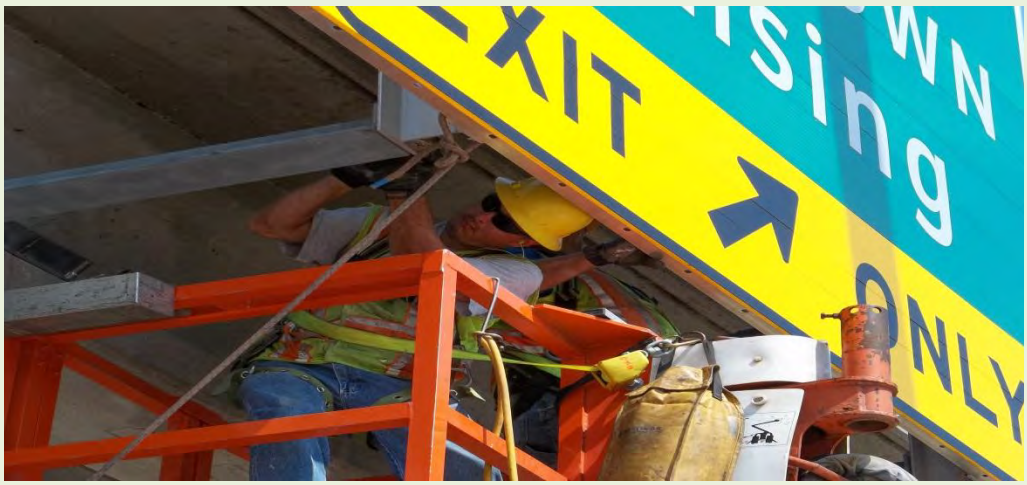

The Wayfinder

MDOT

July 2014

Maintaining and Testing Minimum Sign Retroreflectivity in Michigan

When the 2009 federal Manual on Uniform Traffic Control Devices (MUTCD) was released, a sub-section was added establishing the requirement to maintain minimum sign retroreflectivity levels (Section 2A.08). It states that public agencies having jurisdiction of a roadway shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above minimum levels established as in Table 2A-3 of the MUTCD. As a public agency with federally funded projects, MDOT is required to adhere to the sign retroreflectivity requirement established by the MUTCD.

The MUTCD provided guidance for how agencies could establish a method for maintaining retroreflectivity. It described five specific management methods:

1. Visual Nighttime Inspection – Retroreflectivity is assessed by a trained sign inspector in a moving vehicle at night.
2. Measured Sign Retroreflectivity – Retroreflectivity is measured using a retroreflectometer.
3. Expected Sign Life – The sign installation date is installed on the back of new signs and based on the known degradation of the sheeting, signs are replaced as they approach or exceed the expected sign life.
4. Blanket Replacement – All signs in a corridor should be replaced at specified intervals.
5. Control Signs – Replacement of signs is based off of the retroreflectivity levels of control signs in the field.

Individuals who are familiar with MDOT's signing processes will note that MDOT had already been implementing methods 3 and 4. MDOT used an expected sign life of 15 years based on warranty information from the companies that create the retroreflective sheeting and MDOT's signing program uses federal funding for projects either done in-house or contracted out to private firms that replace all of the signs in specific corridors based on the age of the current signs.

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Signing Updates:

Sign Code I13-1b - Click it or Ticket Sign

Maintaining and Testing Minimum Sign Retroreflectivity in Michigan–Cont'd

But as a result of the new federal requirement, MDOT began to use methods 2 and 5 as well. MDOT purchased a sign retroreflectometer and established control signs in several regions throughout the state to test the levels of retroreflectivity without having to test every sign. Control signs were selected based on the year of installation. Signs were selected from jobs that were constructed between 2007 and 2012. Within each segment, about 20 signs were selected. Of those 20 signs, the goal was to test eight yellow signs, three red, four white, one blue, one brown, one fluorescent yellow green (FYG), and three green. Many times, signs of a specific color were not available, so additional signs of other colors were tested. Members of the signing unit completed the retroreflectivity testing of the selected control sings in the last three years. Three retroreflectivity readings were taken per sign and were averaged after the return to the office.

After testing, the data was compiled into a spreadsheet, where graphs were created to show the reading for each sign in relation to the minimum retroreflectivity levels. (Graphs have been included in this document for reference; see Figures 1 & 2.) Two different sets of graphs were created:

- Retroreflectivity Readings by Installation Year
- Retroreflectivity Readings by Inspection Year

