Quantifying Future Infrastructure Needs

West Virginia BMS

West Virginia Division of Highways

Outline

Introduction and Background

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BASE Jumping from New River Bridge - third Saturday in October is Bridge Day

Introduction and Background

MAP-21 legislation requires use of management systems to generate planned investment strategies in the TAMP

§515.7 Process for establishing the asset management plan.

(g) States DOTs shall use the best available data to develop their asset management plans. Pursuant to 23 U.S.C. 150(c)(3)(A)(i), each State DOT shall use bridge and pavement management systems meeting the requirements of §515.17 to analyze the condition of NHS pavements and bridges for the purpose of developing and implementing the asset management plan required under this part.

§515.17 Minimum standards for developing and operating bridge and pavement management systems

(a) Collecting, processing…
(b) Forecasting deterioration…
(c) Determining the benefit-cost over the life cycle of assets…
(d) Identifying short- and long-term budget needs…
(e) Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints

Introduction and Background

MAP-21 legislation requires use of management systems to generate planned investment strategies in the TAMP

In 2018, West Virginia DOH did not have a Bridge Management System

But by mid-2019…

Input Datasets

Inventory and Condition

Bridge Inspection Data
From InspecTech

Rubles Run Bridge, Mon-Fayette Expressway (WV 43)

Input Datasets

Construction History

From InspectTech

Imported Annually (same time as Inventory and Condition)

I-64 Kanawha River Bridge Oct 2008
Photos courtesy of Ahmed Mongi

Input Datasets

Future Committed Projects

Important for running scenario analysis

- Manually maintained in dTIMS
- Updated annually

Attribute	Data Type
BARS Number	Same format as Inventory and Condition.
Local Name of Bridge	Same format as Inventory and Condition.
Com Project Date	Date (MM/DD/YYYY)
Com Proj Year	Number(4) – year calculated as Project Date minus Current Year.
Com Treatment ID	Char(50) – should match treatment labels
Com Proj Number	Char(50) – freeform since not linked
Com Proj Description	Char(100) – freeform since not linked
Com Proj Cost	Number(20,2)

Bridge Types Modeled

4 basic bridge types

Painted Steel – Jointed

Painted Steel – Integral/Semi-Integral

PPC/Weathering Steel – Jointed

PPC/Weathering Steel – Integral/Semi-Integral

Bridge Type	Jointed	Integral/Semi-Integral
Painted Steel	X	X
PPC/Weathering Steel	X	X

Analysis Variables and Objective Function

Variable	Abbr.	Index	Source
Deck Condition Rating	DK	NBI CR	NBI 58: Deck
Superstructure Condition Rating	SUP	NBI CR	NBI 59: Superstructure
Substructure Condition Rating	SUB	NBI CR	NBI 60: Substructure
Wearing Surface Age	WS	Age (yrs.)	Current Year - WS Renew Year (new)
Joints Age	JT	Age (yrs.)	Current Year - JT Renew Year (new)
Paint Age	PT	Age (yrs.)	Current Year - PT Renew Year (new)
Culvert Condition Rating	CVT	NBI CR	NBI 62: Culverts

Analysis Variables and Objective Function

Variable	Abbr.	Index	Source
Composite Condition Rating	CCR	Composite CR	Function of: NBI 58: Deck; NBI 59: Superstructure; NBI 60: Substructure; NBI 62: Culverts
Composite Weight	CW	Composite Weight	Function of: NBI 29: ADT
Weighted Composite Condition Rating	COMP	Weighted composite CR	Function of: Composite Condition Rating; Composite Weight; Deck Area
NHS National Metric GFP Classification	NAT_NHS_GFP	G, F, P (Good, Fair, Poor)	Function of: DK; SUP; SUB; CVT (see above)
NHS National Measure Percent Good	NAT_NHS_PCT_GOOD	Percent (%)	Function of: NAT_NHS_GFP; NBI 49: Structure Length; NBI 52: Deck Width or NBI 32: Approach Roadway Width for culverts
NHS National Measure Percent Fair	NAT_NHS_PCT_FAIR	Percent (%)	Function of: NAT_NHS_GFP; NBI 49: Structure Length; NBI 52: Deck Width or NBI 32: Approach Roadway Width for culverts
NHS National Measure Percent Poor	NAT_NHS_PCT_POOR	Percent (%)	Function of: NAT_NHS_GFP; NBI 49: Structure Length; NBI 52: Deck Width or NBI 32: Approach Roadway Width for culverts

