NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE 148

INDICATORS OF QUALITY IN MAINTENANCE

CHARLES R. MILLER
Tallahassee, Florida

Topic Panel

C. E. CHITTY, *California Department of Transportation (Ret.)*
ADRIAN G. CLARY, *Transportation Research Board*
ROBERT H. GOODIN, *City of Rockville Department of Public Works*
ERNEST HUCKABY, *Federal Highway Administration*
TERRY M. MITCHELL, *Federal Highway Administration*
GERALD L. RAY, *Louisiana Department of Transportation and Development*
JACK W. ROBERTS, *Florida Department of Transportation*

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council is an assurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to maintenance managers, maintenance engineers, and others concerned with the development of quality indicators for maintenance management. Detailed information is presented on the formulation and use of these quality indicators.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

Indicators of quality are an integral part of any maintenance management system. This report of the Transportation Research Board describes and discusses the use of quality standards to assess the effectiveness of highway maintenance activities. It

examines the use of these standards in the context of traditional management techniques and maintenance management systems. The trade-offs between quality and quantity standards are also considered.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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ACKNOWLEDGMENTS

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Adrian G. Clary, Engineer of Maintenance, Transportation Research Board, assisted the NCHRP Project 20-5 Staff and the Topic Panel.

Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

INDICATORS OF QUALITY IN MAINTENANCE

SUMMARY

Product quality has become a primary goal of industry due to the public's perceptions that foreign goods are often superior to domestic products. Highway maintenance may be considered a product with purchasers—vehicle operators who pay motor fuel taxes, user fees, and other taxes. Maintenance engineers should be as concerned as any other provider about the quality of their product.

Quality can best be assured through the application of systematic management techniques. Maintenance management systems (MMS) provide a means by which a quality product can be obtained. Although MMS were first instituted more than 20 years ago, a significant number of highway maintenance agencies do not have fully operational systems. A considerable number of those that have MMS do not have the standards against which the quality of their maintenance can be measured.

Maintenance management systems were originated primarily to improve productivity, but from the beginning some agencies recognized the need for maintenance standards of performance and quality as well as quantity. Quality in maintenance requires performance and quality standards and an assurance procedure such as the control process in the classic management cycle. "Control" is an evaluation of completed or continuing work that compares it with the plan for the work and suggests any changes that may be required in future plans to meet the agency's objectives.

Some highway maintenance agencies have developed quality assurance programs using indicators of quality. These programs usually consist of inspection procedures that provide an evaluation of the existing level of service in comparison with the agency's quality standards. Maintenance engineers should be aware that highway users and others have their own conceptual measures of maintenance quality. Their "indicators of quality" must be considered if maintenance programs are to have the vocal constituency needed to support the adequate funding required for quality maintenance programs.

CHAPTER ONE

INTRODUCTION

BACKGROUND—THE SEARCH FOR QUALITY

Quality has become a word familiar to anyone who watches television, listens to radio, or reads newspapers or magazines. Driven by the knowledge that much of the public believes that American-made goods are inferior to those made overseas—especially in Japan—American industries have embarked on a massive effort to improve their products. "Quality is Job One," the current motto of the Ford Motor Company, typifies the thinking of much of American industry today, in sharp contrast to its patronizing response to critics a few years ago.

Although highway maintenance has not been subject to the competitive pressures driving industry, there are forces compelling maintenance engineers to look for ways to improve the quality of their operations. Some of these forces are similar to those cited in a paper presented in a Maintenance Management Workshop at Ohio State University, July 22–24, 1968 (*1*). At that time the improvement was the implementation of maintenance management systems. Today, with many systems in place, maintenance engineers are finding that some of the same factors that led to the development of MMS remain as difficult to manage as ever (author's comments in parentheses):

- Rapid changes in technology
(more complicated features to maintain, requiring sophisticated maintenance equipment)
- Restricted labor market
(need for a higher percentage of skilled workers)
- Constriction of maintenance funds to maximize construction
(and other DOT activities)
- Campaigns to tighten fiscal and administrative controls of highway departments
("waste in government" campaigns)

Another "force for change" is the perception of many critics that public employees are inherently inefficient and government programs are poorly managed. This has led to the increased demand for privatization of work heretofore considered the exclusive province of government, providing a type of competition to public employees.

Quality improvement is one way of addressing these problems. Quality is not a new concern for some maintenance engineers. It was a consideration in the adoption of maintenance management systems beginning in the 1960s. These early systems focused on the application of proven management techniques used in private industry to improve the overall efficiency and effectiveness of highway maintenance programs. For example, the 1960 Iowa Maintenance Study reached 34 wide-ranging conclusions covering the whole spectrum of highway maintenance (*2*). Quality was emphasized only in regard to the need for better management practices:

> The collective pattern of the findings in Section E unmistakably shows a need for improving the degree and quality of supervision and management practiced in maintaining primary and interstate highways in Iowa (*2*, p. 43).

Of course, all of the findings in the Iowa Study did not necessarily apply to all of the other states but, as noted in *Synthesis 110* (*3*, p. 4), other research had indicated that management problems were common to all, varying only in degree.

The findings of the Iowa Study provided an incentive for many agencies to implement maintenance management systems. There was considerable diversity in those early maintenance management systems, for reasons explained in *Synthesis 110* (*3*, p. 3), but what most of them had in common was an emphasis on productivity improvement. This is understandable because it was through improving productivity that the greatest and most immediate gains were to be realized. Reading through the reports on maintenance management in the early years reveals this emphasis on productivity improvement through better planning, organizing, scheduling, and reporting, but there is little mention of quality. For example, in a report prepared for the Maintenance Management Workshop at Ohio State University, V.L. Dorsey of the Washington Department of Highways observed, "It becomes obvious then that the area in which most of the savings could be made would be in the better utilization of labor" (*4*, p. 142). The need for standards was recognized in the same report: "In order to make use of the time standards developed, it was necessary that a set of standards be devised to specify the desired level of maintenance. . ." (*4*). These standards were typical of many in setting a level of service by establishing a threshold value to trigger action and stating the end result desired. This was comparatively easy for some routine maintenance activities such as mowing (e.g., begin operations when growth reaches 18 in. and cut to a height of 6 in.) but proved more difficult for many other activities. This probably helps to explain why a maintenance management survey conducted by the AASHTO Committee on Maintenance in 1981 found that only 27 of the 53 agencies responding had developed quality standards (*5*).

A series of maintenance management workshops has been sponsored by the Highway Research Board (HRB), now the Transportation Research Board (TRB), with the support of the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO). The first one at Ohio State University in 1968 (*HRB Special Report 100*) was followed by others at the Uni-

versity of Illinois in 1970 (*Highway Research Record No. 347*); Las Vegas, Nevada, in 1975; Hilton Head, South Carolina, in 1980 (*Transportation Research Record 781*); and Gulf Shores, Alabama, in 1984 (*Transportation Research Record 951*). None of these reports reveal any general concern with quality of maintenance.

Since the planning for the Gulf Shores workshop, there has been a growing concern about the need for quality assurance, including in highway maintenance. This led to a request by AASHTO that TRB prepare a synthesis on quality assurance in maintenance. However, the topic panel considered the subject too broad and decided to limit it to "Indicators of Quality in Maintenance."

DEFINITIONS

One of the necessities in preparing a document of this sort is agreement on the meaning of the key words. The research for this project revealed a considerable difference of opinion as to what constitutes an "indicator of quality"—even in the objectives stated by the panel.

This question was resolved by beginning with definitions of the root words:

indicate—	a. to point out or point to
	b. to be a sign, symptom, or indicator of
indicator—	one that indicates
quality—	a. a degree of excellence
	b. superiority in kind

From these basic definitions, the following definition was adopted in preparing this document:

indicator of quality—(1) Evidence that a given task has been accomplished in accordance with the agency's standards. (2) Evidence that an element of the highway (e.g., roadsides) is being maintained in accordance with the agency's standards.

Other definitions used in this document are:

activity—a discrete class of work (e.g., machine mowing, pavement patching, etc.).

network—the entire highway system maintained by an agency or a separately identifiable major portion thereof (e.g., the Interstate system).

project—a discrete portion of a highway system (e.g., a bridge or relatively short section of highway).

task—a discrete work assignment (e.g., "renew pavement markings at intersection of SR 62 and SR 50").

CHAPTER TWO

QUALITY IN MAINTENANCE

To establish quality in maintenance, an agency must:

1. Determine what it means by quality and define it by developing standards,
2. Instruct its field maintenance personnel in the intent, meaning, and use of the standards,
3. Develop and implement procedures for evaluating the performance of the program to ensure compliance with agency intent, and
4. Have a consistent budgetary base to provide the resources required to execute the program.

DEFINING QUALITY

The dictionary definition of quality was given in Chapter One. In a highway program, quality has been defined as:

> That characteristic of a product (road or street) that provides a level of performance in terms of service or life. "Quality" doesn't mean "perfect." If the objective of a surface treatment is to carry anticipated traffic safely (service) for eight years (life), then "quality" refers to those characteristics of the surface treatment that are necessary to achieve that objective (*6*).

Ultimately, each agency must decide for itself what it means by "quality," but there are fundamental concepts that should guide the decision-making process. In a paper presented at the 1970 Maintenance Management Workshop, the author said:

> A quality standard may define some or all of the following for a maintenance operation: a level of service; the degree of perfection required; the required frequency; and the allowable level of deterioration (*7*).

A 1984 document provided a further explanation of quality standards:

> Quality Standards provide definite criteria on how each completed activity should look or act as a result of the maintenance effort. They are considered the representation of an agency's maintenance or level-of-service policy. They also indicate the threshold or tolerance levels, when reached, when work should be performed (*3*, p. 7).

Another paper on the subject contains the following:

> The state of the art in highway maintenance needs a generally acceptable definition of highway quality to provide a basis for improved decision-making. . . .
>
> The term "highway quality" undoubtedly has different meanings for different individuals. For example, a pavement maintenance foreman will view a certain segment of highway as needing specific repairs based on his or her evaluation of how severe the cracking, rutting or other deterioration may be. Policymakers at national, state or municipal levels, however, must take a wider view and balance the quality of a segment of the system (and a user's reaction to it) against that of other segments and, ultimately, the need for funds in competing sectors of the economy such as housing and education.
>
> Because the budget and policy issues affecting legislative decision are basically influenced by the actual level of maintenance and vice versa, it is desirable that methods of measuring and quantifying highway quality be consistent. . . .
>
> Furthermore, maintenance of a highway network must be responsive to user opinions about how well the system satisfies perceived needs. . . .To enable an adequate response by legislative officials to user perceptions of quality, a generally understood and recognized method of quality measurement and its maintenance implications is essential. Policymakers must be informed of the effects of their maintenance funding decisions in a readily understood manner.
>
> With the foregoing considerations in mind, one finds that an adequate consistent definition of highway quality should:
>
> 1. Be based on measurements needed to describe the condition of the highway components from a detailed engineering and technical viewpoint to assist engineers and maintenance and management personnel;
> 2. Have a structure that assists in formulating direct relations with construction and maintenance performance standards;
> 3. Be consistent with potential national and international standards to assist in establishing uniform measurement and quality-assessment procedures and methods of comparison; and
> 4. Be readily adaptable to displaying broad areas of impacts resulting from specific budgeting strategies to policy makers (*8*).

Regardless of the method used in developing the agency's quality statements, to be effective they must be properly communicated to field maintenance personnel. They are usually transmitted in the form of standards that one author explains as follows:

> There are three types of standards used in maintenance management systems:
>
> 1. *quality standards* to describe the results to be achieved;
> 2. *quantity standards* to identify the amount of work and resources necessary to meet the quality standard or a predetermined level of service; and
> 3. *performance standards* to describe a general method of performing a task, the resources required, and rate at which the work is to be performed (*3*, pp. 6, 7).

QUALITY STANDARDS

From the beginning, the need to establish quality standards was recognized by some agencies. In a report on the activities in Ontario, delivered at the 1968 Workshop, the authors state:

Quality standards must be established for the major areas of maintenance such as surface, shoulders, and roadside for the various classes of highway. By establishing quality standards, the levels of service to be maintained on these classes of highways are specifically defined. The essential features of quality standards are that quantitative limits are established whenever possible and common goals for all similar management units are established. By setting these quantitative limits objective decisions, based on measurable factors, can be made by field supervisors who must decide whether or not work should be performed and, if so, how much work (*9*).

Levels of Service

Levels of service, which are guided by quality standards, may be defined in several different ways. As shown in Figure 1, a level of service may be stated by defining specific threshold values that trigger the requirement for maintenance activity.

It may also be defined by stating the maintenance effort authorized for a specific activity, such as mowing for weed control (*10*):

3.230 WEED CONTROL

3.231 MOWING

Mowing for weed control generally will be limited to areas outside those specified to be mowed under Section 3.142. Weeds and light brush shall be mowed as close to the ground as possible and cuttings will be limited to no more than two per year unless otherwise authorized by the District Maintenance Engineer.

---

k. Patching - the correction of pavement defects by the application of bituminous mix as done by maintenance forces.

1.200 FLEXIBLE AND RIGID PAVEMENT MAINTENANCE

The purpose of this standard is to establish the guide lines by which the roadway surfaces of the Interstate and other functional classes of highways shall be maintained and to establish the degree each type of distress can be tolerated before remedial physical maintenance measures must be undertaken.

1.210 FLEXIBLE PAVEMENTS

1. Rutting

Rutting will be tolerated to the degree specified in Table 1. Where rutting occurs in excess of that specified, the deficiency shall be corrected at the earliest opportunity.

	Interstate	Principal	Major	Collector	Other
Maximum allowable depth of rut on multilane or 70 mph highways	1/2"	1/2"	1/2"	1/2"	1/2"
Maximum allowable depth of rut on two lane 60 mph or under highways	1/2"	1/2"	1/2"	3/4"	1"
Maximum allowable depth of rut on bituminous treated roadway surfaces	1/2"	3/4"	3/4"	1"	1"

TABLE 1

2. Waves, Sags and Humps

These types of flexible pavement distresses add to the discomfort of the road user and can become a hazard if allowed to become severe.

On all functional classes of highways where 70 mph speed limits are allowed, repairs will be made wherever 50% or more of any given 100 feet of roadway is observed to exhibit characteristics of waves, sags or humps in excess of 1" in height per 10' section.

All other roadways with posted speed limits of 60 mph or less will be considered for repair when observed to exhibit these characteristics in excess of 2" in height per 10' section except that waves, sags or humps 4" in height or over will be corrected as soon as practicable after reported or observed.

FIGURE 1 Level of service guidelines for flexible pavements.

A third method of defining a level of service states (*10*):

Inspection of these structures shall be made during routine patrols by maintenance personnel and timely repairs made when necessary.

The several ways in which levels of service can be expressed was summarized in a paper presented at the 1970 Maintenance Management Workshop at the University of Illinois:

Levels of maintenance take many forms. They may be a written description or a numerical value. A level may be set by the frequency of a maintenance effort or a predetermined number of inspections in a specified time. A level may be the replacement of the missing, the repair of the damaged, or the elimination of the undesirable (*11*).

Purpose of Service Levels

Maintenance levels of service (quality standards) serve at least three functions:

1. provide direction to field personnel to ensure uniformity of maintenance effort throughout the agency,
2. provide a tool for scheduling and budgeting, and
3. define a uniform level of service to which the highway user is entitled.

The first two are often enunciated, but, although often implied, the third is seldom expressed except in general terms and is never quantified. This is unfortunate because "highways are constructed, operated, and maintained with public funds for the public good" (*12*, p 41).

Establishing Service Levels

Historically, service levels have been established by maintenance personnel with minimal outside participation. The initial efforts were usually statements of the prior experience of the organization. One popular method was to assemble a group of knowledgeable personnel, including operators, crew leaders, and supervisors, in addition to engineers, and produce a set of standards based on a consensus of their varied experience and viewpoints of the desired end product. Levels of service developed in this manner are essentially extensions of past practices of the agency, and as such are highly subjective.

Oglesby advocated the use of the systems approach to develop cost-effective maintenance levels that "maximize the public good" (*12*).

Continuing interest in this concept led to NCHRP Project 14-5 to develop an objective methodology for establishing maintenance levels of service. The results of this research, published in *NCHRP Report 223* (*13*), provide a method of developing maintenance levels of service that eliminates some of the subjectivity in most of the methods currently in use. The methodology also makes possible the involvement of persons other than maintenance personnel, including members of the general public or representative groups. Apparently no agency has adopted this procedure as of this writing, but it might be considered as a means of involving others in the process of establishing levels of service and therefore enhancing their credibility and enlarging support for their funding.

The identification of problems in using the methodology led to a follow-on research effort, NCHRP 14-5(2), the results of which were published in *NCHRP Report 273* (*14*).

CURRENT PRACTICE

In an effort to identify current practice and active research in the use of indicators of quality in maintenance, a questionnaire was circulated to all 50 states and a number of Canadian provinces and selected local agencies.

The first question in the Survey of Current Practice (Appendix A) asked: "Does your agency have a formal Maintenance Management System (MMS)?" Of the 55 agencies (49 states) answering this question, 10 (9 states) have no MMS (Appendix B). One state (Massachusetts) reported abandoning an MMS because of decreased funding. This is interesting in view of the conventional wisdom that one attribute of an MMS is effectiveness in coping with changes—including diminished resources. The number of states using an MMS has remained fairly constant since a survey was conducted by the AASHTO Maintenance Committee in 1981 (*5*). Of course, indicators of quality may be useful apart from an MMS, but their utility is certainly enhanced when in company with formal management procedures.

Question 3 asked: "Does your agency have formal statements of 'maintenance service levels,' 'thresholds of acceptable deficiencies,' or other indicators of quality at the project or network level, either as part of a MMS or otherwise?"

The summary of responses to the questionnaire (Appendix B) indicates that, of the 51 agencies responding to this question, 22 answered "no." Perhaps the reason advanced by the Alabama Highway Department is representative of these agencies: "Because of the liability involved, we removed all reference to any maintenance standards (thresholds of acceptable deficiencies) from our maintenance manuals including the MMS Manuals."

The concern about the contribution of stated levels of service to tort liability exposure was expressed in a paper presented at the Gulf Shores Maintenance Management Workshop in 1984:

> Levels of service have been employed in the Caltrans maintenance program over the years and have apparently evolved full circle. Initially, levels of service were described in objective and quantifiable terms to communicate policy and promote understanding and consistency throughout the field maintenance organization. The objective, quantifiable levels of service were deemed inappropriate by the Caltrans legal staff because they were believed to increase tort liability (negligent maintenance). Currently at Caltrans there is an attempt to revert to quantifiable, objective measures (*15*).

An opposite viewpoint was expressed in another paper at the same meeting: "One way to minimize risk of liability is to operate within accepted standards and guidelines" (*16*).

(The reader should note that the subject of tort liability is covered in *Synthesis 106: Practical Guidelines for Minimizing Tort Liability* and will be covered by Topic 20-22, "Highway Tort Liability Management Programs." The subject is also covered on a continuing basis in the Legal Research Digest Series and in Selected Studies in Highway Law, which are part of NCHRP Project 20-6, Legal Problems Arising Out of Highway Programs.)

Although some difficulty was found in interpreting the answers of agencies responding positively to the question on levels of service, about half of them referred to their performance standards. It would appear that, in most cases, performance standards are more applicable to the activity level, and an adequate definition of level of service at the project or network level requires quantity and quality standards as well.

The following are examples of level-of-service statements. They are either a direct response by the agency or derived from information provided by the agency.

California

In research performed for the FHWA (*17*), California has developed level-of-service guidelines that identify three types of maintenance:

1. Responsive—To be handled as needed. For this type of maintenance, the level of service is defined by how rapid a response is normally appropriate.
2. Scheduled—Work performed on a scheduled basis. For this type, the level of service is defined by the number of cycles performed on an annual basis.
3. Planned—This type of maintenance is not considered routine and is to be done only when included in an approved maintenance plan, such as a major maintenance plan or the Bridge Painting Program.

