



Client: City of Traverse City
Project Name: 8th Street Restriping Study
Location: Traverse City, Michigan
Project Number: 12944622
Issue Date: January 6, 2015

**PROJECT
MEMORANDUM**

TO: **Russ Soyring
Tim Lodge, PE
City of Traverse City**

FROM: **Mike DeVries, PE**

SUBJECT: **8th Street Restriping Study**

INTRODUCTION

The City of Traverse City, Michigan restriped 8th Street between Lake Avenue and Woodmere Avenue as a 3-lane pavement with bicycle lanes on September 15, 2014. Prior to the restriping, 8th Street operated as a four-lane undivided roadway with no bicycle lanes. The City agreed to restripe 8th Street as a pilot project at the request of a citizen petition dated April 28, 2014 in an attempt to calm traffic and reduce vehicle speeds along 8th Street. The City will be reconstructing 8th Street in 2018, and the pilot project is intended to help determine what the future cross-section of 8th Street should be when the road is reconstructed.

EXISTING ROADWAY CONDITIONS

8th Street is a heavily-traveled east-west street in Traverse City. The location of Boardman Lake limits the number of east-west roads that are available within the city for east-west travel. 8th Street carries an Average Daily Traffic (ADT) volume of approximately 22,000 vehicles per day between Boardman Avenue and Woodmere Avenue, based on counts completed by the City in 2011, 2012, and 2013. Traffic volumes are slightly smaller west of the Boardman River where the ADT is between 19,000 and 20,000 vehicles per day. Traffic counts in Traverse City are seasonal, so volumes along 8th Street may be smaller than these stated volumes during the winter months and higher during the summer months, particularly during Cherry Festival. The speed limit along 8th Street is 25 mph.

RESTIPING

The pavement marking and signing plans for the restriping are included in **Appendix A**. As shown on these plans, 8th Street was restriped with 11-foot travel lanes, a 10-foot two-way center left-turn lane, and 6-foot bicycle lanes. A double white line was used to separate the bicycle lane from the through lanes west of Boardman Avenue because the roadway cross-section is slightly wider there. At Woodmere Avenue, the inside northbound left-turn lane was hatched, providing only a single northbound left-turn lane.

TRAFFIC SIGNAL TIMING MODIFICATIONS

As part of the restriping, signal timings were modified at Boardman Avenue to provide more green time for 8th Street. Prior to the restriping, the Boardman Avenue signal operated with a 100-second cycle length during peak hours with 60 seconds given to 8th Street and 40 seconds given to Boardman Avenue (a 60/40 split). URS created a new signal timing chart that maintained the 100-second cycle, but provided a 66/34 split, giving 6 more seconds of green time to 8th Street. A field review showed that additional green time on 8th Street was warranted, so the 100-second dial was modified on November 14 to provide a 75/25 split during peak hours. In other

words, 8th Street gets 75% of the available green time now as opposed to 60% of the available green time prior to the restriping.

The traffic signal at Woodmere Avenue is an actuated signal with minimum and maximum green times coded into the traffic signal controller as shown in **Table 1**. The signal does not run a consistent cycle length, but responds to traffic conditions as they change throughout the day using the minimum and maximum green time parameters that are coded into the controller. No changes to these actuated traffic signal parameters were made after the restriping. The signal operates at its maximum possible efficiency during peak hours as it responds to vehicle actuations and pedestrian push-button actuations. Field observations revealed that queue lengths were of sufficient length that each of the three signal phases listed in Table 1 operated at the maximum green time for most of the afternoon peak hour. Pedestrian push-buttons are provided for crossing the east, west, and south legs. When activated, vehicular movements across the crosswalk are stopped.

Table 1. Actuated Signal Settings at 8th Street/Woodmere Avenue

Phase	Minimum Green (sec)	Maximum Green (sec)
Eastbound Thru	15	50
Westbound Left-Turn	10	15
Northbound Left-Turn	12	45

TRAFFIC COUNT COMPARISON

URS collected traffic volume data on a number of streets in the Traverse City area, including 8th Street, prior to the restriping of 8th Street and then again following the restriping. The purpose of these “before” and “after” traffic counts was to determine whether traffic patterns changed as a result of the restriping. The “before” counts were collected on Tuesday through Thursday, September 9-11, 2014. The restriping occurred the following week on Monday and Tuesday, September 15 and 16, 2014. The “after” traffic counts were not collected until 8th Street had operated as a 3-lane cross-section for five (5) weeks, allowing time for motorists to become accustomed to the restriping and change their travel habits if they so desired. The “after” traffic counts were collected on Tuesday through Thursday, October 21-23, 2014. Both the “before” and “after” counts were collected after Labor Day during midweek days when school was in session, so there is not likely a significant “seasonal adjustment” that would be required when comparing the “before” and “after” counts. The results of the two sets of daily traffic counts are depicted in **Table 2** atop the next page.

