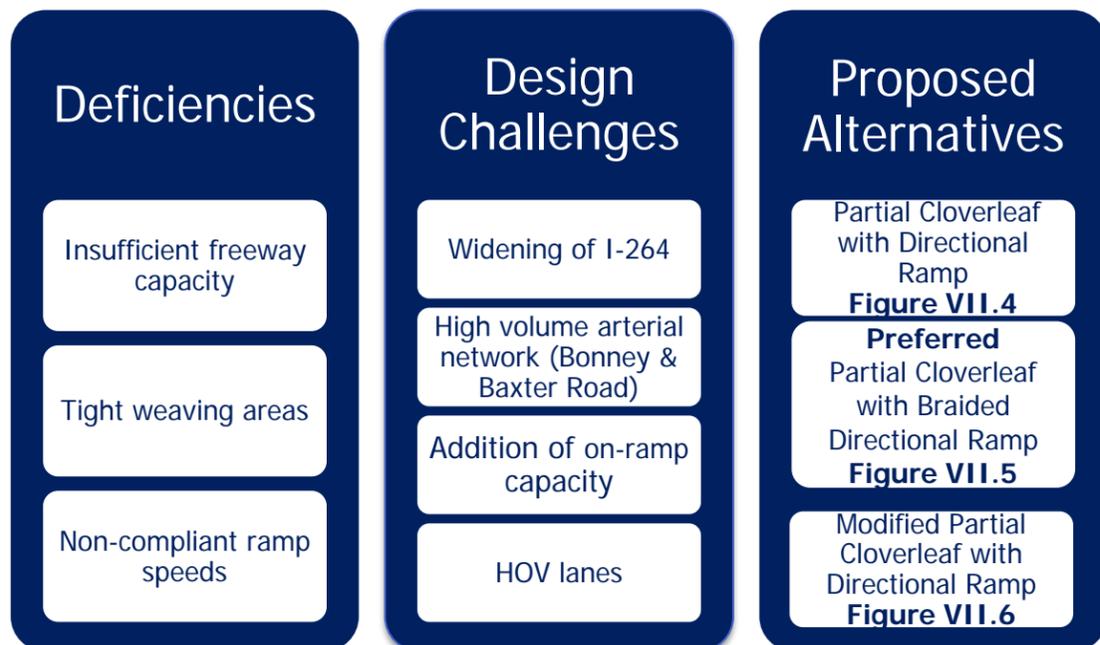


VII. Independence Boulevard Interchange



VII.1 Existing Conditions

Existing conditions present at the Independence Boulevard interchange are described in this chapter focusing on roadway geometry, volumes, capacity analysis, and crash history.

VII.1.1 Geometry, Speeds, Lanes, Traffic Control

Figures VII.1 and VII.1A display a summary of the existing roadway geometry. The Independence Boulevard interchange is configured in a conventional cloverleaf design. Concurrent flow HOV lanes are provided through the interchange in each direction of travel immediately adjacent to the median barrier. Several geometric deficiencies have been documented at the interchange and some of the more notable deficiencies include:

- Less than 14.5' vertical clearance on Independence Boulevard under I-264
- Ramp speeds are non-compliant at 8 locations
- Exit ramp speed not posted on exit ramp to side road
- Acceleration lane length is non-compliant at 2 locations
- Intersection spacing is non-compliant at 1 location
- Pedestrian access is not provided along Independence Boulevard

Additional details on the existing conditions geometry at the Independence Boulevard interchange can be found in the Technical Appendix.

VII.1.2 Volumes & Operations

Figure VII.2: Existing Volumes displays the existing weekday peak hour volumes for the year 2014. Traffic counts were conducted during early December 2014, with counts conducted on Tuesdays, Wednesdays and/or Thursdays. The peak hour counts document the typical commuter pattern on I-264, with heavier volumes in the westbound direction during the AM peak period and in the eastbound direction during the PM peak period. On Independence Boulevard, the heavier volumes are in the northbound direction in the AM peak period and in the southbound direction in the PM peak period.

Table 7.1 displays a summary of the results of the capacity analysis of existing conditions using the Highway Capacity Manual (HCS) software package, and as shown in the results, the interchange exhibits two deficiencies. First, west of the interchange area the westbound I-264 mainline freeway lanes operate at LOS E in the AM peak hour, and second, the westbound I-264 mainline weave operates with LOS E in the AM peak hour. All of the other movements at the Independence Boulevard interchange operate with LOS D or better using the HCS capacity analysis methodology.

Movement (Type)	AM Peak Hour		PM Peak Hour	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
EB I-264 between Witchduck Rd and Independence Blvd (Freeway)	28.5	D	34.6	D
EB I-264 to SB Independence Blvd (Diverge)	9.7	A	17.9	B
NB/SB Independence Blvd & I-264 EB (Weave)	27.7	C	34.4	D
NB Independence Blvd to EB I-264 (Merge)	20.3	C	23.2	C
EB I-264 between Independence Blvd and Rosemont Rd (Freeway)	23.5	C	27.0	D
WB I-264 between Independence Blvd and Rosemont Rd (Freeway)	34.2	D	28.3	D
WB I-264 to NB Independence Blvd (Diverge)	31.8	D	27.7	C
NB/SB Independence Blvd & I-264 WB (Weave)	46.0	E	32.7	D
SB Independence Blvd to WB I-264 (Merge)	33.3	D	28.7	D
WB I-264 between Witchduck Rd and Independence Blvd (Freeway)	44.2	E	33.4	D

