Development and Implementation of the Next Generation Bridge Management System for Wisconsin Phase II

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WisDOT ID no. 0092-13-06
February 2016

Research & Library Unit

Wisconsin Highway Research Program

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Technical Report Documentation Page

1. Report No. 0092-13-06	2. Government Accession No	3. Recipient's Catalog No
4. Title and Subtitle Development and Implementation of the Next Generation Bridge Management System for Wisconsin Phase 2		5. Report Date February 2016 6. Performing Organization Code
7. Authors Jose Aldayuz		8. Performing Organization Report No.
9. Performing Organization Name and Address Michael Baker International 3601 Eisenhower Avenue Alexandria, VA 22304		10. Work Unit No. (TRAIS) 11. Contract or Grant No. WisDOT Project No. 0092-13-06
12. Sponsoring Agency Name and Address Wisconsin Department of Transportation Research & Library Unit 4802 Sheboygan Ave. Madison, WI 53707		13. Type of Report and Period Covered Final Report, 2013-2016 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Michael Baker International (Baker) was selected as the team to delineate the initial path on the implementation of the next generation bridge management system (BMS) in its continued partnership with the Wisconsin Department of Transportation.

Phase II of this research project included the preparation of WisDOT specific BMS artifacts that will facilitate and advance with the implementation of a next generation bridge management system for Wisconsin DOT.

This report depicts a summary of the work completed.

17. Key Words Bridges, Bridge management systems		18. Distribution Statement No restriction. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield VA 22161	
18. Security Classif.(of this report) Unclassified	19. Security Classif. (of this page) Unclassified	20. No. of Pages	21. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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This research was funded through the Wisconsin Highway Research Program by the Wisconsin Department of Transportation and the Federal Highway Administration under Project No. 0092-13-06. The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Wisconsin Department of Transportation or the Federal Highway Administration at the time of publication.

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Contents

Foreword

Michael Baker International (Baker) was selected as the team to delineate the initial path on the implementation of the next generation BMS in its continued partnership with the Wisconsin Department of Transportation. During the design stage of Pontis 5.2 and the use of the recently released BrM 5.2.2 (Pontis 5.2 succesor), we acquired a clear understanding of the direction of the future BrM 5.2.3 release.

Phase II of this research project included the preparation of WisDOT specific BMS artifacts that will facilitate and advance with the implementation of using BrM 5.2.3 in conjunction with HSI to have the Next Generation Bridge Management System for Wisconsin. Although Baker worked to adjust the timeline of Phase II to match the release of BrM 5.2.3, it was just not feasible. Most of the information found in this report is based on the release of BrM 5.2.2.

Phase II of the *"Development and Implementation of the Next Generation Bridge Management System for Wisconsin"* Project included five distinct tasks:

1. Develop WisDOT-specific Cost Data and Protocols for updating and maintaining the element costs information
2. Develop WisDOT-specific Element Deterioration Models
3. Develop WisDOT-specific Utility Functions
4. Develop WisDOT-specific Risk Assessment Criteria
5. Prepare Phase II Report

The following sections depict a summary of the work completed. Appendix A contains the forms developed for the cost elicitation as well as a cost summary. Appendix B contains the deterioration models comparison summary and recommended values. And Appendix C contains a report used to complete Task 4 of this Phase.

Task 1: Develop WisDOT-specific Cost Data and Protocols for updating and maintaining the element costs information

To complete Task 1, Baker collected and documented cost for different preservation and replacement activities for 25 elements depicted below. The values associated with these activities are intended to form the cost models for these elements. The collection of data was done via elicitation process from the WisDOT region Bridge Maintenance Engineers.

The objective was to obtain direct cost for suggested element-specific feasible actions in the general following categories:

- Protect
- Repair
- Rehabilitate
- Replace

User costs and traffic maintenance costs will be needed by BrM 5.2.3 modeling and will need to be collected under a separate effort.

Decks/Slabs

El. No.	Element Name	Units	Type
12	Reinforced Concrete Deck	ft^2	NBE
13	Prestressed Concrete Deck	ft^2	NBE
38	Reinforced Concrete Slab	ft^2	NBE

Bridge Rails

El. No.	Element Name	Units	Type
330	Metal Bridge Railing	ft	NBE

Superstructure

El. No.	Element Name	Units	Type
107	Steel Open Girder	ft	NBE
109	PS Open Girder	ft	NBE
113	Steel Stringer	ft	NBE
152	Steel Floorbeam	ft	NBE

Joints

El. No.	Element Name	Units	Type
300	Strip Seal Expansion Joint	ft	BME
301	Pourable Joint Seal	ft	BME
302	Compression Joint Seal	ft	BME
303	Modular Joint	ft	BME
304	Open Expansion Joint	ft	BME
305	Assembly Joint w/o Seal	ft	BME

Bridge Approach/Roadway Elements

El. No.	Element Name	Units	Type
321	Reinforced Concrete Approach Slab	ft^2	BME

Substructure

El. No.	Element Name	Units	Type
205	RC Column	EA	NBE
210	RC Pier Wall	ft	NBE
215	RC Abutment	ft	NBE
234	RC Pier Cap	ft	NBE

Wearing Surfaces

El. No.	Element Name	Units	Type
8511	*AC Overlay*	ft^2	*AD/BME*
8512	*AC Overlay & Membrane*	ft^2	*AD/BME*
8513	*Thin Polymer Overlay*	ft^2	*AD/BME*
8514	*Concrete Overlay*	ft^2	*AD/BME*
8515	*Polyester Concrete Overlay*	ft^2	*AD/BME*

Steel Protective Coatings

El. No.	Element Name	Units	Type
8516	*Painted Steel*	ft^2	*AD/BME*

Bearings

El. No.	Element Name	Units	Type
310	Elastomeric	EA	NBE

A printout of the first two deliverables for this task can be found in Appendix A. The deliverables are:

- A Microsoft Excel Workbook with 25 survey forms to be send to the regions – Delivered in 2015
- An Excel Workbook with the results of the elicitation process for the 25 elements depicted in this document – Appendix A
- A document summarizing the protocols to obtain the cost information to further update BrM 5.2.3 – This Report

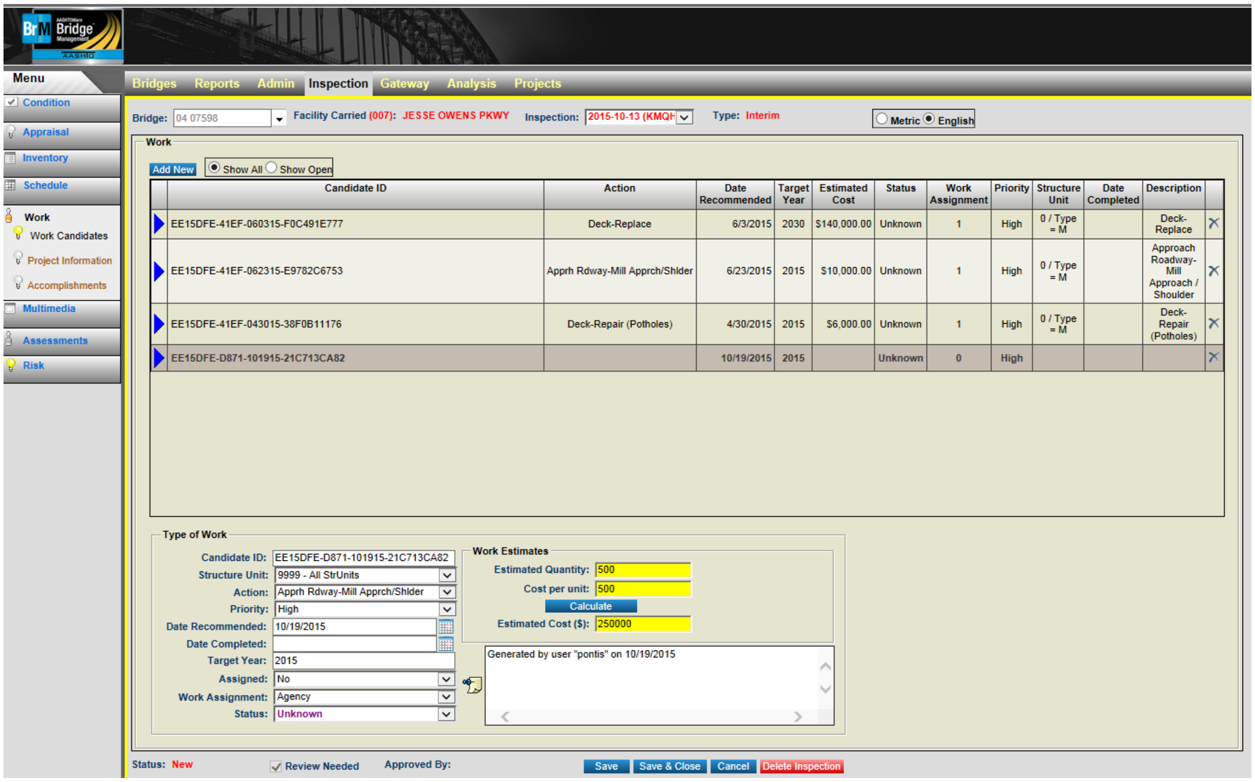
Updating Costs in BrM 5.2.3

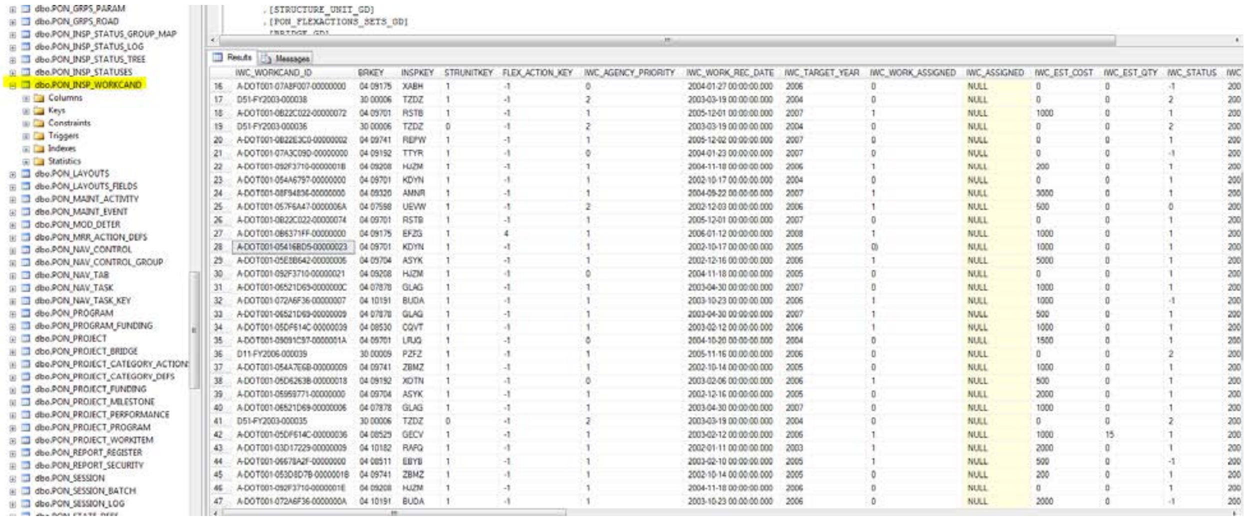
BrM 5.2.3 will consider two types of work candidates to forecast bridge needs:

- Work candidates recommended by the inspectors/bridge managers
- Work candidates recommended by the system

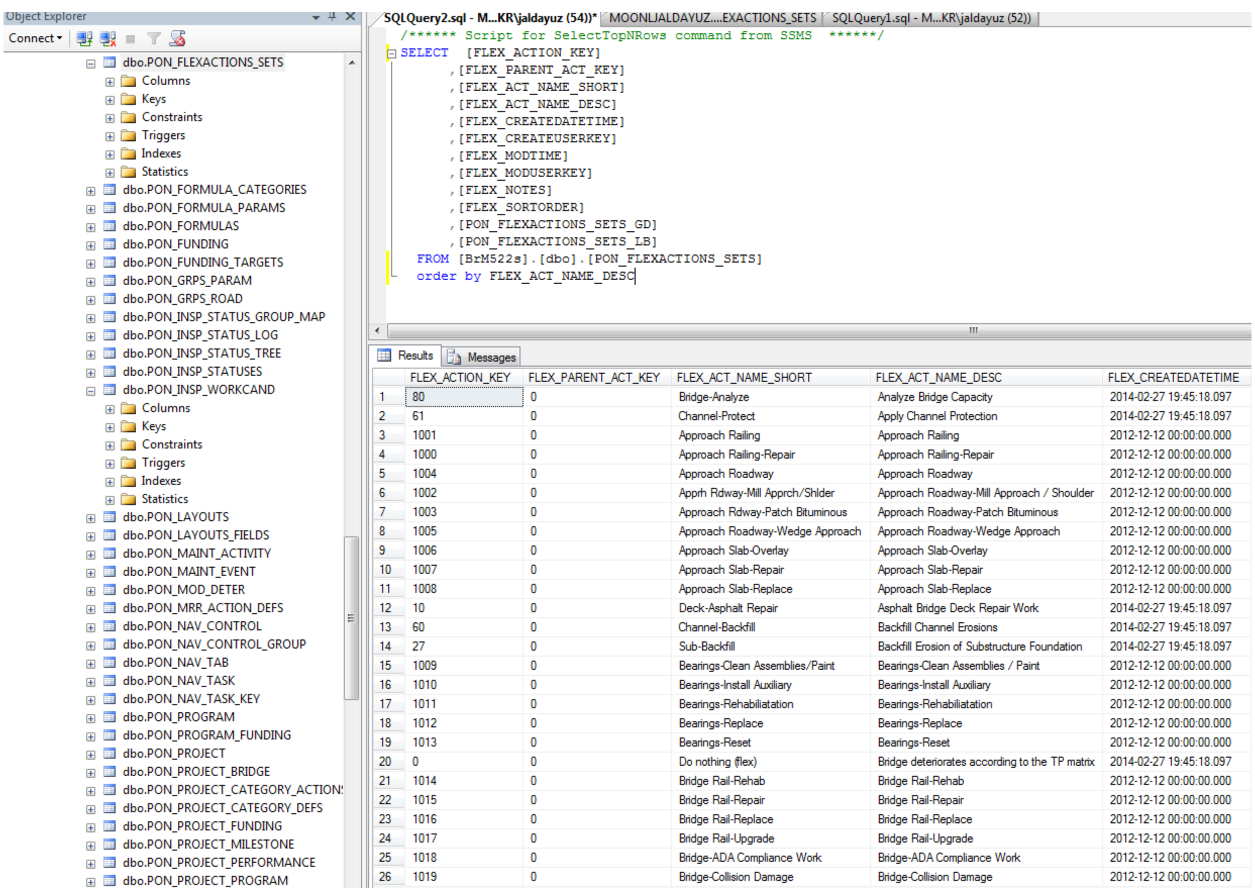
Cost for work candidates recommended by the inspectors/bridge managers

The cost for work candidates recommended by the inspector are stored in the PON_INSP_WORKCAND table. These costs can be entered via the BrM 5.2.3 or through an update SQL statement to the table





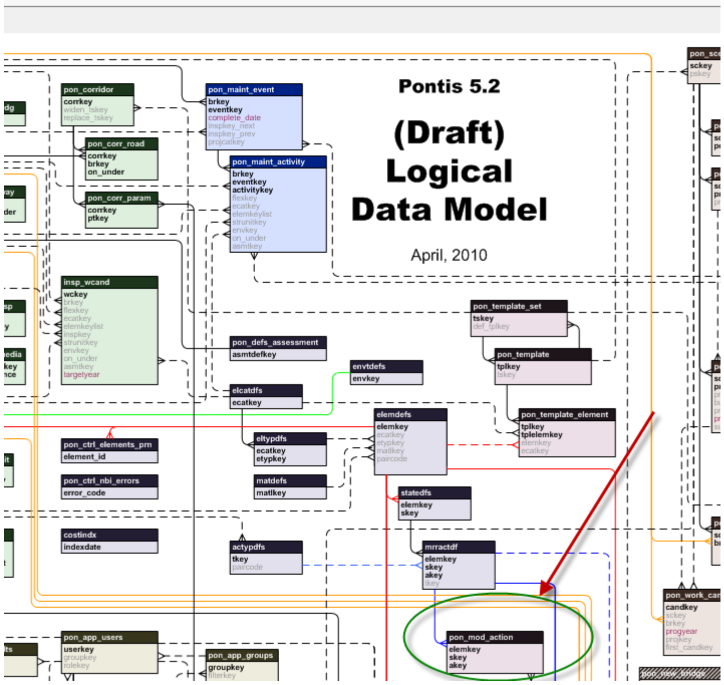
The inspector/bridge management engineer work candidates pertaining to the flex actions are stored in the PON_FLEXACTIONS_SETS table. We recommend to update this list to reflect WisDOT practices.



	FLEX_ACTION_KEY	FLEX_PARENT_ACT_KEY	FLEX_ACT_NAME_SHORT	FLEX_ACT_NAME_DESC	FLEX_CREATEDATETIME
1	80	0	Bridge-Analyze	Analyze Bridge Capacity	2014-02-27 19:45:18.097
2	61	0	Channel-Protect	Apply Channel Protection	2014-02-27 19:45:18.097
3	1001	0	Approach Railing	Approach Railing	2012-12-12 00:00:00.000
4	1000	0	Approach Railing-Repair	Approach Railing-Repair	2012-12-12 00:00:00.000
5	1004	0	Approach Roadway	Approach Roadway	2012-12-12 00:00:00.000
6	1002	0	Apprh Rdway-Mill Apprch/Shlder	Approach Roadway-Mill Approach / Shoulder	2012-12-12 00:00:00.000
7	1003	0	Approach Rdway-Patch Bituminous	Approach Roadway-Patch Bituminous	2012-12-12 00:00:00.000
8	1005	0	Approach Roadway-Wedge Approach	Approach Roadway-Wedge Approach	2012-12-12 00:00:00.000
9	1006	0	Approach Slab-Overlay	Approach Slab-Overlay	2012-12-12 00:00:00.000
10	1007	0	Approach Slab-Repair	Approach Slab-Repair	2012-12-12 00:00:00.000
11	1008	0	Approach Slab-Replace	Approach Slab-Replace	2012-12-12 00:00:00.000
12	10	0	Deck-Asphalt Repair	Asphalt Bridge Deck Repair Work	2014-02-27 19:45:18.097
13	60	0	Channel-Backfill	Backfill Channel Erosions	2014-02-27 19:45:18.097
14	27	0	Sub-Backfill	Backfill Erosion of Substructure Foundation	2014-02-27 19:45:18.097
15	1009	0	Bearings-Clean Assemblies/Paint	Bearings-Clean Assemblies / Paint	2012-12-12 00:00:00.000
16	1010	0	Bearings-Install Auxiliary	Bearings-Install Auxiliary	2012-12-12 00:00:00.000
17	1011	0	Bearings-Rehabilitation	Bearings-Rehabilitation	2012-12-12 00:00:00.000
18	1012	0	Bearings-Replace	Bearings-Replace	2012-12-12 00:00:00.000
19	1013	0	Bearings-Reset	Bearings-Reset	2012-12-12 00:00:00.000
20	0	0	Do nothing (flex)	Bridge deteriorates according to the TP matrix	2014-02-27 19:45:18.097
21	1014	0	Bridge Rail-Rehab	Bridge Rail-Rehab	2012-12-12 00:00:00.000
22	1015	0	Bridge Rail-Repair	Bridge Rail-Repair	2012-12-12 00:00:00.000
23	1016	0	Bridge Rail-Replace	Bridge Rail-Replace	2012-12-12 00:00:00.000
24	1017	0	Bridge Rail-Upgrade	Bridge Rail-Upgrade	2012-12-12 00:00:00.000
25	1018	0	Bridge-ADA Compliance Work	Bridge-ADA Compliance Work	2012-12-12 00:00:00.000
26	1019	0	Bridge-Collision Damage	Bridge-Collision Damage	2012-12-12 00:00:00.000

Cost for work candidates recommended by the system

The costs for activities recommended by BrM, pertain to the costs elicited through Phase II of this project. These costs will be stored in the PON_MOD_ACTION table, yet to be created in the BrM 5.2.3 version.



The table will look like this when implemented.

Element key	State key	Action key	Direct cost	Prob of state 1	Prob of state 2	Prob of state 3	Prob of state 4	Cost weight	Effect weight	Protection Factor
elemk	skey	akey	direct_	prob1	prob2	prob3	prob4	cost_v	eff_we	protect
12	1	1	93.98	100	0	0	0	20	20	
12	2	1	324.89	80	10	10	0	20	20	
12	2	2	136.37	100	0	0	0	20	20	
12	3	1	166.82	70	20	10	0	20	20	
12	3	2	159.66	100	0	0	0	20	20	
12	4	1	255.69	100	0	0	0	20	20	
12	4	2	318.31	100	0	0	0	20	20	
13	1	1	93.98	100	0	0	0	20	20	
13	2	1	324.89	80	10	10	0	20	20	
13	2	2	136.37	100	0	0	0	20	20	
13	3	1	166.82	70	20	10	0	20	20	
13	3	2	159.66	100	0	0	0	20	20	
13	4	1	255.69	100	0	0	0	20	20	
13	4	2	318.31	100	0	0	0	20	20	
15	1	1	93.98	100	0	0	0	20	20	
15	2	1	324.89	80	10	10	0	20	20	
15	2	2	136.37	100	0	0	0	20	20	
15	3	1	166.82	70	20	10	0	20	20	
15	3	2	159.66	100	0	0	0	20	20	
15	4	1	255.69	100	0	0	0	20	20	

Summary of Cost Data Collected from the Regions

A copy of the Excel Workbook, along with instructions and containing the elements previously cited, was sent to the Bridge Maintenance Engineers of the Northwest, North Central, Northeast, Southwest and Southeast Regions.

Five offices from four regions completed the cost elicitation providing costs at different levels of completeness. The offices are: La Crosse (SW), Milwaukee (SE), Green Bay (NE), Rhinelander (NC) and Wisconsin Rapids (NC).

The metrics for the information received are as follows:

Element	Total Points	Points With Cost	Ratio	Notes
12	85	33	39%	
13	75	13	17%	Only La Crosse
38	95	31	33%	
107	45	12	27%	
109	45	5	11%	
113	35	1	3%	
152	35	0	0%	No Cost Provided
205	35	5	14%	
210	40	5	13%	
215	45	6	13%	
234	45	3	7%	
241	40	10	25%	
300	60	13	22%	
301	35	4	11%	
302	50	10	20%	
303	40	4	10%	
304	45	0	0%	No Cost Provided
305	60	4	7%	
310	40	4	10%	
321	95	18	19%	
330	30	7	23%	
331	40	11	28%	
8511	70	8	11%	
8512	40	17	43%	
8513	30	10	33%	
8514	50	13	26%	
8515	65	0	0%	No Cost Provided
8516	25	13	52%	

We recommend to use the average cost for those elements where the ratio is greater than 20%. We recommend further work to be done comparing all these costs with those being collected through ongoing NCHRP efforts.

Suggested protocols for developing/collecting and maintaining cost information at the State level

Develop a matrix for all elements in the Wisconsin DOT bridge inventory. The matrix should include recommended actions for element protection, repair, rehabilitation and replacement. This matrix should be used to develop contract work orders for bridge preservation work.

The agency completing the work would fill out the quantities and pertaining cost for each preservation action completed in a particular bridge. These data would be collected, processed and entered in BrM.

Task 2. Develop WisDOT-specific Element Deterioration Models

The delivery of Task 2 is an Excel spreadsheet containing the same 25 elements selected for Task 1. The deterioration models are included in Appendix B of this document will need to be calibrated when the version of AASHTOWare BrM 5.2.3 is released. Baker has reviewed the deterioration models provided by South Dakota, Pennsylvania, Michigan, and the BrM Technical Review Team (TRT) on Deterioration Models.

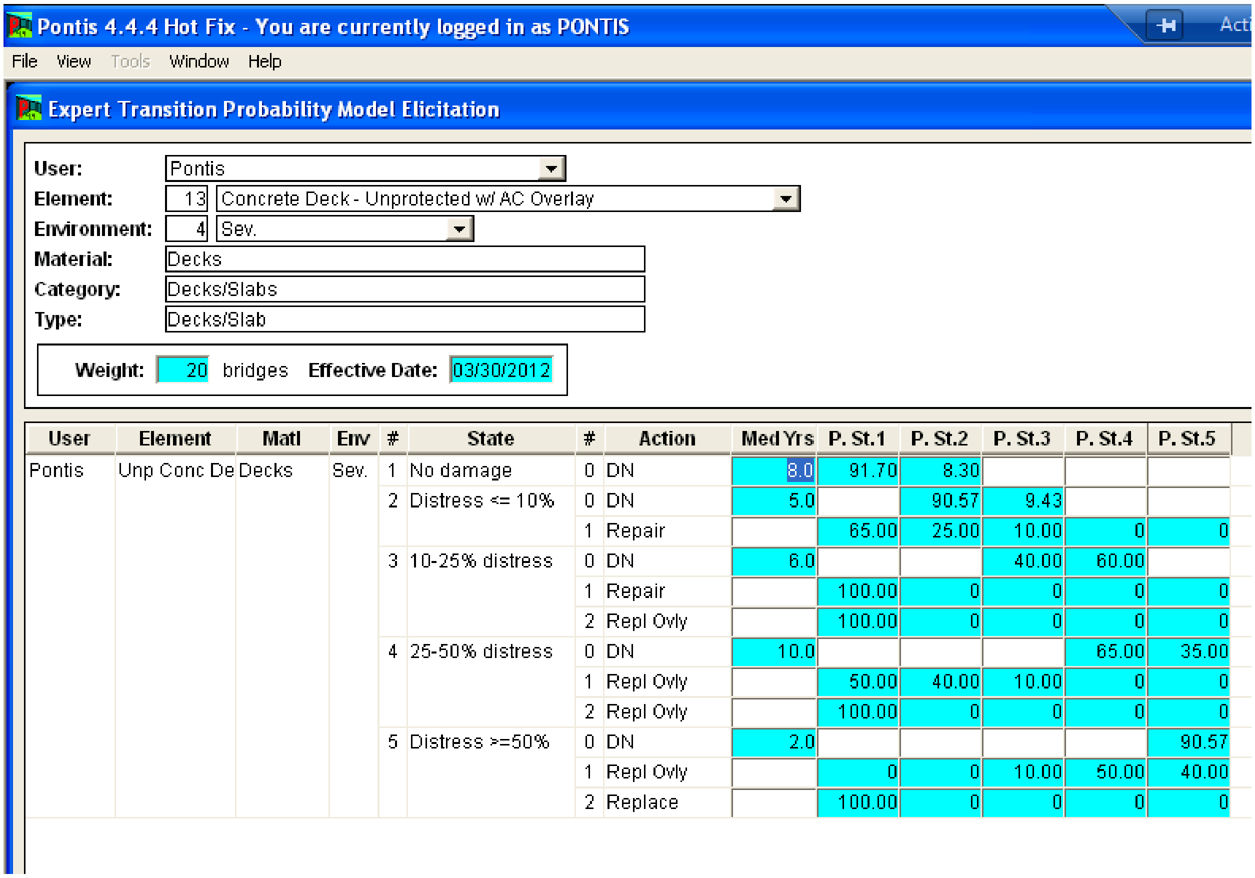
Background

Transition probabilities estimated based on the median number of years between transitions. For example, if it takes T years for 50 percent of a population of elements to transition from one state to the next, then the probability in a one-year period of staying in the starting condition state can be calculated from:

$$P = 0.5^{(1/T)}$$

For example, if it takes a median of six years to transition from state 1 to state 2, then the transition probability of staying in state 1 is 0.89 or 89 percent. If we assume that all the rest of the element deteriorates to state 2, then the transition probability from state 1 to state 2 is (1-*P*) = 0.11 or 11 percent.

The AASHTOWare Pontis 4.X version includes a preservation module where the interface allows the user to either enter the median years or the percentage obtained through an elicitation process.



User	Element	Matl	Env	#	State	#	Action	Med Yrs	P. St.1	P. St.2	P. St.3	P. St.4	P. St.5
Pontis	Unp Conc De	Decks	Sev.	1	No damage	0	DN	8.0	91.70	8.30			
				2	Distress <= 10%	0	DN	5.0		90.57	9.43		
						1	Repair		65.00	25.00	10.00	0	0
				3	10-25% distress	0	DN	6.0			40.00	60.00	
						1	Repair		100.00	0	0	0	0
						2	Repl Ovly		100.00	0	0	0	0
				4	25-50% distress	0	DN	10.0				65.00	35.00
						1	Repl Ovly		50.00	40.00	10.00	0	0
						2	Repl Ovly		100.00	0	0	0	0
				5	Distress >=50%	0	DN	2.0					90.57
						1	Repl Ovly		0	0	10.00	50.00	40.00
						2	Replace		100.00	0	0	0	0

The deterioration models were intertwined with the cost models to trigger preservation policies for each condition state and environment. This is why some of the models provided by other states, vastly differ with the deterioration models expected in BrM.

In the BrM 5.2.2 version, the entry is limited to the median years for the "Do Nothing" action and only one environment. It introduces the Weibull model as an enhancement to the pre-existing Markovian deterioration model. The introduction of the Weibull model aids in managing the known shortcomings of the Markovian model as it applies to the transition from condition state 1 (CS1). The rest of the transitions are modeled via the Markovian model. There are three distinct parameters that need to be configured as part of the element deterioration model: The transition time, the Weibull shaping parameter and the protection parameter.

Transition Time Parameter

A transition time T_i is defined as the median number of years a unit of the element stays in condition state i prior to transitioning to the next state. Based on this definition, one can expect half of an element originally in condition state i to transition to the next state by the specified transition time.

$$P = 0.5^{(1/T_i)}$$

Weibull Shaping Parameter

The Weibull shaping parameter controls the shape of the Weibull distribution. In the case of bridge element model deterioration, the parameter needs to be greater than. A Weibull model with a shaping parameter value of "1" behaves identical to the Markovian model.

The Protection Factor

The protection facto summarizes the full effect of all possible element associations that affect a given element at a given point in time. This protection factor may affect the median years to transition, thus accelerating or decelerating deterioration. It is applied like this:

$$M_i' = M_i \times PF$$

where:

M_i' = adjusted median years to transition from state *i* to state *i*+1

M_i = default median years to transition from state *i* to state *i* +1

PF = protection factor for the element

The default median years may come directly from expert elicitation, provided the expert elicitation question is modified to add, "… and all protecting elements are sound and functioning as intended to protect the element."

It will be noticed that this language is currently a part of the condition state language of protected elements such as painted steel. When the protective coating is separated from the steel, we need a way to preserve the notion of the protective system performing as intended (*PF* = 1.0), and a way to quantify the failure of the coating to do so (*PF* < 1.0).

When there is one protecting element, denoted *P,* the protection factor *PF* is calculated as follows:

$$PF = \sum_i (PP_{ps} \times F_{ps})$$

where:

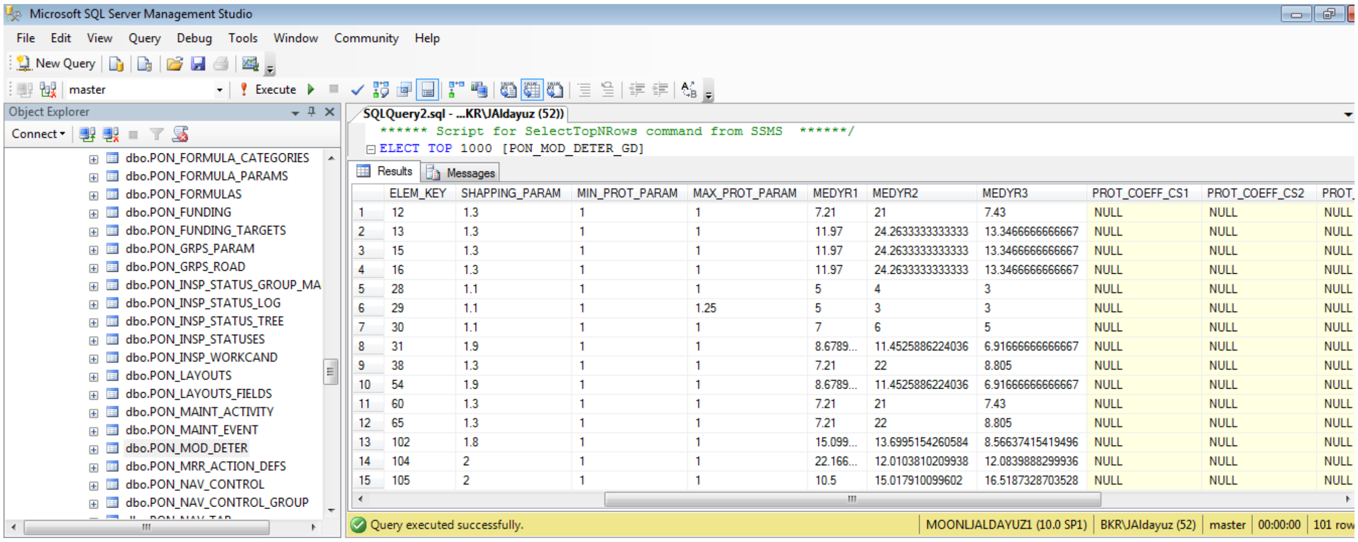
PP_{ps}= Protection parameter for protecting element P_i state *s* (0.0<=PP_{pi}<=1.0)

F_{ps} = Fraction of element *P* in state s_i

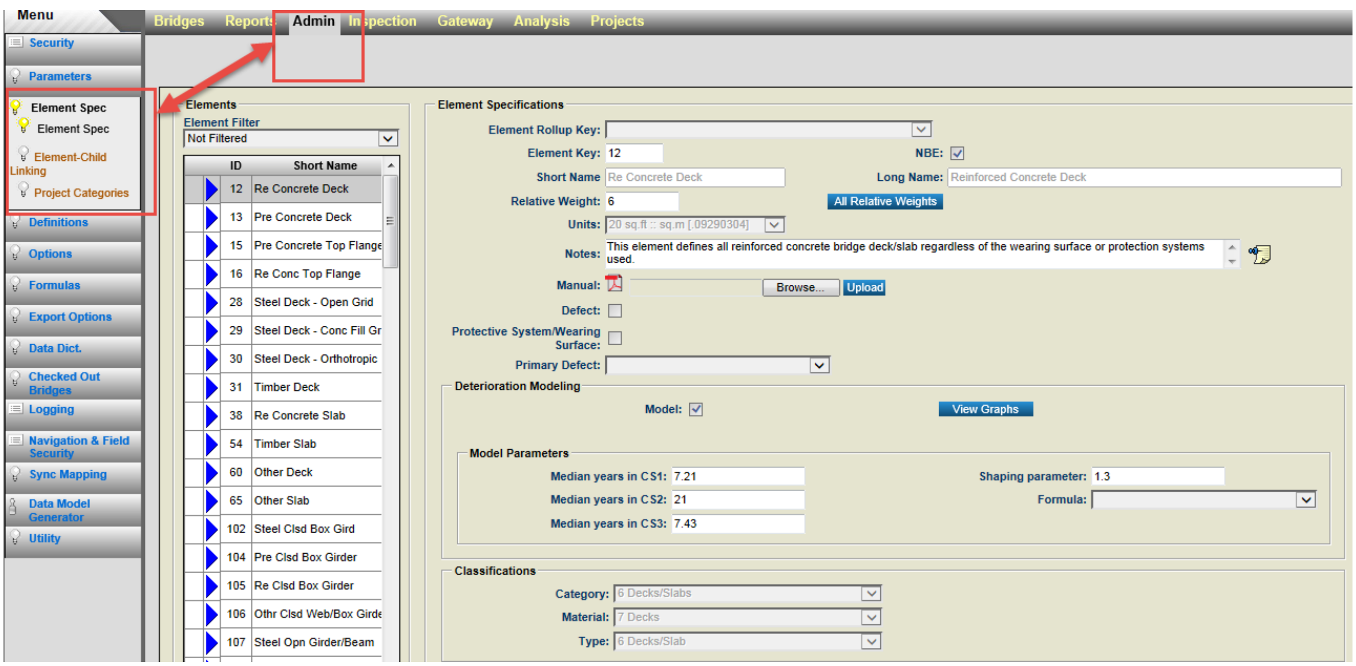
PP_{ps}= Parameter indicates how much of its full protection element *P* gives when it is in condition state *s*. It is evident that the protection factor ranges from 0.0 to 1.0.

Another characteristic of the BrM models is that instead of maintaining separate deterioration models classified by environment, it uses a protection factor that varies by environment. It is compatible with other uses of the factor and vastly simplifies the expert elicitation process and the updating process. While the presentation above assumed that protection factors are <=1.0, this requirement would be lowered for environmental factors. A moderate environment might be 1.0 while a benign environment is 2.0, meaning everything takes twice as long to deteriorate. Agencies will set these factors as appropriate for their own environmental characteristics.

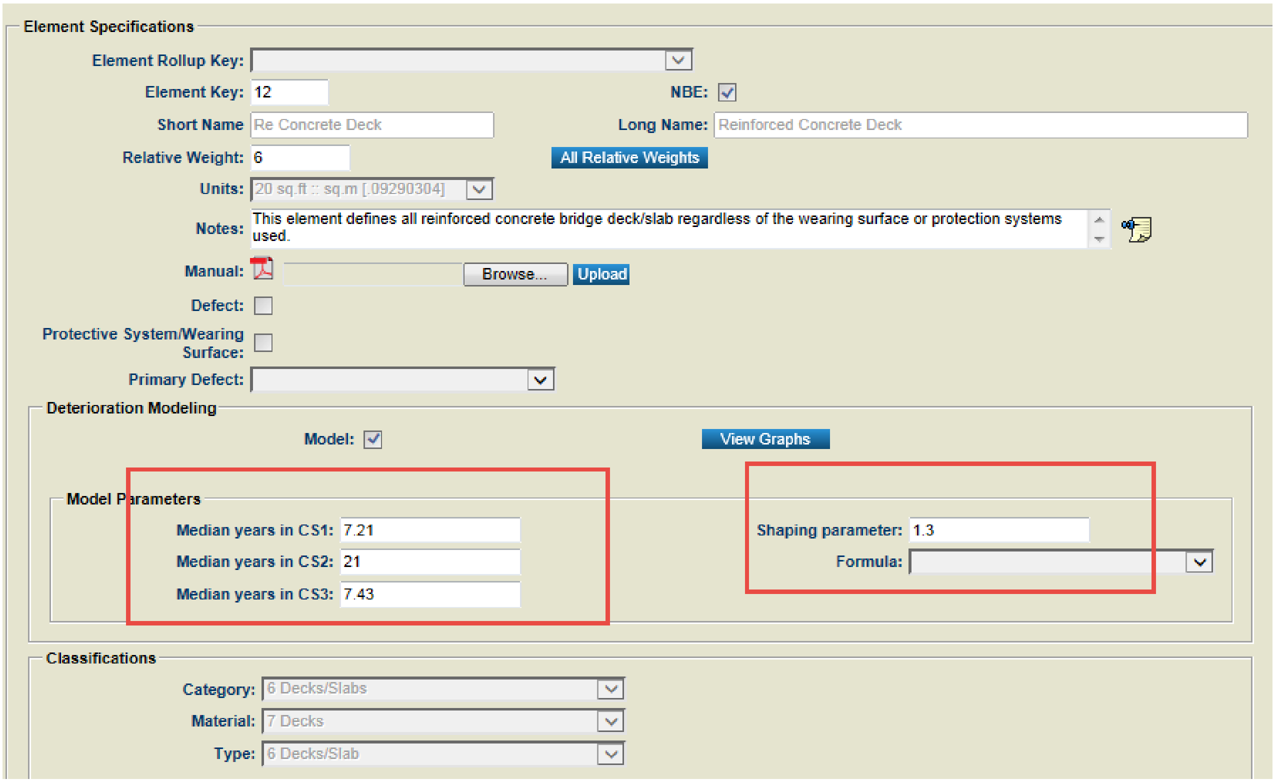
These three parameters are stored in the PON_MOD_DETER table as shown in the following figure:



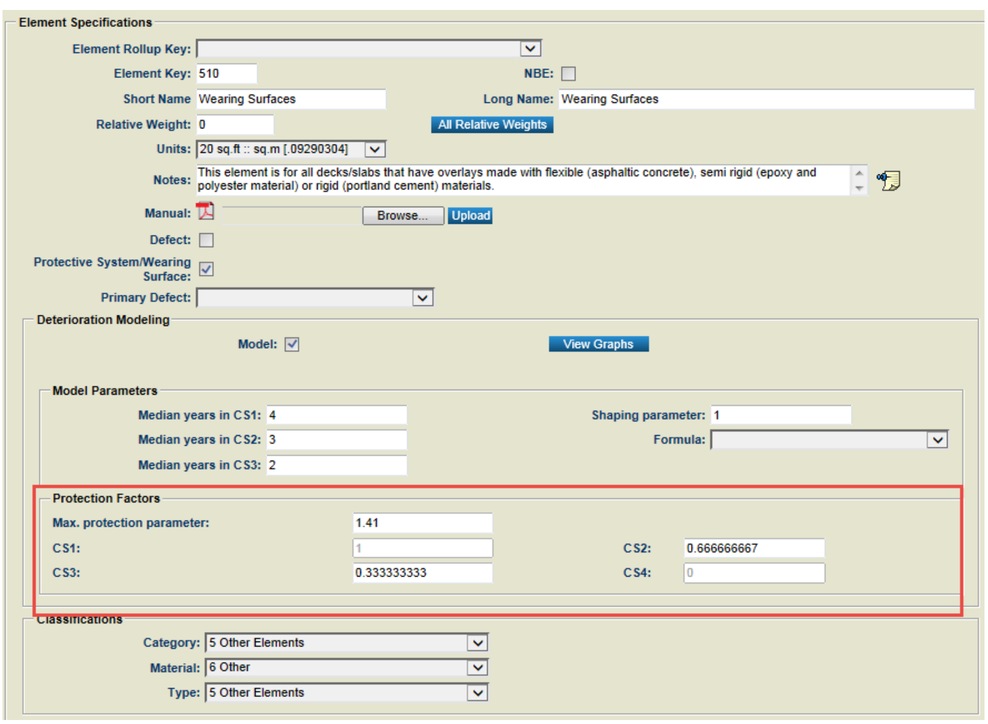
The BrM interface that allows the user to add, modify, or delete the models, is in the Admin Page, Element Specifications button.



Two of the three parameters mentioned in the narrative are located as follows:

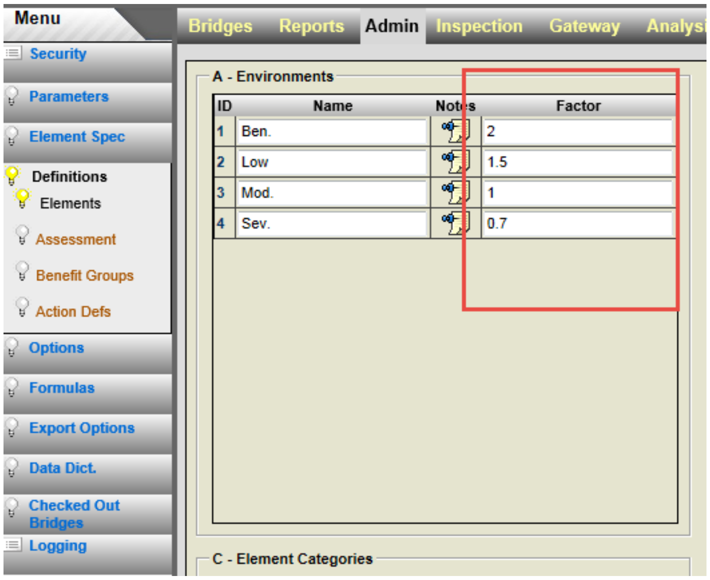


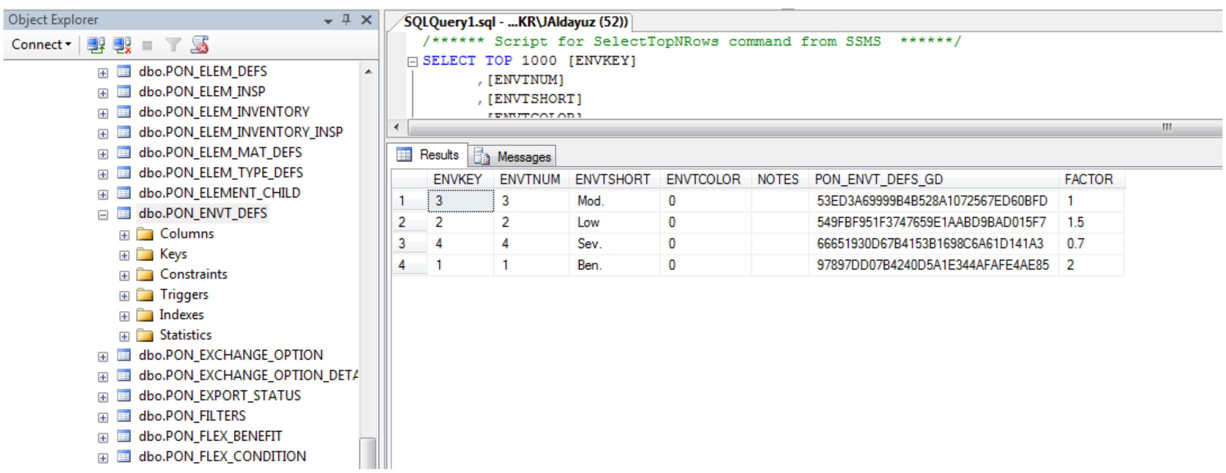
The third value, the protection parameter, is only present on screens related to elements that are protective systems.



The summary deterioration table and associated values for the elements included in this research can be found in Appendix B of this report.

The environment factors are stored in the PONT_ENV_DEFS table and can be edited in the Admin Tab, Elem Spec Group, Definitions Task as shown below.





Process Used to Develop Appendix B

The hypothesis behind using Pontis deterioration models from other states (SD,MI and PA), to obtain the median years elapsed from the Do Nothing to Condition State 1, proved not to be applicable in most cases for the elements included in this research. This fact is apparent in the comparison spreadsheet included in the appendix.

The reason is attributed to the fact that BrM deterioration models are independent for the long term and failure costs to trigger an action. For the Pontis deterioration models, it was a common practice to modify the transition probabilities and the cost to trigger a prescribed preservation policy.

The BrM models provided by the BrM TRT were used to refine the recommended deterioration models. The refining was done based on empirical knowledge and a published report on overlays as noted in the Appendix. It must be noted that the default deterioration models are slightly different than those elicited from the BrM TRT.

Wisconsin DOT Deterioration Models

Table Name PON_MOD_DETER

Element key	Element name for reference (not in pon_mod_deter)	Weibull shape param	Median years state 1	Median years state 2	Median years state 3	PennDOT			South Dakota			Michigan			TRT			Wisconsin Recommended for Env 4			
elemkey	name	shaping_param	medyr1	medyr2	medyr3	PMed1	PMed2	PMed3	SMed1	SMed2	SMed3	MMed1	MMed2	MMed3	TMed1	TMed2	TMed3	shaping_param2	WMed1	WMed2	WMed3
12	Reinforced Concrete Deck	[illegible]	[illegible]	[illegible]	[illegible]	22.00	34.00	13.00	22.00	34.00	13.00	7.50	7.50	6.00	7.20	21.00	7.40	2.00	10.00	25.00	5.00
13	Prestressed Concrete Deck	[illegible]	11.97	24.26	[illegible]	NA	NA	NA	NA	NA	NA	5.50	12.50	9.00	12.00	24.30	13.30	1.70	12.50	25.00	10.00
38	Reinforced Concrete Slab	[illegible]	[illegible]	[illegible]	[illegible]	28.00	16.00	9.00	28.00	16.00	9.00	NA	NA	NA	7.20	22.00	8.80	2.00	10.00	25.00	5.00
107	Steel Open Girder	[illegible]	[illegible]	[illegible]	[illegible]	17.00	14.00	4.00	46.00	10.00	18.00	7.50	12.50	20.00	14.20	9.70	16.00	1.80	14.00	10.00	7.00
109	PS Open Girder	[illegible]	[illegible]	[illegible]	[illegible]	25.00	30.00	30.00	90.00	9.00	9.00	100.00	30.00	50.00	27.50	14.60	14.30	2.00	30.00	15.00	15.00
205	RC Column	2.0	37.44	29.88	21.90	5.00	5.00	5.00	69.00	48.00	43.00	41.00	34.00	125.00	37.40	29.90	21.90	2.50	30.00	30.00	22.00
210	RC Pier Wall	2.0	47.57	30.43	30.52	25.00	35.00	10.00	68.00	50.00	43.00	55.00	30.00	65.00	47.60	30.40	30.50	2.50	30.00	30.00	22.00

BrM 5.2.2 Default

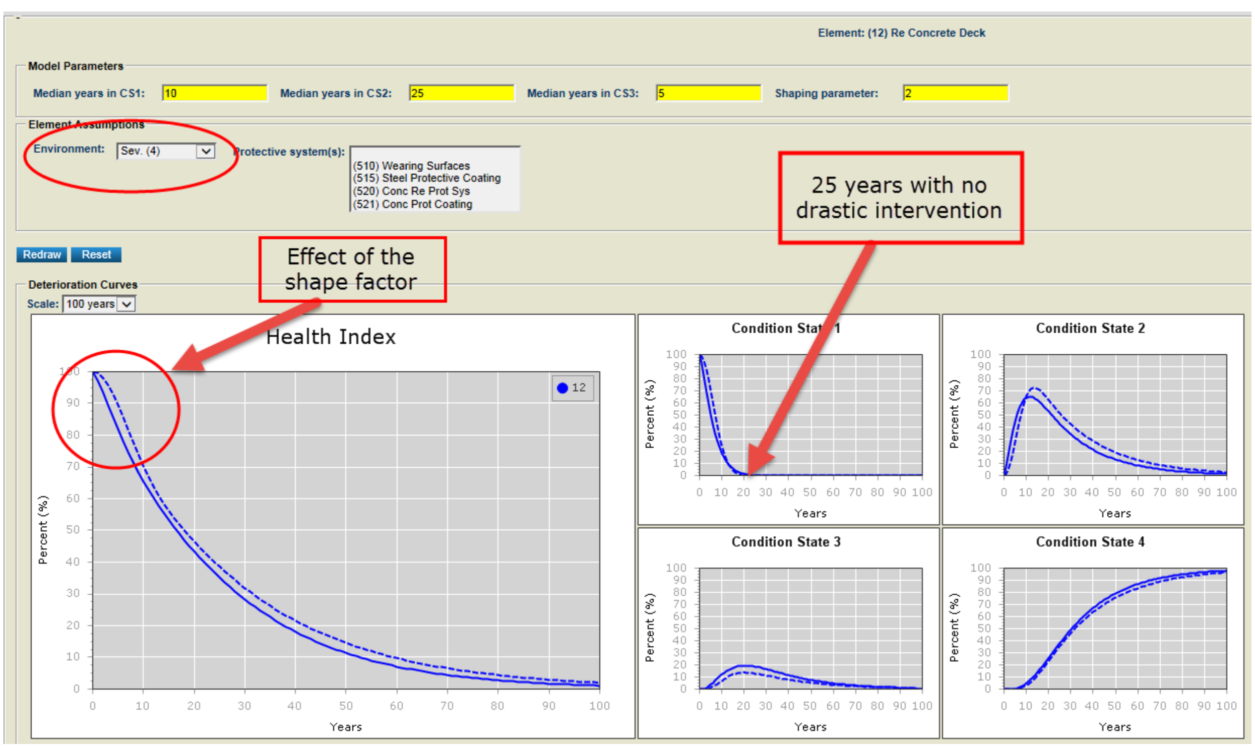
The process to determine the recommended models was to replace the default BrM 5.2.2 models with those recommended by the TRT and then modifying the shaping parameter and/or the median years until the plotting for the condition states will match deterioration observed by empirical experience. In short the determination was based on an elicitation process performed by the BrM TRT and a refinement based on empirical knowledge of deterioration rates in Wisconsin. All the adjustments were completed for condition state 4.

In the case of element 12, the BrM values were changed to those elicited from the BrM TRT and then refined as follows:

Wisconsin DOT Deterioration Models

Table Name PON_MOD_DETER

Element key	Element name for reference (not in pon_mod_deter)	Weibull shape param	Median years state 1	Median years state 2	Median years state 3	TRT			Wisconsin Recommended for Env 4			
elemkey	name	shaping_param	medyr1	medyr2	medyr3	TMed1	TMed2	TMed3	shaping_param2	WMed1	WMed2	WMed3
12	Reinforced Concrete Deck	1.3	7.21	21.00	7.43	7.20	21.00	7.40	2.00	10.00	25.00	5.00
13	Prestressed Concrete Deck	1.3	11.97	24.26	13.35	12.00	24.30	13.30	1.70	12.50	25.00	10.00
38	Reinforced Concrete Slab	1.3	7.21	22.00	8.81	7.20	22.00	8.80	2.00	10.00	25.00	5.00
107	Steel Open Girder	1.8	14.25	9.73	6.77	14.20	9.70	16.00	1.80	14.00	10.00	7.00
109	PS Open Girder	2.0	27.50	14.61	14.29	27.50	14.60	14.30	2.00	30.00	15.00	15.00
205	RC Column	2.0	37.44	29.88	21.90	37.40	29.90	21.90	2.50	30.00	30.00	22.00
210	RC Pier Wall	2.0	47.57	30.43	30.52	47.60	30.40	30.50	2.50	30.00	30.00	22.00



The shaping factor was increased for those elements where the drop on Health Index was too steep. This was done to take full advantage of the Weibull concept. The median years were adjusted to reflect empirical field knowledge for duration of each condition state using the pertinent graph after the modifications were made.

Once BrM 5.2.3 is released, these recommended values can be calibrated using a set of test bridges. Potential changes after the calibration can be performed using the process previously outlined.

Task 3. Develop WisDOT-specific Utility Functions

The original motivation behind introducing utility functions was to address the problem, noted by many states, that life-cycle cost alone does not fully describe the goals of bridge preservation and improvement. It is true that the agency desires to keep life-cycle costs as low as possible, including the costs to road users. But the public also has other expectations, such as mobility, safety, the perception of safety, protection from natural and man-made hazards, and the preservation of community image and property value. A solution that minimized life-cycle cost alone, did not satisfy public expectations of infrastructure condition or other objectives.

The degree of importance of different objectives can vary from one part of the inventory to another, even from one bridge to another. Interstate highway bridges, for example, might give more emphasis to perception of safety, protection from hazards, and lifeline availability, than other bridges. This implies that the relative importance of objectives can vary between bridge level and network level.

At both the bridge and network levels, there are two general ways of incorporating performance measures in an optimization framework: as objectives, or as constraints. At the bridge level, a performance constraint would affect the feasibility of a given treatment in a given situation, or would affect the circumstances under which the treatment might be considered. At the network level, a performance constraint would cause the optimization to consider sub-optimal alternatives that might satisfy the constraint even at the expense of network-wide goals. For example, a substructure condition constraint might cause the model to abandon work on decks if necessary to free up enough money to meet the substructure condition goal, even if the substructure needs are relatively minor.

At both the bridge and network levels, a performance measure can be incorporated in the model objective by means of a utility function. A utility function is a mathematical formula that combines two or more objectives in a manner that gives a weight to each objective consistent with its importance at any level of investment. Utility functions are often non-linear with respect to performance measures, but linear with respect to the value of money. This puts them on a scale to which people can typically relate. Utility functions are based on a theory of relative preferences for different measures of value.

One way of expressing such preferences is to set up hypothetical situations where a decision maker must decide which of two or more competing needs should receive the next dollar of investment. There are several methods for eliciting that kind of information and mathematically transforming the results into utility functions.

The utility function can also be handled as a set of decision variables. In this complementary framework, the user adjusts the relative weights of objectives until certain goals are met, or until it is determined that the goals cannot be met without too much sacrifice of other goals. That type of analysis is actually the essence of decision making, reconciling what is desired against what is possible. It can be performed without requiring mathematical performance constraints, since the user imposes constraints interactively. This makes the analysis fairly simple but places emphasis on an effective graphical depiction of the solution space.

The BrM 5.2.2 software appears to only include Utility Functions at the Network level. It is the Baker opinion that this approach is acceptable to have the utility goals as parents and the performance goals as children criteria.

National Cooperative Highway Research Program (NCHRP) Report 590

The needs identified in the previous section, triggered the commission of a research study sponsored by NCHRP. The first and main task of the study was to develop a methodology that would allow the evaluation of different alternative bridge actions based on a set of goals and the following performance criteria:

- Preservation of bridge condition: National Bridge Inventory (NBI) condition ratings, health index, and sufficiency rating.
- Traffic safety enhancement: Geometric and inventory/operating rating.
- Protection from extreme events: Vulnerability ratings for scour, fatigue/fracture, earthquake, collision, overload, and other human-made hazards.
- Agency cost minimization: Initial cost, life-cycle agency cost.
- User cost minimization: Life-cycle user cost.

The study further recommends the following relative weights for each criterion:

Table 7. Recommended relative weights: Overall goals.

Overall Goal	Relative Weight
Bridge Preservation	0.360
Safety	0.205
Protection from Extreme Events	0.150
Agency Cost	0.175
User Cost	0.110
TOTAL	**1.000**

Source: NCHRP Report 590

Note that the weights can also be considered as percentages.

To summarize:

- A utility is a 0 to 1 (or 0-100) unit less measure that quantifies action/project benefits
- Dissimilar benefits can be combined using utility functions
- Utility curves can be user defined and can include:
    - Condition, load capacity, risks, functional needs, etc.
- The total utility of a project is equal to the weighted sum of the component utilities.
    - Total Utility = $W_1(U_1) + W_2(U_2) + W_3(U_3)\ldots.+ W_n(U_n)$

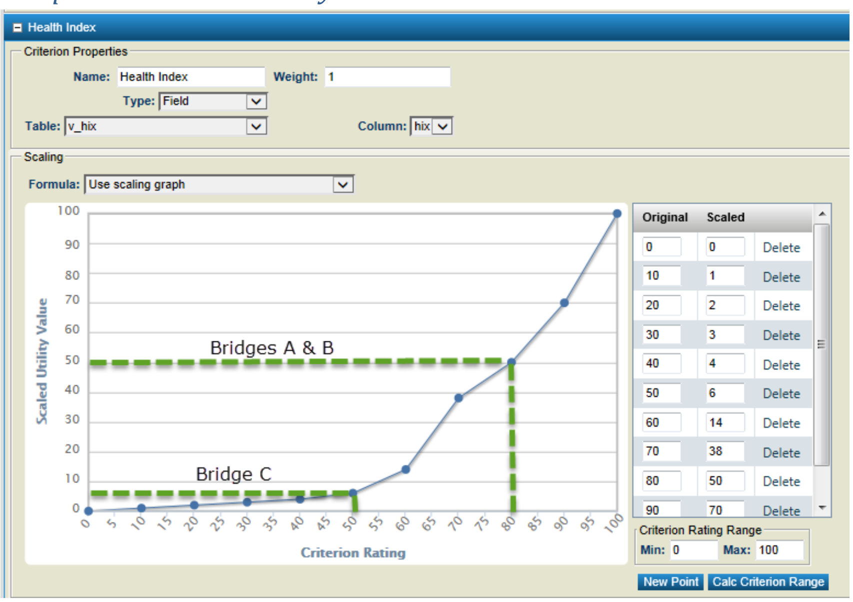
Utility Function Example

It is necessary to illustrate the association with the Utility Function concept and project cost. In order to do that, we will consider three bridges (A, B, and C) and three Utility Functions (Health Index, Scour, and Load Rate), the bridges also have a distinct deck area and project cost.

Bridge	Health Index	Scour (NBI 113)	Inventory Load Rate	Bridge Area	Project Cost	$/sq. ft.
A	80	7	15 tons	3000 sq. ft.	1.2 mil	400
B	80	3	40 tons	6000 sq. ft.	2.5 mil	417
C	50	5	40 tons	9000 sq. ft.	9.0 mil	1000

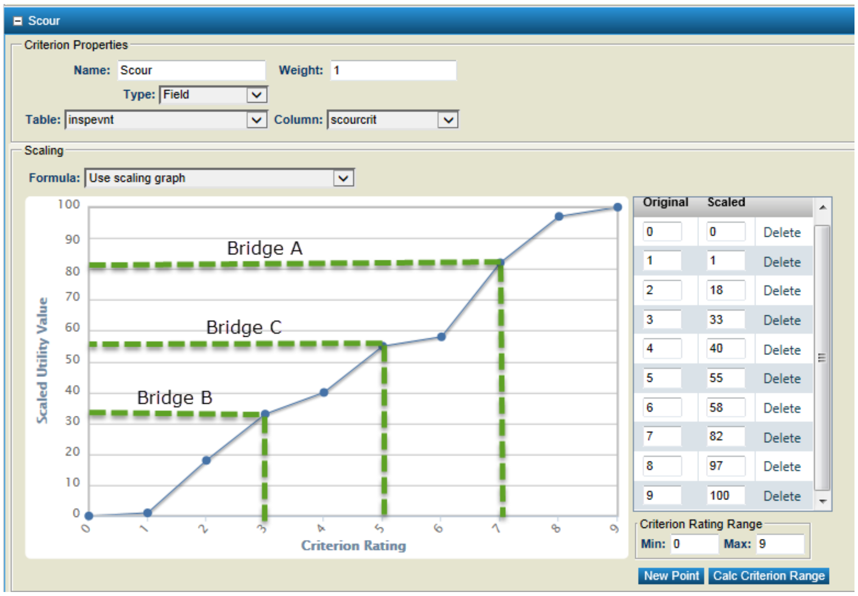
The respective utility relative weights are: $W_{BHI} = 50$, $W_{113} = 30$, and $W_{LR} = 20$

Sample Health Index Utility Curve



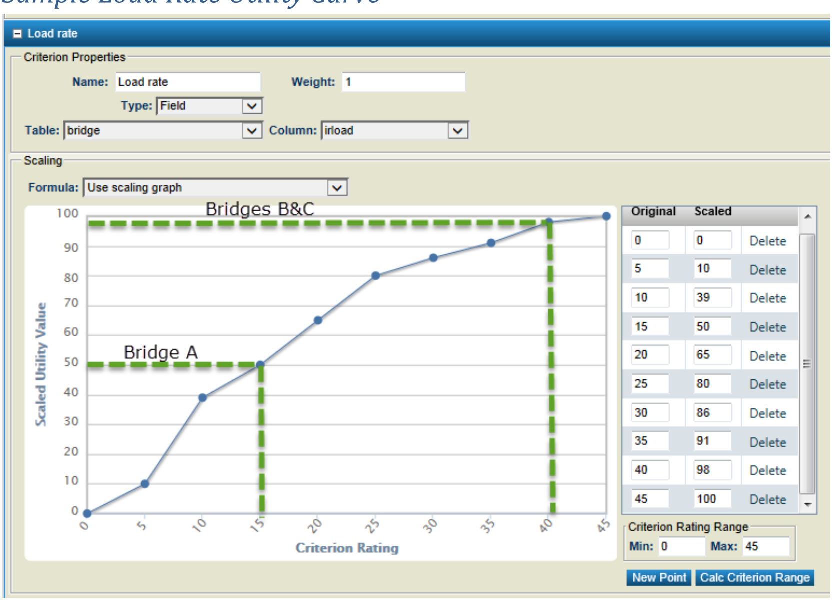
Bridge	Health Index	U_{BHI}
A	80	50
B	80	50
C	50	6

Sample Scour Utility Curve



Bridge	Scour	U_{113}
A	7	82
B	3	33
C	5	55

Sample Load Rate Utility Curve



Bridge	Load Rate	U_{LR}
A	15 tons	50
B	40 tons	98
C	40 tons	98

Summary

Bridge	*BHI*	U_{BHI}	W_{BHI}	Scour	U_{113}	W_{113}	Load Rate	U_{LR}	W_{LR}
A	80	50	50	7	82	30	15 tons	50	20
B	80	50	50	3	33	30	40 tons	98	20
C	80	6	50	5	55	30	40 tons	98	20

Calculations

Total Utility – Bridge A = (100 - 50) * 50 + (100 - 82) * 30 + (100 - 50) * 20 = 4,040
Total Utility – Bridge B = (100 - 50) * 50 + (100 - 33) * 30 + (100 - 98) * 20 = 4,550
Total Utility – Bridge C = (100 - 6) * 50 + (100 - 55) * 30 + (100 - 98) * 20 = 6,225

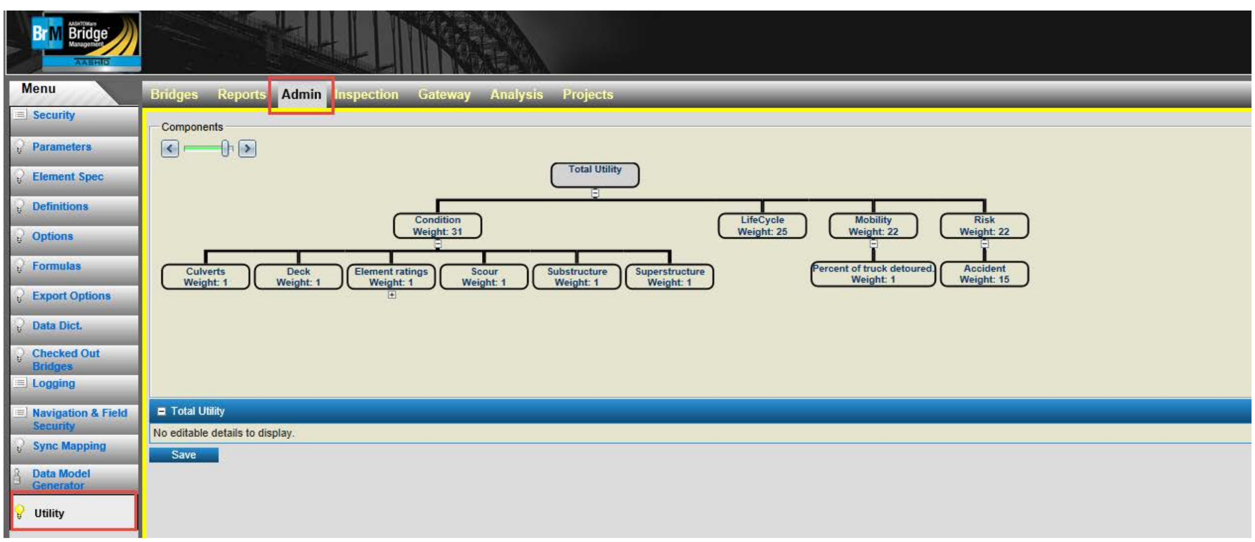
Priority Value Based on Total Utility Divided by Cost per sq. ft.

Bridge	Total Utility	Bridge Area	Project Cost	$/sq. ft.	Priority Value	Rank
A	4,040	3,000 sq. ft.	1.2 mil	400	10.1	2
B	4,550	6,000 sq. ft.	2.5 mil	417	10.9	1
C	6,225	9,000 sq. ft.	9.0 mil	1,000	6.2	3

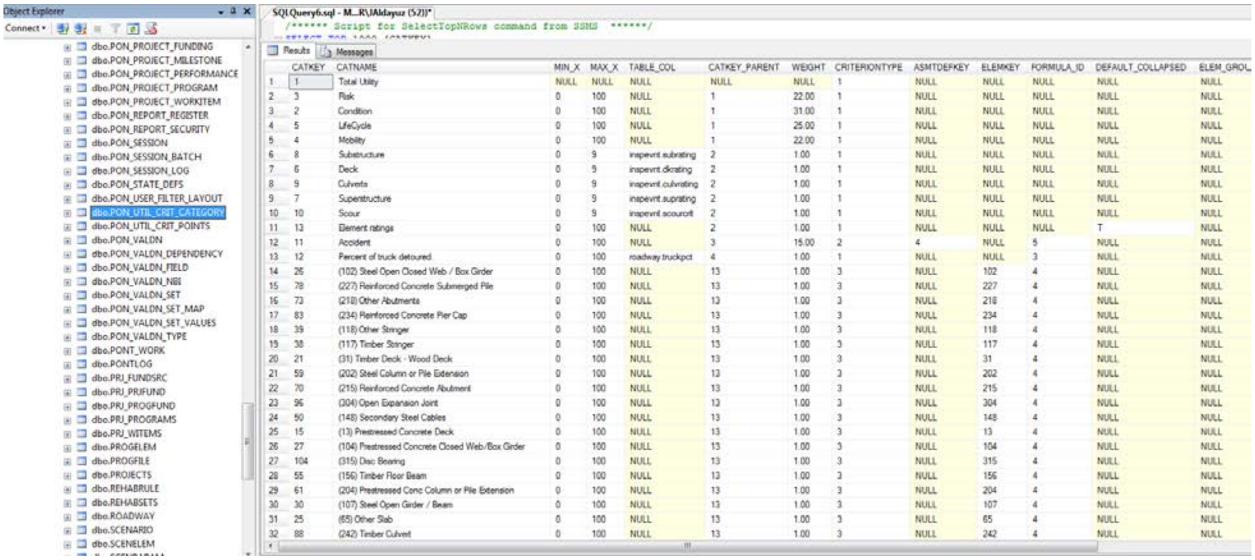
Utility Functions in BrM

BrM 5.2.2 includes the incorporation of a multi-objective analysis using utility functions. Utility function weights can be generated using expert elicitation, or by experimenting with actual programs to evaluate and adjust their effect on program performance. The BrM 5.2.2 User's Manual includes very limited content with regards to the utility function concept, the following instructions are the result of using the BrM 5.2.2 software.

To edit the default utility value, the user need to have access to the Admin tab and press on the utility button as shown below:

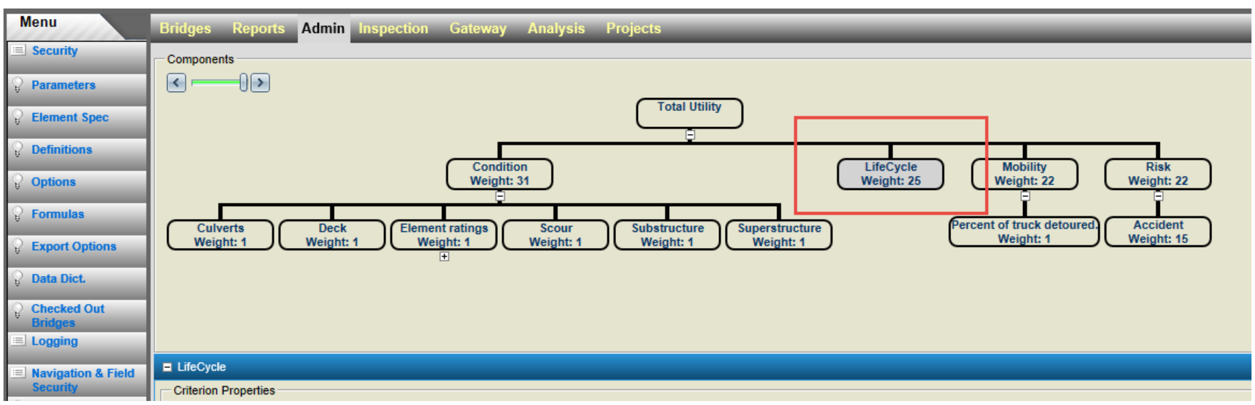


All of these values are included in the PON_UTI_CRIT_CATEGORY table as follows:

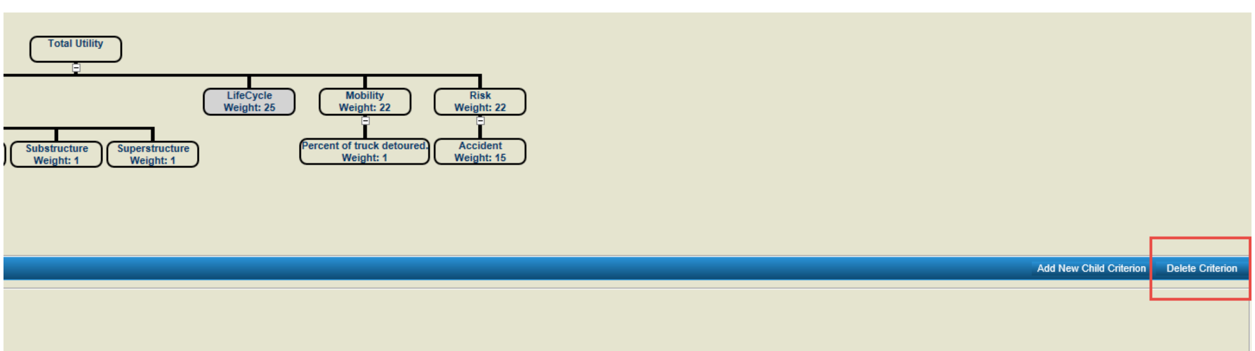


Deleting a criterion.

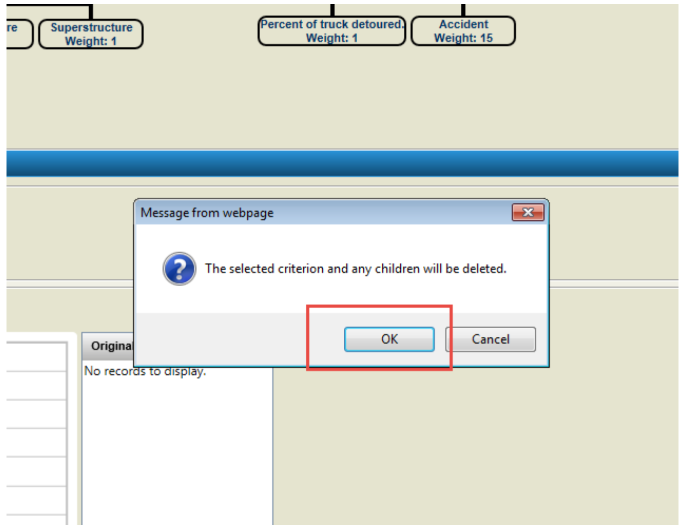
In this example we will delete the life-cycle criterion as WisDOT is not ready yet to consider it. In the Admin Tab Utility button, select the lifecycle label on the graph, you will notice that the box changes its color to grey.



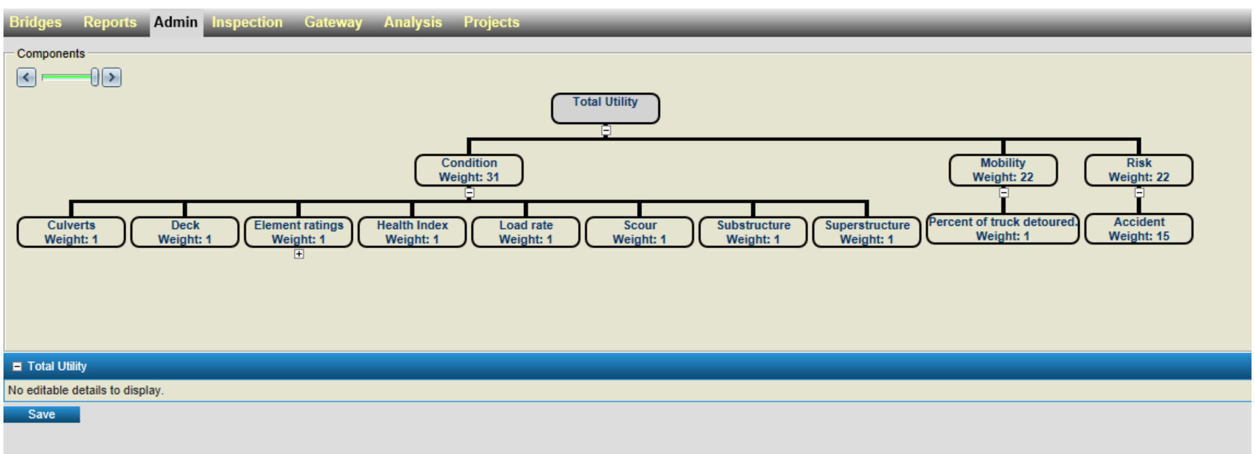
In the same window click on the Delete Criterion button located at the right side of the screen.



Click on the OK button on the following Window



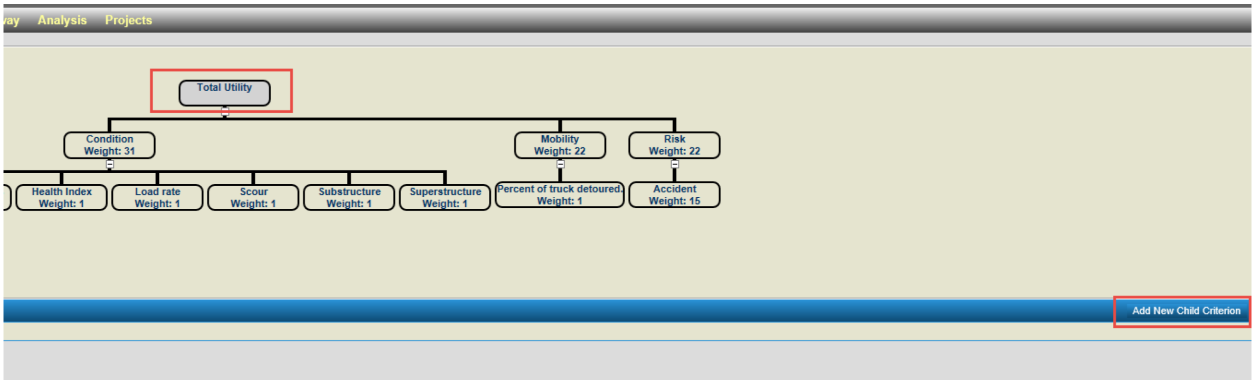
Note: There is no validation check so that the total utility value be equal to 100.



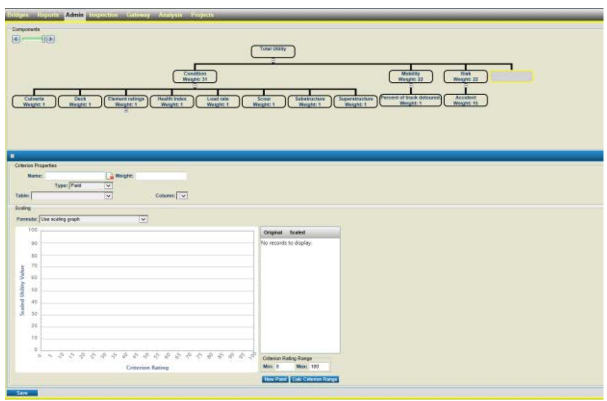
Adding a criterion

In this example we will add a WI Planning criterion, this criterion is discussed in detail on Task 4, WI Specific Risk Assessment Criteria.

