Route 3 North Pavement Preservation SHRP2 Showcase Project

October 13, 2016
National Pavement Preservation Conference
Nashville, TN

Ed Naras
Pavement Management Engineer
MassDOT-Highway Division

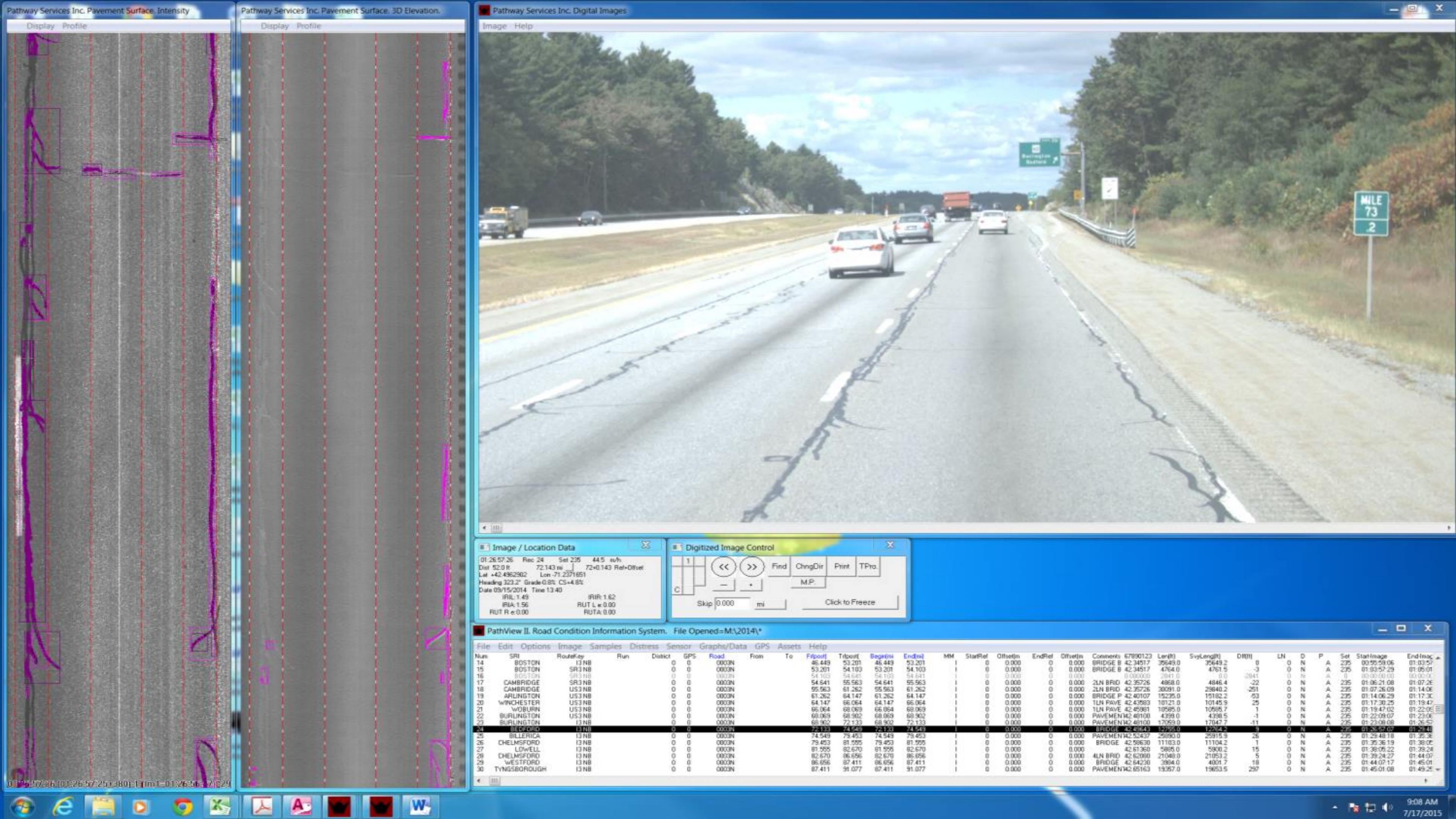
Strategic Highway Research Program 2 (SHRP2)

- Four (4) Broad Areas of Emphasis
  - Highway Safety
  - **Renewal**
    - **Address aging infrastructure through rapid design & construction methods to produce long-lived facilities**
  - Reliability
  - Capacity
- R-26 Pavement Preservation for High Volume Roadways
  - Search for R-26 Implementation Projects.
  - DOT asked to Identify Project and Submit Proposal

SHRP2-R26 Pavement Preservation For High Volume Roadways

- HMA Pavement Preservation Treatments
  - Crack Filling
  - **Crack Sealing**
  - Microsurfacing
  - Chip Seals
  - **Ultra-thin Bonded Wearing Course (UTBO) x3**
  - Thin HMA Overlay
  - Cold milling and overlay
  - Ultrathin HMA Overlay
  - Hot In Place HMA recycling
  - Cold In Place HMA recycling
  - **Profile Milling**
  - Ultra-thin Whitetopping

Automated Pavement Condition Survey


Pathway Services Inc. Pavement Surface. Intensity
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Pathway Services Inc. Pavement Surface. 3D Elevation.
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PathView II. Road Condition Information System. File Opened=M:\2014*
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7/17/2015

