

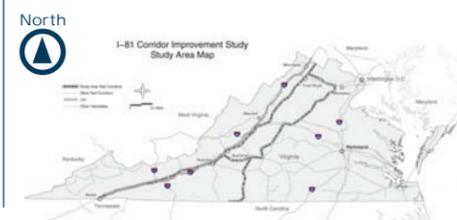
Legend

-  Railroad
-  Rail Concept #3

N



0 5 10 20 Miles



Rail Concept 3

Figure
3.2-3

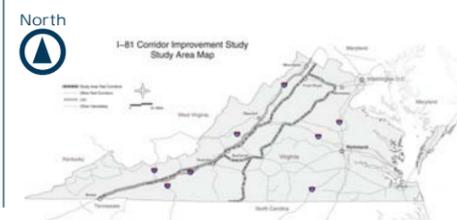
Legend

-  Railroad
-  Rail Concept #4

N



0 5 10 20 Miles



Rail Concept 4

Figure
3.2-4

Roadway Concepts

Roadway concepts were evaluated in conjunction with different toll scenarios. The effect of the tolls was estimated by modeling diversions from I-81 to other transportation facilities for trucks and cars or just trucks. Generally, the higher the toll, the more diversion of traffic from I-81 to other facilities. This diversion lowers the capacity improvement requirements on the I-81 mainline. In addition, traffic that diverts to I-81 due to the improved efficiency created by the proposed improvements (*i.e.*, those that would divert from their normal travel pattern on a facility other than I-81 to I-81 if it were improved) was accounted for in the projection of traffic for each concept.

Five toll scenarios were tested for each concept evaluated:

- No toll
- Low toll for all vehicles (\$0.08 per mile per vehicle (car) / \$0.04 per mile per axle (truck))
- High toll for all vehicles (\$0.14 per mile per vehicle (car) / \$0.07 per mile per axle (truck))
- Low toll for only commercial vehicles (\$0.04 per mile per axle (truck))
- High toll for only commercial vehicles (\$0.07 per mile per axle (truck))

With no toll, capacity and safety improvements along I-81 attract traffic that ordinarily would have taken a different route (either local, regional, or long distance), but is now attracted to a new, improved facility. As toll rates are introduced, travel patterns begin to shift back to those present prior to improvement of the facility as vehicles divert to their original route choices to avoid additional costs. The toll diversion involved a modeling effort described in the *I-81 Corridor Improvement Study Toll Impact Study*. The low and high toll rates were derived from national research and represent a reasonable rate that could be charged. Generally, the higher the toll, the more diversion of traffic from I-81 to other facilities, which reduces the number of required lanes on I-81.

Add 1 Lane Concept

This improvement concept provides one additional lane in each direction and upgraded shoulder widths for the entire length of I-81 in Virginia.

Add 2 Lanes Concept

This improvement concept provides two additional lanes and upgraded shoulder widths in each direction for the entire length of I-81 in Virginia.

Add 3 Lanes Concept

This improvement concept provides three additional lanes and upgraded shoulder widths in each direction for the entire length of I-81 in Virginia.



Uniform 6-Lane Concept

This improvement concept provides an additional lane, where necessary, to make the entire corridor a consistent 3 lanes in each direction and upgraded shoulder widths for the entire length of I-81 in Virginia.

Uniform 8-Lane Concept

This concept provides additional lanes, where necessary, to make the entire corridor a consistent 4 lanes in each direction and upgraded shoulder widths for the entire length of I-81 in Virginia.

Combination Concepts

Roadway and rail improvement concepts were combined to assess their effectiveness in addressing the needs of the I-81 corridor. Rail Concept 3 was chosen as the most appropriate rail concept to combine with roadway concepts because it provides the most diversion of freight from truck to rail per dollar of investment.

The Combination Concepts were evaluated in conjunction with the toll scenarios described in the Roadway Concept section, accounting for traffic that diverts to I-81 because of increased capacity.

Combination Concept 1

This improvement concept provides one additional lane and upgraded shoulder widths in each direction for the entire length of I-81 in Virginia in combination with Rail Concept 3.

Combination Concept 2

This improvement concept provides two additional lanes and upgraded shoulder widths in each direction for the entire length of I-81 in Virginia in combination with Rail Concept 3.

Combination Concept 3

This improvement concept provides three additional lanes and upgraded shoulder widths in each direction for the entire length of I-81 in Virginia in combination with Rail Concept 3.

Combination Concept 4

This improvement concept provides one additional lane, where necessary, to provide three lanes in each direction and upgraded shoulder widths for the entire length of I-81 in Virginia (the Uniform Six-Lane Concept) in combination with Rail Concept 3.

Combination Concept 5

This improvement concept provides two additional lanes in each direction, where necessary, to provide four lanes in each direction and upgraded shoulder widths for the entire length of I-81 in Virginia (the Uniform Eight-Lane Concept) in combination of Rail Concept 3.

Separated Lane Concepts

Concepts involving the separation of lanes were considered and were divided into two types: those involving exclusive separated lanes and those involving non-exclusive separated lanes. Exclusive lanes are barrier-separated lanes with separate interchange ramps to all the interchanges along the roadway. Non-exclusive lanes provide a rumble strip between the separated lanes and the other lanes, which allows vehicles in the separated lanes to merge into the other lanes to use the existing interchange ramps. Separated lane concepts were evaluated with the same toll scenarios as the other concepts, accounting for traffic that diverts to I-81 because of increases in capacity, and also in combination with the addition of zero, one, and two general purposes lanes in each direction.

Separated Lane Concept 1

This improvement concept provides one exclusive barrier-separated truck lane in each direction of travel. It was evaluated in combination with the addition of one or two non-separated lanes and upgraded shoulder widths in each direction. It was evaluated with and without Rail Concept 3 as well as with various toll scenarios.

Separated Lane Concept 2

This improvement concept provides two exclusive barrier-separated truck lanes in each direction of travel. It was evaluated in combination with the addition of zero, one, or two non-separated lanes and upgraded shoulder widths in each direction. It was evaluated with and without Rail Concept 3 as well as with various toll scenarios.

