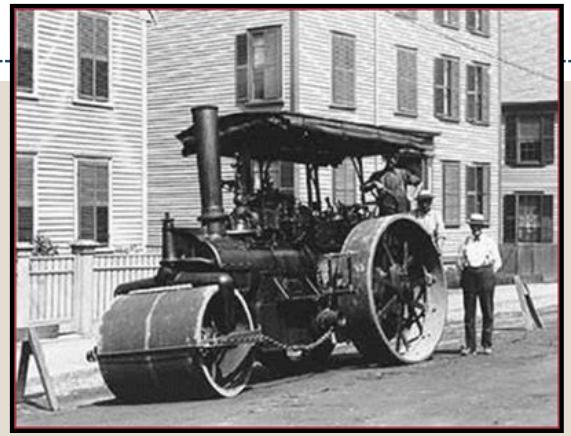
FHWA's Demonstration Project for Enhanced Durability Through Increased Density



Courtesy Asphalt Institute

TIM ASCHENBRENER, P.E.

SENIOR ASPHALT PAVEMENT ENGINEER

PAVEMENT MATERIALS TEAM

OFFICE OF PRECONSTRUCTION, CONSTRUCTION AND PAVEMENTS

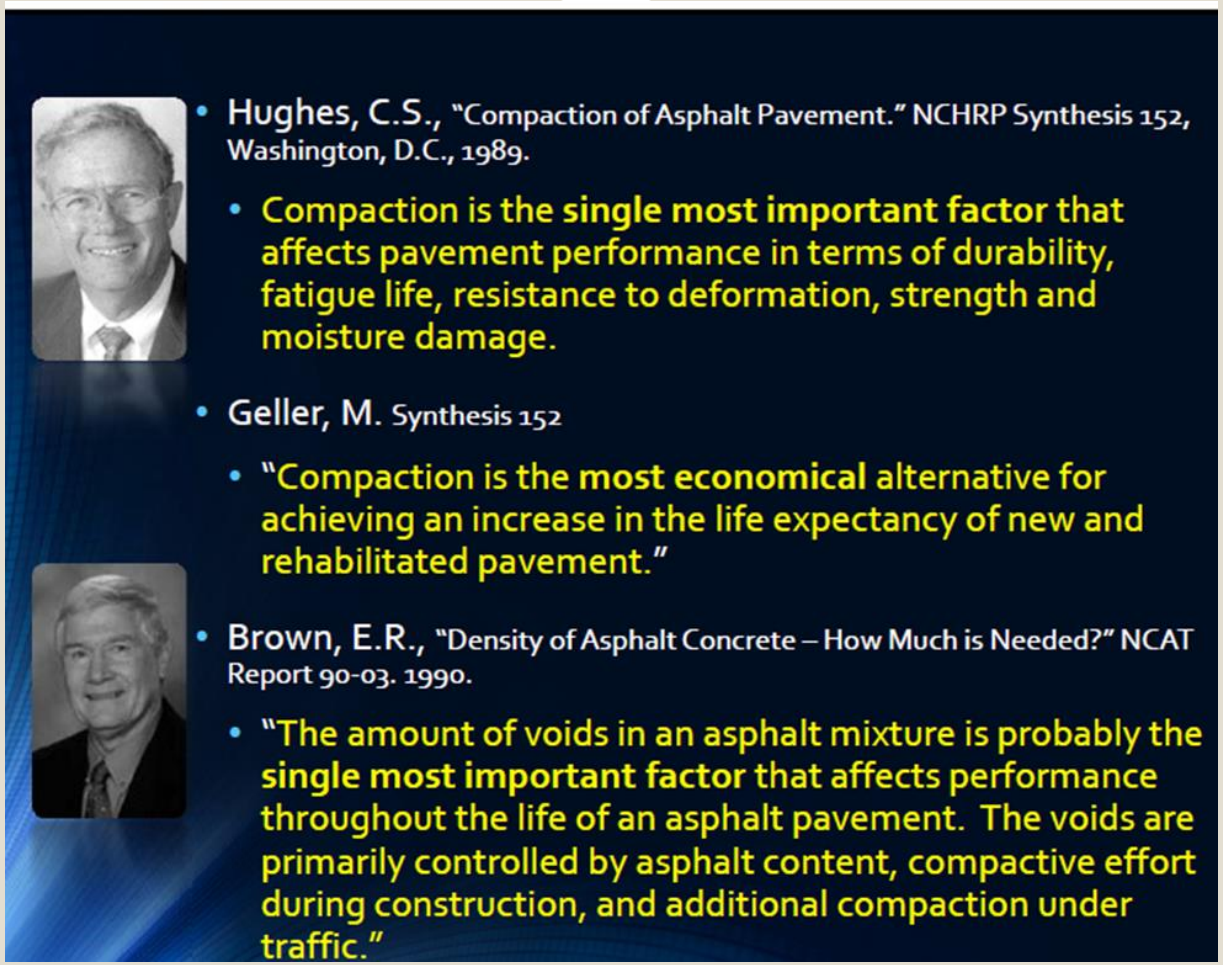
FHWA

U.S. Department of Transportation
Federal Highway Administration

Achieving Increased In-place Density

1. **Density is Important**
2. Gold Medal Examples
3. Density Demonstration Projects

Density Is Important



From an FHWA document

Reasons for Obtaining Density

Cracking

- To improve fatigue cracking resistance
- To improve thermal cracking resistance

Rutting

- To minimize/prevent further consolidation
- To provide shear strength and resistance to rutting

FHWA photo

Moisture Damage

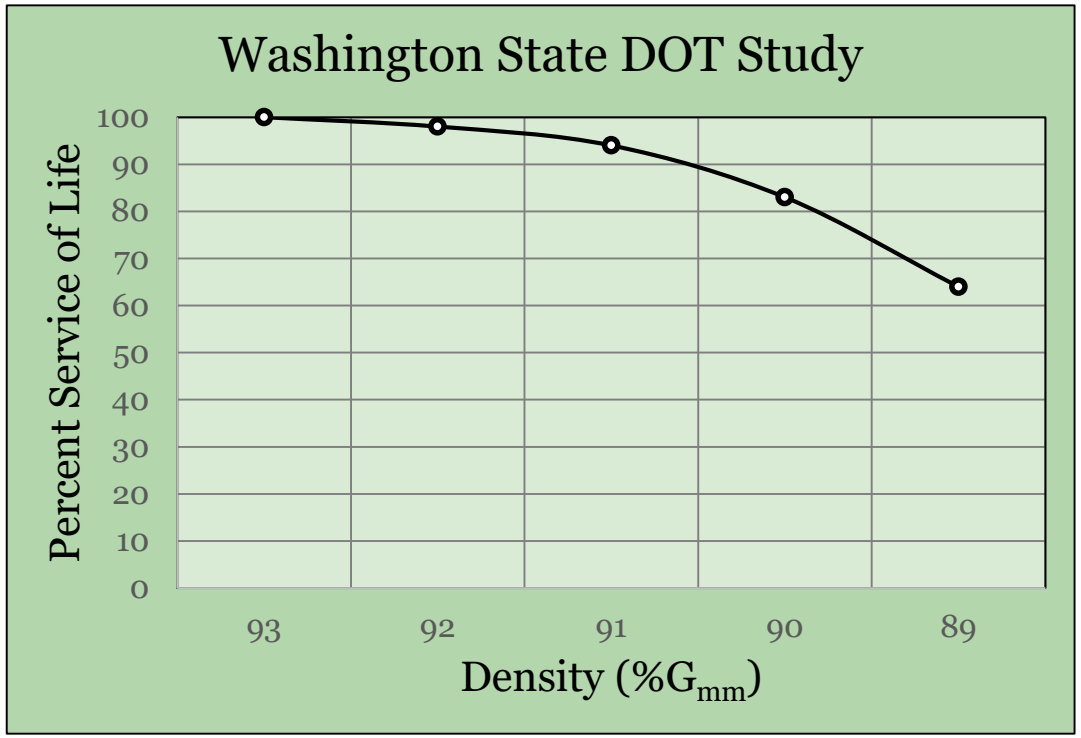
- To ensure the mixture is waterproof (impermeable)

