



Innovative Safety Applications in Tennessee

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TSITE Summer Meeting, July 27th 2017



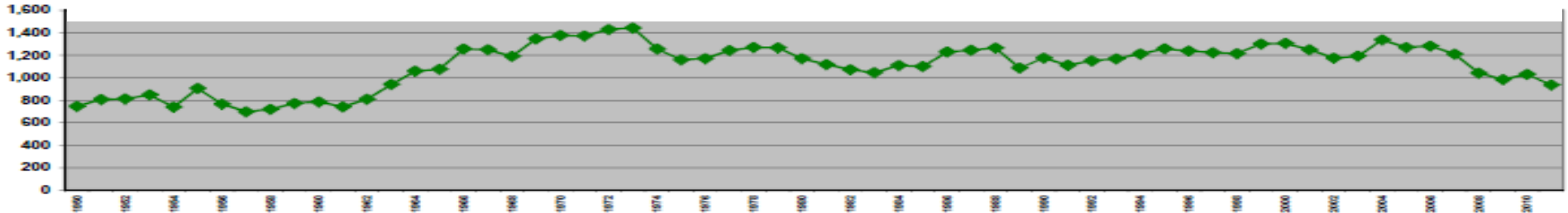
Safety Initiatives and Projects

- Fatal Trends in Tennessee
- Rural Road Diet
 - Chapman Highway
- Urban Bottlenecks
 - I-40 with I-640
 - I-40 between I-275 and US 129
- Wrong Way Safety Solutions
 - Region 1 Pilot

