PennState College of Engineering | LARSON TRANSPORTATION INSTITUTE

I-76 Operating Speed and Speed Limit Compliance Study

SESSION 3E
TRANSPORTATION ENGINEERING AND SAFETY CONFERENCE

December 6, 2018

PENNA TURN PIKE

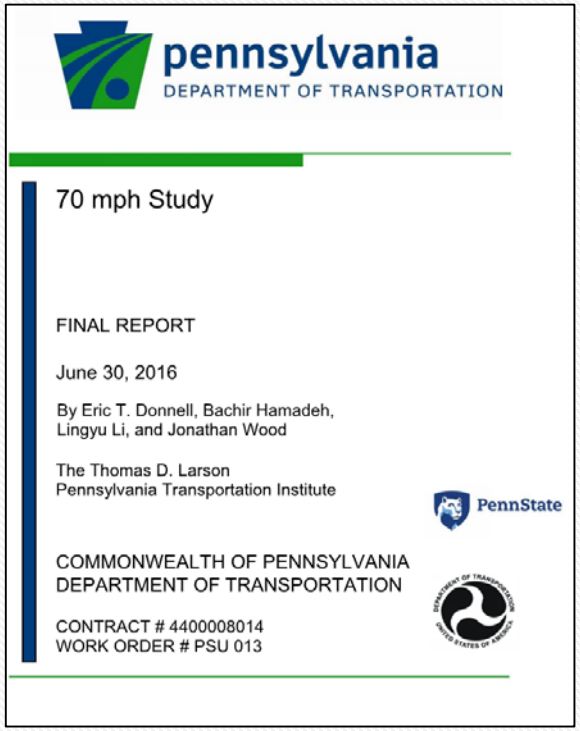
Pennoni

FRENCH ENGINEERING

Project Overview

Project Overview

- Quantify effects of speed limit increase
- Speed compliance and crash history analysis
- Supplement analysis performed by LTI in a previous study
- 65 mph to 70 mph - July 2014


pennsylvania
DEPARTMENT OF TRANSPORTATION

70 mph Study

FINAL REPORT

June 30, 2016

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The Thomas D. Larson Pennsylvania Transportation Institute