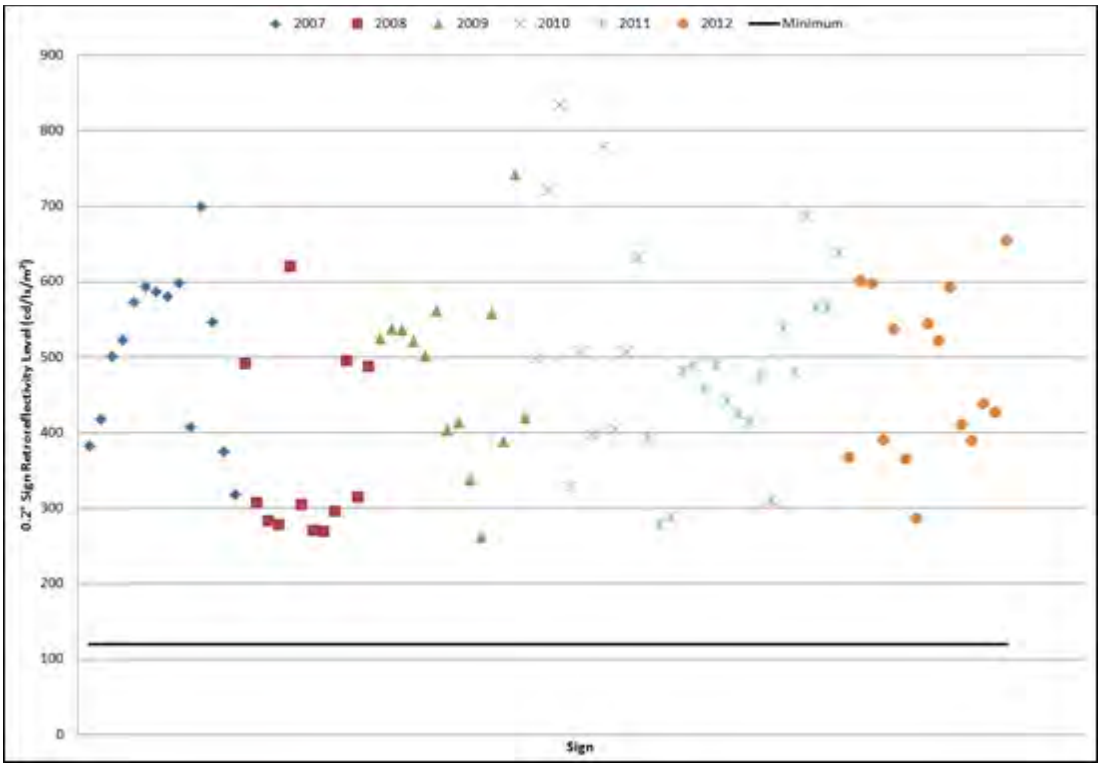


Figure 1: Example Graph Showing White Sheeting Retroreflectivity by Installation Year

The graphs showing the sign retroreflectivity by Installation Year (see Figure 1) are averaged values of all of the sign retroreflectivity readings separated by the year the signs were installed. The purpose of this graph is to show that the retroreflectivity readings of older signs are relatively consistent no matter what year the sign was installed. There is, however, a slight variation in the years. It can be seen that the average sign retroreflectivity value goes down the longer the sign has been in the field.

Maintaining and Testing Minimum Sign Retroreflectivity in Michigan–Cont'd

This confirms the idea behind MDOT's 15-year replacement cycle. When the data has been collected for 15 years after the signs have been installed, it is assumed that the signs that are 15 years old will start to dip below the minimum retroreflectivity levels. Until that data is collected, current readings and trends indicate that signs installed by MDOT will continue to exceed the minimum retroreflectivity levels well into the future.