A review of Table 2 shows that east-west travel does not appear to have redistributed in any significant fashion—at least not in a way that can be attributed to the restriping of 8th Street. In fact, the traffic counts on 8th Street are actually higher since the restriping compared to the counts prior to restriping. Increased traffic on 8th Street was not expected, and it is likely that the construction of the crosswalks at the 8th/Woodmere intersection that was occurring prior to the restriping may have impacted travel patterns. Similarly, changes in traffic volumes on Front Street, State Street, Washington Street, and Webster Street were likely caused by ongoing construction on Washington Street, which was closed for construction between Cass Street and Boardman Avenue during the “after” count period. Table 2 does show a marginal increase in traffic on South Airport Road that may be attributable to the restriping.

A review of Table 2 shows that north-south travel increased on Railroad Avenue. It is likely that the increase in traffic volume on Railroad Avenue can be attributed to the restriping, as the volume increase on Railroad Avenue was all in the northbound direction. It is likely that westbound motorists on 8th Street and northbound motorists on Woodmere Avenue are turning onto northbound Railroad Avenue in lieu of traveling further west on 8th Street

to access north-south routes like Boardman Avenue or Lake Avenue. The destination of the northbound motorists on Railroad Avenue north of 8th Street are unknown. Other than Railroad Avenue, the results in Table 2 do not show a significant change in daily travel patterns that are caused by the 8th Street restriping. This fact is further proved true by a comparison of “before” and “after” peak-hour turning movement counts that were collected at the 8th Street/Boardman Avenue intersection as discussed on page 4 and as shown in Exhibit 1.

Table 2. Traffic Count Comparison

Road Name	Location	“Before” Count	“After” Count	Difference
East-West Streets				
Grandview Parkway	East of Cass Street	32,176	29,942	- 2,234
Front Street (WB)	East of Cass Street	6,035	6,430	+ 395
Front Street	East of Boardman Avenue	5,973	6,036	+ 63
Front Street	West of Franklin Street	6,105	6,270	+ 165
State Street (EB)	East of Cass Street	5,726	6,531 ^{See Note 1}	+ 805
Washington Street	East of Boardman Avenue	1,080	896 ^{See Note 1}	-184
Webster Street	East of Boardman Avenue	1,190	531 ^{See Note 1}	- 659
8 th Street	West of Cass Street	8,422	8,766	+ 344
8 th Street	Over Boardman River	18,090	19,061	+ 971
8 th Street	East of Woodmere Avenue	11,680	14,367	+ 2,687
South Airport Road	East of Cass Street	34,788	35,455	+ 667
South Airport Road	East of Park Drive	30,232	n/a ^{See Note 2}	n/a
North-South Streets				
Union Street	North of 8 th Street	8,267	7,948	- 319
Union Street	South of 8 th Street	7,462	8,137	+ 675
Cass Street	North of 8 th Street	6,117	5,908	- 209
Cass Street	South of 8 th Street	11,062	9,480	- 1,582
Boardman Avenue	North of 8 th Street	5,336	6,044	+ 708
Railroad Avenue	North of 8 th Street	1,099	1,619	+ 520
Park Drive	North of South Airport Road	7,650	7,227	- 423
Woodmere Avenue	South of 8 th Street	14,999	14,727	- 272

Source: URS Corporation

Note 1: Washington was closed from Cass Street to Boardman Avenue during “after” count period.

Note 2: Tube was cut during the “after” count. No “after” data available.

INTERSECTION LEVEL-OF-SERVICE

In order to quantify intersection traffic operations for the “before” and “after” condition, existing “Level-of-Service” (LOS) values were determined using the industry-standard methods of the *Highway Capacity Manual* (HCM), 2010 Edition, published by the Transportation Research Board. *HCM 2010* was used to determine existing peak hour “Levels of Service” of the traffic movements at the Boardman Avenue and Woodmere Avenue signals along 8th Street. The term “Level of Service” (LOS) indicates how well (or poorly) traffic operates based on traffic volumes, lane configurations, and traffic controls. Each level is determined by the average amount of traffic control delay experienced by motorists. LOS “A” represents little or no delays while LOS “F” represents operational failure (extensive delays which may include long vehicular queues). LOS “C” or better is typically considered acceptable during peak hours for small urban areas like Traverse City. The Level-of-Service criteria, as defined by the HCM, are described in **Table 3** for signalized and unsignalized intersections.

