Use of SPFs and CMFs in New Jersey

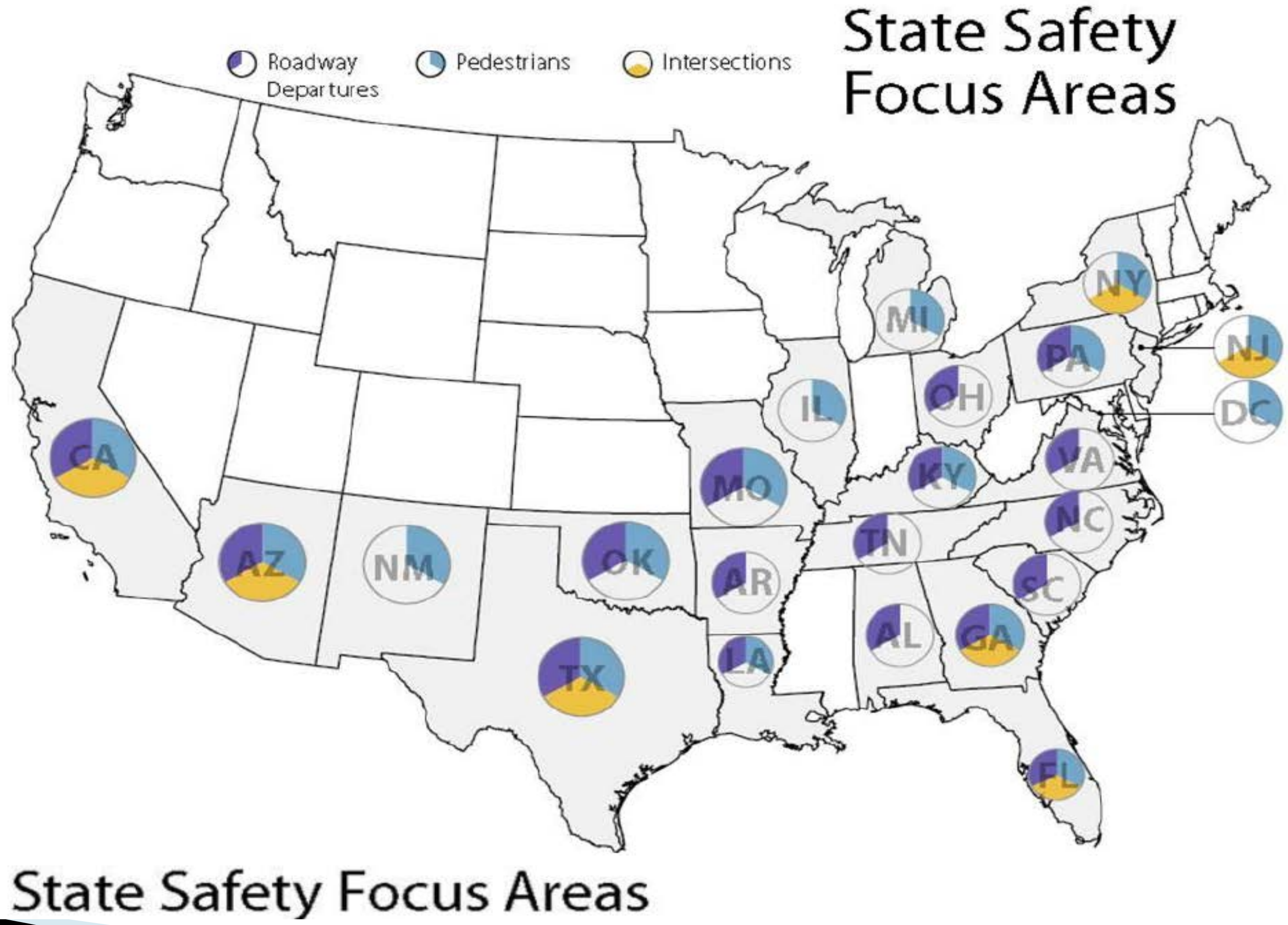
New Jersey Department of Transportation
Bureau of Transportation Data & Safety

Some facts about New Jersey

Toward Zero Deaths™
National Strategy on Highway Safety

- New jersey is the most densely populated state in the country
- 90% of NJ roadways are local
- 2/3 of the overall crashes occur on Local roadways
- Most of NJ is classified as Urban-Suburban
- NJ has 21 counties and 565 municipalities

More facts about New Jersey



Intersection Fatality average	
National	21%
New Jersey	29%

Pedestrian Fatality average	
National	13%
New Jersey	25%

Background of NJDOT's HSIP

- Low Obligation Rate
- Ineligible Project Proposals
- Lacking Systemic Projects
- Missing SHSP Emphasis Areas:
  - Pedestrian Safety
  - Roadway Departure

Background of NJDOT's HSIP

HSIP Annual Apportionment under MAP-21more than doubled

$57 Million

Background of New Jersey's HSIP

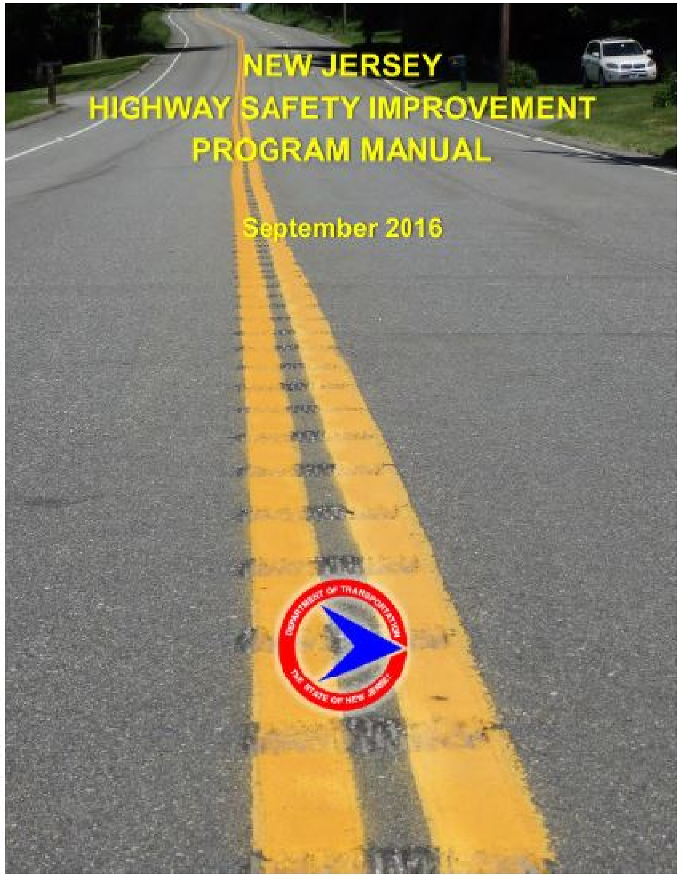
Executive Level Attention

FHWA Division Office & NJDOT Partnering

Background of New Jersey's HSIP

New Jersey's HSIP Guide includes:

