Office of Highway Safety

Road Safety Audit Review - FINAL

Town:	Londonderry	**Date Reviewed:**	October 8, 2015
Route:	VT 100, Middletown Rd and Main St	**Mile points:**	Area of mm 2.99

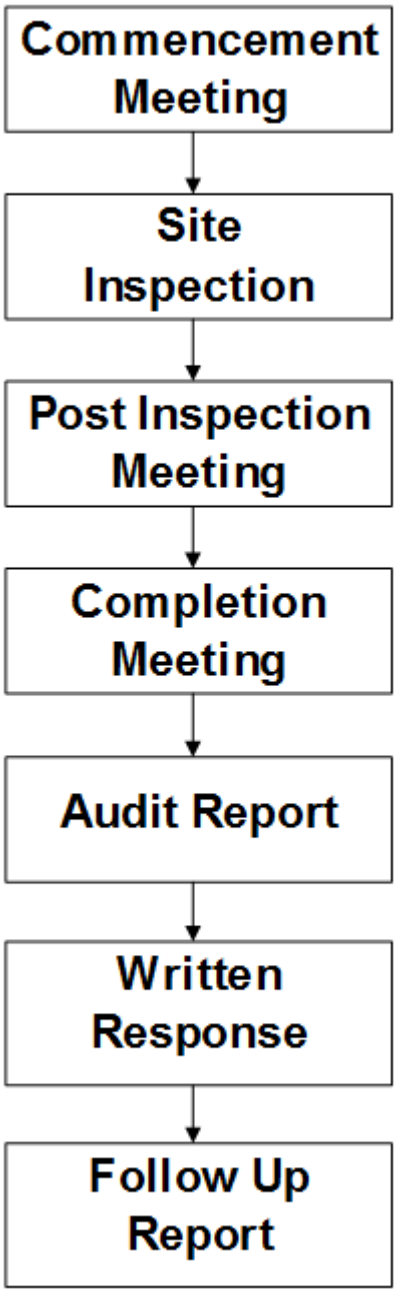
Location Map

RSAR Process

A ***Road Safety Audit Review*** (RSAR) is a formal examination of an existing road in which an independent, multi-discipline team (the Audit Team) reports on potential safety issues.

According to the Federal Highway Administration (FHWA), the purpose of a RSAR is to determine which elements of the road may present a safety concern, to what extent and under what circumstances as well as to identify opportunities to mitigate the identified safety concerns.

Figure 1 - Road Safety Audit Process



The RSAR process is composed of several steps as shown in Figure 1. The process starts with a ***Commencement Meeting*** during which the Audit Team reviews data and gathers community concerns. A ***Site Inspection*** is then performed by the Audit Team. The site visit involves the identification of safety deficiencies as seen in the field. The Audit Team will usually drive through the location of interest to “get a feel” for the area, traveling through each approach in the case of intersections. The team is to then drive at a slower speed to make observations. If needed, the team will also walk the location. Following the site inspection, the Audit Team holds a ***Post Inspection Meeting.*** It is during this meeting that the team members discuss their observations and identify safety issues. The team is to reach a consensus on the importance of each safety issue mentioned. Only those issues for which a consensus is reached are included in the RSAR findings. A RSAR report (Written Report) is prepared.

The ***Written Report*** identifies safety concerns and proposes guidance. These issues and solutions are presented in a tabular format associated to each Responsible Entity for ease of reporting. The ***Responsible Entities*** are any groups who own a roadway feature or who are responsible for making an improvement or for initiating further studies. These could include for example, the VTrans design section, the local town, the local police or the local RPC. Under a comprehensive RSAR process, the Responsible Entities are to provide a Written Response on every suggestion of the

Written Report as to its implementation. The Responsible Entity is not obliged to implement the suggestions. However, the reasons for not implementing a suggestion should be documented (e.g. physical constraints, excessive cost, environmental constraints, etc.).

Location

The location of this RSAR is the intersection of VT 100, Middletown Road and Main Street in South Londonderry.

Purpose of the RSAR

This RSAR was conducted at the request of the Windham Regional Commission (WRC) with the intent of having safety issues identified as they relate to crashes at the subject intersection.

The RSAR herein has sought to identify potential safety hazards and physical features which may affect road user safety. However, it is possible that not every deficiency has been identified. It should further be recognized that the implementation of the guidance in this report may contribute to improve the level of safety of the facility reviewed but not necessarily remove all the risks.

RSAR Participants

Mario Dupigny-Giroux,	Office of Highway Safety, VAOT
Tom Fields,	Office of Highway Safety, VAOT
Matt Mann,	Widham Regional Commission
Kevin Beattie,	Town of Londonderry
Pete Cobb,	Londonderry Volunteer Rescue Squad
George Lang,	South Londonderry Fire
Paul Gordon,	Londonderry Selectboard
Steve Prouty	Road Commissioner

Information Reviewed

Speed Limit

The posted speed limit is 30 mph on VT 100. There is a 20 mph advisory speed in both directions on VT 100 through the intersection.

There is no posted speed limit on Middletown Road or Main Street.

Traffic Volumes

On VT 100 at this intersection and between Winhall Hollow Road and VT 11, the 2012 Average Annual Daily Traffic (AADT) was 1700 vehicles per day.

The latest 12-hour turning movement count was done in 2014 and is summarized in the next figure. The previous count was done in 2012. The 2014 turning movement count indicates that the heaviest movements of travel are on VT 100 traveling from south to north and from north to south.

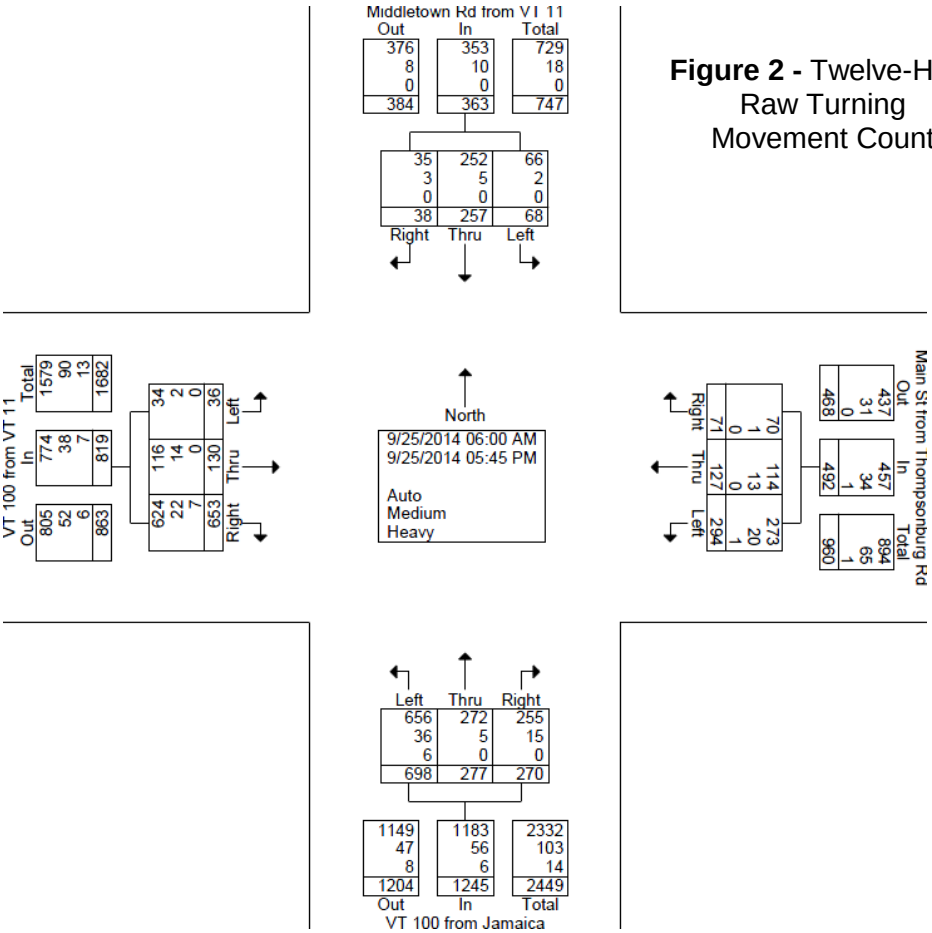


Figure 2 - Twelve-Hour Raw Turning Movement Count

The 2014 Turning Movement Report is provided at the end of this report.

Geometry

This is a four-way intersection with VT 100 through this intersection following a 31-degree curve (to the left when traveling northbound and to the right when traveling southbound on VT 100).

At this intersection, the northbound approach of VT 100 is located on the south side of the intersection while the southbound approach of VT 100 is located on the west side of the intersection. Middletown Rd is located on the north side of the intersection and Main St on the east side.

In terms of vertical alignment, the southbound approach of VT 100 has an 8.9% downgrade, Middletown Rd follows a significant downgrade as it intersects with VT 100 and the Main St approach of the intersection is slightly lower than the VT 100 northbound approach.

Signs and Markings

Approaching the intersection in both directions on VT 100, there are modified turn signs (i.e., a sign displaying both a turning arrow and an intersecting road) with a 20 mph advisory speed plaque below them. These signs are followed by a VT 100 route marker assembly with a directional arrow and a cardinal direction.

There are stop signs on Main St and Middle Town Rd.

Bridge Structure

Bridge 00090 is located on VT 100 on the south approach of the intersection. This bridge was reconstructed in 1972. This bridge was inspected in June 2015. It was found that the structure was in fair condition. The inspection report mentioned that the tear drop rail needed to be repaired.

Pavement Conditions

2011 data show that pavement conditions on VT 100 were rated as very poor by VTrans. Since 2014, pavement conditions have been rated as being good south of the intersection. The pavement conditions north of the intersections are currently rated as good.

Past Projects

The portion of VT 100 south of the “north” approach which also includes VT 100 within the intersection was paved in 2014. The portion north of the “north” approach was paved in 2015.

The traffic signs along VT 100 were installed in 2010.

Future Projects

Middletown Rd was part of a safety review by VTrans in summer 2015. Specifically concerning the intersection with VT 100, a stop a head sign will be installed along with a stop bar and the word markings “STOP”.

Crash History

The crash history was reviewed in the area of the intersection for the five-year period covering the years 2010 to 2014. Crashes that took place during 2015 up to the time of this review were also examined to provide additional insight. This intersection is not currently defined as a high crash location.

A collision diagram and the law enforcement narrative for each of the crashes are provided at the end of this report.

There were a total of three crashes at this intersection between 2010 and 2014. Three additional crashes took place in 2015.

All the crashes that took place at this intersection involved a vehicle that was traveling southbound on VT 100.

The main crash pattern at this intersection is a right angle collision (this corresponds to four of the six crashes at this intersection). Seventy-five percent of the crashes involving this type of crash occurred when a southbound vehicle on VT 100 continued straight onto Main St without yielding to oncoming traffic from the right (VT 100 northbound). In one of the crash reports, the operator at fault specifically stated that he felt that he had the right-of-way.

A second crash pattern of interest is a southbound vehicle that loses traction and control on an icy road surface. Of the six crashes investigated at this intersection, an icy road surface was the contributing factor in three crashes. These crashes were not concentrated in a particular year but happened over several years (one each in 2013, 2014 and 2015), indicating a more recurring issue.

Current Local Concerns

The following comments were obtained during the commencement meeting.

Town representatives mentioned that the intersection had a tight radius for trucks to maneuver through the intersection.

Town representatives mentioned that motorists that stop on Main St have to inch into the intersection in order to see oncoming traffic from VT 100 northbound due to the bridge railing.

Town representatives mentioned that to their knowledge, many of the locals that traveled on VT 100 southbound were slowing down or stopping before entering the intersection.

