Pavement Management Quarterly Webinar
Pavement Management Roadmap
Theme 2: Pavement Management Analysis Tools & Other Applications

June 8, 2023

FEDERAL HIGHWAY ADMINISTRATION (FHWA)
IN COOPERATION WITH:
AASHTO COMMITTEE ON MATERIALS AND PAVEMENTS (COMP)
TRB AKT10, PAVEMENT MANAGEMENT SYSTEMS
TRB AKP10, PAVEMENT CONDITION EVALUATION

U.S. Department of Transportation
Federal Highway Administration

Housekeeping

- This webinar is being recorded. The link will be available at FHWA's Pavement Management website:
  - https://www.fhwa.dot.gov/pavement/mana.cfm

- All phone lines will be muted during presentations.
- Questions: Post in the chat pod.

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Webinar Series

- PAVEMENT MANAGEMENT – PERFORMANCE MANAGEMENT
  - Various Topics
- Thursday (quarterly schedule)
  - Next webinar: TBD

Pavement Management Roadmap:

Pavement Management & Performance - Technology Transfer:

https://www.fhwa.dot.gov/pavement/mana.cfm

Image: FHWA approved

Agenda

TOPIC	SPEAKER
Introduction	**Christy Poon-Atkins, P.E.**, Federal Highway Administration (FHWA)
Theme 2: Pavement Management Analysis Tools and Other Applications – Moderator	**Brad Allen. P.E.**, Applied Pavement Technology (APTech); FHWA contractor
The Consideration of Pavement Management System Data in Pavement Design	**Robert J. Blight**, New Jersey Department of Transportation (NJDOT)
The Implementation of Greenhouse Gas Emission Considerations in Pavement Management	**John Harvey, PhD., P.E.**, Civil & Environmental Engineering; Univ. of CA – Davis (UC Davis) - **Imad Basheer, Ph.D., P.E.**, Caltrans Office of Pavement Management - **Jeremy Lea, Ph.D.**, UC Davis Pavement Research Center
Discussion & Questions	All
Adjourn	

Pavement Management Roadmap
Theme 2: Pavement Management Analysis Tools & Other Applications

Christy Poon-Atkins
Fed. Highway Admin. (FHWA)

Brad Allen
FHWA Contractor

Robert Blight
New Jersey DOT

Dr. John Harvey
UC Davis

Dr. Imad Basheer
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Jeremy Lea
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The Updated Pavement Management Roadmap

Theme 2: Pavement Management Analysis Tools and Other Applications

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Presentation Approach

1.0 Background

2.0 Gap Assessment

3.0 Pavement Management Roadmap Suggestions

1.0 Background

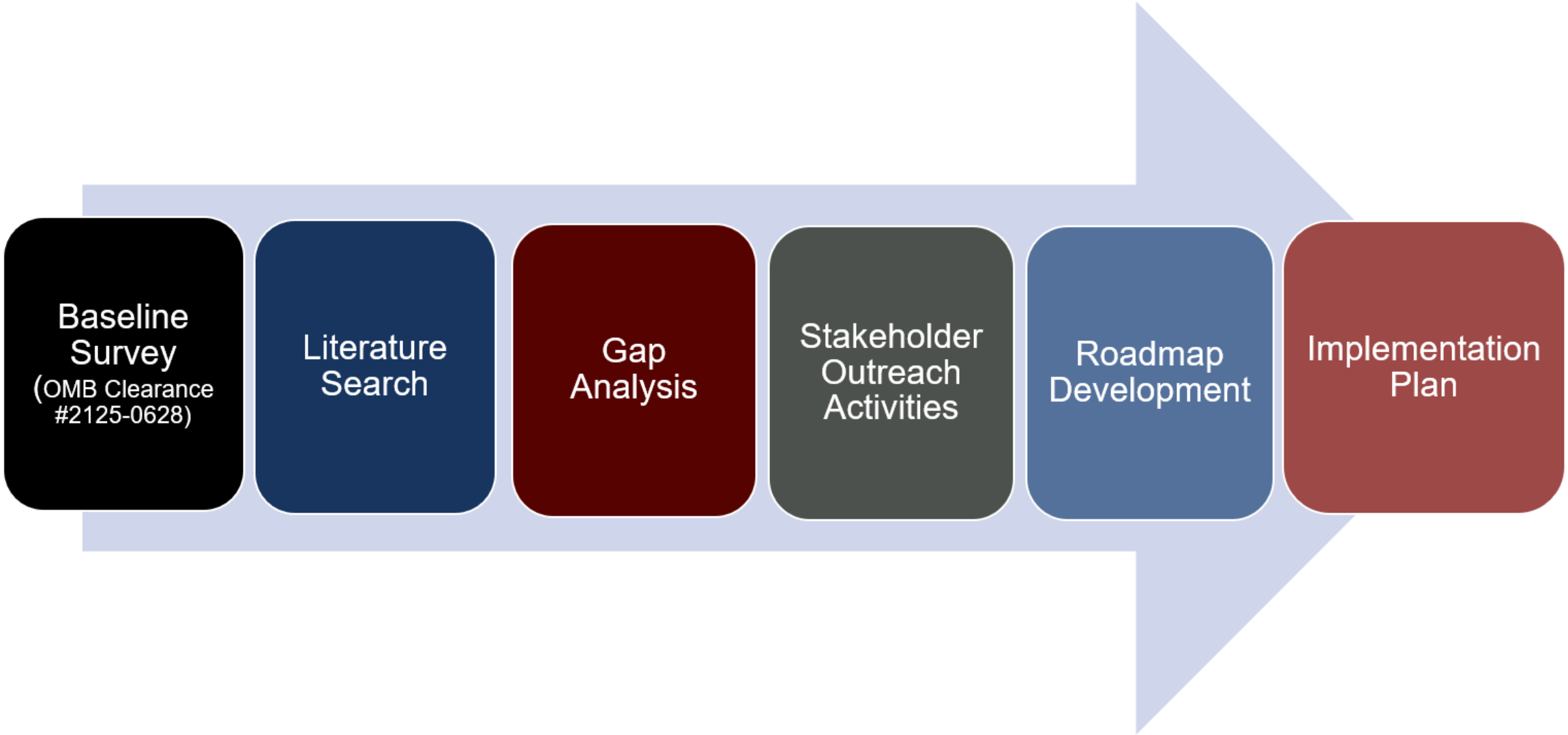
Project Objectives

Project Approach

Project Objectives

- Provide an Updated Pavement Management Roadmap
  - Present a 10-year strategy to drive:
    - Research
    - Transformative innovation development
    - Technology transfer activities
  - Continue to improve pavement management practices

Project Approach



Theme 2: Pavement Management Analysis Tools & Other Applications

Gap Topic 2-1: Modeling

Gap Topic 2-2: Support for Transportation Performance Management (TPM) and Transportation Asset Management (TAM)

Gap Topic 2-3: Project Selection

Gap Topic 2-4: Other Applications for PMS Data & Analysis

3.0 Pavement Management Roadmap Suggestions

Note: The suggested activities are based on the gap assessment and outreach activities. There are no commitments to funding the suggestions implied by the FHWA or any other agency.

Improvement Areas – Theme 2

Performance Modeling – Enhance the reliability and level of confidence in pavement performance models.

Treatment Rules and Impacts – Refine treatment rules and impacts to improve project and treatment suggestions.

PMS Analysis – Strengthen the use of pavement management software to support agency investment- and project-planning decisions.

Performance Measures – Support the expanded use of existing performance measures at the Federal, State, and local levels.

Types of Actions Suggested

Note: The suggested activities are based on the gap assessment and outreach activities. There are no commitments to funding the suggestions implied by the FHWA or any other agency.

Please Enter Questions in the Q&A Pod

FHWA Pavements webpage:
https://www.fhwa.dot.gov/pavement/

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State Methods

New Jersey DOT

&

California DOT (Caltrans) – University of California-Davis (UC Davis)

