

PAAMA

Pennsylvania Association of Asphalt Material Applicators

2024 Conference

PAVEMENT PRESERVATION IN COLD CLIMATES

Lessons from the MnROAD Test Track

www.paama.org
October 2024

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NRRA Executive Director



PAVEMENT PRESERVATION IN COLD CLIMATES

Lessons from the MnROAD test track

Agenda

- MnROAD
- Partnerships / Projects
- Pavement Preservation

**Focus on People, Data, and
Partnership Opportunities**

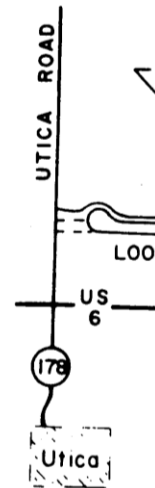


MnROAD – why was it really built?



MnROAD Early History

- **AASHO Road Test (1956-58 built – traffic loadings from 1958-60)**
- **Need for Local Calibrations**
 - MnDOT started Investigation 183 / Flexible Designs (Started 1960's)
 - SHRP/LTPP started for national efforts (8/8/1988)
 - Idea of a cold regions testing facility (1980's)
- **MnROAD Development**
 - Development of Support
 - Getting 25 million in 1990
 - Instrumentation
 - 1992 and 1993 Construction
 - August 2, 1994 Traffic

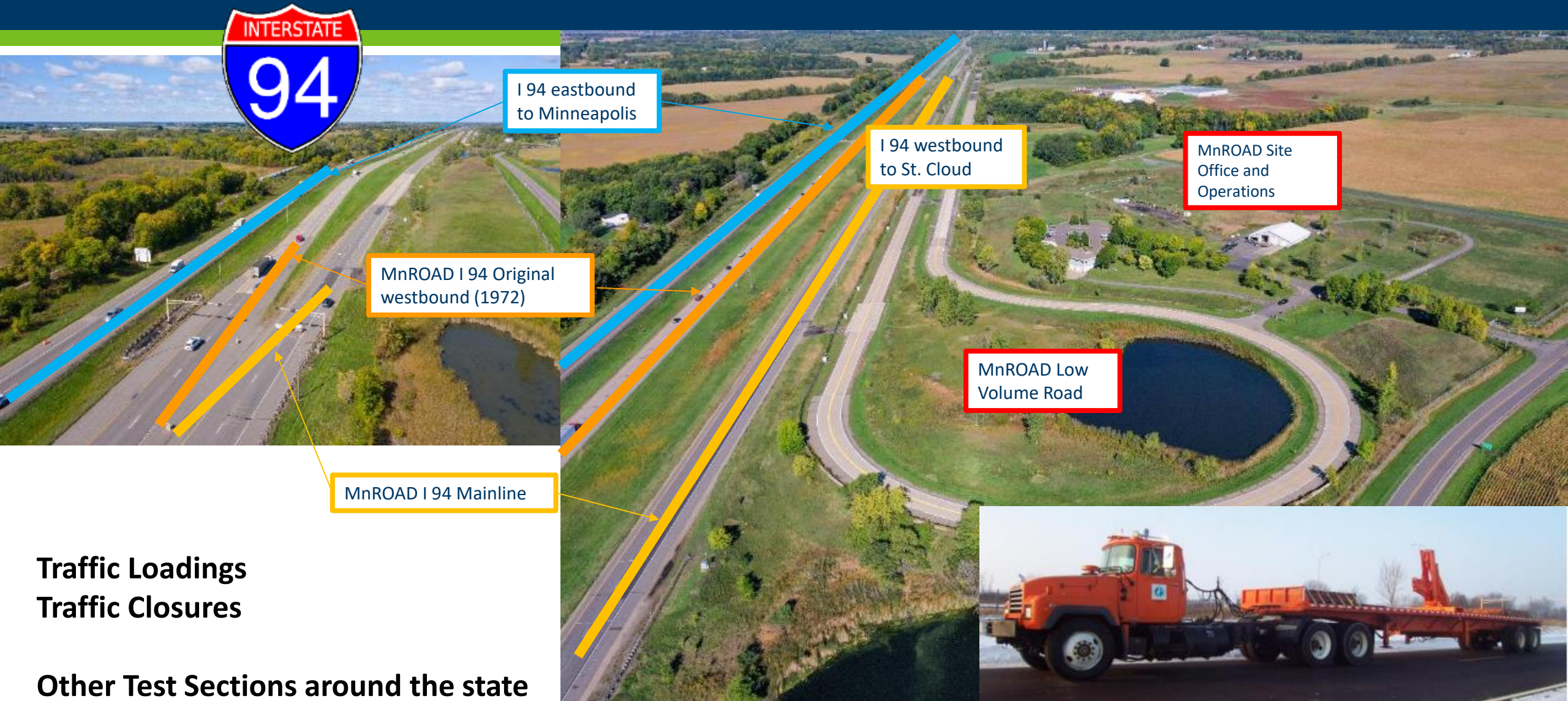


MnROAD Background

- **MnROAD Owned and Operated by Minnesota DOT**
- **HMA & PCC and Geotechnical Research**
- **30 Years of Long-Term Customer Service**
 - Minnesota Department of Transportation
 - Minnesota Local Road Research Board
 - SHRP II / NCHRP / FHWA / Partnerships
 - Pooled Funds Efforts (States) / Industry
- **Partnerships**
 - Pavement Engineering
 - Non-Pavement Research



MnROAD- Minnesota Road Research Facility



Traffic Loadings
Traffic Closures

Other Test Sections around the state

MnROAD Construction / Open Sections

- **MnROAD “Open Cells”** (Pavement Life Left vs Research Life Remaining)
- **Limited space but always open to partnerships**
- **Push the envelope / Dealing with “Risk”**
 - Service Road / Stockpile areas – **high risk**
 - Low Volume Road – **risky**
 - Mainline (I-94) – **some risk**
 - State/county/city roads – **lower risk**



MnROAD Data

- **Performance Monitoring**
 - Albedo Measurements
 - Drone Videos
 - Road Doctor with GPR
 - Detailed Forensics
 - Rolling Weight Deflectometer
 - Rolling Density Meter
 - Many others
 - Working towards greater automation
- All MnROAD Data is public Data

Each Data type has detailed information on the equipment and data collection used

