Safety and Operational Analysis of 4-lane to 3-lane Conversions (Road Diets) in Michigan

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16. Abstract

Road diets, specifically 4-to-3 lane conversions, implemented in various locations in Michigan were studied to determine the safety- and delay-related impacts, develop crash modification factors (CMFs), and develop guidelines that would be useful in deciding when it might be desirable to implement such road diets. The results of the operational analysis support a guideline that suggests that 4-to-3 lane conversions result in significant delay when average daily traffic (ADT) exceeds 10,000 and, more importantly, when peak hour volumes exceed 1,000. A CMF of 0.91 (after adjustment for background citywide trends) for all crash types is recommended although the factor is not statistically different from 1.0. There was considerable site-to-site variation among the 24 sites studied, and this should always be considered when a road diet is contemplated. A study-by-study literature review and suggestions for implementation strategies are also included.

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EXECUTIVE SUMMARY

Priorities for the design of roadways have shifted over the years—from a primary emphasis of increasing capacity to considering the purpose of streets and roads in the context of specific settings (and often referred to as "context sensitive" design). A technique that has gained popularity in recent years is the so-called "road diet" where traditionally-designed 4-lane roads with two lanes in each direction have been converted/reduced to three lanes (often with the addition of bike lanes) with one lane in each direction and a center left-turn-only lane. Such conversions have potential impacts on both travel delay and safety.

The objectives of the study are straightforward and focused on travel delay and safety for typical 4-to-3-lane conversions in Michigan:

1. Determine the safety-related impacts of the conversions.
2. Determine the delay-related impacts of the conversions.
3. Develop a statistically sound crash modification factor for conversions.
4. Develop a guideline that addresses/incorporates the results from the above that would be of assistance to MDOT and other agencies in deciding when it might be desirable to implement such "road diets."

While the report includes a literature and state of practice review, anecdotal observations regarding pedestrian and bicyclist use of road diets, and comments regarding the successful implementation of road diets in communities, this summary is focused on the operational and safety aspects of road diet implementation.

From the operational analysis of several Michigan road diet sites—

- The operational analysis of the several sites provide reasonably consistent results and support a guideline that suggests that 4-to3-lane road diet conversions result in significant increases in delay for **ADTs over 10,000**.
- More importantly, 4-to-3-lane road diet conversions increase delay when **peak hour volumes exceed 1,000**.

- However, it is clear that "local" conditions (e.g., varying geometry, significant variation in turning movements, and variations in cross-street traffic) can have a significant impact on the viability of any proposed road diet. Thus, while an initial culling of potential road diet sites can be accomplished using the general guidelines above, in all instances a detailed operational analysis of the corridor (including operations at each intersection) for both 4- and 3-lane sections should be undertaken before the road diet conversion is implemented.

From the safety analysis of selected 4-to-3 lane road diets in Michigan—

- There is considerable site-to-site variation in the crash-related results although in almost all instances, there was a reduction in the number of crashes.
- Examination of the background (e.g., citywide, countywide) trends showed that in all cases there was a trend toward lower crash frequencies over time.
- The most appropriate methods for controlling for background trends were a simple control for citywide trends and the consideration of comparison sites.
- Average crash modification factors (CMFs), adjusted for citywide trends, were calculated across all 24 sites. The result was that the overall naïve (unadjusted) CMF was estimated as 0.63, and **0.91** after adjustment. Considering only those crash types expected to be affected by the road diet (not necessarily only reduced), the CMF was 0.90. And, finally, considering only those crash types expected to be reduced by a road diet, the adjusted CMF was 0.59. Use of the latter is problematic since there are typically offsetting changes in crash type frequencies. Only the CMF for the "correctable" crashes was statistically different from 1.0.
- While **the best estimate of a usable CMF is 0.91**, it should be noted that this is not statistically different from 1.0 and is an average across all sites. Perhaps more importantly, there is a great deal of variation from site to site.

- Considering effects of other variables on the overall CMF, it was seen that there was not much change due to controlling for other variables except for adjacent land use—residential sites tended to have a lower CMF than mixed-use or commercial sites.
- Changes in crash severity due to road diets were examined and the distributional shift over all sites was estimated (and then compared to statewide changes). The finding was that although there was a slightly more substantial shift to less severe crashes for the road diet sites, it did not seem operationally significant. Moreover, the shift could have easily been due to changes in operating speeds or enforcement rather than the road diets themselves.

Road diets are a useful tool in the traffic engineer's arsenal of making streets and roads a more integral part of the community. As a part of broader plans, they open up "traditional" roads to greater use by pedestrians and, especially, bicyclists. In general, safety benefits can be expected but vary greatly from site to site. When corrected for citywide trends, the results here indicate that only a relatively modest CMF (0.91) is appropriate. This indicates that crash/safety benefits are likely to be considerably less than what is suggested by naïve comparison of before and after crash statistics. Similarly, the results reported here also suggest that operational analyses should always be performed early on in the consideration of a road diet proposal. Moreover, the commonly-quoted threshold ADT of 20,000 for consideration of a road diet should be lower (10,000) and, more importantly, realistic peak-hour analyses (based on actual counts) are much more useful. For the sites evaluated here, the peak-hour threshold volume is estimated as 1,000 vph although this could vary with varying volumes of cross traffic at intersections.

INTRODUCTION AND STATEMENT OF THE PROBLEM

Priorities for the design of roadways have shifted over the years—from a primary emphasis of increasing capacity to considering the purpose of streets and roads in the context of specific settings (and often referred to as "context sensitive" design). Examples of this shift can be seen with the increasing popularity of traffic calming, once the bane of traffic engineers for which the efficient movement of vehicles was the principal criterion, becoming widely accepted and applied. Another technique that has gained popularity in recent years is the so-called "road diet" where traditionally-designed 4-lane roads with two lanes in each direction have been converted/reduced to three lanes (often with the addition of bike lanes) with one lane in each direction and a center left-turn-only lane. Such conversions have potential impacts on both travel delay and safety. In this context, the basic question addressed in this study is "what are the impacts of such conversions in Michigan?" The results of the study will be of use to both MDOT and local road agencies.

OBJECTIVES OF THE STUDY

The original objectives of the study are straightforward and focused on travel delay and safety for typical 4-to-3-lane conversions in Michigan:

5. Determine the safety-related impacts of the conversions.
6. Determine the delay-related impacts of the conversions.
7. Develop a statistically sound crash modification factor for conversions.
8. Develop a guideline that addresses/incorporates the results from the above that would be of assistance to MDOT and other agencies in deciding when it might be desirable to implement such "road diets."

BACKGROUND AND SIGNIFICANCE OF WORK

Lane conversions/reductions are popular with many communities as the technique is viewed as a method that puts concerns of the local community, bicyclists, and pedestrians on a par with motorists passing through neighborhoods. The impacts of such conversions can include increased motorist delay, increases and/or decreases in crashes, and better access to the transportation system for other user groups among others. Like new traffic signals, the impacts often appear to be situation-specific meaning that in some instances traffic crashes can be shown to increase while for others they decrease. The results of the study provide MDOT and other agencies with needed background information so that the outcomes of conversions in specific types of situations will be better understood.

While addressing different issues, work done under previous MDOT contracts on conversions of 2-way streets to 1-way pairs (Lyles et al. 2001) and the effect of new signals (Lyles et al. 1997) both showed that crash and operational changes varied according to the sites being considered. This same phenomenon was noted by Huang and others (2001) in a study of sites in California and Washington specifically for roads where a “road diet” was implemented. Results from several other studies showed that both crash-related and operational measures of effectiveness may vary. In the latter case, for example, if there are significant left-turn volumes on the corridor to be treated, but not particularly high through volumes, operational benefits can be accrued because of the separation of left turns into the center left-turn lane. However, if through volumes are high and the left-turning volume is not, elimination of a through lane can cause operational problems. In previous work done by Taylor for MDOT on road diets (2001), it was found that the crash reduction factor was 27.6% across all volume levels (which, at the time, compared favorably to the 25-30% reduction noted elsewhere). This included a consistent reduction in pedestrian and bicycle-related crashes. Not surprisingly, changes in delay were associated with the volumes on the treated street and the minor/side streets. When volumes were lower (e.g., in residential areas) delay increases were not significant but when major street volumes approach 2,000 vph and minor street volumes approach 200 vph, delay increases and becomes prohibitive.

One of the attractive characteristics of lane conversions is that it is a low-cost alternative—often consisting of only traffic signing and pavement marking changes. If crashes are reduced, benefit-cost ratios are very favorable. Even if there are negative operational impacts, the crash reduction potential may still trump increases in delay. The significant benefit of this project is that it provides MDOT and other agencies of a reliable source of information that can be used in determining whether to propose (or support the proposal of others) lane reduction/road diets.

ORGANIZATION OF THE REPORT

The results of the project are presented in the pages that follow. Syntheses for the several tasks that were completed are presented in the body of the report with more complete results presented in appendices. The following are the sections to the report:

- The literature review includes both traditional technical literature and more informal information from various local studies/presentations on road diets. (See also Appendix A.)
- Results from (qualitative) on-site reviews of several (Michigan) sites focusing on use by pedestrians and bicyclists. (See also Appendix B.)
- An operational analysis of several Michigan sites which focused on determining traffic volume thresholds which indicate when road diets are contraindicated from a delay perspective. (See also Appendix C.)
- A safety-related analysis of 24 sites in Michigan which focused on developing a reliable crash modification factor (CMF) that could be used in determining whether a road diet is appropriate for a given site. (See also Appendix D.)
- Suggestions related to implementation of road diets at new locations were developed based on the experience gained in completing this project and on the experiences elsewhere. (See also Appendix E.)

STUDY SITES

While the mechanism for selecting sites for inclusion in this study is addressed in more detail later in the report, Figure 1 on the next page shows the general location of the 24 sites that were analyzed plus the additional sites (in East Lansing) that were visited to observe pedestrian/bicyclist use.

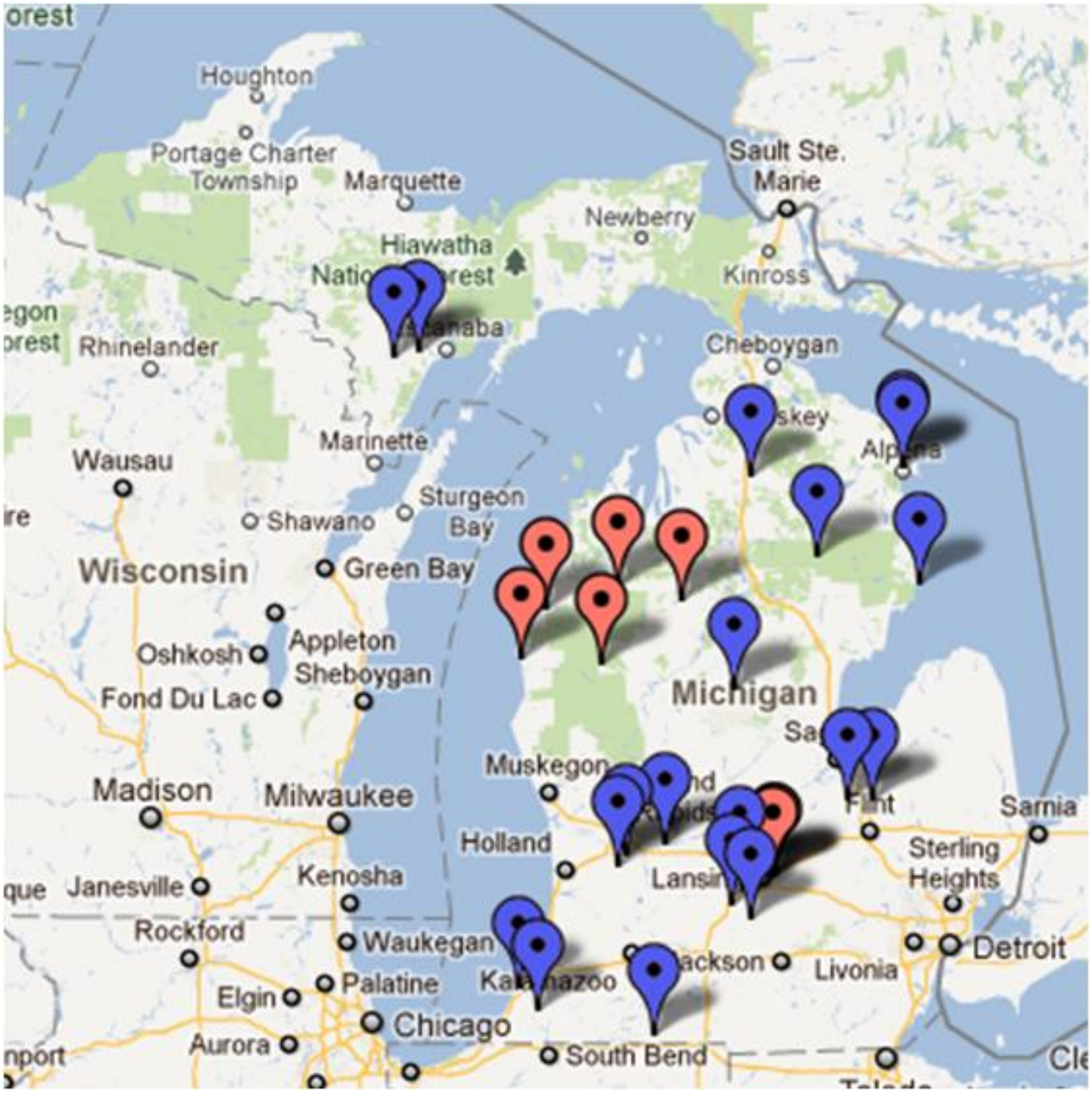


Figure 1. Study sites

The figure shows the sites that were used in the safety analysis in blue and, in red, the sites that were used in the safety analysis and visited as part of the review of pedestrian/bicyclist operations. The exception to the latter are the two (red) sites in East Lansing which were only part of the latter (the site markers overlap and are not visible in the figure). Graphical representations of each site are provided in Appendix F.

METHODS

Several different methods of analysis were utilized in this project and are briefly summarized below. Considerably more detail is provided in the appropriate section of the report.

- **Pedestrian and bicyclist operations.** These operations were qualitatively reviewed through on-site visits. Visual observations were made and recorded at several sites and some users were engaged in discussion although no formal survey instrument was used.
- **Operational analysis of road-diet sites.** Traffic operations of several road-diet sites were quantitatively assessed (using existing traffic data) to determine when potential level of service/delay issues occur when road diets are implemented. The widely-used Synchro software package was used to estimate delay and level of service for the selected sites under conditions of increasing traffic volumes. This was done to ascertain threshold values for when road diets may be contraindicated (from a delay/level of service perspective).
- **Safety-related analysis of road diet sites.** In the context of determining crash-modification factors (CMFs) for road diet implementation, before-and-after safety analyses were undertaken for several road diet sites. Both naïve and more sophisticated analyses were done including variations of case-control approaches where observed changes in overall and selected crash frequencies were controlled for background variation. Further details of these methods are presented in later sections of the report.
- **Acquisition of site information.** A straightforward survey instrument (Appendix G) was used to solicit information about tentative sites from MDOT and local agency personnel.

LITERATURE AND STATE-OF-PRACTICE REVIEW

The literature review included both a search of the traditional literature and a review of road-diet-related experiences in the field. The latter was identified from searching electronic media and following leads obtained from mailing lists and traffic professionals (several of whom could generally be perceived as "advocates" of road-diet-type projects). Some 33 different studies were reviewed for this project as well as several overarching reports. Details are provided in a study-by-study format in Appendix A.

Before discussing the literature, a point should be made about the variation in definition of various crash-related factors. Some practitioners/researchers use the term "accident modification factor" (AMF), while others simply refer to reductions in crashes or percent reductions, and still others use the now-standard "crash modification factor" (CMF). In this report, the latter terminology is used. So, in a comparison of before and after crash statistics, a CMF is correctly interpreted as that number which, when multiplied by the frequency of "before" crashes would give you the expected number of "after" crashes. Thus, the following apply:

- A typically-reported crash reduction percentage between before and after conditions (e.g., crashes were reduced by 15%) would be "converted" to a CMF as follows:

  CMF = 1 minus the percentage change.

  For example, if crashes were reduced by 15%, the CMF = 1 – 0.15 = 0.85. So, for positive improvements (crashes are reduced), the CMF < 1.0.

- If crashes increased, the percentage change (as normally reported) would be negative. In such a case the CMF > 1.0. For example, if crashes increased by 15%, the CMF is calculated as 1 – (-.15) or 1.15.

  The most interesting findings from the literature review can be summarized:

- As a general statement, crash reductions are experienced with most installations and are most typically reported as percentage changes (CMFs would be < 1.0). There is, however, significant variation in the magnitude of the reductions.

- While there appears to be significant "random variation," variation is also introduced because of the great variety in the before/after geometry and operating conditions (e.g., variation in ADT, existing left-turn driveway volumes and adjacent land uses). If the ADT is relatively low and there are few left turns, there is likely to be very little crash reduction; on the other hand, if there are many head-on/left turn crashes, crash reduction is more likely to be substantial. While head-on/left-turn and rear-end/left-turn crashes often are reduced, other crash types such as rear-end/straight in the right lane often increase because of the increased volumes in the right lane (due to the 2-to-1 lane reduction in a given direction).

- Most authors did not report estimates of CMFs per se. The most reliable estimates of CMFs are generally thought to be found on the FHWA-funded website "crash modification factors clearinghouse" maintained by the University of North Carolina Highway Safety Research Center [http://www.cmfclearinghouse.org/]. CMFs posted at this site have been vetted to some degree and a "star rating" is used as a measure of reliability. From that source, road diets are estimated to result in the following CMFs for unspecified roadway types in urban areas: all crash types/all severity levels = 0.63; all crash types/all injury crashes = 1.0; all crash types/property-damage-only (PDOs) = 0.54; angle crashes/all severity levels = 0.63-0.76; and rear-end crashes/all severity levels = 0.59. Based on another study (referenced at the same website), an estimated CMF for all crash types and all severities for minor urban arterials is 0.71.

- Many, if not most, studies were naive in that there was no control for background variation in crash trends. In virtually all areas, the general change in crashes at road diet locations must be somehow adjusted for overall decreases in crashes in the surrounding areas during the study period. Otherwise, too much of the changes in crashes may be attributed to the road diet.

- Travel speed decreases were reported for several studies as a result of road diet implementation. While this would be expected given the more restrictive geometry and a driver's inability to pass another vehicle, an unknown amount of the reduction could simply be due to lowered speed limits and/or increased enforcement.

- In addition to safety, road diets are also implemented as a part of other system changes such as an overall effort in traffic calming or as part of creating a pedestrian/bicyclist-friendly environment.

ON-SITE REVIEWS OF PEDESTRIAN AND BICYCLIST OPERATIONS

As part of the project, several road-diet sites were visited and operations were observed with primary attention being paid to pedestrian and bicyclist use/operations. The intention of this exercise was not to collect extensive quantitative information but rather to get a qualitative idea about how pedestrians and bicyclists are using road diets and their perceptions of how useful they are.

Since the goal was not necessarily to have a representative sample, the investigated road diet sites (see Figure 1 for general locations) were selected based on having "pedestrian/bicyclist safety" identified as one of the motivations for implementing the road diet project (as per responses to the data collection survey) and close proximity from site to site (so that they could be visited in a short time-frame). Five of the eight sites that were visited were located in the northwestern part of Michigan (Cadillac Transportation Service Center [TSC]) and the others were in the East Lansing area:

- M-37 in Baldwin from the US-10 junction extending approximately 200 ft. south of 9th Street;
- M-55/M-66 in Lake City from W Beeler Road to Union Street (Davis Road);
- M-37/M-115 in Mesick from the M-115/M-37 junction to Clark Street;
- US-31 in Manistee from the M-55 junction extending approximately 300 feet northeast of M-110;
- M-116 in Ludington from US-10 to approximately 500 feet north of Lowell Street;
- Burcham Road in East Lansing from Abbot Road to Timberlane Street;
- Abbot Road in East Lansing from Albert Avenue to Whitehills Drive; and
- M-43 in East Lansing from Michigan Avenue to 200 feet northwest of Audubon Road.

For the five sites located within the Cadillac TSC area, visits were conducted during a major holiday weekend (high use expected) to gain as much insight as possible regarding impressions of operations and safety. For the sites located in East Lansing, visits were done during peak usage hours during the day. The primary focus was to investigate pedestrian/bicyclist use and a secondary focus was to investigate pedestrian/bicyclist-motorist interactions. More detailed observations are provided on a site-by-site basis in Appendix B. The following remarks are based on all of the visits.

- Not surprisingly, a lack of pedestrian and bicyclist infrastructure along a road diet results in low levels of non-motorized use of the corridor. This was most evident at the Manistee site, which, despite listing pedestrian safety as a rationale behind conversion, did not have bike lanes or sidewalks over the length of the site.
- The two most notable characteristics of a well-functioning road diet with significant non-motorized use (besides simply having infrastructure) were the presence of pedestrian-oriented attractions and successful traffic calming:
    - Placement along corridors with commercial and pedestrian attractions:
        - The Lake City road diet was along a residential corridor of the road, just south of the city's commercial core. Despite having the infrastructure and observations being made during one of the busiest weekends of the year, there was very little pedestrian activity along the road diet, as there were no notable pedestrian-oriented attractions present; instead, all of the pedestrian activity took place north of the site, along the commercial strip of town.
        - The road diet in Baldwin ended just before reaching the main commercial district in town, therefore it had no apparent impact on pedestrian traffic.
        - While there was little activity observed during the visits to the Mesick site, it appeared (based on the signage, crosswalk locations, and proximity of a public school) that when school is in session, there is a reason for pedestrians and bicyclists to use the road diet infrastructure.
        - The Ludington site was adjacent to a public beach, which acted as a significant pedestrian generator for the road diet corridor.
        - The Burcham Road and Abbot Road sites in East Lansing both attracted a fair amount of pedestrian and bicyclist use by students from the nearby schools and Michigan State University (all of which were in session).

- Successful traffic calming:
  - Through observation and from conversations with local residents, the main cause of the increase in pedestrian usage of the Ludington site was the perception of "calmed" traffic. While the corridor has largely residential land use, the adjacent public beach had always acted as an attraction of pedestrians and bicyclists. Since the traffic was perceived to be moving more slowly (as a result of the road diet), the road was easier to cross and walk along, encouraging beachgoers to walk or bike there, rather than drive and use the parking lot.
  - Although the site in Baldwin was in a commercial area with pedestrian destinations, the road diet did not appear to be designed so that motorists perceived the need to slow down in the corridor, making it appear unsafe to cross or bike along.
  - At the Mesick site, even though the observed pedestrian traffic was low, the road diet appeared to have successfully calmed traffic—just by walking up and down the corridor, it seemed safe for pedestrian and bicyclist activity.
  - At the Burcham Road site, the local crossing guard remarked that she thought the road diet was unsuccessful at calming traffic, thus rendering the implementation somewhat of a failure.

- In several conversations with residents and in observations (both at various sites) of interactions between motorized and non-motorized traffic, it was apparent that there was an intentional lack of proper usage of the road diets by their users and/or a lack of knowledge of what usage is allowed.
  - Bicyclists were often observed riding on sidewalks rather than using the unmarked bike lanes. Pedestrians were also occasionally observed using bike lanes, even when there was an adjacent sidewalk. There appeared to be a better understanding of the purpose of bike lanes at the sites in East Lansing, where there were appropriate pavement markings.
  - There was a perceived lack of clarity regarding right-of-way at crosswalks along the road diets. Typically, motorists correctly assumed they had the right of way;

residents complained, however, that crossing was difficult when vehicles did not routinely yield to pedestrians (most notably in Ludington) even though the motorists actually had the right of way.

  - Motorists occasionally used the two-way left-turn lane (TWLTL) as a waiting (or acceleration) lane in making left turns from a driveway or side-street onto the road diet.
    - On occasions when the TWLTL was used as a waiting/acceleration lane to turn into the far moving lane, motorists in the far lane appeared indecisive, perhaps thinking they were about to be cut off.
    - On a few occasions, motorists were seen making left turns from the right moving lane, rather than moving into the TWLTL and then making the left.

While generally "common sense," the following overarching comments are based on the on-site visits to (qualitatively) assess pedestrian/bicyclist use of road diet sites:

- provisions for pedestrians and bicyclists are most important when there are existing pedestrian/bicyclist generators on the site and/or when the road diet is part of a larger plan for an area;
- if pedestrian/bicyclist provisions are included in the road diet area, they need to be clearly and consistently marked; and
- there appears to be a need for additional information/education regarding appropriate use of the road and pedestrian/bicyclist facilities at road diet sites (by both pedestrians/cyclists *and* motorists), including the use of signs clearly indicating crosswalks and bike lanes at road diet sites.

OPERATIONAL ANALYSIS OF SEVERAL ROAD-DIET SITES

The objective for the operational analysis was to determine if there was a common traffic volume at which the 4-to-3 lane conversion will "fail" from a traffic operations perspective (e.g., level of service [LOS] will drop to D or below). The general rule of thumb is that a road diet should not be implemented when ADT exceeds 20,000 vehicles per day. Since the peak hour is not necessarily always the same fraction of ADT (e.g., in a tourist-oriented area, there may be a more uniform flow over the course of a day), the approach taken for this project was to look at the volume that leads to failure over the course of an hour. Examination of the limits of the traffic volume for which a road diet is appropriate is important since it is a question that typically comes up when road diets are proposed—e.g., will the lane reduction cause congestion; what happens when capacity is reduced?

The conversion of 4-lane to 3-lane sections will impact traffic operations in terms of intersection approach delay. The question is: At what volume does this degradation result in failure of the 3-lane section? To investigate this, a basic operational analysis was conducted using Synchro. The measure of effectiveness (MOE) used to evaluate and compare the operational differences between 4-lane and 3-lane sections for a given traffic volume was approach delay in sec/veh.

Nine signalized intersections from five study sites were used for analysis and are shown in Table 1. The existing data for signal timing, phases and peak hour traffic volumes, along with intersection geometry were obtained and used for the Synchro models.

Table 1. Sites/intersections used for Synchro analysis

Site #	County	City	Intersection
1	Alpena	Alpena	US-23 @ 11th Ave
8	Eaton	Charlotte	Lansing Rd @ Hall St/ Island Hwy
9	Eaton	Eaton Rapids	M-99 @ State St
			M-99 @ Knight St
			M-50 @ Canal St/Brook St
11	Genesee	Clio	M-57 @ Mill St
			M-57 @ Plaza Dr
13	Genesee	Montrose	M-57 @ Saginaw St
			M-57 @ Seymour Rd

The volumes for AM and PM peak hours were obtained, and the analysis was conducted for the worst case (i.e., the higher overall volume). In all instances, the PM peak hour was highest. The existing turning volume percentages for each approach were determined and held constant throughout the analysis. An analysis of existing conditions was done for each site and results were checked for any major issues such as high delay or queue length values (there was none). Once baseline conditions were established, each intersection was then subjected to increasing increments of mainline (road diet) volume to determine when "failure" would occur. The volume increments were 750, 1000, 1250, 1500, 1750, and 2000 vph.

The following assumptions were made:

- The volume increments were for the mainline road-diet approaches only instead of all four legs to avoid a rapid decline in intersection performance at relatively low volumes. In most instances, the non-road-diet approaches were already 3-lane sections and increasing their volumes by the same level would have made the intersection difficult to operate.
- Since it was desired to check the behavior of a 4-to-3-lane conversion at specific traffic volumes, the volume on those approaches was not increased by a fixed percentage, but rather by the same magnitude on both intersection approaches with the road diet.
- The existing signal phasing was used for the study; however, in some cases where the turning volumes were high (>100 vph) a turning bay or storage lane was provided to avoid interference with the mainline traffic. Without storage lanes, the approach delay exceeded LOS F (>80 sec/veh) at very low mainline volumes which was not realistic.
- The signal timings and splits were optimized for each mainline increment to obtain the minimum intersection delay.
- No parking was allowed on any of the intersection approaches.
- A heavy-vehicle percentage of 2% was used throughout. While in some cases this was a bit different from actual data, 2% was used for a uniform comparison.
- The upper limit of LOS D (55 sec/veh delay) was used as a threshold.

The approach delay vs. mainline volume increments (for each road-diet approach) were plotted for all intersections and visually examined to determine the critical volume associated with "failure." See the figure below for an example and Appendix C for results from all sites.

The graph below (Figure 2) shows the approach delay for both 4- and 3-lane sections (existing conditions [blue line] and road diet [red line]) as the mainline volume is varied from 750 to 2000 vph for a signalized intersection at site 9 (northbound direction). In this instance, the approach delay is less then 20 seconds/vehicle for both types of road when the mainline volume is less than 1000 but performance begins to degrade more rapidly for the 3-lane section for mainline volumes of 1250 and 1500 and very quickly beyond that. Graphs similar to this one are shown in Appendix C for each of the sites analyzed.

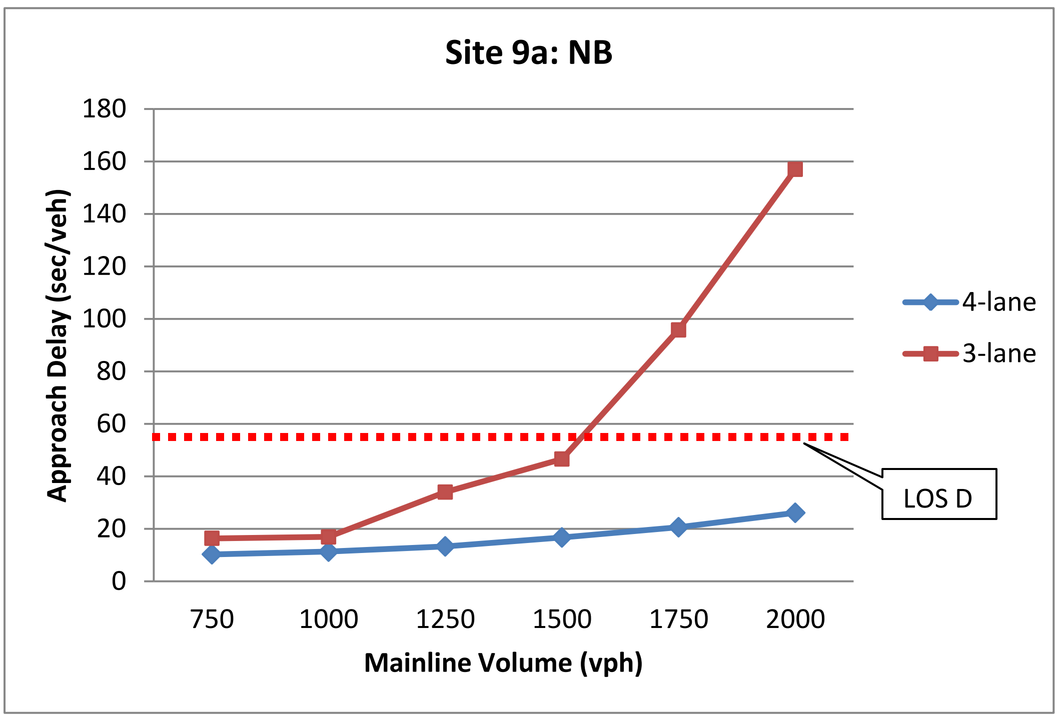


Figure 2. Typical results of approach delay versus mainline volume increments

The results (for all analyzed sites) indicate that for all cases, the approach delay for a road diet stays similar to the 4-lane section up to a mainline volume of approximately 1000 vph. When the mainline volume is increased from 1250 to 1500 vph, for most cases the approach delay for 3-lane sections increases and approached LOS D. It should be noted that the delay results for the two different approaches (e.g., NB vs. SB) for a single intersection may be different. For example, for site 9 (Eaton Rapids), the intersection of M-50 (road diet) and Canal Street/Brook Street has very different delay thresholds for the 3-lane sections for the two approaches. This is attributed to heavy left-turn volume for one approach. Notwithstanding such differences, for most cases the trends are similar for both approaches if the turning volume patterns are similar. For all the 4-lane cases, the approach delays are relatively low and typically stay below the 55 sec/veh threshold for volumes up to ~2000 vph. An obvious reason for this "better" performance for 4-lane sections is more capacity; however, another factor could be the use of turning bays at the intersections and corresponding optimized signal timings. If there are no storage or turning lanes, the approach delay would increase significantly for 4-lane sections.

Table 2 shows a summary gleaned from the results of the Synchro analysis (over all six sites). In general, if the mainline volume increased beyond an interpolated value of 1000-1100 vph for these sites (consistent with the other assumption showed above), the conversion from 4-lane to 3-lane sections will typically have a negative impact on the traffic operations in terms of approach delays. Using a K factor of 0.10 for conversion from peak hour to ADT yields an ADT of 10-11,000 veh/day. This is considerably lower than the 20,000 ADT which appears to be a widely used rule of thumb. The results here suggest that an ADT of greater than 10,000 would be a better figure to use as a critical ADT where a road-diet conversion for a particular site requires detailed operational evaluation. For all of the 3-lane study sections, the average mainline volume was 1500 vph (corresponding ADT of 15,000 vpd) at which the approach delay reached the threshold of 55 sec/veh.

A corridor-level operational analysis study using microscopic simulation models (e.g., VISSIM) would provide an even more detailed evaluation of the operational impacts of a proposed road diet. More detained operational analysis can incorporate multiple factors (e.g., varying levels of heavy traffic volumes, turning movements at the intersection).

Table 2. Interpolated mainline volumes (vph) when approach delay ≥ 55 sec/veh (≥LOS D)

Site #	County	City	Intersection	Interpolated Mainline Volume at Threshold Delay (≥ 55 sec/veh)			
				4-lane		3-lane	
1	Alpena	Alpena	US-23 @ 11th Ave	SB		SB	
				-		1750	
8	Eaton	Charlotte	Lansing Rd @ Hall Street/ Island Highway	NE	SW	NE	SW
				-	-	1600	1550
9	Eaton	Eaton Rapids	M-99 @ State Street	NB	SB	NB	SB
				-	-	1550	1550
			M-99 @ Knight Street	NB	SB	NB	SB
				-	-	1350	1350
			M-50 @ Canal Street/Brook Street	SE	NW	SE	NW
				-	1750	1850	1100
11	Genesee	Clio	M-57 @ Mill Street	EB	WB	EB	WB
				-	-	1150	1300
			M-57 @ Plaza Drive	EB	WB	EB	WB
				-	-	1300	1800
13	Genesee	Montrose	M-57 @ Saginaw Street	EB	WB	EB	WB
				-	-	1350	1650
			M-57 @ Seymour Road	EB	WB	EB	WB
				-	-	1700	1650

The important summary points from the operational analysis include the following:

- The operational analysis of the several sites provide reasonably consistent results and support guidelines that suggest that 4-to-3-lane road diet conversions become problematic for **ADTs greater than 10,000**.
- More importantly, 4-to-3-lane road diet conversions result in increased delay for **peak hour volumes between 1,000 and 1,500**.
- However, it is clear that "local" conditions (e.g., varying geometry, variation in turning movements, and variations in cross-street traffic) can have a significant impact on the viability of any proposed road diet. Thus, while an initial culling for potential road diet sites can be accomplished using the general guidelines above, in all instances a detailed operational analysis of the corridor (including operations at each intersection) for both

4- and 3-lane sections should be undertaken before the proposed road diet conversion is implemented.

A SAFETY-RELATED ANALYSIS FOR SELECTED 4-TO-3 LANE ROAD DIETS

The overarching purpose of the project was to estimate a crash modification factor (CMF or CMFs) that could be used to estimate crash savings that result from the implementation of 4-to-3-lane road diets in Michigan. From the outset it needs to be clear that road diets can have any of the following results (or combinations of results):

- decreases in crashes since, for example, left-turning vehicles are moved out of a through lane and into the reserved turning lane (the TWLTL) at mid-block non-intersection locations;
- increases in crashes since two lanes of through vehicles are moved into a single through lane (e.g., rear-end crashes in the right-hand lane become more likely simply due to higher volumes in the lane);
- decreases in pedestrian and bicyclist crashes because of the provision of better infrastructure for these users; and
- increases in pedestrian and bicyclist crashes since such users/trips are attracted to the improved infrastructure.

In addition, crash increases or decreases can vary substantially given the prevailing ADTs, road usage patterns, adjacent land uses (e.g., are there pedestrian/bicyclist attractors adjacent to the road diet site), turning volumes (especially mid-block), peak hour characteristics, and type of area (e.g., tourist area, university campus, small town) among others. Finally, background variation in crash frequencies (e.g., all crashes are steadily decreasing in a particular city) must be considered when trying to isolate the effect of a road diet.

The point is that there is likely to be significant variation in existing conditions prior to the implementation of a road diet. Crash savings (if there are any) are, likewise, likely to vary substantially with all of these variables.

In this section, the development of a crash modification factor (CMF) for selected 4-to-3 lane road diet sites in Michigan is documented:

- first, site selection is reviewed;
- next, data collection and reduction (e.g., reclassification of crash types) are discussed;
- then, the data analysis is presented including consideration of various methods for controlling for background trends in crash history; and,
- finally, a general CMF for road diets in Michigan is presented.

SITE SELECTION

Site selection for this project was developed through a general solicitation of sites from various MDOT personnel (e.g., TSC and/or regional traffic engineers) and local agencies. MDOT personnel had developed a tentative contact list which was supplemented with suggestions from others. A survey (see Appendix F) was sent to the list with the purpose of identifying potential sites, locations of the road diets, basic information about the site (e.g., type of road diet such as 4-to-3 lane reductions), the reasons for implementing the road diet, start and end dates for the actual implementation, and other basic data. Some 43 initial sites were eventually identified via the survey. Although it had originally been envisioned that different types of road diets might be included in the study, review (with MDOT) of the set of sites that emerged from the survey led to the conclusion that the study be limited to the "standard" 4-to-3 lane road diet conversions.

Some sites were eliminated because they were too recent to have adequate (three years) "after-implementation" data. Other sites were too old to have crash data that were consistent with data for all other sites. Other reasons for eliminating sites included: length too short, other recent site changes, inconsistent or no ADT data, and on-street parking allowed. For the final analysis, a total of 24 sites were generally used. For some of the analysis (e.g., on-site visits to observe pedestrian/bicyclist operations) some older sites were used while for other parts of the analysis, some of the 24 were not used. The latter is discussed in more detail below. Locations of all of the sites (including some that were only visited) were shown earlier in Figure 1. A copy of the spreadsheet for each of the 24 sites used in the crash analysis is in Appendix D.

DATA COLLECTION AND REDUCTION

Once the sites had been identified and agreed-upon, crash data were retrieved for each site (both for the mainline and cross streets near the intersections) as were ADT and other traffic data (e.g., turning data for some sites for the operational analysis). In addition to the electronic crash records, the "hard copies" of all of the relevant UD-10s were retrieved so that the actual crash diagram and narrative could be examined for each crash. This allowed, for example, for a determination of whether cross-street crashes were correctly assigned to the intersection or the cross street itself (and back from the intersection)—i.e., were these crashes at all associated with the road diet.

In addition, crashes were "reclassified" using a more-detailed assignment so that the effects of the road diets could be more accurately assessed. An example of this "reclassification" is assigning a rear-end/straight crash to the right or left lane during the "before" period. Further, crash categories were classified as whether they were expected to be: 1) "correctable" by a road diet (e.g., a rear-end left-turn crash in the left lane which should be corrected with a road diet since the turning vehicle would be out of the regular travel lane as a result of the road diet); or 2) affected by the road diet (e.g., rear-end crashes in the curb lane might increase). Note that while "correctable" crashes are a benefit, the affected crashes might either increase or decrease. Details of the reclassification scheme can be seen in Appendix G.

During the review of the crash data, some crashes were eliminated from consideration in the subsequent analysis. For example, if the crash didn't have anything to do with the roadway or its geometry, it was eliminated. Examples of such an elimination include a crash where a driverless vehicle rolled out of a driveway and crossed the entire roadway before crashing; and another where a police traffic stop resulted in the admission by the (inebriated) driver that she had been involved in a crash "somewhere" within the preceding hour or so, and the crash was coded to the street where the stop occurred. Other crashes that were eliminated included those with animals, those that occurred during (any) construction, and those that occurred on (or were otherwise attributable to) the side streets.

DATA ANALYSIS

Once all of the data had been prepared and reconciled, the analysis was relatively straightforward except for the control for background trends. The data used for any site is illustrated in the spreadsheet on the next page (site 11). Copies of the spreadsheets for all 24 sites are in Appendix D.

With reference to the information shown on the next page, the top section contains a summary of the basic **site characteristics** for site 11 (e.g., county, city, road name). The next section contains the **descriptive statistics** which include the basic crash frequencies by before and after period (and further broken down by year) as well as all of the crash information for background trends (e.g., crashes for the city and county over the same time period). The third section shows a **naïve before/after crash analysis** (no correction for trends) including a graphical representation of the crash frequency by year for the site. The fourth section shows the **before/after crash analysis with a simple adjustment for various background trends**. The final section (only available for some sites) shows the **before/after crash analysis adjusted for trends of an untreated comparison group**. Each of these sections is discussed in more detail in the following paragraphs.

Site characteristics, in addition to simple identification of the site, are also used for grouping similar types of sites when the CMF is developed—for example, the number of driveways, intersections, and average daily traffic (ADT).

Descriptive statistics include all of the basic crash information for the site. For each site, three-year before and after windows are shown. While, in most, if not all, instances the construction duration was short-lived, the crash data for the entire year during which the construction/implementation of the road diet occurred are eliminated from the analysis. Thus, each year in the before-after window for every site is a full calendar year and all before-after comparisons are based on three full years before and after the construction year. This eliminates any issues with one site being completed in the spring while another is completed in the fall. In addition to the overall crash frequencies, crash data are also broken down by

Site Characteristics

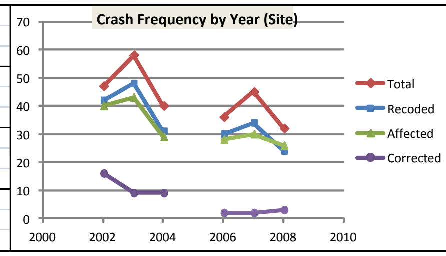
Site No.	11	Length (mi)	1.46
County	Genesee	Land Use	Mixed commercial-residential
City	Clio	No. of Driveways/Intersections	80/12
Route/Road Name	M-57	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1494503/25101		
BMP	9.400	Nearest Cross Street	Washington St.
EMP	10.856	Nearest Cross Street	Liberty St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	14628	14614	14892	13726	13466	16108
Crash Frequency (Total)	47	58	40	36	45	32
Crash Rate	6.05	7.47	5.05	4.94	6.29	3.74
Crash Frequency (Recoded)	42	48	31	30	34	24
Crash Frequency (Intersection-related)	5	8	3	5	5	6
Crash Frequency (Driveway-related)	10	5	7	2	6	0
Crash Frequency (Affected by Road Diet)	40	43	29	28	30	26
Crash Frequency (Corrected by Road Diet)	16	9	9	2	2	3
Crash Frequency (Background, Countywide)	14306	14066	13285	10458	10701	10180
Crash Frequency (Background, Citywide)	44	63	46	43	44	43
Crash Frequency (Background, Trunklines-Countywide)	1854	1854	1752	1400	1321	1218
Crash Frequency (Background, Trunklines-Citywide)	33	39	24	18	30	20

Crash Analysis Method: Simple (Naïve) Before/After Analysis

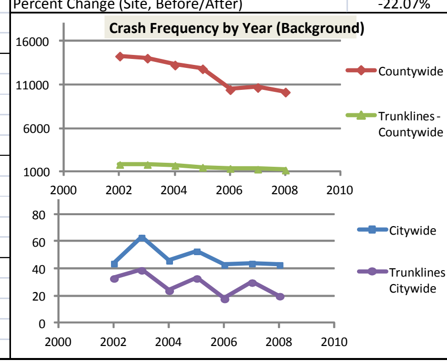
Average Crashes per Year (Before)	48.33
Average Crashes per Year (After)	37.67
Percentage Change	-22.07%
Average Crashes per Year (Recoded, Before)	40.33
Average Crashes per Year (Recoded, After)	29.33
Percentage Change	-27.27%
Average Crashes per Year (Affected, Before)	37.33
Average Crashes per Year (Affected, After)	28.00
Percentage Change	-25.00%
Average Crashes per Year (Corrected, Before)	11.33
Average Crashes per Year (Corrected, After)	2.33
Percentage Change	-79.41%



Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	41657
Average Crashes per Year (Countywide, After)	31339
Percentage Change Overall Countywide	-24.77%
Projected Average Crashes per Year using Countywide Background (Site, After)	36.36
Percent Change for Site Adjusted for Countywide Background	2.70%
Average Crashes per Year (Citywide, Before)	153
Average Crashes per Year (Citywide, After)	130
Percentage Change Overall Citywide	-15.03%
Projected Average Crashes per Year using Citywide Background (Site, After)	41.07
Percent Change for Site Adjusted for Citywide Background	-7.04%
Average Crashes per Year (Trunklines-Countywide, Before)	5460
Average Crashes per Year (Trunklines-Countywide, After)	3939
Percentage Change Overall Trunkline-Countywide	-27.86%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	34.87
Percent Change for Site Adjusted for Trunklines-Countywide Background	5.79%
Average Crashes per Year (Trunklines-Citywide, Before)	96
Average Crashes per Year (Trunklines-Citywide, After)	68
Percentage Change Overall Trunkline-Citywide	-29.17%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	34.24
Percent Change for Site Adjusted for Trunklines-Citywide Background	7.10%

Average Crashes per Year (Site, Before)	48.33
Average Crashes per Year (Site, After)	37.67
Percent Change (Site, Before/After)	-22.07%



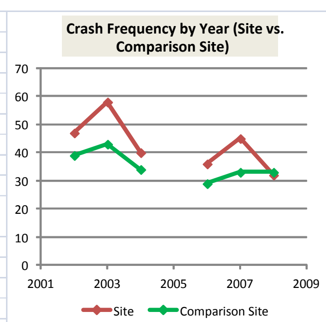
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Shiawassee, Owosso	Route/Road Name	M-52
PR/CS No.	551706		
BMP	16.299	Nearest Cross Street	Main St.
EMP	17.759	Nearest Cross Street	Laura Ln.

Descriptive Statistics	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
Crash Frequency (Total)	39	43	34	29	33	33

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	0.86	
Sample Odds Ratio (year 2-3)	1.09	
Mean of Sample Odds Ratios	0.98	
Standard Error of the Sample Odds Ratios	0.17	
95% Confidence Interval of the Sample Odds Ratio [LL, UL]	0.65	1.30
N-observed,T,B [total observed no. of crashes in before period for treatment group]	145.00	
N-observed,T,A [total observed no. of crashes in after period for treatment group]	113.00	
N-observed,C,B [total observed no. of crashes in before period for comparison group]	116.00	
N-observed,C,A [total observed no. of crashes in after period for comparison group]	95.00	
N-expected,T,A [expected no. of crashes that would have occurred in after period w/out treatment]	118.75	
Variance of N-expected,T,A	367.25	
Crash Modification Factor (CMF)	0.93	
Variance of CMF	0.03	
Standard Error of CMF	0.17	
95% Confidence Interval of the CMF [LL, UL]	0.60	1.26



whether they are intersection- or driveway-related and whether they are correctable or affected. Background data for assessing citywide and countywide trends are also shown. Finally, citywide-trunkline and countywide-trunkline trends are also shown. These can be used to "adjust" the basic before-after comparisons for background trends/variation (addressed below).

The **naïve before/after crash analysis** is a simple comparison of the three-year before and after crash frequencies. (Again, note that percentage reductions [in crashes] are discussed here—the percentage reductions in crashes can be converted to CMFs using the formula where the CMF = 1 – [percent reduction].) A percentage change (based on the before period) is also shown. In addition, similar numbers are shown using recoded crashes and then limiting the crash types to those that are presumed to be affected or correctable by the road diet. A graphical comparison of before and after frequencies is also shown (for total crashes, recoded crashes, affected crashes, and correctable crashes). It should be noted that the results shown for site 11 are fairly typical:

- Considerable year-to-year variation in crash frequencies are noted during both the before and after periods.
- In general, the crash frequencies are lower in the after period than during the before period. If there was no background variation, this would suggest that road diets result in significant crash reductions, regardless of which general group of crashes is examined.
- Crash reductions for "correctable" (by a road diet) crashes are the most substantial—a not-unexpected outcome.

The **before/after crash analysis with a simple adjustment for various background trends** is a consideration of the proposition that some of the observed reduction in crash frequencies is not because of the road diet but rather due to other causes (which may not be known). Background trends are shown for the county in which the road diet is located, for the city, and considering trends in only trunkline crashes for both the county and city. The trunkline trends were added since most of the road diets to be analyzed were on trunklines.

Various arguments can be made for which background trend “best” represents the overall environment for the road diet. After considering all of the sites, it was decided that the citywide trend is the most reasonable and realistic to use as the indicator of what else is occurring in the background of the implementation of the various road diets. The county level includes many roads that are quite different (in design and use) from those being “dieted” and, in some instances, may even include other larger urban areas. For this reason, the countywide data are not considered as representative as the citywide data. In addition, for some sites (in smaller cities), the trunkline category may primarily consist of the road diet site. Thus, the following analysis is based on using the “city trend” as indicative of the environment in which the road diet is undertaken. In each instance, the adjusted percentage change is also shown. That is, what is the effect of the road diet after considering (subtracting out) the background trend. Again, what is shown for site 11 is fairly typical of other results (see Appendix D for all sites):

- There is some year-to-year variation in background trends (i.e., the trend lines shown are not flat or monotonically increasing or decreasing).
- Notwithstanding year-to-year variations, the overarching background trends are that crash frequencies are decreasing.
- The simple (naïve) before-after trends associated with road diet implementation need to be adjusted for the general downward trend in crash frequency being experienced in the various cities where road diets were implemented.
- A considerable portion of the reduction in crash frequency that would be attributed to the road diet under a naïve scenario is accounted for by the background trend. For example (considering site 11 as shown), the average number of crashes per year is reduced from 48.3 to 37.7 or ~22% for the road diet site; but citywide crashes decreased from 153 to 130 or ~15%. Thus, much of the reduction on the road diet site is presumably attributable to the background trend—the modified crash reduction due to the road diet is reduced to ~7% (which corresponds to an adjusted CMF of 0.93).

The **before/after crash analysis adjusted for trends of an untreated comparison group** (last section in the example shown) is another attempt at controlling crash reduction for background trends. In the narrative here, the term CMF is used. As noted earlier, a CMF is used to estimate the number of crashes expected at a site following the implementation of a countermeasure or treatment. In addition to the naïve before/after analysis and comparison with background crash trends, the CMFs for each of the 24 project sites were computed. FHWA's 'A Guide to Developing Quality Crash Modification Factors' (Gross et al., 2010) provides several methods to compute crash modification factors and functions including before/after with comparison sites, empirical Bayes, and full-Bayes studies. While these (and other) methods differ primarily in statistical approach to modeling the crash data, a fundamental requirement for most methods is the availability of data for a group of "comparison sites" which are very similar to the "treatment sites" in physical and operational aspects.

To conduct a before/after analysis with a comparison group, comparison sites were identified using various characteristics such as length of road diet, area type (residential, commercial, or mixed), driveway and intersection density, number of lanes in the before period (including similar bike/pedestrian facilities), treatment year, and ADT. Given the practical difficulties in achieving ideal pairs of comparison and treatment sites, this exercise resulted in the identification of 17 potential comparison sites for 9 of the 24 treatment sites (multiple comparison sites were identified for six treatment sites). Crash data for comparison sites in the before period were then extracted to ascertain suitable matches with specific treatment sites.

In order to determine the suitability of the treatment-comparison pairs, sample odds ratios were computed using the crash data in the before period. The mean, standard error, and 95% confidence intervals of the sample odds ratios were computed to determine if crash frequencies at the comparison site were statistically similar to the treatment site in the before period. This crash data comparison further reduced the number of suitable comparison sites to five to match with the following treatment sites: 1, 3, 8, 11 (shown above), and 13.

For the five treatment sites for which the sample odds ratios resulted in viable comparison sites, the expected number of crashes that would have occurred in the after period without treatment (N-expected,T,A) was computed. The CMF was then computed based on the observed number of crashes in the after period for treatment sites (N-observed,T,A) N-expected,T,A, and the variance of N-expected,T,A (Gross et al., 2010). The variance, standard error, and 95% confidence interval of the CMF were also computed.

The CMF for site 11 (see above) was computed to be 0.93 with a 95% confidence interval of 0.60-1.26. Since the confidence interval includes the value of 1.0, it cannot be stated with 95% confidence that the true value of the CMF is not 1.0. In other words, the treatment did not have a statistically significant effect in reducing the crashes at this site. By way of comparison, the naïve before/after analysis shows a decrease of ~22%, and comparison with background crashes shows a range from a **~7% reduction** when adjusted for citywide crashes to an **increase of ~7%** when adjusted for citywide trunk line crashes. A graphical illustration of the crash trends for site 11 and the comparison site is also shown.

For site 1 (see Appendix D), the CMF was computed as 0.98 with a 95% confidence interval of 0.62 and 1.35. Again, since the confidence interval contains the value of 1.0, it cannot be stated with 95% confidence that the true value of the CMF is not 1.0. In other words, the treatment did not have a statistically significant effect in reducing the crashes at this site. While the naïve before/after analysis shows a decrease of 15.6%, the uncertainly of the treatment effect is somewhat evident from the comparison with background crashes where the effect of treatment yields a reduction of 6.11% when adjusted for countywide crashes, and shows an increase of 6.07% when adjusted for citywide crashes.

For site 3 (see Appendix D), the CMF was computed to be 0.83 with a 95% confidence interval of 0.58 and 1.07. The results relative to the confidence interval are the same as above. The naïve before/after analysis shows a decrease of 34.03%, and comparison with background crashes shows a wide range from 20.58% reduction when adjusted for countywide crashes, and a reduction of only 2.34% when adjusted for citywide trunk line crashes.

The CMF for site 8 (see Appendix D) was computed to be 0.97 with a 95% confidence interval of 0.61 and 1.33. Again, these results are similar to those noted above. The CMF for site 13 (see Appendix D) was computed to be 0.80 with a 95% confidence interval of 0.48 and

1.12, so the results are similar. Overall, the CMFs computed using the before/after analysis with comparison groups were not found to be significant for any site.

The outcome of the exercise using comparison sites to adjust the percentage of crash reductions and/or the CMFs was somewhat disheartening. While it seems intuitively clear that there is some reduction in crashes due to road diets, the results of the most-detailed analysis indicated that it was not statistically significant. However, that analysis is highly dependent on the comparison sites that were selected. It was impossible to find sites that were an exact match for the road diets studied, notwithstanding some measure of statistical fit. Roadway segments upstream and downstream from the road diets were considered as were parallel routes; all to no avail. Sites in different locations were considered and those chosen were the "best possible," but far from perfect. The dilemma was whether to go forward with developing recommended CMFs which may not be statistically defensible. The decision was to go forward and, to the extent possible, develop CMFs based on citywide trends in crashes during the before and after periods. The caveat regarding the suitability of comparison groups being noted.

ESTIMATION OF CMFs AND DISCUSSION

As noted, the site-by-site results (as discussed above) for all 24 sites are presented in Appendix D. These results were synthesized to get a general result that could be used by MDOT as a guideline for what might be expected to result from a road diet implementation. Further work was also done to examine trends in crash severity.

The tasks below were completed to develop CMFs; the results are shown in the summary spreadsheets in the appendix. An abbreviated version of that spreadsheet (showing CMFs) is shown on the next page (Table 3). These spreadsheets contain the results from the following tasks:

- Site-by-site calculations were done as described above.
- A summary of selected site characteristics was prepared for each site and included:
    - site number,

Table 3. Abbreviated summary of CMF-related data

Summary/synthesis for crash analysis (CMFs)

site	~ADT	length (miles)	~avg annual crash	# of drivwys	# of intersecs	type	CMF correction factors: based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	**basic CMF**	basic CMF corrected by city trend	**CMF based on recoded crashes**	recoded CMF corrected by city trend	**CMF for affected crashes**	affected CMF corrected by city trend	**CMF for corrected crashes**	corrected CMF corrected by city trend
1	13442	0.37	34	19	4	com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
2	13261	1.44	41	26	17	com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
3	10965	4.33	53	100	35	res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
4	11062	0.53	3	16	8	com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
8	14328	0.81	39	49	7	com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
9	17020	0.43	38	16	8	com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
11	14572	1.46	43	80	12	mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
13	9016	1.31	25	97	11	mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
16	12342	0.87	24	58	8	res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
18	7137	0.96	5	55	6	res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
20	12639	0.68	7	34	9	res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
22	7663	0.22	6	12	3	com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
23	14652	0.50	20	23	9	com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
25	6512	0.79	10	38	4	res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
26	10855	0.58	4	39	5	res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
29	10747	0.49	7	30	4	res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
30	7676	0.38	10	25	8	mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
33	7049	0.69	10	19	6	mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
34	7719	0.46	6	22	2	com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
36	4995	0.86	5	42	5	mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
37	14164	0.30	10	4	4	com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
39	n/a	0.39	19	14	5	res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
40	3510	0.50	6	31	7	com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
43	13660	0.62	46	27	11	mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
average	10652	1	20	37	8		0.824	0.721	0.821	1.088	**0.630**	**0.91**	**0.67**	**0.95**	**0.62**	**0.90**	**0.31**	**0.59**
std dev	3587.02	0.82	16.09	25.54	6.62		0.080	0.115	0.096	2.002	0.225	0.23	0.42	0.42	0.29	0.31	0.25	0.28
max	17020	4	53	100	35		0.978	0.936	1.073	10.429	1.400	1.69	2.00	2.29	1.43	1.74	1.00	1.37
min	3510	0	3	4	2		0.648	0.467	0.616	0.000	0.323	0.53	0.11	0.24	0.22	0.35	0.00	0.13
										n	24	24		21		21		21
										95% conf	0.090	0.092		0.182		0.134		0.122
										μ-95%	0.540	0.817		0.765		0.762		0.469
										μ+95%	0.720	1.001		1.128		1.030		0.712

- crashes,
- length of road diet,
- approximate average annual crash frequency (over all years—used later to divide sites into high and low accident frequencies), and
- type of site (residential, mixed and commercial—used later to divide sites).

- Percentage changes for the county trends, city trends, and trunklines were calculated for each site (as above) and transferred to the summary spreadsheet—these are used as alternative corrections for considering background variation.
- The percentage reductions (or increases) between the before and after period were calculated for all, recoded, affected, and correctable crashes and transferred to the summary sheet.
- Each of the basic reductions was then "adjusted" using the various corrections for city, county, and other trends (the abbreviated summary below shows only the corrections for city trends; the sheet in Appendix D shows all of the corrections).
- Once the above information was all transferred to the summary sheet, averages (and other statistics) were calculated over all sites with usable data. Confidence intervals for the relevant average CMFs were also calculated.
- All of the percent changes were converted to CMFs (a separate worksheet in the appendix which is shown in abbreviated form below).
- The sites were sorted by relatively high and low "before" crash frequencies (>19 crashes/year vs. 10 or fewer crashes/year), type of adjacent land use (residential, mixed residential and commercial, and commercial), number of driveways (>32 and <32), and number of intersections (8 or less, 9 or more).

The important CMFs in Table 3 are those in bold red. These are: the basic (unadjusted) CMF referred to earlier as the "naïve" CMF and based solely on the overall change in crash frequency between the before and after periods; the basic CMF adjusted for the citywide trend;

and the CMFs for recoded crashes, affected crashes, and correctable crashes. Similar CMFs were calculated considering different stratifications of the sites (e.g., by high and low frequencies of before crashes). (Details on these variations are not shown in the abbreviated version of the spreadsheet but are provided in Appendix D.)

The 95% confidence intervals for the mean values of the CMFs are also shown in the following spreadsheet. Note that in every instance (save for the “correctable” crashes) the confidence interval for the trend-corrected CMF contains the value of 1.0—therefore, the average CMFs are not statistically different from zero. This result is actually similar to that obtained from the more detailed analysis involving comparison sites discussed in the last section.

The relevant CMFs are further summarized in Table 4 below. The naïve CMF is 0.63—that is, if all of the reduction in crashes was attributed to the implementation of the road diets the “after” crashes would be 63% of the “before” crashes. However, it was argued above that the naïve CMFs needed to be adjusted for the background citywide trend in crash frequency. In all instances (see detailed results), the citywide trend over the seven-year period (3 years before, 1 year for construction, and 3 years after) studied was toward decreasing crashes. Thus, the “uncorrected CMF” is adjusted for that (average) trend with the result that the basic CMF (shown in bold green in the table) is estimated as 0.91. That is to say that after the adjustment for the background trend, the “after” crashes on road diet sites would be 91% of the “before” crashes (only a 9% reduction after adjustment). Looking at the recoded crashes and only affected crashes, it is seen that the CMF varies by only a few points. For the crashes expected to be “corrected” by a road diet, the CMF is 0.59—that is, for those crashes expected to be reduced by road diets the “after” crashes would be only 59% of the “before” crashes.