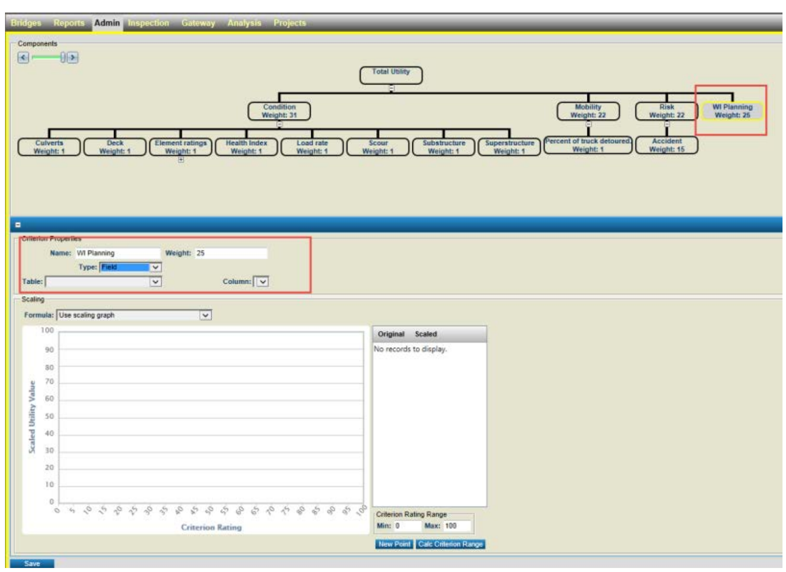
Click on the Total Utility Box, you will notice that the box changes its color to grey, after that click on the Add New Child Criterion button.



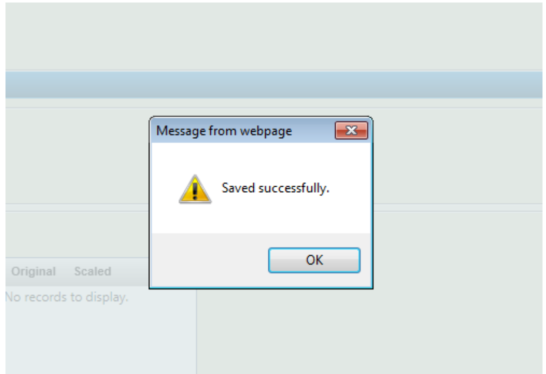
The following window will display:



Note that the box for the new criterion will be blank until the information under the Criterion Properties pane is filled for the Name and Weight fields.



Click on the Save button located at the lower left corner and the following dialog box will appear.



Recommended Utility Functions for WisDOT

It is recommended that WisDOT uses the Utility Curves as determined in NCHRP Report 590. This curves were obtained using data and have a documented origin as opposed of the default values from the BrM 5.2.2 release.

As noted before, Report 590 recommends the following relative weights for performance goals:

Table 7. Recommended relative weights: Overall goals.

Overall Goal	Relative Weight
Bridge Preservation	0.360
Safety	0.205
Protection from Extreme Events	0.150
Agency Cost	0.175
User Cost	0.110
TOTAL	**1.000**

The relative weights were developed using two alternative approaches: the direct questioning approach and the analytic hierarchy process approach. The weights were aggregated across questionnaire participants (NCHRP Panel 12-67 participants) using the average values of their responses. The weights were developed across all levels of the hierarchy of performance criteria. On the second day of the panel meeting, participants were given a chance to review their responses from the previous day's questionnaire. This is a standard Delphi technique used to encourage questionnaire participants to arrive at a consensus. Using the revised (day 2) responses, the relative weights of the bridge performance measures were recomputed. For each performance measure, the reported standard deviation reflects the level of agreement among the participants regarding the relative weight of that performance measure. The smaller the standard deviation, the higher is the level of agreement. The smaller standard deviation values for day 2 show that there was a considerably higher level of agreement among the panel members on that day compared with on day 1.

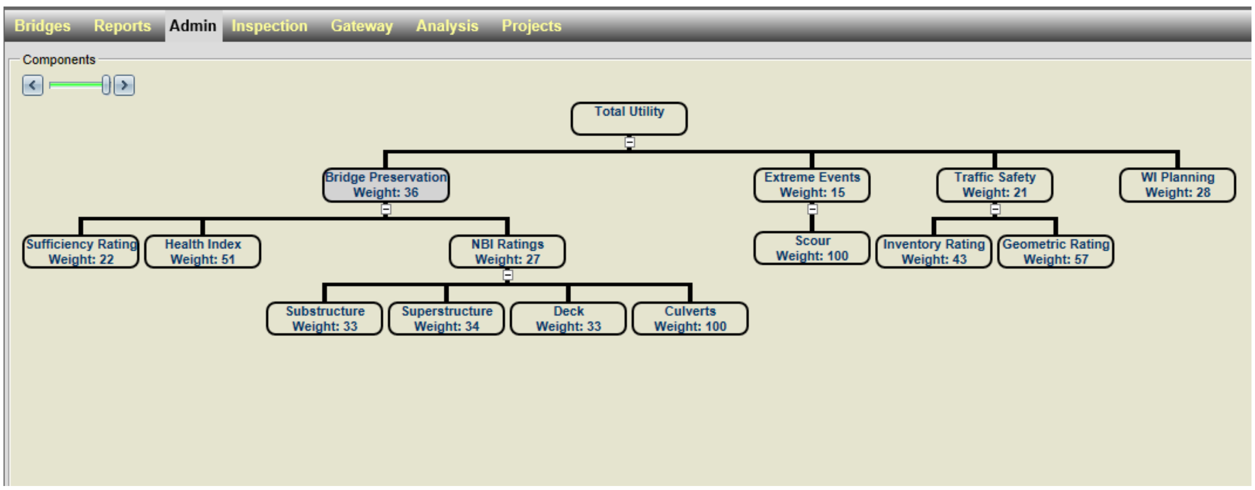
The relative weights can be expressed as a fraction or a percentage. BrM 5.2.2 considers these relative weights as percentage. We recommend to use the following relative weights for the overall goals of WisDOT. The recommended relative weights for the individual performance measures are a slight modification from those recommended in the Report 590.

Overall Goal	Relative Weight
Bridge Preservation	36
Safety	21
Protection from Extreme Events	15
WI Planning*	28
Total	100

Note that Agency Cost and User Cost relative weights found in Report 590 make up the relative weight for the WI Planning overall goal.

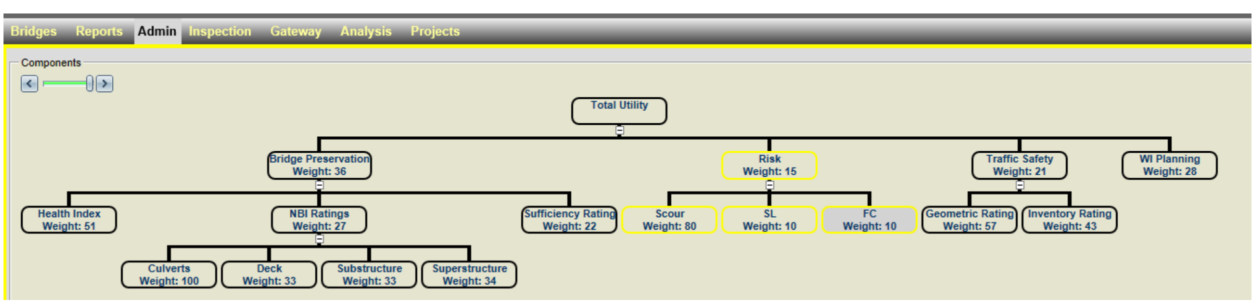
The Wisconsin Planning Utility includes results related to Agency and User Costs associated with a 2008 study entitled *WisDOT Traffic Operations Infrastructure Plan (TOIP)*. Included in this report as Appendix C.

The relative weight values recommended for these goals and their children criteria are:



Note the for the NBI children the sum of the utilities for the Deck, Superstructure, and Substructure is 100. The utility weight for the Culverts is 100 as this two options are mutually exclusive.

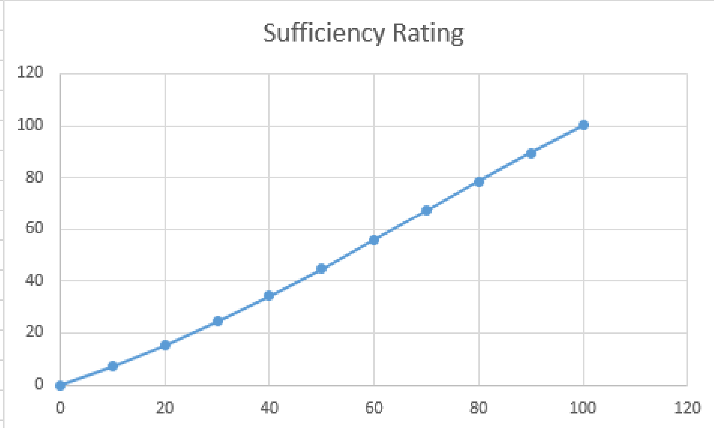
All these utility functions and recommended relative weights can be by updated/modified in the future by using the methodology described at the beginning of this section. The caveat is that every group of subcomponents value needs to add to a 100. As an example, if a decision to change the name of the Extreme Events Utility to Risk and add Fracture Critical (FC) Utility and Section Loss (SL) Utility would be:



Note that the utility values for Scour+SL+FC=100.

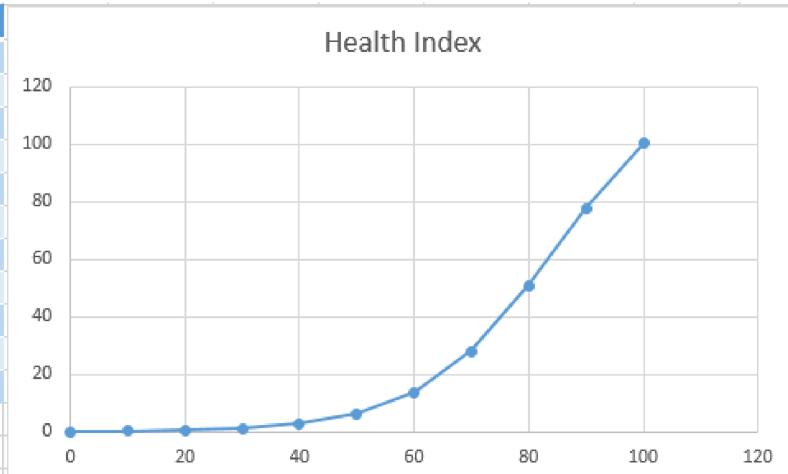
Sufficiency Rating Utility Curve

SR	Value
0	0
10	7
20	15
30	24
40	34
50	45
60	56
70	67
80	79
90	90
100	100



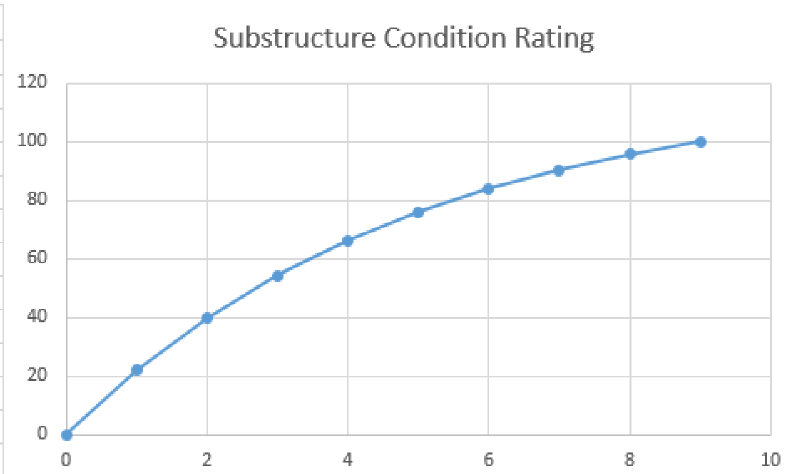
Health Index Utility Curve

HI	Value
0	0
10	0
20	0
30	1
40	3
50	6
60	14
70	28
80	51
90	78
100	100



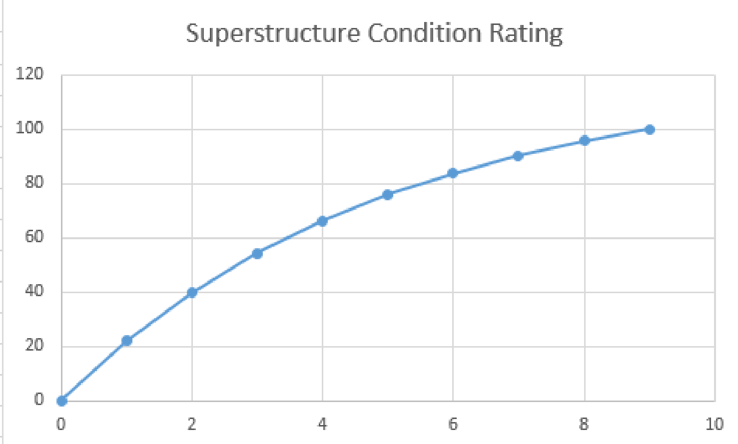
Substructure Utility Curve

SBR	Utility
0	0
1	22
2	40
3	54
4	66
5	76
6	84
7	90
8	96
9	100



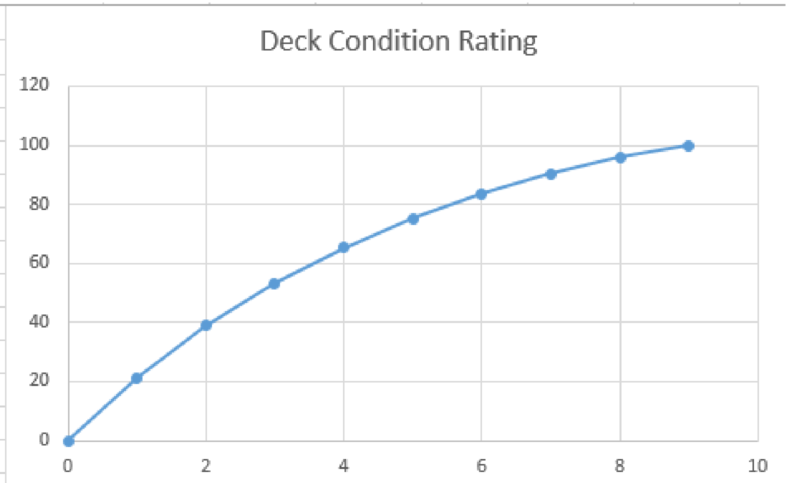
Superstructure Utility Curve

SPR	Utility
0	0
1	22
2	40
3	54
4	66
5	76
6	84
7	90
8	96
9	100



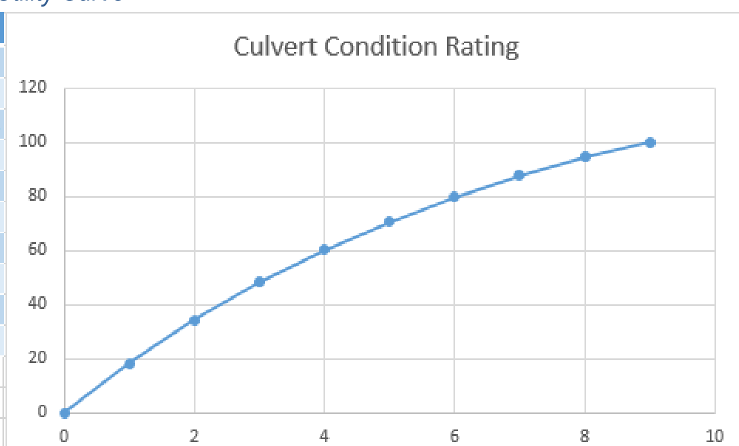
Deck Condition Utility Curve

DCR	Utility
0	0
1	21
2	39
3	53
4	65
5	75
6	83
7	90
8	96
9	100



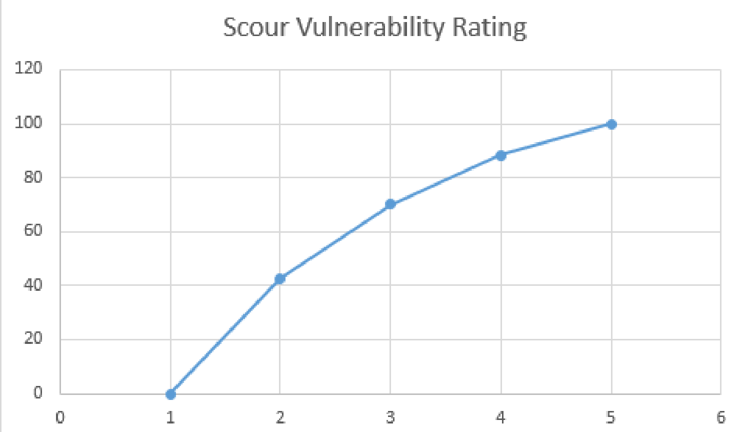
Culvert Condition Utility Curve

CCR	Utility
0	0
1	18
2	34
3	48
4	60
5	71
6	80
7	88
8	95
9	100



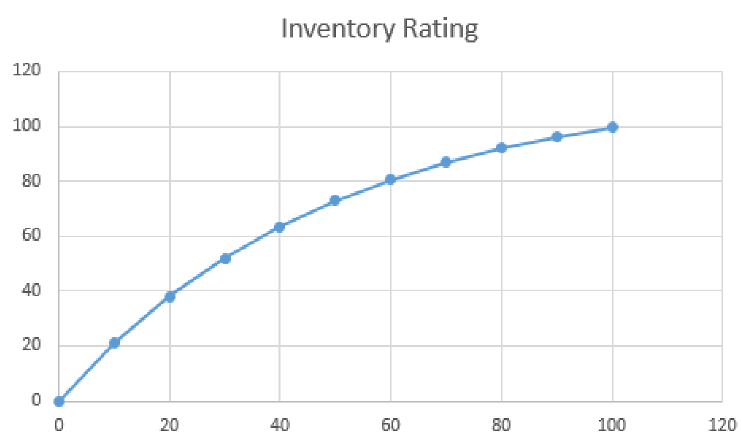
Scour Vulnerability Utility Curve

SVR	Value
1	0
2	43
3	70
4	88
5	100



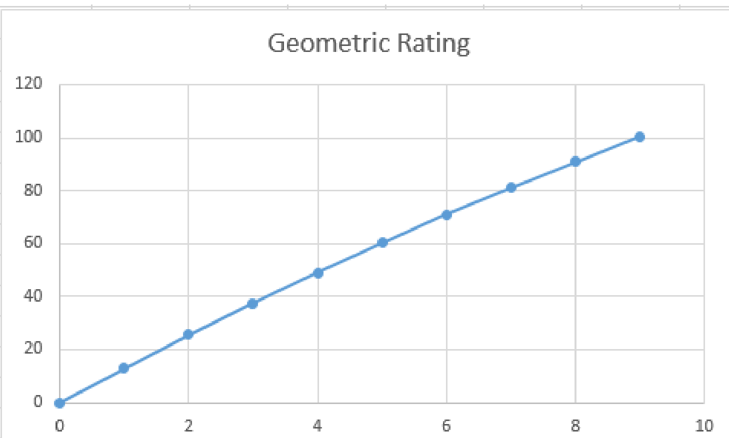
Inventory Rating Utility Curve

IR	Value
0	0
10	21
20	38
30	52
40	64
50	73
60	81
70	87
80	92
90	96
100	100



Geometric Rating Utility Curve

GR	Value
0	0
1	13
2	26
3	38
4	49
5	60
6	71
7	81
8	91
9	100



Task 4. WisDOT-specific Risk Assessment Criteria

Risk is frequently defined as the effect of uncertainty on objectives. When applied to the management of transportation assets, acknowledging and understanding risk can help a transportation agency more effectively plan for possible system and program disruptions and complications, mitigate potential consequences, and improve agency and infrastructure resiliency.

Here are some examples of risks that are of particular importance to transportation agencies and the correspondent utility function associated with it:

Risk Factor	Recommended BrM Utility Function
Asset ageing effects (e.g. steel fatigue or corrosion, advanced deterioration due to insufficient preservation or maintenance)	Bridge Preservation
Natural events (e.g. floods, storms, earth movement)	Extreme Events - Scour
Traffic Safety	Traffic Safety- Inventory Rating – Geometric Safety
Operational Hazards (Vehicle and vessel collisions, failure or inadequacy of safety features, and construction incidents)	WisDOT Planning

In order to develop a WisDOT-specific Risk Assessment Criteria related to operational hazards, it is recommended to use the 2008 TOIP as the bases for its determination. The plan was developed based on the 2030 update of the Wisconsin Long-Range Plan, for which WisDOT adopted a strategic corridor approach. This approach segmented the entire state trunk line system into 37 corridors, referred to as the WisDOT 2030 Multimodal Corridor network.

We recommend to develop a Wisconsin Planning utility function that considers the two TOIP main goals:

1. Develop a methodology and associated tool that will enable the Bureau of Highway Operation (BHO) to evaluate operational projects in the same manner as traditional infrastructure projects; and
2. Integrate operations into the WisDOT planning process

The TOIP is based on traditional WisDOT planning perspectives and processes. It includes language familiar to departments within WisDOT Central Office, as well as the Region Planning staff. The TOIP also utilizes many current WisDOT processes.

The following Criteria and Weighting was used to categorize the 37 corridors.

Table 2.2 Criteria and Weighting

Criteria	Weight
Mobility	50%
ADT Base Year	10%
ADT Forecast Year	7%
HC ADT Base Year	4%
Peak-Hour V/C – LOS	12%
Congestion Forecast	12%
Safety	40%
Crash Rate	15%
Crash Severity	13%
Weather Index	9%
Environmental Conditions	10%
ADT Growth	7%
Event/Traffic Generators	11%

Note: Acronyms: ADT = Average Daily Traffic, HC = Heavy Class, V/C = Volume to Capacity Ratio, LOS = Level of Service.

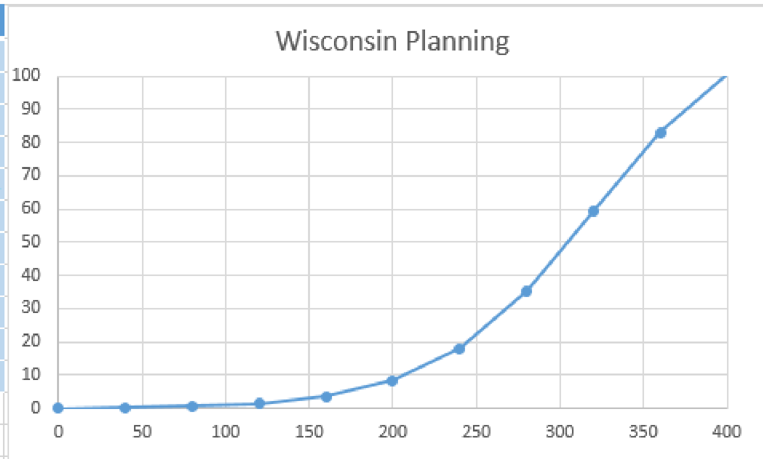
This criteria and weight yields the following scoring for the corridors:

Corridor Name	End Points	Primary Routes	Priority Score
PRIORITY			
Badger State	Eau Claire – Madison	I-94/90, US 12	359
Capitol	Milwaukee - Madison	I-94, US 12/18, WIS 16, 19	275
Fox Valley	Milwaukee – Green Bay	US 41/45	217
South Central Conn.	Madison – Beloit - Chicago	I-90/39, US 51, WIS 213	157
Hiawatha	Milwaukee - Chicago	I-94, US 45, WIS 31, 32	151
EMERGING PRIORITY			
Wisconsin River	Madison – Ironwood, MI	I-39, US 51	123
Chippewa Valley	Eau Claire – Twin Cities	I-94, US 12, WIS 29	107
Wild Goose	Madison – Fox River Valley	US 151/41	99
Peace Memorial	Chippewa Valley – Duluth/Superior	US 53	86
Cornish Heritage	Dubuque - Madison	US 151/18	86
Titletown	Milwaukee – Green Bay	I-43, WIS 32, 57	76
Southern Tier	Janesville/Beloit – Racine/Kenosha	I-43, US 14, WIS 11, 50	57
Glacial Plains	Janesville/Beloit - Milwaukee	I-43, S36, WIS 11, 14	52
REMAINING			
Wisconsin Heartland	Green Bay - Twin Cities	WIS 29	51
Rock River	Janesville/Beloit - Oshkosh	WIS 26	42
Northern Lakes	Twin Cities - Ashland	US 63	36
Wolf/Waupaca Rivers	Stevens Point - Fox Cities	US 10, WIS 110	32
Lake To Lake	Fox Cities to Manitowoc/Two Rivers	US 10, WIS 310	32
Lake Superior	Duluth/Superior - Ironwood, MI	US 2	31
Geneva Lakes	Madison - Lake Geneva - Chicago	US 12, WIS 67	31
Waukesha Connection	Waukesha - Washington County	WIS 83, 164	29
North Country	Iron Mountain - Minneapolis/St. Paul	US 8	26
Northwoods Connection	Oshkosh - Rhinelander	US 45	26
Peshtigo Fire Memorial	Green Bay - Menominee County, MI	US 41, US 141	24
Kettle Country	Fond du Lac - Sheboygan	WIS 23	23
84th Division Railsplitters	Beaver Dam - Port Washington	WIS 33	23
Cranberry Country	Tomah - Oshkosh	WIS 21	22
Coulee Country	La Crosse - Tomah	I-90, WIS 16, 21	21
Frank Lloyd Wright	La Crosse - Madison	US 14	21
Mississippi River	Dubuque - Twin Cities	US 14, WIS 35	20
Lumber Country Heritage	Green Bay - Iron Mountain	US 141	15
Door Peninsula	Green Bay - Door County	WIS 57	15
POW/MIA Rememberance	Abbotsford - Ashland	WIS 31	15
Cheese Country	Dubuque - Janesville/Beloit	WIS 11, 81	9
Marshfield - Rapids Conn.	Stevens Point - Abbotsford	US 10, WIS 13, 34, 54	8
French Fur Trade	Praire du Chien - Dodgeville	US 18	4
Trempealeau River	La Crosse - Eau Claire	WIS 93	2

The WP Utility Value [V(WP)] was calculated using the following functions:

Wisconsin Planning Utility Function 1

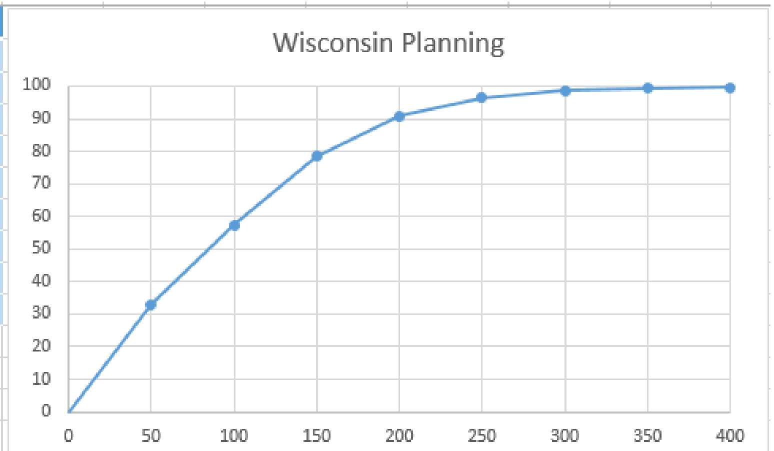
WP	Value
0	0
40	0
80	1
120	2
160	4
200	8
240	18
280	35
320	59
360	83
400	100



$$V(WP1) = 0.098 \times \left(\frac{1211}{1 + e^{0.0852\times(80-0.25WP)}} - 1\right)$$

Wisconsin Planning Utility Function 2

WP	Value
0	0
50	33
100	57
150	78
200	91
250	96
300	99
350	99
400	100



$$V(WP2) = 0.092 \times \left(\frac{1087}{1 + e^{0.02\times(85-WP)}} - 1\right)$$

Corridor Name	End Points	Primary Routes	Priority Score	V(WP1)	V(WP2)
PRIORITY					
Badger State	Eau Claire – Madison	I-94/90, US 12	359	83	99
Capitol	Milwaukee – Madison	I-94, US 12/18, WIS 16, 19	275	33	98
Fox Valley	Milwaukee – Green Bay	US 41/45	217	12	93
South Central Conn.	Madison – Beloit - Chicago	I-90/39, US 51, WIS 213	157	3	81
Hiawatha	Milwaukee – Chicago	I-94, US 45, WIS 31, 32	151	3	79
EMERGING PRIORITY					
Wisconsin River	Madison – Ironwood, MI	I-39, US 51	123	2	68
Chippewa Valley	Eau Claire – Twin Cities	I-94, US 12, WIS 29	107	1	61
Wild Goose	Madison – Fox River Valley	US 151/41	99	1	57
Peace Memorial	Chippewa Valley – Duluth/Superior	US 53	86	1	50
Cornish Heritage	Dubuque – Madison	US 151/18	86	1	50
Titletown	Milwaukee – Green Bay	I-43, WIS 32, 57	76	1	45
Southern Tier	Janesville/Beloit – Racine/Kenosha	I-43, US 14, WIS 11, 50	57	0	36
Glacial Plains	Janesville/Beloit - Milwaukee	I-43, S36, WIS 11, 14	52	0	34
REMAINING					
Wisconsin Heartland	Green Bay - Twin Cities	WIS 29	51	0	34
Rock River	Janesville/Beloit - Oshkosh	WIS 26	42	0	30
Northern Lakes	Twin Cities – Ashland	US 63	36	0	27
Wolf/Waupaca Rivers	Stevens Point - Fox Cities	US 10, WIS 110	32	0	26
Lake To Lake	Fox Cities to Manitowoc/Two Rivers	US 10, WIS 310	32	0	26
Lake Superior	Duluth/Superior - Ironwood, MI	US 2	31	0	25
Geneva Lakes	Madison - Lake Geneva - Chicago	US 12, WIS 67	31	0	25
Waukesha Connection	Waukesha - Washington County	WIS 83, 164	29	0	25
North Country	Iron Mountain - Minneapolis/St. Paul	US 8	26	0	23
Northwoods Connection	Oshkosh – Rhinelander	US 45	26	0	23
Peshtigo Fire Memorial	Green Bay - Menominee County, MI	US 41, US 141	24	0	23
Kettle Country	Fond du Lac - Sheboygan	WIS 23	23	0	22
84th Division Railsplitters	Beaver Dam - Port Washington	WIS 33	23	0	22
Cranberry Country	Tomah – Oshkosh	WIS 21	22	0	22
Coulee Country	La Crosse – Tomah	I-90, WIS 16, 21	21	0	22
Frank Lloyd Wright	La Crosse – Madison	US 14	21	0	22
Mississippi River	Dubuque - Twin Cities	US 14, WIS 35	20	0	21
Lumber Country Heritage	Green Bay - Iron Mountain	US 141	15	0	20
Door Peninsula	Green Bay - Door County	WIS 57	15	0	20
POW/MIA Rememberance	Abbotsford – Ashland	WIS 31	15	0	20
Cheese Country	Dubuque - Janesville/Beloit	WIS 11, 81	9	0	18
Marshfield - Rapids Conn.	Stevens Point - Abbotsford	US 10, WIS 13, 34, 54	8	0	18
French Fur Trade	Praire du Chien - Dodgeville	US 18	4	0	16
Trempealeau River	La Crosse - Eau Claire	WIS 93	2	0	16

V(WP2) is the recommended function for the Wisconsin Planning Utility as it offers a better utility value distribution among the corridors.

It is recommended to add a field to the bridge table indicating the corridor that each bridge belongs and a lookup table for the corresponding utility value.

Task 5: Next Steps for a Successful Implementation of BrM Modeling

Recommendations for a successful implementation are given to cover three basic asset management components:

- Input
- Analysis
- Output

Input

Develop a matrix for costs associated with intervention actions for every condition state for every element.

- This research only includes costs related to actions related to a subset of elements in the WisDOT inventory. A refinement of the cost collected is needed for elements where the information is not robust and for other elements not included in this project.
- Develop a matrix for bridge improvement cost such as widening, raising, and structurally rehabilitation and bridge replacement.
- HSI contains data related to various business practices to the Department. The collection of bridge preservation, rehabilitation and replacement costs should be kept in BrM as opposed to HSI.
- Data related to costs should be kept in BrM, this would allow to develop a complementary interface to develop work orders and collect information for cost models.

Analysis

The recommendations for performance measures, utility functions and deterioration models are based on a national expert elicitation. It is imperative to test these assumptions with BrM 5.2.3, when released.

Although it is anticipated that the national trend would be in line with Wisconsin needs, the process established in BrM is very flexible to vary among the default values. Section 4 of this document clearly demonstrates the BrM system flexibility.

One of the shortcomings of BrM 5.2.2 is the lack of discussion about the improvement model. The original design document outlines the elimination of the repetitive nature of the functional parameters entries in Pontis and just adopt standards depicted in the "*AASHTO A Policy on Geometric Design for Highways and Streets*". The recommendation is to ensure that the Wisconsin Facilities and Development Manual is consistent with the latest AASHTO publication.

The utility function recommendations need to be calibrated in terms of priorities established in recent years. The premise is to follow engineering judgment while having a more robust assessment of the myriad of data. Past replacement projects are always a good test to evaluate the recommendations vs actual data.

Output

Reports for compliance with MAP-21 requirements may need to be created.
It is recommended the use of NCHRP Report 742 entitled "*Communicating the Value of Preservation: A Playbook*". This document has very good information to highlight the importance of Bridge Preservation with stakeholders.

Conclusion

The information provided and values recommended in this report, represent a significant first step towards the customization of BrM 5.2.3 upon its release. This is true for projects other than those related with functional improvements such as raising, widening, strengthening, or replacement. Only after the release of BrM 5.2.3 customization for these projects will be possible.

February 2016 Revisions

Task 1	Comment	Pages Revised
	• Summarize quantity and quality of data in body of report o Number of expected data points o Number of submitted data points o Same as above, but per region • Assess quality of data on some kind of scale • Recommend costs WisDOT should use	• Page 8 contains a Table with the metrics requested, except that one per region. Note that not all the regions responded. • Quality is shown in terms of percentage. • A recommendation was added
	• Need to pull some commentary into the body of the report that addresses the quality of the cost data that was collected. o Not all Regions responded. o Only one response per Region. o Not all Regions provided cost data for each element. o Were the surveys sent to the appropriate contact? Bridge maintenance or bridge planning? • Based on this quality issue, is the data collected reliable or are further efforts required?	• Page 8 contains a note indicating that not all the regions responded. • Survey was sent to Bridge Maintenance Engineers. • Further efforts are needed to refine this data and collect cost for other elements
	The Researcher provided an excel work book that included the collected direct cost. The Researcher has also shown a process to updating cost model in BrM 5.2.3 to be released. A paragraph summarizing the protocols for developing/collecting and maintaining cost information at the state level should be added for clarity.	Page 9 contains a paragraph summarizing the protocols requested
Task 2	• Describe method for determining WisDOT-specific element deterioration values (shaping parameter and median years) to help us update them in the future	Pages 14 and 15 contain a section describing the methodology.

	• There is a recommendation provided on Page 1 of Appendix B. More commentary/explanation is required on how this was derived. • Data from other states is provided…what is the purpose of this information? Was it used to derive the recommendation for WisDOT?	Pages 14 and 15 contain a section describing the methodology.
	• The Researcher has presented a discussion of the deterioration model considering the transition time parameter, the Weibull Shaping parameter and the protection factors. The formulas and the text presented has some typing errors. Please correct those typos. • Page 1 of Appendix 'B' includes the shape parameters and median years for transition from one condition state to the next developed by BrM TRT committee. The Researcher has also added Wisconsin Specific parameters in that excel worksheet. The Researcher should add discussion in the main text ~~of the~~ briefly describing the basis of arriving/development of the Wisconsin specific values and how these values should be updated in future. • The Penn DOT and Michigan DOT preservation models enclosed in Appendix 'B' seems to be based on old Markovian model. A brief discussion of the applicability of any of these models in Wisconsin's case will be helpful.	• Typos are corrected • Pages 14 and 15 contain a section describing the methodology. • Pages 14 and 15 contain a section describing the methodology and also the reason for using models from other agencies.
Task 3	• Describe method for determining WisDOT-specific goals and relative weights shown below to help us update them in the future • WI Planning is based on a 2008 study. To what extent is this reference out-of-date?	• Pages 24 and 25 were revised to include the description. • To the extent that the corridor limits are based on the 2030 WisDOT Long-Range Plan corridor definitions
	• More explanation is required on the use of the WisDOT TOIP report. o How/why is it applicable here?	• Pages 24 and 25 were revised to include the description and provide an explanation that this utility encompasses

		user and agency costs that the TOIP researched based on the WisDOT 2030 Lon-Range Plan Corridor
	Researcher has provided a discussion of the utility functions with different decision variables and compared with those discussed in NCHRP Report 590. The Researcher has also discussed the BrM process of adding/deleting utility function and Wisconsin specific Relative weight. A discussion of how these utility functions and recommended relative weights be maintained/updated in future will enhance the clarity.	Page 25 now includes a discussion an example.
Task 4	• I don't think the TOIP report is applicable here. The criteria used for that effort don't reflect risk criteria for bridges, or aren't comprehensive bridge risks.	Page 29 now includes an explanation about risks and the reason to include an operational risk utility function,
	The Researcher has recommended the use of WISDOT Bureau of Highway Operations' 2008 Traffic Operation Infrastructure Model for developing Wisconsin-specific Risk assessment criteria. The steps required to develop the risk criteria/functions should be explained clearly. Discussion should also be added as to why utility function developed using TOIP model is a good approach. The future use and the protocols required/needed to collect and update the risk functions/components would further enhance the clarity.	Page 29 now includes an explanation about risks and the reason to include an operational risk utility function. Appendix C describes the criteria to assign a ranking to each corridor.
Task 5	This item has not been addressed. The Researcher should provide a general summary and the next steps needed for customizing Wisconsin Specific factors that would provide future research path.	Page 34 now addresses this oversight.

Bridge Element Cost Elicitation Form

WHRP Wisconsin Highway Research Program

REINFORCED CONCRETE BRIDGE DECK

Element #: 12 Units: ft^2 Type: NBE

Typical cost refers to cost without low or high outliers

For each action, fill in the practice that is used by WisDOT to protect, repair, rehabilitate, or replace the bridge element referenced on this form or select the typical practice. Enter the WisDOT typical cost per unit for the selected practice.

Action		Practice	Used	Typ. Cost ($ / Unit)
Protect - Performed on a cyclical basis while the deck is in CS2 or better and exhibits no or minimal distress.				
	Typical Practice:	Wash & remove debris from bridge deck annually.	☐	NA
		Perform sealing and waterproofing procedures every 3-5 years.	☐	NA
	WisDOT Practice:	Sweep and remove debris from bridge deck bi-anually	☑	0.60
		Perform sealing and waterproofing procedures every 10 years.	☑	3.70
Repair - Performed on a condition based need. The deck is typically in CS2 or CS3 and exhibits moderate distress.				
	Typical Practice:	Perform small deck surface repairs for spalls and delaminations.	☑	12.84
		Perform crack sealing procedures if crack widths are 0.007" or larger.	☐	NA
	WisDOT Practice:		☐	
			☐	
Rehabilitate - Performed when repairs are no longer adequate. The deck is typically in CS3 and exhibits heavy distress.				
	Typical Practice:	Perform full depth deck repairs, large area repairs, or deck overlays.	☑	69.75
		Install cathodic protection or electrochemical chloride extraction.	☐	NA
	WisDOT Practice:		☐	
			☐	
Replace - Performed when the deck has gone beyond a state of reasonable repair. The deck is in CS4 and exhibits severe distress.				
	Typical Practice:	Replace the entire deck.	☑	100
	WisDOT Practice:		☐	

Notes: CS1, CS2, CS3, & CS4 refer to Condition States 1-4 as per the 2013 AASHTO Bridge Element Inspection Manual.

Bridge Element Cost Elicitation Form

REINFORCED CONCRETE BRIDGE DECK

Element #: 12 Units: ft^2 Type: NBE

Additional Information:

Protect

Bridge cleaning generally consists of collecting and properly disposing of trash and debris.
Bridge washing involves pressure washing off salts, dust, sand, and any remaining undesired material from exposed concrete bridge deck surfaces, leading to the removal of the chloride from the bridge.
Environmental requirements and considerations play a big role in bridge deck cleaning and washing.
Equipment typically includes hand tools, power brooms, air compressors, and vacuum / water trucks.
Traffic control may need to be maintained for bridge cleaning and washing activities.
Pressure washing and vacuum equipment is recommended to have equipment pressure of at least 30-40 ksi per minute, minimum flow rate of 16 gallons per minute, and a water tank of 4000 gallon capacity.

Deck sealing/waterproofing is done by applying a sealant or similar substance to the concrete deck to reduce its surface porosity and stabilize the outer layer, aiding in resisting water and chloride
Deck preparation has a large impact on the effectiveness of this action. Sand, shot, or air blasting is typically used to eliminate moisture and oil residues on the deck.
Any moisture on the deck must be allowed to properly dry prior to sealant application. Drying time of the deck depends on air temperature and degree of rain fall, typically ranging from 1 to 3 days.
Sealants should also be applied to curbs and barriers in the splash zone.
An abrasive material may also need to be applied to the deck to create the necessary anti-skid traffic surface.

Repair

Deck surface repairs are considered a temporary repair since all of the chloride contaminated concrete is typically not removed prior to the repair.
Deck surface repairs vary in depth and may or may not impact the top reinforcing mat.
If the repair is above the top reinforcing mat and is of the epoxy type, repair patch depths may be limited to 1".
If the repair is below the top reinforcing mat, remove and replace the damaged steel, providing at least an 18 inch overlap for the new steel and a minimum of 3/4 of an inch clearance around all steel.
Deck surface repairs may include adding sacrificial anodes in the patched areas to help protect the rebar.

Epoxy resins are polymeric or semi-polymeric substances, also known as polymer sealers.
Penetrating sealers such as silane, siloxanes, and siliconates, provide the deck with water repellant properties up to a certain depth.
Pore blockers such as silicates, epoxy coatings, urethanes coatings, acrylic coatings, and polyester coatings, fill the surface pores of the deck to prevent water penetration.
Ensure the crack surfaces or entire deck is thoroughly cleaned prior to applying the sealant.
For a few large dormant cracks, saw-cut if needed and then seal with an epoxy or epoxy injection.
For a few large moving cracks, seal the cracks with a flexible sealer similar to a deck expansion joint.
For a few small cracks, it may be possible to apply the polymer sealer to each crack with a squeeze bottle.
For many small cracks, coat the entire deck surface with the polymer treatment.

Bridge Element Cost Elicitation Form

REINFORCED CONCRETE BRIDGE DECK

Element #: 12 Units: ft^2 Type: NBE

Additional Information Continued:

Rehabilitate

Shielding must be provided during concrete removal to prevent concrete & debris from falling below the deck.
Removal of the deteriorated concrete usually involves the use of a 30 lb max. class size jack hammer.
All full depth deck repairs should be performed for a width from centerline to centerline of stringers.
Removable formwork of sufficient strength is necessary for the concrete pour.
Replace the corroded reinforcement and ensure a minimum overlap of 18 inches for the new steel.
Existing concrete surfaces should be roughened for a better bond to the new concrete.
All damaged concrete should be repaired prior to the installation of CP or ECE.

Rigid or flexible overlays are installed to provide a smooth, durable, water resistant wearing surface.
Rigid types include cement concrete, latex-modified, silica fume, microsilica or fly ash, and slag overlays.
Flexible types include thin polymer, polyester, and asphalt concrete overlays.
Overlay procedures may include milling of the existing deck surface or installation of a waterproof membrane.
Overlay installation typically ranges from 1 to 3 days.

Cathodic protection (CP) is used to control the corrosion of the reinforcement by making it the cathode of an electrochemical cell.
Typical cathodic protection procedures include connecting the reinforcing to a more easily corroded "sacrificial metal" (sacrificial anode). This sacrificial metal corrodes instead of the reinforcing steel.
Electric continuity must be verified in the steel rebar network in order for cathodic protection to work.
Any reinforcing steel within 1/2" of the top of the concrete deck must be electrically insulated.
The activated titanium mesh can now be installed and covered by a deck overlay.
Reference cells are an optional addition to a cathodic protection system to provide routine monitoring.

Electrochemical chloride extraction procedures (ECE) include applying an electric current between the embedded steel and an external anode.
Typically, a catalyzed titanium mesh anode is placed between layers of synthetic felt wetted with electrolyte, covered by a plastic sheet and then an overlay a couple weeks later.
This process extracts the chloride ions from the chloride-contaminated reinforced concrete deck.
ECE procedures can also be considered to mitigate ongoing corrosion of the embedded steel reinforcing.

Replace

Full deck replacement requires a set of engineered bridge plans.
The existing superstructure and substructure should be determined to have a remaining service life that is at least as long as the replacement deck service life will be.
Traffic detours and/or staged construction is typically required.
Deck replacement is a costly and involved event.

Wisconsin DOT 2015 Bridge Preservation Cost Elicitation Summary

This workbook sumarizes a cost elicitation survey conducted in 2015. The following regions responded to the elicitation:

- La Crosse
- Milwaukee
- Green Bay
- Rhinelander
- Wisconsin Rapids

The bridge preservation costs for each element is depicted in each one of the worksheets of this workbook.
The following convention was used consistenly in each one of the worksheets:

Comment on the headers were used to depict region wide practices noted in the survey. Hover cursor over the cell corner to read them
Milwaukee

Some Regions provided costs in a different unit than reqeested by the BrM system or a range. Or the regions provided just a cooment and no cost.
These situations have a comment in the cost cell at the practice level
$ 95.00
Whenever a range was provided, its average was used

The letters NP mean Not Provided

Added WisDOT Bridge Preservation Practices are depicted in blue font:

Reinforced Concrete Overlay
Rosphalt Overlay

Typical dimensions of bridge components were used to convert units provided by the regions to units required by BrM.

The costs are computed though a formula so it would be easier to recompute if someone would disgree with the typical dimensions used.
All typycal dimension are in FT or SF unless noted.

Typical Brige		
Widht		44
Length		150
Area		6600
Total Deck		
Replacement C	$	462,000.00
Divide by width for		
lineal feet	$	10,500.00

Worksheets with a red TAB denote that no costs were provided for the element

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE BRIDGE DECK	12	Protect	Wash & remove debris from bridge deck annually/biannually	$ 0.14	NP	NP	NP	$ 0.20	$ 0.17
			Sweep and remove debris from bridge deck annually	$ 0.11	$ 0.01	NP	NP	$ 0.20	$ 0.11
			Seal w/Concrete Sealer	$ 0.25	$ 0.20	$ 0.14	NP	$ 0.30	$ 0.22
			Thin Epoxy Overlay	$ 4.50	$ 5.00	NP	NP	$ 5.00	$ 4.83
			Polymer Modified Overlay	$ 30.00	NP	NP	NP	NP	$ 30.00
			Clean and Flush Drains	NP	NP	NP	NP	NP	NP
		Repair	Perform small deck surface repairs for spalls and delaminations.	$ 75.00	$ 80.00	NP	NP	NP	$ 77.50
			Perform crack sealing procedures if crack widths are 0.007" or larger.	$ 1.72	NP	NP	NP	NP	$ 1.72
			Deck Patching ;	$ 150.00	$ 100.00	NP	NP	NP	$ 125.00
			Repair Spalls	$ 75.00	NP	NP	NP	NP	$ 75.00
		Rehabilitate	Perform large area repairs	$ 150.00	NP	NP	NP	NP	$ 150.00
			Install Cathodic protection	NP	NP	NP	NP	NP	NP
			Bituminous Overlay	$ 15.00	$ 7.00		NP	NP	$ 11.00
			Concrete Overlay	$ 35.00	$ 22.00	$ 19.00	NP	$ 15.00	$ 22.75
			Rosphalt Overlay	NP	$ 11.00	NP	NP	NP	$ 11.00
			Cathodic Protection	NP	NP	NP	NP	NP	NP
		Replace	Replace Decks	$ 60.00	$ 65.00	$ 90.00	NP	$ 75.00	$ 72.50

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
PRESTRESSED CONCRETE	13	Protect	Wash & remove debris from bridge deck annually.	$ 0.14	NP	NP	NP	NP	$ 0.14
BRIDGE DECK			Sweep & remove debris from bridge deck annually	$ 0.11	NP	NP	NP	NP	$ 0.11
			Seal w/Concrete Sealer	$ 0.25	NP	NP	NP	NP	$ 0.25
			Thin Epoxy Overlay	$ 4.50	NP	NP	NP	NP	$ 4.50
			Polymer Modified Overlay	$ 30.00	NP	NP	NP	NP	$ 30.00
		Repair	Perform small deck surface repairs for spalls and delaminations.	$ 75.00	NP	NP	NP	NP	$ 75.00
			Perform crack sealing procedures if crack widths are 0.007" or larger.	$ 1.72	NP	NP	NP	NP	$ 1.72
			Deck Patching ;	$ 150.00	NP	NP	NP	NP	$ 150.00
			Repair Spalls	$ 75.00	NP	NP	NP	NP	$ 75.00
			Perform large area repairs	$ 150.00	NP	NP	NP	NP	$ 150.00
			Perform prestressed strand repairs for the bridge deck.	NP	NP	NP	NP	NP	NP
			Bitumenous Overlays	$ 15.00	NP	NP	NP	NP	$ 15.00
			Concrete Overlay	$ 35.00	NP	NP	NP	NP	$ 35.00
			Full Depth Crack Repairs	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire deck	$ 60.00	NP	NP	NP	NP	$ 60.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE SLAB	38	Protect	Wash & clean debris from bridge deck annually.	$ 0.14	NP	NP	NP	$ 0.20	$ 0.17
			Sweep & remove debris from bridge deck bi-annually	$ 0.11	$ 0.01	NP	NP	$ 0.20	$ 0.11
			Perform sealing and waterproofing procedures every 3-5 years.	$ 0.25	$ 0.20	$ 0.14	NP	$ 0.30	$ 0.22
			Thin Epoxy Overlay	$ 4.50	$ 5.00	NP	NP	$ 5.00	$ 4.83
			Polymer Modified Overlay	$ 30.00	NP	NP	NP	NP	$ 30.00
			Clean and Flush Drains	NP	NP	NP	NP	NP	NP
		Repair	Perform small slab surface repairs for spalls and delaminations.	$ 75.00	$ 80.00	NP	NP	NP	$ 77.50
			Perform crack sealing procedures if crack widths are 0.007" or larger.	$ 1.72	NP	NP	NP	$ 0.20	$ 0.96
			Deck Patching ;	$ 150.00	$ 100.00	NP	NP	$ 10.00	$ 86.67
			Repair Spalls	$ 75.00	NP	NP	NP	NP	$ 75.00
		Rehabilitate	Perform large area repairs, FRP repairs	$ 150.00	NP	NP	NP	NP	$ 150.00
			electrochemical chloride extraction.	NP	NP	NP	NP	NP	NP
			Bituminous Overlay	$ 15.00	$ 7.00	NP	NP	NP	$ 11.00
			Concrete Overlay	$ 35.00	$ 22.00	$ 19.00	NP	$ 15.00	$ 22.75
			Epoxy injection	NP	NP	NP	NP	NP	NP
			Cathodic Protection	NP	NP	NP	NP	NP	NP
			Reinforced Concrete Overlay	NP	$ 19.00	NP	NP	NP	$ 19.00
			Rosphalt Overlay	NP	$ 11.00	NP	NP	NP	$ 11.00
		Replace	Replace Slab	NP	NP	NP	NP	$ 100.00	$ 100.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
	107	Protect	Wash & clean the steel girders, and remove any debris.	$ 7.00	NP	NP	NP	$ 1.13	$ 4.06
STEEL OPEN GIRDERS			Spot paint, zone paint, or overcoat areas of the steel girders.	NP	NP	NP	NP	$ 18.00	$ 18.00
		Repair	Complete recoating of the steel superstructure.	NP	$ 54.00	NP	NP	$ 40.50	$ 47.25
			Repair any cracks in the steel girders by "drilling out" the crack tip.	$ 80.00	NP	NP	NP	NP	$ 80.00
			Heat straightening	$ 500.00	NP	NP	NP	NP	$ 500.00
		Rehabilitate	Remove and replace areas of section loss in girders with new steel.	$ 125.00	NP	NP	NP	NP	$ 125.00
			Retrofit problematic details, such as fatigue prone, fracture critical, etc.	$ 150.00	NP	NP	NP	$200	$ 175.00
			Steel Retrofit	NP	NP	NP	NP	NP	NP
		Replace	Replace the steel girders, which typically involves the replacement of the entire superstructure and deck.	NP	$ 337.50	NP	NP	$ 450.00	$ 393.75

Typical steel girder	
Height	4.5
Length	1
Area	4.5

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
PRESTRESSED OPEN GIRDERS	109	Protect	Wash & clean the concrete girders, and remove any debris.	NP	NP	NP	NP	NP	NP
			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	NP	NP	NP
			Thin Epoxy Overlay	NP	NP	NP	NP	NP	NP
		Repair	Seal cracks using epoxy injection, penetrating sealers, or dry packing.	NP	NP	NP	NP	NP	NP
			Repair spalls with CIP con/shotcrete or preplaced aggregate patching.	$ 150.00	NP	NP	NP	NP	$ 150.00
		Rehabilitate	Perform shear crack stitching, beam end repairs, or FRP wrapping.	NP	NP	$ 1,200.00	NP	NP	$ 1,200.00
			Perform prestressed strand repairs for the girders.	NP	NP	NP	NP	NP	NP
		Replace	Replace the prestressed concrete girders, which typically involves the replacement of the entire superstructure and deck.	NP	$ 11,250.00	NP	NP	NP	$ 11,250.00
			Replace one girder (Impact Damage)	NP	$ 900.00	$ 600.00	NP	NP	$ 750.00

Typical Brige	
Widht	44
Length	150
Area	6600
Tipical area per girder	
Width	9
Length	150
Typ Area	1350
Total Deck	
Replacement Cost	$ 495,000.00
Divide by width for lineal feet	$ 11,250.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
	113	Protect	Wash & clean the steel stringers, and remove any debris.	NP	NP	NP	NP	NP	NP
STEEL STRINGERS			Spot paint, zone paint, or overcoat areas of the steel stringers.	NP	NP	NP	NP	NP	NP
		Repair	Complete recoating of the steel superstructure.	NP	NP	NP	NP	NP	NP
			Repair any cracks in the steel stringers by "drilling out" the crack tip.	NP	NP	NP	NP	NP	NP
		Rehabilitate	Remove and replace areas of section loss in stringers with new steel.	NP	NP	NP	NP	NP	NP
			Retrofit problematic details, such as fatigue prone, fracture critical, etc.	NP	NP	NP	NP	NP	NP
		Replace	Replace the steel stringers, which may involve the replacement of the entire superstructure and deck.	NP	NP	$ 10,500.00	NP	NP	$ 10,500.00

Typical Brige		
Widht		44
Length		150
Area		6600
Total Deck Replacement Cost	$	462,000.00
Divide by width for lineal feet	$	10,500.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
	152	Protect	Wash & clean the steel floorbeams, and remove any debris.	NP	NP	NP	NP	NP	NP
STEEL FLOORBEAMS			Spot paint, zone paint, or overcoat areas of the steel floorbeams.	NP	NP	NP	NP	NP	NP
		Repair	Complete recoating of the steel superstructure.	NP	NP	NP	NP	NP	NP
			Repair any cracks in the floorbeams by "drilling out" the crack tip.	NP	NP	NP	NP	NP	NP
		Rehabilitate	Remove and replace areas of section loss in girder with new steel.	NP	NP	NP	NP	NP	NP
			Retrofit problematic details, such as fatigue prone, fracture critical, etc.	NP	NP	NP	NP	NP	NP
		Replace	Replace the steel floorbeams, which typically involves the replacement the adjacent superstructure and deck.	NP	NP	NP	NP	NP	NP
				NP	NP	NP	NP	NP	

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE COLUMNS	205	Protect	Wash & remove debris/vegetation from column and surrounding area.	NP	NP	NP	NP	$ 6.82	$ 6.82
			Perform sealing every 3-5 years.	NP	NP	NP	NP	NP	NP
		Repair	Perform concrete repairs for spalls and delaminations.	$ 500.00	$ 2,736.00	NP	NP	$ 177.78	$ 1,137.93
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	NP	NP	NP
		Rehabilitate	Install column jackets using reinforced concrete or FRP.	$ 1,000.00	NP	NP	NP	NP	$ 1,000.00
			Install cathodic protection or electrochemical chloride extraction.	NP	NP	NP	NP	NP	NP
			Epoxy injection	NP	NP	NP	NP	$ 100.00	$ 100.00
			FRP Reinforcement	NP	NP	NP	NP	NP	NP
		Replace	Remove and replace the entire concrete column.	NP	NP	NP	NP	NP	NP

Typical Column	
Projected witdh	3
Height	16
Area	96
Affected Area Assumed	30%

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE	210	Protect	Wash & remove debris/vegetation from pier and surrounding area.	NP	NP	NP	NP	$ 6.82	$ 6.82
PIER WALLS			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	NP	NP	NP
		Repair	Perform concrete repairs for spalls and delaminations.	$ 1,200.00	$ 1,520.00	NP	NP	$ 177.78	$ 965.93
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	NP	NP	
		Rehabilitate	Perform crack stitching repairs for cracks greater than 1/2" wide.	NP	NP	NP	NP	NP	NP
			Install cathodic protection or electrochemical chloride extraction.	NP	NP	NP	NP	NP	NP
			Epoxy injection	NP	NP	NP	NP	$ 100.00	$ 100.00
		Replace	Remove and replace the entire concrete pier.	NP	NP	NP	NP	NP	NP

Typical Pier Wall	
Projected witdh	6
Height	16
Area	96

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE	215	Protect	Wash & remove debris/vegetation from abutments and surroundings.	$ 60.00	NP	NP	NP	$ 6.82	$ 33.41
ABUTMENTS			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	NP	NP	NP
		Repair	Perform concrete repairs for spalls and delaminations.	$ 1,200.00	$ 1,520.00	NP	NP	$ 177.78	$ 965.93
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	NP	NP	NP
			Crack Sealing	NP	NP	NP	NP	NP	NP
		Rehabilitate	Perform crack stitching repairs for cracks greater than 1/2" wide.	NP	NP	NP	NP	NP	NP
			Install cathodic protection or electrochemical chloride extraction.	NP	NP	NP	NP	NP	NP
			Epoxy injection	NP	NP	NP	NP	$ 100.00	$ 100.00
		Replace	Remove and replace the entire concrete abutment.	NP	NP	NP	NP	NP	NP

Typical Abutment		
Width	$ 44.00	
Height	$ 16.00	
Area	$ 704.00	sq ft
Area	$ 78.22	sqyd

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE PIER CAPS	234	Protect	Wash & remove debris/vegetation from pier caps and surroundings.	NP	NP	NP	NP	$ 6.82	$ 6.82
			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	NP		NP
		Repair	Perform concrete repairs for spalls and delaminations.	NP	$ 27.78	NP	NP	$ 27.78	$ 27.78
			Perform crack sealing or stitching procedures, crack width dependent.	NP	NP	NP	NP		NP
		Rehabilitate	Install external post tensioning or FRP to strengthen the pier cap.	NP	NP	NP	NP	NP	NP
			Install cathodic protection or electrochemical chloride extraction.	NP	NP	NP	NP	NP	NP
			FRP Reinforcement	NP	NP	NP	NP	NP	NP
		Replace	Remove and replace the entire concrete pier cap.	NP	NP	NP	NP	NP	NP
			Replace concrete Pier Cap	NP	NP	NP	NP	NP	NP

Typical Pier Cap		
Length	44	
Hight	2.5	
Area	110	SF
	12.22	SY

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE	241	Protect	Remove debris/vegetation from culvert and surroundings.	NP	$ 12.50	NP	NP	$ 20.83	$ 16.67
CULVERT			Clean and flush the length of the culvert to remove excess sediment.	NP	NP	NP	NP	$ 104.17	$ 104.17
		Repair	Perform concrete repairs for spalls and delaminations.	NP	$ 9,500.00	NP	NP	NP	$ 9,500.00
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	NP	NP	NP
		Rehabilitate	Replace culvert headwalls or wingwalls.	NP	$ 6,250.00	$ 1,875.00	NP	$ 2,500.00	$ 3,541.67
			Perform culvert slip lining procedures.	NP	NP	NP	NP	NP	NP
			Install wing strapping channel to stabilize tipped wings	NP	$ 250.00	NP	NP	NP	$ 250.00
		Replace	Remove and replace the entire culvert.	NP	NP	$ 2,000.00	NP	$ 15,000.00	$ 8,500.00

Typical Culvert	
Width	24
Length	100
Area	2400

Typical Wing	
Height	8
Length	16
Area	128

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
STRIP SEAL	300	Protect	Clean and remove debris from all deck joints annually.	$ 10.00	$ 0.75	NP	NP	$ 2.27	$ 4.34
EXPANSION JOINTS			Check joint water tightness after rain or by flooding deck (2 yr cycle).	$ 1.00	NP	NP	NP	NP	$ 1.00
			Expansion Joints -Clean	$ 10.00	NP	NP	NP	NP	$ 10.00
			Expansion Joints -Seal	NP	NP	NP	NP	$ 10.00	$ 10.00
		Repair	Re-seal bond between neoprene gland and steel headers.	NP	NP	NP	NP	NP	NP
			Repair any scattered minor tearing in the neoprene gland.	NP	$ 200.00	NP	NP	$ 11.36	$ 105.68
			Expansion Repair	NP	NP	NP	NP	NP	NP
			Patch paving block or deck adjacent to joint	NP	$ 80.00	NP	NP	NP	$ 80.00
			Re-weld broken steel extrusion and/or broken anchors	NP	$ 92.50	NP	NP	NP	$ 92.50
		Rehabilitate	Replace the entire neoprene gland. Anchor the new gland to the existing steel headers.	NP	$ 75.00	NP	NP	NP	$ 75.00
		Replace	Replace the entire deck joint, including the steel headers, and make repairs to any defects in the adjacent concrete deck.	$ 34.09	NP	NP	NP	NP	$ 34.09
			Expansion Joints -Replace	NP	NP	NP	NP	$ 22.73	$ 22.73

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
POURABLE JOINT SEALS	301	Protect	Clean and remove debris from all deck joints annually.	NP	$ 0.75	NP	NP	NP	$ 0.75
			Check joint water tightness after rain or by flooding deck (2 yr cycle).	NP	NP	NP	NP	NP	NP
		Repair	Re-seal any portions for the pourable joint seal that have debonded from the concrete deck.	NP	$200	NP	NP	NP	$ 200.00
			Expansion Joints -Repair	NP	NP	NP	NP	NP	NP
		Rehabilitate	Remove old pourable joint seal material while leaving concrete deck intact. Install new backer material and re-pour joint.	NP	$ 50.00	NP	NP	NP	$ 50.00
		Replace	Replace the entire deck joint. Remove and repair adjacent concrete deck up to 18" from joint, install backer material, and re-pour joint.	NP	$ 212.50	NP	NP	NP	$ 212.50
			Expansion Joints -Replace	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
COMPRESSION JOINT SEALS	302	Protect	Clean and remove debris from all deck joints annually.	NP	$ 0.75	NP	$ 4.55	$ 4.55	$ 3.28
			Check joint water tightness after rain or by flooding deck (2 yr cycle).	NP	NP	NP	NP	NP	NP
			Expansion Joints -Clean	NP	NP	NP	$ 2.27	$ 2.27	$ 2.27
		Repair	Re-install any areas of bulging in compression joint seal.	NP	NP	NP	$ 75.00	$ 75.00	$ 75.00
			Re-seal (apply adhesive to) areas of neoprene joint showing leakage.	NP	$ 200.00	NP	NP	NP	$ 200.00
			Expansion Repair	NP	NP	NP	NP	NP	NP
		Rehabilitate	Replace the entire neoprene compression seal.	NP	$ 65.00	NP	NP	NP	$ 65.00
			Saw cut adjacent concrete deck to provide better fit for joint seal.	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire deck joint, repair adjacent concrete deck, and install armor steel headers on concrete deck if necessary.	NP	$ 232.50	NP	NP	NP	$ 232.50
			Expansion Joints -Replace	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
	303	Protect	Clean and remove debris from all deck joints annually.	NP	$ 1.50	NP	$ 11.36	$ 11.36	$ 8.08
MODULAR JOINTS			Check joint water tightness after rain or by flooding deck (2 yr cycle).	NP	NP	NP	NP	NP	NP
		Repair	Re-install neoprene seal locations debonded from center/edge beams.	NP	NP	NP	NP	NP	NP
			Re-seal areas of modular joint showing leakage.	NP	$ 200.00	NP	NP	NP	$ 200.00
			Expansion Repair	NP	NP	NP	NP	NP	NP
		Rehabilitate	Replace all of the neoprene box seals.	NP	NP	NP	NP	NP	NP
			Replace steel center beams or supporting steel elements if necessary.	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire deck joint, repair adjacent concrete deck, and re-install edge/center beams, supporting steel, and neoprene seals.	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
OPEN EXPANSION JOINTS	304	Protect	Clean and remove debris from all areas surrounding open joints.	NP	NP	NP	NP	NP	NP
			Closely inspect all super/substructure components below joints.	NP	NP	NP	NP	NP	NP
			Expansion Joints -Clean	NP	NP	NP	NP	NP	NP
		Repair	Patch any areas of adjacent concrete deck that have chipped or spalled due to vehicular traffic.	NP	NP	NP	NP	NP	NP
			Expansion Repair	NP	NP	NP	NP	NP	NP
		Rehabilitate	Patch all spalled/delaminated areas in adjacent concrete deck.	NP	NP	NP	NP	NP	NP
			Install new steel armor or replace damaged steel armor at joint.	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire deck joint, repair adjacent bridge elements, & install a different type of deck joint to accommodate necessary movement.	NP	NP	NP	NP	NP	NP
			Expansion Joints -Replace	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
ASSEMBLY JOINTS WITHOUT SEALS	305	Protect	Clean and remove debris from drainage troughs at deck joints quarterly.	NP	NP	NP	NP	NP	NP
			Check joint water tightness & condition of drainage trough (2 yr cycle).	NP	NP	NP	NP	NP	NP
			Expansion Joints -Clean	NP	NP	NP	NP	NP	NP
			Check and flush drainage pipes attached to troughs - biennially	NP	$ 62.50	NP	NP	NP	$ 62.50
		Repair	Re-align any bent fingers of joint (due to snow plow damage, etc).	NP	$ 200.00	NP	NP	NP	$ 200.00
			Repair and re-seal any damaged or leaking areas of drainage trough.	NP	NP	NP	NP	NP	NP
			Expansion Repair	NP	NP	NP	NP	NP	NP
			Replace missing bolts	NP	$ 200.00	NP	NP	NP	$ 200.00
		Rehabilitate	Re-align bent fingers or repair broken fingers with welded steel plates.	NP	$ 200.00	NP	NP	NP	$ 200.00
			Replace entire drainage trough below joint.	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire deck joint, including steel plates & drainage trough, and make repairs to any defects in the adjacent concrete deck.	NP	NP	NP	NP	NP	NP
			Expansion Joints -Replace	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
ELASTOMERIC	310	Protect	Clean and wash the steel elements, and remove any debris.	NP	NP	NP	NP	NP	NP
BEARINGS			bearings, and re-coat exposed steel with a protective system (paint).						
		Repair	Clean corrosion from anchor bolts and other external steel at	NP	NP	NP	NP	NP	NP
			bearings, and re-coat exposed steel with a protective system (paint).	NP	NP	NP	NP	NP	NP
		Rehabilitate	Spot paint any locations of steel elements showing early deterioration.	NP	$ 8.00	NP		NP	$ 8.00
			Zone paint any areas of steel elements under regular distress.	NP	NP	NP	NP	NP	NP
		Replace	Replace the Elastomeric Bearings.		$ 900.00		NP	NP	$ 900.00
			Perform overcoating procedures on large areas of steel elements.	NP	$ 7.00	NP	NP	NP	$ 7.00
			Complete recoating of the steel superstructure.	NP	$ 12.00	NP	NP	NP	$ 12.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED CONCRETE APPROACH SLAB	321	Protect	Wash & clean the approach slabs annually, and remove any debris.	NP	NP	NP	$ 0.18	$ 0.18	$ 0.18
			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	NP	NP	NP
		Repair	Perform concrete repairs for spalls and delaminations.	$ 75.00	NP	NP	NP	NP	$ 75.00
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	NP	NP	
			Approach seal Crack	$ 2.00	NP	NP	NP	NP	$ 2.00
			Approach Patch bituminous	$ 30.00	NP	NP	NP	NP	$ 30.00
			Approach Patch Concrete	$ 75.00	NP	NP	NP	NP	$ 75.00
			Approach Repair Beam guard	NP	NP	NP	NP	NP	NP
			Approach Patch Concrete	NP	NP	NP	NP	NP	NP
		Rehabilitate	Perform in place settlement repair by grout injection (mudjacking).	NP	NP		NP	NP	NP
			Complete recoating of the steel superstructure.	NP	$ 12.00	NP	NP	NP	$ 12.00
			Mud Jacking	NP	NP	NP	$ 4.17	$ 4.17	$ 4.17
			Full depth Crack Repairs	NP	NP	NP	$ 1.19	$ 1.19	$ 1.19
			Full depth patch	NP	$ 100.00	NP	NP	NP	$ 100.00
			Cut hole in pavement, fill undermining with slurry, patch hole	NP	$ 125.00	NP	NP	NP	$ 125.00
			Mill and Overlay	NP	NP	NP	$ 7.14	$ 7.14	$ 7.14
		Replace	Replace the concrete approach slabs and stabilize underlying soil.	NP	NP	NP	$ 29.76	$ 29.76	$ 29.76
			Replace concrete approach slab (not including pavement removal cost)	NP	$ 16.50	NP	NP	NP	$ 16.50
			Potentially repair paving block failure	NP	NP	NP	NP	NP	NP

Typical Approach Slab	
Width	42
Length	20
Area	840

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
METAL BRIDGE	330	Protect	Paint, galvanize, or apply a zinc-rich coating to protect from corrosion.	NP	NP	NP	$ 4.00	$ 4.00	$ 4.00
RAILING			Insulate metal railing from other materials to prevent galvanic corrosion.	NP	NP	NP	NP	NP	NP
		Repair	Straighten slightly damaged or bent rail sections.	NP	$ 20.00	NP	$ 45.00	$ 45.00	$ 36.67
			Tighten anchor bolts, nuts, or connection hardware.	NP	$ 1.00	NP	NP	NP	$ 1.00
		Rehabilitate	Replace anchor bolts, single posts, or a portion of the rail.	NP	NP	NP	NP	NP	NP
		Replace	Replace the entire bridge rail, including posts, plates, and anchor bolts.	NP	$ 40.00	NP	NP	NP	$ 40.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
REINFORCED	331	Protect	Wash & remove debris from the bridge rails and gutter lines annually.	NP	NP	NP	$ 0.50	$ 0.50	$ 0.50
CONCRETE BRIDGE			Perform sealing and waterproofing procedures every 3-5 years.	NP	NP	NP	$ 4.00	$ 4.00	$ 4.00
		Repair	Install reflectors and ensure/provide adequate drainage along rails.	NP	NP	NP	NP	NP	NP
			Perform crack sealing procedures if crack widths are 0.007" or larger.	NP	NP	NP	$ 4.00	$ 4.00	$ 4.00
			Patching spalls and delams - small sections	NP	$ 297.50	NP	NP	NP	$ 297.50
		Rehabilitate	Perform large concrete repairs for spalls and delaminations.	NP	$ 288.75	NP	$ 40.00	$ 40.00	$ 122.92
			Replace concrete section at areas showing deck anchorage corrosion.	NP	NP	NP	NP	NP	NP
		Replace	Remove and replace the concrete bridge rails and anchorage to deck.	NP	$ 106.94	NP	NP	NP	$ 106.94

Typical Concrete Railing		
Height	3.5	
Length	150	
Width	1.5	
Area	525.00	SF
Volume	787.5	
Volume	29.17	CY

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
AC OVERLAY	8511	Protect	Clean, wash, and remove debris from deck overlay and gutter lines.	NP	NP	NP	NP	NP	NP
			Clean and flush out debris from the drainage inlets.	NP	NP	NP	NP	NP	NP
			Deck Seal	NP	NP	NP	NP	NP	NP
			Seal joint along parapet with hot tar	NP	$ 7.00	NP	NP	NP	$ 7.00
			Sweep deck (annually)	NP	$ 0.01	NP	NP	NP	$ 0.01
		Repair	Seal cracks in the AC overlay using Hot Pour or Cold Pour procedures.	NP	$ 8.00	NP	NP	NP	$ 8.00
			Perform asphalt surface patches for potholes in AC overlay.	NP	$ 21.50	NP	NP	NP	$ 21.50
			Seal Cracks	NP	$ 8.00	NP	NP	NP	$ 8.00
			Repair Patch	NP	NP	NP	NP	NP	NP
			Repair Potholes	NP	NP	NP	NP	NP	NP
			Temporary cold patch repairs	NP	$ 15.00	NP	NP	NP	$ 15.00
		Rehabilitate	Apply a thin seal coat over the top of the AC overlay.	NP	NP	NP	NP	NP	NP
			Mill top surface of AC overlay and apply new AC overlay lift (1.5" min.)	NP	$ 5.00	NP	NP	NP	$ 5.00
		Replace	Remove and replace the entire AC overlay, and the top 1/4" of the concrete deck (mill concrete deck prior to replacing overlay).	NP	$ 7.00	NP	NP	NP	$ 7.00

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
AC OVERLAY & MEMBRANE	8512	Protect	Clean, wash, and remove debris from deck overlay and gutter lines.	NP	NP	NP	$ 0.15	$ 0.15	$ 0.15
			Clean and flush out debris from the drainage inlets.	NP	NP	NP	$ 0.03	$ 0.03	$ 0.03
			Seal joint along parapet with hot tar	NP	$ 7.00	NP	NP	NP	$ 7.00
			Sweep deck (annually)	NP	$ 0.01	NP	NP	NP	$ 0.01
		Repair	Seal cracks in the AC overlay using Hot Pour or Cold Pour procedures.	NP	$ 8.00	NP	$ 4.00	$ 4.00	$ 5.33
			Perform asphalt surface patches for potholes in AC overlay.	NP	$ 22.50	NP	$ 35.00	$ 35.00	$ 30.83
			Temporary cold patch repairs	NP	$ 15.00	NP	NP	NP	$ 15.00
		Rehabilitate	Apply a thin seal coat over the top of the AC overlay.	NP	NP	NP	NP	NP	NP
			Mill top surface of AC overlay and apply new AC overlay lift (1.5" min.)	NP	$ 5.00	NP	NP	NP	$ 5.00
		Replace	Remove and replace the entire AC overlay, waterproof membrane, and the top 1/4" of the concrete deck (milled area).	NP	$ 8.00	NP	$ 45.00	$ 45.00	$ 32.67

Typical Brige	
Widht	44
Length	150
Area	6600

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
THIN POLYMER OVERLAY	8513	Protect	Clean, wash, and remove debris from deck overlay and gutter lines.	NP	NP	NP	$ 0.15	$ 0.15	$ 0.15
			Clean and flush out debris from the drainage inlets.	NP	NP	NP	$ 0.03	$ 0.00	$ 0.02
			Sweep deck (annually)	NP	$ 0.01	NP	NP	NP	$ 0.01
		Repair	Seal cracks in the thin polymer overlay using an epoxy sealant or similar sealant material.	NP	NP	NP	$ 8.00	$ 8.00	$ 8.00
		Rehabilitate	Repair the deteriorated area of the concrete deck, chip away existing overlay in adjacent area, then re-apply new overlay within that area.	NP	NP	NP	15	$ 15.00	$ 15.00
		Replace	Remove entire overlay and top 1/4" of deck by milling the surface, repair any deteriorated concrete, then re-apply entire overlay.	NP	NP	NP	NP	$ 6.00	$ 6.00

Typical Brige	
Widht	44
Length	150
Area	6600

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
CONCRETE OVERLAYS	8514	Protect	Clean, wash, and remove debris from deck overlay and gutter lines.	NP	NP	NP	$ 0.15	$ 0.15	$ 0.15
			Clean and flush out debris from the drainage inlets.	NP	NP	NP	NP	NP	NP
			Thin Epoxy Overlay	NP	$ 4.00	NP	8	$ 8.00	$ 6.67
			Sweep deck (annually)	NP	$ 0.01	NP	**NP**	NP	$ 0.01
		Repair	Seal cracks in the concrete overlay using the PCC hot pour method, an epoxy sealant, or another similar sealant material.	NP	NP	NP	NP	NP	NP
			Temporary cold patch repairs	NP	$ 15.00	NP	NP	NP	$ 15.00
			Perform sm-med deck surface repairs for spalls and delams (partial depth).	NP	$ 80.00		NP	NP	$ 80.00
			Polymer Overlay	NP	NP	NP	$ 8.00	$ 8.00	$ 8.00
				NP	NP	NP	NP	NP	NP
		Rehabilitate	Repair the deteriorated area of the concrete deck, remove existing overlay in adjacent area, then re-apply new overlay within that area.	NP	NP	NP	$ 10.00	$ 10.00	$ 10.00
		Replace	Remove entire overlay and top 1/4" of deck by milling the surface, repair any deteriorated concrete, then re-apply entire overlay.	NP	$ 17.00	NP	NP	NP	$ 17.00

