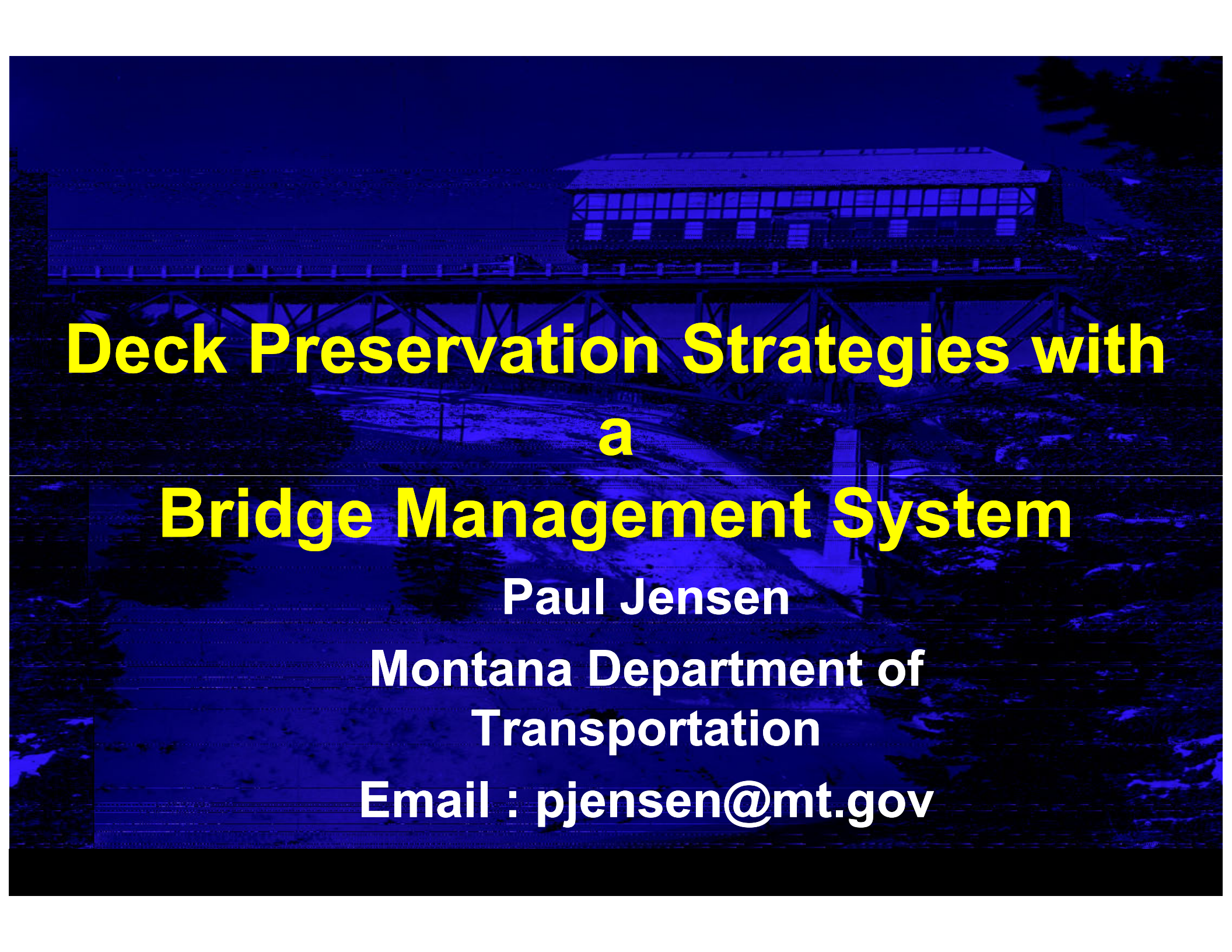
