IHSDM Safety Analysis on I-83 Sec 079

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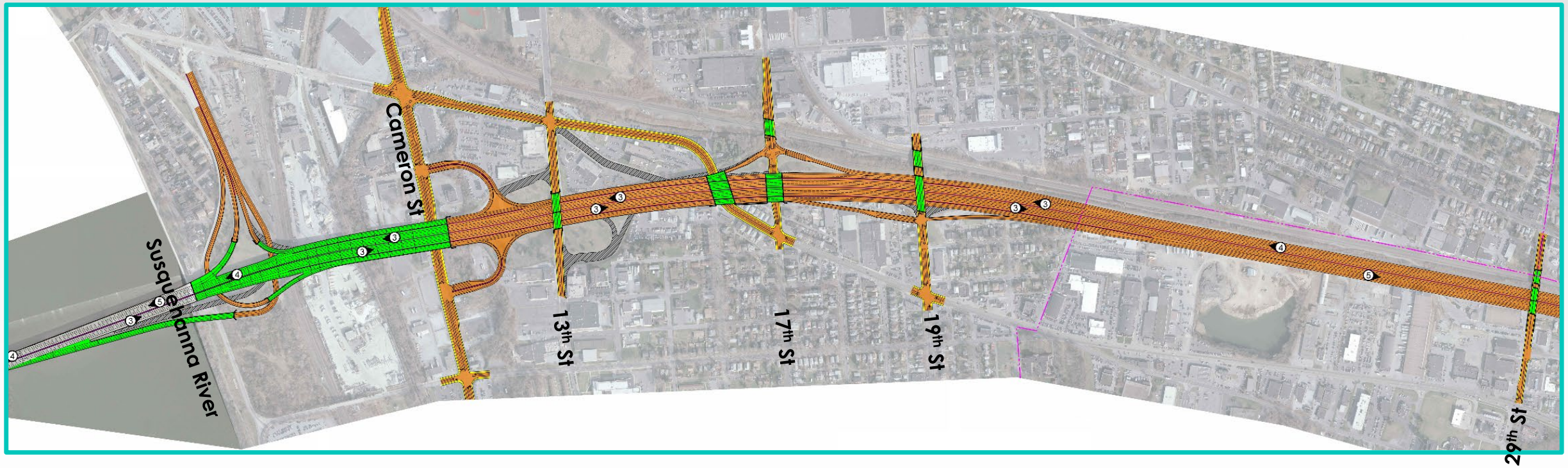
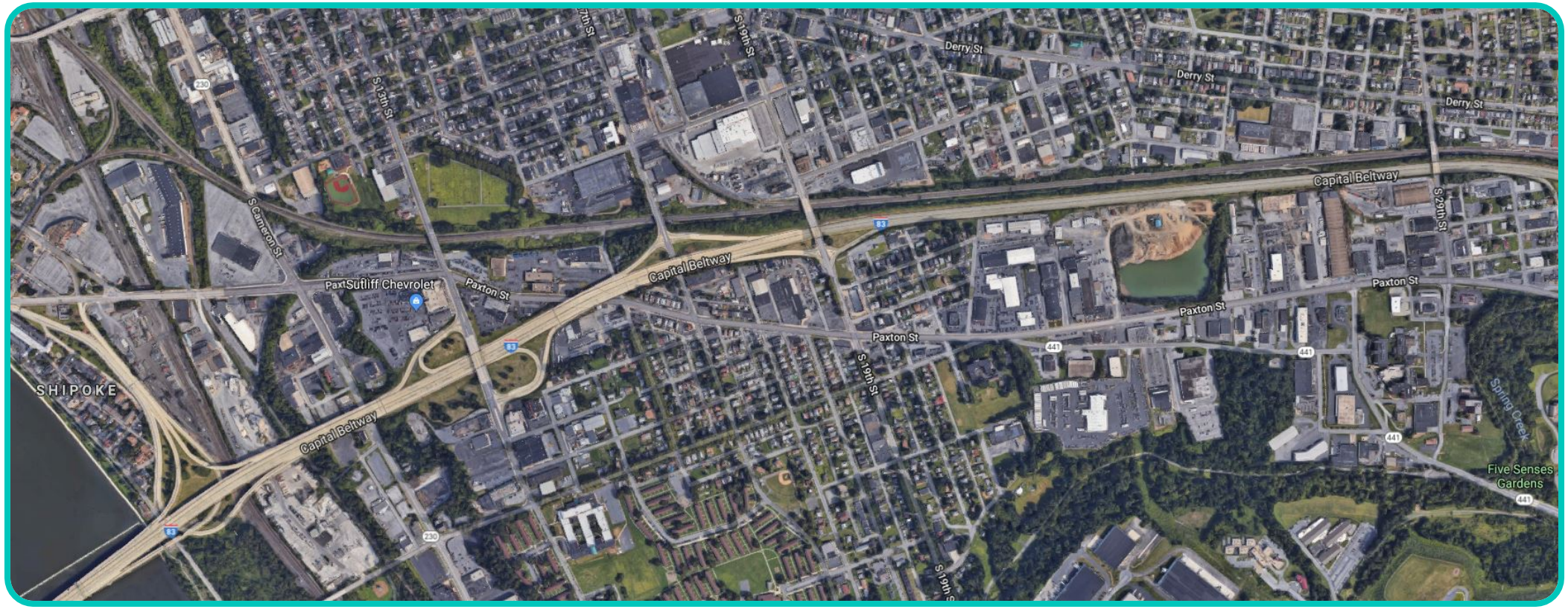
I-83 Capitol Beltway & Master Plan

East Shore Section 3 (Section 079) Limits

29th Street to Susquehanna River

East Shore Section 3 (Section 079) Construction Projects





Scope of the I-83 HSM Analysis

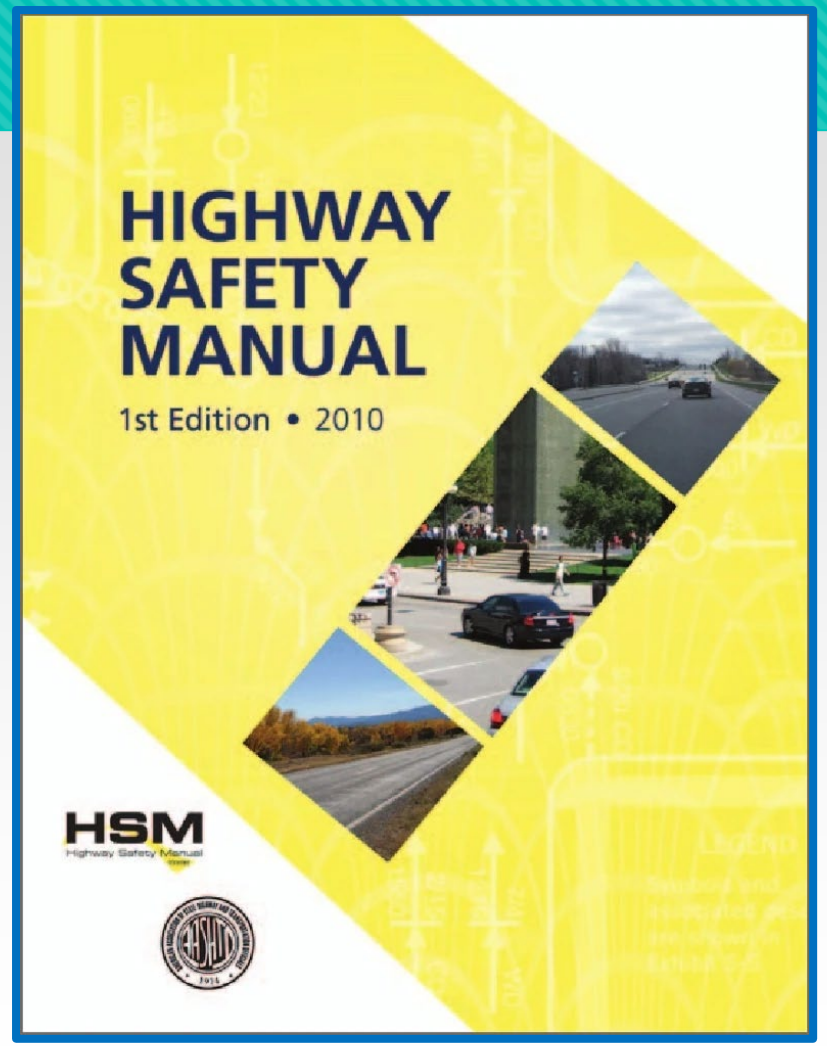
- Completed for Point of Access Study
- Evaluate the safety performance of:
  - Existing Configuration
  - 2050 No Build
  - 2050 Preferred Build Alternative
- Components Analyzed:
  - Freeway Segments
  - Crossroad Ramp Terminal Intersections
  - Arterials
- Used IHSDM software & PennDOT Spreadsheet tool