Measurement	Frequency	Comment
Aging Samples	1 / year	Cores taken to monitor aging of HMA mix and PCC joint condition Modified LTPP Survey on all cells
Distress Survey	2 / year	
Dynamic Load Testing	4 / year	Dynamic load testing of sensors. Loading from MnROAD truck and FWD.
Joint Faulting/ Shoulder Dropoff	2 / year	Use an automated Georgia Faultmeter per modified LTPP protocol
Friction	1-2 / year	KJ Law profiler, grip tester and dynamic friction tester used
Falling Weight Deflectometer	8 / year	Testing schedule varies throughout the year. Routine and special testing on HMA and PCC.
HMA Rutting/ Crack Cupping	3 / year	Advanced Laser Profile System (ALPS) used to characterize rutting and crack cupping
Noise	3 / year	On Board Sound Intensity (OBSI) measurements and sound absorption
Piezometer	4 / year	Monitoring well measurements
Permeability	2-4 / year	Test permeability of pervious/porous test cells
Ride Quality	2-4 / year	Pathways and lightweight profiler Sound absorption measurements.
Sound Absorption	3 / year	
Surface Texture	1 / year	Sand Patch and Circular Texture Meter

MnROAD Sensor Data

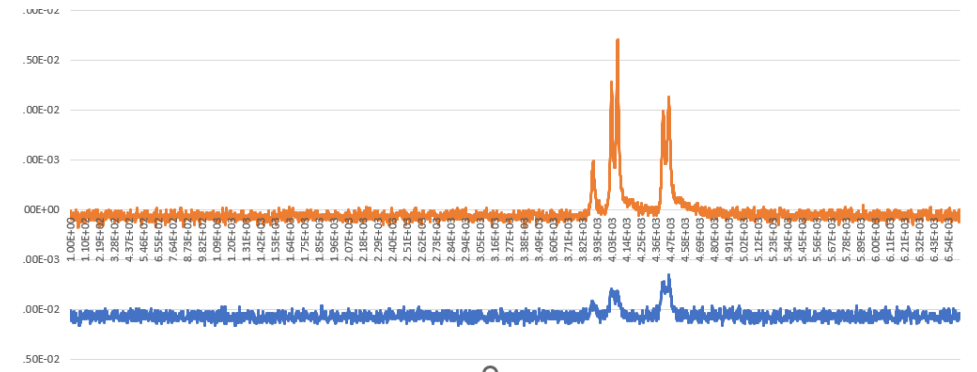
- **Static (Environmental - every 15 min)**

- Temperature
- Moisture
- Joint Opening
- Concrete Maturity
- Environmental Stain
- Pressure
- Ground Water
- Frost Depth



- **Dynamic Data**

- Live Traffic Loading - Controlled Loading
- Earth Pressure Cells
- Pore-Water Pressure
- Asphalt and Concrete Stains
- Displacement



- **Weather Stations (2 onsite)**

- **Traffic Data (Weigh in Motion)**

MnROAD Data Sharing



U.S. Department of Transportation
Federal Highway Administration

About Programs Resources Briefing Room Contact Search FHWA

LTPP InfoPave™: Non-LTPP

Data Bucket (0) | Help | FHWA InfoHighway

HOME DATA VISUALIZATION ANALYSIS TOOLS LIBRARY OPERATIONS **NON-LTPP**

MnROAD Data

Overview Select Sections Data Availability View Data Maps Library Download Data

Overview

MnROAD includes two test roadways, located along westbound I-94 between Albertville and Monticello, Minnesota. It is owned and operated by the Minnesota Department of Transportation in cooperation with its National Road Research (NRRR) partners. MnROAD test roadways have over 80 unique pavement test “cells” designed to investigate the performance of different pavement designs and materials and exposed to actual vehicles and Minnesota climate. Their performance is monitored by sensors within the road structure, as well as many non-destructive and surface tests, such as ride quality testing, deflection measurements (falling-weight deflectometer), and visual distress surveys. In addition to the two test roadways, several other test sections on other roadways are tracked and evaluated within the MnROAD system.

Here is how you can use this MnROAD data portal:

- Select sections using attributes of your interest.
- View the data using several available features.
- Download data by selecting the desired tables and file format.
- Click here for a quick help video.

Section ID

MnROAD data is presented by Section ID. Section ID is comprised of the cell the study is in, which lane the data applies to, and the start year of the Section ID. A new start year for a section ID is given when a layer is added or a new study begins. For example, data for the driving lane of cell 5 that received microsurfacing in 2012 is in Section ID 5-D-2012.

The roadways within the MnROAD system are:

- MnROAD Mainline – Interstate 94** is a 3.5-mile-long roadway that receives high-volume traffic diverted from I-94 original westbound.
- MnROAD Original – Interstate 94** is the original I-94 westbound alignment, which receives traffic when the MnROAD Mainline is closed for evaluation or maintenance. This Interstate highway consists of a concrete pavement built in 1972.

Online Data

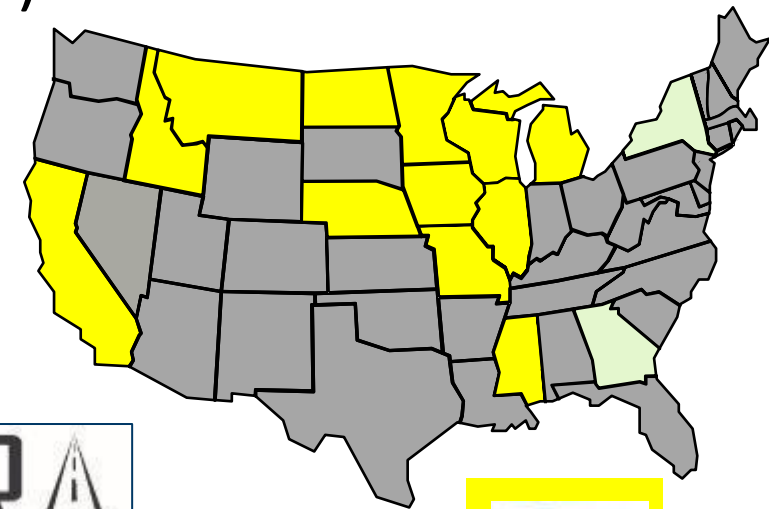
- Overview
- Select Sections
- Data Availability
- View Data
- Maps
- Library
- Download Data

Custom Data Requests

NRRA Pooled Fund Membership Commitments

TPF-5(466) - Fee Structure / year (five years)

- **Phase-1 complete (5 yr) – Now into Phase-2 (year 2/5)**
- **14 Full Agency Commitments (yellow)**
 - \$75K /\$150K Annual Commitment
 - 12 States, Illinois Tollway, LRRB
 - FHWA is also a contributing partner
- **2 ICT Commitments (Green)**
 - \$25K (ICT Team only – Veta Efforts)
- **~85+ Associate membership**
 - 2K/year - Associations, Industry, Consultants, Universities



NRRA – Teams and Outreach Activities

Monthly

- Research Pays off Seminars (online)
- Team Meetings (online)
 - 4 Quarterly + 8 Individual Meetings
 - NRRA General Updates
 - Project Status Reports
 - Common Topic of Interest
 - Low Carbon Materials workgroup added

Yearly

- Transportation Research Board (2 per agency)
- NRRA focused Meeting (2+ per agency)

