FDM 11-38-1 General

August 15, 2023

The purpose of this section is to introduce the expectations of performing safety analyses under performance-based practical design (PBPD) (FDM 11-1-10) philosophies through the implementation of WisDOT's Safety Certification Process (SCP). The SCP adopts the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM) analysis methods and economic appraisal process.

1.1 Overview

WisDOT is continuously balancing fiscal realities with competing highway needs. As such, all asset improvements (safety, pavement, structures) must be employed with the right fix at the right time and in the right location. This "right fix, right time, right location" philosophy is fundamental to PBPD practice. Refer to FDM 11-1-5 for WisDOT's *Asset Management by a Practical Design System Preservation Approach* that incorporates the SCP.

The safety analysis portion of PBPD places emphasis on substantive safety, i.e., long-term safety performance of a roadway, through consistent identification of safety needs while still considering nominal safety by addressing roadway elements that have less than lower minimum design criteria. Nominal safety is the safety assumed "built-in" to the design criteria. What is important to understand is a roadway's substantive safety does not always correlate to its level of nominal safety. It is not uncommon for a roadway to be nominally safe (i.e., all design elements meet design criteria) but at the same time be substantively unsafe (i.e., has crashes that are higher than expected). Similarly, some roadways that are nominally unsafe (one or more design elements do not meet design criteria) can and do function at a high level of substantive safety. This process will allow for more accurate scoping of the true purpose and need of projects and result in more efficient expenditures throughout the system.

WisDOT's SCP uses network screening tools to identify locations that experience more crashes than similar sites; therefore, they have a higher potential for safety improvement. These "safety sites of promise" are then subject to a crash vetting process, predictive crash modeling, and economic appraisal (benefit-cost) methodologies, to identify and evaluate alternatives for locations on the highway network.

1.2 Purpose

Quantifying safety early in the project development process is key to determining safety improvement impacts to projects. Proposed safety improvements in a project must be balanced with other competing fiscal needs such as operational, environmental, and pavement factors. Historically, safety benefits have been assumed inherent, or "built-in", to design policies and practices. The safety treatments were proposed at locations that were identified using the existing (observed) short-term crash data. This method was not representative of the long-term conditions of the subject location as it did not account for the Regression to the Mean (RTM) of crash data. RTM is defined as the natural variation of crash data. A location that was being reviewed could be analyzed when it was seeing a randomly high fluctuation of crashes, but the long-term period saw the location operating within typical safety norms. Likewise, a location could be overlooked from review due to it having a randomly low fluctuation of crashes. Figure 1.1 displays RTM bias.

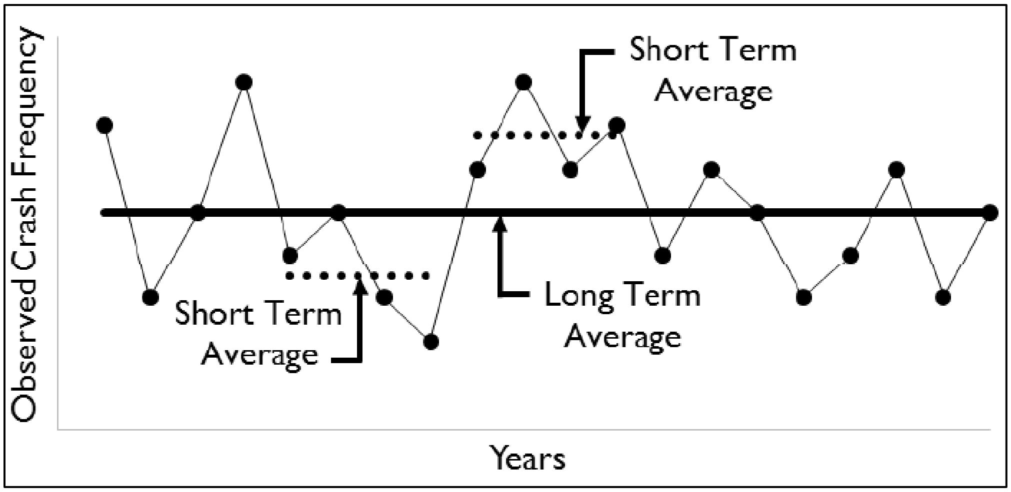

***Figure 1.1* Variation in short-term observed crash frequency to illustrate RTM bias**

There are methods and tools available to quantify safety benefits in the development and analysis of alternatives in projects while accounting for RTM. This allows WisDOT to employ a PBPD approach. Within the safety evaluation of a project, to facilitate the safety comparison of alternatives, predictive crash modeling and an economic appraisal is used to compare the cost of crashes to the cost of roadway improvements. Predictive crash modeling is used to estimate crash frequencies and severities for alternatives on a project. Economic appraisal techniques are then used to assign average costs to the crashes for each alternative to monetize safety benefits. In this way, safety can be compared with other costs (construction, real estate) to evaluate alternatives. For a discussion on alternative viability, see FDM 11-38-15.1.

1.3 Applications

Different project types are completed by WisDOT and local agencies to improve the transportation network in Wisconsin. This section outlines when the Safety Certification Process should be completed. Direct all questions about this policy to DOTBTOSafetyEngineering@dot.wi.gov.

The Safety Certification Process (SCP) is required for most perpetuation and rehabilitation improvement projects. FDM 11-1-10 Attachment 10.1 has more specific guidance on which project types require the SCP.

For miscellaneous (MISC) concept codes a Safety and Operations Certification Document (SOCD) may still be required. Coordination with WisDOT's Bureau of Traffic Operations (BTO) Traffic Analysis and Safety Unit is required to determine if the process is applicable.

1.3.1 Exceptions and Special Considerations

1.3.1.1 Emergency Projects

Emergency projects do not require an SOCD. Emergency projects are projects which impose immediate danger to the public. Criteria meeting these definitions are detailed in the Highway Maintenance Manual Chapter 3-1-20. Examples of these incidents include:

- Structure failure
- Culvert failure that damages or threatens a portion of the highway
- Flooding/slope failure that damages or threatens a portion of the highway
- Pavement failure
- Obstruction on the road (utility poles, trees, etc.)
- Concrete barrier wall damage that impacts safety
- Hazardous material spills

Non-emergency projects requiring an expedited letting that do not impose an immediate danger to the public (e.g., maintenance-related pavement project) may still require an SOCD. Safety countermeasures could still be included within these projects if they do not impact the overall schedule. If safety countermeasures are considered within these projects, an SOCD is required.