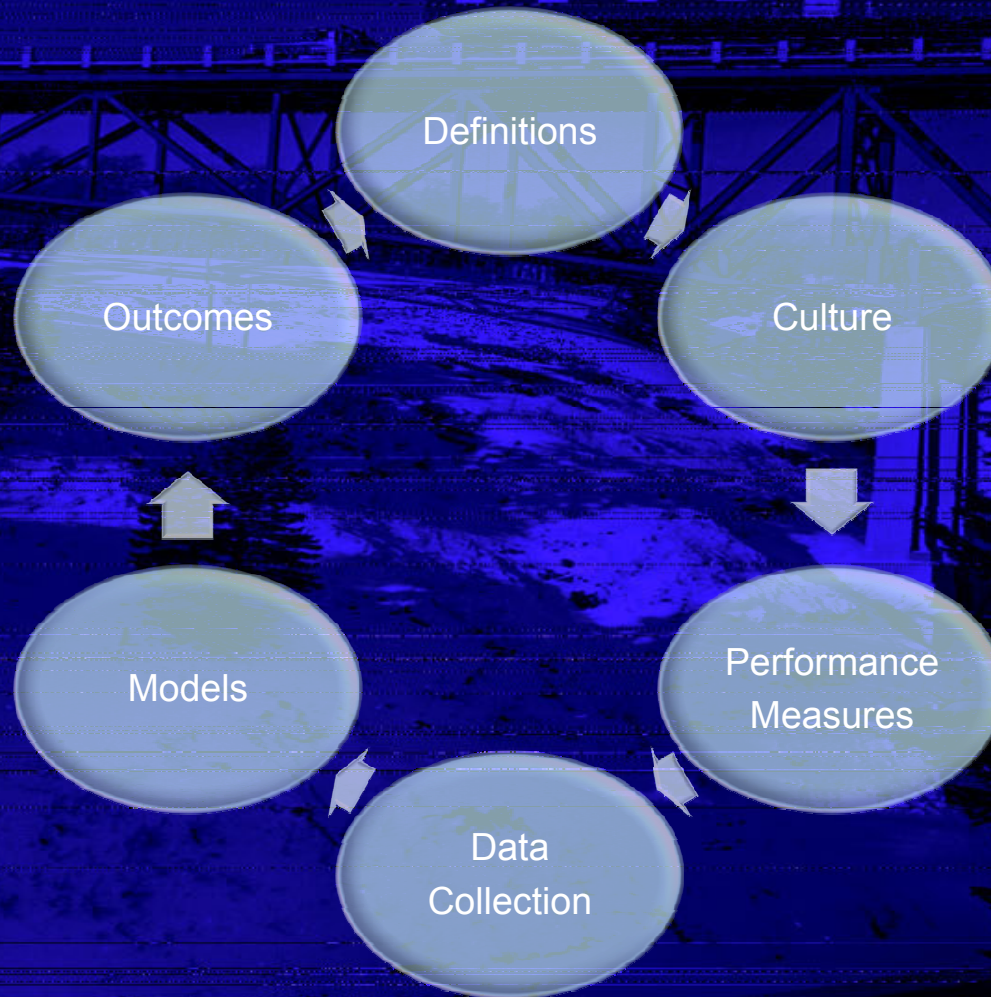




