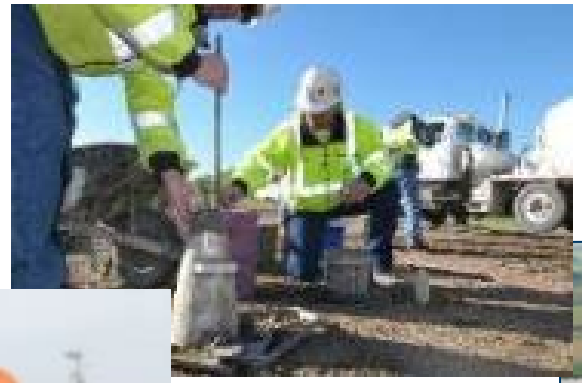





NRRA
National Road Research Alliance
Strategic Implementation Through Cooperative Pavement Research

MnROAD
SAFER, SMARTER, SUSTAINABLE PAVEMENTS
THROUGH INNOVATIVE RESEARCH

National Road Research Alliance & MnROAD Overview

April 2024

Benjamin Worel, P.E.(MN)
MnROAD Operations Engineer
NRRA Executive Director

DEPARTMENT OF TRANSPORTATION

MnROAD and NRRA

- **MnROAD**
- **National Road Research Alliance**
- **MnROAD NCAT Partnership**
- **Partnership Highlight**
  - Preservation Study - Inplace Recycling as the example project

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
  - Soil Foundation
  - Instrumentation
  - 1992 and 1993 Construction
  - August 2, 1994 Traffic

MnROAD Background

- **MnROAD Owned and Operated by Minnesota DOT**
- **HMA and PCC 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
- **Major Experiments**
  - Phase I (1994-2006)
  - Phase II (2007-2016)
  - Phase III (2017-2022) – NRRA/NCAT
  - Phase IV (2022) – NRRA/NCAT
- **MnDOT Funded Construction**
  - Used to support 2018, 2022, 2024 NRRA research efforts

MnROAD- Minnesota Road Research Facility

mndot.gov

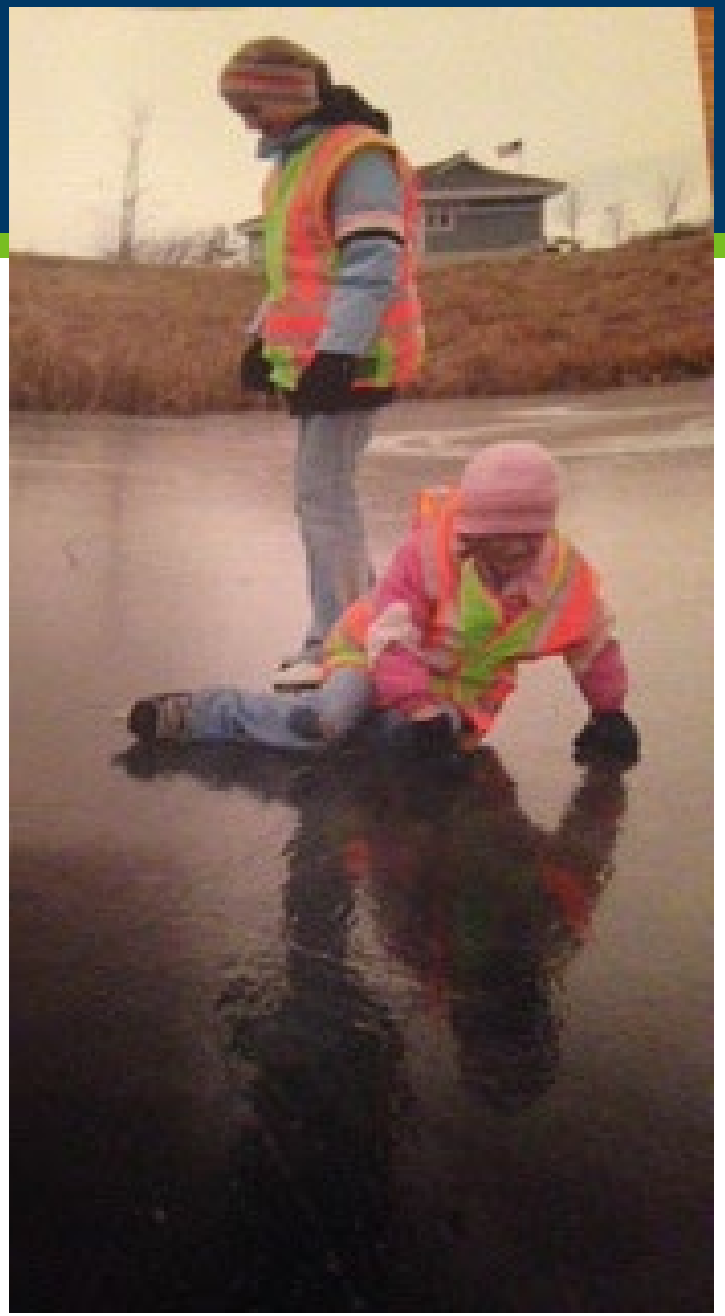
Also now includes

- **Farm Loop**
- **MN-6**
- **US-169 / CSAH-8**
- **15th Street**
- **70th Street**
- **+ Others**

Mack Tractor (93406) with Fruehauf Trailer (93410)

MnROAD Research Team

- **Experienced Research Staff**
  - 27 Road Research under Jeff Brunner
    - Working in both MnROAD and Other Areas
  - Active Maplewood Lab and Materials Engineers
- **MnROAD Operations**
  - Ben Worel, PE
  - Emil Bautista, PHD, PE
  - Joseph Podolsky, PHD, PE
  - Michal Vrtis, PHD, PE
  - Jacob Calvert, PE
  - **Jeff Tabery**
  - Craig Nolden
  - Dan Roushar
  - Jesse Shank
  - Troy Huebner
  - Steve Olson



MnROAD Data Overview

- **Performance Monitoring**
- **List is missing**
  - Albedo Measurements
  - Drone Videos
  - Road Doctor with GPR
  - Detailed Forensics
  - Rolling Weight Deflectometer
  - Rolling Density Meter
  - Many others

  - Working towards greater automation

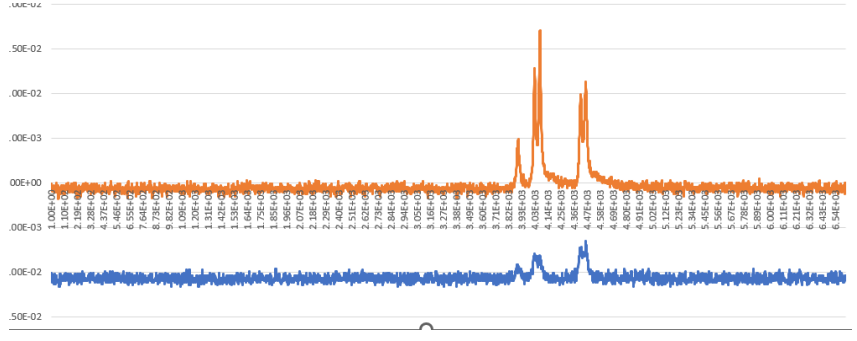
Each Data type has detailed information on the equipment and data collection used

Measurement	Frequency	Comment
Aging Samples	1 / year	Cores taken to monitor aging of HMA mix and PCC joint condition
Distress Survey	2 / year	Modified LTPP Survey on all cells
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	3 / year	Sound absorbtion measurements.
Surface Texture	1 / year	Sand Patch and Circular Texture Meter

MnROAD Sensors

- **Sensors**
  - MnROAD Data Collection Network
  - ~15,000+ Sensors Installed
  - Static (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



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

MnROAD has a lot of data at 15 min over 30 years

- TC_VALUES – Thermal Couple
- Database Rows per year (couple examples – we have data for all years since 1993)
  - This is the data for every 15 min over the years / divide by 4 for hourly data counts

TC_VALUES_1993	219,082
TC_VALUES_1994	4,361,834
TC_VALUES_1995	7,888,437
TC_VALUES_1996	9,036,303
TC_VALUES_1997	9,307,036
TC_VALUES_1998	37,118,997
TC_VALUES_1999	32,969,266

TC_VALUES_2000	36,313,454
TC_VALUES_2001	36,325,871
TC_VALUES_2002	36,030,290
TC_VALUES_2003	34,983,990
TC_VALUES_2004	34,846,369
TC_VALUES_2005	34,798,633
TC_VALUES_2006	31,924,999
TC_VALUES_2007	22,583,576
TC_VALUES_2008	17,021,130
TC_VALUES_2009	31,009,700

TC_VALUES_2010	33,361,302
TC_VALUES_2011	36,104,073
TC_VALUES_2012	36,961,766
TC_VALUES_2013	37,419,772
TC_VALUES_2014	39,391,812
TC_VALUES_2015	39,484,608
TC_VALUES_2016	37,557,349
TC_VALUES_2017	34,827,131
TC_VALUES_2018	36,282,500
TC_VALUES_2019	36,860,342

TC_VALUES_2020	36,628,516
TC_VALUES_2021	34,737,282
TC_VALUES_2022	25,537,210

Current years data goes to (2023 is the current year)

TC_VALUES	3,129,907

NRRA Development

- **History**
  - 4 state consortium (CA, MN, TX, WA)
  - Frozen Four (IL, MI, MN, WI)
  - TERRA (IA, MN, MI, NY, NY, WI)
  - NRRA

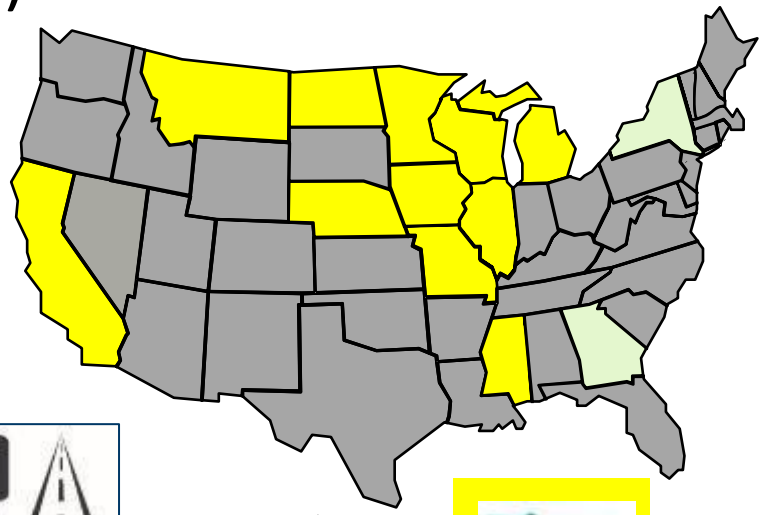
Benefits

- Strength in numbers
- Less costly for doing research
- Allow states to cross boarders
- Less project duplication (we all don't do the same project)
- Greater Communication (State/Consultant/University/Associations)
- Buy-In (everyone is apart of the process)
- Shared Resource (MnROAD)

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)
- **13 Full Agency Commitments (yellow)**
  - $75K /$150K Annual Commitment
  - 11 States, Illinois Tollway, LRRB
  - FHWA is also a contributing partner
- **2 ICT Commitments (Green)**
  - $25K (ICT Team only – Veta Efforts)
  - GA and NY
- **~85+ Associate membership**
  - 2K/year - Associations, Industry, Consultants, Universities



