MAINTENANCE QUALITY ASSURANCE PEER EXCHANGE 2

Project 08-15
April 2009

Midwest Regional University Transportation Center
College of Engineering
Department of Civil and Environmental Engineering
University of Wisconsin, Madison

Authors: Teresa Adams, Scott Janowiak, Will Sierzchula, and Jason Bittner
University of Wisconsin-Madison

Principal Investigator: Teresa Adams, PhD.
Professor, Department of Civil and Environmental Engineering, University of Wisconsin-Madison

Technical Report Documentation Page

1. Report No. MRUTC 08-15	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Maintenance Quality Assurance Peer Exchange 2		Report Date April 2009 6. Performing Organization Code	
7. Authors Teresa Adams, Scott Janowiak, Will Sierzchula, and Jason Bittner University of Wisconsin-Madison		8. Performing Organization Report No. MRUTC 08-15	
9. Performing Organization Name and Address National Center for Freight and Infrastructure Research and Education (CFIRE) College of Engineering University of Wisconsin-Madison 1415 Engineering Drive, Madison, WI 53706		10. Work Unit No. (TRAIS) 11. Contract or Grant No. 0092-08-34	
12. Sponsoring Organization Name and Address Wisconsin Department of Transportation 4802 Sheboygan Avenue Madison, WI 53705		13. Type of Report and Period Covered Final Report 11/20/2007 – 5/1/2009 14. Sponsoring Agency Code	
15. Supplementary Notes Project completed for the Midwest Regional Transportation Center with support from the Wisconsin Department of Transportation through the Transportation Asset Management Pooled Fund Research Program.			
16. Abstract This report documents a comprehensive study of twenty three maintenance quality assurance (MQA) programs throughout the United States and Canada. The policies and standards of each program were synthesized to create a general assessment on the condition of MQA programs in 2008. These data were then compared to similar data compiled in 2005. The resulting study is a comparison between MQA programs in 2004 and 2008. The data can be used to aid in the process of modifying the policies of current MQA programs to improve existing measures or create new ones. Further discussion of MQA policies and implementation should be continued to align with the constantly developing needs of roadways across the nation.			
17. Key Words Maintenance, Maintenance quality assurance (MQA), performance measures, asset management	18. Distribution Statement No restrictions.		
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. Of Pages 48	22. Price 0

Form DOT F 1700.7 (8-72)

DISCLAIMER

This research was funded by the Midwest Regional University Transportation Center.
The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof. The contents do not necessarily reflect the official views of the Midwest Regional University Transportation Center, the University of Wisconsin, the Wisconsin Department of Transportation, or the USDOT's RITA at the time of publication.

The United States Government assumes no liability for its contents or use thereof. This report does not constitute a standard, specification, or regulation.

The United States Government does not endorse products or manufacturers. Trade and manufacturers names appear in this report only because they are considered essential to the object of the document.

ACKNOWLEDGEMENTS

This report is the result of a study funded by the Transportation Asset Management Pooled Fund Research Program in conjunction with the National MQA Peer Exchange held in Durham, North Carolina in September 2008. The following individuals were members of the 2008 Peer Exchange Planning Committee: Jennifer Brandenburg, Chair, North Carolina Department of Transportation; Teresa Adams, University of Wisconsin-Madison; Brad Allen, New York State Department of Transportation; Rico Baroga, Washington State Department of Transportation; William Beatty, Federal Highway Administration; Jason Bittner, University of Wisconsin-Madison; Scott Bush, Wisconsin Department of Transportation; James Carney, Missouri Department of Transportation; Celso Gatchalian, Federal Highway Administration; Rhonda Johnson, North Carolina Department of Transportation; Steve Lund, Minnesota Department of Transportation; Will Sierzchula, University of Wisconsin-Madison; Lee Smithson, American Association of State Highway and Transportation Officials; James Sorenson, Federal Highway Administration; Jon Swartz, Montana Department of Transportation; and Steve Wilcox, New York Department of Transportation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report is the latest in a series of projects following the development of maintenance quality assurance (MQA) programs across the United States and Canada. MQA research efforts can be traced back to a June 2000 gathering of transportation officials, the National Workshop on Commonly Recognized Measures for Maintenance. Four years later, the 2004 MQA Peer Exchange was held in Madison, Wisconsin. This further encouraged the dialogue concerning the development of MQA programs throughout North America. The conference helped establish a network of MQA professionals, introduced methods of MQA correspondence with legislature and the public, and created a standardized terminology programs can implement to improve communication across states. A related report, by the Midwest Regional University Transportation Center's (MRUTC) Project 06-01 entitled "Maintenance Quality Assurance – Synthesis of Measures," used the Peer Exchange and its creation of the MQA Document Library as a starting point to summarize the state of MQA programs in 2004. In 2008, a follow up MQA Peer Exchange was held in Durham, North Carolina. Here the MQA dialogue continued, highlighting trends and developments appearing in the field since 2004. The MQA Document Library has been maintained, with programs submitting new rating manuals, rating sheets, and other documentation relating to their operation. It is out of this 2008 MQA Peer Exchange and the new and updated additions to the MQA Document Library that this report was born. This report complements Project 06-01. It serves an update on the state of MQA programs in 2008, outlining the past, present, and future of MQA programs across the United States and Canada.

This and the 2005 report were funded by the Transportation Asset Management Pooled Fund Research Program. The study was completed in conjunction with the National MQA Peer Exchange held in Durham, North Carolina in September 2008, hosted by the North Carolina Department of Transportation. The Peer Exchange planning committee coordinated the efforts behind the Peer Exchange.

The MQA Document Library, located and maintained on the MRUTC website, provided the foundation for the research in this report. The documents of 23 programs were individually analyzed, and their contents searched in order to classify the maintenance categories and features measured in each program. After the careful classification of information, spreadsheets were created to compile the categories, features, standards, and measures of each program into a concise and comprehensive document. These spreadsheets are the source material for the tables, figures, and accompanying analysis found in this report.

To continue the dialogue previously developed by Project 06-01, this report incorporates the structure of that document, integrating information compiled for the 2005 report to allow easy comparison to the 2008 data.

The results of the research methodology provide a snapshot of the state of MQA programs in 2008. The report is comprehensive of all programs; details of the individual MQA programs are available from the MQA document library. Many of the 23

programs' documents within the MQA document library are categorized as "rating manuals" or "rating sheets." These categories were the most heavily researched for the purposes of this report. Other relevant documents within the online library address such issues as MQA budgeting, customer surveys, and presentations given at various conferences.

This report includes broad comparisons of MQA programs in 2008 relative to 2004. Fewer features are being measured within several major maintenance categories in 2008 than in 2004. The categories with the largest decreases in measured features were drainage and traffic management. Other maintenance categories, such as vegetation and bridges, were measured at greater levels in 2008 than in 2004. These fluctuating numbers reflect the shifting priorities of MQA programs within the greater context of roadway safety. Still other features, such as pavements and shoulders, were measured at similar levels in 2004 and 2008. Pavements and shoulders have often been the categories with the most established maintenance procedures. As such, it is understandable these maintenance assessment policies waivered little since 2004.

Many of the most commonly measured features, such as potholes, shoulder drop off, debris, and guardrail functionality, are on the frontlines of roadway user safety. These features are measured by 61-74% of the programs. Maintenance backlogs for these features can lead to serious safety issues on the roads. MQA programs have clearly delineated maintenance priorities as displayed in MQA policies. Simple pavement surface defects on pavement or inadequate slope mowing manifest themselves as low priorities in the greater context of MQA programs.

This research allows MQA programs to evaluate their operations in light of recognized trends and developments in the constantly shifting MQA landscape. It also contributes to the continued understanding of a national model for MQA implementation. The data in this report can be used to aid in the process of modifying the policies of current MQA programs to improve existing measures or create new ones. MQA programs play a role in ensuring the safety, productivity, and operational efficiency of our nation's roadways. This report emphasizes the notion that there are many maintenance features that contribute to maintaining the desired levels of safety, productivity, and efficiency on the road. Further discussion of MQA policies and implementation should be continued to align with the constantly developing needs of roadways across the nation.

CHAPTER 1: INTRODUCTION

1.1 OBJECTIVES AND PURPOSE

There are several objectives of this report, all serving the advancement of the understanding of the past, present, and future of maintenance quality assurance programs across the United States and Canada. One goal is to provide a synthesis of the plethora of measures implemented by different MQA programs in 2008. With a complex array of MQA programs utilizing various practices and terminology, it is essential to consolidate the different programs into a standardized system of understanding and analysis. In addition, this report strives to compare the state of MQA programs of 2004 to those of 2008. A comparison between years allows for a discussion regarding trends in MQA programs that ultimately direct its past, present, and future.

1.2 METHODOLOGY

The direction of this report is heavily influenced by the Midwest Regional University Transportation Center's (MRUTC) Project 06-01, entitled "Maintenance Quality Assurance – Synthesis of Measures," authored by Adams and Smith and written in 2005[1]. 06-01 standardized MQA terminology, offered a compilation of tables and figures highlighting commonly measured features across 26 MQA programs of 2004, and assembled charts outlining the qualitative standards in each of the commonly measured maintenance categories. This 2009 report recreates these products of the 2005 report, updated to accommodate the developments within MQA programs.

This snapshot of 2008 MQA programs includes the analysis of 22 state programs and the program of the Canadian province of Ontario. The MQA terminology and commonly measured maintenance categories established in 2005 are used again here to offer a consistent platform for comparison. Table 1.1 identifies the states and Canadian provinces that participated in the 2004 and 2008 syntheses. It is important to note the differences in state participation between the studies. While exact comparisons cannot be made due to the inconsistency of state participation, general trends and conclusions can be derived from the data collected. In addition, Project 06-01 incorporated commonly measured features into the final report. This report incorporates all measured features into the calculated statistics, not just commonly measured features.

Table 1.1: State participation, 2004 & 2008

State	2004	2008
AB	X	
AL		X
CA	X	X
CO	X	
DC	X	
FL		X
IA	X	X
IN	X	
KS	X	X
KY	X	X
LA		X
MD	X	X
MI		X
MN	X	X
MO	X	X
MS	X	X
MT	X	
NC	X	X
NE	X	
NY	X	X
OH	X	X
OK		X
ON	X	X
SC	X	X
SD	X	
TN	X	X
TX	X	X
UT	X	X
VA	X	
WA	X	X
WI	X	X
Total	**26**	**23**

MQA program policies, rating manuals, and handbooks were obtained from the MRUTC MQA Documents and Materials Library, located on the MRUTC website[2]. These documents formed the foundation and source material for the report. Using the maintenance categories identified in 2005, the documents were analyzed, compiling each program's policies for maintenance measurement into a unified body of data. It is here where the complexities and nuances of MQA programs had to best be standardized under the difficulty of subjectivity. Human judgment was necessary to determine the categorization of features and standardization of the decidedly non-uniform programs.

The measurement of maintenance features, as well as their standards, thresholds, and measures per segment, were all recorded in an effort to consolidate information. The qualitative tables from the 2005 report were integrated here, forming the basis of comparison in similarly created tables in this report. Commonly cited standards and measures per segment were included to portray the greater trends in MQA programs. Typically, "commonly cited" standards or measures are defined as being used in at least three programs. In cases where no "commonly cited" standards and measures per segment were found, all noted standards and measures per segment were included. Given the non-standard nature of taxonomies for maintenance, these tables represent a wide-lens view into the evolution of MQA trends.

1.3 ORGANIZATION

The following report consists of four chapters.

Chapter 2 presents state inventories of features for each of the maintenance categories. It also displays figures that highlight commonly measured features in each of the maintenance categories. A comparison table displaying statistics of 2004 and 2008 maintenance categories offers basic points of analysis. Brief textual syntheses of the aforementioned tables and figures are included for each maintenance category.

Chapter 3 presents a comparative synthesis of measures between 2004 and 2008. Included in these tables are the common standards and measures used for each maintenance feature. A brief textual analysis highlights main differences and trends for each maintenance category.

Chapter 4 offers more general comments and suggestions for future research in the field of MQA programs.

CHAPTER 2: INVENTORY OF MAINTENANCE CATEGORIES & FEATURES

This chapter serves as an overview of the maintenance categories and their features and characteristics present in the MQA program included in the study. There were nine major categories identified consistently present across programs. These are the same categories included in the 2004 synthesis, with two exceptions. Roadsides and vegetation have been split into their own categories, increasing the number of categories. In addition, the "roadway" category has been split into "pavement" and "shoulder" features. As such, the nine identified categories are the following: pavement, shoulders, drainage, traffic management, roadsides, vegetation, snow and ice, bridges, and rest areas.

This chapter presents three perspectives of analysis for each maintenance category. First, it provides an inventory of each state's implementation of each of the identified category features. It is here where one notices trends in measurement within and between MQA programs studied. Secondly, it includes a figure outlining popularity of commonly measured category features. This allows for a closer inspection of popularly measured maintenance features. Lastly, a brief comparison table is included highlighting the basic category statistics in 2004 and 2008 MQA programs.

