Michigan DOT

Bridge Management System

Presented to Domestic Scan on Bridge Management - Webinar

November 19, 2009

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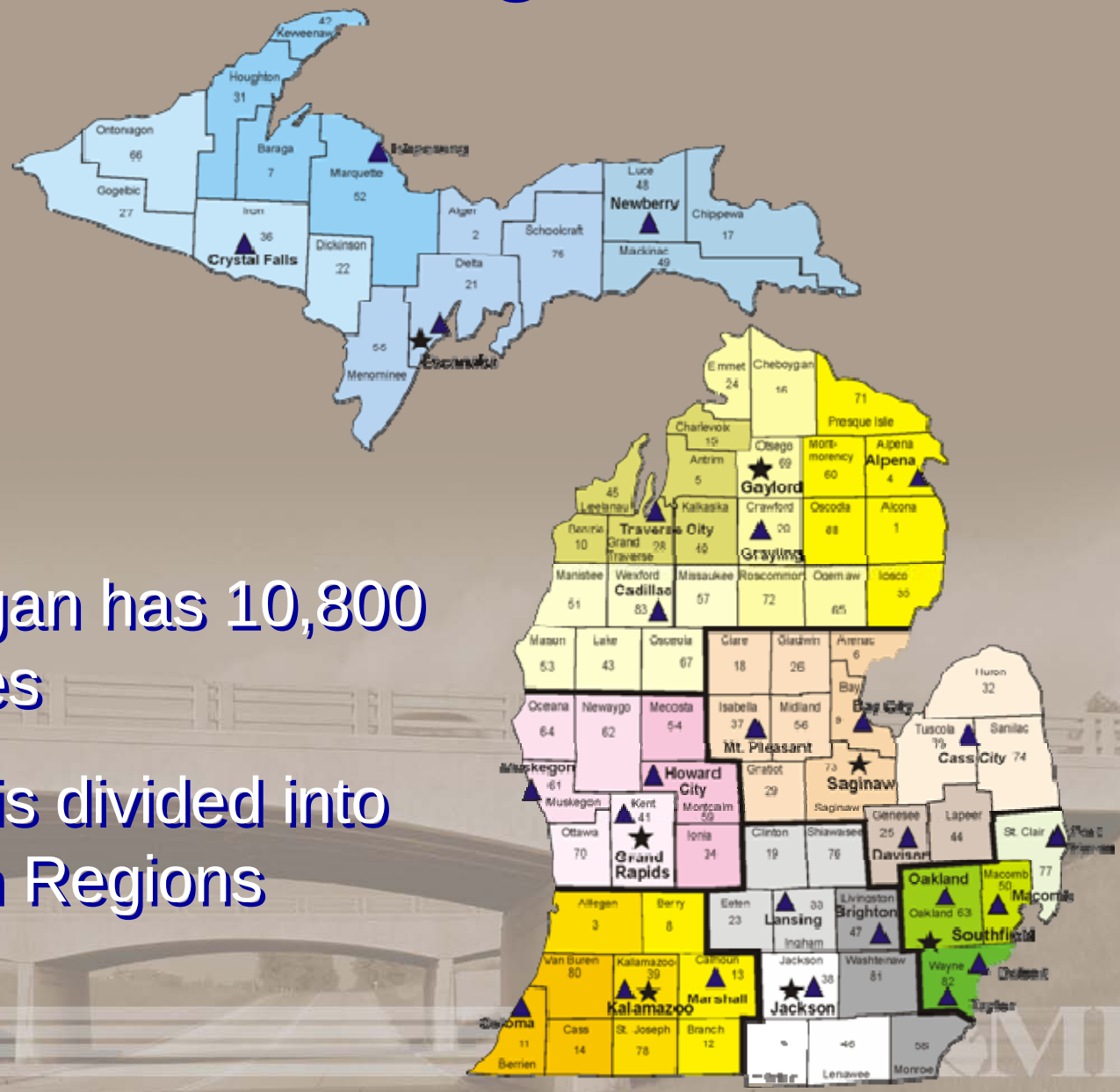
Michigan DOT



Michigan has 10,800 Bridges

State is divided into Seven Regions

Asset Management

Project Selection Process
- Coordinate w/Other Systems
- Call for Projects
- Scoping
- Programming

Bridge Management System
- Set Goals
- Develop Strategies
- Deterioration Modeling
- Project Cost
- Preservation Rules
- Network Management

Bridge Inspection
- Safety and Evaluation
- Data Collection
- Data Management

Construction
- Replacement
- Rehabilitation
- Preventive Maintenance
- Track Project Cost

Design
- Preliminary Design
- Final Design
- Engineers Estimate

MDOT

Michigan DOT Goals Established in 1998

- Immediately address the needs of 100% of structures of critical concern
- 95% of freeway bridges in good or fair condition by 2008
- 85% of non-freeway bridges in good or fair condition by 2008

Performance Measures

- Performance Measure - A quantifiable, enduring measure of outcomes, outputs, efficiency, or cost-effectiveness. In general, measures should be related to an agency's mission, goals and programs, and should not merely measure one-time or short-term activities (i.e. - should be ongoing or periodic measurement).

What is a need indicator?

- Data collected that identifies a specific work type or activity.
- Example – Deck concrete spalling or delaminating identifies deck patching

