2018 Purdue Road School Introduction to INDOT Bridge Asset Management Procedures

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Outline

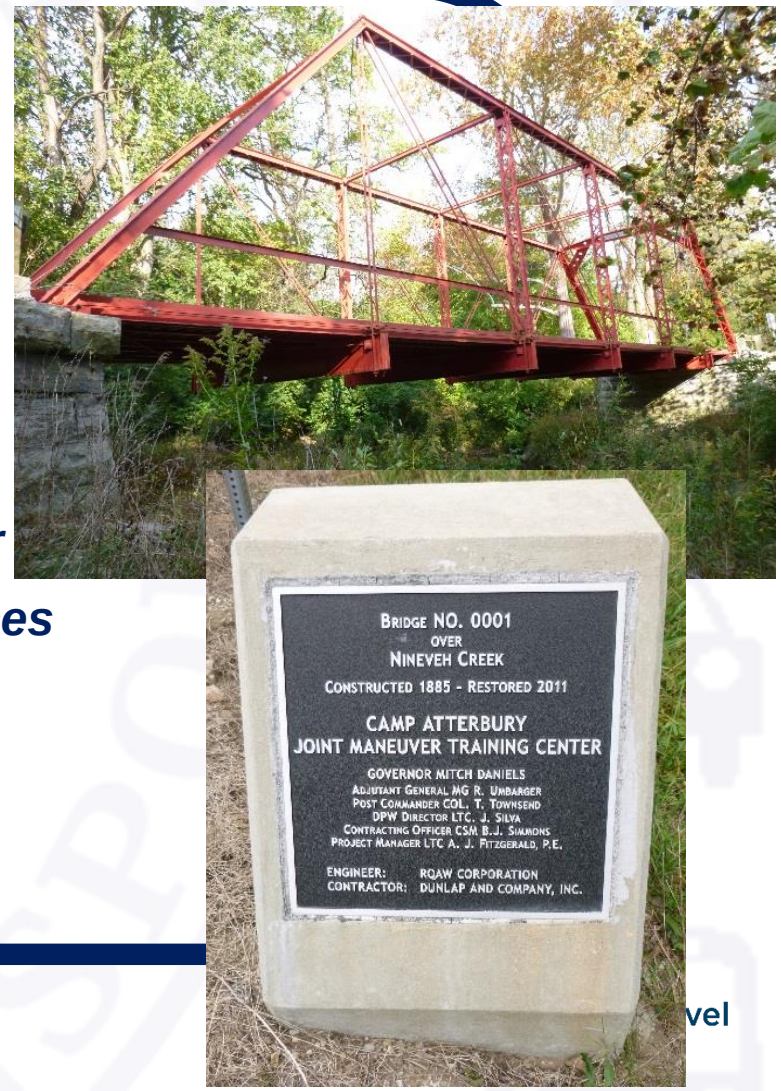
- Asset Management Definitions
- INDOT Bridge Asset Management
  - Statistics
  - Function
  - Bridge Asset Team
  - Project Scoring
  - Integration of Bridge Management System (BMS)

What Is Transportation Asset Management?

AASHTO'S Definition:

The definition according to the American Association of State Highway and Transportation Officials' (AASHTO's) Subcommittee on Asset Management is:

*" Transportation Asset Management is a **strategic and systematic process** of operating, maintaining, upgrading and expanding physical assets effectively **throughout their lifecycle.** It focuses on **business and engineering practices** for resource allocation and utilization, with the objective of better decision making **based upon quality information and well-defined objectives**."*



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Transportation Asset Management Definition

- FHWA's Definition:

According to FHWA's website: "Transportation Asset Management is a process used for managing transportation infrastructure with the objective **of improved decision making for resource allocation".** It explains further that the Asset Management aides in making 'informed decisions' about managing your network over the **whole life-cycle considering network performance, economic, and engineering.**

Transportation infrastructure assets includes ; **pavements, bridges, culverts**, signs, pavement markings and other roadway and roadside features.

This presentation only focuses mainly on bridge and culvert assets.

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INDOT Asset Management

Background:

- INDOT initiated the Asset Management Program in 2010.

- Pavement Asset management
- Bridge Asset Management
- Safety Asset Management
- Mobility Asset Management
- Statewide Asset Management (Rest Area, Environmental Study…,etc.)

Asset Management Teams:

- Individual Asset Management Teams, i.e. Bridge Asset Management Team (BAMT)
- Program Management Group (PMG)/Team
- Executive Funds Team (EFT)

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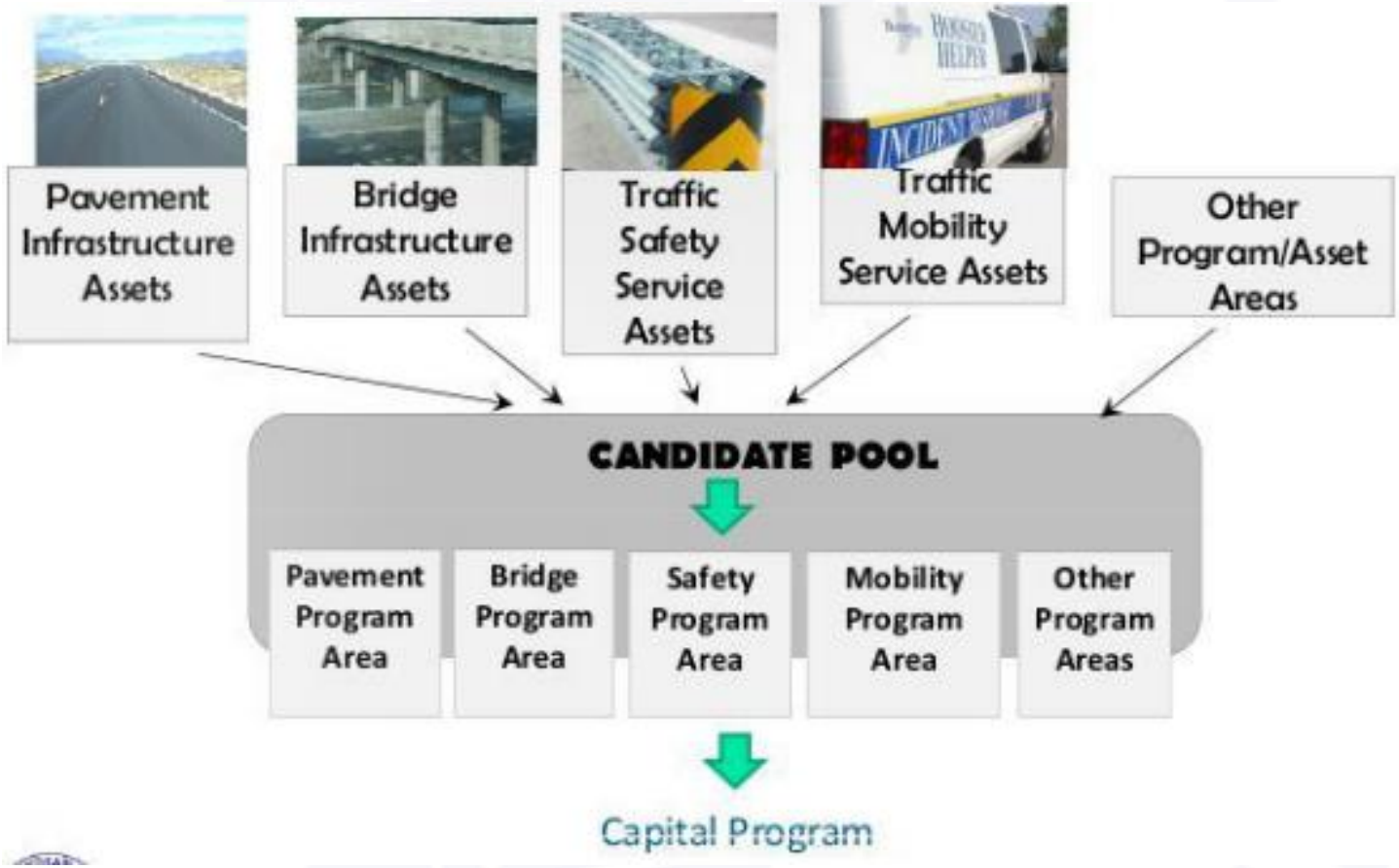
INDOT Asset Management