Table 2.1: Summary of 2008 inventory

Category	Features / Characteristics		
	Min.	Max.	Avg.
Pavements	2	15	9
Shoulders	1	11	4.4
Drainage	2	10	4.6
Traffic Management	2	10	6.8
Roadsides	1	8	3.7
Vegetation	2	8	3.3
Snow / Ice	1	5	2.4
Bridges	2	8	4.6
Rest Areas	2	21	6.3

Table 2.1 presents the minimum, maximum, and average number of features of each maintenance category. Pavement features, encompassing flexible and rigid pavements, are the most commonly measured, followed by traffic management features. Snow and ice features are the least commonly measured. The following chapter takes a closer look at the dynamics within each individual category.

2.1 PAVEMENTS

Table 2.1 shows each state's implementation of the measurements of 32 identified pavement features. 83% (19 of 23) of programs implement pavement maintenance measurements into their MQA programs. Wisconsin measures 42% (15 of 36) of the identified pavement features, the most of any state. Iowa follows, measuring 39% (14 of 36) of the features. 17% (4 of 23) of the states do not include the measurement of pavement features in their MQA programs. It is most likely these states evaluate pavement maintenance needs under programs independent of MQA policies.

Table 2.2: 2008 inventory of pavement features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
PAVEMENT (flexible & rigid)	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X	X		X	X	19	83%
Rutting	X	X		X	X	X	X		X		X	X	X		X				X	X			X	14	61%
Potholes	X	X	X	X	X	X	X		X		X	X			X		X	X	X			X		15	65%
Raveling / stripping (surface)	X	X					X				X		X						X				X	7	30%
Cracking	X	X	X	X	X		X		X		X	X		X					X	X			X	13	57%
Joints (seal)				X								X		X					X				X	5	22%
Spalls / popouts		X					X								X				X					4	17%
Depressions / bumps	X	X	X	X	X				X		X	X		X					X					10	43%
Edge break up (edge raveling)	X		X								X												X	4	17%
Shoving	X	X									X		X											4	17%
Bleeding / flushing	X	X	X	X			X		X		X												X	8	35%
Faulting	X			X			X																X	4	17%
Pavement surface	X			X																				2	9%
Aligator cracks		X		X			X																X	4	17%
Transverse cracks													X										X	2	9%
Transverse distortion																							X	1	4%
Longitudinal cracks							X								X								X	3	9%
Longitudinal distortion																							X	1	4%
Patching		X		X	X				X		X	X						X					X	8	35%
Pavement drop-off to shoulder	X																							1	4%
Rideability / ride quality													X							X				2	9%
Roadway cleaning				X					X			X	X						X			X		6	26%
Surface defects													X									X		2	9%
Surface distress																							X	1	4%
Coarse raveling		X	X											X					X					4	17%
Pavement edge																				X				1	4%
Paved & unpaved shoulders																			X	X				2	9%
Slab failure		X											X									X		3	13%
Pavement width				X														X						2	9%
Skid					X																			1	4%
Rolldown			X	X					X		X	X	X											6	26%
Deformations				X							X	X					X		X			X		6	26%
Punchouts												X												1	4%
Pavement quality index																		X						1	4%
Block cracking																							X	1	4%
Failures																				X				1	4%
Weathering		X																						1	4%
Total (36)	11	13	7	14	6	2	9	0	8	0	11	10	9	4	4	0	2	4	11	6	0	5	15		
Percentage (100%)	31%	36%	19%	39%	17%	6%	22%	0%	22%	0%	31%	28%	25%	11%	11%	0%	6%	11%	31%	17%	0%	14%	42%		

Figure 2.1 is based on the 19 states measuring pavement features, and includes features being measured by three or more programs. 79% (15 of 19) of the programs measure potholes, the most frequently rated feature. 74% (14 of 19) measure rutting. The least commonly measured features are specific distresses such as longitudinal cracks and slab failure. These features are measured in 16% of the programs (3 of 19).

Figure 2.1: Common pavement features

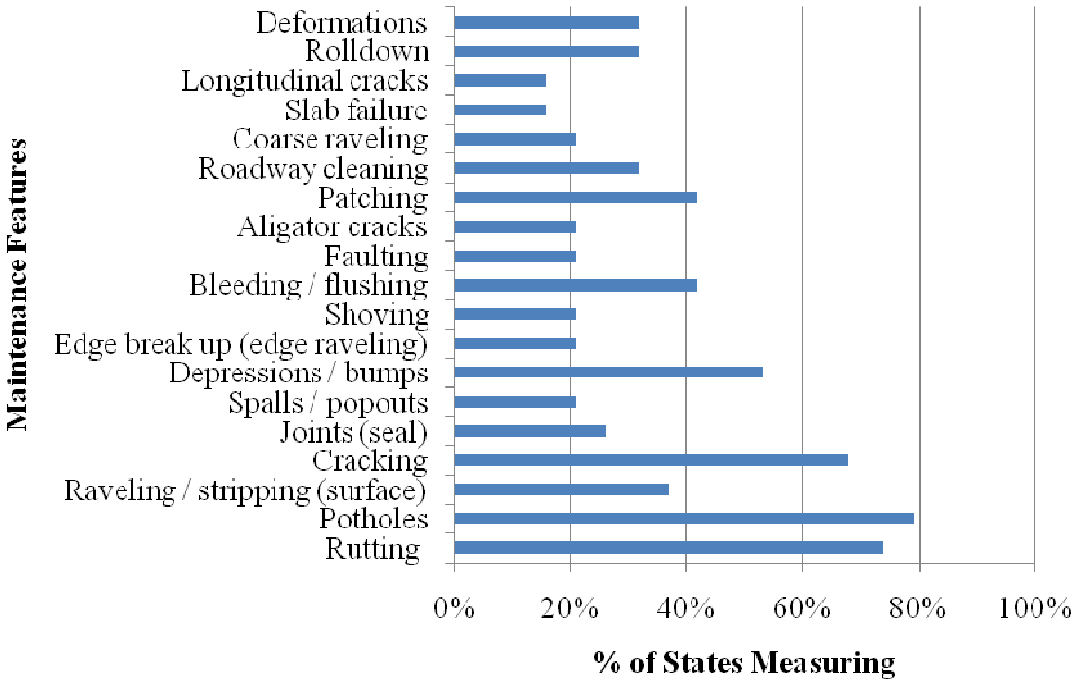

Table 2.3: Measurement trends for pavement features

	2004	2008
Min. features	2	2
Max. features	15	15
Avg. features	8.7	9.0
Std. dev. features	3.7	3.8
% of states measuring features	73%	83%

2008 brought states measuring slightly more pavement features, as identified in the comparison between the MQA policy handbooks and resources of 2004 and 2008. States measured an average of 0.3 more features in 2008 than in 2004. In addition, there was greater state participation in 2008, with 83% of programs incorporating pavement features into their MQA programs. The dominantly measured features of 2004, such as potholes, rutting, and cracking, remained the most frequently measured features in 2008.

2.2 SHOULDERS

Table 2.4 displays each state's implementation of the measurements of 20 identified shoulder features. 87% (20 of 23) of MQA programs included in the study measure shoulder features. Kansas measures the most shoulder features, incorporating 55% (11 of 20) into their MQA program. Missouri, measuring the second-highest number of shoulder features, incorporates 45% (9 of 20) of them into their MQA procedures. Three programs, Minnesota, Oklahoma, and Texas, do not include shoulder features in their MQA programs.

Figure 2.2 is based on states measuring shoulder features, and includes features being measured by at least three programs. "Drop-off to ground / mainline drop-off / build up" is the most commonly measured shoulder feature. 80% (16 of 20) of the MQA programs measuring pavement incorporate this feature. 65% (13 of 20) of MQA programs measure the feature designated "drop-off to shoulder / pavement shoulder joint." The least commonly measured shoulder feature is rutting, with 15% (3 of 20) of MQA programs implementing it.

Figure 2.2: Common shoulder features

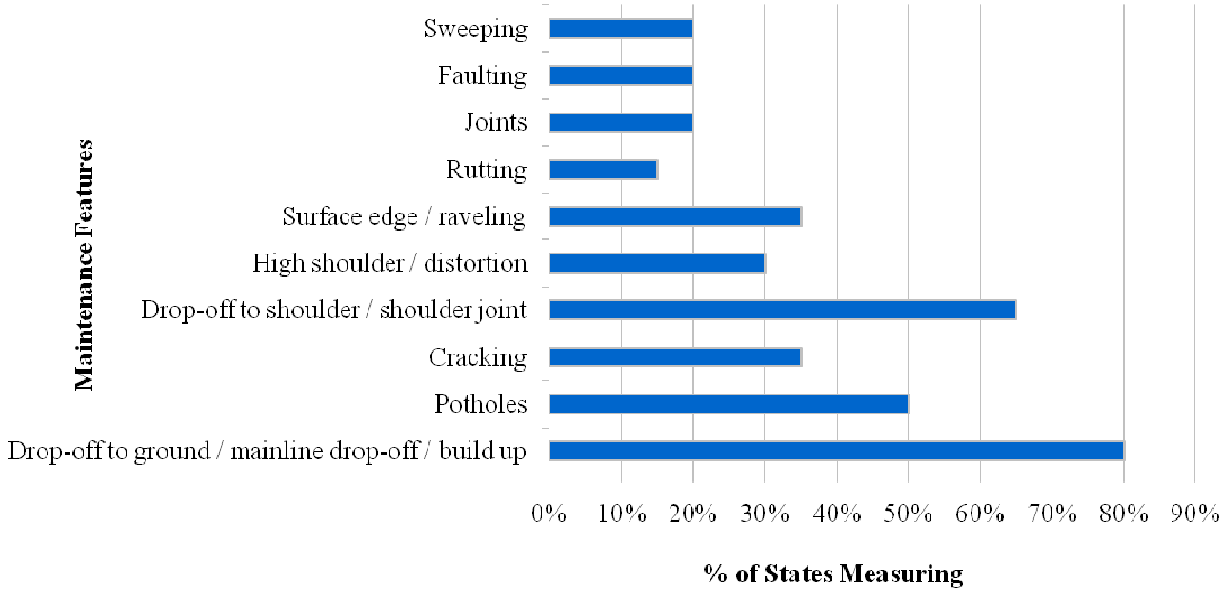

Table 2.4: 2008 inventory of shoulder features

Feature	State or Province																							# (23)	% (100%)
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI		
SHOULDERS (paved and unpaved)	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**		**X**	**X**	**X**	**20**	**87%**
Shoulder drop off to ground / mainline drop-off / build-up		X		X	X	X		X	X		X	X	X	X	X			X	X		X	X	X	**16**	**70%**
Potholes				X	X	X		X	X		X	X							X			X	X	**10**	**43%**
Cracking	X	X		X	X			X			X								X				X	**8**	**35%**
Pavement drop-off to shoulder/ pavement shoulder joint		X		X	X	X			X		X	X		X	X			X	X		X		X	**13**	**57%**
Non-positive drainage/ drainage					X						X													**2**	**9%**
High shoulder / distortion					X	X	X				X		X	X										**6**	**26%**
Surface-edge raveling								X	X		X	X							X			X	X	**7**	**30%**
Shoulder cross slope				X																			X	**2**	**9%**
Rutting					X		X														X			**3**	**13%**
Vegetation growth					X						X													**2**	**9%**
Shoulder joint separation				X				X																**2**	**9%**
Litter debris																							X	**1**	**4%**
Joints	X	X			X														X					**4**	**17%**
Faulting				X	X						X								X					**4**	**17%**
Shoving					X																			**1**	**4%**
Sweeping							X					X					X					X		**4**	**17%**
Slope			X						X															**2**	**9%**
Shoulder washouts																			X					**1**	**4%**
Erosion																							X	**1**	**4%**
Humps, sags, or other deficiencies																						X		**1**	**4%**
Total (20)	**2**	**4**	**1**	**7**	**11**	**4**	**3**	**5**	**5**	**0**	**9**	**5**	**2**	**3**	**2**	**0**	**1**	**2**	**8**	**0**	**3**	**5**	**8**		
Percentage (100%)	**10%**	**20%**	**5%**	**35%**	**55%**	**20%**	**15%**	**25%**	**25%**	**0%**	**45%**	**25%**	**10%**	**15%**	**10%**	**0%**	**5%**	**10%**	**40%**	**0%**	**15%**	**25%**	**40%**		

Table 2.5 shows that states measured, on average, slightly fewer shoulder features in 2008 than in 2004. It is important to look at the qualitative differences within the data sets. Drainage numbers drastically decreased in the 2008 data after significant importance in the 2004 set, downsizing to two from seven. It is likely the shoulder drainage feature has been aggregated into the separate, more all-encompassing drainage category. 2008 data shows the inclusion of two features regarding joints. The 2008 data also sees vegetation growth as no longer a commonly measured feature of shoulders. Various types of drop-offs, cracking, and potholes are the most commonly measured shoulder feature in both 2004 and 2008.

