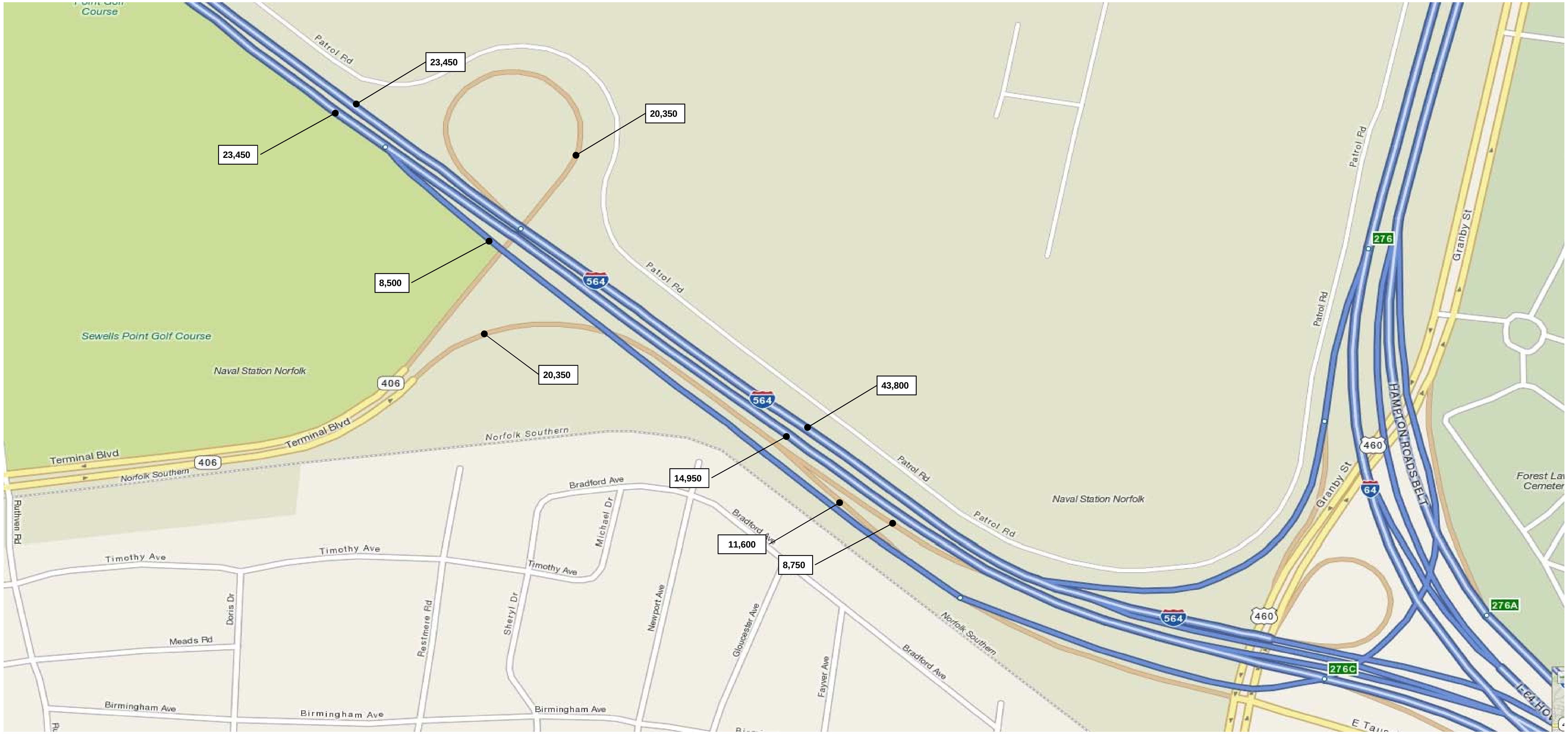
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 Daily (ADT) Volumes

Figure F-1: Sheet 5 of 6

October 12, 2012



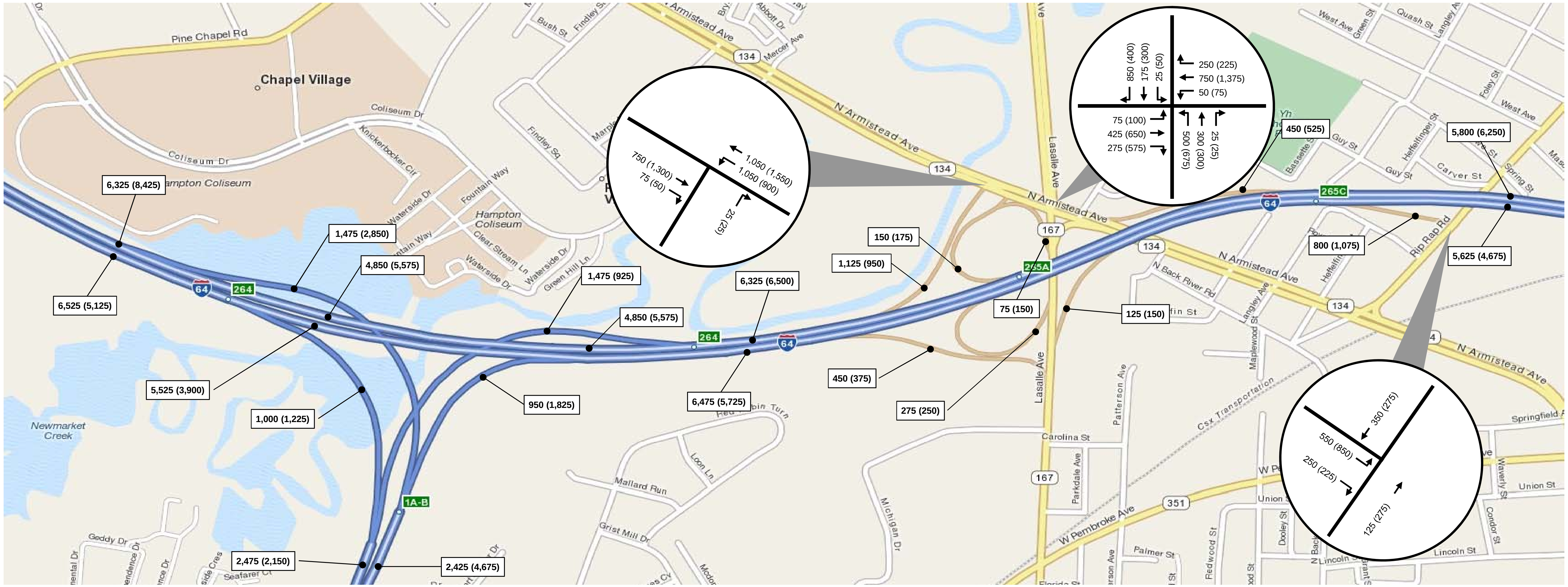
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 Daily (ADT) Volumes

Figure F-1: Sheet 6 of 6

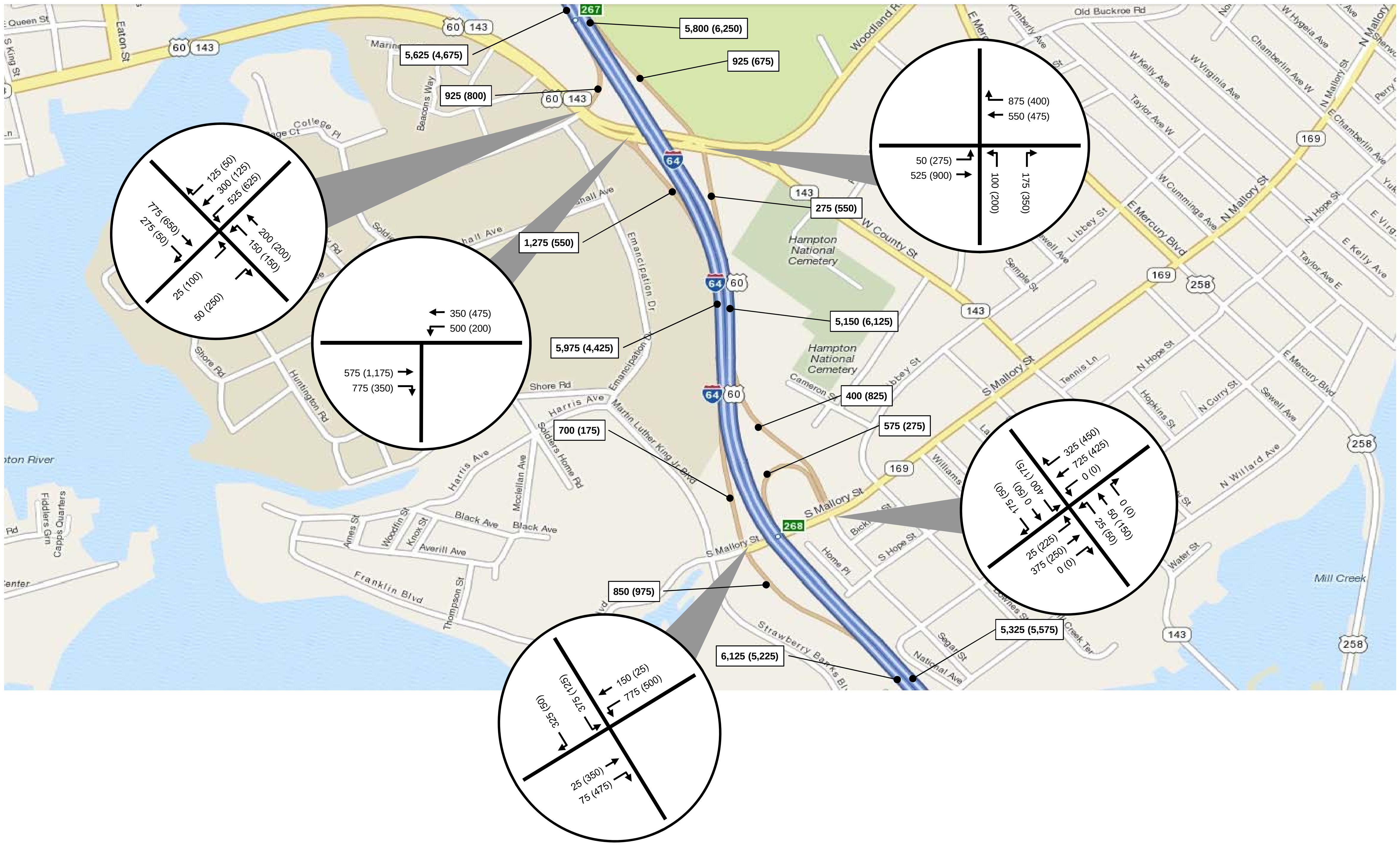
October 12, 2012



2020 Build 10 AM (PM) Peak Hour Volumes

Figure F-2: Sheet 1 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Peak Hour Volumes

Figure F-2: Sheet 2 of 6

October 12, 2012

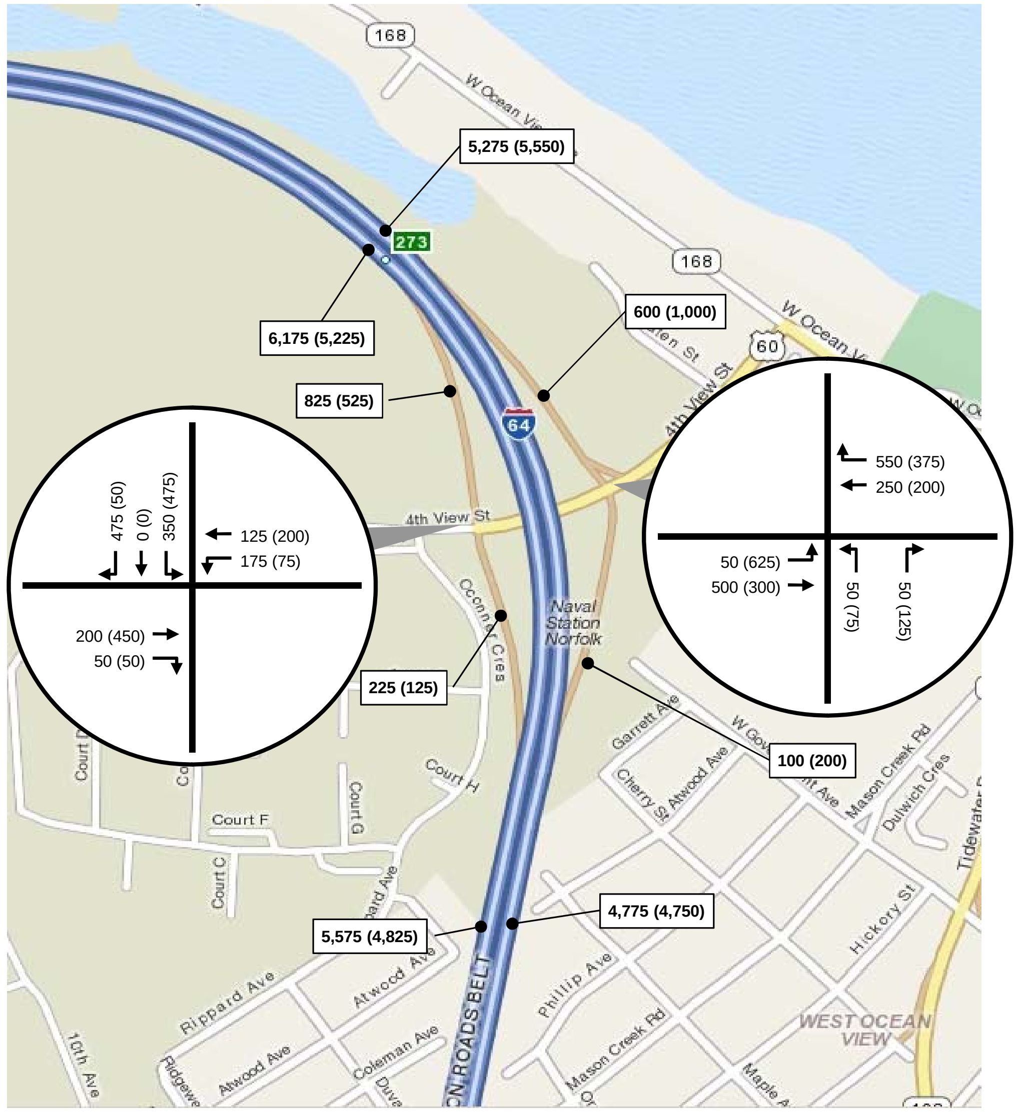
2020 Build 10 AM (PM) Peak Hour Volumes

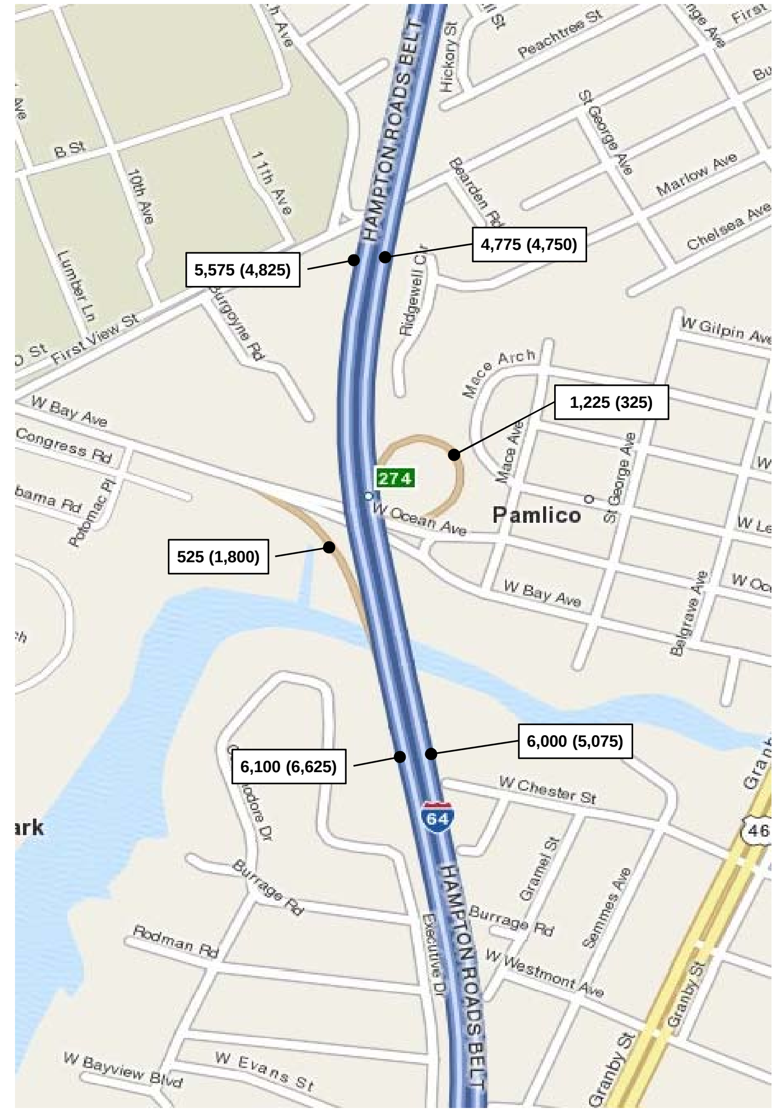
Figure F-2: Sheet 3 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation





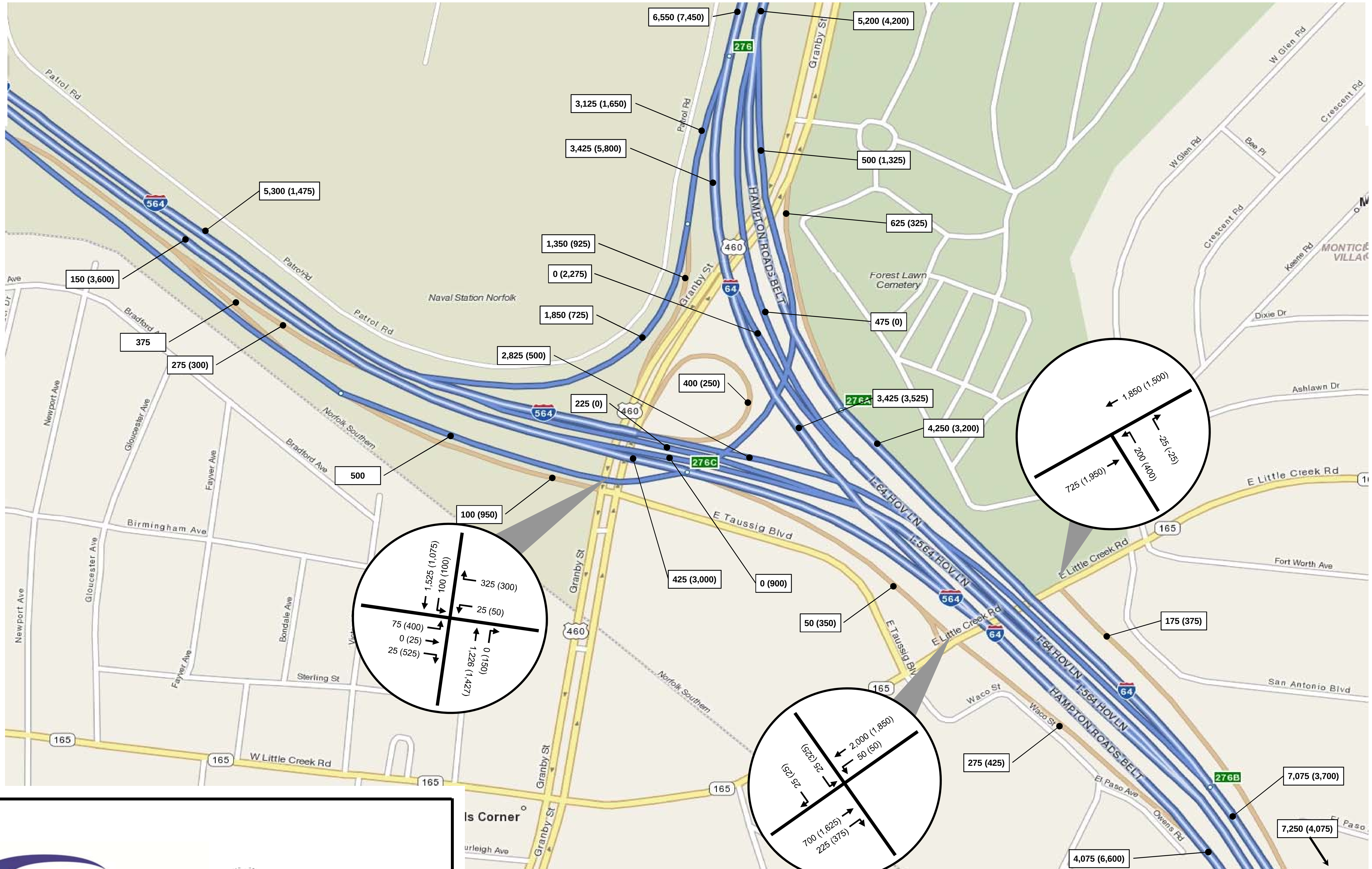
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Peak Hour Volumes

Figure F-2: Sheet 4 of 6

October 12, 2012



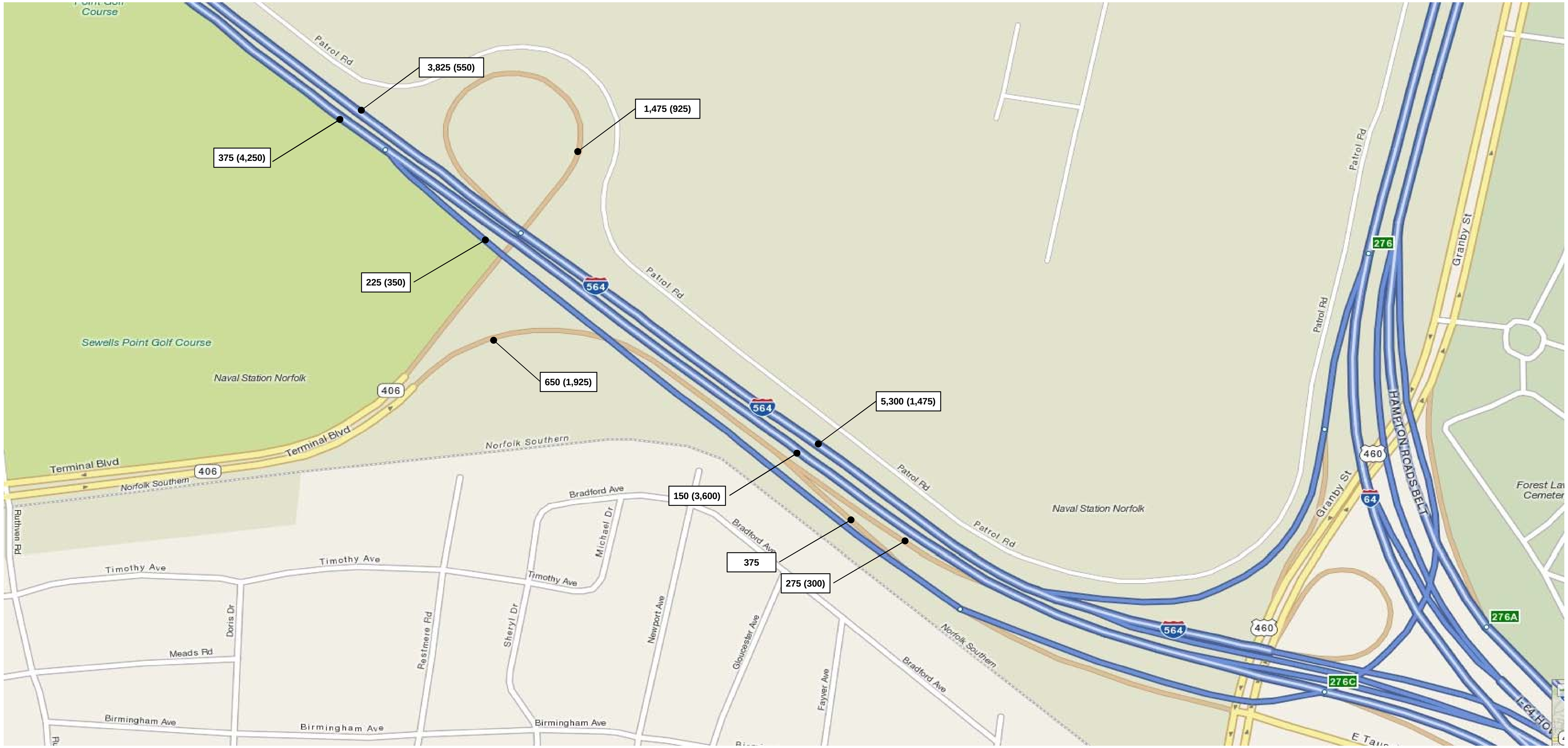
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Peak Hour Volumes

Figure F-2: Sheet 5 of 6

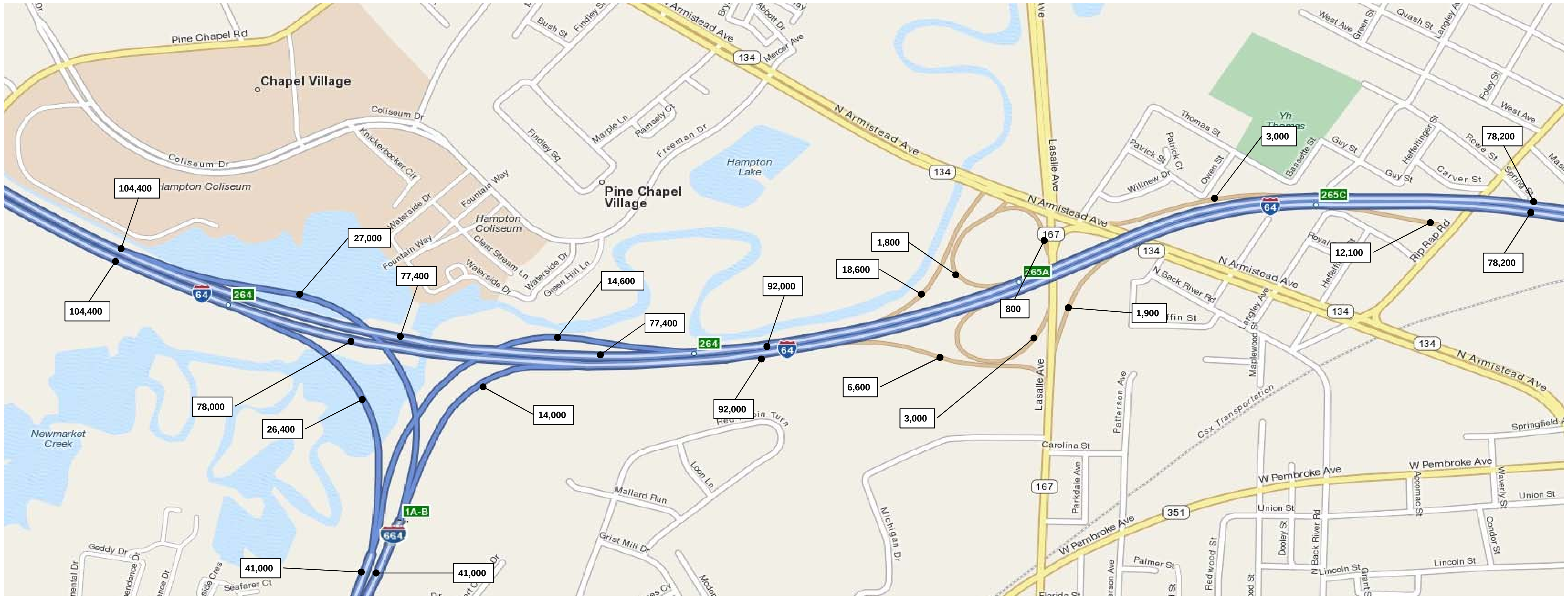
October 12, 2012



2020 Build 10 AM (PM) Peak Hour Volumes

Figure F-2: Sheet 6 of 6

October 12, 2012



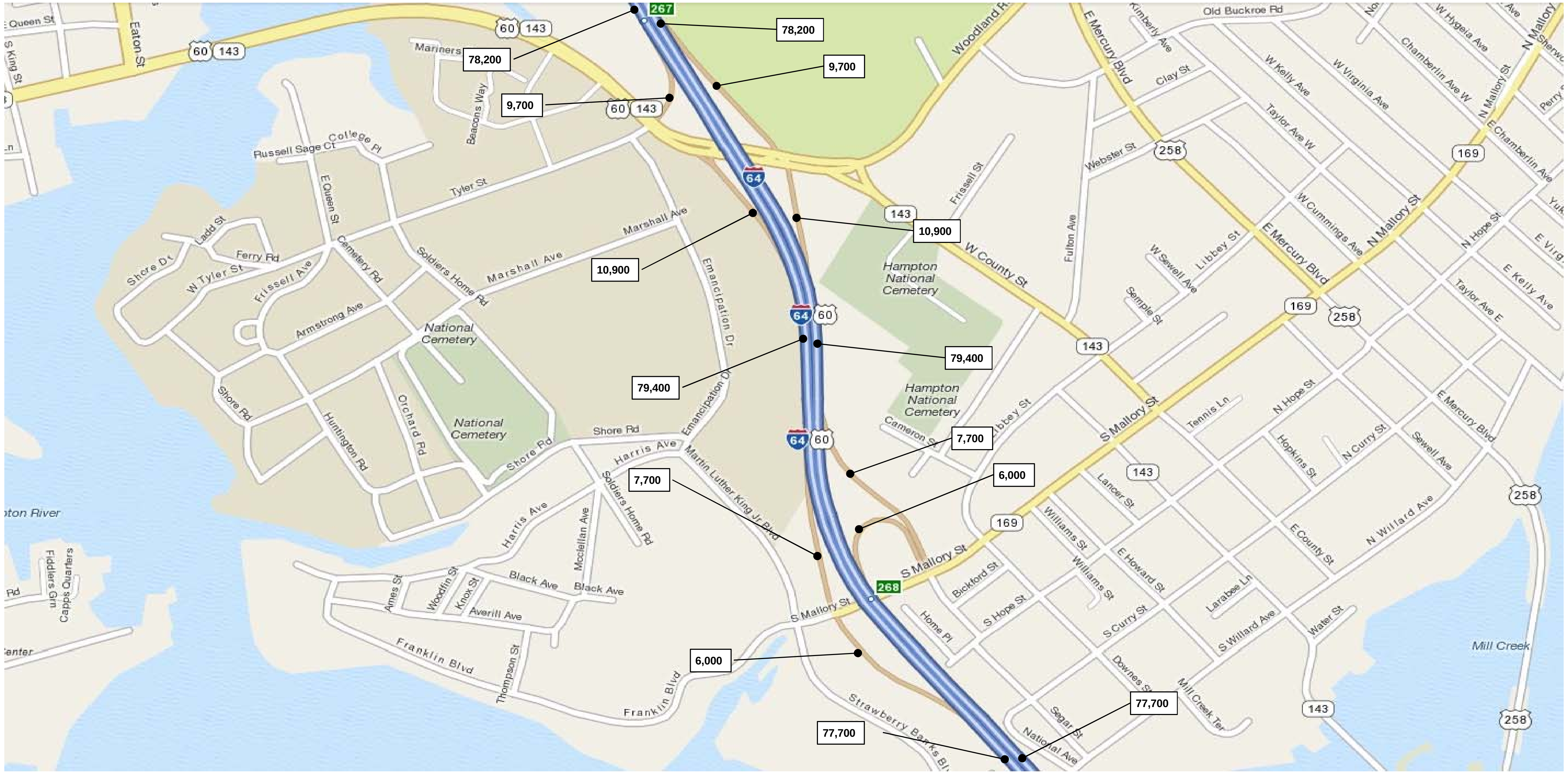
2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 1 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