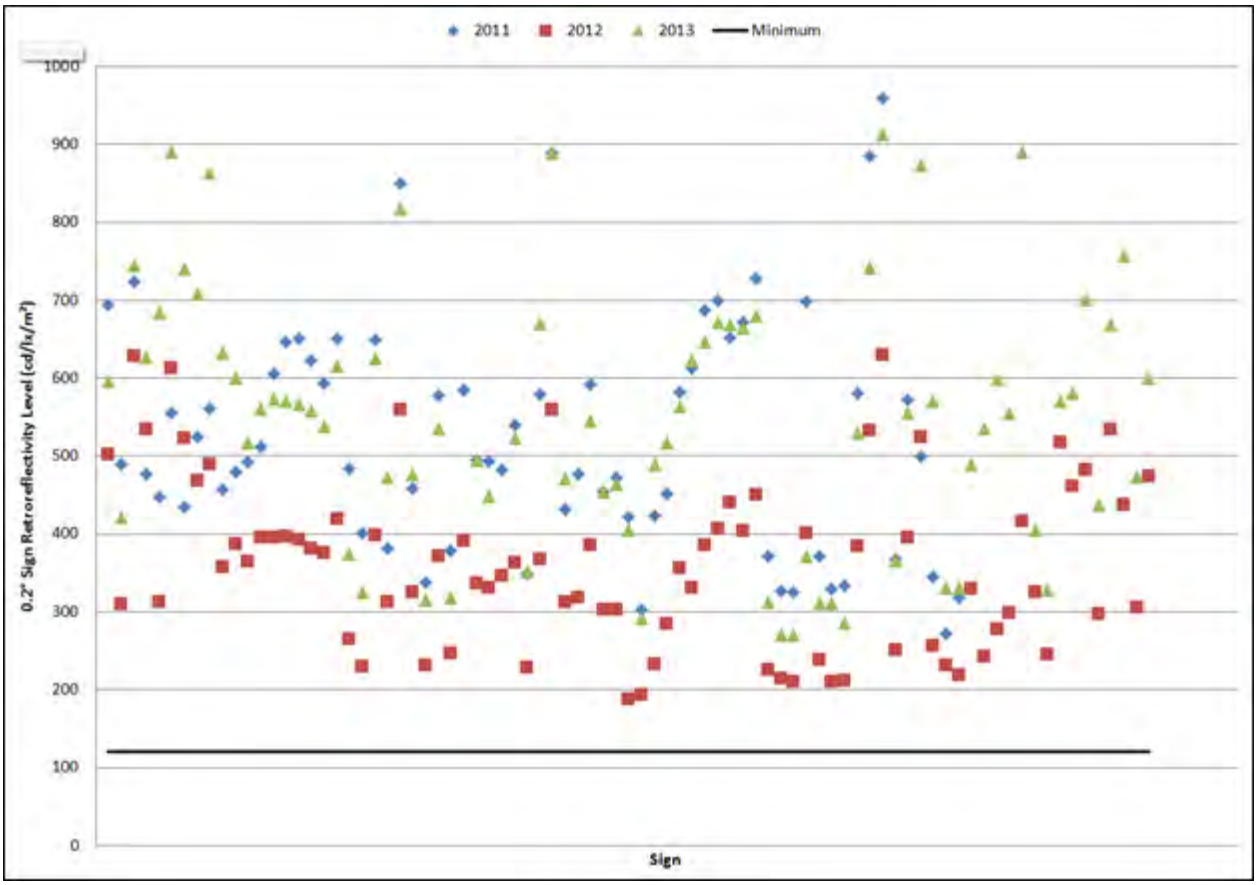


Figure 2: Example Graph Showing White Sheeting Retroreflectivity by Inspection Year

The graphs showing the sign retroreflectivity by Inspection Year (see Figure 2) show each reading on each sign separated by the year the signs were tested. The purpose of this graph is to show that the retroreflectivity readings of each sign remains relatively consistent no matter what year it was tested. There is no dramatic "drop-off" in retroreflectivity from year to year. Just like the graphs that show sign retroreflectivity reading by installation year, there is a slight variation between years, but there is no evidence to contradict MDOT's typical 15-year replacement cycle.

Maintaining and Testing Minimum Sign Retroreflectivity in Michigan–Cont'd

Looking back on the data collection, there were multiple factors that may have negatively impacted the retroreflectivity readings:

- Weather – On many days, weather was less than ideal. Care was taken to protect the retroreflectometer, but moisture on the signs was definitely a factor.
- Condensation – Readings were sometimes taken early in the morning, and often, signs had condensation on them. The condensation was wiped off the signs so accurate readings could be taken.
- Dust – Signs often were covered with dust, and this most likely affected the retroreflectivity readings.
- Equipment Malfunction – Sometimes, the retroreflectometer would malfunction and give erroneous readings. These readings were removed from the data sample.

Even with all of these negative impacts, care was taken to make sure all retroreflectivity readings were as accurate as possible. The Signing Unit is confident that the data collected is an accurate representation of what exists in the field.

While the Signing Unit has been taking readings for the last three years, it is proposed that readings be taken every other year. This way, there should be a more significant drop in sign retroreflectivity in the one-year gap. Justification for this method is based on consistent readings of data obtained over the last three years.

If any other information regarding the retroreflectivity standards, processes, data, or future methodology is requested, please contact me.

CONTACT INFORMATION
BRETT SCAFURI
SCAFURIB1@michigan.gov

GIS-Based Mapping for Non-Freeway Signing Design

Before 2013, the majority of non-freeway signing projects were designed using the Michigan Traffic Sign Inventory System (MTSIS). In 2013, the MDOT Signing Unit changed the design process for non-freeway signing projects by including contract signing plans, instead of MTSIS Log Job Contracts, for most MDOT region signing upgrade contracts. The reason for the change is to make it easier for designers, reviewers, project engineers and contractors to design and construct signing projects using plans.

A process to create base mapping for signing plans was established using the following tools:

a. Available Geographic Information Systems (GIS) mapping information from the Michigan Geographic Data Library website.
b. ARCGIS software and its interoperability with Power Geopak.
c. Bentley Map, a Power Geopak module that performs some of the tasks usually done in ARCGIS (such as attribute labeling), but inside the Power Geopak software package.
d. Global Positioning System (GPS) equipment for data collection.
e. Power Geopak software for plan development of alignments and signing information in state plane coordinates (Power Geopak has the capability of placing the information in the correct geographic coordinate system).

By following this process, base mapping and Geopak trunkline alignments are developed and used to create non-freeway and freeway signing plans where survey information is not available. Other applications may include mapping for scoping projects, road safety audits, etc.

Process to Develop GIS-Based Mapping

1. Download Framework Information per County:

In order to create a county base map, the hydrography, political and transportation frameworks, along with public land survey section information is suggested as a minimum. Other information can be incorporated from the Michigan Geographic Data Library, depending on how detailed the final product needs to be. The information is available from http://www.mcgi.state.mi.us/mgdl/?rel=ext&action=cext.

The framework information corresponds to a series of segments for each feature that will be included in the base map. These features are, railroad lines, creeks, rivers and other bodies of water, roads, limits of cities, villages, and towns, and location of section lines. Figure 1 shows the 'allroads_001v13a.shp' shape file when referenced into Micro Station without doing any manipulation.