**Table 3. Peak-Hour Level-Of-Service Ranges at Intersections
 Highway Capacity Manual (2010)**

Level-of-Service	Signalized Intersections Control Delay (sec/veh)	Unsignalized Intersections Control Delay (sec/veh)
A	<10	<10
B	10 – 20	10 – 15
C	20 – 35	15 – 25
D	35 – 55	25 – 35
E	55 – 80	35 – 50
F	>80	>50

Source: 2010 Highway Capacity Manual

8th/Boardman

URS collected peak-hour turning movement counts at the 8th Street intersection with Boardman Avenue before and after the restriping. The AM peak hour occurs between 7:30 and 8:30 AM. The PM peak hour occurs between 4:30 and 5:30 PM although traffic was primarily concentrated between approximately 5:00 PM and 5:30 PM. The peak-hour turning movement volumes and associated Levels of Service results are shown in **Exhibit 1** on the next page.

Exhibit 1 shows that the peak-hour traffic volumes for the “before” and “after” conditions are very similar on both the 8th Street and Boardman Avenue approaches to the intersection. For instance, Exhibit 1 shows the westbound “through” movement at Boardman Avenue to be 642 vehicles during the AM peak hour and 856 vehicles during the PM peak hour during the “before” condition. The westbound “through” movement was counted as 636 vehicles during the AM peak hour and 862 vehicles in the PM peak hour during the “after” condition—almost no change in these volumes during their respective peak hours. There does not appear to be a major change in traffic volume on of the three intersection approaches in the “after” condition, indicating that most motorists appear to have maintained their current travel patterns through the corridor since the restriping occurred. It is not known whether the lack of change in traffic patterns is due to the limited number of alternate east-west routes available or because motorists feel comfortable with the traffic operations they are experiencing along 8th Street (and thus do not feel compelled to change their route).

Exhibit 1 also shows the Levels of Service of the various traffic movements at the 8th Street/Boardman Avenue intersection. The capacity analysis shows that the “before” and “after” Level of Service (average delay times)

for motorists on the 8th Street approaches is similar, while delays on the Boardman Avenue approach have increased since the restriping. It is important to note that the results in Exhibit 1 for the “after” condition assume the 100-second cycle with 75/25 green time splits that were installed in mid-November. The signal is likely operating more efficiently now than for most of the “after” condition leading up to mid-November due to the installation of incorrect timings at the 8th/Boardman intersection.

The actual levels of delay for the two 8th Street approaches for the “after” condition are likely worse than shown in Exhibit 1 for the PM peak hour, because eastbound traffic on 8th Street backs up from Woodmere Avenue into the Boardman Avenue signal from approximately 5:00 PM to 5:30 PM. The congestion at the Woodmere Avenue intersection impacts operations at the Boardman Avenue intersection. Field reviews confirm that the Levels of Service for the 8th Street approaches are likely worse in the PM peak hour than shown in Exhibit 1.

8th/Woodmere

URS was unable to collect peak-hour turning movement counts at the 8th Street intersection with Woodmere Avenue before the restriping due to ongoing construction at Woodmere Avenue in September 2014. New crosswalks and ADA-compliant pedestrian ramps were under construction prior to the restriping, so accurate “before” peak-hour turning movement counts could not be collected, as some traffic movements were temporarily prohibited at that time. New peak-hour turning movement counts were collected after the restriping. The AM peak hour occurs between 7:30 and 8:30 AM, while the PM peak hour occurs between 4:30 and 5:30 PM although traffic was primarily concentrated between approximately 5:00 PM and 5:30 PM. The peak-hour turning movement volumes and associated Levels of Service results for the “after” condition are shown in **Exhibit 2**.

