



Human Factors in Traffic Engineering

Bryan Bartnik, P.E.

Agenda



Fatality Trends in Tennessee

Distracted Driving

Impaired and Drowsy Driving

Connected & Autonomous Vehicles

Project Discussion

Agenda



Fatality Trends in Tennessee

Distracted Driving

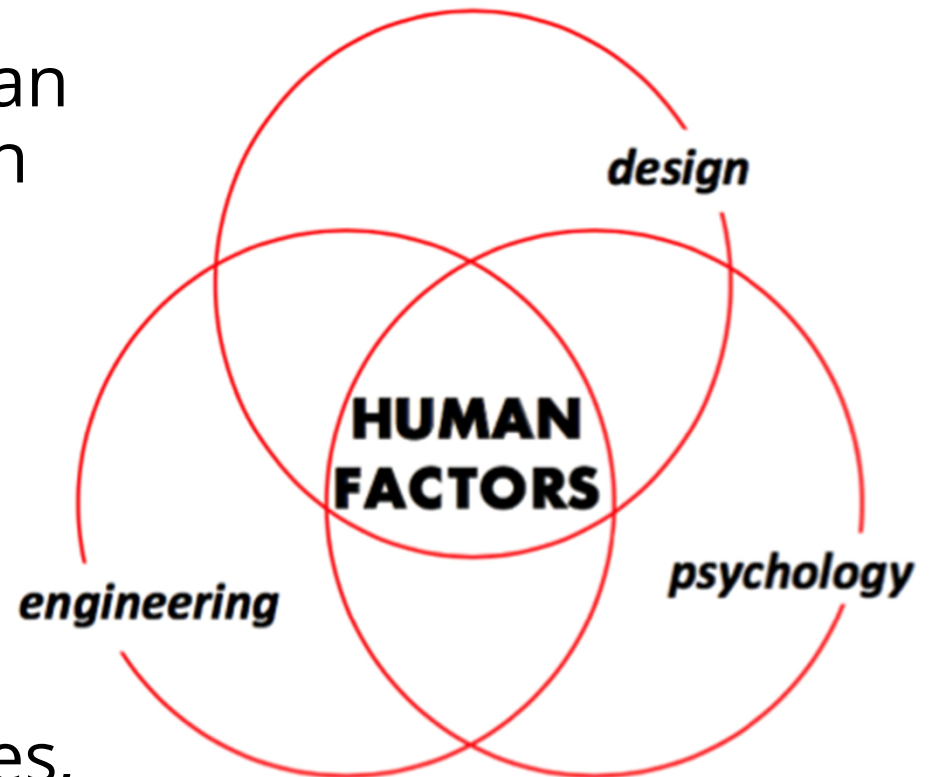
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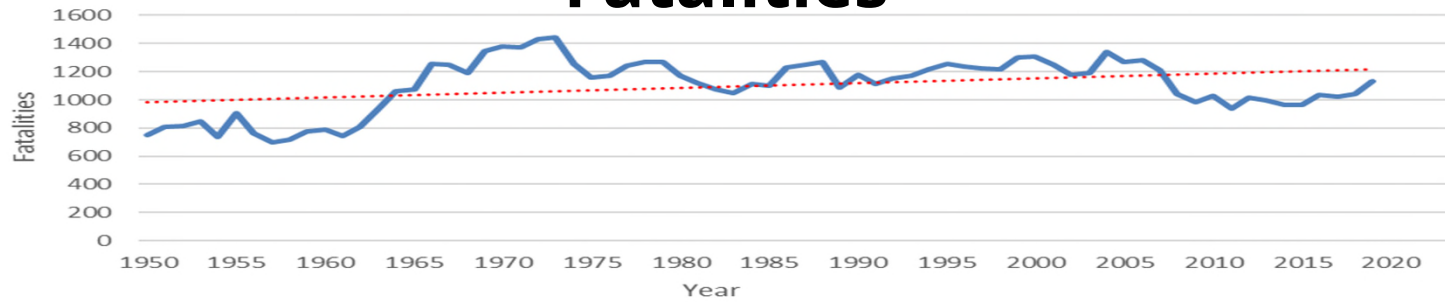
Human Factors

- The application of knowledge about human abilities, limitations, and other human characteristics to the design of equipment, tasks, and jobs.
- Simply, designing and building around people.
- Why? In **over 90%** of crashes, the critical reason for the crash is driver behavior

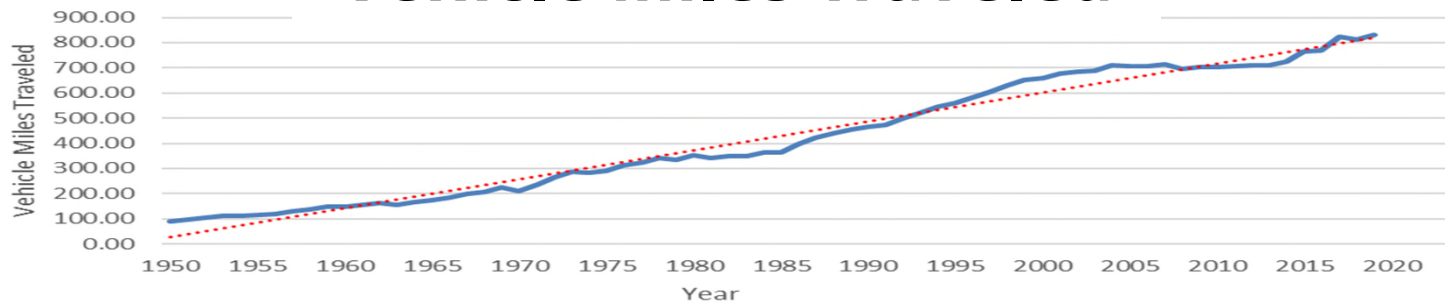


Fatality Trends in Tennessee – 1950 to 2018

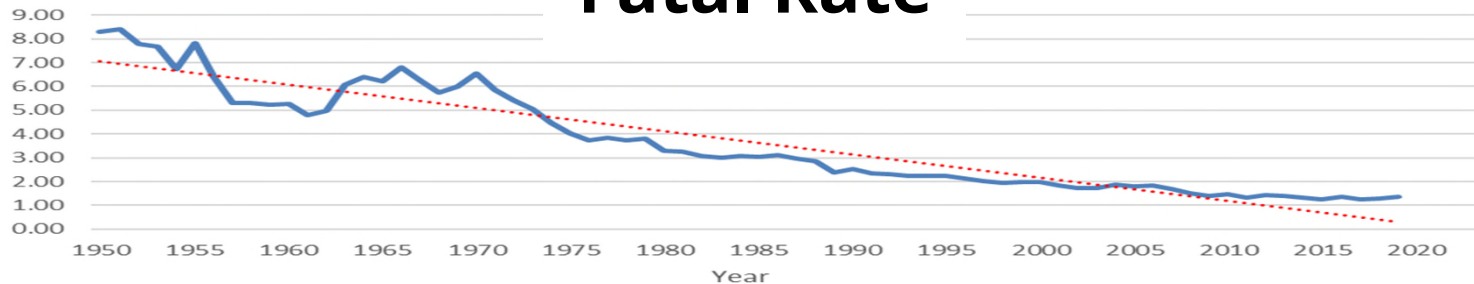
Fatalities



Vehicle Miles Traveled

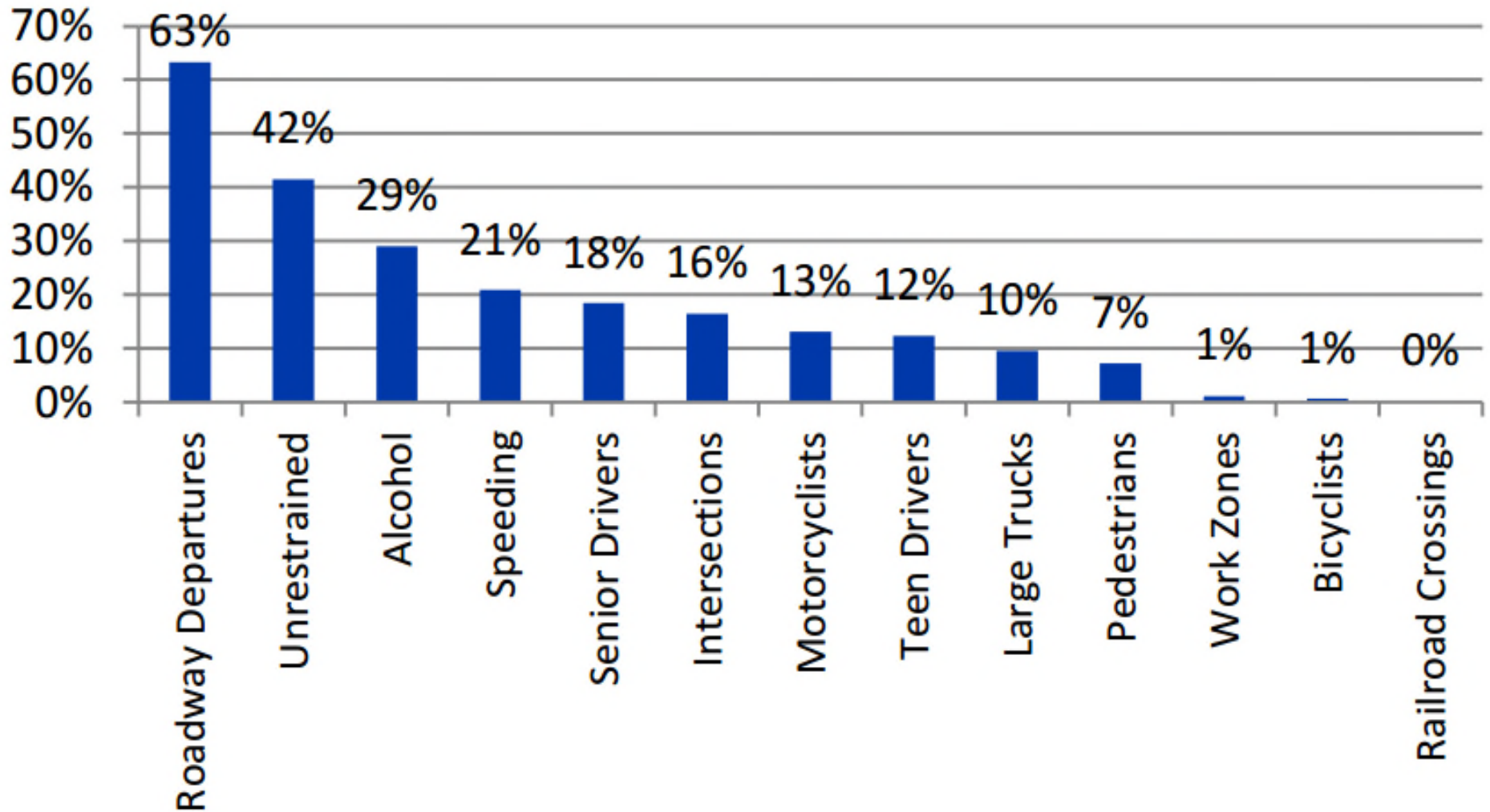


Fatal Rate



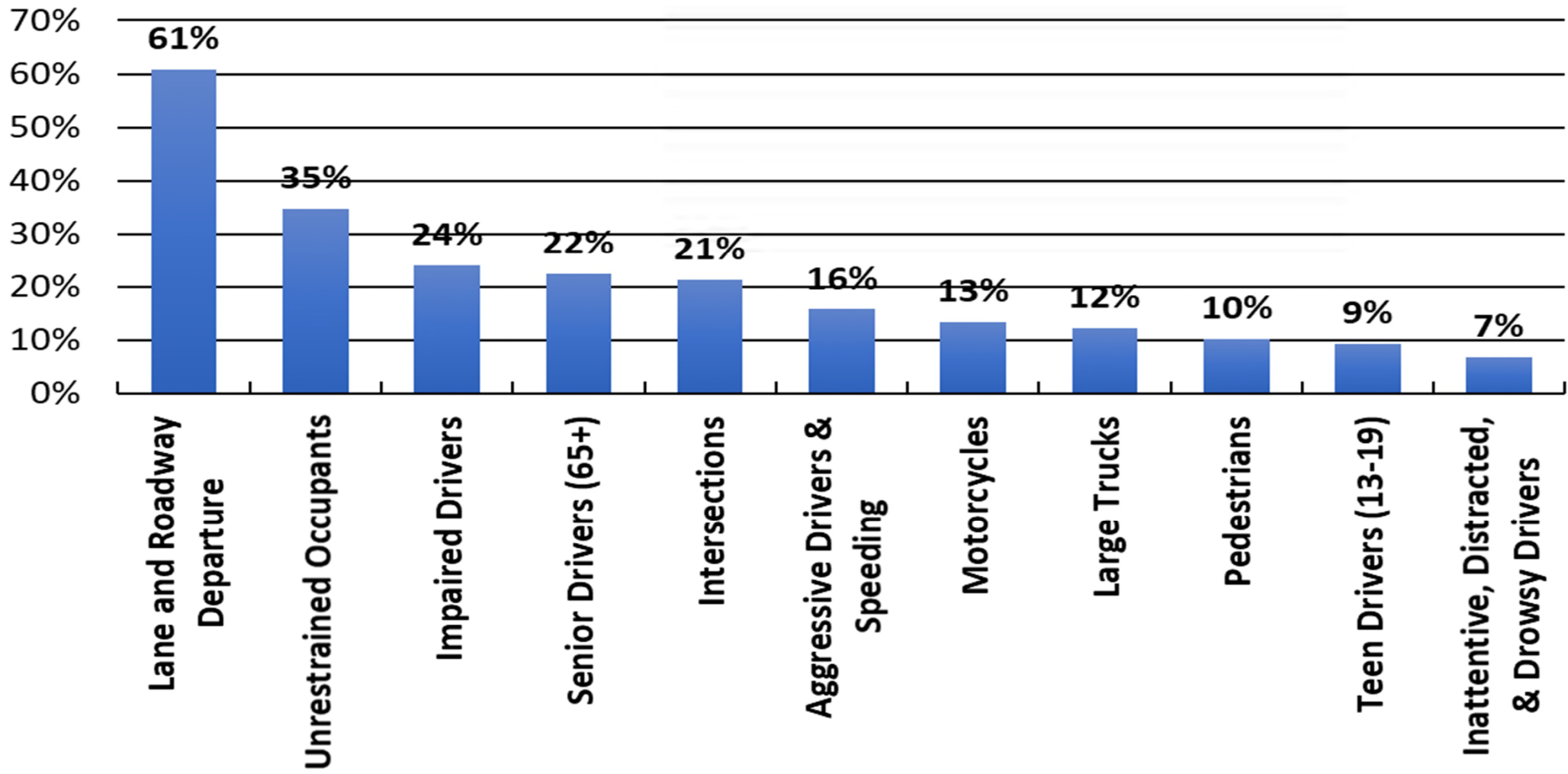
Fatality Trends in Tennessee – 2014 SHSP

Fatalities Percent of Total by Contributing Factor



Fatality Trends in Tennessee – 2020 SHSP

Fatalities Percent of Total by Contributing Factor



Agenda

- Fatality Trends in Tennessee
- Distracted Driving
- Impaired and Drowsy Driving
- Connected & Autonomous Vehicles
- Project Discussion

What is distracted driving?

There are **3** main types of distraction:

Visual

Taking your eyes off the road



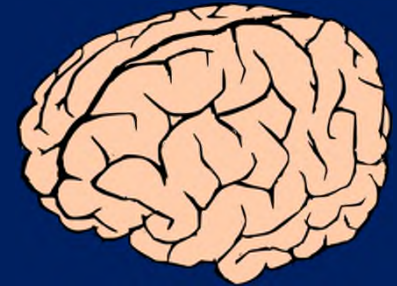
Manual

Taking your hands off the wheel



Cognitive

Taking your mind off what you're doing



Distracted Driving

Common distractions drivers face:

- Cell Phone
- Passengers
- Radio
- Food & Drinks
- Rubbernecking



Distracted Driving

- In 2019, distracted driving **killed 3,142** people and **injured 424,000** (NHTSA)
- **9%** of all drivers **younger than 20** involved in fatal crashes were reported to be distracted while driving (NHTSA)
- Using a cell phone while driving, either hand-held or hands-free, can delay a driver's reactions as much as having a blood alcohol concentration at or above the legal limit of .08%



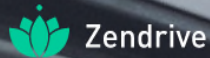
5 seconds...

Five seconds is the average time your eyes are off the road while texting. At 55mph, that's enough time to cover the length of a football field.



Source: 2009, VTTI

Zendrive Distracted Driving Study (April '18)



Platform Solutions ▾ Industries ▾ Resources ▾ Company ▾

Contact

Data Study

2018 snapshot: Distracted driving is 100x worse than thought

Distracted driving is far worse than we thought. How bad? 100 times worse than the most reliable data available. Zendrive's 2018 Distracted Driving Snapshot reveals that 69-million drivers use their phones behind the wheel every day, far higher than the 660,000 daily distracted drivers reported by government data.

We also know that we really shouldn't be playing with our phones while driving, as it contributes to 26 percent of all collisions. But until now, we didn't have accurate data on the extent of the problem. To mark Zendrive's 100-billionth mile of driver data analyzed, we tried to quantify how bad the distracted driving problem is in the US.