Bridge Asset Management

Bridge Asset Management (BAM) is one of the sub-elements of the Transportation Asset Management (TAM).

(BAM) uses Asset Management principles to make decisions based on accurate data and sound engineering & economic analysis. Therefore, it is essential to have good accurate information regarding asset condition, performance and other required data needed with a long term view of the asset.

BAM's Goal:

To provide a desired level of service and performance for the network in a most cost effective manner.

INDOT and LPA Bridge Statistics

- Approximately 330 Toll Road Bridges
- Approximately 5900 INDOT Bridges
- Approximately 13200 Local Bridges (LPA)
- Approximately 2900 NHS Bridges
- 19 Border bridges
- Approximately 9000 INDOT Culverts
- 6 Complex Bridges
- 5 Tunnels

Proposed Bridge Projects

- Inspection
  - At least once every two years
  - Data entered into BIAS
- Forecasting w/ BMS (dTIMS)
  - NBI Data from BIAS
  - Data from scheduling for committed costs from projects (SPMS)
- Spreadsheets / Collector App
  - Bridge Asset Engineers review and possibly alter data
  - Bridge Asset Engineers score projects
- Scope
  - Establish scope and documents for potential projects

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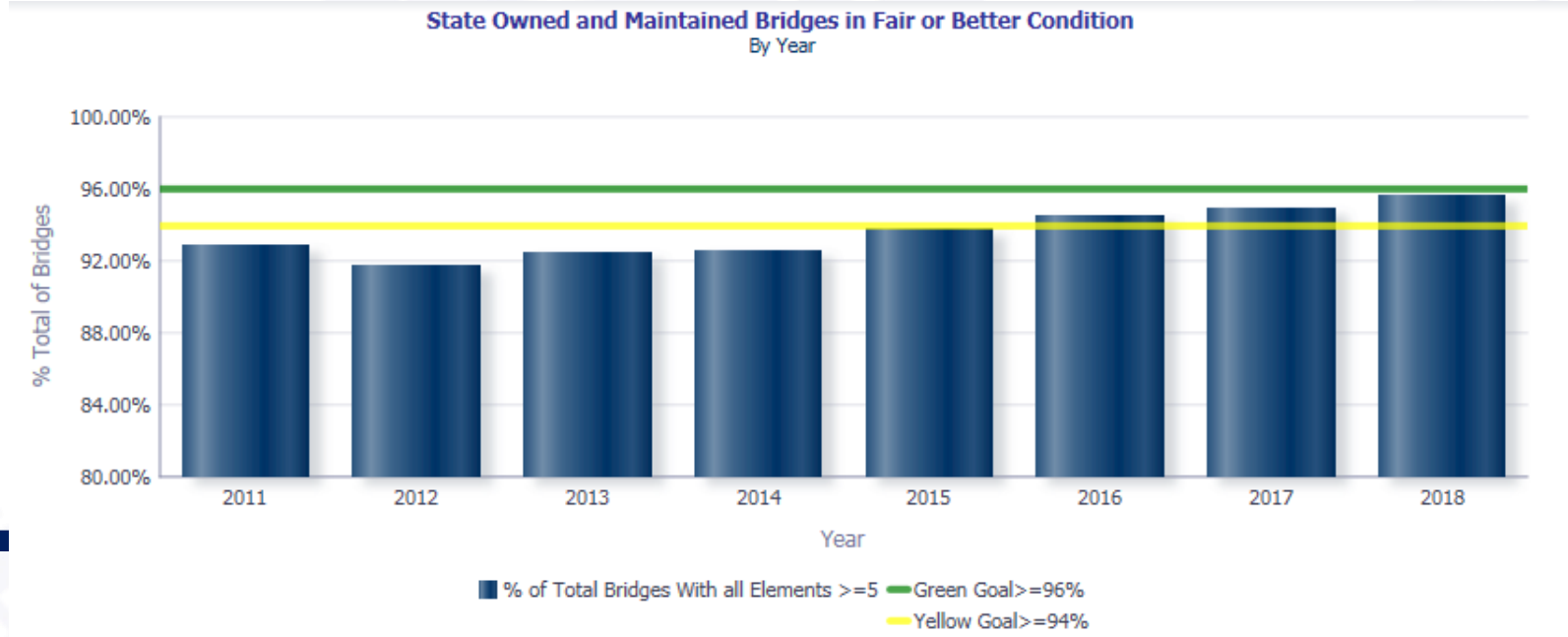
Funding during the Bridge Asset Management Call

- The bridge funding is divided into following:
  - **3-5 year Call for Projects per budget year**
  - Bridge/Culvert Preventive Maintenance Agreement (BCPMA)
  - Border Bridges
  - other
- Programming Steps
  1. Call for Projects
  2. Each District submits their list
  3. Deliberations / Project Rankings
  4. BAMT submits prioritized list to Program Management Group (PMG)
  5. PMG recommends a funding level
  6. Goes to a committee for final approval

Bridge Asset Management

INDOT Bridge Asset Management Office Function:

- Perform bridge data analysis using Bridge Management System (BMS) software tools such as Deighton Transportation Infrastructure Management System (dTIMS)
- Develop criteria to analyze bridge data for evaluating bridge condition.
- Continually monitor and report on conditions of INDOT bridge assets.



