RESOURCE SYSTEMS GROUP
INCORPORATED

MEMORANDUM

To: David Roberts
From: Brian Grady and Robert Chamberlin
Subject: Mary Street/Williston Road Alternatives Analysis
Date: 18 September 2000

PURPOSE

This technical memorandum summarizes the results of the Mary Street project access and roadway alternatives. The following describes the approach to the analysis, the results of our analysis and our conclusions regarding each alternative.

APPROACH

There were 3 components to this project:

- Develop Base Year Traffic/Land Use Information
- TModel Runs for 2000/2005
- Conduct Operational/Design Analysis for Selected Intersections

Develop Base Year Traffic/Land Use Information

For this component, a site visit was conducted and the necessary roadway geometries were collected. We then acquired signal timing data and turning movement counts for 6 intersections: Dorset/Williston, White/Williston, Hinesburg/Williston, Dorset/Market, Mary/Williston and Clarion/Williston. Land use information from previous work we have conducted in the project area was consolidated and incorporated into the model runs. Modifications to the land use file (mpo98.lux) were also made to reflect more accurate geo-location of employment in the analysis TAZs.

TModel Runs for 2000/2005

The Chittenden County Travel Demand Model for Year 2000 and Year 2005 conditions was run with the network assumptions and alternatives outlined in Table 1.

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Table 1: Network and Alternative Scenarios for the Mary Street Analysis

Alternative	Mary Street Alignments	Year 2000 Network (all Alternatives)	Year 2005 Network (all Alternatives)
1	Mary Street open to Market Street, all movements allowed at Williston Road intersection.	Market St. not open to Hinesburg Rd.; Main St. reconstruction complete	Market St. open to Hinesburg Rd.; Kennedy Drive reconstruction, Exit 13 NB On Ramp, Shelburne Rd. reconstruction, and Southern Connector complete.
2	Mary Street open to Market Street, right turn enter/exit only at the Williston Road intersection.		
3	Mary Street consolidated with Clarion driveway, all movements allowed at Williston Road intersection. Connects through to Market St.		