Typical Brige	
Widht	44
Length	150
Area	6600

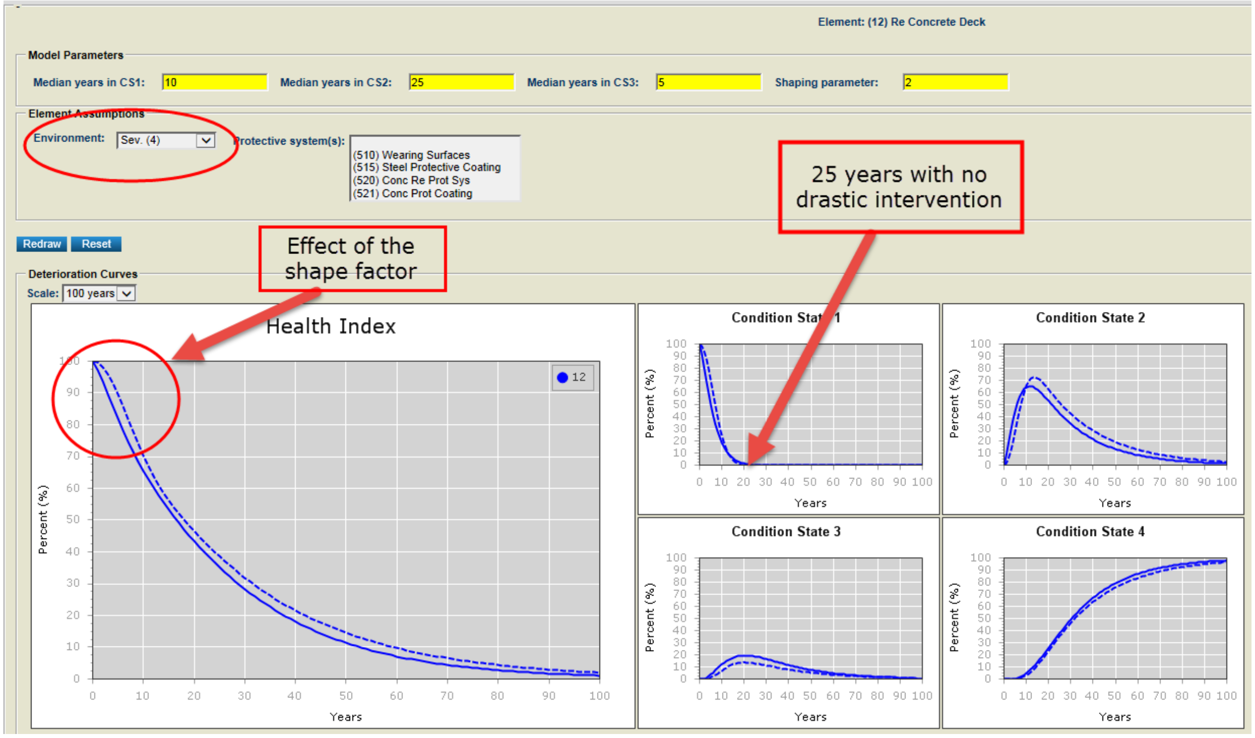
Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
POLYESTER CONCRETE OVERLAYS	8515	Protect	Clean, wash, and remove debris from deck overlay and gutter lines.	NP	NP	NP	NP	NP	NP
			Clean and flush out debris from the drainage inlets.	NP	NP	NP	NP	NP	NP
			Seal w/Concrete Sealer	NP	NP	NP	NP	NP	NP
			Thin Epoxy Overlay	NP	NP	NP	NP	NP	NP
			Polymer Modified Overlay	NP	NP	NP	NP	NP	NP
		Repair	Seal cracks in the polyester concrete overlay using an	NP	NP	NP	NP	NP	NP
			epoxy sealant or similar sealant material.	NP	NP	NP	NP	NP	NP
			Seal Cracks	NP	NP	NP	NP	NP	NP
			Repair Patch	NP	NP	NP	NP	NP	NP
			Repair Potholes	NP	NP	NP	NP	NP	NP
		Rehabilitate	Repair the deteriorated area of the concrete deck, chip away existing overlay in adjacent area, then re-apply new overlay within that area.	NP	NP	NP	NP	NP	NP
		Replace	Remove entire overlay and top 1/4" of deck by milling the surface, repair any deteriorated concrete, then re-apply entire overlay.	NP	NP	NP	NP	NP	NP
			Replace Polyster Concrete Overlay	NP	NP	NP	NP	NP	NP

Element Name	Number	Action	Practice	LaCrosse	Milwaukee	Green Bay	Rhinelander	Wisconsin Rapids	Average
PAINTED STEEL	8516	Protect	Clean and wash the steel elements, and remove any debris.	NP	NP	NP	$ 0.40	$ 0.40	$ 0.40
		Repair	Spot paint any locations of steel elements showing early deterioration.	NP	$ 8.00	NP	$ 1.50	$ 1.50	$ 3.67
			Zone paint any areas of steel elements under regular distress.	NP		NP	$ 1.25	$ 1.25	$ 1.25
		Rehabilitate	Perform overcoating procedures on large areas of steel elements.	NP	$ 7.00	NP	$ 3.00	$ 3.00	$ 4.33
		Replace	Complete recoating of the steel superstructure.	NP	$ 12.00	NP	$ 13.00	$ 13.00	$ 12.67

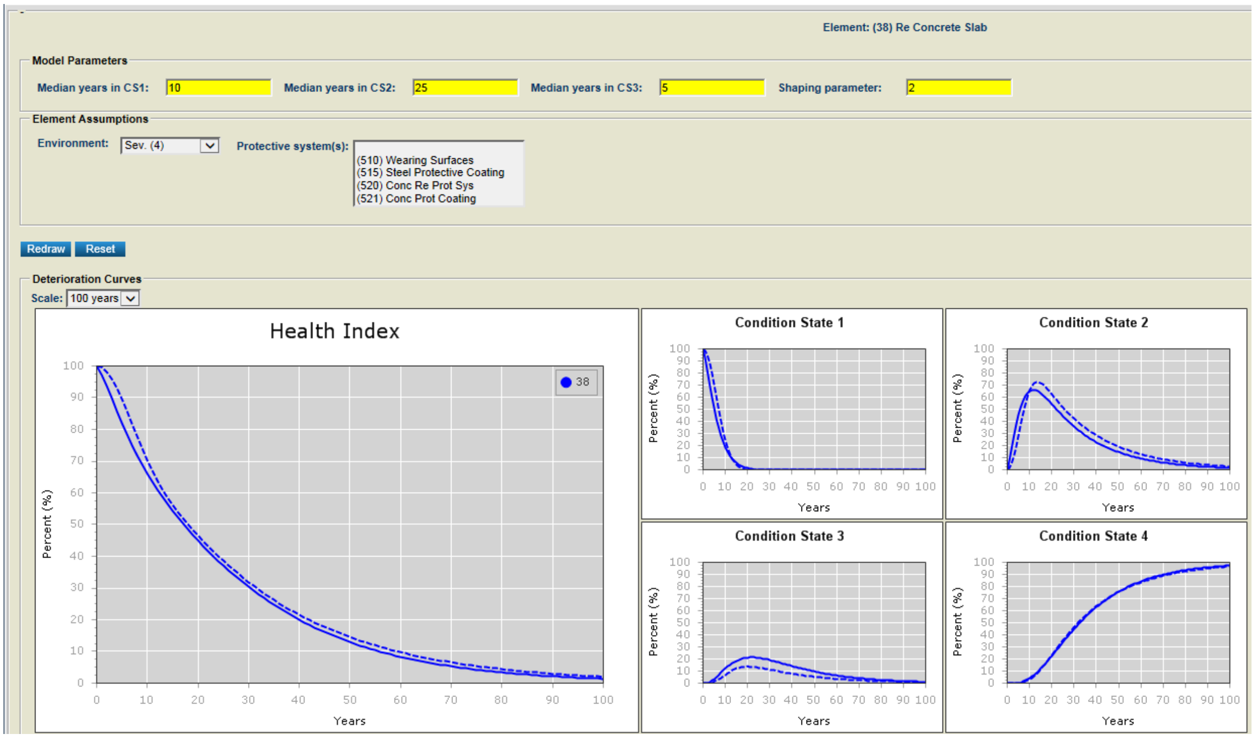
Wisconsin DOT Deterioration Models

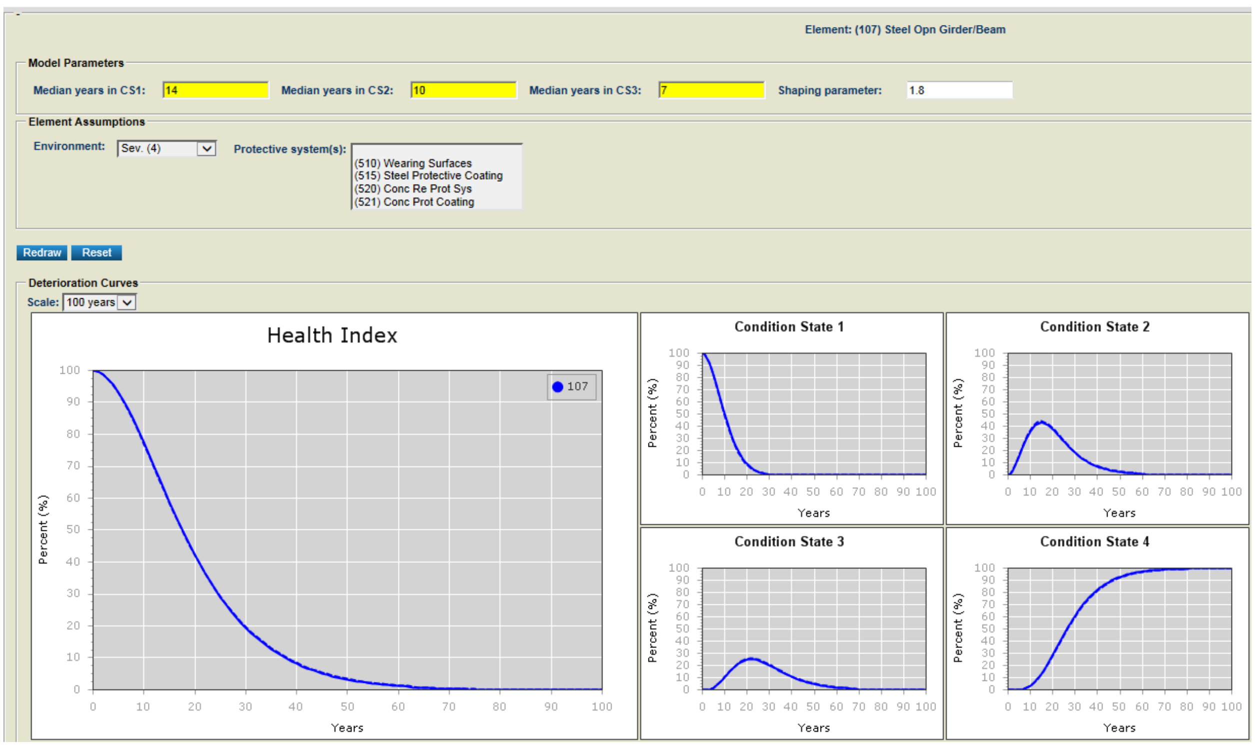
Table Name PON_MOD_DETER

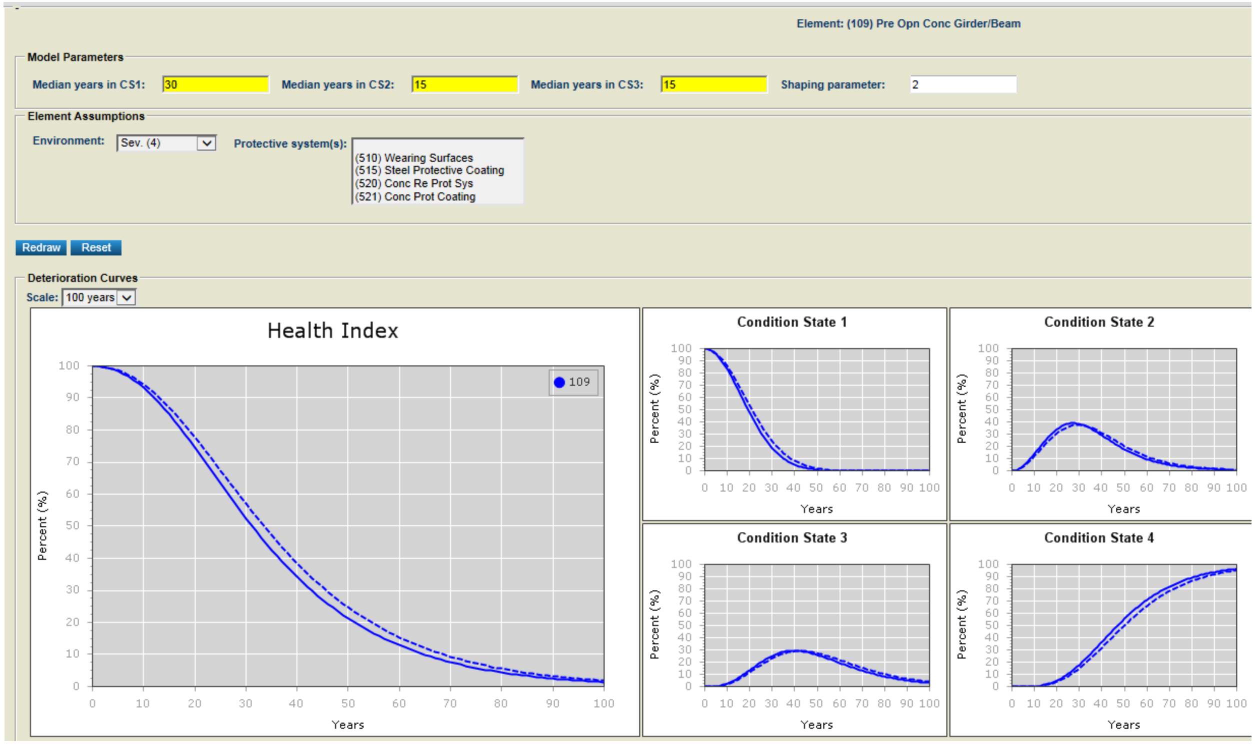
Element key	Element name for reference (not in pon_mod_deter)	Weibull shape param	Median years state 1	Median years state 2	Median years state 3	PennDOT			South Dakota			Michigan			TRT			Wisconsin Recommended for Env 4			
elemkey	name	shaping _param	medyr1	medyr2	medyr3	PMed1	PMed2	PMed3	SMed1	SMed2	SMed3	MMed1	MMed2	MMed3	TMed1	TMed2	TMed3	shaping_ param2	WMed1	WMed2	WMed3
12	Reinforced Concrete Deck	1.3	7.21	21.00	7.43	22.00	34.00	13.00	22.00	34.00	13.00	7.50	7.50	6.00	7.20	21.00	7.40	2.00	10.00	25.00	5.00
13	Prestressed Concrete Deck	1.3	11.97	24.26	13.35	NA	NA	NA	NA	NA	NA	5.50	12.50	9.00	12.00	24.30	13.30	1.70	12.50	25.00	10.00
38	Reinforced Concrete Slab	1.3	7.21	22.00	8.81	28.00	16.00	9.00	28.00	16.00	9.00	NA	NA	NA	7.20	22.00	8.80	2.00	10.00	25.00	5.00
107	Steel Open Girder	1.8	14.25	9.73	6.77	17.00	14.00	4.00	46.00	10.00	18.00	7.50	12.50	20.00	14.20	9.70	16.00	1.80	14.00	10.00	7.00
109	PS Open Girder	2.0	27.50	14.61	14.29	25.00	30.00	30.00	90.00	9.00	9.00	100.00	30.00	50.00	27.50	14.60	14.30	2.00	30.00	15.00	15.00
205	RC Column	2.0	37.44	29.88	21.90	5.00	5.00	5.00	69.00	48.00	43.00	41.00	34.00	125.00	37.40	29.90	21.90	2.50	30.00	30.00	22.00
210	RC Pier Wall	2.0	47.57	30.43	30.52	25.00	35.00	10.00	68.00	50.00	43.00	55.00	30.00	65.00	47.60	30.40	30.50	2.50	30.00	30.00	22.00
215	RC Abutment	2.0	32.82	28.11	22.72	25.00	35.00	10.00	68.00	50.00	43.00	32.00	32.00	31.00	32.80	28.10	22.70	2.50	30.00	30.00	22.00
234	RC Pier Cap	2.0	35.20	24.93	23.92	35.00	35.00	35.00	68.00	50.00	43.00	65.00	25.00	41.00	35.20	24.90	23.90	2.50	35.00	20.00	15.00
241	RC Culvert	2.0	22.79	28.26	17.40	99.00	99.00	99.00	100.00	100.00	100.00	40.00	40.00	20.00	22.80	28.30	17.40	2.00	20.00	28.00	20.00
300	Strip Seal Expansion Joint	1.0	15.50	11.01	4.94	7.00	7.00	4.00	40.00	50.00	7.00	NA	NA	NA	15.50	11.00	4.90	2.70	15.00	7.00	5.00
301	Pourable Joint Seal	1.0	3.73	2.75	2.72	11.00	40.00	7.00	11.00	32.00	7.00	NA	NA	NA	3.70	2.80	2.70	1.00	4.00	3.00	3.00
302	Compression Joint Seal	1.0	5.39	2.28	3.05	7.00	7.00	4.00	3.00	6.00	7.00	NA	NA	NA	5.40	2.30	3.10	1.00	5.00	2.00	3.00
303	Modular Joint	1.4	4.53	7.35	2.61	3.00	5.00	7.00	3.00	6.00	7.00	NA	NA	NA	4.50	7.30	2.60	1.40	5.00	7.00	3.00
304	Open Expansion Joint	1.0	11.53	14.44	2.61	15.00	50.00	7.00	15.00	50.00	7.00	NA	NA	NA	11.50	14.40	2.60	1.50	10.00	15.00	3.00
305	Assembly Joint w/o Seal	1.4	4.60	3.53	2.30	NA	NA	NA	69.00	35.00	7.00	NA	NA	NA	4.60	3.50	2.30	1.40	5.00	7.00	3.00
310	Elastomeric	1.9	24.57	27.07	8.90	35.00	65.00	10.00	69.00	35.00	7.00	35.00	65.00	7.00	24.60	27.10	8.90	3.00	25.00	30.00	10.00
321	Reinforced Concrete Approach Slab	1.3	15.77	18.52	17.57	16.00	20.00	16.00	16.00	20.00	16.00	10.00	25.00	25.00	15.80	18.50	17.60	2.00	15.00	20.00	18.00
330	Metal Bridge Railing	1.8	29.00	13.04	9.00	69.00	17.00	17.00	69.00	19.00	19.00	15.00	15.00	10.00	29.00	13.00	9.00	1.80	30.00	13.00	10.00
331	Reinforced Concrete Bridge Railing	2.0	28.00	20.00	18.00	66.00	50.00	40.00	60.00	50.00	40.00	25.00	50.00	70.00	28.00	20.00	18.00	2.0	28.00	20.00	18.00
8511	AC Overlay	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	3.00	2.00	2.00
8512	AC Overlay & Membrane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	6.00	4.00	4.00
8513	Thin Polymer Overlay	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	5.00	4.00	2.00
8514	Concrete Overlay	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.50	7.00	5.00	3.00
8515	Polyester Concrete Overlay	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	3.00	2.00	2.00
8516	Painted Steel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.80	6.00	4.00	2.00

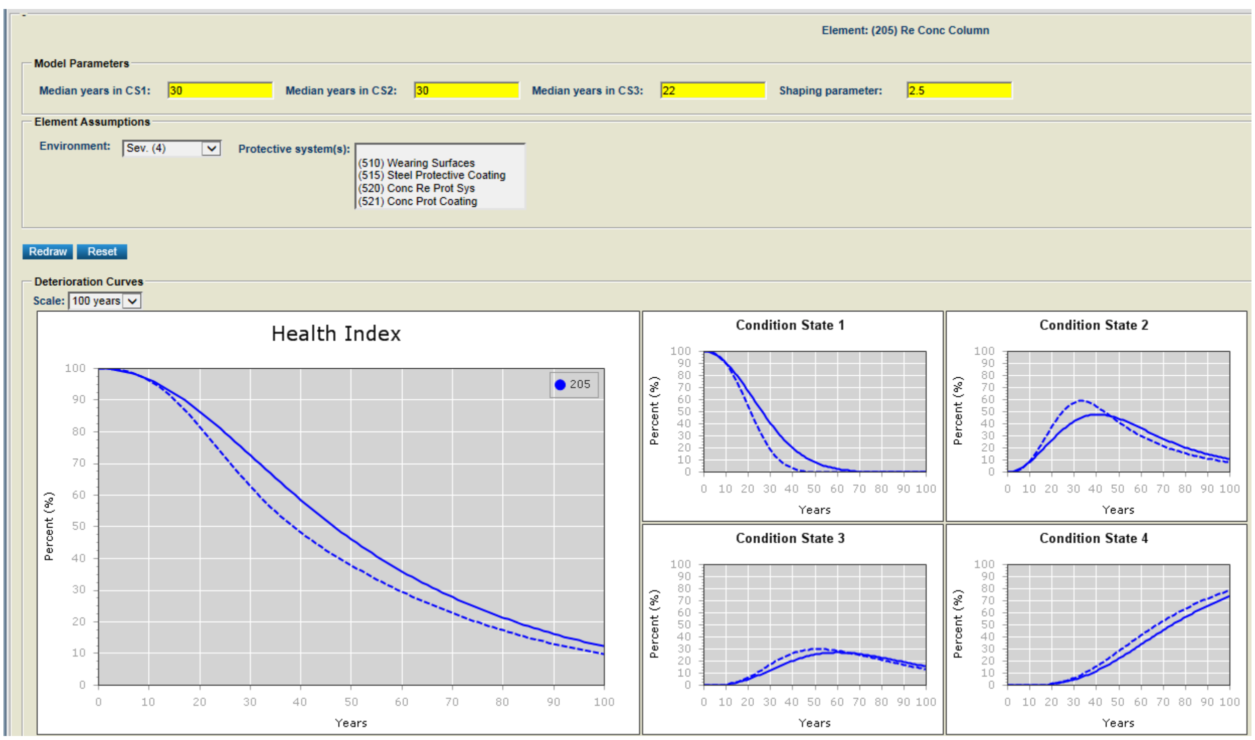

Element: (12) Re Concrete Deck
Model Parameters
Median years in CS1: 10
Median years in CS2: 25
Median years in CS3: 5
Shaping parameter: 2
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
25 years with no drastic intervention
Effect of the shape factor
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
12
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (13) Pre Concrete Deck
Model Parameters
Median years in CS1: 12.5
Median years in CS2: 25
Median years in CS3: 10
Shaping parameter: 1.7
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Slightly higher decay in HI than default values
35 Years with no intervention
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
13
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

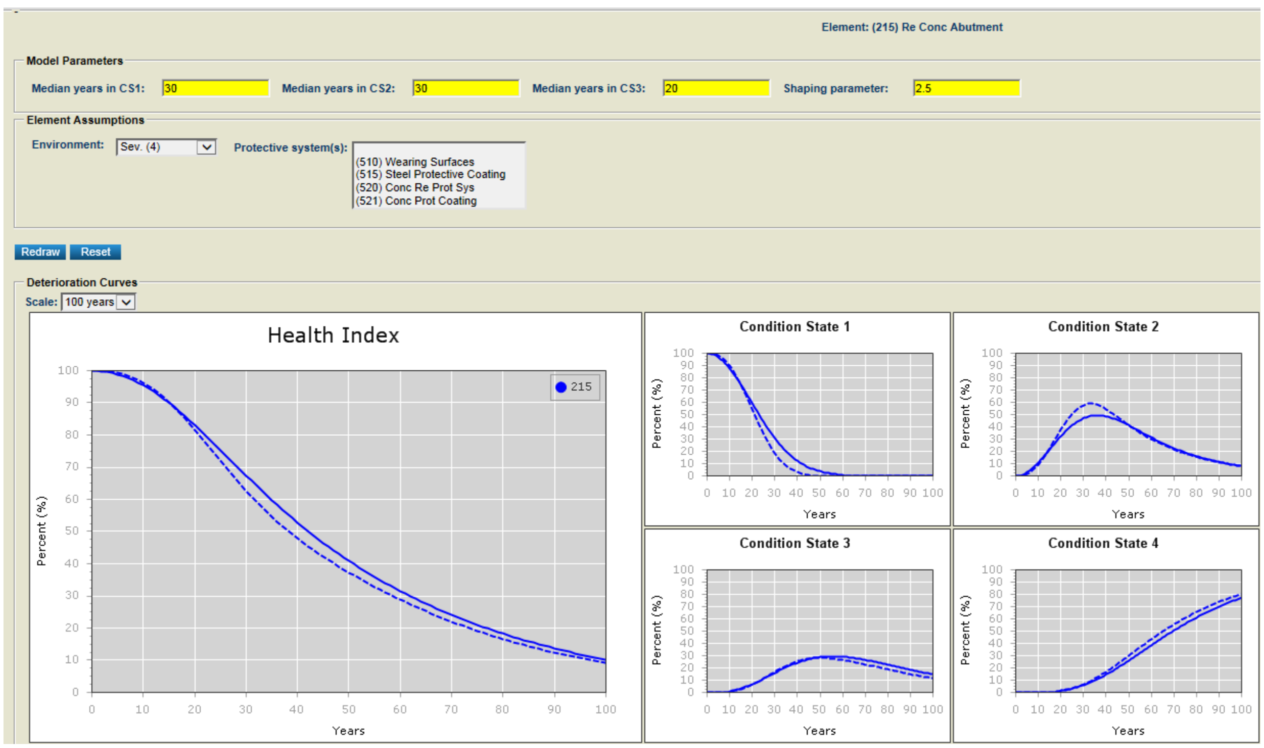

Element: (38) Re Concrete Slab
Model Parameters
Median years in CS1: 10
Median years in CS2: 25
Median years in CS3: 5
Shaping parameter: 2
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
38
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

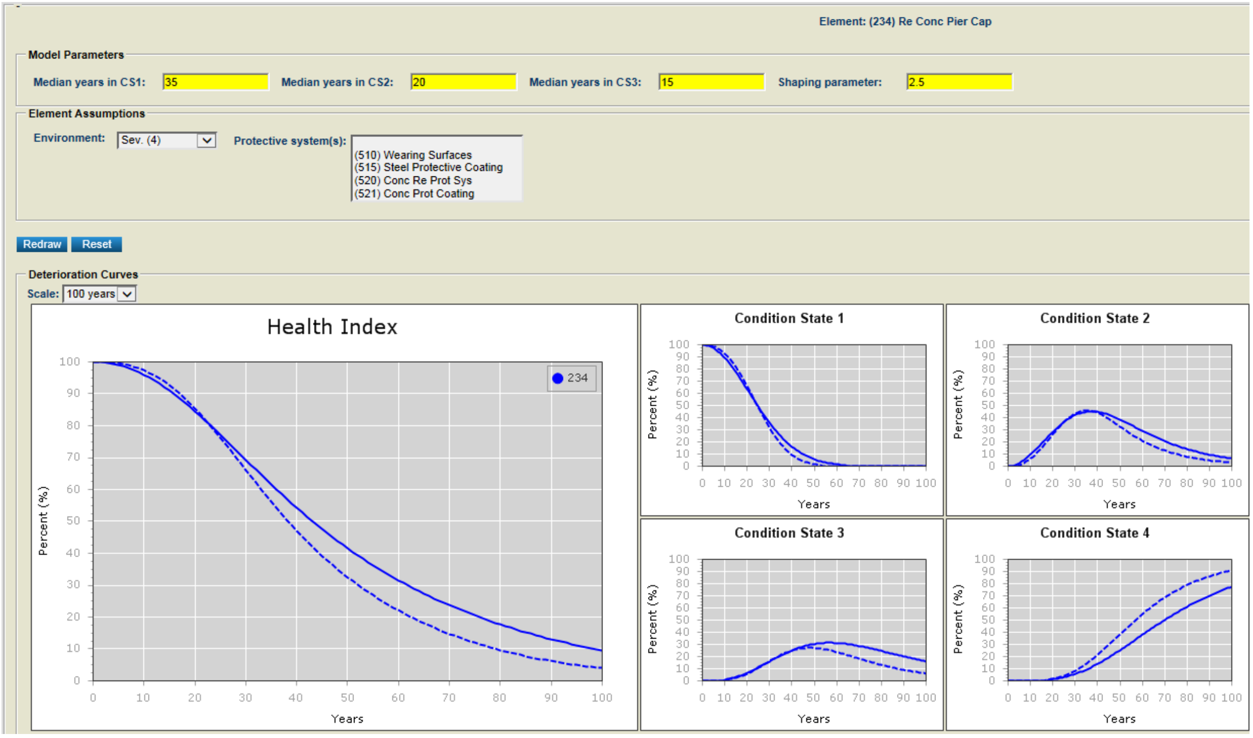

Element: (107) Steel Opn Girder/Beam
Model Parameters
Median years in CS1: 14
Median years in CS2: 10
Median years in CS3: 7
Shaping parameter: 1.8
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
107
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

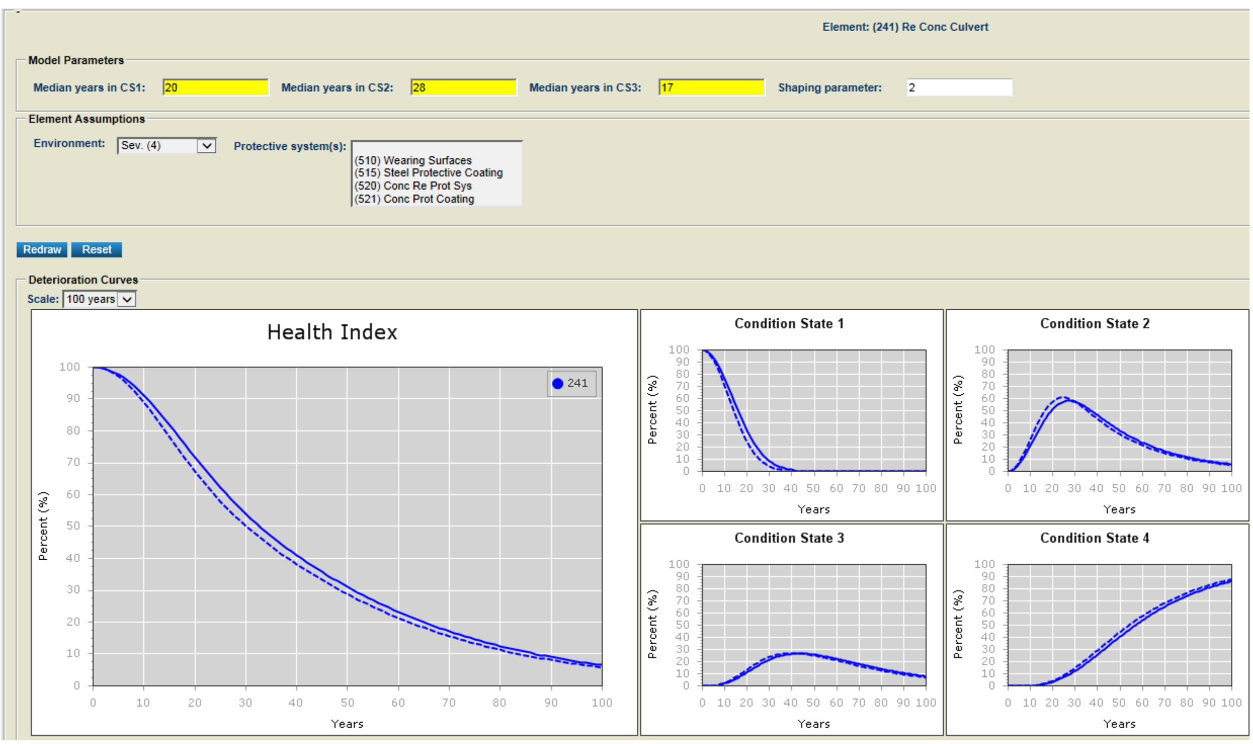

Element: (109) Pre Opn Conc Girder/Beam
Model Parameters
Median years in CS1: 30
Median years in CS2: 15
Median years in CS3: 15
Shaping parameter: 2
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
109
Condition State 1
Condition State 2
Condition State 3
Condition State 4
Percent (%)
Years

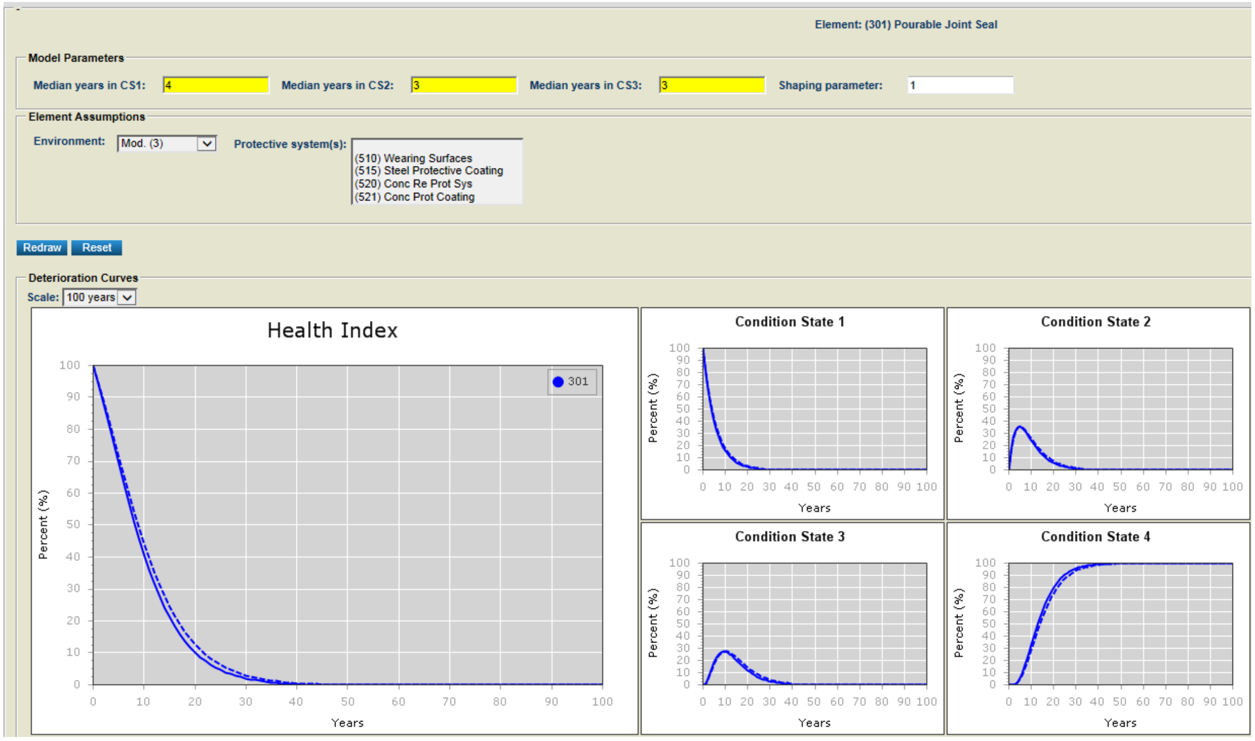

Element: (205) Re Conc Column
Model Parameters
Median years in CS1: 30
Median years in CS2: 30
Median years in CS3: 22
Shaping parameter: 2.5
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
205
Condition State 1
Condition State 2
Condition State 3
Condition State 4
Percent (%)
Years

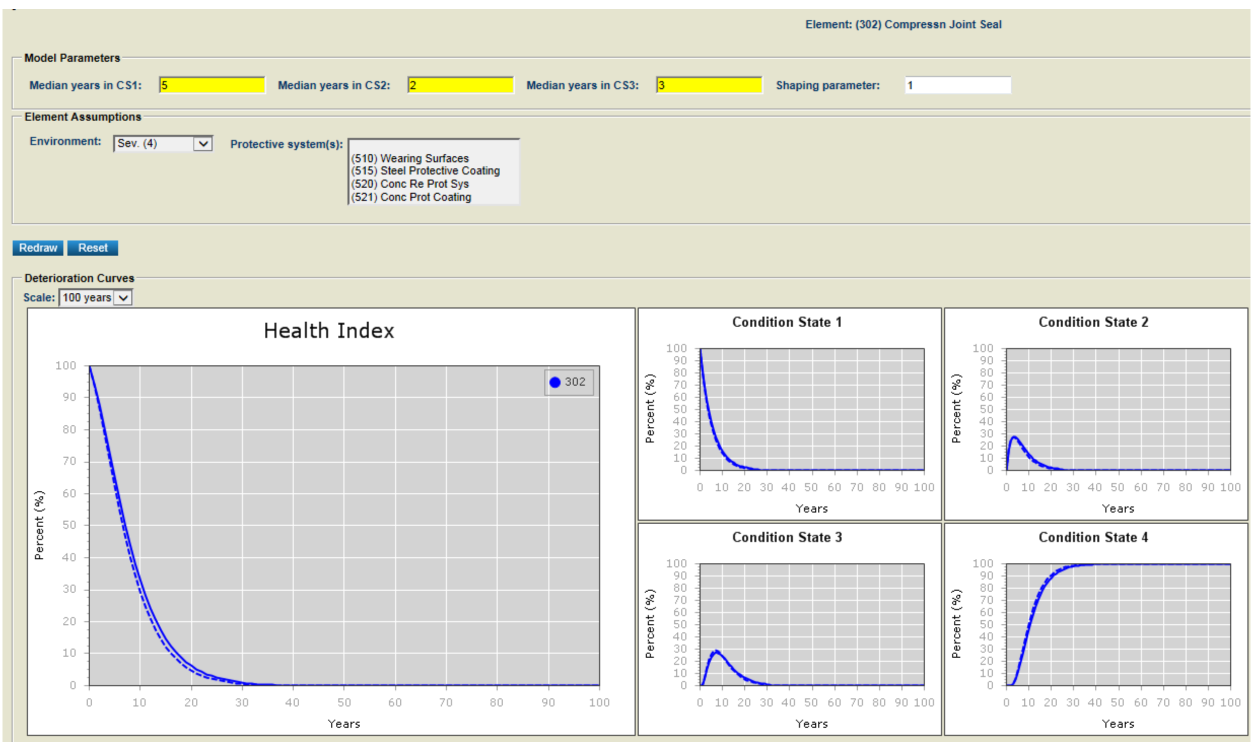

Element: (210) Re Conc Pier Wall
Model Parameters
Median years in CS1: 30
Median years in CS2: 30
Median years in CS3: 22
Shaping parameter: 2.5
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
210
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

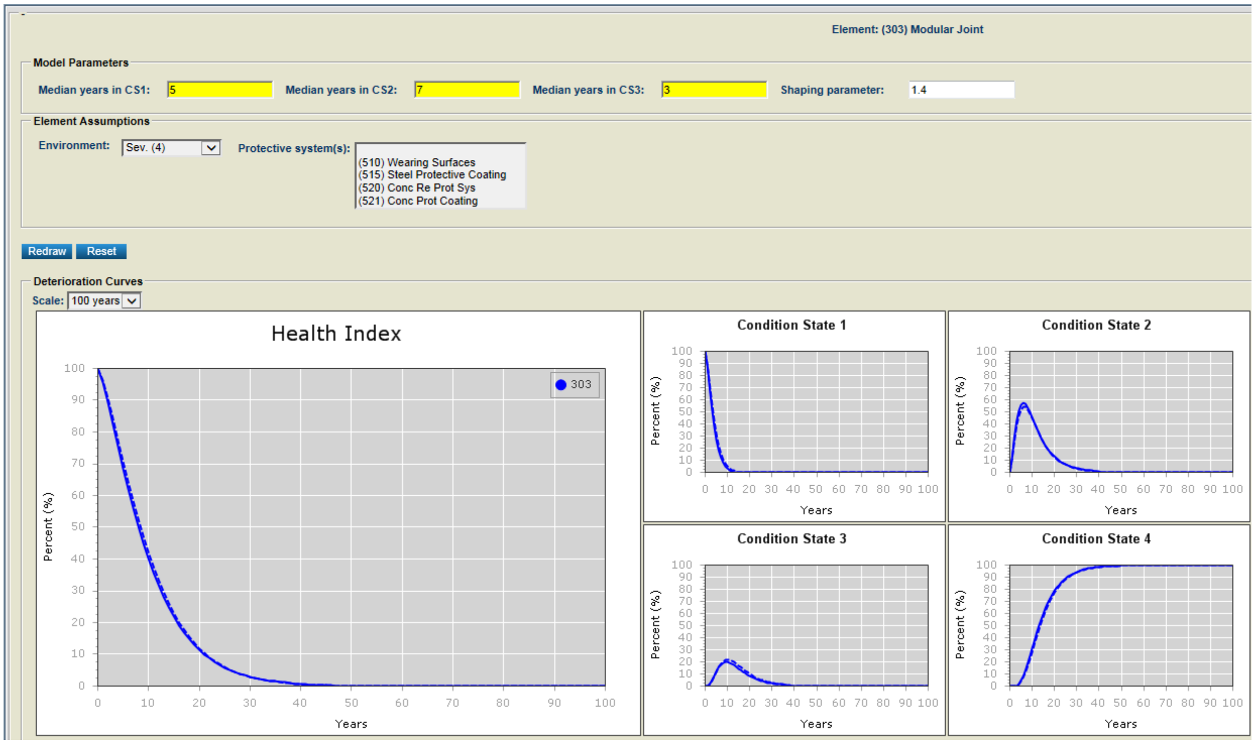

Element: (215) Re Conc Abutment
Model Parameters
Median years in CS1: 30
Median years in CS2: 30
Median years in CS3: 20
Shaping parameter: 2.5
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
215
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

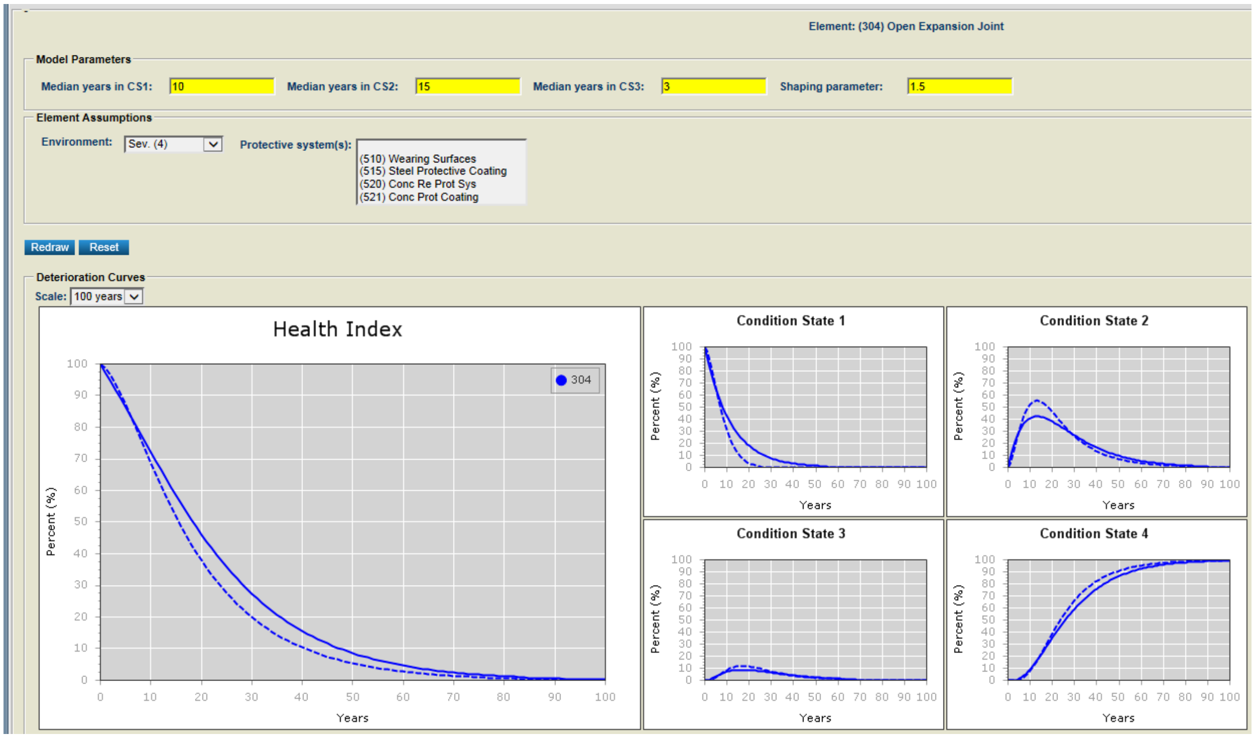

Element: (234) Re Conc Pier Cap
Model Parameters
Median years in CS1: 35
Median years in CS2: 20
Median years in CS3: 15
Shaping parameter: 2.5
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
234
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

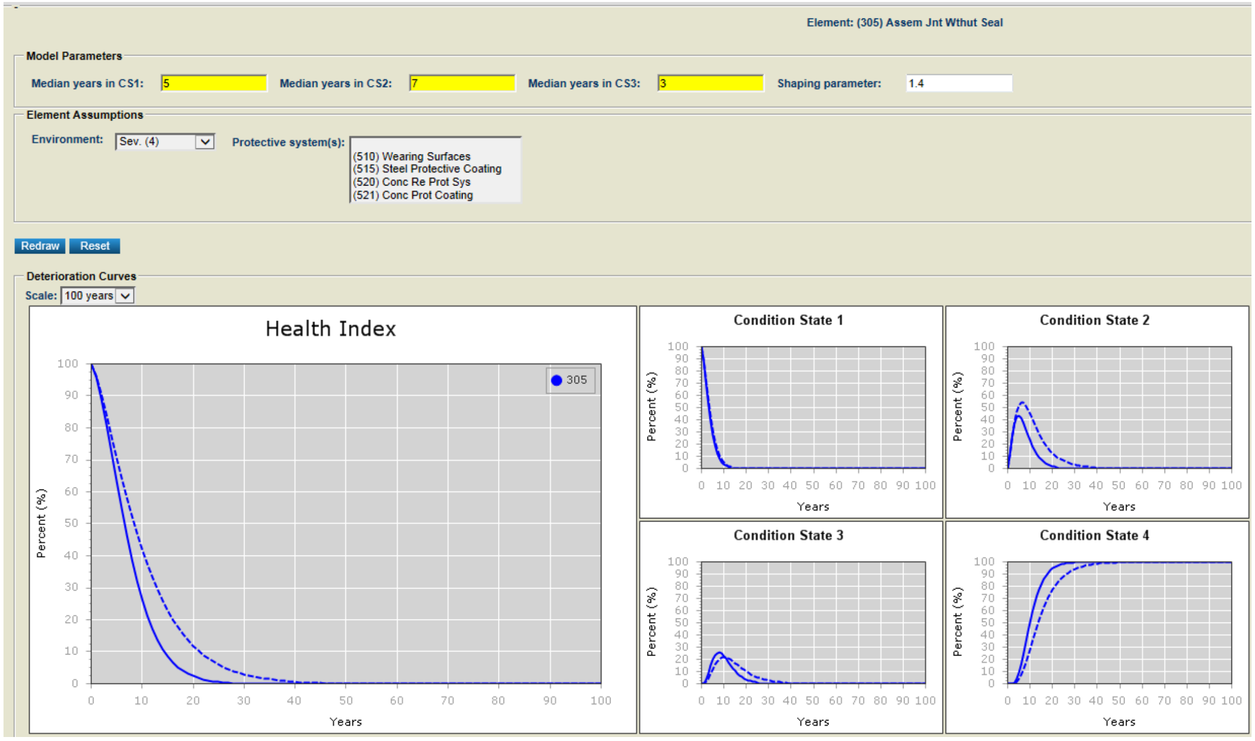

Element: (241) Re Conc Culvert
Model Parameters
Median years in CS1: 20
Median years in CS2: 28
Median years in CS3: 17
Shaping parameter: 2
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
241
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

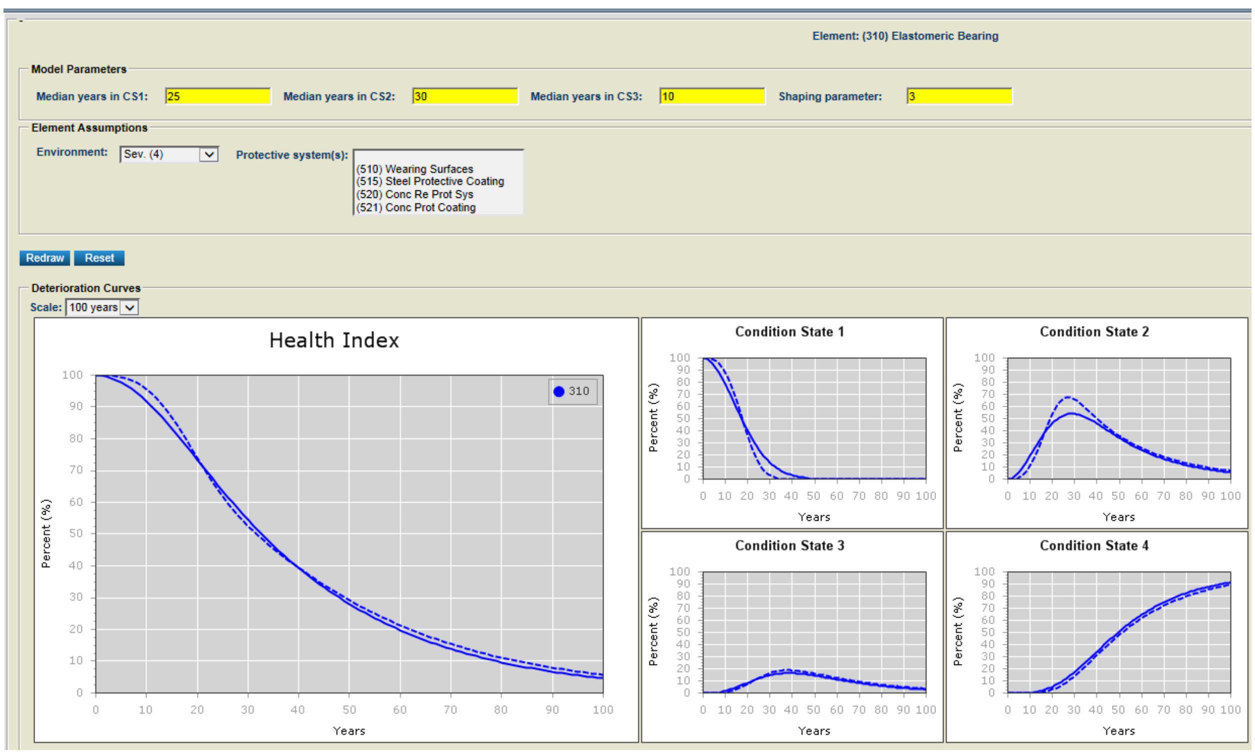

Element: (301) Pourable Joint Seal
Model Parameters
Median years in CS1: 4
Median years in CS2: 3
Median years in CS3: 3
Shaping parameter: 1
Element Assumptions
Environment: Mod. (3)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
301
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

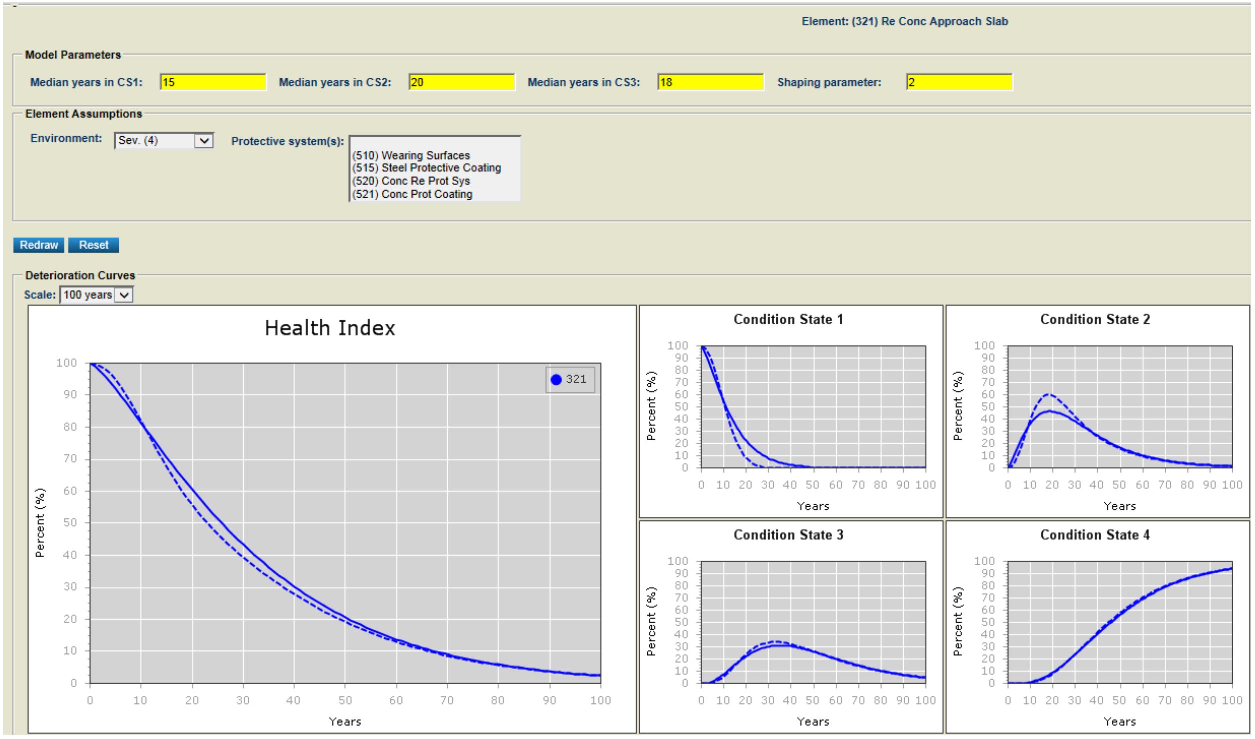

Element: (302) Compressn Joint Seal
Model Parameters
Median years in CS1: 5
Median years in CS2: 2
Median years in CS3: 3
Shaping parameter: 1
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
302
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

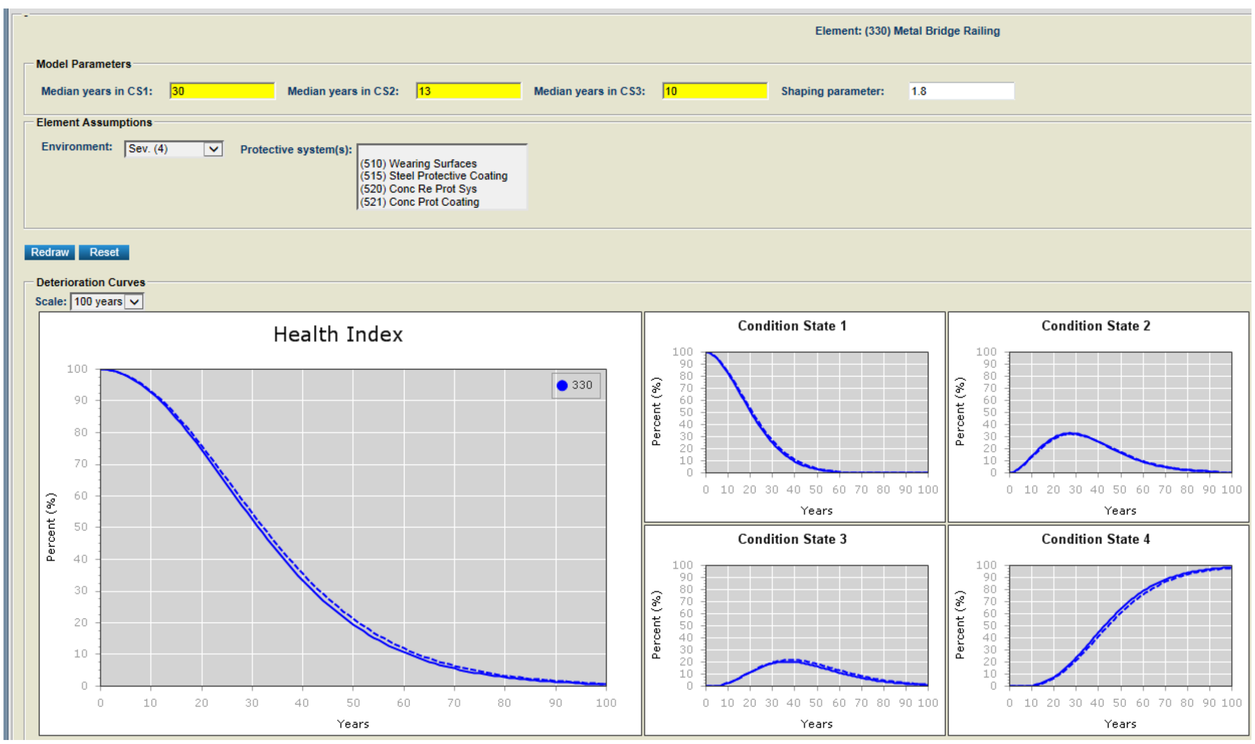

Element: (303) Modular Joint
Model Parameters
Median years in CS1: 5
Median years in CS2: 7
Median years in CS3: 3
Shaping parameter: 1.4
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
303
Condition State 1
Condition State 2
Condition State 3
Condition State 4
Percent (%)
Years

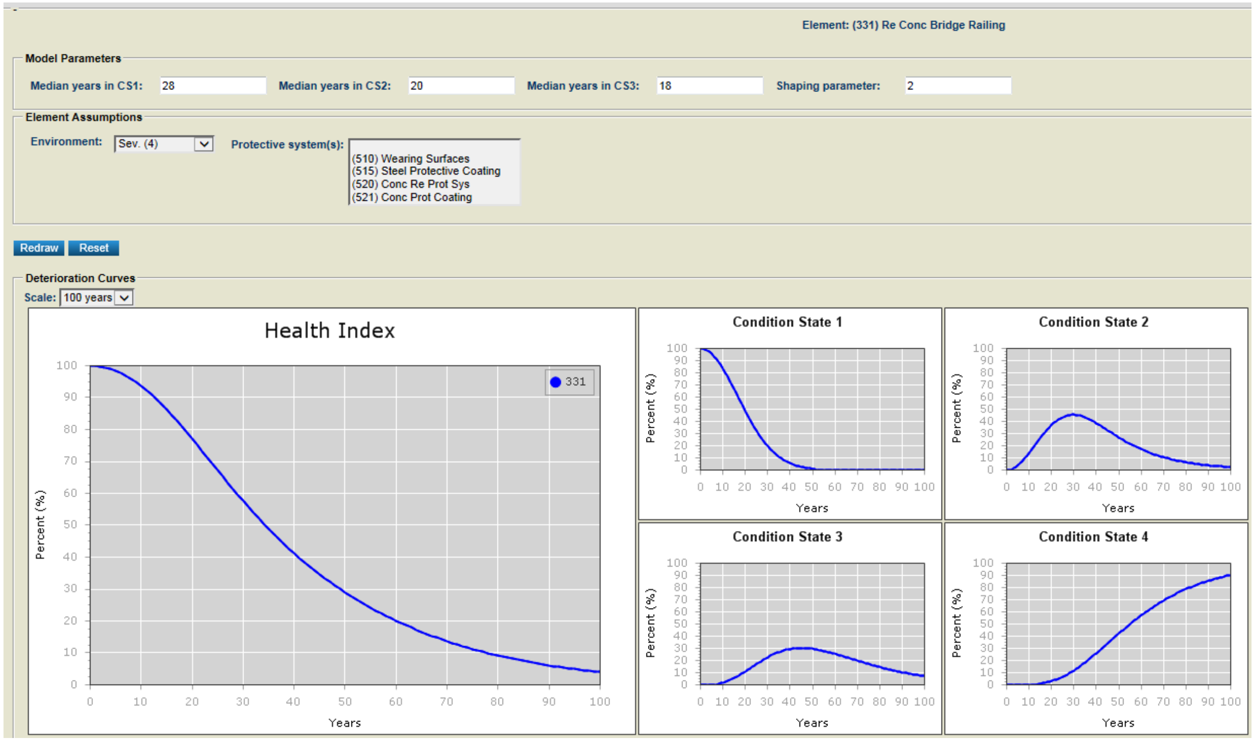

Element: (304) Open Expansion Joint
Model Parameters
Median years in CS1: 10
Median years in CS2: 15
Median years in CS3: 3
Shaping parameter: 1.5
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
304
Condition State 1
Condition State 2
Condition State 3
Condition State 4
Percent (%)
Years


Element: (305) Assem Jnt Wthut Seal
Model Parameters
Median years in CS1: 5
Median years in CS2: 7
Median years in CS3: 3
Shaping parameter: 1.4
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
305
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (310) Elastomeric Bearing
Model Parameters
Median years in CS1: 25
Median years in CS2: 30
Median years in CS3: 10
Shaping parameter: 3
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
310
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (321) Re Conc Approach Slab
Model Parameters
Median years in CS1: 15
Median years in CS2: 20
Median years in CS3: 18
Shaping parameter: 2
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
321
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

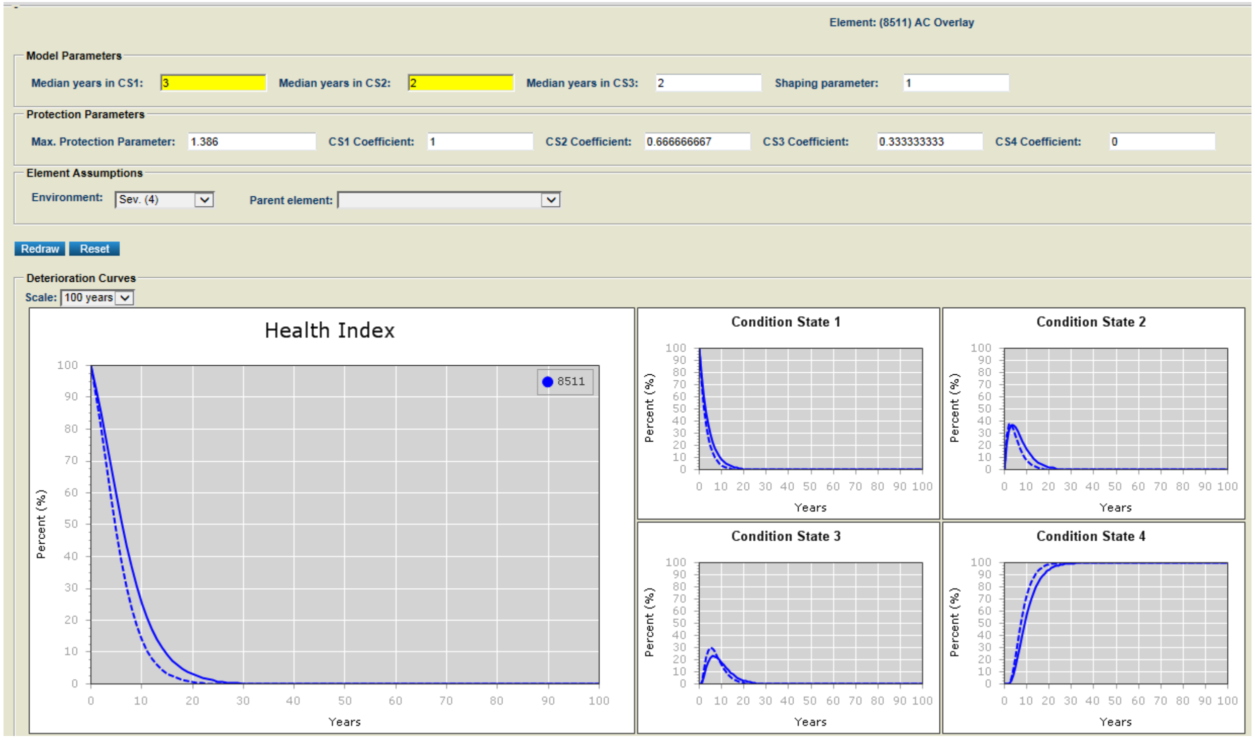

Element: (330) Metal Bridge Railing
Model Parameters
Median years in CS1: 30
Median years in CS2: 13
Median years in CS3: 10
Shaping parameter: 1.8
Element Assumptions
Environment: Sev. (4)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
330
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4



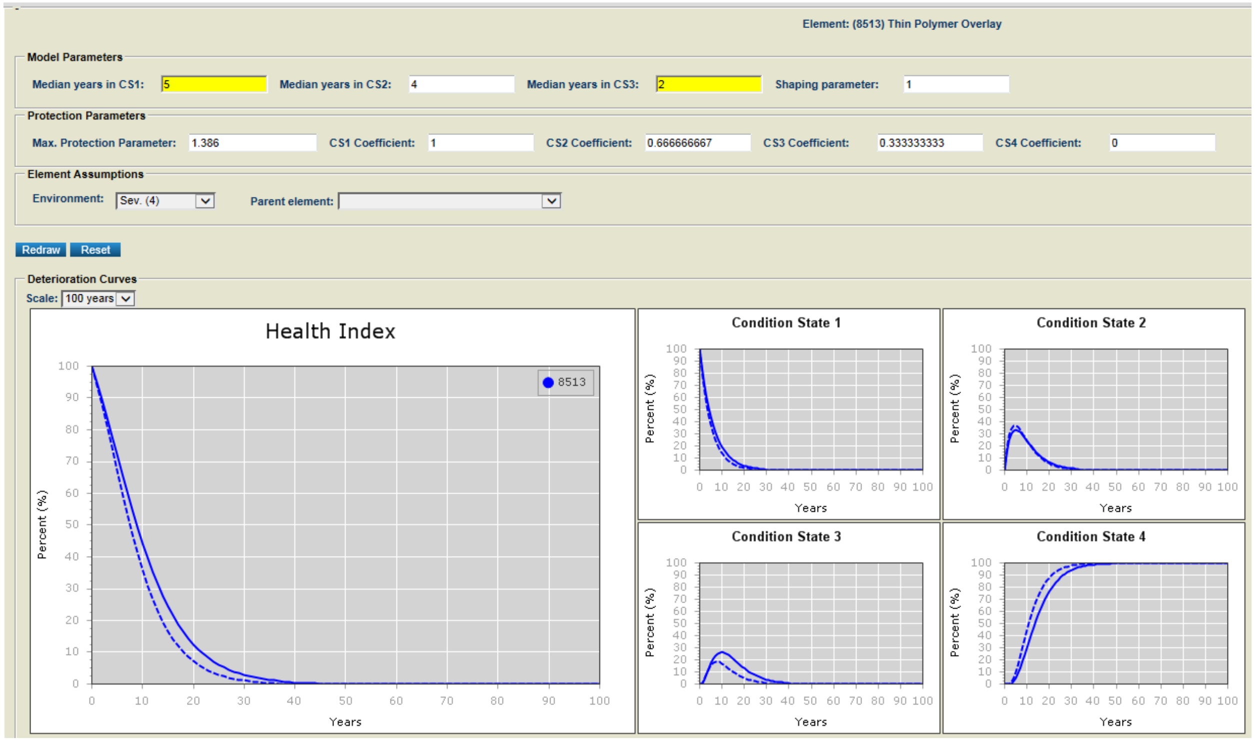
Rehabilitation Method	Expected Service Life Range (years) [Mean]	Cost Range ($/sq. ft.) [Mean]	Overlay Thickness (in.) [Mean]	Estimated Installation Time	Current Use
Rigid Overlays					
High Performance Concrete Overlays	10 - 40 [16 - 29]	5 - 45 [17 - 25]	1 - 5 [1.6 - 3.5]	>3 days	Mixed
Low Slump Concrete Overlays	10 - 45 [16 - 32]	4 - 45 [13 - 19]	1.5 - 4 [2.0 - 3.1]	>3 days	Static
Latex Modified Concrete Overlays	10 - 50 [14 - 29]	1 - 150 [18 - 39]	1 - 5 [1.5 - 2.7]	<24 hrs (UHELMC)*, 1-3 days (LMC)**	Mixed
Asphalt-Based Overlays					
Asphalt Overlays with a Membrane	3 - 40 [12 - 19]	1.5 - 23.5 [3.1 - 7.6]	1.5 - 4 [2.4 - 3.1]	>3 days	Static
Miscellaneous Asphalt Overlays	5 - 20 [8 - 15]	1 - 3 [1 response]	0.38 - 2.5 [0.8 - 1.5]	1 - 3 days	Static
Other Rehabilitation Systems					
Polymer Overlays	1 - 35 [9 - 18]	3 - 60 [10 - 17]	0.13 - 6 [0.5 - 1.4]	<24 hrs	Increasing
Crack Repair	2 - 75 [19 - 33]	***	N/A	<24 hrs	Static
Sealers	1 - 20 [4 - 10]	0.33 - 15 [3 - 5]	N/A	<24 hrs	Increasing
Deck replacement	15 - 50 [27 - 32]	15 - 100 [43 - 53]	N/A	>3 days	Static

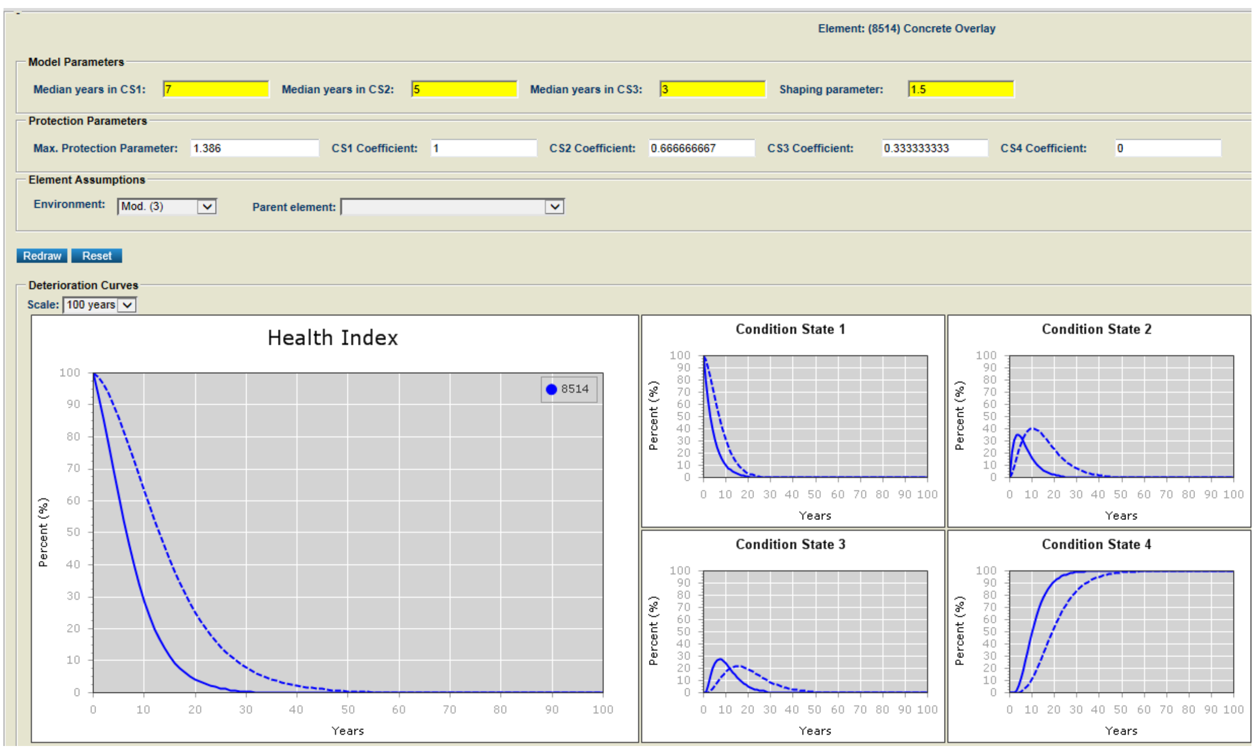
* Ultra high early cement with latex
**High early (Type III) cement with latex
*** Survey respondents did not provide cost estimates

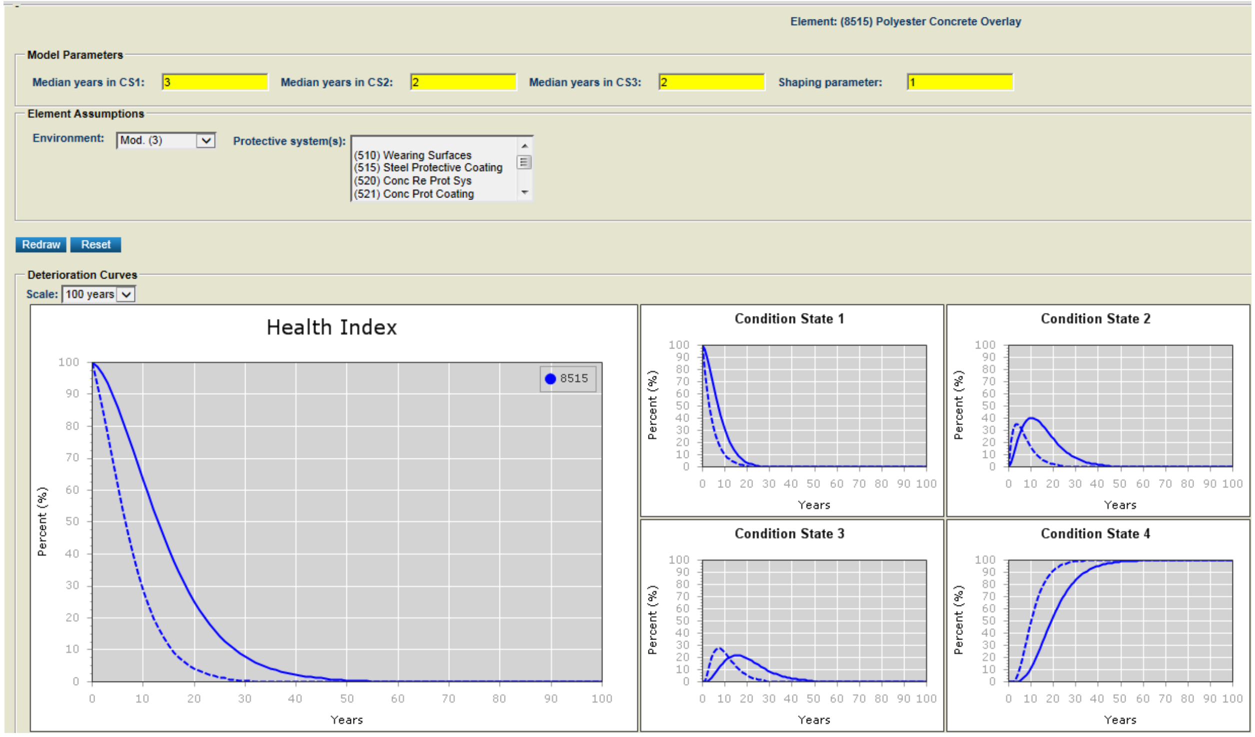
Source MCHRP Project 20-7 Task 234 1

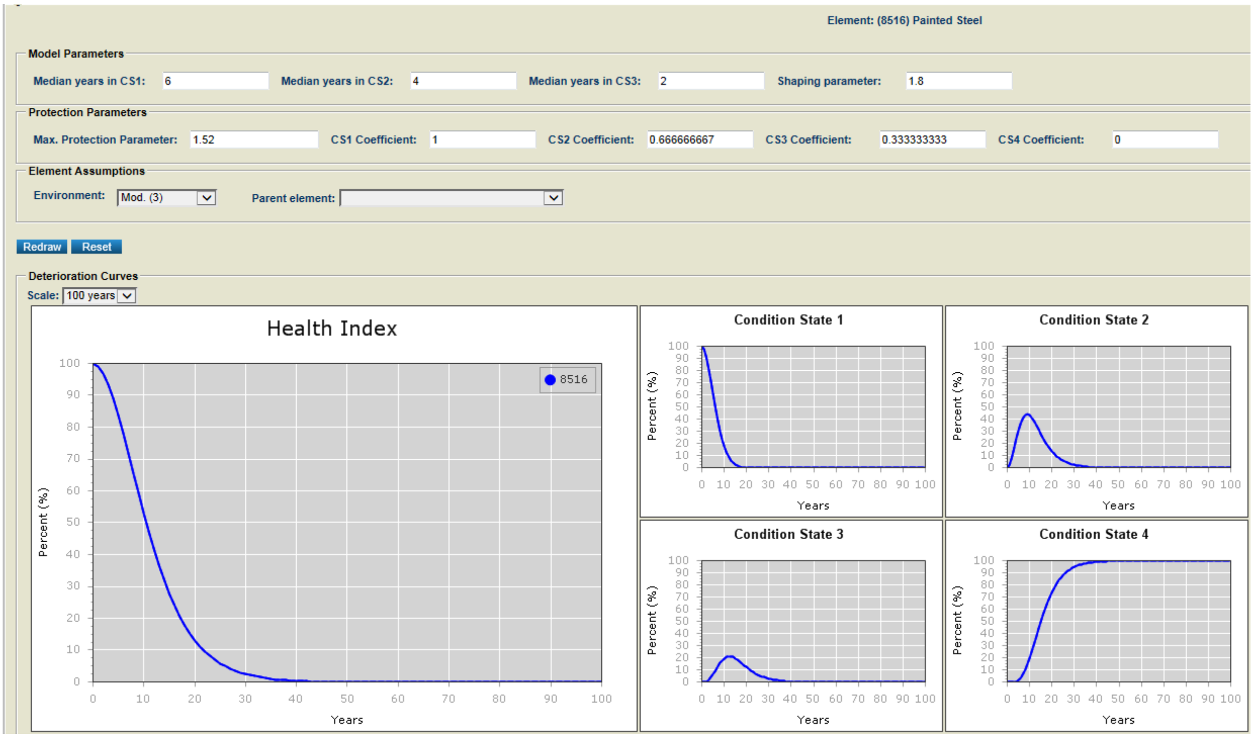

Element: (8511) AC Overlay
Model Parameters
Median years in CS1: 3
Median years in CS2: 2
Median years in CS3: 2
Shaping parameter: 1
Protection Parameters
Max. Protection Parameter: 1.386
CS1 Coefficient: 1
CS2 Coefficient: 0.666666667
CS3 Coefficient: 0.333333333
CS4 Coefficient: 0
Element Assumptions
Environment: Sev. (4)
Parent element:
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8511
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (8512) AC Overlay
Model Parameters
Median years in CS1: 6
Median years in CS2: 4
Median years in CS3: 4
Shaping parameter: 1
Protection Parameters
Max. Protection Parameter: 1.386
CS1 Coefficient: 1
CS2 Coefficient: 0.666666667
CS3 Coefficient: 0.333333333
CS4 Coefficient: 0
Element Assumptions
Environment: Sev. (4)
Parent element:
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8512
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (8513) Thin Polymer Overlay
Model Parameters
Median years in CS1: 5
Median years in CS2: 4
Median years in CS3: 2
Shaping parameter: 1
Protection Parameters
Max. Protection Parameter: 1.386
CS1 Coefficient: 1
CS2 Coefficient: 0.666666667
CS3 Coefficient: 0.333333333
CS4 Coefficient: 0
Element Assumptions
Environment: Sev. (4)
Parent element:
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8513
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (8514) Concrete Overlay
Model Parameters
Median years in CS1: 7
Median years in CS2: 5
Median years in CS3: 3
Shaping parameter: 1.5
Protection Parameters
Max. Protection Parameter: 1.386
CS1 Coefficient: 1
CS2 Coefficient: 0.666666667
CS3 Coefficient: 0.333333333
CS4 Coefficient: 0
Element Assumptions
Environment: Mod. (3)
Parent element:
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8514
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (8515) Polyester Concrete Overlay
Model Parameters
Median years in CS1: 3
Median years in CS2: 2
Median years in CS3: 2
Shaping parameter: 1
Element Assumptions
Environment: Mod. (3)
Protective system(s):
(510) Wearing Surfaces
(515) Steel Protective Coating
(520) Conc Re Prot Sys
(521) Conc Prot Coating
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8515
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4


Element: (8516) Painted Steel
Model Parameters
Median years in CS1: 6
Median years in CS2: 4
Median years in CS3: 2
Shaping parameter: 1.8
Protection Parameters
Max. Protection Parameter: 1.52
CS1 Coefficient: 1
CS2 Coefficient: 0.666666667
CS3 Coefficient: 0.333333333
CS4 Coefficient: 0
Element Assumptions
Environment: Mod. (3)
Parent element:
Redraw
Reset
Deterioration Curves
Scale: 100 years
Health Index
8516
Percent (%)
Years
Condition State 1
Condition State 2
Condition State 3
Condition State 4

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Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 12 (3)

Concrete Deck- Black Bars (Bay/Univ)

Long-Term Optimal Unit Cost($): 2.45

Failure Probability (%): 9.97

Element Failure Unit Costs($)

Agency Cost: ,076,380.25

User Cost: 0.00

Metric Units: sq.m.