Table 2.5: Measurement trends for shoulder features

	2004	2008
Min. features	1	1
Max. features	10	11
Avg. features	4.8	4.4
Std. dev. features	2.9	2.8
% of states measuring features	73%	87%

2.3 DRAINAGE

Table 2.6 displays each state's implementation of the measurements of 29 identified drainage features. 96% (22 of 23) of the programs included in the study measure drainage features. Missouri measures 34% (10 of 29) of the identified features, the highest of any program. Florida measures 31% (9 of 29), the second-highest rate of any program. Oklahoma does not incorporate drainage features into their MQA program.

Figure 2.3 is based on states measuring drainage features, and includes features measured by at least three MQA programs. The most common drainage feature measured, at 86% (19 of 22), is ditches. Catch basins and drop inlets are measured by 64% (14 of 22). The least measured drainage features are specialized drainage features: side drains, paved ditches, outfall ditches, drains, and ditch erosion. These features are measured by 14% (3 of 22) of the states.

Figure 2.3: Common drainage features

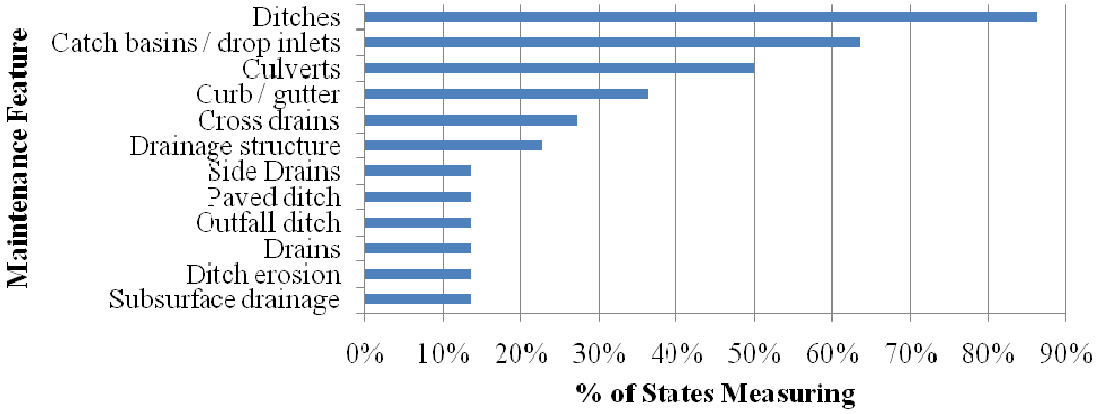

Table 2.6: 2008 inventory of drainage features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
DRAINAGE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	22	96%
Ditches	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X			X	X	X	19	83%
Catch basins / drop inlets			X		X		X	X	X		X	X	X		X		X	X	X		X	X		14	61%
Curb / gutter					X	X	X	X			X		X				X	X						8	35%
Culverts				X			X	X	X		X			X	X		X		X			X	X	11	48%
Subsurface drainage									X					X									X	3	13%
Slopes / slope failures /washouts		X																				X		2	9%
Cross drains		X	X									X	X						X	X				6	26%
Drainage structure	X		X			X								X	X									5	22%
Surface drains		X																					X	2	9%
Storm drains											X												X	2	9%
Driveway pipe																		X						1	4%
Crossline pipe													X					X						2	9%
Ditch erosion					X												X				X			3	13%
Box culverts											X													1	4%
Pipe culverts											X													1	4%
Drainage litter															X									1	4%
Drains				X	X																		X	3	13%
Outfall ditch			X								X	X												3	13%
Median ditch			X								X													2	9%
Paved ditch											X	X							X					3	13%
Pipes							X			X														2	9%
Ramps		X																						1	4%
Open drainage structures			X											X										2	9%
Edge drains & under drains					X							X												2	9%
Side drains			X									X							X					3	13%
Roadway sweeping			X																		X			2	9%
Blocked ditches																		X						1	4%
Lateral ditches																		X						1	4%
Misc. structures																		X						1	4%
Total (29)	2	5	9	3	6	3	5	4	4	2	10	6	5	5	5	0	5	5	5	1	4	4	6		
Percentage (100%)	7%	17%	31%	10%	21%	10%	17%	14%	14%	7%	34%	21%	17%	17%	17%	0%	17%	17%	17%	3%	14%	14%	21%		

Table 2.7 shows that 2008 programs measured drainage features at a rate 19% greater than in 2004. The average number of features, however, dropped by 1.1 features. The most commonly measured drainage features, ditches, catch basins, drop inlets, and culverts, remained the same between 2004 and 2008.

Table 2.7: Measurement trends for drainage features

	2004	2008
Min. features	2	2
Max. features	9	10
Avg. features	5.7	4.6
Std. dev. features	1.9	2.3
% of states measuring features	77%	96%

2.4 ROADSIDES

Table 2.8 displays each state's implementation of the measurements of 17 identified roadside features. 87% (20 of 23) of the MQA programs included in the study measure at least one roadside feature. Tennessee measures the highest percentage of identified roadside features, 47% (8 of 17). California, Kansas, and Missouri closely follow. All of these states measure 35% (6 of 17) of the roadside features. Minnesota, Oklahoma, and Washington do not integrate roadside features into their MQA programs.

Figure 2.4 is based on the percentage of states measuring roadside features, and includes features measured by at least three programs. 70% (14 of 20) of states measure litter and debris, the most measured roadside feature. 55% (11 of 20) programs consider brush and tree encroachment on roadways, the second highest implemented measure. Few programs evaluate animal carcasses and graffiti, at 15% (3 of 20).

Figure 2.4: Common roadside features

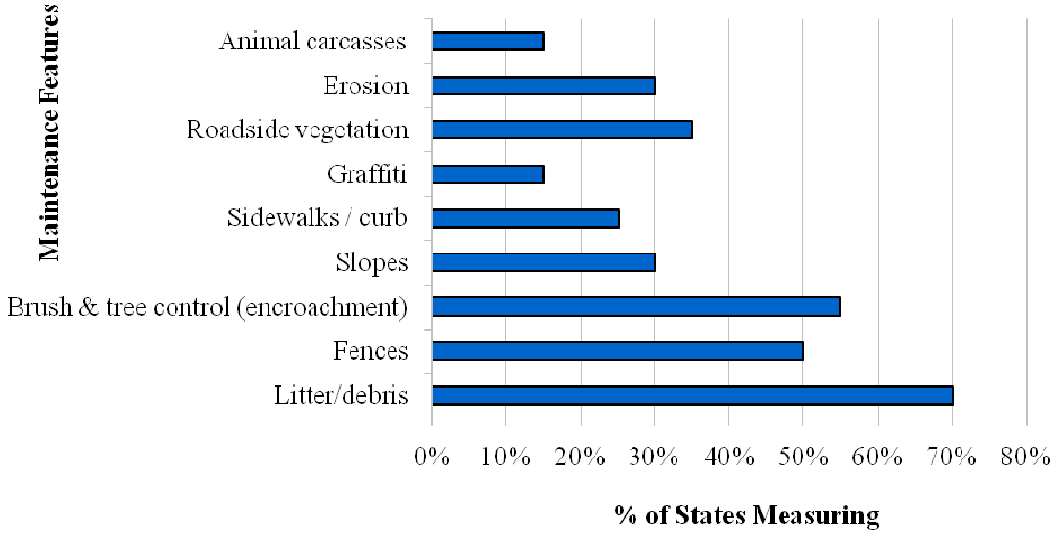

Table 2.8: 2008 inventory of roadside features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
ROADSIDE	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	20	87%
Litter/debris	X	X		X	X		X	X	X		X		X				X	X	X		X		X	14	61%
Fences		X	X	X	X	X					X						X		X		X		X	10	43%
Brush / tree control (encroachment)		X			X		X	X	X		X	X	X					X	X	X				11	48%
Slopes			X	X	X						X		X						X					6	26%
Sidewalks /curb			X								X							X			X		X	5	22%
Sweeping																			X	X				2	9%
Graffiti		X									X								X					3	13%
Retaining walls														X									X	2	9%
Ramps		X																						1	4%
Roadside vegetation		X			X										X		X	X	X	X				7	30%
Erosion	X				X		X		X			X							X					6	26%
Animal carcases				X													X				X			3	13%
General aesthetics						X																		1	4%
Visual obstruction						X																		1	4%
Roadway / shoulder vertical obstruction						X																		1	4%
Mailboxes																				X				1	4%
General public rating																				X				1	4%
Total (17)	2	6	3	4	6	4	3	2	3	0	6	2	3	1	1	0	4	4	8	5	4	0	4		
Percentage (100%)	12%	35%	18%	24%	35%	24%	18%	12%	18%	0%	35%	12%	18%	6%	6%	0%	24%	24%	47%	29%	24%	0%	24%		

Table 2.9 shows that the average number of roadside features evaluated in MQA programs decreased slightly between 2004 and 2008, by 0.5 of a feature. The dominant features remained the same, with litter, fences, tree encroachment, and slopes the most commonly measured features in both data sets.

Table 2.9: Measurement trends for roadside features

	2004	2008
Min. features	2	1
Max. features	8	8
Avg. features	4.2	3.7
Std. dev. features	1.7	1.8
% of states measuring features	81%	87%

2.5 VEGETATION

Table 2.10 shows each state's implementation of the measurements of 21 identified vegetation features. 83% (19 of 23) of the MQA programs included in the study incorporate vegetation features. California and Florida both measure the highest percentage of vegetation features, 38% (8 of 21). Alabama, North Carolina, and South Carolina follow, each measuring 24% (5 of 21) of the identified vegetation features. 17% (4 of 23) of the included MQA programs do not incorporate vegetation features into their MQA programs.

Figure 2.5 is based on the percentage of states measuring vegetation features, and includes features measured by at least three MQA programs. Mowing and grass height is the most measured feature by a significant margin, with 74% (14 of 19) of states measuring it. 42% (8 of 19) of MQA programs measure levels of litter. Only 16% (3 of 16) measure tree trimming or turf condition.

Figure 2.5: Common vegetation features

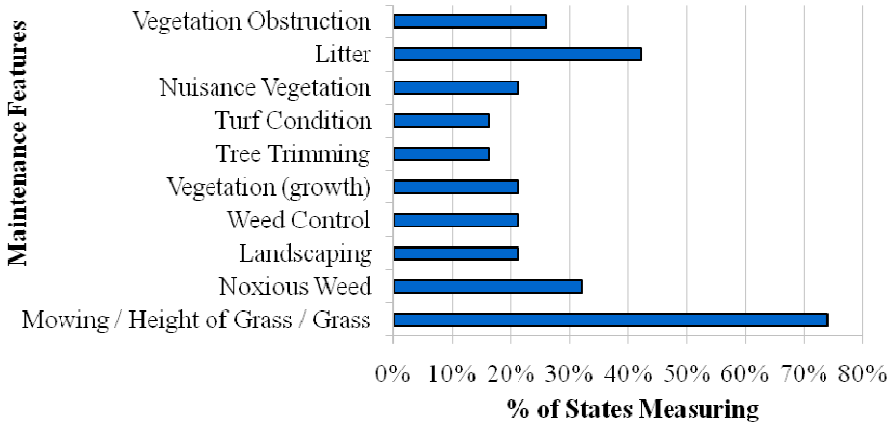

Table 2.10: 2008 inventory of vegetation features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
VEGETATION	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**19**	**83%**
Mowing / height of grass / grass	X			X			X	X	X		X	X	X			X		X	X	X	X		X	**14**	**61%**
Noxious weed				X			X			X											X	X	X	**6**	**26%**
Landscaping			X					X					X						X					**4**	**17%**
Weed control	X	X					X				X													**4**	**17%**
Vegetation (growth)	X	X											X						X					**4**	**17%**
Tree trimming	X	X	X																					**3**	**13%**
Turf condition			X										X					X						**3**	**13%**
Curb trees / sidewalk edge			X															X						**2**	**9%**
Nuisance vegetation	X		X									X										X		**4**	**17%**
Litter			X					X	X						X	X			X			X	X	**8**	**35%**
Vegetation obstruction		X											X		X						X	X		**5**	**22%**
Slope mowing			X													X								**2**	**9%**
Chemical control										X						X								**2**	**9%**
Roadside mowing			X																					**1**	**4%**
Dead / diseased tree removal							X																	**1**	**4%**
Sidewalk vegetation																		X						**1**	**4%**
Limb height																		X						**1**	**4%**
Volunteer plants		X																						**1**	**4%**
Mulch		X																						**1**	**4%**
Groundcover		X																						**1**	**4%**
Irrigation		X																						**1**	**4%**
Total (21)	**5**	**8**	**8**	**2**	**0**	**0**	**4**	**3**	**2**	**2**	**2**	**2**	**5**	**0**	**2**	**4**	**0**	**5**	**4**	**1**	**3**	**4**	**3**		
Percentage (100%)	**24%**	**38%**	**38%**	**10%**	**0%**	**0%**	**19%**	**14%**	**10%**	**10%**	**10%**	**10%**	**24%**	**0%**	**10%**	**19%**	**0%**	**24%**	**19%**	**5%**	**14%**	**19%**	**14%**		

Table 2.11 shows the average number of vegetation features measured between 2004 and 2008 increased by 0.8 of a feature, up to 3.3 from 2.5 per state. The range also widened by two features, from 1-5 to 2-8. The most commonly measured features of mowing and noxious weeds remained constant between 2004 and 2008.