CONSIDERATION OF PAVEMENT MANAGEMENT SYSTEM DATA IN PAVEMENT DESIGN

NEW JERSEY DEPARTMENT OF TRANSPORTATION

OVERVIEW

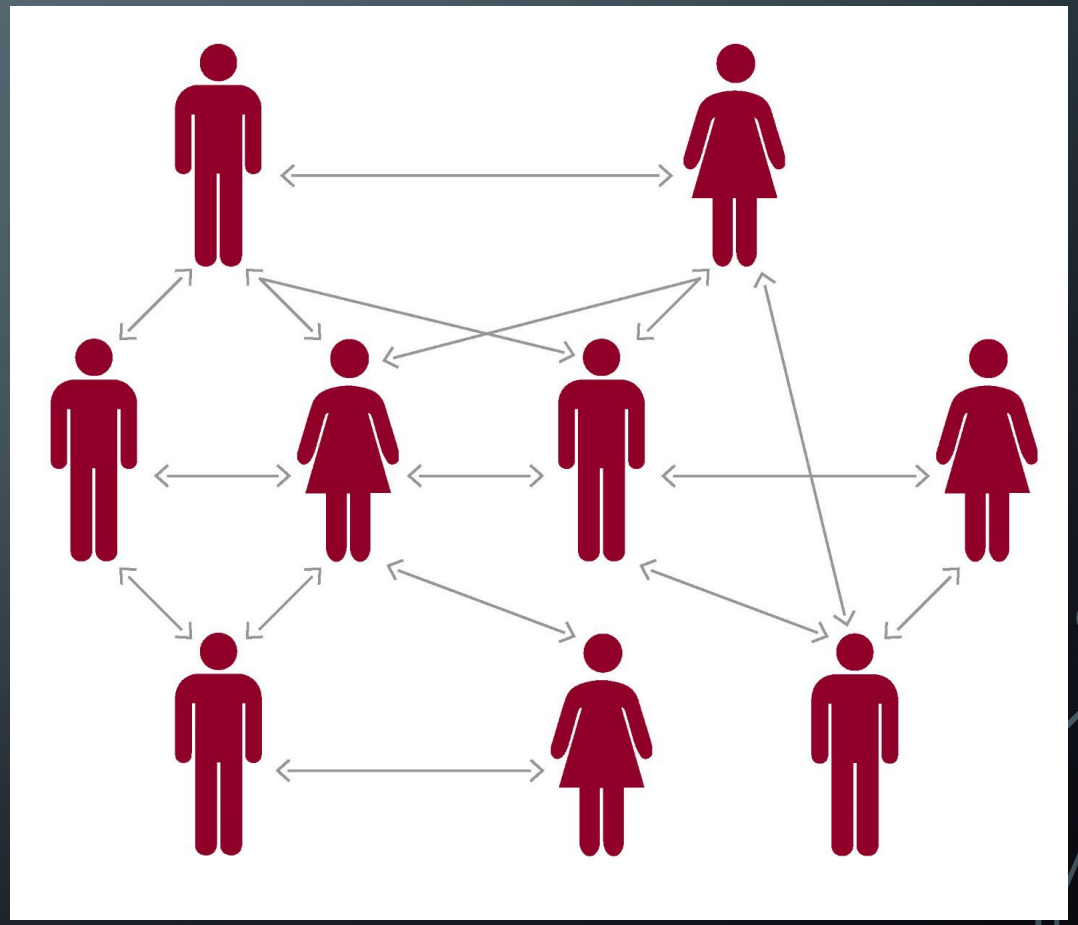
- Introduction
- Organizational Structure
- Pavement Management Practices and Procedures
- Pavement Design Practices and Procedures
- Summary

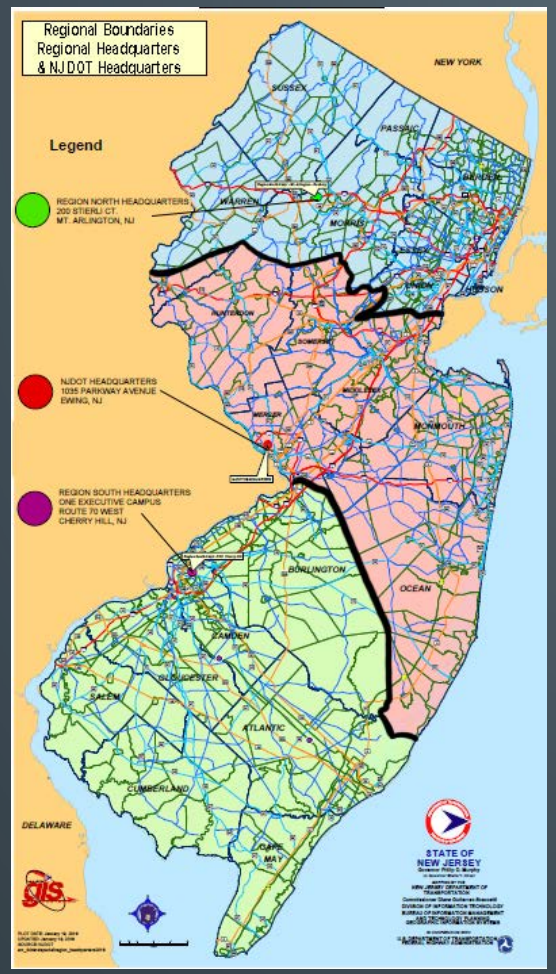
INTRODUCTION – PAVEMENT & DRAINAGE MANAGEMENT & TECHNOLOGY

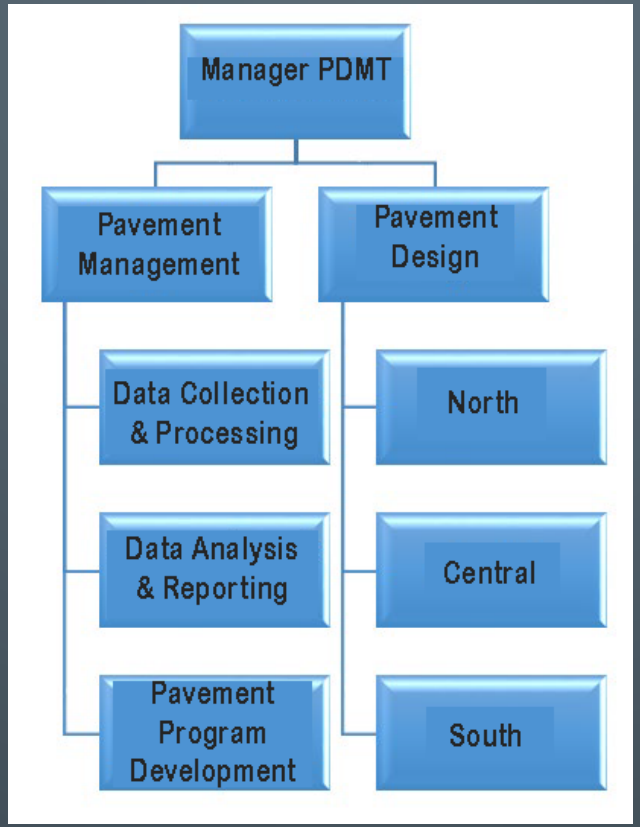
- Pavement Management
- Pavement Design & Technology
- Drainage Management
- Guiderail Management

ORGANIZATIONAL STRUCTURE

- **Pavement Management/Pavement Design**
  - Housed together
  - Centralized programming and design
  - Regional offices for Operations, Materials and Construction







PAVEMENT HEADQUARTERS - ORGANIZATION

- Close coordination between Pavement Management and Pavement Design teams
- Coordination between Pavement Design and other stakeholders
  - Operations and Maintenance
  - Project Management
  - Construction & Materials

PRIMARY GOALS

Improving the quality and performance of pavements and minimizing costs through best Pavement Management & Design practices to achieve NJDOT Mission.

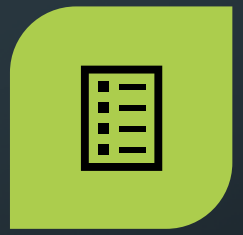
Support NJ Transportation Asset Management (A risk-based process through which highway assets are managed across their whole life cycle to serve the needs of roadway users most cost-effectively.)

PAVEMENT MANAGEMENT

COLLECT HIGHWAY PAVEMENT CONDITION DATA (ANNUALLY)

ANALYZE DATA & ASSESS CONDITION OF ROADWAY NETWORK

DATA QC BY PM AND PD STAFF



DEVELOP LIST OF PROPOSED NEEDS FOR RESURFACING/REHAB/RECON & PRESERVATION PROJECTS

OPTIMIZE CONDITION AND FUTURE PERFORMANCE OF THE NETWORK

DATA COLLECTION (SHS & NHS)

- Annual collection (approx. 5000 miles) of mainline pavement condition, except for skid data which is on an as need basis

  HPMS requires NHS Interstate annually and Non-Interstate every other year

  Note: We also collect condition data on Palisade Parkway and Garden State Parkway which are not SHS

- Network inventory data collected from rightmost lane only in both directions of travel

  (*HPMS requires only in primary direction*)

- Data processed & recorded in 1/10-mile intervals

  (HPMS also requires reporting every 1/10th mile)