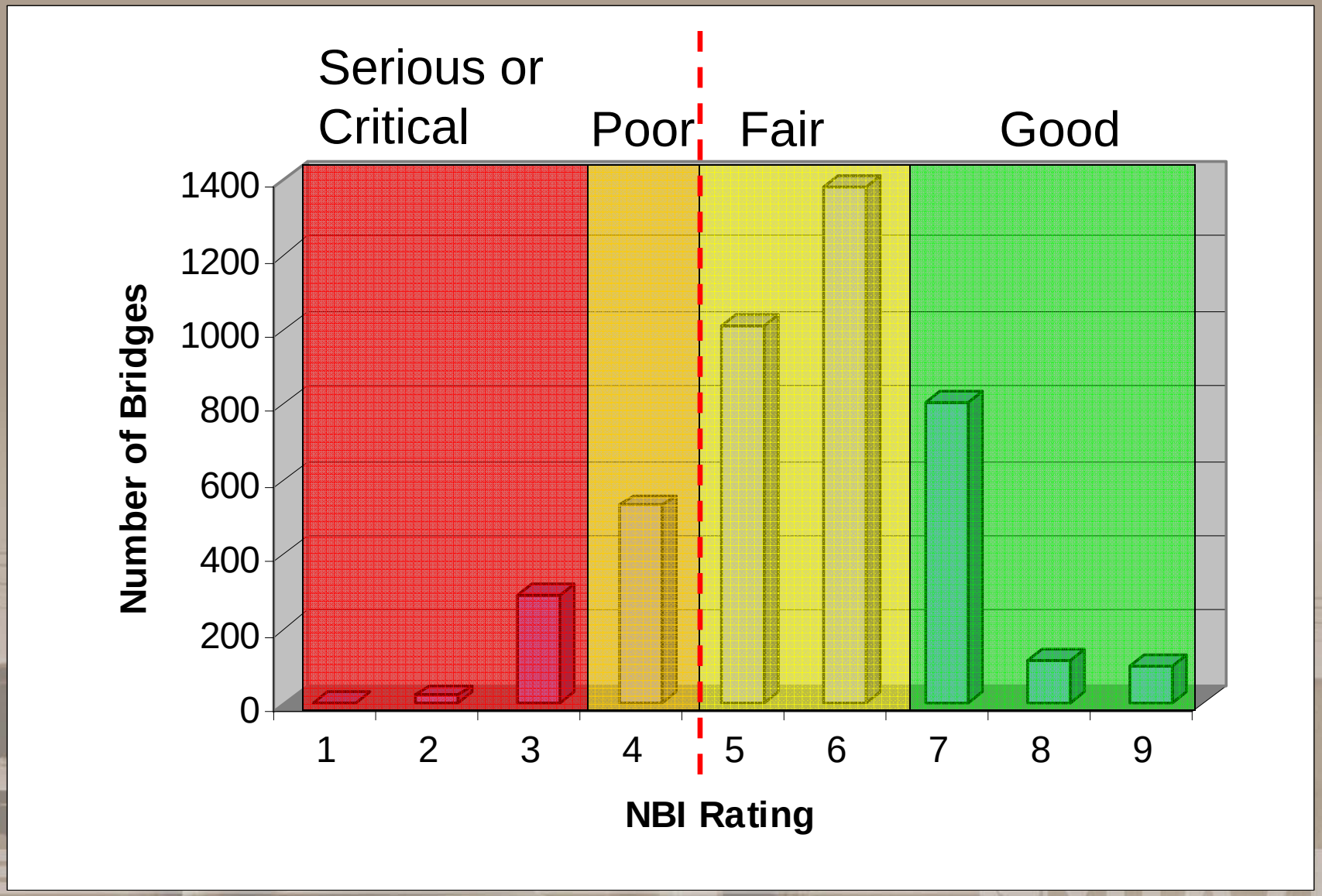
Condition State 2 - "Delaminated"

Condition State 3 - "Spalled with Bit. Patch."

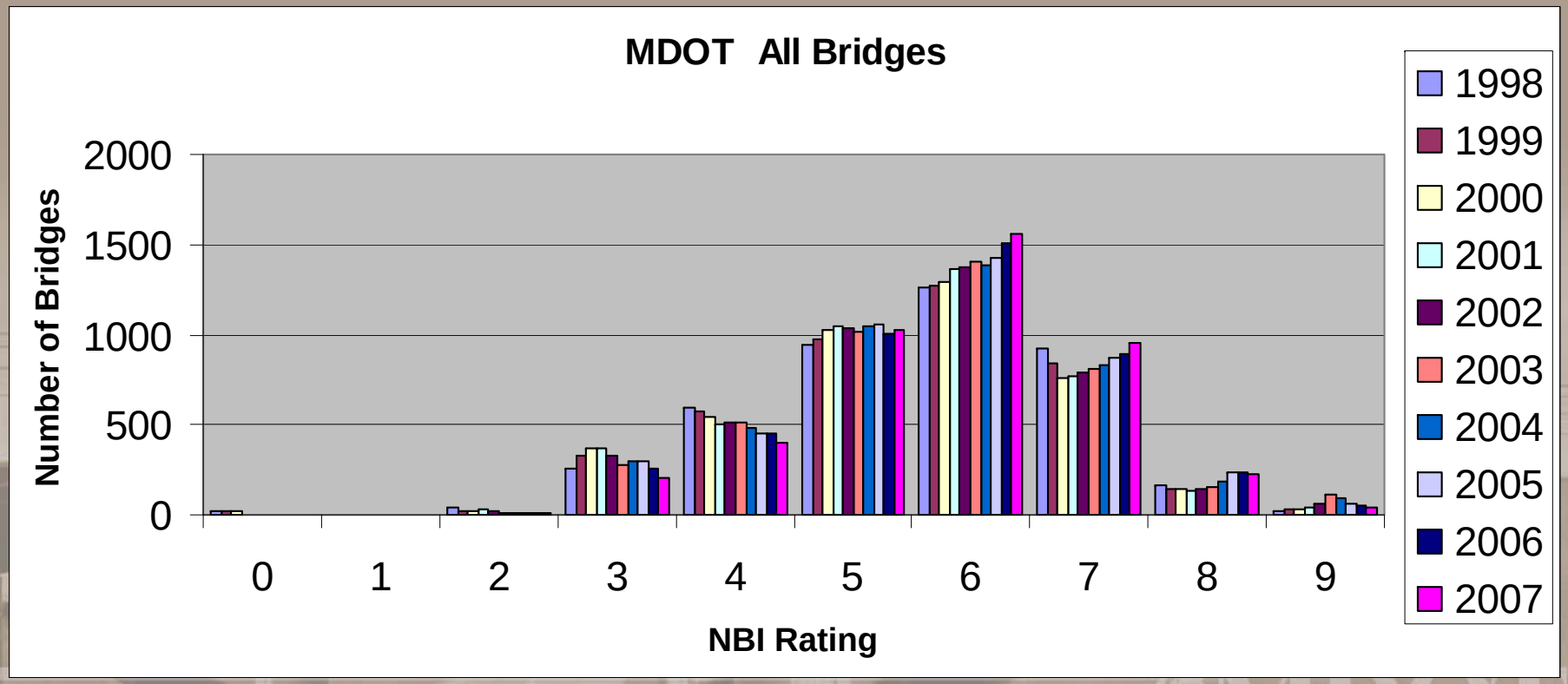
Michigan DOT Performance Measures

- Condition goals based upon NBI condition ratings
- Rating of "Major Elements"
  - Deck, superstructure, and substructure
  - "Weakest Link" determines rating for bridge

