NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Integrating Non-Destructive Evaluation in Bridge Preservation and Management

February 25, 2025

1:00PM – 2:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

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AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will showcase the integration of NDE results into the bridge preservation decision-making process. Presenters will highlight cost savings by comparing the combined expense of NDE and subsequent interventions to the costs associated with deferring NDE-informed actions.

Learning Objectives

At the end of this webinar, you will be able to:

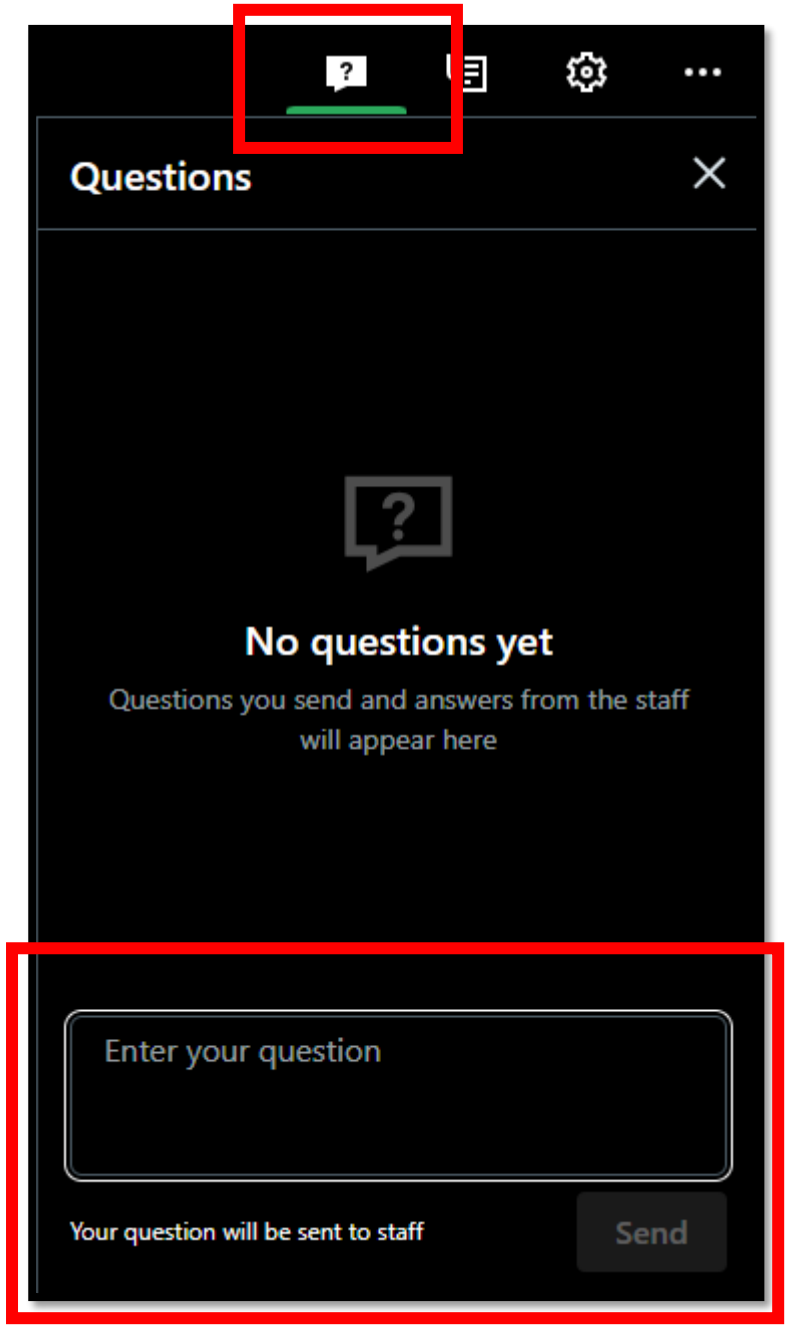
(1) Use a NDE framework for an informed preservation decision-making

(2) Identify the economic impacts for NDE-informed actions

(3) Provide examples of states' NDE use to guide their preservation actions

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

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Federal Highway Administration

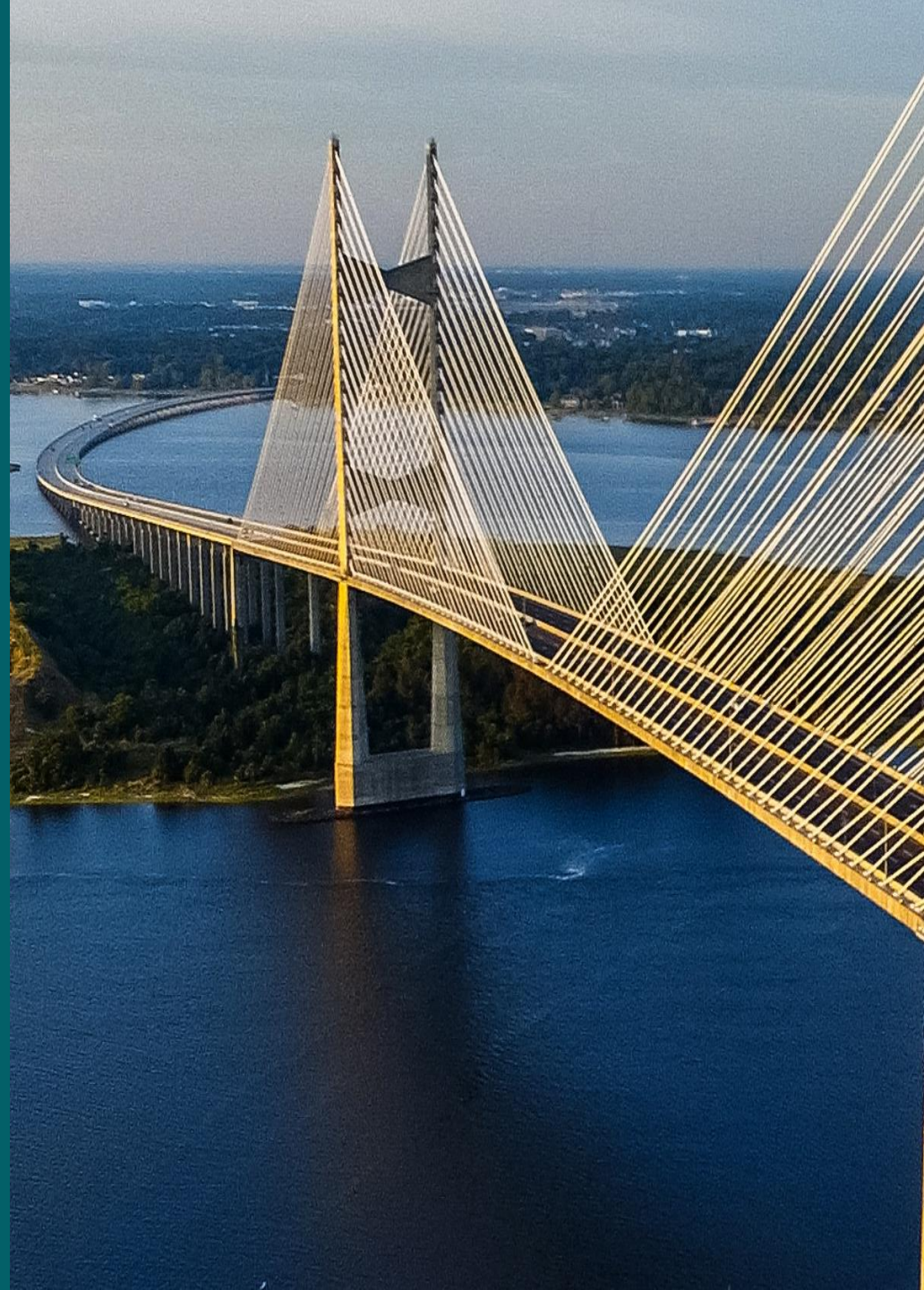
Turner-Fairbank
Highway Research Center

Incorporating Nondestructive Evaluation (NDE) Methods into Bridge Deck Preservation Strategies

Presented by:

Hoda Azari, Ph.D., Federal Highway Administration
NDE Program Manager, Turner-Fairbank Highway Research Center

Michael Brown, Ph.D., P.E., Wiss, Janney, Elstner Assoc.
Associate Principal



Source: FHWA.

Concrete Deck/Wearing Surface Types

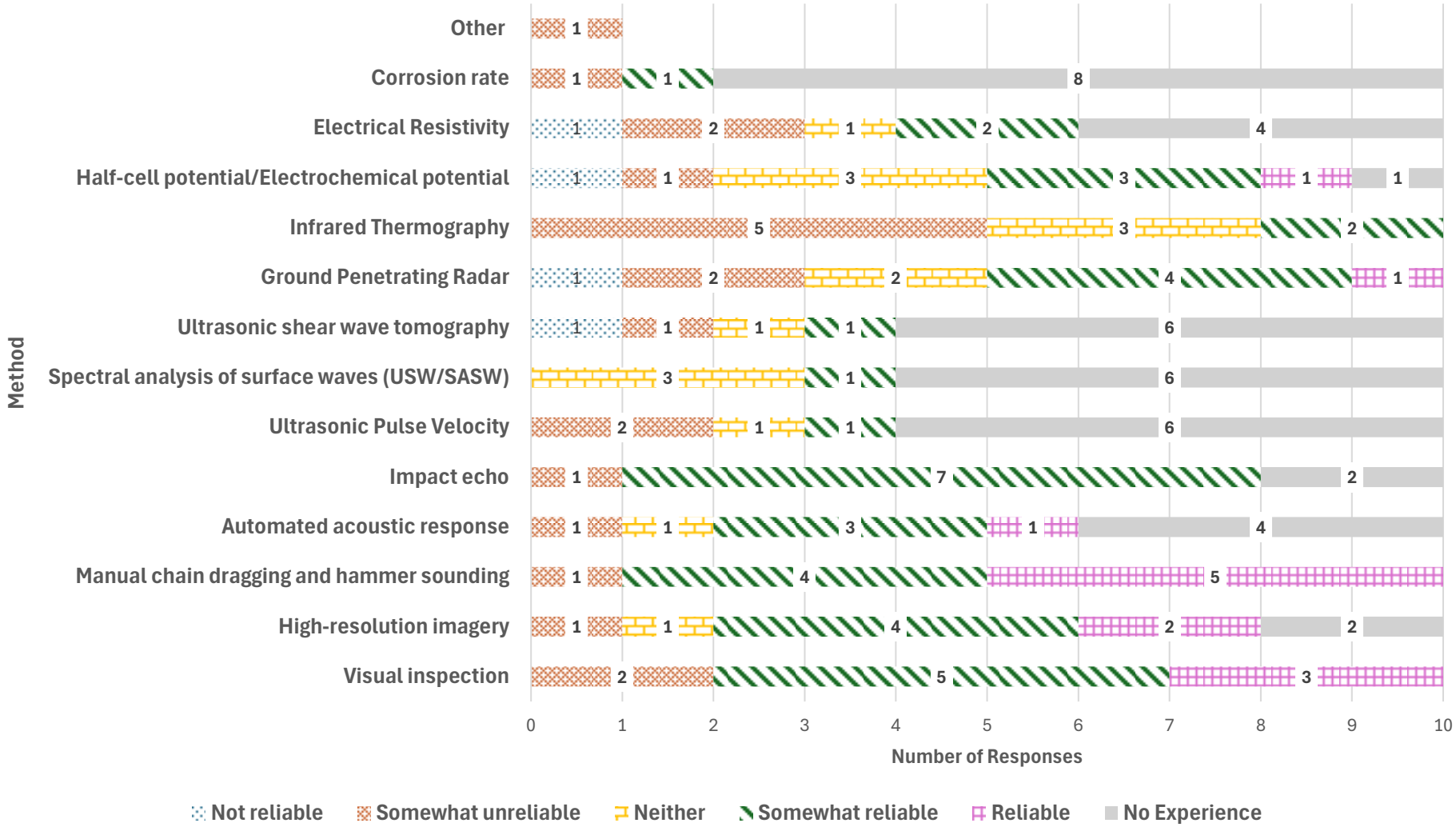
- Bare concrete.
- Various sealers:
  - Penetrating sealers.
  - Healer-sealer.
  - Crack sealers.
- Bituminous overlays:
  - Hot-mix asphalt (HMA).
  - Warm-mix asphalt (WMA).
  - polymer-modified HMA.
- Polymer overlays:
  - Thin bonded polymer overlay (TBPO).
  - Premixed polymer concrete (PPC).
  - Urethanes.
- Cementitious overlays:
  - Portland cement concrete (PCC).
  - Low-slump dense concrete (LSDC).
  - Silica fume concrete (SFC).
  - Latex-modified concrete (LMC).
  - Ultra-high performance concrete (UHPC).
- Reinforcement (not a surface type, but important to durability):
  - Black bars.
  - Epoxy-coated bars.
  - Corrosion-resistant or stainless-steel bars.
  - Polymer composite bars.

Summary of NDE Application (Concrete)

Test Method	Impact Echo	Ultrasonic Tomography	Ultrasonic Pulse Velocity	GPR	Half-Cell Potential	Electrical Resistivity
Thickness	✓	✓	✓	✓	-	-
Delamination	✓	✓	-	✓ *	-	-
Honeycomb/Void	✓	✓	✓	-	-	-
Relative Concrete Quality	-	✓	✓	-	-	-
Ungrouted Tendons	✓	✓	-	-	-	-
Cold Joint	-	✓	-	✓	-	-
Rebar Layout	-	✓	-	✓	-	-
Rebar Cover	-	✓	-	✓	-	-
Active Corrosion	-	-	-	✓	✓	-
Inadequate Rebar Protection	-	-	-	-	-	✓

* = If corrosion induced; - = not applicable; GPR = ground-penetrating radar.

Level of Confidence—Concrete Decks



Source: FHWA.

Summary of Findings—Impediments

Impediments:

- Misconceptions about NDE limitations and capabilities.
- Constraints on production use.
- Inconsistent guidance.
- Lack of owner expertise.
- Expense.

Condition Rating-Based Thresholds

Rating	Primary Criteria (Defect 1080 Delamination/Spall/Patch Area)	Preservation/Maintenance Action
9*	0 percent Spalls and delamination	Surface sealer, do nothing
8	0 percent < Spalls and delamination < 2 percent	Repair and surface sealer, fill cracks, thin-polymer overlay**
7	2 percent < Spalls and delamination < 5 percent	Repair and surface sealer, fill cracks, thin-polymer overlay, HMA+membrane, premixed polymer overlay
6	5 percent < Spalls and delamination < 10 percent	Repair and/or mill/hydro-demolition and HMA+membrane, premixed polymer overlay, rigid overlay
5	10 percent < Spalls and delamination < 20 percent	Repair and/or mill/hydro-demolition and HMA+membrane, premixed polymer overlay, rigid overlay
4***	20 percent < Spalls and delamination < 30 percent	Repair and/or mill/hydro-demolition and late-life asphalt overlay, rigid overlay, replace
3***	30 percent < Spalls and delamination	Replace, mill/hydro-demolition and late-life asphalt overlay, repair and rigid overlay

*Some agencies place sacrificial/protective layer at construction such as HMA with membrane or dense concrete overlay.
**Some agencies do not apply polymer overlays until they reach a certain maturity.
***Not considered as preservation actions.

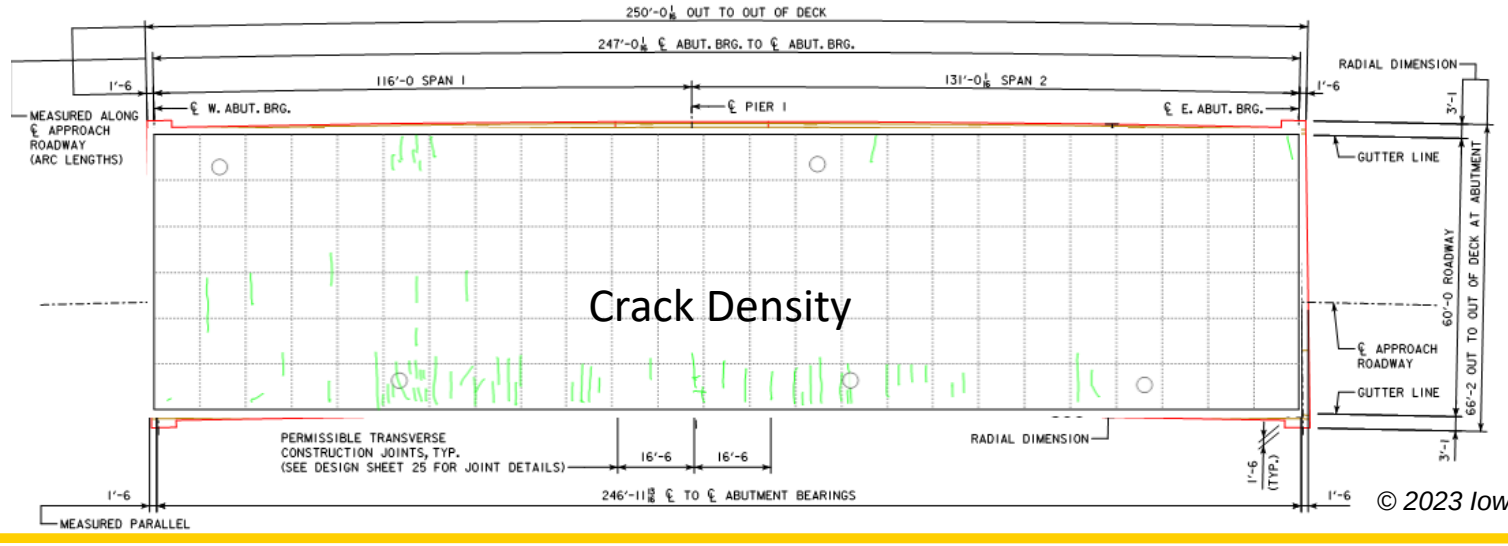
Framework for NDT-Specific Thresholds

- NDE methods used to directly guide the selection of bridge deck preservation strategies.
- Approach was complex with limited available literature and supporting data to fully develop NDT thresholds for all available NDE techniques.
- Focus was to develop a guiding framework.
- Example NDE methods:
  - GPR (concrete cover distribution).
  - High-resolution imagery (crack / spall / patch quantification).
  - Half-cell potential (HCP) (active corrosion probability).

High Resolution Imagery (Crack Assessment)

High-resolution imagery:

- Potential for use as a QA/QC method for crack mapping of newly constructed bridge decks.
- Information related to crack density and width can be used to guide the selection of preservation techniques.



© 2023 Iowa DOT.[1]

[1]ElBatanouny, M., K. Hawkins, M. Abdelrahman, J. Lawler, T. Nelson, and P. Krauss. 2022. *Guide to Remediate Bridge Deck Cracking*. Ames, IA: Iowa Highway Research Board.