The basic CMF is the one that is suggested for general estimates for proposed road diet projects. This is with the strong caveat that there is significant variation among sites. For example, the results in Table 3 show that the (citywide-trend-adjusted) CMFs for the 24 sites studied varied from 0.53 to 1.69 although most sites had CMFs less than 1.0. It should be noted that the site with the highest CMF had a low number of crashes so that a large percentage

Table 4. Comparison of mean values of CMFs

type of CMF	un-corrected CMF	CMFs corrected for city trend: basic CMF	CMF for recoded crashes	CMF for affected crashes	CMF for corrected crashes
average over all sites	**0.63**	**0.91**	**0.95**	**0.90**	**0.59**
potential adjustments for different characteristics					
high crash	0.65	0.92	0.91	0.92	0.54
low crash	0.61	0.90	0.98	0.88	0.63
res	0.55	0.78	0.77	0.91	0.51
mix	0.68	0.94	1.06	0.90	0.52
com	0.67	0.99	1.05	0.88	0.72
low driveway density (<32)	0.63	0.93	1.07	0.87	0.66
high driveway density (>32)	0.63	0.88	0.81	0.92	0.51
low number of intersections (8 or less)	0.61	0.90	0.95	0.83	0.61
high number of intersection (9 or more)	0.67	0.93	0.93	1.05	0.55

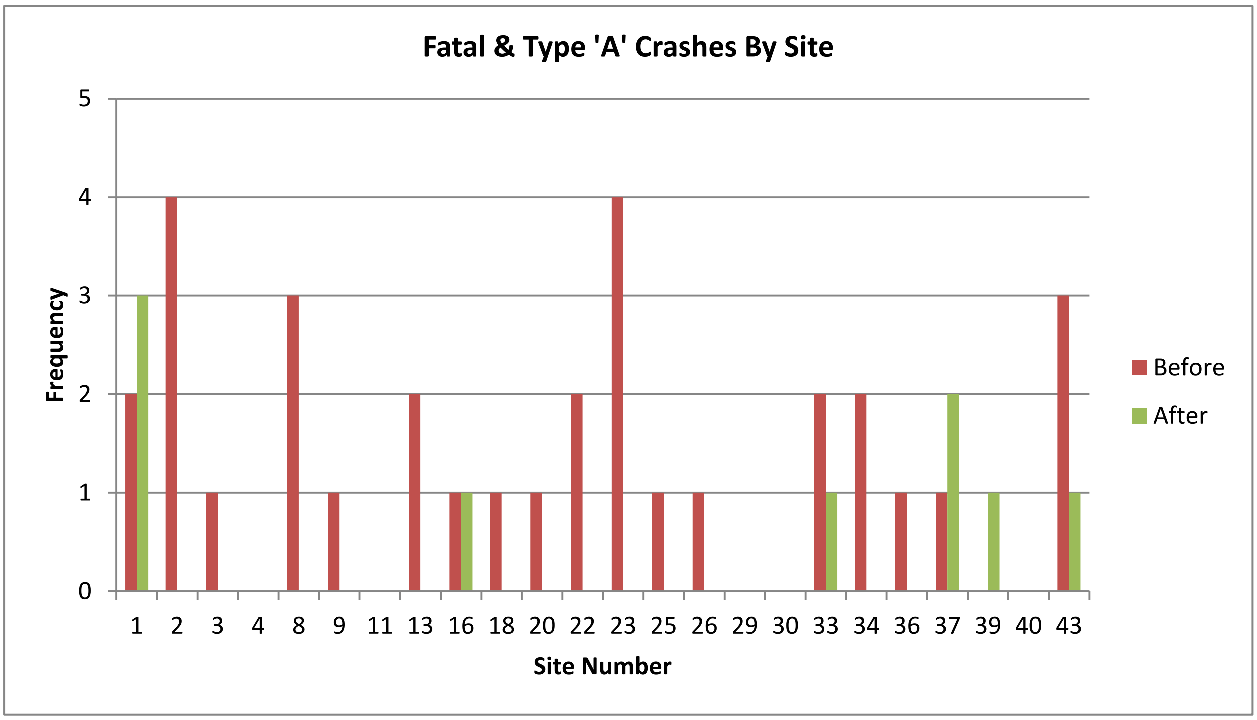
change was relatively easy to achieve. For such reasons, the sites were disaggregated by crash frequency (and other factors) as seen in Table 4—this was to illustrate how the CMF might vary from one grouping to another. For example, the basic (adjusted) CMF is seen to be 0.92 for "high" crash sites and 0.90 for "low" frequency sites. Looking at the "basic CMF" column, it is noted that most of the groupings don't make much difference—with only a couple of points of difference from one grouping to another. The most notable exception is the grouping by type of adjacent land use. The results here suggest that the CMF for "residential" sites might result in more crash savings (CMF = 0.78) than for commercial or mixed-use sites (CMFs = 0.99 and 0.94, respectively). The way the "potential adjustments" should be interpreted is, for example: while the overarching CMF for all sites is expected to be around 0.91, a residential site might result in a lower CMF than would be achieved at a mixed-use or primarily commercial site.

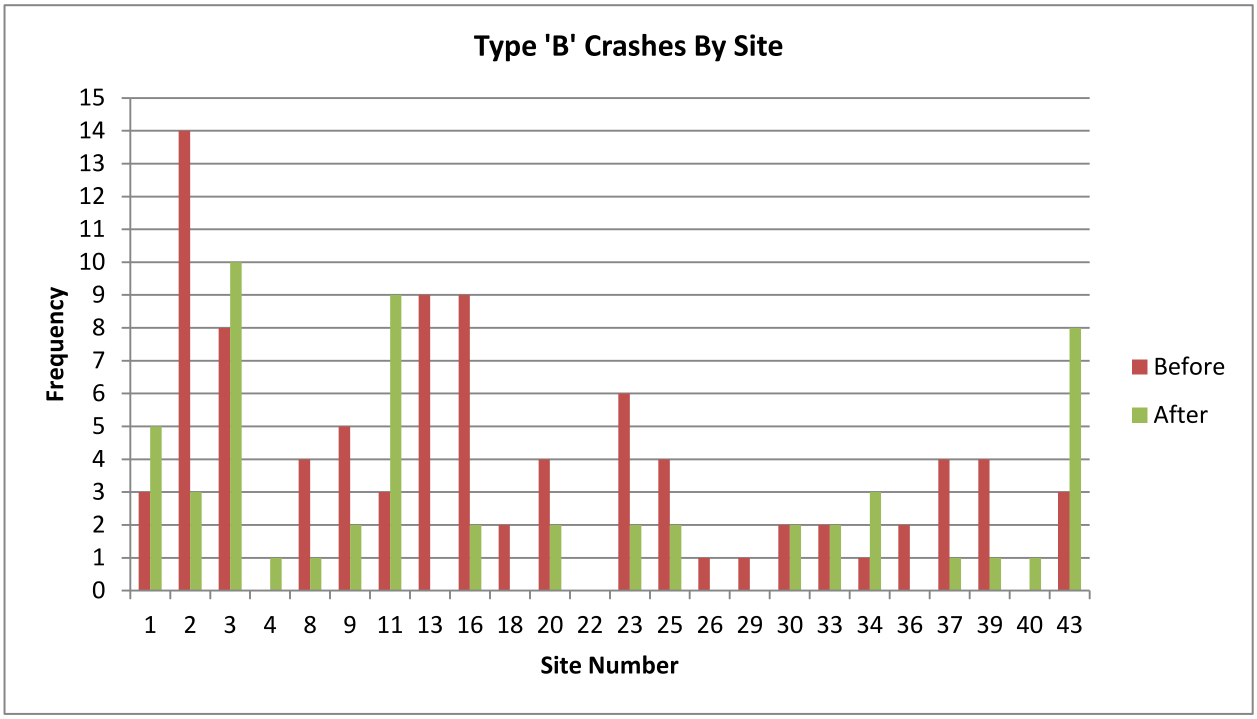
The exception to the above is the collection of those crash types that are expected to be "corrected" by a road diet. The overall CMF is estimated at 0.59 and (as shown in the detailed results) is statistically different from zero. So, while there is more confidence in this result, it should be noted that there are some offsetting changes in the frequencies of other crash types.

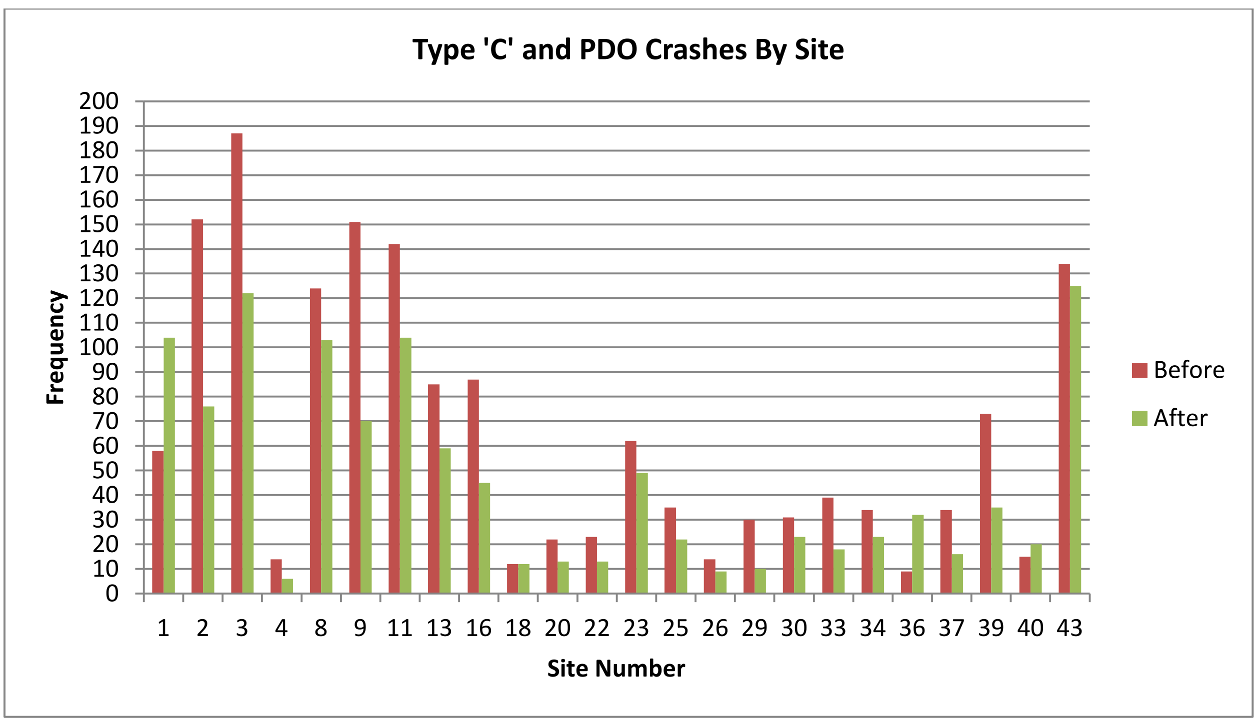
So, used only for selected crash types, this CMF has utility but it is not necessarily good for estimating overall changes.

CRASH SEVERITY

Changes in crash severity might also be expected as a result of the implementation of road diets. Changes in severity must be handled with care as there are many factors in play—e.g., changes in speed limits and/or operating speeds can shift severity distributions regardless of whether road diets are being implemented. The overarching trends in Michigan are that the total number of crashes and all types of severity are decreasing over time (from 1996 through 2010) although not without some year-to-year fluctuation. The three graphs below show the before and after frequency of three severity classifications (fatal + A crashes, B crashes, and C +







PDO crashes) by site. As can be seen, and has been repeatedly noted, there is considerable variation by site although the trend is for an overall reduction (which was noted earlier for all crashes over all sites). Perhaps the best indication for severity effects is the shift in the distribution of severity for the sites studied. This overall trend (all sites combined) is shown in Table 5.

Table 5. Shift in crash severity for all sites

crash type	before	after
fatal + A	33 (2%)	9 (1%)
B	91 (5.4%)	57 (4.9%)
C + PDO	1567 (92.7%)	1109 (94.4%)

It would appear that there is a slight trend toward less severe crashes on the road diet sites. For rough comparison purposes, an examination of overall statewide trends in severity (using the same severity groupings as for Table 5) is shown below from 2001 to 2010.

Table 6. Shift in statewide crash severity between 2001 and 2010

crash type	2001	2004	2007	2010
fatal + A	2.4%	2.4%	2.3%	2.0%
B	5.2%	4.8%	4.7%	4.8%
C + PDO	92.4%	92.8%	93.1%	93.2%

One issue in comparing the severity shift for the sites is that the actual time periods for the before and after windows varies by site (for example, before-after for site 1 compares 1997-1999 with 2001-2003 while the before-after for site 2 compares 2004-2006 with 2008-2010). That notwithstanding, there are distributional shifts in overall statewide severity over the 10-year period of: a 0.4 percentage point decrease in fatal+A crashes, a 0.4 percentage point decrease in B crashes, and a 0.8 percentage point increase in C+PDO crashes. This compares to a 1 point decrease in fatal+A, a 0.5 point decrease in B, and a 1.7 point increase in C+PDO for the road diet sites. This suggests that the road diet shifts are slightly larger and more positive (from a safety perspective) than overall statewide trends would suggest over the last 10 years or so. Such small differences do not seem operationally significant and could easily be attributable to things like changes in operating speeds, changes in enforcement, or just random variation.

SUMMARY AND DISCUSSION

The development of a crash modification factor (or factors) for road diets in Michigan was the primary objective of this study. In all, 24 separate sites were studied with this goal in mind. Overall changes in crash experience before and after the implementation of the 4-to-3 lane road diets were evaluated and then controlled for background variation. The latter was done through examining citywide and countywide trends (trends on trunklines were also examined) and through consideration of comparison sites (i.e., untreated "control" sites). Changes in crash severity were also examined. The following is a summary of the results of those analyses.

- There is considerable site-to-site variation in the crash-related results although in almost all instances, there was a reduction in the number of crashes.
- Examination of the background (e.g., citywide, countywide) trends showed that in all cases there was a trend toward lower crash frequencies over time. This is a clear indication that before-to-after comparisons of road diet implementations (or any other change to the road system infrastructure) must be evaluated with explicit control for the background trends.
- Several approaches for controlling for background variation were pursued. The most appropriate were deemed to be a simple control for citywide trends and the consideration of comparison sites.
- Good/acceptable comparison sites could be identified for only a few of the 24 sites and none of the eventual comparisons gave statistically significant results—that is, the calculated CMFs for specific sites were not statistically different from 1.0.
- Average CMFs, adjusted for citywide trends, were calculated across all 24 sites. The result was that the overall naïve (unadjusted) CMF was estimated as 0.63 and **0.91** after adjustment. Considering only those crash types expected to be affected by the road diet (not necessarily only reduced), the CMF was 0.90. And, finally, considering only those crash types expected to be reduced by a road diet, the adjusted CMF was 0.59.

Use of the latter is problematic since there are typically offsetting changes in crash type frequencies. Only the CMF for the "correctable" crashes was statistically different from 1.0.

- While the best estimate of a usable CMF is 0.91, it should be noted that this is not statistically different from 1.0 and is an average across all sites. Perhaps more importantly, there is a great deal of variation from site to site.
- Considering effects of other variables on the overall CMF, it was seen that there was not much change due to high vs. low overall crash frequency sites, nor was there much difference due to driveway or intersection density. However, sites where the land use adjacent to the road diet was primarily residential tended to have a lower CMF than mixed-use or commercial sites.
- Changes in crash severity due to road diets were also examined. The question was whether the distribution of severity changed—i.e., do crashes tend to be more or less severe after road diets are put in place. Again, it was noted that there was considerable variation from site to site (and often the numbers of crashes, especially the more serious, were quite small). The distributional shift over all sites was estimated and compared to statewide shifts over the general analysis period. The finding was that although there was a slightly more substantial shift to less severe crashes for the road diet sites, it did not seem operationally significant. Moreover, the shift could have easily been due to changes in operating speeds, enforcement, or simply random variation rather than the road diets themselves.

IMPLEMENTATION OF ROAD DIETS

One of the issues with road diets (and, really, any street or road improvement) is how and when to engage the public if the action is being initiated by MDOT or other agency. Road diets in Michigan are typically perceived as a safety improvement although there may also be upkeep and maintenance savings as well. A more-detailed implementation guide is presented in Appendix E but summary comments are presented below.

Historically, traffic engineers (and the public agencies they work for) have been perceived as being primarily concerned with expanding or at least maintaining street and road capacity and enhancing traffic flow. However, over the last decade or so, there has been increasing interest in how streets and roads "fit" into the adjacent environment—conversations about complete streets, traffic calming, green design, accommodating pedestrians and bicyclists, and so forth have become much more common. The road diet concept has gained considerable traction with various agencies, and road diets are often proposed by traffic engineers as being better for non-motorized users and having safety benefits. Ironically, some communities resist proposals for road diets because they can reduce capacity in some situations. Regardless of why a road diet is being proposed (e.g., a single stand-alone project, part of a pedestrian/bicyclist plan, part of a complete streets program), there needs to be engagement of the local community if the project is to be smoothly implemented.

ROAD DIET IMPLEMENTATION

Road diets have been implemented in many states including California, Washington, Iowa, Minnesota, Florida, and, of course, Michigan. For the purpose of developing an implementation guide, studies that present information on the process of implementing a road diet were further reviewed. These studies included advantages and disadvantages of a road diet, motivating factors for conversion, and lessons learned following the project (e.g., Gallagher 2007).

The apprehension regarding (or overt dislike of) road diets stems from the counter-intuitiveness of reducing the capacity of the roadway while maintaining an acceptable level of service. To challenge the general thinking, many agencies implementing road diets have experienced success by utilizing techniques that both educate and involve the community.

An implementation guide encompasses all aspects of the project in a beginning-to-end fashion. Continuous community involvement should be maintained through each phase of the road diet conversion. There are three basic phases: pre-construction (phase I), construction (phase II), and post-construction (phase III) with the following objectives for each phase:

- phase I—community education and acceptance for the road diet project;
- phase II (which can be very short if the project is primarily re-striping)—mitigate any negative effects associated with construction and roadway operations; and
- phase III—demonstrate how the road diet fulfilled community objectives while highlighting the benefits of the new corridor.

Success of a road diet project can be measured on several levels, however, when a road diet fulfills the needs of a community while maintaining the necessary function of the corridor, success is generally recognized.

In **phase I, community education and acceptance**, it is essential to promote community involvement and a sense of ownership from the outset. Many agencies implementing road diets have involved the public through town hall meetings, workshops, and newspaper postings which detail the road diet project specifically (Gallagher 2007). Others have found success by implementing road diet projects through city master plans or other citywide initiatives such as Complete Streets or a community bicycle plan. For example, Michigan's Genesee County Metropolitan Alliance adopted a "Complete Streets" approach where "Transportation improvements in Genesee County are planned, designed and constructed to encourage walking, bicycling, and transit use while promoting safety for all users" (GCMPC undated). Another example includes the "pedscape plan" adopted in Charlotte, North Carolina (Sak 2007). These techniques provide an accepting atmosphere because residents are more receptive to change and look forward to "reinventing" their community with a broader scope. Additionally, this couples the road diet with other actions which may, for example, have as a goal restoring an out-dated downtown setting. The intent of public meetings during this phase should be to:

- gain an understanding of the needs of a community by generating a list of transportation, economic, and safety objectives;
- develop a broad plan (e.g., a master plan, complete streets program) which considers community objectives and provides a list of projects which fulfill these objectives and provides a context for the road diet;
- provide several alternatives to road diets and explain how different alternatives succeed or fail to meet the goals of corridor and the community;
- demonstrate how a road diet will affect all modes of transportation by providing equal access to motorists, cyclists, and walkers while maintaining safety; and
- perhaps most importantly, provide an unbiased assessment of both the advantages and disadvantages of road diets—overstating the benefits of a road diet sets the project up for failure in the public eye.

With reference to the last point, the operational and safety effects of road diets in Michigan presented earlier in this report provide realistic and relevant information that can be used in “phase I” activities. It is important to not oversell the effects of road diets and to point out the high degree of variance in the safety outcomes that are associated with them.

To maintain community involvement from beginning to end, many engineers/planners involved with road diet projects have utilized public forums such as blogs or social networking sites (e.g., Kazis 2011). This sort of public forum allows citizens to voice concerns, opinions, or support concerning the process of the design and implementation. In turn, this gives the agency an opportunity to answer questions which generally alleviate concerns voiced by community members. Such sites can also provide a central hub for pertinent information regarding street closures, detours, and project progress. Use of the electronic media is much better than relying solely on just one or two “standard” public hearings or meetings in that the new media allow for a dynamic process.

During **phase II, implementation/construction**, public concern, which can arise during the planning phase, can be heightened when construction begins. The degree of discontent will largely be based on the extent of the project. If a road diet is implemented simply by pavement marking re-striping, negative response will be minimal. If the project requires reconstruction, causing travel/commuting to become difficult, additional measures will be necessary to alleviate any concerns. Regardless of the size of the project, any precautions that will lessen the stress associated with the road diet should be taken. Based on past experiences, the following techniques have been used to maintain a positive attitude throughout the community during the construction phase:

- reduce the impact of constructing the road diet on the community by shortening the construction timeline as possible (Sak 2007);
- provide proper detours to maintain access and mobility through the area;
- if logical/possible, consider public transportation options through the corridor;
- select a design which uses the existing curb line;
- change traffic signal timing before construction to allow motorists to become acquainted with the new cycle lengths (Sak 2007);
- implement the road diet in concert with other projects (e.g., installing new utilities); and
- again, use a blog or website to keep users up-to-date on the progress of the project while relaying important detour and closure information.

An often overlooked part of a road diet project is **phase III, project follow-up** to analyze, for example, the post-implementation operational characteristics to understand if the project was successful. This assessment will be important to members of the community who will want to understand if the project met the intended objectives. Similarly, other agencies will be interested if this type of roadway conversion could be successful in their own communities. Success of a road diet should be based on the totality of the project and not just, for example, on motorist delay.

A follow-up evaluation of a road diet plays an important role in the success of the project. By assessing the characteristics of the updated roadway and presenting findings to community members, a sense of satisfaction and accomplishment can be instilled in the community. Finally, information collected from a converted site can be of use to other agencies considering a similar roadway conversion.

TYPICAL QUESTIONS AND INFORMATION NEEDS REGARDING ROAD DIETS

It is instructive to present a list of typical questions that have come up (Sak 2007) or issues that have been identified (City of Orlando 2002) in various venues regarding road diets. Thinking about these questions/topics in the context of a specific proposal may help frame the content for future presentations.

Some questions (Sak 2007):

- Where does the additional traffic go when the capacity is reduced by half?
- When some communities are widening roadways, why are we narrowing ours?
- How will bus stops be accommodated with a road diet?
- How will emergency response units be affected?
- What if it doesn't work?

Some typical measures of effectiveness (MOEs) that might be developed for a project (City of Orlando 2002):

- increased traffic on neighboring streets
- speeding
- pedestrian and bicyclist volumes
- vehicle (and/or pedestrian/vehicle) crashes
- on-street parking use rates
- resident and merchant pedestrian satisfaction
- parking satisfaction

Actions to address overarching concerns:

- Conduct a thorough analysis of the corridor and make certain a road diet is suitable alternative for the roadway.

- Avoid implementing a road diet without community involvement.
- Develop a plan that not only encompasses the road diet project but the community as a whole such as complete streets or a new bicycle/pedestrian initiative.
- Avoid overstating the benefits of a road diet
- Publish road diet success stories in local newspapers or blogs.
- Use blogs or social networking sites to provide as much information as possible to community members while providing a forum to express any concerns.
- Provide opportunity for additional beautification elements such as stamped concrete, brick accents, planter boxes, curb out-crops, and added landscaping.

SUMMARY AND DISCUSSION

A three-phase process associated with planning, constructing/implementing, and follow-up on road diet projects was presented. The major points to be emphasized during execution of that process are:

- Road diets should not be "oversold" with respect to expected benefits, especially safety benefits. The estimated CMF (last section) is relatively modest and is an average of many sites—this suggests that "guaranteeing" crash savings of a certain magnitude would misrepresent what will be experienced in any specific situation. Actual benefits could be significantly higher or lower.
- Both the pros and cons associated with road diets need to be presented and thoughtfully discussed with the community.
- Use of social media to discuss (and resolve) road diet proposals can be successful as an adjunct to traditional public hearings and other traditional community-involvement techniques.

SUMMARY AND CONCLUSIONS

The summary and conclusions from this study of selected road diet conversions in Michigan include the following points.

From the literature and state of practice reviews—

- As a general statement, crash reductions are experienced with most installations and are most typically reported as percentage changes (CMFs would be < 1.0). There is, however, significant variation in the magnitude of the reduction.
- While there appears to be significant "natural variation" in crash reduction percentage (and CMFs), variation is also introduced because of the variance in the before/after geometry and operating conditions at road diet sites.
- Most studies did not result in the estimate of CMFs per se. The most reliable estimates of CMFs are generally thought to be found on the FHWA-funded website "crash modification factors clearinghouse" maintained by the University of North Carolina Highway Safety Research Center [http://www.cmfclearinghouse.org/]. From that source, road diets are estimated to result in the following CMFs for unspecified roadway types in urban areas: all crash types/all severity levels = 0.63; all crash types/all injury crashes = 1.0; all crash types/PDOs-only = 0.54; angle crashes/all severity levels = 0.63-0.76; and rear-end crashes/all severity levels = 0.59.
- Many, if not most, studies did not control for background variation in crash trends. In virtually all areas, the general decrease in crashes at road diet locations must be adjusted for overall changes in crashes in the surrounding areas during the study period. Otherwise, too much of the reduction in crashes may be attributed to the road diet.

From the on-site assessment of pedestrian and bicyclist use of road diets—

- Provisions for pedestrian and bicyclist are most important when there are existing pedestrian/bicyclist generators on the site and/or when the road diet is part of a larger plan for an area.

- If pedestrian/bicyclist provisions are included in the road diet area, they need to be clearly and consistently (i.e., always) marked.
- While there appears to be a need for additional information/education regarding appropriate use of the road and pedestrian/bicyclist facilities at road diet sites, supplemental signs indicating crosswalks and bike lanes should be considered for routine inclusion at road diet sites.

From the operational analysis of several Michigan road diet sites—

- The operational analysis of the several sites provide reasonably consistent results and support a guideline that suggests that 4-to3-lane road diet conversions result in significant increases in delay for **ADTs over 10,000**.
- More importantly, 4-to-3-lane road diet conversions increase delay when **peak hour volumes of exceed 1,000**.
- However, it is clear that "local" conditions (e.g., varying geometry, significant variation in turning movements, and variations in cross-street traffic) can have a significant impact on the viability of any proposed road diet. Thus, while an initial culling of potential road diet sites can be accomplished using the general guidelines above, in all instances a detailed operational analysis of the corridor (including operations at each intersection) for both 4- and 3-lane sections should be undertaken before the road diet conversion is implemented.

From the safety analysis of selected 4-to-3 lane road diets in Michigan—

- There is considerable site-to-site variation in the crash-related results although in almost all instances, there was a reduction in the number of crashes.
- Examination of the background (e.g., citywide, countywide) trends showed that in all cases there was a trend toward lower crash frequencies over time.
- The most appropriate methods for controlling for background trends were a simple control for citywide trends and the consideration of comparison sites.

- Good/acceptable comparison sites could be identified for only a few of the 24 sites and none of the eventual comparisons gave statistically significant results—that is, the calculated CMFs for specific sites were not statistically different from 1.0.
- Average CMFs, adjusted for citywide trends, were calculated across all 24 sites. The result was that the overall naïve (unadjusted) CMF was estimated as 0.63, and **0.91** after adjustment. Considering only those crash types expected to be affected by the road diet (not necessarily only reduced), the CMF was 0.90. And, finally, considering only those crash types expected to be reduced by a road diet, the adjusted CMF was 0.59. Use of the latter is problematic since there are typically offsetting changes in crash type frequencies. Only the CMF for the "correctable" crashes was statistically different from 1.0.
- While **the best estimate of a usable CMF is 0.91**, it should be noted that this is not statistically different from 1.0 and is an average across all sites. Perhaps more importantly, there is a great deal of variation from site to site.
- Considering effects of other variables on the overall CMF, it was seen that there was not much change due to controlling for other variables except for adjacent land use—residential sites tended to have a lower CMF than mixed-use or commercial sites.
- Changes in crash severity due to road diets were examined and the distributional shift over all sites was estimated (and then compared to statewide changes). The finding was that although there was a slightly more substantial shift to less severe crashes for the road diet sites, it did not seem operationally significant. Moreover, the shift could have easily been due to changes in operating speeds or enforcement rather than the road diets themselves.

From the implementation of road diets—

- Road diets should not be "oversold" with respect to expected benefits, especially safety benefits. Actual benefits of a road diet can vary significantly by site.

- Both the pros and cons associated with road diets need to be presented and thoughtfully discussed with the community.
- Use of social media to discuss (and resolve) road diet proposals can be successful as an adjunct to traditional public hearings and other traditional community-involvement techniques.

Road diets are a useful tool in the traffic engineer's arsenal of making streets and roads a more integral part of the community. As a part of broader plans, they open up "traditional" roads to greater use by pedestrians and, especially, bicyclists. In general, safety benefits can be expected but vary greatly from site to site. When corrected for citywide trends, the results here indicate that only a relatively modest CMF (0.91) is appropriate. This indicates that crash/safety benefits are likely to be considerably less than what is suggested by naïve comparison of before and after crash statistics. Similarly, the results reported here also suggest that operational analyses (e.g., using Synchro) should always be performed early on in the consideration of a road diet proposal. Moreover, the commonly-quoted threshold ADT of 20,000 for consideration of a road diet should be lower (10,000) and, more importantly, realistic peak-hour analyses (based on actual counts) are much more useful. For the sites evaluated here, the peak-hour threshold volume is estimated as 1,000 vph although this could vary with varying volumes of cross traffic at intersections.

RECOMMENDATIONS FOR IMPLEMENTATION OF RESEARCH FINDINGS

The recommendations for implementation of the research findings are presented below as "action items" for MDOT and based on the discussion in each section of the report.

- The results of the literature review and the article-by-article review in Appendix A should be made available to MDOT and local-agency engineers and planners who are interested in and/or dealing with road diet projects.
- When pedestrian/bicyclist provisions are included in a road diet, they need to be clearly and consistently (i.e., always) marked.
- MDOT should share the following quantitative, operations-related findings of this research with the FHWA and suggest changes to the appropriate section of the **Michigan Operations Manual** which is addressed to "4-to-3 Lane Conversions."
    - The ADT threshold for considering such road diets should be changed to ≤10,000.
    - More importantly, detailed operational analysis should be done when ADTs are 10,000 or more **OR** when peak hour volumes exceed 1,000.
    - Finally, because of the variation in intersection geometry, turning volumes, and signal timing from site to site, detailed operations analysis **always** be done.
- Results of the safety analysis and development of crash modification factors (CMFs) related to 4-to-3 lane road diets should also be shared with the FHWA (as above).
    - When studies of the effects (or effectiveness) of road diets are done, there must always be control for background trends with citywide trends generally being the most appropriate to consider.
    - The overall naïve (unadjusted) estimated CMF is 0.63 and **0.91** after adjusting for citywide trends. Considering only those crash types expected to be affected by the road diet (not necessarily only reduced), the estimated CMF is 0.90. If only those crash types expected to be reduced by a road diet are considered, the adjusted CMF is 0.59. Use of the latter is problematic since there are typically offsetting changes in crash type frequencies. Only the CMF for the "correctable" crashes was statistically different from 1.0.

- Operations- and safety-related results should be incorporated into any presentation material developed by MDOT and local agencies regarding the planning and implementation of road diets.
- Road diets should not be “oversold” with respect to expected benefits, especially safety benefits. Actual benefits of a road diet can vary significantly by site.
- Both the pros and cons associated with road diets need to be presented and thoughtfully discussed with the community.
- Use of social media to discuss (and resolve) road diet proposals can be successful as an adjunct to traditional public hearings and other traditional community-involvement techniques.

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APPENDIX A

DETAILED LITERATURE REVIEW (by project/study)

This literature review is ordered on a study-by-study basis with the important aspects of each study summarized in turn. There are two sections: those studies pertaining to both the safety and operational characteristics of road diets and those pertaining primarily to the operational characteristics. The listing below shows the order of the studies for easy reference if it is desired to review a specific study. All page numbers shown below refer to this appendix.

SAFETY AND OPERATIONAL CHARACTERISTICS OF ROAD DIETS

The Conversion of Four Lane Undivided Urban Roadways to Three Lane Facilities

June 1999
Thomas M. Welch, P.E.
Office of Transportation Safety, Iowa DOT
http://contextsensitivesolutions.org/content/reading/conversion-of-four-lane/resources/conversion-of-four-lane/

The intent of this report, prepared for the TRB/ITE Urban Street Symposium 1999, is to present the state of the practice of "road diets". The report illustrates the results of expanding two-lane roadways to 4-lanes in a simple before-and-after analysis. Table 1 explains these implications.

Table 1: Results from converting a 4-lane roadway to a 3-lane roadway

Corridor Element	Change
• Traffic Volume	Increased 4 percent
• Corridor Travel Delay	Increased 4 percent
• Mid-block 85th% Speed	Increased 2.5 mph
• Traffic Traveling More than 5 mph Over Speed Limit	Increased from 0.5 percent to 4.2 percent
• Accident Rate	Increased 14 percent
• Injury Rate	Increased 88 percent
• Total Value Loss	Increased 280 percent

The author discusses several "road diet" experiments that have taken place throughout the U.S.

- 17th St. West, Billings, Montana (1979) with ADT of 9,200 – 10,000 and speed limit of 35 mph had a decrease in accidents from 37 in the 20 months prior to treatment to 14 in the 20 months following treatment.
- US-71 (Flindt Dr.), Storm Lake, Iowa with ADT of 8,500 where a "very positive community reactions" was received.
- Clay Street, Muscatine, Iowa where "an immediate large reduction in accidents" was reported.
- US-12, Helena, Montana with ADT of 18,000 in a commercial area with numerous commercial access points resulted in the "number of accidents decreased, good traffic flow was maintained, and community residents prefer the three-lane facility over the former four-lane roadway".
- 21st ave. East, Duluth, Minnesota with ADT of 17,000 is another example discussed.

Advantages and disadvantages of “road diet” treatments are identified. Advantages include reduced crash rates, reduced speeds, pedestrian safety, traffic calming effects, and improved emergency response time. Reduced crash rates result from the improved sight distance of the design and reduced number of lanes for cross-traffic to navigate. Crash statistics on Minnesota Trunk Highway 49 (Rice St), Minnesota with an ADT of 16,400 are summarized in Table 2. Pedestrian safety is discussed with respect to using the TWLTL as a pedestrian refuge. The inability of aggressive drivers to change lanes several times within a corridor resulted in a decrease in 85th percentile speed where the flow speed is set by the lead drivers.

Table 2: Comparison of frequency of crash type for before and after road diet treatment

MTH-49 (Rice Street), Hoyt Avenue to Demont Avenue Ramsey County, MN			
Collision Type	Number of Collisions		Percent Change
	Before	After	
Rear End	68	39	-43
Sideswipe Passing	16	10	-38
Left Turn	23	20	-13
Right Angle	36	31	-14
Right Turn	2	2	0
Head On	5	0	-100
Sideswipe Opposing	2	1	-50
Off Road Left	1	2	+100
Off Road Right	4	1	-75
Other	5	8	+120
Total	162	117	-28

Additional “road diet” examples as well as collision reduction are presented in Table 3 for sites in Seattle, Washington.

Table 3: Comparison of frequency of crash type for before and after road diet treatment

Data on Street Conversions - Seattle, Washington					
ROADWAY SECTION	DATE CHANGE	ADT (BEFORE)	ADT (AFTER)	CHANGE	COLLISION REDUCTION
Greenwood Ave. N, from N 80th St. to N 50th St.	April 1995	11872	12427	4 lanes to 2 lanes plus TWLTL plus bike lanes	24 to 10 58%
N 45th Street in Wallingford Area	December 1972	19421	20274	4 lanes to 2 lanes plus TWLTL	45 to 23 49%
8th Ave. NW in Ballard Area	January 1994	10549	11858	4 lanes to 2 lanes plus planted median with turn pockets as needed	18 to 7 61%
Martin Luther King Jr. Way, north of I-90	January 1994	12336	13161	4 lanes to 2 lanes plus TWLTL plus bike lanes	15 to 6 60%
Dexter Ave. N, East side of Queen Anne Area	June 1991	13606	14949	4 lanes to 2 lanes plus TWLTL plus bike lanes	19 to 16 59%
24th Ave. NW, from NW 85th St. to NW 65th St.	October 1995	9727	9754	4 lanes to 2 lanes plus TWLTL	14 to 10 28%
Madison St., from 7th Ave. to Broadway	July 1994	16969	18075	4 lanes to 2 lanes plus TWLTL	28 to 28 0%
W Government Way/Gilman Ave. W, from W Ruffner St. to 31st. Ave. W	June 1991	12916	14286	4 lanes to 2 lanes plus TWLTL plus bike lanes	6 to 6 0%
12th Ave., from Yesler Way to John St.	March 1995	11751	12557	4 lanes to 2 lanes plus TWLTL plus bike lanes	16 to 16 0%
				Total	185 to 122 34%

Disadvantages include increased travel delay, increased delay at driveways, and loss of passing opportunities. The author presents corridor LOS analyses as an example, where a section of an Iowa roadway is analyzed with 4-Lane and 3-Lane TWLTL cross-sections. Results from this analysis conclude that delay increases, however LOS is maintained when converting from a 4-lane roadway to a 3-lane roadway.

Guidelines for the Conversion of Urban Four-Lane Undivided Roadways to Three-Lane Two-Way Left-Turn Lane Facilities

April 2001
Keith K. Knapp – Iowa State University
Center for Transportation Research Education (CTRE)
Iowa Department of Transportation
http://www.intrans.iastate.edu/reports/4to3lane.pdf

This report presents a comprehensive summary of Road Diets by presenting past research, case studies, and a simulated analysis of four-lane to three-lane conversions. Additionally, the report presents feasibility determination factors to be used when assessing the alternatives to convert a four-lane site as well as providing concluding recommendations.

Past research includes a study on the effectiveness of implementing TWLTLs while converting from four-lanes to three-lanes (Nemeth, 1978). The study concluded that the reduction in through lanes increased delay however access was improved. Further, traffic congestion was increased significantly to a point where drivers used the TWLTL as a passing lane. Walton et al. conducted a study to determine the limiting ADT at which a Road Diet should be implemented. ADT in the range of 5,000 – 12,000 were suggested based on the results of the study. Hummer and Lewis conducted a study to compare the safety of two-lane undivided, three-lane, and four-lane undivided roadways. Results indicated that three-lane roadways had lower crash rates in medium and high-density residential and commercial land use areas.

Case studies included two from Montana, two from Minnesota, five from California, one from Washington, and six from Iowa. Limited data was presented for these case studies, however, the sites with the most complete data are presented in the summary table. Specifically, the sites in Iowa were considered in greater depth, including statistics on level-of-service, vehicle speeds, delay, crashes, and public opinion surveys.

The presented traffic flow simulation is thorough including a simulation software comparison, sensitivity analysis factors (e.g. total entering volume, access point density, and access point left-turn volume), and methods of simulation. The resulting data included before-and-after travel speeds, LOS, and crash frequencies.

Feasibility determination factors were presented with thorough descriptions including:

- Roadway Function and Environment
- Overall Traffic Volume and Level of Service
- Turn Volumes and Patterns
- Frequent-Stop and/or Slow-Moving Vehicles
- Weaving, Speed, and Queues

- Crash Types and Patterns
- Pedestrian and Bike Activity
- Right-of-Way Availability, Cost, and Acquisition Impacts
- General Characteristics: Parallel Roadways, Offset Minor Street Intersections, Parallel Parking, Corner Radii, and At-Grade Railroad Crossings

Final recommendations include:

- Choosing alternatives on a case-by-case basis
- Roadways with bi-directional peak-hour volumes less than 1,500 vph (15,000 ADT) should be considered and less than 1,750 vpd should be considered with caution
- Roadways currently operating as a "defacto" three-lane roadway should be considered

Methods:

- Simple Before and After comparison.
- CORSIM was used to analyze the LOS provided by four-lane undivided and three-lane TWLTL roadways.
- Fixed characteristics of the roadway included:
    - The roadway segment was 1/4-mile long.
    - Through traffic volumes were equally distributed in each direction along the major roadway segment (i.e., there was a 50/50 directional split).
    - Pretimed two-phase signalized intersections exist at each end of the roadway segment.
    - The timing of the two-phase signals was optimized using the SYNCHRO software approach (e.g., delay minimization) and assuming they comprised a two-signal system.
    - No left- or right-turn lanes exist along the four-lane undivided roadway.
    - No right-turn lanes exist along the three-lane roadway.
    - Right- and left-turn volumes each represent 10 percent of the through volume at each signalized intersection.
    - Right-turn volumes entering/exiting the number of access points used in an individual simulation represented 10 percent of the traffic flow.
    - The turn volumes entering/exiting each access point and minor street are equal.
    - There were no through volumes at the four-leg access points (see Figure 3), and the minor street approach volumes at the signalized intersections were assumed to be equal to 40 percent of the major roadway traffic flow at the intersection.
    - A 30 mph travel speed was assumed for both cross sections.
    - Only four-leg intersections occur between the major roadway and the access points and minor streets.
    - All minor street and access point approaches have a single lane.
- Each cross section was simulated with various combinations of total entering volume, access point left-turn volumes, and access point densities.

Evaluation of Lane Reduction "Road Diet" Measures on Crashes and Injuries

2002

H.F. Huang, C.V. Zegeer, J.R. Stewart

Viewed in hardcopy print

The intent of this study was to investigate the effects of road diets on crashes and injuries by investigating 23 road diet sites in California and Washington. A four-group study design was utilized by identifying road diet and comparison sites and compiling data for before and after implementation of each road diet. Comparison sites were selected to be similar in terms of roadway functional class, type of development, speed limit, intersection spacing, and access control. For data purposes, a three-month transition period was defined as the month before installation, month of installation, and month following installation. Crashes occurring during this transition period were discarded from the study. Due to limited sample size, several road diet sites were removed from the analysis of determining change in crashes per month. Of the 25 road diet sites, 8 sites were suitable to be incorporated in the analysis.

Following the traditional before and after analysis the following was concluded:

- A 2% – 42% reduction in crashes took place.
- Crash type remained the same between road diet and comparison sites.
- Road diets accounted for a reduction in crash severity.

The study presents a literature review of additional road diet examples in California, Iowa, Michigan, Minnesota, Montana, Canada, Pennsylvania, and Washington. This study seems to be a precursor to the previous Huang et al. study.

Methods:

- Crash variables of interest include date, location (intersection/midblock), crash type, injuries, fatalities, time, number of vehicles, and various conditions.
- A 3-month transition period was considered where no data was used.
- The amount of data for before and after periods varied considerably.
- Intersections at each end of the road diet were considered transition areas and were not considered in the analysis.
- Crashes per month were normalized so as to compare reductions of sites having different lengths.

Urban Minor Arterial Four-Lane Undivided to Three-Lane Conversion Feasibility: An Update

July 2003

K. K. Knapp, K. L. Giese, W. Lee

http://docs.google.com/viewer?a=v&q=cache:LiReHQ4b4kgJ:www.urbanstreet.info/2nd_sym_proceedings/Volume%25202/Knapp.pdf+The+Safety+and+Operational+Effects+of+%22Road+Diet%22+Conversions+in+Minnesota&hl=en&gl=us&pid=bl&srcid=ADGEESg4RotFMBPdrpg8QoV4G2RdrIk7KEG9I_8tzKlVnyFm7EZ4lJPSQg1dbE0InTr2E4HmZxuYPmkGDQY50_YhG_dogKgtVZjyQqV1jee01iJK-B9Rp-n2N86lurKDWb57Q2swmNT7&sig=AHIEtbRIeQGF3t5WCBSelZ6x-iNG0Yqssw

The intent of this paper is to provide information to the 2nd Urban Street Symposium in Anaheim, California in 2003. The paper summarizes research, guidelines, previous case study results and an analysis using CORSIM software to investigate traffic flow differences of similar four-lane to three-lane conversions.

Case studies mentioned in this paper include sites located in Iowa, Montana, Minnesota, California, and Washington. These road diet locations have been cited in numerous papers that provide information on road diets. Results of each study indicate a reduction in 85th percentile speed and 17% – 62% reduction and crashes. Again, these sites were reinvestigated by Huang et al. with more rigorous statistical techniques where the reduction in crashes was found to be 6% and a negligible change in crash severity and type.

The paper continues by presenting and discussing feasibility determination factors as presented by the Iowa Department of Transportation:

- Roadway function and environment;
- Overall traffic volume and level of service;
- Turning volumes and patterns;
- Frequent-stop and slow-moving vehicles;
- Weaving, speed, and queues;
- Crash type and patterns;
- Pedestrian and bike activity;
- Right-of-way availability, cost, and acquisition impacts; and
- General characteristics; parallel roadways, offset minor street intersections, parallel parking, corner radii, and at-grade railroad crossings.

As part of the Iowa Department of Transportation project, the overall traffic volume and "level of service" feasibility determination factor was further investigate to determine the maximum volume of vehicles that can be serviced before significant operational impacts take place. The analysis compared the average arterial travel speed, arterial LOS, and intersection LOS of similar four-lane undivided and three-lane roadways for peak-hour volumes of 500, 750, 875, and 1000 vph. The analysis concluded that minimal effects took place up to 750 vph and travel speeds decreased by 1.9 mph at 1,000 vph. The arterial LOS was the same for each cross-section up to 875 vph where a LOS D resulted for the three-lane roadway and a LOS C resulted for the four-lane roadway. The analysis considered variables including total entering traffic volumes, different levels of left-turn traffic, access point densities, heavy vehicles, and bus stops.

Methods:

- CORSIM was used to analyze the sensitivity of delay due to factors including entering traffic volumes, different levels of left-turn traffic, access point densities, percent heavy vehicles, and bus stop activities.

The Effect of Four-Lane to Three-Lane Conversion on the Number of Crashes and Crash Rates in Iowa Roads

June 2005

W. Li and A. Carriquiry

http://www.iowadot.gov/crashanalysis/pdfs/iowa4to3laneconversion_fullbayes_june2005.pdf

The intent of this study is to present findings of a statistical study on road diets and their effectiveness in reducing the number of motor vehicle accidents. The study was conducted on roadways in Iowa and provides an in-depth description of the statistical modeling approaches used to determine the effectiveness of road diets.

The study uses 30 paired sites in Iowa, the same sites that have been the subject of several studies conducted on behalf of the Iowa Department of Transportation. Several data parameters were collected for each site including local population, AADT, and crashes. A Bayesian approach was used to account for regression to the mean and seasonal effects were also considered throughout the analysis. The study provides a great deal of statistical information as far as the approach however lacks any information on site selection and specific characteristics of each site.

The following were concluded through the study:

- The reduction in the expected number of crashes per year and mile was 32.3% for a treated site and 7.1% for a control site.
- The estimated expected reduction in the number of crashes per year, mile, and 100,000,000 AADT were 44.3% and 25.5% respectively for treated and control sites.
- The expected number of monthly crashes per mile tends to be higher during winter months.

Methods:

- Bayesian method.
- Seasonal effects were accounted for by including smooth trigonometric functions with three different periods representing the four seasons of the year.
- 15 treated and 15 comparison sites were analyzed where local population and traffic volumes were accounted for.
- Independent variables include the four seasons of the year, treatment type (road diet or control), time, and interaction of treatment and time.

Matched Pair Safety Analysis of Four-Lane to Three-Lane Roadway Conversions in Iowa

2006

Thomas B. Stout, P.E.

http://www.ctre.iastate.edu/mtc/papers/2005/stout.pdf

The intent of this paper is to conduct a statistical analysis on crash data compiled for 11 sites in Iowa. The research was focused on evaluating the safety impacts of road diets using a Before-and-After with Yoked Pairs (comparison sites) analysis. The data included five years of traffic crash data for "before" and "after" the implementation of a road diet. Comparison sites were identified by the following characteristics:

- Volume (ADT) within 20% of the study roadway
- City population within 20% of the study roadway's city population (a nearby roadway was used in the Des Moines and Storm Lake studies; in all other cases it was necessary to find sites in other cities)
- Similar "character" (aerial photography was used to assess type of development, number of access points, and physical limitations/topographic features)
- Length within 20% of the study roadway.

The purpose of the study was to determine safety-related impacts of Road Diets including changes in:

- frequency of crashes
- crash rate
- nature/type of crashes
- injury character or severity of the crashes
- involvement of drivers 65 and older, 75 and older, and 25 and younger

Conclusions of the study include a 58% reduction in fatal crashes, 40% reduction in major injury crashes, 67% decrease in minor injury crashes, and 56% decrease in possible injury crashes. Further, a decrease in crash rate per driveway density unit resulted following a road diet conversion.

Successful Road Diet conversions are more likely under the following circumstances:

- There is a history of crashes that are amenable to solution by providing a two-way left-turn lane
- Traffic volume is generally less than about 20,000 ADT
- There is a high density of access points
- There are large turning volumes

The benefits of conversion may include the following:

- A reduction of 21 to 38 percent in the frequency and rate of crashes
- A similar reduction in the number and severity of injury crashes

- Reductions in the involvement of age groups that are traditionally at risk, those 25 and under as well as those 65 and older
- A significant reduction in the number of crash types related to left-turns and stopped traffic.

Methods:

- Before-and-After Yoked Pair Method
- Driveway density was used to classify the "character" of the roadway (type of development) and to find a relationship to the number of crashes.
- Crash data was collected for a 5-year before and 5-year after period.
- Control sites were selected based on: Volume (ADT) within 20% of the study roadway; city population within 20% of the study roadway's city population; similar "character" (aerial photography was used to assess type of development, number of access points, and physical limitations/topographic features); and length within 20% of the study roadway.

Safety Impacts of "Road Diets" in Iowa

2006

Thomas B. Stout, Michael Pawlovich, Reginald R. Souleyrette, and Alicia Carriquiry

http://www.iowadot.gov/crashanalysis/pdfs/ite_draft_4to3laneconversion_papersubmission_2005.pdf

The intent of this paper is to reanalyze data used in a previous study, *Evaluation of Lane Reduction "Road Diet" Measures on Crashes and Injuries* conducted by Huang et al. The previous study used a classical statistical approach and concluded that Road Diets reduced crash frequencies by 6% and had minimal impacts on reducing crash rates. The *Safety Impacts of "Road Diets" in Iowa* study used the same data, however the authors utilized a Before-and-After (B/A) with "yoked-pairs" and the Full Bayes (FB) statistical approaches. The study concluded that a Road Diet could account for 25% reduction in crash frequency per mile and a 19% reduction in crash rate.

This study analyzed the same 15 treatment and 15 control sites in Iowa that were used in the previous study. Information to evaluate the effectiveness of Road Diets was compiled by the Iowa Department of Transportation Office of Traffic and Safety. The sites were mostly located in small urbanized areas with populations ranging from 1,169 to 198,682. The sites experienced annual daily traffic in the range of 2,000 to 17,400 vehicles.

The B/A analysis included data collected for the 5 years previous to treatment and the following 5 years after treatment. Within the examined data, crash frequency, rate, severity, type, driver age, and major cause were all considered. The study determined a 28% reduction in total crash frequency and a 21% reduction in total crash rates when compared to city-wide crashes. Further, major injury crashes were reduced by 11%, minor injury crashes reduced by 30%, and possible injury crashes reduced by 31% compared to city-wide results. Results from the B/A analysis are shown for each site in Table 1.

Table 1: Percent change in Type of Crash for Study Segment

CITY	Head-On	Rear-End	Angle/Left-turn	Broadside	Sideswipe-same	Sideswipe - opposing	Unknown
Blue Grass	25.0	-47.9	-100.0	-50.0	-72.2		-91.7
Council Bluffs		-89.6	66.7	66.7	-100.0		-100.0
Des Moines	-58.3	9.8	-84.2	6.4	87.5	150.0	-61.1
Glenwood	-30.8	-28.8	0.0	-34.7	37.5	300.0	-86.7
Indianola	-37.5	19.9	-50.9	1.6	42.9		-77.9
Iowa Falls	-9.1	-72.2	-64.3	-100.0	-100.0	150.0	-100.0
Lawton		-100.0	-100.0	-16.7	-58.3		-100.0
Manchester	150.0	8.7	-75.0	-50.0	87.5	-100.0	-100.0
Mason City	25.0	-85.3		-16.7	-100.0		-100.0
Osceola	-31.8	-35.8	13.6	-74.1	-91.7	25.0	-100.0
Rock Rapids	0.0	-71.4	-100.0	0.0	-90.0		-100.0
Sioux Center	-89.6	0.7	-81.4	-37.5	-54.2	25.0	-95.5
Sioux City	-58.3	66.7		-58.3	66.7		-100.0
Storm Lake	1066.7	128.4	-68.3	-60.0	-69.7		-52.4
Overall	-41.7	-35.0	-73.5	-40.9	-49.3	100.0	-85.2

The FB analysis included data collected for 23 years (1982-2004) for the 30 site locations. Each site having different treatment dates resulted in a variation of before and after crash data for each site. The study determined a 25.2% reduction in crash frequency per mile and an 18.8% reduction in crash rate.

Final Remarks:

- A 25% reduction in crash frequency per mile and a 19% reduction in crash rate. This differs from the Huang, et al. study which reported a 6% reduction in crash frequency per mile.
- A similar reduction in the number and severity of injury crashes
- Reductions in the involvement of age groups that are traditionally at risk, those 25 and under as well as those 65 and older
- A significant reduction in the number of crashes types related to left-turns and stopped traffic.
- A 34% reduction in the number of injury crashes, as well as a reduction in the severity of the crashes that do occur.

Methods:

- Classical Before-and-After (B/A) with comparison sites and Full Bayes (FB) methods.
- B/A used 5 years of data before and 5 years after while FB used 23 years total independent of when the road diet was implemented.
- The same comparison sites were selected for the FB and B/A analyses.

- For FB, given the random and rare nature of crash events, a hierarchical Poisson model where the log mean was expressed as a function of time period, seasonal effects, and a random effect corresponding to each site included was fitted to the crash frequencies.
- FB was adopted for estimation of model parameters. In the Bayesian approach, model parameters are treated as random variables and the goal is to estimate the distribution of likely values of the parameters given prior values and data.

Iowa's Experience with Road Diet Measures: Use of Bayesian Approach to Assess Impacts on Crash Frequencies and Crash Rates

February 2007

M.D. Pawlovich, L. Wen, A. Carriquiry, T. Welch

http://trb.metapress.com/content/488084n420265182/

The intent of this study was to investigate the safety effects a road diet has on Iowa roadways. This study is the analytical document of which many papers and handbooks have been developed from. The sites had volumes ranging from 2,030 to 15,350 and were located in smaller urbanized areas in Iowa. The study employs a Bayesian method to estimate model parameters and draw inferences from the data.

The study uses 15 road diet sites and 15 comparison sites in Iowa. Crash data was available for each site from 1982 to 1994 however due to different intervention dates the available before and after crash data varied. Comparison sites were identified based on traffic volumes, geometry, and local population size each known to have effects on overall safety. It was noted that crash frequency and rate decreased for all treated and non-treated sites during the investigated period however treated sites showed a sharper decline. Following the Full Bayesian analysis it was concluded that road diets in Iowa could account for a 23.2% – 27.8% reduction in crash frequency per mile and a 17.9% – 20% decrease in crash rate.

Factors that have been controlled for include time effects, conversion month, and seasonal effects on crash frequency and traffic volumes.

Methods:

- Fully Bayesian data analysis.
- 15 treated and 15 comparison sites.
- Seasonality effects were considered.
- A comprehensive summary of statistical details are presented.
- End-of-site treatments are not presented.

Road Diet Handbook - Overview

2007

Jennifer A. Rosales, P.E., Professional Associate

http://www.oregonite.org/2007D6/paper_review/D4_201_Rosales_paper.pdf

The intent of this paper is to provide an overview of the published book *Road Diet Handbook: Setting Trends for Livable Streets*. The book presents advantages and disadvantages to road diets with respect to safety effects, operational effects, and livability effects. The handbook is intended to become a guide to local departments of transportation to determine the overall feasibility of a road diet for a given roadway. The paper provides a brief overview of previous studies, case studies, and practice guidelines.

Previous studies are summarized with respect to economic effects and walkability, safety, operations, and road diet examples.

Six case studies are presented including sites in Dunedin, New Zealand; Toronta, Canada; Athens, Georgia; Clear Lake, Iowa; and two in Vancouver, Washington. Supplemental to the common road diet characteristics was a survey that was conducted in the local areas collecting information on:

- Household/business characteristics
- Perceptions on the street's traffic, safety, activities (street life) and friendliness
- Recommended improvements
- Reactions to the road diet
- Comfort and safety for pedestrians, bicyclists, and transit users
- Increased landscaping and beautification opportunities
- Improved quality of life and street character

Results of the surveys were mixed and suggestions for improvement included reducing speeds, prohibiting trucks, reducing traffic, and adding street trees and planters.

Both this paper and the corresponding handbook are summarized by lessons learned and road diet guidelines. Guidelines are presented pertaining to feasibility factors, left-turn treatments, transitions, bicycle facilities, on-street parking, and pedestrians.

Reading *Road Diet Handbook: Setting Trends for Livable Streets* would provide a more thorough understanding of the implications related to road diets.

Methods:

- Simple Before and After analysis.
- Safety (crashes, speeds, pedestrians) and operations (volumes, delay) were investigated.

Implementation:

- Consider road diet projects when multiple opportunities arise such as a pavement reconstruction project, presence of an adjacent parallel route, or jurisdictional roadway transfer.
- Consider community requests to evaluate and implement road diet projects. With technical evaluation and community involvement with stakeholder groups, road diet projects are more likely to be successful.
- A public education campaign that goes along with a road diet project needs to emphasize the notion that this is a safety enhancement project and that it may require trade-offs in capacity and speed.
- Increase public education regarding the use of the two-way left turn lane.
- Manage community expectations with clear communication and documentation. Identify project goals, performance measures, expectations and conduct follow-up evaluations.
- Coordinate road diet projects with concurrent pavement overlay projects, if possible. A road diet striping plan on new pavement results in less driver confusion.
- Install trees and planters to soften the landscape.

Four-Lane to Three-Lane Conversions: An Update and a Case Study

June 2007

K.K. Knapp and J.A. Rosales

http://docs.google.com/viewer?a=v&q=cache:6GIuebHZ9x8J:www.urbanstreet.info/3rd_symp_proceedings/Four-Lane%2520to%2520Three-Lane.pdf+The+Safety+and+Operational+Effects+of+%22Road+Diet%22+Conversions+in+Minnesota&hl=en&gl=us&pid=bl&srcid=ADGEESiWvuhqgofRjX4jCUKTF2nZTpUAh3apmvecoyHhR6FuAb6LkZOcCKkeNiihVqaOO6fsOAjafO_zalYdfTh74HSEsf8HnkLOLJ4XYUFBRyH4jaKu0SZ9VDlgQR3qAZ1WsZsAnXYP&sig=AHIEtbQvD7GgjAdG0TNtgUzupddITewvrA

The intent of this paper was to provide information regarding road diets to the 3rd Urban Street Symposium in Seattle, Washington in June 2007. The paper presents guideline recommendations and some feasibility determination factors for potential road diet projects and concludes with a case study of a road diet candidate in Wisconsin.

The feasibility determination factors were provided by the Iowa Department of Transportation guidelines. The existing and expected status of all of the following factors should be evaluated before determining if a road diet is suitable.

- Match roadway environment with function.
- Road diets have been successful on roadways up to 24,000 ADT however operational impacts may be noticed for a roadway above 20,000 ADT.
- Determine turning volumes and patterns.
- Investigate the frequency of slow moving or large vehicles using the roadway.
- Pedestrian and bicycle activity should be considered.
- Right of Way, costs, and acquisition impacts should be investigated.

Recommendation guidelines set forth by the Iowa Department of Transportation are as follows:

- The feasibility of implementing a road diet should be considered on a case-by-case basis.
- Both existing and expected characteristics of the roadway should be considered.
- Simulation suggests that peak-hour volumes less than 750 vph may experience negligible operational impacts, while caution should be used on roadways ranging from 750 – 875 vph, and above 875 vph indicated a more severe impact to operations.

The paper continues to address the livability benefits presented by Rosales:

- Improved walkability and easier street crossing,
- Increased pedestrian and bicycle use,

- Slower vehicle speeds,
- Users feeling “safer” and more “comfortable” along the roadway,
- Economic growth in adjacent and nearby businesses,
- Increased new home and business improvement projects,
- Redevelopment and renovation work at a quicker pace, and
- Increased front yard activity.

The paper concludes with a case study in which the feasibility factors mentioned were applied on a road diet candidate in Colby, Wisconsin. Because the roadway was only analyzed for feasibility purposes, no before-after data were collected nor analyzed to determine the success of the road diet.

Methods:

- Presented an analysis of the suitability of a road diet candidate using the developed feasibility determination factors.