In implementing this plan, state highways were classified as Class 1, 2, or 3, based on the type and volume of traffic they serve. At times, the level of service is different for these highway classes, with the more important generally receiving a higher level of service.

A further classification of highway system routes is based on location and usage [average daily traffic (ADT)]. At times, the level of service may be different for these highway classes also.

There are four priority levels, any one of which can be assigned to a given maintenance task. These priorities, from highest to lowest, are:

- Safety
- Preservation of the facility
- Traffic service
- Appearance

Figures 2 and 3 are examples of responsive and scheduled maintenance, respectively, taken from the Caltrans Level of Service Manual (*18*).

Florida

The Florida DOT has Maintenance Condition Standards. Most are written to allow levels of service to be systematically adjusted for multiple considerations (e.g., available resources, safety, user comfort, protection of investment, and aesthetics) in a logical and theoretically sound manner. This method allows differing levels of service to be established for various road classifications (facility types). This method also allows updating, if and when new data become available. Figure 4 is the Florida DOT Maintenance Condition Standard for Drainage.

PRIORITY - THE WHY CODE
1 - SAFETY
2 - PRESERVATION OF THE FACILITY
3 - TRAFFIC SERVICE
4 - APPEARANCE

RESPONSIVE MAINT.
U - URGENT
Q - QUICK
R - ROUTINE
S - SEASONAL
D - DELAYED

SCHEDULED MAINTENANCE
F-XX - TIMES PER YEAR
F-M - PER OPERATING MANUAL
F-S - PER MASTER SCHEDULE

PLANNED MAINTENANCE
P-M - PLANNED MAINT
M - NOT TO BE DONE

A FAMILY - FLEXIBLE PAVEMENT

MAINTENANCE PROBLEM TASK DESCRIPTION	*******LEVELS OF SERVICE******* ALL STATE HWYS	HWY CLASS 1 2 3	RURAL URBAN RUR URB	PRIORITY WHY CODE
PROBLEM - PERIODIC INSPECTIONS				
INSPECTION OF PAVEMENT SURFACES	F-52			2
PROBLEM 1 - CRACK AND JOINT MAINTENANCE				
CLEAN FILL AND SEAL CRACKS THAT ARE 0.25 INCHES WIDE OR WIDER	F-1			2
PROBLEM 2 - POOR RIDE QUALITY				
LEVEL BRIDGE APPROACHES WHEN IRREGULARITY EXCEEDS 1.50 INCHES PER 50 FEET	R			2
LEVEL SURFACE IRREGULARITIES EXCEEDING 1.50 INCHES PER 50 FEET	R			3
PROBLEM 3 - STRUCTURAL PAVEMENT FAILURE				
FILL WHEEL RUTS OVER 1 INCH DEEP	S			1
REMOVE AND REPLACE FAILED BASE	R			2
FILL DRIP-TRACK RUTS OVER 0.50 INCHES DEEP			R	2

(Continued on next page)

FIGURE 2 Levels of service—responsive maintenance.

Georgia

The Maintenance Section of the Georgia DOT has a maintenance service level standard of preserving all roadways, structures, and facilities as they were originally constructed in order to provide reasonable levels of safety and convenience to highway users and to ensure proper utilization of all resources.

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PLANNED MAINTENANCE
P-M - PLANNED MAINT
M - NOT TO BE DONE

H FAMILY - BRIDGES

MAINTENANCE PROBLEM TASK DESCRIPTION	*******LEVELS OF SERVICE******* ALL STATE HWYS	HWY CLASS 1 2 3	RURAL URBAN RUR URB	PRIORITY WHY CODE
PROBLEM - PERIODIC INSPECTIONS				
INSPECT GATES, BARRIERS AND OTHER TRAFFIC PROTECTIVE DEVICES FOR MANNED MOVEABLE BRIDGES	F-365			1
INSPECT AND TEST NAVIGATION LIGHTS, NAVIATION AIDS AND WARNING SYSTEMS FOR MANNED MOVEABLE BRIDGES	F-365			1
INSPECT AND TEST OVERHEIGHT VEHICLE DETECTION SYSTEMS	F-52			2
SUPERVISOR TO MAKE BRIEF WALK-AROUND INSPECTIONS OF ALL BRIDGES BOTH ABOVE AND BELOW DECKS		F-2 F-4 F-4		1
INSPECT GATES, BARRIERS AND OTHER TRAFFIC PROTECTIVE DEVICES FOR UNMANNED MOVEABLE BRIDGES	F-12			1
INSPECT AND TEST NAVIGATION LIGHTS, AVIATION AIDS AND WARNING SYSTEMS FOR UNMANNED BRIDGES OVER SHIPPING CHANNELS	F-52			1
INSPECT AND TEST NAVIGATION LIGHTS, AVIATION AIDS AND WARNING SYSTEMS FOR UNMANNED BRIDGES OVER OTHER NAVIGAYBLE CHANNELS	F-12			1

(Continued on next page)

FIGURE 3 Levels of service—scheduled maintenance.

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

DRAINAGE

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

STORM DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 90 RURAL ARTERIAL - 85 URBAN LIMITED ACCESS - 90 URBAN ARTERIAL - 85
SIDE DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 75 RURAL ARTERIAL - 75 URBAN LIMITED ACCESS - 80 URBAN ARTERIAL - 80
CROSS DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 80 RURAL ARTERIAL - 80 URBAN LIMITED ACCESS - 85 URBAN ARTERIAL - 85
ROADSIDE DITCH (NON-PAVED)	the ditch bottom is (varies) feet or more below the outside edge of pavement. RURAL LIMITED ACCESS - 3 RURAL ARTERIAL - 3 URBAN LIMITED ACCESS - 2 1/2 URBAN ARTERIAL - 2 1/2
MEDIAN DITCH (NON-PAVED)	the ditch bottom is 2 feet or more below the inside edge of pavement.
OUTFALL DITCH	the ditch bottom is at or within the lower 1/3 of the distance between natural ground and the design flowline.
CURB INLET	90% of the opening is not obstructed.
OTHER INLETS	85% of the openings is not obstructed.
MISC. DRAINAGE STRUCTURE	90% of the installation functions as designed.
ROADWAY SWEEPING	material accumulation is no greater than 3/4 inch deep in the travelled way or 2½ inches deep in the gutter.

FIGURE 4 Levels of service—drainage.

Hawaii

The Hawaii DOT Highways Division Maintenance Guidelines promulgate a maintenance level for most activities. For example:

Activity	*Maintenance Level*
PHYSICAL MAINTENANCE—ROADSIDE	at right and left of travelway: • Freeways—rapair drops or buildups of more than 2". • Other Highways—repair drops or buildups of more than 3". Ruts and potholes should be repaired as they are reported.

Idaho

The Idaho DOT has established four levels of service for a number of activities. The levels are based on average daily traffic, accident rate, and physical features of each route. For example, under Traffic Service Levels, the service levels for Delineators:

Level 1 Delineators on curves, transitions, and intersections—repair/replace as soon as is practical.
Level 2 same as Level 1
Level 3 same as Level 1
Level 4 same as Level 1

Delineators on tangents:

Level 1 Repair/replace where approximately 10% are missing or have lost reflectivity.

Level 2 Repair/replace where approximately 20% are missing or have lost reflectivity.

Level 3 Repair/replace where approximately 30% are missing or have lost reflectivity.

Level 4 Repair/replace where approximately 40% are missing or have lost reflectivity.

Iowa

In response to Question 4 of the survey, the Iowa DOT reported:

> We do not have sufficient resources to be at all places at all times in any of our maintenance operations. To properly allocate our people and to provide an appropriate level of service, we have identified service level highways and generally respond to provide service to the higher service level roads first when relatively equal needs are evident on different service level roads. We do not specifically identify a separate quality of maintenance for different service level roads except in the snow and ice removal program where we have identified some specific criteria for level of maintenance.

Montana

Montana highway officials, in response to the survey, stated: Variable "thresholds of acceptable deficiencies" are established at the beginning of each budget period, based on a comparison of available funding and the current network condition inventory.

New York

The New York DOT has published Highway Maintenance Guidelines that contain level-of-service standards (*19*). The guidelines establish four classifications of highways: (a) Class A1—expressways with low average running speeds, (b) Class A2—expressways with high average running speeds, (c) Class B—minor state highways with one-way design hourly volume of 200 to 500 vehicles, and (d) Class C—minor state highways with a one-way hourly volume of fewer than 200 vehicles. Pavement and shoulder standards differentiate between the classes of highways (e.g., permissible drop-off or low shoulder at pavement edge is 1 in. for class A1 and A2, $^1/_2$ in. for Class B, and 3 in. for Class C). Standards for other activities are generally uniform for all highway classes.

South Dakota

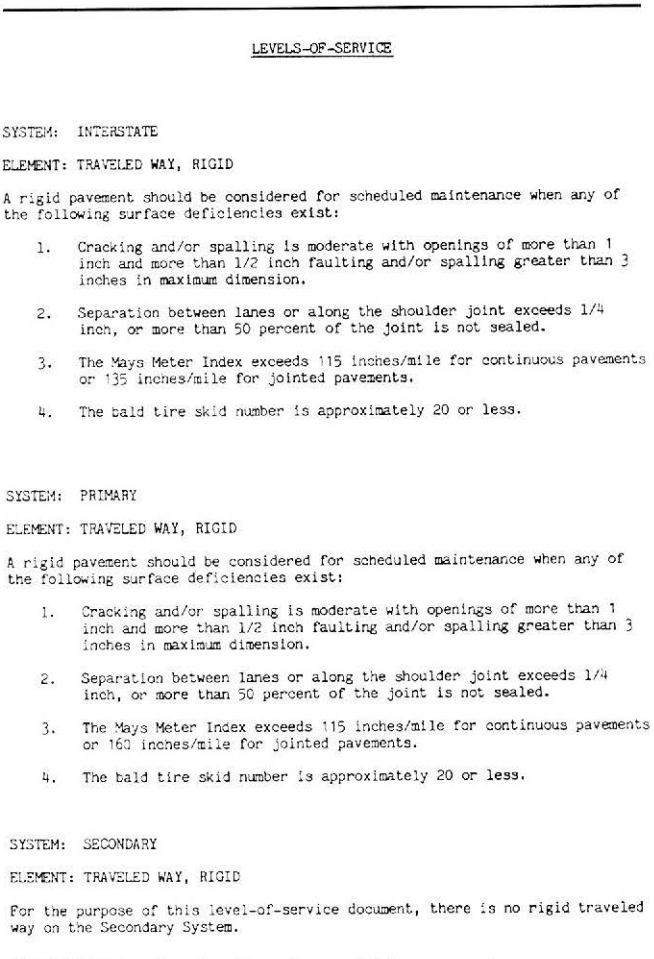
South Dakota DOT performance standards contain a quality statement (level of service) where applicable. For example, for portland cement concrete surface repair: "All spalls greater than $^1/_2$ inch in depth shall be repaired by removing the unsound material and patching."

Virginia

The Virginia Department of Highways' Levels-of-Service for Maintenance Conditions manual (*20*) provides differential standards for Interstate, primary, and secondary roads. Figure 5 is the level of service for rigid pavement.

Oakland County, Michigan

"The Oakland County Road Commission Maintenance Management System outlines the service levels by maintenance district and by road classification within the district" (response to Question 3). The performance standards classify work by type (e.g., routine), explain who is empowered to authorize the activity (e.g., district superintendent), and indicate the limits on work (e.g., card controlled). Performance criteria (level-of-service) statements indicate when activity is to be performed (e.g., potholes generally should be repaired as needed). If the pothole presents an immediate and significant hazard (usually more than 2 in. deep and 12 in. in diameter), repairs should be made as soon as possible. Less severe potholes can be left until routine work is scheduled.



LEVELS-OF-SERVICE

SYSTEM: INTERSTATE

ELEMENT: TRAVELED WAY, RIGID

A rigid pavement should be considered for scheduled maintenance when any of the following surface deficiencies exist:

1. Cracking and/or spalling is moderate with openings of more than 1 inch and more than 1/2 inch faulting and/or spalling greater than 3 inches in maximum dimension.
2. Separation between lanes or along the shoulder joint exceeds 1/4 inch, or more than 50 percent of the joint is not sealed.
3. The Mays Meter Index exceeds 115 inches/mile for continuous pavements or 135 inches/mile for jointed pavements.
4. The bald tire skid number is approximately 20 or less.

SYSTEM: PRIMARY

ELEMENT: TRAVELED WAY, RIGID

A rigid pavement should be considered for scheduled maintenance when any of the following surface deficiencies exist:

1. Cracking and/or spalling is moderate with openings of more than 1 inch and more than 1/2 inch faulting and/or spalling greater than 3 inches in maximum dimension.
2. Separation between lanes or along the shoulder joint exceeds 1/4 inch, or more than 50 percent of the joint is not sealed.
3. The Mays Meter Index exceeds 115 inches/mile for continuous pavements or 160 inches/mile for jointed pavements.
4. The bald tire skid number is approximately 20 or less.

SYSTEM: SECONDARY

ELEMENT: TRAVELED WAY, RIGID

For the purpose of this level-of-service document, there is no rigid traveled way on the Secondary System.

FIGURE 5 Levels of service—rigid pavement.

PERFORMANCE STANDARDS

As one author has put it, "Performance standards are one of the most essential elements of a highway maintenance management system" (*21*). Performance standards provide the basic guidance that field crews require to plan and organize their work, including:

- personnel requirements,
- equipment,
- material,
- expected production, and
- (sometimes) a statement of desired quality.

Performance standards also explain the purpose of the activity and a general procedure to be followed in executing the work.

The author of *NCHRP Synthesis of Highway Practice 110: Maintenance Management Systems* states:

> Without standards of performance, wide variations in staffing patterns and work procedures can be expected. When the rate of accomplishment is not predictable, there is no realistic basis for defining resource requirements. Agencies without performance standards, therefore, are dependent on historical production information data without assurance that these data represent the most economical way of doing work. Well-defined performance standards will provide this assurance (*3*, p. 8).

Establishing Performance Standards

As in the case of establishing quality standards, each agency must determine the type of performance standards that best suit the needs of its style of management. Performance standards are all basically the same but may differ considerably, as Bell states:

> When reviewing performance standards from approximately thirty different states, it was noted that the basic content of the performance standards was quite similar. The recommendations for optimal crew size and equipment mix and average production values, however, were found to be quite different. . . .It is difficult to draw any conclusions from the performance standard comparisons because of the varying geographic, demographic and climatic conditions that exist in different states. These factors affect the recommendations for equipment and materials mix that are specified in the performance standards. An additional complication in this comparison is that not all states organize their work activities in the same manner (*21*).

How have agencies gone about establishing their performance standards? As Anderson explains: "The majority of states and provinces that have developed performance standard values have relied on the consensus of experienced maintenance engineers and supervisors" (*3*, p.10).

The performance standards thus developed often require adjustment, as explained in a paper presented at the 1980 Maintenance Management Workshop:

> Initially our standards were established using subjective judgments and were confirmed by field reports of crew operations. Periodic adjustments to these standards were also based on subjective judgment which oftentimes resulted in considerable and sometimes nonconclusive discussion. It soon became apparent that without a clear cut scientific method of determining an accurate standard, our entire MMS was lacking (*22*, p. 15)

The problems stemming from the performance standards established by consensus, which usually perpetuate the past practices of the agency, and the subjective adjustment of these initial standards, led some agencies to look for other methods of developing them. One procedure for accomplishing this is explained by Stivers (*22*, pp. 15–17). Motion pictures of work crew activities were analyzed using a stopwatch. This use of the old industrial engineering "time and motion" studies provided data to help create performance standards.

Current Practice

Given the importance attached to performance standards by the agencies that use them, it is somewhat surprising to find that of the 53 agencies (47 states) answering Question 2 of the survey, only 21 (19 states) reported having performance standards.

As has been mentioned, performance standards of different agencies are basically similar, describing the general method of performing a task, the resources required, and a rate at which the work is to be performed. Figures 6 and 7 are representative performance standards.

Because many performance standards do not contain requirements for the end product of activities, they do not provide a basis for quality evaluation except in a subjective manner. Some agencies have supplemented their performance standards with guides or handbooks that do contain quality guidelines. The following is a typical quality statement from a mowing guide:

> T-1 Maintenance Tips
>
> The list below provides general guidelines that should be followed when roadside mowing is performed.
>
> 1. The established mowing height is 6 inches for all rural mowing areas. A higher standard of maintenance may be required at rest area facilities, office complexes and sites within urban limits. At these locations no more than one-third of the blade height of the desired grass (excluding seed heads) should be removed during a mowing cycle. This will result in a healthier turf better able to compete with undesired vegetation.
> 2. Do not scalp or mow excessively close to the ground line. Mowing too close to the ground increases soil temperature, contributes to erosion, lowers plant tolerance to cold and drought, results in the thinning of the turf and increases undesirable vegetation.
> 3. Mow only when necessary. Consider seasons, locations, and turf conditions when scheduling mowing operations. Mowing should not be performed during periods of drought or growth stress.
> 4. Mow or disc a strip 5 to 10 feet in width to permit inspection and repair of the fence line on rural limited-access facilities. This is to be performed annually at the discretion of the Maintenance Engineer.
> 5. Make smooth, free-flowing transitions when changing cutting width.
> 6. To avoid damage to the mowing equipment, do not mow unnecessarily close to roadside obstacles, such as signs, delineator posts, fences and guiderails.
> 7. Never mow beyond the Department right-of-way line. Under normal conditions, mowing beyond the right-of-way line is a violation of state law.
> 8. Never mow over debris that would damage the equipment or that might be picked up and thrown out by the mower. Stop and remove objects such as old tires, limbs and other debris from the mowing area (*23*).

ACTIVITY CODE:
6210.360
STANDARD NO.
300

SIDELINE PIPE

I. Definition - Pipe installed parallel to roadway in ditches or other low areas to provide access to private property, improve drainage, enhance scenic quality or improve safety of the roadway.

II. Responsibility - Resident Maintenance Engineer - Section Foreman

III. Scheduling Considerations - Laying of sideline pipe is a continuing operation on a 12 month basis. The exception is when freezing temperature adversely affects joint mortar.

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

IV. Crew Size and Equipment -

1 Foreman
1 Front End Loader Operator
2 Truck Drivers
2 Laborers

1 Pickup Truck
2 Dump Trucks
1 Front End Loader with backhoe
Hand Tools

V. Methods and Procedures -

(1) Determine correct size of pipe and transport to installation site.
(2) Place necessary signs and warning devices.
(3) Prepare pipe bed to proper line and grade, taking care to provide firm subgrade for pipe.
(4) Place pipe on prepared grade with "spigot end" downgrade, fitting joints together as closely as possible.
(5) Mortar joints thoroughly to seal pipe.
(6) Backfill with suitable material, compacting in approximately 6" layers.
(7) Clean area.
(8) Remove signs and move to next work site.

Expected Performance: Daily Production will vary widely due to terrain and pipe size. Average performance should be as follows:

Daily Production - 4 - Twenty foot sections per day

Productivity - 0.7 man hrs. per foot

Prepared By:
Engineering District
No. 6

Reviewed By:

State Maintenance Engineer

Approved By:

State Highway Engineer

FIGURE 6 Performance standard—pipe laying.

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

PERFORMANCE STANDARD

ACTIVITY: Fill Cracks | NUMBER: 103 | EFFECTIVE: 7/1/86

DESCRIPTION & PURPOSE

The cleaning and filling of cracks in bituminous pavements to prevent passage of water through the pavement and into the base or subgrade.