Analysis Methodology

- Methodology of the Highway Safety Manual
- New way to quantitatively evaluate safety
- Old Way: Crash Rates

$$\frac{\text{Total Crashes (5 yrs)} \times 1{,}000{,}000 \text{ miles}}{\text{AADT} \times 365 \text{ days} \times 5 \text{ yrs} \times \text{Segment Length (miles)}}$$

  - Doesn't account for roadway geometric conditions
- New Way: "Data-Driven" Analysis:
  - Uses roadway geometry, traffic volume, and historical crash data to estimate predicted safety performance of an existing or proposed roadway



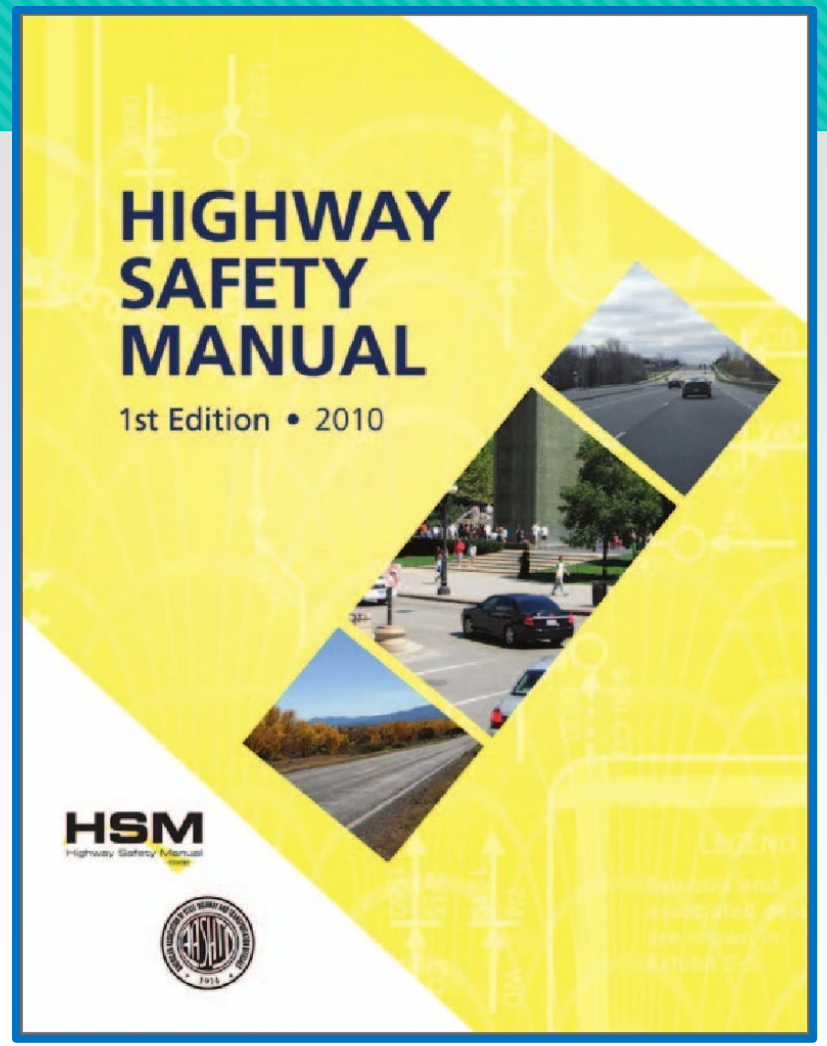
HSM Methodology Overview

- Predictive Method, General Form:

  Predicted crash frequency =

  SPF x (CMF1 x CMF2 x …) x C

- SPF – Safety Performance Function
- CMF – Crash Modification Factors
- C – Calibration Factor



HSM Methodology Overview

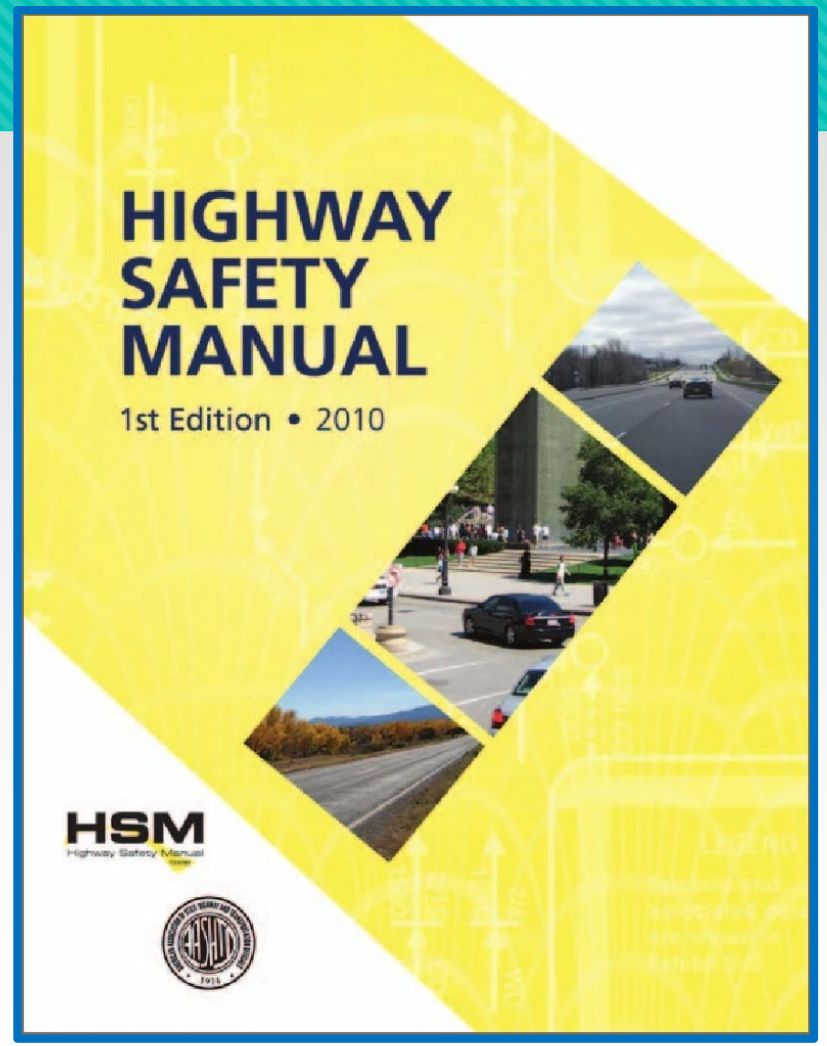
- SPF, Safety Performance Function:
  - Regression models created for different facility types: Rural two-lane roads, multi-lane roads, urban/suburban arterials, freeways, intersections, etc
  - Developed for certain base conditions of that facility type