Separated Lane Concept 3

This improvement concept provides two non-exclusive separated truck lanes in each direction of travel. It was evaluated in combination with the addition of zero, one, or two non-separated lanes and upgraded shoulder widths in each direction. It was evaluated with and without Rail Concept 3 as well as with various toll scenarios.

It is estimated that approximately 20 percent of the total truck volume would be mixed with passenger cars at any given point.

Separated Lane Concept 4

This concept provides two exclusive barrier-separated car lanes in each direction of travel. It was evaluated in combination with the addition of zero, one, or two non-separated lanes and

upgraded shoulder widths in each direction. It was evaluated with and without Rail Concept 3 as well as with various toll scenarios.

Separated Lane Concept 5

This improvement concept provides two non-exclusive separated car lanes in each direction of travel. It was evaluated in combination with the addition of zero, one, or two non-separated lanes and upgraded shoulder widths in each direction. It was evaluated with and without Rail Concept 3 as well as with various toll scenarios.

Cars can travel in either the non-exclusive car lanes or the non-separated lanes. This concept provides the same separation as Separated Lane Concept 4, but passenger cars have the option of traveling with trucks and it is estimated that approximately 20 percent of passenger cars would travel with trucks.

A summary of the No-Build Concept and 211 combinations of TSM, road improvements, rail improvements and various toll scenarios that were considered is presented in Table 2.3-2



Table 2.3-2 Potential Improvement Concepts

Stand Alone Concept	No Toll	Tolling Scenarios			
		Toll All		Toll Trucks Only	
		Low	High	Low	High
No-Build	✓				
TSM	✓				
Highway					
Add 1 lane in each direction	✓	✓	✓	✓	✓
Add 2 lanes in each direction	✓	✓	✓	✓	✓
Add 3 lanes in each direction	✓	✓	✓	✓	✓
Uniform 6-lane cross-section	✓	✓	✓	✓	✓
Uniform 8-lane Cross-Section	✓	✓	✓	✓	✓
Add 1 lane in each direction with Rail 3 (Combination Concept 1)	✓	✓	✓	✓	✓
Add 2 lanes in each direction with Rail 3 (Combination Concept 2)	✓	✓	✓	✓	✓
Add 3 lanes in each direction with Rail 3 (Combination Concept 3)	✓	✓	✓	✓	✓
Uniform 6-lane cross-section with Rail 3 (Combination Concept 4)	✓	✓	✓	✓	✓
Uniform 8-lane Cross-Section with Rail 3 (Combination Concept 5)	✓	✓	✓	✓	✓
Rail					
Rail 1 (R1)	✓				
Rail 2 (R2)	✓				
Rail 3 (R3)	✓				
Rail 4 (R4)	✓				

Table 2.3-2: Potential Improvement Concepts (continued)

Stand Alone Concept	Tolling Scenarios				Rail Concepts		
	No Toll	Toll All		Toll Trucks Only		No Rail	Rail 3
		Low	High	Low	High		
Two Lane Exclusive Truckway¹ with:							
6 to 8 Exclusive Car Lanes	✓	✓	✓	✓	✓	✓	✓
8 to 10 Exclusive Car Lanes	✓	✓	✓	✓	✓	✓	✓
Four Lane Exclusive Truckway with:							
4 to 6 Exclusive Car Lanes	✓	✓	✓	✓	✓	✓	✓
6 to 8 Exclusive Car Lanes	✓	✓	✓	✓	✓	✓	✓
8 to 10 Exclusive Car Lanes	✓	✓	✓	✓	✓	✓	✓
Four Lane Non-Exclusive Truckway² with:							
4 to 6 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓
8 to 10 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓
10 to 12 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓
Four Lane Exclusive Car Lanes³ with:							
4 to 6 Exclusive Truck Lanes	✓	✓	✓	✓	✓	✓	✓
6 to 8 Exclusive Truck Lanes	✓	✓	✓	✓	✓	✓	✓
8 to 10 Exclusive Truck Lanes	✓	✓	✓	✓	✓	✓	✓
Four Lane Exclusive Car Lanes⁴ with:							
4 to 6 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓
6 to 8 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓
8 to 10 General Purpose Lanes	✓	✓	✓	✓	✓	✓	✓

- 1 Exclusive truckway provides separate access/egress at all interchanges from a separated lane or separated lanes. Only trucks can travel in the separated lanes. Cars must travel in exclusive car lanes and use existing interchange configuration.
- 2 Non-Exclusive truckway allows trucks in separated lanes to cross into general purpose lanes to access existing interchanges. Only trucks can travel in the separated lanes. Cars can only travel in general purpose lanes. However, trucks can also use the general purpose lanes to access/egress existing interchanges. Up to 70 percent of trucks are expected to use the general purpose lanes. It is assumed that trucks do not travel in these lanes for long distances.
- 3 Exclusive car lanes provide separate access/egress at all interchanges from separated lanes. Only cars can travel in the separated lanes. Trucks must travel in exclusive truck lanes and use existing interchange configuration.
- 4 Exclusive car lanes provide separate access/egress at all interchanges from separated lanes. Only cars can travel in the separated lanes. Trucks must travel in the general purpose lanes. However, cars can choose to travel in either the exclusive or general purpose lanes for their entire trip. Twenty percent of cars are expected to use the general purpose lanes

The identification and analysis of the concepts described above was an iterative process. The results and findings of concurrent technical reports often led to the restructuring of concepts or creation of new concepts. Based on the findings presented in the *Toll Impact Study*, traffic diversions due to tolls along I-81 would not reduce traffic demands sufficiently to address corridor needs in 2035. Furthermore, it is inconsistent with existing Federal transportation law to toll an interstate facility unless improvements are made. In addition, the use of tolls collected on an interstate to make improvements to other modes of transportation (*e.g.*, railroads) is prohibited. Therefore toll scenarios are considered operational characteristics to



the concepts identified and were only evaluated in combination with these concepts. (There is no analysis of tolls that considers 2035 No-Build conditions.)