Deck Preservation Strategies with a Bridge Management System

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Development Of A Roadmap



Everyone On The Same Page

Definitions

- ❖ New Construction
- ❖ Preservation Includes (Deck, Super, Sub)
 - ❖ Preventive (Not Always Condition Responsive),
 - ❖ Rehabilitation
 - ❖ Reconstruction
- ❖ Reactive Maintenance (Unplanned Activities)
- ❖ Key Words:
 - ❖ Life Extension
 - ❖ Cost Effectiveness
 - ❖ Proactive

Three Track Nominations

Definitions

- ❖ **Reactionary Maintenance (by Bridge)**
 - ❖ **Emergency Repairs**
 - ❖ **Limited Contract Repairs**
 - ❖ **DOT In-house Repairs**
- ❖ **Preventive Maintenance (by Corridor)**
 - ❖ **Contract Deck Sealing**
 - ❖ **Contract Surface Rehab (Mill-And-Fill)**
- ❖ **Rehab, Replacement (by Bridge - Capital)**
 - ❖ **Contract Work**
 - ❖ **Tied to State Transportation Improvement Plan (STIP)**

Culture Of Change

Culture

- ❖ **Upper Management (Across All Areas)**
 - ❖ High Level
 - ❖ Performance Goals
 - ❖ Resource Allocation
 - ❖ Political Considerations
- ❖ **Mid Management (Infrastructure)**
 - ❖ Detail Roll-up Of Expectations
 - ❖ Priority Over Costs
 - ❖ Area Of Performance
- ❖ **Technical Experts**
 - ❖ Models
 - ❖ Development Of Program Levels
 - ❖ Area Of Performance

Basis For Measurement Development

Performance Measures

- ❖ Current Vs. Needed
- ❖ Monitor Trends
- ❖ Develop Both Short And Long Term Goals
- ❖ Return On Investment
- ❖ Funding Constraints
- ❖ Higher Expectations From The Public
- ❖ Affordable Level-of-Service

FHWA's Guidance for Approval Systematic Process

Performance
Measures

1. Define How The Needs Are Identified.
2. Outline How The Needs Are Prioritized And Programmed.
3. Define The Outcome Or Goal, Including Resources Necessary & Timeframes To Reach The Outcome/Goal.
4. Demonstrate That The Proposed Activity Is A Cost-effective Means Of Extending The Service Life Of A Bridge.
5. Dedicate Resources Necessary To Reach Defined Outcome/Goal.
6. Annually Track, Evaluate, And Report On Progress In Reaching Outcome/Goal And Adjust Resources Accordingly.

Performance
Measures

Deck Performance Measure

- ❖ Best Practice Is the Health Index
 - ❖ Dose Not Account for Smart Flags
 - ❖ Range of Values Small for Large Change in Condition
- ❖ Calculated by Equation 4.2.1 of Pontis Technical Manual (Page 4-9)

$$\text{Health Index} = \frac{\sum_n \text{Element Cost} * \text{Element Quantity} * \text{Percent Condition State}}{\sum_n \text{Element Cost} * \text{Total Element Quantity}} * 100$$

Deck Performance Measure Montana Modified

Performance
Measures

- ❖ Used Core Computation
- ❖ Included Smart Flags in Calculation
 - ❖ Used Grouping From NBI Translator
 - ❖ Smart Flag Cost From Total Cost of Element Group (Deck, Bearings, Joints, Approach Slabs)
 - ❖ Limited One Smart Flag by Span Group

$$HI_{mt} = \frac{(\sum_e \text{Cost} * \text{Qty} * \text{Pct in State}) + (\sum_s (\sum_e \text{Cost} * \text{Qty}) * \text{Qty} * \text{Pct in State}))}{(\sum_e \text{Cost} * \text{Qty}) + (\sum_s (\sum_e \text{Cost} * \text{Qty}) * \text{Qty}))} * 100$$

Montana HI

- ❖ Larger Spread of HI Values
- ❖ Gave Better Feel for Need
- ❖ Inventory Averages
 - ❖ HI_{avg} (No SF in Computation) = 90
 - ❖ HI_{avg} (SF in Computation) = 88
- ❖ Bridges With Smart Flags
 - ❖ HI_{avg} (No SF in Computation) = 83
 - ❖ HI_{avg} (SF in Computation) = 59

Data Collection

Data
Collection

- ❖ **Deterioration - From Field Observation**
 - ❖ **NBI Inspections**
 - ❖ **Element Inspections**
- ❖ **Cost Data**
 - ❖ **Contract Data**
- ❖ **Scheduled Contract Work**
 - ❖ **State Transportation Improvement Plan (STIP)**
- ❖ **Maintenance Work Records**

