High Friction Surface Treatment (HFST)

The use of High Friction Surface Treatments to Improve Safety on Horizontal Curves

KWIKBOND POLYMERS

What is a High Friction Surface Treatment?

These are pavement surface treatment systems that are composed of "tough" polish-resistant, abrasion-resistant aggregates bonded to the pavement surface using a resin.

What Is High Friction Surface Treatment?

HFST in the US

One large city undertook a program to improve intersections after finding that about 70 percent of all crashes occurred at intersections, whether wet or not. A highly skid-resistant overlay was applied at more than 800 intersections and other potential problem areas, such as approaches to pedestrian crossings. A study of the project indicated a 31-percent reduction in crashes. Although the skid treatment was expensive (epoxy resin with a calcined bauxite aggregate), the results were cost-effective.[26] Intersection approaches on grades would be prime candidates for surface improvements to alleviate urban wet-weather crashes.

- The benefits of HFST's may have first been reported by Hatherly and Young in 1976.
- They reported that the use of calcined bauxite aggregate and a resin binder had demonstrated a 31% decrease in crashes at intersections where HFST was applied.

. L. Hatherly and A. Young, "The Location and Treatment of Urban Skidding Hazard Sites," *Transportatio* *Research Record 623*, Transportation Research Board, National Research Council, Washington, D.C., 1976.

Proven Countermeasures

2008 Countermeasures

1. Roadway Safety Audit**
2. Median Barriers
3. Walkways
4. Left and Right Turn Lanes at Stop-Controlled Intersections
5. Yellow Change Intervals
6. Rumble Strips and Rumble Stripes*
7. Roundabouts
8. Medians and Pedestrian Refuge Areas
9. Safety Edge

2011 Countermeasures

1. Roundabouts
2. Safety Edge
3. Medians and Pedestrian Refuge Areas
4. Longitudinal Rumble Strips and Stripes on 2-lane Roads*
5. Corridor Access Management
6. Backplates and Retroreflective Borders
7. Enhanced Delineation and Friction for HC
8. Pedestrian Hybrid Beacon
9. "Road Diets" (Roadway Reconfiguration)

"…we encourage safety practitioners to consider a new set of countermeasures …that are research-proven, but not widely applied on a national basis. "

"While States should still be considering the application of all of the countermeasures listed in the 2008 guidance, this memo supersedes the previous guidance. "

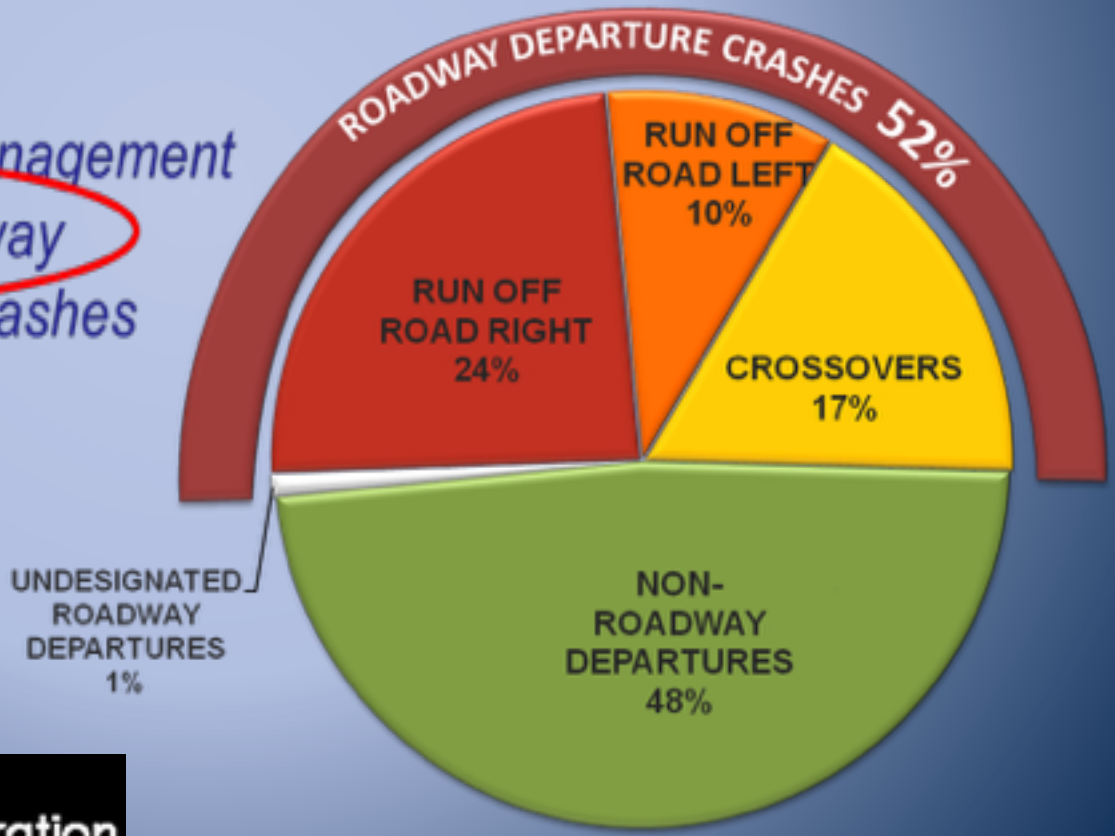
U.S. Department of Transportation
Federal Highway Administration

