Roland Court – Exit 15 Alternatives Analysis

Winooski, VT

November 4, 2004

Chittenden County Metropolitan Planning Organization

Communities working together to meet Chittenden County's transportation needs

Chittenden County Metropolitan Planning Organization

30 Kimball Ave., Suite 206
South Burlington, Vermont 05403
t 802-660-4071
f 802-660-4079
www.ccmpo.org/info@ccmpo.org

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Prepared by:

Resource Systems Group, Inc.
100 Dorset Street, Suite 20
South Burlington, VT 05403
t 802-383-0118
f 802-383-0122

RSG INC.
RESOURCE SYSTEMS GROUP, INC.

MEMORANDUM

To: Susan Smichenko, PE
Chittenden County MPO
From: Joe Segale, PE
Subject: Roland Court – Exit 15 Alternatives Analysis
Date: 4 November 2004

This study evaluates the operational and safety benefits of four alternative designs to the VT 15 intersection with the I-89 Exit 15 northbound off-ramp and with Roland Court located in the City of Winooski, VT. This study was completed by Resource Systems Group, Inc. for the City of Winooski with funds provided through the Chittenden County Metropolitan Planning Organization's technical assistance program.

Roland Court is a dead-end residential street located in close proximity to a slip lane from the northbound off-ramp. Vehicles attempting to exit Roland Court experience long delays due to the amount of through traffic on VT 15 and the continuous flow of traffic from the slip lane.

In the short term, the study recommends that a left turn pocket for vehicles from Roland Court be provided in the existing median between VT 15 eastbound and westbound travel lanes. This improvement will reduce delay significantly for vehicles exiting Roland Court.

In the long term, the study recommends that the CCMPO and City of Winooski work with VTrans and FHWA to eliminate the northbound off-ramp slip lane in conjunction with modifying the existing signalized northbound off-ramp to include one exclusive left turn lane, one shared left-right turn lane, and one exclusive right turn lane. This change will reduce delay at the off-ramp and will improve safety by eliminating a conflict point on VT 15 and separating the off-ramp from Roland Court.

Sincerely,
Resource Systems Group, Inc.

Joseph Segale, P.E.
Senior Project Consultant

100 Dorset Street, Suite 20 ▪ South Burlington, Vermont 05403
TEL 802.383.0118 ▪ FAX 802.383.0122 ▪ www.rsginc.com

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Peter Keating, Sr. Transportation Planner
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Susan Smichenko, Sr. Transportation Planner
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TABLE OF CONTENTS

INTRODUCTION....1

BACKGROUND....1

ROADWAY CHARACTERISTICS....4

ALTERNATIVES....6

EFFECT OF ALTERNATIVES ON CONGESTION....13

SAFETY....23

SUMMARY AND RECOMMENDATION....26

APPENDIX A – TRAFFIC VOLUME ADJSUTMENTS

APPENDIX B – LEVEL OF SERVOCE WORKSHEETS

APPENDIX C – VTRANS SAFETY DATA

APPENDIX D – COMMENTS and RESPONSES

LIST OF TABLES

Table 1. Design Hour Compared to Fair Day Volumes in the PM Peak Hour 12
Table 2. Relationship between Level of Service and Delay for Intersections....16
Table 3. PM Peak Hour LOS - VT 15 with Southbound On-Ramp 17
Table 4. 2010 PM Peak Hour Queuing Analysis - VT 15 with Southbound On-Ramp 17
Table 5. AM Peak Hour LOS - VT 15 with Southbound On-Ramp 17
Table 6. 2010 AM Peak Hour Queuing Analysis - VT 15 with Southbound On-Ramp 17
Table 7. 2010 PM Peak Hour LOS - VT 15 with Northbound Off-Ramp 18
Table 8. 2010 AM Peak Hour LOS - VT 15 with Northbound Off-Ramp 19
Table 9. 2010 PM Peak Hour Queuing Analysis - VT 15 with Northbound Off-Ramp....19
Table 10. 2010 AM Peak Hour Queuing Analysis - VT 15 with Northbound Off-Ramp 20
Table 11. 2010 PM Peak Hour Northbound Off-Ramp Right-Turn Queue Length Estimate Using Simulation 20
Table 12. 2010 PM Peak Hour LOS - VT 15 with Roland Court 21
Table 13. 2010 AM Peak Hour LOS - VT 15 with Roland Court....21
Table 14. Average Delay per Vehicle Exiting Roland Court in the 2010 PM Peak Hour Based on Traffic Simulation Model (Seconds) 23
Table 15. Study Area Crashes 1997 to 2001 23
Table 16. High Accident Location Analysis based on 1997-2001 VTrans Crash Data....24
Table 17. Type and Cause of Crashes 25
Table 18. Qualitative Effect of Alternatives on Safety relative to "Do Nothing" 26
Table 19. Alternative 4 Cost Estimate....27

LIST OF FIGURES

Figure 1. Alternative 6 as Recommended in the January 2002 Study....3

Figure 2. Functional Classification Hierarchy....4

Figure 3. Hourly Variation of Traffic at the VT 15 intersections with the Exit 15 Ramps....6

Figure 4. Do Nothing Alternative....7

Figure 5. Alternative 1....8

Figure 6. Alternative 2....9

Figure 7. Alternative 3....10

Figure 8. Alternative 4....11

Figure 9. 2004 PM Peak Design Hour Volumes....14

Figure 10. 2010 PM Peak Design Hour Volumes without Redevelopment Project....14

Figure 11. PM Peak Hour Traffic from the Redevelopment Project....14

Figure 12. 2010 PM Peak Design Hour with Redevelopment Project....14

Figure 13. 2004 AM Peak Design Hour Volumes....15

Figure 14. 2010 AM Peak Design Hour Volumes without Redevelopment Project....15

Figure 15.A M Peak Hour Traffic from the Redevelopment Project....15

Figure 16. 2010 AM Peak Design Hour with Redevelopment Project....15

Figure 17. Simulation Model at VT 15 with I-89 Ramps and Roland Court - Existing Geometry....22

INTRODUCTION

This study evaluates the operational and safety benefits of modifications to the VT 15 intersection with the I-89 Exit 15 northbound off-ramp and with Roland Court located in the City of Winooski, VT. Roland Court is a dead-end City Street located in close proximity to a slip lane from the northbound off-ramp. Vehicles attempting to exit Roland Court experience long delays due to the amount of through traffic on VT 15 and the almost continuous flow of traffic from the slip lane. In a January 2002 study conducted for the CCMPO and the City of Winooski, installation of a left turn pocket in the existing median between eastbound and westbound VT 15 for left turning vehicles from Roland Court, and elimination of the slip lane is recommended. This study evaluates four refinements to the original recommendation and recommends short term and long term improvements. This report includes the following sections:

- Background – summarizing the 2002 study;
- Description of Roadway Characteristics;
- Alternatives Description;
- Congestion analysis under 2004 existing conditions and 2010 under a Do-Nothing scenario and four alternatives;
- Safety; and
- Summary and Recommendations.

An earlier version of this report was published on March 2, 2004. The March 2, 2004 report included three alternatives. This version of the report includes a fourth alternative and addresses comments submitted by the Federal Highway Administration (see Appendix D).

BACKGROUND

In January of 2002, a study was completed by Lamoureux and Dickinson Consulting Engineers that evaluated alternatives to addressing safety and operational issues at the intersection of Roland Court with VT 15 in the City of Winooski. Roland Court intersects with VT 15 adjacent to a right-turn slip lane from the northbound off-ramp at Exit 15. As a result, there is a continuous flow of traffic, particularly in the morning and afternoon peak hours, that makes it difficult for vehicles to exit Roland Court. The 2002 study evaluated a "do nothing" scenario and five improvement alternatives. The alternatives included:

1. Do nothing;
2. Traffic Calming;
3. Restrict access at Roland Court to Right-Turn In/Right-Turn Out only;
4. Provide a connection from Roland Court to the I-89 Off-Ramp that would allow left turning vehicles to use the traffic signal;

5. Eliminate the I-89 northbound off-ramp right turn slip lane; and
6. Signalize Roland Court and Florida Avenue

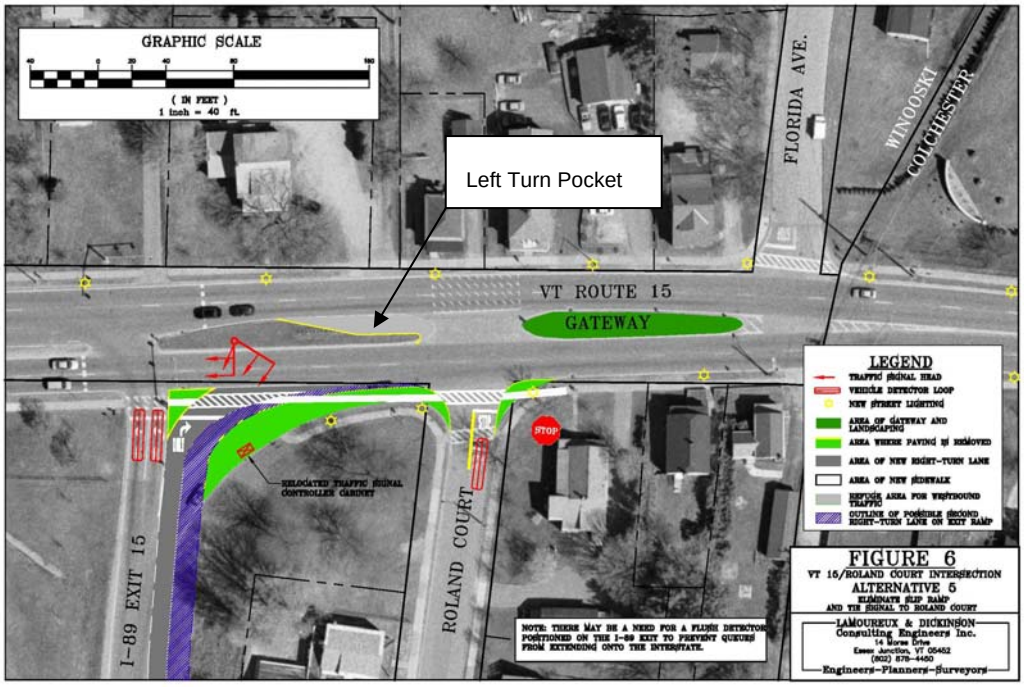
At a public meeting held by the City Council in October of 2001, the consensus was that removal of the right-turn slip lane was the preferred alternative. The preferred alternative is shown in Figure 1 and consists of the following components:

- The right turn slip lane would be eliminated. A new right turn lane would be constructed and controlled by a traffic signal.
- Right-turns-on red would still be allowed. However, a detector loop would be installed on Roland Court that would activate a fiber optic "No Right Turn on Red" sign. This design would insure a gap in eastbound traffic on VT 15 when vehicles leave Roland Court.
- Vehicles turning left from Roland Court would still be confronted with westbound traffic on VT 15. Therefore, a left turn pocket is recommended in the island between eastbound and westbound VT 15 as shown in Figure 1.

The 2002 study considered the general advantages and disadvantages of each alternative and provided a qualitative comparison of the costs, benefits, natural and cultural resource impacts, and the potential permits required.

This analysis will determine whether or not eliminating the slip lane, and rerouting right-turning vehicles through the traffic signal, will improve conditions for vehicles exiting Roland Court without causing operational and safety problems at the Exit 15 ramps.

Figure 1. Alternative 6 as Recommended in the January 2002 Study



ROADWAY CHARACTERISTICS

JURSIDICTION

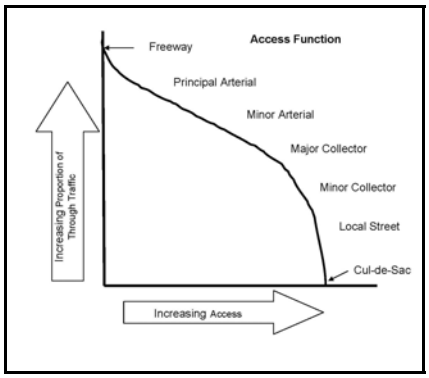
VT 15 is a class 1 town highway in the study area and is therefore owned and maintained by the City of Winooski. The City also owns and maintains the traffic signals controlling the ramps. The on and off-ramps are a component of the interstate system and are owned and maintained by VTrans. Roland Court is a class 3 town highway and is owned and maintained by the City of Winooski.

FUNCTIONAL CLASS

The highway functional classification system, depicted in Figure 2, is organized as a hierarchy of facilities, based on the degree to which the roadway facility serves mobility (through traffic) and access to adjacent land uses. VT 15 is classified as a principal arterial. Its function is to primarily serve through traffic. Roland Court is classified as a local street. Its function is to provide access to adjacent land (direct access to many homes). In an ideal situation, principal arterials only intersect with the interstate system through interchanges such as Exit 15 and to local road systems at intersections (often signalized) with minor arterials or collector streets (Lime Kiln Road for example). In this ideal situation, local streets would connect to collector streets that eventually connect to an arterial. This hierarchy allows the consolidation of vehicle trips that can then be served efficiently with properly designed intersections. When a local street attempts to connect directly to an arterial, the problems experienced at Roland Court often occur. Through volumes are so heavy on the arterial that vehicles have difficulty exiting and entering the local street. And because volumes are so low on the local street, solutions such as traffic signals are not warranted.

In the real world, local streets often connect to arterials. In these situations, providing adequate distance between other intersections and separating turning vehicles from through vehicles on the arterial can help address the access problem. Under the existing situation, there is no separation distance between the northbound off-ramp slip lane and Roland Court and there are no turning lanes available to separate VT 15 through vehicles from vehicles entering and exiting Roland Court.

Figure 2. Functional Classification Hierarchy



PHYSICAL CHARACTERISTICS

The following characteristics are based upon information provided in the January 2002 Study, field observations, and VTrans paving plans prepared by Webster-Martin, Inc. in 1995.

Horizontal Alignment – VT 15's horizontal alignment is generally straight. Roland Court is on a straight alignment that intersects VT 15 at a 90 degree angle.

Terrain and Vertical Alignment – VT 15 has a 6.5% down grade in the westbound direction as it passes by Roland Court. The grade flattens west of the northbound off-ramp.

Design Speed – The posted speed limit through the study area is 25 miles per hour. The posted speed increases to 35 miles per hour at the Colchester town line located approximately 120 feet eat of Roland Court.

VT 15 Roadway Width – VT 15 has four eleven-foot wide travel lanes with two-foot wide shoulders and a 16 foot wide island both east and west of Roland Court. Between the northbound and southbound ramps, westbound VT 15 consists of two eleven foot travel lanes for through traffic with a two foot shoulder and an 11 foot wide exclusive left turn lane. Eastbound VT 15 between the ramps consists of two eleven foot travel lanes and a one foot shoulder. A four foot wide concrete median separates the westbound and eastbound lanes between the ramps. The northbound off-ramp consists of two eleven foot wide left turn lanes controlled by a traffic signal and a twenty foot wide right-turn slip lane controlled by a stop sign. The VT 15 eastbound approach to the southbound on-ramp consists of two eleven foot wide travel lanes and a right turn slip lane to the ramp.

Roland Court Roadway Width – Roland Court is 24.5 feet wide with one travel lane in each direction. The Roland Court approach to VT 15 consists of a shared left-right turn lane. The VT 15 westbound approach to Roland Court is striped and signed as a "Do Not Block Intersection" zone.

Sight Distance – Lamoureux and Dickinson measured available sight distance from Roland Court to the east and west at 475 feet and greater than 1,000 feet respectively. These available sight distances exceed the recommended distance of 275 feet for a 25 mile per hour posted speed limit.

TRAFFIC VOLUMES

The average annual daily traffic volume on VT 15 between East Spring Street and Exit 15 was 20,100 vehicles per day in 2002 (VTrans station D-234). The average annual daily traffic volume east of Exit 15 is estimated at 17,080 vehicles per day[1]. Based on the count conducted by Lamoureux and Dickinson, Roland Court generates approximately 200 vehicle trips per day.

Figure 3 shows how traffic volumes vary throughout a typical weekday using data collected by VTrans in June of 2002. The chart shows distinctive peaks between the hours of 7:00-8:00 AM and between 5:00-6:00 PM.

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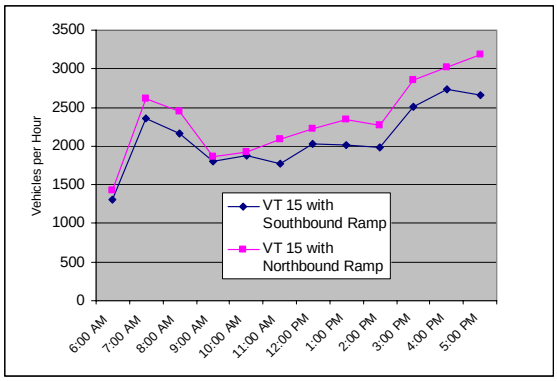
[1] Traffic directly east of Exit 15 is approximately 15% less than traffic directly west of Exit 15. This ratio is based upon the turning movement count conducted by VTrans in June of 2002.

Figure 3 also shows the afternoon peak hour has the highest level of traffic during a typical day. Additional information on traffic volumes used in this analysis is provided further on in this report.

Figure 3. Hourly Variation of Traffic at the VT 15 intersections with the Exit 15 Ramps



ALTERNATIVES

A "Do Nothing" scenario and four alternatives that refine the recommendation of the 2002 Study are evaluated. All of the alternatives focus on lane configurations for the northbound off-ramp and Roland Court. The southbound on-ramp is affected only by changes in traffic signal timings.

- The Do-Nothing scenario provides a base-line for comparing the performance of the three alternatives. It assumes the existing lane geometry shown in Figure 4 on page 7 with optimized traffic signal timings.
- Alternative 1, shown in Figure 5 on page 8 includes the Roland Court left-turn pocket. No additional changes are included to the northbound off-ramp. The analysis of this alternative isolates the benefits of the Roland Court left-turn pocket.
- Alternative 2, shown in Figure 6 on page 9 includes in the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes one right turn lane and two left turn lanes controlled by a traffic signal at the northbound off-ramp.
- Alternative 3, shown in Figure 7 on page 10 includes the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes two right turn lanes and one left turn lane controlled by a traffic signal at the northbound off-ramp.
- Alternative 4, shown in Figure 8. Alternative 4includes the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes one exclusive left turn lane, one shared left/right turn lane and one exclusive right turn lane controlled by a traffic signal at the northbound off-ramp.