PERFORMANCE GUIDELINE	SCHEDULING CATEGORY	AUTHORIZATION REQUIRED	QUANTITY OF WORK
	Seasonal	Area	Limited

Only cracks 3/8" (Pencil width) or greater are to be cleaned and filled.
Perform if possible when cracks are open widest.

JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN

TYPICAL CREW SIZE

2 Truck Drivers/Workers
1 Compressor Operator
1 Distributor Operator
*1 Flagman

5 Crew Total

*Add or delete flagmen as required.

WORK METHOD

*1. Place safety devices and signs.
2. Blow cracks clean with air compressor.
3. Fill crack with filler to within 1/4" of the top of the surface to allow for pavement expansion.
4. Cover crack lightly with sand to prevent tracking.

EQUIPMENT

NO	CLASS CODE	DESCRIPTION
1	01	Pickup
1	03	Truck
1	62	**Distributor Truck
1	71	Compressor
1	56	Arrow Board-Trl. Mounted

*ADOTM-1-V-4812-11-3

MATERIAL

5 OR 6 Sand
51 Emulsified Asphalt
63 Emulsified Asphalt (CRF)

DAILY PRODUCTION RANGE

100 to 180 Gallons

NOTES

**Substitution of # 63, Crack Filling Pot is permissible.

Sealing Bridge deck and bridge approach slab joints should be charged to Activity 165.

FIGURE 7 Performance standard—fill cracks.

QUANTITY STANDARDS

Quantity standards are a necessary feature of a maintenance management system that provides managers at all levels the information required to build a work plan. They enable managers to calculate the resources required to perform at a predetermined level—generally based on an inventory of maintainable features and planning values—and also to arrange and rearrange the different activities to produce a workable plan balanced against the resources available. Responses to a survey of maintenance management reported in *Maintenance Aid Digest* MAD-26 (*5*) revealed that 36 of the 53 states and provinces responding had quantity standards.

Quantity standards have developed in much the same way as other standards in maintenance management systems. Initially, they were based on past performance records, when they were available, or on the best estimates of experienced personnel. They, as other standards, require periodic review and adjustment as the work load changes or improved equipment or methods increase productivity.

Quantity standards are expressed in various ways in different agencies' maintenance management systems. Quite often, they are part of performance standards or derived from them. They are sometimes derived from a highway feature inventory or a "converted" inventory that incorporates planning values for various activities and highway conditions. The procedures in *NCHRP Report 223* (*13*) provide an effective method of balancing various levels of service in a number of activities against available or proposed resources. The procedures are based on principles of decision analysis and they provide a well-defined, step-by-step procedure to analyze information and establish optimum levels of service for the given resources.

CHAPTER THREE

QUALITY ASSURANCE

As is the case with other management principles currently used for highway maintenance, quality assurance is derived from techniques developed by manufacturing industries long ago.

Maslin et al. have explained that "quality assurance refers to all activities necessary to verify, audit, and evaluate quality" (*6*).

The basic requirements for a quality assurance program are:

- systematic management procedures (MMS),
- definition of desired results (quality standards),
- procedures to accomplish work (performance standards),
- a quality control procedure, and
- availability of adequate resources.

One necessary component of a quality assurance program is quality control, which the dictionary defines as "an aggregate of activities (as design analysis and statistical sampling with inspection for defects) designed to ensure adequate quality in manufactured products."

For highway purposes, quality control has been defined as a procedure that:

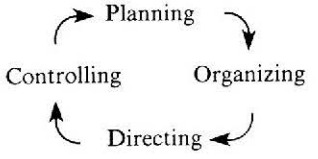
> . . .ensures that the specified ingredients are combined in certain ways and placed in a definite manner so that the end product will have the desired level of performance in terms of service and life. Quality control activities are specific steps taken during construction or maintenance to control the quality of materials and workmanship (*6*).

QUALITY CONTROL IN MAINTENANCE MANAGEMENT

Quality control is based on the control function of management theory developed using a systems approach. Leslie et al. describe the control function and how it relates to the other basic functions (*9*):

> Planning—the selection, from among alternatives, of courses of future action. This is the function by which management determines what goals are to be accomplished (objectives for the organization) and a timetable for reaching these goals.
> Organizing—the establishment of a grouping of activities and authority relationships in which people know what their tasks are, how their tasks relate to each other, and where authority for decisions needed to accomplish these tasks rests—including staffing to carry out tasks.
> Directing—the issuance of policies, procedures, instructions, and plans in order that the organization's efforts can be directed toward the accomplishment of established goals.
> Controlling—the measuring and correcting of activities of workers to ensure that their activities are contributing to the achievement of planned goals.

The management function is usually graphically depicted in a circular format:



This format aids in understanding that management is an endless cyclical process and that "controlling" (the evaluation of completed or continuing activities) not only follows "directing" but precedes "planning" for the next cycle.

This understanding is important because the control process is generally the least understood and most poorly utilized portion of the management cycle. The lack of understanding probably stems from the fact that control is commononly used to mean to have power over or rule rather than to verify or regulate.

Using the Control Process

The failure by those who do understand it to properly use the control process occurs in part because of the mistaken belief that controlling is the exclusive province of higher levels of management. For effective management, it is essential that all levels, beginning with the crew leader, use the control process by evaluating the completed work to see if it is satisfactory, and, if it is not, to determine the reasons why and take corrective action.

It should be understood that the cause for less than satisfactory end results may lie in any portion of the management cycle. For example, the "plan" may be faulty, the "organization" may not provide the proper resources, or the "direction" may be imprecise or misunderstood. Thus, the entire procedure must be examined in exercising the control process of evaluation rather than focusing exclusively on the performance of the workers, as is sometimes the case.

QUALITY IMPROVEMENT

Quality assurance cannot exist in a vacuum; instead it must be part of an overall program dedicated not only to the attainment of quality in existing operations but to the active search for ways to improve the quality of the program.

Many agencies have programs of one sort or another intended to improve their operations. One of the more common is an employee suggestion program, in which employees are given a

reward for adopted suggestions, usually based on part of the savings (e.g., 10 percent of the first year's savings).

A number of agencies have used the quality circle concept—an American idea adopted by the Japanese, brought to a high state of usefulness by them, and subsequently reimported into this country. Quality circles could be described as structured bull sessions in which the workers involved in an activity are encouraged to present their ideas for improvement. Quality circles are more than a fad; there are several thousand quality circles in existence assisted by an international association, local chapters, conventions, and other support mechanisms.

Quality Improvement Programs

Industry and some government agencies have gone beyond the quality circle concept by instituting highly structured and intensive quality improvement programs with full-time staff to manage the program and provide training and support to the participants.

For example, the Florida Department of Transportation (FDOT) instituted a Quality Improvement Program (QIP) officially beginning July 1, 1985. The quality teams are formed throughout FDOT to identify and solve problems in their own area of operations. An example cited from the maintenance area is:

> Relocation of a gasoline storage tank, combined with installation of a higher efficiency pump, recommended by a team of maintenance yard employees, speed daily fueling operations for savings estimated at $9,000 annually.

As of May 1987, there were 1554 employees actively involved in quality improvement teams, or 17 percent of the total workforce of 9440.

Total program expenditure to May 1987 was $1,651,791, covering 13 full-time QIP staff and training costs but not including salaries of the teams for their time involved in the program. This is absorbed as part of FDOT's commitment to quality improvement. Total program benefits to the same date are calculated to be $8,267,205, giving a 5.0 benefit-cost ratio.

CHAPTER FOUR

INDICATORS OF QUALITY IN MAINTENANCE

For the most part, indicators of quality used by highway maintenance organizations conform to the definition given in Chapter One. There are some indicators of maintenance quality used by persons outside maintenance organizations that do not conform. These special cases are discussed in the section titled "Indicators of Quality in Maintenance Used by Others." Questions two and three of the survey attempted to discover the extent to which standards are in use relating to activities (Question two) and projects or systems (Question three).

EVALUATING QUALITY AT THE ACTIVITY LEVEL

Performance standards are the basis for evaluating quality at the activity level. The difficulty in applying them to highway maintenance arises from the fact that the area of activity is scattered geographically, unlike that of the manufacturing environment, where all activities are carried out in a single building or plant. Most maintenance engineers will agree with the following statement from a paper presented at the 1968 Maintenance Management Workshop (*24*):

> Determinations of method and procedure, quality and workmanship require on-the-spot observations before, during, and/or after the performance of specific activities. To some extent gross method, quality, or procedural deviations will reflect themselves in the productivity rates in the long run. However, when possible, actual observations are desirable.

Although maintenance engineers will agree with the desirability of direct observation of activities in order to assess quality, the practical difficulty is that usually only those actively engaged in the task are present while the work is in progress; thus there is no independent evaluation of quality possible. Although some activities, such as machine mowing, can be partially evaluated after the fact, many cannot, so other means are needed to evaluate these activities.

West and Jorgensen state that gross deviations from quality standards (among other things) would manifest themselves in productivity rates in the long run. This may be true in a perverse way, because workers overly concerned about productivity might skimp on the quality of their work if in so doing they can show satisfactory productivity. Crews that consistently exceed the norms for productivity might be suspected of taking short cuts in the quality of their work, but before reaching this conclusion other possibilities should be considered. Such factors as the skill and experience of the workers, the availability of specialized equipment, differences in the exact nature of a task within the same scope, and environmental variables can all materially affect productivity while quality remains essentially constant. A study of maintenance operations in Pennsylvania concluded that "the quality of output as measured in this study, failed to appear as a significant explainer of costs" (*25*). That study did not attempt to evaluate individual tasks or projects but rather examined activities on a county-wide basis. The evaluators of the quality of the work were the district engineers, who have overall responsibility for the department's activities in a number of counties. They were provided with stated objective criteria to guide their evaluations. When the quality-of-output variable did not appear to be a significant explanation of cost for any activity, the authors concluded that "it could be that the evaluating of quality by the district engineers was not a valid measurement." This is always a problem when more than one person or crew is involved in using evaluation procedures that have any subjective component.

Current Practice

Twenty-one agencies reported using performance standards, which provide indicators of quality at the activity level. Not all of these agencies reported having a positive means of assuring compliance with the performance standards. The most usual approach relies on field supervisors. Typical of that approach is the one used by the Louisiana Department of Transportation (*26*):

> Responsibilities of parish superintendents include the inspection of work operations while they are being performed to make sure the right methods and procedures are being used. . . .Completed work should always be inspected to make sure that the workmanship is of good quality.

A comprehensive approach to quality assurance at the activity level is utilized by a few agencies. Representative of that is Oakland County, Michigan. In their survey reply they state:

> Each of our maintenance districts has a superintendent and two or more foremen. Part of their job duties is quality control. They review the work that is being done or has been done by our maintenance forces to ensure the quality of the work. In addition to that, the administration in Maintenance Headquarters reviews the work being done by the districts on a random basis. The Oakland County Road Commission has a complaint department which receives complaints from the public. Some of these complaints concern the lack of quality of the work being done on the road system. This serves as the final check on the quality of the maintenance being performed on our road system.

Some agencies have adopted procedures utilizing central office and/or district office review of work activities to assure compliance with performance standards. For example, Florida has

recently begun Quality Assessment Reviews, the guiding principles of which are:

1. The quality of one operation is identifiable and measurable.
2. A maintenance unit can best be assessed by observing the actual field operations of crews from that unit.
3. The inventory and scheduling of work is essential for efficient and effective field operations.
4. Significant and permanent productivity improvements can only occur through people. We must provide the proper training, tools, equipment and materials to ensure the most efficient and effective operation.
5. Quality work and proper recording of time, activities, completed work and equipment charges must occur.

The Quality Assessment Review involves the entire scope of activity in the maintenance unit but, as noted in item 2 above, an important part is the review of field activities. In conducting the activity reviews, the inspection team rates the activity using the following guide:

Yes	*No*	
10	0	1) Does crew have work order?
5	0	2) Does work order provide adequate site location information?
10	0	3) Is crew working where work order requires?
5	0	4) Does crew arrive at work site in a reasonable time?
10	0	5) Is the work to be performed scheduled from work needs survey?
15	0	6) Is the work being performed the best long-range solution?
10	0	7) Does crew have proper tools to do the job?
10	0	8) Does crew have proper equipment to do the job?
5	0	9) Are tools in good condition?
10	0	10) Is equipment in good condition?
15	0	11) Does crew have the right kind and amount of materials to do the job?
15	0	12) Does crew follow work standards and guidelines?
10	0	13) Is crew staffed properly to do assigned work?
10	0	14) Are crew members productive at worksite?
10	0	15) Do employees wear proper personal protective safety items?
15	0	16) Does traffic control adhere to Department work zone standards?
10	0	17) Is completed work properly measured and recorded?
5	0	18) Are time charges made correctly?
5	0	19) Are material charges made correctly?
5	0	20) Are equipment charges made correctly?
5	0	21) Is crew adhering to Department work break regulation?

The points are scored on an all-or-none basis and totaled. The totals are then converted to percentages. There is no passing or failing grade, but the scores do allow comparison between units.

Pennsylvania has been using a procedure to rate the quality of activities for several years. In that agency's system, field quality assurance evaluations are conducted on selected activities by a variety of central office, district, and county personnel. The following work activities have formal quality assurance checklists used to evaluate management and work methods. Numerical ratings for each step in the work activity are summarized to yield an overall evaluation:

- pothole patching
- shoulder cutting
- pipe installation
- surface treatment
- mechanized patching
- leveling
- joint sealing
- crack sealing
- stockpile management
- work zone traffic control

Additionally, the department annually checks such items as safety (field and garage), sick-leave control, planning, and other management-related areas as part of an annual County Accreditation Program. Figures 8 and 9 are the quality evaluation form for pipe replacement and the applicable quality assurance indicators. The forms for other activities currently available are contained in Appendix C.

EVALUATING QUALITY AT THE PROJECT LEVEL

As mentioned previously, project, as defined in this synthesis, means a discrete portion of a highway system (e.g., a bridge or relatively short section of highway).

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

PIPE REPLACEMENT (711-7324) - 3/87

EVALUATOR _____ DISTRICT _____
DATE _____ COUNTY _____
SR _____ SEG _____ OFFSET _____ FOREMAN _____ # _____

	SCORE	COMMENTS
A. 1. GRADE LINE ESTABLISHED		
2. INLET AND OUTLET FLOW ESTABLISHED		
3. LOCATION		
4. SIZE		

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
				0.50	

B. 1. TRENCH WIDTH		
2. UNSUITABLE MATERIAL		
3. BEDDING		
4. JOINTS		
5. DEPTH OF COVER		
6. BACKFILL		

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
				0.30	

C. 1. PAVEMENT CUTTING		
2. PIPE ALIGNMENT		
3. END TREATMENT		
4. DAMAGED PIPE		
5. LENGTH		

SCORING SUMMARY SECTION C	TOTAL	NO. ITEMS RATED IN C	AVG. SCORE C	WEIGHTED FACTOR	WEIGHTED SCORE C
				0.20	

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

ACTIVITY RATING		
	4.75 = 5.00	VERY GOOD
	3.65 = 4.74	GOOD
	2.30 = 3.64	MINIMUM ACCEPTABLE
	LESS THAN 2.30	UNSATISFACTORY

ACTIVITY RATING IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE OR IF ANY SECTION B ITEMS ARE SCORED LESS THAN TWO.

FIGURE 8 Quality evaluation form—pipe replacement.

Pipe Replacement 3/87
Quality Assurance Evaluation Indicators

Grade Line Established
1. Improper slope.
3. Grade slightly irregular-min. slope 1/4"/ft.
5. Uniform slope minimum 1/4"/ft.

Inlet/Outlet Flow Established
1. Inlet & outlet ditches restricted >30%.
3. Inlet & outlet ditches partially restricted <30%.
5. Inlet & outlet ditches open-no restrictions.

Location
1. Pipe in wrong location-(skew or location).
5. Pipe in proper location.

Size
1. Reduced size of existing pipe or installed 36" or greater w/o hyd. study.
3. Replace existing 15" in kind
5. Install 18" up to 35"; 36" and greater replaced with hydraulic study.

Trench Width
1. Too narrow <2' wider than pipe diameter.
2. Too wide >3' wider than pipe diameter.
4. Sufficient width-width varies from 2' to 3' wider than pipe diameter.
5. Meets RC10 & 30 requirements.*

Unsuitable Material
1. Unsuitable material not removed (Ref: RC30).
3. Unsuitable material removed insufficient depth >6" <12".
5. Unsuitable material removed-proper depth (Ref. RC30 & Pub. 408).

Bedding
1. No bedding.
2. Insufficient depth (<4"); not compacted and/or no cradle.
3. Sufficient depth (>4"); not compacted and no cradle.
4. Sufficient depth (>4"); not compacted or no cradle.
5. Sufficient depth (>4"); properly compacted and properly shaped cradle.

Joints
1. No joint filler (caulk, mortar or bands).
2. Pipes not joined properly.
3. Improper sealant or mismatched bands.
4. Slight misalignment (vertical or horizontal).
5. Pipes properly mortared or joined.

Depth of Cover
1. Less than 6" cover to subgrade (where possible to attain).
5. > 6" cover to subgrade or not possible to attain.

Backfill
1. Using exist excavation-no compaction.
2. Using exist excavation-w/compaction.
3. 2A or 2RC material compacted in lifts >4".
5. 2A or 2RC material properly compacted in 4" lifts.

* 2' wider then pipe diameter up to & including 48" pipe, 2.5' wider for pipe diameter greater than 48". Width to trench wall measured at bell or band. Additional width permitted for safety to protect workers. Additional width permitted one side to handle running water during installation.

Pavement Cutting
1. Not cut
3. Jackhammer.
5. Saw cut.

Pipe Alignment
1. No daylight visible.
2. >3" deviation in alignment.
3. Minor misalignment (<3" deviation in alignment).
5. Perfect alignment.

End Treatment
1. No end treatment(s).
3. Loose field stone end wall(s).
4. Good dry wall inlet end.
5. Concrete, masonary or treated timber head wall; inlet; or flared end section scheduled.

Damaged Pipe
1. Damaged ends and/or holes in pipe.
2. Damaged ends or major unrepaired coating damage.
3. No end damage-minor unrepaired coating damage.
4. No end damage-coating damage repaired.
5. No visible damage.

Length
1. Inlet and outlet ends do not meet existing flow line/slope.
3. Inlet within 6" of flow line and outlet within 12" of proper supported length.
5. Inlet and outlet ends meet existing flow lines/slope.

FIGURE 9 Quality assurance indicator.

Using this definition did not produce many useful responses, possibly because of the difficulty of determining when work done on "a discrete portion of a highway system" is a normal, routine-maintenance operation or a special undertaking that would require a different type of management and reporting.

One way this definition can be applied is in the collection of either the cost of all maintenance or the cost of specific activities for a limited portion of the highway. The latter was utilized in Florida in the 1950s to collect the cost of maintaining an extensive beautification planting on a section of rural highway. In the 1960s, Florida participated in an interstate maintenance cost study that used a number of special control sections. In both of these examples, project or job limits were established to collect costs. With greatly improved electronic data collection and processing capabilities available today, it would be possible and desirable to introduce the assessment of quality into cost data bases, which should enhance the value of the information obtained.

The Florida Maintenance Management Information System (MMIS) assigns a unique job number to each bridge on the system and thereby accumulates the cost of all activities performed on each bridge and uses the information to relate cost to the amount of work accomplished. Although not fully implemented at this time, this system provides the means of performing quality evaluation on bridge maintenance activities.

Two parts of the system have been implemented—bridge inspection and deficiency repairs. All bridge inspection and repair activities are reported to the MMIS.