Similarly, no combinations of stand-alone concepts were considered initially. This allowed stand-alone improvements to be isolated so that their effect on increasing capacity or reducing demand could be determined. Based on the findings of the *Transportation Technical Report*) and the *Freight Forecast and Diversion Technical Report*, it was determined that improvements to rail would not in themselves address 2035 corridor needs. Therefore, the five combination concepts joining rail and capacity improvements were developed. Rail improvements were also incorporated with the separated lanes concepts in order to evaluate the combined effects of these improvements.

Lastly, the transportation analyses indicated that adding separated lanes to the existing cross-section would also not be sufficient to accommodate 2035 corridor needs. These concepts were appropriately refined to include the addition of non-separated lanes as well.

Potential typical sections of the stand-alone concepts are illustrated in the Appendix.

3

Concept Evaluation

The evaluation performed to determine the improvement concepts' ability to meet the Purpose and Need of the I-81 corridor included traffic operational analyses. The methodology used for the evaluation is described in the following sections. Potential cross-sections and templates were developed and used to approximate cost and to provide a footprint for use in environmental impact analyses.

3.1 Traffic Operations

The details and methodology of traffic operations can be found in the *I-81 Corridor Study Transportation Technical Report*. For the purposes of the evaluation results presented in Section 3.2, the overlying assumptions of that report are noted below:

- The level of service standard for interstate freeway corridors is LOS C or better along urban mainline segments and LOS B or better along rural mainline segments. Any level of service lower than those standards were deemed to be deficient and in need of improvement.
- In addition, the operational analysis of each concept identified where the I-81 mainline provided excess capacity, which was defined as those mainline sections where the removal of one or more lanes in one or both directions would still allow operations to meet the standards.
- The traffic operational analysis consisted of determining the future (2035) level of service on the mainline of I-81 between the 91 interchanges in the 325-mile corridor. A total of 650 miles of mainline were represented in the analysis, 325 miles in each direction.
- The mainline location with the steepest grade and the fewest number of lanes between interchanges was selected as the point of analysis for each I-81 segment. Analyzing concepts under these conditions produced the worst case level of service on a roadway segment-by-segment basis. If a "Build" concept (or portion of a "Build" concept) is advanced to Tier 2, the analyses would subdivide the segments between interchanges and conduct mainline analyses using actual composite grades.

3.1.1 Toll Effect

The details and methodology used for Tolls is provided in the *I-81 Corridor Study Toll Impact Study*. The effects of tolls are also detailed in the *I-81 Corridor Study Transportation Technical Report*. In general, the findings of these reports indicate that vehicles may divert from local and regional roadways to I-81 if improvements are made and no toll is imposed. Should a toll be imposed, it is possible that vehicles would divert back to the local and regional roadway network. Generally, the higher the toll, the more diversion of traffic from I-81 to adjacent facilities. This diversion lowers the capacity improvement requirements on the I-81 mainline.

Five toll scenarios were tested for each concept evaluated:

- No Toll - reflects the operations associated with using the 2035 traffic projections without tolls. On average, 10 percent of vehicles may divert from local and regional roadways to I-81.
- Toll All Vehicles – Low Toll - reflects the operations associated with using the 2035 No Toll traffic projections and the effect of a low toll (\$0.08 per mile per vehicle (car) and \$0.04 per mile per axle (truck)). On average, eight percent of vehicles may divert back to local and regional roadways.
- Toll All Vehicles – High Toll - reflects the operations associated with using the 2035 No Toll traffic projections and the effect of a high toll (\$0.14 per mile per vehicle (car) and \$0.07 per mile per axle (truck)). On average, 16 percent of vehicles may divert back to local and regional roadways.
- Toll Commercial Vehicles Only – Low Toll – reflects the operations associated with using the 2035 traffic No Toll traffic projections and the effect of a low toll (\$0.04 per mile per axle). On average two percent of vehicles may divert back to local and regional roadways.
- Toll Commercial Vehicles Only – High Toll – reflects the operations associated with using the 2035 traffic No Toll traffic projections and the effect of a high toll (\$0.07 per mile per axle). On average nine percent of vehicles may divert back to local and regional roadways.

Toll scenarios were evaluated in conjunction with the rail concepts even though no toll revenue could be collected on I-81 and used to fund rail improvements. This evaluation was conducted for informational purposes and to confirm that Rail Concept 3 was the proper selection for use in combination with other concepts.

3.2 Evaluation Results

Evaluation results are presented in Table 3.2-1. The concepts' ability to meet the capacity needs of the corridor is summarized in ensuing paragraphs.



Table 3.2-1 Evaluation Results

Non-Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Comm	High Toll Comm	With R3 ⁵	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶		
No-Build																
	✓						N/A	N/A	N/A	N/A	N/A	N/A	594	18		
TSM¹																
	✓						N/A	N/A	N/A	N/A	N/A	N/A	594	18	\$0.08 B	\$0.1 B
Highway																
Add 1 lane in each direction 6 to 8-lane cross-section	✓						N/A	N/A	N/A	N/A	N/A	N/A	396	37	\$5.1 B	\$7.5 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	325	89		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	237	131		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	378	68		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	364	104		
Combination Concept 1 Add 1 lane in each direction In combination with Rail 3	✓					✓	N/A	N/A	N/A	N/A	N/A	N/A	378	67	\$5.6 B	\$8.2 B
		✓				✓	N/A	N/A	N/A	N/A	N/A	N/A	294	99		
			✓			✓	N/A	N/A	N/A	N/A	N/A	N/A	169	150		
				✓		✓	N/A	N/A	N/A	N/A	N/A	N/A	328	75		
Add 2 lanes in each direction Results in 8 to 10 -lane Cross-section	✓						N/A	N/A	N/A	N/A	N/A	N/A	76	254	\$7.8 B	\$11.4 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	51	325		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	20	413		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	62	272		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	61	286		
Combination Concept 2 Add 2 lanes in each direction In Combination with Rail 3	✓					✓	N/A	N/A	N/A	N/A	N/A	N/A	59	272	\$8.3 B	12.2 B
		✓				✓	N/A	N/A	N/A	N/A	N/A	N/A	30	356		
			✓			✓	N/A	N/A	N/A	N/A	N/A	N/A	1	481		
				✓		✓	N/A	N/A	N/A	N/A	N/A	N/A	62	322		
					✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	33	365		