English Units: (SF)

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			24.75	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	91.17	8.83	0.00	0.00	0.00	27.94
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	968.46
State: 2 Fair, < 2% Deter		Optimal Percent in State:			32.99	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	91.17	8.83	0.00	0.00	43.73
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	78.95
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	968.46
State: 3 Fair, 2-10% Deter		Optimal Percent in State:			38.62	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	90.57	9.43	0.00	68.42
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	97.21
2	Deep Overlay	349.83	90.00	10.00	0.00	0.00	0.00	377.62
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	968.46
State: 4 Poor, 10-25% Deter		Optimal Percent in State:			3.64	Unit Benefit:		23.27
0	Do Nothing	0.00	0.00	0.00	0.00	89.09	10.91	127.88
>> 1	Shallow Overlay	67.27	60.00	20.00	20.00	0.00	0.00	104.60
2	Deep Overlay	349.83	80.00	20.00	0.00	0.00	0.00	379.45
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	968.46
State: 5 Serious, >25% Deter		Optimal Percent in State:			0.00	Unit Benefit:		102,164.02
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,540.41
>> 1	Shallow Overlay	336.37	50.00	25.00	25.00	0.00	0.00	376.38
2	Deep Overlay	349.83	70.00	30.00	0.00	0.00	0.00	380.96
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	968.46

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Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 13 (3)

Concrete Deck With HMA Overlay- No Membrane (Bay/Univ)

Long-Term Optimal Unit Cost($): 1.14
Failure Probability (%): 9.97

Element Failure Unit Costs($)
Agency Cost: ,076,380.25
User Cost: 0.00

Metric Units: sq.m.
English Units: (SF)

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			6.99	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	88.16	11.84	0.00	0.00	0.00	7.36
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	948.85
State: 2 Fair, <2% Deter		Optimal Percent in State:			23.51	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	94.61	5.39	0.00	0.00	10.46
1	HMA Overlay	67.27	90.00	10.00	0.00	0.00	0.00	74.59
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	948.85
State: 3 Fair, 2-10% Deter		Optimal Percent in State:			22.90	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	92.59	7.41	0.00	20.13
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	72.77
2	Deep Overlay	349.83	90.00	10.00	0.00	0.00	0.00	357.10
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	948.85
State: 4 Poor, 10-25% Deter		Optimal Percent in State:			44.90	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	96.22	3.78	33.69
1	Shallow Overlay	67.27	60.00	20.00	20.00	0.00	0.00	77.34
2	Deep Overlay	349.83	80.00	20.00	0.00	0.00	0.00	357.44
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	948.85
State: 5 Serious, >25% Deter		Optimal Percent in State:			1.70	Unit Benefit:		102,206.52
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,284.64
>> 1	Shallow Overlay	67.27	50.00	25.00	25.00	0.00	0.00	78.13
2	Deep Overlay	349.83	70.00	30.00	0.00	0.00	0.00	357.86
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	948.85

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Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 14 (3)

Concrete Deck With HMA Overlay and Membrane (Bay/Univ)

Long-Term Optimal Unit Cost($): 1.37
Failure Probability (%): 9.97

Element Failure Unit Costs($)
Agency Cost: ,076,380.25
User Cost: 0.00

Metric Units: sq.m.
English Units: (SF)

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			6.92	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	88.16	11.84	0.00	0.00	0.00	8.84
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	950.26
State: 2 Fair, <2% Deter		Optimal Percent in State:			23.39	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	94.61	5.39	0.00	0.00	12.57
1	Shallow Overlay	80.73	90.00	10.00	0.00	0.00	0.00	89.57
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	950.31
State: 3 Fair, 2-10% Deter		Optimal Percent in State:			22.97	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	92.59	7.41	0.00	24.19
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	74.42
2	Deep Ovly	363.28	90.00	10.00	0.00	0.00	0.00	372.01
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	950.26
State: 4 Poor, 10-25% Deter		Optimal Percent in State:			45.03	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	96.22	3.78	40.47
1	Shallow Overlay	80.73	60.00	20.00	20.00	0.00	0.00	92.83
2	Deep Overlay	363.28	80.00	20.00	0.00	0.00	0.00	372.42
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	950.26
State: 5 Serious, >25% Deter		Optimal Percent in State:			1.70	Unit Benefit:		102,204.27
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,298.13
>> 1	Shallow Overlay	80.73	50.00	25.00	25.00	0.00	0.00	93.86
2	Deep Overlay	363.28	70.00	30.00	0.00	0.00	0.00	372.93
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	950.26

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Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 18 (3)

Concrete Deck With Thin Epoxy Overlay (Bay/Univ)

Long-Term Optimal Unit Cost($): 1.54

Failure Probability (%): 9.97

Element Failure Unit Costs($)

Agency Cost: ,076,380.25

User Cost: 0.00

Metric Units: sq.m.

English Units: (SF)

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			9.41	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	89.89	10.11	0.00	0.00	0.00	10.69
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	952.02
State: 2 Fair, <2% deter		Optimal Percent in State:			18.22	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	92.17	7.83	0.00	0.00	15.96
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	61.52
2	Replace	941.84	100.00	0.00	0.00	0.00	0.00	952.02
State: 3 Fair, 2-10% deter		Optimal Percent in State:			28.39	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	26.12
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	76.77
2	Deep Overlay	363.28	90.00	10.00	0.00	0.00	0.00	373.90
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	952.02
State: 4 Poor, 10-25% deter		Optimal Percent in State:			42.08	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	45.57
1	Shallow Overlay	80.73	60.00	20.00	20.00	0.00	0.00	94.85
2	Deep Overlay	3,983.33	80.00	20.00	0.00	0.00	0.00	3,994.51
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	952.02
State: 5 Serious, >25% deter		Optimal Percent in State:			1.90	Unit Benefit:		102,203.99
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,299.83
>> 1	Shallow Overlay	80.73	50.00	25.00	25.00	0.00	0.00	95.84
2	Deep Overlay	363.28	70.00	30.00	0.00	0.00	0.00	374.97
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	952.02

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Preservation Model Details

Element (Environment): 22 (3)

Concrete Deck With Rigid Overlay (Bay/Univ)

Metric Units: sq.m.
English Units: (SF)

Long-Term Optimal Unit Cost($): 2.52
Failure Probability (%): 9.97
Element Failure Unit Costs($)
Agency Cost: ,076,380.25
User Cost: 0.00

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			18.50	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	89.89	10.11	0.00	0.00	0.00	27.44
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	967.98
State: 2 Fair, <2% deter		Optimal Percent in State:			31.85	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	92.17	7.83	0.00	0.00	40.98
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	78.32
2	Replace	941.84	100.00	0.00	0.00	0.00	0.00	967.98
State: 3 Fair, 2-10% deter		Optimal Percent in State:			46.53	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	67.07
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	95.87
2	Deep Overlay	370.06	90.00	10.00	0.00	0.00	0.00	397.32
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	967.98
State: 4 Poor, 10-25% deter		Optimal Percent in State:			3.12	Unit Benefit:		5.56
0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	122.55
>> 1	Shallow Overlay	80.73	60.00	20.00	20.00	0.00	0.00	117.00
2	Deep Overlay	370.06	80.00	20.00	0.00	0.00	0.00	398.78
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	967.98
State: 5 Serious, >25% deter		Optimal Percent in State:			0.00	Unit Benefit:		102,164.20
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,539.36
>> 1	Shallow Overlay	336.37	50.00	25.00	25.00	0.00	0.00	375.17
2	Deep Overlay	370.06	70.00	30.00	0.00	0.00	0.00	400.06
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	967.98

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Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 23 (3)

Concrete Deck- Rigid Deep Overlay (Bay/Univ)

Metric Units: sq.m.
English Units: (SF)

Long-Term Optimal Unit Cost($): 3.84
Failure Probability (%): 6.70

Element Failure Unit Costs($)
Agency Cost: -3.00
User Cost: 0.00

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			35.27	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	89.89	10.11	0.00	0.00	0.00	0.00
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	941.84
State: 2 Fair, <2% deter		Optimal Percent in State:			58.79	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	89.89	10.11	0.00	0.00	0.00
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	50.81
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	941.84
State: 3 Fair, 2-10% deter		Optimal Percent in State:			5.94	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	0.00
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	64.58
2	Deep Overlay	370.06	90.00	10.00	0.00	0.00	0.00	370.06
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	941.84
State: 4 Poor, 10-25% deter		Optimal Percent in State:			0.00	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	0.00
1	Shallow Overlay	940.80	60.00	20.00	20.00	0.00	0.00	940.80
2	Deep Overlay	370.06	80.00	20.00	0.00	0.00	0.00	370.06
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	941.84
State: 5 Serious, >25% deter		Optimal Percent in State:			0.00	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	0.00	93.30	0.00
1	Shallow Overlay	336.37	50.00	25.00	25.00	0.00	0.00	336.37
2	Deep Overlay	370.06	70.00	30.00	0.00	0.00	0.00	370.06
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	941.84

Preservation Model Details

Element (Environment): 24 (3)

Concrete Deck With Stainless Steel Bars (Bay/Univ)

Long-Term Optimal Unit Cost($): 0.80

Failure Probability (%): 9.97

Element Failure Unit Costs($)

Agency Cost: ,076,380.25

User Cost: 0.00

Metric Units: sq.m.

English Units: (SF)

Action (>> = recommended)			Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State:	1	Good	Optimal Percent in State:			21.85	Unit Benefit:		0.00
>>	0	Do Nothing	0.00	97.27	2.73	0.00	0.00	0.00	2.56
	1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State:	2	Fair, <2% deter	Optimal Percent in State:			32.77	Unit Benefit:		0.00
>>	0	Do Nothing	0.00	0.00	97.27	2.73	0.00	0.00	7.24
	1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	53.72
	2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State:	3	Fair, 2-10% deter	Optimal Percent in State:			17.80	Unit Benefit:		0.00
>>	0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	20.47
	1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	68.80
	2	Shallow Overlay	349.83	90.00	10.00	0.00	0.00	0.00	352.66
	3	Relace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State:	4	Poor, 10-25% deter	Optimal Percent in State:			26.39	Unit Benefit:		0.00
>>	0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	35.70
	1	Shallow Overlay	67.27	60.00	20.00	20.00	0.00	0.00	74.01
	2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.91
	3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State:	5	Serious, >25% deter	Optimal Percent in State:			1.19	Unit Benefit:		102,206.95
	0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,282.03
>>	1	Shallow Overlay	67.27	50.00	25.00	25.00	0.00	0.00	75.09
	2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.94
	3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28

Michael Baker International

Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 25 (3)

Concrete Deck With Nonmetallic Bars (Bay/Univ)

Metric Units: sq.m.
English Units: (SF)

Long-Term Optimal Unit Cost($): 0.80
Failure Probability (%): 9.97
Element Failure Unit Costs($)
Agency Cost: ,076,380.25
User Cost: 0.00

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			21.85	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	97.27	2.73	0.00	0.00	0.00	2.56
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 2 Fair, <2% deter		Optimal Percent in State:			32.77	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	97.27	2.73	0.00	0.00	7.24
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	53.72
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 3 Fair, 2-10% deter		Optimal Percent in State:			17.80	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	20.47
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	68.80
2	Shallow Overlay	349.83	90.00	10.00	0.00	0.00	0.00	352.66
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 4 Poor, 10-25% deter		Optimal Percent in State:			26.39	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	35.70
1	Shallow Overlay	67.27	60.00	20.00	20.00	0.00	0.00	74.01
2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.91
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 5 Distress > 25%		Optimal Percent in State:			1.19	Unit Benefit:		102,206.95
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,282.03
>> 1	Shallow Overlay	67.27	50.00	25.00	25.00	0.00	0.00	75.09
2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.94
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28

Michael Baker International

Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 26 (3)

Concrete Deck With Coated Bars (Bay/Univ)

Metric Units: sq.m.
English Units: (SF)

Long-Term Optimal Unit Cost($): 0.80
Failure Probability (%): 9.97

Element Failure Unit Costs($)
Agency Cost: ,076,380.25
User Cost: 0.00

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			21.85	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	97.27	2.73	0.00	0.00	0.00	2.56
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 2 Fair, <2% deter		Optimal Percent in State:			32.77	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	97.27	2.73	0.00	0.00	7.24
1	Epoxy Overlay	50.81	90.00	10.00	0.00	0.00	0.00	53.72
2	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 3 Fair, 2-10% deter		Optimal Percent in State:			17.80	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	20.47
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	68.80
2	Shallow Overlay	349.83	90.00	10.00	0.00	0.00	0.00	352.66
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 4 Poor, 10-25% deter		Optimal Percent in State:			26.39	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	35.70
1	Shallow Overlay	67.27	60.00	20.00	20.00	0.00	0.00	74.01
2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.91
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 5 Serious, >25% deter		Optimal Percent in State:			1.19	Unit Benefit:		102,206.95
0	Do Nothing	0.00	0.00	0.00	0.00	0.00	90.03	102,282.03
>> 1	Shallow Overlay	67.27	50.00	25.00	25.00	0.00	0.00	75.09
2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.94
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28

Michael Baker International

Asset Management
Bridge Management

Preservation Model Details

Element (Environment): 27 (3)

Concrete Deck With Cathodic Protection (Bay/Univ)

Long-Term Optimal Unit Cost($): 0.80

Failure Probability (%): 9.97

Element Failure Unit Costs($)

Agency Cost: ,076,380.25

User Cost: 0.00

Metric Units: sq.m.

English Units: (SF)

Action (>> = recommended)		Direct Unit Cost($)	Transition Probabilities (%) 1	2	3	4	5	Long-Term Cost($)
State: 1 Good		Optimal Percent in State:			21.85	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	97.27	2.73	0.00	0.00	0.00	2.56
1	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28
State: 2 Fair, <2% deter		Optimal Percent in State:			32.77	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	97.27	2.73	0.00	0.00	7.24
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State: 3 Fair, 2-10% deter		Optimal Percent in State:			17.80	Unit Benefit:		0.00
>> 0	Do Nothing	0.00	0.00	0.00	93.30	6.70	0.00	20.47
1	Patch Deck	64.58	60.00	40.00	0.00	0.00	0.00	68.80
2	Shallow Overlay	349.83	90.00	10.00	0.00	0.00	0.00	352.66
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>> 0	Do Nothing	0.00	0.00	0.00	0.00	95.48	4.52	35.70
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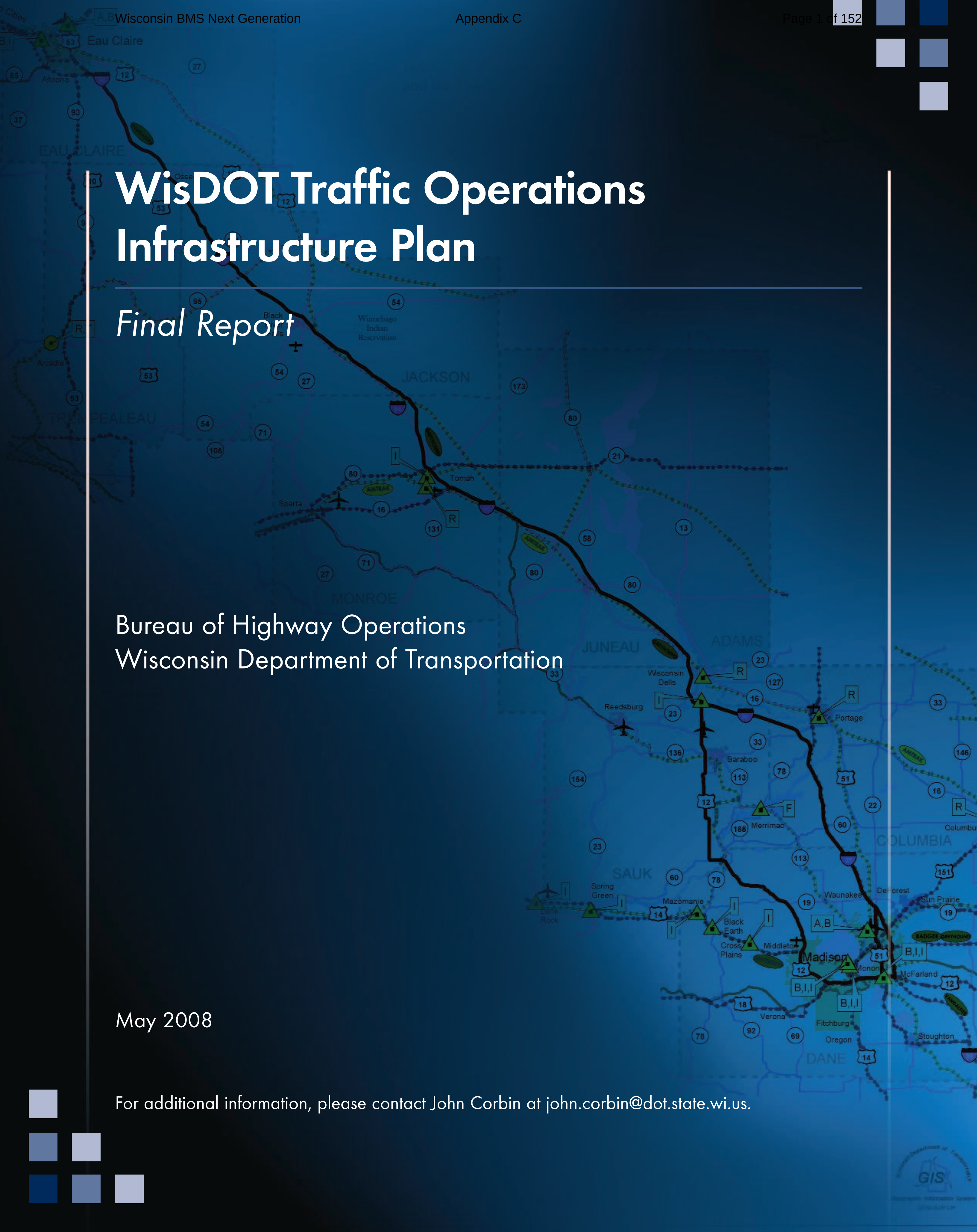
>> 1	Shallow Overlay	67.27	50.00	25.00	25.00	0.00	0.00	75.09
2	Deep Overlay	336.37	75.00	25.00	0.00	0.00	0.00	339.94
3	Replace Deck	941.84	100.00	0.00	0.00	0.00	0.00	944.28

WisDOT Traffic Operations Infrastructure Plan

Final Report

Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008



For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

final report

WisDOT Traffic Operations Infrastructure Plan

prepared for

Bureau of Highway Operations Wisconsin Department of Transportation

date

May 2008

A Reader's Guide to the Traffic Operations Infrastructure Plan

This report is the central document for the *Wisconsin Traffic Operations Infrastructure Plan* (TOIP). The TOIP, a long-range planning effort undertaken by the Bureau of Highway Operations, outlines Wisconsin's statewide traffic operations infrastructure needs and opportunities, culminating in a series of operational technology recommendations and associated costs. The TOIP is intended to summarize recommendations in a format that is intuitive and understandable.

Recommendations are given on a statewide level and are further broken out by corridor (corridor limits are based on the 2030 Long-Range Plan corridor definitions).

Five important Appendices are associated with this report. Each offers greater detail into the recommendations; as well as details on the methodology itself and resources for future technologies to enhance operations. The Appendices are:

- **Appendix A –** Traffic Management and Surveillance Operations Infrastructure Plans and Cost Estimations;
- **Appendix B –** Traveler Information Operations Infrastructure Plans and Cost Estimations;
- **Appendix C –** Signal Systems Operations Infrastructure Plans and Cost Estimations;
- **Appendix D –** TOIP Data Processing; and
- **Appendix E –** Technology Scan.

Given that this report and the accompanying Appendices are lengthy, the following tips are offered for navigating this document:

- If you are interested in the fullest possible understanding of the TOIP methodology and recommendations, read the entire document then visit Appendices A, B, and C for greater detail on specific corridor recommendations.
- If you are interested in the overall statewide recommendations and associated costs, go directly to Section 3.
- If you are interested in the recommendations for a specific corridor or roadway, visit Section 2.5.1 to learn how to read the maps, identify the corridor from Table 3.1, and turn directly to the 2-page corridor description and associated recommendations map (you can check the List of Maps Table of Contents page to find the page number for the maps). Appendices A,B, and C will provide greater detail on specific corridor recommendations.
- If you are interested in how the TOIP methodology works, see Section 2.
- If you are interested in the recommendations surrounding a particular functional area, such as traffic management, traveler information, or signal systems, visit the appropriate Appendix listed above.

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Priority and Emerging Priority Corridors

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For Corridor details, including primary roadways and endpoints, please see Table 3.1

1.0 Introduction and Overview

The Wisconsin Department of Transportation (WisDOT) was an early adopter of transportation operations and Intelligent Transportation Systems (ITS); participating in such key ITS deployments as Milwaukee's Monitor system and the Gary-Chicago-Milwaukee ITS Priority Corridor. In recent years, however, operations and physical highway improvements have been viewed by some as competitive, when in reality they are complementary strategies that together can improve service to the public. This has resulted in a scarcity of funds that has limited the deployment of ITS and related operations projects in Wisconsin.

In July 2006, the WisDOT initiated a Traffic Operations Infrastructure Plan (TOIP) with two goals:

1. Develop a methodology and associated tool that will enable the Bureau of Highway Operation (BHO) to evaluate operational projects in the same manner as traditional infrastructure projects; and
2. Integrate operations into the WisDOT planning process.

These goals presented several challenges. Some of the concerns that needed to be addressed are listed below.

- There is a division of operational responsibilities between various parts of the WisDOT organization, as well as county and local agencies, that can inhibit consensus on a clear direction for operations.
- Planning agencies and departments have traditionally been concerned with allocation of capital funds and infrequently incorporate consideration of life-cycle operations, maintenance, and component replacement cost consideration.
- Operational issues have received limited attention in corridor planning activities such as feasibility studies, Environmental Analyses (EA), and Environmental Impact Studies (EIS).
- The ITS architecture process is primarily a system engineering process and, as such, has not yet been effectively integrated with the planning process in most corridors and regions.
- Much of the planning for ITS in Wisconsin and other states is based upon a consensus definition of preference and needs of highway operations and public safety staff. There has generally been a lack of "pavement equivalent" highway system performance measures to enable equivalent consideration of traffic operations and traffic management infrastructure alongside more conventional highway infrastructure investments.

It should be noted that these concerns are not unique to WisDOT and present significant issues to a large number of transportation organizations around the country.

WisDOT's planning processes provide a framework designed to incorporate all types of transportation improvements, as well as land use and environmental concerns. Integration with the framework, however, requires a solution where:

- Feasible and affordable alternatives are identified;
- Analytical methods and tools are available to evaluate the alternatives; and
- A mechanism is available to facilitate meaningful participation by those responsible for operational activities, including planning, design, implementation, operations, and maintenance.

For the 2030 update of the Wisconsin Long-Range Plan, WisDOT adopted a strategic corridor approach. This approach segmented the entire state trunkline system into 37 corridors, referred to as the WisDOT 2030 Multimodal Corridor network. These corridors include both interstate and parallel arterial segments and provide a comprehensive approach to transportation planning that recognizes not only the main transportation route along a segment but ancillary factors such as land use, traffic generators and others. This unique approach provided an opportunity for the traffic TOIP team to include operations as a integral part in developing solutions for these corridors in the out years of the transportation plan. The traffic TOIP effort, therefore, decided early on to adopt the WisDOT 2030 Multimodal Corridor network as the basis for discussion and planning of operational enhancements.

In order to address these challenges, WisDOT, developed the TOIP methodology and associate plan for traffic operations infrastructure investment. This methodology provides a quantifiable approach which identifies appropriate operations solutions/projects that could be developed for any given corridor within the WisDOT system. It serves as the basis for communication of operations traffic TOIP results and integration into the WisDOT planning process.

As noted earlier, the TOIP provides operations technology deployment recommendations. These recommendations will fall around three functional areas:

1. Ramp control and surveillance;
2. Travel warning and information systems; and
3. Traffic signal systems.

Finally, the TOIP methodology provides a mechanism by which, these recommendations can be integrated into the WisDOT project planning and project delivery processes.

This report details all aspects of the TOIP. Section 1.0 provides and overview of this project and sets the context. Section 2.0 describes the methodology; its development and overall process. Section 3.0 describes the results of the methodology, with detailed operational recommendations for all 37 corridors. This section also includes detailed cost implication of the plan, as well as operational recommendations by metro areas around the State. Finally, Section 4.0 discusses how the TOIP should be integrated into WisDOT planning and programming processes. The report also includes three appendices which provide details behind the functional recommendations provided as a summary in Section 3.0, listed below.

- **Appendix A –** Traffic Management and Surveillance Operations Infrastructure Plans and Cost Estimations;
- **Appendix B –** Traveler Information Operations Infrastructure Plans and Cost Estimations; and
- **Appendix C –** Signal Systems Operations Infrastructure Plans and Cost Estimations.

The final two appendices provide more details on the methodology itself as well as a resource for future technologies to enhance operations.

- **Appendix D –** TOIP Data Processing; and
- **Appendix E –** Technology Scan.

2.0 Approach and Methodology

This section outlines the TOIP methodology. It begins with an overview of goals of the methodology, followed by a detailed explanation of the methodology's criteria, thresholds, and recommendations. A discussion of data sources and data processing techniques is then followed by a discussion of how the final recommendations are presented.

2.1 METHODOLOGY DEVELOPMENT

The ultimate goal of the TOIP was the development of a methodology which would evaluate operational projects in the same manner as traditional infrastructure projects while integrating operations into the overall WisDOT planning process. There were number of characteristics that the methodology had to adopt.

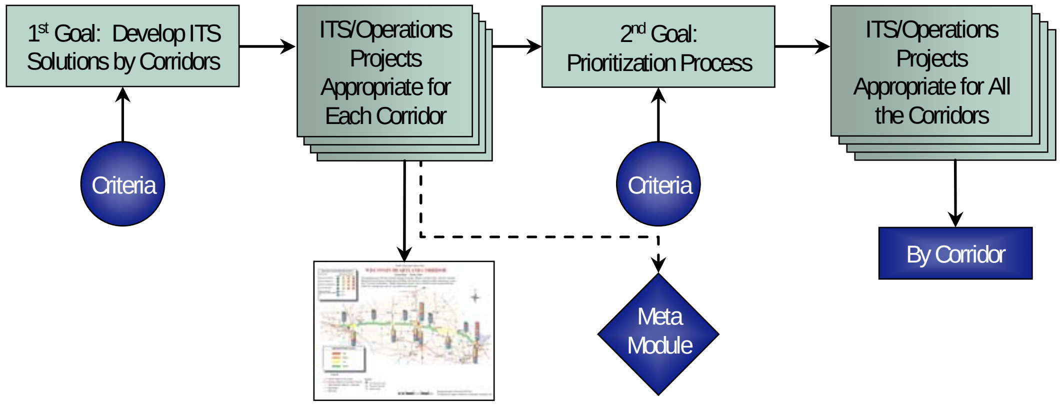
First and foremost the TOIP had to be based on traditional WisDOT planning perspectives and processes. It had to speak to departments within WisDOT Central Office, as well as the Region Planning staff. The TOIP also needed to utilize as many current WisDOT processes as possible. There was a strong direction not to "invent the wheel" and leverage appropriate current processes.

To ensure these overall goals were met, various WisDOT stakeholders were contacted as part of the methodology's development and their input was requested. Staff from WisDOT both Central Office and all five regions were contacted. WisDOT offices contacted included the Bureau of Planning, Programming and Budget, the Division of Transportation Investment Management, and Traffic.

Overall, all of the staff contacted voiced a strong support for operations/ITS. There was unanimous support for a mechanism by which operations/ITS needs can be identified across the State. Furthermore, most staff felt that operations would be more easily integrated if the TOIP based its approach on planning processes and mechanisms already in place. There also was strong support for the TOIP to provide a prioritized list of where operational improvements were most needed across the State. Finally, there was a strong feeling that the TOIP should not create a mechanism which prolongs the project development timeline. This input translated into two main goals for the TOIP which are illustrated in Figure 2.1.

The figure outlines two goals which translate into two separate but related methodologies. The first methodology, has a goal to develop ITS solutions by corridors (ITS Solutions Methodology). The goal of the second methodology (Prioritization Methodology) is to develop a prioritized list by corridors of the ITS solutions developed in the first methodology. Please note, that criteria drive both processes as inputs. These criteria and the associated thresholds will be discussed in detail later in this section.

Figure 2.1 Methodology Goals



Two related planning efforts also came to light during the outreach to the WisDOT stakeholders. The first was the update of the statewide long-range plan (LRP) that was being updated concurrently to the developed of this project. The LRP update based its recommendations on the Multimodal Corridor concept described above. As mentioned earlier, it was decided that the TOIP methodology would be applied at the WisDOT 2030 Multimodal Corridor level to maximize the effective communication of results and facilitate integration with the overall WisDOT planning process, though it could easily be adapted to operate at different scales. The 37 corridors that would form the baseline of the update to the plan are presented in Table 2.1.

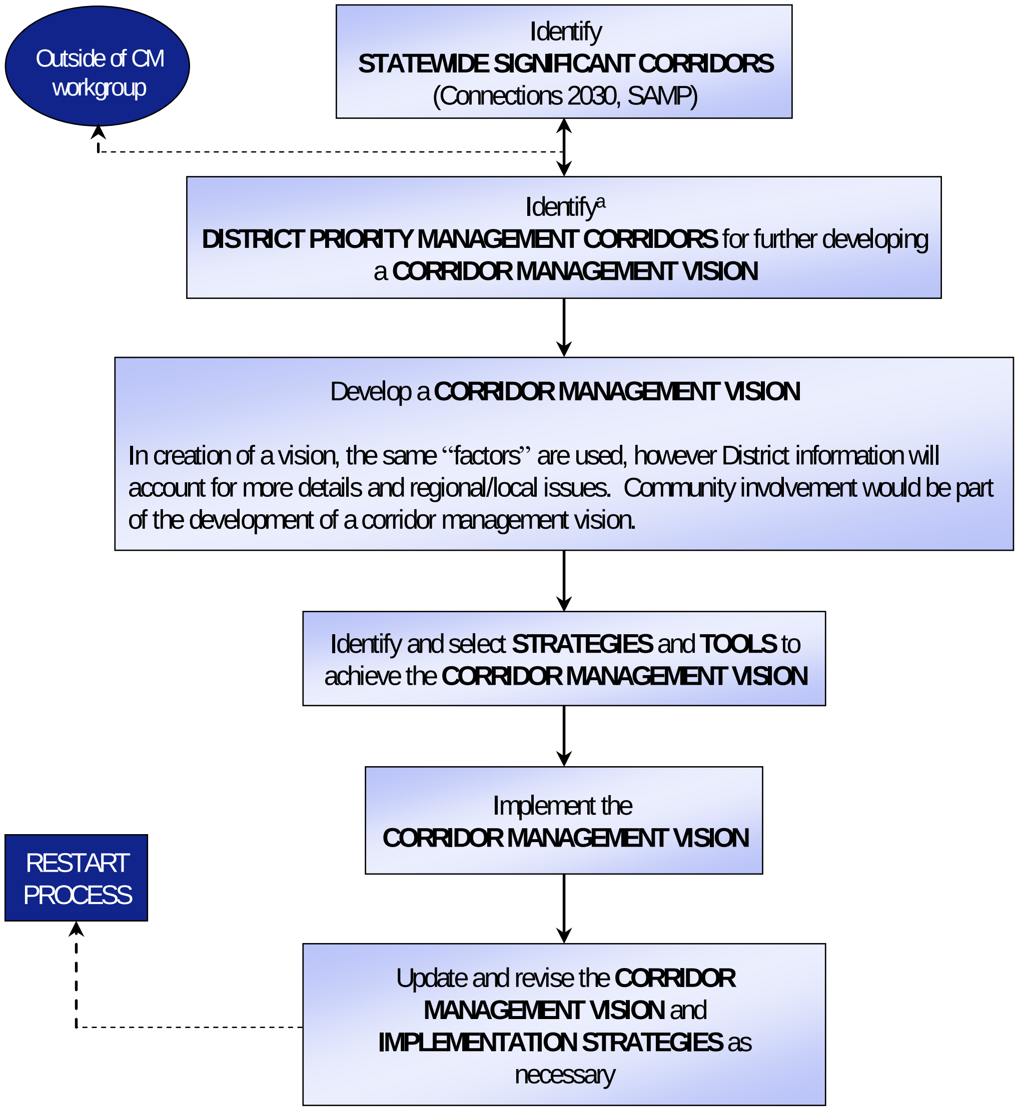
The second related planning effort was the already established WisDOT Corridor Management Process. This process, developed by WisDOT staff, was meant to change the mindset of WisDOT planning, from a project only perspective to one that provides "vision" of a corridor, as well as provide a coordinated approach to planning, development, and operations that considers the system from a "corridor" perspective. Included within this process is a consistent and coordinated application of various activities, strategies, and tools to achieve a corridor management vision, as well as provide the "umbrella" process under which decisions are made. The basic flow of the corridor planning process is shown in Figure 2.2.

The TOIP is envisioned to interface with this process in two distinct ways. The first would be to take relevant criteria from this process and utilized it in the final TOIP methodology. These criteria are established by WisDOT and are detailed in the "Identify Region Priority Management Corridors for further developing a Corridor Management Vision" part of the process. The TOIP also would provide input into the "Develop a Corridor Management Vision" stage of the process by providing recommended operations/ITS solutions or projects by corridor, as well as providing an overall statewide operations/ITS prioritization, again by corridor.

Table 2.1 Connections 2030 Corridors

Corridor	End Points	Corridor	End Points
84th Division Railsplitters	Beaver Dam – Port Washington	Marshfield – Rapids	Stevens Point – Abbotsford
Badger State	Eau Claire – Madison	Mississippi River	Dubuque – Twin Cities
Capitol	Milwaukee – Madison	North Country	Iron Mountain – Twin Cities
Cheese Country	Dubuque – Janesville/ Beloit Rock County	Northern Lakes	Minneapolis/St. Paul
Chippewa Valley	Eau Claire – Twin Cities	Northwoods Connection	Oshkosh – Rhinelander
Cornish Heritage	Dubuque – Madison	Peace Memorial	Chippewa Valley – Duluth/ Superior
Coulee Country	La Crosse – Tomah	Peshtigo Fire Memorial	Green Bay – Menominee County, Michigan
Cranberry Country	Tomah – Oshkosh	POW/MIA Remembrance	Abbotsford – Ashland
Door Peninsula	Green Bay – Door County	Rock River	Janesville/Beloit – Oshkosh
Fox Valley	Milwaukee – Green Bay	South Central Connection	Madison – Beloit – Chicago
Frank Lloyd Wright	La Crosse – Madison	Southern Tier	Janesville/Beloit-Racine/ Kenosha
French Fur Trade	Prairie du Chien – Dodgeville	Titletown	Milwaukee – Green Bay
Geneva Lakes	Madison – Lake Geneva – Chicago	Trempealeau River	La Crosse – Eau Claire
Glacial Planes	Janesville/Beloit – Milwaukee	Waukesha Connection	Waukesha – Washington County
Hiawatha	Milwaukee to Chicago	Wild Goose	Madison – Fox River Valley
Kettle Country	Fond du Lac – Sheboygan	Wisconsin Heartland	Eau Claire to Green Bay
Lake Superior	Duluth/Superior – Ironwood, Michigan	Wisconsin River	Madison – Ironwood, MI
Lake To Lake	Fox Cities to Manitowoc/ Two Rivers	Wolf/Waupaca Rivers	Stevens Point to Fox Cities
Lumber Country Heritage	Green Bay – Iron Mountain		

Figure 2.2 Corridor Management Process Flow Chart



[a] This includes both quantitative and qualitative analysis.

Note: Corridors not identified as a "Priority Management Corridor" would continue being "managed," however, activities might be less rigorous and more administrative in scope.

2.2 Methodology Overview

Based on the goals and issues detailed in the previous sections as inputs, the TOIP was developed and is discussed in detail in this section. The ultimate goal was to provide an understandable, uniform, and data-driven set of initial operations technology deployments and strategies for the WisDOT 2030 Multimodal Corridors. The TOIP methodology is generally applied at the WisDOT 2030 Multimodal Corridor level to maximize the effective communication of results and facilitate integration with the overall WisDOT planning process, though it can easily be adapted to operate at different scales.

The units of analysis within the TOIP methodology are individual roadway segments. In order for the analysis to be useful, the roadway segments used for analysis have relatively homogenous characteristics in terms of traffic volume, roadway capacity, and abutting land use. Urban freeway segments generally are in the range of 5 to 15 miles, while rural segments are longer, from 15 up to as many as 50 miles. Arterial segments are generally somewhat shorter, particularly in urban areas. It is important to note that the traffic TOIP methodology factors roadway type into the results. Different thresholds are applied and technology recommendations vary for the six roadway types, which include: urban interstate; urban expressway; urban other; rural interstate; rural expressway; and rural other.

One of the principal traffic TOIP results is a deployment density class (DDC) recommendation for every considered length of roadway. This recommendation is given in the form of a baseline, low, medium, or high designation. This creates a uniform standard for operations technology recommendations throughout the State in an easily communicable and understandable format. Following designation, roadways are paired with operations technology solution sets.

The key elements of the traffic TOIP methodology necessary to reach a DDC recommendation are introduced below. Greater detail follows in later sections.

- **Criteria –** Criteria are data values selected for input into the traffic TOIP methodology. They are focused on Mobility, Safety, and Environmental Conditions. Criteria are the drivers of the traffic TOIP methodology.
- **Tiers –** Tiers are developed to group roadways by the level of recommended operations technology deployment. They include baseline (requiring minimal deployment), low (requiring low levels of deployment), medium (requiring a moderate level of deployment, frequently found in smaller urban areas and on the outskirts of larger urban areas), and high (requiring high levels of deployment, generally found in the most heavily trafficked roadways in Wisconsin). Threshold values determine which tier a length of roadway falls into for a given criterion.
- **Thresholds –** Thresholds are applied to the criteria in order to match them with tiers. For example, threshold levels for Average Daily Traffic (ADT) were determined such that a value of below 7,500 ADT/Lane would place it in a baseline tier, while a value of between 7,500 and 15,000 would place it in a low tier. The tier grouping of each criterion is a major input into the scoring.
- **Scoring –** Points are given for the results of each criterion. If the criterion falls into the baseline tier, zero points are awarded the segment. Low-, medium-, and high-tier designations result in scores of one, three, and five

respectively. Once the scoring is complete, the inputs go through a weighting process before the final results are determined.

- **Weighting –** Weighting prioritizes the selected criteria based on their importance as a driver of operations technology deployment. Weights were selected by WisDOT stakeholders and are applied to the scoring for each criterion, resulting in a final value which determines the DDC of the segment.
- **Deployment Density Classes –** DDC match the tiers described earlier (baseline, low, medium, high), but reflect the overall score of a roadway segment rather than just one criteria. The scoring breaks for DDCs are as follows:
  - Baseline – Below 92.96;
  - Low – From 92.96 to 158.1;
  - Medium – From 158.2 to 224.21; and
  - High – Greater than 224.21.

This result is then used to identify the package of operational solutions appropriate to the segment. Figure 2.3 offers a sample of the TOIP methodology to demonstrate how the pieces fit together.

Figure 2.3 Methodology Approach

It should be noted, that the data sources to exercise the TOIP methodology are discussed in detail in Section 2.3 of this report, with additional calculation information found in Appendix D. For a complete and detailed explanation of the methodology, please see Figure 2.7.

2.2.1 Criteria

Criteria were developed as inputs into the traffic TOIP methodology. From an initial list of 42 possible criteria, 10 criteria were chosen by the WisDOT stakeholders. The final 10 criteria were selected based on their fulfillment of the following standards:

- Consistency with the criteria used in the corridor-level planning and other WisDOT planning efforts;
- Ability to realistically measure the effectiveness of alternatives;
- Allowance of operational alternatives to be compared with each other and with other types of improvements;
- Availability in a reliable, quality controlled and regularly updated format; and
- Ability to be easily summarized for presentation to decision-makers and the public.

The selected criteria were grouped into three categories: Mobility, Safety, and Environmental Conditions. Following the determination of the finalized criteria, WisDOT stakeholders assigned a relative weight to be applied to each criterion in the traffic operations infrastructure plan methodology. The criteria, along with their weight, are shown in Table 2.2. Please note, the main criteria weights sum to 100, while the sub criteria weights also sum to 100. This approach matches the WisDOT Corridor Management process.

Table 2.2 Criteria and Weighting

Criteria	Weight
Mobility	50%
ADT Base Year	10%
ADT Forecast Year	7%
HC ADT Base Year	4%
Peak-Hour V/C – LOS	12%
Congestion Forecast	12%
Safety	40%
Crash Rate	15%
Crash Severity	13%
Weather Index	9%
Environmental Conditions	10%
ADT Growth	7%
Event/Traffic Generators	11%

Note: Acronyms: ADT = Average Daily Traffic, HC = Heavy Class, V/C = Volume to Capacity Ratio, LOS = Level of Service.

It is important to note that there are three operationally centric criteria utilized in the TOIP methodology. This was done to add more operational sensitivity to the decision-making process. The three are Peak-Hour Volume-to-Capacity Ratio, Impacts of Weather, and Event/Traffic Generators. All criteria utilize accepted WisDOT data sources (details can be found in Section 2.3) and of the inclusion of these comprehensive key features is one of the elements which sets this planning effort ahead of past efforts across the country to integrate operations into planning.

2.2.2 Thresholds

Thresholds are used to group the criteria values for a given segment of roadway into a tier. Several sources were considered when developing the threshold values. AASHTO standards were utilized for Peak-Hour V/C and Congestion Forecast. Distribution of crash rates around the statewide median was used to develop thresholds for Crash Rates and Crash Severity. For others, a logical review of the distribution patterns was necessary to develop meaningful Thresholds, all of which are displayed in Table 2.3. As mentioned earlier, thresholds are applied differently based on roadway classification.

Table 2.3 Thresholds

	Urban			Rural		
Tier	**Interstate**	**Expressway**	**Other**	**Interstate**	**Expressway**	**Other**
ADT Base Year (ADT/Lane)						
1	< 7,500	< 7,500	< 7,500	< 7,500	< 7,500	< 7,500
2	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000
3	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500
4	> 22,500	> 22,500	> 22,500	> 22,500	> 22,500	> 22,500
ADT Forecast Year (ADT/Lane)						
1	< 7,500	< 7,500	< 7,500	< 7,500	< 7,500	< 7,500
2	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000	7,500 to 15,000
3	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500	15,001 to 22,500
4	> 22,500	> 22,500	> 22,500	> 22,500	> 22,500	> 22,500
Growth Rate						
1	<20%	<20%	<20%	<20%	<20%	<20%
2	20% to 35%	20% to 35%	20% to 35%	20% to 35%	20% to 35%	20% to 35%
3	36% to 50%	36% to 50%	36% to 50%	36% to 50%	36% to 50%	36% to 50%
4	> 50%	> 50%	> 50%	> 50%	> 50%	> 50%
HC ADT Base Year						
1	<4%	<4%	<4%	<6%	<6%	<6%
2	4% to 8%	4% to 8%	4% to 8%	6% to 10%	6% to 10%	6% to 10%
2	9% to 11%	9% to 11%	9% to 11%	11% to 13%	11% to 13%	11% to 13%
4	>11%	>11%	>11%	>13%	>13%	>13%
Peak-Hour V/C						
1	LOS A, B, C	LOS A, B, C	LOS A, B, C	LOS A, B	LOS A, B	LOS A, B
2	LOS D	LOS D	LOS D	LOS C	LOS C	LOS C
3	LOS E	LOS E	LOS E	LOS D	LOS D	LOS D
4	LOS F	LOS F	LOS F	LOS E, F	LOS E, F	LOS E, F
Congestion Forecast						
1	LOS A, B, C	LOS A, B, C	LOS A, B, C	LOS A, B	LOS A, B	LOS A, B
2	LOS D	LOS D	LOS D	LOS C	LOS C	LOS C
3	LOS E	LOS E	LOS E	LOS D	LOS D	LOS D
4	LOS F	LOS F	LOS F	LOS E, F	LOS E, F	LOS E, F
Crash Rate (Total Crashes per Vehicle Mile)						
1	< 65.5653	< 173.3688	< 270.3232	< 37.9827	< 52.2407	< 94.4407

	Urban			Rural		
Tier	Interstate	Expressway	Other	Interstate	Expressway	Other
2	65.5653 to 98.34795	173.3688 to 260.0532	270.3232 to 405.4848	37.9827 to 56.97405	52.2407 to 78.36105	94.4407 to 141.66105
3	98.34796 to 131.1306	260.0533 to 346.7376	405.4849 to 540.6464	56.97406 to 75.9654	78.36106 to 104.4814	141.66106 to 188.8814
4	> 131.1306	> 346.7376	> 540.6464	> 75.9654	> 104.4814	> 188.8814
Crash Severity (Fatalities and Incapacitating Injuries per Vehicle Mile)						
1	< 158	< 58.85	< 140.5	< 34	< 11.5	< 31.75
2	158 to 316	58.85 to 117.7	140.5 to 281	34 to 68	11.5 to 23	31.75 to 63.5
3	317 to 474	117.8 to 176.55	282 to 421.5	69 to 102	24 to 34.5	63.6 to 95.25
4	> 474	> 176.55	> 421.5	> 102	> 34.5	95.25
Weather (Average Annual Snowfall in Inches (cm))						
1	< 30 (76.2)	< 30 (76.2)	< 30 (76.2)	< 30 (76.2)	< 30 (76.2)	< 30 (76.2)
2	30 to 60 (76.2 to 150)	30 to 60 (76.2 to 150)	30 to 60 (76.2 to 150)	30 to 60 (76.2 to 150)	30 to 60 (76.2 to 150)	30 to 60 (76.2 to 150)
3	61 to 80 (151 to 203.2)	61 to 80 (151 to 203.2)	61 to 80 (151 to 203.2)	61 to 80 (151 to 203.2)	61 to 80 (151 to 203.2)	61 to 80 (151 to 203.2)
4	> 80 (203.2)	> 80 (203.2)	> 80 (203.2)	> 80 (203.2)	> 80 (203.2)	> 80 (203.2)
Event Generators						
1	0	0	0	0	0	0
2	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5
3	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10
4	>10	>10	>10	>10	>10	>10

2.2.3 Deployment Density Classes

In addition to the operations centric criteria, another unique attribute of the TOIP was the development of the DDC. DDCs are used to illustrate the concept that for any operations/ITS recommendation, there are multiple components and in reality a range of options available to the planner and designer. With the TOIP methodology, depending on the final score of a specified link, there are unique operations/ITS recommendations based on that score. For most operations/ITS planning studies, specific recommendations are provided. However, for this planning effort, it was recognized that the recommendations could vary for a number of reasons. Furthermore, since the TOIP itself is meant to be a resource and not a strict policy document, ranges were decided upon as the best way to convey recommendations. These ranges of recommendations were illustrated through the use of a spectrum. The goal is to illustrate that recommendations are really based on a variety or spectrum of choices.

Figure 2.7 presents a complete view of how the methodology is composed, as well as the relationship between the criteria, weights, thresholds, and scores. Figure 2.8 then presents an example of how the complete methodology is executed on a link to create a TOIP score for that link. The next subsection discusses what data sources TOIP utilizes to execute the methodology and how these scores are illustrated, as well as associated operations/ITS recommendations.

For example, for a low-level recommendation, the surveillance recommendation would be to utilize CCTV only at key hotspots; whereas a high-level recommendation would be complete CCTV coverage of a corridor. The spectrum concept also allowed different recommendations for different operations/ITS functional areas by roadway functional classification. To simplify displays of the spectrum, Figures 2.4 to 2.6 illustrate the spectrum recommendations for all functional classes which the TOIP considers. Functional classifications were combined by the following methodology:

- Roadway Type A – Urban Interstate/Expressway;
- Roadway Type B – Rural Interstate/Expressway; and
- Roadway Type C – Arterial (Urban/Rural Other).

When reviewing the final results of the TOIP by corridor in Section 3.0, it is best to refer to these spectrum charts for the most thorough understanding of the recommendations.

Figure 2.4 Spectrum of Deployment Density

Roadway Type A – Urban Interstate/Expressway

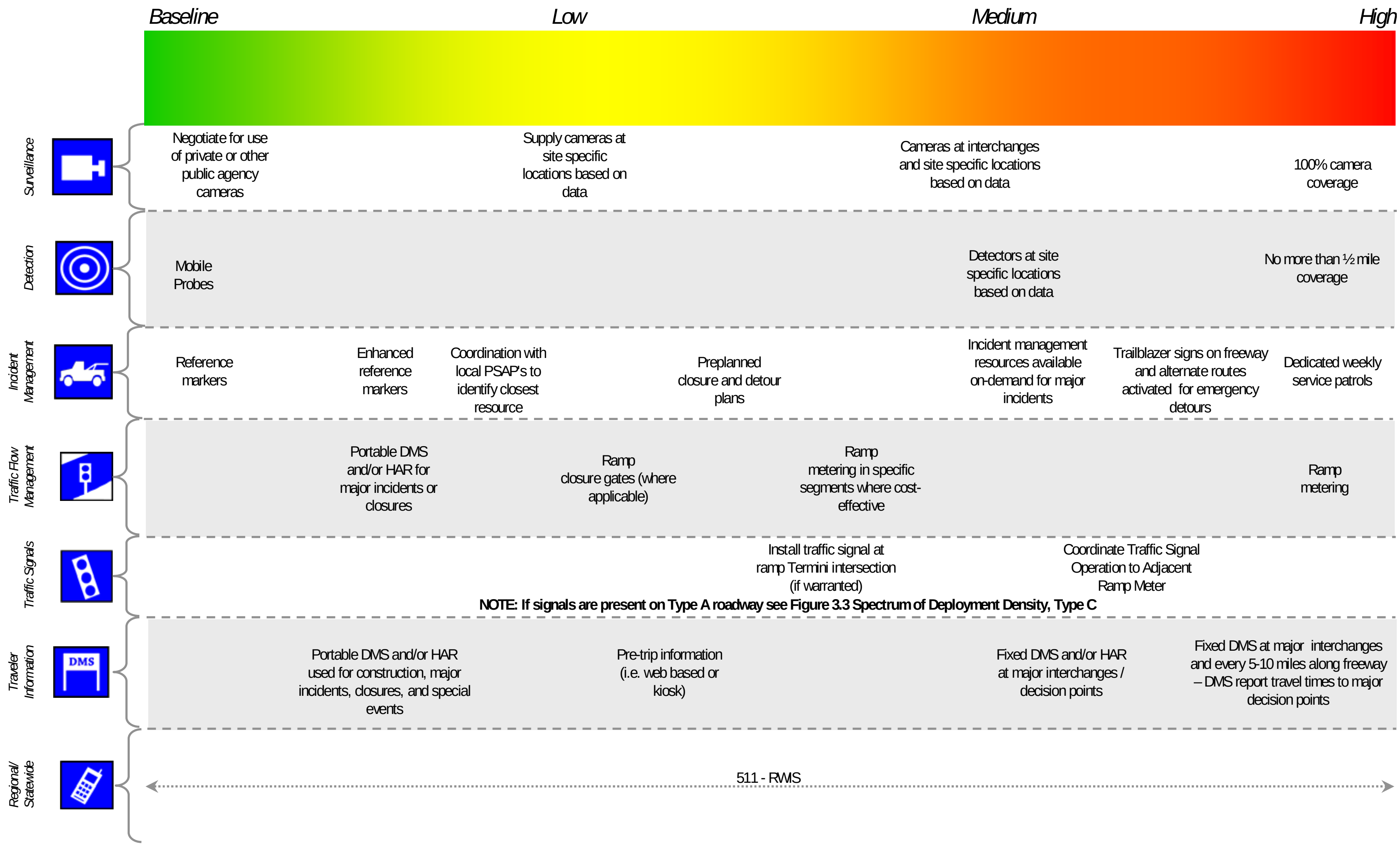


Figure 2.5 Spectrum of Deployment Density

Roadway Type B – Rural Interstate/Expressway

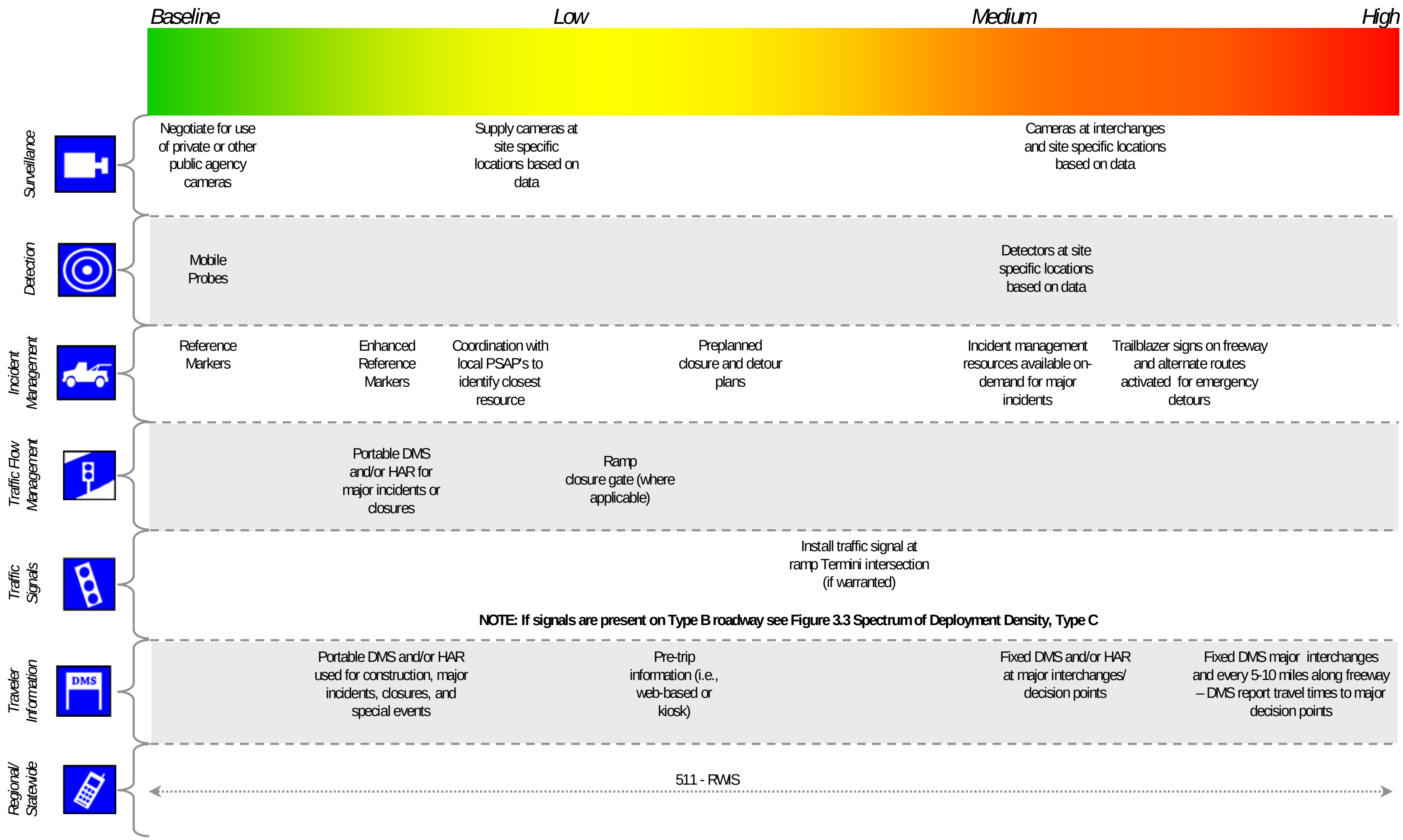


Figure 2.6 Spectrum of Deployment Density

Roadway Type C – Arterial (Urban/Rural)

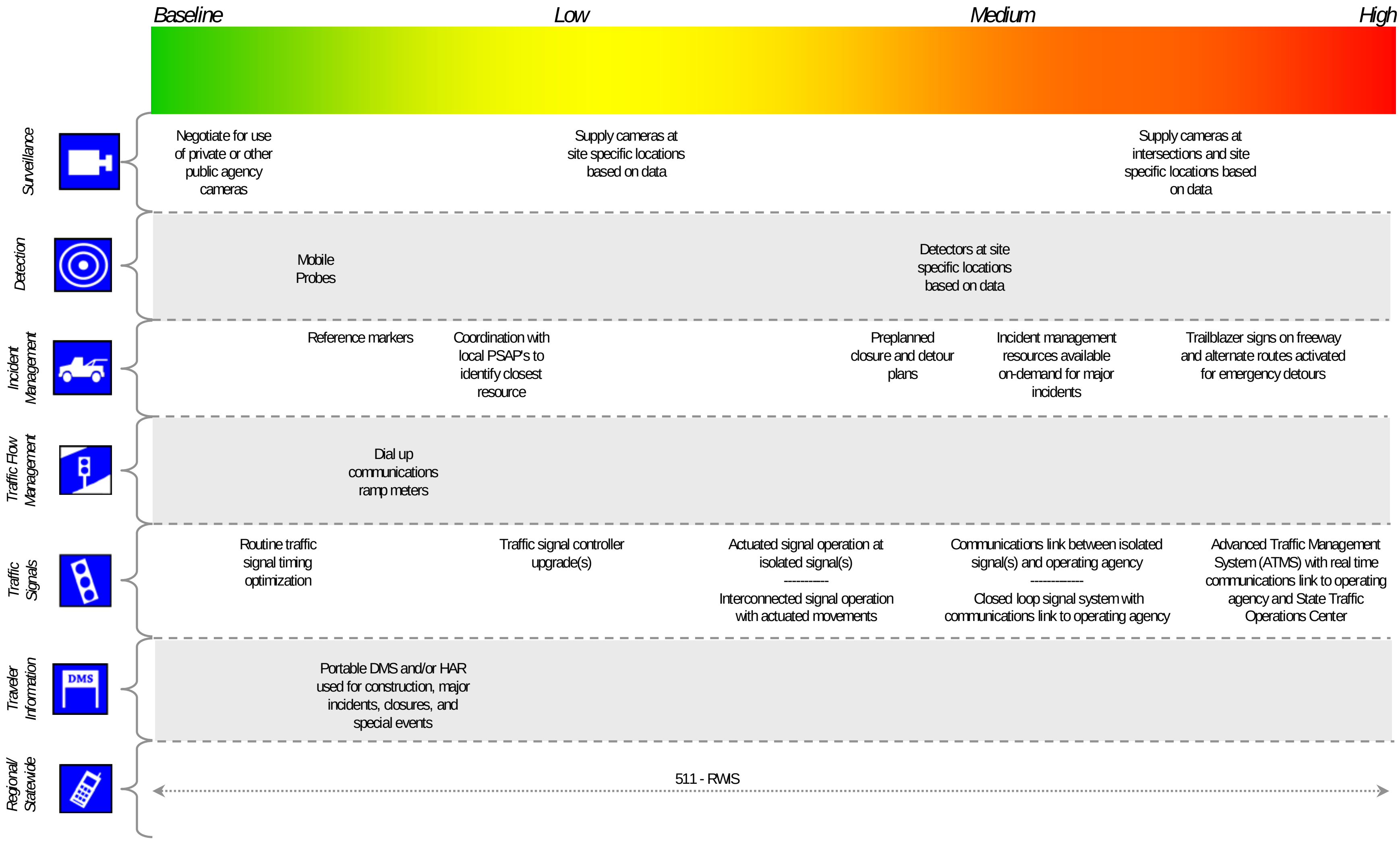


Figure 2.7 Criteria, Thresholds, and Weights

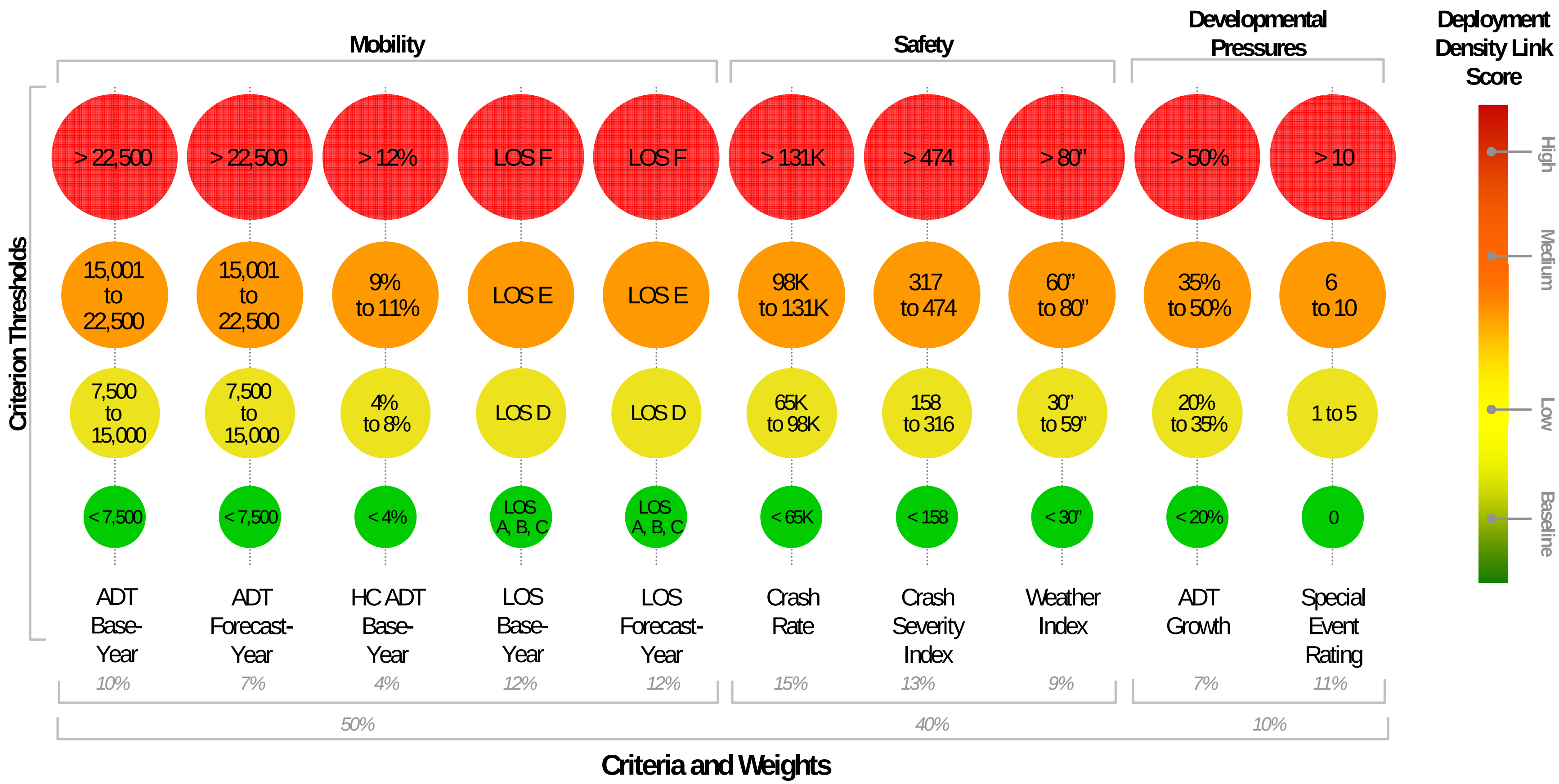
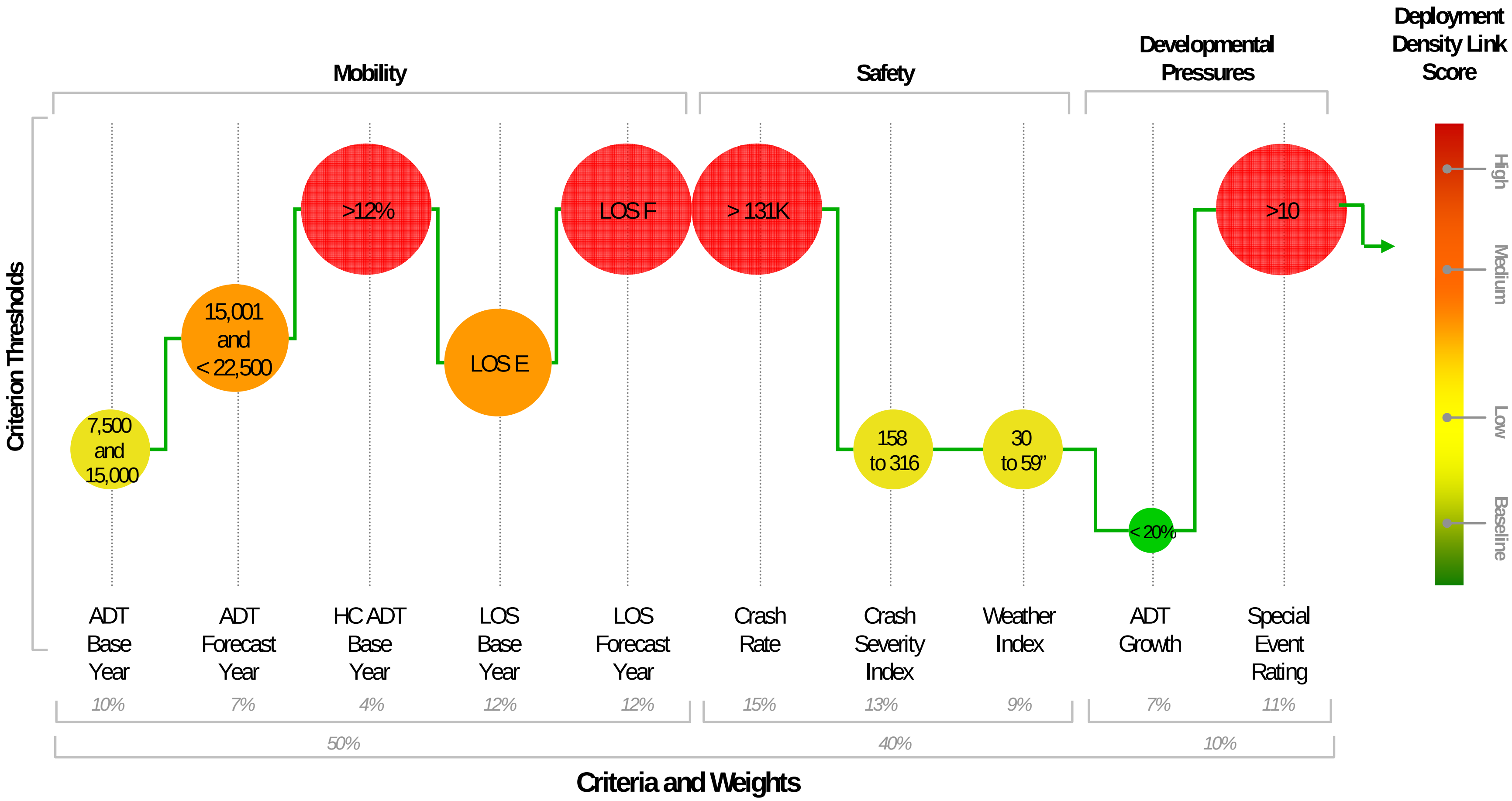


Figure 2.8 Sample of Roadway Segment Scoring



2.3 Data Sources and Collection

An important objective of TOIP's methodology was to ensure that the data driving the operational needs assessment was easily accessible from standard WisDOT sources. This helps ensure that the methodology can be revisited and updated easily in the future as part of ongoing long-range planning activities.

Based on the input of the WisDOT Program Development and Analysis Section and a review of available data sources, the methodology was designed to run on three distinct datasets, the primary one being WisDOT's MetaManager data. Additional data came from the University of Wisconsin Traffic Operations (TOPS) Laboratory and WisDOT's Traffic Forecasting Division.

2.3.1 MetaManager

MetaManager, a comprehensive data repository for WisDOT, was developed by the Division of Transportation Investment Management's Bureau of State Highway Programs to meet data requirements for a variety of needs and performance analyses. The MetaManager Management System data is the best statewide information source available for evaluating system needs and measuring program impacts. MetaManager geographically integrates a variety of data, including pavement information, system deficiencies, safety, congestion, and other information. The data also include future projections of physical condition.

MetaManager serves as the major source of data for the TOIP effort, populating eight of the 10 criteria selected for inclusion. The data currently are maintained by the Program Development and Analysis Section whose assistance was critical to this planning effort.

Table 2.4 highlights the eight criteria included in operational needs assessment, along with the source fields from MetaManager which were used to determine the criteria value.

Table 2.4 MetaManager Criteria

Criteria	MetaManager Source Fields
ADT Base Year	AADTYR_1
ADT Forecast Year	AADT2030
HC ADT Base Year	TRKDYR_1, AADTYR_1
Peak-Hour V/C – LOS	LOSYR_1
Congestion Forecast	LOS2030
Crash Rate	RATE
Crash Severity	SEVINDX
ADT Growth	AADTYR_1, AADT2030

The MetaManager field defining functional class (FCLASS) also was utilized to determine recommendations, which vary for the six roadway types (urban interstate, urban expressway, urban other, rural interstate, rural expressway, and rural other), as described in Section 2.2.

It is important to note that prior to use of the MetaManager criteria (or the weather or special event criteria discussed below) to score the operational needs of a particular roadway segment, an aggregation or "roll-up" process was performed. Through this process, the number of unique MetaManager links was reduced to create units of analysis of sufficient length for the communication of recommendations. This process is explained in greater detail in Appendix D.

2.3.2 Weather Data

In order to address a variety of factors that drive the deployment of operations technology, the inclusion of the impact of weather was considered an important element for the success of the TOIP's data-driven deployment recommendations.

Weather data utilized in the methodology was processed by the University of Wisconsin TOPS Laboratory and documented in the 2006 paper *Application of Road Weather Safety Audit to the Wisconsin Highway System* (Qin, Noyce, Martin, and Khan). The two general categories of data considered for use were weather observation data and weather-related crash data. Observation data include information on the occurrence and intensity of adverse weather conditions, including snow, ice, rain, and fog. There are a variety of observation stations in Wisconsin that are maintained by both private and public sector organizations. WisDOT has its own network of approximately 60 Environmental Sensor Stations (ESS) that provide information for use in WisDOT's maintenance activities. Information also is provided to the public through the WisDOT web site (http://www.dot.state.wi.us/travel/gis/rwis.htm). This information is supplemented by data from 43 AWOS/ASOS (Automated Weather Observation System/Automated Surface Observation System) stations located at Wisconsin's airports (http://www.faa.gov/asos/map/wi.cfm). Additional stations are provided through the National Weather Service (NWS) and a volunteer observer network, the Cooperative Observing Program (COOP) that is coordinated by the NWS. The Wisconsin State Climatology Office (http://www.aos.wisc.edu/%7Esco/stations/menu.html) compiles and provides real-time information from the COOP.

While real-time weather observations are available from a variety of sources, there are several challenges involved in utilizing this information for the operational needs assessment methodology:

- Real-time observations from the sources described above are relatively easy to obtain. However, in order to provide meaningful data for planning evaluation continuous archived data over a period of one year or more is required. These datasets can be costly and are also very large and difficult to manipulate.

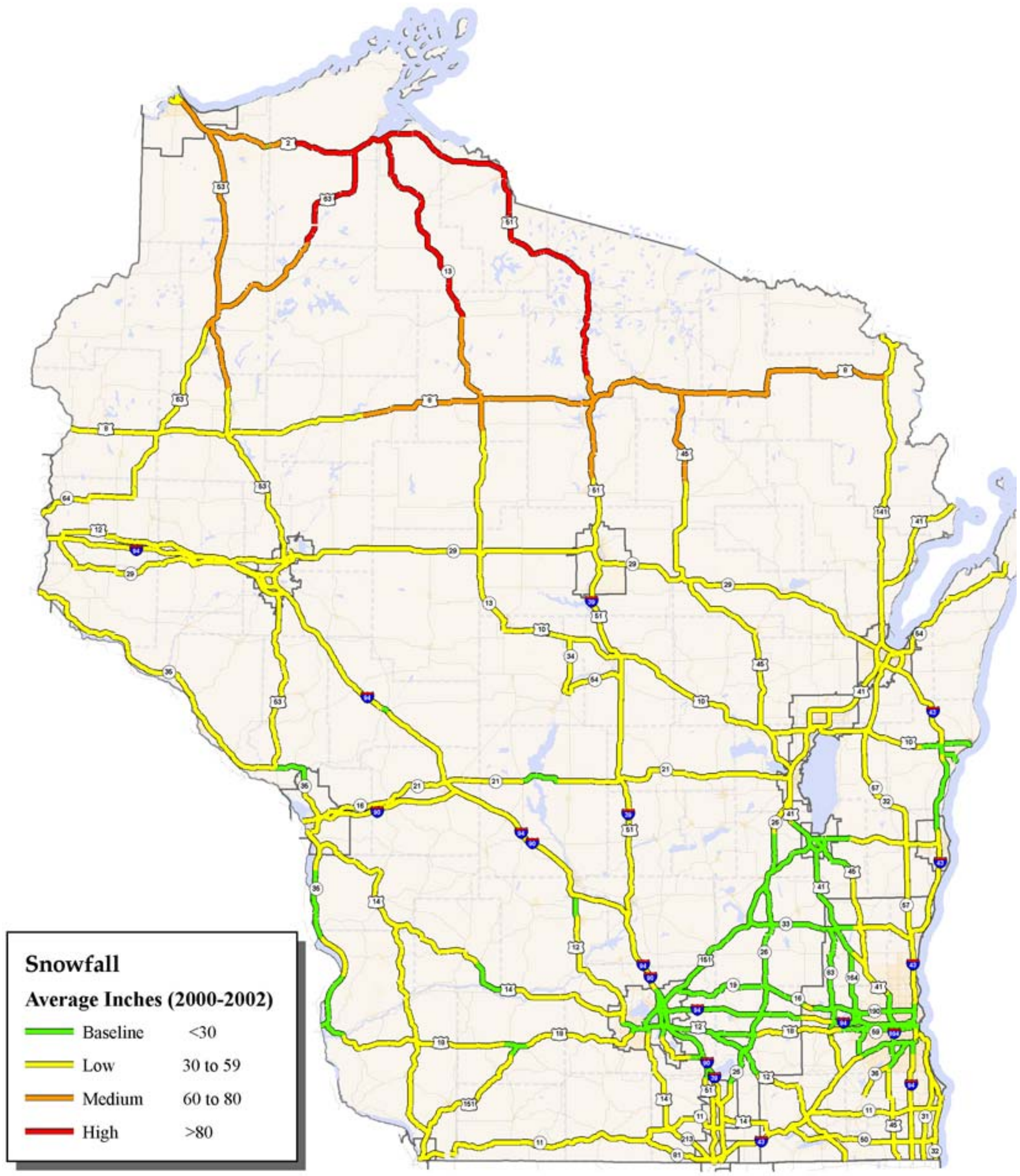
- Weather observations are from single points that may or may not be located on a roadway. TOIP analysis requires that estimates be obtained for all segments of the Connections 2030 Multimodal Corridors.
- Some weather observation stations track precipitation intensity and amounts, while others only indicate the presence of precipitation. Many stations collect only atmospheric data, not surface temperatures, which would be helpful in establishing the presence of ice or snow on roadways. WisDOT's ESS stations, for example, provide data on surface conditions but do not provide information on precipitation intensity.

These limitations meant that significant processing of weather data was required prior to use in the analysis. The UW TOPS Laboratory report addressed all of these issues, providing useful datasets for inclusion in the planning process. Continuous data on snow, rain, and fog conditions were developed from Wisconsin's AWOS stations, as well as 151 stations that are part of the NWS Cooperative Observing Program (COOP). Data from three years (2000 to 2002) were smoothed into a continuous surface, using a kriging process. Fog observations, however, were available only for about 20 ESS stations. While the kriging process enables the data to be extrapolated to the entire State, the low number of specific observations for fog means that even though it is an important criteria, it was deemed too limited a dataset for the TOIP at this time. In the future with a greater number of observations, fog could be incorporated. Since snow generally has a greater impact than rain on transportation mobility and safety, the snowfall data developed by the TOPS lab was utilized as the criteria in the process intended to capture the impact of weather on operational needs. The data provided was classified into tiers as indicated below and shown in Figure 2.9.

- Tier 1 = < 30 inches;
- Tier 2 = 30 to 59 inches;
- Tier 3 = 60 to 80 inches; and
- Tier 4 = >80 inches.

While weather observation data are continuously available, extensive processing would be required to replicate the TOPS Laboratory analysis. Unlike traffic and safety data, however, climatological data do not require frequent updating in order to be used in an operational needs assessment. If and when additional weather analysis is conducted by TOPS or another organization, the dataset can be expanded and/or updated.

Figure 2.9 Snowfall Levels



2.3.3 Special Events Data

Incorporating the impact of special events, a frequent driver for the deployment of operations technologies such as dynamic messaging signs and traveler information, also involved significant data processing.

The event data utilized in the TOIP methodology was collected by WisDOT. Staff in the Traffic Forecasting Division had previously assembled a list of events within the State of Wisconsin with greater than 10,000 individuals in attendance. The list included the names, location, duration, frequency, attendance, and dates of 86 events. This list served as the foundation for the analysis of the impact of events on the operational needs score for roadway segments. While this list is not a recurring product of WisDOT with scheduled updates and institutional accuracy standards, it provides a solid foundation for future analyses to use to capture event impact on operations/ITS deployments. The complete list can be found in Table 2.5.