NRRA National Road Research Alliance

Illinois Tollway

LRRB Local Road Research Board

U.S. Department of Transportation Federal Highway Administration

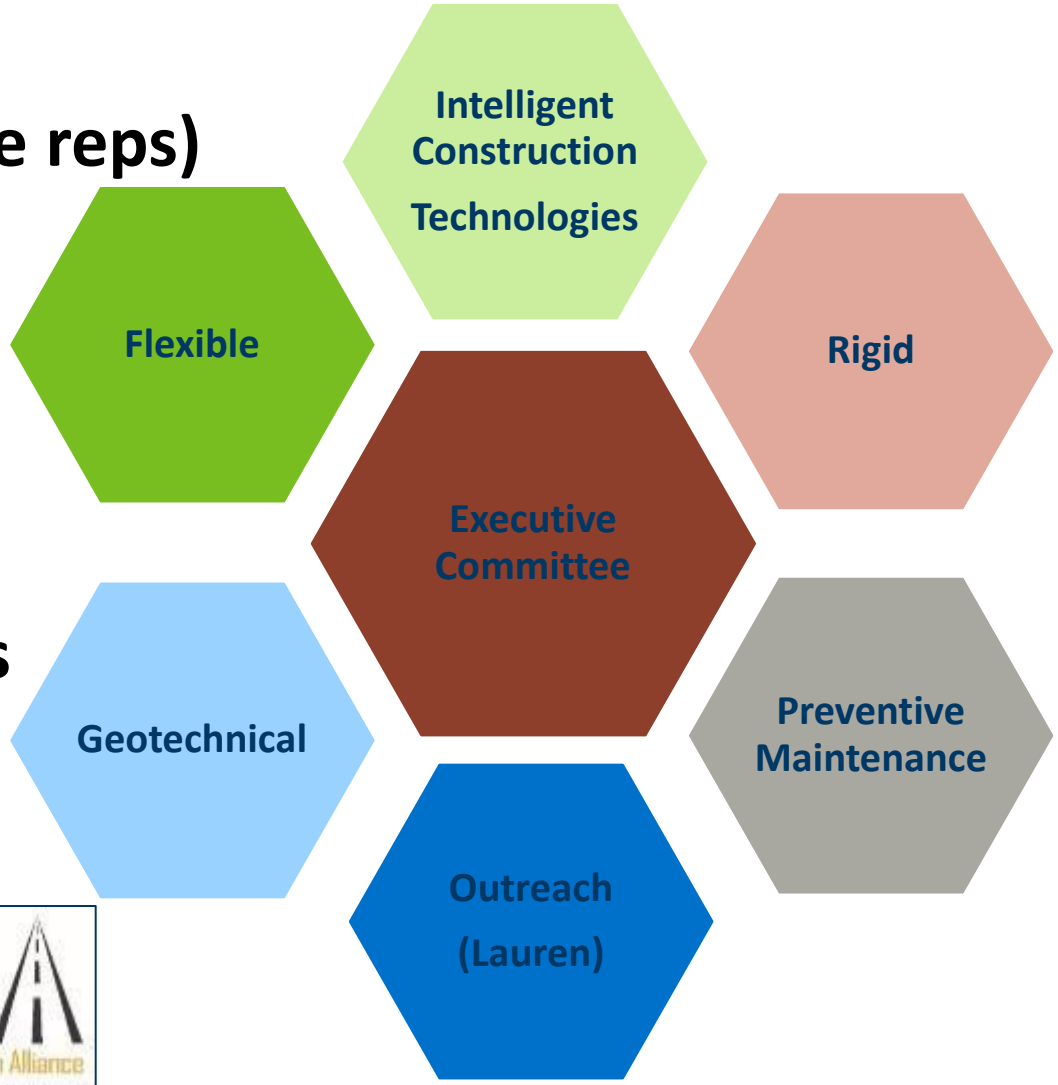
NRRA Current Activities

- **NRRA has averaged ~$1 million research/year**
- **NRRA Funded 48 projects (phase1) and 29 projects (phase2)**
  - Short and long term research
  - Multiple Universities and Consultants Contracted

- **NRRA Project Development**
  - Ideas developed and prioritized in technical teams
  - Executive Committee reviews and approves
- **2017 & 2022 MnDOT provided MnROAD construction funding**
- **2024(+) MnDOT has budgeted 1 million annual I-94 construction funding**

NRRA Organizational Structure

- **Executive Committee (2 reps/agency)**
- **5 Technical Teams (agency and associate reps)**
  - Technical Chairs
  - MnDOT Representative
- **MnROAD Facility Utilized as needed**
- **Outreach is done in the technical teams**
  - **Lauren Dao, MnDOT**



NRRA
National Road Research Alliance

NRRA – Outreach Activities

Monthly

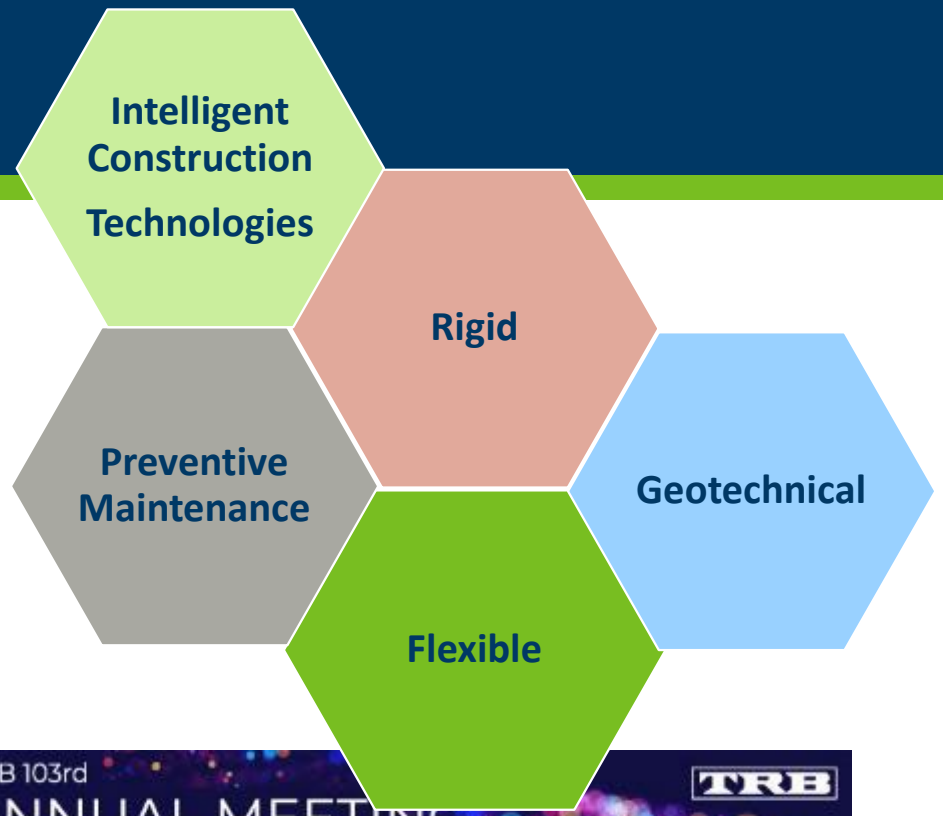
- Research Pays off Seminars (online)
- Team Meetings (online)
  - NRRA General Updates
  - Project Status Reports
  - Common Topic of Interest

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 – Executive Committee Membership

Caltrans
Reimond Garcia*
Tom Pyle*

FHWA
Steve Cooper
Peter Eakman

Illinois
Brian Pfeifer*
Charles Wienrank*

Illinois Tollway
Dan Gancarz*
Cindy Williams*

Iowa
Chris Brakke*
Jeff De Vries*

Michigan
Kevin Kennedy*

Minnesota
Jeff Brunner
Lauren Dao
Duane Hill*
Ben Worel*

Minnesota LRRB
Jim Foldesi* (St. Louis County)

Mississippi
Alex Middleton*
Cindy Smith*

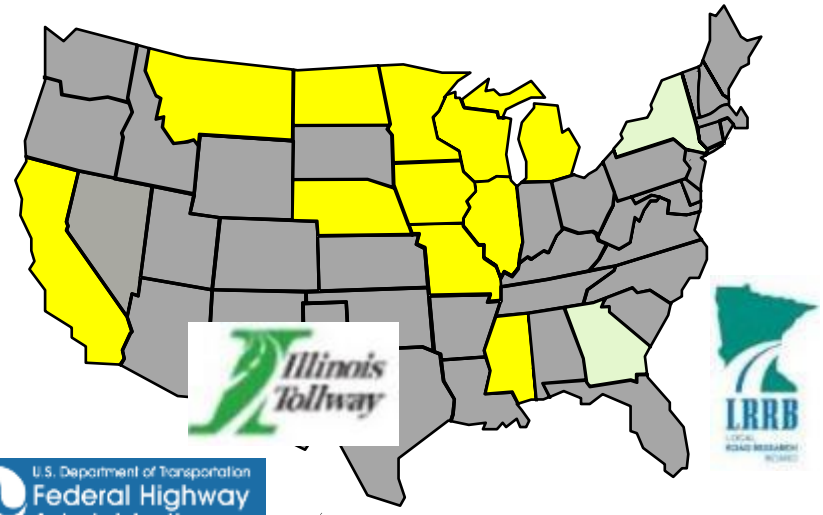
Missouri
Brett Trautman*

Montana
Oak Metcalfe*
Matt Needham*

Nebraska
Wally Heyen*
Robert Rea*

North Dakota
Amy Beise*
Aaron Perez*

Wisconsin
Eric Lyngdal*
Barry Paye*



GA and NY → ICT Only

National Road Research Alliance (North Dakota Technical Team Membership)

Executive Committee
Amy Beise*
Aaron Perez*

Rigid
Amy Beise
Brian Bennes
Adam Berglund
Kaylin Kautzman
Matt Luger
TJ Murphy*

Preventative Maintenance
Amy Beise
Adam Berglund
Curt Dunn
Kaylin Kautzman
Aaron Perez
Stephanie Weigel*

Intelligent Construction
Amy Beise*
David Bruins
Curt Dunn*
Nathan Haaland
Darin Lindblom
Carey Schreiner

Flexible
Curt Dunn, chair
Andy Ayash
Amy Beise
Brian Bennes
Adam Berglund
Kaylin Kautzman
Matt Linneman
Arlen Norris
Korby Seward
Tyler Wollmuth*

Geotechnical
Amy Beise
Brent Flaa*
Matt Kurle
Colter Schwagler*

* = Voting Member

2022 MnROAD Construction Overview

Main theme from NRRA: Sustainability and Resilience

What new materials will help meet future sustainability guidelines?