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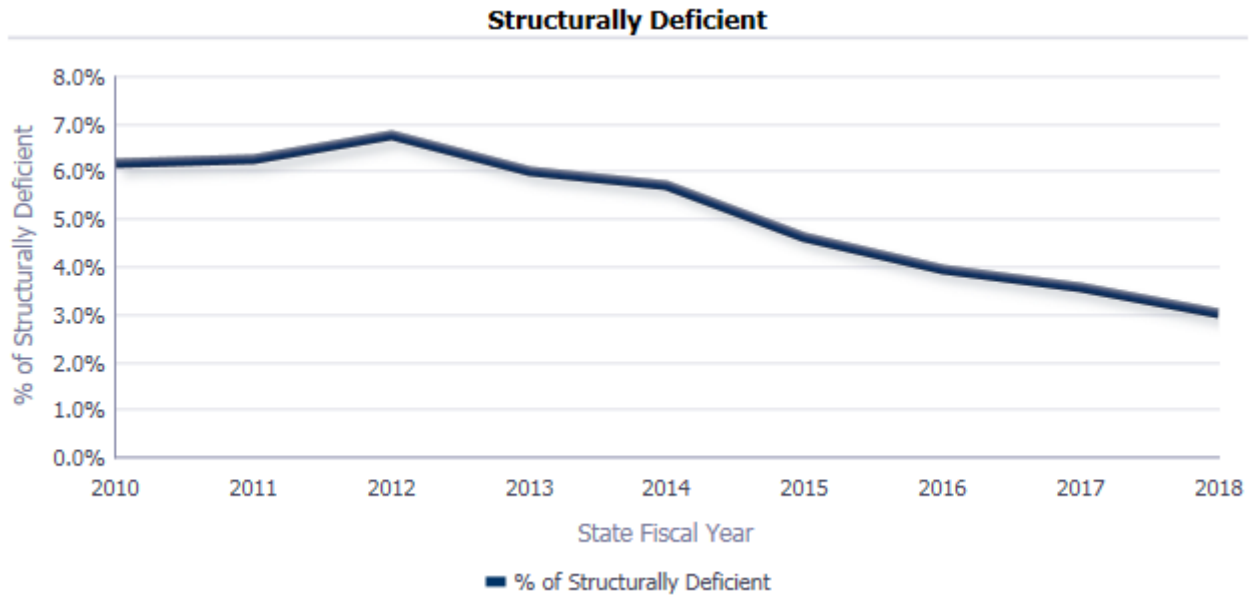
Bridge Asset Management

INDOT Bridge Asset Management Office Function (cont'd):

- Develop and recommend policies to enhance the bridge network conditions.
- Develop and/or update the current models in the BMS to forecast statewide bridge network needs with estimated costs.
- Prepare bridge condition annual reports.



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Bridge Asset Management

INDOT Bridge Asset Management Office Function (cont'd):

- Interact with key partners including FHWA, consultants, research institutions and others to advance the bridge issues.
- Affect individual bridge or large culvert projects by providing support in the data analysis, project identification and development process.
- Chair the INDOT Bridge Asset Management Team in Bridge & Large Culvert (4'-20') Project Selection and Prioritization Process.
- Involved with Change Management of projects under development due to scope, funding, or letting changes.

Bridge Asset Management

INDOT Bridge Asset Management Team (BAMT):

- 10 member team w/ 6 district representatives, one rep. from bridge maintenance div. plus 3 from bridge div (bridge inspection, bridge rehab groups and the bridge asset group).
- All senior professional engineers.
- Developed a set Business Rules and Scoring System to compare and prioritize projects.
- Business Rules and Score sheets were based on principle Work Types.
- It was “Worst first” approach then adjusted to a “life-cycle” costing.
- More of a focus on Preservation projects.
- Spreadsheets were developed to score projects more efficiently.

Bridge Asset Management

Bridge Asset Team Role:

- Meet Regularly (Monthly)
- Propose & Score projects
- Deliberate on proposed projects for the following programs
  - BCPMA (2 years out) – Preservation projects
  - Short term call / Placeholder (3 years out)
  - Long term call (5 years out)
- Prioritize projects based on 0-100 score
- Submit projects to next team (PMG) for approval for funding.

Bridge Asset Management

Project Scoring Factors:

- Preservation projects (BCPI-Now BCPMA) were given high priority with score of 100 automatically. Projects don't compete against each other. Only have to meet preservation rules from BCPMA document and Chapter 412 from design manual.

Appendix B: *Large and Small Culvert Candidate Criteria*

Large Culvert Candidate Criteria

Corrective Treatments	Culvert Component	Condition Rating	Barrel/Box or Slab Rating
Culvert Liner (Both Type 1 &2 Structures)	Barrel/Box	= 2-5	N/A(2)
Structural Patching	Slab/Barrel/Box	> 4	N/A
Scour/Erosion Mitigation	Channel Scour	< 6	> 5
Cutoff Wall Repair/Replacement	Footings	< 6	> 5
Headwall/Wingwall Repair/Replacement	Headwall/Anchors/ Wingwalls	< 6	> 5
Tiedown/Anchor Repair/Replacement	Headwall/Anchors	< 6	> 5

Slopewall Repair/Replacement	Substructure (60)	<6	WS/D/SS>4
Bearing Repair/Replacement	Superstructure (59)	<6	WS/D/SS>4
Scour Mitigation	NBI Scour Evaluation Code (113)	2-3	Not Programmed for Bridge Replacement
Deck Crack Sealing	Wearing Surface (58.01)	>5	D/SS>5
Brush Cutting/Herbicide Application [1]	Deficiency Noted	N/A	WS/D/SS>4
Railing Repair [1]	Deficiency Noted	N/A	WS/D/SS>4
Relief/Terminal Joint Repair [1]	Approach (72)	<6	WS/D/SS>4
Upgrading End Treatments, Guardrail, Railing, Attenuators [1, 4]	N/A	N/A	WS/D/SS>4
Adding Reinforced Concrete Deck to an Adjacent Box Beam Bridge without a Deck [5]	Superstructure (59) and Substructure (60)	(59) >5 (60) >4	N/A

[1] Items may only be included in a project incorporating other preventative maintenance treatments
[2] WS = Wearing Surface (58.01); D = Deck (58); SS = Superstructure (59) and Substructure (60)
[3] Treatments should raise the condition of the rating to 5 or higher
[4] When found to be cost-effective
[5] Treatment is applicable to LPA bridges only. The minimum allowable deck thickness is 5 in.