NRRA Website

- Best Information on Team Members and Funded Project Tracking



NRRA Research Efforts

- NRRA has averaged ~\$1 million research/year
- NRRA Funded 50 projects (phase1) and 29 (phase2)

Phase-I	Phase-II	Short Term					Other	Long Term					University	Consultant	State	RFP
		HMA	PCC	Geo	ICT	PM	Testing	HMA	PCC	Geo	ICT	PM				
Totals Phase -I	50	4	6	2	1	3	1	7	11	6	4	4	24	25	1	0
		16					33					50				
Totals Phase-II	29	0	0	0	0	0	1	11	5	4	4	4	18	8	0	3
		0					29					26				
Grand Totals	79	4	6	2	1	3	2	18	16	10	8	8	42	33	1	3
		16					62					76				

- MnDOT provided MnROAD construction funding for 2017, 2022, 2024

NRRA Spray-Applied Rejuvenator Study

- **12 different products applied in 2021**
- **Applied at 3 locations**
 - MnROAD 58-28 (50')
 - MnROAD 58-34 (50')
 - St. Michael (500')
- **Measuring long-term:**
 - Friction, paint reflectivity, permeability, asphalt binder
- **Over ~2,250 cores taken in 3 years of study**



2024 MnROAD Construction

- **Mainline (I-94)**
 - Low Carbon Concrete Materials – 8 Sections
- **Low Volume Road**
 - Road Soup - Low Volume Road
 - Reconstruction of Water Repellency
 - CAT / NCAT Asphalt Friction with SDX paver
- **Service Road**
 - TPF-5(504): Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing (4 years) - 12 test sections
- **Yummet PCC Mix**
 - Patching on Cell-37 (Nov 4th)



Future

- **New and Innovative Materials**

- Low Cementitious
- Additives
- Recycled Materials

- **Intelligent Construction**

- Rolling Density Meter
- Paver Thermal Profiles
- Intelligent Compaction
- New Equipment
- Other things

- **Low Carbon Materials**

ENVIRONMENTAL IMPACTS

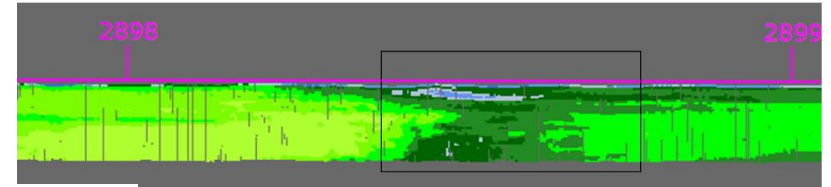
Declared Product:
 Mix 3A21-RGSC • MAPLE GROVE READY-MIX Plant
 Description: 3900.3A21-RGSC.20AEBM.ZC30.G7
 Compressive strength: 3900 PSI at 28 days

Declared Unit: 1 m³ of concrete (1 cyd)

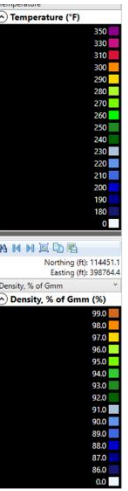
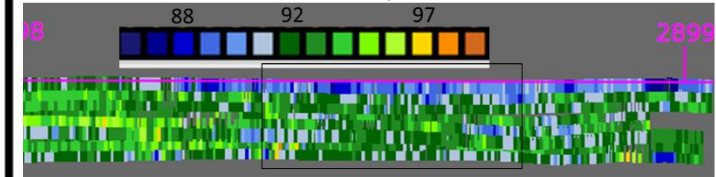
Global Warming Potential (kg CO ₂ -eq)	220 (188)
Ozone Depletion Potential (kg CFC-11-eq)	7.07E-6 (5.40E-6)
Acidification Potential (kg SO ₂ -eq)	0.65 (0.50)
Eutrophication Potential (kg N-eq)	0.29 (0.22)
Photochemical Oxidant Creation Potential (kg O ₃ -eq)	15.6 (11.9)
Abiotic Depletion, non-fossil (kg Sb-eq)	4.37E-5 (3.34E-5)
Abiotic Depletion, fossil (MJ)	1,541 (1,025)
Total Waste Disposed (kg)	0.51 (0.38)
Consumption of Freshwater (m ³)	3.08 (2.35)

Product Components: natural aggregate (ASTM C33), type 1L cement (ASTM C25), batch water (ASTM C1602), fly ash (ASTM C618), admixture (ASTM C194), admixture (ASTM C262)

PMTM Measured Temperature at Placement, °F



DPS Measured Density, %Gmm



MnROAD / NCAT Partnership

Formalized Partnership working on National Needs:

- Full scale accelerated test facilities
- North / South Climatic Zones / Sections
- CAPRI (NCAT Lead National HMA Consortium)

Cracking Group Experiments

- 6 year of partnership with 10 Government Agencies
- HMA cracking test for LTC and fatigue cracking

Additive Group Experiment

- NCAT focus on fatigue cracking
- MnROAD focus on Reflective Cracking
- Continued National Research Coordination

Preservation Group Experiments

- Life extending benefits of pavement preservation techniques
- 8+ year of partnership with over 24+ agencies
- Developing next phase – started in January 2024



MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research



**National Center for
Asphalt Technology**
NCAT
at AUBURN UNIVERSITY

Pavement Preservation Group Study

Objective was to quantify the life-extending benefits of various treatments

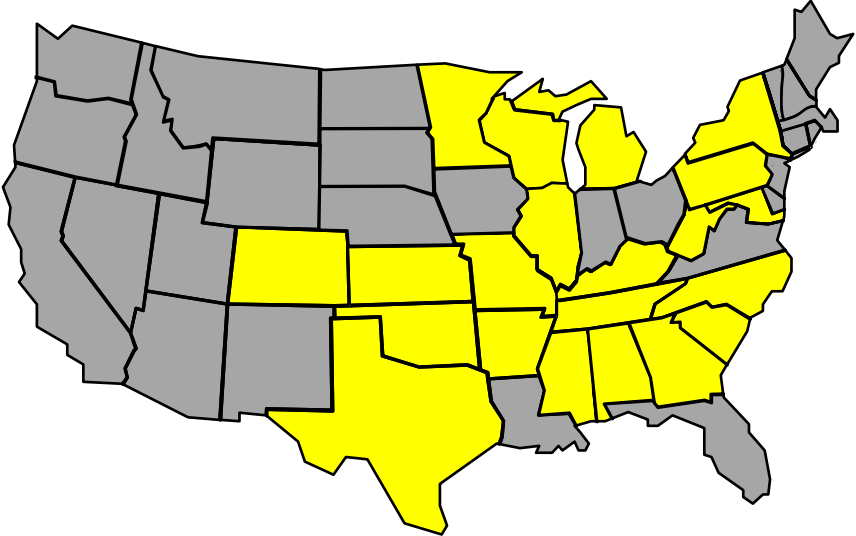


Sponsors

PG Phase II Partners

21 Agencies/FHWA/FP2

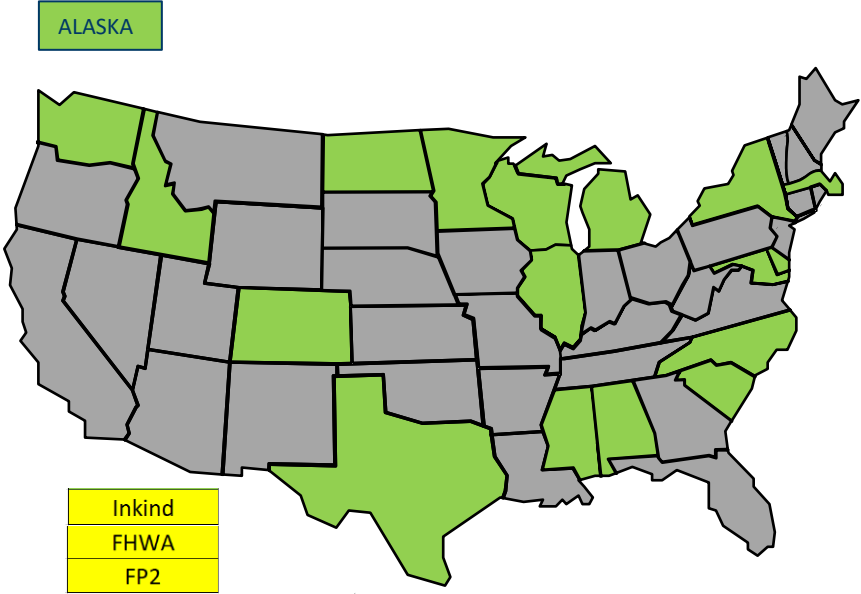
\$5,150,000
Completed!



PG Phase III Partners

18 Agencies so far

Commitment Level: \$50,000/yr., Minimum 3 years
Current budget \$4,500,000



- Alabama
- Alaska
- Colorado
- Delaware
- Idaho
- Illinois
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- New York
- North Carolina
- North Dakota
- South Carolina
- Texas
- Washington
- Wisconsin

PG Study Timeline

2023 End of Phase II 

2019

70th Street



North cold recycled treatments placed on 70th Street in Albertville/Otsego, MN



2015

NCAT-MnROAD



NCAT-MnROAD partnership is established.