National Road Research Alliance

45 New Test Sections

- 4 – In-Place Recycling
- 4 – Preventive Maintenance
- 6 – PCC Innovative Patching / Diamond Grinding
- 16 – PCC Reduced Cement
- 1 – PCC WIM area
- 2 – PCC Recycled Fiber
- 2 – HMA Perpetual Pavement
  - 1 of 2 with Wicking Geotextile
- 10 – Reflective Cracking Challenge

Partners Donated Materials

- CAT – HMA Milling
- Geotextile Fabric
- VRAM – J-Band
- CIR Rejuvenator Donation

MnDOT Furnished Materials

- HMA Plant Mix Furnished (~1/2 mixes)
  - Additive Suppliers
- PCC Plant Mix Furnished (all mixes)
  - Additive Suppliers

2022 MnROAD Construction Support

NRRA Teams

- Flexible
- Rigid
- Geotechnical
- Pavement Maintenance
- Intelligent Construction

MnDOT

- Tina Nohrenberg
- Steven Allen
- Jesse Shank
- Brian Levanduski
- Craig Nolden
- Tom Scholer

- Designers
- Letting
- Research Services
- STIP Funding

MnDOT Research

- Tom Burnham
- Bernard Izevbekhai
- Michael Wallace
- Annika Christiansen
- Rob Golish
- Maria Masten
- Troy Huebner
- Steve Olson
- Dan Roushar
- Jason Donahoe
- Bob Strommen
- Raul Velasquez
- Ceren Aydin
- Ben Worel
- Michael Vrtis
- Jacob Calvert
- Emil Bautista
- Joseph Podolsky
- Jeff Tabery
- Eddie Johnson
- Glenn Engstrom
- Jeff Brunner

University/Consulting

- American Engineering
- Applied Pavement Technology
- Auburn University
- Braun Intertec
- Caterpillar
- i-Engineering
- Ingios
- Iowa State University
- Michigan State University
- Michigan Tech
- Nichols Consulting
- Sutter Engineering
- Terracon
- Texas Transportation Institute
- Transtec Group
- University of Missouri-Columbia
- University of New Hampshire
- NDSU (fiber optic sensors)
- University Texas El Paso
- FHWA PCC Mobile Lab
- NCAT HMA Mobile Lab

Material Suppliers

- Avangard Plastic
- Dow Plastic
- Entech Rubber
- Liberty Tire Rubber
- Ace Fibers
- Forta Fibers

- 3M (Natural Pozzolan)
- Ash Grove (ACM)
- Burgess Pigments (Natural Pozzolan)
- Carbon Cure
- Carbon Limit (Blended ASCM)
- Carbon Upcycling (Processed Fly Ash)
- Continental Cement (High Limestone)
- CP Tech Center (Optimized Mix)
- Hess Pumice (Natural Pozzolan)
- TerraCO2 (Manufactured Fly Ash)
- Ultra-High Materials
- Urban Mining (Ground Glass)
- Flint Hills
- Cargill (Rejuvenator)
- Heritage (J-Band)
- Solmax (wicking geotextile)

Contractors

- Bolton and Menk
- CS McCrossan (Prime)
- PCI (Subcontractor)
- Martin Marietta (HMA mix)
- Aggregate Industries (Concrete)
- Cemstone (Concrete)

2022 MnROAD Reflective Cracking Challenge

- **Study Designed to match research to Typical agency applications**
  - BOB = bituminous over bituminous ~50% network

Statewide (All Districts)

Pavement	Percent	Miles
BIT	12%	1,682
BOB	50%	7,104
BOC	22%	3,136
CON	17%	2,377
CRCP	0%	2
All	**100%**	**14,301**

Pavement	PQI	RQI	SR
BIT	3.6	3.5	3.8
BOB	3.3	3.2	3.4
BOC	3.4	3.3	3.6
CON	3.6	3.4	3.9
CRCP	3.8	3.6	4.0
All	**3.4**	**3.3**	**3.6**

NRRA Reflective Cracking Challenge
NCAT Additive Group

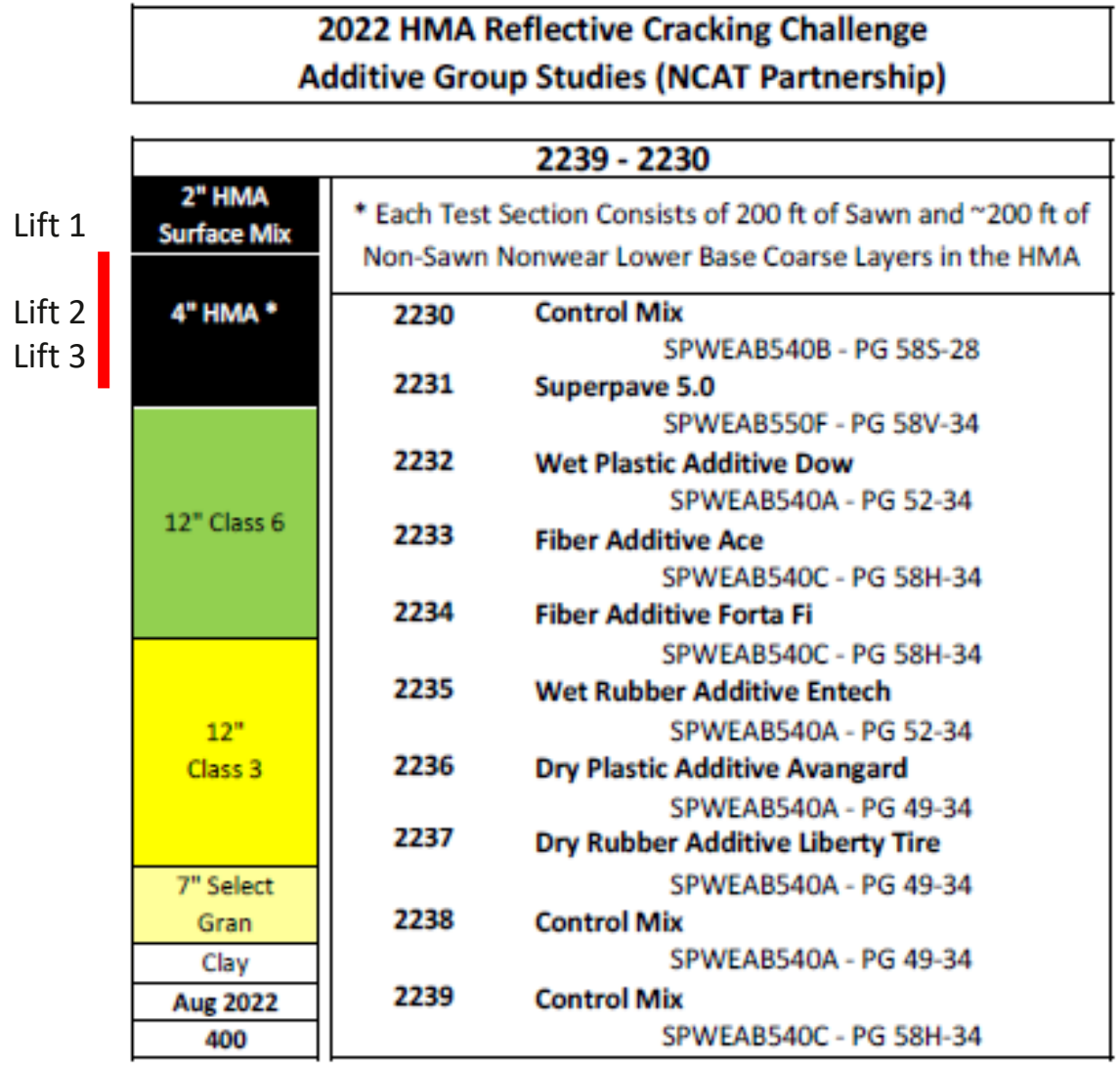
2022 MnROAD Construction

Partnerships

- Tied to NCAT Additive Group (NY participation)
  - Additive Donations similar
- CAT Milling – Initial Milling
- VRAM donated

Contractor

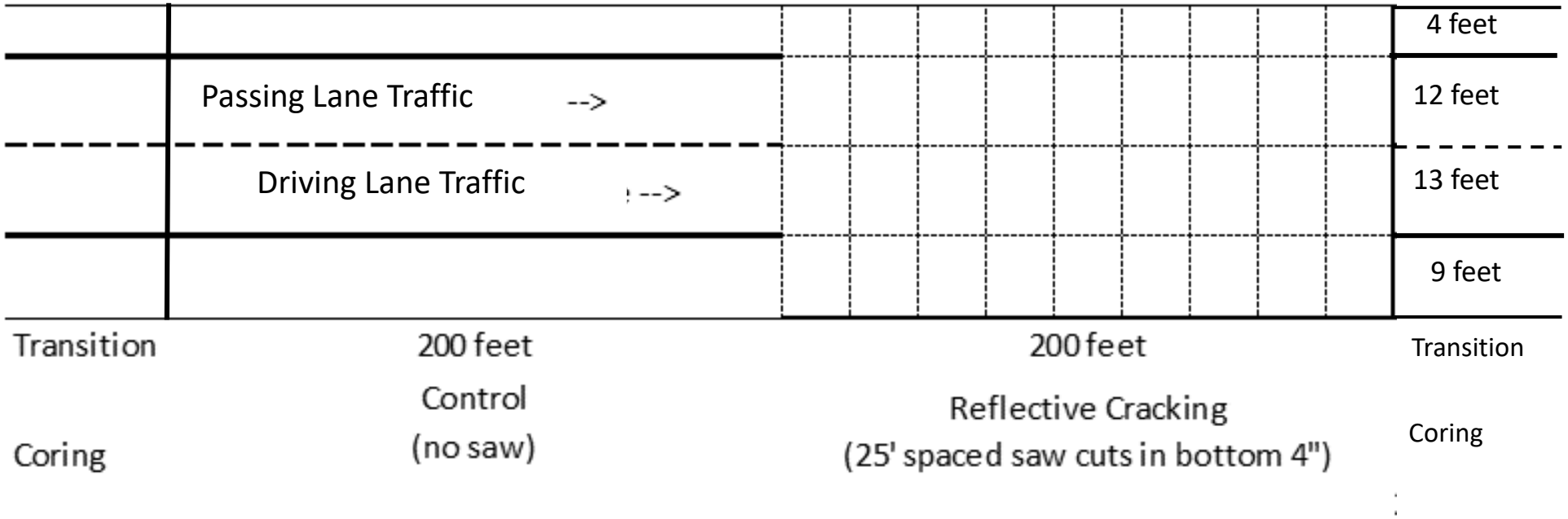
- Paves All HMA (Lift 3 and 2)
- Saws and 1” Milling (Lift 2)
- Places donated VRAM
- Paves HMA surfaces (Lift 1)
  - Contractor provided 2230 and 2231
  - MnDOT provided rest of the mixes



NRRA Reflective Cracking Challenge
MnROAD Test Sections

10 Test Sections with different HMA surfaces

- Tied to NCAT additive group 2021 construction (NY Contribution)
- Missouri funded 400K to tie Missouri Test Sections into each study
- ~450’ of paving per surface mix (50’ transitions)
- 200’ of sawing to recreate/induce reflective cracking
- Milled before final 2” was placed