Comparison of empirical Bayes and full Bayes approaches for before–after road safety evaluations

January 2010

B. Persaud, B. Lana, C. Lyon, and R. Bhim

http://www.cmfclearinghouse.org/study_detail.cfm?stid=192

This paper provides additional information on the Empirical Bayes and Full Bayes statistical approaches to determine the effect a road diet has on reducing the number of crashes on a treated roadway. This study is a follow-up to several studies conducted on road diet sites in Iowa by Persaud et al., Pawlovich et al., and Stout. This study uses the identical data presented in these other studies but identifies similarities and differences when using the Full Bayes approach.

The paper provides substantial background to the Full-Bayes approach and utilizes 15 yoked-pair sites for analysis. Following analysis it was concluded that the crash reduction rate ranged from 49 – 55%. A crash modification factor (CMF) was determined to be 0.47 for the given data set.

Methods:

- Full Bayes (FB) and Empirical Bayes (EB) methods.
- Used 15 treatment and 15 comparison sites from Iowa for FB while EB supplemented an additional 296 comparison sites as required.
- EB accounted for temporal effects in weather, demography, crash reporting, vehicle technology, and design standard improvements.
- FB accounted for temporal effects in weather, demography, crash reporting, vehicle technology, and design standard improvements.
- FB was a before-after approach that developed a crash rate model with traffic volume as an independent variable.

Evaluation of Lane Reduction "Road Diet" Measures on Crashes

June 2010

http://www.fhwa.dot.gov/publications/research/safety/10053/index.cfm

The intent of this report was to reanalyze the data used in two previously published reports concerning "road diets" and their effectiveness on reducing the number of crashes on a given roadway. The first study was conducted in six cities in California and two cities in Washington where 30 treatment sites and 51 reference sites were identified. Table 1 presents descriptive statistics of the evaluated sites. Using the empirical Bayes (EB) method on the identical data set, it was determined that following treatment, a 19% decrease in vehicle crashes can be attributed to implementation of a "road diet". The previous study determined only a 6% decrease in vehicle crashes.

Table 1: Descriptive statistics of evaluated "road diet" sites

DATABASE/SITE TYPE	CHARACTERISTIC	MEAN	MINIMUM	MAXIMUM
Iowa Treatment (15 sites)	Years before	17.53	11.00	21.00
	Years after	4.47	1.00	11.00
	Crashes/mile-year before	23.74	4.91	56.15
	Crashes/mile-year after	12.19	2.27	30.48
	AADT before	7,987	4,854	11,846
	AADT after	9,212	3,718	13,908
	Average length (mi)	1.02	0.24	1.72
Iowa Reference (296 sites)	Years	21.8	5	23
	Crashes/mile-year	26.8	0.2	173.7
	AADT	8,621	296	27,530
	Average length (mi)	0.99	0.27	3.38
HSIS Treatment (30 sites)	Years before	4.7	1.8	8.5
	Years after	3.5	0.6	8.8
	Crashes/mile-year before	28.57	0.00	111.10
	Crashes/mile-year after	24.07	0.00	107.62
	AADT before	11,928	5,500	24,000
	AADT after	12,790	6,194	26,376
	Average length (mi)	0.84	0.08	2.54
HSIS Reference (51 sites)	Years	7.82	4.50	12.17
	Crashes/mile-year	42.19	5.96	169.73
	AADT	15,208	1,933	26,100
	Average length (mi)	0.95	0.10	3.31

The second study was conducted in Iowa where 11 treatment sites and 24 reference sites were used in the original study and a 25% decrease in vehicle crashes was reported. This study supplemented the 15 reference sites with 281 additional reference sites. The use of the EB method on the updated data set resulted in a 47% decrease in vehicle crashes following implementation of a "road diet". This study also developed crash modification factors (CMF) for the data as presented in Table 2.

Table 2: Results of the EB method reanalysis of Iowa and HSIS data concerning "road diets"

Crash Type Studied and Estimated Effects			
State/Site Characteristics	Accident Type	Number of Treated Sites	CMF (Standard Deviation)
Iowa: Predominately U.S. and State routes within small urban areas (average population of 17,000)	Total crashes	15 (15 mi)	0.53 (0.02)
California/Washington: Predominately corridors within suburban areas surrounding larger cities (average population of 269,000)	Total crashes	30 (25 mi)	0.81 (0.03)
All sites	Total crashes	45 (40 mi)	0.71 (0.02)

Other findings:

A 4 – 5 mph reduction in the 85th percentile free flow and 30% reduction in vehicles traveling more than 5 mph over the speed limit were found in an Iowa site. The authors speculate this calming affect would be less likely in larger cities.

In the original Iowa study, 15 treatment sites and 30 reference sites were considered while only 11 treatment sites and 24 reference sites were used due to data being omitted due to small sample sizes of crashes, short segments, short data history, and low AADT.

Methods:

- Empirical Bayes Method
- California and Washington (HSIS) 30 treatment and 51 reference sites matched by functional class, type of development, speed limit, intersection spacing, and access control.
- The Iowa database included data from original 15 treatment and 15 reference supplemented by 281 additional reference sites.
- A model was developed with calibration factors accounting for accident reporting practices, demography, and weather for Iowa. However calibration factors could not be utilized in the study concerning "road diets" in California and Washington.
- Sites of longer length were given more weight.

Road Diets – Fixing the Big Road

1999

Dan Burden and Peter Lagerway

http://www.walkable.org/assets/downloads/roaddiets.pdf

The intent of this report is to summarize the state-of-practice of Road Diets as of 1999. The report includes several examples of Road Diets from several states, territories, and countries including: Washington, Pennsylvania, Michigan, Ontario Canada, California, Massachusetts, Maryland, Texas, Ottawa Canada, Colorado, Oregon, and the United Kingdom.

The report presents examples of mobility and access improvement as well as safety improvements. The report also includes examples of Road Diets being placed on roadways with well over 20,000 ADT. For example, Lake Washington BLVD, Kirkland, Washington had 30,000 ADT before conversion with beneficial results.

The paper recommends characteristics of ideal Road Diet candidates including:

- Moderate volumes (8-15,000 ADT)
- Roads with safety issues
- Transit corridors
- Popular or essential bicycle routes/links
- Commercial reinvestment areas
- Economic enterprise zones
- Historic streets
- Scenic roads
- Entertainment districts
- Main streets

Methods:

- Simple Before and After comparison focused on ADT and reason for road diet treatment.

Implementation:

- It is essential to involve the public through highly interactive processes (focus groups, work shops, and interactive designs).

Summary Report: Evaluation of Lane Reduction "Road Diet" Measures and Their Effects on Crashes and Injuries

March 2004

Herman F. Huang, J. Richard Stewart, and Charles V. Zegeer

http://www.planning.kytc.ky.gov/congestion/RoadDiets/Road%20Diet%20Safety%20Study.pdf

The intent of this paper is to summarize a statistical study of road diets and their effectiveness on reducing crash statistics in treated sites. The study includes several sites in California and Washington as these states are involved in the Federal Highway Administration's Safety Information System where quality vehicle and crash data are available. Road Diets were identified by local traffic engineers in 8 cities including: Bellevue, Wa, Seattle, Wa, Mountain View, CA, Oakland, CA, Sacramento, CA, San Francisco, CA, San Leandro, CA, and Sunnyvale, CA. Finally, 12 Road Diets and 25 comparison sites were included in the study.

The comparison sites had an average crash frequency of 41% compared to an average crash frequency of 35.8% for road diet sites indicating road diets reduce the total number of crashes.

Crash rates were determined using 8 Road Diet sites and 14 comparison sites. The ADTs of Road Diet sites ranged from 5,658 – 8,133 in the before period and from 8,300 – 16,482 in the after period. ADTs of comparison sites ranged from 5,480 – 24,183 in the before period and from 7,006 – 26,100 in the after period. Both Road Diet and comparison sites experienced decreased crash rates and had no significant difference between the treated and untreated sites.

Crash severity was nearly the same at Road Diet sites and comparison sites and the statistical analysis determined that Road Diets had no significant affect on crash severity. An analysis by crash type was found to have similar results.

Final Remarks:

- Crash frequencies at road diets in the after period were approximately 6 percent lower than at the corresponding comparison sites.
- Crash rates did not change significantly from the before period to the after period. Although crash rates were lower at road diets than at comparison sites, road diets did not perform better or worse (from the before period to the after period) relative to comparison sites.
- Road diet conversions did not affect crash severity.
- Road diet conversions did not result in a significant change in crash types.
- This report is a summary of Study 11 located in this document.

Methods:

- Before and After with comparison sites method.
- California and Washington (HSIS) 30 treatment and 51 reference sites matched by functional class, type of development, speed limit, intersection spacing, and access control. Reduced to 12 treatments and 25 comparisons.
- Seasonal variations in crash data were taken into account. Variations in crash reporting techniques were controlled for by selecting comparison sites in the same city as the road diet site.
- Crash Frequencies: A Cochran-Mantel-Haenszel test of overall significance was used to show that the reduction in crashes was statistically significant.
- Crash Rates: Negative binomial regression models were fit to the crash frequencies at each site. The explanatory variables were traffic volume, city, site type (treated or comparison), time period (before or after), and a site type-by-time-period interaction. Segment length was included as a constant factor so the number of crashes on a segment was proportional to its length.
- Statistical analyses were conducted for crash severity and crash type as well.

Evaluation of Lane Reduction "Road Diet" Measures on Crashes and Injuries

May 2005

Herman F. Huang, J. Richard Stewart, and Charles V. Zegeer

https://docs.google.com/viewer?a=v&q=cache:teqtEQ0DiiYJ:136.142.82.185/freshman/academic/engr0715/Archives/y2008/Team8/research_lanereduc.pdf+&hl=en&gl=us&pid=bl&srcid=ADGEESjdejW91b0eAdMOrvu4y8XpFmP4DbUUUMZTjqyNZDTWpcal_uJeXjMVRf7CFc9lPKyE-f2OvFDIlADR6mBOShzTrsWpiV1kkb5yhPr_L_feJRYIdMMmletr_2D1qEGg1b2JGndl&sig=AHIEtbQzjp4MsCXIspcA84MhOb0sqjNTdw

This paper presents a statistical study on Road Diet sites in California and Washington. Data were collected for before and after periods for both treated sites and comparison sites. A list of 30 Road Diet sites and 50 matching comparison sites were compiled for eight cities. Crash data were compiled, in most cases, for 3 years before and 3 years after treatment for each site including date of crash, crash type, number of injuries, and number of fatalities. A subset of 12 Road Diets and 25 comparison sites was chosen for statistical analysis.

Based on the results of the study the following was concluded:

- Crashes at road diet and comparison sites were not significantly different indicating that the comparison sites are viable.
- Road Diets could be responsible for reducing the number of crashes by 6%.
- Negligible reductions in crash severity and crashes by type were determined between Road Diet and comparison sites.
- Crash rates did not change significantly from before and after a Road Diet was implemented.
- Road diets did not result in a significant change in crash type.

Methods:

- Yoked-Comparison before-and-after and a negative binomial of crashes per mile using two groups.
- Negative binomial allowed effects of treatment while controlling for ADT, city, and length of study segment.
- Crash data were characterized by date of crash, crash type, number of injuries and number of fatalities.
- A 3-month transition period was considered to separate the “before” and “after” periods.
- 3-years of “before” and 3-years of “after” data were collected.
- Intersections were taken as the transition area of the road diet and were excluded from the study.

- Crash Rates: Negative binomial regression models were fit to the crash frequencies at each site. The explanatory variables were traffic volume, city, site type (treated or comparison), time period (before or after), and a site type-by-time-period interaction. Segment length was included as a constant factor so the number of crashes on a segment was proportional to its length.

Complete Streets Technical Report
Genesee County Metropolitan Planning Commission
http://www.co.genesee.mi.us/gcmpc-plan/LRTPWeb/TechReports/CStreets.pdf

The intent of this report is to introduce an innovative approach to urban road design that The Genesee County Metropolitan Alliance has adopted, *Complete Streets*. The Complete Streets vision statement for Genesee County is summarized as, "Transportation improvements in Genesee County are planned, designed and constructed to encourage walking, bicycling, and transit use while promoting safety for all users". The report summarizes the definition of a Complete Street, identifies design elements of a Complete Street, and provides a list of benefits of a Complete Streets program.

Although there are several approaches to complete a street, this report presents an in-depth look at low-cost and simple techniques which includes road diets. The Genesee County Metropolitan Planning Commission (GCMPC) identified candidate road diet roadways in Genesee County to determine the feasibility of converting these roadways from four-lanes to three-lanes. Data was collected for each four-lane roadway including crash data, lane widths, speed limits, surface condition, ADT, number of traffic signals, and land uses. These data were used to develop a rating scale to determine on a case-by-case basis whether the roadway was suitable for a Road Diet. The recommendations of the GCMPC study were shared with local road agencies to develop strategies for implementing Road Diets on ideal candidates. It should be noted that these are all future sites that have not been converted as of the date of this study.

Existing Road Diet sites were also studied to determine the effectiveness of Road Diets on reducing crash frequencies and crash rates. The results are divided into type of crash as well as total non-alcohol/non-deer related crashes. The results are somewhat misleading because the before and after periods are generally different lengths of time. With this in mind, it was determined that Road Diets reduced the total number of crashes by 15% – 47%. Total crashes for these sites are presented in the summary table.

Methods:
- Simple Before and After comparison.

Implementation:
- Complete a sidewalk inventory of Genesee County.
- Include questions about the need for Complete Streets in future transportation surveys.
- Provide local training opportunities about Complete Streets for transportation planners, road agencies and engineers on an annual basis.

- Provide technical assistance to road agencies when needed about implementing Complete Streets in their communities.
- Document and publicize success stories about implementation of Complete Streets.

City of University Place Traffic Safety

http://docs.google.com/viewer?a=v&pid=gmail&attid=0.1&thid=12f35889d6a9b876&mt=application/vnd.ms-powerpoint&url=http://mail.google.com/mail/?ui%3D2%26ik%3D0c6430dfb7%26view%3Datt%26th%3D12f35889d6a9b876%26attid%3D0.1%26disp%3Dsafe%26zw&sig=AHIEtbRY_y5-dtkLssQFhYiZpWcHgHMC6Q

This presentation provides information on the varying effects that different traffic controlling strategies have on average traveling speeds, traffic crashes, and injuries. Following implementation of a road diet a 37% decrease in traffic accidents occurred and a 54% – 60% decrease in injuries resulted.

Methods:

- Simple before and after comparison of accidents, injuries, and speeds.

Guidelines for 4-Lane to 3-Lane Conversions

September 2001

W.C. Taylor, I.K. Lim, M. Mahmood

Viewed in hardcopy print

The intent of this study was to develop guidelines for Michigan Department of Transportation to use in reviewing requests from local communities to convert four-lane urban trunklines to the three-lane configuration. The study also provides a literature review of documents that have investigated the safety and operational impacts of a road diet. Objectives of the literature review were to determine the change in traffic crashes, change in traffic characteristics such as speeds, and characteristics of road segments that affect change in crashes or change in characteristics.

The study provides an operational analysis to investigate the effects of road diets on vehicle delay. The analysis tested various combinations of main street volumes, access volumes, turning volumes, and driveway densities for a given site. Two variables were identified as having impacts on the delay to vehicles entering from the minor street; the headway distribution on the major street and the minor street volume. It was concluded that for the given volume range on Abbott Rd. the headway distribution had little effect on the minor street delay. It was also concluded that from 60 vph to 120 vph the queue time increased by 1 to 2 seconds however 180 vph creates a queue time greater than the gap acceptance time on the major street. The author determined that in this high volume situation, traffic signal warrants would be met and signals would be implemented. Major street delay was also shown to increase due increasing volume and increasing left-turn movements.

A model was produced from the single site analysis to include several different scenarios. Parameters to be used in the model include major street volumes, minor street volume, access point average spacing, and percent of vehicles turning left from the major street. The model encompasses major street volumes from 1000 to 2000 vph for 5 to 10% left turn volumes.

Final conclusions include:

- A 27.6% average reduction in crashes following a road diet treatment
- A decrease from 21 to 5 pedestrian and bicycle involvement crashes and reduction of intersection crashes from 238 to 129.
- Minor street delay increases as major street volume increases however delay is not significant until minor street volumes approach 180 vph.
- The number of injury crashes reduced.

Methods:

- Simple before and after comparison.

- Nine sites were identified for use in analysis.
- Pedestrian and bicycle related crashes were investigated at three of nine sites.
- NETSIM was used to model the relationship between delay, headway distribution, minor street volume, and left-turn volumes.

Edgewater Drive Before & After Re-Striping Results

November 2002

City of Orlando – Transportation Planning Bureau

http://www.sacog.org/complete-streets/toolkit/files/docs/City%20of%20Orlando_Edgewater%20Drive%20Before%20&%20After%20Re-Striping%20Results.pdf

The intent of this study is to analyze the effectiveness of a four-lane to three-lane conversion in the City of Orlando. The conversion is part of the College Park "Neighborhood Horizon Plan" which identifies 74 neighborhood improvement projects. One of these projects was to transfer jurisdiction of Edgewater Drive from the Florida Department of Transportation to the City of Orlando. This transfer would allow the City of Orlando to improve the section of roadway by adding crosswalks, underground utilities, parking, and bicycle lanes.

The study considers crash and injury data, speed analysis, traffic volumes, parking volumes, pedestrian and cycling volumes, travel times, property values, and community impacts. 3-years of crash data were considered for the "before" period and 4-months of data were considered for the "after" period. Due to the small sample size of "after" data, some conclusions may be inaccurate. It was found that crash rates decreased 34% and injuries decreased 68%. Similarly, a significant decrease in excessive speeds resulted while travel times within the corridor increased in most cases. Further, the annual daily traffic reduced on average by 12% and the utilization of parking increased from 29% to 41% on Edgewater Drive following treatment. It was also noted that the number of pedestrians and cyclists using the corridor increased significantly. Finally, property values were shown to increase at an annual rate of 8% – 10% and 1% – 2% for residential and commercial properties, respectively.

Unlike other studies, this study reported results from a community survey conducted "before" and "after" implementation of the road diet. The community survey and traffic analysis were used to assess whether the list of measures of effectiveness (MOEs) had been met. The list of MOEs and whether they were achieved or not are as follows:

- Avoid Increasing Traffic On Neighborhood Streets - YES
- Reduce Speeding on Edgewater Dr - YES
- Increase Bicyclist Volumes - YES
- Increase Pedestrian Volumes - YES
- Reduce Crashes - YES
- Increase On-Street Parking Use Rates - YES
- Increase Pedestrian Satisfaction (Residents) - YES
- Increase Pedestrian Satisfaction (Merchants) - NO

    - Increase Parking Satisfaction (Residents) - YES

Methods:

- Simple before and after comparison.

Implementation:

- Advertised public meetings to discuss alternatives.
- Development of measures of effectiveness to assess whether the project met intended goals.

Arterial Street Traffic Calming with Three-Lane Roads

2002

T. A. Sohrweide, B. Buck, and R. Wronski

http://www.ite.org/traffic/documents/AB02H5501.pdf

The intent of this report is to discuss the effects of converting two roadways from 4-lanes to 3-lanes. The paper focuses on the both operational and safety effects due to road diets by discussing reduction in speed and decreased number of crashes following conversion.

Portland Avenue in Burnsville, Minnesota was a four-lane undivided roadway. The city had been receiving complaints of excessive speeds along the corridor as well as sight obstructions for left-turning vehicles at a major intersection. To resolve the left-turning movement issue at the intersection the City considered widening the roadway and incorporating left-turn lanes at the intersection ($790,000). The second alternative the City considered was reducing the roadway to three-lanes and a TWLTL ($250,000). Following implementation of the road diet it was noted that traffic accidents at the major intersection reduced from 4.3 accidents per year to 2.8 accidents per year. Additionally, average speeds and 85th percentile speeds decreased.

North Main St. in River Falls, Wisconsin was being investigated to determine if the warrants were met for a traffic signal. The warrants were met and a traffic signal was to be installed however the City decided to implement additional changes at the same time. Additional issues included the safety of pedestrians and motorists as well as excessive speeding. Engineers to the city constructed a list of advantages and disadvantages for retaining the 4-lane cross-section or implementing the 3-lane cross-section. The city moved forward with the road diet and the following resulted:

- Average and 85th percentile speeds decreased following conversion.
- Minor road intersection delay was either maintained or reduced following conversion.
- Total accidents reduced from 22 to 7 in the year following conversion, however it was not determined whether the new traffic signal or road diet had a significant affect on reduced accidents.
- ADT reduced from 19,200 to 16,240 and it was assumed that traffic was using a highway bypass and not local streets.
- The City conducted a survey to gain insight on public opinion which was generally negative.

Methods:

- Simple before and after comparison of crashes and speeds.

Implementation:

- City handed out 246 surveys following treatment with 87 being returned.
    - How would you say that the reconfiguration has affected stress experienced when entering Main Street?
    - How do you feel the average time it takes to enter Main Street from a side street has changed?
    - Would you say the conversion of Main Street from a four-lane to a three-lane has a positive or negative impact on the ability of side street traffic to enter Main Street?

US-12 Downtown Sturgis Traffic Study: Final Report

December 2004

Prepared by URS

Viewed in hardcopy print

The intent of this report is to provide recommendations to Michigan Department of Transportation (MDOT) and the City of Sturgis for the reconstruction of US-12 through the City of Sturgis. MDOT proposed reconstructing US-12 as a five-lane cross-section including a two-way left-turn lane (TWLTL) while the City of Sturgis proposed a three-lane cross-section with bike lanes and parallel parking. Because the three-lane and five-lane reconstructions share similar cross-sections, the three-lane can be expanded to five-lanes if this becomes necessary.

URS recommended the three-lane cross-section for reconstruction to provide safety to the downtown. Because the three-lane alternative does not provide adequate level-of-service for the future (year 2026), the roadway is recommended to be monitored and expanded to five-lanes when necessary.

The report continues with a brief crash data analysis and current/future capacity analysis for the different alternatives proposed for the roadway. No substantial information is given for the before and after effects of the reconstruction.

Methods:

- Analysis and comparison of three alternative geometry designs for existing and future conditions (2026) considering a 2.5% growth rate.
- 2000 Highway Capacity Manual methods to determine peak-hour Levels of Service.

Safety and Operational Characteristics of Two-Way Left-Turn Lanes

June 2006

David Noyce, Vijay Talada, Tim J. Gates

http://www.lrrb.org/pdf/200625.pdf

The purpose of this report was to evaluate the safety and operational impacts of converting a four-lane undivided roadway to a three-lane roadway with a TWLTL in the State of Minnesota. The report provides a comprehensive list of previous research conducted on road diets and the effectiveness of TWLTLs. Nine road diet sites were identified in Minnesota based on sufficient site information for the before and after periods of the treated site. These data included speed, volume, driveway density, and crash statistics. Nine comparison sites were also identified to account for factors such as changing ADT, seasonal trends, and other natural phenomenon. Comparison sites were chosen based on similar cross-sections, ADT, speed limit, intersection and driveway density, and land use.

Three statistical methods were used to analyze the data including traditional before-after approach, yoked comparison/group comparison, and Empirical Bayes methods. Following each analysis it was concluded that the change in ADT was insignificant for each site. Using the traditional approach it was concluded that the percentage reduction in crashes ranged from 12.9% – 54.1%. Using the group comparison method it was concluded that the percentage reduction in crashes ranged from 39.3% – 71.6% where two sites exhibited increases in crash rates (9.8% and 50.5%). Using the Empirical Bayes method it was concluded that the percentage reduction in crashes ranged from 37.3% – 54.3%.

Methods:

- Simple before and after, Empirical Bayes, and Yoked-Paired comparison methods.
- Investigated change in number, severity, and types of crashes as well as 85th percentile speed and ADT.
- Volume, speeds, geometric, and access data were collected for nine treatment and nine comparison sites.
- “ADT data were collected for one year prior to and after conversion.”
- Five years of before and five years of after crash data were used.
- No specifics on end-of-site treatment.

Safer Streets: The Measured Effectiveness of Hartford's Citywide Traffic Calming Program

2007

F. Clara Fang, Joseph H. Rimiller and Najib O. Habesch

http://www.ite.org/traffic/documents/AB07H3401.pdf

The intent of this paper is to investigate and discuss the effects due to implementing a road diet in Hartford, Connecticut. Road diets have become part of Hartford, Connecticut's comprehensive traffic calming master plan and in an effort to study the effects, "before" and "after" data have been collected and analyzed using the Before-and-After method and Empirical Bayesian method.

Five road diets were implemented in Hartford within similar time frames including Wethersfield Ave., Franklin Ave., Maple Ave., Tower Ave., and North Main St. Before and after data were collected including ADT and total crashes. Twelve control sites were also identified and data were collected enabling an Empirical Bayesian analysis to be conducted.

The following conclusions resulted due to implementation of road diets:

- Crashes reduced between 7% and 57% except for one case where the crashes increased. This increase is attributed to the low amount of crashes in the before period.
- Reduction in crashes was attributed to the reduction in speeds up to 6 mph.
- The before-and-after and Empirical Bayesian analysis resulted in similar conclusions indicating that regression to the mean was not present.
- Factors such as crash type and injuries were not analyzed however the authors urge that these statistics be a point of analysis.

Methods:

- Simple before and after comparison and Empirical Bayes method.
- Five treated sites and 12 comparison sites.
- Crashes and speeds were investigated.
- No detailed information on data collection or end treatments.

Implementation:

- Neighborhood Traffic Calming Master Plan.
- Focus sessions with groups including emergency services, senior citizens, transit personnel, merchants, and disabled.
- Workshops where characteristics of their neighborhood were identified and chosen as beneficial to enhance.
- A final plan was developed and presented to the general public and stakeholders for review.

Technical Memorandum: Road Diet Project Review

April 2010

Cynthia Redinger, P.E. – Washtenaw County Road Commission

Viewed in hardcopy print

The intent of this technical memorandum is to provide information and data for a road diet site in Washtenaw County. Washtenaw County Road Commission implemented road diets Grove Road and Ford Boulevard. These roadways were four-lane cross-sections with high driveway density, no dedicated left turn lanes, and no bike lanes which contradicted the non-motorized plan for Washtenaw County. This memorandum presents before and after traffic volumes, crash patterns, vehicular speed statistics, and quality of life concerns. The road diet implemented on Grove Road was constructed in two phases (Phase I and Phase II) where Phase I was completed in 2004 and Phase II was completed in 2006.

The before and after analysis of Ford Boulevard resulted in the following conclusions:

- Traffic volumes were not significantly affected following implementation of a road diet
- 85^{th} percentile speed reduced by 6 – 11 mph.
- The annual number of total crashes was 8.45 for 4-years before treatment and 9 for 2-years following treatment indicating that total crashes increased.
- No information on pedestrian/cyclist volumes, however the memorandum indicates that the public opinion was positive.

The before and after analysis of Grove Road resulted in the following conclusions:

- Traffic volumes were not significantly affected although traffic volumes have been decreasing citywide over the past decade.
- The average annual number of total crashes per year for Phase I was 15.5 for the before period and 8.1 for the after period indicating a significant reduction in crashes.
- The average annual number of total crashes per year for Phase II was 16.2 for the before period and 14.9 for the after period indicating a subtle decrease in crashes.

Methods:

- Simple before and after comparison.

Stone Way N Rechannelization: Before and After study

May 2010

City of Seattle – Department of Transportation

http://www.seattle.gov/transportation/docs/StoneWaybeforeafterFINAL.pdf

The report focuses on one treated roadway, Stone Way N, in Seattle, Washington. Stone Way N was reduced from 4-lanes to 3-Lanes with a Two-way-left-turn-lane for 1.2. The roadway carries 13,000 ADT along with metro bus routes. The adjacent land is residential and commercial with eight schools, two public libraries, and five parks. The study utilizes a simple before-and-after approach and categorizes "before" as April 5, 2005 – August 6, 2007 and "after" as August 7, 2007 – December 4, 2009.

The study concludes that the 85th percentile speeds decreased following the "road diet" treatment. The number of vehicles traveling over the speed limit by 10 mph or more was reduced by 75% (150 vehicles per day to 25 vehicles per day).

Additionally, the ADT decreased by 6% while bicycle traffic increased by 35%. Peak flow declined between 5% – 13% and off peak flow varied from a 2% increase to a 5% decrease. However, the volume of motor vehicles also decreased citywide between 2006 and 2008. Adjacent roadways averaged larger decreases in ADT and peak hour traffic volumes. Decreases of ADT varied from 12 – 34% while decreases in peak volumes varied from 6 – 49%. However, one roadway had a 2% increase in PM peak hour volumes and another had a 27% increase in AM peak hour volumes.

Most collision types were reduced but the number of collisions involving cyclists remained constant. However, due to the additional number of cyclists the collision rate decreased. The rate of rear end collisions increased, however the majority of these crashes occurred in the transition area from four-lanes to three-lanes.

Table 1: Reduction in collision type for before and after period

COLLISIONS BY TYPE			
	2005-07	2007-09	Change
Right Turn	1	0	-100%
Pedestrian	5	1	-80%
Sideswipe	14	6	-57%
Angle	34	15	-56%
Left Turn	12	9	-25%
Parked Car	34	29	-15%
Head On	1	1	0%
Pedalcyclist	7	7	0%
Rear End	17	28	65%
Total	**159**	**137**	**-14%**
Injury	52	35	-33%
Percent Injury	33%	25%	

OPERATIONAL CHARACTERISTICS OF ROAD DIETS

Two-Way Left-Turn Lanes: State-of-the-Art Overview and Implementation Guide

1978

Z. A. Nemeth

Viewed in hardcopy print

The intent of this study was to investigate the effectiveness of installing Two-Way Left-Turn Lanes (TWLTL) on the operational and safety of a roadway. The research included a nationwide expert opinion survey, literature review, and before-and-after field studies.

Ninety questionnaires were mailed and 70 were returned representing 36 states and one city in Canada. The questionnaire contained questions to investigate the effect of the TWLTL on traffic safety, the effect of the TWLTL on traffic flow characteristics, and conditions conducive to the installation of such a median lane. The questionnaire addressed experience (length of time and number of TWLTLs implemented) where most of the respondents had 1 – 10 years experience with 1 – 10 uses. Significant improvement of operations was noticed by 66% of respondents. Public reaction was noted as favorable by 62% of respondents while most of the controversy developed from the lane markings and signage.

The report continues by presenting several warrants that would require installation of a TWLTL as well as design details including number of lanes, lane widths, and treatment at intersections.

One case study that was presented was in fact a road diet example where a four-lane arterial was restriped to three-lanes with a TWLTL. It was noted that the average speed decreased however, due to unfamiliarity of the "new" TWLTL design, there seemed to be erratic (weaving) driving conditions.

The paper concludes with a checklist that should be utilized when determining if a TWLTL would be feasible and effective. Key components of the checklist include existing physical conditions, existing traffic conditions, future development, and accident histories.

Methods:

- Expert opinion survey and simple before-and-after comparison.

Using Roadway Conversions to Integrate Land Use and Transportation– The East Boulevard Experience

April 2007

Joshua E. Saak

http://sdite.org/presentations2007/2A-Saak-Road%20Diet%20Implementation%20in%20NC%20-%20The%20East%20Blvd.%20Experience.pdf

This presentation was prepared for the SDITE annual meeting in Knoxville, TN on April 23, 2007. The presentation presents a road diet that was implemented on East Boulevard in Charlotte, North Carolina.

The presentation provides two population estimates of 651,000 and 1.6 million (metro-area). The 651,000 may be the city population. East Boulevard is classified as an arterial traveling through a neighborhood with 21,400 ADT traveling at "relatively high speeds". The roadway provides access to multiple land uses including parks, commercial, hospital, and residential. The East Boulevard Pedscape Plan, adopted in 2002, was a significant reason that the roadway was converted. The Pedscape Plan established guidelines for streetscape improvements, provided standards for public properties, and made recommendations for public properties. Another significant driver for implementation was public safety concerns.

The road diet consisted of over ½ mile of East Boulevard including three signalized intersections of which two were one-way crossing streets. The conversion included changing signal timing, surface milling, refuge island construction, resurfacing/striping, and landscaping. Following implementation, the ADT of the roadway decreased from 21,400 to 18,400, however, it increased to 22,000 a short time later. The 85th percentile speed was shown to decrease by almost 3 mph and the crash rate reduced 34%.

The presentation concludes with outlining the objectives of the road diet implementation, addressing public concerns, procedure in gaining support and approval from residents, and lessons learned.

Methods:

- Simple before and after comparison of pedestrians, ADT, speed, crash, and injury.

Implementation:

- Residents wanted a more comfortable roadway for bike, pedestrians, transit patrons, and motorists.

- Residents wanted to enhance pedestrian activity on sidewalks and to improve pedestrian crossings (safety).
- Residents wanted more sidewalk cafes, outdoor seating, landscaping, and to restore the historic nature of the downtown.
- Worked with residents regarding the proposed project and design details.
- Conducted detailed Synchro analysis to show LOS would not significantly decrease.
- Neighborhood voted unanimously to approve the project.
- Road diets should begin at the neighborhood level and they are counterintuitive so education is key.
- Limiting the construction time reduces complaints.
- Obtain support from city organizations.
- Implement new signal timing before constructing road diet.
- Retain the option to go back to the original condition.

Road Diet Treatment – Ocean City, NJ

February 2007

Daniel Kueper

https://docs.google.com/viewer?a=v&q=cache:AvmAGpBC7UcJ:www.eugene-or.gov/portal/server.pt%3Fopen%3D18%26objID%3D267728%26parentname%3DSearchResult%26parentid%3D1%26mode%3D2%26in_hi_userid%3D2%26cached%3Dtrue+&hl=en&gl=us&pid=bl&srcid=ADGEEShaT9xhGfEpCMCM6ZTRnTdMOTe-2DwhFjsJgXH-dmO5-YGz3nnLBaG46UBGnyfuN5hKep4lTPSv7VgOHbsYow8X_-nKED4x8on3z1mhgE-N3y9o9hTC6Jg-JiSeeDvQAW0z_Au3&sig=AHIEtbRcy8td09kxcsawuyd_Qmv2KY_Zag

This report presents findings resulting from a Road Diet implemented on West Avenue in Ocean City, NJ. Ocean City is a resort town with an annual population ranging from 15,000 in the winter to 150,000 during the summer. The city received several complaints from pedestrians regarding difficulty crossing the roadway. To resolve these complaints the city decided a road diet was the best alternative. West Avenue is a minor arterial roadway that spans 6 miles. ADT's increase to a maximum of 15,000 in the summer season.

Implementation of the road diet resulted in a reduction in speeds by 1 mph for 50th-percentile speeds (35 mph to 34 mph). Similarly, 85th-percentile speeds were reduced by 1 mph (38 mph to 37 mph). Additionally, the number of motorists traveling 10 mph or more over the speed limit of 30 mph was reduced from 12% to 4%. Motorist delay increased 3 seconds at both intersections however a LOS B was maintained. The number of crashes remained unchanged, however, the average number of crashes occurring each year was relatively low (2 crashes in 2004 and two crashes in 2005).

Methods:

- Simple before and after comparison of speed characteristics

Using Road Diets to Integrate Land Use and Transportation – The East Boulevard Experience

2007

Joshua E. Saak, P.E.

Viewed in hardcopy

The intent of this paper was to discuss the process of implementing a road diet on East Boulevard in Charlotte, North Carolina. The paper provides a background of the local area and roadway and discusses reasons for the change in roadway cross-section. The paper continues by presenting characteristics of the collected data as well as the results from analyses using Synchro and VISSIM. A conclusion of the results is provided followed by a brief before-and-after study and finally, a brief list of lessons learned are presented.

The local area surrounding East Boulevard was interested in restoring a multi-modal atmosphere through their Pedestrian Overlay District plan and the need for roadway resurfacing provided the opportunity. In considering a road diet, the City decided to conduct a traffic study to investigate the needs of the community with regard to East Boulevard. The City collected traffic counts, spot speeds, and lane widths to be used in Synchro and VISSIM analyses.

Synchro results indicated that delay and LOS would be negligibly affected. VISSIM results indicated a more prominent change between the four-lane and three-lane alternatives where speeds were shown to decrease, delay was shown to increase 31%, and travel time increased 13% during peak hours.

Although a formal before-and-after study was not conducted, results of continued data collection concluded that ADT decreased from 21,400 to 18,400 and 85th percentile speeds decreased between 1 – 5 mph.

Finally, several lessons were learned through this process including the following insight:

- The project should begin at the neighborhood level
- Road diets seem counterintuitive to citizens
- Implementing new signal timing before construction is beneficial
- The construction period is difficult especially in downtown districts
- Before/after studies are important

Methods:

- Synchro analysis to evaluate possible road diet effects with measures of effectiveness including v/c ratio, level of service, and average control delay per intersection.

- VISSIM analysis to evaluate possible road diet effects with measures of effectiveness including average speed, total travel time, average network speed, and average delay per vehicle.
- Simple before and after comparison.

Implementation:

- East Boulevard Pedestrian Overlay District plan
- Community involvement is essential to the implementation and success of the project.

Multi-objective Optimization of a Road Diet Network Design

March 2011

Keemin Sohn

http://www.sciencedirect.com.proxy1.cl.msu.edu/science?_ob=MImg&_imagekey=B6VG7-52NC4NM-2-16&_cdi=6031&_user=1111158&_pii=S0965856411000516&_origin=search&_zone=rslt_list_item&_coverDate=07%2F31%2F2011&_sk=999549993&wchp=dGLbVtb-zSkzV&md5=37e07642a82329aa90796c869393d1e5&ie=/sdarticle.pdf

The intent of this paper is to present a computer algorithm to be used by decision makers to determine the design and implementation of a road diet. The algorithm is comprised of two models: a model where tradeoffs (capacity and delay) between motorists and cyclists took place and a model where tradeoffs between motorists and society took place where variations in mode choice were possible. Use of the algorithm provides a systematic approach to design road diet projects where the primary concern is to provide adequate access for cyclists by cautiously adjusting the capacity and delay of motorists. Although the models have considerable downfalls considering the omission of several key variables, the algorithms nonetheless provide an interesting approach to road diet design.

APPENDIX B

DETAILED ON-SITE REVIEWS OF SELECTED SITES IN MICHIGAN

The intent of this report is to summarize observations made at several road diet sites pertaining to the operational and safety characteristics as they relate to pedestrians and cyclists. Road diet sites were identified by Michigan Department of Transportation and selected by Michigan State University. The investigated road diet sites were selected based on close proximity from site to site as well as having “pedestrian/bicyclist safety” identified as a motivation for implementing the road diet project in the **MSU “road diet” project: project/implementation site data request** form (Road Diet Survey Form). The 8 sites investigated were located in the northwestern part of Michigan and are briefly described as:

- M-37 in Baldwin, MI from the US-10 junction extending approximately 200 ft. south of 9th St.
- M-55/M-66 in Lake City, MI from W Beeler Rd. to Union St. (Davis Rd.)
- M-37/M-115 in Mesick, MI from the M-115/M-37 junction to Clark St.
- US-31 in Manistee, MI from M-55 junction extending approximately 300 ft. northeast of M-110
- M-116 in Ludington, MI from US-10 extending approximately 500 ft. north of Lowell St.
- Burcham Rd. in East Lansing, MI from Abbot Rd. to Timberlane St.
- Abbot Rd. in East Lansing, MI from Albert Ave. to Whitehills Dr.
- M-43 in East Lansing, MI from Michigan Ave. to 200 ft. northwest of Audubon Rd.

For the 5 sites located within the Cadillac TSC area, visits were conducted during a major holiday weekend to gain as much insight as possible regarding operational and safety characteristics. For the sites located in East Lansing, visits were done in anticipation of peak usage hours during the day. Primary focus was to investigate pedestrian/cyclist use and a secondary focus was to investigate pedestrian/cyclist-motorist interactions. Observations will be summarized on a site-by-site basis followed by concluding remarks on the general characteristics of road diet conversions.

SR 22: Baldwin, Michigan, Lake County – M-37

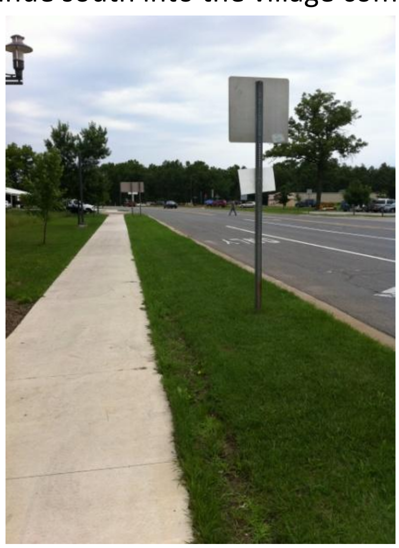
The village of Baldwin, Michigan had a population of 1,208 according to the 2010 Census, with an estimated median household income of $15,811. As a tourist destination, it draws mainly from camping, hunting, and fishing traffic, as the village is close to several rivers and within the Manistee National Forest. During the visits made to Baldwinno one spoken to mentioned that the pedestrian and bicycle traffic was unusual that day.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along M-37, which acts as the major arterial road through town, included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. A 5-lane road with two-way left-turn lane (TWLTL) and a parking lane exists within the village commercial district just south of the road diet site. Beginning just south of 9th St., the road diet continues to the north for 0.2 miles ending at the M-37 junction with US-10, after which the road tapers into a 2-lane road. At this point, the speed limit changes from 30 mph in town and along the site, to 40 mph, heading north out of town.

- Visit #1: Friday, July 1 – arrival at 12:15 pm
- Visit #2: Saturday, July 2 – arrival at 10:15 am

Geometric/Marking Observations:

- Sidewalks are separated from the curb by about 10 feet; they extend the entire length of the road diet and continue south into the village commercial center.



View of sidewalk facing south along M-37

- There is an unsignalized crosswalk located on the north side of the 10th St. intersection.

- There were no observed uses of this crosswalk; nearly all pedestrian crossings were done at midblock locations throughout the site, whenever there was a long enough break in traffic for a safe crossing to be made.

Single pedestrian crosswalk

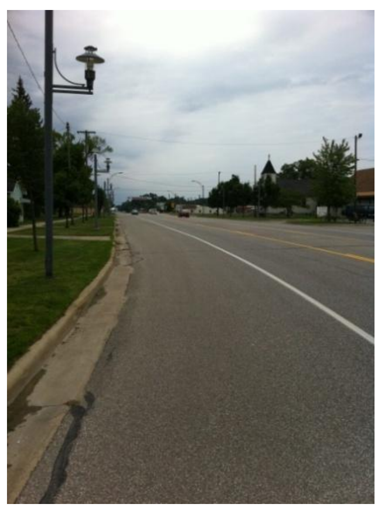
- There are no signalized intersections on the site, however, the US-10 junction is a stop-controlled intersection, where NB/SB traffic has a dual flashing yellow beacon, and EB/WB traffic has a dual flashing red beacon.
  - Traffic was heavy enough that it was difficult for EB/WB traffic to find gaps in which to turn onto M-37, especially turning left, resulting in long delays.
  - There are unsignalized crosswalks in every direction at this intersection.

Dual flashing beacon intersection

- There is a snowmobile crossing right at the south edge of the road diet site.

Snowmobile crossing

- There are wide (~7 ft.) unmarked lanes on each shoulder, that are presumably intended to be used as bike lanes.
    - Lanes are wide enough that cars easily drift into them, especially at road curves; they essentially create extra-wide moving lanes that allow cars to travel much faster than the speed limit.
    - There were also occasions witnessed where these lanes were used as right-turn lanes.



View of wide shoulder facing south

Pedestrian/Bicyclist Observations:

- 30 minute count on Visit #1:
    - 13 pedestrians (inc. skateboard, wheelchair, and stroller)
    - 0 bicyclists

- 15 minute count on Visit #2:
  - 8 pedestrians
  - 1 bicyclist
- There was very little activity of either pedestrians or bicyclists along the site.
  - No trends in type or purpose of pedestrian were noticeable.
- Most pedestrian crossing occurred mid-block and often required a long wait to find a safe gap in traffic.
- During Visit #1, a wheelchair pedestrian was witnessed experiencing difficulty crossing US-10 at the intersection with M-37; another pedestrian went into the road to direct traffic in order to allow the wheelchair time to cross the road.

Resident Interactions:

- The road diet was constructed in 1998, so no one was able to recall what the road was like prior to construction.
- In a conversation with a local pedestrian during Visit #1, the following comments were made:
  - The M-37/US-10 intersection is very dangerous.
  - Several accidents occur per month.
  - Waits to cross the street can be up to 30 minutes.
  - Speeding is an issue, and cars have to take higher risks to turn into traffic.
- In a conversation with a local pedestrian during Visit #2, the following comments were made:
  - It is easier to cross M-37 along the road diet than either at the US-10 intersection or along the wider section of road south of the site.

Conclusions:

- While there is infrastructure present (sidewalks, crosswalks, bike lanes), very little pedestrian and bicyclist activity occurs along the road diet site. There appears to be much more traffic just south of the site, where the heavier commercial district acts as a pedestrian generator.
- Vehicle traffic through the road diet seems to exceed the speed limit of 30 mph. It gives the road more of a feel of a wide, fast-moving highway than of a pedestrian-friendly road, making crossing difficult and forcing long delays.
- The road diet did not seem to be successful in either calming traffic or in encouraging safe pedestrian and bicycle traffic, even though these were stated reasons behind the construction.

SR 26: Lake City, Michigan, Missaukee County – M-55/M-66

The city of Lake City, Michigan had a population of 836 according to the 2010 Census, with an estimated median household income of $29,130. It is a popular tourist destination, and is a seasonal home for many more who own or rent cottages around Lake Missaukee. During the two visits made, the town was heavily populated by tourists visiting for a local 4th of July festival. One local business owner said that that weekend was the busiest that the town had experienced and that throughout the rest of the year both traffic and pedestrian volumes were relatively low.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along M-55/M-66, which is the main arterial road through the city, included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. South of the road diet, M-55/M-66 is a 2-lane road. The road diet begins just south of 1st St. and continues for 0.6 miles until it becomes a 2-lane road with parking lanes on either side, just north of Union St. The speed limit for the majority of the road diet is 35 mph, although it changes to 45 heading south a short distance north of 1st St.

- Visit #1: Friday, July 1 – arrival at 2:10 pm
- Visit #2: Saturday, July 2 – arrival at 11:55 am

Geometric/Marking Observations:

- There is a sidewalk on the east side of the road, which extends nearly the entire length of the site (there are none between Union St. and Hill St.) and it is not separated from the edge of the road.
  - On the opposite side of the road, pedestrians used the bike lane for walking.

Sidewalk directly adjacent to pavement

- There are no crosswalks along the site.
    - Traffic did not yield to pedestrians, and all crossing was done mid-block and rushed through gaps in traffic.
- There are unmarked bike lanes on both sides of the road diet.
    - There were several instances where cars parked along the road diet in the bike lanes, mostly on the side without the sidewalk.

View of bike lane facing north

- On the west side of the road there were staircases that headed down the slope, towards the boardwalk along the beach.
    - Since there is no sidewalk along this side of the road, there is nowhere for people using these staircases to go once they get to the top, forcing them to either cross mid-block to reach the sidewalk across the street, or to walk in the bike lane.
- There were no signalized intersections along the road diet site.

Vehicular Traffic Observations:

- There was noticeable northbound traffic back-up during both visits, although it was much worse during Visit #2. During that visit, traffic was backed up all the way to the south end of the road diet site.
    - Although this was likely an anomaly because of the 4th of July celebrations in Lake City, it presented an example of the road diet not adequately dealing with the traffic load.
    - Many of the cars in the back-up were carrying kayaks and bicycles, suggesting a high tourist population.
    - To get around heavy traffic, motorcycles were seen using bike lanes as right turn lanes.
- Since the beach extends along the west side of the road diet, there are only turning opportunities to use the TWLTL on one side of the road, and most of those are residential driveways. Thus, the TWLTL was not used very often for turning.
    - There were cars seen using the TWLTL for passing in traffic.
    - Some cars used the TWLTL as a waiting lane to turn left onto M-55/M-66, although that maneuver is not legal.
    - Because of the heavy traffic in the northbound lane, there was occasionally backup in the TWLTL as cars had to wait to find gaps to make the left turn.

Pedestrian/Bicyclist Observations:

- 15 minute count on Visit #1:
    - 24 pedestrians
        - Almost all of these pedestrians were seen in large groups heading north from either Union St. or the public beach parking lot near the north end of the road diet site.
    - 4 bicyclists
- 15 minute count on Visit #2:
    - 7 pedestrians
    - 1 bicyclist
- There was significantly more pedestrian traffic along the commercial district just north of the road diet, than there was along the more residential area where the road diet was in place.
- There was very little activity of either pedestrians or bicyclists along the site.
- Most pedestrian crossings occurred mid-block and often required a long wait to find a safe gap in traffic.

    - Because of the heavy traffic, pedestrian crossing was especially difficult, and there were several occasions witnessed where pedestrians were forced to cross in otherwise unsafe circumstances.
- Although the road diet extends along the beach, most beachgoers park in the public lot near the north end of the road diet and go straight along the boardwalk, avoiding walking along the road.

Resident Interactions:

- In a conversation with a local pedestrian walking her dog during Visit #1, the following comments were made:
    - An increase in pedestrian and bicyclist traffic was noticed when the road diet was implemented, especially with tourists.
    - She liked having the TWLTL to make the left turn into her driveway.
    - She said she felt safer walking along the road since the change.

Conclusions:

- The constant heavy stream of northbound traffic observed in the site visit was out of the ordinary and put an abnormal strain on the road diet site.
- With the single adjacent sidewalk, and the lack of crosswalks, pedestrian traffic does not appear to be encouraged along the main portion of the road diet.
- Pedestrians are forced to make mid-block crossings, through heavy traffic.
- Most pedestrian and bicyclist traffic occurs north of the road diet, along the commercial district of Lake City.

SR 33: Mesick, Michigan, Wexford County – M-37/M-115

The village of Mesick, Michigan has a population of 394 according to the 2010 Census, with an estimated median household income of $25,313. Although there are nearby fishing and camping areas, even on a holiday weekend over which the two visits were made, there did not appear to be much tourist traffic.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along M-37/M-115, which is the main arterial road through the city, included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. West of the junction of M-37 and M-115, where the road diet begins, the road tapers into a 2-lane road, as it does on the other end of the 0.7 mile long site, just east of Clark St. The speed limit is 35 mph throughout the site, and it becomes 45 mph as you leave the road diet, heading in either direction.

- Visit #1: Friday, July 1 – arrival at 4:15 pm
- Visit #2: Saturday, July 2 – arrival at 12:20 pm

Geometric/Marking Observations:

- There are sidewalks that run nearly the entire length (but not further in either direction) of the road diet, on both sides of the road.
    - They are separated from the road/parking lanes, and are well landscaped and look very clean; the road is clearly intended to encourage pedestrian activity.

View of landscaped sidewalk along M-37

- There are crosswalks on both sides of nearly every intersection.

- There are also several signs informing drivers of the location of the crosswalks, as well as advanced signs warning them of upcoming crosswalks.

Crosswalk with warning road sign

- Except for the far western portion of the road diet, in which there does not appear to be as heavy a commercial presence, parking lanes line both sides of the road diet. They appear to be used frequently as most storefronts do not have adjacent parking lots.

View of parking lanes facing west

- There are unmarked bike lanes on both sides of the road diet site.

View of bike lanes facing west

Pedestrian/Bicyclist Observations:

- During Visit #1, after a 10 minute pedestrian count upon arrival witnessed no pedestrian activity, the attempt for a longer formal data collection period was abandoned. Throughout the approximately hour-long site visit there were perhaps a total of 5 pedestrians and 1 bicyclist seen.
- 20 minute count on Visit #2:
  - 3 pedestrians
  - 1 bicyclist
- There was very little pedestrian activity to note during either visit – the only real pedestrian activity witnessed was of people crossing the street (usually mid-block) to go from their parked cars to storefronts and vice versa.
  - At the west end of the road diet are both the Mesick public elementary, and Jr./Sr. high school (The high school is located further south, behind the elementary school, but still appears likely to supply significant pedestrian traffic to the road diet.). It appeared as if the pedestrian infrastructure may have been put in place to handle larger volumes from the schools, when it is in session.
- Although there are crosswalks present throughout the site, most pedestrian crossing witnessed was still done mid-block, especially when it was to get to a car parked in the parking lanes.
  - Crossing, either at the crosswalks, or mid-block, was not very difficult, as the level of vehicle traffic was relatively low, though fairly constant.
  - When there were interactions between crossing pedestrians and vehicles, the vehicles correctly assumed right-of-way.

- The few bicyclists seen along the road diet used the sidewalks rather than the bike lanes.

Resident Interactions:

- In a conversation with a local pedestrian during Visit #2, the following comments were made:
  - Pedestrian crossing was noted as a problem as people cross mid-block.
  - Pedestrians are hesitant to use the TWLTL as a refuge when crossing the street.

Conclusions:

- This seems to be an example of a very well-functioning road diet. Vehicle traffic was relatively calm, and there was never any back-up, and there didn't seem to be any problems regarding pedestrian safety or access.
- The wide lanes, parking lanes, and well-landscaped sidewalks gave the town a very quaint feel that would seem to encourage pedestrian and bicycle activity, however it was not used very much.
  - Presumably, there is heavier traffic from the nearby school when it is in session.

SR 24: Manistee, Michigan, Manistee County – US-31

The city of Manistee, Michigan had a population of 6,226 according to the 2010 Census, with an estimated median household income of $37,721. Located between Lake Michigan and Manistee Lake, it is a popular camping, boating, and fishing tourist location, and, especially over the 4th of July weekend when the visit was made, there is a lot of extra traffic from seasonal visitors.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along US-31, which is the main arterial road through the city, included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. Just east of the junction with M-55, the road tapers into a 2-lane road, and just east of Lakeshore Rd. it becomes a 5-lane road with a TWLTL. The road diet goes through a commercial district, and ends before the downtown part of town. The speed limit throughout the site is 40 mph.

- Visit #1: Friday, July 1 – arrival at 6:00 pm

Geometric/Marking Observations:

- There are no sidewalks, bike lanes, or cross walks along the road diet site. It is simply a 3-lane road with a TWLTL and no space between the moving lanes and the curb.

Lack of pedestrian or bicyclist infrastructure

Vehicular Traffic Observations:

- Traffic was constant and heavy along the road diet site and there was congestion throughout.

    - Turning left, both onto and off of the road diet site was very difficult because of congestion, and forced cars to take bigger risks. Throughout the hour-long observation, there were several occasions witnessed, where horns were sounded, and squeeling tires were heard as vehicles made aggressive maneuvers.
- In one instance, a car attempting to turn left onto the site found a gap in the near lane, and turned into the TWLTL and used it as a waiting lane to get into the far lane. An oncoming truck, however, though that he was being cut off and slammed on the brakes and sounded his horn.

Pedestrian/Bicyclist Observations:

- There were very few pedestrians or bicyclists seen along the road diet site, which was not surprising given the lack of sidewalks or bike lanes.
    - One bicyclist was seen riding along the grass on the side of the road and sometimes venturing onto the side of the road. When this happened, vehicles had to swerve into the TWLTL to pass him.
- The congestion of vehicles on the road and the fast, aggressive style made walking along the side of the road seem unsafe.

Conclusions:

- It is surprising that pedestrian safety was listed as a rationale for the road diet in Manistee, since there is no infrastructure in place to accommodate pedestrians or bicycles.

SR 25: Ludington, Michigan, Mason County – M-116

The city of Ludington, Michigan had a population of 8,076 according to the 2010 Census, with an estimated median household income of $33,369. Located along Lake Michigan, it is a very popular tourist location, with a large campground and many hotels in the surrounding area. Both visits were done over the 4th of July weekend, when the city was especially busy with tourists.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along M-116 included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. The road diet site does not go through the main commercial district of town, but is a 0.8 mile stretch of road that extends along the public beach in Ludington. The road diet begins at US-10, and it ends just north of Lowell St., where it tapers into a 2-lane road. The speed limit is 35 mph on M-116 where the road goes along the beach; north of this portion of the road diet, the speed limit changes to 45 mph.

- Visit #1: Friday, July 1 – arrival at 7:35 pm
- Visit #2: Saturday, July 2 – arrival at 8:10 am

Geometric/Marking Observations:

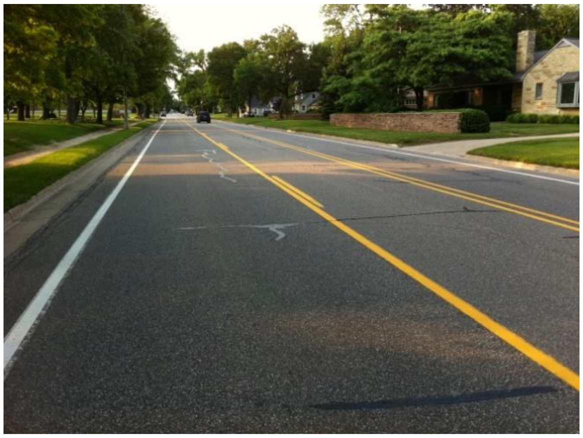
- There are sidewalks, separated from the road by about 5 feet, along the entirety of the road diet site, on both sides of the road until just north of the beach, where it ends on one side. These sidewalks join a larger network of sidewalks in the neighborhood east of the site and along the main commercial district in Ludington.

View of sidewalk facing north

- There are crosswalks at most of the cross streets.

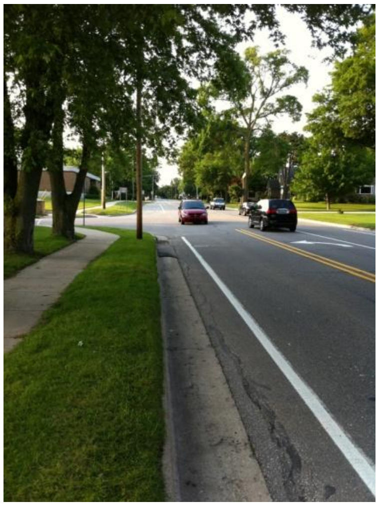
View of crosswalk on M-116

- Because there is a public beach parking lot that runs parallel to the road diet, and only has one entrance, there are no possible left turns from the northbound lane for the majority of the road diet site. Therefore, the TWLTL is striped with a double solid line on one side, essentially making it a one way turn lane and a waiting lane for cars making left turns onto the road.



TWLTL with solid double line on one side

- There are unmarked bike lanes throughout the site on both sides of the road.



View of bike lane facing north

Vehicular Traffic Observations:

- Although the speed limit is 35 mph, traffic seemed to always be traveling at even slower speeds.
    - There are lots of motorcycles that travel along M-116, and they all seem to travel at speeds less than 35 mph as well.
- Except for the driveway into the public beach parking lot, the rest of the driveways were residential along the road diet site, and they were all on the side of the road opposite the beach, meaning that the TWLTL was rarely occupied outside of the turn lane into the beach parking lot.
- The volume of vehicular traffic was obviously much higher during Visit #1 (Friday evening) than during Visit #2 (Saturday morning), but it was never high enough that the road was congested.
- Some cars were seen making left turns out of the outside lane, rather than using the TWLTL.

Pedestrian/Bicyclist Observations:

- 20 minute count on Visit #1 (south end of site):
    - 17 pedestrians
    - 6 bicyclists
- 15 minute count on Visit #1 (middle of site):
    - 24 pedestrians
    - 11 bicyclists
- 30 minute count on Visit #2 (middle of site):
    - 46 pedestrians
    - 9 bicyclists

- During both visits, most of the pedestrian traffic seems to be travel across the road and to the beach. People seemed to walk along the beach rather than actually travelling on the sidewalks along the road.
    - Almost all pedestrians crossed at one of the crosswalks, rather than mid-block. The highest frequency of these crossings occurred at the intersection of Haight St. and Pere Marquette St., which, after conversation with a pedestrian, were along the most direct path to the campground.
    - Pedestrians and bicyclists typically crossed M-116 from the neighborhood to the east towards the beach and back. Although some of the bicycle traffic was to and from a skate park at the south end of the site. This usually meant that they travelled on the sidewalks rather than in the bike lanes.
- During Visit #1, most of the pedestrians and bicyclists travelled in groups to and from the beach, and during Visit #2, most of them were morning exercisers (runners, etc.).
- There was much less pedestrian and bicyclist traffic on the section of the site north of the public beach, and on this portion of the site, they were mostly residents travelling north and south along the road to and from the beach, using the sidewalks and bike lanes.
    - Even on the northern part of the site, bicyclists tend to use the sidewalks rather than the bike lanes.
- The vehicular traffic on M-116 was light enough that pedestrians and bicyclists so there was never much delay.

Resident Interactions:

- In a conversation with two local pedestrians during Visit #1, the following comments were made:
    - General perception of the road diet was that it was a very positive change.
    - The change increased pedestrian traffic significantly.
    - Lots of bikes are seen using the bike lanes.
    - Their single complaint was that cars did not yield to pedestrians at crosswalks, and that there is no designation informing drivers that pedestrians have the right-of-way, indicating a lack of education on traffic law, since vehicles legally have the right-of-way in such a situation.
- In a conversation with a pair of bicyclists during Visit #1, the following comments were made:

    - They came through the neighborhood to the east, from the campground, and crossed to go to the beach. They followed a bike path network that goes from the campground to the beach.
    - They prefer to ride on sidewalks, which they can do in the neighborhood, and do not like riding on "the road" on M-116.
        - They did not seem to be aware of the purpose of the bike lanes, which may not be surprising given that they were tourists and that the bike lanes were unmarked.
- In a conversation with a local pedestrian walking his dog during Visit #2, the following comments were made:
    - General perception of the road diet was very positive and that was the case for everyone he knew locally.
    - The most positive change was that the road diet slowed down vehicles, making it much safer for pedestrians to walk along the road and to cross it to go towards the beach.
        - When it was a 4-lane road, there were lots of vehicles, especially motorcycles, that would race alongside each other down M-116.
    - He never noticed any times when traffic would back up.
    - When the change was first announced, his wife was very skeptical, as were many others, but after experiencing its effects, they were unanimously in favor of it.