1.3.1.2 Local Considerations

Local agencies can follow a process similar to the SCP to evaluate safety countermeasures along their local roadway network; however, the SCP uses network screening tools that were developed for use on the State Trunk Network (STN) and these are not available for the local roadway network at this time. Network screening for the local roadway network would be based on historical knowledge of safety concerns or a review of recent crash history compared to statewide average crash rates. Access to WisDOT's statewide average crash rate publication is available under the *Safety and Operations Certification* section on the Traffic Operations Manual webpage. Once locations are identified, local roadway projects can follow similar steps as outlined in the SCP to produce an SOCD. Local road crash information can be obtained from the University of Wisconsin Traffic Operations and Safety (TOPS) Lab or from local databases maintained by engineering or police departments.

WisDOT's BTO Traffic Analysis and Safety Unit is available to provide guidance to the local agency on the SCP; however, completion, review, and approval of any documentation on the analysis methodology and results are the responsibility of the local agency.

If an SOCD is not prepared for a project, S-3 application must be used. Use of criteria less than S-3 application requires Design Justification and will be documented within the Design Study Report (DSR). A local agency may complete an SOCD as a justification for use of criteria less than S-3 application. See FDM 11-1-10 for information regarding S-3 application.

1.3.1.3 Highway Safety Improvement Program Projects

The SCP and Highway Safety Improvement Program (HSIP) follow separate processes. For a standalone Highway Safety Improvement Program (HSIP) project which originates outside of the normal improvement program, the HSIP application can replace the SOCD. For projects loaded into the improvement program which undergo the SCP network screening and receive HSIP funding, the HSIP application cannot replace the SCD and both the HSIP and SCP processes will need to be completed.

1.3.1.4 Federal Majors Projects

Federal Majors Projects can follow the SCP but will not produce a formal SOCD. It is recommended that Federal Majors Projects utilize the SCP by identifying potential Safety Sites of Promise through network screening and diagnosing the issues at these locations for potential safety countermeasures. Following the SCP can aid in the decision making for what to include within the project to align with the purpose and need.

Consideration between the timeframe of the study and construction is needed for these projects when reviewing crash information. The intent of the SCP is to identify safety needs within the conceptual phase of a project and not reevaluate during the life cycle of the project unless significant changes occur (e.g., traffic volumes increase substantially, land use/development changes, highways rerouted, etc.).

1.4 Acronyms and Definitions

Tables 1.1 and 1.2 provide common acronyms and definitions that are used throughout the Safety Certification Process.

Table 1.1 Acronyms

Acronym	Definition
AADT	Average Annual Daily Traffic
CMF	Crash Modification Factor
EB	Empirical Bayes
FDM	Facilities Development Manual
FHWA	Federal Highway Administration
HSM	Highway Safety Manual
IHSDM	Interactive Highway Safety Design Manual
LOSS	Level of Service of Safety
NEPA	National Environmental Policy Act
PBPD	Performance-Based Practical Design
RTM	Regression to the Mean
SOCD	Safety and Operations Certification Document
SCM	Safety Certification Mapping Tool
SCP	Safety Certification Process
SCW	Safety Certification Worksheet
SPF	Safety Performance Function
STN	State Trunk Network

Table 1.2 Definitions

SCP Element	Definition
Base Case	The base case is the scenario each alternative will be compared to. In most cases, the base case scenario will not include safety improvements and should be modeled as the existing geometric and traffic control conditions for the evaluation period.
Calibration Factor	A factor to adjust crash frequency estimates produced from a safety prediction procedure to approximate local conditions. The factor is computed by comparing existing crash data at the state, regional, or local level to estimates obtained from predictive models.
Crash Cost	Crashes result in economic costs including the costs of vehicle repairs, providing emergency services, traffic delays, medical services, workplace productivity losses, and damage to private property and roadway infrastructure. Crashes involving death or severe injury may also result in intangible costs such as physical pain or emotional suffering. These costs are referred to as quality-adjusted life years (QALY). The comprehensive costs of a crash are the sum of the economic and QALY costs. Detailed information regarding FHWA default crash costs can be found in the FHWA Crash Cost for Highway Safety Analysis.
Crash Modification Factor (CMF)	A CMF is a factor estimating the potential changes in crash frequency or crash severity due to installing a specific treatment. The CMFs in the HSM have been developed based on rigorous and reliable scientific process. As an example, a 0.70 CMF corresponds to a 30 percent reduction in crashes. A 1.2 CMF corresponds to a 20 percent increase in crashes.

SCP Element	Definition
Crash Reports	Wisconsin police crash reports are available in two different versions: • DT4000 represents the current version of the Wisconsin crash report and is based on national standards for crash data elements and attributes. The DT4000 crash reports were implemented on January 1, 2017. • MV4000 represents the previous version of the Wisconsin crash report and was retried at the end of 2016.
Discount Rate	Discount rates, used in the economic appraisal, reflect the time value of money. That is, benefits and costs experienced in the near-term are worth more than benefits and costs experienced at the end of the evaluation period. For more information, reference FHWA Highway Safety Benefit-Cost Analysis Guide.
Empirical Bayes (EB)	EB is a statistical method that weights the predicted crash frequency and the observed crash frequency.
Expected Crash Frequency	The number of crashes obtained by weighting the predicted crash frequency and the observed crash frequency using the EB method.
Interactive Highway Safety Design Model (IHSDM)	IHSDM is a suite of software analysis tools used to evaluate the safety operational and economic effects of design decisions on roadways. This software provides a Crash Prediction Module to implement the HSM Part C methodology. Refer to FHWA website for more information.
Intersection Network Screening Spreadsheet	WisDOT's tool for intersection network screening, which contains WisDOT intersection inventory data.
Meta-Manager	WisDOT's facilities asset management database.
Observed Crash Frequency	The number of crashes at a specific, site. Observed crashes are often reported for a 5-year period.
Predicted Crash Frequency	The number of crashes determined by using a safety performance function (SPF).
Regression to the Mean (RTM)	The natural variation in crash data. If regression to the mean is not accounted for, a site might be selected for study when the crashes are at a randomly high fluctuation or overlooked from study when the site is at a randomly low fluctuation.
Safety Flag	Meta-Manager indication for a roadway segment that has a crash rate that is one standard deviation above the statewide average for its peer group. Intersection Network Screening indication for an intersection with a Level of Service of Safety category 4 (LOSS 4) for either Total or KABC crashes and at least two crashes.
Safety Performance Function (SPF)	SPFs are equations that predict crash frequency and severity as a function of traffic volume and roadway characteristics (e.g., number of lanes, median type, intersection control, number of approach legs).
Safety Site of Promise	Segment or intersection within a project's limits that have a potential for safety improvement.