High-Resolution Imagery (Treatment Criteria)

Data-driven selection of crack remediation options based on cracking characteristics of a generic Iowa DOT bridge deck.[1]

Crack Width	Low Crack Density (< 0.10 ft/ft^2)	Moderate Crack Density (0.10 to < 0.22 ft/ft^2)	Severe Crack Density (0.22 to < 0.37 ft/ft^2)	Very Severe Crack Density (≥ 0.37 ft/ft^2)
Narrow cracks < 5 mils or map cracks	Do Nothing or Penetrating Sealer; Flood Coat	Do Nothing or Penetrating Sealer; Flood Coat	Do Nothing or Penetrating Sealer; Flood Coat	Flood Coat; Penetrating Sealer; Do Nothing
5 to < 15 mils	Do Nothing; Penetrating Sealer + Reapplication; Crack Fill or Flood Coat; Polymer Overlays	Flood Coat; Penetrating Sealer + Reapplication; Thin Polymer Overlay or Premixed Polymer Overlay	Flood Coat; Polymer Overlays	Polymer Overlays; Flood Coat
15 to < 30 mils	Crack Fill or Flood Coat; Thin Polymer Overlay	Flood Coat; Thin Polymer Overlay or Premixed Polymer Overlay	Flood Coat; Thin Polymer Overlay or Premixed Polymer Overlay	Flood Coat; Thin Polymer Overlay or Premixed Polymer Overlay
30 to < 40 mils	Crack Fill; Thin Polymer Overlays	Thin Polymer Overlay; Premixed Polymer Overlay	Thin Polymer Overlay; Premixed Polymer Overlay	Thin Polymer Overlay; Premixed Polymer Overlay
≥ 40 mils	Requires further investigation	Requires further investigation	Requires further investigation	Requires further investigation

[1]ElBatanouny, M., K. Hawkins, M. Abdelrahman, J. Lawler, T. Nelson, and P. Krauss. 2022. *Guide to Remediate Bridge Deck Cracking*. Ames, IA: Iowa Highway Research Board.

Approach

Recommendations for NDE programs were classified into three categories:

- New construction.
- Early to middle-age structures.
- Bridge deck repair or rehabilitation.

The lifecycle cost analysis (LCCA) in Task 4 and the decision tree examples developed in Task 5 focus on these tree stages of the deck lifecycle.

New Construction

- Use GPR to map the location and cover depth of the reinforcement.
- Review high-resolution imagery for crack density and width.
- Include VDOT new decks in example case studies.

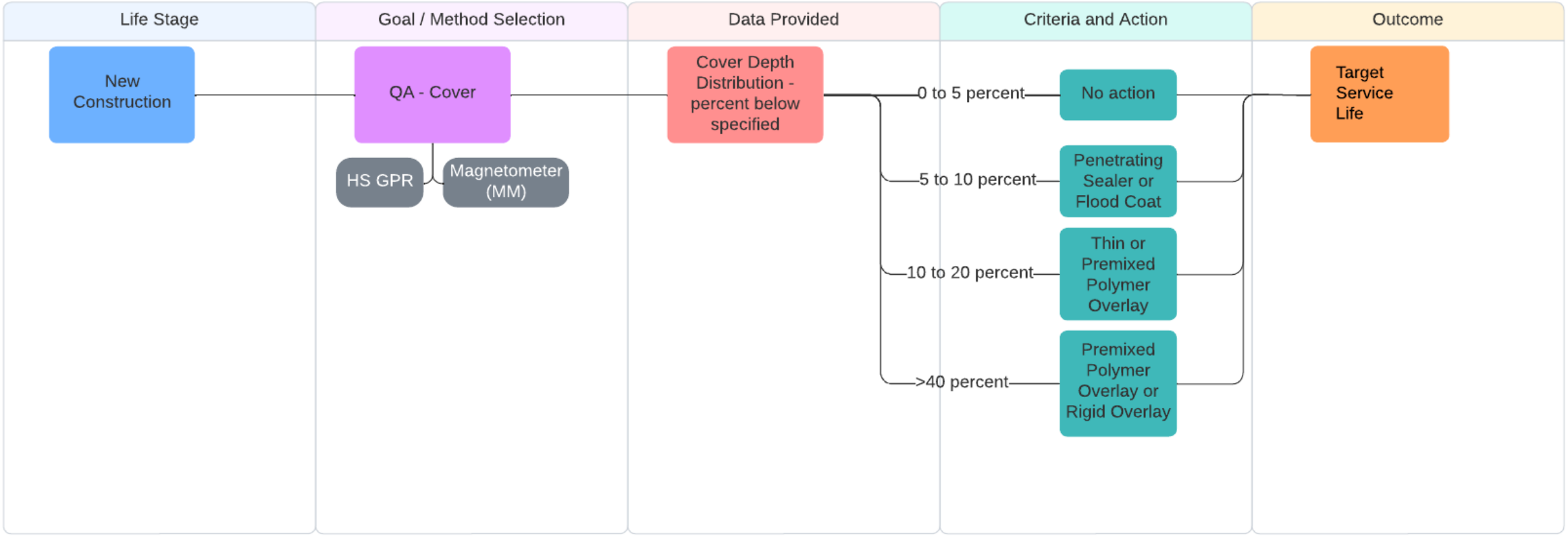
GPR to Map the Location and Cover Depth of the Reinforcement

EUAC of generic bridge deck with various assumed concrete cover.

Treatment Alternative	Cover Depth				
	2.5 inch	2.0 inch	1.5 inch	1.0 inch	0.5 inch
Uncracked Deck	$18,796	$24,096	$30,738	$37,742	$43,607
Penetrating Sealer*	$18,573	$23,552	$29,308	$35,382	$41,034
Thin-Polymer Overlay*	$16,343	$19,321	$22,818	$25,319	$26,429
Premixed Polymer Overlay*	$16,296	$18,519	$20,864	$23,427	$26,189

EUAC = equivalent uniform annual cost.
*Includes NDE cost, assumes agency is responsible for treatment costs.

Decision Tree—New Construction Criteria



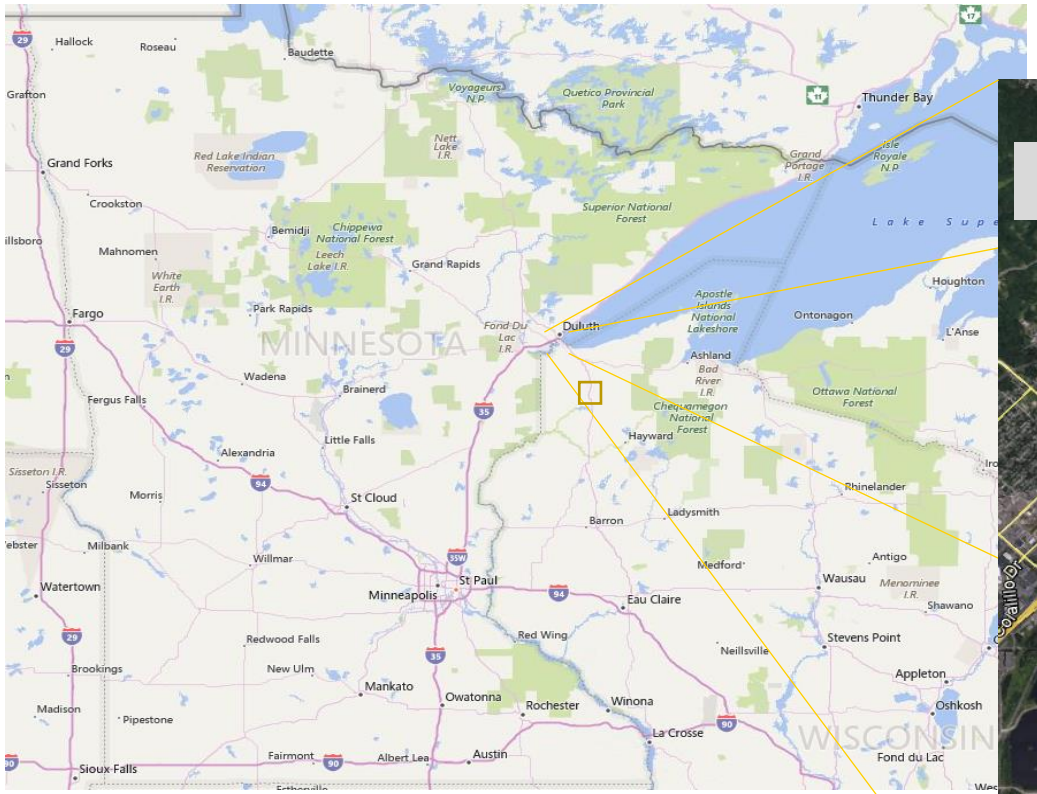
Source: FHWA.

Early to Middle-Age Structures—Overview

Early to middle-age bridges are those that have been in service long enough where exposure to environment may lead to early deterioration or damage:

- Using NDE on bridges within this life stage can help with early detection of damage, which can enable selecting or prioritizing preservation and maintenance of specific bridge decks to achieve optimal allocation of resources.
- Applying NDE techniques at this life stage on a network of bridges can help with asset management planning.

Case Study—John A. Blatnik Bridge



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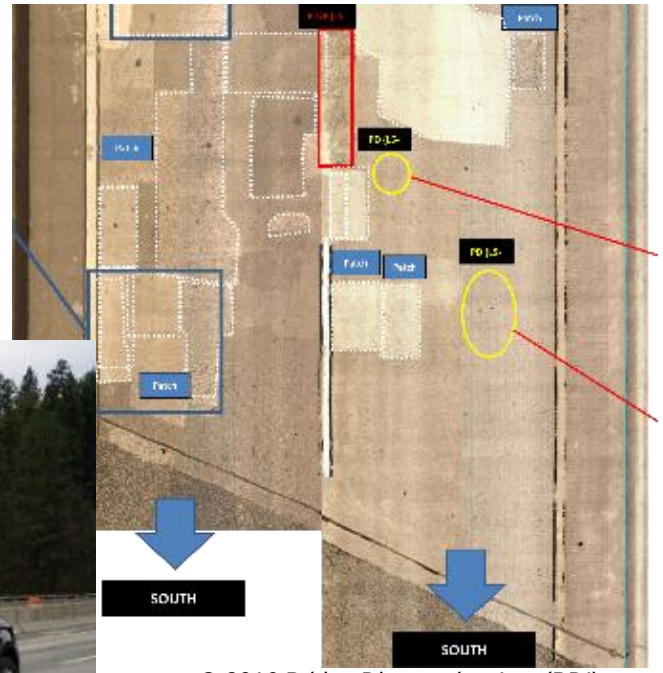
Deck Evaluation

- NDE:
  - High-resolution video.
  - GPR.
  - Infrared thermography.
  - Automated acoustic sounding.
- Sampling and testing:
  - Cores.
  - Chlorides.
- Ground truth:
  - Sounding.
  - Supplemental NDE.



© 2016 Bridge Diagnostics, Inc. (BDI).

© 2016 Infrasense.

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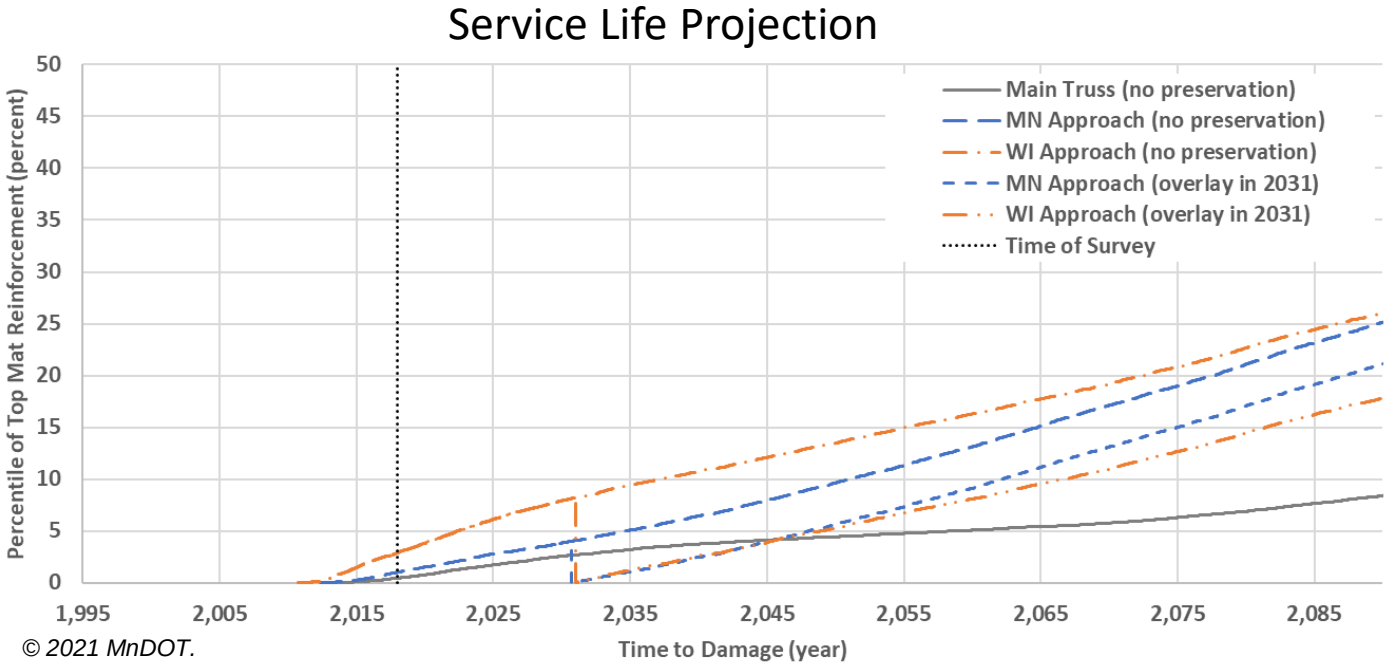
Prognosis

OUTCOME—Deck is still general condition rating (GCR) of 6; MnDOT is considering whether overlay is needed in 2032; long-term plan to replace the bridge has been initiated.

- Eight of 77 cores had Cl^- > 500ppm at reinforcement depth.
- Carbonation – negligible to 0.3 inch.
- GPR: 3.2-inch average cover depth.
- GPR: 7.8 percent deck area attenuation.
- IR: 1.4 percent deck area delaminated.
- DAR: 1.7 percent deck area degraded.
- HRV: 0 percent deck patching.



Deck is currently in good condition, despite abundant surface cracking in sacrificial wearing course. Previous treatment of cracks appears effective in slowing chloride ingress. Average chloride concentration is 1.2 lb./yd^3 (300ppm) at top bar. Approaches are expected to require major preservation within 20 yr, whereas the main truss deck, with greater cover, may last longer with periodic patching.

RECOMMENDATION—A properly placed new structural overlay in the near term would eliminate cracking and remove chloride contamination that is driving diffusion. The life of the deck could easily be extended 20 to 30 yr longer.

Economic Comparison of Potential Treatment Plans for John A. Blatnik Bridge

	Plan With NDE			Plan Without NDE		
Year	**Event**	**Cost**	**EUAC**	**Event**	**Cost**	**EUAC**
2018	Inspection	$ 221,000	$ 7,215	-	-	-
2032	Mill and overlay Wisconsin approach	$ 7,199,702	$ 216,530	Whole deck overlay	$ 11,855,232	$ 356,544
2045	Mill and overlay Minnesota approach	$ 3,207,156	$ 89,374	-	-	-
2052	-	-	-	Deck replacement	$ 107,213,867	$2,867,547
2080	Deck replacement	$ 107,213,867	$2,433,264	-	-	-
-	-	∑	$2,746,383		∑	$3,224,092
-	-	-	-	-	Savings/year	$ 477,708

- = not applicable.

Asset Management Planning (Project/Network)

Early to Middle Age—No or Little Visible Deterioration

Purpose: screening to determine if deterioration (or precursors) are present:

- Assess rate of degradation; improve accuracy of condition assessment.
- Trigger preventive actions (cleaning, sealing, thin overlays).
- Help prioritize needs (which bridges to work on first).
- Inform deterioration curves for BMS.

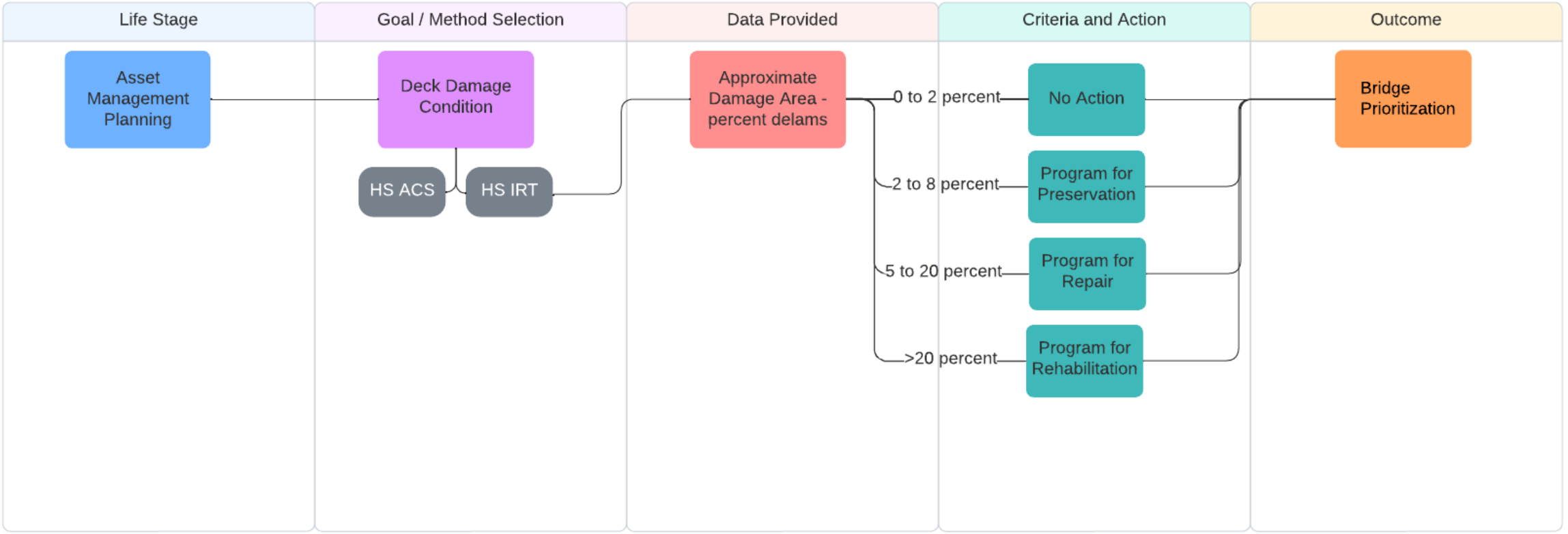
Network level—GPR characterization of cover may inform a resistance factor for deterioration to be applied to BMS and influence rate of deterioration.

- Other techniques: GPR attenuation, HCP, HRI, IR.
- Weighting of various NDE inputs to develop a composite condition index?

Project level—Michigan multideck sounding project: Wisconsin thermography NDE hierarchy.[1]

[1]Wisconsin Department of Transportation. 2020. *Structure Inspection Manual Part 1 - Appendix A: Deck Scanning Policy.* Madison, WI: Wisconsin Department of Transportation. https://wisconsindot.gov/dtsdManuals/strct/inspection/insp-fm-pt1appxa.pdf, last accessed May 16, 2024.

Decision Tree—Asset Management Criteria



Source: FHWA.