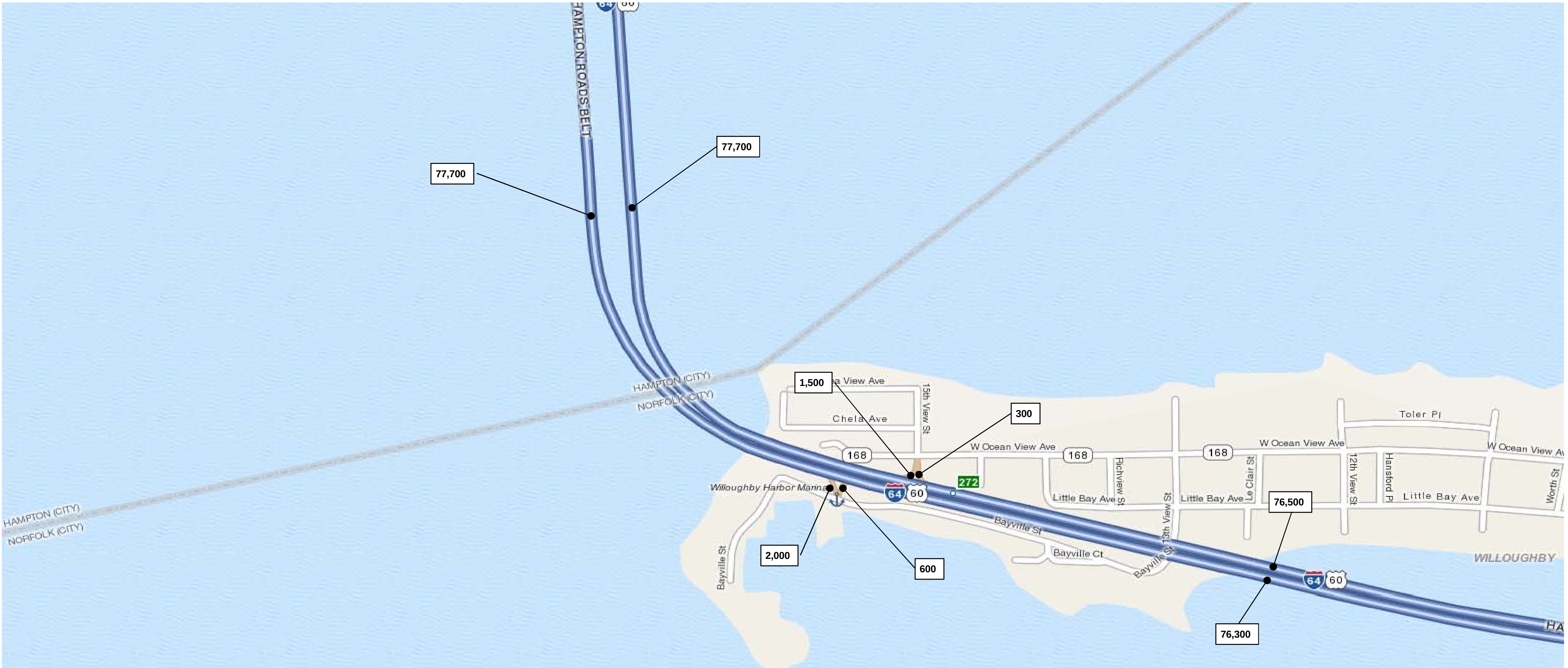
Hampton Roads Bridge Tunnel EIS

VDOT

2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 2 of 6

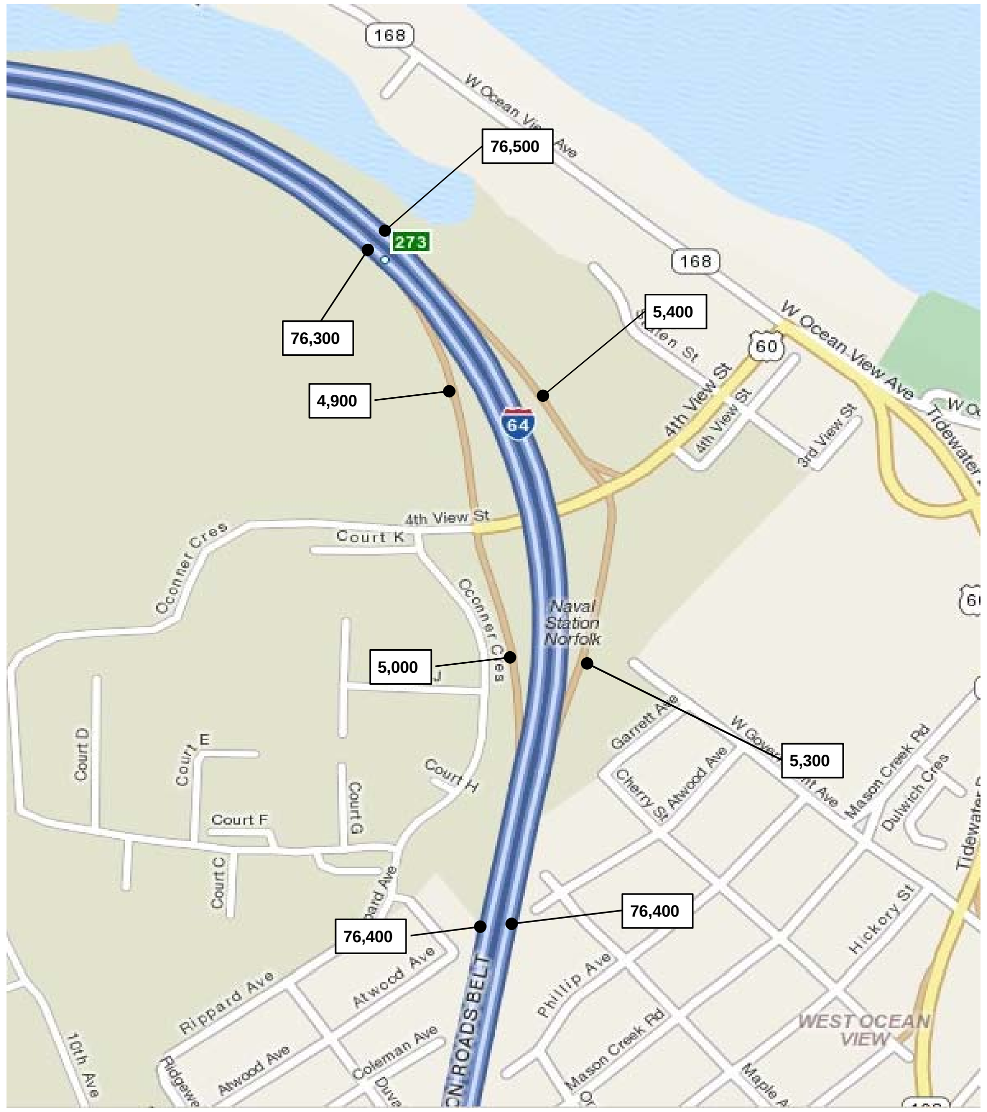
October 12, 2012

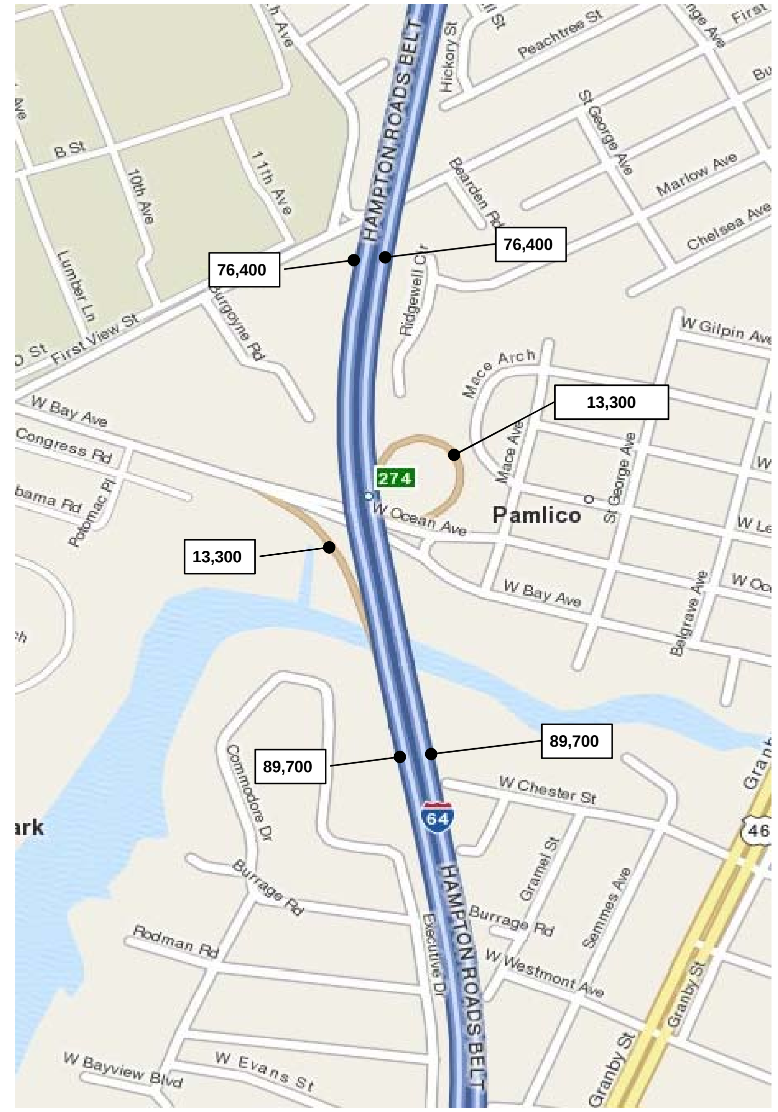


2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 3 of 6

October 12, 2012





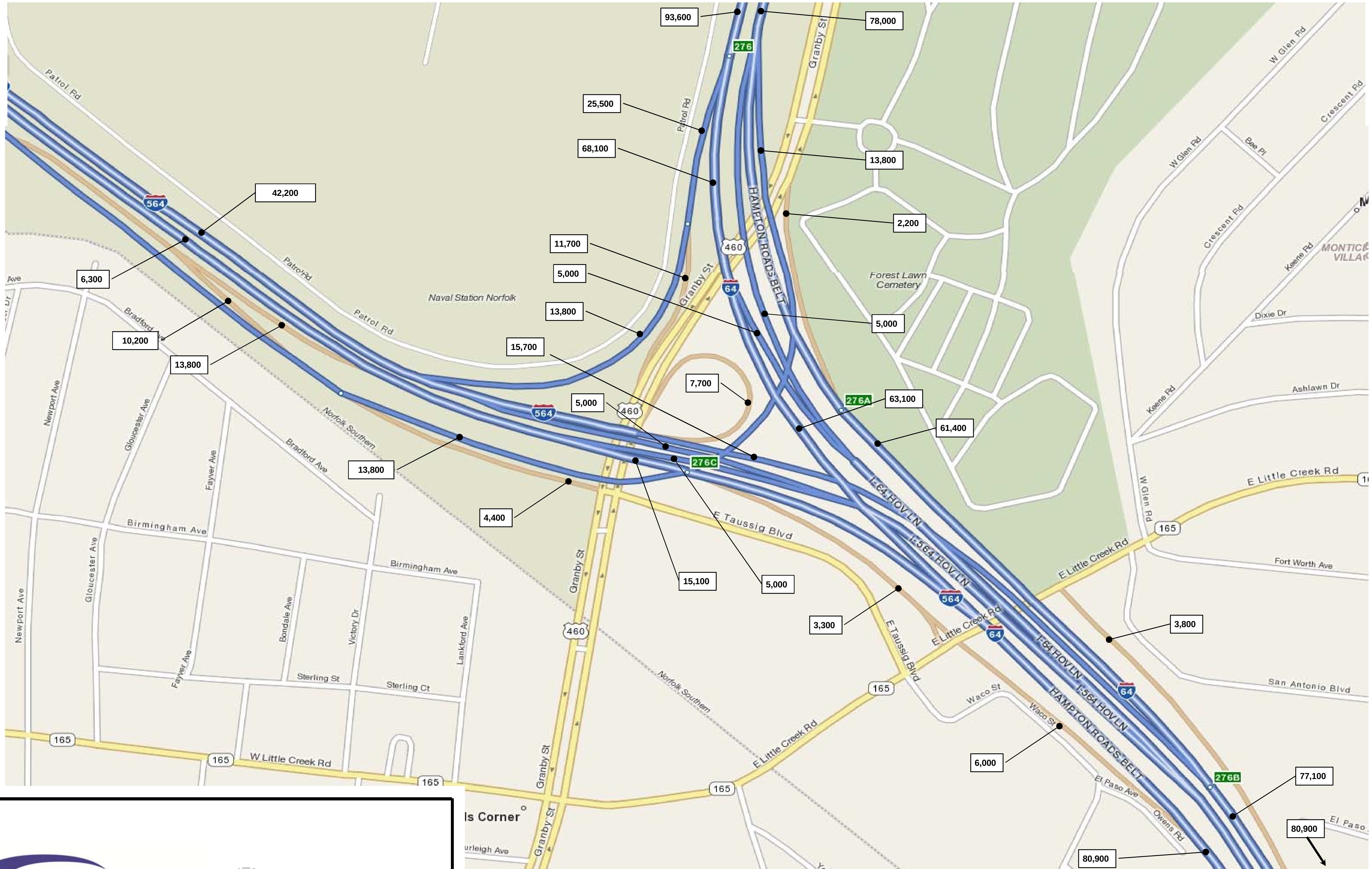
Hampton Roads Bridge Tunnel EIS

VDOT
Virginia Department of Transportation

2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 4 of 6

October 12, 2012



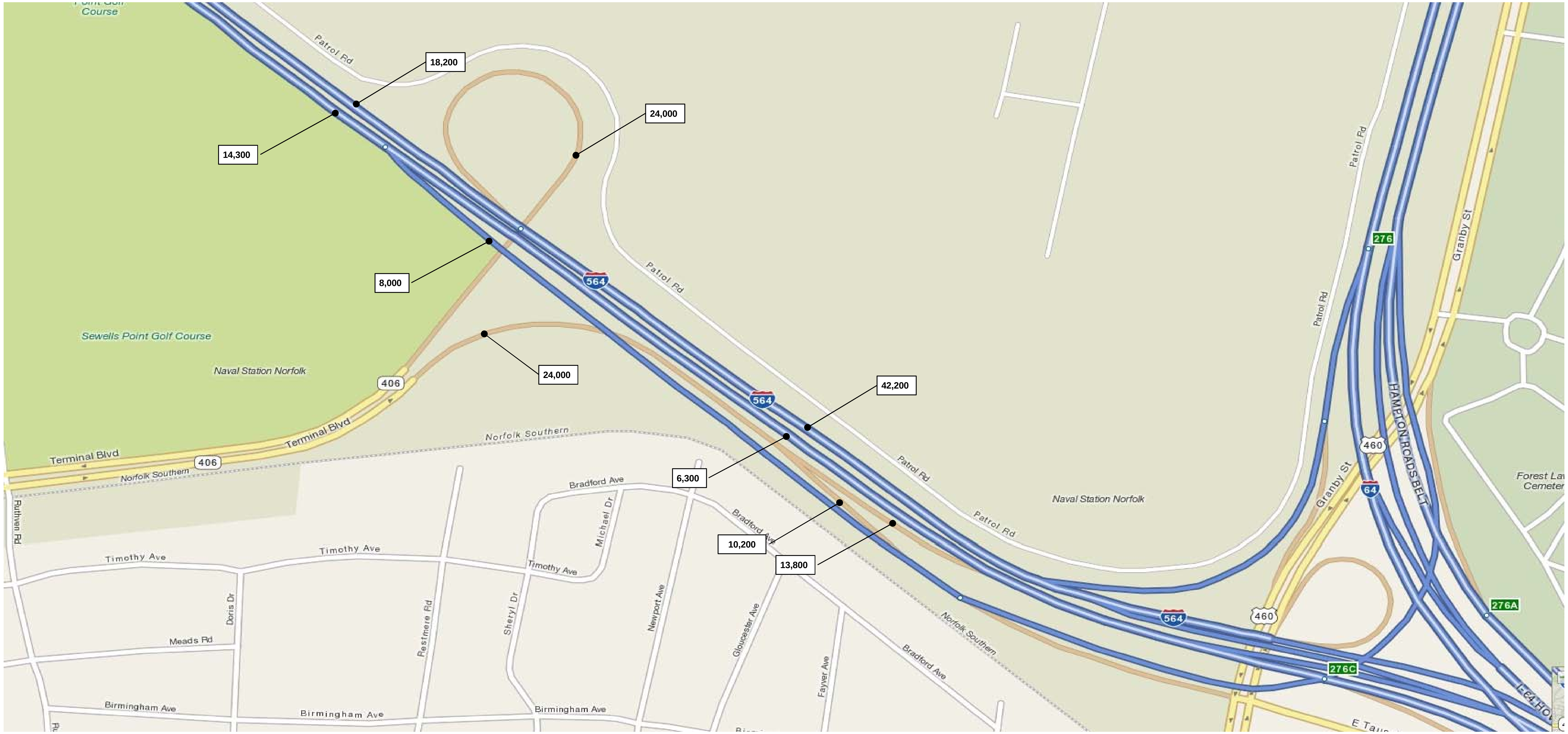
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 5 of 6

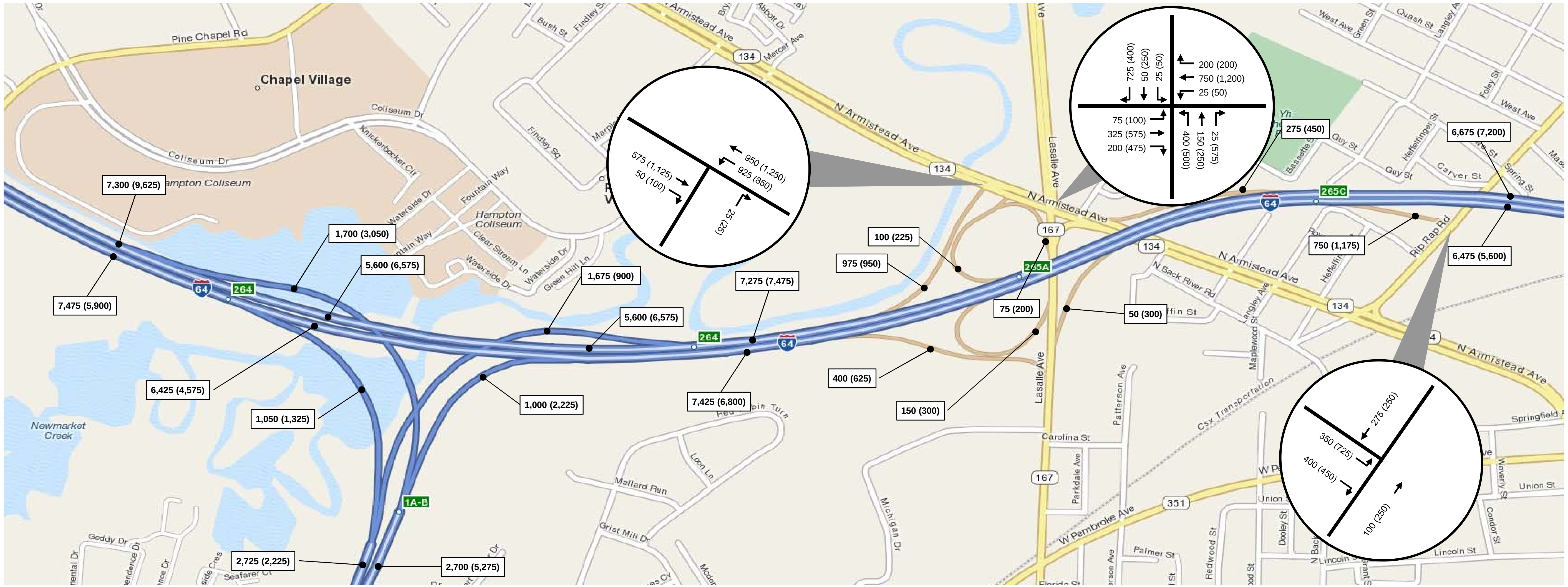
October 12, 2012



2040 Build 10 Daily (ADT) Volumes

Figure F-3: Sheet 6 of 6

October 12, 2012



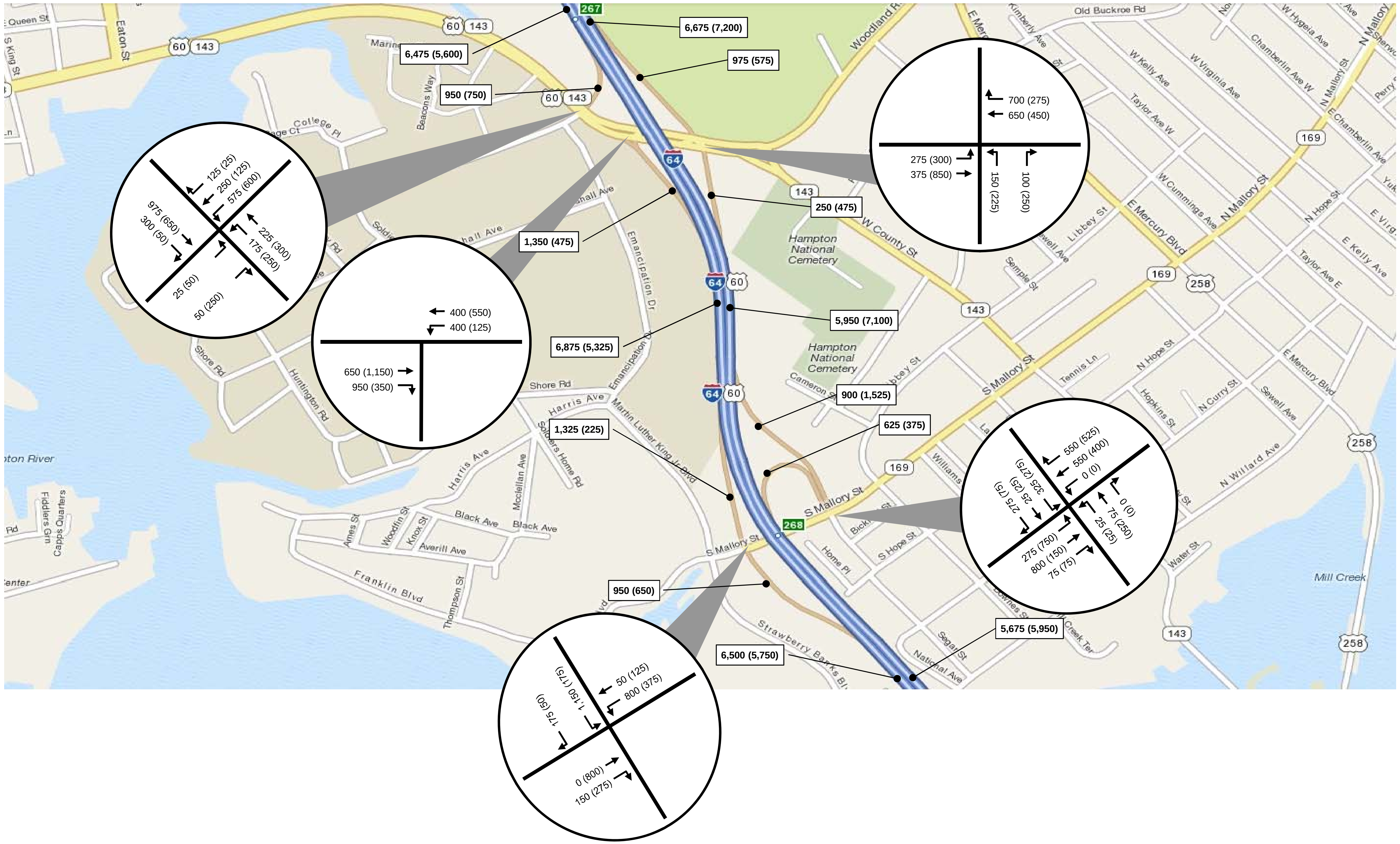
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 AM (PM) Peak Hour Volumes