FDM 11-38-10 Policy — November 15, 2023

10.1 General

The Safety Certification Process (SCP) follows the Highway Safety Manual's (HSM's) Road Safety Management Process (RSMP). This is a step-by-step process of determining whether safety improvements should be included on a project by quantifying alternatives, monetizing the resulting safety benefits, completing benefit-cost comparisons of the alternatives, and documenting decisions and judgements throughout the process.

This requires the analyst to use and document sound engineering judgement and experience based on specific project conditions, context, and modal priorities.

The SCP will be used to support all safety improvements on a WisDOT project and generally includes the following steps (See Safety Certification Process flowchart):

1. **Network Screening for Safety Sites of Promise:** A screening procedure which identifies

segments and intersections (Safety Sites of Promise) with the highest potential for crash reduction to best utilize resources.

2. **Diagnosis of Safety Sites of Promise:** Investigate the Safety Sites of Promise to understand why crashes are occurring, identify the contributing factors at those sites, and vet crashes where there is no engineering solution. Crashes that are treatable through an engineering solution should remain regardless of a specific pattern or trend.
3. **Countermeasure Identification:** Analyze whether geometric features contributed to the crash history and identify possible countermeasures.
4. **Safety Evaluation and Economic Appraisal:** This two-part procedure involves predictive crash modeling and application of economic appraisals to determine benefit-cost ratios. Overall, these two procedures allow direct safety benefit comparison of alternatives.
5. **Documentation:** A Safety and Operations Certification Document (SOCD) is produced which serves to document the process, engineering judgment, and support for safety improvements within a project. If operational improvements are investigated through the Operations Certification Process (OCP), the results are also documented within the SOCD. See FDM 11-52-15 for more information on the OCP.

10.2 Network Screening for Safety Sites of Promise

10.2.1 General

All WisDOT projects required to complete a SOCD start with a network screening. The goal of this first step is to identify the project's Safety Sites of Promise, which are roadway segments or intersections along the project corridor that have a high potential to reduce crashes with targeted, cost-effective improvements. Only segments or intersections that are identified as a Safety Site of Promise are required to move forward within the SCP. Any segment or intersection that is not identified as a Safety Site of Promise can be investigated as part of the SCP but are not required. Any locations investigated shall follow the same procedures as outlined throughout this policy.

10.2.2 Network Screening for Safety Sites of Promise Procedure

The following procedure shall be used to identify Safety Sites of Promise along a specific project corridor:

For segments:

1. Obtain the Meta-Manager spreadsheet for the Region in which the project is located.
   a. Refer to the Meta-Manager User Guide for further information regarding the data within the Meta-Manager spreadsheet and the associated calculations.
2. In the Safety tab, locate the PDP segments that make up the project corridor.
3. Identify flagged segments. Segments are flagged if any of the following conditions are true:
   a. The Total Crash Rate (RATEFLAG) is at least one standard deviation above the peer group average (has a value of 1.0 or greater).
   b. The KAB Crash Rate (MMGR_KAB_CRSH_RT_FL) is at least one standard deviation above the peer group average (has a value of 1.0 or greater).
   c. The Pedestrian Crash Total (MMGR_PED_CRSH_TOT) has at least one crash.
   d. The Bicycle Crash Total (MMRG_BIKE_CRSH_TOT) has at least one crash.

Refer to Figure 10.1 for a sample screenshot of the Meta-Manager safety worksheet crash flags.

PDP_ID	ACSI_INTS_NM	HWY&DIR	RATEFLAG	MMGR_BIKE_CRSH_TOT	MMGR_PED_CRSH_TOT	MMGR_KAB_CRSH_RT_FL
845	USH 66 EB	010E	10.78	1	0	3.86
846		010E	7.81	0	0	0.00
847	OLD HWY 18	010E	1.06	2	0	0.00
848	BRILOWSKI RD	010E	0.00	1	1	0.00
849	BADGER AVE	010E	0.00	0	0	0.00
850	ALGOMA ST	010E	0.00	0	0	0.00
851	STOCKTON RD	010E	0.00	0	0	0.00
852		010E	0.00	0	0	0.00
853	CTH K	010E	1.03	0	0	1.16
854	CTH QQ	010E	1.27	0	0	0.00
872		010E	0.00	0	0	1.01

Figure 10.1 ***Sample Screenshot of Meta-Manager Safety Worksheet***

4. Review and validate input data. This includes checking the roadway type (peer group) and Annual Average Daily Traffic (AADT) volume for consistency along a corridor. Refer to Figure 10.2 and Figure 10.3 for example screenshots of Meta-Manager data and how to validate the data. If inputs are not accurate, revise the data and recalculate the associated flags.