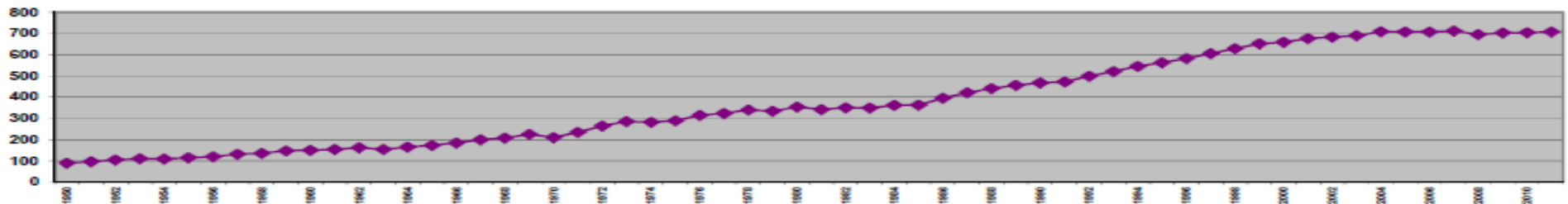


Fatality Trends in Tennessee – 1950 to 2011

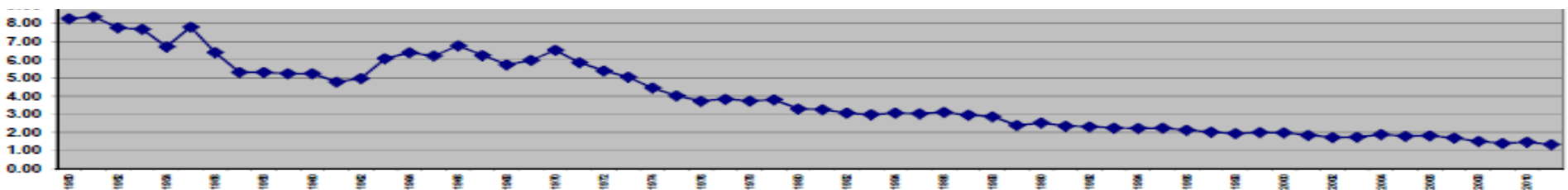
Fatalities



VMT

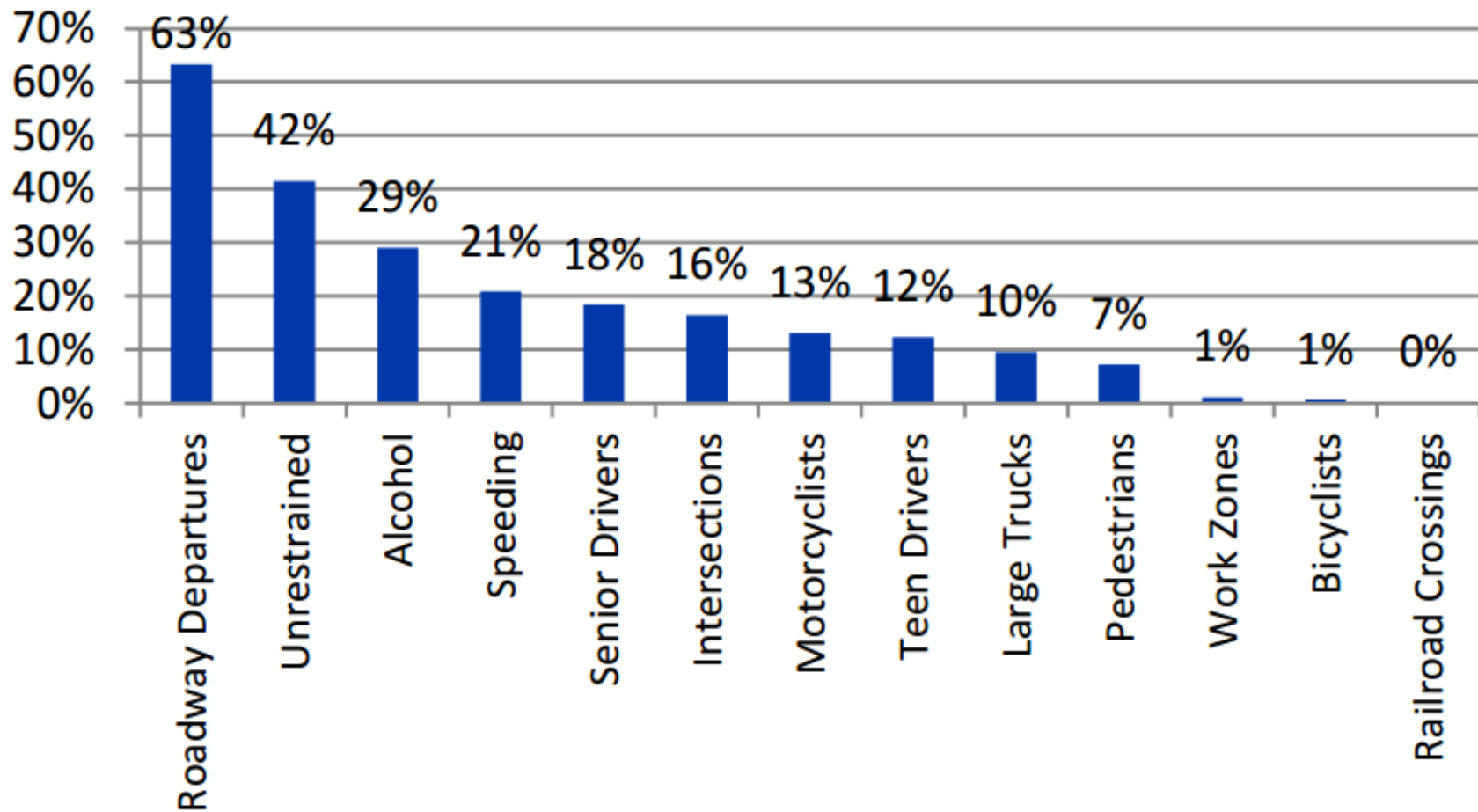


Fatal Rate



Fatality Trends in Tennessee

Fatalities Percent of Total by Contributing Factor



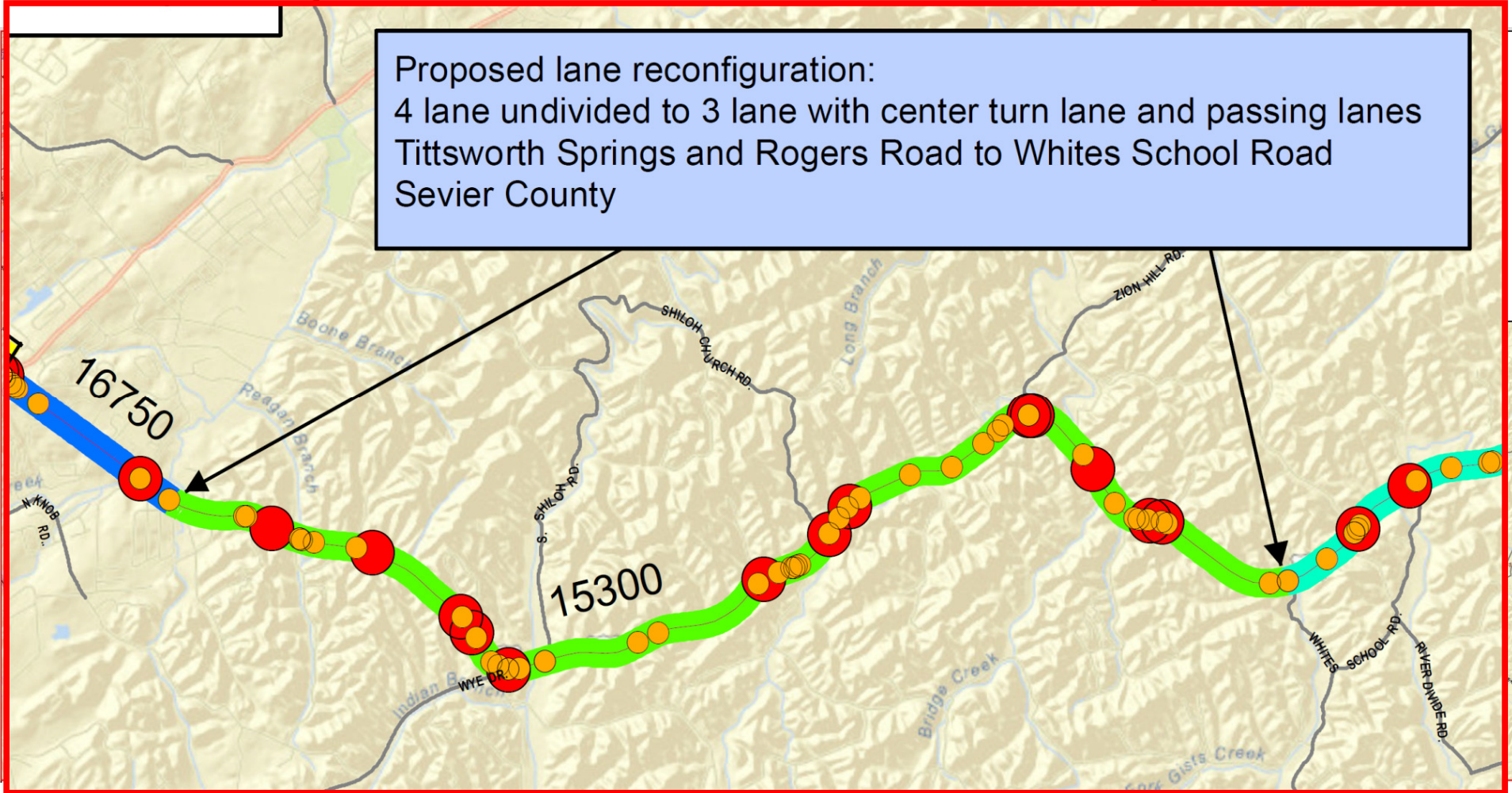
US 441, Chapman Highway



- 24-mile Route from Knoxville to Sevierville
- 3 counties & 5 different State Routes designations
- Varies from Urban 5-Lane (40k AADT) to Rural multi-lane (13K AADT)
- Before Interstate – Route was the Gateway to the Smoky Mountains

US 441, Chapman Highway

Proposed lane reconfiguration:
4 lane undivided to 3 lane with center turn lane and passing lanes
Tittsworth Springs and Rogers Road to Whites School Road
Sevier County



Existing Chapman Highway Typical Section

7.2-mile Section from Seymour to Sevierville

(4) Narrow lanes (10.5 feet wide)
Limited Shoulders (2 to 4 feet)
No buffer between opposing traffic
Speed Limit 55 mph
Significant Vertical and Horizontal Curves
Challenging Topography

Crash Data (2006 – 2015)
14 Fatal Crashes
48 Incapacitating Injury Crashes
198 Other Injury Crashes
685 Total Crashes
38% Severe Crashes



Coordination and Communication

Implementation Partners

- Internal
 - Regional Director
 - Traffic
 - State Forces (Floating)
 - Design
 - Construction
 - Commissioner
 - Others
- External
 - General Public
 - Public Officials
 - Property Owners
 - Contractors



Communication between many is required and is not a natural strength for engineers.

4 C's

- Clarity of Purpose
- Concise Content
- Customers Context
- Communicate with

Chapman Highway Alternative 1

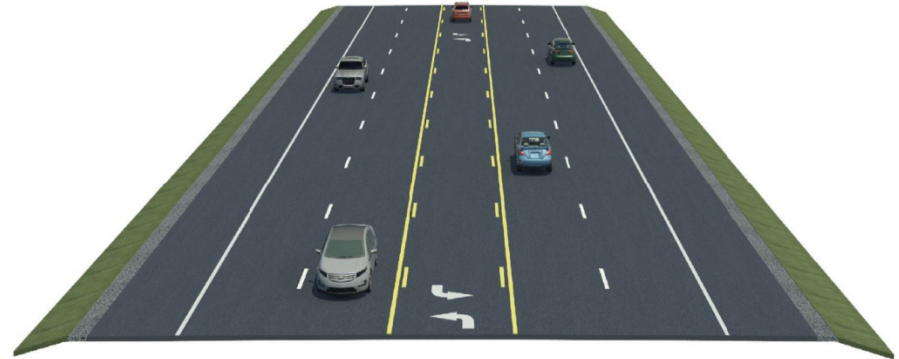
Widen to 5-Lane

Pros

- Efficient Operations
- Future Capacity
- Center Turn Lane
- Travel Time Reliability
- Safety

Cons

- **Cost approximately \$82 million**
 - Volumes do not require concept in near future
 - Competes for funding with other Regional Projects
- Time for Delivery
- Project Impacts
 - ROW Acquisition
 - Environmental
 - Utility Relocations



Typical Section
5 Lane Rural

Cost Information for 5-L Widening Projects

Chapman (Evans to Burnett Ln)
Length – 0.9 Miles
Cost – \$5.9 million

Chapman (Macon to SR-338)
Length – 1.18 Miles
Cost – \$19 million

Average Cost per mile – \$11.4 million
Estimated Cost for 7.2 miles - \$82 million

Chapman Highway Alternative 2

Modified 3-Lane with Passing

Pros

- Safety
- **Cost Feasible = \$2.1 million**
- No ROW, Environmental or Utility issues
- Safe designated passing areas
- **Center Turn Lane**
 - Buffer between opposing traffic
 - Safe Refuge for turning traffic
 - Reduces Rear-end crashes
 - Reduces delays for left-turning traffic
 - Improves access
- **Paved 7 ft. Shoulders**
 - Refuge for emergency or disabled vehicles
 - Recovery area for errant vehicle
 - Safe refuge for mail carrier
 - Use for right turning traffic



- **Posted Speed Reduced to 50 mph**
(Reducing speed differentials)
- **Eliminates Weaving**
- **Simplifying road scanning** and gap selection for entering vehicles

Crash Reduction Factors

- Adding a Center Turn Lane
 - Total Crashes – Reduction of 37%
- Adding Paved Shoulders
 - Up to 47% Reduction of roadway departure type crashes, depending on shoulder width