Bridge inspection is quality controlled in several ways:

1. Bridges are assigned to alternate inspection teams from one inspection to another so that reports of one team serve as a check on previous inspections.
2. District bridge inspection supervisors periodically perform a check inspection behind each team.
3. A district chief bridge inspector holds monthly meetings with all bridge inspection teams, including consultants inspecting local bridges, to discuss any deviations and ensure that all inspection personnel are using consistent procedures and uniform interpretations.

Deficiency repairs are quality controlled through deficiency reports. As part of each inspection report, a deficiency report is prepared and submitted to the district bridge engineering section, which performs a load analysis to determine if the deficiencies reported require a load restriction. The report then goes to the district structures engineer, who approves/disapproves the report. Those deficiencies to be corrected by state forces are sent to the area maintenance engineers for action. A quality evaluation is performed by reinspection of the bridge after the deficiencies are corrected to ensure that any corrections affecting load-carrying capacity have been properly executed.

EVALUATING QUALITY AT THE NETWORK LEVEL

Evaluation of quality at the network level is generally based on an agency's maintenance level of service. Of the 51 agencies (46 states) responding to Question 3, 29 (26 states) reported having an established level of service, threshold of deficiency statements, or other indicators of quality at the network level.

The proceedings of the 1968 Maintenance Management Workshop contain two papers relative to the evaluation of a highway pavement on a system-wide basis. The first (*27*) describes the process of evaluation and the second (*28*) explains the application of the results to a specific system—the New York State Thruway—and its general significance to the states faced with a then relatively new but already aging Interstate system.

A third paper at the same workshop describes a process that, although it differs in some respects from more sophisticated systems developed later, provided the genesis for systems in use today. An example of the process is shown below (*10*, p. 133):

> INSPECT ROADS (field)
>
> Input
> Existing road system.
> Output
> Total work load necessary to maintain roads to level specified in quality standards.
> Process
> Prior to the start of the summer maintenance season, each field unit conducts a detailed road inspection in which all work necessary to maintain the road to the level specified in the quality standard is recorded by activity, on road inspection forms.

Two years later, at the 1970 Maintenance Management Workshop, a paper was presented on a procedure in use in Louisiana:

> Each six months, all roads are inspected as a means of pinpointing work needs. . . .At the same time this inspection is made, each control unit is given a rating of "excellent," "good," "fair," or "poor." These ratings are given a numerical value of 4, 3, 2, and 1 and are weighted by the length of section. An index is computed on the sum of the condition ratings for all of the roads in each parish. . . .These inspections are made by the same personnel each time. This index will indicate if the level of maintenance under the management system is being maintained at the desired quality level (*29*).

Another paper reported on an Ohio project that introduced the basic principles of system-wide evaluation procedures in current use. As reported (*30*):

> The consultant proposed that the quality of highway maintenance can be evaluated in terms of its influence on four factors contributing to the level of service on the highway. . . .
> 1. The physical integrity of the elements of the highway;
> 2. The safety of the facility for the user;
> 3. The rideability of the pavement; and
> 4. The aesthetics of the highway.
>
> Three conditions were established as a framework for the conduct of the development study:
> 1. The method should be based on a sample of the highway system in order to minimize inspection time;
> 2. The measurement should be based on objective criteria which could be obtained by regular maintenance personnel; and
> 3. The results of the evaluation should be presented in a simple easily understood format.
>
> The quality of highway maintenance influences both the physical integrity of the highway and the users of the highway; and the influence on the user can be divided into three areas of safety, rideability and aesthetics. . . .Although there are about 50 maintenance activities performed by maintenance forces, each having varying impact on the four areas of influence, it did not seem practical or necessary to try to evaluate each maintenance activity. In place of a detailed study, the total maintenance effort was divided into eight categories. . .(a) ice and snow removal, (b) pavement main-

tenance, (c) shoulder maintenance, (d) vegetation control, (e) maintenance of structures, (f) roadsides and medians, (g) drainage, and (h) appurtenances.

. . .The characteristics of the basic elements of the highway system affecting user safety were next set forth. An inadequate condition was defined as a "Recordable Condition." A code was assigned the "Recordable Conditions" and the definitions used to identify the conditions, as follows:

1. Pavement	a. Obstructions
2. Shoulder	b. Deterioration
3. Structure	c. Drop Off
4. Guardrail	d. Slipperiness
5. Drainage	e. Corrosion
6. Traffic Control	f. Functional Failure
7. Vegetation	g. Erosion
8. Roadway	

Each recordable condition is identified by one number and one letter in combination (i.e., a hole in the pavement surface will be 1b).

As has been stated, this Ohio project was the forerunner of most of the more sophisticated systems now in use for evaluating the quality of maintenance at the system level.

Current Practice

The 29 agencies that reported that they have established maintenance levels of service (LOS) were asked to explain how they were used at the network level. From the replies received, it appears that many agencies rely on subjective appraisals of district and central office personnel, based on unstructured "windshield" inspections. Six agencies reported structured procedures for evaluating the effectiveness of their LOS standards—five of them using more or less objective criteria.

California

The California Department of Transportation (Caltrans) has developed a structured process to aid management in determining the degree of compliance with its LOS. This process was developed in a research effort under the aegis of the FHWA (*17*). The Caltrans approach is covered at length because it provides the most detailed explanation of a process of this nature. The instructions for the conduct of the 1988 review are contained in Appendix D.

A description of the California organization from the Caltrans Maintenance Manual (*18*), Volume 2, Chapter 7, is contained in Appendix E.

Florida

The Florida Department of Transportation (FDOT) instituted a formal LOS review in 1984. The procedure was developed by maintenance personnel and has been reviewed and revised based on actual experience in applying it to the field. Appendix F contains the instructions for conducting the review revised through November 1, 1987.

The following description of the Florida procedure is from a paper presented at the 1986 AASHTO Annual Meeting (*31*):

> In 1984, the Florida Department of Transportation began development of a formalized process to measure level of service achieved and to be able to predict levels of service under various production efforts. A committee of veteran maintenance engineers functioned as a task group to develop the quality evaluation system.
>
> The group identified four classes of highways; rural limited access, rural arterial, urban limited access, and urban arterial and a fifth facility type—special route—for special situations such as recreation areas.
>
> Highway facility elements were identified as: pavement, roadside, drainage, traffic services, and aesthetics. Next, element characteristics were identified. For example, Roadside was divided into seven components: shoulders, front slopes, back slopes, turnouts, sidewalks, bike paths, and fences.
>
> A defect criterion was developed for each of the characteristics. Consideration was given to the different classifications of highways, and in many cases different criteria were established for each highway class. Some adjustment was made after field testing. Each element was weighted with respect to its importance to the highway facility and each characteristic was rated in importance on a scale of 1 to 10. For calculating purposes, the element characteristic scores were adjusted so that the element score equals 100. The rating is derived from the total possible points at any sample site divided into the sum of the point of the characteristics that meet or exceed the condition criteria. Two-person teams are used to collect field data. Generally, one team per district is adequate to complete each quarterly survey in each county. A computer program selects random sites by section and milepost for each type facility. A minimum of 30 sites is required to rate each facility type and 90 to 120 sample sites are required in each unit. There are many different ways to evaluate the data and there is unlimited use for the information.

Louisiana

The Louisiana Department of Transportation and Development has continued the inspection procedure previously described, with two significant changes—the inspections are now made annually and the deficiencies are quantified. The maintenance effort to correct deficiencies for each mile of each control section is estimated by the parish superintendent in the production units for each activity (e.g., tons of premix, miles of shoulder blading, etc.). These inspections are performed by the parish superintendent and the district maintenance specialist and serve the dual purpose of establishing the deficiencies from the preceding year and providing information for planning the following year's program.

The Louisiana inspection form and instructions for its use are contained in Appendix G.

Ohio

The Ohio Department of Transportation continues to use the recordable conditions survey, the development of which was covered in the preceding section.

The system has been in effect for 16 years, and some changes have been implemented, including limiting the total recorded deficiencies on any two-mile section to 100 to obviate the skewing of the data for a county because an extremely bad road was included in the test samples.

In conducting the survey, two crews cover each of the state's 88 counties four times each year, testing up to 25 two-mile sections in each county, depending on the mix of the systems in the county. The survey data are segregated by several road classifications—Interstate, primary four lane (divided and un-

divided), and rural and secondary routes. There are a maximum of five two-mile test sections per route class per county.

The data are presented on a series of bar graphs:

- a quarterly report to each district on 14 graphs
- an annual 88-county summary distributed statewide
- a two-year county history to spot trends

Recently two additional reports have been added:

- a seven- to eight-year county history
- a regional bar chart, grouping similar districts

This latter report was added to present a more equitable picture of districts and counties that have special problems related to environment and traffic (e.g., coal mining areas).

The Ohio Recordable Condition Manual and reporting forms are contained in Appendix H.

Pennsylvania

The Pennsylvania Department of Transportation (PennDOT) does not manage its maintenance programs based on defined "service levels" or "threshold" standards as such. The department has a generalized policy that high-volume systems such as the Interstate system or Priority Commercial Network (PCN) are to receive higher levels of service. The department has moved more toward performing preventive maintenance on "cycles" rather than waiting until the roadway condition reaches a given state to trigger activity.

In 1983, PennDOT instituted an annual review of all 43,000 miles of roadway under the program Systematic Technique to Analyze and Manage Pennsylvania's Pavements (STAMPP). The data collected are used in maintenance work planning and overall pavement management. But the data are not the sole source to determine the maintenance work plan.

The STAMPP program has been expanded to include shoulders, guiderail, and drainage systems. A new location referencing scheme was adopted that inventories the network in one-half-mile segments. This length was selected as a practical size from both an inventory and pavement management standpoint.

Summer help is used to perform the condition survey using a form for each segment. For each condition such as pavement cracking, potholes, clogged drainage, or deteriorated guiderail, the form is completed with a number from 0 to 9, indicating the extent and severity of the condition.

Pavements are surveyed annually and guiderail and drainage systems every four years. Figure 10 is the condition survey input form for rigid pavement and shoulder.

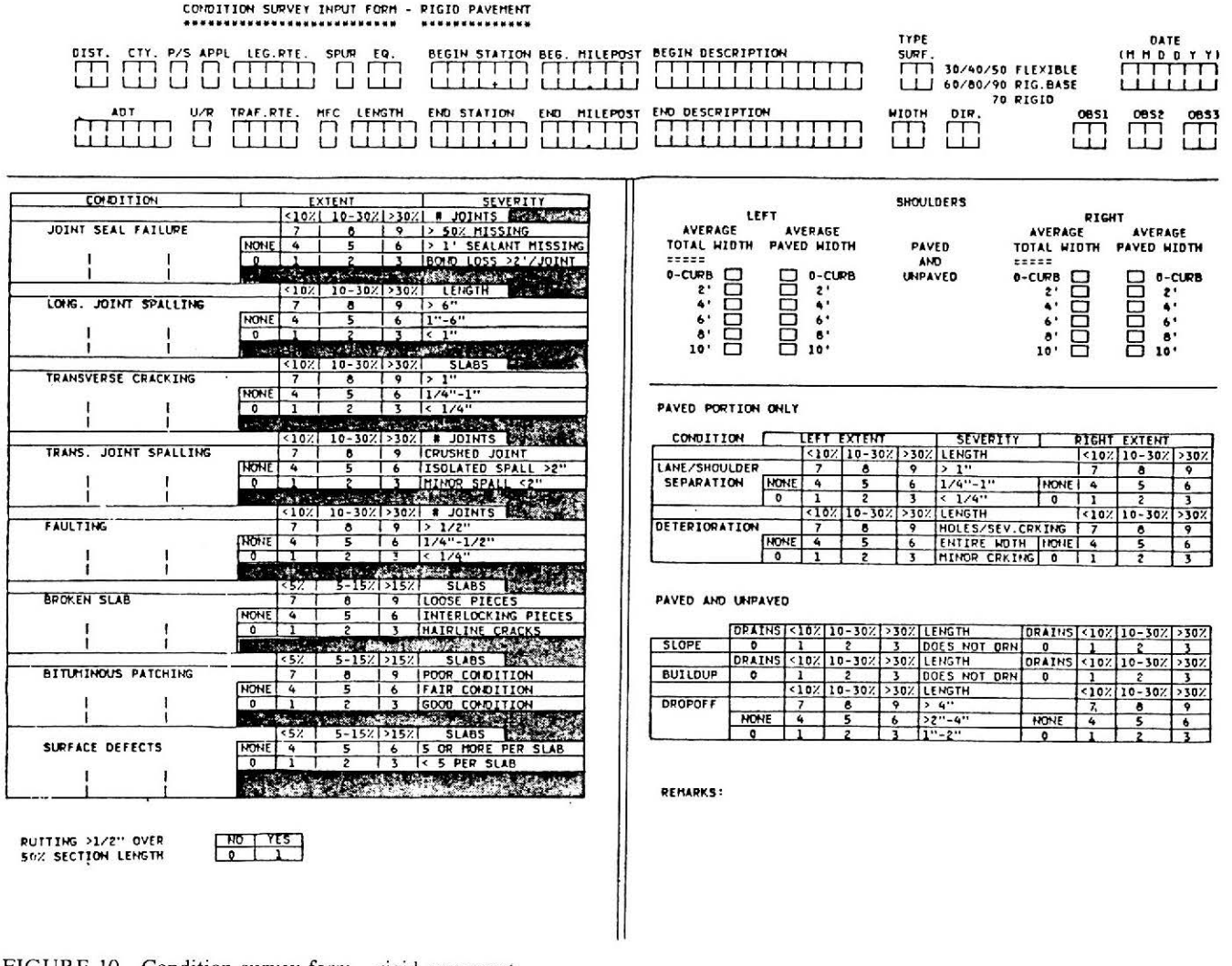


FIGURE 10 Condition survey form—rigid pavement

In addition to STAMPP and the field quality assurance evaluations previously mentioned, PennDOT conducts an annual county accreditation program in which such items as safety (field and garage), sick-leave control, planning, and other management-related functions are evaluated.

As mentioned above, the preceding five agencies use objective criteria for their LOS reviews. The criteria used are, in effect, these agencies' indicators of quality. For comparison purposes, these indicators have been assembled in Table 1.

It should be noted that Table 1 is not a comprehensive compilation of the indicators used by all five agencies because only those considerations used by at least two agencies are included. California in particular has developed indicators for a large number of considerations that are not currently used by any of the other four agencies. For a more complete review of indicators used by these agencies, the reader should refer to Appendixes E through H. (The available information for Pennsylvania is included in the text.)

The sixth agency reporting a structured LOS review procedure is the Iowa Department of Transportation. This procedure is reported separately because it is admittedly a subjective process.

Iowa

The following information is taken from "Maintenance Quality Evaluation FY '85," Iowa Department of Transportation (*32*):

> The Maintenance Quality Survey Program is a subjective evaluation of Iowa's Primary and Interstate Highway System. The purpose of this program is to evaluate the quality of the maintenance being performed on these highways. The information contained is intended to be used as a comparison of the quality of highway maintenance between the residencies and districts only. All surveys were conducted by the same two-person team.
>
> The one mile test sections were randomly selected by the residencies with the aid of a computer. The four main areas reviewed in each mile section were broken down into smaller sub-areas and were evaluated on a 1-10 scale (with 10 considered high). The areas and sub-areas with their relative weights are:

1. Pavement Surface	40%
a. Patching	35%
b. Joint and Crack Filling or Sealing	35%
c. Surface Restoration	30%
2. Shoulder Maintenance	30%
a. Surface Condition	40%
b. Pavement Edge Drop-off & Joint	40%
c. Slope	20%
3. Traffic Services	20%
a. Signs and Guardrail	50%
b. Markings	50%
4. Roadside	10%
a. Median and Row (weeds, trees, & brush)	40%
b. Roadside Ditch Drainage & Litter Control	30%
c. Shoulder, Median & Row Mowing	30%

> Each sub-area was rated by each team member and the ratings were multiplied by their respective weights. These were then added together to give the main area rating. This rating was multiplied by the weight for that main area. The main areas were then added together to obtain a maintenance quality level for the test mile section. The two raters' scores are averaged to establish the final overall maintenance level.
>
> Upon completion of the field inspection, the data were compiled, tabulated and graphed for ease of comparison between the residencies and districts.

TABLE 1

INDICATORS OF QUALITY

Element	Consideration	California 5 mile Section 1/10 mile Increment	Florida 1/10 mile Sample	Louisiana 1 mile Section	Ohio 2 mile Section	Pennsylvania 1/2 mile Section
ROAD & SHOULDERS						
Travelway, Flexible	Holes	No holes	None larger than 1/2 ft^2 in area & 1 1/2 in. deep. Pervious base not exposed in any hole	No holes	No deterioration exceeding 2 in. in depth and 24 $in.^2$ in area or where base is exposed	No potholes
	Edge Raveling	No edge spalls	90% of total pavement edge is raveled less than 4 in. No continuous section of edge raveling of 4 in. or wider exceeds 25 ft in length	No edge raveling	N/A	Not more than 10% of edge of pavement is cracked
	Cracking	No alligator cracks No cracks more than 1/4 wide	No Class III cracking	Only isolated severely cracked areas	N/A	No unsealed cracks
	Rutting	No wheel ruts over 1 in. deep. No drip track ruts over 1/2 in.	Rutting areas not more 3/4 in. in average depth	No rutting that causes a rough ride or 1/2 in. ponding of water on surface	N/A	Not more than 50% of one lane with rut over 1/2 in. deep
	Depression	No irregularities over 1 1/2 in. in 50 ft	No measurement exceeds 1/2 in. deep within the initial 10 ft increments Measurement of each depressed area must be made in both directions	None that exceed 1 in. deep in 10 ft or when water ponds over 1/2 in. deep	No depression that exceeds 2 in. in depth	No depression that gives passengers a jolt
	Shoving	No irregularities over 1 1/2 in. in 50 ft	Shoved area does not exceed a cumulative 25 ft^2	No bumps exceeding 3/4 in. in 5 ft	No bumps exceeding 2 in. in height	No bump that gives passengers a jolt

TABLE 1 (*Continued*)

Element	Consideration	California 5 mile Section 1/10 mile Increment	Florida 1/10 mile Sample	Louisiana 1 mile Section	Ohio 2 mile Section	Pennsylvania 1/2 mile Section
Travelway, Rigid	Holes	No holes	None larger than 1/2 ft^2 in area and 1 1/2 in. in depth	No broken slabs over 1 yd^2 in area	No deterioration exceeding 2 in. in depth and 24 $in.^2$ in area or exposes base or reinforcing steel	No scaling, popouts or isolated spalls, 1 ft^2 or in area
	Rutting	None over 1 in.	Rutting areas not more 3/4 in. average depth	No spalled areas more 6 in. wide or 1 in. or more deep. No unlevel irregular surface areas, 1 yd^2 in area, 1 in. above or below the normal road surface	N/A	No rutting 1/2 in. or 50% of length of section
	Cracks	No open cracks more than 1/2 in. wide	90% of roadway slabs have no unsealed cracks wider than 1/8 in.	N/A	N/A	No crack over 1/4 in. or with low severity spalling over 50% of length. No faulted cracks
	Joints	No open cracks more than 1/4 in. wide	85% of the linear feet of transverse and longitudinal joint material appears to function as intended	No joint filler oxidized and dead or adhesion failure along 1/3 or more of length. Expansion joint closed to 3 in. or less	No joints that have heaved causing a bump of more than 2 in. in height	No joints with 1 ft or more of sealant missing or with foreign materials
	Faulting	No deviation over 1/2	See Voids	N/A	N/A	No difference in elevation elevation greater than 1/4 in.
	Voids	No open cracks over 1/2 in. wide	90% of slabs exhibit no evidence of pumping	N/A	N/A	N/A
	Delamination	See Structural	95% of surface is free from delamination	N/A	N/A	N/A
	Structural	No localized slab failure, no transverse spalls over 4 inches, no longitudinal spalls	N/A	N/A	N/A	N/A
Shoulders, Paved	Holes	Same as travelway	Same as travelway	See below	No obstruction or hole that exceeds 2 in. depth and 12 in. diameter, or exposes the base or reinforcing steel	Same as travelway
	Drop-off	No edge of travelway drop-off over 1 in.	No edge of travelway drop-off when shoulder and travelway are same construction	See Depressions	No drop-off between the pavement and shoulder exceeding 2 in. in depth and 10 ft in length	No drop-off over 2 in.
	Cracking	Same as travelway	Same as travelway	Less than 20% of surface exhibits cracking, oxidation, pitting or severe raveling	Same as travelway	Same as travelway
	Depressions	Same as travelway	Same as travelway	No depressions over 1 in. deep or causing water to pond over 1/2 in. deep	Same as travelway	Same as travelway
Shoulders, Unpaved	Drop-off	No excessive drop-off	No shoulder drop-off exceeds 3 in. deep within 1 ft of pavement edge for 25 ft continuous	No edge ruts over 3 in.	No edge of pavement over 2 in. deep and 10 ft long	No drop-off over 2 in.
	Variation from Template	No vertical drop-off or depressions adjacent to pavement. No ruts	No deviations exist 5 in. below or 2 in. above original design. No washboard areas exist having a total differential greater than 5 in. from low spot to high spot	N/A	No obstructions that a vehicle cannot be safely driven through or over	No movement of shoulder or collection of debris so that over 10% of shoulder does not drain