1. Purpose
2. Program Overview
3. HSIP Funds Eligibility
4. HSIP Project Development Process
5. HSIP Reporting

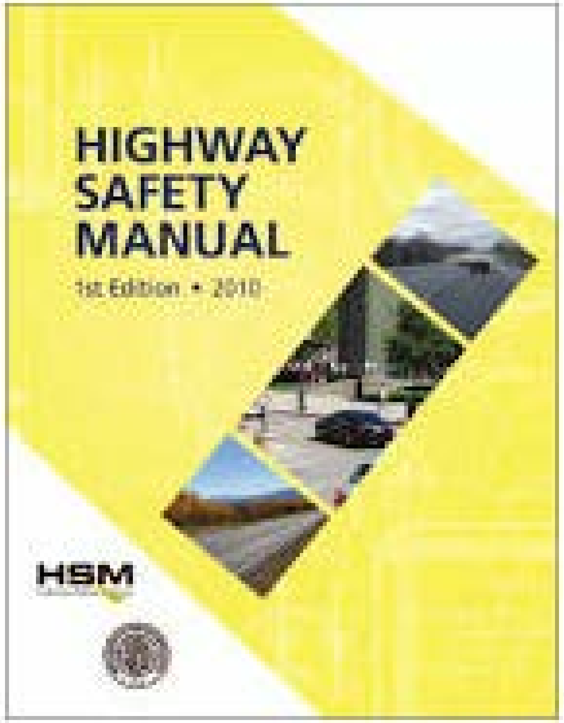


New Jersey's HSIP Manual Item #4

Capitol Programs Delivery
Concept Developments

- An HSM Predictive Analysis is required for alternatives for all HSIP projects > $250K

- The Preferred Alternative Must Yield a B/C > 1



Alternative Analysis using SPFs

Urban and Suburban Arterial Predictive Method

Worksheet 2A – General Information and Input Data for Urban and Suburban Arterial Intersections

General Information		Location Information	
Analyst	RC	Roadway	CR 516 (Leonardville Rd) - EXISTING
Agency or Company	Monmouth County	Intersection	Intersection with East Rd (MP 16.93)
Date Performed	09/17/15	Jurisdiction	Township of Middletown, Monmouth County
		Analysis Year	2016

Input Data		Base Conditions	Site Conditions
Intersection type (3ST, 3SG, 4ST, 4SG)		–	4SG
$AADT_{major}$ (veh/day)	$AADT_{MAX}$ = 67,700 (veh/day)	–	11,378
$AADT_{minor}$ (veh/day)	$AADT_{MAX}$ = 33,400 (veh/day)	–	6,327
Intersection lighting (present/not present)		Not Present	Present
Calibration factor, C_i		1.00	1.00
Data for unsignalized intersections only:		–	–
Number of major-road approaches with left-turn lanes (0,1,2)		0	0
Number of major-road approaches with right-turn lanes (0,1,2)		0	0
Data for signalized intersections only:		–	–
Number of approaches with left-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]		0	0
Number of approaches with right-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]		0	0
Number of approaches with left-turn signal phasing [for 3SG, use maximum value of 3]		–	0
Type of left-turn signal phasing for Leg #1		Permissive	Not Applicable
Type of left-turn signal phasing for Leg #2		–	Not Applicable
Type of left-turn signal phasing for Leg #3		–	Not Applicable
Type of left-turn signal phasing for Leg #4 (if applicable)		–	Not Applicable
Number of approaches with right-turn-on-red prohibited [for 3SG, use maximum value of 3]		0	4
Intersection red light cameras (present/not present)		Not Present	Not Present
Sum of all pedestrian crossing volumes (PedVol) – Signalized intersections only			50
Maximum number of lanes crossed by a pedestrian (n_{lanesx})		–	2
Number of bus stops within 300 m (1,000 ft) of the intersection		0	2
Schools within 300 m (1,000 ft) of the intersection (present/not present)		Not Present	Present
Number of alcohol sales establishments within 300 m (1,000 ft) of the intersection		0	0

Worksheet 2B – Crash Modification Factors for Urban and Suburban Arterial Intersections

(1)	(2)	(3)	(4)	(5)	(6)	(7)
CMF for Left-Turn Lanes	CMF for Left-Turn Signal Phasing	CMF for Right-Turn Lanes	CMF for Right Turn on Red	CMF for Lighting	CMF for Red Light Cameras	Combined CMF
CMF 1i	*CMF 2i*	*CMF 3i*	*CMF 4i*	*CMF 5i*	*CMF 6i*	*CMF_{COMB}*
from Table 12-24	from Table 12-25	from Table 12-26	from Equation 12-35	from Equation 12-36	from Equation 12-37	(1)*(2)*(3)*(4)*(5)*(6)
1.00	0.99	1.00	0.92	0.91	1.00	0.83

Worksheet 2C – Multiple-Vehicle Collisions by Severity Level for Urban and Suburban Arterial Intersections

(1)	(2)			(3)	(4)	(5)	(6)	(7)	(8)	(9)
Crash Severity Level	SPF Coefficients			Overdispersion Parameter, k	Initial N_{bimv}	Proportion of Total Crashes	Adjusted N_{bimv}	Combined CMFs	Calibration Factor, C_i	Predicted N_{bimv}
	from Table 12-10			from Table 12-10	from Equation 12-21		$(4)_{TOTAL}$*(5)	(7) from Worksheet 2B		(6)*(7)*(8)
	a	b	c							
Total	-10.99	1.07	0.23	0.39	2.763	1.000	2.763	0.83	1.00	2.298
Fatal and Injury (FI)	-13.14	1.18	0.22	0.33	0.824	$(4)_{FI}/((4)_{FI}+(4)_{PDO})$ 0.310	0.856	0.83	1.00	0.712
Property Damage Only (PDO)	-11.02	1.02	0.24	0.44	1.835	$(5)_{TOTAL}-(5)_{FI}$ 0.690	1.907	0.83	1.00	1.586

- For calculation of benefits, use the values provided by Highway Safety Manual (HSM) for 2001 crash costs as listed in the table below. These values should adjusted to current year values.

