Evaluation of M-99 (Broad Street) Road Diet and Intersection Operational Investigation

City of Hillsdale, Hillsdale County, Michigan

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Final Report

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INTRODUCTION

The purpose of this report is to provide the results of an independent review and analysis of traffic flow, safety, and other impacts to the community that would be incurred by converting the existing four-lane section on M-99 from North Street to Steamburg Road to a three-lane section consisting of a through lane in each direction and a two-way center left-turn lane for a road diet. Additionally, an operational study was conducted at the intersection of M-99 (Broad Street), North Street and Hillsdale Street to analyze the existing geometry and proposed alternative intersection designs. This report documents the study methodology, the findings, and recommendations.

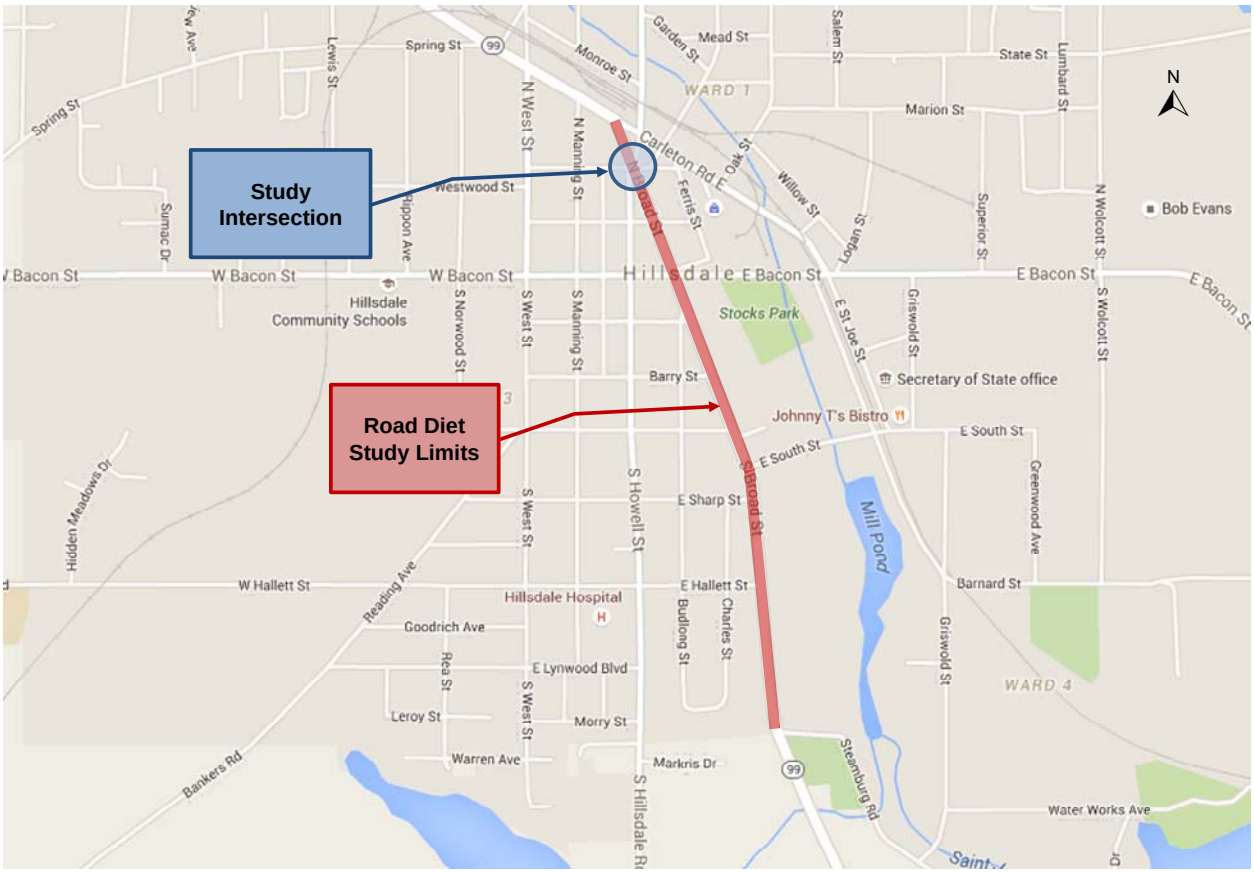

Figure 1. M-99 (Broad Street) study area in the City of Hillsdale.