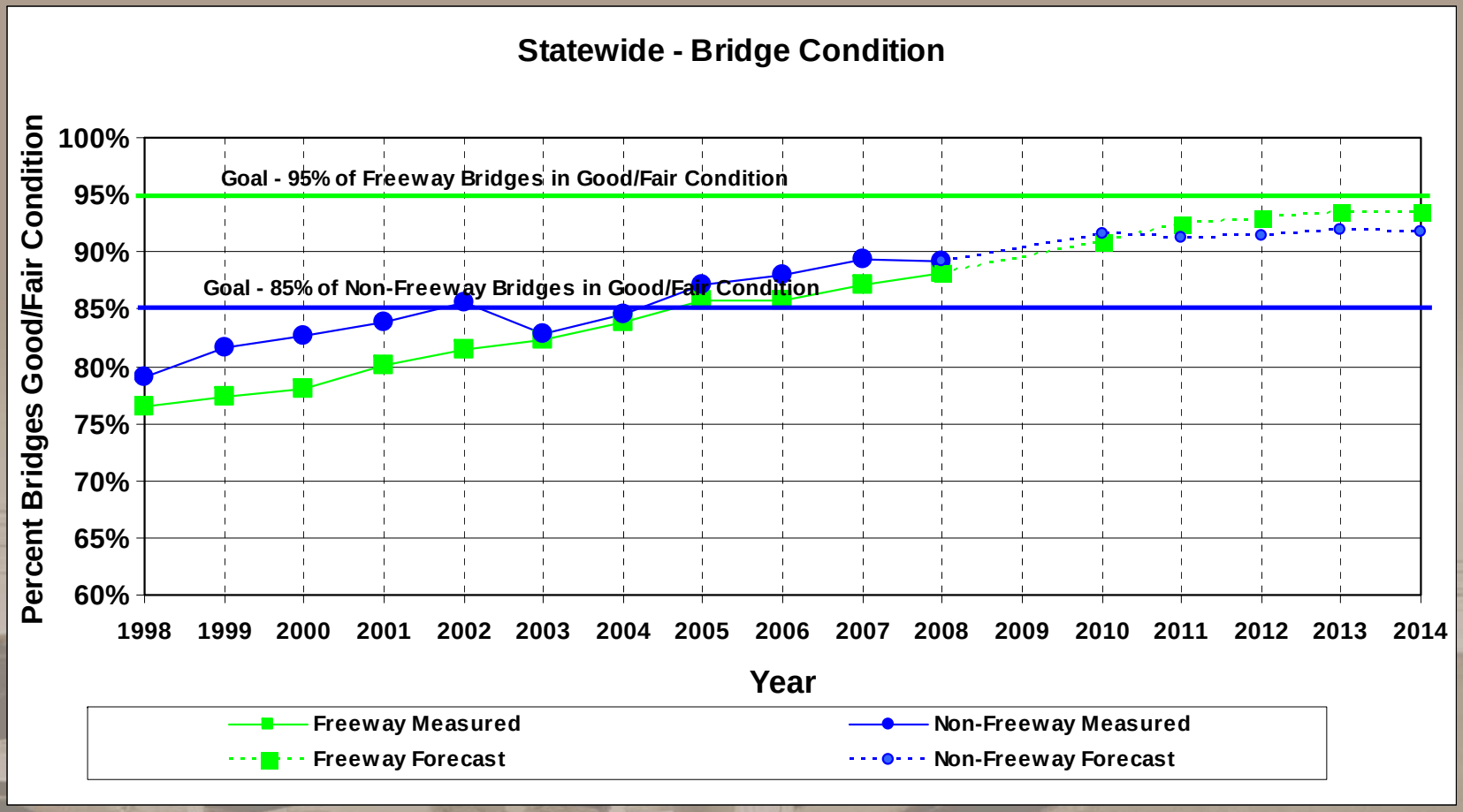
Bridge Condition Ratings



Performance Measure
Monitor Number of Bridges In Each Condition State



Monitoring Progress Towards Goals



“Mix of Fixes” Strategy”

- **Replacement – NBI rating of 4 or less**
- **Rehabilitation – NBI rating between typically 4 and 5**
- **CPM - C**apital **P**reventive **M**aintenance. NBI rating typically 5 or 6
- **MDOT Allocates 20% Funds to preventive Maintenance, 30% rehabilitation, and 50% Replacement**

Michigan's Bridge data

- National Bridge Inspection (NBI)
  - 0-9 rating scale
- AASHTO Commonly Recognized (CoRe) Elements (Pontis)
- Inspector Recommendations

NBI

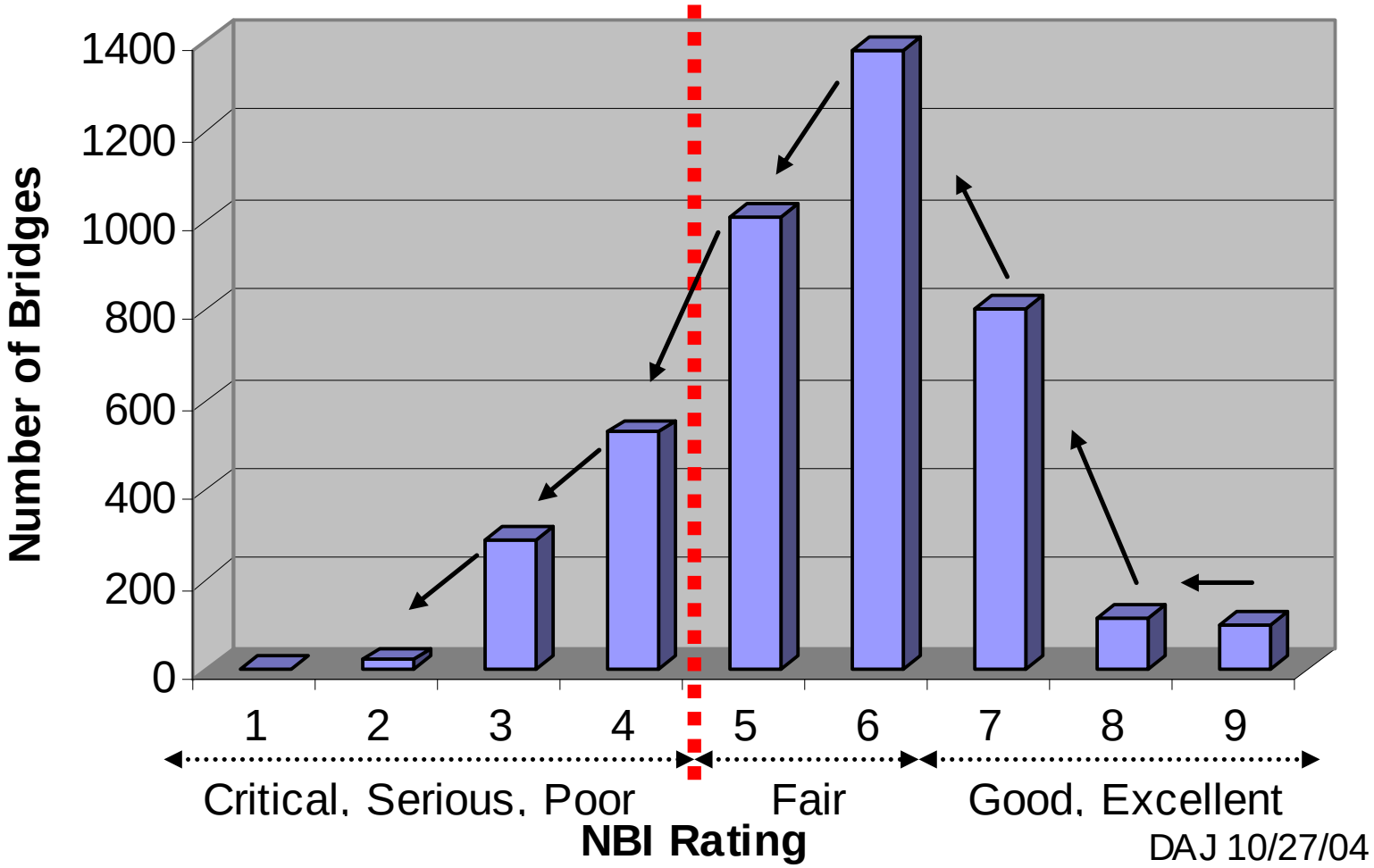
Bridge Safety Inspection Report (BSIR)