Figure F-4: Sheet 1 of 6

October 12, 2012



HRBT
Hampton Roads Bridge Tunnel EIS

VDOT
Virginia Department of Transportation

2040 Build 10 AM (PM) Peak Hour Volumes

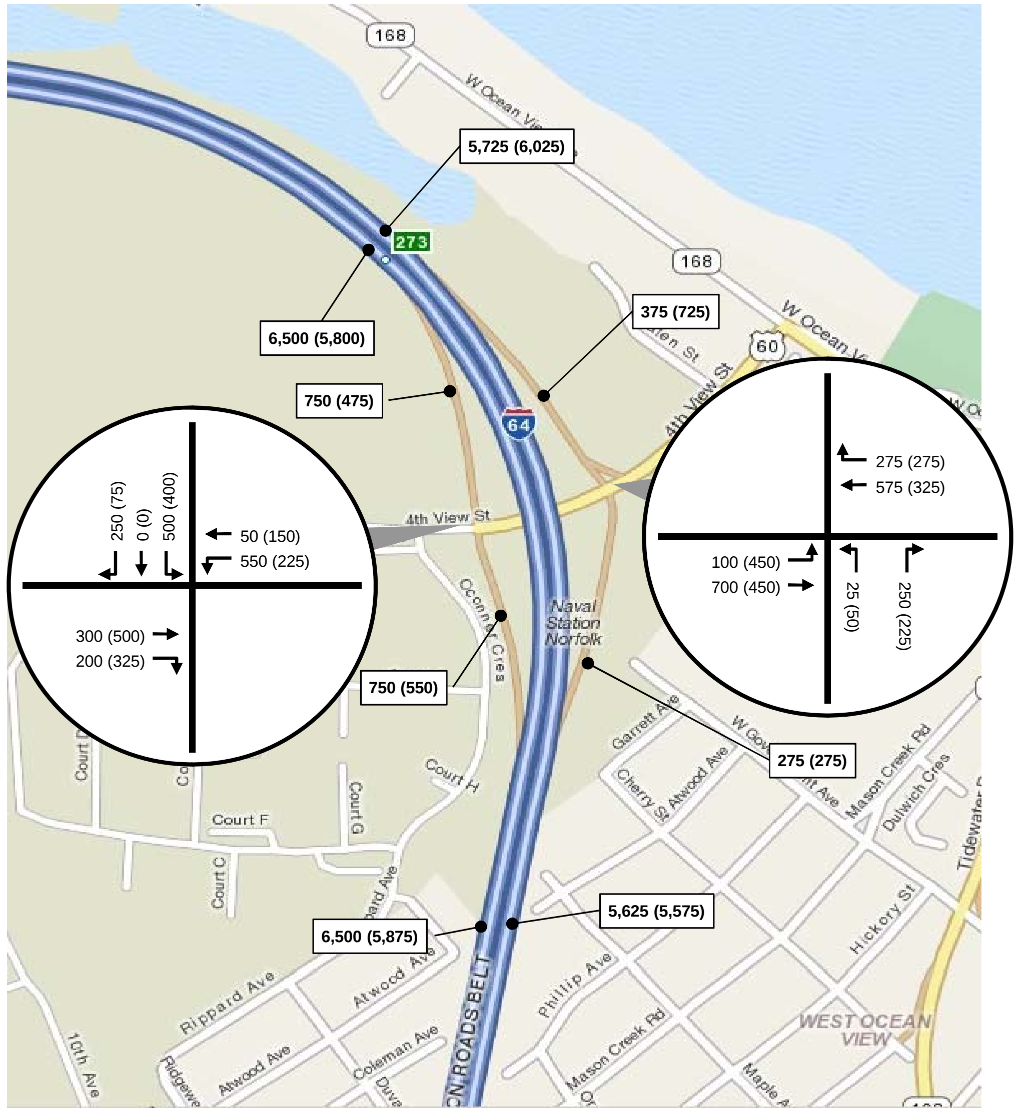
Figure F-4: Sheet 2 of 6

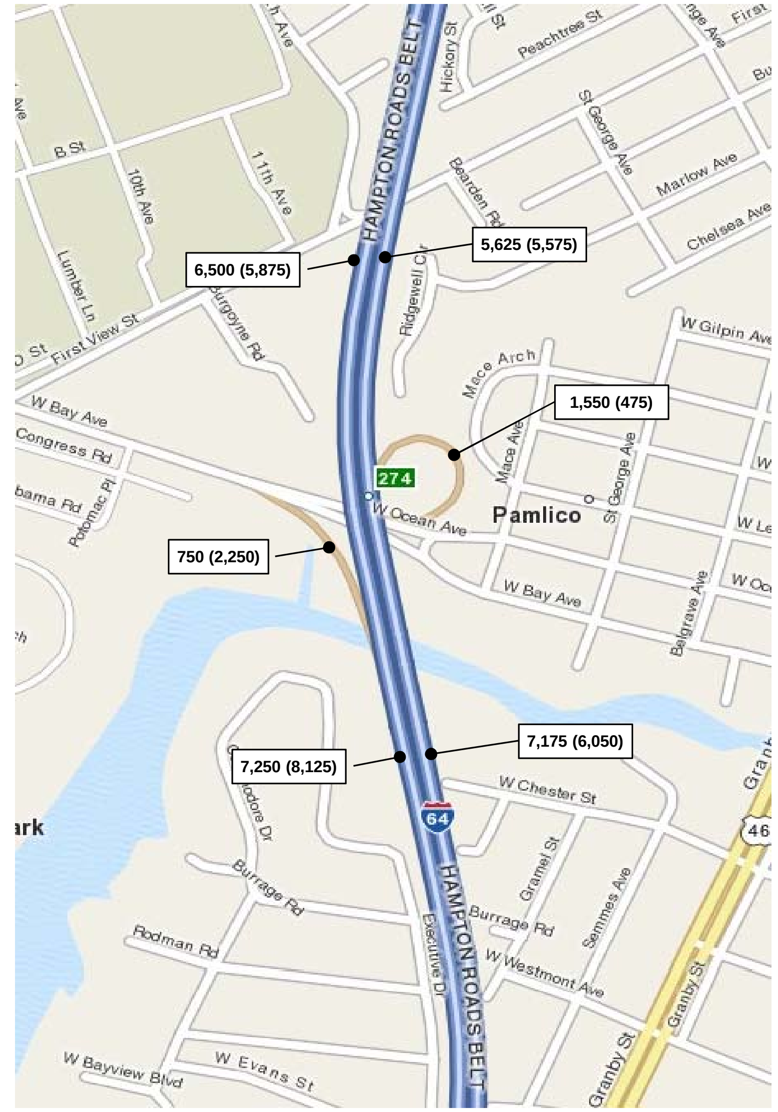
October 12, 2012

2040 Build 10 AM (PM) Peak Hour Volumes

Figure F-4: Sheet 3 of 6

October 12, 2012





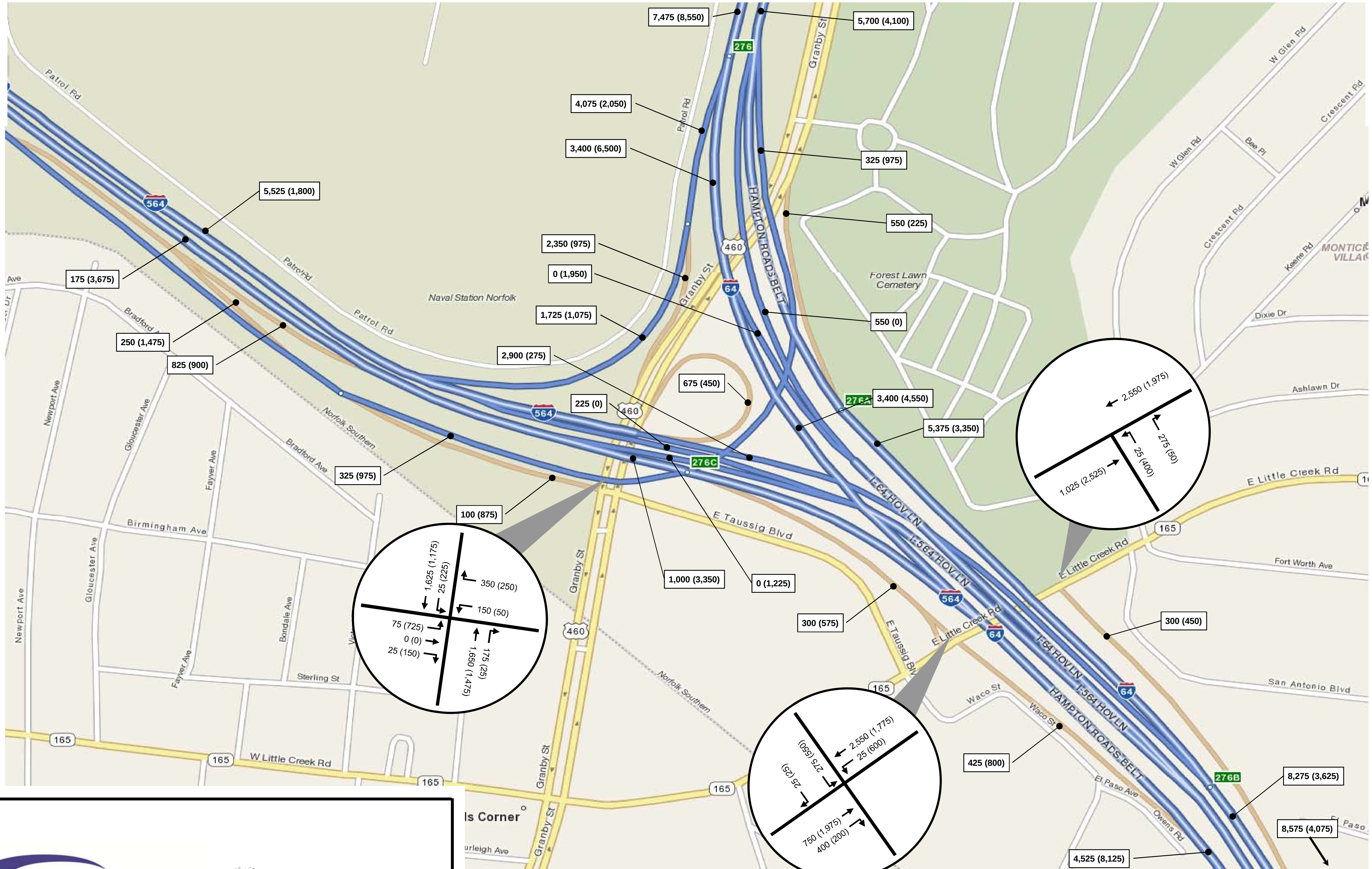
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 AM (PM) Peak Hour Volumes

Figure F-4: Sheet 4 of 6

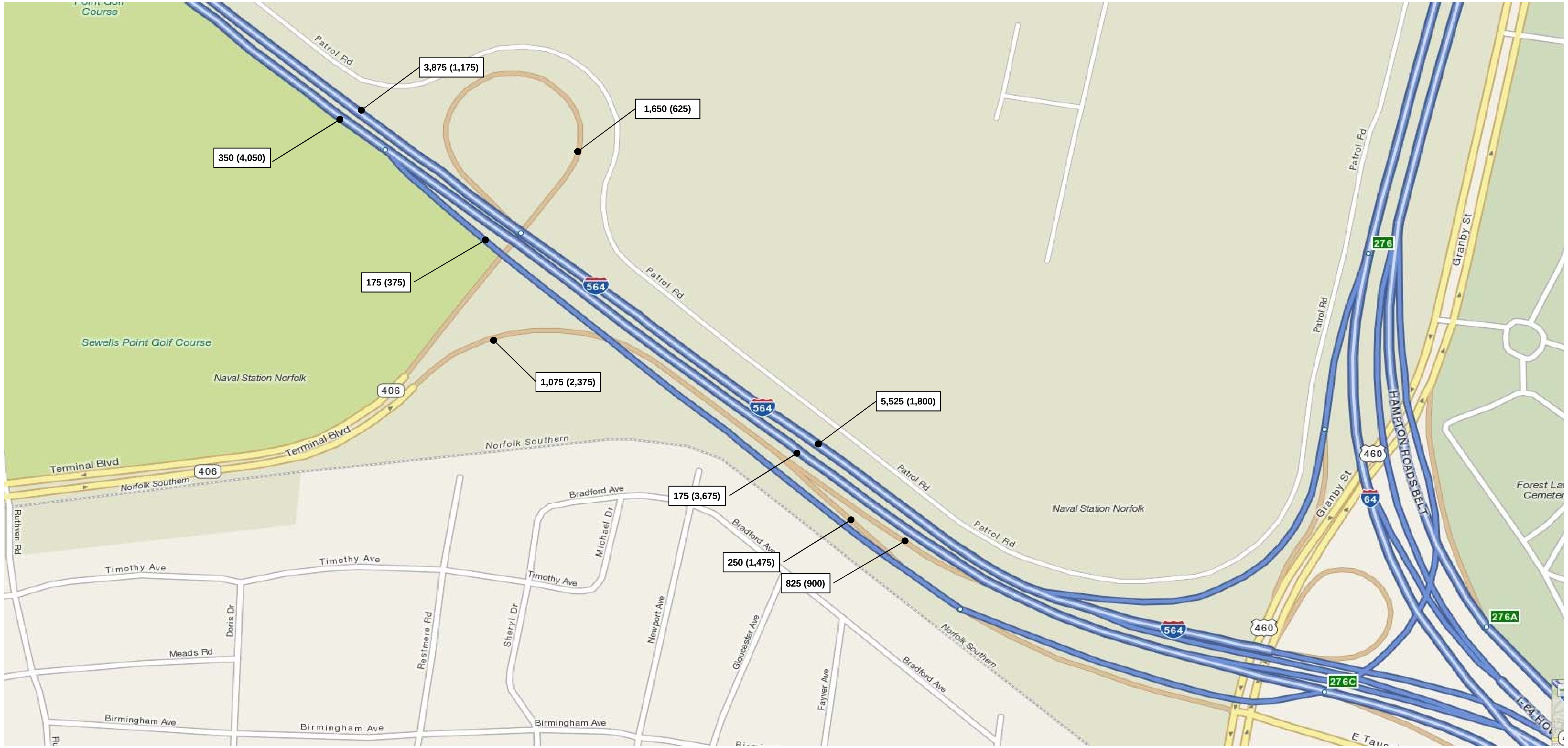
October 12, 2012



2040 Build 10 AM (PM) Peak Hour Volumes

Figure F-4: Sheet 5 of 6

October 12, 2012



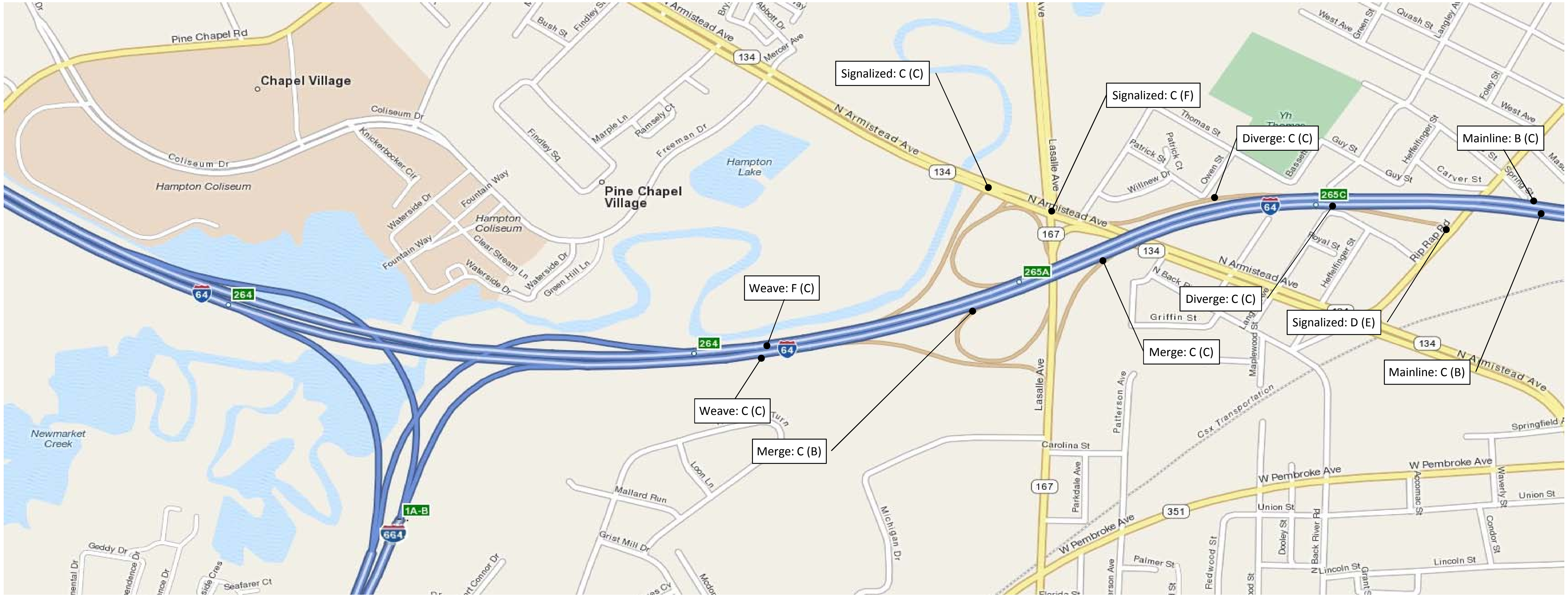
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 AM (PM) Peak Hour Volumes

Figure F-4: Sheet 6 of 6

October 12, 2012



Note: Analysis results should be used with caution, as volumes and lane configurations are at the limits of the HCM methodology

HRBT Hampton Roads Bridge Tunnel EIS

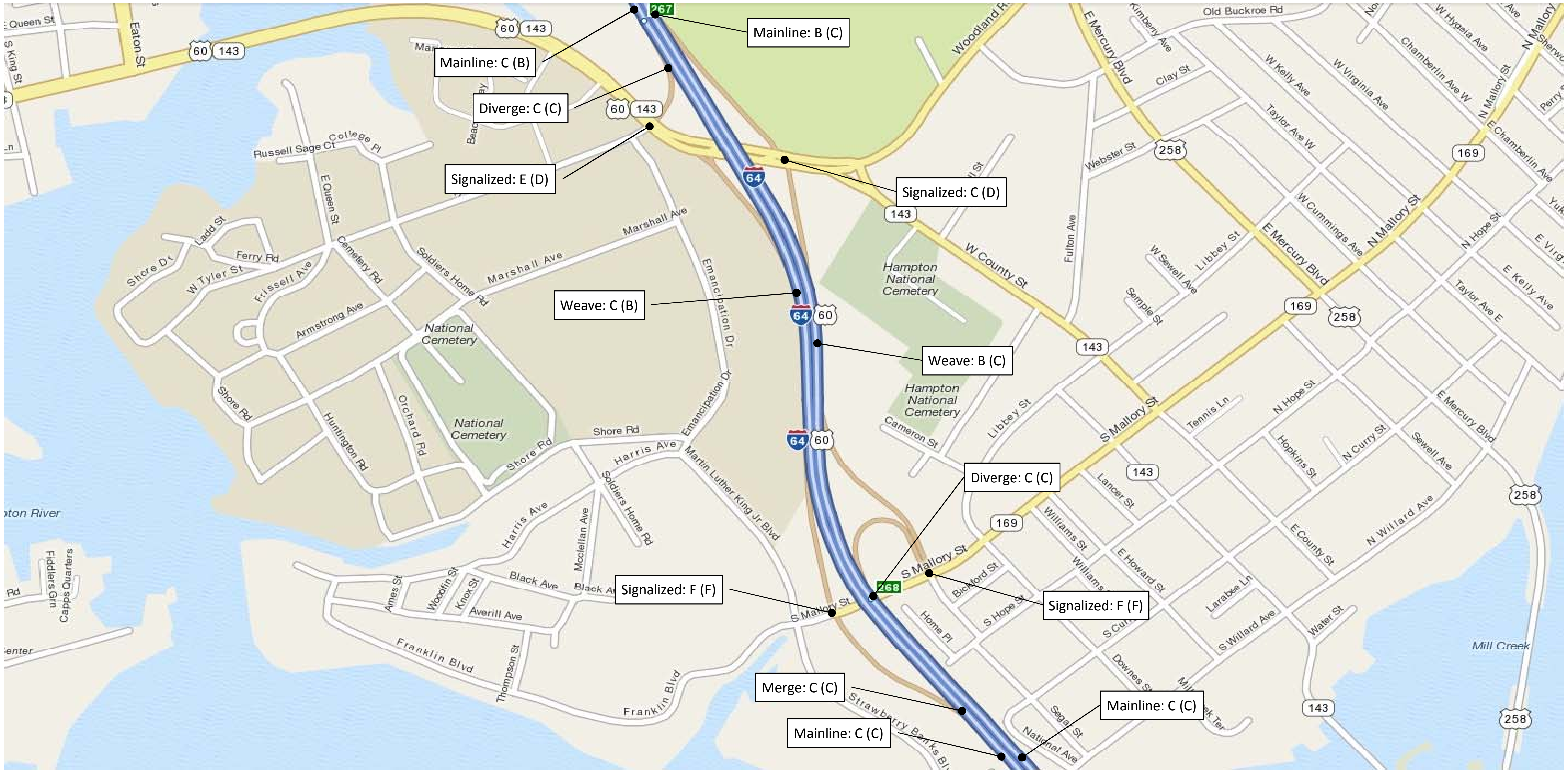
VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Level of Service