PDP_ID	PDP_FRM	PDP_TO	PDP_MILE	HWY&DIR	RATEFLAG	MMGR_KAB_CRSH_RT_FL	MMGR_BIKE_CRSH_TOT	MMGR_PED_CRSH_TOT	HSTL_AADT_5_YR
2907	014E191 007	014E191 044	0.37	014E	0.00	0.00	0	0	10960
2908	014E191 044	014E191 067	0.23	014E	0.00	0.00	0	1	10960
2909	014E191 067	014E192P000	0.14	014E	0.00	0.00	0	0	10960
2910	014E192P000	014E192P017	0.17	014E	1.13	0.00	0	0	12740
2911	014E192P017	014E193M000	0.16	014E	0.00	0.00	0	0	12740
2912	014E193M000	014E193M009	0.09	014E	0.00	0.00	0	0	12740
2913	014E193M009	014E194 000	1.24	014E	0.00	0.00	1	0	9040
2914	014E194 000	014E195 027	1.06	014E	0.00	0.00	0	0	12740
2915	014E195 027	014E198 000	1.79	014E	0.00	0.00	0	0	12740
2916	014E198 000	014E199 080	1.31	014E	0.00	0.00	0	0	12740
2917	014E199 080	014E199 091	0.11	014E	1.76	0.00	0	0	12740
2918	014E199 091	014E200 000	0.18	014E	1.36	0.00	0	0	12740
2919	014E200 000	014E200 057	0.57	014E	1.47	2.43	0	1	18410

Review the flagged AADTs and look for significant inconsistencies amongst the adjacent segments

Figure 10.2 ***Review Flagged Segments for Potential Faulty AADTs***

PDP_ID	PDP_FRM	PDP_TO	PDP_MILE	SFTY_TRVL_CLS_CD
1192	011E001D000	011E001D011	0.11	420
1193	011E001D011	011E001G000	0.04	430
1194	011E001G000	011E001K000	0.33	310
1195	011E001K000	011E001L019	0.20	420
1196	011E001L019	011E001L029	0.10	420
1197	011E001L029	011E003 000	1.02	420
1198	011E003 000	011E003 138	1.38	420
1199	011E003 138	011E003 143	0.05	420
1200	011E003 143	011E009M000	1.45	420
1201	011E009M000	011E010 000	1.01	420
1202	011E010 000	011E011 000	1.01	420
1203	011E011 000	011E013 000	1.63	420
1204	011E013 000	011E014 032	1.02	420
1205	011E014 032	011E014 054	0.22	440

Review flagged locations and look for inconsistent peer groups (travel classes)

Figure 10.3 ***Review Peer Groups for Inconsistencies***

5. Validated flagged segments are identified as Safety Sites of Promise and shall continue through the

SCP.

6. Document all Meta-Manager PDP segments in the Safety Certification Worksheet (SCW). Provide additional documentation for flagged segments in the Network Screening for Safety Sites of Promise section of the SCW (See [Safety Certification Worksheet template](#)).

For intersections:

1. Obtain the Intersection Network Screening spreadsheet.
2. Identify the INT_IDs for the project's intersections using the maps linked in the Intersection Maps tab.
3. Locate the project's intersections in the Network Screening tab using the INT_IDs. Refer to Figure 10.4 for a sample screenshot of the intersection screening results.

INT_ID	Intersection Name (IX_NAME)	LOSS (TOTAL)	PSI (TOTAL)	LOSS (KABC)	PSI (KABC)	Flagged Location (Yes/No)	Region	County	Area Type	Number of Legs	Control Type	Number of Lanes	Major AADT	Minor AADT
IX_05_06307	STH 32 & 16th Ave	LOSS 1	-5.60	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06340	STH 29 & Bodart St	LOSS 1	-2.55	LOSS 2	-0.41	No	NE	Brown	URBAN	3	TWSC	2	10208	433
IX_05_06342	STH 32 & Gross Ave	LOSS 2	-3.95	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06353	STH 54 & University Wa	LOSS 3	3.08	LOSS 4	6.64	Yes	NE	Brown	URBAN	3	SIGNAL	2	14660	6335
IX_05_06365	USH 141 & Quincy St N	LOSS 2	-0.50	LOSS 2	-0.37	No	NE	Brown	URBAN	3	TWSC	2	11626	433
IX_05_06370	STH 32 & Nicolet Ave	LOSS 2	-4.77	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06372	STH 29 & Museum Pl	LOSS 2	-1.76	LOSS 3	0.37	No	NE	Brown	URBAN	3	TWSC	2	13970	433
IX_05_06382	STH 29 & Pearl St N & P	LOSS 1	-4.63	LOSS 2	-1.26	No	NE	Brown	URBAN	4	TWSC	2	13970	433
IX_05_06404	STH 32 & Marquette Av	LOSS 2	-4.77	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06406	USH 141 & STH 29 & ST	LOSS 1	-23.40	LOSS 2	-4.17	No	NE	Brown	URBAN	4	SIGNAL	2	18406	10208
IX_05_06409	STH 29 & Broadway St	LOSS 1	-17.70	LOSS 2	-3.84	No	NE	Brown	URBAN	4	SIGNAL	2	13970	6121
IX_05_06422	STH 54 & Webster Ave	LOSS 1	-21.13	LOSS 2	-2.30	No	NE	Brown	URBAN	4	SIGNAL	2	11896	13428
IX_05_06430	STH 32 & Redwood Dr	LOSS 2	-3.95	LOSS 3	0.36	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06436	STH 29 & Chestnut Ave	LOSS 2	-1.59	LOSS 3	0.23	No	NE	Brown	URBAN	4	TWSC	2	9860	433
IX_05_06446	USH 141 & Madison St	LOSS 1	-21.90	LOSS 1	-5.04	No	NE	Brown	URBAN	4	SIGNAL	2	18406	2301

Figure 10.4 Sample Screenshot of the Intersection Network Screening Spreadsheet

4. Review and validate input data. This includes, but is not limited to, checking the control type, AADT and crash totals for each intersection. If inputs are incorrect, revise the data and confirm the calculations were updated. Refer to Figure 10.5 for an example of data corrections and the updated screening results.