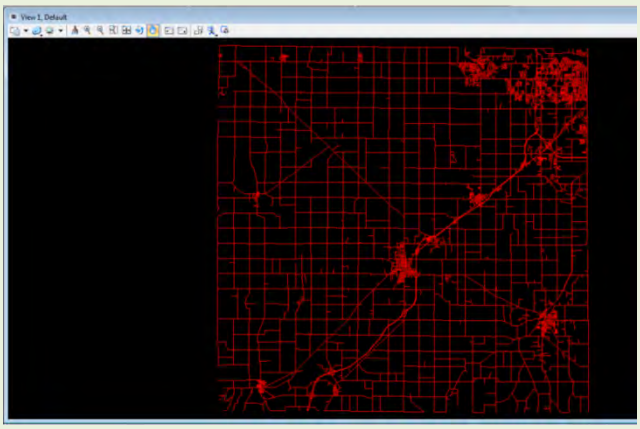


Figure 1. Transportation Framework Shapefile

2. Manipulate Information in ArcGIS and Power Geopak using Bentley Map:

The transportation framework information includes the centerlines of all local, state and interstate routes of a county. To create the base map, the edges of pavement were obtained in ArcGIS by buffering available lane mile information (provided by the MDOT Asset Management Group). Upon obtaining the existing widths of pavement, a shape file is created to be referenced into Micro Station. Figure 2 below shows the pavement widths after buffering the centerlines of the roadways.

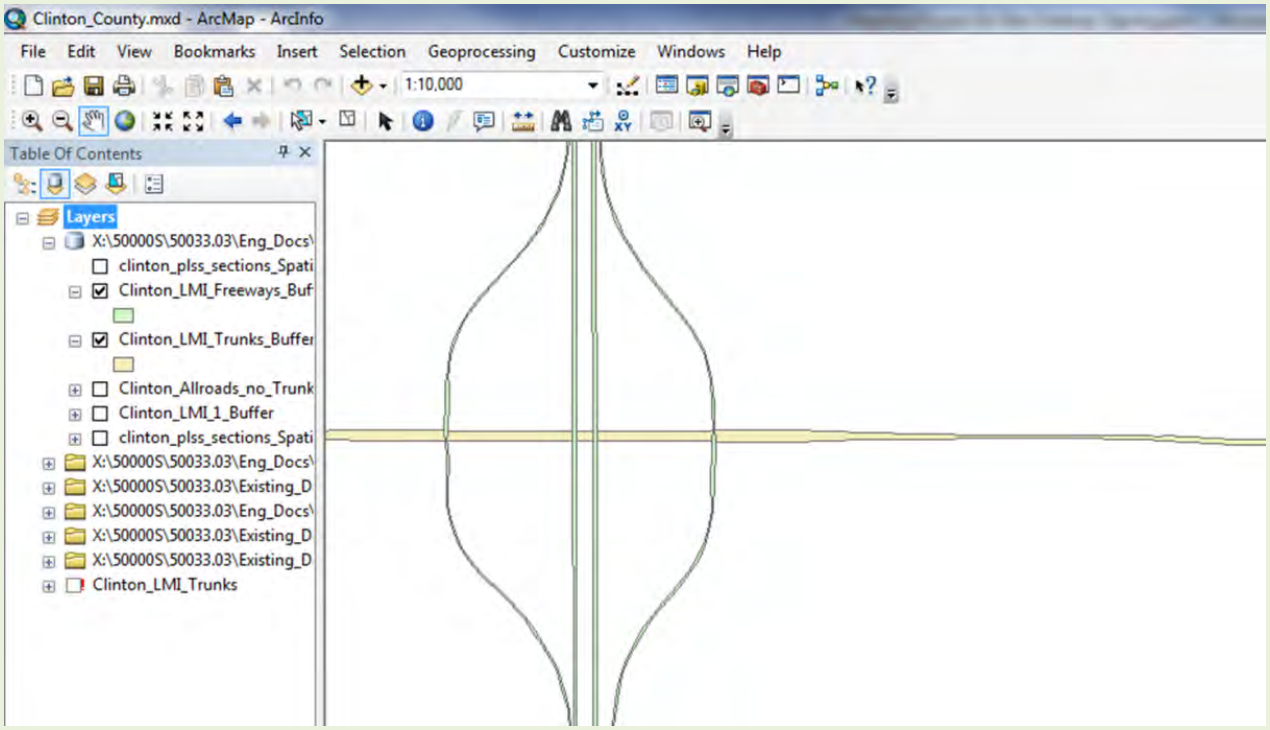


Figure 2. Lane Buffers in ArcMap

Once the data has been manipulated, the line work can be exported as a shapefile and imported into MicroStation. Also all the downloaded framework files are used to label the base map using Bentley Map. When annotating features in Bentley Map, a model is created. Models usually created are road names, railroad names, hydro information, cities and villages.