Roadway Departure Countermeasures

- Longitudinal Rumble Strips and Stripes on 2-Lane Roads
- Enhanced Delineation and Friction for Horizontal Curves
- Safety EdgeSM

Roadway Departure Risk Management

1. *Keep Vehicles on Roadway*
2. *Reduce Likelihood of Crashes*
3. *Minimize Severity*



U.S. Department of Transportation
Federal Highway Administration

Enhanced Delineation and Friction for Horizontal Curves

- Low-cost treatments.
- Includes signs and markings to that help drivers safely negotiate curves or…
- Additional pavement friction to address geometric deficiencies

Safety Impacts:

- Vary based on application
- Up to 43% reduction of all fatal crashes

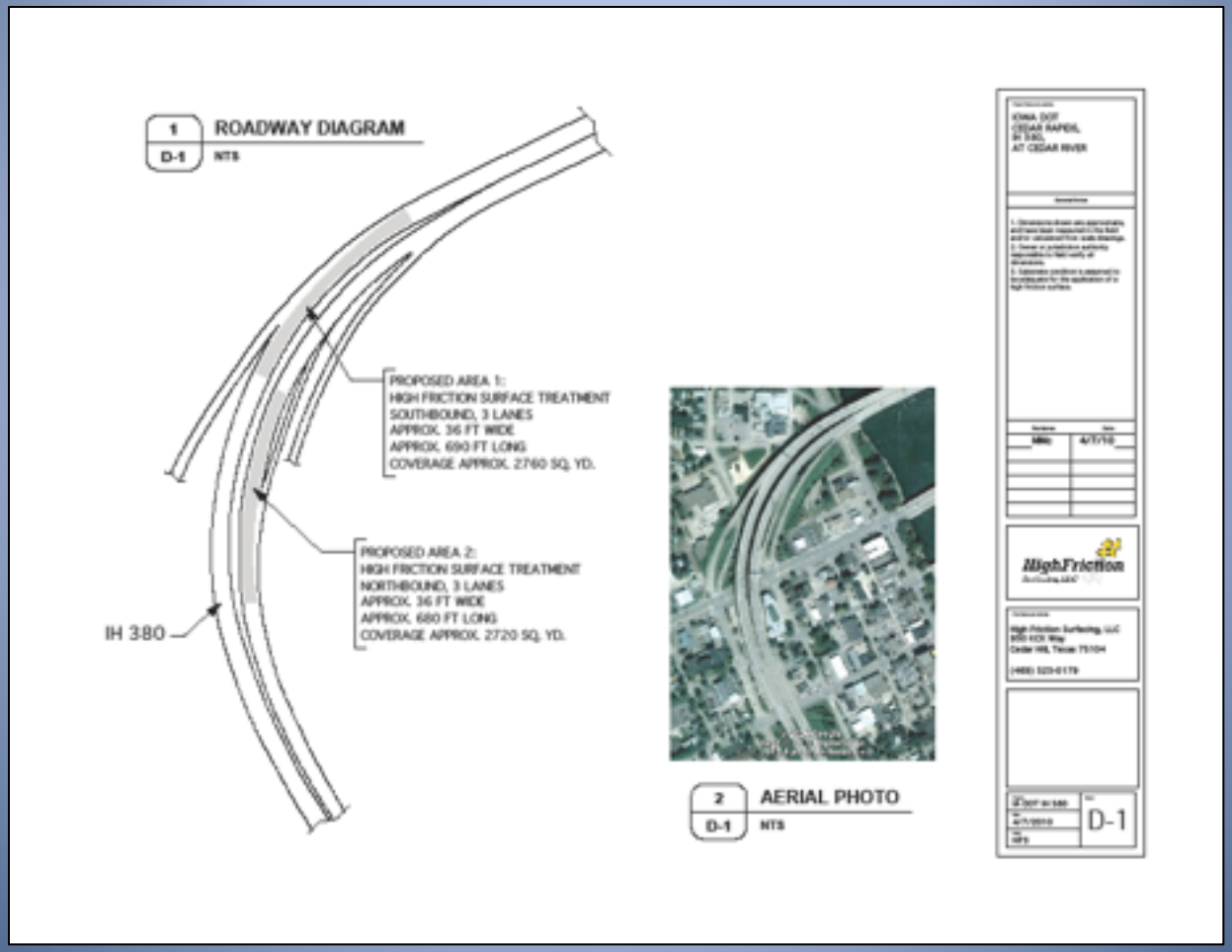
U.S. Department of Transportation
Federal Highway Administration

Surface Enhancements At Horizontal Curves (SEAHC)

- The goal of this effort is to isolate and demonstrate the effects of increased surface friction on the number of accidents at these select locations. (2009-2011)

- **July 2014 – The FHWA announces that they have verified a 74% reduction in roadway departure crashes within the 30 HFST locations installed through the SEAC Program so far**

Bridge Decks – Safety or Preservation?