Figure 4. Do Nothing Alternative

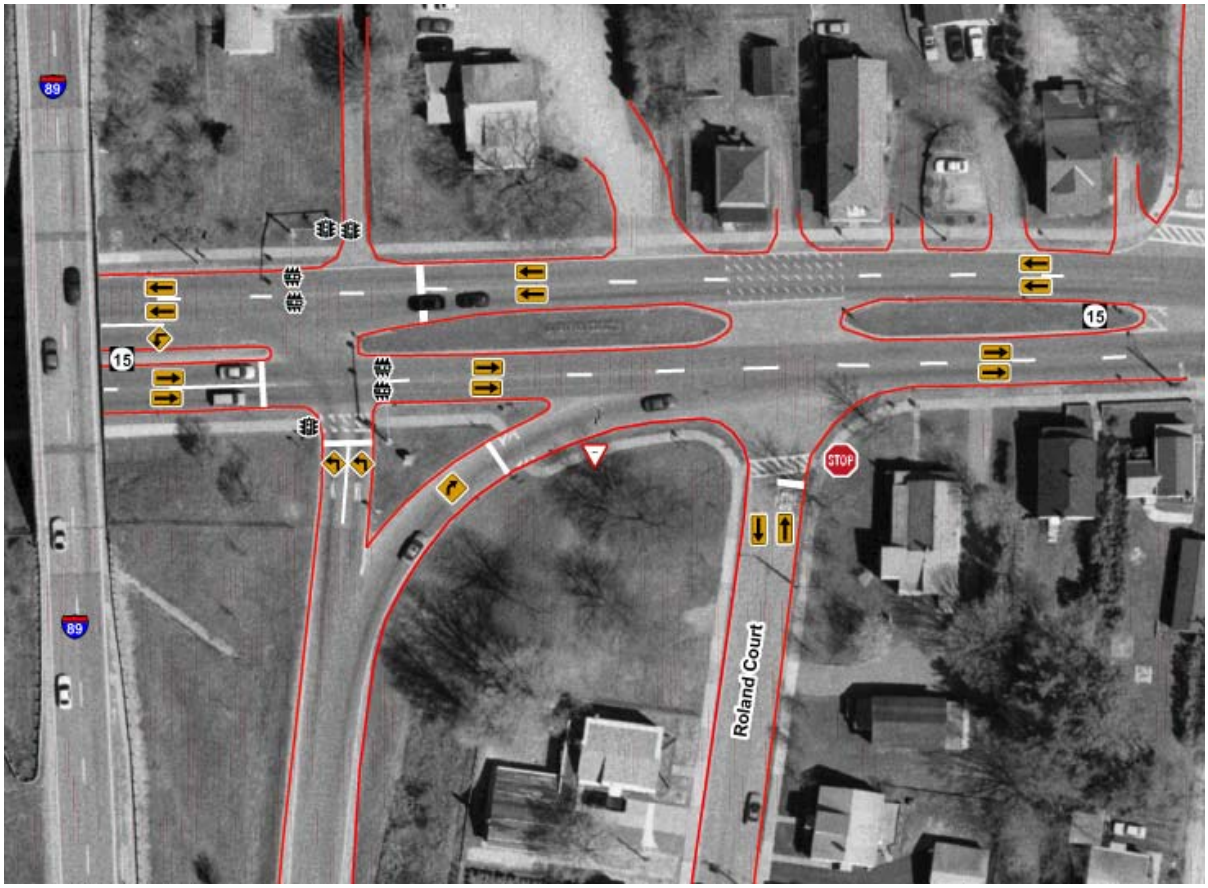


Figure 5. Alternative 1

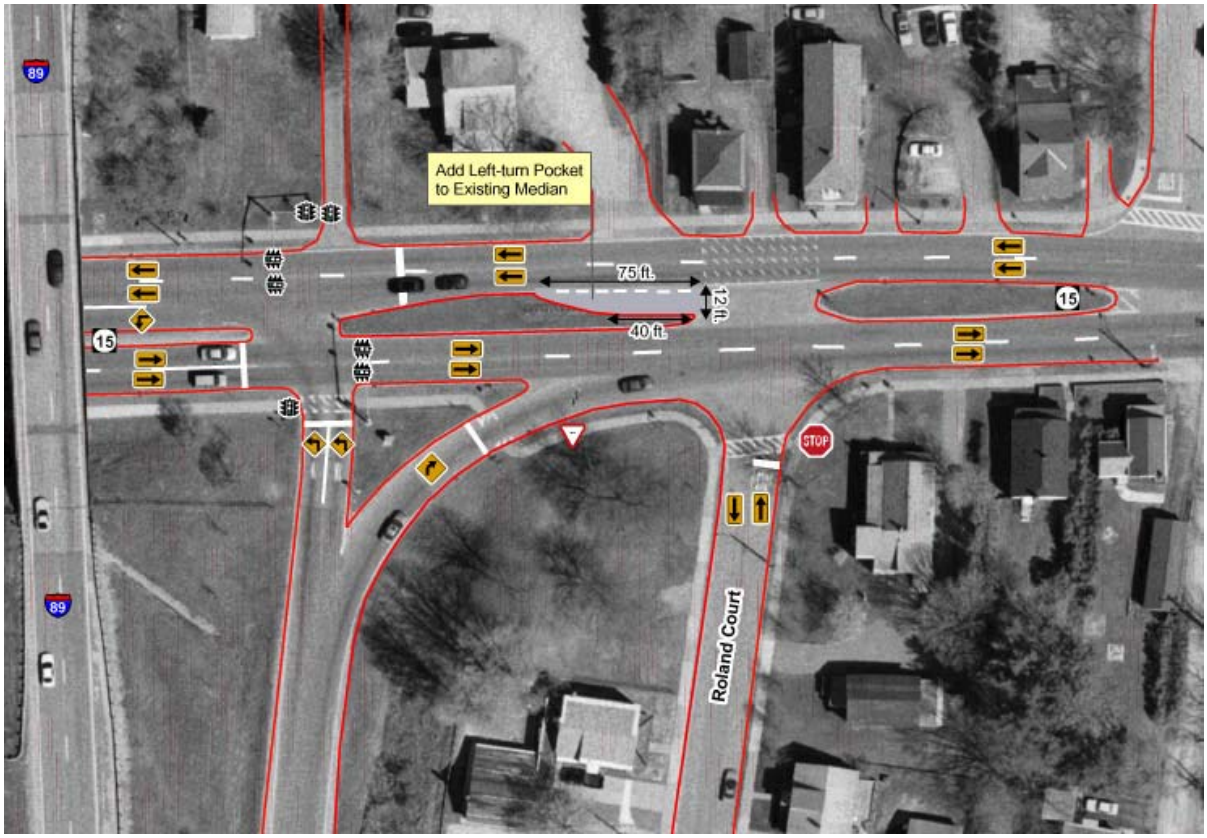


Figure 6. Alternative 2

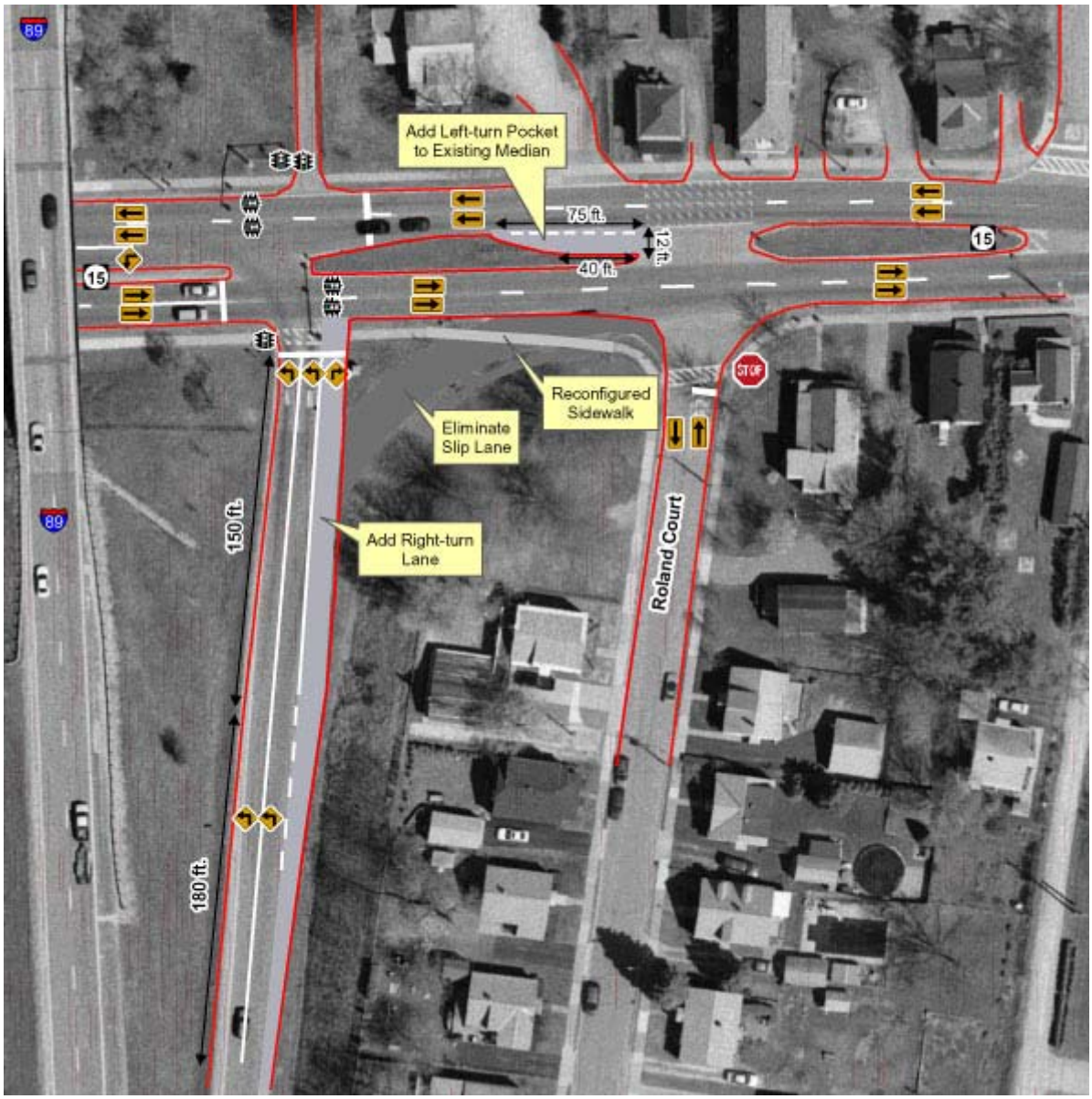


Figure 7. Alternative 3

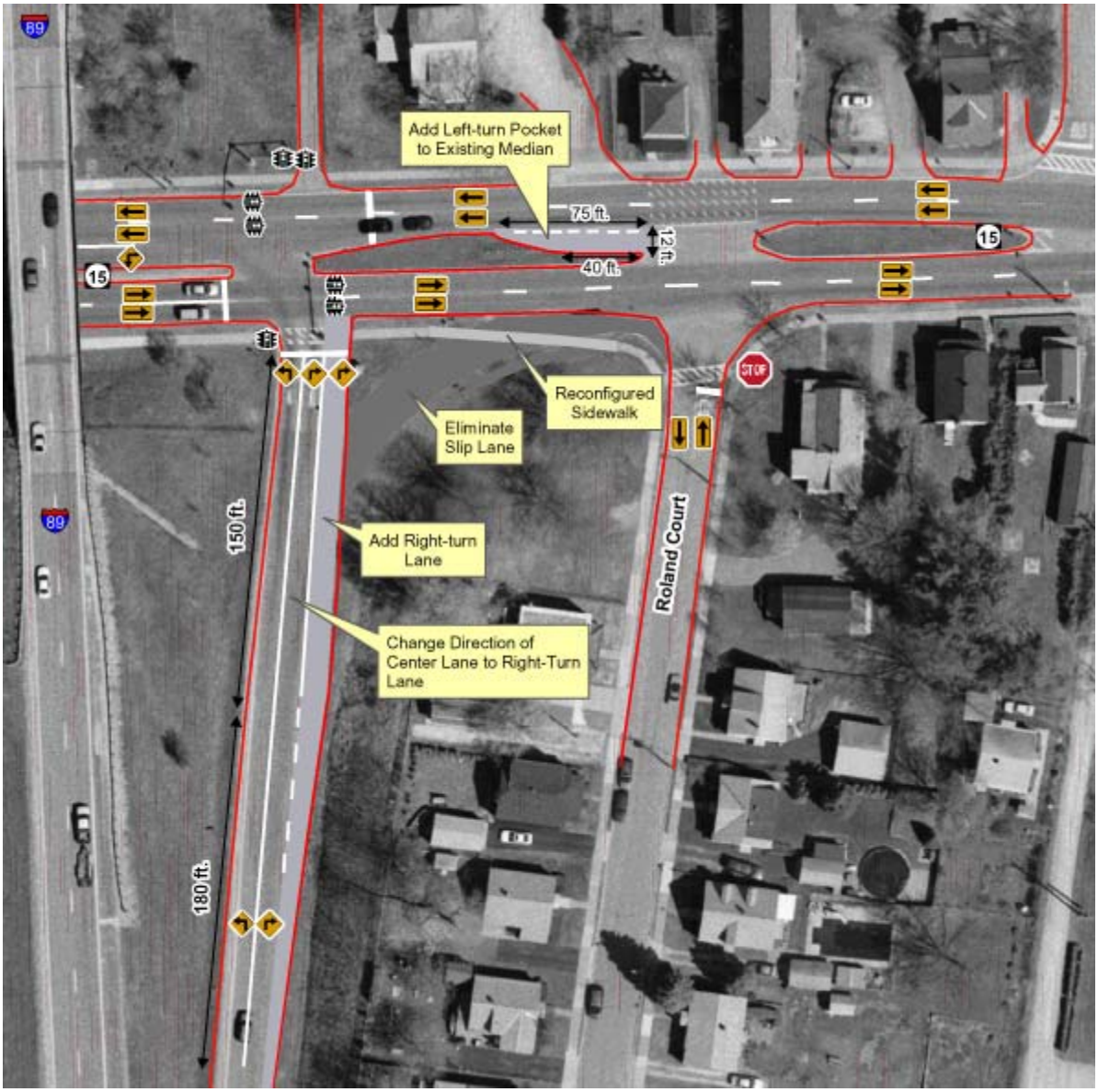
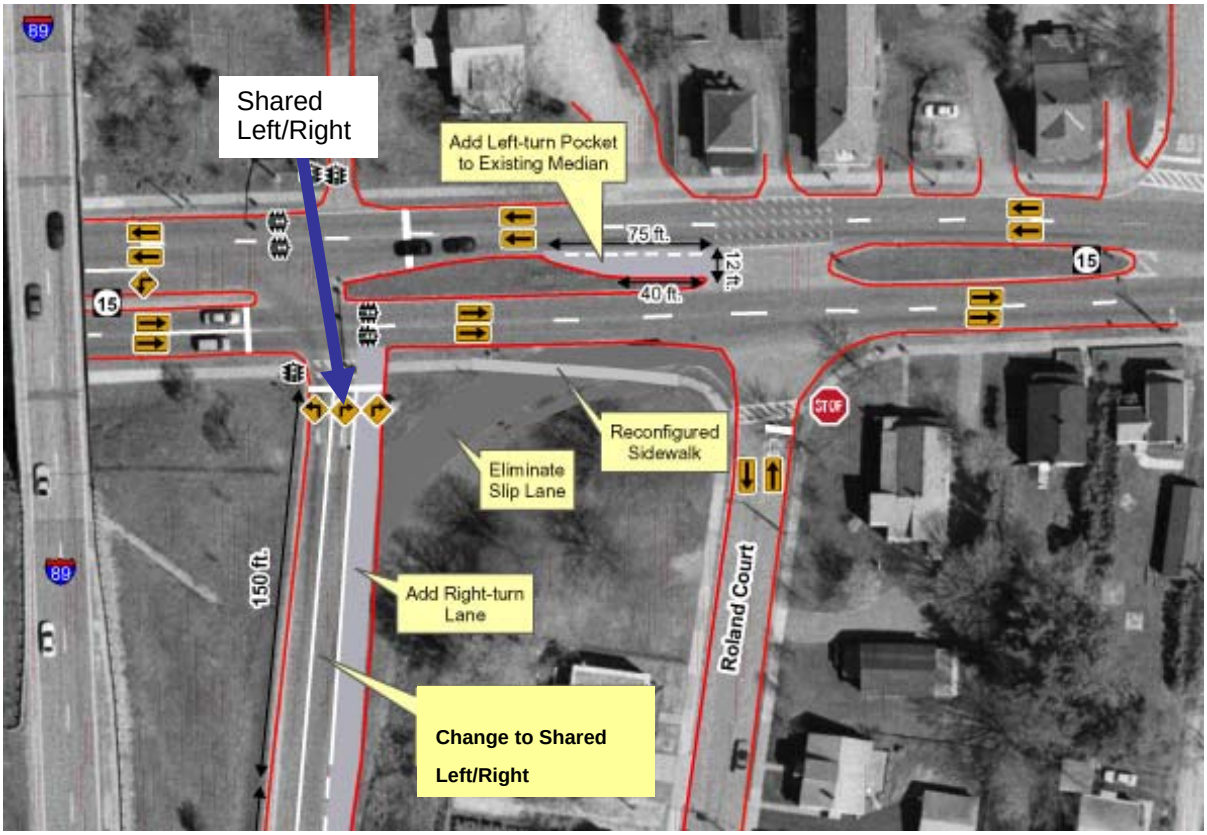


Figure 8. Alternative 4



EXISTING AND FUTURE TRAFFIC VOLUMES

The alternatives analyzed in this study are based upon traffic passing through the intersections of VT 15 with the southbound and northbound ramps and Roland Court in 2010 under design hour conditions. This section explains how traffic volumes collected in the field are used as a basis to determine future volumes at the study intersections.

2004 DESIGN HOUR VOLUMES

AM and PM peak hour traffic volumes at the I-89 Exit 15 on and off ramps are based upon ground counts conducted by VTrans on June 19, 2002. Traffic volumes at the Roland Court intersection with VT 15 are based upon ground counts conducted by Lamoureux and Dickinson on April 12, 2001 during the PM peak hour and April 10, 2001 during the AM peak hour. These counts were adjusted in two ways. First, the AM and PM turning movement counts were adjusted to reflect the design hour (DHV) of traffic. The DHV is the 30th highest hour of traffic for the year and is used as the design standard in Vermont. All design hour adjustments employ data from Continuous Traffic Counter (CTC) D040, located on US 7 in Colchester between Sunderland Woods and the Severance/Blakely Road intersection. This counter records traffic volumes twenty-four hours per day, 365 days per year and therefore provides a comprehensive picture of how traffic volumes vary throughout the year in the study area.

Exit 15 is affected by traffic from the Essex Fairground, especially when the Champlain Valley Exposition (the "Fair") is underway in late summer. Table 1 compares the 2002 design hour volume traffic at each of the ramps to traffic counted by the CCMPO in August of 2003 while the Fair was underway. During the PM peak hour, the design hour volume is higher than traffic counted during a Fair day. Therefore, the traffic from the design hour is used in this analysis.

Table 1. Design Hour Compared to Fair Day Volumes in the PM Peak Hour

VT 15 Intersection With:	*2002 Design Hour Volume*	*2003 Fair Day Volume*
Exit 15 Southbound On-Ramp	2951	2924
Exit 15 Northbound Off Ramp	3506	3292

Appendix A shows how the raw traffic counts were adjusted. Figure 9 and Figure 13 present the 2004 PM and AM peak design hour volumes at each intersection.

BACKGROUND GROWTH

The second adjustment accounts for increases in background traffic stemming from general regional growth between the year the count was conducted and the study years. These background growth factors are also based on VTrans station D040. Adjustments from 2002 to 2010 were made using the long term growth factors developed by VTrans for station D040 as documented in the "2002 Red Book". The growth factors developed by VTrans indicate a projected average annual growth in traffic of 1.8% per year. Figure 10 and Figure 14 present the 2010 PM and AM peak hour volumes at each of the intersections.

2010 ANALYSIS VOLUMES

Traffic from the Winooski Downtown Redevelopment project has been included in the 2010 design hour volumes and is shown in Figure 11 and Figure 15. These projections are taken directly from the traffic impact study prepared by RSG for the project[1]. The estimated traffic from the Winooski Redevelopment Project was added to the estimated background traffic for 2010 to create the 2010 analysis volumes presented in Figure 12 and Figure 16.

EFFECT OF ALTERNATIVES ON CONGESTION

This section quantifies and compares the effect of each alternative on congestion, in terms of delay and vehicle queues, for the southbound on-ramp, northbound off-ramp, and Roland Court intersections with VT 15. The concept of level of service is explained and results presented for 2004 existing condition, and for the "Do Nothing" and three improvement alternatives in 2010.

LEVEL OF SERVICE DESCIPTION

Level of Service (LOS) is the standard measure used to quantify the operational performance of intersections and road segments as perceived by the driver. The grades A, B, C, D, E and F are the five possible LOS ratings. An LOS A indicates that the facility is operating exceptionally well with free flow, while an LOS F indicates that demand exceeds capacity and the facility is failing. There is almost universal agreement that levels of service A, B and C are acceptable and LOS F is not. Whether or not LOS D is acceptable depends on the location of the intersection or road segment in question. On rural highway facilities where speeds are often higher and drivers expect a higher level of mobility, LOS D may not be acceptable. In urban areas and activity centers where drivers expect and are accustomed to greater delays, an LOS D is often wide spread and considered acceptable. In some cases, LOS E may be acceptable in urban areas and activity centers.

The VTrans policy on level of service is:

- LOS C is desirable for rural facilities;
- LOS D is desirable for urban facilities; and
- LOS E or F may be permitted in an urban setting if the remedy, such as adding new lanes, would significantly impact the surrounding natural or built environment.

This policy will be applied in comparing the four alternatives.