Table 2.11: Measurement trends for vegetation features

	2004	2008
Min. features	1	2
Max. features	5	8
Avg. features	2.5	3.3
Std. dev. features	1.2	1.6
% of states measuring features	81%	83%

2.6 TRAFFIC MANAGEMENT

Table 2.12 displays each state's implementation of the measurements of 30 identified traffic management features. 96% (22 of 23) of the programs included in the study measure at least one traffic management feature. California, Florida, Mississippi and the Canadian province of Ontario each measure 33% (10 of 30) of the features in their MQA programs, the highest recorded in the study. Oklahoma does not incorporate traffic management into their MQA policy.

Table 2.12: 2008 inventory of traffic management features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
TRAFFIC SERVICES	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	22	96%
Non-regulation signs		X		X	X	X	X	X				X	X		X		X		X		X		X	13	57%
Regulation signs	X	X		X	X	X	X	X			X	X	X		X		X		X		X		X	15	65%
Guiderail / guardrail	X	X	X	X		X			X	X	X	X		X	X		X	X	X	X	X	X		17	74%
Line striping		X	X	X	X		X	X				X			X					X	X			10	43%
Pavement markings	X	X			X			X	X	X	X		X						X		X	X	X	12	52%
Impact attenuators		X	X		X	X		X		X	X	X			X			X	X	X				12	52%
Delineator			X					X			X				X					X	X		X	7	30%
Barrier wall / concrete barriers		X		X	X			X	X	X	X	X	X		X		X		X				X	13	57%
Raised pavement markings	X	X	X				X		X			X			X		X	X	X	X		X		12	52%
Highway lighting			X	X							X	X												4	17%
Guard cable										X	X						X	X						4	17%
Object markers			X	X							X		X											4	17%
Traffic signals	X						X					X	X				X							5	22%
End terminal																		X		X				2	9%
Pavement symbol			X									X	X				X	X						5	22%
Guide markers		X			X								X											3	13%
Ramps		X																						1	4%
Guide posts																						X		1	4%
Overhead Signs														X										1	4%
Beacons																	X							1	4%
Illumination																	X							1	4%
Signs > 30 sq. ft			X																	X				2	9%
Anchor assembly															X									1	4%
Signs < 30 sq. ft			X																	X				2	9%
Regulatory / warning sign assemblies						X																		1	4%
Guide sign assemblies						X																		1	4%
Leaning / vegetation																		X						1	4%
Thermoplastic																		X						1	4%
Texturing																				X				1	4%
Total (30)	5	10	10	7	7	6	5	7	4	5	9	10	8	2	9	0	10	6	7	8	6	4	5		
Percentage (100%)	17%	33%	33%	23%	23%	20%	17%	23%	13%	`17%	30%	33%	27%	7%	30%	0%	33%	20%	23%	27%	20%	13%	17%		

Figure 2.6 displays the percentage of states measuring traffic management features, and includes features measured by at least three MQA programs. The most commonly measured traffic management feature at 77% (17 of 22) is guardrails / guiderails. This is followed by regulatory signs, with 68% (15 of 22) of the programs measuring the feature. Pavement symbols, separate from pavement markings and measured by 14% (3 of 22) of the programs, is the least commonly measured traffic services feature.

Figure 2.6: Common traffic management features

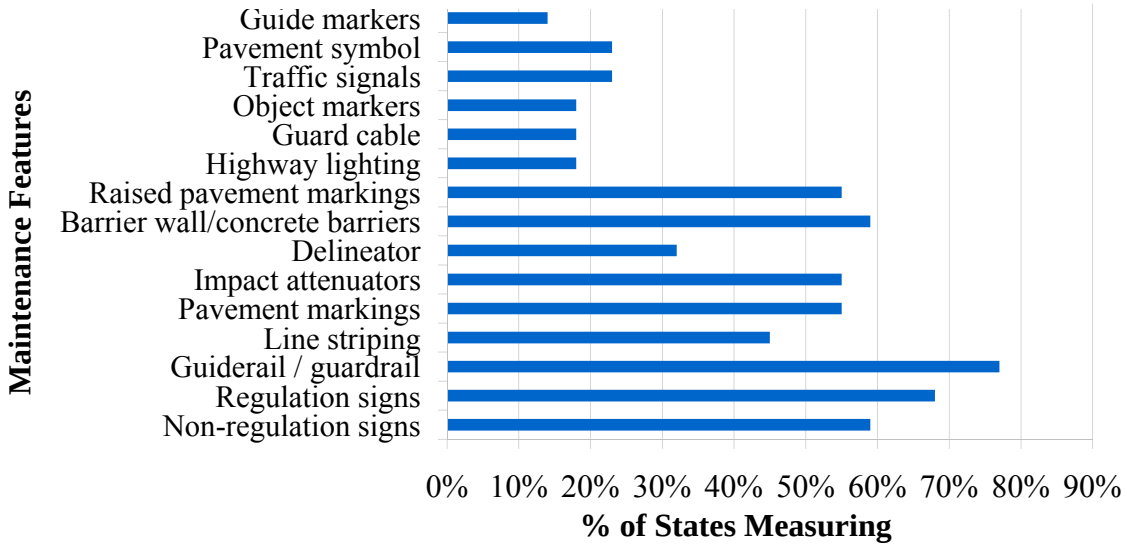

Table 2.13 shows the average number of traffic management features declined from 2004 to 2008, dropping to an average of 6.8 from 7.9 per state. However, program participation in traffic management maintenance evaluation jumped 11%, from 85% to 96%. The prevalence of line striping decreased significantly by 33%, down to 45% from 78%. Guiderails, guardrails, and signage remained the dominant features evaluated across the data sets.

Table 2.13: Measurement trends for traffic management features

	2004	2008
Min. features	1	2
Max. features	11	10
Avg. features	7.9	6.8
Std. dev. features	2.5	2.3
% of states measuring features	85%	96%

2.7 SNOW & ICE

Table 2.14 shows a sharp decrease in the number of states participating in the measurement of winter maintenance features since 2004. It is possible states consider winter maintenance measurement in programs independent of MQA policies.

Table 2.14: Measurement trends for snow and ice features

	2004	2008
Min. features	1	1
Max. features	4	5
Avg. features	1.7	2.4
Std. dev. Features	0.9	1.5
% of states measuring features	50%	22%

Figure 2.7 displays the percentage of states measuring snow and ice features, and includes all features due to the small sample size of five states. Every identified winter maintenance feature is measured by a single program (20%), except for "hours to bare pavement." This feature is measure by two programs (40%).

Figure 2.7: Common snow and ice features

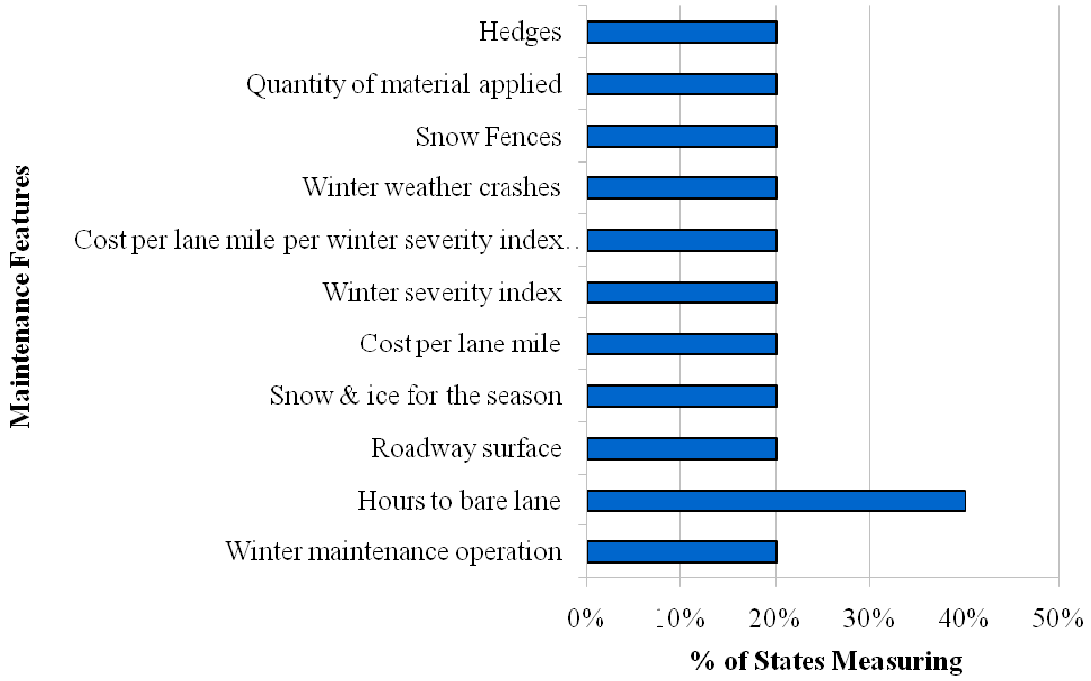

Table 2.15 features each state's implementation of the measurements of 11 identified snow and ice features. 22% (5 of 23) of the MQA programs included in the study measure snow and ice features. Wisconsin measures 45% (5 of 11) of the identified features, the most of any program. Utah, Minnesota, and the Canadian province of Ontario each measure 18% (2 of 11) of the features. 78% (18 of 23) of the programs included in the study do not incorporate any measurements of winter maintenance features.

Table 2.15: 2008 inventory of snow and ice features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
SNOW & ICE	X									X							X				X		X	5	22%
Winter maintenance operation										X														1	4%
Hours to bare lane										X													X	2	9%
Roadway surface																					X			1	4%
Snow & ice for the season	X																							1	4%
Cost per lane mile																							X	1	4%
Winter severity index																							X	1	4%
Cost per lane mile per winter severity index point																							X	1	4%
Winter weather crashes																							X	1	4%
Snow Fences																	X							1	4%
Quantity of material applied																					X			1	4%
Hedges																	X							1	4%
Total (11)	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	0	5		
Percentage (100%)	9%	0%	0%	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	18%	0%	45%		

2.8 BRIDGES

Table 2.16 reveals several changes to the core measurements of bridge maintenance between 2004 and 2008. Fewer states are measuring more features. Bridge railings, joints, and graffiti remained heavily measured. In addition to the generalized feature of bridge structure also found in 2004, 2008 brought other more specific features pertaining to structural integrity such as bridge bearings and cracking into MQA programs. 2008 also introduced the inclusion of the "bridge deck" feature, recorded by three states.

Table 2.16: Measurement trends for bridge features

	2004	2008
Min. features	1	2
Max. features	9	8
Avg. features	3.9	4.6
Std. dev. features	3.4	2.2
% of states measuring features	38%	22%

Figure 2.8 shows the percentage of states measuring bridge features, and includes all category features, due to the small sample size of five states. Graffiti is the most commonly measured bridge feature. 80% of the states (4 of 5) measure bridge graffiti. Five of the 13 identified bridge features are measured by a single MQA program.

Figure 2.8: Common bridge features

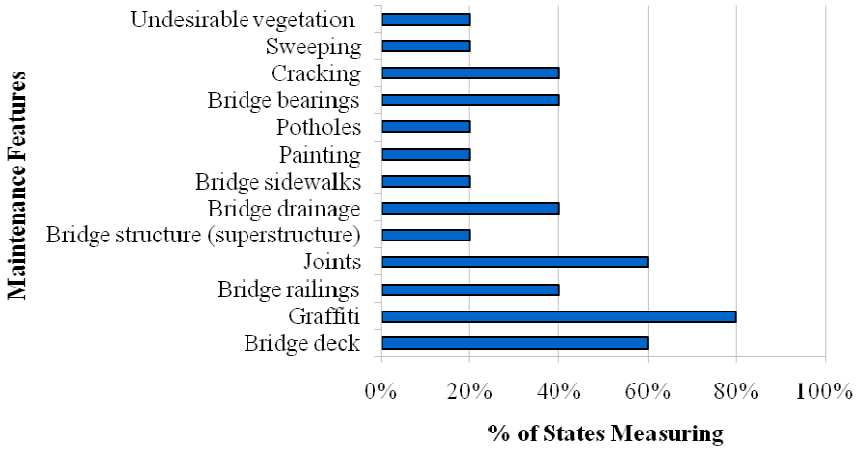

Table 2.17 shows each state's implementation of the measurements of 13 identified bridge features. 22% (5 of 23) of the states included in the study incorporate bridge features into their MQA policies. Mississippi measures 62% (8 of 13) of the bridge features into their program, the most of any state included in the study. The lowest percentage of features measured by a program is 15% (2 of 13), by Alabama. 78% (18 of 23) states do not include bridge maintenance into their MQA programs. It is important to note that many states have separate programs called bridge management systems (BMS). While the bridge category in MQA programs measures things often not included in BMS programs, such as sweeping, painting, and graffiti, BMS programs can often be the primary tool for bridge maintenance.