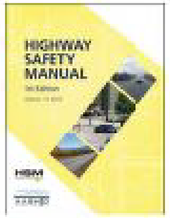


Table 4A-1. Crash Cost Estimates by Crash Severity

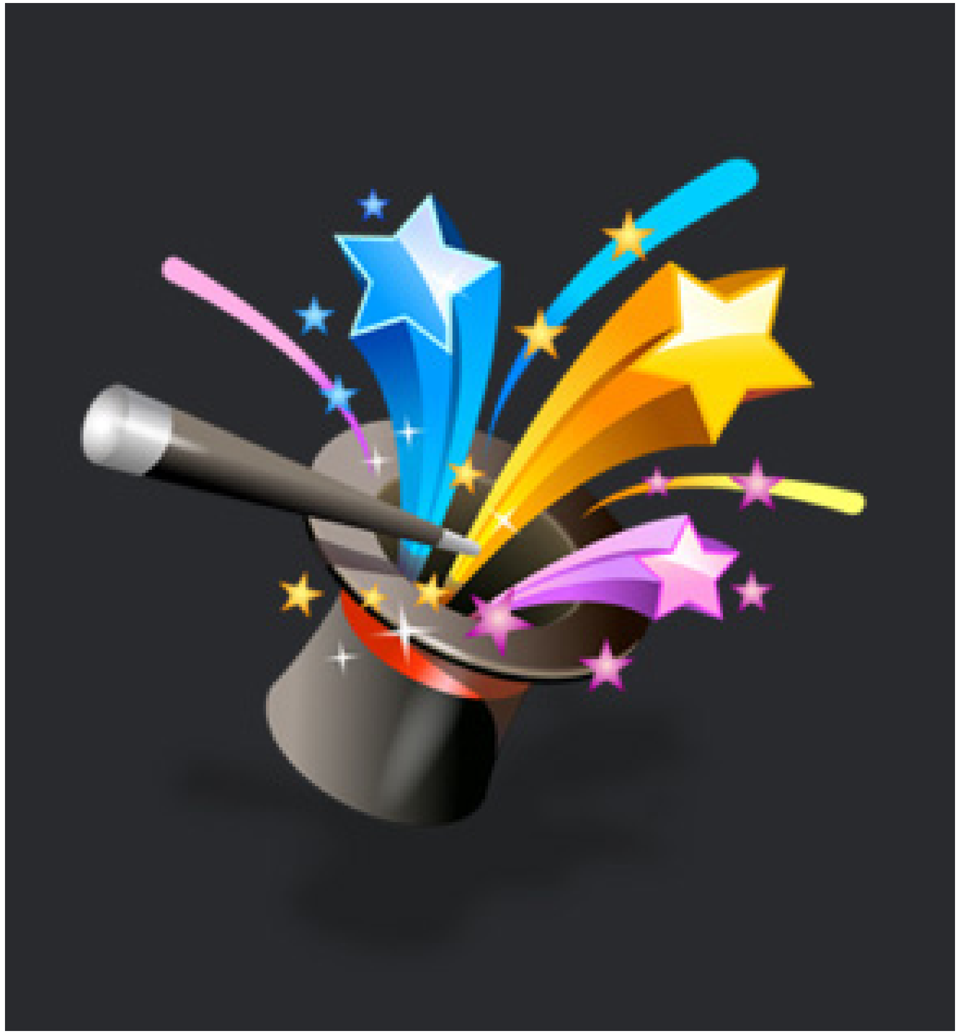
Crash Type	Human Capital Crash Costs	Comprehensive Crash Costs
Fatal (K)	$1,245,600	$4,008,900
Disabling Injury (A)	$111,400	$216,000
Evident Injury (B)	$41,900	$79,000
Possible Injury (C)	$28,400	$44,900
PDO (O)	$6,400	$7,400

Source: *Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries*, FHWA-HRT-05-051, October 2005

- Calculate the Benefits/Project Costs (B/C), which include the design costs, right of way costs and construction costs for the above figures.
- If B/C>1, provide the results to BTDS for review and consideration of HSIP funds. Please note, when calculating B/C the entire costs of project should be considered.
- If B/C<1 project is no longer eligible for HSIP funding.

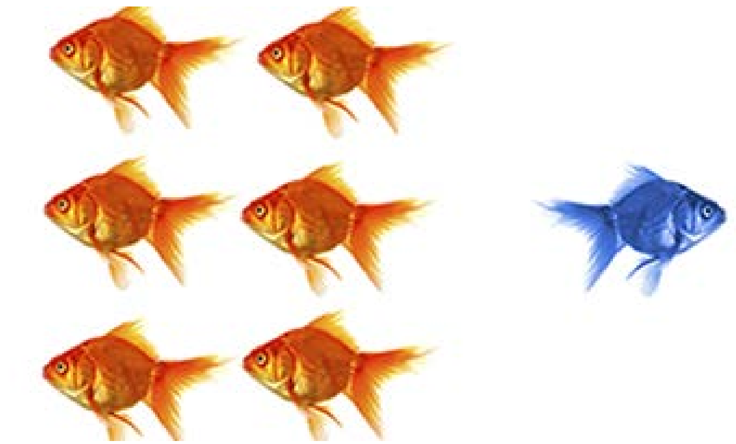
- If the identified infrastructure improvements are greater than $250,000 in cost then a Predictive Safety Analysis using the (HSM) will be required in the CD Phase. This process requires the following elements:
  - Crash Diagram reflecting the individual crashes at the screened location.
  - Site Characteristics Data site characteristics data are needed for two types of sites— homogeneous roadway segments and intersections
  - Traffic Volume Data
  - Crash History Data- application of crash history data is limited to certain conditions and methodologies within the HSM.
  - Calculation of the benefits from the reduced crashes correlated with the Predicted Safety Performance for the proposed alternatives.