Test sections placed on high-volume road (US-280) near Opelika, AL



2016

Northern Sections

North Treatments placed on CSAH 8 and US 169 in Pease, MN



2012

Lee Road 159

First test sections placed on low-volume county road in Auburn, AL



Current Status



145 Test
Sections



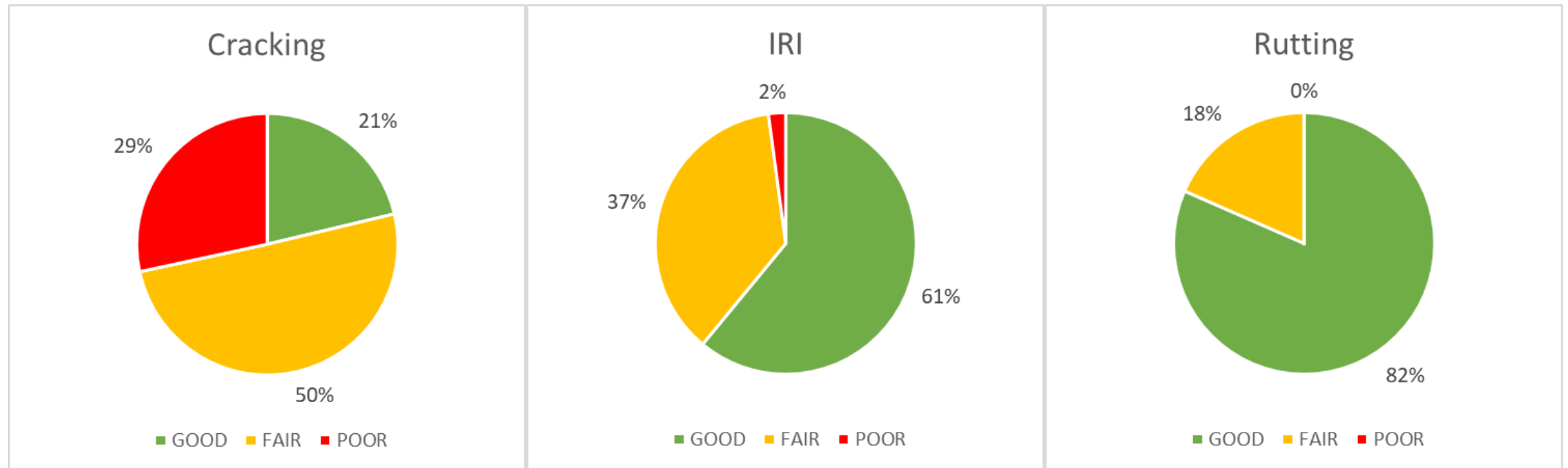
~13 lane
miles



>100 lane mile-
years worth of
data

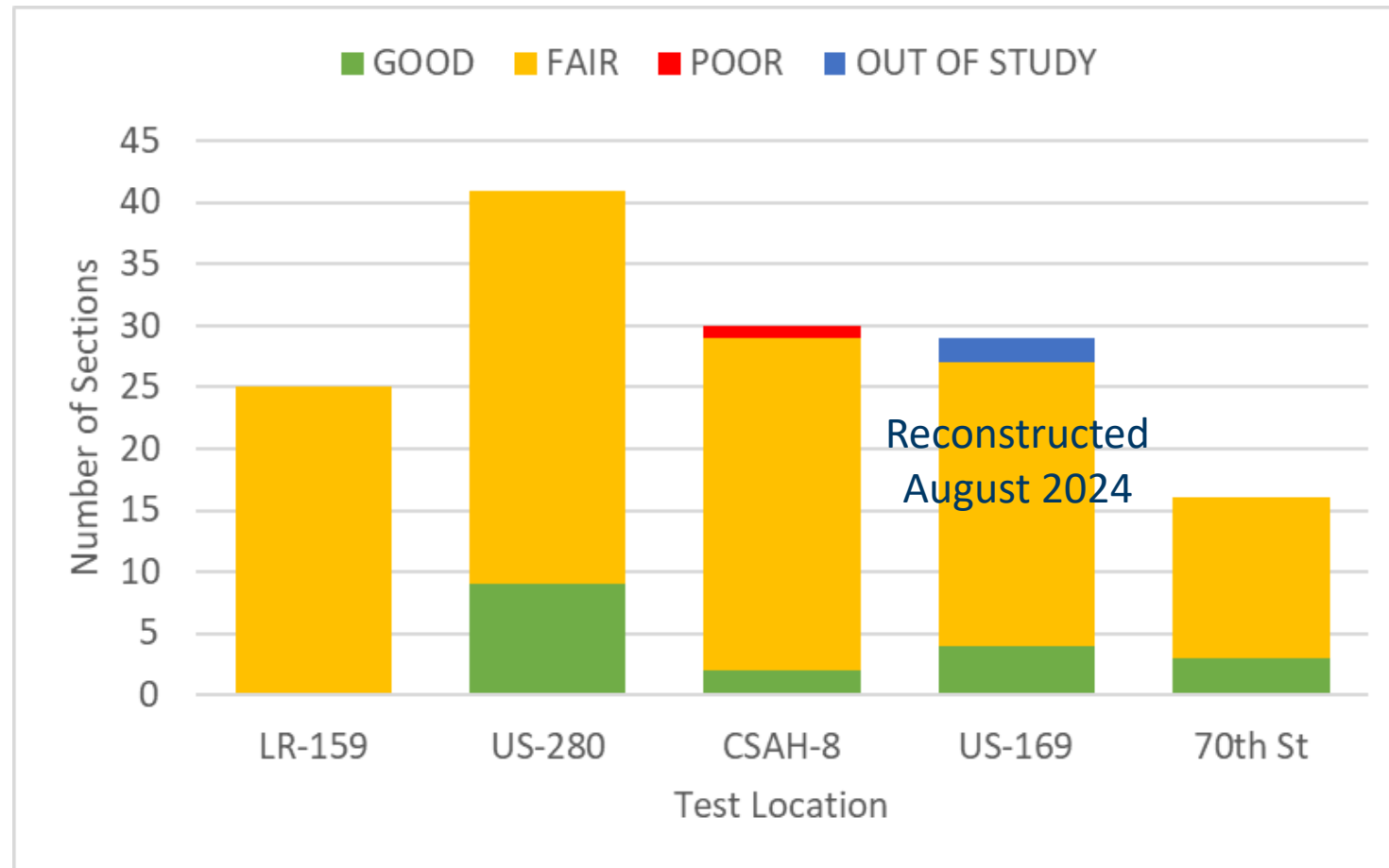
Phase II

- Condition category by performance measure



Phase II

- Overall condition category



aub.ie/PG-tool

Treatment

- Crack sealing only
- Single layer chip seal** ✓
- Single layer chip seal with crack sealing
- Triple layer chip seal
- Double layer chip seal
- Cape seal

Condition

- Good** ✓
- Fair
- Poor

Time

0.0
0.5
1.0
1.5
2.0
2.5

MAIN PANEL

Treatments Location (Google Maps)

Single layer chip seal

IRI (in/mile) for Treatment

Rutting (mm) for Treatment



Time to Poor (control)

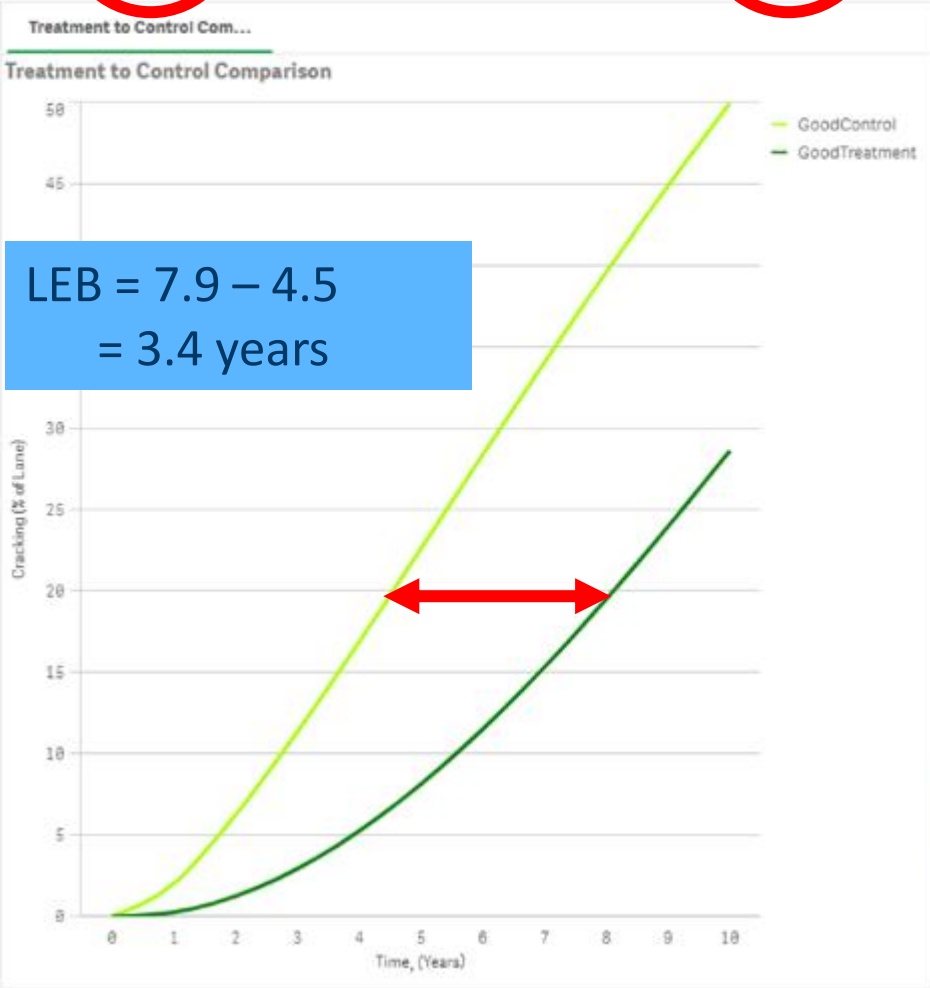
4.5

Crack Reduction (Average)

13.3

Time to Poor (treatment)

7.9



Overall Section Condition

FAIR

Cracking % of Area



Rutting (mm)



IRI (in/mile)



aub.ie/PG-webinars

Pavement Preservation Webinars

The NCAT-MnRoad PG Study Findings Webinar series is designed to discuss the construction, performance, and conclusions from our test sections, with a focus on implementation of findings. Below are the recordings of past webinars.

Crack Seal Webinar NCAT & MnROAD presents PG Study Findings Webinar Series

TOPIC: **CRACK SEAL**

for more information visit our websites
www.ncat.us
www.dot.state.mn.us/mnroad

Watch on YouTube

QR code with handwritten note "SCAN ME" pointing to it.