INT_ID	Intersection Name (IX_NAME)	LOSS (TOTAL)	PSI (TOTAL)	LOSS (KABC)	PSI (KABC)	Flagged Location (Yes/No)	Region	County	Area Type	Number of Legs	Control Type	Number of Lanes	Major AADT	Minor AADT
IX_05_06307	STH 32 & 16th Ave	LOSS 1	-5.60	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06340	STH 29 & Bodart St	LOSS 1	-2.55	LOSS 2	-0.41	No	NE	Brown	URBAN	3	TWSC	2	10208	433
IX_05_06342	STH 32 & Gross Ave	LOSS 2	-3.95	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06353	STH 54 & University Wa	LOSS 3	3.08	LOSS 4	6.64	Yes	NE	Brown	URBAN	3	SIGNAL	2	14660	6335
IX_05_06365	USH 141 & Quincy St N	LOSS 2	-0.24	LOSS 2	-0.31	No	NE	Brown	RURAL	3	TWSC	2	11626	433
IX_05_06370	STH 32 & Nicolet Ave	LOSS 2	-4.77	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06372	STH 29 & Museum Pl	LOSS 2	-1.76	LOSS 3	0.37	No	NE	Brown	URBAN	3	TWSC	2	13970	433
IX_05_06382	STH 29 & Pearl St N & P	LOSS 1	-4.63	LOSS 2	-1.26	No	NE	Brown	URBAN	4	TWSC	2	13970	433
IX_05_06404	STH 32 & Marquette Av	LOSS 2	-4.77	LOSS 2	-0.88	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06406	USH 141 & STH 29 & ST	LOSS 1	-23.40	LOSS 2	-4.17	No	NE	Brown	URBAN	4	SIGNAL	2	18406	10208
IX_05_06409	STH 29 & Broadway St	LOSS 1	-24.14	LOSS 2	-0.63	No	NE	Brown	URBAN	4	RAB	2	13970	6121
IX_05_06422	STH 54 & Webster Ave	LOSS 1	-21.13	LOSS 2	-2.30	No	NE	Brown	URBAN	4	SIGNAL	2	11896	13428
IX_05_06430	STH 32 & Redwood Dr	LOSS 2	-3.95	LOSS 3	0.36	No	NE	Brown	URBAN	3	TWSC	2	25670	433
IX_05_06436	STH 29 & Chestnut Ave	LOSS 2	-0.12	LOSS 4	0.41	Yes	NE	Brown	URBAN	4	TWSC	2	5512	433
IX_05_06446	USH 141 & Madison St	LOSS 1	-21.90	LOSS 1	-5.04	No	NE	Brown	URBAN	4	SIGNAL	2	18406	2301

Figure 10.5 Review Intersection Data Inputs for Errors

5. Identify flagged intersections. These are Safety Sites of Promise and shall continue through the SCP.
   a. Intersections are flagged when the Level of Service of Safety (LOSS) is a category 4 for either Total Crashes or KABC Crashes and at least two crashes occurred at the intersection. Refer to the Intersection Network Screening User Guide for more information about LOSS and the Intersection Network Screening spreadsheet.
6. Document all intersections within the project corridor in the SCW. Provide additional documentation for flagged intersections in the Network Screening for Safety Sites of Promise section of the SCW (See [Safety Certification Worksheet template](#)).

A web-based application called the Safety Certification Mapping (SCM) tool is available on the [WisTransPortal](#) to assist analysts with documenting Safety Sites of Promise in the SCW.

Project corridors that do not have any flagged segments or intersections do not require a safety evaluation. Decisions regarding project segments and intersections shall be documented in the SOCD. Refer to [FDM 11-38-15](#) for information on the SOCD.

10.3 Diagnosis of Safety Sites of Promise

10.3.1 General

After determining the project corridor includes at least one Safety Site of Promise, a comprehensive crash diagnosis procedure ensues. Historical crash data are reviewed to verify the crashes are correctable through engineering countermeasures.

10.3.2 Diagnosis of Safety Sites of Promise Procedure

Within the SCP, the Diagnosis for Safety Sites of Promise procedure is used to further investigate Safety Sites of Promise to understand what is causing crashes, identify the contributing factors to crashes at those sites, and vet crashes where there is no engineering solution. The procedure is outlined below:

1. Obtain crash reports
2. Review each crash report
3. Vet crashes
4. Document crashes, contributing factors, and engineering judgement

Step 1: Obtain crash reports

Obtain the crash reports for all flagged segments and intersections identified by Network Screening for Safety Sites of Promise.

Step 2: Review each crash report

The analyst should review each crash report to determine contributing factors leading to the crash.

After reviewing the crashes individually, the analyst should review crashes collectively, looking for trends in the data. Consider sorting the crash records by:

1. Type
2. Severity
3. Contributing factors (e.g., geometric conditions, pavement quality conditions, etc.)
4. Daylight condition (e.g., day, night)
5. Road condition (e.g., dry, wet, snow, ice)
6. Time of day/year

Step 3: Vet crashes

After reviewing the contributing factors and trends, identify which crashes should be targeted for engineering improvements. Crashes that are treatable through an engineering solution should remain regardless of a specific pattern or trend. Use engineering judgement to determine which crashes should be vetted out and considered in other safety, educational or enforcement programs.

1. Vet out crashes that occurred outside of the flagged segment or intersection limits or were incorrectly located.
2. Vet out crashes where the initial cause of the crash was due to an animal.
3. Vet out crashes relating to roadway conditions not affiliated with the highway or geometric conditions (e.g., debris on the roadway).
4. Vet out crashes with vehicle factors (e.g., blown tire, engine fire, etc.) as the primary cause of the crash with no other roadway geometric contributing factors.
5. If present, evaluate bicycle and pedestrian crashes. Identify if human error or roadway geometrics were a contributing factor to the crash and determine if there are engineering countermeasures that could be used to mitigate the crashes. In most cases, bicycle or pedestrian crashes are infrequent occurrences with no apparent trends or patterns. Considerations should be given to roadway characteristics and roadway context when evaluating countermeasures for these types of crashes.

Step 4: Document crashes, contributing factors, and engineering judgement

As crash reports are reviewed, it is a best practice to document the contributing factors within the WisTransPortal crash data spreadsheet. If any of the crashes are vetted out, document these decisions in a "*Vetted Comments*" column within the WisTransPortal crash data spreadsheet (refer to Figure 10.6). Identify the number of crashes reviewed and the number of crashes correctible by an engineering solution in the Diagnosis of Safety Sites of Promise section of the SCW. The crashes correctible by an engineering solution shall be further evaluated in the Countermeasure Identification procedure.