Aging

- To minimize oxidation of the asphalt binder

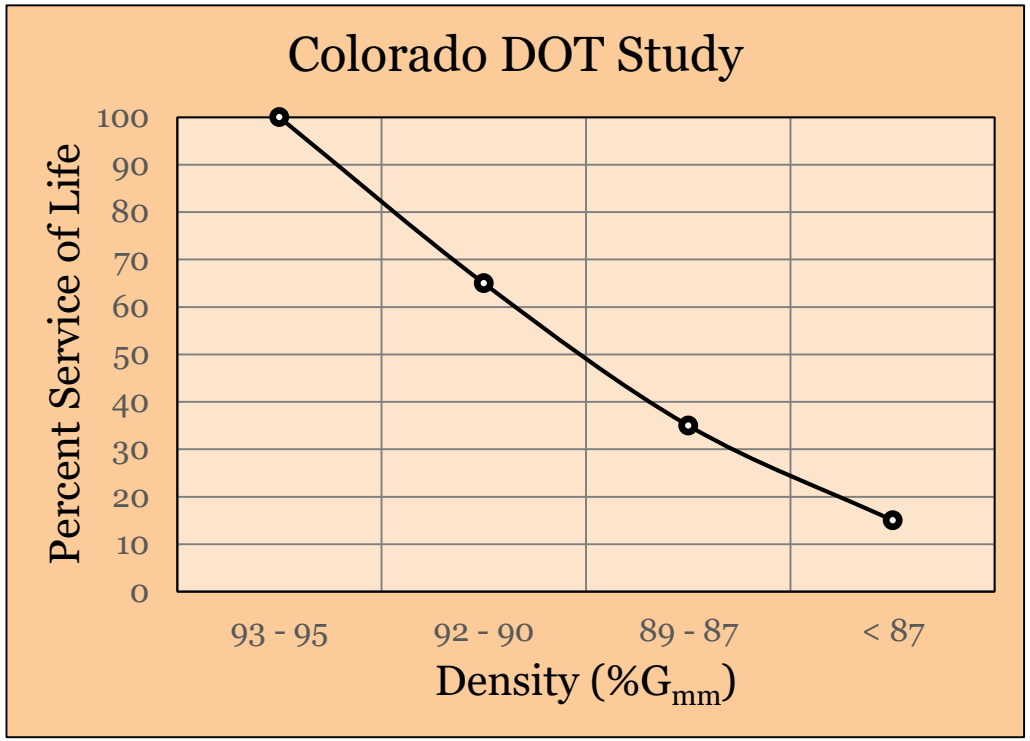
Density is important, but not a cure-all

How Much Density (%G_{mm}) is Enough?
Loss of Pavement Service Life



Thicker Pavements

TRR 1217, 1989

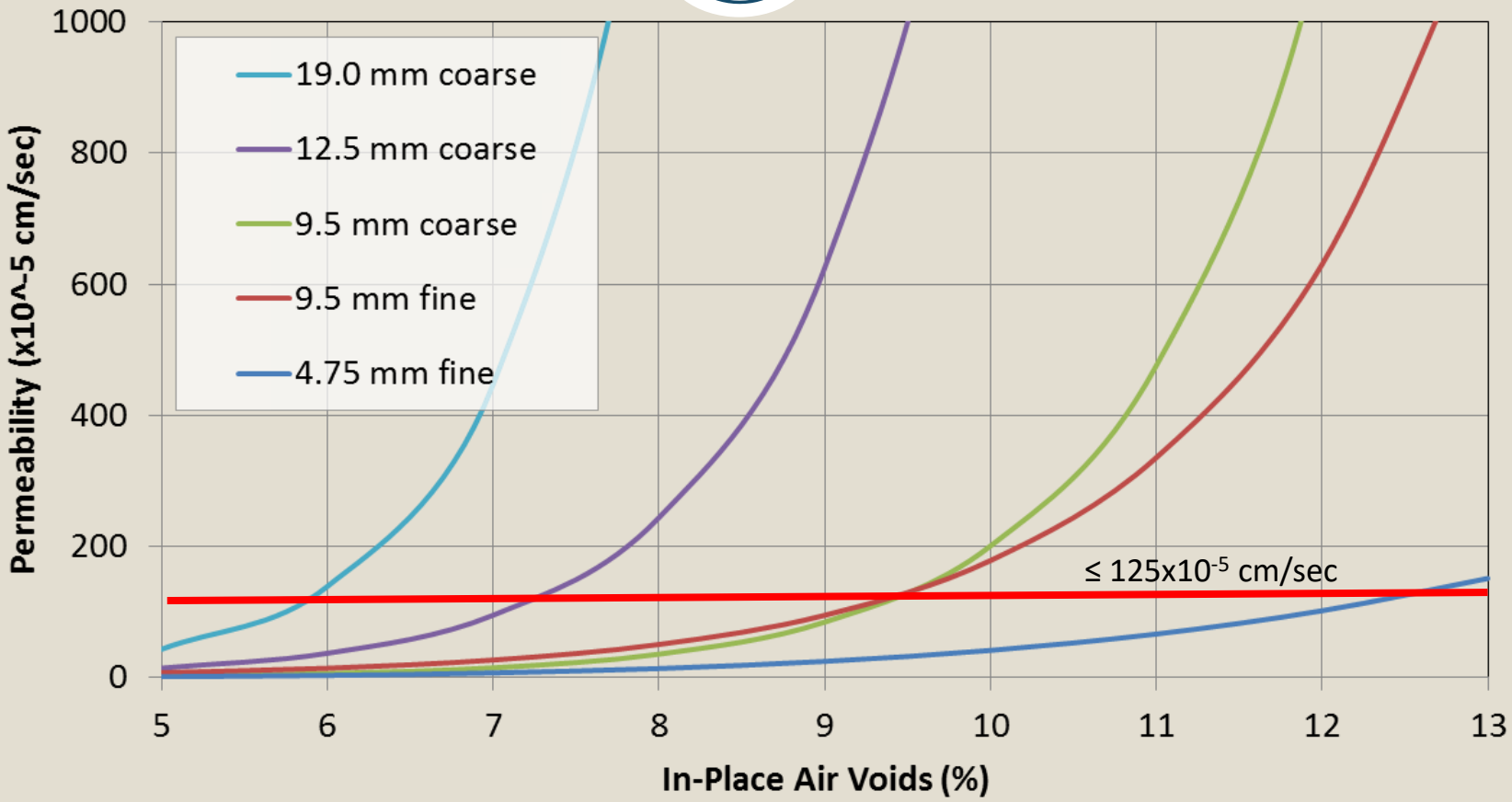


Typical Pavements

CDOT 2013-4, 2013

Reduced in-place density at the time of construction results in significant loss of service life!

How Much Density (%G_{mm}) is Enough?
NCAT Permeability Study



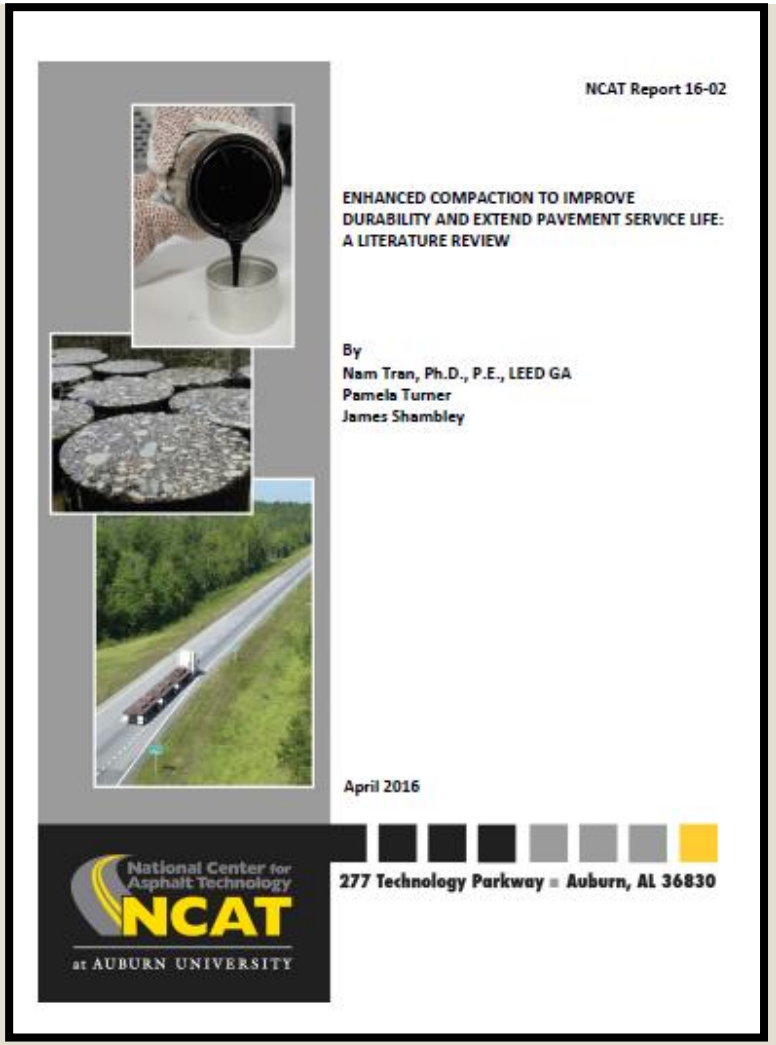
Finer NMAS mixes generally less permeable at equivalent air void levels!