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[1] T*raffic Impact Analysis: The Downtown Winooski Revitalization Project, Winooski Vermont*, July 2000.

Figure 9. 2004 PM Peak Design Hour Volumes

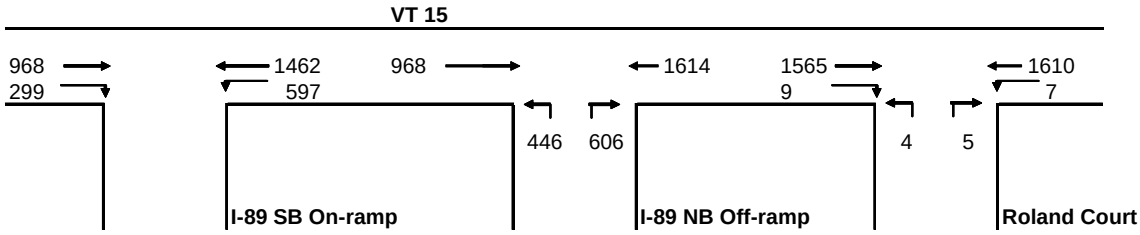


Figure 10. 2010 PM Peak Design Hour Volumes without Redevelopment Project

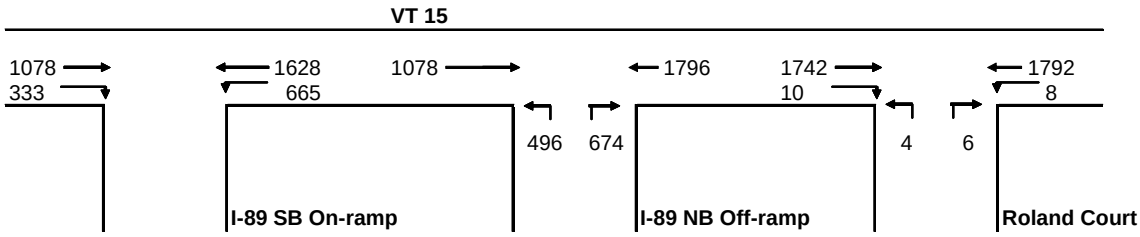


Figure 11. PM Peak Hour Traffic from the Redevelopment Project

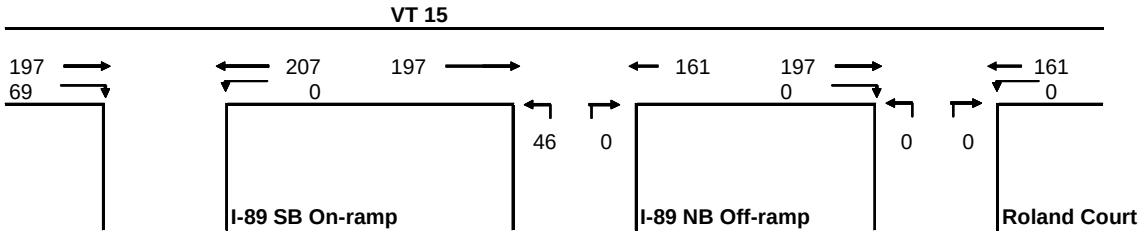


Figure 12. 2010 PM Peak Design Hour with Redevelopment Project

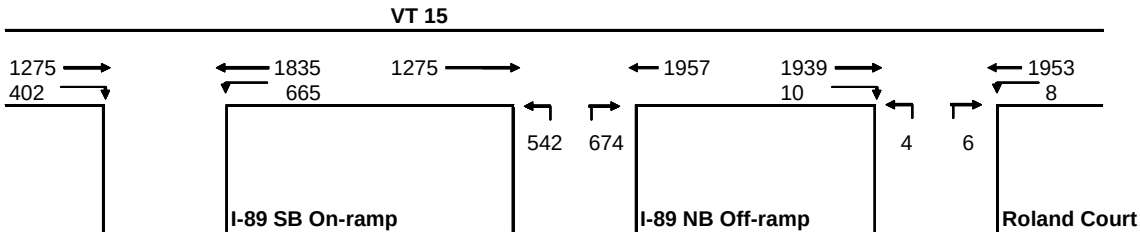


Figure 13. 2004 AM Peak Design Hour Volumes

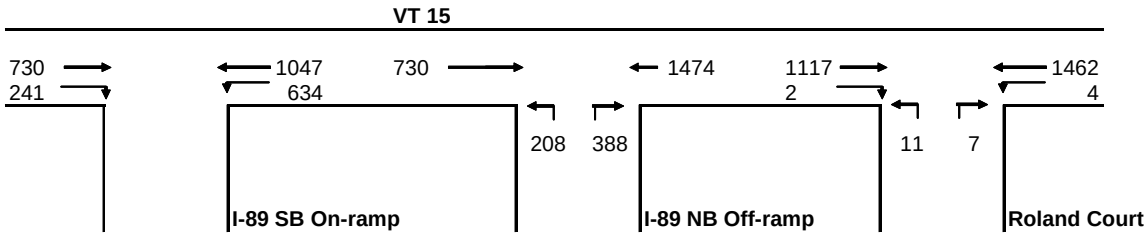


Figure 14. 2010 AM Peak Design Hour Volumes without Redevelopment Project

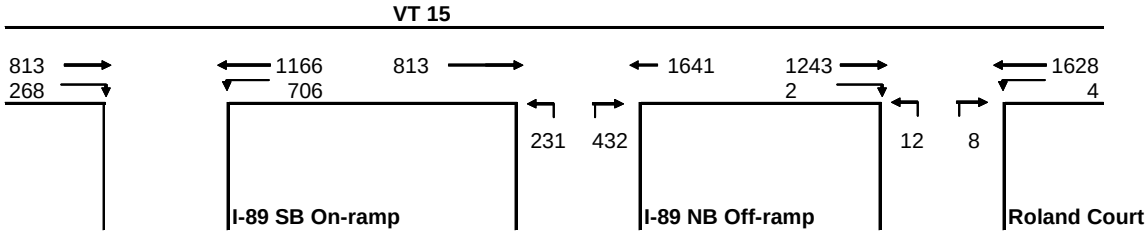


Figure 15. A M Peak Hour Traffic from the Redevelopment Project

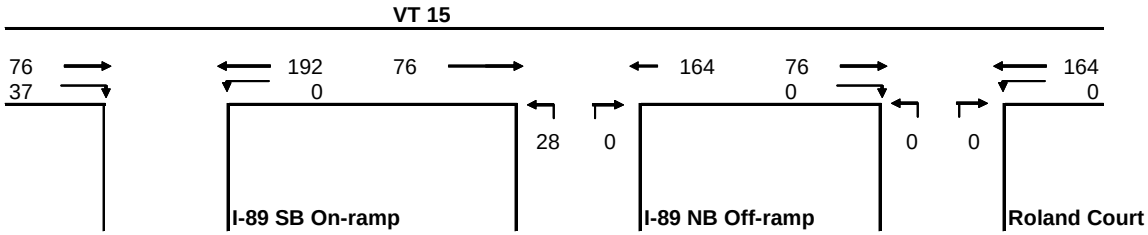
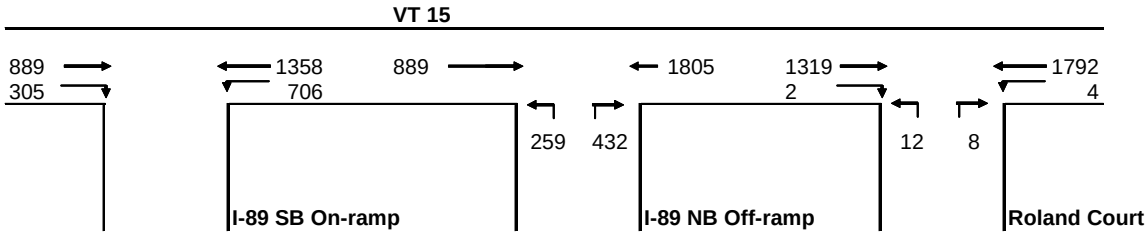


Figure 16. 2010 AM Peak Design Hour with Redevelopment Project



Level of service for both signalized and stop-controlled intersections is measured in terms of average delay per vehicle. The delay, referred to as control delay, includes the time required to slow down when approaching an intersection, the time a vehicle is stopped, the time required for a line of vehicles (the queue) to move up to the intersection, and the time required to accelerate. **Table 2** presents the relationship between LOS and control delay.

Table 2. Relationship between Level of Service and Delay for Intersections

LOS	Characteristics	Stop-Controlled (Seconds)	Traffic Signal (Seconds)
A	Little or no delay	< 10	< 10.0
B	Short delays	> 10 and < 15	> 10 and < 20
C	Average delays	>15 and < 25	>20 and < 35
D	Long delays	> 25 and < 35	> 35 and < 55
E	Very Long delays	> 35 and < 50	> 55 and < 80
F	Extreme delays	> 50	> 80

Level-of-service is estimated using the SYNCHRO highway capacity software package which provides outputs consistent with the procedures outlined in the 2000 Highway Capacity Manual. Appendix B contains the detailed level of service worksheets. In addition to traffic volumes, key inputs include the number of left, through, and right turn lanes at each intersection and the traffic signal timing plans. The results presented below are based on the existing or proposed lane configurations and control type (signalized or un-signalized) at each study intersection, and assume that the traffic signal timing plans have been optimized.

QUEUING ANALYSIS

A queue is a line of stopped vehicles waiting to pass through an intersection. Queue lengths are estimated for each lane group where there is a constraint and compared to the amount of available storage space (results are presented in feet). If an estimated queue is longer than the available storage space, backed up vehicles will cause blocking problems, a common characteristic of severely congested locations. The most critical areas to consider are:

- The left turn lane on the VT 15 westbound approach to the southbound on-ramp because there is no additional space available to absorb spillover;
- The northbound off-ramp because of the potential for queues that extend back to the I-89 mainline (a problem now showing up at other exits in Chittenden County); and
- VT 15 westbound between Florida Avenue and the northbound off-ramp because queues will utilize the space reserved for vehicles exiting Roland Court if there is not enough room.

RESULTS

VT 15 with Southbound On-Ramp

As indicated in Table 3 and Table 5, projected level of service remains acceptable at the southbound on-ramp under all alternatives. Although there are no modifications to lane geometry at the southbound on-ramp, the timing plan will change at this intersection in response to the modifications at the northbound off-ramp resulting in slight changes in level of service and delay. Table 4 and Table 6 demonstrate that that available storage length for the westbound left-turn lane is adequate under all scenarios.

Table 3. PM Peak Hour LOS - VT 15 with Southbound On-Ramp

		2004		2010 Do Nothing		2010 Alternative 1		2010 Alternative 2		2010 Alternative 3		2010 Alternative 4	
Approach	Lane	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)
VT 15 Eastbound	(2) Thru	B	16	B	17	B	17	C	24	C	23	C	23
	(1) Left	B	10	B	20	B	19	B	15	B	16	B	17
VT 15 Westbound	(2) Thru	A	0	A	0	A	0	A	0	A	0	A	0
Overall Intersection		A	7	A	9	A	9	B	11	B	11	B	11

Table 4. 2010 PM Peak Hour Queuing Analysis - VT 15 with Southbound On-Ramp

	2010 Do Nothing		2010 Alternative 1		2010 Alternative 2		2010 Alternative 3		2010 Alternative 4	
Approach	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue
VT 15 Westbound	340	266	340	226	340	300	340	250	340	280

All units are in feet

Table 5. AM Peak Hour LOS - VT 15 with Southbound On-Ramp

		2004		2010 Do Nothing		2010 Alternative 1		2010 Alternative 2		2010 Alternative 3		2010 Alternative 4	
Approach	Lane	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)	LOS	Delay (Seconds)
VT 15 Eastbound	(2) Thru	B	12	C	20	B	17	B	16	B	17	B	18
	(1) Left	B	17	B	11	B	12	B	13	B	17	B	14
VT 15 Westbound	(2) Thru	A	0	A	0	A	0	A	0	A	0	A	0
Overall Intersection		A	8	A	9	A	8	A	8	A	9	A	9

Table 6. 2010 AM Peak Hour Queuing Analysis - VT 15 with Southbound On-Ramp

	2010 Do Nothing		2010 Alternative 1		2010 Alternative 2		2010 Alternative 3		2010 Alternative 4	
Approach	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue	Available Storage	Estimated Queue
VT 15 Westbound	340	252	340	253	340	143	340	309	340	246

All units are in feet

VT 15 with Northbound Off-Ramp

Table 7 and Table 9 present LOS during the PM and AM peak hours for each lane at the VT 15 intersection with the northbound off-ramp. These tables also describe the lane changes under each alternative. For existing conditions in 2004 and in 2010 (Do Nothing), and Alternative 1, level of service for the right-turn slip lane is presented separately from the rest of the off-ramp because it is not controlled by the traffic signal. As a result, it has been analyzed as a separate un-signalized intersection. For Alternatives 2, 3 and 4, the right turn lane is controlled by the traffic signal and is therefore analyzed as a component of the signalized intersection.

Under the 2004, Do-Nothing, and Alternative 1 scenarios the signalized portion of the northbound off-ramp is projected to operate at acceptable levels of service. However, the right-turn slip lane operates at LOS F in 2004 with an average delay per vehicle of almost two minutes during the PM peak hour. Under the 2010 Do-Nothing scenario, the average delay per vehicle is projected to exceed 5 minutes. As noted further in the report, this LOS estimate does not account for the additional gaps in VT 15 eastbound traffic created by the traffic signal at the off-ramp. Therefore, these delay estimates for the slip lane may be higher than actually experienced.

In Alternative 2, the slip lane is removed and one right-turn lane is combined into the signalized approach. The result is a three lane approach that includes one right turn lane and two left turn lanes. Although the delay per vehicle decreases substantially, LOS remains at F for right turning vehicles.

In Alternative 3, the off-ramp is reconfigured to include one left turn lane and two right turn lanes controlled by a traffic signal. The right-turn slip lane is removed. PM peak hour LOS for the left turn movement from the off-ramp drops from B to D with an average delay of 47 seconds per vehicle. LOS for the right turning vehicles improves from F under Alternative 2 to C with an average delay of 26 seconds per vehicle.

In Alternative 4, the off-ramp is reconfigured to include one exclusive left turn lane, one shared left/right lane, and one exclusive right-turn lane controlled by a traffic signal. This configuration provides acceptable level of service for all movements and reduces delay for left turning vehicles from the off-ramp relative to the other alternatives.

Table 7. 2010 PM Peak Hour LOS - VT 15 with Northbound Off-Ramp

		2004		2010 Do Nothing		2010 Alternative 1			2010 Alternative 2			2010 Alternative 3			2010 Alternative 4		
Approach	Lanes	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
VT 15 Eastbound	(2) Thru	A	0	A	1	(2) Thru	A	4	(2) Thru	A	7	(2) Thru	A	6	(2) Thru	A	1
VT 15 Westbound	(2) Thru	A	8	B	11	(2) Thru	B	12	(2) Thru	D	47	(2) Thru	C	34	(2) Thru	B	24
NB Off-Ramp	(2) Left	B	19	C	24	(2) Left	C	24	(2) Left	C	20	(1) Left	D	47	(1) Left	C	32
									(1) Right	F	121	(2) Right	C	26	(1) Left/Right	C	32
															(1) Right	D	43
Overall Intersection		A	7	A	9		B	11		D	43		C	26		C	21

		2004		2010 Do Nothing		Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Approach	Lanes	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
Right Turn Slip Lane	(1) Right	F	112	F	307	(1) Right	F	307	*Not Applicable*			*Not Applicable*			*Not Applicable*		

Table 8. 2010 AM Peak Hour LOS - VT 15 with Northbound Off-Ramp

		2004		2010 Do Nothing		2010 Alternative 1			2010 Alternative 2			2010 Alternative 3			2010 Alternative 4		
Approach	Lanes	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
VT 15 Eastbound	(2) Thru	A	0	A	0	(2) Thru	A	2	(2) Thru	A	4	(2) Thru	A	5	(2) Thru	A	3
VT 15 Westbound	(2) Thru	B	5	A	8	(2) Thru	A	9	(2) Thru	C	22	(2) Thru	B	13	(2) Thru	B	12
NB Off-Ramp	(2) Left	B	19	C	23	(2) Left	B	18	(2) Left	B	16	(1) Left	C	28	(1) Left	C	26
									(1) Right	D	37	(2) Right	C	27	(1) Left/Right	C	26
															(1) Right	D	36
Overall Intersection		5	A	A	7		A	8		B	19		B	14		B	13

		2004		2010 Do Nothing		Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Approach	Lanes	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
Right Turn Slip Lan	(1) Right	C	19	D	30	(1) Right	D	30	*Not Applicable*			*Not Applicable*			*Not Applicable*		

Table 9 and Table 10 present the estimated queue lengths for the different lanes at the VT 15 intersection with the northbound off-ramp based upon standard highway capacity analysis procedures. These estimates suggest that the vehicle queues would be excessive for the right turns from the slip lane if left in its current configuration (controlled by a stop sign). Under the Do-nothing and Alternative 1 scenarios, the projected PM peak hour queue length is 960 feet. This queue is projected to decrease significantly when the slip lane is controlled by a traffic signal as assumed under Alternatives 2-4.

FHWA commented that this result is not reasonable. The slip lane, even when controlled by a stop sign, allows vehicles to exit almost continuously when compared to a traffic signal. To address this comment, the queues were re-estimated using traffic simulation. The results, presented in Table 11, indicate that:

- Queue lengths are not as long as estimated using the standard highway capacity analyses procedures;
- Comparing Alternative 2 to Alternative 1 suggests that signalizing the slip lane would increase queue lengths;
- Providing two right turn lanes controlled by the a traffic signal in Alternative 3 has about the same queue length as a single right-turn slip lane controlled by a stop sign; and
- Providing the shared left/right and right-turn lanes in Alternative 4 reduces queue lengths relative to all other alternatives.

Table 9. 2010 PM Peak Hour Queuing Analysis - VT 15 with Northbound Off-Ramp

		2010 Do Nothing		2010 Alternative 1			2010 Alternative 2			2010 Alternative 3			2010 Alternative 4		
Approach	Lane	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue
VT 15 Eastbound	(2) Thru	340	6	(2) Thru	340	73	(2) Thru	340	91	(2) Thru	340	92	(2) Thru	340	2
VT 15 Westbound	(2) Thru	330	287	(2) Thru	330	315	(2) Thru	330	694	(2) Thru	330	601	(2) Thru	330	576
NB Off-Ramp	(2) Left	130	141	(2) Left	130	141	(2) Left	130	146	(1) Left	130	408	(1) Left	130	225
	Right Slip Lane	370	960	ight Slip Lar	370	960	(1) Right	370	586	(2) Right	370	173	(1) Left/Right	370	287
													(1) Right	370	287

All units are in feet

Table 10. 2010 AM Peak Hour Queuing Analysis - VT 15 with Northbound Off-Ramp

		2010 Do Nothing		2010 Alternative 1			2010 Alternative 2			2010 Alternative 3			2010 Alternative 4		
Approach		Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue	Lanes	Available Storage	Estimated Queue
VT 15 Eastbound	(2) Thru	340	0	(2) Thru	340	34	(2) Thru	340	49	(2) Thru	340	56	(2) Thru	340	0
VT 15 Westbound	(2) Thru	330	260	(2) Thru	330	243	(2) Thru	330	466	(2) Thru	330	367	(2) Thru	330	349
NB Off-Ramp	(2) Left	130	71	(2) Left	130	60	(2) Left	130	59	(1) Left	130	167	(1) Left	130	81
	Right Slip Lane	370	175	Right Slip Lane	370	175	(1) Right	370	203	(2) Right	370	59	(1) Left/Right	370	90
													(1) Right	370	90

All units are in feet

Table 11. 2010 PM Peak Hour Northbound Off-Ramp Right-Turn Queue Length Estimate Using Simulation

Scenario	Configuration	Right Turn Queue Length (Feet)
Do Nothing	Right Slip Lane with Stop Sign	226
Alternative 1	Right Slip Lane with Stop	390
Alternative 2	(1) Right Controlled by Traffic Signal	645
Alternative 3	(2) Right Controlled by Traffic Signal	380
Alternative 4	(1) Shared Left/Right and (1) Right Controlled by Traffic Signal	150

VT 15 with Roland Court

The LOS results presented in Table 12 and Table 13 are summarized by movement rather than lane groups. The Roland Court approach to VT 15 consists of a single shared left/right turn lane. Typically, left and right turning vehicles using a shared left/right lane are assigned the same LOS. LOS is presented in this analysis by movement to account for the double move required by left turning vehicles from Roland Court to VT 15 westbound when the left turn pocket is included in Alternatives 1-4. Under these scenarios, a vehicle making a left turn from Roland Court to VT 15 westbound must (1) make a through movement from Roland Court to the left turn pocket, and (2) merge from the pocket into VT 15 westbound.