ACCDNMBR	ONHWY	ATSTR	ACCDDATE	NTFYHOUR	MNRCOLL	ROADCOND	ACCDSVR	Vetted Comments
130204427	8		2/14/2013	18	REAR	WET	PD	Inattentive driving, following too close
130301806	8		3/9/2013	18	NO	WET	PD	swerved to avoid object in road
130507368	8		5/24/2013	15	ANGL		PD	Miscoded, not on project corridor
130808069	8		8/30/2013	15	ANGL		INJ	
130808676	8		8/26/2013	5	NO	WET	INJ	Poor visibility and too fast for conditions
131210811	8	SWANSON RD	12/22/2013	20	NO	SNOW	PD	Snowy road, too fast for conditions
140110952	8		1/25/2014	9	NO	ICE	PD	Icy road, too fast for conditions
140210998	8		2/23/2014	2	NO	SNOW	INJ	Snowy road, too fast for conditions
140706007	8		7/25/2014	14	ANGL		INJ	
140909842	8		9/12/2014	9	ANGL		INJ	

Figure 10.6 Sample WisTransPortal Crash Data Spreadsheet with vetting comments

10.4 Countermeasure Identification

10.4.1 General

If there are crashes that can be mitigated with engineering countermeasures, they are evaluated further to determine if existing geometric features contributed to the type and severity of those crashes. If existing geometric features did not contribute to the crashes, other possible countermeasures should be identified to target the contributing factors.

10.4.2 Countermeasure Identification Procedure

The procedure is as follows:

1. Review the crash data and contributing factors for each Safety Site of Promise as identified in the Diagnosis of Safety Sites of Promise procedure.
2. Determine possible countermeasures that target the type or severity of the crashes. A countermeasure selection table is a tool that can be used to help identify potential countermeasures. See an example countermeasure table. This example table identifies crash types, potential contributing factors, and common countermeasures. This table does not contain all available countermeasures and should only be used as a brainstorming resource.
3. Document countermeasures identified or that no practical countermeasures exist in the SCW and SOCD.
    a. For intersection sites of promise, if a proposed countermeasure includes a change of traffic control, a Phase I Scoping Intersection Control Evaluation (ICE) shall be completed. Further information on the ICE process can be found in FDM 11-25-3.

10.5 Safety Evaluation and Economic Appraisal

10.5.1 General

The Safety Evaluation and Economic Appraisal procedure is initiated if safety improvements are identified within the Countermeasure Identification procedure. Each safety improvement identified shall be evaluated to determine the cost-effectiveness. This is a two-step procedure which involves determining the safety effectiveness of potential countermeasures and performing an economic appraisal.

10.5.2 Safety Evaluation Procedure

The Safety Evaluation procedure uses predictive crash modeling methodology to quantify the future safety performance of each potential countermeasure to account for RTM bias. This modeling shall be completed using the Interactive Highway Safety Design Model (IHSDM) software when applicable, or the Highway Safety Benefit-Cost Analysis Tool when IHSDM cannot be used. Predictive modeling is used to compare long-term safety performance for any proposed alternatives.

10.5.2.1 Safety Evaluation Procedure Steps

1. Determine the base case scenario
2. Determine the analysis method for the base case and each alternative
3. Compare the analysis methods and determine an overall method for the evaluation
4. Compile the required data for the analysis
5. Perform the safety analysis
6. Document the results

Step 1. Determine the base case scenario

The base case scenario for each Safety Site of Promise is the condition that the proposed alternatives are compared to. In most cases, the base case will not include safety improvements and is considered the "no-build" or "replace in kind" scenario. If the base case involves no improvements, it should be modeled with existing roadway geometric and traffic control conditions for the evaluation period, beginning with the year after construction of the improvement is completed.

Step 2. Determine the analysis method for the base case and each alternative

When determining which analysis method to use, it is important to know the distinction between the types of Crash Modification Factors (CMFs). There are two types of CMFs used throughout this procedure:

1. HSM Part C CMFs, called CMF adjustment factors herein. CMF adjustment factors are used in conjunction with the HSM Safety Performance Functions (SPFs). These CMFs adjust the base conditions of the SPFs.
2. HSM Part D CMFs, called external CMFs herein. External CMFs are used to modify the SPF prediction to more closely represent the site conditions.

A Safety Evaluation Procedure (Methodology Selection) flowchart is available to guide analysts through determining the correct analysis method.

Method 1: CMF applied to Observed Crashes (Estimated Crash Frequency)

- This method multiplies the Observed Crash Frequency with external CMFs.
- Use when the site configuration or traffic volumes are outside of the applicable ranges of the SPFs.
- This method does not account for RTM bias.
- The Highway Safety Benefit-Cost Analysis Tool is used to implement this method.
- This is the least reliable method and should be used only if no other method is appropriate.
- The results obtained with this method are the "Estimated Crash Frequency".

Method 2: SPF with or without External CMFs (Predictive Crash Frequency)

- The IHSDM software is used to implement this method.
- Use this method when Empirical Bayes (EB) is not applicable, which the HSM defines as:
  - *Projects in which a new alignment is developed for a substantial proportion of the project length*
  - *Intersections at which the basic number of legs or type of traffic control is changed as part of the project*
  - *Segments where the number of through lanes changes, other than short passing lane sections*
  - *Any other major geometric improvement where the observed crash data for the existing conditions is not indicative of the crash experience that is likely to occur in the future*
- Observed crash history is not used in this method.

- This method is more reliable than Method 1, but less reliable than Method 3.
- The results obtained with this method are the “Predicted Crash Frequency”.

Method 3: SPF with or without External CMFs weighted by Observed Crashes (Expected Crash Frequency)

- The IHSDM software is used to implement this method.
- This method utilizes EB, which weights the predicted crashes from the SPFs with the observed crashes, to obtain the most reliable results. When performing EB, all observed crashes are included, not just the remaining crashes identified in the Countermeasure Identification procedure.
- Use this method when EB is applicable, which the HSM defines as:
    - *Sites at which the roadway geometrics and traffic control are not being changed (e.g., the future no-build alternative)*
    - *Projects in which the roadway cross section is modified but the basic number of through lanes remains the same*
    - *Projects in which minor changes in alignment are made, such as flattening individual horizontal curves while leaving most of the alignment intact*
    - *Projects in which a passing lane or a short four-lane section is added to a rural two-lane, two-way road to increase passing opportunities*
- This is the most reliable method and should be used unless EB is not applicable.
- The results obtained with this method are the “Expected Crash Frequency”.

Table 10.1 shows the required inputs for each of the safety evaluation methods.