- * VR > Max
- ** VFO + VR12 > Max
- *** VFI + V12 > Max

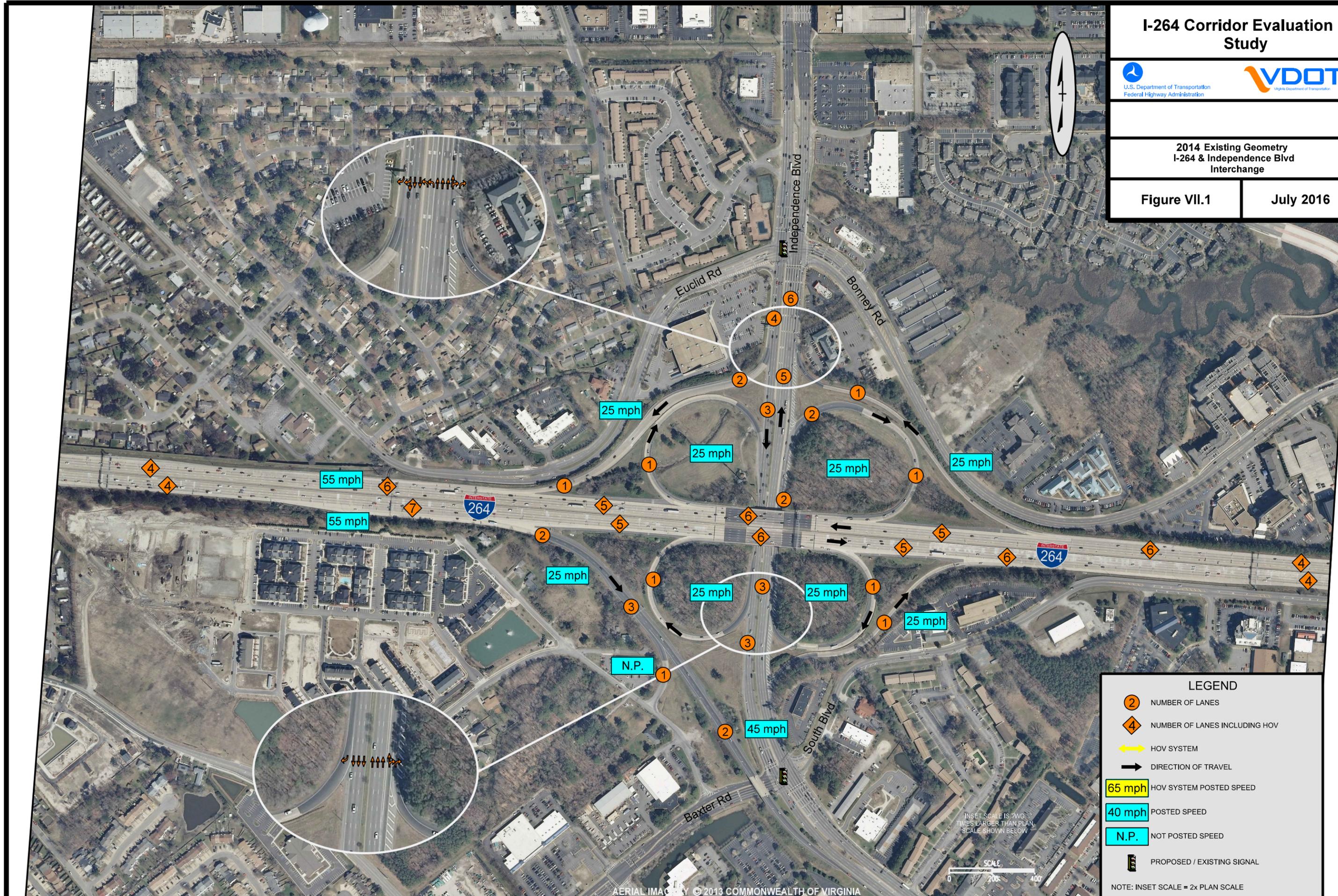
I-264 Corridor Evaluation Study



2014 Existing Geometry
I-264 & Independence Blvd
Interchange

Figure VII.1

July 2016



LEGEND

- 2 NUMBER OF LANES
- 4 NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

I-264 Corridor Evaluation Study

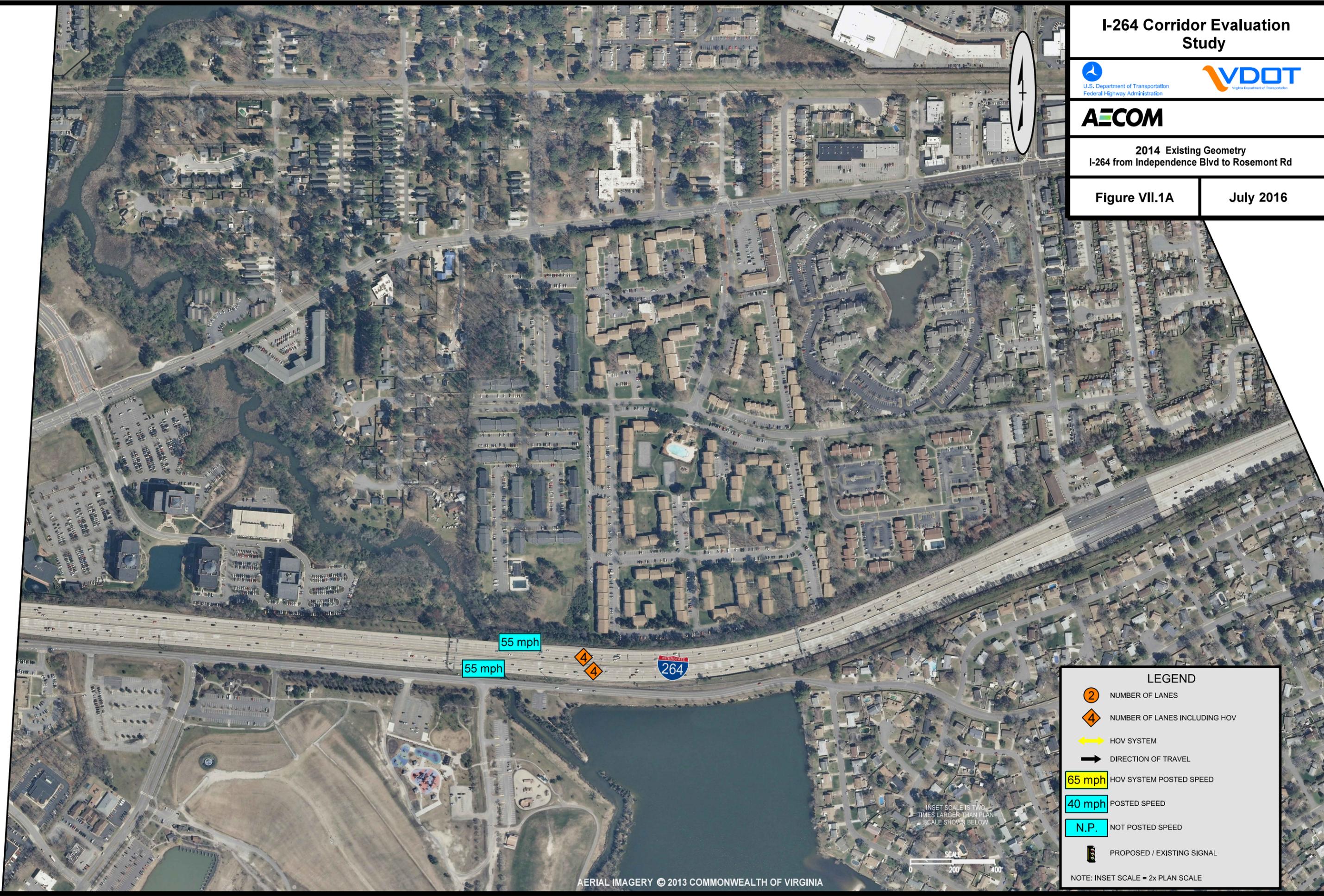


AECOM

2014 Existing Geometry
I-264 from Independence Blvd to Rosemont Rd

Figure VII.1A

July 2016



LEGEND

-  NUMBER OF LANES
-  NUMBER OF LANES INCLUDING HOV
-  HOV SYSTEM
-  DIRECTION OF TRAVEL
-  65 mph HOV SYSTEM POSTED SPEED
-  40 mph POSTED SPEED
-  N.P. NOT POSTED SPEED
-  PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

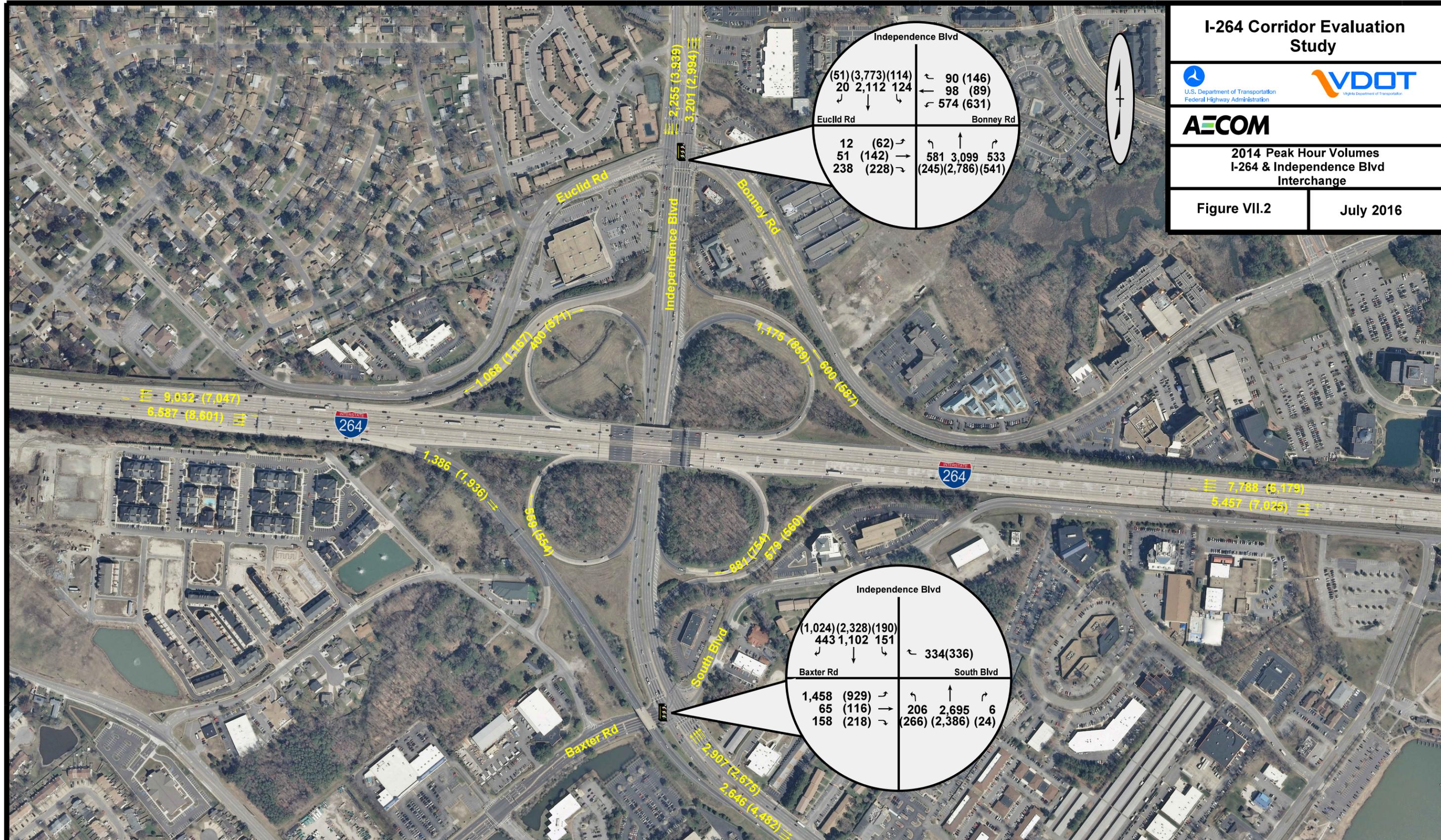
I-264 Corridor Evaluation Study



2014 Peak Hour Volumes
I-264 & Independence Blvd Interchange

Figure VII.2

July 2016



Independence Blvd

(51) (3,773) (114)	← 90 (146)
20 2,112 124	← 98 (89)
	← 574 (631)
Euclid Rd	Bonney Rd
12 (62) →	↖ ↗
51 (142) →	↖ ↗
238 (228) →	↖ ↗
	↑ 581 3,099 533
	(245) (2,786) (541)