OBJECTIVE AND SCOPE

The objective of this study was to examine the impacts of converting the existing four-lane section on M-99 from North Street to Steamburg Road to a three-lane section consisting of a through lane in each direction and a two-way center left-turn lane for a road diet. The primary purpose of the road diet on the M-99 corridor is to provide a two-way center left-turn lane to separate slower moving turning traffic from higher speed through traffic. The additional roadway width that remains from a road diet conversion is typically used for bike lanes or for on-street parking.

Additionally, an operational study was conducted at the intersection of M-99 (Broad Street), North Street and Hillsdale Street to analyze the existing geometry and proposed alternative intersection designs.

The scope of the study includes the following items.

- Description of the study area and existing traffic operations of the street system.
- An evaluation of the morning and afternoon peak hour traffic conditions for converting the existing four-lane section on M-99 (Broad Street) from North Street to Steamburg Road to a three-lane section.
- An evaluation of the morning and afternoon peak hour traffic conditions for two alternative designs of the five-legged intersection of M-99 (Broad Street), North Street, and Hillsdale Street.

STUDY PROCEDURE

To achieve the study objectives and scope, the investigations involved the collection and analysis of geometric, traffic control, and traffic volume data for the study intersections. The data collection effort and the analysis procedures are summarized in the following paragraphs.

Data Collection

Data collection included manual collection of directional vehicle turning movement counts for the morning and afternoon peak period and collection of intersection geometry.

Manual directional turning movements were obtained at the following intersections from 7:00 to 9:00 a.m. and from 2:00 to 6:00 p.m. The data are summarized in Appendix A, and the existing counts at the intersection of M-99 (Broad Street), North Street, and Hillsdale Street are shown in Figure 2 below.

- M-99 (W. Carleton Road), E. Carleton Road and M-99 (N. Broad St)
- M-99 (N. Broad Street), North Street, and Hillsdale Street
- M-99 (N. Broad Street) and McCollum Street
- M-99 (N. Broad Street), Bacon Street and Cook Street
- M-99 (S. Broad Street) and Steamburg Road

The traffic signal timing permits were obtained from the permits furnished by MDOT to the City of Hillsdale for use in the analysis and are included in Appendix B. The geometric layout, lane widths, lane-use configurations, etc. were obtained from Google Earth.

AM Peak Hour

PM Peak Hour

Figure 2. Morning and afternoon peak hour counts at the intersection of M-99 (Broad Street), North Street, and Hillsdale Street.

ANALYSIS

The study included a description of the study area, a crash analysis, and capacity analyses to determine the operational results of the road diet conversion and an alternative design for the five-legged intersection.

Existing Conditions

The M-99 (Broad Street) study corridor runs from Carleton Road to the north to Steamburg Road to the south. Currently, M-99 consists of a four-lane cross section with two lanes in each direction. The downtown district is located on the project section north of Bacon Street as shown in Figure 3. On-street parallel parking exists on southbound M-99 north and south of North Street/Hillsdale Street, and on northbound M-99 south of North Street/Hillsdale Street. South of Bacon Street, the land use becomes residential and on-street parking is not permitted. According to the MDOT Bureau of Transportation Planning counts, the Average Daily Traffic on M-99 from Carleton Road to Bacon Street was 8,575 vehicles per day, and from Bacon Street to Steamburg Road was 8,100 vehicles per day in the year 2014. The posted speed limit on M-99 is 30 miles per hour north of Sharp Street, and 35 miles per hour south of Sharp Street.

The intersection of M-99 (Broad Street), North Street, and Hillsdale Street is a five-legged intersection with unusual geometry. As previously mentioned, M-99 consists of a four-lane cross section with two lanes in each direction. From eastbound North Street, vehicles can turn onto both directions of M-99 (Broad Street) or to southbound Howell Street, which is a one-way street. The north leg of Hillsdale Street is one-way in the northbound direction, and the east leg of North Street is one-way in the eastbound direction. Left turns are not permitted from any approach at the study intersection.

Figure 3. View of M-99 (Broad Street) in downtown Hillsdale.