Town representatives mentioned that there were several crashes that had not been reported (mostly vehicles traveling southbound and losing control on snow or ice).

Safety Concerns Identified

This section lists the areas of safety concern identified by the audit team during the site inspection and from the analysis of available data. This section also reports the potential remedial actions identified by the audit team. The concerns are not listed in order of importance.

1st Concern

There is poor corner sight distance when stopped on the Main St approach and looking towards the VT 100 northbound approach (i.e., when looking to the left).

The following series of three pictures show what is seen by a vehicle that is stopped where the stop sign is located, where the stop bar should be located and when creeping into the road.

This poor condition is mainly caused by the presence of the bridge railing which makes it very difficult to see oncoming traffic through it as one approaches the intersection.

It is also difficult to see oncoming traffic wen stopped at the stop sign. It is only when the nose of the vehicle is in the road that an operator can start seeing traffic.

It is questionable whether the presence of the flower boxes contributes to the limited visibility and if it is possible to see the top of a small car without them being there.

Brush in this quadrant including the vine that is growing up the sign posts is also somewhat distracting.

Approaching the Intersection

Stopped at the Stop Sign

Stopped where the Stop Bar Should Be

Creeping into the Road

Short Term Actions (up to a year)

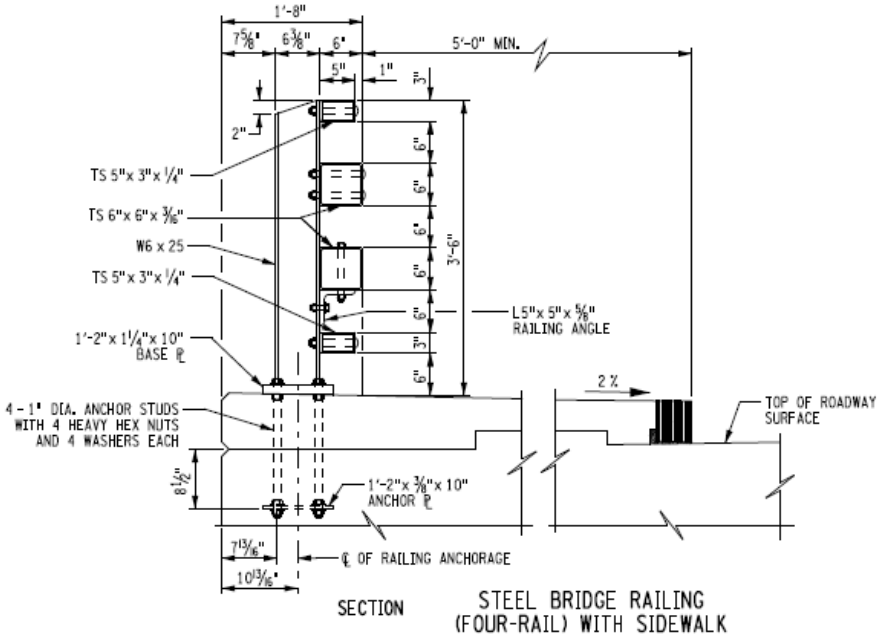
To improve the positioning of vehicles when they stop on the Main St approach so that visibility to oncoming traffic is improved, a stop bar and the “STOP” word markings should be installed (The proper location for a stop bar is typically four feet from the edge of the road). In addition, the yellow center line should be extended up to the stop bar.

Brush in this quadrant should be trimmed.

Should the flower boxes be removed (or lowered so the top is flush with the bridge rail)?

Mid to Long Term Actions

Evaluate the possibility of designing and installing an acceptable railing that would permit vehicles on the bridge from being visible to cars on Main St. For example, would the design on the right serve that purpose?



2nd Concern

Some operators who are traveling southbound on VT 100 with the intention of continuing on Main Street are not yielding to traffic that is coming from VT 100 northbound (i.e., traffic that is coming from the right).

Immediate to Short Term Actions (up to a year)

The idea of the following short term actions is to make it more obvious to motorists who are coming from VT 100 southbound and continuing straight onto Main St that they have to yield to traffic coming from the right of the intersection.

There are currently modified turn signs on VT 100 in both directions. The size of these signs is currently 30” x 30”. The size required by the Manual on Traffic Control Devises (MUTCD) for these signs is 36” x 36”. The signs should be upgraded to the larger size.

Install a dotted white edgeline extension through the intersection. There is already an extension for the yellow centerline. Having the edgeline delineated in a similar manner would enhance the fact that the main movement is around the curve.

Install a “Main St” street name sign above the stop sign on Main St.

MUTCD sign W4-4ap is a yellow plaque that says “traffic from left does not stop” (or to the right as applicable). The Manual on Traffic Control Devises stipulates that if such a sign is to be used, that it shall be installed under a stop sign.

While its usage might not be as intended, installing this plaque along with the modified turn sign on the southbound approach would be one way to convey to motorists that they should yield to traffic that is coming from the right.

Alternatively, a warning diamond sign with the same text message (Traffic from Right Does not Stop) could be installed following the modified intersection sign.

Yet, another alternative could be to create a sign with the similar concept than MUTCD sign R10-15. For example, a design such as the one shown at the right could be explored. This sign would also be installed following the modified turn sign.

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Option A: Install the W4-4ap plaque with the existing modified turn assembly.

Option B: Various arrangements could be considered if one of the following concepts was used.

1) Install sign at location A.

2) Move the VT 100 South sign at location A and install the sign where the VT 100 South sign was.

3) Install the sign at the intersection at location B (but not to interfere with corner sight distance). Optionally Move the VT 100 South sign at location A.

Under option B and even under option A, a warning beacon could be installed above the sign to add additional emphasis.

There are currently 20 mph advisory speed plaques in both directions on VT 100. These were verified during the field inspection with a ball bank indicator. A reading of 14 degrees was obtained at 20 mph in the southbound direction and a reading of 12 degrees was obtained at 15 mph confirming that the 20 mph advisory speed in appropriate in the southbound direction.

Northbound, readings of 15 to 17 degrees were obtained at a speed of 15 mph. Maintaining a speed of 20 mph through the curve in this direction is harder to achieve and additional measurements should be taken to confirm the advisory speed in this direction.

3rd Concern

At this location, VT 100 southbound prior to the intersection is prone to icing and instances of motorists not being able to slow down and continuing across the intersection are common.

Immediate to Short Term Actions

As a first step, the Town and the District should meet to discuss winter maintenance at this intersection.

Mid Term Actions

To reduce the incidences of crashes occurring on an icy road surface, the use of an anti-icing overlay could be considered. As demonstrated by VTrans in a recent research project, the anti-icing product manufactured under the name Cargill SafeLane® HDX Overlay showed to be efficient at reducing crashes. However, due to unresolved problems with durability, the recommendation has been to halt the use of this product on Vermont roads.

It appears that the manufacturer recently developed another product that can be added to a typical asphalt mix. Although VT 100 at this location was recently resurfaced, due to the history of icy-road related crashes at this site, this location remains a candidate location that could be

considered as part of a new research project for the application of an anti-icing surface with this type of additive.

Another approach could be to warn motorists that the road surface is icy. This could be achieved by using a dynamic ice warning system.

The system would include a diamond warning sign with the text ICING MAY OCCUR WHEN FLASHING. This sign would be installed in advance of the intersection, at the top of the hill on VT 100 southbound. The sign would be flashing when ice is detected. This could be achieved by using a regular warning beacon above the sign or with a series of Light Emitting Diode units (LEDs) in the border of the sign.

Detection of icy conditions would be achieved with a non-intrusive road surface sensor capable of detecting ice on the road surface. The system could have the capabilities of being monitored remotely using a web-based application.

Other Countermeasures Considered

There were two remedial actions that were discussed and evaluated to a certain degree within this report.

The first was an overhead intersection flashing beacon. The Manual on Uniform Traffic Control Devices stipulates that the signal indications on each face of the beacon shall be circular yellow or circular red. In addition, the Manual on Uniform Traffic Control Devices also stipulates that the flashing yellow signal indication shall not face conflicting approaches.

In the current case, the main flow of traffic is on VT 100 and if an overhead intersection beacon was installed, this flow of traffic would be controlled with a yellow flashing indication on both approaches. These yellow indications would indicate that traffic on VT 100 had the right-of-way. However, VT 100 has one approach on the south side of the intersection and the other one on the west side of the intersection. Because both VT 100 approaches would face a yellow indication, this would result in a conflict and an overhead beacon would not be allowed by the Manual on Uniform Traffic Control Devices. Consequently, an intersection flashing beacon with

a circular yellow indications on VT 100 and a circular red indications on the side roads is not appropriate at this location. Given the current geometry and traffic patterns, the only way that an intersection flashing beacon could be installed is if the intersection was controlled by stop signs on all approaches and that all the indications on the beacon were red.

The second action that was evaluated is controlling the intersection with stop signs on all approaches. Clearly, stopping all traffic at this intersection from all approaches would eliminate the confusion that some VT 100 southbound motorists who want to cross the intersection onto Main St have with respect to them having the right-of-way (2nd concern previously discussed).

On the other hand, the Manual on Uniform Traffic Control Devices provides guidance as to when it is appropriate to control traffic with multi-way stop signs. One of the leading criteria is that the traffic volumes be approximately equal on all approaches. Another set of criteria are bundled into warrants. A formal warrant analysis was performed by VTrans. Based on the volumes and crash criteria, it was found that multi-way stop operation was not warranted at this location. The results of the warrants are presented at the end of this report. Based on this information alone, multi-way stop controlled for this intersection cannot be supported.

While the main warrants do not support the application of multi-way stop control, the Manual on Uniform Traffic Control Devices provides other guidance that may be considered. One of these other conditions is the need to control left-turn conflicts. Crossing over onto Main St from VT 100 southbound could possibly be considered a left turn maneuver since the continuous (through) movement is along the curve on VT 100. Another condition would be where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop. This condition could possibly describe the first concern mentioned earlier.

Action Plans

The safety concerns and potential actions that were identified in the previous sections are further summarized in the next table. In this table, the safety issues of concern are listed in the first column. The second set of columns identifies the groups that are most likely capable of implementing the solutions that are shown in the third column.