SHS- State Highway System maintained by the NJDOT
NHS- Nation Highway System

PMS TESTING EQUIPMENT

HIGH SPEED PROFILER/AUTOMATED DATA COLLECTION

LOCKED WHEEL SKID RESISTANCE TESTING

PAVEMENT DATA COLLECTED BY IN-HOUSE CREW

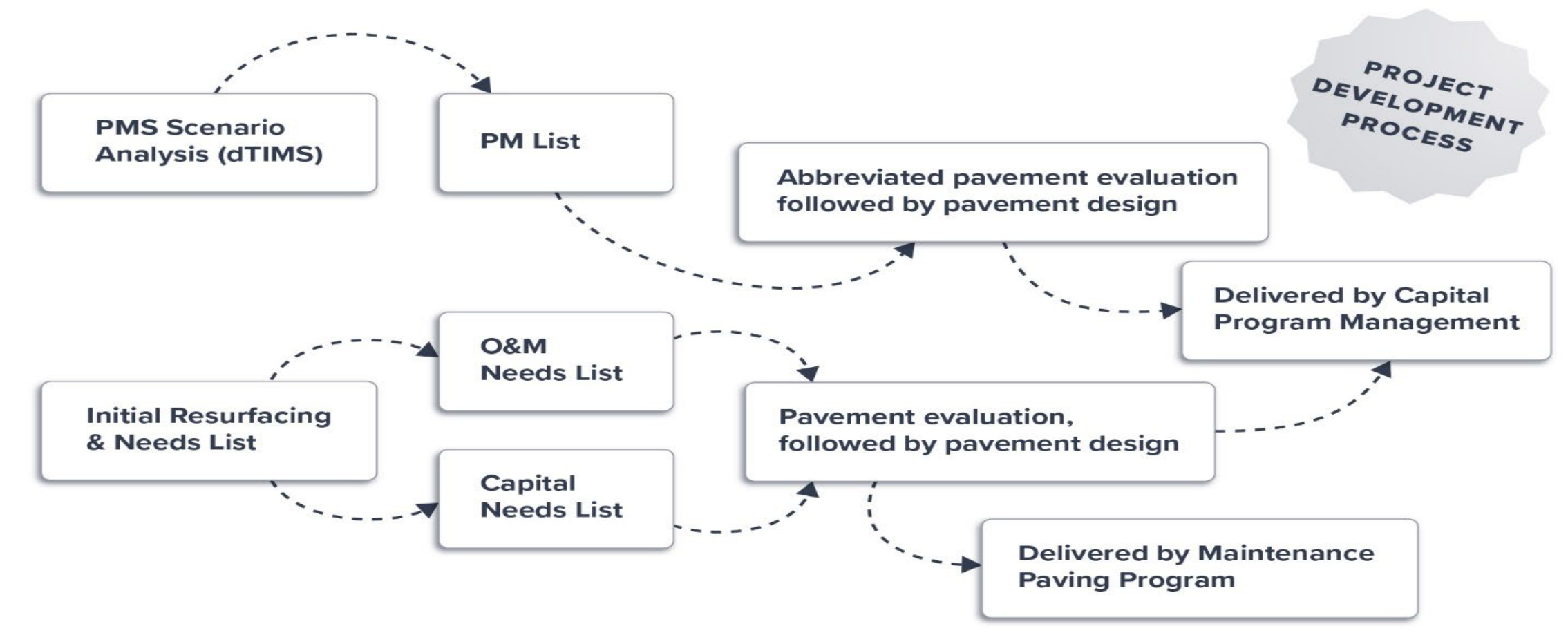
High Resolution Video Images

- Right of Way
  - Downward 3 D Camera for cracking identification and severity
- International Roughness Index (IRI)
  - Lasers measure deviations of the pavement surface from a perfectly flat condition & develop road profile
- Rut depth
  - Depressions in wheel paths
- Macro Texture

Note: The appearance of this cover page is slightly different from the original. Minor edits to text color were performed to comply with 508 requirements with owner's permission.

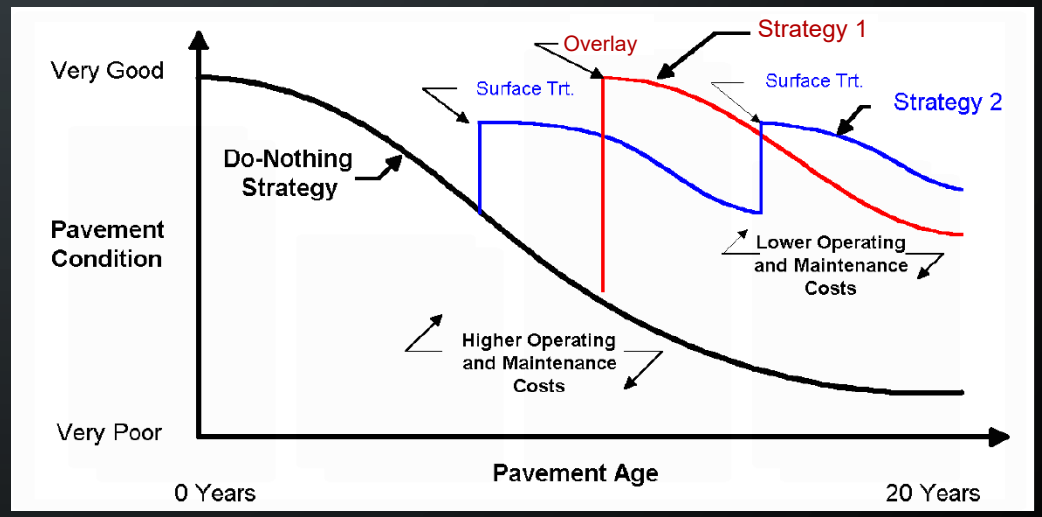
- ***Collected data is analyzed by in-house team.***
- ***QC of data is performed by both Pavement Management and Pavement Design teams in accordance with FHWA approved Data Quality Management Manual***

PAVEMENT PROJECT INITIATION PROCESS



PAVEMENT MANAGEMENT – PAVEMENT NEEDS LIST GENERATION & SYSTEM PERFORMANCE

- dTIMS is Pavement Management Analyses Software for Life Cycle Cost Analyses
- Develop optimal treatment scenarios
- Predict System performance for various budgets



IN-HOUSE PAVEMENT PROJECT NEEDS LISTS IDENTIFICATION & DEVELOPMENT

- Preservation
  - Time and Condition Based
  - Good to fair condition of pavement is considered.
- Resurfacing/Rehabilitation/Reconstruction
  - Condition Based
  - Poor to fair condition of pavement is considered
  - Identify at project level review from the resurfacing list.

PRESERVATION PROJECT SELECTION

- Time based (2 - 8-years age of last treatment)
- Assess condition and performance
- Select specific preservation treatment based on
  - Road type
  - Condition
  - Traffic volumes
  - Other unique project characteristics

PAVEMENT CONDITION CRITERIA

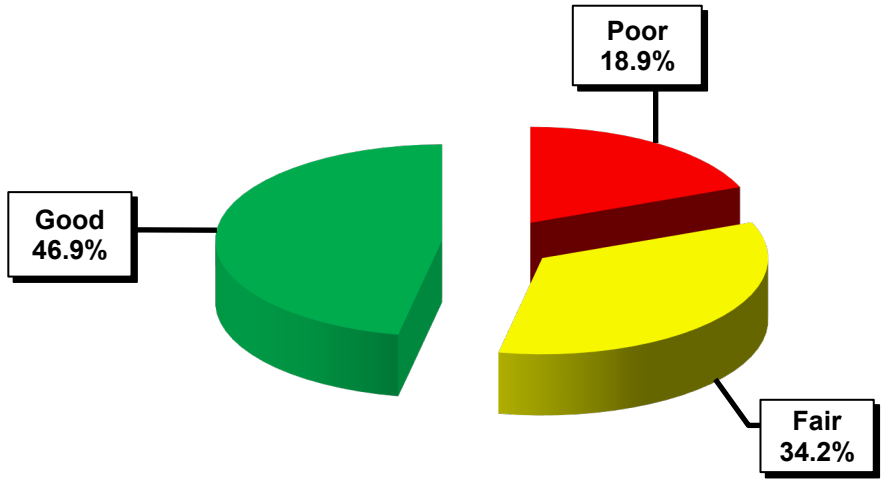
SDI equation and triggers are being re-evaluated for the automated distresses

Condition Status	Condition Index Criteria (IRI = International Roughness Index, in/mi; SDI = Surface Distress Index, 0 – 5 Scale)	Potential Pavement Treatment Needs
Deficient (Poor)	**IRI > 170 *OR* SDI ≤ 2.4**	Resurfacing/Rehab/Reconstruct
Fair	**SDI / IRI Combinations Between Good & Deficient** **(95 ≤ IRI ≤ 170 *And* SDI > 2.4)** ***OR*** **(IRI < 95 *And* 2.4 < SDI < 3.5)**	Resurfacing/Rehab/Reconstruct Or Do Nothing Or Preservation
Good	**IRI < 95 *AND* SDI ≥ 3.5**	Preservation or Do Nothing