NCAT Additive Group -Surface HMA Mix Details

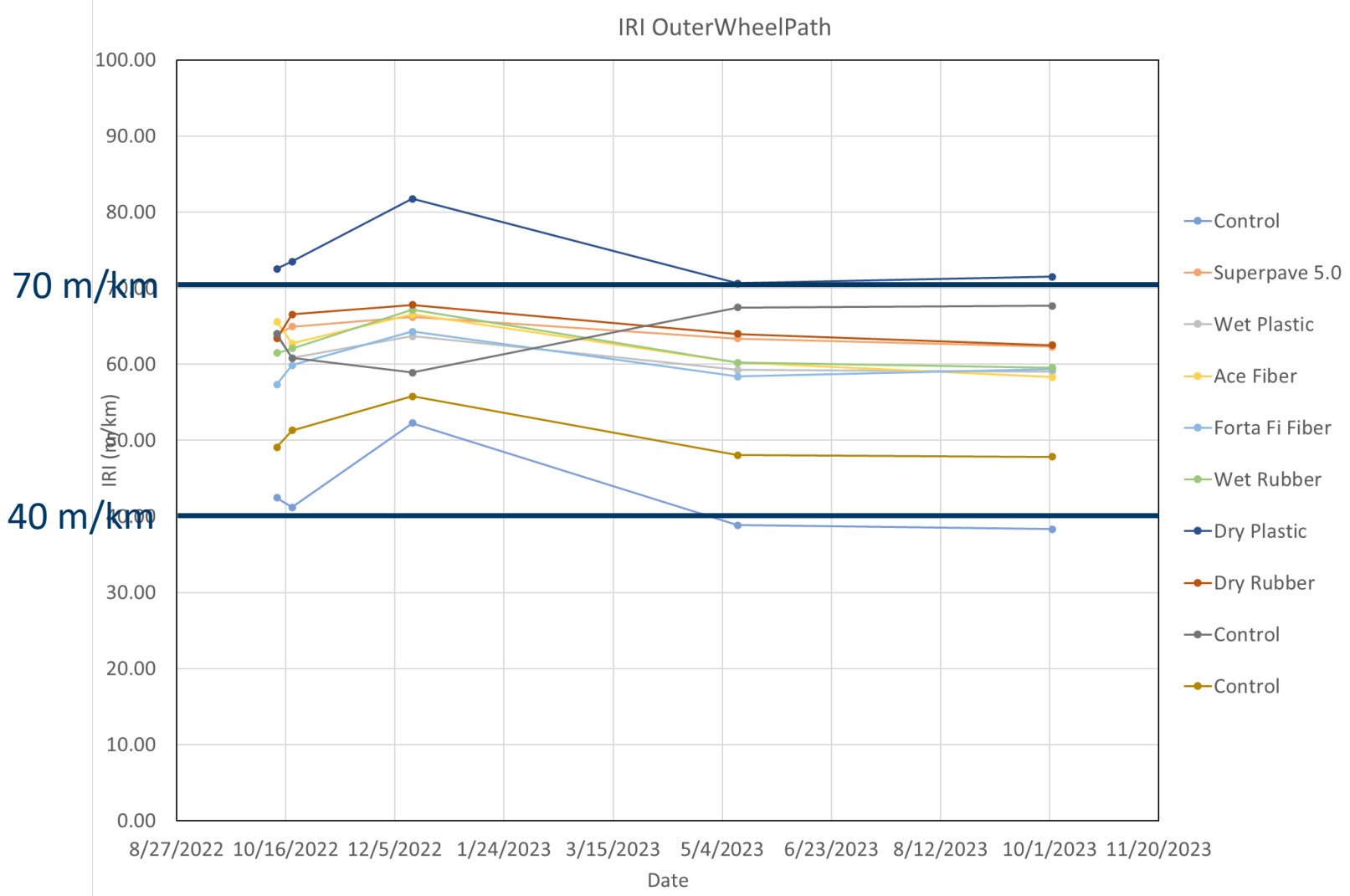
- **10 Sections with differing surface HMA**
  - Controls
    1. PG 58H -34 (modified)
    2. PG 58S -28 (unmodified)
    3. PG ~49 -34 (unmodified)
  - Additive Sections
    4. Aramid Fiber 1 w/ PG 58H -34 (modified)
    5. Aramid Fiber 2 w/ PG 58H -34 (modified)
    6. Dry Plastic Additive w/ PG ~49 -34
    7. Dry Rubber Additive w/ PG ~49 -34
    8. Wet Plastic Additive
    9. Wet Rubber Additive

    } **w/ PG 52-34 from Mathy**
  - Super Pave 5.0
    10. PG 58V -34 (modified) (NRRA)

- **All mixes contain**
  - MnDOT Traffic Level 5 (10<30 mESALS)
  - Superpave Gyratory BMD
  - ¾” Max Agg (SP 12.5mm)
  - 20% RAP

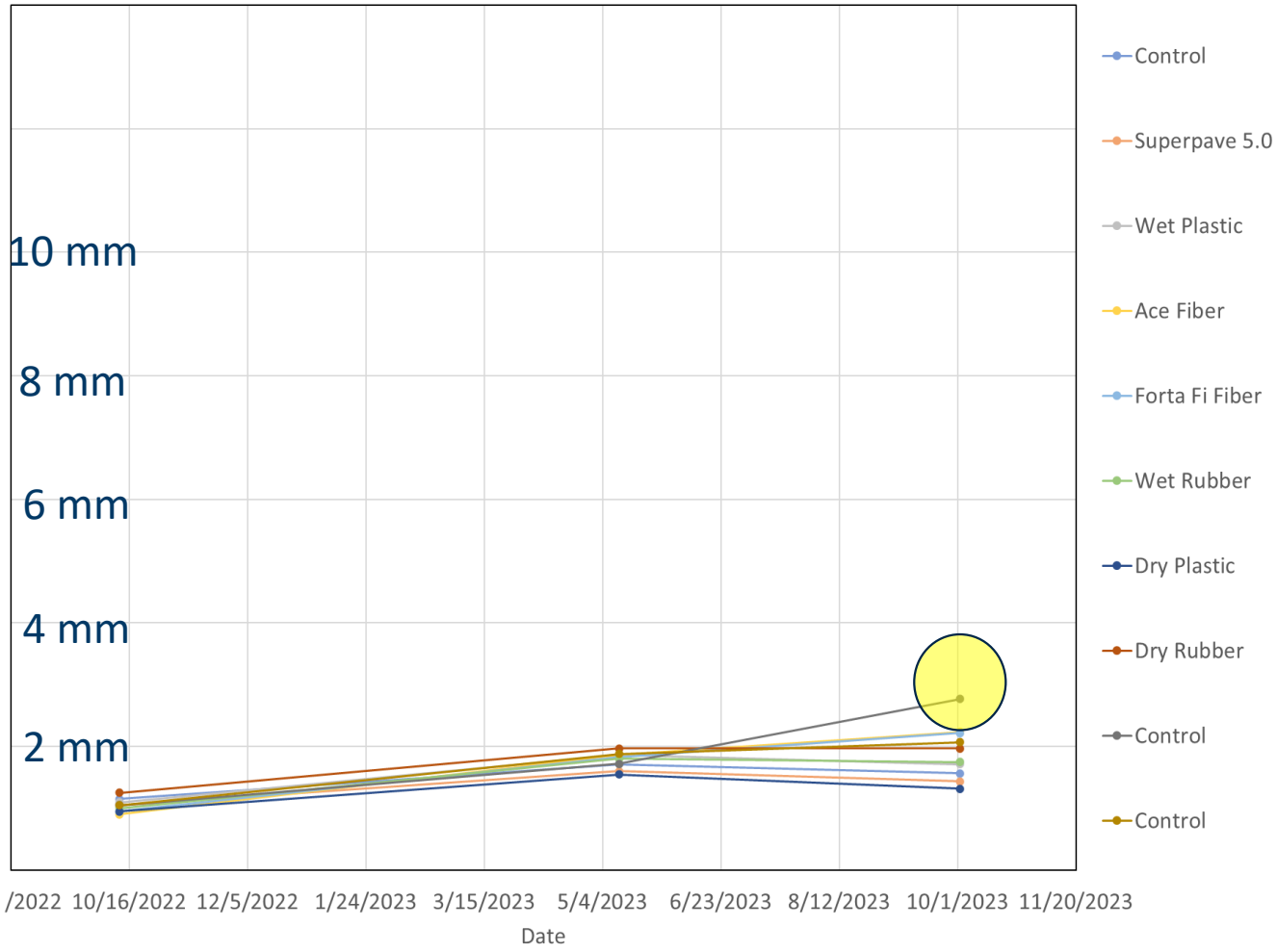
Reflective Cracking Challenge Performance

Good initial ride and no change over 1st year



Reflective Cracking Challenge Performance

No rutting over 1st year but maybe developing in PG49-34 Control Section



NRRA - 2022 MnROAD Reduced Cement Studies

Partnerships

- Developed by Larry Sutter and Tom VanDam (NRRA Contract)
- Additives Donated by multiple partners

Contractor

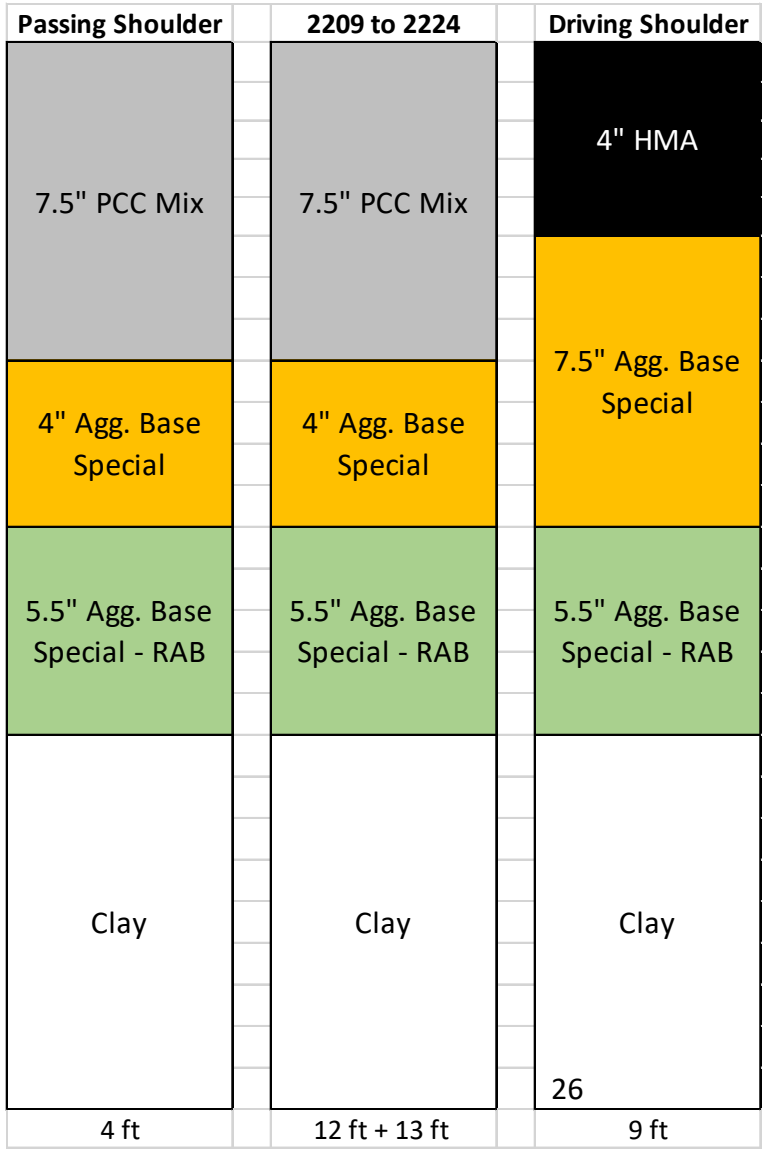
- Removes Existing Concrete and Base / Common Excavation (Clay)
- Places Aggregate Bases / Paves PCC Mix (Paver)

MnDOT

- Furnished PCC Mix / Instrumentation

3 NRRA Contracts

- Use of alternative pozzolanic materials – Nichols/Applied Pavement Technology
- Use of carbon dioxide – Iowa State
- Use of alternative cementitious materials – Applied Pavement Technology/Nichols



NRRA – 2022 MnROAD Reduced Cement Products

2022 Concrete Alternatives (East)

2224 - 2217

~15' Panels - 13' Driving and 12' Passing - 1.25" Dowels
4' PCC Passing Shoulder and 9' HMA Driving Shoulder
Traditional Diamond Grinding Done Sept 8-10, 2022 As Noted