- Example: Freeway Segment, Multi-Vehicle Crashes

$$N_{spf,fs,n,mv,z} = L^* \times \exp(a + b \times \ln[c \times AADT_{fs}])$$

- Where:
  - L* = effective length of segment
  - AADT= traffic volume
  - a, b, c = coefficients specific to the SPF (and given in the HSM)

- Base conditions:
  - Lane Width = 12 ft
  - Inside Shoulder Width = 6 ft
  - Median with = 60 ft
  - Length of Horizontal Curve = 0 (not present)
  - Length of Median Barrier = 0 (not present)
  - Length of Type B Weave Section = 0 (not present)



HSM Methodology Overview

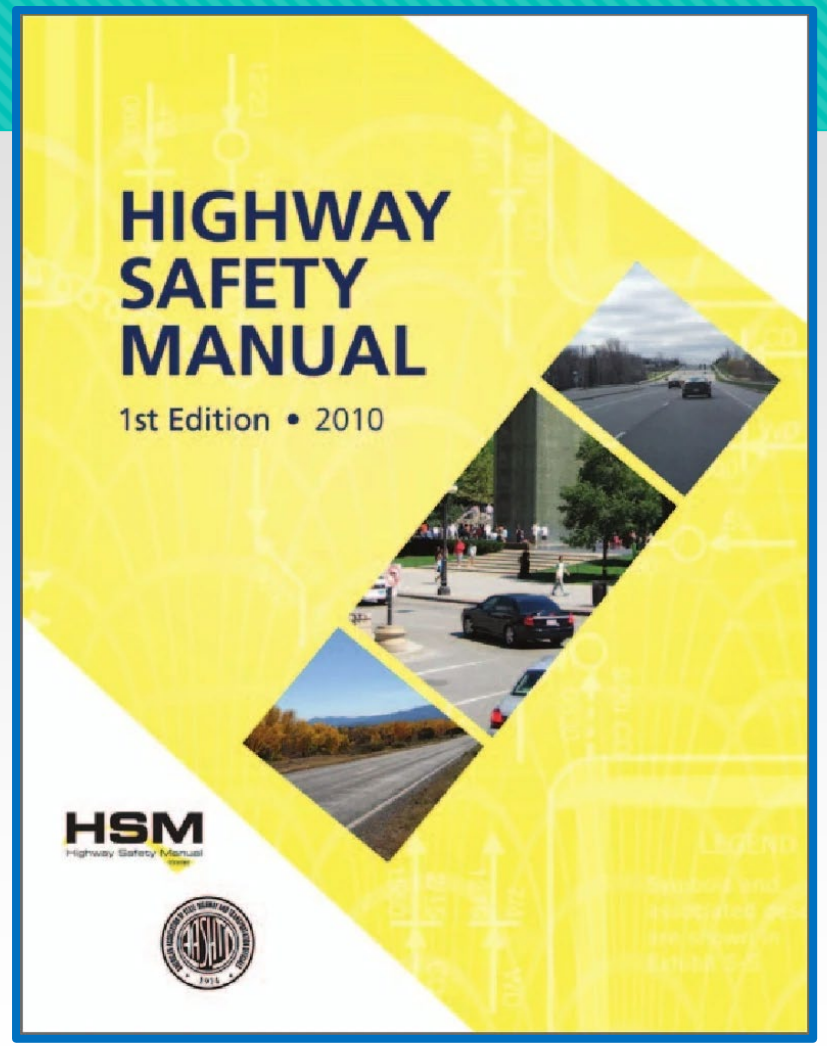
- CMF, Crash Modification Factors
  - A factor or a function
  - "Adjustment Factors": Used to adjust SPF for any difference between your study site's geometric conditions and the base conditions for the SPF

- Example:

  Lane Width, CMF_2 = exp (*a* x [WI – 12], if WI < 13 ft

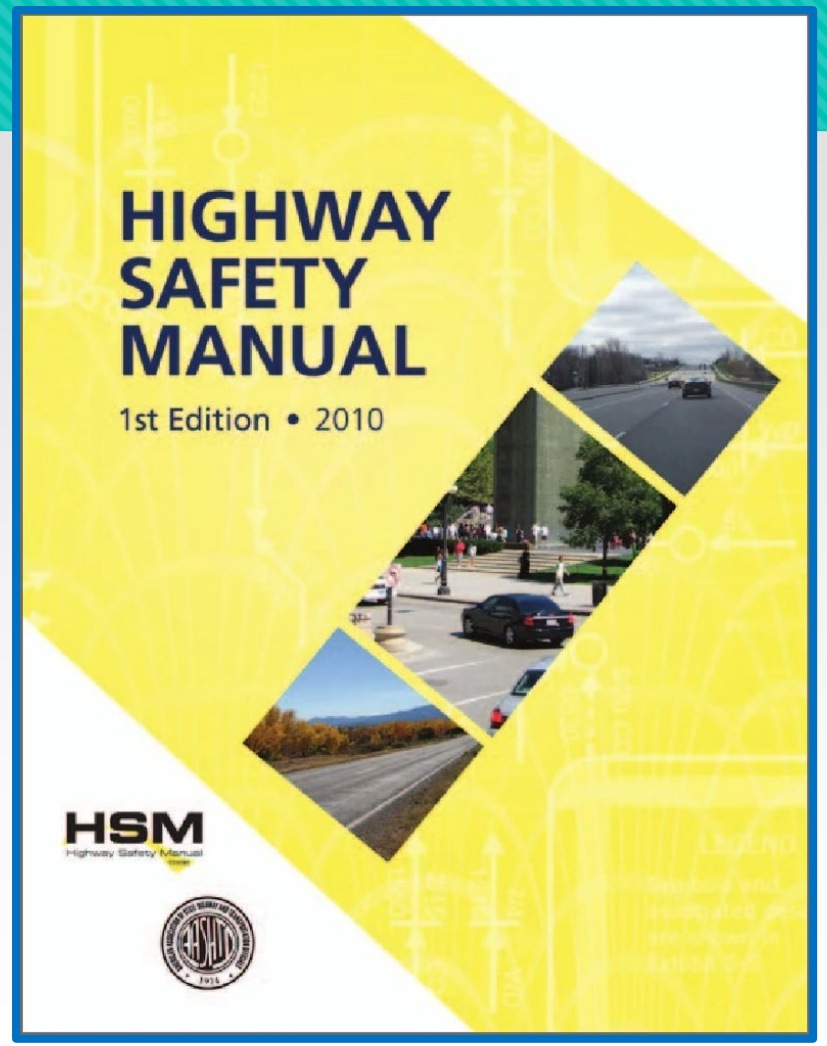
  = b, if WI >= 13 ft

- C, Calibration Factor
  - Calibrates the SPF for local conditions
  - Pennsylvania is currently developing these