Table 3.2.1 Evaluation Results (Continued)

Non-Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Comm	High Toll Comm	With R3 ⁵	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶		
Add 3 lanes in each direction Results in 10 to 12-lane cross-section	✓						N/A	N/A	N/A	N/A	N/A	N/A	0	574	\$11.2 B	\$16.4 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	0	599		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	0	630		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	0	588		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	0	599		
Combination Concept 3 Add 3 lanes in each direction In combination with Rail 3	✓					✓	N/A	N/A	N/A	N/A	N/A	N/A	0	591	\$11.7 B	\$17.1 B
		✓				✓	N/A	N/A	N/A	N/A	N/A	N/A	0	620		
			✓			✓	N/A	N/A	N/A	N/A	N/A	N/A	0	649		
				✓		✓	N/A	N/A	N/A	N/A	N/A	N/A	0	588		
					✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	0	617		
Uniform 6-lane cross-section (Add 1 lane in each direction except in Bristol and Wytheville)	✓						N/A	N/A	N/A	N/A	N/A	N/A	411	24	\$4.9 B	\$7.2 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	339	75		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	242	108		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	392	54		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	372	84		
Combination 4 Uniform 6 -lane cross-section In combination with Rail 3	✓					✓	N/A	N/A	N/A	N/A	N/A	N/A	393	54	\$5.4 B	\$7.9 B
		✓				✓	N/A	N/A	N/A	N/A	N/A	N/A	306	83		
			✓			✓	N/A	N/A	N/A	N/A	N/A	N/A	174	127		
				✓		✓	N/A	N/A	N/A	N/A	N/A	N/A	393	54		
					✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	290	101		



Table 3.2.1 Evaluation Results (Continued)

Non-Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non- Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Comm	High Toll Comm	With R3 ⁵	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶		
Uniform 8-lane cross-section (Add 2 lanes in each direction, but add 1 lane in Bristol and Wytheville)	✓						N/A	N/A	N/A	N/A	N/A	N/A	76	239	\$7.5 B	\$11.0 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	51	311		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	20	408		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	62	258		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	61	278		
Combination Concept 4 Uniform 8-lane cross-section In combination with Rail 3	✓					✓	N/A	N/A	N/A	N/A	N/A	N/A	59	257	\$8.0 B	\$11.7 B
		✓				✓	N/A	N/A	N/A	N/A	N/A	N/A	30	344		
			✓			✓	N/A	N/A	N/A	N/A	N/A	N/A	1	476		
				✓		✓	N/A	N/A	N/A	N/A	N/A	N/A	62	257		
					✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	33	360		
Rail																
Rail 1 (R1) ²	✓						N/A	N/A	N/A	N/A	N/A	N/A	604	4	\$0.1 B	\$0.2 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	540	8		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	480	42		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	579	4		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	539	8		
Rail 2 (R2) ³	✓						N/A	N/A	N/A	N/A	N/A	N/A	594	46	\$0.5 B	\$0.7 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	530	110		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	439	170		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	575	71		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	528	111		



Table 3.2.1 Evaluation Results (Continued)

Non-Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Comm	High Toll Comm	With R3 ⁵	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶	Deficient Miles ⁶	Excess Miles ⁶		
Rail 3 (R3) ⁵	✓						N/A	N/A	N/A	N/A	N/A	N/A	583	56	\$0.5 B	\$0.7 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	551	120		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	500	211		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	583	75		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	528	122		
Rail 4 (R4) ⁴	✓						N/A	N/A	N/A	N/A	N/A	N/A	572	67	\$3.7 B	\$5.4 B
		✓					N/A	N/A	N/A	N/A	N/A	N/A	503	99		
			✓				N/A	N/A	N/A	N/A	N/A	N/A	396	150		
				✓			N/A	N/A	N/A	N/A	N/A	N/A	553	67		
					✓		N/A	N/A	N/A	N/A	N/A	N/A	522	122		



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non- Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Comm	High Toll Comm	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 1⁷																
Add one exclusive truck lane in each direction plus one exclusive car lane in each direction	✓						14	302	384	0	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
		✓					5	439	371	0	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
			✓				1	482	237	0	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
				✓			14	302	294	0	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
					✓		14	302	257	0	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
Results in 8- to 10-lane cross-section	✓					✓	14	302	291	0	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
		✓				✓	5	439	264	0	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
			✓			✓	1	482	191	0	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
				✓		✓	14	302	217	0	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
					✓	✓	14	302	199	0	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
(Add one exclusive truck lane in each direction plus two exclusive car lane in each direction)	✓						0	636	384	0	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
		✓					0	645	371	0	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
			✓				0	649	237	0	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
				✓			0	636	294	0	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
					✓		0	636	257	0	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
Results in 10- to 12-lane cross-section	✓					✓	0	636	291	0	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
		✓				✓	0	645	264	0	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
			✓			✓	0	649	191	0	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
				✓		✓	0	636	217	0	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
					✓	✓	0	636	199	0	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 2⁷																
Add two exclusive truck lanes In each direction. Results in 8- to 10-lane cross-section	✓						348	22	65	266	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
		✓					211	69	53	279	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
			✓				168	90	40	413	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
				✓			348	22	42	356	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
					✓		348	22	36	393	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
	✓					✓	348	22	42	359	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
		✓				✓	211	69	21	386	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
			✓			✓	168	90	0	459	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
				✓		✓	348	22	10	433	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
Add two exclusive truck lanes In each direction plus one exclusive car lane in each direction Results in 10- to 12-lane cross-section					✓	✓	348	22	0	451	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
	✓						14	302	65	266	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
		✓					5	439	53	279	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
			✓				1	402	40	413	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
				✓			14	302	42	356	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
					✓		14	302	36	393	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
	✓					✓	14	302	42	359	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
		✓				✓	5	439	21	386	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
			✓			✓	1	402	0	459	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
			✓		✓	14	302	10	433	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B	
				✓	✓	14	302	0	451	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B	