Table 2.5 Events Utilized in Methodology

Events		
Harley Davidson Celebration	Wisconsin State Fair	EAA AirVenture
PGA Golf Tournament	Great Circus Parade	Iola Old Car Show and Swap Meet
Art Fair on the Square	Sweet Corn Festival	Summerfest
Ducks Unlimited Great Outdoor Festival	Artstreet	31st Warrens Cranberry Festival Art/Craft Show
Badger Football	Packer Football	Bay View's South Shore Frolic
German Fest	Super National Truck and Tractor Pull	Greater Milwaukee Open
Irish Fest	Hilldale Brat Fest	Concerts (X-Fest, OzzFest)
Country Rock Fest USA	Oktoberfest	Madison Blues Festival
Great River Festival of Jazz	Festa Italiana	Brewer Baseball
World Championship Off-Road Races	Wisconsin State Cow Chip Throw	African World Festival
Concerts, Sports	Cinco de Mayo Springfest	Artrageous Weekend
Polish Fest	Road America 500	American Birkebeiner
Bayfest	Indian Summer Festival	Northern State Fair
Hodag Country Music Festival	Country Jam USA	World Dairy Expo
Walleye Weekend	CART FedEx Championship Series	Bucks Basketball, Sports, Concerts
Art Fair on the Green	Fish Day	Cranberry Festival
Syttende Mai Folk Festival	Holiday Folk Fair International	Green County Cheese Days
Star Spangled Celebration	Lumberjack World Championships	Chocolate Festival
Great Wisconsin Cheese Festival	Miller Lite Ride for the Arts	Wisconsin Film Festival
Prairie Villa Rendezvous	Concerts, Fairs	Klondike Days and World Championship Oval Sled Dog Sprints
Kohler/SCCA Chicago Region June Sprints	Motorola 220/CART FedEx Series	Scottish Fest/Milwaukee Highland Game
Hot Air Affair	Home of the Hamburger Celebration	NASCAR Midwest/Sat Night Races

World Championship Snowmobile Derby	Flake Out Festival	Winterfest and U.S. National Snow Sculpting Competition
Bald Eagle Watching Days	Snowflake International Ski Jumping Tournament	Badger State Winter Games
Kites on Ice	Journal-Sentinel Sports Show	Big Whopper Weekend
National Hydroplane Races	Badger State Summer Games	Wisconsin Farm Progress Days
World Championship Snowmobile Watercross	Wilhelm Tell Fest	Gays Mills Apple Festival
Wade House Civil War Weekend	Watermelon Festival	Apostle Islands Lighthouse Celebration
Chequamegon Fat Tire Festival	Apple Festival	

The first step in the analysis was to geocode the event locations. Each event/ venue was searched using Google or the Wisconsin tourism web site. In cases where an address is available, it was entered into Google Earth to obtain latitude/ longitude coordinates. For events that covered a larger area, an attempt is made to locate a central facility or geographic center (i.e., center of Capital Square in Madison) to locate the event.

The second step was determining which segments of the roadway are affected by the presence of the event. For each point location, a buffer was calculated to determine which roadway segments may have a need for operations/ITS deployment. The buffer was calculated by taking the square root of total attendance and dividing by 100. This produces a result that seems consistent with estimates of the operations/ITS deployments needed to guide travelers and manage traffic for large events such as Summerfest. Using this methodology, roadway segments within 10 miles of a 1,000,000 person per day event are considered to be affected. Roadway segments within 1 mile of a 10,000 person per day event are affected.

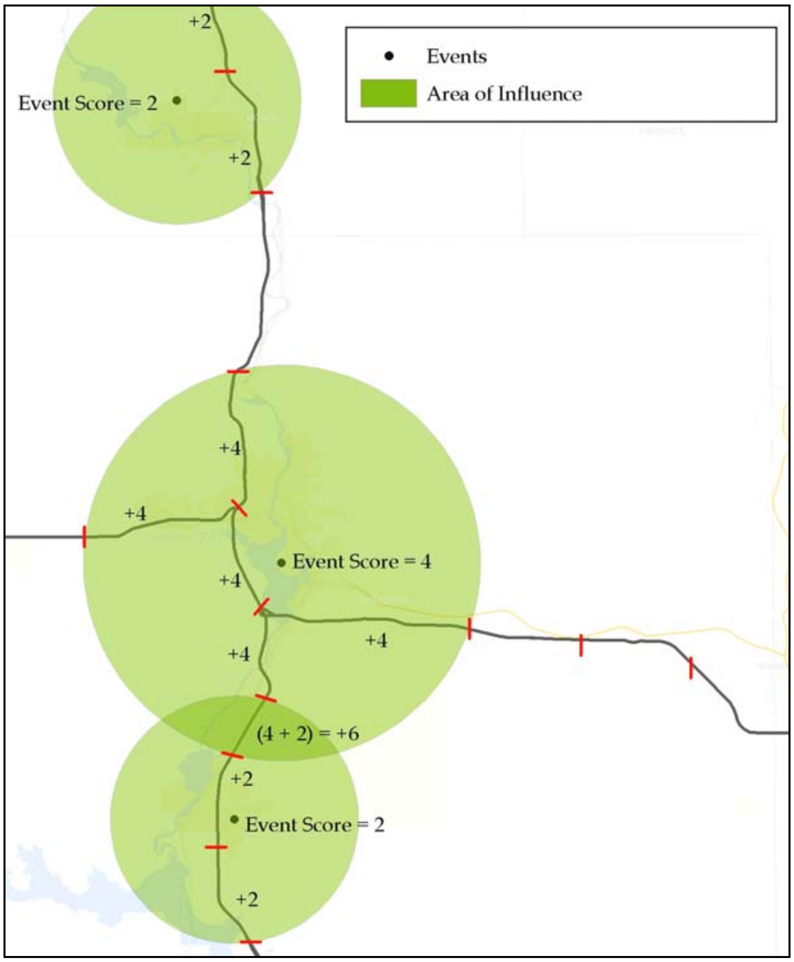
The third step was to assign scores to the roadway network. Scores are intended to reflect the impact of an event on the transportation network and thus the need for operations/ITS deployment. A higher score should reflect a greater need for operations/ITS deployment due to event generated traffic and related issues. The factors considered in assigning individual event impact scores are the total event attendance, the total duration in days, and frequency of the event (such as the numerous Green Bay Packer home games). The score was calculated (similarly to the second step) by taking the square root of attendance per day and dividing by 100. The result is that a 1,000,000 person per day event would contribute a score of 10 to any affected roadway (within 10 miles in this instance).

The final step was to assign the scores to the roadway segments. Using ESRI's ArcInfo, the segments which intersected with an event buffer, are assigned the values for all of the buffers they crossed. For example, a segment which crossed buffers with scores of one, two, and one, respectively would receive a total score of four. These values are accumulated in a new field along with the MetaManager data by segment. This process is illustrated in Figure 2.10.

In order to calculate the impact of events on the overall operational needs score for every roadway segment, the event score is divided into four tiers as follows:

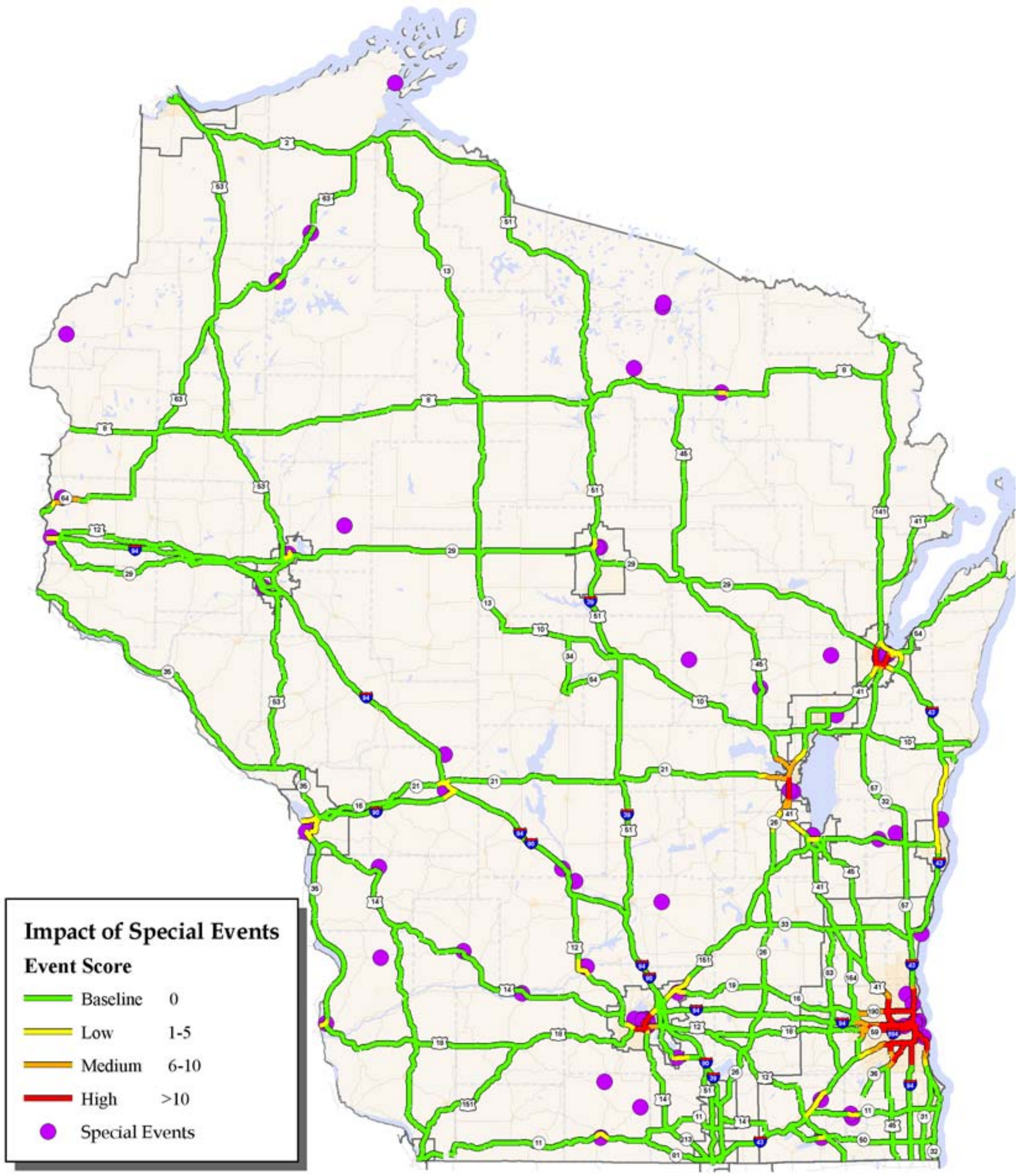
- Tier 1 = 0;
- Tier 2 = 1 to 5;
- Tier 3 = 6 to 10; and
- Tier 4 = > 10.

Figure 2.10 Event Scoring Methodology Example



The highest tier includes roadways in and surrounding Milwaukee (hosting Summerfest and the State Fair, as well as Harley-Davidson key anniversaries), near Oshkosh (reflecting the strong impact of the EAA AirVenture annual festival), and some roadways in downtown Madison (hosting Badger Football games and numerous downtown festivals). Tier 3 roadways frequently are found on the fringes of event centers and Tier 2 roadways are generally located near relatively isolated, rural events. Tier 1 roadways, which have no significant impact from events, include about 86 percent of all roadways in the 2030 Corridors. The average roadway segment event score is about 1.6. Figure 2.11 illustrates the results of this approach on a statewide level.

Figure 2.11 Statewide Impacts of Special Events



This analysis is suitable for a sketch operational needs planning effort but does not go to the level of a focused event-generated traffic analysis. Circular buffers are used to capture the impact of an event. These are a substitute for potentially more complicated and difficult processes of assigning the impact of events on roadways. Consideration of network utilization, trip assignment, and population centers as traffic generators could be more accurate. For example, Summerfest in downtown Milwaukee is considered as having an equal impact on roadways in all directions. In reality, Summerfest is more likely to draw larger traffic volumes from population centers to the south (such as Chicago) than the north. Another element in which this methodology was simplified involves proximity. A roadway link at the outer fringes of a circular buffer is impacted in the same way as a roadway at the center of a buffer. A more detailed analysis could include incorporation of a distance factor that would provide different scores based on distance from the event.

Overall, the special event data serves as a solid foundation for comparative analysis of the roadway network. The results appear to reflect reality. Provided the event list is periodically updated and checked for accuracy, this analysis is fairly easy to replicate.

2.4 Data Processing

All of the necessary data processing for the methodology described in Section 2.0 is done through the use of an analytic tool developed as part of the TOIP and explained in this section. Greater detail on the data processing is available in Appendix D.

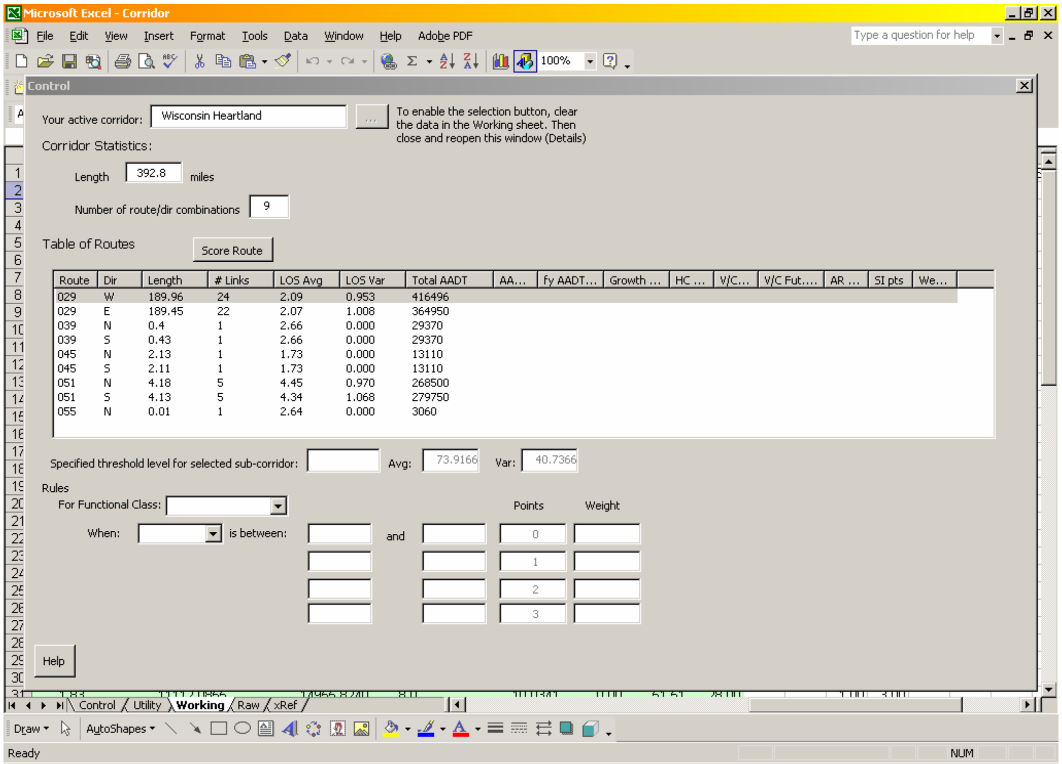
2.4.1 Results Processing

The raw MetaManager, weather, and event data, detailed in the previous sections, is complied into a single dataset within an Excel spreadsheet for portability and to allow for easy analysis. This spreadsheet also contains the weights and thresholds discussed above. Since there are over 10,000 unique roadway segments in the 2030 Multimodal Corridors dataset, an automated macro was developed within Excel which scores all the segments using a process similar to that shown in Figure 2.12.

A Visual Basic (VB) Graphic User Interface (GUI) was developed for the spreadsheet that allows the user to select a specific corridor, execute the methodology, and receive summary statistics. An image of this GUI is presented in Figure 2.12. The GUI allows the capability to modify the inputs of the methodology (weights, thresholds, tiers, scores, and functional class assignments) should additional sensitivity analyses be required or if in the future these elements need to be modified based on changing conditions.

The end product of the analysis tool is a Deployment Density Class assignment for each roadway segment of high, medium, low, or baseline, which summarizes the overall level of operational need based on data-driven quantifiable analysis.

Figure 2.12 Spreadsheet Tool Screenshot



2.4.2 Integration into Display

The analysis tool also produces reference files needed to illustrate the results in standard Geographic Information Systems (GIS) software. Further detail on this process is available in Appendix D.

2.5 From Results to Recommendations

In this section, it is explained how the results are applied to each of the 37 roadways of the 2030 Multimodal Corridors and synthesized into a concise range of recommendations and priorities through a series of maps.

The success of the TOIP is dependent on an effective mechanism to clearly, quickly, and effectively convey the outputs of the methodology described in Section 2.0. Integrating this effort with existing WisDOT corridor planning and programming processes also remained an important goal. It was decided early in the TOIP process that the presentation materials for traffic operations infrastructure recommendations would use the GIS maps developed for the Connection 2030 planning effort as a recommendations template in order to benefit from the WisDOT agency's familiarity with the presentation style and content.

For the maps to be effective, they needed to illustrate a number of elements. First they needed to illustrate where along the corridor high, medium, low, or baseline levels (or densities) of operations/ITS deployments are appropriate.

In addition, the maps needed to delineate the ITS solutions proposed within those limits. For example, the map needed to illustrate within a given limit that an urban area needs a high level of operations/ITS deployments. The map also must specify what types of technologies are recommended to meet these needs, i.e., cameras, sensors, or dynamic message signs. Furthermore it must illustrate this information over a variety of corridor lengths, some in excess of 200 miles.

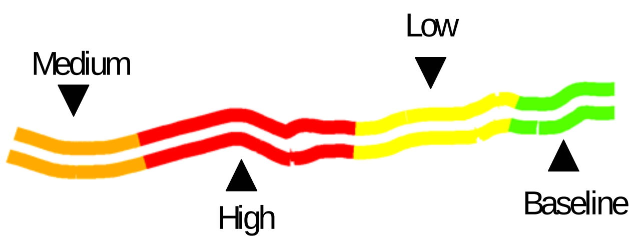
It is important to note that these maps are not intended to provide site-specific locations of ITS devices or deployments, but only provide guidance to WisDOT regional planners and programmers when more detailed corridor studies are conducted.

2.5.1 How to Read the Maps in This Report

All corridor maps in this report are presented in a two-page format. One left-hand page of text explains the high-level operations technology recommendations. The right-hand page for each of the corridors is a corridor map that displays DDC and Signposts with specific technology recommendations for each roadway segment.

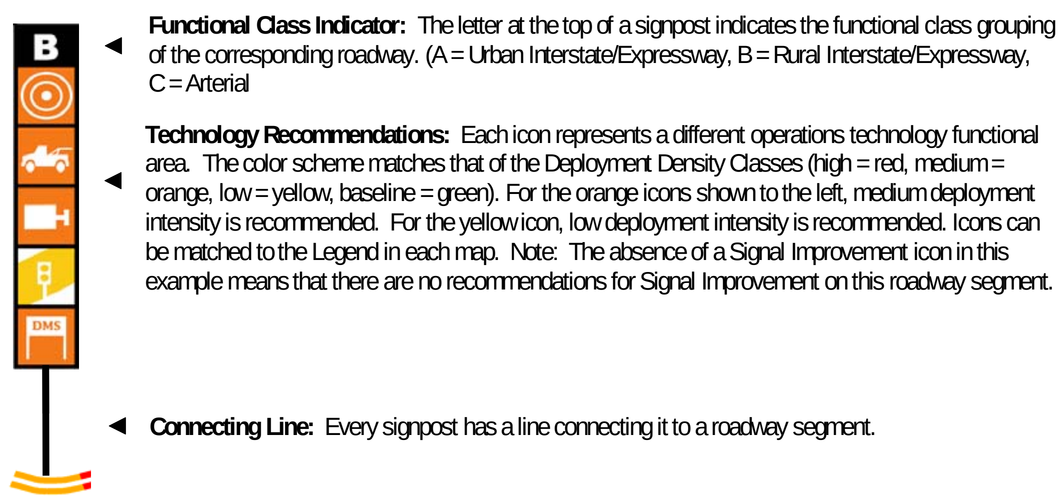
DDC are a recommendation for the level of operations technology deployment that should be considered for a given segment of roadway. These recommendations are intended to allow for flexibility in the more detailed corridor-level studies that are likely to precede deployment. Color coded links on the corridor maps illustrate where high, medium, low, and baseline DDCs are recommended, shown as red, orange, yellow, and green respectively. DDC is calculated based on a variety of operational performance measures, including traffic volumes and patterns, safety, and the impacts of weather and special events. An example of the display standards for DDC found in all maps in this report is shown in Figure 2.13. For greater detail on the function and calculation of DDCs, refer to Section 2.2.3.

Figure 2.13 Deployment Density Class Display Sample



Signposts are composed of a series of icons and are used to capture technology recommendations in greater detail than DDC. They illustrate the specific types of technologies being recommended, as well as the intensity of technology deployment recommended for a specific segment of roadway. They allow for variation of intensities. For example, a roadway segment with significant safety concerns but a low DDC may receive a high Incident Management recommendation. The technology functional areas considered separately include Detection, Incident Management, Signal Improvements, Surveillance, Traffic Flow Management, and Traveler Information. Figure 2.14 shows a sample signpost with explanatory text.

Figure 2.14 Signpost Sample

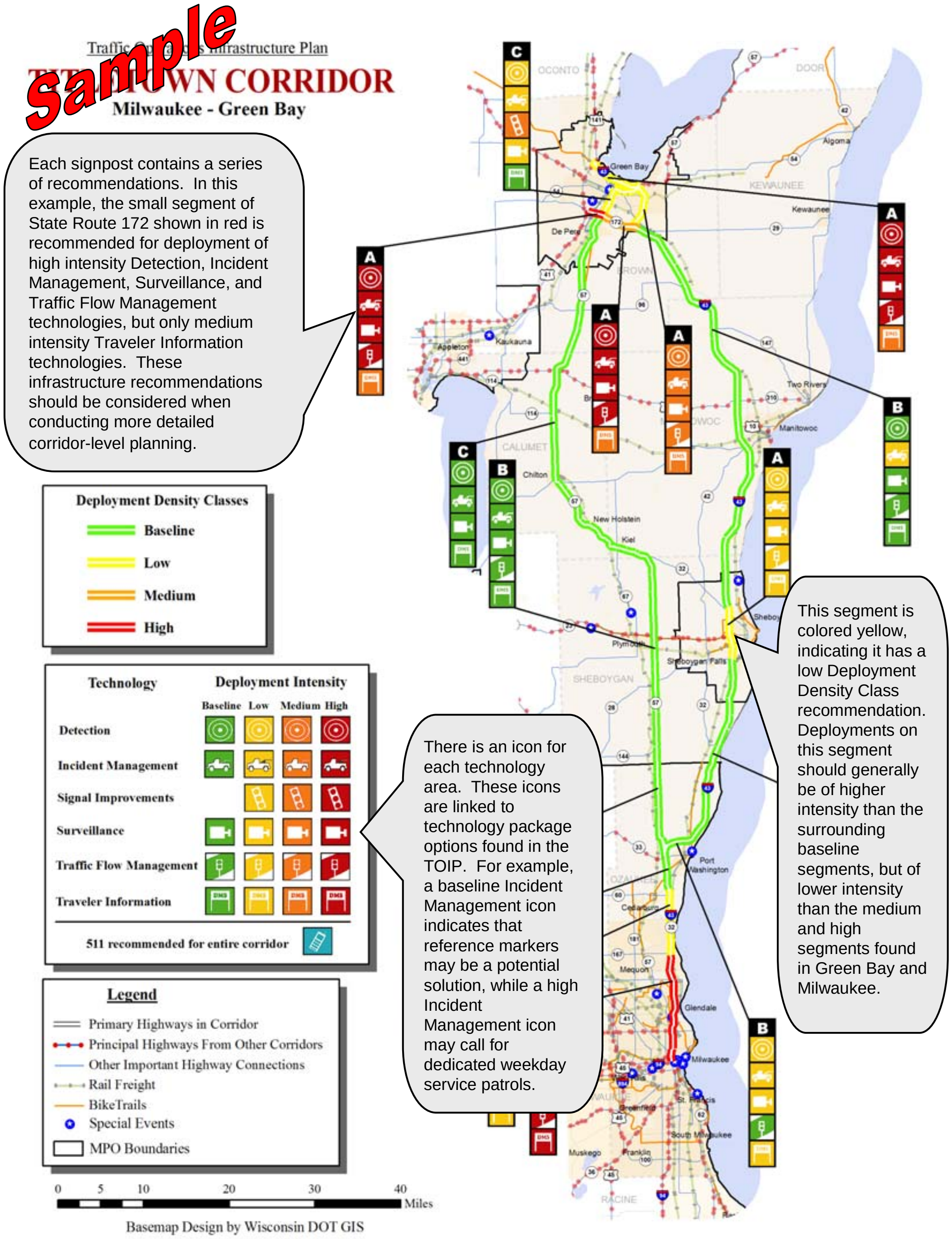


Each icon of the signpost must be referenced to the technology spectrums (Figures 2.4, 2.5, and 2.6) to see the specific sets of technology recommendations they indicate. The technology spectrums are an important part of the corridor recommendations and the reader may find it helpful to print the three spectrums as a companion document while viewing the maps in Section 3.0.

Figure 2.15 shows all the pieces together in a sample corridor map with explanatory overlays.

In conclusion, it may be helpful to think about the recommendations in two simple ways. The need for operational infrastructure (based on the data-driven methodology) is captured by the DDC as a range from baseline to high. The recommended set of solutions to meet that need is captured by the signposts (based on a professional review of roadway characteristics). In order to fully understand the signpost recommendations, the technology spectrums (Figures 2.4, 2.5, and 2.6) need to be consulted.

Figure 2.15 Sample Corridor Map with Explanatory Overlays



3.0 Results

The planning-level recommendations of the TOIP are outlined in Section 3.0. The section begins with a statewide overview of the recommended deployment density levels for the entire 2030 Multimodal Corridor network. The second goal of the TOIP, the corridor prioritization process referenced in Figure 2.1, is explained in this section and the top corridors in the State of Wisconsin from an operations/ITS viewpoint (both Priority and Emerging Priority) are identified. Costs are also summarized in this section for the Priority and Emerging Priority Corridors. In order to break out the recommendations into functional layers, statewide recommendations for each technology area are also summarized in a series of maps. These maps are meant to further refine the recommendations and illustrate for each technology or functional group where operations infrastructure is most needed. Finally, a series of maps shows the corridor-level recommendations for all of the corridors and major metropolitan areas in Wisconsin.

3.1 Statewide Overview

To identify which proposed operational infrastructure deployments best serve the mobility and connectivity needs of Wisconsin, each of the 37 Connections 2030 Multimodal Corridors was evaluated. Recommendations on a statewide level are captured through the DDC statewide map shown in Figure 3.1. As can be observed, the operational needs of Wisconsin roadways are most significant in the high-traffic areas of Milwaukee, Madison, the Fox Valley and the Chippewa Valley, plus the roadway connections between these activity centers and external activity centers such as Chicago and Minneapolis.

Based on the DDC results, the corridors were prioritized by level of operational need. The resulting top corridors were defined as Priority Corridors. The second tier of corridors were defined as Emerging Priority Corridors. Collectively, they connect almost every major metro area in Wisconsin and encompass the most critical freight and tourism routes in the State. These corridors are intended to be the focus of traffic operations infrastructure investment.

The prioritization methodology identifies those corridors with the greatest need for traffic operations infrastructure investment. The DDCs serve as the basis for analysis of corridor needs on a statewide level. A simple weighing process determines the Priority Scores in Table 3.1. Each centerline mile of high DDC adds a score of three to the overall Priority Score. medium DDC adds two while low DDC adds one.

WisDOT Traffic Operations Infrastructure Plan

Figure 3.1 Statewide Deployment Density Class Recommendations

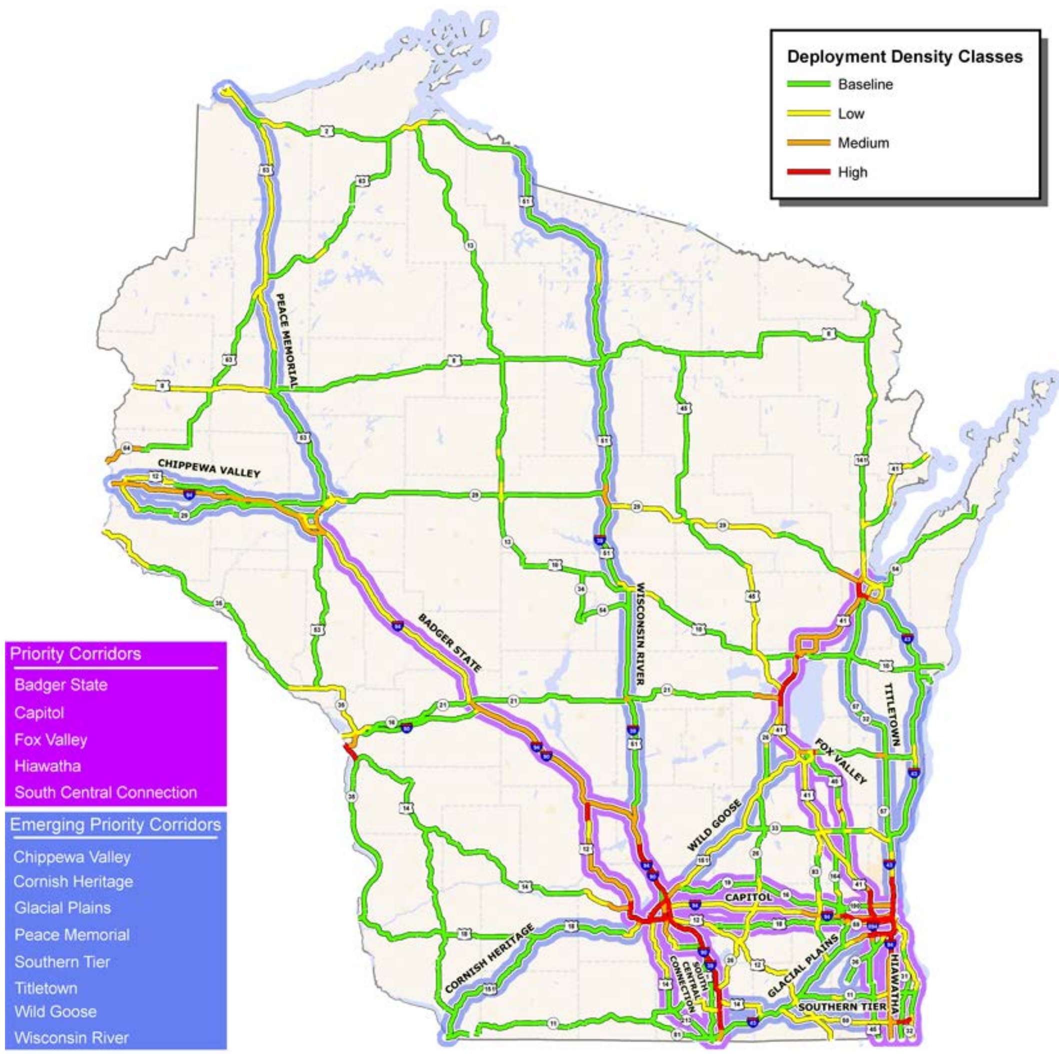
Table 3.1 Corridors by Priority Class

Name	Endpoints	Primary Routes	Priorit y Score
PRIORITY			
Badger State	Eau Claire – Madison	I-94/90, US 12	359
Capitol	Milwaukee - Madison	I-94, US 12/18, WIS 16, 19	275
Fox Valley	Milwaukee – Green Bay	US 41/45	217
South Central Conn.	Madison – Beloit - Chicago	I-90/39, US 51, WIS 213	157
Hiawatha	Milwaukee - Chicago	I-94, US 45, WIS 31, 32	151
EMERGING PRIORITY			
Wisconsin River	Madison – Ironwood, MI	I-39, US 51	123
Chippewa Valley	Eau Claire – Twin Cities	I-94, US 12, WIS 29	107
Wild Goose	Madison – Fox River Valley	US 151/41	99
Peace Memorial	Chippewa Valley – Duluth/Superior	US 53	86
Cornish Heritage	Dubuque - Madison	US 151/18	86
Titletown	Milwaukee – Green Bay	I-43, WIS 32, 57	76
Southern Tier	Janesville/Beloit – Racine/Kenosha	I-43, US 14, WIS 11, 50	57
Glacial Plains	Janesville/Beloit - Milwaukee	I-43, S36, WIS 11, 14	52
REMAINING			
Wisconsin Heartland	Green Bay - Twin Cities	WIS 29	51
Rock River	Janesville/Beloit - Oshkosh	WIS 26	42
Northern Lakes	Twin Cities - Ashland	US 63	36
Wolf/Waupaca Rivers	Stevens Point - Fox Cities	US 10, WIS 110	32
Lake To Lake	Fox Cities to Manitowoc/Two Rivers	US 10, WIS 310	32
Lake Superior	Duluth/Superior - Ironwood, MI	US 2	31
Geneva Lakes	Madison - Lake Geneva - Chicago	US 12, WIS 67	31
Waukesha Connection	Waukesha - Washington County	WIS 83, 164	29
North Country	Iron Mountain - Minneapolis/St. Paul	US 8	26
Northwoods Connection	Oshkosh - Rhinelander	US 45	26
Peshtigo Fire Memorial	Green Bay - Menominee County, MI	US 41, US 141	24
Kettle Country	Fond du Lac - Sheboygan	WIS 23	23
84th Division Railsplitters	Beaver Dam - Port Washington	WIS 33	23
Cranberry Country	Tomah - Oshkosh	WIS 21	22
Coulee Country	La Crosse - Tomah	I-90, WIS 16, 21	21
Frank Lloyd Wright	La Crosse - Madison	US 14	21
Mississippi River	Dubuque - Twin Cities	US 14, WIS 35	20
Lumber Country Heritage	Green Bay - Iron Mountain	US 141	15
Door Peninsula	Green Bay - Door County	WIS 57	15
POW/MIA Rememberance	Abbotsford - Ashland	WIS 31	15
Cheese Country	Dubuque - Janesville/Beloit	WIS 11, 81	9
Marshfield - Rapids Conn.	Stevens Point - Abbotsford	US 10, WIS 13, 34, 54	8
French Fur Trade	Praire du Chien - Dodgeville	US 18	4
Trempealeau River	La Crosse - Eau Claire	WIS 93	2

The results are shown in Table 3.1 for each 2030 Multimodal Corridor from highest to lowest priority. It is worth noting that the breakpoints were chosen carefully as part of the analysis. Though the split between the Wisconsin Heartland Corridor with a score of 51 and the Glacial Plains Corridor with a score of 52 may appear arbitrary, the Wisconsin Heartland Corridor is not elected as an Emerging Priority Corridor as the majority of its Priority Score occurs on a short segment of U.S. 51 which is overlapped by the Wisconsin River Corridor, and therefore already included in the Emerging Priority Corridor set.

The Priority and Emerging Priority Corridors are shown in Figure 3.2.

Figure 3.2 Priority and Emerging Priority Corridors



3.1.1 Statewide Surveillance and Traffic Flow Management

The recommendations for statewide surveillance, detection, incident management, and traffic flow management are shown as a series of maps. Greater detail is available for recommendations in this functional area in Appendix A.

Figure 3.3 Statewide Detection Recommendations

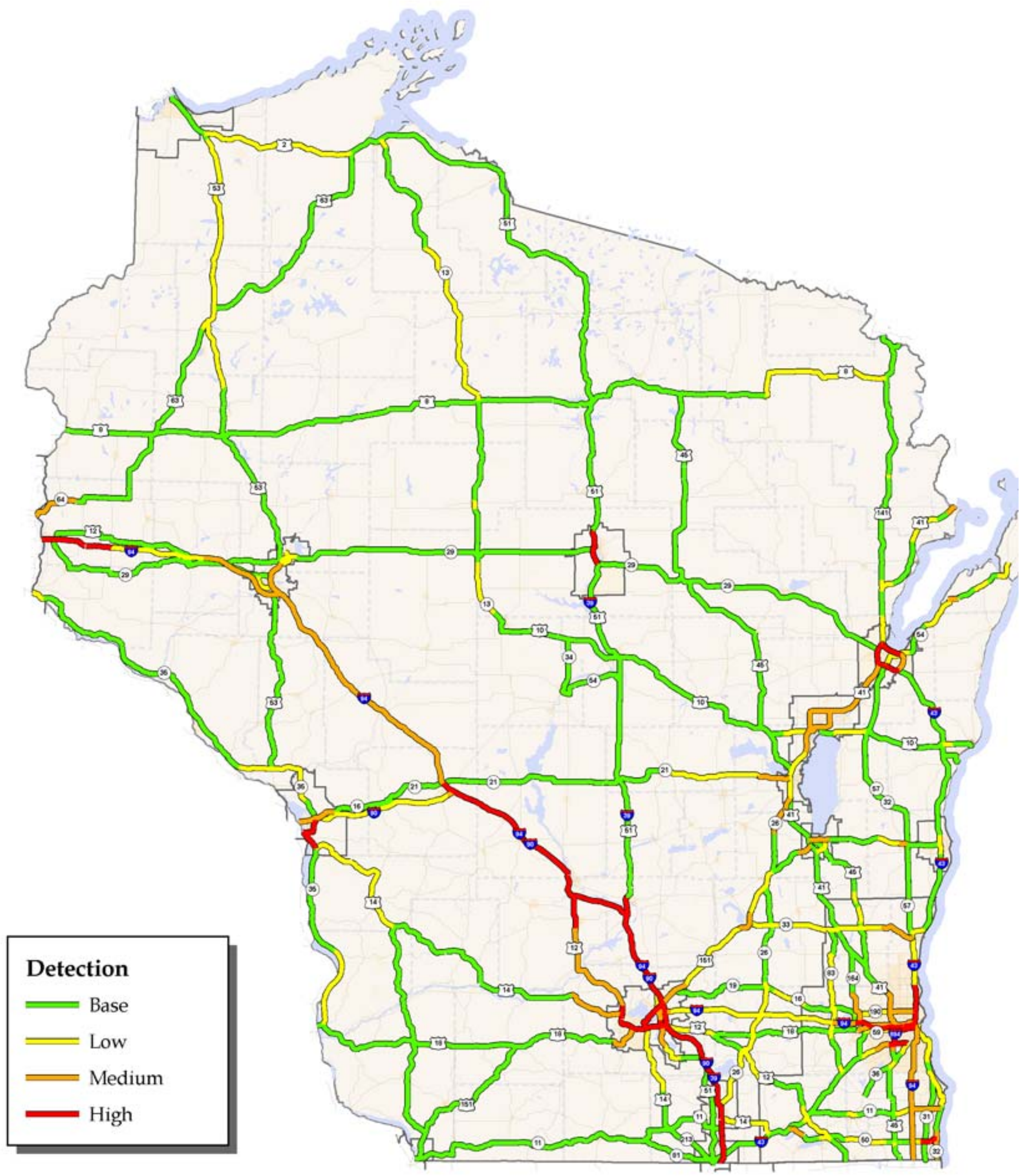


Figure 3.4 Statewide Surveillance Recommendations

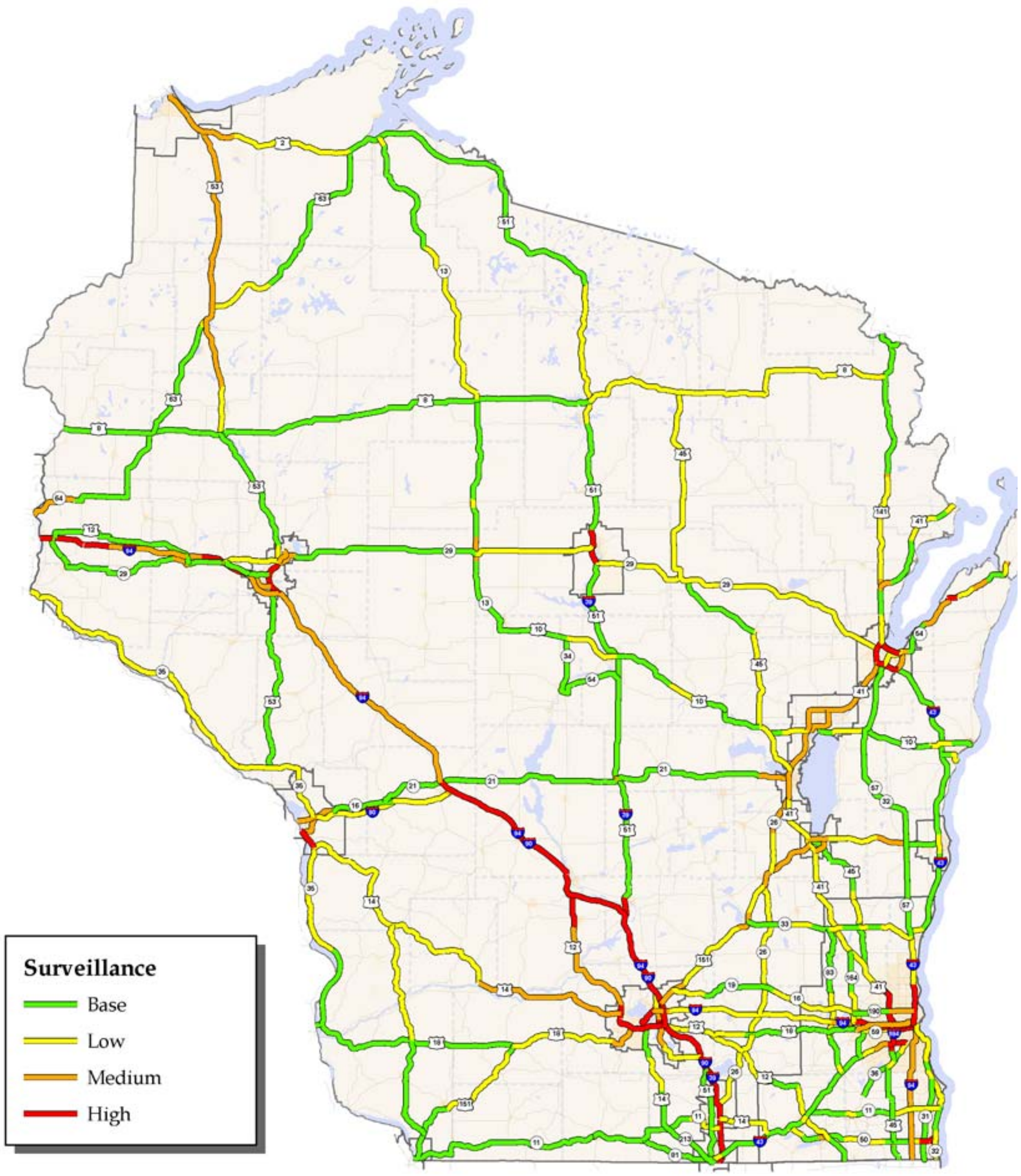
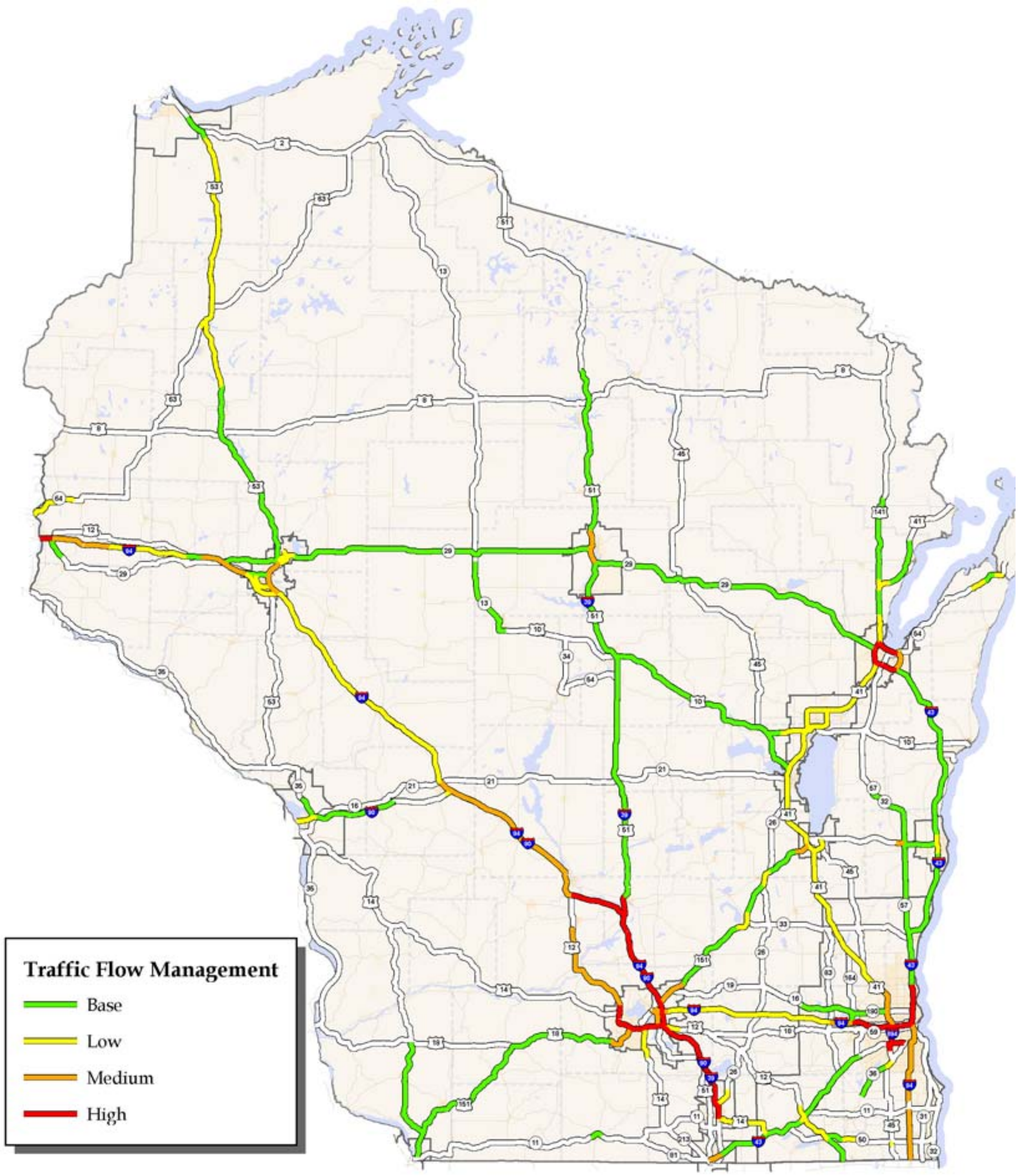


Figure 3.5 Statewide Incident Management Recommendations

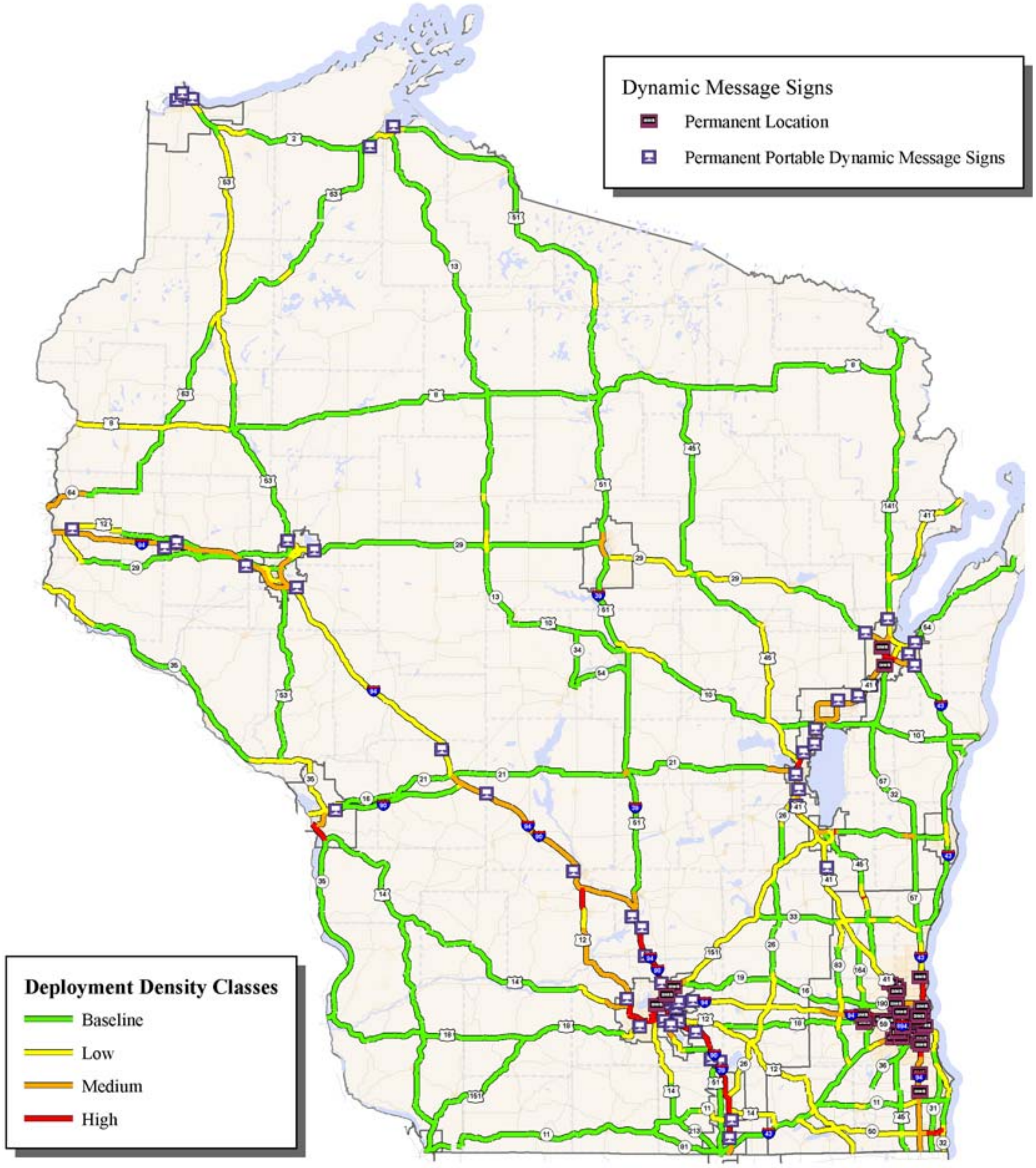
Figure 3.6 Statewide Traffic Flow Management Recommendations



3.1.2 Statewide Traveler Information

The recommendations for statewide traveler information are shown in Figure 3.7. Greater detail is available for recommendations in this functional area in Appendix B. Please note, due to the nature of signal deployments, a statewide view is not feasible. For details on the advanced signal system recommendations, please refer to Appendix C of this document.

Figure 3.7 Statewide Traveler Information Recommendations



3.2 COST SUMMARY

The following planning-level cost estimates provide an overview of the capital, operations, maintenance and replacement costs for the recommendations outlined in this report.

Total Program Costs

Total Cost of Operations Plan Statewide*:

Capital	Operations	Maintenance	Replacement
$63,700,00	$7,500,00	$3,100,000	$1,740,000

Total Cost of Priority Corridors (5):

Capital	Operations	Maintenance	Replacement
$39,400,00	$4,100,000	$1,700,000	$1,000,000

Total Cost of Emerging Priority Corridors (8):

Capital	Operations	Maintenance	Replacement
$21,700,000	$3,000,000	$1,000,000	$700,000

Non Corridor Related Costs (i.e. 511)

Capital	Operations	Maintenance	Replacement
$2,600,000	$400,000	$400,000	$40,000

*** Includes the 13 Priority and Emerging Priority Corridors**

Statewide Costs by Technology Layer

	Capital	Operations	Maintenance	Replacement
Surveillance	$11,600,000	$720,000	$250,000	$160,000
Detection	$3,900,000	$1,800,000	$100,000	$20,000
Incident Management	$5,000,000	$3,600,000	$400,000	$300,000
Traffic Flow Management	$5,300,000	$400,000	$100,000	$100,000
Traveler Information	$13,600,000	$900,000	$1,600,000	$200,000
Signals	$17,600,000	$1,000,000	$600,000	$9000,000
Comm.	$6,800,000	$700,000	$20,000	$-

Costs by Corridor

	Corridor	Capital	Operations	Maintenance	Replacement
Priority	**Badger State**	$9,700,000	$1,100,000	$300,000	$200,000
Priority	**Capitol**	$13,900,000	$1,600,000	$700,800	$300,000
Priority	**Fox Valley**	$6,700,000	$600,000	$300,000	$100,000
Priority	**South Central Connection**	$8,000,000	$1,000,000	$200,000	$200,000
Priority	**Hiawatha**	$6,300,000	$700,000	$300,000	$200,000
Emerging Priority	**Wisconsin River**	$2,400,000	$400,000	$100,000	$60,000
Emerging Priority	**Chippewa Valley**	$3,000,000	$300,000	$100,000	$40,000
Emerging Priority	**Wild Goose**	$3,900,000	$300,000	$200,000	$100,000
Emerging Priority	**Peace Memorial**	$1,300,000	$300,000	$70,000	$40,000
Emerging Priority	**Cornish Heritage**	$4,400,000	$300,000	$200,000	$200,000
Emerging Priority	**Titletown**	$5,700,000	$1,000,000	$200,000	$100,000
Emerging Priority	**Southern Tier**	$2,000,000	$200,000	$50,000	$70,000
Emerging Priority	**Glacial Plains**	$2,800,000	$400,000	$100,000	$50,000

Notes:

All costs in 2007 dollars.

For corridor limits see page 2-3 of this document.

The sum of cost by corridor does not equal total program costs as the overlapping segments have been removed in the calculation.

Costs not included in this estimate: any costs related to an STOC and communications cost associated with DMS.

Details on these cost estimates with assumptions can be found in each appropriate functional appendix.

3.3 Priority and Emerging Priority Corridor Recommendations

Each of the Priority and Emerging Priority Corridors has been reviewed at much closer detail and recommendations are provided for both operational needs and potential technology solutions. The maps are presented in a two-page format. One left-hand page of text explains the high-level operations technology recommendations. The right-hand page for each of the corridors is a corridor map that displays Deployment Density Classes and Signposts with specific technology recommendations for each roadway segment. The display standards for corridor maps match those explained in Section 2.5.1 "How to Read the Maps in this Report."

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Badger State Corridor

Corridor Overview

The Badger State Corridor includes the Madison MPO and Chippewa Falls – Eau Claire MPO Regions as well as I-94 from Eau Claire to Madison, I-90 from Tomah to Madison and I-39 from Portage to Madison. The Corridor includes a system interchange with I-90 and I-94 near Tomah. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High recommendations for surveillance and traffic flow management technologies fall primarily in the Madison metropolitan area, which is already instrumented somewhat heavily with traffic operations devices. Surveillance and detection recommendations remain high north from Madison to the I-90/94 split. There is a combination of medium and low recommendations further north on I-94. (See *TOIP Appendix A* for further details.)

Traveler Information

- The segment of I-94 from Eau Claire to Tomah is recommended for medium density deployment. Recommendations include a portable DMS be deployed between Black River Falls and Tomah upstream from the I-90/94 system interchange to provide incident and alternative route guidance as well as for weather and construction alerts. I-90/94 from Tomah through Madison is classified as medium density deployment. Portable DMS along the corridor will be maintained to provide incident and alternate route guidance as well as being used for weather and construction alerts. The majority of the deployments were installed as part of the earlier Blue Route project. The Blue Route uses US 51 (Stoughton Road) from US 12/18 (the Madison Beltline) at the south to its intersection with I-39/90/94 at the north. An additional portable DMS is recommended for southbound US 51 for the Blue Route as well as to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

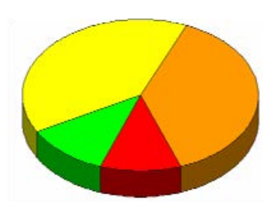
Signal Systems

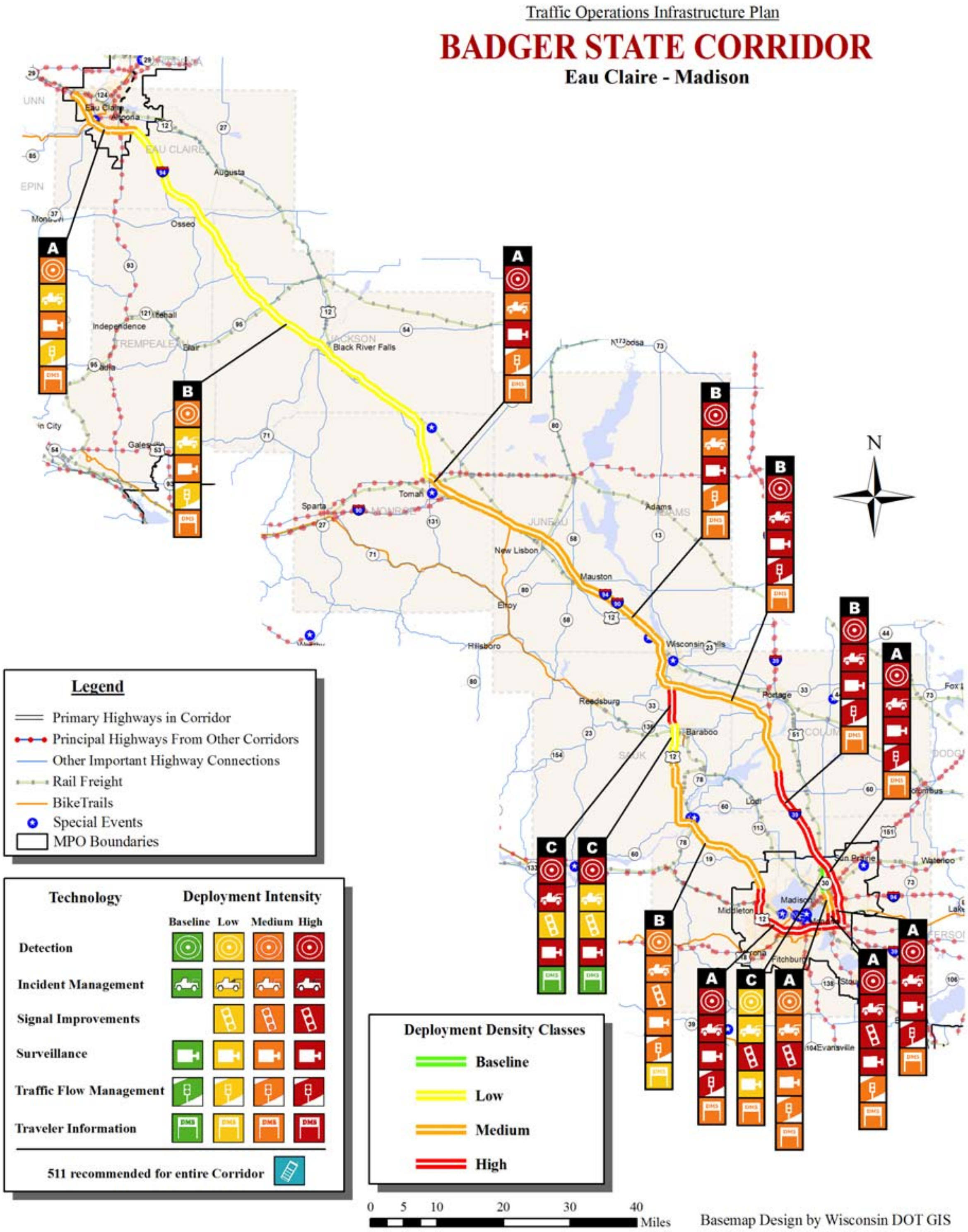
- Various traffic signal deployments are recommended throughout the Corridor. For example, a 9 signal, 5 mile closed loop signal system with ATMS and real time communication link to operating agencies and the STOC is recommended on US 151 south to US 12/18. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
241

Deployment Density Class	Miles	% of Corridor
Baseline	27.5	11.4%
Low	94.6	39.3%
Medium	92.2	38.2%
High	26.8	11.1%





Traffic Operations Infrastructure Plan
BADGER STATE CORRIDOR
Eau Claire - Madison
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire Corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 5 10 20 30 40 Miles
Basemap Design by Wisconsin DOT GIS
N
Eau Claire
Augusta
Osseo
Independence
Blair
Black River Falls
Tomah
Sparta
New Lisbon
Mauston
Elroy
Hillsboro
Adams
Wisconsin Dells
Portage
Reedsburg
Baraboo
Lodi
Middleton
Madison
Fitchburg
Sun Prairie
Waterloo
Columbus
Evansville

Capitol Corridor

Corridor Overview

The Capitol Corridor includes the Madison MPO and Milwaukee-Waukesha Regions as well as I-94 from Madison to Milwaukee, WIS 151/19/16 from Madison to Milwaukee, and US 18 from Madison to Milwaukee. The Corridor includes system interchanges with US 41/45 and I-43 in Milwaukee. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and recurring congestion during the weekday peak periods in the Milwaukee-Waukesha urban areas and weather disturbances during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High deployment levels are recommended for the Milwaukee are, which is already heavily instrumented. It is recommended to extend the traffic operations infrastructure further west to accommodate increased traffic volumes and growth along these segments. Although Madison is not currently as heavily instrumented as Milwaukee, it is recommended that technologies continue to be implemented to maintain the level of traffic operations capability as the area grows.
- One of the main traffic operations strategies that is recommended in this Corridor that is less significant in other corridors is incident management. Along US 12 and US 18, a medium level of incident management is recommended to mitigate safety concerns. (See *TOIP Appendix A* for further details.)

Traveler Information

- The majority of the freeways within the Milwaukee-Waukesha Metro Region are recommended for high density deployment. Permanent DMS are recommended throughout the Region to provide real time travel time information to key destinations as well as information on incident and alternative route guidance as well as for weather and construction alerts.
- The majority of highways entering the Madison area within the Madison MPO Region are recommended for medium density deployment. Portable DMS are recommended throughout the Corridor. The majority of the deployments were installed as part of the earlier Blue Route project. The Blue Route uses US 51 (Stoughton Road) from US 12/18 (the Madison Beltline) at the south to its intersection with I-39/90/94 at the north. An additional portable DMS is recommended for southbound US 51 for the Blue Route as well as to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

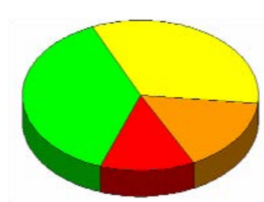
Signal Systems

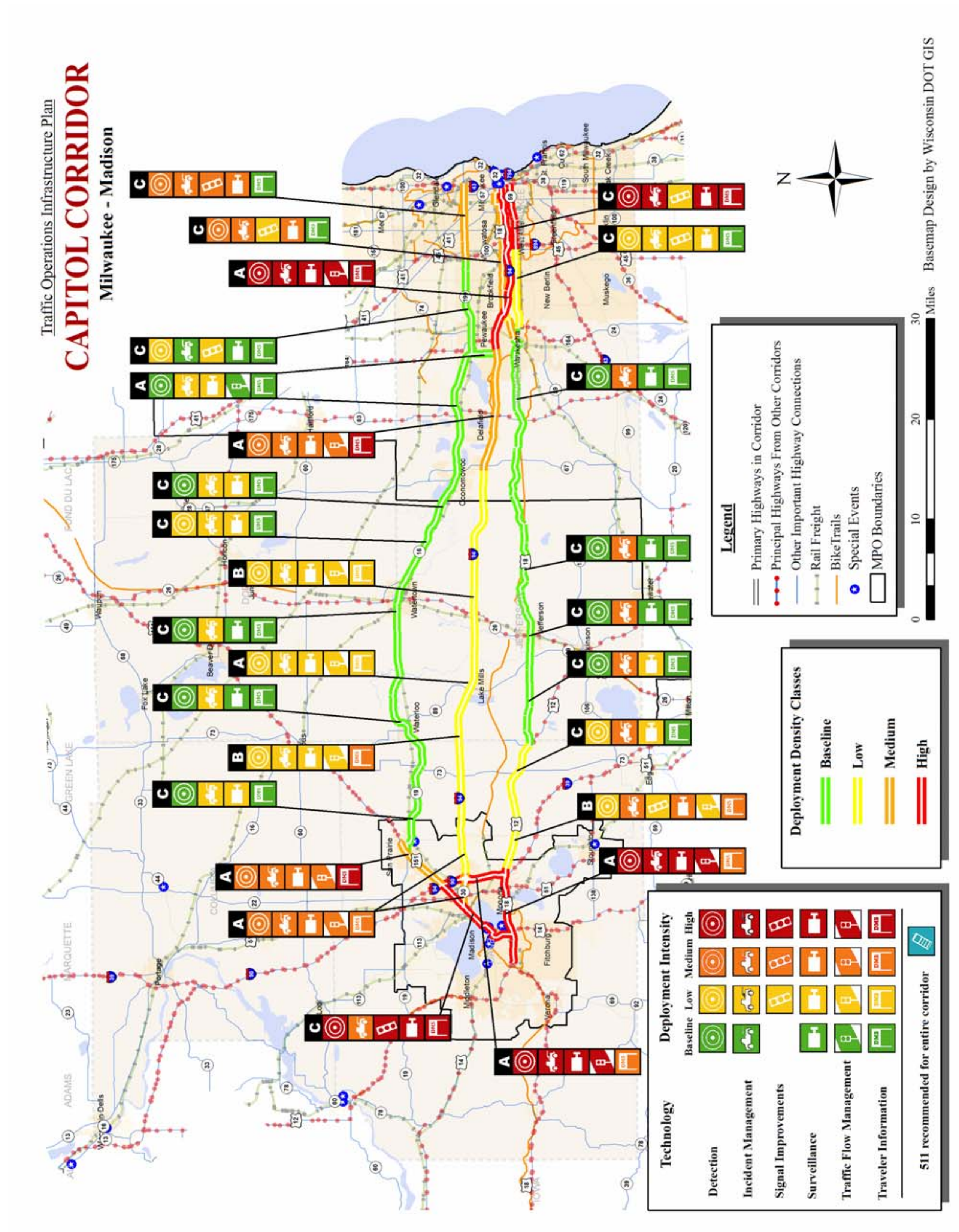
- Various signal upgrades on the Corridor are recommended, such as targeted ATMS deployments in the Madison area with real time communications links to operating agencies and the STOC. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **264**

Deployment Density Class	Miles	% of Corridor
Baseline	99.7	37.7%
Low	88.1	33.3%
Medium	42.0	15.9%
High	34.4	13.0%





Traffic Operations Infrastructure Plan
CAPITOL CORRIDOR
Milwaukee - Madison
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Miles
Basemap Design by Wisconsin DOT GIS

Fox Valley Corridor

Priority Corridor

Corridor Overview

The Fox Valley Corridor includes the Milwaukee-Waukesha, Appleton-Oshkosh-Fond-du-Lac, and Green Bay Regions as well as US 41 from Milwaukee to Green Bay, and US 45 between Milwaukee and Fond du Lac. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), significant event traffic, and weather disturbances occur during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Although few traffic operations devices exist in this corridor outside the Milwaukee area, infrastructure implementation is planned for US 41 from Oshkosh to the Green Bay area. Currently, plans call for 34 cameras, 50 traffic detectors, and nine (9) DMS between the WIS 26 interchange south of Oshkosh and Suamico to the north of Green Bay. The low and medium recommendations on the Brown, Outagamie, and Winnebago County portions of this Corridor assume the planned infrastructure will fulfill the majority of the Corridor's need. (See *TOIP Appendix A* for further details.)

Traveler Information

- The segment of US 41/45 from I-94 to the split is recommended for high density deployment due to significant recurring congestion. It is recommended that permanent DMS be deployed inbound into the Milwaukee metro area. For the Fond du Lac area, it is recommended that portable DMS be located on US 41 approaching the city from the south and north. For the Oshkosh area, it is recommended that portable DMS be located on US 41 approaching the city from the south and north to provide incident and alternate route guidance as well as being used for weather, construction, and traffic event (EAA Fly-in) alerts. In addition, it is recommended that a portable DMS be located north of the WIS 26 exit for southbound traffic to provide additional alternate route guidance. For the Appleton area, it is recommended that portable DMS be located on US 41 approaching the city from the south and north to provide incident and alternate route guidance via WIS 441. For the Green Bay area, it is recommended that a combination of portable DMS and permanent DMS be located approaching the US 41, I-43, and WIS 172 ring road around the city to provide guidance and weather, construction, and event (Green Bay Packer games) alerts. (See *TOIP Appendix B* for further details.)

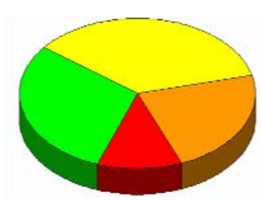
Signal Systems

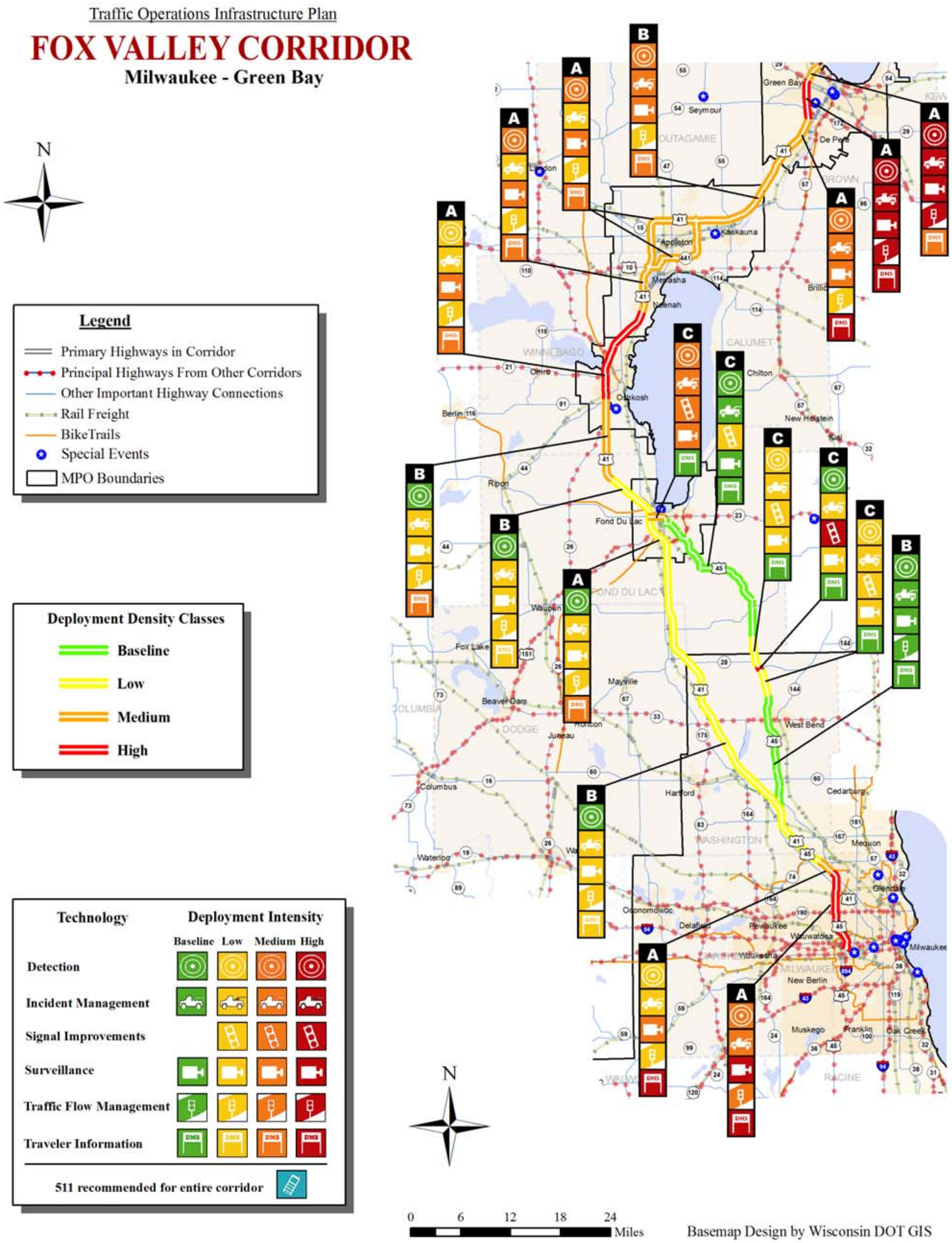
- Various signal upgrades are recommended. For example, along US 45, 18 traffic signal controller upgrades to a closed loop signal system with communications link to operating agencies are recommended from WIS 175 south to 8th Street.. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
187

Deployment Density Class	Miles	% of Corridor
Baseline	55.9	29.9%
Low	66.7	35.7%
Medium	42.5	22.7%
High	21.8	11.7%





Traffic Operations Infrastructure Plan
FOX VALLEY CORRIDOR
Milwaukee - Green Bay
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 6 12 18 24 Miles
Basemap Design by Wisconsin DOT GIS

South Central Connection Corridor

Corridor Overview

The South Central Corridor includes the Madison MPO and Janesville-Beloit Regions as well as I-39/90 from the Illinois border to Madison, and US 14, WIS 59/213 from Beloit to Madison, and US 51 from Beloit to Madison. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Recommendations call for high levels of infrastructure within the Madison metropolitan area, accompanying existing instrumentation.
- High levels of surveillance, incident management, detection, and traffic flow management are all recommended along I-39/90 south of Madison due to heavy traffic counts and safety concerns. (See *TOIP Appendix A* for further details.)

Traveler Information

- I-39/90 from the Illinois border through Janesville is recommended for medium density deployment. Portable DMS are recommended for southbound into Beloit and southbound and northbound into Janesville.
- I-39/90 through Madison classified as medium density deployment. Portable DMS along the corridor will be maintained to provide incident and alternate route guidance as well as being used for weather and construction alerts. The majority of the deployments were installed as part of the earlier Blue Route project. The Blue Route uses US 51 (Stoughton Road) from US 12/18 (the Madison Beltline) at the south to its intersection with I-39/90/94 at the north. An additional portable DMS is recommended for southbound US 51 for the Blue Route as well as to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

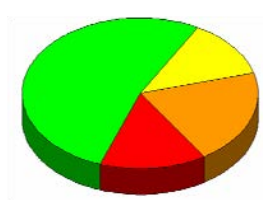
Signal Systems

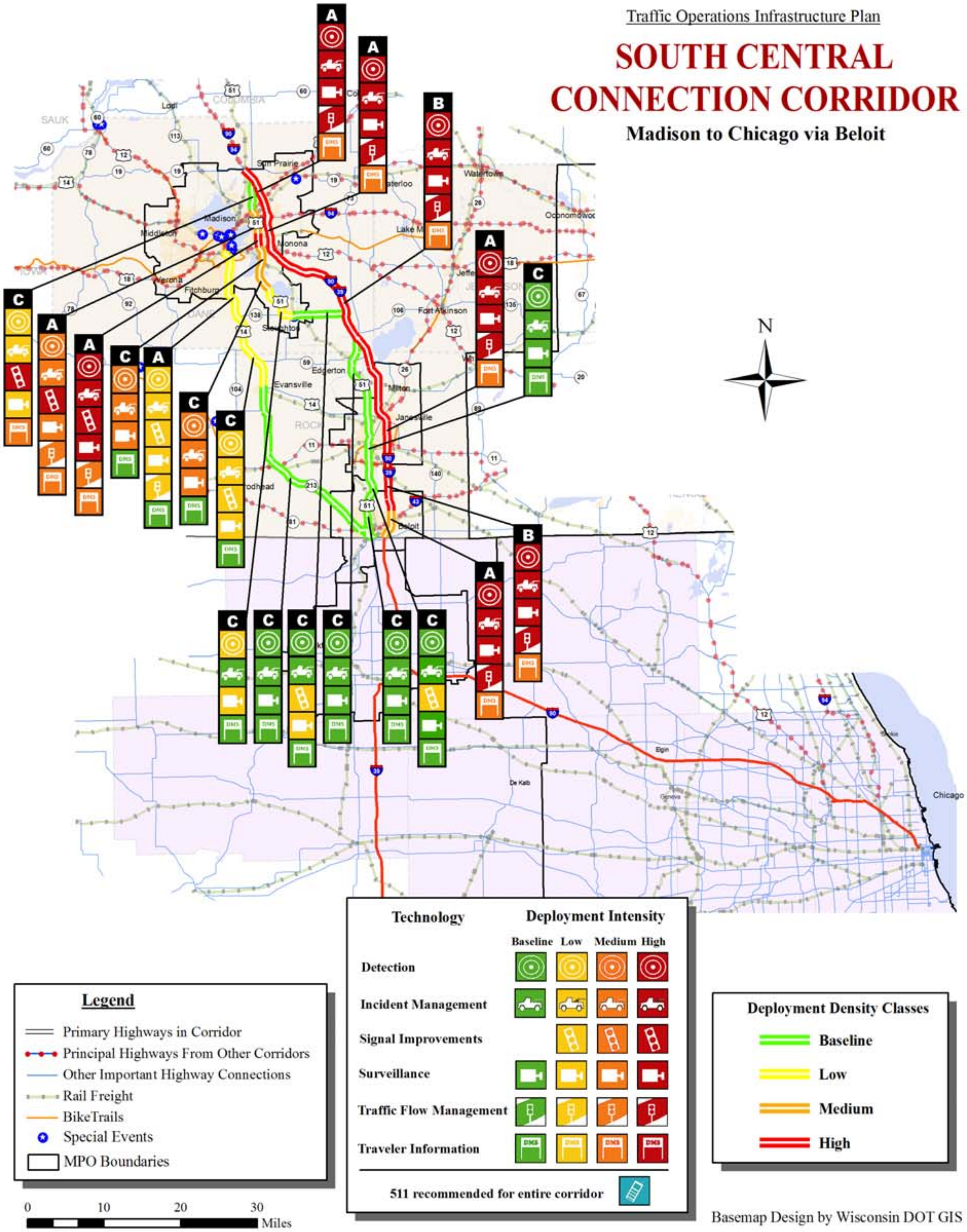
- Various signal upgrades are recommended on the Corridor. US 51 consists of nine signalized intersections as well as grade separated interchanges. The segment is part of the "Madison Blue Route" and is used as an alternate route when I-39/I-90/I-94 has reduced capacity due to an incident. Recommendations include 9 traffic signal controller upgrades to a closed loop signal system with ATMS and real time communication link to operating agencies and the STOC. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
161

Deployment Density Class	Miles	% of Corridor
Baseline	55.9	29.9%
Low	66.7	35.7%
Medium	42.5	22.7%
High	21.8	11.7%




Traffic Operations Infrastructure Plan
SOUTH CENTRAL CONNECTION CORRIDOR
Madison to Chicago via Beloit
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 10 20 30 Miles
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Basemap Design by Wisconsin DOT GIS

Hiawatha Corridor

Corridor Overview

The Hiawatha Corridor includes the Milwaukee-Waukesha Region area as well as I-94 from downtown Milwaukee (I-43) to the Illinois border, I-894 from I-43 to I-94, and parallel routes WIS 45, WIS 31 and WIS 32. The corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), recurring congestion westbound into the Milwaukee metro area during daily peak periods and weather disturbances during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has several segments where high traffic operations deployment densities are recommended. It is recommended that the segments in and around Milwaukee should have medium to high deployment levels. These deployment levels should continue along I-94 to the Illinois border. There are already a substantial number of cameras installed along I-94 and it is recommended to maintain this level of deployment and even add to it with the increased traffic volumes and forecasted growth of the area.
- Outside I-94, the recommendations are consistently high within the Milwaukee area and are substantially lower in the rural areas. There are a few hotspot areas where lesser levels of incident management and detection resources should be applied to mitigate crash and congestion concerns. (See *TOIP Appendix A* for further details.)