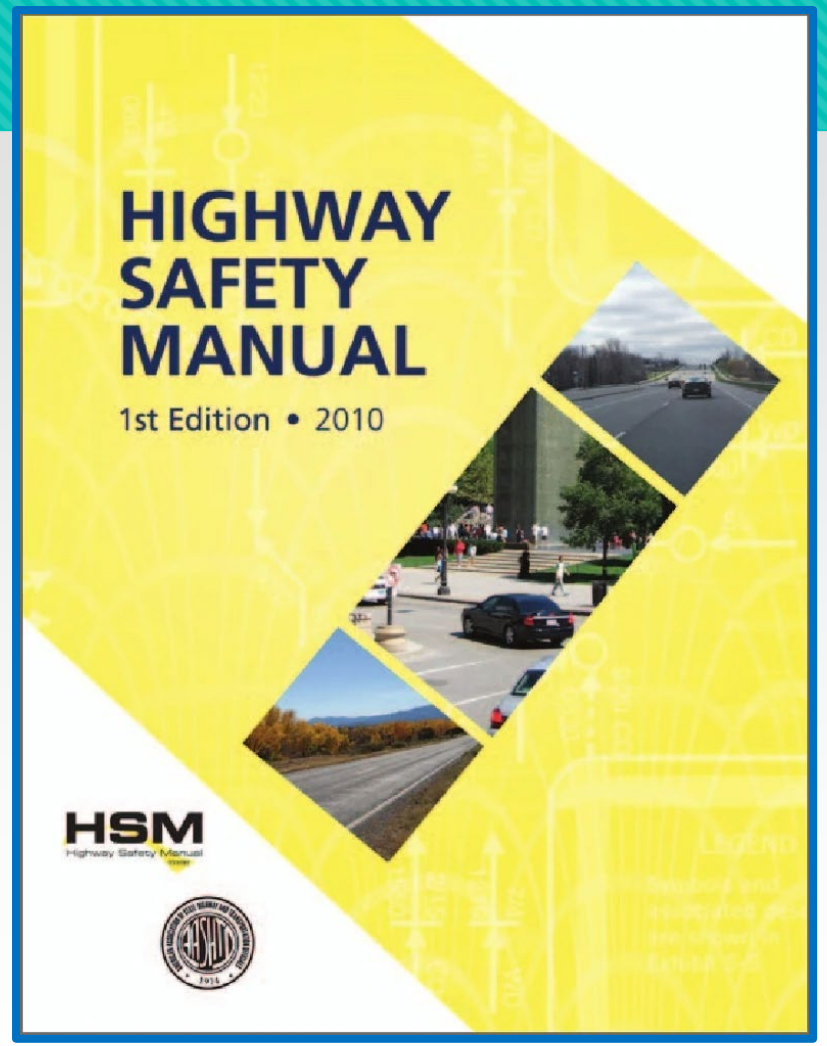
HSM Methodology Overview

- Key Part of the Methodology = Segmentation
- Start a new segment wherever there is a change in any base condition:
  - Number of Lanes
  - Cross-Section (Lane width, shoulder width, etc)
  - Roadside Conditions
  - Alignment Change
  - Change in AADT
- HSM contains guidance for how to segment
- Segments can be of varying length
- HSM analysis results are reported by segment



HSM Methodology Overview

- Results: What does the HSM Analysis give us?
  - **Predicted** Average Crash Frequency, $N_{PREDICTED}$: the number of crashes that can be expected for our site when compared with similar sites
  - **Expected** Average Crash Frequency, $N_{EXPECTED}$: the number of crashes that can be expected for our site when compared with similar sites and weighted for the observed crash history at our site
  - Potential for Safety Improvement, PSI = Expected - Predicted
    - Does <u>not</u> mean that a facility is "safe" or "not safe"
    - PSI > 0 = site experiences more crashes than predicted when compared with similar sites
    - PSI < 0 = site experiences less crashes than predicted when compared with similar sites
    - Tool used to prioritize projects



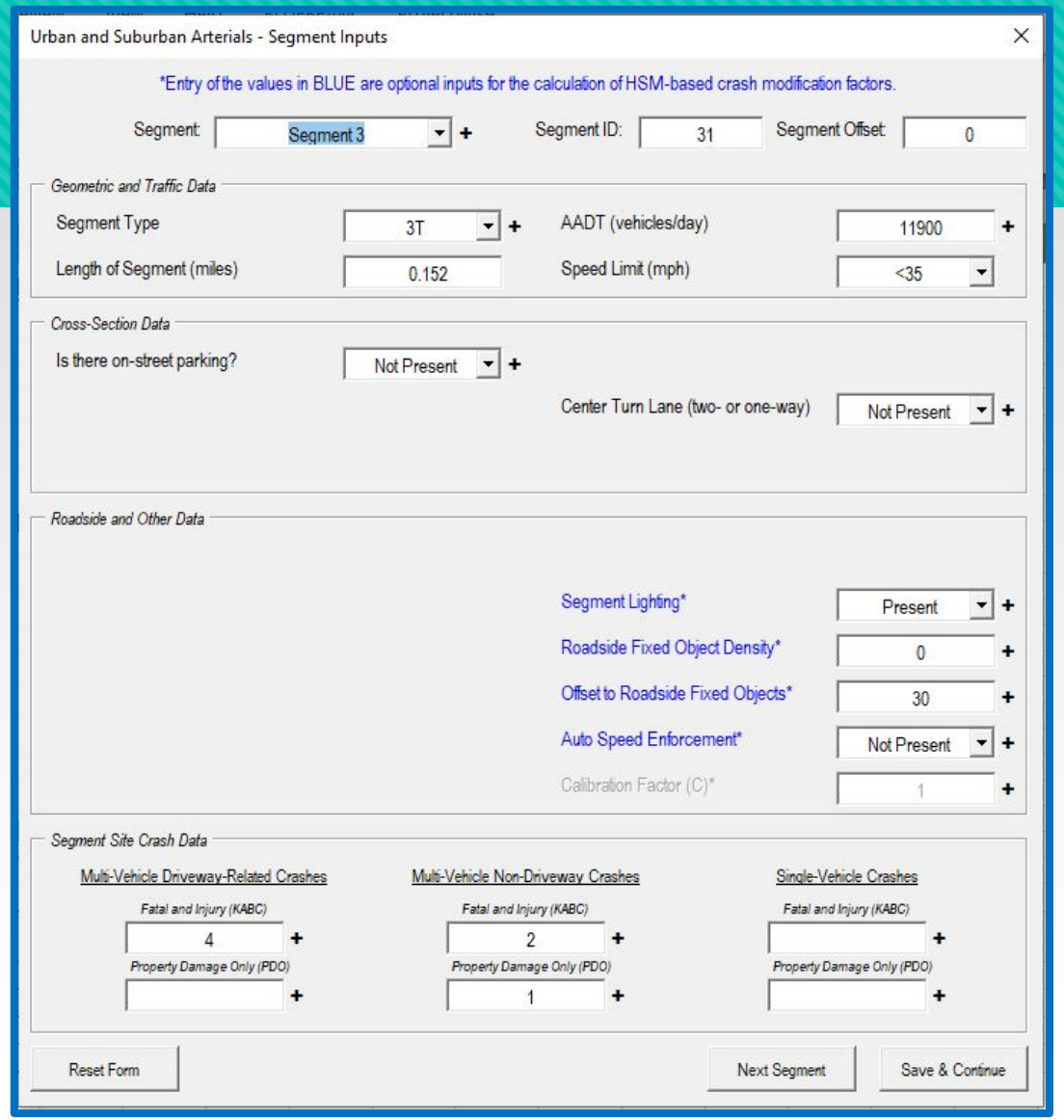
Tools for HSM Analysis

PennDOT Tool

- Can be used for:
  - Rural Two-Lane Roads
  - Rural Multilane Highways
  - Urban/Suburban Arterials
  - Intersections