Under the Do Nothing scenario, the level of service for vehicles exiting Roland Court is projected at F for the AM and PM peak hours.

Under Alternative 1, which includes the left turn pocket but does not eliminate the right turn slip lane from the northbound off-ramp:

- LOS remains at F for left turns from Roland Court, but delay per vehicle is reduced significantly in the PM peak hour;
- LOS improves to E during the AM peak hour for left turning vehicles from Roland Court with delay per vehicle almost cut in half; and
- LOS improves for right turning vehicles from Roland Court from F to E in the PM peak hour and F to C in the AM peak hour.

LOS results for the left and right turning vehicles from Roland Court are identical for Alternatives 1 through 4. The improvement can be attributed to the left turn pocket. The pocket allows vehicles turning left from Roland Court to cross eastbound traffic as a through movement. These vehicles do not have to wait as long because they are only crossing one direction of opposing traffic. Delay for right turning traffic from Roland Court is also reduced because they are not blocked by vehicles waiting to make a left turn.

Table 12. 2010 PM Peak Hour LOS - VT 15 with Roland Court

		2004		2010 Do Nothing		Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Approach	Moveme	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
Roland Court	Left	F	80	F	205	Left	F	60	Left	F	60	Left	F	60	Left	F	60
Northbound	Right	F	80	F	205	Right	E	40	Right	E	40	Right	E	40	Right	E	40
VT 15 Westbound	Left	A	0	A	0	Left	C	18	Left	C	18	Left	C	18	Left	C	18

Table 13. 2010 AM Peak Hour LOS - VT 15 with Roland Court

		2004		2010 Do Nothing		Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Approach	Moveme	LOS	Delay (Seconds)	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)	Lanes	LOS	Delay (Seconds)
Roland Court	Left	F	50	F	99	Left	E	43	Left	E	43	Left	E	43	Left	E	43
Northbound	Right	F	50	F	99	Right	C	25	Right	C	25	Right	C	25	Right	C	25
VT 15 Westbound	Left	A	0	A	0	Left	B	12	Left	B	12	Left	B	12	Left	B	12

One of the primary purposes of this study was to assess the affect of closing the right turn slip lane on traffic attempting to exit Roland Court. It is reasonable to expect that eliminating the slip lane will cut off a continuous flow of traffic thereby providing additional gaps in VT 15 traffic available to vehicles attempting to exit Roland Court. To test the effect of closing the slip lane, a traffic simulation model was built for the study area. This model simulates individual vehicles as they travel through the study area intersections and road segments using the traffic volume estimates, traffic signal timings, and lane geometry specific to each alternative. Figure 17 shows an example of the simulation model that was constructed for the existing geometry. The model estimates the amount of traffic that can enter and exit each intersection under the various conditions. Changes to the system, such as eliminating the slip lane and revising the timing plans at the Exit 15 traffic signals, affects traffic flow in the study area.

Figure 17. Simulation Model at VT 15 with I-89 Ramps and Roland Court - Existing Geometry

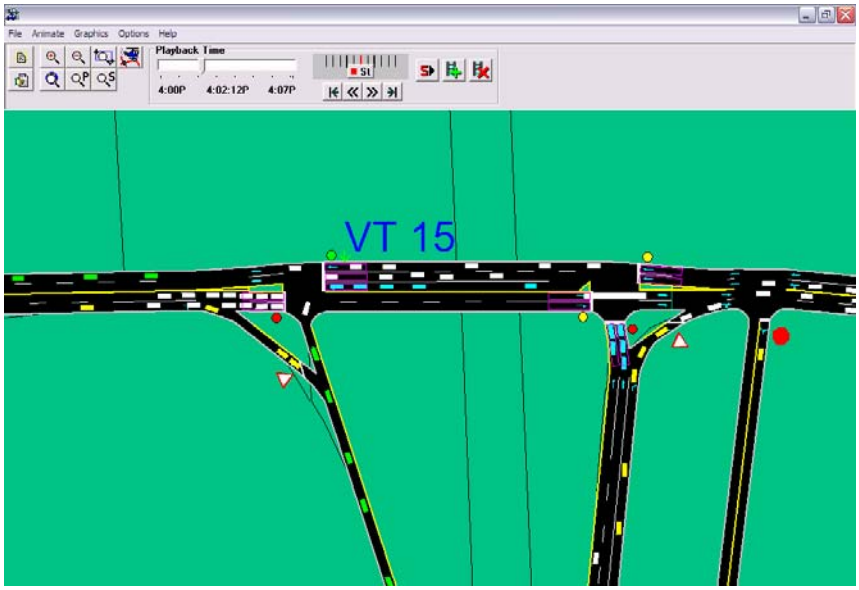


Table 14 shows level of service and delay for vehicles exiting from Roland Court based on the traffic flows generated by the simulation model. For Alternatives 2, 3 and 4, the level of service for the left turning vehicles accounts for the double movement required from Roland Court to the left turn pocket and from the pocket to westbound VT 15. Table 14 indicates that:

- The left turn pocket significantly reduces delay for vehicles exiting Roland Court;
- Eliminating the slip lane reduces delay slightly for vehicles exiting Roland Court in the PM peak hour; and
- Eliminating the slip lane does not result in any significant change in delay during the AM peak hour for Alternatives 2 and 3 but does result in a slight improvement under Alternative 4 from 43 seconds to 40 seconds for left turning vehicles.

LOS and delay estimates were also made for Alternatives 2, 3 and 4 assuming no right-turns-on-red were allowed from the northbound off-ramp. No significant differences in delay resulted.

Table 14. Average Delay per Vehicle Exiting Roland Court in the 2010 PM Peak Hour Based on Traffic Simulation Model (Seconds)

	PM Peak Hour		AM Peak Hour	
Scenario	Left Turn	Right Turn	Left Turn	Right Turn
Do Nothing (with slip lane)	LOS F 172 seconds	LOS F 172 seconds	LOS F 98 Seconds	LOS F 98 Seconds
Alternative 1 (with slip lane)	LOS F 57 seconds	LOS E 37 seconds	LOS E 43 Seconds	LOS C 24 Seconds
Alternative 2 (no slip lane)	LOS F 52 Seconds	LOS D 33 Seconds	LOS E 44 Seconds	LOS C 25 Seconds
Alternative 3 (no slip lane)	LOS F 52 Seconds	LOS D 33 Seconds	LOS E 44 Seconds	LOS C 25 Seconds
Alternative 4 (no slip lane)	LOS F 51 Seconds	LOS D 35 Seconds	LOS E 40 Seconds	LOS C 23 Seconds

SAFETY

This section evaluates the potential effect of the proposed alternatives on safety. Crashes that have occurred over a five year period (1997 to 2001) are summarized and compared to state averages. This comparison determines whether or not an intersection is a high accident location and can help establish a need for action. The type and cause of crashes are summarized to identify reoccurring crash patterns that may (1) be addressed by the alternatives under consideration; (2) be made worse if an alternative is implemented; or (3) not be affected positively or negatively by an alternative.

Table 15 summarizes the total number of crashes, injuries, and fatalities that were reported at each intersection between 1997 and 2001. The complete list of crashes is contained in Appendix C. Crash reports are filed by the Vermont State Police when a fatality or incapacitating injury is involved, and/or property damage equals or exceeds $1,000. The largest number of crashes in the study area occurred at the VT 15 intersection with the northbound-off ramp.

Table 15. Study Area Crashes 1997 to 2001

VT 15 Intersection with:	Total Reported Crashes	Fatalities	Crashes with Injuries	Total Injuries
Southbound On-Ramp	4	0	3	9
Northbound Off-Ramp	23	0	20	33
Roland Court	2	0	2	4

To put these numbers into perspective, the number of crashes is divided by the number of vehicles passing through each intersection (see Table 16). An intersection is identified as a high accident location (HAL) when the actual crash rate (crashes per million vehicles) exceeds a critical crash rate. The critical rate varies by functional class and is calculated using statewide averages that are

developed by VTrans. Ideally, statewide average rates would be from the same time period as the data being analyzed. However, the most recent statewide average rates available from VTrans are based on 1992 to 1996 data. It is likely that statewide average crash rates have changed since the 1992-1996 period because of changes in reporting requirements. Therefore, the HAL analysis presented below identifies only "potential" HALs.

The VTrans 1990-1994 High Accident Report identified the northbound off-ramp as a high accident location. Its actual to critical accident ratio was 2.175 and it was ranked as the second worst location in Chittenden County and sixth worst statewide. New traffic signals were installed in 1996 at both ramps to address the safety problem. As indicated in Table 15, the actual to critical accident ratio has dropped significantly from 2.175 to 0.991 at the northbound off-ramp intersection with VT 15. This change indicates that the traffic signal upgrade, which also included new signage, paving, and striping, was effective at improving safety.

Table 16. High Accident Location Analysis based on 1997-2001 VTrans Crash Data

High Accident Location Input Information	Intersection		
	VT 15/I-89 SB On-Ramp	VT 15/I-89 NB Off Ramp	VT 15/Roland Court
Number of Years	5	5	5
Total Accidents	4	23	2
Avg. Incoming ADT	24,592	29,217	25,733
Satewide Average Rate	0.411	0.411	0.411
Actual Rate for the Intersection	0.178	0.863	0.085
Critical Rate	0.907	0.871	0.897
Actual/Critical Ratio	**0.196**	**0.991**	**0.095**
Potential High Accident Location?	**No**	**No**	**No**

Table 17 summarizes the type and cause of crashes at each intersection. At the northbound off-ramp, most of the crash types fall under the "other" category. RSG requested additional information from VTrans on the direction of travel of vehicles involved in crashes to help further define the type of crash. A review of that supplemental information indicates that the predominant type of crash under the "other" category at the northbound off-ramp is a rear-end collision. The most common cause of an accident is disregard for the traffic signs, signals, and road markings.

The two crashes that occurred at the Roland Court intersection were classified as rear end and were caused by inattention and driving too fast for conditions. There were no crashes reported between through vehicles on VT 15 and vehicles turning into Roland Court. The low crash rate at Roland Court can be attributed to the low number of vehicles entering and exiting Roland Court (approximately 20 vehicles during the peak hours) and the familiarity of residents with the intersection.

Table 17. Type and Cause of Crashes

	Type			Cause			
VT 15 Intersection with:	Rear-End	Sideswipe	Other	Disregard Traffic Signs, Signals or Road Markings	Inattention	Failed to yield ROW	Other
Southbound On-Ramp	2	0	2	2		0	2
Northbound Off-Ramp	4	1	18	12	2	3	6
Roland Court	2	0	0	0	1	0	1

Affect of Alternatives on Safety

Table 18 provides a qualitative assessment on the effect of Alternatives 1-4 on safety compared to a Do Nothing scenario. The qualitative effect is described as negative (-), neutral (o), or positive (+).

Southbound On-Ramp. The effect on safety is neutral for all alternatives because none result in changes to the configuration of this intersection or cause queues that would block access to the on-ramp.

Northbound Off-Ramp. Alternative 1 leaves the northbound off-ramp in its current configuration which includes the separate right-urn slip lane. Although the crash data do not indicate a safety problem with the northbound off-ramp slip lane, the LOS analysis identified excessive delays. The increased delay may increase driver frustration and aggressiveness. Therefore, Alternative 1 will have a negative effect on safety.

Alternative 2 results in a doubling of the queue length on the northbound off-ramp. This result reduces the distance between the ramp-mainline junction and vehicles stopped in the queue which increases the chance for rear-end collisions. By eliminating the slip lane, a conflict point on VT 15 is removed thereby improving safety at that location. Therefore, Alternative 2 has an overall neutral effect on safety.

Alternative 3 will result in improved safety over existing conditions. Combining the right-turn slip lane into the approach controlled by the traffic signal reduces delay, does not increase queue lengths, and eliminates a conflict point on VT 15.. The consolidation also provides additional separation between the off-ramp and Roland Court allowing more reaction time for drivers between the two intersections.

Alternative 4 has the same benefits as Alternative 3, but would improve safety further by reducing queues along the off-ramp.

Roland Court. Alternatives 1 - 4 all include the left turn pocket in the median. This pocket will reduce the potential for crashes between left turning vehicles exiting Roland Court and through traffic on VT 15. By allowing two separate movements, a driver needs to find gaps in only one direction of traffic at a time. This change simplifies the decision making process. Furthermore, because drivers will not have to wait as long to exit Roland Court, they will be less frustrated, less aggressive, and less likely to take chances with smaller gaps in the trough traffic stream on VT 15. Alternatives 2 and 4 improve safety further at Roland Court by eliminating the right-turn slip lane.

This change eliminates a conflict point and provides additional reaction time for vehicles entering and exiting Roland Court.

Table 18. Qualitative Effect of Alternatives on Safety relative to "Do Nothing"

	Alterative 1	Alternative 2	Alternative 3	Alternative 4
Southbound On-Ramp	O	O	O	O
Northbound Off-Ramp	-	O	+	++
Roland Court	+	++	++	++

SUMMARY AND RECOMMENDATION

This study evaluates the operational and safety benefits of proposed modifications to the VT 15 intersections with the I-89 Exit 15 northbound off-ramp and Roland Court. A recommendation was initially developed in a January 2002 study conducted by Lamoureux and Dickinson for the CCMPO and the City of Winooski. That study recommends installation of a left turn pocket in the existing median for left turning vehicles from Roland Court. The study also recommends that the northbound off-ramp right-turn slip lane be eliminated. This current analysis evaluates the following refinements to that recommendation relative to a do nothing scenario:

- Alternative 1 includes the Roland Court left-turn pocket. No additional changes are included to the northbound off-ramp;
- Alternative 2 includes the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes one right turn lane and two left turn lanes controlled by a traffic signal at the northbound off-ramp;
- Alternative 3 includes the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes two right turn lanes and one left turn lane controlled by a traffic signal at the northbound off-ramp; and
- Alternative 4 includes the Roland Court left-turn pocket, eliminates the northbound-off ramp right-turn slip lane, and includes one exclusive left turn lane, one shared left/right turn lane and one exclusive right turn lane controlled by a traffic signal at the northbound off-ramp.

This analysis is based upon projections to 2010 during the AM and PM peak hours and includes traffic from the Winooski Redevelopment project.

Between 2004 and 2010, the average delay per vehicle attempting to exit Roland Court is projected to increase from 1.3 to 3.4 minutes per vehicle during the PM hour. During the AM peak, the average delay is not as severe, but is projected to increase from 50 seconds to 99 seconds between 2004 and 2010. Recent safety data indicated that crashes between vehicles exiting Roland Court and through traffic on VT 15 have not been a problem. However, as delays continue to increase, frustration and the potential for crashes will increase as drivers attempt to enter VT 15 traffic.

Overall level of service is projected to remain acceptable on all signalized approaches of the VT 15 intersection with the I-89 Exit 15 on and off-ramps. However, LOS F is projected for the stop-controlled right-turn slip lane in 2010.

Alternative 1, which includes the left turn pocket in the existing VT 15 median, should be implemented as soon as possible. The left turn pocket will reduce delay significantly for vehicles exiting Roland Court.

In the long term, the City and CCMPO should work with VTrans and FHWA to eliminate the northbound off-ramp right-turn slip lane. Alternative 4, which eliminates the northbound-off ramp right-turn slip lane, and includes one exclusive left turn lane, one shared left/right turn lane and one exclusive right turn lane controlled by a traffic signal, is recommended. Alternative 4 is projected to reduce vehicle queues along the northbound off-ramp compared to Alternatives 1-3 and the Do-Nothing scenario, while maintaining acceptable levels of service for all movements. The reduction in vehicle queues may also improve safety by reducing the potential for rear-end crashes between vehicles exiting the I-89 mainline and vehicles stopped at the traffic signal.

COSTS

Order of magnitude cost estimates for the two major components of Alternative 4 are presented in Table 19. The estimates are based upon unit costs applied to a rough approximation of the quantities associated with each component. Unit cost sources include the VTrans Preliminary Engineering unit price list, national sources, and the January 2003 Roland Court study completed by Lamoureux and Dickinson. A 50 percent contingency has been included plus engineering costs. These estimates assume no changes to the existing drainage system and do not include the cost of right-of-way acquisition (which is probably not necessary for this project) or the cost for new street lighting.

Table 19. Alternative 4 Cost Estimate

Component	Capital Cost
Left Turn Pocket	$ 25,000
Exit 15 Northbound Ramp Reconfiguration	$ 200,000

APPENDIX A

TRAFFIC VOLUME ADJUSTMENTS

AM Raw Traffic Count Data

I-89 (Exit 15) / VT 15
Winooski, Vermont
19-Jun-02
SB On-Ramp

		EB	WB	NB	SB	
	LT	0	586	0	0	
	TH	674	968	0	0	
	RT	232	0	0	0	2460
	Enter	906	1554	0	0	2460
	Exit	674	968	0	818	2460
	% Trucks	3.0%	4.0%			
	PHF	0.86				
	Peak Hour	7:15 to 8:15)				

I-89 (Exit 15) / VT 15
Winooski, Vermont
19-Jun-02
NB Off-Ramp

		EB	WB	NB	SB	
	LT	0	0	200	0	
	TH	703	1419	0	0	
	RT	0	0	374	0	2696
	Enter	703	1419	574	0	2696
	Exit	1077	1619	0	0	2696
	% Trucks	3.0%	4.0%	6.0%		
	PHF	0.89				
	Peak Hour	7:15 to 8:15)				

		EB	WB	NB	SB	
Roland Court TG	LT	0	4	11	0	
Winooski, Vermont	TH	1075	1408	0	0	
	RT	2	0	7	0	2507
	Enter	1077	1412	18	0	2507
	Exit	1082	1419	0	6	2507
	% Trucks	3.0%	0.0%	0.0%		
	PHF					
	Peak Hour	7:15 to 8:15)				

DHV & Annual Adjustments

Count Year	Factor to 2004
2002	1.04

Station D040
4-5:00pm

Year	DHV	orresp. Count	Avg Adj
1999	1669	1710	0.976
2000	1599	1609	0.994
2001	1697	1659	1.023
2002	1693	1664	1.017

		Average DHV Adj.	1.003
Count Year:	2002	Annual Adjustment	1.036
		Total Adjustment	1.039

AM DHV Adjusted to 2004

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	609	0	0	
	TH	700	1005	0	0	
	RT	241	0	0	0	###
	Enter	941	1614	0	0	###
	Exit	700	1005	0	850	###

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	0	208	0	
	TH	730	1474	0	0	
	RT	0	0	388	0	###
	Enter	730	1474	596	0	###
	Exit	1119	1682	0	0	###

		EB	WB	NB	SB	
Roland Court TG	LT	0	4	11	0	
Winooski, Vermont	TH	1117	1462	0	0	
	RT	2	0	7	0	###
	Enter	1119	1466	18	0	###
	Exit	1124	1473	0	6	###

Balance of Volumes

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT		25			
	TH	30	42			
	RT					98
	Enter	30	68	0	0	98
	Exit	30	42	0	25	98

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT					
	TH					
	RT					0
	Enter	0	0	0	0	0
	Exit	0	0	0	0	0

		EB	WB	NB	SB	
Roland Court TG	LT					
Winooski, Vermont	TH					
	RT					0
	Enter	0	0	0	0	0
	Exit	0	0	0	0	0

Balanced AM DHV 2004

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB
	LT	0	634	0	0
	TH	730	1047	0	0
	RT	241	0	0	0
	Enter	971	1682	0	0
	Exit	730	1047	0	875

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB
	LT	0	0	208	0
	TH	730	1474	0	0
	RT	0	0	388	0
	Enter	730	1474	596	0
	Exit	1119	1682	0	0