Treatment Selection Matrix

Treatment Code	Treatment Name
A_C_S	Asphalt Crack Seal
A_R_S	Asphalt Route and Seal
M_S	Micro-surfacing
[illegible]	Rubber Chip Seal
P_P_S_T	Paver Placed Surface Treatment
THIN	[illegible]
A_R_G_G_O	Asphalt Rubber Gap Graded Overlay
OGFCW	OGFC w/leveling
OGFCDB	OGFC w/ 2" dense binder
FUNCC	Functional Overlay with Saw and Seal
THICKC	Thick Overlay with Saw and Seal
FUNCA	Functional Overlay (mill 2" overlay 2")
STRUC	Structural Overlay (mill 2" overlay 4")
RECL	Full Depth Reclamation
RECN	Reconstruction

Index	Alligator				Transverse					Longitudinal				Raveling			Roughness		Rutting		
Value	ALIG 1	ALIG 2	ALIG 3	ALIG	TRAN 1	TRAN 2	TRAN 3	TRAN 4	TRAN 5	LONG 1	LONG 2	LONG 3	LONG 3	RAVL 1	RAVL 2	RAVL 3	RUFF 1	RUFF 2	RUT 1	RUT 2	RUT 3
5																					
4.9																					
4.8																					
4.7																					
4.6																					
4.5																					
4.4																					
4.3																					
4.2																					
4.1																					
4					A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.9					A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.8					A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.7	A C S	A R G G O			A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.6	A C S	A R G G O			A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.5	A C S	A R G G O			A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.4	A C S	A R G G O			A C S	P P S T	A R G G O	OGFCW			OGFCW	A R G G O									
3.3	A C S	A R G G O			A C S	P P S T	A R G G O	OGFCW		A C S	OGFCW	A R G G O									
3.2	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		P P S T	OGFCDB	A R G G O									
3.1	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		P P S T	OGFCDB	A R G G O									
3	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		P P S T	OGFCDB	A R G G O		M S			M S				
2.9	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		P P S T	OGFCDB	A R G G O		M S			M S				
2.8	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		P P S T	OGFCDB	A R G G O		M S			M S				
2.7	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		FUNCA	OGFCDB	FUNCC		M S			M S		A R G G O	OGFCW	
2.6	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		FUNCA	OGFCDB	FUNCC		M S			M S		A R G G O	OGFCW	
2.5	OGFCDB	A R G G O	FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		FUNCA	OGFCDB	FUNCC		P P S T	OGFCW	A R G G O	P P S T	OGFCW	OGFCW	OGFCW	
2.4			FUNCA	FUNCC	A R S	OGFCDB	FUNCA	FUNCC		FUNCA	STRUC	FUNCC	THICKC	P P S T	OGFCW	A R G G O	P P S T	OGFCW	OGFCW	OGFCW	
2.3			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC	P P S T	OGFCW	A R G G O	P P S T	OGFCW	OGFCDB	OGFCW	
2.2			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC	P P S T	OGFCW	A R G G O	A R G G O	OGFCDB	OGFCDB	OGFCW	
2.1			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC	P P S T	OGFCW	A R G G O	A R G G O	OGFCDB	OGFCDB	FUNCA	FUNCC
2			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC	P P S T	OGFCW	A R G G O	A R G G O	OGFCDB	RECN	FUNCA	FUNCC
1.9			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	A R G G O	OGFCDB	RECN	FUNCA	FUNCC
1.8			FUNCA	FUNCC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	FUNCA	FUNCC	RECN	FUNCA	FUNCC
1.7			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	FUNCA	FUNCC	RECN	FUNCA	FUNCC
1.6			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	FUNCA	FUNCC	RECN	FUNCA	FUNCC
1.5			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	FUNCA	FUNCC	RECN	FUNCA	FUNCC
1.4			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		OGFCDB	A R G G O	FUNCA	FUNCC	RECN	STRUC	THICKC
1.3			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
1.2			STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
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1	RECN		STRUC	THICKC	RECN	STRUC	FUNCA	FUNCC	THICKC	FUNCA	STRUC	FUNCC	THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.9	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC	FUNCC	THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.8	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.7	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.6	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.5	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.4	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.3	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.2	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0.1	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC
0	RECN		STRUC	THICKC	RECN	STRUC			THICKC		STRUC		THICKC		FUNCC	FUNCA	FUNCA	FUNCC	RECN	STRUC	THICKC

Project: Route 3 Burlington-Tyngsboro

- Location: From I-95(Rt 128) to NH State Line
  - 20.6 Centerline Miles
    - 6 Travel Lanes+ Shoulders & Breakdown lanes
    - 1M SY of Mainline
    - 400K SY of Shoulder & Breakdown Lane
  - Route 3N Widening completed approx. 10 years ago.
  - Minor rutting (0.2" average).
- Ideal Candidate for Pavement Preservation
  - Minor Cracking & Light Surface Ravelling
  - Crack Sealing Performed last year.