- Strengths
  - Well understood
  - Well accepted
  - Shows criticality of major elements
  - Comments (descriptive)
  - Clearly defines good, fair, poor
- Weaknesses
  - Does not distinguish categories within major elements (bare deck or rigid overlay)
  - No quantities
  - Entire portion of element in one condition state
  - Comments (can not be queried)

Pontis (CoRe Elements)

- Strengths
  - Distinguishes categories within major elements (ex. - bare deck or rigid overlay, Unpainted beams or painted)
  - Has quantities
  - Portions of element in different condition states (descriptive)
  - Flexible architecture to data base structure (can easily add new elements.)
  - Smart flags, sub elements
  - Designed for computerized linear analysis
- Weaknesses
  - Not as well understood
  - Not very often being used in business process
  - Does not show criticality of need very well
  - No Comments (descriptive)
  - Variable number of condition states confusing
  - Good, fair, poor not immediately apparent

Deterioration



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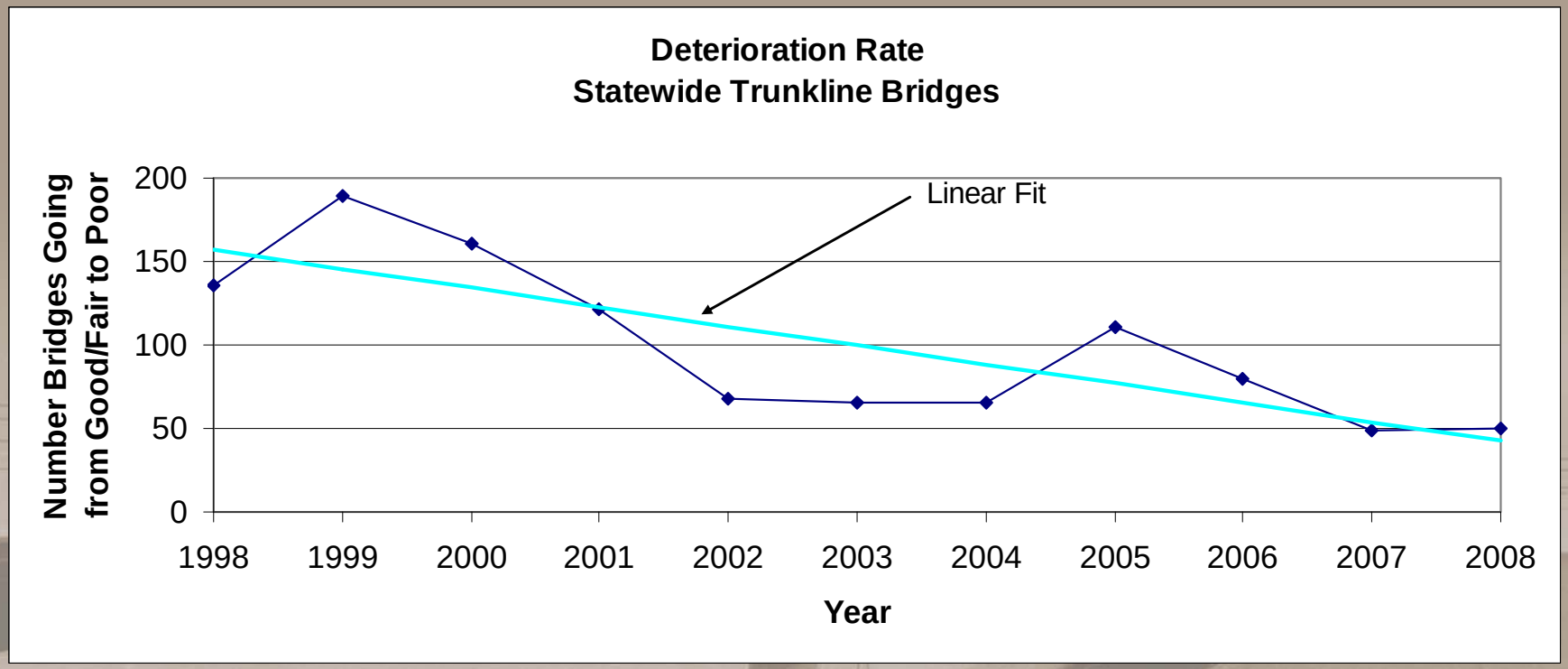
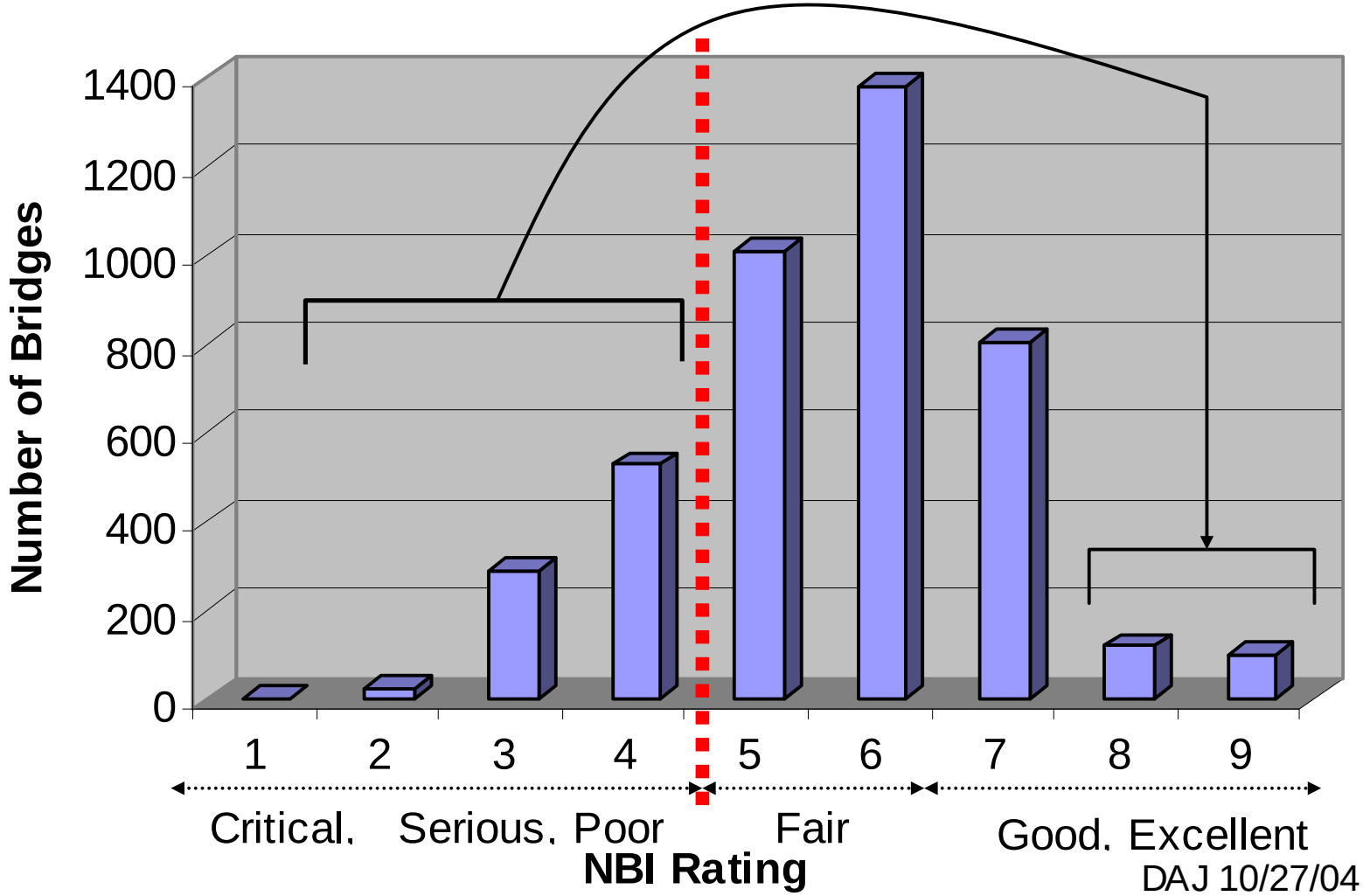
Performance Measure
Monitor Bridge Deterioration Rate



