

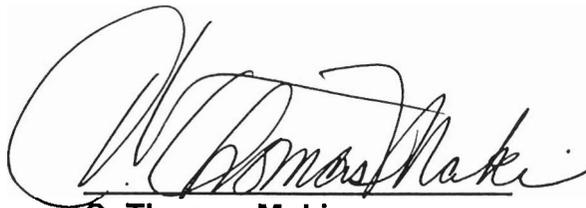
# Strategic Investment Plan for Trunkline Bridges

## Goals and Strategy Section

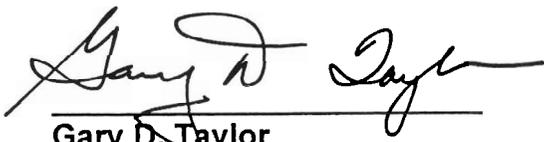
May 14, 1998

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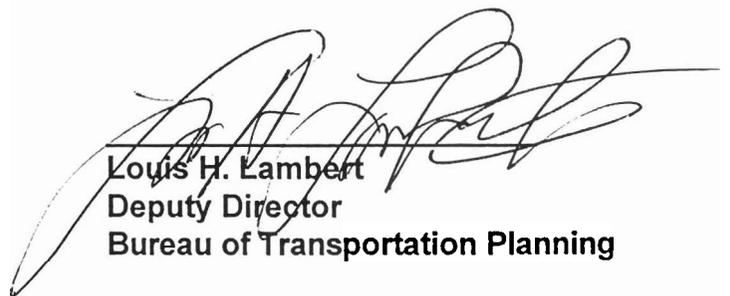
Improvement of the state trunkline bridge network condition is critical to successfully accomplishing MDOT's mission. This "Goals and Strategies Section" of our Strategic Investment Plan for Trunkline Bridges will stand as the cornerstone of our commitment to long range strategic planning and investment in our trunkline bridge network.



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## PREFACE

This document represents our “first step”, of many steps we will take as an organization, on our journey to good planning and tactical investing in our trunkline bridge network. Paradigms will need to shift as we transition to an organization where asset management, involving long range strategic planning and investing, becomes a routine part of our daily business process.

A grateful acknowledgment goes to the following members of the Bridge Management Team who willingly participated in the development of the “Goals and Strategies Section” of MDOT’s Strategic Investment Plan for Trunkline Bridges.

Bobbi Welke, Southwest Region  
Roger Safford, Metro Region  
Mark Chaput, Transportation Planning  
Susan Gorski, Transportation Planning  
Bob Kelley, Design Division  
Sonny Jadun, Maintenance Division  
Jon Nekritz, FHWA

Many hours of “out of box” discussion and debate by these individuals resulted in a document that will reshape our traditional ways of thinking about, and addressing the needs of, our bridge network.

Glenn Bukoski  
Bridge Management Team, Chairperson

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## **Bridge Network Goals**

The goal of MDOT's Strategic Investment Plan for Trunkline Bridges is to preserve the trunkline bridge network to insure safety and serviceability, while optimizing all available resources. Specifically the network condition goals are:

As a priority on the network, immediately address the needs of **100%** of the ***structures of critical concern***.

To improve the overall condition of the ***freeway bridge network*** so that **95%** of the structures on that network are rated **good** or **fair** by **2008**.

To improve the overall condition of the ***non-freeway bridge network*** so that **85%** of the structures on that network are rated **good** or **fair** by **2008**.

## **Bridge Network Strategies**

### **Bridge Network Management Strategy:**

The Michigan Department of Transportation bridge network consists of 4,579 structures. The network includes grade separations, waterway crossings, plaza structures, pedestrian structures, railroad structures, and culverts. Bridges are evaluated and rated based on data collected about the condition of bridge elements. These elements represent the individual components which make up the bridge, the three major bridge elements considered are deck, superstructure, and substructure.

The current status of the bridge network condition is 22% poor (see Appendix A for existing network condition graphs). This current condition status and the absence of long term network goals dictated the need to change the way we do business. An integrated network management strategy is necessary to achieve the proposed network condition goals in a cost effective manner. The recommended strategy incorporates components of Maintenance and Preservation/Modernization.

- I. **Maintenance** - Scheduled or reactive work activities that maintain existing serviceability. Historically, maintenance was focused on reactive activities. However, failure to consistently perform scheduled maintenance activities has accelerated the deterioration of the bridges. A new emphasis on conducting a Capital Scheduled Maintenance (CSM) program is recommended while sustaining the necessary reactive activities. CSM activities maintain serviceability and reduce deterioration rates preventing "good" from becoming "fair structures. (See Glossary for CSM definition)
- II. **Preservation/Modernization** - Programmed work activities that restore or improve element integrity and ensure network safety and serviceability. A key assumption of the recommended strategies outlined below is that the identified maintenance activities are being performed. The following categories contain the core activities that impact the network condition, projects will be selected and prioritized with a Regional perspective.