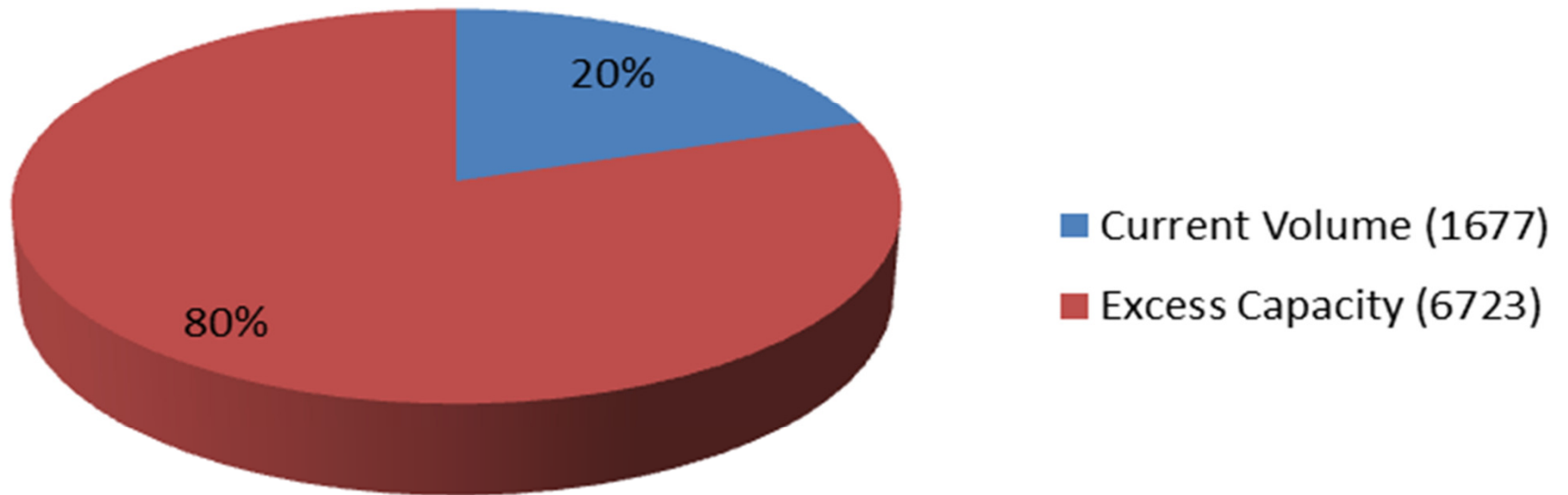
Impact Over 10 years

Total Crash Reduction = 250

Severe Crash Reduction = 104

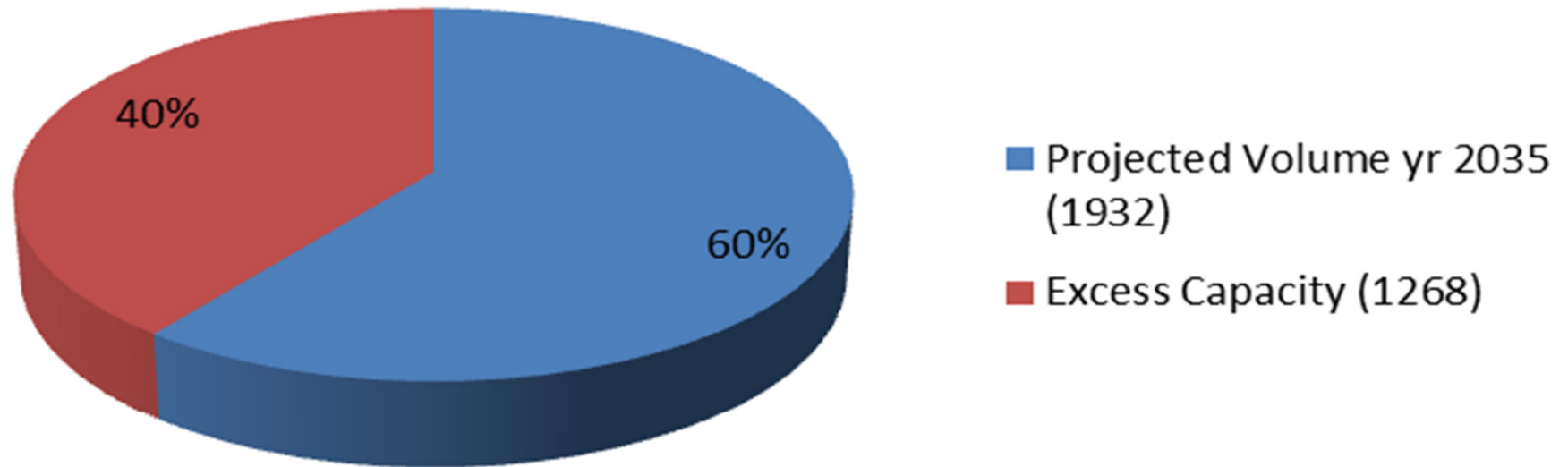
Current Roadway Section

Capacity Utilization - Existing Conditions



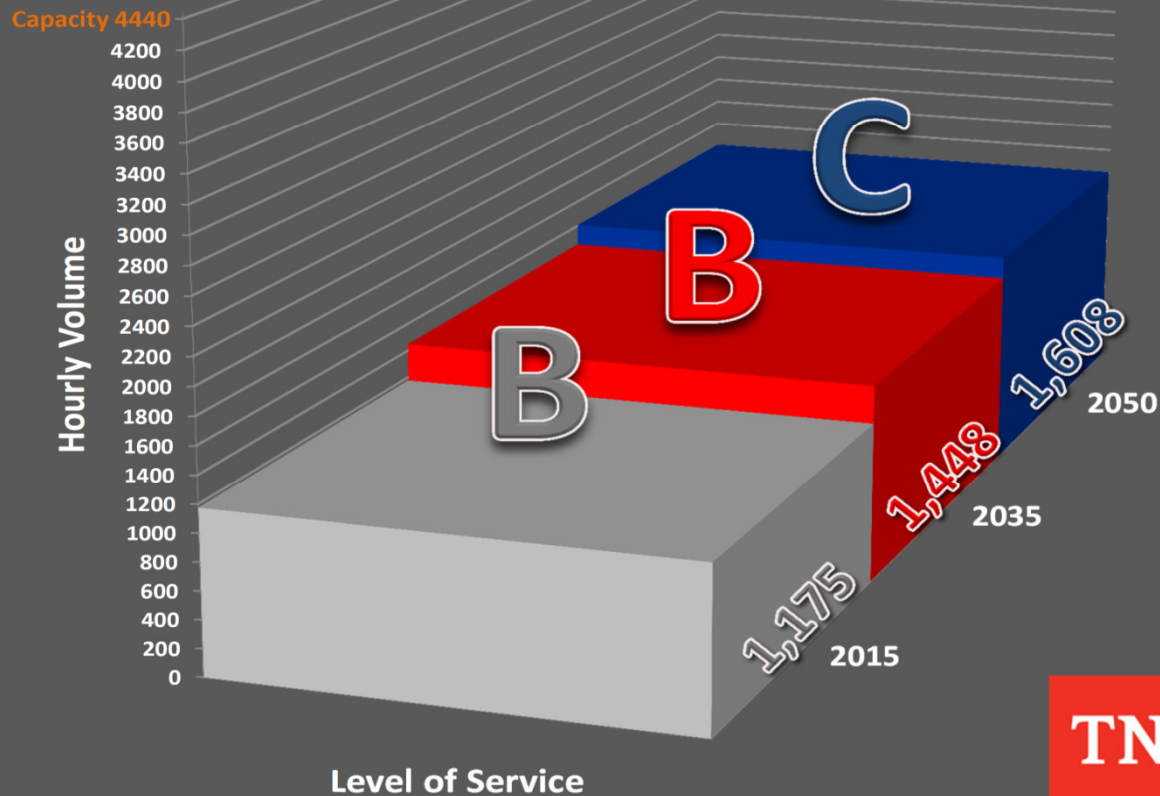
Proposed Roadway Section

Capacity Utilization - Projected 2035



Roadway Capacity and LOS

3-Lane Section with Passing Zones



Level-of-Service (LOS)

LOS A



LOS B



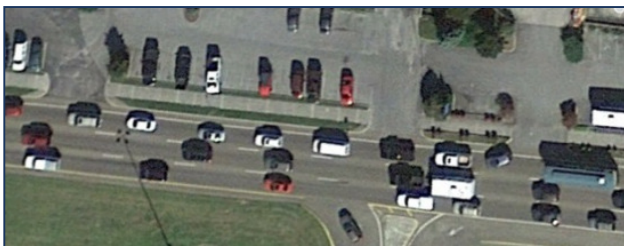
LOS C



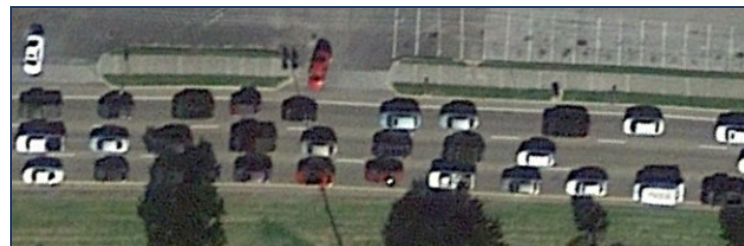
LOS D



LOS E



LOS F

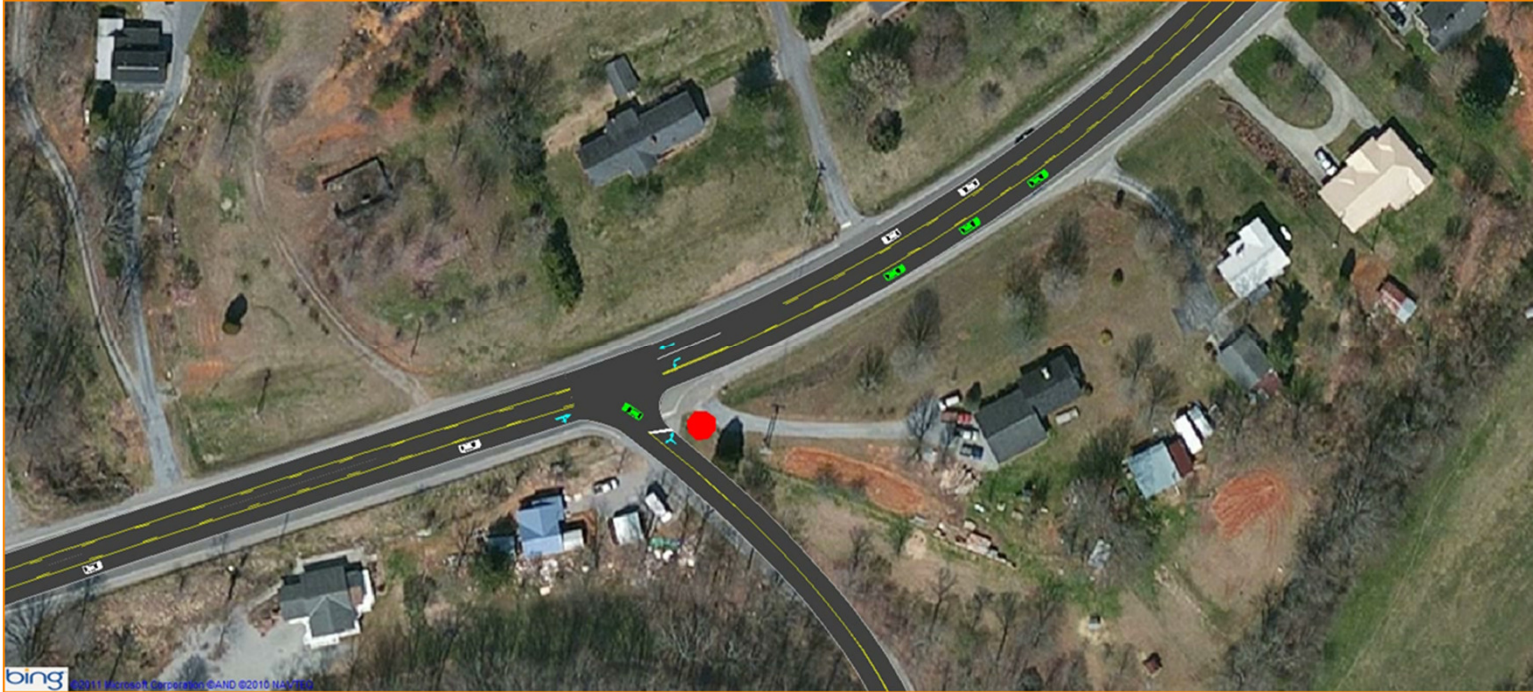


Synchro Model - Existing Sugar Loaf



Delay 101.1sec

Synchro Model - Proposed Sugar Loaf



Delay 36.3sec

Project Summary

- **Time** - Less than 2 years from conception to construction
- **Cost** - \$2,006,669.71
- **Cost Saving** - \$80 million
- **60% 3-Lane** **40% 3-Lane with passing lane**
- **Thin-Lift Overlay**
- **Enhanced Pavement Markings** – 6" lines, Snowplowable Markers, Edge line Rumble Stripes and Channelization for Open Frontage
- **Reduced Speed Limit** - 50 mph & Trucks Use Right Lane

