Design/Build vs. Traditional Construction User Delay Modeling: An Evaluation of the Cost Effectiveness of Innovative Construction Methods for New Construction

Part 1

I-15 Reconstruction in Davis County

Evaluation of Various Traffic Maintenance Plans

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Disclaimer

ABSTRACT

This paper evaluates impact of various I-15 reconstruction closure scenarios on the travelers in Ogden area. The purpose of the research was to investigate impact of the scenarios and facilitate decision about future maintenance of traffic during the reconstruction. The original Wasatch Front Regional Council (WFRC) transportation planning model was converted from the TP+ software to the VISUM software. The VISUM model of the whole WFRC area was then calibrated and validated. Coefficient of determination between modeled and observed traffic volumes was 0.78. The model was then reduced, by partial network generation process in VISIM, to the Ogden area. Another set of calibration and validation was performed. The coefficient of determination has improved to 0.88. Twenty one reconstruction closure scenarios were developed in consultation with UDOT project managers. Traffic assignments were executed for each scenario for five diurnal periods. Measures of effectiveness were reported for two spatial levels: area wide and corridor specific. Five investigated corridors were: I-15, Riverdale Road, SR-126, Wall Avenue, and Washington Boulevard. For the whole area scenario 18 was found little better than the other scenarios in terms of total delays. All scenarios that assume that two lanes remain open on I-15 during the reconstruction were significantly better than those with only one open lane on the I-15 mainline during the reconstruction. In respect to the addition of one lane on SR-126 between 450 N and 12th Street, the model estimates savings of US $878,800.00 over two years of reconstruction. The model failed to estimate acceptably accurate V/C ratios on the corridors. This was due to low fidelity traffic model used in transportation planning applications. The other corridor-specific measures were found to be comparable with the field observations.

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UTL	Utah Traffic Laboratory
UDOT	Utah Department Of Transportation
MOT	Maintenance Of Traffic
V/C	Volume/Capacity
STIP	State Transportation Improvement Plan
FT	Fast Track
TB	Traditional Build
DB	Design Build
WFRC	Wasatch Front Regional Council
LOS	Level Of Service
AADT	Average Annual Daily Traffic
UTM	Universal Transformation Mercator

1. INTRODUCTION

1.1 Background

The Utah Traffic Lab (UTL) has conducted several research projects for the Utah Department of Transportation (UDOT) to evaluate the impact of highway construction on road users. All of these projects dealt with the impact of various construction scenarios on travelers. The impacts have been measured as hours of delay, percentage of congested roads, and money values.

The first project evaluated the various construction alternatives for reconstruction of I-15 in Salt Lake County, Utah. The three scenarios Design Build (DB), Traditional Build (TB), and No Build (NB) were compared. The DB method, also known as Fast Track (FT), was used for the reconstruction and has proven itself as the best scenario in terms of user delays.

The second project was a compilation of several State Transportation Improvement Plan (STIP) projects. This study analyzed the STIP projects for FT and TB contracting methods to identify the impact that each method would have on road users. The scope of this study was limited to analyzing five selected STIP projects within Salt Lake County and modeling various build scenarios using transportation planning tools. In general, the FT method was proven to be the best for users.

The project described in this report represents one of the STIP projects that will be investigated for UDOT as a part of the multi-year contract. The overall goal is to constantly evaluate the impacts of the construction on road users. The results should be reported to UDOT and should be used to help in the decision-making process for Maintenance of Traffic (MOT) plans and contraction methods. The evaluation process has been recognized by UDOT as an important part of justifying the application of innovative building concepts. The process has been included in UDOT's Work Zone Safety and Mobility Program.

The project which is analyzed in this report represents reconstruction on the stretch of I-15 that extends from the I-84 junction to the 2700 North interchange in Ogden, Weber County, Utah. The construction includes reconstruction and widening of mainline I-15 with major interchange modifications at 31^{st} street and 12^{th} street.

1.2 Research Objective

Both of the previous projects dealt with measuring various scenarios of construction-induced delays for the entire duration of the projects. The construction scenarios were modeled as occurred or planned during the entire construction duration, and impacts were summarized for each alternative. Regardless of whether an analysis has been performed before or after the construction, the results have never been used to develop MOT plans or ease congestion during the reconstruction.

The objective of this project, however, is to evaluate different scenarios of work zone closures so that UDOT can specify requirements for MOT plans in request for the proposal. In other words, based on the results, UDOT will be able to specify how many lanes should remain open and what other actions should be performed to keep traffic moving during the construction.

1.3 Research Tasks

The specific tasks underlying this objective are

1. Build and calibrate the VISUM model for the entire Wasatch Front region
2. Build and calibrate the VISUM model for the Ogden area
3. Interview UDOT project managers and develop a set of scenarios
4. Model scenarios
5. Run traffic assignments and record Measures of Effectiveness (MOEs)
6. Meet with UDOT's Technical Advisory Committee (TAC) and present findings
7. Draft and submit a final report

2. METHODOLOGY

2.1 Building the Wasatch Region Network in VISUM

The first research task was to build the entire Wasatch region network in VISUM. VISUM is a transportation planning software that assigns trips on links in the network based on provided Origin-Destination (OD) tables. OD tables represent the number of trips between each pair of traffic analysis zones in the region. The Wasatch Front Regional Council (WFRC) has an existing model in transportation planning software called TP+. The network was supposed to be converted into VISUM format. The conversion procedure was complex and involved checking for inconsistencies in nodes, links, and connectors. Here is the summary of the conversion process.

2.1.1 Nodes and Zones

Nodes in the network represent intersections. They generally represent the start and end points of the network. The WFRC model provided both coordinates and numbers of the respective nodes. Coordinates for nodes and zones were both in Universal Transverse Mercator (UTM) format. Zones are the origins and destinations of trips in the network. Zones are connected to the network by connectors.

2.1.2 Links and Connectors

Links usually describe roads and railway tracks in a transportation network. A link is generally described as a directed edge. The two directions of a link are two separate objects which have been assigned the same link number. Connectors attach zones to the link networks. They represent the access and egress routes between the centroids of the zones and nodes.

2.1.3 Compulsory Attributes for the VISUM Network

There are certain attributes in VISUM which are compulsory and need to be assigned to the network to form nodes, links, zones, and connectors. Table 2.1 shows which attributes are compulsory for each network object.

Table 2.1 Compulsory Attributes for the VISUM Network Objects

Network Object	**Compulsory Attributes**
Nodes:	Node number, X-coordinate and Y-coordinate.
Zones	Number, X-coordinate and Y-coordinate.
Links	Link number, From node number, To node number.
Connectors	From zone number, To node number, Direction, Transportation system.

Figure 2.1 shows VISUM network for the Wasatch Front region based on the WFRC transportation planning model.

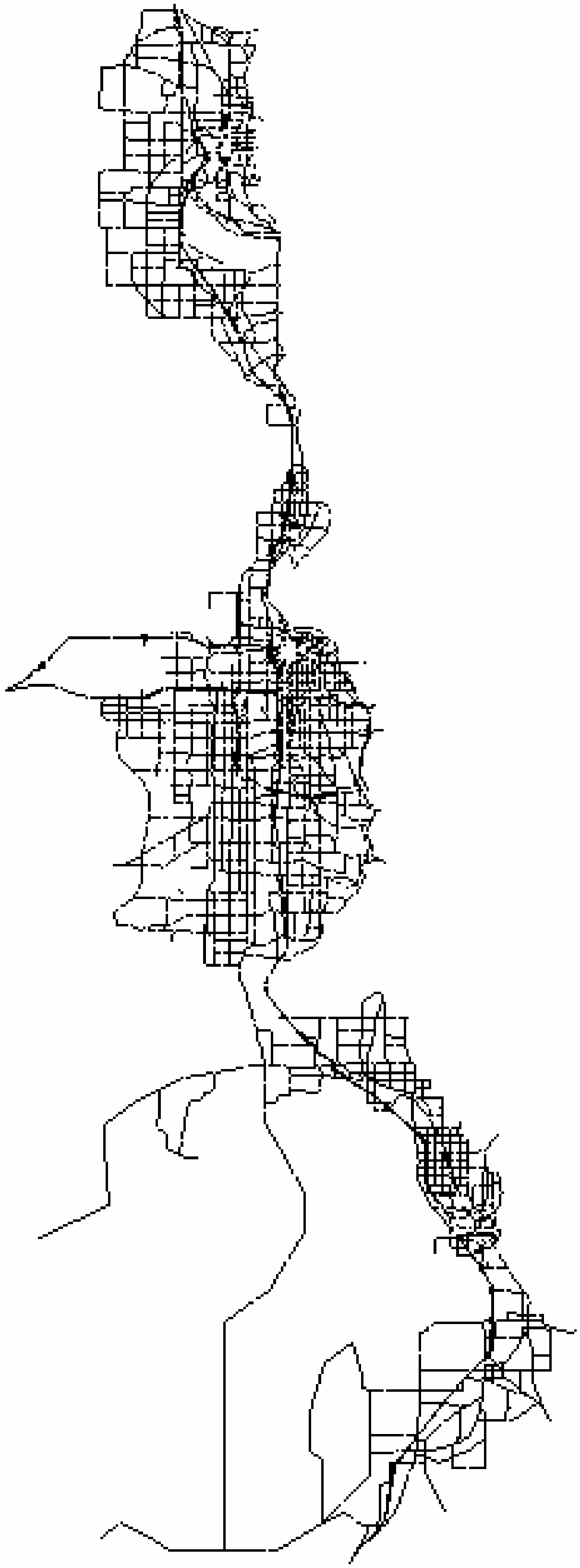

Figure 2.1 VISUM Network of the Wasatch Front Region

2.1.4 Conversion from TP+ to VISUM network

The WFRC TP+ model does not have zones as separate network objects, so zones are represented as the first 1500 nodes of the network. Similarly, the connectors do not exist as separate objects in the WFRC model but they are considered a subgroup of the links. Therefore, several filtering operations in Excel had to be conducted to define the connectors as separate VISUM objects. Another problem encountered during the conversion was that the link numbers from the TP+ network are different between the two nodes for different directions, so a small programming procedure was written to properly align the numbers for the consecutive links (of the same road section but opposite directions). All WFRC attributes, some of which are very important for the calibration process, were saved as user-defined attributes in the VISUM network.

2.1.5 Calibration of the Wasatch Front regional model

Calibration of the model for the whole Wasatch Front region was done based on 2001 traffic counts. Traffic counts were taken on about one-third of the total number of links. These counts were inputted by the WFRC and taken as regular UDOT counts. Differences between some of the volumes for 2001 and 2003 have proven that flow variations on some of the links were not substantial. Calibration of the assignment performance was done for the PM peak period. The WFRC used a factor of 24% to multiply Average Annual Daily Traffic (AADT) counts to get relevant PM peak period volumes. The PM peak period is considered to be from 3 PM to 6 PM. Figure 2.2 shows the results of the calibration. The coefficient of determination (R^2) is 0.78. This shows that modeled and counted volumes are highly correlated.