#### **Core Activities - (CPM/R&R)**

- **Capital Preventive Maintenance (CPM)** - Scheduled work activities that restore element integrity. CPM activities prevent "fair" structures from becoming "poor" structures. (See Glossary for CPM definition; see Appendix B describing parallels between road and bridge CPM activities.)

- **Rehabilitation (R)** - Programmed work activities that improve element integrity. Rehabilitation work activities improve condition ratings to "fair" or "good". Project selection will be considered on a worst first basis. (See Glossary for Rehabilitation definition.)
- **Replacement (R)** - Replacement work activities improve condition ratings from "poor" to "good". Project selection will be considered on a worst first basis. (See Glossary for Replacement definition.)

### **CPM/R&R Modeling Tool**

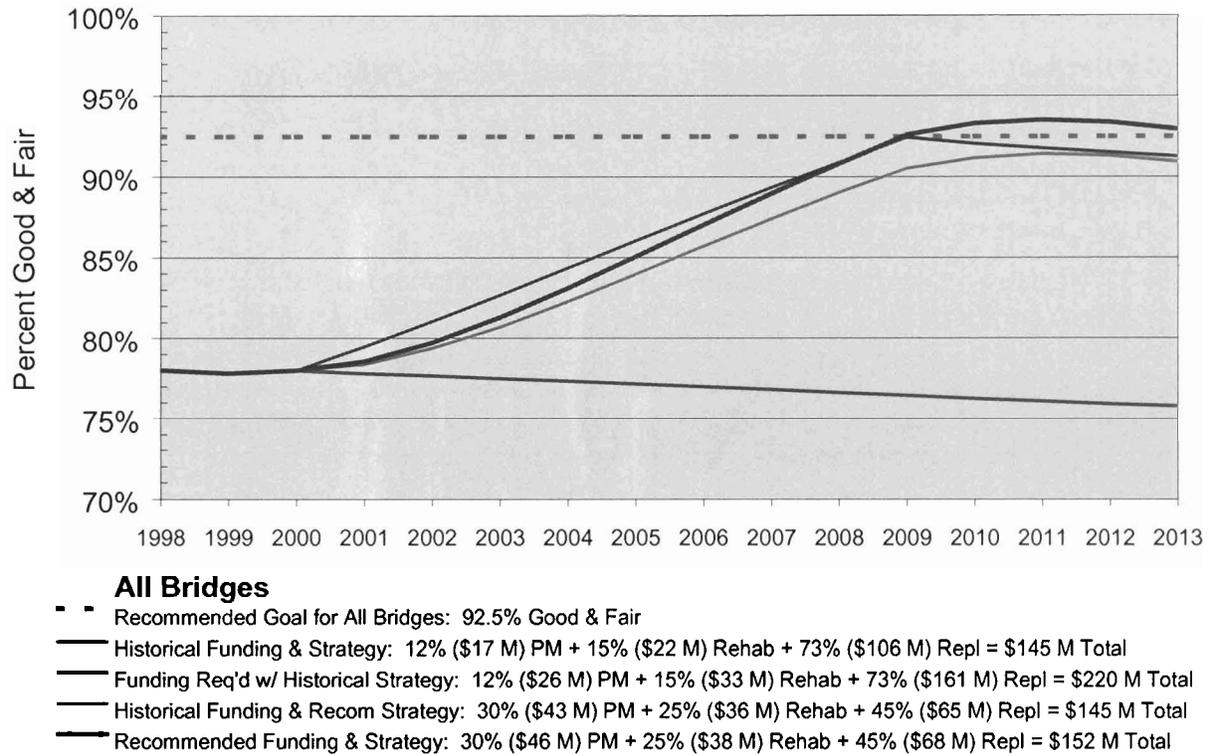
Pontis is an element level analysis tool that projects element condition level into the future. Beyond the element level, a tool was needed to predict future network condition in the context of "good", "fair" and "poor". A modeling tool, the Bridge Condition Forecasting System (BCFS), was developed for this purpose, and is similar to the Road Quality Forecasting System (RQFS). BCFS uses average deterioration rates and average costs (without inflation escalators), based on historical data and professional judgement. The ability of BCFS to accurately predict the impact of a particular strategy (mix of fixes), depends on the accuracy of the assumptions made in the model. (See Appendix C for BCFS model assumptions)

BCFS uses current NBI data, which is essentially a parallel of the Pontis bridge inspection data. The group of structures modeled in BCFS represent 88% of the entire statewide bridge network. This structure group does not include Big Bridges which will be addressed separately. Also not included are pedestrian structures, railroad structures or culverts for which cost and condition data is handled differently than highway bridges.

BCFS was used to develop a recommended statewide strategy. The statewide strategy developed is a mix between CPM/R&R and is 30%, 25% and 45% respectively. MDOT acknowledges the need to transition to this strategy from the historical strategy in order to accommodate paradigm shifts and the overall impact to the industry. (See Appendix D for the Strategy Transition Plan)

BCFS can also be used in Regional strategy development to address the varying distribution of needs for each Region. Each Region will consider issues such as current network needs, cost and user impact which cause their region to deviate from averages used in the statewide modeling. Individual Regional strategies must aggregate to conform to the statewide strategy.