As shown in Exhibit 2, the eastbound “through” movement and the northbound-to-westbound left-turn movement operate poorly during the PM peak hour in the “after” condition. The dedicated eastbound right-turn lane is underutilized because of the long eastbound queues that form at the signal, blocking eastbound motorists from getting into the right-turn lane to turn south on Woodmere Avenue. (On multiple occasions, eastbound vehicles were observed using the bicycle lane as a driving lane to pass the queue of standing eastbound cars to reach the dedicated right-turn lane.) These long eastbound queues force the actuated traffic signal to provide maximum green time for the eastbound approach. If the eastbound right-turn lane were longer, it is possible that the maximum green time need not be provided for the

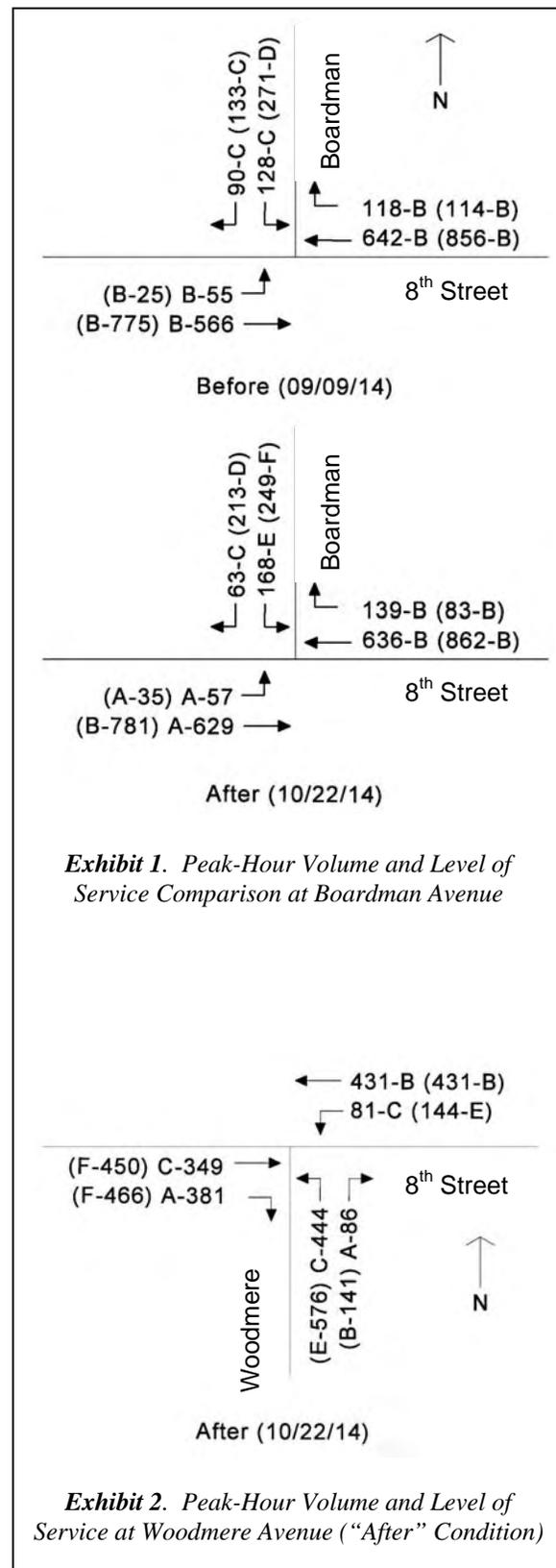


Exhibit 1. Peak-Hour Volume and Level of Service Comparison at Boardman Avenue

Exhibit 2. Peak-Hour Volume and Level of Service at Woodmere Avenue (“After” Condition)

eastbound approach, thus allowing a greater percentage of green time to be provided for the high-volume northbound Woodmere Avenue approach.

Exhibit 2 shows that, during the AM peak hour, the eastbound through movement and the northbound-to-westbound left-turn movements operate at Level of Service “C” overall. Field observations, however, reveal that these movements operate with delays that correspond more closely with Level of Service “E” during the 7:45 AM to 8:00 AM timeframe when eastbound queues block access to the right-turn lane at Woodmere Avenue.

QUEUE LENGTHS

URS observed queue lengths that formed at the Boardman Avenue and Woodmere Avenue traffic signals after the restriping (but before the signal timing at Boardman Avenue was changed to the 100-second cycle with 75/25 splits). The queue of waiting vehicles for each movement was manually counted at the beginning of the green phase for that movement. The queue data were collected on Wednesday, October 22, 2014 throughout the 7-9 AM and 4-6 PM peak periods. The maximum queue lengths that were observed are shown in **Table 4**. There were other times throughout the AM and PM peak periods where queue lengths did not reach the maximum values shown in Table 4.