Iowa - SEAC Project
Crash Reduction

I-380 Cedar River Crossing, Cedar Rapids, IA					
	Before HFST		After HFST		
	May 1, 2008 - April 30, 2012		June 13, 2012 - June 12 2013*		
	5-yr Total	Annual Avg (5 yrs)	Annual (1 yr)		
Crashes:	54	10.8	4		
Injuries	28	5.6	1		
Tractor/Semi-trailer	8	1.6	0		
Property Damage	$981,616	$196,323	$9,500		
Lost Control/Speed Too Fast/Evasive	29	5.8	0		
Road Surface Contributing	9	1.8	0		
Wet Roadway	17	3.4	2	(1 asleep)	
Snow/Ice/Slush	17	3.4	0		
* 2013 data is preliminary					

Preliminary Crash Reduction Results

- Michigan – SEAC Projects
  - Site 1
    - 3 yr before: 26 crashes (8 wet)
    - 1 yr after: 4 crashes (1 wet)
  - Site 2
    - 3 yr before : 55 crashes (15 wet)
    - 1 yr after: 16 crashes (2 wet, 3 snow/ice)
  - Site 3
    - 3 yr before : 22 crashes (7 wet)
    - 1 yr after: 2 crashes (1 icy)
  - Site 4
    - 3 yr before : 25 crashes (12 wet)
    - 1 yr after: 3 crashes (1 wet, 1 icy, 1 alcohol)

Every Day Counts (EDC) Innovative Initiative

- Started in 2009 with EDC I (14 initiatives)
- EDC II started in 2012 (13 initiatives)
  - Shortening Project Delivery
  - Accelerating Technology
  - Innovative Deployment
- http://www.fhwa.dot.gov/everydaycounts

FHWA Demonstration Projects

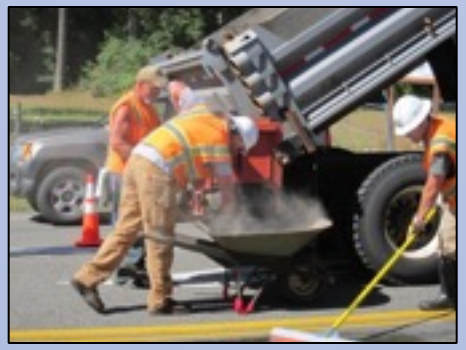
July 14, 2014 – Providence, RI

July 30, 2014 – Thurston County , WA

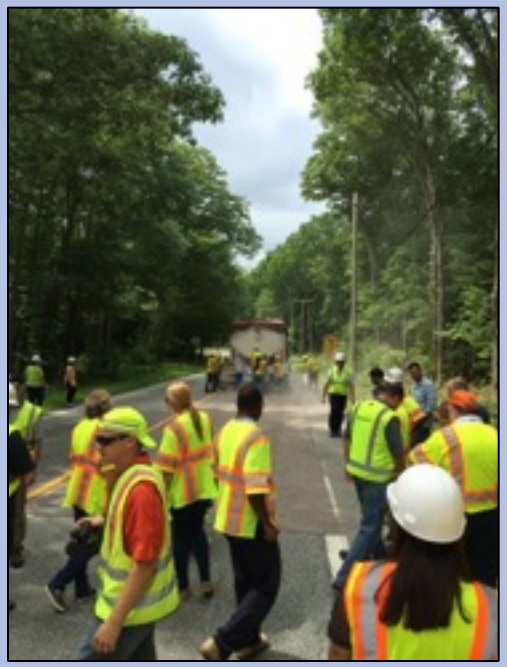
Thurston County FHWA
Hand Applied HFST Demo Installation








Providence, RI FHWA
Fully Automated HFST Demonstration



Expectations for Crash Reduction with HFST

PennDOT Demonstration Project

PA SR 611 – Zero accidents since installation in 2007

– As of June 2014

1996-2007 – 22 crashes
Three deaths and 4 injuries in eight years

Kentucky Results

High Friction Surfaces

- Close to 100 sites selected and installed in 2010-2012. Preliminary evaluation of 26 projects shows a 69% reduction in crashes

KYTC / HFST Statewide Contract

KENTUCKY RESULTS

A particular HFST installation in KY reported 55 wet weather and 3 dry weather crashes over a three period prior to the installation of HFST, in the 2.5 year period after the installation at the same location 5 wet weather and 1 dry weather crashes were reported.