Figure 4 shows a view of the one-way, one lane southbound approach at Howell Street at M-99 and North Street. Howell Street is located in the dense downtown commercial area with angled parking on the east side and parallel parking on the west side of the roadway. Currently, only two options exist for a motorist to access Howell Street, which is either to turn right from the eastbound approach of North Street or to make a slight right-turn from southbound M-99.

Figure 4. View of the southbound approach at Howell Street at M-99 (Broad Street).

Figure 5 on the following page shows a view of the eastbound approach of the west leg of North Street, which is a two-way, two-lane roadway. The approach is the only leg of the intersection controlled by a stop sign. As shown in the figure, a channelizing island is present to force motorists to turn right onto southbound Howell Street, and also restrict movement onto M-99. Angled parking exists on the north side and parallel parking on the south side of the roadwawy. Currently, the only access to the westbound North Street from the study intersection is via right-turns from southbound M-99.

Figure 5. View of the eastbound approach of North Street west of M-99 (Broad Street).

Figure 6 shows a northeast view of the Hillsdale Street and North Street approaches on the east side of M-99. Hillsdale Street is a one-way, one-lane roadway with angled parking on the west side. The east leg of North Street is a two-way, two lane roadway with slightly angled parking on the north side and 90° parking on the south side. The roadway is unusual as the westbound lane ends at M-99 and westbound traffic is not permitted onto M-99, but eastbound traffic is permtied . The only access these streets is via right-turns from northbound M-99.

Figure 6. Hillsdale Street and North Street on the east side of M-99 (Broad Street).

Traffic Analysis Procedures

The software package, *Synchro 9* was used to conduct intersection analyses for proposed design conditions. *Synchro 9* is a software package used for modeling and optimizing traffic signal timing at intersections. The program utilizes the methods of the ***Highway Capacity Manual 2010*** to calculate capacity. The delay calculated in *Synchro* is average control delay, which is the same measure used to describe intersection operations in the ***Highway Capacity Manual 2010)***.

The key features and capabilities of *Synchro* include capacity analysis, coordination, actuated signals, and the development of time-space diagrams. The program optimizes the split, cycle length, and offsets to reduce delays.

Capacity analyses were conducted to measure the performance of intersections in terms of Level of Service (LOS). Levels of service range from A, which represents the best traffic condition to F, which is the worse condition.

Along with the level of service, intersection capacity is quantified in terms of average control delay, which is measured in seconds of delay per vehicle. Control delay includes the initial deceleration delay, queue move-up time, stopped delay, and acceleration delay. The level of service criteria for signalized intersections is given in Table 1.

Table 1. Level of service criteria for signalized intersections.

Level of Service	Description	Control Delay per vehicle, in seconds
A	Little delay, favorable progression.	≤ 10
B	Low delay, good progression.	>10-20
C	Average delay, fair progression.	>20-35
D	Longer delay, unfavorable progression.	>35-55
E	High delay, poor progression.	>55-80
F	Unacceptable delay, very poor progression.	>80

Source: Transportation Research Board, ***Highway Capacity Manual 2000***.

Capacity Analyses

Capacity analyses were conducted for the existing year 2016 roadway network utilizing the Synchro software for the study intersections. The results of the intersection capacity analyses are summarized in Table 2.

The stop-controlled intersection of M-99 (Broad St), North Street, and Hillsdale Street was incorporated into the Synchro model but the software does not generate delay results due to limitations of the Synchro software for the unusual geometry. In addition, the delay cannot be measured based on standard Highway Capacity Manual 2010 due the prohibition of left-turn movements at the intersection, as the left-turn movement on the minor approach dictates delay at a stop-controlled intersection. Delay at the intersection is negligible for morning and afternoon peak hours due to the free flowing condition on the major road, combined with prohibition of left-turns, and the existence of only one stop sign at the west leg of North Street. In addition, any delay due to right-turn movements is considered negligible as the only stop-controlled right-turn movement is from eastbound North Street, which has very low volumes (0 vehicles in the morning and 17 vehicles in the afternoon).

As shown in the table, the study intersections operate at level of service A or B for existing conditions during the morning and afternoon peak hours. As previously mentioned, the intersection of M-99 (Broad St), North Street, and Hillsdale Street is not shown in the table, but the delay is considered to be negligible.

Table 2. Highway capacity results for the study intersections for existing conditions.