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 2⁷																
Add two exclusive truck lanes in each direction plus two exclusive car lanes in each direction	✓						0	636	65	266	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
		✓					0	645	53	279	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
			✓				0	649	40	413	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
				✓			0	636	42	356	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
					✓		0	636	36	393	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
	✓					✓	0	636	42	359	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
Results in 12- to 14-lane cross-section		✓				✓	0	645	21	386	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
			✓			✓	0	649	0	459	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
				✓		✓	0	636	10	433	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
					✓	✓	0	636	0	451	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
Separated Lane Concept 3⁸																
Add two non-exclusive truck lanes in each direction.	✓						N/A	N/A	N/A	N/A	10	422	495	10	\$9.3B	\$13.6 B
		✓					N/A	N/A	N/A	N/A	0	425	335	19	\$9.3B	\$13.6 B
			✓				N/A	N/A	N/A	N/A	0	494	266	69	\$9.3B	\$13.6 B
Results in 8- to 10-lane cross-section				✓			N/A	N/A	N/A	N/A	0	453	452	12	\$9.3B	\$13.6 B
					✓		N/A	N/A	N/A	N/A	0	478	440	12	\$9.3B	\$13.6 B
	✓					✓	N/A	N/A	N/A	N/A	0	460	452	12	\$9.8B	\$14.4 B
		✓				✓	N/A	N/A	N/A	N/A	0	468	335	22	\$9.8B	\$14.4 B
			✓			✓	N/A	N/A	N/A	N/A	0	494	240	74	\$9.8B	\$14.4 B
			✓		✓	N/A	N/A	N/A	N/A	0	529	424	12	\$9.8B	\$14.4 B	
				✓	✓	N/A	N/A	N/A	N/A	0	556	413	13	\$9.8B	\$14.4 B	



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 3^a																
Add two non-exclusive truck lanes in each direction plus one general purpose lane in each direction.	✓						N/A	N/A	N/A	N/A	10	422	64	155	\$9.9B	\$14.5 B
		✓					N/A	N/A	N/A	N/A	0	425	18	315	\$9.9B	\$14.5 B
			✓				N/A	N/A	N/A	N/A	0	494	10	384	\$9.9B	\$14.5 B
				✓			N/A	N/A	N/A	N/A	0	453	62	198	\$9.9B	\$14.5 B
					✓		N/A	N/A	N/A	N/A	0	478	59	210	\$9.9B	\$14.5 B
		✓				✓	N/A	N/A	N/A	N/A	0	460	62	198	\$10.4B	\$15.2 B
Results in 10- to 12-lane cross-section		✓				✓	N/A	N/A	N/A	N/A	0	468	11	315	\$10.4B	\$15.2 B
			✓			✓	N/A	N/A	N/A	N/A	0	494	9	410	\$10.4B	\$15.2 B
				✓		✓	N/A	N/A	N/A	N/A	0	529	57	226	\$10.4B	\$15.2 B
				✓	✓	N/A	N/A	N/A	N/A	0	556	47	237	\$10.4B	\$15.2 B	
Add two non-exclusive truck lanes in each direction plus two general purpose lanes in each direction.	✓						N/A	N/A	N/A	N/A	10	422	0	586	\$10.3B	\$15.1 B
		✓					N/A	N/A	N/A	N/A	0	425	0	632	\$10.3B	\$15.1 B
			✓				N/A	N/A	N/A	N/A	0	494	0	640	\$10.3B	\$15.1 B
				✓			N/A	N/A	N/A	N/A	0	453	0	598	\$10.3B	\$15.1 B
					✓		N/A	N/A	N/A	N/A	0	478	0	591	\$10.3B	\$15.1 B
Results in 12 to 14-lane cross-section	✓					✓	N/A	N/A	N/A	N/A	0	460	0	588	\$10.8B	\$15.8 B
		✓				✓	N/A	N/A	N/A	N/A	0	468	0	639	\$10.8B	\$15.8 B
			✓			✓	N/A	N/A	N/A	N/A	0	494	0	641	\$10.8B	\$15.8 B
				✓		✓	N/A	N/A	N/A	N/A	0	529	0	593	\$10.8B	\$15.8 B
					✓	✓	N/A	N/A	N/A	N/A	0	556	0	603	\$10.8B	\$15.8 B



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non- Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 4⁹																
Add two exclusive car lanes in each direction plus zero additional exclusive truck lanes in each direction	✓						362	8	65	279	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
		✓					211	55	53	292	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
			✓				168	76	40	426	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
				✓			362	8	42	369	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
					✓		362	8	36	406	N/A	N/A	N/A	N/A	\$11.2B	\$16.4 B
Results in 8- to 10-lane cross-section	✓					✓	362	8	42	372	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
		✓				✓	211	55	21	399	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
			✓			✓	168	76	0	472	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
				✓		✓	362	8	10	446	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
					✓	✓	362	8	0	464	N/A	N/A	N/A	N/A	\$11.7B	\$17.1 B
Add two exclusive car lanes In each direction plus one exclusive truck lane in each direction.	✓						362	8	0	585	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
		✓					211	55	0	597	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
			✓				168	76	0	610	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
				✓			362	8	0	608	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
					✓		362	8	0	614	N/A	N/A	N/A	N/A	\$12.2B	\$17.9 B
Results in 10- to 12-lane cross-section	✓					✓	362	8	0	608	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
		✓				✓	211	55	0	629	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
			✓			✓	168	76	0	650	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
				✓		✓	362	8	0	640	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B
					✓	✓	362	8	0	650	N/A	N/A	N/A	N/A	\$12.7B	\$18.6 B