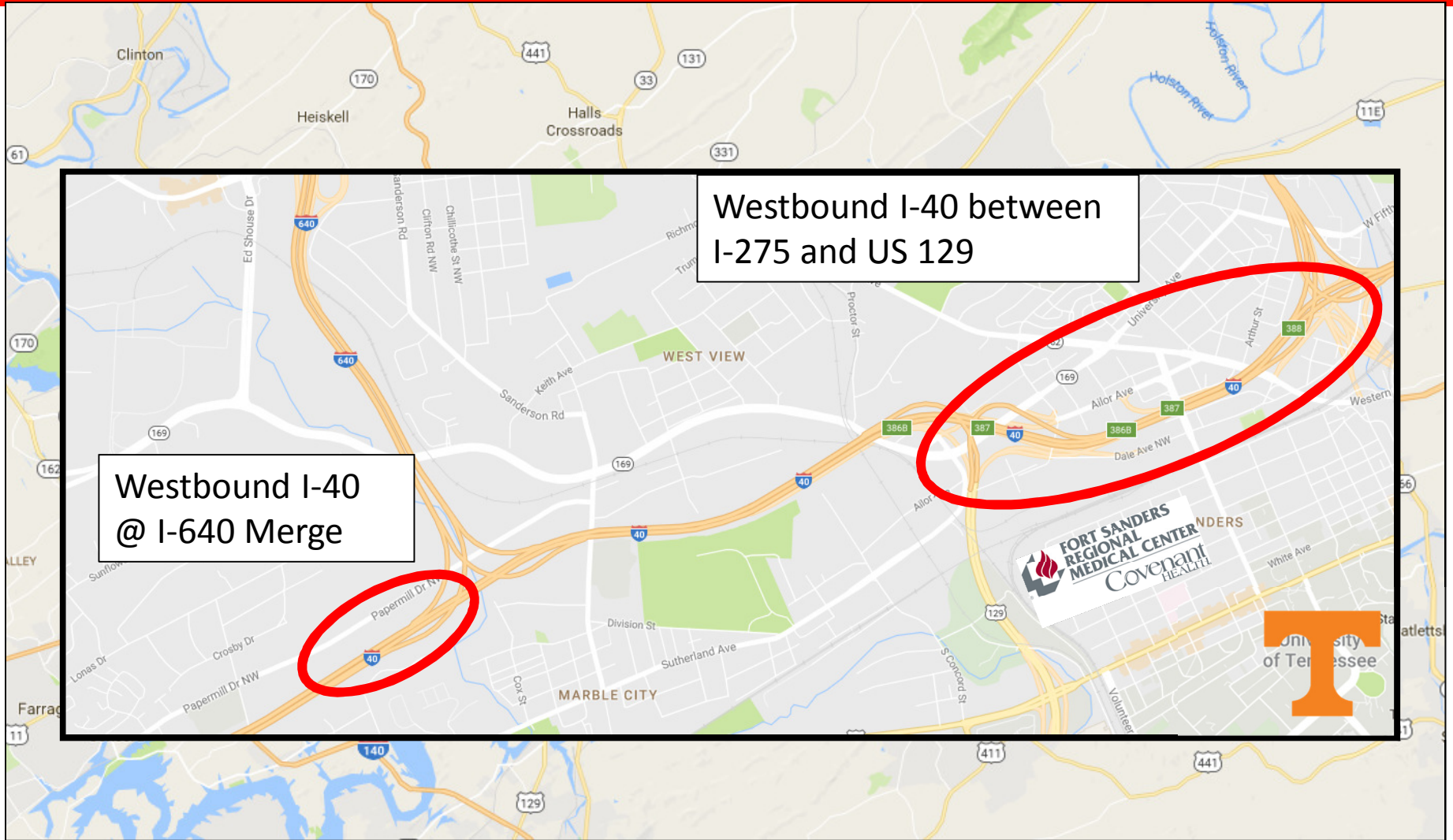
Before and After Study Chapman Highway			Crashes	Fatals	Incapacitating		Injury	
Study Period	Time Period		Total	Total	Total	Yearly Average	Total	Yearly Average
After	12/1/2016	7/1/2017	212	27	1	1.7	12	20.7
Before	9/30/2006	9/30/2016	3653	616	12	4.4	183	18.3
	9/30/2013	9/30/2016	1096	167	2	3.0	49	16.3
	9/30/2015	9/30/2016	366	56	0	3.0	19	18.9

Study Period	Crashes	Incapacitating	Minor Injury
After 212 Days	-24.5%	-60.8%	13.0%
Before 10-years	0.0%	0.0%	0.0%