CONDITION-DRIVEN PREVENTATIVE MAINTENANCE
ELIGIBILITY CRITERIA
Figure 412-1A

Bridge Asset Management

Project Scoring Factors:

- There are several bridge scoring systems:
  - Bridge projects
    - Thin Deck Overlay
    - Rigid Deck Overlay
    - Deck Replacement
    - Super Replacement
    - Bridge Replacement
  - Bridge Painting projects
  - Scour projects
  - Culverts
    - Replacements
    - Liners

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Scoring Sheet

BRIDGE SCORE INPUT

Des #					
NBI #			80596		
AADT			3500 <= AADT < 5000	3820	
Functional Classification			Other Principle Arterial (Urban)	14	
Total Estimated Cost			$600,000	Not Found	<-- (SPMS)
Fiscal Year			2023		
Proposed Treatment			Deck Overlay		
Bridge Inspection Information			Override		Scores
Structure Length	Dec Ft	282.2		282.2	
Width Out to Out	Dec Ft	50.3		50.3	9
Wearing Surface Rating	1-9	6		6	9
Deck Rating	1-9	7		7	0
Superstructure Rating	1-9	7		7	0
Substructure Rating	1-9	8		8	0
Culvert Rating	1-9	0			
Geometry (Override only)	1-9	9	Override for super/sub if <6		N/A
Paint	1-9,N	N			
Scour Critical	1-9,N	N			
Fracture Critical	Y/N	N			
Hydraulic Adequacy	1-9,N	N			
Historical Significance	1-5	5			

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Developed by R.E Montgomery and modified by Jaffar Golkhajeh in accordance with BAMT rules for FY 2023 call & ACP on 7/7/17

Proposed Treatment Added Life		20	
		Life	Score
Deck Overlay		20	9
Deck Replacement		35	0
Superstructure Replacement		55	0
Total Replacement		75	0
Thin Deck Overlay		12	9

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BRIDGE SCORE SHEET

Bridge #	031-34-08829	Location	US 31 SB/NB, mi 01.40 S SR 931
Project Status	Not Found		
NBI	80596		
District	03 - Greenfield		
Route	US35/SR22WB CR400N	Work Type (SPMS)	Not Found
County	034 - HOWARD		
Ref Post	161 + 8	Trans System (SPMS)	Not Found
Area Of Deck	14194.66 SF	Prop Treatment	Deck Overlay

The Proposed Treatment for this Structure is Deck Overlay

CONDITION SCORE	9	X	5	=	45
COST EFFECTIVENESS SCORE	8	X	3	=	24
FUNCTIONAL CLASSIFICATION	6	X	1	=	6
AADT SCORE	3	X	1	=	3
SUPPLEMENTARY	0	X	7	=	0
TOTAL PROJECT SCORE					78

Four Main Scoring Factors

Scoring Factor Number (SF)	Bridge Scoring Factor Description	Score	Weights to Convert to 100 Point Scale (W)	Maximum Possible Weighted Score
# 1	Condition	0-10	5	50
# 2	Cost-Effectiveness	0-10	3	30
# 3	Functional Classification Priority	0-10	1	10
# 4	AADT Impacts	0-10	1	10
Sub-Total				100
Supplementary (S) Factor	Earmarks & Other Financial Contributions by External Means	0-5	7	35
Grand Total				135

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Scoring Factor #1 : Condition

- Scoring Factor #1 specifically captures the condition of the asset.

Scoring Factor Number	Principal Element Bridge Scoring Factor Description	Weights to Convert to 100-Point Scale	Maximum Possible Weighted Score
# 1	Condition		
	(1) Wearing Surface	5	50
	(2) Deck	5	50
	(3) Superstructure	5	50
	(4) Substructure	5	50
	(5) Deck Geometry	5	50

Table 2. List of Condition Factor Elements and Weights

Scoring Factor #1 : Condition

Superstructure Scoring Table (Use for Superstructure Replacement Projects)

Superstructure Condition	Score Values for Superstructure Condition Assuming Substructure > 4 (0 otherwise)									
	Deck Condition									
	0	1	2	3	4	5	6	7	8	9
0	10	10	10	10	10	10	10	10	10	10
1	10	10	10	10	10	10	10	10	10	10
2	10	10	10	10	10	10	10	10	10	10
3	10	10	10	10	10	10	10	10	10	10
4	10	10	10	10	10	10	10	10	10	10
5	10	10	10	10	9	6	3	3	3	3
6	3	3	3	3	2	2	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0

Table 6. Superstructure Scoring Table

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Scoring Factor #2 : Cost Effectiveness

- There may be many different ways and methods to determine bridge project cost-effectiveness, but their purposes are the same which is “best bang for the buck” or dollars well spent. Scoring Factor # 2 captures the merits of the investment in the bridge as it relates to its deficiencies.

Cost Effectiveness		
From	**To**	**Cost Effectiveness Points**
$0.00	<$1.00	10
$1.00	<$2.00	8
$2.00	<$3.00	8
$3.00	<$4.00	6
$4.00	<$5.00	6
$5.00	<$6.00	4
$6.00	<$7.00	4
$7.00	<$8.00	2
$8.00	<$9.00	2
$9.00	<$10.00	0
$10.00	>$10.00	0

Table 8. Cost Effectiveness Table

Scoring Factor # 3 : Functional Classification Priority

- Priority will be given to bridges which are more important in term of functional classification and volume of traffic carried.

Scoring Factor Number	Bridge Scoring factor Description	Functional Classification Points
# 3	Functional Classification	
	Principal Arterial –Interstate (Urban)	10
	Principal Arterial –Interstate (Rural)	9
	Principal Arterial –Other Freeways and Expressways (Urban)	8
	Principal Arterial –Other (Rural)	7
	Other Principle Arterial (Urban)	6
	Minor Arterial (Urban)	5
	Minor Arterial (Rural)	4
	Collector (Urban)	3
	Major Collector (Rural)	2
	Minor Collector (Rural)	1
	Local	0

Table 9. List of Road Functional Classifications and Points

Scoring Factor # 4 : Annual Average Daily Traffic (AADT)

- Scoring Factor #4's points will be based on traffic volume.