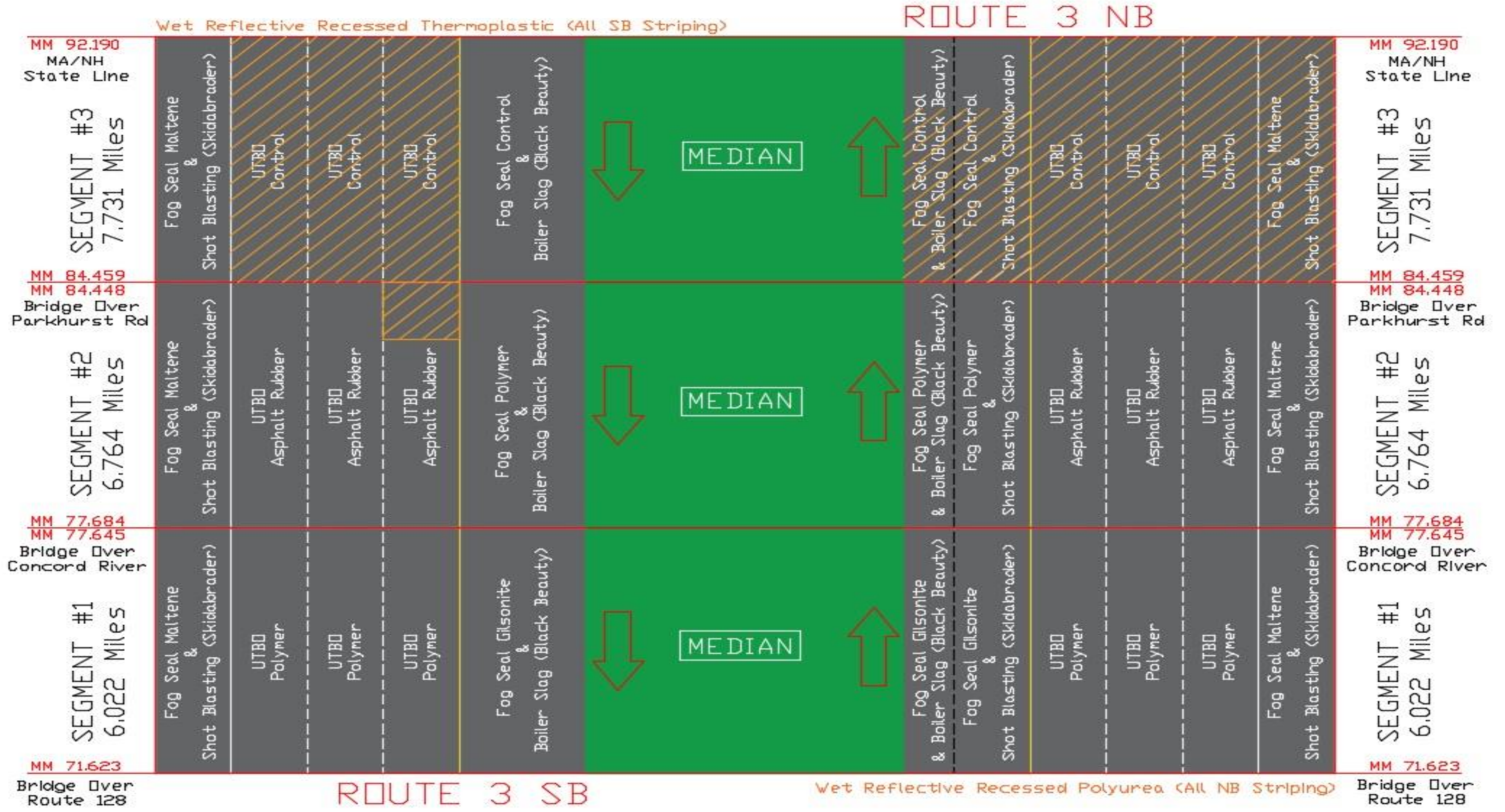
Bid - $8.1M Awarded to Brox Industries.

ROUTE 3 NORTH PROJECT

Pavement Condition - A Closer Look….

Demonstration Treatments

- Ultrathin Bonded Overlays (UTBO)
  - UTBO with PG 64-28 Binder (Control)
  - UTBO with PG 58-28 Asphalt Rubber Binder (Rec.)
  - UTBO with PG 64V-28 Binder (Polymer Modified)
- Maltene Rejuvenator Fog Seal (Breakdown Lane)
  - Asphalt fog seals compared to rejuvenating seals
- "Green Chemistry" Rejuvenator Fog Seal (1500 LF of Southbound Breakdown Lane)
  - Delta S, a "Green Chemistry Rejuvenator by Collaborative Aggregates
- Fog Seals (High Speed Shoulder Only)
  - CRS-2 (Unmodified Emulsified Binder)
  - Gilsonite Emulsion
  - CRS-2Pd (Polymer Modified Emulsified Binder)
- Texture added to breakdown lane & shoulders.
  - Skidabrader and Boiler Slag "aka Black Beauty".