PennState

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

CONTRACT # 4400008014
WORK ORDER # PSU 013

FRENCH ENGINEERING

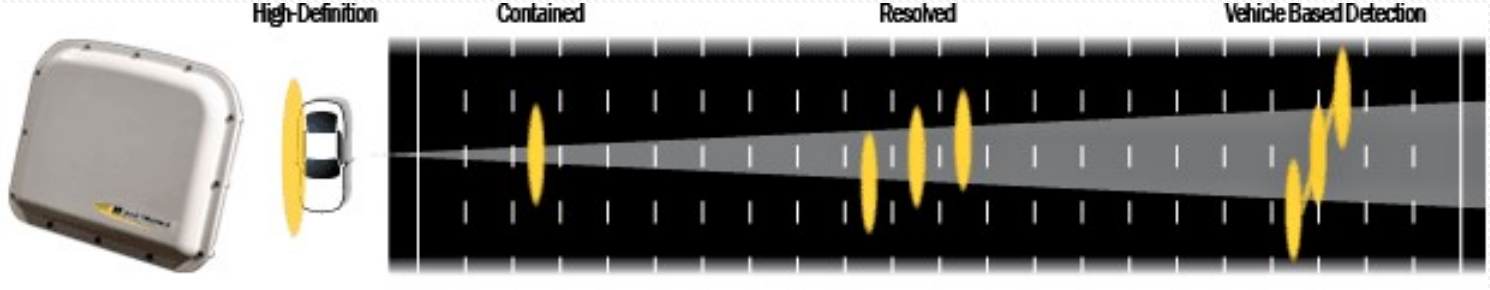
Pennoni

PENNA TURN PIKE

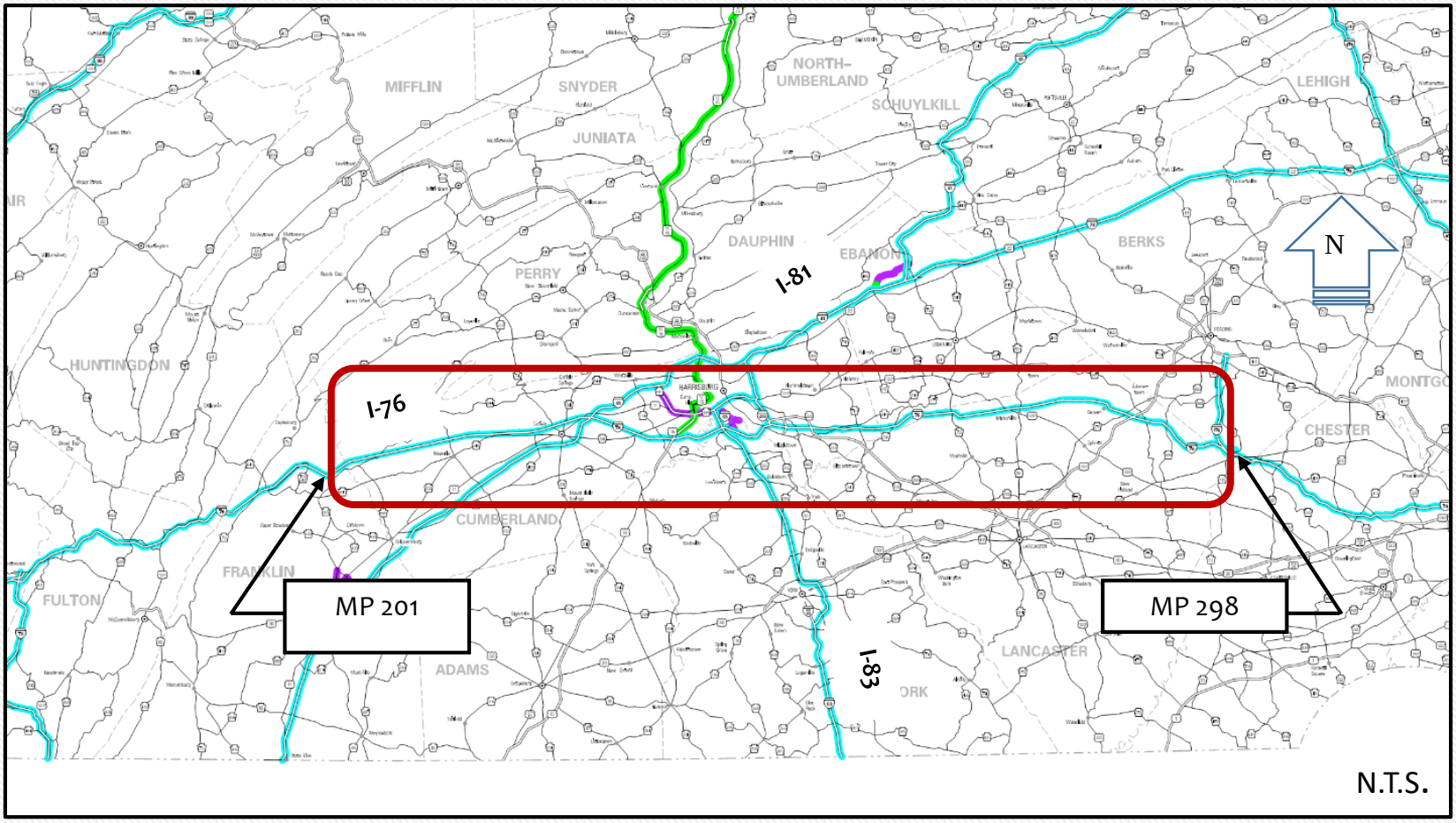
Project Overview

- Study area
  - Blue Mountain IC (MP 201) to
  - Morgantown IC (MP 298)