Analysis Variables and Objective Function

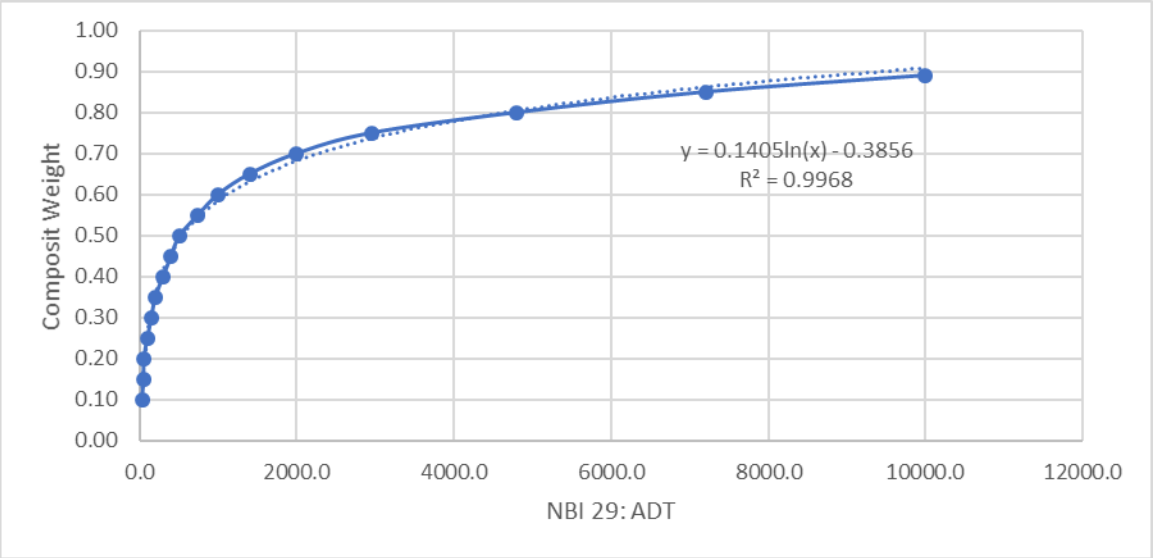
Composite Condition Rating (CCR)

$$Composite\ Condition\ Rating = 0.3 \times NBI\ 58: Deck + 0.35 \times NBI\ 59: Superstructure + 0.35 \times NBI\ 60: Substructure + 1.0 \times NBI\ 62: Culverts$$

Analysis Variables and Objective Function

Composite Weight (CW)

$$Composite\ Weight = \begin{cases} 0.1405 \times ln(NBI\ 29{:}\ ADT) - 0.3856, & 30 < NBI\ 29{:}\ ADT < 10{,}000 \end{cases}$$



Treatments or Actions

Treatment	Analysis Variable	Trigger	Counter	Description
Seal Deck	WS	0 yrs.	NA	Seal with linseed oil or epoxy resin.
Replace Joints	WS JT	0 yrs. 10 yrs.	NA	Replace seals and minor armor repairs.
Spot Paint	PT	15 yrs.	2	Painting approximately 20% of surface area.
Patch Deck	DK	CR 5	1	Partial depth patching.
Overlay	WS	20 yrs.	2	Hydro-demolish, overlay, and replace joint seals and armor.
Substructure Rehabilitation	SUB	CR 5	1	Patching concrete surfaces at bearing seats and exposed areas.
Etc...				