Independence Blvd

(1,024) (2,328) (190)	← 334 (336)
443 1,102 151	
Baxter Rd	South Blvd
1,458 (929) →	↖ ↗
65 (116) →	↖ ↗
158 (218) →	↖ ↗
	↑ 206 2,695 6
	(266) (2,386) (24)

LEGEND

XXX	AM PEAK HOUR VOLUME
(XXX)	PM PEAK HOUR VOLUME



Table 7.2 summarizes the results of the existing conditions CORSIM analysis. CORSIM produced similar results to the HCS 2010 analysis. Many of the movements are operating with LOS D conditions and a few LOS E conditions in the CORSIM analysis. CORSIM showed very poor service levels for the merge segment from southbound Independence Boulevard to westbound I-264 with LOS E conditions in the AM peak hour. AM peak hour field conditions appear to operate slightly better than the CORSIM analysis shows for this movement. This is likely because the acceleration lane becomes the shoulder lane that continues through Witchduck Road. When the shoulder is closed, motorists still use it as an acceleration lane until they find a suitable gap in the traffic stream. This behavior does not occur in CORSIM, thus worse levels of service are reported.

It should be noted that neither the HCS nor CORSIM analysis included the eastbound I-264 off-ramp merge with southbound Independence Boulevard approaching the Edwin Drive intersection. While this two-lane ramp movement is deficient and routinely forms queues extending from the merge area back into the eastbound I-264 off-ramp diverge movement area on the freeway, City staff indicated they would not consider improvements involving the widening of Independence Boulevard through and beyond the Edwin Drive intersection because of the extensive impacts to businesses and right of way. Consequently, this movement was not analyzed, and improvement alternatives to address the deficiency were not developed as part of this study. However, this movement will need to be evaluated in greater detail in the future.

Movement (Type)	AM Peak Hour		PM Peak Hour	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
EB I-264 between Witchduck Rd and Independence Blvd (Freeway)	29.5	D	30.2	D
EB I-264 to SB Independence Blvd (Diverge)	25.2	C	27.0	C
NB/SB Independence Blvd & I-264 EB (Weave)	21.3	C	21.0	C
NB Independence Blvd to EB I-264 (Merge)	20.9	C	21.1	C
EB I-264 between Independence Blvd and Rosemont Rd (Freeway)	23.5	C	23.2	C
WB I-264 between Independence Blvd and Rosemont Rd (Freeway)	33.6	D	26.2	D
WB I-264 to NB Independence Blvd (Diverge)	31.5	D	24.4	C
NB/SB Independence Blvd & I-264 WB (Weave)	31.3	D	23.2	C
SB Independence Blvd to WB I-264 (Merge)	39.1	E	27.3	C
WB I-264 between Witchduck Rd and Independence Blvd (Freeway)	39.4	E	30.2	D

Table 7.3 summarizes the existing conditions SimTraffic capacity analysis of the two signalized intersections on the Independence Boulevard corridor. The analysis shows poor service levels with the exception of the Baxter Road/South Boulevard at Independence Boulevard intersection in the AM peak hour, which exhibits LOS D.

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Euclid Road/Bonney Road & Independence Boulevard	110.5	F	134.2	F
Baxter Road/South Boulevard & Independence Boulevard	36.5	D	67.4	E

Table 7.4 presents a summary of the existing conditions SimTraffic queueing analysis, and the results show that vehicle queues extending from the traffic signals are currently accommodated by the storage available on the respective off-ramps. The 95th percentile queue from the eastbound I-264 off-ramp to northbound Independence Boulevard is long in the AM peak hour due to congestion on the weave segment on Independence Boulevard entering westbound I-264.

Intersection	Ramp Length (feet)	AM Peak Hour		PM Peak Hour	
		Average (feet)	95th % (feet)	Average (feet)	95th % (feet)
WB I-264 Off-Ramp to NB Independence Boulevard	1,460	9	74	3	39
EB I-264 Off-Ramp to NB Independence Boulevard	1,110	91	356	2	25

Capacity Analysis indicates that most ramps at the Independence Boulevard interchange are currently operating with adequate capacity. Two key exceptions are noted.

VII.1.3 Crashes

Figure VII.3 displays the 4-year crash history at Independence Boulevard for the years 2009-2012. Crashes in both directions of travel appear to be evenly distributed through the interchange area. The ramps in both directions of travel show a high density of crashes, which are likely related to a combination of congestion and geometric deficiencies. The northbound Independence Boulevard ramp to westbound I-264 also shows a high density of crashes nearest Independence Boulevard, which is likely a function of the queues that extend back from the congested intersection of northbound Independence Boulevard with Bonney Road.

When comparing crash frequencies the mainline freeway segments both east and west of the interchange area, Figure VII.3 also shows that the frequency of crashes to the west is much heavier. The greater crash frequency to the west is likely a product of heavier volumes and more severely congested conditions.

Location	Type of Crash											Severity			
	Rear End	Angle	Head On	Sideswipe - Same Dir.	Fixed Object in Road	Train	Non-Collision	Fixed Object Off Road	Motorcyclist	Other	Misc.	Total	Property Damage Only	Injury	Fatal
EB ML	81	15	0	10	0	1	0	18	0	1	0	126	84	42	0
WB ML	65	11	1	13	0	0	3	15	0	0	0	108	55	53	0
EB Ramps	31	2	0	5	0	0	3	19	1	0	1	62	39	23	0
WB Ramps	32	5	1	10	1	0	1	30	0	0	1	81	61	20	0
Total	209	33	2	38	1	1	7	82	1	1	2	377	239	138	0

Table 7.5 summarizes the crash history by direction and type of freeway facility (Ramp, CD or mainline) at the Independence Boulevard interchange for the period 2009-2012. A total of 377 crashes occurred in the interchange vicinity and a majority of the crashes (209) involved rear end crashes and a similar majority (234) occurred on the mainline freeway. There were 138 injury crashes and 0 fatal crashes. The two most frequent types of crashes, Rear End and Fixed Object Off-Road, make up 77% of the total number of crashes.

VII.2 Forecasted Conditions

The analysis of forecasted conditions includes the development and evaluation of future volumes and operations for the year 2040. The No Build Alternative and three improvement alternatives are described, followed by an explanation of the basis for the selection of the preferred alternative. Cost and impacts for the preferred alternative are listed at the end of this section as well. Table 7.6 displays the forecasted conditions volumes for the No Build Alternative (regular font) and Build Alternatives (**bold font**) at the Independence Boulevard interchange for the year 2040. Existing volumes are also listed (*in italics*) in order to provide for comparison. In general, the volumes show moderate change in growth entering and exiting the interchange area.