Annual Average Daily Traffic (AADT)		
From	To	AADT Points
0	999	0
1,000	1,999	1
2,000	3,499	2
3,500	4,999	3
5,000	6,999	4
7,000	8,999	5
9,000	9,999	6
10,000	13,999	7
14,000	19,999	8
20,000	34,999	9
35,000	>35,000	10

Table 10. AADT Point Table

Scoring Sheet

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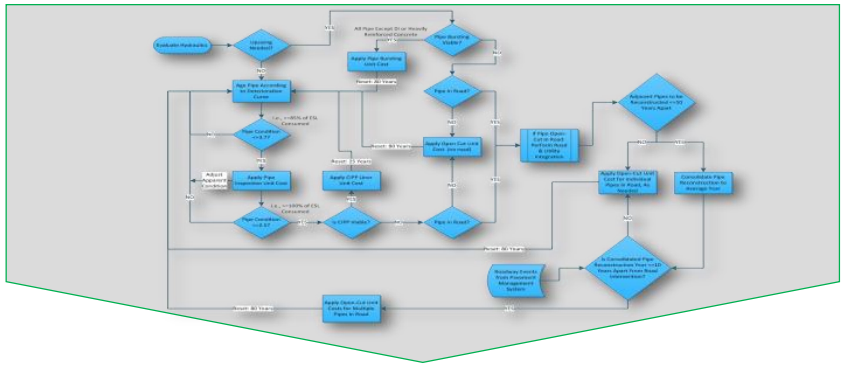
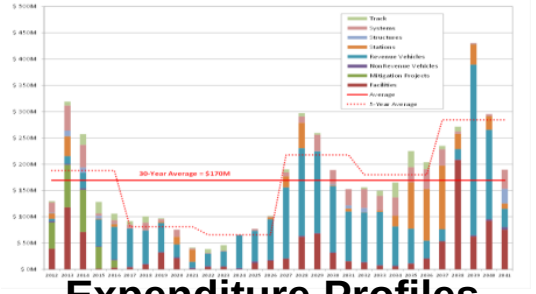
Use of dTIMS as BMS Analysis Tool

Process Flow / Decision-Rules

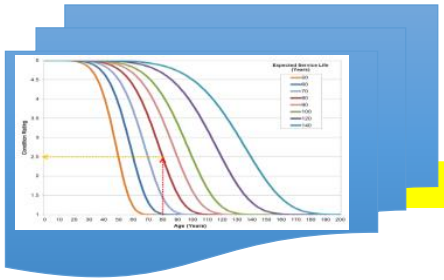




Expenditure Profiles

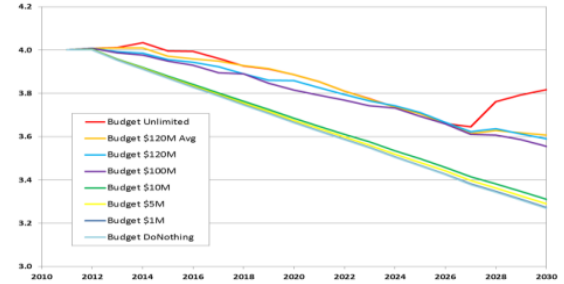
ASSET INVENTORY
- Bridge Type
- Bridge Width & Length
- Bridge Install Date

Deterioration Curves



DEIGHTON dTIMS CT

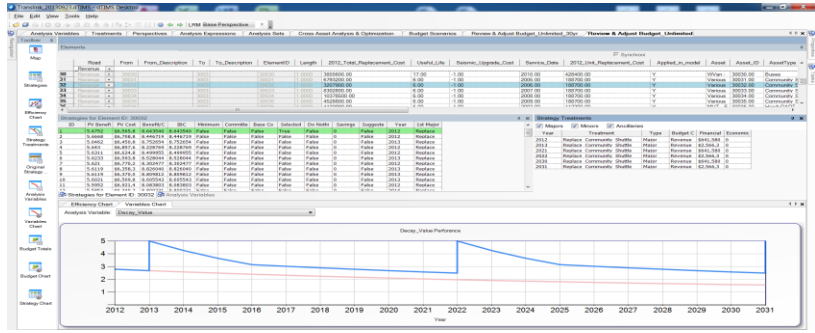
Analysis & Optimization



Network Condition

INTERVENTIONS
- Thin Deck Overlay
- Deck Overlay
- Super Replacement
- Bridge Replacement

Unit Cost Tables



Drill-Down to Asset Level

deighton

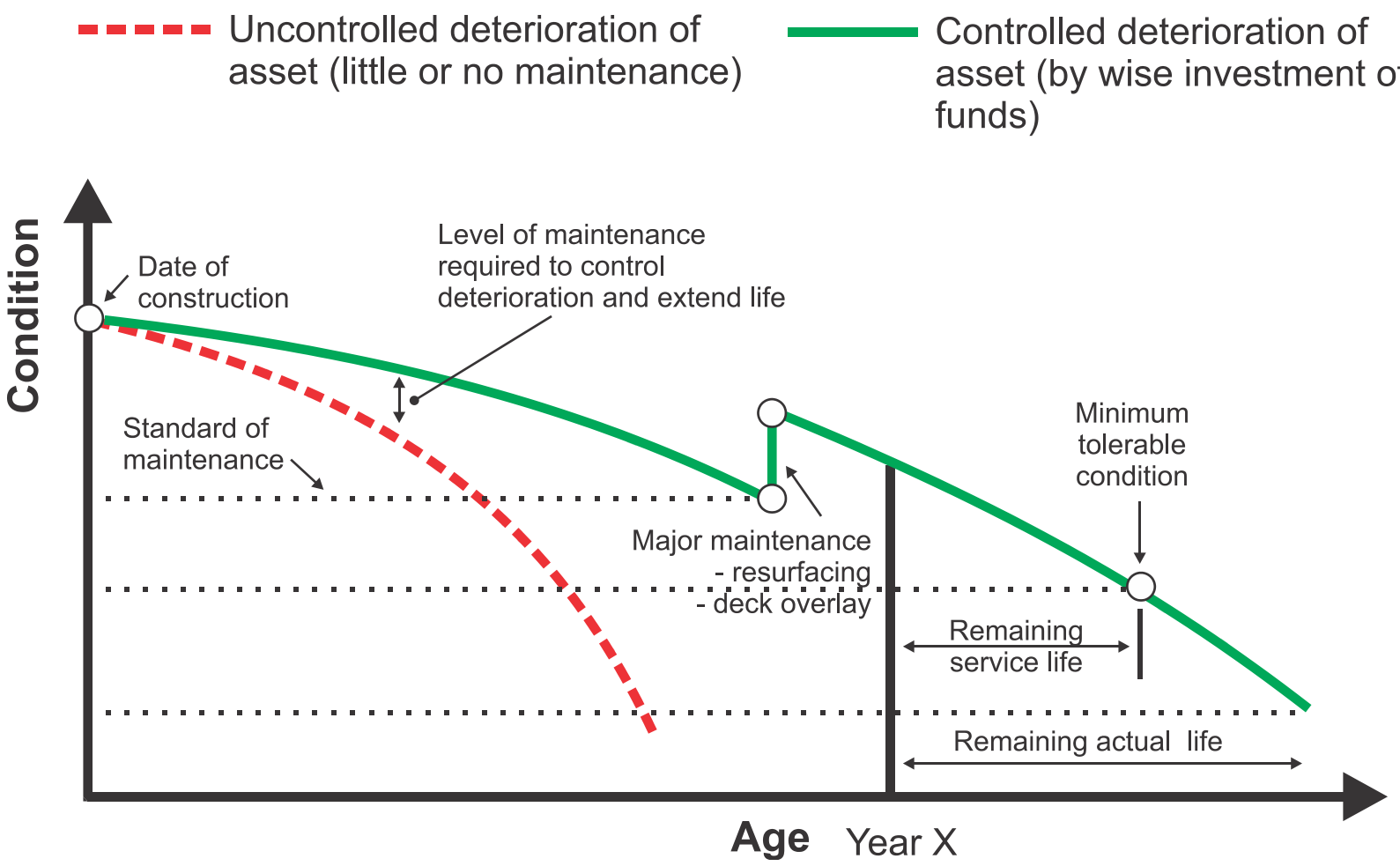
BMS Inputs - Data

- NBI data set
- INDOT own data fields
- Work History
  - This includes as many historical projects as possible for each bridge.
  - Used to determine component age and number of historical overlays
- Committed projects from SPMS
- NBE in future?