MDT Data Collection

Data
Collection

- ❖ Collecting NBI Data Since 1980
- ❖ Collecting AASHTO CoRe Data Since 1995
 - ❖ CoRe : Commonly Recognized Elements
- ❖ All Data Warehoused in Oracle Database
- ❖ Data Structure Uses AASHTOWare Pontis Schema
- ❖ Data Analysis Uses Pontis and “Home Grown” Applications

Historical Review (NBI)

Data
Collection

- ❖ Breakdown of NBI Data
 - ❖ Deck, Superstructure and Substructure
 - ❖ Snapshot Past 25, 10, 5, 1 Years
- ❖ Review for Trends and Limit the Program Scope

<u>Deck</u>	<u>1980</u>	<u>1995</u>	<u>2000</u>	<u>2004</u>
Worse than 5	1.8%	0.9%	0.8%	1.3%
Equal to 5	2.9%	3.6%	4.3%	4.8%
Better than 5	95.2%	95.2%	84.1%	91.4%
<u>Superstructure</u>				
Worse than 5	2.3%	1.6%	1.1%	0.4%
Equal to 5	3.1%	4.3%	4.3%	6.1%
Better than 5	94.7%	94.0%	83.8%	93.5%
<u>Substructure</u>				
Worse than 5	3.3%	2.6%	2.6%	1.9%
Equal to 5	3.9%	4.5%	6.3%	3.6%
Better than 5	92.9%	92.9%	91.1%	89.5%

Conclusion From NBI Data

Data
Collection

- ❖ Superstructure and Substructure
 - ❖ Work Condition (Worse Than 5) Down Trend
 - ❖ Watch Condition (5) Went up
 - ❖ Do Nothing (Better Than 5) No Trend
 - ❖ Factors
 - ❖ Removal of Short Span Timber Bridges
 - ❖ Seismic Retro Fitting
 - ❖ Replacement of Older Inventory
- ❖ Deck
 - ❖ Work Condition Upward Trend
 - ❖ Watch Condition Went up
 - ❖ Do Nothing - No Trend
 - ❖ Factor
 - ❖ Increase in Traffic
 - ❖ Increase Use in Liquid Deicers

Historical Review (AASHTO CoRe)

Data
Collection

- ❖ Breakdown of Deck Elements
- ❖ Snapshot Past 10, 5, 1 Years

<u>Deck CoRe Elements</u>	<u>1995</u>	<u>2000</u>	<u>2004</u>
States 4 & 5	0.3%	0.7%	1.2%
State 3	1.0%	3.7%	4.3%
States 1 & 2	98.7%	95.7%	94.6%

Deck Smart Flags Use

States 2 thru 5	0.6%	8.3%	7.3%
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Conclusion From Element Data

Data
Collection

- ❖ Data Collection Started in Year 10
- ❖ Cracking and Soffit Defects on the Rise
- ❖ Deck Ride Quality on Downward Trend

Overall Conclusion

Data
Collection

- ❖ Need to Develop a Long Term Preventive Maintenance Strategy
- ❖ Decks and Associated Elements As a Focus
- ❖ Use Deterioration Models From Pontis
- ❖ Develop a Performance Measure for the Constrained Data

Issues Effecting Preservation Activities

Models

❖ Data

❖ Process Misalignment

- ❖ Safety Compliance
- ❖ Asset Management

❖ Data Misalignment

- ❖ Structural Defects
- ❖ Protection Defects

◆ Predicting Deterioration

- ◆ Dependent On Expert Option
- ◆ Replacement-in-kind
- ◆ Strategic Approach
 - ◆ Remaining Live
 - ◆ Life Cycle

BMS (Pontis) Parameters

Models

- ❖ Limit the Data Set
 - ❖ Decks and Slabs
 - ❖ Bearing
 - ❖ Joints
 - ❖ Deck Smart Flags
- ❖ Develop Probabilistic Model for Elements
- ❖ Develop Deterministic Rules for Smart Flags
- ❖ Limit the Work to Scheduled Work
- ❖ Allow a Zero Budget
- ❖ Store Element Deterioration by Year
- ❖ Simulate for 10 Years