Table 2.17: 2008 inventory of bridge features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
BRIDGES	**X**											**X**		**X**			**X**					**X**		**5**	**22%**
Bridge deck	X											X		X										**3**	**13%**
Graffiti	X											X		X								X		**4**	**17%**
Bridge railings												X										X		**2**	**9%**
Joints												X		X			X							**3**	**13%**
Bridge structure (superstructure)																	X							**1**	**4%**
Bridge drainage												X										X		**2**	**9%**
Bridge sidewalks																						X		**1**	**4%**
Painting																						X		**1**	**4%**
Potholes																	X							**1**	**4%**
Bridge bearings														X			X							**2**	**9%**
Cracking												X					X							**2**	**9%**
Sweeping												X												**1**	**4%**
Undesirable vegetation												X												**1**	**4%**
Total (13)	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**0**	**4**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**5**	**0**		
Percentage (100%)	**15%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**62%**	**0%**	**31%**	**0%**	**0%**	**38%**	**0%**	**0%**	**0%**	**0%**	**38%**	**0%**		

2.9 REST AREAS

Table 2.18 presents each state's implementation of the measurements of 24 identified rest area features. 26% (6 of 23) of the states included in the study incorporate rest area maintenance measurements into their MQA programs. California measures the highest percentage of rest area features, including 88% (21 of 24) of the features. Louisiana and Mississippi each measure 13% (3 of 24) of the features, the second highest rate. 74% (17 of 23) of the states do not include rest area maintenance into their MQA programs. Many states utilize a rubric policy to measure rest area maintenance, involving a continuum of standards delineating qualitative points of separation such as "poor," "fair," or "good." It is possible California adopts a more detailed, separated maintenance review policy, accounting for their highly detailed set of features.

Figure 2.9 is based on the percentage of states measuring rest area features, and includes every identified category feature, due to the small sample size of six states. The "condition of buildings" feature is the most commonly measured rest area feature, with 83% (5 of 6) of the programs including it in their MQA program. It is possible programs use "condition of buildings" as an umbrella feature to cover a broad categorization of maintenance needs. California is the only state to measure specific maintenance features, such as "walkways," "irrigation," and "plumbing fixtures."

Figure 2.9: Common rest area features

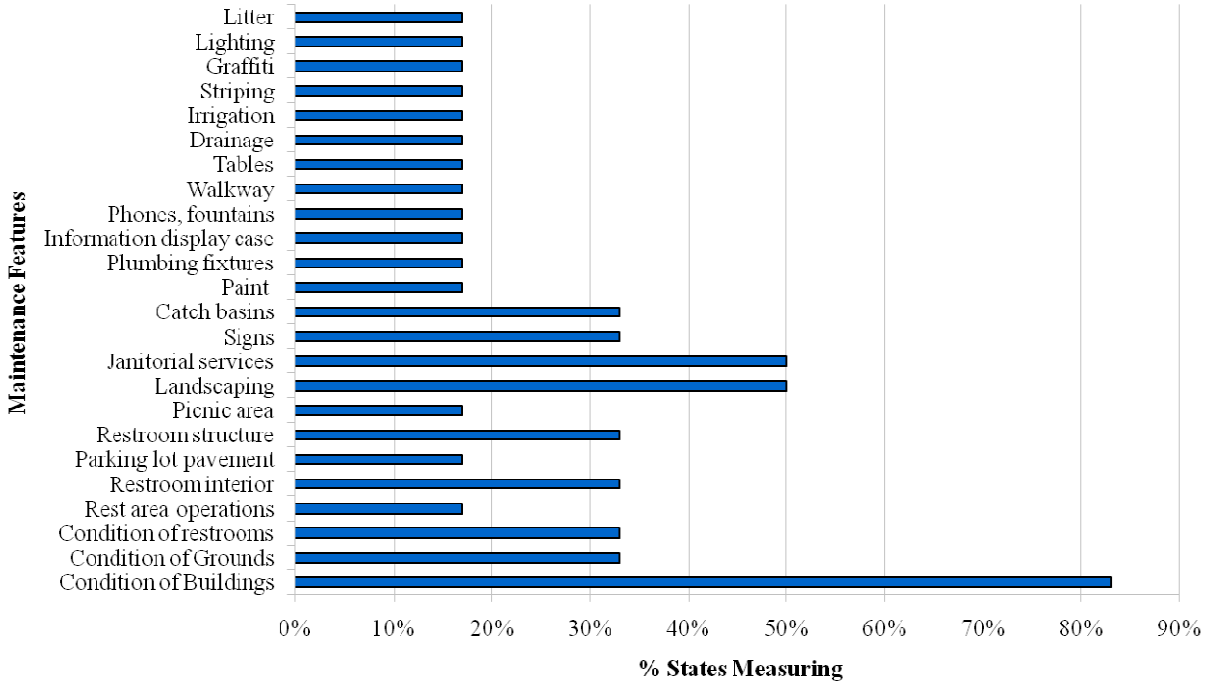

Table 2.18: 2008 inventory of rest area features

Feature	State or Province																								
	AL	CA	FL	IA	KS	KY	LA	MD	MI	MN	MO	MS	NC	NY	OH	OK	ON	SC	TN	TX	UT	WA	WI	# (23)	% (100%)
REST AREAS	X	X					X					X					X				X			6	26%
Condition of Buildings	X	X					X					X									X			5	22%
Condition of Grounds	X	X																						2	9%
Condition of restrooms		X																			X			2	9%
Rest area operations																					X			1	4%
Restroom interior		X																			X			2	9%
Parking lot pavement		X																						1	4%
Restroom structure		X																			X			2	9%
Picnic area																					X			1	4%
Landscaping							X					X									X			3	13%
Janitorial services		X					X					X												3	13%
Signs		X															X							2	9%
Catch basins		X															X							2	9%
Paint		X																						1	4%
Plumbing fixtures		X																						1	4%
Information display case		X																						1	4%
Phones, fountains		X																						1	4%
Walkway		X																						1	4%
Tables		X																						1	4%
Drainage		X																						1	4%
Irrigation		X																						1	4%
Striping		X																						1	4%
Graffiti		X																						1	4%
Lighting		X																						1	4%
Litter		X																						1	4%
Total (24)	2	21	0	0	0	0	3	0	0	0	0	3	0	0	0	0	2	0	0	0	7	0	0		
Percentage (100%)	8%	88%	0%	0%	0%	0%	13%	0%	0%	0%	0%	13%	0%	0%	0%	0%	8%	0%	0%	0%	27%	0%	0%		

Utah, newly evaluating rest area conditions, implemented strong rest area evaluation policy similar to efforts in California. California measured a significantly larger amount of rest area features than any other state, so Table 2.19 presents statistics both with and without California included in the overall 2008 numbers. 2008 saw a slight drop in average number of rest area features measured without including California.

Table 2.19: Measurement trends for rest area features

	2004	2008	2008 (w/o CA)
Min. features	1	2	2
Max. features	8	21	7
Avg. features	3.6	6.3	3.4
Std. dev. features	2.8	7.4	2.1
% of states measuring features	35%	26%	22%

As previously noted, it is important to consider the implications the development of the rubric grading system has on final 2008 numbers. Several states use grading rubrics, such as Utah and Washington. These rubrics complicate the standardization of the evaluation of MQA programs. The difficulty in classifying rubric-based measurement systems likely affects any calculated statistics. Included is Table 2.20, a copy of the rubric in Utah's MQA program. This rubric highlights the dominantly qualitative approach in evaluating rest area maintenance[3].

Table 2.20: Rest areas condition rating, Louisiana DOTD 2006

Condition Rating	Janitorial Services	Building and Appurtenances	Landscape
1 – Excellent	Restrooms are clean and sanitary. Room smells freshly sanitized. No graffiti or litter is visible. Walls, countertops, and floors are clean and dry. Soap and paper supplies are full. Trash containers are less than one-quarter full.	Building is in good repair. Partitions, doors, dispensers, and hand dryers are in place without defects. Walls, roof, and skylights are functional and free of defects. RV dump station is functional and clean.	Landscape planting is healthy, lush, and free of weeds. Lawns are mowed. Sidewalks and parking areas are clean and free of defects. Picnic tables are clean and free of defects. Site is free of noticeable litter.
2 – Good	Restrooms are clean and sanitary with no undesirable odor. No graffiti or litter is visible. Walls, countertops, and floors are clean but may have minor water spots. Soap and paper supplies have adequate supply. Trash containers are less than one-half full.	Building is in good repair with some minor surface defects. Functional partitions, doors, dispensers, and hand dryers are in place. RV dump station is functional.	Landscape plantings are healthy but may have a minor amount of weeds. Lawns are mowed. Sidewalks and parking areas are clean but exhibit some minor defects. Picnic tables are clean with minor defects. Site is free of noticeable litter.
3 – Fair	Restrooms appear clean with no undesirable odor. Minor graffiti is visible. Walls, countertops, and floors are clean but may have a significant amount of water spots. Floors contain a minor amount of litter. Soap and paper supplies have adequate supply. Trash containers are two-thirds full.	Building has some moderate surface and minor functional defects. One partition door may be missing, and one dispenser or hand dryer may be nonfunctional. A light may be out and mirrors may be missing. RV dump station is functional.	Landscape plantings exhibit some stress with a moderate amount of weeds and damaged or dying branches. Lawns are dry and infrequently mowed. Sidewalks and parking lots are clean with noticeable defects. Picnic tables are clean with minor defects. Site has minor amount of noticeable litter.
4 – Poor	Restrooms appear dirty and unsanitary, and may exhibit an undesirable odor. Significant graffiti may be visible. Countertops are wet and water spotted, floors are wet and dirty. Soap and paper dispensers may be empty. Substantial litter is visible.	Building has some significant surface and moderate functional defects. More than one partition door may be missing, more than one dispenser or hand dryer may be nonfunctional, a light may be out, and mirrors may be missing. RV dump station is temporarily out of order.	Landscape plantings contain noticeable weeds and damaged or dying branches. Lawns are not mowed. Sidewalks and parking lots are noticeably dirty with major defects. Picnic tables need cleaning and exhibit major defects. Site has significant noticeable litter.
5 – Not acceptable	Restrooms are unsuitable for use. Trash containers are full.	Building and/or appurtenances are unsuitable for use.	Landscape plantings have significant weeds and damaged or dying branches. Lawns are dry and not mowed. Sidewalks and parking lots are significantly dirty with major defects. Picnic tables need cleaning and exhibit major defects. Site has extensive litter.

CHAPTER 3: SYNTHESES OF STANDARDS AND MEASURES PER SEGMENT, 2004 & 2008

This chapter presents a synthesis and comparison of common standards and measures used by MQA programs in 2004 and 2008. The tables from Chapter 4 of Project 06-01 were integrated with the newly constructed standards and measures syntheses of 2008 to form new tables offering easy comparisons between 2004 and 2008 data.

It is essential to understand the definitions used in this chapter. According to Project 06-01, a "standard is a tolerance level or criterion that helps to identify when a feature is not 'functioning as intended'; a tolerance level or criterion that helps to identify whether a characteristic requires maintenance attention or a characteristic's condition is unacceptable." In addition, Project 06-01 defines a measure as "a description of how to quantify the deficiency of a maintenance feature or characteristic[4]."

It is important to note several conditions of this chapter. These tables present the identified standards and measures used by MQA programs. However, the task of identifying these standards and measures is a subjective one, and thus requires the use of human judgment. As a result, other standards and measures can exist outside of those identified in this report. The general inconsistencies of standards and measures across MQA programs make it difficult to create a system of standardization. While a feature may be commonly measured among states, the standards and measures used to define a deficiency can differ greatly. Due to its subjective nature, the information presented here should not be viewed as a definitive source, but rather a broad view to consider trends and snapshots of MQA policies.

3.1 PAVEMENTS

There are several changes in standards and measures from 2004 to 2008. First, several features, such as spalls, popouts, and faulting, have increased measurements as a percentage rating of pavement with a given feature. In 2004, the measurement of affected surface area was a more common standard. In contrast, several cracking features, such as alligator cracks and longitudinal cracks have shifted from a percentage measurement to a linear measurement, such as length of cracking to determine acceptable standards.