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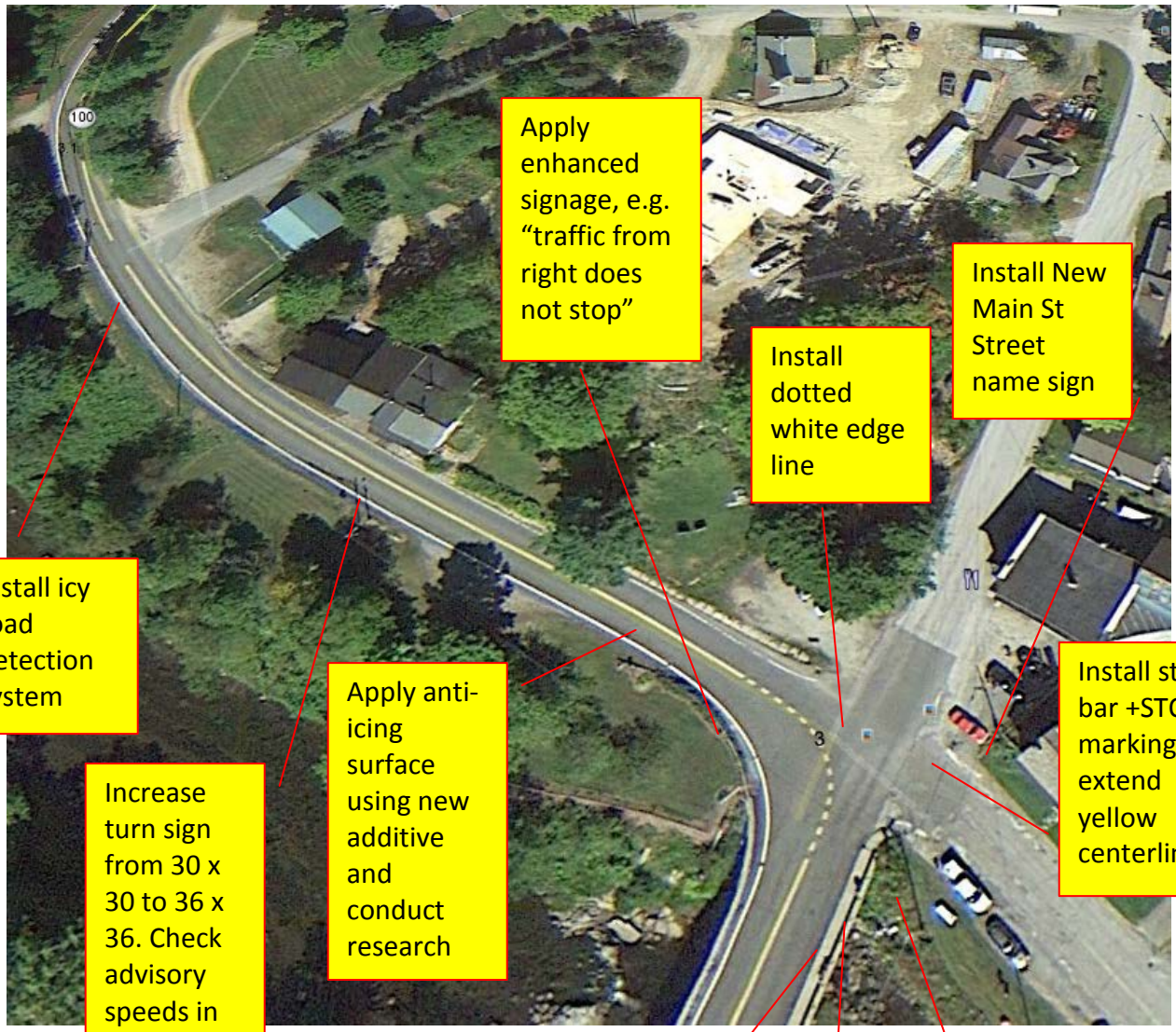
Summary of Suggested Actions



Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
1ST Concern Poor corner sight distance when stopped on the Main St approach and looking towards the VT 100 northbound approach (including difficulty to see oncoming traffic when approaching the intersection due to the bridge railing).		X		X				**Short Term Actions (up to a year)** Install a stop bar (4 ft from edge of road) and the "STOP" word markings on the Main Street Approach. Extend the double yellow centerline up to the new stop bar (include the change in the annual markings plan).			
		X		X				Trim brush in southeast quadrant, including along sign posts.			
		X						Consider removing or lowering the flower boxes.			
						X		**Mid to Long Term Actions** Evaluate the possibility of designing and installing an acceptable railing that would permit vehicles on the bridge from being visible to cars on Main St.			

Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
			X					**Short Term Actions (up to a year)** Increase the size of the modified turn signs which show intersecting roads from 30" x 30" to 36" x 36" (via work order).			
2ND Concern Southbound VT 100 vehicles that continue on Main Street are not yielding to traffic that is coming from VT 100 northbound (i.e., coming from the right).			X					Install a dotted white edgeline extension through the intersection to supplement the yellow extension (via work order).			
		X						Install a "Main St" street name sign above the stop sign on Main St.			
			X					Evaluate the use of enhanced signage such as Traffic from Right Does not Stop. Possibly emphasize new sign by adding a flashing beacon (via work order).			

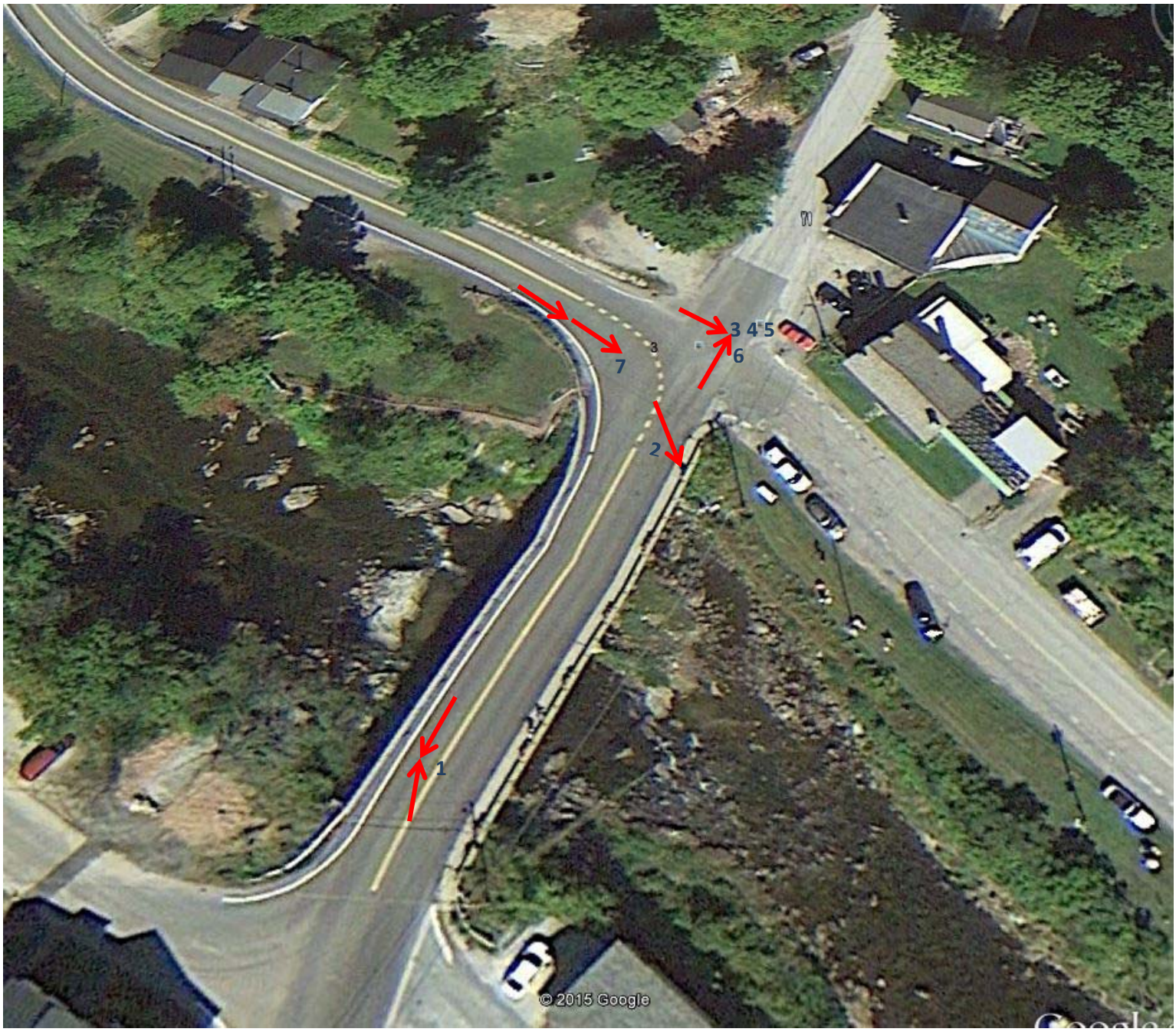
Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
		X	X					**Short Term Actions** The Town and the District should meet to discuss winter maintenance at this intersection.			
3RD Concern Due to an icy road surface on VT 100 SB, motorists are not being able to slow down and are continuing across the intersection.			X					Evaluate the advisory speeds, especially northbound (via work order).			
					X		X	**Mid Term Actions** Conduct a new research project for the application of an anti-icing surface with the new additive developed by Cargill, **OR**			
	X		X		X			Warn motorists that the road surface is icy using a dynamic ice warning system with icy conditions detected using a non-intrusive road surface sensor (via work order, HRRR project or HSIP project).			

Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
			X					VT 100 SB motorists are expecting traffic from the right to stop when crossing. Traffic on Main St has a hard time seeing oncoming traffic from the left after stopping. Evaluate the extent of these conditions and the potential application of all-way stop control.			

Collision Diagram

2010 to Now

(i.e., what is currently available as of October 13, 2015)



Vermont Agency of Transportation

Date: 10/13/2015

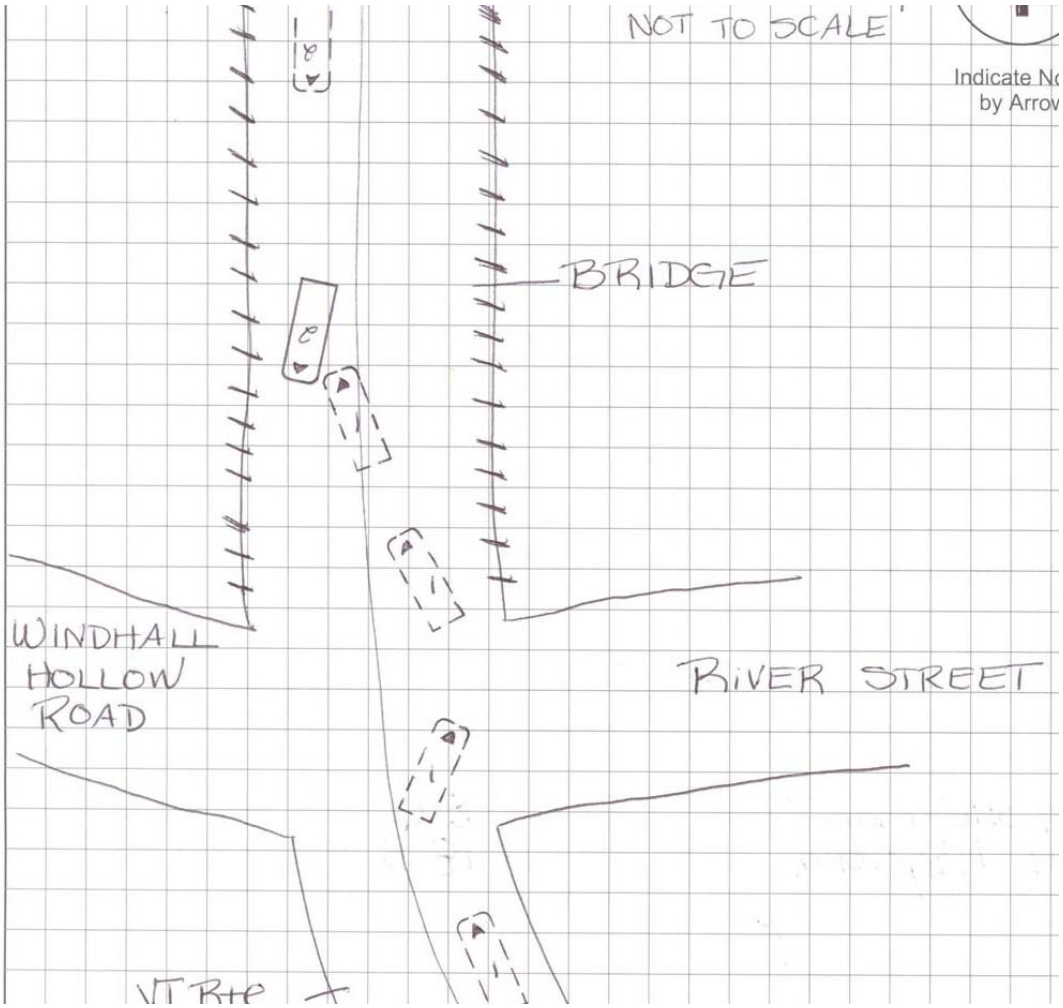
General Yearly Summaries - Crash Listing: State Highways and All Federal Aid Highway Systems