Conduct Operational/Design Analysis for Selected Intersections

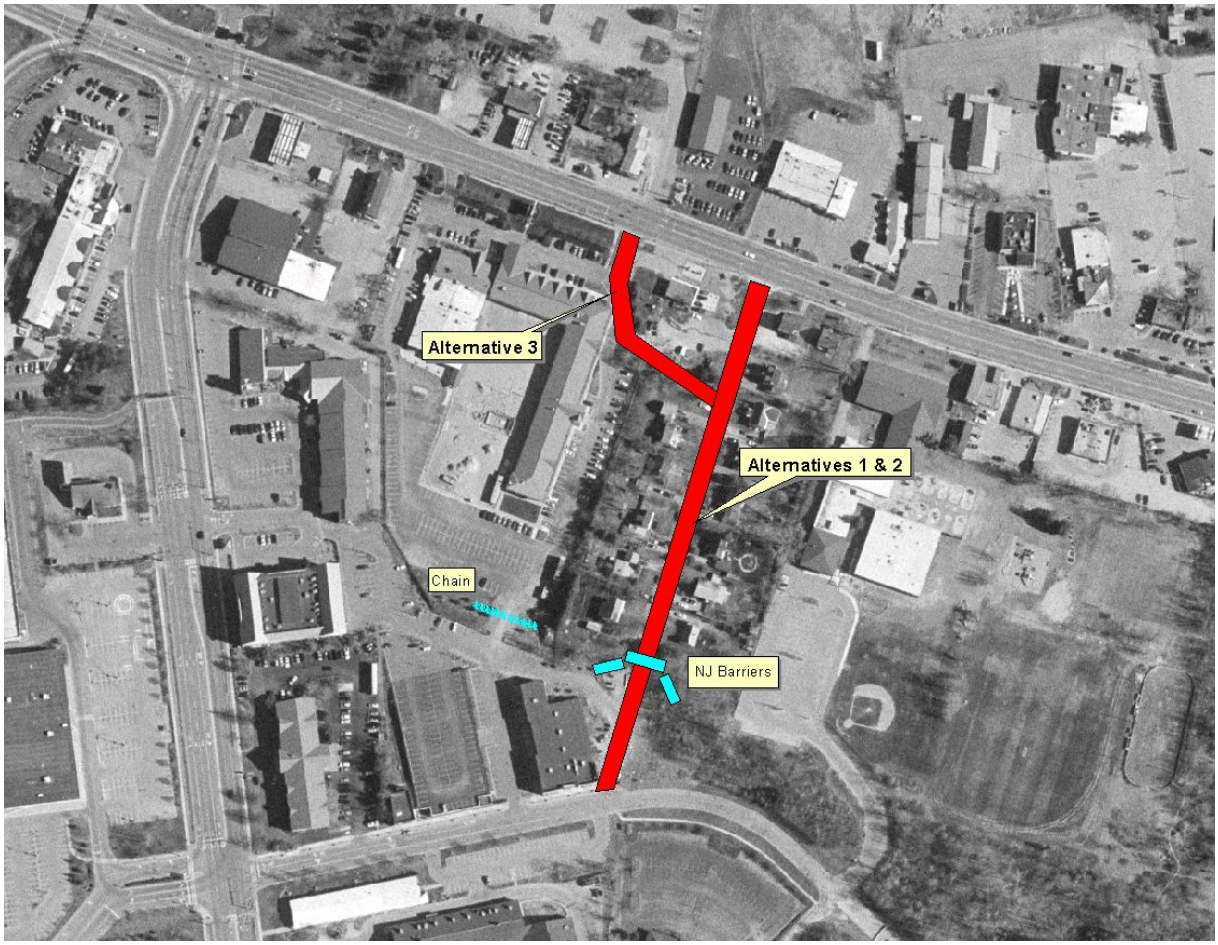
Turning movement outputs from the Transportation Model were used to pivot the PM Design Hour Volume[1] adjusted turning movement counts to produce volume changes at each of the 6 study intersections. Raw model output for the Hinesburg/Market intersection is provided for 2005 only. An operational and design analysis was conducted for three other intersections: Mary/Williston, Clarion/Williston and Market/Mary. Specifically, the Road Runner software developed by Resource Systems Group, Inc. was used in conjunction with the Highway Capacity Manual to conduct a Level of Service and queuing analysis at these intersections.

ROADWAY GEOMETRY & CONFIGURATION

New Jersey barriers now prevent motorists from accessing the Mary Street cul de sac via Market Street. Implementing Alternatives 1 and 2 would only require the removal of the New Jersey barriers and a small amount of new pavement. Alternative 3 would require more improvements to the current infrastructure. The City of South Burlington has preliminary plans to route Mary Street behind the existing gas station at the corner of Mary Street and Williston Road to provide access to Mary Street at the Clarion Drive intersection with Williston Road. There is sufficient width to allow the on street parking on Mary Street in Alternatives 1 and 2. See Figure 1 for an aerial photo of the project site.

[1] The design hour reflects the 30th highest hour of traffic in a year.

Figure 1: Aerial Photo of the Project Site



ANALYSIS & RESULTS

2000/2005 Turning Movement Volumes

The PM peak hour counts were adjusted to the 2000 Design Hour Volume (DHV). A 2000 Base Case run was conducted to provide a pivot point for the model's turning movement output. Turning movement data at each of the study intersections was saved for all TModel runs. The Base Case turning volumes were then subtracted from the 2000 and 2005 Alternatives 1, 2 and 3 turning movement volumes. These differences were then added to the 2000 DHV adjusted turning movement counts to yield pivoted turning movement volumes for each alternative. Table 2 summarizes the location of the turning movement data.