3. Create Geopak Alignments:

Using the 'allroads_001v13a.shp' shape files line work, a geopak alignment is created per trunk line. Framework uses mile points (MP) for control sections (CS) and physical reference (PR) points to determine a location along a segment of roadway. Taking advantage of this system already established, alignments with stationing for CS numbers and corresponding MP can be developed. In addition, the stationing for these alignments would match the mile point information for PR Finder, since the information found in PR Finder also comes from Framework and it is available at http://www.mcgi.state.mi.us/prfinder/ . During design, locating a sign by MP is a very useful tool for existing signs. It will help determining proposed signing locations and addressing potential conflicts with existing utilities, driveways, property lines, etc.

4. Create Base Maps:

All models with the labels, and shapefiles with formatted line work, are referenced and merged into the base map. The Stationing is also referenced into the base map. Then the edges of pavement, interchanges and intersections line work is cleaned-up. The section line information from the Michigan Geographic Data Library website is not as accurate, so it needs to be checked against right of way plans to determine their correct location and to check road's names.

5. Field Verification:

Once the alignments are set up, create and cut sheets to go out in the field and do field verifications by collecting information with GPS handheld units with antenna receivers, if possible, to verify geometric features. This field verification is necessary especially in locations where there transportation framework differs from what is actually out in the field. Sometimes when construction projects are completed, it takes some time for the Framework to be updated.

The information to be verified in the field is:

a. Intersection geometry and type of traffic control.
b. Number of lanes and limits of tapers.
c. Road names.
d. Major driveways and acceleration/deceleration lanes.
e. Limits of guardrail.
f. Bridge limits.

Points taken in the field are processed and referenced into the base map to refine the line work. Aerial mapping is used to finalize the base map. A sample of the final product is shown in Figures 3 below:

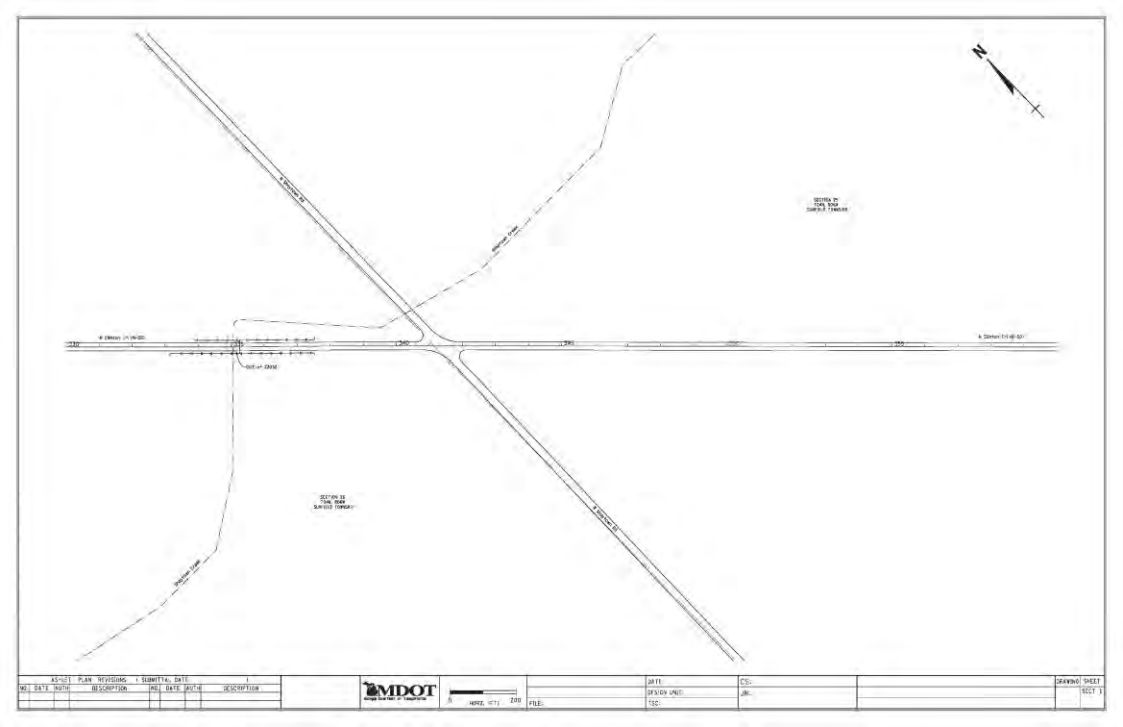


Figure 3. Typical Sheet with Base Mapping to be Used for Signing Design (1:200 Scale)

For signing design, Figure 4 shows completed plan sheet:

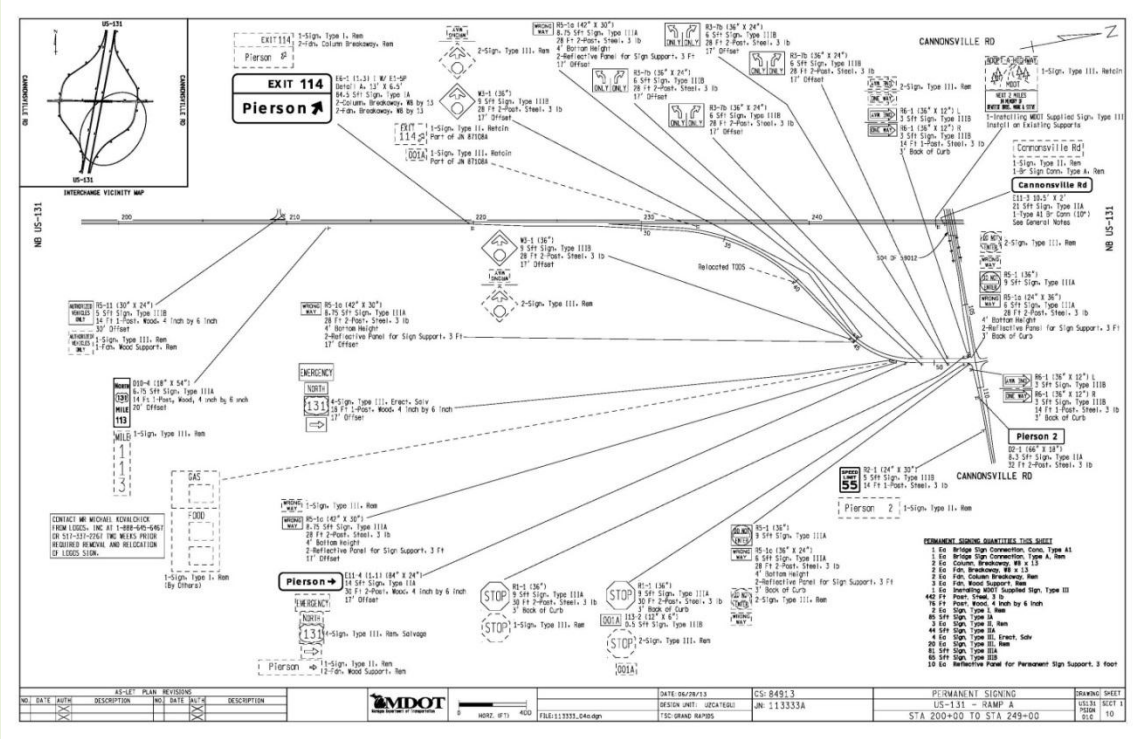


Figure 4. Typical Freeway Signing Sheet using Base Mapping Process
Existing Signing Inventory was Collected with GPS Units in State Plane Coordinates

MDOT completed a contract in August 2013 for the base mapping of Metro, Grand and University regions, and a second contract for the mapping of North, Bay and Southwest regions will be completed by the end of August 2014. Available mapping for MDOTers is located in ProjectWise at: pw:\\HCS591PWISPA901.som.ad.state.mi.us:MDOTProjectWise\Documents\Reference Documents\Traffic Reference\Alignments_Statewide\. For signing projects with consultant firms, MDOT will provide the base mapping for the county/counties that are included in the project.

The advantages of this method are that a standardized process for signing design can be established, following the structure of road design plans, using base mapping for signing that comes from the same source and that it is tied to the framework system, making it a very useful tool for signing design, with improved accuracy.

As the processes for data collection, design, plan development and contract completion are evolving, our goal is to achieve an approach that facilitates our workflow minimizes error, allows for control checks and it is continuously improving.

If you need additional information regarding the use of the Framework and alignments base mapping for the development of signing plans, please contact me.

CONTACT INFORMATION
MONICA URIBE
URIBEM1@michigan.gov

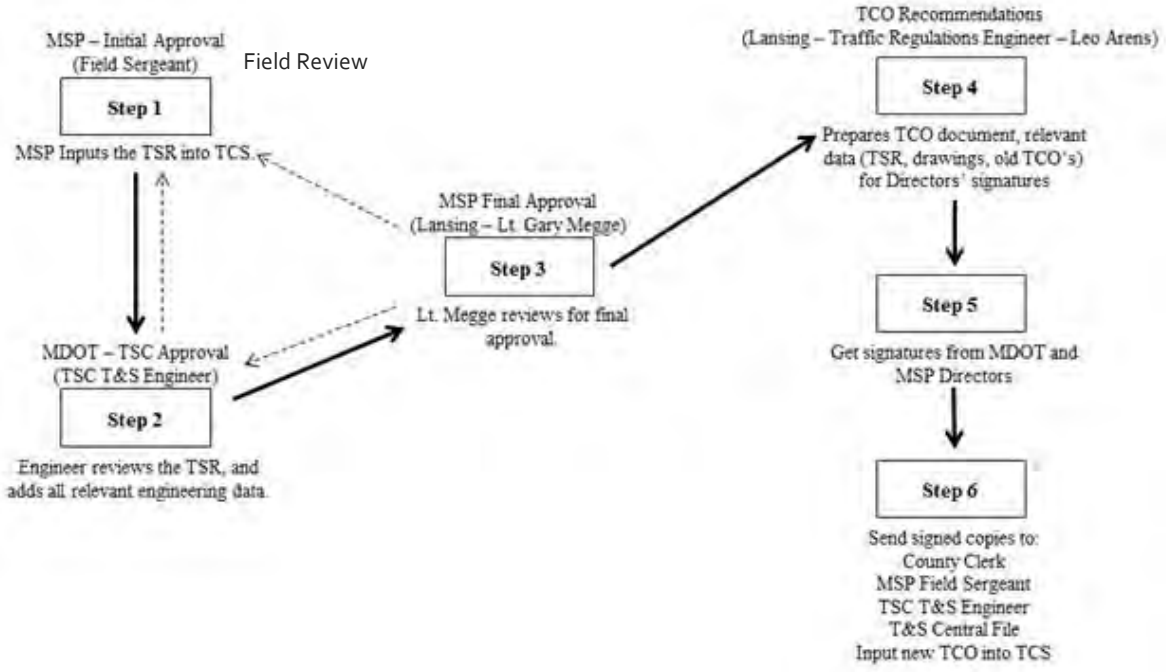
Process to Change a Traffic Control Order (TCO)