### Projected Bridge Network Condition Based on Various Funding & Strategies



BCFS

August 1998

**Figure 1** Graph to illustrate strategy comparisons for current and recommended funding levels.

In addition to the core activities of CPM/R&R, work activities for Big Bridge and Special Needs structures will be separately addressed and prioritized from a statewide perspective. Funding for these structures is recognized as a separate category within the Bridge Preserve Program.

- **Big Bridge** - Large or unique bridges that are a subset of the statewide bridge network which require centralized management. The Big Bridge Committee needs to be reconvened to perform the following duties: 1) finalize an official list of Big Bridges statewide, 2) coordinate the development of a long term needs plan which would include investment time lines and associated maintenance manuals for each Big Bridge, 3) develop an annual statewide investment plan to meet the long term Big Bridge needs. (See Glossary for Big Bridge definition.)

- **Special Needs Bridges** - Bridges with localized significant deterioration. The identification of the total backlog of these needs is expected by the end of 1998. **The backlog is expected to be retired in three years.** (See Glossary for Special Needs Bridges definition.)

## **Network Inspection and Data Inventory Strategies:**

To properly assess needs, develop strategies and monitor network improvement, it is imperative to have accurate, up-to-date inventory and condition data. The next strategies address improvements to inspection and data management functions.

### **Inspection Strategies**

- Review the current inspection frequency guidelines and make recommendations to the Engineering Operations Committee (EOC), (e.g. adjust inspection cycle on good bridges to four years as allowed by National Bridge Inspection Standards, establish a systematic detailed inspection process for poor bridges).
- Perform inspections on all bridges upon the completion of any work that would impact the current inventory data. Specific inspection procedures and guidelines will be developed.
- Establish a statewide Quality Assurance/Quality Control (QA/QC) plan for bridge inspections managed centrally.
- Develop and provide the necessary tools and training to the inspectors to insure timely accurate updates to the inventory.
- Develop and provide the tools and training the inspectors will require to accurately and appropriately formulate "fix" recommendations based on structure history and condition.

### **Inventory (data) Strategies**

- The inventory needs to include all data items established by Federal and State requirements and any others necessary to implement this plan.
- The Department must allocate the necessary resources and tools to insure the functionality, accuracy and timeliness of the inventory.

- 
- Establish inventory update procedures for maintenance or permit activities.
  - Establish a Statewide QA/QC plan for the inventory data.
  - Develop the necessary reporting and monitoring capabilities for the effective use of the data in decision making.

## **Bridge Network Capital Investment**

The recommended capital investment to successfully implement the proposed network management strategies and meet the network condition goals is **\$185,000,000** annually (see Appendix E for Bridge Network Capital Investment summary). The recommended funding levels were assessed separately for Maintenance and Preservation/Modernization. Estimates for the inspection and inventory strategy implementation has not been determined at this time and will be provided as part of the final Strategic Investment Plan document.

- I. **Maintenance:** Based on preliminary discussions with the regions, an initial statewide capital investment of **\$ 10,000,000** for CSM activities is recommended. This funding will be managed as part of the Bridge Preserve Program and will be allocated to the regions based on need.

A comprehensive scheduled maintenance plan needs to be developed in each region, under the general guidance of the central office. The maintenance plans will delineate time lines for scheduled work activities and will make recommendations for regional allocations based on need.

An annual statewide investment recommendation will be finalized by September 31, 1998.

- II. **Preservation/Modernization:** Average annual budget of **\$175,000,000** is recommended:

- ▶ \$171,000,000 Annual investment for highway bridge network modeled by BCFS (CPM/R&R - Big Bridge - Special Needs )
- ▶ \$ 4,000,000 An annual investment for pedestrian structures, RR structures and culverts, which were not modeled by BCFS.

**CPM/R&R** - An annual budget of \$152,000,000 is recommended for capital investment in the core activities based on the BCFS strategy analysis. This recommendation is based on a mix of CPM, rehabilitation and replacement necessary to reach the network condition goals.

**Big Bridge** - An interim annual budget of \$ 10,000,000 will continue to be allocated for capital investment in Big Bridges until a statewide strategy is developed. A separate investment strategy is required that will prioritize and address statewide Big Bridge needs.

**Special Needs** - Annual budget of \$ 9,000,000 is recommended for capital investment to retire the existing Special Needs backlog by 2005. This line item within the preservation budget will then be reassessed to determine if continuation of the category and budget is necessary.