***Table 10.1* Required Inputs for the Safety Evaluation Procedure**

Inputs for Each Analysis Method	**Method**		
	1	**2**	**3**
Geometry and traffic control for each segment or intersection with remaining crashes	Required	Required	Required
Roadway segment AADTs or intersection approach AADTs for all years in the evaluation period and historical years when using EB	Required	Required	Required
All observed crash data for each segment or intersection being analyzed	Required		Required
SPFs contained in IHSDM		Required	Required
WisDOT calibration factors, stored in IHSDM Admin file		Required	Required
CMFs for countermeasures	Required	As Needed	As Needed

Step 3. Compare the analysis methods and determine the overall method for the evaluation

Results generated using different methods should not be compared so careful planning is needed to ensure the most reliable analysis method is used at a specific project location. In some rare cases, it may make sense to apply one method at one project location and another method at a separate project location. This should be documented in the SOCD and the results should not be compared to one another.

Step 4. Compile the required data for the analysis

1. Determine the years of the observed crash period.
    a. Use up to five of the most recent years of crash data.
    b. Confirm no geometric or traffic control changes have occurred over the duration of the crash data. If changes have occurred, utilize only the years of crash data after the change, with a minimum of two years of data.
2. Compile the crash data for the observed crash period.
    a. Identify the number, type, and severity of the crashes.
3. Obtain the AADTs for the observed crash period.
4. Determine the AADTs for the evaluation period.
    a. Obtain, at a minimum, the forecasted volumes for the first year and last year of the evaluation period. The analysis tools will automatically interpolate between the two volumes for each year. If additional forecasted volumes are known, they should be included.
5. If external CMFs are needed for the base case or any alternative, obtain the appropriate CMFs from the WisDOT CMF Table. Refer to TEOpS 12-3 for WisDOT's CMF policy.
    a. For each CMF, document the treatment name and CMF# in IHSDM.
    b. For each countermeasure, assume the *Start CMF Year* is the first year of the evaluation period (i.e., the first year after construction is completed) and the *End CMF Year* is the last year of the evaluation period.
6. For each analysis location, identify the largest "footprint" for all the alternatives. This is the area that should be evaluated for all alternatives, including the base case.
7. For each alternative, obtain roadway characteristics and geometric inputs.
8. Determine the years of the evaluation period.
    a. The evaluation period shall be ten years for all safety analyses
    b. The first year of the evaluation period is the first year the roadway is open to traffic after the proposed construction is completed

Step 5. Perform the safety analysis

For the base case and each alternative, perform the safety analysis with the method identified in Step 3. Determine the number of total crashes, fatal and injury (KABC) crashes, and property damage only (PDO) crashes.

- Method 1 uses the Highway Safety Benefit-Cost Analysis Tool
- Methods 2 and 3 use the IHSDM software for analysis

When using IHSDM, select the WisDOT Calibration File, as shown in Figure 10.7.

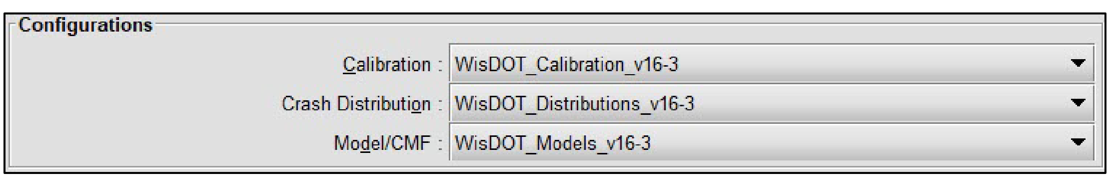

Figure 10.7 IHSDM Crash Analysis Configurations

Step 6. Document the results

For the base case and each alternative, document the number of total crashes, fatal and injury (KABC) crashes, and property damage only (PDO) crashes in the SOCD. Also, document any External CMFs that were used and any other assumptions or judgements pertinent to the analysis.

10.5.3 Economic Appraisal Procedure

The purpose of the Economic Appraisal procedure is to compare the estimated safety benefits of a proposed safety improvement with the estimated costs of that improvement. The economic appraisal procedure can be used to determine the cost-effectiveness of proposed safety improvements, identify and prioritize improvements with the highest return on investment, and help select an alternative in the decision-making process. To ensure projects are compared consistently, the evaluation period (i.e., return on investment period) is assumed to be ten (10) years. Key outputs of this process include an estimated benefit-cost ratio and the net-present value of each safety improvement alternative. Each of these outputs should be considered when selecting the most appropriate improvement option. Refer to Table 1.2 for definitions of terms used in the Economic Appraisal procedure.

10.5.3.1 Cost Estimating

The SCP focuses on evaluating safety impacts of each proposed alternative and currently does not evaluate other factors such as vehicle travel time, delay, vehicle operating costs, or vehicle emissions. A cost estimate shall be completed for each of the alternatives, including the base case. The base cost includes any cost associated with the programmed improvement strategy (Perpetuation, Rehabilitation, Modernization) that would occur regardless of any proposed alternatives. Cost estimates for alternatives shall include any program costs associated with the construction of the alternative. These costs include the let construction cost and other associated costs with the improvement (e.g., real estate, utilities, railroad, etc.). Costs that are excluded from the analysis include any design or construction delivery, maintenance, and operating costs. To provide project consistency, each alternative shall be evaluated within the economic appraisal using the actual cost of the improvement (i.e., not the cost difference between the base case and alternative. Any cost estimates evaluated within the economic appraisal are to be viewed as a snapshot in time.

10.5.3.2 Crash Costs

Crash costs are estimated monetary values that a state agency adopts to quantify the impact of a change in safety performance as part of a benefit-cost analysis.

Table 10.2 summarizes the approved crash costs for use in the Economic Appraisal procedure.

Table 10.2 Crash Costs for Benefit-Cost Analysis in 2022 Dollars

Crash Severity (WisDOT terminology)	KABCO Abbreviation (Most severe injury in crash)	Crash Severity (HSM Terminology)	WisDOT Crash Cost
Fatal	K	Fatal	$14,373,202
Suspected Serious Injury	A	Serious Injury or Disabling	$752,435
Suspected Minor Injury	B	Evident Injury or Non-disabling	$237,861
Possible Injury	C	Possible Injury	$136,044
Property Damage Only (PDO)	O	No Injury	$17,859

Wisconsin-specific crash costs were developed using the methods described in FHWA's Crash Costs for Highway Safety Analysis guide. These crash costs were developed along with the Highway Safety Benefit-Cost Analysis Tool and can be downloaded for use in IHSDM in the tools section below. Crash costs are periodically updated to reflect changes in economic measures.