Repair or Rehabilitation (Project Level)

Middle to Advanced Age—Manifest Deterioration

Purpose—Detailed assessment and quantification of damage:

- Used to select between potential preservation actions.
- Used to prepare bid documents and construction estimates (e.g., HRI, IR, and automated sounding).
- Used for post-project validation of repairs.

Decision Tree—Repair Project Criteria

Condition rating-based thresholds.

Rating	Primary Criteria (Defect 1080 Delamination/Spall/Patched Area)	Preservation/Maintenance Action
9*	0 percent spalls and delamination	Surface sealer, do nothing
8	0 percent < spalls and delamination < 2 percent	Repair and surface sealer, fill cracks, thin-polymer overlay**
7	2 percent < spalls and delamination < 5 percent	Repair and surface sealer, fill cracks, thin-polymer overlay, HMA+membrane, premixed polymer overlay
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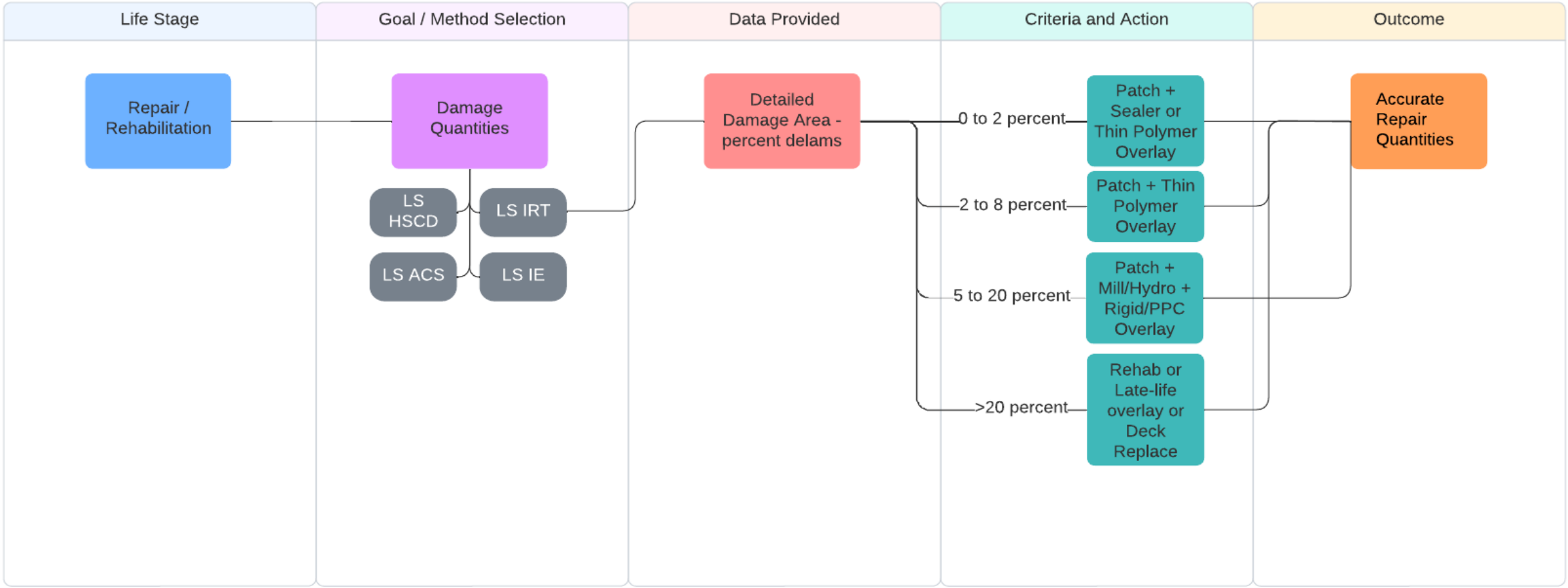
*Some agencies place sacrificial/protective layer at construction such as HMA with membrane or dense concrete overlay; **Some agencies do not apply polymer overlays until they reach a certain maturity.

Decision Tree—Repair Including Criteria



Source: FHWA.

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U.S. Department of Transportation
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How the Indiana DOT Uses NDT to Guide Preservation Decisions

Anne Rearick

Director of Bridge Management

Indiana Department of Transportation

Overview

- Current Applications
- Usage of NDT results
- Aerial Infrared
- Impact Echo
- Pole Mounted IR
- Research
- What’s next

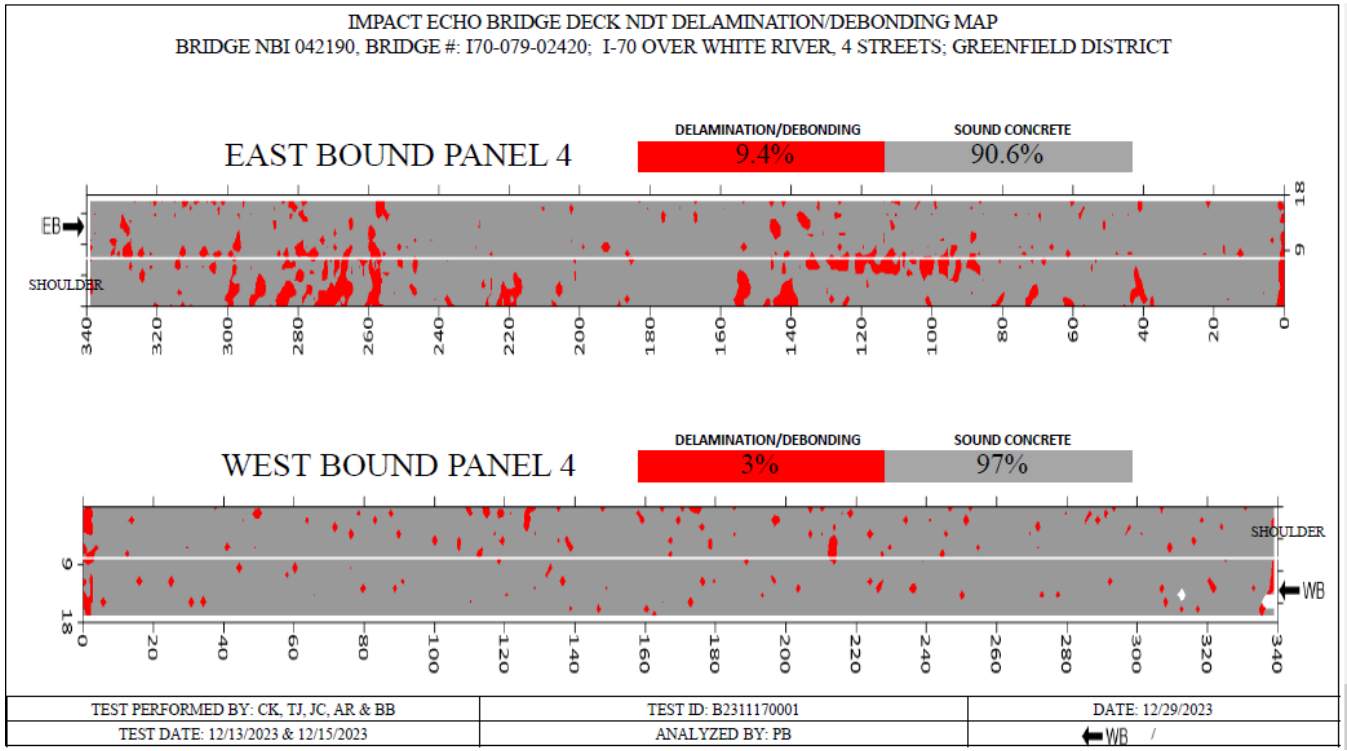
Current Applications

- Network Level
  - Aerial Infrared
  - Approximately 200 bridges per year
  - Focusing on Interstate and NHS Routes
- Project Level
  - Impact Echo
  - Pole Mounted

Usage of NDT Results

- Construction of second LMC overlay decision
- Deciding on LMC overlay vs deck replacement
- Lowering of NBI deck and wearing surface condition ratings
- Determining ideal bridge deck candidates for epoxy injection
- Forensic investigations
- Condition assessment for load ratings

Usage of NDT Results

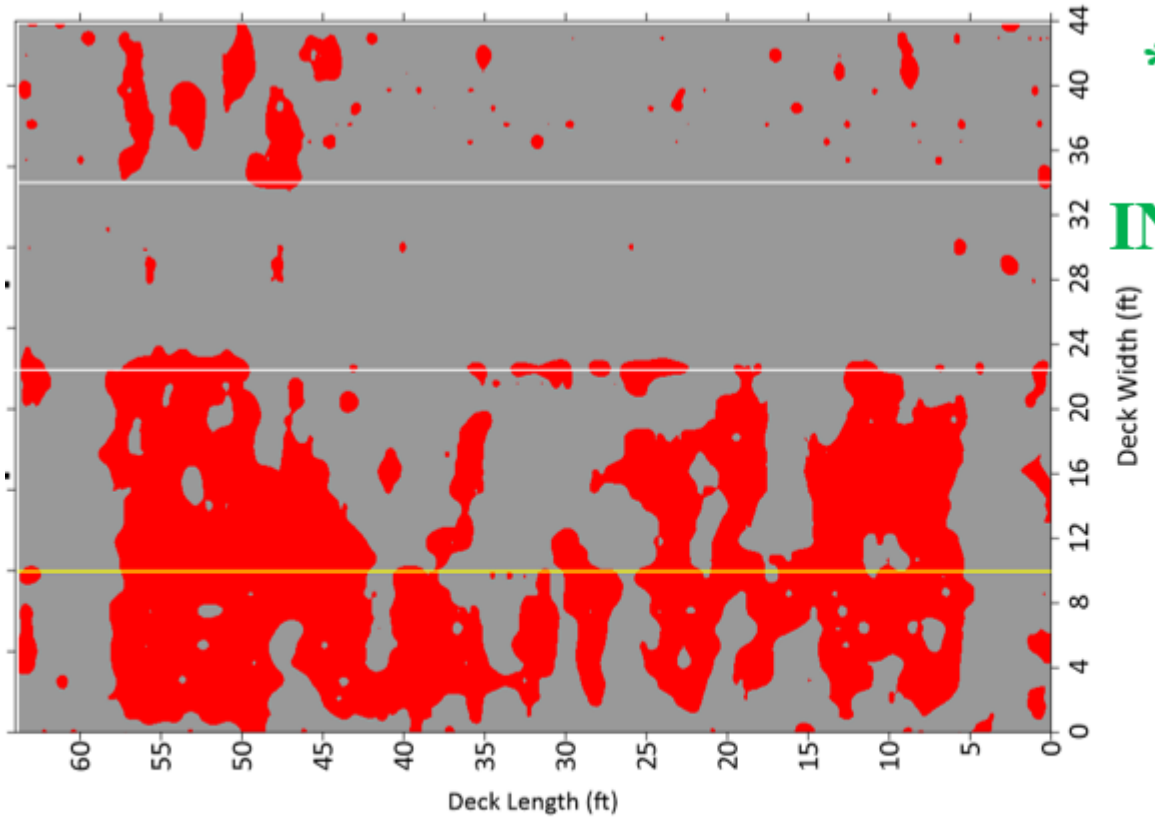


”We would like to proceed with obtaining the impact echo by the end of this year.

Please let me know how we can help to get this done.

For additional background, we have this project currently under design for a rigid deck overlay and given the large size and importance of this bridge, we want to have as much information as possible to make an informed decision about the proposed bridge treatment. **For context, the results of the impact echo will help us determine the treatment type and whether we need to spend $35M or $70M on this bridge**.”