Fog Seal Webinar NCAT & MnROAD presents PG Study Findings Webinar Series

TOPIC: **FOG SEAL**

for more information visit our websites
www.ncat.us
www.dot.state.mn.us/mnroad

Watch on YouTube

QR code

Chip Seal Webinar NCAT & MnROAD presents PG Study Findings Webinar Series

TOPIC: **CHIP SEAL**

for more information visit our websites
www.ncat.us
www.dot.state.mn.us/mnroad

Watch on YouTube

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Micro Surfacing Webinar NCAT & MnROAD presents PG Study Findings Webinar Series

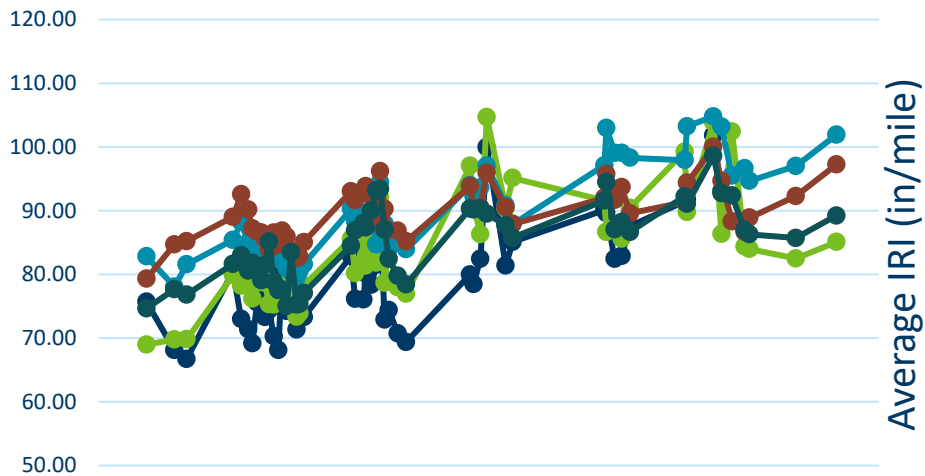
TOPIC: **MICRO SURFACING**

for more information visit our websites
www.ncat.us
www.dot.state.mn.us/mnroad

Watch on YouTube

QR code

MnDOT's Take-Aways: General



- No rutting
- Effects of wet / freeze thaw
- Thinlays working well
- Mastic improves IRI on transverse thermal cracks
- Combination treatments doing well
- Fibermat sections are performing well



MnDOT's Take-Aways: MnROAD In-Place Recycling

MnROAD demonstrated SFDR does remove effects of reflective cracking

- 2007 SFDR of 3 Mainline Test Sections (SFDR with 3" HMA Surface)
- 2022 Construction
 - Microsurfacing
 - Thin Bonded Wearing Coarse
 - 2nd Round of SFDR with HMA Overlay with and without rejuvenator

Perpetual Recycling with Thinlays/Microsurfacing							
2208	2207	2206	2205 Micro	2204 Micro	2203	2202	2201
1" UTWBC	1" UTWBC	1" TBWC	1" TBWC 2008	1" 64-34 2008	1" UTBWC	1" UTWBC	1" UTWBC
2"64-34	2" HMA	2"64-34	2"64-34	2"64-34	2"64-34	2" HMA	2" HMA
4" CIR without Rejuvenator	4" CIR with Rejuvenator	6" FDR + EE	6" FDR + EE	6" FDR + EE	6" FDR + EE	3" CIR without Rejuvenator	3" CIR with Rejuvenator
4" FDR + EE	4" FDR + EE	2" FDR	2" FDR	6" FDR	6" FDR	1" HMA 2017	1" HMA 2017
9" FDR + Fly Ash	9" FDR + Fly Ash	2" Class 5	2" Class 5	4" Class 4	4" Class 4	33" Class 4	33" Class 4
Clay	Clay	33" Class 3	33" Class 3	Clay	Clay	Clay	Clay
Oct 2022	Oct 2022	Oct 2022	Oct 2022	Oct 2022	Oct 2022	Oct 2022	Oct 2022
256	265	246	245	246	245	177	249

Visual Cracking data (percent cracking)

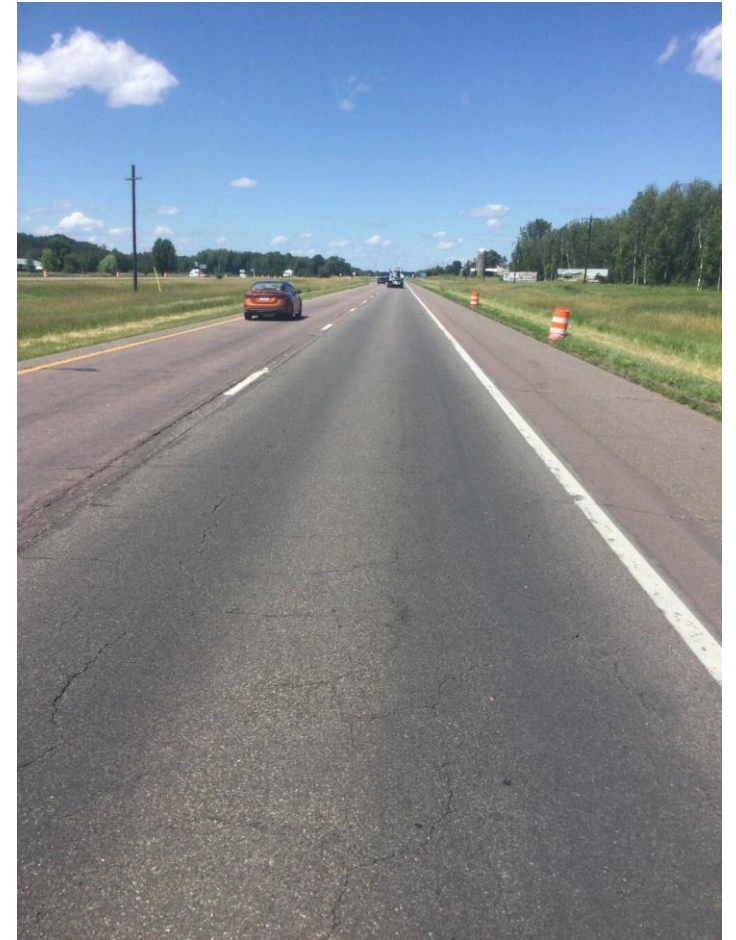
Description	Group	Section	PRE	POST	1/3/2020	5/28/2020	10/14/2020	1/4/2021	8/25/2021	1/13/2022	8/30/2022
SFDR Emulsion	TREAT	7001	All fully cracked	0.00	1.43	4.65	4.73	4.87	5.48	6.13	6.90
SFDR Foam	TREAT	7002		0.00	1.83	3.67	3.80	4.22	6.75	7.40	8.00
CIR Foam	TREAT	7003		0.00	0.00	0.15	0.20	0.60	2.20	2.48	3.07
CIR Emulsion	TREAT	7004		0.00	0.00	0.15	0.32	0.38	1.75	1.90	2.15
CCPR Emulsion	TREAT	7005		0.00	0.00	0.00	0.03	0.05	1.22	1.68	2.10
3" Mill & Fill + Thinlay	CONV	7006		0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.36
CCPR Foam	TREAT	7007		0.00	0.00	0.00	0.00	0.00	0.98	1.37	1.91
Thinlay	CONTROL	7008		0.00	1.87	3.38	4.80	5.63	9.03	15.00	15.77
Thinlay	CONTROL	7011		0.00	4.23	11.22	11.88	14.15	18.77	30.08	31.82
Thinlay	CONTROL	7012		0.00	2.37	6.30	6.82	8.35	12.65	20.20	21.23
Thinlay	CONTROL	7013		0.00	2.78	5.62	6.13	7.67	11.53	18.97	21.48
Thinlay	CONTROL	7014		0.00	7.35	10.70	11.57	13.02	17.08	26.90	28.35
Thinlay	CONTROL	7015		0.00	1.83	4.38	4.87	5.80	12.02	20.52	22.33
2" Mill & Fill + Thinlay	CONV	7016		0.00	0.00	0.00	0.00	0.00	0.28	0.52	1.50
CCPR Foam	TREAT	7017		0.00	0.00	0.00	0.00	0.00	0.98	1.22	1.37
Thinlay	CONTROL	7018		0.00	0.55	2.13	2.28	3.43	10.07	14.68	17.02