(10 total lanes crossing HRBT)

Figure F-5: Sheet 1 of 6

October 12, 2012



HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Level of Service

(10 total lanes crossing HRBT)

Figure F-5: Sheet 2 of 6

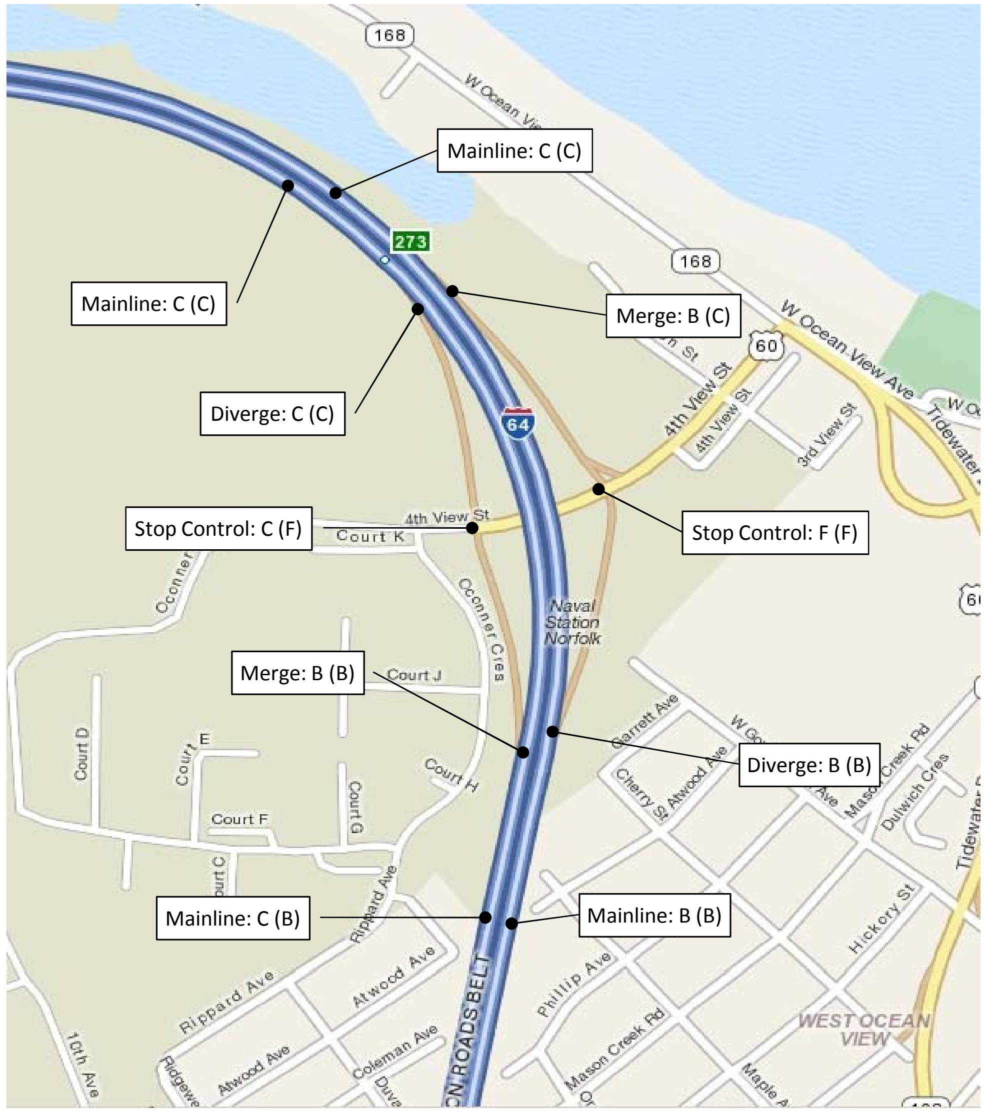
October 12, 2012

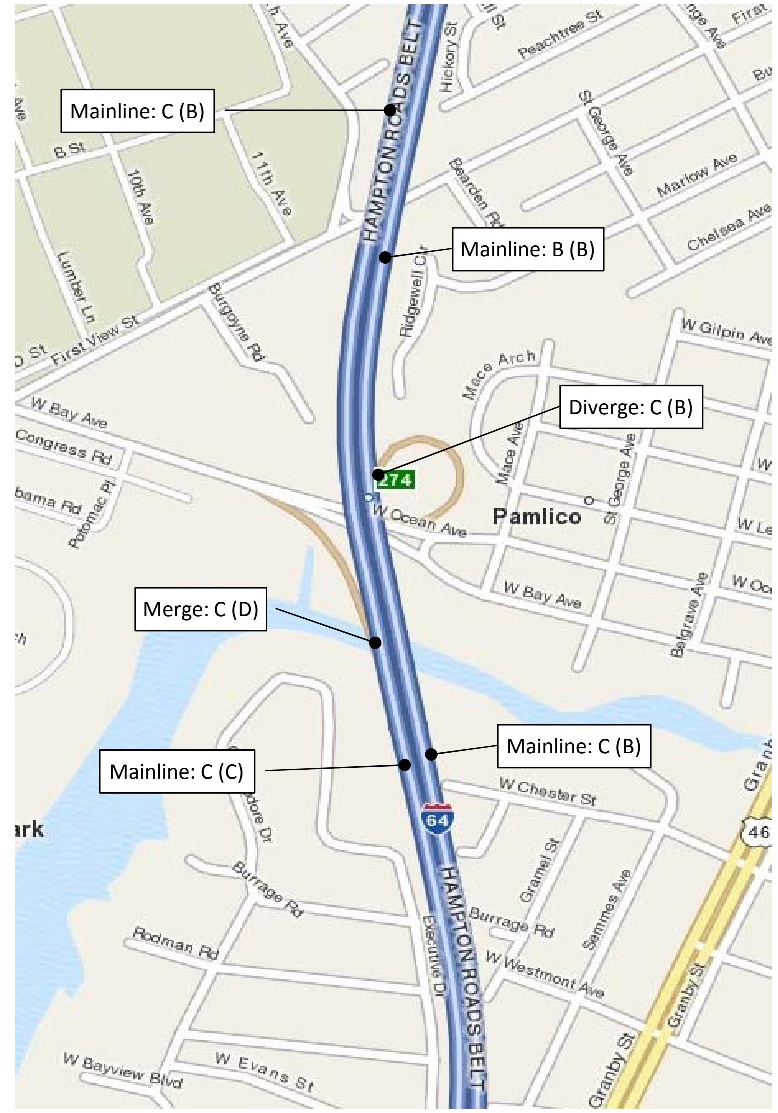
2020 Build 10 AM (PM) Level of Service

(10 total lanes crossing HRBT)

Figure F-5: Sheet 3 of 6

October 12, 2012





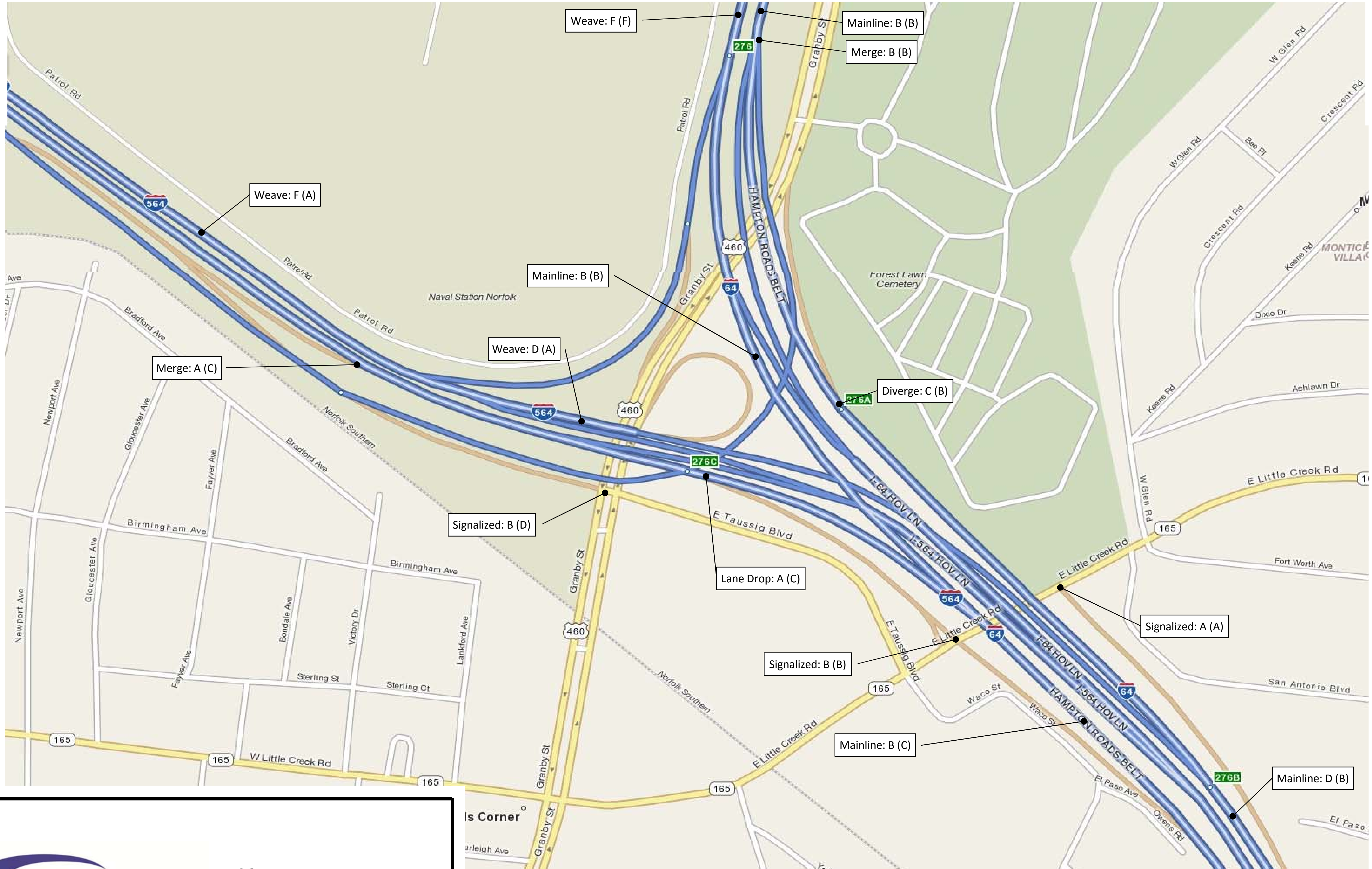
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2020 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-5: Sheet 4 of 6

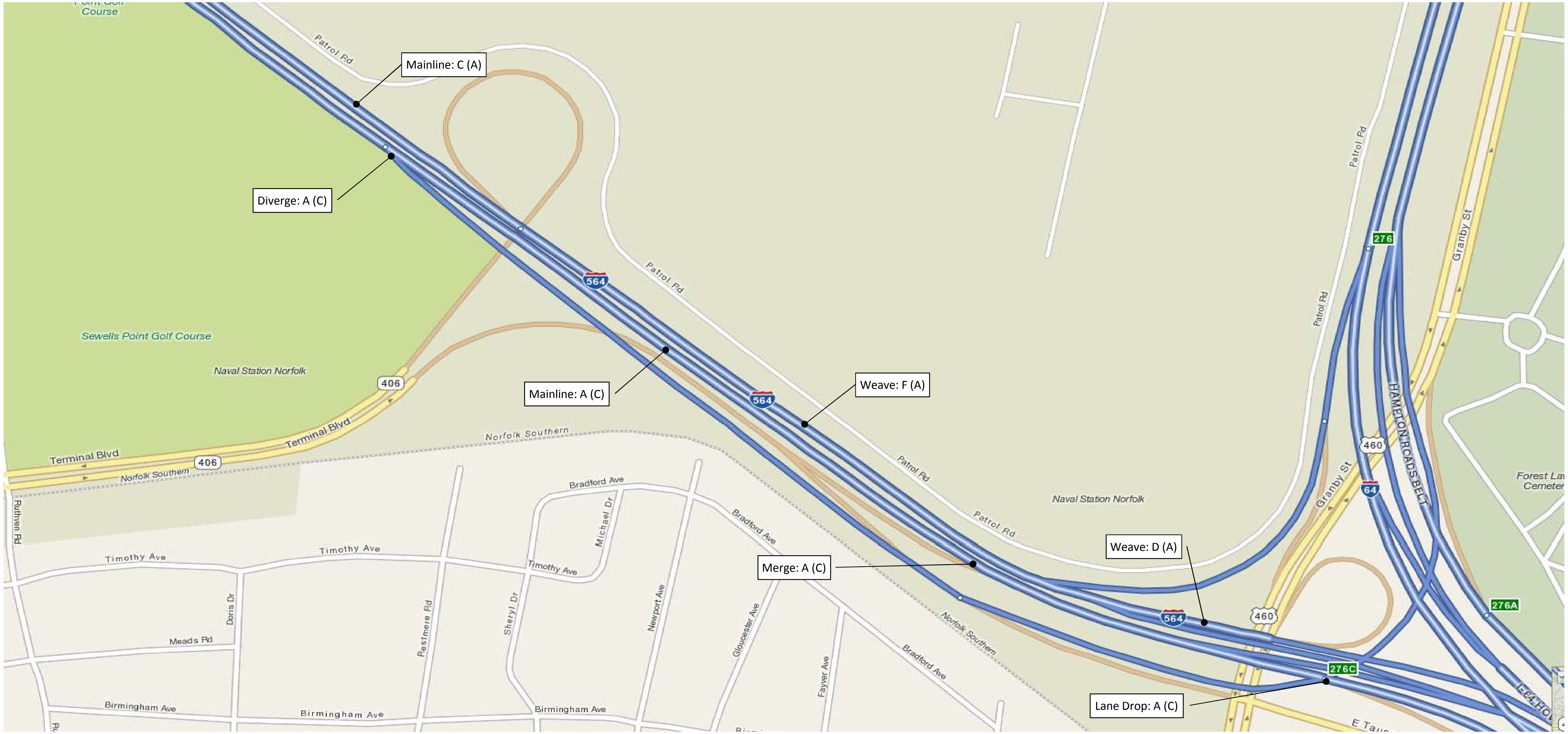
October 12, 2012



2020 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-5: Sheet 5 of 6

October 12, 2012



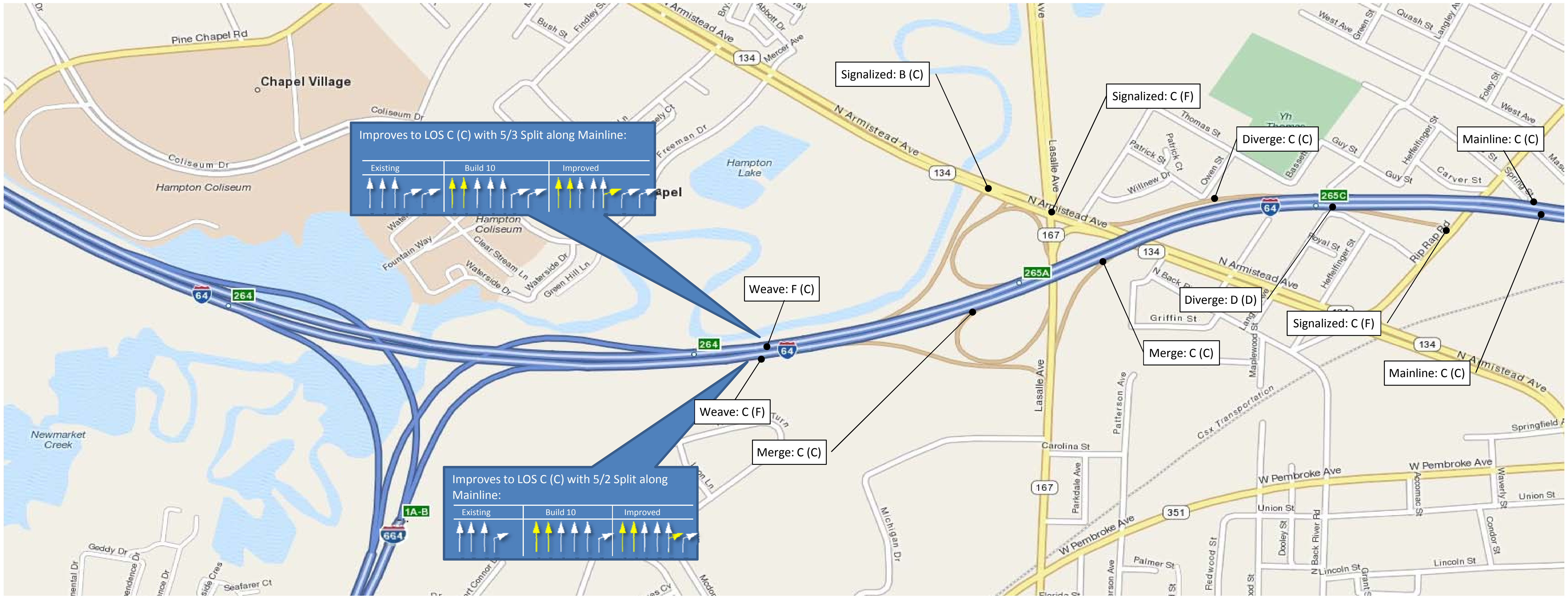
2020 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-5: Sheet 6 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



Note: Analysis results should be used with caution, as volumes and lane configurations are at the limits of the HCM methodology