From NCAT Report 03-02

National Center for Asphalt Technology (NCAT) Report 16-02 (2016) (Funded by FHWA)

"A **1% decrease in air voids** was estimated to:

- **improve fatigue** performance by 8.2 and 43.8%
- **improve the rutting** resistance by 7.3 to 66.3%
- **extend the service life** by conservatively 10%"



http://eng.auburn.edu/research/centers/ncat/files/technical-reports/rep16-02.pdf

Achieving Increased In-place Density

1. • Density is Important
2. • **Gold Medal Examples**
3. • Density Demonstration Projects

Some "Gold Medal" Density (% G_{mm}) Specifications Purpose

- Identify density (% G_{mm}) specifications that are success stories.
- Since this is an Olympic year, these success stories are considered "gold medal" examples.

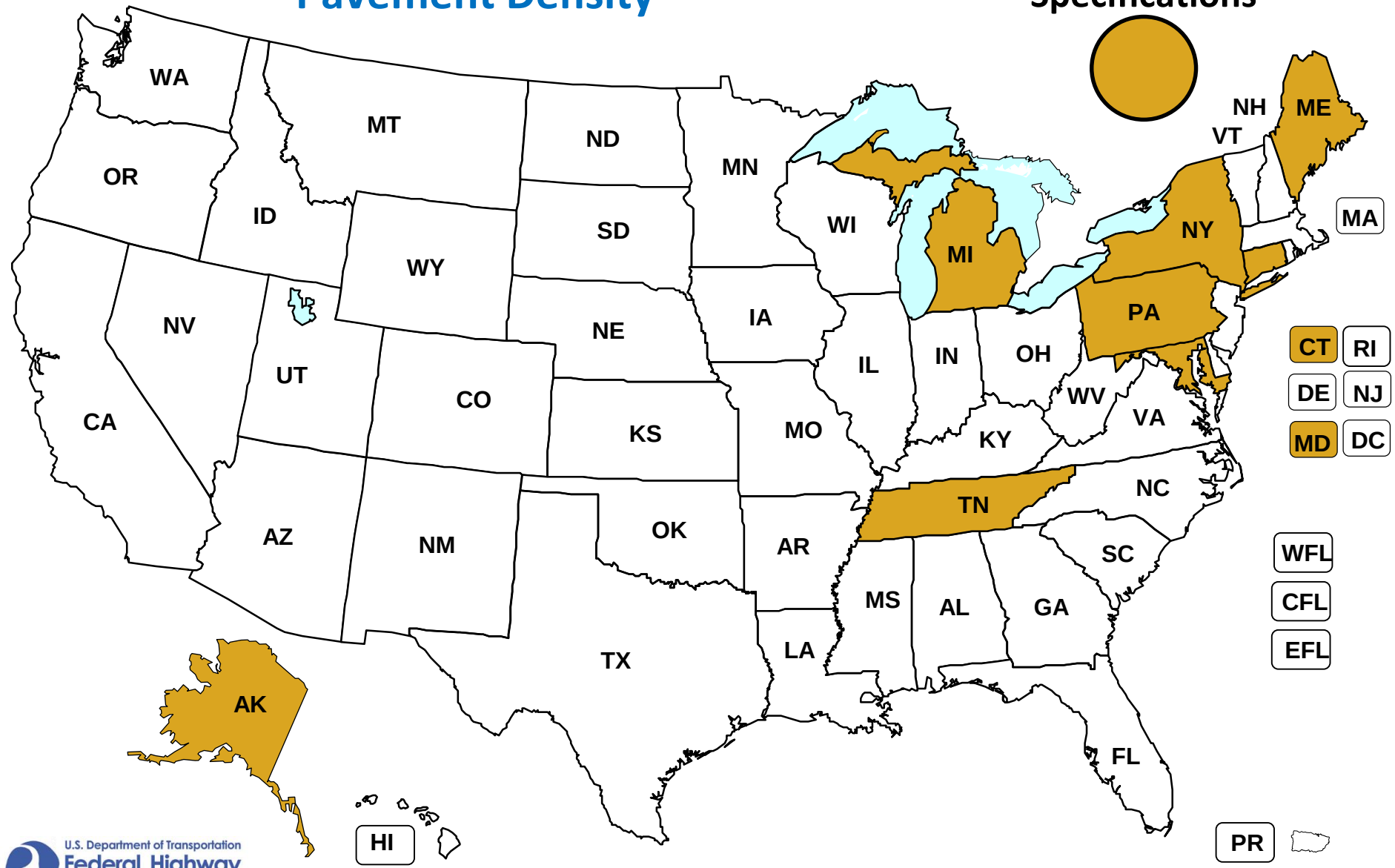
Image Pixabay

Some "Gold Medal" Density ($\%G_{mm}$) Specifications

- Alaska DOT&PF
- Maine DOT
- Maryland DOT SHA
- Michigan DOT
- New York State DOT
- Pennsylvania DOT
- Tennessee DOT

Note: There are likely more. Contact me if you think you have one.