Interstate & Direction	Movement		2014 Existing Volumes		2040 No Build Alternative		2040 Build Alternatives	
			AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
	From	To						
I-264 EB	Mainline before Independence		<i>6,587</i>	<i>8,601</i>	7,354	9,590	8,120	10,596
	EB I-264	SB Independence Blvd	<i>1386</i>	<i>1,936</i>	1,578	2,169	1,669	2,371
	SB Independence Blvd	EB I-264	<i>559</i>	<i>554</i>	603	608	624	618
	EB I-264	NB Independence Blvd	<i>881</i>	<i>754</i>	1,010	849	1,116	967
	NB Independence Blvd	EB I-264	<i>579</i>	<i>560</i>	623	614	632	603
	Mainline after Independence		<i>5,457</i>	<i>7,025</i>	5,992	7,795	6,592	8,480
I-264 WB	Mainline before Independence		<i>7,788</i>	<i>6,179</i>	8,607	6,763	9,392	7,453
	WB I-264	NB Independence Blvd	<i>600</i>	<i>587</i>	654	633	667	668
	WB I-264	Bonney Rd	<i>0</i>	<i>0</i>	0	0	100	108
	NB Independence Blvd	WB I-264	<i>1,175</i>	<i>859</i>	1,334	989	1,458	1,046
	WB I-264	SB Independence Blvd	<i>400</i>	<i>571</i>	433	612	432	620
	SB Independence Blvd	WB I-264	<i>1,068</i>	<i>1,167</i>	1,215	1,344	1,357	1,472
	Mainline after Independence		<i>9,032</i>	<i>7,047</i>	10,068	7,852	11,117	8,683

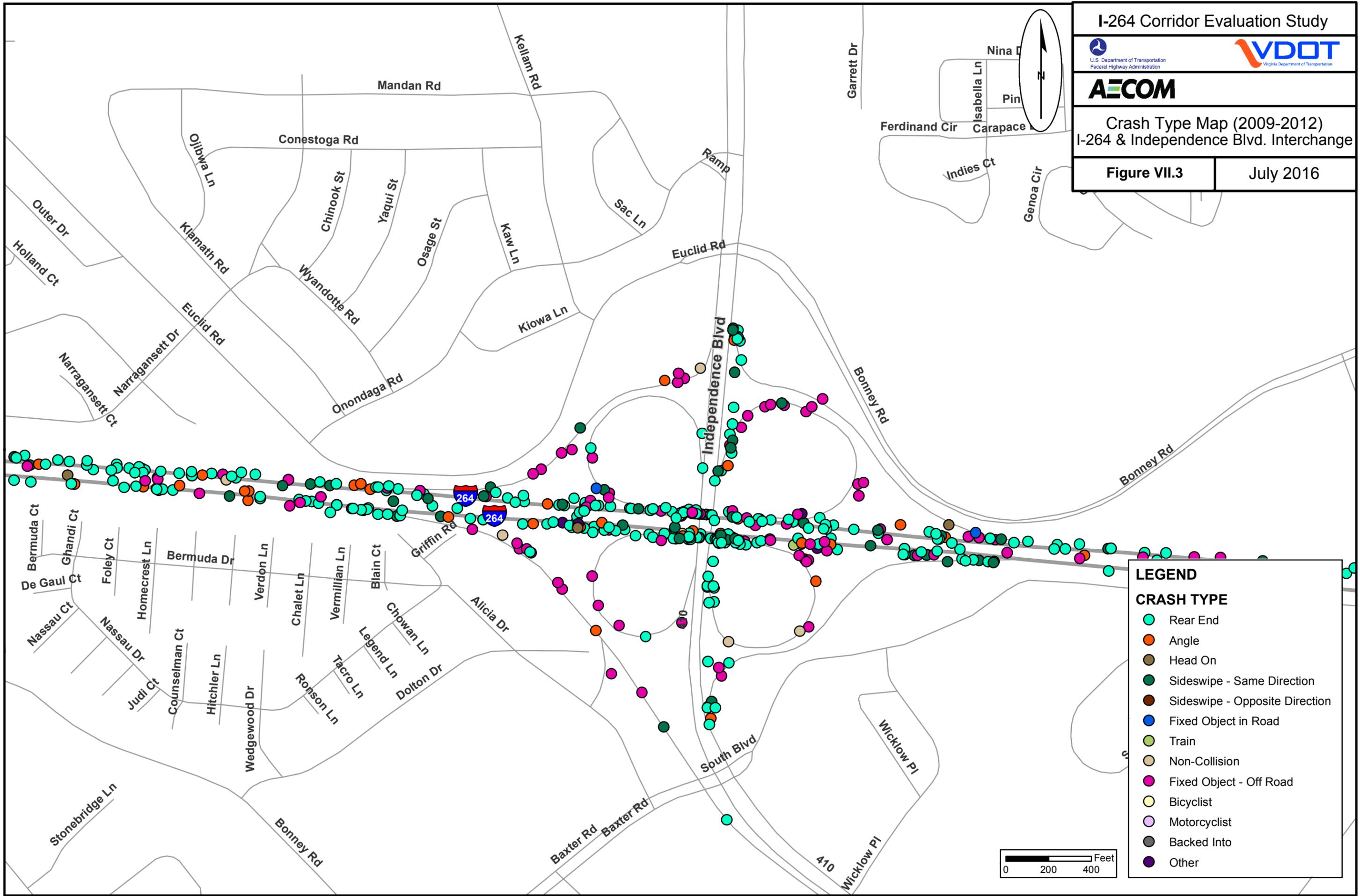
I-264 Corridor Evaluation Study



Crash Type Map (2009-2012)
I-264 & Independence Blvd. Interchange

Figure VII.3

July 2016



It should also be noted that – as previously discussed in the section on the development of forecasts - the travel demand model network for all year 2040 forecasts included the proposed flyover extending from Bonney Road (east of Grayson Road) north to Lavender Lane at Virginia Beach Boulevard. This connection has been recommended in the City's *Pembroke SGA Plan*, and is also identified on the *Master Transportation Plan*.

VII.2.1 Forecasted Volumes & Operations

The roadway geometry for the No Build Alternative for this interchange is the same as that for existing conditions. No improvements are currently funded in the current *Six-Year Improvement Program*.

Shown later in this section, **Table 7.9** displays a summary of the results of the HCS and CORSIM capacity analysis of the No Build Alternative. The results of the HCS analysis show that since traffic volumes throughout the interchange is forecasted to exhibit moderate growth, service levels have deteriorated from those found under existing conditions. The interchange exhibits major deficiencies in all westbound movements during at least one peak hour. Eastbound I-264 west of the interchange displays LOS E in the PM peak hour and the weave section displays LOS E in both peak hours. The CORSIM analysis results show poor service levels throughout the interchange. Here also, the results have deteriorated to those found under existing conditions and are similar to the HCS capacity analysis of the No Build Alternative.

To reiterate, the merge of the eastbound I-264 Off-ramp with southbound Independence Boulevard approaching Edwin Drive has not been included in this analysis.

The results of the HCS and CORSIM capacity analysis indicate the forecasted year 2040 volumes will be inadequately accommodated on the interchange ramps. Deficiencies involve both the mainline freeway lanes and individual interchange ramps associated more with the westbound movements at the interchange.

The results of the HCS and CORSIM capacity analysis indicate the forecasted year 2040 volumes will be inadequately accommodated on the interchange ramps. Deficiencies involve both the mainline freeway lanes and individual interchange ramps associated more with the westbound movements at the interchange.

Capacity Analysis indicates that majority of the movements at the Independence Boulevard interchange will deteriorate and operate with inadequate capacity through 2040.

Table 7.7 summarizes the 2040 No Build Alternative SimTraffic capacity analysis of the Independence Boulevard corridor. The analysis shows poor service levels for the two intersections during both peak hours. The service levels have deteriorated from existing conditions at all intersections for each peak hour. The close spacing of the signalized intersections combined with heavy volumes cannot be accommodated by the existing interchange configuration and existing intersection locations.

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Euclid Road/Bonney Road & Independence Boulevard	145.4	F	144.7	F
Baxter Road/South Boulevard & Independence Boulevard	146.5	F	96.3	F

Table 7.8 presents a summary of the 2040 No Build SimTraffic queuing analysis, and the results show that vehicle queues extending from the traffic signals spill back to interstate and impact freeway operations at certain peak periods of the day. The eastbound off-ramp to northbound Independence Boulevard exhibits 95th percentile queues spilling onto the interstate in the PM peak hour. Reported queue lengths were only reported up to a maximum 1,500 feet in length, modeling demonstrated much longer lengths because the modeled ramps were much longer than the actual ramps. The actual ramp length is only 1,110 feet. This ramp also exhibits an increase in queue length in the AM peak hour in comparison to the existing conditions.

Intersection	Ramp Length (feet)	AM Peak Hour		PM Peak Hour	
		Average (feet)	95th % (feet)	Average (feet)	95th % (feet)
WB I-264 Off-Ramp to NB Independence Boulevard	1,460	5	61	22	134
EB I-264 Off-Ramp to NB Independence Boulevard	1,110	195	553	411	+1,500

VII.2.2 Improvement Alternatives

In addition to the capacity deficiencies for the No Build Alternative, geometric deficiencies and any major maintenance activities (such as bridge replacement) should be designed to incorporate consideration of a plan for future improvements. To that end, three improvement alternatives have been developed and analyzed. These are shown in **Figures VII.4, VII.5 and VII.6**. Geometric compliance has been intentionally provided with all proposed improvements.

The first improvement alternative in **Figure VII.4 – Partial Cloverleaf with Directional Ramp** – consists of building a new on-ramp towards eastbound and westbound I-264 originating at the Baxter Road intersection. The on-ramp will split off into two directions: a fly-over towards westbound I-264 to merge with the southbound Independence on-ramp, and an on-ramp that merges with eastbound I-264.