From 01/01/10 To 10/13/15 General Yearly Summaries Information

	*	Reporting Agency/ Number	Town	Mile Marker	Date MM/DD/YY	Time	Weather	Contributing Circumstances	Direction Of Collision	Number Of Injuries	Number Of Fatalities	Number Of Untimely Deaths	Direction	Road Group
Route: VT-100														
		VTVSP0400/13D10 1762	Londonderry	0	06/10/2013	13:22				0	0	0		SH
		VTVSP0400/13D10 4135	Londonderry	0.13	12/29/2013	21:50				0	0	0		SH
		VTVSP0400/13D10 4154	Londonderry	0.13	12/30/2013	22:19				0	0	0		SH
		VTVSP1000/11D20 0275	Londonderry	0.3	01/24/2011	08:30	Clear	Failure to keep in proper lane, Inattention	Single Vehicle Crash	0	0	0	N	SH
		VTVSP0400/13D10 3981	Londonderry	0.5	12/18/2013	15:25	Cloudy	Driving too fast for conditions, Failure to keep in proper lane	Single Vehicle Crash	0	0	0	N	SH
		VTVSP0400/14D10 3652	Londonderry	0.98	11/26/2014	13:40	Snow	Failed to yield right of way, Failure to keep in proper lane, No improper driving	Rear End	0	0	0	N	SH
		VTVSP0400/15D10 2284	Londonderry	0.98	07/18/2015	15:10	Clear	Failure to keep in proper lane, Fatigued, asleep	Single Vehicle Crash	1	0	0	N	SH
		VTVSP0400/11D10 1820	Londonderry	0.99	06/23/2011	07:10	Cloudy	Followed too closely, Inattention, No improper driving	Rear End	1	0	0	N	SH
		VTVSP0400/14D10 3023	Londonderry	1.16	09/29/2014	05:45	Clear	Other improper action	Single Vehicle Crash	0	0	0		SH
		VTVSP0400/10D10 0200	Londonderry	1.4	01/19/2010	22:46	Snow	Driving too fast for conditions, Operating defective equipment	Same Direction Sideswipe	0	0	0	S	SH
		VTVSP0400/14D10 3562	Londonderry	1.69	11/19/2014	07:40	Clear	Failure to keep in proper lane, Other Inside Vehicle	Single Vehicle Crash	0	0	0	S	SH
		VTVSP0400/10D10 0911	Londonderry	1.88	03/26/2010	18:02	Clear	Under the influence of medication/drugs/alcohol, Failed to yield right of way	No Turns, Thru moves only, Broadside ^<	0	0	0	N	SH
		VTVSP0400/10D10 1184	Londonderry	1.89	04/30/2010	14:40	Clear	Failed to yield right of way, No improper driving	Left Turn and Thru, Same Direction Sideswipe/Angle Crash vv--	0	0	0	S	SH
		VTVSP0400/11D10 0245	Londonderry	1.89	01/22/2011	16:14	Cloudy	Failure to keep in proper lane, Under the influence of medication/drugs/alcohol, No improper driving	Right Turn and Thru, Broadside ^<--	0	0	0	N	SH
		VTVSP0400/10D10 0050	Londonderry	1.92	01/04/2010	16:13	Clear	No improper driving, Failed to yield right of way	No Turns, Thru moves only, Broadside ^<	0	0	0	S	SH
		VTVSP0400/12D10 3017	Londonderry	2.33	09/16/2012	11:47	Clear	Driving too fast for conditions, Distracted	Single Vehicle Crash	1	0	0	N	SH
		VTVSP1000/10D20 0710	Londonderry	2.45	03/14/2010	00:05	Snow	Driving too fast for conditions	Single Vehicle Crash	0	0	0	N	SH
		VTVSP0400/12D10 0431	Londonderry	2.93	02/06/2012	15:45	Clear	Wrong side or wrong way, Fatigued, asleep	Single Vehicle Crash	0	0	0	S	SH
1		VTVSP0400/14D10 0063	Londonderry	2.95	01/04/2014	12:46	Clear	Driving too fast for conditions, Failure to keep in proper lane, No improper driving	Opp Direction Sideswipe	0	0	0	N	SH
2		VTVSP0400/13D10 4061	Londonderry	2.98	12/26/2013	12:07	Clear	Driving too fast for conditions	Single Vehicle Crash	0	0	0	S	SH
3		VTVSP0400/14D10 0042	Londonderry	2.99	01/03/2014	09:16	Clear		No Turns, Thru moves only, Broadside ^<	0	0	0	N	SH
5		VTVSP0400/13D10 3055	Londonderry	3	09/28/2013	15:18	Clear	Failed to yield right of way, Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner, No improper driving		0	0	0		SH
7		VTVSP0400/15D10 0353	Londonderry	3	02/02/2015	17:43	Clear	Inattention, Followed too closely, No improper driving	Rear End	0	0	0	S	SH
4		VTVSP0400/15D10 1494	Londonderry	3	05/15/2015	15:09	Cloudy	No improper driving	No Turns, Thru moves only, Broadside ^<	1	0	0		SH
6		VTVSP0400/15D10 2689	Londonderry	3	08/22/2015	16:42	Clear	No improper driving, Failed to yield right of way	Left Turn and Thru, Broadside v<--	0	0	0	N	SH
		VTVSP0400/14D10 2348	Londonderry	3.18	07/30/2014	17:11	Clear	Under the influence of medication/drugs/alcohol, Not Distracted	Single Vehicle Crash	0	0	0		SH

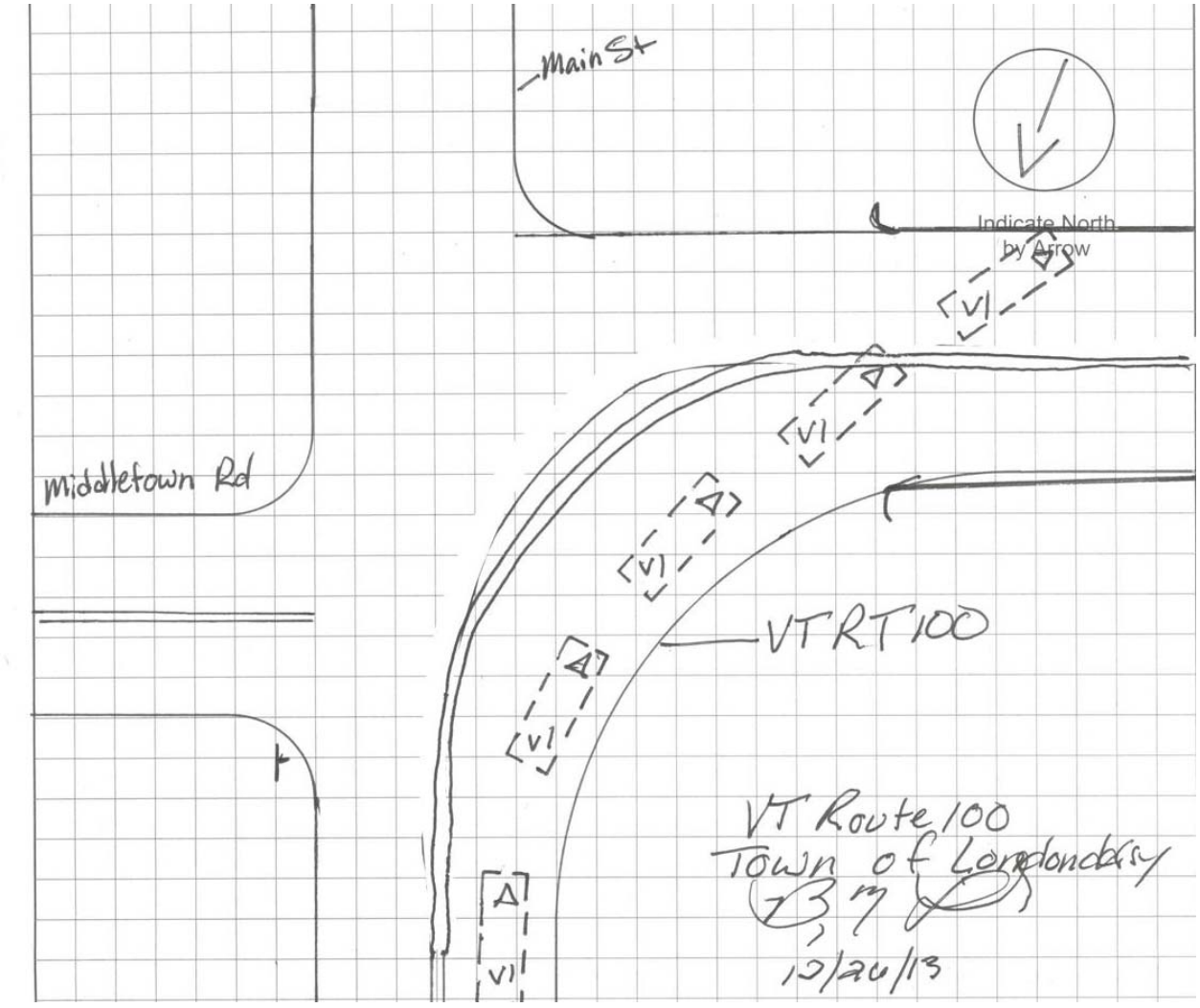
**Crash occurred prior to the last Highway Improvement Project. This data should not be used in a crash analysis. UNK indicates the Mile Marker is Unknown.*

14D100063 **1**



On 01/04/14, at approximately 1246 hours, two-vehicle crash on the bridge on Rte 100 in the town on S. Londonderry. There were unknown injuries. Weather at the time was sunny with precipitation. The roadways were snow covered and slippery. Op 1 advised he was traveling down the hill at a speed believed to be 20 miles an hour when he lost control of his vehicle and then collided with a vehicle traveling in the opposite direction. Operator #2 was traveling south over the bridge on Rte 100 when she observed the oncoming vehicle start to skid out of control. Investigation revealed that op 1 was traveling north on Rte 100, down a steep hill in the town of S. Londonderry just south of the West River bridge. Op 1's vehicle started to skid out of control into the southbound lane subsequently hitting Op 2 vehicle.