## **Network/Program Measurements**

Annually assess the following:

### Network level

- The resultant network condition improvement based on the previous years actual program
- The statewide progress made toward reaching the network condition goals for freeway and non-freeway
- The regional progress made toward reaching the network condition goals for freeway and non-freeway
- Network distribution of good/fair/poor

### Program level

- If the actual projects let match the proposed strategy planned
- If not, do the actual projects result in a strategy that maintains direction toward achieving the program goal
- If the actual network condition improvements match the modeled projected network condition improvement
- If the projects let reduce the number of structures which require 6 month or 12 month inspection

Based on the results of an annual analysis, implement adjustments in the strategies (“mix of fixes”), between CPM, rehabilitation, and replacement, to maintain the course for reaching the network goals by 2008.

## Glossary

“Big Bridges”:	Segment of the bridge network which includes all movable bridges (bascules, vertical lift, and swing), segmental bridges, and bridges with deck areas in excess of 9,300 m <sup>2</sup> (100,000 ft <sup>2</sup> ).
capital preventive maintenance (CPM):	Scheduled work activities that restore element integrity, and reduce deterioration rates on “fair” structures. Work activities typically would include joint replacement, pin and hanger replacement, zone and complete painting, scour protection, deck patching, thin overlays, and pedestrian fencing. These work activities have been modeled to equate to a “+1” condition rating improvement for the element(s) addressed. Preventive maintenance prevents “fair” structures from becoming “poor” structures. Any fix life realized is a function of the element being restored.
capital scheduled maintenance (CSM):	Scheduled maintenance activities that maintain existing serviceability, and reduce deterioration rates on “good” structures. Work activities typically would include superstructure washing, flushing drainage systems, minor concrete patching and repairs, spot painting, concrete sealing, and joint repairs. Scheduled maintenance activities prevents “good” structures from becoming “fair” structures.
condition rating:	Numerical values for condition are assigned to individual elements of a bridge that describes an existing physical condition (1-9): “Poor” = Condition rating ≤ 4, “Fair” = Condition rating = 5 or 6, “Good” = Condition rating ≥ 7

For the purposes of this document this numerical value will represent the lowest numerical rating of any of the following major elements: 1) the deck 2) the superstructure and 3) the substructure.

detailed inspection:

Close up, hands on inspection of elements to detect deficiencies not readily detected during a routine inspection. This inspection will typically require lift equipment to get the inspector close to the elements being inspected. Non-destructive tests are conducted as part of this inspection.

Engineering Operations  
Committee (EOC):

Principal technical policy making body in the Bureau of Highways on engineering, research, and related matters.

freeway bridge network:

All bridges that carry freeway traffic or structures over the freeway. This group includes structures within freeway interchanges, pedestrian (P) structures, railroad (X) structures, and any freeway service drives under MDOT's jurisdiction.

non-freeway bridge network:

All other trunkline structures under MDOT jurisdiction

rehabilitation:

Programmed work activities that improve element integrity. Work activities typically would include deep overlays, superstructure repair (beam end repairs, bearing rehabilitation, diaphragm repair/replacement), extensive substructure repair, substructure replacement. Any fix life realized is a function of the element being improved. Rehabilitation work activities improve condition ratings to "fair" or "good".

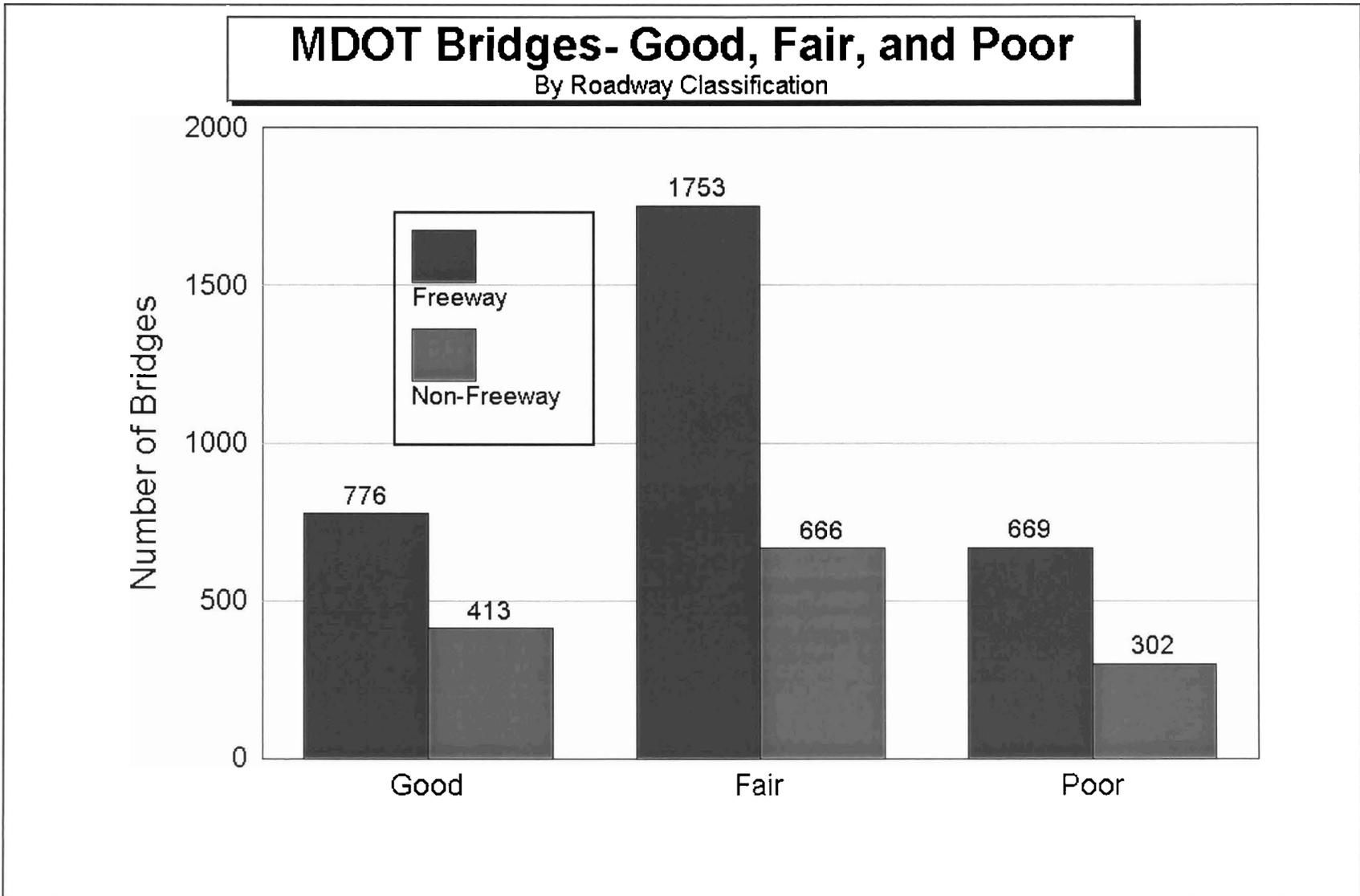
replacement:

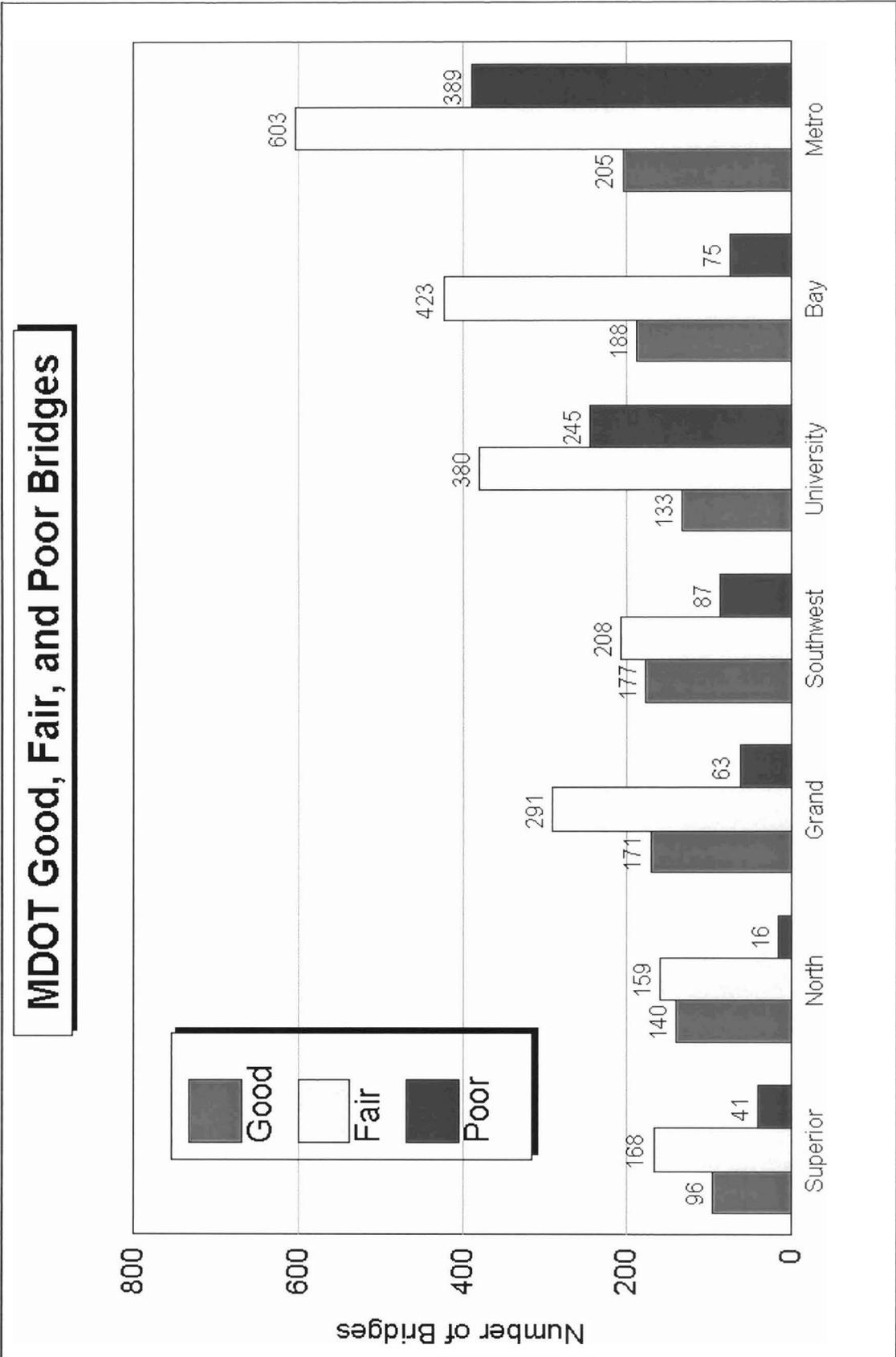
Programmed deck replacement, superstructure replacement, or full structure replacement. Replacement work activities improve condition ratings from "poor" to "good".