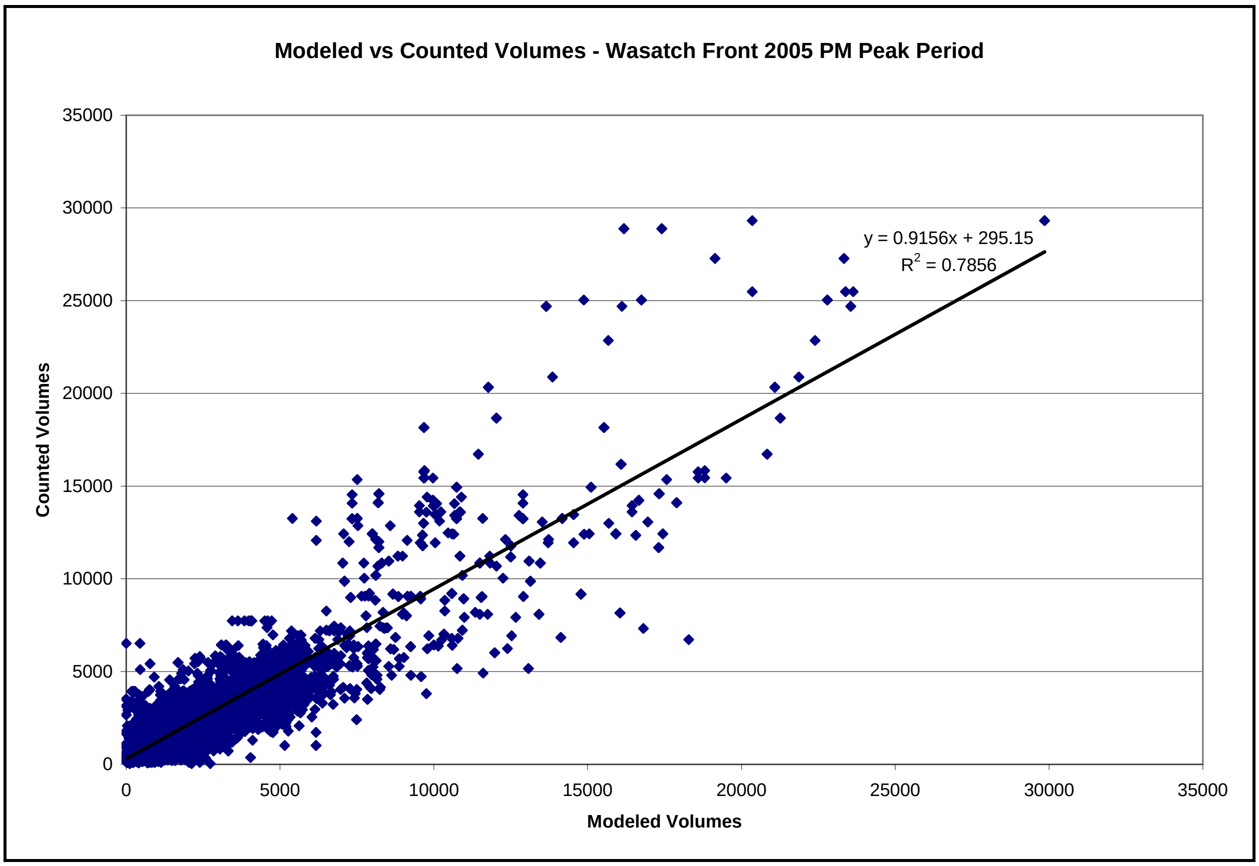

Figure 2.2 Calibration Results for the Wasatch Front Region

2.2 Reducing the VISUM network to the Ogden area

There are two reasons for reducing the Wasatch Front region network to the Ogden area network. The first is that the network is smaller and easier to handle and calibration of each piece of the network might have different results from other pieces of the network or the entire network. Yet, by reducing the network to the Ogden area, nothing is changed in the quality of the modeling process and reduction does not affect final outputs.

2.2.1 Partial network generation

The network (model) is reduced by using the *Subnetwork generator*, a VISUM add-on module. A subnetwork for the Ogden area has been generated from the overall Wasatch Front network in such a way that comparable assignment results are obtained. The partial network generator considers the paths of an existing assignment from the calibrated Wasatch Front region network. It then generates new zones at the network's interfaces at which traffic flows enter or leave the Ogden subnetwork. These "virtual" boundary zones (subnetwork external zones) are added to the partial matrices of the demand segments so that no traffic demand in the subnetwork is lost. Figure 2.3 shows the Ogden subnetwork generated from the overall Wasatch Front region network.

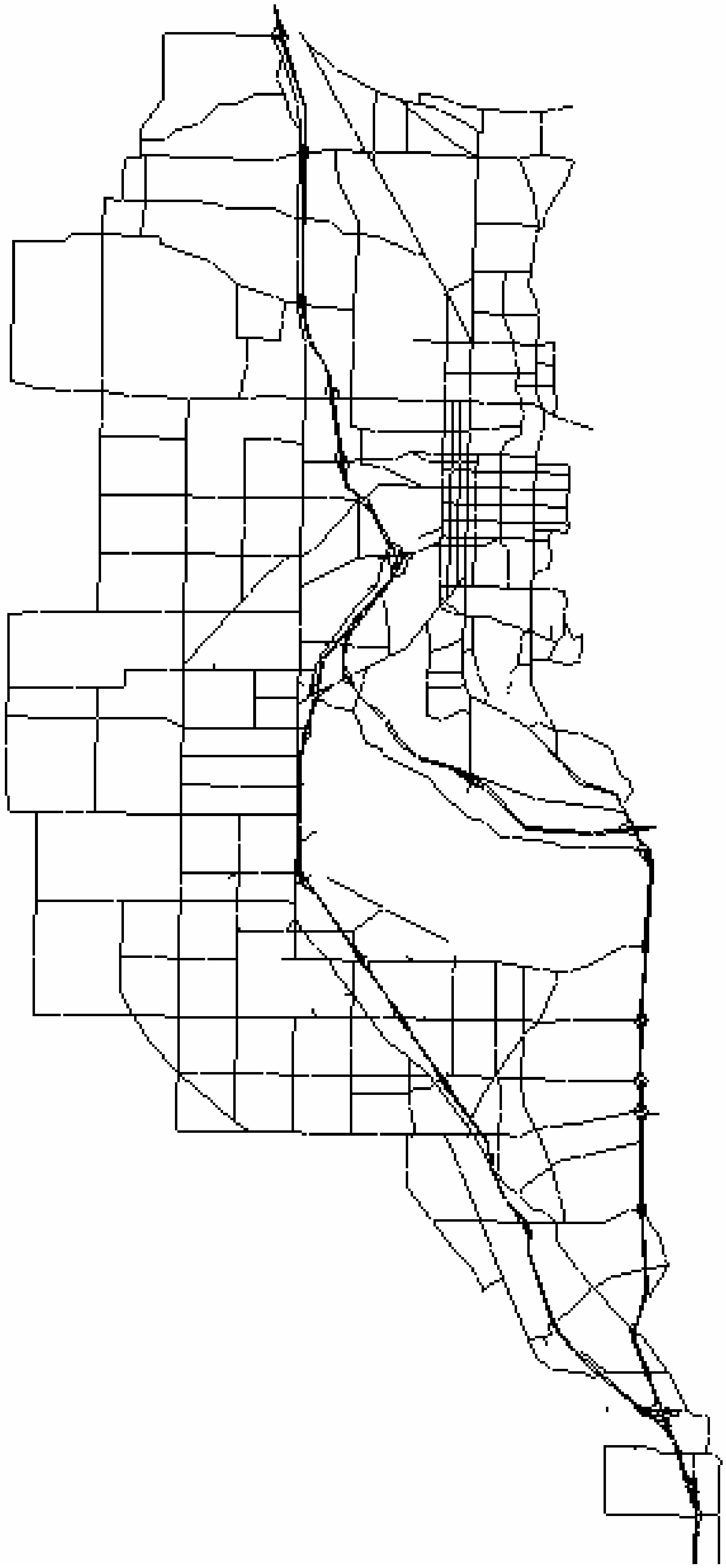

Figure 2.3 VISUM Network of the Ogden Area

2.2.2 Calibration of the Ogden area model

The *Cali*, a VISUM add-on module, is used to calibrate the reduced Ogden network. This module offers a calibration function which generates projection factors for origin and destination sums of an OD matrix based on available assignment results. The matrix is then projected to the sum values using a balancing procedure.

By comparing the calculated volume with the count data, the counted cross sections supply information about “adjustment factors,” which need to be taken into account. It also has to be taken into account that an OD relation can traverse several counted cross sections and might become influenced by several adjustment factors. However, the results shown in Figure 2.4 show that the calibration process for the Ogden subnetwork has been more successful than the calibration of the entire region. The coefficient of determination (R^2) is much higher (0.89) than for the regional network. This shows that modeled volumes for the PM peak period for the Ogden area are much more correlated with traffic counts than before the network is reduced. In short, the whole procedure increased the level of quality for the outputs from the model.

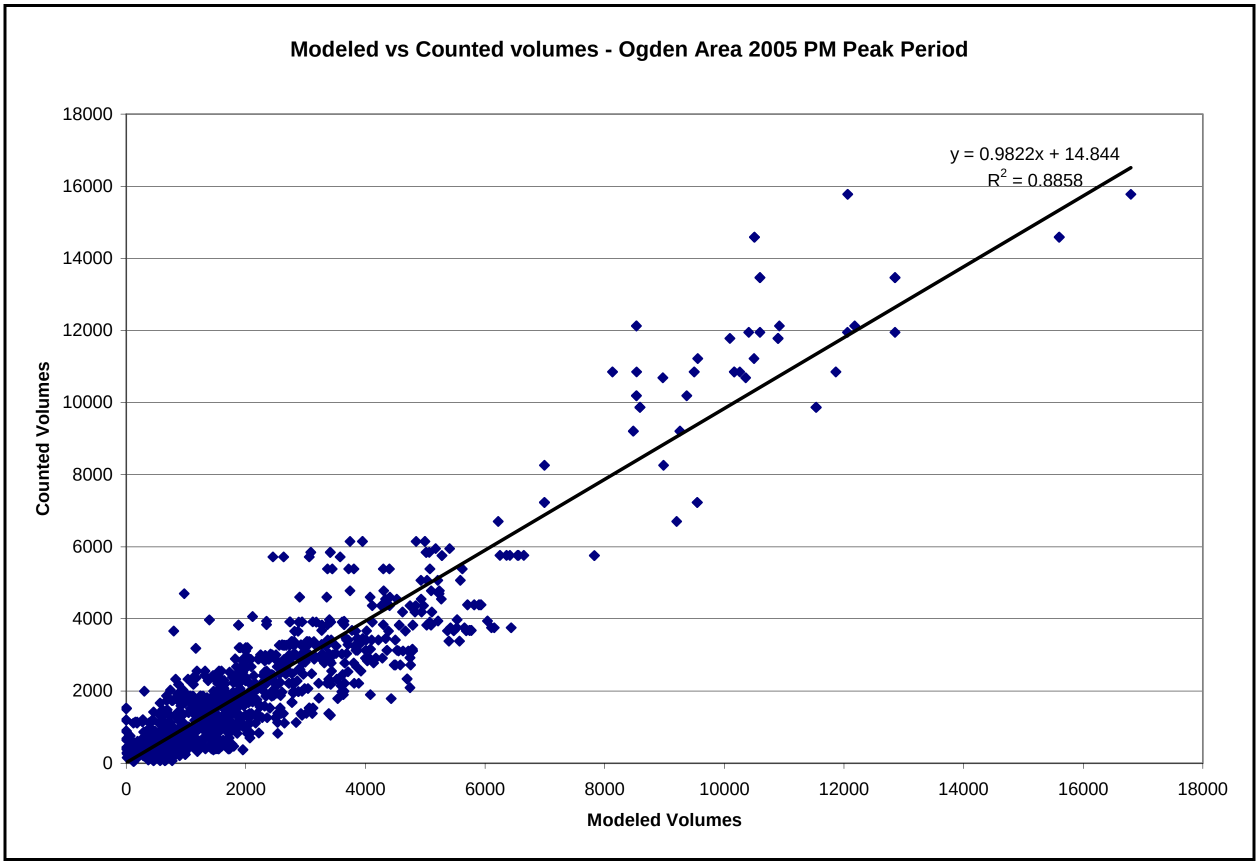

Figure 2.4 Calibration Results for the Ogden Area

2.3 Developing Reconstruction Closure Scenarios

There are several factors that UDOT wanted to be considered when developing scenarios for the reconstruction. UDOT's major concern is road user delays during the construction. Therefore, priority should be given to those MOT plans which produce the least congestion and efficiently use available detour routes. With this in mind, the UDOT project team has developed three major approaches from which all scenarios have been developed. One thing is common for all scenarios: weeknight works are considered to occur for any scenario during the whole construction period. Therefore, the total nighttime (10 PM to 6 AM) closures on I-15 (complete shutdown of the I-15 mainline) are modeled for all scenarios.

2.3.1 I-15 Scenarios

The first major approach that concerned UDOT was the number of lanes that should remain open on I-15 during daytime constructions. One option was that one full lane on I-15 remains open in each direction during the entire construction period. The alternative was that two lanes, with significantly reduced capacity, remain open. These two lanes would be up to 11-feet wide and they would be temporary lanes made of what is now one lane and a shoulder. This option would assume that only a foot of shoulder is provided to the right of the lanes.

From these alternatives, and based on the relevant recommendations for work zone freeway closures (HCM 2000), we have developed two basic scenarios:

1. One full lane is provided with a capacity of 1550 vehphpl
2. Two narrowed lanes are provided with a capacity of 1750 vehphpl

In other words, the total capacity per hour is around 2.26 times greater for the second alternative. The capacities for both alternatives are taken based on the HCM (HCM 2000) recommendations. In the first case, the capacity reflects average capacity for the long-range work zones when the number of lanes on the freeway mainline is reduced from two to one. The second capacity reflects reduction in capacity that comes as a result of narrowing the lanes and shoulders.