To quote an official from the KYTC

"this one project paid for all the other projects in the state"

Total Project Cost = $66,500

Wisconsin

Case Study #1 – Marquette Interchange

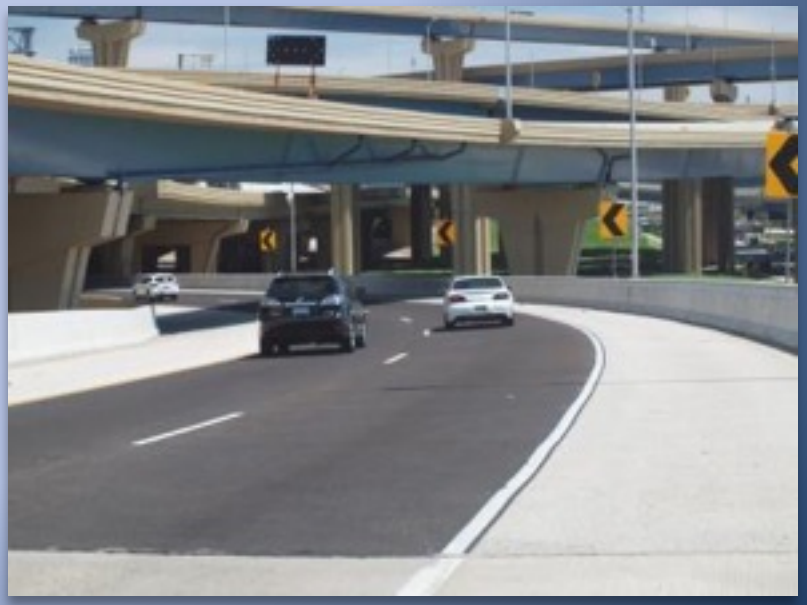
Construction Completed: November 2008

Application Type: Rehabilitation

Treatment Date: October 2011

Purpose: High Incident Rate

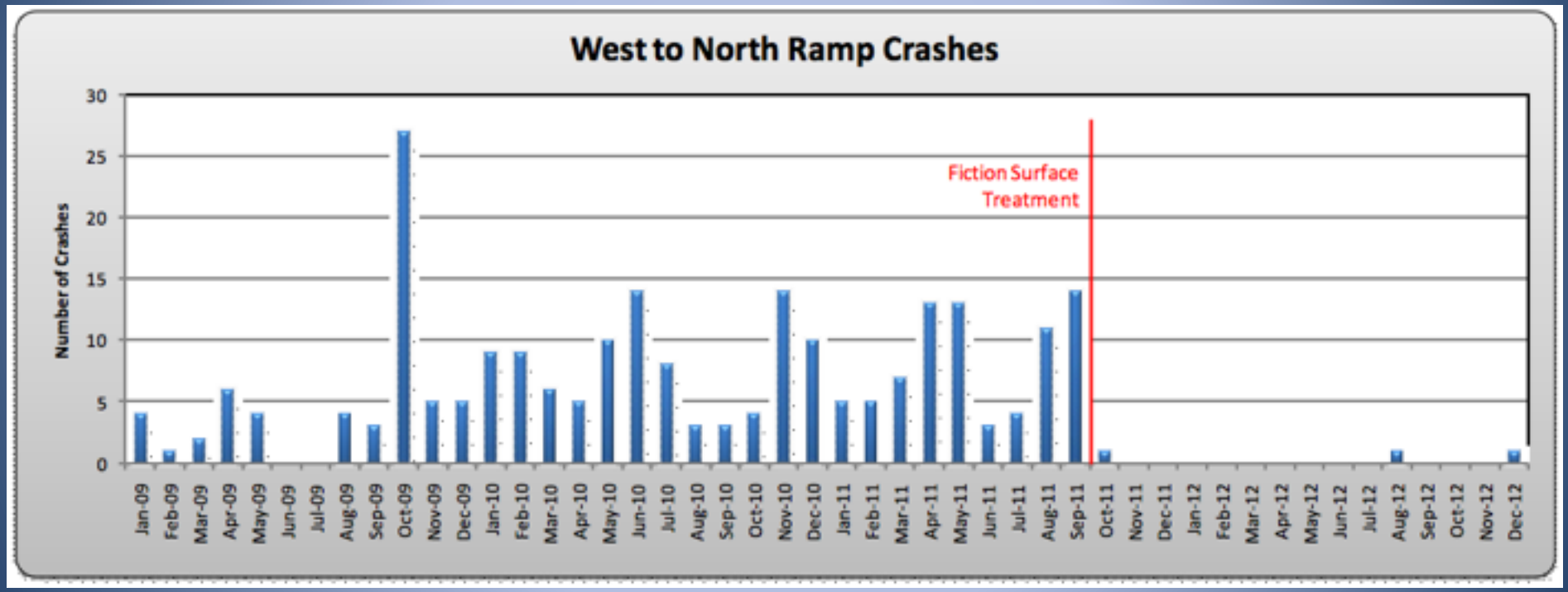
- ***2009: 61 crashes***
- ***2010: 95 crashes***
- ***2011: 76 crashes***