Policy ≠ Reality



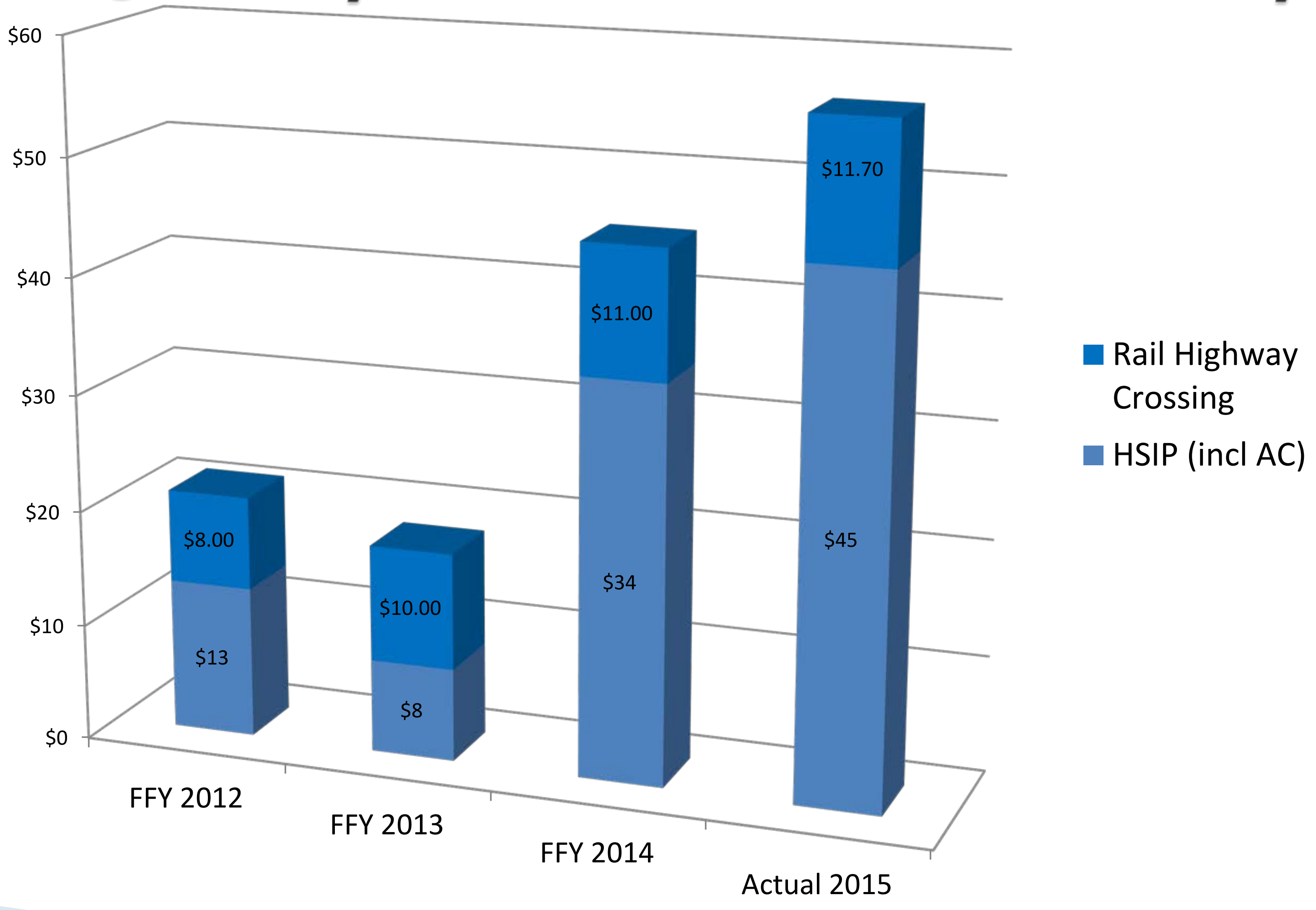
Changing Attitudes

- New Jersey's HSIP Manual Roll Out
- Developing Expertise
  - In-House Staff
  - Consultant Training
- Advanced User Workshops
- Customized Training for Local Safety Project Applications
- Ongoing Support



New Jersey’s EDC-3 STIC Grant

New Jersey's HSIP Success Story



Spreadsheet CMF, Clearinghouse CMF and SPF Use

New Jersey Department of Transportation
Bureau of Transportation Data & Safety

Using SPFs to predict crashes

Figure 1:

HSM Methods to estimate the expected average crash frequency:

Method 1 – Apply the Part C predictive method for both the existing and proposed conditions.

Method 2 – Apply the Part C Predictive method for the existing condition and apply an appropriate project CMF for the proposed condition.

Method 3 – If the Part C predictive method is not available, use an applicable SPF for the existing condition and apply an appropriate project CMF for the proposed condition.

Method 4 – Use observed crash frequency for the existing condition and apply an appropriate project CMF for the proposed condition.