ROUTE 3 NB
Wet Reflective Recessed Thermoplastic (All SB Striping)
MM 92.190
MA/NH State Line
SEGMENT #3 7.731 Miles
MM 84.459
MM 84.448
Bridge Over Parkhurst Rd
SEGMENT #2 6.764 Miles
MM 77.684
MM 77.645
Bridge Over Concord River
SEGMENT #1 6.022 Miles
MM 71.623
Bridge Over Route 128
Fog Seal Maltene & Shot Blasting (Skidabrader)
UTBO Control
UTBO Control
UTBO Control
Fog Seal Control & Boiler Slag (Black Beauty)
MEDIAN
Fog Seal Control & Boiler Slag (Black Beauty)
Fog Seal Control & Shot Blasting (Skidabrader)
UTBO Control
UTBO Control
UTBO Control
Fog Seal Maltene & Shot Blasting (Skidabrader)
Fog Seal Maltene & Shot Blasting (Skidabrader)
UTBO Asphalt Rubber
UTBO Asphalt Rubber
UTBO Asphalt Rubber
Fog Seal Polymer & Boiler Slag (Black Beauty)
MEDIAN
Fog Seal Polymer & Boiler Slag (Black Beauty)
Fog Seal Polymer & Shot Blasting (Skidabrader)
UTBO Asphalt Rubber
UTBO Asphalt Rubber
UTBO Asphalt Rubber
Fog Seal Maltene & Shot Blasting (Skidabrader)
Fog Seal Maltene & Shot Blasting (Skidabrader)
UTBO Polymer
UTBO Polymer
UTBO Polymer
Fog Seal Gilsonite & Boiler Slag (Black Beauty)
MEDIAN
Fog Seal Gilsonite & Boiler Slag (Black Beauty)
Fog Seal Gilsonite & Shot Blasting (Skidabrader)
UTBO Polymer
UTBO Polymer
UTBO Polymer
Fog Seal Maltene & Shot Blasting (Skidabrader)
ROUTE 3 SB
Wet Reflective Recessed Polyurea (All NB Striping)

Ultrathin Bonded Overlay (UTBO)

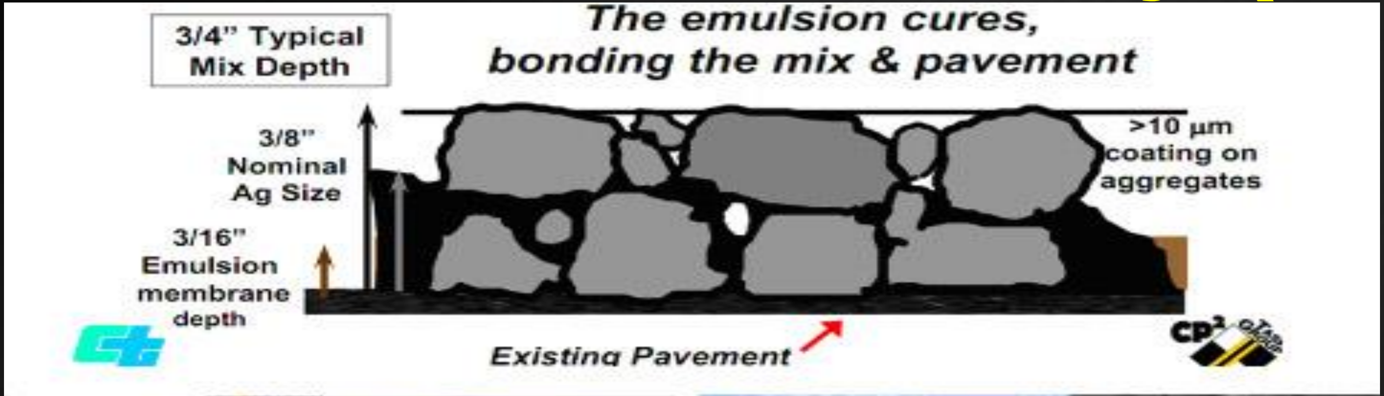
- **How is this different from typical overlay.**
  - Uses a spray paver
  - “Gap-Graded” aggregate gradation has larger air voids that allow bond-coat to migrate into the HMA.
  - DOT Modified UTBO specification to be “hybrid ½”
    - Not conventional 3/8” or ½” aggregate
  - Ramps Omitted & Retained Rumble Strips
    - Time and Money
  - Different Ride Quality Specification
    - Set reasonable expectations for 5/8” thick overlay”

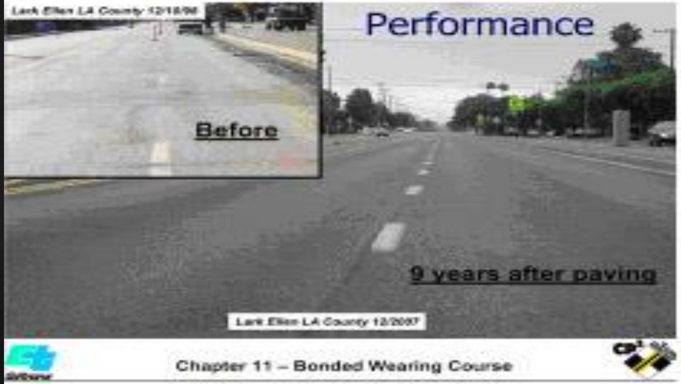
TRANSITION MILLING

Route 3 North Project Ramp Keys

UTBO “Spray Paver”

Ultrathin Bonded Overlay (UTBO)





Shoulder Treatments

- US-Rte 3 was widened approximately 10 years ago.
  - Added 3’rd travel lane & high speed shoulder
  - Full build out for additional lane at bridges.
- Needed Cost Effective Treatment for 400,000 sy of shoulders.
- Fog Seals – Nashville Pavement Preservation Conference.