Conclusions:

- This seems to be an example of a very successful, well-functioning road diet. Traffic seems to be very calm and safe for pedestrians and bicyclists. It seems that the road diet has encouraged beachgoers to walk or bike to the beach rather than driving and parking in the lot.
- Of the visited sites, this site by far had the most pedestrian activity, although it did not have the most vehicular traffic.

SR 42: East Lansing, Michigan, Ingham County – Burcham Rd.

The city of East Lansing, Michigan had a population of 48,579 according to the 2010 Census, with an estimated median household income of $27,898. As the location of Michigan State University, it is home to a large student population, who are younger and more active than the average population in non-college cities. There is, to be expected, a higher level of pedestrian and bicycle traffic from this demographic than in other places studied. All visits to the sites in East Lansing were done on weekdays during the school year, in order to witness the impact of student traffic on the road diet sites.

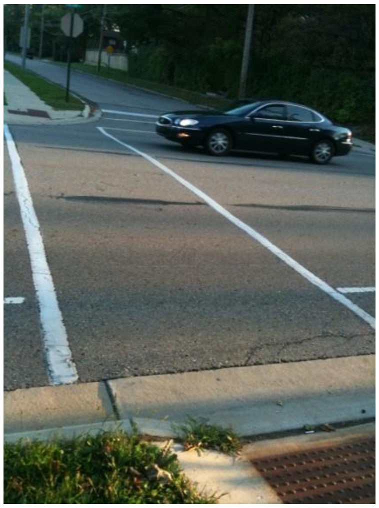
According to the Road Diet Survey Form, the primary motivations for implementing a road diet along Burcham Rd. included traffic calming, a reduction of left-turn problems both mid-block and at intersections, a reduction in traffic volumes, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. Along Burcham Rd., in addition to a lot of MSU student housing, are three East Lansing public schools (EL High School, MacDonald Middle School, and Marble Elementary School), as well as a nearby private school, contributing high volumes of pedestrian and bicyclist traffic to the corridor. The road diet begins at the western end of Burcham Rd., at Abbot Rd. – across Abbot Rd., Burcham Rd. becomes a driveway for the East Lansing Community Center. The road diet site is 1.6 miles long, and, at its eastern end, it tapers into a 2-lane road. The speed limit for the entire length is 25 mph.

- Visit: Tuesday, September 13 – arrival at 7:30 am

Geometric/Marking Observations:

- There are sidewalks on both sides of the road that run nearly the entire length of the site (on the north side of the road, there is no sidewalk for the easternmost 0.25 mi). They vary in width of separation from the road throughout the road diet, depending on the surrounding land use, and they connect with a larger network of sidewalks within the surrounding residential neighborhoods.

- There are crosswalks throughout the site, especially around the schools, which are, in general, used correctly.



View of crosswalk at Bailey St.

  - Traffic, which was consistently heavy, did not always yield to pedestrians and bicyclists waiting to cross the street around the high school. Pedestrians often made aggressive crossing maneuvers, forcing traffic to wait for them to cross.
  - Many of the crosswalks included traffic signs indicating their location and purpose.

Pedestrian crossing sign

  - Near the middle and elementary schools, there were crossing guards that would stop traffic to allow the safe crossing of students in the crosswalks.
  - There was a noticeable lack of crosswalks between school areas, where there are large MSU student apartment complexes. Pedestrians at these destinations crossed midblock at any gap in vehicular traffic.

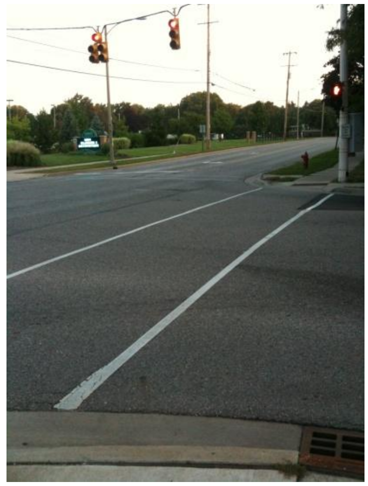
- There are marked bike lanes on both sides of the road diet site.

Bike lane marking

- There was a signalized intersection with Abbot Rd. at the western end of the road diet, as well as one with Hagadorn Rd. in the middle of site.

Signalized intersection at Abbot Rd.

- Both signalized intersections also have signalized pedestrian crosswalks.



Signalized crosswalk at Abbot Rd.

- There are no other stop or yield signs along the mainline of the road diet.

Vehicular Traffic Observations:

- Traffic volumes were very high during the visit, as many cars were entering and exiting the schools' parking lots, as well as all of the public school buses. This, at times, made for very congested traffic.
  - Although volumes were high, vehicle delay appeared to be relatively low for turns into the schools. The TWLTL functioned well in allowing traffic to continue steadily, while cars attempting to turn into the schools were able to wait for an appropriate gap.
    - There was significant backup as cars attempted to exit the parking lot and turn onto Burcham Rd. Since vehicles in the TWLTL making turns into the parking lot assumed right-of-way, it was nearly impossible to make a left turn onto Burcham Rd. through the line of waiting cars.
  - Despite the occasional backup, there were never any signs of aggression witnessed, or dangerous driving in regards to vehicle-vehicle interactions.
- Drivers appeared to be well-educated as to the purposes and use of the geometric features of the TWLTL and bike lanes. This is likely at least partially due to the regularity inherent to the types of trips being made on this site (bus drivers, parents dropping of kids, student housing, etc.).

Pedestrian/Bicyclist Observations:

- 15 minute count in front of the high school:
  - 19 pedestrians

    - 16 bicyclists
    - Outside of one or two recreational runners, these pedestrians and bicyclists were exclusively headed towards the high school from various surrounding residential areas.
- 15 minute count on near the elementary school:
    - 18 pedestrians
    - 10 bicyclist
    - While many of these pedestrians were students (and their parents), there appeared to be more recreational traffic during this count (runners, recreational bicyclists, walkers with strollers, etc.), but this was likely due to the fact that the count was done about 30 minutes after the first one.
- Most of the pedestrian and bicyclist traffic was associated with the nearby schools, and was therefore most highly concentrated in those areas.
    - Students often travelled in the neighborhoods south of Burcham Rd. and only came to the road diet to cross to the high school, rather than walking along Burcham Rd. for a majority of their trip.
- As there were no crossing guards for traffic at the high school, pedestrians and bicyclists were forced to find safe gaps in traffic on their own. This was often difficult with such heavy vehicular traffic, and there was one incident witnessed where two pedestrians crossed in a short gap and a car had to stop suddenly to avoid a collision.
- Bicyclists often used sidewalks rather than bike lanes, despite the clear markings. Runners often used the bike lanes rather than the sidewalks.
- Several bicyclists were seen using the TWLTL to cross the street and make left turns off of Burcham Rd. Although they were using the bike lanes while travelling along the road diet site, they would enter vehicle traffic in order to make those left turns.

Resident Interactions:

- In a conversation with a crossing guard during a period of low pedestrian traffic, the following comments were made:
    - Pedestrians are not as safe as they were before the implementation of the road diet.
    - There are fewer students who walk to school than there were before the change.
    - Vehicle speeds are still too high, and conditions are not safe for crossing without the control of the crossing guard.
        - There used to be a guard at the crosswalk near Bailey St., where students cross to the high school. There is not anymore, and it is an unsafe location to cross.

    - Vehicles do not understand how to use the TWLTL; they often make left turns out of the far lane and hold up other traffic.

Conclusions:

- The road diet appeared to be successful at slowing down vehicular traffic. Despite the comments of the crossing guard, there were never any excessive speeds noticed along the site.
- While the speed of traffic was fairly calm, volumes were high, and there was occasional congestion and delay, especially in traffic turning onto Burcham Rd.
    - Pedestrian crossing was occasionally difficult and forced people to attempt to cross in unsafe gaps.
- A large majority of traffic, vehicular, pedestrian, and bicyclist, was associated with the schools along the corridor.
    - Most vehicular traffic was between Abbot Rd. and Hagadorn Rd., where the schools are located. Traffic along the road diet site east of Hagadorn Rd. was significantly lower than it was west of the intersection.
- Contrary to the observations of the interviewed crossing guard, there appeared to be a reasonable level of understanding as to the proper use of the TWLTL, which contributed to a better flow of traffic throughout the road diet, relative to some of the sites visited in Northern Michigan.

SR 43: East Lansing, Michigan, Ingham County – Abbot Rd.

The city of East Lansing, Michigan had a population of 48,579 according to the 2010 Census, with an estimated median household income of $27,898. As the location of Michigan State University, it is home to a large student population, who are younger and more active than the average population in non-college cities. There is, to be expected, a higher level of pedestrian and bicycle traffic from this demographic than in other places studied. All visits to the sites in East Lansing were done on weekdays during the school year, in order to witness the impact of student traffic on the road diets.

According to the Road Diet Survey Form, the primary motivations for implementing a road diet along Abbot Rd. included traffic calming, a reduction of left-turn problems both mid-block and at intersections, and an improvement in overall safety of the corridor, including that of pedestrians and bicyclists. There is a mixture of residential (MSU student housing) and commercial/institutional (including the East Lansing Library and Post Office) land uses along this section of Abbot Rd. The road diet begins Albert Ave. and continues north for 0.6 mi. to Whitehills Dr., where the road tapers into a 5-lane road with aTWLTL. The speed limit for the entire length of the site is 25 mph.

- Visit: Tuesday, September 13 – arrival at 7:30 am

Geometric/Marking Observations:

- There are sidewalks on both sides of the road that run the entire length of the road diet and are separated from the road by approximately 5 ft. They connect with a larger network of sidewalks within the surrounding residential neighborhoods.
- There are crosswalks throughout the road diet, located at nearly every intersection, signalized or otherwise.
- There are bike lanes on both sides of the road diet, with simple arrow markings indicating proper direction, although the bicycle symbol is not present in the lanes.
- There is a signalized intersection with Albert Ave. at the southern end of the road diet, as well as with Burcham Rd. and Library Ln. in the middle of site.
    - All three signalized intersections also have signalized pedestrian crosswalks.
    - There are no other stop or yield signs along the mainline of the road diet.

Vehicular Traffic Observations:

- Traffic volumes were high throughout the visit, and many of the vehicles were associated with the public high school located nearby on Burcham Rd.

- There was significant delay (a queue of nearly 20 cars) at both the intersections of Library Ln. and Burcham Rd.
    - This queuing stopped at about 7:50, however, presumably, with the end of the high school arrival and drop-off period.
- Vehicles regularly used the TWLTL as a merging lane to make left turns onto Abbot Rd. from the side streets and driveways.

Pedestrian/Bicyclist Observations:

- 15 minute count at Library Ln:
    - 4 pedestrians
    - 33 bicyclists
    - There were significantly more bicyclists than pedestrians along this portion of the site. Many of these bicyclists turned onto Burcham Rd. and headed toward the high school.
- 15 minute count at Albert Ave:
    - 27 pedestrians
    - 37 bicyclist
    - The majority of these pedestrians and bicyclists were college students, rather than high school students, headed south towards the MSU campus.
- There was a mixture of college (MSU) and high school (ELHS) students travelling along this site during this morning period of study.
- Bicyclists used both the bike lanes (sometimes using the wrong one according to direction), and the sidewalks.
    - A general trend was noticed that bicyclists headed towards the high school tended to ride on the sidewalks, while college students rode in the bike lanes.
- Pedestrians typically crossed appropriately at the crosswalks, while bicyclists would cross mid-block, whenever there was a safe gap.

Conclusions:

- The road diet appears to be successful at making pedestrian and bicycle travel reasonably safe for both the local high school traffic and MSU student traffic.
- This time period was one of high vehicular traffic volumes – perhaps temporarily above the capacity of the road diet – causing significant backup at the signalized intersections.

Grand River Ave: East Lansing, Michigan, Ingham County – M-43

The city of East Lansing, Michigan had a population of 48,579 according to the 2010 Census, with an estimated median household income of $27,898. As the location of Michigan State University, it is home to a large student population, who are younger and more active than the average population in non-college cities. There is, to be expected, a higher level of pedestrian and bicycle traffic from this demographic than in other places studied. All visits to the sites in East Lansing were done on weekdays during the school year, in order to witness the impact of student traffic on the road diets.

While this corridor was not a site included in this study, it was selected as a viable candidate for a site visit due to its status as a recent, local road diet that is located in a heavy pedestrian area. The road diet begins at Michigan Ave. and continues northwest for 0.9 mi until it tapers into a 2-lane road near Audubon Rd. There is some commercial land use at the east end of the road diet, but the majority is residential. The speed limit is 25 mph throughout the site.

- Visit: Thursday, September 15 – arrival at 12:45 pm

Geometric/Marking Observations:

- There are sidewalks on both sides of the road that run the entire length of the road diet and are separated from the road by approximately 5 ft. They connect with a larger network of sidewalks within the surrounding residential neighborhoods.
- There are crosswalks throughout the road diet, located at nearly every intersection, signalized or otherwise.
    - There are several signs located along the site indicating the location of crosswalks and presence of pedestrians.
- There are unmarked bike lanes on both sides of the road diet site.
- There are signalized intersections at Hillcrest Ave., Harrison Ave., and Kensington Rd.
    - All three signalized intersections also have signalized pedestrian crosswalks.
    - There are no other stop or yield signs along the mainline of the road diet site.

Vehicular Traffic Observations:

- There was delay at the intersection with Harrison Ave. that led to a queue of about 15 vehicles.

Pedestrian/Bicyclist Observations:

- 15 minute count at Harrison Ave:

- 7 pedestrians
- 3 bicyclists

- 15 minute count at Hillcrest Ave:
  - 13 pedestrians
  - 8 bicyclist
- The majority of all pedestrian and bicyclist traffic along this corridor was made up of college students.
- Bicyclists tended to use the sidewalks rather than ride in the designated bike lanes.
  - When they did ride in the bike lanes, they managed to safely remain in view of drivers at all times, leading to a minimization of bicyclist/vehicle conflict at intersections.

Conclusions:

- The bike lanes appeared to be successful in making bicyclist/vehicle interactions safer, when bicyclists actually used them.
  - There appeared to be either a lack of education regarding the use of the bike lanes (they were unmarked, unlike others in East Lansing), or a lack of comfort about using them among riders.

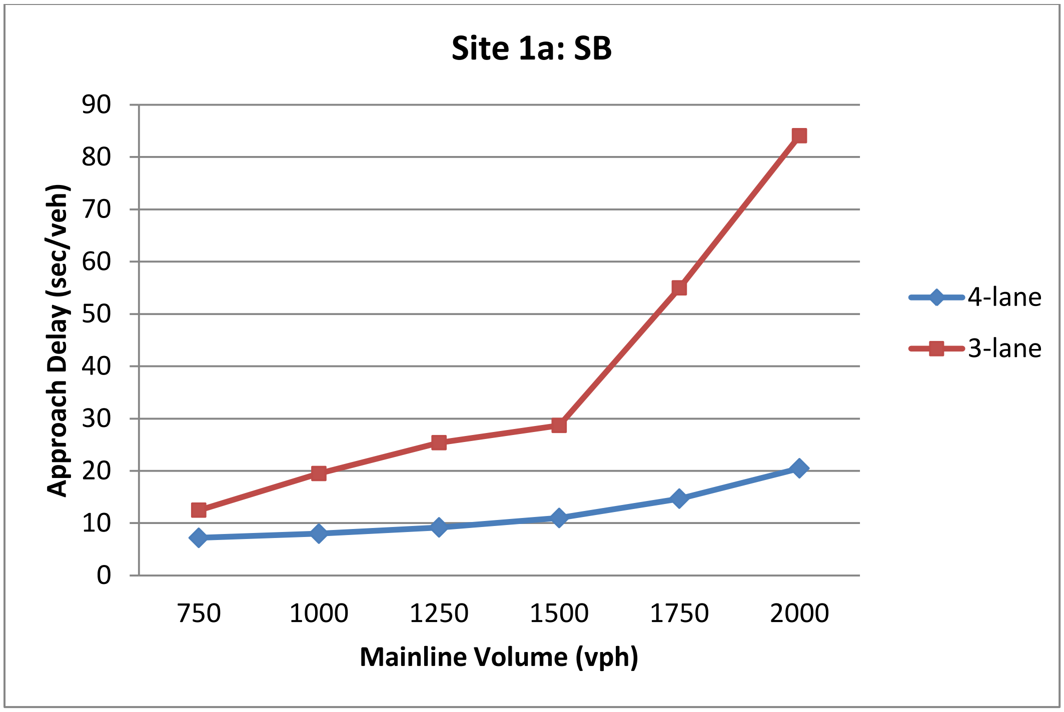
Overall Summary/Conclusions

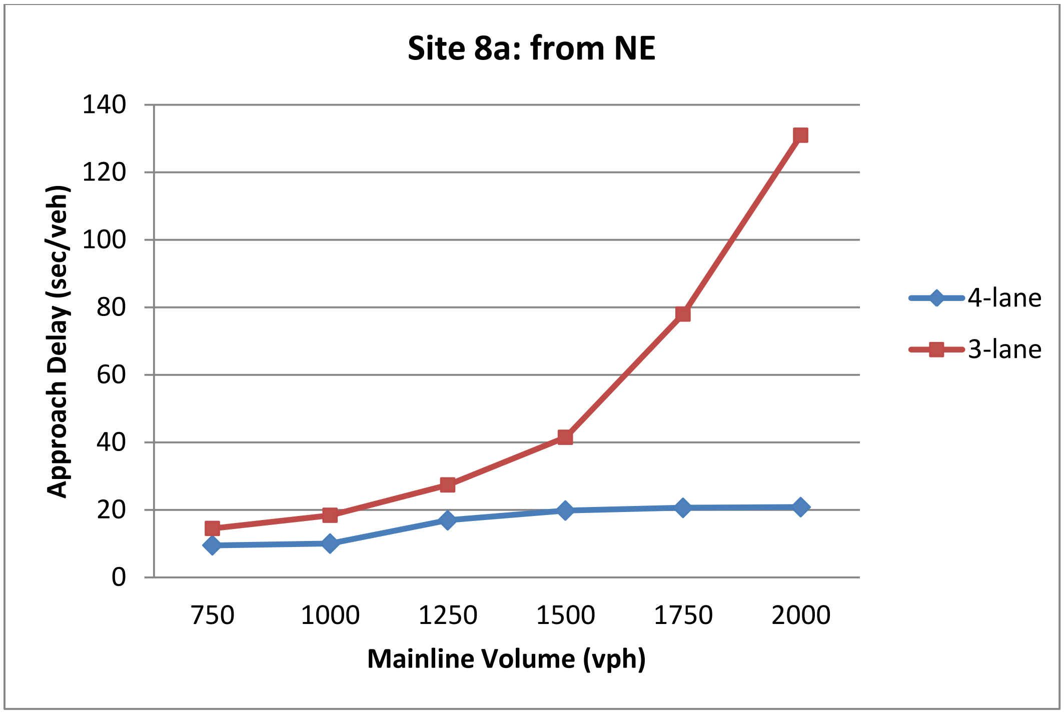
- Unsurprisingly, a lack of pedestrian and bicyclist infrastructure along a road diet site resulted in a very low amount of non-motorized use of the corridor.
- The two most notable characteristics of a well-functioning road diet with significant non-motorized use (besides simply having infrastructure) were:
    - Placement along corridors with commercial and pedestrian attractions:
        - The site in Lake City was located along a residential corridor of the road, just south of the city's commercial core. Despite having the infrastructure, and observations being made during the busiest weekend of the year, there was very little pedestrian activity along the site, as there was no pedestrian oriented attraction at this site; instead, all of the pedestrian activity took place north of the site, along the commercial strip of town.
        - The road diet in Baldwin ended just before reaching the main commercial district in town, therefore it had no impact on the majority of pedestrian traffic in Baldwin.
        - While there was little activity observed during the visits to Mesick, it could be inferred, based on the signage, crosswalk locations, and location of the public school, that when school is in session, there is a reason for pedestrians and bicyclists to use the infrastructure present along the road diet.
        - The site in Ludington was located along the public beach, which acted as a significant pedestrian generator for the corridor. The Burcham Rd. and Abbot Rd. sites in East Lansing both attracted lots of pedestrian and bicycle use from students from the nearby schools and Michigan State University.
    - Successful traffic calming:
        - Based on observations and conversations with local residents, the main cause of the increase in pedestrian usage along the Ludington site, appeared to be the calming of traffic. While the area is largely residential in land use, the adjacent public beach had always acted as an attraction for pedestrians and bicyclists, and now that traffic was slower, the road was easier to cross and walk along, encouraging beachgoers to walk or bike there, rather than drive and use the parking lot.
        - Although the site in Baldwin was in a relatively commercial area, with pedestrian destinations, the road diet was designed such that traffic still sped through the corridor, making it appear unsafe to cross or bike along.

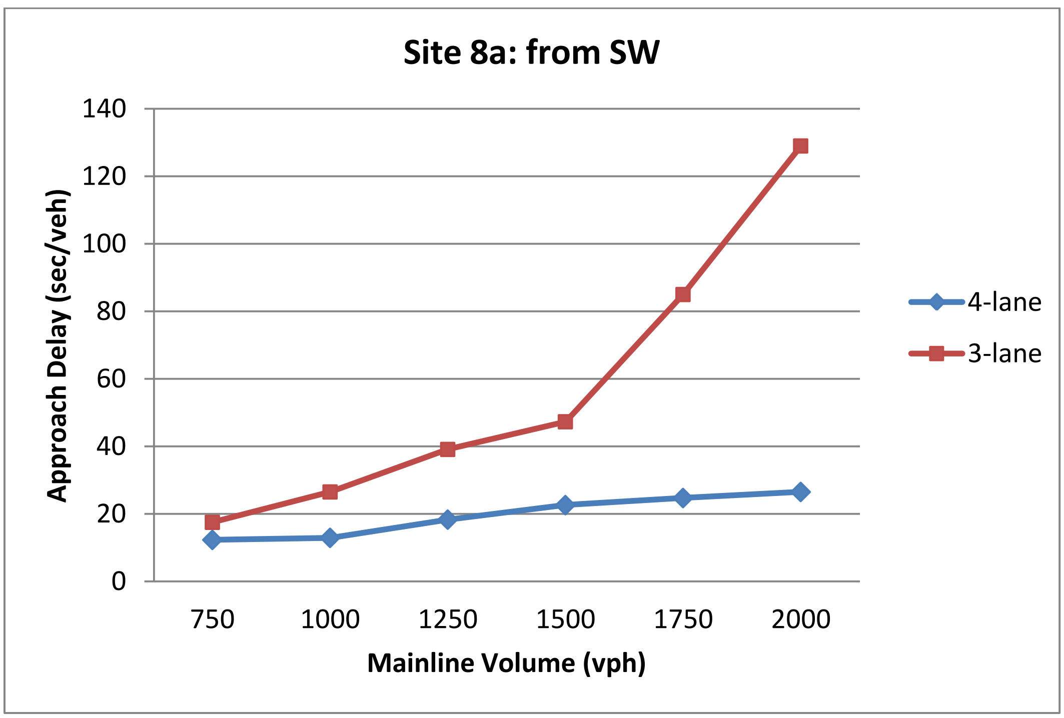
        - Along the Mesick site, even though the observed pedestrian traffic was low, the road diet had successfully calmed traffic, and, simply by walking up and down the corridor, you could feel that it was safe for pedestrian and bicyclist activity.
- In several conversations with residents and in observations of interactions between motorized and non-motorized vehicles, it could be seen that, at some locations, there was a lack of proper education regarding the use of different aspects of the road diet projects.
    - Bikers were often seen riding on sidewalks rather than using the bike lanes, which were never designated as such. Pedestrians were also occasionally observed using bike lanes, even when there was an adjacent sidewalk. There appeared to be a better understanding of the purpose of bike lanes at the sites in East Lansing, where there were bicycle markings on the pavement.
    - There seemed to be a lack of clarity regarding right-of-way at crosswalks along the road diet sites. Typically, vehicles correctly assumed it; residents complained, however, that crossing was difficult when vehicles did not yield to pedestrians – most notably in Ludington.
    - Vehicles occasionally used the TWLTL as a waiting lane in making left turns onto the road diet; others did not, although it was unclear whether that was because they were aware that it was an illegal maneuver or because they just felt uncomfortable doing so.
        - On those occasions that the TWLTL was used as a waiting lane to turn into the far moving lane, drivers in the far lane were uneasy, and thought that they were being cut off.

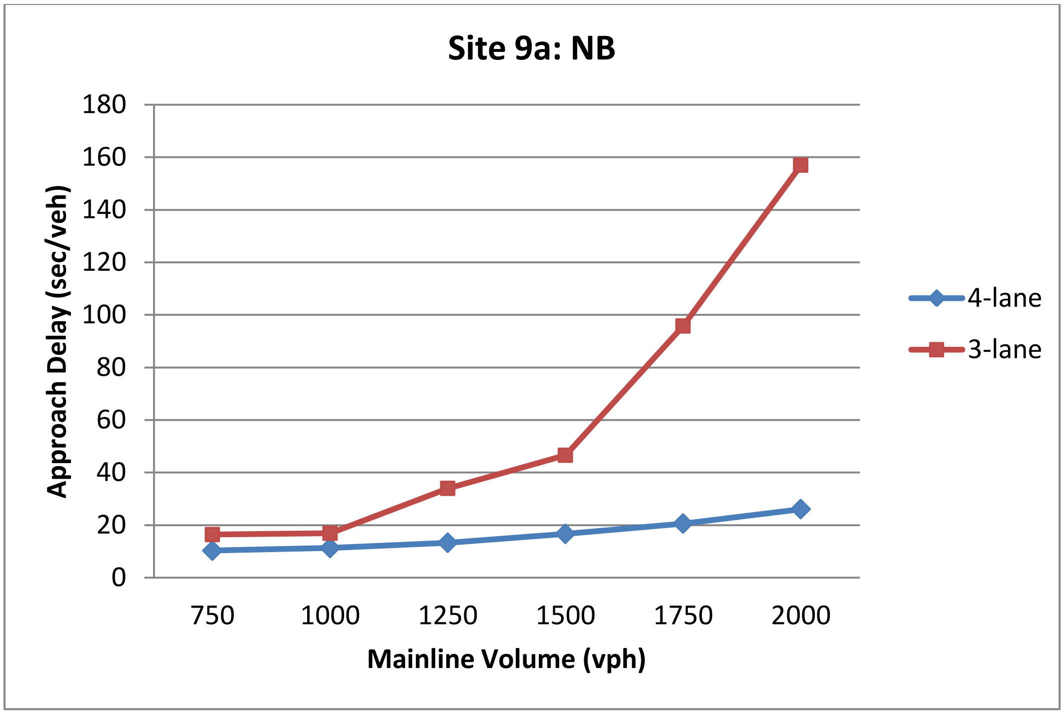
APPENDIX C

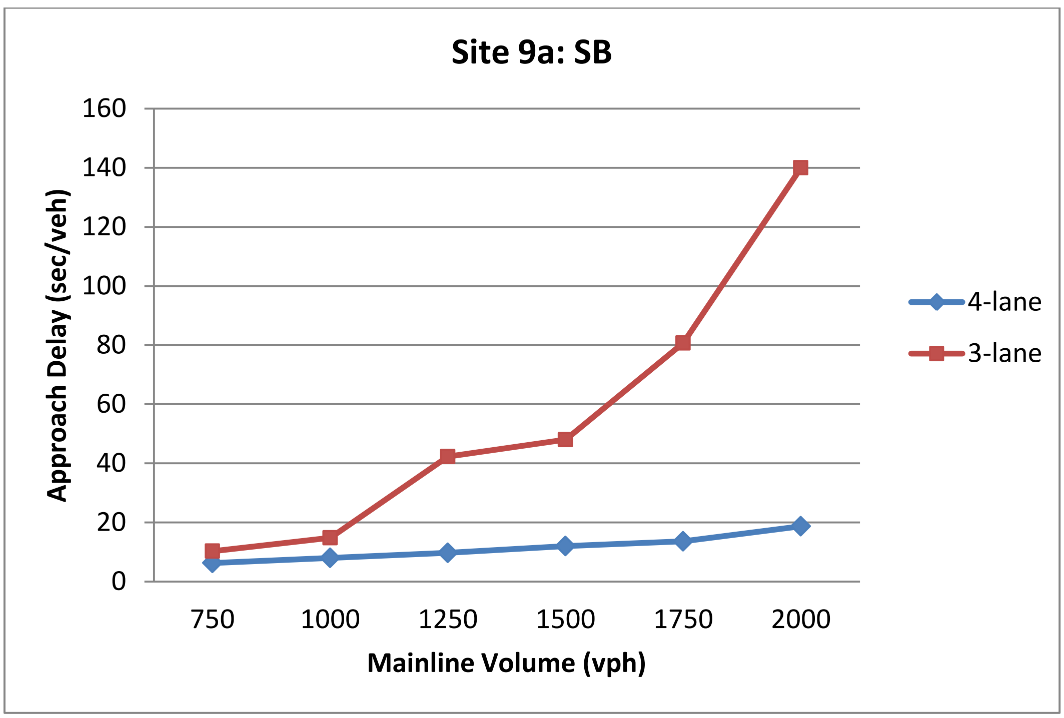
OPERATIONAL ANALYSIS—ADDITIONAL RESULTS

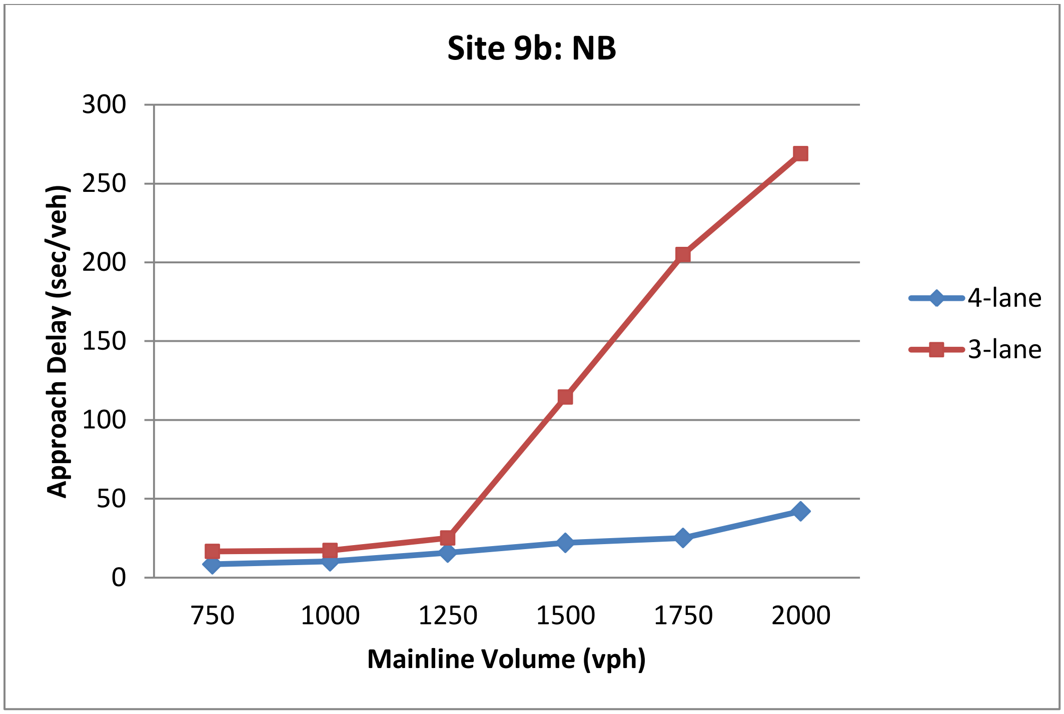

Site 1a: SB
Approach Delay (sec/veh)
90
80
70
60
50
40
30
20
10
0
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

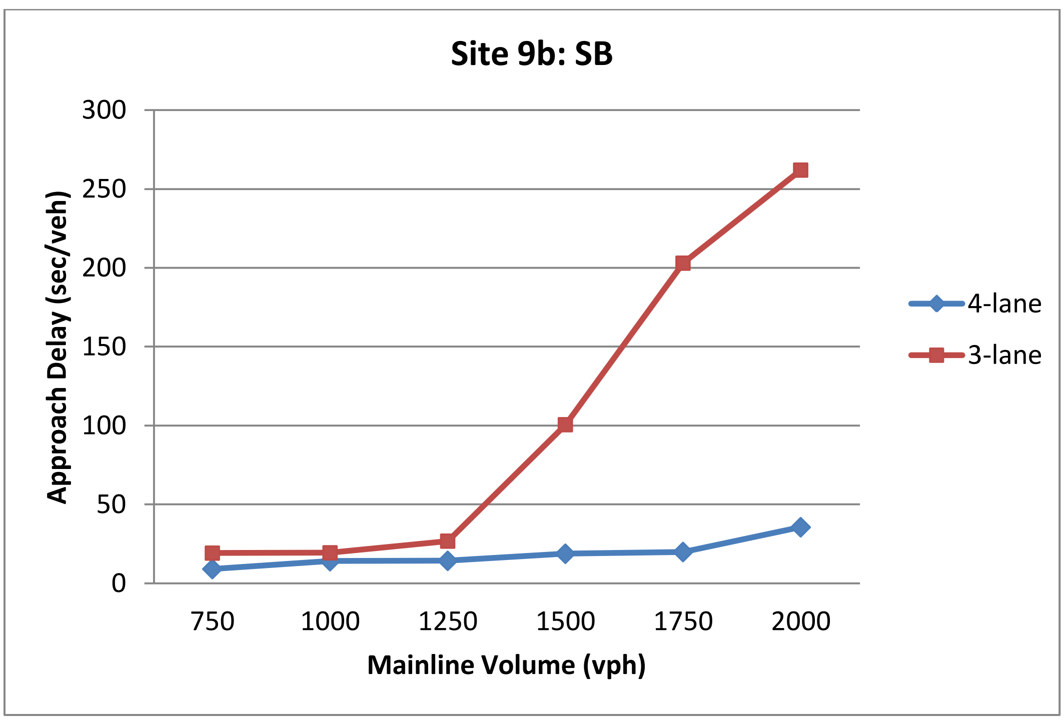

Site 8a: from NE
140
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

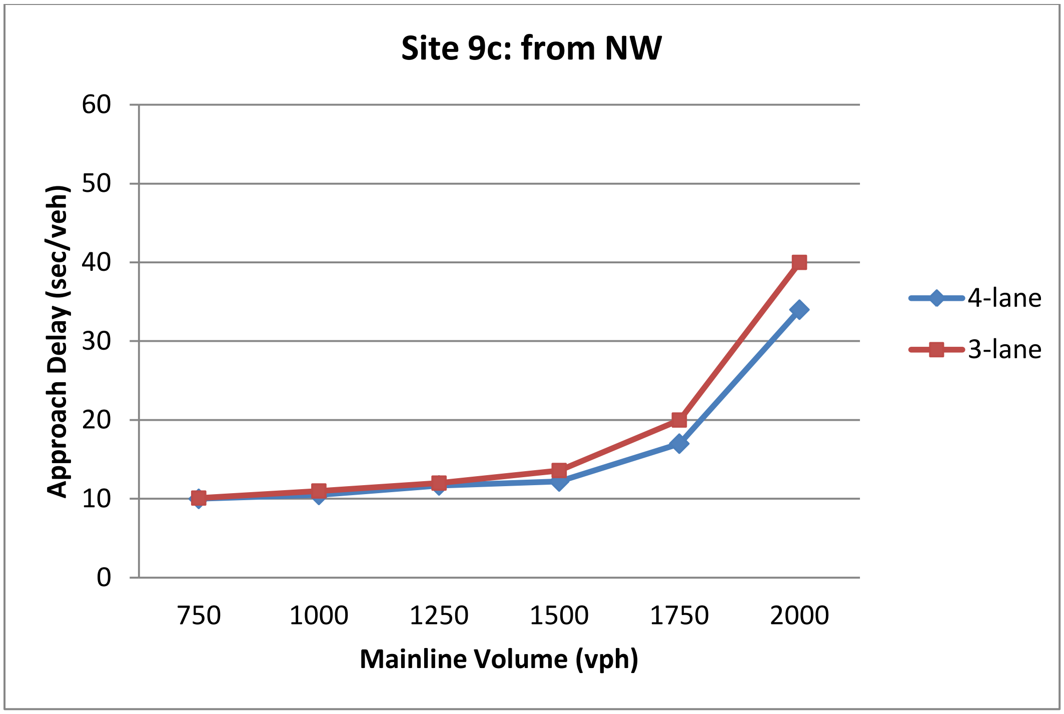

Site 8a: from SW
140
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

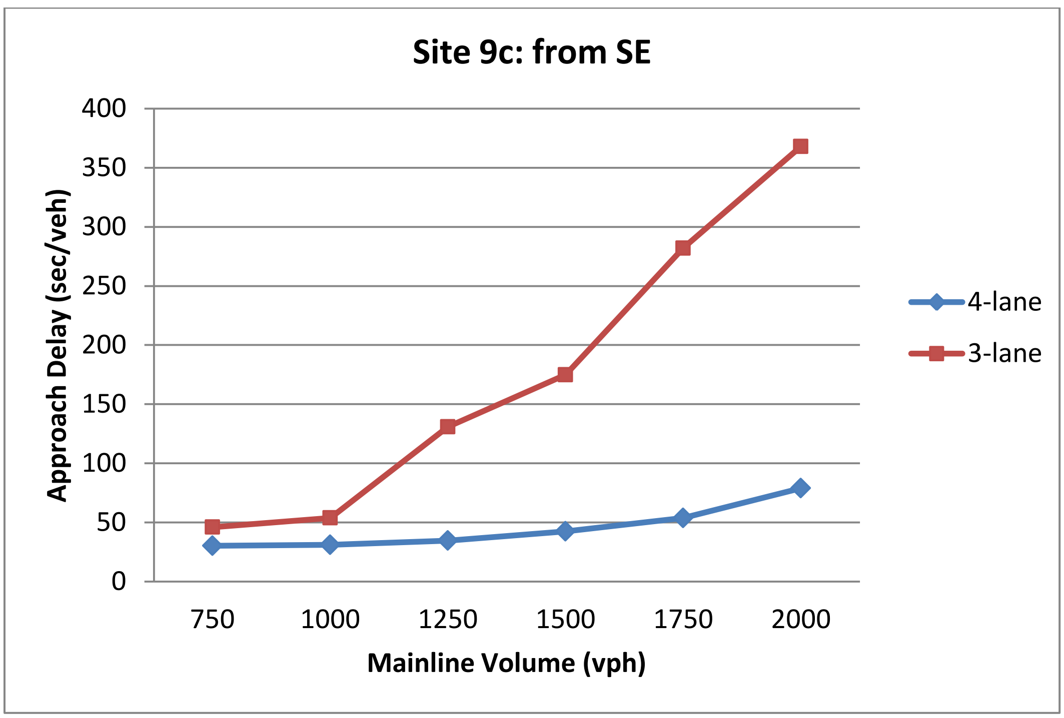

Site 9a: NB
180
160
140
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

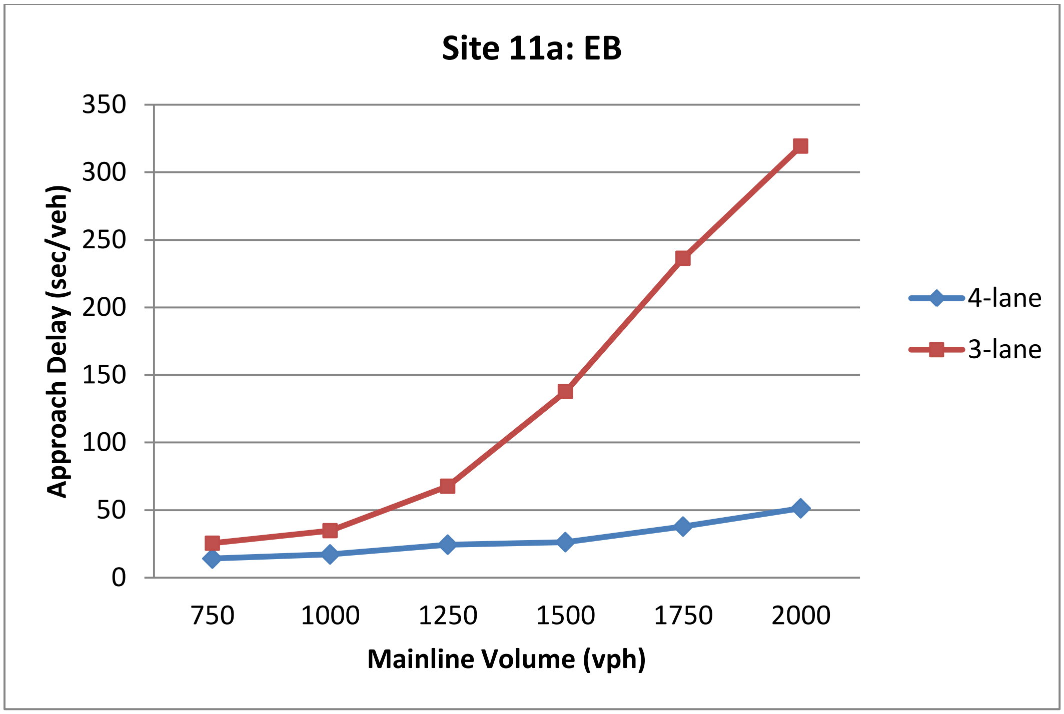

Site 9a: SB
160
140
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

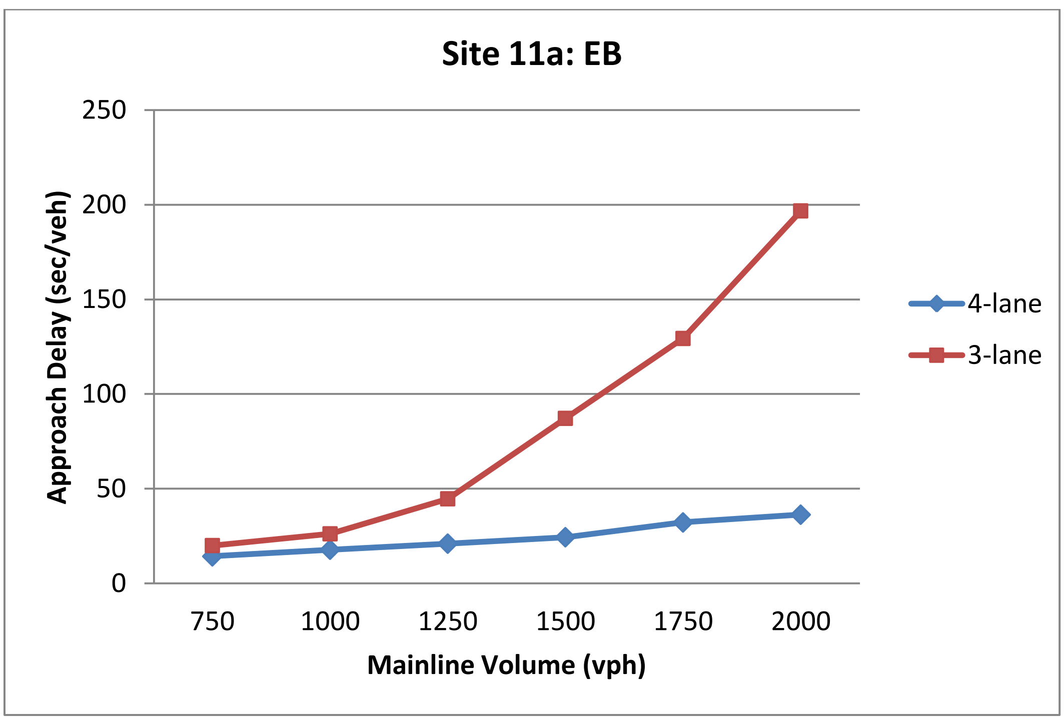

Site 9b: NB
300
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

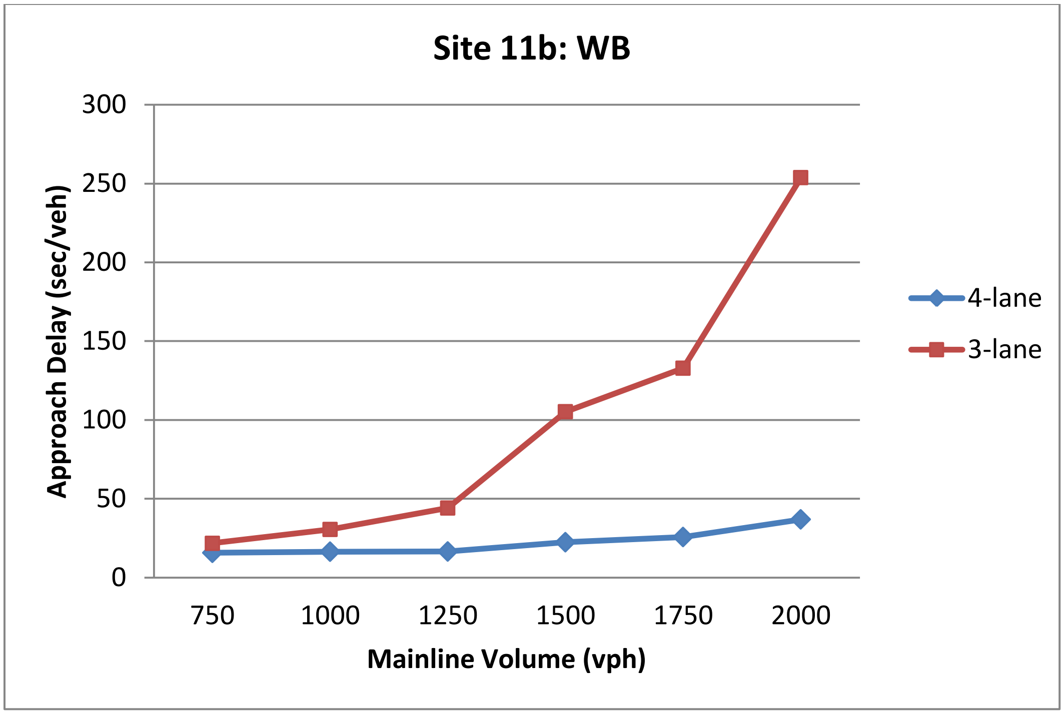

Site 9b: SB
300
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

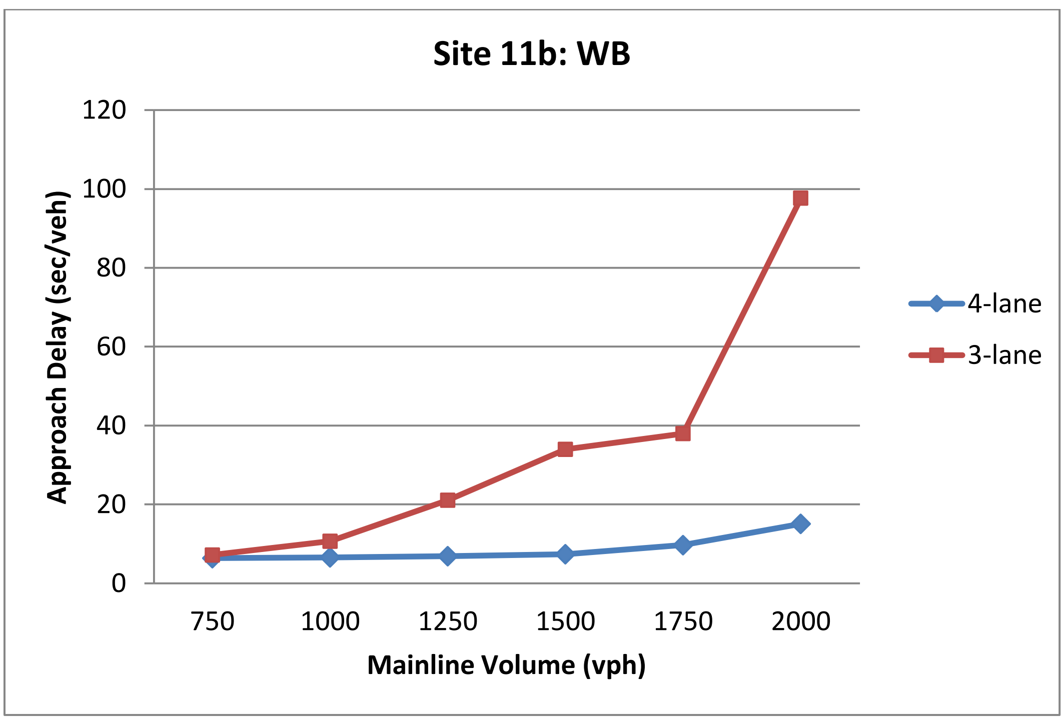

Site 9c: from NW
60
50
40
30
20
10
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

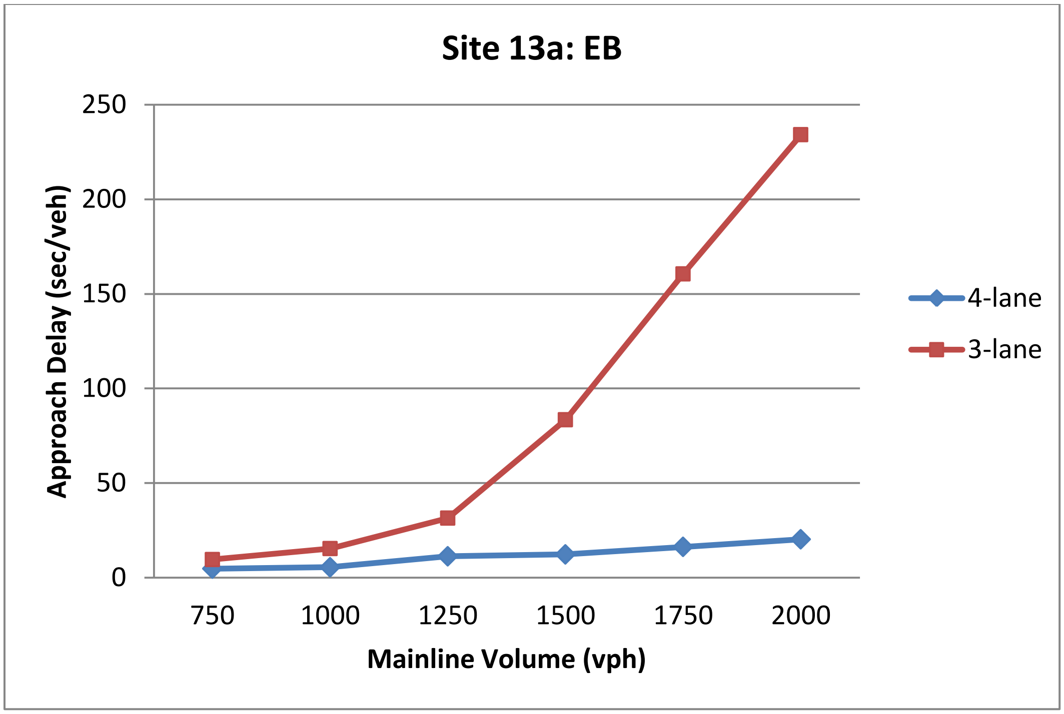

Site 9c: from SE
400
350
300
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane


Site 11a: EB
350
300
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

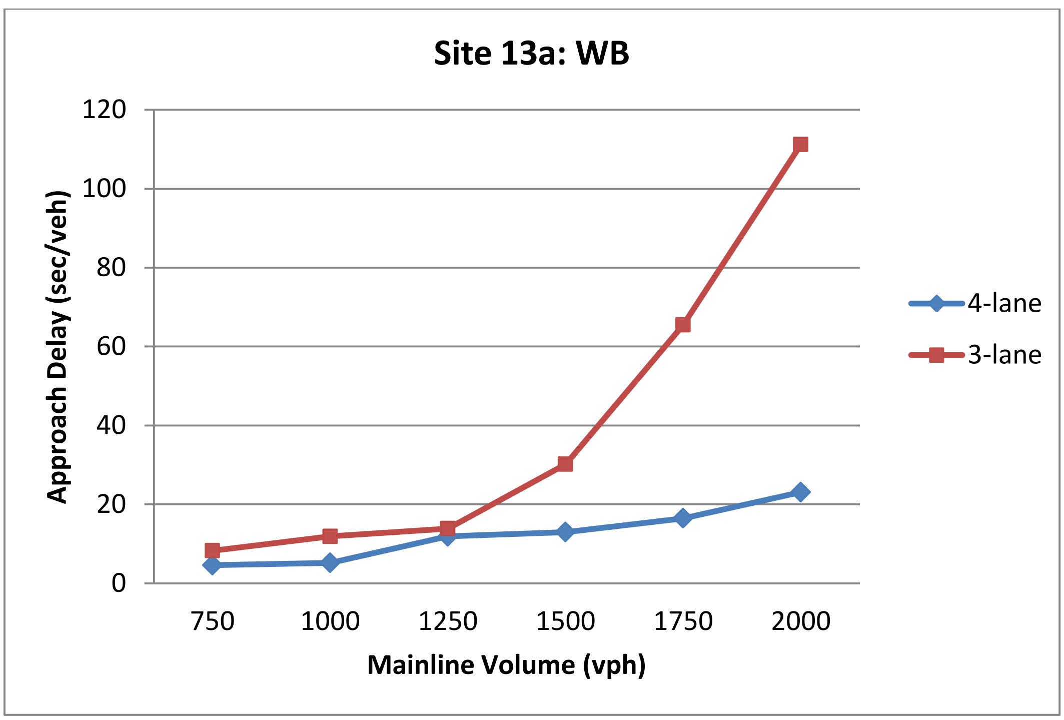

Site 11a: EB
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane


Site 11b: WB
Approach Delay (sec/veh)
300
250
200
150
100
50
0
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

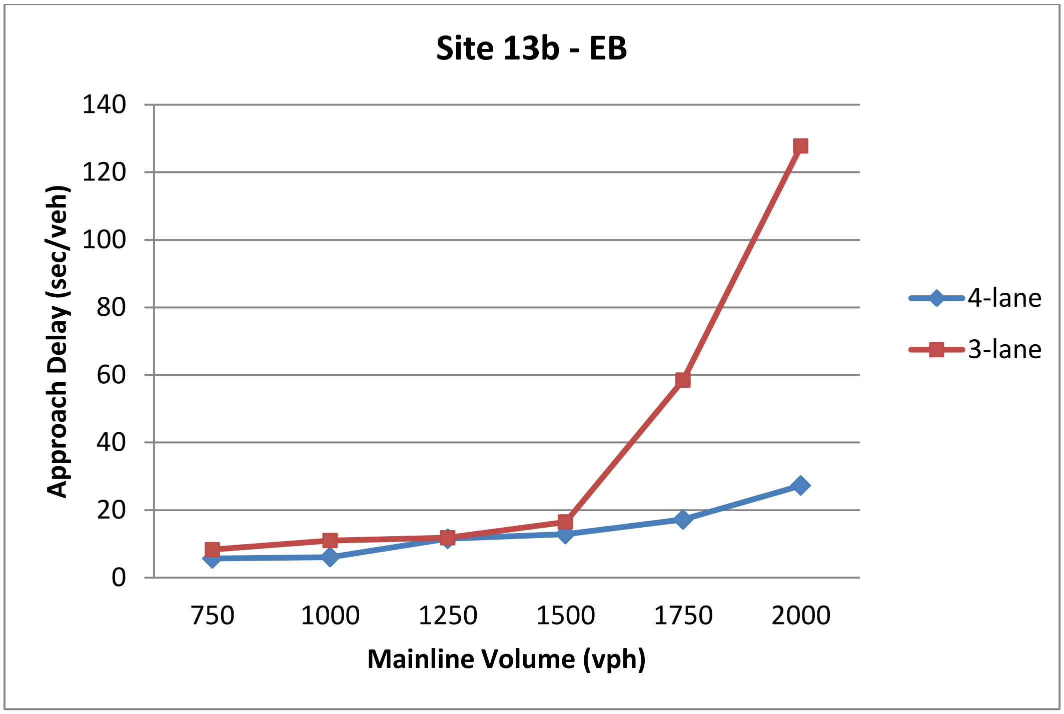

Site 11b: WB
Approach Delay (sec/veh)
120
100
80
60
40
20
0
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

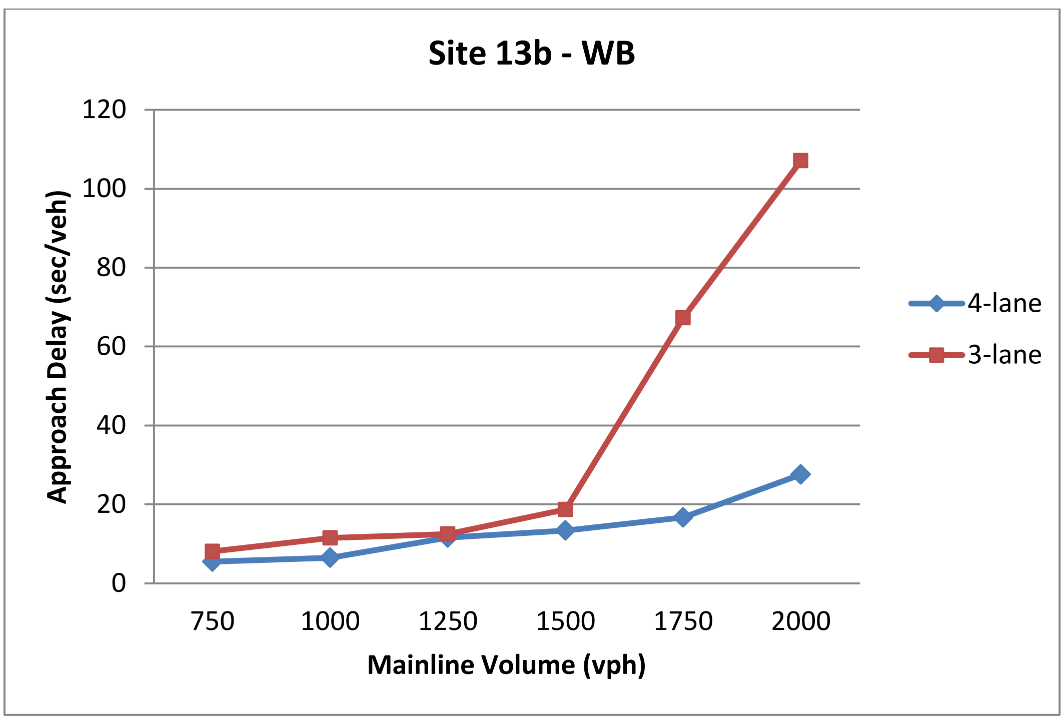


Site 13a: EB
250
200
150
100
50
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane



Site 13a: WB
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane


Site 13b - EB
140
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane


Site 13b - WB
120
100
80
60
40
20
0
Approach Delay (sec/veh)
750
1000
1250
1500
1750
2000
Mainline Volume (vph)
4-lane
3-lane

APPENDIX D

SAFETY ANALYSIS—DETAILED SITE-BY-SITE INFORMATION

Summary/synthesis for crash analysis (CMFs)

site	~ADT	length (miles)	~avg annual crash	# of drivwys	# of intersecs	type	CMF correction factors: based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	basic CMF corrected by city trend	CMF based on recoded crashes	recoded CMF corrected by city trend	CMF for affected crashes	affected CMF corrected by city trend	CMF for corrected crashes	corrected CMF corrected by city trend
1	13442	0.37	34	19	4	com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
2	13261	1.44	41	26	17	com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
3	10965	4.33	53	100	35	res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
4	11062	0.53	3	16	8	com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
8	14328	0.81	39	49	7	com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
9	17020	0.43	38	16	8	com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
11	14572	1.46	43	80	12	mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
13	9016	1.31	25	97	11	mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
16	12342	0.87	24	58	8	res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
18	7137	0.96	5	55	6	res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
20	12639	0.68	7	34	9	res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
22	7663	0.22	6	12	3	com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
23	14652	0.50	20	23	9	com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
25	6512	0.79	10	38	4	res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
26	10855	0.58	4	39	5	res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
29	10747	0.49	7	30	4	res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
30	7676	0.38	10	25	8	mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
33	7049	0.69	10	19	6	mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
34	7719	0.46	6	22	2	com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
36	4995	0.86	5	42	5	mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
37	14164	0.30	10	4	4	com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
39	n/a	0.39	19	14	5	res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
40	3510	0.50	6	31	7	com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
43	13660	0.62	46	27	11	mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
average	10652	1	20	37	8		0.824	0.721	0.821	1.088	0.630	0.91	0.67	0.95	0.62	0.90	0.31	0.59
std dev	3587.02	0.82	16.09	25.54	6.62		0.080	0.115	0.096	2.002	0.225	0.23	0.42	0.42	0.29	0.31	0.25	0.28
max	17020	4	53	100	35		0.978	0.936	1.073	10.429	1.400	1.69	2.00	2.29	1.43	1.74	1.00	1.37
min	3510	0	3	4	2		0.648	0.467	0.616	0.000	0.323	0.53	0.11	0.24	0.22	0.35	0.00	0.13
										n	24	24		21		21		21
										95% conf	0.090	0.092		0.182		0.134		0.122
										μ-95%	0.540	0.817		0.765		0.762		0.469
										μ+95%	0.720	1.001		1.128		1.030		0.712