This improvement alternative also provides a split ramp providing access to Bonney Road from the westbound I-264 off-ramp to northbound Independence Boulevard. **Figures VII.4 – VII.6 also show construction along Bonney Road east of Independence Boulevard that will be needed to accommodate freeway widening and – where applicable - the slip ramp merge**

All interchange weave movements are eliminated, and additional capacity on I-264 has been included with six lanes provided through the interchange and 7 lanes provided west of the interchange.

The second improvement alternative in **Figure VII.5 – Partial Cloverleaf with Braided Directional Ramp** – provides for converting the northbound Independence Boulevard approach into two separate ramps with one ramp splitting toward eastbound I-264 and the other toward westbound I-264. One ramp accommodates only traffic from northbound Independence Boulevard, enabling motorists to avoid delays at the signalized intersection. The second ramp will allow traffic from Baxter Road and southbound Independence Boulevard to access I-264.

This improvement alternative removes all weave movements and additional capacity on I-264 has been included with six lanes through the interchange and 7 lanes west of the interchange.

The third improvement alternative in **Figure VII.6 – Modified Partial Cloverleaf with Directional Ramp** - converts the northbound Independence Boulevard approach into two separate ramps to access both eastbound and westbound I-264. The “Broken Back Curve” allows traffic from Baxter Road and southbound Independence Boulevard to access eastbound I-264.

This improvement alternative also provides a split ramp providing access to Bonney Road from the westbound I-264 off-ramp to northbound Independence Boulevard.

All weave movements are eliminated and additional capacity on I-264 has been included with six lanes through the interchange and 7 lanes west of the interchange.

The improvement alternatives have been analyzed using the same procedures – HCS and CORSIM - used in the analysis of existing conditions and No Build Alternative. The results of the

capacity analysis for all the forecasted year 2040 alternatives (including the No Build Alternative) are shown in **Table 7.9**. A density listed with a (+) was analyzed as a freeway segment due to HCS limitations for evaluating add lanes (where an on-ramp creates a continuous additional lane to the freeway) and drop lanes (where a continuous freeway lane drops to an off-ramp). The Independence Boulevard interchange Build Alternative improvements have locations where the geometry is atypical and is not capable of being appropriately analyzed using HCS 2010 procedures.

In addition, SimTraffic simulation software capacity and queue analysis was conducted for each improvement alternative at signalized intersections and the results for all the year 2040 improvement alternatives are shown in **Table 7.10** and **Table 7.11**.

Partial Cloverleaf with Directional Ramp

The results in **Table 7.9** display all movements associated with the interchange operating with LOS D or better conditions. The mainline freeway section west of the interchange exhibits LOS D in the eastbound direction for the PM peak hour and westbound direction for the AM peak hour.

For the signalized intersections along the Independence Boulevard study area, the SimTraffic capacity analysis summarized in **Table 7.10** indicates that the intersection of Baxter Road and the on-ramps to I-264 will exhibit LOS F in the AM peak hour and LOS D in the PM peak hour. The Euclid Road and Bonney Road intersection will exhibit poor service levels with LOS E in the AM peak hour and LOS F in the PM peak hour.

Table 7.11 presents a summary of the SimTraffic queueing analysis, and the results show that vehicle queues extending from the traffic signals will be accommodated by the storage available on the respective off-ramps. Heavier queueing is displayed in the PM peak hour for all three alternative improvements, especially on the eastbound I-264 off-ramp towards northbound Independence Boulevard.

Partial Cloverleaf with Braided Directional Ramp

The results in **Table 7.9** show that all of the movements associated with the interchange exhibit adequate service levels of D or better. The results are similar to the first alternative improvement with the mainline freeway section west of the interchange exhibits LOS D in the eastbound direction for the PM peak hour and westbound direction for the AM peak hour.

For the signalized intersections along the Independence Boulevard study area, the SimTraffic capacity analysis summarized in **Table 7.10** indicates that the intersection of Baxter Road and the on-ramps to I-264 will exhibit adequate service levels of D or better. The Euclid Road and Bonney Road intersection will exhibit poor service levels with LOS E in the AM peak hour and LOS F in the PM peak hour.

VII.2.2 Improvement Alternatives

In addition to the capacity deficiencies for the No Build Alternative, geometric deficiencies and any major maintenance activities (such as bridge replacement) should be designed to incorporate consideration of a plan for future improvements. To that end, three improvement alternatives have been developed and analyzed. These are shown in **Figures VII.4, VII.5 and VII.6**. Geometric compliance has been intentionally provided with all proposed improvements.

The first improvement alternative in **Figure VII.4 – Partial Cloverleaf with Directional Ramp** – consists of building a new on-ramp towards eastbound and westbound I-264 originating at the Baxter Road intersection. The on-ramp will split off into two directions: a fly-over towards westbound I-264 to merge with the southbound Independence on-ramp, and an on-ramp that merges with eastbound I-264.

This improvement alternative also provides a split ramp providing access to Bonney Road from the westbound I-264 off-ramp to northbound Independence Boulevard. **Figures VII.4 – VII.6 also show construction along Bonney Road east of Independence Boulevard that will be needed to accommodate freeway widening and – where applicable - the slip ramp merge**

All interchange weave movements are eliminated, and additional capacity on I-264 has been included with six lanes provided through the interchange and 7 lanes provided west of the interchange.

The second improvement alternative in **Figure VII.5 – Partial Cloverleaf with Braided Directional Ramp** – provides for converting the northbound Independence Boulevard approach into two separate ramps with one ramp splitting toward eastbound I-264 and the other toward westbound I-264. One ramp accommodates only traffic from northbound Independence Boulevard, enabling motorists to avoid delays at the signalized intersection. The second ramp will allow traffic from Baxter Road and southbound Independence Boulevard to access I-264.

This improvement alternative removes all weave movements and additional capacity on I-264 has been included with six lanes through the interchange and 7 lanes west of the interchange.

The third improvement alternative in **Figure VII.6 – Modified Partial Cloverleaf with Directional Ramp** - converts the northbound Independence Boulevard approach into two separate ramps to access both eastbound and westbound I-264. The “Broken Back Curve” allows traffic from Baxter Road and southbound Independence Boulevard to access eastbound I-264.

This improvement alternative also provides a split ramp providing access to Bonney Road from the westbound I-264 off-ramp to northbound Independence Boulevard.

All weave movements are eliminated and additional capacity on I-264 has been included with six lanes through the interchange and 7 lanes west of the interchange.

The improvement alternatives have been analyzed using the same procedures – HCS and CORSIM - used in the analysis of existing conditions and No Build Alternative. The results of the

capacity analysis for all the forecasted year 2040 alternatives (including the No Build Alternative) are shown in **Table 7.9**. A density listed with a (+) was analyzed as a freeway segment due to HCS limitations for evaluating add lanes (where an on-ramp creates a continuous additional lane to the freeway) and drop lanes (where a continuous freeway lane drops to an off-ramp). The Independence Boulevard interchange Build Alternative improvements have locations where the geometry is atypical and is not capable of being appropriately analyzed using HCS 2010 procedures.

In addition, SimTraffic simulation software capacity and queue analysis was conducted for each improvement alternative at signalized intersections and the results for all the year 2040 improvement alternatives are shown in **Table 7.10** and **Table 7.11**.

Partial Cloverleaf with Directional Ramp

The results in **Table 7.9** display all movements associated with the interchange operating with LOS D or better conditions. The mainline freeway section west of the interchange exhibits LOS D in the eastbound direction for the PM peak hour and westbound direction for the AM peak hour.

For the signalized intersections along the Independence Boulevard study area, the SimTraffic capacity analysis summarized in **Table 7.10** indicates that the intersection of Baxter Road and the on-ramps to I-264 will exhibit LOS F in the AM peak hour and LOS D in the PM peak hour. The Euclid Road and Bonney Road intersection will exhibit poor service levels with LOS E in the AM peak hour and LOS F in the PM peak hour.

Table 7.11 presents a summary of the SimTraffic queueing analysis, and the results show that vehicle queues extending from the traffic signals will be accommodated by the storage available on the respective off-ramps. Heavier queueing is displayed in the PM peak hour for all three alternative improvements, especially on the eastbound I-264 off-ramp towards northbound Independence Boulevard.

Partial Cloverleaf with Braided Directional Ramp

The results in **Table 7.9** show that all of the movements associated with the interchange exhibit adequate service levels of D or better. The results are similar to the first alternative improvement with the mainline freeway section west of the interchange exhibits LOS D in the eastbound direction for the PM peak hour and westbound direction for the AM peak hour.