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

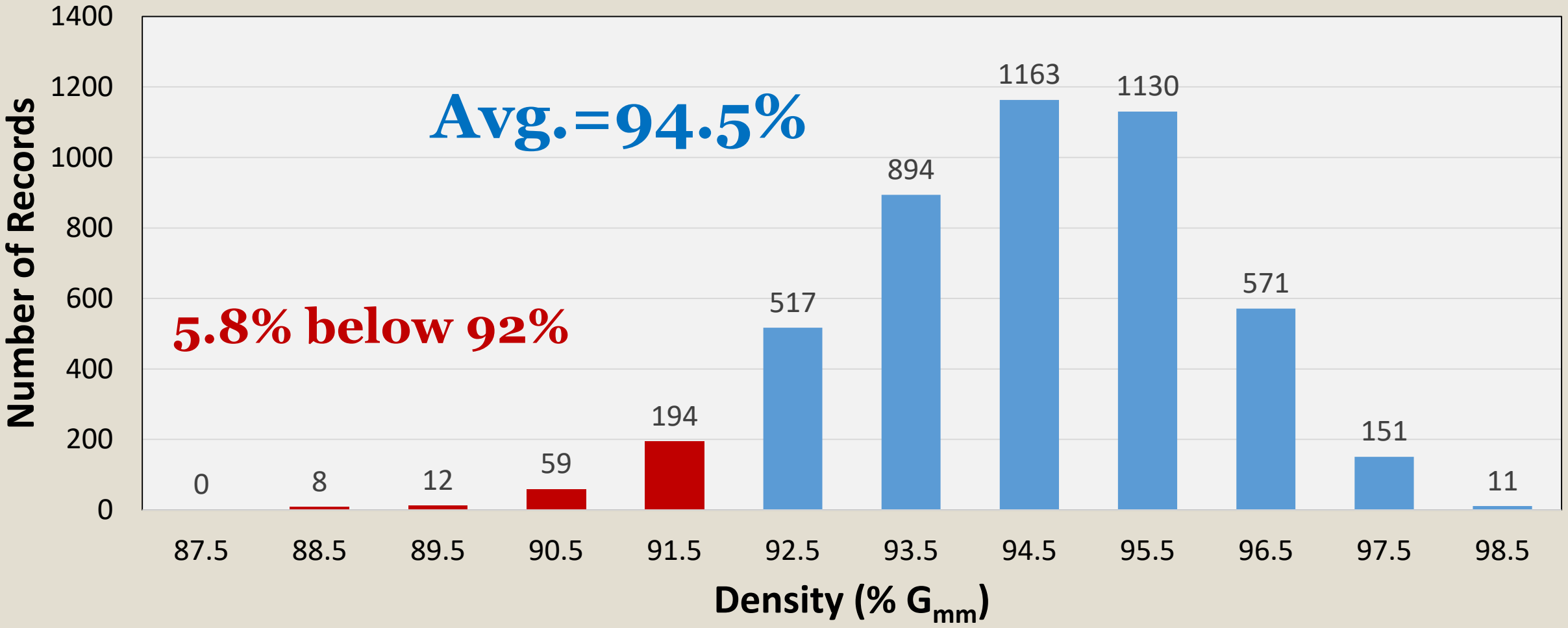


U.S. Department of Transportation
Federal Highway Administration

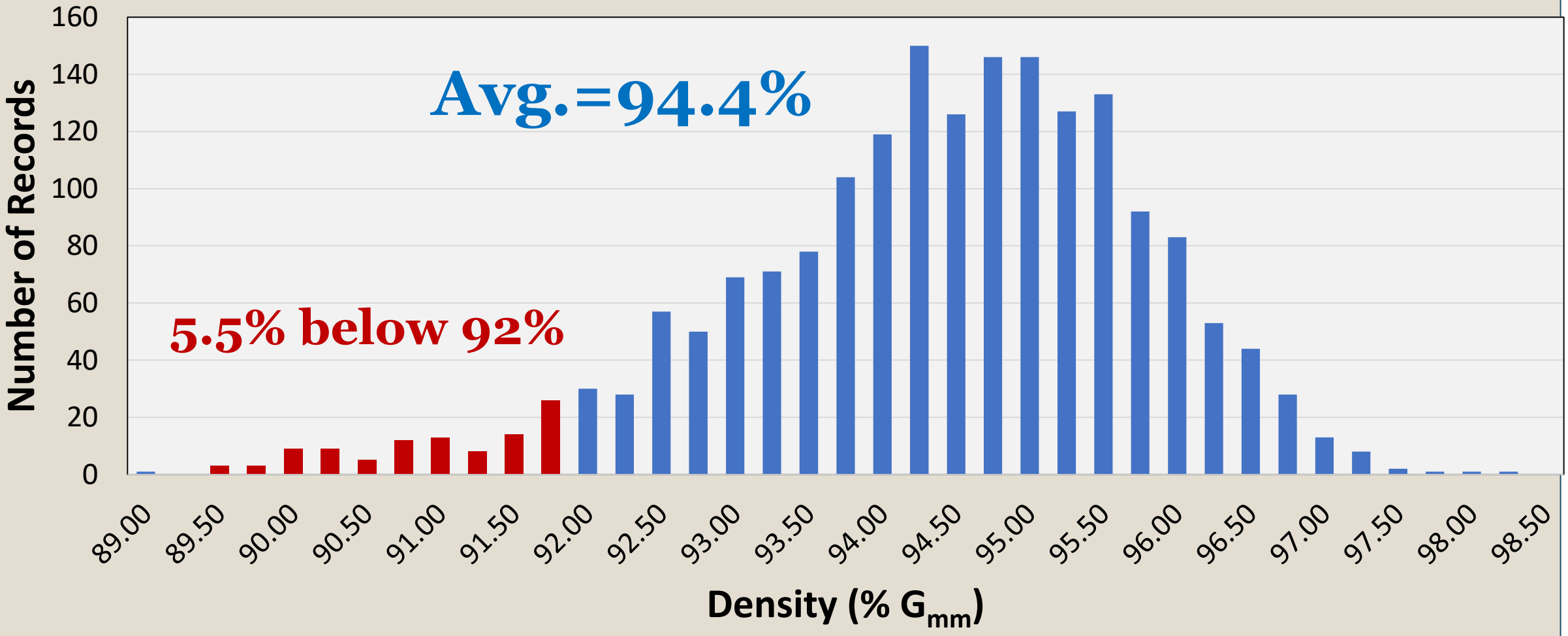
Gold Medal Density (% G_{mm}) Specifications Project Information

	State D	AK	ME	MD	MI	NY	PA	TN
Year(s) of Data Analyzed	2016	2015	2013 to 2017	2017	2015	2017	2017	2015 to 2017
Mix Type	Type C	Type II 19mm & Superpave 12.5 mm	9.5, 12.5 and 19 mm	Dense Graded	9.5, 12.5 and 19 mm	Series 50 9.5, 12.5 and 19 mm	High level wearing surface 9.5, 12.5 & 19mm	D-mix (3/8" NMAS)
Type of Projects	N/A	Interstate and principal arterial	All mainline projects		All projects> 5,000 tons	Full or partially controlled roadways		Interstate and SR Freeways
Acceptance Testing	Agency only	Agency only	Agency only	Contractor validated by agency	Agency only	Agency only	Agency only	Agency only

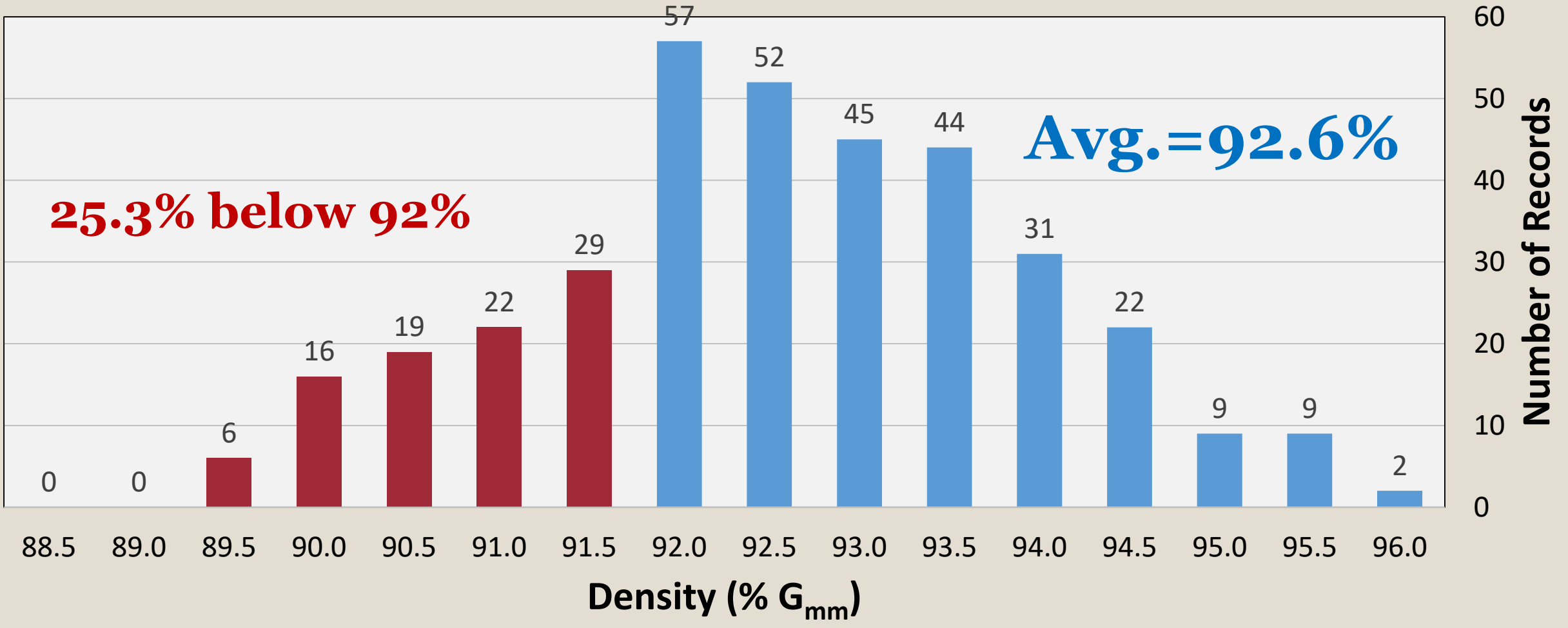
Maine DOT
Statewide Results 2013 to 2017