Wisconsin

Case Study #1 – Marquette Interchange

Post-Application Incident Statistics



97% REDUCTION

High Friction Surface Course (HFSC) Before and After Study

	County	Route	Installation Date	BEFORE Date Range	AFTER Date Range	Total Cost	BEFORE TOTAL Crashes/ Year	AFTER TOTAL Crashes/ Year	TOTAL Crash Percent Reduction	BEFORE WET Crashes/ Year	AFTER WET Crashes/ Year	WET Crash Percent Reduction
1	Charleston	I-526 @ US 17	11/30/2010	01/01/2004 to 09/15/2008	11/30/2010 to 11/30/2011	$73,977	4.0	0.0	100.0%	3.8	0.0	100.0%
2	Cherokee	I-85 @ US 29	6/30/2009 or 07/01/2009	06/01/2006 to 06/01/2009	10/01/2009 to 11/30/2011	$25,000	8.3	0.0	100.0%	6.3	0.0	100.0%
3	Greenville	US 25 (near S-41)	10/23/2008	01/01/2003 to 10/23/2008	10/24/2008 to 11/30/2011	$1,178,130	9.6	4.2	56.5%	8.1	2.6	68.1%
4	Horry	SC 31 @ SC 9	4/22/2010	01/01/2004 to 03/15/2010	04/22/2010 to 11/30/2011	$159,835	8.2	2.5	69.7%	3.4	1.2	63.3%
5	Horry	SC 31 @ SC 544	4/22/2010	01/01/2005 to 03/15/2010	04/22/2010 to 11/30/2011	$59,985	2.1	1.9	11.9%	0.4	0.0	100.0%
6	Horry	SC 31 @ US 501	4/22/2010	01/01/2006 to 03/15/2010	04/22/2010 to 11/30/2011	$159,835	12.6	5.0	60.6%	5.2	2.5	52.6%
	TOTALS:					**$1,656,761**	**45.0**	**13.5**	**69.9%**	**27.2**	**6.3**	**76.9%**

Assumptions and Disclosures

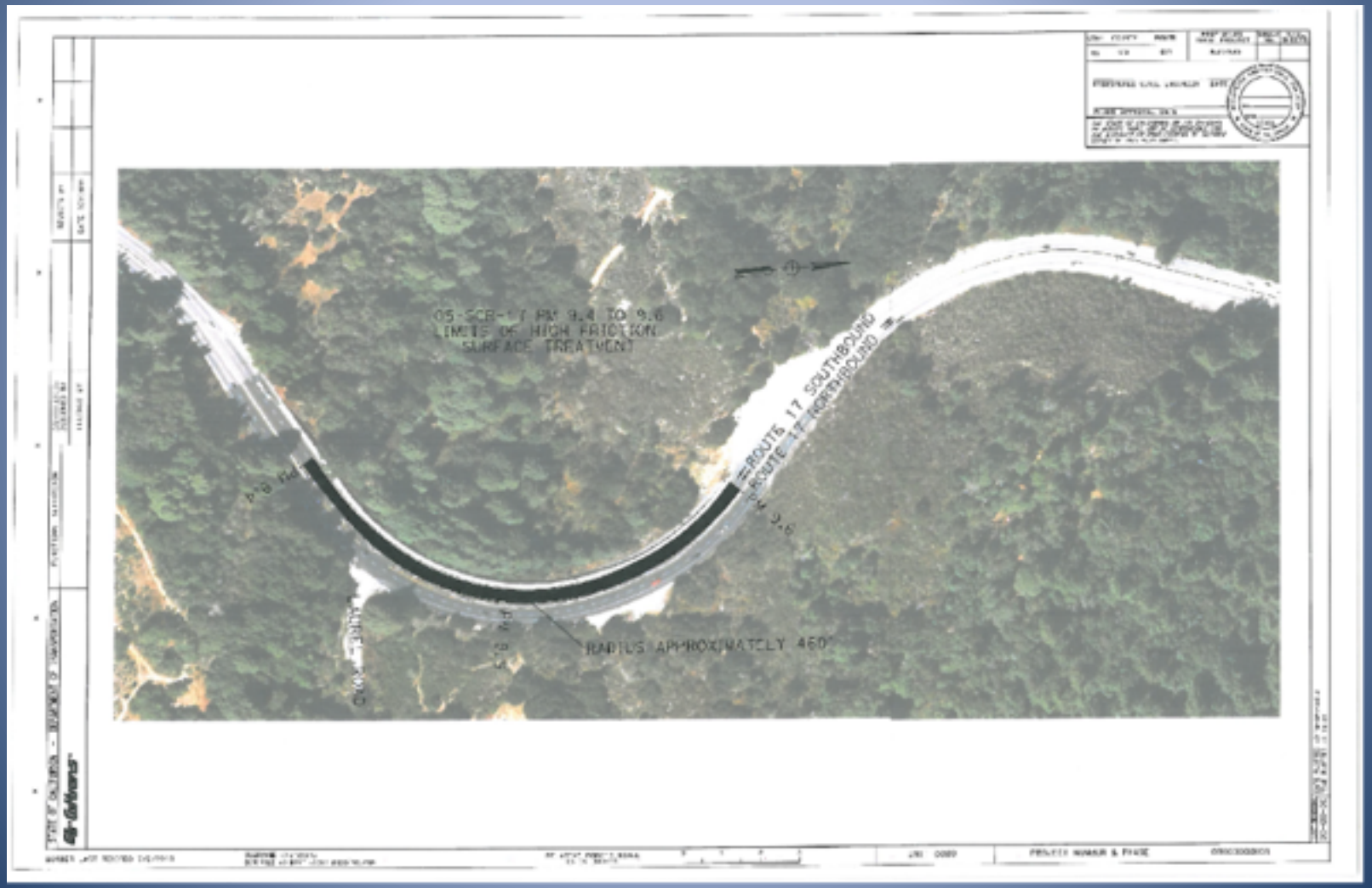
1. We used an interest rate of 0.75% and a service life of 15 years in order to estimate an annual cost.
2. The total cost displayed for a project includes other line items that may not necessarily be a part of each HFSC project.
3. HFSC installations at ramps incorporated some signing improvements that also increased safety.