Intersection	Approach Direction									
	AM Peak Hour					PM Peak Hour				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total
M-99 (N Broad St) and Carleton Rd	B 10.4	B 12.2	C 32.2	- -	B 17.8	B 12.3	B 13.3	C 27.5	- -	B 15.4
M-99 (N Broad St) and McCollum St	C 20.1	B 17.6	A 6.4	B 10.8	A 9.9	B 19.9	B 18.7	B 11.6	B 12.4	B 13.3
M-99 (N Broad St), Bacon St, and Cook St	B 19.7	C 22.6	B 11.0	A 6.2	B 13.6	C 21.0	C 23.6	B 11.1	A 5.6	B 12.3
M-99 (Hudson Rd) and Steamburg Rd	- -	B 11.9	A 0.0	A 0.2	A 1.0	- -	B 13.7	A 0.0	A 0.4	A 1.0

Notes: The letter denotes the level of service.
The value is the average control delay, in seconds per vehicle.

For many years, safety concerns, and inefficient traffic operations created by multilane approaches and commercial development has been a concern at the five-legged intersection of M-99 (Broad Street), North Street, and Hillsdale Street. In 2006, WadeTrim conducted a traffic study which proposed re-routing M-99 from the east to the west of City Hall which led to reconstructing the intersection to its current geometry. The intersecting side streets at M-99 produces an abnormally large intersection area and adds many more decision points that drivers must identify and address.

Figure 7 shows the existing geometry of the intersection of M-99 (Broad Street), North Street, and Hillsdale Street. Currently, M-99 traffic is free flowing, and left-turns are not permitted from M-99 to any of the side streets. No movements onto M-99 are allowed from the side streets at the intersection.

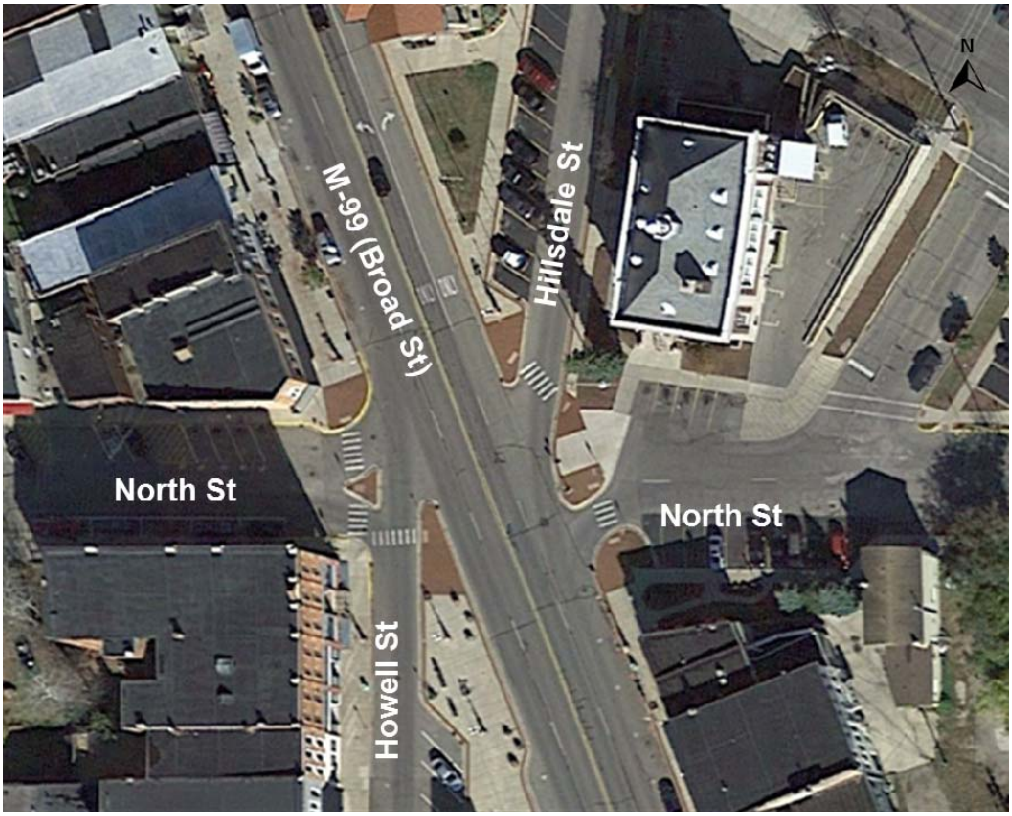

Figure 7. Overview of the M-99 (Broad Street), North Street, and Hillsdale Street intersection.