- Not yet available for:
  - Freeways & Ramps
  - Roundabouts

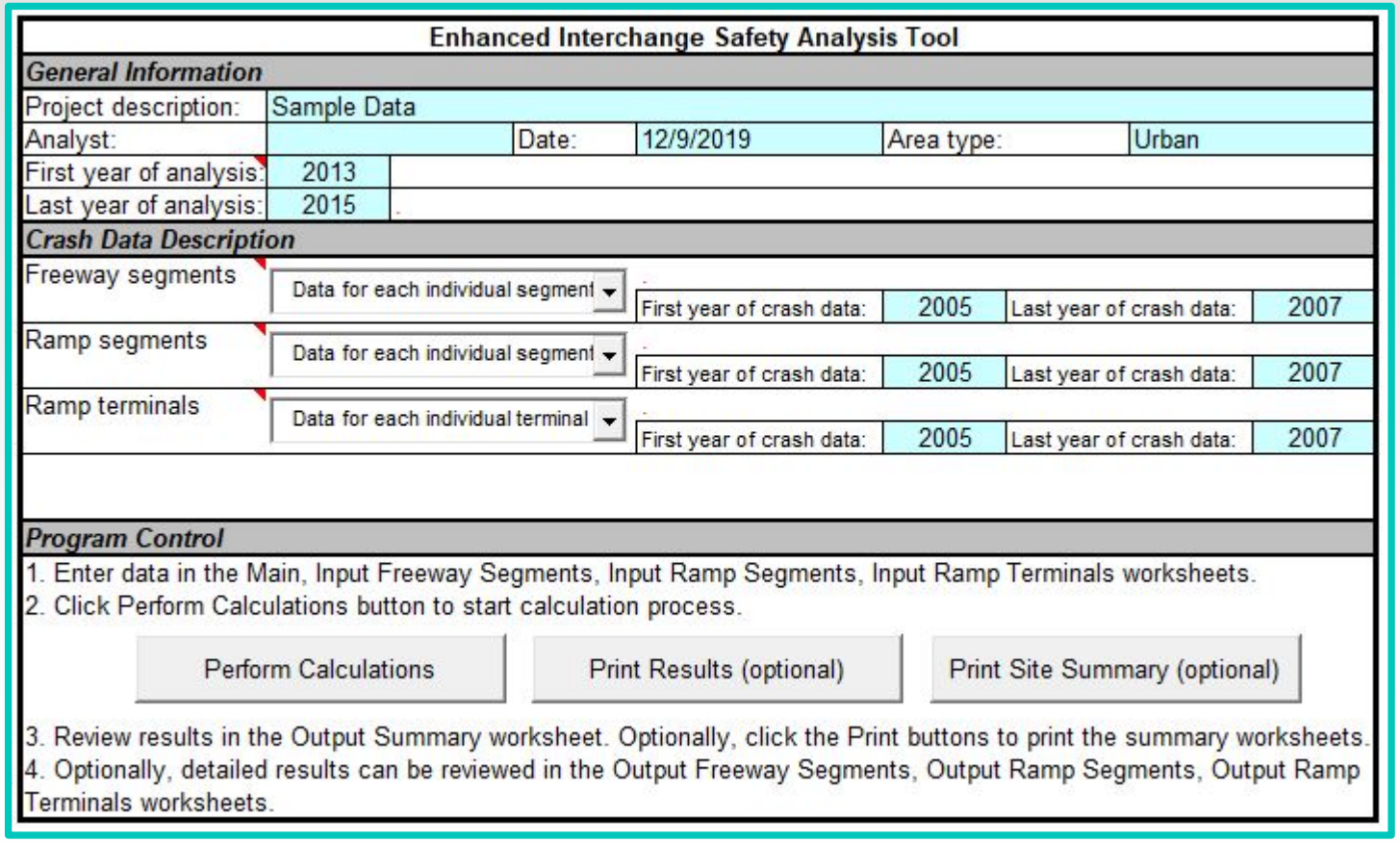
- Data Needed:
  - Need Segments/Offsets



Tools for HSM Analysis

FHWA ISATe

- Can be Used for:
  - Freeway Segments
  - Ramp Segments
  - Ramp Terminal Intersections
- Data Needed:
  - Segment Freeways Manually
  - Requires Cross Section Data
  - Curve Information



Enhanced Interchange Safety Analysis Tool

General Information

Project description:	Sample Data				
Analyst:		Date:	12/9/2019	Area type:	Urban
First year of analysis:	2013				
Last year of analysis:	2015				

Crash Data Description

Freeway segments	Data for each individual segment	First year of crash data:	2005	Last year of crash data:	2007
Ramp segments	Data for each individual segment	First year of crash data:	2005	Last year of crash data:	2007
Ramp terminals	Data for each individual terminal	First year of crash data:	2005	Last year of crash data:	2007

Program Control

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Perform Calculations | Print Results (optional) | Print Site Summary (optional)

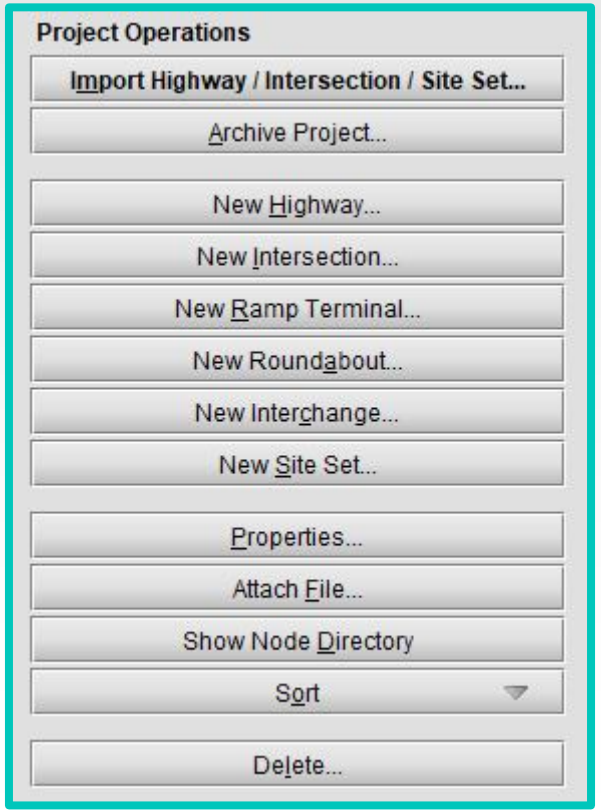
3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Tools for HSM Analysis