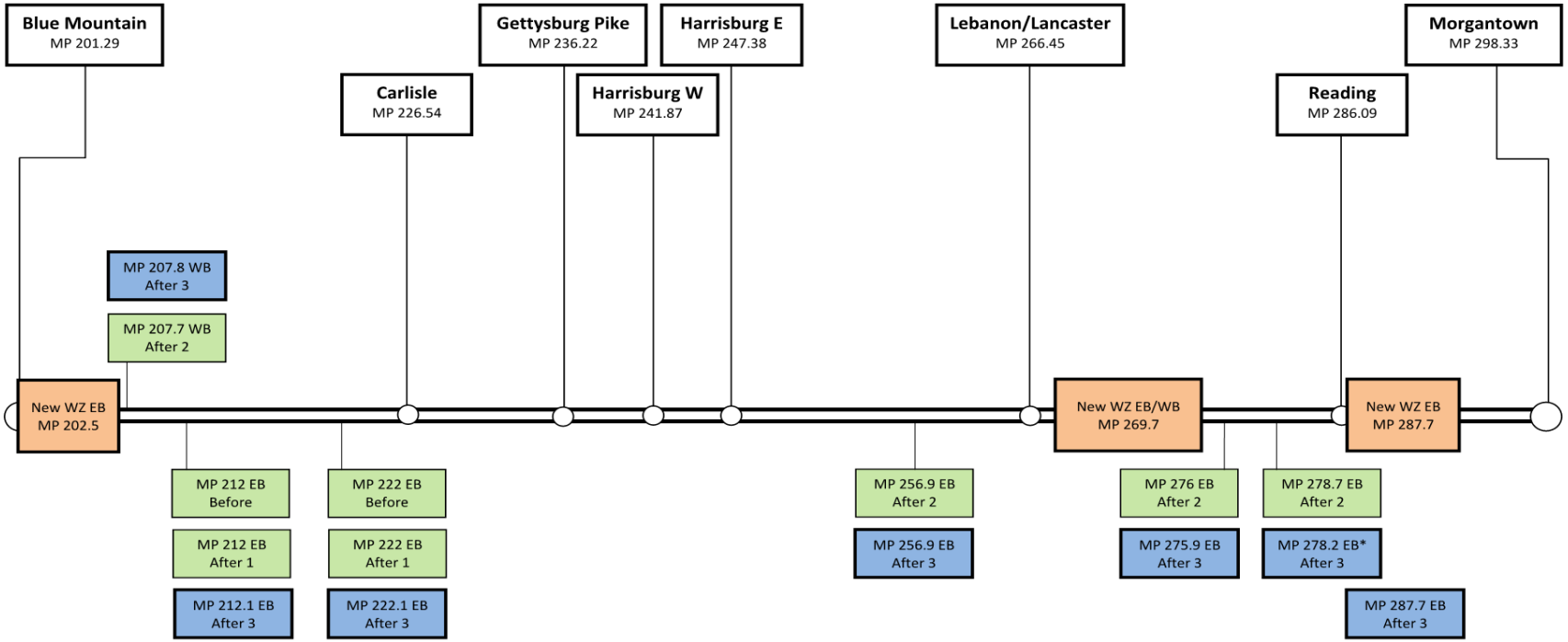
- Data collected using Wavetronix devices
  - 48 hours (min.) data collection periods
  - Data recorded by lane
  - Data recorded in five-minute increments with time stamps



Project Location



Data Collection Locations



Before	Data Collected 06/17/2014
After 1	Data Collected 09/29-30/2014
After 2	Data Collected 05/28/2015
After 3	Data Collected 05/09/2018 through 06/07/2018 and 07/24-25/2018*

New WZ

Not a Work Zone

New DC Point After 3

I-76 Operating Speed and Speed Limit Compliance Study

Data Collection Locations Used for Compliance Analysis – May 2018

Data Collection Points from
70 MPH Study by The Thomas D. Larson Pennsylvania Transportation Institute
and
Tri-State Traffic Data on behalf of Pennoni

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Data Collection Dates

- "**Before**" - 06/17/2014
- **SPEED LIMIT CHANGE TO 70 MPH - July 2014**
- "**After 1" -** 09/29-30/2014
- **"After 2"** - 05/28/2015
- "**After 3"**
  - 05/09-10/2018
  - 05/15-16/2018
  - 06/07/2018
  - 07/24-25/2018

Speed Limit Compliance

Overview of Speed Limit Compliance Analysis

- Compare speeds before and after the speed limit change in July 2014
- "**Before**" data was taken from the LTI study
- Speed data were collected in work zone and non-work zone locations

Parameters Investigated

Four speed-related parameters were investigated:

1. Mean speed
2. Speed variance
3. 85th percentile speed
4. Proportion of observed vehicles exceeding the posted speed limit

Tests for Statistical Significance

- Independent samples t-test for mean speeds
- Independent samples t-test for 85th percentile speeds
- F-test for speed variance
- Z-test for the proportion of vehicles exceeding the posted speed limit

Before and After Speed
Non-Work Zone Locations – Before and After

Location	Time Period	Sample	Mean Speed (mph)	85th % Speed (mph)	Variance (mph²)	% Exceeding Speed Limit (mph)
212 EB	Before	100	66.5	73	33.1	51
	After 1	100	70.0	74	22.1	60
	After 3	1918	76.7	81	23.0	92
222 EB	Before	100	68.1	73	30.5	70
	After 1	100	66.1	73	45.2	28
	After 3	1971	72.4	78	27.8	69
COMBINED	Before	200	**67.3**	**73**	**32.2**	**61**
	After 1	200	**68.1 (+1%)**	**74 (+1%)**	**37.2(+16%)**	**39 (-36%)**
	After 3	3889	**74.5 (+11%)**	**80 (+10%)**	**30.1 (-7%)**	**80 (+31%)**

Work Zone Speed Data

Location	Sample Size	Mean (mph)	85% (mph)	Variance (mph^2)	% Exceeding Speed Limit
202.5 EB Construction Total Reconstruction	1721	63.8	67.0	7.8	95.0
269.6 EB & WB – Construction Single Lane (nighttime hours)	1890	67.0	71.0	27.3	93.0
287.7 EB Maintenance Single Lane (daylight hours)	5966	55.4	60.5	33.6	54.4