Table 3.1: Standards and measures for pavement features

	2004 (18 States)			2008 (18 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Rutting	16	▪ Ruts in excess of the allowed depth	▪ Depth of ruts ▪ # of ruts ▪ Average rut depth	13	▪ Ruts in excess of allowed depth (0.25 – 0.5 in. common)	▪ # of ruts exceeding depth threshold ▪ Length of rutting
Potholes	14	▪ Potholes in excess of the allowed depth or area require attention	▪ Area of potholes ▪ # of potholes	15	▪ Potholes in excess of the allowed depth or area (1.5 in. deep, 0.5 sq. ft. common)	▪ Total # of potholes ▪ Total area of potholes
Cracking	12	▪ Cracks in excess of the allowed width, depth, or length	▪ Length of cracks ▪ # of unsealed cracks ▪ Area of cracking ▪ % of cracking	12	▪ Cracks in excess of the allowed width, depth, or length (0.125 in. wide common)	▪ Length of cracks ▪ Length of unfilled cracks
Raveling / Surface stripping	13	▪ Any cumulative raveling greater than the allowed length or area requires attention	▪ % of surface with raveling ▪ Area of raveling	6	▪ Cumulative raveling (4 in. wide common) greater than allowed length (25 – 50 ft. common)	▪ % of surface with raveling

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Bleeding / Flushing	6	▪ Bleeding / flushing in excess of allowed area	▪ Area of bleeding / flushing	7	▪ Bleeding / flushing in excess of the allowed area (100 – 200 sq. ft. common)	▪ Area of bleeding / flushing
Alligator cracking	6	▪ Cracks in excess of the allowed length, depth, or area in square feet	▪ Area of cracking ▪ Width of cracking ▪ % surface with cracking	3	▪ Area and length of cracking	▪ Length of cracking ▪ Area of cracking
Depressions / Bumps	8	▪ All areas of depressions / bumps in excess of the allowed size in square feet	▪ Height of depression / bumps ▪ Width of depression / bumps ▪ Area of depression / bumps	10	▪ Height / depth of depressions / bumps (1.5 in. common)	▪ Height / depth of bumps / depressions ▪ Total surface area of bump / depression ▪ Total #
Shoving	7	▪ All shoving greater than the allowed depth	▪ Depth of shoving ▪ Area of shoving	4	▪ Shoving exceeding the allowed area (25 sq. ft. common)	▪ Total area of shoved area
Edge break-up / Edge raveling	7	▪ Edge break-up in excess of the allowed depth requires attention	▪ Depth of break-up ▪ Length of break	3	▪ Edge break-up / raveling exceeding allowable width or length	▪ Total length of edge raveling ▪ Width of edge raveling

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Transverse cracks	6	▪ Cracks in excess of the allowed length, depth, or area requires attention	▪ Length of cracking ▪ Width of cracking ▪ Separation of blocks with cracking ▪ % of pavement with transverse cracking ▪ # of unsealed cracks ▪ # of slabs with cracking	1	▪ Unsealed transverse cracks greater than an allowable width (0.25 in.) longer than allowable length (120 ft.)	▪ Total length of unsealed transverse cracks
Patching	5	▪ All patches larger than the allowed area in square feet	▪ Area of needing repair ▪ # of patches per lane	7	▪ Patching larger than allowed area in square feet ▪ Excessive height differential between patch and adjacent pavement (0.25 in. common)	▪ Total square feet of pavement ▪ Total square feet of patching / area that needs patching ▪ Total # of deficient patches

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Rideability / Ride quality (composite)	4	▪ Any travel way where it is difficult to maintain speeds requires attention ▪ Surfaces where cracks cause unevenness ▪ Surfaces that are cracked, worn, or torn away require attention	▪ IRI (roughness) index	2	▪ None found	▪ None found
Longitudinal cracks	6	▪ Cracks in excess of the allowed length, depth, or area	▪ Length of cracking ▪ Width of cracking ▪ % of pavement with cracking ▪ # of slabs with cracking	2	▪ Greater than allowable width (0.25 in. common)	▪ Linear feet of cracking
Surface oxidation	3	▪ Surfaces where texture is worn ▪ Surfaces with extensive large popouts require attention	▪ % of pavement surface with unwanted deficiencies or oxidized surface	0		
Joints (seals)	11	▪ All unsealed joints ▪ Joints unable to keep out water	▪ % of joints not functioning as intended ▪ Length of unsealed joints	4	▪ % of joints unsealed and greater than an allowable width (0.25 – 0.50 in. common) ▪ 10 – 25% common	▪ Total length of joints ▪ Total length of unsealed joints ▪ % joints unsealed

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Spalls / Popouts	9	▪ Spalls / popouts greater than a specified area in square feet or depth	▪ Area of spalling ▪ Depth of spalls ▪ # of slabs with spalls	4	▪ Area of spalls / popouts (1 sq. ft. common) ▪ % of travel way with spalls (5-10% common)	▪ Total # of spalls ▪ Total square feet ▪ % travel surface with spalls
Faulting	6	▪ Faults greater than the allowed depth require attention	▪ Length of cracks ▪ # of unsealed cracks ▪ Area of cracking ▪ % of pavement with cracking	3	▪ Depth of faulting (0.25 – 0.50 in. common) ▪ % of faulting (90% common) ▪ # of faults per lane (2 – 3 common)	▪ Total # of faults ▪ % of faulting ▪ Total length of faulting (for crack faults)

3.2 SHOULDERS

According to the data, MQA have relaxed the standards for defining maintenance needs on shoulder features. Shoulder-to-ground drop-off limits were significantly higher in 2008 than in 2004, with a common allowable limit increasing an inch from two to three inches. The standards for allowable width in surface-edge raveling more than doubled between 2004 and 2008, moving from a common standard of one to two inches, to four to six inches. In addition, percentages of defected areas increased in popularity as a measure. This appears in the features of "shoulder cross slope," "vegetation," and "sweeping," in 2008.

Table 3.2: Standards and measures for shoulder features

	2004 (19 States)			2008 (20 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Shoulder drop-off to ground / Mainline drop-off / Build-up	16	▪ Shoulder drop-off requires attention when lower than travel way (e.g. 0.5 – 2 in.)	▪ Longitudinal length where drop-off is lower than warranted ▪ Drop-off height where deficient ▪ # of occurrences of deficient drop-off ▪ % of shoulder with deficient drop-off	16	▪ Drop-off exceeds allowable limit (e.g. 1.5 - 3.0 in. common) ▪ Build-up exceeds allowable limit (e.g. 0.5 in common)	▪ Longitudinal length ▪ # of occurrences ▪ % of shoulder with deficient drop-off
Potholes	11	▪ All potholes greater than a specified depth (e.g. 0.5 – 4 inches) require attention ▪ All potholes greater than a specified area require attention	▪ Depth of potholes ▪ Area of potholes ▪ # of deficient potholes	10	▪ Potholes greater than a specified depth (e.g. 0.5 - 2 in. deep common) ▪ Potholes greater than a specified area (e.g. 0.5 – 1 sq. ft. common)	▪ Depth of potholes ▪ Area of potholes ▪ # of deficient potholes

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Cracks	11	▪ Cracks greater than the allowed width (e.g. 0.25-1 in.) require attention ▪ All unsealed cracks require attention	▪ Length of cracking	7	▪ Cracks greater than the allowed width (e.g. 0.25 – 0.50 in. common) ▪ Unsealed cracks	▪ Total length of cracking ▪ % of sealed cracks ▪ Type of crack
Pavement drop-off to shoulder / Pavement shoulder joint	7	▪ Pavement drop-off greater than the allowed length requires attention ▪ Pavement drop-off requires attention when a certain percentage of the joint or drop-off has failed	▪ Longitudinal length of drop-off ▪ # of uncorrected defects ▪ Height of pavement to shoulder drop-off	13	▪ Excessive height (e.g. 2 – 4 in. common)	▪ Longitudinal length ▪ Height of drop-off
Surface-edge raveling	6	▪ Raveling requires attention when greater than allowed size in square feet (e.g. 1 -2 in.) ▪ Raveling requires attention when the width of deficient area is greater than allowed (e.g. 1 – 4 inches)	▪ Area of raveling ▪ % of pavement surface with raveling	7	▪ Width of raveling (e.g. 4 – 6 in. common) ▪ Length of raveling (e.g. 50 ft. common)	▪ Area of raveling ▪ Length of raveling
Non-positive drainage	7	▪ Drainage requires attention when standing or ponding water evident	▪ Area of non-positive drainage	2	▪ When ponding is evident, potential (e.g. depressions, ruts, negative slopes, high shoulders)	▪ None found

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
High shoulder / Distortion	6	▪ Shoulder requires attention if height relative to travel-way is greater than allowed (e.g. 0.5 – 2.0 in.)	▪ Height of distorted / high shoulder ▪ Longitudinal length of distorted / high shoulder	6	▪ Height relative to travel-way (e.g. 1 – 2 in. common)	▪ Length of deficiency
Rutting	5	▪ Ruts in excess of the allowed depth require attention	▪ Width of rutting ▪ Length of rutting	3	▪ Width (e.g. 0.250 – 0.375 in. common) ▪ Depth (e.g. 0.50 – 2.0 in. common)	▪ Width of rutting ▪ Length of rutting ▪ % area of rutting
Shoulder cross slope	5	▪ Cross slope requires attention if grade of cross slope does not meet requirements (usually expressed as a percentage) ▪ Slope needs attention if flooding or ponding is observed ▪ Slope requires attention if negative slope is observed	▪ Length of deficiency	2	▪ Cross slope requires attention if grade of cross slope does not meet requirements (usually expressed as a percentage) ▪ Slope needs attention if flooding or ponding is observed ▪ Slope requires attention if negative slope is observed	▪ Length of deficiency ▪ % area of deficiency

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Vegetation	4	▪ None found	▪ Area of vegetated cover	2	▪ Obstructs road signs	▪ % area of vegetated cover ▪ Height
Sweeping	1			4	▪ Presence of sand, small debris on the shoulder	▪ % of shoulder area with sand, accumulated material
Litter Debris	3			1	▪ Any object large enough to pose a safety threat	▪ # of objects
Faulting	2			4	▪ Depth discrepancy (e.g. 0.25 – 0.375 in. common)	▪ # of faults ▪ Longitudinal length of faulted cracks

3.3 DRAINAGE

Several drainage features in 2008 outline standards and measurements per segment in more detail than in 2004. This is particularly noticeable in the catch basin / drop inlets and curb / gutter feature, as well as the curb and gutter feature. While a majority of the features were measured in consistent numbers between 2004 and 2008, two features experienced significant drops in state participation. Both subsurface drainage and slope features had a participation drop of five MQA programs between 2004 and 2008, from eight to three and seven to two, respectively.

Table 3.3: Standards and measures for drainage features

	2004 (20 States)			2008 (22 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Ditches	20	▪ Ditches require attention when percent of ditch accumulation is greater than allowed ▪ Ditches require attention when blocked by a certain amount ▪ Ditches require attention when depth of standing water in pipe is greater than allowed	▪ Length or percent of ditch debris ▪ Length or percent of blocked ditches ▪ Percent of ditch debris accumulation ▪ Length of ditch scour ▪ Length or percent of ditch segment to be cleaned	18	▪ Ditches Require Attention when blocked by a certain amount ▪ Ditches require attention when blocked by a certain type of obstruction i.e. trees or brush	▪ Length of debris in ditch. ▪ # of drains ▪ Linear feet of unpaved or paved ditches ▪ Ditches where the flow is blocked or inhibited

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Catch basin/Drop inlets	12	▪ Inlet requires attention when full by more than the allowed amount (e.g. 25 – 50%) (expressed as a percentage of total inlet capacity)	▪ Number of inlets and catch basins ▪ Number of deficient inlets and catch basins	13	▪ Inlet requires attention when the cavity is blocked by a certain amount (e.g. 25%) ▪ Inlet grate is damaged (broken or missing) or rusted to the extent that the material cross section has been noticeably reduced ▪ Evidence of standing water on the pavement ▪ Sediment in the catch basin blocks the outlet pipe opening by 50 percent or more (use a flashlight if necessary to observe the amount of buildup).	▪ Measure opening of the drain inlet. ▪ # of deficient inlets and catch basins ▪ # of inlets and catch basins

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Curb and gutter	12	▪ Curb and gutter requires attention if blocked by more than the allowed percentage (e.g. 25-75%) ▪ Curb and gutter requires attention when functioning at less than the allowed percentage of design capacity (e.g. 50-90 %)	▪ Length of blocked curb and gutter	8	▪ Require attention if blocked by a certain amount or damaged ▪ Any damaged gutter should be noted, such as cracking, settlement, misalignment, or deterioration. ▪ Fails if there is scattered debris i.e. animals, mufflers ▪ 90% of all joints shall be flush and filled with joint material	▪ Linear feet of curb and gutter for blocked area ▪ Evaluate each gutter for damage ▪ Measure the longitudinal length ▪ Length wherever a gutter is not functioning as designed due to an obstruction 2 inches or for at least 2 feet of curb length
Culverts	8	▪ Culverts require attention when blocked by more than the allowed percentage (e.g. 25%)	▪ Number of culverts ▪ Number of obstructed or blocked culverts	11	▪ Culverts require attention when blocked by more than an allowed percentage (e.g. 25%)	▪ % of blocked pipe opening ▪ # of culverts ▪ # of culverts with structural deficiencies

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Subsurface drainage	8	▪ Subsurface drainage requires attention if functioning at less than a given percentage of design capacity (e.g. 90%)	▪ Length of subsurface drainage ▪ Length of deficient subsurface drainage ▪ Percent of inhibited flow area	3	▪ Standing water one inch in depth or greater covering six feet or more of the paved surface for 10 linear feet. ▪ Water flow or end protection is obstructed	▪ # of drains ▪ # of deficient drains
Slopes / Slope failures	7	▪ Slope requires attention if a slide or erosion jeopardizes structural integrity; slide blocks shoulders or travel lanes	▪ Number of slope failures (degree of slope (foreslope) measured to determine potential for damage)	2	▪ Slope requires attention if the slope impedes drainage or affects adjacent property	▪ # of deficiencies ▪ Cumulative square feet of erosions and slides
Drainage structures	5	▪ Drainage structures require attention if the percentage of inhibited flow area is greater than allowed	▪ Number of drainage structures ▪ Number of deficient drainage structures ▪ Percent of inhibited flow area	5	▪ Drainage structures require attention if the percentage of inhibited flow area is greater than allowed (e.g. 25%)	▪ # of drainage structures ▪ # of deficient drainage structures
Storm drains	4	▪ Drains require attention if a given percentage of cross-sectional area is restricted ▪ Drains require attention if functioning at a less than optimal percentage of the design capacity	▪ Number of drains ▪ Number of deficient drains	2	▪ Drains require attention if more than 90% of the cross-sectional area is obstructed and not functioning as intended.	▪ None found

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Pipes	3	▪ Pipes require attention if blocked by a percentage that is not allowed (e.g. 25-50%), or if damaged or obstructed	▪ Number of pipes ▪ Number of blocked, damaged or obstructed pipes	2	▪ Pipes require attention if blocked by a percentage that is not allowed (e.g. 25-50%), or if damaged or obstructed	▪ # of pipes in a segment. ▪ # of damaged pipes in a segment.