4-Legged Signalized Intersection

Countermeasures in the proposed conditions include:

- Install exclusive left-turn lane (NB approach)
- Install exclusive right-turn lanes (EB and SB approaches)
- Protected left-turn timing phase (NB approach)

- Replace 8” signal heads with 12” signal heads (CMF = 0.54; angle type)
- Additional vehicle signal heads (CMF = 0.72; primary signal)
- Additional countdown signal heads (CMF = 0.30; vehicle/pedestrian type)
- Additional crosswalks (CMF = 0.81; not all crash type)
- Signal backplate (CMF =0.85; all crash and severity type)

	A–G	H	J–K
14	Data for unsignalized intersections only:	--	
15	Number of major-road approaches with left-turn lanes (0,1,2)	0	
16	Number of major-road approaches with right-turn lanes (0,1,2)	0	
17	Data for signalized intersections only:	--	
18	Number of approaches with left-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]	0	
19	Number of approaches with right-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]	0	
20	Number of approaches with left-turn signal phasing [for 3SG, use maximum value of 3]	--	
21	Type of left-turn signal phasing for Leg #1	Permissive	Perr
22	Type of left-turn signal phasing for Leg #2	--	Not A
23	Type of left-turn signal phasing for Leg #3	--	Not A
24	Type of left-turn signal phasing for Leg #4 (if applicable)	--	Not A
25	Number of approaches with right-turn-on-red prohibited [for 3SG, use maximum value of 3]	0	
26	Intersection red light cameras (present/not present)	Not Present	Not I
27	Sum of all pedestrian crossing volumes (PedVol) -- Signalized intersections only		
28	Maximum number of lanes crossed by a pedestrian (n_{lanesx})	--	
29	Number of bus stops within 300 m (1,000 ft) of the intersection	0	
30	Schools within 300 m (1,000 ft) of the intersection (present/not present)	Not Present	Not I
31	Number of alcohol sales establishments within 300 m (1,000 ft) of the intersection	0	

Worksheet 2B -- Crash Modification Factors for Urban and Suburban Arterial Intersections

(1)	(2)	(3)	(4)	(5)	(6)
CMF for Left-Turn Lanes	CMF for Left-Turn Signal Phasing	CMF for Right-Turn Lanes	CMF for Right Turn on Red	CMF for Lighting	CMF for Red Light
CMF 1i	*CMF 2i*	*CMF 3i*	*CMF 4i*	*CMF 5i*	*CMF 6i*
from Table 12-24	from Table 12-25	from Table 12-26	from Equation 12-35	from Equation 12-36	from Equation 1
0.90	0.99	0.92	1.00	0.91	1.00

Built-in CMFs in the Part C Spreadsheets (Worksheet 2B)

Countermeasures in the proposed conditions include:

- **Install exclusive left-turn lane (NB approach)**
- **Install exclusive right-turn lanes (EB and SB approaches)**
- **Protected left-turn timing phase (NB approach)**

- **Replace 8" signal heads with 12" signal heads (CMF = 0.54; angle type)**
- **Additional vehicle signal heads (CMF = 0.72; primary signal)**
- **Additional countdown signal heads (CMF = 0.30; vehicle/pedestrian type)**
- **Additional crosswalks (CMF = 0.81; not all crash type)**
- **Signal backplate (CMF =0.85; all crash and severity type)**

For 2019, which is the expected first year after construction, we have the following results:

	Existing (by Part C)	Proposed Turn Lanes (by Part C)	Plus Backplate (CMF = 0.85)	Proposed
Fatal/Injury	1.8	1.5	1.5 x 0.85 =	1.28
PDO	3.4	3.0	3.0 x 0.85 =	2.55
Total	5.2	4.5	4.5 x 0.85 =	3.83

Sample of a situation where the “exact fit” SPF was not available for a 6-Legged intersection

New Jersey Department of Transportation
Bureau of Transportation Data & Safety

6-Legged Intersection

<u>Current Traffic Control:</u>

German Rd = overhead flashing beacons
Parson Rd = stop signs with supplemental flashing beacons
Allen Rd = stop signs with supplemental flashing beacons

<u>AADT (2015):</u>

German Road = 4,700 vpd
Parson Rd and Allen Rd combined = 3.200 vpd

<u>Proposed Countermeasure:</u>

6-leg roundabout

6-Legged Intersection

From Table14-4 of the Highway Safety Manual:

Converting a Stop-Controlled Intersection into a Modern Roundabout

Setting	Crash Type	CMF	Standard Error
Rural (One Lane)	All Types (All Severeties)	0.29	0.04

6-Legged Intersection

	Calculated Results		
Injury Severity		Estimated Cost	
		2001*	2017
Fatal	(K)	$4,008,900	$5,863,734.00
Fatal and/or Injury	(K/A/B/C)	$158,200	$229,212.00
Disabling Injury	(A)	$216,000	$311,026.00
Evident Injury	(B)	$79,000	$113,627.00
Possible Injury	(C)	$44,900	$64,072.00
Property Damage Only	(O)	$7,400	$10,369.00

* *Societal Crash Costs by Severity, FHWA-HRT-05-051, October 2005*

$1,450,000	PROJECT COST ESTIMATE	
$5,462,859	TOTAL CRASH REDUCTION BENEFIT	
3.77	BENEFIT/COST RATIO	S

6-Legged Intersection

<u>Current Traffic Control:</u>

German Rd = overhead flashing beacons
Parson Rd = stop signs with supplemental flashing beacons
Allen Rd = stop signs with supplemental flashing beacons

<u>AADT (2015):</u>

German Road = 4,700 vpd
Parson Rd and Allen Rd combined = 3.200 vpd

<u>Proposed Countermeasure:</u>

6-leg roundabout

6-Legged Intersection

Table 19. Intersection-level safety prediction model for total crashes.

Number of Circulating Lanes	Safety Performance Functions [Validity Ranges]		
	3 legs	4 legs	5 legs
1	$0.0011(AADT)^{0.7490}$ [4,000 to 31,000 AADT]	$0.0023(AADT)^{0.7490}$ [4,000 to 37,000 AADT]	$0.0049(AADT)^{0.7490}$ [4,000 to 18,000 AADT]
2	$0.0018(AADT)^{0.7490}$ [3,000 to 20,000 AADT]	$0.0038(AADT)^{0.7490}$ [2,000 to 35,000 AADT]	$0.0073(AADT)^{0.7490}$ [2,000 to 52,000 AADT]
3 or 4	Not In Dataset	$0.0126(AADT)^{0.7490}$ [25,000 to 59,000 AADT]	Not In Dataset
Dispersion factor, k=0.8986			

Table 20. Intersection-level safety prediction model for injury crashes.