Fog Seal – Asphalt Emulsion

- A light spray application of dilute asphalt emulsion used primarily to seal an existing asphalt surface.
- Application rate - 0.06-0.20 gal/sy
- "Top of the Curve" Preservation Treatment
- One of the most cost effective preservation treatments

Fog Seal - Rejuvenating

- Rejuvenators have oils that soften the existing binder, thus reducing its viscosity.
- Improves the flexibility of the binder, reducing raveling and future loss of aggregate.
- Replace the “maltenes” in the asphalt.
- Dosage rate based on the “Penetration” or viscosity of the rejuvenated asphalt binder.

Surface Friction Considerations

- Fog Seals or Rejuvenating Seals can cause short term reductions in skid resistance by 10%.
- How will this be addressed?
  - High Velocity Shot Blasting (Skidabrader)
  - Boiler Slag (aka "Black Beauty")
- To evaluate friction and safety, Contract required skid testing.

Surface Friction High Velocity Shot Blasting "Skidabrader"

“Skidabrader”

High Velocity Shot Blasted Surface

Surface Friction - Skid Testing

Skid Testing

Section 1.

Section 1	Before		After Skidabrader		1 Hour After Treatment		4 Hour After Treatment		Right Lane	
Distance	SN(40S)	Peak	SN(40S)	Peak	SN(40S)	Peak	SN(40S)	Peak	SN(40S)	Peak
0	54.20	101.77	77.20	109.90	43.90	73.52	37.00	87.59	50.10	97.92
500	53.40	95.02	73.10	105.69	43.40	57.54	36.00	56.63	48.90	92.51
1000	56.20	101.07	71.50	112.49	42.10	60.88	34.00	68.27	46.20	89.29
1500	67.20	93.21	74.50	109.39	44.40	53.91	38.00	59.03	46.00	80.51
2000	66.70	98.93	75.50	115.88	42.70	58.41	39.00	59.40		
average	59.54	98.00	74.36	110.67	43.30	60.85	36.80	66.18	47.80	90.06

Surface Friction Outflow Meter

Rejuvenating Seal

Rejuvenated HMA Mixture Testing

Pavement Technology, Inc.

Massachusetts Department of Transportation
Project No. NHP-002S(660)

State Route 3

Sample Identification	Viscosity 60°C, Poises	Phase Angle, °	MODULUS, 60°C, Pa		
			Complex	Elastic	Viscous
Southbound Lane					
Untreated	28711	72.4	28787	8704	27439
Treated	21571	74.3	21628	5842	21571
Northbound Lane					
Untreated	59590	69.4	59747	20997	55936
Treated	32470	73.8	32555	9063	31269

Fog Seal

Fog Seal – Emulsified Asphalt

- Add asphalt to pavement surface.
- Seals & Waterproofs.
- Retard future oxidation.
- Delays further stone loss by holding aggregate in place.
- Improve visual aesthetic of the surface appearance.
- **On high speed roadway, exercise care to retain friction and safety.**

RT 3 NB After UTBO & Fog Sealing

Rt 3. North – What Else?

- MassDOT monitors:
  - Condition
  - Ride
  - Skid
- Pilot project for wet retroreflective pavement markings.
  - Wet reflective polyurea.
  - Wet reflective thermoplastic
  - Use a different element that has improved visibility in wet weather.
  - Retroreflectivity testing required upon placement of markings.
- Slotted Pavement Markers not used.

Sustainability

- **Economic.**
  - $9+M Preservation Project (10 years)
  - $30+M As Conventional Mill and Fill in Several Years
- **Environmental.**
  - 63% Lower CO2 Emissions (Annualized)
  - 64% Lower Energy Consumption (Annualized)
  - 62% Lower Cost (Annualized)
  - Preservation work allows reallocation of conserved financial and natural resources.
  - Sustainable Materials incorporated in Fog Seal Treatments
- **Social.**
  - Ride Quality Improvements
  - Noise Improvements ("Hybrid" 3/8"-1/2" For Quiet Pavement)…
  - Safety Improvements by Eliminating Localized Rutting.

Bridge Approaches

Bridge Approach Leveling

Bridge Approach - Survey

Control Strip IRI
Should we micromill the whole road?

	Left Lane	Center Lane	Right Lane
Before	84.9in/mi.*	67.0in/mi.	79.8in/mi.*
After UTBO	55.2in/mi.	54.8in/mi.	54.3in/mile
Improvement	**35%**	**18%**	**32%**

* Note: Left lane and Right lane milled for shimming.