Alternatives 1 and 2 for the intersection are shown in Figure 8. Alternative 1 includes signalization of the intersection, while Alternative 2 includes signalization of the intersection and closing Hillsdale Street to through traffic. Both will require minor reconstruction to open the minor legs of the intersection to traffic. In particular, the North Street approaches at the intersection will need to be reconfigured to allow through movements in the eastbound and westbound across M-99. The proposed alternatives include installation of an actuated two-phase traffic signal and pedestrian signals to safely and efficiently allow movements at the intersection.

Alternative 1 is shown in the first configuration in Figure 8, with the northbound and southbound approaches of M-99 including a dedicated left-turn lane that will permit turns only onto North Street. Due to the sharp angle of skew and limited turning radius, left-turns will be prohibited onto Howell Street and Hillsdale Street. Both the westbound and eastbound approaches of North Street will allow movements in every direction. Hillsdale Street and Howell Street will continue to consist of departure legs only, with one-way traffic northbound only on Hillsdale Street and one-way traffic southbound only on Howell Street. For this reason, a third phase to the signal timing is not needed at the intersection. Alternative 2 is similar to Alternative 1, with the exception of the closure of the Hillsdale Street leg, as the City is considering options for a private parking lot or pocket park.

Alternative 1 – Signalize Intersection.

Alternative 2 – Signalize Intersection & Remove Hillsdale St.

Figure 8. Conceptual diagram of the proposed alternatives at the M-99 (Broad Street), North Street, and Hillsdale Street intersection.

Capacity analyses were conducted for the roadway network by reducing the number of through lanes from four to three. The results of the intersection capacity analyses for the intersections in the study area are summarized in Table 3.

Based on existing intersection geometry, traffic signal control, and volumes, all of the intersections in the study operate at level of service A or B. When compared to existing conditions, the road diet conversion is expected to have a minor effect on delay at the signalized intersections, with an increase of 4 seconds or less in delay per vehicle when compared to the existing delay at the intersections shown in Table 2. Delay at the unsignalized intersection of M-99 and Steamburg Road is expected to slightly improve, which is due to the westbound traffic having to cross only 3 lanes instead of 4 lanes of traffic from the stop-controlled approach.

Table 3 also shows the results the results of the capacity analysis for the proposed alternatives at the intersection of M-99 (Broad Street), North Street, Howell Street and Hillsdale Street intersection. As shown in the table, the intersection is expected to operate at level of service A during the morning and afternoon peak hours (5.9 and 7.7 seconds of delay per vehicle, respectively) with an actuated traffic signal for Alternative 1.

The intersection of M-99 (Broad Street), North Street and Howell Street for Alternative 2 is also expected to experience level of service A during the morning and afternoon peak hours (5.6 and 7.7 seconds of delay per vehicle, respectively) with removal of the Hillsdale Street leg. The removal of the leg has an insignificant effect on delay as traffic only departs onto the Hillsdale Street leg and there is no approaching volume. It is estimated that with the removal of the leg, a majority of the traffic using Hillsdale Street will be diverted to eastbound North Street. This traffic was added to the North Street and Carleton Road intersection in the Synchro models, and found to operate at levels of service A and B during the morning and afternoon peak hours, respectively.

Table 3. Highway capacity results for the study intersections with the proposed three-lane conversion and intersection alternative.

Intersection	Approach Direction									
	AM Peak Hour					PM Peak Hour				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total
M-99 (N Broad St) and Carleton Rd	B 10.4	B 11.3	C 32.2	- -	B 17.8	B 12.4	B 11.6	C 28.8	- -	B 15.5
M-99 (N Broad St), North St, Howell St and Hillsdale St ***(Alternative 1)***	C 29.5	C 32.7	A 2.8	A 4.2	A 5.9	C 30.1	C 31.5	A 5.5	A 4.3	A 7.7
M-99 (N Broad St), Howell St, and North St ***(Alternative 2)***	C 33.1	C 32.7	A 2.6	A 3.7	A 5.6	C 30.7	C 32.1	A 5.4	A 4.2	A 7.7
M-99 (N Broad St) and McCollum St	C 20.1	B 17.6	A 9.9	B 12.0	B 12.1	B 19.9	B 18.7	B 15.2	B 17.7	B 17.0
M-99 (N Broad St), Bacon St, and Cook St	B 19.7	C 22.6	B 12.6	A 6.6	B 14.5	C 20.7	C 22.7	B 11.5	A 7.6	B 13.1
M-99 (Hudson Rd) and Steamburg Rd	- -	B 11.5	- -	A 0.2	A 0.9	- -	B 11.9	- -	A 0.4	A 0.9