Usage of NDT Results

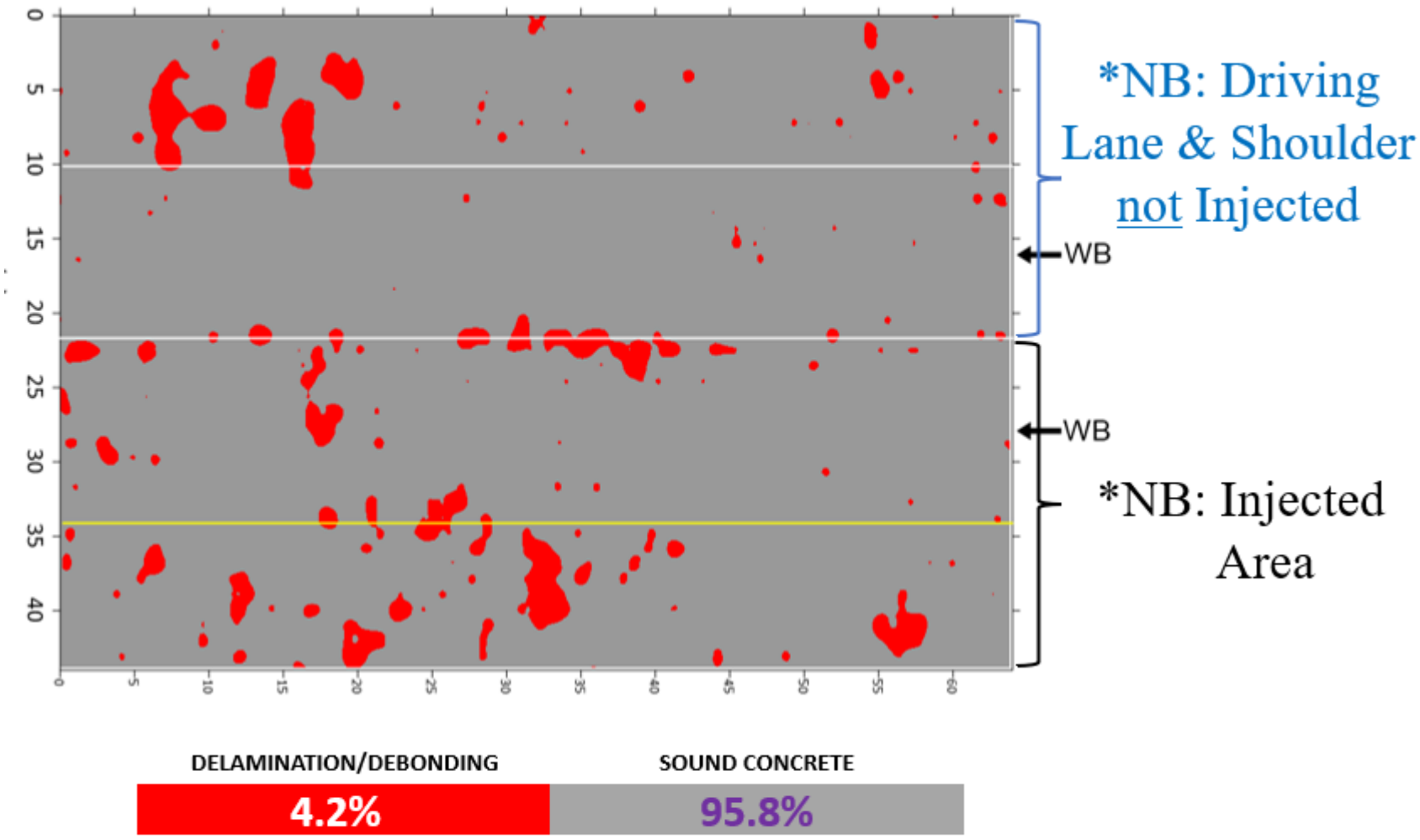


*BEFORE EPOXY INJECTION

DELAMINATION/DEBONDING	SOUND CONCRETE
27.2%	72.8%

Usage of NDT Results

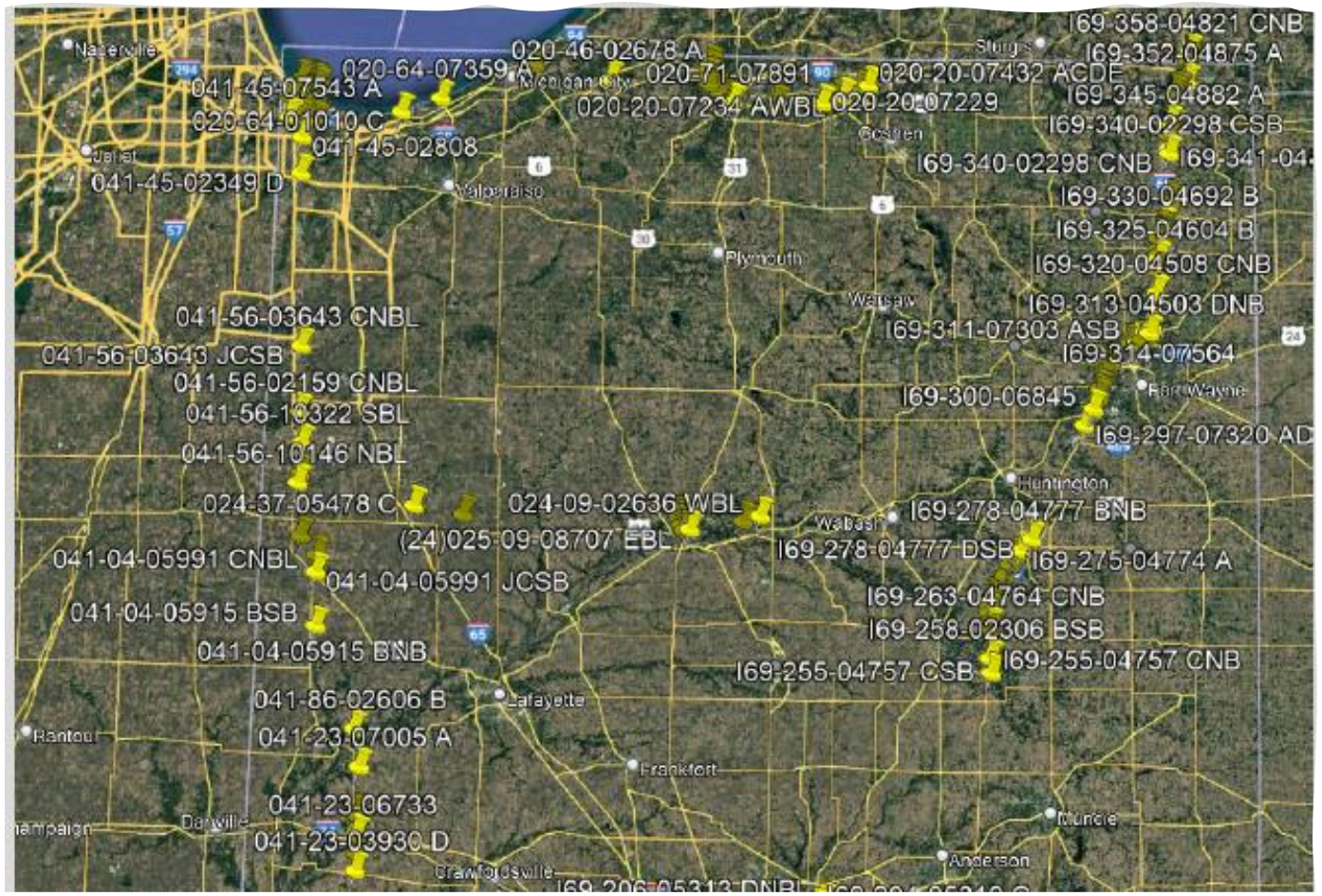
***AFTER EPOXY INJECTION**



Aerial Infrared

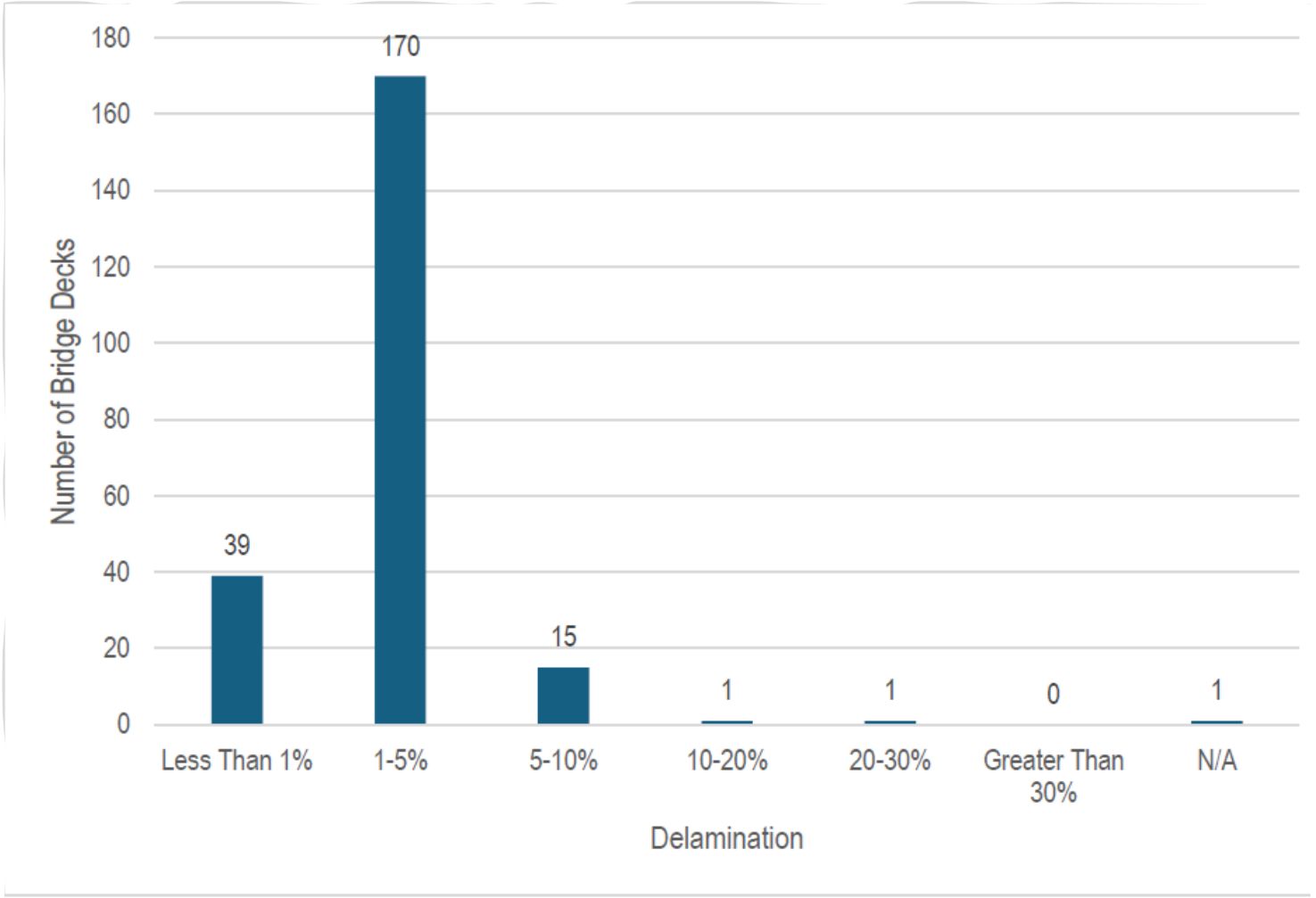
226 bridge decks

- Network level
- Focusing on Interstate and NHS routes



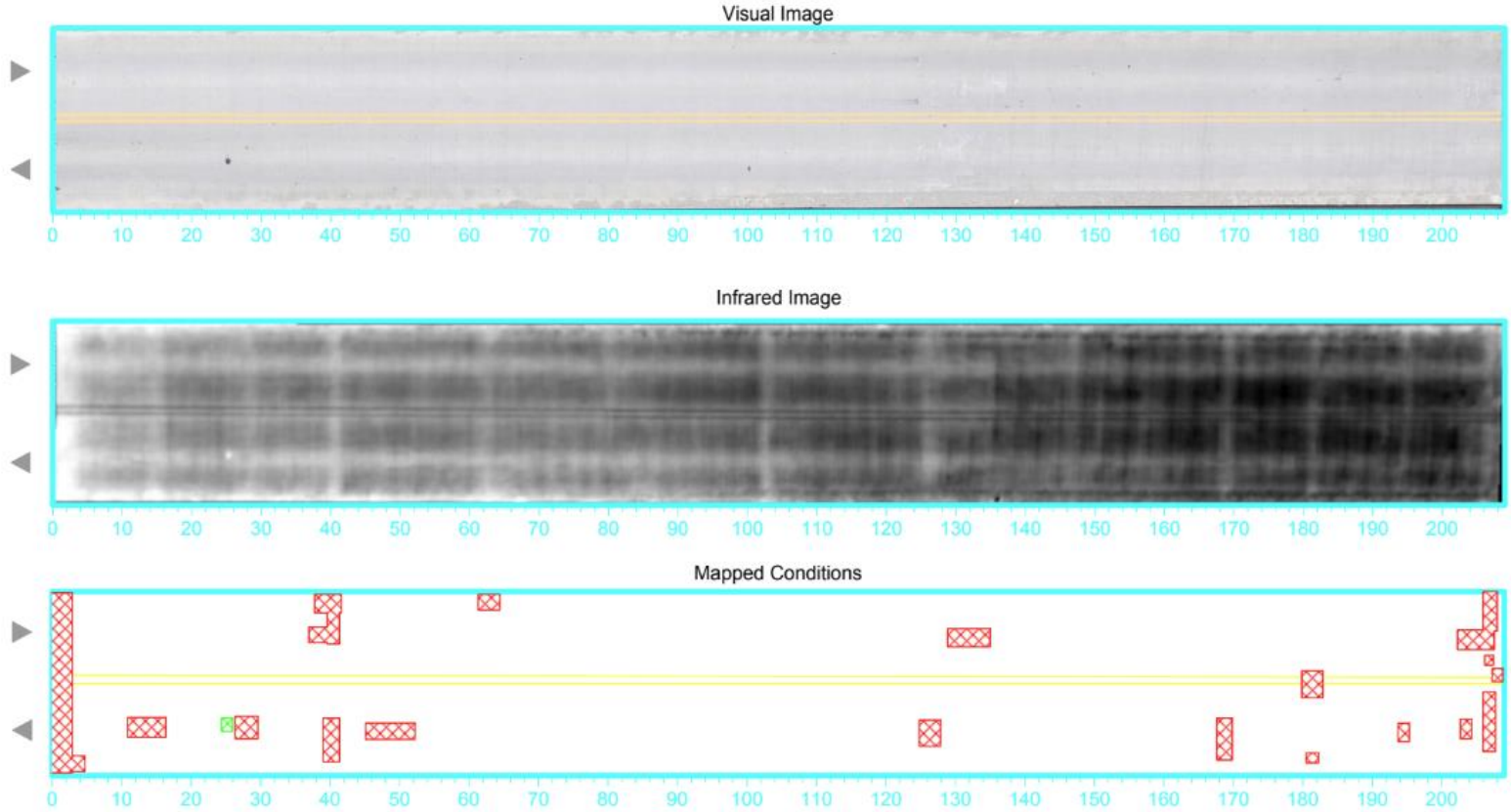
Aerial Infrared

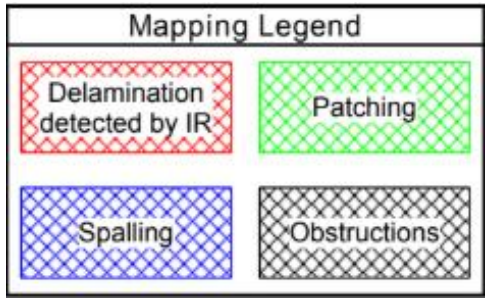
226 bridge decks



Aerial Infrared

I69-323-04603





Aerial Infrared

I69-323-04603

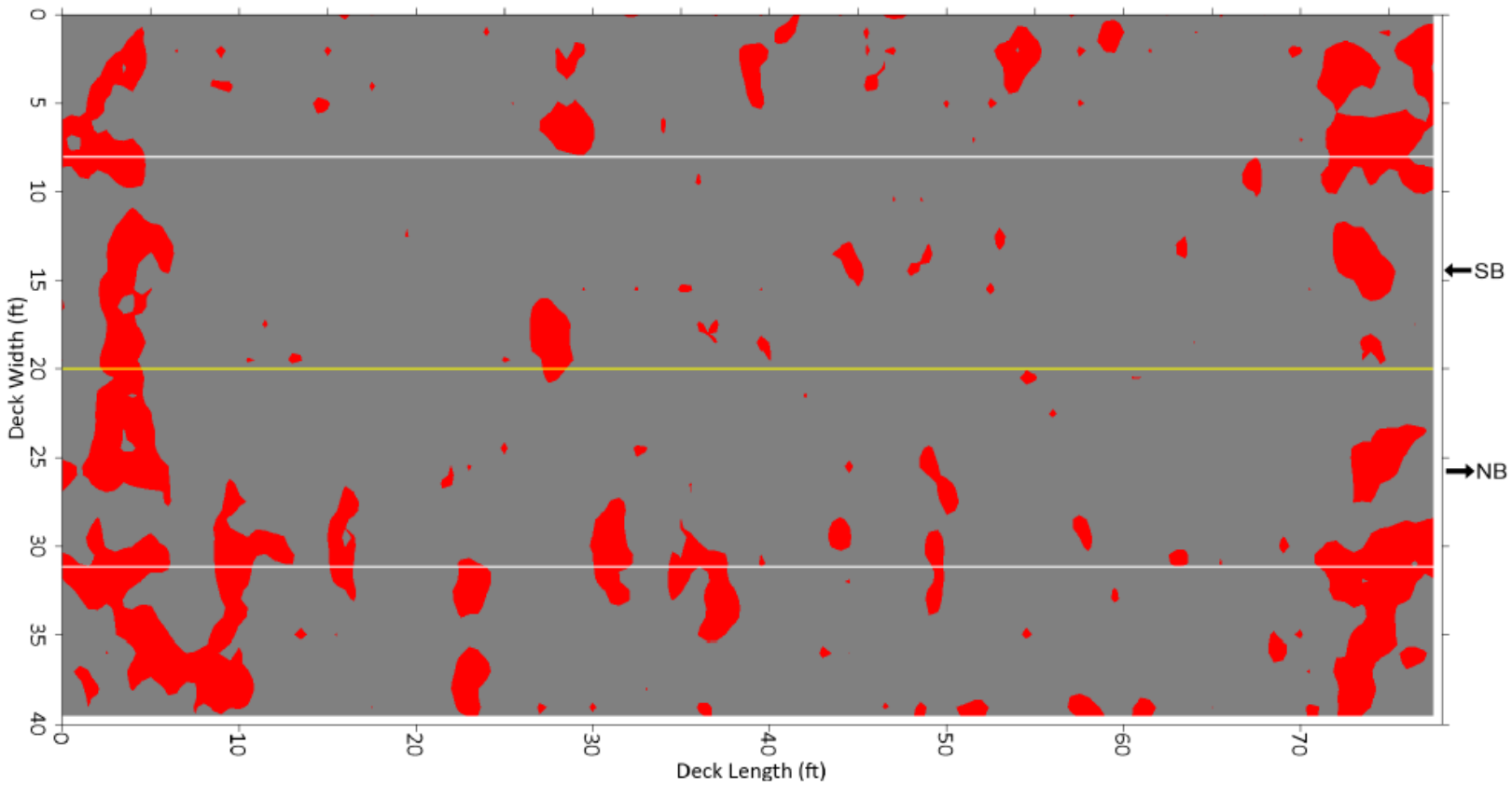
Quantity Summary	
Delamination %	5.1
Delamination (ft^2)	284
Patching %	<1
Patching (ft^2)	3
Spalling %	0.0
Spalling (ft^2)	0

Impact Echo

- Preferred method
- used when more detail is needed i.e. for patching quantities
- Determine epoxy injection appropriateness and effectiveness

Impact Echo

NBI 490 Bridge 001-17-06097, SR 1 over Sol Shank Ditch



DELAMINATION	SOUND CONCRETE
9.1%	90.9%

FROM INDOT BRIDGE INSPECTION REPORT (10/14/2021)

DECK CONDITION RATING = 6	WEARING SURFACE CONDITION RATING = 6

Pole Mounted IR

NBI 26370 SR 135 over I-64 EB/WB

- Used on routes with high ADT such as interstates and interchanges
- Often chosen when there has been a previous overlay
- Used on longer bridges (> 500’)
- Shows deep delamination

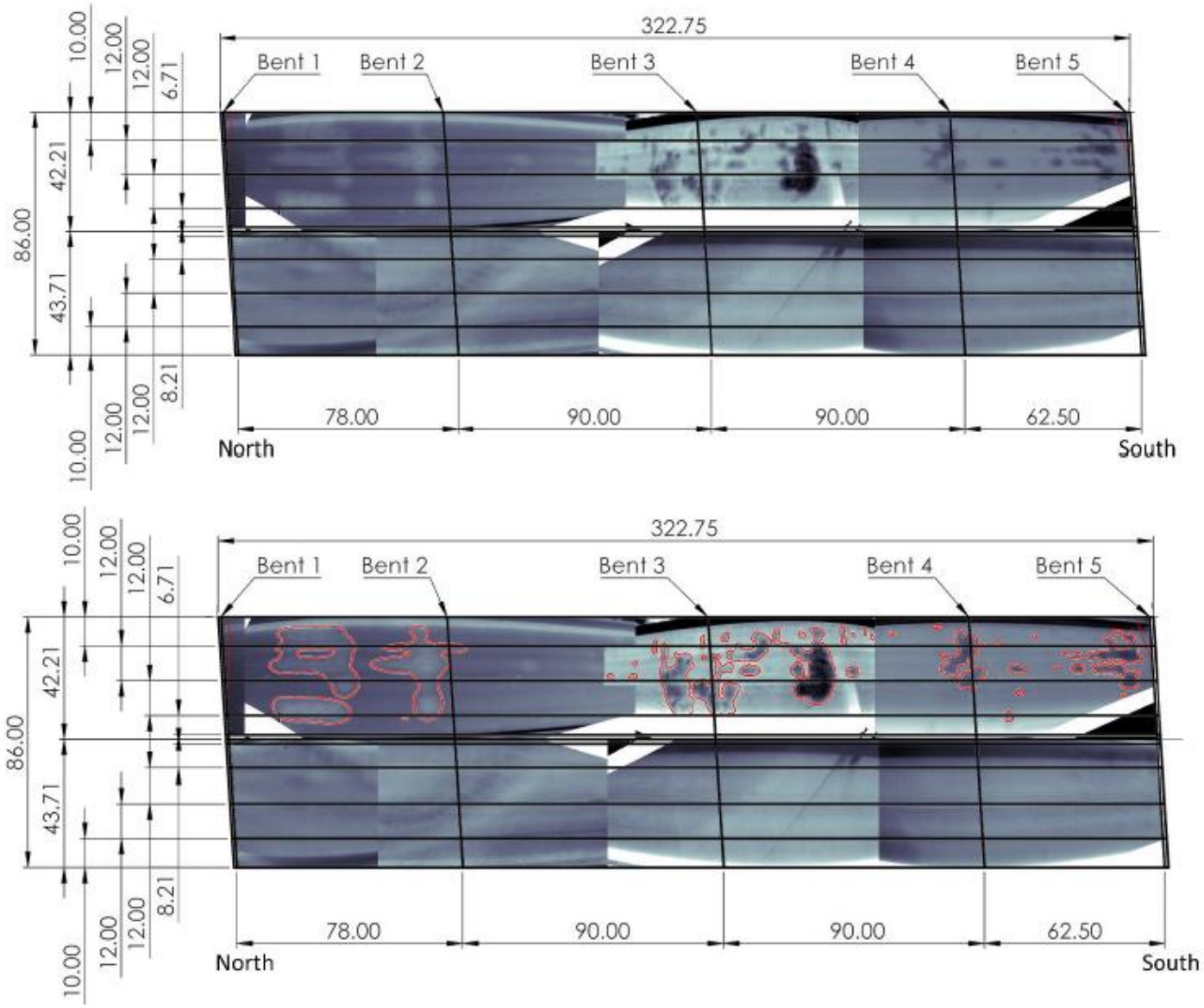
Pole Mounted IR

NBI 26370 SR 135 over I-64 EB/WB

Setup Locations

Pole Mounted IR

NBI 26370 SR 135 over I-64 EB/WB



IR-UTD images

Pole Mounted IR

NBI 26370 SR 135 over I-64 EB/WB

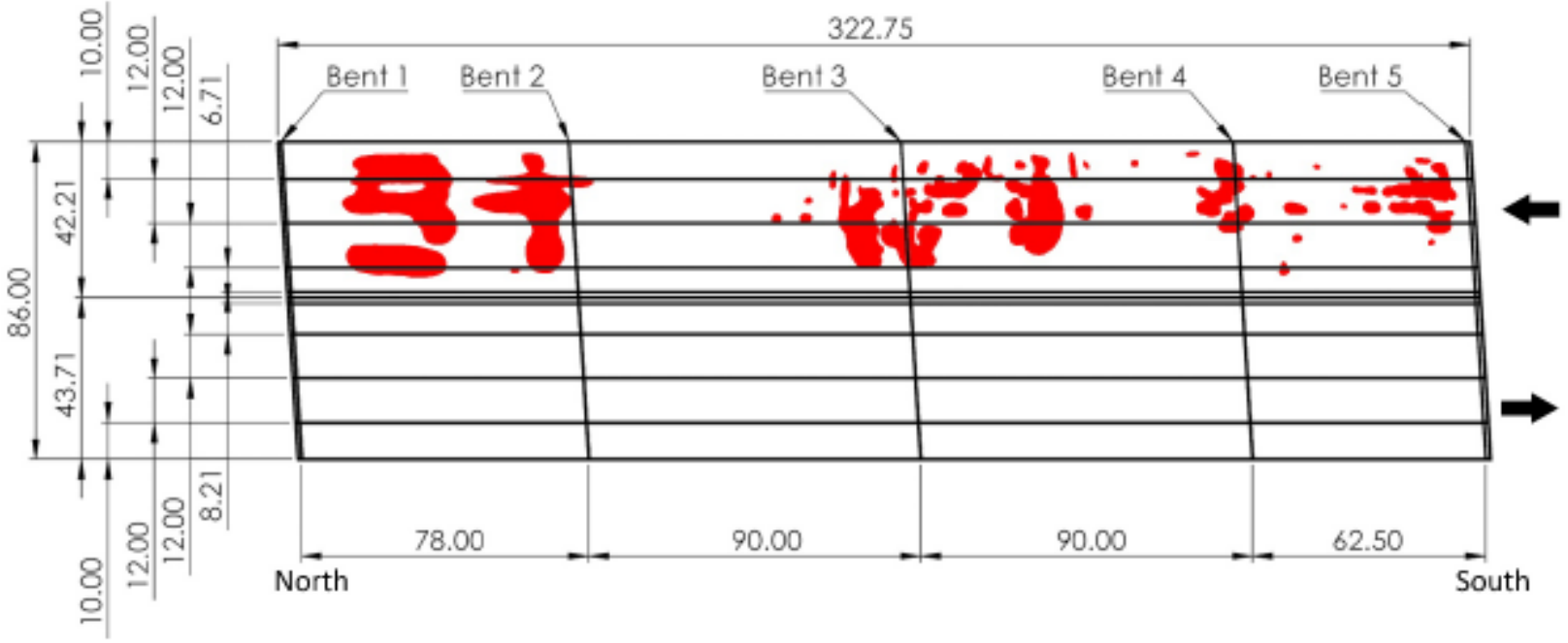
Setup #	Positions	Defect Indication Area (sq. ft.)	Measurement Area (sq. ft.)	Percent Defect Indication
15	3	1251.0	7,007	17.9%
16	2	793.3	4,117	19.3%
		2,044.3	**11,124**	**18.3%**

Setup #	Positions	Defect Indication Area (sq. ft.)	Measurement Area (sq. ft.)	Percent Defect Indication
17	3	0.0	6,210	0.0%
18	2	0.0	4,044	0.0%
		0.0	**10,254**	**0.0%**

Defect Indications

Pole Mounted IR

NBI 26370 SR 135 over I-64 EB/WB



Defect Indications

Research

Long Term Project and Network Level Implementation Plan for Indiana

- Bridge deck testing program with various consultants and different NDT testing methods
- Informative but led to more questions
  - Reliability of NDT data
  - Suitability of NDT methods for various deck surface/conditions
  - How to interpret and integrate results of NDT deck inspections

Research

Evaluation of the Accuracy of Non-Destructive Testing (NDT) Methods for the Condition Assessment of Bridge Decks and Integration of NDT into the Asset Management Program

- Compare the NDT results with deck cores
- Investigate best practices for incorporating NDT results into a bridge management plan

Research

Evaluation of Utilizing 3D GPR for Quality Assurance of bridge Deck Rebar Cover and Delamination Screening

- Selected 20 decks
- Ground truthing
- Investigating how to include in contracts

What’s next

- Develop business rules for incorporation of NDT results into bridge management system
- Try new technologies such as automated sounding.