Replacement Projects

- Deck Replacement
- Superstructure Replacement
- Bridge Replacement

Replacement ($1.2 - $1.8 Million)



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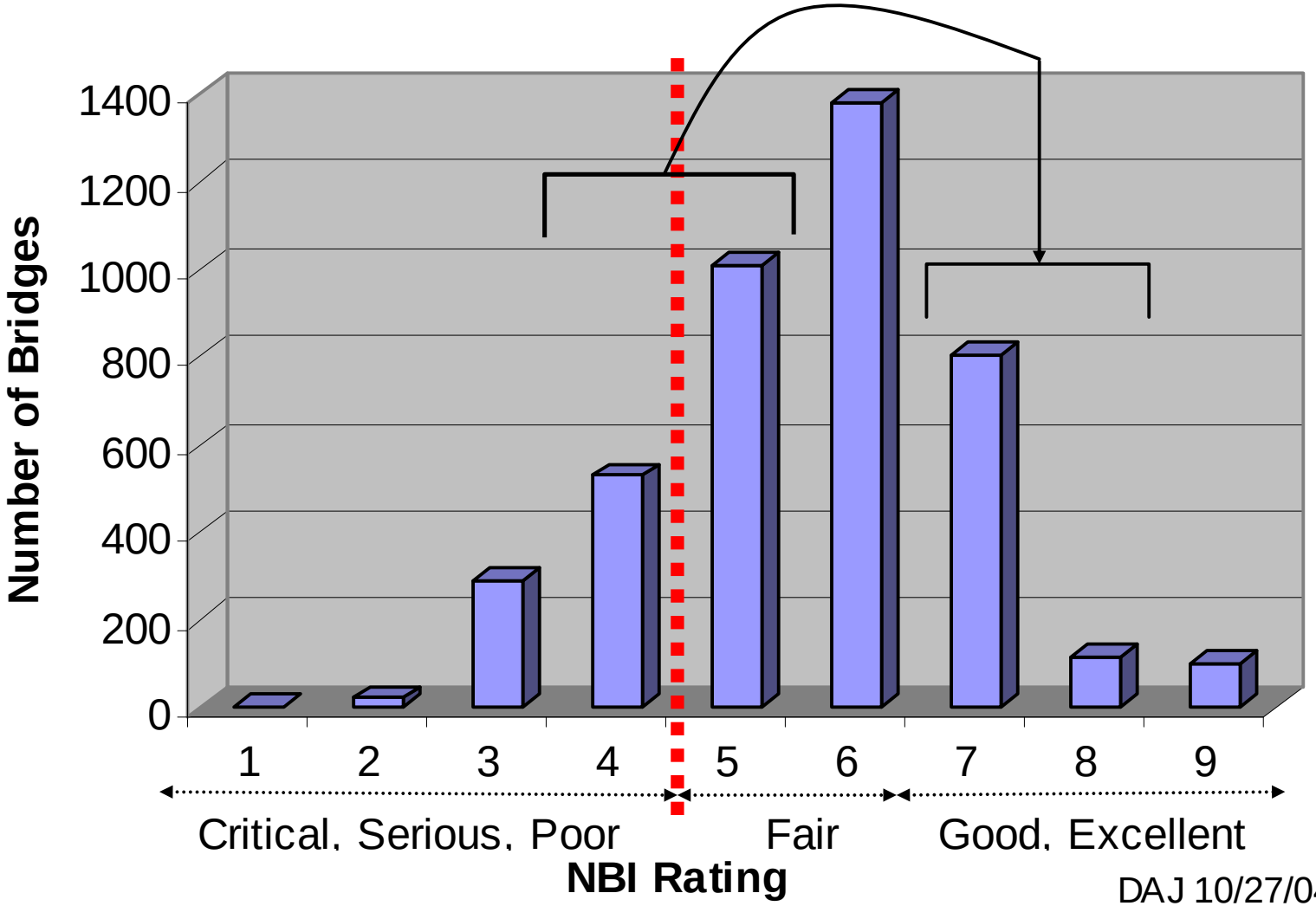
Rehabilitation Projects