BMS Inputs – Analysis Parameters

- Key Performance Indicators
  - NBI condition ratings such as Deck, Super, Sub, Wearing Surface, Culvert
  - Bridge Quality Index
  - Project Scoring
  - Cost effectiveness
  - Overlay count
  - Component age

Deterioration Models



BMS Inputs – Analysis Parameters

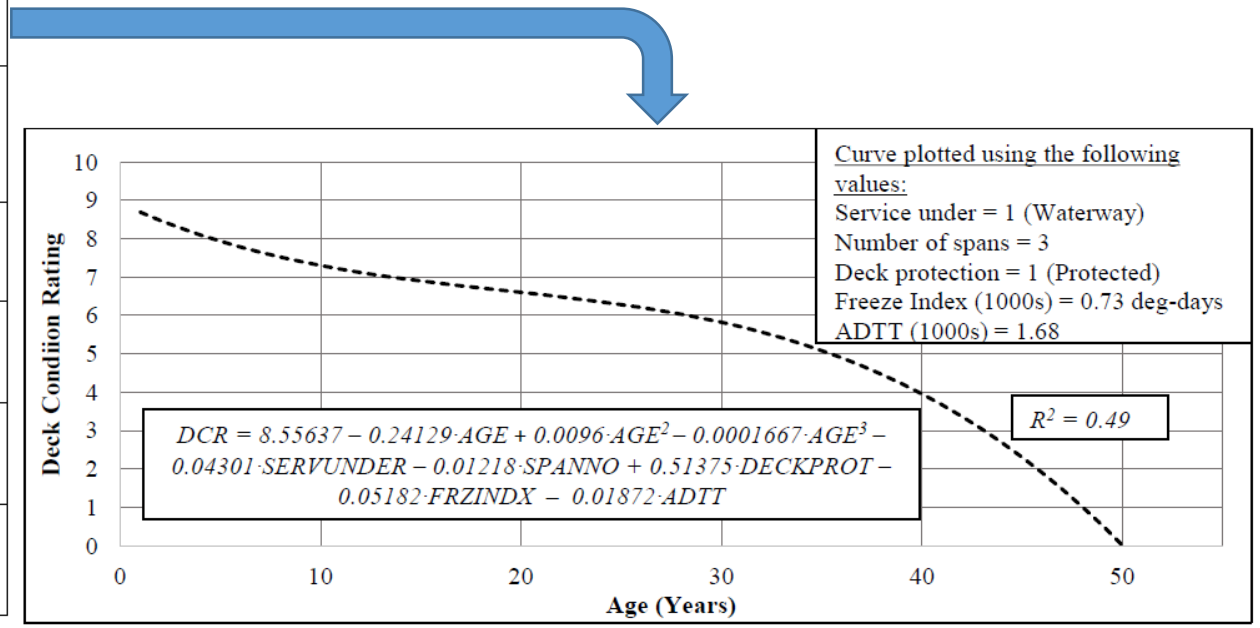
- Deterioration modelling for KPIs
  - Curves developed using historical data for each NBI rating
  - Purdue participated in some curve development
  - Deterministic curves are used (example on next slide)

Bridge Management in dTIMS

Component Level Predictive Models – INDOT / Purdue Study

Table 5.1 Summary of the Deterministic Models for Bridge Deck Deterioration

BRIDGE COMPONENT	DISTRICTS	FUNCTIONAL CLASS	DETERIORATION MODEL
DECK	NORTHERN	NHS	$DCR = 8.55637 - 0.24129 \cdot AGE + 0.0096 \cdot AGE^2 - 0.0001667 \cdot AGE^3 - 0.04301 \cdot SERVUNDER - 0.01218 \cdot SPANNO + 0.51375 \cdot DECKPROT - 0.05182 \cdot FRZINDX - 0.01872 \cdot ADTT$
		NON-NHS	$DCR = 9.22454 - 0.244998 \cdot AGE + 0.01158 \cdot AGE^2 - 0.00021831 \cdot AGE^3 - 0.00136 \cdot SKEW - 0.01023 \cdot SPANNO + 0.39602 \cdot DECKPROT - 0.03037 \cdot FRZINDX - 0.01397 \cdot NRFTC - 0.08597 \cdot ADTT$
	CENTRAL	NHS	$DCR = 8.1961 - 0.16459 \cdot AGE + 0.0068 \cdot AGE^2 - 0.0001442 \cdot AGE^3 - 0.06213 \cdot INT - 0.04249 \cdot SERVUNDER - 0.0005587 \cdot LENGTH + 0.50755 \cdot DECKPROT - 0.00769 \cdot NRFTC$
		NON-NHS	$DCR = 7.6959 - 0.09989 \cdot AGE + 0.00234 \cdot AGE^2 - 0.00005094 \cdot AGE^3 - 0.06901 \cdot SERVUNDER - 0.00119 \cdot LENGTH + 0.33696 \cdot DECKPROT - 0.03016 \cdot ADTT$
	SOUTHERN	NHS	$DCR = 8.58845 - 0.09752 \cdot AGE + 0.00341 \cdot AGE^2 - 0.0000855 \cdot AGE^3 - 0.00186 \cdot SKEW - 0.00041603 \cdot LENGTH + 0.53671 \cdot DECKPROT - 0.06989 \cdot FRZINDX - 0.04431 \cdot ADTT$
		NON-NHS	$DCR = 8.05846 - 0.14617 \cdot AGE + 0.00663 \cdot AGE^2 - 0.00015219 \cdot AGE^3 - 0.00098333 \cdot LENGTH + 0.43363 \cdot DECKPROT - 0.06043 \cdot FRZINDX - 0.14681 \cdot ADTT$



Deterministic curves are useful when predicting a **rating** into the future.