Table 2: Location of Turning Movement Data

Appendix	Data Description
Appendix A	Turning Movement Differences for 2000 Alternatives 1,2,3
Appendix B	Pivoted Turning Movement Volumes for 2000 Alternatives 1,2,3
Appendix C	Turning Movement Differences for 2005 Alternatives 1,2,3
Appendix D	Pivoted Turning Movement Volumes for 2000 Alternatives 1,2,3

Turning movement volumes for the Mary/Market intersection have also been included in Appendix B. This intersection does not currently exist. Therefore, the 2000 volumes are raw model output and have not been pivoted against actual count data. The 2005 raw model output for Mary/Market is included in Appendix D. Turning movements for the Hinesburg/Market intersection have also been included in Appendix D. This intersection will not exist until 2005. Therefore, the 2005 volumes are raw model output and have not been pivoted against actual count data.

Off-Model Turning Movement Volume Adjustments

Analyzing the turning movement data for Alternatives 1 and 3 revealed results that did not completely agree with our professional judgment. Vehicles exiting University Mall destined for I-89 were using the new Mary/Market connection instead of turning left onto Dorset Street northbound. The model was clearly overstating the attractiveness of this new route. For this reason, an off-model adjustment was determined to be necessary. To accomplish this, we performed a select zone analysis and redistributed vehicles accordingly.

The adjusted turning movement volumes for the 2000 Alternative 1, 2 and 3 runs can be seen in Appendix E. The adjusted turning movement volumes for the 2005 Alternative 1, 2 and 3 runs can be seen in Appendix F. The volumes in Appendix E and F were used in the level of service and queuing analysis.

Key Roadway Link Volumes

Table 3 contains the link volumes (both directions) for the key roadways in the project area. The volume reported for Mary Street represents the link south of the Mary/Williston intersection. The volume reported for Williston Road represents the link west of the Mary/Williston intersection. The volume for Dorset Street represents the link north of the Dorset/Market intersection. The volume for Hinesburg Road represents the link south of the Williston/Hinesburg intersection.

Connecting Mary Street through to Market Street reduces the traffic volume on Dorset Street north of Market Street and on Williston Road west of Mary Street. There is a greater volume reduction in the 2005 alternatives. This is a counter-intuitive result. However, this result has more to do with the improvements scheduled for Exit 13 (which are coded into the 2005 network) than the Mary Street project. The ability to access I-89 northbound south of Williston Road has relieved some of the congestion on Dorset Street and Williston Road.

Table 3: Key Roadway Link Volumes and Percentage Change

Scenario	Mary Street Traffic Volume	Williston Road	% Change	Dorset Street	% Change	Hinesburg Road	% Change
Base	27	2884	-	2191	-	1259	-
2000 Alt1	425	2787	-3.4%	1808	-17.5%	1251	-0.6%
2000 Alt2	313	2824	-2.1%	1906	-13.0%	1262	0.2%
2000 Alt3	321	2675	-7.2%	1819	-17.0%	1256	-0.2%
2005 Alt1	580	2691	-6.7%	1790	-18.3%	1112	-11.7%
2005 Alt2	346	2687	-6.8%	1803	-17.7%	1194	-5.2%
2005 Alt3	473	2558	-11.3%	1825	-16.7%	1233	-2.1%

Operational/Design Analysis for Selected Intersections

The operational and design analysis was conducted for three intersections: Mary/Williston, Clarion/Williston and Market/Mary. Specifically, the Road Runner software developed by Resource Systems Group, Inc. was used in conjunction with the Highway Capacity Manual to first conduct a level of service and then a queuing analysis at these intersections.

Mary Street & Market Street

Table 4 shows the results of the Level of Service (LOS) analysis for the Mary/Market intersection. The intersection was analyzed as a two-way stop-controlled T-intersection in all scenarios. Mary Street is the stop-controlled leg of this intersection.