2.3.2 SR-126 Scenarios

UDOT has considered widening the existing roadbed on SR-126 between 450 N and 12th Street from one to two lanes. This project is anticipated as a mitigating measure for the traffic detoured from I-15 during the reconstruction. UDOT wanted to know the impact that the widening might have on user delays. The results from the model are likely to affect UDOT's decision whether to widen the road. We have modeled two basic scenarios based on this approach:

1. One lane available on SR-126 between 450 N and 12th Street (existing condition)
2. Two lanes available on SR-126 between 450 N and 12th Street (widened road)

2.3.3 Interchange Closure Scenarios

UDOT is planning major interchange modifications at only two of the interchanges along the reconstructed section of I-15. However, there are many combinations of various closures that might happen on the on and off ramps at all interchanges along the I-15 section. Only a few of those have been suggested by UDOT employees to be modeled for closure. The following lists these interchange closures:

1. Interchange at 12th Street fully closed
2. Interchange at 31st Street fully closed
3. Interchanges at 12th Street and 31st Street fully closed
4. NB off ramps and SB on ramps at the 21st Street and 31st Street interchanges closed
5. NB off ramps and SB on ramps at the 12th Street and 24th Street interchanges closed

The first two scenarios for interchange closures are considered independently from the last three scenarios. Table 2.2 summarizes all 20 developed scenarios and the base scenario (existing conditions). All scenarios have been modeled for five periods during the day. The periods are:

- AM Peak Period (6-9 AM)
- MD Period (9 AM - 3 PM)
- PM Peak Period (3-6 PM)
- Evening Period (6-10 PM)
- Night Period (10 PM - 6 AM)

Delay results are summarized and reported as daily values. Average V/C results are obtained only for the PM peak hour and reported as an average for both directions for the entire length of each street.

Table 2.2 Developed scenarios

Base Scenario	**As is**
Scenario 1	One full lane on I-15, One lane on SR-126, 24&12 NB Off & SB On closed
Scenario 2	One full lane on I-15, One lane on SR-126, 21&31 NB Off & SB On closed
Scenario 3	One full lane on I-15, Two lanes on SR-126, 24&12 NB Off & SB On closed
Scenario 4	One full lane on I-15, Two lanes on SR-126, 21&31 NB Off & SB On closed
Scenario 5	Two reduced lanes on I-15, One lane on SR-126, 24&12 NB Off & SB On closed
Scenario 6	Two reduced lanes on I-15, One lane on SR-126, 21&31 NB Off & SB On closed
Scenario 7	Two reduced lanes on I-15, Two lanes on SR-126, 24&12 NB Off & SB On closed
Scenario 8	Two reduced lanes on I-15, Two lanes on SR-126, 21&31 NB Off & SB On closed
Scenario 9	One full lane on I-15, One lane on SR-126, 12th Closed_Full
Scenario 10	One full lane on I-15, One lane on SR-126, 31th Closed_Full
Scenario 11	One full lane on I-15, One lane on SR-126, 12&31 Closed_Full
Scenario 12	One full lane on I-15, Two lanes on SR-126, 12th Closed_Full
Scenario 13	One full lane on I-15, Two lanes on SR-126, 31th Closed_Full
Scenario 14	One full lane on I-15, Two lanes on SR-126, 12&31 Closed_Full
Scenario 15	Two reduced lanes on I-15, One lane on SR-126, 12th Closed_Full
Scenario 16	Two reduced lanes on I-15, One lane on SR-126, 31th Closed_Full
Scenario 17	Two reduced lanes on I-15, One lane on SR-126, 12&31 Closed_Full
Scenario 18	Two reduced lanes on I-15, Two lanes on SR-126, 12th Closed_Full
Scenario 19	Two reduced lanes on I-15, Two lanes on SR-126, 31th Closed_Full
Scenario 20	Two reduced lanes on I-15, Two lanes on SR-126, 12&31 Closed_Full

3. RESULTS

In this chapter, the MOEs that have been used to distinguish between various reconstruction closures are defined. Then total area MOEs are presented. Finally, specific corridor MOEs are provided for the reconstructed section of I-15 and four major North-South arterials that will mitigate most of the congestion caused by the closed I-15 lanes. The arterials are:

- Riverdale Road
- SR-126
- Wall Avenue
- Washington Boulevard

3.1 Measures of Effectiveness

All MOEs presented in the next pages are provided in two forms: tabular and graphical. The graphical form is needed in order to visually distinguish good and poor scenarios. The tabular form is provided for an easy computation of the differences between the scenarios. The following MOEs are defined as primary system performance measures during the construction period:

Vehicle Hours of Delay – is the amount of time in hours it takes for a vehicle to travel at the congested speed minus the time to travel at the ideal speed. The total VHD for a system is the product of this number and the total number of vehicles traveling within the system at a given modeling time.

Delay per Vehicle – is the amount of time in seconds it takes for a vehicle to travel at the congested speed minus the time to travel at the freeflow speed. Table 3.1 shows travel times on each corridor at the free flow speed. The travel times for the existing conditions (base scenario), or any other scenario can be obtained as sum of the free-flow travel time and delay per vehicle for relevant scenario.

Volume/tCapacity (V/C) Ratio (Saturation) – is the ratio between volume, computed through the assignment process by VISUM, and the user defined capacity of the road. The capacity is defined as capacity per hour per lane multiplied by the number of lanes on the link and by duration of the analysis. For the purpose of this study, the analysis period is limited to one hour (PM peak hour). Capacities per hour per lane are provided by the WFRC as a part of their road classification system. However, one should notice that these V/C ratios are to be used only for planning purposes and should not be compared with V/C ratios and LOS from the traffic operations tools.

Table 3.1 Travel Times at Free Flow Speed for Each Corridor

	Corridor Travel Time	
	Northbound	**Southbound**
I-15	7m 29s	7m 29s
Riverdale Road	6m 3s	6m 3s
SR-126	9m 54s	9m 54s
Wall Avenue	8m 31s	8m 29s
Washington Boulevard	14m 14s	14m 14s

3.2 Area MOEs

Weeknight construction works are assumed for all scenarios. These works assume total closure of I-15 between 2700 North and 31st South. Results obtained from the model show total of 22 hours of delay for the entire network. When this number is compared with 5 hours of the delay (for the entire network) it seems that increase in delay is significant. However, both these figures mean less than a second of delay per vehicle traveling between 10 PM and 6 AM. There are chances that the model is underestimating night delay due to the nature of transportation planning models. This is because capacity of the roads is overestimated because capacity is considered for eight hours although the peak night demand occurs within two or three hours. Nevertheless, general results of the model show that one should not expect significant delays due to the night closures of I-15.

Table 3.2 and Figure 3.1 show total delay in hours for each scenario. The delays are aggregated for the whole network area. The results show that Scenario 18 generates the least delays. Other scenarios that produce comparable delays are 7, 19, and 20. However, one should not forget that the difference between two comparable scenarios can be significant when multiplied by number of days and monetary value for each delay hour. For example, if Scenario 7 were used instead of Scenario 18 during one month, the monetary cost would be around US $9,000.

Table 3.2 Total Area Delay Hours Per Day Per Scenario

Scenario #	**Total Delay (hours)**
Base Scenario	10816.56
Scenario 1	15704.71
Scenario 2	16084.55
Scenario 3	15548.81
Scenario 4	15844.38
Scenario 5	11504.02
Scenario 6	11917.61
Scenario 7	11341.54
Scenario 8	11816.99
Scenario 9	15762.34
Scenario 10	15877.08
Scenario 11	15896.27
Scenario 12	15645.48
Scenario 13	15658.08
Scenario 14	15651.4
Scenario 15	11453.31
Scenario 16	11526.49
Scenario 17	11501.31
Scenario 18	11322.14
Scenario 19	11401.56
Scenario 20	11400.68

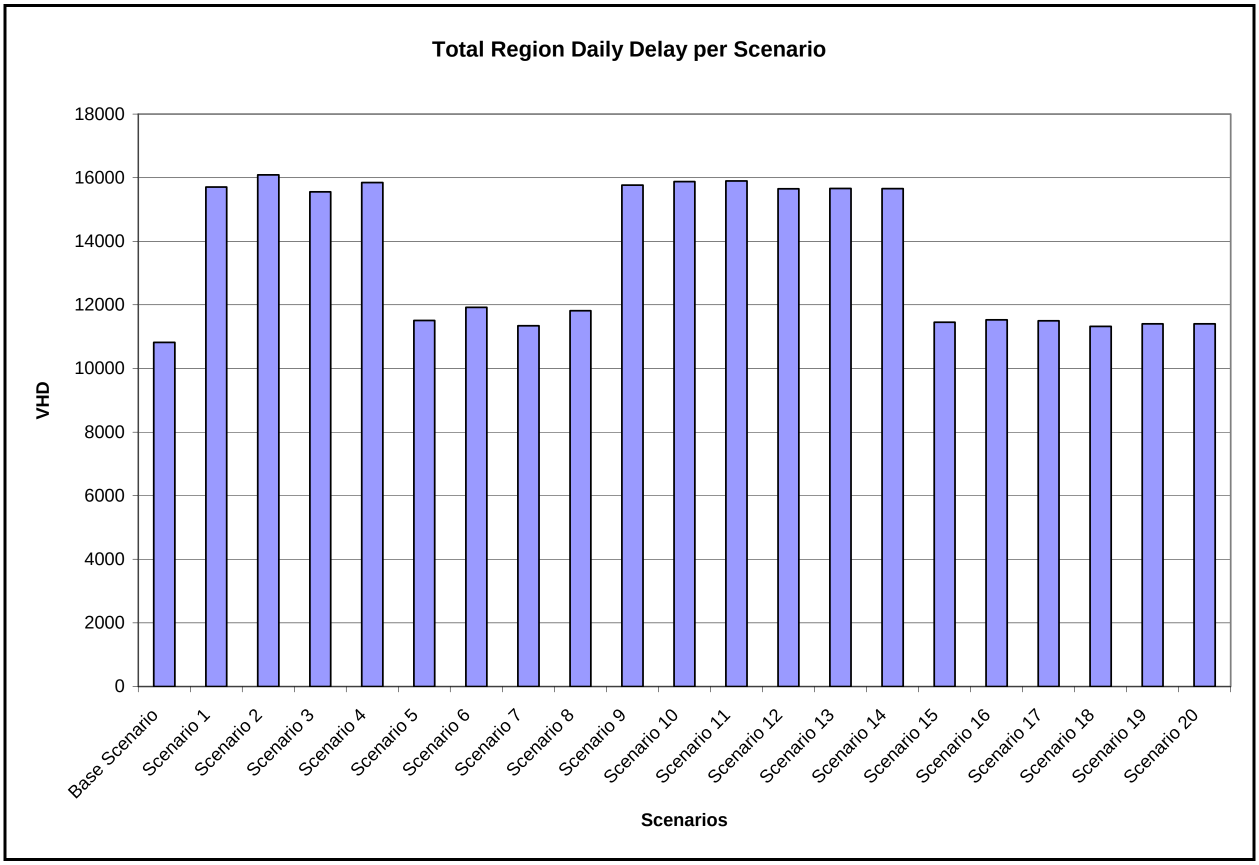

Figure 3.1 Total Area Delay Hours Per Day Per Scenario

3.3 I-15 MOEs

3.3.1 Delay

Table 3.3 Delay Hours Per Day on Reconstructed Section of I-15 Per Scenario

Scenario #	Total Delay (hours)
Base Scenario	463
Scenario 1	1532
Scenario 2	1495
Scenario 3	1481
Scenario 4	1421
Scenario 5	722
Scenario 6	709
Scenario 7	659
Scenario 8	668
Scenario 9	1531
Scenario 10	1502
Scenario 11	1518
Scenario 12	1491
Scenario 13	1456
Scenario 14	1461
Scenario 15	742
Scenario 16	730
Scenario 17	715
Scenario 18	694
Scenario 19	684
Scenario 20	659