Traveler Information

- I-94 from downtown Milwaukee to WIS 11, and I-894 are recommended for high density deployment. Permanent DMS are recommended to provide real time travel time information to key destinations as well as provide information on provide incident and alternative route guidance as well as for weather and construction alerts. (See *TOIP Appendix B* for further details.)

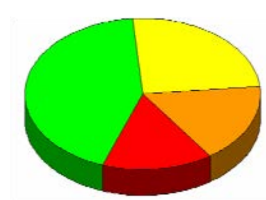
Signal Systems

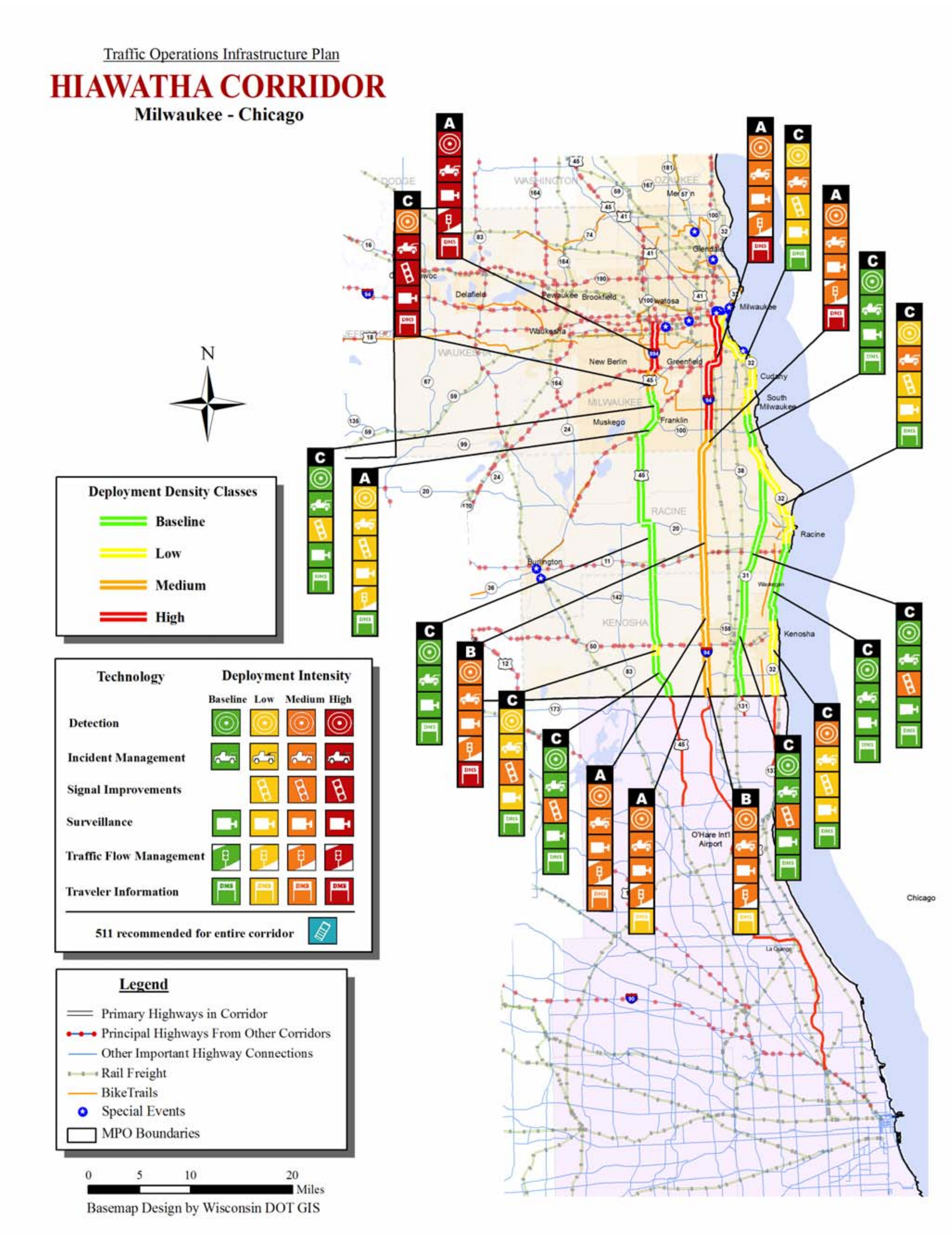
- There are various signal recommendations throughout the Corridor, such as along the north end of US 45/WIS 100 (Layton Avenue south to Speedway Drive) where an ATMS with real time communications links to operating agencies and the STOC is recommended. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
144

Deployment Density Class	Miles	% of Corridor
Baseline	61.9	43.0%
Low	35.9	24.9%
Medium	24.2	16.8%
High	22.1	15.3%




Traffic Operations Infrastructure Plan
HIAWATHA CORRIDOR
Milwaukee - Chicago
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 5 10 20
Miles
Basemap Design by Wisconsin DOT GIS
A
B
C
DMS
Milwaukee
New Berlin
Greenfield
Cudahy
South Milwaukee
Franklin
Muskego
Racine
Kenosha
Burlington
O'Hare Int'l Airport
Chicago
Delafield
Waukesha
Brookfield
Glendale
RACINE
KENOSHA
MILWAUKEE

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Wisconsin River Corridor

Corridor Overview

The Wisconsin River Corridor includes a portion of the Madison MPO Region and US 51 from the Michigan border (Ironwood) to Wausau (I-39) and I-39 from Wausau to I-90/94 and I-39/90/94 to Madison (I-94). This 260-mile Corridor is part of a major passenger and freight corridor linking north central Wisconsin and south central Wisconsin and Illinois. It is a critical tourist corridor between the population centers in Illinois and southern Wisconsin to the major recreation areas in the north. It also provides critical economic links for the industrial and commercial communities of Wausau, Wisconsin Rapids, Stevens Point, and Marshfield.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Heavy deployment levels are recommended for I-39/90/94 through and north of the Madison metropolitan, supplementing the current heavy instrumentation. Recommendation levels fall off north of the I-39 split with I-90/94.
- A combination of medium and high deployments are recommended for US 51 in Wausau., though current expansion projects in the region will likely reduce operational needs. (See *TOIP Appendix A* for further details.)

Traveler Information

- I-39/90/94 from I-39 through Madison is classified as medium density deployment. Portable DMS along the corridor will be maintained to provide incident and alternate route guidance as well as being used for weather and construction alerts. The majority of the deployments were installed as part of the earlier Blue Route project. The Blue Route is an alternate route signing concept for when a major incident on the interstate requires a lengthy closure or results in major delays. The Blue Route uses US 51 (Stoughton Road) from US 12/18 (the Madison Beltline) at the south to its intersection with I-39/90/94 at the north. An additional portable DMS is recommended for southbound US 51 for the Blue Route as well as to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

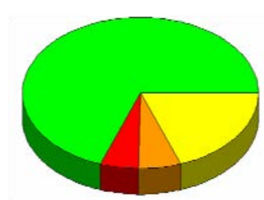
Signal Systems

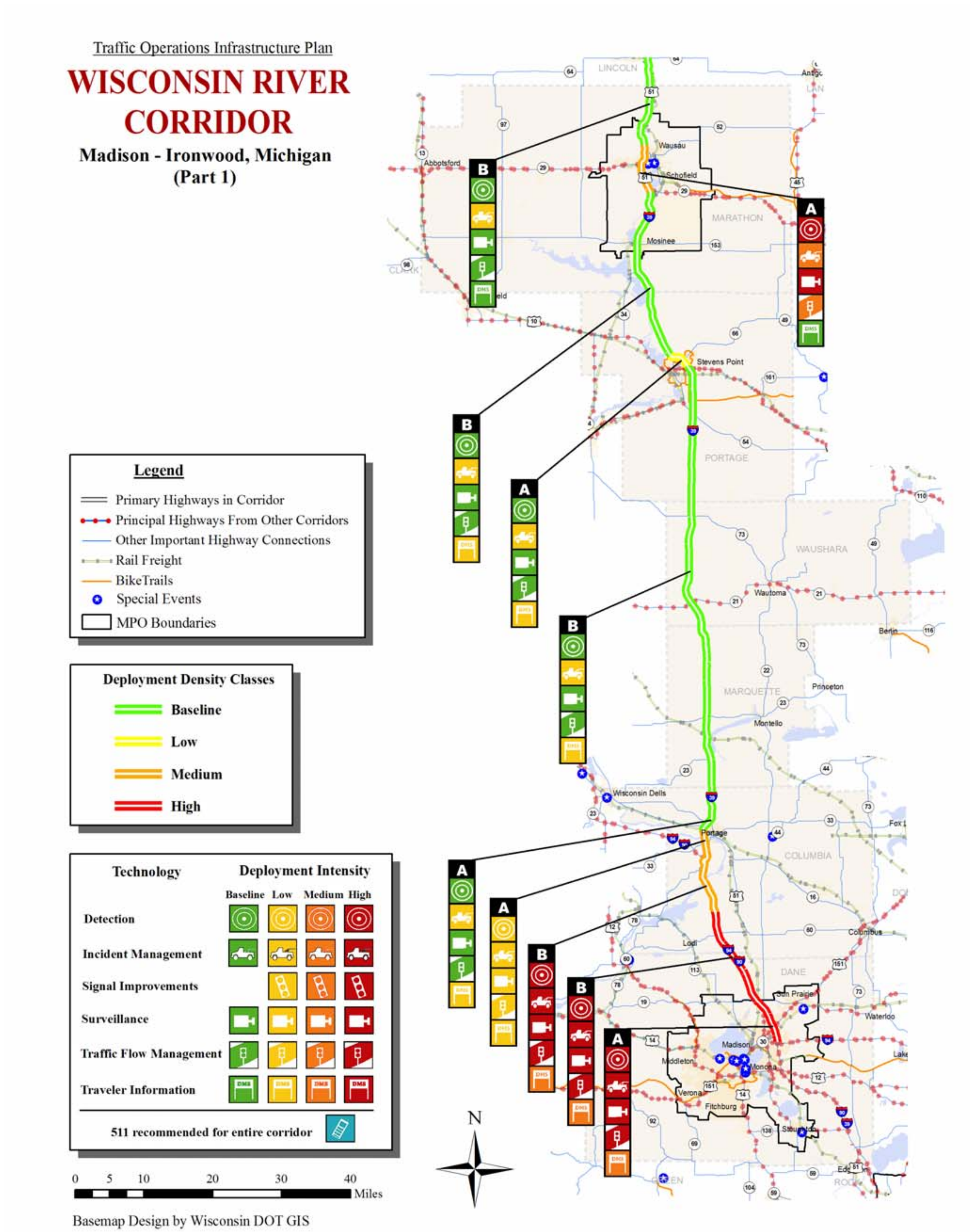
- Various low level traffic signal deployments are recommended throughout the Corridor; primarily signal controller upgrades. (See *TOIP Appendix C* for further details.)

Corridor Statistics

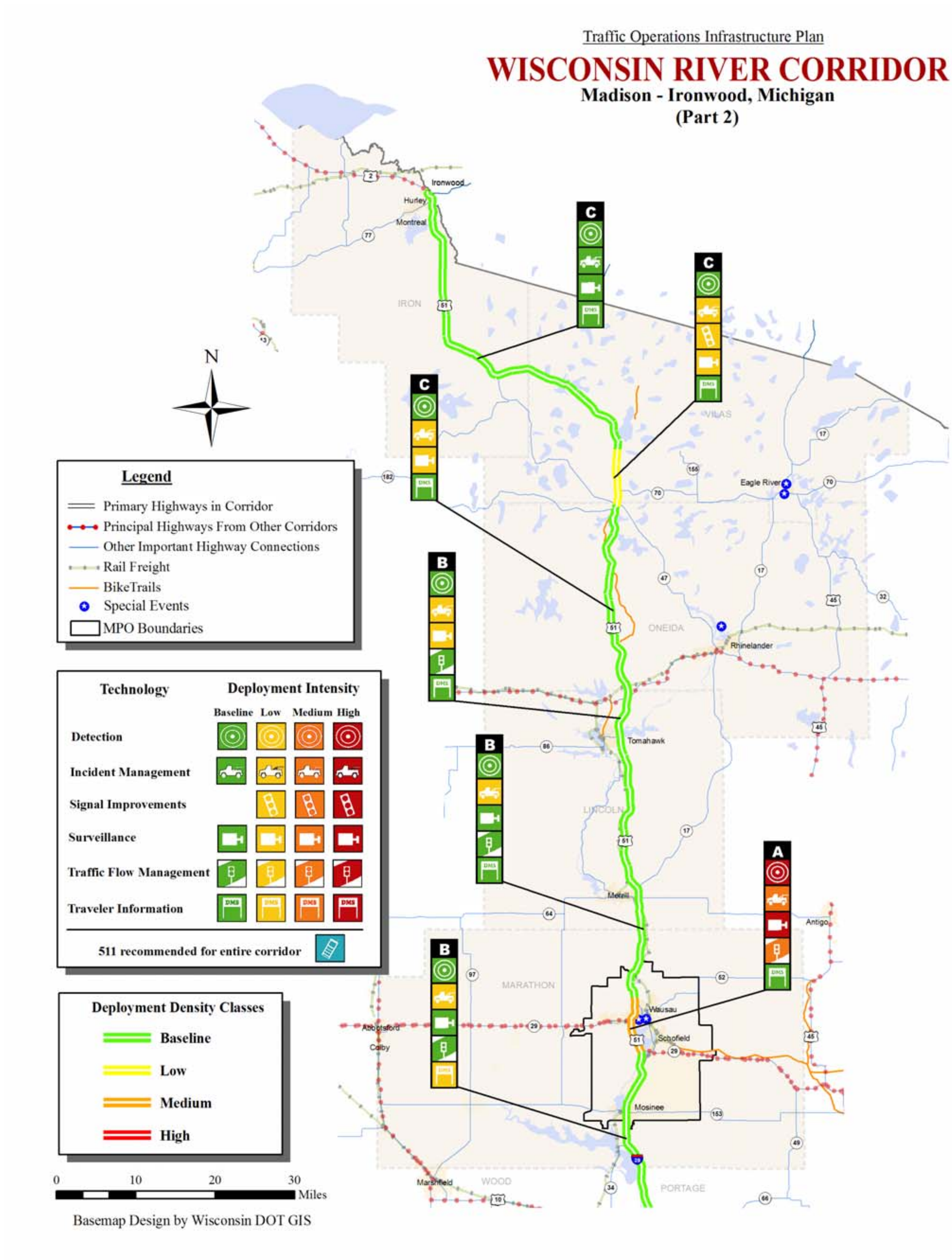
Total Miles =
260

Deployment Density Class	Miles	% of Corridor
Baseline	180.3	69.4%
Low	50.7	19.5%
Medium	14.9	5.7%
High	14.0	5.4%





Traffic Operations Infrastructure Plan
WISCONSIN RIVER CORRIDOR
Madison - Ironwood, Michigan
(Part 1)
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 5 10 20 30 40
Miles
N
Basemap Design by Wisconsin DOT GIS
Wausau
Schofield
Mosinee
Abbotsford
MARATHON
Stevens Point
PORTAGE
WAUSHARA
Wautoma
Berlin
MARQUETTE
Princeton
Montello
Wisconsin Dells
Portage
COLUMBIA
Columbus
Lodi
DANE
Sun Prairie
Waterloo
Madison
Middleton
Monona
Verona
Fitchburg
Stoughton



Traffic Operations Infrastructure Plan
WISCONSIN RIVER CORRIDOR
Madison - Ironwood, Michigan
(Part 2)
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 10 20 30
Miles
Basemap Design by Wisconsin DOT GIS
Ironwood
Hurley
Montreal
IRON
VILAS
ONEIDA
LINCOLN
MARATHON
WOOD
PORTAGE
Eagle River
Rhinelander
Tomahawk
Merrill
Antigo
Wausau
Schofield
Abbotsford
Colby
Mosinee
Marshfield
A
B
C

Chippewa Valley Corridor

Corridor Overview

The Chippewa Valley Corridor includes I-94 from the Minnesota border (Hudson) to Eau Claire as well as the parallel routes of US 12 and WIS 29 as well as the Eau Claire – Chippewa Falls MPO Region. Major traffic generators in this corridor are the Twin Cities metropolitan area and the Eau Claire/Chippewa Falls region. Over half of Minnesota's population resides in the Twin Cities metropolitan area, with growth encompassing the western portion of the Chippewa Valley Corridor. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), recurring congestion westbound into Minneapolis during the daily peak periods and weather disturbances during the winter months.

Note: The realignment of US 53 is likely to impact recommendations in the future.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High levels of surveillance, detection, and traffic flow management are recommended on I-94 near the Wisconsin-Minnesota border. Incident management is recommended at a medium level for the length of I-94 due to safety and weather incident concerns.
- The realignment of US 53 is likely to influence recommendations within Eau Claire-Chippwa Falls significantly. (See *TOIP Appendix A* for further details.)

Traveler Information

- The entire segment of I-94 is recommended for medium density deployment. Portable DMS are recommended for westbound traffic approaching Hudson and westbound and eastbound approaching the Knapp hill to provide additional weather warnings.
- For the Chippewa Falls – Eau Claire MPO Region, it is recommended that portable DMS be located on major approaches to the Chippewa Falls/Eau Claire ring road (I-94, WIS 29, and US 53) to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

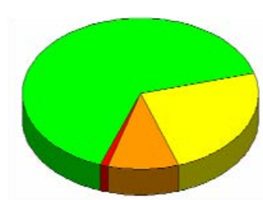
Signal Systems

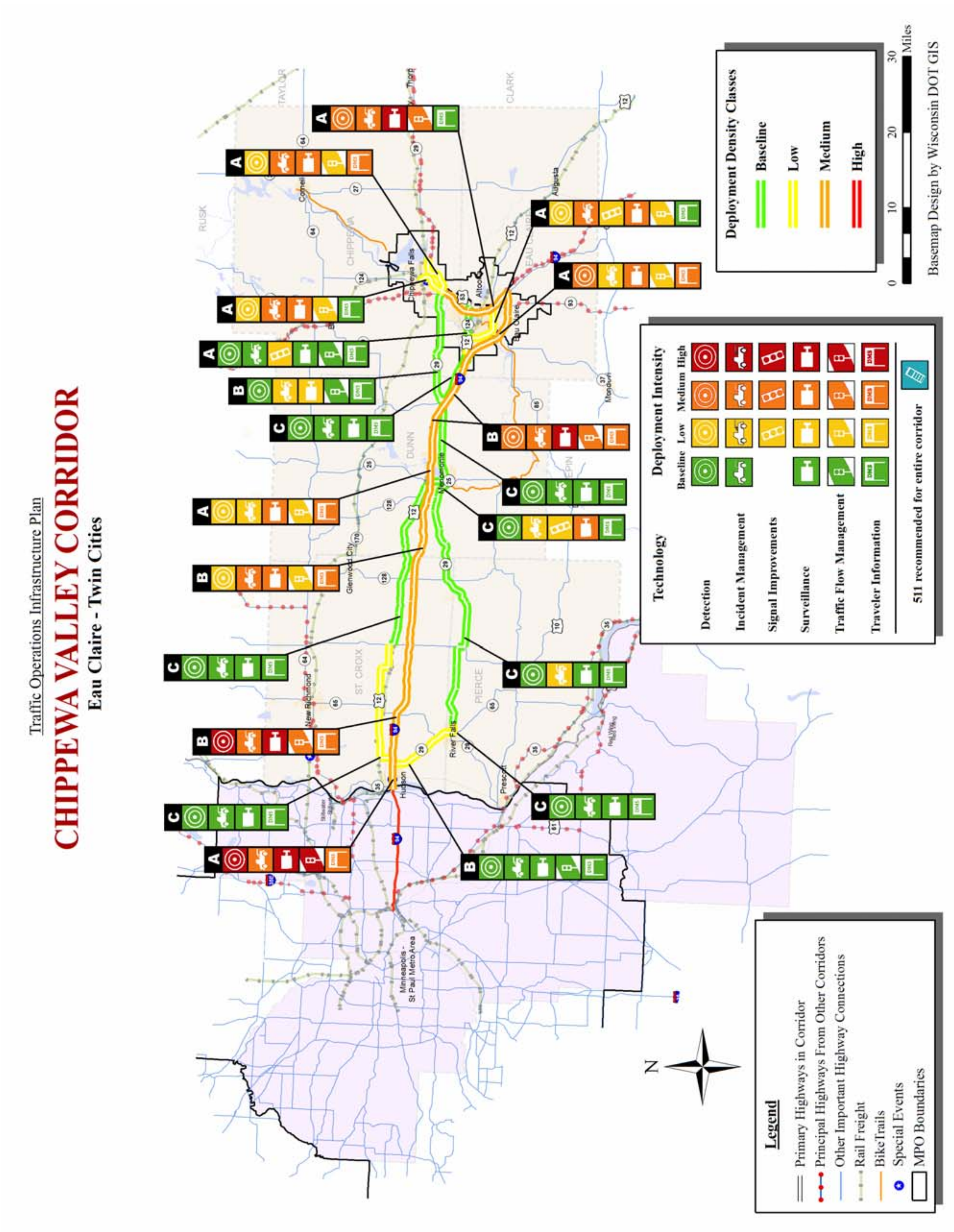
- Signal recommendations throughout the Corridor are low level and consist primarily of traffic signal controller upgrades. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
230

Deployment Density Class	Miles	% of Corridor
Baseline	149.5	65.1%
Low	55.5	24.2%
Medium	22.3	9.7%
High	2.4	1.0%





Traffic Operations Infrastructure Plan
CHIPPEWA VALLEY CORRIDOR
Eau Claire - Twin Cities
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 10 20 30 Miles
Basemap Design by Wisconsin DOT GIS
Minneapolis - St Paul Metro Area
Hudson
New Richmond
River Falls
Prescott
Glenwood City
Menomonie
Eau Claire
Chippewa Falls
Altoona
Augusta
Cornell
ST. CROIX
PIERCE
DUNN
CHIPPEWA
CLARK
RUSK
TAYLOR

Wild Goose Corridor

Corridor Overview

The Wild Goose Corridor includes US 151 from Madison (US 12) to Fond du Lac (US 41), WIS 26 from US 151 to Oshkosh (WIS 26), and US 41 from Fond du Lac to Oshkosh (US 45) as well as portions of the Madison MPO and Appleton-Oshkosh-Fond du Lac Regions. This Corridor is part of a major passenger and freight corridor linking Green Bay and the Fox River Valley and Madison and points further south and west. It is an important tourist corridor between the population centers in Iowa and the recreation areas of northeastern Wisconsin, including Door County. The Corridor is also a major commuter route for the growing communities in Dodge County and northeastern Dane County.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High levels of operations infrastructure are called for within the currently heavily instrumented Madison metropolitan area.
- The Appleton/Oshkosh/Fond du Lac Region likewise shows high operational needs, though the planned instrumentation of US 41 leads to reduced recommended levels of deployment.
- Recommendations on US 151 between Madison and Fond du Lac are low, with some medium deployments recommended near Beaver Dam due to elevated crash rates. (See *TOIP Appendix A* for further details.)

Traveler Information

- US 151 between downtown Madison and Sun Prairie is recommended for high density deployment. Permanent DMS are recommended to provide real time travel time information to key destinations as well as provide information on provide incident and alternative route guidance as well as for weather and construction alerts.
- Medium density deployment is recommended for the majority of the US 41 corridor. For the Fond du Lac area, it is recommended that portable DMS be located on US 41 approaching the city from the south and north.
- For the Oshkosh area, it is recommended that portable DMS be located on US 41 approaching the city from the south and north to provide guidance as well as being used for weather, construction, and traffic event (EAA Fly-in) alerts. In addition, it is recommended that a portable DMS be located north of the WIS 26 exit for southbound traffic. (See *TOIP Appendix B* for further details.)

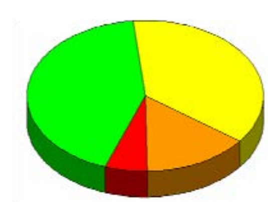
Signal Systems

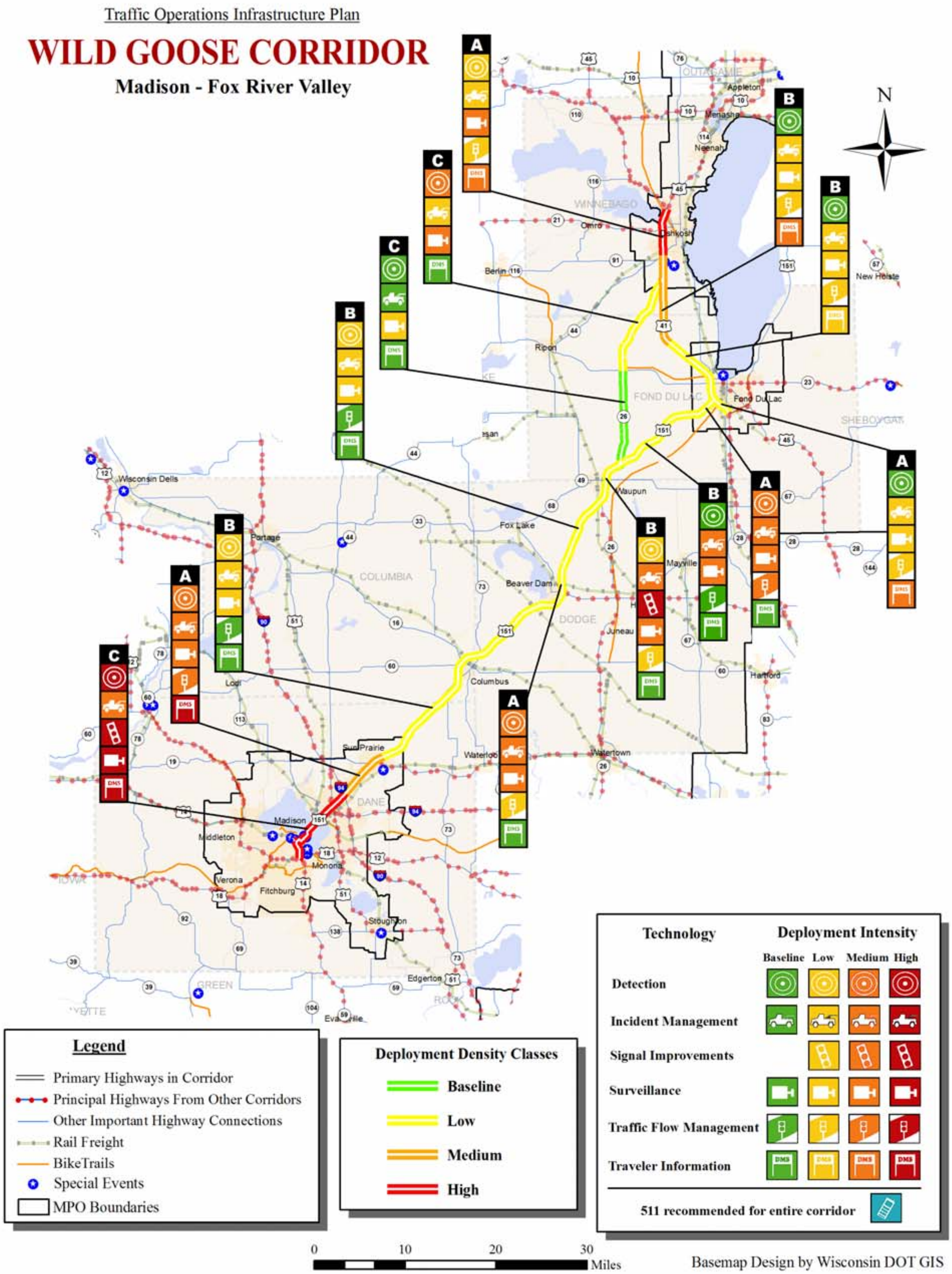
- Targeted high level traffic signal deployments throughout the corridor include ATMS with real time communications link to operating agencies and the STOC in the Madison region. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **118**

Deployment Density Class	Miles	% of Corridor
Baseline	50.8	42.9%
Low	43.5	36.7%
Medium	17.1	14.5%
High	7.0	5.9%




Traffic Operations Infrastructure Plan
WILD GOOSE CORRIDOR
Madison - Fox River Valley
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0
10
20
30
Miles
Basemap Design by Wisconsin DOT GIS

Peace Memorial Corridor

Corridor Overview

The Peace Memorial Corridor includes a portion of the Eau Claire-Chippewa Falls MPO Region as well as US 53 from Eau Claire (I-94) to the Minnesota border (Duluth/Superior).

Note: The realignment of US 53 is likely to impact recommendations in the future.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Recommendations for surveillance are high on US 53 in Eau Claire-Chippewa Falls, though the realignment of US 53 is likely to impact deployment needs significantly. Medium levels of detection, incident management, and traffic flow management are also called for.
- Incident management is recommended at a medium level in the primarily rural portion of US 53 north of Rice Lake due safety and severe weather impact concerns.
- The Superior/Duluth region has medium levels of surveillance recommended. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment in Superior where Portable DMS are recommended for northbound US 2/53 to provide incident and alternate route guidance (two bridges into Minnesota) as well as being used for weather and construction alerts.
- For the Chippewa Falls – Eau Claire MPO Region, it is recommended that portable DMS be located on major approaches to the Chippewa Falls/Eau Claire ring road (I-94, WIS 29, and US 53) to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor, which includes statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

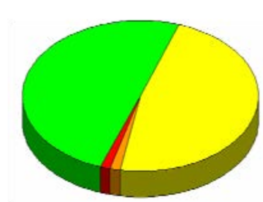
Signal Systems

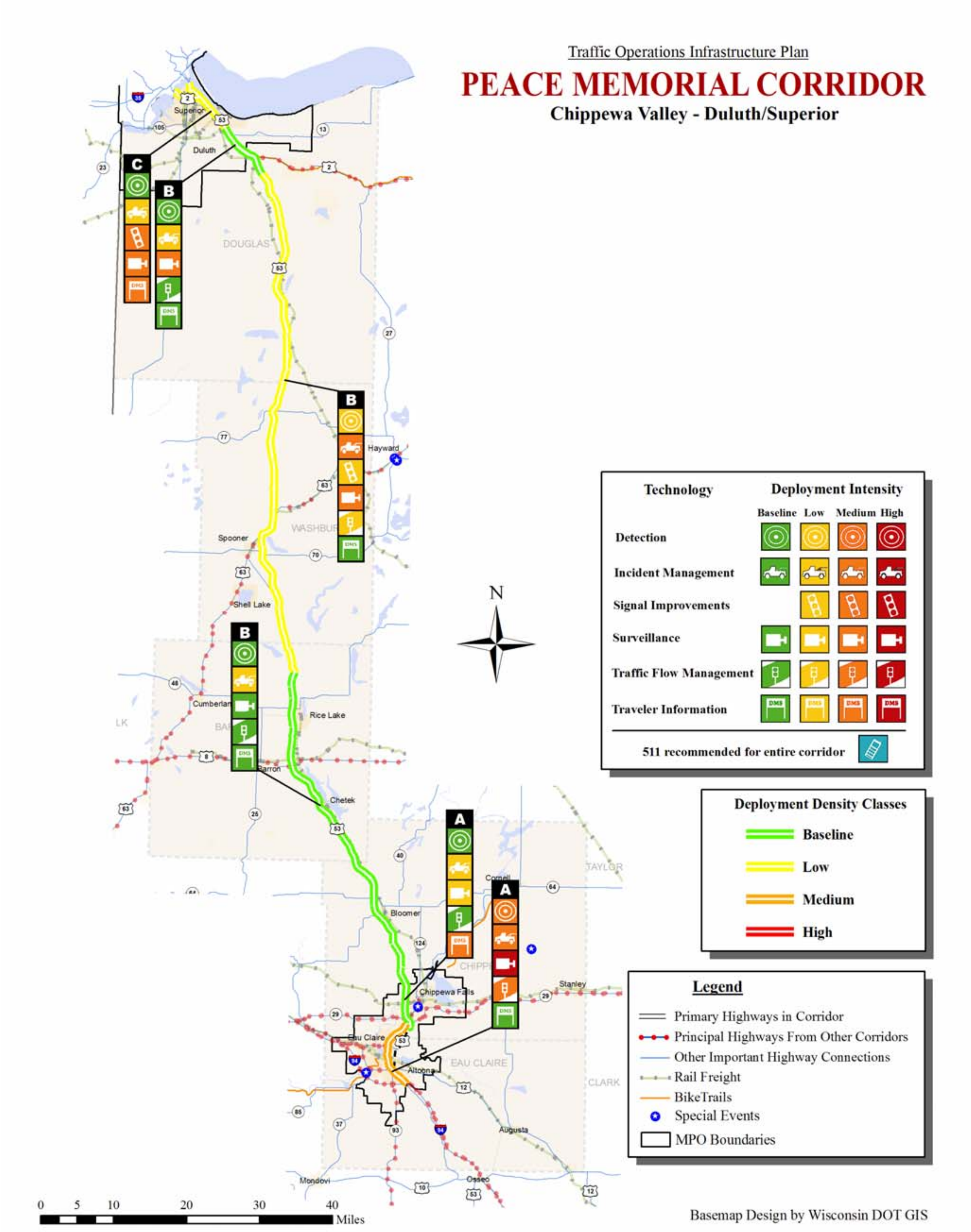
- Various low level traffic signal deployments are recommended throughout the Corridor; primarily signal controller upgrades. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
159

Deployment Density Class	Miles	% of Corridor
Baseline	79.3	49.9%
Low	75.5	47.5%
Medium	1.9	1.2%
High	2.4	1.5%




Traffic Operations Infrastructure Plan
PEACE MEMORIAL CORRIDOR
Chippewa Valley - Duluth/Superior
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
N
Superior
Duluth
DOUGLAS
Hayward
WASHBURN
Spooner
Shell Lake
Cumberland
Rice Lake
Barron
Chetek
Bloomer
Cornell
Chippewa Falls
Stanley
Eau Claire
Altoona
EAU CLAIRE
CLARK
TAYLOR
Augusta
Mondovi
Osseo
A
B
C
0 5 10 20 30 40
Miles
Basemap Design by Wisconsin DOT GIS

Cornish Heritage Corridor

Corridor Overview

The Cornish Heritage Corridor includes US 18/151 from the Iowa border (Dubuque) to Columbus and a portion of the Madison MPO Region. This Corridor accommodates regional travel between Iowa and the Madison area and experiences high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months. The segment from Verona to Sun Prairie also experiences recurring congestion during the weekday peak periods. The long-range vision for the Cornish Heritage Corridor is a continuous freeway from the Wisconsin/Iowa state line to the Madison beltway.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High levels of infrastructure are recommended for the Madison metropolitan area, supplementing existing traffic operations infrastructure devices.
- Recommendations on US 18/151 are generally for baseline deployment in this Corridor due to limited operational needs. Baseline deployment includes statewide initiatives such as 511 and STOC operations. In the Platteville area, recommendations for low incident management and surveillance reflect the input of transportation professionals. (See *TOIP Appendix A* for further details.)

Traveler Information

- US 18/151 from Verona to Madison is recommended for medium density deployment. Portable DMS are recommended for US 18/151 prior to and along the Madison Beltline to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- US 151 between downtown Madison and Sun Prairie is recommended for high density deployment. Permanent DMS are recommended to provide real time travel time information to key destinations as well as provide information on incident and alternative route guidance as well as for weather and construction alerts. (See *TOIP Appendix B* for further details.)

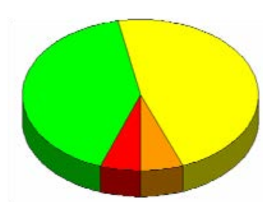
Signal Systems

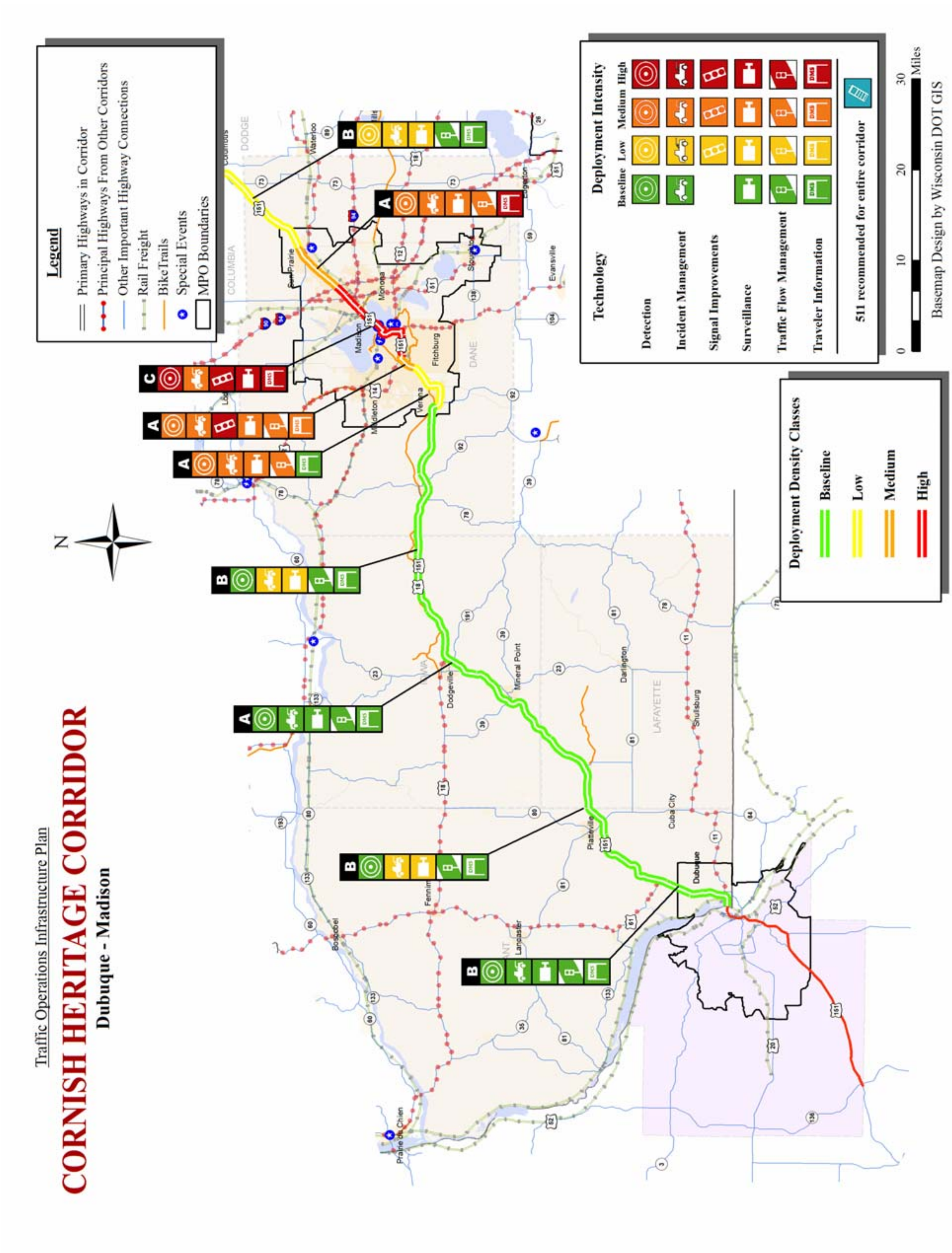
- Various signal upgrades are recommended on the Corridor, such as along US 18/US 151 where an Advanced Traffic Management System (ATMS) with real time communications link to operating agencies and the STOC is recommended. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
113

Deployment Density Class	Miles	% of Corridor
Baseline	46.8	41.3%
Low	53.7	47.4%
Medium	6.4	5.7%
High	6.4	5.6%





Traffic Operations Infrastructure Plan
CORNISH HERITAGE CORRIDOR
Dubuque - Madison
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 10 20 30 Miles
Basemap Design by Wisconsin DOT GIS
Deployment Density Classes
Baseline
Low
Medium
High
Madison
Fitchburg
Middleton
Verona
Monona
Sun Prairie
Waterloo
Stoughton
Evansville
Dodgeville
Mineral Point
Darlington
Shullsburg
Cuba City
Platteville
Dubuque
Lancaster
Fennimore
Boscobel
Prairie du Chien
DANE
LAFAYETTE
COLUMBIA
DODGE

Titletown Corridor

Corridor Overview

The Titletown Corridor includes I-43/WIS 32 from Milwaukee (I-94) to Green Bay (US 41) and WIS 57 from I-43 to Green Bay (WIS 172) and WIS 172 from US 41 to I-43. Major traffic generators in this Corridor are the metropolitan areas of Milwaukee and Green Bay. Other traffic generators are the Manitowoc and Sheboygan areas. The Corridor experiences significant regional traffic, high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- The Titletown Corridor has generally low and baseline recommendations outside of Milwaukee and Green Bay. Incident management recommendations remain low throughout I-43 reflecting a crash severity rating that is higher than typical for baseline roadway segments.
- Cameras at the two Fox River freeway crossings in the Green Bay area are planned to be installed. Also, traffic operations deployment is planned for the US 41 parallel corridor from Oshkosh to the Green Bay area and may include portions of the Titletown Corridor, fulfilling or influencing the high deployment recommendations in Green Bay. (See *TOIP Appendix A* for further details.)

Traveler Information

- High density deployment is recommended for I-43 beginning at I-94 and running through the northern Milwaukee suburbs. The segment experiences significant recurring congestion on a daily basis. It is recommended that permanent DMS be deployed inbound into the Milwaukee metro area. The DMS should be equipped with real time travel time capability as well as incident and weather warnings.
- Medium density deployment is recommended for WIS 172 and I-43 north of WIS 172. It is recommended that Portable DMS be located approaching the US 41, I-43, and WIS 172 ring road around the city to provide incident and alternate route guidance as well as for weather, construction, and event (Green Bay Packer games) alerts. (See *TOIP Appendix B* for further details.)

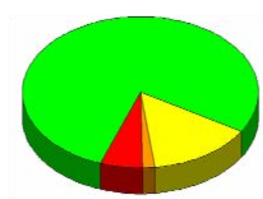
Signal Systems

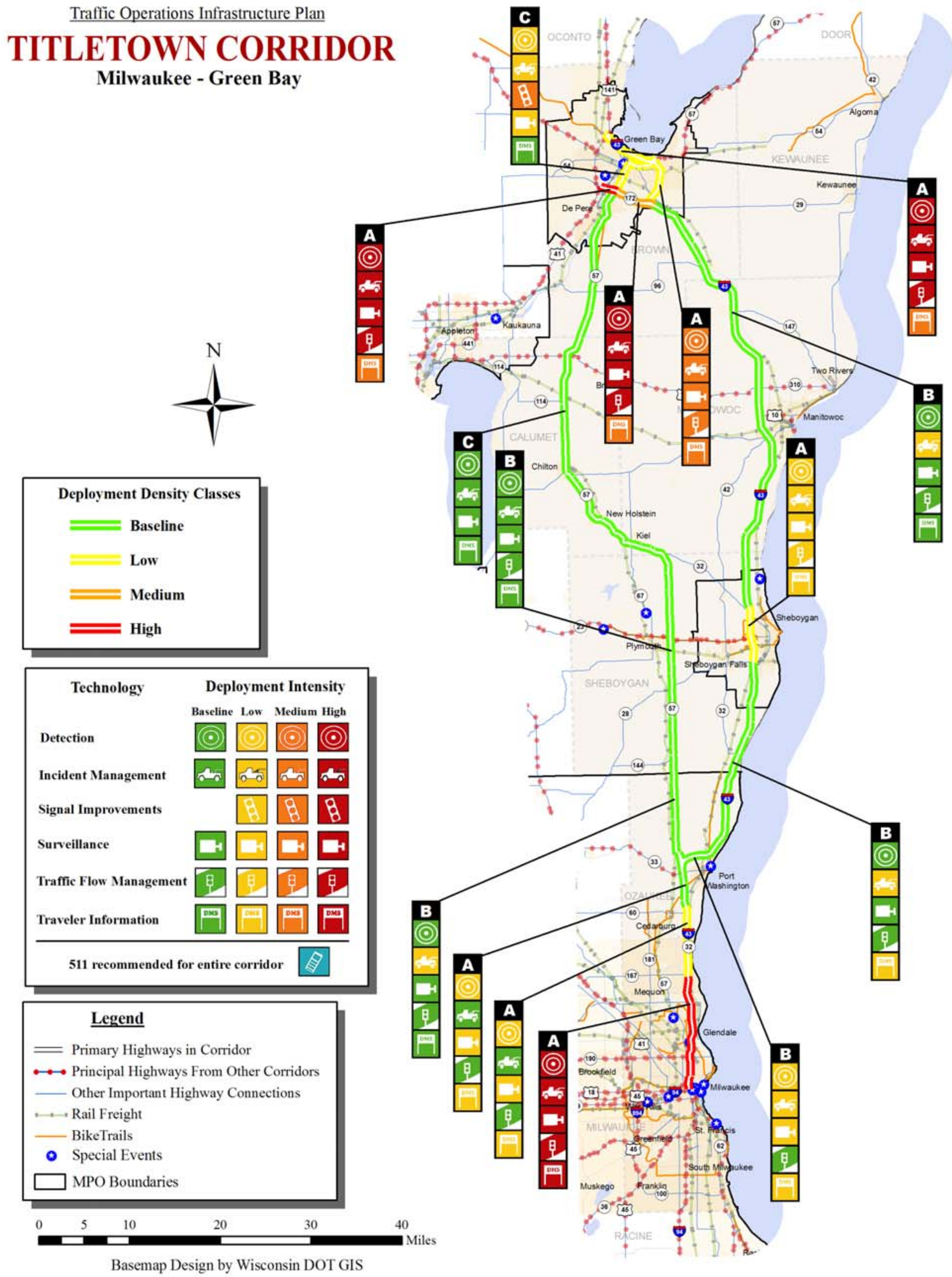
- Various low level traffic signal deployments are recommended throughout the Corridor; primarily signal controller upgrades and targeted closed loop systems. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
215

Deployment Density Class	Miles	% of Corridor
Baseline	167.7	78.1%
Low	30.8	14.3%
Medium	4.0	1.9%
High	12.3	5.7%




Traffic Operations Infrastructure Plan
TITLETOWN CORRIDOR
Milwaukee - Green Bay
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0
5
10
20
30
40
Miles
Basemap Design by Wisconsin DOT GIS
OCONTO
DOOR
Green Bay
Algoma
KEWAUNEE
Kewaunee
De Pere
BROWN
Kaukauna
Appleton
Two Rivers
Manitowoc
CALUMET
Chilton
New Holstein
Kiel
Sheboygan
Plymouth
Sheboygan Falls
SHEBOYGAN
Port Washington
OZAUKEE
Cedarburg
Mequon
Glendale
Brookfield
Milwaukee
MILWAUKEE
Greenfield
St. Francis
South Milwaukee
Muskego
Franklin
RACINE
A
B
C

Southern Tier Corridor

Corridor Overview

The Southern Corridor includes I-43 from Beloit to Elkhorn, and US 14 from Janesville (I-39/90) to I-43, and WIS 50 from Delavan (I-43) to Kenosha. This Corridor is part of a major passenger and freight corridor between the metro areas of Janesville and Beloit (and points south and west) and the metro areas of Racine and Kenosha. The Southern Tier Corridor serves major industrial and manufacturing areas in southern Wisconsin. It also serves some of the richest agricultural land in the state as well as the major tourism/recreational areas in Walworth County.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Recommendations show that there are hotspots in the Lake Geneva, Delvan-Elkhorn and Kenosha areas that would benefit from surveillance and increased incident management resources.
- Detection and surveillance recommendations fluctuate between low and baseline, being generally heavier on WIS 50 than WIS 11. (See *TOIP Appendix A* for further details.)

Traveler Information

- Low density deployment of traveler information technologies is recommended for the entire length of I-43.
- Baseline density deployment is recommended for the remainder of the Corridor (US 14, WIS 11/50), which includes statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

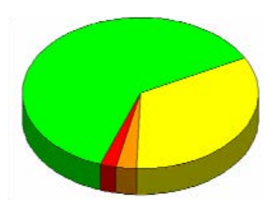
Signal Systems

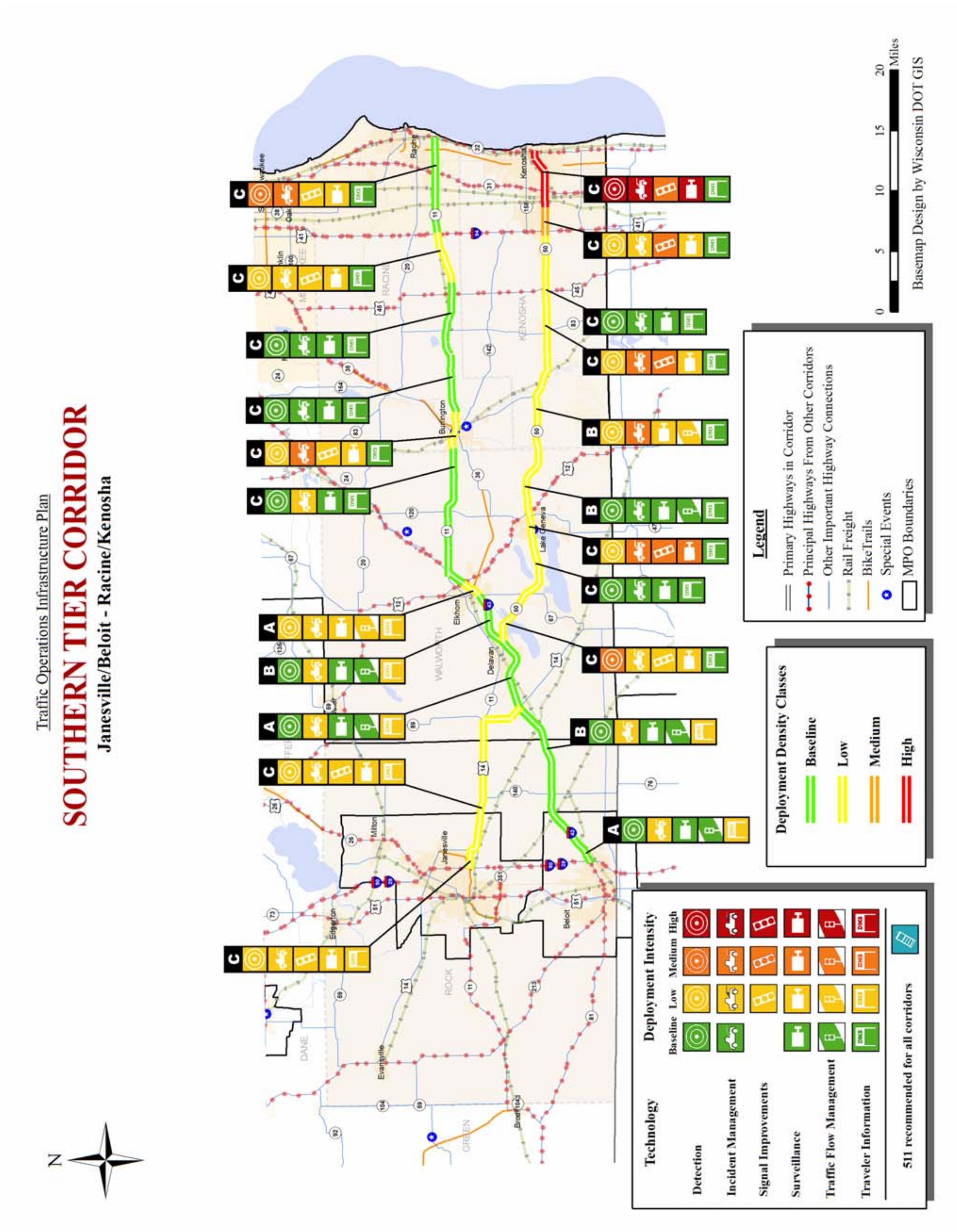
- Various low level traffic signal deployments are recommended throughout the Corridor; primarily signal controller upgrades and targeted closed loop systems. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **125**

Deployment Density Class	Miles	% of Corridor
Baseline	77.3	61.7%
Low	41.5	33.1%
Medium	3.7	2.9%
High	2.8	2.2%




Traffic Operations Infrastructure Plan
SOUTHERN TIER CORRIDOR
Janesville/Beloit - Racine/Kenosha
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for all corridors
0 5 10 15 20 Miles
Basemap Design by Wisconsin DOT GIS
Janesville
Beloit
Milton
Edgerton
Evansville
Brodhead
Delavan
Elkhorn
Lake Geneva
Burlington
Racine
Kenosha
ROCK
WALWORTH
KENOSHA
RACINE
GREEN
DANE

Glacial Plains Corridor

Corridor Overview

The Glacial Plains Corridor includes a portion of the Janesville-Beloit Region as well as I-43 from Beloit (I-39/90) to I-94 in Milwaukee as well as WIS 11/14 from Janesville (I-39/90) to I-43, and WIS 36 from WIS 20 to I-894. This Corridor accommodates regional travel between Illinois and the Milwaukee area and experiences high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months. The eastern section of I-43 experiences significant recurring congestion during the weekday peak periods through the Milwaukee metro area.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- High levels of surveillance, detection, incident management, and traffic flow management are recommended on I-43 within Milwaukee on this already heavily instrumented Corridor segment. On the most eastern segment, weekday service patrols are recommended.
- Moving west, lower deployment recommendations are made which would extend the existing surveillance and detection deployments.
- Outside of the Milwaukee area, the recommendations are baseline to low with a low level of incident management carried almost throughout the corridor. (See *TOIP Appendix A* for further details.)

Traveler Information

- High density deployment is recommended for I-43 (New Berlin to I-94) as enters the Milwaukee metro area. Permanent DMS are recommended to provide real time travel time information to key destinations as well as information on incident and alternative route guidance as well as for weather and construction alerts. (See *TOIP Appendix B* for further details.)

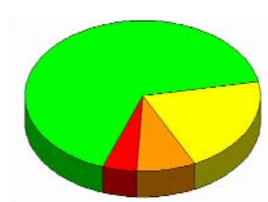
Signal Systems

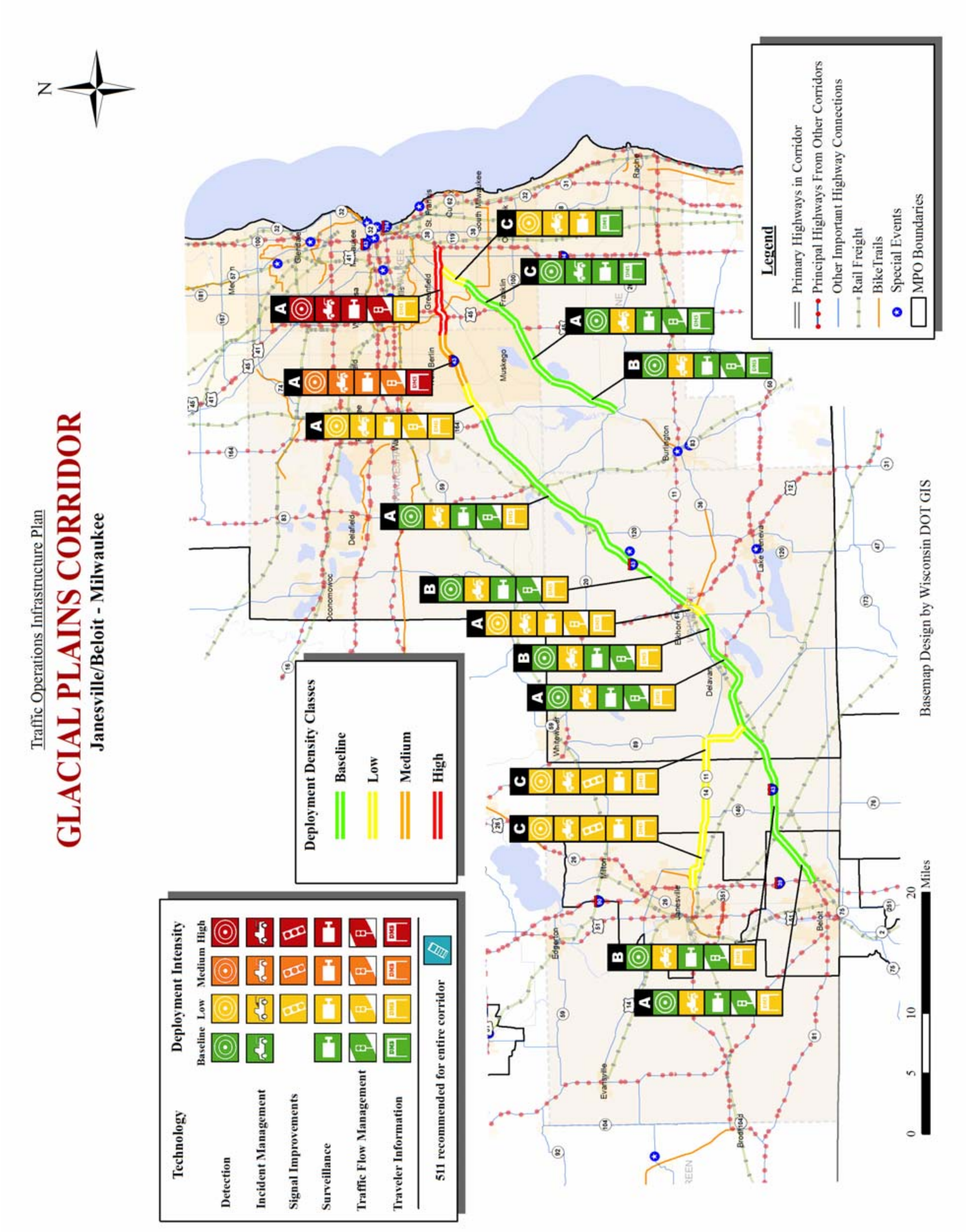
- Various low level traffic signal deployments are recommended throughout the Corridor; primarily signal controller upgrades. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
102

Deployment Density Class	Miles	% of Corridor
Baseline	67.8	66.4%
Low	21.3	20.8%
Medium	8.1	8.0%
High	4.9	4.8%





Traffic Operations Infrastructure Plan
GLACIAL PLAINS CORRIDOR
Janesville/Beloit - Milwaukee
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Basemap Design by Wisconsin DOT GIS
0
5
10
20
Miles
N

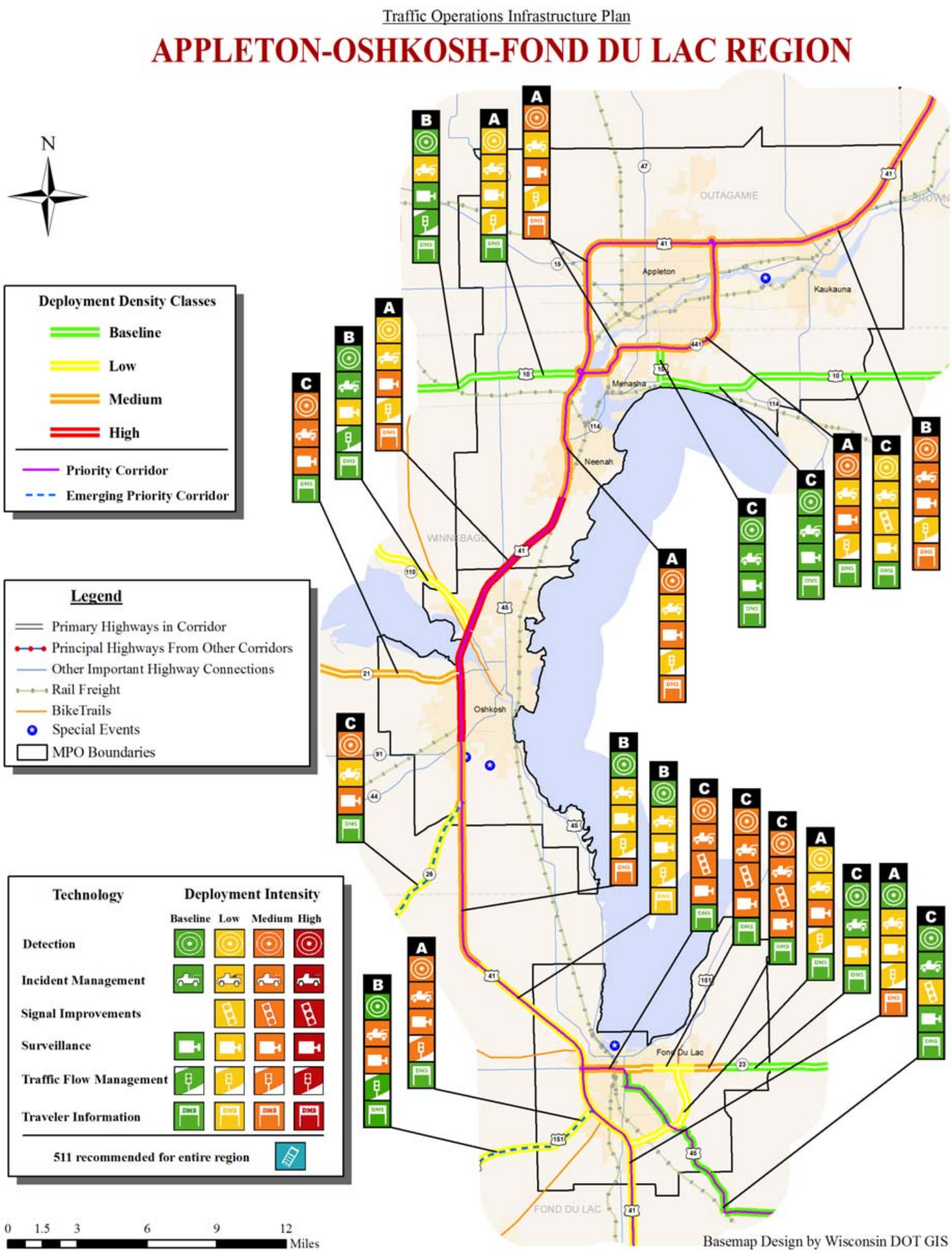
3.4 METRO NODES

Recommendations are also summarized in the form of metropolitan area maps, refered to as "metro node" maps. These summaries are intended to offer the reader a glance at the technology needs and recommendations within major metropolitan areas of Wisconsin, where multiple 2030 Multimodal Corridors frequently converge.

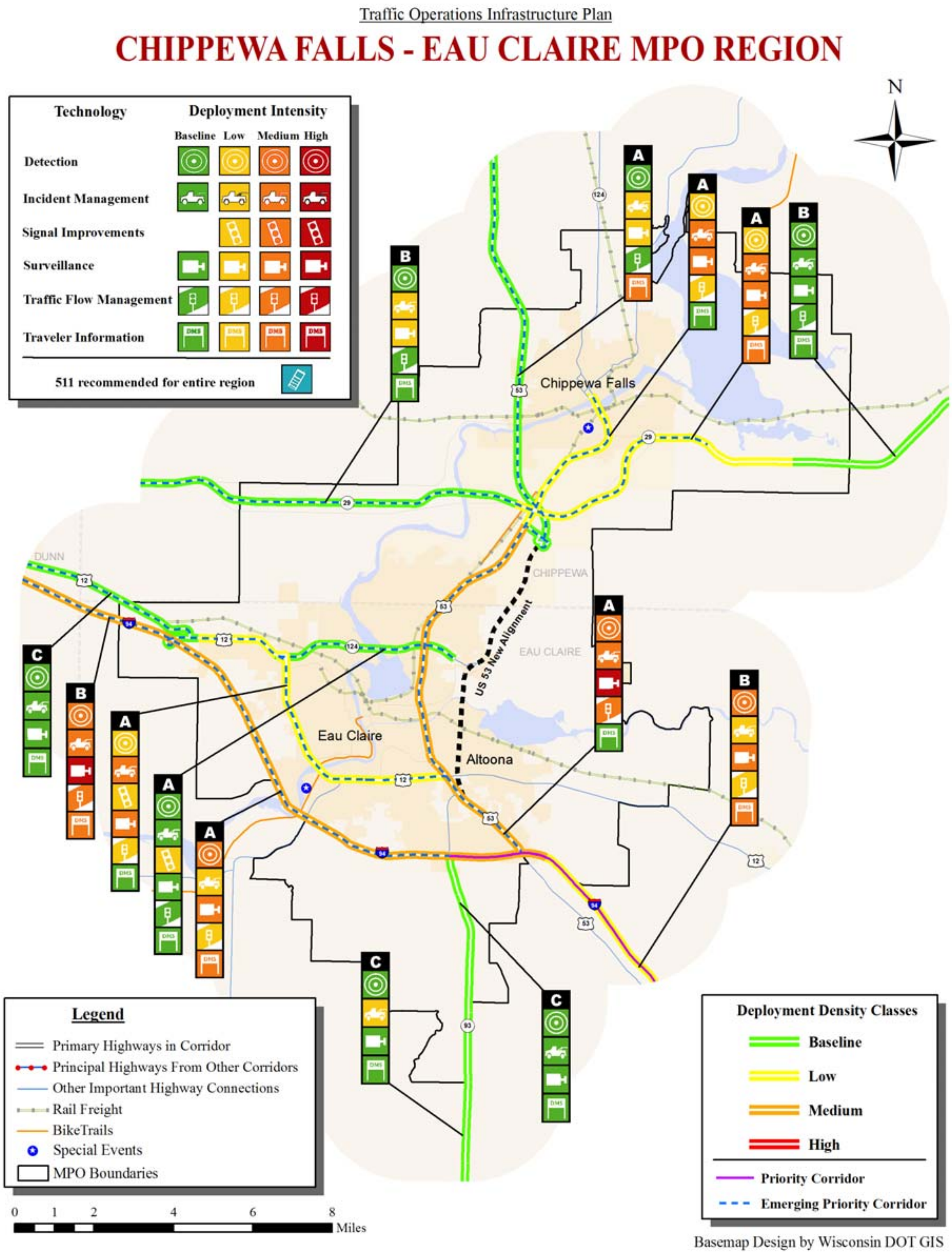
Metro node maps follow the same display standards as the corridor maps (refer to Section 2.5.1 "How to Read the Maps in this Report" for further explanation) with the additional detail of displaying where the primary corridors are Priority or Emerging Priority. Priority Corridors have a solid purple centerline while Emerging Priority Corridors have a dashed blue centerline.

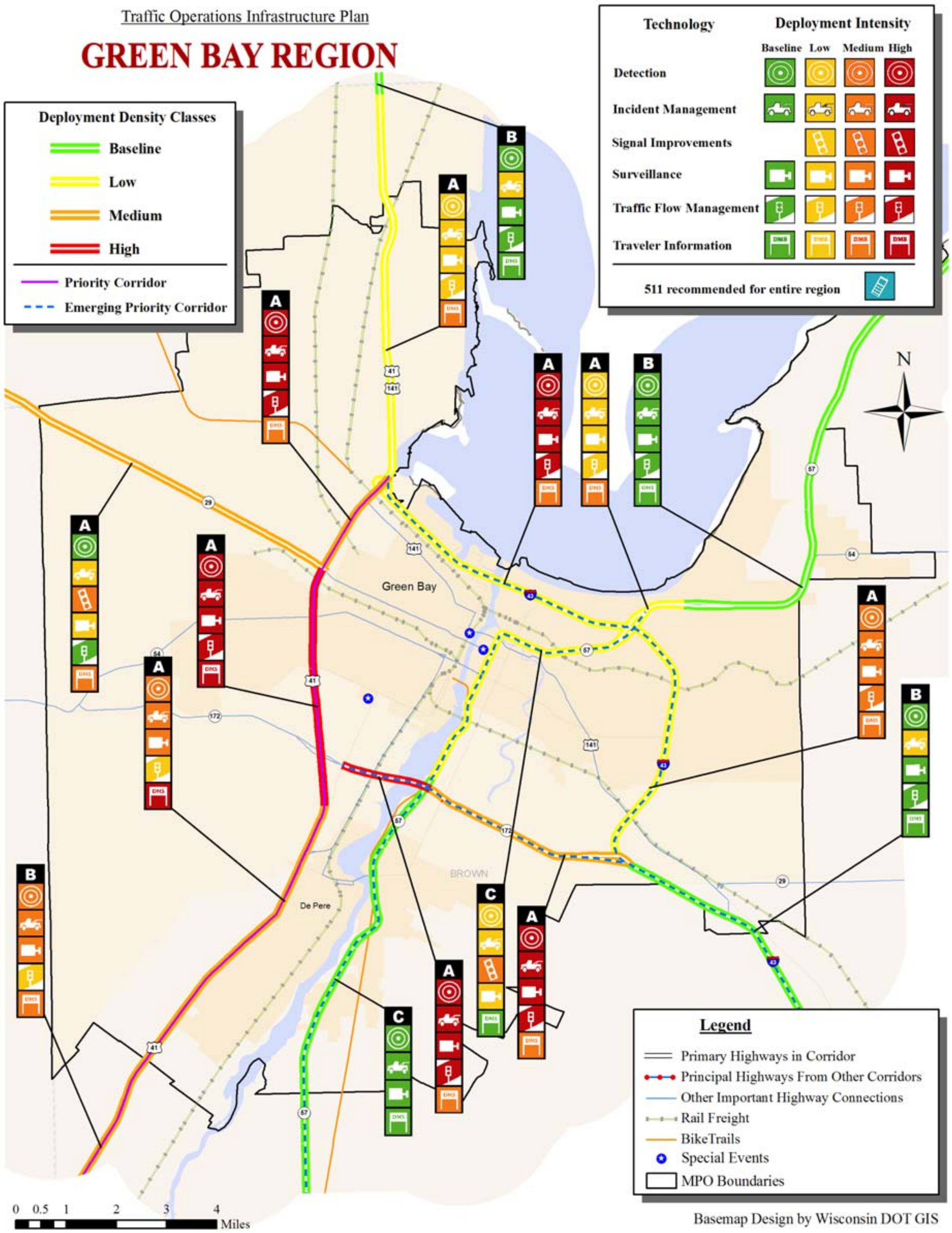
Metro node maps are included for the following metro areas in Wisconsin.

- Appleton-Oshkosh-Fond du Lac
- Chippewa Falls-Eau Claire
- Green Bay
- Janesville-Beloit
- Madison
- Milwaukee-Waukesha

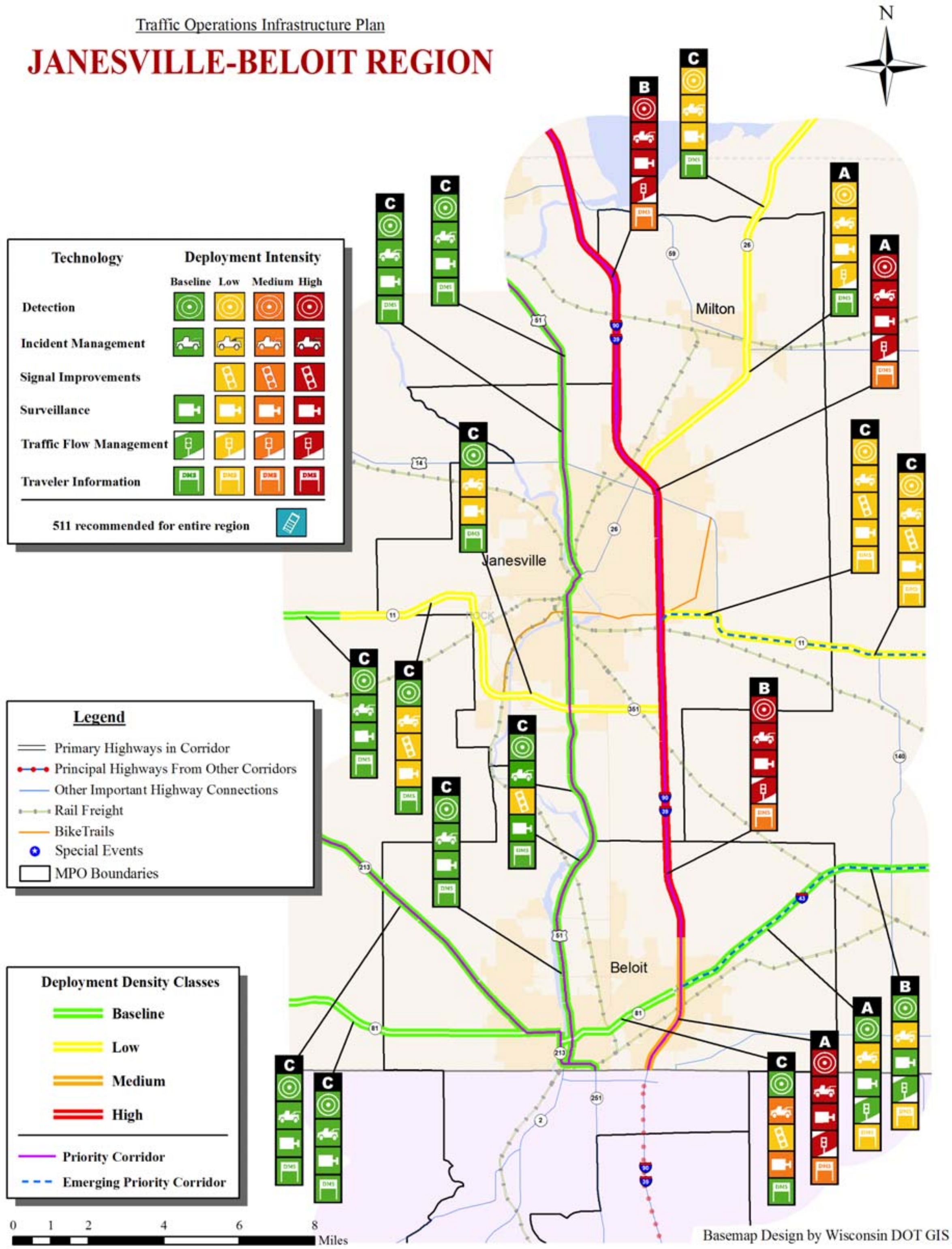


Traffic Operations Infrastructure Plan
APPLETON-OSHKOSH-FOND DU LAC REGION
N
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
OUTAGAMIE
Appleton
Kaukauna
Menasha
Neenah
WINNEBAGO
Oshkosh
Fond Du Lac
FOND DU LAC
0 1.5 3 6 9 12 Miles
Basemap Design by Wisconsin DOT GIS

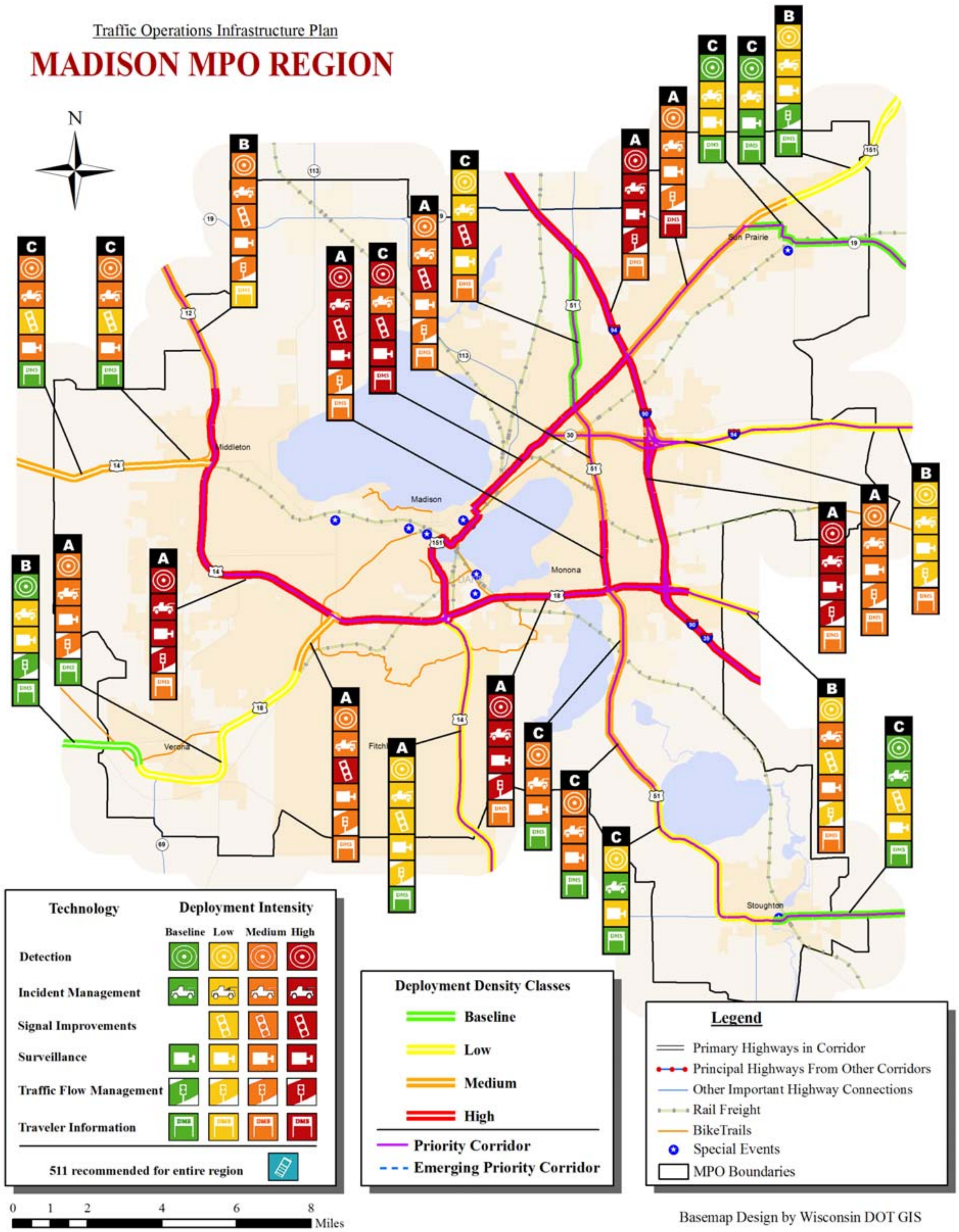

Traffic Operations Infrastructure Plan
CHIPPEWA FALLS - EAU CLAIRE MPO REGION
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
N
Chippewa Falls
Eau Claire
Altoona
US 53 New Alignment
DUNN
CHIPPEWA
EAU CLAIRE
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
0 1 2 4 6 8 Miles
Basemap Design by Wisconsin DOT GIS



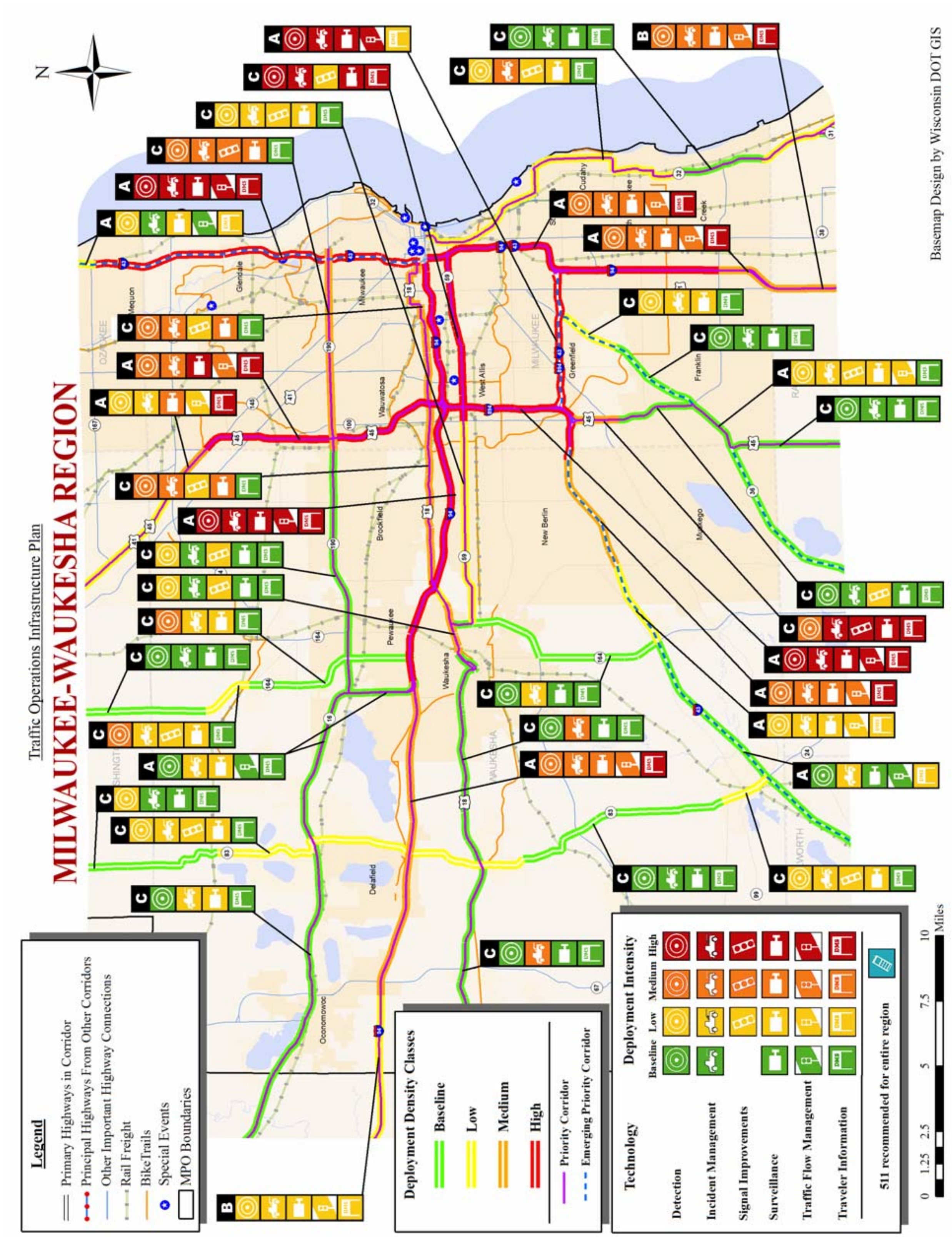
Traffic Operations Infrastructure Plan
GREEN BAY REGION
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
Green Bay
De Pere
BROWN
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 0.5 1 2 3 4 Miles
Basemap Design by Wisconsin DOT GIS



Traffic Operations Infrastructure Plan
JANESVILLE-BELOIT REGION
N
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
0 1 2 4 6 8 Miles
Milton
Janesville
Beloit
Basemap Design by Wisconsin DOT GIS



Traffic Operations Infrastructure Plan
MADISON MPO REGION
N
Middleton
Madison
Monona
Sun Prairie
Verona
Fitchburg
Stoughton
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0
1
2
4
6
8
Miles
Basemap Design by Wisconsin DOT GIS


MILWAUKEE-WAUKESHA REGION
Traffic Operations Infrastructure Plan
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Priority Corridor
Emerging Priority Corridor
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire region
Miles
0
1.25
2.5
5
7.5
10
Basemap Design by Wisconsin DOT GIS

3.5 Remaining Corridors

The remaining 2030 Multimodal Corridors are shown in alphabetical order.