7.5" PCC Astro Turf	**2217** (254 ft)	**Carbon Cure Control (Cemstone) - *Grind*** ASTMC595 Type1L(10) + 30% FlyAsh
	2218 (302 ft)	**Control Mix (Agg Industries)** ASTMC595 Type1L(10) + 30% FlyAsh
	2219 (268 ft)	**Optimized Mix - CPTech (Agg Industries) - *Grind*** ASTMC595 Type1L(10) + 30% FlyAsh
4" Class-5Q	**2220** (195 ft)	**Burgess Pigments - Natural Pozzolan (Agg Industries) - *Grind*** ASTMC595 Type1L(10)+12% metakaolin+18% FlyAsh (12% Replacement)
5.5" Class-5	**2221** (234 ft)	**3M - Natural Pozzolan (Agg Industries)** ASTMC595 Type1L (10)+15% Natural Pozzolan+15% Prairie State Fly Ash (NOT Coal Creek) (30% Replacement)
	2222 (230 ft)	**Hess Pumice - Natural Pozzolan (Agg Industries)** ASTMC595 Type1L(10)+30% natural pozzolan (30% Replacement)
	2223 (257 ft)	**Continental Cement - High Limestone (Agg Industries)** Blended PLC with 20% limestone+30% FlyAsh (70% Replacement)
Clay	**2224** (169 ft)	**Carbon Limit - Blended ASCM (Agg Industries) - *Grind*** Natural Pozzolan Mix+catalyst at 30% replacement level (30% Replacement)
Oct 2022 **Varies**		

2022 Concrete Alternatives (West)

2216 - 2209

~15' Panels - 13' Driving and 12' Passing - 1.25" Dowels
4' PCC Passing Shoulder and 9' HMA Driving Shoulder
Traditional Diamond Grinding Done Sept 8-10, 2022 As Noted

7.5" PCC Astro Turf	**2209** Limited	**ACM - Ultra High Materials (Agg Industries) - *Grind*** Hydraulic non-portland cement (100% Replacement) - 25' Replaced 9/15/22
	2210 (270 ft)	**Carbon Cure RGC1 (Cemstone) - *Grind*** Optimized Mix+ASTMC595 Type1L(10)+CarbonCure added+30% ash (0% Replacement)
4" Class-5Q	**2211** (263 ft)	**Carbon Cure RGC2 (Cemstone) - *Grind*** Control Mix+CarbonCure added @same dosage used in optimized mixture, scaled to cement of control (0% Replacement)
	2212 (272 ft)	**Carbon Cure RGC3 (Cemstone) - *Grind*** CarbonCure optimized mixture+ASTMC595 Type1L(10)+NO CarbonCure added+30% ash (0% Replacement)
5.5" Class-5	**2213** (230 ft)	**Carbon Upcycling - Porcessed FlyAsh (Agg Industries)** ASTMC595 Type1L(10) reduced cementitious+30% ASCM (30% Replacement)
	2214 (225 ft)	**Ash Grove - ACM (Agg Industries) - *Grind*** LC3 (100% Replacement) - 8' replaced 9/15/2022
Clay	**2215** (124 ft)	**Urban Mining - Ground Glass (Agg Industies) - *Grind*** ASTMC595 Type1L(10)+30% ground glass pozzolan (30% Replacement)
Oct 2022 **Varies**	**2216** (243 ft)	**TerraCO2 - Manufactured FlyAsh (Agg Industries) - *Grind*** ASTMC595 Type1L(10)+30% ASCM (35% Replacement)

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 1,500 cores taken in first 2 years of study**

2019 NRRA Mix Rejuvenator Study

- 2019 mill/inlay job in Northern Minnesota (Emily, MN)
- 7 Rejuvenating Products
- 40% RAP content – targeted xx-34 (original 58-28)
- Measuring long-term:
  - Field performance, asphalt binder + mix properties,
- NRRA Funded for additional 4 years!

NRRA HMA Perpetual Pavement

- **Test Sections Built**
  - 2022 – Minnesota 8.5” HMA perpetual pavement
  - 2023 – Wisconsin Deep Strength HMA 2 sections (12.5” HMA) Osseo, WI on I-94
  - All sections have instrumentation for temperature, moisture, strain and pressure
- **Combined Research – RFP coming out 2024**

DPS National Pooled Fund Program

DPS Contacts - Materials & Road Research - MnDOT
www.dot.state.mn.us

Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS) [TPF-5(443)]

- **Objective:** Use the DPS method to improve asphalt pavement density
  - Increased coverage and comprehensiveness of assessment
  - Timely information to improve construction process
  - Reduce coring
- **Lead Agency:** MnDOT
  - Contact: Kyle Hoegh, kyle.hoegh@state.mn.us (MnDOT)
- **Committed agencies: MN, FHWA, GA, ID, MD, ME, MO, MS, ND, NY, OH, PADOT, UT, WA, WI**
- **100% SP&R Approval:** Approved
- **Commitment level**: $25K/year

U.S. Department of Transportation Federal Highway Administration

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DEPARTMENT OF TRANSPORTATION

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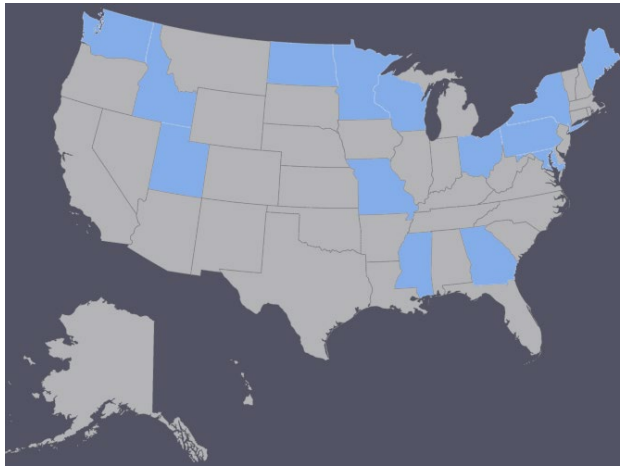


TPF - Study Detail
www.pooledfund.org

Official TPF

Density Profiling System - Office of Materials an...
www.dot.state.mn.us

MnDOT TPF

DPS National Pooled Fund Program

DPS Contacts - Materials & Road Research - MnDOT

www.dot.state.mn.us

Informational Materials

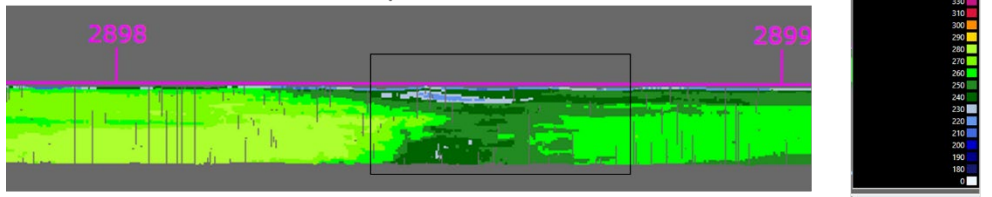
CONTRACTORS ROUTINELY cut cores from the roadway after construction to verify the pavement meets minimum density requirements. These singular random coring locations are used as the basis for acceptance of a larger portion of the pavement. The density results affect contractors and owners alike; for owners such as transportation agencies, a good core result can foretell the road's long-term durability, while contractors often have conditional financial incentives

By rolling a DPS unit over the newly paved roadway, crews measured the pavement's density in real time.

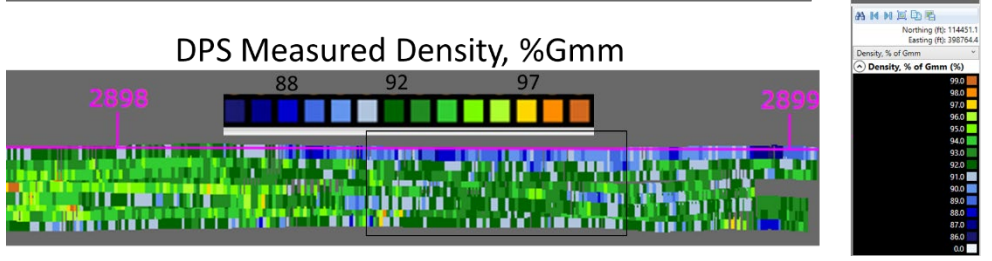
Training/Peer Exchange Opportunities

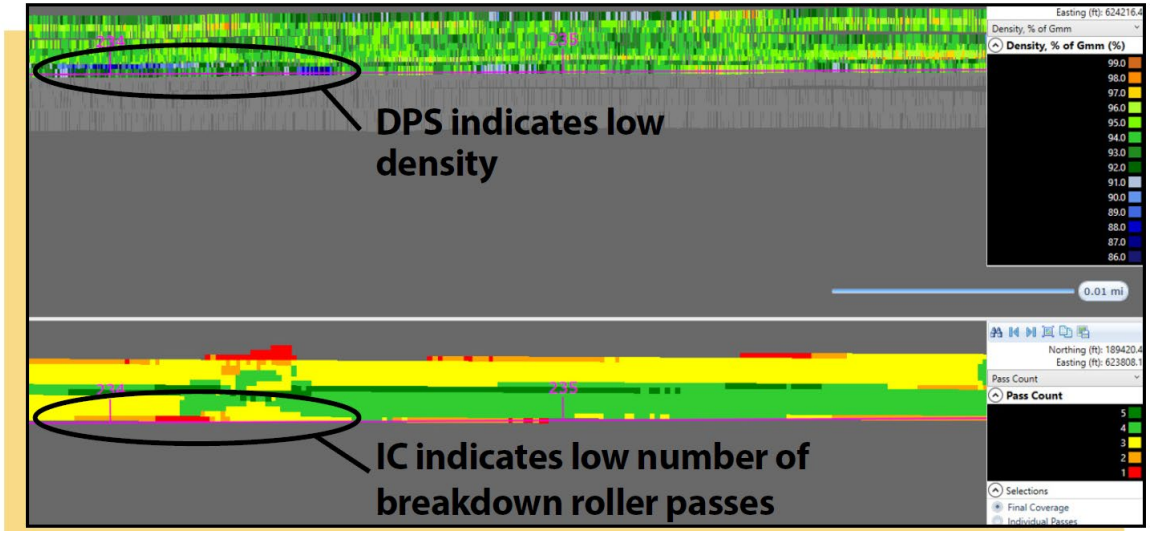
Process Improvement: Leveraging ICT technologies

PMTP Measured Temperature at Placement, °F



DPS Measured Density, %Gmm





Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing

TPF-5(504): Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing (4 years)

- **Objective:** Develop testing and analysis procedures for automatic detection and rating of stripped section for project and network level pavement evaluations
- **Lead Agency:** MnDOT
  - Contact: Eyoab Zegeye, eyoab.zegeye@state.mn.us (MNDOT)
- **Committed agencies:** MN, IL, MO, TN, MS, TX, GA & FHWA
- **Pending**: CA, KS, WI, VA and IN
- **100% SP&R Approval:** Approved
- **Commitment level**: $25K/year

U.S. Department of Transportation
Federal Highway Administration

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DEPARTMENT OF TRANSPORTATION