For the signalized intersections along the Independence Boulevard study area, the SimTraffic capacity analysis summarized in **Table 7.10** indicates that the intersection of Baxter Road and the on-ramps to I-264 will exhibit adequate service levels of D or better. The Euclid Road and Bonney Road intersection will exhibit poor service levels with LOS E in the AM peak hour and LOS F in the PM peak hour.

Table 7.11 presents a summary of the SimTraffic queueing analysis, and the results show that vehicle queues extending from the traffic signals will be accommodated by the storage available on the respective off-ramps.

Partial Cloverleaf with Directional Ramp

The results in **Table 7.9** show that all of the movements associated with the interchange exhibit adequate service levels of D or better. The capacity analysis results are very similar to the two previous alternative improvements.

For the signalized intersections along the Independence Boulevard study area, the SimTraffic capacity analysis summarized in **Table 7.10** indicates that the intersection of Baxter Road and the on-ramps to I-264 will exhibit adequate service levels of D or better. The Euclid Road and Bonney Road intersection will exhibit poor service levels with LOS E in the AM peak hour and LOS F in the PM peak hour.

Table 7.11 presents a summary of the SimTraffic queueing analysis, and the results show that vehicle queues extending from the traffic signals will be accommodated by the storage available on the respective off-ramps.

Overall, the PM peak hour is likely worse in the Build Alternatives for the Euclid Road/Bonney Road and Independence Boulevard intersection primarily because the No Build Alternative limits more flow at the Baxter Road intersection decreasing the volume at Euclid Road/Bonney Road, thereby reducing its delay. The AM peak hour is better in the Build Alternatives because these scenarios have less congestion at the Baxter intersection allowing traffic from the Euclid Road/Bonney Road intersection to flow more easily towards the Baxter Road intersection.

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

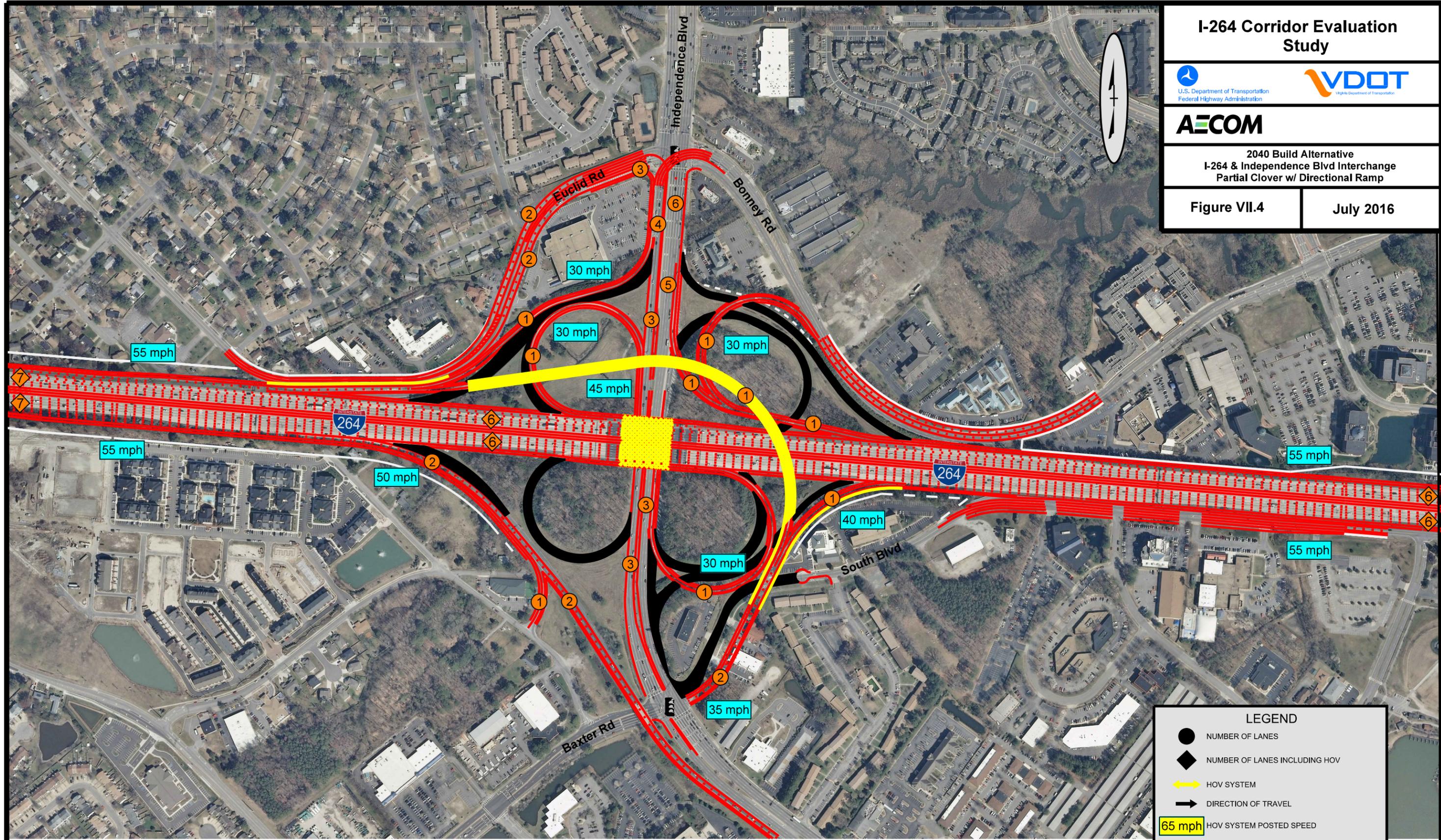


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2040 Build Alternative
I-264 & Independence Blvd Interchange
Partial Clover w/ Directional Ramp

Figure VII.4

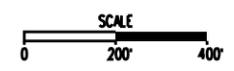
July 2016



LEGEND

- NUMBER OF LANES
- NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE



I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

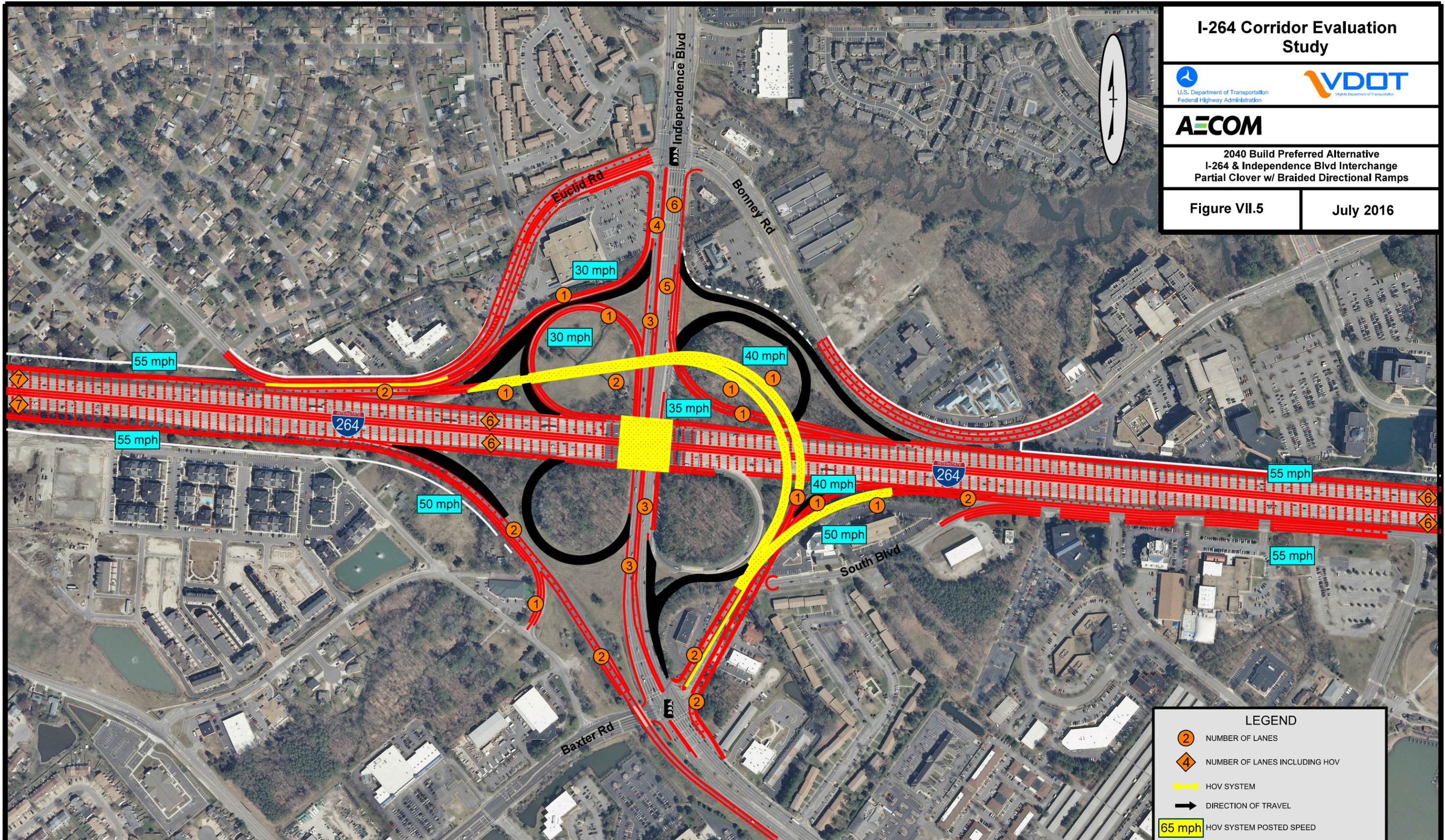
VDOT
Virginia Department of Transportation