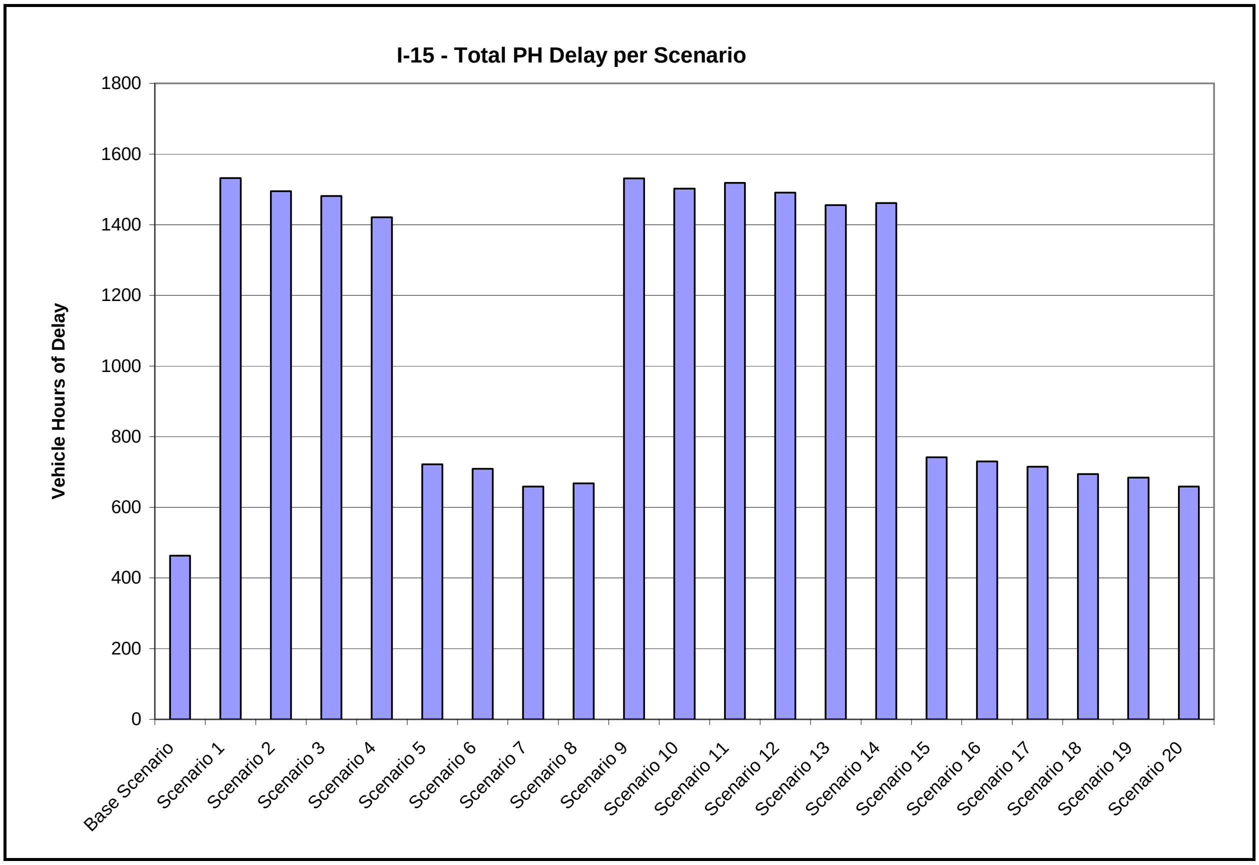

Figure 3.2 Delay Hours Per Day on Reconstructed Section of I-15 Per Scenario

3.3.2 Delay Per Vehicle

Table 3.4 Peak Hour Delay Per Vehicle (sec) Per Scenario on I-15

	Delay/Vehicle (sec/veh)	
	Southbound	**Northbound**
Base Scenario	9	149
Scenario 1	372	759
Scenario 2	371	769
Scenario 3	354	737
Scenario 4	357	731
Scenario 5	29	255
Scenario 6	20	260
Scenario 7	29	233
Scenario 8	20	245
Scenario 9	368	759
Scenario 10	389	747
Scenario 11	391	757
Scenario 12	361	735
Scenario 13	379	722
Scenario 14	379	727
Scenario 15	36	254
Scenario 16	36	251
Scenario 17	36	246
Scenario 18	36	237
Scenario 19	35	236
Scenario 20	35	227

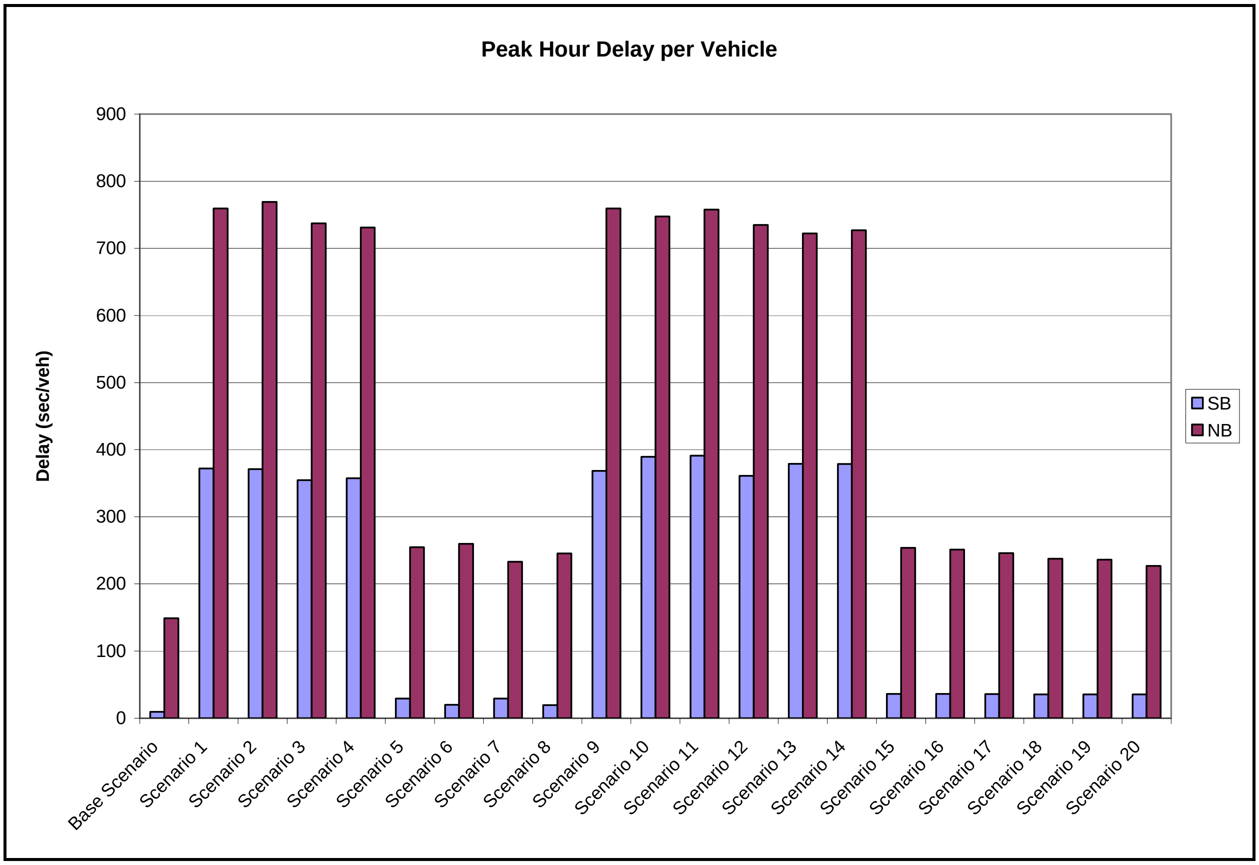

Figure 3.3 Peak Hour Delay Per Vehicle (sec) Per Scenario on I-15

3.3.3 V/C

Table 3.5 Averaged Peak Hour V/C Ratio on Reconstructed Section of I-15 Per Scenario

Scenario #	**Average V/C**
Base Scenario	83
Scenario 1	115
Scenario 2	118
Scenario 3	113
Scenario 4	117
Scenario 5	89
Scenario 6	89
Scenario 7	88
Scenario 8	89
Scenario 9	114
Scenario 10	118
Scenario 11	118
Scenario 12	113
Scenario 13	116
Scenario 14	117
Scenario 15	90
Scenario 16	91
Scenario 17	91
Scenario 18	89
Scenario 19	90
Scenario 20	90

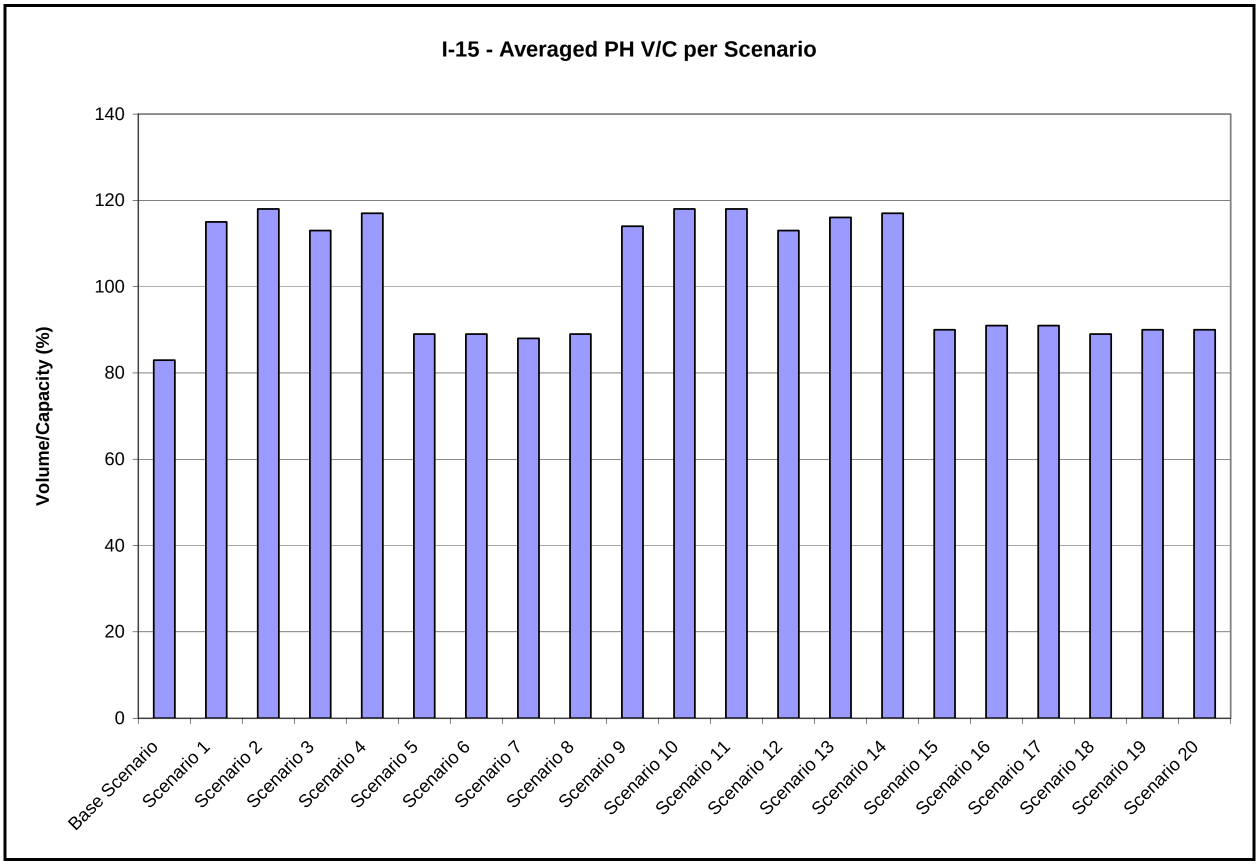

Figure 3.4: Averaged Peak Hour V/C Ratio on Reconstructed Section of I-15 Per Scenario

3.4 Riverdale Road MOEs

3.4.1 Delay

Table 3.6 Delay Hours Per Day on Riverdale Road Per Scenario

Scenario #	**Total Delay (hours)**
Base Scenario	236
Scenario 1	454
Scenario 2	503
Scenario 3	451
Scenario 4	493
Scenario 5	295
Scenario 6	323
Scenario 7	291
Scenario 8	323
Scenario 9	458
Scenario 10	490
Scenario 11	491
Scenario 12	463
Scenario 13	486
Scenario 14	488
Scenario 15	294
Scenario 16	284
Scenario 17	283
Scenario 18	291
Scenario 19	282
Scenario 20	283