Number of Circulating Lanes	Safety Performance Functions [Validity Ranges]		
	3 legs	4 legs	5 legs
1 or 2	$0.0008(AADT)^{0.5923}$ [3,000 to 31,000 AADT]	$0.0013(AADT)^{0.5923}$ [2,000 to 37,000 AADT]	$0.0029(AADT)^{0.5923}$ [2,000 to 52,000 AADT]
3 or 4	Not In Dataset	$0.0119(AADT)^{0.5923}$ [25,000 to 59,000 AADT]	Not In Dataset
Dispersion factor, k=0.9459			

NCHRP Report 672 (Roundabout: An Informational Guide, Second Edition)

Page 5-23, Exhibit 5-19 and Exhibit 5-20

6-Legged Intersection

For 2019, which is the expected first year after construction, we have the following results:

	Existing Condition [Intersection] (by Part C)		Proposed Condition [Roundabout] (by SPF)	Crash Reduction
Fatal/Injury	**2.1**		**0.6**	**1.5**
PDO	**2.7**	**increase ->**	**3.7**	**(1.0)**
Total	**4.8**		**4.3**	**0.5**

While there is an increase in PDO, there is a substantial decrease in F/I crashes. Monetizing the increase/decrease in crashes using the HSM Comrehensive Crash Costs, in 2017 dollar value:

Benefit Cost for Reduced F/I	**1.5 x $229,212**	**=**	**$ 343,818**
Increased Crash Cost For PDO	**(1.0 x $10,369)**	**=**	**($ 10,369)**
Net Crash Reduction Benefit Per Year			**$ 333,449**

6-Legged Intersection

(blue box)	Calculated Results

Injury Severity		Estimated Cost	
		2001*	2017
Fatal	(K)	$4,008,900	$5,863,734.00
Fatal and/or Injury	(K/A/B/C)	$158,200	$229,212.00
Disabling Injury	(A)	$216,000	$311,026.00
Evident Injury	(B)	$79,000	$113,627.00
Possible Injury	(C)	$44,900	$64,072.00
Property Damage Only	(O)	$7,400	$10,369.00

* *Societal Crash Costs by Severity, FHWA-HRT-05-051, October 2005*

$1,450,000	PROJECT COST ESTIMATE
$5,183,244	TOTAL CRASH REDUCTION BENEFIT
3.57	BENEFIT/COST RATIO

S

6-Legged Intersection

Calculated Results

Injury Severity		Estimated Cost	
		2001*	2017
Fatal	(K)	$4,008,900	$5,863,734.00
Fatal and/or Injury	(K/A/B/C)	$158,200	$229,212.00
Disabling Injury	(A)	$216,000	$311,026.00
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* *Societal Crash Costs by Severity, FHWA-HRT-05-051, October 2005*

$1,450,000	PROJECT COST ESTIMATE
$5,462,859	TOTAL CRASH REDUCTION BENEFIT
3.77	BENEFIT/COST RATIO

S

Calculated Results

Injury Severity		Estimated Cost	
		2001*	2017
Fatal	(K)	$4,008,900	$5,863,734.00
Fatal and/or Injury	(K/A/B/C)	$158,200	$229,212.00
Disabling Injury	(A)	$216,000	$311,026.00
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$5,183,244	TOTAL CRASH REDUCTION BENEFIT
3.57	BENEFIT/COST RATIO

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Thank you!

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Sample project regarding selecting an appropriate CMF

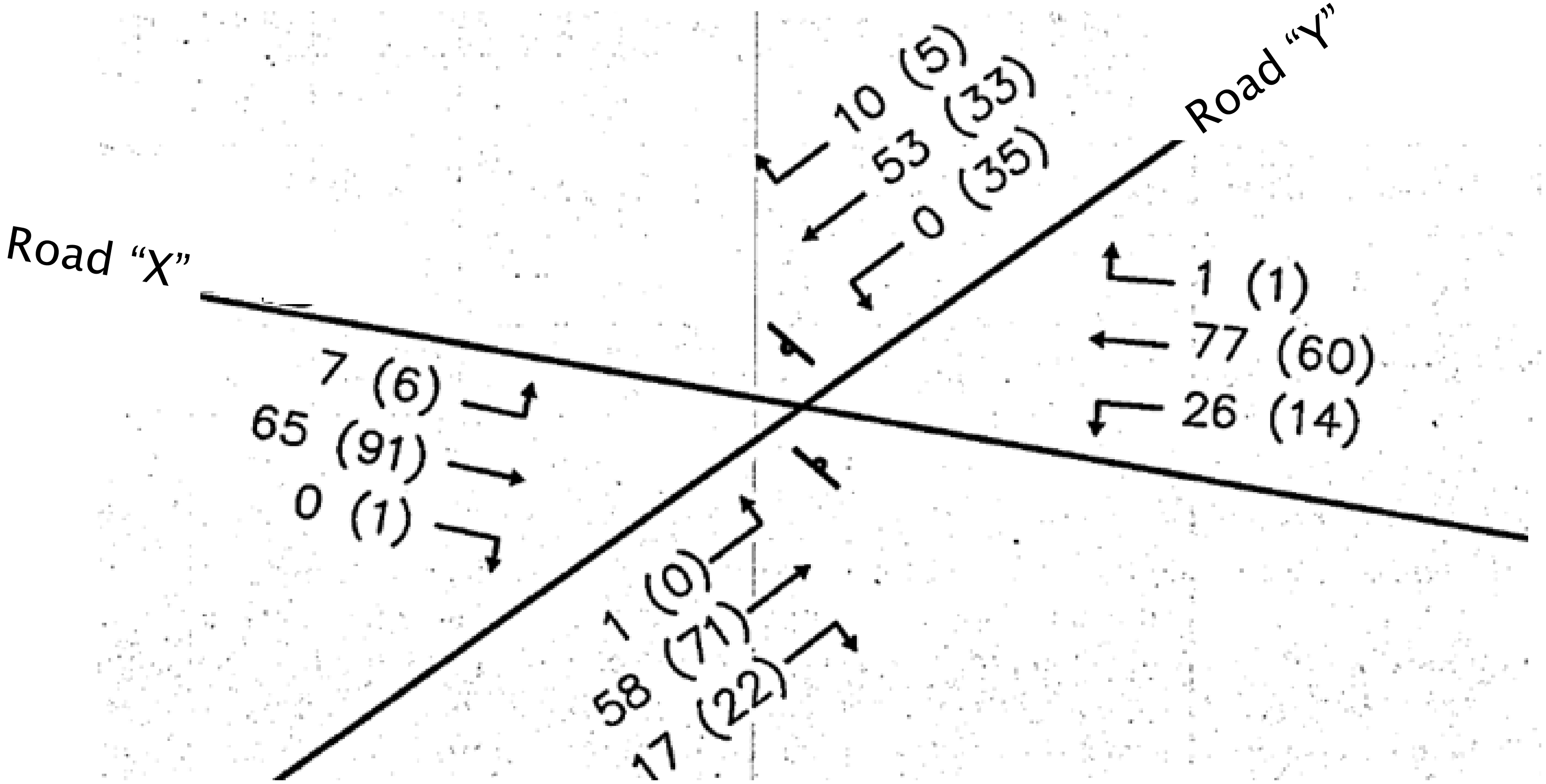
New Jersey Department of Transportation
Bureau of Transportation Data & Safety