3.4 ROADSIDE & VEGETATION

The 2004 and 2008 MQA policies on roadside and vegetation maintenance are noticeably similar on all levels. However, several standards for features in 2008 are more streamlined, perhaps to make measurement easier. For example, roadside litter in 2008 was considered litter regardless of its visibility while traveling at the posted speed. Graffiti adopted a pass/fail standard in 2008, simplified from its more complex measurement in 2004. Fewer states are measuring roadside and vegetation features. The number of programs measuring fences decreased by five, from 15 to 10. Slopes saw a 50% reduction in the number of programs implementing their measurement into maintenance assessment, reducing from 12 to six.

Table 3.4: Standards and measures for roadside and vegetation features

	2004 (21 States)			2008 (20 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Litter / debris (roadside)	15	▪ Litter needs removal if visible at posted speed ▪ Litter larger than an identified dimension (e.g. fist size) requires removal	▪ Length of litter ▪ # of pieces of litter counted ▪ % of site with litter	14	▪ Wide variation in litter standards and definition (from zero-tolerance to 100 pieces, 1 5-gallon trash bag, etc.) ▪ Litter larger than an identified dimension (e.g. fist size) requires removal	▪ # of pieces of litter
Fences	15	▪ Fence requires attention if it fails to provide a positive barrier, missing, or damaged	▪ Length of fence ▪ % of fence requiring repair ▪ Length of deficient fence	10	▪ Deficiencies prohibit proper intended function ▪ Examples of deficiencies include broken fence links, insufficient height, sizeable gaps or holes	▪ Length of fence ▪ Length of deficient fence

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Brush and tree control	12	▪ Brush requires attention if obstructing vision, obstructing sight distance, or obstructing clear zone ▪ Brush requires attention if encroaching upon travel way or blocking signage	▪ # of instances of trees in the clear zone ▪ # of vegetation obstructions per segment ▪ % of travel way free of encroachment	11	▪ Obstruction of clear zone, signage, drainage, vision, etc. ▪ Encroachment upon travel way (vertical clearance of 15 – 18 feet common)	▪ # of dead trees in clear zone ▪ Length of insufficient brush and tree control
Mowing	13	▪ Grass requires mowing once a given percentage of grassy area exceeds the allowed height	▪ % of vegetated area mowed to standard ▪ Average grass height over a specific length ▪ Length of grassy area that is above the allowed height	14	▪ Given percentage exceeds determined height (1-5% common)	▪ Total area ▪ Total area of excessive grass height ▪ Average height

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Slopes	12	▪ Slopes require attention if the width of erosion is greater than allowed ▪ Slopes require attention if the depth of observed ruts or washouts is more than allowed	▪ Length of slopes ▪ Length of deficient slopes	6	▪ Erosion width greater than allowed ▪ Depth of observed ruts or washouts deficient (6'' common)	▪ Length of slopes ▪ Length of deficient slopes ▪ # of deficiencies
Noxious weeds	9	▪ Weeds require removal if visible clumps are present ▪ Weeds require removal if the percentage of infestation is more than allowed	▪ Length of highway where noxious weeds are present ▪ % of noxious weeds present per segment ▪ Area of roadside ▪ Area of infestation	6	▪ % of allowed noxious weeds (5 – 10% common) ▪ Specific weeds determined on a state-by-state basis	▪ Area of roadside ▪ Area of infestation ▪ % of area infestation

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Landscaping	7	▪ Landscaping requires attention once area is no longer maintained at its original condition	▪ Area of landscaping ▪ Area of poor landscaping ▪ % of landscape that is poorly maintained	4	▪ Landscaping requires attention once area is no longer maintained at its original condition	▪ % of landscape poorly maintained
Sidewalks / curb	7	▪ Sidewalk requires attention once the percentage of sidewalk under visible distress exceeds allowed amount	▪ Area of sidewalk ▪ Area of sidewalk that needs repair ▪ Length of sidewalk ▪ Length of non-functioning sidewalks	5	▪ Sidewalk requires attention once the percentage of sidewalk under visible distress exceeds allowed amount ▪ Encroachment of vegetation / debris	▪ Length of sidewalk ▪ Length of non-functioning sidewalk
Graffiti	6	▪ Graffiti requires attention if visible at posted speed	▪ Area with graffiti ▪ % of surface free of graffiti ▪ # of hours following notification of deficiency that graffiti is removed	3	▪ Pass / fail standard	▪ None found

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Litter removal (vegetated areas)	6	▪ Litter requires removal when visible at posted speeds ▪ Litter requires removal when present within mowing limit or located at an unacceptable distance from mowing limit	▪ # of pieces of litter	8	▪ Wide variation in litter standards and definition (from zero-tolerance to 100 pieces, 1 5-gallon trash bag, etc.) ▪ Litter larger than an identified dimension (e.g. fist size) requires removal	▪ # of pieces of litter
Retaining walls	4	▪ Wall requires attention when undermining of rip-rap slope, paved ditch slope, or pavement is evident	▪ % of weep holes with blocked drainage ▪ Linear feet of wall ▪ Linear feet of deficient wall	2	▪ None found	▪ None found
Turf condition	4	▪ Turf requires attention if no longer maintained at its original condition	▪ Longitudinal length of poor sod ▪ % of turf maintained at below healthy condition	3	▪ % of poor turf condition (25 – 30% common) ▪ Examples of poor condition include bare, dead, diseased, or distressed turf	▪ Length of segment ▪ Length of deficient areas

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Curb trees / sidewalk edge	3	▪ Sidewalk requires attention if there is an encroachment of grass or vegetation along sidewalk	▪ Length of sidewalk ▪ Longitudinal length of deficient sidewalk	2	▪ Encroachment of grass or vegetation along sidewalk	▪ Length of sidewalk ▪ Length of deficient sidewalk
Hazardous debris / animal carcasses	0	▪ Carcasses on shoulder, visible from the roadway or in roadway require removal	▪ % of carcass removed following notification ▪ Time taken to remove carcass	3	▪ Debris / carcasses large enough to pose a safety threat	▪ # of pieces of hazardous debris / carcasses

3.5 TRAFFIC MANAGEMENT

2008 MQA programs saw an increased emphasis on the functionality of traffic management features. More important than specific levels of object condition is its ultimate effectiveness in desired conditions. For example, the specificities of 2004's standards for regulatory and non-regulatory signs became simplified to nighttime effectiveness in 2008. No longer are regulatory and non-regulatory signs designated deficient by improper height, alignment, or worn message. In addition, several features in 2008, such as pavement markings, delineators, and barrier walls / concrete barriers, saw the inclusion of a percentage tolerance threshold to indicate when maintenance is needed. There was an increase in the number of states measuring pavement symbols, from two in 2004 to five in 2008. Pavement symbols and pavement markings are similar categories, with MQA programs possibly blurring the boundaries and depositing certain features acceptable into either category. This serves as a possible explanation for the decrease in the measurement of pavement markings, from 16 to 12.

Table 3.5: Standards and measures for traffic management features

	2004 (22 States)			2008 (22 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Non-regulatory signs and regulatory signs	20 / 20	▪ Signs require attention if there is insufficient reflectivity, worn or missing characters in message, incorrect sign height, incorrect lateral clearance, or a deviation of post alignment from vertical is evident	▪ # of signs	13 / 15	▪ Anything preventing nighttime effectiveness of the sign	▪ # of signs
Guiderail / Guardrail	18	▪ Count as deficient any guardrail that is functionally or structurally impaired	▪ Longitudinal length of any guardrail that is not functioning as designed or has been damaged ▪ % damaged as a function of original design capacity	17	▪ Any guardrail that is functionally or structurally impaired ▪ Common deficiencies include severe dents, twisted blocks, insufficient height	▪ Length of guardrail ▪ Length of structurally deficient guardrail ▪ Length of guardrail with insufficient height

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Pavement markings	16	▪ Markings require attention if extent of wear is greater than desired	▪ # of markings	12	▪ Marking wear is greater than desired, marking loses function	▪ Length of markings
		▪ Markings require attention if distance of line from original location is greater than desired	▪ # of deficient markings		▪ Standards of wear include reflectivity, general obstruction	▪ Length of deficient markings
			▪ Amount (length) of line damage		▪ % of total length of line markings are deficient (0–10% common standard)	
			▪ Distance of pavement markings from original location			
			▪ Retroreflectivity			
Linestriping	17	▪ Requires attention when percentage of paint missing from line exceeds allowed amount	▪ Length of lines in segment	10	▪ % of paint missing (20-25% common standard)	▪ Length of lines
		▪ Line require attention if line is not visible from required distance	▪ Length of worn, missing or damaged striping		▪ General deficiency in line function (loss of reflexivity, obstruction)	▪ Length of deficient lines
		▪ Line requires attention if distance of line from original location is greater than desired	▪ Distance of line striping from original location			
			▪ Retroreflectivity of line striping			

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Impact attenuators	15	▪ Attenuators require attention if functioning at less than allowed percentage of design capacity	▪ # of attenuators needing repairs ▪ Length of deficient attenuators ▪ % of attenuators free of defects	12	▪ Possess deficiencies that prohibit intended function (e.g. previous impact)	▪ # of attenuators ▪ # of deficient attenuators
Delineators	13	▪ Delineators require attention if a given percentage of reflectivity is missing or worn ▪ Delineator requires attention if vertical height alignment or perpendicularity varies by more than allowed amount	▪ # of delineators that should be present ▪ # of delineators missing or defective	7	▪ % of delineators deficient (20-25% common standard) ▪ Examples of deficiencies include low reflectivity levels, improper vertical and horizontal alignment)	▪ # of delineators ▪ # of deficient delineators
Barrier wall / Concrete barrier	13	▪ Walls require attention once deficient or not functioning as originally intended	▪ # of crash barriers ▪ # of crash barriers deficient or malfunctioning barriers	13	▪ % of barriers is deficient (0-5% common standard) ▪ Examples include structural cracks, improper alignment, gouges	▪ Length of barrier ▪ Length of deficient barrier

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Raised pavement markings	9	▪ Raised markings require attention if a given percent of original installation is deficient or not functioning as intended	▪ # of RPMs that should be present in the segment ▪ # of deficient RPMs	12	▪ % of RPMs non-functional or missing (10-30% common standard) ▪ Examples of deficiencies include poor reflexivity, improper installation	▪ # of RPMs present ▪ # of RPMs that should be present / non-functional
Highway lighting	7	▪ Lighting requires attention if a given percentage of installation is not functioning ▪ Lighting requires attention if the structural integrity of the lighting is compromised	▪ # of highway lights ▪ # of highway lights deficient ▪ % of lights along segment that are functional / not functional	4	▪ % of highway lights rated deficient (5-10% common standard) ▪ Examples of deficiencies include damaged poles, exposed electrical work, out-of-service lights	▪ # of highway lights ▪ # of deficient lights ▪ % of deficient lights

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Guard cable	7	▪ Cable requires attention if damaged to the point of functional deficiency ▪ Cable requires attention is there is deviation of horizontal alignment from design height	▪ Length of cable ▪ Length of deficient cable ▪ # of cables not functioning as intended	4	▪ Deficiencies that prohibit proper functioning ▪ Examples of deficiencies include poor tension, incorrect vertical and horizontal alignment	▪ Length of guard cable ▪ Length of deficient guard cable
Object markers	3	▪ Markers require attention if consecutively non-functional markers observed	▪ # of consecutive non-functional markers	4	▪ % of object markers deficient (0% common standard) ▪ Examples of deficiencies include improper vertical and horizontal alignment, poor reflectivity, missing markers)	▪ # of object markers ▪ # of deficient / missing markers

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Traffic signals	3	▪ Signals require attention if not working properly	▪ # of signals with lamp outages, improper signal operation, or damage ▪ % of traffic lights with bulbs not working, structural damage or non-functioning loops	5	▪ Signals not working properly (burnt out bulbs, control system malfunction)	▪ # of traffic signals ▪ # of deficient traffic signals
Intelligent transportation systems	2	▪ ITS requires attention if the percentage of non-functioning systems is more than allowed	▪ % of ITS systems not working	0		
Pavement symbol	2			5	▪ % deficient pavement symbol markings (0-30% common) ▪ Examples of deficiencies include 50% of symbol worn, poor reflectivity	▪ # of pavement symbols ▪ # of deficient pavement symbols

3.6 SNOW & ICE

Few programs document policies for snow removal and general winter road maintenance. However, there are several interesting observations derived from programs that do. Standards for hours to bare pavement after snowfall lowered from 2004 – 2008. A Minnesota state survey concluded that the public's general level of expected road conditions immediately after snow fall is not completely bare pavement, but simply a clear path between the wheels[5].