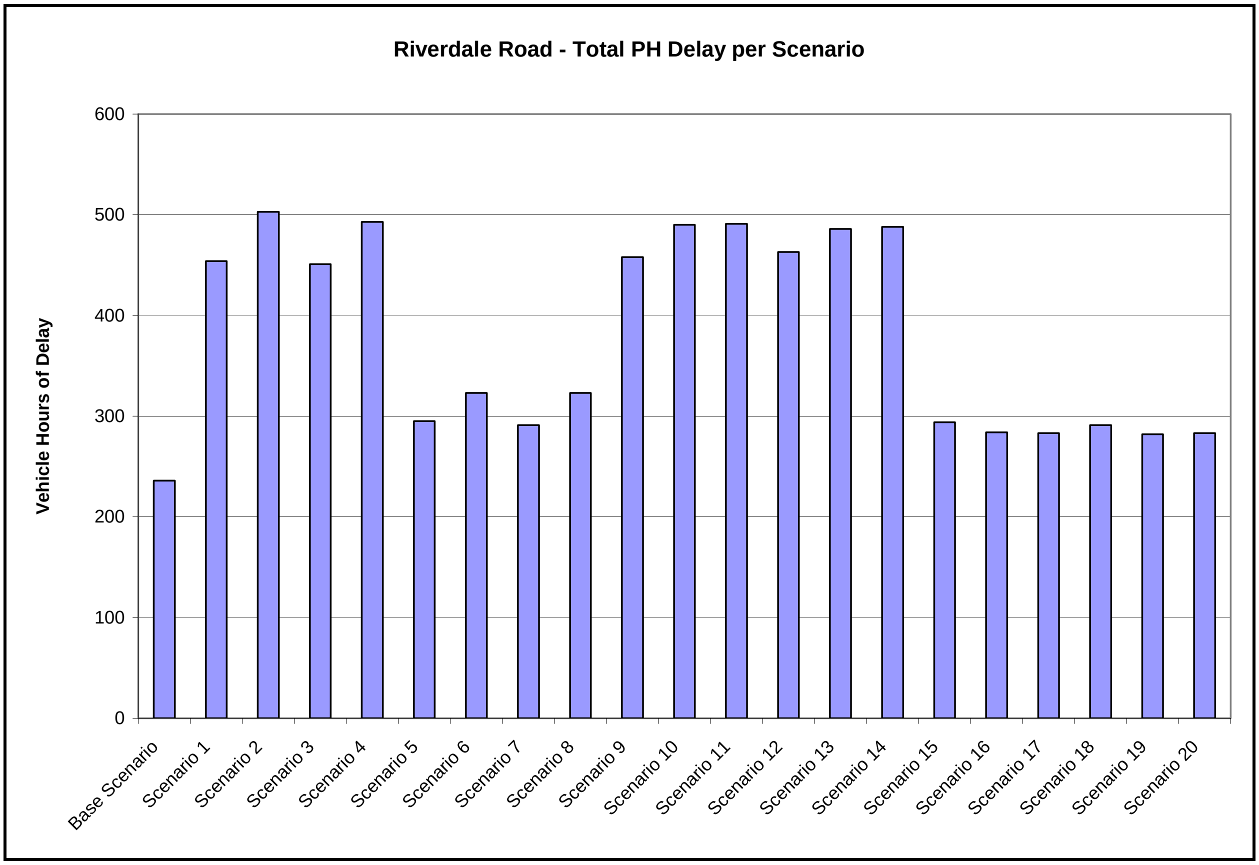

Figure 3.5 Delay Hours Per Day on Riverdale Road Per Scenario

3.4.2 Delay Per Vehicle

Table 3.7 Peak Hour Delay Per Vehicle (sec) Per Scenario on Riverdale Road

	Delay/Vehicle (sec/veh)	
	Southbound	**Northbound**
Base Scenario	90	65
Scenario 1	128	132
Scenario 2	134	147
Scenario 3	130	130
Scenario 4	133	144
Scenario 5	97	88
Scenario 6	103	97
Scenario 7	97	86
Scenario 8	102	98
Scenario 9	128	134
Scenario 10	129	145
Scenario 11	131	144
Scenario 12	132	133
Scenario 13	130	143
Scenario 14	131	143
Scenario 15	97	87
Scenario 16	89	91
Scenario 17	89	91
Scenario 18	97	86
Scenario 19	88	91
Scenario 20	88	91

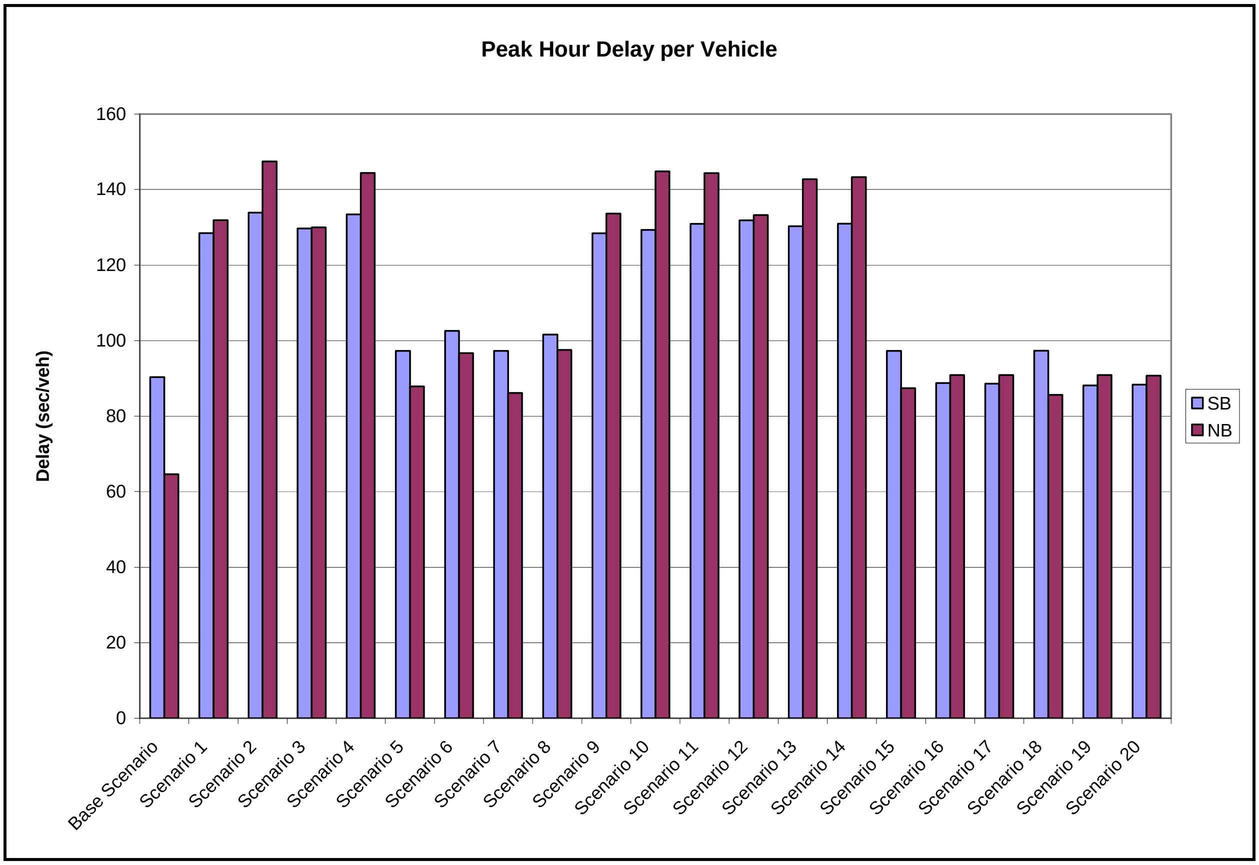

Figure 3.6 Peak Hour Delay Per Vehicle (sec) Per Scenario on Riverdale Road

3.4.3 V/C

Table 3.8 Averaged Peak Hour V/C Ratio on Riverdale Road Per Scenario

Scenario #	**Average V/C**
Base Scenario	94
Scenario 1	108
Scenario 2	109
Scenario 3	108
Scenario 4	109
Scenario 5	99
Scenario 6	102
Scenario 7	99
Scenario 8	102
Scenario 9	108
Scenario 10	109
Scenario 11	109
Scenario 12	108
Scenario 13	109
Scenario 14	109
Scenario 15	99
Scenario 16	99
Scenario 17	99
Scenario 18	99
Scenario 19	99
Scenario 20	99

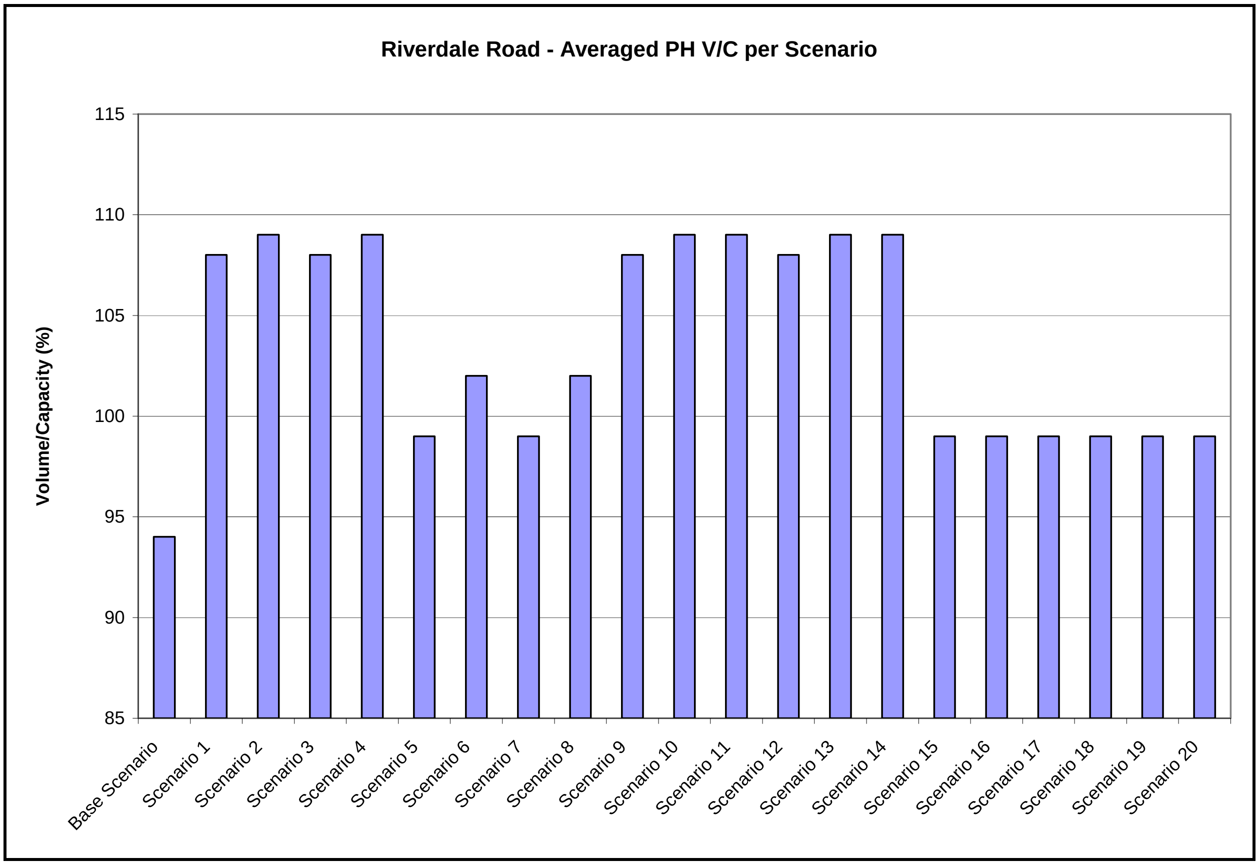

Figure 3.7 Averaged Peak Hour V/C Ratio on Riverdale Road Per Scenario

3.5 SR-126 MOEs

3.5.1 Delay

Table 3.9 Delay Hours Per Day on SR-126 Per Scenario

Scenario #	Total Delay (hours)
Base Scenario	61
Scenario 1	328
Scenario 2	339
Scenario 3	288
Scenario 4	300
Scenario 5	106
Scenario 6	130
Scenario 7	68
Scenario 8	95
Scenario 9	324
Scenario 10	324
Scenario 11	335
Scenario 12	297
Scenario 13	294
Scenario 14	299
Scenario 15	106
Scenario 16	111
Scenario 17	103
Scenario 18	77
Scenario 19	67
Scenario 20	73