Table 4: Estimated PM Peak Hour Level of Service at Mary Street / Market Street

Scenario	South Bound Left Turn		South Bound Right Turn		East Bound Left Turn		Overall Delay/Vehicle [sec]	
2000Alt1	0	N/A	3	A	2	A	3	A
2000Alt2	0	N/A	3	A	3	A	3	A
2000Alt3	0	N/A	3	A	2	A	3	A
2005Alt1	10	B	4	A	3	A	3	A
2005Alt2	20	C	4	A	3	A	3	A
2005Alt3	13	B	4	A	3	A	3	A

The 2000 Base Case LOS was not calculated because these roads do not currently intersect one another. The LOS for the southbound left turn in the 2000 Alternatives 1, 2 and 3 is not applicable (N/A) because there is no westbound approach in the 2000 model year. However, in the 2005 model year the connection to Hinesburg Road has been made and the southbound left turn is permitted. In the 2005 alternatives, the southbound left turn is delayed. This is due to the relatively large conflicting flow in the eastbound direction. Despite the increased delay associated with the southbound left turn, the intersection continues to function well overall (3 seconds of delay/vehicle) as a stop-controlled intersection in all scenarios.

A queuing analysis for the Mary/Market intersection was not conducted because of the good level of service.

Mary Street & Williston Road

Table 5 below shows the PM peak hour roadway volumes on Mary Street and Williston Road for each of the scenarios analyzed. The Alternative 3 volumes include the alignment with the Clarion Driveway.

Table 5: Estimated PM Peak Hour Volumes on Mary Street and Williston Road

Scenario	Williston Road East Bound Approach	Williston Road West Bound Approach	Mary Street North Bound Approach	Mary Street South Bound Exiting
Base	1452	1440	9	18
2000 Alt1	1249	1703	198	227
2000 Alt2	1202	1622	290	23
2000 Alt3	1225	1468	242	79
2005 Alt1	1230	1594	274	306
2005 Alt2	1210	1477	232	114
2005 Alt3	1172	1360	328	145

The total volume on Mary Street with Alternative 1 is 425 vehicles in 2000 and 580 vehicles in 2005. Alternative 2 has less total volume due to the prohibition on left turns. The total volumes resulting from Alternative 3 are 321 vehicles in 2000 and 473 vehicles in 2005. Therefore, Alternative 3 provides complete access to Williston Road while attracting 100 fewer vehicles than Alternative 1.

Table 6 shows the results of the Level of Service analysis for the Mary/Williston intersection. The intersection was analyzed as a two-way stop-controlled T-intersection in all scenarios. Mary Street is the stop-controlled leg of this intersection.

Table 6: Estimated PM Peak Hour Level of Service at Mary Street / Williston Road

Scenario	Mary Street North Bound Left Turn		Mary Street North Bound Right Turn		Williston Road West Bound Left Turn		Overall Delay/Vehicle [sec]	
Base	O/C [1]	F	14	C	13	C	1	A
2000Alt1	O/C	F	20	D	23	D	O/C	F
2000Alt2	0	N/A	57	F	0	N/A	5	B
2005Alt1	O/C	F	24	D	21	D	O/C	F
2005Alt2	0	N/A	27	D	0	N/A	2	A

In the Base Case, the delay for the northbound left turn is extreme (over-capacity ~ O/C). Although this is an unacceptable level of service, only 2 vehicles per hour (vph) make northbound lefts in the PM peak hour. In the 2000 Alternative 1 scenario, the northbound left turn demand increases to 49 vehicles and then to 69 vehicles in the 2005 Alternative 1 scenario. This causes greater delays for this failing northbound left turn movement. The Alternative 2 scenarios maintain acceptable overall levels of service by prohibiting left turns. However, the northbound right turn movement has an F and D level of service in 2000 and 2005 respectively. This is due to the large conflicting eastbound flow on Williston Road.

A queuing analysis for the Mary/Williston intersection was not conducted because the queue length on Mary Street is not bounded. The queuing analysis for Williston Road is included in the next section.

Clarion Driveway & Williston Road

Table 7 shows the results of the Level of Service analysis for the Clarion/Williston intersection. The intersection was analyzed as a four-way signalized intersection in all scenarios.

[1] Over-capacity (O/C) – reported when the delay/vehicle exceeds 180 seconds. HCM procedure do not accurately calculate delays in excess of 180 seconds.