Zendrive Distracted Driving Study (April '18)

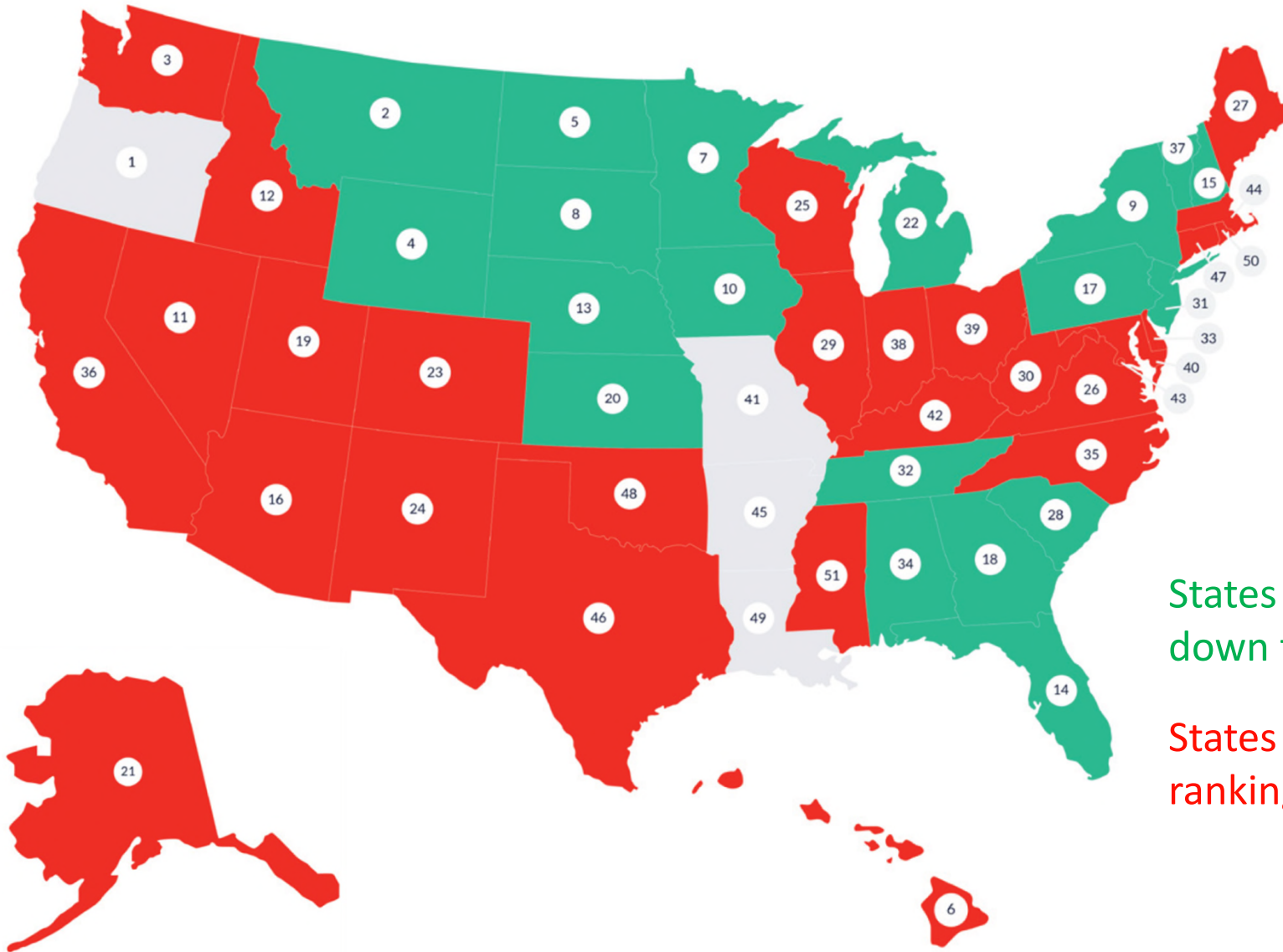
- 3 month study analyzing:
 - 7.1 billion vehicle miles traveled
 - 4.5 million drivers
- Determined that over 60% of people use their phones at least once on any trip
 - Talking / Calls
 - Texting
 - Checking / Sending Emails
 - Using Apps
- Average driver used the phone for **3.5 minutes per hour**



Zendrive

❖ Study assumes ALL use of cell phone is equally distracting

Zendrive Distracted Driving Study



Tennessee ranked as the 32nd most distracted state

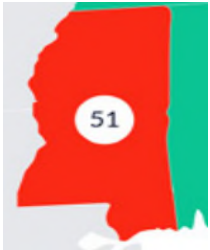
States in GREEN moved down the rankings

States in RED moved up the rankings

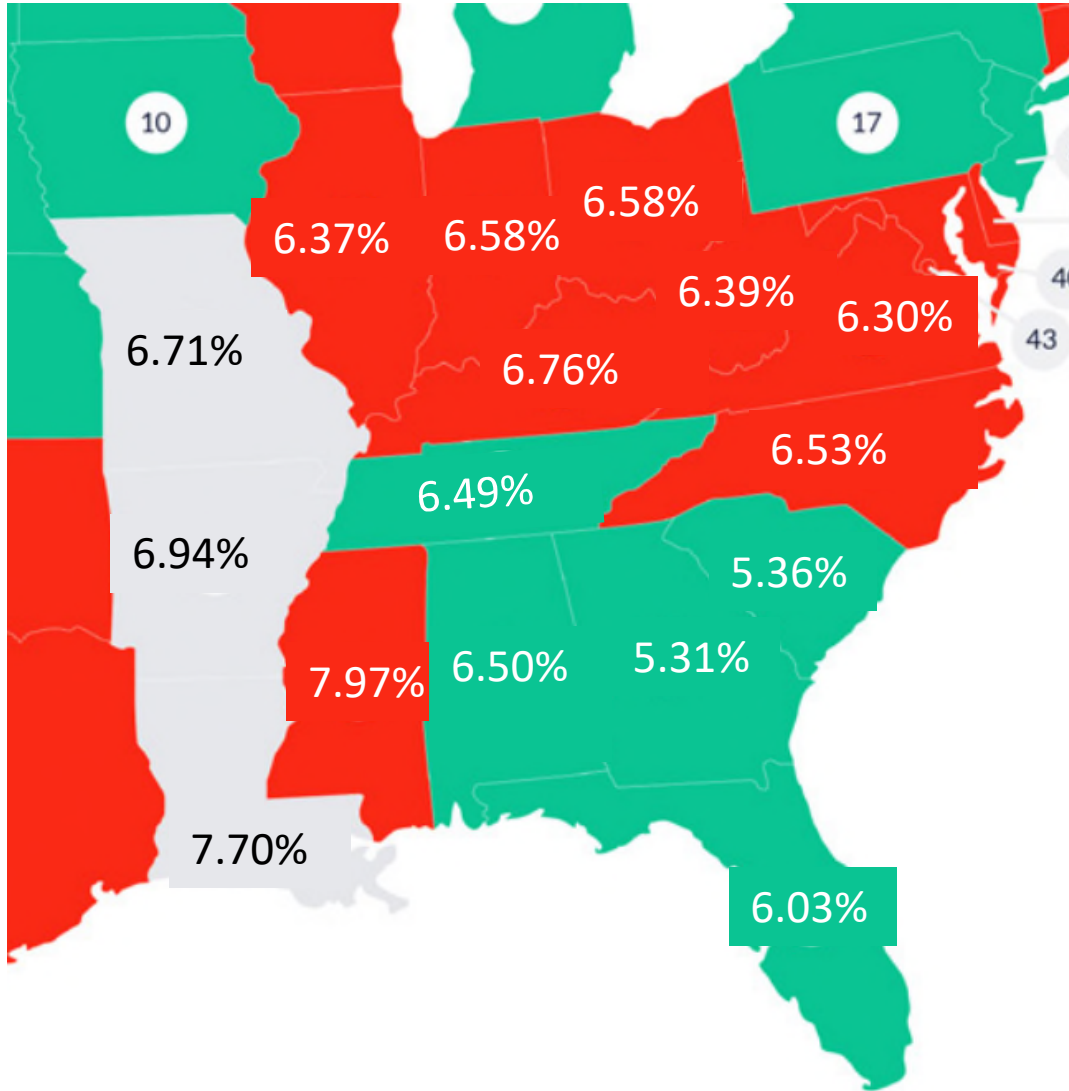
Zendrive Distracted Driving Study



Most Distracted:
Mississippi at **7.97%**



Least Distracted:
Oregon at **5.24%**



Average Percent of Time People Use Their Phone While Driving

Calculated by:

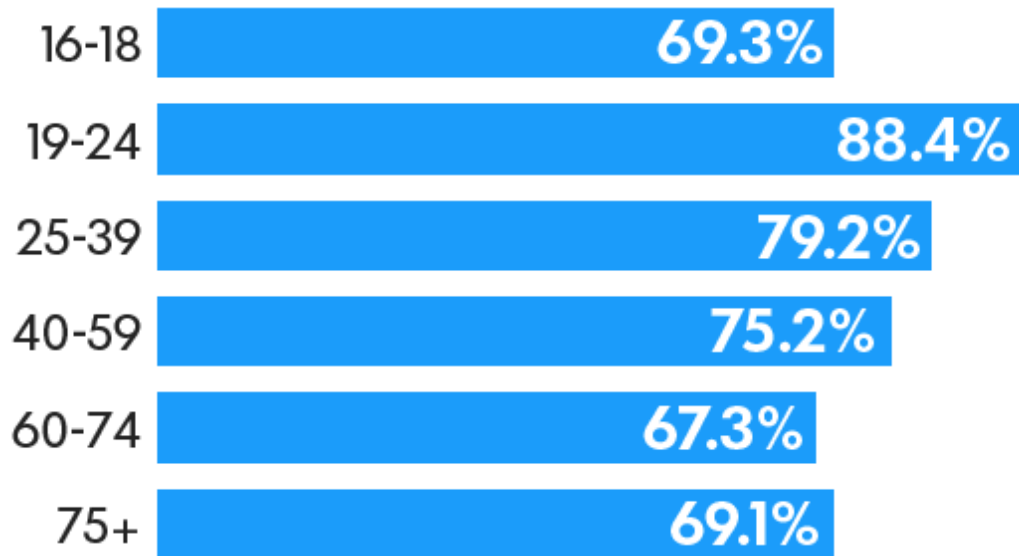
Average Daily Time Drivers Use a Phone

Average Daily Trip Time

Millennial Drivers – 2016 Study

RISKY BEHAVIOR ON THE ROAD

The percentage of drivers who reported speeding, red light running or texting while driving in the past 30 days, by age group:



SOURCE AAA Foundation for Traffic Safety survey of 2,511 licensed drivers, Aug. 25-Sept. 6

Frank Pompa, USA TODAY



The survey of **2,511** drivers from Aug. 25 through Sept. 6 by market research firm GfK found:

- Millennials acknowledged typing or sending a text or email while driving at nearly **twice the rate** of other drivers (59.3% to 31.4%).
- Nearly **half of Millennials** reported running a red light even if they could have stopped safely, compared with 36% of the rest of drivers.
- Nearly **12% of Millennials** said it was acceptable to speed 10 mph over the speed limit in a school zone, compared with 5% of other drivers.

Are you paying attention?

https://www.youtube.com/watch?v=IGQmdoK_ZfY&feature=emb_title

18

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Fatality Trends in Tennessee

Distracted Driving

Impaired and Drowsy Driving

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Project Discussion

Impaired Driving

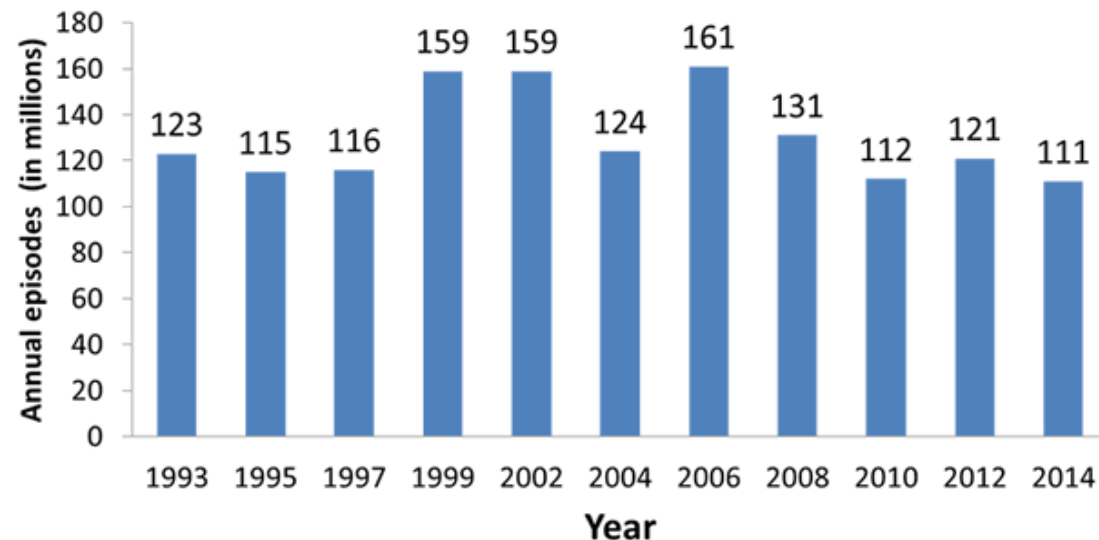
- Alcohol and some drugs are depressants. Depressants slow down the functioning of the brain and nervous system.
- The following skills and abilities become impaired:
 - Reaction Time
 - Multi-tasking
 - Comprehension
 - Attention Span
 - Tracking



Danger of Impaired Driving

- In 2019, there were 10,142 impaired driving fatalities **1 every 52 minutes**
- An average drunk driver has driven drunk **80 times** before first arrest.
- **1 in 3 people** will be involved in an alcohol related crash in their lifetime.
- In 2019, **28%** of fatal crashes involved impaired drivers

Annual Self-reported Alcohol-impaired Driving Episodes among U.S. Adults, 1993–2014



Drowsy Driving

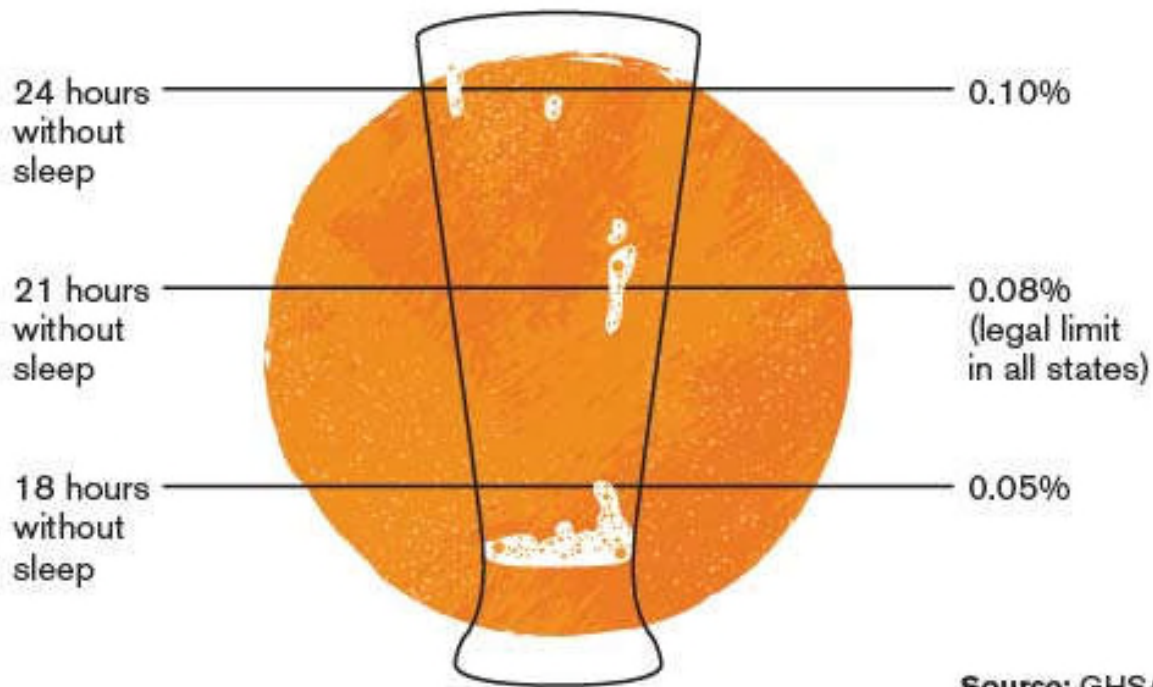
- About **1 in 25** adult drivers reported having **fallen asleep while driving** in the previous 30 days
- NHTSA (2017) estimates related to drowsy driving
 - 91,000 crashes
 - 50,000 injuries
 - 800 deaths
- Warning signs of drowsy driving
 - Yawning or blinking frequently
 - Missing your exit
 - Drifting from your lane



Effects of Drowsy Driving

- Going too long without sleep mimics the effects of alcohol on the body
 - Being awake for 18 hours is roughly equivalent to a BAC of 0.05%
 - Being awake for 24 hours is roughly equivalent to a BAC of 0.10%

Lack of sleep mimics blood alcohol concentration



How to Avoid Drowsy Driving



- Get enough sleep and build a healthy sleep schedule
 - Treat any sleep disorders with your doctor
- Plan your trip ahead of time
- Avoid alcohol, downers, or prescription medications that make you tired
- Stop in a safe place, get out of the vehicle and move around
- Stop in a safe place and take a nap