Chapman Highway – Post Construction



Urban Bottlenecks Knoxville Area

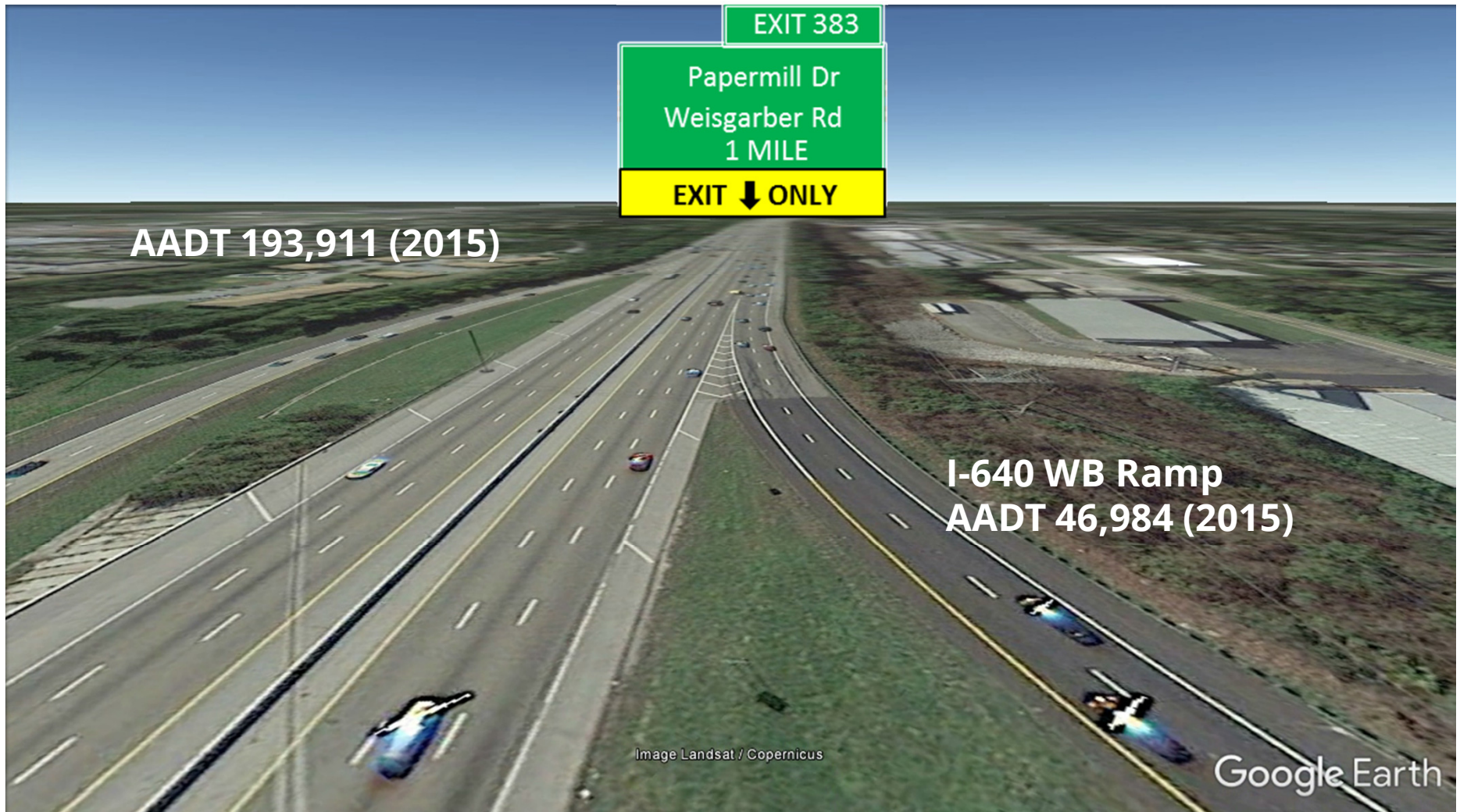


Urban Bottleneck

I-40 with I-640

Before

Westbound Merge



Urban Bottleneck

I-40 with I-640

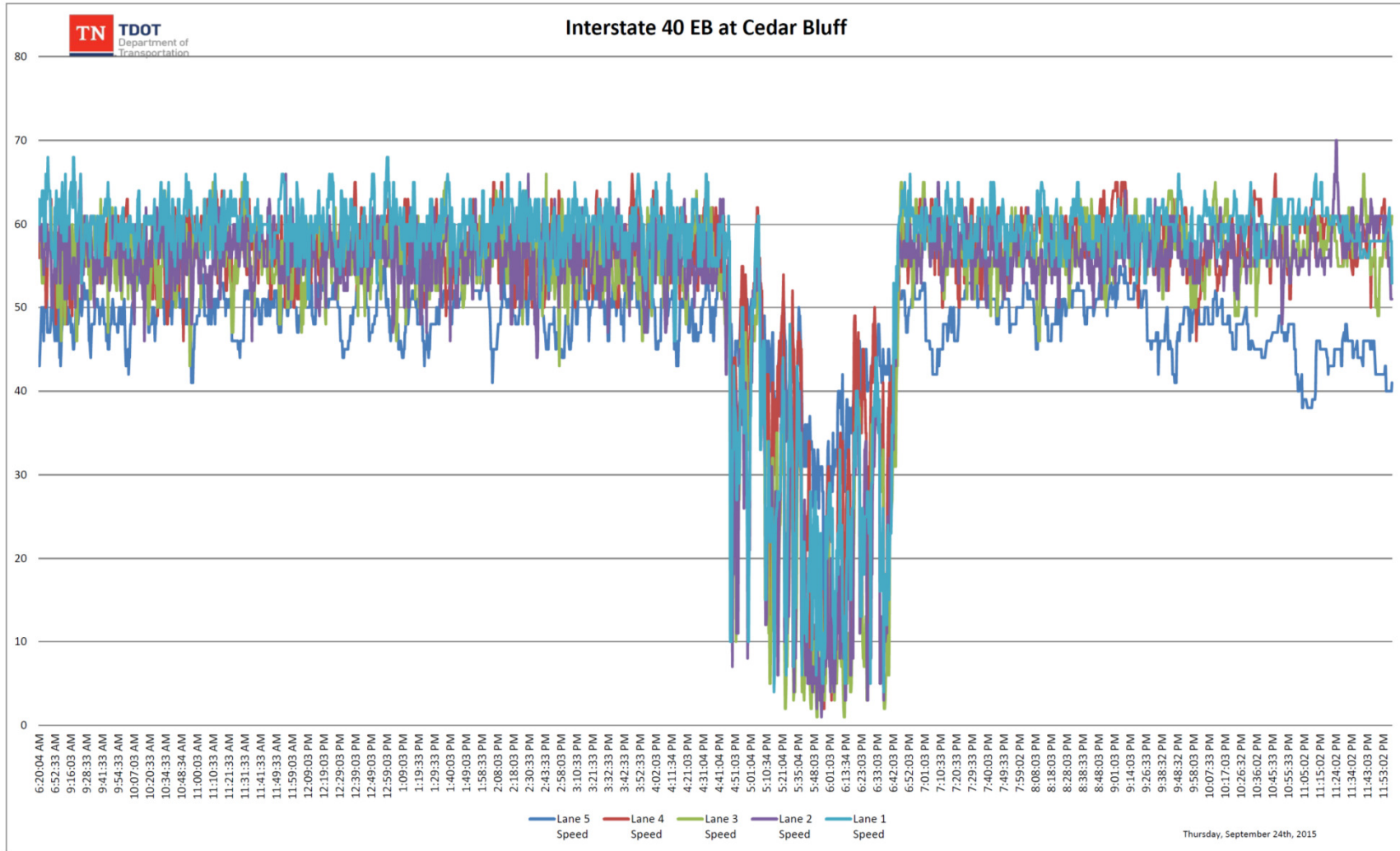
After

Westbound Merge



Measuring Effectiveness

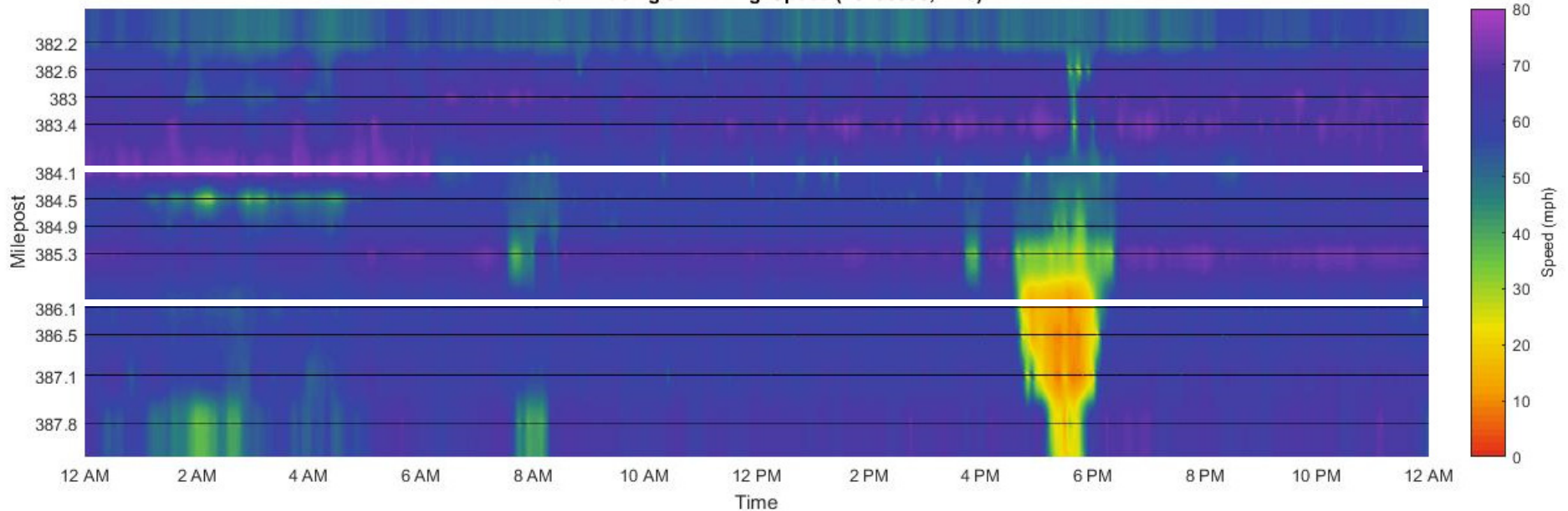
RDS Speed Data



Measuring Effectiveness Speed Heat Map



I-40 WB using 5-min Avg. Speed (20150903, Thu)

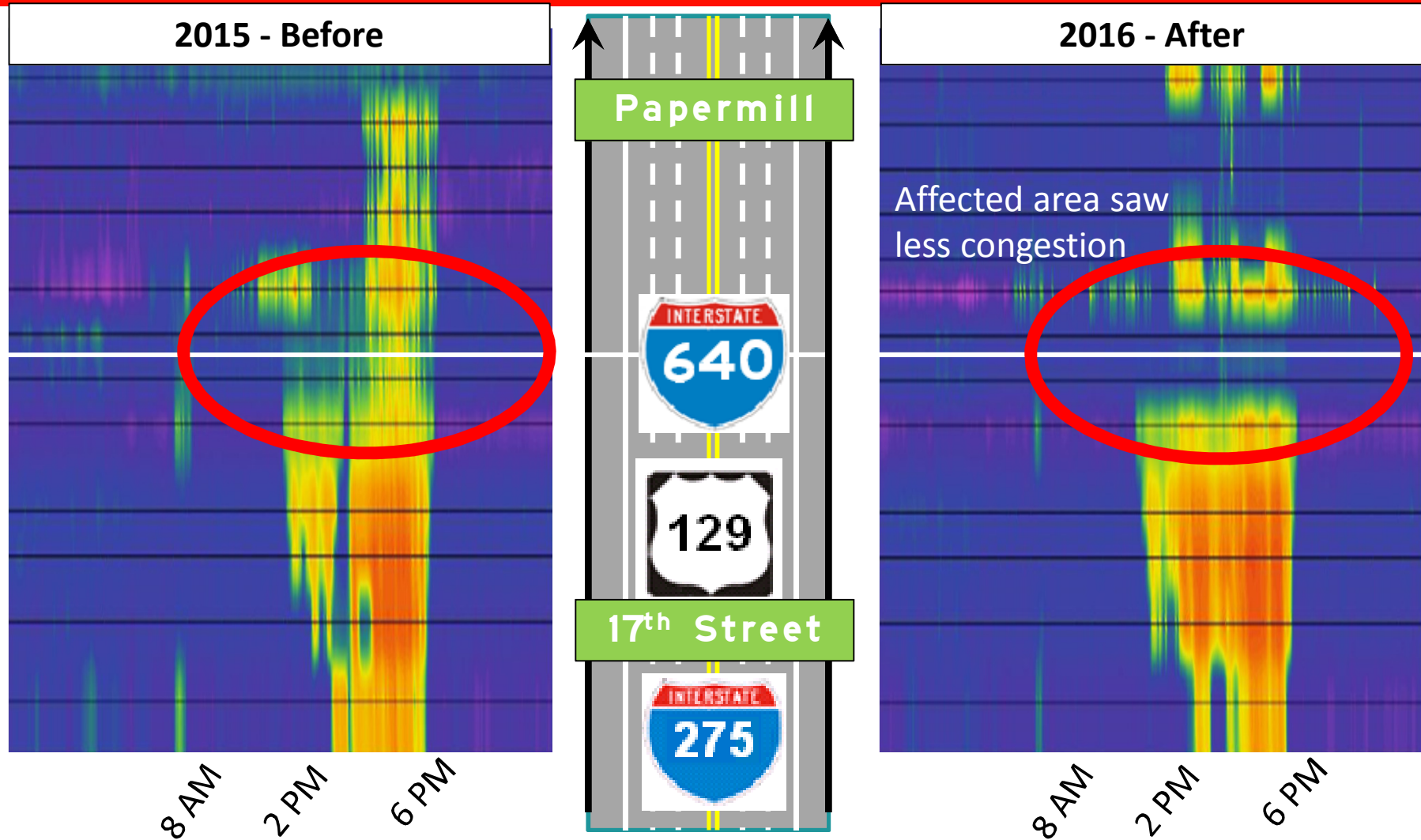


- 12 Horizontal lines from RDS data
- University of TN prepared 21 maps
 - 10 hours each
- Thanks to Dr. Lee Han, Mr. Bumjoon Bae and Mr. Brandon Whetsel