Special Needs Bridges:

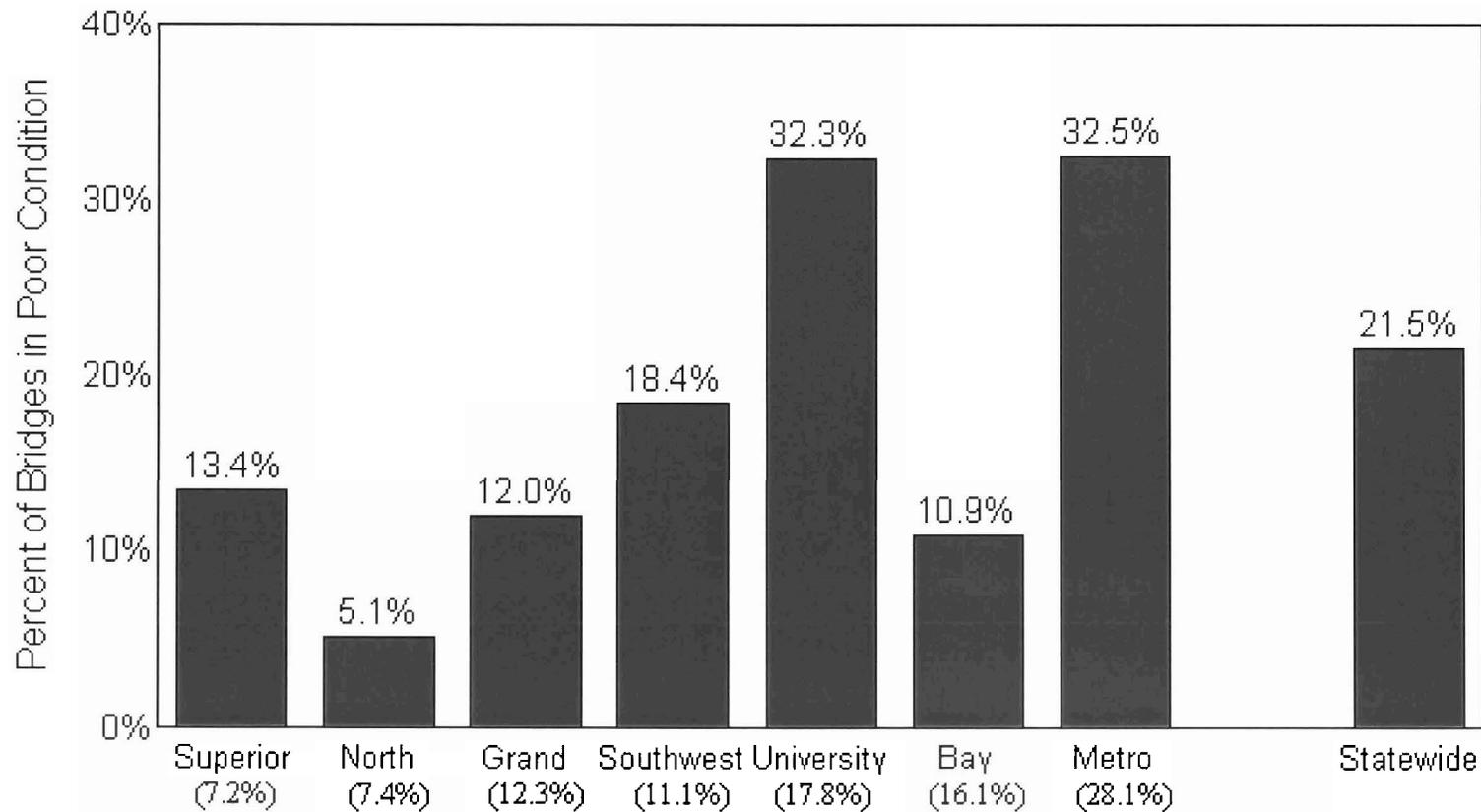
Bridges which have been found to be in need of rehabilitation to correct structural deficiencies discovered in the structures initial detailed inspection. A finite list of these special bridge needs will be established as the networks initial detailed inspection cycle is completed (anticipated completion Nov 98).