10.5.4 Safety Evaluation and Economic Appraisal Tools

The following tools shall be used when conducting the Safety Evaluation and Economic Appraisal:

1. **IHSDM**
    a. IHSDM applies the HSM analysis methods and economic appraisal process. WisDOT created state-specific files to improve the reliability of the crash analysis and economic appraisal results. Analysts shall use the following files:

File Purpose	File Name
Calibration Data Sets	WisDOT_Calibration_v16-3
Crash Distribution Data Sets	WisDOT_Distributions_v16-3
Model Data Sets	WisDOT_Models_v16-3
Economic Analysis Model Data Sets	WisDOT_Economics_v16-3

These files can be downloaded from WisDOT's Traffic Operations Manual webpage under the *Safety and Operations Certification* section. To utilize these files within IHSDM, save a copy in the "config" folder.

Additional information and detailed tutorials can be found at: https://highways.dot.gov/research/safety/interactive-highway-safety-design-model/interactive-highway-safety-design-model-ihsdm-overview

2. **Highway Safety Benefit-Cost Analysis Tool**
    a. Used only for Method 1 analyses. The calculations for the economic appraisal are completed in the same manner as those implemented in the IHSDM.
3. **WisDOT CMF Table**
    a. Contains a list of WisDOT-approved CMFs, as well as a CMF calculator to combine CMFs. For more information regarding WisDOT's CMF policy, go to TEOpS 12-3.

FDM 11-38-15 Documentation *November 15, 2023*

15.1 Safety and Operations Certification Document (SOCD)

The SCP's purpose is to analyze the full range of alternatives and strategies in order to meet the purpose and need of the project by mitigating identified safety issues. To document the SCP, a Safety and Operations Certification Document (SOCD) is produced (See SOCD template or guidance document). The SOCD documents all alternatives evaluated within the process, regardless of resulting benefit-cost ratio values, and should not state a definitive recommendation for an alternative. The benefit-cost ratio that is calculated through the Economic Appraisal procedure captures only the safety benefit of a project. For a Safety Site of Promise, alternatives with a benefit-cost ratio of greater than 1.0 are economically justified from a safety perspective and are considered reasonable alternatives. Alternatives with a benefit-cost ratio between 0 and 1 may be considered reasonable when combined with other factors in addition to safety (e.g., operations, bicycle/pedestrian, oversize/overweight (OSOW), and environmental). These other benefits can be considered for a more comprehensive analysis but are not included within the SOCD. The other benefits and factors would be documented as part of the Final Scope Certification (FSC) document, see FDM 11-4-3. The National Environmental Policy Act (NEPA) process isn't complete until all input is appropriately considered for the project. In some cases, it is possible that an alternative that does not have the highest safety benefit-cost ratio is the preferred alternative. For alternatives that improve safety not identified as a Safety Site of Promise, a benefit-cost ratio of greater than 2.0 is required to economically justify the improvement from a safety perspective.

15.2 Safety and Operations Certification Document Amendment

After the SOCD has been signed, if a new alternative is developed or project limits are expanded, the SCP shall be followed and documented with an amendment to the SOCD (See SOCD-Amendment template or guidance document). If this occurs within the scoping phase of a project, the amended SOCD shall be documented within the FSC and supersedes the original SOCD. If this occurs after the scoping phase, the SOCD amendment shall be documented within the Design Study Report (DSR) and environmental document, as appropriate.

15.3 Approval Process

Approval by the Bureau of Traffic Operations (BTO), Traffic Analysis and Safety Unit, is required for all projects with SOCDs that consider safety countermeasures and complete the Safety Evaluation and Economic Appraisal Procedure. This review and approval process shall occur prior to approval by the Regional Planning or Traffic Supervisor. The intent of BTO's review is to ensure the policy, methods, and tools described in FDM 11-38 are applied appropriately and consistently statewide. Review of detailed inputs and outputs shall be completed by the Region.

Send the SOCD and all supporting documents to DOTBTOSafetyEngineering@dot.wi.gov. BTO will review the SOCD and provide comments or concurrence to the Region within 15 business days.

The Regional Planning or Traffic Supervisor shall approve all project Safety and Operations Certification

Documents. For projects that do not require a SOCD, per FDM 11-1-10 Attachment 10.1, the supervisor can delegate to the analyst to approve the SOCD.

FDM 11-38-20 Examples of the Safety Certification Process — August 16, 2022

20.1 Examples of the Safety Certification Process

Examples for the Safety Certification Process can be found on the Traffic Operations Manuals web page:

https://wisconsindot.gov/Pages/doing-bus/local-gov/traffic-ops/manuals-and-standards/manuals.aspx

The examples cover each method and associated Economic Appraisals. These examples are limited in nature and are for demonstrative purposes in exemplifying the Safety Certification Process.

FDM 11-38-99 References — August 13, 2021

99.1 References

1. Highway Safety Benefit-Cost Analysis Guide. FHWA Safety Program. Federal Highway Administration. February 2018. https://safety.fhwa.dot.gov/hsip/docs/fhwasa18001.pdf

2. Crash Modification Factors in Practice, Quantifying Safety in the Roadway Safety Management Process. FHWA Office of Safety. Federal Highway Administration.

3. Highway Safety Benefit-Cost Analysis Tool: Reference Guide. FHWA Safety Program. Federal Highway Administration.

4. Crash Modification Factors in Practice, Using CMFs to Quantify Safety in the Development and Analysis of Alternatives. FHWA Office of Safety. Federal Highway Administration.

5. Highway Safety Manual. American Association of State Highway and Transportation Officials. 2010.

6. Highway Safety Manual User Guide. National Cooperative Highway Research Program 17-50. Lead States Initiative for Implementing the Highway Safety Manual. August 2014.

7. Crash Cost for Highway Safety Analysis. FHWA Safety Program. Federal Highway Administration. January 2018. https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf

8. Interactive Highway Safety Design Model (IHSDM): Overview. Federal Highway Administration. September 10, 2021. https://highways.dot.gov/research/safety/interactive-highway-safety-design-model/interactive-highway-safety-design-model-ihsdm-overview