Outcomes

Reporting

- ❖ Development of “Indifference Curve”

- ❖ Report

- ❖ By Bridge (by Year)

- ❖ Recommended Action

- ❖ Benefit / Cost Ratio

- ❖ Hi_{mt}

- ❖ Categorize by Good, Watch, Bad

- ❖ By Route (Break on County and Year)

- ❖ Average Hi_{mt}

- ❖ Network Indifference Curve

- ❖ Network Benefit / Cost Ratio

- ❖ Network Cost to Improve

- ❖ Count by Good, Watch, Bad Groupings

Groupings

Outcomes

❖ Good Condition

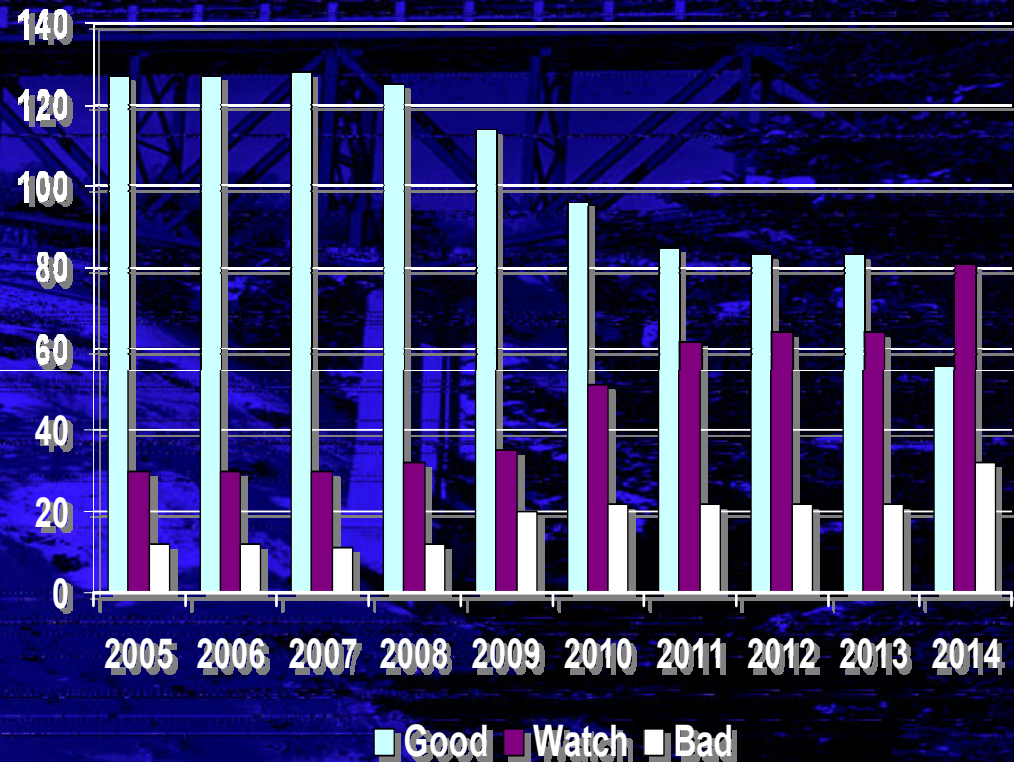
- ❖ Hi_{mt} Greater Than 70
- ❖ No Defects