		EB	WB	NB	SB
Roland Court TG	LT	0	4	11	0
Winooski, Vermont	TH	1117	1462	0	0
	RT	2	0	7	0
	Enter	1119	1466	18	0
	Exit	1124	1473	0	6

2010 AM - Background

Annual Adjustments to 2010

2004 to 2010 Growth Adjustment	1.11

I-89 (Exit 15) / VT 15 SB On-Ramp Winooski, Vermont		EB	WB	NB	SB	
	LT	0	706	0	0	
	TH	813	1166	0	0	
	RT	268	0	0	0	2953
	Enter	1081	1872	0	0	2953
	Exit	813	1166	0	974	2953

I-89 (Exit 15) / VT 15 NB Off-Ramp Winooski, Vermont		EB	WB	NB	SB	
	LT	0	0	231	0	
	TH	813	1641	0	0	
	RT	0	0	432	0	3117
	Enter	813	1641	664	0	3117
	Exit	1245	1872	0	0	3117

VT 15/Roland Court Winooski, Vermont		EB	WB	NB	SB	
	LT	0	4	12	0	
	TH	1243	1628	0	0	
	RT	2	0	8	0	2898
	Enter	1245	1632	20	0	2898
	Exit	1251	1640	0	7	2898

Winooski Redev. AM Traffic

		EB	WB	NB	SB	
	LT	0	0	0	0	
	TH	76	192	0	0	
	RT	37	0	0	0	305
Enter		113	192	0	0	305
Exit		76	192	0	37	305

		EB	WB	NB	SB	
	LT	0	0	28	0	
	TH	76	164	0	0	
	RT	0	0	0	0	268
Enter		76	164	28	0	268
Exit		76	192	0	0	268

		EB	WB	NB	SB	
	LT	0	4	0	0	
	TH	76	164	0	0	
	RT	0	0	0	0	240
Enter		76	164	0	0	240
Exit		76	164	0	0	240

AM 2010 with Winooski Redev. Traffic

I-89 (Exit 15) / VT 15 Winoo		EB	WB	NB	SB	
	LT	0	706	0	0	
	TH	889	1358	0	0	
	RT	305	0	0	0	3258
Enter		1194	2064	0	0	3258
Exit		889	1358	0	1011	3258

I-89 (Exit 15) / VT 15 Winoo		EB	WB	NB	SB	
	LT	0	0	259	0	
	TH	889	1805	0	0	
	RT	0	0	432	0	3385
Enter		889	1805	692	0	3385
Exit		1321	2064	0	0	3385

Rolar Winoo		EB	WB	NB	SB	
	LT	0	4	12	0	
	TH	1319	1792	0	0	
	RT	2	0	8	0	3138
Enter		1321	1796	20	0	3138
Exit		1327	1804	0	7	3138

PM Raw Traffic Count Data

I-89 (Exit 15) / VT 15
Winooski, Vermont
19-Jun-02

		EB	WB	NB	SB	
	LT	0	516	0	0	
	TH	876	1264	0	0	
	RT	288	0	0	0	2944
	Enter	1164	1780	0	0	2944
SB On-Ramp	Exit	876	1264	0	804	2944
	Trucks	1.0%	2.0%			
	PHF	0.89				
	Peak Hour	4:30 to 5:30)				

I-89 (Exit 15) / VT 15
Winooski, Vermont
19-Jun-02

		EB	WB	NB	SB	
	LT	0	0	429	0	
	TH	932	1553	0	0	
	RT	0	0	583	0	3497
	Enter	932	1553	1012	0	3497
NB Off-Ramp	Exit	1515	1982	0	0	3497
	% Trucks	1.0%	3.0%	1.0%		
	PHF	0.89				
	Peak Hour	4:30 to 5:30)				

Roland Court TG
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	7	4	0	
	TH	1506	1549	0	0	
	RT	9	0	5	0	3080
	Enter	1515	1556	9	0	3080
	Exit	1511	1553	0	16	3080
	% Trucks	1.0%	3.0%	0.0%		
	PHF					
	Peak Hour	4:30 to 5:30)				

DHV & Annual Adjustments

Count Year	Factor to 2004
2002	1.04

Station D040	Year	DHV	resp. Count	Avg Adj
4-5:00pm	1999	1669	1710	0.976
	2000	1599	1609	0.994
	2001	1697	1659	1.023
	2002	1693	1664	1.017
			Average DHV Adj.	1.003
Count Year:	2002		Annual Adjustment	1.036
			Total Adjustment	1.039

PM Adjusted to 2004-No Build

I-89 (Exit 15) / VT 15
Winooski, Vermo

		EB	WB	NB	SB	
	LT	0	536	0	0	
	TH	910	1313	0	0	
	RT	299	0	0	0	3059
	Enter	1209	1849	0	0	3059
	Exit	910	1313	0	835	3059

I-89 (Exit 15) / VT 15
Winooski, Vermo

		EB	WB	NB	SB	
	LT	0	0	446	0	
	TH	968	1614	0	0	
	RT	0	0	606	0	3634
	Enter	968	1614	1052	0	3634
	Exit	1574	2059	0	0	3634

Roland Court TG
Winooski, Vermo

		EB	WB	NB	SB	
	LT	0	7	4	0	
	TH	1565	1610	0	0	
	RT	9	0	5	0	3200
	Enter	1574	1617	9	0	3200
	Exit	1570	1614	0	16	3200

Balance of Volumes

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT		61			
	TH	58	149			
	RT					268
	Enter	58	210	0	0	268
	Exit	58	149	0	61	268

0

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT					
	TH					
	RT					0
	Enter	0	0	0	0	0
	Exit	0	0	0	0	0

Roland Court TG
Winooski, Vermont

		EB	WB	NB	SB	
	LT					
	TH					
	RT					0
	Enter	0	0	0	0	0
	Exit	0	0	0	0	0

Balanced PM 2004 DHV

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	597	0	0	
	TH	968	1462	0	0	
	RT	299	0	0	0	
	Enter	1268	2059	0	0	
	Exit	968	1462	0	896	

I-89 (Exit 15) / VT 15
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	0	446	0	
	TH	968	1614	0	0	
	RT	0	0	606	0	
	Enter	968	1614	1052	0	
	Exit	1574	2059	0	0	

Roland Court TG
Winooski, Vermont

		EB	WB	NB	SB	
	LT	0	7	4	0	
	TH	1565	1610	0	0	
	RT	9	0	5	0	
	Enter	1574	1617	9	0	
	Exit	1570	1614	0	16	

2010 PM Background

Annual Adjustments to 2010

2010 Growth Adjustment (2004 to 2010)	1.11

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
SB On-Ramp	LT	0	665	0	0	
Winooski, Vermont	TH	1078	1628	0	0	
	RT	333	0	0	0	3704
	Enter	1411	2293	0	0	3704
	Exit	1078	1628	0	998	3704

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
NB Off-Ramp	LT	0	0	496	0	
Winooski, Vermont	TH	1078	1796	0	0	
	RT	0	0	674	0	4045
	Enter	1078	1796	1171	0	4045
	Exit	1752	2293	0	0	4045

		EB	WB	NB	SB	
VT 15/Roland Court	LT	0	8	4	0	
	TH	1742	1792	0	0	
Winooski, Vermont	RT	10	0	6	0	3562
	Enter	1752	1800	10	0	3562
	Exit	1748	1796	0	18	3562

Winooski Redev. PM Traffic

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
Winooski, Vermont	LT	0	0	0	0	
	TH	197	207	0	0	
	RT	69	0	0	0	473
	Enter	266	207	0	0	473
	Exit	197	207	0	69	473

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
Winooski, Vermont	LT	0	0	46	0	
	TH	197	161	0	0	
	RT	0	0	0	0	404
	Enter	197	161	46	0	404
	Exit	197	207	0	0	404

		EB	WB	NB	SB	
VT 15/Roland Court	LT	0	0	0	0	
Winooski, Vermont	TH	197	161	0	0	
	RT	0	0	0	0	358
	Enter	197	161	0	0	358
	Exit	197	161	0	0	358

PM 2010 with Winooski Redev. Traffic

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
Winooski, Vermont	LT	0	665	0	0	
	TH	1275	1835	0	0	
	RT	402	0	0	0	4177
	Enter	1677	2500	0	0	4177
	Exit	1275	1835	0	1067	4177

I-89 (Exit 15) / VT 15		EB	WB	NB	SB	
Winooski, Vermont	LT	0	0	542	0	
	TH	1275	1957	0	0	
	RT	0	0	674	0	4449
	Enter	1275	1957	1217	0	4449
	Exit	1949	2500	0	0	4449

		EB	WB	NB	SB	
VT 15/Roland Court	LT	0	8	4	0	
Winooski, Vermont	TH	1939	1953	0	0	
	RT	10	0	6	0	3920
	Enter	1949	1961	10	0	3920
	Exit	1945	1957	0	18	3920

APPENDIX B

LEVEL OF SERVICE WORKSHEETS

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	730	634	1047
Queue Length 50th (ft)	81	157	0
Queue Length 95th (ft)	135	119	0
Internal Link Dist (ft)	28		293
50th Up Block Time (%)	43%		
95th Up Block Time (%)	54%	2%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	355		
Intersection Summary			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	730	0	634	1047	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	730	0	634	1047	0	0
Lane Group Flow (vph)	730	0	634	1047	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	20.0		20.0	50.0		
Effective Green, g (s)	21.0		21.0	50.0		
Actuated g/C Ratio	0.42		0.42	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1516		758	3610		
v/s Ratio Prot	c0.20		c0.35	0.29		
v/s Ratio Perm						
v/c Ratio	0.48		0.84	0.29		
Uniform Delay, d1	10.5		13.0	0.0		
Progression Factor	1.00		0.76	1.00		
Incremental Delay, d2	1.1		7.0	0.2		
Delay (s)	11.6		16.8	0.2		
Level of Service	B		B	A		
Approach Delay (s)	11.6			6.4	0.0	
Approach LOS	B			A	A	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.0%	ICU Level of Service	B

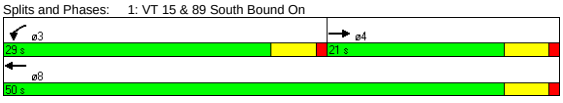
c Critical Lane Group

Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	29	21	50
Maximum Split (%)	58%	42%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		50
Control Type	Actuated-Coordinated	
Natural Cycle		50

Offset: 40 (80%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBT	WBT	NBL
Lane Group Flow (vph)	730	1474	208
Queue Length 50th (ft)	0	100	27
Queue Length 95th (ft)	0	174	48
Internal Link Dist (ft)	293	20	11
50th Up Block Time (%)		29%	53%
95th Up Block Time (%)		35%	62%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		476	120
Intersection Summary			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	0.95			0.95	0.97	
Frt	1.00			1.00	1.00	
Flt Protected	1.00			1.00	0.95	
Satd. Flow (prot)	3610			3610	3502	
Flt Permitted	1.00			1.00	0.95	
Satd. Flow (perm)	3610			3610	3502	
Volume (vph)	730	0	0	1474	208	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	730	0	0	1474	208	0
Lane Group Flow (vph)	730	0	0	1474	208	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						
Protected Phases	4			8	2	
Permitted Phases						
Actuated Green, G (s)	33.1			33.1	6.9	
Effective Green, g (s)	34.1			34.1	7.9	
Actuated g/C Ratio	0.68			0.68	0.16	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	2462			2462	553	
v/s Ratio Prot	0.20			c0.41	c0.06	
v/s Ratio Perm						
v/c Ratio	0.30			0.60	0.38	
Uniform Delay, d1	3.2			4.3	18.8	
Progression Factor	0.05			1.00	1.00	
Incremental Delay, d2	0.3			1.1	0.4	
Delay (s)	0.4			5.4	19.3	
Level of Service	A			A	B	
Approach Delay (s)	0.4			5.4	19.3	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	5.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.3%	ICU Level of Service	A

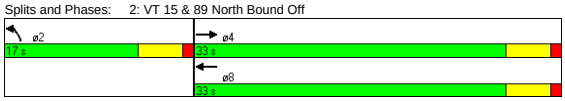
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	17	33	33
Maximum Split (%)	34%	66%	66%
Minimum Split (s)	14	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		50
Control Type	Actuated-Coordinated	
Natural Cycle		40

Offset: 0 (0%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 & 89 North Bound Off



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1117	2	4	1462	11	7
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1117	2	4	1462	11	7
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1119		1857	560
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		83	99
cM capacity (veh/h)			620		65	472

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	745	374	491	975	18
Volume Left	0	0	4	0	11
Volume Right	0	2	0	0	7
cSH	1700	1700	620	1700	97
Volume to Capacity	0.44	0.22	0.01	0.57	0.18
Queue Length (ft)	0	0	0	0	16
Control Delay (s)	0.0	0.0	0.2	0.0	50.2
Lane LOS			A		F
Approach Delay (s)	0.0		0.1		50.2
Approach LOS					F

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	730	0	0	1474	0	388
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	730	0	0	1474	0	388
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			730		1467	365
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	39
cM capacity (veh/h)			870		119	632

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NE 1
Volume Total	365	365	737	737	388
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	388
cSH	1700	1700	1700	1700	632
Volume to Capacity	0.21	0.21	0.43	0.43	0.61
Queue Length (ft)	0	0	0	0	105
Control Delay (s)	0.0	0.0	0.0	0.0	19.3
Lane LOS					C
Approach Delay (s)	0.0		0.0		19.3
Approach LOS					C

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	50.9%	ICU Level of Service	A

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	968	597	1462
Queue Length 50th (ft)	121	93	0
Queue Length 95th (ft)	177	m#181	0
Internal Link Dist (ft)	28		293
50th Up Block Time (%)	50%		
95th Up Block Time (%)	54%	5%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	500		

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	968	0	597	1462	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	968	0	597	1462	0	0
Lane Group Flow (vph)	968	0	597	1462	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	18.0		22.0	50.0		
Effective Green, g (s)	19.0		23.0	50.0		
Actuated g/C Ratio	0.38		0.46	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1372		830	3610		
v/s Ratio Prot	c0.27		c0.33	0.40		
v/s Ratio Perm						
v/c Ratio	0.71		0.72	0.40		
Uniform Delay, d1	13.1		10.9	0.0		
Progression Factor	1.00		0.75	1.00		
Incremental Delay, d2	3.1		2.2	0.2		
Delay (s)	16.2		10.3	0.2		
Level of Service	B		B	A		
Approach Delay (s)	16.2			3.2	0.0	
Approach LOS	B			A	A	

Intersection Summary

HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	B

c Critical Lane Group

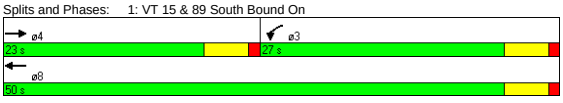
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	27	23	50
Maximum Split (%)	54%	46%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	50
Control Type	Actuated-Coordinated
Natural Cycle	40

Offset: 40 (80%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBT	WBT	NBL
Lane Group Flow (vph)	968	1614	446
Queue Length 50th (ft)	0	138	60
Queue Length 95th (ft)	0	204	97
Internal Link Dist (ft)	293	20	11
50th Up Block Time (%)		34%	66%
95th Up Block Time (%)		35%	70%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		560	303

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	0.95			0.95	0.97	
Frt	1.00			1.00	1.00	
Flt Protected	1.00			1.00	0.95	
Satd. Flow (prot)	3610			3610	3502	
Flt Permitted	1.00			1.00	0.95	
Satd. Flow (perm)	3610			3610	3502	
Volume (vph)	968	0	0	1614	446	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	968	0	0	1614	446	0
Lane Group Flow (vph)	968	0	0	1614	446	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						
Protected Phases	4			8	2	
Permitted Phases						
Actuated Green, G (s)	30.4			30.4	9.6	
Effective Green, g (s)	31.4			31.4	10.6	
Actuated g/C Ratio	0.63			0.63	0.21	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	2267			2267	742	
v/s Ratio Prot	0.27			c0.45	c0.13	
v/s Ratio Perm						
v/c Ratio	0.43			0.71	0.60	
Uniform Delay, d1	4.7			6.3	17.8	
Progression Factor	0.00			1.00	1.00	
Incremental Delay, d2	0.4			1.9	1.4	
Delay (s)	0.4			8.2	19.2	
Level of Service	A			A	B	
Approach Delay (s)	0.4			8.2	19.2	
Approach LOS	A			A	B	

Intersection Summary				
HCM Average Control Delay	7.3	HCM Level of Service	A	
HCM Volume to Capacity ratio	0.68			
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	64.0%	ICU Level of Service	B	

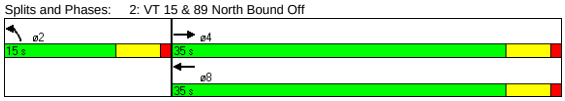
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	15	35	35
Maximum Split (%)	30%	70%	70%
Minimum Split (s)	14	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		50
Control Type	Actuated-Coordinated	
Natural Cycle		45

Offset: 0 (0%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 & 89 North Bound Off



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1565	9	7	1610	4	5
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1565	9	7	1610	4	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1574		2388	787
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		86	99
cM capacity (veh/h)			415		28	334

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1043	531	544	1073	9
Volume Left	0	0	7	0	4
Volume Right	0	9	0	0	5
cSH	1700	1700	415	1700	57
Volume to Capacity	0.61	0.31	0.02	0.63	0.16
Queue Length (ft)	0	0	1	0	13
Control Delay (s)	0.0	0.0	0.5	0.0	80.2
Lane LOS			A		F
Approach Delay (s)	0.0		0.2		80.2
Approach LOS					F

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	57.3%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	968	0	0	1614	0	606
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	968	0	0	1614	0	606
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			968		1775	484
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	0
cM capacity (veh/h)			707		74	529

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NE 1
Volume Total	484	484	807	807	606
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	606
cSH	1700	1700	1700	1700	529
Volume to Capacity	0.28	0.28	0.47	0.47	1.15
Queue Length (ft)	0	0	0	0	516
Control Delay (s)	0.0	0.0	0.0	0.0	112.4
Lane LOS					F
Approach Delay (s)	0.0		0.0		112.4
Approach LOS					F

Intersection Summary			
Average Delay	21.4		
Intersection Capacity Utilization	70.9%	ICU Level of Service	C

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	889	706	1358
Queue Length 50th (ft)	142	181	0
Queue Length 95th (ft)	202	#252	0
Internal Link Dist (ft)	28		293
50th Up Block Time (%)	54%		
95th Up Block Time (%)	57%	8%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		7%	
Queuing Penalty (veh)	490	50	

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	889	0	706	1358	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	706	1358	0	0
Lane Group Flow (vph)	889	0	706	1358	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	20.0		30.0	60.0		
Effective Green, g (s)	21.0		31.0	60.0		
Actuated g/C Ratio	0.35		0.52	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1264		933	3610		
v/s Ratio Prot	c0.25		c0.39	0.38		
v/s Ratio Perm						
v/c Ratio	0.70		0.76	0.38		
Uniform Delay, d1	16.8		11.5	0.0		
Progression Factor	1.00		0.72	1.00		
Incremental Delay, d2	3.3		2.6	0.2		
Delay (s)	20.1		10.9	0.2		
Level of Service	C		B	A		
Approach Delay (s)	20.1			3.9	0.0	
Approach LOS	C			A	A	

Intersection Summary

HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C

c Critical Lane Group

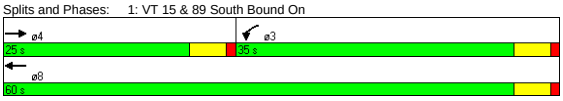
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	35	25	60
Maximum Split (%)	58%	42%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	60
Control Type	Actuated-Coordinated
Natural Cycle	55

Offset: 46 (77%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBT	WBT	NBL
Lane Group Flow (vph)	889	1805	259
Queue Length 50th (ft)	0	166	43
Queue Length 95th (ft)	0	260	71
Internal Link Dist (ft)	293	20	11
50th Up Block Time (%)		28%	64%
95th Up Block Time (%)		32%	69%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		540	171