IHSDM

- Can be used for:
  - Entire Project Network
  - Freeways (No Need to Segment Manually)
  - Rural, Suburban, Urban Environments
  - Freeways, Ramps, C-D Roads
  - Arterial, Local, Collector
  - Ramp Terminals, Intersections
- Latest Update can analyze Roundabouts
- Requires Detailed Data
  - Cross sections, Alignments
  - Additional Geometric Design Elements

IHSDM
Interactive Highway Safety Design Model

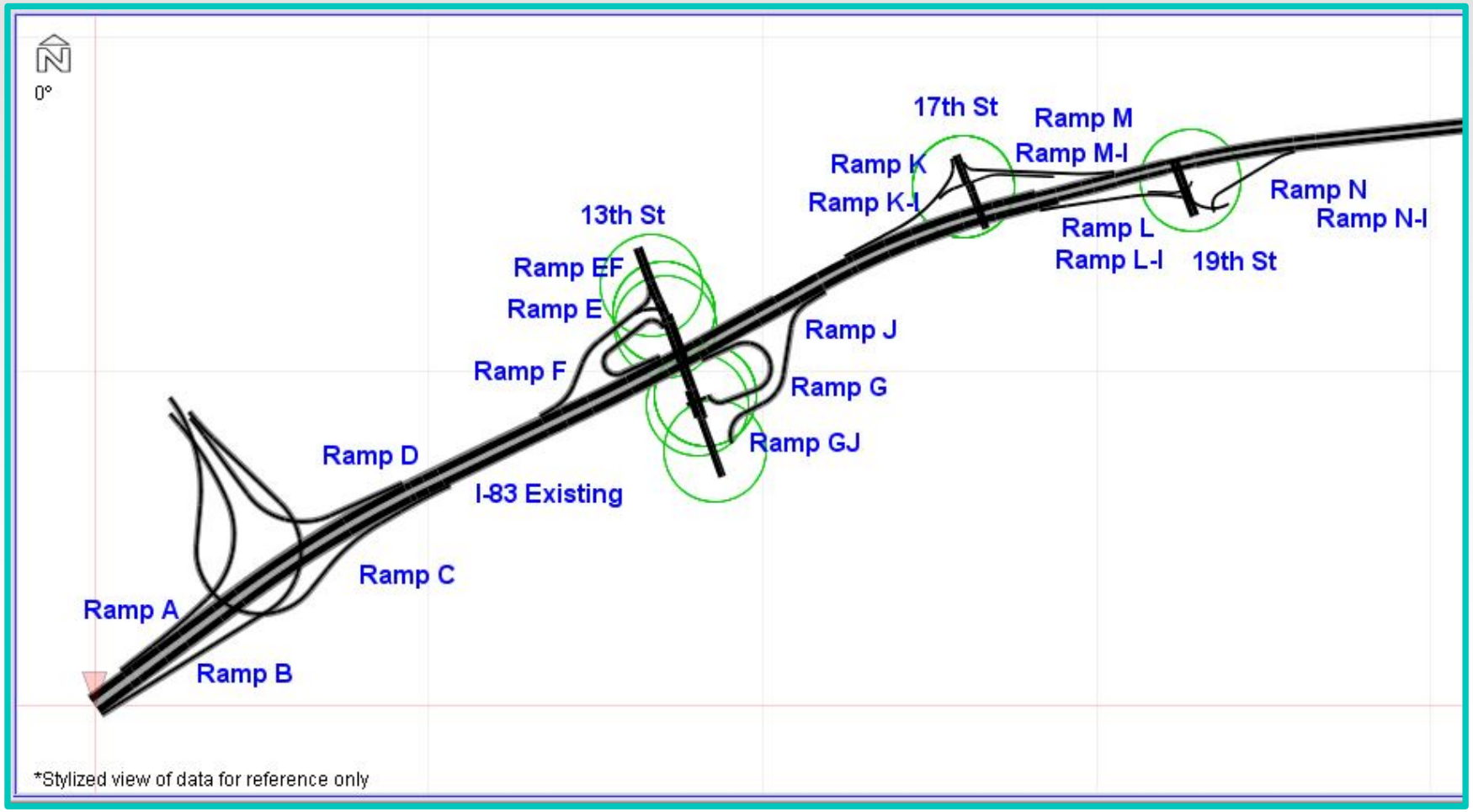


Tools for HSM Analysis Summary

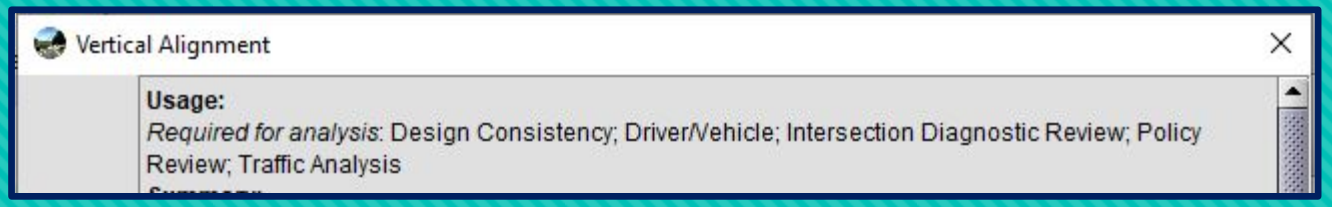
	Can be used for:										Data Needed:					
	Freeways	Ramps	Ramp Terminal Intersections	Rural Two-Lane Roads	Rural Multi-Lane Highways	Urban/ Suburban Arterials	Intersections	Local & Collector Rds	CD Roads	Roundabouts	Segment/ Offsets	Manually Segment Freeways	Cross Section Data	Curve Information	Alignments/ Baselines	Stations/ Locations for Geometric Changes
PennDOT Tool				✓	✓	✓	✓				✓					
FHWA ISATe	✓	✓	✓									✓	✓	✓		
IHSDM	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓

I-83 HSM Analysis

- IHSDM Crash Prediction Module
  - Existing, No Build, and Build Conditions
  - Freeway Segments & Crossroad Ramp Terminals



I-83 HSM Analysis



Edit: I-83 Build (v1)

File Edit Help

Select a module view:

Crash Prediction Data

- Crash Prediction Data
  - Horizontal Alignment
  - Vertical Alignment
  - Lane
  - Lane Offset
  - Ramp Connection
  - Shoulder Section
  - Cross Slope
  - Annual Average Daily Tra
  - Median
  - High Volume Section
  - Weaving Section
  - Median Barrier
  - Outside Barrier
  - Clear Zone
  - User Defined CMF
  - Site-Specific Crash Data

Horizontal Alignment

This table contains data that define the horizontal alignment of the highway centerline. Horizontal alignment element types are Tangent, Curve (simple curve), Spiral (between a Tangent and a Curve, or part of a Spiral-Spiral pair), and Deflection (horizontal deflection angle without horizontal curve).