❖ Watch

- ❖ Hi_{mt} Between 50 and 69
- ❖ Bridges Have Defects That Need Monitoring

❖ Bad

- ❖ Hi_{mt} Less Than 50
- ❖ Defects Needing Corrective Action



Indifference Curve

Outcomes

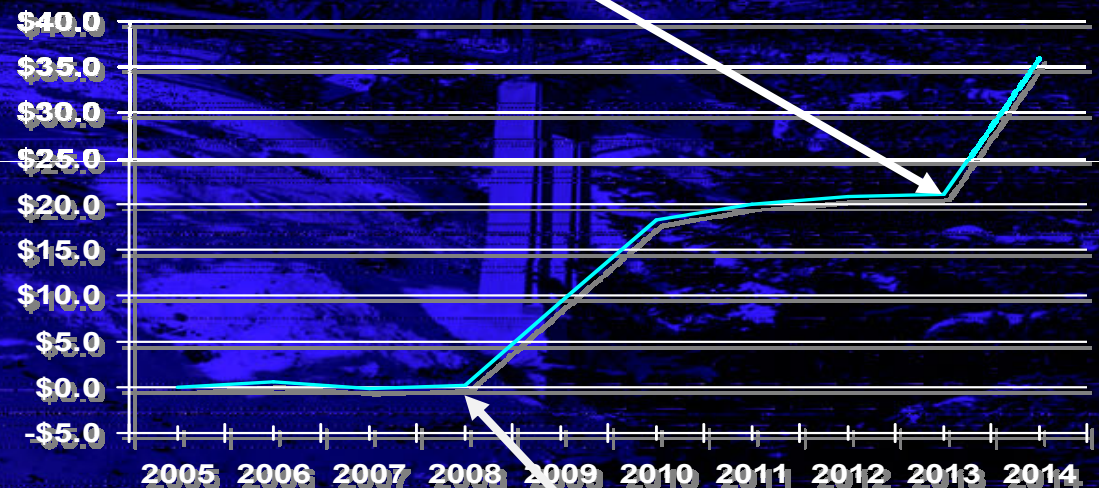
Needing Work Before Input Into a Capital Program

Maximum PM Cost < Capital Cost

- ❖ Need Cost or Bridge Count by Year

- ❖ Plot Cost (Bridge) and Year

- ❖ Take Action Before Going Near Vertical



First Time to Consider Work
(Lest Cost)

Program Development

Outcomes

- ❖ **Develop Different Budgets**
- ❖ **Run Scenarios**
- ❖ **Plot Long Term Effects**
- ❖ **Settle on Program Parameters and Budget**

Check for Corridor Improvement

Outcomes

- ❖ Input Projects, Scopes and Cost Into Pontis
- ❖ Run the Scenario With Proposed Budgets
- ❖ Compare Network Level Results
 - ❖ Fulfill Performance Goals?
 - ❖ Budgets Adequate for Scope?
 - ❖ Peaks and Valleys of Needs Smooth Out?