TABLE 1 (*Continued*)

Element	Consideration	California 5 mile Section 1/10 mile Increment	Florida 1/10 mile Sample	Louisiana 1 mile Section	Ohio 2 mile Section	Pennsylvania 1/2 mile Section
Shoulders, Turnout	General	Same as paved shoulder	Flexible pavement - no defect is greater than 1/2 ft^2 area and 1/2 in. deep. No Class III cracks. PCC pavement: no vertical fracture, horizontal crack or settlement exceeds 3/4 in.	N/A	N/A	N/A
Roadside Front Slope	Ruts, Washouts	N/A	None deeper than 5 in.	No ruts in slopes over 3 in. deep and/or 6 in. wide	N/A	No sediment in drainage system
Fencing	Function	No unauthorized entry	No unrestrained entry	No unrestrained entry	N/A	N/A
TRAFFIC SERVICES						
Raised Pavement Markers	Function	70% of RPMs in place	70% of the required markers are functional (reflective). No more than 120 of continuous centerlines or lane lines are without a reflective marker	No missing or damaged markers worn to the extent that they are not effective in controlling traffic	N/A	Not more than 200 ft missing
Striping	Function	Reflectivity 50% of new	70% of original installation functions as intended	No striping worn to the extent that it is not effective in controlling traffic; or worn to the point that less than 50% of the stripe is visible for extended distances (miles)	No missing or faded striping in excess of 100 ft that does not delineate the pavement edge or center	No striping more than 12 months old. No expressway lane line more than 6 months old
Pavement Symbol	Function	Reflectivity 50% of new	70% of original installation functions as intended	N/A	No missing or nonreflective pavement symbols	Not more than 50% worn
Attenuator	Function	100% functional	90% of device functions as intended	No units below full functional capacity or not completely extended with all cells operational and filled with material	N/A	No system non-functional
Guiderail	Function	100% functional	90% of installation functions as intended	No guardrail damaged or displaced so that it no longer functions as a safety device	No guiderail or barrier wall that will not properly function due to damage or deterioration the post, hardware or element	No post deflected more than 15°. No cracking or or structural rust. No missing hardware
Barrier Wall	Function	100% functional	99% of installation functions as intended	N/A	See Guiderail	No barrier out of place
Warning Signs	Function	100% functional	95% of required signs present and functioning as intended	No signs illegible by vandalism, age, or condition. Signs are to be used until length of service is reached	No signs that are missing, faded, or damaged (twisted post, painted sign, etc.) that causes sign to not function properly	No signs or markers ineffective due to age, vandalism. or condition
Regulatory Signs	Function	100% of Stop or other signs prohibiting traffic movements in place	95% of required signs present and functioning	Same as warning signs	Same as warning signs	Same as warning signs
Information Signs	Function	50% functional	85% of required signs present and functioning as intended	Same as warning signs	N/A	Same as warning signs
Hazard and Guide Markers	Function	N/A	80% of required markers present and functioning as intended	No missing, dirty or damaged markers worn to the extent that they are not effective in controlling traffic	No missing or damaged markers	None ineffective due to age, condition, or vandalism

TABLE 1 (*Continued*)

Element	Consideration	California 5 mile Section 1/10 mile Increment	Florida 1/10 mile Sample	Louisiana 1 mile Section	Ohio 2 mile Section	Pennsylvania 1/2 mile Section
Sign Lighting	Function	Not more than 2% out	75% of the required installation is functioning as intended	No lighting out of service	N/A	No lights out of service
Roadway Lighting	Function	Not more than 2% out excepting knocked-down standards	90% of the required is functioning as intended	No lighting out of	N/A	No lights out of service
DRAINAGE						
Storm Drain	Obstruction	Drains functional	Cross-section area not obstructed: Rural limited access: 90% Rural arterial: 85% Urban ltd. access: 90% Urban arterial: 85%	No culvert blocked to the point of impairing drainage	N/A	Not more than 1/2 clogged, bottom rotted, or joints separated
Side Drain	Obstruction	Drain functional	Cross-section area not obstructed: Rural limited access: 75% Rural arterial: 75% Urban ltd. access: 80% Urban arterial: 80%	N/A	No drain where 50% of the cross-section is obstructed	Same as Storm Drain
Cross Drain	Obstruction	Drain functional	Cross-section area not obstructed: Rural limited access: 80% Rural arterial: 80% Urban ltd. access: 85% Urban arterial: 85%	N/A	No drain where 50% of the cross-section is obstructed	Same as Storm Drain
Roadside Ditch (nonpaved)	Shape, Obstruction	No obstruction, proper shape	Bottom below the outside edge of pavement: Rural limited access: 3.0 ft; Rural arterial: 3.0 ft; Urban limited access: 2.5 ft; Urban arterial: 2.5 ft	No buildup of sedimentation or vegetation that impedes drainage of roadway or causes property damage. No accumulation of foreign material and vegetation in ditches that impedes flow of water	No ditch where 50% of the cross-section is obstructed	No bottom erosion 12 in. or more, less than 1/2
Median Ditch (nonpaved)	Shape, Obstruction	No obstruction, proper shape	Bottom is 2 ft or more below inside edge of pavement	N/A	N/A	Same as Roadside Ditch
Outfall Ditch	Shape, Depth, Elevation	No obstruction, proper shape	Ditch bottom is at or within the lower 1/3 of distance between natural ground and the design flow line	N/A	N/A	Ditch bottom erosion not more than 12 inches. Less than 1/2 cross-section obstructed
Curb Inlet	Obstruction	Inlet functional	90% of opening not obstructed	N/A	Less than 50% of inlet obstructed	Less than 50% of inlet obstructed
Other Inlets	Obstruction	Inlet functional	85% of opening not obstructed	N/A	Same as curb inlet	Same as curb inlet
Shoulder Growth	Height or Appearance	No weeds impairing signs, safety devices, guardrails, or sight distance. Conforms to Roadway Vegetation Control Policy	Not more than 1% of vegetation exceeds height limits below. This excludes bahia seed stalks & decorative flowers allowed to remain for aesthetics. The area shall be maintained in accordance with the mowing guide. Rural limited access: 24 in.; Rural arterial: 18 in.; Urban limited access: 13 in.; Urban arterial: 12 in.	Grass does not exceed 12 in. in rural areas or 8 in. in urban areas	No growth over 15 in. high. No scalped areas	No clumping or excessive browning due to untimely cutting

TABLE 1 (*Continued*)

Element	Consideration	California 5 mile Section 1/10 mile Increment	Florida 1/10 mile Sample	Louisiana 1 mile Section	Ohio 2 mile Section	Pennsylvania 1/2 mile Section
Slope Growth	Height or Appearance	Conforms to Roadway Vegetation Control	Not more than 1% of vegetation exceeds 24 in. high. This excludes bahia seed stalks and decorative flowers allowed to remain for aesthetics. The area shall be maintained in accordance with the mowing guide	N/A	Same as above	Same as above
Land-scaping	Appearance	At least 50% on sliding scale excellent to poor	Vegetation is maintained in a healthy, attractive condition	No unsightly landscaping or growth obstructing sight distance	N/A	N/A
Tree Trimming	Appearance, Obstruction	No obstructions	No encroachment of tree, tree limbs or vegetation in or over travelway or clear zone lower than 14 1/2 ft or lower than 10 ft over sidewalks	No brush obstructing sight distance or clear view of signs, or brush that creates fire hazard at bridges or risks damage to fence	N/A	N/A
Turf	Appearance	50% on sliding scale excellent to poor	Turf is maintained in a relatively healthy condition and mowing area 90% free of undesirable grass and broadleaf weeds	No unsightly weeds	N/A	No unsightly growth
Litter	Aesthetics	N/A	Volume of litter does not exceed 6 ft^3 per acre excluding roadway pavement	Right of way appears aesthetically pleasing	No 1/10 mile section with more than 10 pieces of litter (one side of road)	'Keep PA Beautiful Day' April before mowing operations begin
Roadway Debris	Accumulation	N/A	Material accumulation is no greater than 3/4 in. deep in the traveled way or 2 1/4 in. deep in the gutter	No debris or trash on or along curb and shoulder that interferes with proper drainage, safety, or aesthetics	N/A	Anti-skid accumulation in curbed areas and on structures removed in

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Status of Maintenance Management Systems

More than 20 years after the first highway maintenance management systems were implemented, a number of agencies have never adopted one, whereas others have tried and then abandoned their efforts.

A majority of the operational systems are not complete in that they lack either performance standards or quality standards and, in many instances, both. Some systems appear to be little more than cost-accounting mechanisms.

Of the 45 agencies that reported having maintenance management systems, only 14 have both performance standards and quality standards, 4 have performance standards only, 13 have quality standards only, and 14 have neither. South Carolina, which does not have an MMS, reported having both performance standards and quality standards.

Importance of Performance and Quality Standards

The focus of early maintenance management systems on productivity measures in many cases continues today. Productivity is a measure of efficiency but not effectiveness. The difference in the two can be illustrated by the analogy of a basketball player who becomes disoriented and shoots the ball through his own basket, scoring for the opposing team. He is performing efficiently what he was trained to do but his effectiveness is less than zero. Maintenance management systems that have only productivity measures are not only failing to determine effectiveness but may be inhibiting it through encouraging field forces to take short cuts in their work in order to show better productivity.

Performance standards and quality standards should provide a measure of the effectiveness of the workers' efforts, that is, the quality of the work. Properly applied, they will provide a measure of the extent to which the agency is achieving what should be its goal of satisfying the public's need for an adequate, safe highway system.

Agencies that have not defined a level of service are operating under one that is determined by the workers in the field and one that is highly inconsistent, because the workers' perception of quality may vary from place to place and time to time.

Inhibiting Factors

A number of factors inhibit the implementation of maintenance management systems and deter maintenance managers from seeking further improvement in existing systems through the additional and full use of performance and quality standards.

First and foremost is the lack of any organized constituency for maintenance. The public and the media may demand improvements to the highway system—the building of new roads or bridges or the improvement of old ones. They might even support bond issues or increased taxes to fund these improvements. But there is no great outcry for improved maintenance except to correct a localized problem, and certainly no support for increased revenues for maintenance. This is especially true if it is perceived that more money spent on routine maintenance means less for construction and other activities.

The lack of an organized constituency for maintenance affects the legislative authorities who control transportation "purse strings" and usually allocate funds to "grease the squeaking wheel." Legislators' interest in maintenance usually begins and ends with the satisfaction of the requests of their constituents to correct localized problems.

Highway administrators are likely to react to the same perception of the public's desires as the legislators, and at budget time favor those activities in public demand. Many times, maintenance engineers have been told to conserve funds for the construction program. Many administrators have no interest in participating in the formulation of maintenance policy, and some of them measure the quality of the maintenance organization by its response to any special request that they make.

It is entirely possible that maintenance engineers' own views of the perceived lack of importance in regard to their programs contribute to this lack of support from outside the maintenance organization. This lack of understanding of the importance of cultivating support is evident in the replies to Questions 7 through 10 of the Survey of Current Practice (see Appendix I).

Administrators' perceptions of a maintenance management system are sometimes limited to its use as a budgeting tool with which they can ask the maintenance managers to manipulate their need for resources to achieve program objectives in order to determine how specific reductions (either dollars or percentages) of their budget requests might be achieved. They are not likely to support an effort to upgrade an MMS if the effort is going to require extensive resources unless it can be shown that positive benefits will result.

Recent moves toward more decentralized organizational structures, particularly in larger agencies, have increased the difficulty for maintenance engineers to secure compliance with maintenance standards in some agencies. In having to operate through increased layers of authority, maintenance engineers have become remote figures to field personnel, who are accountable to a district engineer whose portfolio includes many activities in addition to maintenance.

Another organizational problem is the field workers' attitude toward maintenance management systems mentioned in *Synthesis 110* (*3*). The promise made to them in the beginning that MMS would help them work smarter but not harder has not always been fulfilled, often for reasons beyond the control of the maintenance organization. The workers are likely to view with suspicion any "improvements" to an MMS that increase their reporting requirements without any evident advantage to them.

RECOMMENDATIONS

General

Given more than 20 years of maintenance management research and the plethora of work already done, it is difficult to suggest original research for general application. It would be far easier to make suggestions for a specific agency. However, there are conditions that merit consideration.

There has been much concern in recent years about the problem of technology transfer to local governments. Although this concern is justified, the information gathered in preparing this synthesis indicates that there is also a problem of some magnitude in effectively communicating research results to the states and provinces.

Participants in public forums, such as the AASHTO Maintenance Committee and TRB functions, continue to ask questions about subjects that have been thoroughly researched, indicating that they are not using all the information available and may not be aware of published research results.

It is becoming evident that, except in a few progressive agencies, there has been a period of virtual stagnation following the enthusiasm that marked the initial 10 years or so after the introduction of the principles of maintenance management.

Specific Suggestions

- An annotated bibliography of maintenance management publications is needed to serve as a reference for maintenance managers.

Because of the volume of publications covering more than 20 years of research, it might be necessary to be selective in preparing the proposed bibliography. If this is done, it should not be on an age basis, because some of the earliest work is still valid today.

- AASHTO, FHWA, and TRB should encourage transportation agencies to ensure that research results are reaching the proper personnel.

From the repetitive questions asked about some subjects in discussion sessions at AASHTO and TRB functions, it appears that some maintenance engineers are unaware of sources of published information. This probably applies to other practitioners as well.

- The question of the relationship of quality standards and tort liability should be resolved.

With one state removing all reference to quality standards because of potential tort liability and another state eliminating quality references for the same reason and then restoring them, there is obviously considerable disagreement on this subject. Although it is not established, the question of tort liability could be an influencing factor with the many agencies that do not have quality standards.

- There is a need to develop simplified procedures to involve transportation administrators, executive levels of government, legislators, and public representatives in the formulation of maintenance policies and standards to broaden support for adequate funding of maintenance programs.

Maintenance needs to have the same type of support that construction programs achieve through the involvement of all of the groups named above.

- The issue of cost-effectiveness (benefits/costs) of maintenance management systems should be settled.

This is not strictly speaking a research need. Perhaps it could be handled through a TRB session or through the AASHTO Maintenance Committee with a number of case studies. However initiated, a credible publication of the information is needed to which those that raise the question from time to time could be referred.

- Effectiveness (of lack of it) of maintenance job skills training.
- Improvement of management skills in maintenance organizations.

These two issues are presented together because there is a possible causal relationship between the failure of well-developed job skills training programs to produce desired results and the need for improved management in the field. These issues should be addressed by AASHTO and FHWA.

- There is a need for a procedure (indicator) to determine the quality of maintenance at the activity level.

Most engineers responsible for maintenance in the larger agencies will admit (some only when pressed) that they have no fully reliable means of assuring compliance with the agency's performance standards. The means most often cited in response to the Current Practices questionnaire was that the responsibility lay with field managers or that high levels made periodic reviews. (Author's note: This might determine compliance with a level of service but not necessarily performance standards.)

- TRB should encourage more multidisciplinary symposia.

Maintenance management would be enhanced if maintenance engineers were exposed to the ideas of practitioners of other disciplines, such as lawyers, human behaviorists, economists, and others. The Sunday before the TRB Annual Meeting would be a cost-effective time to schedule these meetings.

- AASHTO, FHWA, and TRB should consider a Maintenance Management Workshop for 1990 that would serve as a general review of the status of MMS and answer as many of the questions raised above as possible.

The last two maintenance management workshops assumed a fairly uniform level of MMS implementation, which the workshops were designed to enhance. It has become evident that this premise was far from correct and many agencies have need of exposure to the basics. Maintenance Management 1990 could ask three questions:

1. "Where are we?"
2. "How did we get here?"
3. "Where do we want to go?"

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APPENDIX A

SURVEY OF CURRENT PRACTICE

Agency _____

1. Does your agency have a formal Maintenance Management System (MMS)?

(1)_____

2. Does your agency have a procedure, either as part of a MMS or otherwise, to ascertain that work performed is of acceptable quality?

(2)_____

If answer (2) is "yes", please explain on attached sheet(s) or attach a copy of your procedure.

3. Does your agency have formal statements of "maintenance service levels","thresholds of acceptable deficiencies", or other indicators of quality at the project or network level either as part of a MMS or otherwise?

(3)_____

If answer (3) is "yes", please explain on attached sheet(s) or attach a copy of your procedures. Explain how they are applied at the project and/or network level.

4. Are your quality indicators used for:

a. attaining management objectives? (4a)_____

b. budget control? (4b)_____

c. work plan adherence? (4c)_____

d. equipment utilization? (4d)_____

e. field safety? (4e)_____

f. maintenance of traffic? (4f)_____

g. fleet accident rate? (4g)_____

h. repair costs? (4h)_____

i. personnel management? (4i)_____

j. office operations? (4j)_____

If your answer to any of the above is "yes", please explain on the attached sheet(s) or, if you have provided a copy of your procedure, refer to the appropriate section(s).

5. If your answer to question 2 and/or 3 is "yes", were your procedures:

a. developed "in house"? (5a)_____

b. developed by a consultant? (5b)_____

c. adopted from another agency? (5c)_____

d. initiated by other means? (5d)_____

Please explain your reply to the above on the attached sheet(s).

6. If your answer to question number 2 was "yes";

a) how long have your procedures been in use? (6a)_____

b) do you believe they provide good, fair or poor indicators of the quality of your program? (6b)_____

7. Do levels of Management in your agency above the maintenance organization use indicators of quality to rate the maintenance program? (These might be official or unofficial, fair or unfair, and might be explained by anecdote.) (7)_____

8. Do executive levels of government outside your agency use indicators of quality to rate the maintenance program (Official or unofficial, fair or unfair)? (8)_____

9. Does your legislative body express an interest in your maintenance program using indicators of quality of its own? (9)_____

10. Do you evaluate media commentary as an indicator of the quality of your maintenance program? (10)_____

If your answer to 7,8,9 and/or 10 is "yes", please explain on the attached sheet(s)

11. Has your agency conducted any formal studies or research on quality indicators in maintenance by consultant or "in house"? (11)_____

If your answer to (11) is "yes", please explain on attached sheet(s) or attach copies of studies and/or research.