Total Crash Analysis			Wet Crash Analysis		
Crash Total / Year (Before)	45.0	This equals 31.4 fewer total crashes per year or a percentage decrease of 69.9%.	Wet Crashes / Year (Before)	27.2	This equals 20.9 fewer wet crashes per year or a percentage decrease of 76.9%.
Crash Total / Year (After)	13.5		Wet Crashes / Year (After)	6.3	

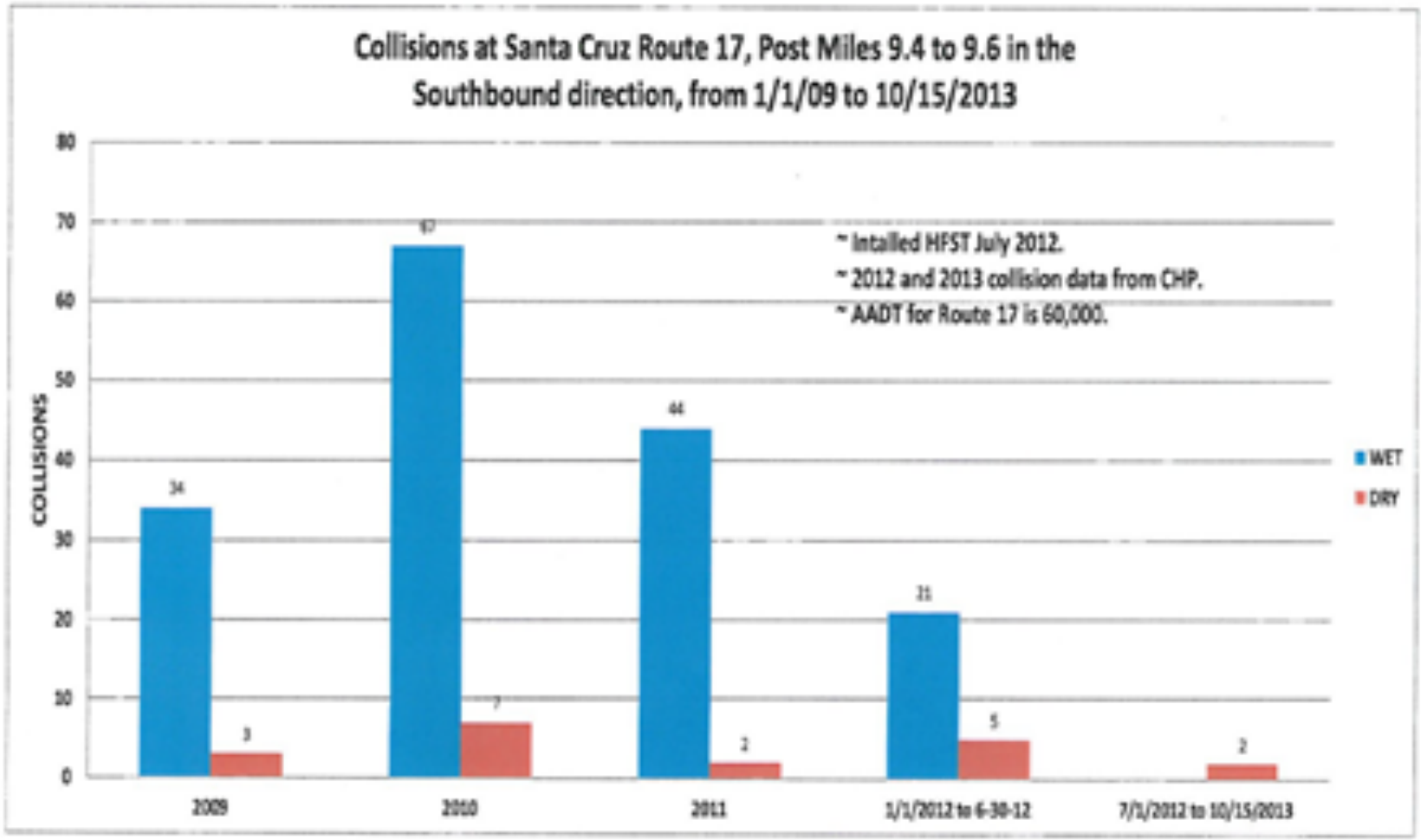
Benefit/Cost Ratios			Net Annual Benefit		
TOTAL Benefit/ Cost Ratio	23.80	Both the total and wet benefit/cost ratios exceed 1.0 indicating that HFSC is a very cost-effective countermeasure.	TOTAL Net Annual Benefit	$2,670,000	Based on total crashes, there is a net benefit (annual benefits less annual costs) of $2.67 million yearly for a 15 year service life for these 6 projects.
WET Benefit/ Cost Ratio	3.93		WET Net Annual Benefit	$340,000	