Summary/synthesis for crash analysis (CMFs)--split by "high" and "low" crash frequencies

							CMF correction factors					corrected (		ded crashes		ted crashes		rashes w/c
site	~ADT	length (miles)	~avg annual crash			type	based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	basic CMF corrected by city trend	CMF based on recoded crashes	recoded CMF corrected by city trend	CMF for affected crashes	affected CMF corrected by city trend	CMF for corrected crashes	corrected CMF corrected by city trend
3	10965	4.33	53			res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
43	13660	0.62	46			mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
11	14572	1.46	43			mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
2	13261	1.44	41			com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
8	14328	0.81	39			com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
9	17020	0.43	38			com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
1	13442	0.37	34			com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
13	9016	1.31	25			mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
16	12342	0.87	24			res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
23	14652	0.50	20			com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
39	n/a	0.39	19			res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
					summary statistics for "high" crash	avg	0.85	0.73	0.85	0.71	0.65	0.92	0.61	0.91	0.63	0.92	0.24	0.54
						std dev	0.08	0.11	0.09	0.15	0.16	0.12	0.17	0.19	0.22	0.22	0.08	0.11
						max	0.98	0.94	1.07	0.93	0.89	1.11	0.81	1.13	0.92	1.23	0.36	0.74
						min	0.72	0.56	0.72	0.47	0.46	0.65	0.31	0.47	0.30	0.46	0.13	0.36
33	7049	0.69	10			mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
25	6512	0.79	10			res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
30	7676	0.38	10			mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
37	14164	0.30	10			com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
29	10747	0.49	7			res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
20	12639	0.68	7			res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
22	7663	0.22	6			com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
34	7719	0.46	6			com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
40	3510	0.50	6			com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
36	4995	0.86	5			mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
18	7137	0.96	5			res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
26	10855	0.58	4			res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
4	11062	0.53	3			com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
					summary statistics for "low" crash	avg	0.81	0.71	0.79	1.41	0.61	0.90	0.71	0.98	0.61	0.88	0.36	0.63
						std dev	0.08	0.12	0.09	2.72	0.27	0.30	0.54	0.55	0.34	0.38	0.31	0.37
						max	0.95	0.88	0.97	10.43	1.40	1.69	2.00	2.29	1.43	1.74	1.00	1.37
						min	0.65	0.47	0.62	0.00	0.32	0.53	0.11	0.24	0.22	0.35	0.00	0.13

Summary/synthesis for crash analysis (CMFs)--split by res, com, and mix

							CMF correction factors					corrected (		ded crashes		ted crashes		rashes w/c
site	~ADT	length (miles)	~avg annual crash			type	based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	basic CMF corrected by city trend	CMF based on recoded crashes	recoded CMF corrected by city trend	CMF for affected crashes	affected CMF corrected by city trend	CMF for corrected crashes	corrected CMF corrected by city trend
3	10965	4.33	53			res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
16	12342	0.87	24			res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
18	7137	0.96	5			res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
20	12639	0.68	7			res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
25	6512	0.79	10			res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
26	10855	0.58	4			res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
29	10747	0.49	7			res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
39	n/a	0.39	19			res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
					summary	avg	0.83	0.76	0.85	2.01	0.55	0.78	0.54	0.77	0.67	0.91	0.27	0.51
					statistics	std dev	0.06	0.07	0.08	3.40	0.15	0.18	0.24	0.30	0.42	0.48	0.26	0.30
					for "res"	max	0.95	0.87	0.97	10.43	0.80	1.00	0.81	1.13	1.43	1.74	0.80	1.09
					sites	min	0.76	0.69	0.71	0.68	0.32	0.53	0.11	0.24	0.22	0.35	0.00	0.13
11	14572	1.46	43			mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
13	9016	1.31	25			mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
30	7676	0.38	10			mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
33	7049	0.69	10			mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
36	4995	0.86	5			mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
43	13660	0.62	46			mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
					summary	avg	0.82	0.74	0.80	0.59	0.68	0.94	0.76	1.06	0.60	0.90	0.22	0.52
					statistics	std dev	0.08	0.14	0.09	0.32	0.15	0.07	0.43	0.40	0.14	0.16	0.09	0.17
					for "mix"	max	0.97	0.94	0.91	0.90	0.89	1.00	1.50	1.74	0.75	1.13	0.33	0.80
					sites	min	0.75	0.53	0.69	0.00	0.51	0.80	0.43	0.70	0.42	0.69	0.13	0.36
1	13442	0.37	34			com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
2	13261	1.44	41			com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
4	11062	0.53	3			com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
8	14328	0.81	39			com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
9	17020	0.43	38			com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
22	7663	0.22	6			com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
23	14652	0.50	20			com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
34	7719	0.46	6			com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
37	14164	0.30	10			com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
40	3510	0.50	6			com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
					summary	avg	0.83	0.67	0.81	0.65	0.67	0.99	0.74	1.05	0.56	0.88	0.40	0.72
					statistics	std dev	0.10	0.12	0.11	0.22	0.30	0.29	0.55	0.53	0.21	0.20	0.29	0.31
					for "com"	max	0.98	0.88	1.07	0.93	1.40	1.69	2.00	2.29	0.86	1.12	1.00	1.37
					sites	min	0.65	0.47	0.62	0.29	0.36	0.61	0.18	0.55	0.22	0.59	0.13	0.46

Summary/synthesis for crash analysis (CMFs)--split by number of driveways (<32 and >32 driveways)

							CMF correction factors					corrected (		ded crashes		ted crashes		crashes w/c
site	*ADT	length (miles)	*avg annual crash	# of drivwys	# of intersecs	type	based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	basic CMF corrected by city trend	CMF based on recoded crashes	recoded CMF corrected by city trend	CMF for affected crashes	affected CMF corrected by city trend	CMF for corrected crashes	corrected CMF corrected by city trend
37	14164	0.30	10	4	4	com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
22	7663	0.22	6	12	3	com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
39	n/a	0.39	19	14	5	res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
4	11062	0.53	3	16	8	com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
9	17020	0.43	38	16	8	com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
1	13442	0.37	34	19	4	com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
33	7049	0.69	10	19	6	mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
34	7719	0.46	6	22	2	com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
23	14652	0.50	20	23	9	com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
30	7676	0.38	10	25	8	mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
2	13261	1.44	41	26	17	com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
43	13660	0.62	46	27	11	mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
29	10747	0.49	7	30	4	res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
40	3510	0.50	6	31	7	com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
					summary	avg	0.83	0.70	0.83	0.70	0.63	0.93	0.76	1.07	0.56	0.87	0.35	0.66
					statistics	std dev	0.09	0.13	0.10	0.20	0.28	0.27	0.53	0.51	0.22	0.24	0.27	0.30
					for	max	0.98	0.94	1.07	0.93	1.40	1.69	2.00	2.29	0.92	1.23	1.00	1.37
					*dways<3	min	0.65	0.47	0.62	0.29	0.32	0.53	0.18	0.55	0.22	0.44	0.00	0.21
20	12639	0.68	7	34	9	res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
25	6512	0.79	10	38	4	res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
26	10855	0.58	4	39	5	res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
36	4995	0.86	5	42	5	mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
8	14328	0.81	39	49	7	com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
18	7137	0.96	5	55	6	res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
16	12342	0.87	24	58	8	res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
11	14572	1.46	43	80	12	mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
13	9016	1.31	25	97	11	mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
3	10965	4.33	53	100	35	res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
					summary	avg	0.820	0.753	0.805	1.636	0.629	0.876	0.559	0.806	0.672	0.919	0.263	0.510
					statistics	std dev	0.058	0.080	0.088	3.101	0.129	0.163	0.217	0.263	0.351	0.391	0.217	0.254
					for	max	0.948	0.870	0.967	10.429	0.800	1.108	0.788	1.104	1.429	1.739	0.800	1.085
					*dways>3	min	0.752	0.636	0.691	0.000	0.438	0.568	0.111	0.242	0.222	0.353	0.000	0.130

Summary/synthesis for crash analysis (CMFs)--split by number of intersections

							CMF correction factors					corrected (		ded crashes		ted crashes		crashes w/c
site	~ADT	length (miles)	~avg annual crash	# of drivwys	# of intersecs	type	based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	basic CMF corrected by city trend	CMF based on recoded crashes	recoded CMF corrected by city trend	CMF for affected crashes	affected CMF corrected by city trend	CMF for corrected crashes	corrected CMF corrected by city trend
34	7719	0.46	6	22	2	com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
22	7663	0.22	6	12	3	com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
1	13442	0.37	34	19	4	com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
25	6512	0.79	10	38	4	res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
29	10747	0.49	7	30	4	res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
37	14164	0.30	10	4	4	com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
26	10855	0.58	4	39	5	res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
36	4995	0.86	5	42	5	mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
39	n/a	0.39	19	14	5	res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
18	7137	0.96	5	55	6	res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
33	7049	0.69	10	19	6	mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
8	14328	0.81	39	49	7	com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
40	3510	0.50	6	31	7	com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
4	11062	0.53	3	16	8	com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
9	17020	0.43	38	16	8	com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
16	12342	0.87	24	58	8	res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
30	7676	0.38	10	25	8	mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
					summary statistics for ~intersect	avg	0.815	0.714	0.821	1.249	0.613	0.898	0.679	0.952	0.561	0.835	0.332	0.606
						std dev	0.072	0.113	0.107	2.379	0.255	0.274	0.492	0.507	0.242	0.288	0.282	0.332
						max	0.948	0.877	1.073	10.429	1.400	1.691	2.000	2.291	0.917	1.229	1.000	1.365
						min	0.648	0.467	0.616	0.000	0.323	0.529	0.111	0.242	0.222	0.353	0.000	0.130
20	12639	0.68	7	34	9	res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
23	14652	0.50	20	23	9	com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
13	9016	1.31	25	97	11	mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
43	13660	0.62	46	27	11	mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
11	14572	1.46	43	80	12	mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
2	13261	1.44	41	26	17	com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
3	10965	4.33	53	100	35	res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
					summary statistics for ~intersect	avg	0.847	0.737	0.821	0.696	0.672	0.935	0.636	0.932	0.752	1.048	0.257	0.553
						std dev	0.100	0.126	0.071	0.160	0.135	0.024	0.109	0.052	0.372	0.352	0.113	0.116
						max	0.978	0.936	0.913	0.929	0.890	0.977	0.750	1.003	1.429	1.739	0.400	0.710
						min	0.722	0.563	0.721	0.474	0.470	0.908	0.468	0.878	0.390	0.827	0.125	0.356

Summary/synthesis for crash analysis (CMFs)--split by type of treatment

site	~ADT	length (miles)	~avg annual crash	# of drivwys	# of intersecs	type	CMF correction factors: based on county trend	based on city trend	based on trunkline county trend	based on trunkline city trend	basic CMF	corrected (: basic CMF corrected by city trend	CMF based on recoded crashes	ded crashes: recoded CMF corrected by city trend	CMF for affected crashes	ted crashes: affected CMF corrected by city trend	CMF for corrected crashes	rashes w/c: corrected CMF corrected by city trend
1	13442	0.37	34	19	4	com	0.91	0.78	1.07	0.84	0.84	1.06	n/a	n/a	n/a	n/a	n/a	n/a
8	14328	0.81	39	49	7	com	0.81	0.68	0.79	0.66	0.79	1.11	0.79	1.10	0.81	1.12	0.21	0.53
40	3510	0.50	6	31	7	com	0.65	0.71	0.62	0.68	1.40	1.69	2.00	2.29	0.60	0.89	0.67	0.96
2	13261	1.44	41	26	17	com	0.98	0.56	0.88	0.47	0.47	0.91	0.47	0.91	0.39	0.83	0.13	0.56
3	10965	4.33	53	100	35	res	0.87	0.73	0.87	0.68	0.66	0.93	0.62	0.90	0.59	0.86	0.30	0.57
4	11062	0.53	3	16	8	com	0.78	0.63	0.83	0.72	0.36	0.72	0.18	0.55	0.22	0.59	1.00	1.37
9	17020	0.43	38	16	8	com	0.81	0.60	0.78	0.54	0.46	0.86	0.45	0.86	0.52	0.92	0.33	0.74
11	14572	1.46	43	80	12	mix	0.75	0.85	0.72	0.71	0.78	0.93	0.73	0.88	0.75	0.90	0.21	0.36
13	9016	1.31	25	97	11	mix	0.84	0.64	0.83	0.51	0.61	0.98	0.56	0.92	0.50	0.86	0.15	0.51
16	12342	0.87	24	58	8	res	0.84	0.84	0.83	0.90	0.49	0.65	0.31	0.47	0.30	0.46	0.27	0.43
18	7137	0.96	5	55	6	res	0.76	0.80	0.71	10.43	0.80	1.00	0.77	0.97	0.83	1.04	0.17	0.37
20	12639	0.68	7	34	9	res	0.80	0.69	0.75	0.79	0.60	0.91	0.69	1.00	1.43	1.74	0.40	0.71
22	7663	0.22	6	12	3	com	0.93	0.47	0.77	0.41	0.52	1.05	n/a	n/a	n/a	n/a	n/a	n/a
23	14652	0.50	20	23	9	com	0.72	0.76	0.78	0.93	0.69	0.93	0.75	0.99	0.86	1.10	0.36	0.60
25	6512	0.79	10	38	4	res	0.81	0.71	0.89	0.72	0.59	0.88	0.58	0.87	0.88	1.16	0.80	1.09
29	10747	0.49	7	30	4	res	0.78	0.79	0.86	0.83	0.32	0.53	0.40	0.61	0.24	0.44	0.00	0.21
36	4995	0.86	5	42	5	mix	0.76	0.72	0.69	0.00	0.52	0.80	0.43	0.70	0.42	0.69	0.13	0.40
37	14164	0.30	10	4	4	com	0.87	0.88	0.81	0.91	0.49	0.61	0.68	0.80	0.50	0.62	0.33	0.46
26	10855	0.58	4	39	5	res	0.95	0.87	0.97	0.96	0.44	0.57	0.11	0.24	0.22	0.35	0.00	0.13
33	7049	0.69	10	19	6	mix	0.81	0.53	0.87	0.67	0.51	0.98	0.59	1.06	0.67	1.13	0.33	0.80
39	n/a	0.39	19	14	5	res	0.81	0.69	0.91	0.77	0.48	0.79	0.81	1.13	0.92	1.23	0.24	0.55
43	13660	0.62	46	27	11	mix	0.97	0.94	0.91	0.78	0.89	0.95	n/a	n/a	n/a	n/a	n/a	n/a
30	7676	0.38	10	25	8	mix	0.76	0.76	0.80	0.90	0.76	1.00	1.50	1.74	0.69	0.93	0.30	0.54
34	7719	0.46	6	22	2	com	0.79	0.67	0.76	0.29	0.64	0.97	0.56	0.89	0.62	0.95	0.20	0.53
average	10652	1	20	37	8		0.824	0.721	0.821	1.088	0.630	0.91	0.67	0.95	0.62	0.90	0.31	0.59
std dev	3587.02	0.82	16.09	25.54	6.62		0.080	0.115	0.096	2.002	0.225	0.23	0.42	0.42	0.29	0.31	0.25	0.28
max	17020	4	53	100	35		0.978	0.936	1.073	10.429	1.400	1.69	2.00	2.29	1.43	1.74	1.00	1.37
min	3510	0	3	4	2		0.648	0.467	0.616	0.000	0.323	0.53	0.11	0.24	0.22	0.35	0.00	0.13

Site Characteristics

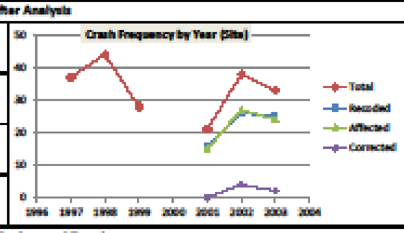
Site No.	1	Length (mi)	0.37
County	Alpena	Land Use	Commercial
City	Alpena	No. of Driveways/Intersections	19/4
Route/Road Name	US-23	Treatment Type	Reconstruction within existing curbs/new signal timings
PR/CS No.	1024202/4032		
BMP	0.971	Nearest Cross Street	11th Ave.
EMP	1.338	Nearest Cross Street	14th Ave.

Descriptive Statistics

	Before Period			After Period		
Year	1997	1998	1999	2001	2002	2003
ADT	14008	12347	12644	14327	13669	13655
Crash Frequency (Total)	37	44	28	21	38	33
Crash Rate	19.72	26.60	16.53	10.94	20.75	18.04
Crash Frequency (Recoded)				16	26	25
Crash Frequency (Intersection-related)				4	2	5
Crash Frequency (Driveway-related)		no data prior to 2001		0	4	1
Crash Frequency (Affected by Road Diet)				15	27	24
Crash Frequency (Corrected by Road Diet)				0	4	2
Crash Frequency (Background, Countywide)	895	851	889	730	856	799
Crash Frequency (Background, Citywide)	442	379	448	308	356	330
Crash Frequency (Background, Trunklines-Countywide)	116	111	131	115	137	132
Crash Frequency (Background, Trunklines-Citywide)	43	34	56	37	43	32

Crash Analysis Method: Simple (Naive) Before/After Analysis

Average Crashes per Year (Before)	36.33
Average Crashes per Year (After)	30.67
Percentage Change	-15.60%
Average Crashes per Year (Recoded, Before)	n/a
Average Crashes per Year (Recoded, After)	22.33
Percentage Change	n/a
Average Crashes per Year (Affected, Before)	n/a
Average Crashes per Year (Affected, After)	22.00
Percentage Change	n/a
Average Crashes per Year (Corrected, Before)	n/a
Average Crashes per Year (Corrected, After)	2.00
Percentage Change	n/a

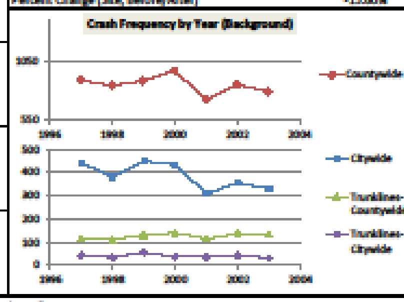


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	2635
Average Crashes per Year (Countywide, After)	2385
Percentage Change Overall Countywide	-9.49%
Projected Average Crashes per Year using Countywide Background (Site, After)	32.89
Percent Change for Site Adjusted for Countywide Background	-6.13%
Average Crashes per Year (Citywide, Before)	1269
Average Crashes per Year (Citywide, After)	994
Percentage Change Overall Citywide	-21.67%
Projected Average Crashes per Year using Citywide Background (Site, After)	28.46
Percent Change for Site Adjusted for Citywide Background	6.07%
Average Crashes per Year (Trunklines-Countywide, Before)	358
Average Crashes per Year (Trunklines-Countywide, After)	384
Percentage Change Overall Trunkline-Countywide	7.26%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	38.97
Percent Change for Site Adjusted for Trunklines-Countywide Background	-22.86%
Average Crashes per Year (Trunklines-Citywide, Before)	133
Average Crashes per Year (Trunklines-Citywide, After)	112
Percentage Change Overall Trunkline-Citywide	-15.79%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	30.60
Percent Change for Site Adjusted for Trunklines-Citywide Background	0.19%

Average Crashes per Year (Site, Before)	36.33
Average Crashes per Year (Site, After)	30.67
Percent Change (Site, Before/After)	-15.60%



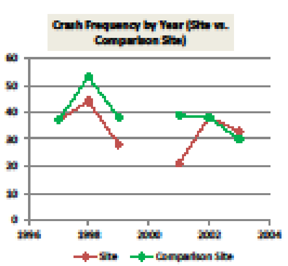
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Oakland, Royal Oak	Route/Road Name	11 Mile Rd.
PR/CS No.	4400088		
BMP	7.740	Nearest Cross Street	Knowles St.
EMP	8.550	Nearest Cross Street	Campbell Rd.

Descriptive Statistics	Before Period			After Period		
Year	1997	1998	1999	2001	2002	2003
Crash Frequency (Total)	37	53	38	39	38	30

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	1.15	
Sample Odds Ratio (year 2-3)	1.07	
Mean of Sample Odds Ratios	1.11	
Standard Error of the Sample Odds Ratios	0.06	
95% Confidence Interval of the Sample Odds Ratio (LL, UL)	1.00	1.22
N-observed,T,B (total observed no. of crashes in before period for treatment group)	109.00	
N-observed,T,A (total observed no. of crashes in after period for treatment group)	92.00	
N-observed,C,B (total observed no. of crashes in before period for comparison group)	128.00	
N-observed,C,A (total observed no. of crashes in after period for comparison group)	107.00	
N-expected,T,A (expected no. of crashes that would have occurred in after period w/out treatment)	91.12	
Variance of N-expected,T,A	218.62	
Crash Modification Factor (CMF)	0.98	
Variance of CMF	0.03	
Standard Error of CMF	0.18	
95% Confidence Interval of the CMF (LL, UL)	0.62	1.35



Site Characteristics

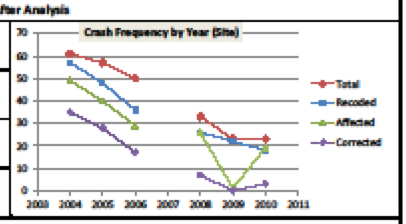
Site No.	2	Length (mi)	1.44
County	Berrien	Land Use	Commercial
City	Berrien Springs	No. of Driveways/Intersections	26/17
Route/Road Name	M-139	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	3111292/11052		
BMP	0.580	Nearest Cross Street	Madison St.
EMP	2.019	Nearest Cross Street	Sunset Dr.

Descriptive Statistics

	Before Period			After Period		
Year	2004	2005	2006	2008	2009	2010
ADT	13867	13784	14489	12705	12793	11926
Crash Frequency (Total)	61	57	50	33	23	23
Crash Rate	8.38	7.87	6.57	4.95	3.42	3.67
Crash Frequency (Recoded)	57	48	36	26	22	18
Crash Frequency (Intersection-related)	22	9	8	6	0	3
Crash Frequency (Driveway-related)	14	13	4	4	0	2
Crash Frequency (Affected by Road Diet)	49	40	29	26	1	19
Crash Frequency (Corrected by Road Diet)	35	28	17	7	0	3
Crash Frequency (Background, Countywide)	4702	4202	3541	4776	3927	3474
Crash Frequency (Background, Citywide)	83	52	57	34	33	41
Crash Frequency (Background, Trunklines-Countywide)	1219	1128	987	1145	915	859
Crash Frequency (Background, Trunklines-Citywide)	56	39	40	20	18	26

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	56.00
Average Crashes per Year (After)	26.33
Percentage Change	-52.98%
Average Crashes per Year (Recoded, Before)	47.00
Average Crashes per Year (Recoded, After)	22.00
Percentage Change	-53.19%
Average Crashes per Year (Affected, Before)	39.33
Average Crashes per Year (Affected, After)	15.33
Percentage Change	-61.02%
Average Crashes per Year (Corrected, Before)	26.67
Average Crashes per Year (Corrected, After)	3.33
Percentage Change	-87.50%

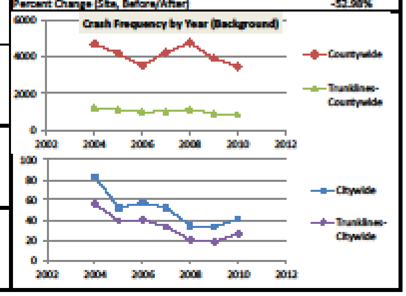


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	12445
Average Crashes per Year (Countywide, After)	12177
Percentage Change Overall Countywide	-2.15%
Projected Average Crashes per Year using Countywide Background (Site, After)	54.79
Percent Change for Site Adjusted for Countywide Background	-50.82%
Average Crashes per Year (Citywide, Before)	192
Average Crashes per Year (Citywide, After)	108
Percentage Change Overall Citywide	-43.75%
Projected Average Crashes per Year using Citywide Background (Site, After)	31.50
Percent Change for Site Adjusted for Citywide Background	-9.23%
Average Crashes per Year (Trunklines-Countywide, Before)	3334
Average Crashes per Year (Trunklines-Countywide, After)	2919
Percentage Change Overall Trunkline-Countywide	-12.45%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	49.03
Percent Change for Site Adjusted for Trunklines-Countywide Background	-40.53%
Average Crashes per Year (Trunklines-Citywide, Before)	135
Average Crashes per Year (Trunklines-Citywide, After)	64
Percentage Change Overall Trunkline-Citywide	-52.59%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	26.55
Percent Change for Site Adjusted for Trunklines-Citywide Background	-0.38%

Average Crashes per Year (Site, Before)	56.00
Average Crashes per Year (Site, After)	26.33
Percent Change (Site, Before/After)	-52.98%



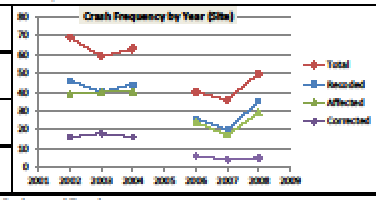
Site Characteristics			
Site No.	3	Length (mi)	4.33
County	Berrien	Land Use	Residential
City	St. Joseph	No. of Driveways/Intersections	100/35
Route/Road Name	I-94BL	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1360705/11012		
BMP	1.150	Nearest Cross Street	Edgewood Path
EMP	5.484	Nearest Cross Street	Hatch St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	12062	12961	12091	9794	9765	9118
Crash Frequency (Total)	69	59	63	40	36	50
Crash Rate	3.62	2.88	3.29	2.58	2.33	3.47
Crash Frequency (Recoded)	46	40	44	26	20	35
Crash Frequency (Intersection-related)	15	17	13	6	6	3
Crash Frequency (Driveway-related)	4	5	9	5	2	4
Crash Frequency (Affected by Road Diet)	39	40	40	24	17	29
Crash Frequency (Corrected by Road Diet)	16	18	16	6	4	5
Crash Frequency (Background, Countywide)	5069	4715	4702	3541	4220	4776
Crash Frequency (Background, Citywide)	348	327	287	237	229	232
Crash Frequency (Background, Trunklines-Countywide)	1315	1123	1219	987	1041	1145
Crash Frequency (Background, Trunklines-Citywide)	207	172	148	130	108	122

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	63.67
Average Crashes per Year (After)	42.00
Percentage Change	-34.03%
Average Crashes per Year (Recoded, Before)	43.33
Average Crashes per Year (Recoded, After)	27.00
Percentage Change	-37.69%
Average Crashes per Year (Affected, Before)	39.67
Average Crashes per Year (Affected, After)	23.33
Percentage Change	-41.18%
Average Crashes per Year (Corrected, Before)	16.67
Average Crashes per Year (Corrected, After)	5.00
Percentage Change	-70.00%

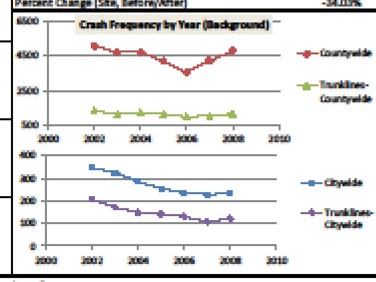


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	14486
Average Crashes per Year (Countywide, After)	12537
Percentage Change Overall Countywide	-13.45%
Projected Average Crashes per Year using Countywide Background (Site, After)	55.10
Percent Change for Site Adjusted for Countywide Background	-20.58%
Average Crashes per Year (Citywide, Before)	962
Average Crashes per Year (Citywide, After)	698
Percentage Change Overall Citywide	-27.44%
Projected Average Crashes per Year using Citywide Background (Site, After)	46.19
Percent Change for Site Adjusted for Citywide Background	-6.59%
Average Crashes per Year (Trunklines-Countywide, Before)	3657
Average Crashes per Year (Trunklines-Countywide, After)	3173
Percentage Change Overall Trunkline-Countywide	-13.23%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	55.24
Percent Change for Site Adjusted for Trunklines-Countywide Background	-20.80%
Average Crashes per Year (Trunklines-Citywide, Before)	527
Average Crashes per Year (Trunklines-Citywide, After)	360
Percentage Change Overall Trunkline-Citywide	-31.69%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	43.49
Percent Change for Site Adjusted for Trunklines-Citywide Background	-2.34%

Average Crashes per Year (Site, Before)	63.67
Average Crashes per Year (Site, After)	42.00
Percent Change (Site, Before/After)	-34.03%



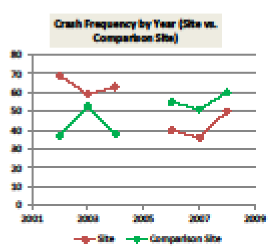
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Ottawa, Holland	Route/Road Name	Ottawa Beach Rd./Douglas Ave.
PR/CS No.	732105		
BMP	2.265	Nearest Cross Street	160th Ave.
EMP	5.688	Nearest Cross Street	River Ave.

Descriptive Statistics	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
Crash Frequency (Total)	67	75	69	55	51	60

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	1.27	
Sample Odds Ratio (year 2-3)	0.84	
Mean of Sample Odds Ratios	1.05	
Standard Error of the Sample Odds Ratios	0.31	
95% Confidence Interval of the Sample Odds Ratio [LL, UL]	0.45	1.65
N-observed,T,B [total observed no. of crashes in before period for treatment group]	191.00	
N-observed,T,A [total observed no. of crashes in after period for treatment group]	126.00	
N-observed,C,B [total observed no. of crashes in before period for comparison group]	211.00	
N-observed,C,A [total observed no. of crashes in after period for comparison group]	166.00	
N-expected,T,A [expected no. of crashes that would have occurred in after period w/out treatment]	150.27	
Variance of N-expected,T,A	361.25	
Crash Modification Factor (CMF)	0.83	
Variance of CMF	0.02	
Standard Error of CMF	0.13	
95% Confidence Interval of the CMF [LL, UL]	0.58	1.07



Site Characteristics

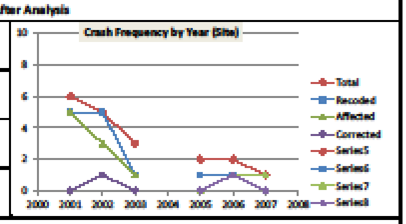
Site No.	4	Length (mi)	0.53
County	Clare	Land Use	Commercial
City	Clare	No. of Driveways/Intersections	16/8
Route/Road Name	M-115	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1041702/18022		
BMP	16.443	Nearest Cross Street	Maple Rd./ Pioneer Pkwy.
EMP	16.969	Nearest Cross Street	Ann Arbor Trail/ 4th St.

Descriptive Statistics

	Before Period			After Period		
Year	2001	2002	2003	2005	2006	2007
ADT	8549	11954	11942	12863	12515	8550
Crash Frequency (Total)	6	5	3	2	2	1
Crash Rate	3.66	2.18	1.31	0.81	0.83	0.61
Crash Frequency (Recoded)	5	5	1	1	1	0
Crash Frequency (Intersection-related)	0	0	0	0	0	0
Crash Frequency (Driveway-related)	1	3	0	0	0	0
Crash Frequency (Affected by Road Diet)	5	3	1	0	1	1
Crash Frequency (Corrected by Road Diet)	0	1	0	0	1	0
Crash Frequency (Background, Countywide)	909	1017	996	847	729	712
Crash Frequency (Background, Citywide)	109	105	101	82	60	58
Crash Frequency (Background, Trunklines-Countywide)	239	266	267	216	219	204
Crash Frequency (Background, Trunklines-Citywide)	65	71	73	58	45	47

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	4.67
Average Crashes per Year (After)	1.67
Percentage Change	-64.29%
Average Crashes per Year (Recoded, Before)	3.67
Average Crashes per Year (Recoded, After)	0.67
Percentage Change	-81.82%
Average Crashes per Year (Affected, Before)	3.00
Average Crashes per Year (Affected, After)	0.67
Percentage Change	-77.78%
Average Crashes per Year (Corrected, Before)	0.33
Average Crashes per Year (Corrected, After)	0.33
Percentage Change	0.00%

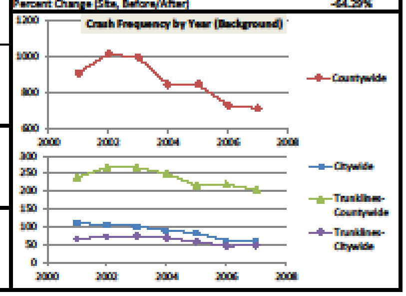


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	2922
Average Crashes per Year (Countywide, After)	2288
Percentage Change Overall Countywide	-21.70%
Projected Average Crashes per Year using Countywide Background (Site, After)	3.65
Percent Change for Site Adjusted for Countywide Background	-42.59%
Average Crashes per Year (Citywide, Before)	315
Average Crashes per Year (Citywide, After)	200
Percentage Change Overall Citywide	-36.51%
Projected Average Crashes per Year using Citywide Background (Site, After)	2.96
Percent Change for Site Adjusted for Citywide Background	-27.78%
Average Crashes per Year (Trunklines-Countywide, Before)	772
Average Crashes per Year (Trunklines-Countywide, After)	639
Percentage Change Overall Trunkline-Countywide	-17.23%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	3.86
Percent Change for Site Adjusted for Trunklines-Countywide Background	-47.06%
Average Crashes per Year (Trunklines-Citywide, Before)	209
Average Crashes per Year (Trunklines-Citywide, After)	150
Percentage Change Overall Trunkline-Citywide	-28.23%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	3.35
Percent Change for Site Adjusted for Trunklines-Citywide Background	-36.06%

Average Crashes per Year (Site, Before)	4.67
Average Crashes per Year (Site, After)	1.67
Percent Change (Site, Before/After)	-64.29%



Site Characteristics

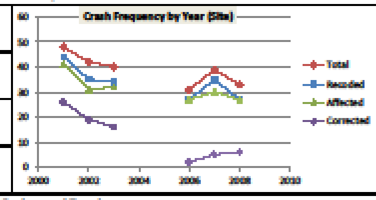
Site No.	8	Length (mi)	0.81
County	Eaton	Land Use	Commercial
City	Charlotte	No. of Driveways/Intersections	49/7
Route/Road Name	I-69BL	Treatment Type	Reconstruction within existing curbs
PR/CS No.	566006/23012		New signals - New configuration
BMP	0.170	Nearest Cross Street	Pleasant St.
EMP	0.980	Nearest Cross Street	Butternut Dr.

Descriptive Statistics

	Before Period			After Period		
Year	2001	2002	2003	2006	2007	2008
ADT	15135	14763	15933	13176	13044	13914
Crash Frequency (Total)	48	42	40	31	39	33
Crash Rate	10.73	9.62	8.49	7.96	10.11	8.02
Crash Frequency (Recoded)	44	35	34	27	35	27
Crash Frequency (Intersection-related)	4	5	6	3	4	3
Crash Frequency (Driveway-related)	21	11	8	2	4	5
Crash Frequency (Affected by Road Diet)	41	31	32	27	30	27
Crash Frequency (Corrected by Road Diet)	26	19	16	2	5	6
Crash Frequency (Background, Countywide)	3042	3268	2905	2332	2647	2506
Crash Frequency (Background, Citywide)	339	366	333	229	228	253
Crash Frequency (Background, Trunklines-Countywide)	1159	1311	1101	936	992	890
Crash Frequency (Background, Trunklines-Citywide)	205	237	206	138	142	147

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	43.33
Average Crashes per Year (After)	34.33
Percentage Change	-20.77%
Average Crashes per Year (Recoded, Before)	37.67
Average Crashes per Year (Recoded, After)	29.67
Percentage Change	-21.24%
Average Crashes per Year (Affected, Before)	34.67
Average Crashes per Year (Affected, After)	28.00
Percentage Change	-19.23%
Average Crashes per Year (Corrected, Before)	20.33
Average Crashes per Year (Corrected, After)	4.33
Percentage Change	-78.69%

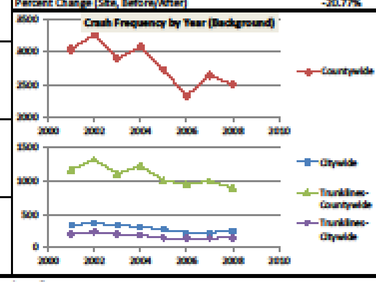


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	9215
Average Crashes per Year (Countywide, After)	7485
Percentage Change Overall Countywide	-18.77%
Projected Average Crashes per Year using Countywide Background (Site, After)	35.20
Percent Change for Site Adjusted for Countywide Background	-2.00%
Average Crashes per Year (Citywide, Before)	1038
Average Crashes per Year (Citywide, After)	710
Percentage Change Overall Citywide	-31.60%
Projected Average Crashes per Year using Citywide Background (Site, After)	29.64
Percent Change for Site Adjusted for Citywide Background	10.83%
Average Crashes per Year (Trunklines-Countywide, Before)	3571
Average Crashes per Year (Trunklines-Countywide, After)	2818
Percentage Change Overall Trunkline-Countywide	-21.09%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	34.20
Percent Change for Site Adjusted for Trunklines-Countywide Background	0.32%
Average Crashes per Year (Trunklines-Citywide, Before)	648
Average Crashes per Year (Trunklines-Citywide, After)	427
Percentage Change Overall Trunkline-Citywide	-34.10%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	28.55
Percent Change for Site Adjusted for Trunklines-Citywide Background	13.34%

Average Crashes per Year (Site, Before)	43.33
Average Crashes per Year (Site, After)	34.33
Percent Change (Site, Before/After)	-20.77%



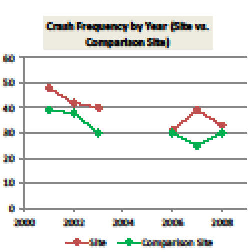
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Oakland, Royal Oak	Route/Road Name	11 Mile Rd.
PR/CS No.	4400088		
BMP	7.740	Nearest Cross Street	Knowles St.
EMP	8.550	Nearest Cross Street	Campbell Rd.

Descriptive Statistics	Before Period			After Period		
Year	2001	2002	2003	2006	2007	2008
Crash Frequency (Total)	39	38	30	30	25	30

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	1.06	
Sample Odds Ratio (year 2-3)	0.79	
Mean of Sample Odds Ratios	0.92	
Standard Error of the Sample Odds Ratios	0.19	
95% Confidence Interval of the Sample Odds Ratio (LL, UL)	0.55	1.30
N-observed,T,B (total observed no. of crashes in before period for treatment group)	130.00	
N-observed,T,A (total observed no. of crashes in after period for treatment group)	103.00	
N-observed,C,B (total observed no. of crashes in before period for comparison group)	107.00	
N-observed,C,A (total observed no. of crashes in after period for comparison group)	85.00	
N-expected,T,A (expected no. of crashes that would have occurred in after period w/out treatment)	103.27	
Variance of N-expected,T,A	307.18	
Crash Modification Factor (CMF)	0.97	
Variance of CMF	0.03	
Standard Error of CMF	0.18	
95% Confidence Interval of the CMF (LL, UL)	0.61	1.33



Site Characteristics

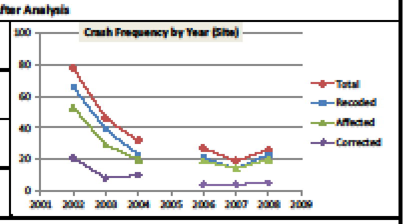
Site No.	9		Length (mi)	0.43
County	Eaton		Land Use	Commercial
City	Eaton Rapids		No. of Driveways/Intersections	16/8
Route/Road Name	M-50/M-99		Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	568804/23091	565810/23051		
BMP	6.151	9.850	Nearest Cross Street	King St.
EMP	6.571	9.860	Nearest Cross Street	Main St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	16883	18372	18262	17382	15977	15242
Crash Frequency (Total)	78	46	32	27	19	26
Crash Rate	29.44	15.95	11.16	9.90	7.58	10.87
Crash Frequency (Recoded)	66	39	23	21	14	23
Crash Frequency (Intersection-related)	13	5	0	2	2	6
Crash Frequency (Driveway-related)	7	6	3	2	4	1
Crash Frequency (Affected by Road Diet)	53	29	20	19	14	20
Crash Frequency (Corrected by Road Diet)	21	8	10	4	4	5
Crash Frequency (Background, Countywide)	3268	2905	3082	2332	2647	2506
Crash Frequency (Background, Citywide)	176	131	128	106	81	73
Crash Frequency (Background, Trunklines-Countywide)	1311	1101	1217	936	992	890
Crash Frequency (Background, Trunklines-Citywide)	127	92	87	72	49	45

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	52.00
Average Crashes per Year (After)	24.00
Percentage Change	-53.85%
Average Crashes per Year (Recoded, Before)	42.67
Average Crashes per Year (Recoded, After)	19.33
Percentage Change	-54.69%
Average Crashes per Year (Affected, Before)	34.00
Average Crashes per Year (Affected, After)	17.67
Percentage Change	-48.04%
Average Crashes per Year (Corrected, Before)	13.00
Average Crashes per Year (Corrected, After)	4.33
Percentage Change	-66.67%

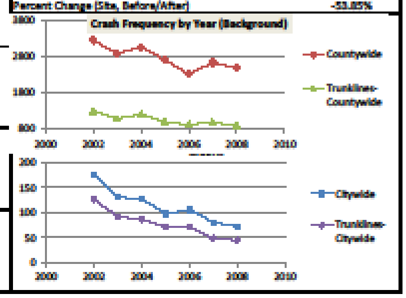


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	9255
Average Crashes per Year (Countywide, After)	7485
Percentage Change Overall Countywide	-19.12%
Projected Average Crashes per Year using Countywide Background (Site, After)	42.06
Percent Change for Site Adjusted for Countywide Background	-34.72%
Average Crashes per Year (Citywide, Before)	435
Average Crashes per Year (Citywide, After)	260
Percentage Change Overall Citywide	-40.23%
Projected Average Crashes per Year using Citywide Background (Site, After)	31.08
Percent Change for Site Adjusted for Citywide Background	-13.62%
Average Crashes per Year (Trunklines-Countywide, Before)	3629
Average Crashes per Year (Trunklines-Countywide, After)	2818
Percentage Change Overall Trunkline-Countywide	-22.35%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	40.38
Percent Change for Site Adjusted for Trunklines-Countywide Background	-31.50%
Average Crashes per Year (Trunklines-Citywide, Before)	306
Average Crashes per Year (Trunklines-Citywide, After)	166
Percentage Change Overall Trunkline-Citywide	-45.75%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	28.21
Percent Change for Site Adjusted for Trunklines-Citywide Background	-8.09%

Average Crashes per Year (Site, Before)	52.00
Average Crashes per Year (Site, After)	24.00
Percent Change (Site, Before/After)	-53.85%



Site Characteristics

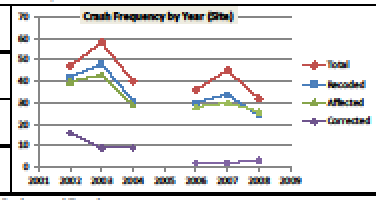
Site No.	11	Length (mi)	1.46
County	Genesee	Land Use	Mixed commercial-residential
City	Clio	No. of Driveways/Intersections	80/12
Route/Road Name	M-57	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1494503/25101		
BMP	9.400	Nearest Cross Street	Washington St.
EMP	10.856	Nearest Cross Street	Liberty St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	14628	14614	14892	13726	13466	16108
Crash Frequency (Total)	47	58	40	36	45	32
Crash Rate	6.05	7.47	5.05	4.94	6.29	3.74
Crash Frequency (Recoded)	42	48	31	30	34	24
Crash Frequency (Intersection-related)	5	8	3	5	5	6
Crash Frequency (Driveway-related)	10	5	7	2	6	0
Crash Frequency (Affected by Road Diet)	40	43	29	28	30	26
Crash Frequency (Corrected by Road Diet)	16	9	9	2	2	3
Crash Frequency (Background, Countywide)	14306	14066	13285	10458	10701	10180
Crash Frequency (Background, Citywide)	44	63	46	43	44	43
Crash Frequency (Background, Trunklines-Countywide)	1854	1854	1752	1400	1321	1218
Crash Frequency (Background, Trunklines-Citywide)	33	39	24	18	30	20

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	48.33
Average Crashes per Year (After)	37.67
Percentage Change	-22.07%
Average Crashes per Year (Recoded, Before)	40.33
Average Crashes per Year (Recoded, After)	29.33
Percentage Change	-27.27%
Average Crashes per Year (Affected, Before)	37.33
Average Crashes per Year (Affected, After)	28.00
Percentage Change	-25.00%
Average Crashes per Year (Corrected, Before)	11.33
Average Crashes per Year (Corrected, After)	2.33
Percentage Change	-79.41%

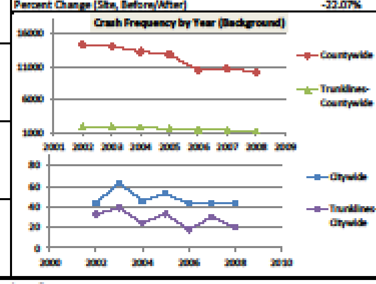


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	41657
Average Crashes per Year (Countywide, After)	31339
Percentage Change Overall Countywide	-24.77%
Projected Average Crashes per Year using Countywide Background (Site, After)	36.36
Percent Change for Site Adjusted for Countywide Background	2.70%
Average Crashes per Year (Citywide, Before)	153
Average Crashes per Year (Citywide, After)	130
Percentage Change Overall Citywide	-15.03%
Projected Average Crashes per Year using Citywide Background (Site, After)	41.07
Percent Change for Site Adjusted for Citywide Background	-7.04%
Average Crashes per Year (Trunklines-Countywide, Before)	5460
Average Crashes per Year (Trunklines-Countywide, After)	3939
Percentage Change Overall Trunkline-Countywide	-27.86%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	34.87
Percent Change for Site Adjusted for Trunklines-Countywide Background	5.79%
Average Crashes per Year (Trunklines-Citywide, Before)	96
Average Crashes per Year (Trunklines-Citywide, After)	68
Percentage Change Overall Trunkline-Citywide	-29.17%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	34.24
Percent Change for Site Adjusted for Trunklines-Citywide Background	7.10%

Average Crashes per Year (Site, Before)	48.33
Average Crashes per Year (Site, After)	37.67
Percent Change (Site, Before/After)	-22.07%



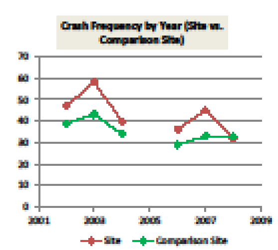
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Shiawassee, Owosso	Route/Road Name	M-52
PR/CS No.	551706		
BMP	16.299	Nearest Cross Street	Main St.
EMP	17.759	Nearest Cross Street	Laura Ln.

Descriptive Statistics	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
Crash Frequency (Total)	39	43	34	29	33	33

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	0.86	
Sample Odds Ratio (year 2-3)	1.09	
Mean of Sample Odds Ratios	0.98	
Standard Error of the Sample Odds Ratios	0.17	
95% Confidence Interval of the Sample Odds Ratio [LL, UL]	0.65	1.30
N-observed,T,B [total observed no. of crashes in before period for treatment group]	145.00	
N-observed,T,A [total observed no. of crashes in after period for treatment group]	113.00	
N-observed,C,B [total observed no. of crashes in before period for comparison group]	116.00	
N-observed,C,A [total observed no. of crashes in after period for comparison group]	95.00	
N-expected,T,A [expected no. of crashes that would have occurred in after period w/out treatment]	118.75	
Variance of N-expected,T,A	367.25	
Crash Modification Factor (CMF)	0.93	
Variance of CMF	0.03	
Standard Error of CMF	0.17	
95% Confidence Interval of the CMF [LL, UL]	0.60	1.26



Site Characteristics

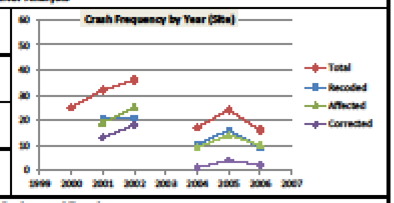
Site No.	13	Length (mi)	1.31
County	Genesee	Land Use	Mixed commercial-residential
City	Montrose	No. of Driveways/Intersections	97/11
Route/Road Name	M-57	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1494503/25101		
BMP	1.313	Nearest Cross Street	Robinhood Dr.
EMP	2.625	Nearest Cross Street	Seymour Rd.

Descriptive Statistics

	Before Period			After Period		
Year	2000	2001	2002	2004	2005	2006
ADT	9201	9312	8529	8306	8255	10494
Crash Frequency (Total)	25	32	36	17	24	16
Crash Rate	5.67	7.18	8.81	4.27	6.07	3.18
Crash Frequency (Recoded)	no data prior to 2001	21	21	10	16	9
Crash Frequency (Intersection-related)		6	6	2	4	4
Crash Frequency (Driveway-related)		4	5	0	3	1
Crash Frequency (Affected by Road Diet)		19	25	9	14	10
Crash Frequency (Corrected by Road Diet)		13	18	1	4	2
Crash Frequency (Background, Countywide)	15053	14181	14306	13285	12842	10458
Crash Frequency (Background, Citywide)	21	34	33	18	21	17
Crash Frequency (Background, Trunklines-Countywide)	1919	1900	1854	1752	1583	1400
Crash Frequency (Background, Trunklines-Citywide)	12	22	23	6	12	11

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	31.00
Average Crashes per Year (After)	19.00
Percentage Change	-38.71%
Average Crashes per Year (Recoded, Before)	21.00
Average Crashes per Year (Recoded, After)	11.67
Percentage Change	-44.44%
Average Crashes per Year (Affected, Before)	22.00
Average Crashes per Year (Affected, After)	11.00
Percentage Change	-50.00%
Average Crashes per Year (Corrected, Before)	15.50
Average Crashes per Year (Corrected, After)	2.33
Percentage Change	-84.95%

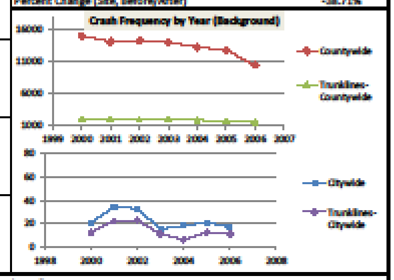


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	43540
Average Crashes per Year (Countywide, After)	36585
Percentage Change Overall Countywide	-15.97%
Projected Average Crashes per Year using Countywide Background (Site, After)	26.05
Percent Change for Site Adjusted for Countywide Background	-22.74%
Average Crashes per Year (Citywide, Before)	88
Average Crashes per Year (Citywide, After)	56
Percentage Change Overall Citywide	-36.36%
Projected Average Crashes per Year using Citywide Background (Site, After)	19.73
Percent Change for Site Adjusted for Citywide Background	-2.35%
Average Crashes per Year (Trunklines-Countywide, Before)	5673
Average Crashes per Year (Trunklines-Countywide, After)	4735
Percentage Change Overall Trunkline-Countywide	-16.53%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	25.87
Percent Change for Site Adjusted for Trunklines-Countywide Background	-22.18%
Average Crashes per Year (Trunklines-Citywide, Before)	57
Average Crashes per Year (Trunklines-Citywide, After)	29
Percentage Change Overall Trunkline-Citywide	-49.12%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	15.77
Percent Change for Site Adjusted for Trunklines-Citywide Background	10.41%

Average Crashes per Year (Site, Before)	31.00
Average Crashes per Year (Site, After)	19.00
Percent Change (Site, Before/After)	-38.71%



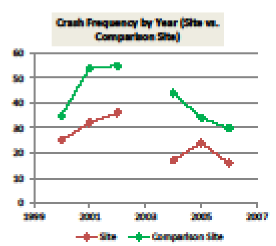
Crash Analysis Method: Before/After with Comparison Group

Comparison Site Location (County, City)	Ingham, Lansing	Route/Road Name	Grand River Ave.
PR/CS No.	3330066/33081		
BMP	0.597	Nearest Cross Street	Andrea Dr.
EMP	2.057	Nearest Cross Street	Coolidge St.

Descriptive Statistics	Before Period			After Period		
Year	2000	2001	2002	2004	2005	2006
Crash Frequency (Total)	35	54	55	44	34	30

Crash Modification Factor Computation

Sample Odds Ratio (year 1-2)	1.14	
Sample Odds Ratio (year 2-3)	0.87	
Mean of Sample Odds Ratios	1.00	
Standard Error of the Sample Odds Ratios	0.19	
95% Confidence Interval of the Sample Odds Ratio [LL, UL]	0.62	1.38
N-observed,T,B (total observed no. of crashes in before period for treatment group)	93.00	
N-observed,T,A (total observed no. of crashes in after period for treatment group)	57.00	
N-observed,C,B (total observed no. of crashes in before period for comparison group)	144.00	
N-observed,C,A (total observed no. of crashes in after period for comparison group)	108.00	
N-expected,T,A (expected no. of crashes that would have occurred in after period w/out treatment)	69.75	
Variance of N-expected,T,A	131.14	
Crash Modification Factor (CMF)	0.80	
Variance of CMF	0.03	
Standard Error of CMF	0.16	
95% Confidence Interval of the CMF [LL, UL]	0.48	1.12



Site Characteristics

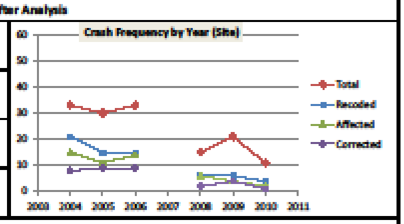
Site No.	16	Length (mi)	0.87
County	Kent	Land Use	Residential
City	Grand Rapids	No. of Driveways/Intersections	58/8
Route/Road Name	60th St.	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	409510		
BMP	0.307	Nearest Cross Street	Division St.
EMP	1.180	Nearest Cross Street	Leisure Dr.

Descriptive Statistics

	Before Period			After Period		
Year	2004	2005	2006	2008	2009	2010
ADT	17115	n/a	10883	n/a	11291	10077
Crash Frequency (Total)	33	30	33	15	21	11
Crash Rate	6.05	n/a	9.52	n/a	5.84	3.43
Crash Frequency (Recoded)	21	15	15	6	6	4
Crash Frequency (Intersection-related)	10	8	6	5	3	1
Crash Frequency (Driveway-related)	5	2	2	1	0	0
Crash Frequency (Affected by Road Diet)	15	11	14	6	4	2
Crash Frequency (Corrected by Road Diet)	8	9	9	2	4	1
Crash Frequency (Background, Countywide)	21991	19311	16437	17718	15651	15265
Crash Frequency (Background, Citywide)	9023	7359	6418	6731	6161	6257
Crash Frequency (Background, Trunklines-Countywide)	4597	3816	3419	3285	3190	3346
Crash Frequency (Background, Trunklines-Citywide)	1406	1043	990	933	1000	1179

Crash Analysis Method: Simple (Naive) Before/After Analysis

Average Crashes per Year (Before)	32.00
Average Crashes per Year (After)	15.67
Percentage Change	-51.04%
Average Crashes per Year (Recoded, Before)	17.00
Average Crashes per Year (Recoded, After)	5.33
Percentage Change	-68.63%
Average Crashes per Year (Affected, Before)	13.33
Average Crashes per Year (Affected, After)	4.00
Percentage Change	-70.00%
Average Crashes per Year (Corrected, Before)	8.67
Average Crashes per Year (Corrected, After)	2.33
Percentage Change	-73.08%

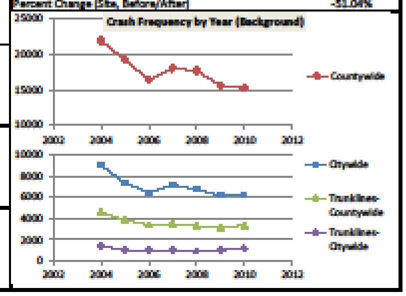


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	57739
Average Crashes per Year (Countywide, After)	48634
Percentage Change Overall Countywide	-15.77%
Projected Average Crashes per Year using Countywide Background (Site, After)	26.95
Percent Change for Site Adjusted for Countywide Background	-35.27%
Average Crashes per Year (Citywide, Before)	22800
Average Crashes per Year (Citywide, After)	19149
Percentage Change Overall Citywide	-16.01%
Projected Average Crashes per Year using Citywide Background (Site, After)	26.88
Percent Change for Site Adjusted for Citywide Background	-35.03%
Average Crashes per Year (Trunklines-Countywide, Before)	11832
Average Crashes per Year (Trunklines-Countywide, After)	9821
Percentage Change Overall Trunkline-Countywide	-17.00%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	26.56
Percent Change for Site Adjusted for Trunklines-Countywide Background	-34.05%
Average Crashes per Year (Trunklines-Citywide, Before)	3439
Average Crashes per Year (Trunklines-Citywide, After)	3112
Percentage Change Overall Trunkline-Citywide	-9.51%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	28.96
Percent Change for Site Adjusted for Trunklines-Citywide Background	-41.53%

Average Crashes per Year (Site, Before)	32.00
Average Crashes per Year (Site, After)	15.67
Percent Change (Site, Before/After)	-51.04%



Site Characteristics

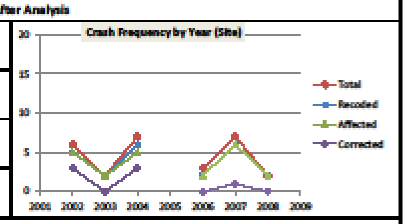
Site No.	18	Length (mi)	0.96
County	Kent	Land Use	Residential
City	Byron Center	No. of Driveways/Intersections	55/6
Route/Road Name	Byron Center Ave.	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	434808		
BMP	2.010	Nearest Cross Street	92nd St.
EMP	2.965	Nearest Cross Street	Prescott St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	8812	6846	n/a	4929	5583	9515
Crash Frequency (Total)	6	2	7	3	7	2
Crash Rate	1.95	0.84	n/a	1.75	3.60	0.60
Crash Frequency (Recoded)	5	2	6	2	6	2
Crash Frequency (Intersection-related)	1	0	2	2	4	2
Crash Frequency (Driveway-related)	4	0	0	0	0	0
Crash Frequency (Affected by Road Diet)	5	2	5	2	6	2
Crash Frequency (Corrected by Road Diet)	3	0	3	0	1	0
Crash Frequency (Background, Countywide)	23440	22950	21991	16437	18066	17718
Crash Frequency (Background, Citywide)	670	668	581	414	553	563
Crash Frequency (Background, Trunklines-Countywide)	4832	4868	4597	3419	3514	3285
Crash Frequency (Background, Trunklines-Citywide)	0	3	4	16	28	29

Crash Analysis Method: Simple (Naive) Before/After Analysis

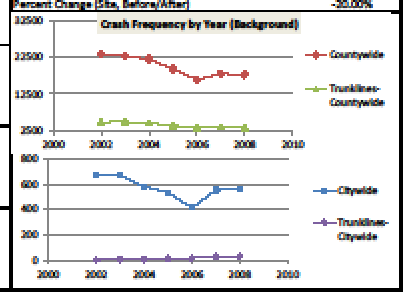
Average Crashes per Year (Before)	5.00
Average Crashes per Year (After)	4.00
Percentage Change	-20.00%
Average Crashes per Year (Recoded, Before)	4.33
Average Crashes per Year (Recoded, After)	3.33
Percentage Change	-23.08%
Average Crashes per Year (Affected, Before)	4.00
Average Crashes per Year (Affected, After)	3.33
Percentage Change	-16.67%
Average Crashes per Year (Corrected, Before)	2.00
Average Crashes per Year (Corrected, After)	0.33
Percentage Change	-83.33%



Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	68381
Average Crashes per Year (Countywide, After)	52221
Percentage Change Overall Countywide	-23.63%
Projected Average Crashes per Year using Countywide Background (Site, After)	3.82
Percent Change for Site Adjusted for Countywide Background	3.63%
Average Crashes per Year (Citywide, Before)	1919
Average Crashes per Year (Citywide, After)	1530
Percentage Change Overall Citywide	-20.27%
Projected Average Crashes per Year using Citywide Background (Site, After)	3.99
Percent Change for Site Adjusted for Citywide Background	0.27%
Average Crashes per Year (Trunklines-Countywide, Before)	14297
Average Crashes per Year (Trunklines-Countywide, After)	10218
Percentage Change Overall Trunkline-Countywide	-28.53%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	3.57
Percent Change for Site Adjusted for Trunklines-Countywide Background	8.53%
Average Crashes per Year (Trunklines-Citywide, Before)	7
Average Crashes per Year (Trunklines-Citywide, After)	73
Percentage Change Overall Trunkline-Citywide	942.86%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	52.14
Percent Change for Site Adjusted for Trunklines-Citywide Background	-962.86%

Average Crashes per Year (Site, Before)	5.00
Average Crashes per Year (Site, After)	4.00
Percent Change (Site, Before/After)	-20.00%

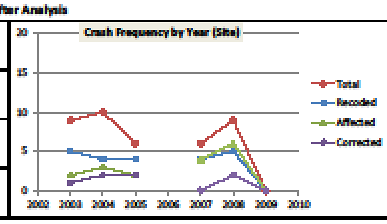


Site Characteristics			
Site No.	20	Length (mi)	0.68
County	Kent	Land Use	Residential
City	Lowell	No. of Driveways/Intersections	34/9
Route/Road Name	Hudson St.	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	3416247		
BMP	4.550	Nearest Cross Street	Chatham St.
EMP	5.228	Nearest Cross Street	Hunt St.