- <u>Deck overlays</u>
- Superstructure Repairs
- Substructure Repairs

Rehabilitation ($500 - 700 Thousand)



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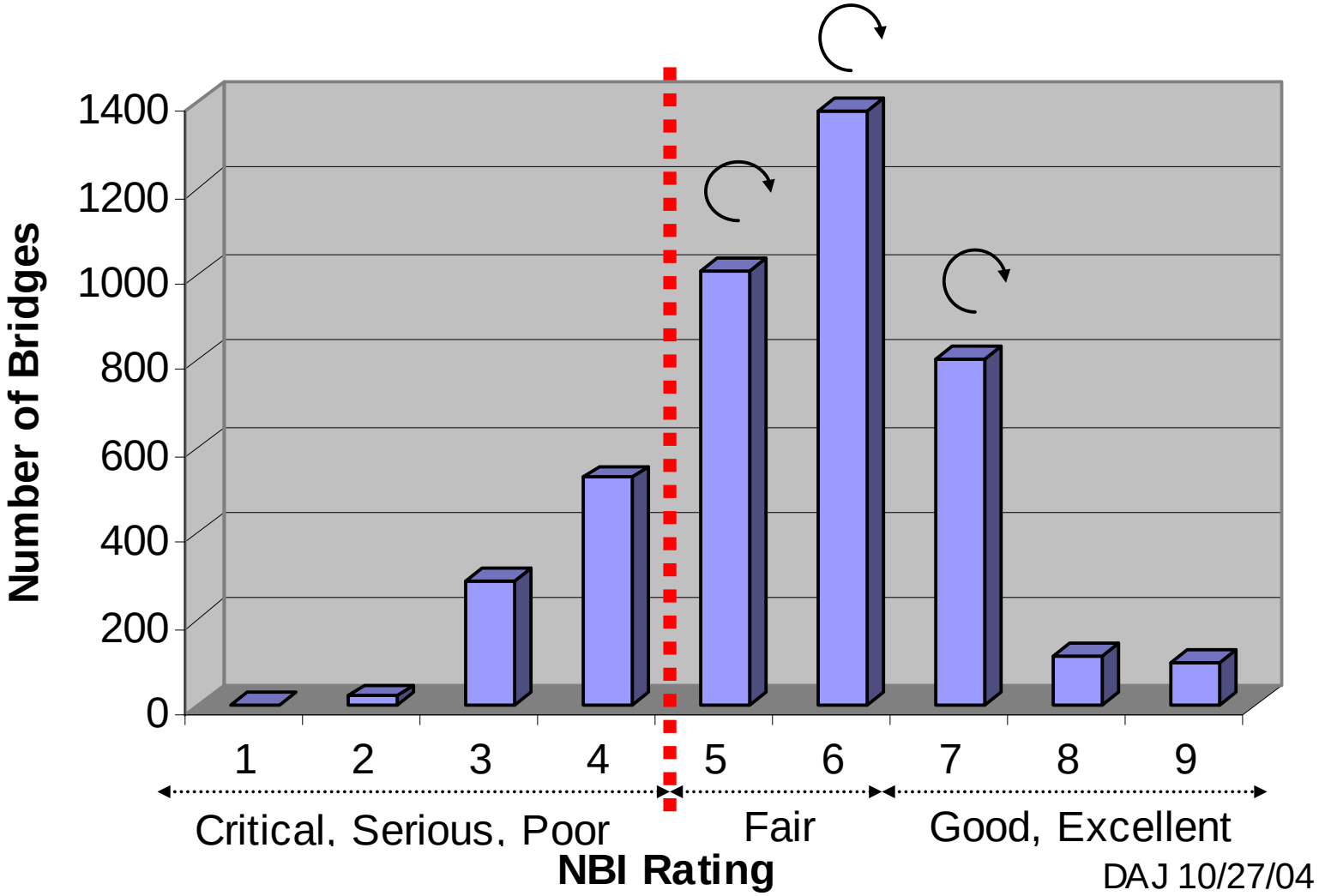
Preventive Maintenance Projects

- Joint Replacements
- Pin & Hanger Replacements
- Complete Painting
- Zone Painting
- Epoxy Overlays
- Deck Patching
- (many more)…

Preventive Maintenance ($200 - $300 Thousand)



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Goals and Objectives of Preventive Maintenance

- Slow the deterioration rate of bridges and bridge elements.
- Maintain population of bridges in fair condition (prevent them from becoming poor).
  - Performance Measure – Number of bridges entering poor category.
- However, Bridges in poor and serious condition also need PM

Transition Probabilities also work very well with the NBI ratings

3 Year Average

	Transition Probability Matrix							Percent		
	0	1	2	3	4	5	6	7	8	9
9	0	0	0	0	0	0	0	0.0806452	0.3524194	0.5669355
8	0	0	0	0	0	0.0070423	0.0035211	0.2130282	0.7764085	1.2213837
7	0	0	0	0	0.0008929	0.0061095	0.0750529	0.9179448	2.7388835	
6	0	0	0	0.0014465	0.0056687	0.0447737	0.9481112	8.095806	3.9602673	
5	0	0	0	0.0041703	0.0527135	0.9431162	13.008661	12.056073		
4	0	0	0	0.0293359	0.9706641	11.835356	25.064734			
3	0	0	0.0065134	0.9934866	23.279647	36.90009				
2	0	0	1	106.07231	60.179737					
1	#DIV/0!	#DIV/0!								