AECOM

2040 Build Preferred Alternative
I-264 & Independence Blvd Interchange
Partial Clover w/ Braided Directional Ramps

Figure VII.5

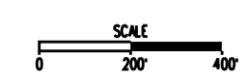
July 2016



LEGEND

- 2 NUMBER OF LANES
- 4 NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- 🚦 PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE



I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

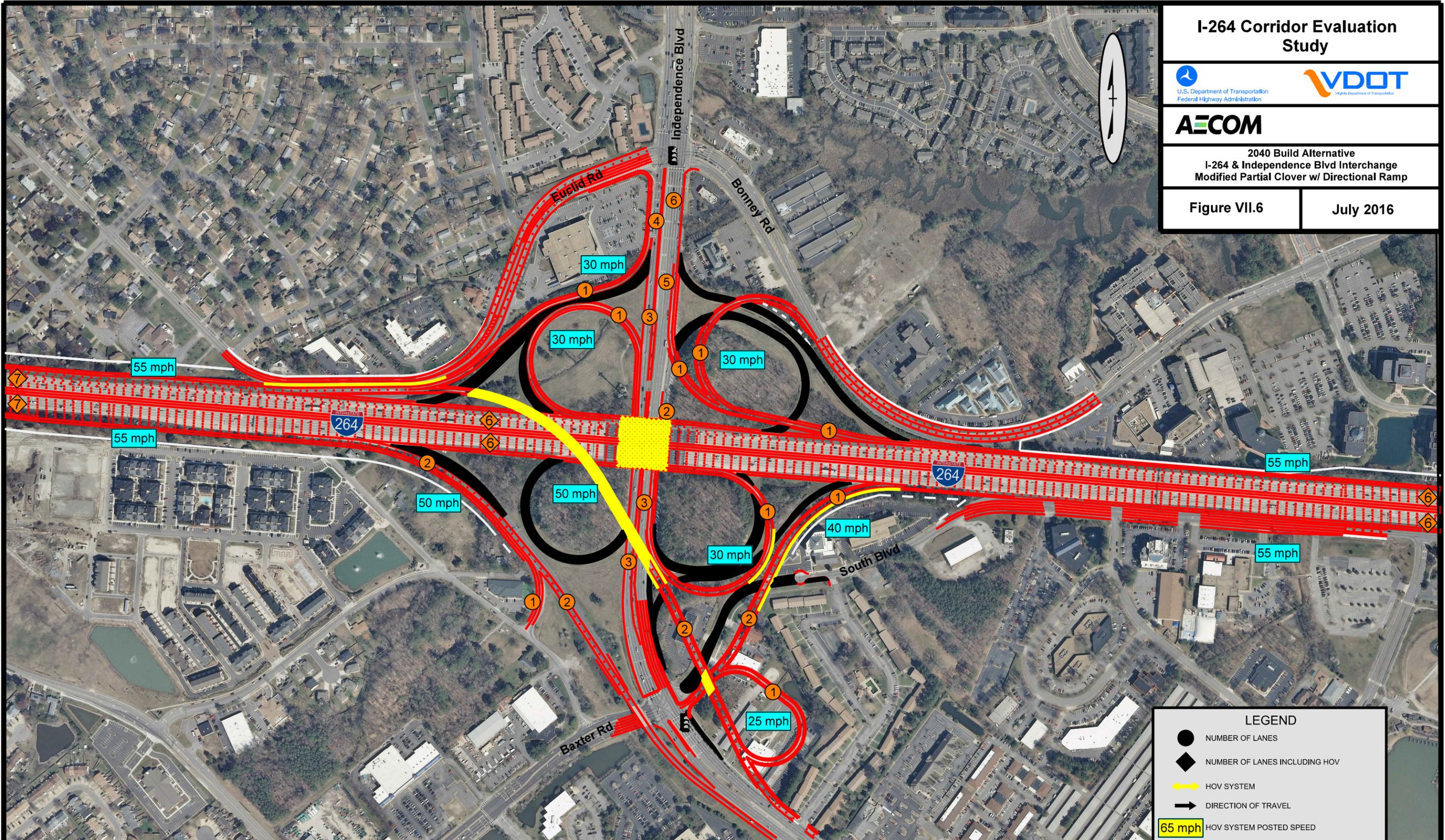
VDOT
Virginia Department of Transportation

AECOM

2040 Build Alternative
I-264 & Independence Blvd Interchange
Modified Partial Clover w/ Directional Ramp

Figure VII.6

July 2016



LEGEND

- NUMBER OF LANES
- ◆ NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- 🚦 PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

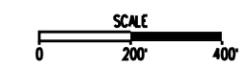


Table 7.9
Summary of Capacity Analysis Results
Year 2040 Alternatives: Independence Boulevard & I-264