Thank you!

Questions?

Anne Rearick

arearick@indot.in.gov

Wisconsin case studies of NDE-driven Deck Preservation

Philip Meinel, P.E.

Structures Asset Management Engineer

TRB Webinar

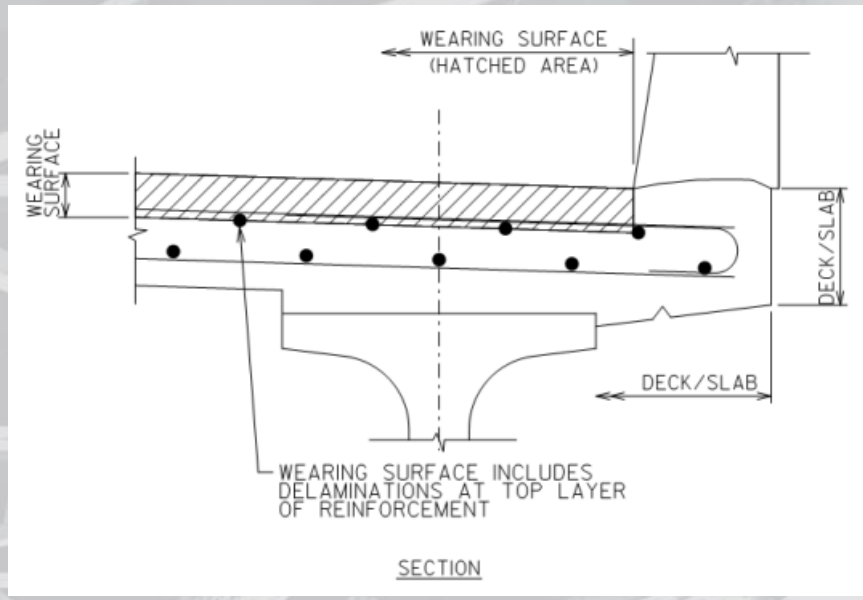
February 25, 2025

BUREAU OF STRUCTURES

How'd we get here?

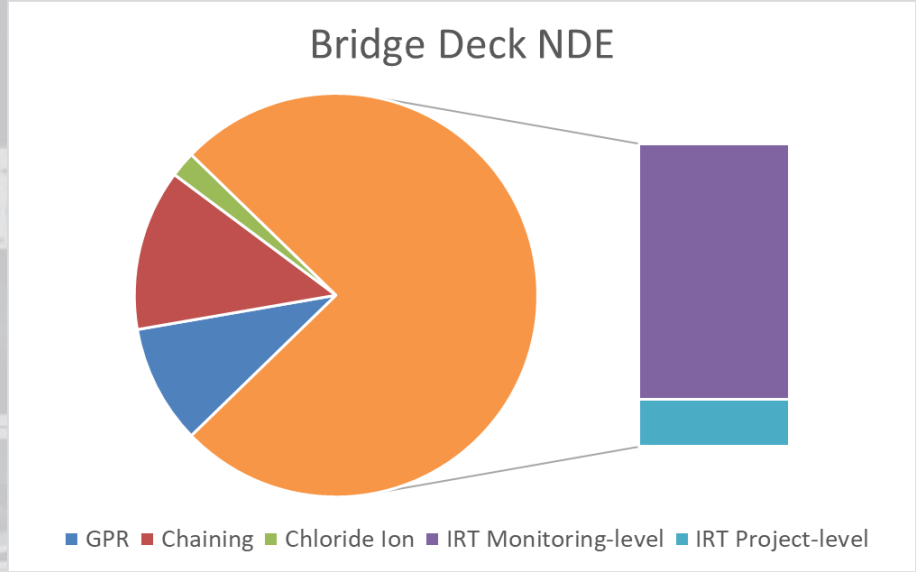
- 2016 Optimizer software
  - WI Structures Asset Management System proposes structure work
- 2017 Full program review
  - 800+ state-owned structures within 6 year program
- 2018 Central office approval of all structure work
  - Certification document required
- 2019 Approval software
  - Structures Certification Tool
- 2020 Bridge deck NDE program implemented statewide

Which Decks?



- Emphasis on state-owned structures
- Key National Bridge Elements
  - 12/38 Reinforce Concrete Deck/Slab (77% of inventory)
- Key Agency Defined Elements
  - 8000, 8508-8515 Wearing Surfaces (every deck)
- Key element defects
  - 1080 Delamination/spalls/patching in Deck/Slab underside
  - 3210 Debonding/delamination/spalls/patching in Wearing Surfaces

Which NDE?



- Infrared Thermography (IRT)
  - Level 0 – Aerial IRT
  - Level 1 – Vehicle based IRT with estimated defect quantities
  - Level 2 – Vehicle based IRT with mapped defects
  - Level 3 – Vehicle based IRT with mapped deck preparation areas
- Chloride ion testing (semi-destructive coring)
  - AASHTO T260 water soluble test
- GPR, IE, and automated sounding as needed

NBI Item 58	Top Deck Element Distress Area (%)	Bottom Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from Action	Application Frequency (in years)
≥7	-	-	Deck Sweeping/Washing	Extend Service Life	1 to 2
	5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
	3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
	-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
	3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
	>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck)	(1140 OR 1150) < 20% for timber deck	Polymer Modified Asphalt Overlay	Service life extended	10 to 15
	>20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% for concrete deck			
	>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck)	(1140 OR 1150) < 20% for timber deck	HMA w/ membrane	Service life extended	5 to 15
	>20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% for concrete deck			
	3210 < 5%	1080 < 1%	Polyester Polymer Concrete	Service life extended	20 to 30
	3210 < 2% (applied to bare deck)	1080 < 1%	Thin Polymer Overlay	Service life extended	7 to 15
	8513 CS3 + CS4 > 15% (reapplication)				

Case 1

Case 2

Table 42.5-2

Concrete Deck/Slab Eligibility Matrix

	NBI Item 58	Top Deck Element Distress Area (%)	Bottom Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from Action	Application Frequency (in years)
Concrete Deck/Slab	6	-	-	Deck Sweeping/Washing	Extend Service Life	1 to 2
		5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
		3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
		-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
		3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
		>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck)	(1140 OR 1150) < 20% for timber deck	Polymer Modified Asphalt Overlay	Improve NBI (58) ≥ 7	10 to 15
		>20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% for concrete deck			
		>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck)	(1140 OR 1150) < 20% for timber deck	HMA w/ membrane	Improve NBI (58) ≥ 7	5 to 15
		>20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% for concrete deck			
		8513 CS3 + CS4 > 15% (reapplication)	1080 < 1%	Thin Polymer Overlay	Service life extended	7 to 15
		>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck)	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
		>20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)				

Case 3

Case 4

	NBI Item 58	Top Deck Element Distress Area (%)	Bottom Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from Action	Application Frequency (in years)
Concrete Deck/Slab	5	5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
		3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
		-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
		3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
		>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck) OR >20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
	4	>20% (3220 OR 8911 CS3 + CS4) OR >15% 3210 (applied to bare deck) OR >20% (3210 OR 8911 CS3 + CS4) OR >50% 3220 (reapplication)	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
	≤ 4	-	1080 > 15% OR 1130 CS3 + CS4 > 50%	Deck Replacement	Improve NBI (58) = 9	25 to 45

Case 5

Case 6

Case 1: Polyester Polymer Concrete (PPC)

B-40-365 IH 41 SB over CNW RR

- Bridge Manual guidance
  - Deck NBI rating ≥ 7
    - Delamination 1080 < 1% of the deck underside
  - Delamination 3210 < 5% of the wearing surface
  - If deck age > 20 years old, test chloride concentration

Note: PPC overlays are expensive and new to WisDOT. As a result, use of PPC overlays should be limited to preservation projects that meet the requirements outlined in Figure 40.5-2 or as approved by the Bureau of Structures.

Case 1: Polyester Polymer Concrete (PPC)

B-40-365 IH 41 SB over CNW RR

- B-40-365 condition
  - ✓ Deck NBI = 7
    - ✓ Delamination 1080 from visual = 0%
  - ✓ Delamination 3210 from IRT = 0%
  - Deck age = 25 years old
    - ✓ Average chloride content = 0.47 lb/cy

Overlay Approved

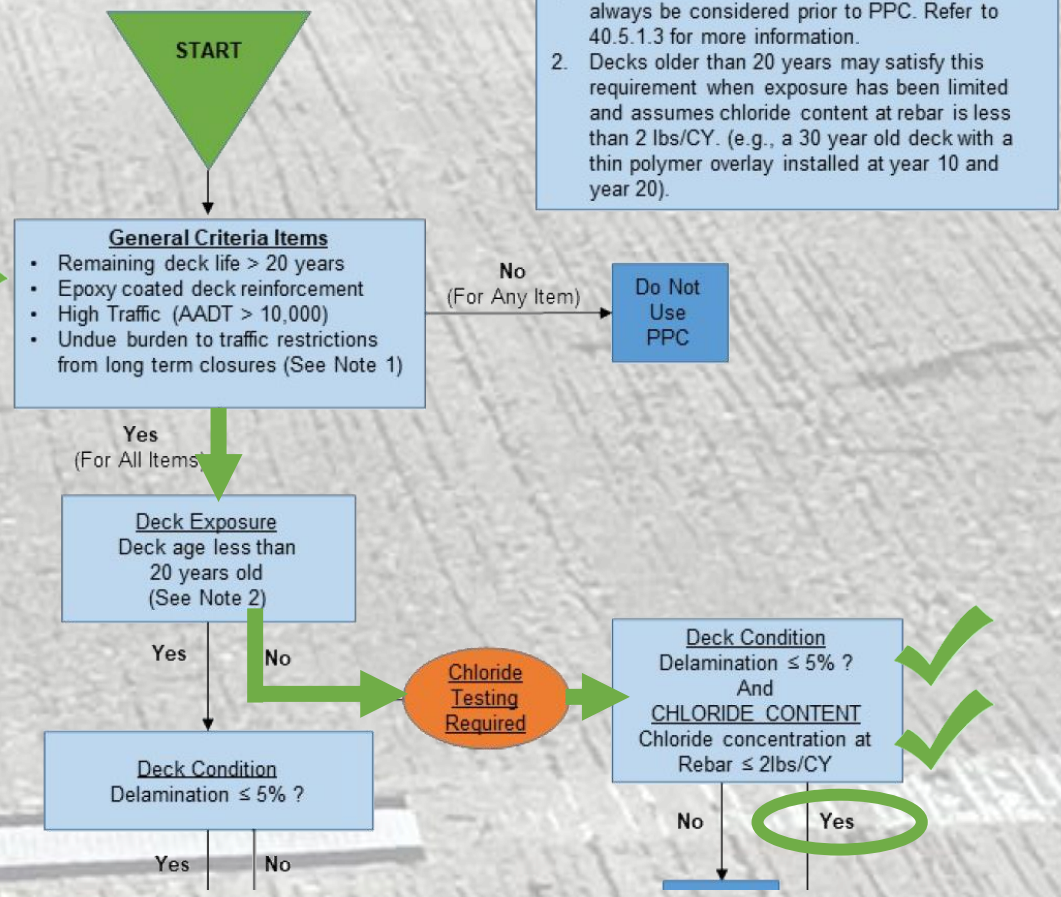


Figure 40.5-2
Polyester Polymer Concrete Overlay Usage Flowchart

Case 2: Thin Polymer Overlay (TPO)

B-18-161 USH 53 NB over Otter Creek

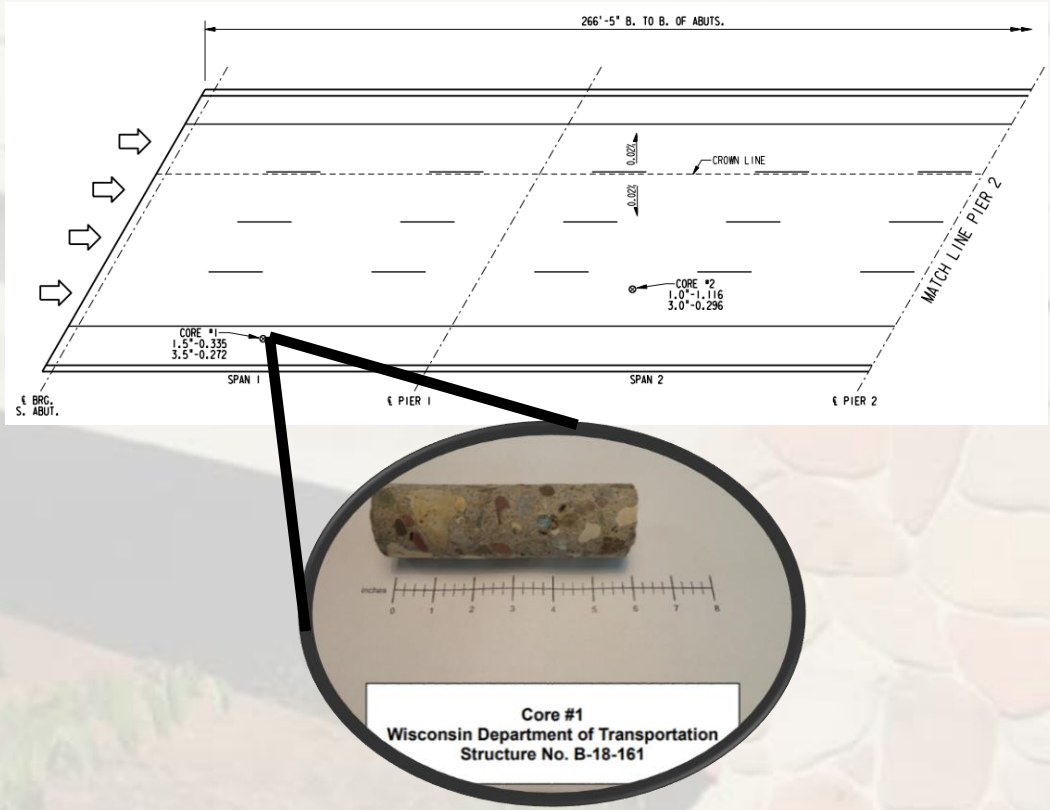
- Bridge Manual guidance
  - Deck NBI rating ≥ 7
    - Delamination 1080 < 1% of the deck underside
  - Delamination 3210 < 2% of the wearing surface
  - If deck age > 10 years old, test chloride concentration

Case 2: Thin Polymer Overlay (TPO)

B-18-161 USH 53 NB over Otter Creek

- B-18-161 condition
  - ✓ Deck NBI = 7
    - ✓ Delamination 1080 from visual = 0%
  - ✓ Delamination 3210 from IRT = 0%
  - Deck age = 16 years old
    - ✓ Average chloride content = 0.45 lb/cy

Overlay Approved



Case 3: Re-application of TPO

B-49-82 STH 13/34 over Mill Creek

- Bridge Manual guidance
  - Deck NBI rating ≥ 6
    - Delamination 1080 < 1% of the deck underside
  - Delamination (concrete below TPO) < 2% of the wearing surface
  - Debonding/spalling of existing TPO 8513 > 15% (projected)
  - Test chloride concentration < 2 lb/cy at rebar level