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	0.95			0.95	0.97	
Frt	1.00			1.00	1.00	
Flt Protected	1.00			1.00	0.95	
Satd. Flow (prot)	3610			3610	3502	
Flt Permitted	1.00			1.00	0.95	
Satd. Flow (perm)	3610			3610	3502	
Volume (vph)	889	0	0	1805	259	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	0	1805	259	0
Lane Group Flow (vph)	889	0	0	1805	259	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						
Protected Phases	4			8	2	
Permitted Phases						
Actuated Green, G (s)	40.6			40.6	9.4	
Effective Green, g (s)	41.6			41.6	10.4	
Actuated g/C Ratio	0.69			0.69	0.17	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	2503			2503	607	
v/s Ratio Prot	0.25			c0.50	c0.07	
v/s Ratio Perm						
v/c Ratio	0.36			0.72	0.43	
Uniform Delay, d1	3.7			5.6	22.1	
Progression Factor	0.00			1.00	1.00	
Incremental Delay, d2	0.3			1.8	0.5	
Delay (s)	0.3			7.5	22.6	
Level of Service	A			A	C	
Approach Delay (s)	0.3			7.5	22.6	
Approach LOS	A			A	C	

Intersection Summary				
HCM Average Control Delay	6.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B

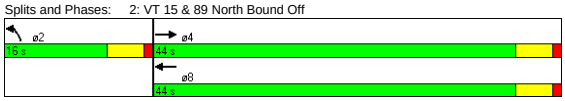
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	16	44	44
Maximum Split (%)	27%	73%	73%
Minimum Split (s)	14	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		60
Control Type	Actuated-Coordinated	
Natural Cycle		50

Offset: 56 (93%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 & 89 North Bound Off



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1319	2	4	1792	12	8
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1319	2	4	1792	12	8
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1321		2224	660
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		67	98
cM capacity (veh/h)			519		36	405

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	879	442	601	1195	20
Volume Left	0	0	4	0	12
Volume Right	0	2	0	0	8
cSH	1700	1700	519	1700	57
Volume to Capacity	0.52	0.26	0.01	0.70	0.35
Queue Length (ft)	0	0	1	0	32
Control Delay (s)	0.0	0.0	0.2	0.0	98.5
Lane LOS			A		F
Approach Delay (s)	0.0		0.1		98.5
Approach LOS					F

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	61.2%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	889	0	0	1805	0	432
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	889	0	0	1805	0	432
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			889		1792	444
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	23
cM capacity (veh/h)			758		72	561

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NE 1
Volume Total	444	444	902	902	432
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	432
cSH	1700	1700	1700	1700	561
Volume to Capacity	0.26	0.26	0.53	0.53	0.77
Queue Length (ft)	0	0	0	0	175
Control Delay (s)	0.0	0.0	0.0	0.0	29.7
Lane LOS					D
Approach Delay (s)	0.0		0.0		29.7
Approach LOS					D

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	58.0%	ICU Level of Service	A

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	1275	665	1835
Queue Length 50th (ft)	166	138	0
Queue Length 95th (ft)	#282	m#266	m0
Internal Link Dist (ft)	28		293
50th Up Block Time (%)	50%		
95th Up Block Time (%)	53%		
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	654		

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	1275	0	665	1835	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	665	1835	0	0
Lane Group Flow (vph)	1275	0	665	1835	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	20.6		19.4	50.0		
Effective Green, g (s)	21.6		20.4	50.0		
Actuated g/C Ratio	0.43		0.41	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1560		736	3610		
v/s Ratio Prot	c0.35		c0.37	0.51		
v/s Ratio Perm						
v/c Ratio	0.82		0.90	0.51		
Uniform Delay, d1	12.5		13.9	0.0		
Progression Factor	1.00		0.79	1.00		
Incremental Delay, d2	4.9		8.5	0.3		
Delay (s)	17.3		19.5	0.3		
Level of Service	B		B	A		
Approach Delay (s)	17.3			5.4	0.0	
Approach LOS	B			A	A	

Intersection Summary

HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	C

c Critical Lane Group

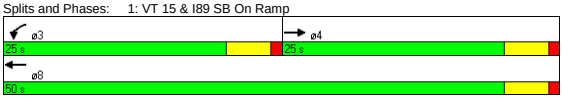
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	25	25	50
Maximum Split (%)	50%	50%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	50
Control Type	Actuated-Coordinated
Natural Cycle	45

Offset: 40 (80%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & I89 SB On Ramp



Lane Group	EBT	WBT	NBL
Lane Group Flow (vph)	1275	1957	542
Queue Length 50th (ft)	0	188	78
Queue Length 95th (ft)	m6	#287	#141
Internal Link Dist (ft)	293	20	11
50th Up Block Time (%)		33%	70%
95th Up Block Time (%)		34%	74%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		661	391

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	
Lane Util. Factor	0.95			0.95	0.97	
Frt	1.00			1.00	1.00	
Flt Protected	1.00			1.00	0.95	
Satd. Flow (prot)	3610			3610	3502	
Flt Permitted	1.00			1.00	0.95	
Satd. Flow (perm)	3610			3610	3502	
Volume (vph)	1275	0	0	1957	542	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	0	1957	542	0
Lane Group Flow (vph)	1275	0	0	1957	542	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						
Protected Phases	4			8	2	
Permitted Phases						
Actuated Green, G (s)	31.0			31.0	9.0	
Effective Green, g (s)	32.0			32.0	10.0	
Actuated g/C Ratio	0.64			0.64	0.20	
Clearance Time (s)	5.0			5.0	5.0	
Vehicle Extension (s)	3.0			3.0	3.0	
Lane Grp Cap (vph)	2310			2310	700	
v/s Ratio Prot	0.35			c0.54	c0.15	
v/s Ratio Perm						
v/c Ratio	0.55			0.85	0.77	
Uniform Delay, d1	5.0			7.1	18.9	
Progression Factor	0.11			1.00	1.00	
Incremental Delay, d2	0.5			4.1	5.3	
Delay (s)	1.1			11.2	24.3	
Level of Service	A			B	C	
Approach Delay (s)	1.1			11.2	24.3	
Approach LOS	A			B	C	

Intersection Summary				
HCM Average Control Delay	9.6	HCM Level of Service	A	
HCM Volume to Capacity ratio	0.83			
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	76.2%	ICU Level of Service	C	

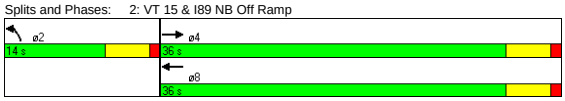
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	14	36	36
Maximum Split (%)	28%	72%	72%
Minimum Split (s)	14	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary			
Cycle Length			50
Control Type	Actuated-Coordinated		
Natural Cycle			55

Offset: 0 (0%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 & I89 NB Off Ramp



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1939	10	8	1953	4	6
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1939	10	8	1953	4	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1949		2936	974
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		65	98
cM capacity (veh/h)			296		11	251

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1293	656	659	1302	10
Volume Left	0	0	8	0	4
Volume Right	0	10	0	0	6
cSH	1700	1700	296	1700	27
Volume to Capacity	0.76	0.39	0.03	0.77	0.37
Queue Length (ft)	0	0	2	0	29
Control Delay (s)	0.0	0.0	1.0	0.0	204.8
Lane LOS			A		F
Approach Delay (s)	0.0		0.3		204.8
Approach LOS					F

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	67.8%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	1275	0	0	1957	0	674
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1275	0	0	1957	0	674
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1275		2254	638
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	0
cM capacity (veh/h)			540		35	420

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NE 1
Volume Total	638	638	978	978	674
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	674
cSH	1700	1700	1700	1700	420
Volume to Capacity	0.38	0.38	0.58	0.58	1.61
Queue Length (ft)	0	0	0	0	960
Control Delay (s)	0.0	0.0	0.0	0.0	307.5
Lane LOS					F
Approach Delay (s)	0.0		0.0		307.5
Approach LOS					F

Intersection Summary			
Average Delay	53.1		
Intersection Capacity Utilization	83.6%	ICU Level of Service	D

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	889	706	1358
Queue Length 50th (ft)	112	146	0
Queue Length 95th (ft)	165	m#243	0
Internal Link Dist (ft)	28		294
50th Up Block Time (%)	50%		
95th Up Block Time (%)	55%	8%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		6%	
Queuing Penalty (veh)	465	50	

Intersection Summary
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	889	0	706	1358	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	706	1358	0	0
Lane Group Flow (vph)	889	0	706	1358	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type		Perm	Prot			
Protected Phases	4		3	8		
Permitted Phases		4				
Actuated Green, G (s)	17.0		23.0	50.0		
Effective Green, g (s)	18.0		24.0	50.0		
Actuated g/C Ratio	0.36		0.48	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1300		866	3610		
v/s Ratio Prot	c0.25		c0.39	0.38		
v/s Ratio Perm						
v/c Ratio	0.68		0.82	0.38		
Uniform Delay, d1	13.6		11.1	0.0		
Progression Factor	1.00		0.68	1.00		
Incremental Delay, d2	2.9		4.1	0.2		
Delay (s)	16.5		11.6	0.2		
Level of Service	B		B	A		
Approach Delay (s)	16.5			4.1	0.0	
Approach LOS	B			A	A	

Intersection Summary			
HCM Average Control Delay	7.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C

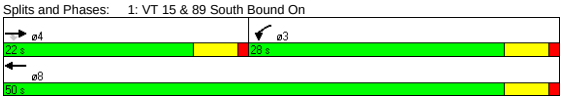
c Critical Lane Group

Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	28	22	50
Maximum Split (%)	56%	44%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		50
Control Type	Actuated-Coordinated	
Natural Cycle		45

Offset: 44 (88%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL
Lane Group Flow (vph)	889	1805	259
Queue Length 50th (ft)	18	160	34
Queue Length 95th (ft)	34	243	60
Internal Link Dist (ft)		104	42
50th Up Block Time (%)		20%	
95th Up Block Time (%)		25%	31%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		404	40

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NWL	NWR
Lane Configurations								
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			
Lane Util. Factor		0.88		0.95	0.97			
Frt		0.85		1.00	1.00			
Flt Protected		1.00		1.00	0.95			
Satd. Flow (prot)		2842		3539	3502			
Flt Permitted		1.00		1.00	0.95			
Satd. Flow (perm)		2842		3539	3502			
Volume (vph)	0	889	0	1805	259	0	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	889	0	1805	259	0	0	0
Lane Group Flow (vph)	0	889	0	1805	259	0	0	0
Heavy Vehicles (%)	2%	0%	2%	2%	0%	2%	0%	2%
Turn Type								
Protected Phases		4		8	2			
Permitted Phases		4						
Actuated Green, G (s)		31.7		32.7	8.3			
Effective Green, g (s)		32.7		32.7	9.3			
Actuated g/C Ratio		0.65		0.65	0.19			
Clearance Time (s)		5.0		4.0	5.0			
Vehicle Extension (s)		3.0		3.0	3.0			
Lane Grp Cap (vph)		1859		2315	651			
v/s Ratio Prot		0.31		c0.51	c0.07			
v/s Ratio Perm								
v/c Ratio		0.48		0.78	0.40			
Uniform Delay, d1		4.4		6.1	17.9			
Progression Factor		0.33		1.00	1.00			
Incremental Delay, d2		0.6		2.7	0.4			
Delay (s)		2.1		8.8	18.3			
Level of Service		A		A	B			
Approach Delay (s)	2.1			8.8	18.3		0.0	
Approach LOS	A			A	B		A	

Intersection Summary				
HCM Average Control Delay	7.6	HCM Level of Service	A	
HCM Volume to Capacity ratio	0.70			
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	64.0%	ICU Level of Service	B	

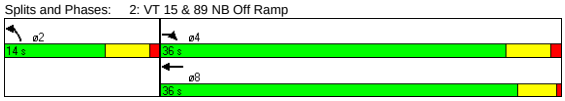
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	14	36	36
Maximum Split (%)	28%	72%	72%
Minimum Split (s)	14	21	20
Yellow Time (s)	4	4	3.5
All-Red Time (s)	1	1	0.5
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary			
Cycle Length			50
Control Type	Actuated-Coordinated		
Natural Cycle			50

Offset: 48 (96%), Referenced to phase 4:EBR and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 & 89 NB Off Ramp



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1321			1328	1328	660	682	1329	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			100	92	98	100	100	100
cM capacity (veh/h)	1622			519			112	153	405	308	153	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	879	442	4	20	0
Volume Left	0	0	4	0	0
Volume Right	0	2	0	8	0
cSH	1700	1700	519	203	1700
Volume to Capacity	0.52	0.26	0.01	0.10	0.00
Queue Length (ft)	0	0	1	8	0
Control Delay (s)	0.0	0.0	12.0	24.6	0.0
Lane LOS			B	C	A
Approach Delay (s)	0.0		12.0	24.6	0.0
Approach LOS				C	A

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	46.5%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	889	0	0	0	0	432
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	889	0	0	0	0	432
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			889		889	444
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	23
cM capacity (veh/h)			758		283	561

Direction, Lane #	EB 1	EB 2	NE 1
Volume Total	444	444	432
Volume Left	0	0	0
Volume Right	0	0	432
cSH	1700	1700	561
Volume to Capacity	0.26	0.26	0.77
Queue Length (ft)	0	0	175
Control Delay (s)	0.0	0.0	29.7
Lane LOS			D
Approach Delay (s)	0.0		29.7
Approach LOS			D

Intersection Summary			
Average Delay	9.7		
Intersection Capacity Utilization	58.0%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	4	1792	12	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	4	1792	12	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		904	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	100
cM capacity (veh/h)			1622		276	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	601	1195	12
Volume Left	4	0	12
Volume Right	0	0	0
cSH	1622	1700	276
Volume to Capacity	0.00	0.70	0.04
Queue Length (ft)	0	0	3
Control Delay (s)	0.1	0.0	18.6
Lane LOS	A		C
Approach Delay (s)	0.0		18.6
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	59.7%	ICU Level of Service	A

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	1275	665	1835
Queue Length 50th (ft)	166	136	0
Queue Length 95th (ft)	#282	m#223	m0
Internal Link Dist (ft)	28		294
50th Up Block Time (%)	50%		
95th Up Block Time (%)	53%		
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	654		

Intersection Summary
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	1275	0	665	1835	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	665	1835	0	0
Lane Group Flow (vph)	1275	0	665	1835	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type		Perm	Prot			
Protected Phases	4		3	8		
Permitted Phases		4				
Actuated Green, G (s)	20.6		19.4	50.0		
Effective Green, g (s)	21.6		20.4	50.0		
Actuated g/C Ratio	0.43		0.41	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1560		736	3610		
v/s Ratio Prot	c0.35		c0.37	0.51		
v/s Ratio Perm						
v/c Ratio	0.82		0.90	0.51		
Uniform Delay, d1	12.5		13.9	0.0		
Progression Factor	1.00		0.80	1.00		
Incremental Delay, d2	4.9		8.2	0.3		
Delay (s)	17.3		19.2	0.3		
Level of Service	B		B	A		
Approach Delay (s)	17.3			5.3	0.0	
Approach LOS	B			A	A	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	C

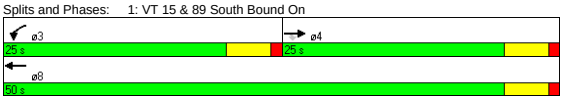
c Critical Lane Group

Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	25	25	50
Maximum Split (%)	50%	50%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary	
Cycle Length	50
Control Type	Actuated-Coordinated
Natural Cycle	50

Offset: 40 (80%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL
Lane Group Flow (vph)	1275	1957	542
Queue Length 50th (ft)	41	192	78
Queue Length 95th (ft)	m73	#315	#141
Internal Link Dist (ft)		104	42
50th Up Block Time (%)		22%	42%
95th Up Block Time (%)		28%	59%
Turn Bay Length (ft)			
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)		491	274

Intersection Summary
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NWL	NWR
Lane Configurations								
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			
Lane Util. Factor		0.88		0.95	0.97			
Frt		0.85		1.00	1.00			
Flt Protected		1.00		1.00	0.95			
Satd. Flow (prot)		2842		3539	3502			
Flt Permitted		1.00		1.00	0.95			
Satd. Flow (perm)		2842		3539	3502			
Volume (vph)	0	1275	0	1957	542	0	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	1275	0	1957	542	0	0	0
Lane Group Flow (vph)	0	1275	0	1957	542	0	0	0
Heavy Vehicles (%)	2%	0%	2%	2%	0%	2%	0%	2%
Turn Type		custom						
Protected Phases		4		8	2			
Permitted Phases		4						
Actuated Green, G (s)		31.0		32.0	9.0			
Effective Green, g (s)		32.0		32.0	10.0			
Actuated g/C Ratio		0.64		0.64	0.20			
Clearance Time (s)		5.0		4.0	5.0			
Vehicle Extension (s)		3.0		3.0	3.0			
Lane Grp Cap (vph)		1819		2265	700			
v/s Ratio Prot		0.45		c0.55	c0.15			
v/s Ratio Perm								
v/c Ratio		0.70		0.86	0.77			
Uniform Delay, d1		5.9		7.2	18.9			
Progression Factor		0.46		1.00	1.00			
Incremental Delay, d2		1.3		4.7	5.3			
Delay (s)		3.9		11.9	24.3			
Level of Service		A		B	C			
Approach Delay (s)	3.9			11.9	24.3		0.0	
Approach LOS	A			B	C		A	

Intersection Summary				
HCM Average Control Delay	11.0	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.84			
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	76.2%	ICU Level of Service	C	

c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Coord	Coord
Maximum Split (s)	14	36	36
Maximum Split (%)	28%	72%	72%
Minimum Split (s)	14	21	20
Yellow Time (s)	4	4	3.5
All-Red Time (s)	1	1	0.5
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary			
Cycle Length			50
Control Type	Actuated-Coordinated		
Natural Cycle			55

Offset: 0 (0%), Referenced to phase 4:EBR and 8:WBT, Start of Green

Splits and Phases: 2: VT 15 &

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1949			1960	1960	974	994	1965	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			100	93	98	100	100	100
cM capacity (veh/h)	1622			296			37	61	251	181	61	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	1293	656	8	10	0
Volume Left	0	0	8	0	0
Volume Right	0	10	0	6	0
cSH	1700	1700	296	112	1700
Volume to Capacity	0.76	0.39	0.03	0.09	0.00
Queue Length (ft)	0	0	2	7	0
Control Delay (s)	0.0	0.0	17.5	40.3	0.0
Lane LOS			C	E	A
Approach Delay (s)	0.0		17.5	40.3	0.0
Approach LOS				E	A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	63.9%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	1275	0	0	0	0	674
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	1275	0	0	0	0	674
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			1275		1275	638
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	0
cM capacity (veh/h)			540		159	420

Direction, Lane #	EB 1	EB 2	NE 1
Volume Total	638	638	674
Volume Left	0	0	0
Volume Right	0	0	674
cSH	1700	1700	420
Volume to Capacity	0.38	0.38	1.61
Queue Length (ft)	0	0	960
Control Delay (s)	0.0	0.0	307.5
Lane LOS			F
Approach Delay (s)	0.0		307.5
Approach LOS			F

Intersection Summary			
Average Delay	106.3		
Intersection Capacity Utilization	83.6%	ICU Level of Service	D

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	8	1953	4	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	8	1953	4	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		992	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1622		241	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	659	1302	4
Volume Left	8	0	4
Volume Right	0	0	0
cSH	1622	1700	241
Volume to Capacity	0.00	0.77	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.1	0.0	20.2
Lane LOS	A		C
Approach Delay (s)	0.0		20.2
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	64.2%	ICU Level of Service	B

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	889	706	1358
Queue Length 50th (ft)	139	132	0
Queue Length 95th (ft)	207	m143	m0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	52%		
95th Up Block Time (%)	58%	1%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	487		

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	889	0	706	1358	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	706	1358	0	0
Lane Group Flow (vph)	889	0	706	1358	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	23.6		26.4	60.0		
Effective Green, g (s)	24.6		27.4	60.0		
Actuated g/C Ratio	0.41		0.46	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1480		824	3610		
v/s Ratio Prot	c0.25		c0.39	0.38		
v/s Ratio Perm						
v/c Ratio	0.60		0.86	0.38		
Uniform Delay, d1	13.9		14.5	0.0		
Progression Factor	1.00		0.57	1.00		
Incremental Delay, d2	1.8		4.7	0.2		
Delay (s)	15.7		13.0	0.2		
Level of Service	B		B	A		
Approach Delay (s)	15.7			4.5	0.0	
Approach LOS	B			A	A	