After 2/After 3 Data Collection Locations and Timing

AFTER 2

- May 2015 – MP 207.7 westbound
- May 2015 – MP 256.9 eastbound
- May 2015 – MP 276 eastbound
- May 2015 – MP 278.7 eastbound

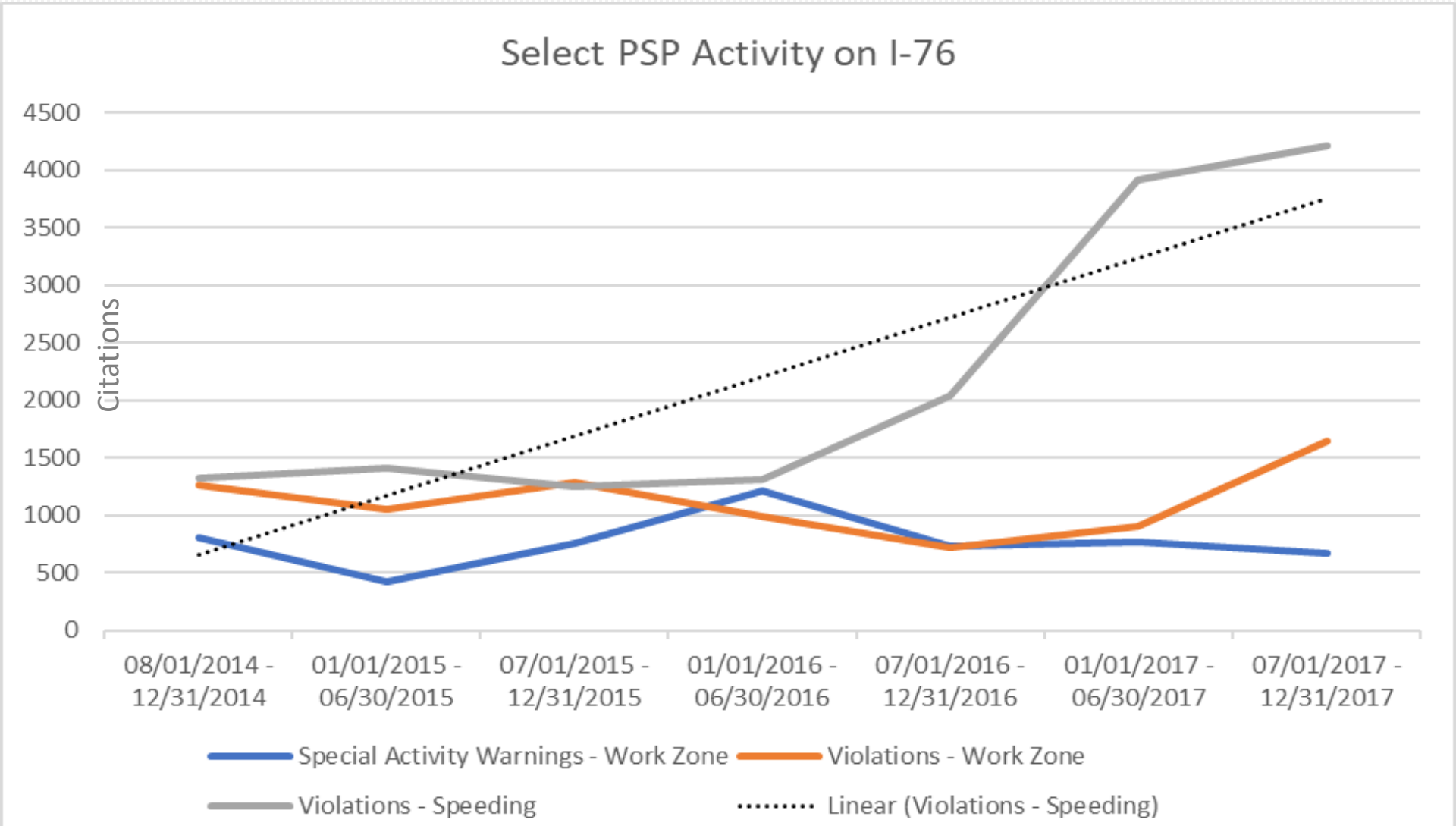
AFTER 3

- May 2018 – MP 207.8 westbound
- May 2018 – MP 256.9 eastbound
- May 2018 – MP 275.9 eastbound
- July 2018 – MP 278.2 eastbound
- May 2018 – MP 287.7 eastbound

After 2 and After 3 Speed Additional Non-Work Zone Locations

Location	Time Period	Sample	Mean Speed (mph)	85th Percentile (mph)	Speed Variance (mph²)	% Exceeding Speed Limit
207.8, 256.9, 275.9, 278.2 COMBINED	After 2	800	69.7	75	24.7	44.6
	After 3	12,061	74.0 **(+6%)**	76 **(+1%)**	24.9 **(+1%)**	71.3 **(+60%)**
207.8, 256.9, 275.9, 278.2, 287.7 COMBINED	After 2	800	69.7	75	24.7	44.6
	After 3	16,457	73.7 **(+6%)**	78 **(+4%)**	23.5 **(-5%)**	71.5 **(+60%)**