Selecting an appropriate CMF

6 crashes occurred at this intersection between 2010 and 2014.

5 of the crashes were right angle crashes

Selecting an appropriate CMF



2014 EXISTING PEAK HOUR
WEEKDAY TRAFFIC VOLUMES

Selecting an appropriate CMF

- Category: Intersection traffic control (40)
  - Subcategory: Traffic control type (33)
    - Countermeasure: Convert minor-road stop control to all-way stop control
    - Countermeasure: Convert stop control to yield control
    - Countermeasure: Install a traffic signal
    - Countermeasure: Install a traffic signal (major road speed limit at least 40 mph)
  - Subcategory: Signal phasing or timing (7)

Selecting an appropriate CMF

▾ Countermeasure: Convert minor-road stop control to all-way stop control

Compare	CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.25 [B]	75	★★★★★	Angle	All	Urban	Lovell and Hauer, 1986	Countermeasure name changed to match ... [read more]
☐	0.52 [B]	48	★★★★★	All	All	Rural	Harwood et al., 2000	Countermeasure name changed to match ... [read more]
☐	0.57 [I]	43	★★★★☆	Vehicle/pedestrian	All	Urban	Lovell and Hauer, 1986	Countermeasure name changed to match ... [read more]
☐	0.3 [B]	70	★★★★☆	All	A,B,C	Urban	Lovell and Hauer, 1986	Countermeasure name changed to match ... [read more]
☐	0.82 [B]	18	★★★☆☆	Rear end	All	Urban	Lovell and Hauer, 1986	Countermeasure name changed to match ... [read more]
☐	0.71	29	★★☆☆☆	Angle	All	Urban	Lovell and Hauer, 1986	Countermeasure name has been slightly ... [read more]
☐	0.2	80	★☆☆☆☆	Angle	All	Urban	Polanis, 1999	Countermeasure name has been slightly ... [read more]

Compare | Reset Compare

▾ Countermeasure: Install a traffic signal

Compare	CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.56 [B]	44	★★★★★	All	All	Rural	Harkey et al., 2008	Countermeasure name has been slightly ... [read more]
☐	0.23 [B]	77	★★★★★	Angle	All	Rural	Harkey et al., 2008	Countermeasure name changed to match ... [read more]
☐	0.33	67	★★★★☆	Angle	K,A,B,C	Urban	McGee et al., 2003	Countermeasure name has been slightly ... [read more]
☐	0.4 [B]	60	★★★★☆	Left turn	All	Rural	Harkey et al., 2008	Countermeasure name changed to match ... [read more]
☐	1.58 [I]	-58	★★★★☆	Rear end	All	Rural	Harkey et al., 2008	Countermeasure name has been slightly ... [read more]
☐	0.656	34.4	★★★★☆	All	All	Not specified	Wang and Abdel-Aty, 2014	CMF applies to intersections with ... [read more]
☐	1.119	-11.9	★★★★☆	All	All	Not specified	Wang and Abdel-Aty, 2014	CMF applies to intersections with ... [read more]

Selecting an appropriate CMF

Convert two-way w/o flashing beacons to all-way stop with flashing beacons

All crash types, all crash severities, all area types

CMF = 0.183 (4 stars)
Reduces 81.7 % of crashes

Convert high speed rural intersection to 4-Legged Roundabout

All crash types, all crash severities, rural area

CMF = 0.32 (4 stars)
Reduces 68 % of crashes

Install a traffic control signal

All crash types, all crash severities, rural area

CMF = 0.56 (5 stars)
Reduces 44 % of crashes

How a CMF for signal head backplates was used to weigh the cost and the benefit of implementing backplates on a wide scale

New Jersey Department of Transportation
Bureau of Transportation Data & Safety

Installation of backplates with retroreflective borders on existing steel mast arms

Installation of backplates with retroreflective borders on existing steel mast arms

CMF
CRASH MODIFICATION FACTORS CLEARINGHOUSE

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About the CMF Clearinghouse | Using CMFs | Developing CMFs | Additio

Home » Search Results

Search Results

There was 1 CMFs returned for your search on "**1410**". [modify your search].

Star Quality Rating

- 1 (0)
- 2 (0)
- 3 (0)
- 4 (1)
- 5 (0)

Country

- U.S. & Canada (0)
- International (1)

Crash Type

Crash Severity

Results Control: Collapse All | Expand All

Click on the links below to expand individual categories.

Category: Intersection traffic control (1)

Subcategory: Traffic control visibility (1)

Countermeasure: Add 3-inch yellow retroreflective sheeting to signal backplates

Compare	CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference
☐	0.85	15	★★★★☆	All	All	Urban	Sayed et al., 2005

Compare | Reset Compare

**NOTE: You can compare CMFs across countermeasures, subcategories, and categories.*

Source: FHWA

Safety Benefit:

15%

Reductions in total crashes

Source: CMF Clearinghouse, CMF ID 1410.