STATUS OF NJ STATE HIGHWAY SYSTEM PAVEMENTS

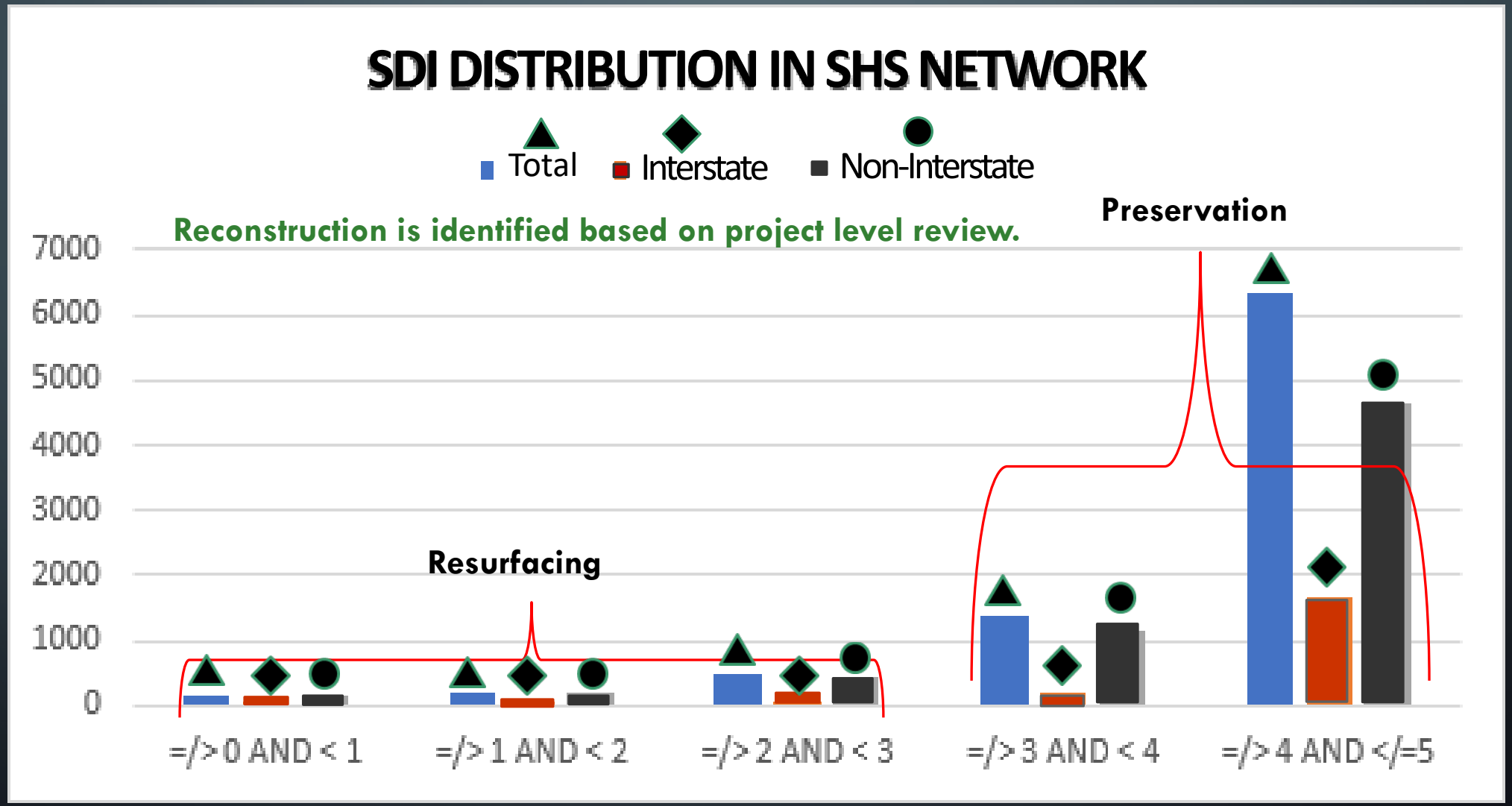
Current Functional Adequacy of NJ State Highway System (Based on Roughness & Distress)

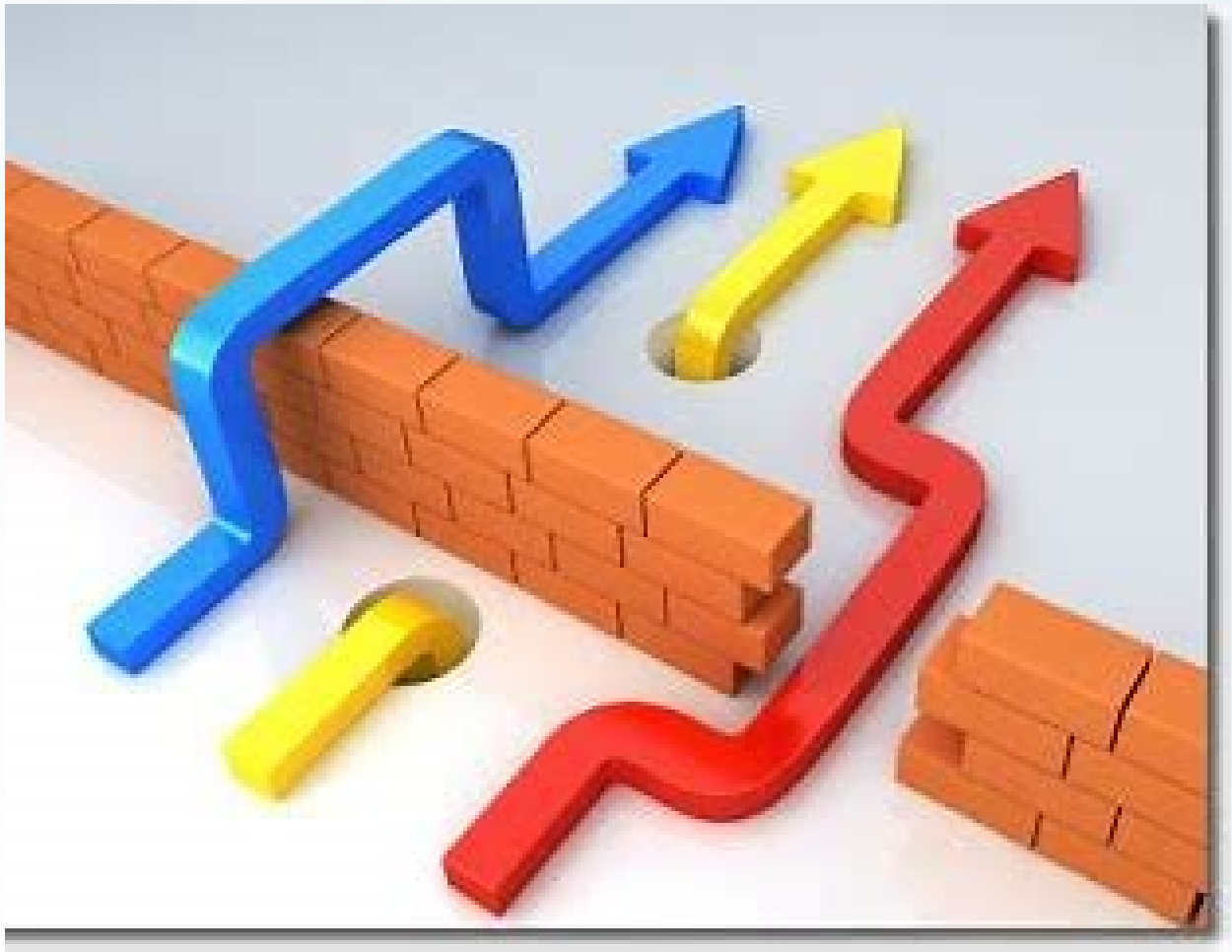
Target State of GOOD Repair= 80% Good and Fair



Source: NJDOT Pavement Management System, 2022 Data

FUTURE STRATEGY FOR RESURFACING AND PRESERVATION PROJECTS



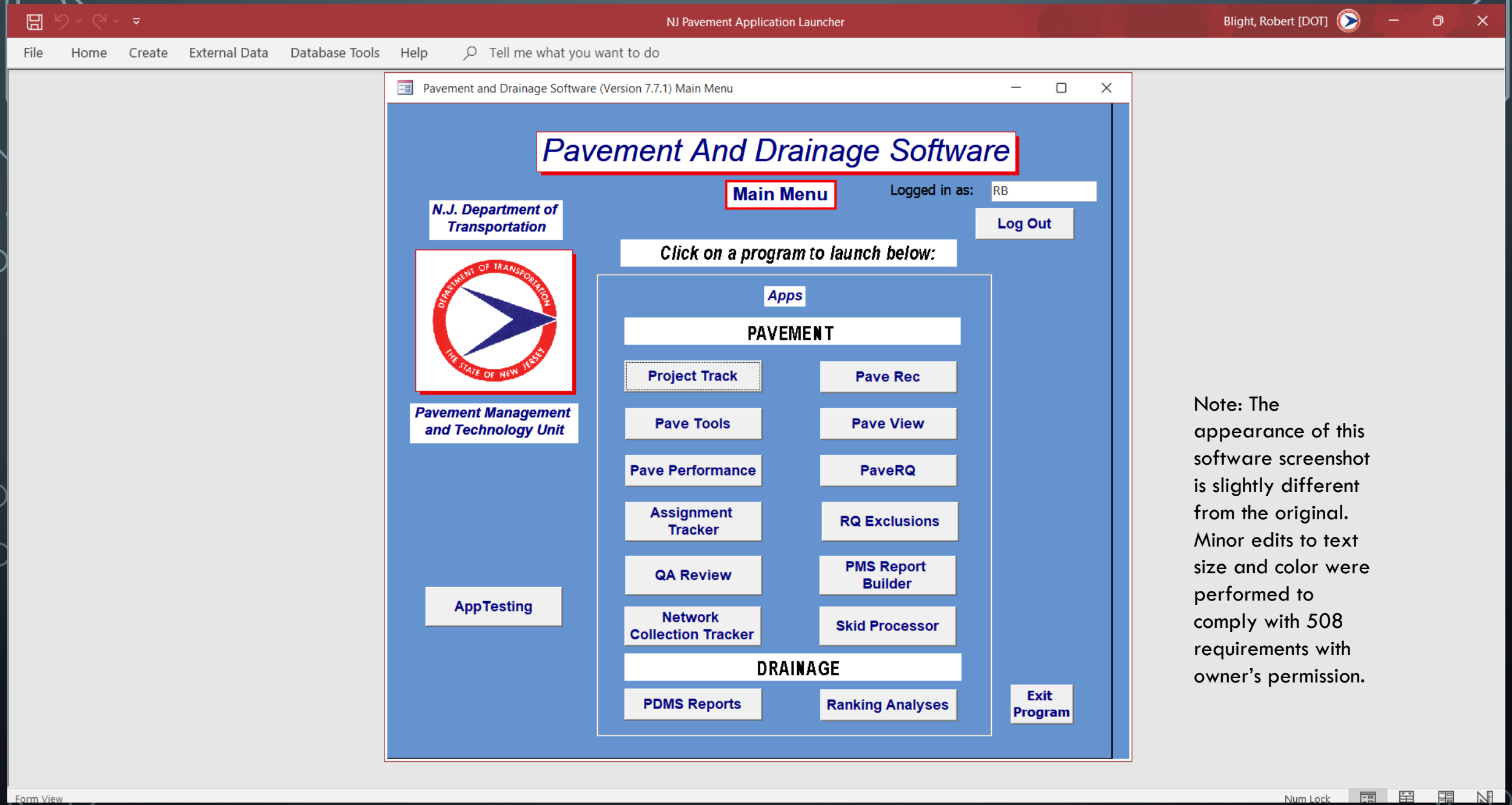


PAVEMENT MANAGEMENT TO DESIGN WORKFLOW

- In house designed and developed software application
- “One-Stop Shopping” for Pavement Design, Pavement Management, and Drainage Management staff