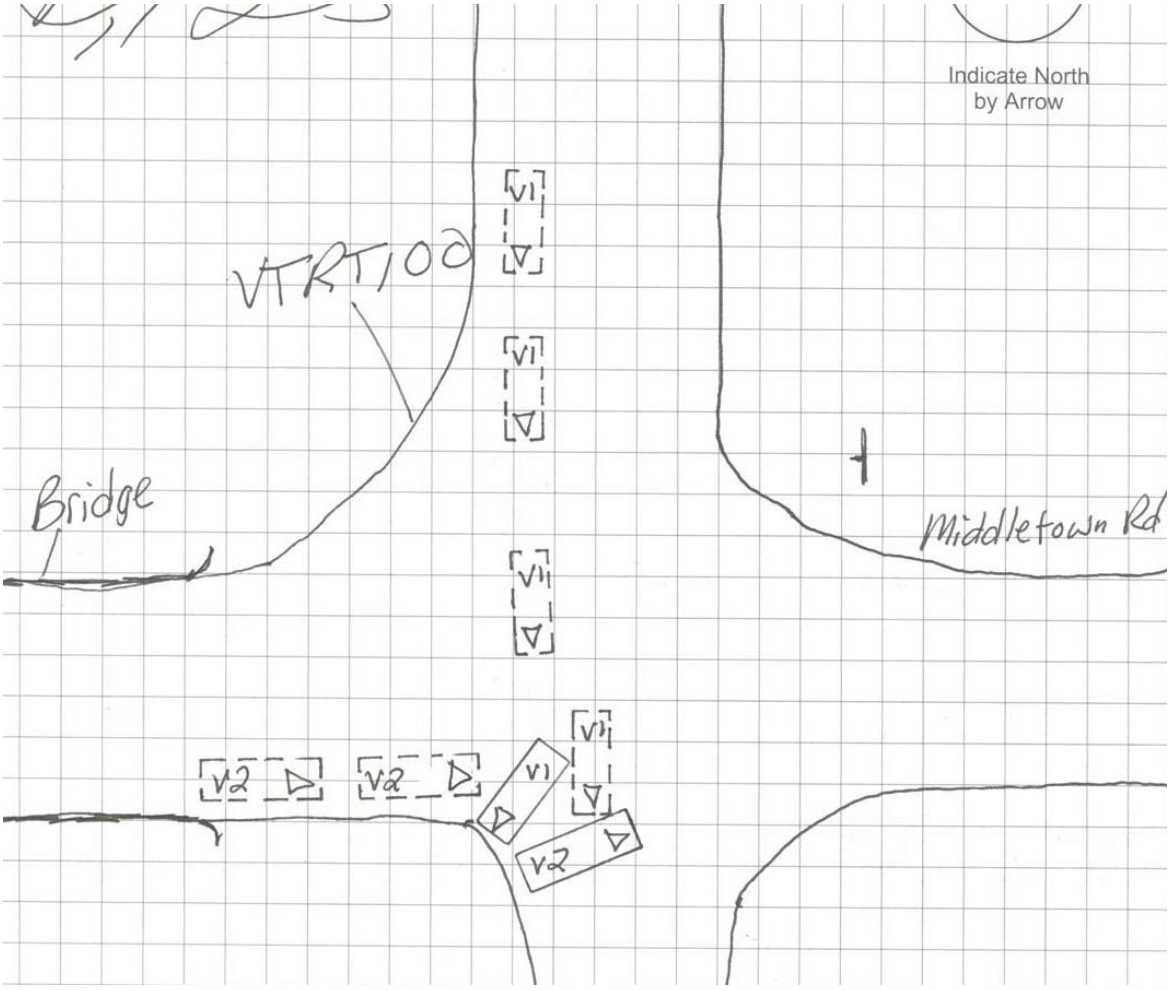
13D104061 **2**



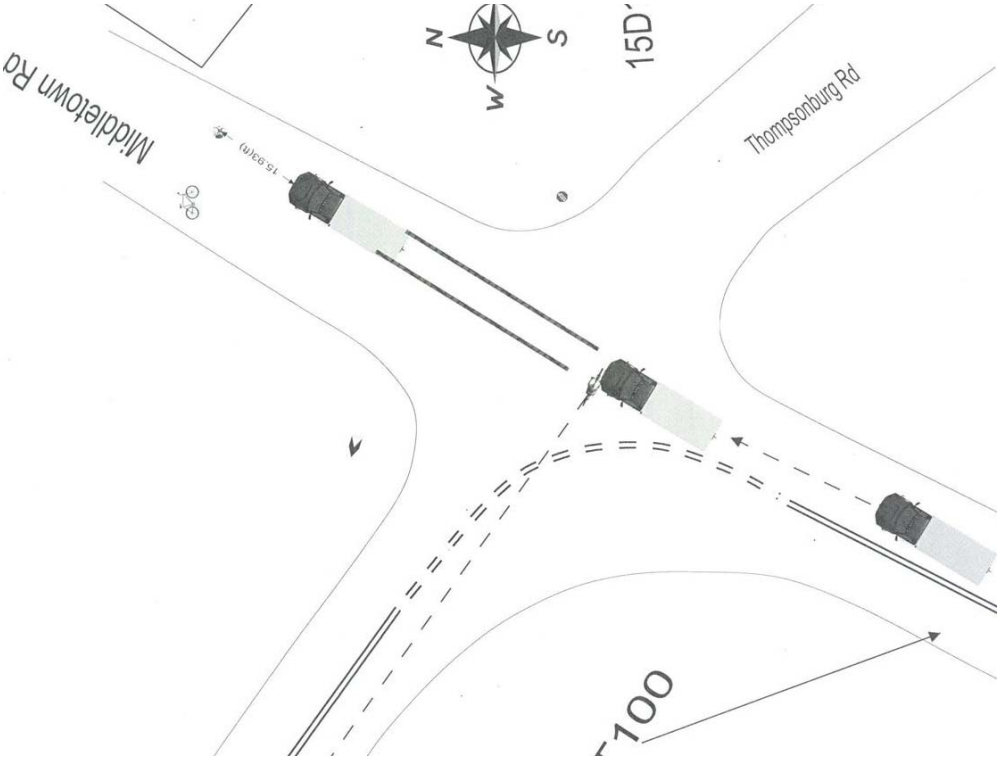
On December 26, 2013 at approximately 1207 hours, a one car motor vehicle crash located at the intersection of Vermont Route 100 and Main Street, in the Village of South Londonderry. The weather at the time consisted of fair skies and the blacktop roadway was icy in spots. Op 1 advised she was traveling southbound at approximately 20 miles per hour, on Vermont Route 100. Operator # 1 advised Vehicle # 1 lost traction causing Vehicle # 1 to cross the center line and crash into a guardrail of the bridge. Operator # 1 advised she was uninjured. Investigation revealed Vehicle # 1 was traveling Southbound on Vermont Route 100. Vehicle # 1 lost traction causing Operator # 1 to lose control of her vehicle and cross the center line and crash into a guardrail of the bridge.

14D100042 **3**

On January 3, 2014 at approximately 0916 hours, two-car motor vehicle crash located on Route 100, at the intersection of Main Street. The weather at the time consisted of clear skis and the gravel roadway was icy. Operator # 1 advised he was traveling southbound on Route 100 at approximately 15 miles per hour, when he lost traction from the icy road conditions, causing Vehicle # 1 to crash into Vehicle # 2. Operator # 1 advised he was not injured. Operator # 2 advised he was traveling northbound on Route 100 at approximately 5 miles per hour, preparing to turn right onto Main Street. Operator # 2 advised as he was making the right turn, he observed Vehicle # 1 lose control of his vehicle and crash into Vehicle # 2. Operator # 2 advised he was not injured. Investigation revealed that Vehicle # 1 was traveling southbound on Route 100. As Vehicle # 1 was approaching the intersection of Main Street, Vehicle # 1 lost control and crashed into Vehicle #2 while Vehicle # 2 was in the northbound lane of Route 100 and turning onto Main Street.



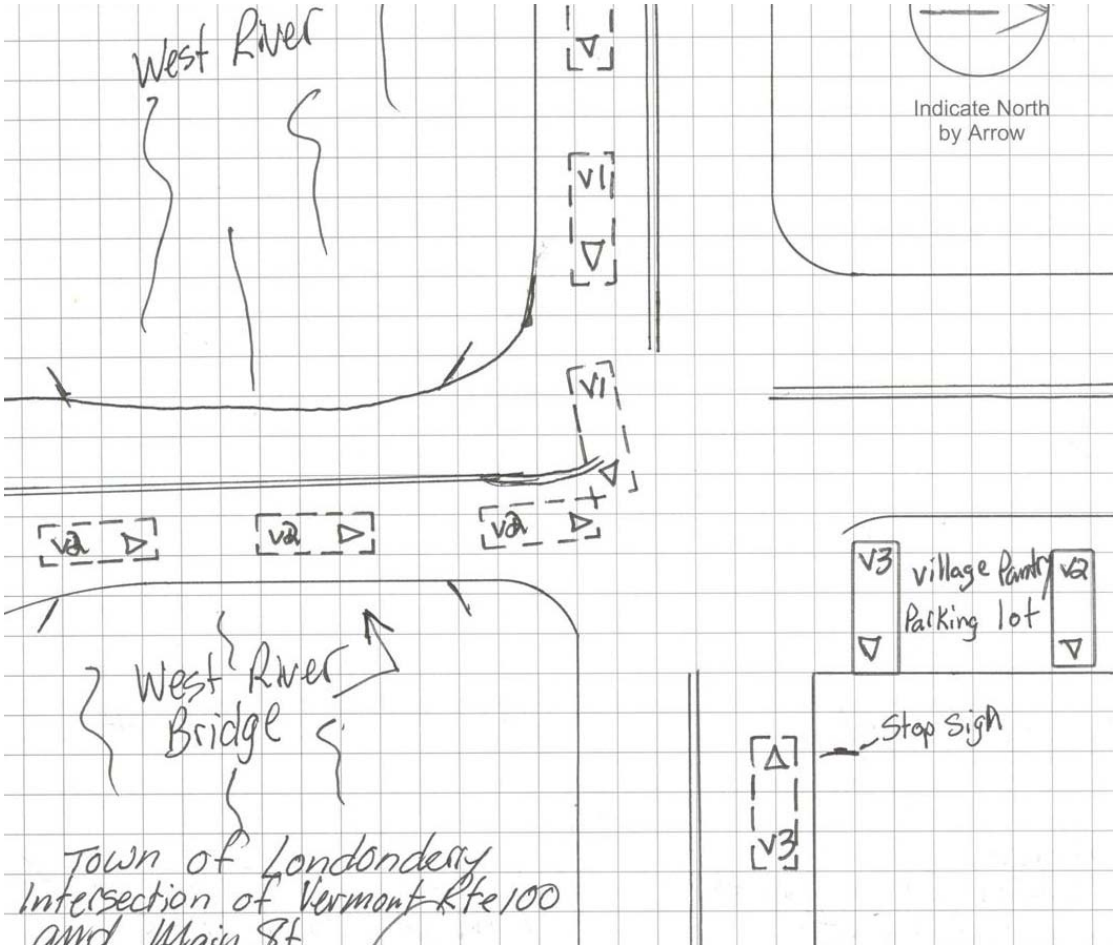
15D101494 **4**



On 05/15/15 at approximately 1510 hours, a bicyclist versus truck crash at the intersection of Route 100 and Middletown. Op 1 advised she was travelling north on VT 100 and continuing straight at the intersection to travel onto Middletown Road. Said she was traveling approximately 25 to 28 mph and didn't see the bicyclist until he collided with the front left of her vehicle. Witness 1 was travelling in front of OP 1 and continued north on VT 100 at the intersection. She advised she saw the bicyclist travelling south on VT 100 entering the intersection without yielding to traffic. Witness 2 was following Op 1 and advised he saw the entire crash. He said it did not appear the bicyclist slowed or looked for oncoming traffic and attempted to cross VT 100 to continue on Thompsonburg Road. He said the bicycle was travelling quickly. Skid marks measured approximately 37'8" in length originated in the northbound lane of Route 100 and ended at the rear tires of vehicle #1. Utilizing the skid, the to stop formula and a friction coefficient of .76, the officer determined that the skid to stop speed would be approximately 29 MPH, which corroborated the statement of operator #1. On 05/16/15 officer spoke with the bicyclist's mother, he asked her what her son had said about the crash. She said that he was riding his road bike with the intention of traveling across Route 100 on to Thompsonburg Road. He said that he thought that the truck was slowing down but then sped up. On 05/19/15 son advised that he did not remember much about the crash but he did have a tracker app (Road Bike Pro) running which

indicated that the collision happened in his lane and he was going 7 MPH. Based upon the statements received and the physical evidence, specifically the skid marks left by vehicle #1, the officer believe that this crash occurred as a result of the bicyclist failing to yield to vehicle #1 as it was making way toward Middletown Road from the northbound lane of Route 100. It was the intention of the bicyclist to cross the northbound lane of Route 100 and travel east on Thompsonburg Road. Vehicle #1 was traveling north in the northbound lane of Route 100 and was intending to travel straight onto Middletown Road.