Descriptive Statistics	Before Period			After Period		
Year	2003	2004	2005	2007	2008	2009
ADT	n/a	n/a	13799	n/a	12908	11209
Crash Frequency (Total)	9	10	6	6	9	0
Crash Rate	n/a	n/a	1.76	n/a	2.82	0.00
Crash Frequency (Recoded)	5	4	4	4	5	0
Crash Frequency (Intersection-related)	2	2	2	3	5	0
Crash Frequency (Driveway-related)	0	0	0	0	0	0
Crash Frequency (Affected by Road Diet)	2	3	2	4	6	0
Crash Frequency (Corrected by Road Diet)	1	2	2	0	2	0
Crash Frequency (Background, Countywide)	22950	21991	19311	18066	17718	15651
Crash Frequency (Background, Citywide)	100	102	101	66	74	69
Crash Frequency (Background, Trunklines-Countywide)	4868	4597	3816	3514	3285	3190
Crash Frequency (Background, Trunklines-Citywide)	58	65	59	45	49	49

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	8.33
Average Crashes per Year (After)	5.00
Percentage Change	-40.00%
Average Crashes per Year (Recoded, Before)	4.33
Average Crashes per Year (Recoded, After)	3.00
Percentage Change	-30.77%
Average Crashes per Year (Affected, Before)	2.33
Average Crashes per Year (Affected, After)	3.33
Percentage Change	42.86%
Average Crashes per Year (Corrected, Before)	1.67
Average Crashes per Year (Corrected, After)	0.67
Percentage Change	-60.00%

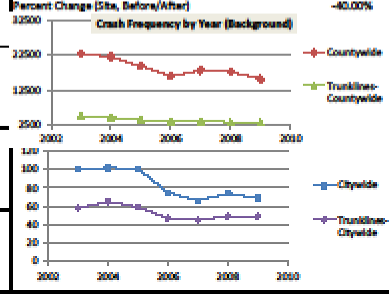


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	64252
Average Crashes per Year (Countywide, After)	51435
Percentage Change Overall Countywide	-19.95%
Projected Average Crashes per Year using Countywide Background (Site, After)	6.67
Percent Change for Site Adjusted for Countywide Background	-20.05%
Average Crashes per Year (Citywide, Before)	303
Average Crashes per Year (Citywide, After)	209
Percentage Change Overall Citywide	-31.02%
Projected Average Crashes per Year using Citywide Background (Site, After)	5.75
Percent Change for Site Adjusted for Citywide Background	-8.98%
Average Crashes per Year (Trunklines-Countywide, Before)	13281
Average Crashes per Year (Trunklines-Countywide, After)	9989
Percentage Change Overall Trunkline-Countywide	-24.79%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	6.27
Percent Change for Site Adjusted for Trunklines-Countywide Background	-15.21%
Average Crashes per Year (Trunklines-Citywide, Before)	182
Average Crashes per Year (Trunklines-Citywide, After)	143
Percentage Change Overall Trunkline-Citywide	-21.43%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	6.55
Percent Change for Site Adjusted for Trunklines-Citywide Background	-18.57%

Average Crashes per Year (Site, Before)	8.33
Average Crashes per Year (Site, After)	5.00
Percent Change (Site, Before/After)	-40.00%



Site Characteristics

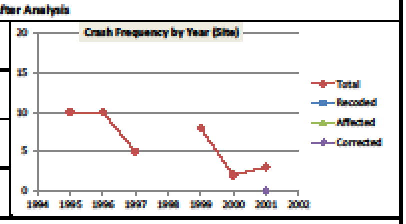
Site No.	22	Length (mi)	0.22
County	Lake	Land Use	Commercial
City	Baldwin	No. of Driveways/Intersections	12/3
Route/Road Name	M-37	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1338906/43011		
BMP	5.816	Nearest Cross Street	9th St.
EMP	6.033	Nearest Cross Street	Washington St.

Descriptive Statistics

	Before Period			After Period		
Year	1995	1996	1997	1999	2000	2001
ADT	6421	5700	8860	8448	8241	8307
Crash Frequency (Total)	10	10	5	8	2	3
Crash Rate	19.66	22.15	7.12	11.96	3.06	4.56
Crash Frequency (Recoded)						3
Crash Frequency (Intersection-related)						3
Crash Frequency (Driveway-related)		no data prior to 2001			no data prior to 2001	0
Crash Frequency (Affected by Road Diet)						3
Crash Frequency (Corrected by Road Diet)						0
Crash Frequency (Background, Countywide)	313	337	314	292	328	279
Crash Frequency (Background, Citywide)	34	32	24	22	2	18
Crash Frequency (Background, Trunklines-Countywide)	50	56	57	42	41	42
Crash Frequency (Background, Trunklines-Citywide)	19	23	14	14	1	8

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	8.33
Average Crashes per Year (After)	4.33
Percentage Change	-48.00%
Average Crashes per Year (Recoded, Before)	n/a
Average Crashes per Year (Recoded, After)	3.00
Percentage Change	n/a
Average Crashes per Year (Affected, Before)	n/a
Average Crashes per Year (Affected, After)	3.00
Percentage Change	n/a
Average Crashes per Year (Corrected, Before)	n/a
Average Crashes per Year (Corrected, After)	0.00
Percentage Change	n/a

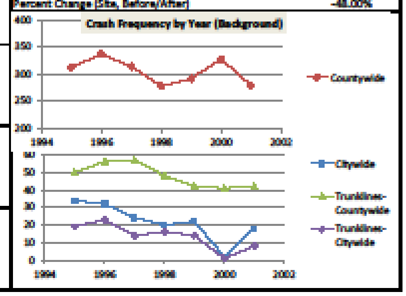


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	964
Average Crashes per Year (Countywide, After)	899
Percentage Change Overall Countywide	-6.74%
Projected Average Crashes per Year using Countywide Background (Site, After)	7.77
Percent Change for Site Adjusted for Countywide Background	-41.26%
Average Crashes per Year (Citywide, Before)	90
Average Crashes per Year (Citywide, After)	42
Percentage Change Overall Citywide	-53.33%
Projected Average Crashes per Year using Citywide Background (Site, After)	3.89
Percent Change for Site Adjusted for Citywide Background	5.33%
Average Crashes per Year (Trunklines-Countywide, Before)	163
Average Crashes per Year (Trunklines-Countywide, After)	125
Percentage Change Overall Trunkline-Countywide	-23.31%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	6.39
Percent Change for Site Adjusted for Trunklines-Countywide Background	-24.69%
Average Crashes per Year (Trunklines-Citywide, Before)	56
Average Crashes per Year (Trunklines-Citywide, After)	23
Percentage Change Overall Trunkline-Citywide	-58.93%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	3.42
Percent Change for Site Adjusted for Trunklines-Citywide Background	10.93%

Average Crashes per Year (Site, Before)	8.33
Average Crashes per Year (Site, After)	4.33
Percent Change (Site, Before/After)	-48.00%



Site Characteristics

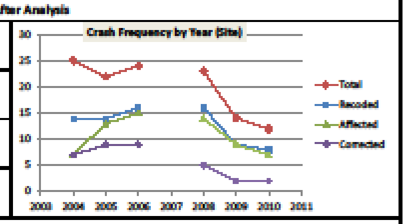
Site No.	23	Length (mi)	0.50
County	Iosco	Land Use	Commercial
City	Oscoda Township	No. of Driveways/Intersections	23/9
Route/Road Name	US-23	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1251607/35032		
BMP	24.014	Nearest Cross Street	Divison St.
EMP	24.511	Nearest Cross Street	Evergreen Dr.

Descriptive Statistics

	Before Period			After Period		
Year	2004	2005	2006	2008	2009	2010
ADT	16647	16856	13859	12970	13528	14054
Crash Frequency (Total)	25	22	24	23	14	12
Crash Rate	8.28	7.19	9.55	9.78	5.70	4.71
Crash Frequency (Recoded)	14	14	16	16	9	8
Crash Frequency (Intersection-related)	4	5	7	2	5	1
Crash Frequency (Driveway-related)	0	0	1	0	1	1
Crash Frequency (Affected by Road Diet)	7	13	15	14	9	7
Crash Frequency (Corrected by Road Diet)	7	9	9	5	2	2
Crash Frequency (Background, Countywide)	589	529	471	431	381	335
Crash Frequency (Background, Citywide)	164	163	130	139	107	101
Crash Frequency (Background, Trunklines-Countywide)	98	76	71	69	74	48
Crash Frequency (Background, Trunklines-Citywide)	5	6	3	6	5	2

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	23.67
Average Crashes per Year (After)	16.33
Percentage Change	-30.99%
Average Crashes per Year (Recoded, Before)	14.67
Average Crashes per Year (Recoded, After)	11.00
Percentage Change	-25.00%
Average Crashes per Year (Affected, Before)	11.67
Average Crashes per Year (Affected, After)	10.00
Percentage Change	-14.29%
Average Crashes per Year (Corrected, Before)	8.33
Average Crashes per Year (Corrected, After)	3.00
Percentage Change	-64.00%

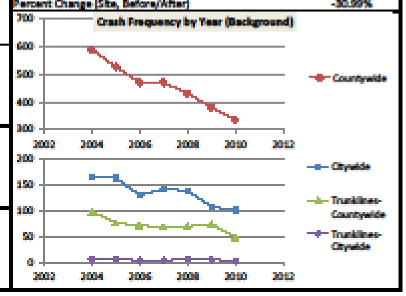


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	1589
Average Crashes per Year (Countywide, After)	1147
Percentage Change Overall Countywide	-27.82%
Projected Average Crashes per Year using Countywide Background (Site, After)	17.08
Percent Change for Site Adjusted for Countywide Background	-3.17%
Average Crashes per Year (Citywide, Before)	457
Average Crashes per Year (Citywide, After)	347
Percentage Change Overall Citywide	-24.07%
Projected Average Crashes per Year using Citywide Background (Site, After)	17.97
Percent Change for Site Adjusted for Citywide Background	-6.92%
Average Crashes per Year (Trunklines-Countywide, Before)	245
Average Crashes per Year (Trunklines-Countywide, After)	191
Percentage Change Overall Trunkline-Countywide	-22.04%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	18.45
Percent Change for Site Adjusted for Trunklines-Countywide Background	-8.95%
Average Crashes per Year (Trunklines-Citywide, Before)	14
Average Crashes per Year (Trunklines-Citywide, After)	13
Percentage Change Overall Trunkline-Citywide	-7.14%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	21.98
Percent Change for Site Adjusted for Trunklines-Citywide Background	-23.84%

Average Crashes per Year (Site, Before)	23.67
Average Crashes per Year (Site, After)	16.33
Percent Change (Site, Before/After)	-30.99%



Site Characteristics

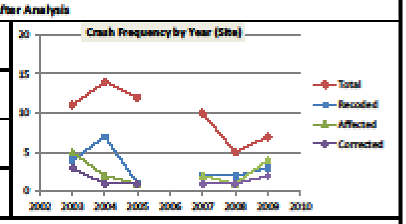
Site No.	25	Length (mi)	0.79
County	Mason	Land Use	Residential
City	Ludington	No. of Driveways/Intersections	38/4
Route/Road Name	M-116	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	215810/53011		
BMP	0.158	Nearest Cross Street	Ludington Ave.
EMP	0.952	Nearest Cross Street	Albert Ct./ Lowell St.

Descriptive Statistics

	Before Period			After Period		
Year	2003	2004	2005	2007	2008	2009
ADT	9817	9842	9783	4240	2686	2705
Crash Frequency (Total)	11	14	12	10	5	7
Crash Rate	3.87	4.91	4.23	8.14	6.42	8.93
Crash Frequency (Recoded)	4	7	1	2	2	3
Crash Frequency (Intersection-related)	2	3	1	0	1	2
Crash Frequency (Driveway-related)	0	0	0	1	0	0
Crash Frequency (Affected by Road Diet)	5	2	1	2	1	4
Crash Frequency (Corrected by Road Diet)	3	1	1	1	1	2
Crash Frequency (Background, Countywide)	959	924	909	822	772	681
Crash Frequency (Background, Citywide)	225	232	209	157	172	147
Crash Frequency (Background, Trunklines-Countywide)	58	62	57	51	62	44
Crash Frequency (Background, Trunklines-Citywide)	28	28	23	20	21	16

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	12.33
Average Crashes per Year (After)	7.33
Percentage Change	-40.54%
Average Crashes per Year (Recoded, Before)	4.00
Average Crashes per Year (Recoded, After)	2.33
Percentage Change	-41.67%
Average Crashes per Year (Affected, Before)	2.67
Average Crashes per Year (Affected, After)	2.33
Percentage Change	-12.50%
Average Crashes per Year (Corrected, Before)	1.67
Average Crashes per Year (Corrected, After)	1.33
Percentage Change	-20.00%

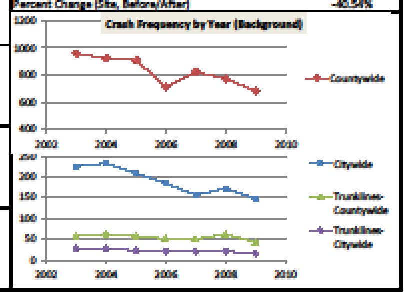


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	2792
Average Crashes per Year (Countywide, After)	2275
Percentage Change Overall Countywide	-18.52%
Projected Average Crashes per Year using Countywide Background (Site, After)	10.05
Percent Change for Site Adjusted for Countywide Background	-22.02%
Average Crashes per Year (Citywide, Before)	666
Average Crashes per Year (Citywide, After)	476
Percentage Change Overall Citywide	-28.53%
Projected Average Crashes per Year using Citywide Background (Site, After)	8.81
Percent Change for Site Adjusted for Citywide Background	-12.01%
Average Crashes per Year (Trunklines-Countywide, Before)	177
Average Crashes per Year (Trunklines-Countywide, After)	157
Percentage Change Overall Trunkline-Countywide	-11.30%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	10.94
Percent Change for Site Adjusted for Trunklines-Countywide Background	-29.24%
Average Crashes per Year (Trunklines-Citywide, Before)	79
Average Crashes per Year (Trunklines-Citywide, After)	57
Percentage Change Overall Trunkline-Citywide	-27.85%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	8.90
Percent Change for Site Adjusted for Trunklines-Citywide Background	-12.69%

Average Crashes per Year (Site, Before)	12.33
Average Crashes per Year (Site, After)	7.33
Percent Change (Site, Before/After)	-40.54%



Site Characteristics

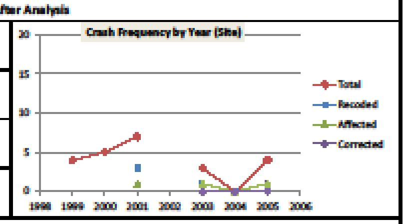
Site No.	26	Length (mi)	0.58
County	Missaukee	Land Use	Residential
City	Lake City	No. of Driveways/Intersections	39/5
Route/Road Name	M-55/M-66	Treatment Type	New markings
PR/CS No.	1283106/57012		
BMP	11.053	Nearest Cross Street	Beeler Rd./ 1st St.
EMP	11.637	Nearest Cross Street	Union St.

Descriptive Statistics

	Before Period			After Period		
Year	1999	2000	2001	2003	2004	2005
ADT	11492	11513	11605	11305	9795	9423
Crash Frequency (Total)	4	5	7	3	0	4
Crash Rate	1.63	2.04	2.83	1.24	0.00	1.99
Crash Frequency (Recoded)			3	1	0	0
Crash Frequency (Intersection-related)			1	0	0	0
Crash Frequency (Driveway-related)	no data prior to 2001		1	0	0	0
Crash Frequency (Affected by Road Diet)			3	1	0	1
Crash Frequency (Corrected by Road Diet)			1	0	0	0
Crash Frequency (Background, Countywide)	355	322	298	309	323	292
Crash Frequency (Background, Citywide)	42	37	36	39	30	31
Crash Frequency (Background, Trunklines-Countywide)	132	143	115	125	136	116
Crash Frequency (Background, Trunklines-Citywide)	29	22	29	30	27	20

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	5.33
Average Crashes per Year (After)	2.33
Percentage Change	-56.25%
Average Crashes per Year (Recoded, Before)	3.00
Average Crashes per Year (Recoded, After)	0.33
Percentage Change	-88.89%
Average Crashes per Year (Affected, Before)	3.00
Average Crashes per Year (Affected, After)	0.67
Percentage Change	-77.78%
Average Crashes per Year (Corrected, Before)	1.00
Average Crashes per Year (Corrected, After)	0.00
Percentage Change	-100.00%

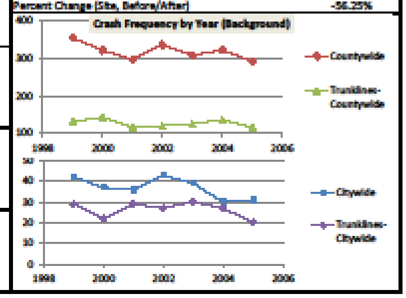


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	975
Average Crashes per Year (Countywide, After)	924
Percentage Change Overall Countywide	-5.23%
Projected Average Crashes per Year using Countywide Background (Site, After)	5.05
Percent Change for Site Adjusted for Countywide Background	-51.02%
Average Crashes per Year (Citywide, Before)	115
Average Crashes per Year (Citywide, After)	100
Percentage Change Overall Citywide	-13.04%
Projected Average Crashes per Year using Citywide Background (Site, After)	4.64
Percent Change for Site Adjusted for Citywide Background	-49.21%
Average Crashes per Year (Trunklines-Countywide, Before)	390
Average Crashes per Year (Trunklines-Countywide, After)	377
Percentage Change Overall Trunkline-Countywide	-3.33%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	5.16
Percent Change for Site Adjusted for Trunklines-Countywide Background	-52.92%
Average Crashes per Year (Trunklines-Citywide, Before)	80
Average Crashes per Year (Trunklines-Citywide, After)	77
Percentage Change Overall Trunkline-Citywide	-3.75%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	5.13
Percent Change for Site Adjusted for Trunklines-Citywide Background	-52.50%

Average Crashes per Year (Site, Before)	5.33
Average Crashes per Year (Site, After)	2.33
Percent Change (Site, Before/After)	-56.25%



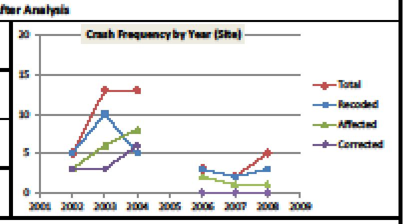
Site Characteristics			
Site No.	29	Length (mi)	0.49
County	Otsego	Land Use	Residential
City	Gaylord	No. of Driveways/Intersections	30/4
Route/Road Name	M-32	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1079903/69021		
BMP	11.407	Nearest Cross Street	Oak Ave.
EMP	11.902	Nearest Cross Street	Hayes Rd.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	11998	12105	10424	10793	10621	8538
Crash Frequency (Total)	5	13	13	3	2	5
Crash Rate	2.31	5.94	6.90	1.54	1.04	3.24
Crash Frequency (Recoded)	5	10	5	3	2	3
Crash Frequency (Intersection-related)	4	6	3	1	0	1
Crash Frequency (Driveway-related)	0	0	0	0	0	0
Crash Frequency (Affected by Road Diet)	3	6	8	2	1	1
Crash Frequency (Corrected by Road Diet)	3	3	6	0	0	0
Crash Frequency (Background, Countywide)	898	965	991	803	737	686
Crash Frequency (Background, Citywide)	331	317	317	287	257	222
Crash Frequency (Background, Trunklines-Countywide)	301	303	282	292	245	228
Crash Frequency (Background, Trunklines-Citywide)	248	229	213	217	190	163

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	10.33
Average Crashes per Year (After)	3.33
Percentage Change	-67.74%
Average Crashes per Year (Recoded, Before)	6.67
Average Crashes per Year (Recoded, After)	2.67
Percentage Change	-60.00%
Average Crashes per Year (Affected, Before)	5.67
Average Crashes per Year (Affected, After)	1.33
Percentage Change	-76.47%
Average Crashes per Year (Corrected, Before)	4.00
Average Crashes per Year (Corrected, After)	0.00
Percentage Change	-100.00%

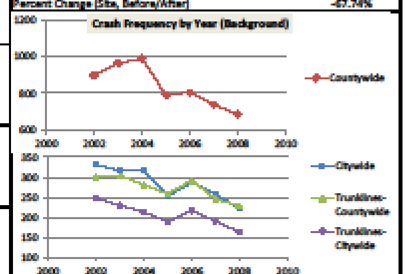


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	2854
Average Crashes per Year (Countywide, After)	2226
Percentage Change Overall Countywide	-22.00%
Projected Average Crashes per Year using Countywide Background (Site, After)	8.06
Percent Change for Site Adjusted for Countywide Background	-45.74%
Average Crashes per Year (Citywide, Before)	965
Average Crashes per Year (Citywide, After)	766
Percentage Change Overall Citywide	-20.62%
Projected Average Crashes per Year using Citywide Background (Site, After)	8.20
Percent Change for Site Adjusted for Citywide Background	-47.12%
Average Crashes per Year (Trunklines-Countywide, Before)	886
Average Crashes per Year (Trunklines-Countywide, After)	765
Percentage Change Overall Trunkline-Countywide	-13.66%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	8.92
Percent Change for Site Adjusted for Trunklines-Countywide Background	-54.09%
Average Crashes per Year (Trunklines-Citywide, Before)	690
Average Crashes per Year (Trunklines-Citywide, After)	570
Percentage Change Overall Trunkline-Citywide	-17.39%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	8.54
Percent Change for Site Adjusted for Trunklines-Citywide Background	-50.35%

Average Crashes per Year (Site, Before)	10.33
Average Crashes per Year (Site, After)	3.33
Percent Change (Site, Before/After)	-67.74%



Site Characteristics

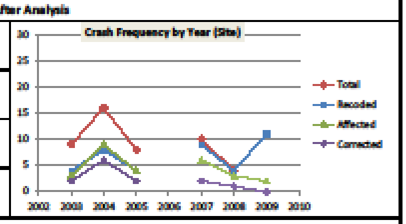
Site No.	30	Length (mi)	0.38
County	St. Joseph	Land Use	Mixed commercial-residential
City	Sturgis	No. of Driveways/Intersections	25/8
Route/Road Name	US-12	Treatment Type	Reconstruction changing roadway width
PR/CS No.	232106/78022		
BMP	17.967	Nearest Cross Street	Maple St.
EMP	18.350	Nearest Cross Street	Lakeview Ave.

Descriptive Statistics

	Before Period			After Period		
Year	2003	2004	2005	2007	2008	2009
ADT	7462	7417	8209	8070	6592	8303
Crash Frequency (Total)	9	16	8	10	4	11
Crash Rate	8.63	15.43	6.97	8.86	4.34	9.48
Crash Frequency (Recoded)	4	8	4	9	4	11
Crash Frequency (Intersection-related)	0	5	3	4	2	1
Crash Frequency (Driveway-related)	0	0	0	0	1	1
Crash Frequency (Affected by Road Diet)	3	9	4	6	3	2
Crash Frequency (Corrected by Road Diet)	2	6	2	2	1	0
Crash Frequency (Background, Countywide)	1574	1719	1552	1400	1162	1141
Crash Frequency (Background, Citywide)	286	335	305	275	225	206
Crash Frequency (Background, Trunklines-Countywide)	392	440	395	382	292	308
Crash Frequency (Background, Trunklines-Citywide)	85	96	95	102	77	70

Crash Analysis Method: Simple (Naive) Before/After Analysis

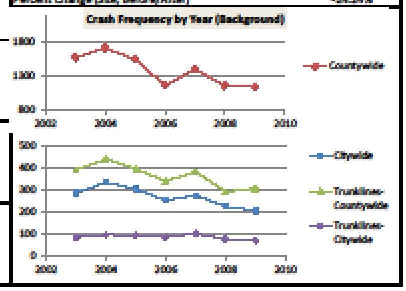
Average Crashes per Year (Before)	11.00
Average Crashes per Year (After)	8.33
Percentage Change	-24.24%
Average Crashes per Year (Recoded, Before)	5.33
Average Crashes per Year (Recoded, After)	8.00
Percentage Change	50.00%
Average Crashes per Year (Affected, Before)	5.33
Average Crashes per Year (Affected, After)	3.67
Percentage Change	-31.25%
Average Crashes per Year (Corrected, Before)	3.33
Average Crashes per Year (Corrected, After)	1.00
Percentage Change	-70.00%



Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	4845
Average Crashes per Year (Countywide, After)	3703
Percentage Change Overall Countywide	-23.57%
Projected Average Crashes per Year using Countywide Background (Site, After)	8.41
Percent Change for Site Adjusted for Countywide Background	-0.67%
Average Crashes per Year (Citywide, Before)	926
Average Crashes per Year (Citywide, After)	706
Percentage Change Overall Citywide	-23.76%
Projected Average Crashes per Year using Citywide Background (Site, After)	8.39
Percent Change for Site Adjusted for Citywide Background	-0.48%
Average Crashes per Year (Trunklines-Countywide, Before)	1227
Average Crashes per Year (Trunklines-Countywide, After)	982
Percentage Change Overall Trunkline-Countywide	-19.97%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	8.80
Percent Change for Site Adjusted for Trunklines-Countywide Background	-4.28%
Average Crashes per Year (Trunklines-Citywide, Before)	276
Average Crashes per Year (Trunklines-Citywide, After)	249
Percentage Change Overall Trunkline-Citywide	-9.78%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	9.92
Percent Change for Site Adjusted for Trunklines-Citywide Background	-14.46%

Average Crashes per Year (Site, Before)	11.00
Average Crashes per Year (Site, After)	8.33
Percent Change (Site, Before/After)	-24.24%



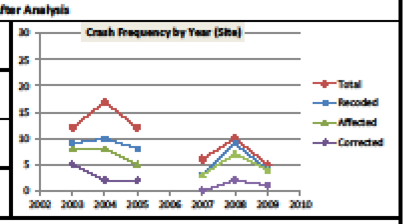
Site Characteristics			
Site No.	33	Length (mi)	0.69
County	Wexford	Land Use	Mixed commercial-residential
City	Mesick	No. of Driveways/Intersections	19/6
Route/Road Name	M-115/M-37	Treatment Type	New markings
PR/CS No.	1127810/83012		
BMP	5.241	Nearest Cross Street	M-37
EMP	5.930	Nearest Cross Street	Clark St.

Descriptive Statistics

	Before Period			After Period		
Year	2003	2004	2005	2007	2008	2009
ADT	7349	7275	7039	7033	6702	6894
Crash Frequency (Total)	12	17	12	6	10	5
Crash Rate	6.49	9.29	6.78	3.39	5.93	2.88
Crash Frequency (Recoded)	9	10	8	3	9	4
Crash Frequency (Intersection-related)	2	5	2	3	4	1
Crash Frequency (Driveway-related)	2	1	1	0	0	0
Crash Frequency (Affected by Road Diet)	8	8	5	3	7	4
Crash Frequency (Corrected by Road Diet)	5	2	2	0	2	1
Crash Frequency (Background, Countywide)	1259	1317	1033	1038	992	895
Crash Frequency (Background, Citywide)	20	24	18	11	13	9
Crash Frequency (Background, Trunklines-Countywide)	522	668	497	518	499	446
Crash Frequency (Background, Trunklines-Citywide)	12	17	10	7	10	9

Crash Analysis Method: Simple (Naive) Before/After Analysis

Average Crashes per Year (Before)	13.67
Average Crashes per Year (After)	7.00
Percentage Change	-48.78%
Average Crashes per Year (Recoded, Before)	9.00
Average Crashes per Year (Recoded, After)	5.33
Percentage Change	-40.74%
Average Crashes per Year (Affected, Before)	7.00
Average Crashes per Year (Affected, After)	4.67
Percentage Change	-33.33%
Average Crashes per Year (Corrected, Before)	3.00
Average Crashes per Year (Corrected, After)	1.00
Percentage Change	-66.67%

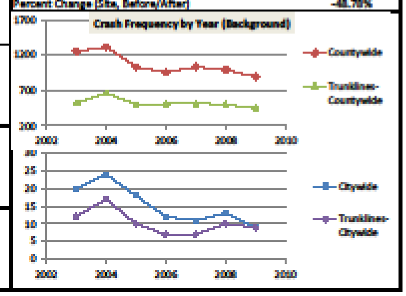


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	3609
Average Crashes per Year (Countywide, After)	2925
Percentage Change Overall Countywide	-18.95%
Projected Average Crashes per Year using Countywide Background (Site, After)	11.08
Percent Change for Site Adjusted for Countywide Background	-29.83%
Average Crashes per Year (Citywide, Before)	62
Average Crashes per Year (Citywide, After)	33
Percentage Change Overall Citywide	-46.77%
Projected Average Crashes per Year using Citywide Background (Site, After)	7.27
Percent Change for Site Adjusted for Citywide Background	-2.01%
Average Crashes per Year (Trunklines-Countywide, Before)	1687
Average Crashes per Year (Trunklines-Countywide, After)	1463
Percentage Change Overall Trunkline-Countywide	-13.28%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	11.85
Percent Change for Site Adjusted for Trunklines-Countywide Background	-35.50%
Average Crashes per Year (Trunklines-Citywide, Before)	39
Average Crashes per Year (Trunklines-Citywide, After)	26
Percentage Change Overall Trunkline-Citywide	-33.33%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	9.11
Percent Change for Site Adjusted for Trunklines-Citywide Background	-15.45%

Average Crashes per Year (Site, Before)	13.67
Average Crashes per Year (Site, After)	7.00
Percent Change (Site, Before/After)	-48.78%

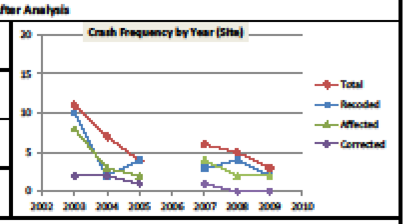


Site Characteristics			
Site No.	34	Length (mi)	0.46
County	Delta	Land Use	Commercial
City	Bark River	No. of Driveways/Intersections	22/2
Route/Road Name	US-2/US-41	Treatment Type	Reconstruction changing roadway width
PR/CS No.	1351805/21021		
BMP	0.827	Nearest Cross Street	D Rd.
EMP	1.286	Nearest Cross Street	12th Rd.

Descriptive Statistics	Before Period			After Period		
Year	2003	2004	2005	2007	2008	2009
ADT	8174	8133	7089	7896	7509	7512
Crash Frequency (Total)	11	7	4	6	5	3
Crash Rate	8.03	5.14	3.37	4.54	3.97	2.38
Crash Frequency (Recoded)	10	2	4	3	4	2
Crash Frequency (Intersection-related)	3	1	1	3	1	2
Crash Frequency (Driveway-related)	2	0	0	0	0	0
Crash Frequency (Affected by Road Diet)	8	3	2	4	2	2
Crash Frequency (Corrected by Road Diet)	2	2	1	1	0	0
Crash Frequency (Background, Countywide)	1123	1165	977	882	879	826
Crash Frequency (Background, Citywide)	48	47	35	35	27	25
Crash Frequency (Background, Trunklines-Countywide)	121	101	87	67	88	79
Crash Frequency (Background, Trunklines-Citywide)	8	5	8	3	1	2

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	7.33
Average Crashes per Year (After)	4.67
Percentage Change	-36.36%
Average Crashes per Year (Recoded, Before)	5.33
Average Crashes per Year (Recoded, After)	3.00
Percentage Change	-43.75%
Average Crashes per Year (Affected, Before)	4.33
Average Crashes per Year (Affected, After)	2.67
Percentage Change	-38.46%
Average Crashes per Year (Corrected, Before)	1.67
Average Crashes per Year (Corrected, After)	0.33
Percentage Change	-80.00%

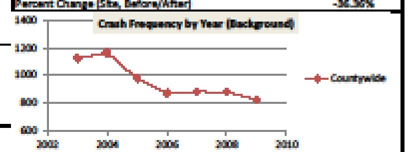


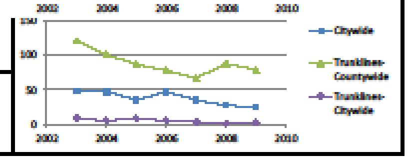
Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	3265
Average Crashes per Year (Countywide, After)	2587
Percentage Change Overall Countywide	-20.77%
Projected Average Crashes per Year using Countywide Background (Site, After)	5.81
Percent Change for Site Adjusted for Countywide Background	-15.60%
Average Crashes per Year (Citywide, Before)	130
Average Crashes per Year (Citywide, After)	87
Percentage Change Overall Citywide	-33.08%
Projected Average Crashes per Year using Citywide Background (Site, After)	4.91
Percent Change for Site Adjusted for Citywide Background	-5.29%
Average Crashes per Year (Trunklines-Countywide, Before)	309
Average Crashes per Year (Trunklines-Countywide, After)	234
Percentage Change Overall Trunkline-Countywide	-24.27%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	5.55
Percent Change for Site Adjusted for Trunklines-Countywide Background	-12.09%
Average Crashes per Year (Trunklines-Citywide, Before)	21
Average Crashes per Year (Trunklines-Citywide, After)	6
Percentage Change Overall Trunkline-Citywide	-71.43%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	2.10
Percent Change for Site Adjusted for Trunklines-Citywide Background	35.06%

Average Crashes per Year (Site, Before)	7.33
Average Crashes per Year (Site, After)	4.67
Percent Change (Site, Before/After)	-36.36%





Site Characteristics

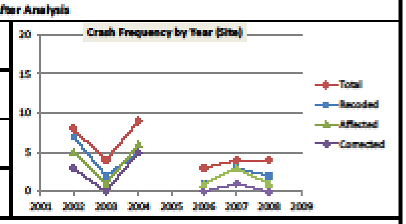
Site No.	36		Length (mi)	0.86
County	Delta		Land Use	Mixed commercial-residential
City	Powers		No. of Driveways/Intersections	42/5
Route/Road Name	US-41		Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	1322308/55012	1920201/55022		
BMP	41.802	0.000	Nearest Cross Street	3rd St.
EMP	42.277	0.383	Nearest Cross Street	Spring Rd.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	5408	5457	5402	4584	4678	4443
Crash Frequency (Total)	8	4	9	3	4	4
Crash Rate	4.72	2.34	5.32	2.09	2.73	2.87
Crash Frequency (Recoded)	7	2	5	1	3	2
Crash Frequency (Intersection-related)	2	1	3	1	2	0
Crash Frequency (Driveway-related)	2	0	1	0	0	0
Crash Frequency (Affected by Road Diet)	5	1	6	1	3	1
Crash Frequency (Corrected by Road Diet)	3	0	5	0	1	0
Crash Frequency (Background, Countywide)	1153	1123	1165	871	882	879
Crash Frequency (Background, Citywide)	51	58	69	50	35	44
Crash Frequency (Background, Trunklines-Countywide)	115	121	101	78	67	88
Crash Frequency (Background, Trunklines-Citywide)	2	0	0	0	0	0

Crash Analysis Method: Simple (Naïve) Before/After Analysis

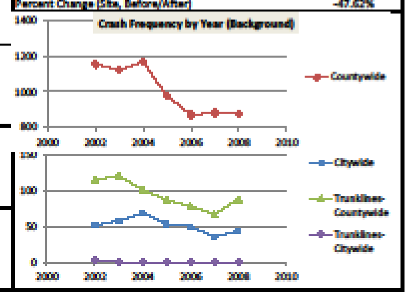
Average Crashes per Year (Before)	7.00
Average Crashes per Year (After)	3.67
Percentage Change	-47.62%
Average Crashes per Year (Recoded, Before)	4.67
Average Crashes per Year (Recoded, After)	2.00
Percentage Change	-57.14%
Average Crashes per Year (Affected, Before)	4.00
Average Crashes per Year (Affected, After)	1.67
Percentage Change	-58.33%
Average Crashes per Year (Corrected, Before)	2.67
Average Crashes per Year (Corrected, After)	0.33
Percentage Change	-87.50%



Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	3441
Average Crashes per Year (Countywide, After)	2632
Percentage Change Overall Countywide	-23.51%
Projected Average Crashes per Year using Countywide Background (Site, After)	5.35
Percent Change for Site Adjusted for Countywide Background	-24.11%
Average Crashes per Year (Citywide, Before)	178
Average Crashes per Year (Citywide, After)	129
Percentage Change Overall Citywide	-27.53%
Projected Average Crashes per Year using Citywide Background (Site, After)	5.07
Percent Change for Site Adjusted for Citywide Background	-20.09%
Average Crashes per Year (Trunklines-Countywide, Before)	337
Average Crashes per Year (Trunklines-Countywide, After)	233
Percentage Change Overall Trunkline-Countywide	-30.86%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	4.84
Percent Change for Site Adjusted for Trunklines-Countywide Background	-16.76%
Average Crashes per Year (Trunklines-Citywide, Before)	2
Average Crashes per Year (Trunklines-Citywide, After)	0
Percentage Change Overall Trunkline-Citywide	-100.00%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	0.00
Percent Change for Site Adjusted for Trunklines-Citywide Background	52.38%

Average Crashes per Year (Site, Before)	7.00
Average Crashes per Year (Site, After)	3.67
Percent Change (Site, Before/After)	-47.62%



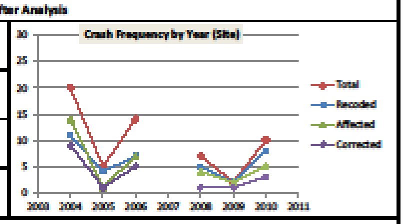
Site Characteristics			
Site No.	37	Length (mi)	0.30
County	Eaton	Land Use	Commercial
City	Grand Ledge	No. of Driveways/Intersections	4/4
Route/Road Name	M-100	Treatment Type	Repaving within existing curbs with new markings
PR/CS No.	566510/23072		
BMP	9.511	Nearest Cross Street	River St.
EMP	9.808	Nearest Cross Street	Washington St.

Descriptive Statistics

	Before Period			After Period		
Year	2004	2005	2006	2008	2009	2010
ADT	14135	14460	14315	13201	14216	14657
Crash Frequency (Total)	20	5	14	7	2	10
Crash Rate	13.05	3.19	9.02	4.89	1.30	6.29
Crash Frequency (Recoded)	11	4	7	5	2	8
Crash Frequency (Intersection-related)	8	0	5	1	1	0
Crash Frequency (Driveway-related)	0	0	0	0	0	0
Crash Frequency (Affected by Road Diet)	14	1	7	4	2	5
Crash Frequency (Corrected by Road Diet)	9	1	5	1	1	3
Crash Frequency (Background, Countywide)	3082	2732	2332	2506	2201	2389
Crash Frequency (Background, Citywide)	177	145	135	143	142	116
Crash Frequency (Background, Trunklines-Countywide)	1217	1003	936	890	826	848
Crash Frequency (Background, Trunklines-Citywide)	128	87	84	94	94	85

Crash Analysis Method: Simple (Naïve) Before/After Analysis

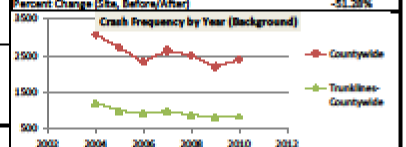
Average Crashes per Year (Before)	13.00
Average Crashes per Year (After)	6.33
Percentage Change	-51.28%
Average Crashes per Year (Recoded, Before)	7.33
Average Crashes per Year (Recoded, After)	5.00
Percentage Change	-31.82%
Average Crashes per Year (Affected, Before)	7.33
Average Crashes per Year (Affected, After)	3.67
Percentage Change	-50.00%
Average Crashes per Year (Corrected, Before)	5.00
Average Crashes per Year (Corrected, After)	1.67
Percentage Change	-66.67%

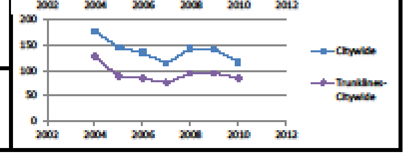


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	8146
Average Crashes per Year (Countywide, After)	7096
Percentage Change Overall Countywide	-12.89%
Projected Average Crashes per Year using Countywide Background (Site, After)	11.32
Percent Change for Site Adjusted for Countywide Background	-38.39%
Average Crashes per Year (Citywide, Before)	457
Average Crashes per Year (Citywide, After)	401
Percentage Change Overall Citywide	-12.25%
Projected Average Crashes per Year using Citywide Background (Site, After)	11.41
Percent Change for Site Adjusted for Citywide Background	-39.03%
Average Crashes per Year (Trunklines-Countywide, Before)	3156
Average Crashes per Year (Trunklines-Countywide, After)	2564
Percentage Change Overall Trunkline-Countywide	-18.76%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	10.56
Percent Change for Site Adjusted for Trunklines-Countywide Background	-32.52%
Average Crashes per Year (Trunklines-Citywide, Before)	299
Average Crashes per Year (Trunklines-Citywide, After)	273
Percentage Change Overall Trunkline-Citywide	-8.70%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	11.87
Percent Change for Site Adjusted for Trunklines-Citywide Background	-42.59%

Average Crashes per Year (Site, Before)	13.00
Average Crashes per Year (Site, After)	6.33
Percent Change (Site, Before/After)	-51.28%





Site Characteristics

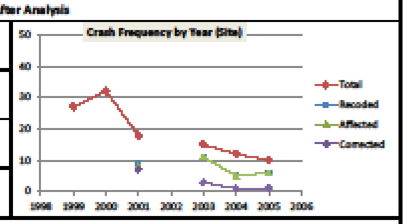
Site No.	39	Length (mi)	0.39
County	Alpena	Land Use	Residential
City	Alpena	No. of Driveways/Intersections	14/5
Route/Road Name	9th Ave.	Treatment Type	New markings
PR/CS No.	3040011		
BMP	0.615	Nearest Cross Street	Chisolm St.
EMP	1.005	Nearest Cross Street	Oldfield St.

Descriptive Statistics

	Before Period			After Period		
Year	1999	2000	2001	2003	2004	2005
ADT	n/a	n/a	n/a	n/a	n/a	n/a
Crash Frequency (Total)	27	32	18	15	12	10
Crash Rate	n/a	n/a	n/a	n/a	n/a	n/a
Crash Frequency (Recoded)			9	11	5	6
Crash Frequency (Intersection-related)			4	10	2	2
Crash Frequency (Driveway-related)	no data prior to 2001		0	0	0	0
Crash Frequency (Affected by Road Diet)			8	11	5	6
Crash Frequency (Corrected by Road Diet)			7	3	1	1
Crash Frequency (Background, Countywide)	889	979	730	799	685	612
Crash Frequency (Background, Citywide)	448	434	308	330	240	248
Crash Frequency (Background, Trunklines-Countywide)	131	140	115	132	149	71
Crash Frequency (Background, Trunklines-Citywide)	56	38	37	32	42	27

Crash Analysis Method: Simple (Naïve) Before/After Analysis

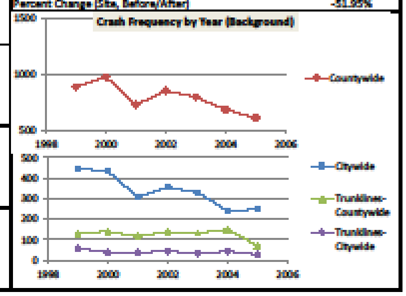
Average Crashes per Year (Before)	25.67
Average Crashes per Year (After)	12.33
Percentage Change	-51.95%
Average Crashes per Year (Recoded, Before)	9.00
Average Crashes per Year (Recoded, After)	7.33
Percentage Change	-18.52%
Average Crashes per Year (Affected, Before)	8.00
Average Crashes per Year (Affected, After)	7.33
Percentage Change	-8.33%
Average Crashes per Year (Corrected, Before)	7.00
Average Crashes per Year (Corrected, After)	1.67
Percentage Change	-76.19%



Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)	
Average Crashes per Year (Countywide, Before)	2598
Average Crashes per Year (Countywide, After)	2096
Percentage Change Overall Countywide	-19.32%
Projected Average Crashes per Year using Countywide Background (Site, After)	20.71
Percent Change for Site Adjusted for Countywide Background	-32.63%
Average Crashes per Year (Citywide, Before)	1190
Average Crashes per Year (Citywide, After)	818
Percentage Change Overall Citywide	-31.26%
Projected Average Crashes per Year using Citywide Background (Site, After)	17.64
Percent Change for Site Adjusted for Citywide Background	-30.09%
Average Crashes per Year (Trunklines-Countywide, Before)	386
Average Crashes per Year (Trunklines-Countywide, After)	352
Percentage Change Overall Trunkline-Countywide	-8.81%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	23.41
Percent Change for Site Adjusted for Trunklines-Countywide Background	-43.14%
Average Crashes per Year (Trunklines-Citywide, Before)	131
Average Crashes per Year (Trunklines-Citywide, After)	101
Percentage Change Overall Trunkline-Citywide	-22.90%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	19.79
Percent Change for Site Adjusted for Trunklines-Citywide Background	-29.05%

Average Crashes per Year (Site, Before)	25.67
Average Crashes per Year (Site, After)	12.33
Percent Change (Site, Before/After)	-51.95%



Site Characteristics

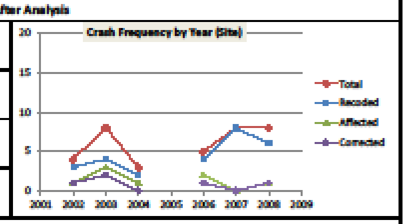
Site No.	40	Length (mi)	0.50
County	Oscoda	Land Use	Commercial
City	Big Creek	No. of Driveways/Intersections	31/7
Route/Road Name	M-33	Treatment Type	Reconstruction within existing curbs
PR/CS No.	1334402/68011		New signal timing
BMP	9.395	Nearest Cross Street	14th St.
EMP	9.892	Nearest Cross Street	9th St.

Descriptive Statistics

	Before Period			After Period		
Year	2002	2003	2004	2006	2007	2008
ADT	3828	3797	3885	3659	3225	2667
Crash Frequency (Total)	4	8	3	5	8	8
Crash Rate	5.76	11.61	4.26	7.53	13.67	16.54
Crash Frequency (Recoded)	3	4	2	4	8	6
Crash Frequency (Intersection-related)	1	1	1	1	0	0
Crash Frequency (Driveway-related)	0	0	0	1	0	1
Crash Frequency (Affected by Road Diet)	1	3	1	2	0	1
Crash Frequency (Corrected by Road Diet)	1	2	0	1	0	1
Crash Frequency (Background, Countywide)	236	237	217	166	141	140
Crash Frequency (Background, Citywide)	118	118	111	87	81	78
Crash Frequency (Background, Trunklines-Countywide)	90	99	87	68	54	48
Crash Frequency (Background, Trunklines-Citywide)	54	61	49	43	38	30

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	5.00
Average Crashes per Year (After)	7.00
Percentage Change	40.00%
Average Crashes per Year (Recoded, Before)	3.00
Average Crashes per Year (Recoded, After)	6.00
Percentage Change	100.00%
Average Crashes per Year (Affected, Before)	1.67
Average Crashes per Year (Affected, After)	1.00
Percentage Change	-40.00%
Average Crashes per Year (Corrected, Before)	1.00
Average Crashes per Year (Corrected, After)	0.67
Percentage Change	-33.33%

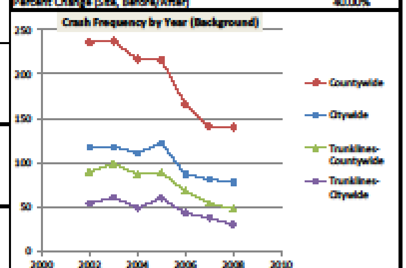


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	690
Average Crashes per Year (Countywide, After)	447
Percentage Change Overall Countywide	-35.22%
Projected Average Crashes per Year using Countywide Background (Site, After)	3.24
Percent Change for Site Adjusted for Countywide Background	75.22%
Average Crashes per Year (Citywide, Before)	347
Average Crashes per Year (Citywide, After)	246
Percentage Change Overall Citywide	-29.11%
Projected Average Crashes per Year using Citywide Background (Site, After)	3.54
Percent Change for Site Adjusted for Citywide Background	69.11%
Average Crashes per Year (Trunklines-Countywide, Before)	276
Average Crashes per Year (Trunklines-Countywide, After)	170
Percentage Change Overall Trunkline-Countywide	-38.41%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	3.08
Percent Change for Site Adjusted for Trunklines-Countywide Background	78.41%
Average Crashes per Year (Trunklines-Citywide, Before)	164
Average Crashes per Year (Trunklines-Citywide, After)	111
Percentage Change Overall Trunkline-Citywide	-32.32%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	3.38
Percent Change for Site Adjusted for Trunklines-Citywide Background	72.32%

Average Crashes per Year (Site, Before)	5.00
Average Crashes per Year (Site, After)	7.00
Percent Change (Site, Before/After)	40.00%



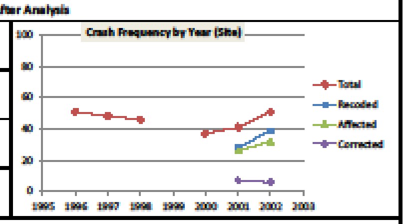
Site Characteristics			
Site No.	43	Length (mi)	0.62
County	Ingham	Land Use	Mixed commercial-residential
City	East Lansing	No. of Driveways/Intersections	27/11
Route/Road Name	Abbott Rd.	Treatment Type	New markings
PR/CS No.	349410		
BMP	0.174	Nearest Cross Street	Albert Ave.
EMP	0.791	Nearest Cross Street	Whitehills Dr./ Oxford Rd.

Descriptive Statistics

	Before Period			After Period		
Year	1996	1997	1998	2000	2001	2002
ADT	n/a	15190	n/a	8239	n/a	17550
Crash Frequency (Total)	51	48	46	37	41	51
Crash Rate	n/a	14.03	n/a	19.94	n/a	12.90
Crash Frequency (Recoded)					28	39
Crash Frequency (Intersection-related)					7	9
Crash Frequency (Driveway-related)		no data prior to 2001		no data prior to 2001	2	2
Crash Frequency (Affected by Road Diet)					26	32
Crash Frequency (Corrected by Road Diet)					7	6
Crash Frequency (Background, Countywide)	11549	11560	10376	11048	10712	10768
Crash Frequency (Background, Citywide)	1178	1215	1229	1132	1114	1144
Crash Frequency (Background, Trunklines-Countywide)	3067	3086	2781	2716	2745	2698
Crash Frequency (Background, Trunklines-Citywide)	312	352	373	311	259	242

Crash Analysis Method: Simple (Naïve) Before/After Analysis

Average Crashes per Year (Before)	48.33
Average Crashes per Year (After)	43.00
Percentage Change	-11.03%
Average Crashes per Year (Recoded, Before)	n/a
Average Crashes per Year (Recoded, After)	33.50
Percentage Change	n/a
Average Crashes per Year (Affected, Before)	n/a
Average Crashes per Year (Affected, After)	29.00
Percentage Change	n/a
Average Crashes per Year (Corrected, Before)	n/a
Average Crashes per Year (Corrected, After)	6.50
Percentage Change	n/a

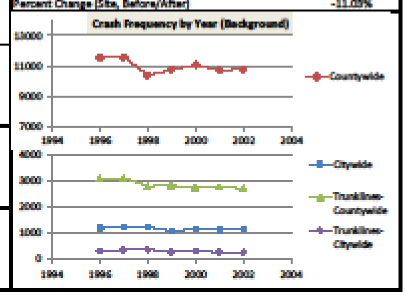


Crash Analysis Method: Before/After Comparison with Background Trends

Background Area Location (County, City)

Average Crashes per Year (Countywide, Before)	33485
Average Crashes per Year (Countywide, After)	32528
Percentage Change Overall Countywide	-2.86%
Projected Average Crashes per Year using Countywide Background (Site, After)	46.95
Percent Change for Site Adjusted for Countywide Background	-8.18%
Average Crashes per Year (Citywide, Before)	3622
Average Crashes per Year (Citywide, After)	3390
Percentage Change Overall Citywide	-6.41%
Projected Average Crashes per Year using Citywide Background (Site, After)	45.24
Percent Change for Site Adjusted for Citywide Background	-4.63%
Average Crashes per Year (Trunklines-Countywide, Before)	8934
Average Crashes per Year (Trunklines-Countywide, After)	8159
Percentage Change Overall Trunkline-Countywide	-8.67%
Projected Average Crashes per Year using Trunklines-Countywide Background (Site, After)	44.14
Percent Change for Site Adjusted for Trunklines-Countywide Background	-2.36%
Average Crashes per Year (Trunklines-Citywide, Before)	1037
Average Crashes per Year (Trunklines-Citywide, After)	812
Percentage Change Overall Trunkline-Citywide	-21.70%
Projected Average Crashes per Year using Trunklines-Citywide Background (Site, After)	37.85
Percent Change for Site Adjusted for Trunklines-Citywide Background	10.66%

Average Crashes per Year (Site, Before)	48.33
Average Crashes per Year (Site, After)	43.00
Percent Change (Site, Before/After)	-11.03%



APPENDIX E

ADDITIONAL IMPLEMENTATION INFORMATION

Road Diet Implementation – A community guide

Road diets have been gaining considerable attention as a relatively new roadway conversion that promotes safety to all modes of transportation while maintaining the intended function of the corridor. In many instances, conversion of a roadway by road diet has achieved positive results. These results have been published and discussed by transportation officials and researchers, however, the methods and techniques by which success has been achieved are discussed only briefly. The intent of this section is to provide a complete guide to the implementation of a road diet within a community.

Road diets have been implemented in several states including California, Washington, Iowa, Minnesota, Michigan, Connecticut, and Florida. Many of these projects have extensively evaluated the effects on crash reduction associated with road diets.[1-8] However, for the purpose of developing an implementation guide, studies that present information on the process of implementing a road diet were further reviewed. These studies included advantages and disadvantages of a road diet, motivating factors for conversion, and lessons learned following the project.[9-15]

Although the implementation of road diets has generally had positive results, the new roadway design can face many challenges which generally originate from resistance within a community. Primarily, the dislike of road diets stems from the counter-intuitiveness of maintaining an acceptable level of service while reducing the capacity of the roadway. To challenge the general thinking, many agencies implementing road diets have experienced success by utilizing techniques that both educate and involve the community.

A concise implementation guide, which organizes the project and gives community goals primary importance, can assist in overcoming many of the challenges associated with road diet implementation.

An implementation guide should encompass all aspects of the project in a beginning-to-end fashion. Continuous community involvement should be maintained through each phase of the road diet conversion. In general, the project can be divided into pre-construction (Phase I), construction (Phase II), and post-construction (Phase III) with the following primary objectives for each phase:

- Phase I - Community education and acceptance for the road diet project.
- Phase II - Mitigate any negative effects associated with construction and roadway operations.
- Phase III - Demonstrate how the road diet fulfilled community objectives while highlighting the benefits of the new corridor.

Success of a road diet project can be measured on several levels, however, when a road diet fulfills the needs of a community while maintaining the necessary function of the corridor, success is generally recognized.

Phase I – Community education and acceptance

Road diets can have lasting effects on a community, therefore it is essential to promote community involvement from the beginning. In doing this, citizens gain a sense of ownership for the road diet project and the decisions being made are felt as their own. Many agencies implementing road diets have involved the public through town hall meetings, workshops, and newspaper postings which detail the road diet project specifically.[8,10] Others have found success by implementing road diet projects through city master plans or other citywide initiatives such as Complete Streets or a community bicycle plan. For example, the Michigan's Genesee County Metropolitan Alliance adopted a "Complete Streets" approach where "Transportation improvements in Genesee County are planned, designed and constructed to encourage walking, bicycling, and transit use while promoting safety for all users".[12] Another example includes the pedscape plan adopted by the city of Charlotte, North Carolina.[10] These techniques provide an accepting atmosphere because residents are more receptive to change and look forward to "reinventing" their community in a broader scope. Additionally, this groups a road diet project with other beautification elements that aim to restore out-dated downtown settings. The intent of public meetings should be as follows:

- Gain an understanding of the needs of a community by generating a list of transportation, economic, and safety objectives.
- Develop a broad scope plan such as a master plan, which considers community objectives and provides a list of projects which fulfill these objectives.
- Consider supplemental redevelopment motifs such as complete streets, green streets, or a community bicycle/walking plan.
- Provide several alternatives to road diets and explain how elements of the alternatives fail to meet the goals of corridor and the community.
- Demonstrate how a road diet will affect all modes of transportation by providing equal access to motorists, cyclists, and walkers while maintaining safety.
- Provide both benefits and disadvantages of road diets – overstating the benefits of a road diet sets the project up for failure in the public eye.

Public involvement could be in the form of focus sessions including emergency services, senior citizens, transit personnel, merchants, and the disabled to identify areas of the community they see as beneficial to improve.[8] Once a list of clear objectives is established, several alternatives which meet the objectives should be developed. Proposing several alternatives alongside a road diet provides the opportunity to make decisions about the project. A review of the advantages and disadvantages of each alternative generally affirms that the road diet alternative provides the most benefit to all users. Although a detailed preliminary analysis is not always needed, demonstrating before and after level of service and similar corridor characteristics can strengthen the argument.

Work with residents on the project and design details and reiterate that the roadway can be restored to the original cross-section if the project is unsuccessful. Employing stamped concrete, brick accents, planter boxes, curb out-crops, and other city beautification techniques can also aid in gaining community approval. While there are a limited number of studies that have focused on economic impacts of road diets, research has cited that economic activity has increased along road diet sites accompanied by an increase in average residential housing values.[15]

To maintain community involvement from beginning to end, many road diet projects have utilized public forums such as blogs or social networking sites.[16-19] A public forum allows citizens to voice concerns, opinions, or praise concerning the process of the design and implementation. In turn, this gives the implementing agency an opportunity to answer questions which generally alleviate concerns voiced by community members. These sites also provide a central hub for pertinent information regarding street closures, detours, and project progress.

Phase II – Road diet construction

Public concern generally arises during the planning phase of the project however it can become agitated when construction begins. The degree of discontent will largely be based on the extent of the redesign. If a road diet is being converted simply by pavement remarking, negative response will be minimal. If the project requires reconstruction, causing commuting to become difficult, additional measures will be necessary to alleviate public concerns. Regardless of the size of the project, any precautions that will lessen the stress associated with the road diet should be taken. Based on past road diet experiences, the following techniques have been used to maintain a positive attitude throughout the community during the construction phase:[10]

- Reduce the impact of constructing the road diet on the community by shortening the construction timeline.
- Provide proper detours to maintain access and mobility through or around the project site.
- Consider public transportation options through the corridor.
- Select a design which uses the existing curb width.

- Change signal timing before construction to allow motorists to become acquainted with the new cycle lengths.
- Implement a road diet when other projects are being considered such as installing new utilities, repaving, new sidewalks, or new striping of the roadway.

Clearly, by reducing the construction timeline the negative effects of the new roadway design will be reduced. Primary focus should be placed on restoring mobility to motorists as this is generally where most discontent arises. In addition to motorist mobility, there is a need to address access for motorists, cyclists, and walkers. This requires proper phasing of the project, while roadway construction is the primary concern, sidewalks, cross-walks, planters, and landscaping elements become secondary. Proper detours are necessary to redirect traffic through or around the project. If possible, two-lanes should continuously remain available for two-way through traffic. If this is not possible, one lane should remain open for through traffic in one direction while a detour redirects the other direction of traffic around the site. Many cases require signal timing to be changed due to the new traffic characteristics of the three-lane roadway. It is important to change the signal timing prior to any construction taking place to allow motorists to become acquainted with the new cycle lengths and intersection operations.[10] Additionally, this allows engineers to ensure proper cycle lengths have been designed for the new three-lane TWTL and given level of traffic. Finally, just as a road diet should be included in a community master plan, other updating elements should be included in the construction phase to minimize any future reconstruction.

Again, the use of a blog or website can keep users up-to-date on the progress of the project while relaying important detour and closure information.

Phase III – A follow-up demonstrating road diet success

A road diet is a substantial redesign of a roadway and therefore the resulting operational characteristics should be studied to determine if the project was successful. This assessment will be important to members of the community who will want to know if the project met the intended objectives. Similarly, other agencies will be interested to know if this type of roadway conversion would be successful in their own communities. Success of a road diet should not be based solely on motorist delay and similar operational characteristics, but on the project in its entirety including cyclists, walkers, and local businesses. The following aspects of the project should be addressed as they relate to the road diet project:[10,15]

- Level of service, intersection delay, and similar corridor characteristics including cross street traffic.
- Assessment of motorist speed characteristics.

- Overall safety of for walkers, cyclists, and motorists.
- Operational difficulties such as improper use of the two-way left-turn lane.
- Walker and cyclists volumes.
- Resulting parking characteristics.
- Economic activity for business and change in residential housing values.