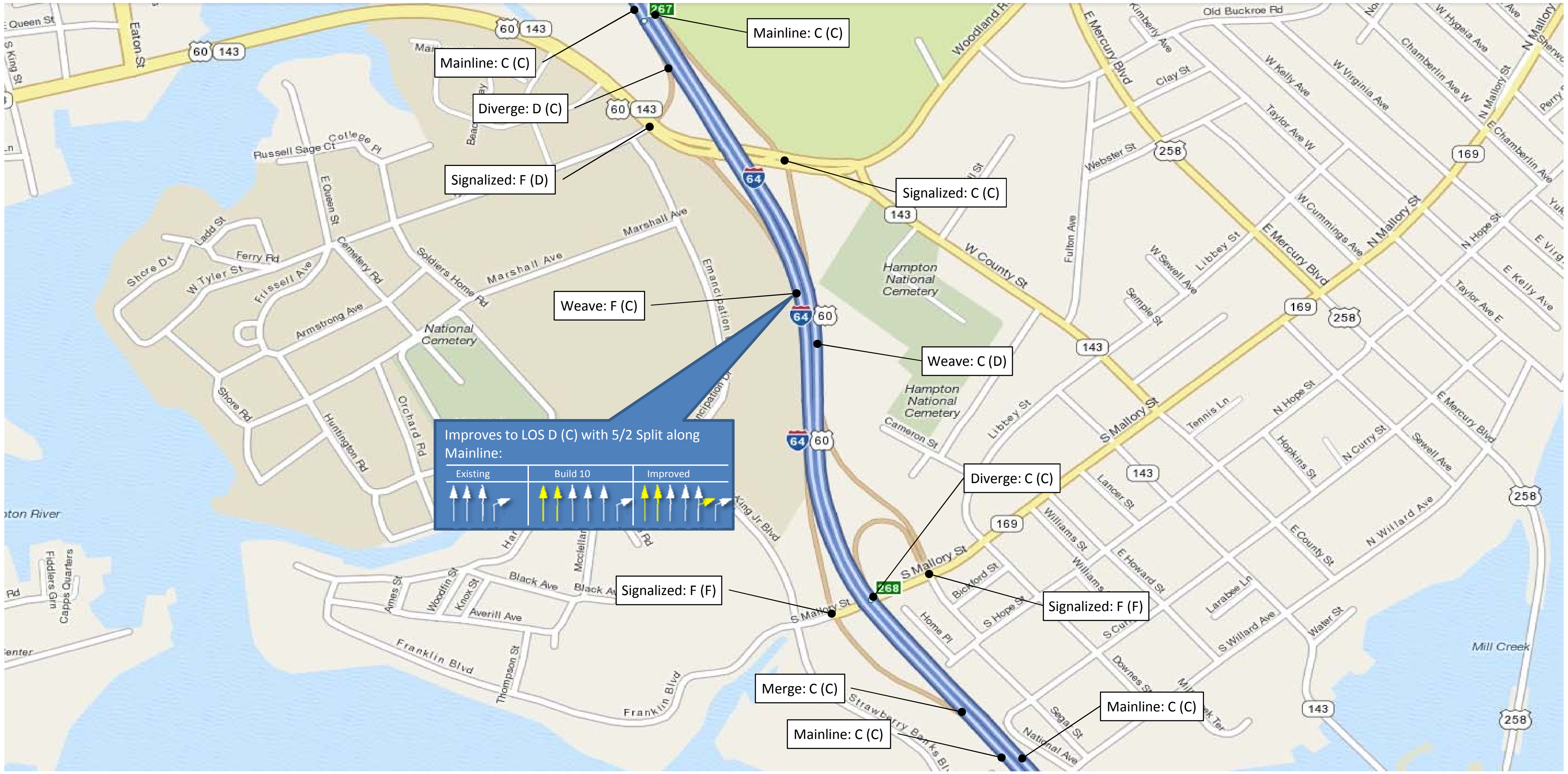
HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-6: Sheet 1 of 6

October 12, 2012



2040 Build 10 AM (PM) Level of Service

(10 total lanes crossing HRBT)

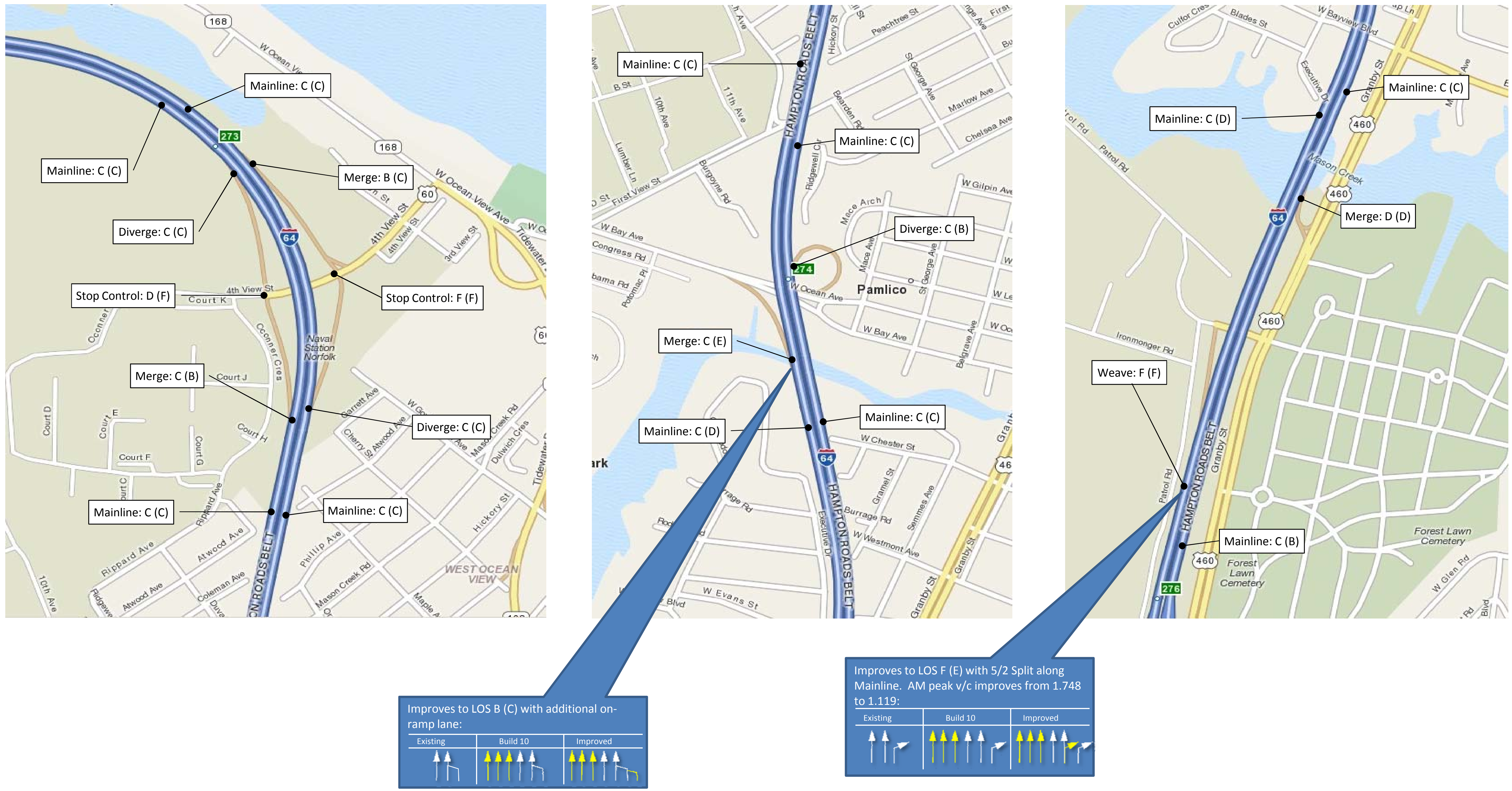
Figure F-6: Sheet 2 of 6

October 12, 2012

2040 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-6: Sheet 3 of 6

October 12, 2012



Note: projected volumes put HCS analysis at limits of methodology.
Results should be verified using simulation.

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation

2040 Build 10 AM (PM) Level of Service
(10 total lanes crossing HRBT)

Figure F-6: Sheet 4 of 6

October 12, 2012

2040 Build 10 AM (PM) Level of Service

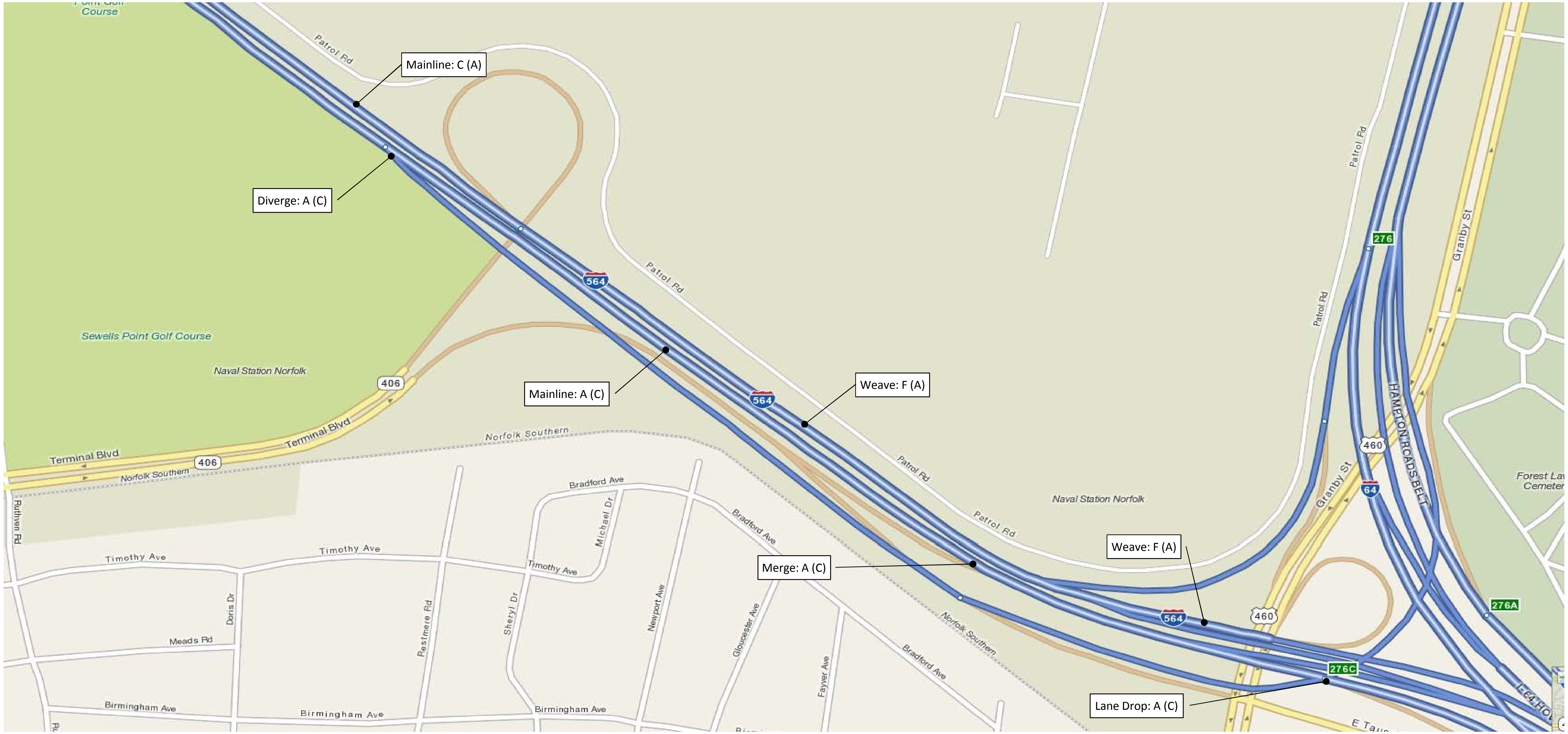
(10 total lanes crossing HRBT)

Figure F-6: Sheet 5 of 6

October 12, 2012

HRBT Hampton Roads Bridge Tunnel EIS

VDOT Virginia Department of Transportation



2040 Build 10 AM (PM) Level of Service

(10 total lanes crossing HRBT)

Figure F-6: Sheet 6 of 6

October 12, 2012

Appendix G. **Toll Diversion Study**

1.0 Introduction

As part of the I-64 Hampton Roads Bridge Tunnel (HRBT) Environmental Impact Statement (EIS) and Related Studies, a series of toll scenarios were modeled to develop potential traffic forecasts for the year 2040. The purpose of this modeling was to explore toll diversion, which can manifest itself in several different ways which the model can consider. People can take different routes that bypass the tolls; people can choose to travel to different places so they don't have to use the toll facility; or people may choose to take a different mode (e.g., transit, HOV, etc.). The model reacts to the change in travel time or the equivalent cost from the tolls. The tolling scenarios were based on an 8-Lane Build Alternative with a series of tolls on the I-64 HRBT and then on HRBT and the I-664 Monitor Merrimac Memorial Bridge Tunnel (MMMBT). The tolls were tested in both scenarios on the bridges/tunnels at one dollar, two dollars, and three dollars.

Before the tolls were tested, a series of different build alternatives were evaluated. Table 1.1 presents the average daily traffic (ADT) for various build alternatives for the year 2040. These forecasts were developed using the pre-existing travel demand forecast model for Hampton Roads. The model was supplied by VDOT at the beginning of the study.

Table 1.1 - Preliminary ADT Forecast Build Alternatives

		Year 2040			
Freeway Segment	**Existing**	**No Build**	**6-Lane Build**	**8-Lane Build**	**10-Lane Build**
East of US 258	151,800	195,800	202,400	206,200	208,800
East of I-664	115,700	130,000	143,800	167,400	184,000
East of VA 167	88,300	110,000	126,800	146,400	156,400
East of VA 143	88,200	106,600	130,800	150,200	158,800
East of VA 169 (crossing)	88,300	112,200	136,600	150,200	155,400
East of 4th View Street	77,800	88,600	120,400	141,400	152,800
East of West Bay Avenue	88,700	100,400	137,600	164,400	179,400
East of I-564	122,000	137,600	150,000	160,200	165,000

Based on the results of the preliminary build alternatives, it was determined that the 8-Lane Build Alternative would be carried forward for testing with different tolling strategies. The 8-Lane Build Alternative addressed the future demand adequately. When the facility was expanded to 10 lanes the demand began to level off, and the marginal increase in demand was relatively small compared to the change between the four, six, and eight lane alternatives.

1.1 Travel Demand Model Modifications

Tolls impact the decisions that travelers make in terms of destinations, mode, and route. The travel demand on toll roads is directly related to motorists' value of time. Value of time is tied to income. Incorporating income into the travel demand forecasting model was necessary in order to model toll facilities and understand the toll diversion impacts. The value of time is different for different trip purposes, and different trip purposes occur at different times of the day. For example, morning traffic consists more heavily of commuting trips (i.e., home-based work trip purpose) than shopping or other discretionary trips. Commuting trips also have a different value of time associated with them. The existing Hampton Roads Transportation Planning Organization (HRTPO) model did not have any income stratification, and the process assigned trips for one time period representing the entire day. In order to incorporate the tolls into the model process, several enhancements were made to the existing model provided by VDOT for this study. These enhancements included:

- Stratification of trips into income quartiles to better represent differences in the value of time during the assignment step;
- Partitioning of the trip table into three time periods (morning peak, evening peak, and off-peak);
- Incorporation of a feedback loop to the trip distribution step; and
- Improved application of the assignment algorithm.

These improvements allow for the impacts of congestion and tolls on travel choices to be modeled more precisely. In making these modifications, an important goal was to keep the model output consistent with the existing model validation.

Income Stratification

There are several potential approaches to represent value of time in a regional travel demand model. Given the requirements and the resources for this study, the most appropriate approach was determined to be modifications to the assignment step of this four-step because it was the most straightforward option. In the pre-assignment step of the model, the trip tables are factored from production and attraction format to origin and destination format. At this step in the model the trip tables were disaggregated into four income quartiles and divided into three time periods.

The Census American Community Survey (ACS) and National Household Travel Survey (NHTS) were used as primary data sources for the income stratification. These data permitted income strata to be generated for each TAZ. Typically lower income households have fewer daily motorized trips, therefore adjustments in trip rates for each income quartile were made to account for these types of differences. These adjustment factors were taken from the NHTS data for this region. The factors were checked against ACS data for reasonableness. The household income quartiles were divided as follows based on year 2010 dollars:

- Household income less $25,000;
- Household income greater or equal to $25,000 and less than $50,000;
- Household income greater or equal to $50,000 and less than $75,000; and
- Household income greater than $75,000.

The income category definition used for this study is based on the median income. The median annual household income for the region is $56,700. The objective was to split the households into four groups with equal increments of household income and even household distribution in each group. Table 1-2 shows the distribution of households in each income category. The cut-offs generate a roughly even distribution in each category. The percentage of households below the poverty line in the model region based on the ACS 2005-2009 data is 8.8 percent, which is small compared to the percentage in the other income groups.

Table 1-2. Household Distribution in Each Income Category (ACS 2005-2009)

Income Category	Number of Households	Percentage
Less than $25,000	115,600	19%
Greater or equal to $25,000 and less than $50,000	152,800	25%
Greater or equal to $50,000 and less than $75,000	126,800	21%
Greater or equal to $75,000	213,900	35%

Response to tolls in the model was tied to motorists' value of time data derived from the ACS data for each income group. The values of time by trip purposes and income group are shown in Table 1-3. The value of time for home-based work (HBW) trips was determined to be 50 percent of the average hourly wage. The value of time for high-occupancy vehicle (HOV) trips was determined to be 100 percent of the hourly wage. The value of time for home-based other (HBO) trips was determined to be one-third of the hourly wage. External trips used a value of time of 50 percent of the hourly wage and truck trips used 100 percent of the hourly wage. The toll cost was converted into a time penalty based on the value of time and added to the congested travel time.

Table 1-3. Value of Time per Hour by Trip Purposes and Income Groups

Trip Purpose	Income 1	Income 2	Income 3	Income 4
HBW	$4.66	$9.31	$13.99	$30.54
HBO	$3.10	$6.20	$9.32	$20.36
HOV	$9.32	$18.61	$27.98	$61.08
NHB	$10.59	$10.59	$10.59	$10.59
External	$10.59	$10.59	$10.59	$10.59
Truck	$21.17	$21.17	$21.17	$21.17

The tolls were included in the highway network and are therefore considered in the network skims. The network skims are the product of the compilation of the travel time between all origins and destinations in the network. The toll costs were converted into time penalties and included in the skims. The travel times and other skim related data are a key input for the calculation of choice of trip destination and travel mode. The choice of mode in Hampton Roads is limited on HRBT and MMMBT, and the tolls had little impact on mode choice. The tolls did have a greater impact on trip destination and route choice.