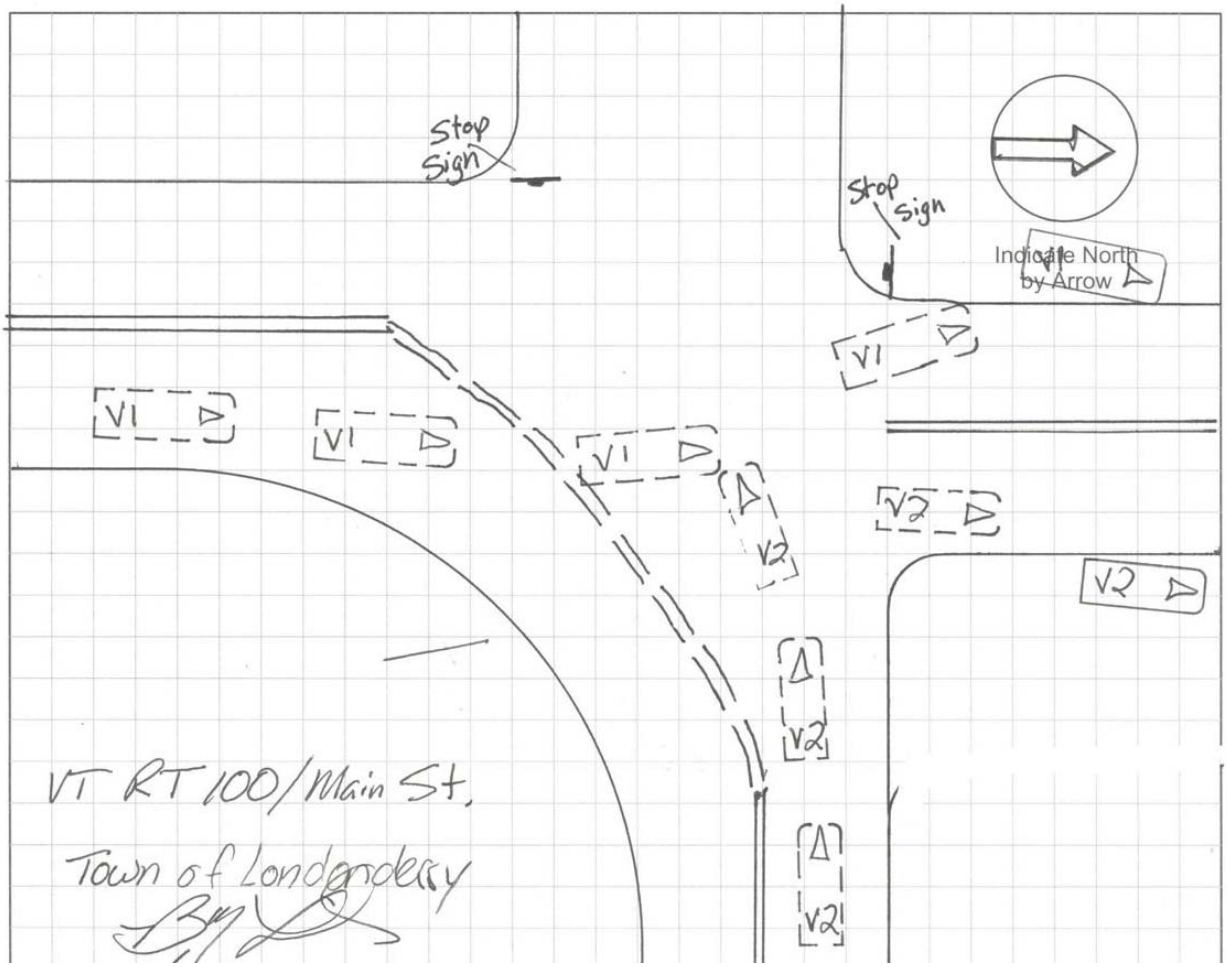
13D103055 **5**



On September 28, 2013 at approximately 1518 hours, a three-car motor vehicle crash located at the intersection of Vermont Route 100 and Main Street. The weather at the time consisted of clear skies and the blacktop roadway was clear and dry. Operator # 2 advised he was traveling northbound on Route 100 at approximately 20 miles per hour. Operator # 2 advised as he was approaching the intersection of Middletown Road, he observed Vehicle # 1 traveling Southbound on Vermont Route 100. Operator # 2 advised Vehicle # 1 turned left off of Route 100 and onto Main St. Operator # 2 advised when Vehicle # 1 turned onto Main St. Vehicle # 1 failed to yield and crashed into Vehicle # 2. Operator # 2 advised after Vehicle # 1 crashed into Vehicle # 2, he observed Vehicle # 1 then crashed into Vehicle # 3, that was stopped at the stop sign at the intersection of Main St. and Route 100. Operator # 2 advised that he was unable to tell what Vehicle # 1's registration was, but could only provide that Vehicle # 1 was a blue pick-up truck, and that it continued to leave the scene north on Main St. and then onto Thompsonberg Rd. Operator # 3 advised he was stopped at the stop sign on Main St. and was waiting to safely turn south on Route 100. Before he made the turn, he advised he witnessed a blue pick-up truck, (Vehicle # 1), traveling southbound on Route 100. Operator # 3 advised he observed Vehicle # 1 then failed to yield to Vehicle # 2 before turning onto Main St., crashing into Vehicle # 2's front bumper and then bouncing off of Vehicle # 2 and into the front driver side fender of Vehicle # 3.

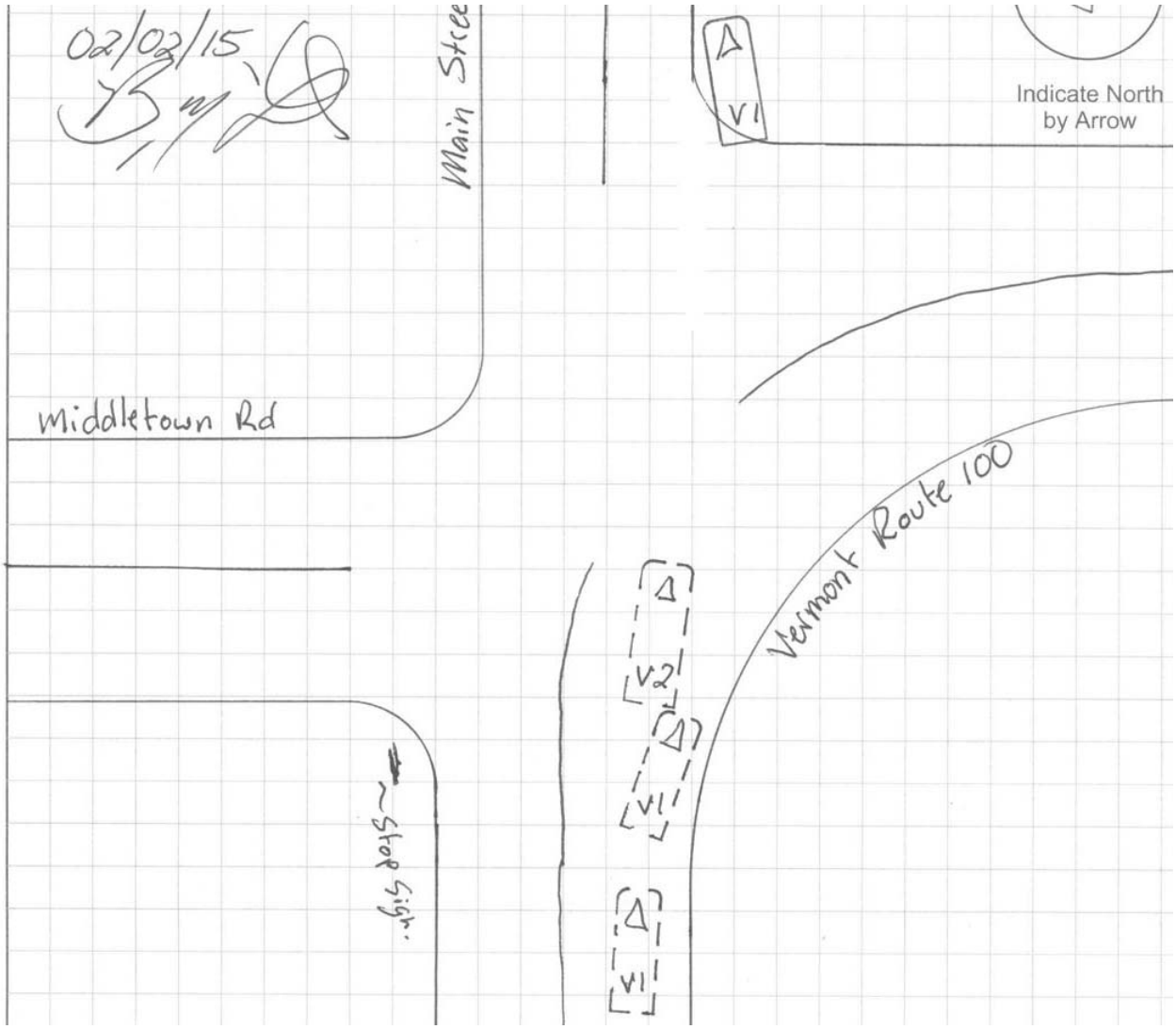
Operator # 3 advised he also witnessed Vehicle # 1 leave the scene of the crash and continue north on Main St. and continuing onto Thompsonberg Rd. Investigation revealed that Vehicle # 1 was traveling southbound on Route 100 approaching the intersection of Main St., when Vehicle # 1 failed to yield to Vehicle # 2 when he was traveling northbound on Route 100 at the same time. Vehicle # 1 then continued through the intersection glancing off of Vehicle # 3, causing minor damage to the front driver side fender.

15D102689 **6**



On August 22, 2015 at approximately 1642 hours, a two-car motor vehicle crash located at the intersection of Vermont Route 100 and Main Street, in the Town of Londonderry. Operator # 1 advised he was traveling southbound on Vermont Route 100 at approximately 35 miles per hour. Operator # 1 advised he was preparing to turn off Vermont Route 100 and onto Main Street. He advised he observed Vehicle # 2 traveling northbound. Operator # 1 advised he was going straight and felt he had the right of way. Statements- Operator # 2 advised he was traveling northbound on Vermont Route 100 at approximately 30 miles per hour, when he observed Vehicle # 1 traveling southbound. Operator # 2 advised she continued north and was then crashed into by Vehicle # 1. Investigation revealed that Vehicle # 1 was traveling south on Vermont Route 100. When Vehicle # 1 got to the intersection of Main Street, Vehicle # 1, turned left onto Main Street without yielding to Vehicle # 2 that was traveling north on Vermont Route 100.

15D100353 **7**



On February 2, 2015 at approximately 1741 hours, a two-car motor vehicle crash located at the intersection of Vermont Route 100 and Main Street, Operator # 1 advised she was traveling southbound on Vermont Route 100 at approximately 20 miles per hour, when she advised she observed Vehicle # 2 stopped with the left turn signal activated, waiting to turn left onto Main Street. Operator # 1 advised she attempted to stop, but was unable to stop due to the ice covered road surface causing Vehicle # 1 to crash into the rear of Vehicle # 2. Operator # 2 advised he was stopped on Vermont Route 100, waiting for northbound traffic to pass, and turn left onto Main Street. While waiting for northbound traffic to clear, he advised his vehicle was struck from behind by Vehicle # 1. Investigation revealed that Vehicle # 1 was traveling southbound on Vermont Route 100. As Vehicle # 1 was approaching the intersection of Vermont Route 100 and Main Street, Vehicle # 1 crashed into the rear of Vehicle # 2 that was waiting to turn left onto Main Street.