Table 4. Maximum Queue Lengths Observed by Movement

8 th Street / Boardman Avenue						
Peak Hour	EB Left	EB Thru	WB Thru/Right		SB Left	SB Right
AM	4	12	19		8	3
PM	3	25+	25+		9	7
8 th Street / Woodmere Avenue						
Peak Hour	EB Thru	EB Right	WB Left	WB Thru	NB Left	NB Right
AM	14	1	4	15	16	3
PM	25+	8	8	18	25+	6

Source: URS Corporation

A review of the queue lengths in Table 4 shows long queues for the 8th Street approaches to Boardman Avenue and the northbound and eastbound approaches at the 8th Street/Woodmere intersection during the PM peak hour. The 25+ vehicle queue shown for these movements is a minimum, as the observer could not see the entire queue length beyond 25 cars.

The 25+ vehicle queue on the 8th Street approaches to Boardman Avenue and the eastbound approach to Woodmere Avenue lasted from approximately 5:00 PM to 5:30 PM. These queues were of such length that 8th Street was a continuous stream of slow-moving vehicles between Boardman Avenue and Woodmere Avenue during the 5:00 PM to 5:30 PM timeframe. Field observations revealed that, on some occasions, northbound-to-westbound left-turners at Woodmere Avenue was unable to complete their left-turns due to westbound queues spilling back from Boardman Avenue into the Woodmere Avenue signal. Similarly, eastbound queues on 8th Street extended from Woodmere Avenue back to Boardman Avenue, sometimes impacting the ability of southbound-to-eastbound left-turners from completing a left-turn at Boardman Avenue.

The 25+ vehicle queue on the northbound approach to Woodmere Avenue lasted from approximately 4:43 PM to 4:52 PM and then from 5:10 PM to 5:20 PM. Queues of 25+ cars were also observed on the northbound approach to Woodmere Avenue at 4:09 PM. The 25+ vehicle queue on the northbound approach grew past the Boyd Avenue intersection, and northbound motorists were regularly seen driving on the bicycle lane south of Boyd Avenue to get past the long left-turn queue in order to proceed to 8th Street and make a right turn.

The maximum queue times for the northbound and eastbound approaches at Woodmere Avenue overlap each other, which means that the queues are not a result of poor signal timing but rather are a result of “oversaturated” conditions. There is more demand during these time periods than the traffic signal can serve. As noted previously, the maximum green times at Woodmere Avenue were provided for the three primary signal phases throughout most of the afternoon peak hour.

SPEED STUDY

The City’s Engineering Department conducted a speed study of the 8th Street corridor before and after the restriping occurred. The results are shown in **Table 5** below.

Table 5. Traffic Speeds on 8th Street

	West of Boardman Avenue		East of Franklin Street	
	Before	After	Before	After
Average Speed	27 mph	26 mph	29 mph	27 mph
85 th Percentile Speed	33 mph	29 mph	34 mph	32 mph
Total Percentage Above Speed Limit	67.6%	59.7%	85.8%	78.6%

Source: City of Traverse City Engineering Department

As shown in Table 5, the restriping of 8th Street has led to slightly decreased speeds along 8th Street, including a reduction in average travel speed, the 85th percentile speed (the speed at which only 15% of drivers exceed) and the total percentage of drivers that exceed the posted 25 mph speed limit. It should be noted that these speeds were collected during off-peak hours when 8th Street was not saturated with traffic. During the AM- and PM-peak periods under the “after” condition, traffic speeds are less than 25 mph due to traffic congestion and extensive vehicular queuing.

CRASH ANALYSIS

An analysis of crashes along 8th Street in the restriping area was completed. Crash data was obtained for the period from September 17, 2014 through November 2, 2014 (after the restriping). Crash data for the same time period in 2011, 2012, and 2013 was also evaluated. The limits of the 8th Street crash data evaluation was from 250 feet west of Boardman Avenue to 250 feet east of Woodmere Avenue, a distance of 0.66 miles.

Since the “after” crash data is very recent, it is possible that some reported crashes may not have yet been entered into the State of Michigan crash database. Non-fatal crashes generally take about 14 days after the occurrence of the crash before the crash report is entered into the crash database. As a result, some of the 2014 crashes occurring in late October through early November may not be reported yet. Fatal crash reports can take longer after the occurrence of the crash before the report is entered into the crash database, especially if the fatal crash is a criminal case.