California's Experience with HFST

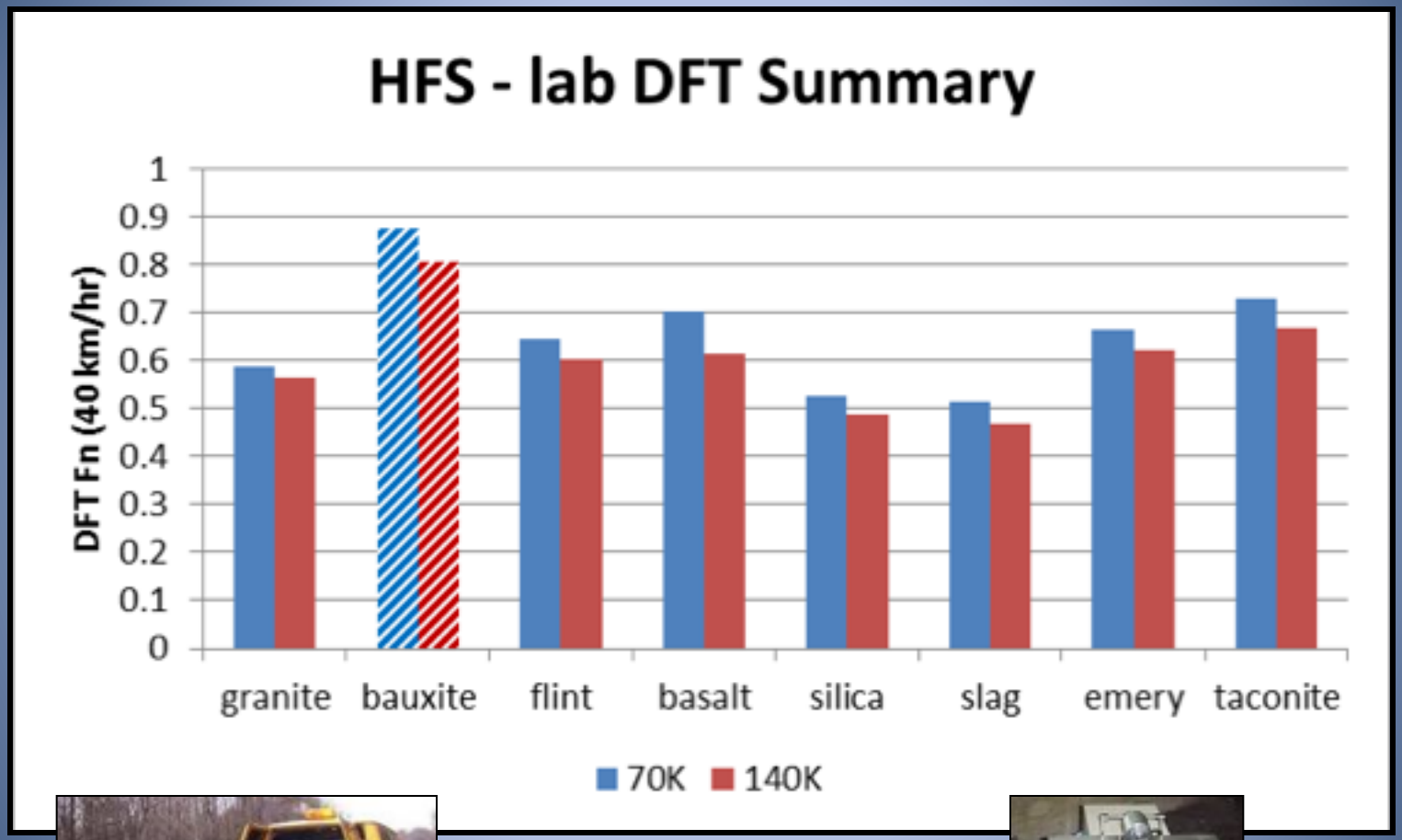
Total Planned - 229 locations



Does HFST have a successful track record



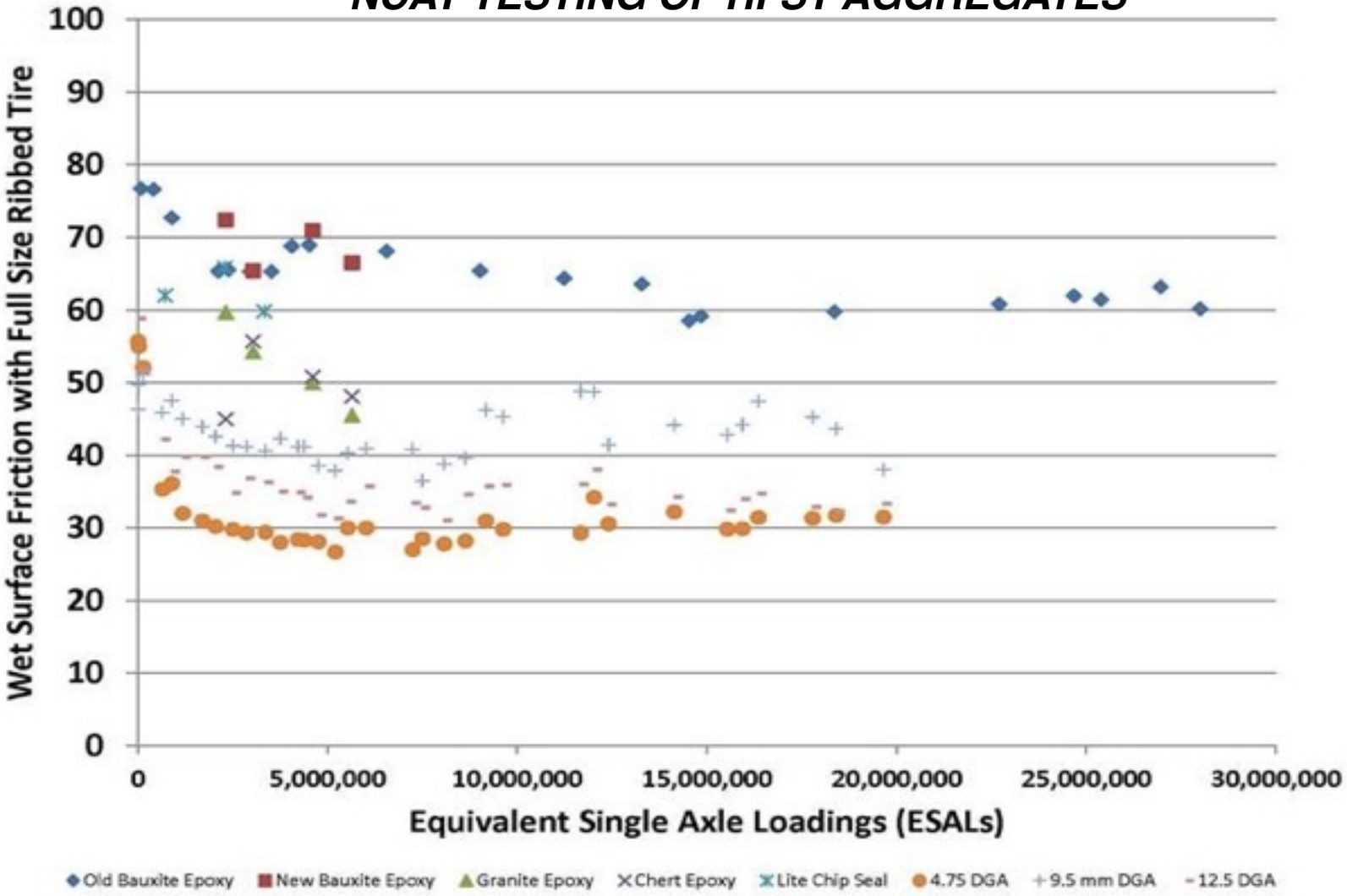
Early NCAT Testing of HFST Aggregates



Dynamic Friction Tester
ASTM E-1911

Aggregate – Calcined Bauxite

NCAT TESTING OF HFST AGGREGATES



Manual Application - HFST

A high friction surface treatment installed with automated application equipment

- Does not require any manual work
- Mixes, monitors and installs an exact volume of polymer resin and cover aggregate enclosed in one mobile unit
- Installs at 12 foot full lane widths at 26 linear feet per minute
- Will install up to 2600 sy2 per hour before requiring to be refilled

AUTOMATED APPLICATION

Limitations / Mixing

Hand Mixing

- Ratio - Visual
- Time - Timer
- Temperature - Viscosity
- Mixer – Jiffy Style

Mechanical Mixing

- Ratio – Pump Maintenance
- Time - Automated
- Temperature - Controlled
- Mixer - Automated

Pavement Condition

Why is a sound substrate important?

Stresses induced in a weak asphalt pavement may result in this type of delamination

Limitations & Risks / Temperature

Cold Weather

- Polymers thicken as temperature drops
- Thicker polymers do not mix as easily
- Thicker polymers may not penetrate the substrate or wick well into aggregates
- May not meet designed properties
- “Return to traffic” times dramatically reduced

Hot Weather

- Binder may set too fast to allow proper embedment of aggregate
- Viscosity may become too thin to allow proper mil thickness of the binder

High Friction Surface Treatment (HFST)

This is why we use HFST

KWIKBOND POLYMERS

City of Columbia, MO Bike Lane Recycled Materials

EATHER WEG

1824

MADE IN USA FLOW

EATHER DI

City of Chicago, central business district bus lane

City of Auckland, NZ bus lanes

THANK YOU!

KWIKBOND POLYMERS

ANY QUESTIONS?