Time of Day Assignment

The assignment step in the model was modified from a daily assignment to three time periods. These periods were defined as morning peak (6:00 a.m. to 9:00 a.m.), evening peak (4:00 p.m. to 7:00 p.m.), and the off-peak. Time of day factors were based on values derived from the NHTS for this region and reviewed for reasonableness against other nearby jurisdictions. The factors were static and applied by purpose. The purpose of this refined assignment process was to improve the application of pricing policies. This approach typically improves the assignment process by adding more iterations of assignment and allowing for the affects of congestion to be better accounted for in route choice. The starting point for the post-processing and development of design hour volumes for both weekday morning and evening is still based on the daily total of the three time periods. Table 1-4 shows the time of day factors by purpose and period.

Table 1-4. Time of Day Factors by Trip Purposes

Trip Purpose	Direction	Morning Peak Period	Evening Peak Period	Off-Peak
Home Based Work	Production	32.85%	1.49%	15.66%
	Attraction	0.30%	29.23%	20.47%
Home Base Other	Production	13.83%	12.32%	23.85%
	Attraction	2.59%	14.80%	32.61%
Non-Home Based	Production	5.51%	12.02%	32.47%
	Attraction	5.51%	12.02%	32.47%
External	Production	8.26%	10.43%	31.31%
	Attraction	8.26%	10.43%	31.31%
Internal Truck	Production	9.15%	10.35%	30.50%
	Attraction	9.15 %	10.35%	30.50%
Internal to External Truck	Production	12.17%	7.10%	30.74%
	Attraction	6.17%	13.56%	30.27%
External Truck	Production	9.50%	9.00%	31.50%
	Attraction	9.50%	9.00%	31.50%

Feedback Loop

The following paragraph is an excerpt from the Hampton Roads **Model Improvement Report** (dated January 2009, by The Corradino Group, page 25**)**.

> The highway pre-assignment step is now part of the feedback loop and has also undergone significant structural and functional changes. After the initial trip distribution is run using free flow times, a daily highway assignment is made. Then the loaded network is skimmed again to produce congested impedances which are fed back to the trip distribution step. The feedback loop is repeated until convergence criteria are met, or until a maximum number of iterations has been performed. After the feedback loop is complete, the pre-assignment model produces the final skims from the congested network. These passed on to the mode choice step.

This model documentation clearly indicates that the model was designed to produce congested impedances that were to be fed back to the trip distribution step. The documentation also has a flowchart figure to show the initial design. Based on the communication from VDOT, this feedback was streamlined during the development of the truck component of the Hampton Roads model.

However, from the flow chart taken from the CUBE interface of the model that CS received in September 2011, it was evident that in the trip distribution step, the free flow times and not congested times were being input. As part of the modifications to address

tolling that were made to the existing model, CS fixed the feedback loop. The fix in the model structure made the trip distribution step much more sensitive to congestion and pricing.

Assignment Algorithm Improvements

The volume delay function (VDF) recalculates the travel time on a link based on the volume to capacity ratio. The purpose of the volume delay function is to capture the effects of traffic flow on travel time. The volume of traffic on a given link is directly related to the travel time, and as volume increases, travel time increases. Volume delay functions capture this relationship. As the traffic increases on one particular route, travel time is recalculated using the volume delay function and trips will use other routes with shorter or equal travel times. The assignment process continues until all trips experience the minimal travel time between each origin and destination pair. Once this condition is met, the network is at equilibrium. The volume delay function and the parameters in the function are important in the assignment step of the model.

The pre-existing model received from VDOT used the standard BPR volume delay function. In order to better account for the impacts of toll and the time of day application on route choice across Hampton Roads, a more sophisticated volume delay function was used. The function was taken from more recent model update work being done on the model set. A conical VDF was used instead of the BPR function. The equation and parameters are given as follows:

$$\frac{t}{t_0} = 2 + \sqrt{\alpha^2 \left(1 - {}^{v}/_{c}\right)^2 + \beta^2} - \alpha\left(1 - {}^{v}/_{c}\right) - \beta$$

t = congested travel time

t_o = initial travel time

Freeways

α=9.0

β= (2.0* α -1)/(2.0* α -2)

Principal arterials

α =7.0

β = (2.0* α-1)/(2.0* α -2)

Minor arterials

α =4.5

β = (2.0* α -1)/(2.0* α -2)

Collectors

α =2.0

β = (2.0* α -1)/(2.0* α -2)

1.2 Post-Processing

Post-processing refers to analytical procedures to adjust the raw outputs that are produced by the travel demand forecasting model to account for model variations. Currently, the guide for post-processing travel demand model forecasts is the National Cooperative Highway Research Program Report 255 (NCHRP Report 255), Highway Traffic Data for Urbanized Area Project Planning and Design. Although this report was published in 1982, it is still the current nationally recognized technical resource for post-processing and was cited in the Federal Highway Administration (FHWA) guidance published in April 2010 on application of travel demand and forecasting for National Environmental Policy Act (NEPA) studies.

Post-processing is necessary because the assignment algorithm in the travel demand forecasting model process is macroscopic. As a result of the travel demand forecasting model network limitations and the macroscopic characteristics of the assignment, certain adjustments may need to be made to the link volumes. The highway network that is used in a travel demand model is a simplified representation of the actual roadway network and does not include all the roads, intersections or access points (e.g., curb cuts, driveways) in the actual roadway system. Therefore, the results that are produced from the assignment need to be adjusted to compensate for these missing roadways and overassignment to certain links in the model. Post-processing also makes adjustments for capacity limitations which are not fully represented in the model. The post-processing refinement should not be viewed as a separate step in the travel demand forecasting process, but rather as an extension of the highway assignment.

The post-process refinement applies a set of procedures using spreadsheets as outlined in NCHRP Report 255. The spreadsheets take competing routes for a certain link in the model and redistribute the traffic between them to adjust for the assignment algorithm limitations mentioned above. These competing routes constitute a cutline. There are two parts to the process.

The first part is to correct for model bias. This correction is based on the difference between the count data and the model output for the validation year. The difference in the count and model results is applied to the future year forecast. The differences are computed —as an absolute and a percentage; and the two are averaged and used as adjustments.

As the second part, the model bias corrected volume is then refined across competing (parallel) routes based on the volume to capacity for each route and a count factor. The count factor relates to land use and the fact that some facilities, despite being the same type, attract more trips by the nature of their location or other factors.

The facility of primary interest in the I-64 Hampton Roads Bridge Tunnel (HRBT) Environmental Impact Statement (EIS) and Related Studies is I-64. Therefore, the cutlines used in the post-processing were primarily defined to refine and develop forecasts on I-64 for use in the traffic and environmental analysis.

To capture the impact of tolls, the toll link capacity was adjusted based on the volume relationship between the tolled links and the competing parallel non-tolled links. This process was the same process used in forecasting for the Inter County Connector toll road in Maryland. The forecasting approaches used in that project were highlighted by FHWA in April 2010 as an example of good practice in their guidance on application of travel demand and forecasting in NEPA.

Following the initial NCHRP Report 255 post-processing link refinements, there was another step in developing the pre-final toll forecasts. This step scaled the post-processed toll ADT volumes so as to be comparable with the No Toll 8-Lane Build Alternative forecast that was previously generated and submitted in February 2012 using the pre-existing model set delivered by VDOT for use on this project. The pivoting process was necessary in order to maintain consistency between the results of these earlier runs using the pre-existing model and the later runs performed using the model as enhanced for the tolling studies.

After the pre-final forecasts were prepared, a review of the I-64 HRBT and I-664 Monitor Merrimac Memorial Bridge Tunnel (MMMBT) forecasts was conducted for all six tolling scenarios. This review led to a secondary refinement to the capacity of I-64 (HRBT) and I-664 (MMMBT) under the toll scenarios, which resulted in adjustments in the forecast volumes for the toll only scenarios on HRBT with tolls of $1 and of $3. These adjustments in the post-processing resulted in a logical progression of forecast volume changes on MMMBT while not resulting in a significant change to the forecast volumes on HRBT.

2.0 Tolling Results

The tolling scenarios were based on an 8-Lane Build Alternative with a series of tolls on the I-64 HRBT and then on both HRBT and I-664 MMMBT. The tolls were tested in both scenarios on the bridges/tunnels at one dollar, two dollars, and three dollars. The tolls were coded into the model network and the model was run.

The raw model output for the different toll scenarios were post-processed using the techniques outlined in National Cooperative Highway research Program (NCHRP) Report 255. For the NCHRP Report 255 worksheets that covered the facilities crossing Hampton Roads, adjustments were made to compensate for the impact of the tolls on demand. These adjustments included scaling the capacity used in the second half of the link refinement process to reflect the impact of the tolls. The adjustments were based on the raw model results. This is a similar process as was applied in another EIS that was presented as a case study in a guidance document on travel forecast and the National Environmental Policy Act (NEPA) process published by the U.S. Federal Highway Administration (FHWA) in April 2010.

Following the initial NCHRP Report 255 based post-processing link refinements, there was a another step in developing the pre-final toll forecasts. This next step scaled the the post-processed toll ADT volumes so as to be comparable with the No Toll 8-Lane Build Alternative forecast that was previously generated and submitted in February 2012 using the pre-existing model set delivered by VDOT for use on this project. The pivoting process was requested in order to maintain consistency between the results of these earlier runs using the pre-existing model and the later runs performed using the model as enhanced for tolling studies. The pivoting simply took the results from the enhanced model and applied the difference between the enhanced model results for the no toll results and the enhanced model results for toll runs to the previously submitted results for the no toll 8-Lane Build Alternative.

After the pre-final forecasts were prepared, a review of the HRBT and MMMBT forecasts was conducted for all six tolling scenarios. The review led to a secondary adjustment in the forecast volumes for the HRBT-only toll scenarios with tolls of $1 and of $3. For the $1 toll scenario, the refinement capacity for HRBT was increased by 10 percent. The non-tolled capacity for the 8-Lane Build Alternative on HRBT was 160,000 vehicles per day (vpd). The pre-final capacity adjustment for the $1 toll only on HRBT reduced the capacity on HRBT to 99,000 vpd (based on raw model results). After the review, the capacity on HRBT was increased to 108,900 vpd for the final forecast (based on the review).

Similar adjustments were made to the $3 HRBT-only toll scenario. In this scenario, the refined capacity on HRBT was decreased by approximately 5 percent. The pre-final capacity on HRBT was 78,400 vpd (based on raw model results) and the post-review final capacity was 74,600 vpd. These adjustments in the post-processing resulted in a logical progression of forecast volume changes on MMMBT while not resulting in a significant change to the forecast volumes on HRBT.

Tables 2-1a/b and Tables 2-2a/b show the final average daily traffic (ADT) 2040 forecast volumes for each of the scenarios. Tables 2-1a/b show the ADT forecast for the basic freeway segments along I-64 in the study corridor. Tables 2-2a/b show the ADT crossing Hampton Roads on I-64 and I-664. Figure 2-1 and Figure 2-2 show the ADT for I-64 and I-664 under each tolling scenario. Tables 2-3a/b show the raw model output for the three facilities crossing Hampton Roads, although raw model output is not recommended for direct use.

The following observations can be made about the forecast results:

- When a toll is placed only on HRBT some of the demand shifts to the MMMBT.
- As the toll increases on HRBT without a toll on MMMBT, more traffic shifts from I-64 to I-664.
- Under the HRBT-only toll scenarios, the volume to capacity ratio on I-64 varies across the different tolling scenarios but not significantly. The volume to capacity ratio is based on an estimated capacity of 2,000 vehicles per hour per lane. This is a general estimate given the area and facility type.
- The volume to capacity ratio for the I-64 HRBT crossing under the no toll scenario is 0.79 for the peak direction in the peak hour. With the tolls, the ratio goes from 0.60 to 0.46.

- With tolls on HRBT, the traffic shifting to I-664 results in a higher volume to capacity ratio than on HRBT. Under the no toll scenario, the volume to capacity ratio on the MMMBT is 0.89. With tolls on HRBT the volume to capacity ratio on MMMBT ranges from 1.04 to 0.96.
- With tolls on both facilities, the volume to capacity ratios for both HRBT and MMMBT indicate that the facilities are operating below capacity. On HRBT, the volume to capacity ratio ranges from 0.58 to 0.45. On MMMBT, the volume to capacity ratio ranges from 0.90 to 0.73.
- The reduction in the vehicles crossing on HRBT between the no toll 8 lane alternative and the toll scenarios ranges from 16 percent when only HRBT is tolled at one dollar to a maximum of 37 percent when HRBT and MMMBT are both tolled at three dollars.
- The reduction in total vehicles crossing Hampton Roads when there is a toll implemented ranges from a decrease of seven percent for the one dollar toll only on HRBT to a decrease of 30 percent when both facilities are tolled at three dollars.
- When both bridge/tunnel facilities are tolled, there is a greater change in regional travel patterns instead of simply shifting demand between I-64 and I-664.

Figure 2-1 – HRBT-Only Toll Average Daily Traffic

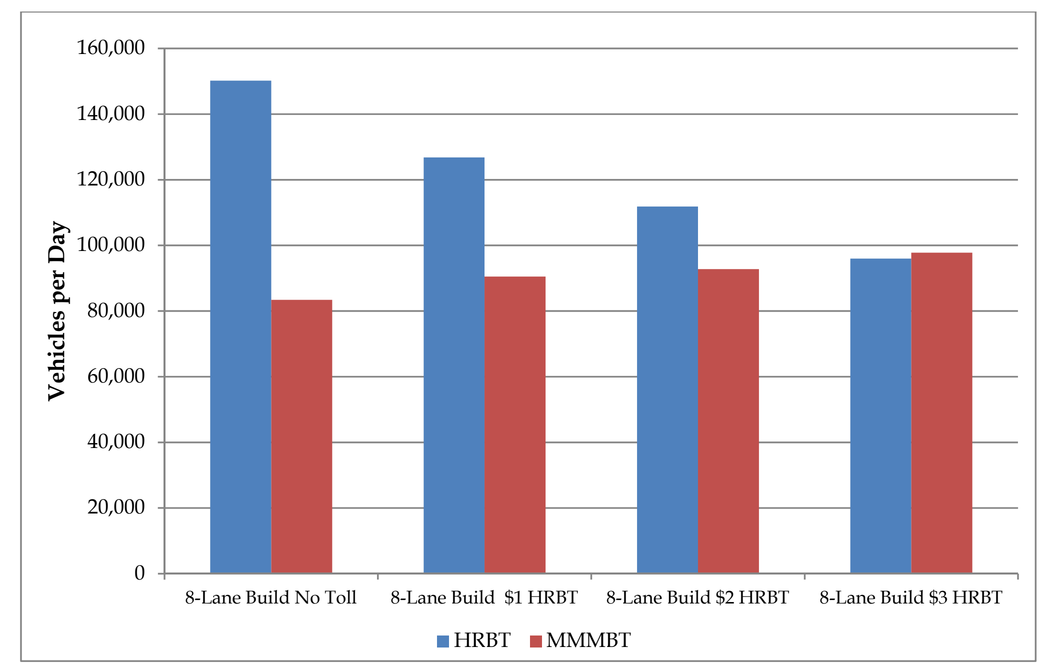


Figure 2-2 – HRBT and MMMBT Toll Average Daily Traffic

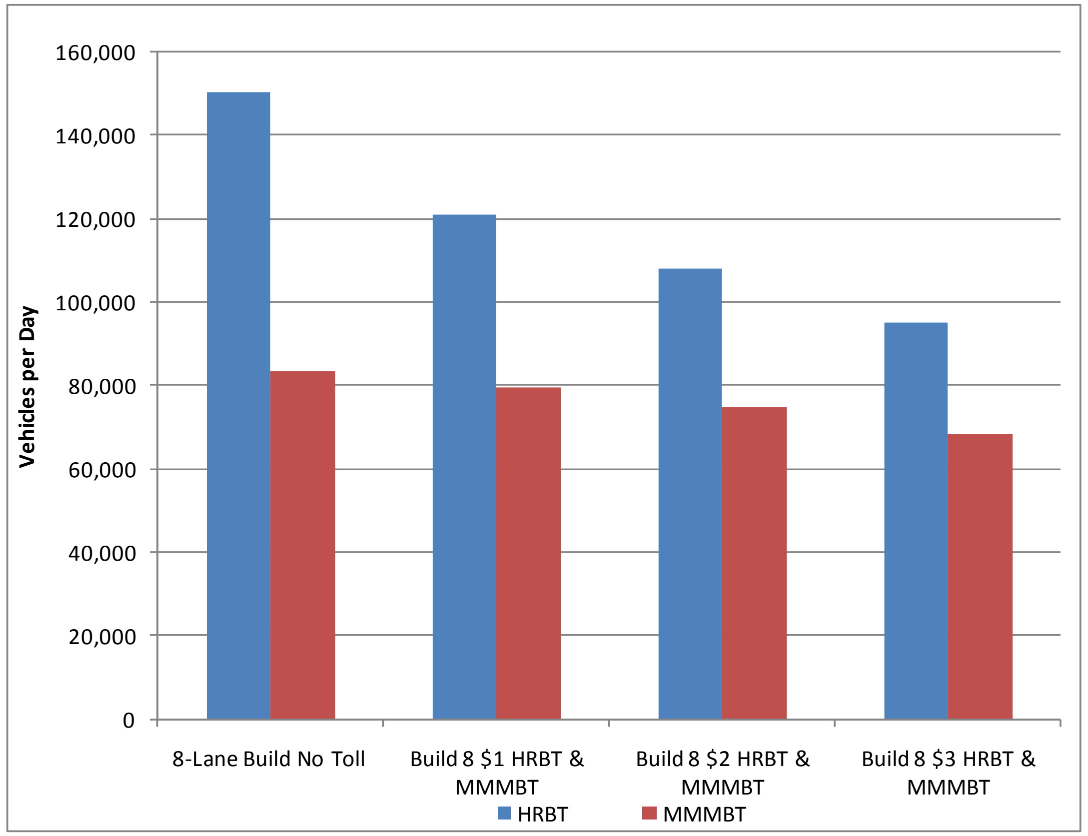


Table 2-1a. I-64 Freeway Segments Average Daily Traffic

Highway Link	Existing	8-Lane Build No Toll	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT
East of US 258	151,800	206,200	199,200	195,100	191,700
East of I-664	115,700	167,400	155,100	143,900	132,100
East of VA 167	88,300	146,400	133,100	121,900	110,500
East of VA 143	88,200	150,200	132,400	116,500	100,300
East of VA 169	88,300	150,200	126,800	111,800	96,000
East of 4th View Street	77,800	141,400	123,200	108,500	93,200
East of West Bay Avenue	88,700	164,400	147,300	133,900	118,900
East of I-564	141,700	176,800	168,100	160,700	157,600

Table 2-1b. I-64 Freeway Segments Average Daily Traffic

Highway Link	Existing	8-Lane Build No Toll	8-Lane Build $1 HRBT & MMMBT	8-Lane Build $2 HRBT & MMMBT	8-Lane Build $3 HRBT & MMMBT
East of US 258	151,800	206,200	199,500	193,400	186,800
East of I-664	115,700	167,400	160,700	151,900	138,400
East of VA 167	88,300	146,400	138,400	129,800	117,200
East of VA 143	88,200	150,200	139,400	127,300	109,600
East of VA 169	88,300	150,200	121,000	108,000	95,100
East of 4th View Street	77,800	141,400	130,300	118,800	102,200
East of West Bay Avenue	88,700	164,400	154,500	145,000	128,300
East of I-564	141,700	176,800	171,600	165,400	160,100

Table 2-2a. Hampton Roads Bridge/Tunnel Crossing Forecast Volumes

Facility	8-Lane Build No Toll	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT
I-64 (HRBT)	150,200	126,800	111,800	96,000
I-664 (MMMBT)	83,400	90,500	92,800	97,800
Crossing Total	233,600	217,300	204,600	193,800
Percent on I-64	64%	58%	55%	50%

Table 2-2b. Hampton Roads Bridge/Tunnel Crossing Forecast Volumes

Facility	8-Lane Build No Toll	8-Lane Build $1 HRBT & MMMBT	8-Lane Build $2 HRBT & MMMBT	8-Lane Build $3 HRBT & MMMBT
I-64 (HRBT)	150,200	121,000	108,000	95,100
I-664 (MMMBT)	83,400	79,500	74,900	68,400
Crossing Total	233,600	200,500	182,900	163,500
Percent on I-64	64%	60%	59%	58%

Table 2-3a. Raw Model Output for Hampton Roads Crossing Volumes

Facility	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT
US 17 (James River Bridge)	55,200	58,500	61,300
I-664 (MMMBT)	78,700	85,700	94,500
I-64 (HRBT)	126,500	109,400	90,900
Total	260,400	253,600	246,700

Note: This data is directly taken from the model and is not post-processed using the techniques outlined in NCHRP Report 255.