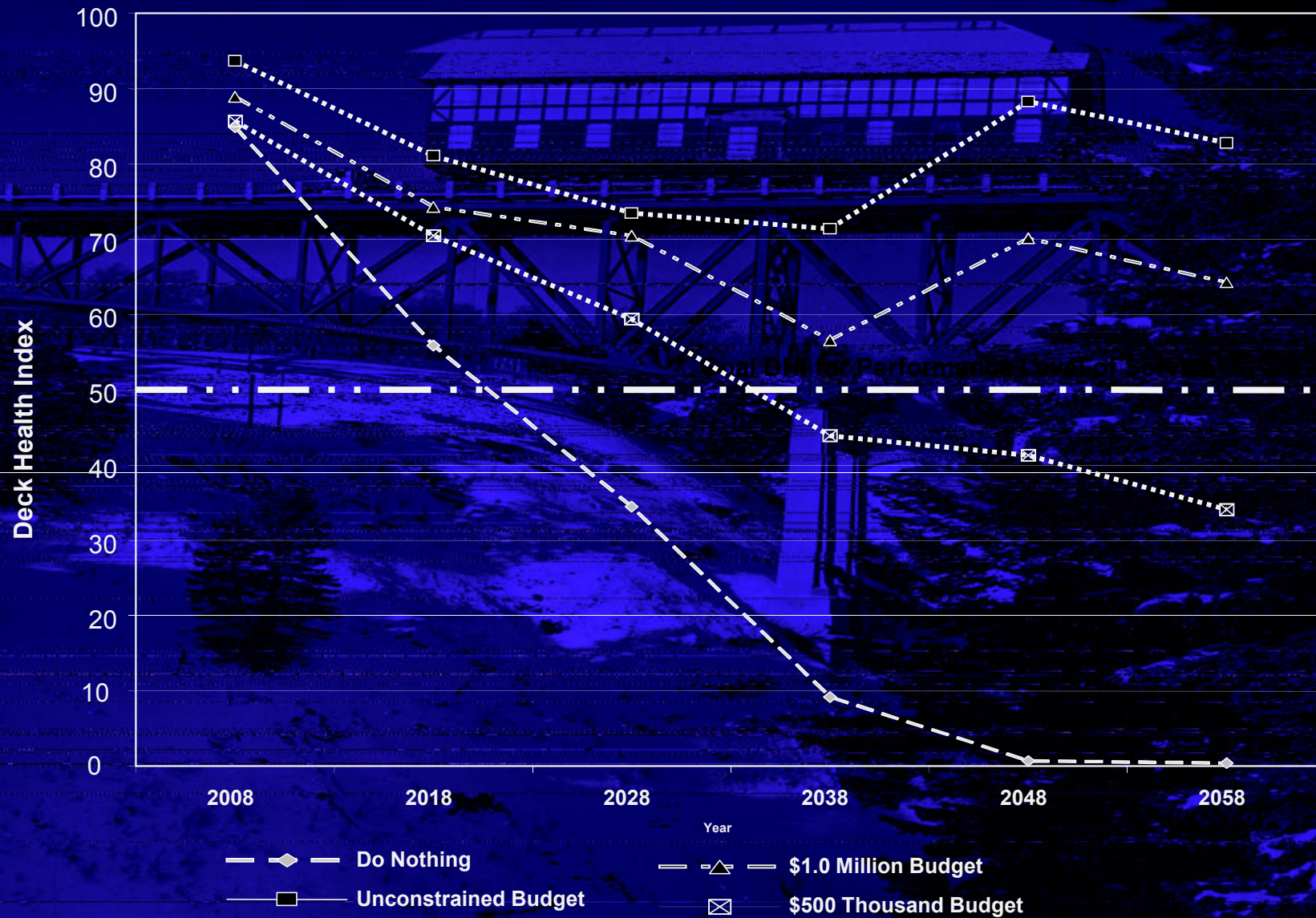
Development Results

Outcomes

Year	Do Nothing		Unconstrained Budget		Maximum \$1.0 Million Annual Budget		Maximum \$500 Thousand Annual Budget	
	Need to Correct	Deck Health Index	Accumulative Expenditures	Deck Health Index	Accumulative Expenditures	Deck Health Index	Accumulative Expenditures	Deck Health Index
2008	\$1,485,733	84.9	\$1,485,733	93.7	\$437,341	88.9	\$114,927	85.7
2018	\$6,936,027	55.9	\$3,590,750	81.1	\$1,798,384	74.3	\$1,233,546	70.5
2028	\$12,276,500	34.5	\$7,093,280	73.5	\$4,453,960	70.5	\$1,202,671	59.4
2038	\$24,551,826	9.2	\$10,910,317	71.4	\$6,279,637	56.6	\$1,260,291	43.9
2048	\$35,136,686	0.7	\$17,972,034	88.3	\$11,744,147	70.1	\$2,439,881	41.3
2058	\$35,696,378	0.4	\$22,354,797	82.8	\$13,603,630	64.3	\$1,693,066	34.1