# APPENDIX A



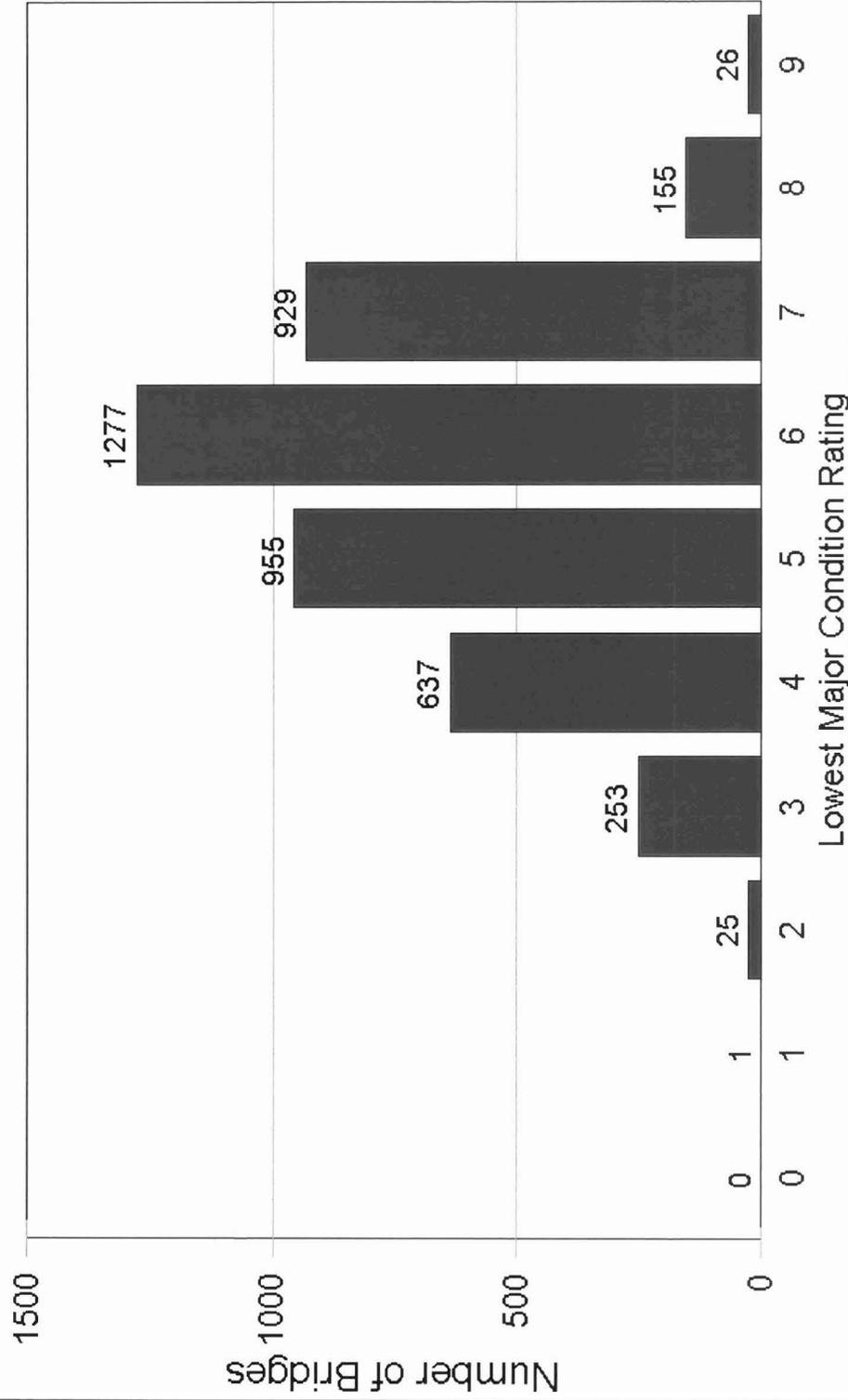


### Bridges in Poor Condition By Region



Region Name / Percent of Statewide Bridge Network in Region

### Lowest Major Condition Rating



Major Condition Ratings are Deck, Superstructure, and Substructure Ratings

# APPENDIX B

## **CAPITAL PREVENTIVE MAINTENANCE (CPM) - Road / Bridge Comparisons**

- CPM for roads - a specific program developed in partnership with FHWA. The program has specific criteria on work type eligibility, maximum length of fixes, reduced traffic impact, a streamlined project development process, a condensed bid document package, and a special environmental waiver. The road CPM program was historically developed, isolated from the road preserve program, but a recent change in philosophy is requiring the integration of those programs. The main characteristic of the road CPM program is to keep fair pavements from becoming poor. The dramatic impact that this program has on the condition levels of the road system is well documented within the RQFS model.