Select PSP Activity on I-76



Conclusions to Speed Study

- Speeds have increased
- Increase is generally proportional to speed limit increase
- More drivers are exceeding the speed limit
- Lower speed limit may lower mean and 85th percentile speed, but may have higher variance
- Work zone compliance is best in short-term, one lane open
- Where work zone speed compliance was not as good, drivers did slow, just not to the speed limit

Crash Analysis

Crash Analysis Study Area

- Originally MP 201 to MP 298, Pared Down Based on the Following Major Construction Projects During the Study Period (Widening to Six Lanes):
  - 2009 = MP 210-215
  - 2012 = MP 215-220
  - 2013 = MP **199**-202
  - 2014 = MP 206-210
  - 2016 = MP 250-**252**
  - 2017 = MP 220-227
  - 2018 = MP 243-245

- Final Study Area = 252 to 298
- Two Interchanges (Lebanon – Lancaster and Reading)
- Two Service Plazas (Lawn and Bowmansville)

Previous Work by LTI Compared to Proposed Work

- Empirical Bayes methodology was identified for follow-up analysis when **"After"** data were available
- Proposed Analysis Study Periods
  - **Before** 2009 – 8 /2014
  - **After** 8/2014 – 4/ 2016
- Also performed analysis with **"After"** period extending to end of 2017
- Results were very similar to **"After"** period ending 4/2016

Background on Empirical Bayes

Safety Performance Function (SPF), calibrated to existing crash history, used to predict crashes before and after the change. "After" experience then compared to actual.

$$N_{total} = e^{-8.885} \times L^{0.871} \times AADT^{1.009} \times e^{-0.522 \times FN} \times e^{0.115 \times DC}$$

Where:

N_{total} = expected number of total crashes per year for a roadway segment
L = segment length (miles)
FN = friction number indicator (1 if FN is greater than 32; 0 otherwise)
$AADT$ = average annual daily traffic (vehicles per day)
DC = degree of curvature

Odds Ratio and Experience Across Turnpike

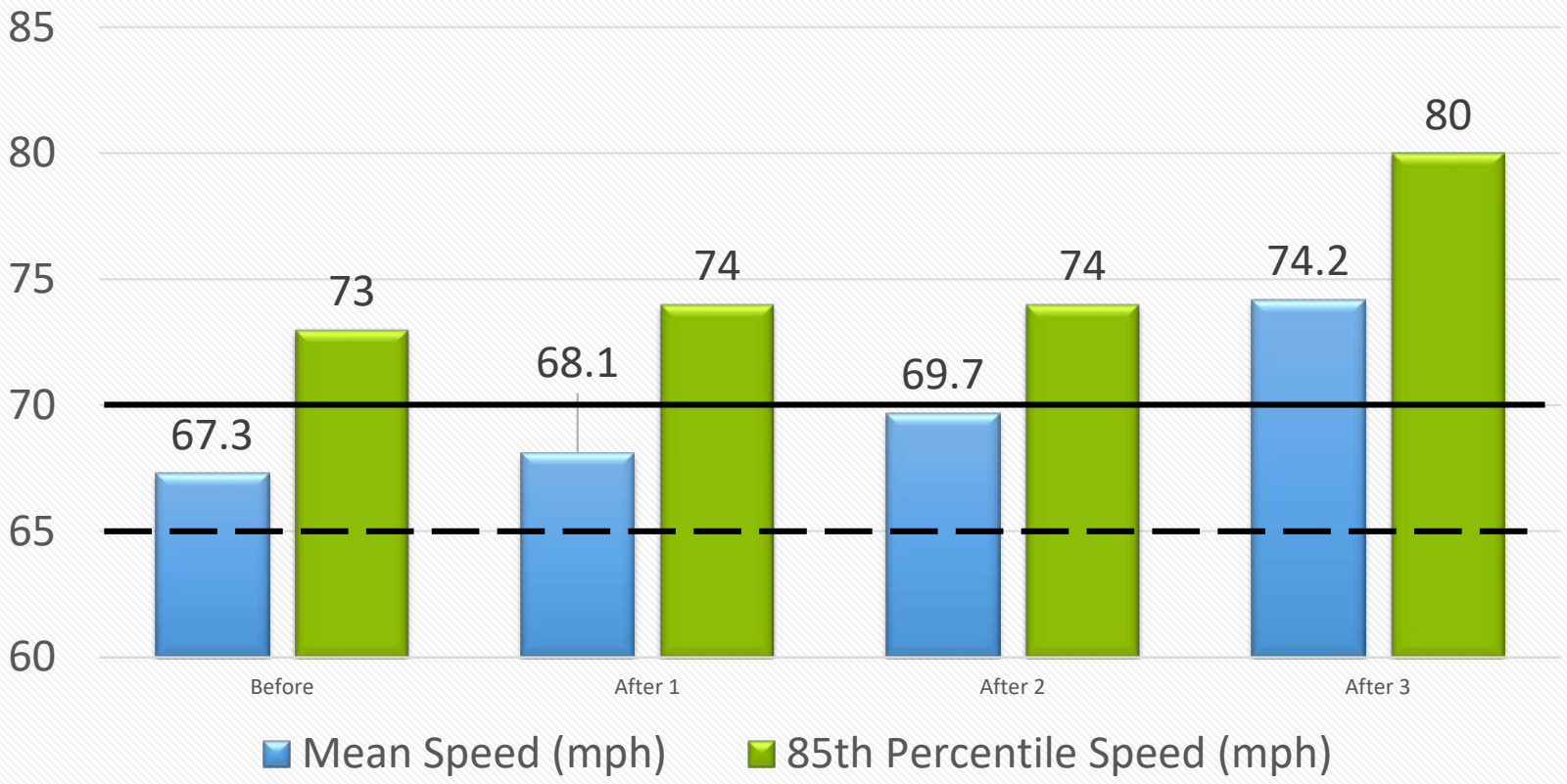
- **Crash Rate Before = 0.33 crashes / MVMT (million vehicle-miles traveled)**
- **Crash Rate After = 0.27 crashes / MVMT (before-to-after ratio of 0.82)**
- Crash Rate After/Before Experience Across Turnpike
  - To West = 0.92
  - To East = 0.79
  - Combined = 0.86
- Odds Ratio = 0.82 / 0.86 = 0.95
- **0.95 < 1.0, conclude that increase in speed limit did not cause increase in crashes**