Ride data

Section Description	Group	INITIAL	10/23/19	8/11/20	9/2/20	9/16/20	10/8/20	4/25/22	5/4/22	10/12/22	12/6/22	2/17/23	3/20/23	4/27/23	6/21/23
7001 SFDR Emulsion	TREAT	316.85	76.33	79.78	84.97	82.00	77.55	88.23	87.17	88.60	85.40	140.65	160.57	90.90	89.93
7002 SFDR Foam	TREAT	385.30	66.88	73.70	75.90	74.23	75.65	84.03	84.80	104.35	92.15	127.35	124.60	101.90	126.87
7003 CIR Foam	TREAT	377.00	67.72	71.77	70.32	71.42	72.18	77.83	75.67	79.78	80.48	120.25	167.10	85.00	90.50
7004 CIR Emulsion	TREAT	396.25	69.08	66.62	69.13	70.58	66.87	67.33	66.77	69.00	69.28	92.50	120.33	77.40	77.63
7005 CCPR Emulsion	TREAT	375.65	74.33	86.27	77.30	80.22	81.95	88.63	84.27	83.77	82.63	124.50	140.27	86.80	82.25
7006 3" Mill & Fill + Thinlay	CONV	418.40	48.52	50.08	53.15	49.23	54.15	54.63	52.27	53.37	53.05	82.60	90.13	54.70	55.10
7007 CCPR Foam	TREAT	428.90	60.88	66.73	62.85	69.50	61.78	67.83	65.90	71.07	72.65	117.35	110.37	71.70	75.28
7008 Thinlay	CONTR L	428.90	89.20	107.77	107.42	108.57	102.47	114.63	112.87	118.73	117.30	153.55	160.87	115.50	122.48
7011 Thinlay	CONTR L	318.65	81.73	96.80	97.27	94.55	96.38	110.47	111.17	113.78	136.60	189.60	225.80	128.55	127.90
7012 Thinlay	CONTR L	306.80	75.62	82.47	80.77	83.52	83.78	95.83	90.33	95.07	95.93	139.25	188.73	102.35	104.87
7013 Thinlay	CONTR L	274.25	65.30	77.25	75.50	75.78	73.82	74.23	76.00	74.28	76.03	107.05	135.43	77.10	77.02
7014 Thinlay	CONTR L	334.60	78.43	87.23	86.22	87.90	87.50	88.57	89.37	92.37	87.40	123.95	129.47	86.05	95.03
7015 Thinlay	CONTR L	297.90	72.40	86.08	84.92	84.70	82.95	89.73	88.07	90.60	98.15	144.30	168.53	94.15	97.65
7016 2" Mill & Fill + Thinlay	CONV	293.50	42.33	45.97	44.02	44.87	44.83	48.47	47.67	48.38	50.98	90.10	123.90	53.75	55.33
7017 CCPR Foam	TREAT	383.85	63.90	68.35	70.28	68.27	67.47	67.93	67.77	67.95	68.88	105.95	109.07	70.60	68.62
7018 Thinlay	CONTR L	383.85	89.97	98.97	96.38	99.53	97.62	105.40	105.03	107.92	104.55	147.45	141.50	105.90	108.32

MnDOT's Take-Aways: Chip Seals

- Fog Sealing of Chip Seals are needed – snow plow damage
- Crack Sealing before any treatment
- Route and Seal not as effective (two cracks)
- Multiple Chip Seals
 - Low Volume – Double Better Durability
 - High Volume – Single better due to bleeding



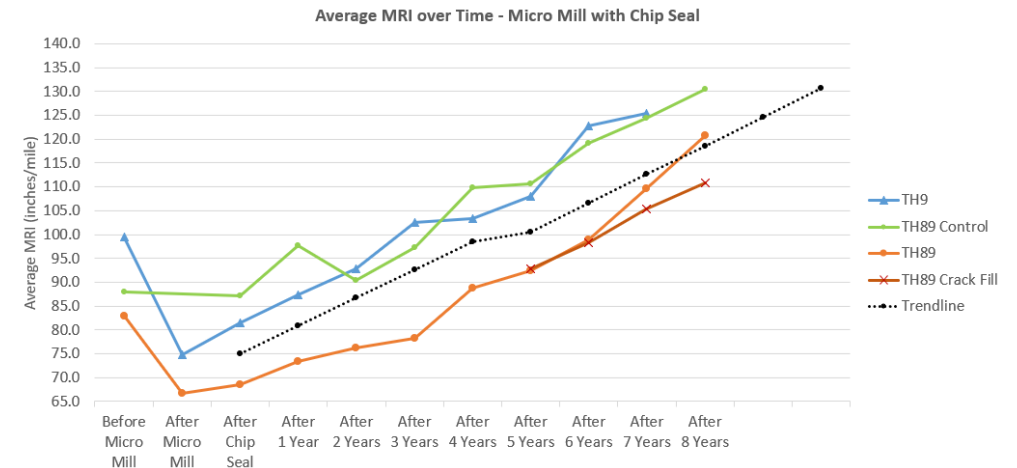
MnDOT's Take-Aways: Micro Milling before Treatments

Findings

- Seven years of ride performance data (micro mill with chip seal) average service life was extended for four years at an annual cost of \$5,500 per lane mile.
- Six years of ride performance data (micro mill with micro surfacing) average service life was extended for ten years at an annual cost of \$4,380 per lane mile.
- Six years of ride performance data (micro mill with UTBWC) average service life was extended for more than ten years at an annual cost of \$4,755 per lane mile.