Probability stay in that condition state (highlighted yellow)

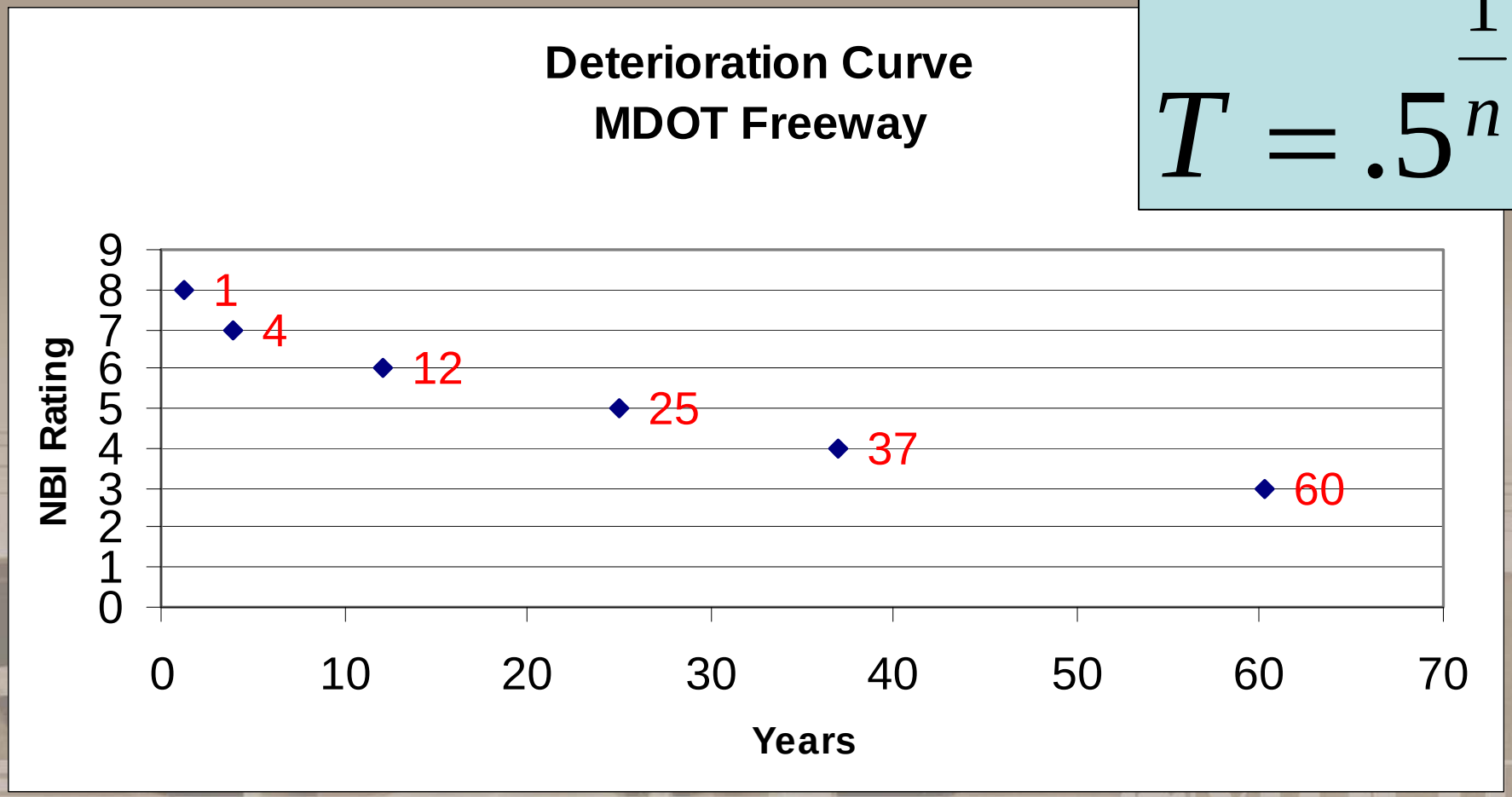
When the entire element is in one condition state, you can monitor the transition probability that the element will drop more than one condition state. Example – Above 57% bridges that were rated 9 remained 9, 35% dropped to 8, and 8% dropped to 7.

Management of MDOT's "Big Bridges"

- Complex bridges, including movable bridges, post tensioned segmental concrete bridges, and bridges with larger deck area (over 100,000 square feet) are inspected and managed by a statewide "Bridge Operations Unit" based out of Lansing.
- Goal is to always maintain these bridges in good or fair condition

Convert Transition Probability to Deterioration Rate for Display Purposes and Comparison.

$$T = .5^{\frac{1}{n}}$$



Bridge Decks

- Number one overarching need Indicator
- The condition of bridge decks most often drive bridge projects.

Bridge Deck Preservation Matrix

BRIDGE DECK PRESERVATION MATRIX

CONDITION STATE				REPAIR OPTIONS (c)	POTENTIAL RESULT TO NBI		NEXT ANTICIPATED EVALUATION
Deck Surface NBI #58a	Deck Surface Deficiencies % (a)	Deck NBI #58	Deck Underside Deficiencies % (b)		Item # 58a Deck Surface Rating	Item # 58 Deck Rating	
N/A	N/A	N/A	N/A	CSM Activities	No Change (d)	No Change (d)	1 to 8 years
NBI = 5, 6, 7	2% to 5%	NBI > 5	N/A	Deck Patch / Seal Cracks	Up by 1 pt.	No Change (d)	3 to 10 years
				Epoxy Overlay	NBI now 8, 9	No Change	10 to 15 years
		NBI ≤ 5	N/A	Deck Patch	Up by 1 pt.	No Change	3 to 10 years
				Hold	No Change	No Change	1 to 8 years
NBI = 5	5% to 15%	N/A		Hold	No Change	No Change	1 to 8 years
				Deck Patch	Up by 1 pt.	No Change	3 to 10 years
NBI = 4 or 5	15% to 30%	NBI = 5,6	<10%	Deep Concrete Overlay	NBI now 8, 9	Up by 1 or 2 pts.	25 to 30 years
		NBI = 3 or 4	10% to 30%	Shallow Concrete Overlay	NBI now 8, 9	Up by 1 pt	10 to 15 years
		NBI = 2 or 3	>30%	HMA Overlay with waterproofing membrane(e)	NBI now 8, 9	No Change	8 to 10 years
NBI= ≤ 4	>30%	NBI = > 5	<5 %	Deep Concrete Overlay	NBI now 8, 9	Up by 1 or 2 pts.	20 to 25 years
		NBI = 3, 4, or 5	5% to 30%	Shallow Concrete Overlay	NBI now 8, 9	Up by 1 pt	10 years
				HMA Overlay with waterproofing membrane(e)	NBI now 8, 9	No Change	5 to 7 years
		NBI = 2 or 3	>30%	Replace Deck	NBI now 9	NBI now 9	40+ years
				HMA Cap (f)	NBI now 8, 9	No Change	1 to 3 years

a.) Percent of deck surface area that is spalled, delaminated, or patched with temporary patch material.
b.) Percent of deck underside area that is spalled, delaminated or map cracked.
c.) The ⅄Hold⅃ option implies that there is on going maintenance of filling potholes with cold patch and scaling of incipient spalls.
d.) Sustains the current condition longer.
e.) Hot Mix Asphalt overlay with waterproofing membrane. Deck patching required prior to placement of waterproofing membrane.
f.) Hot Mix Asphalt cap without waterproofing membrane for ride quality improvement. Deck must be replaced in 1 to 3 years and be in the 5 year plan.