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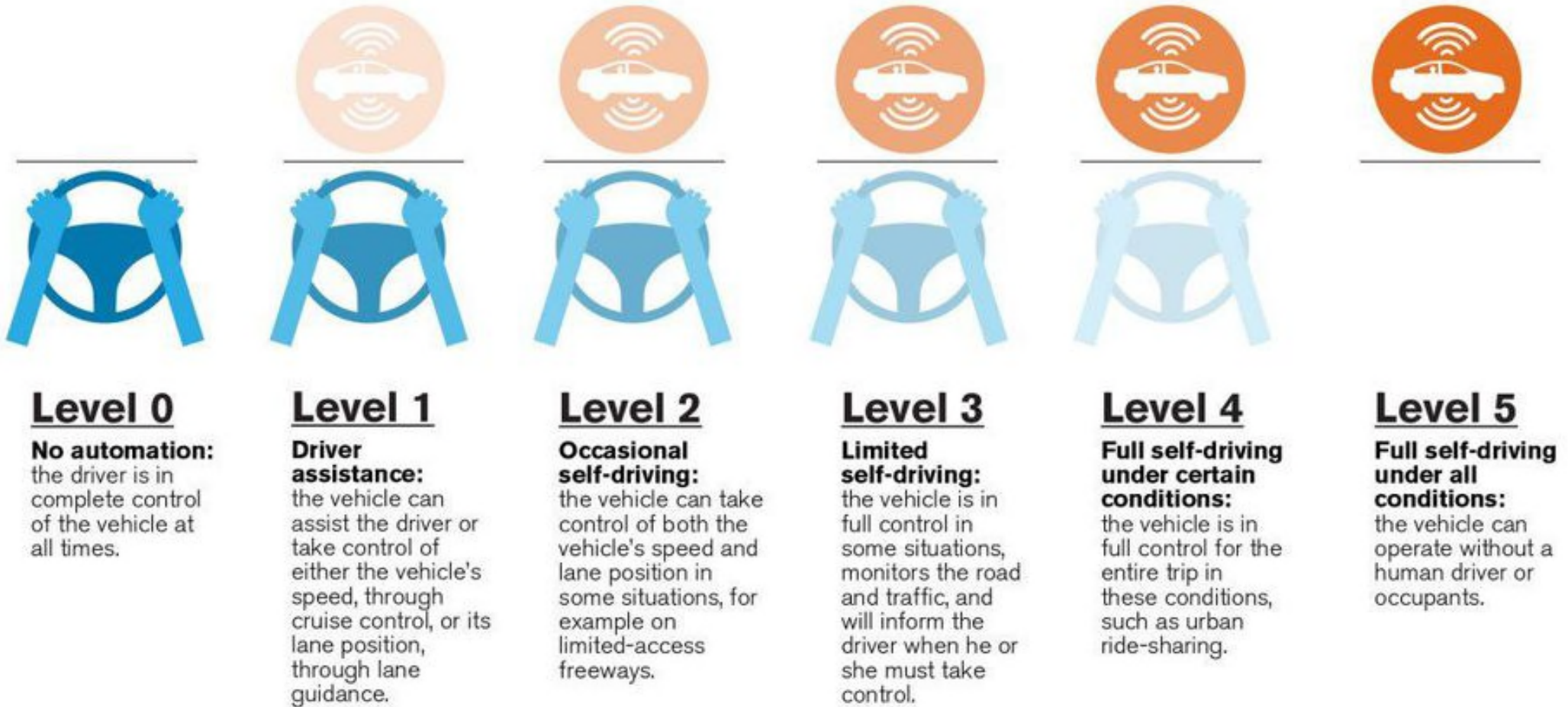
Connected & Autonomous Vehicles

Project Discussion

Connected & Autonomous Vehicles

- Connected Vehicle Communication Types
 - V2I – vehicle to infrastructure
 - V2V – vehicle to vehicle
- Features of Connected Vehicles
 - Transmit signals around your vehicle that can “see” and talk to other vehicles and infrastructure
 - Allows for in vehicle warnings of various features
 - Unexpected roadway conditions
 - Horizontal curves
 - Intersections
 - Congestion

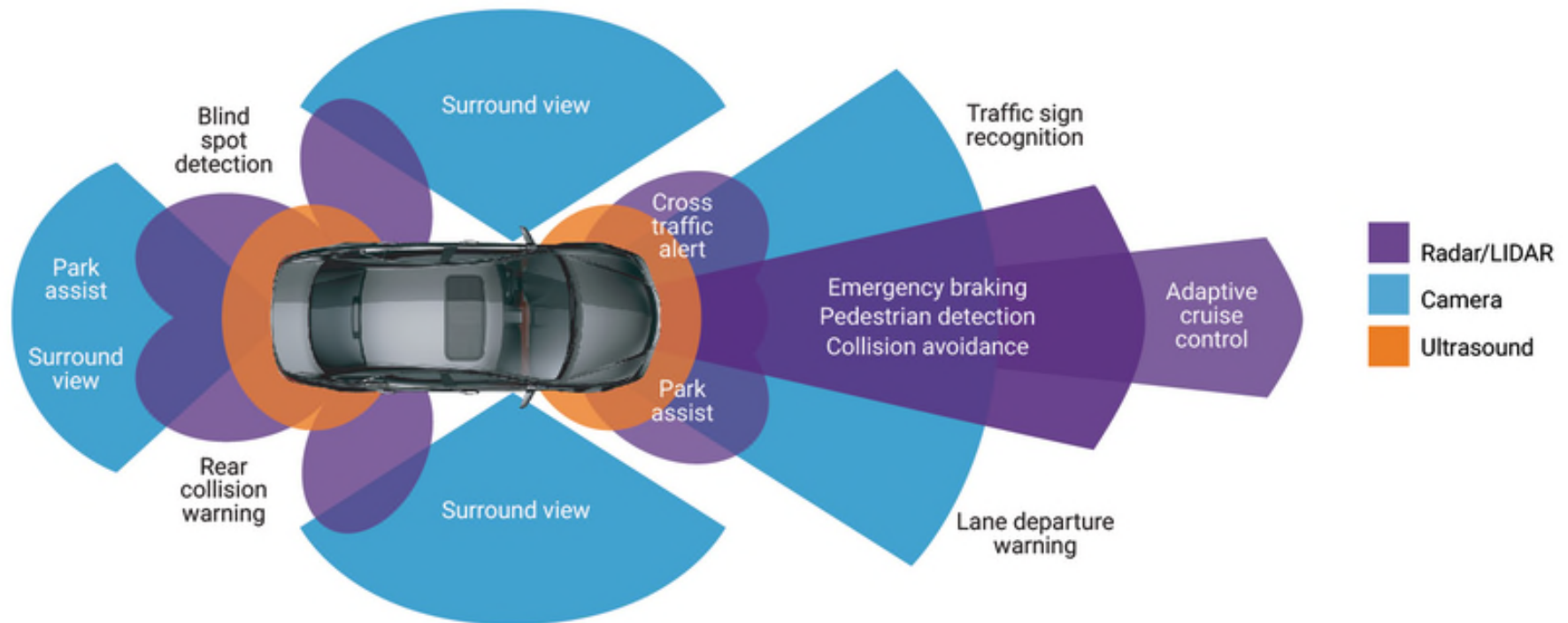
Levels of Autonomy



Source: SAE & NHTSA

Level 2 – Partial Automation

- Adaptive cruise control
- Lane keeping assist
- Blind spot detection
- Automatic emergency braking



Benefits of CAVs: “The Simple Solution to Traffic”



https://www.youtube.com/watch?v=iHzzSao6ypE&ab_channel=CGPGrey

Timeline of CAV Impacts

- Autonomous Vehicle Implementation Predictions
Implications for Transport Planning – April 15, 2022
 - <https://www.vtpi.org/avip.pdf>
- Level 5 Autonomous may be commercially available by the late 2020s
 - High costs and limited performance
- Independent mobility for affluent non-drivers may begin in the 2030s
- Additional benefits (reduced congestion, increased safety, energy conservation, etc.) likely to be seen after CAVs become more affordable in the 2040s to 2060s

Issues with CAVs

- Construction Areas
- Roadway Surfaces (Pot Holes)
- Several automotive manufacturers are working on completely autonomous vehicles.
 - May not be consistent

This technology is unable to operate by faded lane markings, damaged signs or signals, and the many inconsistencies found on the majority of our roadways.



Steps TDOT is Taking to Prepare for CAVs

- Improving Maintenance Areas/Work Zones
 - Avoid potential confusing markings – tar crack seals, eradicated markings
 - Perform a daytime assessment of pavement marking contrast
 - Consider dry and wet retro levels
- Improve Pavement Marking Inspections Statewide



Steps TDOT is Taking to Prepare for CAVs

- Moving towards a 6' line
 - All new projects/resurfacings include 6" lines
 - Retrace contract working to transition other routes to 6" lines
- Ensuring uniformity in signs and pavement markings
 - Increase consistency in Pavement Marking
 - Dotted lines
 - Gore markings
 - Treatments to designate special treatments including HOV, bike etc.
 - Shapes of arrows and other horizontal signing treatments
 - Increased consistency in sign inspection and maintenance programs

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The logo consists of a red square containing the letters 'TN' in white, serif font. Below the red square is a thin, dark blue horizontal bar.

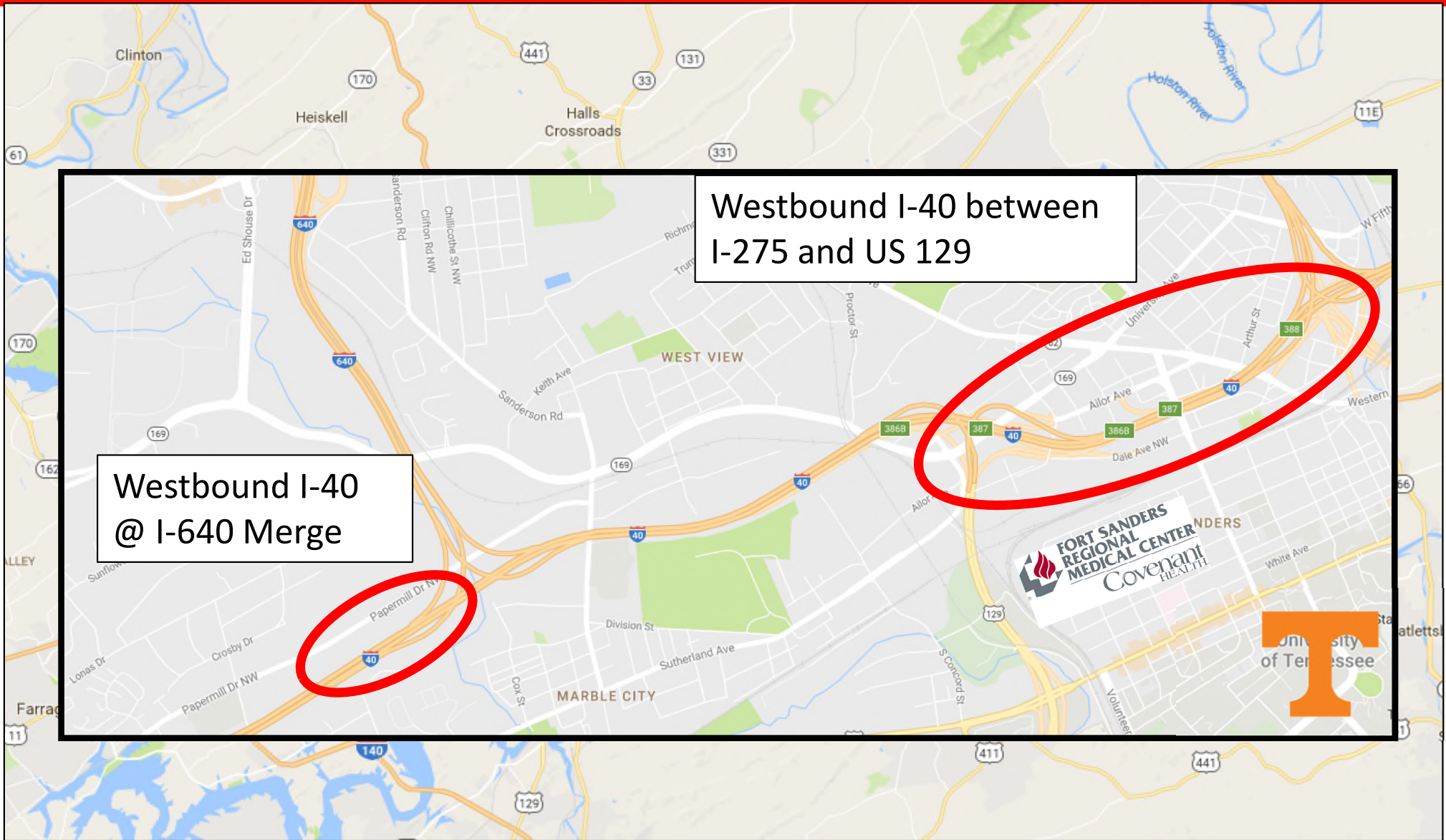
TN

TM

Urban Bottlenecks

Urban Bottlenecks

Knoxville Area

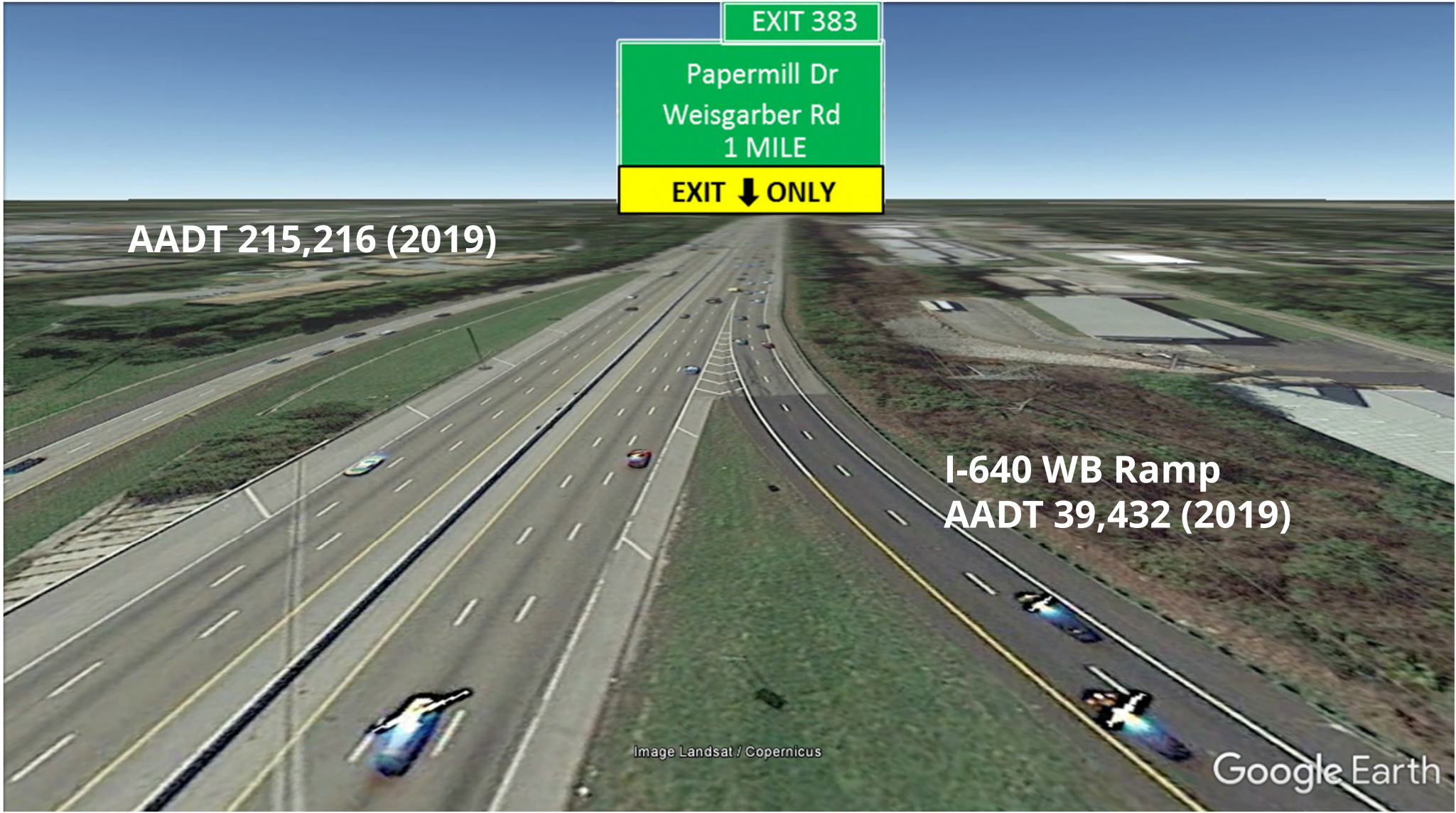


Urban Bottleneck

I-40 with I-640

Before

Westbound Merge



AAADT 215,216 (2019)

I-640 WB Ramp
AAADT 39,432 (2019)