12. Are you aware of any research on quality indicators in maintenance currently in progress? (12)_____

If your answer to (12) is "yes", please provide information on the attached sheet(s)

13. Are you aware of any published or unpublished manuscripts on indicators of quality in maintenance? (13)_____

If your answer to (13) is "yes", please attach copies of any in your possession or provide a list including sources on the attached sheet(s).

14. Do you have any recommendations for research on indicators of quality in maintenance?

(14)_____

If your answer to (14) is "yes", please respond on attached sheet(s).

15. Do you have any comments or suggestions?

(15)_____

If your answer to (15) is "yes", please respond on attached sheet(s).

Survey Completed by:

Name:_____

Title:_____

Address:_____

_____

Telephone:_____

Person to be contacted for more information:

Name:_____
Telephone:_____

PLEASE MAIL COMPLETED SURVEY FORM WITH ATTACHMENTS TO:

Charles R. Miller, P.E.
2314 Mavis Circle
Tallahassee, FL 32301

PLEASE MAIL TO ARRIVE BY MARCH 15, 1987

APPENDIX B

HIGHLIGHTED RESULTS OF RESPONSES TO SURVEY QUESTIONS

The management of maintenance involves a number of activities and concerns that affect the field operations and are subject to and influenced by quality control procedures.

Questions 4a through 4j of the Survey of Current Practice were propounded to determine how agencies are using quality indicators in some of the related activities and areas of concern. Table B-1 is a summary of responses to all questions.

Agencies answering "yes" to any part of Question 4 were asked to provide additional information. Not all did so, and some of the replies received were not responsive to the question. Table B-2 provides a summary of how many agencies responded and shows how many states are represented among the respondents. The responsive replies are presented without qualification, following each part of the question:

4a. Are your quality indicators used for attaining management objectives?

California:

> The procedures adopted to implement the levels of service statements are designed to assist in attaining management objectives.

Florida:

> The Maintenance Condition Rating System is a tool for management to evaluate program effectiveness.

Georgia:

> Maintenance standards are established to assure attainment of desired levels of maintenance to provide uniformity and consistency throughout the State. The standards define desired levels of maintenance service, estimate work requirements in terms of quantitative measurements, establish work methods that are most effective and establish average daily production rates.

Hawaii:

> Maintaining the highway at the desired maintenance level is a management objective.

Iowa:

> To properly allocate our people and to provide an appropriate level of service, we have identified service level highways and generally respond to provide service to the higher service level roads first when relatively equal needs are evident on different service level roads. We do not specifically identify a separate quality of maintenance except in the snow and ice removal program.

Kansas:

> Quality indicators are used to assure that operations are performed in a manner that maximizes protection of the system (network) and minimizes repeat maintenance.

Louisiana:

> The quality-of-service objectives are established to protect the State's investment in transportation facilities and provide a minimally acceptable level of comfort and convenience to the traveling public.

Montana:

> Maintenance Management System budget component is used by Districts to develop work plans based on available funding and condition inventory. Top management requires performance at, say, 90 percent of approved work plan and all work must be accomplished within budget.

Oklahoma:

> The needs studies and sufficiency ratings provide a basis for prioritizing work on the system.

Pennsylvania:

> Some managers use Quality Assurance results as indicators in achieving management objectives.

South Dakota:

> Procedures assist in attaining the objective of maintaining a safe roadway and protecting the investment.

Utah:

> Some annual maintenance inspections are conducted by the District Directors, Maintenance Engineers, Supervisors, Foremen or Analysts. All state roads are inspected.

District of Columbia:

> Procedures further the management objective of providing better riding surfaces.

Oakland County, Michigan:

> The basic Maintenance Management system generates a computerized report which shows at any time during the course of the fiscal year where each district is in terms of comparison between planned work and work completed. The report also

TABLE B-1

SUMMATION OF RESPONSES TO SURVEY OF CURRENT PRACTICE

Agency	Question 1	2	3	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	5a	5b	5c	5d	6a	6b	7	8	9	10	11	12	13	14	15
Alabama	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	N	Y	Y	N	Y
Alaska	N	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	N	N	N	N	N
Arizona	Y	N	Y	--	--	--	--	--	--	--	--	--	--	Y	--	--	--	--	--	N	N	N	N	N	N	N	N	N
Arkansas	Y	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	N	N	N	N	Y
California	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	Y	N	N	2 yr	F	Y	Y	Y	Y	Y	N	Y	--	N
Colorado	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	--	--	--	3 yr	F	Y	N	Y	N	N	N	N	--	N
Connecticut	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	17 yr	G	Y	Y	Y	Y	Y	Y	Y	N	N
Delaware	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	Y	N	Y	N	N	Y
Florida	Y	Y	Y	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	2 yr	G	Y	Y	N	N	Y	N	Y	Y	N
Georgia	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	--	Y	--	--	17 yr	G	Y	N	N	N	N	N	N	N	N
Hawaii	N	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	--	--	--	--	--	N	N	N	N	N	N	N	N	N
Idaho	Y	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	--	--	N	N	N	N	N	N	N	N	N
Illinois	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	--	--	--	6 yr	G	N	N	N	Y	Y	N	Y	Y	Y
Indiana	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	N	N	N	N	N
Iowa	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	11 yr	G	N	N	Y	Y	N	N	N	Y	Y
Kansas	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N	N	6+ yr	F	Y	Y	Y	Y	N	Y	Y	N	Y
Kentucky	Y	N	N	N	N	Y	N	N	Y	N	N	Y	N	--	--	--	--	--	--	Y	Y	Y	N	N	N	Y	Y	N
Louisiana	Y	Y	Y	Y	N	Y	N	N	N	N	N	N	N	Y	Y	--	--	18 yr	F	Y	N	N	N	N	N	N	N	N
Maine	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Maryland	Y	Y	N	N	N	N	N	N	N	N	N	N	N	--	--	--	--	--	--	N	N	N	N	N	Y	Y	N	N
Massachusetts	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Michigan	Y	N	N	N	N	N	N	N	N	N	N	N	N	--	--	--	--	--	--	N	N	N	N	N	N	Y	N	N
Minnesota[a]	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	3 yr	G	N	N	N	N	N	N	N	N	N
Mississippi	Y	N	Y	--	--	--	--	--	--	--	--	--	--	Y	--	--	--	--	--	Y	Y	Y	N	N	N	N	N	Y
Missouri	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	Y	--	--		10-15 yr	P	Y	N	N	N	N	N	N	N	N
Montana	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	Y	N	N	3 yr	G	Y	N	N	N	N	N	N	N	N
Nebraska	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	--	--	--	--	--
Nevada	Y	Y	Y	N	N	Y	N	N	N	N	N	N	N	Y	Y	N	N	15 yr	G	N	N	Y	N	N	Y	N	N	N
New Hampshire	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N/A	54 yr	Y	Y	Y	Y	Y	N	N	N	N	Y
New Jersey	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Y	Y	Y	N	N	N	N	N	N
New Mexico	Y	N	Y	--	--	--	--	--	--	--	--	--	--	--	Y	--	--	--	--	Y	Y	Y	N	N	N	N	N	N
New York	Y	N	Y	N	--	N	N	N	N	N	N	N	N	Y	--	--	--	--	--	N	N	N	Y	N	N	N	N	N
North Carolina	Y	N	N	N	N	N	N	N	N	N	N	N	N	--	--	--	--	--	--	--	--	--	N	N	N	N	N	N
North Dakota	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N	--	Y	--	--	UD[b]	F	Y	N	N	Y	8th	N	Y	N	N
Ohio	Y	N	Y	--	--	--	--	--	--	--	--	--	--	Y	Y	N	N	--	--	--	--	--	--	Y	Y	Y	Y	Y
Oklahoma	Y	Y	Y	Y	--	--	--	--	--	--	--	--	--	Y	--	--	--	20 yr	--	N	N	N	N	N	N	N	N	N
Oregon	Y	N	Y	Y	N	N	N	Y	N	N	N	N	N	Y	--	--	--	--	--	Y	N	N	N	N	N	N	N	N
Pennsylvania	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	4 yr	G	Y	N	N	N	N	N	N	N	N
Rhode Island[c]																												
South Carolina	N	Y	Y	Y	N	Y	N	Y	Y	N	N	Y	N	Y	N	N	N	64	G	Y	Y	Y	Y	N	N	N	N	N
South Dakota	Y	N	Y	Y	N	N	Y	N	N	N	N	N	N	Y	--	--	--	--	--	N	--	N	Y	N	N	N	N	N
Tennessee[d]	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Texas	N	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	N	N	N	N	N	Y
Utah	Y	Y	N	Y	N	N	N	N	N	N	N	N	N	Y	Y	--	--	18 yr	G	N	N	N	N	N	N	N	--	--
Vermont	N	N	N	--	--	--	--	--	--	--	--	--	--	--	-	--	--	--	--	N	N	N	Y	N	N	N	N	N
Virginia	Y	N	Y	Y	--	--	--	--	--	--	--	--	--	Y	--	--	--	3 yr	N	Y	Y	N	Y	N	Y	N	Y	Y
Washington	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y	--	--	--	19 yr	F	Y	Y	N	Y	UD[b]	Y	Y	N	N
West Virginia	Y	N	Y	--	--	--	--	--	--	--	--	--	--	Y	--	--	--	--	--	N	N	N	N	N	N	N	N	N
Wisconsin	N	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	Y	N	Y	N	N	N
Wyoming[e]	Y	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
New Brunswick	Y	N	Y	N	N	Y	Y	Y	N	N	N	N	N	Y	Y	N	N	15 yr	F	Y	Y	N	N	N	N	N	N	--
Nova Scotia	Y	N	--	--	Y	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	--
Ontario	Y	N	Y	--	--	--	--	--	--	--	--	--	--	Y	Y	Y	N	--	--	Y	Y	N	Y	Y	N	N	Y	N
Dist. of Columbia	N	Y	N	Y	--	--	--	--	--	--	--	--	--	Y	--	--	--	?	F	?	?	?	Y	N	N	N	N	Y
Prince Georges Co.	Y	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N	N	N	Y	N	N	N	N	N
Oakland Co., Mich.	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	N	Y	Y	--	--	?	G	Y	Y	N	Y	Y	N	N	--	N

[a] MMS is in pilot study phase. Implement department-wide 1/1/88.
[b] Under development.
[c] Did not reply to questionnaire.
[d] Did not complete questionnaire. Letter stated that Tennessee has "no formalized system to ascertain whether routine maintenance work is performed at a level of acceptable quality."
[e] Did not complete questionnaire. Letter stated that MMS was developed in 1973 and Wyoming feels that it has improved overall quality but has no objective criteria other than standards.

indicates for each work activity in each district how the district's productivity measures up to the standards for productivity that have been set by the Department.

4b. Are your quality indicators used for budget control?

California:

The procedures adopted assign responsibilities for budget control.

Montana:

The approved work plan must be accomplished within budget.

New York:

The procedures are part of a performance budget.

TABLE B-2

RESPONSES TO QUESTION 4 OF SURVEY OF CURRENT PRACTICE

Question 4	a	b	c	d	e	f	g	h	i	j
Agencies Responding to Survey Question	34	31	31	31	31	31	31	31	31	31
Number of States Represented	31	30	29	29	29	29	29	29	29	29
Agencies Responding Yes to Survey Question	21	11	14	9	9	8	3	5	9	1
Number of States Represented	19	10	12	7	8	8	3	5	8	1

Pennsylvania:

> While not part of the work quality indicators, budget control has standards and is monitored.

Utah:

> Adopted procedures provide for budget control.

4c. Are your quality indicators used for work plan adherence?

California:

> The procedure provides responsibility for work plan adherence.

Pennsylvania:

> While not part of the work quality indicators, work plan adherence has its own control procedures.

Utah:

> Adopted procedure provides for work plan adherence.

4d. Are your quality indicators used for equipment utilization?

Pennsylvania:

> Equipment utilization has its own indicators and is monitored.

South Dakota:

> Equipment utilization dictated by performance standard provisions where applicable.

4e. Are your quality indicators used for field safety?

Florida:

> Field safety is constantly monitored.

Pennsylvania:

> Field safety is evaluated during field quality assurance checks.

4f. Are your quality indicators used for maintenance of traffic?

Pennsylvania:

> Work zone traffic control is evaluated during field quality assurance checks.

4g. Are your work plan indicators used for fleet accident rate,
4h. repair costs,
4i. personnel management, or
4j. office operations?

Pennsylvania:

> In one form or another, these areas all have standards, indicators or statewide averages which are monitored.

Author's note: Pennsylvania was the only agency that responded to all of the above questions and probably represents the thinking of most agencies that have a maintenance management system. Many agencies who answered "yes" to some of Questions 4a–4j could have considered the facts to be so obvious that expansion was not necessary.

Maintenance engineers need to be concerned not only with their own indicators of the quality of their program but with the indicators (perceptions) of others. This concern is necessary not only as a duty to the public but also (and more pragmatically) because quite often the "others" are in a position to influence or directly affect the maintenance program.

Three questions (7–9) were asked on the survey in an attempt to learn what indicators might be used—or at least the responders' perception of them. Question 10 asked about the evaluation of media commentary. The responses are summarized in Table I-1.

A majority of those responding indicated a belief that individuals outside of their maintenance organization had no indicators (perceptions) of the quality of their operation even though the questions pointed out that those indicators could be official or unofficial and fair or unfair. Reality is probably better observed by the agency (Kansas) that responded, "Opinions, like noses, are possessed by everybody." This truism should be of interest and concern to all maintenance engineers.

Based on the author's experience, all four questions should have been answered "yes," but only four agencies did so.

Selected agency comments on questions 7 through 10 appear in Appendix I.

APPENDIX C

PENNSYLVANIA QUALITY ASSURANCE EVALUATION FORMS

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

LIQUID BITUMINOUS SURFACE TREATMENT (711-7124) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. TRAFFIC CONTROL		
	2. CLEAN SURFACE		
	3. CRACK SEAL		
	4. POTHOLES PATCHED		
	5. OIL TEMPERATURE		
	6. SURFACE TEMPERATURE		
	7. OIL APPLICATION RATE		
	8. AGGREGATE APPLICATION RATE		
	9. SPRAY PATTERN		

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
				0.50	

B.	1. DRY SURFACE			
	2. BASE			
	3. ROLLING PATTERN			
	4. OPERATIONAL SEQUENCE			

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
				0.30	

C.	1. WIDTH			
	2. LONGITUDINAL JOINT			
	3. END NOZZLES			
	4. CONSISTENT MATERIAL FLOW			

SCORING SUMMARY SECTION C	TOTAL	NO. ITEMS RATED IN C	AVG. SCORE C	WEIGHTED FACTOR	WEIGHTED SCORE C
				0.20	

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

ACTIVITY RATING		
4.75 = 5.00	VERY GOOD	_____
3.65 = 4.74	GOOD	_____
2.30 = 3.64	MINIMUM ACCEPTABLE	_____
LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY RATING IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE OR IF ANY SECTION B ITEMS ARE SCORED LESS THAN TWO.

Traffic Control
1. None-heavy and/or high speed traffic on roadway.
3. Traffic kept off of fresh material until cured, or minimal traffic control for low volume-low speed traffic.
5. Traffic detoured or pilot car used.

Clean Surface
1. Dust, mud, chips or shoulder cutting debris on pavement.
3. No sweeping but roadway mostly clean.
5. Clean surface.

Crack Seal
1. Required, not done.
3. 80% of required sealing done.
5. 100% of required sealing done.

Potholes Patched
1. Patching required but not done.
3. Few small holes, <1/2" deep.
5. No patching required/all patched.

Oil Temperature
1. Outside of temperature application bands of vendor's material certification.
5. Within temperature application bands of vendor's material certification.

Surface Temperature
1. <60 degrees F.
5. 60 degrees F or more.

Oil Application Rate
1. Too light or too heavy varied by >10% from Design; no design prepared or distributor not calibrated.
3. According to design for most areas of job.
5. According to design, adjusted where required, and varied <10% from Design.

Width
1. Oil and/or stone spread too narrow or too wide. (>10% of job).
3. Minor deviations from full width.
5. Covers existing pavement 100% - no deviations.

End Nozzles
1. No end nozzles on distributors.
3. End nozzles on all distributors, both ends of spray bar used 90-95% of job.

Aggregate Application Rate
1. Too light or too heavy with streaks, varied by >10% from Design, stone chipper not calibrated, or no design prepared.
3. Good for most areas of job.
5. According to Design for all areas of job.

Spray Pattern
1. Streaking visible on one or more nozzles.
3. Uniform coverage - minor pattern visible at beginning only.
5. Uniform coverage - no pattern visible.

Dry Surface
1. Wet.
3. Dry with minor damp areas <10% of job.
5. Completely dry.

Base
1. Obvious base failures, no corrective action taken where required.
3. Minor base failure, 90% of areas repaired; all base failures repaired in accordance with procedures in 711-7126 with some exceptions.
5. Base failures repaired in accordance with procedures in Activity 711-7126.

Rolling Pattern
1. One roller with backrolling, steel rollers only, or rubber tire contact pressure <35 or >55 psi.
3. Rubber tire and steel rollers with no steel wheel backrolling.
5. Sufficient rubber tired rollers to cover full width in one pass, proper rolling technique and contact tire pressure.

Operational Sequence
1. Operations uncoordinated.
3. Minor delays and problems resolved quickly with orderly, well-organized solutions.
5. Operations well coordinated-no delay, problems or confusion.

Longitudinal Joint
1. Centerline streak or overlap obvious.
3. Minor deviations on < 5.0% of job.
4. Minor deviations on < 1% of job.
5. No centerline streak or overlap obvious on 100% of job.

Consistent Material Flow
1. Numerous routine delays for oil or stone deliveries.
3. Routine delays 10 min avg.
5. Delays < 5 min. avg. for oil or stone deliveries.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

SHOULDER CUTTING (711-7215) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. SLOPE	_____	
	2. LONGITUDINAL GRADE	_____	
	3. WIDTH - CUT AREA	_____	
	4. WIDTH - FILL AREA	_____	
	5. POTENTIAL FOR EROSION	_____	
	6. DROP - OFF	_____	

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
	_____	_____	_____	0.70	_____

B.	1. GRADED MATERIAL REMOVED FROM DRAINAGE FACILITIES	_____	
	2. COMPACTION	_____	
	3. PAVEMENT CLEAN	_____	

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
	_____	_____	_____	0.30	_____

FINAL SCORE	(TOTAL WEIGHTED SCORES)		_____
ACTIVITY RATING	4.75 = 5.00	VERY GOOD	_____
	3.65 = 4.74	GOOD	_____
	2.30 = 3.64	MINIMUM ACCEPTABLE	_____
	LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE.

Quality Assurance Evaluation Indicators

Slope
1. Non-uniform slope.
5. Uniform slope - 3/4" to 1 1/2" per foot.

Longitudinal Grade
1. Non-uniform grade - potential for water pockets.
3. Uniform grade, minor depressions.
5. Uniform grade, no depressions.

Width - Cut Area
1. Improper width.
3. Proper width. Non uniform.
5. Proper width, uniform to toe of cut slope, per field conditions.

Width - Fill Area
1. Improper width.
5. Proper width, edge of fill, face of guiderail, per field conditions.

Potential for Erosion
1. No grade established to flow lines.
2. Lip not removed from fill section, bleeders not cut or flow line blocked.
3. Minor debris in drainage facilities, bleeders cut under guide rail, or side dozing scheduled, no lip in fill sections.
5. Flow lines established-material compacted where required, no lip in fill sections, bleeders cut under guide rail or side dozing scheduled.

Drop Off
1. Greater than 1".
5. No Drop-off, less than 1".

Graded Material Removed from Drainage Facilities
1. Loose material not removed from drainage facilities or lip blocking shoulder drainage from entering inlets/pipes.
3. Minor handwork done to facilitate drainage - water can enter drainage facility.
5. Drainage facilities functioning - no graded material obstructing run-off.