TH 89 after placement of chip seal (2013)



Micro mill with chip seal performance chart

Next Steps by MnDOT PM Research Implementation Team

- Tasks

- Improve maintenance tracking
(field documentation → Pavement Management)
- Continue to monitor field performance
- Present at Mini MEO Meeting,
- Promote on Bituminous Web Page, Update Manuals and Guidance,
- Conference Presentations, and
- Update HPMA tree



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Phase III → TPF-5(522) lead by MnDOT

Improving the Quality of Pavement Preservation Construction and Data Collection Practices

Focus

- State Implementation / agency demonstration projects

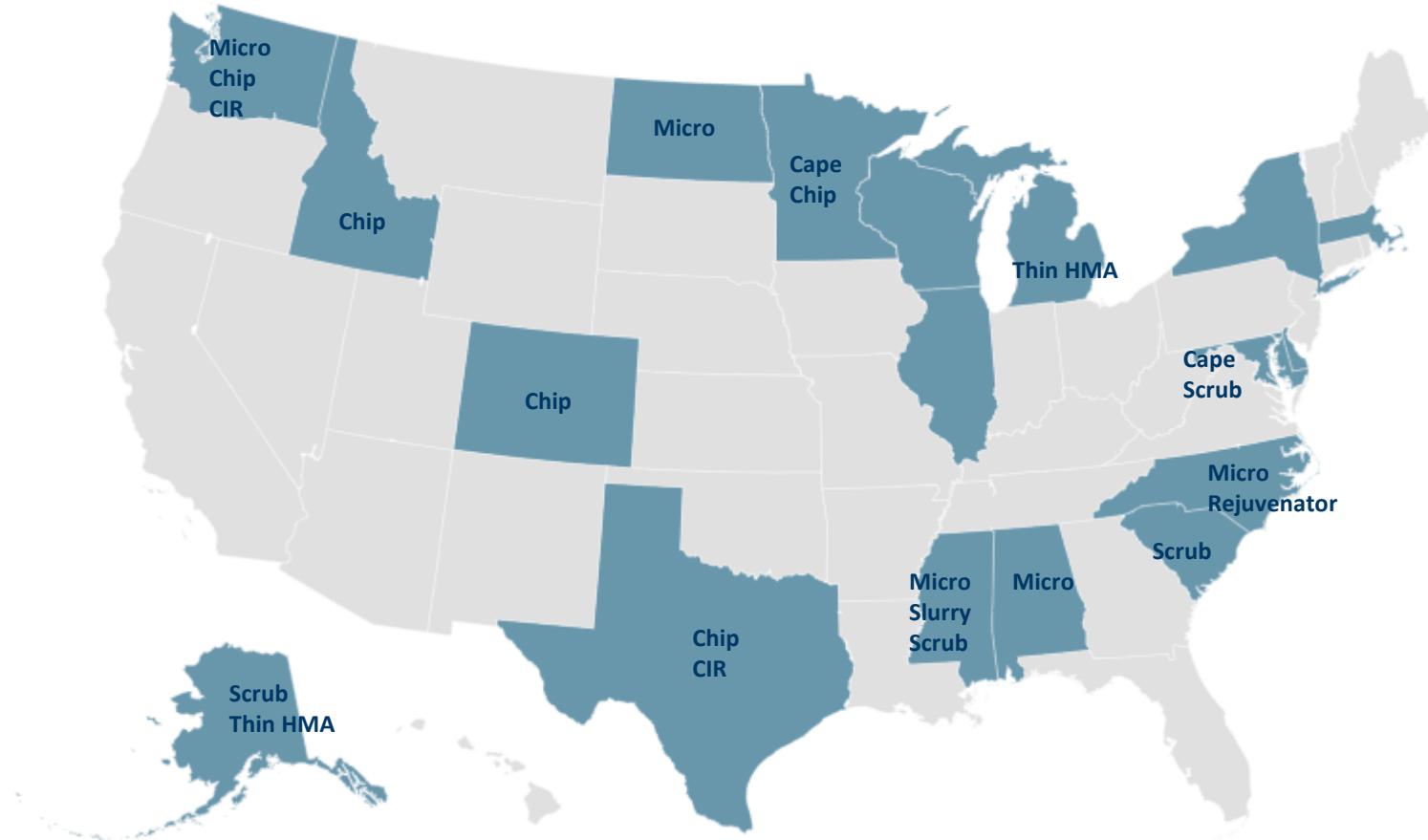
Two consultants

- NCAT (research) and NCPP (implementation)

Scope of work

- Performance monitoring of existing sections
- Technical assistance for the construction of new sections
- Development and revision of reporting requirements
- Performance monitoring of new sections
- Outreach and dissemination of results

Possible Treatments



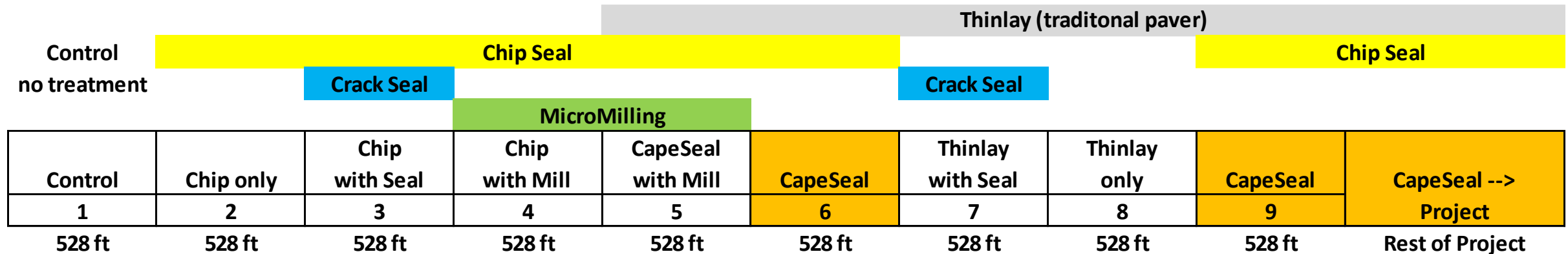
MnDOT Possible Treatments

Primary Focus

- CapeSeal not used in Minnesota (Performed well CSAH8 and US-169)
- Focus of the PG3 Effort/Support

Secondary Efforts

- Crack Sealing / Micro milling / Thinlays



Process

Project section nomination

Section review/approval

Pre-construction: spec review, training

Construction: on-site tech support

Performance monitoring & analysis

Construction On-Site Support

Detailed data collection

- Materials
- Application rates
- Equipment
- Practices
- Issues

Sampling

Data Collection & Analysis

- How do new sections compare to PG2 sections?
- Cover all climatic regions
- Data collection
 - Less frequent
 - Performed by each agency
 - FHWA working to help support

PG3 Summary

- PG Study has been a significant effort
 - Promote pavement preservation
 - Data-driven
- Good results continue to draw support
- Industry is key partner
- More outreach, dissemination of results
- Local cost inputs will be included

Questions / Comments

Working together you can be a part of something bigger than yourself

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