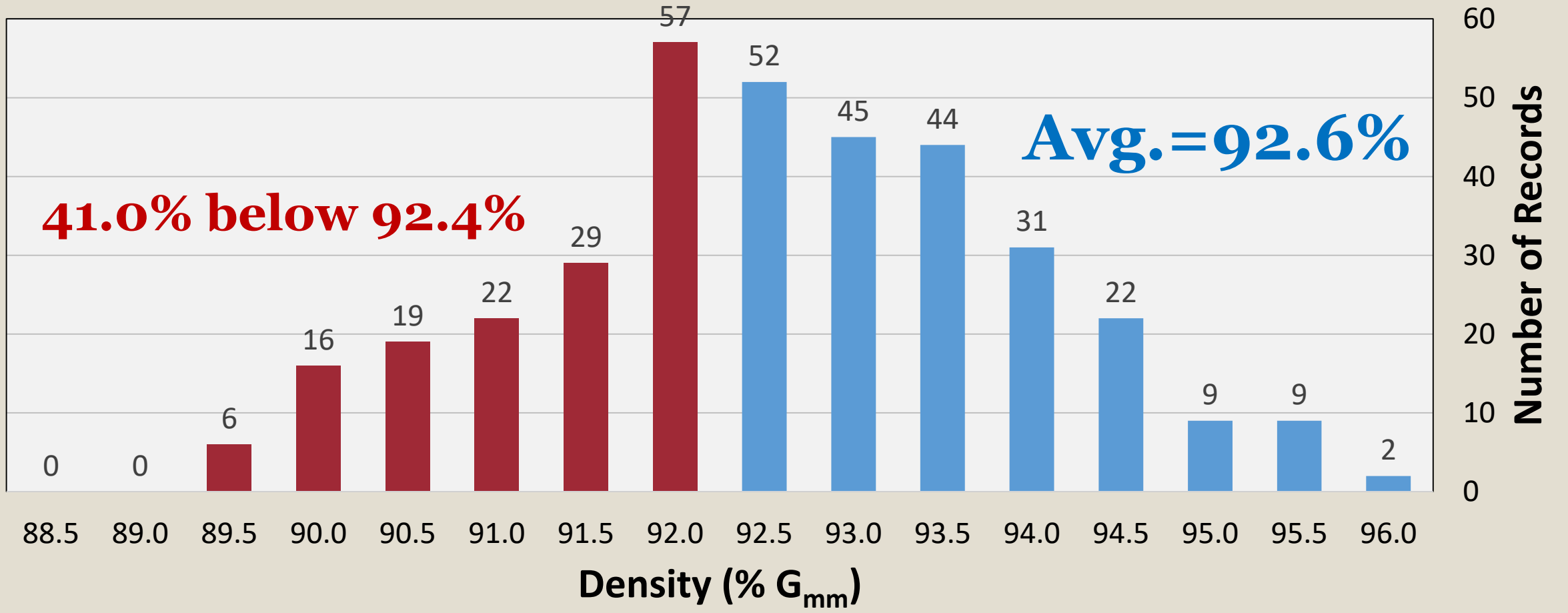
Michigan DOT
Statewide Results from 2015