PAVEMENT DESIGN – PAVEMENT EVALUATION

- Pavement evaluation:
- Consultants perform project level pavement evaluation report:
  - FWD, coring, DCP and GPR.
  - Existing pavement layer thickness, material and subgrade properties, condition, and any drainage issues.
  - AASHTO soil classification.
  - Traffic data.
- Pavement Design Unit (PDU):
  - Reviews, analyzes and derives inputs for pavement design.
  - Recommends appropriate treatment options.



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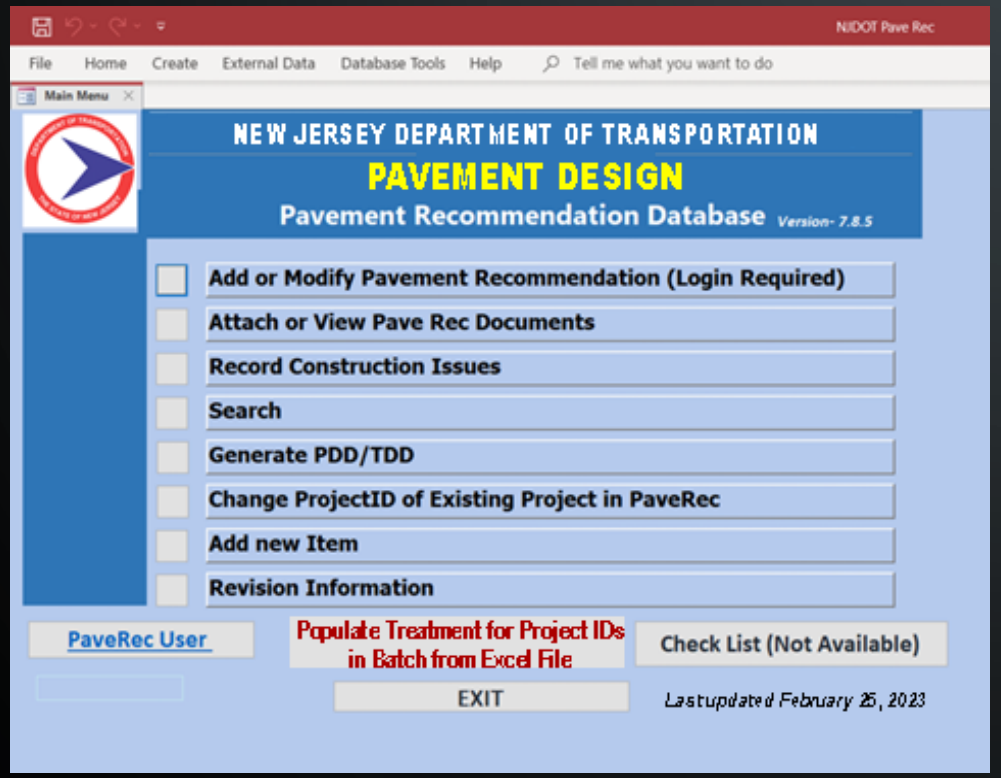
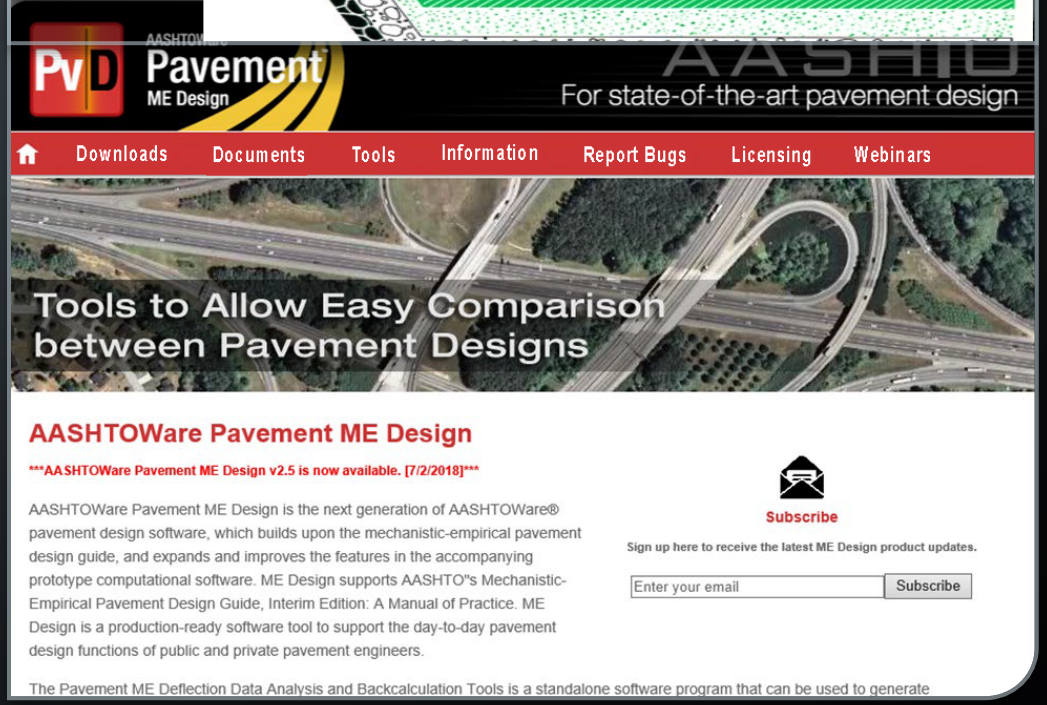
PAVEMENT DESIGN: PROCEDURE



AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES



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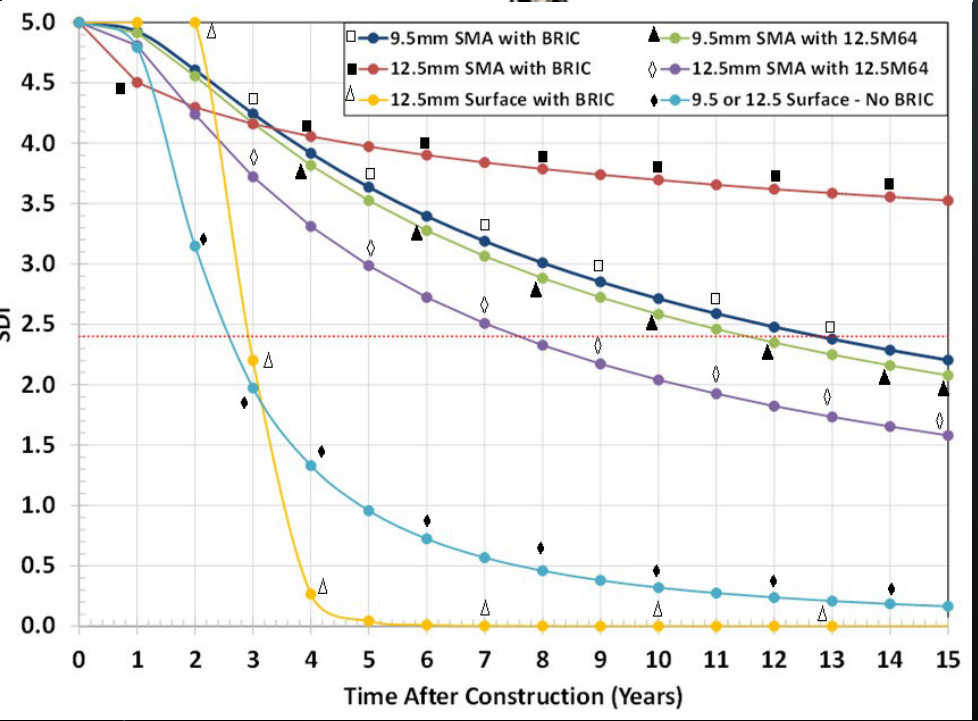