Year 2040 Alternative		No Build Alternative				Partial Cloverleaf with Directional Ramp				Partial Cloverleaf with Braided Directional Ramp				Modified Partial Cloverleaf with Directional Ramp			
Time of Day		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
Dir	Movement (Type)	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS
HCS Analysis Results																	
East-bound I-264	EB I-264 between Witchduck Rd and Independence Blvd (Freeway)	32.6	D	41.6	E	20.0	C	27.2	D	20.0	C	27.2	D	20.0	C	27.2	D
	EB I-264 to SB Independence Blvd (Diverge)	12.5	B	19.5	B	20.0 ⁺	C	27.2 ⁺	D	20.0 ⁺	C	27.2 ⁺	D	20.0 ⁺	C	27.2 ⁺	D
	NB/SB Independence Blvd & I-264 EB (Weave)	40.6	E	46.4	E	-	-	-	-	-	-	-	-	-	-	-	-
	EB I-264 to NB Independence Blvd (Diverge)	-	-	-	-	18.6 ⁺	C	25.3 ⁺	C	18.6 ⁺	C	25.3 ⁺	C	18.6 ⁺	C	25.3 ⁺	C
	NB Independence Blvd to EB I-264 (Merge)	22.2	C	25.4	C	16.3 ⁺	B	21.7 ⁺	C	14.2 ⁺	B	18.6 ⁺	C	16.3 ⁺	B	21.7 ⁺	C
	SB Independence Blvd to EB I-264 (Merge)	-	-	-	-	16.3 ⁺	B	21.7 ⁺	C	14.2 ⁺	B	18.6 ⁺	C	16.3 ⁺	B	21.7 ⁺	C
	EB I-264 between Independence Blvd and Rosemont Rd (Freeway)	25.9	C	30.3	D	19.0	C	26.1	D	19.0	C	26.1	D	19.0	C	26.1	D
West-bound I-264	WB I-264 between Independence Blvd and Rosemont Rd (Freeway)	40.2	E	31.6	D	32.5	D	22.7	C	32.5	D	22.7	C	32.5	D	22.7	C
	WB I-264 to NB Independence Blvd (Diverge)	35.1	E	30.3	D	32.5 ⁺	D	22.7 ⁺	C	32.5 ⁺	D	22.7 ⁺	C	32.5 ⁺	D	22.7 ⁺	C
	NB/SB Independence Blvd & I-264 WB (Weave)	V/C = 0.946	F	47.4	E	-	-	-	-	-	-	-	-	-	-	-	-
	WB I-264 to SB Independence Blvd (Diverge)	-	-	-	-	29.6 ⁺	D	20.7 ⁺	C	29.6 ⁺	D	20.7 ⁺	C	29.6 ⁺	D	20.7 ⁺	C
	NB/SB Independence Blvd to WB I-264 (Merge)	37.2	F*	32.2	D	26.7 ⁺	D	19.9 ⁺	C	26.7 ⁺	D	19.9 ⁺	C	26.7 ⁺	D	19.9 ⁺	C
	WB I-264 between Witchduck Rd and Independence Blvd (Freeway)	57.9	F	39.6	E	31.9	D	22.7	C	31.9	D	22.7	C	31.9	D	22.7	C
CORSIM Analysis Results																	
East-bound I-264	EB I-264 between Witchduck Rd and Independence Blvd (Freeway)	24.4	C	48.8	F	19.7	C	26.9	D	19.6	C	26.9	D	19.7	C	26.9	D
	EB I-264 to SB Independence Blvd (Diverge)	21.6	C	34.3	D	19.7	B	27.2	C	19.6	B	27.0	C	19.7	B	27.2	C
	NB/SB Independence Blvd & I-264 EB (Weave)	18.5	B	23.3	C	-	-	-	-	-	-	-	-	-	-	-	-
	EB I-264 to NB Independence Blvd (Diverge)	-	-	-	-	16.1	B	20.5	C	16.0	B	20.5	C	16.1	B	20.5	C
	NB Independence Blvd to EB I-264 (Merge)	17.6	B	23.5	C	17.1	B	22.2	C	16.4	B	20.5	C	17.1	B	22.2	C
	SB Independence Blvd to EB I-264 (Merge)	-	-	-	-	-	-	-	-	13.9	B	18.2	B	-	-	-	-
	EB I-264 between Independence Blvd and Rosemont Rd (Freeway)	19.3	C	26.0	C	18.2	C	23.8	C	18.1	C	23.8	C	18.2	C	23.8	C
West-bound I-264	WB I-264 between Independence Blvd and Rosemont Rd (Freeway)	86.4	F	31.6	D	26.9	C	20.9	C	27.0	D	20.9	C	26.9	D	20.9	C
	WB I-264 to NB Independence Blvd (Diverge)	85.9	F	42.0	E	25.8	C	19.9	B	25.8	C	20.2	C	25.8	C	19.9	B
	NB/SB Independence Blvd & I-264 WB (Weave)	104.6	F	50.5	F	-	-	-	-	-	-	-	-	-	-	-	-
	WB I-264 to SB Independence (Diverge)	-	-	-	-	21.7	C	16.5	B	21.8	C	16.9	B	21.7	C	16.5	B
	SB Independence Blvd to WB I-264 (Merge)	113.4	F	63.7	F	26.5	C	19.8	B	26.5	C	19.9	B	26.5	C	19.8	B
	WB I-264 between Witchduck Rd and Independence Blvd (Freeway)	118.8	F	72.2	F	27.7	D	20.7	C	27.7	D	20.7	C	27.7	D	20.7	C

Table 7.10 Summary of 2040 Build SimTraffic Capacity Analysis I-264 at Independence Boulevard Improvement Alternatives				
Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Partial Cloverleaf with Directional Ramp (Figure VII.4)				
Euclid Road/Bonney Road	64.4	E	186.0	F
Baxter Road/I-264 On-ramps	101.1	F	45.8	D
Partial Cloverleaf with Braided Directional Ramp (Figure VII.5)				
Euclid Road/Bonney Road	79.7	E	182.1	F
Baxter Road/I-264 On-ramps	41.5	D	32.4	C
Modified Partial Cloverleaf with Directional Ramp (Figure VII.6)				
Euclid Road/Bonney Road	59.5	E	183.2	F
Baxter Road/I-264 On-ramps	45.4	D	42.0	D

Table 7.11 Summary of 2040 Build Conditions SimTraffic Queue Analysis I-264 at Independence Boulevard Improvement Alternatives					
Intersection	Ramp Length (feet)	AM Peak Hour		PM Peak Hour	
		Average (feet)	95th % (feet)	Average (feet)	95th % (feet)
Partial Cloverleaf with Directional Ramp (Figure VII.4)					
WB I-264 Off-Ramp to NB Independence Blvd	1,460	3	35	10	89
EB I-264 Off-Ramp to NB Independence Blvd	1,110	3	44	51	389
Partial Cloverleaf with Braided Directional Ramp (Figure VII.5)					
WB I-264 Off-Ramp to NB Independence Blvd	1,460	3	28	24	145
EB I-264 Off-Ramp to NB Independence Blvd	1,110	3	33	27	257
Modified Partial Cloverleaf with Directional Ramp (Figure VII.6)					
WB I-264 Off-Ramp to NB Independence Blvd	1,460	5	45	3	31
EB I-264 Off-Ramp to NB Independence Blvd	1,110	2	21	14	164

VII.2.3 Alternative: Cost

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

Alternative	Cost (in \$million)
Partial Cloverleaf with Directional Ramp	\$444.7
Partial Cloverleaf with Braided Directional Ramp	\$465.6
Modified Partial Cloverleaf with Directional Ramp	\$424.0

VII.2.4 Stakeholder Coordination

A series of coordination meetings were held with staff from the City of Virginia Beach. In general, representatives from the City were supportive of the evaluation process and the selection of the Partial Cloverleaf with Braided Directional Ramp as the preferred alternative.

VII.2.5 Impacts

Identification of potential impacts on key resources from construction of the three improvement alternatives was evaluated using desktop GIS mapping analysis. Detailed exhibits are in the Technical Appendix. Summarized in **Table 7.12**, the results show that the three alternatives would impact water resources (wetlands, for example) but would not impact Section 4(f) properties (public parks, for example). The Partial Cloverleaf with Directional Ramp would impact 14 adjacent buildings, Partial Cloverleaf with Braided Directional Ramp alternative improvement would impact 12 adjacent buildings and the Modified Partial Cloverleaf with Directional Ramp alternative improvement would impact 17 adjacent buildings.

Table 7.12 Independence Boulevard Interchange Improvement Alternative Impacts				
Improvement Alternative	WATER	BUILDINGS	RESIDENTIAL	POTENTIAL SECTION 4F
Partial Cloverleaf with Directional Ramp	Y	14	0	N
Partial Cloverleaf with Braided Directional Ramp	Y	12	0	N
Modified Partial Cloverleaf with Directional Ramp	Y	17	0	N

The cost estimates for the three alternatives were in a fairly tight range, and each alternative was within 10% of the cost of the other alternatives. The many similarities of the three alternatives made choosing a preferred alternative a difficult task.

Prior to detailed analysis, the Partial cloverleaf with directional ramp alternative was considered the leading candidate for the preferred alternative. However, after thorough investigation of the arterial traffic signal operations, it was determined that the Baxter Road intersection could not operate adequately in the design year with this configuration. Overcapacity conditions at the Baxter Road intersection showed the potential to produce extensive queuing that would impact interchange operations.

Both the Partial cloverleaf with braided directional ramps alternative and the Modified partial cloverleaf w/ directional ramp alternative demonstrated adequate service levels and acceptable queuing at the Baxter Road intersection. Most importantly, the Partial cloverleaf with braided directional ramps alternative exhibited the least amount of impacts of the three alternatives.

The principal difference between the two remaining alternatives was that the Partial cloverleaf w/ braided directional ramps alternative produced less intrusive impacts to properties located in the southeast quadrant of the Baxter Road intersection. The added loop ramp in the Modified partial cloverleaf w/ directional ramp alternative impacts several commercial properties, and the disruption is not offset by improved service.

Although the Partial cloverleaf w/ braided directional ramps alternative would cost the most, consideration of the reduced impacts it would generate are the basis of its selection as the Preferred Alternative.

Although the Partial cloverleaf w/ braided directional ramps alternative (Figure VII.5) would cost the most, consideration of the reduced impacts it would generate are the basis of its selection as the Preferred Alternative.

VII.3 Recommendation

With the exception of the eastbound I-264 merge with southbound Independence Boulevard approaching Edwin Drive (which was not included in this analysis), each of the 3 Build Alternatives would provide adequate service levels for all the interstate movements associated with the Independence Boulevard interchange. The key (and most expensive) improvements are the widening of I-264 in each direction through the interchange, involving replacement of and raising of the bridges over Independence Boulevard.

All three Build Alternatives show deficiencies at the Bonney Road/Euclid Road intersection. Assuming the intersection has been improved with the addition of a third left turn lane on the westbound Bonney Road approach, signal timing can be adjusted so this intersection does not negatively impact the interchange operations. However, for this intersection to provide adequate service, grade separation will be needed.

In contrast, the Baxter Road intersection will operate adequately under either the Partial cloverleaf w/ braided directional ramps alternative or the Modified partial cloverleaf w/ directional ramp alternative.