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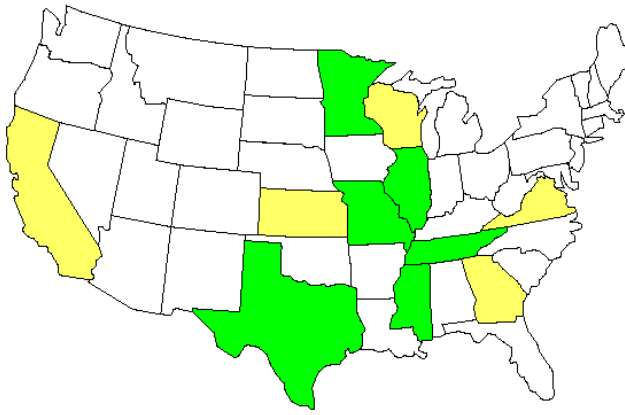
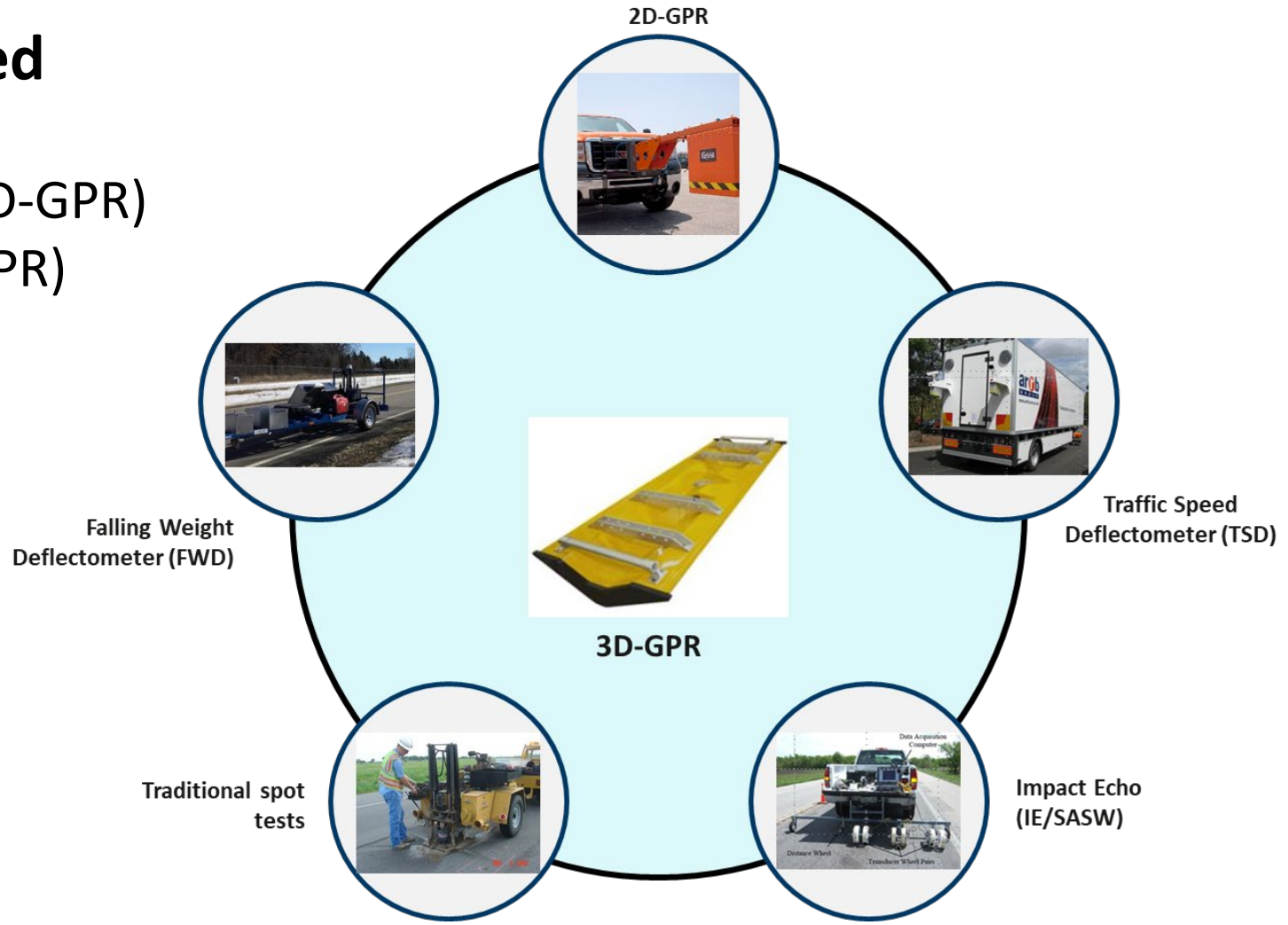


SCAN US

Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing

- **Testing Technologies Considered**
  - MnDOT Road Doctor
  - 3D Ground Penetrating Radar (3D-GPR)
  - 2D Ground Penetrating Radar (GPR)
  - Falling Weight Deflectometer
  - Traffic Speed Deflectometer
  - Impact Echo IE/SASW
  - Coring/Boring



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)

MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research

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

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Preservation Group Experiments

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

National Pavement Preservation Study
2 Climates & 2 Traffic Levels

	Minnesota		Alabama
		**Climate**	
Construction 2016		High **Traffic** Low	 Construction 2015
2016	 CSAH-8		 2012

NCAT/MnROAD Preservation Group (PG) Effort (Northern In-Place Recycling – 70th Street)

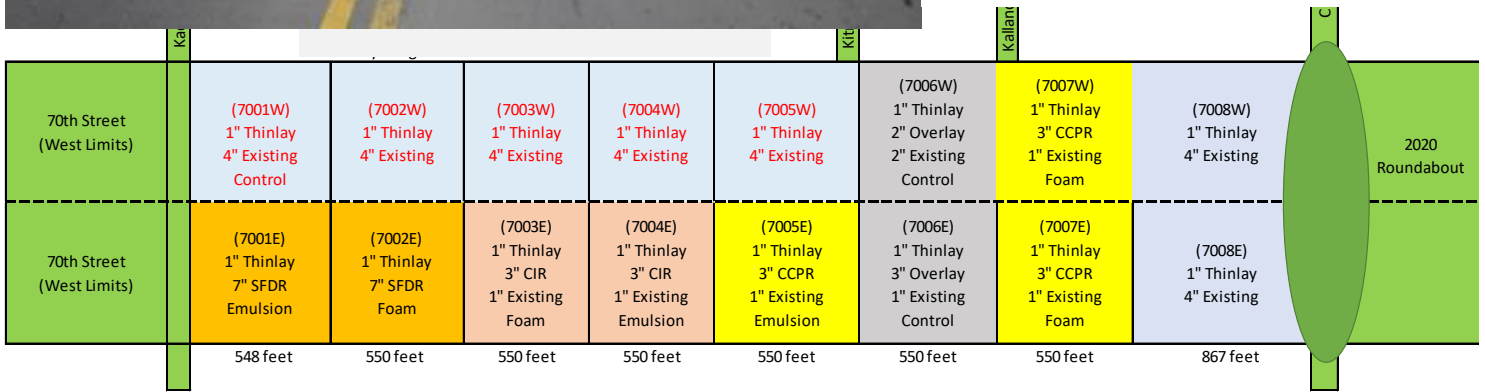
2019 Construction (Thinlays over)

- Control (no other work)
- SFDR (foam-emulsion)
- CIR (foam-emulsion)
- CCPR (foam-emulsion)
- 2 Regular Mill/Fills

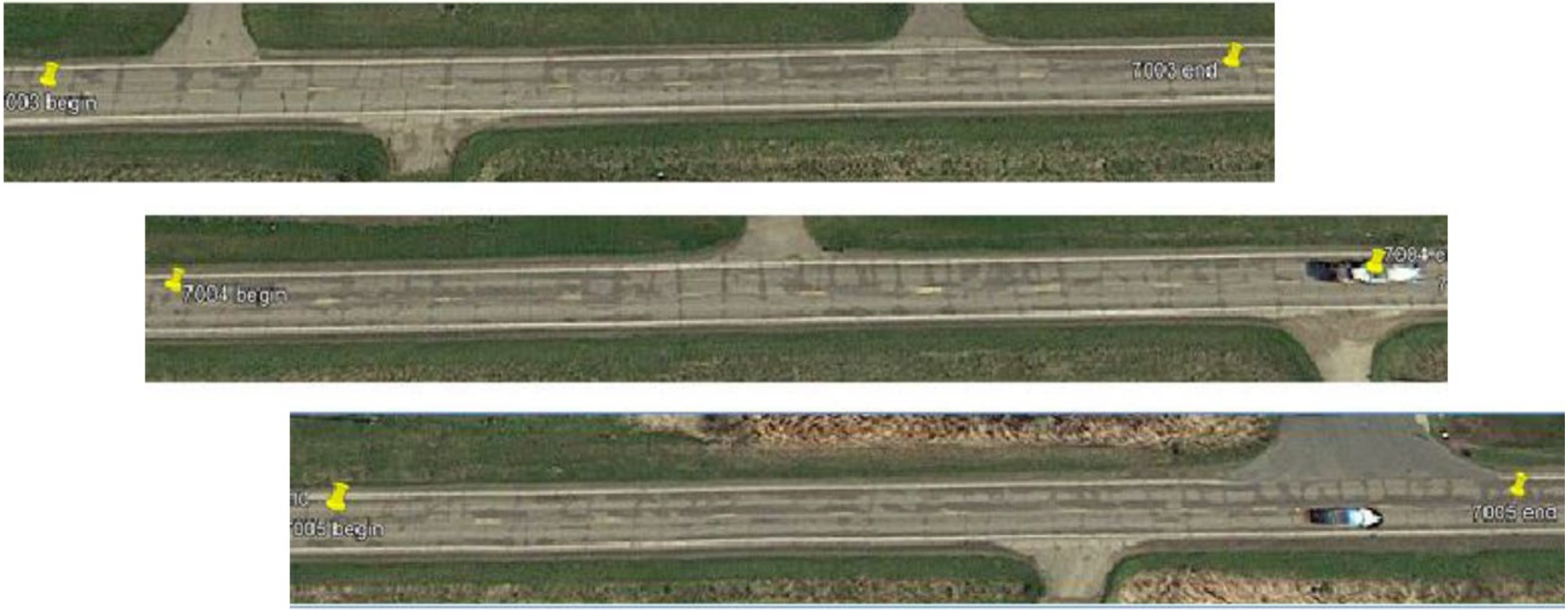
2 Year Observations

- Ride (IRI)
  - 2019 IRI over 300 in/mi
  - 2021 IRI 60-100 in/mi
- Reflective Cracking
  - Difference in controls and recycled sections cracking
- Rutting – not an issue

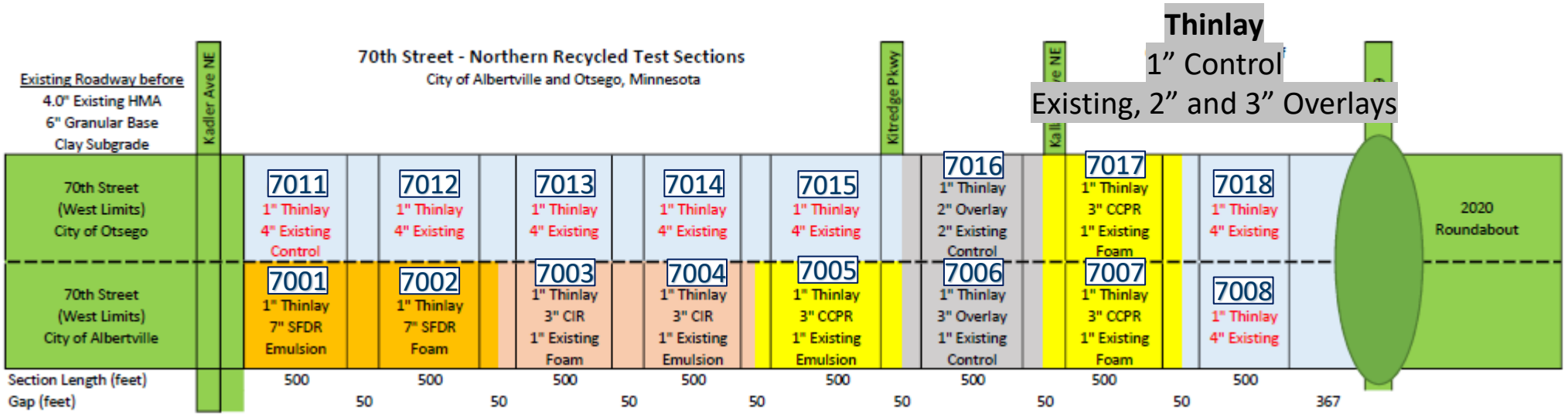
1 Mile
16 Test Sections



Pre-existing cracking – Google Earth



Pavement Preservation Northern Recycling
70th Street As Built (1/10 mile)