The Vermont Agency of Transportation

Traffic Research/Highway Division
Turning Movement Report

Counter: TU 0119
Counted by: T Bessette
Weather: Sunny, warm
Town: 100-5 Londonderry

File Name : 100-5merged14
Site Code : 31310865
Start Date : 9/25/2014
Page No : 1

Groups Printed- Auto - Medium - Heavy

	Middletown Rd from VT 11 From North			Main St from Thompsonburg Rd From East			VT 100 from Jamaica From South			VT 100 from VT 11 From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
06:00 AM	0	3	0	1	1	0	0	1	3	0	2	3	14
06:15 AM	0	1	0	4	0	0	4	1	0	0	1	2	13
06:30 AM	0	3	0	15	2	2	8	0	1	0	3	11	45
06:45 AM	1	7	0	16	4	5	8	3	2	1	4	16	67
Total	1	14	0	36	7	7	20	5	6	1	10	32	139
07:00 AM	2	9	1	8	0	3	8	4	6	0	1	18	60
07:15 AM	0	6	0	17	4	5	8	6	7	0	1	10	64
07:30 AM	2	12	2	10	3	0	9	7	4	1	0	8	58
07:45 AM	2	4	1	16	2	0	9	9	7	0	0	9	59
Total	6	31	4	51	9	8	34	26	24	1	2	45	241
08:00 AM	0	4	3	13	3	1	20	6	5	1	2	5	63
08:15 AM	0	5	0	6	2	0	8	3	3	1	1	17	46
08:30 AM	1	7	3	6	1	0	8	4	3	0	2	12	47
08:45 AM	1	7	1	5	1	0	17	4	4	0	1	13	54
Total	2	23	7	30	7	1	53	17	15	2	6	47	210
09:00 AM	0	4	0	6	3	0	14	4	5	1	2	18	57
09:15 AM	0	6	0	5	1	1	14	4	7	0	2	15	55
09:30 AM	3	7	2	6	4	0	11	14	7	0	5	15	74
09:45 AM	0	3	0	7	3	1	10	7	5	0	2	4	42
Total	3	20	2	24	11	2	49	29	24	1	11	52	228
10:00 AM	3	5	1	4	1	4	10	7	10	3	5	6	59
10:15 AM	3	9	3	2	6	2	11	7	4	1	3	15	66
10:30 AM	2	9	0	2	4	2	13	3	7	0	0	8	50
10:45 AM	6	3	0	4	7	2	13	2	8	1	0	17	63
Total	14	26	4	12	18	10	47	19	29	5	8	46	238
11:00 AM	1	1	2	3	5	4	10	5	7	0	4	11	53
11:15 AM	0	3	1	3	2	2	24	6	3	1	3	6	54
11:30 AM	3	9	0	3	2	1	22	5	7	2	2	16	72
11:45 AM	3	3	1	6	3	2	18	3	5	3	1	15	63
Total	7	16	4	15	12	9	74	19	22	6	10	48	242
12:00 PM	1	8	1	6	5	4	14	7	8	1	5	19	79
12:15 PM	1	10	2	5	3	0	22	3	10	1	4	15	76
12:30 PM	3	2	1	8	4	1	16	8	4	0	4	15	66
12:45 PM	1	4	1	6	2	1	22	3	6	0	7	9	62
Total	6	24	5	25	14	6	74	21	28	2	20	58	283
01:00 PM	0	6	0	5	3	0	19	5	4	0	4	17	63
01:15 PM	0	1	0	6	2	4	18	8	3	0	4	12	58
01:30 PM	2	8	0	2	3	2	18	6	4	1	2	17	65
01:45 PM	0	5	0	5	2	2	17	4	5	1	1	13	55
Total	2	20	0	18	10	8	72	23	16	2	11	59	241
02:00 PM	0	4	1	3	5	1	20	7	4	0	2	16	63
02:15 PM	0	4	1	4	1	1	11	8	2	2	1	11	46

The Vermont Agency of Transportation

Traffic Research/Highway Division
Turning Movement Report

Counter: TU 0119
Counted by: T Bessette
Weather: Sunny, warm
Town: 100-5 Londonderry

File Name : 100-5merged14
Site Code : 31310865
Start Date : 9/25/2014

Groups Printed- Auto - Medium - Heavy

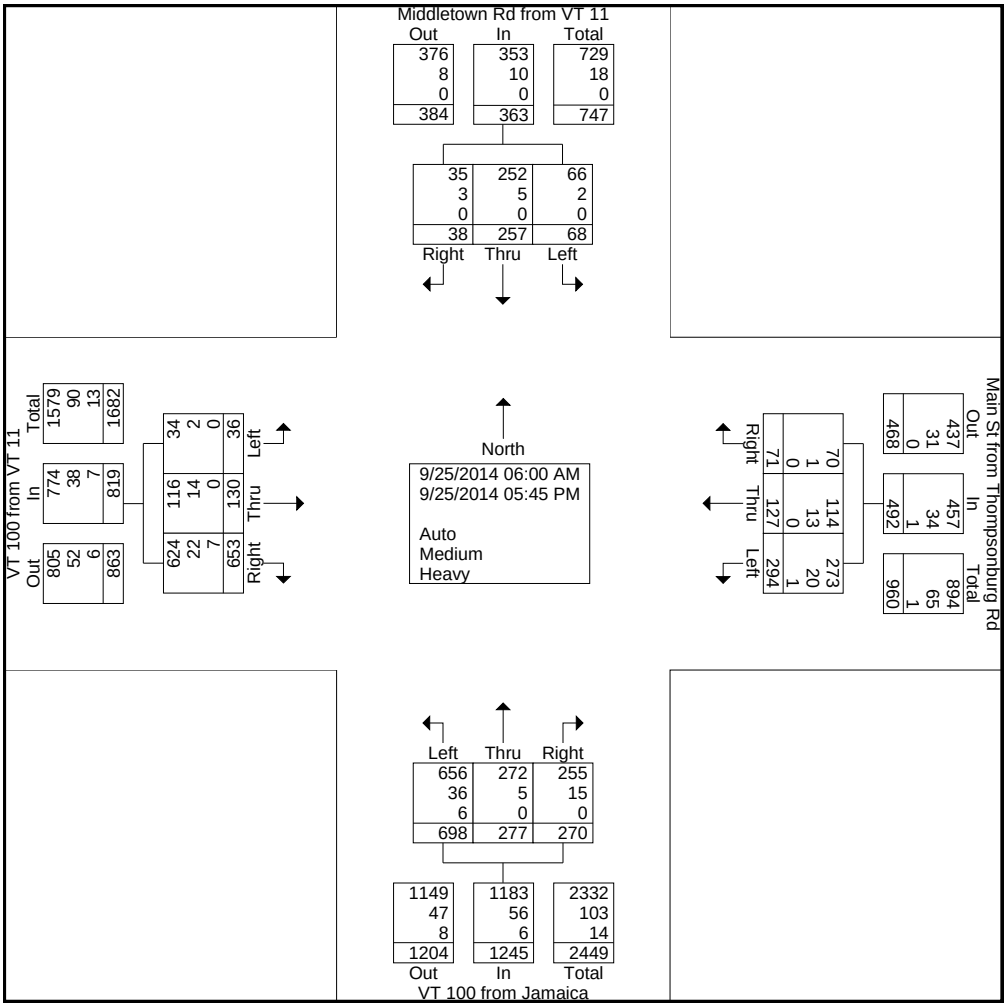
	Middletown Rd from VT 11 From North			Main St from Thompsonburg Rd From East			VT 100 from Jamaica From South			VT 100 from VT 11 From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
02:30 PM	3	6	1	7	4	1	14	9	3	2	7	10	67
02:45 PM	1	6	0	5	2	2	10	4	9	0	1	15	55
Total	4	20	3	19	12	5	55	28	18	4	11	52	231
03:00 PM	2	7	0	3	1	1	21	2	8	1	3	20	69
03:15 PM	2	8	1	3	2	1	22	5	12	1	2	19	78
03:30 PM	3	10	2	4	5	3	22	9	17	2	2	17	96
03:45 PM	0	2	2	8	0	0	20	10	9	2	9	21	83
Total	7	27	5	18	8	5	85	26	46	6	16	77	326
04:00 PM	3	5	1	8	2	2	22	4	9	2	6	18	82
04:15 PM	1	5	0	7	4	2	21	11	2	0	3	18	74
04:30 PM	0	2	1	3	3	1	18	12	3	0	6	16	65
04:45 PM	2	7	1	13	3	0	17	14	11	0	2	12	82
Total	6	19	3	31	12	5	78	41	25	2	17	64	303
05:00 PM	3	3	0	6	2	2	16	9	4	0	2	33	80
05:15 PM	0	4	0	2	1	1	15	4	7	1	4	15	54
05:30 PM	0	7	1	5	2	2	18	5	5	0	1	17	63
05:45 PM	7	3	0	2	2	0	8	5	1	3	1	8	40
Total	10	17	1	15	7	5	57	23	17	4	8	73	237
Grand Total	68	257	38	294	127	71	698	277	270	36	130	653	2919
Apprch %	18.7	70.8	10.5	59.8	25.8	14.4	56.1	22.2	21.7	4.4	15.9	79.7	
Total %	2.3	8.8	1.3	10.1	4.4	2.4	23.9	9.5	9.2	1.2	4.5	22.4	
Auto	66	252	35	273	114	70	656	272	255	34	116	624	2767
% Auto	97.1	98.1	92.1	92.9	89.8	98.6	94	98.2	94.4	94.4	89.2	95.6	94.8
Medium	2	5	3	20	13	1	36	5	15	2	14	22	138
% Medium	2.9	1.9	7.9	6.8	10.2	1.4	5.2	1.8	5.6	5.6	10.8	3.4	4.7
Heavy	0	0	0	1	0	0	6	0	0	0	0	7	14
% Heavy	0	0	0	0.3	0	0	0.9	0	0	0	0	1.1	0.5

The Vermont Agency of Transportation

Traffic Research/Highway Division
Turning Movement Report

Counter: TU 0119
Counted by: T Bessette
Weather: Sunny, warm
Town: 100-5 Londonderry

File Name : 100-5merged14
Site Code : 31310865
Start Date : 9/25/2014
Page No : 3