Image Landsat / Copernicus

Google Earth

Urban Bottleneck

I-40 with I-640

After

Westbound Merge

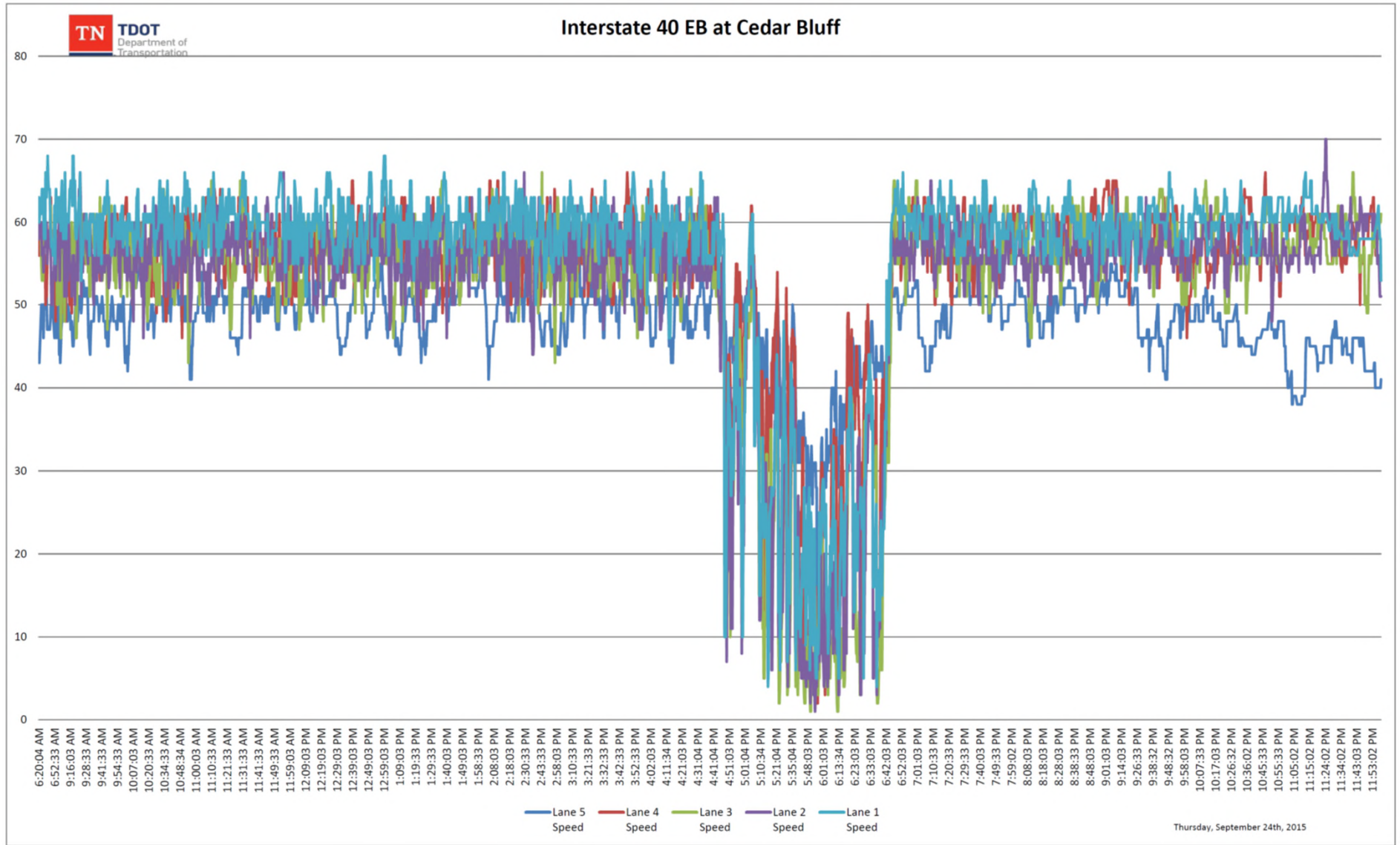


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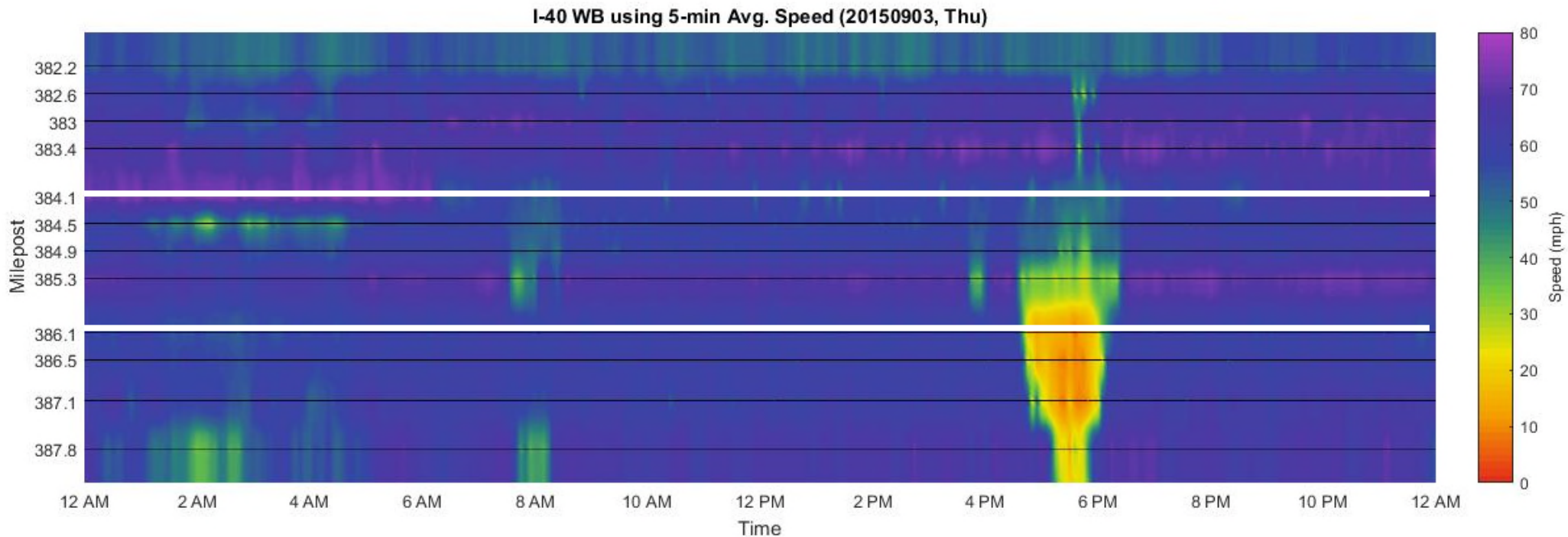
Measuring Effectiveness

RDS Speed Data



Measuring Effectiveness

Speed Heat Map



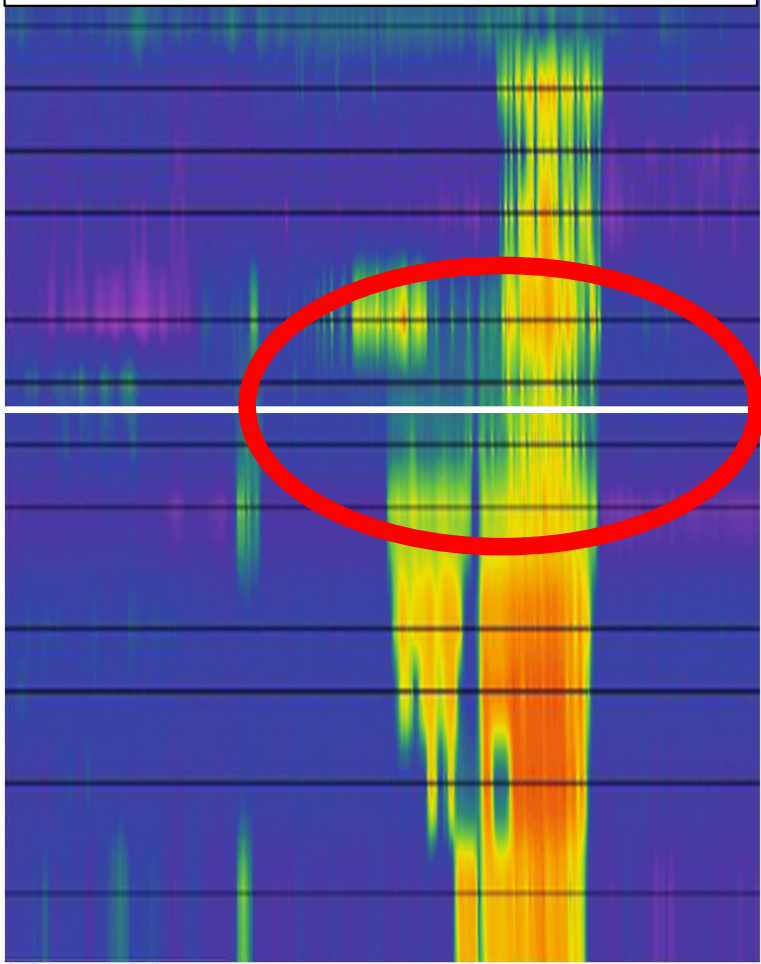
- 12 Horizontal lines from RDS data
- University of TN prepared 21 maps
 - 10 hours each
- Thanks to Dr. Lee Han, Mr. Bumjoon Bae and Mr. Brandon Whetsel