Crash Analysis Conclusions

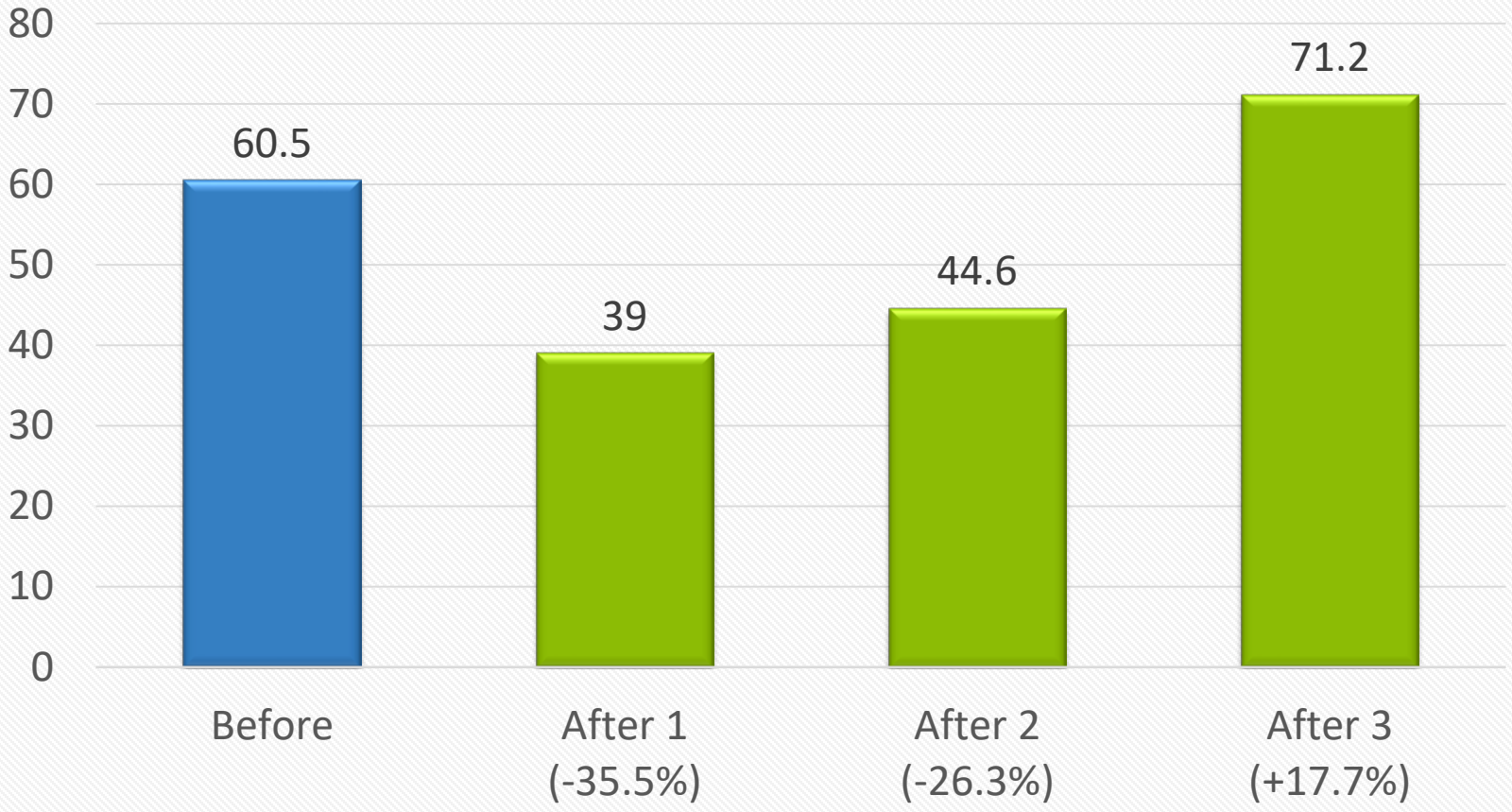
- Analysis suggests a reduction in crashes in the after period
- Crashes were down on the Turnpike as a whole
- **Crash experience not negatively impacted by the increase in speed limit**