Table 2-3b. Raw Model Output for Hampton Roads Crossing Volumes

Facility	8-Lane Build $1 HRBT & MMMBT	8-Lane Build $2 HRBT & MMMBT	8-Lane Build $3 HRBT & MMMBT
US 17 (James River Bridge)	60,300	68,700	76,500
I-664 (MMMBT)	58,900	54,200	52,100
I-64 (HRBT)	136,000	121,600	101,600
Total	255,200	244,500	230,200

Note: This data is directly taken from the model and is not post-processed using the techniques outlined in NCHRP Report 255.

Elasticity is a quantitative measure of travel demand response to price changes that influence demand. A common method for value road pricing studies is to use the shrinkage ratio. The shrinkage ratio is the change in demand relative to the original demand divided by the change in price relative to the original price. Table 2-4 shows the shrinkage ratio for each of the toll scenarios as compared to the no toll scenario.

Table 2-4. HRBT Daily Traffic and Shrinkage Ratio

	8-Lane Build No Toll	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT	8-Lane Build $1 HRBT & MMMBT	8-Lane Build $2 HRBT & MMMBT	8-Lane Build $3 HRBT & MMMBT
ADT	150,200	126,800	111,800	96,000	121,000	108,000	95,100
Ratio		-0.18	-0.34	-0.56	-0.24	-0.39	-0.58

The shrinkage ratios show that as the toll is increased, the demand decreases. There is some change in route choice, but there are also changes in the trip distribution patterns as the there is a decrease in the total volume crossing Hampton Roads.

3.0 Traveler Response to Diversion

The impact of tolling both HRBT and MMMBT resulted in changes in both travel patterns and route selection. When only HRBT is tolled, some of the traffic moves to MMMBT. This is evident in the percent of traffic crossing HRBT as a total of the traffic crossing both MMMBT and HRBT. It decreases from 64 percent of the traffic on HRBT with no toll to 50 percent when the toll on HRBT is three dollars. When the toll is applied to both HRBT and MMMBT, the percent of traffic on each facility remains relative static. Table 3-1 shows the change in daily traffic volumes on I-64 for the freeway segments in the study area. The segments at the ends of the study area show a smaller percent change from the no toll scenario. The segments in between vary much more as the toll is changed.

Table 3-1. Change in Daily Traffic on I-64 Freeway Segments

Highway Link	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT	8-Lane Build $1 HRBT & MMMBT	8-Lane Build $2 HRBT & MMMBT	8-Lane Build $3 HRBT & MMMBT
East of US 258	-3%	-5%	-7%	-3%	-6%	-9%
East of I-664	-7%	-14%	-21%	-4%	-9%	-17%
East of VA 167	-9%	-17%	-25%	-5%	-11%	-20%
East of VA 143	-12%	-22%	-33%	-7%	-15%	-27%
East of VA 169	-16%	-26%	-36%	-19%	-28%	-37%
East of 4th View Street	-13%	-23%	-34%	-8%	-16%	-28%
East of West Bay Avenue	-10%	-19%	-28%	-6%	-12%	-22%
East of I-564	-5%	-9%	-11%	-3%	-6%	-9%

As previously noted, the tolls were coded onto the highway network and included in the network skims. The network skims are inputs to other steps in the model process including trip distribution and mode choice. There was very little impact in mode choice. This is reasonable given the non-SOV network and availability of other modes for crossing Hampton Roads. There were changes in the trip distribution and the destination choice. Table 3-2 shows the change in the number of daily trips crossing Hampton Roads.

Table 3-2. Daily Trips Crossing Hampton Roads

Origin	8-Lane Build $1 HRBT	8-Lane Build $2 HRBT	8-Lane Build $3 HRBT	8-Lane Build $1 HRBT & MMMT	8-Lane Build $2 HRBT & MMMT	8-Lane Build $3 HRBT & MMMT
South Hampton Roads	92,611	88,379	84,726	87,469	79,790	73,753
Virginia Peninsula	95,321	90,830	86,624	90,149	82,564	76,445

There is approximately a nine percent decrease in the trips with an origin and destination across the Virginia Peninsula and South Hampton Roads as the toll is increased from one dollar on HRBT to three dollars. When both HRBT and MMMBT are tolled there is a 15 percent decrease in the number of trips with origin and destination pairs across Hampton Roads. As the toll increases, trips find different destinations, and when both crossing bridges/tunnels are tolled there is a higher percent of change in the destinations and less total traffic crossing Hampton Roads. Figure 3-1 shows a chart of the trips with origins that have destinations across Hampton Roads.

Figure 3-1. Daily Trips Crossing Hampton Roads by Toll Scenario and Origin Location with Destination Across Hampton Roads

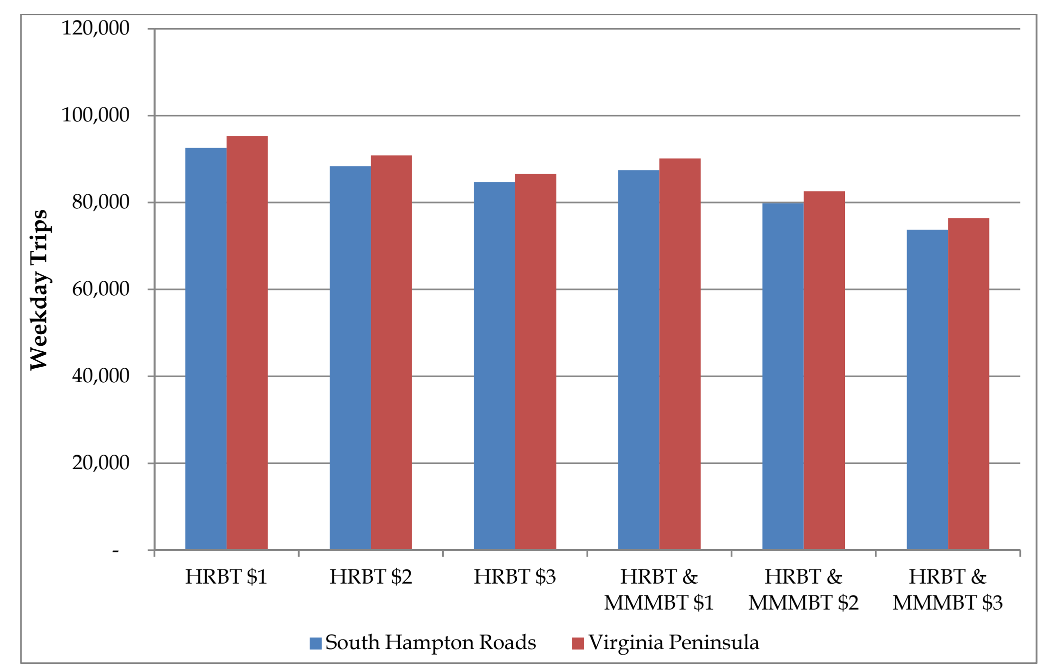


Table 3.3a through Table 3.3f present the trip tables for all vehicle trips by jurisdiction for each tolling scenario modeled. The trip distribution tables illustrate the expected shift in demand in origin-destination pairs primarily served by the toll facilities as the toll rate increases. For example, the Hampton/Newport News to Norfolk interchanges decrease as the toll increases. At the same time, trips internal to Hampton and Newport News increase by similar magnitudes as the decreases.

Table 3-3a. Trip Distribution – 8-Lane Build, HRBT $1 Toll

8-Lane Build HRBT $1 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	443,672	106,182	68,470	30,369	130,087	2,721	7,730	5,754	270	938	1,967	1,570	580
Norfolk	43,309	454,846	7,975	2,898	111,923	777	3,136	3,334	129	337	813	798	240
Portsmouth	69,037	26,823	117,315	19,500	15,812	1,419	3,786	2,869	97	304	648	595	199
Suffolk	46,112	21,114	23,968	288,752	19,661	21,051	9,930	7,384	291	1,534	3,072	2,166	898
Virginia Beach	112,326	176,936	10,432	5,383	957,337	1,552	4,535	3,984	240	723	1,589	1,275	478
Isle of Wright	5,460	6,380	2,153	19,472	6,882	69,561	8,049	5,774	197	825	1,750	1,349	475
Newport News	5,234	8,319	2,233	3,272	7,355	2,413	364,933	89,000	4,065	7,072	15,822	45,404	1,451
Hampton	3,529	9,947	1,790	2,436	4,772	1,753	93,193	250,360	4,107	1,300	2,687	12,560	614
Poquoson	532	1,057	196	289	858	206	8,900	10,481	11,009	324	647	4,900	120
Williamsburg	200	329	84	135	293	74	1,649	389	46	20,533	18,248	11,174	107
James City County	2,584	5,467	836	1,146	4,945	757	7,959	2,254	188	47,415	148,486	35,107	751
York	2,073	4,086	745	1,093	3,539	748	63,351	24,453	5,054	20,124	28,876	66,789	960
Gloucester	1,618	3,589	507	641	3,229	410	3,229	1,158	97	846	1,888	2,840	58,906

Table 3-3b. Trip Distribution – 8-Lane Build, HRBT $2 Toll

8-Lane Build HRBT $2 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	444,042	106,351	68,399	30,271	129,978	2,710	7,559	5,561	262	946	1,975	1,571	582
Norfolk	43,216	455,933	7,939	2,885	112,671	769	2,757	2,349	144	268	696	685	205
Portsmouth	69,011	26,918	117,458	19,435	15,806	1,406	3,703	2,802	97	307	652	594	200
Suffolk	46,131	21,122	23,986	288,959	19,640	20,916	9,878	7,261	291	1,544	3,083	2,173	900
Virginia Beach	112,091	178,058	10,402	5,376	957,901	1,553	3,909	3,526	167	700	1,472	1,089	465
Isle of Wright	5,467	6,386	2,154	19,568	6,885	69,725	7,852	5,549	196	830	1,756	1,348	476
Newport News	5,170	7,900	2,213	3,251	6,809	2,389	365,450	89,551	4,085	7,050	15,804	45,375	1,443
Hampton	3,465	8,158	1,767	2,424	4,466	1,732	93,933	251,629	4,131	1,304	2,700	12,624	611
Poquoson	521	999	195	290	762	205	8,945	10,572	11,018	323	645	4,912	119
Williamsburg	199	287	83	135	276	74	1,659	391	46	20,540	18,270	11,193	106
James City County	2,565	5,352	832	1,144	4,788	756	8,024	2,274	189	47,461	148,577	35,144	749
York	2,045	3,853	737	1,088	3,275	740	63,561	24,597	5,061	20,133	28,886	66,885	957
Gloucester	1,611	3,538	505	641	3,179	410	3,268	1,173	98	850	1,884	2,870	58,906

Table 3-3c. Trip Distribution – 8-Lane Build, HRBT $3 Toll

8-Lane Build HRBT $3 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	444,498	106,484	68,430	30,142	129,902	2,697	7,257	5,314	259	959	1,997	1,572	589
Norfolk	42,974	457,234	7,856	2,857	112,698	761	2,351	1,992	125	250	604	578	186
Portsmouth	69,092	26,891	117,760	19,365	15,800	1,392	3,534	2,655	94	313	662	591	203
Suffolk	46,202	21,042	23,924	289,323	19,671	20,715	9,746	7,055	289	1,560	3,109	2,178	907
Virginia Beach	111,789	178,712	10,352	5,351	958,382	1,551	3,630	3,137	138	692	1,428	1,003	461
Isle of Wright	5,470	6,458	2,138	19,660	6,924	70,030	7,478	5,209	193	837	1,767	1,344	479
Newport News	5,044	7,372	2,133	3,190	6,560	2,358	366,096	89,799	4,095	7,025	15,821	45,394	1,435
Hampton	3,307	6,556	1,653	2,368	4,009	1,712	94,907	252,828	4,147	1,317	2,715	12,667	610
Poquoson	511	910	187	285	723	203	9,003	10,654	11,025	325	646	4,911	118
Williamsburg	198	284	83	135	268	74	1,655	392	46	20,577	18,241	11,189	106
James City County	2,550	5,297	828	1,143	4,740	756	8,057	2,287	190	47,455	148,596	35,184	748
York	2,018	3,652	723	1,076	3,162	733	63,643	24,843	5,074	20,074	28,858	66,943	953
Gloucester	1,597	3,523	502	639	3,155	409	3,295	1,183	99	849	1,889	2,856	58,941

Table 3-3d. Trip Distribution – 8-Lane Build, HRBT and MMMBT $1 Toll

8-Lane Build HRBT and MMMBT $1 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	444,478	106,600	68,883	30,815	130,439	2,750	6,438	4,933	231	874	1,863	1,409	581
Norfolk	43,253	454,761	7,971	2,902	111,839	777	3,213	3,432	133	343	826	814	243
Portsmouth	69,571	26,948	117,821	19,767	15,956	1,432	3,055	2,218	98	251	574	511	188
Suffolk	46,706	21,262	24,261	289,198	19,789	21,064	9,175	6,431	274	1,527	3,075	2,147	902
Virginia Beach	112,182	176,940	10,422	5,388	957,261	1,557	4,600	4,073	244	734	1,616	1,297	486
Isle of Wright	5,414	6,359	2,119	19,333	6,858	69,570	8,147	5,848	202	837	1,774	1,373	479
Newport News	4,489	8,137	1,770	2,779	7,244	2,390	366,305	89,630	4,080	7,050	15,822	45,391	1,436
Hampton	2,930	9,630	1,195	1,919	4,646	1,728	94,112	251,539	4,113	1,305	2,689	12,589	608
Poquoson	473	1,033	178	246	844	205	8,962	10,567	11,015	326	648	4,905	118
Williamsburg	167	329	54	124	293	75	1,656	393	46	20,587	18,233	11,186	106
James City County	2,480	5,451	796	1,132	4,932	757	8,013	2,281	189	47,451	148,498	35,152	748
York	1,898	4,026	659	1,006	3,495	741	63,528	24,732	5,060	20,099	28,849	66,838	952
Gloucester	1,578	3,576	486	632	3,217	410	3,273	1,179	99	852	1,901	2,866	58,889

Table 3-3e. Trip Distribution – 8-Lane Build, HRBT and MMMBT $2 Toll

8-Lane Build HRBT and MMMBT $2 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	445,222	106,965	69,184	30,923	130,394	2,741	5,613	4,323	182	877	1,811	1,289	573
Norfolk	43,132	455,627	7,940	2,898	112,766	769	2,891	2,473	147	274	708	694	209
Portsmouth	69,892	27,134	118,120	19,808	16,037	1,415	2,499	1,844	86	254	552	492	182
Suffolk	47,013	21,388	24,352	289,696	19,839	20,892	8,529	5,926	269	1,539	3,091	2,145	906
Virginia Beach	111,854	178,239	10,392	5,398	958,072	1,563	3,695	3,596	168	717	1,501	1,081	481
Isle of Wright	5,390	6,354	2,093	19,383	6,851	69,813	7,969	5,505	202	847	1,792	1,380	482
Newport News	4,013	7,668	1,424	2,488	6,387	2,334	367,700	90,679	4,115	6,971	15,773	45,386	1,426
Hampton	2,682	7,642	957	1,610	4,304	1,675	95,436	253,230	4,138	1,300	2,688	12,654	604
Poquoson	408	964	150	226	741	198	9,039	10,745	11,032	323	644	4,920	117
Williamsburg	159	286	53	118	274	75	1,668	399	47	20,593	18,260	11,208	106
James City County	2,381	5,306	759	1,118	4,741	757	8,123	2,327	192	47,554	148,596	35,233	746
York	1,719	3,749	609	957	3,178	726	63,921	25,045	5,085	20,079	28,847	66,962	946
Gloucester	1,549	3,506	479	632	3,150	411	3,343	1,212	100	856	1,903	2,897	58,915

Table 3-3f. Trip Distribution – 8-Lane Build, HRBT and MMMBT $3 Toll

8-Lane Build HRBT and MMMBT $3 Toll	Chesapeake	Norfolk	Portsmouth	Suffolk	Virginia Beach	Isle of Wright	Newport News	Hampton	Poquoson	Williamsburg	James City County	York	Gloucester
Chesapeake	446,057	107,014	69,252	30,815	130,394	2,699	5,209	3,743	169	889	1,833	1,282	579
Norfolk	42,985	456,555	7,861	2,872	113,200	757	2,412	2,114	125	255	613	576	190
Portsmouth	70,047	27,152	118,562	19,721	16,067	1,376	2,196	1,590	82	260	562	483	184
Suffolk	47,012	21,443	24,308	290,307	19,899	20,537	8,100	5,572	266	1,561	3,135	2,153	917
Virginia Beach	111,668	179,094	10,361	5,388	959,019	1,563	3,030	2,871	123	686	1,420	936	481
Isle of Wright	5,342	6,454	2,041	19,335	6,931	70,478	7,389	5,021	198	861	1,818	1,379	489
Newport News	3,747	7,084	1,276	2,317	5,683	2,240	368,708	91,527	4,133	6,949	15,654	45,401	1,413
Hampton	2,200	6,422	761	1,430	3,636	1,588	96,684	254,592	4,165	1,301	2,699	12,725	602
Poquoson	378	880	137	214	667	189	9,109	10,878	11,041	321	640	4,925	116
Williamsburg	158	277	52	119	241	75	1,689	404	47	20,592	18,267	11,221	105
James City County	2,347	5,189	750	1,125	4,599	756	8,246	2,360	194	47,539	148,680	35,255	744
York	1,654	3,501	575	932	2,927	701	64,177	25,355	5,099	20,081	28,829	67,011	935
Gloucester	1,529	3,464	474	638	3,101	410	3,424	1,235	102	854	1,893	2,919	58,887