Case 3: Re-application of TPO

B-49-82 STH 13/34 over Mill Creek

Elements

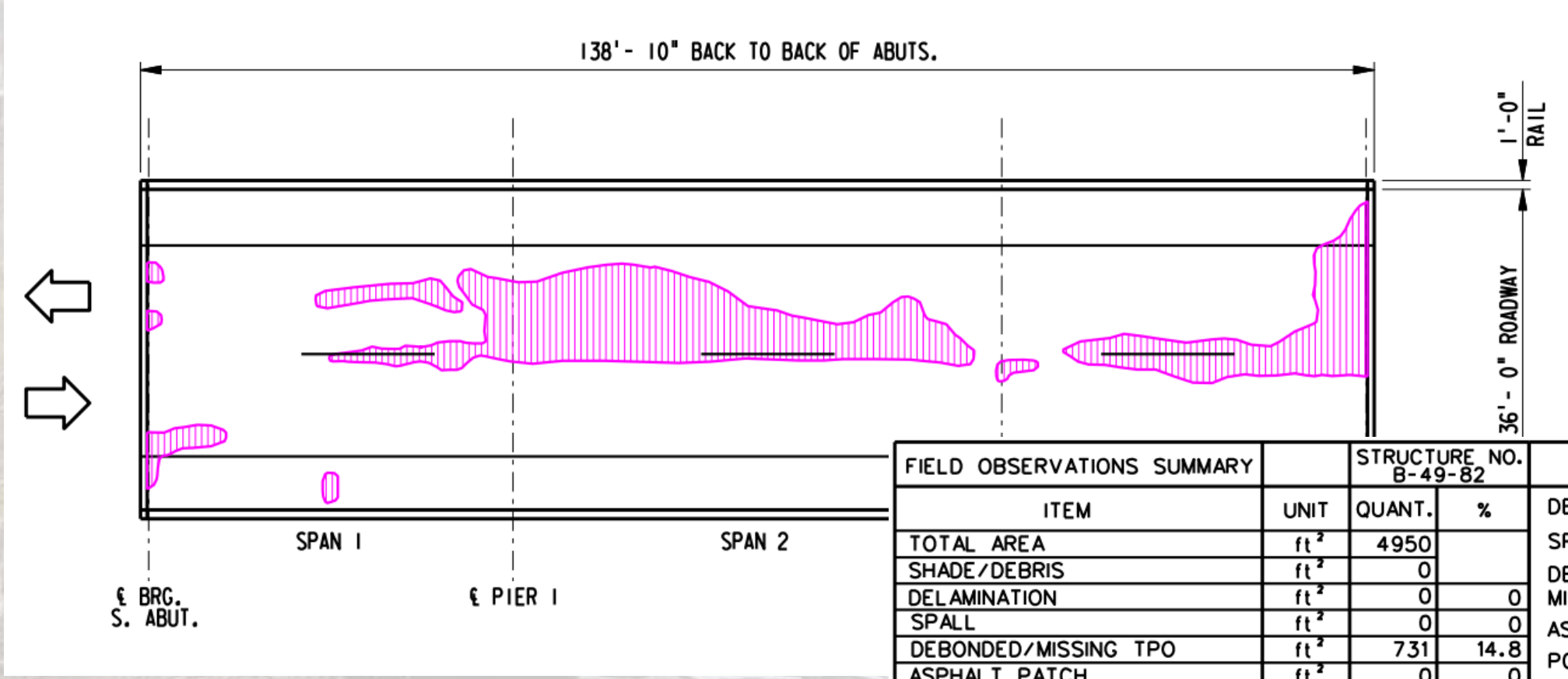
Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	38		**Reinforced Concrete Slab** 1994. **STAINLESS DRIP EDGE INSTALLED 2020/21. GOOD CONDITION.**	SF	5,225	4,906	297	22	0
		1080	Delamination - Spall - Patched Area SM SPALL NW CORNER NEAR JOINT; 1 SF C2 SPAN2: 2 SPALLS 1X1 ON W FACE UNDER POST NEAR PIER 2;1 SF C2, AND NEAR PIER 1; 1 SF C3. SPALL ON EAST FACE UNDER POST NEAR PIER 2; 1 SF C3.	SF		0	2	2	0
		1130	Cracking (RC) SPAN1: LONGIT @CL W/LT EFFL; 40 SF C2. 2 DIA CRKS W/EFFL; 40 SF C2. LONGIT @W DRIP EDGE; 20 SF C2. LONGIT @E DRIP EDGE; 15 SF C2. SPAN2: LONGIT @CL W/LT EFFL; 55 SF C2. E BOTTOM EDGE MIDPT LONGIT W/TRANSV; 20 SF C3. W BOTTOM EDGE MIDPT; 25 SF C2. SPAN3: DIAG NE & NW; 40 SF C2. LONGIT @CL W/LT EFFL; 40 SF C2. LONGIT W/TRANSV CRK @EAST SIDE MIDSPAN; 20 SF C2.	SF		0	295	20	0
	8513		Thin Polymer Overlay HISTORICAL ONLY: CONCRETE SCALLING AT SE CORNER,EAST OF DRIVING LANE COVERED WTH POLYMER. POLYMER OVERLAY,FLEXOLITH, 2013	SF	5,225	**5,189**	0	**36**	0
		3210	Debonding/Spall/Patched Area/Pothole **10'X3'** DELAM/**SPALL** IN NB LANE NEAR SOUTH END IN RT WHEEL PATH, **30**SF C3. **1'x6' SPALL ALONG NORTH END IN SB LN. 6' C3**	SF		0	0	**36**	0

b49-082_21_Rd12.jpg

Linked Element(s):
Reinforced Concrete Slab -> Thin Polymer Overlay

Case 3: Re-application of TPO

B-49-82 STH 13/34 over Mill Creek



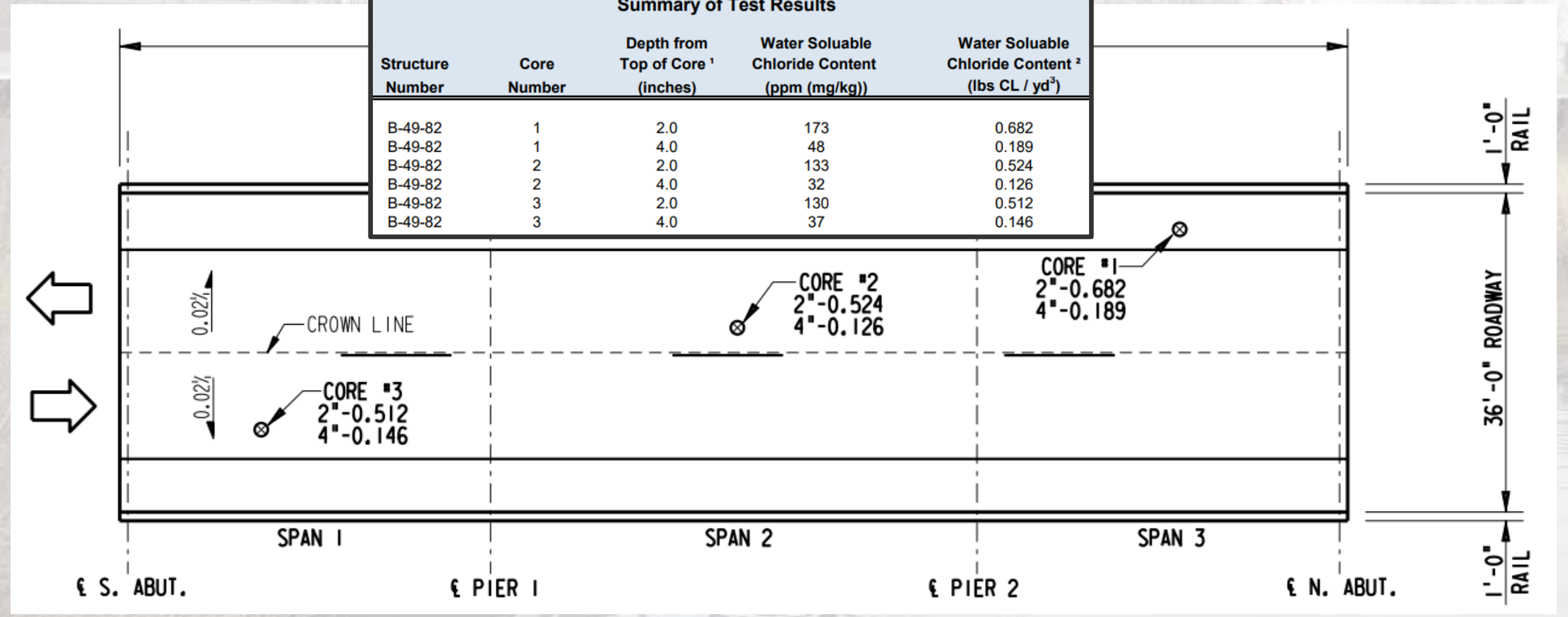
FIELD OBSERVATIONS SUMMARY		STRUCTURE NO. B-49-82		LEGEND
ITEM	UNIT	QUANT.	%	DELAMINATION
TOTAL AREA	ft^2	4950		SPALL
SHADE/DEBRIS	ft^2	0		DEBONDED/ MISSING TPO
DELAMINATION	ft^2	0	0	ASPHALT PATCH
SPALL	ft^2	0	0	PCC PATCH
DEBONDED/MISSING TPO	ft^2	731	14.8	SHADE/DEBRIS
ASPHALT PATCH	ft^2	0	0	
PCC PATCH	ft^2	0	0	

Case 3: Re-application of TPO

B-49-82 STH 13/34 over Mill Creek

Summary of Test Results

Structure Number	Core Number	Depth from Top of Core [1] (inches)	Water Soluable Chloride Content (ppm (mg/kg))	Water Soluable Chloride Content [2] (lbs CL / yd^3)
B-49-82	1	2.0	173	0.682
B-49-82	1	4.0	48	0.189
B-49-82	2	2.0	133	0.524
B-49-82	2	4.0	32	0.126
B-49-82	3	2.0	130	0.512
B-49-82	3	4.0	37	0.146

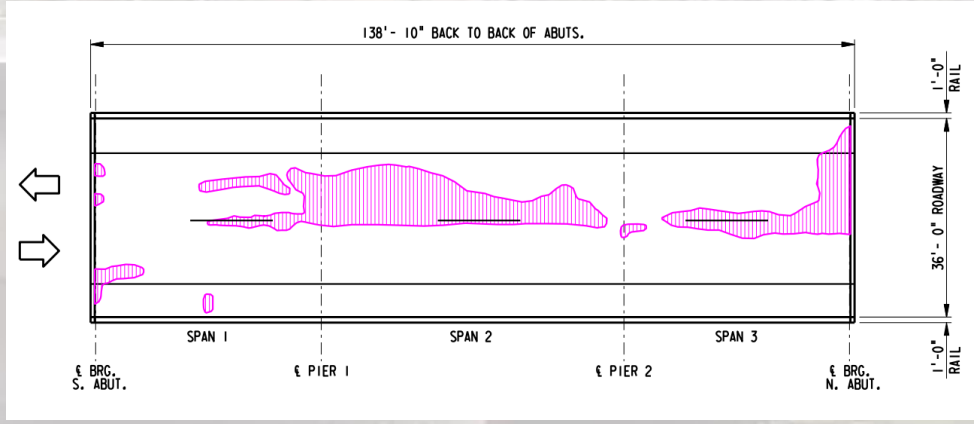


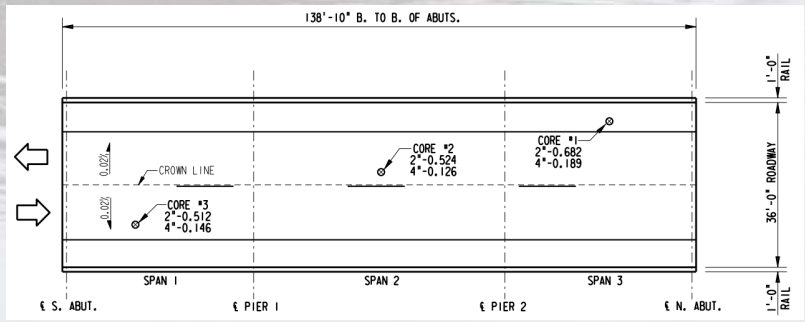
Case 3: Re-application of TPO

B-49-82 STH 13/34 over Mill Creek

- B-49-82 condition
  - ✓ Deck NBI = 7
    - ✓ Delamination 1080 from visual < 0.1%
  - ✓ Delamination in concrete from IRT = 0%
  - ✓ Debonding/spalling of existing TPO from IRT = 14.8%
  - ✓ Average chloride content = 0.36 lb/cy

Overlay Approved





Case 4: Concrete Overlay

B-11-8 STH 13 over Waubeek Road

- Bridge Manual guidance
  - Deck NBI rating ≥ 6
    - Delamination 1080 < 5% of the deck underside
  - Delamination 3210 > 15% of the bare wearing surface (ADE 8000)

Case 4: Concrete Overlay

B-11-8 STH 13 over Waubeek Road

- 2020 – Inspector only recorded 16 SF spalling found by visual inspection (36 year old deck)

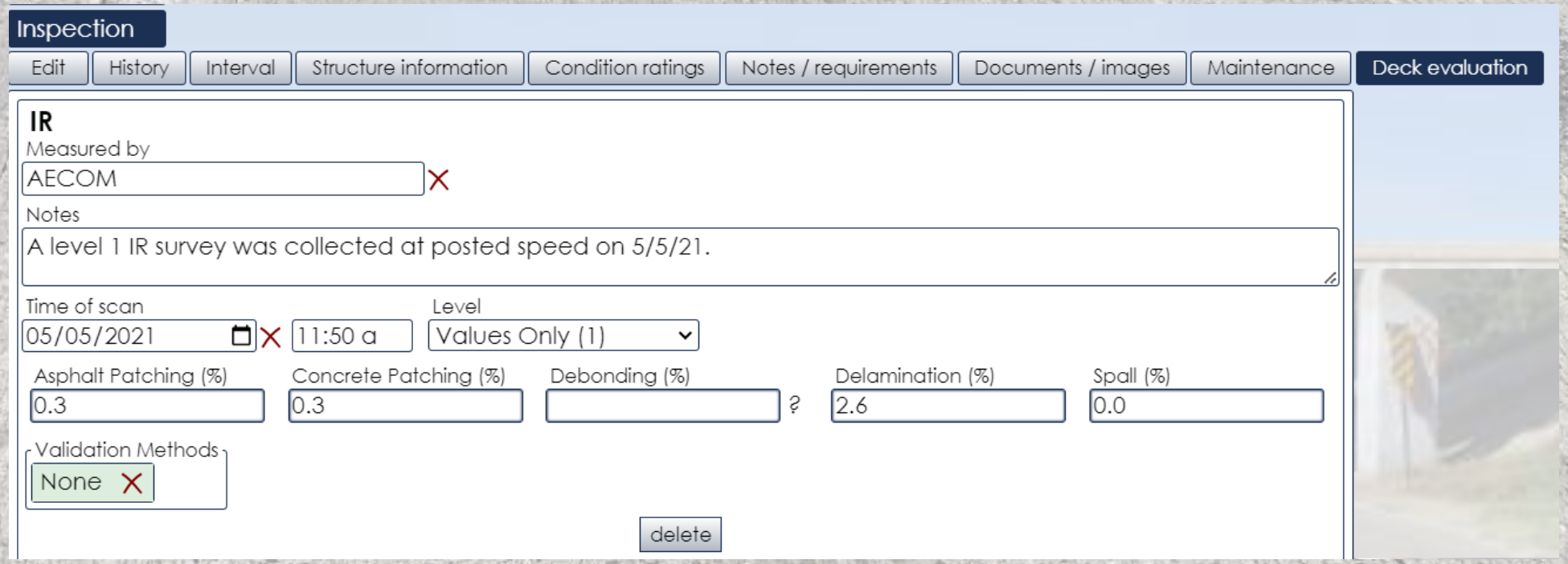
Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	**12**		**Reinforced Concrete Deck-Coated Reinforcing**	SF	4,190	3,716	472	2	0
		1080	Delamination - Spall - Patched Area Under side of deck at SW and NE corners 2' CS3 **(PIC)**	SF		0	0	2	0
		1130	Cracking (RC) Leaching transverse cracks in all 3 spans.	SF		0	472	0	0
	8000		Wearing Surface (Bare)	SF	3,842	**3,673**	**100**	**69**	0
		3210	Debonding/Spall/Patched Area/Pothole Spalls in SB lane. **(PICS)**	SF		0	0	**16**	0
		3220	Crack (Wearing Surface) Both end blocks need repair. Transverse and longitudinal cracks at ends.	SF		0	**100**	**53**	0

Case 4: Concrete Overlay

B-11-8 STH 13 over Waubeek Road

- 2020 – Inspector only recorded 16 SF spalling
- 2021 – IRT recommends adding 111 SF CS2 delamination and concrete patching and 12 SF CS3 asphalt patching



Case 4: Concrete Overlay

B-11-8 STH 13 over Waubeek Road

- 2020 – Inspector only recorded 16 SF spalling
- 2021 – IRT recommends adding CS2 qty
- 2022 – Inspector added 111 SF of CS2 delamination (assumes areas of CS3 overlap)

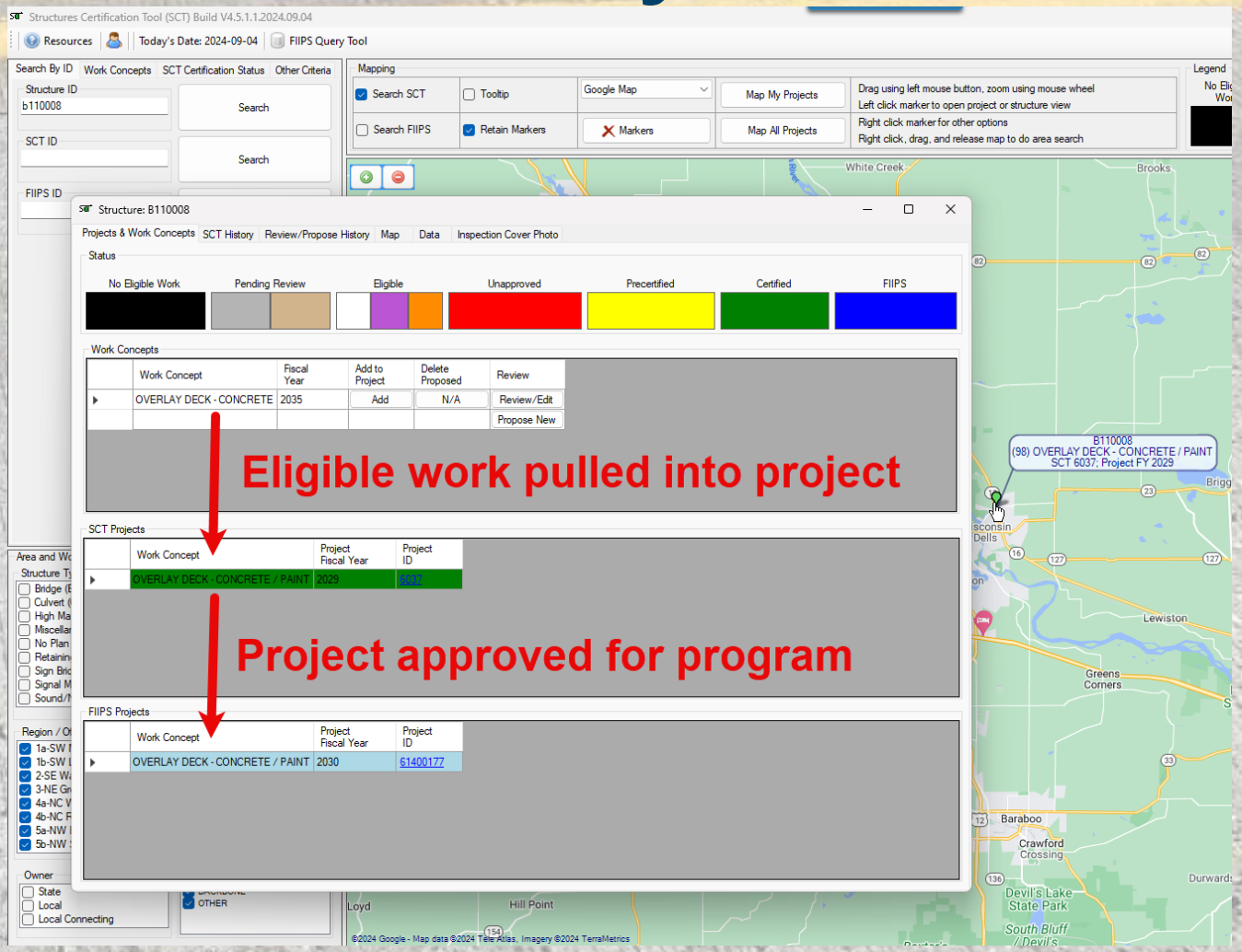
Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	**12**		**Reinforced Concrete Deck-Coated Reinforcing**	SF	4,190	**3,715**	472	**3**	0
		1080	Delamination - Spall - Patched Area Under side of deck at SW and NE corners 2' CS3.	SF		0	0	2	0
		1130	Cracking (RC) Leaching transverse cracks in all 3 spans. **Heavy efflorescence under SE corner of deck.**	SF		0	472	**1**	0
	8000		Wearing Surface (Bare)	SF	3,842	**3,562**	**211**	69	0
		3210	Debonding/Spall/Patched Area/Pothole Spalls in SB lane. **May 2021 Level 1 IR deck survey indicates 0.3% asphalt patching, 0.3% concrete patching, 2.6% delamination and no spalling.**	SF		0	**111**	16	0
		3220	Crack (Wearing Surface) Both end blocks need repair. Transverse and longitudinal cracks at ends.	SF		0	100	53	0