Deck Health Index Over Time

Outcomes

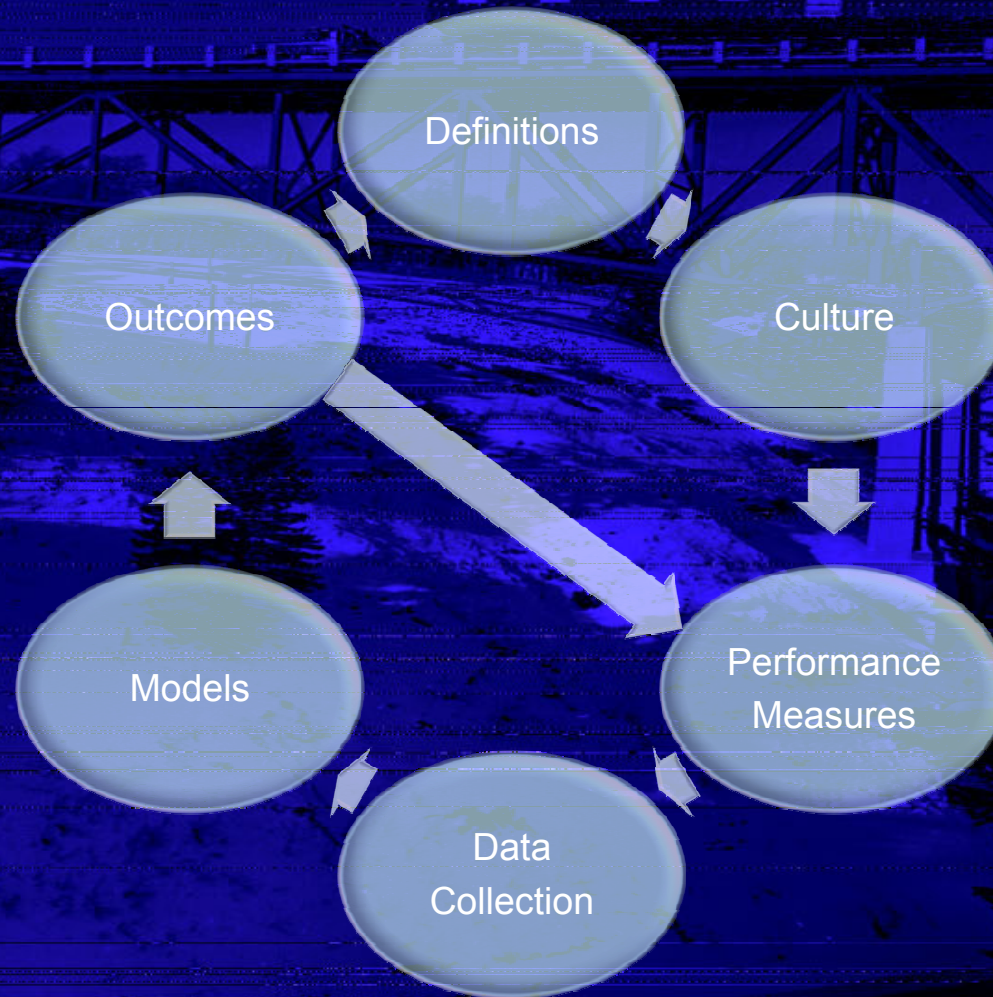


Field Review and Set Scope

Outcomes

- ❖ Rank Corridors From Worst to Best
- ❖ Review Recommended Action From Pontis With Field Observations
- Kick Some Rocks**
- ❖ Develop Scopes for Each Bridge
- ❖ Detailed Estimate for Each Bridge in the Corridor

Development Of A Roadmap



Conclusion

- ❖ **Defining The Difference Between Reactive Maintenance, Preventive Maintenance, Preservation And Rehabilitation.**
- ❖ **Development And Definition Of Bridge Preservation Strategies.**
- ❖ **Developing Deterioration Models For The Bridge As A Whole And For The Preservation Work.**
- ❖ **Development Of Bridge Management Policies That Address The Interaction Of Network Benefits And Needs With Individual Bridge Benefits And Needs.**