Measuring Effectiveness

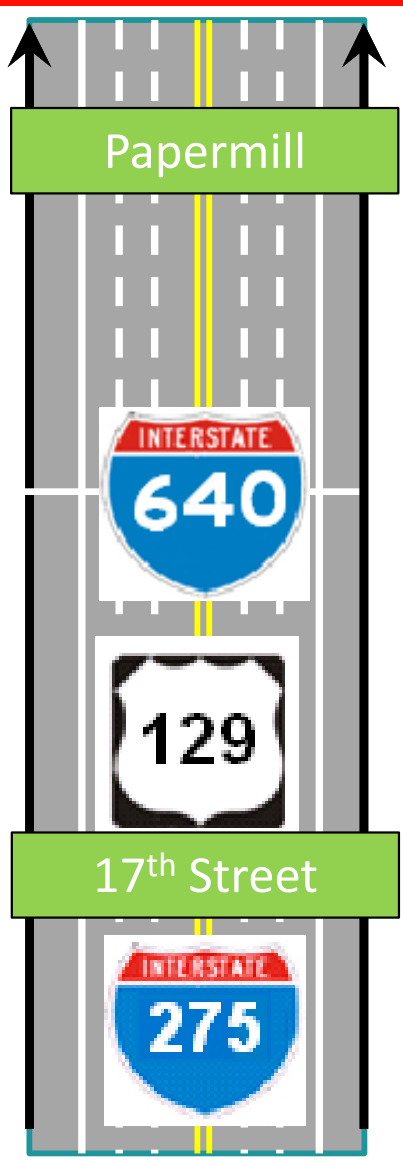
Westbound I-40 with I-640

Friday Before Labor Day

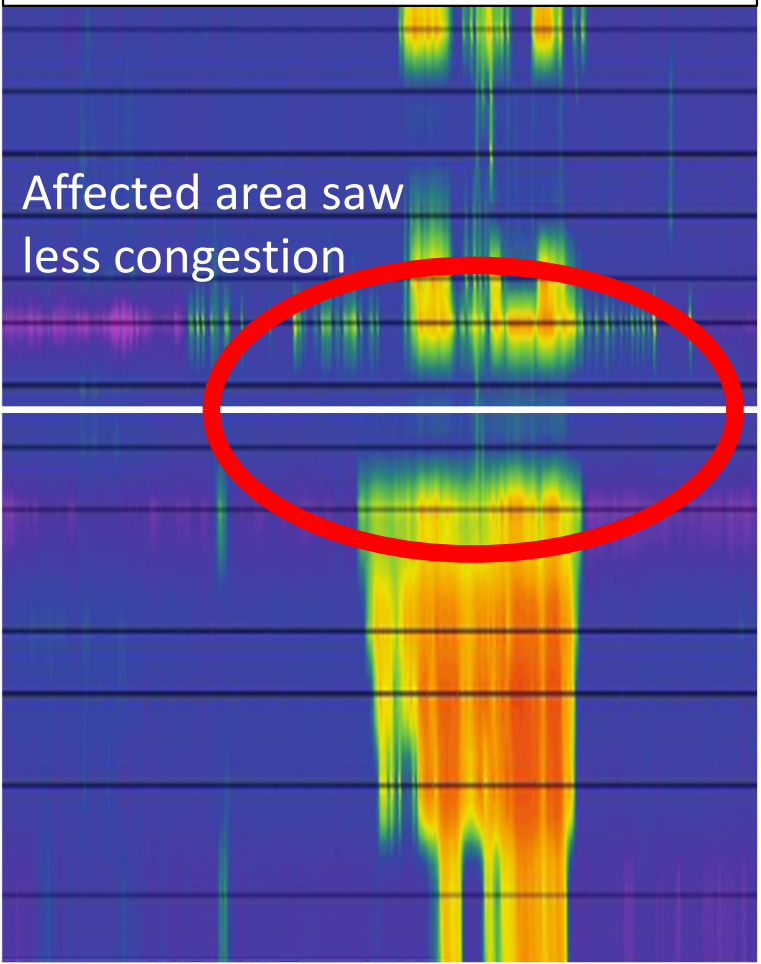
2015 - Before



8 AM
2 PM
6 PM



2016 - After



Affected area saw less congestion

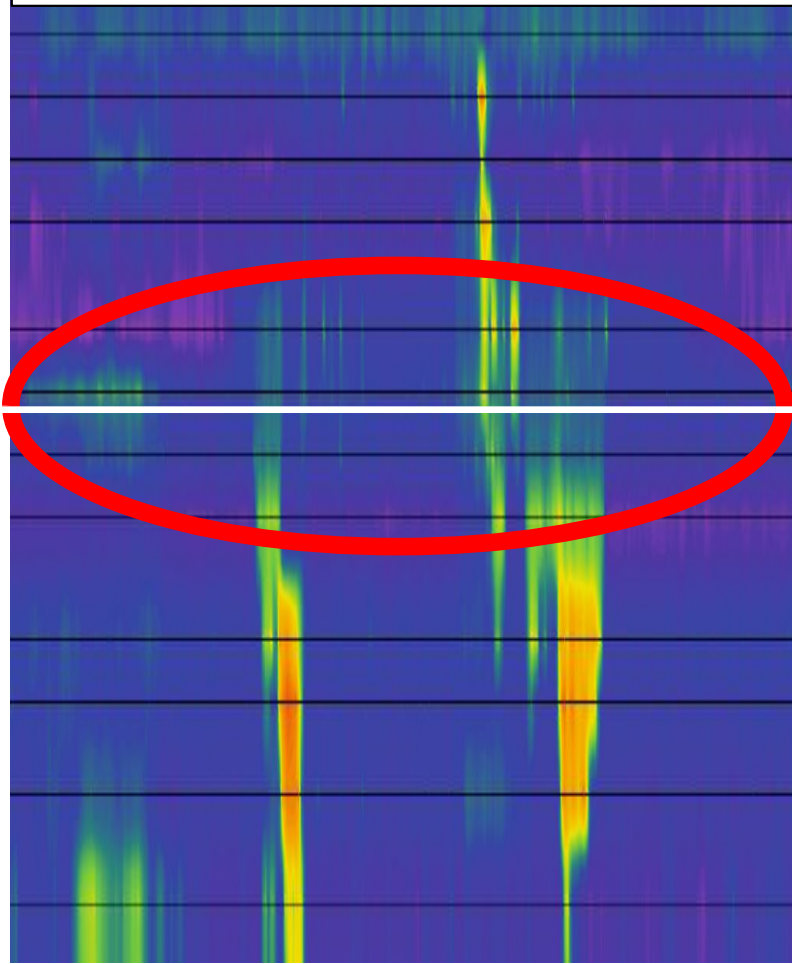
8 AM
2 PM
6 PM

Measuring Effectiveness

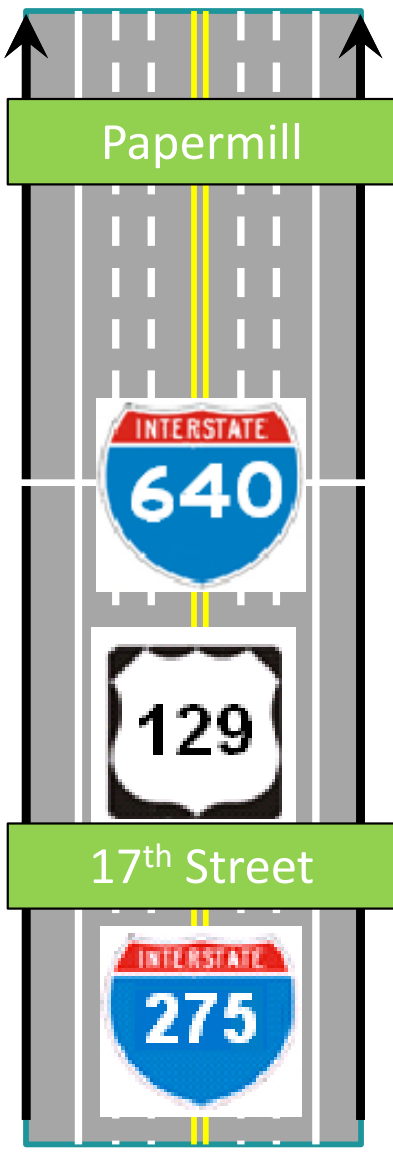
Westbound I-40 with I-640

Wednesday After Labor Day

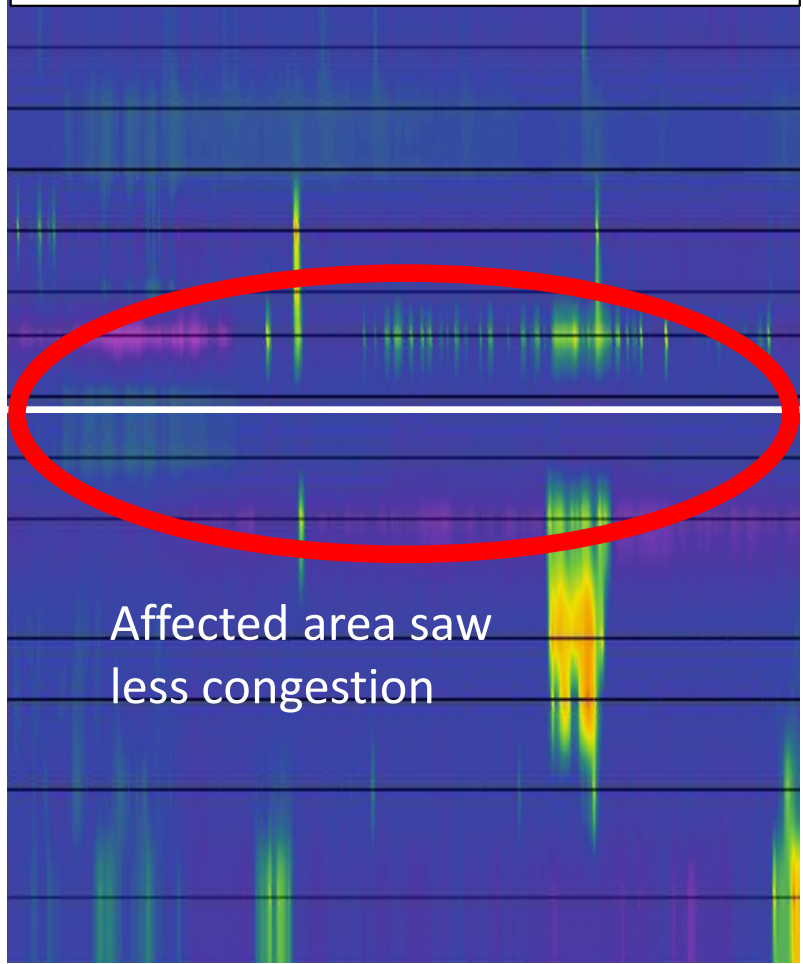
2015 - Before



8 AM
2 PM
6 PM



2016 - After



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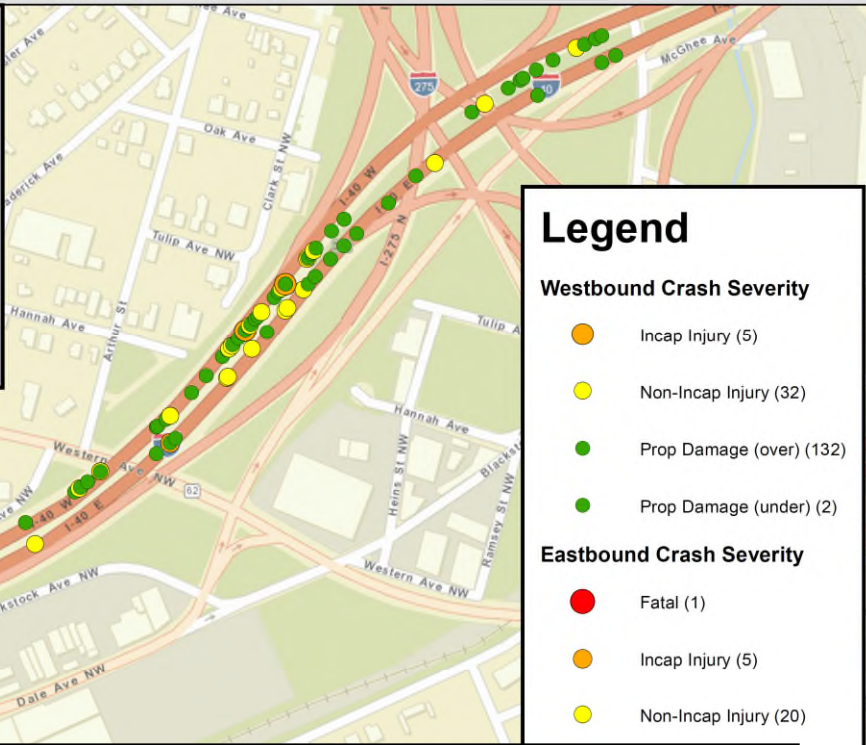
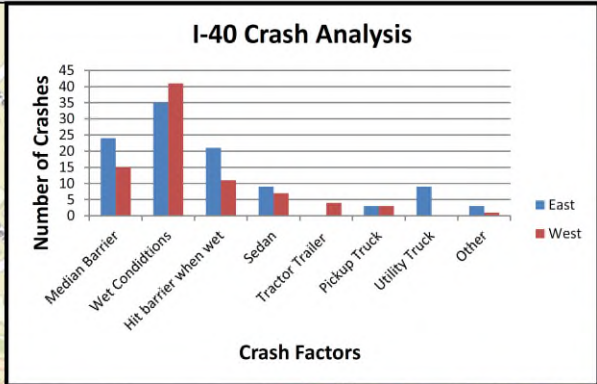
8 AM
2 PM
6 PM

Urban Bottleneck

I-40 between I-275 and US 129



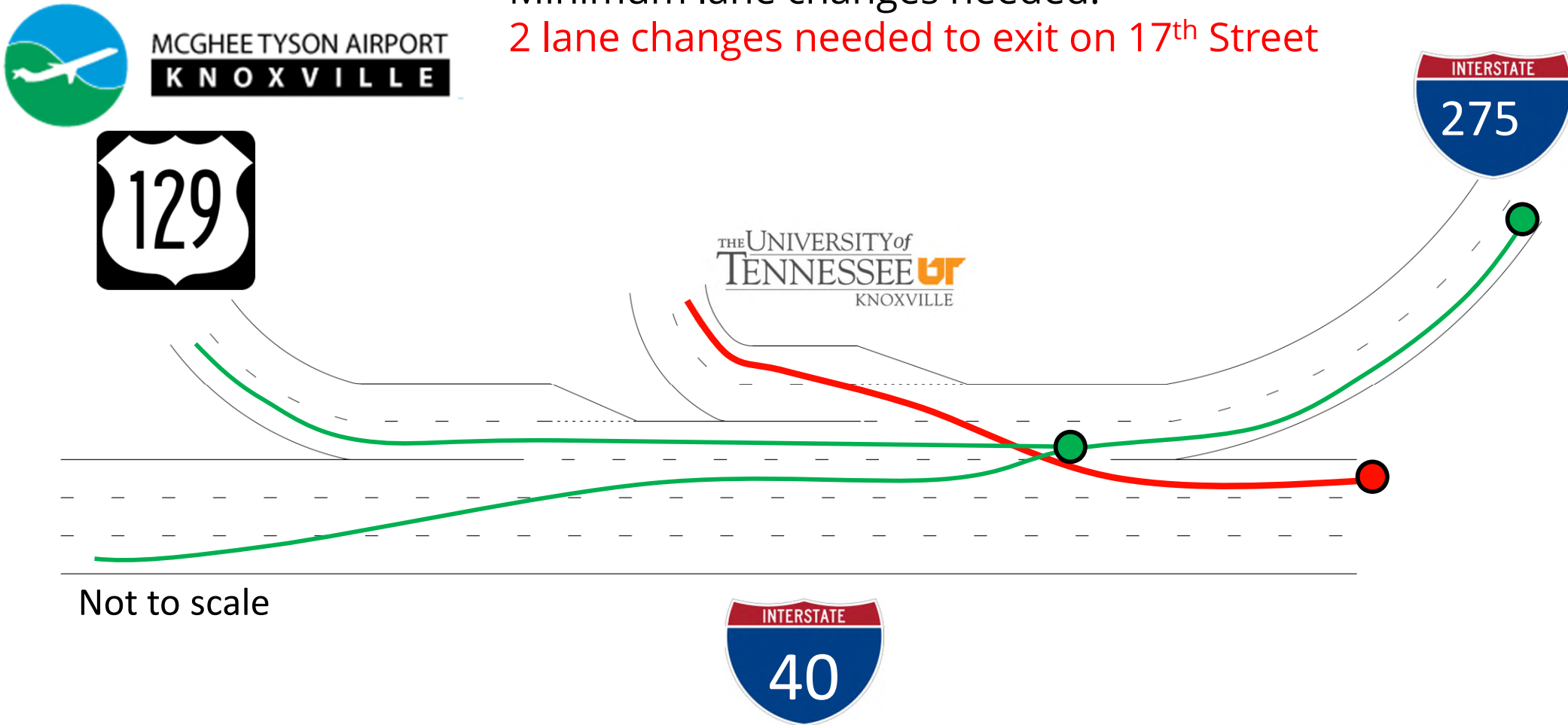
| | | | | | |
|--|-----------------------|-----------------------|----------------------------|---------|--|
| Interstate 40, Knox County | | | LM 17.840 to 18.910 | | |
| WB Section from I-275 Interchange to Alcoa Hwy Exit | | | | | |
| 171 Crashes - 2013 to 2015 | Actual | - 1.671 | Acc/MVM | | |
| State Average - 1.036 | Acc/MVM | Critical | - 1.275 | Acc/MVM | |
| A/S Ratio = 1.61 | A/C Ratio | = 1.31 | | | |
| 0 Fatal Crash | 5 Incap. Injury Crash | 32 Other Injury Crash | | | |
| Interstate 40, Knox County | | | LM 17.840 to 18.910 | | |
| EB Section from I-275 Interchange to Alcoa Hwy Exit | | | | | |
| 81 Crashes - 2013 to 2015 | Actual | - 0.791 | Acc/MVM | | |
| State Average - 1.036 | Acc/MVM | Critical | - 1.275 | Acc/MVM | |
| A/S Ratio = 0.76 | A/C Ratio | = 0.62 | | | |
| 1 Fatal Crash | 5 Incap. Injury Crash | 20 Other Injury Crash | | | |



| | Before | | | | | |
|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 10 Year | | 3 Year | | 1 Year | |
| | Westbound | Eastbound | Westbound | Eastbound | Westbound | Eastbound |
| Total Crashes | 373 | 311 | 176 | 85 | 68 | 31 |
| Percent by Direction | 55% | 45% | 67% | 33% | 69% | 31% |