Treatments or Actions

Only certain actions applicable to certain bridge types

Also important to model the effects of each action on each index being tracked

And of course costs for each action

Bridge Painting, WV Turnpike

Deterioration Models

Deterioration models were defined using combination of

Expert elicitation

NBI Markov modeling

Example Bridge Deterioration

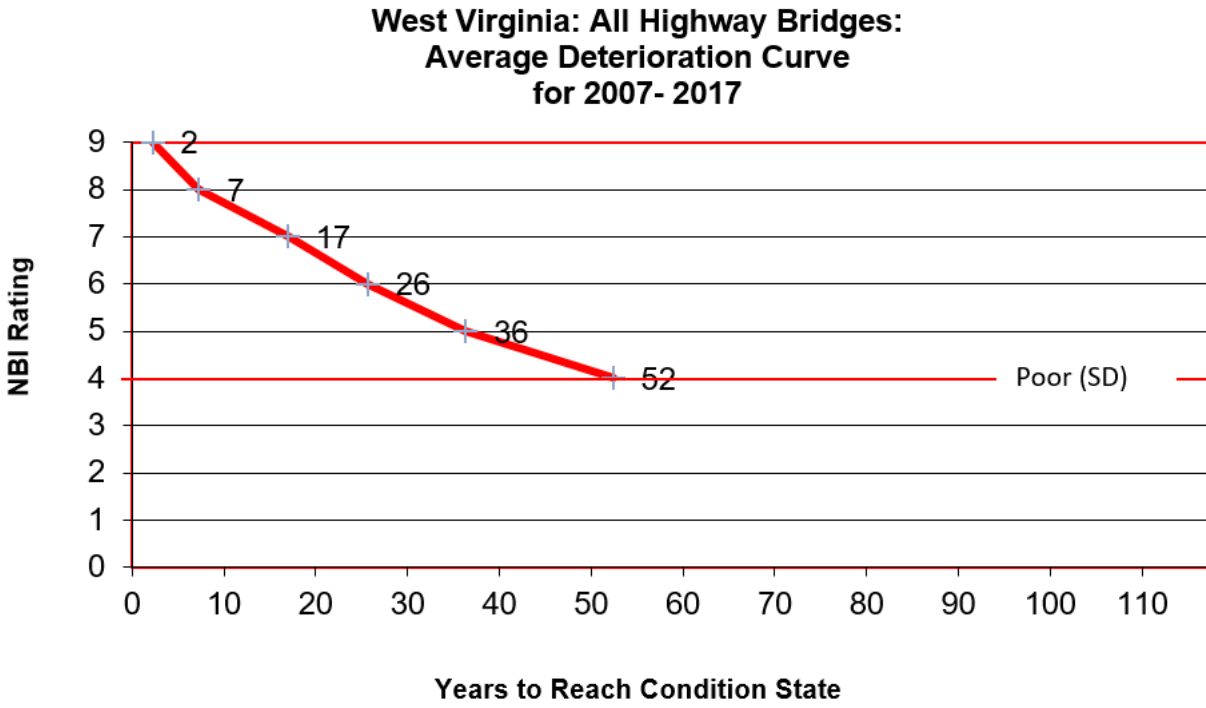
Deterioration Models

Expert elicitation

Variable	Component	Baseline Life Expectancy
DK	Deck	40 years
SUP	Painted Steel	40 years
SUP	Precast Prestressed Concrete (PPC) or Weathering Steel	60 years
SUB	Substructures of Jointed Bridges	40 years
SUB	Substructures of Integral/ Semi-Integral Bridges	60 years