84th Division Railsplitters Corridor

Corridor Overview

The 84th Division Railsplitters includes WIS 33 from Beaver Dam to Port Washington. The Corridor includes the cities of Horicon, Allentown, West Bend, and Saukville. This Corridor is part of an important passenger and freight corridor linking Beaver Dam and Port Washington and serves an important agricultural region of the state.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has very little implemented technology and there is little need for it for most of the Corridor. In West Bend, there is a need for some incident management resources due to the crash rate and AADT. Also, heading into Port Washington, there is some need for detection due to congestion issues. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

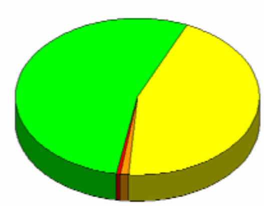
Signal Systems

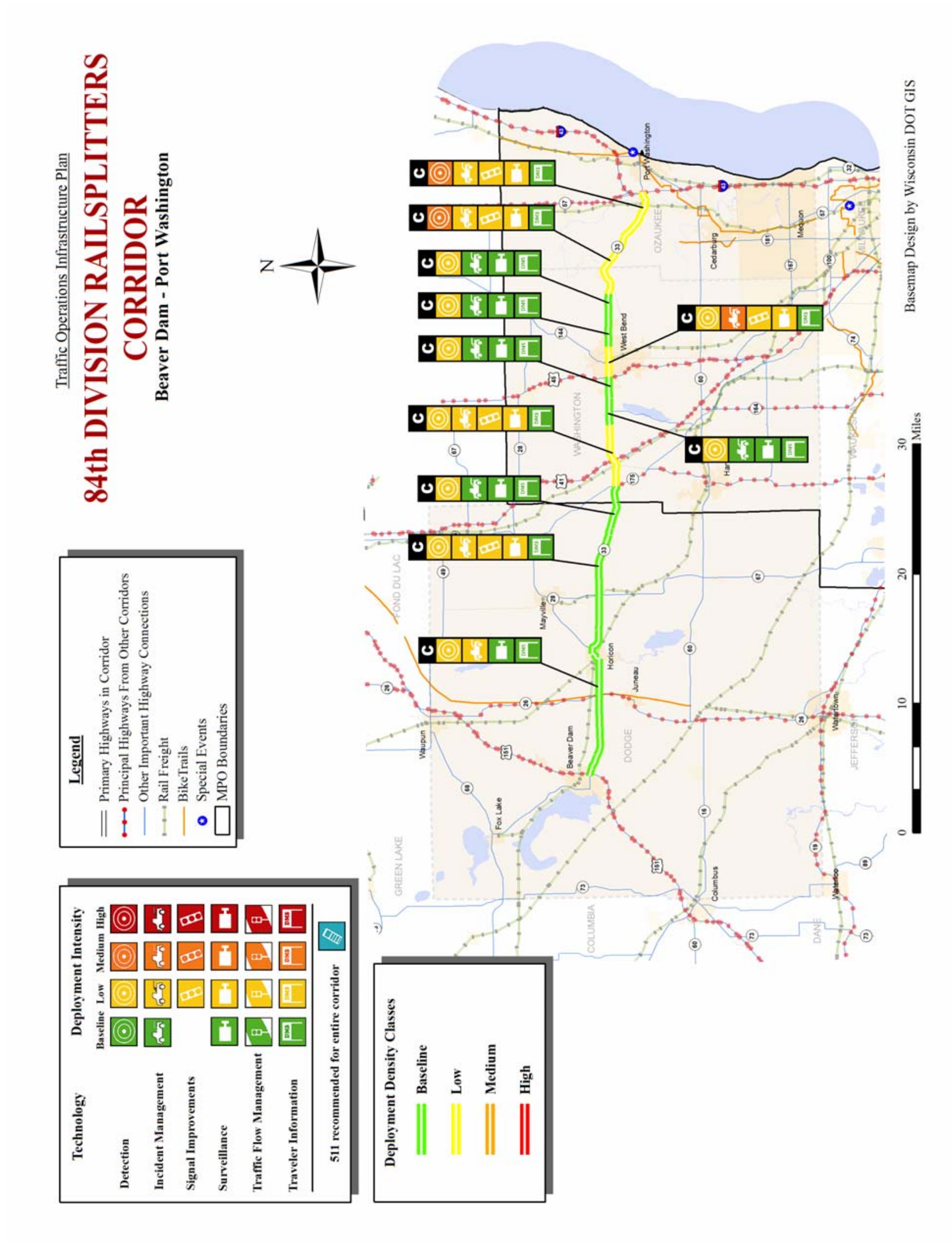
- Southeast of Beaver Dam on WIS 33, low signal deployment density recommendations are made from Roosevelt Drive to Raceway Road. Through West Bend, low signal deployment density recommendations are made on WIS 33 from CTH Z east to Trenton Road. Low signal deployment density recommendations are made on WIS 33 from CTH I to I-43/WIS 57 west of Port Washington. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
48

Deployment Density Class	Miles	% of Corridor
Baseline	25.7	54.0%
Low	21.1	44.4%
Medium	0.5	0.9%
High	0.3	0.7%




Traffic Operations Infrastructure Plan
84th DIVISION RAILSPLITTERS CORRIDOR
Beaver Dam - Port Washington
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
N
0
10
20
30
Miles
Basemap Design by Wisconsin DOT GIS
Port Washington
West Bend
Cedarburg
Mequon
Mayville
Horicon
Juneau
Beaver Dam
Waupun
Fox Lake
Columbus
Watertown
Waterloo
DODGE
WASHINGTON
OZAUKEE
FOND DU LAC
GREEN LAKE
COLUMBIA
DANE
JEFFERSON

Cheese Country Corridor

Corridor Overview

The Cheese Country Corridor includes WIS 11 between the Iowa border (Dubuque) and Janesville as well as WIS 81 from WIS 11 to Beloit (I-43).. This Corridor traverses some of the richest farm land in the country and serves a major agricultural region of southwestern Wisconsin. It also serves as a connection between the metro areas of Janesville and Beloit with Dubuque, Iowa..

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has very little traffic operations infrastructure and little technology is recommended for the Corridor. There are currently three RWIS sites, but very few ATR stations. As the Corridor enters Janesville and Beloit, there is a need for somewhat increased technology and incident management resources. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

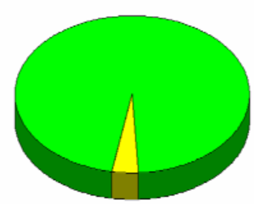
Signal Systems

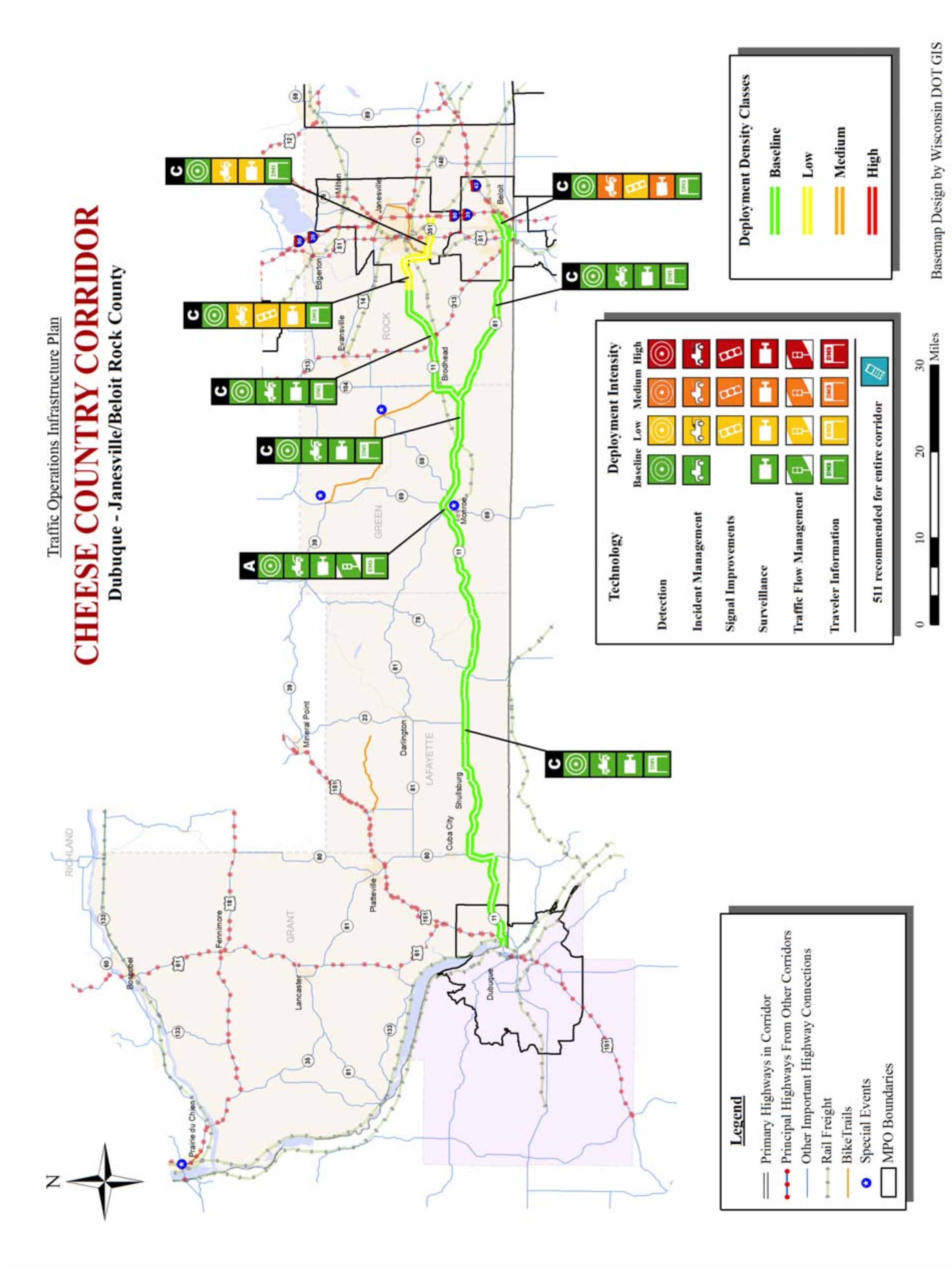
- East of Dubuque, Iowa, low signal deployment density recommendations are made on WIS 11 from US 61/US 151 east to WIS 35. In the Janesville-Beloit Area MPO, low signal deployment density recommendations are proposed on WIS 81 from WIS 213 east to I-39/I-90. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **122**

Deployment Density Class	Miles	% of Corridor
Baseline	113.0	93.0%
Low	8.2	6.7%
Medium	0.3	0.3%
High	0.0	0.0%





Traffic Operations Infrastructure Plan
CHEESE COUNTRY CORRIDOR
Dubuque - Janesville/Beloit Rock County
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Basemap Design by Wisconsin DOT GIS
0
10
20
30
Miles
N
Prairie du Chien
Boscobel
Fennimore
Lancaster
Platteville
Dubuque
Cuba City
Shullsburg
Darlington
Mineral Point
Monroe
Brodhead
Evansville
Edgerton
Milton
Janesville
Beloit
GRANT
LAFAYETTE
GREEN
ROCK
RICHLAND

Coulee Country Corridor

Corridor Overview

The Coulee Country Corridor includes I-90 from the Minnesota border to Tomah (I-94) and WIS 16 from La Crosse to Sparta, and WIS 21 from Sparta to Tomah (I-94). This Corridor accommodates regional travel between Minnesota and Tomah and experiences high peaking on weekends (Friday afternoon and evening and Sunday afternoon), and weather disturbances during the winter months. The corridor also provides an important economic link to western Wisconsin, as well as a link to Fort McCoy.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor connects two cities with needs for traffic operations infrastructure. Currently, there is little technology implemented on the Corridor. It is recommended that cameras and detectors be installed in La Crosse. Incident management resources should be implemented in both Tomah and La Crosse, especially on WIS 16 in La Crosse and WIS 21 and I-90 near Tomah. (See *TOIP Appendix A* for further details.)

Traveler Information

- The majority of I-90 between the Minnesota border and Tomah is recommended for low density deployment. The short segment east of WIS 16 is recommended for medium density deployment. A portable DMS is recommended for westbound traffic approaching the La Crosse to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

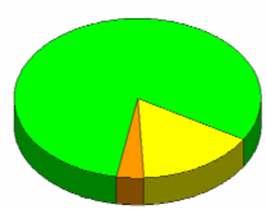
Signal Systems

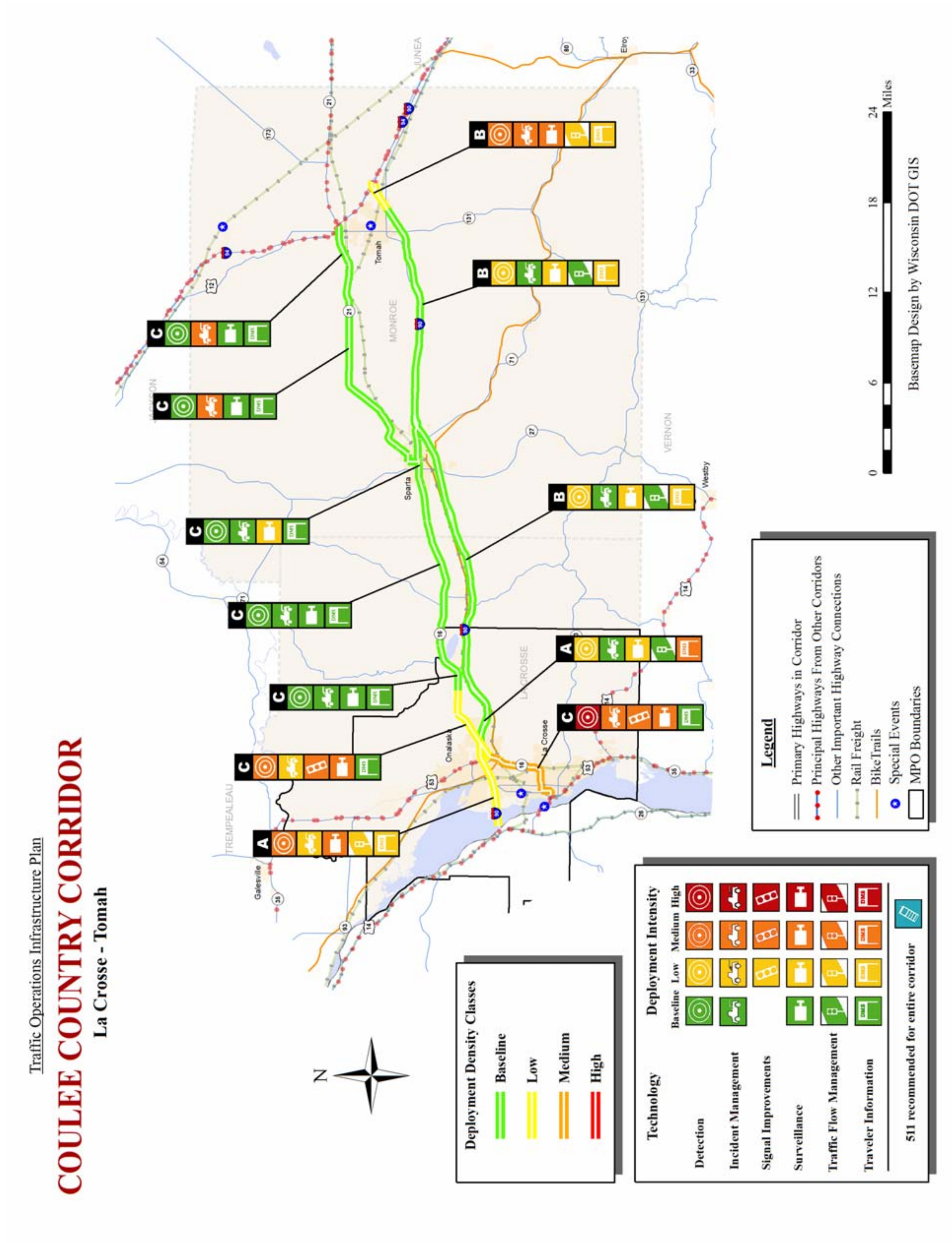
- Within the La Crosse area, medium signal deployment density recommendations are proposed on WIS 16 from US 53 east to CTH M. Low signal deployment density recommendations are made on WIS 16 from CTH M east to WIS 108, WIS 71/WIS 27 east to CTH I, and from CTH M east to I-94. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
93

Deployment Density Class	Miles	% of Corridor
Baseline	75.3	80.9%
Low	14.4	15.5%
Medium	3.4	3.7%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
COULEE COUNTRY CORRIDOR
La Crosse - Tomah
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 6 12 18 24 Miles
Basemap Design by Wisconsin DOT GIS
Galesville
TREMPEALEAU
Onalaska
La Crosse
LACROSSE
Sparta
MONROE
Tomah
VERNON
Westby

Cranberry Country Corridor

Corridor Overview

The Cranberry County Corridor includes WIS 21 between Tomah (I-94) to Oshkosh (US 41).. The Corridor includes the cities of Wautoma and Omro.
The Corridor is part of a passenger and freight corridor linking the Fox Valley and I-90 and points westerly in southern Minnesota, South Dakota and beyond. The corridor also serves the Wisconsin River flowage, Waushara County and Winnebago County tourism/recreation areas.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- In general, this Corridor has little to no implemented technology. The few places that demand some level of deployment density are around the Coloma area, in Wautoma and from Omro to USH 41. The hotspot in Coloma is due to some poor safety factors. It is recommended to have some incident management resources available to this area, such as in Stevens Point. The segment from Omro has several high congestion and crash factors. The recommendations should mitigate some of these factors and match the technology deployments scheduled for US 41. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

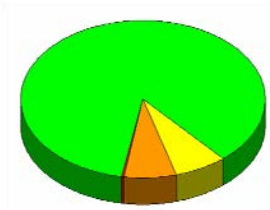
Signal Systems

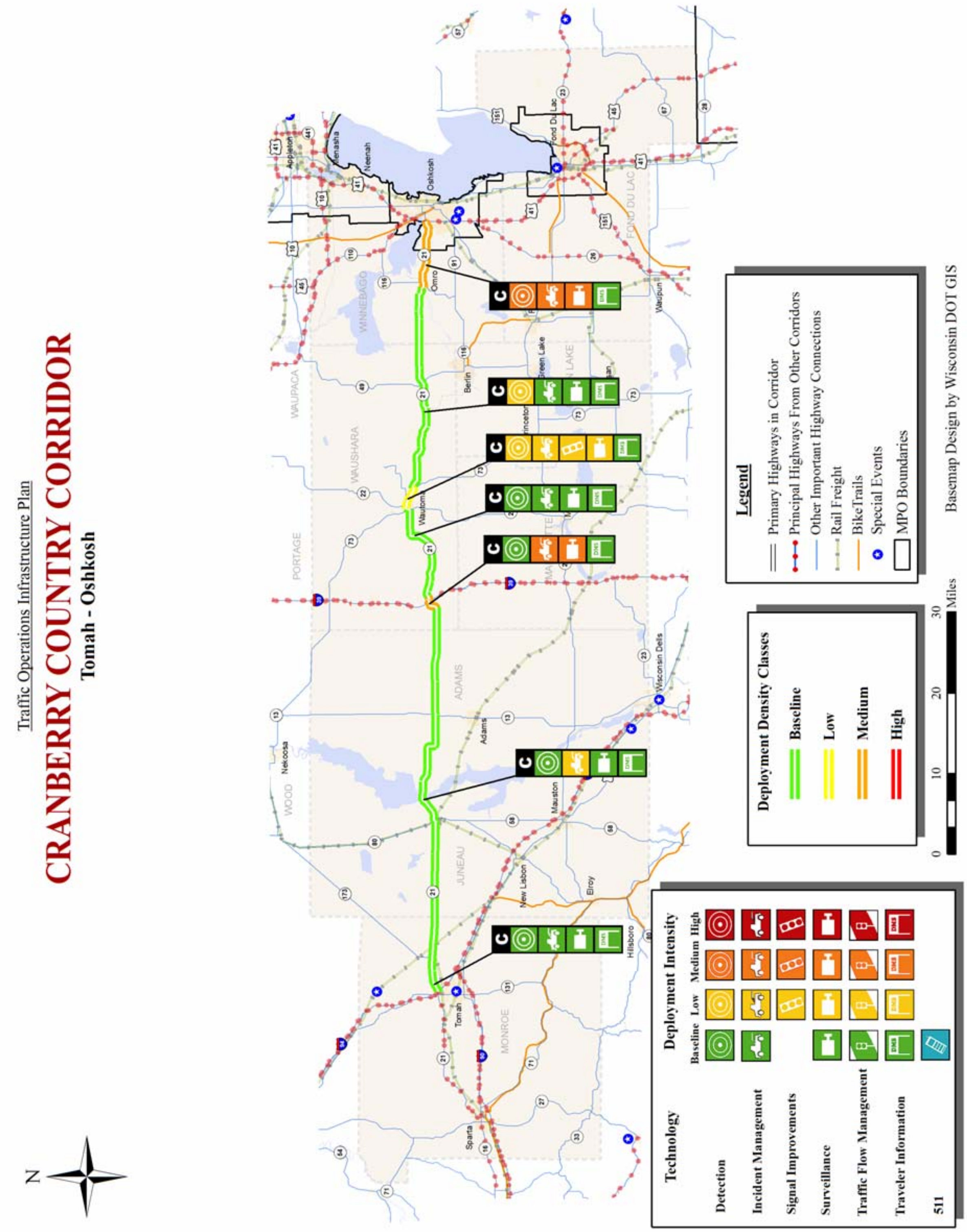
- Low signal deployment density recommendations are made on WIS 21 from I-94 to McCoy Boulevard and from Old WIS 21 to County FF in Monroe and Waushara Counties, respectively. WisDOT is working with local jurisdictions to develop a long-range plan for WIS 21 from Rivermoor Road to US 41 in Winnebago County. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
102

Deployment Density Class	Miles	% of Corridor
Baseline	87.4	85.8%
Low	6.9	6.8%
Medium	7.2	7.1%
High	0.3	0.3%




Traffic Operations Infrastructure Plan
CRANBERRY COUNTRY CORRIDOR
Tomah - Oshkosh
N
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511
Deployment Density Classes
Baseline
Low
Medium
High
0 10 20 30 Miles
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Basemap Design by Wisconsin DOT GIS
Tomah
Sparta
Mauston
New Lisbon
Elroy
Hillsboro
Adams
Nekoosa
Wisconsin Dells
Wautoma
Berlin
Princeton
Green Lake
Omro
Oshkosh
Neenah
Menasha
Appleton
Fond Du Lac
Waupun
MONROE
JUNEAU
WOOD
ADAMS
PORTAGE
WAUSHARA
WAUPACA
WINNEBAGO
FOND DU LAC

Door Peninsula Corridor

Corridor Overview

The Door Peninsula Corridor provides the principal access to one of the State's premier recreation areas, Door County. The Corridor includes WIS 57 from Green Bay (I-43) to Sturgeon Bay. WIS 57 accommodates significant recreational traffic during weekends. The highway also provides access to one of the state's largest ship building and repair facilities in Sturgeon Bay.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- There is very little traffic operations infrastructure coverage in this Corridor. There are no RWIS sites or cameras in the Corridor, although there are approximately five ATR stations. Only one of these ATR stations can be accessed remotely. In general, there is not a strong need for much technology on this Corridor as the Corridor mostly consists of arterial roads. However, there are some hotspots with high crash factors that demand increased surveillance and incident management deployment levels. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment adjacent to I-43. Portable DMS is recommended for southbound WIS 57 to incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

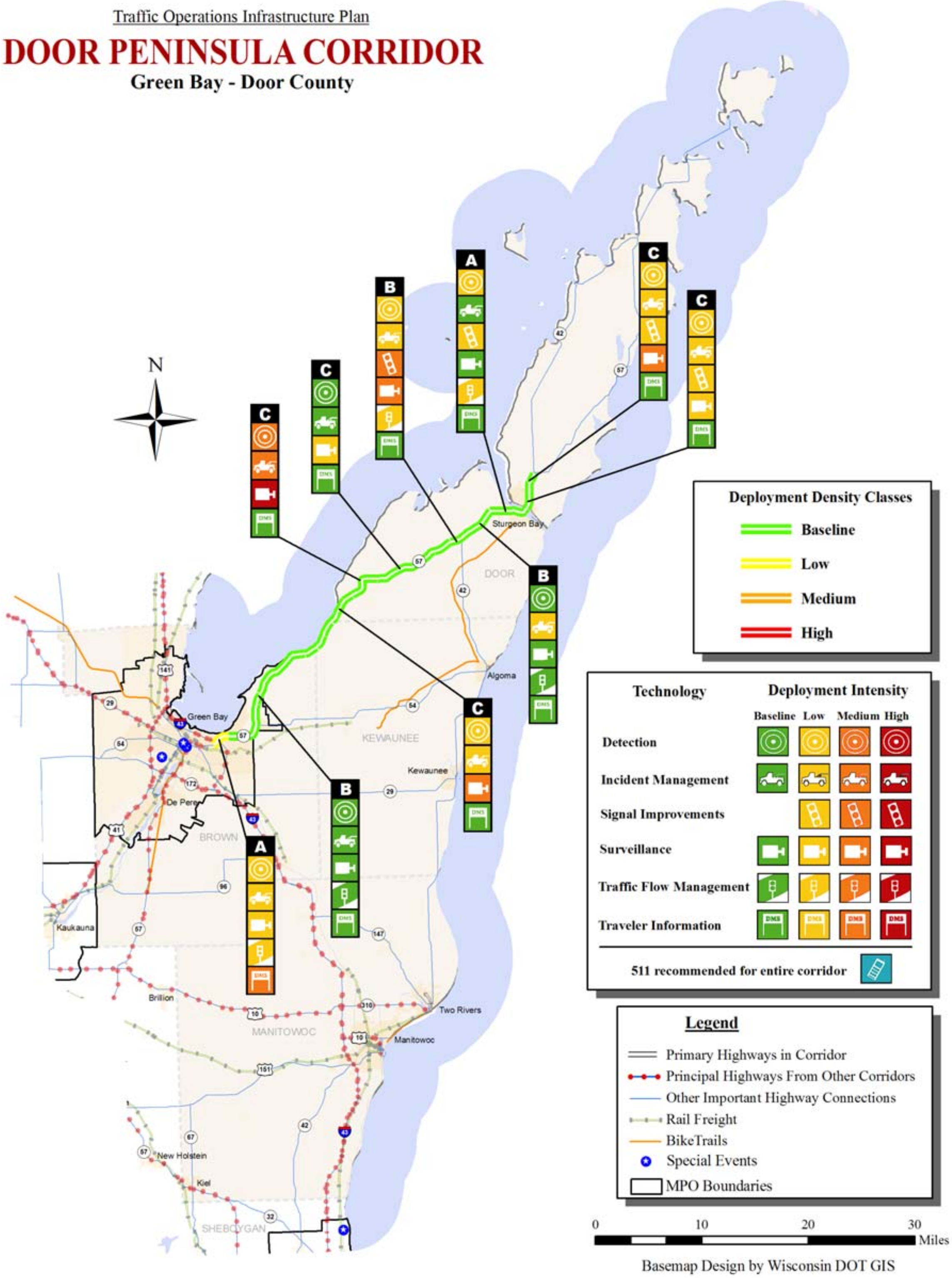
Signal Systems

- Low signal deployment density recommendations are made on WIS 57 from WIS 42/CTH MM to WIS 42/WIS 57 through Sturgeon Bay. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **45**

Deployment Density Class	Miles	% of Corridor
Baseline	31.5	70.3%
Low	12.0	26.7%
Medium	1.3	2.9%
High	0.0	0.0%


Traffic Operations Infrastructure Plan
DOOR PENINSULA CORRIDOR
Green Bay - Door County
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 10 20 30 Miles
Basemap Design by Wisconsin DOT GIS
Sturgeon Bay
DOOR
Algoma
KEWAUNEE
Kewaunee
Green Bay
De Pere
BROWN
Kaukauna
Brillion
MANITOWOC
Two Rivers
Manitowoc
New Holstein
Kiel
SHEBOYGAN

Frank Lloyd Wright Corridor

Corridor Overview

The Frank Lloyd Write Corridor includes US 14/61/53 from La Crosse to Madison (US 12) as well as a portion of the Madison MPO Region. This Corridor is part of a major passenger alternative to I-90 linking La Crosse and Madison and points south and east. It is a critical corridor serving the agricultural economies of this part of the state, and provides one of the few crossings of the Wisconsin River in southern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has little technology deployed and requires little technology for most of its length. However, the segment in La Crosse requires heavy technology deployment. As the Corridor enters the Madison area, some increased traffic operations infrastructure should be implemented. There is currently one RWIS site along the Corridor and very few ATR stations. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

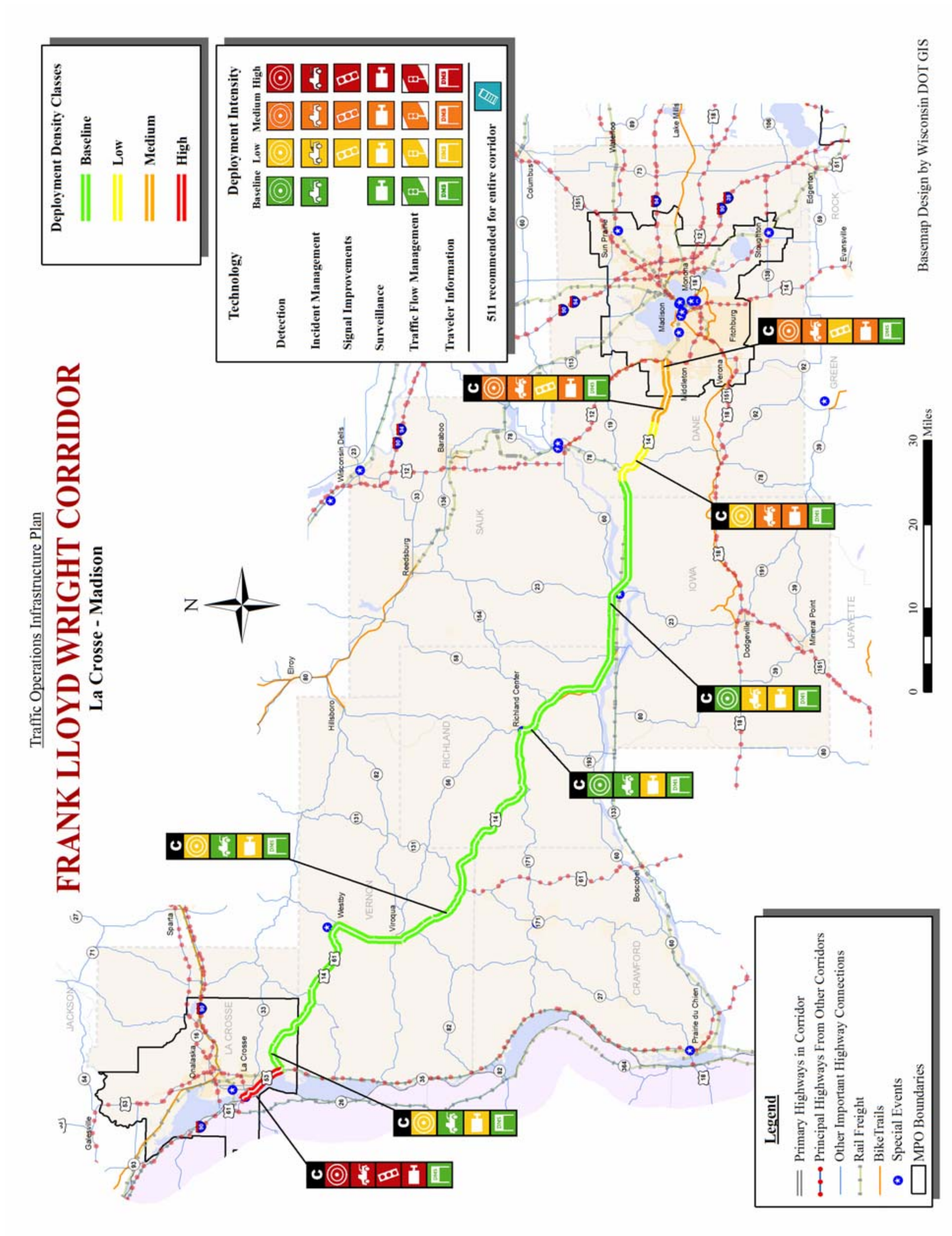
Signal Systems

- In the La Crosse area, low signal deployment density recommendations are made on US 61 from the Wisconsin/Minnesota state line south to US 14/WIS 35. West of the Madison Area MPO on US 14, low signal deployment density recommendations are proposed from Mazomanie east to US 12. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
121

Deployment Density Class	Miles	% of Corridor
Baseline	102.6	84.9%
Low	16.5	13.7%
Medium	1.4	1.1%
High	0.4	0.3%


Traffic Operations Infrastructure Plan
FRANK LLOYD WRIGHT CORRIDOR
La Crosse - Madison
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
N
0 10 20 30 Miles
Basemap Design by Wisconsin DOT GIS

French Fur Trade Corridor

Corridor Overview

The French Fur Trade Corridor includes US 18 from the Minnesota border (Prairie du Chien to Dodgeville. This Corridor is part of an important link between northern Iowa and Madison and points east. It serves a major agricultural area of southwestern Wisconsin and important tourism/recreation areas along the lower Wisconsin and Mississippi Rivers, as well as the historic river town of Prairie du Chien.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has very little traffic operations infrastructure implemented and it is recommended that because of the low volumes on the roadways, there is little need for it. There are currently one RWIS stations and only one ATR station, although this site can be accessed remotely. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

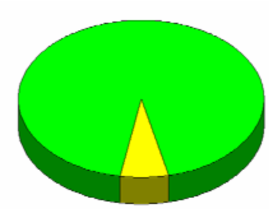
Signal Systems

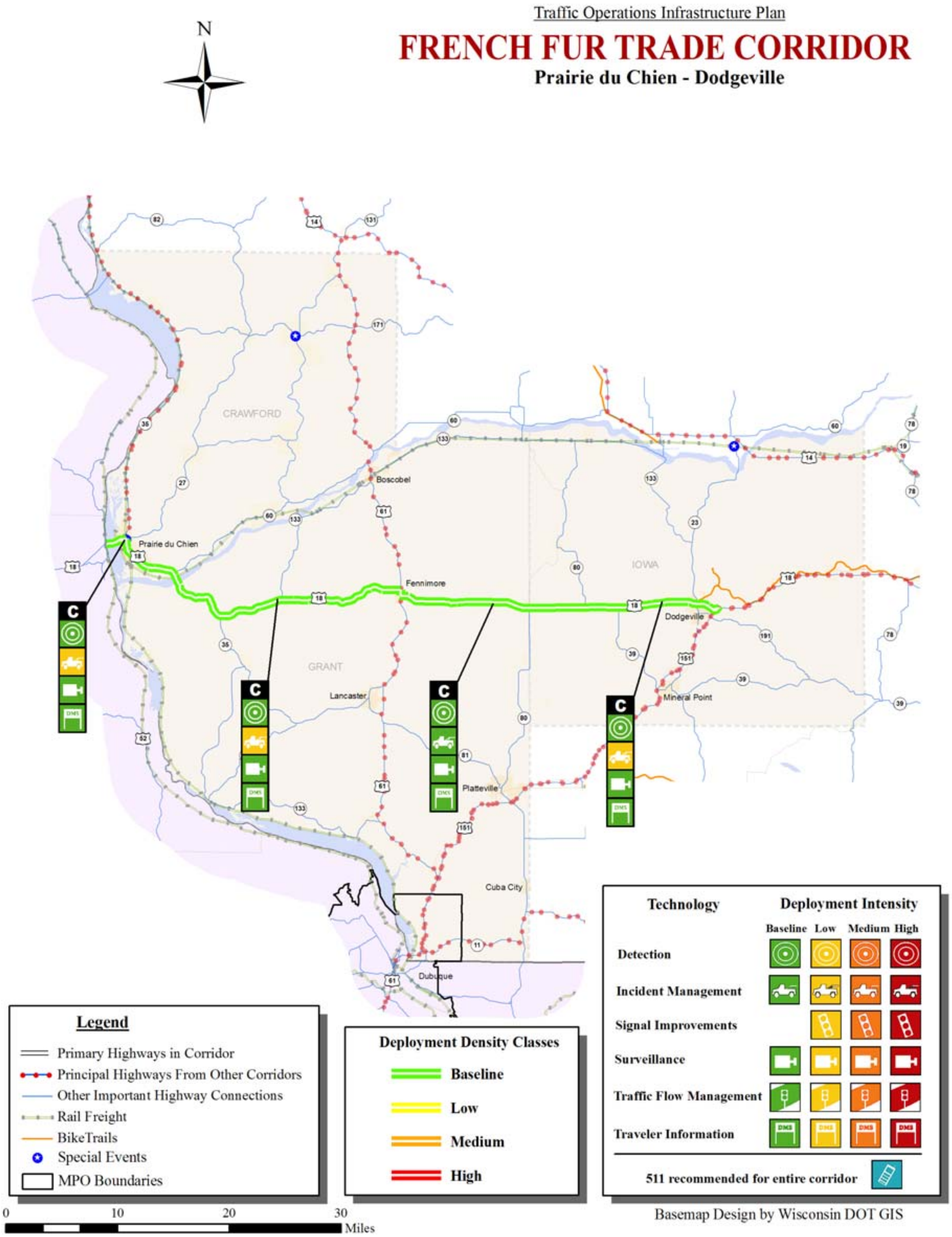
- Low signal deployment density recommendations are made on US 18 in Grant County from Cemetery Road to CTH Q. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **61**

Deployment Density Class	Miles	% of Corridor
Baseline	56.8	93.6%
Low	3.9	6.4%
Medium	0.0	0.0%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
FRENCH FUR TRADE CORRIDOR
Prairie du Chien - Dodgeville
N
CRAWFORD
GRANT
IOWA
Boscobel
Prairie du Chien
Fennimore
Dodgeville
Lancaster
Mineral Point
Platteville
Cuba City
Dubuque
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 10 20 30
Miles
Basemap Design by Wisconsin DOT GIS

Geneva Lakes Corridor

Corridor Overview

The Geneva Lakes Corridor includes US 12 from Madison (I-39/90/94) to the Illinois border south of Lake Geneva as well as a portion of the Madison MPO Region. This Corridor is an important interstate passenger corridor between the Lake Geneva tourism/recreation areas, south central Wisconsin and Chicago. It also serves a major agricultural area of southeastern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has fairly consistently low to baseline technology needs. There is currently only one RWIS station and a few automatic data recorder stations along the Corridor. There is some need for surveillance and incident management coming out of Madison, but as the Corridor heads into Illinois, there is little need for traffic operations infrastructure due to the low volume of traffic on the Corridor. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment adjacent to I-39/90/94. Portable DMS is recommended for westbound US 12 to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

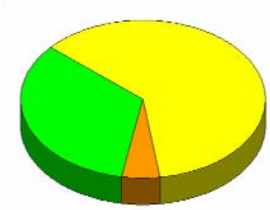
Signal Systems

- Through Fort Atkinson, low signal deployment density recommendations are proposed on US 12 from CTH C to Rockwell Avenue. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **71**

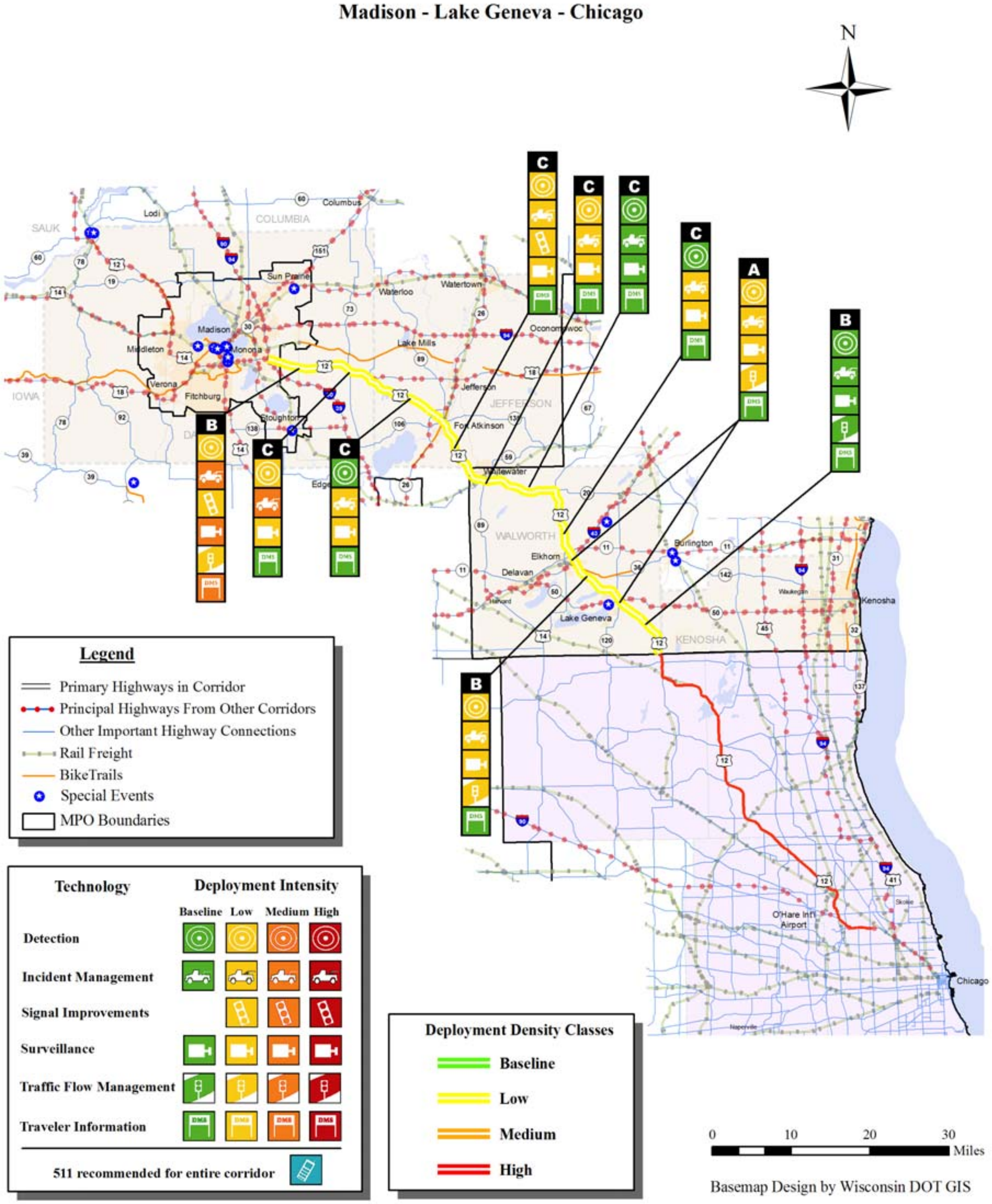
Deployment Density Class	Miles	% of Corridor
Baseline	23.8	33.6%
Low	43.5	61.5%
Medium	3.5	4.9%
High	0.0	0.0%



Traffic Operations Infrastructure Plan

GENEVA LAKES CORRIDOR

Madison - Lake Geneva - Chicago



Kettle Country Corridor

Corridor Overview

The Kettle Country Corridor includes WIS 23 from Fond du Lac (US 41)to Sheboygan (I-43) and US 151 from US 41 to WIS 23. This Corridor is part of a passenger and freight corridor linking Sheboygan and points west via Fond du Lac. It is an important tourist corridor serving the Kettle Moraine and Elkhart Lake tourism/recreation areas. The Corridor also serves a major agricultural area of eastern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Although there is currently little traffic operations infrastructure implemented on this Corridor, there are several segments along the Corridor that could benefit from it. Especially around the Fond Du Lac area, there is a need for congestion monitoring and surveillance. Also, there are several segments that would benefit from increased incident management resources. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

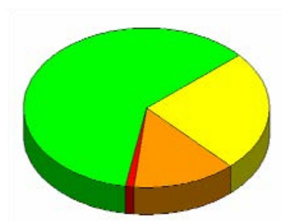
Signal Systems

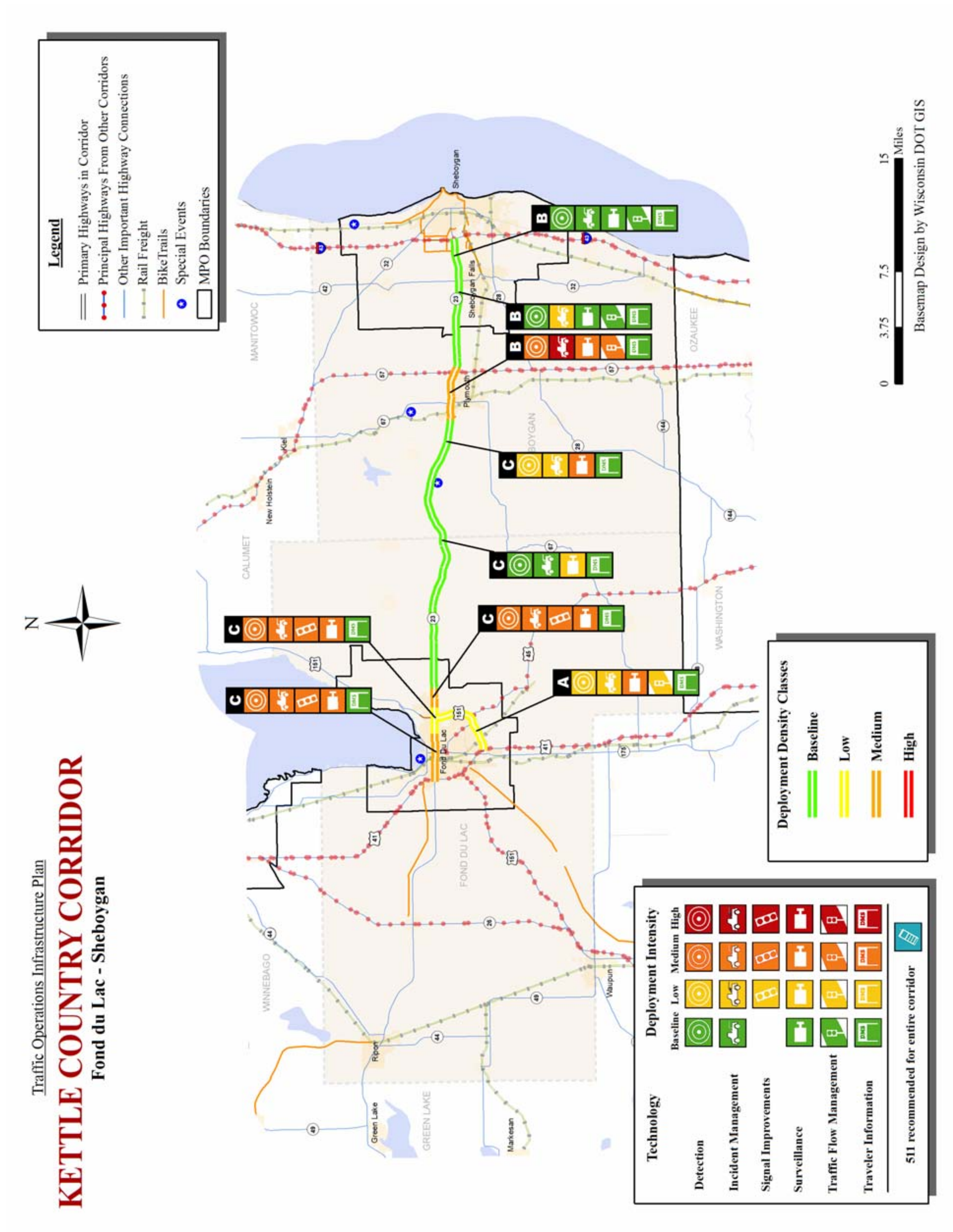
- In the Appleton-Oshkosh-Fond du Lac Area MPO, medium signal deployment density recommendations are made on WIS 23 from US 41 to CTH UU. Low signal deployment density recommendations are proposed on US 151 from US 41 east to WIS 23 through Fond du Lac. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
42

Deployment Density Class	Miles	% of Corridor
Baseline	25.6	60.8%
Low	10.3	24.5%
Medium	5.7	13.5%
High	0.5	1.1%




Traffic Operations Infrastructure Plan
KETTLE COUNTRY CORRIDOR
Fond du Lac - Sheboygan
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 3.75 7.5 15 Miles
Basemap Design by Wisconsin DOT GIS
Sheboygan
Sheboygan Falls
Plymouth
Fond Du Lac
MANITOWOC
CALUMET
OZAUKEE
WASHINGTON
FOND DU LAC
WINNEBAGO
GREEN LAKE
Ripon
Waupun
Green Lake
Markesan
New Holstein
Kiel

Lake Superior Corridor

Corridor Overview

The Lake Superior Corridor includes US 2 from the Minnesota border (Duluth/Superior) and to the Michigan border (Ironwood).. This Corridor is part of an important passenger and freight corridor between Michigan and points to the east into Canada, Duluth-Superior, northern Minnesota and much of western Canada. It provides access to the major rail/water intermodal connections at the Twin Ports of Duluth-Superior. The Corridor also provides access to the Apostle Islands National Lakeshore and other tourism/recreational areas in the southern Lake Superior region.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has little implemented traffic operations technology. There are three RWIS sites along the Corridor and few ATR stations. While most of the deployment density recommendations are in the low to baseline range, there is an increased need for traffic operations infrastructure near Superior. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment in Superior where Portable DMS are recommended for northbound US 2/53 to provide incident and alternate route guidance (two bridges into Minnesota) as well as being used for weather and construction alerts.
- Medium density deployment is also recommended for the segment through Ashland where Portable DMS are recommended to provide weather alert warnings for eastbound and westbound traffic approaching Chequamegon Bay along US 2.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

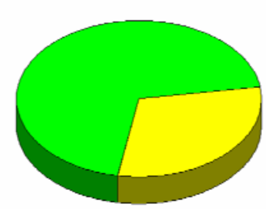
Signal Systems

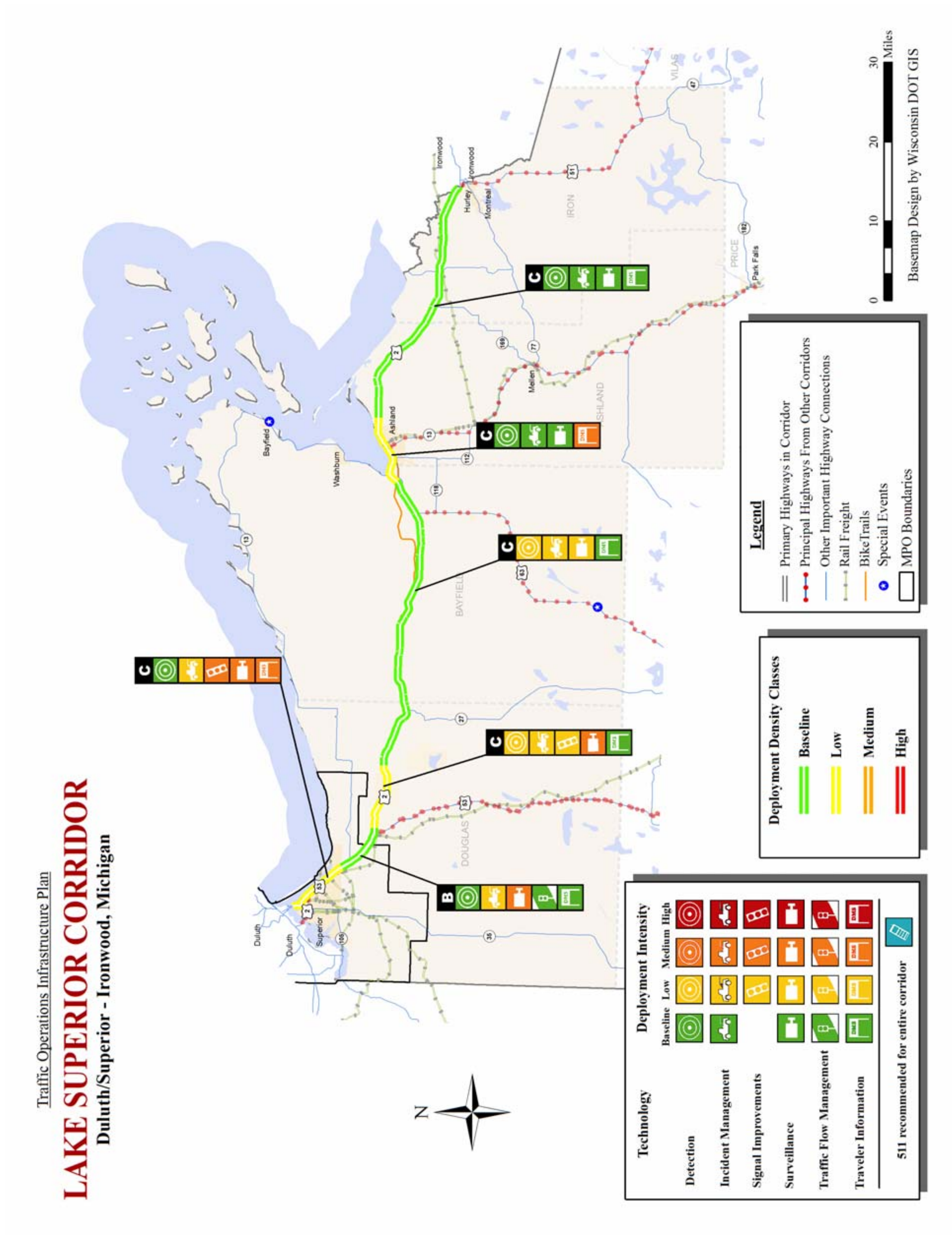
- Low signal deployment density recommendations are made on US 2/US 53 from I-535 east to 57th Avenue/Moccasin Mike Road through Superior. In Bayfield and Ashland Counties, low signal deployment density recommendations are proposed on US 2 from US 63 east to Ackley Road. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
102

Deployment Density Class	Miles	% of Corridor
Baseline	71.2	69.7%
Low	31.0	30.3%
Medium	0.0	0.0%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
LAKE SUPERIOR CORRIDOR
Duluth/Superior - Ironwood, Michigan
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0
10
20
30
Miles
Basemap Design by Wisconsin DOT GIS
Duluth
Superior
Bayfield
Washburn
Ashland
Mellen
Hurley
Montreal
Ironwood
Park Falls
DOUGLAS
BAYFIELD
ASHLAND
IRON
PRICE
VILAS
N

Lake to Lake Corridor

Corridor Overview

The Lake to Lake Corridor includes US 10 from Appleton (US 41) to Lake Michigan (Manitowoc) and WIS 210 from US 10 to Two Rivers. This Corridor is part of a passenger and freight corridor linking central Wisconsin, the Fox Cities and the Manitowoc-Two Rivers area. With the ferry service across Lake Michigan, It also becomes part of an interstate connection to west central Michigan and points east.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor currently has very little implemented technology. There is an RWIS site on the west end and a few manually-collected ATR stations. There is little need for technology on the Corridor except in the Appleton area. The segment of US 10 in Appleton should receive similar technology to US 41. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

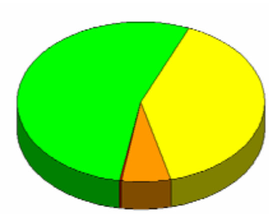
Signal Systems

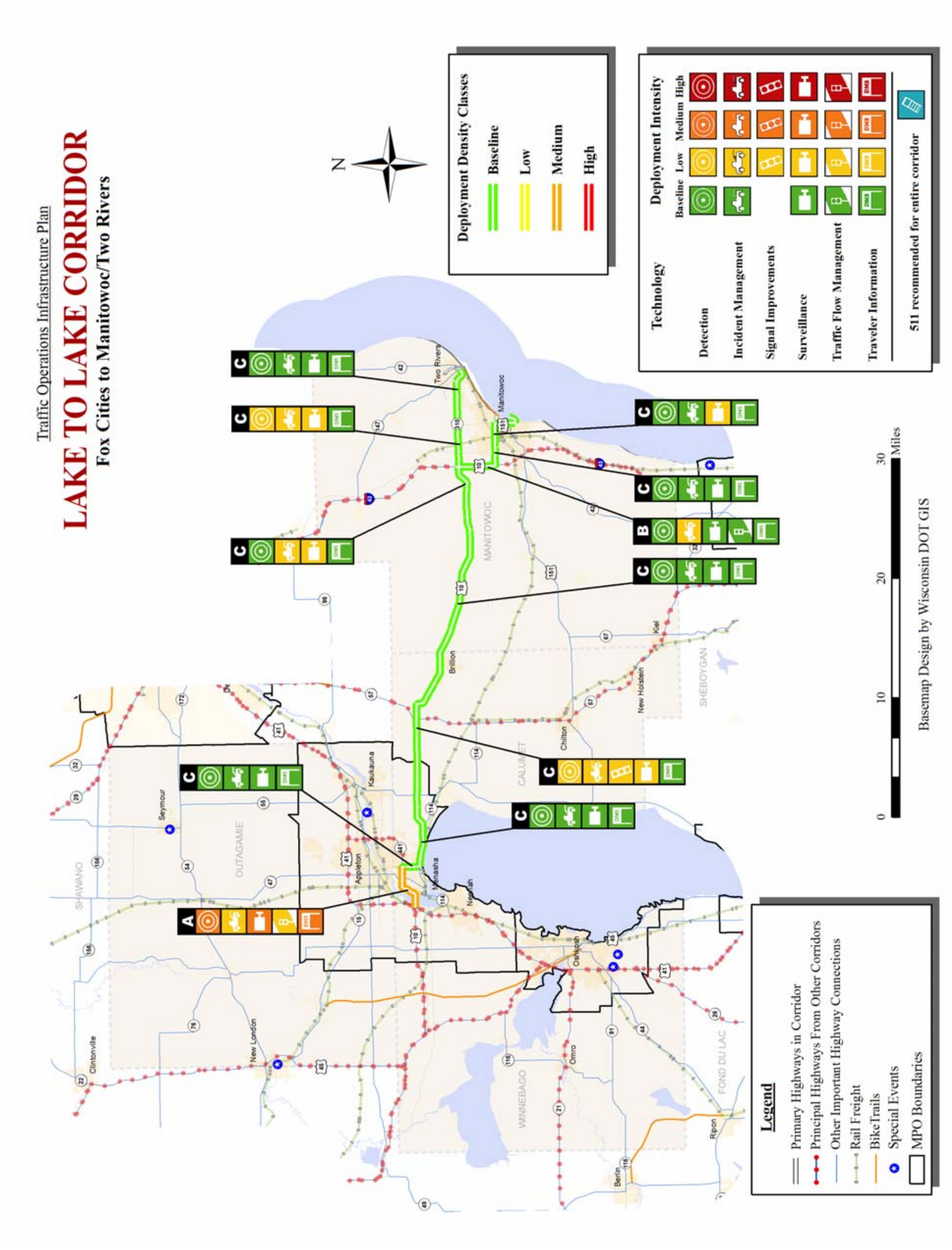
- Low signal deployment density recommendations are made on US 10 from WIS 114 to CTH PP in Calumet County. Additionally, low signal deployment density recommendations are proposed on US 10 in Manitowoc from CTH R to Madison Street/Maritime Drive. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
59

Deployment Density Class	Miles	% of Corridor
Baseline	31.8	53.7%
Low	23.4	39.6%
Medium	3.8	6.4%
High	0.2	0.3%




Traffic Operations Infrastructure Plan
LAKE TO LAKE CORRIDOR
Fox Cities to Manitowoc/Two Rivers
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Basemap Design by Wisconsin DOT GIS
0 10 20 30 Miles
N

Lumber Country Heritage Corridor

Corridor Overview

The Lumber Country Heritage Trail Corridor includes US 41/141 from the Michigan border (Iron Mountain) to Green Bay (I-43) as well as a portion of the Green Bay Region. A major traffic generator in this Corridor is the metropolitan area of Green Bay. This Corridor provides the principal freight and passenger access to and from much of Michigan's Upper Peninsula and eastern Wisconsin. The Corridor is important to the forest products and paper industry. The Corridor is also important for access to the tourism/recreation areas of northeastern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Very little ITS coverage exists in this Corridor. No road weather information system (RWIS) sites or cameras exist in this Corridor. Approximately seven automatic traffic recorders exist in this Corridor, but only two can be accessed remotely.
- ITS device implementation is planned for the southernmost portion of this Corridor in the Green Bay area as part of the larger US 41 ITS deployment from Oshkosh to the Green Bay area. Plans call for the installation of two closed circuit television (CCTV) cameras, three traffic detectors, and a DMS for southbound traffic from Suamico through the I-43 interchange in Green Bay.
- Low to medium levels of surveillance are recommended north of Green Bay. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment adjacent to I-43/US 41. Portable DMS is recommended for southbound US 41/141 to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

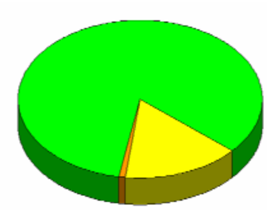
Signal Systems

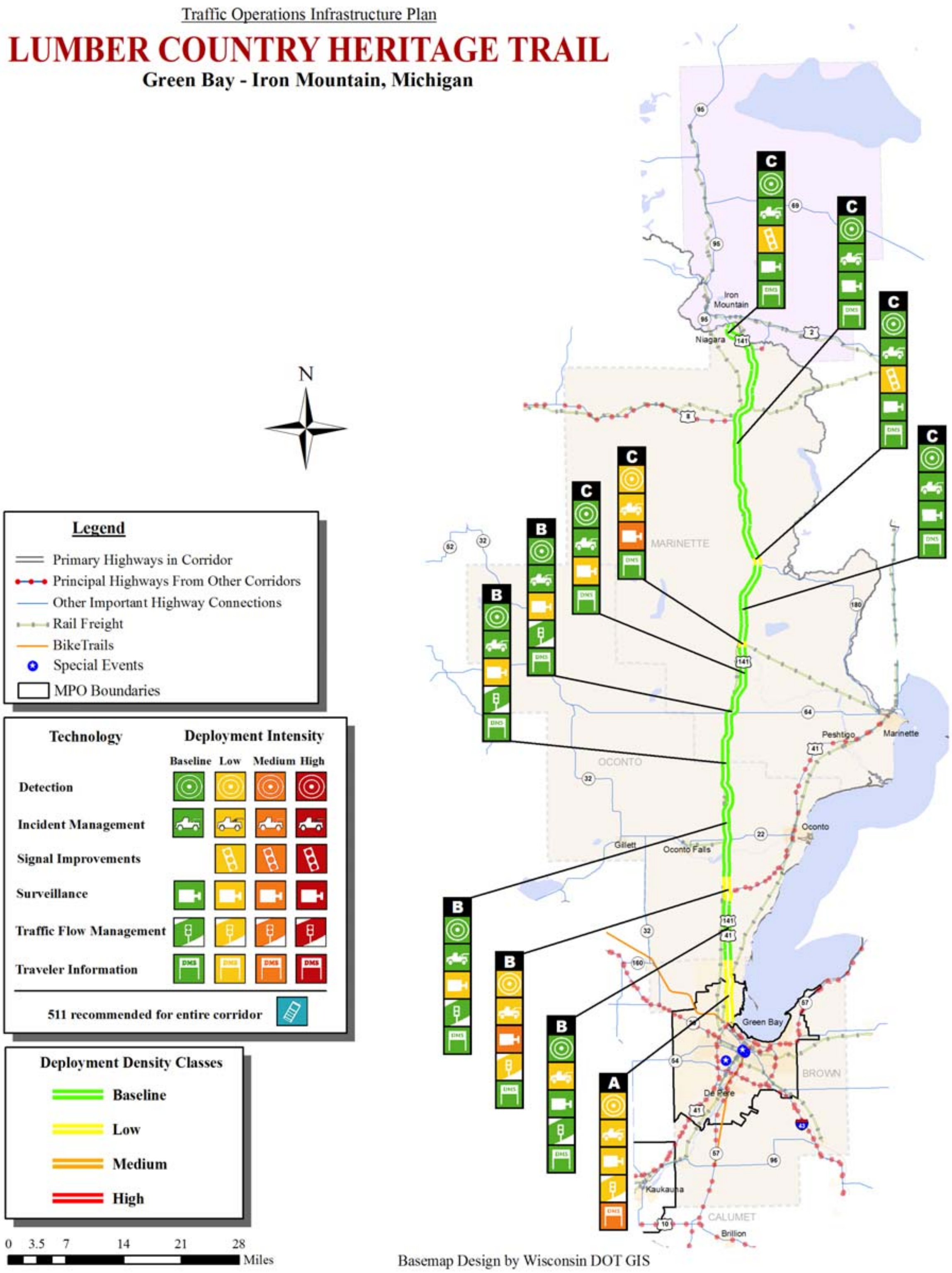
- In Marinette County, low signal deployment density recommendations are made on US 141 from Old Highway 41 south to Owl Lane. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **90**

Deployment Density Class	Miles	% of Corridor
Baseline	75.4	83.7%
Low	13.9	15.4%
Medium	0.8	0.9%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
LUMBER COUNTRY HERITAGE TRAIL
Green Bay - Iron Mountain, Michigan
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 3.5 7 14 21 28
Miles
Iron Mountain
Niagara
MARINETTE
OCONTO
Peshtigo
Marinette
Oconto
Gillett
Oconto Falls
Green Bay
De Pere
BROWN
Kaukauna
CALUMET
Brillion
A
B
C
Basemap Design by Wisconsin DOT GIS

Marshfield/Rapids Connection Corridor

Corridor Overview

The Marshfield-Rapids Connection Corridor includes WIS 13 from Abbotsford through Marshfield, US 10 from Marshfield to Stevens Point (I-39), WIS 34 from US 10 to Wisconsin Rapids, and WIS 54 from Wisconsin Rapids to Stevens Point (I-39).. This Corridor is part of a major passenger and freight corridor serving several important industrial communities in central Wisconsin. It is also an important link to the medical center of Marshfield.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has very little traffic operations infrastructure implemented and it is recommended that because of the low volumes on the roadways, there is little need for it. There are currently two RWIS stations and very few ATR stations. In Abbotsford, it is recommended that a camera and some incident management resources be added to mitigate the relatively high crash factors. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

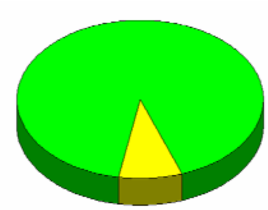
Signal Systems

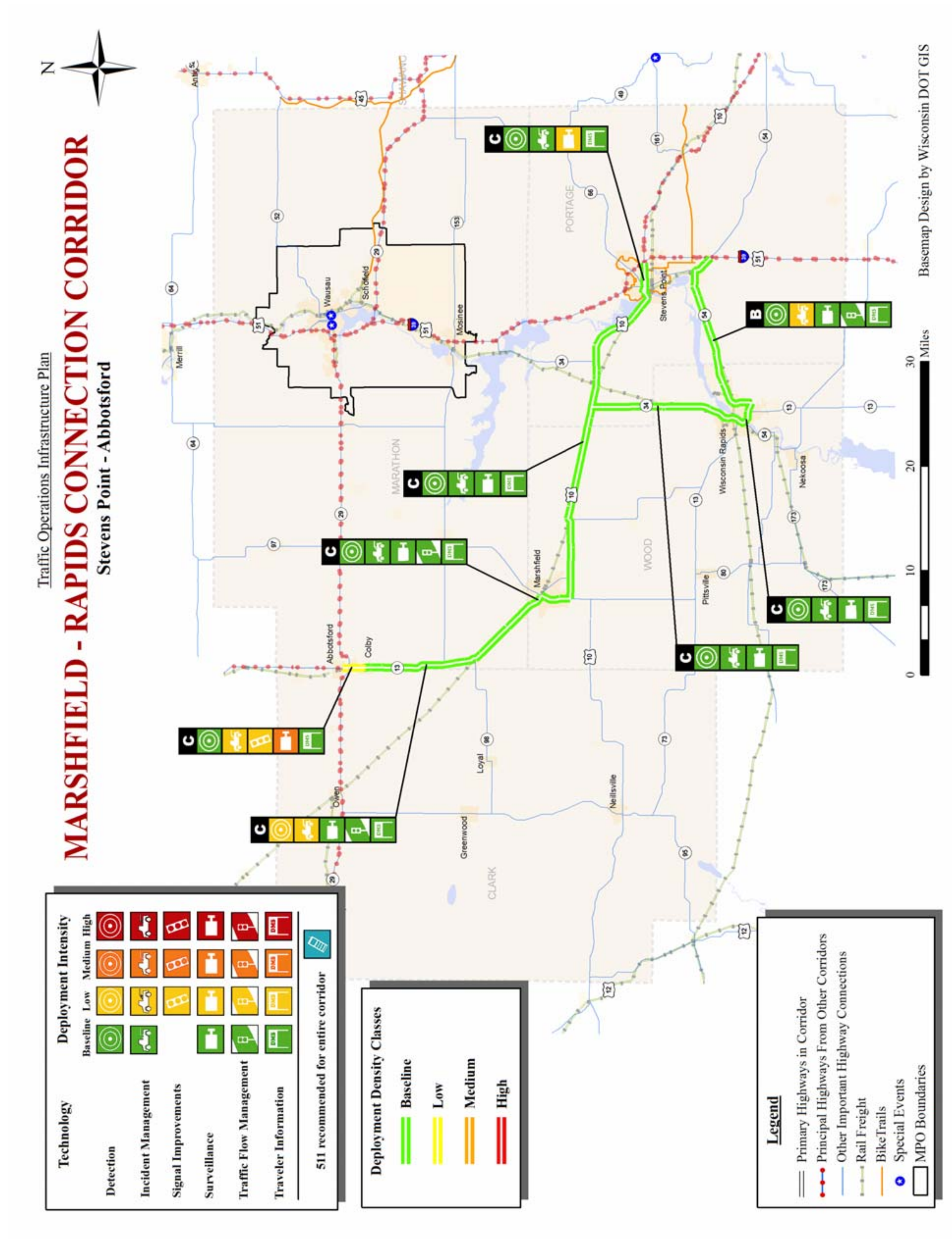
- Through Wisconsin Rapids, low signal deployment density recommendations are made on Riverview Expressway (WIS 54) from WIS 13/WIS 73/Grand Avenue south to WIS 13/8th Street. South of Stevens Point, low signal deployment density recommendations are proposed on WIS 54 from CTH B south to I-39. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
93

Deployment Density Class	Miles	% of Corridor
Baseline	85.6	91.8%
Low	7.7	8.2%
Medium	0.0	0.0%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
MARSHFIELD - RAPIDS CONNECTION CORRIDOR
Stevens Point - Abbotsford
N
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Basemap Design by Wisconsin DOT GIS
Miles
0
10
20
30
Abbotsford
Colby
Marshfield
Stevens Point
Wisconsin Rapids
Wausau
Schofield
Mosinee
Merrill
Pittsville
Nekoosa
Loyal
Greenwood
Neillsville
Owen
MARATHON
PORTAGE
WOOD
CLARK

Mississippi River Corridor

Corridor Overview

The Mississippi River Corridor includes WIS 35 from the Minnesota border (Prescott) to the Iowa border (Prairie du Chien), and US 61 from La Crosse to the Iowa border (Debuque).. This Corridor is a major rail freight corridor containing part of the Burlington Northern Santa Fe and Canadian Pacific mainlines linking the Twin Cities and Chicago. It also includes the major waterborne freight corridor of the Upper Mississippi River Waterway System. It contains Wisconsin's only National Scenic Byway - the Great River Road.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has relatively little implemented technology and has little need for technology except for through La Crosse, where the Corridor should receive a very high deployment density. Almost all the other segments have baseline recommendations with some low recommendations to mitigate specific congestion or safety needs. There are currently two RWIS sites on the Corridor and very few ATR stations outside the La Crosse area. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

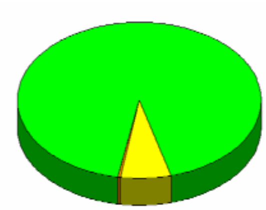
Signal Systems

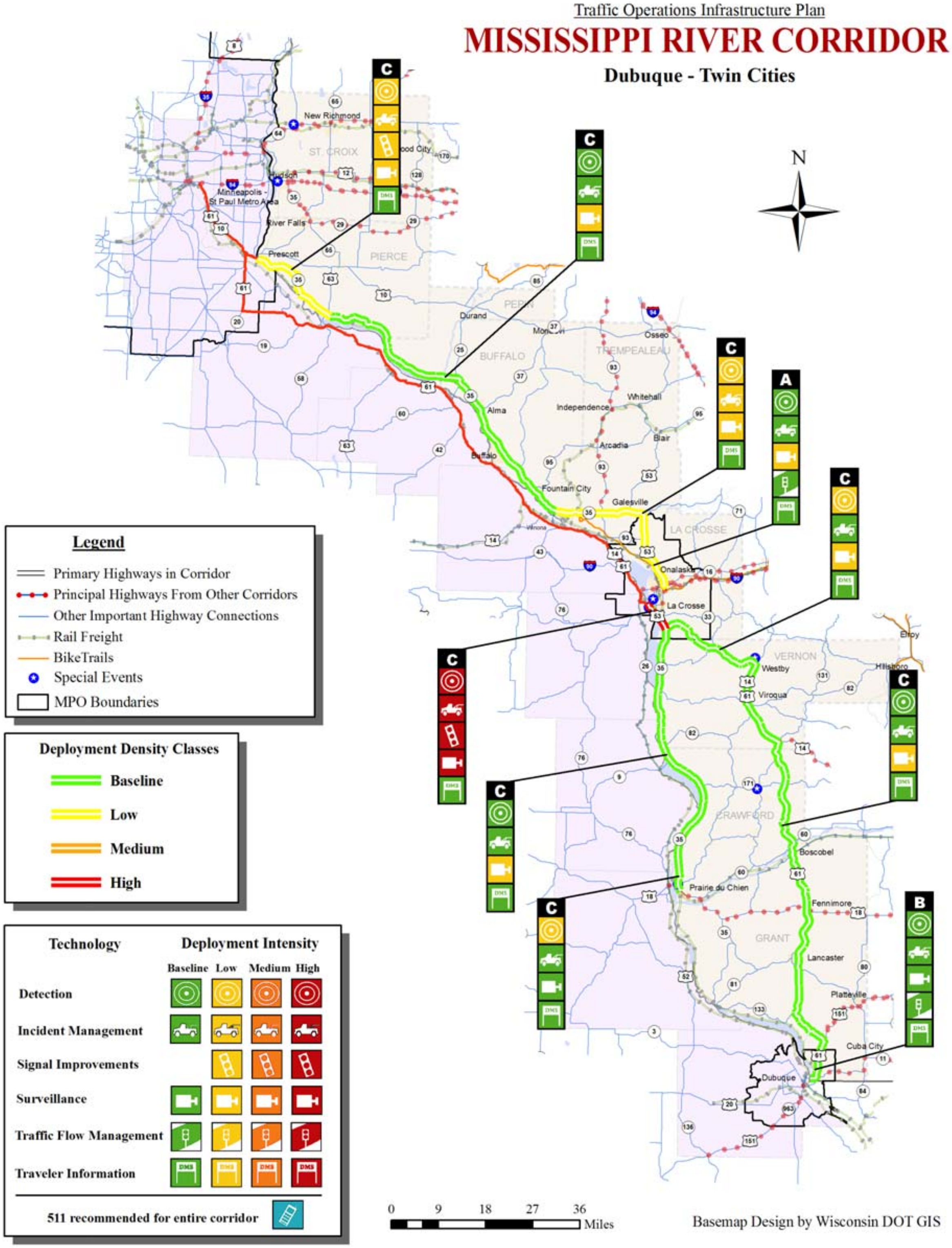
- Low signal deployment density recommendations are made south of Prescott on WIS 35 from MN/WI border south to WIS 63. West of Galesville on WIS 54/WIS 93 from Bridge to Winona east to US 53, low signal deployment density recommendations are proposed. In the La Crosse area, low signal deployment density recommendations are made on US 61 from the Wisconsin/Minnesota state line south to US 14/WIS 35. Low signal deployment density recommendations are proposed on WIS 35 from CTH K south to South Town Lane in Prairie du Chien. Additionally, in Fennimore, low signal deployment density recommendations are made on US 18 from Cemetery Road to CTH Q. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
290

Deployment Density Class	Miles	% of Corridor
Baseline	269.9	93.2%
Low	19.3	6.7%
Medium	0.5	0.2%
High	0.0	0.0%





Traffic Operations Infrastructure Plan
MISSISSIPPI RIVER CORRIDOR
Dubuque - Twin Cities
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 9 18 27 36 Miles
Basemap Design by Wisconsin DOT GIS
New Richmond
Hudson
Minneapolis - St Paul Metro Area
River Falls
Prescott
Durand
Alma
Buffalo
Fountain City
Galesville
Independence
Whitehall
Arcadia
Blair
Osseo
Onalaska
La Crosse
Westby
Viroqua
Prairie du Chien
Boscobel
Fennimore
Lancaster
Platteville
Cuba City
Dubuque
ST. CROIX
PIERCE
PEPIN
BUFFALO
TREMPEALEAU
LA CROSSE
VERNON
CRAWFORD
GRANT

North Country Corridor

Corridor Overview

The North Country Corridor includes US 8 from the Minnesota border (St. Croix Falls) to the Michigan border (Iron Mountain).. This Corridor is part of an important passenger and freight corridor between the Twin Cities, most of northern Wisconsin and the Upper Peninsula of Michigan. The Corridor is critical in connecting the tourism/recreation areas of northern Wisconsin to the Twin Cities market. It also provides important service to the forest products industry.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has little implemented traffic operations technology. There are four RWIS sites along the Corridor and few ATR stations. All the deployment density recommendations are in the low to baseline range. While some of the most basic incident management strategies should be implemented, there is little reason for more traffic operations deployments. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

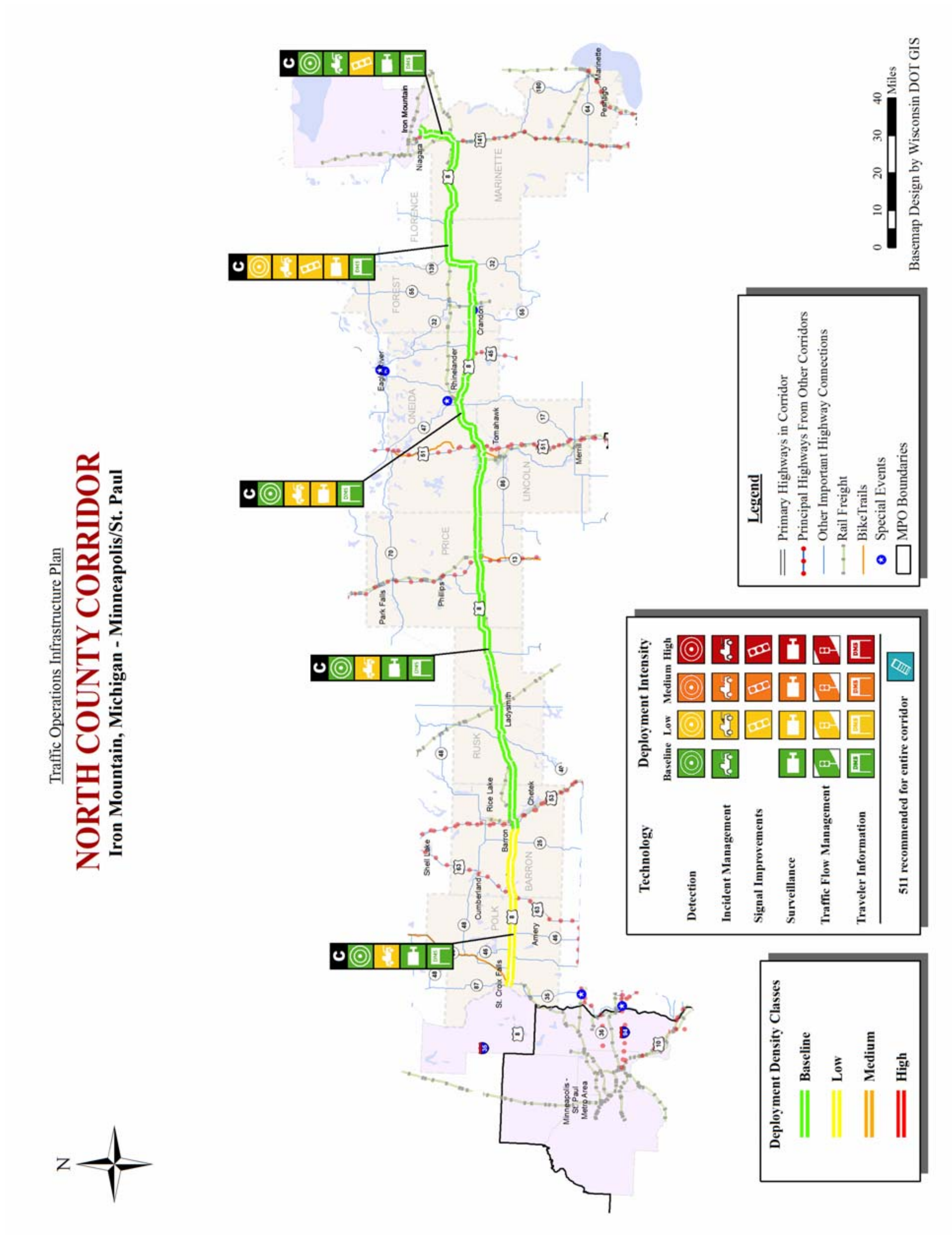
Signal Systems

- On US 8 west of St. Croix Falls, low signal deployment density recommendations are made from the Wisconsin/Minnesota border east to WIS 46. Low signal deployment density recommendations are also proposed on US 8 from Spring Creek Drive east to WIS 47 in Oneida County. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
255

Deployment Density Class	Miles	% of Corridor
Baseline	230.8	90.4%
Low	22.9	9.0%
Medium	1.8	0.7%
High	0.0	0.0%


Traffic Operations Infrastructure Plan
NORTH COUNTY CORRIDOR
Iron Mountain, Michigan - Minneapolis/St. Paul
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
Bike Trails
Special Events
MPO Boundaries
0 10 20 30 40 Miles
Basemap Design by Wisconsin DOT GIS
Iron Mountain
Niagara
Marinette
Peshtigo
FLORENCE
MARINETTE
FOREST
Crandon
Rhinelander
Eagle River
ONEIDA
Tomahawk
Merrill
LINCOLN
PRICE
Park Falls
Phillips
RUSK
Ladysmith
Rice Lake
Chetek
Barron
BARRON
Shell Lake
Cumberland
POLK
Amery
St. Croix Falls
Minneapolis - St. Paul Metro Area
C

Northern Lakes Corridor

Corridor Overview

The Northern Lakes Corridor includes WIS 64 from the Minnesota border (Stillwater) to US 63 east of New Richmond, and US 63 from WIS 64 to Ashland. This Corridor is part of a major passenger and freight corridor linking the Twin Cities and northern Wisconsin. The Corridor is critical in connecting the tourism/recreation areas of northwestern Wisconsin to the Twin Cities market.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor currently has minimal deployed traffic operations infrastructure. There are a few ATR stations along the Corridor and they can be accessed remotely. While the technology recommendations are generally low, it is recommended that incident management resources be used throughout the Corridor. The main segment where technology could help mitigate congestion and safety issues is on the western end of the Corridor. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment is recommended for the entire Corridor up to US 2. Baseline recommendations include statewide initiatives such as 511 and STOC operations. From US 2, medium density deployment is recommended where Portable DMS are recommended to provide weather alert warnings for eastbound and westbound traffic approaching Chequamegon Bay along US 2. (See *TOIP Appendix B* for further details.)