Compaction (As Conditions Permit)
1. No compaction.
3. Compacted, minor movement.
5. Compacted, no movement under roller.

Pavement Clean
1. Broom not used.
3. Broom used, pavement not clean.
5. Broom used, pavement clean.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

STOCKPILE MANAGEMENT · 3/87

EVALUATOR _____ STOCKPILE NO. _____

DATE _____ LOCAL NAME _____

DISTRICT _____ STATE ROUTE _____

COUNTY _____ SEG _____ OFFSET _____

		SCORE	COMMENTS
A.	1. CHEMICAL COVERING	_____	.....
	2. CHEMICAL CONDITION	_____	.....
	3. HOT PILE COVERING	_____	.....
	4. HOT PILE CONDITION	_____	.....
	5. A/S CONDITION	_____	.....
	6. EQUIPMENT HEATERS	_____	.....

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
	_____	_____	_____	0.80	_____

B.	1. LIGHTING	_____	.....
	2. SITE MAINTENANCE	_____	.....
	3. HOUSEKEEPING · WINTER	_____	.....
	4. PLOW STORAGE	_____	.....

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
	_____	_____	_____	0.40	_____

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

ACTIVITY RATING		
	4.81 = 5.00	VERY GOOD _____
	3.80 = 4.80	GOOD _____
	2.20 = 3.79	MINIMUM ACCEPTABLE _____
	LESS THAN 2.20	UNSATISFACTORY _____

ACTIVITY IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE.

Stockpile Management
Quality Assurance Indicators

Chemical Covering
1. Not covered.
3. Partially covered, >90%.
5. Completely Covered

Chemical Condition
1. Unuseable material.
3. Useable, some lumps or foreign material mixed.
5. Free flowing, non contaminated.

Hot Pile Covering*
1. Not covered.
3. Partially covered, >90%.
5. Completely covered.

Hot Pile Condition
1. Unuseable material.
3. Useable, some lumps or foreign material mixed.
5. Free flowing, non contaminated.

Anti Skid Condition
1. Frozen, unable to break down with loader.
3. Frozen, able to break down with loader or foreign material mixed.
5. Free flowing, non contaminated.

Equipment Heaters
1. None
3. Insufficient quantity.
4. Sufficient quantity-poor layout or condition.
5. Sufficient quantity for equipment assigned - accessible.

Lighting
1. None
3. Illuminates loading area only.
5. Sufficient illumination.

Site Maintenance
1. Disorganized and untidy.
5. Neat and orderly-properly planned and developed.

Housekeeping - Winter
1. No after storm yard cleanup.
3. Majority of chemical spillage cleaned up.
5. All chemical spillage cleaned up.

Plow Storage
1. Not accessible for efficient mounting
3. Accessible-not blocked for efficient mounting or not stored on stable surface.
5. Accessible and blocked - stored on stable surface.

*Anti skid with more than 20% salt added is considered to be a hot pile.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

PIPE REPLACEMENT (711-7324) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ OFFSET _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. GRADE LINE ESTABLISHED		
	2. INLET AND OUTLET FLOW ESTABLISHED		
	3. LOCATION		
	4. SIZE		

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
				0.50	

B.	1. TRENCH WIDTH		
	2. UNSUITABLE MATERIAL		
	3. BEDDING		
	4. JOINTS		
	5. DEPTH OF COVER		
	6. BACKFILL		

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
				0.30	

C.	1. PAVEMENT CUTTING		
	2. PIPE ALIGNMENT		
	3. END TREATMENT		
	4. DAMAGED PIPE		
	5. LENGTH		

SCORING SUMMARY SECTION C	TOTAL	NO. ITEMS RATED IN C	AVG. SCORE C	WEIGHTED FACTOR	WEIGHTED SCORE C
				0.20	

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

ACTIVITY RATING		
4.75 = 5.00	VERY GOOD	_____
3.65 = 4.74	GOOD	_____
2.30 = 3.64	MINIMUM ACCEPTABLE	_____
LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY RATING IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE OR IF ANY SECTION B ITEMS ARE SCORED LESS THAN TWO.

Quality Assurance Evaluation Indicators

Grade Line Established
1. Improper slope.
3. Grade slightly irregular-min. slope 1/4"/ft.
5. Uniform slope minimum 1/4"/ft.

Inlet/Outlet Flow Established
1. Inlet & outlet ditches restricted >30%.
3. Inlet & outlet ditches partially restricted <30%.
5. Inlet & outlet ditches open-no restrictions.

Location
1. Pipe in wrong location-(skew or location).
5. Pipe in proper location.

Size
1. Reduced size of existing pipe or installed 36" or greater w/o hyd. study.
3. Replace existing 15" in kind
5. Install 18" up to 35"; 36" and greater replaced with hydraulic study.

Trench Width
1. Too narrow <2' wider than pipe diameter.
2. Too wide >3' wider than pipe diameter.
4. Sufficient width-width varies from 2' to 3' wider than pipe diameter.
5. Meets RC10 & 30 requirements.*

Pavement Cutting
1. Not cut
3. Jackhammer.
5. Saw cut.

Pipe Alignment
1. No daylight visible.
2. >3" deviation in alignment.
3. Minor misalignment (<3" deviation in alignment).
5. Perfect alignment.

End Treatment
1. No end treatment(s).
3. Loose field stone end wall(s).
4. Good dry wall inlet end.
5. Concrete, masonary or treated timber head wall; inlet; or flared end section scheduled.

Unsuitable Material
1. Unsuitable material not removed (Ref: RC30).
3. Unsuitable material removed insufficient depth >6" <12".
5. Unsuitable material removed-proper depth (Ref. RC30 & Pub. 408).

Bedding
1. No bedding.
2. Insufficient depth (<4"); not compacted and/or no cradle.
3. Sufficient depth (>4"); not compacted and no cradle.
4. Sufficient depth (>4"); not compacted or no cradle.
5. Sufficient depth (>4"); properly compacted and properly shaped cradle.

Joints
1. No joint filler (caulk, mortar or bands).
2. Pipes not joined properly.
3. Improper sealant or mismatched bands.
4. Slight misalignment (vertical or horizontal).
5. Pipes properly mortared or joined.

Depth of Cover
1. Less than 6" cover to subgrade (where possible to attain).
5. > 6" cover to subgrade or not possible to attain.

Backfill
1. Using exist excavation-no compaction.
2. Using exist excavation-w/compaction.
3. 2A or 2RC material compacted in lifts >4".
5. 2A or 2RC material properly compacted in 4" lifts.

Damaged Pipe
1. Damaged ends and/or holes in pipe.
2. Damaged ends or major unrepaired coating damage.
3. No end damage-minor unrepaired coating damage.
4. No end damage-coating damage repaired.
5. No visible damage.

Length
1. Inlet and outlet ends do not meet existing flow line/slope.
3. Inlet within 6" of flow line and outlet within 12" of proper supported length.
5. Inlet and outlet ends meet existing flow lines/slope.

* 2' wider then pipe diameter up to & including 48" pipe, 2.5' wider for pipe diameter greater than 48". Width to trench wall measured at bell or band. Additional width permitted for safety to protect workers. Additional width permitted one side to handle running water during installation.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

MECHANIZED PATCHING (711-7122) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ OFFSET _____ SEG _____ OFFSET _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. BASE REPAIR	_____	
	2. CRACKS SEALED	_____	
	3. POTHOLES PATCHED	_____	
	4. SURFACE CLEAN	_____	
	5. SURFACE DRY	_____	
	6. TACK COAT APPLIED	_____	
	7. MATERIAL TEMPERATURE	_____	
	8. COMPACTION	_____	
	9. PROPER DEPTH	_____	

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
	_____	_____	_____	0.50	_____

B.	1. AIR TEMPERATURE	_____		
	2. PAVEMENT TEMPERATURE	_____		
	3. LONGITUDINAL JOINT	_____		
	4. TRANSVERSE JOINT	_____		

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
	_____	_____	_____	0.30	_____

C.	1. NOTCHES CUT	_____		
	2. SURFACE TOLERANCE	_____		
	3. TRAFFIC CONTROL	_____		
	4. PATCHES LOCATED	_____		
	5. PROPER WIDTH	_____		
	6. CONSISTENT MATERIAL FLOW	_____		

SCORING SUMMARY SECTION C	TOTAL	NO. ITEMS RATED IN C	AVG. SCORE C	WEIGHTED FACTOR	WEIGHTED SCORE C
	_____	_____	_____	0.20	_____

FINAL SCORE	(TOTAL WEIGHTED SCORES)		_____
ACTIVITY RATING	4.75 = 5.00	VERY GOOD	_____
	3.65 = 4.74	GOOD	_____
	2.30 = 3.64	MINIMUM ACCEPTABLE	_____
	LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY RATING IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE OR IF ANY SECTION B ITEMS ARE SCORED LESS THAN TWO.

Base Repair
1. Obvious base failure, no corrective action taken where required.
3. Minor base failure - 90% of area repaired.
5. All base repaired per standard.

Cracks Sealed
1. Required, not done.
3. 80% of required sealing
5. 100% of required sealing done.

Potholes Patched
1. Required, not done.
3. All holes > 1" deep patched.
5. None required - 100% patched.

Surface Clean
1. Sweeping required, not done.
3. Broom used pavement not 100% clean.
5. Broomed, pavement clean.

Surface Dry
1. Wet.
3. Damp areas.
5. Completely dry.

Tack Coat Applied (ID only Except AC-5)
1. None or 75% covered.
3. 75% to 99% covered.
5. 100% covered (408 section 460.3(b)).

Material Temperature
1. Outside of temperature application bands of vendor's material certification or 408 spec.
5. Within temperature application bands of vendor's material certification or 408 spec. (Sec. 401.3 (G)).

Compaction
1. Incorrect compaction equipment or incorrect rolling pattern.
3. H & B paver - 1 steel wheel; other FB paver-2 similar steel wheel;ID paver-Tandem and 3 wheel or rubber tire.
5. FB paver - tandem & 3 wheel, ID paver - vibratory tandem & 3 wheel or tandem, three wheel & rubber tire.*
* Short Section-Vibratory roller only permitted. 408 Section 401.3(h).

Proper Depth**
1. Not per standard for material used.
5. Per standard for material used.
** Maint. Manual Chapter 3 Section 1
1" FJ-1 & FB-1;1 1/2" ID-2;
2" ID-3.

Air Temperature
1. < 40 degrees entire project or before April 1 or after October 31.
2. < 40 degrees for 50% project.
3. < 40 degrees for 10% project.
4. 40 to 60 degrees - 100% project.
5. > 60 degrees - 100% project.

Pavement Temperature
1. < 40 degrees entire project.
2. < 40 degrees for 50% project.
3. < 40 degrees for 10% project.
4. 40 - 60 degrees 100% project.
5. > 60 degrees 100% project.

Longitudinal Joint***
1. No 3" overlap on previously placed lane, irregular rough joint.
2. 3" overlap non uniform, irregular rough joint, rake used.
3. 3" overlap, 90% uniform,broom or lute coarse aggregate onto unrolled lane.
4. XXX
5. 3" overlap uniform, broom or lute coarse aggregate onto unrolled lane.
***Disregard 3" limit on narrow roads with FB material.

Transverse Joint (ID Only)

1. None - edge not straight.
2. Roller moves over rounded edge, joint not trimmed to I-section depth.
3. Roller moves over rounded slope - joint trimmed, not tacked.
4. Roller moves over rounded slope - joint trimmed, tacked.
5. Bulkhead or saved joint, tacked, straight-edge, smooth joint - (Ref. 408, Section 401.3(J)2).

Notches Cut (ID only)

1. None
2. Notches not cut to standard.
3. Standard notches cut same day - delayed operations.
4. Standard notches cut same day - no delay.
5. Notches cut according to standards, cut ahead of operations located by A.M.M., cut with saw or milled.

Surface Tolerance

1. No straight edge on project.
2. Straight edge on project - not used.
3. Straight edge used, some irregularity > 3/16".
4. XXX
5. Straight edge used, irregularities < 3/16". (Ref. 408, Sec. 401.3(k)).

Traffic Control

1. None - heavy and/or high speed traffic.
2. One flagger at paver location.
3. Flaggers - each end.
4. Flaggers - pass flag or radios.
5. Adequate traffic control - newly complete course attained stability and adhesion, material <140 degrees.

Patches Located

1. Not located.
2. Some patches located.
3. General area located.
4. Located by foreman or other crew members.
5. A.M.M. locates patches with paint or keel.

Proper Width

1. Finished width too narrow or too wide.
2. Finished width accurate for 90% pr ject.
4. Minor deviations from full width, width accurate 91-99% of project.
5. Covers existing pavement 100%, no overlap.

Consistent Material Flow****

1. Numerous delays in material deliveries.
2. Occasional > 20 min. delays in material deliveries.
3. Routine delays exceeding 10 min.
4. No more than two delays > 5 min. in material deliveries.
5. Delays < 5 min. in material delivery.

****Not Applicable-FOB projects or rental trucks-comments to note problem and action taken.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

MANUAL PATCHING (711-7121) · 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. DRAINAGE	_____	.....
	2. BASE REPAIR	_____	.....
	3. CUTTING	_____	.....
	4. CLEANING	_____	.....
	5. TACKING*	_____	.....
	6. FILLING	_____	.....
	7. MATERIAL CONDITION	_____	.....
	8. COMPACTION	_____	.....

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
	_____	_____	_____	0.70	_____

B.	1. MARKING	_____	.....
	2. SEALING	_____	.....
	3. CLEAN UP	_____	.....
	4. RIDEABILITY	_____	.....
	5. SAFETY	_____	.....

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
	_____	_____	_____	0.30	_____

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

ACTIVITY RATING		
4.75 = 5.00	VERY GOOD	_____
3.65 = 4.74	GOOD	_____
2.30 = 3.64	MINIMUM ACCEPTABLE	_____
LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE.

Drainage
1. Obvious water problem - no corrective action taken.
3. Obvious water problem - temp. repairs done to correct or programmed.
5. Obvious water problem - permanently corrected.

Base Repair
1. Obvious base failure - no corrective action taken.
3. Surface repairs made. Base repairs are programmed.
5. Obvious base failure - base failure corrected.

Cutting*
1. Cutting not done.
2. Sides not cut vertically.
3. Cut from outside-in.
5. Cut inside-out w/vertical sides.

Cleaning
1. Free water or debris in hole.
4. Broomed - properly cleaned.**
5. Compressed air-properly cleaned.

Tacking***
1. Not tacked (where required) or improperly applied.
3. Non-uniform film-<100% coverage.
5. Uniform film-100% coverage.

Filling
1. Material placed to improper depth, corners not filled.
3. Material shoveled into hole to proper depth, material distributed w/rake.
5. Material shoveled into hole to proper depth, material distributed w/lute & corners properly filled.****

Material Condition
1. Hard, lumpy, stripped, crusted cold mix or unworkable hot mix.
3. Useable with reduced workability.
5. Within temperature specifications, workable.

Compaction
1. No compaction, truck wheel used for compaction, not compacted in corners or spillage not removed from adjacent surfaces.
3. Compacted, edges not properly pinched.
4. Properly compacted w/vibratory plate.
5. Properly compacted w/essick vibratory roller or 4-6 ton roller.

Marking
1. No holes marked.
3. Some holes marked.
5. All holes properly marked.

Sealing (Optional)
1. Wrong material.
3. Proper material, non uniform application, not sanded.
5. Proper material, uniform application, sanded.

Clean-up
1. Debris left on pavement and or shoulders.
5. Area properly cleaned.

Rideability
1. Any depression or bump >1/2".
3. Depression or bump between 1/4" & 1/2".
5. No depression or bump >1/4".

Safety
1. Improper personal protection devices.
3. Minor infractions noted.
5. No infractions noted.

* With District approval, not required if roadway preparation for overlay scheduled for same construction season.
** If patch is to be placed on aggregate, gravel or native stone base - broomed - properly cleaned - may be scored a 5.
*** Tacking not required with cold mix.
**** Rake is permissable with cold stockpile mix.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

LEVELING (711-7131) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

		SCORE	COMMENTS
A.	1. BASE REPAIR	_____	
	2. CRACKS SEALED	_____	
	3. POTHOLES PATCHED	_____	
	4. SURFACE CLEAN	_____	
	5. SURFACE DRY	_____	
	6. TACK COAT APPLIED	_____	
	7. MATERIAL TEMPERATURE	_____	
	8. COMPACTION	_____	

SCORING SUMMARY SECTION A	TOTAL	NO. ITEMS RATED IN A	AVG. SCORE A	WEIGHTED FACTOR	WEIGHTED SCORE A
	_____	_____	_____	0.50	_____

B.	1. AIR TEMPERATURE	_____	
	2. PAVEMENT TEMPERATURE	_____	
	3. LONGITUDINAL JOINT	_____	
	4. TRANSVERSE JOINT	_____	

SCORING SUMMARY SECTION B	TOTAL	NO. ITEMS RATED IN B	AVG. SCORE B	WEIGHTED FACTOR	WEIGHTED SCORE B
	_____	_____	_____	0.30	_____

C.	1. NOTCHES CUT	_____	
	2. SURFACE TOLERANCE	_____	
	3. TRAFFIC CONTROL	_____	
	4. LIMITS LOCATED	_____	
	5. PROPER WIDTH	_____	
	6. CONSISTENT MATERIAL FLOW	_____	

SCORING SUMMARY SECTION C	TOTAL	NO. ITEMS RATED IN C	AVG. SCORE C	WEIGHTED FACTOR	WEIGHTED SCORE C
	_____	_____	_____	0.20	_____

FINAL SCORE (TOTAL WEIGHTED SCORES) _____

*ACTIVITY RATING	4.75 = 5.00	VERY GOOD	_____
	3.65 = 4.74	GOOD	_____
	2.30 = 3.64	MINIMUM ACCEPTABLE	_____
	LESS THAN 2.30	UNSATISFACTORY	_____

ACTIVITY RATING IS UNSATISFACTORY IF ANY SECTION A ITEMS ARE SCORED LESS THAN THREE OR IF ANY SECTION B ITEMS ARE SCORED LESS THAN TWO.

Quality Assurance Evaluation Indicators

Base Repair
1. Obvious base failure, no corrective action taken.
3. Obvoius base failure, 90% of areas repaired.
5. All base repaired per standard.

Cracks Sealed
1. Required, not done.
3. 80% of required sealing done.
5. None required or 100% sealed.

Potholes Patched
1. Required not done.
3. 80% of required patching done.
5. None required or 100% patched.

Surface Clean
1. Sweeping required, not done.
3. Broom used, pavement not 100% clean.
5. Broomed, pavement clean.

Surface Dry
1. Wet.
3. Damp areas.
5. Completely dry.

Tack Coat Applied (ID Only-Except AC-5)
1. None
3. 75-99% coverage.
5. 100% coverage (408 Sec. 460.3(B).

Material Temperature
1. Outside of temperature application bands of vendor's material certification or 408 spec.
5. Within temperature application bands of vendor's material certification or 408 spec. (Sec. 401.3(C).

Compaction
1. Incorrect compaction equipment or incorrect rolling pattern.
3. H & B paver-1 steel wheel; other FB paver-2 similar steel wheel rollers; ID paver-tandem & 3 wheel or rubber tire.
5. FB paver-tandem and 3 wheel; ID paver-vibratory tandem & 3 wheel or rubber tire tandem, 3 wheel & rubber tire.

Air Temperature*
1. < 40 degrees, entire project.
2. < 40 degrees, for >25% of project.
3. < 40 degrees, for <25% of project.
4. 40 to 60 degrees-100% of project.
5. > 60 degrees, 100% of project.
* Air temperature below 50F, trucks must be insulated and tarped.