It is important to demonstrate how the road diet maintains the function of the corridor even though the capacity has been reduced. This can be accomplished by evaluating traffic characteristics including level of service, delay, ADTs, and motorist's speeds. In many cases, level of service and ADTs have been reduced slightly while delay has slightly increased. Similarly, it has been shown through several examples that conversion of a roadway by road diet is successful in reducing the 85th percentile speed as well as the maximum speed.[10] Although results may indicate that some of these characteristics have been negatively affected, it is possible to provide the information in a positive light. Generally, a primary objective of a road diet is to restore safety to all users. By reducing motorist's speeds, fewer high-speed accidents are expected to occur, and pedestrians and cyclists experience greater comfort in cross-walks and bike lanes, respectively.[10] At this point it is also necessary to remind community members that the intent of a road diet is to provide benefits to all users of the corridor.

Another aspect of safety can be considered regarding the proper use of the updated roadway. Following several site visits conducted in Michigan it was determined that problems exist with the proper use of the two-way left-turn lane. Significant problems such as delay and accidents can arise if the TWLTL is not being used by left-turning vehicles. For this reason, literature and signage about the proper use of the TWLTL should be presented in various phases. Additionally, a site visit of the updated roadway can determine if the message has been effectively conveyed.

Another objective of a road diet may be to restore the city center of a community by providing a safe and aesthetically pleasing atmosphere. Although this is somewhat subjective, by evaluating the pedestrian/cyclists volumes, parking characteristics of the converted site, and economic activity, one can gain some insight. If the corridor experiences higher walker/cyclist volumes it can be presumed that a sense of safety has been restored to these modes of transportation. If on-street parking is provided by the updated roadway, it should be determined if parking is being utilized by employees or consumers of local businesses. In general, on-street parking should provide access to consumers of local businesses. Additionally, economic data from local businesses can be acquired to assess whether the road diet has promoted business. Finally, a survey can be distributed to community members to assess whether the road diet has had a positive influence on the city center. The survey should address whether motorist's/walker's/cyclist's comfort levels have changed and how community members have changed their use of the city center.

A follow-up evaluation of a road diet plays an important role in the success of the project. By assessing many of the characteristics of the updated roadway and presenting findings to community members, a sense of satisfaction and accomplishment can be instilled in the community. Finally, information collected from a converted site can be of use to other agencies considering a similar roadway conversion.

Additional comments

Several presentations, developed by transportation engineers around the country, have made it evident that starting at the community level has many advantages when implementing a road diet. The following list, presented by Joshua E. Saak in a presentation about the East Boulevard, Charlotte, North Carolina road diet, suggests common questions that can be expected from community members:

- Where does the additional traffic go when the capacity is reduced by half?
- When most communities are widening roadways, why are we narrowing ours?
- How will bus stops be accommodated with a road diet?
- How will emergency response units be affected?
- What if it doesn't work?

Responses for these questions should be developed to provide inquirers with the proper information.

A list of objectives, or measures of effectiveness, should be developed in Phase I of the project. The following list of possible MOEs was presented by the City of Orlando – Transportation Planning Bureau for the Edgewater Drive road diet restriping plan:

- Avoid increased traffic on neighboring streets
- Reduce speeding
- Increase bicyclist volumes
- Increase pedestrian volumes
- Reduce crashes
- Increase on-street parking use rates
- Increase resident and merchant pedestrian travel satisfaction
- Increase parking satisfaction

Although a list of MOEs will be specific to a community it is important that it represents the ideals of the community. Further, the final road diet plan should aim to fulfill many of the MOEs if success is to be expected.

The following list presents additional ways to be successful and gain community acceptance for road diet projects. It also provides things the implementing agency should avoid when proposing a road diet.

- Conduct a thorough analysis of the corridor and make certain a road diet is a suitable alternative for the roadway.
- Avoid implementing a road diet without community involvement.
- Develop a plan that not only encompasses the road diet project but the community as a whole such as complete streets, a new bicycle/pedestrian initiative, or economic plan.
- Avoid overstating the benefits of a road diet as this sets the project up for failure in the public eye.
- Publish other road diet success stories in local newspapers or blogs.
- Use blogs or social networking sites to provide as much information as possible to community members while providing a forum to express any concerns.
- Provide an opportunity for additional beautification elements such as stamped concrete, brick accents, planter boxes, curb out-crops, and added landscaping.

Although these techniques have been successful, they are not overarching. Road diet success has been achieved by many implementing agencies following different approaches. Again, success of a road diet project can be measured on several levels, however, when a road diet fulfills the needs of a community while maintaining the necessary function of the corridor, success is generally recognized.

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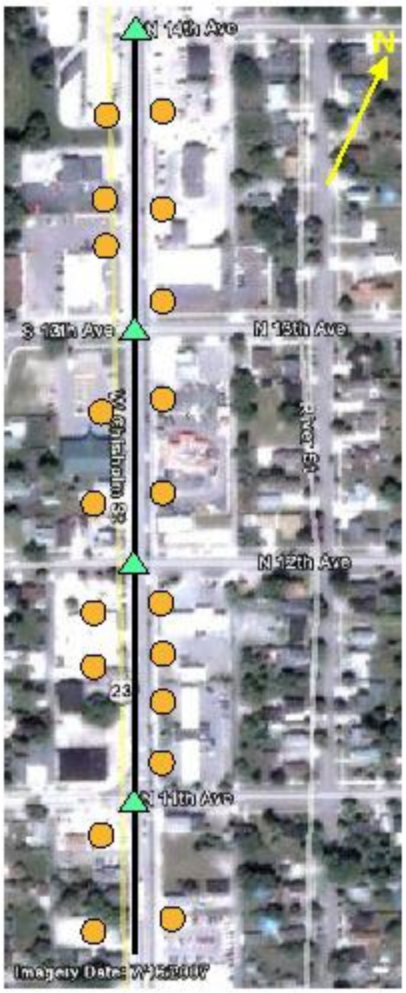
APPENDIX F

SITE AERIAL VIEWS

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
1	Alpena	Alpena	2000	US-23	Chisholm	0.4



Notes:	
Driveway Density	Total Street Intersections: 4 Total Commercial Driveways: 19 Total Residential Driveways: 0 Length: 0.4 mi
Adjacent Land Use	
ADT	1999 – 15,100 (320 Comm) 2001 – 16,800 (130 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Total Street Intersections: 17 Total Commercial Driveways: 22 Total Residential Driveways: 4 Length: 1.4 mi Street Intersections: 3 Commercial Driveways: 1 Residential Driveways: 1
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 6 Residential Driveways: 0 Total: 9
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 7 Residential Driveways: 3 Total: 11
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 5 Residential Driveways: 0 Total: 6
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Street Intersections: 7 Commercial Driveways: 3 Residential Driveways: 0 Total: 9
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
2	Berrien	Berrien Springs	2007	M-139 (formerly Old 31)	N/A	1.4

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 0 Residential Driveways: 0 Total: 2
Adjacent Land Use	
ADT	2006 – 11,100 (280 Comm) 2008 – 11,300 (70 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	**Total Street Intersections: 35** **Total Commercial Driveways: 37** **Total Residential Driveways: 63** **Length: 4.3 mi** Street Intersections: 4 Commercial Driveways: 0 Residential Driveways: 1
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

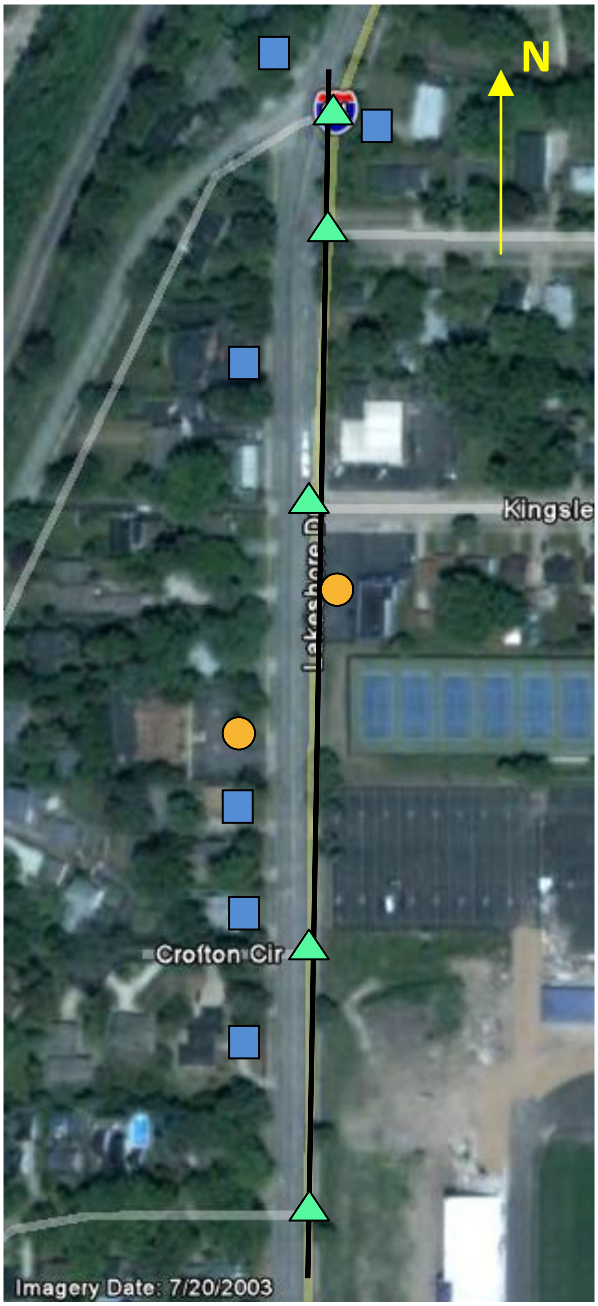
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 1 Residential Driveways: 3 Total: 8
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 1 Residential Driveways: 9 Total: 12
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3



Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 2 Residential Driveways: 6 Total: 13
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 2 Residential Driveways: 0 Total: 4
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 1 Residential Driveways: 1 Total: 3
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

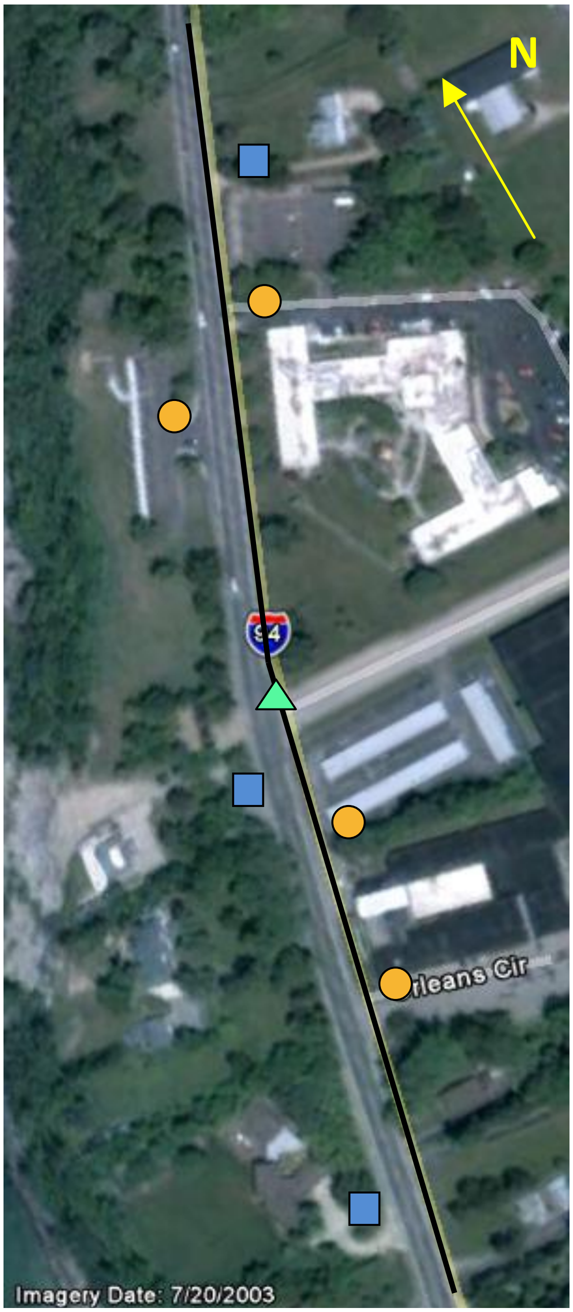
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 4 Residential Driveways: 0 Total: 5
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

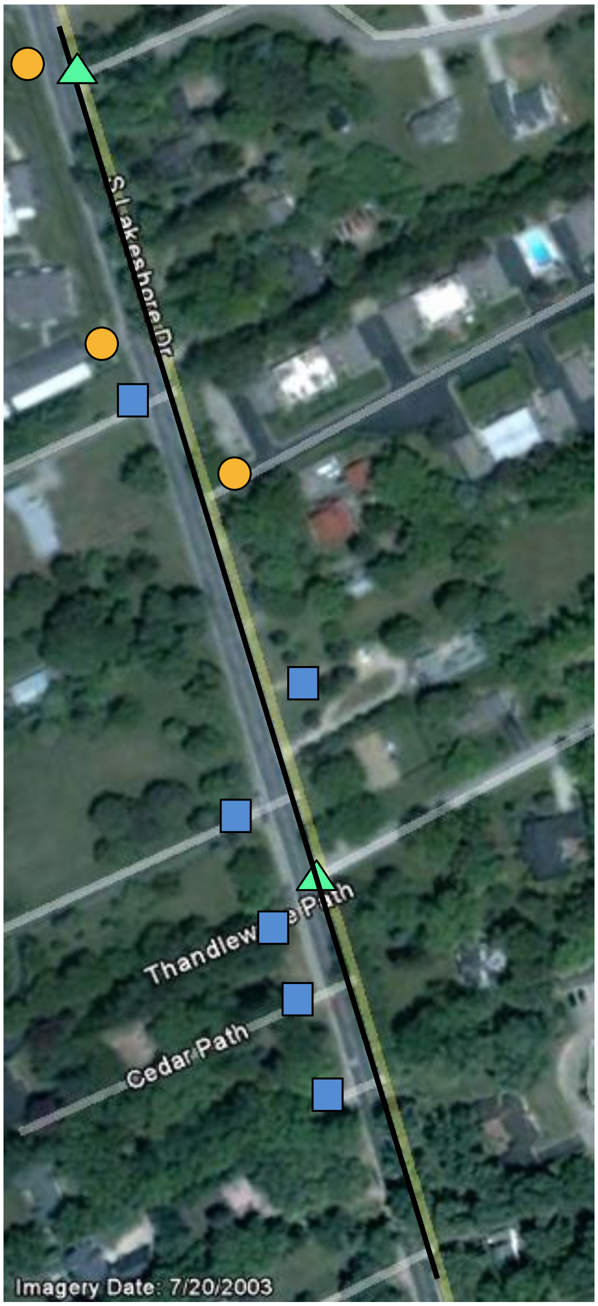
Notes:	
Driveway Density	Street Intersections: 0 Commercial Driveways: 1 Residential Driveways: 12 Total: 13
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3



Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 4 Residential Driveways: 3 Total: 8
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3



Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 3 Residential Driveways: 6 Total: 11
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 0 Residential Driveways: 8 Total: 10
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

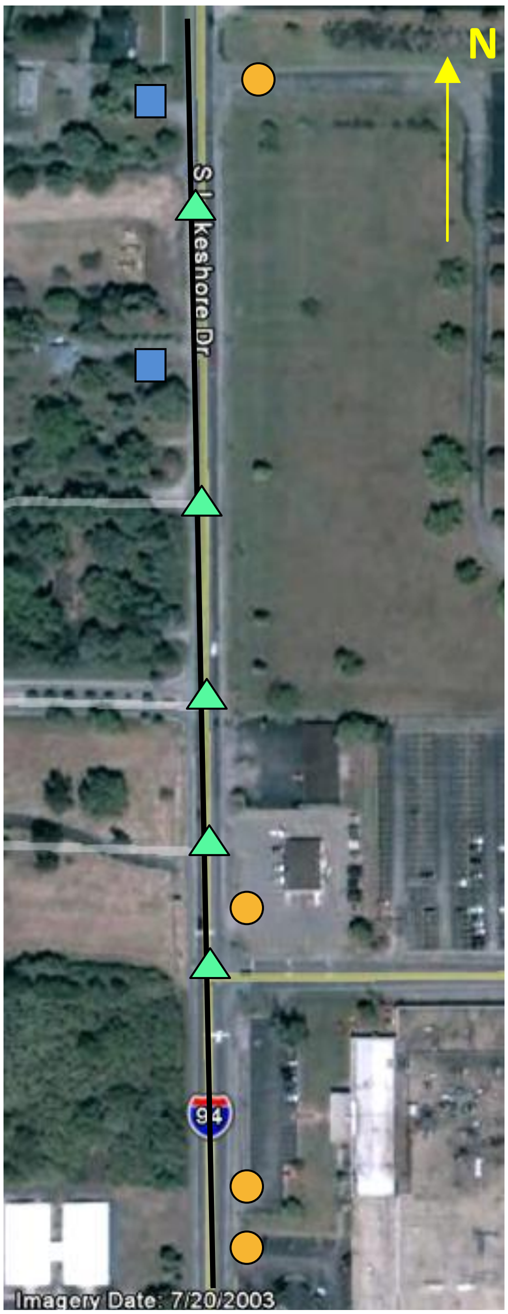
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 7 Total: 8
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3

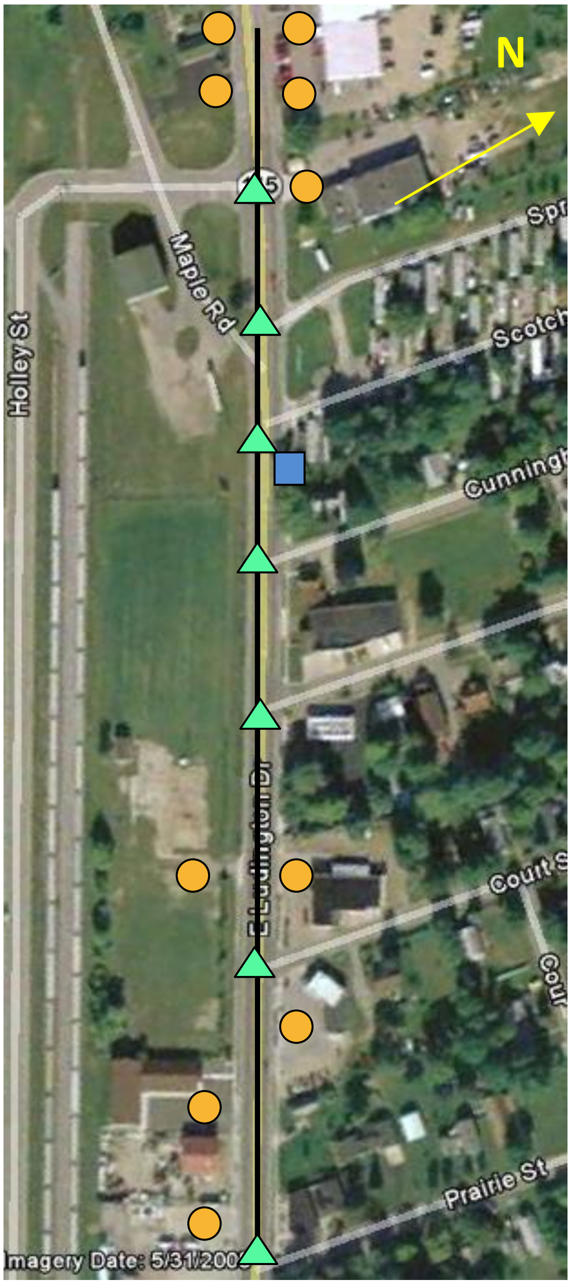
Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 4 Residential Driveways: 5 Total: 11
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
3	Berrien	St. Joseph	2005	I-94BL	N/A	4.3



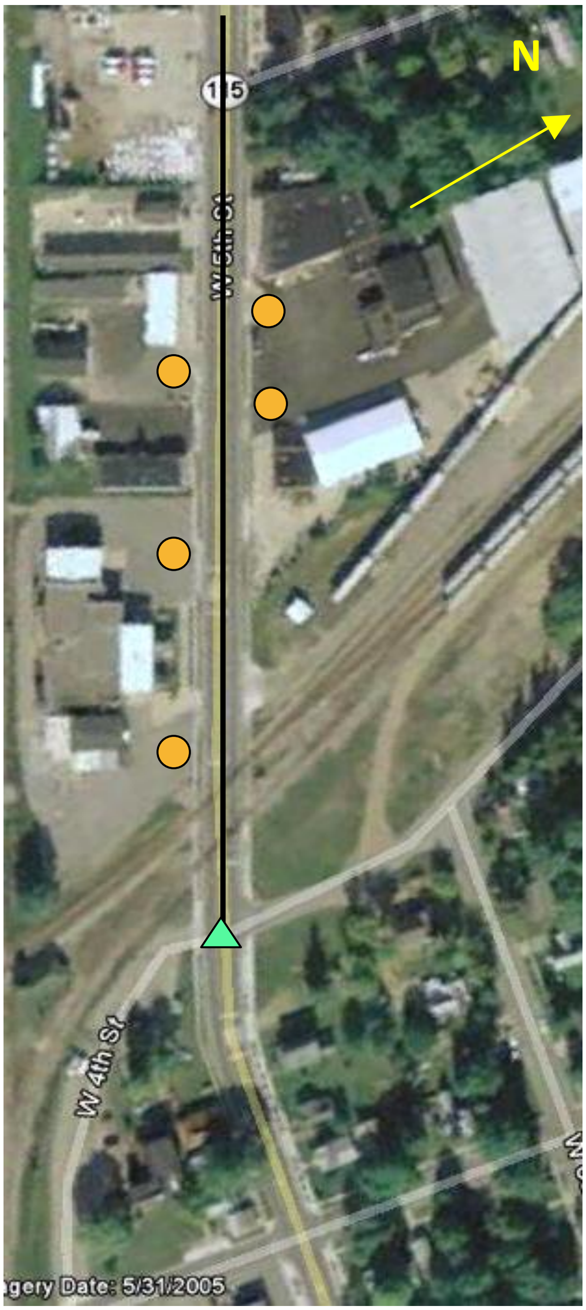
Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 4 Residential Driveways: 2 Total: 11
Adjacent Land Use	
ADT	2004 – 12,600-32,900 (850 Comm) 2006 – 10,500-18,00 (840 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
4	Clare	Clare	2004	M-115	N/A	0.5



Notes:	
Driveway Density	**Total Street Intersections: 8** **Total Commercial Driveways: 15** **Total Residential Driveways: 1** **Length: 0.5 mi** Street Intersections: 7 Commercial Driveways: 10 Residential Driveways: 1
Adjacent Land Use	
ADT	2003 – 9,400 (320 Comm) 2005 – 7,600 (370 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
4	Clare	Clare	2004	M-115	N/A	0.5

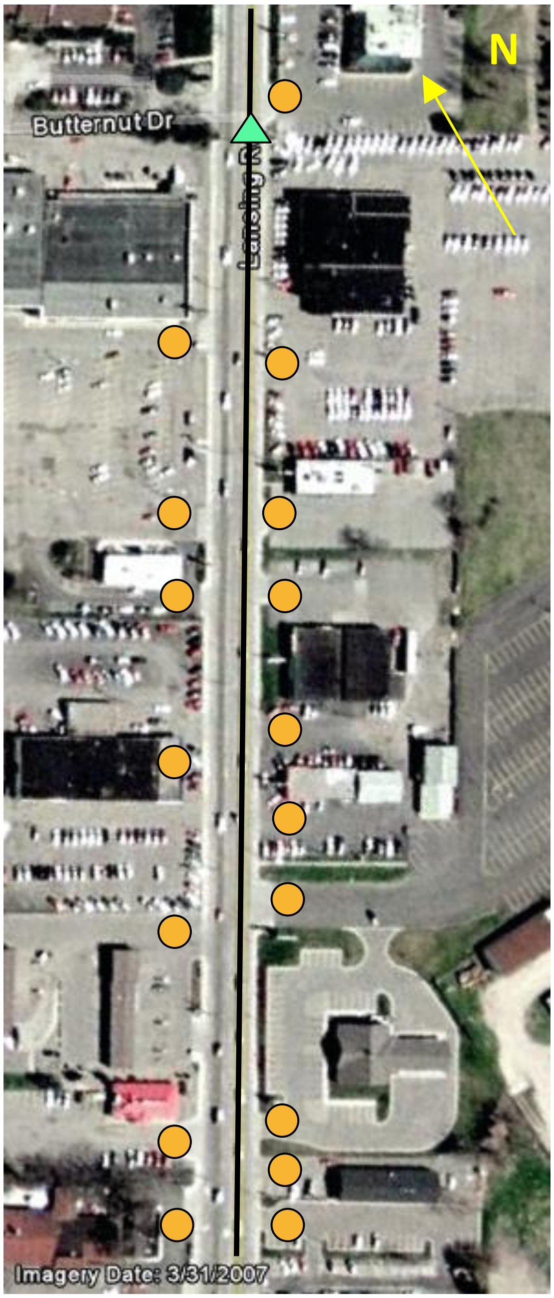


Driveway Density	Street Intersections: 1 Commercial Driveways: 5 Residential Driveways: 0 Total: 6
Adjacent Land Use	
ADT	2003 – 9,400 (320 Comm) 2005 – 7,600 (370 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
8	Eaton	Charlotte	2004	I-69BL	N/A	0.8

Notes:	
Driveway Density	**Total Street Intersections: 7** **Total Commercial Driveways: 42** **Total Residential Driveways: 7** **Length: 0.8 mi** Street Intersections: 0 Commercial Driveways: 6 Residential Driveways: 1
Adjacent Land Use	
ADT	2003 – 15,900 (420 Comm) 2005 – 13,200 (440 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
8	Eaton	Charlotte	2004	I-69BL	N/A	0.8

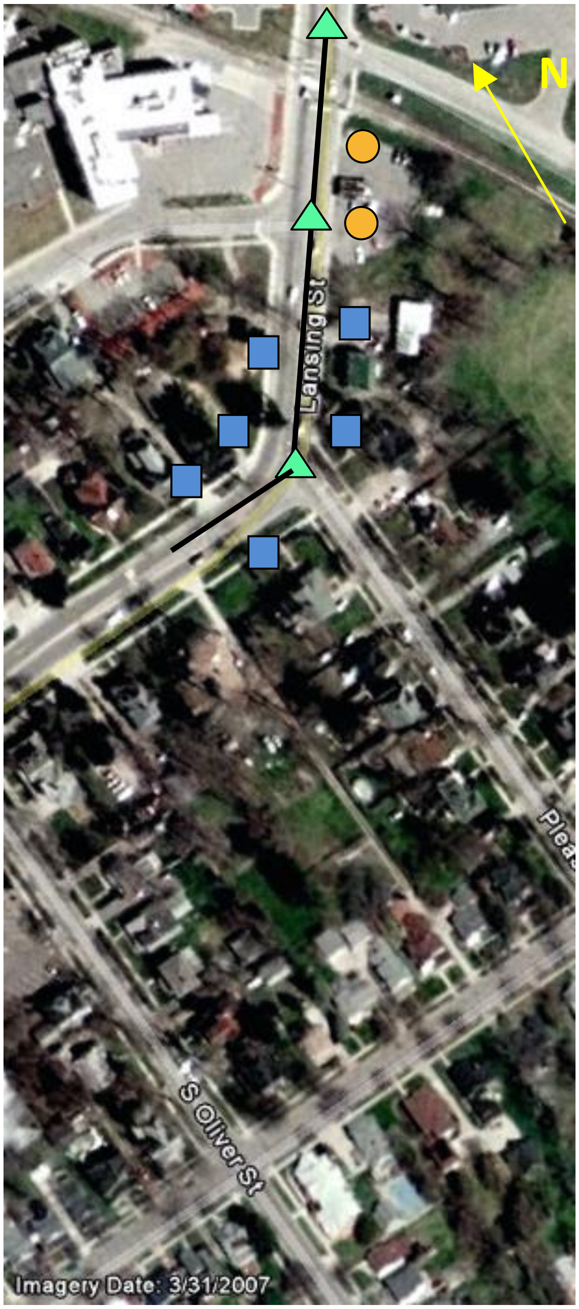


Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 17 Residential Driveways: 0 Total: 18
Adjacent Land Use	
ADT	2003 – 15,900 (420 Comm) 2005 – 13,200 (440 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
8	Eaton	Charlotte	2004	I-69BL	N/A	0.8

Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 17 Residential Driveways: 0 Total: 20
Adjacent Land Use	
ADT	2003 – 15,900 (420 Comm) 2005 – 13,200 (440 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
8	Eaton	Charlotte	2004	I-69BL	N/A	0.8



Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 2 Residential Driveways: 6 Total: 11
Adjacent Land Use	
ADT	2003 – 15,900 (420 Comm) 2005 – 13,200 (440 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
9	Eaton	Eaton Rapids	2005	M-50/M-99	N/A	0.5

Notes:	
Driveway Density	**Total Street Intersections: 8** **Total Commercial Driveways: 13** **Total Residential Driveways: 3** **Length: 0.5 mi** Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 3
Adjacent Land Use	
ADT	2004 – 16,900 (420 Comm) 2006 – 12,700 (340 Comm)

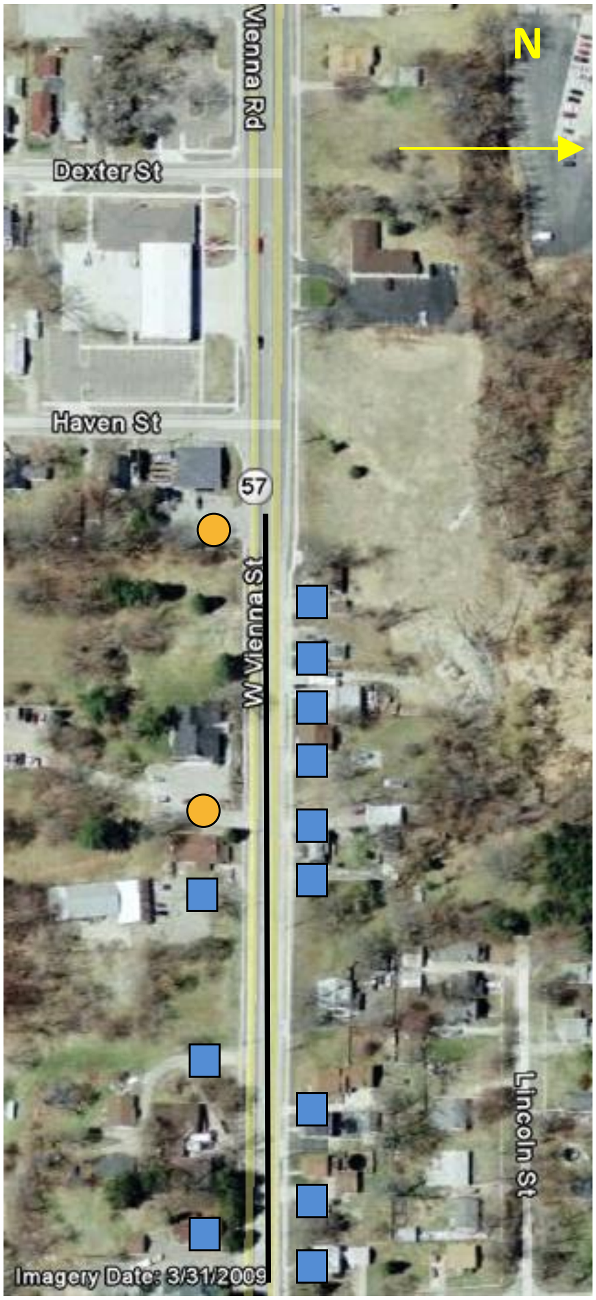
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
9	Eaton	Eaton Rapids	2005	M-50/M-99	N/A	0.5

Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 4 Residential Driveways: 0 Total: 8
Adjacent Land Use	
ADT	2004 – 16,900 (420 Comm) 2006 – 12,700 (340 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
9	Eaton	Eaton Rapids	2005	M-50/M-99	N/A	0.5

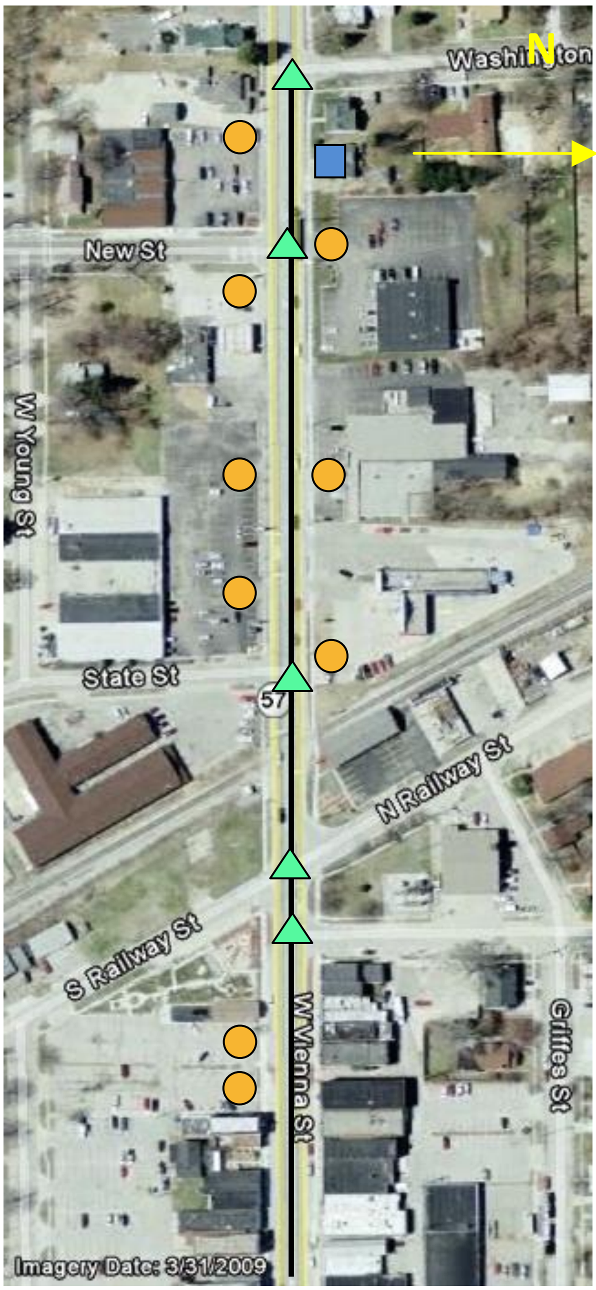
Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 9 Residential Driveways: 0 Total: 18
Adjacent Land Use	
ADT	2004 – 16,900 (420 Comm) 2006 – 12,700 (340 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5



Notes:	
Driveway Density	**Total Street Intersections: 12** **Total Commercial Driveways: 29** **Total Residential Driveways: 51** **Length: 1.5 mi** Street Intersections: 0 Commercial Driveways: 2 Residential Driveways: 12
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5

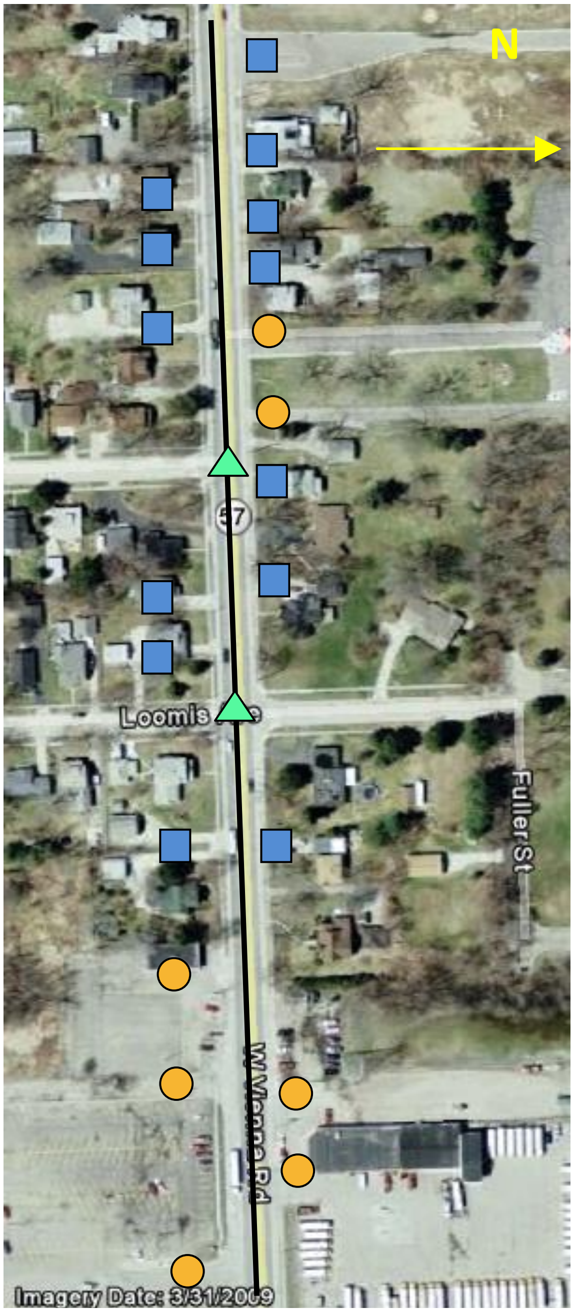


Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 9 Residential Driveways: 1 Total: 15
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5

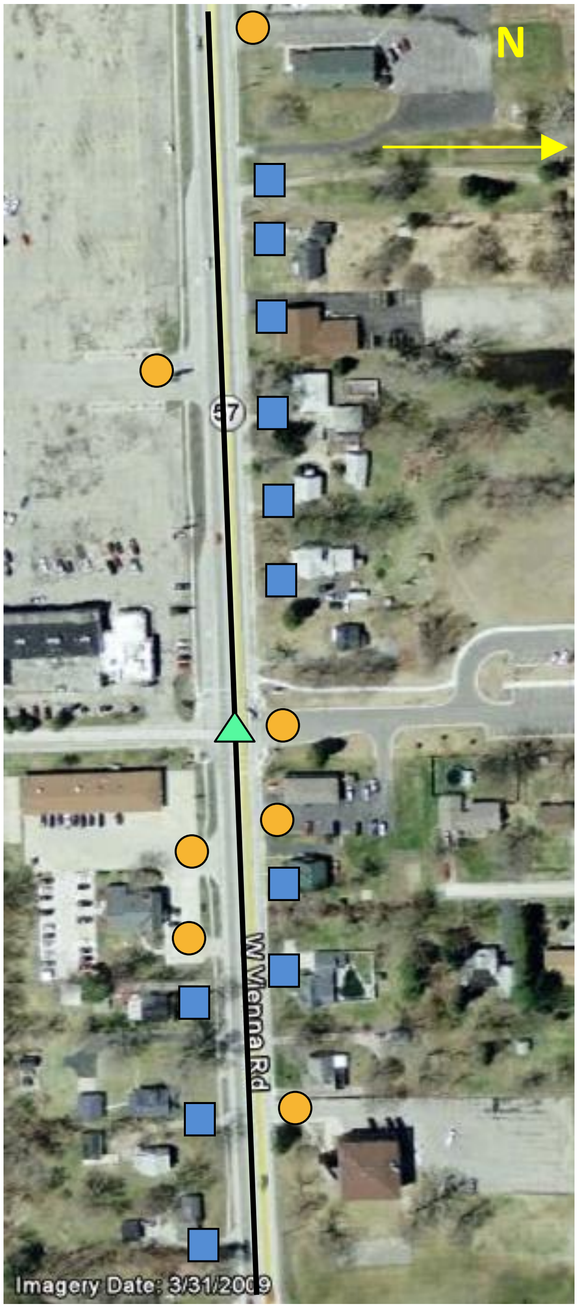
Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 4 Residential Driveways: 10 Total: 17
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5



Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 7 Residential Driveways: 13 Total: 22
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5

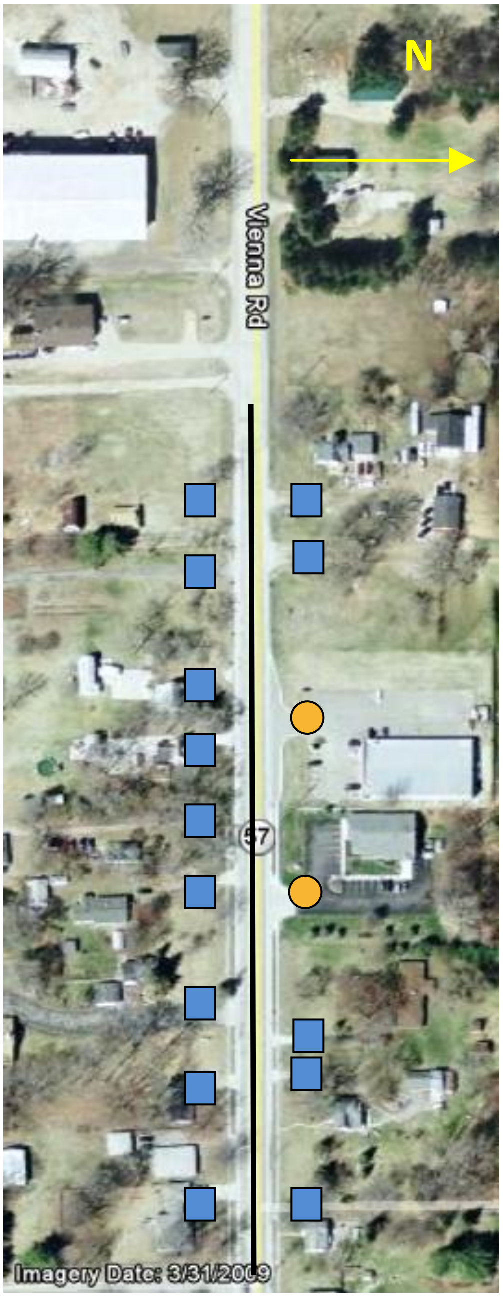


Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 7 Residential Driveways: 11 Total: 18
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
11	Genesee	Clio	2005	M-57	Vienna Rd	1.5

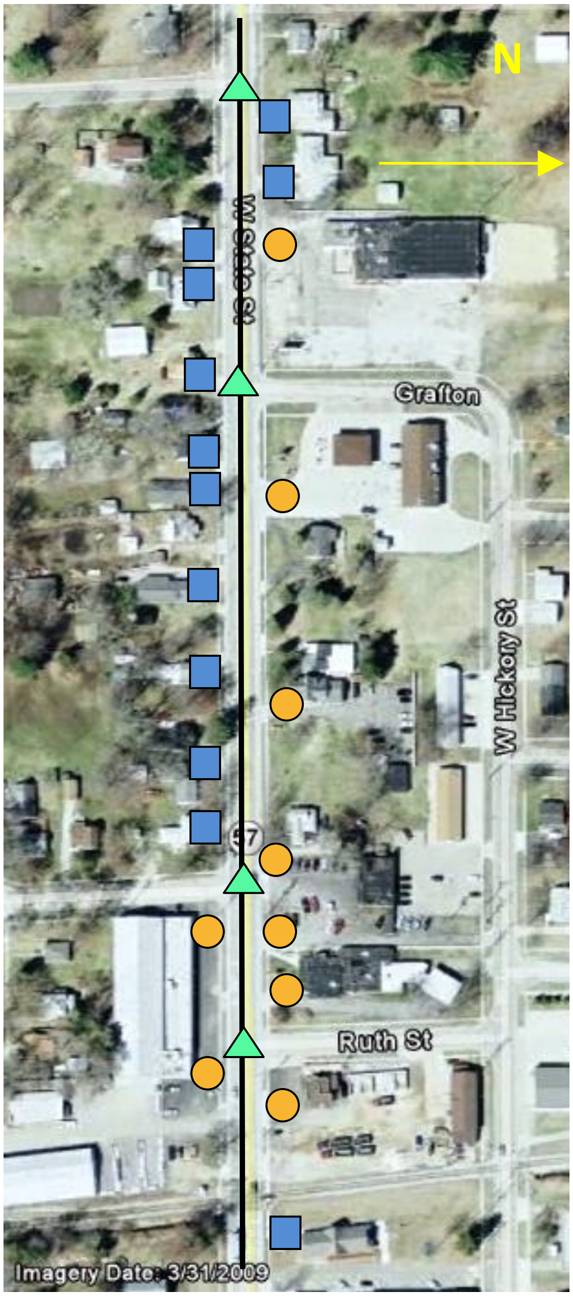
Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 4 Total: 6
Adjacent Land Use	
ADT	2004 – 13,900-160 (540 Comm) 2006 – 15,800 (480 Comm)

13	Genesee	Montrose	2003	M-57	State St	1.3
Sr. #	**county**	**city**	**Year of Construction**	**US or MDOT route #**	**street/road name (if not US or MDOT #)**	**length of project (nearest 0.1 miles)**



Notes:	
Driveway Density	**Total Street Intersections: 11** **Total Commercial Driveways: 35** **Total Residential Driveways: 62** **Length: 1.3 mi** Street Intersections: 0 Commercial Driveways: 2 Residential Driveways: 14
Adjacent Land Use	
ADT	2002 – 6,900-8,200 (730 Comm) 2004 – 6,900-7,900 (770 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
13	Genesee	Montrose	2003	M-57	State St	1.3

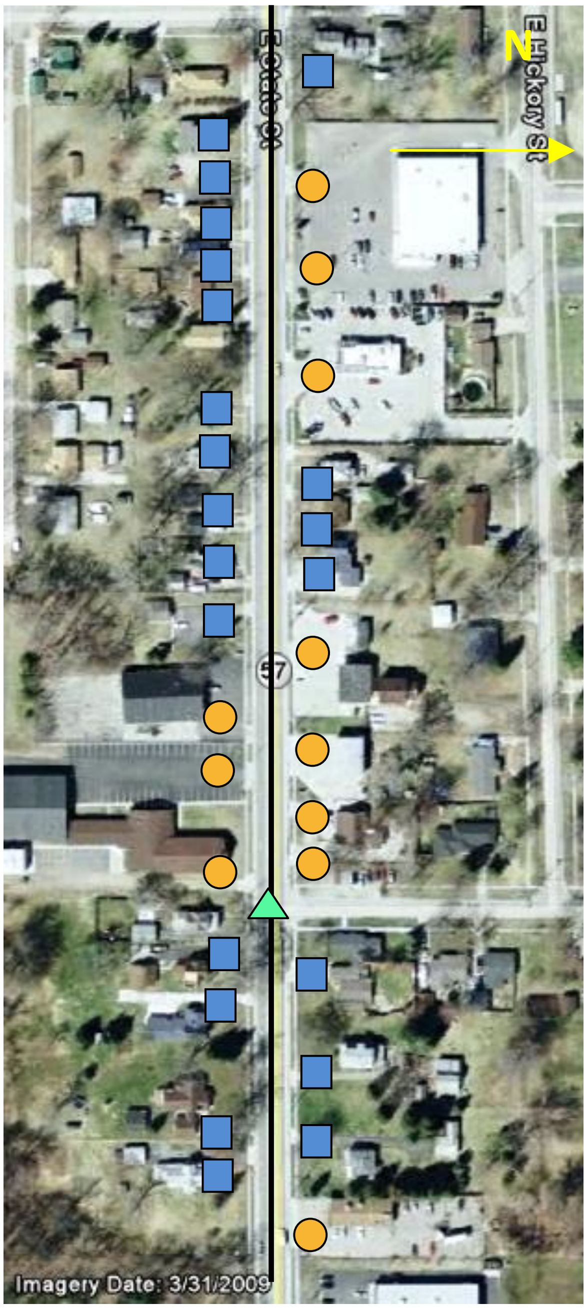


Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 9 Residential Driveways: 12 Total: 33
Adjacent Land Use	
ADT	2002 – 6,900-8,200 (730 Comm) 2004 – 6,900-7,900 (770 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
13	Genesee	Montrose	2003	M-57	State St	1.3

Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 5 Residential Driveways: 14 Total: 24
Adjacent Land Use	
ADT	2002 – 6,900-8,200 (730 Comm) 2004 – 6,900-7,900 (770 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
13	Genesee	Montrose	2003	M-57	State St	1.3

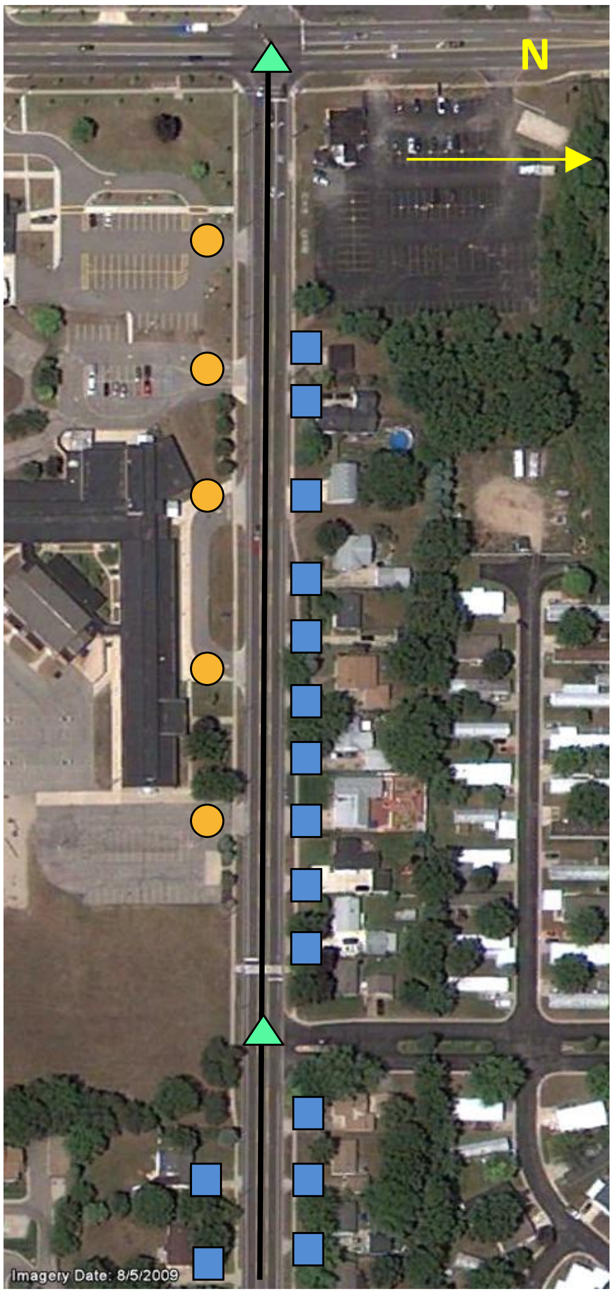


Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 11 Residential Driveways: 21 Total: 33
Adjacent Land Use	
ADT	2002 – 6,900-8,200 (730 Comm) 2004 – 6,900-7,900 (770 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
13	Genesee	Montrose	2003	M-57	State St	1.3

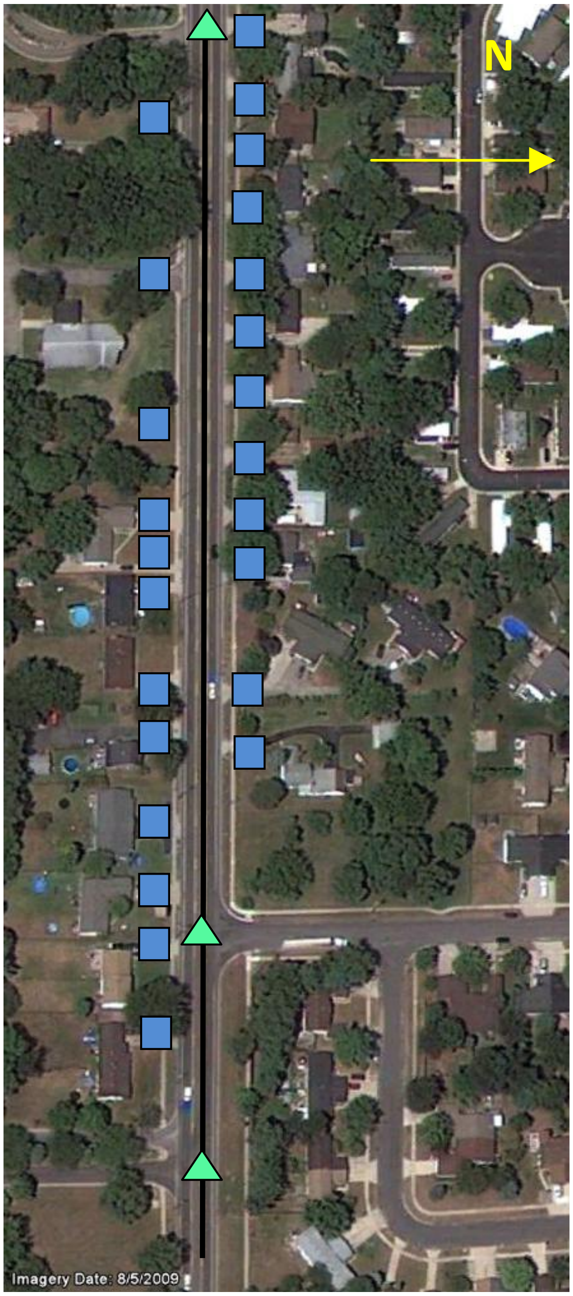
Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 8 Residential Driveways: 1 Total: 10
Adjacent Land Use	
ADT	2002 – 6,900-8,200 (730 Comm) 2004 – 6,900-7,900 (770 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
16	Kent	Grand Rapids	2007	N/A	60th Street	0.9



Notes:	
Driveway Density	**Total Street Intersections: 8** **Total Commercial Driveways: 7** **Total Residential Driveways: 51** **Length: 0.9 mi** Street Intersections: 2 Commercial Driveways: 5 Residential Driveways: 15
Adjacent Land Use	
ADT	2006 – 10,833 2009 – 11,291

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
16	Kent	Grand Rapids	2007	N/A	60th Street	0.9



Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 0 Residential Driveways: 24 Total: 27
Adjacent Land Use	
ADT	2006 – 10,833 2009 – 11,291

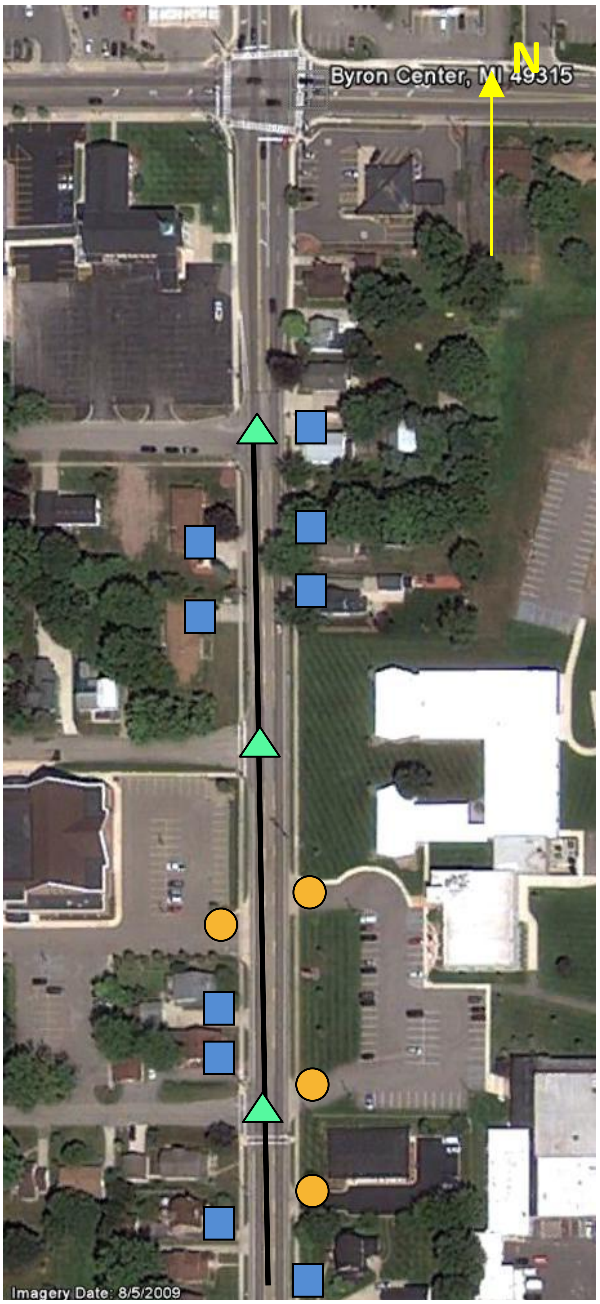
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
16	Kent	Grand Rapids	2007	N/A	60th Street	0.9

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 2 Residential Driveways: 12 Total: 16
Adjacent Land Use	
ADT	N2006 – 10,833 2009 – 11,291

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
16	Kent	Grand Rapids	2007	N/A	60th Street	0.9

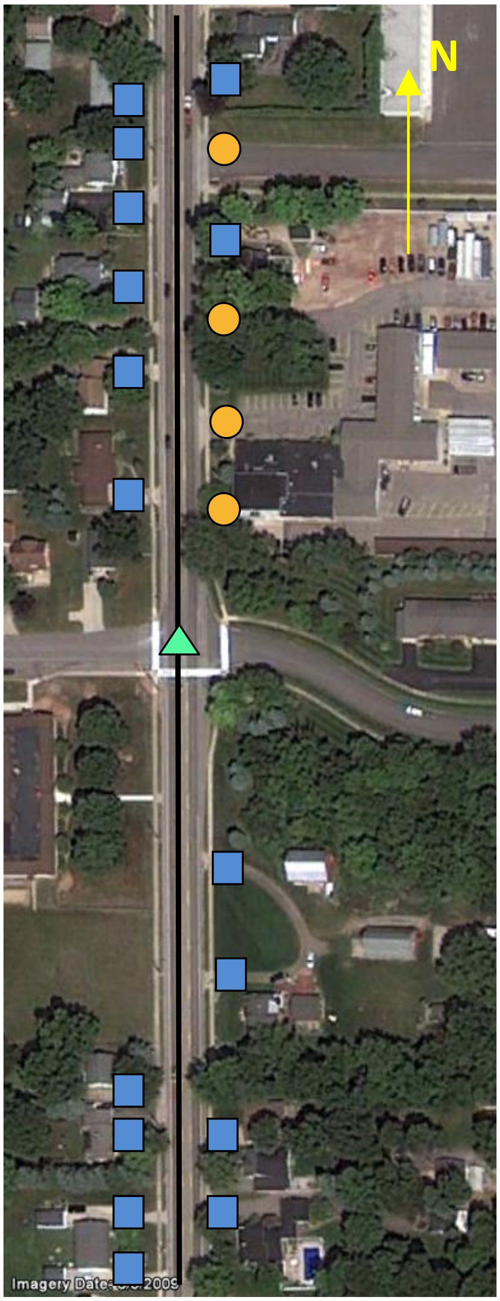
Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 0 Total: 2
Adjacent Land Use	
ADT	2006 – 10,833 2009 – 11,291

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
18	Kent	Byron Center	2005	N/A	Byron Center Ave	1.0



Notes:	
Driveway Density	**Total Street Intersections: 6** **Total Commercial Driveways: 11** **Total Residential Driveways: 44** **Length: 1.0 mi** Street Intersections: 3 Commercial Driveways: 4 Residential Driveways: 9
Adjacent Land Use	
ADT	2007 – 5,583 2008 – 9,515

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
18	Kent	Byron Center	2005	N/A	Byron Center Ave	1.0



Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 4 Residential Driveways: 16 Total: 21
Adjacent Land Use	
ADT	2007 – 5,583 2008 – 9,515

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
18	Kent	Byron Center	2005	N/A	Byron Center Ave	1.0

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 3 Residential Driveways: 9 Total: 13
Adjacent Land Use	
ADT	2007 – 5,583 2008 – 9,515

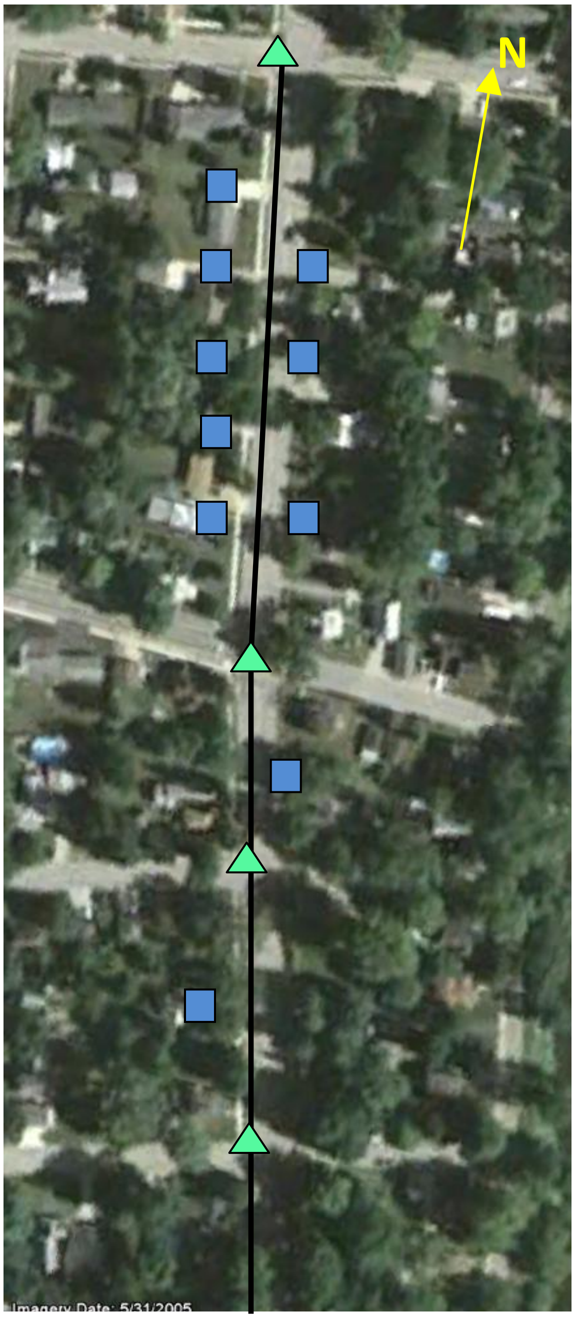
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
18	Kent	Byron Center	2005	N/A	Byron Center Ave	1.0