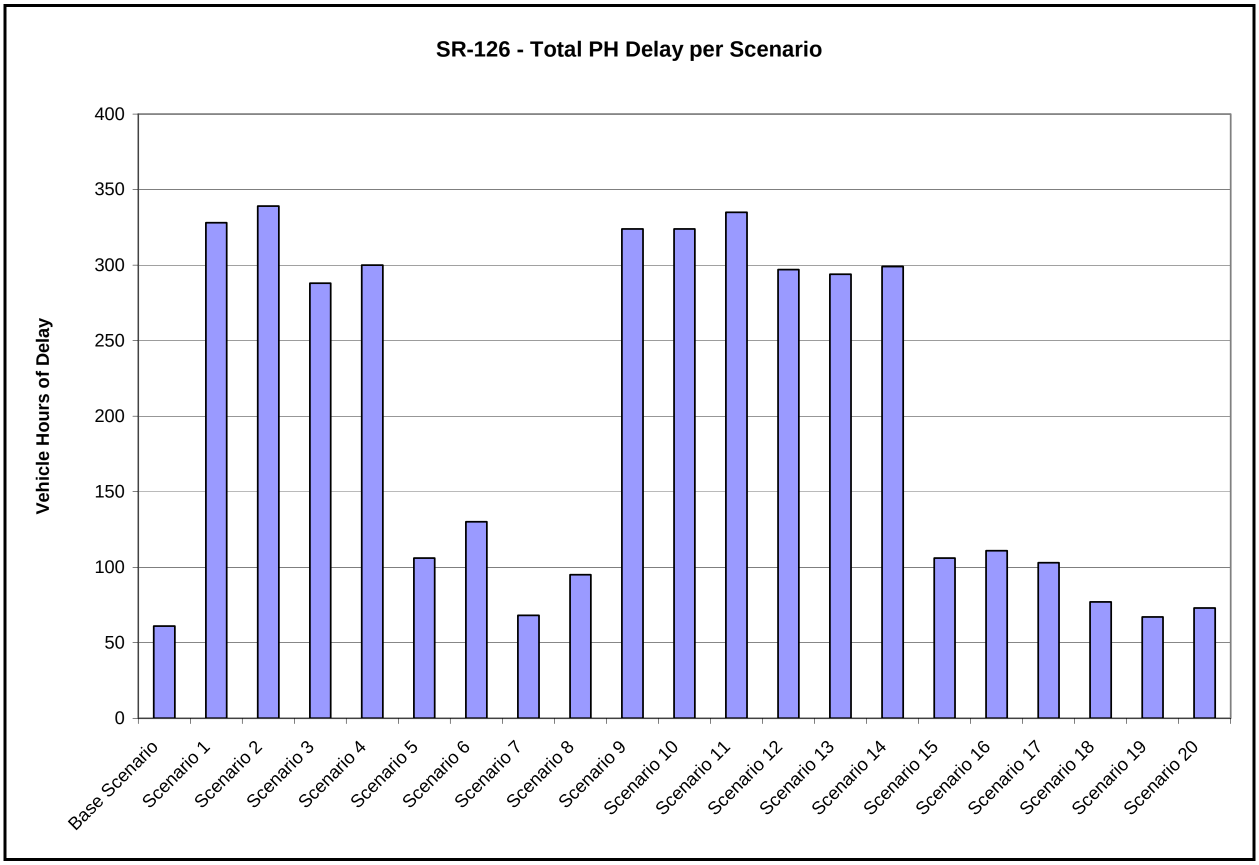

Figure 3.8 Delay Hours Per Day on SR-126 Per Scenario

3.5.2 Delay per Vehicle

Table 3.10 Peak Hour Delay Per Vehicle (sec) Per Scenario on SR-126

	Delay/Vehicle (sec/veh)	
	Southbound	**Northbound**
Base Scenario	5	75
Scenario 1	74	281
Scenario 2	71	291
Scenario 3	40	236
Scenario 4	48	243
Scenario 5	21	110
Scenario 6	33	119
Scenario 7	5	73
Scenario 8	19	83
Scenario 9	65	284
Scenario 10	65	284
Scenario 11	62	297
Scenario 12	42	246
Scenario 13	43	239
Scenario 14	42	249
Scenario 15	21	109
Scenario 16	28	108
Scenario 17	28	100
Scenario 18	5	80
Scenario 19	8	68
Scenario 20	8	76

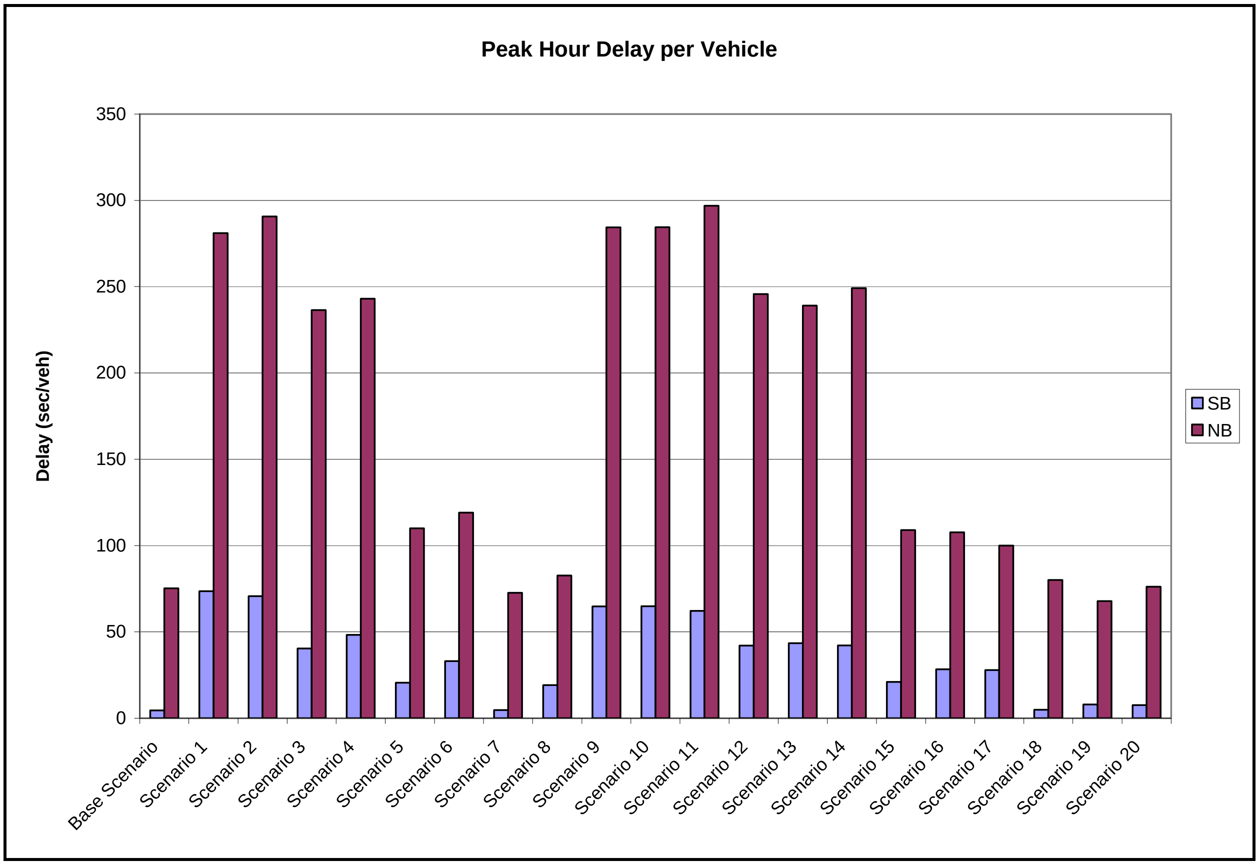

Figure 3.9 Peak Hour Delay Per Vehicle (sec) Per Scenario on SR-126

3.5.3 V/C

Table 3.11 Averaged Peak Hour V/C Ratio on SR-126 Per Scenario

Scenario #	Average V/C
Base Scenario	60
Scenario 1	94
Scenario 2	95
Scenario 3	86
Scenario 4	87
Scenario 5	69
Scenario 6	73
Scenario 7	59
Scenario 8	62
Scenario 9	94
Scenario 10	93
Scenario 11	94
Scenario 12	87
Scenario 13	86
Scenario 14	87
Scenario 15	70
Scenario 16	71
Scenario 17	70
Scenario 18	61
Scenario 19	61
Scenario 20	61

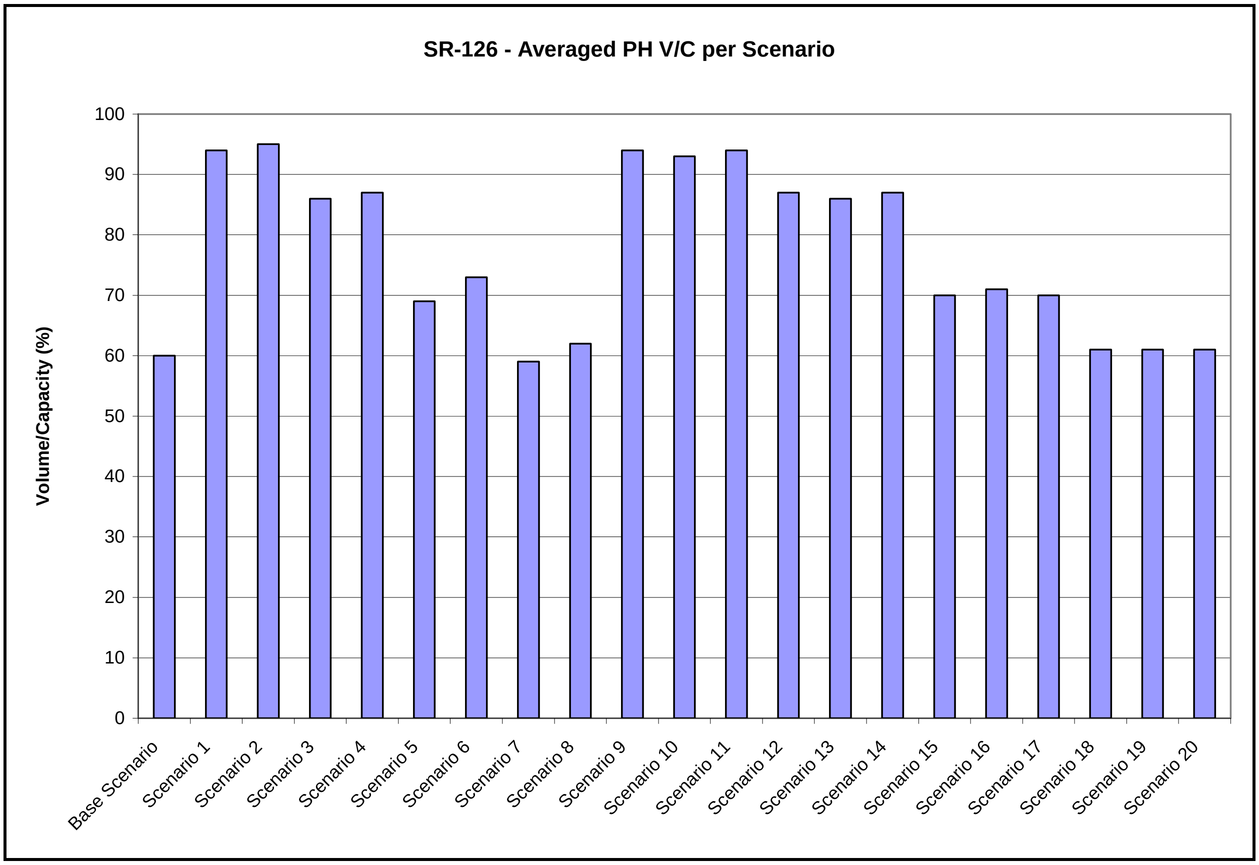

Figure 3.10 Averaged Peak Hour V/C Ratio on SR-126 Per Scenario

3.6 Wall Avenue MOEs

3.6.1 Delay

Table 3.12 Delay Hours Per Day on Wall Avenue Per Scenario

Scenario #	**Total Delay (hours)**
Base Scenario	107
Scenario 1	273
Scenario 2	266
Scenario 3	264
Scenario 4	244
Scenario 5	143
Scenario 6	152
Scenario 7	145
Scenario 8	152
Scenario 9	277
Scenario 10	270
Scenario 11	263
Scenario 12	267
Scenario 13	263
Scenario 14	256
Scenario 15	142
Scenario 16	154
Scenario 17	155
Scenario 18	143
Scenario 19	152
Scenario 20	151