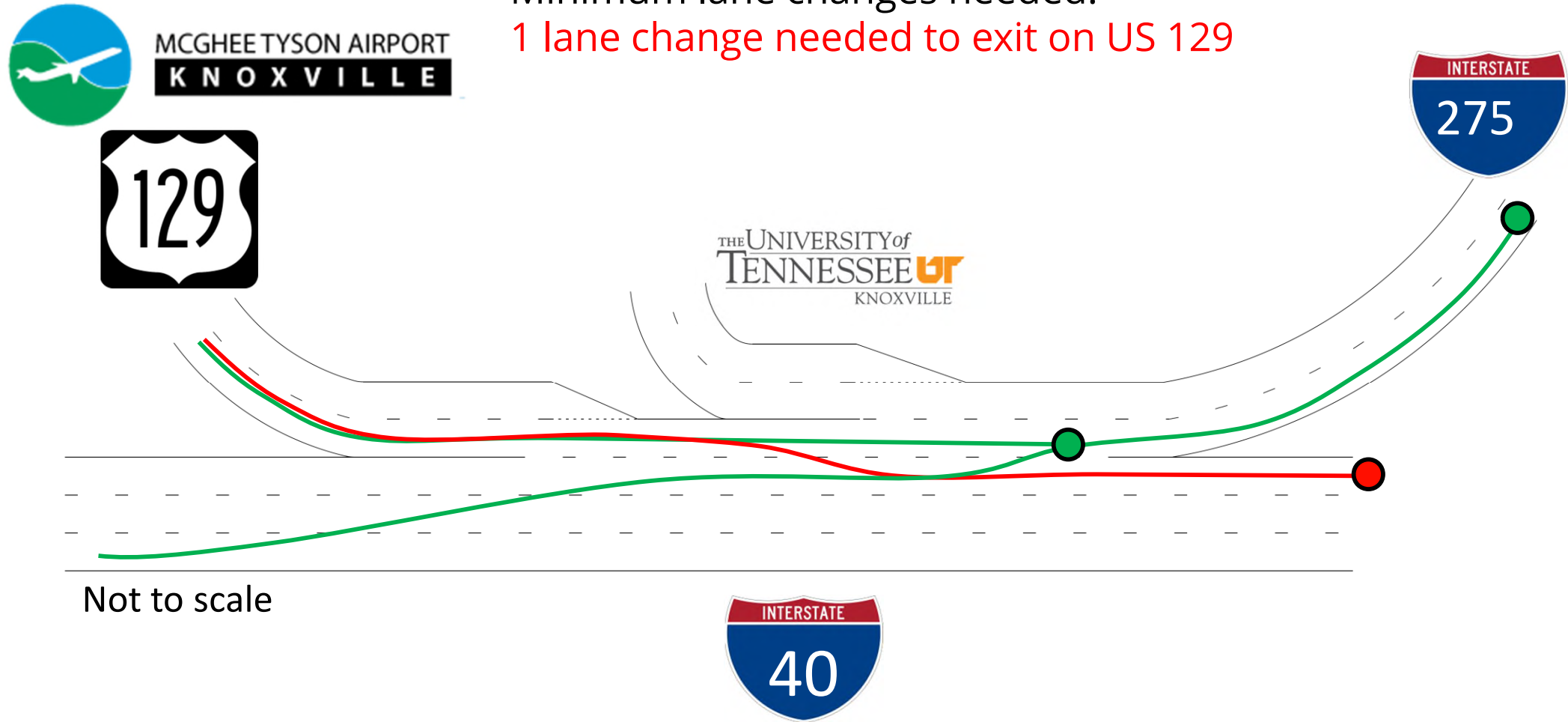
Before: I-40/I-275 to 17th Street

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

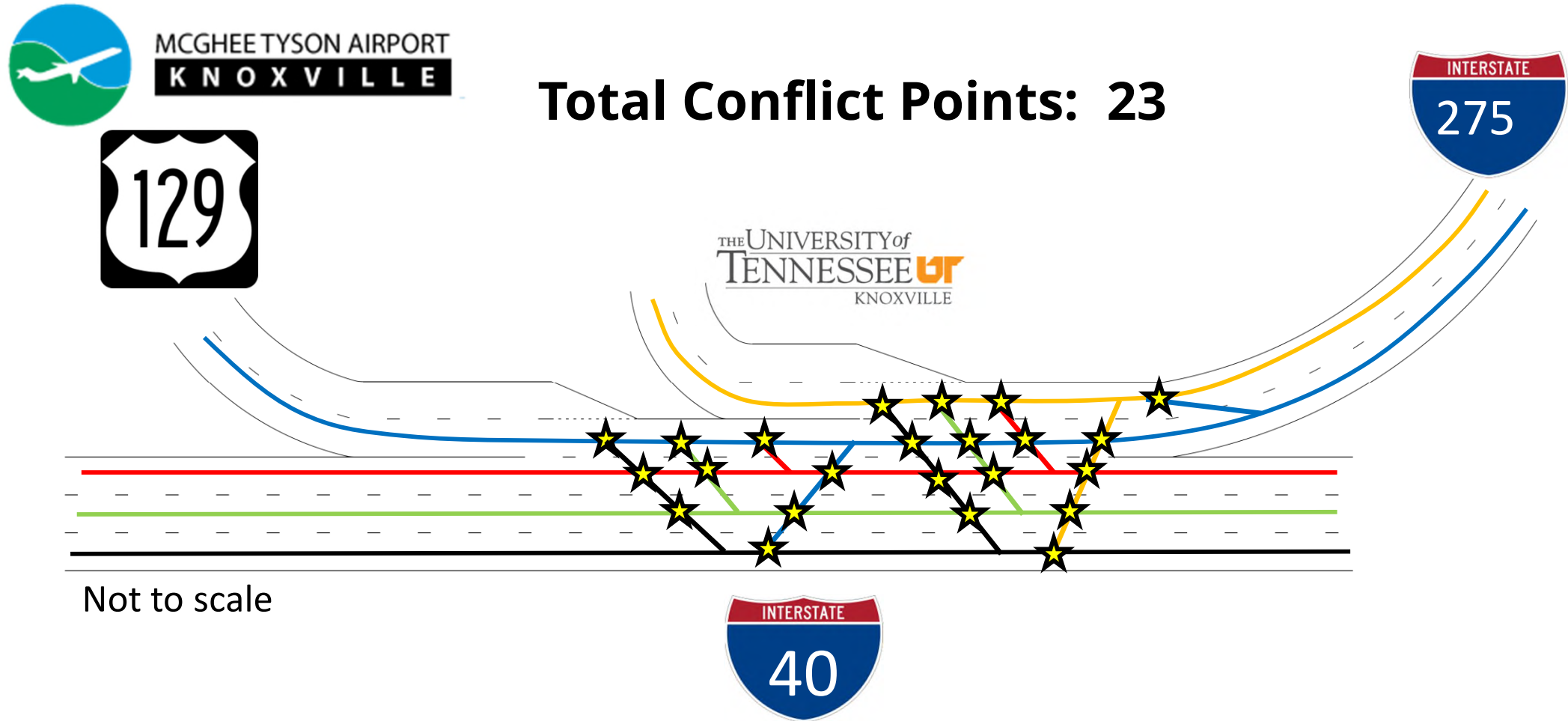


Before: I-40/I-275 to US 129, Alcoa Highway

Minimum lane changes needed:
1 lane change needed to exit on US 129



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



I-275/WB I-40 Merge – Existing Conditions

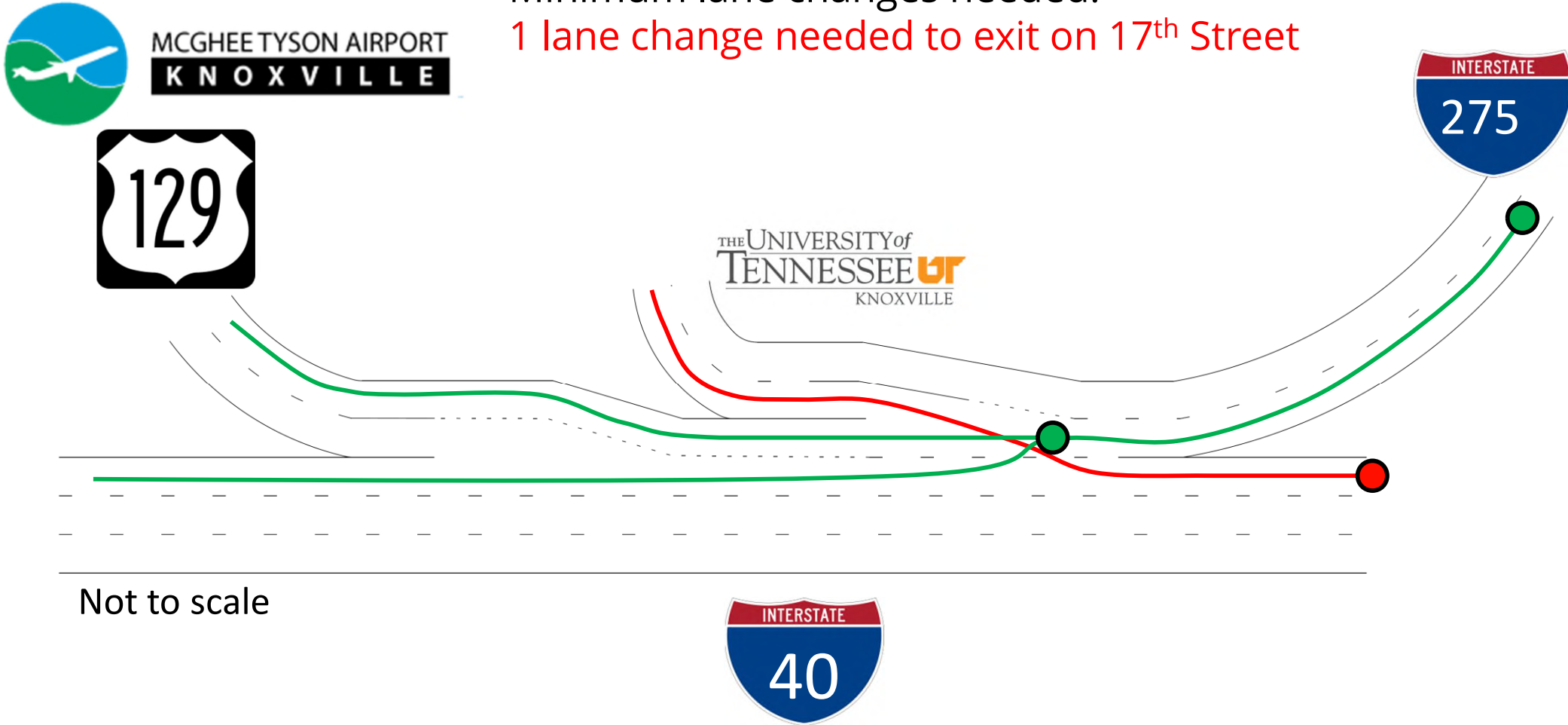


I-40 Downtown Knoxville – Signing Plan



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

Minimum lane changes needed:
1 lane change needed to exit on 17th Street

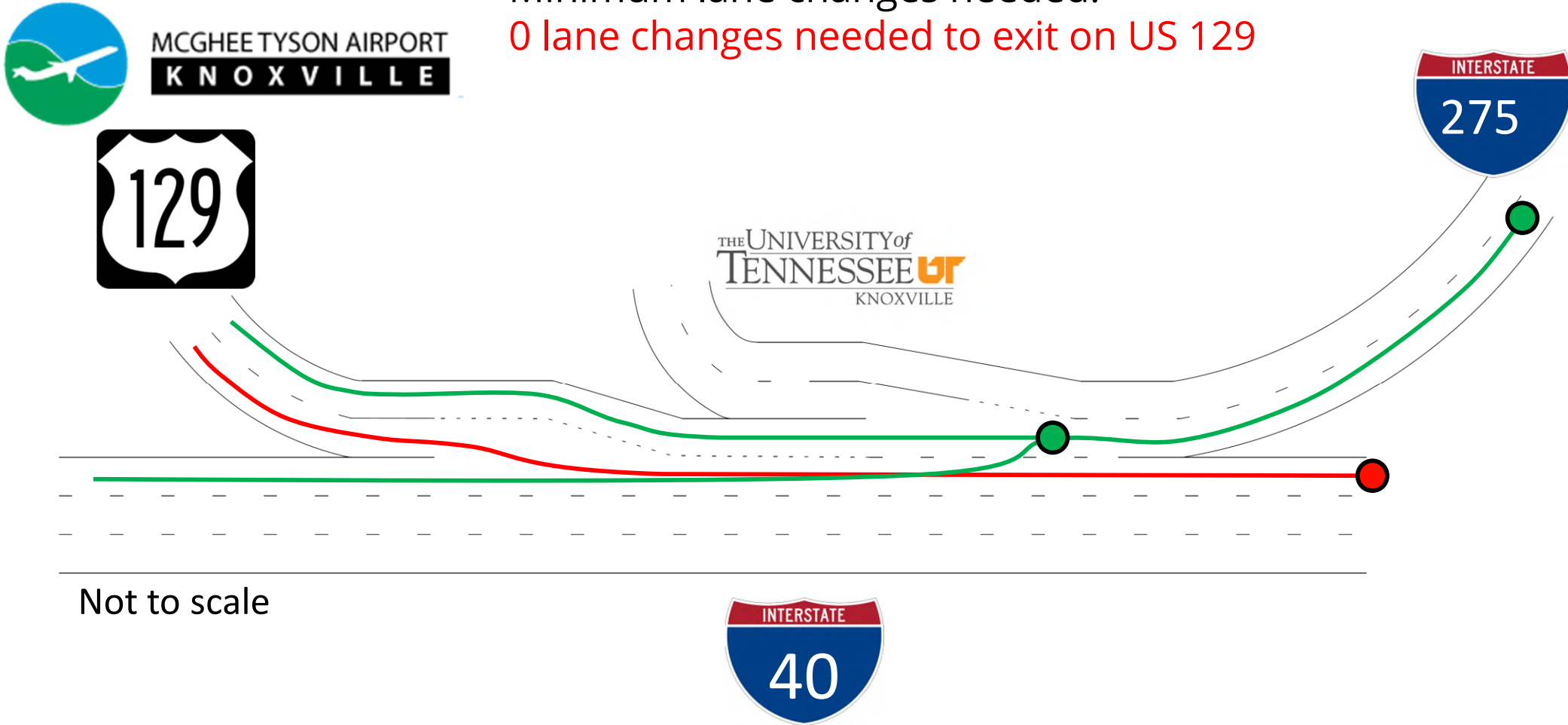


Not to scale



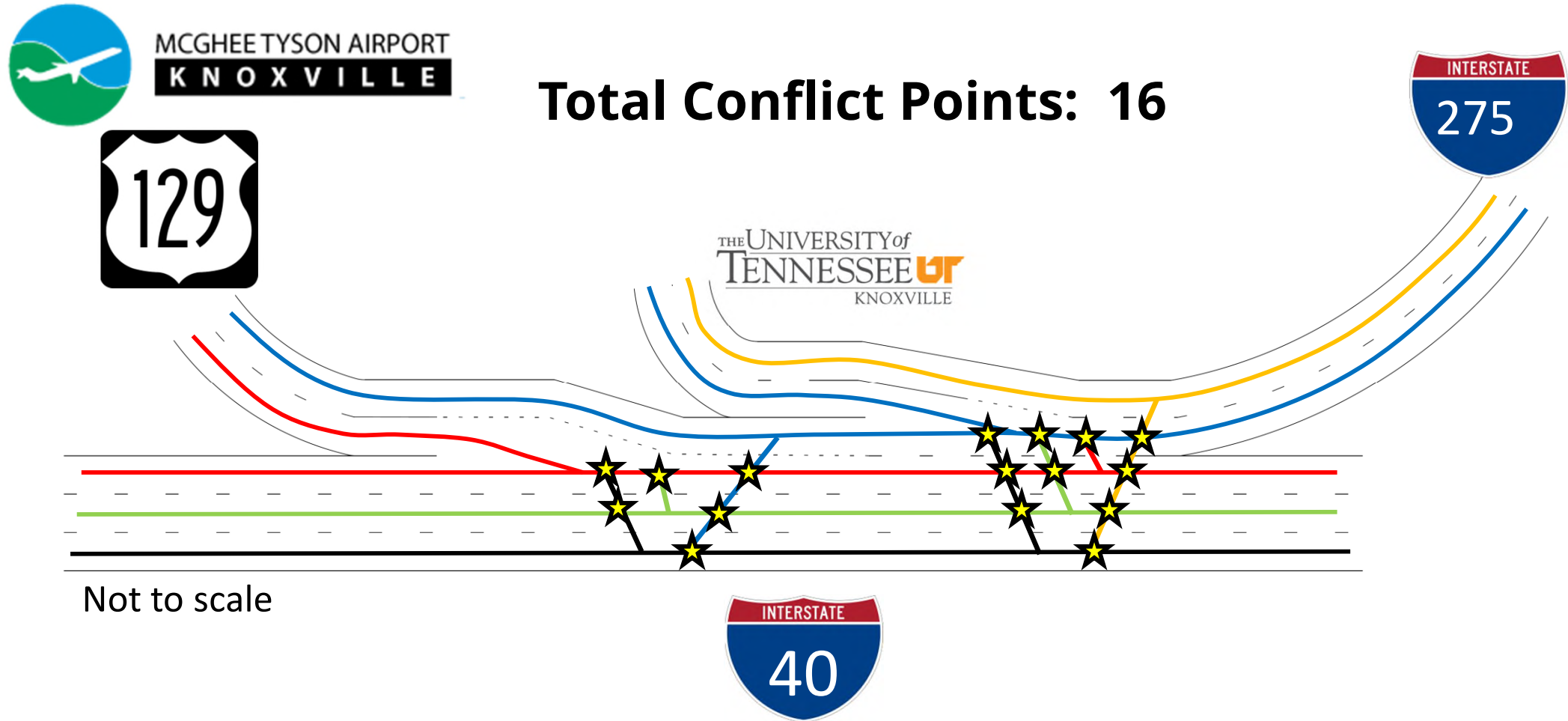
After: I-40/I-275 to US 129, Alcoa Highway

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



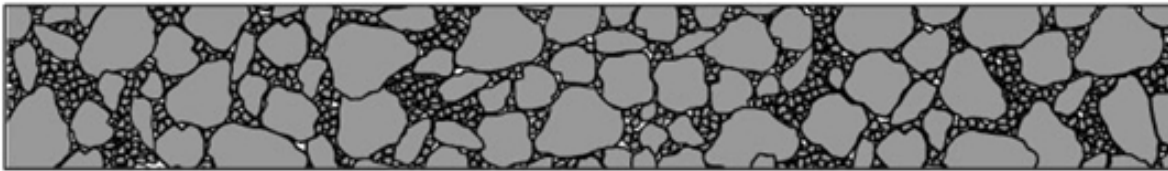
Not to scale

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

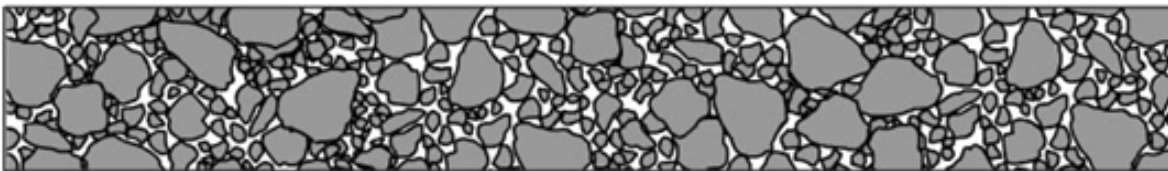


Open-Graded Friction Course, OGFC

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



Traditional Pavement



OGFC

Post Construction Photographs



I-40 Downtown Knoxville - Flythrough

2015 - Before

2017 - After

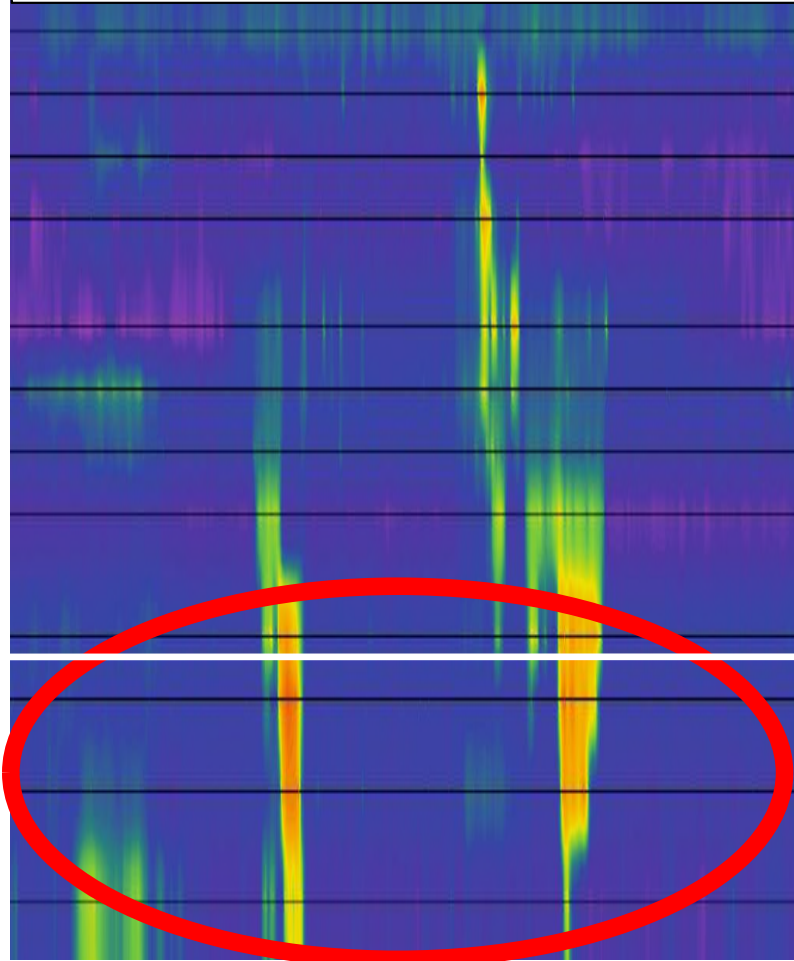


Measuring Effectiveness

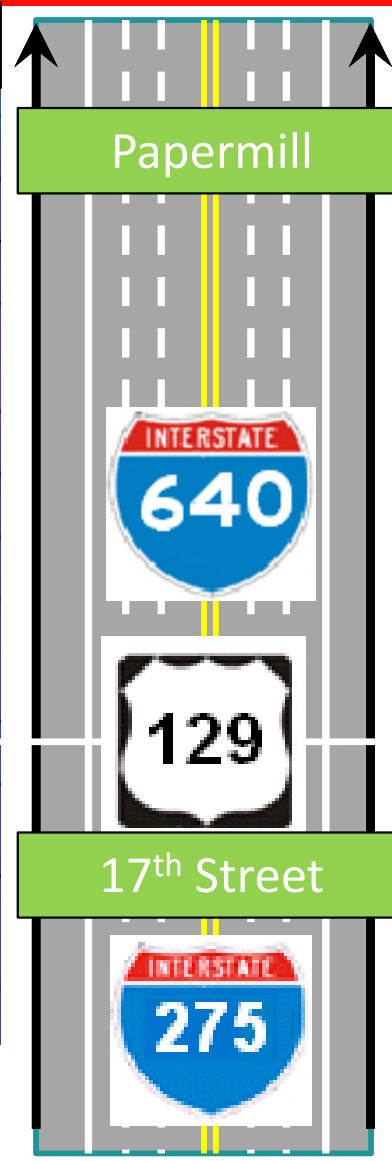
I-40 between I-275 and US 129

Wednesday (September 2015 vs January 2017)

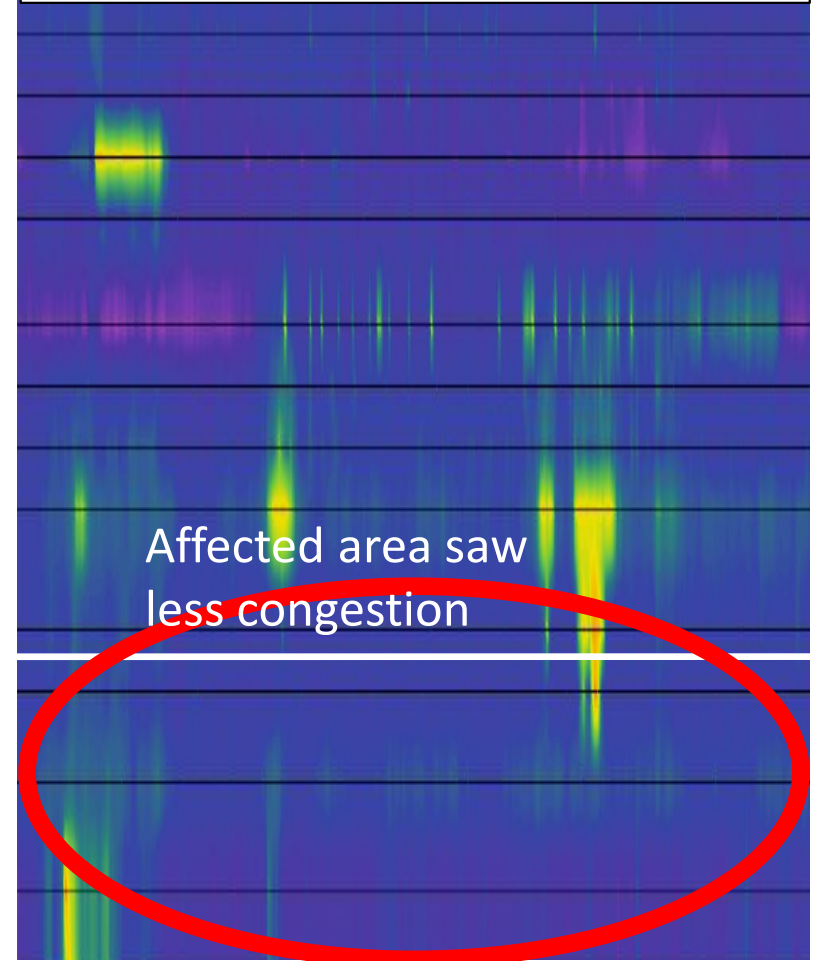
2015 - Before



8 AM 2 PM 6 PM



2017 - After



Affected area saw less congestion

8 AM 2 PM 6 PM

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
 - Improvements made without Widening

| Study Period | | Westbound Crashes | |
|--------------|---------|-------------------|----------------|
| | | Yearly Average | Percent Change |
| After | 3 Years | 17.3 | -70.5% |
| Before | 3 Years | 58.7 | |