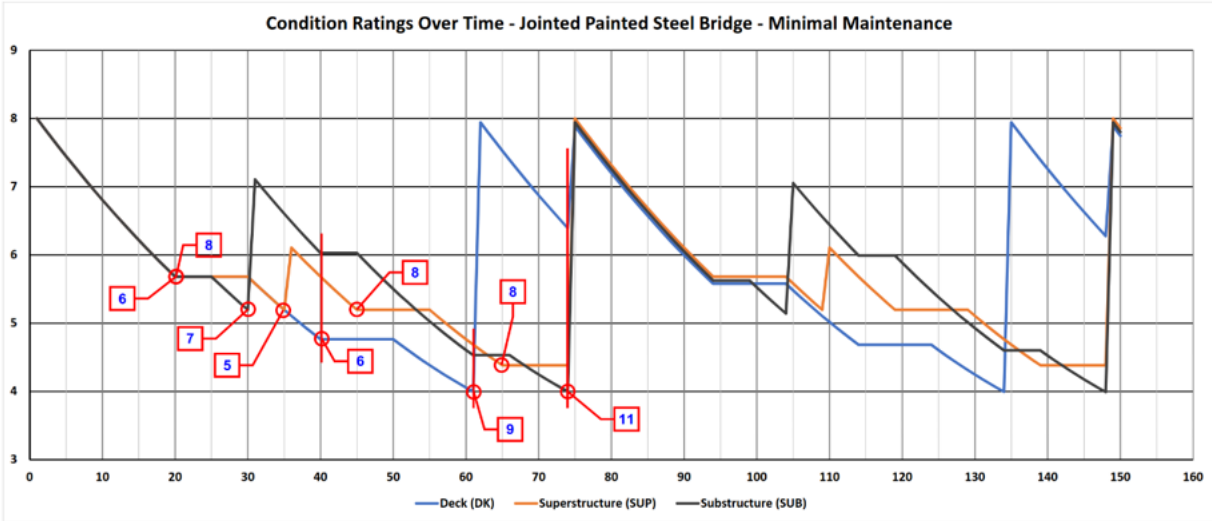
Deterioration Models

Markov modeling using NBI data



Deterioration Models

Modeling deterioration and effects of treatments also validated using expert elicitation before coding