Bridge Deck Matrixrev110404.wpd **November 4, 2004 Rev.**

Need Indicators are Deck Top and Bottom Surface Condition

- Top Surface
  - 2 to 5% - deck patch, epoxy overlay
  - 5% to 15% - deck patch
  - > 15% - rigid overlays, HMA overlays

- Bottom Surface
  - < 10% - deep overlay
  - 10% to 30% shallow overlay
  - > 30% replace deck.

For more information see MDOT Bridge Deck Preservation Matrix

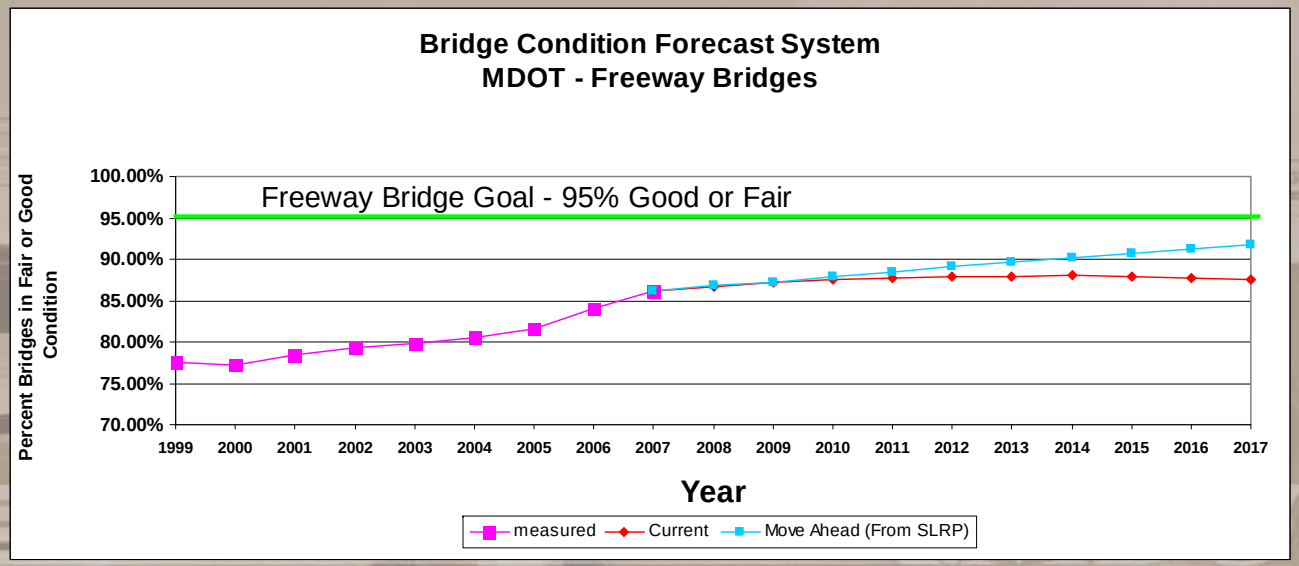
We are also working on better need indicators for delaminated rigid overlays

We often have bridge decks having rigid overlays (concrete, latex modified, or silica-fume) having very small percentage of spalls (< 2%) but having large percentage of delaminations (30% plus).

Question – How long will it take delaminated area to spall?

Bridge Condition Forecast System

- Evaluates different mix of fixes (PM, Rehab, and Replacement
- Compares different yearly budgets
- Uses average cost per deck area
- Deteriorates population of bridges using transition probabilities
- User sets which bridges will be worked on and what end result is



Pontis Calibration

Comparison of Pontis Selected Projects vs Actual Let Projects

Key	
34 Bridges	"Underscoped", Pontis Recommended Less Work Than Actually Let
22 Bridges	"Overscoped", Pontis Recommended More Work Than Actually Let
26 Bridges	"Good Scope", Pontis Recommended The Same or Nearly Same Work As Let

Actual Let Projects				Pontis Project Recommendations				
Job No	Let Date	Let Work Descr	Let Cost	Year	Element	Action	Item Cost	Proj Cost
100217	10/12	Bridge Replacement	824,826	2015	Conc Dk Black Bars	Repl Elem	174,850	174,850
100577	10/10	Substr Rpr, Dk & Beam Patch, Thrie Bm	149,856	2017	Conc Dk Black Bars	Ovly Deck	149,046	294,064
					Strip Seal Exp Joint	Repl Elem	138,000	
					Reinf Conc Pier Cap	Rehab Elem	7,018	
100577	10/10	Substr Rpr, Bm Rpr, Crack Rpr, Dk patch, Th	38,845	2017	Bridge	Replace	574,271	574,271
79086	04/09	Deep Overlay & Rail Repl	260,000	2012	Pourable Joint Seal	Repl Elem	27,600	37,892
					Conc Dk Black Bars	Min Repair	10,292	
79086	04/09	Deep Overlay & Rail Repl	260,000	2012	Conc Dk Black Bars	Min Repair	10,292	37,892
					Pourable Joint Seal	Repl Elem	27,600	
					Strip Seal Exp Joint	Repl Elem	49,680	
				017	Conc Dk Black Bars	Min Repair	9,704	66,884
					Pourable Joint Seal	Repl Elem	7,500	
					Strip Seal Exp Joint	Repl Elem	48,025	
				017	Conc Dk Black Bars	Min Repair	10,666	65,891
					Pourable Joint Seal	Repl Elem	7,200	
					Strip Seal Exp Joint	Repl Elem	51,335	
				017	Conc Dk Black Bars	Min Repair	9,830	68,965
					Pourable Joint Seal	Repl Elem	7,800	

Identify Possible Projects, Work Types and Estimate of Cost

Detailed Scopes

- The routine (visual) bridge inspection is not enough to determine actual bridge project needs.
- Chain drag bridge deck
- Sound concrete surfaces
- Measure section loss of corroded beams
- Compare costs of different fixes (sometimes using life cycle cost analysis)

Thank You