Bond Coat and Quantities

Date	Area Covered (SY)	Emolsion Used (Gallons)	Application Rate Spec. range(0.18-0.22) gal/y2	Total Mix Used (Tons)
6/17/2015	14,227.80	2,600.00	0.1827	583.09
6/18/2015	20,666.90	3,975.00	0.1923	907.00
6/21/2015	2,340.50	460.00	0.1965	80.89
6/22/2015	18,784.40	3,700.00	0.1970	662.00
6/24/2015	25,815.50	4,824.00	0.1869	857.55
6/25/2015	28,645.10	5,446.00	0.1901	1100.88
6/29/2015	15,072.50	3,021.00	0.2004	598.25
6/30/2015	22,143.10	4,119.00	0.1860	801.43
7/1/2015	14,938.70	2,826.00	0.1892	646.48
7/6/2015	11,457.00	2,130.00	0.1859	479.20
7/7/2015	23,157.80	4,380.00	0.1891	881.23
7/8/2015	22,778.80	4,290.00	0.1883	887.75
7/13/2015	22,931.10	4,170.00	0.1818	918.47
7/15/2015	26,222.70	4,963.00	0.1893	1039.84
7/16/2015	20,702.50	3,958.00	0.1912	900.32
7/17/2015	23,228.00	4,190.00	0.1804	948.93
7/20/2015	20,949.33	3,875.00	0.1850	892.98
7/21/2015	12,303.70	2,288.00	0.1860	507.29
Total:	**346,365.43**	**65,215.00**	**0.1888**	**760.75**

Ride Quality (IRI) – Acceptance Data

Quality Limits

		Ride Quality (IRI in / mile)
	Upper Eng. Limit (UEL):	100.00
	Upper Spec. Limit (USL):	85.00
	TARGET:	**65.00**
	Lower Spec. Limit (LSL):	N/A
	Lower Eng. Limit (LEL):	N/A

		1	**2**	**3**	**4**	**5**	**6**
Lane		**Lerf Lane**		**Center Lane**		**Right Lane**	
		wheel path		*wheel path*		*wheel path*	
		Left	*Right*	*Left*	*Right*	*Left*	*Right*
No. of Samples	n	216	216	230	230	208	208
Mean	x	51.33	52.78	53.68	49.00	52.00	50.74
Std Dev	s	7.40	7.33	7.86	8.02	8.82	8.94
Variance	s^2	54.76	53.73	61.78	64.32	77.79	79.92
Q_U	(USL - X)/s	4.55	4.40	3.98	4.49	3.74	3.83
Q_L	(X - LSL)/s	N/A	N/A	N/A	N/A	N/A	N/A
P_U		100	100	100	100	100	100
P_L		100	100	100	100	100	100
PWL	$(P_U + P_L) - 100$	100	100	100	100	100	100
Pay Factor ((55 + 0.5 Quality Level)/100)		1.05	1.05	1.05	1.05	1.05	1.05
Pay Adjustment		$ 6,244.39	$ 6,244.39	$ 6,244.39	$ 6,244.39	$ 6,244.39	$ 6,244.39

Binder Content – Acceptance Data

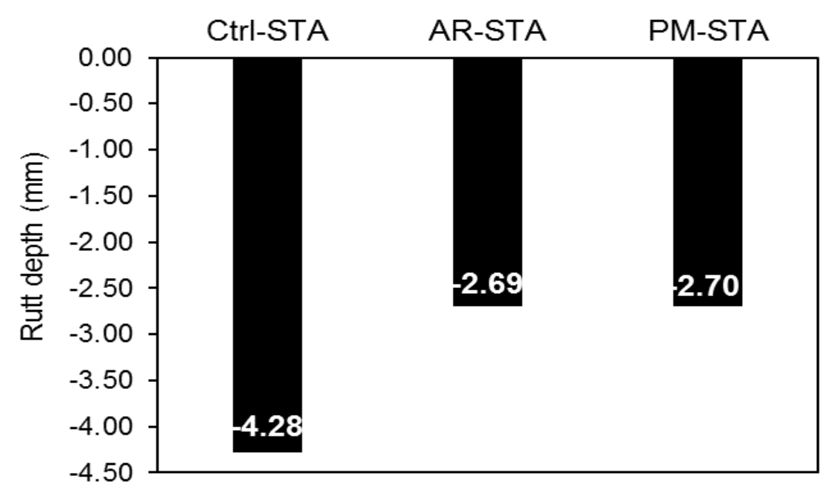
Quality Limits	Air Voids (%)	VMA (%)	VFA (%)	PG Binder Content (%)	In-place Density (%)	Thickness (Inches)
Engineering Limit (+/-):	2.0	1.0	5.0	0.6	2.50	30%
Specification Limit (+/-):	1.3			0.4	2.50	20%
Upper Eng. Limit (UEL):	2.0	1.0	5.0	5.4	2.50	0.00
Upper Spec. Limit (USL):	1.3			5.2	2.50	0.00
TARGET:				4.8		
Lower Spec. Limit (LSL):	-1.3			4.4	-2.50	0.00
Lower Eng. Limit (LEL):	-2.0	-1.0	-5.0	4.2	-2.50	0.00

Quantities	Air Voids (%)			PG Binder Content (%)	In-place Density (%)	Thickness (Inches)
Total Quantity (Lot 1) =				270000.00		