The following steps need should be followed when a TCO needs to be updated:

1. Speed Study completed by MDOT or Michigan State Police (MSP).
2. Traffic Survey Report (TSR) filled out by MSP with TCO recommendations.
3. Forwarded to Transportation Service Center (TSC) Traffic & Safety (T&S) engineer for review.
4. If the TCO is correct, the T&S engineer forwards it to Lansing for MSP Final Approval (Lt. Gary Megge). If the TCO is not correct, the T& S engineer sends it back to the MSP field sergeant or T & S engineer.
5. If correct, Lt. Gary Megge forwards the TCO to traffic regulations engineer (TRE). If not correct, he sends it back to field sergeant or TSC T&S engineer.
6. TRE will review and process TCO document and get signatures from the directors of MDOT and MSP. Completed TCO will be sent to the field sergeant, TSC T&S engineer and County Clerk's Office.

TCO Reference Information:

- "Inside MDOT"
- Traffic & Safety
- Link Under "Internal Guides"



CONTACT INFORMATION
LEO ARENS
ARENSL@michigan.gov

CONTACT INFORMATION
LT. GARY MEGGE
MEGGEG@michigan.gov

Update to Guidelines for Advance Placement of Warning Signs

MDOT has recently revised the Advance Warning Signs and Horizontal Alignment Signs section of the MDOT Signing Design, Placement, and Application Guidelines. We have added Table 3, which is a revised Minimum Advance Warning Sign Placement Distance and is to be used instead of MMUTCD Table 2C-4.

Posted Speed (mph)	Table 3: Minimum Advance Warning Sign Placement Distance (ft)														
	Condition A[1]	Condition B (mph)													
		0[2]	5[3]	10[3]	15[3]	20[3]	25[3]	30[3]	35[3]	40[3]	45[3]	50[3]	55[3]	60[3]	65[3]
25	325	155	125	100[4]	100[4]	100[4]									
30	460	200	150	115	100[4]	100[4]	100[4]								
35	565	250	185	125	115	100[4]	100[4]	100[4]							
40	670	305	225	150	135	125	120	115	100[4]						
45	775	360	280	200	185	175	160	150	125	100[4]					
50	885	425	350	275	250	225	215	200	175	150	100[4]				
55	990	495	425	350	335	325	300	275	240	200	175	150			
60	1100	570	510	450	425	400	375	350	315	275	240	200	150		
65	1200	645	585	525	515	500	475	450	415	375	315	275	215	150	
70	1250	730	675	625	615	600	575	550	515	475	425	375	315	250	150

NOTES:	
1	Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. For other examples of signs for this condition, see "Condition A, Complex Maneuvers" in Table 4.
2	Typical condition in the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. For other examples of signs for this condition, see "Condition B, Stop Condition" in Table 4.
3	Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn and Curve signs with advisory speed plaques. For other examples of signs for this condition, see "Condition B, Decelerate to Indicated Advisory Speed" in Table 4.
4	The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

This revision was done to provide designers and field personnel with better information so that advance warning signs can be placed in a more effective and consistent way. The new minimum distances are based on the information from the National Committee on Uniform Traffic Control Devices and the Stop Conditions conform more closely to AASHTO Stopping Sight Distance criteria.

Placement Condition	Category	Sign Code	Sign or Plaque
A	Complex Maneuvers	W4-1	Merge
		W4-2	Lane Ends
		W4-3	Added Lane
		W4-5	Entering Roadway Merge
		W4-5P	NO MERGE AREA
		W4-6	Entering Roadway Added Lane
		W4-7	THRU TRAFFIC MERGE LEFT
		W9-1*	RIGHT LANE ENDS
		W9-2*	LANE ENDS MERGE LEFT
		W9-7	RIGHT LANE EXIT ONLY AHEAD

Table 4.- Condition A - Applicable Warning Signs

B	Stop Condition	W2-6	Circular Intersection
		W3-1	Stop Ahead
		W3-2	Yield Ahead
		W3-3	Signal Ahead
	Decelerate to Indicated Advisory Speed	S4-5	School Speed Reduction
		S4-5a	XX MPH SCHOOL ZONE AHEAD
		W3-5	Speed Reduction
		W3-5a	XX MPH SPEED ZONE AHEAD
		W13-1P	Advisory Speed
		W13-2	EXIT Advisory Speed
		W13-3	RAMP Advisory Speed
		W13-6	EXIT Advisory Speed
		W13-6a	EXIT Advisory Speed
		W13-7	RAMP Advisory Speed
		W13-7a	RAMP Advisory Speed

Table 4.- Condition B - Applicable Warning Signs

We have added another table, Table 4 Applicable Warning Signs. It lists applicable warning signs and the type of placement condition in which they shall be used. There is additional guidance added to this section of the document that is intended to address situations not covered in the MMUTCD or other guidance documents. Our goal is to increase signing uniformity for the benefit of the driver.