Intersection Summary

HCM Average Control Delay	7.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C

c Critical Lane Group

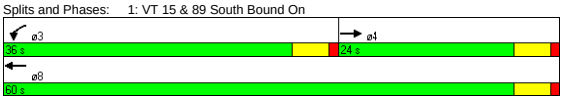
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	36	24	60
Maximum Split (%)	60%	40%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	60
Control Type	Actuated-Coordinated
Natural Cycle	45

Offset: 18 (30%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL	NBR2
Lane Group Flow (vph)	889	1805	259	432
Queue Length 50th (ft)	30	283	35	87
Queue Length 95th (ft)	49	#466	59	#203
Internal Link Dist (ft)		117	11	
50th Up Block Time (%)		30%	50%	57%
95th Up Block Time (%)		36%	57%	61%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		594		

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NBR2	NWL	NWR
Lane Configurations									
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0		
Lane Util. Factor		0.88		0.95	0.97		1.00		
Frt		0.85		1.00	1.00		0.85		
Flt Protected		1.00		1.00	0.95		1.00		
Satd. Flow (prot)		2787		3539	3433		1583		
Flt Permitted		1.00		1.00	0.95		1.00		
Satd. Flow (perm)		2787		3539	3433		1583		
Volume (vph)	0	889	0	1805	259	0	432	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	889	0	1805	259	0	432	0	0
Lane Group Flow (vph)	0	889	0	1805	259	0	432	0	0
Turn Type		custom					Perm		
Protected Phases				8	2				
Permitted Phases		4					2		
Actuated Green, G (s)		32.0		32.0	18.0		18.0		
Effective Green, g (s)		33.0		33.0	19.0		19.0		
Actuated g/C Ratio		0.55		0.55	0.32		0.32		
Clearance Time (s)		5.0		5.0	5.0		5.0		
Lane Grp Cap (vph)		1533		1946	1087		501		
v/s Ratio Prot				c0.51	0.08				
v/s Ratio Perm		0.32					0.27		
v/c Ratio		0.58		0.93	0.24		0.86		
Uniform Delay, d1		8.9		12.4	15.2		19.3		
Progression Factor		0.32		1.00	1.00		1.00		
Incremental Delay, d2		1.3		9.2	0.5		17.5		
Delay (s)		4.1		21.6	15.7		36.8		
Level of Service		A		C	B		D		
Approach Delay (s)	4.1			21.6	28.9			0.0	
Approach LOS	A			C	C			A	

Intersection Summary				
HCM Average Control Delay	18.5	HCM Level of Service		B
HCM Volume to Capacity ratio	0.90			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)		8.0
Intersection Capacity Utilization	64.5%	ICU Level of Service		B

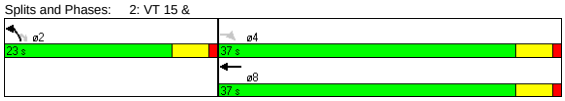
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	23	37	37
Maximum Split (%)	38%	62%	62%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary		
Cycle Length		60
Control Type		Pretimed
Natural Cycle		60

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 &



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1321			1328	1328	660	682	1329	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			100	92	98	100	100	100
cM capacity (veh/h)	1622			519			112	153	405	308	153	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	879	442	4	20	0
Volume Left	0	0	4	0	0
Volume Right	0	2	0	8	0
cSH	1700	1700	519	203	1700
Volume to Capacity	0.52	0.26	0.01	0.10	0.00
Queue Length (ft)	0	0	1	8	0
Control Delay (s)	0.0	0.0	12.0	24.6	0.0
Lane LOS			B	C	A
Approach Delay (s)	0.0		12.0	24.6	0.0
Approach LOS				C	A

Intersection Summary				
Average Delay	0.4			
Intersection Capacity Utilization	46.5%	ICU Level of Service		A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	4	1792	12	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	4	1792	12	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		904	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	100
cM capacity (veh/h)			1622		276	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	601	1195	12
Volume Left	4	0	12
Volume Right	0	0	0
cSH	1622	1700	276
Volume to Capacity	0.00	0.70	0.04
Queue Length (ft)	0	0	3
Control Delay (s)	0.1	0.0	18.6
Lane LOS	A		C
Approach Delay (s)	0.0		18.6
Approach LOS			C

Intersection Summary				
Average Delay	0.1			
Intersection Capacity Utilization	59.7%	ICU Level of Service		A

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	1275	665	1835
Queue Length 50th (ft)	281	243	0
Queue Length 95th (ft)	366	m300	m0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	51%	3%	
95th Up Block Time (%)	52%	8%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		6%	
Queuing Penalty (veh)	655	51	

Intersection Summary
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	1275	0	665	1835	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	665	1835	0	0
Lane Group Flow (vph)	1275	0	665	1835	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	34.0		36.0	80.0		
Effective Green, g (s)	35.0		37.0	80.0		
Actuated g/C Ratio	0.44		0.46	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1579		835	3610		
v/s Ratio Prot	c0.35		c0.37	0.51		
v/s Ratio Perm						
v/c Ratio	0.81		0.80	0.51		
Uniform Delay, d1	19.6		18.3	0.0		
Progression Factor	1.00		0.67	1.00		
Incremental Delay, d2	4.5		2.3	0.2		
Delay (s)	24.1		14.6	0.2		
Level of Service	C		B	A		
Approach Delay (s)	24.1			4.0	0.0	
Approach LOS	C			A	A	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	C

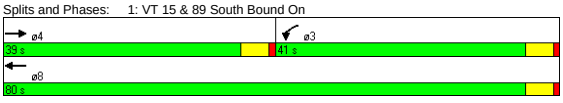
c Critical Lane Group

Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	41	39	80
Maximum Split (%)	51%	49%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		80
Control Type	Actuated-Coordinated	
Natural Cycle		45

Offset: 24 (30%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL	NBR2
Lane Group Flow (vph)	1275	1957	542	674
Queue Length 50th (ft)	92	~559	103	~381
Queue Length 95th (ft)	#91	#694	146	#586
Internal Link Dist (ft)		117	11	
50th Up Block Time (%)		37%	58%	59%
95th Up Block Time (%)		41%	59%	60%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		768		

Intersection Summary
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NBR2	NWL	NWR
Lane Configurations									
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0		
Lane Util. Factor		0.88		0.95	0.97		1.00		
Frt		0.85		1.00	1.00		0.85		
Flt Protected		1.00		1.00	0.95		1.00		
Satd. Flow (prot)		2787		3539	3433		1583		
Flt Permitted		1.00		1.00	0.95		1.00		
Satd. Flow (perm)		2787		3539	3433		1583		
Volume (vph)	0	1275	0	1957	542	0	674	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	1275	0	1957	542	0	674	0	0
Lane Group Flow (vph)	0	1275	0	1957	542	0	674	0	0
Turn Type		custom					Perm		
Protected Phases				8	2				
Permitted Phases		4					2		
Actuated Green, G (s)		42.0		42.0	28.0		28.0		
Effective Green, g (s)		43.0		43.0	29.0		29.0		
Actuated g/C Ratio		0.54		0.54	0.36		0.36		
Clearance Time (s)		5.0		5.0	5.0		5.0		
Lane Grp Cap (vph)		1498		1902	1244		574		
v/s Ratio Prot				c0.55	0.16				
v/s Ratio Perm		0.46					0.43		
v/c Ratio		0.85		1.03	0.44		1.17		
Uniform Delay, d1		15.8		18.5	19.3		25.5		
Progression Factor		0.24		1.00	1.00		1.00		
Incremental Delay, d2		3.7		28.4	1.1		95.7		
Delay (s)		7.4		46.9	20.4		121.2		
Level of Service		A		D	C		F		
Approach Delay (s)	7.4			46.9	76.3			0.0	
Approach LOS	A			D	E			A	

Intersection Summary				
HCM Average Control Delay	43.6	HCM Level of Service	D
HCM Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	93.0%	ICU Level of Service	E

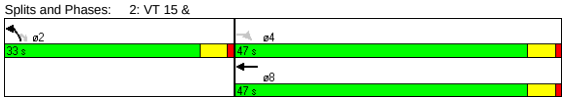
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	33	47	47
Maximum Split (%)	41%	59%	59%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary	
Cycle Length	80
Control Type	Pretimed
Natural Cycle	80

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 &



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1949			1960	1960	974	994	1965	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			100	93	98	100	100	100
cM capacity (veh/h)	1622			296			37	61	251	181	61	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	1293	656	8	10	0
Volume Left	0	0	8	0	0
Volume Right	0	10	0	6	0
cSH	1700	1700	296	112	1700
Volume to Capacity	0.76	0.39	0.03	0.09	0.00
Queue Length (ft)	0	0	2	7	0
Control Delay (s)	0.0	0.0	17.5	40.3	0.0
Lane LOS			C	E	A
Approach Delay (s)	0.0		17.5	40.3	0.0
Approach LOS				E	A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	63.9%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	8	1953	4	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	8	1953	4	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		992	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1622		241	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	659	1302	4
Volume Left	8	0	4
Volume Right	0	0	0
cSH	1622	1700	241
Volume to Capacity	0.00	0.77	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.1	0.0	20.2
Lane LOS	A		C
Approach Delay (s)	0.0		20.2
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	64.2%	ICU Level of Service	B

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	889	706	1358
Queue Length 50th (ft)	147	273	0
Queue Length 95th (ft)	236	m309	0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	47%	4%	
95th Up Block Time (%)	58%	9%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		8%	
Queuing Penalty (veh)	468	59	

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	889	0	706	1358	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	706	1358	0	0
Lane Group Flow (vph)	889	0	706	1358	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	28.4		31.6	70.0		
Effective Green, g (s)	29.4		32.6	70.0		
Actuated g/C Ratio	0.42		0.47	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1516		841	3610		
v/s Ratio Prot	c0.25		c0.39	0.38		
v/s Ratio Perm						
v/c Ratio	0.59		0.84	0.38		
Uniform Delay, d1	15.6		16.4	0.0		
Progression Factor	1.00		0.75	1.00		
Incremental Delay, d2	1.7		4.6	0.2		
Delay (s)	17.3		16.9	0.2		
Level of Service	B		B	A		
Approach Delay (s)	17.3			5.9	0.0	
Approach LOS	B			A	A	

Intersection Summary

HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C

c Critical Lane Group

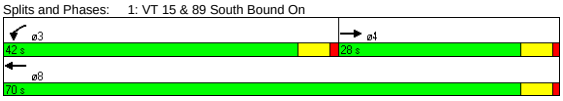
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	42	28	70
Maximum Split (%)	60%	40%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	70
Control Type	Actuated-Coordinated
Natural Cycle	50

Offset: 16 (23%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL	NBR2
Lane Group Flow (vph)	889	1805	259	432
Queue Length 50th (ft)	0	269	97	23
Queue Length 95th (ft)	56	367	167	59
Internal Link Dist (ft)		117	11	
50th Up Block Time (%)		24%	67%	38%
95th Up Block Time (%)		28%	70%	58%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		465		

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NBR2	NWL	NWR
Lane Configurations									
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0		
Lane Util. Factor		0.88		0.95	1.00		0.88		
Frt		0.85		1.00	1.00		0.85		
Flt Protected		1.00		1.00	0.95		1.00		
Satd. Flow (prot)		2787		3539	1770		2787		
Flt Permitted		1.00		1.00	0.95		1.00		
Satd. Flow (perm)		2787		3539	1770		2787		
Volume (vph)	0	889	0	1805	259	0	432	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	889	0	1805	259	0	432	0	0
Lane Group Flow (vph)	0	889	0	1805	259	0	432	0	0
Turn Type		custom					Perm		
Protected Phases				8	2				
Permitted Phases		4					2		
Actuated Green, G (s)		43.0		43.0	17.0		17.0		
Effective Green, g (s)		44.0		44.0	18.0		18.0		
Actuated g/C Ratio		0.63		0.63	0.26		0.26		
Clearance Time (s)		5.0		5.0	5.0		5.0		
Lane Grp Cap (vph)		1752		2225	455		717		
v/s Ratio Prot				c0.51	0.15				
v/s Ratio Perm		0.32					0.16		
v/c Ratio		0.51		0.81	0.57		0.60		
Uniform Delay, d1		7.1		9.9	22.6		22.9		
Progression Factor		0.51		1.00	1.00		1.00		
Incremental Delay, d2		0.9		3.3	5.1		3.7		
Delay (s)		4.5		13.2	27.7		26.6		
Level of Service		A		B	C		C		
Approach Delay (s)	4.5			13.2	27.0			0.0	
Approach LOS	A			B	C			A	

Intersection Summary				
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	Err%	ICU Level of Service	H

c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	22	48	48
Maximum Split (%)	31%	69%	69%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary	
Cycle Length	70
Control Type	Pretimed
Natural Cycle	60

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 &

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1319	2	4	0	0	0	12	8	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1321			1328	1328	660	682	1329	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			100	92	98	100	100	100
cM capacity (veh/h)	1622			519			112	153	405	308	153	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	879	442	4	20	0
Volume Left	0	0	4	0	0
Volume Right	0	2	0	8	0
cSH	1700	1700	519	203	1700
Volume to Capacity	0.52	0.26	0.01	0.10	0.00
Queue Length (ft)	0	0	1	8	0
Control Delay (s)	0.0	0.0	12.0	24.6	0.0
Lane LOS			B	C	A
Approach Delay (s)	0.0		12.0	24.6	0.0
Approach LOS				C	A

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	46.5%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	4	1792	12	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	4	1792	12	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		904	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	100
cM capacity (veh/h)			1622		276	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	601	1195	12
Volume Left	4	0	12
Volume Right	0	0	0
cSH	1622	1700	276
Volume to Capacity	0.00	0.70	0.04
Queue Length (ft)	0	0	3
Control Delay (s)	0.1	0.0	18.6
Lane LOS	A		C
Approach Delay (s)	0.0		18.6
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	59.7%	ICU Level of Service	A

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	1275	665	1835
Queue Length 50th (ft)	245	241	0
Queue Length 95th (ft)	328	m250	m0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	51%	3%	
95th Up Block Time (%)	52%	4%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %			
Queuing Penalty (veh)	658		

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	1275	0	665	1835	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	665	1835	0	0
Lane Group Flow (vph)	1275	0	665	1835	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	29.0		31.0	70.0		
Effective Green, g (s)	30.0		32.0	70.0		
Actuated g/C Ratio	0.43		0.46	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1547		825	3610		
v/s Ratio Prot	c0.35		c0.37	0.51		
v/s Ratio Perm						
v/c Ratio	0.82		0.81	0.51		
Uniform Delay, d1	17.7		16.3	0.0		
Progression Factor	1.00		0.85	1.00		
Incremental Delay, d2	5.1		1.6	0.1		
Delay (s)	22.8		15.5	0.1		
Level of Service	C		B	A		
Approach Delay (s)	22.8			4.2	0.0	
Approach LOS	C			A	A	

Intersection Summary

HCM Average Control Delay	10.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	C

c Critical Lane Group

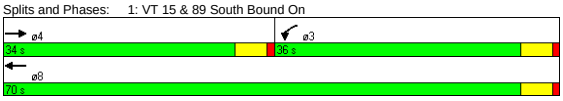
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	36	34	70
Maximum Split (%)	51%	49%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	70
Control Type	Actuated-Coordinated
Natural Cycle	40

Offset: 18 (26%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBR	WBT	NBL	NBR2
Lane Group Flow (vph)	1275	1957	542	674
Queue Length 50th (ft)	75	401	223	114
Queue Length 95th (ft)	92	#601	#408	173
Internal Link Dist (ft)		117	11	
50th Up Block Time (%)		33%	64%	57%
95th Up Block Time (%)		39%	66%	59%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		703		

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR	NBR2	NWL	NWR
Lane Configurations									
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0		
Lane Util. Factor		0.88		0.95	1.00		0.88		
Frt		0.85		1.00	1.00		0.85		
Flt Protected		1.00		1.00	0.95		1.00		
Satd. Flow (prot)		2787		3539	1770		2787		
Flt Permitted		1.00		1.00	0.95		1.00		
Satd. Flow (perm)		2787		3539	1770		2787		
Volume (vph)	0	1275	0	1957	542	0	674	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	1275	0	1957	542	0	674	0	0
Lane Group Flow (vph)	0	1275	0	1957	542	0	674	0	0
Turn Type		custom					Perm		
Protected Phases				8	2				
Permitted Phases		4					2		
Actuated Green, G (s)		38.0		38.0	22.0		22.0		
Effective Green, g (s)		39.0		39.0	23.0		23.0		
Actuated g/C Ratio		0.56		0.56	0.33		0.33		
Clearance Time (s)		5.0		5.0	5.0		5.0		
Lane Grp Cap (vph)		1553		1972	582		916		
v/s Ratio Prot				c0.55	c0.31				
v/s Ratio Perm		0.46					0.24		
v/c Ratio		0.82		0.99	0.93		0.74		
Uniform Delay, d1		12.7		15.4	22.7		20.8		
Progression Factor		0.28		1.00	1.00		1.00		
Incremental Delay, d2		2.8		18.6	23.7		5.2		
Delay (s)		6.3		33.9	46.5		26.1		
Level of Service		A		C	D		C		
Approach Delay (s)	6.3			33.9	35.1			0.0	
Approach LOS	A			C	D			A	

Intersection Summary				
HCM Average Control Delay	26.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	Err%	ICU Level of Service	H

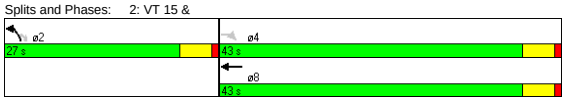
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBR	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	27	43	43
Maximum Split (%)	39%	61%	61%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary	
Cycle Length	70
Control Type	Pretimed
Natural Cycle	80

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 &



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1939	10	8	0	0	0	4	6	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1949			1960	1960	974	994	1965	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			100	93	98	100	100	100
cM capacity (veh/h)	1622			296			37	61	251	181	61	1084

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	SB 1
Volume Total	1293	656	8	10	0
Volume Left	0	0	8	0	0
Volume Right	0	10	0	6	0
cSH	1700	1700	296	112	1700
Volume to Capacity	0.76	0.39	0.03	0.09	0.00
Queue Length (ft)	0	0	2	7	0
Control Delay (s)	0.0	0.0	17.5	40.3	0.0
Lane LOS			C	E	A
Approach Delay (s)	0.0		17.5	40.3	0.0
Approach LOS				E	A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	63.9%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Yield	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	8	1953	4	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	8	1953	4	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		992	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1622		241	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	659	1302	4
Volume Left	8	0	4
Volume Right	0	0	0
cSH	1622	1700	241
Volume to Capacity	0.00	0.77	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.1	0.0	20.2
Lane LOS	A		C
Approach Delay (s)	0.0		20.2
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	64.2%	ICU Level of Service	B

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	1275	665	1835
Queue Length 50th (ft)	245	250	0
Queue Length 95th (ft)	328	m281	m0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	51%	4%	
95th Up Block Time (%)	52%	7%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		4%	
Queuing Penalty (veh)	658	24	

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	1275	0	665	1835	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	665	1835	0	0
Lane Group Flow (vph)	1275	0	665	1835	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	29.0		31.0	70.0		
Effective Green, g (s)	30.0		32.0	70.0		
Actuated g/C Ratio	0.43		0.46	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1547		825	3610		
v/s Ratio Prot	c0.35		c0.37	0.51		
v/s Ratio Perm						
v/c Ratio	0.82		0.81	0.51		
Uniform Delay, d1	17.7		16.3	0.0		
Progression Factor	1.00		0.87	1.00		
Incremental Delay, d2	5.1		2.3	0.2		
Delay (s)	22.8		16.6	0.2		
Level of Service	C		B	A		
Approach Delay (s)	22.8			4.6	0.0	
Approach LOS	C			A	A	

Intersection Summary

HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	C

c Critical Lane Group

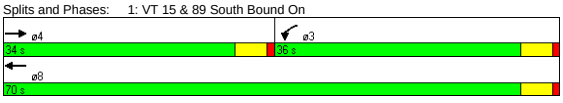
Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lag	Lead	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	36	34	70
Maximum Split (%)	51%	49%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary