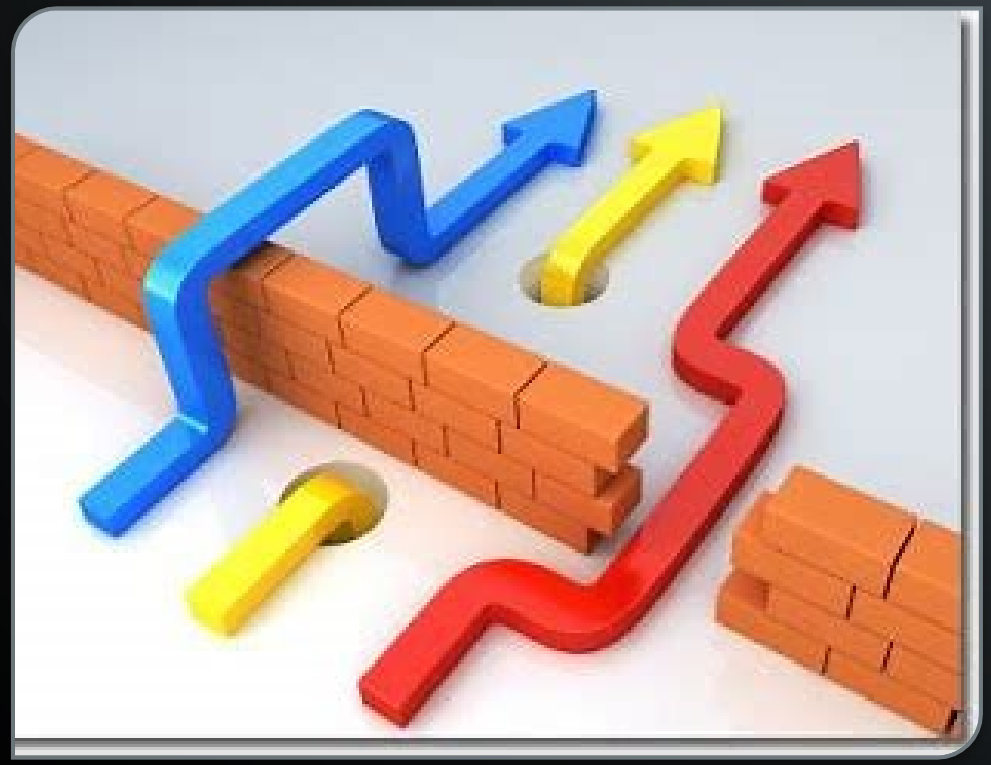
PAVEMENT DESIGN: PROCEDURE

- Evaluate design efficiency using pavement evaluation and past performance data.
  - Additional performance achieved through enhanced materials (SMA, BRIC, BRBC)
- Modify/enhance pavement management performance models and pavement design recommendations based upon performance
  - Life Cycle Cost Analysis

SUMMARY – COMMUNICATION, EVALUATION, FEEDBACK & ADJUSTMENT

- Pavement Management/Pavement Design – In the same Unit under Highway Design
- Pavement management and pavement design staff intimately involved in PMS data QC
- Pavement Decision Making – centralized and based on project level pavement evaluation
- Multiple PM and PD databases, applications and data resources to enhance communication and assist PD/PM staff to design/manage cost-effective treatments and optimal network performance.
- Pavement designers provide constant feedback to pavement management on appropriateness of a treatment recommendation.

SUMMARY – BARRIERS & SOLUTIONS



- Project Delivery time
- Structural Health Assessment
- Construction & Materials Quality Data in PMS
- More Reliable Performance Modeling
- Other opportunities for improvements
  - Continued improvement to data quality, mapping, and data resource and technology coordination

QUESTIONS

Robert Blight, Manager

NJDOT Bureau of Pavement & Drainage Management & Technology

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The Implementation of Greenhouse Gas Emission Considerations in Pavement Management

Pavement Management Quarterly Webinar
June 8th, 2023

John Harvey, Jeremy Lea (UCPRC)
Imad Basheer (Caltrans)

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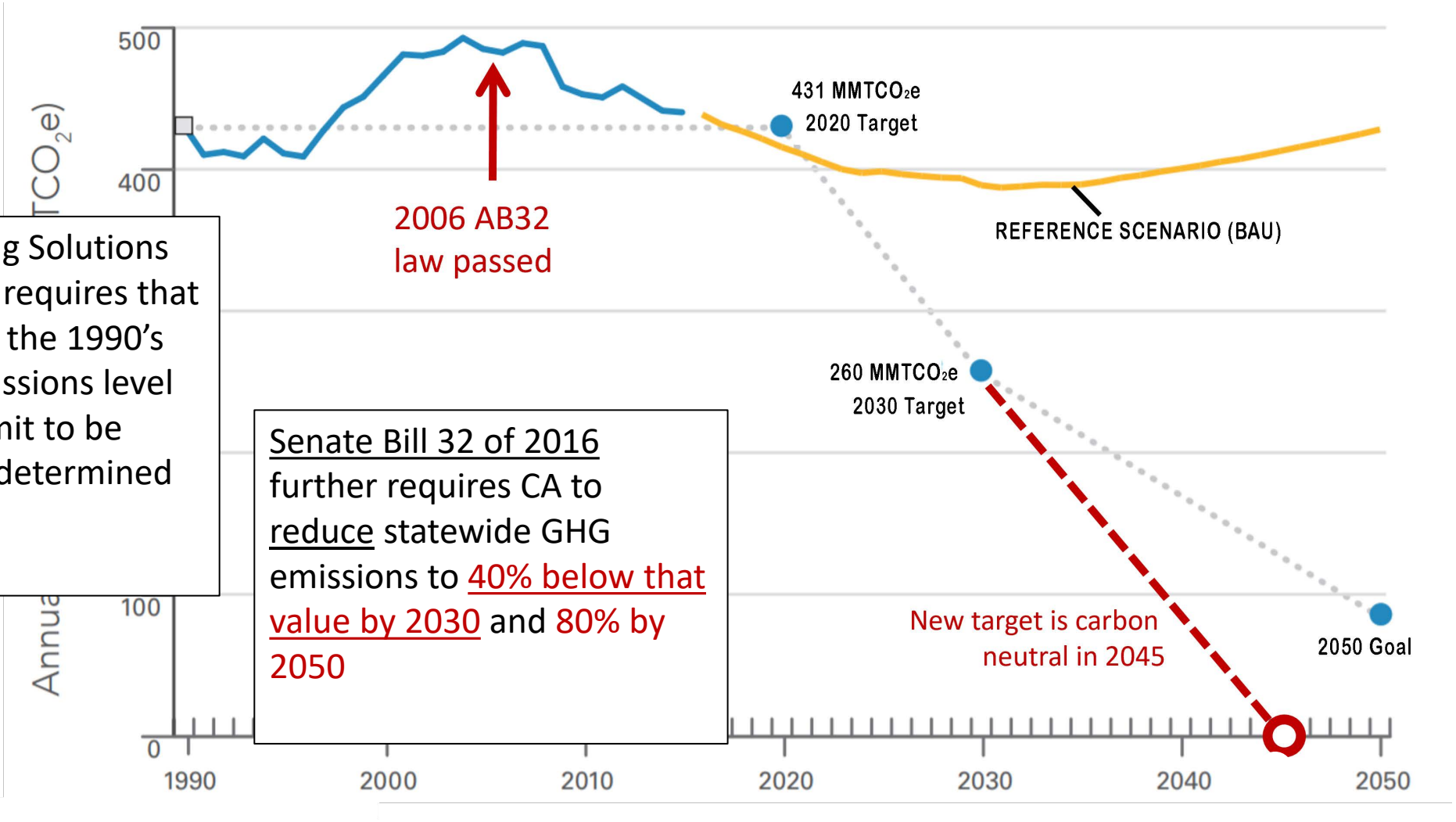
California State GHG Goals

The Global Warming Solutions Act of 2006 (AB32) requires that the ARB determine the 1990's statewide GHG emissions level and use it as the limit to be achieved by 2020 (determined at 431 MMTCO2e)