***Table 7:** Estimated PM Peak Hour Level of Service at Clarion Drive / Williston Road*

Scenario	Williston Road East Bound		Williston Road West Bound		Clarion Drive North Bound		Clarion Drive South Bound		Overall Delay/Vehicle [sec]	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Base	9.2	B	11.2	B	16.9	C	17.0	C	10.5	B
2000Alt1	7.1	B	16.1	C	16.8	C	17.0	C	12.6	B
2000Alt2	6.6	B	9.8	B	16.8	C	17.0	C	8.7	B
2000Alt3	4.5	A	38.1	D	23.5	C	19.6	C	22.8	C
2005Alt1	6.9	B	12.5	B	16.8	C	17.0	C	10.4	B
2005Alt2	6.7	B	6.6	B	16.8	C	17.0	C	7.0	B
2005Alt3	6.3	B	19.1	C	21.3	C	17.0	C	14.1	B

An acceptable level of service was maintained for all but one alternative with the signal timing and phasing plan currently in use. An E level of service was calculated for the 2000 Alternative 3. The westbound approach fails in the 2000 Alternative 3 with the current signal timing because of a high left turn demand (82 vehicles). However, by reallocating 5 more seconds of green time from the north/south movement to the east/west movement, the level of service can be improved to a C with 22.8 seconds of delay/vehicle. The opening of Market Street to Hinesburg Road in 2005 reduces the number of westbound lefts at this intersection to 59 vehicles. Therefore, without modifying the signal timing, the 2005 Alternative 3 has a C level of service for the westbound approach.

The level of service at the Clarion/Williston intersection improves in 2005. This is a counter-intuitive result. As was discussed earlier, this result has to do with the improvements scheduled for Exit 13 (which are coded into the 2005 network) than the Mary Street project. The ability to access I-89 northbound south of Williston Road has relieved some of the congestion on Dorset Street and Williston Road.

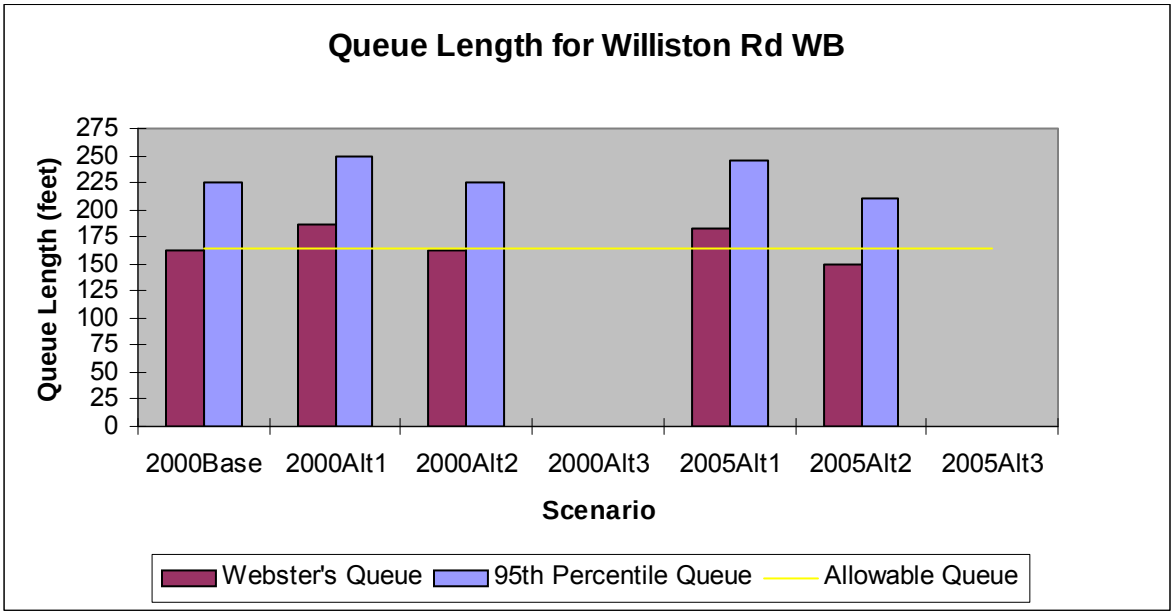
A queuing analysis was conducted for the Clarion/Williston intersection to determine if the resulting queues would interfere with the traffic flow at upstream and downstream intersections. Queue lengths for the westbound and eastbound approach were calculated. Webster's queue length and the 95th percentile queue length were calculated for all scenarios. Webster's queue length is the average queue length. The 95th percentile queue will not be exceeded 95% of the time during the peak hour. The westbound approach queue lengths for each alternative are provided in Table 8.