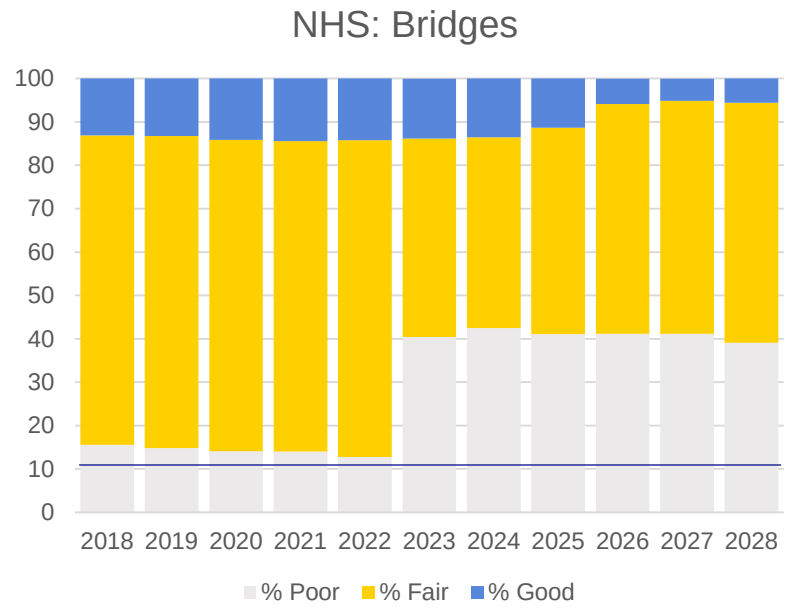


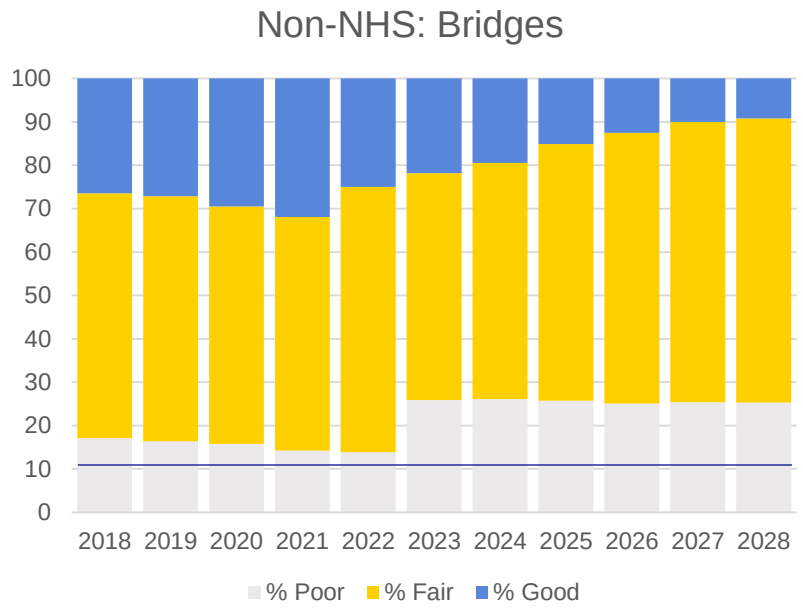
Legend:

1. Seal Deck
2. Replace Joints
3. Spot Paint
4. Patch Deck
5. Superstructure Rehabilitation
6. Overlay
7. Substructure Rehabilitation
8. Re-Paint
9. Re-Deck
10. Superstructure Replacement
11. Structure Replacement