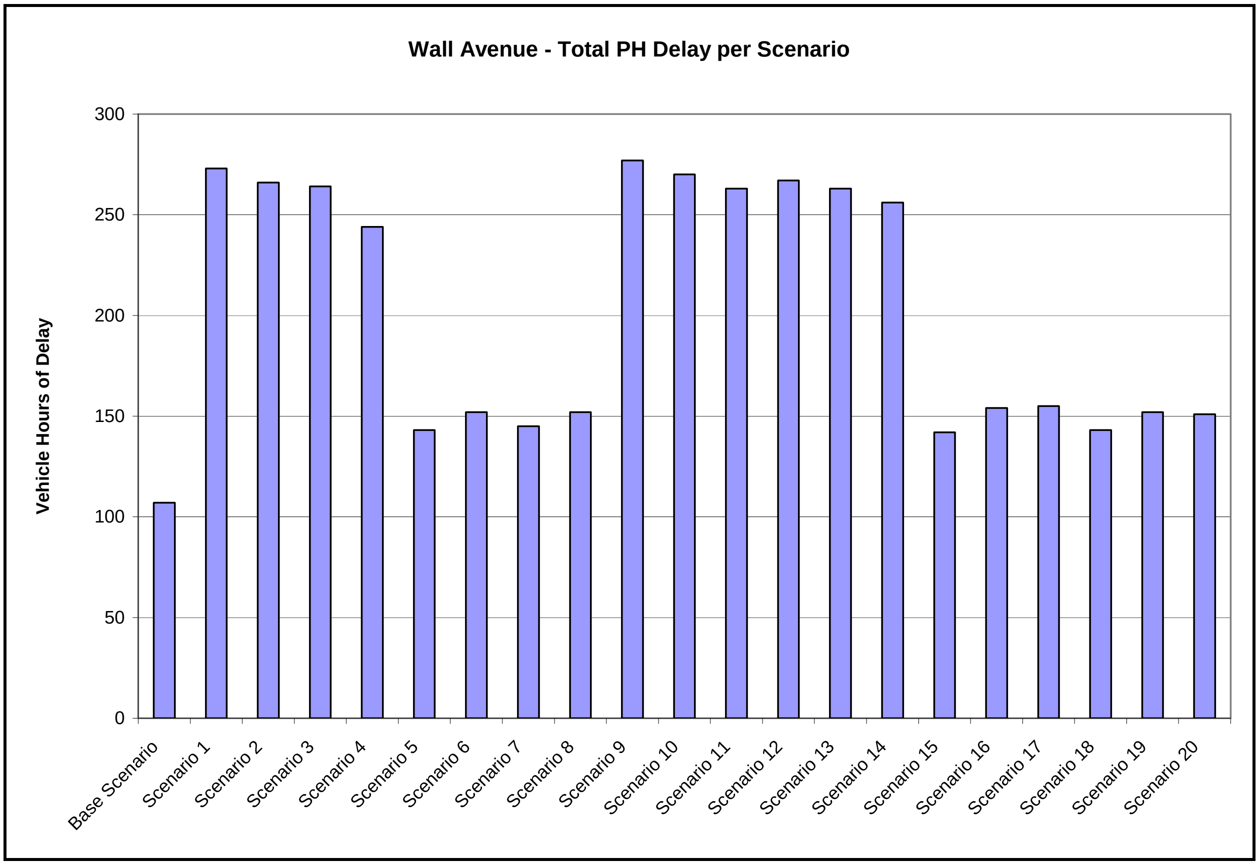

Figure 3.11 Delay Hours Per Day on Wall Avenue Per Scenario

3.6.2 Delay per Vehicle

Table 3.13 Peak Hour Delay Per Vehicle (sec) Per Scenario on Wall Avenue

	Delay/Vehicle (sec/veh)	
	Southbound	**Northbound**
Base Scenario	26	86
Scenario 1	55	188
Scenario 2	66	174
Scenario 3	56	180
Scenario 4	67	158
Scenario 5	34	109
Scenario 6	41	110
Scenario 7	35	110
Scenario 8	42	109
Scenario 9	57	189
Scenario 10	68	176
Scenario 11	69	170
Scenario 12	56	182
Scenario 13	67	172
Scenario 14	67	166
Scenario 15	34	108
Scenario 16	38	115
Scenario 17	38	116
Scenario 18	35	109
Scenario 19	39	112
Scenario 20	40	111

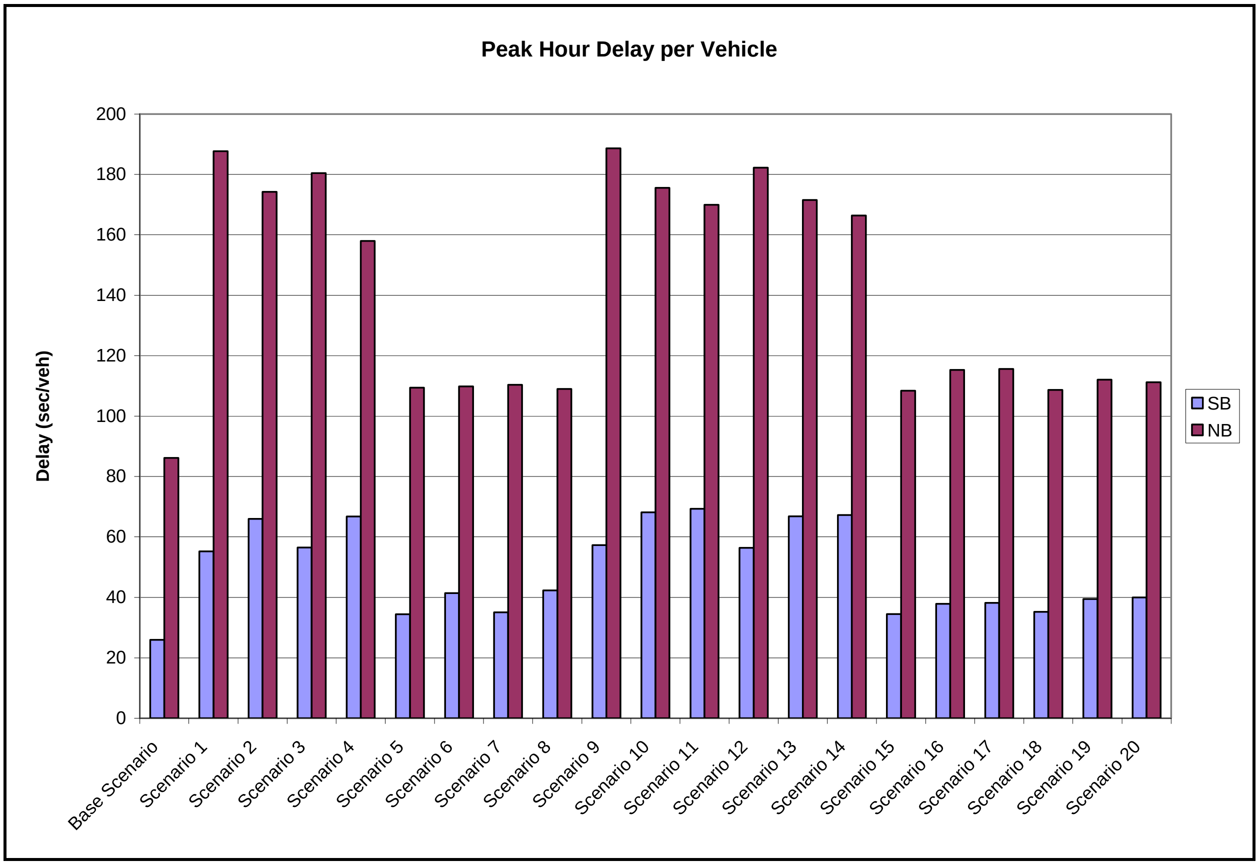

Figure 3.12 Peak Hour Delay Per Vehicle (sec) Per Scenario on Wall Avenue

3.6.3 V/C

Table 3.14 Averaged Peak Hour V/C Ratio on Wall Avenue Per Scenario

Scenario #	**Average V/C**
Base Scenario	82
Scenario 1	100
Scenario 2	101
Scenario 3	99
Scenario 4	100
Scenario 5	88
Scenario 6	89
Scenario 7	88
Scenario 8	89
Scenario 9	100
Scenario 10	101
Scenario 11	101
Scenario 12	100
Scenario 13	101
Scenario 14	100
Scenario 15	88
Scenario 16	90
Scenario 17	90
Scenario 18	88
Scenario 19	90
Scenario 20	90

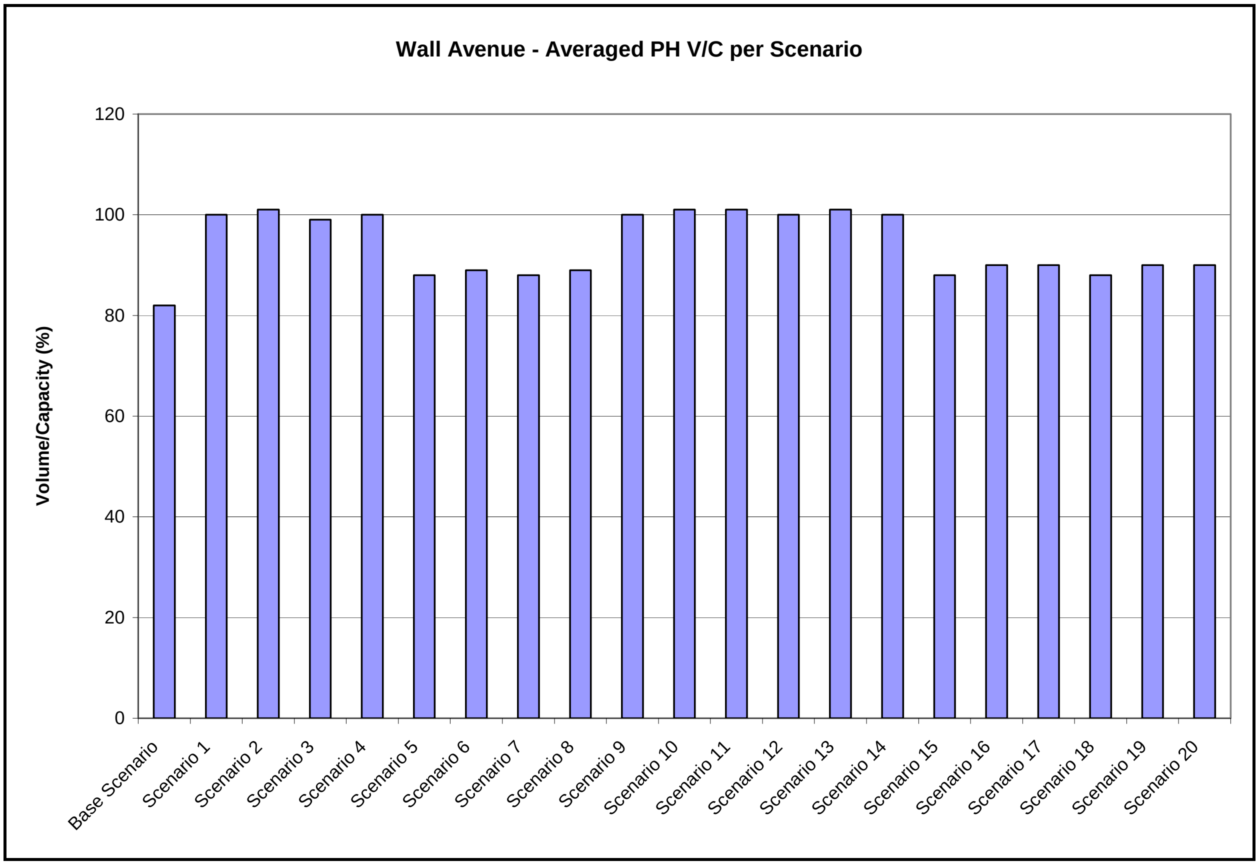

Figure 3.13 Averaged Peak Hour V/C Ratio on Wall Avenue Per Scenario

3.7 Washington Boulevard MOEs

3.7.1 Delay

Table 3.15 Delay Hours Per Day on Washington Boulevard Per Scenario

Scenario #	Total Delay (hours)
Base Scenario	318
Scenario 1	592
Scenario 2	610
Scenario 3	576
Scenario 4	588
Scenario 5	371
Scenario 6	376
Scenario 7	371
Scenario 8	374
Scenario 9	596
Scenario 10	598
Scenario 11	601
Scenario 12	572
Scenario 13	582
Scenario 14	584
Scenario 15	370
Scenario 16	380
Scenario 17	376
Scenario 18	371
Scenario 19	378
Scenario 20	384