Table 8: Estimated Westbound Approach Queue Length at Clarion Drive / Williston Road

Scenario	Webster's (ft)	95th Percentile (ft)	Allowable Queue (ft)
Base	163	225	165
2000Alt1	186	249	165
2000Alt2	163	226	165
2000Alt3	O/C	O/C	165
2005Alt1	183	245	165
2005Alt2	149	211	165
2005Alt3	139	201	165

The allowable queue length for this approach is 165 feet. This is the distance from the Clarion/Williston stop-bar back to the Mary/Williston intersection. The bar graph in Figure 2 below visually displays the data in Table 8.

Figure 2: Queue Length for Williston Road Westbound at Clarion Drive / Williston Road



If the queues extend beyond the allowable queue (165 feet) vehicles will not be able to enter/exit Mary Street, resulting in further delays. The queue length in the 2000 Base Case is already infringing on the Mary Street intersection. The queue lengths associated with Alternative 2 are the shortest because of the prohibited left turns. The queue lengths for Alternative 3 are of no concern because the entrance to Mary Street will be blocked off in this alternative. The queues with Alternative 1 will block access to Mary Street in both the year 2000 and 2005.

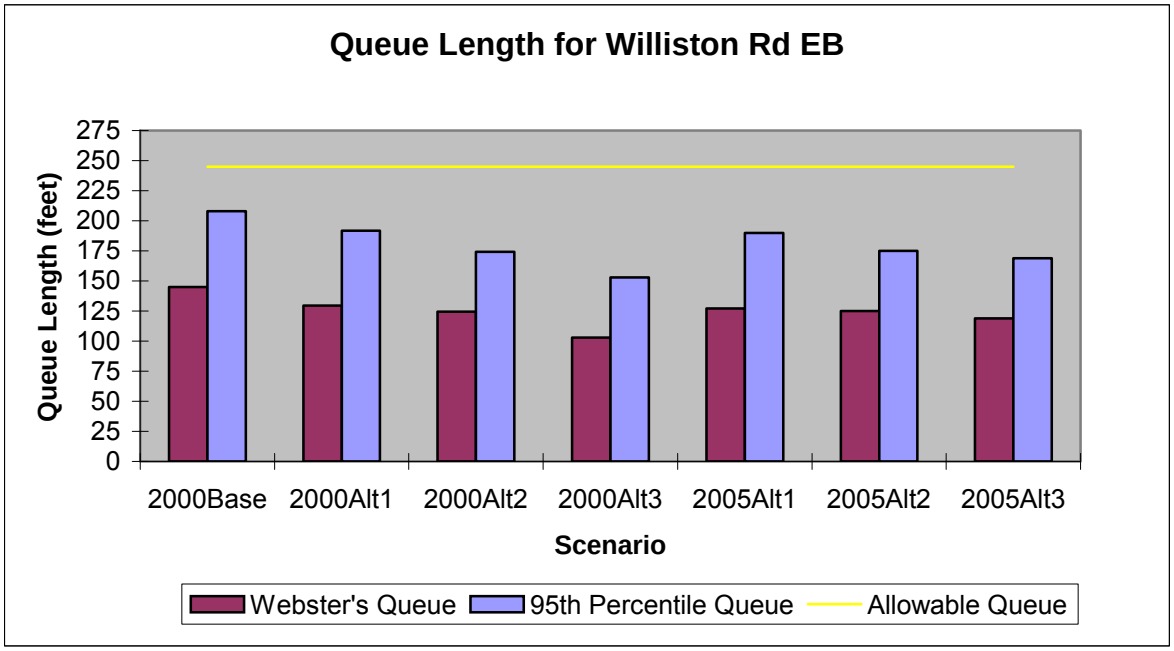
The eastbound approach queue lengths for each alternative are given in Table 9.