Case 4: Concrete Overlay

B-11-8 STH 13

- Visual only inspection
  - No work action
- Visual with IRT results
  - 2035 concrete overlay



Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- Bridge Manual guidance
  - Deck NBI rating ≥ 5
    - Delamination 1080 < 5% of the deck underside
  - Delamination 3210 > 20% of the existing concrete overlay (ADE 8514)

Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- April 2021 – Inspector only recorded 154 SF delamination estimated by partial chaining

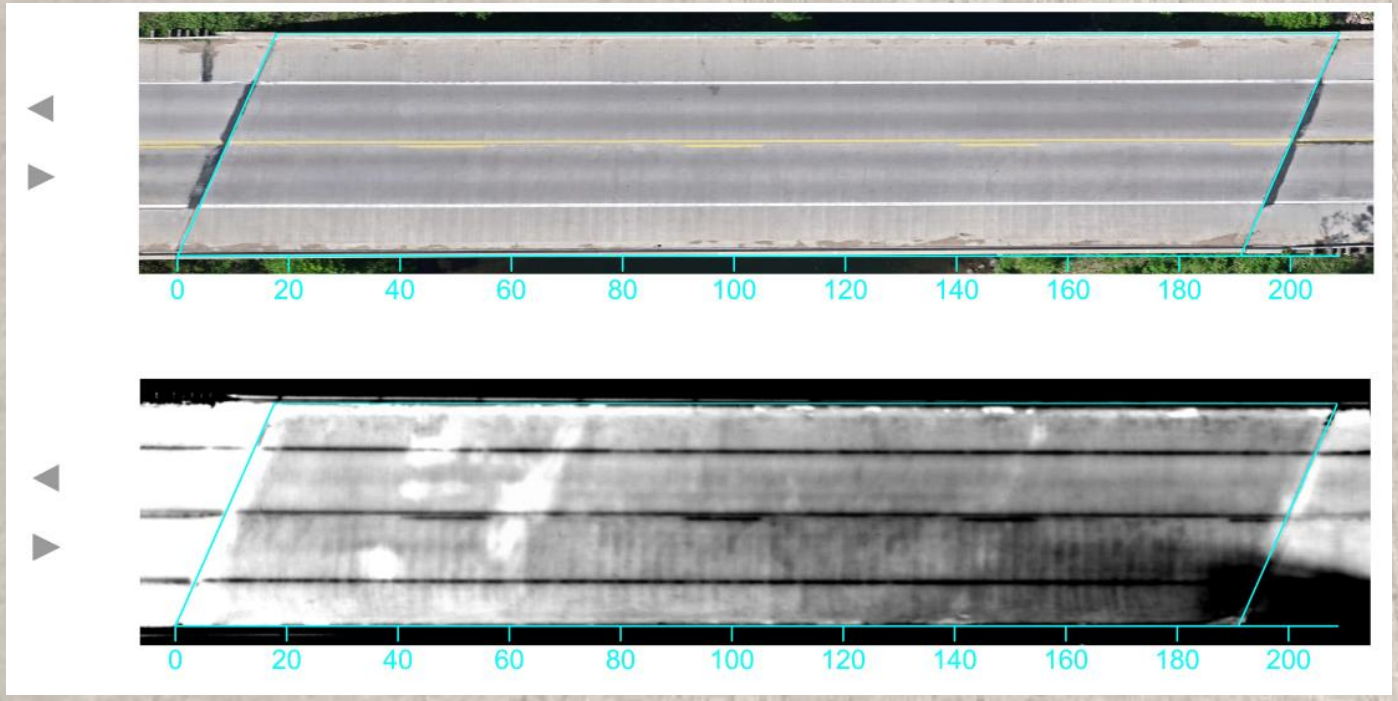
Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	**12**		**Reinforced Concrete Deck** concret overlay 2004	SF	8,255	8,071	184	0	0
		1130	Cracking (RC) 8/10/2015 See attached drawings. 2017 Hairline cracking est 25% of deck.	SF		0	184	0	0
	8514		Concrete Overlay concrete overlay 2004	SF	8,255	**7,509**	711	**35**	0
		3210	Debonding/Spall/Patched Area/Pothole 8/10/2015 See attached drawings. 2019 Estimate 1% delaminations from chaining the shoulders.	SF		0	154	0	0
		3220	Crack (Wearing Surface) 8/10/2015 See attached drawings. **CS3 transverse south end.**	SF		1,654	557	**35**	0

Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- April 2021 – Inspector only recorded 154 SF delamination estimated by partial chaining
- June 2021 – Aerial IRT recommends adding 657 SF CS2 delamination



Quantity Summary	
Delamination Quantity (%)	11
Delamination Quantity (ft^2)	811

Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- April 2021 – Inspector only recorded 154 SF delamination estimated by partial chaining
- 2022 – Vehicle IRT confirms and refines aerial IRT results, recommends adding 757 SF CS2 delamination

STRUCTURE NO.: B-65-18

LEVEL 1 IR INSPECTION SHEET

SURFACE TYPE - YEAR
Concrete Overlay - 2004

ESTIMATED % TOTAL DISTRESS*: 11.9%

DATE - TIME OF SURVEY	HSI TOTAL ROADWAY AREA (sq. ft.)	AREA IN SHADE/DEBRIS (sq. ft.)	HSI AREA INSPECTED (sq. ft.)
7/29/2022 - 2:20 PM	7,668	0	7,668

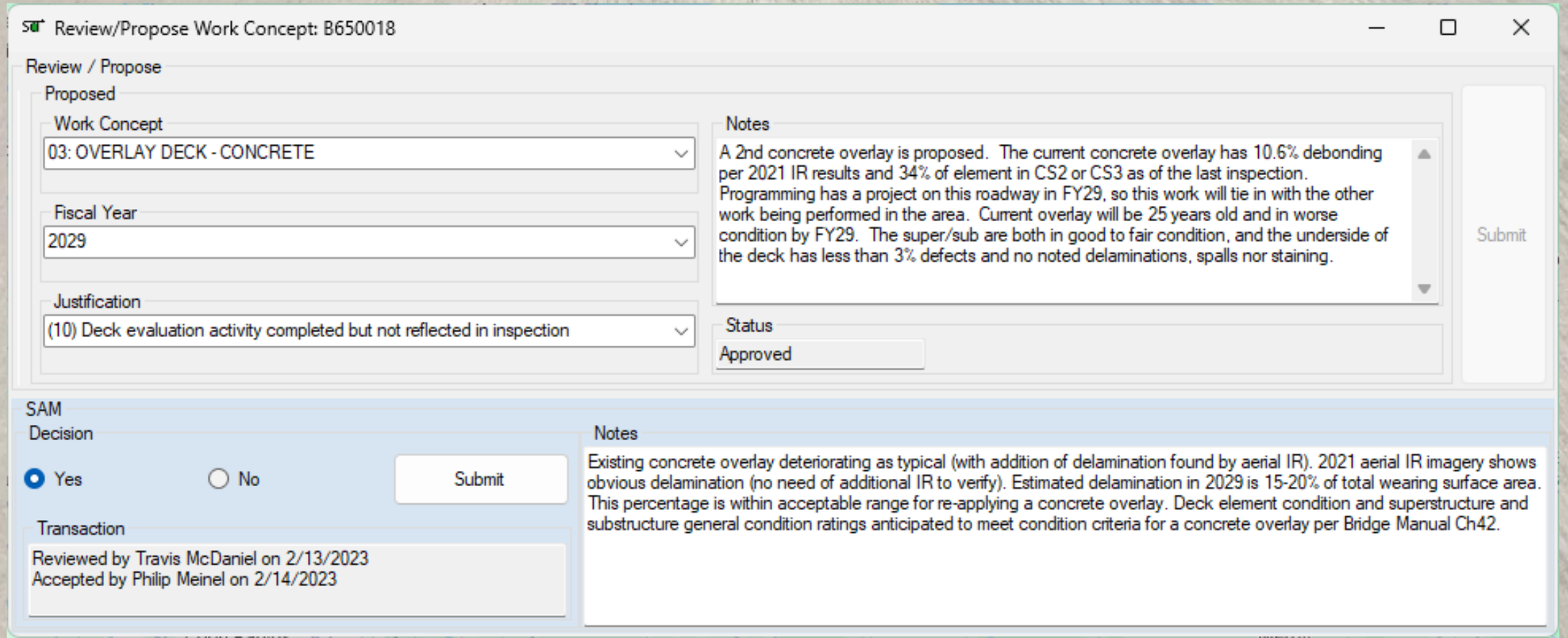
WEATHER
Temperature: 80
Condition: Partly Cloudy

	TYPE OF DEFECT					
	Asphalt Patching	Concrete Patching	Debonding	Delamination	Spalling	Sounding Y/N
SF	0	0	0	911	0	N
% OF AREA INSPECTED	0.0%	0.0%	0.0%	11.9%	0.0%	
COMMENTS:	Plow damage at joints					

Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- Immediate review and programming of work



Case 5: Re-application of Concrete Overlay

B-65-18 STH 48 over Red Cedar Narrows

- 2021 – Inspector only recorded 154 SF delamination estimated by partial chaining
- 2022 – Vehicle IRT confirms and refines aerial IRT results, recommends adding 757 SF CS2 delamination
- 2023 – Inspector records additional CS2 delamination

8514		Concrete Overlay concrete overlay 2004	SF	7,668	4,354	3,012	302	0
	3210	Debonding/Spall/Patched Area/Pothole **2022 Deck IR Recommends CS2= 912 SF for** delaminations. **Two 1x1 shallow spalls Span 1 south** shoulder. **2x2** delam**ination, EB Lanes Span 2 Midspan.**	SF		0	912	0	0
	3220	Crack (Wearing Surface) CS3 transverse cracks at both ends **of bridge** adjacent to joints **-** full width. **CS3= 86 SF** SW edge 2 narw diagonals. **CS2= 20 SF; Same NE. CS2= 20 SF.** **Minor pattern** cracking **over P1 and P2, 10ft each side. 10% CS3. CS2= 1547 SF; CS3= 173** **Narrow** transverse **cracks (4 in span 1, 4 in span 2, 3 in span 3) full width. CS2= 473 SF** **Pattern cracking east end, south shoulder. CS2= 40 SF** **Wide transverse cracks WB lane, Span 2 at PPT Relief joint. CS3= 43 SF.**						

Case 5: Re-application of Concrete Overlay

B-65-18 STH 48

- Visual/partial chaining
  - No work action
- Visual with IRT results
  - 2030 concrete overlay

Structure: B650018

Projects & Work Concepts | SCT History | Review/Propose History | Map | Data | Inspection Cover Photo

Status

No Eligible Work	Pending Review	Eligible	Unapproved	Precertified	Certified	FIIPS

Work Concepts (***Review/Propose History***)

Work Concept	Fiscal Year	Add to Project	Delete Proposed	Review
OVERLAY DECK - CONCRETE	2030	Add	N/A	Review/Edit
OVERLAY DECK - CONCRETE	2029	Add	Delete	Review/Edit
				Propose New

Eligible work pulled into a project

SCT Projects

Work Concept	Project Fiscal Year	Project ID
OVERLAY DECK - CONCRETE	2030	6079

Project approved for program

FIIPS Projects

Work Concept	Project Fiscal Year	Project ID
OVERLAY DECK - CONCRETE	2032	85700072

Case 6a: Replace Deck

B-27-44 IH 94 WB over UP RR

- Bridge Manual guidance
  - Deck NBI rating ≤ 4
  - Delamination 1080 > 15% of the deck underside
    - What? How? NDE?
      - Mostly visual
        - Added agency defect 8904 Discoloration
      - Performing more sounding verification
      - Piloting underdeck IRT

Case 6a: Replace Deck

B-27-44 IH 94 WB over UP RR

- 2017 – Visual inspection
  - Deck rating = 4
  - 1080 delam/spalling = 27%
  - 3210 debond/delam = 0.3%

NBI Ratings

	File	New
Deck	4	4
Superstructure	5	5
Substructure	7	6
Culvert	N	N
Channel	N	N
Waterway	N	N

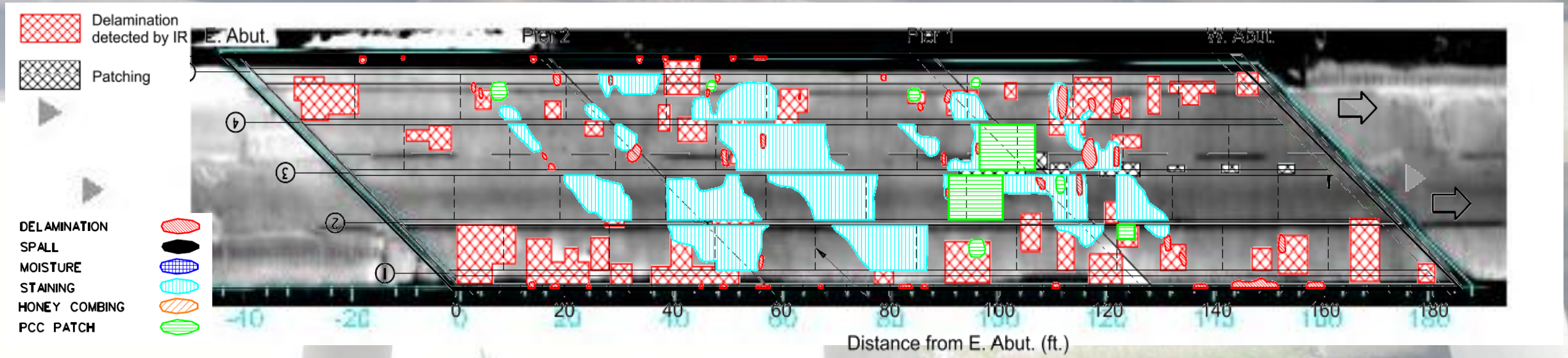
Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	12		**Reinforced Concrete Deck**	SF	8,018	1,800	5,018	1,200	0
			Few transverse / longitudinal / map cracks throughout.						
		1080	Delamination - Spall - Patched Area	SF		0	2,000	200	0
			Span 1: 3'x4' delam/spall in Bay 2 next to west abutment. Multiple areas of delam/deterioration above P1. Span 2: 2-2'x2' Full Depth patches in Bay 4. 3'x3' full depth patch in Bay 1. Span 3: 4'x4' Full Depth patch Bay 4. Heavy delam/cracking over piers and under sawcut deflection joints. Large areas of delam and spalling. Bottom of deck is wet and punky under sawcut joints.						
		1130	Cracking (RC)	SF		0	3,018	1,000	0
			Few locations of heavy map cracking/discoloration. Heavier cracking over piers.						
	8514		Concrete Overlay	SF	8,018	3,493	4,000	525	0
		3210	Debonding/Spall/Patched Area/Pothole	SF		0	0	25	0
			2x3 spall along sawcut joint near pier 1. Multiple AC patched spalls at sawcuts.						
		3220	Crack (Wearing Surface)	SF		0	4,000	500	0
			Transverse / longitudinal / map cracks throughout.						

Case 6a: Replace Deck

B-27-44 IH 94 WB over UP RR

- 2021 – Wearing surface IRT estimates 16% debonding/delamination of concrete overlay
- 2022 – Underside deck IRT estimates 3.8% delam/patch and 13.3% staining



Case 6a: Replace Deck

B-27-44 IH 94 WB over UP RR

- 2023 – Visual inspection
  - Deck rating = 4
  - 1080 delam/spalling = 18%
  - 3210 debond/delam = 27%

NBI Ratings

	File	New
Deck	4	4
Superstructure	5	5
Substructure	7	6
Culvert	N	N
Channel	N	N
Waterway	N	N

Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	12		**Reinforced Concrete Deck - Black Steel Reinforcing**	SF	8,018	**2,969**	**4,047**	**1,002**	0
			Slope paving and ground under Pier 1 is covered in concrete powder and chlorides that are washing through deck at spalling/delam areas. (See picture) Heavy leaching through deck.						
		1080	Delamination - Spall - Patched Area	SF		0	**1,029**	**402**	0
			Span 1: **bays 3 and 4** areas of delamination **and spalling. (100SF=CS2, 2SF=CS3)** Span 2: 2-2'x2' Full Depth patches in Bay 4. 3'x3' full depth patch in Bay 1. **(13SF=CS2)** Span 3: 4'x4' Full Depth patch Bay 4. **(16SF=CS2)** Heavy delam/cracking over piers and under sawcut deflection joints. Large areas of delam and spalling. Bottom of deck is wet and punky under sawcut joints. **(900SF=CS2, 400SF=CS3)**						
		1130	Cracking (RC)	SF		0	3,018	600	0
			Locations of heavy map cracking/discoloration. 15' each side of pier. (3018SF=CS2, 600SF=CS3)						
		8904	Discoloration	SF		0	0	200	200
			Large areas of discoloration over both piers. Evidence of heavy leaching at both areas. See pictures Worst area is over pier 1, near centerline, below deck spall on surface.						
	8514		Concrete Overlay	SF	7,445	**2,457**	**3,861**	**1,127**	0
		3210	Debonding/Spall/Patched Area/Pothole	SF		0	**1,861**	**127**	0
			Multiple **asphalt** patched spalls at sawcuts **and east deck ends.** **1861SF=CS2 and 127SF=CS3** from **6/16/2022** IR **deck evaluation**						
		3220	Crack (Wearing Surface)	SF		0	2,000	1,000	0
			Heavy Transverse / longitudinal / map cracks throughout. **(200SF=CS2, 1000SF=CS3)**						

Case 6a: Replace Deck

B-27-44 IH 94 WB over UP RR

- B-27-44 condition
  - ✓ Deck NBI rating = 4
  - ✓ Delamination 1080 = 18% of the deck underside

Deck Replacement Approved

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- Original scope of work proposed prior to 2018
  - Prevailing engineering judgement estimated 40-50 year service life for bridge decks
  - Deck would be 46 years old at time of project

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- Bridge Manual guidance for deck replacement
  - Deck NBI rating ≤ 4
  - Delamination 1080 > 15% of the deck underside

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- 2018 – Visual inspection
  - Deck rating = 5
  - 1080 delam/spalling = 0.3%
  - 3210 debond/delam = 16%
    - 10-15% estimate from 2016 IRT

NBI Ratings

	File	New
Deck	5	5
Superstructure	6	6
Substructure	7	7
Culvert	N	N
Channel	N	N
Waterway	N	N