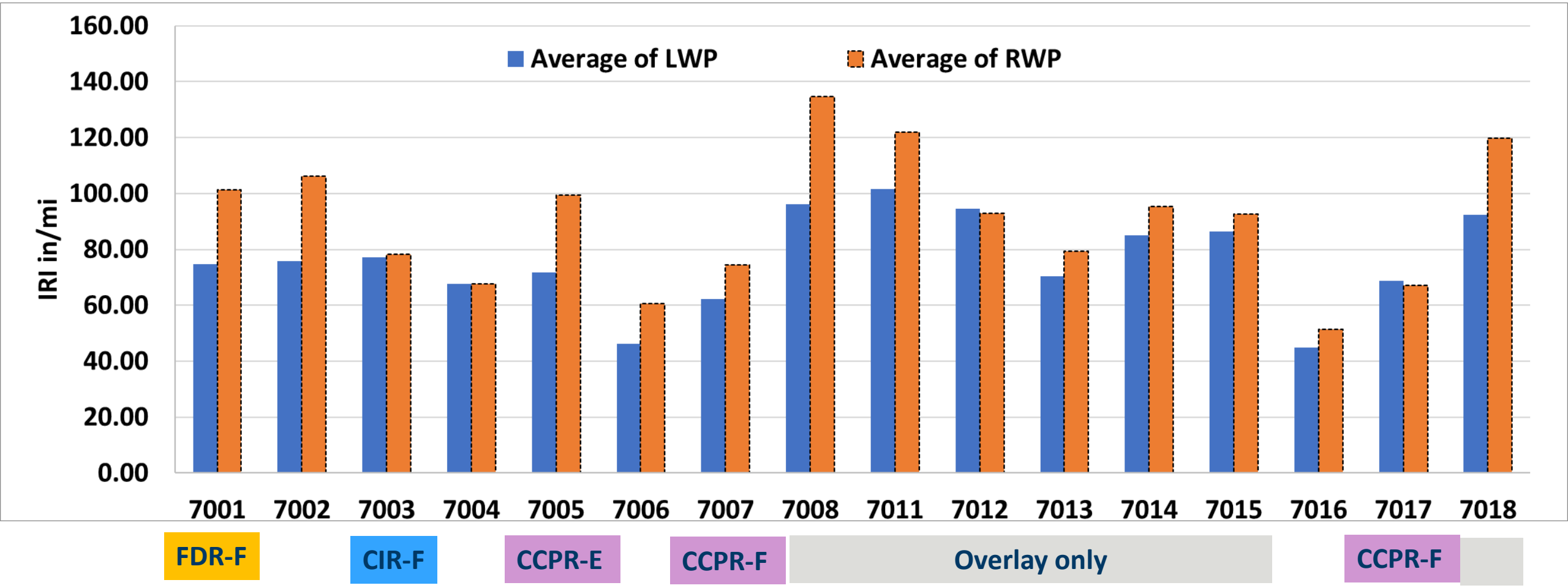


Stabilized Full Depth Reclamation
Emulsion + Foam with Control

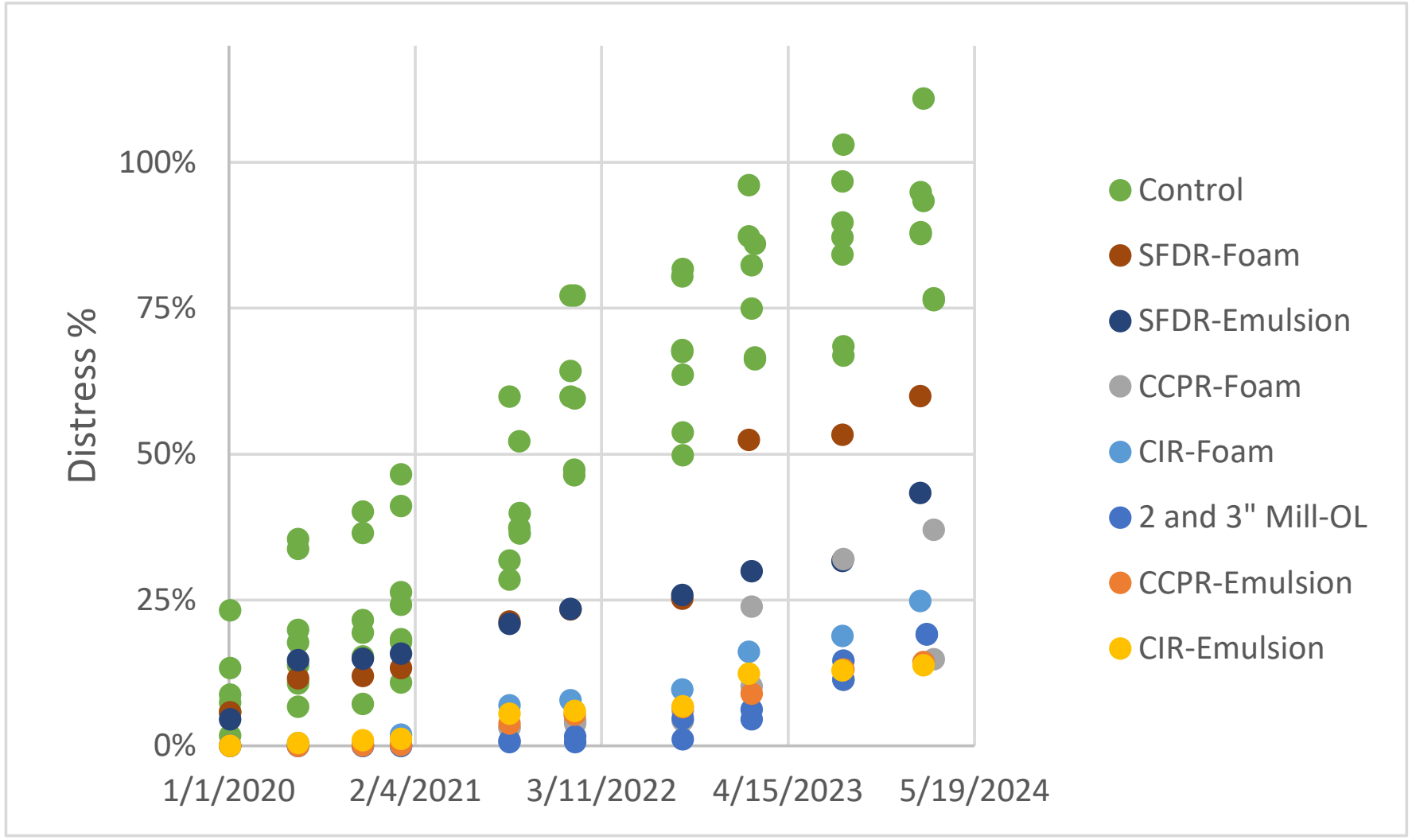
Cold In-place Recycling
Foam + Emulsion with Control

Cold Central Plant Recycling
Emulsion + Foam with Control

Performance – Ride (September 2023)

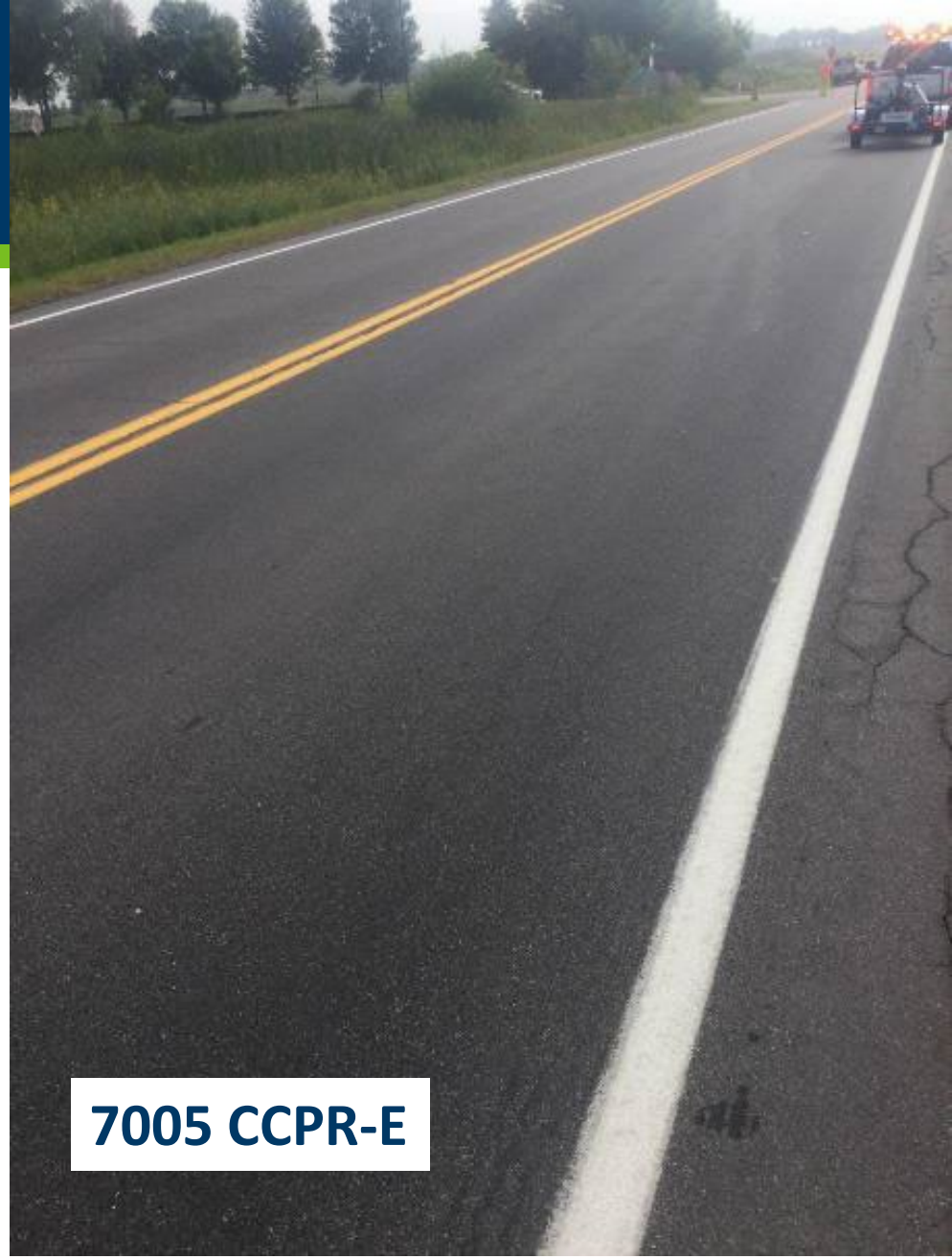


Performance – Total Returning Cracking (September 2023)