Table 3.6: Standards and measures for snow and ice features

	2004 (10 States)			2008 (5 States)		
Feature	**# of States**	**Standards**	**Measures per Segment**	**# of States**	**Standards**	**Measures per Segment**
Hours to bare lane	5	▪ None found	▪ # of hours taken to achieve bare pavement	1	▪ Bare between wheel paths	▪ # of hours taken to achieve bare between wheel paths
Plowing activity		▪ No roadway ice or snow accumulations shall be present 12 hours after the local state supervisor is notified	▪ # of hours after storm that plowing is completed	None found		
Statewide salt usage	0	▪ None found	▪ # of hours after storm that salting is completed ▪ Amount of salt required to achieve pre-storm conditions	1	▪ None found	▪ Cubic yards used in observation hour

3.7 BRIDGES

The bridge graffiti feature developed more defined standards and measures in 2008. In addition, the bridge railing feature developed more detailed parameters for what constitutes damage, such as bending, corrosion, or cracking. Little detail was found pertaining to bridge structure, measured by only one program. As such, it is believed any features pertaining to structural integrity have been integrated elsewhere in the bridge category.

Table 3.7: Standards and measures for bridge features

Feature	2004 # States (10)	Standards	Measures per Segment	2008 # States (5)	Standards	Measures per Segment
Bridge deck (composite)	4	▪ All deficiencies larger than the allowed depth or length (e.g. minimum size 6'' x 6'' x 1'' depth or larger)	▪ % of deck surface with deficiencies	3	▪ Unrepaired deck spalling 4'' or greater	▪ % of bridges with spalling in wheel path
		▪ Deck requires cleaning if sand or debris is present	▪ Total square feet of deficient deck		▪ Surface w/ visible sand / debris	▪ % of surface area covered in sand or debris
		▪ Sand or debris requires removal if flow of water or drainage on bridge deck is adversely affected	▪ Total square feet of sand or debris			

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Drain holes	3	▪ Blocked drain holes require attention ▪ Drain holes functioning at less than a given percentage (e.g. < 90%) of design capacity	▪ None found	0		
Joints	3	▪ Joints functioning at less than an allowable % (e.g. < 90%) of functional capacity ▪ % (e.g. 95%) of joint is blocked by debris or dirt ▪ Unable to inhibit the longitudinal movement of the superstructure	▪ None found	3	▪ Missing, loose, or damaged parts ▪ Buildup of foreign material ▪ Prohibition of bridge movement	▪ # of bridge joints ▪ # of deficient bridge joints
Bridge railing	3	▪ All damaged rails require attention ▪ Railing requires attention if a given % does not function as intended (e.g. 90%) ▪ Out of place rails require attention	▪ None found	2	▪ Bending, damage, corrosion, cracking	▪ Total feet of bridge railing ▪ Total feet of deficient railing ▪ % deficiencies w/ deferred repair over a year
Bridge approach	2	▪ Elevation difference is greater than allowed (e.g. 1.5 inches)	▪ None found	0		

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Bridge Structure	2	▪ All dents that impact structural integrity require attention ▪ Erosion that would have an adverse effect on thru roadway or structure requires attention ▪ Graffiti requires removal if more than the allowed % of structure is covered	▪ % of structure covered with graffiti ▪ % of graffiti removed within the required time following report	1	The analysis of bridge structure has largely been broken down into more specific areas of interest, as represented throughout the table	
Painting	1	▪ Steel structures exceeding the "non-deteriorated" range by more than a given % of rust (e.g. 1%)	▪ None found	0		
Graffiti	3			4	▪ Graffiti present	▪ % of bridge surfaces containing graffiti ▪ Generalized levels of acceptability

3.8 REST AREAS

The most significant change, as displayed in the rest area portion of the synthesis table, is the development of a grading rubric in several states used for the evaluation of the condition of rest areas (see Table 2.20). A continuum of measurements concerning trash bins, soap containers, cleanliness, weeds, and other aesthetic and sanitary characteristics of rest areas has been constructed in order to better evaluate maintenance conditions.

Table 3.8: Standards and measures of rest areas

Feature	2004 # States (9)	Standards	Measures per Segment	2008 # States (5)	Standards	Measures per Segment
Parking area	2		▪ Condition of parking area	0	▪ It is common for states to utilize a grading rubric system in evaluating rest area conditions. As such, the standards and thresholds are qualitative in nature	▪ Adequate lighting
Condition of buildings	5		▪ Appearance of building exterior	5	▪ Examples include adequate lighting, adequate supplies of soap and paper, low levels of noxious weeds, janitorial condition of restrooms	

Feature	2004 # States	Standards	Measures per Segment	2008 # States	Standards	Measures per Segment
Condition of grounds	5		▪ Appearance of grounds (landscaping, litter, etc.)	2	▪ See above	▪ Levels of litter, landscape condition (e.g. mowing, weeds)
Condition of restrooms	4		▪ Functionality of plumbing and dryers in restrooms	2		▪ Adequate amounts of soap and paper ▪ Trash bin levels
Restroom interior	3		▪ Cleanliness and appearance of building interior	2		▪ Sanitation condition ▪ Condition of stalls, plumbing, etc.

CHAPTER 4: DISCUSSION AND CONCLUSION

This report serves as an update of Project 06-01, "Maintenance Quality Assurance – Synthesis of Measures," completed in 2005. This document was patterned after the 2005 report. MQA programs can use this report as a resource to compare themselves with other programs, contributing to a program's decision-making progress that could ultimately direct its future. The broad trends captured here present a snapshot of MQA programs, essentially serving as a barometer for the state of MQA in 2008.

4.1 ASSUMPTIONS

As discussed in Chapter 1, it is important to recognize that this report analyzes the programs of a different set of states than the 2004 report. Three less programs were included in this report, from 26 to 23. Both studies included a different set of participating states, with some programs included in both studies. While exact comparisons cannot be made due to the inconsistency of state participation, general trends and conclusions can be derived from the collected data. Taking these facts into account, it is important to realize this study serves as a snapshot of the state of MQA programs in 2008.

The use of the word "common" appears throughout the report, such as "commonly measured" features or "commonly cited" standards. As discussed earlier, "common" standards or measures typically refer to those implemented by three or more programs. If the sample size is too small, all identified features, measures, or standards were included.

The report also assumes familiarity with established MQA terminology. The continued recognition and expansion of this language is important to progress the standardized documentation and national communication about MQA programs.

4.2 OBSERVATIONS

Fewer features are being measured within several major maintenance categories in 2008 than in 2004. The categories with the largest decreases in measured features were drainage and traffic management. These features saw the average number of measured features decrease by 1.1 features. Other maintenance categories, such as vegetation and bridges, were measured at greater levels in 2008 than in 2004. In 2008, vegetation and bridge features increased their measurement by 0.8 and 0.7 features, respectively. These fluctuating numbers reflect the shifting priorities of MQA programs within the greater context of roadway safety. Still other features, such as pavements and shoulders, were measured at similar levels in 2004 and 2008. Pavements and shoulders have often been the categories with the most established maintenance procedures. As such, it is understandable these maintenance assessment policies waivered little since 2004.

It is interesting to examine the most commonly measured features across categories to understand possible reasoning behind commonality. Many of the most commonly measured features, such as potholes, shoulder drop off, debris, and guardrail

functionality, are on the frontlines of roadway user safety. These features are measured by 61-74% of the programs. Maintenance backlog in features such as these can lead to serious safety issues on the roads. While no maintenance infraction should ultimately be viewed as unimportant, MQA programs have clearly delineated maintenance priorities as displayed in MQA policies. Simple pavement surface defects on pavement or inadequate slope mowing manifest themselves as low priorities in the greater context of MQA programs.

Certain categories possess more features to be measured than others. For example, the categories of pavement, traffic management, and drainage have 36, 30, and 29 features, respectively, measured by at least one MQA program. The categories of vegetation, shoulder, and roadside have 21, 20 and 17 features, respectively, measured by at least one MQA program. The bridge and snow / ice categories measure the fewest features, 13 and 11 respectively. The rest area category operates under unique circumstances. The presence of California's strong rest area maintenance assessment policy drives the number of measured features to 24. Without California, that number reduces to 12. These category emphases are a further manifestation of an MQA program's paramount responsibility of ensuring safety in roadway travel. Pavement and traffic management conditions receive more attention than the vegetation and roadside conditions surrounding their operation.

MQA programs must ultimately consider several things on the path toward success. A level of ease of use must be attained. Understandable terminology and the logical classification of categories and their features, without delving into overt complexities, contribute toward an MQA program's smooth implementation. The programs included in this study have shown progress in these areas. MQA programs must also consider the realistic effectiveness of active policies. This 2008 report shows signs of programs directing themselves toward policies driven more by qualitative properties than quantitative ones. Take for example the standards of regulatory and non-regulatory signs in the traffic management category. The specificities of such standards like sign alignment and percent of worn text are replaced by the simple standard of "effectiveness" and "nighttime readability." One can also similarly look at Louisiana's implementation of the rest area maintenance rubric, Table 2.20, to see a further example of the qualitative nature of maintenance measurement. Here we find a "condition rating" scale, ranging from 1 ("excellent") to 5 ("not acceptable"). A suite of qualities pertaining to rest area maintenance, such as odor, cleanliness, presence of graffiti, and trash receptacle levels are holistically considered, after which a final rating is given. The qualitative analysis used in determining rest area maintenance makes it difficult to standardize measurement across MQA programs.

Many of the MQA documents reviewed for this project implement a visual approach in communicating appropriate maintenance measurement procedures. Pictures highlight the correct manner in which measurements need to be taken to assure valid results. Step-by-step instructions assist a field worker through the correct procedures for measurement. More visual and textual details provided in MQA manuals and guides can only increase the probability of more precise and accurate recorded information.

4.3 LIMITATIONS

It is important to note that while snapshots are beneficial in providing quick, general perspectives about their image, all snapshots forfeit a sense of context in exchange for their convenience. Inconsistencies among MQA programs manifest themselves frequently throughout this report. The reasons for these inconsistencies cannot be captured in a report structured such as this. It is of extreme importance to consider the contexts in which these MQA programs operate. For example, each state operates under unique climate situations. The needs of Wisconsin are going to differ from those of Louisiana. These weather conditions can direct the emphases a program gives to a certain maintenance categories and its standards and measures. In addition, maintenance programs similar to MQA but possessing a different taxonomy can be over-looked in any goal to standardize, compare, and contrast maintenance procedures. This is especially true of the pavement and bridge categories. Ideally, program to program comparisons could be made, but the variables present within the realm of MQA programs make it an extremely difficult task.

It is also important to note that this report does not consider the quality with which these programs are implemented, nor is that the report's intention. However, the policies put in place to evaluate the employees assessing maintenance quality in the field should be just as important as the policies these employees are supposed to adhere to. Further research should address this issue.

REFERENCES

1. Adams, Teresa M., and Janille Smith. "Maintenance Quality Assurance – Synthesis of Measures." MRUTC Project 06-01. Midwest Regional University Transportation Center, University of Wisconsin-Madison. Madison, WI. 2005.

2. http://www.mrutc.org/outreach/mqa/library/.

3. "Work Stream 9: Maintenance Planning and Budgeting; Level-of-Service Data Collection Manual." Louisiana Department of Transportation and Development. Baton Rouge, LA. 2006.

4. Adams, Teresa M., and Janille Smith. "Maintenance Quality Assurance – Synthesis of Measures." MRUTC Project 06-01. Midwest Regional University Transportation Center, University of Wisconsin-Madison. Madison, WI. 2005.

5. Cook Research & Consulting, Inc. "Bare Pavement 2007." Project S-405. Mn/DOT Market Research. St. Paul, MN. 2007.