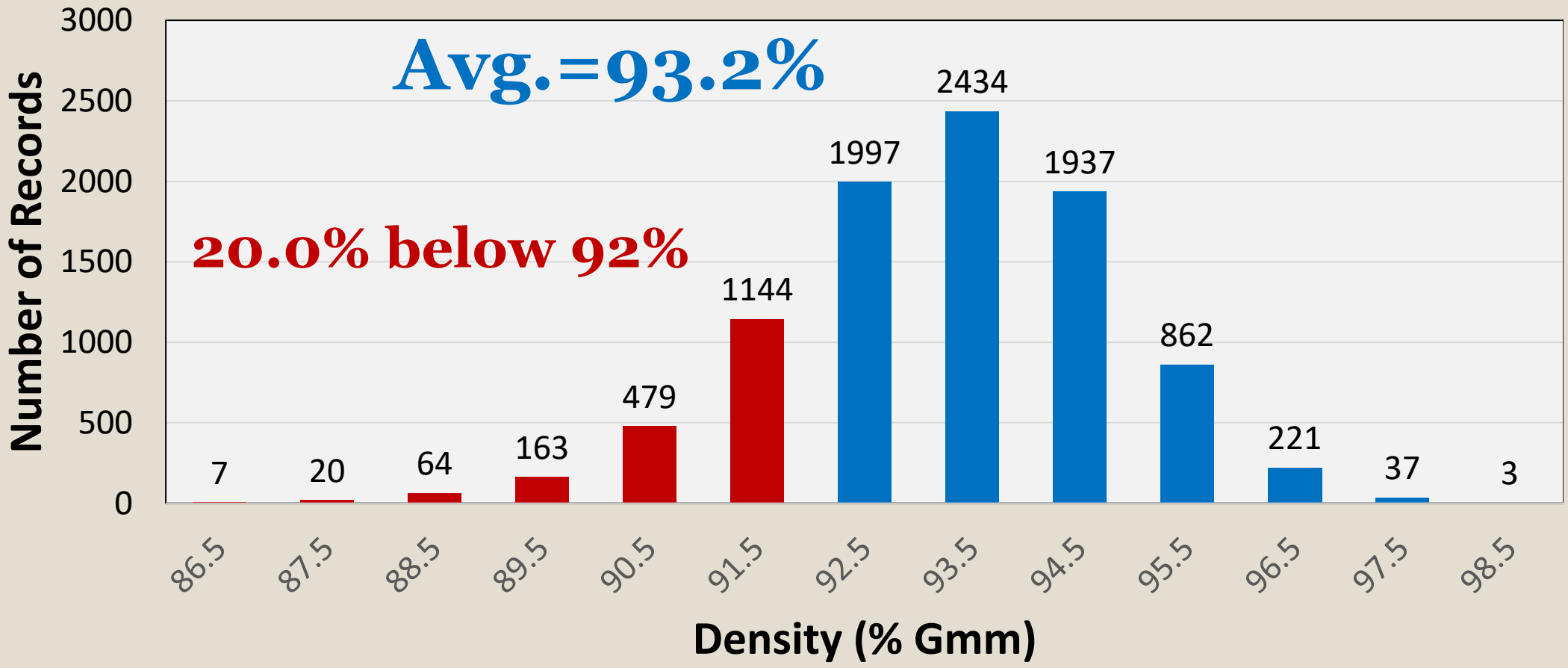
State D
Statewide Results from 2016



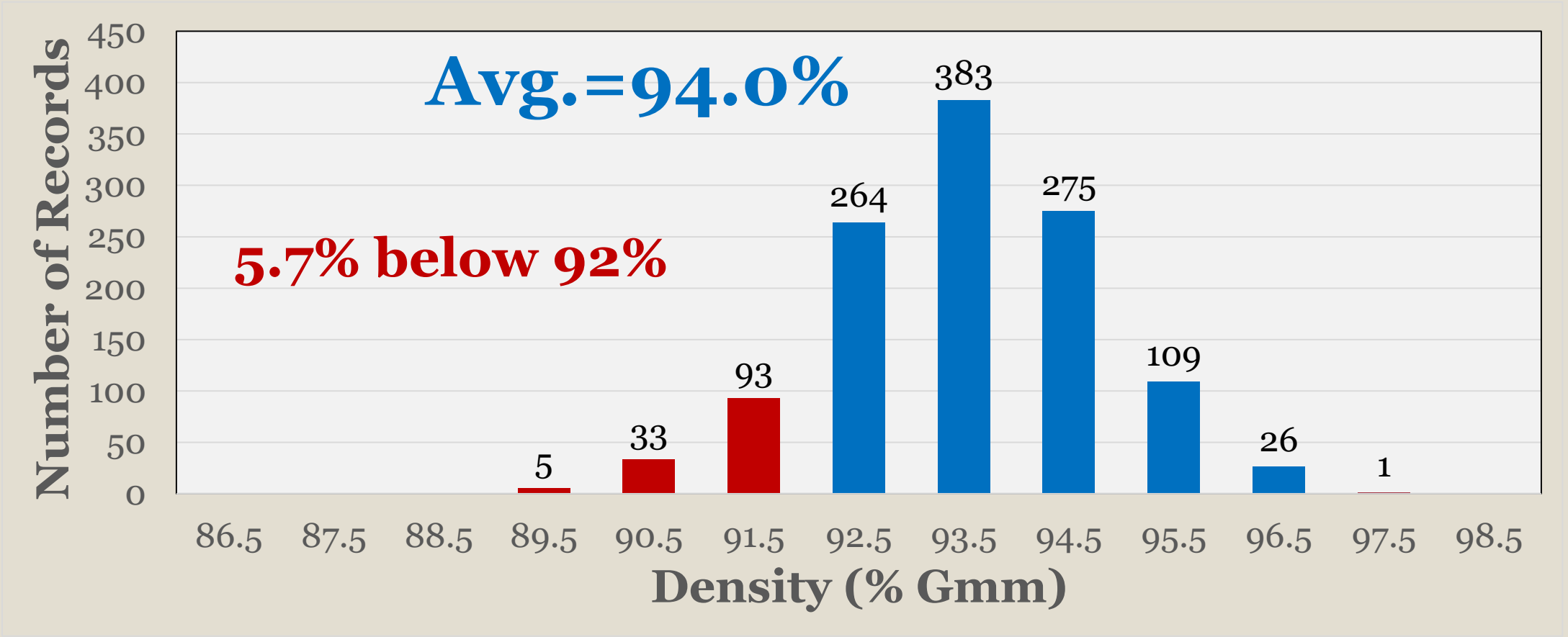
State D
Statewide Results from 2016



Arizona DOT
Statewide Results from 2017



Arizona DOT
Two Demonstration Projects in 2018



Specification Comparison

2017 Standard	2018 Demonstration Projects
• PWL	• PWL
• USL = 9.0 %	• USL = 8.0 %
• Average Air Voids = 6.8%	• Average Air Voids = 6.0%
• Lot Standard Deviation = 1.36	• Lot Standard Deviation = 0.86
• **> 8% Air Voids = 20.0%**	• **> 8% Air Voids = 5.7%**

Gold Medal Density (% G_{mm}) Specifications
Specification/Criteria/Results

	State D	AK	ME	MD	MI	NY	PA	TN
Type of Specification		PWL	PWL		PWL	PWL	PWL	
Limits (% G_{mm})		93.0 to 100.0	92.5 to 97.5		92.5 to 100.0	92.0 to 97.0	92.0 to 98.0	
Incentive for Only Density		5.0%	2.5%		2.0%	5.0%	2.0%	
Max. Incent. (% G_{mm})		≈96.0	≈93.5		≈94.5	≈94.0	≈94.0	
Avg. (% G_{mm})		94.9	94.5		94.4	94.2	94.4	
Std. Dev. of Lots		1.76	1.20		1.03	1.01	1.46	
< 92% G_{mm}		5.6%	5.8%		5.5%	5.0%	3.1%	

Gold Medal Density (% G_{mm}) Specifications
Specification/Criteria/Results

	State D	AK	ME	MD	MI	NY	PA	TN
Type of Specification	Lot Avg.	PWL	PWL	Lot Avg. & Ind. Sublot	PWL	PWL	PWL	Lot Avg.
Limits (% G_{mm})	91.5 to 95.0	93.0 to 100.0	92.5 to 97.5	92.0 to 97.0	92.5 to 100.0	92.0 to 97.0	92.0 to 98.0	92.0 to 97.0
Incentive for Only Density	1.5%	5.0%	2.5%	5.0%	2.0%	5.0%	2.0%	2.0%
Max. Incent. (% G_{mm})	92.75	≈96.0	≈93.5	94.0	≈94.5	≈94.0	≈94.0	94.0
Avg. (% G_{mm})	92.6	94.9	94.5	94.0	94.4	94.2	94.4	93.9
Std. Dev. of Lots	N/A	1.76	1.20	1.03	1.03	1.01	1.46	N/A
< 92% G_{mm}	25.3%	5.6%	5.8%	5.3%	5.5%	5.0%	3.1%	11.0%

Gold Medal Density (% G_{mm}) Specifications
Specification/Criteria/Results

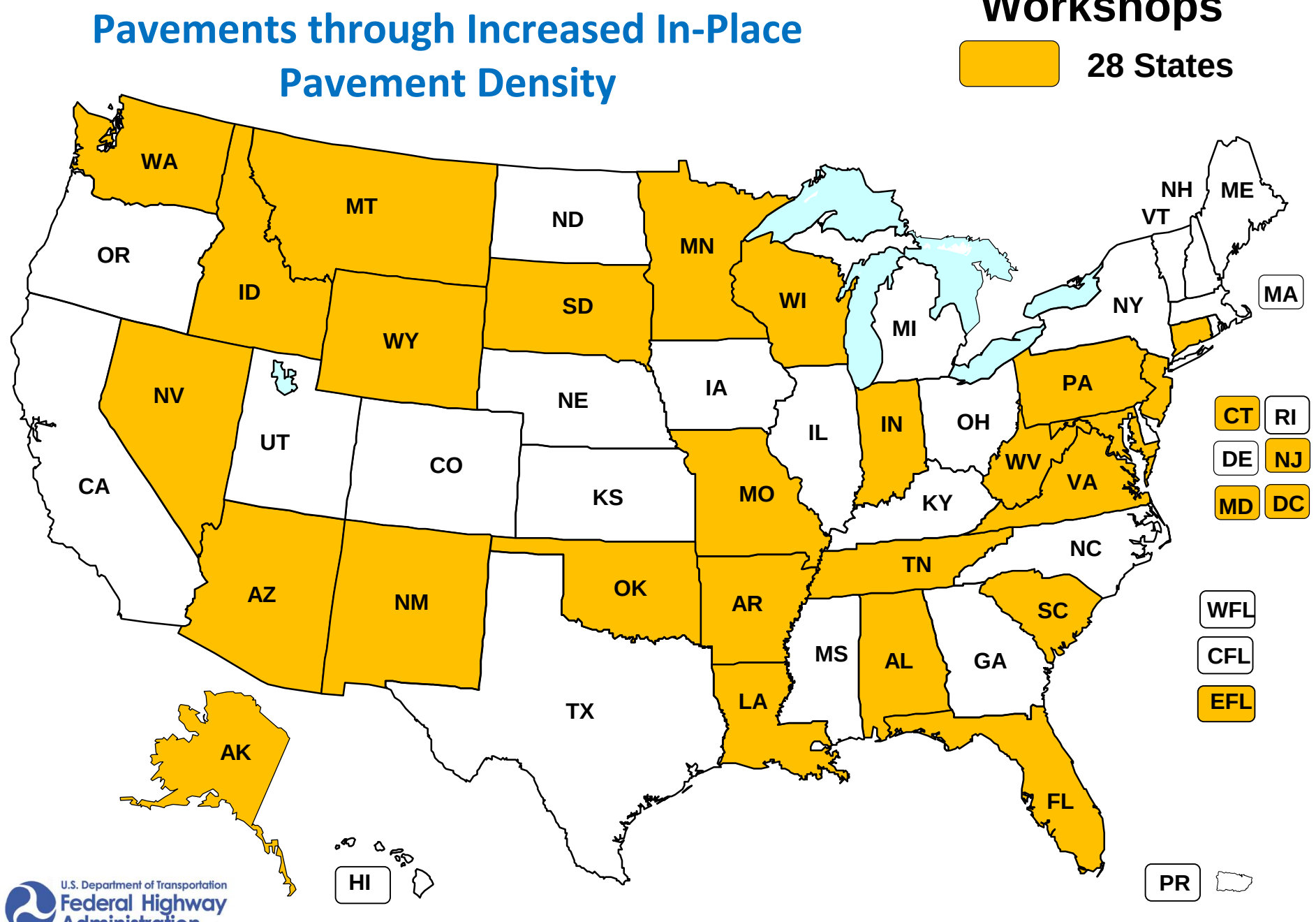
Longitudinal Joint

	State D	AK	ME	MD	MI	NY	PA	TN
Type of Specification	None	Lot Avg.	PWL	None	Lot Avg.	Under Development	PWL	Lot Avg.
Limits (% G_{mm})	---	>91.0	>91.0	---	>90.5	---	>90.0	>91.0
Incentive for Only Joint Density	---	$1.50 per L.F. (≈6.25%)	2.0%	---	$1.00 per L.F. (≈4.0%)	---	$5000 per Lot (≈2.5%)	1.25%