Cycle Length	70
Control Type	Actuated-Coordinated
Natural Cycle	45

Offset: 16 (23%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBT	WBT	NBL	NBR
Lane Group Flow (vph)	1275	1957	843	373
Queue Length 50th (ft)	4	368	151	127
Queue Length 95th (ft)	2	#576	#225	#287
Internal Link Dist (ft)	293	1	11	
50th Up Block Time (%)		41%	62%	61%
95th Up Block Time (%)		41%	64%	64%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		811		

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	0.95			0.95	0.97	0.91
Frt	1.00			1.00	0.95	0.85
Flt Protected	1.00			1.00	0.97	1.00
Satd. Flow (prot)	3539			3539	3314	1441
Flt Permitted	1.00			1.00	0.97	1.00
Satd. Flow (perm)	3539			3539	3314	1441
Volume (vph)	1275	0	0	1957	542	674
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1275	0	0	1957	542	674
Lane Group Flow (vph)	1275	0	0	1957	843	373
Turn Type						Perm
Protected Phases				8	2	
Permitted Phases	4					2
Actuated Green, G (s)	40.0			40.0	20.0	20.0
Effective Green, g (s)	41.0			41.0	21.0	21.0
Actuated g/C Ratio	0.59			0.59	0.30	0.30
Clearance Time (s)	5.0			5.0	5.0	5.0
Lane Grp Cap (vph)	2073			2073	994	432
v/s Ratio Prot				c0.55	0.25	
v/s Ratio Perm	0.36					0.26
v/c Ratio	0.62			0.94	0.85	0.86
Uniform Delay, d1	9.4			13.4	23.0	23.1
Progression Factor	0.04			1.00	1.00	1.00
Incremental Delay, d2	0.7			10.4	8.9	19.9
Delay (s)	1.1			23.8	31.9	43.0
Level of Service	A			C	C	D
Approach Delay (s)	1.1			23.8	35.3	
Approach LOS	A			C	D	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	D

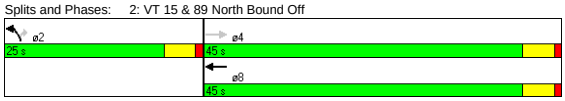
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	25	45	45
Maximum Split (%)	36%	64%	64%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary	
Cycle Length	70
Control Type	Pretimed
Natural Cycle	75

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 & 89 North Bound Off



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1939	10	0	0	0	0	4	6	0	8	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1939	10	0	0	0	0	4	6	0	8	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1949			1948	1944	974	978	1949	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	94	98	100	87	100
cM capacity (veh/h)	1622			296			35	64	251	191	64	1084

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	1293	656	10	8
Volume Left	0	0	0	0
Volume Right	0	10	6	0
cSH	1700	1700	116	64
Volume to Capacity	0.76	0.39	0.09	0.13
Queue Length (ft)	0	0	7	10
Control Delay (s)	0.0	0.0	38.9	69.4
Lane LOS			E	F
Approach Delay (s)	0.0		38.9	69.4
Approach LOS			E	F

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	63.9%	ICU Level of Service	B

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	8	1953	4	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	8	1953	4	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		992	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1622		241	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	659	1302	4
Volume Left	8	0	4
Volume Right	0	0	0
cSH	1622	1700	241
Volume to Capacity	0.00	0.77	0.02
Queue Length (ft)	0	0	1
Control Delay (s)	0.1	0.0	20.2
Lane LOS	A		C
Approach Delay (s)	0.0		20.2
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	64.2%	ICU Level of Service	B

Lane Group	EBT	WBL	WBT
Lane Group Flow (vph)	889	706	1358
Queue Length 50th (ft)	159	202	0
Queue Length 95th (ft)	236	m246	0
Internal Link Dist (ft)	30		293
50th Up Block Time (%)	51%		
95th Up Block Time (%)	58%	6%	
Turn Bay Length (ft)		325	
50th Bay Block Time %			
95th Bay Block Time %		5%	
Queuing Penalty (veh)	484	38	

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0		
Lane Util. Factor	0.95		1.00	0.95		
Frt	1.00		1.00	1.00		
Flt Protected	1.00		0.95	1.00		
Satd. Flow (prot)	3610		1805	3610		
Flt Permitted	1.00		0.95	1.00		
Satd. Flow (perm)	3610		1805	3610		
Volume (vph)	889	0	706	1358	0	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	706	1358	0	0
Lane Group Flow (vph)	889	0	706	1358	0	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type			Prot			
Protected Phases	4		3	8		
Permitted Phases						
Actuated Green, G (s)	27.8		32.2	70.0		
Effective Green, g (s)	28.8		33.2	70.0		
Actuated g/C Ratio	0.41		0.47	1.00		
Clearance Time (s)	5.0		5.0	5.0		
Vehicle Extension (s)	3.0		3.0	3.0		
Lane Grp Cap (vph)	1485		856	3610		
v/s Ratio Prot	c0.25		c0.39	0.38		
v/s Ratio Perm						
v/c Ratio	0.60		0.82	0.38		
Uniform Delay, d1	16.1		15.9	0.0		
Progression Factor	1.00		0.61	1.00		
Incremental Delay, d2	1.8		4.2	0.2		
Delay (s)	17.9		13.9	0.2		
Level of Service	B		B	A		
Approach Delay (s)	17.9			4.9	0.0	
Approach LOS	B			A	A	

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C

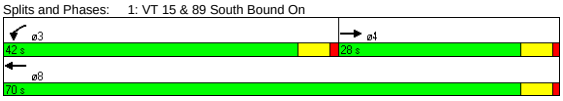
c Critical Lane Group

Phase Number	3	4	8
Movement	WBL	EBT	WBT
Lead/Lag	Lead	Lag	
Lead-Lag Optimize	Yes	Yes	
Recall Mode	None	Coord	Coord
Maximum Split (s)	42	28	70
Maximum Split (%)	60%	40%	100%
Minimum Split (s)	9	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)		5	5
Flash Dont Walk (s)		11	11

Intersection Summary		
Cycle Length		70
Control Type	Actuated-Coordinated	
Natural Cycle		50

Offset: 12 (17%), Referenced to phase 4:EBT and 8:WBT, Start of Green

Splits and Phases: 1: VT 15 & 89 South Bound On



Lane Group	EBT	WBT	NBL	NBR
Lane Group Flow (vph)	889	1805	461	230
Queue Length 50th (ft)	0	256	49	0
Queue Length 95th (ft)	0	349	87	75
Internal Link Dist (ft)	293	1	11	
50th Up Block Time (%)		36%	58%	33%
95th Up Block Time (%)		36%	64%	62%
Turn Bay Length (ft)				
50th Bay Block Time %				
95th Bay Block Time %				
Queuing Penalty (veh)		643		

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	0.95			0.95	0.97	0.91
Frt	1.00			1.00	0.93	0.85
Flt Protected	1.00			1.00	0.97	1.00
Satd. Flow (prot)	3539			3539	3284	1441
Flt Permitted	1.00			1.00	0.97	1.00
Satd. Flow (perm)	3539			3539	3284	1441
Volume (vph)	889	0	0	1805	259	432
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	889	0	0	1805	259	432
Lane Group Flow (vph)	889	0	0	1805	461	230
Turn Type						Perm
Protected Phases				8	2	
Permitted Phases	4					2
Actuated Green, G (s)	44.0			44.0	16.0	16.0
Effective Green, g (s)	45.0			45.0	17.0	17.0
Actuated g/C Ratio	0.64			0.64	0.24	0.24
Clearance Time (s)	5.0			5.0	5.0	5.0
Lane Grp Cap (vph)	2275			2275	798	350
v/s Ratio Prot				c0.51	0.14	
v/s Ratio Perm	0.25					0.16
v/c Ratio	0.39			0.79	0.58	0.66
Uniform Delay, d1	6.0			9.1	23.3	23.9
Progression Factor	0.38			1.00	1.00	1.00
Incremental Delay, d2	0.4			2.9	3.0	9.3
Delay (s)	2.7			12.1	26.4	33.2
Level of Service	A			B	C	C
Approach Delay (s)	2.7			12.1	28.6	
Approach LOS	A			B	C	

Intersection Summary				
HCM Average Control Delay	13.0	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.76			
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	68.5%	ICU Level of Service	B	

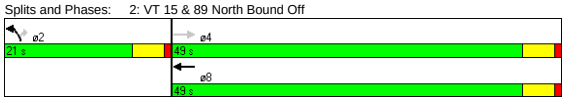
c Critical Lane Group

Phase Number	2	4	8
Movement	NBL	EBT	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Max	Max	Max
Maximum Split (s)	21	49	49
Maximum Split (%)	30%	70%	70%
Minimum Split (s)	21	21	21
Yellow Time (s)	4	4	4
All-Red Time (s)	1	1	1
Minimum Initial (s)	4	4	4
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)	5	5	5
Flash Dont Walk (s)	11	11	11

Intersection Summary	
Cycle Length	70
Control Type	Pretimed
Natural Cycle	60

Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green

Splits and Phases: 2: VT 15 & 89 North Bound Off



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1319	2	0	0	0	0	12	8	0	4	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	1319	2	0	0	0	0	12	8	0	4	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	0			1321			1322	1320	660	674	1321	0
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	92	98	100	97	100
cM capacity (veh/h)	1622			519			112	156	405	314	155	1084

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	879	442	20	4
Volume Left	0	0	0	0
Volume Right	0	2	8	0
cSH	1700	1700	207	155
Volume to Capacity	0.52	0.26	0.10	0.03
Queue Length (ft)	0	0	8	2
Control Delay (s)	0.0	0.0	24.3	28.8
Lane LOS			C	D
Approach Delay (s)	0.0		24.3	28.8
Approach LOS			C	D

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	46.5%	ICU Level of Service	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	4	1792	12	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (veh/h)	0	0	4	1792	12	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume			0		904	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	100
cM capacity (veh/h)			1622		276	1084

Direction, Lane #	WB 1	WB 2	NB 1
Volume Total	601	1195	12
Volume Left	4	0	12
Volume Right	0	0	0
cSH	1622	1700	276
Volume to Capacity	0.00	0.70	0.04
Queue Length (ft)	0	0	3
Control Delay (s)	0.1	0.0	18.6
Lane LOS	A		C
Approach Delay (s)	0.0		18.6
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	59.7%	ICU Level of Service	A

APPENDIX C

VTRANS SAFETY DATA 1997-2001

*	Reporting Agency/ Number	Town	Mile Marker	Date MM/DD/YY	Time	Weather	Contributing Circumstances	Manner Of Collision	Number Of Injuries	Number Of Fatalities	Direction
SB On-Ramp	0418/2827	Winooski City	0.6	12/5/1998	19:36	Rain	Followed too closely	Rear End	0	0	W
SB On-Ramp	0418/303188	Winooski City	0.62	5/19/1997	23:00	Cloudy	Disregarded traffic signs, signals, road markings	Other	5	0	E
SB On-Ramp	0418/8271	Winooski City	0.62	2/18/2000	21:12	Snow	Other improper action	Rear End	2	0	E
SB On-Ramp	0418/14295	Winooski City	0.62	11/8/2001	7:39	Clear	Disregarded traffic signs, signals, road markings	Other	2	0	N
NB Off--Ramp	0418/302916	Winooski City	0.71	4/26/1997	14:00	Clear	Other improper action	Other	0	0	N
NB Off--Ramp	0418/305513	Winooski City	0.71	12/7/1997	20:00	Cloudy	Other improper action	Other	1	0	W
NB Off--Ramp	0418/305633	Winooski City	0.71	12/19/1997	22:00	Clear	Disregarded traffic signs, signals, road markings	Other	0	0	N
NB Off--Ramp	0418/965	Winooski City	0.71	3/26/1998	14:04	Cloudy	Failed to yield right of way	Other	0	0	W
NB Off--Ramp	0418/1235	Winooski City	0.71	5/21/1998	21:02	Rain	Other improper action, Disregarded traffic signs, signals, road markings	Other	1	0	E
NB Off--Ramp	0418/1820	Winooski City	0.71	6/29/1998	16:20	Cloudy	Failed to yield right of way	Same Direction Sideswipe	1	0	E
NB Off--Ramp	0418/1668	Winooski City	0.71	7/6/1998	15:12	Clear	Failed to yield right of way	Other	1	0	W
NB Off--Ramp	0418/2266	Winooski City	0.71	8/30/1998	19:01	Clear	Disregarded traffic signs, signals, road markings	Other	1	0	E
NB Off--Ramp	0418/3506	Winooski City	0.71	11/16/1998	15:08	Cloudy	Other improper action	Rear End	2	0	W
NB Off--Ramp	0418/3504	Winooski City	0.71	11/19/1998	17:28	Cloudy	Disregarded traffic signs, signals, road markings	Other	2	0	E
NB Off--Ramp	0418/3505	Winooski City	0.71	11/30/1998	15:25	Cloudy	Disregarded traffic signs, signals, road markings	Other	1	0	E
NB Off--Ramp	0418/4150	Winooski City	0.71	1/11/1999	18:33	Other	Disregarded traffic signs, signals, road markings	Other	1	0	E
NB Off--Ramp	0418/5166	Winooski City	0.71	5/14/1999	22:13	Clear	Other improper action	Other	0	0	W
NB Off--Ramp	0418/5167	Winooski City	0.71	5/23/1999	18:52	Clear	Inattention	Rear End	0	0	E

*	Reporting Agency/ Number	Town	Mile Marker	Date MM/DD/YY	Time	Weather	Contributing Circumstances	Manner Of Collision	Number Of Injuries	Number Of Fatalities	Direction
NB Off--Ramp	0418/5443	Winooski City	0.71	6/15/1999	8:47	Clear	Followed too closely, Operating defective equipment	Rear End	2	0	W
NB Off--Ramp	0418/9781	Winooski City	0.71	8/28/2000	20:47	Clear	Disregarded traffic signs, signals, road markings, Operating defective equipment	Other	5	0	E
NB Off--Ramp	0418/10065	Winooski City	0.71	9/30/2000	12:20	Clear	Disregarded traffic signs, signals, road markings	Other	2	0	E
NB Off--Ramp	0418/10918	Winooski City	0.71	12/10/2000	20:52	Cloudy	Inattention	Rear End	3	0	W
NB Off--Ramp	0418/12427	Winooski City	0.71	5/13/2001	12:30	Clear	Disregarded traffic signs, signals, road markings	Other	1	0	E
NB Off--Ramp	0418/12559	Winooski City	0.71	5/27/2001	16:50	Clear	Disregarded traffic signs, signals, road markings	Other	2	0	W
NB Off--Ramp	0418/12558	Winooski City	0.71	6/3/2001	14:40	Cloudy	Driving too fast for conditions	Other	4	0	E
NB Off--Ramp	0418/13352	Winooski City	0.71	9/16/2001	17:44	Clear	Disregarded traffic signs, signals, road markings	Other	2	0	E
NB Off--Ramp	0418/14222	Winooski City	0.71	10/11/2001	22:37	Clear	Disregarded traffic signs, signals, road markings, Other improper action	Other	0	0	E
NB Off--Ramp	0418/14223	Winooski City	0.71	11/4/2001	17:32	Unknown	Inattention	Rear End	1	0	W
Roland Ct	0418/303173	Winooski City	0.75	6/3/1997	16:00	Clear	Inattention	Rear End	4	0	E
Roland Ct.	0418/14340	Winooski City	0.75	11/5/2001	15:25	Rain	Driving too fast for conditions	Rear End	2	0	E

APPENDIX D

COMMENTS AND RESPONSES

Joe Segale

From: Joe Segale

Sent: Monday, August 02, 2004 5:14 PM

To: 'Christopher.Jolly@fhwa.dot.gov'

Cc: 'bruce.nyquist@state.vt.us'; 'dick.hosking@state.vt.us'; 'polly.mcmurtry@state.vt.us'; 'slpalmer@onioncity.com'; Susan Smichenko

Subject: Roland Court- Exit 15 Alternative Analysis

Hi Chris -

Hope all is well! Susan Smichenko asked that I reply directly to you in regards to your comments on the Roland Court-Exit 15 Alternatives Analysis (see below).Your comment regarding the queue length estimates for the slip lane makes sense. To address that comment, we used SimTraffic to estimate the queue lengths for right turning vehicles under the do-nothing and four different alternatives for the 2010 PM peak (the critical time period). The results are presented in the table below.

Here are my comments:

- Your assessment that the standard HCM LOS analysis over estimates the queue lengths because it does not account for the gaps created by the up-stream traffic signal is correct. According to the SimTraffic output, the estimated queue length for the slip lane is 226 for the do-nothing scenario and 390 feet for alt 1. Theses estimates are much lower than the 960 feet estimated in our report and memo.

- Alt 2 eliminates the slip lane and combines (1) right-turn lane and two left-turn lanes controlled by the traffic signal. The SimTraffic estimated queue length for right turning vehicles is 645 feet. So, this alternative would create longer queues for the right turning vehicles compared to the slip lane.

- Alt 3 includes 2 right-turn lanes and one left-turn lane controlled by the traffic signal. In this case, the queues are about the same as the queues for the Alternatives with the slip lane.

- Alt 4 includes a single left-turn lane, one shared through/right-turn lane, one right-turn lane. The SimTraffic estimated queue length for right turning vehicles is 150 feet.

Given these results, the conclusion stated in the June 4, 2004 memo, repeated below with comments, is still valid:

> "Based on the results of this analysis, Alternative 4 is recommended over Alternative 3 as a long term improvement strategy for the Exit 15 northbound off-ramp intersection with VT 15. Alternative 4 is projected to reduce vehicle queues along the northbound off-ramp compared to Alternatives 1-3 ***(even based on the results of simulation)*** while maintaining acceptable levels of service for all movements. The reduction in vehicle queues may also improve safety by reducing the potential for rear-end crashes between vehicles exiting the I-89 mainline and vehicles stopped at the traffic signal ***(less true than before because vehicle queues for the slip lane will not reach 960 feet. But Alt 4 does reduce queues compared to the slip lane – so this statement is still valid)***.

Additionally, Alt 4 is the best choice because it would eliminate a conflict point and would provide some separation distance between the off-ramp and Roland Court. Our analysis shows that this consolidation can be provided without causing a problem on the off-ramp.

Queue Length Estimated During Simulation - 2010 PM Peak

Scenario	Configuration	Right Turn Queue Length (Feet)
Do Nothing	Right Slip Lane	226
Alt 1	Right Slip Lane	390
Alt 2	(1) Right	645
Alt 3	(2) Right	380
Alt 4	(1) Shared Left/Right and (1) Right	150

Give me a call if you have any questions.

Joe Segale, P.E.
Resource Systems Group, Inc.
100 Dorset Street, Suite 20
South Burlington, VT 05403
p (802) 383-0118
f (802) 383-0122
jsegale@rsginc.com

-----Original Message-----
From: Jolly, Christopher [mailto:Christopher.Jolly@fhwa.dot.gov]
Sent: Thursday, June 24, 2004 11:06 AM
To: Susan Smichenko
Cc: Bruce Nyquist (E-mail); Polly McMurty (E-mail)
Subject: Roland Court- Exit 15 Alternative Analysis

Susan - The following are comments on the subject analysis dated March 2, 2004 and the Analysis of Alternative 4 dated June 4,2004.

1. Page 10 Table 1- should read "Southbound On-Ramp"

2. Page 15 - first sentence under "Results" - should read "southbound on-ramp"

3. Page 15- Table 6 - should read "AM Peak"

4. Page 16- Should it read Table 7 through Table 10 ? To be consistent either remove or add Table reference for Results on page 15 and page 17.

5. Page 16- VT 15 With Northbound Off-Ramp - Under the Do Nothing and Alternative 1 it is stated that the projected vehicle queue in 2010 for the right turn slip lane is over 900 feet. Does this 900' account for the gaps provided by the existing signal ? It would appear that in the worst case scenario the right turn slip ramp would actually operate as a signalized right turn which would result in LOS F with a 586' queue as

shown for Alternative 2 in Table 8.

6.Pages 18, 19 and 20 - Traffic simulation model- This discussion and Table 13 address exiting Rolland Court. We would like to see additional discussion and results what the simulation model showed for the Interstate ramp traffic.

7. Page 22 - 1st sentence under Northbound Off-Ramp - should be "right-turn"

8. Alternative 4 Analysis- same comment as #5 questioning the 900' queue.

Let me know if you have any questions or would like discuss. Thanks