BMS Inputs – Analysis Parameters

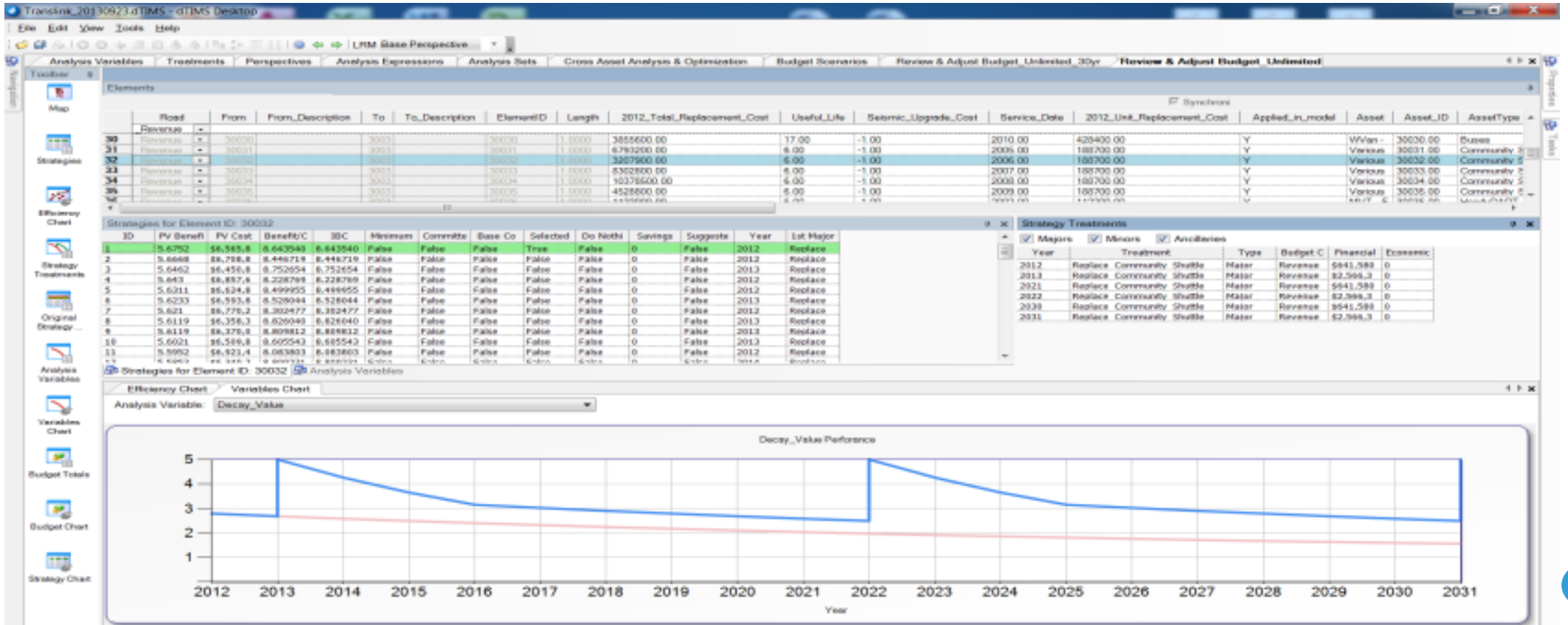
- Treatments
  - Decision trees
    - can use both condition data (e.g. NBI rating) and applicability data (e.g. overlay count)
  - Costs
    - Empirically derived based on historical costs
    - Include both material cost and maintenance of traffic (MOT)
  - Resets
    - Impact to KPIs as a result of applying the treatment
    - Can improve condition or hold condition constant (such as thin deck overlay)

BMS Inputs – Analysis Parameters

- Economic contributors
  - Discount and inflation rate
  - Constraints such as available budgets
    - Optimization routine
  - Analysis period for life-cycle costing
  - Work already committed to

BMS Outputs – Project Level

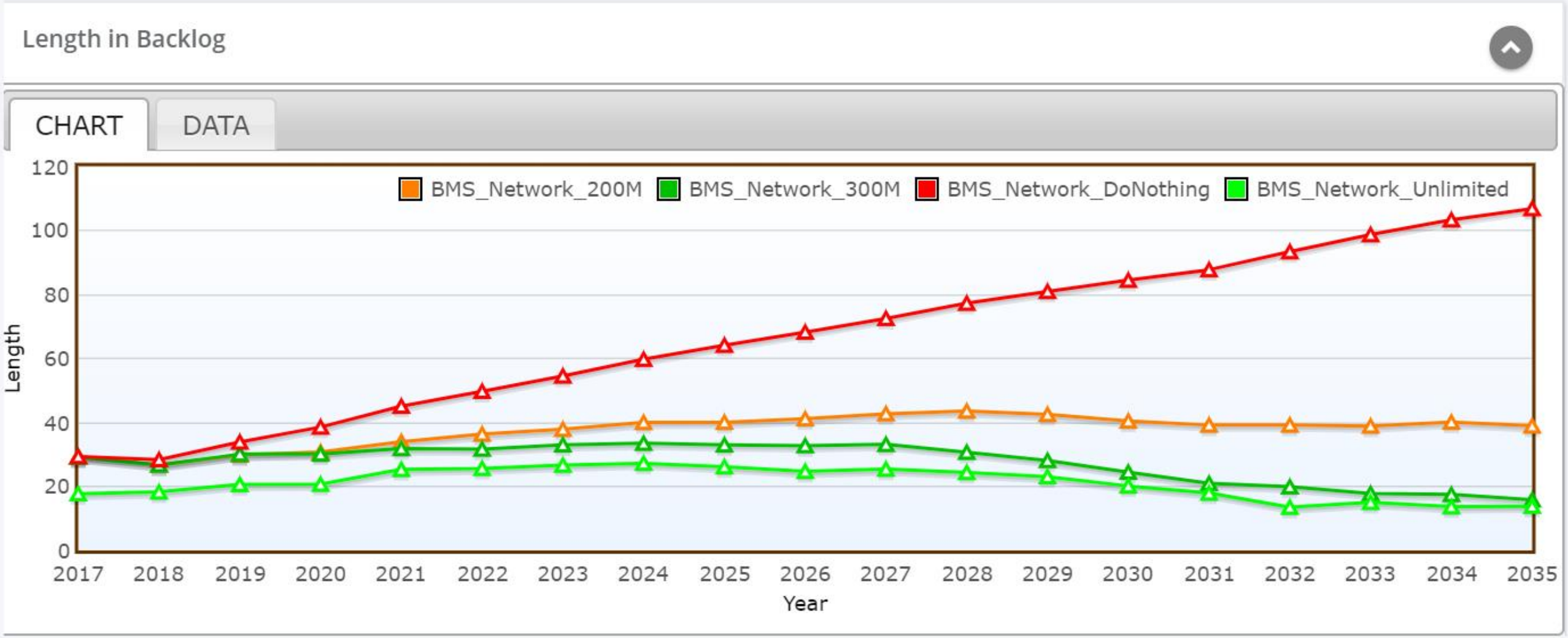
- Detailed work program for every bridge
- Cost and benefit of each strategy
- Condition projection for each KPI