Achieving Increased In-place Density

1. • Density is Important
2. • Gold Medal Examples
3. • **Density Demonstration Projects**

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

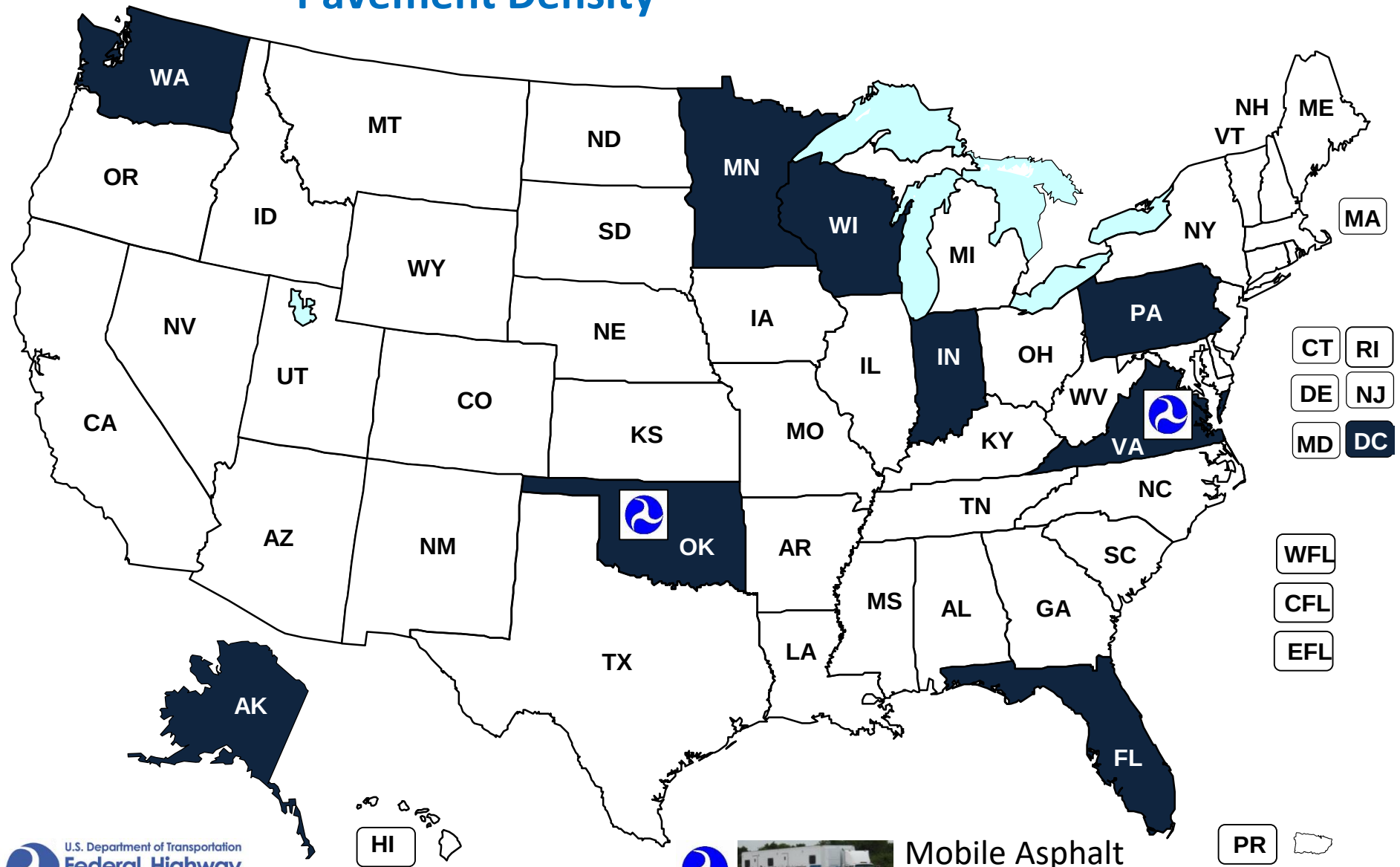


U.S. Department of Transportation
Federal Highway Administration

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

Demonstration Projects

Phase 1 (10 states)



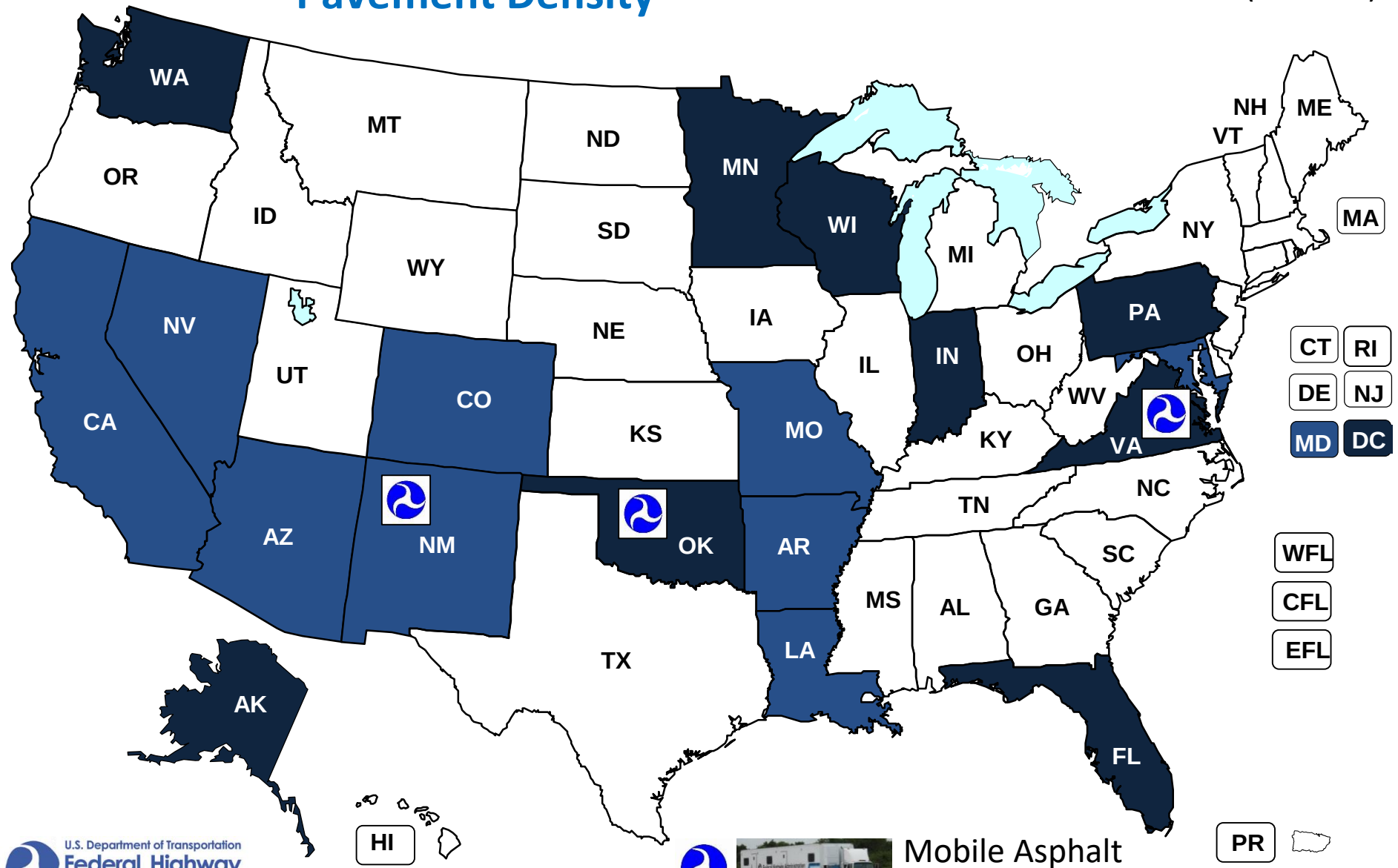
U.S. Department of Transportation
Federal Highway Administration

Mobile Asphalt Testing Trailer (2)

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

Demonstration Projects

- Phase 1 (10 states)
- Phase 2 (9 states)