Table 9: Estimated Eastbound Approach Queue Length at Clarion Drive / Williston Road

Scenario	Webster's (ft)	95th Percentile (ft)	Allowable Queue (ft)
Base	145	208	245
2000Alt1	130	192	245
2000Alt2	125	174	245
2000Alt3	103	153	245
2005Alt1	127	190	245
2005Alt2	125	175	245
2005Alt3	119	169	245

The allowable queue length for the eastbound approach is 245 feet. This is the distance from the Clarion/Williston intersection stop-bar back to the first hotel entrance. Queues extending beyond this allowable queue length will not have the same impact as above. The small driveway 245 feet back from the stop-bar is only an entrance. The closest intersection is the Dorset/Williston intersection, which is more than 600 feet away. The bar graph in Figure 3 visually displays the data in Table 9 above.

Figure 3: Queue Length for Williston Road Eastbound at Clarion Drive / Williston Road



The eastbound queue lengths do not exceed the allowable queue length in the Base Case or for any of the alternatives.

CONCLUSIONS

The level of service at the Mary/Williston intersection is estimated to fail in the Base Case. It also fails with the implementation of Alternative 1. Alternative 2 provides a good overall level of service by prohibiting the left turns entering and exiting Mary Street (the source of the failure in Alternative 1). However, the northbound right turn movement has an F and D level of service in 2000 and 2005 respectively. There is not a significant impact on the level of service at the Mary/Market and Williston/Clarion intersections with the implementation of Alternative 3. The overall LOS at the Williston/Clarion intersection declines from a B to a C in 2000, but improves to a B in 2005. Therefore, from a level of service point of view, Alternative 3 (consolidating the Mary Street intersection with the Clarion Driveway) provides the best operational performance.

There's not a clear winner among the alternatives when the resulting queue lengths are taken into account. The eastbound queue lengths on Williston Road do not result in any blockages of upstream intersections. The westbound queue lengths on Williston Road do result in blockages of Mary Street, specifically with Alternative 1. In Alternative 3, the Mary Street entrance will be blocked off, so the queue lengths are of no real concern. The Base Case volumes are already generating queues that back up to Mary Street in the PM peak hour. Therefore, an additional queue of 10-20 may not necessarily preclude any alternative from being implemented. There are a number of driveways along Williston Road, which will also be blocked under the alternatives considered.

From a design stand point, Alternatives 1 and 2 will be the easiest to implement. After removal of the concrete barriers, only a small amount of pavement will be required to connect Mary Street and Market Street. Signage may not effectively prohibit the left turns in Alternative 2, although it may be self-enforcing. A barrier or median separating the eastbound and westbound lanes on Williston Road could be designed to prohibit the left turns entering and exiting Mary Street.

The two-way volume on Mary Street with Alternative 1 is 425 vehicles in 2000 and 580 vehicles in 2005. Alternative 2 has less volume due to the prohibition on left turns. The two-way volumes resulting from Alternative 3 are 321 vehicles in 2000 and 473 vehicles in 2005. Therefore, Alternative 3 provides complete and unrestricted access to Williston Road while attracting 100 fewer vehicles than Alternative 1.

If you have any questions regarding this analysis, please don't hesitate to contact us.

Appendix A

2000 Turning Movement Volume Differences

Alternative minus Base (2000)

2000 Alt1

Mary & Williston South Burlington, VT	EB	WB	NB	SB	
LT	0	204	334	0	
TH	-167	-104	0	0	
RT	6	0	191	0	464
Enter	-161	100	525	0	464
Exit	24	230	0	210	464

Ramada & Williston South Burlington, VT	EB	WB	NB	SB	
LT	0	-5	3	0	
TH	-159	235	0	0	
RT	3	0	-3	0	74
Enter	-156	230	0	0	74
Exit	-162	238	0	-2	74