Measuring Effectiveness

Westbound I-40 with I-640

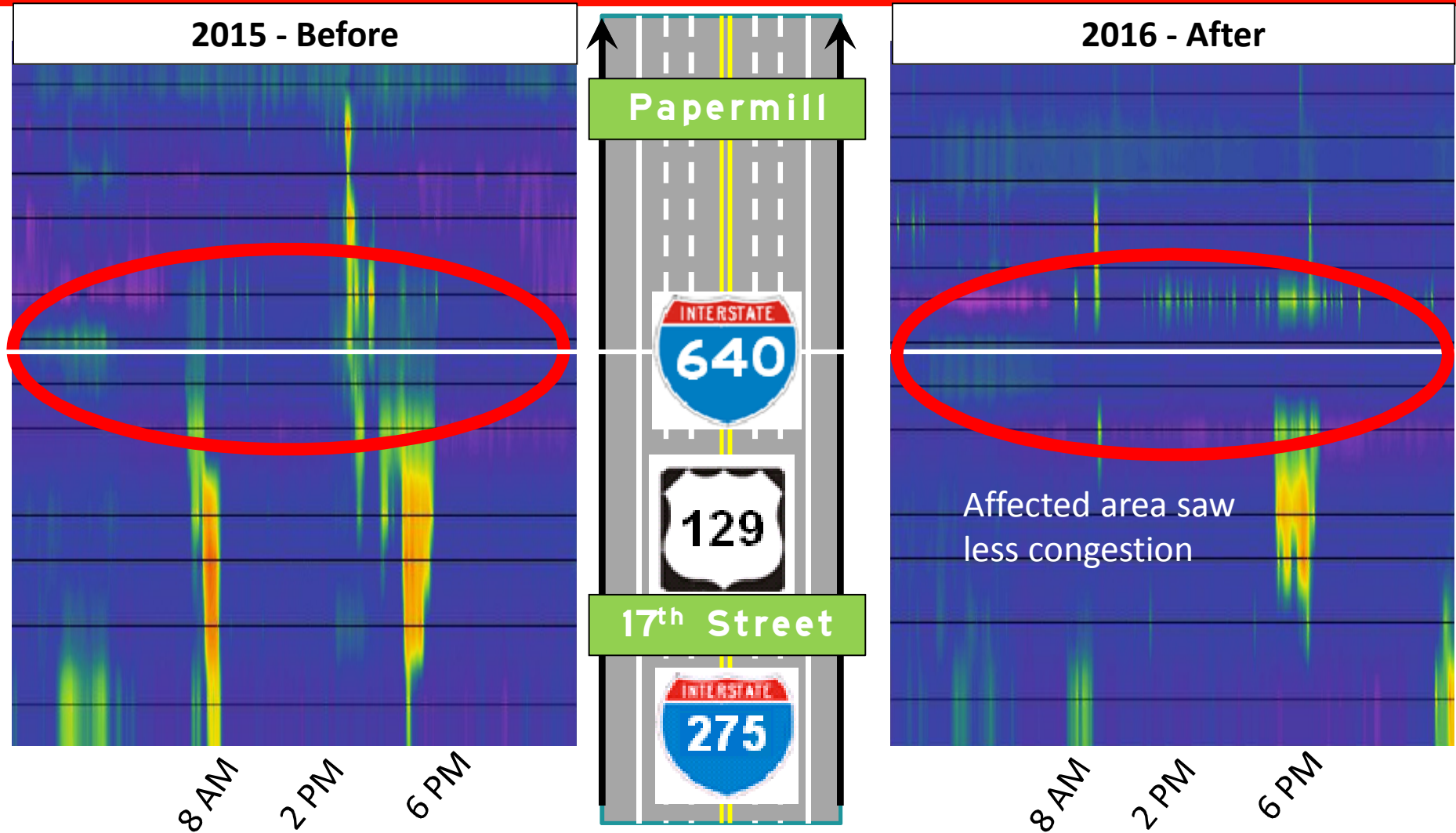
Friday Before Labor Day



Measuring Effectiveness

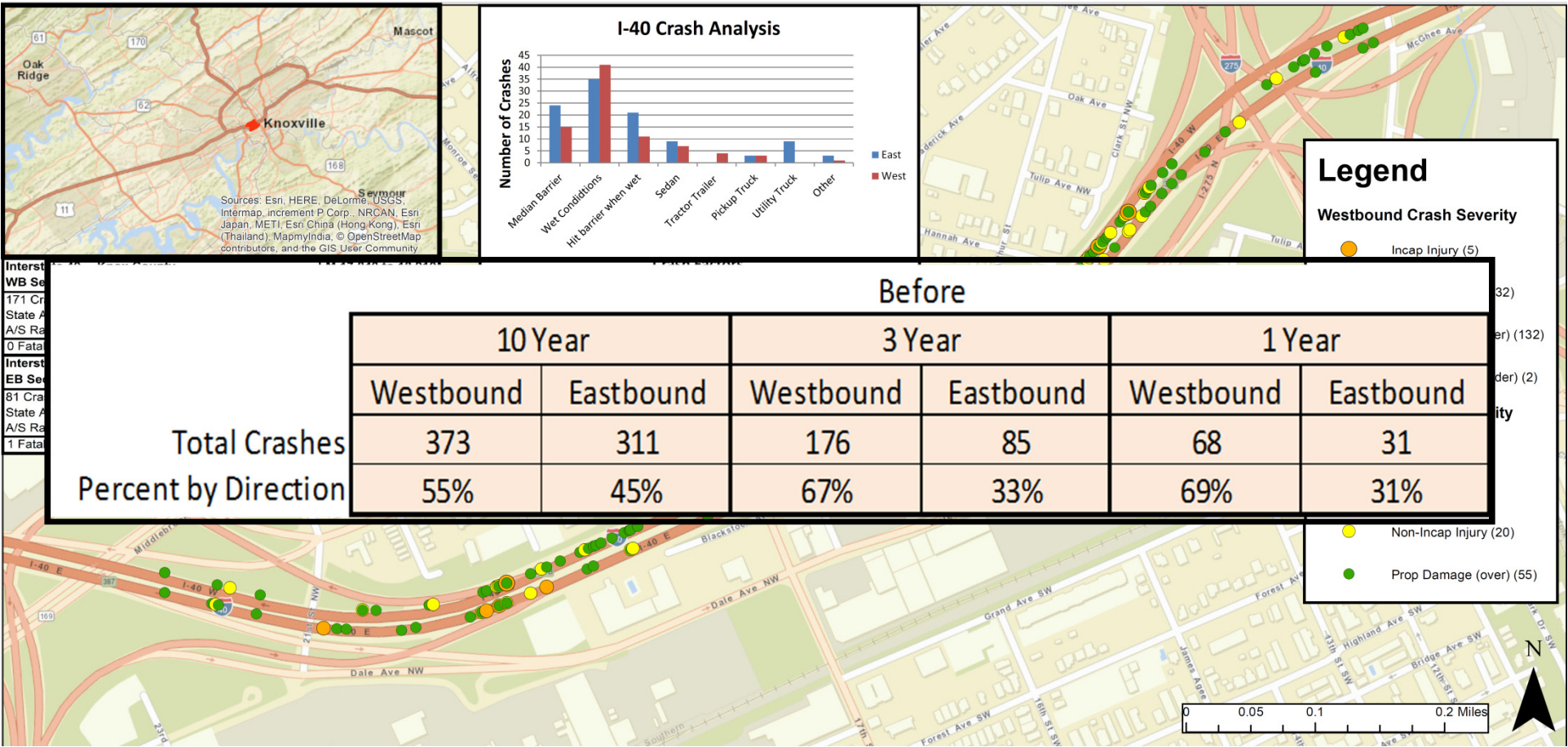
Westbound I-40 with I-640

Wednesday After Labor Day



Urban Bottleneck

I-40 between I-275 and US 129



Wooden Walls?



Before: I-40/I-275 to 17th Street

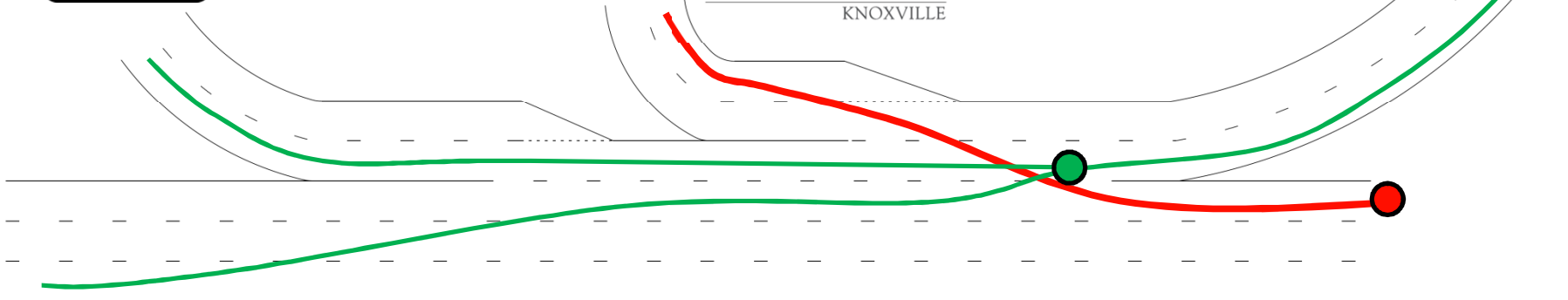
Minimum lane changes needed:
2 lane changes needed to exit on 17th Street



MCGHEE TYSON AIRPORT
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Not to scale



Before: I-40/I-275 to US 129, Alcoa Highway

Minimum lane changes needed:

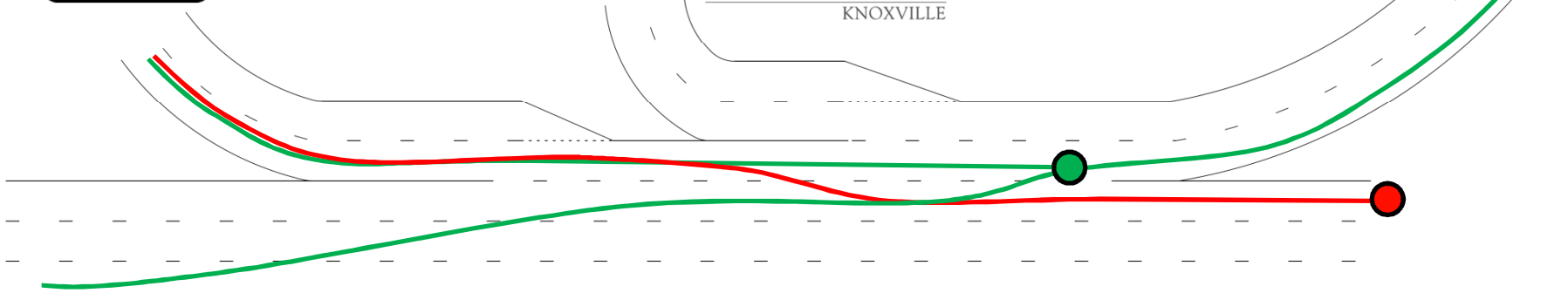
1 lane change needed to exit on US 129



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Before: I-40/I-275 to 17th Street