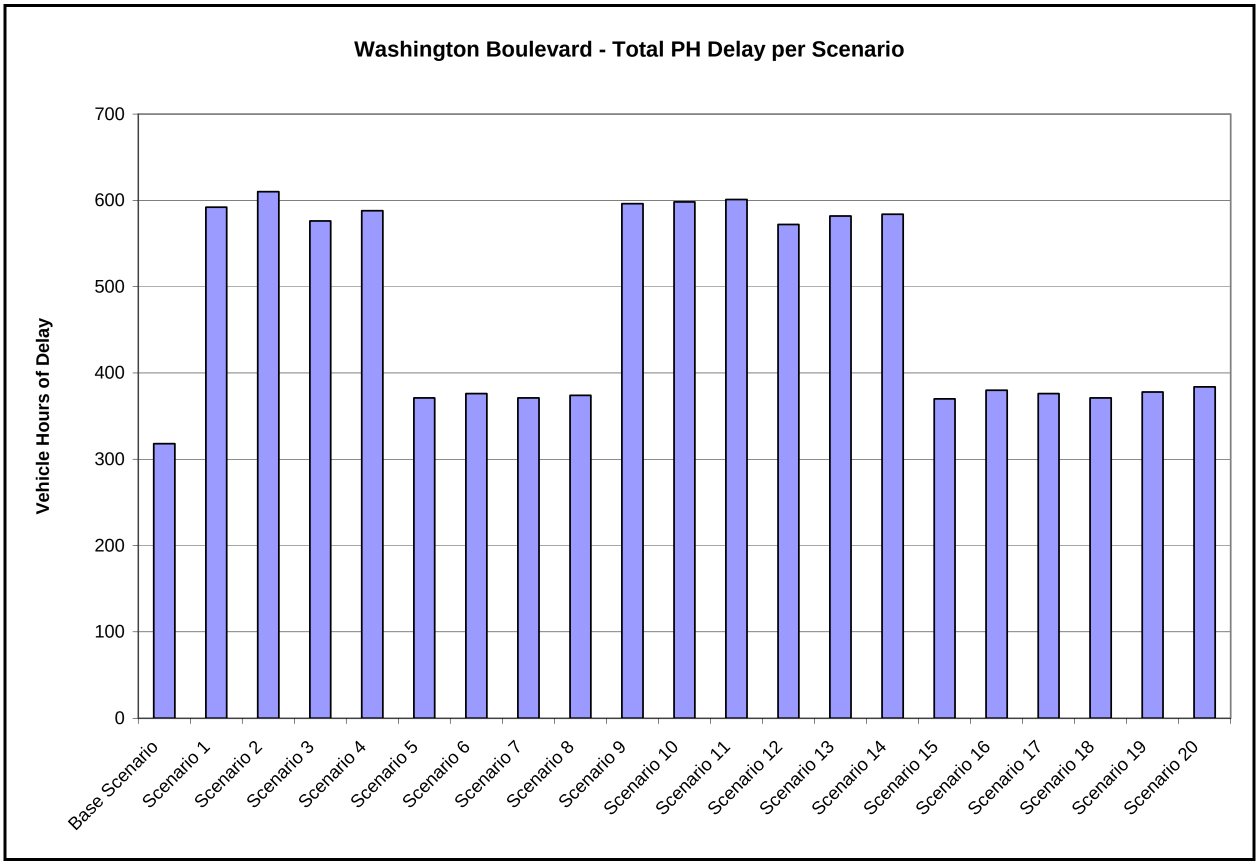

Figure 3.14 Delay Hours Per Day on Washington Boulevard Per Scenario

3.7.2 Delay Per Vehicle

Table 3.16 Peak Hour Delay Per Vehicle (sec) Per Scenario on Washington Boulevard

	Delay/Vehicle (sec/veh)	
	Southbound	**Northbound**
Base Scenario	84	154
Scenario 1	117	273
Scenario 2	121	280
Scenario 3	117	266
Scenario 4	118	272
Scenario 5	93	175
Scenario 6	94	178
Scenario 7	93	175
Scenario 8	94	177
Scenario 9	119	273
Scenario 10	117	278
Scenario 11	117	279
Scenario 12	118	262
Scenario 13	114	272
Scenario 14	115	273
Scenario 15	91	176
Scenario 16	91	181
Scenario 17	90	180
Scenario 18	92	175
Scenario 19	91	179
Scenario 20	92	183

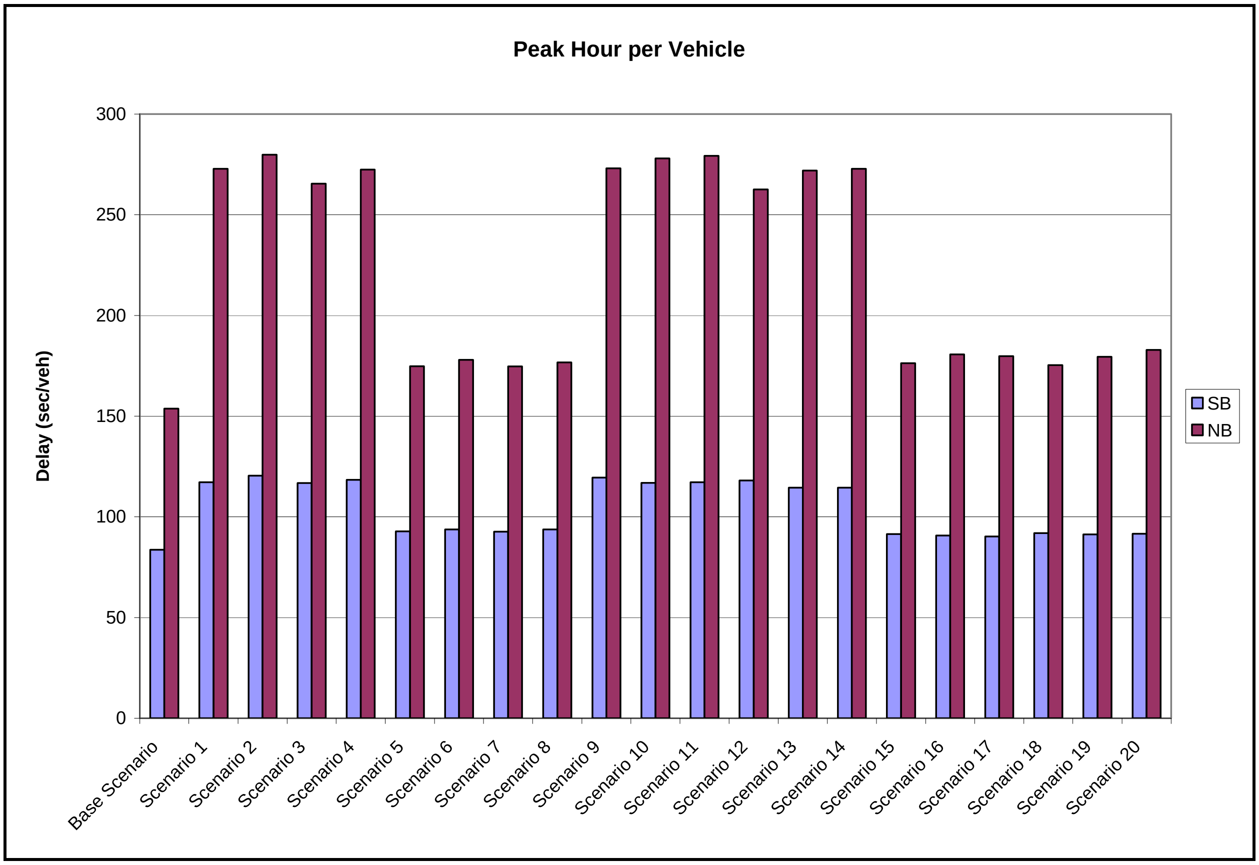

Figure 3.15 Peak Hour Delay Per Vehicle (sec) Per Scenario on Washington Boulevard

3.7.3 V/C

Table 3.17 Averaged Peak Hour V/C Ratio on Washington Boulevard Per Scenario

Scenario #	Average V/C
Base Scenario	90
Scenario 1	101
Scenario 2	102
Scenario 3	101
Scenario 4	101
Scenario 5	93
Scenario 6	93
Scenario 7	93
Scenario 8	93
Scenario 9	102
Scenario 10	102
Scenario 11	102
Scenario 12	101
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Scenario 14	101
Scenario 15	93
Scenario 16	93
Scenario 17	93
Scenario 18	93
Scenario 19	93
Scenario 20	93

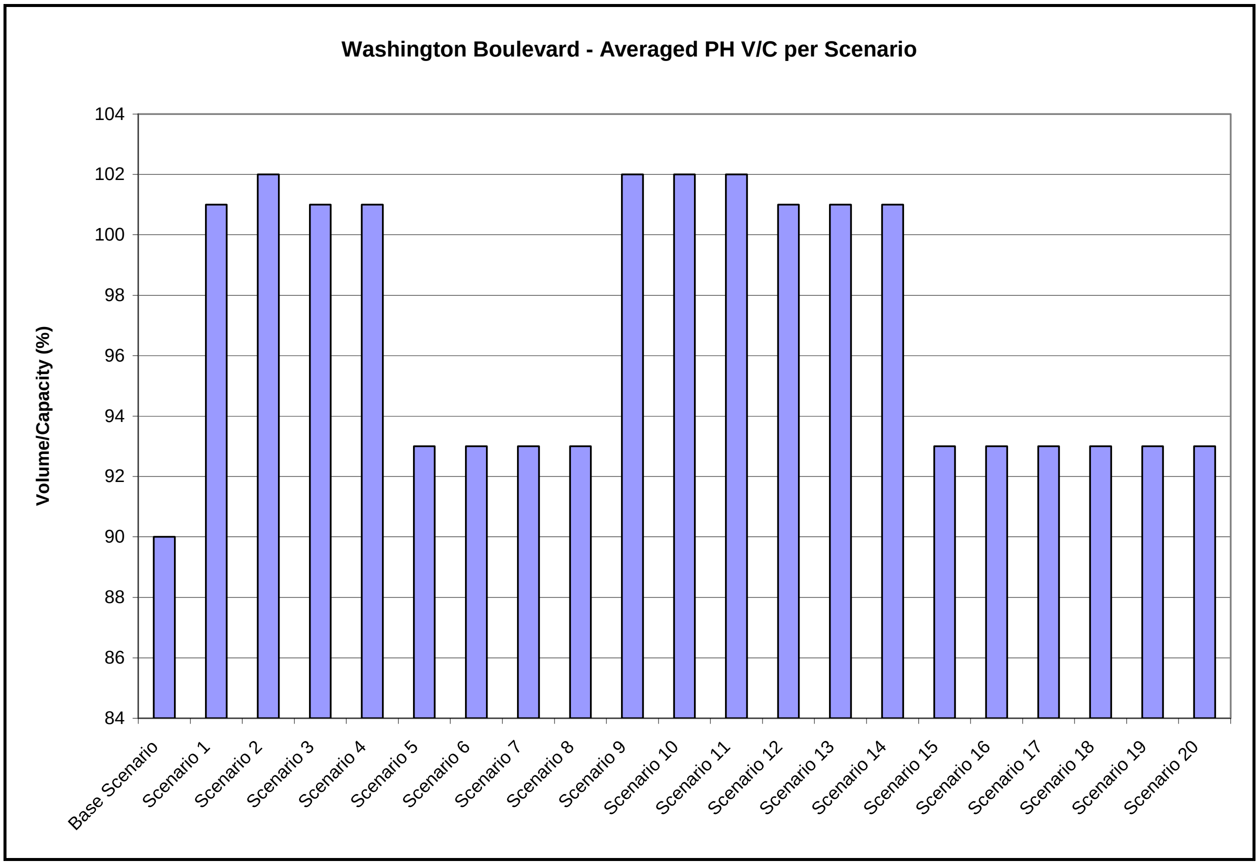

Figure 3.16 Averaged Peak Hour V/C Ratio on Washington Boulevard Per Scenario

4. CONCLUSIONS

The results show various scenarios produce different outputs for various corridors. However, the general results for the entire area show that Scenario 18 is slightly better than the others. In general, one can say that all scenarios which assume two lanes on the reconstructed section of I-15 are comparable. These scenarios are significantly lower than those with only one open lane on the I-15 mainline during the reconstruction.

In respect to the addition of one lane on SR-126 between 450 N and 12th Street, the model estimates savings from 100 to 160 delay-hours per day, depending on the closures of the surrounding interchanges. With an average delay savings of 130 delay-hours per day, the model estimates that the addition of a new lane on the section of SR-126 between 450 N and 12th Street would save around US $878,800.00. This number assumes that constant daily savings of 130 delay-hours are worth US $13.00 per hour for 520 working days during the reconstruction period of two years. However, this number might be slightly overestimated because the model has shown a lack of ability to reproduce accurate saturation rates for the major arterials. This inaccuracy in estimating saturation rates comes from the nature and limitations of transportation planning models. The major limitation seems to be the model’s inability to distribute traffic demand over all links in the real street network. The network used in the model, as in most transportation planning models in the world, consists of freeways, major and minor arterials, and collector roads. In addition, transportation planning models, like the WFRC’s TP+ and UTL’s VISUM model, rarely include signals in their modeling procedures. In order to account for the signalized intersections on the arterials, these models use reduced capacities on the arterial links. It seems that either these capacities are overly reduced by the WFRC or the demand on the links in the model’s network is overestimated. For this reason, if saturation rates on the major arterials in Ogden area were converted to HCM LOS, these values would be much higher than values obtained from traffic operations (or signal optimization) software like SYNCHRO. Other results from the study are more or less comparable with the field observations.

REFERENCES

1. HCM – Highway Capacity Manual. 2000. Transportation Research Board, 2000, Washington, D.C.

2. Statewide Transportation Improvement Program 2004-208, Utah Department of Transportation, 2004

3. Transportation Improvement Program 2004-2008, Wasatch Front Regional Council, December 2003.

4. Martin, P., Stevanovic, A. and Disegni, R. User Impacts of the I-15 Design-Build Reconstruction, Utah Traffic Lab, Report UTL-1001-50, July 2003.