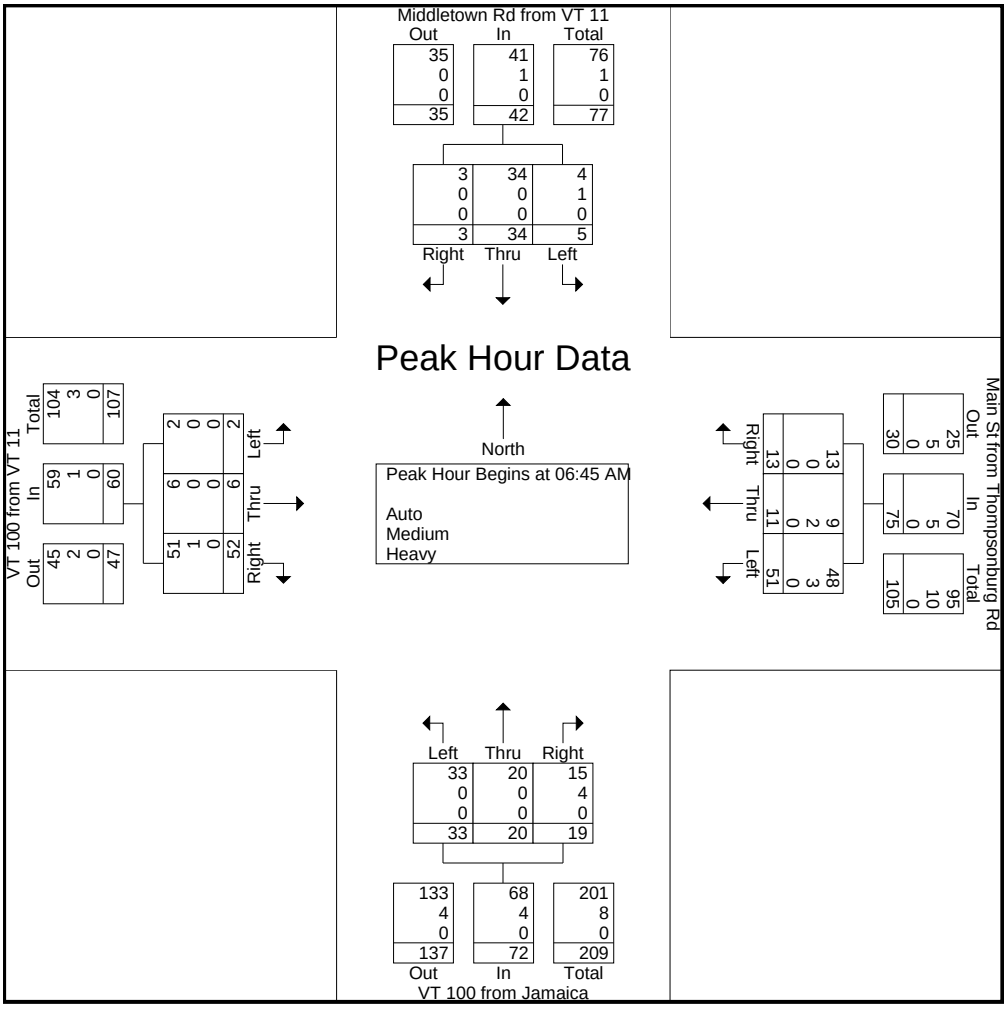
The Vermont Agency of Transportation

Traffic Research/Highway Division
Turning Movement Report

Counter: TU 0119
Counted by: T Bessette
Weather: Sunny, warm
Town: 100-5 Londonderry

File Name : 100-5merged14
Site Code : 31310865
Start Date : 9/25/2014
Page No : 4

	Middletown Rd from VT 11 From North				Main St from Thompsonburg Rd From East				VT 100 from Jamaica From South				VT 100 from VT 11 From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 11:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 06:45 AM																	
06:45 AM	1	7	0	8	16	4	5	25	8	3	2	13	1	4	16	21	67
07:00 AM	2	9	1	12	8	0	3	11	8	4	6	18	0	1	18	19	60
07:15 AM	0	6	0	6	17	4	5	26	8	6	7	21	0	1	10	11	64
07:30 AM	2	12	2	16	10	3	0	13	9	7	4	20	1	0	8	9	58
Total Volume	5	34	3	42	51	11	13	75	33	20	19	72	2	6	52	60	249
% App. Total	11.9	81	7.1		68	14.7	17.3		45.8	27.8	26.4		3.3	10	86.7		
PHF	.625	.708	.375	.656	.750	.688	.650	.721	.917	.714	.679	.857	.500	.375	.722	.714	.929
Auto	4	34	3	41	48	9	13	70	33	20	15	68	2	6	51	59	238
% Auto	80.0	100	100	97.6	94.1	81.8	100	93.3	100	100	78.9	94.4	100	100	98.1	98.3	95.6
Medium	1	0	0	1	3	2	0	5	0	0	4	4	0	0	1	1	11
% Medium	20.0	0	0	2.4	5.9	18.2	0	6.7	0	0	21.1	5.6	0	0	1.9	1.7	4.4
Heavy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Heavy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



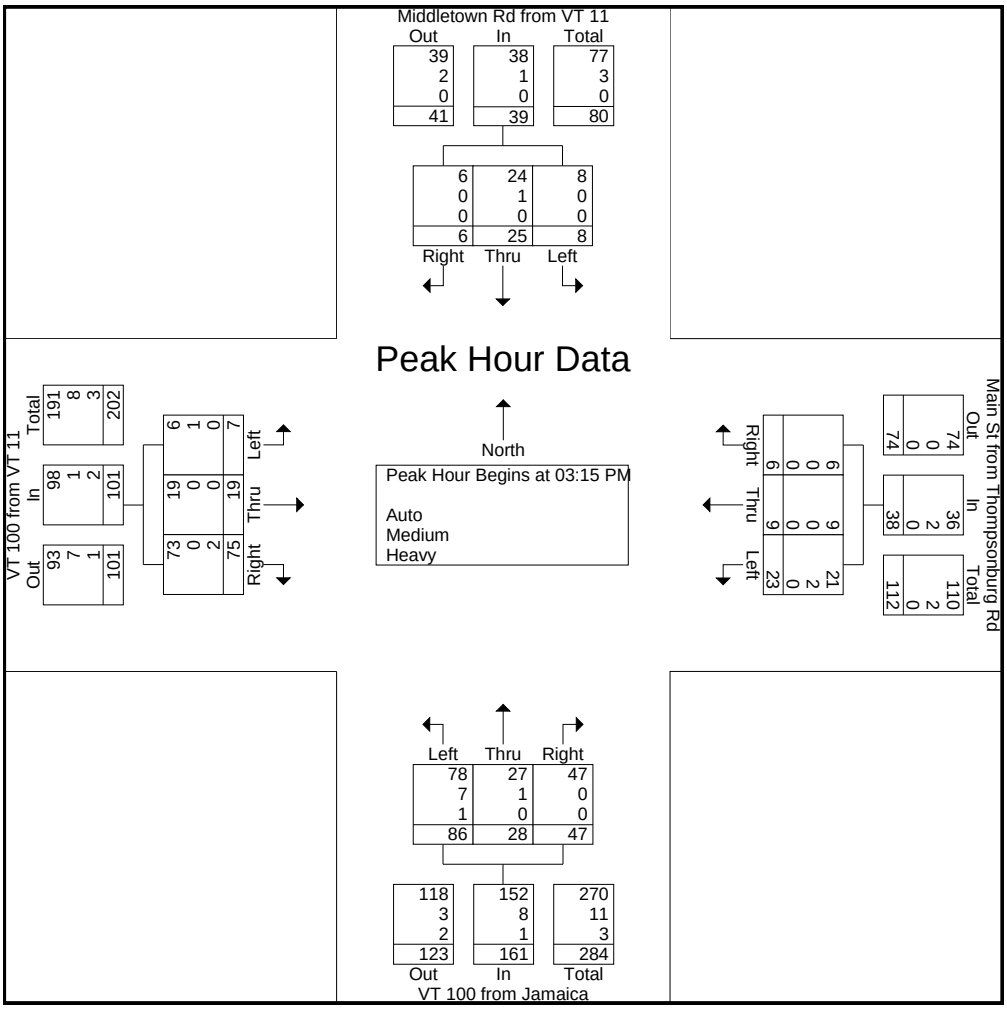
The Vermont Agency of Transportation

Traffic Research/Highway Division
Turning Movement Report

Counter: TU 0119
Counted by: T Bessette
Weather: Sunny, warm
Town: 100-5 Londonderry

File Name : 100-5merged14
Site Code : 31310865
Start Date : 9/25/2014
Page No : 5

	Middletown Rd from VT 11 From North				Main St from Thompsonburg Rd From East				VT 100 from Jamaica From South				VT 100 from VT 11 From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:15 PM																	
03:15 PM	2	8	1	11	3	2	1	6	22	5	12	39	1	2	19	22	78
03:30 PM	3	10	2	15	4	5	3	12	22	9	17	48	2	2	17	21	96
03:45 PM	0	2	2	4	8	0	0	8	20	10	9	39	2	9	21	32	83
04:00 PM	3	5	1	9	8	2	2	12	22	4	9	35	2	6	18	26	82
Total Volume	8	25	6	39	23	9	6	38	86	28	47	161	7	19	75	101	339
% App. Total	20.5	64.1	15.4		60.5	23.7	15.8		53.4	17.4	29.2		6.9	18.8	74.3		
PHF	.667	.625	.750	.650	.719	.450	.500	.792	.977	.700	.691	.839	.875	.528	.893	.789	.883
Auto	8	24	6	38	21	9	6	36	78	27	47	152	6	19	73	98	324
% Auto	100	96.0	100	97.4	91.3	100	100	94.7	90.7	96.4	100	94.4	85.7	100	97.3	97.0	95.6
Medium	0	1	0	1	2	0	0	2	7	1	0	8	1	0	0	1	12
% Medium	0	4.0	0	2.6	8.7	0	0	5.3	8.1	3.6	0	5.0	14.3	0	0	1.0	3.5
Heavy	0	0	0	0	0	0	0	0	1	0	0	1	0	0	2	2	3
% Heavy	0	0	0	0	0	0	0	0	1.2	0	0	0.6	0	0	2.7	2.0	0.9



AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

HIGHWAY DIVISION

TO: Mario Dupigny-Giroux, Traffic Safety Engineer

FROM: Maureen Carr, Traffic Analysis Engineer MC

DATE: November 6, 2015

RE: Londonderry; VT100/Main St/Middletown Rd
AWSC Warrant Analysis

The Traffic Research Unit has completed an All-Way Stop Control warrant analysis for the intersection of VT 100, Main Street, and Middletown Road in Londonderry. The results indicate that an all-way stop is not warranted.

The analysis was based on a VTrans 2012 12-hour turning movement count. The morning half of the count (6:00 AM – 12:00 PM) was conducted on July 13, 2012. The afternoon half of the count (12:00 PM – 6:00 PM) was done on July 12, 2012. Seasonal adjustment factors and annual growth factors were applied to estimate 2016 Annual Average Weekday Daily Traffic.

The all-way stop control warrant analysis (which includes a signal warrant analysis) was based on the 2009 Edition of the Manual on Uniform Traffic Control Devices (MUTCD). All approaches were modeled as single lane approaches. The following warrants were analyzed:

Warrant 1: Eight-Hour Minimum Vehicular Volume.
Warrant 2: Four-Hour Vehicular Volume
Warrant 3B: Peak Hour Volume
Warrant 7: Crash Experience
AWSC Warrant

None of the warrants were met. I have attached a copy of the turning movement count and the AWSC and signal warrant analysis report. If you would like to discuss this project please call me at (802) 522-2645.

CC: Data Analysis Files

Warrants Summary Report

1: VT100/Main/Middletown

Intersection Information:

	Major Street	Minor Street
Street Name	VT100	Middletown
Direction	EB/NB	WB/SB
Number of Lanes	1	1
Approach Speed	30	30

Warrant	Met?	Notes
Warrant 1, Eight-Hour Vehicular Volume		
	No	
Condition A or B Met?	No	0 Hours met (8 required)
Condition A and B Met?	No	0 Hours met (8 required)
Warrant 2, Four-Hour Vehicular Volume		
	No	0 Hours met (4 required)
Warrant 3, Peak Hour		
	No	
Condition A Met?	No	0 Hours met (1 required)
Condition B Met?	No	0 Hours met (1 required)
Warrant 7, Crash Experience		
	No	
Traffic Volume Condition?	No	0 Hours met (8 required)
Ped Condition?	No	0 Hours met (8 required)

Warrants Summary Report

1: VT100/Main/Middletown

Intersection Information:

	Major Street	Minor Street
Street Name	VT100	Middletown
Direction	EB/NB	WB/SB
Number of Lanes	1	1
Approach Speed	30	30

Warrant	Met?	Notes
AWSC Warrant, Multiway Stop Application		
	No	
Condition A Met?	No	
Condition B Met?	No	
Condition C Met?	No	