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non- Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficien t Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 4⁹																
Add two exclusive car lanes in Each direction plus two exclusive trucks lanes in each direction.	✓						362	8	0	650	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
		✓					211	55	0	650	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
			✓				168	76	0	650	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
				✓			362	8	0	650	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
					✓		362	8	0	650	N/A	N/A	N/A	N/A	\$12.5B	\$18.3 B
Results in 12- to 14-lane cross-section	✓					✓	362	8	0	650	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
		✓				✓	211	55	0	650	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
			✓			✓	168	76	0	650	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
				✓		✓	362	8	0	650	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
					✓	✓	362	8	0	650	N/A	N/A	N/A	N/A	\$13.0B	\$19.0 B
Separated Lane Concept 5¹⁰																
Add two exclusive car lanes in each direction plus zero additional general purposes lanes in each direction	✓						141	36	N/A	N/A	N/A	N/A	171	105	\$11.2B	\$16.4 B
		✓					62	78	N/A	N/A	N/A	N/A	133	138	\$11.2B	\$16.4 B
			✓				43	144	N/A	N/A	N/A	N/A	80	204	\$11.2B	\$16.4 B
				✓			141	36	N/A	N/A	N/A	N/A	116	136	\$11.2B	\$16.4 B
					✓		141	36	N/A	N/A	N/A	N/A	104	185	\$11.2B	\$16.4 B
Results in 8- to 10-lane cross-section	✓					✓	141	36	N/A	N/A	N/A	N/A	104	158	\$11.7B	\$17.1 B
		✓				✓	62	78	N/A	N/A	N/A	N/A	96	188	\$11.7B	\$17.1 B
			✓			✓	43	144	N/A	N/A	N/A	N/A	51	274	\$11.7B	\$17.1 B
				✓		✓	141	36	N/A	N/A	N/A	N/A	65	187	\$11.7B	\$17.1 B
					✓	✓	141	36	N/A	N/A	N/A	N/A	63	242	\$11.7B	\$17.1 B



Table 3.2.1 Evaluation Results (Continued)

Separated Facilities																
	Operational Assumptions						Operational Results (Exclusive Car Lanes)		Operational Results (Exclusive Truck Lanes)		Operational Results (Non-Exclusive Truck Lanes)		Operational Results (General Purpose Lanes)		2005 Cost	2015 Cost
	No Toll	Low Toll All	High Toll All	Low Toll Trucks	High Toll Trucks	With R3 ⁵	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²	Deficient Miles ²	Excess Miles ²		
Separated Lane Concept 5¹⁰																
Add two exclusive car lanes in Each direction plus one general purpose lane in each direction.	✓						141	36	N/A	N/A	N/A	N/A	0	479	\$12.2B	\$17.9 B
		✓					62	78	N/A	N/A	N/A	N/A	0	517	\$12.2B	\$17.9 B
			✓				43	144	N/A	N/A	N/A	N/A	0	570	\$12.2B	\$17.9 B
				✓			141	36	N/A	N/A	N/A	N/A	0	534	\$12.2B	\$17.9 B
					✓		141	36	N/A	N/A	N/A	N/A	0	546	\$12.2B	\$17.9 B
Results in 10- to 12-lane cross-section	✓					✓	141	36	N/A	N/A	N/A	N/A	0	546	\$12.7B	\$18.6 B
		✓				✓	62	78	N/A	N/A	N/A	N/A	0	554	\$12.7B	\$18.6 B
			✓			✓	43	144	N/A	N/A	N/A	N/A	0	599	\$12.7B	\$18.6 B
				✓		✓	141	36	N/A	N/A	N/A	N/A	0	585	\$12.7B	\$18.6 B
					✓	✓	141	36	N/A	N/A	N/A	N/A	0	587	\$12.7B	\$18.6 B
Add two exclusive car lanes in each direction plus two general purpose lanes in each direction.	✓						141	36	N/A	N/A	N/A	N/A	0	650	\$12.5B	\$18.3 B
		✓					62	78	N/A	N/A	N/A	N/A	0	650	\$12.5B	\$18.3 B
			✓				43	144	N/A	N/A	N/A	N/A	0	650	\$12.5B	\$18.3 B
				✓			141	36	N/A	N/A	N/A	N/A	0	650	\$12.5B	\$18.3 B
					✓		141	36	N/A	N/A	N/A	N/A	0	650	\$12.5B	\$18.3 B
Results in 12- to 14-lane cross-section	✓					✓	141	36	N/A	N/A	N/A	N/A	0	650	\$13.0B	\$19.0 B
		✓				✓	62	78	N/A	N/A	N/A	N/A	0	650	\$13.0B	\$19.0 B
			✓			✓	43	144	N/A	N/A	N/A	N/A	0	650	\$13.0B	\$19.0 B
				✓		✓	141	36	N/A	N/A	N/A	N/A	0	650	\$13.0B	\$19.0 B
					✓	✓	141	36	N/A	N/A	N/A	N/A	0	650	\$13.0B	\$19.0 B



Table 3.2.1 Evaluation Results (Continued)

Table Notes:

Note: Operational Results represent 325 miles in each direction or 650 total miles.