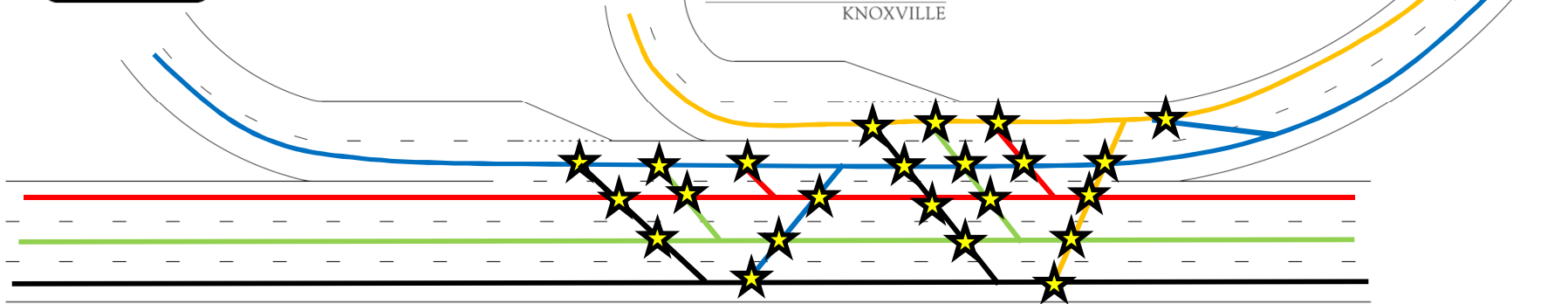
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Total Conflict Points: 23



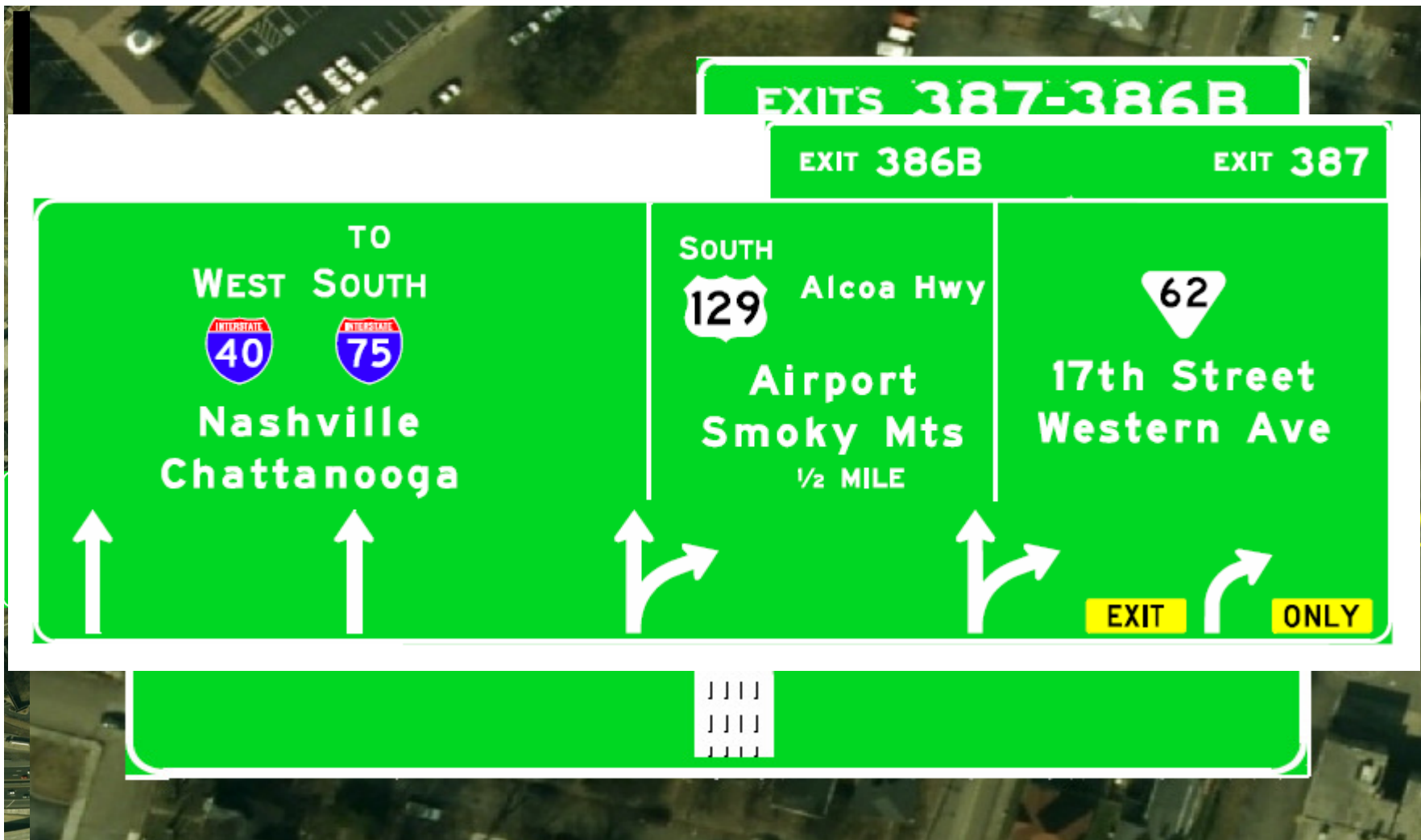
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I-40 Downtown Knoxville – Signing Plan



After: I-40/I-275 to 17th Street

Minimum lane changes needed:

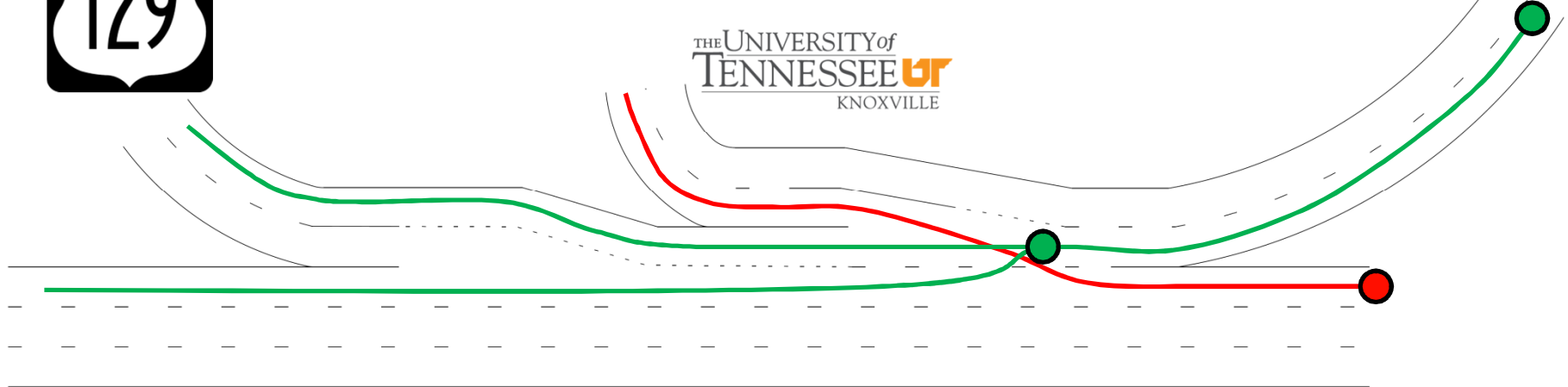
1 lane change needed to exit on 17th Street



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After: I-40/I-275 to US 129, Alcoa Highway

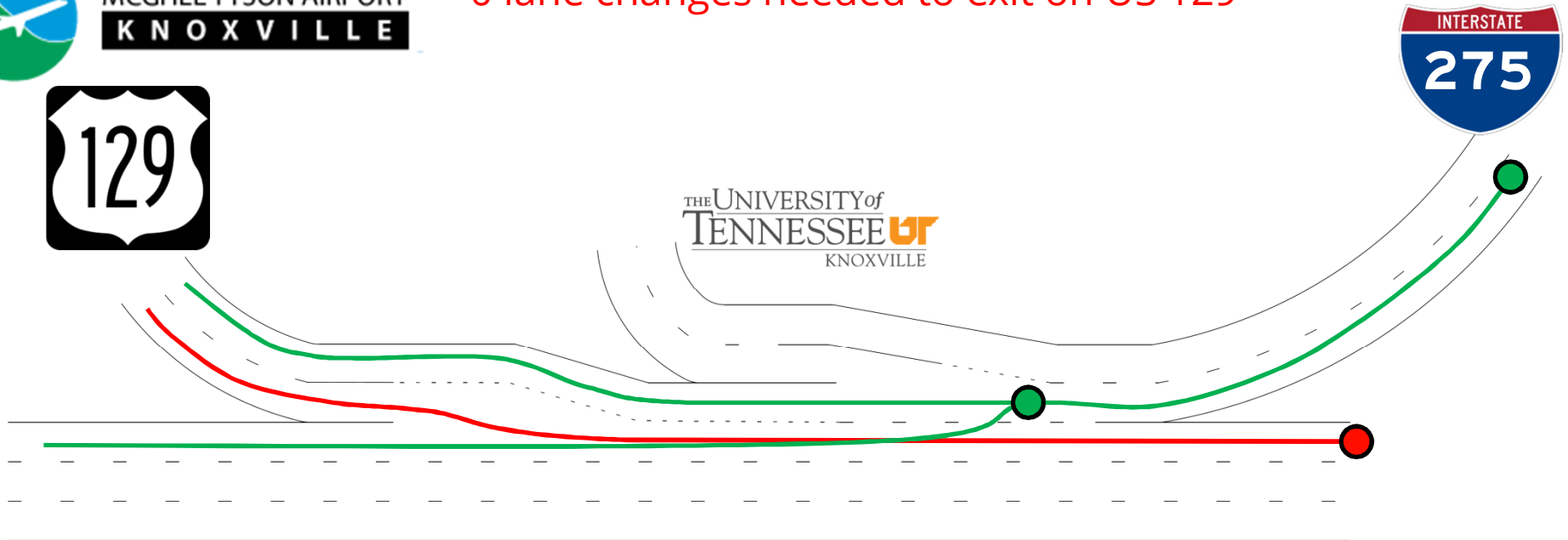
Minimum lane changes needed:
0 lane changes needed to exit on US 129