Six (6) crashes were reported in the “after” time period from September 17, 2014 through November 2, 2014. Of the six crashes, three (3) were rear-end straight, one (1) was rear-end right-turn, one (1) was a bicycle crash, and one (1) was a driveway (angle) crash. Four (4) of the six (6) crashes occurred within one week after the restriping of 8th Street. No alcohol, no fatalities, and four (4) injuries were reported in the six crashes. Of the four injuries, one was a “B” level (serious) injury and three were a “C” level (minor) injury. “B” level injuries involve visible yet non-capacitating injuries and generally include bruising and swelling. “C” level injuries include probable yet non-visible injuries, such as soreness or joint stiffness. Following is a description of the six “after” crashes, in chronological order.

1. **Rear-End Straight crash (westbound) – 700 feet east of Boardman Avenue on 09/17/2014 @ 8:47 AM.** The crash occurred on a dry road surface in daylight. Vehicle 1 was westbound and was rear-ended by Vehicle 2. No injuries were reported.
2. **Bicycle crash – 75 feet west of Boardman Avenue (at Riverine Drive) on 09/17/2014 @ 2:43 PM.** The crash occurred on a dry road surface in daylight. The bicyclist was traveling westbound on the sidewalk on the south side of 8th Street approaching Riverine Drive. The vehicle driver was stopped on Riverine Drive at the northbound approach to 8th Street, waiting for a gap in traffic to turn onto 8th Street. The vehicle driver began to proceed forward and struck the bicyclist as the bicyclist was passing in front of the vehicle. No injuries were reported.
3. **Rear-End Straight crash (eastbound) – 900 feet west of Woodmere Avenue on 09/19/2014 @ 5:24 PM.** The crash occurred on a dry road surface in daylight. Vehicle 2 and Vehicle 3 were stopped for queued traffic in the eastbound lane. Vehicle 1 was eastbound behind both Vehicle 2 and Vehicle 3. Vehicle 1 rear-ended Vehicle 2. The force of the collision caused Vehicle 2 to strike Vehicle 3. One “B” level and one “C” level injury were reported.
4. **Rear-End Right-Turn crash (westbound) – 15 feet east of Boardman Avenue on 09/24/2014 @ 3:08 PM.** The crash occurred on a dry road surface in daylight. Vehicle 3 was westbound and turning right to proceed northbound on Boardman Avenue. Vehicle 2 and Vehicle 1 were behind Vehicle 3. As Vehicle 3 started to turn, the driver had to stop for a westbound bicyclist crossing Boardman Avenue in the bicycle lane. Vehicle 2 stopped behind Vehicle 3. Vehicle 1 was unable to stop in time and rear-ended Vehicle 2. The force of the collision caused Vehicle 2 to strike Vehicle 3. One “C” level injury was reported.
5. **Driveway crash – 25 feet east of Wellington Street on 09/29/2014 @ 4:03 PM.** The crash occurred on a wet road surface in daylight. Vehicle 1 was eastbound and was turning left into a commercial driveway on the north side of 8th Street. Vehicle 2 was a vehicle on westbound 8th Street. As Vehicle 1 turned and crossed the westbound lane, Vehicle 2 struck Vehicle 1. One “C” level injury was reported.
6. **Rear-End Straight crash (eastbound) – 75 feet west of Boardman Avenue on 10/20/2014 @ 7:34 AM.** The crash occurred on a dry road surface at dawn. Vehicle 1 was eastbound approaching Boardman Avenue and could not stop in time and struck the rear of Vehicle 2, which was stopped in traffic. As a result of the impact, Vehicle 2 was forced into the rear of Vehicle 3 which was also stopped for traffic. No injuries were reported.

It is likely that the restriping contributed to some of the crashes that have occurred since the restriping was completed, particularly since four (4) of the six (6) crashes occurred within seven days of the road being restriped. It is likely that the longer queues created at Boardman Avenue and Woodmere Avenue were not expected by motorists, which led to the rear-end crashes. There have only been two crashes since September 24, 2014 (although it is possible there may be more that simply have not been reported yet).

Crashes from September 17 to November 2, in 2011, 2012, and 2013

A crash analysis was performed for the September 17 through November 2 time period for the years 2011, 2012, and 2013—the same time period as the “after” crash analysis. The crashes are summarized in **Table 6** top the next page. No alcohol and or fatalities were reported in the following crashes.

There were an average of four (4) crashes per year in 2011, 2012, and 2013 compared to the six (6) crashes that have occurred since the restriping was completed. There were no sideswipe crashes since the restriping, while there were two sideswipe crashes in the last three years prior to the restriping. (Sideswipe crashes are typically

reduced when restriping from a four-lane pavement to a three-lane pavement.) Table 6 also shows that there were three (3) angle crashes along 8th Street in the previous three years, while no angle crashes have occurred since the restriping.