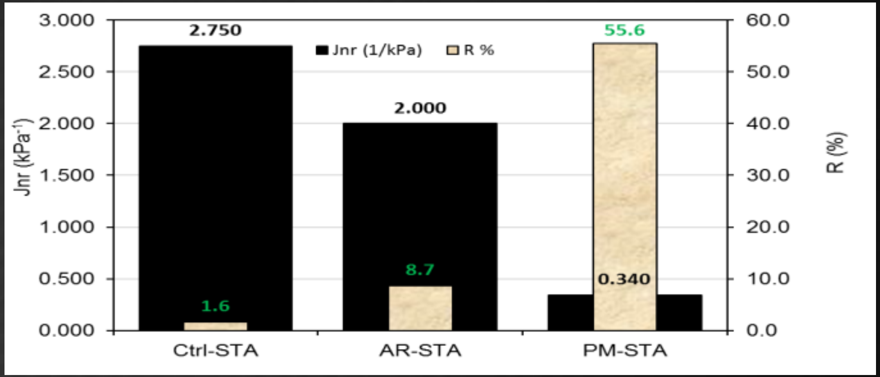
		Air Voids (%)	PG Binder Content (%)	In-place Density (%)	Thickness (Inches)
Number of Samples	n	0	48	0	0
Mean	x	#DIV/0!	4.77	#DIV/0!	#DIV/0!
Std Dev	s	#DIV/0!	0.15	#DIV/0!	#DIV/0!
Variance	s^2	#DIV/0!	0.02	#DIV/0!	#DIV/0!
Q_U	(USL - X)/s	#DIV/0!	2.78	#DIV/0!	#DIV/0!
Q_L	(X - LSL)/s	#DIV/0!	2.40	#DIV/0!	#DIV/0!
P_U		#N/A	100	#N/A	#N/A
P_L		#N/A	100	#N/A	#N/A
PWL	$(P_U + P_L) - 100$	#N/A	100	#N/A	#N/A
Pay Factor ((55 + 0.5 Quality Level)/100)		#N/A	1.05	#N/A	#N/A
Pay Adjustment (Lot 1)		#N/A	$18,832.50	#N/A	#N/A

Rutting Resistant

Extracted and Recovered Binders
ASTM D2172
ASTM D7906



Hamburg Wheel Track Test at 50° C
AASHTO T324



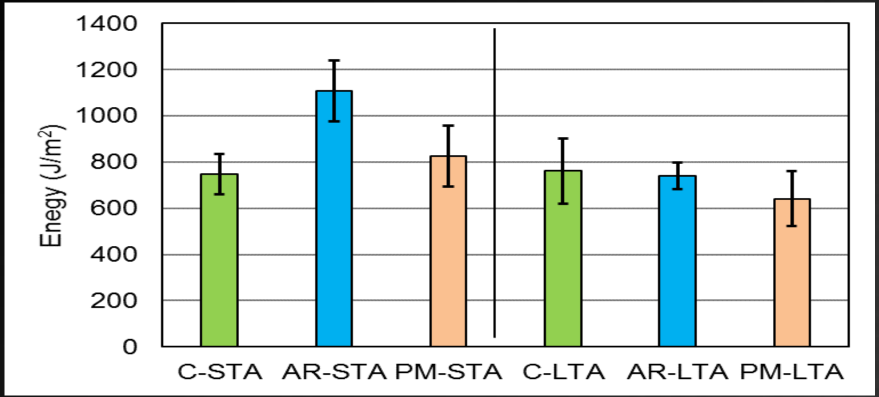
Multiple Stress Creep Recovery test at high end PG and 3.2 kPa
AASHTO TP 70

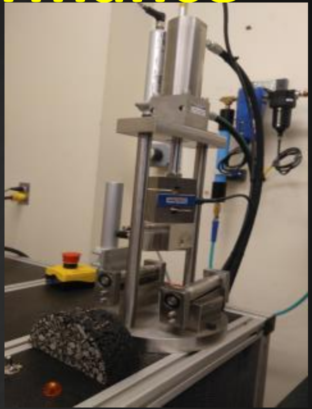
STA = Binders extracted and recovered from cores

LTA = Loose mixture was aged for 24 hours at 135◦C then extracted and recovered

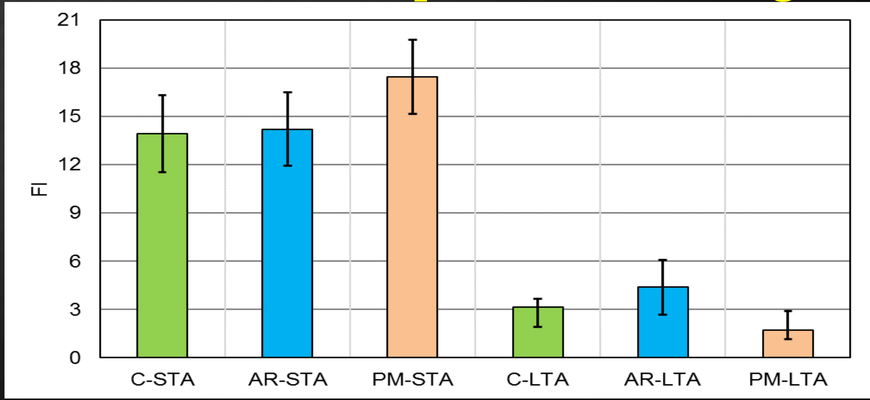
Low & Intermediate Temperature Performance