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Not to scale



After: I-40/I-275 to 17th Street

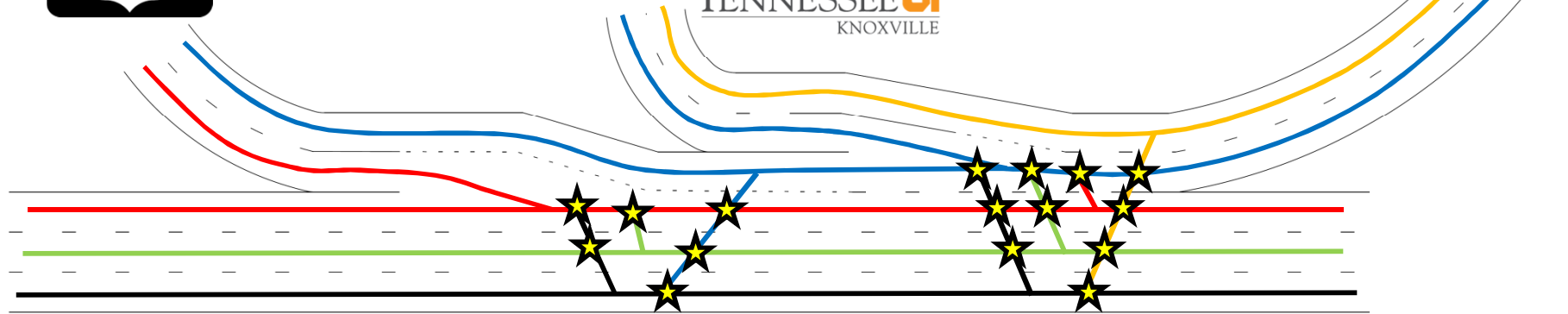


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Total Conflict Points: 16



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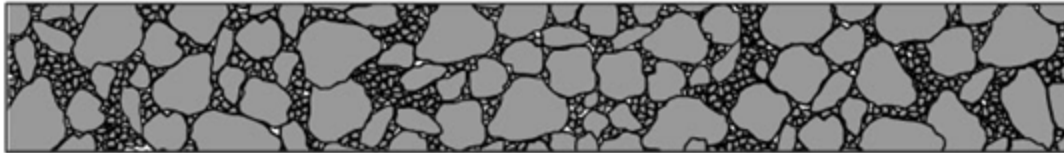


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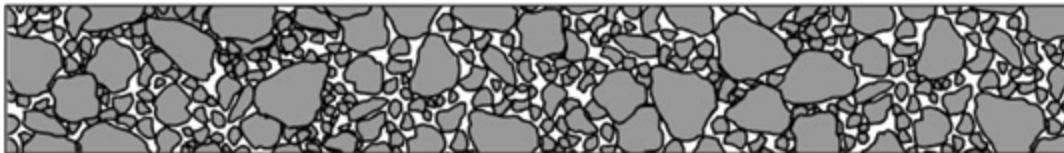


Open-Graded Friction Course, OGFC

- Reduces spray and surface water
- Increases friction
- Shorter pavement lifespan



Traditional Pavement



OGFC

Post Construction Photographs

Knoxville
NEWS SENTINEL
PART OF THE USA TODAY NETWORK



I-40 Downtown Knoxville - Flythrough

2015 - Before



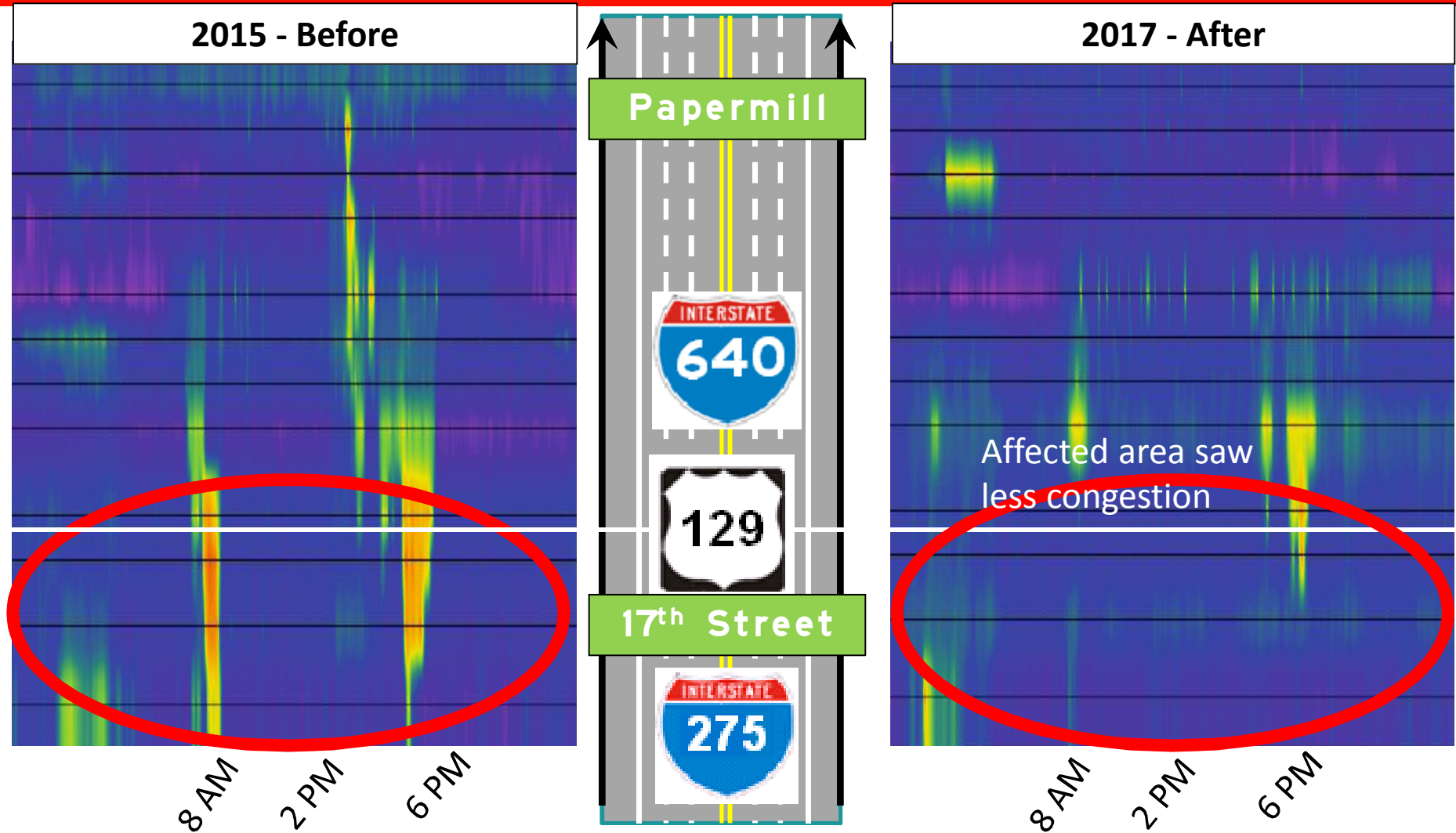
2017 - After



Measuring Effectiveness

I-40 between I-275 and US 129

Wednesday (September 2015 vs January 2017)

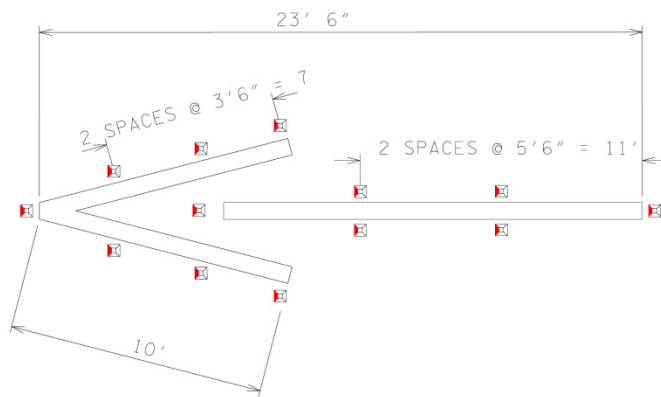


Project Summary

- **Time** - Less than 1 year from conception to construction
- **Cost** - \$2,022,939.90 for paving & \$55,076.64 for signs
- **Wet Weather Crashes**
 - Open Graded Friction Course
- **Simplified Decision Making**
 - Improved Guide Signs
 - Pavement Shields
 - Option Lanes – Longer Time for Decision
- **Improving Interchange**
 - Reducing Conflicts & Lane Changes
 - Option Lanes
 - Changed without Widening

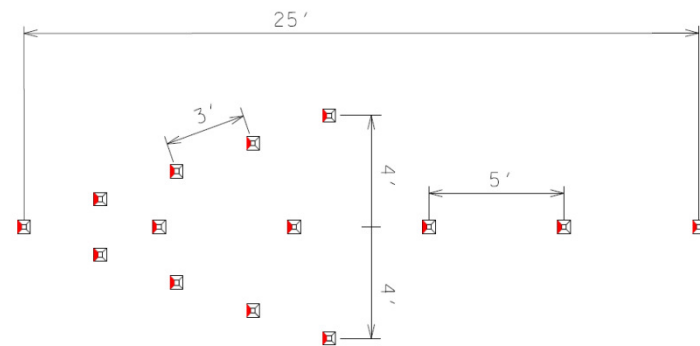
Study Period		Westbound Crashes	
		Yearly Average	Percentage Change
After	242 days	28.7	-57.9%
	1-year	68.0	0.0%

Wrong Way Safety Solutions



13 BI-DIRECTIONAL RED AND WHITE SPMS

WRONG WAY PAVEMENT ARROW WITH
SNOWPLOWABLE PAVEMENT MARKERS TO
BE USED ON SINGLE-LANE RAMPS ONLY



14 MONO-DIRECTIONAL RED ONE-DIRECTIONAL SPMS

WRONG WAY ARROW USING SNOWPLOWABLE
PAVEMENT MARKERS TO BE USED ON
MULTI-LANE RAMPS ONLY

Wrong Way Safety Solutions





Thank you