TN

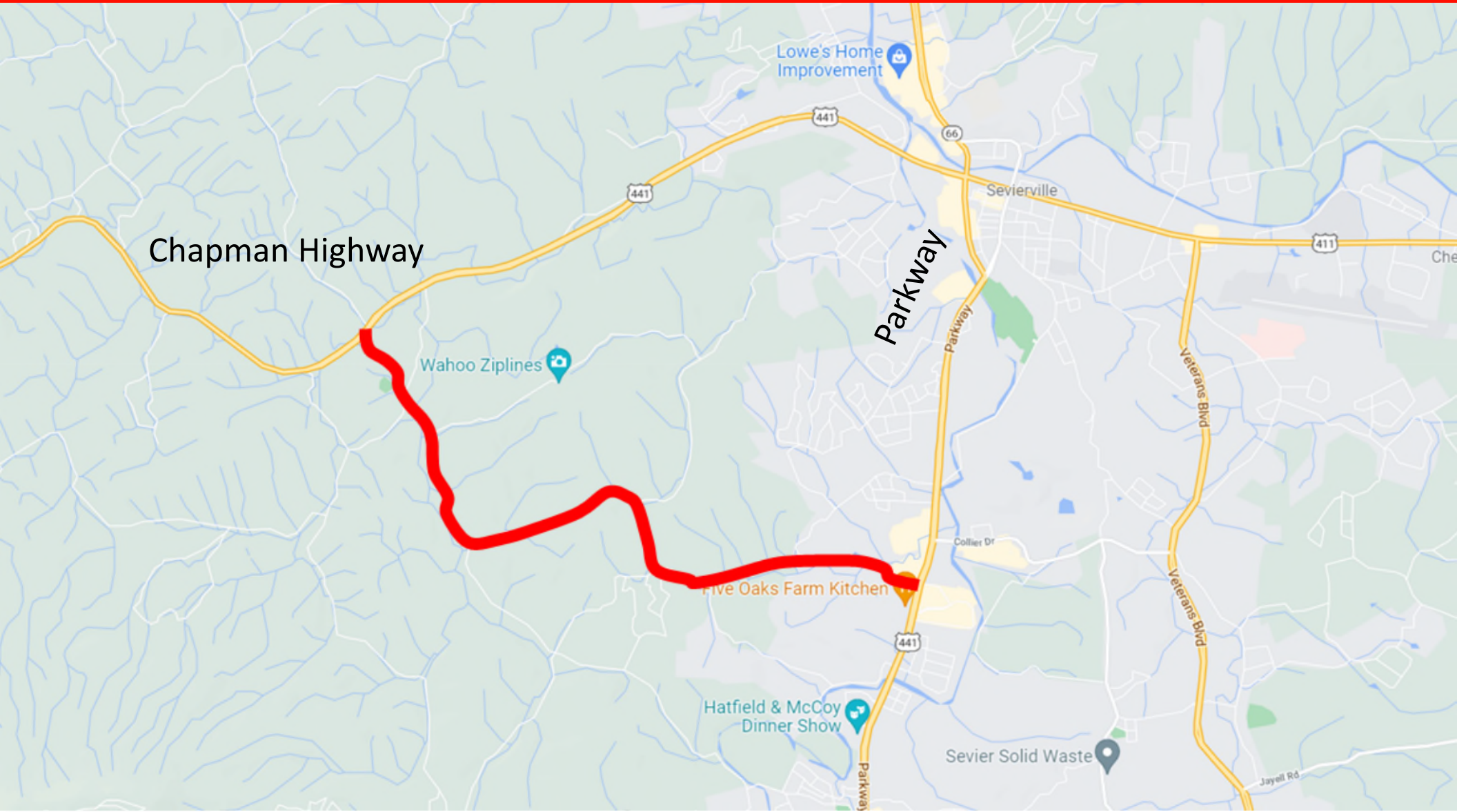
TM

**Sevier County
SR-35, US 441, Chapman
Highway at Pleasant Hill**

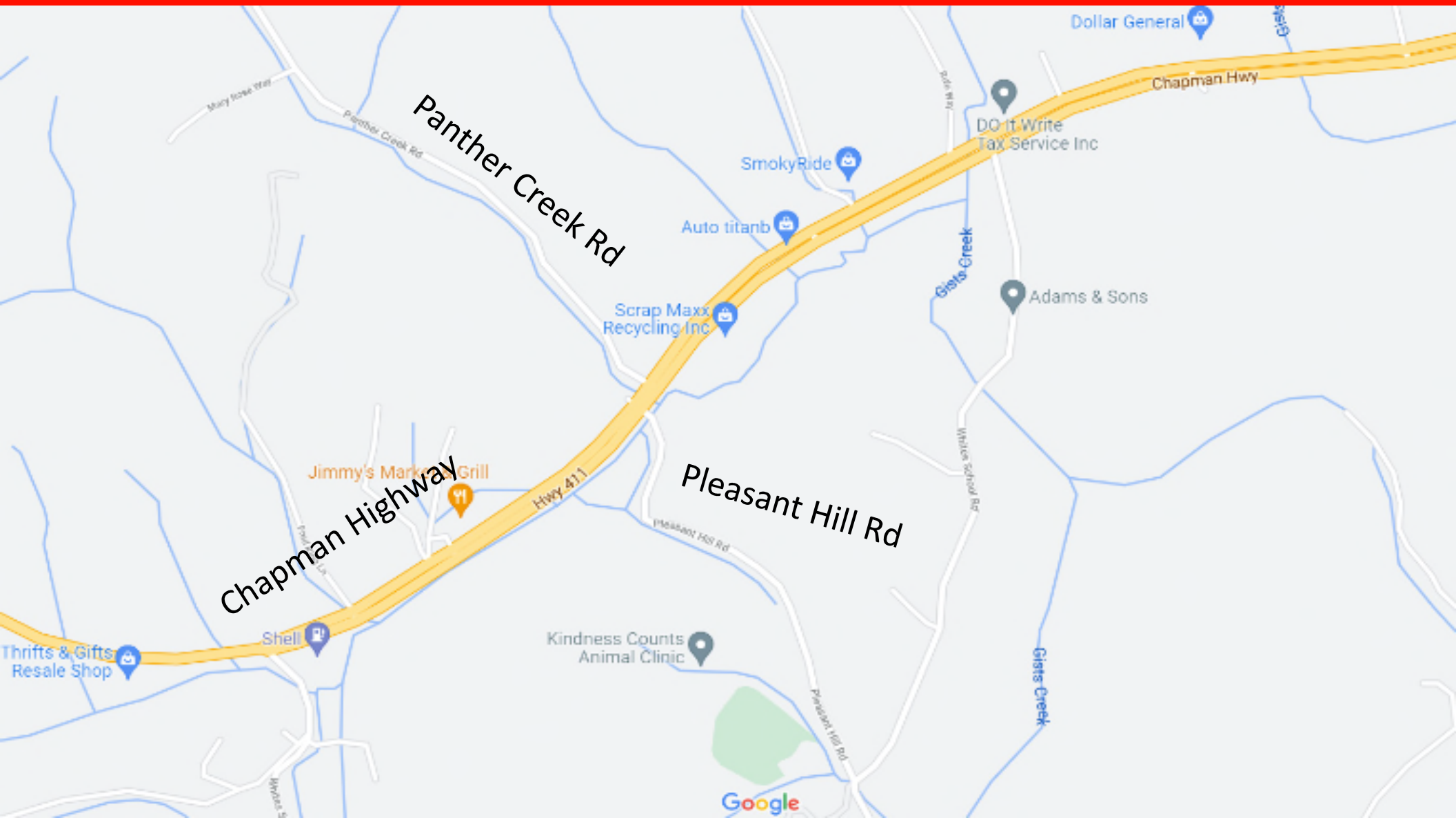
In the News...



Location Map



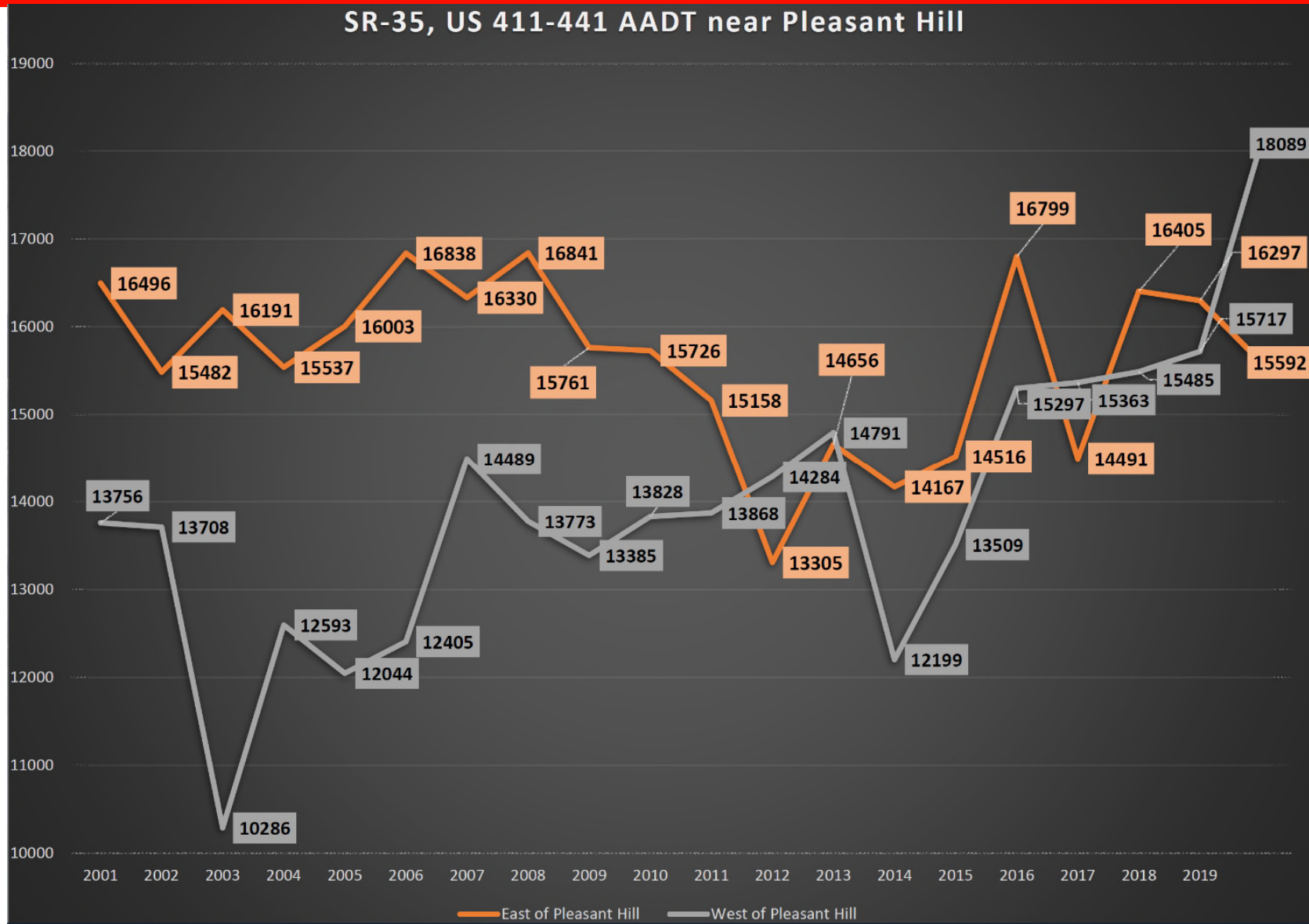
Location Map



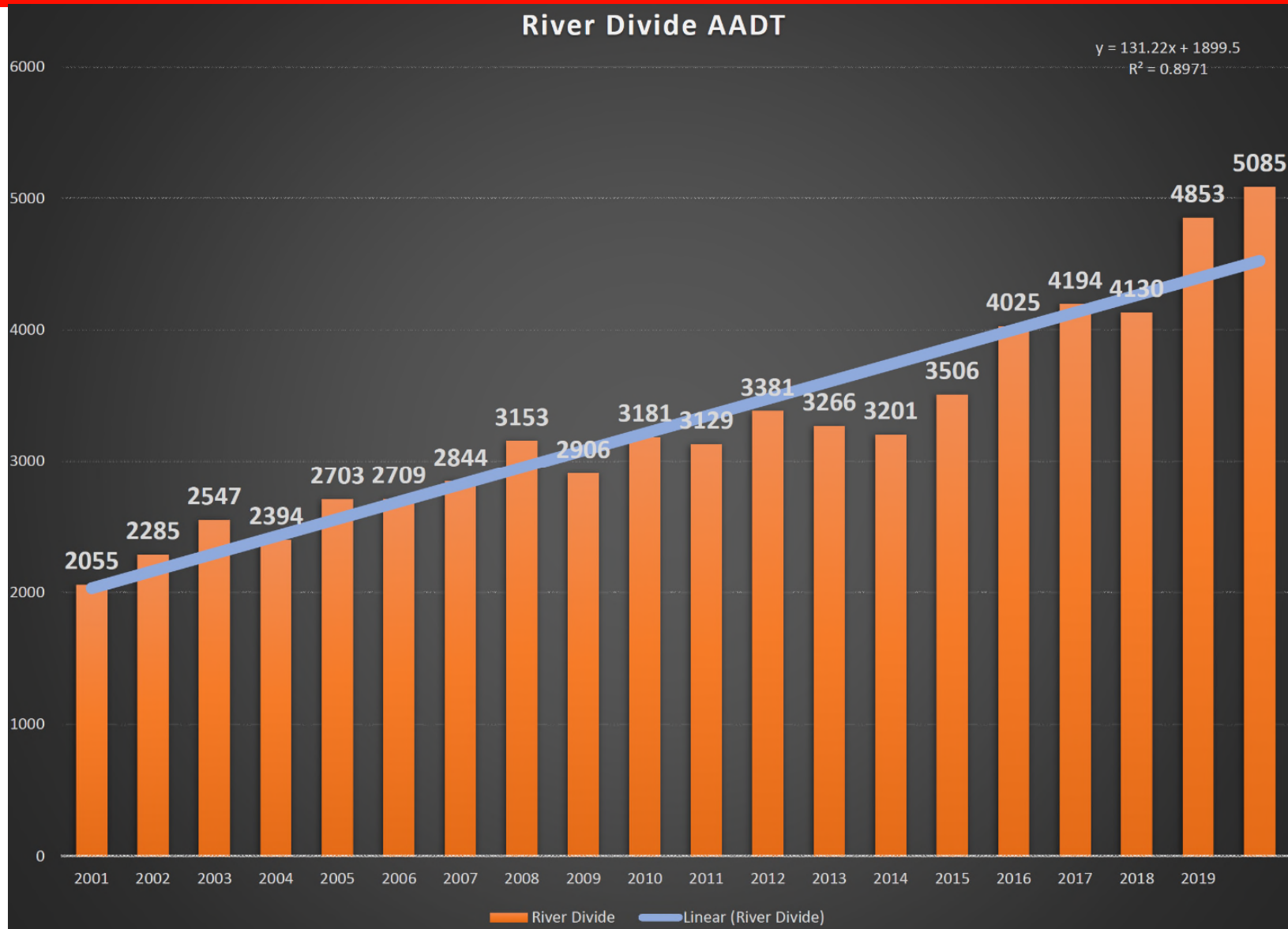
Existing Conditions



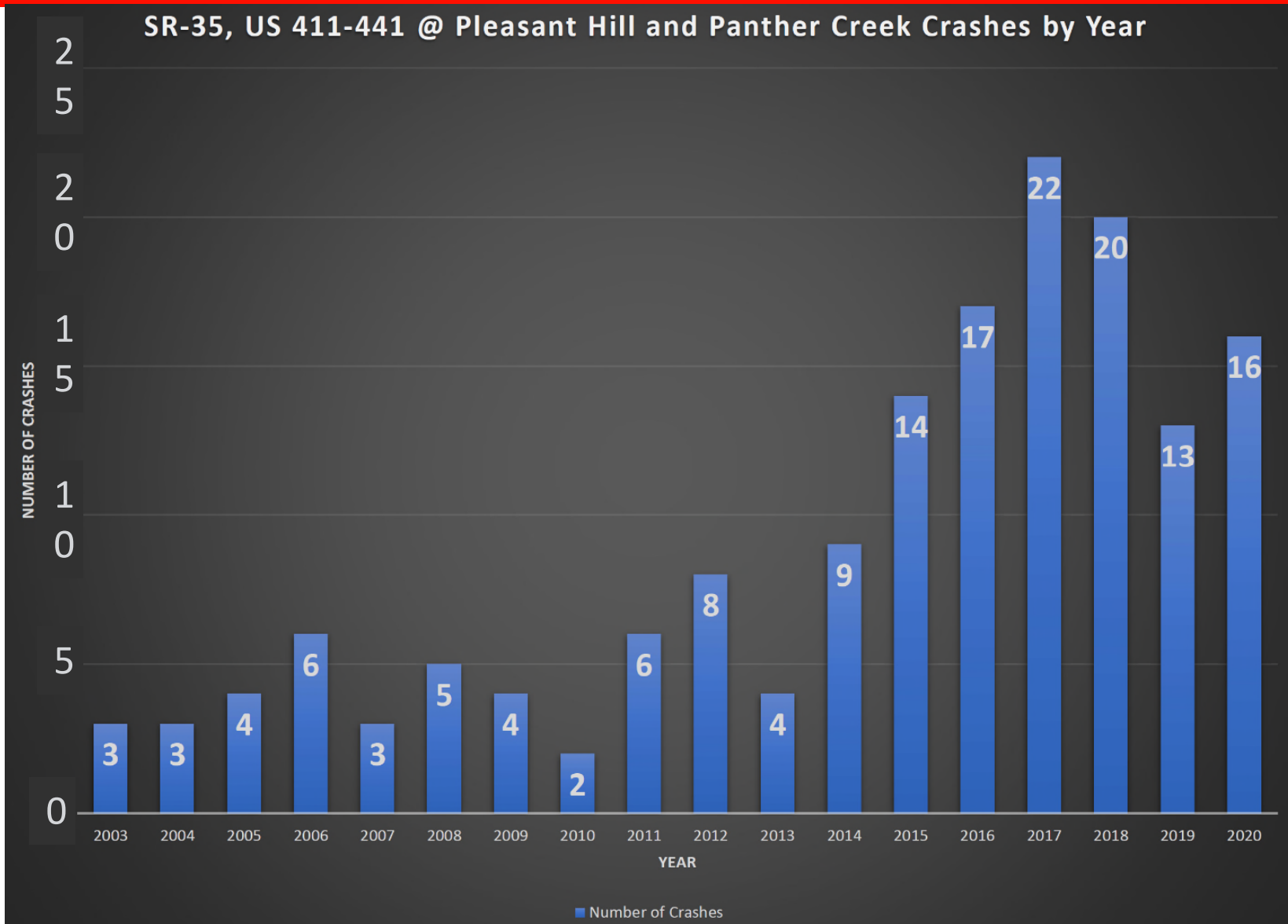
Traffic Volumes – Chapman Highway



Traffic Volumes – River Divide



Crash Numbers



A Life Changing Product

iPhone

ANNOUNCED: Jan. 9, 2007

RELEASED: June 29, 2007

KEY FEATURES:

3.5-inch diagonal screen;
320 x 480 pixels at 163 ppi;
2-megapixel camera

PRICE: 4GB model, \$499;
8GB version, \$599 (with
a two-year contract)

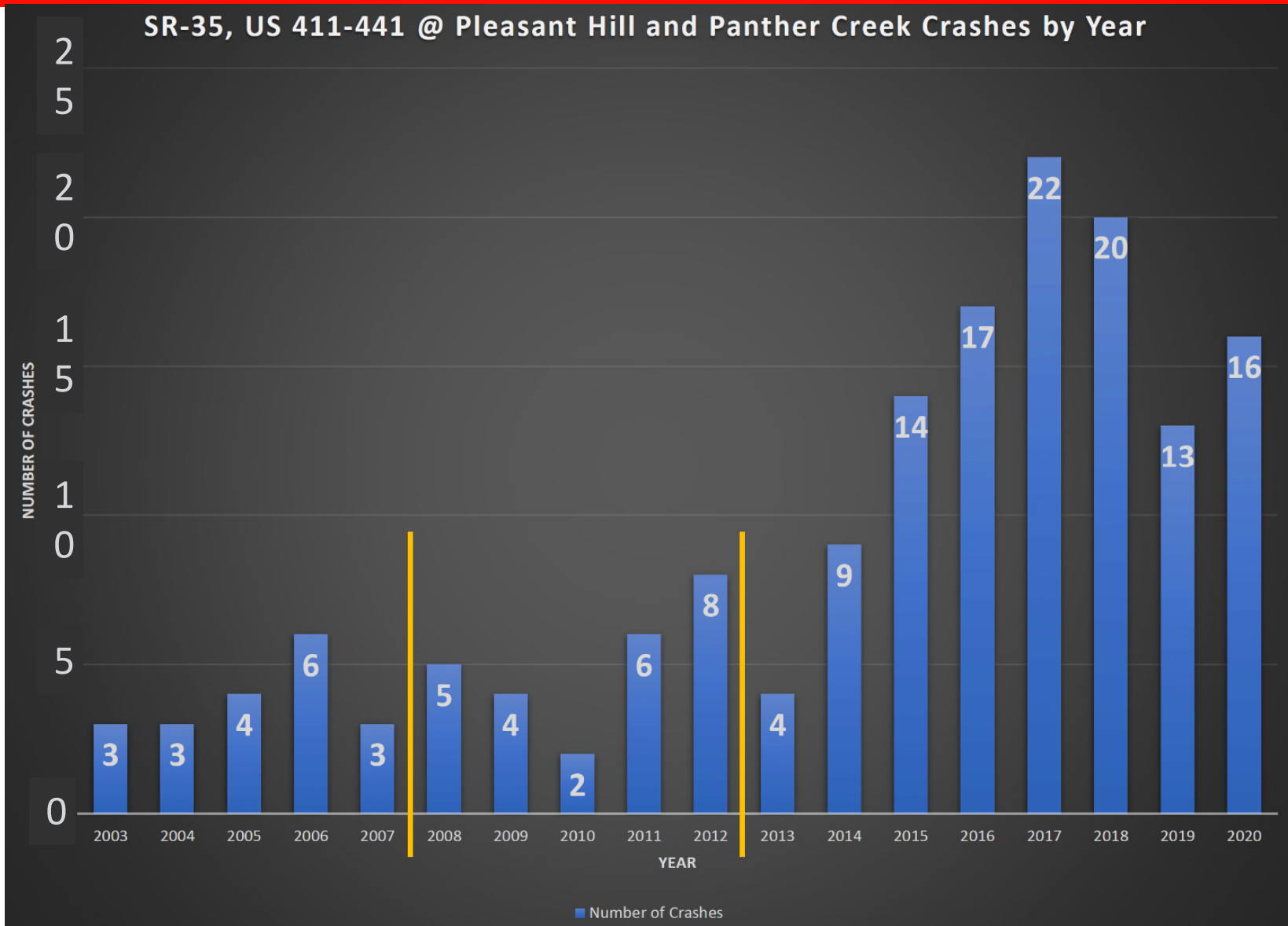


But There's More!

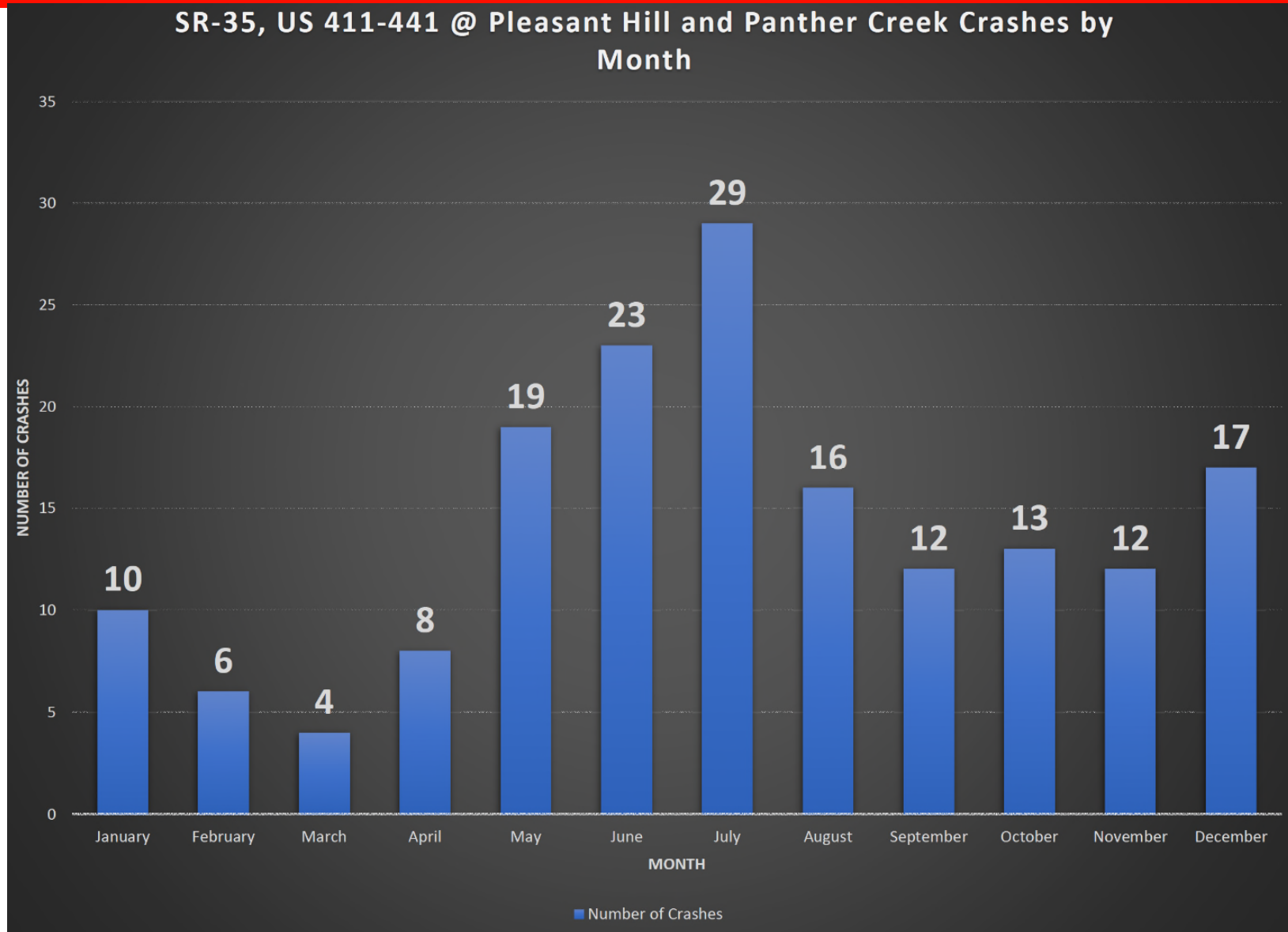
- Google Maps debuted on the iPhone in 2007
- Received over 10 million downloads in 2 days
- Google Maps was Apple's default mapping app until 2012
- Other mapping products have since come out



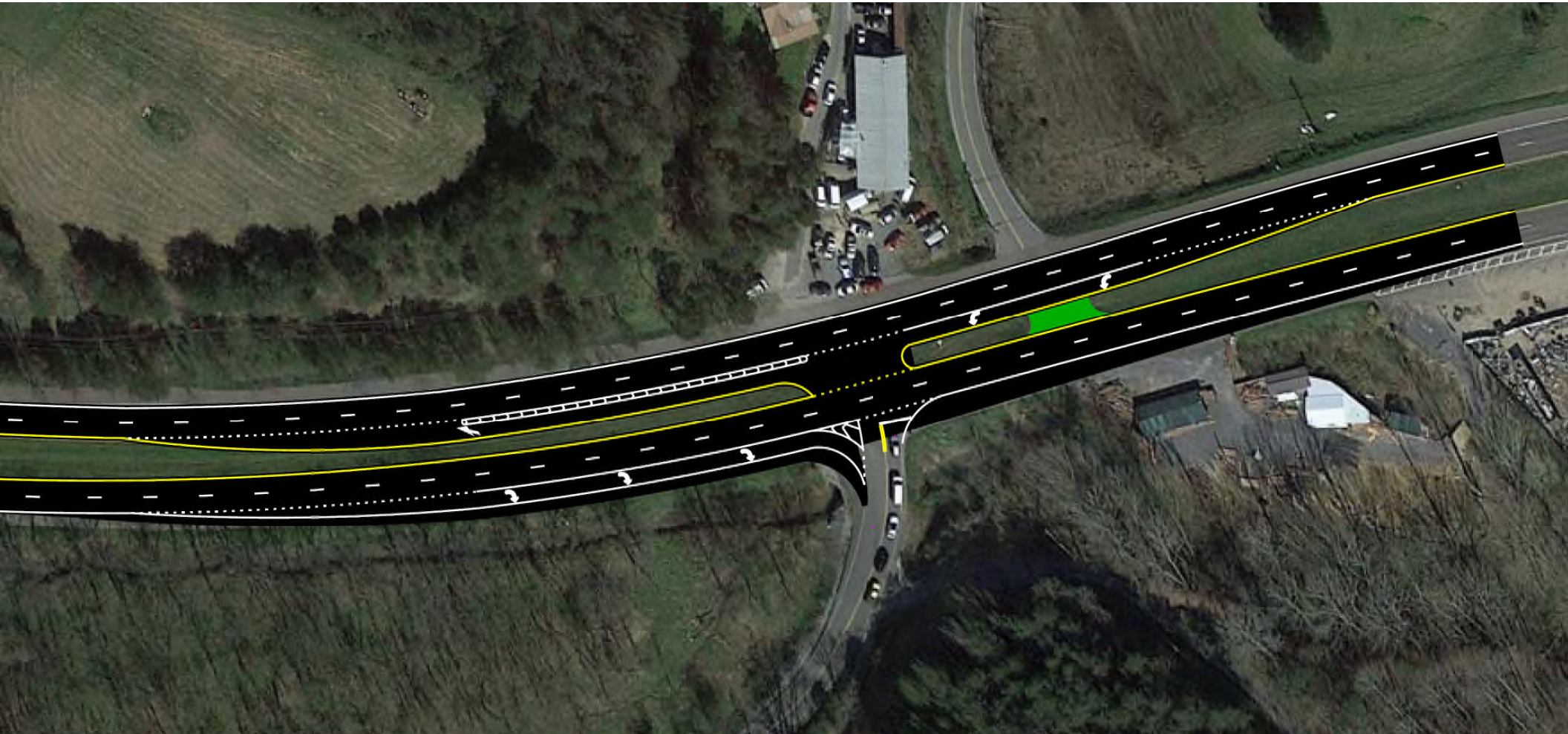
Crash Numbers



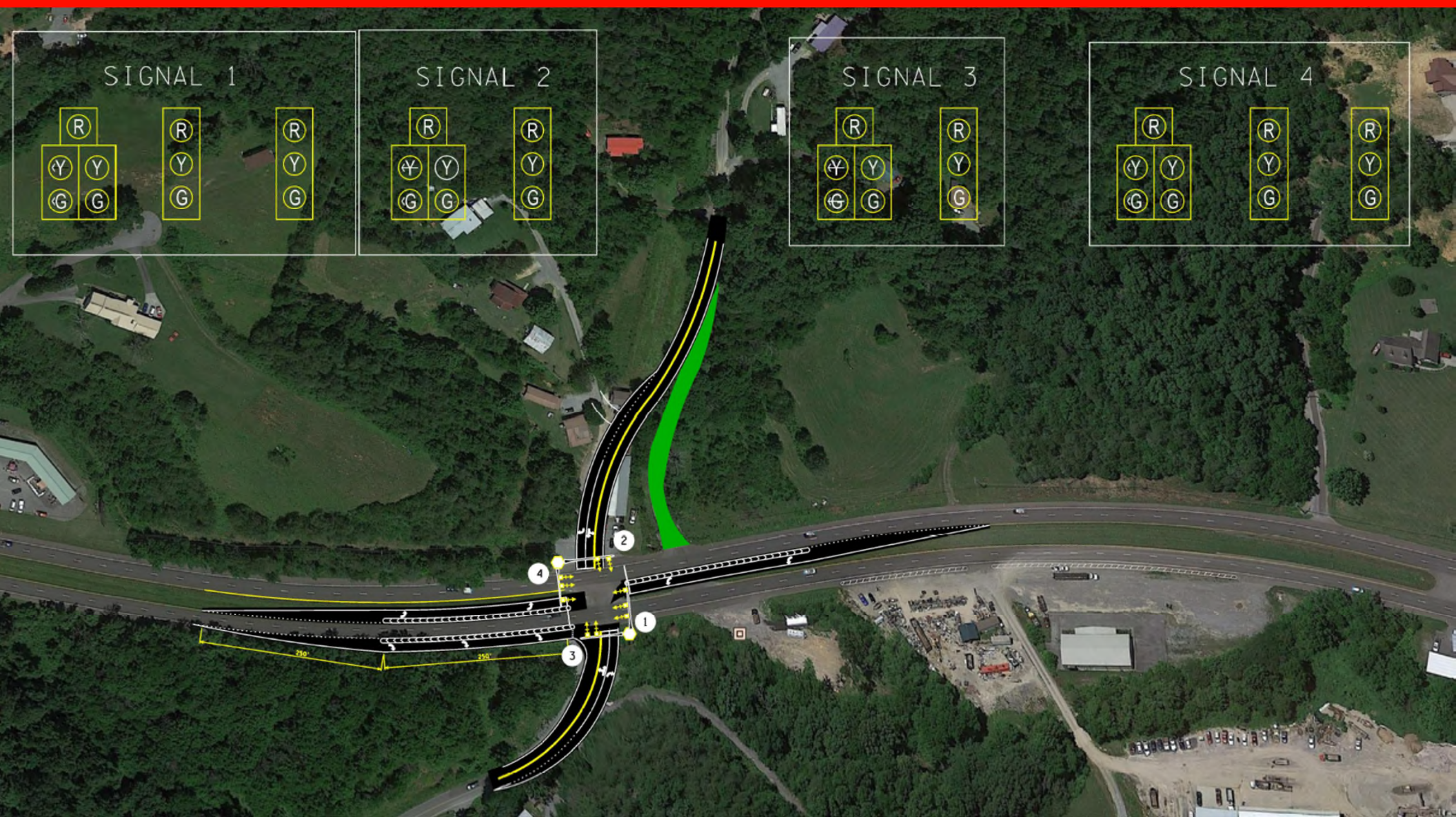
Crashes by Month



Short Term Improvements



Long Term Improvements





Thank You



Questions?

Bryan.Bartnik@tn.gov – 865-594-2456