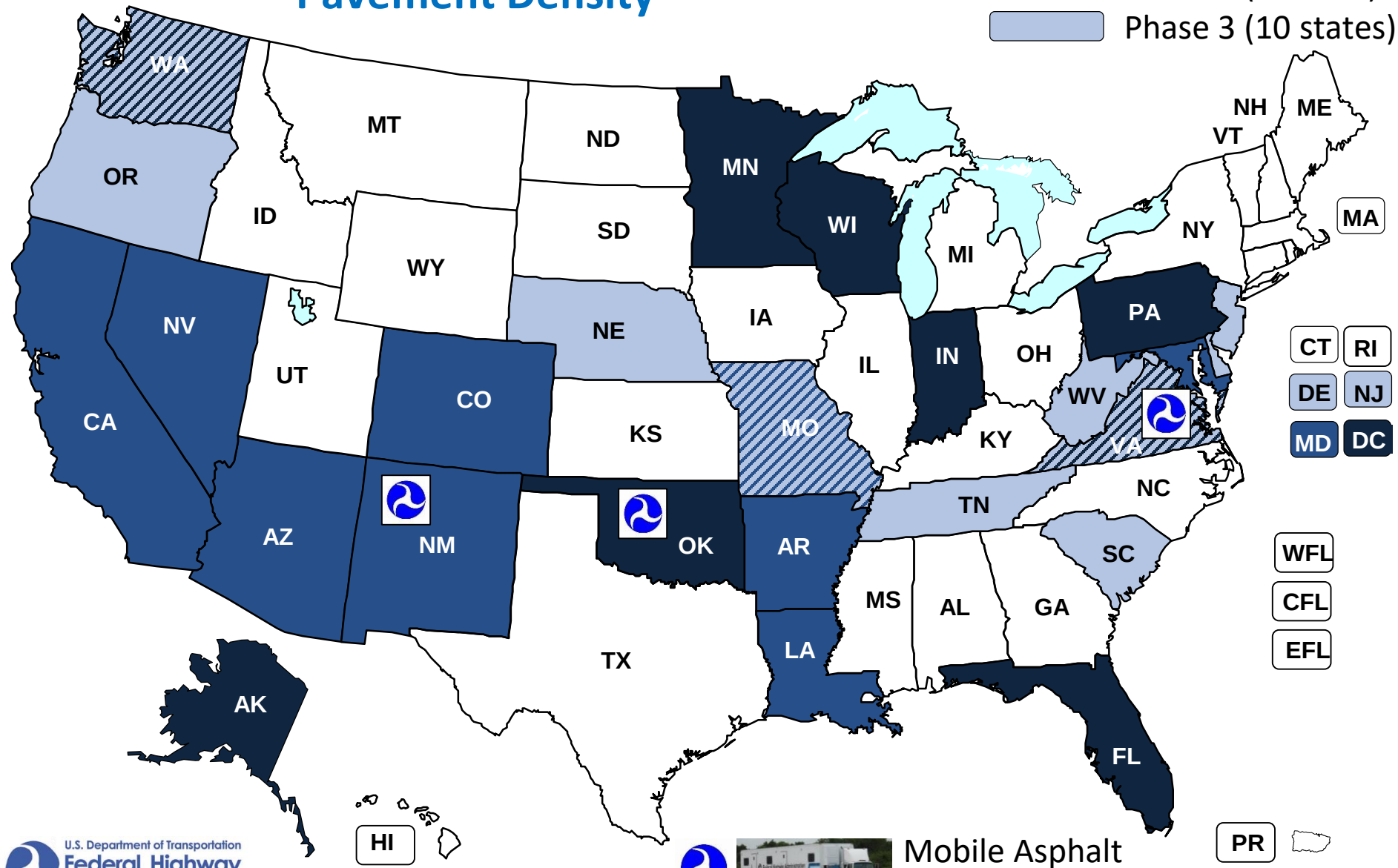
U.S. Department of Transportation
Federal Highway Administration

Mobile Asphalt Testing Trailer (3)

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

Demonstration Projects

- Phase 1 (10 states)
- Phase 2 (9 states)
- Phase 3 (10 states)



U.S. Department of Transportation
Federal Highway Administration

Mobile Asphalt Testing Trailer (3)

Demonstration Project Status

Phase	Year	States	Constructed	State Reports	Summary Report
1	2016	10	10	10	July 2017
2	2017-2018	9	8 (2 re-do's)	2	
3	2018	10	10	0	

Updated: Nov. 1, 2018

Can We Achieve Increased In-place Density?

YES!

- Test sections had increased density (% Gmm):
- 8 of 10 States achieved > 1.0% increase
- 7 of 10 States achieved > 94.0% Gmm
- 6 of 10 States achieved > 95.0% Gmm

- Will there be changes?
- 8 of 10 States are changing specifications

Agency Changes (1 of 2)

- Measuring density (1)
- Reference density (1)
- Density of pavement to meet requirements (4)
  - Some at 90 to 91% Gmm
  - Others at 94% Gmm
- Type of specification (2)
  - 22 states use minimum lot average
  - 25 states use PWL
    - Impacts contractors' target and consistency
- Consistency (2)
  - Standard deviations <1.00 were achievable

(#) – Number of States making changes or in the process

Agency Changes (2 of 2)

- Incentives (3)
  - 37 states have incentives: range from 1 to 10%; average 2.9%
- Mixture design changes (5)
  - Many states changing Superpave to get more asphalt
  - Must also look at density specification
- New technologies (2)
  - Did not help improve density, but were a good trouble-shooting tool

(#) – Number of States making changes or in the process

Contractor Changes

- More passes
  - “Roll until you meet density requirements”
- More rollers
  - Some were using 1 roller
- Type of rollers
  - Pneumatic / Oscillation
- Location of rollers
  - Echelon
- General best practices
  - Temperature / spacing / screed

Courtesy Miguel Montoya

State 4:
Cost / Benefit of Best Practices

- Benefit of 1% Density Increase
  10 percent of $60 / ton mix = $$$$$$
- Cost of 1 Percent Density Increase
  Additional rollers ≤ $
  AVR to 3% W/binder ≤ $$
  WMA Additive ≤ $
  9.5mm vs. 12.5mm ≈ $$

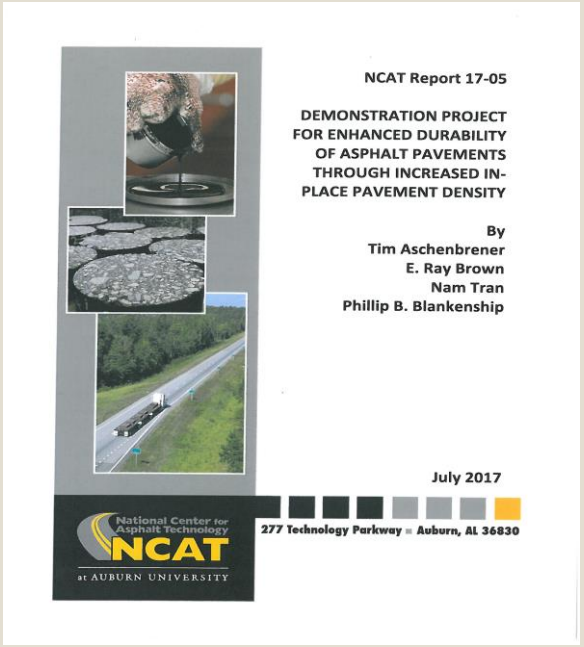
Image: Pixabay; text added

Summary Document Phase 1

NCAT Report 17-05:

"Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density"

July 2017



http://eng.auburn.edu/research/centers/ncat/files/technical-reports/rep17-05.pdf

Next Steps

- Field experiment – Phase 2
  - 8 of 9 states completed construction
  - 2 of 9 states completed reports
- Field experiment – Phase 3
  - 10 of 10 states completed construction
  - 0 of 10 states completed reports
- FHWA's best practices communication
  - Summary documents: Phases 2 and 3
  - Tech Brief
  - Additional workshops
    - Funding dependent

Image: Pixabay

Thank you

QUESTIONS / COMMENTS:

TIM ASCHENBRENER, P.E.
FHWA
SENIOR ASPHALT PAVEMENT ENGINEER
PAVEMENT MATERIALS TEAM
OFFICE OF PRECONSTRUCTION, CONSTRUCTION AND PAVEMENTS
LAKEWOOD, COLORADO

(720) 963-3247
TIMOTHY.ASCHENBRENER@DOT.GOV

Image Pixabay