Type	Start Loc. (Sta. ft)	End Loc. (Sta. ft)	Curve Radius (ft)	Direction of Curve	Curve Side of Road	Radius Position	Deflection Angle (deg)
Tangent	17+55.700	32+09.100			Both Roadbeds		
Curve	32+09.100	42+78.520	5,702.58	Right	Both Roadbeds		
Tangent	42+78.520	49+18.110			Both Roadbeds		
Curve	49+18.110	55+50.450	11,100.00	Left	Both Roadbeds		
Curve	55+50.450	92+39.820	9,130.00	Right	Both Roadbeds		
Tangent	92+39.820	129+00.000			Both Roadbeds		

Add... Edit... Delete... Validate... Help...

I-83 HSM Analysis

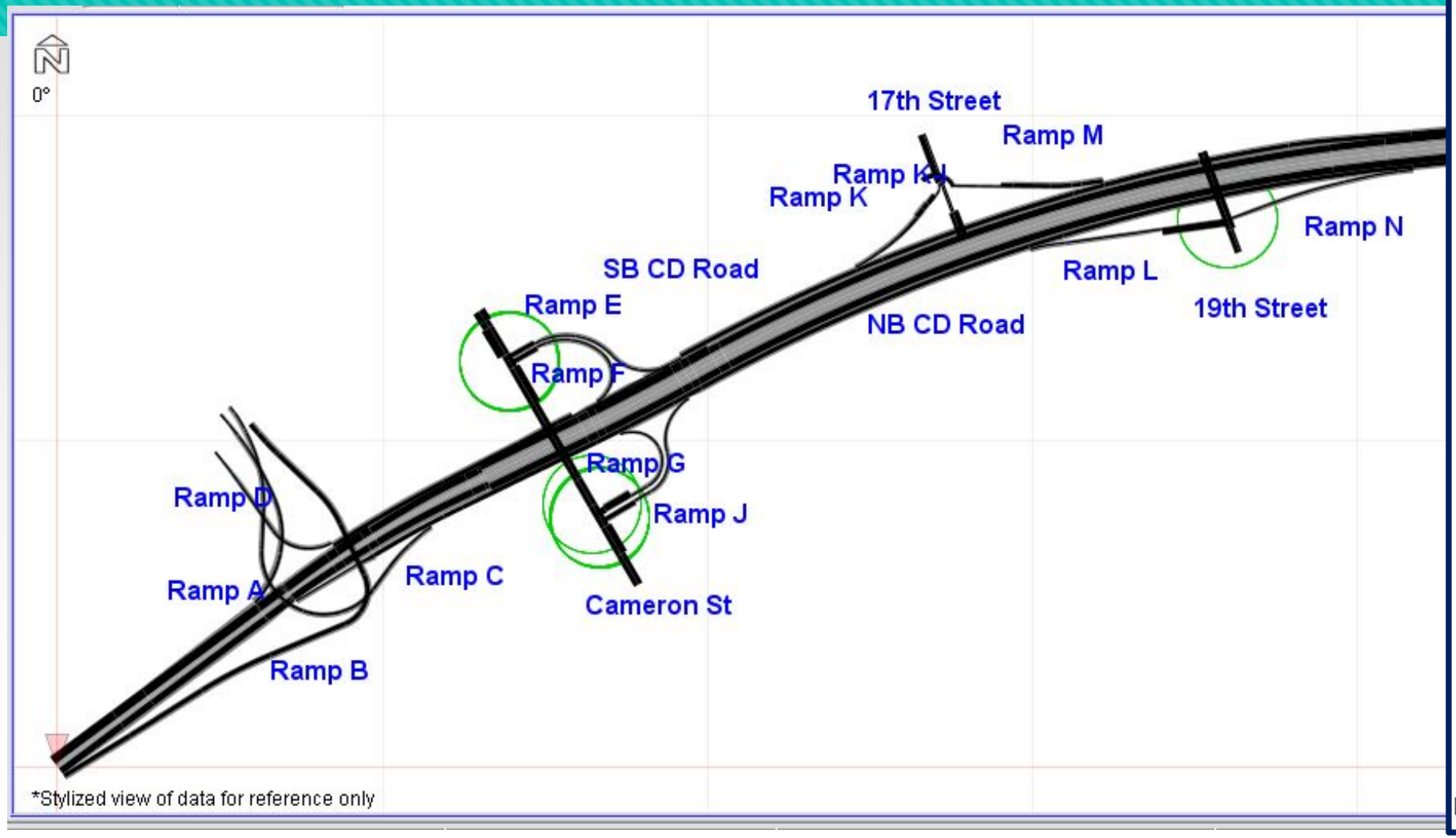
- Data Organization
- Can Import Excel into IHSDM
- Import CAD if available
  - Land XML Files