BMS Outputs – Program Level

- Condition Distribution (Good/Fair/Poor) for entire network or any subset of network for any funding level for next 10 years or beyond
- Average condition trend for entire network or any subset of network for any funding level for next 10 years or beyond
- Data to support federal reporting requirements – percent deck area in Good, Fair and Poor condition
- Funding predictions required to achieve INDOT target criteria

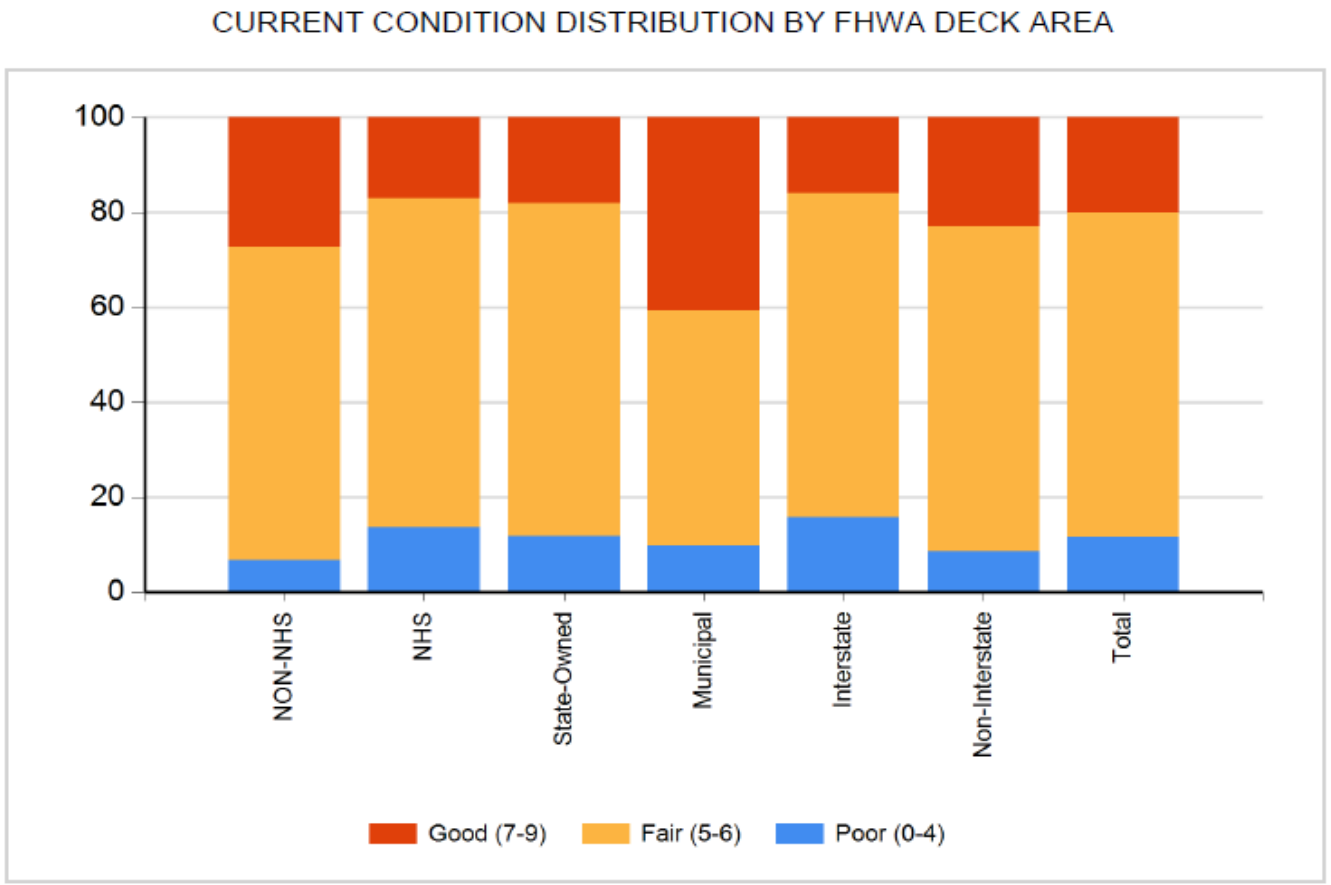
BMS Program Level Sample Outputs



BMS Outputs – Program Level, Federal Reporting

Bridge: State of the System Report

Budget Scenario: Bridge_30yr_235

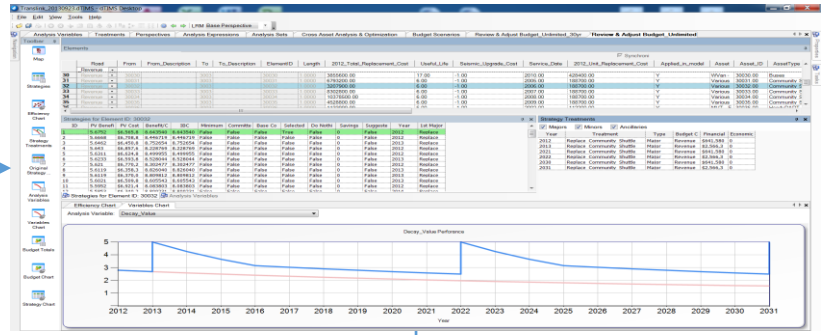


BMS Cycle

Inspection data
Other NBI data

Analysis data

Strategy results including treatment recommendations, costs, projections



Central office and District review

Agree? Disagree? Recommendations for improvement

Improvements made based on recommendations from field and office staff

Expected Benefits

- Recommended annual spending profile for any budget amount
- Quantified inspection budget
- Identification and filling in of data gaps
- Better buy-in from District staff

What's Next

- Inclusion of cost effectiveness in optimization
- Inclusion of economic importance in bridge strategies to Indiana economy
- Inclusion of risk in analysis
- Inclusion of NBE data
- Inclusion of small culverts
- Trade-off analysis with pavement program
  - BMS and PMS becomes AMS
  - Move away from silo based analyses to holistic analyses
  - dTIMS is used for both BMS and PMS at INDOT

Concluding Remarks

- Use of an effective BMS is a key tool in effective asset management. dTIMS has been essential in this process in evaluating our assets on a program level instead of a project level.
- Use of this BMS has helped INDOT to show future bridge conditions with varying funding scenarios to help gain legislative support.
- BMS has support from high level management and will also be used as a tool to support the new requirements of the TAMP required by FHWA.
- Important to move away from a “worst first” investment strategy and adopt the principle of life cycle costing with more of a focus on Preservation Projects.
- INDOT’s Bridge Asset Management Team has been effective when used along side BMS in providing a strong program of “doing the right projects at the right time” to improve the overall condition of the State’s important bridge assets.

Questions??

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