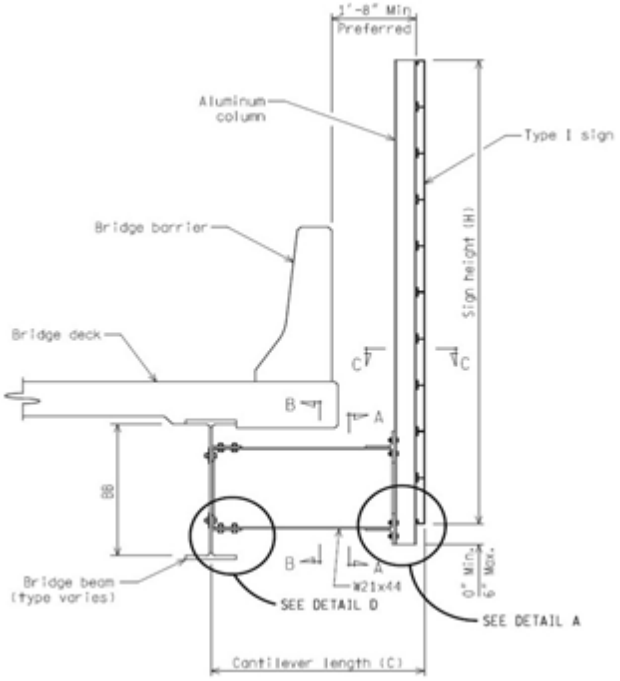
CONTACT INFORMATION
ERIN O'BRIEN
OBRIENE@michigan.gov

Designing for Constructability-Bridge Sign Connections (BSC) – Part II

The January, 2014 issue of this newsletter reported on "Designing for Constructability-Bridge Sign Connections (BSC)." An easy-to-follow flowchart was provided to assist designers in determining a recommended support type based on issues and their associated conditions. In this installment, a common constructability problem will be highlighted: fitment issues.

What is fitment? And what are the negative factors that delay installing a bridge sign connections on steel beams? If contractor findings are verified by Inspection, what are the alternatives to resolve the problem?

In Permanent Freeway Signing contracts, fitment pertains to connection members and hardware of a bolted bridge sign connection suitable for attaching to the bridge beam's web fascia. The size of the bridge beam (BB) as dimensioned in the graphic below is critical data to obtain to ensure to fitment. A Proposed Bridge Sign Connection may be too large to fit on the existing beam that is shallow (BB= 24 inches +/- vertically).



Engineers, designers and contractors should make every effort to field measure if possible, the bridge beam (BB) fascia and take note of existing concrete overhang when designing or prior to fabricating a bridge sign connection. In the majority of cases, the contractor must shift the new connection on beam fascia to avoid old bolt holes, Pin/Hanger assemblies and/or vertical stiffener plates. If any one of the factors cannot be avoided or the bridge beam (BB) is too shallow as verified by inspection, the engineer should consider replacing the bridge sign connection "in-kind" using the same bolt holes as approved by the project manager.

If the existing connection is considered an "old" connection type, the sign size should be checked so that the weight of the sign will be handle by the proposed type of connection. Reduced size text can be used to size the sign, creating a special detail. It is important to emphasize that field work to take measurements is essential to avoid any constructability issues in the future. For further information on this topic, contact Ray Olsen (olsenr@michigan.gov) or Alonso Uzcategui (uzcateguia@michigan.gov).

CONTACT INFORMATION
RAY OLSEN
OLSENR@michigan.gov

2014 Training and Important Events

- **ITS World Congress**
  - September 8 – 11
- **19th Annual Michigan Communities GIS Conference**
  - September 17 – 19
- **MITEC Annual Meeting**
  - December 2-3

Next issue of The Wayfinder:

- Updates to Special Provisions – Brett Scafuri
- Installation of Bridge Connections Steel Beam Bridges – Monica Uribe
- How to Set Up a Speed Limit – Leo Arens
- Updates to Traffic Design Signing & Application Details– Erin O'Brien
- Changes to SHS Details - Ray Olsen

Please send your questions, comments, or corrections to:

MDOT-Traffic_SIGNING@michigan.gov

Questions/Comments?
TRAFFIC SIGNING NEWSLETTER – THE WAYFINDER

LEO ARENS	arensl@michigan.gov
MARK BOTT	bottm@michigan.gov
ERIN O'BRIEN	obriene@michigan.gov
RAY OLSEN	olsenr@michigan.gov
BRETT SCAFURI	scafurib1@michigan.gov
MONICA URIBE	uribem1@michigan.gov
ALONSO UZCATEGUI	uzcateguia@michigan.gov