- CPM for bridges - is not a specific program but a defined level of the preservation program. Specific work items have been identified which address the restoration of element integrity. A streamlined project development process, reduced traffic impact, a condensed bid document package, and special environmental waivers are anticipated characteristics for bridge CPM projects. Strategy development for the Bridge Preserve Program will consider an integration of CPM, rehabilitation and replacement activities. Consistent with road CPM, the main characteristic of bridge CPM work items is to keep fair bridges from becoming poor. The BCFS modeling tool illustrates the impact that these CPM work items have on the bridge network condition levels.

# APPENDIX C

## BRIDGE CONDITION FORECASTING SYSTEM (BCFS) MODEL

To model the effect of various levels of bridge funding and various strategies on future bridge conditions. Variables are the bridge funding level and the “mix of fixes”, or the network wide combination of Preventive maintenance, rehabilitation, and replacement actions.

### Modeling, Assumptions and Limitations

- ▶ **Routine maintenance activities, major bridges, “special needs bridges”, corridor reconstruction projects, culverts, bridge inspection** and other miscellaneous costs are not included in the model. Other funding is assumed to be used for these projects and activities.
- ▶ The model is based on the *lowest* NBI condition rating for each bridge (Item 58 - Deck, Item 59 - Superstructure, and Item 60 - Substructure).
- ▶ The model's 1998 base year network condition distribution is from actual NBI data.
- ▶ Planned programs for 1998 and 1999 are considered fixed, based on a March 1998 program status list.
- ▶ Annual deterioration rates are calculated by averaging actual deterioration rates for MDOT bridges from 1995 to 1996, 1996 to 1997, and 1997 to 1998. Only bridges that stayed the same or deteriorated during the period are used. The deterioration rates used were limited to a drop of 1 combined condition rating point, although actual data shows, in some cases, that ratings can drop several points.
- ▶ Replacement, rehabilitation, and Preventive maintenance budgets are converted to numbers of bridges by dividing the budgeted amount by the average cost for the respective action category.
- ▶ Bridges rated 4 or less are eligible for replacement. The model *replaces* the lowest rated bridges until the replacement budget (number of bridges) is exhausted.
- ▶ Bridges rated 4, 5, or 6 are eligible for rehabilitation. The model *rehabilitates* the lowest rated of these bridges until the rehabilitation budget (number of bridges) is exhausted.
- ▶ Replacement actions are assumed to *improve* bridges to a ‘combined’ condition rating of **8**; and rehabilitation actions *improve* bridges to a ‘combined’ condition rating of **6** for the next year.
- ▶ Bridges with a combined condition rating of 5 and 6 are eligible for preventive maintenance, starting with the 5's, until the preventive maintenance budget is exhausted. Preventive maintenance is modeled by moving the combined condition rating one point higher.
- ▶ Replacement, rehabilitation, and preventive maintenance costs used are based on 1995 - 1998 average construction cost, plus 25% PE & CE.
- ▶ Preventive maintenance costs used are based on 1995 - 1998 average construction costs for full bridge painting, with zone painting assumed to be half that average, and bridge joint assuming \$4 million a year did 100

bridges. Then 25% PE & CE is added. Two PM costs are used, one assuming that 75% of bridge painting is zone painting and the other assuming mostly complete bridge is done.

- ▶ All funding and costs are in 1998 constant dollars.
- ▶ Deterioration rates are applied to the number at each rating less the number on which an action was taken. The new 'combined' condition rating distribution includes the results of replacement, rehabilitation, and preventive maintenance actions.
- ▶ The condition shown for a given year is assumed to be the predicted network condition at the beginning of that program year, prior to that year's investment.

# APPENDIX D

STRATEGY TRANSITION PLAN

Program Year	1998		1999		2000		2001		2002	
	\$	%	\$	%	\$	%	\$	%	\$	%
Program Level	\$145 M		\$157 M		\$152 M		\$152 M		\$152M	
Replacement	106	73	106	68	94	62	82	54	68	45
Rehabilitation	22	15	24	15	26	17	32	21	38	25
CPM	17	12	27	17	32	21	38	25	46	30
CSM	-		\$5M		\$10M		\$10M		\$10M	

# APPENDIX E

<b>BRIDGE NETWORK CAPITAL INVESTMENTS</b>				
<b>Line Items</b>	<b>Strategy %</b>	<b>Strategy \$ Allocation</b>	<b>Amount</b>	<b>Annual Budget</b>
<b>Maintenance</b> • CSM			\$ 10M	\$ 10M
<b>Preservation</b> • "P", "X", "C" • Big Bridges • Special Needs  • CPM • Rehabilitation • Replacement		\$ 4M 10M 9M  \$ 46M 38M 68M	\$ 23M   \$ 152M	\$ 175M
<b>Total PROPOSED ANNUAL BRIDGE NETWORK INVESTMENT:</b>				<b>\$ 185 M</b>