Installation of backplates with retroreflective borders on existing steel mast arms

Sixteen over the roadway signal heads will be equipped with backplates at this intersection

Installation of backplates with retroreflective borders on existing steel mast arms

Worksheet 2A -- General Information and Input Data for Urban and Suburban Arterial Intersections				
General Information		**Location Information**		
Analyst	M Tozzi	Roadway	Route NJ 70	
Agency or Company	NJDOT	Intersection	Massachusetts Avenue	
Date Performed	04/17/17	Jurisdiction	Toms River, NJ	
		Analysis Year	2020	
Input Data		**Base Conditions**	**Site Conditions**	
Intersection type (3ST, 3SG, 4ST, 4SG)		--	4SG	
AADT $_{major}$ (veh/day)	$AADT_{MAX}$ = 67,700 (veh/day)	--	25,720	
AADT $_{minor}$ (veh/day)	$AADT_{MAX}$ = 33,400 (veh/day)	--	9,538	
Intersection lighting (present/not present)		Not Present	Present	
Calibration factor, C_i		1.00	1.00	
Data for unsignalized intersections only:		--	--	
Number of major-road approaches with left-turn lanes (0,1,2)		0	0	
Number of major-road approaches with right-turn lanes (0,1,2)		0	0	
Data for signalized intersections only:		--	--	
Number of approaches with left-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]		0	4	
Number of approaches with right-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]		0	2	
Number of approaches with left-turn signal phasing [for 3SG, use maximum value of 3]		--	4	
Type of left-turn signal phasing for Leg #1		Permissive	Protected / Permissive	
Type of left-turn signal phasing for Leg #2		--	Protected / Permissive	
Type of left-turn signal phasing for Leg #3		--	Protected	
Type of left-turn signal phasing for Leg #4 (if applicable)		--	Protected	
Number of approaches with right-turn-on-red prohibited [for 3SG, use maximum value of 3]		0	0	
Intersection red light cameras (present/not present)		Not Present	Not Present	
Sum of all pedestrian crossing volumes (PedVol) -- Signalized intersections only			240	
Maximum number of lanes crossed by a pedestrian (n_{lanesx})		--	5	
Number of bus stops within 300 m (1,000 ft) of the intersection		0	0	
Schools within 300 m (1,000 ft) of the intersection (present/not present)		Not Present	Not Present	
Number of alcohol sales establishments within 300 m (1,000 ft) of the intersection		0	0	

Worksheet 2L -- Summary Results for Urban and Suburban Arterial Intersections	
(1)	(2)
Crash severity level	**Predicted average crash frequency, $N_{predicted\ int}$ (crashes/year)**
	(Total) from Worksheet 2K
Total	3.8
Fatal and injury (FI)	1.3
Property damage only (PDO)	2.5

Injury Severity		Estimated Cost 2001*	Estimated Cost 2017
Fatal	(K)	$4,008,900	$5,708,202.00
Fatal and/or Injury	(K/A/B/C)	$158,200	$223,295.00
Disability Injury	(A)	$216,000	$303,144.00
Evident Injury	(B)	$79,000	$110,757.00
Possible Injury	(C)	$44,900	$62,492.00
Property Damage Only	(O)	$7,400	$10,128.00

* *Societal Crash Costs by Severity, FHWA-HRT-05-051, October 2005*

$28,800	Project Cost
$790,842	TOTAL CRASH BENEFIT
27.46	Benefit / Cost Ratio

Installation of backplates with retroreflective borders on existing steel mast arms

<u>ESTIMATIONS:</u>

2,850 Traffic Control Signals * 50% on steel mast arm = 1,425

1,425 ÷ 4 traffic control signals have steel on all 4 approaches = 356

cost per intersection with 4 approaches, 2 signal heads per approach and steel on all four corners is $22,880.

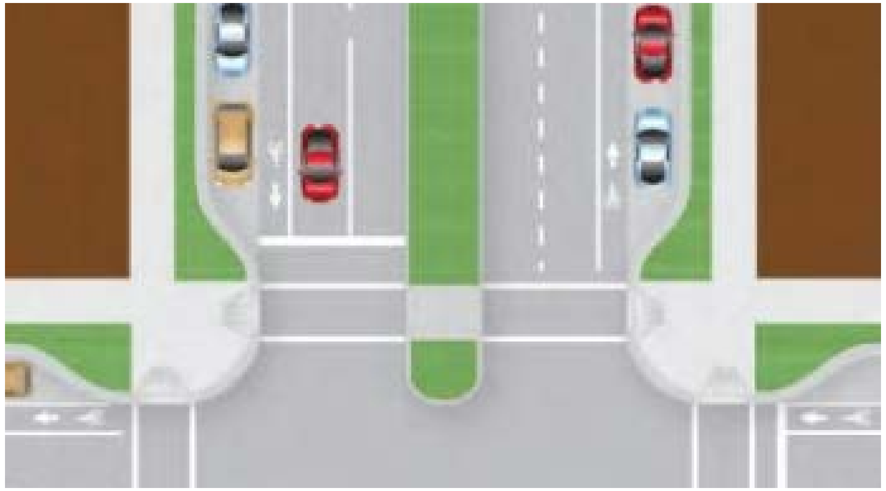
cost per intersection with 2 approaches with steel mast arms on two approaches is $11,440 assuming signal heads are not installed

Approximate cost to install backplates on the entire state signal system = **$ 21,000,000**

CMFs used in evaluating the potential implementation for curb extensions when a CMF for curb extensions is not available

New Jersey Department of Transportation
Bureau of Transportation Data & Safety

CMF for curb extensions



CMFs for curb extensions

Countermeasure: Increase triangle sight distance

Compare	CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.53	48	★★★☆☆	All	A,B,C	Not specified	Elvik, R. and Vaa, T., 2004	
☐	0.89	11	★★★☆☆	All	O	Not specified	Elvik, R. and Vaa, T., 2004	
☐	0.44	56	★★★☆☆	All	K		Rodegerdts et al., 2004	
☐	0.63	37	★★★☆☆	All	A,B,C		Rodegerdts et al., 2004	
☐	1.3	-30	★☆☆☆☆	All	A,B,C	Not specified	Elvik, R. and Vaa, T., 2004	
☐	1.29	-29	★☆☆☆☆	All	O	Not specified	Elvik, R. and Vaa, T., 2004	

Thank you!

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