Findings

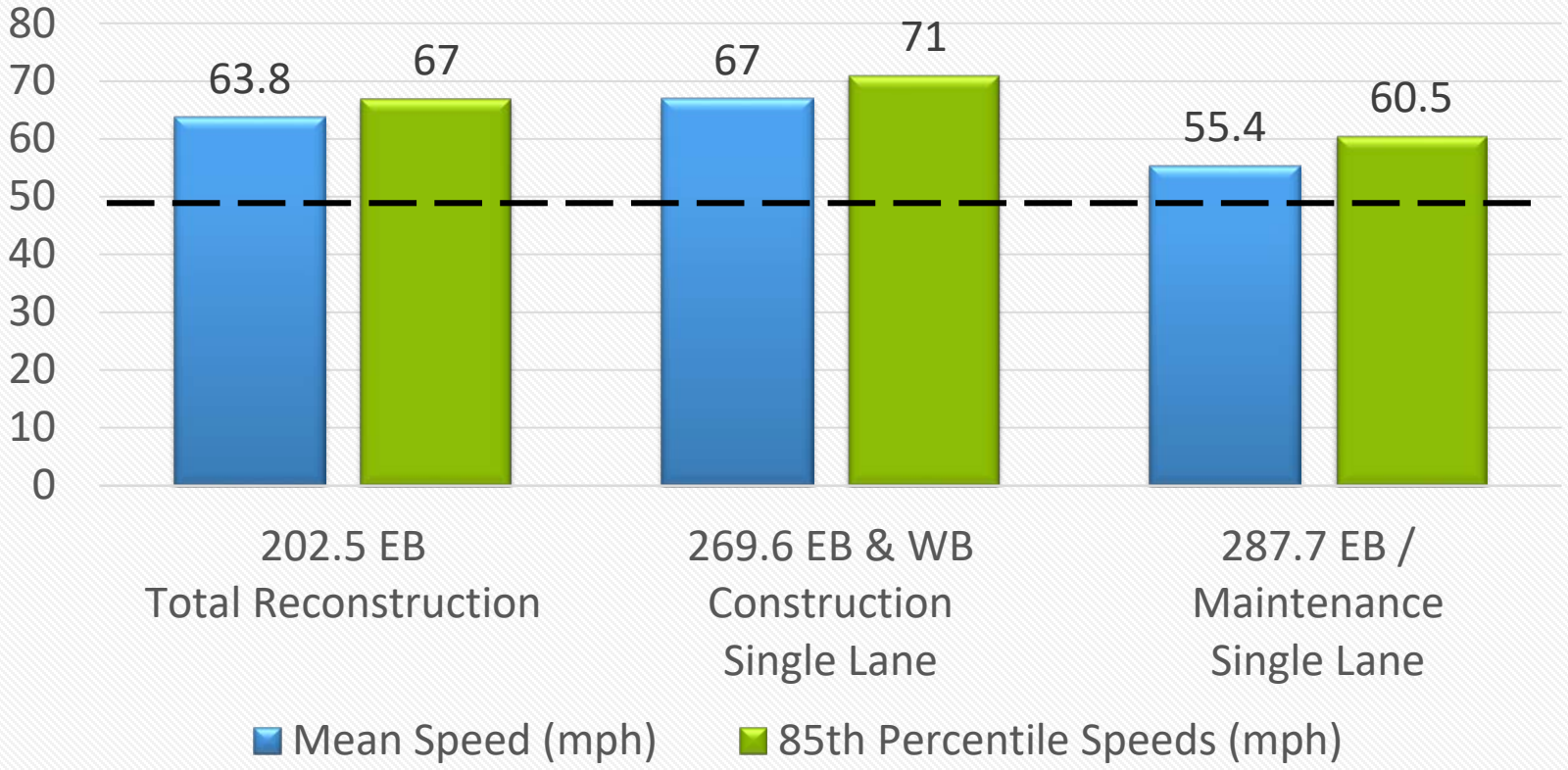
Mean and 85th Percentile - Non-Work Zone Locations