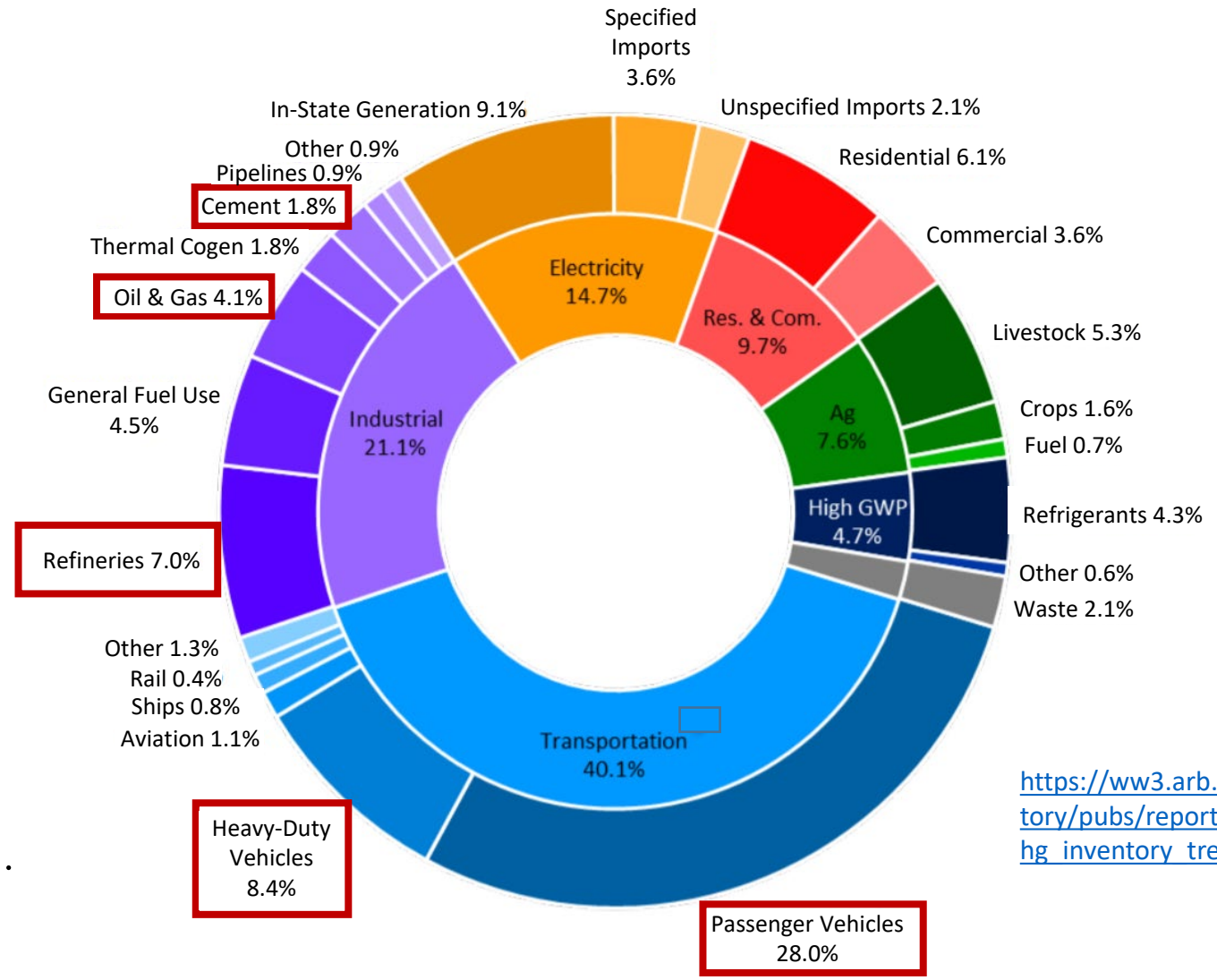


Senate Bill 32 of 2016 further requires CA to reduce statewide GHG emissions to 40% below that value by 2030 and 80% by 2050

https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf

GHG by Economic Sector

- Transportation sector is the largest source
- 40% of the emissions from transportation
  - 96% from tailpipe of cars and trucks
  - 170 $MMTCO_2e$ in 2016
- Pavement materials also have significant contributions



https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf

Pavements & GHG

- State DOTs lack tools to quantify GHG emissions related to pavements, or metrics to quantify GHG changes
- Caltrans and the California Transportation Commission want to integrate climate change into transportation planning
- How can Caltrans, through Pavement Management reduce their GHG emission contribution to the total Transportation Sector's amount?

Caltrans Objectives

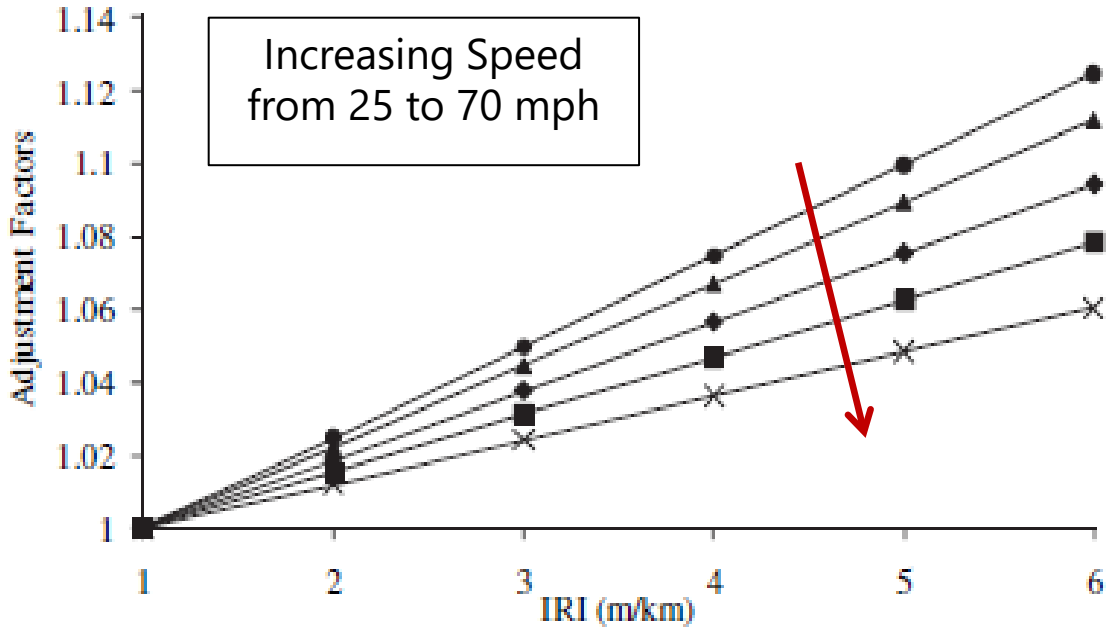
- Enhance effectiveness of Caltrans' PMS (known as PaveM) for quantification of GHG emissions from construction activities and due to ride quality
- Evaluate and compare GHG changes from optimization goals and funding levels
- Evaluate environmental & economical benefits to both pavement agencies & highway users
- Provide Caltrans with a tool to evaluate means that are within its control to reduce GHG emission on the state highway network

Sources of Pavement GHG

- GHG emissions pertain to 3 stages in pavement life:
  - Materials production/transportation
  - Construction
  - Use (vehicle operation/fuel use)
- Quantification of GHG emissions during pavement life is performed in these 3 stages
  - At a project level this is done through Life-Cycle Assessment
  - The first two phases can be merged into one construction “cost”

Traffic emissions

- Vehicle emissions depend on vehicle, engine, tires, speed, mass, slope, curvature, air temperature/density, roughness, deflection and other factors
- Large VMT means we can rely on the law of large numbers (regression to the mean)
- Active area of research



(e) Articulated truck Zaabar & Chatti, NCHRP 720

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Information needed to calculate GHG in PMS

- **Materials & Construction GHG for each treatment**
  - From life-cycle assessment
- **Traffic per lane**
  - Broken down into vehicle classes (truck type)
  - Speed and weight distributions if possible
- **IRI for all lanes on the section and IRI prediction models**
  - Outside lane IRI can be used to predict inner lanes
- **GHG from vehicles**
  - Broken down into the same vehicle classes

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Calculation Procedure

$$E\left[GHG_y|R,IRI\right] = E\left[GHG_y^{M\&C}|R\right] + \sum_{v=1}^{V}\sum_{i=1}^{N_v} E\left[GHG_y^{use}|IRI,\boldsymbol{\theta},v\right]$$

$$= E\left[GHG_y^{M\&C}|R\right] + N \times P[V=v] \times E\left[GHG_y^{use}|IRI,\boldsymbol{\theta},v\right]$$

For year *y*, with treatment *R* and current *IRI*, where *v=1..V* are the vehicle classes, and $N = \sum_v N_v$ is the total traffic volume and per class volumes and $\boldsymbol{\theta}$ is a set of other explanatory variables. Simplify to:

$$E\left[GHG_y^{use}|IRI,\boldsymbol{\theta},v\right] = a_v + b_v \times IRI$$

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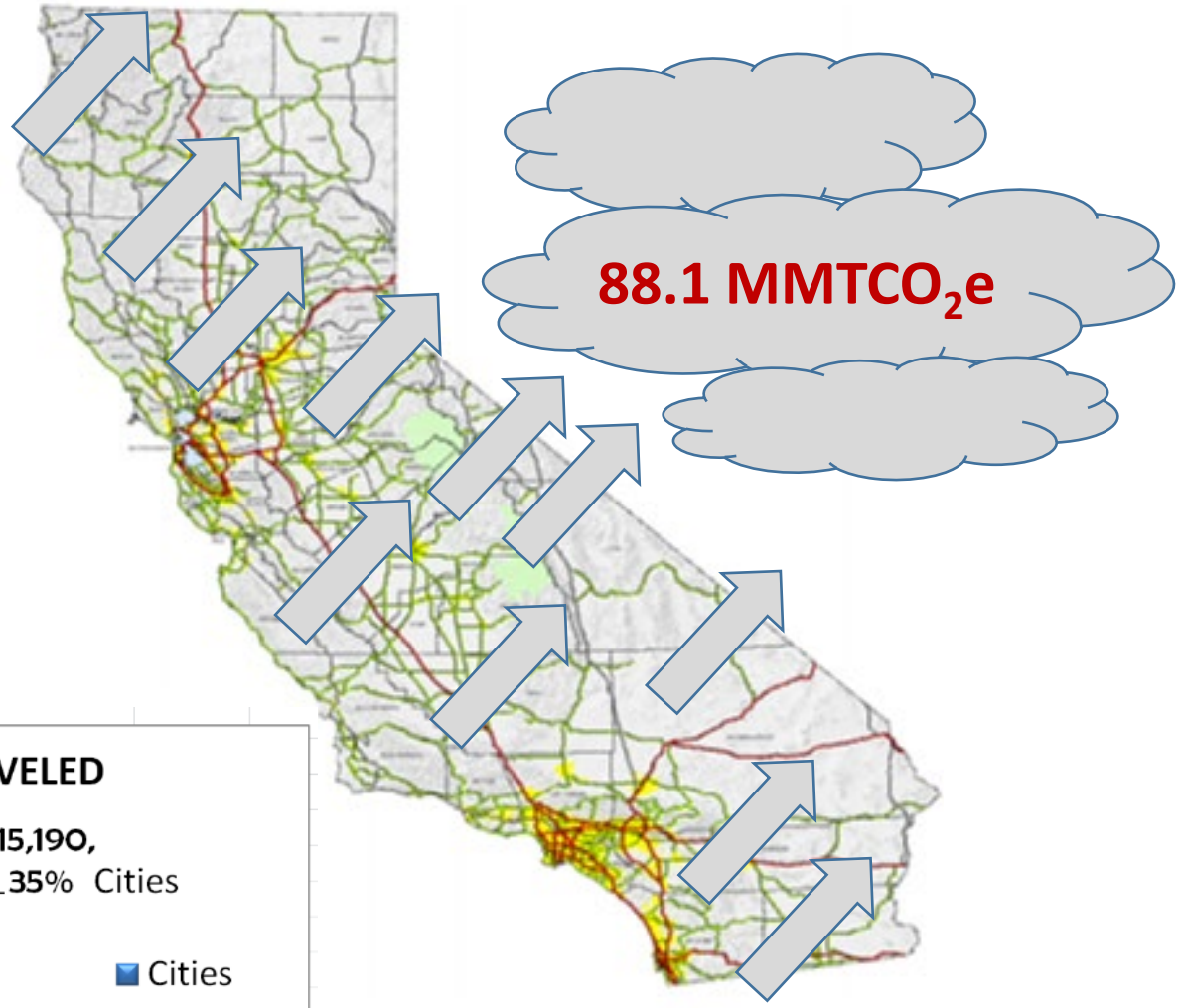
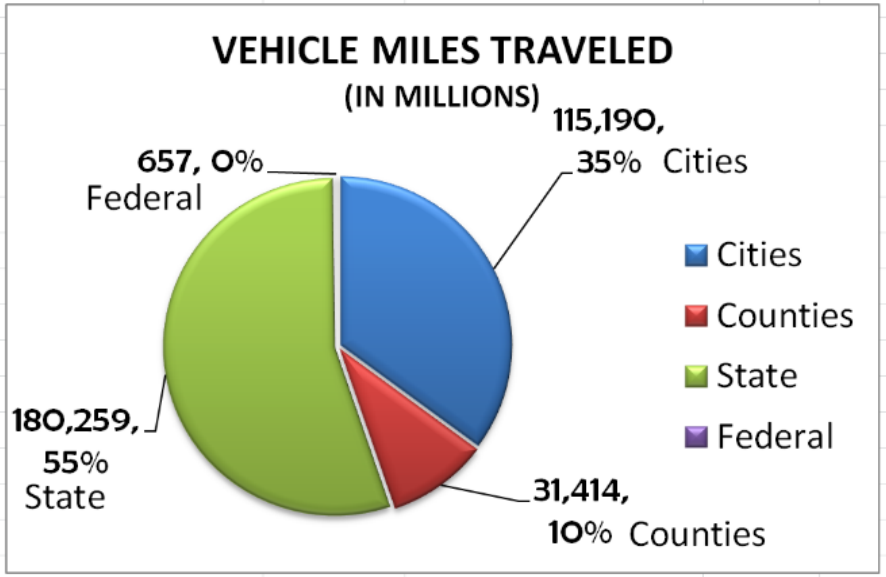
Baseline GHG Level

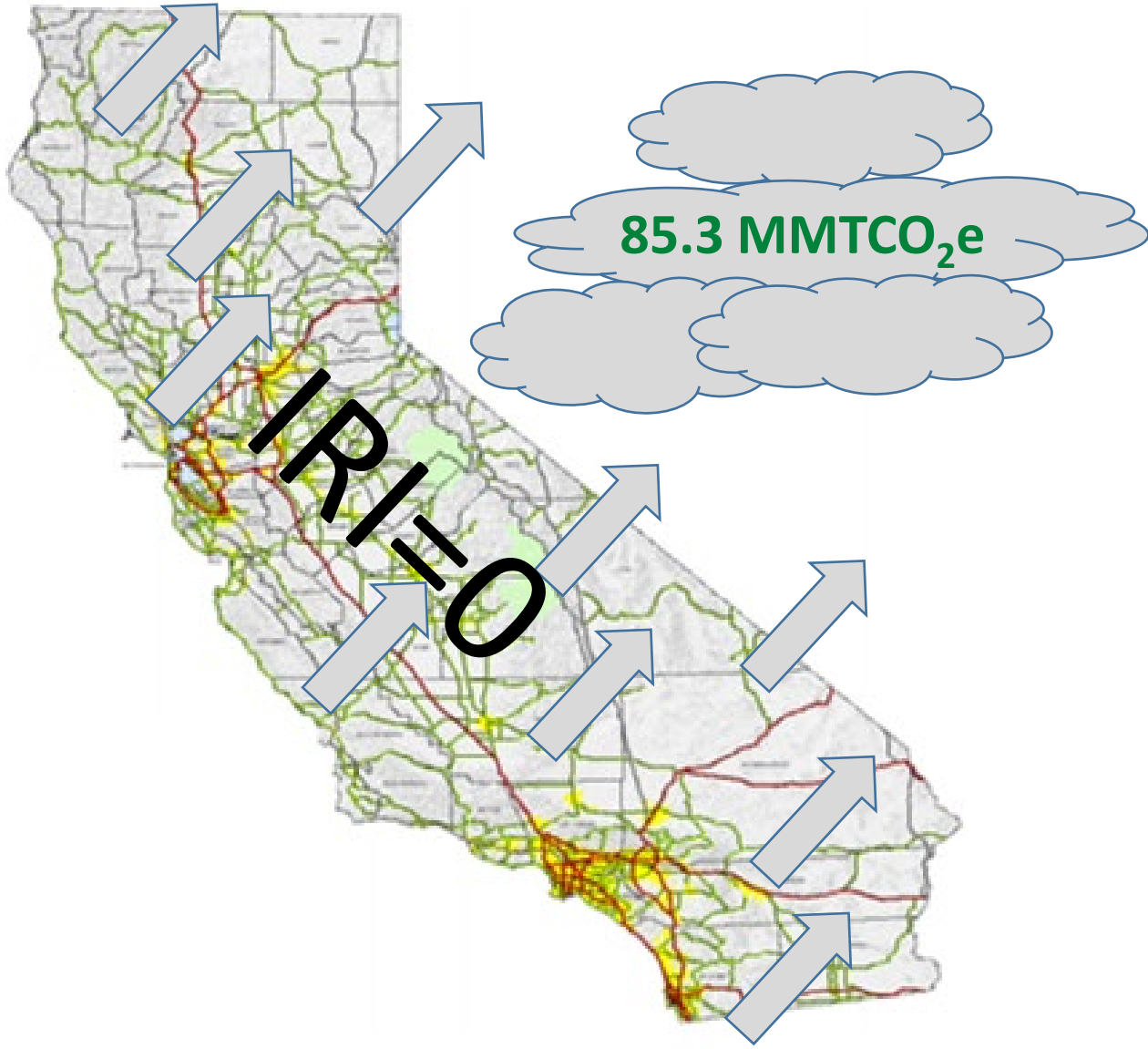
- Entire CA state highway network
- "2016 APCS" snapshot of IRI
- Total calculated by PaveM
- GHG=88.1 MMTCO$_2$e (1 year)
  - Out of 170 MMTCO$_2$e for transportation sector
- This matches with the state highway VMT (55%) of total





Ideal (minimum) GHG

- Ideal if all pavement IRIs drop down to zero! Although, a more practical level is IRI=40 in/mile
- This (IRI=0) drops the current level of GHG of 88.1 MMTCO2 per year to 85.3 MMTCO$_2$e. A reduction of 2.8 MMTCO2e on state highway network. Assuming IRI stays zero and **no GHG from construction**
- As pavement engineers this is the greatest reduction that we can achieve with pavement management



Future Capabilities

- Allow PMS to select projects based on minimization of GHG
- Generate GHG dashboards and GIS maps directly from PaveM
- Improved integration of project-level LCA (using elCAP) and LCCA with PMS
  - Optimized decision trees
  - Increased integration of data and models
- NAPA sponsored framework for implementation of these ideas into other state PMSs

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Some thoughts

- **Does not include electrification of the fleet**
  - Emissions equates to energy, which for EVs equates to range
  - Smooth pavement will continue to be important
- **Smoothness specifications and "building it smooth" are going to be more important in the future**
- **Pavement will not solve climate change**
  - But good pavement management can play a part
  - Projects that show long-term GHG savings (via LCA) might be eligible for alternative funding sources

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- **Thank you!**
- **Thanks to many colleagues at Caltrans and UCPRC**

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Questions?

Image: Pixabay

Thanks!

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