Table 6. Crash Summaries for September 17 through November 2 in 2011, 2012, 2013, and 2014

Year	Crash Types									Injuries
	Total	Angle	Rear-End Straight	Rear-End Left-Turn	Rear-End Right-Turn	Side-Swipe Same	Pedestrian	Bicycle	Driveway	
2011	3	1	2	0	0	0	0	0	0	0
2012	5	0	2	1	0	1	1	0	0	2
2013	4	2	1	0	0	1	0	0	0	0
Total	12	3	5	1	0	2	1	0	0	2
Percent	100%	25.0%	41.7%	8.3%	0.0%	16.7%	8.3%	0.0%	0.0%	
2014	6	0	3	0	1	0	0	1	1	4
Percent	100%	0.0%	50.0%	0.0%	16.7%	0.0%	0.0%	16.7%	16.7%	

Source: TCAT 2.0, Traffic Improvement Association

CONSIDERATIONS

1. The traffic count comparison did not show any major changes in traffic patterns. It is recommended that the City collect additional traffic counts during the spring and summer months in 2015 and compare the data to historical counts to see if any traffic redistribution occurs during the tourist season. Traffic on 8th Street appears to flow well most of the time, becoming bogged down only during the 5:00 to 5:30 PM window. It is not known what impact summer traffic may have on 8th Street or other east-west roadways. Additional data collection during these times is recommended to verify the impact that summer traffic volumes will have on corridor operations. If the City is satisfied with traffic operations along 8th Street following the 2015 summer tourist season, then the City can feel confident that a permanent 3-lane cross-section will operate as intended.
2. If the City decides to maintain the three-lane road diet permanently, it is recommended that additional bicycle markings be applied in the bicycle lane at greater intervals than what has been applied in the trial period.
3. It is recommended that a consistent 5-foot bicycle lane width be utilized throughout the project limits, rather than using a 6-foot bicycle lane in some locations as exists today. Peak-hour congestion tempts motorists to use the bicycle lane space for driving (to get around queued vehicles). A narrower bicycle lane would discourage such action. A 5-foot bicycle lane width is a widely-recommended width by national publications.
4. It is recommended that a 6-inch white lane be used to delineate the bicycle lane (as was used in the restriping). A 4-inch line is not recommended.
5. It is recommended that the City consider installing street lighting with the reconstruction of 8th Street. The road is dark at night, making it more dangerous for bicyclists and pedestrians. Street lighting would improve safety for all modes of travel.

6. It is recommended that the City consider incorporating median refuge islands and mid-block pedestrian crossings as part of the reconstruction of 8th Street, should the City decide to reconstruct the road as a three-lane pavement permanently. Mid-block crossings were considered as part of the restriping trial, but were ultimately not implemented.
7. The City should consider lengthening the eastbound right-turn lane at Woodmere Avenue, so that eastbound “through” motorists do not block eastbound motorists from entering the right-turn lane. **Exhibit 3** depicts a concept that provides additional eastbound right-turn storage at Woodmere Avenue. Increasing the right-turn storage may reduce the amount of green time that is needed to serve the eastbound approach at Woodmere Avenue, which in turn would increase the percentage of overall green time that can be dedicated to the high-volume northbound-to-westbound left-turn movement at Woodmere Avenue. This change could be implemented during the trial period in spring 2015 to see whether the additional right-turn storage improves peak-hour traffic flow, which would help the City determine whether such a change should be considered as part of any permanent road diet solution. Left-turns on all four approaches at the 8th Street/Railroad Avenue intersection would be prohibited to improve safety, and it is recommended that the eastbound bicycle lane as being painted green between Depot View Drive and Woodmere Avenue.