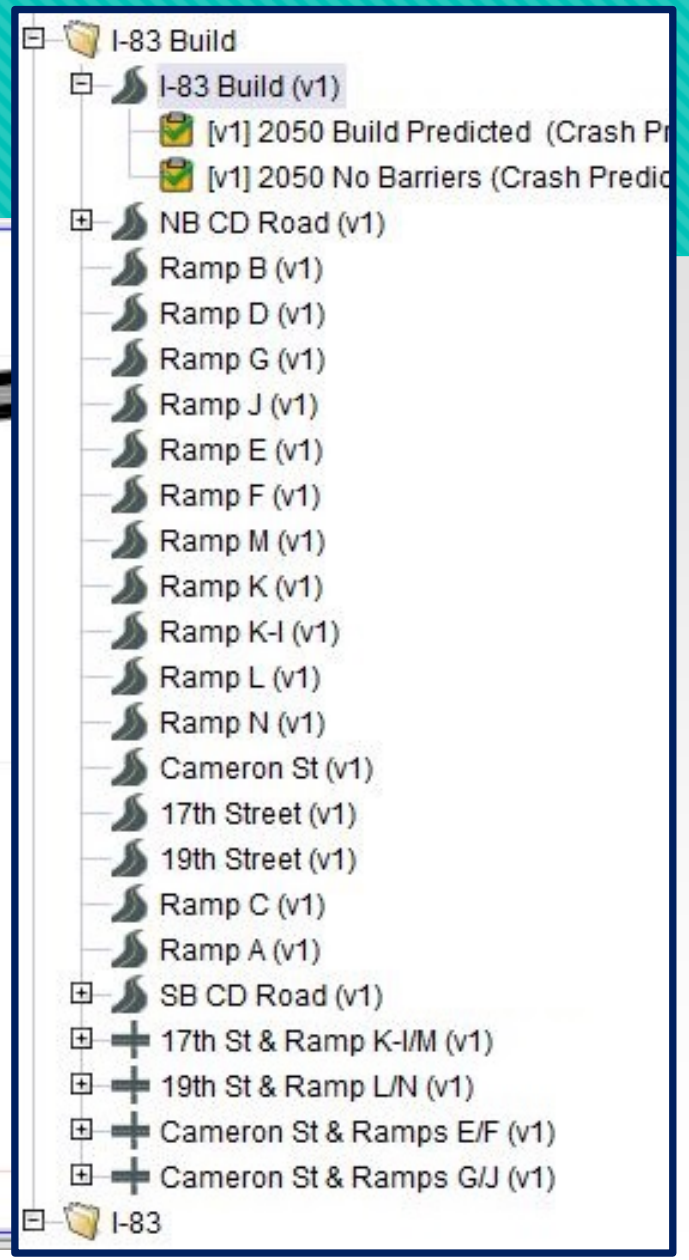
Horizontal Alignment					Lane							Lane Offset						Shoulder Section										
Element Type (Tangent, Curve, Spiral, Deflection)	Begin Station	End Station	Curve Radius (ft)	Direction of Curve (Left or Right)	Start Station	End Station	Side of Road (Left/ Right)	Priority	Type	Start Width (ft)	End Width (ft)	Start Station	End Station	Side of Road (Left/ Right)	Full Offset (ft)	Begin Loc. Full Width	End Loc. Full Width	Rumble Strips (ft)	Start Station	End Station	Side of Road	Shoulder Side (Inside /Outside)	Start Slope	End Slope	Start Width	End Width	Material	Rumble Strips (Y/N)	Priority
Tangent	17+55.70	32+09.10			17+55.70	129+00.00	Right	10	Thru	12.00	12.00	17+55.70	32+14.18	Both	4.00	17+55.70	32+14.18		17+55.70	32+14.18	Both	Inside	-4	-4	4	4	Paved	No	60
Curve	32+09.10	42+78.52	5702.58	Right	17+55.70	129+00.00	Right	20	Thru	12.00	12.00	32+14.18	43+68.33	Both					32+14.18	43+68.33	Both	Inside	-4	-4	4	12	Paved	No	60
Tangent	42+78.52	43+18.11			17+55.70	30+43.73	Right	30	Thru	11.00	11.00	43+68.33	129+00.00	Both	13.00	43+68.33	129+00.00		43+68.33	129+00.00	Both	Inside	-4	-4	12	12	Paved	No	60
Curve	43+18.11	55+50.45	11100	Left	30+43.73	32+22.82	Right	30	Thru	11.00	12.00								17+55.70	21+42.43	Right	Outside	-4	-4	2	13.5	Paved	No	60
Curve	55+50.45	92+39.82	9130	Right	32+22.82	129+00.00	Right	30	Thru	12.00	12.00								21+42.43	30+43.73	Right	Outside	-4	-4	13.5	13.5	Paved	No	60
Tangent	92+39.82	129+00.00			113+51.15	129+00.00	Right	40	Thru	12.00	12.00								30+43.73	32+22.82	Right	Outside	-4	-4	13.5	0	Paved	No	60
					113+51.15	129+00.00	Right	50	Thru	12.00	12.00								32+22.82	36+82.85	Right	Outside	-4	-4	0	14	Paved	No	60
					17+55.70	35+34.41	Left	40	Thru	11.00	11.00								36+82.85	101+31.74	Right	Outside	-4	-4	14	14	Paved	No	60
					35+34.41	37+31.48	Left	40	Acceleration	11.00	11.00								101+31.74	113+00.00	Right	Outside	-4	-4	14	0	Paved	No	60
					43+75.51	56+67.58	Left	40	Acceleration	11.00	11.00								113+00.00	129+00.00	Right	Outside	-4	-4	12	12	Paved	No	60
					98+62.15	129+00.00	Left	40	Thru	12.00	12.00								17+55.70	23+32.49	Left	Outside	-4	-4	2	2	Paved	No	60
					17+55.70	34+80.00	Left	30	Thru	11.00	11.00								23+32.49	30+52.17	Left	Outside	-4	-4	2	18	Paved	No	60
					34+80.00	37+32.12	Left	30	Thru	11.00	12.00								30+52.17	31+67.34	Left	Outside	-4	-4	2	12	Paved	No	60
					37+32.12	129+00.00	Left	30	Thru	12.00	12.00								31+67.50	35+34.41	Left	Outside	-4	-4	12	12	Paved	No	60
					17+55.70	129+00.00	Left	20	Thru	12.00	12.00								35+34.41	37+31.48	Left	Outside	-4	-4	2	14	Paved	No	60
					17+55.70	129+00.00	Left	10	Thru	12.00	12.00								37+31.48	43+75.51	Left	Outside	-4	-4	14	14	Paved	No	60
																			43+75.51	50+15.94	Left	Outside	-4	-4	14	12	Paved	No	60
																			50+15.94	54+57.45	Left	Outside	-4	-4	12	12	Paved	No	60
																			55+08.88	57+24.54	Left	Outside	-4	-4	0	14	Paved	No	60
																			57+25.54	83+62.29	Left	Outside	-4	-4	14	14	Paved	No	60
																			83+62.29	35+76.50	Left	Outside	-4	-4	14	0	Paved	No	60
																			98+59.73	129+00.00	Left	Outside	-4	-4	12	12	Paved	No	60

Notes:

NB Ramp B Gore Point:	17+55.70
SB Ramp A Gore Point:	30+52.17
NB C-D Rd Gore Point:	32+22.82
NB Ramp C Gore Point:	36+82.85
SB Ramp D Gore Point:	37+31.48
SB C-D Rd On-Ramp Gore Point:	55+08.88
SB C-D Off-ramp Split:	98+62.15
Nb C-D Ramp Split:	113+00.00

I-83 HSM Build Analysis





Results Interpretation

- Benefit of IHSDM = segments study area for you
- Challenge = can result in a lot of segments
- Some post-processing required to manage reporting of results

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Effective Length (mi)
1	17+55.700	17+89.700	0.0064
2	17+89.700	18+56.700	0.0127
3	18+56.700	19+24.700	0.0129
4	19+24.700	19+91.700	0.0127
5	19+91.700	20+58.700	0.0127
6	20+58.700	21+25.700	0.0127
7	21+25.700	21+42.430	0.0032

Freeway Section	IHSDM Segments	Segment Description
1	FS1-3	I-83 NB Ramp B Gore Point to I-83 SB Ramp A Gore Point
2	FS4-20	I-83 SB Ramp A Gore Point to I-83 SB Ramp D Gore Point [End of SB C-D Road]
3	FS21-26	I-83 SB Ramp D Gore Point [End of SB C-D Road] to I-83 NB Ramp C Gore Point
4	FS27	I-83 NB Ramp C Gore Point to I-83 SB Ramp F Gore Point
5	FS28-36	I-83 SB Ramp F Gore Point to I-83 SB Ramp E Gore Point [SB C-D Road On-Ramp]
6	FS37	I-83 SB Ramp E Gore Point [SB C-D Road On-Ramp] to I-83 NB Ramp G Gore Point
7	FS38-47	I-83 NB Ramp G Gore Point to I-83 NB Ramp J Gore Point
8	FS48	I-83 NB Ramp J Gore Point to I-83 SB Ramp K Gore Point
9	FS49-58	I-83 SB Ramp K Gore Point to I-83 NB Ramp L Gore Point
10	FS59-61	I-83 NB Ramp L Gore Point to End of 3rd Lane NB
11	FS62-69	End of 3rd Lane NB to I-83 SB Ramp M Gore Point
12	FS70-75	I-83 SB Ramp M Gore Point to I-83 NB Ramp N Gore Point [SB C-D Road Off-Ramp]
13	FS76-78	I-83 NB Ramp N Gore Point [SB C-D Road Off-Ramp] to Eastern Project Limit

Lessons Learned

No Need to Segment

- Gore point locations
  - Ramps and Crossroad locations
    - Use to group together homogenous output segments

Importing to CAD can be a challenge

- Baselines need to be exact, i.e. to the gore points
- InRoads knowledge helpful

Time Management

- Data Compilation
- Program Troubleshooting

Thank you!