Low Temperature Cracking





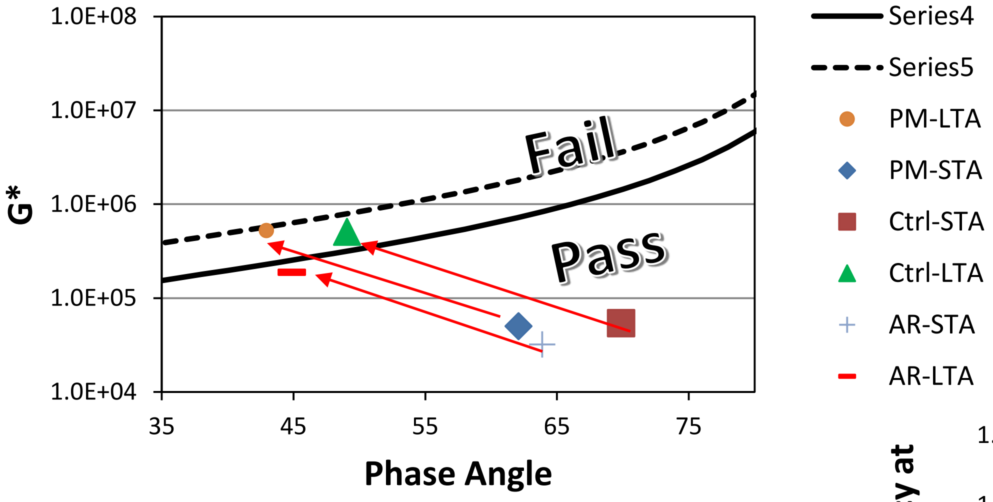
Intermediate Temperature Cracking



Disc Shaped Compact Tension test at -18° C
ASTM D7313

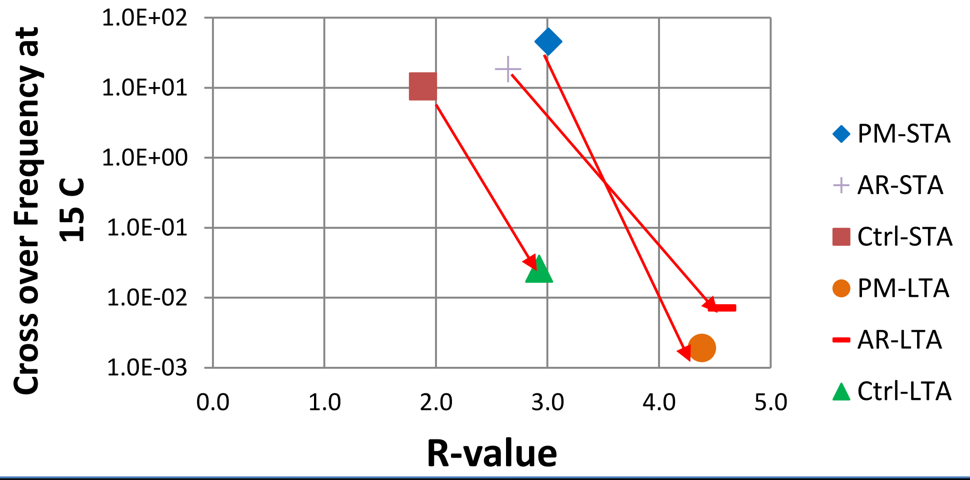
Semicircular Bending test at 25° C
AASHTO TP 105

Master Cure & Black Space Parameters



Black Space Diagram

ω_0 – R-value Space Diagram



More Testing?

- Pavement Condition & Ride Testing - Annual
- Pavement Friction Testing - Annual
- Cores on Rejuvenated Shoulders for Extraction, Recovery & Binder Testing (ongoing).
- Sand-Patch Test comparing textures of rejuvenated to control HMA (working on it).

Skid Test Data (ASTM E501)– 1 Year

Northbound Skid Data						
	High Speed Shoulder	Left Lane	Center Lane	Right Lane	Breakdown Lane	Control (CD Roadway)
Section 1	53.99	45.25	42.83	44.77	66.71	52.54
Section 2	55.48	48.11	44.89	46.91		
Section 3	53.23	48	44.77	45.3		

Southbound Skid Data						
	High Speed Shoulder	Left Lane	Center Lane	Right Lane	Breakdown Lane	Control (CD Roadway)
Section 1	54.28	49.2	46.06	48.73	66.8	55.59
Section 2	52.37	46.75	43.55	47.83		
Section 3	50.39	45.27	41.44	42.39		

Rejuvenators

Binder Extraction & Recovery

Table I

Pavement Technology, Inc.

Massachusetts Department of Transportation – Reclamite Application
Project No: NHP-002S(660)

Top 3/8-inch layer

Sample Identification	Viscosity 60°C, Poises	Phase Angle, °	MODULUS, 60°C, Pa Complex	Elastic	Viscous
Core #1 Control	80431	70.3	80643	27133	75942
Core #2 Treated	31334	74.0	31417	8644	30204

-61.0%

Note: Reclamite fog seal application rate approximately double the Delta S application rate.

Rejuvenators – One Year Later

Untreated

"Rejuvenated"

Reclamite

Delta-S

Conclusions

- *"We need to do more of those types of projects"* (Chief Engineer)
- Time will tell! Not ready to make long term predictions.
- Asphalt Rubber or Polymer UTBO preferred for high volume roadways.
  - 2 Similar High Volume UTBO/Fog Seal Projects Awarded
  - More projects coming….
- Motorists impressed by the speed of the operation.
- Added $$ of re-profiling settled bridge approaches worthwhile!
- Ride Quality improvement is outstanding.
- We now have District Offices asking for these types of projects.

Thank You!!

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