Investment Strategies

Bridge Baseline Funding Conditions Forecast

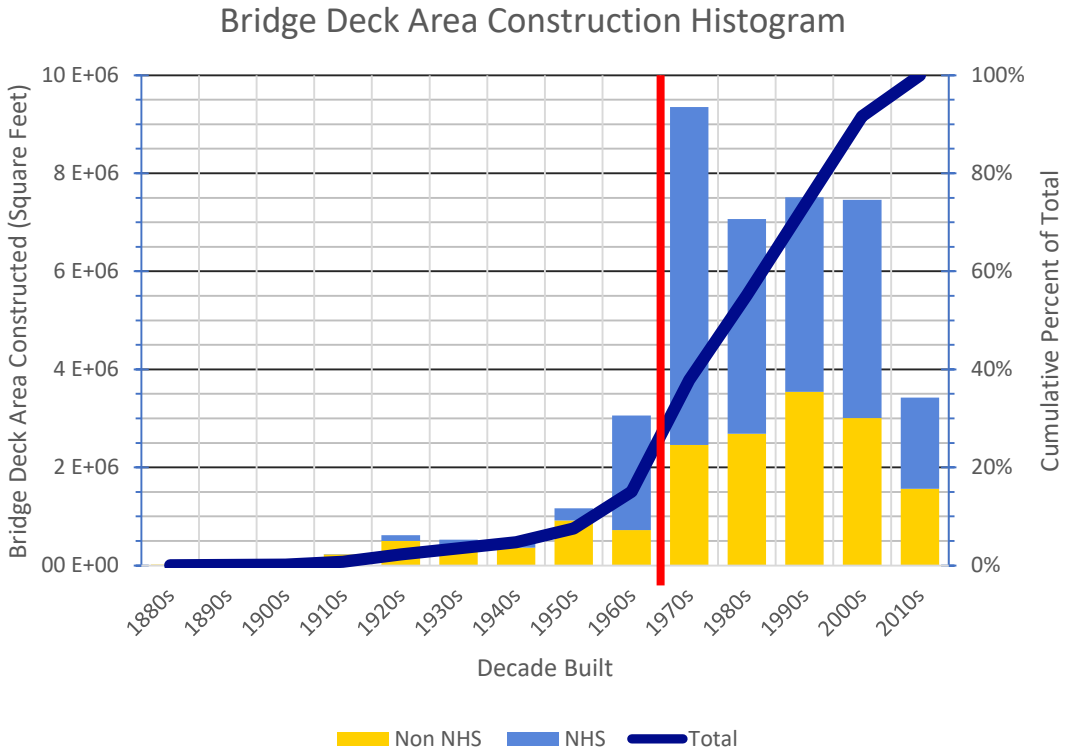




Investment Strategies

Bridge Age

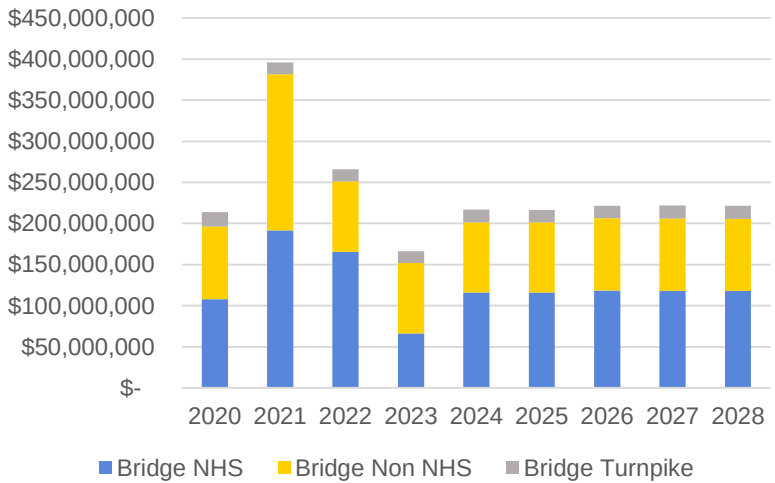
Decade	Individual Decade %/Total Deck Area			Cumulative %/Total Deck Area		
	Total	NHS	Non NHS	Total	NHS	Non NHS
1880s	0%	0%	0%	0%	0%	0%
1890s	0%	0%	0%	0%	0%	0%
1900s	0%	0%	0%	0%	0%	0%
1910s	1%	0%	1%	1%	0%	2%
1920s	1%	0%	3%	2%	0%	5%
1930s	1%	0%	3%	4%	1%	7%
1940s	1%	1%	2%	5%	1%	10%
1950s	3%	1%	6%	8%	2%	15%
1960s	7%	10%	4%	15%	12%	20%
1970s	23%	28%	15%	38%	40%	34%
1980s	17%	18%	16%	55%	58%	51%
1990s	18%	16%	22%	73%	74%	72%
2000s	18%	18%	18%	92%	92%	91%
2010s	8%	8%	9%	100%	100%	100%



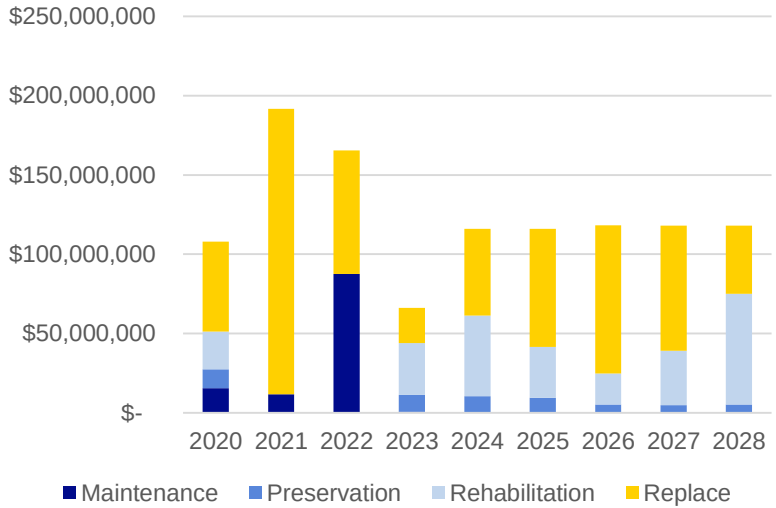
WVDOH TAMP

Bridge Plus $50 Million for NHS Bridges starting in 2024 Scenario

Full Network Funding



NHS Funding by Work Type



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MOTT MACDONALD

THE KERCHER GROUP

Thank you

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