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 10 Total: 11
Adjacent Land Use	
ADT	2007 – 5,583 2008 – 9,515

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
20	Kent	Lowell	2006	N/A	Hudson St	0.7

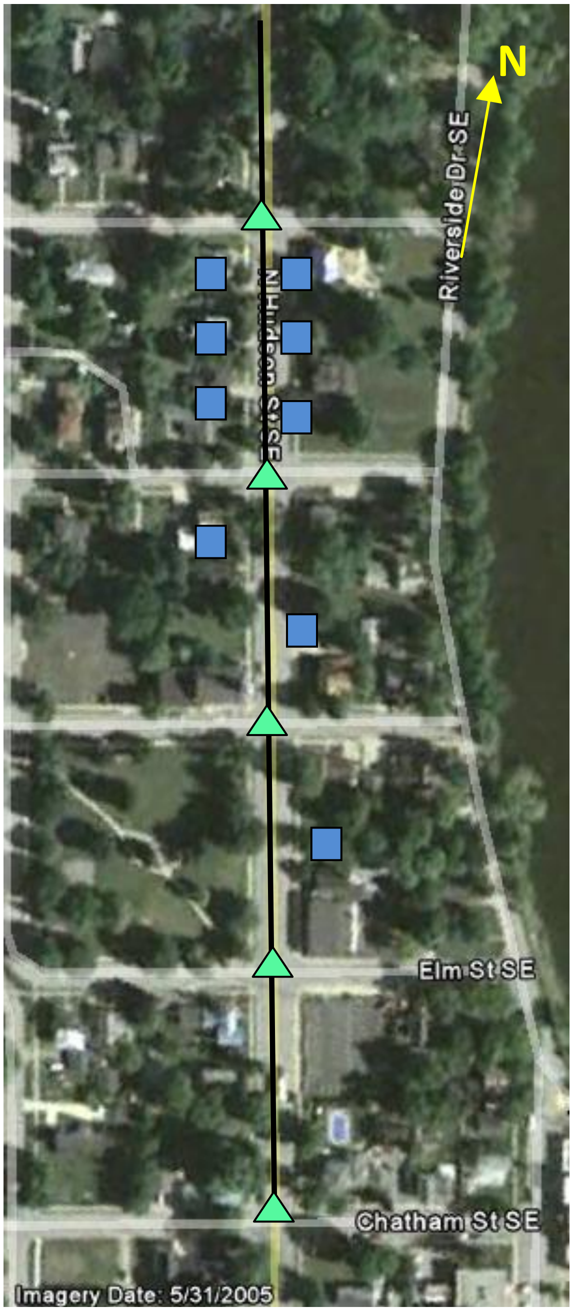
Notes:	
Driveway Density	**Total Street Intersections: 9** **Total Commercial Driveways: 1** **Total Residential Driveways: 33** **Length: 0.7 mi** Street Intersections: 0 Commercial Driveways: 1 Residential Driveways: 14
Adjacent Land Use	
ADT	2005 – 13,799 2008 – 12,908

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
20	Kent	Lowell	2006	N/A	Hudson St	0.7



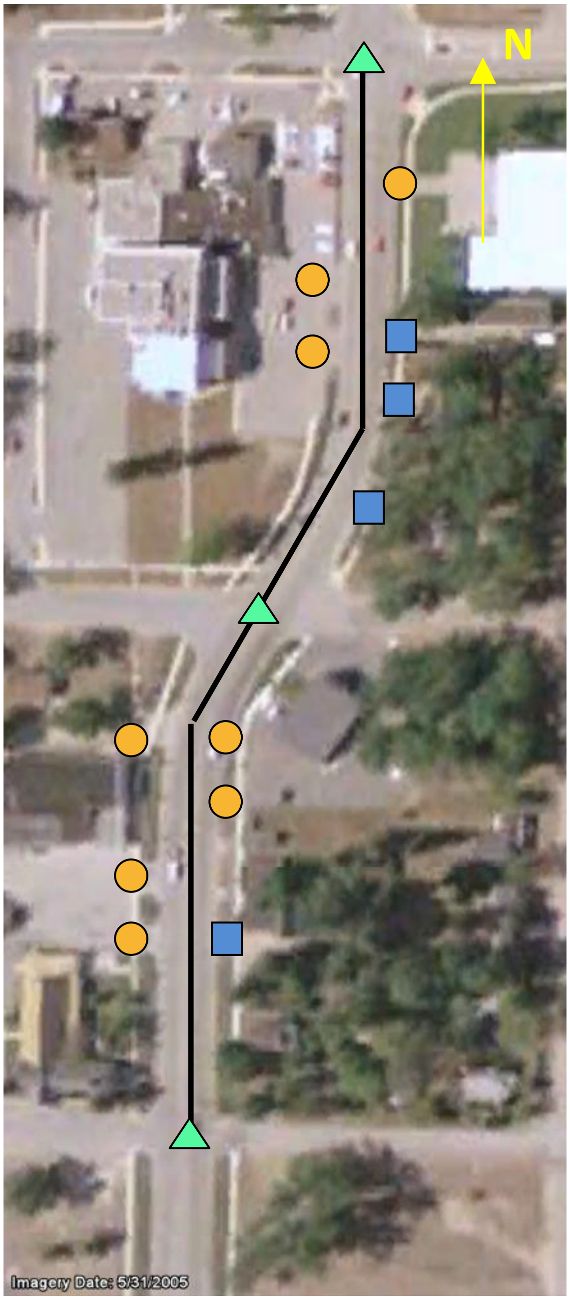
Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 0 Residential Driveways: 10 Total: 14
Adjacent Land Use	
ADT	2005 – 13,799 2008 – 12,908

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
20	Kent	Lowell	2006	N/A	Hudson St	0.7



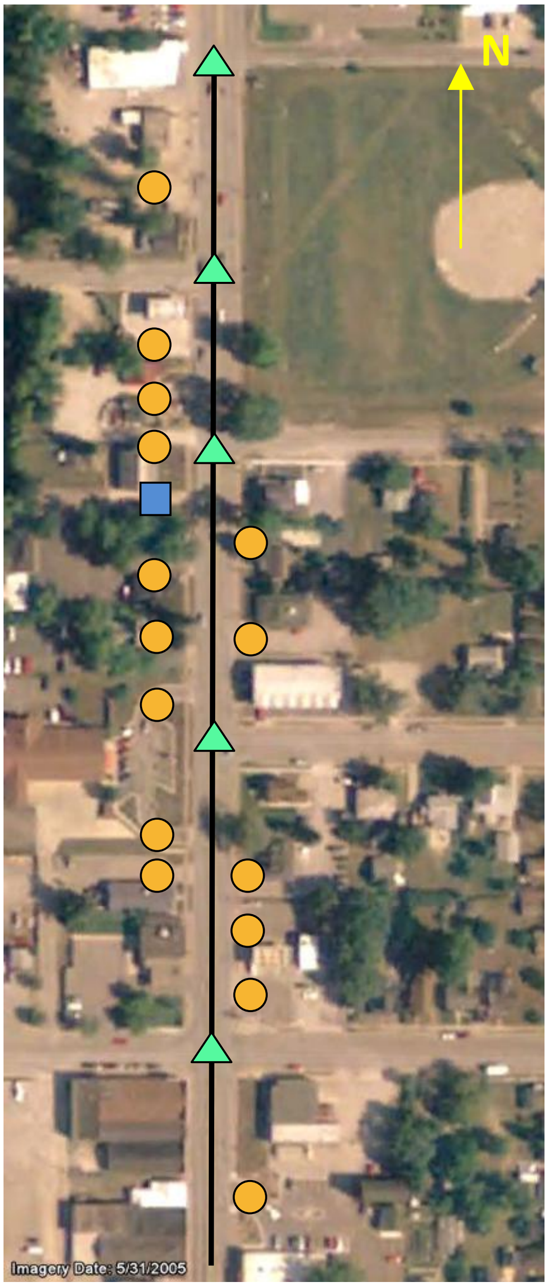
Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 0 Residential Driveways: 9 Total: 14
Adjacent Land Use	
ADT	2005 – 13,799 2008 – 12,908

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
22	Lake	Baldwin	1998	M-37	Michigan Ave	0.2



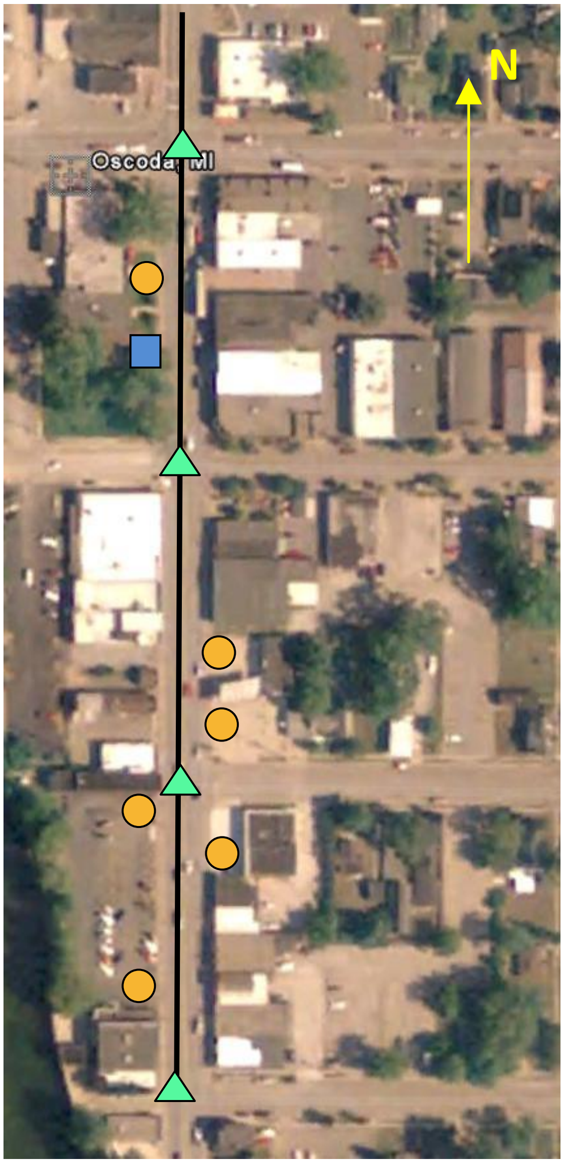
Notes:	
Driveway Density	**Total Street Intersections: 3** **Total Commercial Driveways: 8** **Total Residential Driveways: 4** **Length: 0.2 mi**
Adjacent Land Use	
ADT	1997 – 5,500 (280 Comm) 1999 – 5,800 (290 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
23	Iosco	Oscoda	2007	US-23	N/A	0.5



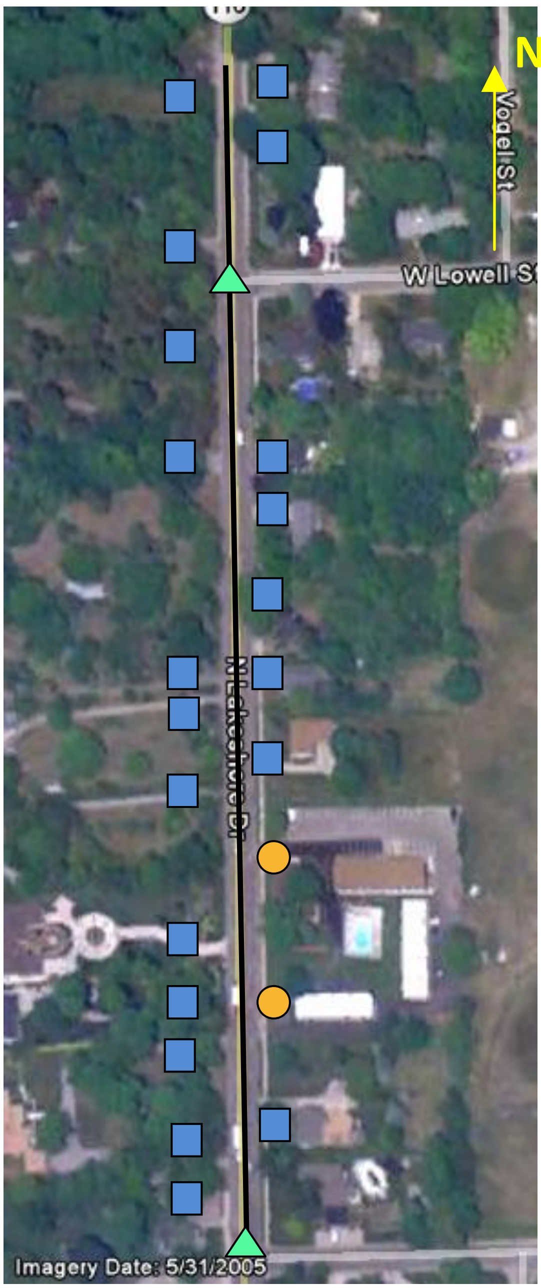
Notes:	
Driveway Density	**Total Street Intersections: 9** **Total Commercial Driveways: 21** **Total Residential Driveways: 2** **Length: 0.5 mi** Street Intersections: 5 Commercial Driveways: 15 Residential Driveways: 1
Adjacent Land Use	
ADT	2006 – 8,600-9,000 (260 Comm) 2008 – 5,100-7,600 (260 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
23	Iosco	Oscoda	2007	US-23	N/A	0.5



Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 6 Residential Driveways: 1 Total: 11
Adjacent Land Use	
ADT	2006 – 8,600-9,000 (260 Comm) 2008 – 5,100-7,600 (260 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
25	Mason	Ludington	2006	M-116	Lakeshore Dr	0.8

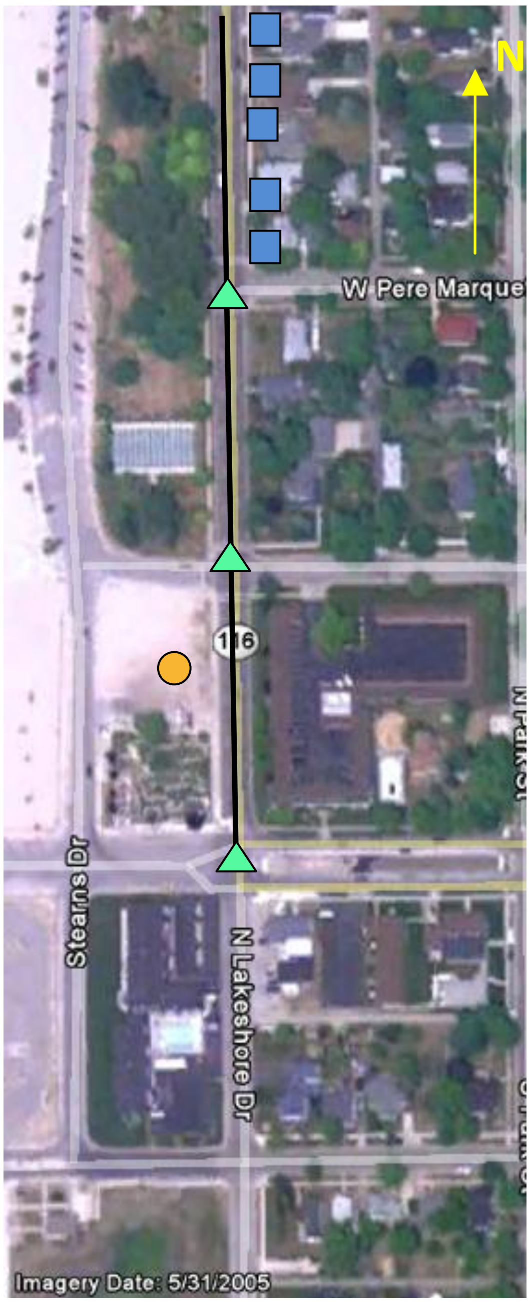


Notes:	
Driveway Density	**Total Street Intersections: 8** **Total Commercial Driveways: 4** **Total Residential Driveways: 34** **Length: 0.8 mi** Street Intersections: 2 Commercial Driveways: 2 Residential Driveways: 20
Adjacent Land Use	
ADT	2005 – 10,000 (120 Comm) 2007 – 4,200 (100 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
25	Mason	Ludington	2006	M-116	Lakeshore Dr	0.8

Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 1 Residential Driveways: 9 Total: 12
Adjacent Land Use	
ADT	2005 – 10,000 (120 Comm) 2007 – 4,200 (100 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
25	Mason	Ludington	2006	M-116	Lakeshore Dr	0.8

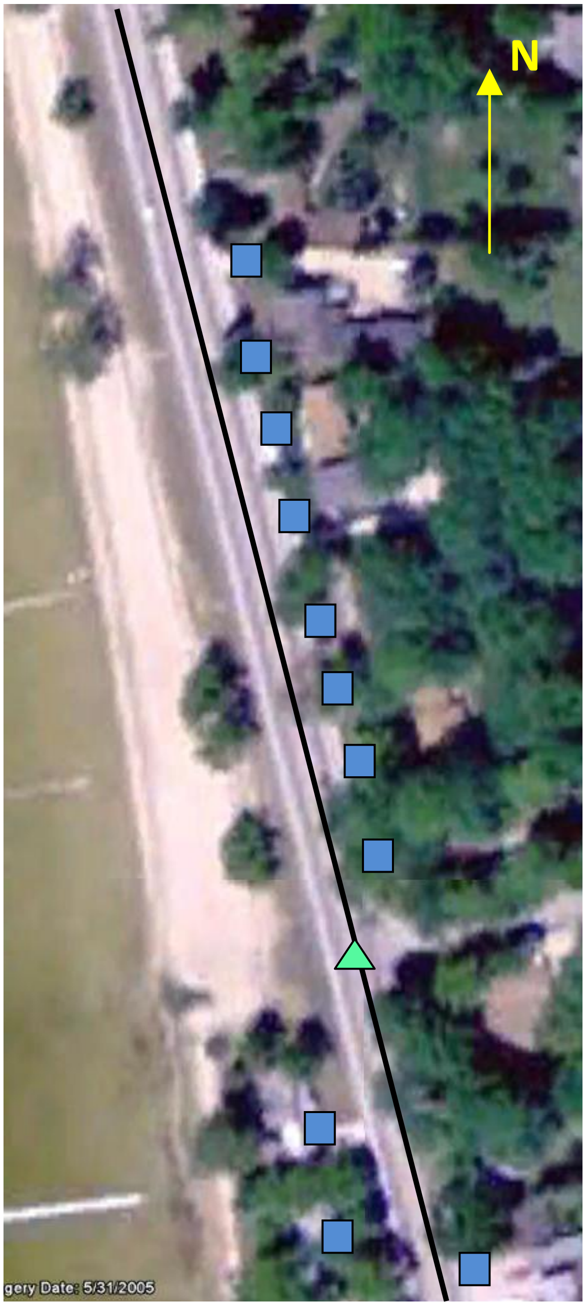


Notes:	
Driveway Density	Street Intersections: 3 Commercial Driveways: 1 Residential Driveways: 5 Total: 9
Adjacent Land Use	
ADT	2005 – 10,000 (120 Comm) 2007 – 4,200 (100 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
26	Missaukee	Lake City	2006	M-55/M-66	Morey Rd/Main St	0.6

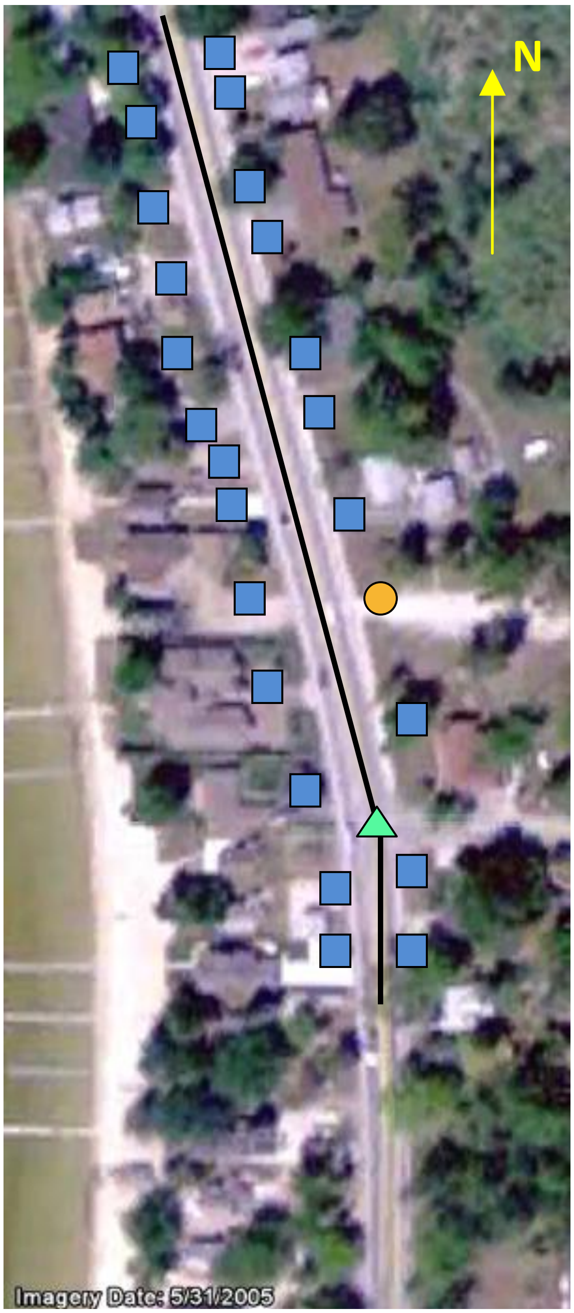
Notes:	
Driveway Density	**Total Street Intersections: 5** **Total Commercial Driveways: 3** **Total Residential Driveways: 36** **Length: 0.6 mi** Street Intersections: 3 Commercial Driveways: 2 Residential Driveways: 2
Adjacent Land Use	
ADT	2001 – 11,800 (820 Comm) 2003 – 11,700 (820 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
26	Missaukee	Lake City	2006	M-55/M-66	Morey Rd/Main St	0.6



Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 11 Total: 12
Adjacent Land Use	
ADT	2001 – 11,800 (820 Comm) 2003 – 11,700 (820 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
26	Missaukee	Lake City	2006	M-55/M-66	Morey Rd/Main St	0.6



Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 1 Residential Driveways: 23 Total: 25
Adjacent Land Use	
ADT	2001 – 11,800 (820 Comm) 2003 – 11,700 (820 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
29	Otsego	Gaylord	2005	M-32	N/A	0.5

Notes:	
Driveway Density	**Total Street Intersections: 4** **Total Commercial Driveways: 2** **Total Residential Driveways: 28** **Length: 0.5 mi** Street Intersections: 2 Commercial Driveways: 2 Residential Driveways: 11
Adjacent Land Use	
ADT	2004 – 10,100 (330 Comm) 2006 – 4,100 (270 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
29	Otsego	Gaylord	2005	M-32	N/A	0.5

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 10 Total: 11
Adjacent Land Use	
ADT	2004 – 10,100 (330 Comm) 2006 – 4,100 (270 Comm)

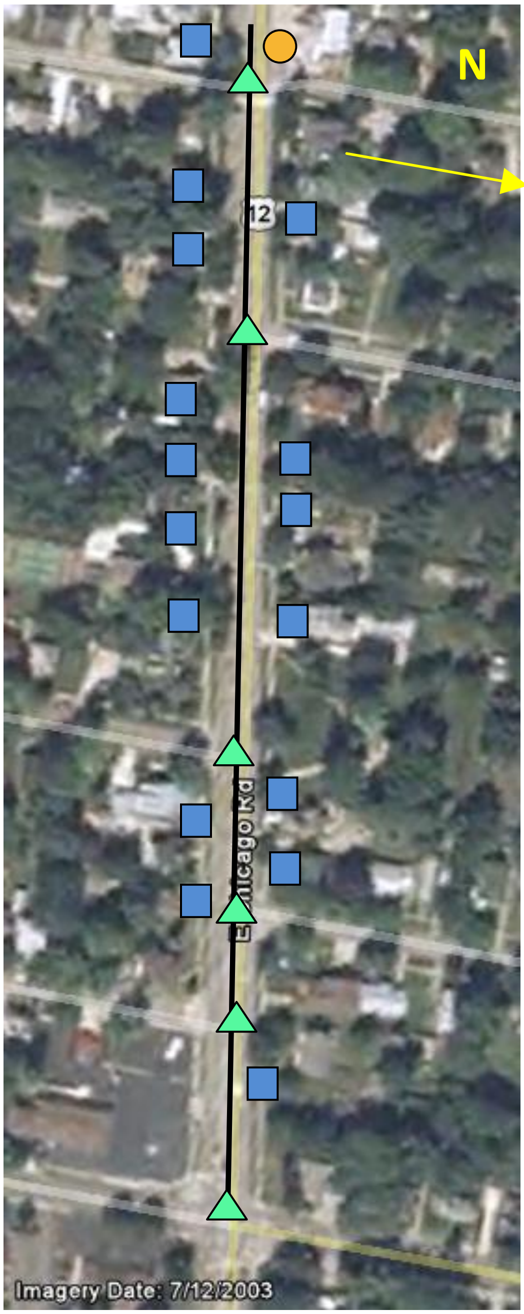
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
29	Otsego	Gaylord	2005	M-32	N/A	0.5

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 7 Total: 8
Adjacent Land Use	
ADT	2004 – 10,100 (330 Comm) 2006 – 4,100 (270 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
30	St. Joseph	Sturgis	2006	US-12	N/A	0.4

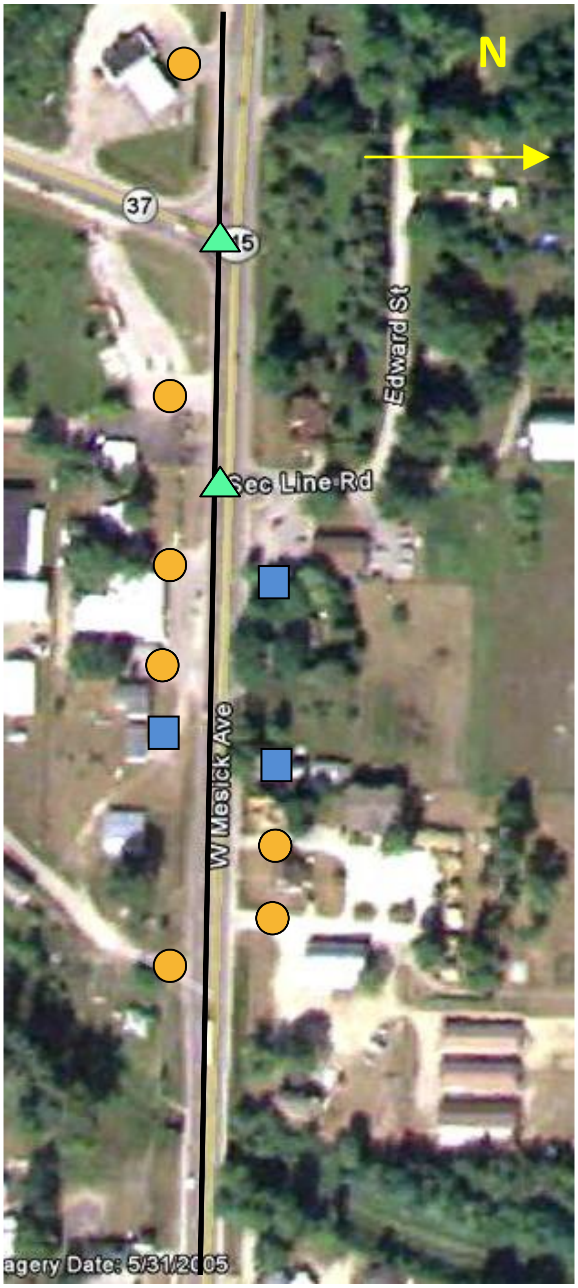
Notes:	
Driveway Density	**Total Street Intersections: 8** **Total Commercial Driveways: 9** **Total Residential Driveways: 16** **Length: 0.4 mi** Street Intersections: 2 Commercial Driveways: 8 Residential Driveways: 0
Adjacent Land Use	
ADT	2005 – 6,500-8,200 (420 Comm) 2009 – 6,300-8,300 (330 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
30	St. Joseph	Sturgis	2006	US-12	N/A	0.4



Notes:	
Driveway Density	Street Intersections: 6 Commercial Driveways: 1 Residential Driveways: 16 Total: 23
Adjacent Land Use	
ADT	2005 – 6,500-8,200 (420 Comm) 2009 – 6,300-8,300 (330 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
33	Wexford	Mesick	2006	M-115/M-37	Mesick Ave	0.7



Notes:	
Driveway Density	**Total Street Intersections: 6** **Total Commercial Driveways: 12** **Total Residential Driveways: 7** **Length: 0.7 mi** Street Intersections: 2 Commercial Driveways: 7 Residential Driveways: 3
Adjacent Land Use	
ADT	2005 – 7,400-7,700 (420 Comm) 2007 – 5,100-5,500 (330 Comm)

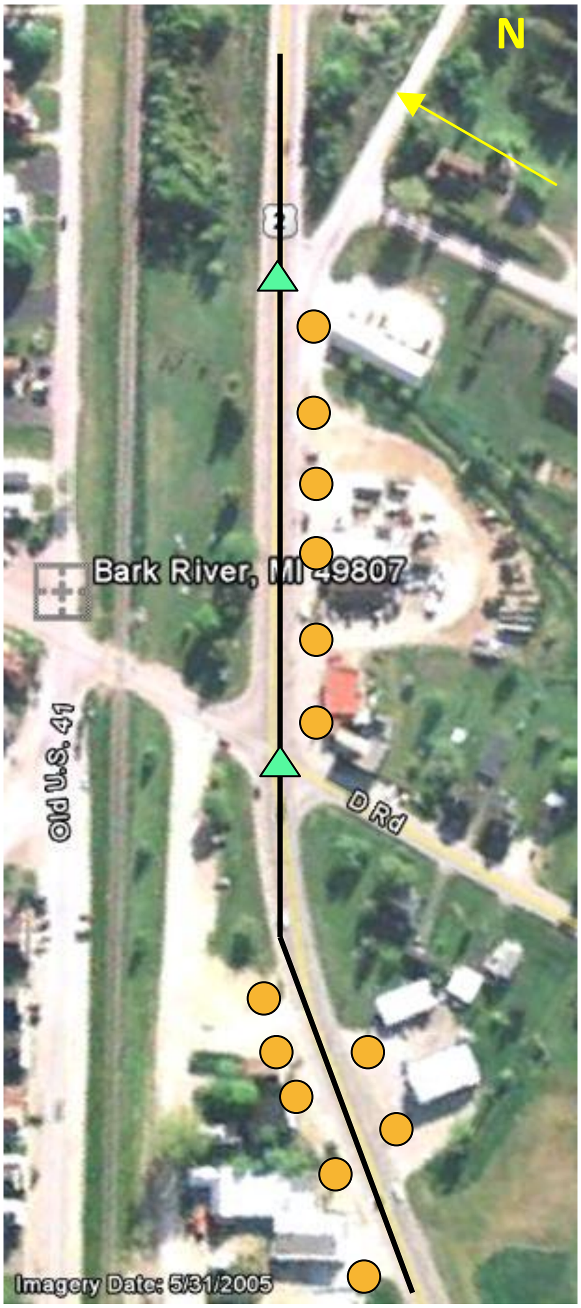
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
33	Wexford	Mesick	2006	M-115/M-37	Mesick Ave	0.7

Driveway Density	Street Intersections: 3 Commercial Driveways: 7 Residential Driveways: 3 Total: 13
Adjacent Land Use	
ADT	2005 – 7,400-7,700 (420 Comm) 2007 – 5,100-5,500 (330 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
33	Wexford	Mesick	2006	M-115/M-37	Mesick Ave	0.7

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 1 Total: 2
Adjacent Land Use	
ADT	2005 – 7,400-7,700 (420 Comm) 2007 – 5,100-5,500 (330 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
34	Delta	Bark River	2006	US-2/US-41	N/A	0.5

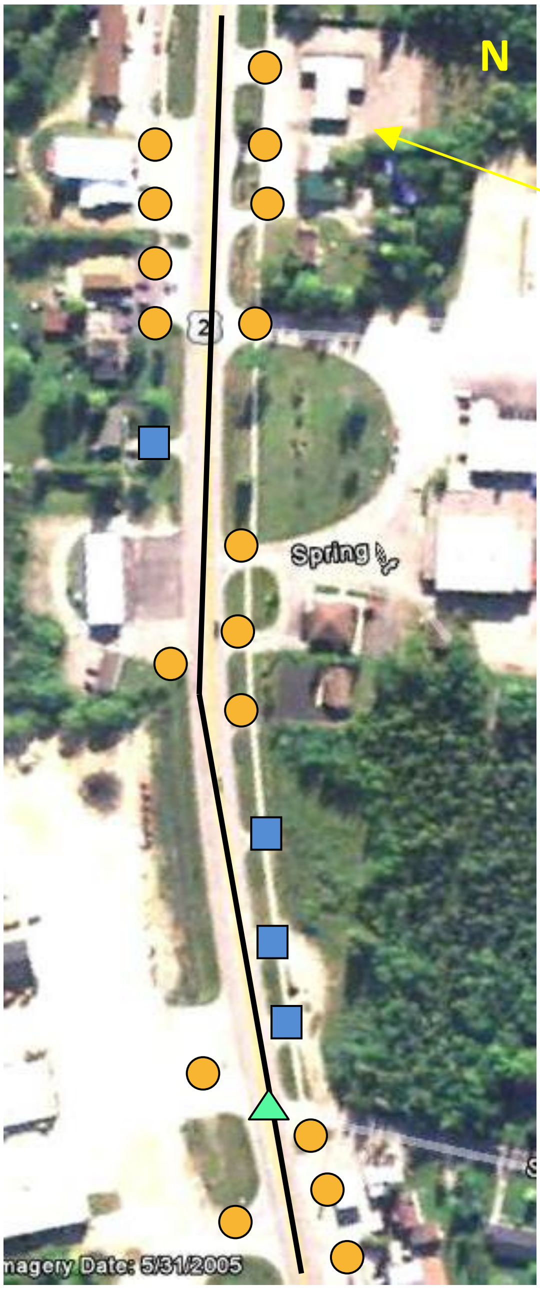


Notes:	
Driveway Density	**Total Street Intersections: 2** **Total Commercial Driveways: 18** **Total Residential Driveways: 4** **Length: 0.5 mi** Street Intersections: 2 Commercial Driveways: 13 Residential Driveways: 0
Adjacent Land Use	
ADT	2005 – 7,100 (330 Comm) 2007 – 7,900 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
34	Delta	Bark River	2006	US-2/US-41	N/A	0.5

Notes:	
Driveway Density	Street Intersections: 0 Commercial Driveways: 5 Residential Driveways: 4 Total: 9
Adjacent Land Use	
ADT	2005 – 7,100 (330 Comm) 2007 – 7,900 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
36	Delta	Powers	2005	US-41	N/A	0.9

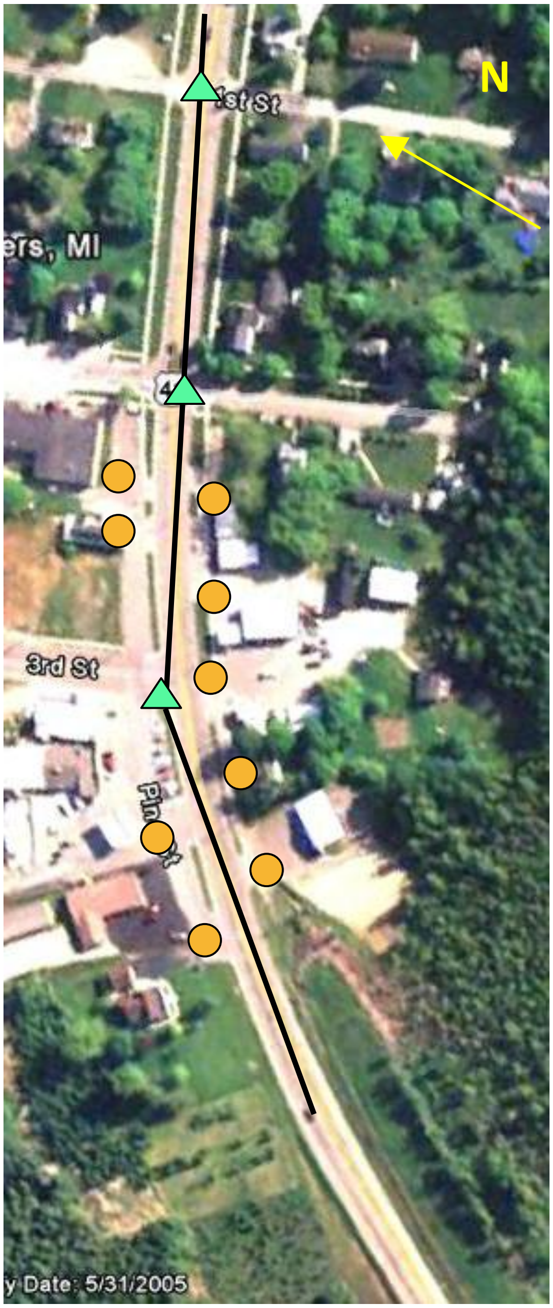


Notes:	
Driveway Density	**Total Street Intersections: 5** **Total Commercial Driveways: 32** **Total Residential Driveways: 10** **Length: 0.9 mi** Street Intersections: 1 Commercial Driveways: 17 Residential Driveways: 4
Adjacent Land Use	
ADT	2004 – 3,100-8,30 (410-600 Comm) 2006 – 2,800-6,500 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
36	Delta	Powers	2005	US-41	N/A	0.9

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 6 Residential Driveways: 6 Total: 13
Adjacent Land Use	
ADT	2004 – 3,100-8,30 (410-600 Comm) 2006 – 2,800-6,500 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
36	Delta	Powers	2005	US-41	N/A	0.9



Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 9 Residential Driveways: 0 Total: 12
Adjacent Land Use	
ADT	2004 – 3,100-8,30 (410-600 Comm) 2006 – 2,800-6,500 (480 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
37	Eaton	Grand Ledge		M-100	Bridge St.	0.3

Notes:	
Driveway Density	**Total Street Intersections: 4** **Total Commercial Driveways: 4** **Total Residential Driveways: 0** **Length: 0.3 mi** Street Intersections: 3 Commercial Driveways: 4 Residential Driveways: 0
Adjacent Land Use	
ADT	2003 – 7,200 (560 Comm) 2007 – 6,300 (430 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
37	Eaton	Grand Ledge		M-100	Bridge St.	0.3

Notes:	
Driveway Density	Street Intersections: 1 Commercial Driveways: 0 Residential Driveways: 0 Total: 1
Adjacent Land Use	
ADT	2003 – 7,200 (560 Comm) 2007 – 6,300 (430 Comm)

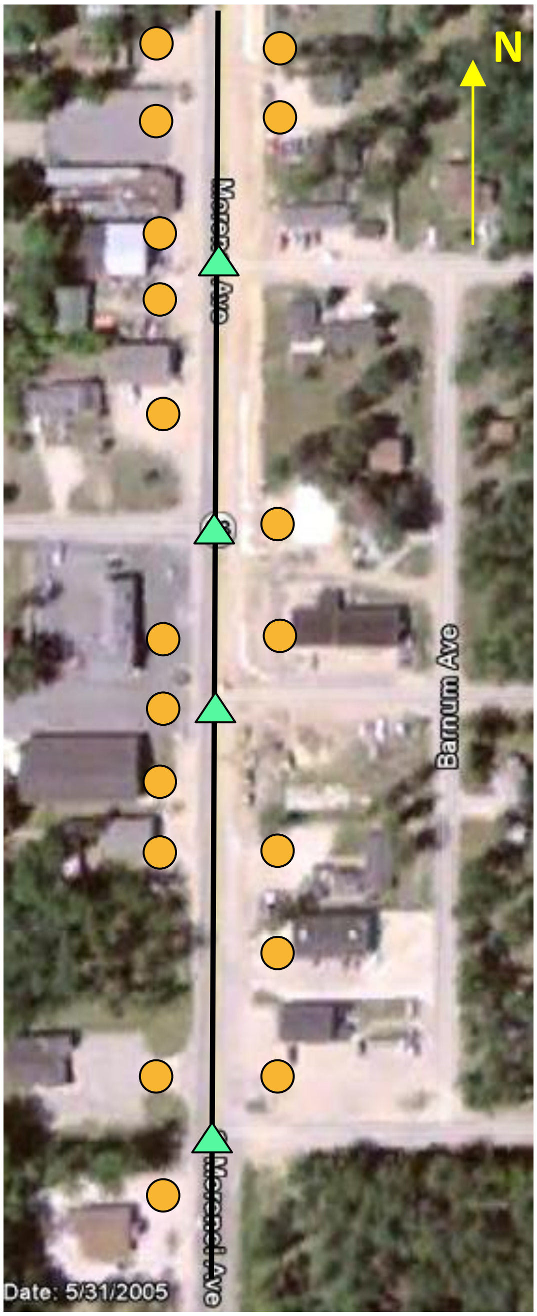
Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
39	Alpena	Alpena	2002	N/A	9th St	0.4

Notes:	
Driveway Density	Total Street Intersections: 5 Total Commercial Driveways: 8 Total Residential Driveways: 6 Length: 0.4 mi
Adjacent Land Use	
ADT	

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
41	Oscoda	Big Creek	2005	M-33	Morenci Ave	0.5

Notes:	
Driveway Density	**Total Street Intersections: 7** **Total Commercial Driveways:29** **Total Residential Driveways: 2** **Length: 0.5 mi** Street Intersections: 3 Commercial Driveways: 11 Residential Driveways: 2
Adjacent Land Use	
ADT	2004 – 3,400 (490 Comm) 2006 – 3,700 (300 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
41	Oscoda	Big Creek	2005	M-33	Morenci Ave	0.5

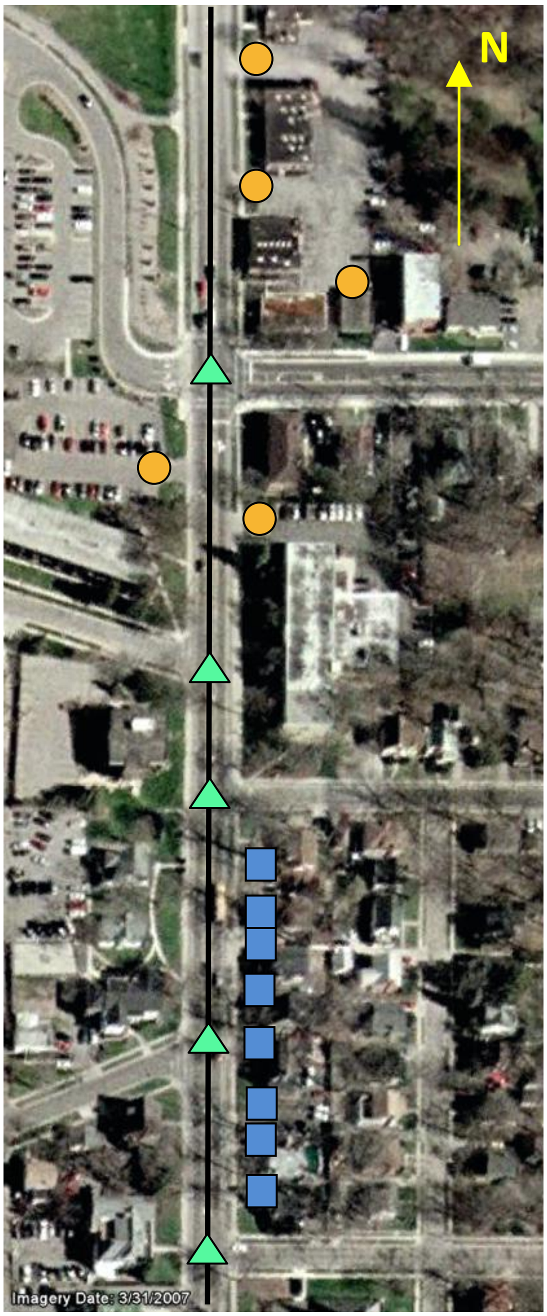


Notes:	
Driveway Density	Street Intersections: 4 Commercial Driveways: 18 Residential Driveways: 0 Total: 21
Adjacent Land Use	
ADT	2004 – 3,400 (490 Comm) 2006 – 3,700 (300 Comm)

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
43	Ingham	East Lansing	1999	N/A	Abbot Rd	0.8

Notes:	
Driveway Density	**Total Street Intersections: 11** **Total Commercial Driveways: 14** **Total Residential Driveways: 13** **Length: 0.8 mi** Street Intersections: 4 Commercial Driveways: 3 Residential Driveways: 4
Adjacent Land Use	
ADT	1997 – 14,311-15,190 2000 – 8,239

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
43	Ingham	East Lansing	1999	N/A	Abbot Rd	0.8



Notes:	
Driveway Density	Street Intersections: 5 Commercial Driveways: 5 Residential Driveways: 8 Total: 18
Adjacent Land Use	
ADT	1997 – 14,311-15,190 2000 – 8,239

Sr. #	county	city	Year of Construction	US or MDOT route #	street/road name (if not US or MDOT #)	length of project (nearest 0.1 miles)
43	Ingham	East Lansing	1999	N/A	Abbot Rd	0.8

Notes:	
Driveway Density	Street Intersections: 2 Commercial Driveways: 6 Residential Driveways: 1 Total: 9
Adjacent Land Use	
ADT	1997 – 14,311-15,190 2000 – 8,239

APPENDIX G

SURVEY INSTRUMENT FOR INITIAL SOLICITATION OF SITE INFORMATION

MSU "road diet" project: project/implementation site data request

The Department of Civil and Environmental Engineering at Michigan State University is conducting an MDOT-sponsored study on current "road diet" applications within the state to develop guidelines for future applications. As part of this study, we are cataloging as many of those applications as possible—please describe all applications within your jurisdiction using the form below. Please provide answers in shaded areas (electronically or on a hard copy): "check" the boxes; provide explanation/comments in shaded areas. (The comment boxes will "expand" as you write—don't worry about changes in the pagination that will also occur.) Instructions for sending us the completed form are at the end.

Notes: (1) If you have more than one site, please fill out one form/site. **(2)** If you have plan-view drawings that you can send (or point us to electronically), at least some of the questions below could be answered by sending us those drawings.

Location	
county	
city	
US or MDOT route # (e.g., US-2, M-36)	
street/road name (if not US or MDOT #)	
comment(s) about location:	
Project/Construction Information	
construction start date (work zone in place)	
construction end date (work zone removed)	
control section number/physical road (PR) number	control section: PR:
length of project (use nearest 0.1 miles)	. miles
beginning point cross street/road	
beginning PR/CS mile point of treatment	
ending point cross street/road	
ending PR/CS mile point of treatment	
type of treatment	check **all that apply…** ☐ no physical changes to road (i.e., diet accomplished by signing and/or marking) ☐ re-paving and/or reconstruction within existing curbs and roadway width ☐ temporary curbs used on existing roadway ☐ re-paving/reconstruction that changes roadway width (permanent change) ☐ completely new roadway with diet in place ☐ new signalization timing ☐ new signals—same configuration (e.g., arrows) ☐ new signals—new configuration ☐ change is reversible if "diet" doesn't work ☐ change is permanent, very difficult to change to other configuration
comment(s) about basic project:	

Reasons/Rationale for Road Diet Project	
please indicate which of the listed reasons provided the motivation for this road diet project (check more than one as needed)	check **all that apply…** ☐ general community initiative ☐ proposed by specific neighborhood please specify: ☐ proposed by special interest group (e.g., bicyclists) please specify: ☐ traffic calming ☐ street/road safety ☐ pedestrian/bicyclist safety ☐ reduce vehicular speeds in corridor ☐ reduce traffic ☐ reduce left-turn problems at intersections ☐ reduce mid-block turning movement problems ☐ part of larger initiative (e.g., bike path network) please specify: ☐ reduce excess capacity of street/road ☐ save money ☐ other, please specify:
comment(s) about project rationale:	
Intersection and Signal Data	
intersection data ***that could be provided*** for intersections in diet section before and after treatment (separately from survey)	☐ list of signalized intersections (for both before and after if different) ☐ type of signal (e.g., fixed, semi-actuated) for each intersection (for both before and after if different) ☐ signal timing (for both before and after if different) ☐ intersection turning counts ☐ PHF values ☐ speed study data ☐ SYNCHRO or HCS work on intersections
comment(s) about intersection/signal data:	

Geometric and Other Descriptive Information	
street/road classification	☐ arterial ☐ collector ☐ local
curb-to-curb street/road width in feet	(insert number)
total number of vehicle travel lanes (not counting parking lanes)	**before** treatment: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
	after treatment: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
normal lane width	**before** treatment: ☐ 9’ ☐ 10’ ☐ 11’ ☐ 12’ ☐ >12’
	after treatment: ☐ 9’ ☐ 10’ ☐ 11’ ☐ 12’ ☐ >12’
parking lanes (in addition to travel lanes)	**before** treatment: ☐ none ☐ 1 side ☐ both sides
	after treatment: ☐ none ☐ 1 side ☐ both sides
TWLTLs	TWLTL **before** treatment: ☐ yes ☐ no
	TWLTL **after** treatment: ☐ yes ☐ no
turning lanes at intersection(s) check **all that apply…** **Note:** if there is significant variation in intersection layouts within the road diet application area, please make a note in the comment section below. Mark the responses to the right that represent the most common layout.	**before** treatment: ☐ no LT lane ☐ expand for left turn ☐ use TWLTL for left turn ☐ expand for right turn ☐ no RT lane
	after treatment: ☐ no LT lane ☐ expand for left turn ☐ use TWLTL for left turn ☐ expand for right turn ☐ no RT lane
sidewalks	**before** treatment ☐ no sidewalks ☐ adjacent to curb ☐ back from curb if yes, distance from curb = width of sidewalk =
	after treatment ☐ no sidewalks ☐ adjacent to curb ☐ back from curb if yes, distance from curb = width of sidewalk =

geometrics continues…

Geometric and Other Descriptive Information (continues)	
bicycle lanes	**before** treatment: ☐ none ☐ one side only ☐ both sides ☐ within traveled way (inside curb) ☐ outside traveled way; if yes, distance from curb = width of bicycle lane =
	after treatment: ☐ none ☐ one side only ☐ both sides ☐ within traveled way (inside curb) ☐ outside traveled way; if yes, distance from curb = width of bicycle lane =
marked/designated mid-block pedestrian crossings	**before** treatment ☐ none ☐ yes if yes, approximate number/block =
	after treatment ☐ none ☐ yes if yes, approximate number/block =
approximate average grade of road	~grade of road = %
number of driveways/block	(estimated)
comments about geometric and related data:	

Traffic Data	
speed limit	**before** treatment mph
	after treatment mph
annual traffic growth factor for corridor	%
traffic data ***that could be provided*** (separately from survey)—we will contact you for these	**before** treatment ☐ ADT estimate ☐ 24-hour count data ☐ intersection turning counts ☐ PHF values ☐ vehicle type counts (total/commercial) ☐ seasonal correction factors ☐ speed study data ☐ traffic growth factor ☐ pedestrian volumes ☐ bicycle volumes ☐ Synchro/HCS network
	after treatment ☐ ADT estimate ☐ 24-hour count data ☐ intersection turning counts ☐ PHF values ☐ vehicle type counts (total/commercial) ☐ speed study data ☐ pedestrian volumes ☐ bicycle volumes ☐ Synchro/HCS network
comments about traffic data:	

<table>
<tr><th colspan="2">Safety Data (crash data are available from other sources, this section refers only to studies that have been done locally)</th></tr>
<tr><td rowspan="2">safety-related studies done in the area that could be provided (separately from survey)—we will contact you for these</td><td>before treatment
☐ written vehicular crash-related study done and available
☐ anecdotal vehicular crash-related information available
☐ written pedestrian/non-motorized-related study done and available
☐ anecdotal pedestrian/non-motorized-related information available</td></tr>
<tr><td>after treatment
☐ written vehicular crash-related study done and available
☐ anecdotal vehicular crash-related information available
☐ written pedestrian/non-motorized-related study done and available
☐ anecdotal pedestrian/non-motorized-related information available</td></tr>
<tr><td colspan="2">comments about safety data:</td></tr>
</table>

Information for follow-up contact on road diet applications…	
name:	
title:	
mailing address:	
e-mail address:	
telephone:	

Other general comments:

Please return the completed form to:

save the file with your answers (identify w/your initials) and send electronically via e-mail:

LYLES@egr.msu.edu (electronic attachments are fine)

hard copy via regular mail:

Richard W. Lyles
Department of Civil and Environmental Engineering
3546 Engineering Building
Michigan State University
East Lansing, Michigan 48824-1226

Questions? Please contact via e-mail: LYLES@egr.msu.edu

APPENDIX H

CRASH RECLASSIFICATION SCHEME

Road Diet Crash Re-Coding

Re-coding for road-diet crashes and expectations of 1) whether a road diet should affect crash frequency and 2) whether a road diet should correct the specific crash type. Note that this chart should be used to re-code crash types—a new variable in the crash record for this study. For example, for a ped-involved crash, MDOT crash type = 13, the re-coded value reflects whether the crash occurred midblock or at an intersection (re-code values = 13A and 13B, respectively. The right-most column could be considered a statement of various hypotheses to be tested.

checked/re-coded crash type	**road diet affects frequency of crash type**	**road diet could correct crash type**
[00] uncoded and errors • check and re-code as possible; otherwise probably eliminate	• n/a	• n/a
[11] overturn	• no	• no
[12] hit train	• no	• no
[13] pedestrian • midblock [13A] • intersection [13B]	• yes • maybe	• yes (refuge) • maybe
[14] bicycle • crossing main street [14A] • longitudinal (going w/or against traffic) [14B]	• yes • yes	• yes • yes
[15] fixed object	• maybe	• maybe
[16] other object	• maybe	• maybe
[17] hit parked vehicle	• n/a for MDOT study sites	• n/a for MDOT study sites
[18] animal • eliminate!	• n/a	• n/a
[19] misc single vehicle (check and re-code as possible)	• maybe	• maybe
[20] misc multiple vehicle (check and re-code as possible)	• maybe	• maybe

additional notes for crash types (e.g., [21] angle-straight) which are re-coded for left lane/right lane occurrence…

- by our convention, the lane indicated is always for the "dieted" street
- example application of convention for crash type [21] angle-straight in an intersection—"left lane-w/veh from left"…the vehicle in the left lane (whether it is getting hit or is doing the hitting) must be on the diet street with the other vehicle from the intersecting street
- for the "after" period, in general, there is no left lane…these crashes should be occurring in the right lane so the "left lane" crashes should be a moot point; if a crash occurs in the TWLTL, it could still be coded as "left lane" w/the understanding that it is in the TWLTL

checked/re-coded crash type	**road diet affects frequency of crash type**	**road diet could correct crash type**
[21] angle-straight [***intersection only***, check to convert into angle drive or angle turn] • left lane –w/veh from left [21A] • left lane –w/veh from right [21B] • right lane –w/veh from left [21C] • right lane –w/veh from right [21D]	• yes • yes • yes • yes	• yes (eliminates conflict) • yes (eliminates conflict) • no (could incr w/vol) • no (could incr w/vol)
[22] angle turn [***intersection only***, check to convert into angle drive or head-on LT] • left lane –w/veh from left [22A] • left lane –w/veh from right [22B] • right lane –w/veh from left [22C] • right lane –w/veh from right [22D]	• no • no • yes • yes	• no (should be no change) • no (should be no change) • no (could incr w/vol) • no (could incr w/vol)
[23] head-on left-turn (not necessarily in intersection) • left lane [23A] • right lane [23B]	• yes • no (should be none)	• maybe (could be offsetting) • no (should be none)
[24] rear-end straight (not necessarily in intersection) watch for veh at front of		

platoon—is it really going straight (this category) or turning left (should be other category, e.g., [34]) • left lane [24A] • right lane [24B]	• yes (eliminates conflict) • yes (incr vol in right lane)	• yes (lane eliminated) • no (could incr w/vol)
checked/re-coded crash type	**road diet affects frequency of crash type**	**road diet could correct crash type**
[25] rear-end left-turn ***in/at intersection*** • left lane [25A] • right lane [25B]	• yes (eliminates conflict) • yes (should be rare in before)	• yes (should eliminate) • yes (if occurs, should elim)
[26] rear-end right-turn ***in/at intersection*** • left lane [26A] • right lane [26B]	• yes (should be rare before) • yes (incr vol in right lane)	• yes (should eliminate) • no (could incr w/vol)
[27] dual left turn—shouldn't be occurring for sites	• should be n/a	• should be n/a
[28] dual right turn—shouldn't be occurring for sites	• should be n/a	• should be n/a
[31] head-on • left lane [31A] • right lane [31B]	• yes, RD reduces likelihood • no, should be rare	• maybe (corrects some instances, incr head-on potential in TWLTL) • no (should be rare)
[32] side-swipe same	• yes	• yes
[33] side-swipe opposite	• yes	• maybe (could be offsetting)
[34] angle-drive (watch for intersection vs. driveway, may need recode) • left-lane [34A] • right-lane (34B]	• yes • yes	• yes • no (could incr w/vol)
[35] rear-end drive (could incl veh turning LT or RT into a driveway and getting		

struck from behind; watch for long lines behind turning veh) • left-lane [35A] • right-lane [35B]	• yes • yes	• yes (should elim type) • no (could incr w/vol)
[36]other drive—hard category, check to recode as 34, 35, 19, 15	• should be n/a	• should be n/a
[37] backing—watch for needed recode as driveway-related—otherwise should be n/a	• should be n/a	• should be n/a

checked/re-coded crash type	**road diet affects frequency of crash type**	**road diet could correct crash type**
[38] parking—should be n/a for project sites	• should be n/a	• should be n/a

Other comments/issues…

Crashes that are really random should be marked for elimination. For example, we had one crash which was a single-vehicle (motorcycle) crash where the throttle stuck and the MC was simply "laid-down" on the pavement/side of road. It was originally coded as an overturn…should be eliminated.

Crash types where all occurrences need to be manually reviewed for relationship to road diet study are:

- [00] uncoded/errors—can any be salvaged;
- [13] pedestrian—what are the circumstances of crash that relate to road diet;
- [14] bicycle—what are circumstances of crash that relate to road diet;
- [15] fixed object—so far, these seem very problematic with respect to having any relationship to the road diet (e.g., skid while turning and hit mailbox or sign post) and so, may be eliminated from analysis
- [16] other object—as fixed object, these seem very problematic with respect to having any relationship to the road diet (e.g., hit a pothole) and so, may be eliminated from analysis
- [19] misc single vehicle crash—can these be re-coded and/or related to road diet;
- [20] misc multiple vehicle crash—can these be re-coded and/or related to road diet (some of these are pretty bizarre and are being eliminated—e.g., a vehicle drifted backwards out of a driveway and across the street where it hit or was hit)

Cross street crashes…

Crashes that are assigned to cross streets (in the crash data base) have also been identified—the UD-10s have been captured, and are being reviewed individually. Basically, one of the following occurs:

- If a crash that was assigned to a side street actually occurred on the diet street, it is reassigned (switched) to the diet street. This is done through a review of the crash diagram. The exception to this is if the side street occurs at the end of the diet (see below).
- If a crash that was assigned to a side street actually occurs on the side street well back from the diet street (e.g., a driveway-related crash 100' back from the diet street) and has no conceivable relation to the road diet, it is eliminated from the analysis.
- If a crash that was assigned to a side street only involved vehicles on the side street (e.g., an angle-turn crash where neither vehicle was already on the diet street), it is eliminated from the analysis (crash has no relation to the diet activity).
- If the side street is an intersecting street at the end of the road diet, a crash involving side street vehicles that are turning on to the diet street toward the diet segment should be "switched" to the diet street. If the vehicle is on the side street and turning away from the diet segment, then it is eliminated as not associated with the diet.
  - For example, consider a N-S side street intersecting w/an E-W diet street but the diet is only on the east side of the intersection w/the west side untreated. If a northbound car turns right (east) toward the diet section and is involved in a crash, it counts in the analysis. If turns left (west) away from diet section, it does **not** count in the analysis.
  - This is also impacted by how the diet ends…sometimes, it is clearly done at the intersection; in other instances, the taper of the diet lanes takes place on the "other" side of the intersection.