Percent Exceeding – Non-Work Zone Locations

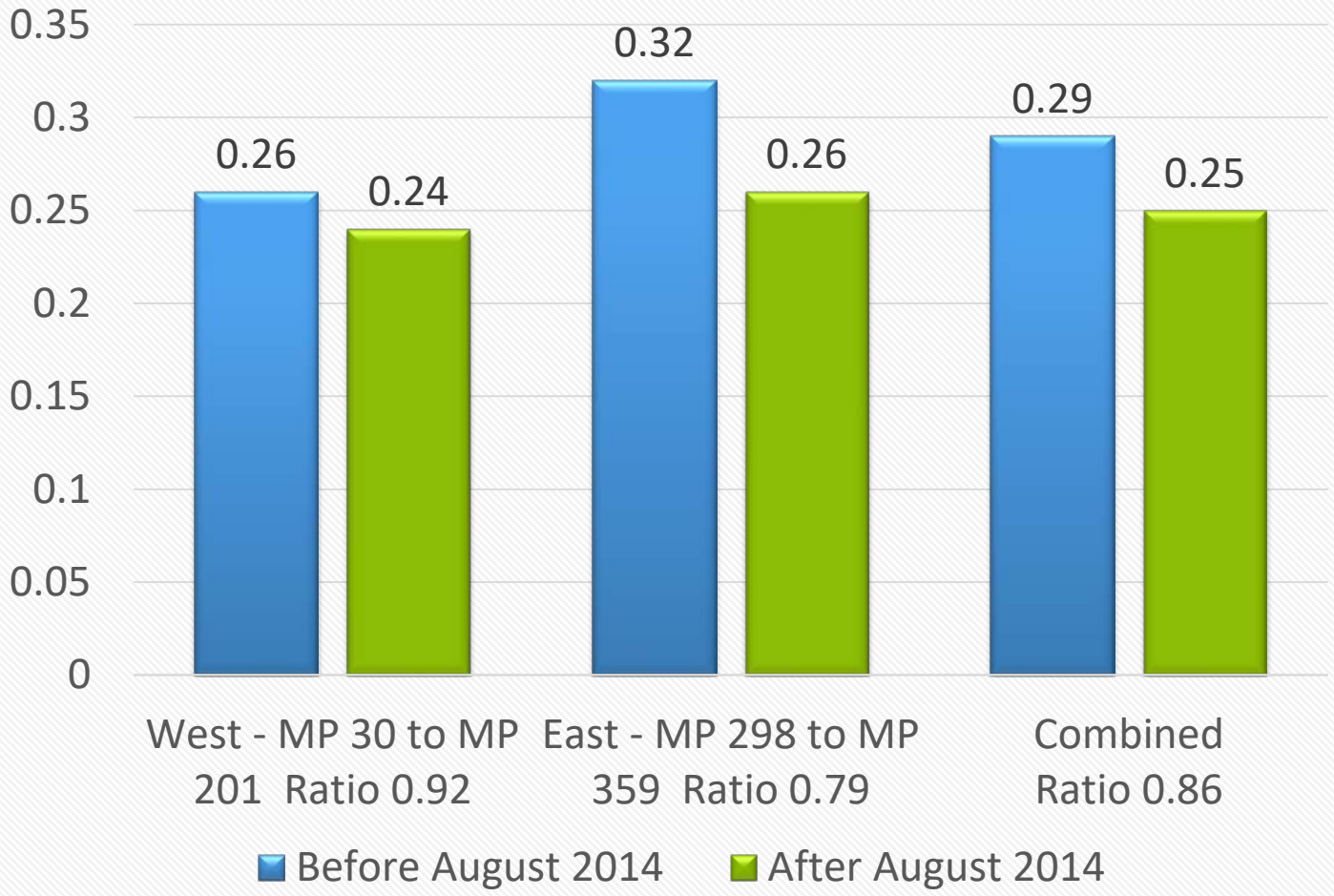


Mean and 85th Percentile – Work Zone Locations



Percent Exceeding – Work Zone Locations

Crash Rates in Control Sections



Questions?