Performance – Cracking (August 2023)

7004 CIR-E



7005 CCPR-E

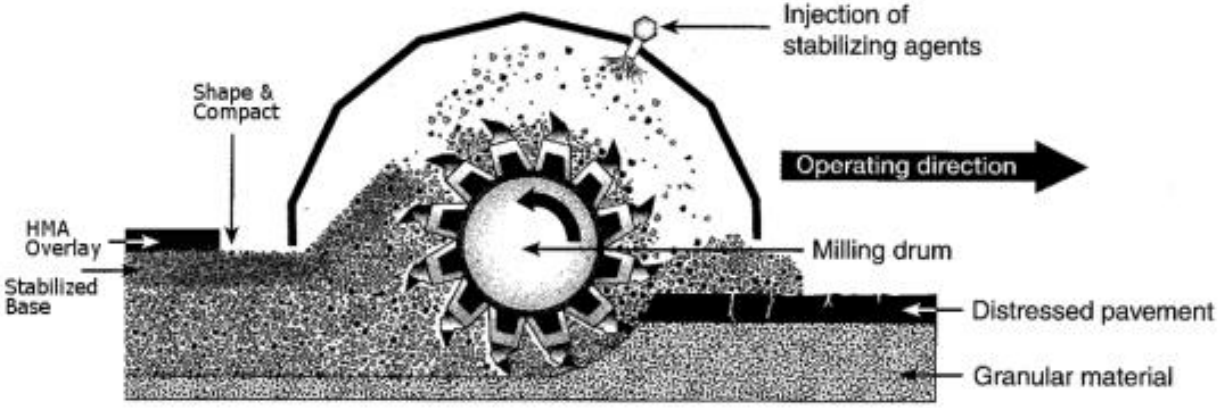
Performance – Cracking (August 2023)

2007 MnROAD FDR Findings (stepping back to MnROAD Tie)

- **2007 Road Science Partnership**
  - 3 Sections (mainline Cells 2,3,4)
- **Observations**
  - 2.75” Interstate surface on engineered FDR
  - Engineered emulsion → balance stiffness/flexibility
- **Benefits**
  - Design for distressed pavements/Full depth repairs
  - **Designed to last 5 years lasted 13+**
  - Cells 2,3 – Excellent Performance
  - Cell 4 – built on clay no base – seasonal Effe

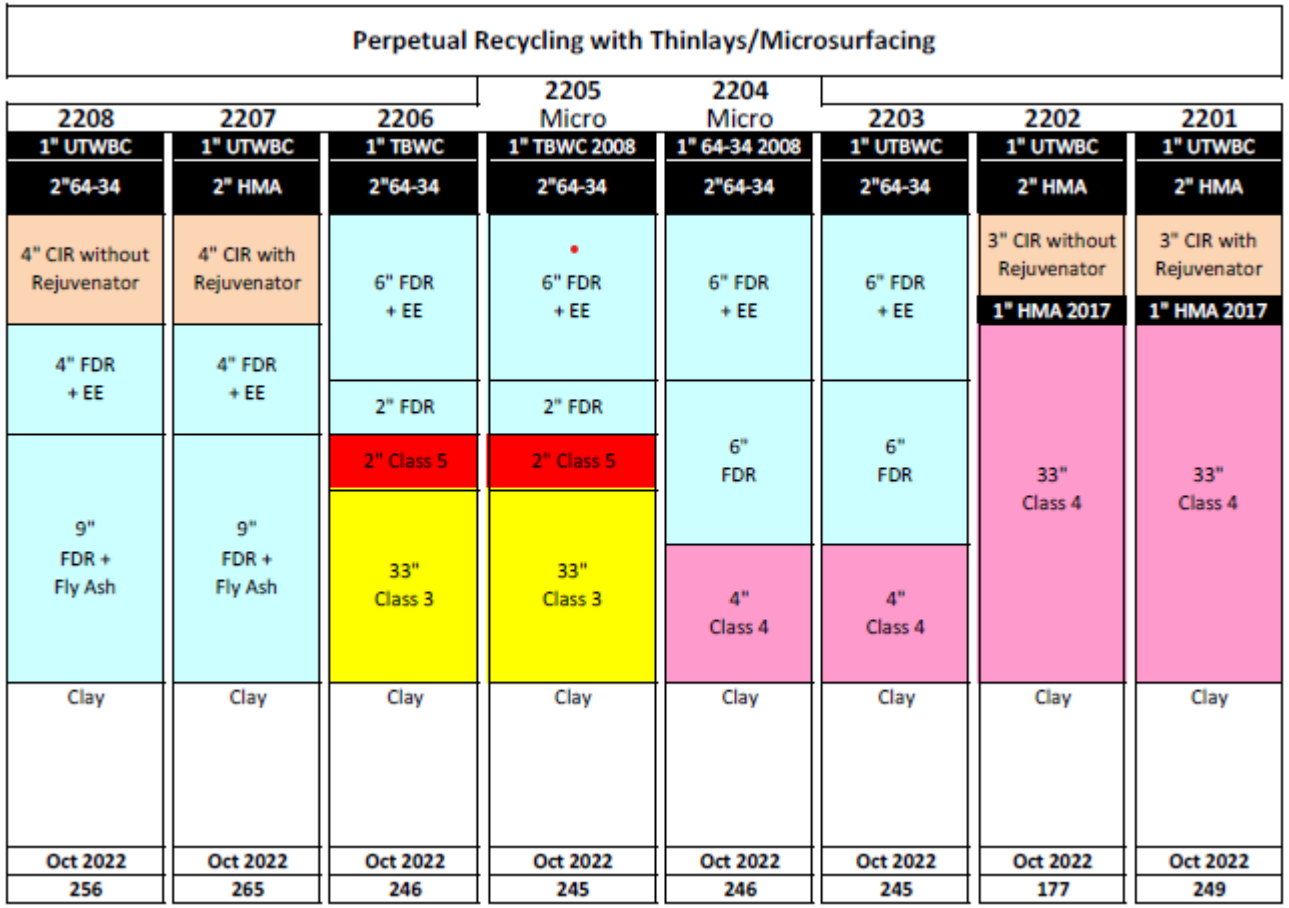
    (poorest performance – cracking and fatigue)

Lots of Promise - Sustainable practice



2022 NRRA Study / MnROAD Construction

- **Built off the 2007 Experiment**
  - **SFDR on existing SFDR**
  - **Redo Surfaces on SFDR (Micro vs TBWC)**
- **NRRA Funded Project**
  - Reclamation and Recycling Techniques to Achieve Perpetual Pavement Characteristics
  - 4 test sections



Cell 4 — SFDR of 2007 SFDR

Cell3 — TBWC or Micro over 2007 SFDR

Cell 2

Cell 1 — First SFDR

NRRA Project - Reclamation and Recycling Techniques to Achieve Perpetual Pavement Characteristics

Research Goals (started in Fall 2023)

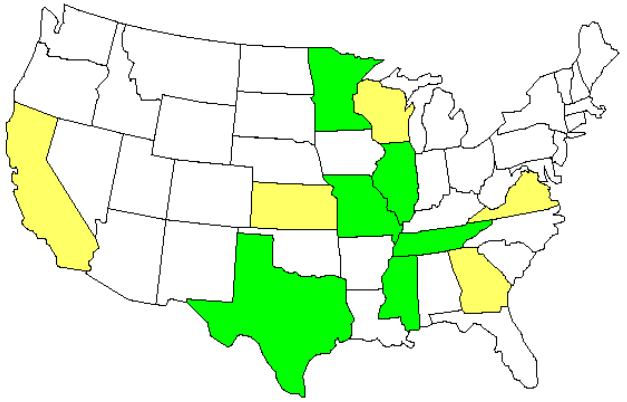
- Create a framework for a standardized methods using MnROAD data:
  - Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA)
- Evaluate recycle pavement life-cycle costs, assess end-user impacts, improve energy efficiency, enhance air quality, and promote resource conservation through the optimization of material selection and design.

LCA and LCCA recycled pavement structures

- MnROAD Mainline 2008 – (1) Full Depth Reclamation (FDR), (2) Stabilized Full Depth Reclamation (SFDR)
  - (a) Engineered Emulsion (EE) Stabilized and (b) Fly Ash Stabilized
- 70th Street (2019) – (1) Stabilized Full Depth Reclamation (SFDR), (2) Cold In Place Recycling (CIR), (3) Cold Central Plant Recycling (CCPR)
  - (a) Foam Stabilized and (b) Engineered Emulsion Stabilized
- MnROAD Mainline 2022 – (1) Cold In Place Recycling (CIR) of original pavement and SFDR pavement (2008)
  - (a) with Rejuvenator and (b) without Rejuvenator

Lead: Emil Bautista (MnDOT) and Emmanuel Adeyanju (UNC – Charlotte NSF graduate intern)

2024 MnROAD Construction



- **RoadSoup (100% Cold Recycle Mix - Spring)**
  - 1 Section – 2” mill/Fill
- **HMA Stripping Study (Spring)**
  - 6 Sections – HMA/HMA
  - 6 Sections – HMA/PCC
  - MnROAD Services Road
  - Study → TPF-5(504): Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing (4 years)
- **Cement Alternatives (July)**
  - 8 Mainline Test Sections – 250 ft each
  - Possible 4 Low Volume Road Test Sections – 250 ft each
  - NRRA Study → Use of Innovative Sustainable and Durable Materials in Concrete Pavements
  - Ties to the 16 test sections and research started in 2022

2024 NRRA Conference

April 30 - May 1, 2024

- Shoreview Community Center (Minneapolis/St Paul)
- NRRA implementation Focus
  - April 30, 2024
    - General Session
    - Team Lead Sessions on implementation of completed NRRA projects
  - May 1, 2024
    - Morning - Team Lead Updates and project highlight
    - Afternoon – MnROAD Open house / demos / meetings / open to ideas

NRRA Technical Teams are developing the agenda for the 1 ½ day conference and different options for the 2nd day at MnROAD.

Partnership Links / Ways to get Involved

Pavement Preservation – Phase III

- MnDOT Lead State
- Solicitation 1581 - https://pooledfund.org/Details/Solicitation/1581

National Road Research Alliance NRRA

- MnDOT Lead State
- TPF-5(466) - https://pooledfund.org/Details/Study/693

Additive Group Study

- NCAT lead pooled fund / NRRA & MnROAD Ties
- TPF-5(469)- https://pooledfund.org/Details/Study/696

DPS National Pooled Fund Program

- MnDOT lead State (15 agencies)
- TPF-5(443)- https://pooledfund.org/Details/Study/667

Continuous Bituminous Pavement Stripping Assessment Through Non-destructive Testing

- MnDOT lead State (8 agencies)
- TPF-5(504)- https://pooledfund.org/Details/Study/733

2024 NRRA Expected RFP

Flexible - Perpetual Pavements in Wet Freeze Climate

- Supported with MnROAD and Wisconsin test sections

Flexible - Recycled Binder Availability

- Efforts to understand how recycled binders effect new HMA

Flexible – Balanced Mix Design

- NRRA supported second phase of research

Rigid - Concrete Sustainability / Cement Alternatives

- Supported with 2024 MnROAD test sections

Future Topics? Reasons to Partner

1. Green Pavements
2. Intelligent Systems
3. Innovative Materials

1. Sustainability/ EPD
2. Database/AI
3. Collaborations/ Partnerships

1. What do you think?
2. What is the future?

Thank You - Ben

Questions / Comments

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

Buzz
Ben Worel
ben.worel@state.mn.us