- 1 TSM = Transportation System Management projects. TSM includes safety, climbing lanes, ITS, Park & Ride lot projects. TSM Enhancements included in all concepts carried forward.
- 2 Rail 1 includes minor level improvements to the Norfolk Southern Piedmont Line from Manassas to Front Royal, VA and north to the state line.
- 3 Rail 2 includes full level of improvements to the Norfolk Southern Piedmont Line within the Commonwealth of Virginia, including Rail 1.
- 4 New Rail Freight hauling technology with Intermodal centers at major intersections.
- 5 Rail 3 includes expansion of Rail 2 to include minor improvements to the Norfolk Southern Shenandoah line within Commonwealth of Virginia, and as the rail concept tested against the highway operational assumptions because Rail 3 provides the best cost-benefit reduction along I-81.
- 6 Based on AASHTO Standards for Levels of Service: Rural-LOS B & Urban-LOS C
- 7 Exclusive truckway provides separate access/egress at all interchanges from a separated lane or separated lanes. Only trucks can travel in the separated lanes. Cars must travel in exclusive car lanes and use existing interchange configuration.
- 8 Non-Exclusive truckway allows trucks in separated lanes to cross into general purpose lanes to access existing interchanges. Only trucks can travel in the separated lanes. Cars can only travel in general purpose lanes. However, trucks can also use the general purpose lanes to access/egress existing interchanges. Up to 70 percent of trucks are expected to use the general purpose lanes. It is assumed that trucks do not travel in these lanes for long distances.
- 9 Exclusive car lanes provide separate access/egress at all interchanges from separated lanes. Only cars can travel in the separated lanes. Trucks must travel in exclusive truck lanes and use existing interchange configuration.
- 10 Exclusive car lanes provide separate access/egress at all interchanges from separated lanes. Only cars can travel in the separated lanes. Trucks must travel in the general purpose lanes. However, cars can choose to travel in either the exclusive or general purpose lanes for their entire trip. Twenty percent of cars are expected to use the general purpose lanes



No-Build Concept

- 594 miles (91 percent) of I-81 would operate below the level of service standard
- 18 miles (0.3 percent) of I-81 would provide more lanes than are needed

As the volume of traffic continues to increase in the future, the delays and congestion experienced along I-81 and at each interchange would not only worsen during the peak hours, but the level of congestion is expected to expand to longer periods of the day and to a greater number of days.

Transportation System Management Concept (TSM)

TSM improvements do not address capacity needs on I-81.

- 594 miles (91 percent) of I-81 would operate below the level of service standard
- 18 miles (0.3 percent) of I-81 would provide more lanes than are needed

Rail Concept 1

Does not address capacity needs along I-81 because not enough freight diverts from the roadway to the railroad.

- 480 to 604 miles (74 to 93 percent) of I-81 would operate below the level of service standard
- 4 to 42 miles (.01 to 6 percent) of I-81 would provide more lanes than are needed

Rail Concept 2

- 439 to 594 miles (68 to 91 percent) of I-81 would operate below the level of service standard
- 4 to 53 miles (.01 to 8 percent) of I-81 would provide more lanes than are needed

Rail Concept 3

- 400 to 583 miles (62 to 90 percent) of I-81 would operate below the level of service standard
- 4 to 54 miles (.01 to 8 percent) of I-81 would provide more lanes than are needed



Rail Concept 4

- 396 to 572 miles (61 to 88 percent) of I-81 would operate below the level of service standard
- 4 to 56 miles (.01 to 9 percent) of I-81 would provide more lanes than are needed

Add One Lane Concept

- 237 to 396 miles (36 to 61 percent) of I-81 would operate below the level of service standard
- 37 to 131 miles (6 to 20 percent) of I-81 would provide more lanes than are needed

Add Two Lanes Concept

- 20 to 76 miles (3 to 12 percent) of I-81 would operate below the level of service standard
- 254 to 413 miles (39 to 64 percent) of I-81 would provide more lanes than are needed

Add Three Lanes Concept

- 0 miles (0 percent) of I-81 would operate below the level of service standard
- 574 to 630 miles (88 to 97 percent) of I-81 would provide more lanes than are needed

Uniform 6-Lane Concept

- 242 to 411 miles (37 to 63 percent) of I-81 would operate below the level of service standard
- 24 to 108 miles (4 to 17 percent) of I-81 would provide more lanes than are needed

Uniform 8-Lane Concept

- 20 to 76 miles (3 to 12 percent) of I-81 would operate below the level of service standard
- 239 to 408 miles (37 to 63 percent) of I-81 would provide more lanes than are needed

Combination Concept 1

- 169 to 378 miles (26 to 58 percent) of I-81 would operate below the level of service standard
- 67 to 150 miles (10 to 23 percent) of I-81 would provide more lanes than are needed



Combination Concept 2

- 1 to 62 miles (0 to 10 percent) of I-81 would operate below the level of service standard
- 272 to 481 miles (42 to 74 percent) of I-81 would provide more lanes than are needed

Combination Concept 3

- 0 miles (0 percent) of I-81 would operate below the level of service standard
- 588 to 649 miles (90 to 100 percent) of I-81 would provide more lanes than are needed

Combination Concept 4

- 174 to 393 miles (27 to 60 percent) of I-81 would operate below the level of service standard
- 54 to 127 miles (8 to 20 percent) of I-81 would provide more lanes than needed

Combination Concept 5

- 1 to 62 miles (0 to 10 percent) of I-81 would operate below the level of service standard
- 257 to 476 miles (40 to 73 percent) of I-81 would provide more lanes than are needed

Separated Lane Concept 1

Refer to Table 3.2-1.

Separated Lane Concept 2

Refer to Table 3.2-1.

Separated Lane Concept 3

Refer to Table 3.2-1.

Separated Lane Concept 4

Refer to Table 3.2-1.

Separated Lane Concept 5

Refer to Table 3.2-1.