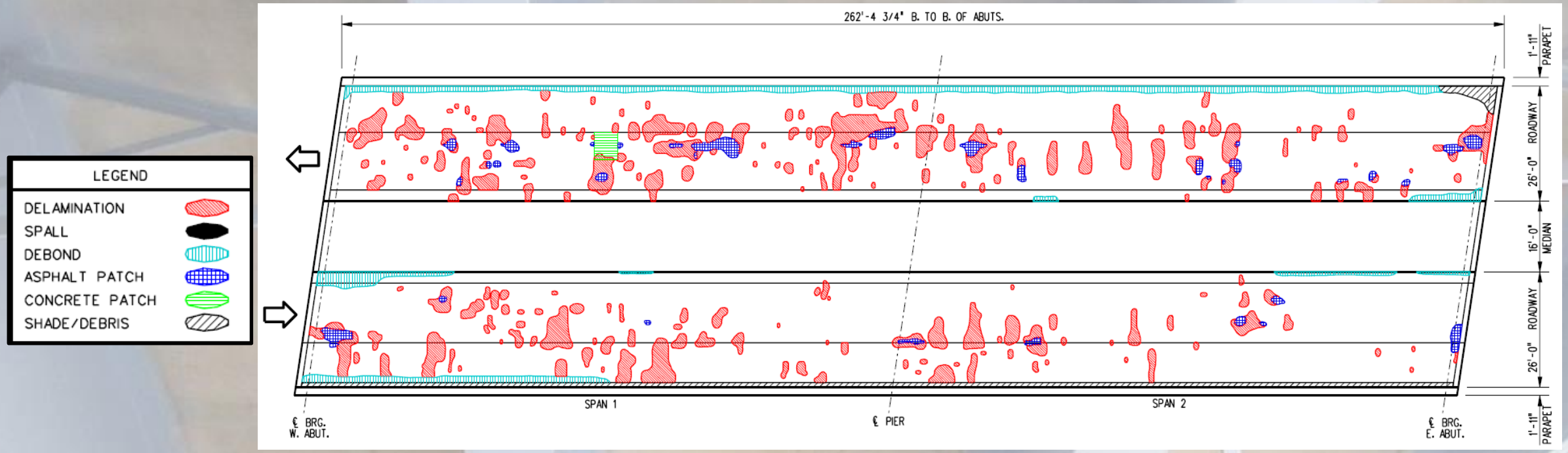
Elements

Chk	Element	Defect	Description	UOM	Total	Quantity in Condition State 1	2	3	4
X	12		**Reinforced Concrete Deck-Black Steel Reinforcing**	SF	18,754	17,746	959	49	0
			Moisture on bottom of deck various locations. 2 spans numbered W to E.						
		1080	Delamination - Spall - Patched Area	SF		0	5	49	0
			Span 1: : NW corner of bridge at joint with rust staining (3 SF CS3); SW corner of deck at joint with rust staining (2 SF CS3); CS3 delam **btwn G2/G3 at pier.** **Span 2: CS2 delam btwn G6/G7 at diaphragm near pier and CS2 delam btwn G1/G2 near pier; CS3 Spall 4'x1' btwn** G1/G2 over NB **Lane 1, CS3 Delam 2'x2' over NB lane 1, CS3 delam btwn G7/G8 near pier; CS3 spall 1'x4' btwn G2/G3 over NB lane 1 with exposed rebar; CS3 spall 1'x3' btwn G3/G4 over NB lane 1 with exposed rebar; CS3** spall btwn G6/G7 over NB **lane 1 with exposed rebar (1 SF).** **Typical scattered locations with CS2 (3SF) and CS3 (26SF) delams and** spalls a**t edge of** girder **flanges in both spans.**						
		1130	Cracking (RC)	SF		534	954	0	0
			HL-narrow trans crks**, some** w/ effl**, some areas with HL map cracking.**						
	8512		AC Overlay w/ Membrane	SF	13,583	9,828	1,119	2,636	0
		8911	Abrasion, Wear, or Rutting (Wear. Surf.)	SF		0	90	0	0
			Overlay surface shows some minor abrasion throughout. Loss of surface <1" deep over the diagonal paint marks in the shoulders, on the edge and yellow lane lines, and scattered locations throughout the bridge.						
		3210	Debonding/Spall/Patched Area/Pothole	SF		0	94	2,053	0
			2016 IR 10-15% delam **and** <2% AC Patch **noted on IR inspection "Numerous large delaminations observed throughout the deck." [15% x 13583 SF = 2037 SF CS3 delams]. Scattered bituminous patches, heavier on the WB side of the bridge 94 SF. Numerous small** patches **over a large area coded as 15 SF CS3. Large** pothole **1 SF CS3.**						
		3220	Crack (Wearing Surface)	SF		0	935	583	0
			Numerous narrow-med trans & longit. crks**. Large map cracked areas in the wheel paths on the WB traffic lane of the bridge. CS2 cracking for an average length of 2' at the edge line toward the shoulder for the length of the bridge. Medium longitudinal cracking in the wheel paths of the WB traffic side.**						

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- 2019 – Wearing surface IRT estimates 17.2% debond/delam/patch

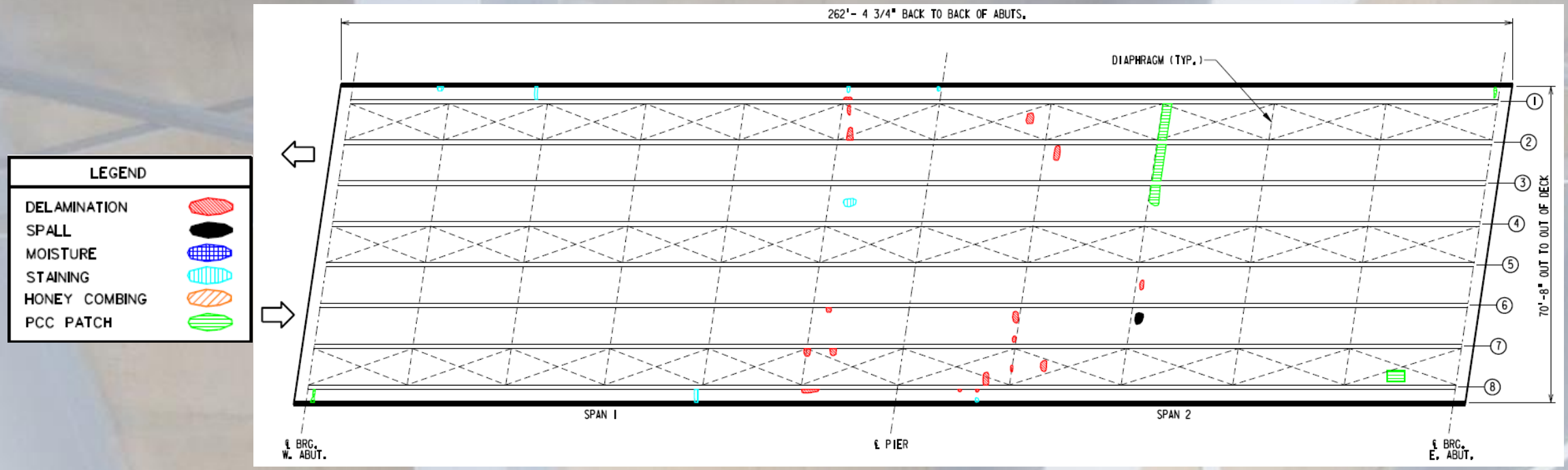


03/22/2022

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- 2022 – Underside IRT estimates 0.5% delam/spall/patch



03/22/2022

Case 6b: Replace Deck down-scoped to Concrete Overlay

B-45-55 CTH D over IH 43

- Bridge Manual guidance for deck replacement
  - ✗ Deck NBI rating ≤ 4
  - ✗ Delamination 1080 > 15% of the deck underside
- Bridge Manual guidance for concrete overlay
  - ✓ Deck NBI rating ≥ 5
    - ✓ Delamination 1080 < 5% of the deck underside
  - ✓ Delamination 3210 > 20% of the existing AC overlay (ADE 8512)

Concrete Overlay Approved

03/22/2022

Programmatic Savings with NDE

Transition scoping methodology from typical service life to projected component and element condition

- 2017 full program review provided a rare opportunity to compare different scoping methods
  - Estimated project savings of $24M per year
    - Avoiding unnecessary overlays, deck replacements, and even full replacements with improved element condition estimates from NDE
  - Redirect funds to preservation activities
    - In 2019-2021, funds were redirected toward thin polymer overlay applications

Thank you!

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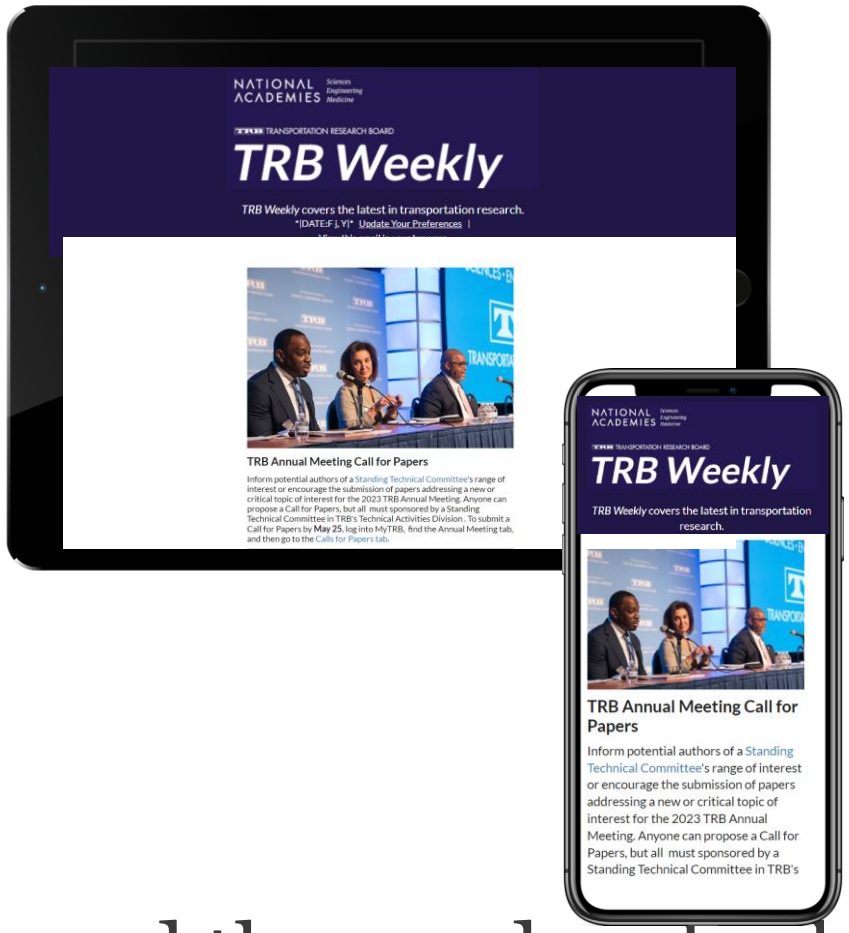

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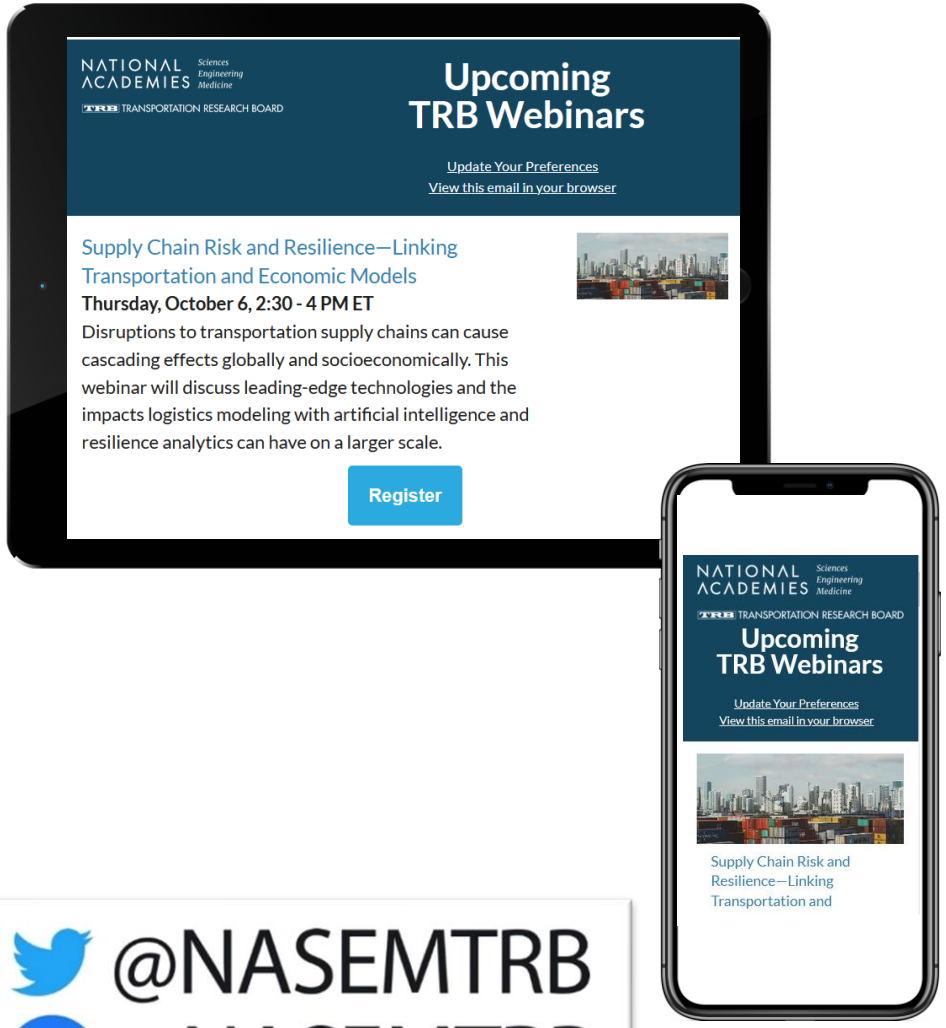

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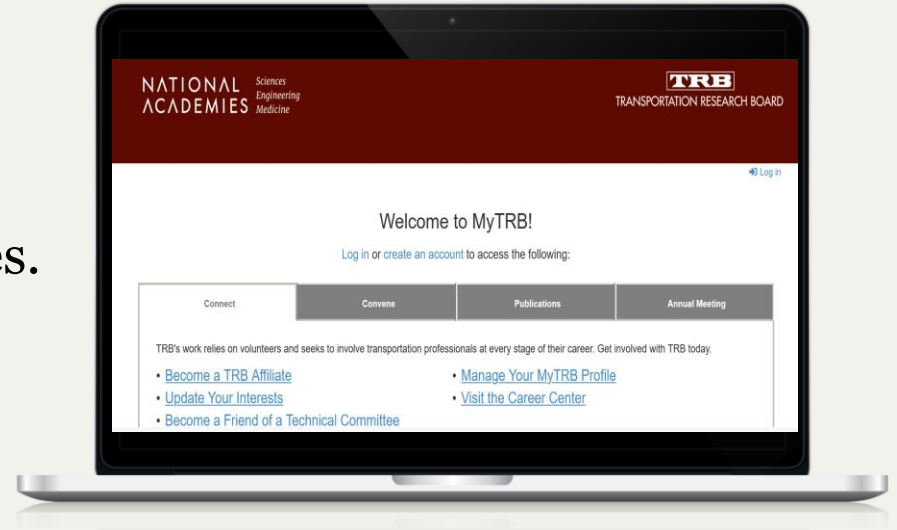

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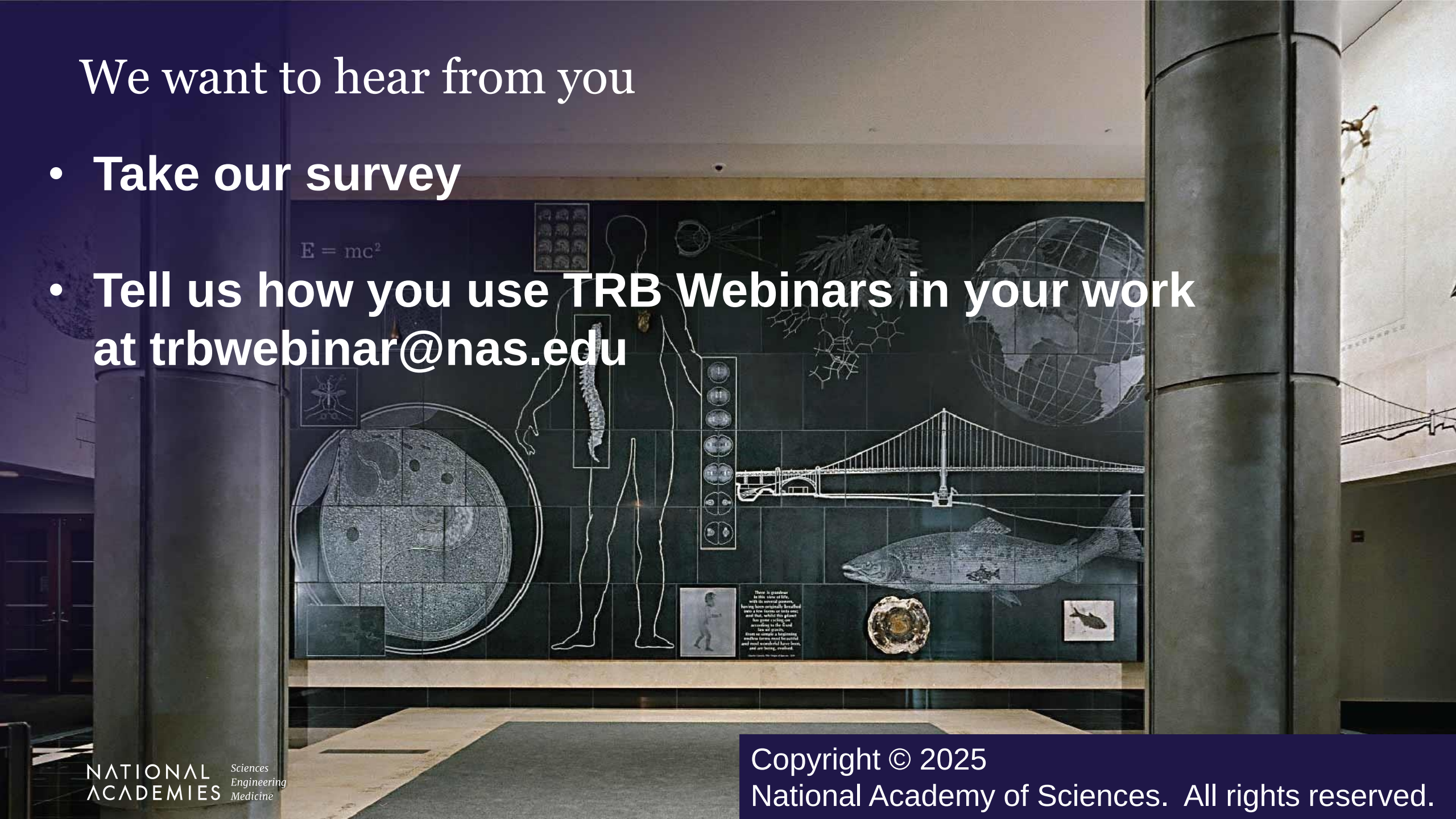

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