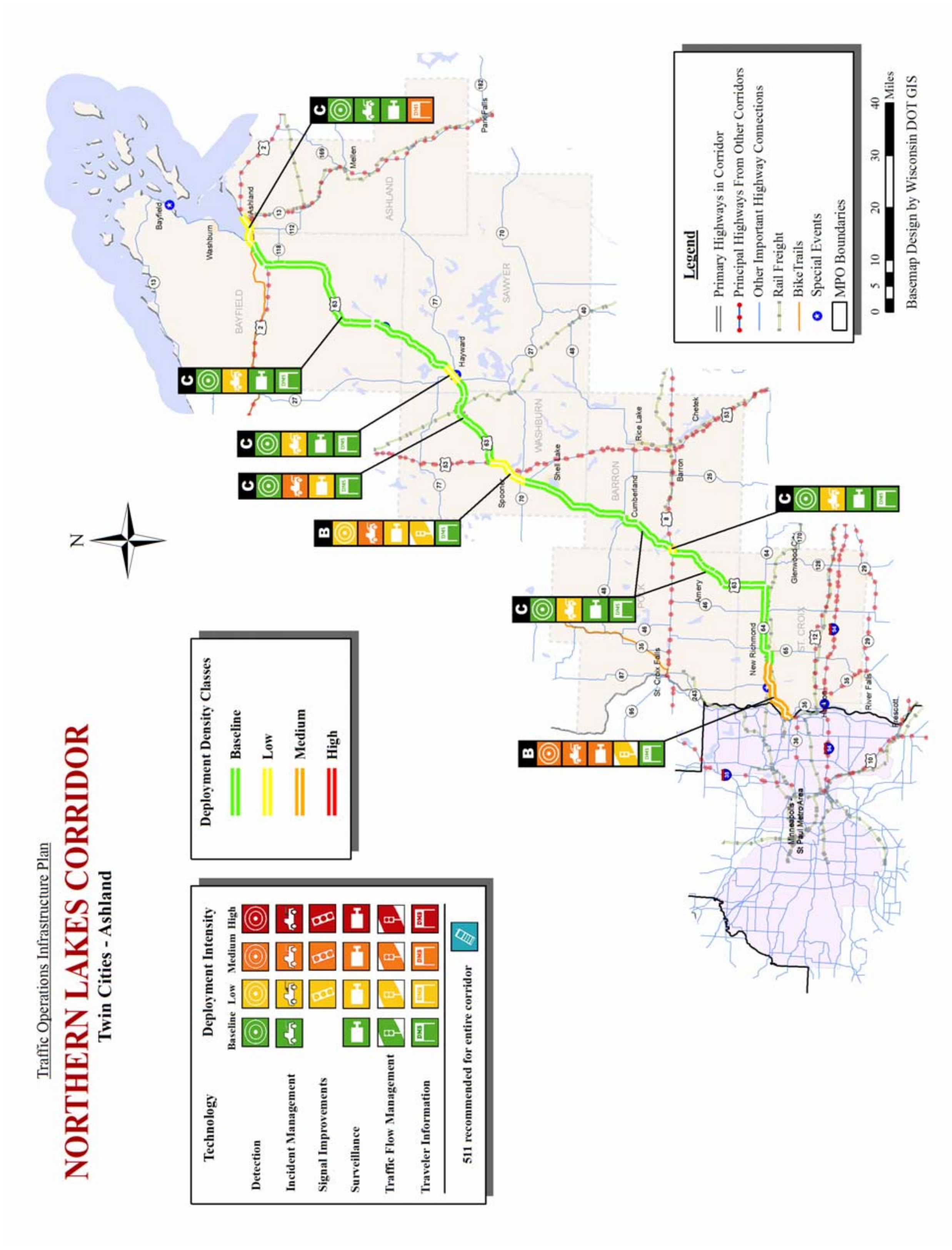
Signal Systems

- Low signal deployment density recommendations are made on WIS 64/WIS 35 from the Wisconsin/Minnesota border east to WIS 65 in St. Croix County. Through Spooner, low signal density recommendations are made on US 63 from the north approach of US 53 south to WIS 70. Low signal density recommendations are proposed on US 63 from Gorski Road southwest to Stress Road in Sawyer County. Additionally, low signal density recommendations are made on US 2 from US 63 east to Ackley Road in Bayfield and Ashland Counties. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **169**

Deployment Density Class	Miles	% of Corridor
Baseline	144.7	85.4%
Low	13.4	7.9%
Medium	11.3	6.7%
High	0.0	0.0%



Traffic Operations Infrastructure Plan
NORTHERN LAKES CORRIDOR
Twin Cities - Ashland
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
0 5 10 20 30 40 Miles
Basemap Design by Wisconsin DOT GIS
N
Bayfield
Washburn
Ashland
Mellen
Park Falls
Hayward
Spooner
Shell Lake
Rice Lake
Chetek
Barron
Cumberland
Amery
Glenwood City
New Richmond
St. Croix Falls
River Falls
Prescott
Minneapolis St Paul Metro Area
BAYFIELD
ASHLAND
SAWYER
WASHBURN
BARRON
POLK
ST. CROIX

Northwoods Connection Corridor

Corridor Overview

The Northwoods Connection Corridor includes US 8 from Rhinelander to US 45, and US 45 to Oshkosh (US 41) as well as a portion of the Appleton-Oshkosh-Fond du Lac Region. This Corridor is part of a major passenger and freight corridor linking east central Wisconsin (and points south and east) and northern Wisconsin. It is also an important link in the connection of southeastern Wisconsin to the tourism and recreational centers of northern Wisconsin. It also serves a major agricultural region of east central Wisconsin, including the potato growing areas of Langlade County.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has little implemented traffic operations technology. There is one RWIS site along the Corridor and few ATR stations. All the deployment density recommendations are in the low to baseline range. This indicates the lack of a need for traffic operations infrastructure on this segment aside from statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

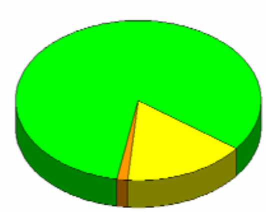
Signal Systems

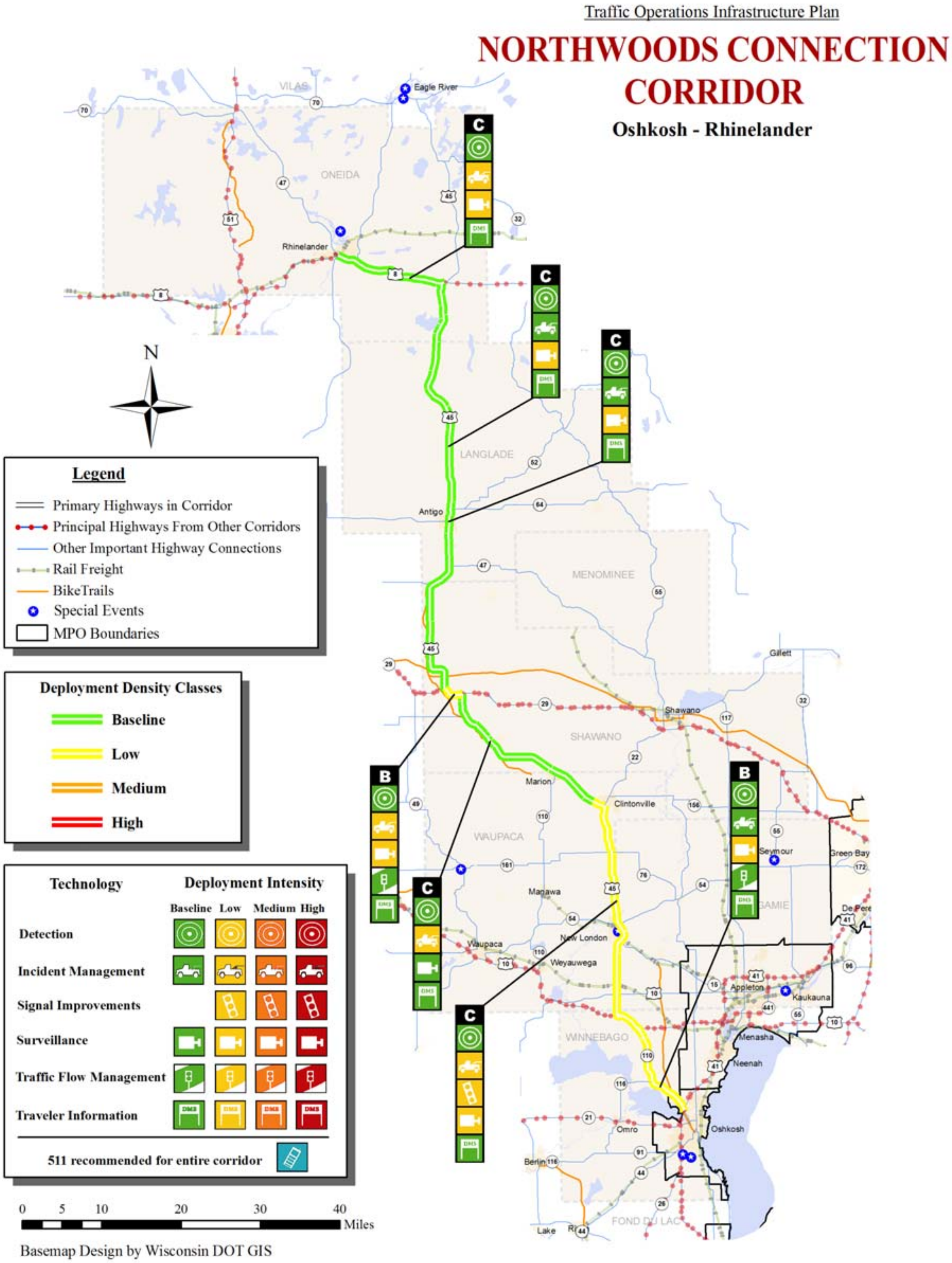
- North of Antigo on US 45, low signal deployment density recommendations are made from CTH C south to WIS 64. Low signal deployment density recommendations are proposed south of Clintonville on US 45 from WIS 22 south to CTH D. In addition, low signal density recommendations are made south of New London from WIS 15 south to US 10 West JCT on US 45. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **140**

Deployment Density Class	Miles	% of Corridor
Baseline	115.5	82.6%
Low	22.5	16.1%
Medium	1.9	1.3%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
NORTHWOODS CONNECTION CORRIDOR
Oshkosh - Rhinelander
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 5 10 20 30 40 Miles
Basemap Design by Wisconsin DOT GIS
Rhinelander
Eagle River
Antigo
Shawano
Clintonville
Marion
New London
Waupaca
Weyauwega
Appleton
Kaukauna
Menasha
Neenah
Oshkosh
Omro
Green Bay
Seymour
Gillett
VILAS
ONEIDA
LANGLADE
MENOMINEE
SHAWANO
WAUPACA
WINNEBAGO
N

Peshtigo Fire Memorial Corridor

Corridor Overview

The Peshtigo Fire Corridor includes US 41 from Green Bay (I-43) to the Michigan border (Menomonee) as well as a portion of the Green Bay Region. This Corridor provides the principal freight and passenger access to and from much of Michigan's Upper Peninsula and the Sault Ste. Marie gateway to Canada. The Corridor is important to the forest products and paper industry.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- Very little ITS coverage exists in this Corridor. No road weather information system (RWIS) sites or cameras exist in this Corridor. Approximately 5 automatic traffic recorders exist in this Corridor, but only one can be accessed remotely.
- ITS device implementation is planned for the southernmost portion of this Corridor in the Green Bay area as part of the larger US 41 ITS deployment from Oshkosh to the Green Bay area. Plans call for the installation of two closed circuit television (CCTV) cameras, three traffic detectors, and a DMS for southbound traffic from Suamico through the I-43 interchange in Green Bay.
- Recommendations north of Green Bay are for a mixture of low and baseline deployments. Incident management is recommended at a low level for the entire Corridor. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment adjacent to I-43/US 41. Portable DMS is recommended for southbound US 41 to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

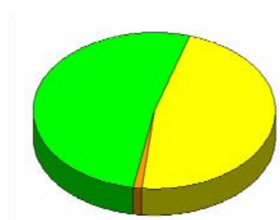
Signal Systems

- Low signal deployment density recommendations are made on US 41/WIS 64 south of Marinette from WIS south to CTH T. On US 41 through Peshtigo, low signal deployment density recommendations are made from Old Peshtigo Road west to Town Line Road. Additionally, low signal deployment density recommendations are made on US 41 from WIS 22/CTH Y south to Doran Street. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **50**

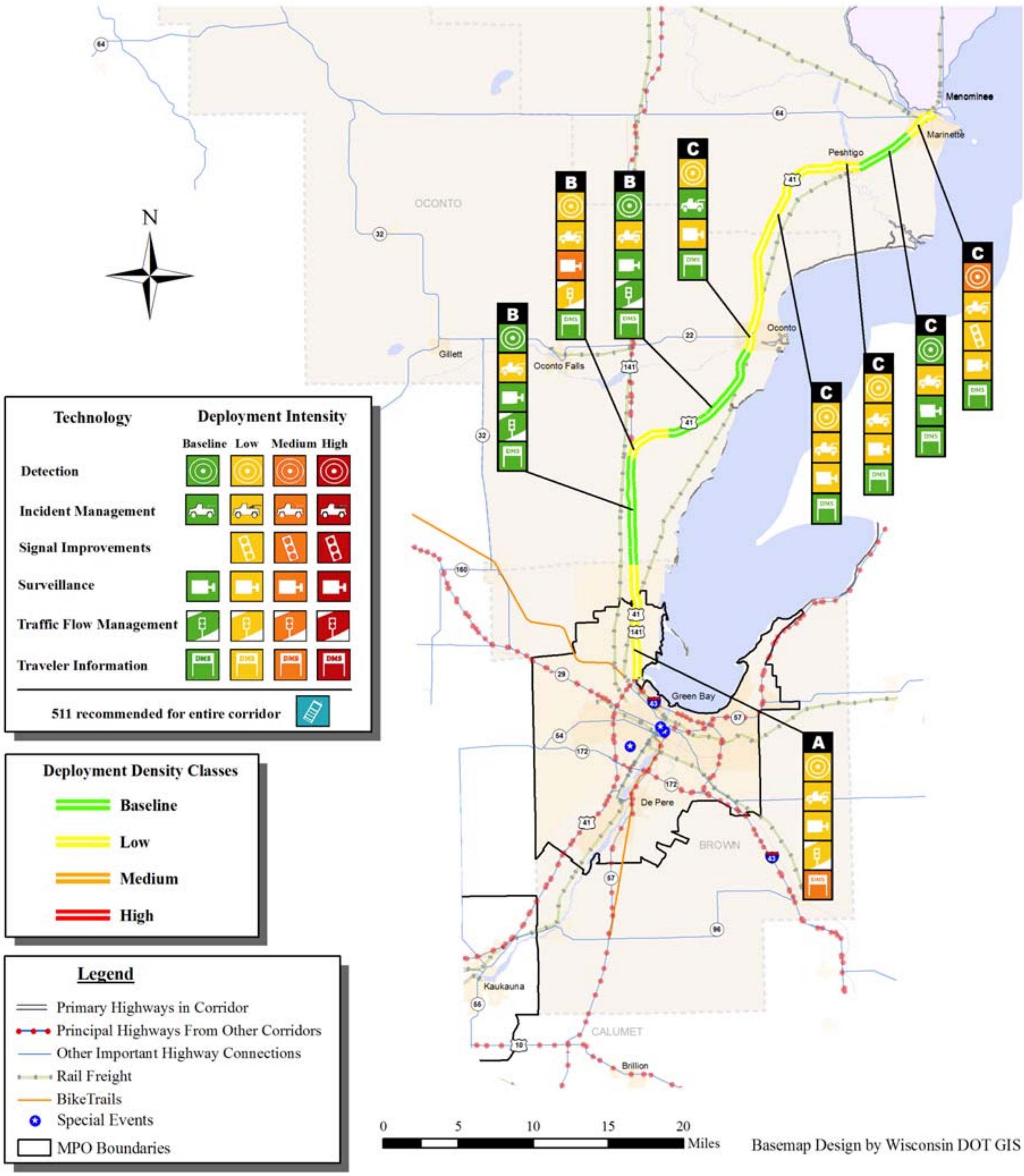
Deployment Density Class	Miles	% of Corridor
Baseline	25.8	52.0%
Low	23.3	47.0%
Medium	0.5	1.0%
High	0.0	0.0%



Traffic Operations Infrastructure Plan

PESHTIGO FIRE MEMORIAL CORRIDOR

Green Bay - Menominee County, Michigan



POW/MIA Remembrance Corridor

Corridor Overview

The POW/MIA Remembrance Corridor includes WIS 13 from Ashland (US 2) to Colby (WIS 29).. This Corridor is part of a passenger and freight corridor linking central and northern Wisconsin. The Corridor serves the tourism/recreational areas of north central Wisconsin. It also serves agriculture and forestry in the north central part of the state.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has little implemented traffic operations technology. There are two RWIS sites along the Corridor and few ATR stations. Almost all the deployment density recommendations are in the low to baseline range. The exception is the medium level of surveillance deployment in Abbotsford which could result in one camera to be installed there to mitigate crash and congestion factors. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

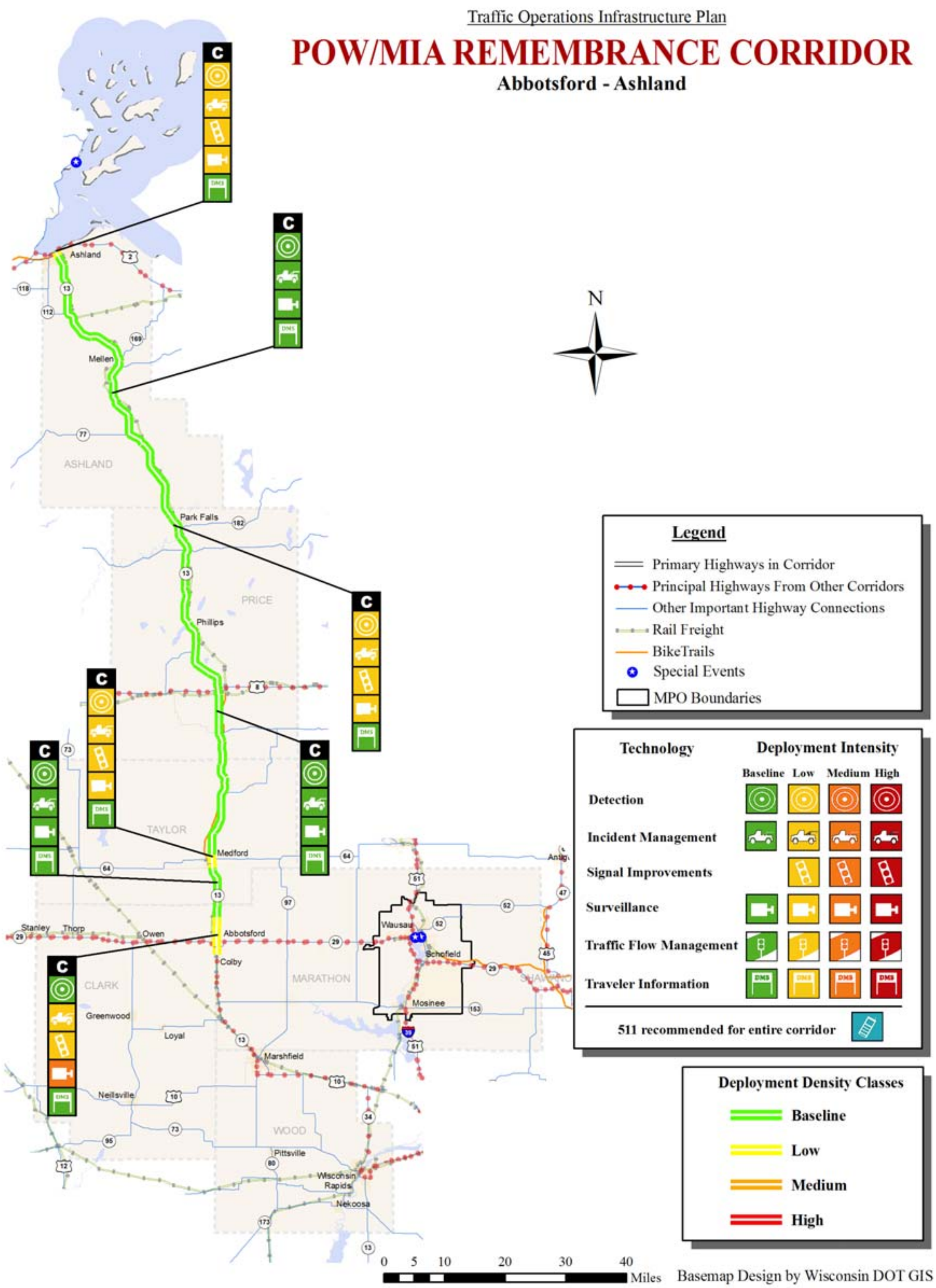
Signal Systems

- Through Medford on WIS 13, medium signal deployment density recommendations are proposed from Allman Avenue south to CTH O. North of Abbotsford, low signal deployment density recommendations are made on WIS 13 from CTH A south to WIS 29. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
129

Deployment Density Class	Miles	% of Corridor
Baseline	116.7	90.4%
Low	10.1	7.8%
Medium	2.3	1.7%
High	0.0	0.0%


Traffic Operations Infrastructure Plan
POW/MIA REMEMBRANCE CORRIDOR
Abbotsford - Ashland
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 5 10 20 30 40 Miles
Basemap Design by Wisconsin DOT GIS
Ashland
Mellen
ASHLAND
Park Falls
PRICE
Phillips
TAYLOR
Medford
Abbotsford
Colby
CLARK
MARATHON
Wausau
Schofield
Mosinee
Marshfield
WOOD
Owen
Stanley
Thorp
Greenwood
Loyal
Neillsville
Pittsville
Wisconsin Rapids
Nekoosa

Rock River Corridor

Corridor Overview

The Rock River Corridor includes WIS 26 from Janesville (I-39/90) to Oshkosh (US 41) as well as a portion of the Appleton-Oshkosh-Fond du Lac Region. This Corridor is part of a major passenger and freight corridor linking Rock County industrial areas with the industrial cities of the Fox River Valley. It is a major truck corridor to the east-west interstate routes in northern Illinois. This Corridor also includes the Horicon National Wildlife Refuge.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has relatively little traffic operations infrastructure. There is a need for surveillance on the north end of the Corridor, just south of Oshkosh. Also, there is a crash hotspot in Wapun which could be mitigated with some incident management resources. Overall, this Corridor has little congestion and relatively little need for more traffic operations infrastructure aside from statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

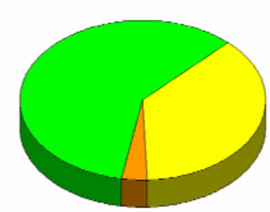
Signal Systems

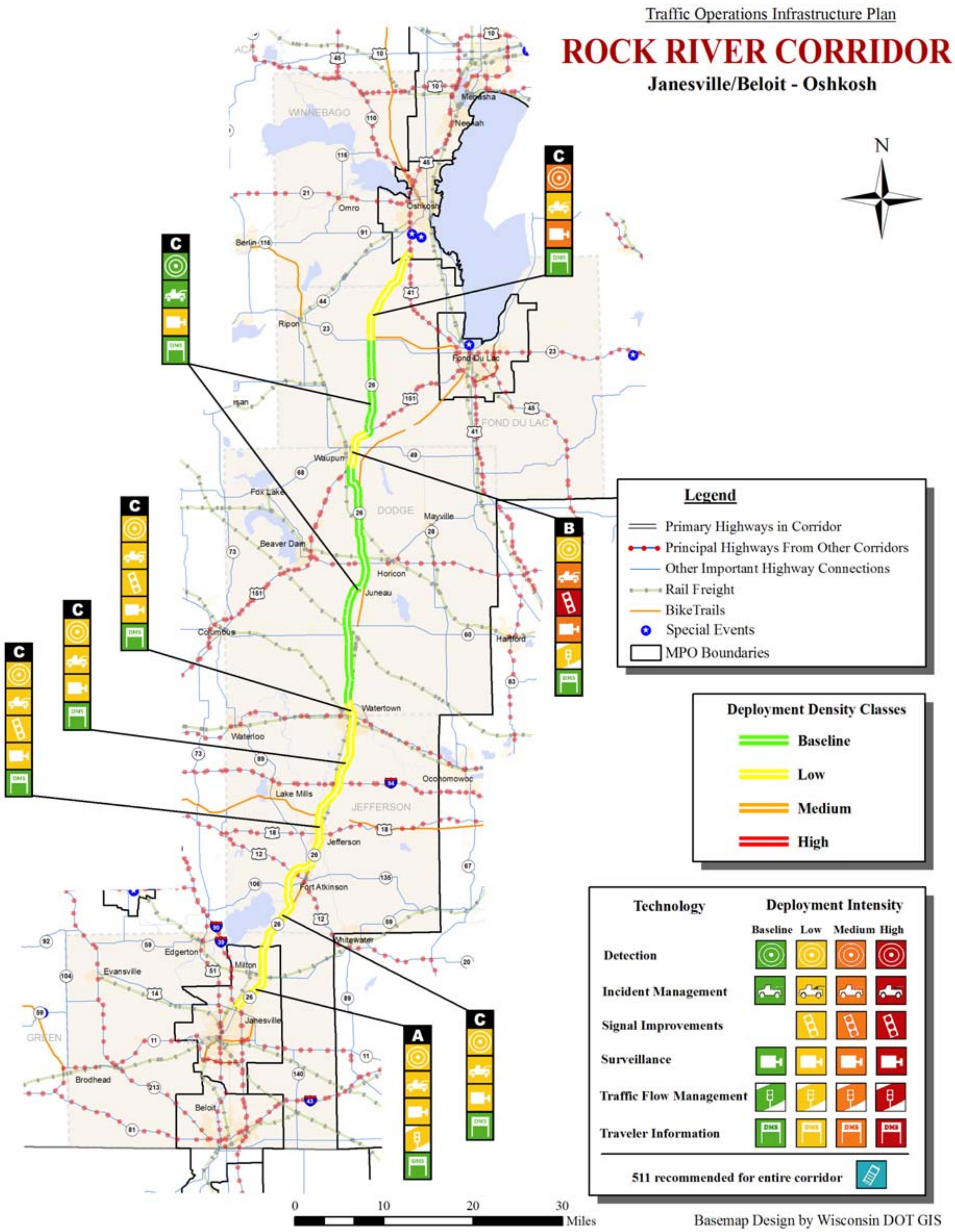
- No signal deployment density recommendations are made in this Corridor as WisDOT has designed bypasses that will be under construction from 2008 – 2015 negating traffic signal technology improvements at this time. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
95

Deployment Density Class	Miles	% of Corridor
Baseline	56.1	59.3%
Low	35.3	37.4%
Medium	3.1	3.3%
High	0.0	0.0%




Traffic Operations Infrastructure Plan
ROCK RIVER CORRIDOR
Janesville/Beloit - Oshkosh
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
0 10 20 30 Miles
Basemap Design by Wisconsin DOT GIS
Oshkosh
Neenah
Menasha
Omro
Ripon
Fond Du Lac
Waupun
Fox Lake
Beaver Dam
Mayville
Horicon
Juneau
Columbus
Hartford
Watertown
Waterloo
Lake Mills
Oconomowoc
Jefferson
Fort Atkinson
Whitewater
Edgerton
Milton
Evansville
Janesville
Brodhead
Beloit
WINNEBAGO
FOND DU LAC
DODGE
JEFFERSON
A
B
C

Trempealeau River Corridor

Corridor Overview

The Trempealeau River Corridor includes WIS 35/US 53 from La Crosse (I-90) to WIS 93, and WIS 93 from WIS 54 to Eau Claire (I-94) as well as a portion of the Eau Claire-Chippewa Falls MPO Region. This Corridor serves as the primary link between the metro areas of La Crosse and Eau Claire. It also serves the furniture manufacturing industry in Arcadia.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This short Corridor has little technology. There is one RWIS site and no ATR stations. The recommendations along this Corridor are very low. Because of the low crash rate, there is a need for a low level of incident management. Other deployment levels are recommended to remain at a baseline level. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

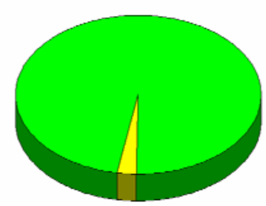
Signal Systems

- East of Arcadia on WIS 93, low signal deployment density recommendations are made from WIS 95 south to Blaschko Avenue. West of Galesville on WIS 54/WIS 93 from Bridge to Winona east to US 53, low signal deployment density recommendations are proposed. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles = **75**

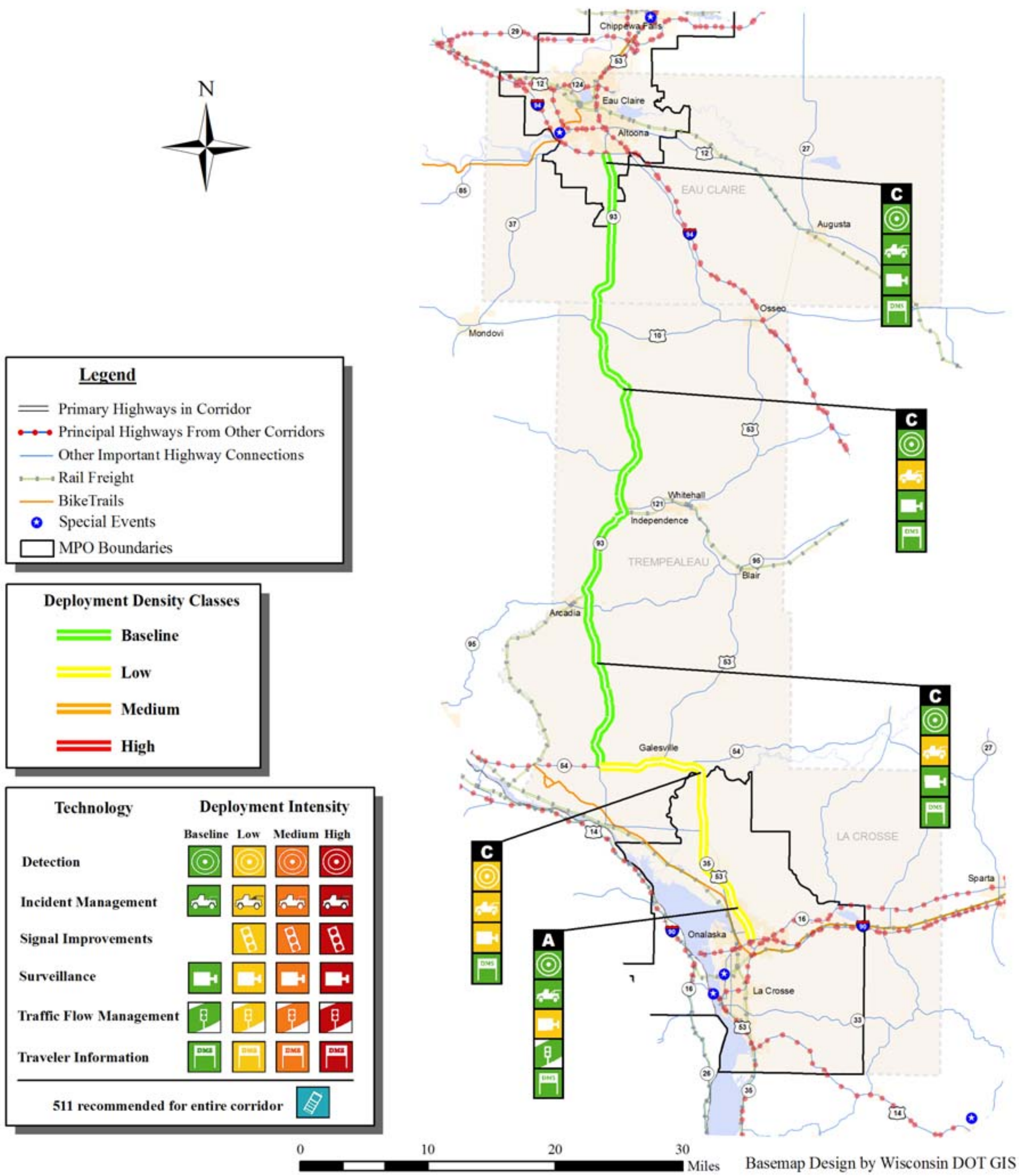
Deployment Density Class	Miles	% of Corridor
Baseline	73.4	97.5%
Low	1.9	2.5%
Medium	0.0	0.0%
High	0.0	0.0%



Traffic Operations Infrastructure Plan

TREMPEALEAU RIVER CORRIDOR

La Crosse - Eau Claire



Waukesha Connection Corridor

Corridor Overview

The Waukesha Connection Corridor includes WIS 83 from WIS 33 south to I-43 and WIS 164 from US 41 south through Waukesha to I-43 as well as a portion of the Milwaukee-Waukesha Region. This Corridor is part of a major passenger and freight corridor linking the growing Waukesha County area to major travel corridors to the north and south. This corridor is also important as a commuter corridor to the economic centers in Waukesha County.

Note: Recommendations are unavailable for a small portion of WIS 164 due to data gaps.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- There is little technology implemented on this Corridor. Currently, there is one RWIS site on this segment. This Corridor has relatively little need for traffic operations infrastructure and because it is so short, the Corridor has relatively consistent recommendations. The only portion that has medium level recommendations is the segment of WIS 164 north of Waukesha. This segment has moderate traffic volumes and should have some detection implemented. Other segments are generally at baseline levels with some low levels where the Corridor connects to higher volume roadways. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

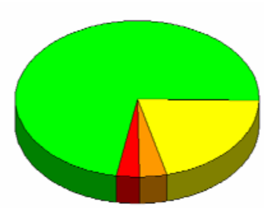
Signal Systems

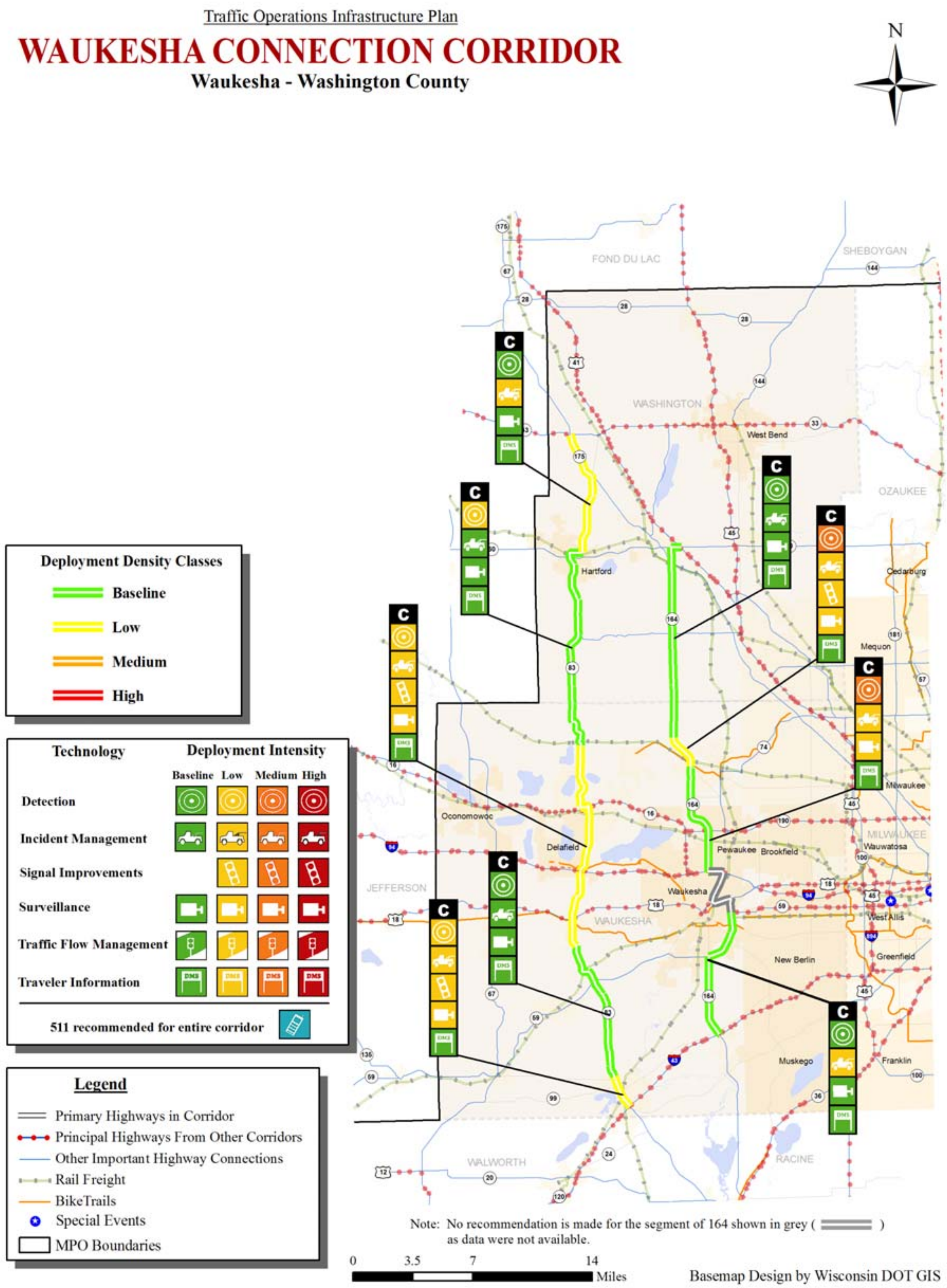
- Low signal deployment density recommendations are made in Washington County on WIS 83 from US 41 south to Arthur Road. In the Milwaukee-Waukesha Area MPO east of Delafield, low signal deployment density recommendations are made on WIS 183 from WIS 16 south to Golf Road. Medium signal deployment density recommendations are proposed on WIS 83 from Golf Road south to Hillside Drive. On WIS 83 from Hillside Drive south to CTH D, low signal deployment density recommendations are. North of I-43, low signal deployment density recommendations are made on WIS 83 from CTH NN south to I-43. In the Milwaukee Area MPO, low signal deployment density recommendations are made on WIS 164 from Plainview Road south to WIS W. South of I-94 in the Milwaukee-Waukesha Area MPO, low signal deployment density recommendations are made on both US 18 from North Street east to I-94/WIS 164 and on WIS 164 from US 18 south to

Corridor Statistics

Total Miles =
78

Deployment Density Class	Miles	% of Corridor
Baseline	56.8	72.4%
Low	16.4	20.9%
Medium	2.9	3.7%
High	2.3	3.0%




Traffic Operations Infrastructure Plan
WAUKESHA CONNECTION CORRIDOR
Waukesha - Washington County
N
Deployment Density Classes
Baseline
Low
Medium
High
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
FOND DU LAC
SHEBOYGAN
WASHINGTON
West Bend
OZAUKEE
Hartford
Cedarburg
Mequon
Milwaukee
MILWAUKEE
Wauwatosa
Oconomowoc
Delafield
Pewaukee
Brookfield
JEFFERSON
Waukesha
WAUKESHA
West Allis
New Berlin
Greenfield
Muskego
Franklin
WALWORTH
RACINE
Note: No recommendation is made for the segment of 164 shown in grey ( )
as data were not available.
0
3.5
7
14
Miles
Basemap Design by Wisconsin DOT GIS

Wisconsin Heartland Corridor

Corridor Overview

The Wisconsin Heartland Corridor includes WIS 29 from I-94 east of Menomonee to Green Bay (US 41). The Corridor includes the Wausau area. This Corridor is part of a major passenger and freight corridor linking Green Bay, Wausau and Eau Claire to the Twin Cities and points further west. It is a critical tourism link between the Twin Cities and tourism destinations in central and eastern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- This Corridor has relatively little deployed traffic operations infrastructure. The sole location where much infrastructure is recommended to be placed is in the Wausau area. Several cameras and detectors are recommended to monitor IH 39. There are three RWIS stations and only a few ATR stations along the Corridor. Most of the ATR stations do not have remote connectivity. (See *TOIP Appendix A* for further details.)

Traveler Information

- Medium density deployment is recommended for the segment adjacent to US 41. Portable DMS is recommended for eastbound WIS 29 to provide incident and alternate route guidance as well as being used for weather and construction alerts.
- Baseline density deployment is recommended for the remainder of the Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations.
- Portable DMS is recommended for WIS 29 east of Chippewa Falls just east of Chippewa Falls on WIS 29 approaching the Chippewa Falls/Eau Claire ring road (I-94, WIS 29, and US 53) to provide incident and alternate route guidance as well as being used for weather and construction alerts. (See *TOIP Appendix B* for further details.)

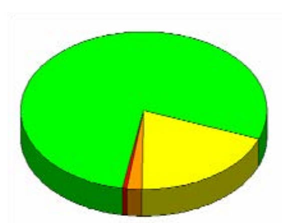
Signal Systems

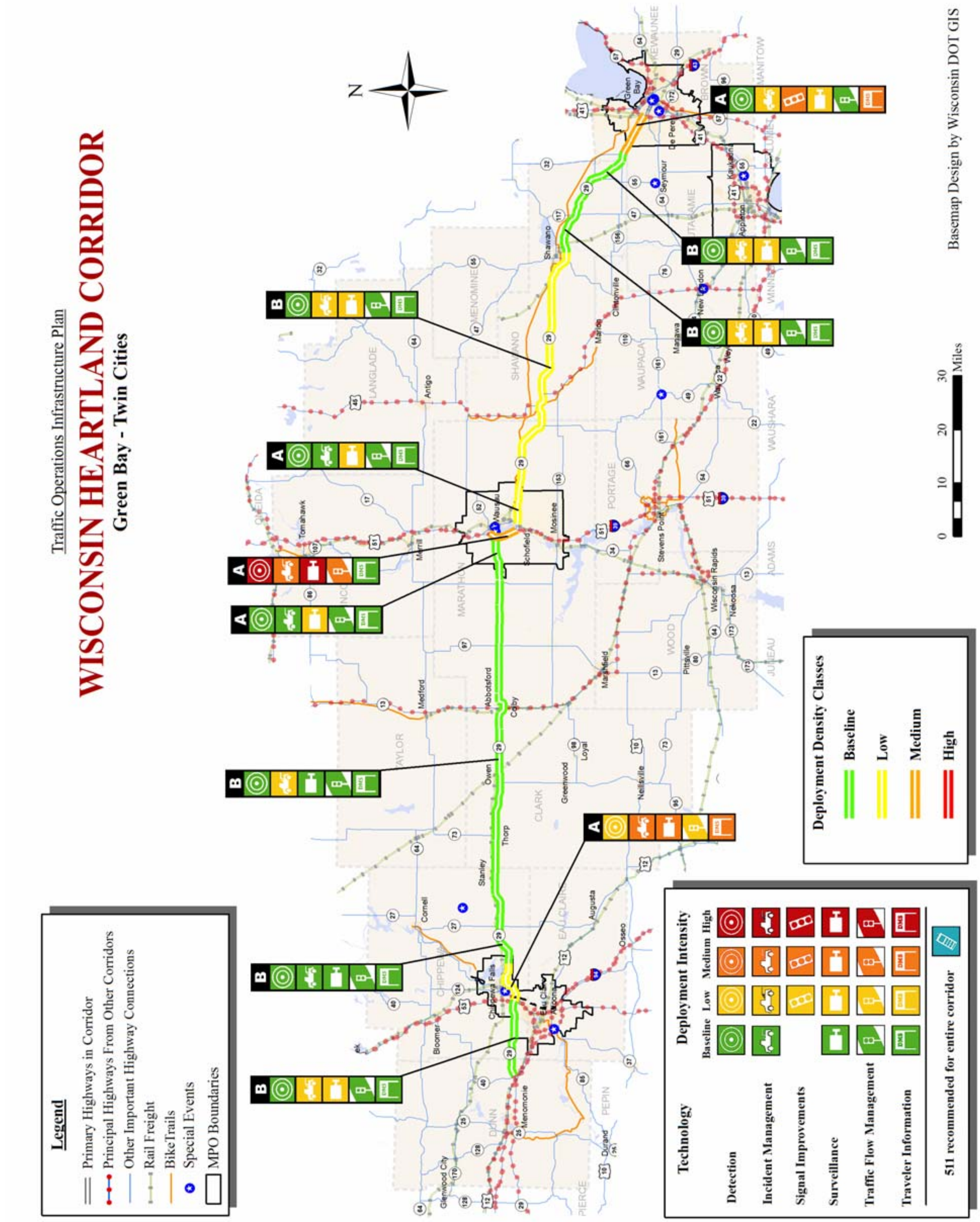
- In the Green Bay Area MPO, medium signal deployment density recommendations are made on WIS 29 from WIS 32 east to Military Ave. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
196

Deployment Density Class	Miles	% of Corridor
Baseline	152.9	77.9%
Low	38.4	19.6%
Medium	3.7	1.9%
High	1.2	0.6%




Traffic Operations Infrastructure Plan
WISCONSIN HEARTLAND CORRIDOR
Green Bay - Twin Cities
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline
Low
Medium
High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0
10
20
30
Miles
Basemap Design by Wisconsin DOT GIS

Wolf/Waupaca Rivers Corridor

Corridor Overview

The Wolf/Waupaca Rivers Corridor includes US 10 from Stevens Point to Menasha (US 41) and US 45 from US 10 to Oshkosh (US 41) as well as a portion of the Appleton-Oshkosh-Fond du Lac Region. This Corridor is part of a major passenger and freight corridor between central Wisconsin and the Fox Valley and points south and east. It is also an important link in the connection of southeastern Wisconsin to the tourism and recreational centers of northern Wisconsin.

Key Operational Infrastructure

Surveillance and Traffic Flow Management

- There is very little technology implemented on this Corridor. There are RWIS sites on the east and west ends of the Corridor and only a few ATR stations. The technology recommendations for the Corridor are very low with slightly higher recommendations near Appleton. (See *TOIP Appendix A* for further details.)

Traveler Information

- Baseline density deployment of traveler information technologies is recommended for the entire Corridor. Baseline recommendations include statewide initiatives such as 511 and STOC operations. (See *TOIP Appendix B* for further details.)

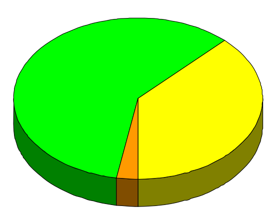
Signal Systems

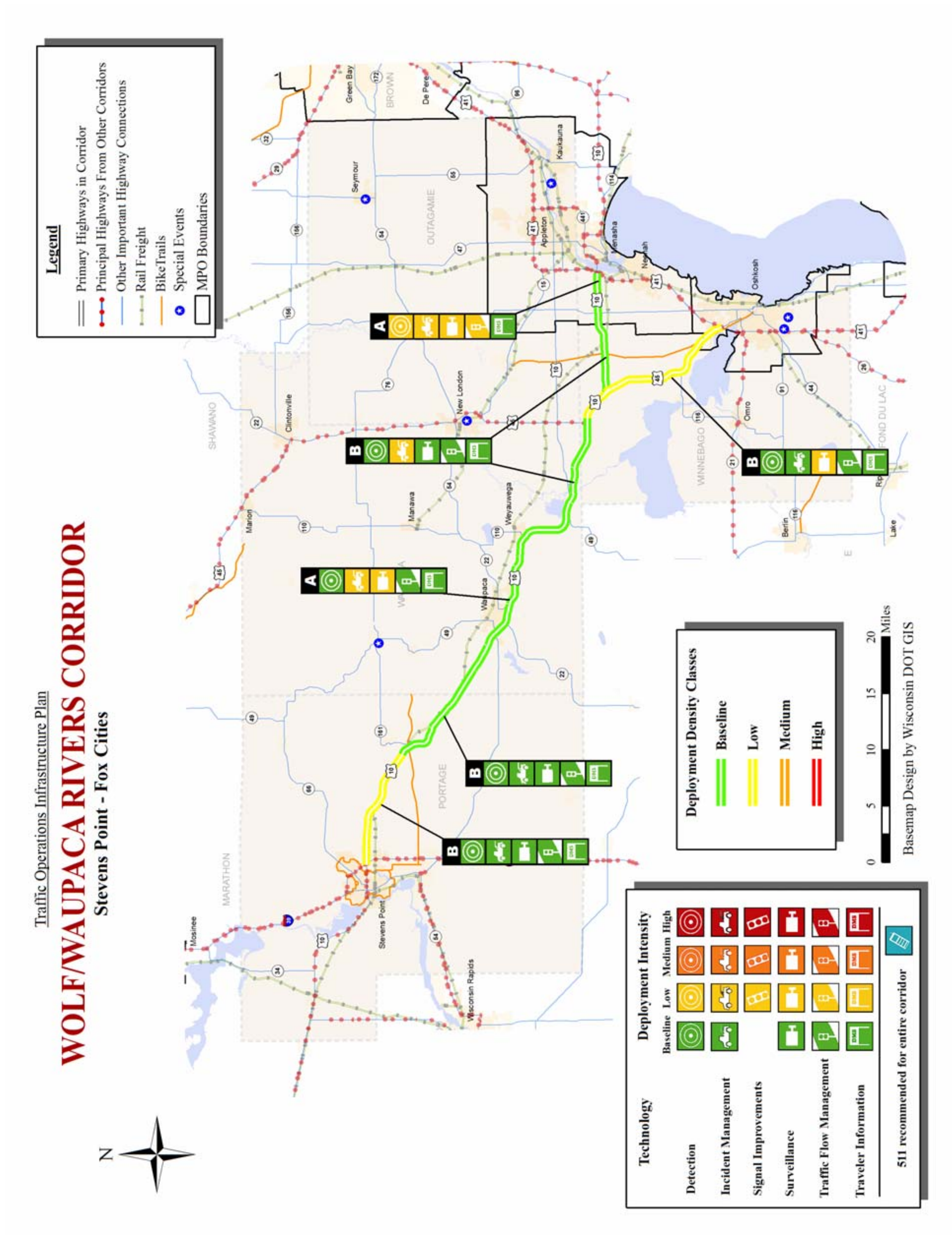
- East of Stevens Point on US 10, low signal deployment density recommendations are made from I-39/US 51 east to Amber Avenue. (See *TOIP Appendix C* for further details.)

Corridor Statistics

Total Miles =
75

Deployment Density Class	Miles	% of Corridor
Baseline	44.3	59.3%
Low	28.3	37.9%
Medium	2.1	2.8%
High	0.0	0.0%





Traffic Operations Infrastructure Plan
WOLF/WAUPACA RIVERS CORRIDOR
Stevens Point - Fox Cities
N
Legend
Primary Highways in Corridor
Principal Highways From Other Corridors
Other Important Highway Connections
Rail Freight
BikeTrails
Special Events
MPO Boundaries
Technology
Deployment Intensity
Baseline Low Medium High
Detection
Incident Management
Signal Improvements
Surveillance
Traffic Flow Management
Traveler Information
511 recommended for entire corridor
Deployment Density Classes
Baseline
Low
Medium
High
0 5 10 15 20 Miles
Basemap Design by Wisconsin DOT GIS
A
B
Mosinee
MARATHON
Stevens Point
Wisconsin Rapids
PORTAGE
Waupaca
Weyauwega
Manawa
Marion
Clintonville
SHAWANO
New London
Seymour
OUTAGAMIE
Green Bay
BROWN
De Pere
Appleton
Kaukauna
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4.0 TOIP Program and Process Integration

The TOIP is a major step forward for BHO, planning and all of WisDOT as they strive to integrate operations into the planning process. It provides a quantitative approach and tool that analyzes the operational needs of the Wisconsin highway system and provides a structured approach to operations/ITS recommendations across the State. It also creates a statewide operations/ITS program that allows planners and programmers to understand, not only the capital program cost implications, but the ongoing maintenance, operations, and replacements commitments as well.

However, the long-term success of the TOIP will ultimately be measured on how effectively it is integrated into the standard practices and procedures of WisDOT. This section provides a brief overview of the steps needed to ensure the TOIP is not only maintained and updated in a structured manner, but that the recommendations of the TOIP process are utilized as new corridor studies are undertaken and design projects are considered throughout the State. It should be noted, that this section only provides guidance into this integration process. The project champions within BHO and the TOPS Lab will be the critical catalyst in solidifying the TOIP approach into the culture of WisDOT.

4.1 Maintenance and Updates of the TOIP

First and foremost, for the TOIP process to continue to have value after the initial consultant support has ended; a stakeholder within the TOIP committee should become the maintainer of the TOIP. There are two main elements to maintain. First, is the dataset from which the TOIP methodology generates its scorings. As mentioned earlier this dataset is a subset of MetaManager data as well as Division of Traffic Forecasting (Special Events) and TOPS Lab (weather). The second element of the TOIP model is the Visual Basic (VB) program within Excel which sits on top of the TOIP dataset and executes the TOIP methodology and produces the smoothed datasets and GIS shape files as exports.

The University of Wisconsin-Madison, TOPS Lab has stepped forward and volunteered to be the maintainer and updater of the TOIP dataset and model. This is a natural progression of as they have been an active and critical partner in the success of the TOIP process to date. During the project development, TOPS Lab created and hosted the project's web site; providing a repository for all project-related materials. A TOPS Lab Project Manager also managed the development of the TOIP methodology and oversaw one of the consultants involved in this effort.

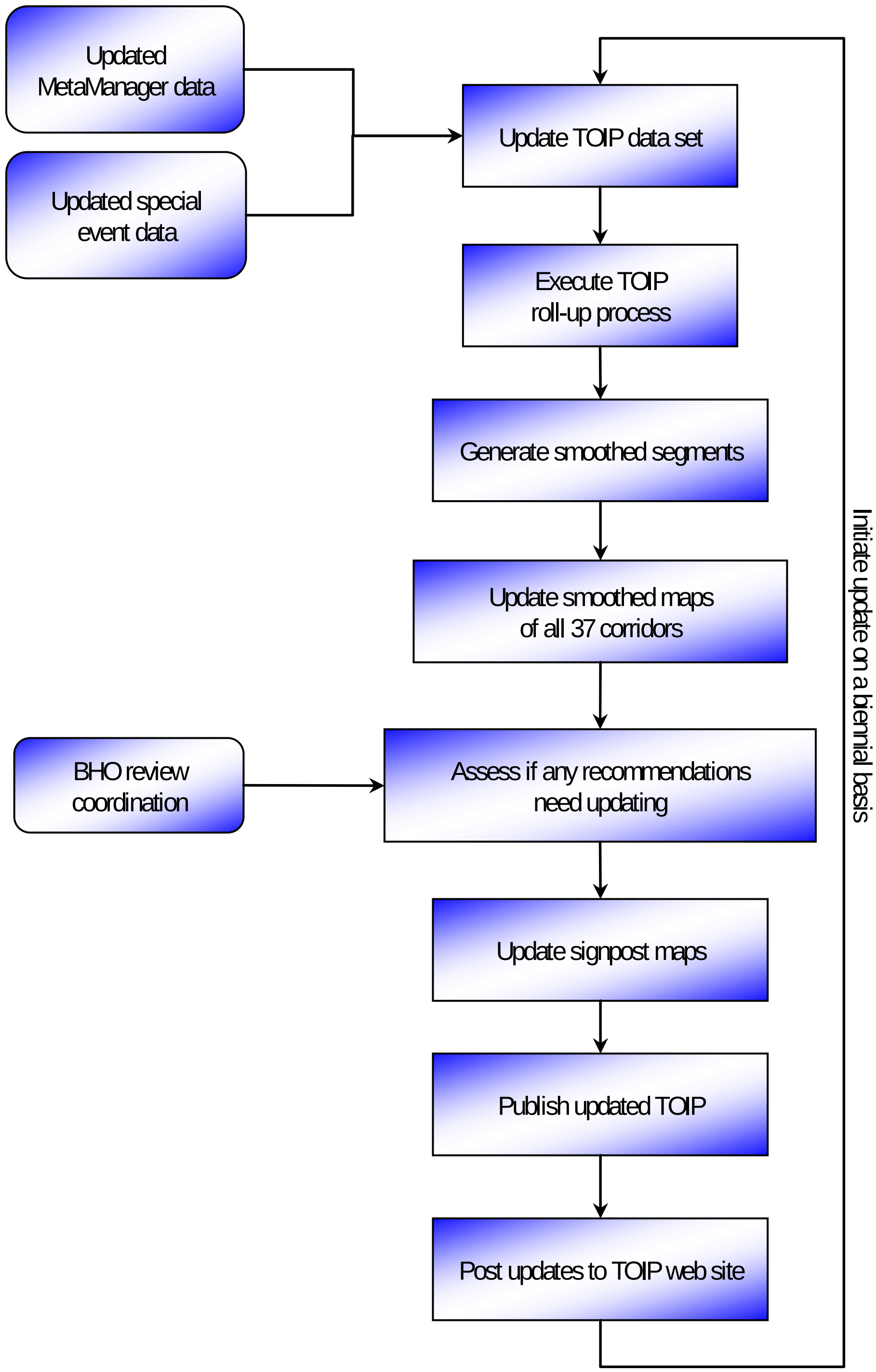
Updating the TOIP is a multistage process and outlined in Figure 4.1. This process begins with the assumption that TOPS would host the official web site for the TOIP which would include all final documentation (including maps and appendices) of the TOIP. The TOPS Lab will update the TOIP dataset and execute the TOIP model in a two-year cycle. They will be responsible for contacting WisDOT and obtaining the updated MetaManager data extract; as well as verifying whether there is any updated Special Event information. The weather information was based on historical snowfall rates and it is not anticipated that it would change significantly from year to year. Therefore, it is not recommended to update this information.

The TOPS Lab would then execute the TOIP VB program and produce the corridor maps based on the GIS output files provided by the TOIP model. Finally, they would conduct an analysis of the new results in coordination with BHO, and determine what actions if any needed to be taken to update any of the overall recommendations. If updates to the signposts are warranted the TOPS lab would also update the corridor signpost maps and associated text and publish a new version of the TOIP. The TOPS Lab would then post the updated report back on the official TOIP web site.

For proper maintenance, a version control process will need to be developed by which this data set is logged and any updates documented. This can be a very simple electronic text document but needs to track critical information such as:

- When the TOIP dataset was accepted by the maintainer;
- Where the TOIP dataset is stored on the maintainer's network;
- Who has access to this dataset and any associated usernames and passwords;
- What sequential numeric version number is assigned following an update;
- What date the update occurred on; and
- What name and contact information are associated with the new version number.

Figure 4.1 Update and Maintenance Process



4.2 Integration with Standard Policy Documents and Handbooks

There are a number of ways in which the TOIP can be incorporated into WisDOT's business practices. One of the first applications will be integrating it into the corridor process upon which much of the TOIP's methodology is based. Figure 4.2 illustrates how it is anticipated the TOIP will act as a recourse to this existing process.

BHO has also begun to identify, where within the DOT's processes, the TOIP should be incorporated. At a minimum, it is recommending that the TOIP should be included into the following:

- Concept Definition Report;
- Program Manual – Authorization Report;
- Design Study Report;
- Integrate into the PS&E Check Off List;
- Integrate into the ITS Design Manual; and
- Integrate into Statewide Traffic Operations and Master Contracts.

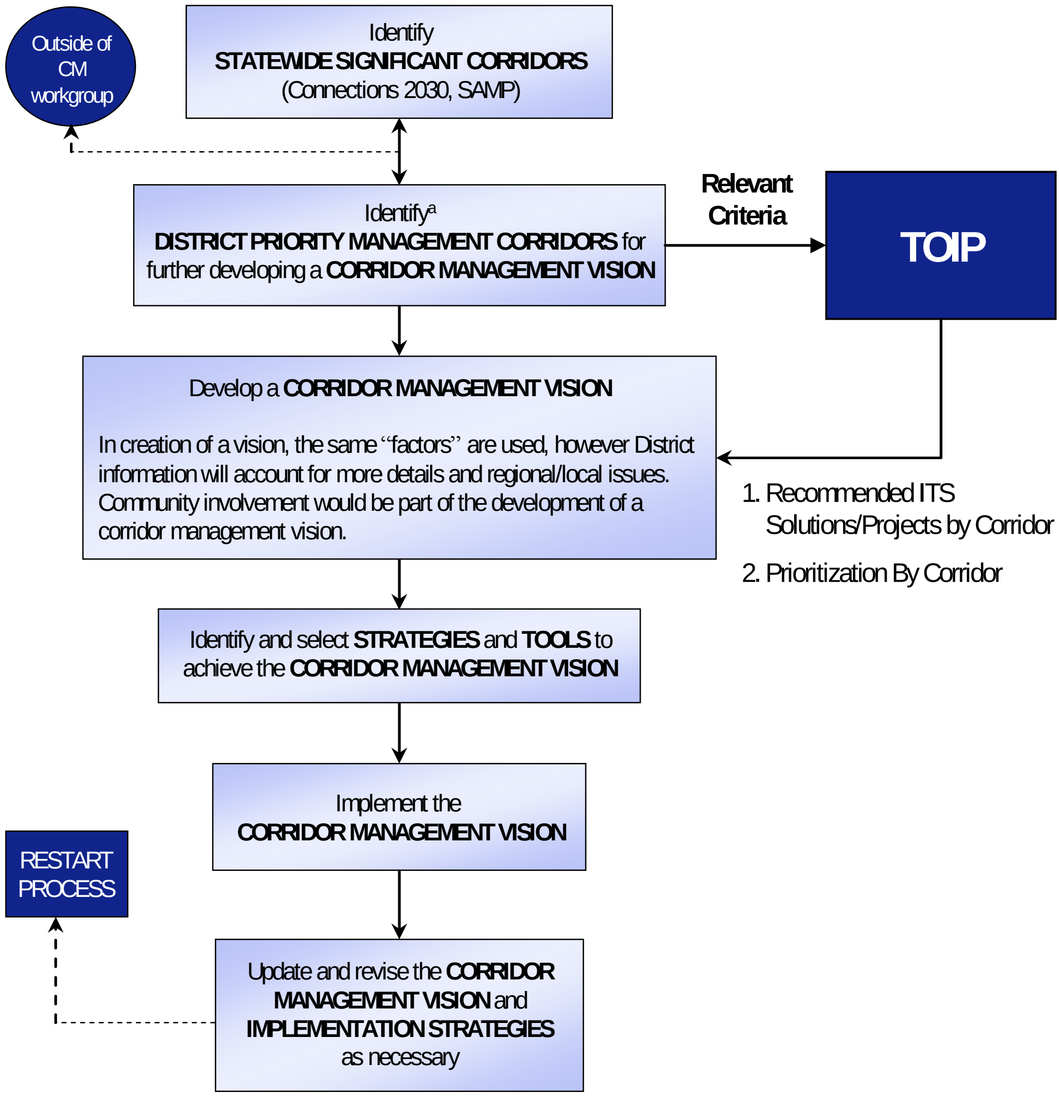
The TOIP can also serve as a marketing resource to regions looking to add operational elements to upcoming projects and should be made available as such.

It is recommended that the BHO champion the integration of the TOIP into these manuals and procedures.

4.3 Integration with Connections 2030

As mentioned earlier, the TOIP worked closely with the WisDOT team developing the update to their long-range plan Connections 2030. Specifically, during the development of the TOIP, the development team did provide a shape file of the DDC levels across the entire State. The file only included those DDC that were high or medium, as the goal was to illustrate the areas along the Wisconsin statewide system with the greatest need for operations/ITS solutions. Guidance was also provided to the long-range planning team on how to integrate operations recommendations into their own summary maps.

Figure 4.2 Integration of TOIP in Corridor Methodology



[a] This includes both quantitative and qualitative analysis.

Note: Corridors not identified as a "Priority Management Corridor" would continue being "managed," however, activities might be less rigorous and more administrative in scope.

4.4 Potential Sophistication of the Plan

The TOIP, like any effective plan, must be maintained as time goes by. There are also however, areas that could make the TOIP process even better.

Inclusion of other operational factors – While the TOIP provides a unique approach to operations/ITS planning by including operations centric criteria in the decision-making process; additional operational criteria could be considered for inclusion in the future to make the role of operations even more important. Currently weather and special events are included in the 10 criteria. In developing the final 10 criteria, over 40 criteria (many operational in nature) were considered. It is recommended that when the TOIP is updated again, these original criteria be looked at again and another assessment should be made as to which could be included in an updated TOIP methodology. Examples of additional operational criteria which could be included are speed change and ADT on crossing routes.

Specifically, the inclusion of fog should be revisited. Fog is a major factor affecting operations across the State, especially in the northern regions. Fog was specifically called out as a desired criteria by the region offices as the methodology was being finalize. At the time of this project's development however, an accurate dataset for fog was not available. However, with weather sensors continually being deployed throughout the State, there is a good chance that a valid fog dataset might be available the next time the TOIP is updated.

The presence of alternate routes was factored into the TOIP through the selection process of the 2030 Multimodal Corridor Network, which couples available alternate routes with major corridors. As a result, corridor solution strategies recognize the importance of alternate routes as a corridor-level consideration. However, the presence of alternate routes is not factored into the quantifiable analysis of roadway operational needs. In the future, the inclusion of alternate routes could be factored into the methodology to increase the priority of operations deployments at critical decision points.

The impact of traffic-generating special events is factored into the recommendations of the TOIP. Greater detail can be incorporated in the future, including stronger links with traffic-generating land uses such as freight distribution centers and recurring event centers (such as amusement parks or concert venues). Links to emergency service centers (such as hospitals, fire and police stations) can also improve the calculation of operations benefits by factoring in potential improvements to emergency service travel times generated by technology deployments.

Display TOIP in a web interactive environment – Although the current TOIP will be posted on the web, the documents will be only available in a .pdf format. The documents are also extremely large. In order to make the TOIP more accessible for all WisDOT users in the region and central office, it is recommended that the TOIP, specifically the corridor maps and recommendations, be presented in a interactive web format. This conversion to a web environment could take on a variety of looks. One to consider would be providing DDC color coded maps for each corridor, when the user moves their curser over a specific segment, the sign post, and other more detailed information could appear. Likewise the cost information could be displayed in summary format, that if the user clicked on a specific cost, could then be “drill down” into more detailed cost breakouts, assumptions, and projections.

An internal extension of the web interactive environment could involve integrating the interactive TOIP methodology tool with an internal webpage display. The TOIP methodology tool allows for the adjustment of threshold levels, criteria weights, and overall DDC scoring thresholds. By presenting this tool in an interactive format with easily accessible visual display, WisDOT staff would gain a greater understanding of the TOIP methodology as it currently functions. Staff could also contribute their knowledge of Wisconsin operational needs by refining inputs, ultimately resulting in a greater level of accuracy. The interactive TOIP tool could be used to present arguments for or against specific long-range plans and prioritization levels, adding a greater layer of quantifiable detail to internal discussions on operational strategies and directions.

Integrate the TOIP into corridor benefit/cost analysis – The TOIP is already being utilized as the baseline for operations/ITS assumption as more detailed analysis, including benefit/cost (B/C) analysis. It is recommended that this approach be integrated into the standard project development process. The TOIP provides an excellent resource and significant information as a corridor project moves into more design-related activities and including it as a part of any further B/C analysis will save significant time and resources as those projects take shape.

Increase MPO-Level Focus – A significant amount of long-range operations planning occurs at the MPO level. The statewide focus of the TOIP functioned on a corridor-level, and it was successful in providing a set of long-range operational strategies focused on the need for high-performance connections between major traffic centers. Increasing the MPO-level focus of future TOIP efforts could improve operational strategy consensus with MPO planning efforts and ensure that operations targeted towards improving statewide performance and operations targeted towards improving localized urban performance are complimentary. One way in which this could be accomplished would be involvement of MPO operations planners in the determination of future criteria and weights as the TOIP is continually refined over time.