Notes: The letter denotes the level of service.
The value is the average control delay, in seconds per vehicle.

Crash Analysis

A crash analysis for the study intersection of M-99 (Broad Street) from M-99 (Carleton Road) to Steamburg Road, and for the road diet conversion limits are provided in the following paragraphs.

Segment on M-99 (Broad Street) from M-99 (Carleton Road) to Steamburg Road

Crash data were collected from the Traffic Improvement Association Traffic Crash Analysis Tool (TCAT 2.0) website for crashes on M-99 between Carleton Road and Steamburg Road for the three-year study period of January 1, 2013 through December 31, 2015. The crash data provides important details of the crash including crash type, severity, special circumstances, conditions of the roadway surface, and the resulting injuries and property damage. This data is used to identify roadway-related causes of crashes and other traffic safety problems.

Table 4 shows a summary of crashes that occurred on M-99 between Carleton Road and Steamburg Road. Forty-seven crashes occurred, or 15.7 crashes per year. The predominant crash types were eleven parking-related collisions, eleven rear end collisions, ten sideswipe same collisions, and nine angle collisions. There were nine crashes involving injury to one or more of the occupants and no fatalities were reported.

Table 4. Collision types on M-99 (Broad Street) from Carleton Road to Steamburg Road.

Crash Type	No. of Crashes	Percentage
Parking	11	23.4
Rear End	11	23.4
Sideswipe Same	10	21.3
Angle	9	19.1
Fixed Object	3	6.4
Head On Left-Turn	1	2.1
On Road	1	2.1
Bicycle	1	2.1
Total	47	100.0
Injury	9	19.1

M-99 (Broad Street), North Street, and Hillsdale Street Intersection

Crash data were collected from the Traffic Improvement Association Traffic Crash Analysis Tool (TCAT 2.0) website for crashes on Dixie Highway between State Park Road and Sandy Creek Road/Waterworks Drive for the three-year study period of January 1, 2013 through December 31, 2015. The crash data provides important details of the crash including crash type, severity, special circumstances, conditions of the roadway surface, and the resulting injuries and property damage. This data is used to identify roadway-related causes of crashes and other traffic safety problems.

Table 5 shows a summary of crashes that occurred at the intersection of Broad Street (M-99), North Street, and Hillsdale Street. Thirteen crashes occurred during the three-year period, or 4.3 crashes per year within the study area. The predominant crash type included 11 parking-related collisions (84.6 percent), which are generally less severe crash types with property damage only. In addition to the parking-related crashes, two sideswipe same direction collisions (15.4 percent). There were no reported injuries or fatalities.

Table 5. Collision types at the intersection of (M-99) Broad Street, North Street, and Hillsdale Street.

Crash Type	No. of Crashes	Percentage
Parking	11	84.6
Sideswipe/same direction	2	15.4
Total	13	100.0
Injury	0	41.2

A collision diagram is shown in Figure 9 at the intersection of (M-99) Broad Street, North Street, and Hillsdale Street. Plotted on the diagram are the locations and types of each crash that occurred during the three-year period. As shown in the diagram, there are several locations with parking-related crash patterns. Five parking-related crashes occurred on the east leg of North Street, two parking-related crashes occurred on the west leg of North Street, and two parking-related crashes occurred on M-99. The two sideswipe crashes occurred on M-99 south of the intersection.