3.3 Conclusions

The *I-81 Corridor Improvement Study* evaluated corridor-length concepts. These concepts were subjected to toll scenarios to illustrate the range of diversion and the impact of that diversion on what may need to be built. Conclusions reached from the concept development process include:

- The No-Build Concept does not satisfy the Purpose and Need.
- The TSM Concept, as a stand-alone concept, does not satisfy the Purpose and Need.
- The TSM Concept could compliment roadway improvements and can be used as an element of other concepts.
- No single consistent corridor-length concept satisfies the needs of I-81 in Virginia without providing more lanes than are needed.
- As stand-alone concepts, rail improvements only slightly decrease the capacity needs on I-81 in 2035. As such, they do not satisfy the Purpose and Need and do not preclude the need for road improvements.
- Rail concepts can compliment roadway improvements through the construction of new intermodal terminals and/or through the construction of or improvement to access roads to new or existing intermodal terminals, respectively, as well as through capacity improvements (*i.e.*, Rail Concept 3).
- The impacts on U.S. Route 11 and other roads (both local roads and other interstate facilities) from traffic that is diverted from I-81 as a result of tolls are low.
- Generally, the higher the toll, the more diversion of traffic from I-81 to other facilities, which reduces the number of required lanes on I-81. Also, trucks are less likely to divert from I-81 than passenger cars because a commercial trucker's value of time is higher than that of a passenger car. In other words, the additional time a trucker would need to travel on another may be more costly to the trucker than the toll itself.
- Nearly ½ of the traffic diverted from I-81 would be absorbed by U.S. Route 11. The remaining traffic diverted from I-81 is evenly distributed among other local roads, including other interstates (*i.e.* I-64 and I-95).
- Under the low toll scenario, traffic increases on the local road network, although in most locations traffic volumes would still be below 2035 No-Build conditions. Implementation of higher tolls on I-81 would result in a slight gain in traffic volumes as compared to the No-Build condition. However, the actual traffic impact on U.S. Route 11 and other roads resulting from the number of additional vehicles is low.
- The addition of one lane in each direction satisfies the Purpose and Need for approximately 39 to 64 percent of the corridor, depending upon the toll scenario.
- One separated truck lane in each direction does not satisfy the Purpose and Need in some sections, does not provide adequate opportunities for passing in all sections and

provides limited opportunities to maneuver in the truck lane in the event of an emergency or evacuation.

- Two separated truck lanes in each direction provide more truck lanes than are needed for 266-650 miles of the corridor depending upon the toll scenario, the inclusion of Rail Concept 3 and the type of separation.
- No concept with two separated lanes in each direction, whether with or without a barrier or designated for truck or passenger vehicles, satisfies the Purpose and Need for the entire corridor without providing excess capacity.
- Non-exclusive separated lanes allow motorists in the separated lanes to weave across other lanes in order to use exit ramps and motorists using entrance ramps to weave across lanes to access the separated lanes. As traffic volume increases, weave segments become deficient in their ability to process demand safely and efficiently; leading to an increase in crash incidents. In addition, there are current national and local policies to eliminate weave sections on interstates. The creation of many weave and multi-merge sections is not supported by these policies and may not address the existing safety deficiencies along I-81. If a “Build” concept (or portion of a “Build” concept) is advanced to Tier 2, specific issues regarding weaving and how to appropriately and safely accommodate the maneuvers in a non-exclusive concept could be evaluated.
- Generally, the higher the toll, the more diversion of traffic from I-81 to other facilities, which slightly lowers the capacity improvement requirements on the I-81 mainline. With a low toll, nine miles of I-81 would need only one additional lane in each direction instead of two. With a high toll scenario, that number increases to 64 miles.
- When considering Rail 3 improvements in conjunction with a low toll, an additional 34 miles (43 total) of I-81 would need only one additional lane in each direction instead of two. With a high toll, an additional 29 miles (93 total) would need one additional lane in each direction instead of two.
- With the implementation of Rail Concept 3, the number of miles on I-81 that need two or more lanes would be reduced by 30 miles (out of a total of 650 miles) as a result of reduced demand on the interstate.
- Diversions due to tolls ranged from 2 to 25 percent of the total traffic depending upon the type and amount of the toll and the types of vehicles being diverted (total vehicles or just commercial vehicles).
- Based on the varying traffic demands, a concept with a variable number of lanes between interchanges of the corridor most efficiently addresses the needs of the roadway. The variable concepts would minimize the social, economic, and environmental impacts from consistent lane concepts and provide an opportunity to limit cost by not providing more lanes than are needed. Depending upon the toll scenario and whether or not Rail Concept 3 is used in combination, the number of miles where one lane is needed can be identified. For those miles where the provision of one additional lane does not meet the level of service standard, there are several potential multi-lane solutions.

As shown in Figure 3.3-1, a total of 239 miles of I-81 need one additional lane in each direction. Specifically, from:

- Exit 3 to Exit 5 northbound;
- Exit 19 to Exit 81 northbound;
- Exit 162 to Exit 168 northbound;
- Exit 243 to Exit 245 northbound;
- Exit 247 to Exit 251 northbound;
- Exit 257 to Exit 269 northbound;
- Exit 273 to Exit 279 northbound;
- Exit 310 to Exit 313 northbound;
- Exit 7 to Exit 10 southbound;
- Exit 17 to Exit 84 southbound;
- Exit 86 to Exit 89 southbound;
- Exit 96 to Exit 101 southbound;
- Exit 105 to Exit 109 southbound;
- Exit 114 to Exit 118 southbound;
- Exit 156 to Exit 167 southbound;
- Exit 168 to Exit 191 southbound;
- Exit 243 to Exit 251 southbound;
- Exit 264 to Exit 277 southbound; and
- Exit 310 to Exit 313 southbound.

For these sections of I-81, the “Build” concepts under consideration are those that provide for one additional lane in each direction. However, certain sections of the corridor (particularly in the central to northern part of the state) may require an additional lane in each direction to properly account for transitions between number of lanes and construction of auxiliary lanes.

All other sections of I-81 need more than one lane in each direction. For those sections, concepts that provide more than one lane in each direction are also still under consideration. Decisions on improvements in those sections (*e.g.*, the separation of cars from commercial vehicles) would be determined in Tier 2 when more site-specific information is available, if a “Build” concept (or a portion of a “Build” concept) is advanced. In addition, the application of tolls or improvements to rail facilities would decrease the number of vehicles on I-81 and, therefore, may increase the number of miles on I-81 that need one additional lane in each direction (instead of two additional lanes). Final decisions on the number of lanes to be constructed would be made at the conclusion of Tier 2, if a “Build” concept (or portion of a “Build” concept) is advanced.