Williston & Dorset South Burlington, VT	EB	WB	NB	SB	
LT	0	-101	-299	0	
TH	13	0	0	0	
RT	-44	339	-169	0	-261
Enter	-31	238	-468	0	-261
Exit	-156	-299	339	-145	-261

Williston & Hinesburg South Burlington, VT	EB	WB	NB	SB	
LT	0	0	2	-1	
TH	-2	25	3	-4	
RT	-8	0	-1	-1	13
Enter	-10	25	4	-6	13
Exit	-4	26	3	-12	13

Williston & White South Burlington, VT	EB	WB	NB	SB	
LT	2	0	0	-1	
TH	-8	30	0	0	
RT	0	0	0	43	66
Enter	-6	30	0	42	66
Exit	-9	73	2	0	66

Dorset & Market South Burlington, VT	EB	WB	NB	SB	
LT	-363	46	0	-14	
TH	412	163	-83	-9	
RT	-1	-19	108	-119	121
Enter	48	190	25	-142	121
Exit	506	44	-465	36	121

2000 Alt2

Mary & Williston South Burlington, VT	EB	WB	NB	SB	
LT	0	0	0	0	
TH	-223	29	0	0	
RT	15	0	283	0	
Enter	-208	29	283	0	104
Exit	60	29	0	15	104

Ramada & Williston South Burlington, VT	EB	WB	NB	SB	
LT	0	-2	5	0	
TH	-206	7	0	0	
RT	1	0	-4	0	-199
Enter	-205	5	1	0	-199
Exit	-210	12	0	-1	-199

Williston & Dorset South Burlington, VT	EB	WB	NB	SB	
LT	0	-6	-24	0	
TH	51	0	0	0	
RT	-20	3	-255	0	-251
Enter	31	-3	-279	0	-251
Exit	-204	-24	3	-26	-251

Williston & Hinesburg South Burlington, VT	EB	WB	NB	SB	
LT	0	0	0	0	
TH	16	8	-10	0	
RT	14	0	-1	-1	26
Enter	30	8	-11	-1	26
Exit	15	7	-10	14	26

Williston & White South Burlington, VT	EB	WB	NB	SB	
LT	38	0	0	0	
TH	31	11	0	0	
RT	0	0	0	5	85
Enter	69	11	0	5	85
Exit	31	16	38	0	85

Dorset & Market South Burlington, VT	EB	WB	NB	SB	
LT	-227	10	0	-24	
TH	245	4	-46	-7	
RT	-1	13	39	3	9
Enter	17	27	-7	-28	9
Exit	260	7	-260	2	9

2000 Alt3

NA *	EB	WB	NB	SB	
LT					
TH					
RT					
Enter					
Exit					

** Mary Street is now aligned with the Ramada Driveway*

Mary/Ramada & Williston South Burlington, VT	EB	WB	NB	SB	
LT	0	68	579	0	
TH	-189	-196	0	0	
RT	-9	0	-6	0	247
Enter	-198	-128	573	0	247
Exit	-195	383	0	59	247

Williston & Dorset South Burlington, VT	EB	WB	NB	SB	
LT	0	-48	-443	0	
TH	-141	0	0	0	
RT	55	431	-58	0	-204
Enter	-86	383	-501	0	-204
Exit	-199	-443	431	7	-204

Williston & Hinesburg South Burlington, VT	EB	WB	NB	SB	
LT	0	1	-3	7	
TH	-66	-37	2	9	
RT	-17	34	5	1	-64
Enter	-83	-2	4	17	-64
Exit	-54	-39	36	-7	-64

Williston & White South Burlington, VT	EB	WB	NB	SB	
LT	-58	0	0	0	
TH	-89	-43	0	0	
RT	0	1	0	-26	-215
Enter	-147	-42	0	-26	-215
Exit	-89	-69	-57	0	-215

Dorset & Market South Burlington, VT	EB	WB	NB	SB	
LT	-552	20	0	-13	
TH	593	102	-153	24	
RT	-1	-16	178	-75	107
Enter	40	106	25	-64	107
Exit	758	27	-721	43	107