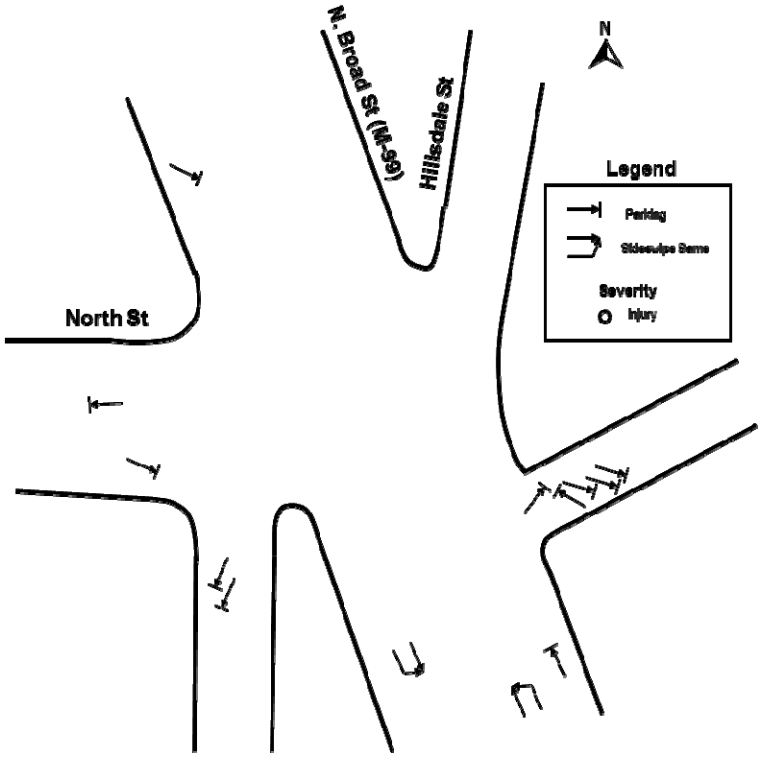

Figure 9. Collision diagram for the intersection of M-99 (Broad Street), North Street, and Hillsdale Street.

Summary

This study was conducted to analyze an alternative design of the intersection of M-99 (Broad St), North Street, and Hillsdale Street. Although the crash analysis does not show an existing safety problem at the intersection, and a traffic signal is not warranted based on traffic volumes alone, the intersecting side streets at M-99 produces an abnormally large intersection area and adds many more decision points that drivers must identify and address. Based on the results of the capacity analyses, both alternative designs of the intersection are beneficial alternatives and are expected to operate at level of service A during the morning and afternoon peak hours. The new configuration will provide a significant benefit the downtown district of the City of Hillsdale, encouraging pedestrians and promoting walkability in the area of the intersection.

The alternatives that were analyzed as part of this study for the intersection will require minor reconstruction to convert the intersection to a six-legged intersection for Alternative 1, or a five-legged intersection for Alternative 2. Alternative 2 is similar to Alternative 1, with the exception of the closure of the Hillsdale Street leg. There are several benefits to closure of the leg, including converting the area to a private parking lot or pocket park, which the City is considering as an option. Other benefits include less signal equipment, as pedestrian signals and traffic signal heads will not being necessary on the Hillsdale Street leg. In addition, pedestrians using the sidewalk on the east side of the intersection will have less crossing distance and less area of exposure. As part of both options, the North Street approaches at the intersection will need to be reconfigured to allow through movements in the eastbound and westbound across M-99. It is recommended to realign North Street for through movements and install actuated traffic signals with pedestrian signals and push buttons. The proposed alternative will include installation of an actuated two-phase traffic signal and pedestrian signals to safely and efficiently allow movements at the intersection.

Converting M-99 from a four-lane cross section to a three-lane cross section, or a road diet, was also analyzed as part of this study, and included capacity analyses at the intersections within the roadway segment from Carleton Road to Steamburg Road. The primary purpose of the road diet on the M-99 corridor is to provide a two-way center left-turn lane to separate slower moving turning traffic from higher speed through traffic. The additional roadway width that remains from a road diet conversion is typically used for bike lanes or for on-street parking.

It was found that the intersections will continue to operate at Level of Service B or better during the morning and afternoon peak hours with the road diet conversion, similar to existing conditions. Although there is not an existing head on left-turn problem on M-99, the crash history shows that eleven rear end collisions, ten sideswipe same collisions, and nine angle collisions occurred during the three-year study period on the study segment. These types of crashes are expected to be reduced with the installation of the two-way center left-turn lane. In addition, the Average Daily Traffic of 8,575 on M-99 falls well below the 20,000 vehicles per day general threshold for a road diet.