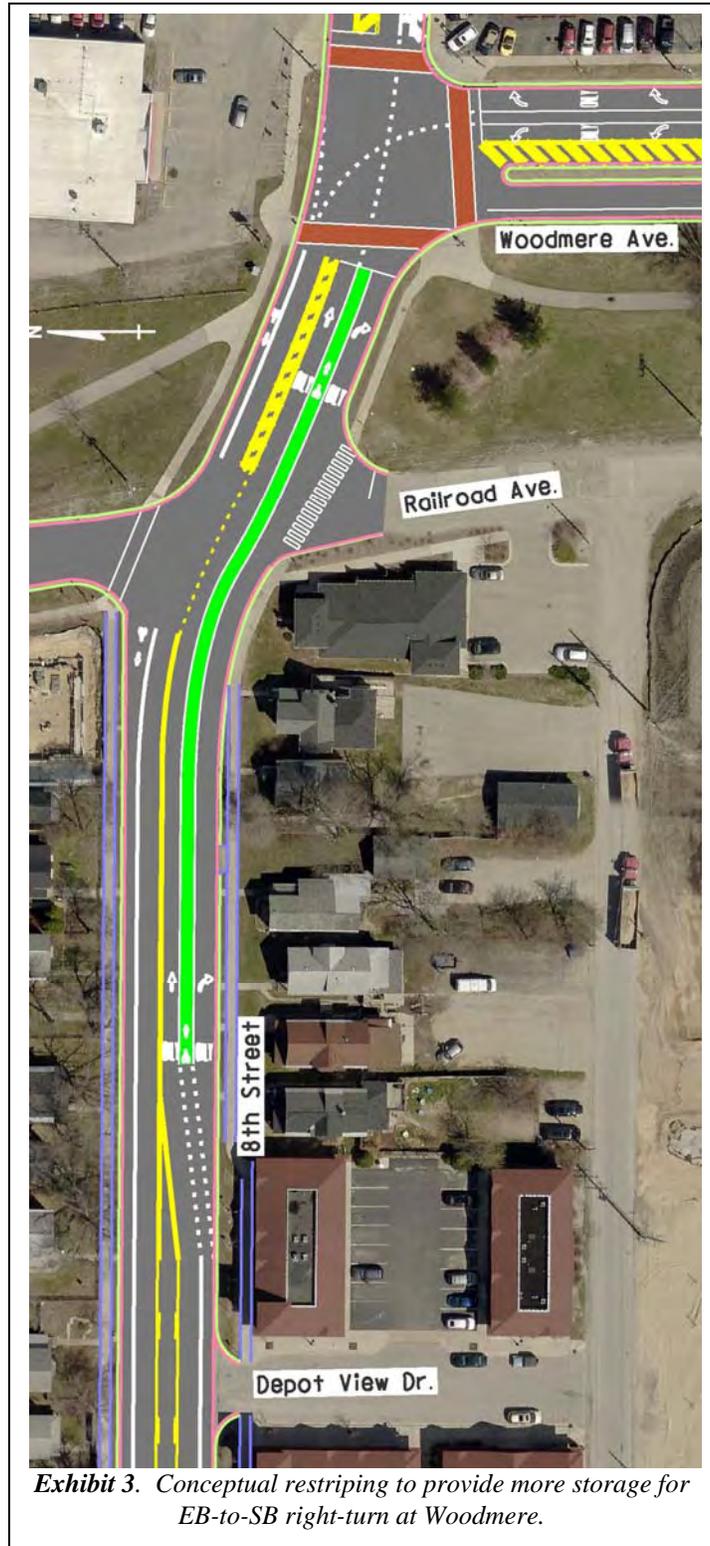


Exhibit 3. Conceptual restriping to provide more storage for EB-to-SB right-turn at Woodmere.

8. An eastbound-to-northbound left-turn signal phase is not recommended at Boardman Avenue at this time. Although there are not many gaps in the westbound traffic stream during peak hours, the eastbound left-turn volumes are less than 60 vehicles in peak hours (see Exhibit 1 on page 5). There are a sufficient number of traffic signal cycles in each hour to serve eastbound-to-northbound left-turners as “sneakers” at the end of the 8th Street green phase. If eastbound-to-northbound left-turn volumes exceed 100 vehicles in a peak hour, then a protected left-turn green arrow should be considered.

9. It is recommended that vehicle actuation be provided on the Boardman Avenue leg of the 8th Street/Boardman Avenue intersection. Pedestrian push buttons are not recommended, rather, the signal should be timed to always provide the minimum amount of time for pedestrians to cross 8th Street at the Boardman Avenue intersection. Actuation will allow the Boardman Avenue signal phase to end early after the minimum time required for pedestrians is reached if no vehicles are present on the Boardman Avenue approach.
10. Due to the extensive queuing on 8th Street between Boardman Avenue and Woodmere Avenue during peak hours, URS does not recommend the construction of single-lane roundabouts at the Boardman Avenue or Woodmere Avenue intersections. Preliminary capacity analyses using the peak-hour data collected in October 2014 and field observations indicate that the potential exists for queues to build along 8th Street from one roundabout into the other roundabout (if they were to be single-lane roundabouts), creating a safety concern. Dual-lane roundabouts would work acceptably from a traffic operations standpoint during peak hours, but there is limited right-of-way available to construct them.