Pavement Temperature
1. < 40 degrees, entire project.
2. < 40 degrees, >25% of project.
3. < 40 degrees, <25% of project.
4. 40 to 60 degrees, 100% of project.
5. > 60 degrees. 100% of project.

Longitudinal Joint**
1. No overlap, irregular rough joint.
2. 3" non uniform overlap, raked irregular, rough joint.
3. 3" overlap, 90% uniform, broom or lute.
5. 3" uniform overlap, broom or lute coarse aggregate onto unrolled lane.
** Disregard 3" limit on narrow roads with FB material.

Transverse Joint-(ID only)
1. None-edge not straight.
2. Roller or traffic moves over rounded edge, joint not trimmed.
3. Roller or traffic moves over rounded edge, joint trimmed, not tacked.
4. Roller or traffic moves over rounded edge, joint trimmed and tacked.
5. Bulkhead or sawed joint, tacked, straight edge, smooth, 408 sec. 401.3(K).

Notches Cut (ID Only >1")
1. None
2. Not cut to standard.
3. Standard cut, cutting delayed operations.
5. Standard cut, did not delay operations.

Surface Tolerance (Hot Mix)
1. No straight edge on project.
2. Straight edge on job, not used.
3. Straight edge used, > 3/16" irregularity.
5. Straight edge used, irregularities < 3/16" 408 Sec. 401.3(K).

Traffic Control
1. None - high speed/heavy traffic.
2. One flagger at paver.
3. Flaggers at each end.
4. Flaggers, pass flag or radios.
5. Adequate traffic control, pilot vehicle or traffic kept off until stable.

Limits Located
1. Not located.
3. General Limits located.
4. Notches/limits located by foreman.
5. Notches/limits located by A.M.M.

Proper Width
1. Finished width too wide or narrow.
2. Width accurate 90% of job.
4. Minor, isolated deviations-width accurate 91%-99% of job.
5. Width accurate 100% of job.

Consistent Material Flow***
1. Numerous delays in material delivery.
2. Occasional >20 minute delays.
3. Routine delays over 10 minutes.
4. No more than two delays >5 minutes in material deliveries.
5. Delays < 5 minutes.

*** Not applicable - FOB projects or rental trucks - comments to note problem and action taken.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

CONCRETE PAVEMENT JOINT SEALING (711-7147) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

CONCRETE PAVEMENT TYPE (CIRCLE ONE) 1 2 3

	SCORE	COMMENTS
1. CLEANING EQUIPMENT		
2. CLEAN VERTICAL FACE		
3. DRY VERTICAL FACE		
4. SEALING EQUIPMENT		
5. MATERIAL		
6. PAVEMENT TEMPERATURE		
7. MATERIAL TEMPERATURE		
8. BACKER ROD/BOND BREAKER		
9. FILLING		
10. ADHERENCE		
11. SAFETY		

SCORING SUMMARY	TOTAL	NO. ITEMS RATED	AVG. SCORE	

FINAL SCORE _____

ACTIVITY RATING		
	4.75 = 5.00	VERY GOOD
	3.65 = 4.74	GOOD
	2.30 = 3.64	MINIMUM ACCEPTABLE
	LESS THAN 2.30	UNSATISFACTORY

THE ACTIVITY IS UNSATISFACTORY IF ANY OF THE SCORES ABOVE (EXCEPT SAFETY) IS LESS THAN THREE.

Quality Assurance Evaluation Indicators
(Not for Shoulder/Pavement Joint)

Type 1 & 2 Pavements	Type 3 Pavements
Cleaning Equipment 1. Compressor. 3. Hook & compressor. 4. Hook, wire brush & compressor. 5. Saw/sandblast & compr or waterblast & compr.	Cleaning Equipment 1. No cleaning equipment. 3. Compressor only. 5. Compressor plus additional equipment (hook, wire-brush).
Clean Vertical Face 1. Not clean. 5. Clean.	Clean Vertical Face 1. Not clean. 5. Clean
Dry Vertical Face 1. Damp or wet vert. face. 5. Dry vert. face.	Dry Vertical Face 1. Damp or wet vert. face. 5. Dry vert. face.
Sealing Equipment 1. Incorrect equipment for material used. 5. Correct equipment for material used.	Sealing Equipment 1. Incorrect equipment for material used. 5. Correct equipment for material used.
Material 1. Any other sealant. 3. AC w/rubber with District approval. 5. D-3405 sealant or better.	Material 1. Any other sealant. 5. AC w/rubber, AC w/fiber.
Pavement Temperature 1. <40F. 5. >40F.	Pavement Temperature (Not applicable).
Material Temperature 1. Not within mfgrs. recommendation. 5. Within mfgrs. spec.	Material Temperature 1. Not within manufacturers recommendation. 5. Within manufacturers specifications.
Backer Rod/Bond Breaker* 1. Not used. 5. Used	Backer Rod/Bond Breaker (Not applicable).
Filling 1. Material overbands joint. 3. 1/4" - 1/2" below pave. surface, no overbanding. 5. Uniformly 1/4" below pavement surface.	Filling (Not applicable).
Adherence 1. Non-adherence to vert. face. 3. 90% - 99% adherence. 5. 100% adherence.	Adherence 1. Non-adherence. 3. 80% adherence. 5. 100% adherence.
Safety 1. Improper personal protection devices. 3. Some infractions noted. 5. Proper personal protection devices.	Safety 1. Improper personal protection devices. 3. Some infractions noted. 5. Proper personal protection devices.

*Required for type 1 joint rehabilatation only.

Note:

Type 1 Pavement - Excellent Condition - Remaining service life of 10 or more years.

Type 2 Pavement - Fair to Good Condition - Remaining service life of 5 to 10 years.

Type 3 Pavement - Poor Condition - Remaining service life of 5 years or less.

BUREAU OF MAINTENANCE AND OPERATIONS
QUALITY ASSURANCE EVALUATION

BITUMINOUS CRACK SEALING (711-7128) - 3/87

EVALUATOR _____ DISTRICT _____

DATE _____ COUNTY _____

SR _____ SEG _____ SEG _____ FOREMAN _____ # _____

RIGID BASE _____

FLEXIBLE BASE _____

	SCORE	COMMENTS
1. ROUTING		
2. CLEAN CRACK		
3. DRY CRACK		
4. SEALING EQUIPMENT		
5. MATERIAL		
6. MATERIAL TEMPERATURE		
7. FILLING		
8. SAFETY		

SCORING SUMMARY	TOTAL	NO. ITEMS RATED	AVG. SCORE	

FINAL SCORE _____

ACTIVITY RATING			
	4.75 = 5.00	VERY GOOD	_____
	3.65 = 4.74	GOOD	_____
	2.30 = 3.64	MINIMUM ACCEPTABLE	_____
	LESS THAN 2.30	UNSATISFACTORY	_____

THE ACTIVITY IS UNSATISFACTORY IF ANY OF THE SCORES ABOVE (EXCEPT SAFETY) IS LESS THAN THREE.

BITUMINOUS PAVEMENT CRACK SEALING 3/87
QUALITY ASSURANCE EVALUATION INDICATORS
(Not for Surface Preparation Projects)

Rigid or Flexible Base Pavements

Routing (optional)
1. XXXX
5. 1/2" - 3/4" x 1/2" deep with vertical sides.

Dry Crack
1. Damp or wet crack.
5. Dry crack.

Material
1. Any other sealant.
3. RC 250 (Winter only).
5. AC w/rubber or fibers.*
*(Prepackaged Sealants Acceptable)

Filling
1. Not all cracks sealed.
3. Not filled uniformly.
5. Uniformly filled & sealed.

Clean Crack
1. Not cleaned.
5. All loose material removed.

Sealing Equipment
1. Wrong equipment for sealant being used.
5. Equipment appropriate for sealant being used.

Material Temperature
1. Not within mfgrs. specification.
5. Within mfgrs. spec.

Safety
1. Improper personal protection devices.
3. Some infractions noted.
5. Proper personal protection devices.

APPENDIX D

CALTRANS INSTRUCTIONS FOR 1988 HIGHWAY MAINTENANCE REVIEW

INSTRUCTIONS FOR 1988
HIGHWAY MAINTENANCE REVIEW

Introduction

The information resulting from this review will be used in future management decisions that will affect all district and HM programs, statewide. Specific actions include:

1) Analysis of current Levels of Service criteria (Chapter 3, Maintenance Manual Vol. 2);

2) Analysis of current resource allocations within HM programs statewide;

3) Analysis of current Maintenance Review procedures and methodology.

Additionally, results of this review may be used to support future requests for additional resources. Therefore, the importance of reporting accurate, current and factual information cannot be stressed too strongly. All survey results should reflect "what is" not "what should or will be."

Significant deviations from these instructions must receive prior approval. The Office of Resources Management will be the primary contact for procedural questions regarding the administration of this review. Concerning procedural matters, address questions or requests to either Mike Speer (ATSS 492-1079) or Marty Van Zandt (ATSS 492-9786). Questions about the questionnaire or requests for clarification, additional information or technical assistance on specific evaluation or measurement issues should be directed to Headquarters Reviewers: Doug Boyd (Districts 1, 4, 5, 6) (ATSS 485-9974), Ed Delano (Districts 2, 3, 10, 11) (ATSS 485-4649), and Dave Delvey (Districts 7, 8, 9) (ATSS 454-9457).

Training

A Headquarters Reviewer will accompany each district review team on a survey of at least one sample segment as "on-the-job" training in field evaluation criteria and procedures. Scheduling for training will be coordinated by headquarters to begin during the last week of February or the first week in March 1988. Feedback from the training sessions may be used to make technical or procedural changes to the questionnaire or its administration. Comments and recommendations for changes should be forwarded to the Office of Resources Management as early as feasible. Any changes to the survey will be weighed against its effects on timeliness and consistency.

Sampling

Identification of sample segments will be conducted by the Office of Resources Management on a random basis stratified by district and geographic Road Maintenance Area. Three five-mile sample segments will be drawn from each Area with the exception of those Areas in Districts 4 and 7 under thirty Centerline miles in total length. From those Areas, two samples will be obtained at random and the additional sample segment will be drawn from the Areas in the district with the largest "E" Family inventory (based on Inventory Item #E410) ranked in descending order. The total number of samples per district will not change. (See attached revised listing of "Road Mtce Areas by District").

Note: "E" Family experienced the highest percentage level of effort in PYs expended for Districts 4 and 7 in FY 86/87.

A primary list of survey sample segments will be provided to the Headquarters Reviewers and District Review Team permanent members by February 24, 1988. Each HQ Reviewer will identify approximately 10% (minimum of one sample segment per district) of each district's sample for the purposes of training and headquarter's review. In the event that a sample segment cannot be used for the survey, the Office of Resources Management will provide an alternate segment.

District Review Team

The District Review Team(s) will consist of one permanent member - an Area Superintendent or higher, and the Region Manager for the sample segments drawn from his region. The remaining members (Maintenance Engineer, Landscape Maintenance Leadworker, CalTrans Electrician, clerical, etc.) should be assigned on an as needed basis. The permanent team member(s) will be the primary district contact for distribution of survey materials, coordination of district survey activities, and completion and forwarding of district survey forms.

Scheduling

District field survey activities may begin upon receipt of survey materials and notification of primary sample segments. District Review Teams should coordinate training sessions with the HQ Reviewer. It may be necessary to schedule portions of the field review during off-peak and/or nighttime hours. April 1, 1988 is the target date for receipt of all completed survey forms.

Mail all completed survey forms to: Division of Highway Maintenance, Office of Resources Management, 1120 N St., Rm. 3200, Sacramento, CA 95814, Attn: Mike Speer. Each team should not mail any forms until all sample segments assigned have been completed. (Mail all sets as a complete package while retaining copies in the district office). Contact Marty Van Zandt or Mike Speer prior to March 31, 1988 if additional time for completion of the survey is required.

Survey Package

1) Questionnaire - Two complete questionnaire masters are included in the survey package. A copy of the questionnaire should be xeroxed and completed for each sample segment surveyed. Follow the instructions for each Maintenance Program as outlined in the questionnaire. It may be beneficial to copy and utilize a "field" copy of the questionnaire during the survey and complete a "smooth" copy in the office to avoid confusion over illegible or erroneous entries.

2) Survey Cover sheet - Two cover sheet masters are included in the survey package. A copy of the cover sheet should be xeroxed and completed for each sample segment surveyed. Complete the top half of the form for every sample segment. "Date(s)" section refers to the date or dates of the actual field survey for that segment. "Time spent in Field" is the actual hours spent surveying the segment including nighttime hours. "Time spent in Office" is the actual hours spent completing calculations and final report copies. "Others" refers to any specialists or clerical assistance used during field work, not in-office report preparation.

Space has been provided to briefly describe any unique situations or circumstances which may have affected the field survey or evaluation of any inventory item contained in the sample segment. Also space is provided for "Suggestions/Comments" concerning any aspect of the process including questionnaire administration or wording, procedures, timing, etc. Should additional space for comments be necessary, use the back of this form or attach a separate sheet. Reviewers are encouraged to provide any recommendations which may improve the quality of the Maintenance Review.

At the bottom of this form, space has been provided to note any discrepancies in the Inventory Listing provided for the sample segment.

3) "A & B" Family Field Checklist - A checklist form divided into blocks representing each 0.1 mile in the segment is provided for recording A and B Family questionnaire responses.

4) Caltrans Vegetation Control Policies - A pamphlet containing departmentally-approved roadside vegetation control policies is provided to aid in evaluating roadside maintenance condition.

Safety

All Caltrans and district policies and procedures regarding safe work practices must be adhered to at all times during the survey. Special care should be exercised whenever a survey team member is required to physically inspect inventory items on or adjacent to the travelled way.

District Review Teams should be receiving complete survey packages between February 18 and February 23, 1988. Primary sample segment listings with Inventory Listings will be mailed February 23-24, 1988. Upon receipt of materials, check each item for completeness and accuracy. Any problems discovered at this time should be directed to the Office of Resource Management for resolution.

Current Level of Service criteria contained in Chapter 3, Maintenance Manual Vol. 2 should be referred to as specific guidelines in evaluating individual Family inventory items. Upon receipt of the completed district survey packages, the Office of Resources Management will tabulate the results and prepare the final report.

Attachments

1) Sample questionnaire

2) Revised Road Mtce Areas by District

3) Sample Survey Cover Sheet

4) Caltrans Vegetation Control Policies

(revised 2/29/88)

General Instruction: Any question applying to nonexistent inventory (e.g., landscaping in non-landscaped areas) should not be rated. Use "N/A" in place of percentage score for those questions.

An example of a worksheet for the A & B Families has been provided. It may be modified or expanded for other families as determined by the individual raters. Only questionnaire scores should be submitted upon survey completion.

HM-1 Program (A and B Families) Questions

General procedures for A and B Families

First drive slowly through the entire sample segment taking note of the general condition of the surfacing including shoulders. Then return and go through again slowly looking at each 0.1 mile increment to see if deficiencies noted in the following questions are present. Tally up the number of deficient 0.1 mile increments. Subtract this number from 50 and multiply by 2. This will give the level of service evaluation.

For example, assume in a 5 mile sample there are 10 increments that have cracks over 1/4 inches wide not properly filled: (50 - 10) 2 = 80; the result would be an evaluation number of 80 or that 80% is in compliance. (An example of a worksheet has been provided for recording field scores by 0.1 mile increments) It may be necessary to leave the vehicle and walk along the road periodically to properly evaluate the pavement and get a "feel" for the magnitude of the deficiency. Bridge approaches will be rated on the % deficient compared to the number of bridges in the 5 mile sample.

Family A - Flexible Pavements

1. Have the pavement cracks that are over 1/4" wide been properly filled?

   Number of increments deficient: _____ Evaluation % _____

2. Have irregular approaches to bridges been corrected when irregularity exceeds 1 1/2" per 50'?

   Number of increments deficient: _____ Evaluation % _____

3. Have surface irregularities exceeding 1.1/2" per 50' been corrected?

   Number of increments deficient: _____ Evaluation % _____

4. Have wheel ruts over 1" deep been corrected?

   Number of increments deficient: _____ Evaluation % _____

5. Has badly failed base and surfacing been removed and replaced?

Number of increments deficient: _____ Evaluation % _____

6. Have drip-track ruts over 1/2" deep been filled?

Number of increments deficient: _____ Evaluation % _____

7. Have AC blankets or spot chip seals been placed when alligator cracking exceeds 30%?

Number of increments deficient: _____ Evaluation % _____

8. Are potholes filled?

Number of increments deficient: _____ Evaluation % _____

9. Are fog seals or pavement rejuvenator treatments placed where pavement is badly oxidized and tending to ravel?

Number of increments deficient: _____ Evaluation % _____

10. Have pavement drop-offs (between travelled way and adjoining pavement: driveways, paved shoulders, bridge approaches, etc.) in excess of 1" been corrected?

Number of increments deficient: _____ Evaluation % _____

11. Have edge spalls been repaired?

Number of increments deficient: _____ Evaluation % _____

12. Are there any bleeding locations that haven't been corrected?

Number of increments deficient: _____ Evaluation % _____

Family B - Rigid Pavement

1. Are random cracks over 1/4" filled?

Number of increments deficient: _____ Evaluation % _____

2. Are shoulder joints over 1/4" wide filled?

Number of increments deficient: _____ Evaluation % _____

3. Are (formed or sawed) longitudinal and transverse cracks over 1/4" wide filled?

Number of increments deficient: _____ Evaluation % _____

4. Are adjacent slabs levelled if the vertical deviation at the joint exceeds 1/2"?

Number of increments deficient: _____ Evaluation % _____

5. Have slabs been levelled when the vertical deviation totals over 1.1/2" in 50 feet?

Number of increments deficient: _____ Evaluation % _____

6. Have transverse spalls exceeding 4" been repaired?

Number of increments deficient: _____ Evaluation % _____

7. Have all longitudinal spalls been repaired?

Number of increments deficient: _____ Evaluation % _____

8. Have localized slab failures been corrected?

Number of increments deficient: _____ Evaluation % _____

9. Have bridge approach and departure slabs with a harsh ride been corrected?

Number of increments deficient: _____ Evaluation % _____

10. Are paved shoulders and interchange ramps badly oxidized or ravelled?

Number of increments deficient: _____ Evaluation % _____

11. Have base and pavement failures (including shoulders and interchange ramp) been corrected?

Number of increments deficient: _____ Evaluation % _____

12. Are all readily noticeable shoulder and interchange ramp cracks sealed?

Number of increments deficient: _____ Evaluation % _____

13. Have shoulder and interchange ramp joint vertical displacements that exceed 3/4" been corrected?

Number of increments deficient: _____ Evaluation % _____

HM-2 Program (C, D, and E Families) Questions

General Procedures for C, D, and E Families

First drive slowly through the entire length of sample segment taking note of the general condition of travelled way and adjacent paved shoulders with regard to litter and debris. Also note the location of landscaped areas, drainage facilities and irrigation. Then return and drive through the sample segment looking at each 0.1 mile increment evaluating the deficiencies as addressed by the following questions.

Except where specifically noted, it is the general condition of the inventory item in question (e.g., drainage facilities, fencing, irrigation) over the entire length of the sample segment that should be rated. Rating of items will be on a percentage basis with 0 representing total non-compliance or poorest quality and 100% representing total compliance or best quality.

Family C - Slopes/Drainage/Vegetation

1. Unpaved shoulders and other emergency areas are in acceptable condition (free of ruts or excessive erosion, over 2", at pavement edge).

   What percentage of sampled unit is in above-described condition? _____%

2. Roadway vegetation in unlandscaped areas is maintained in conformance with the Roadside Vegetation Control (DOHM Memorandum of February 24, 1987) policy (including approved exceptions).

   What percentage of sampled unit is as described? _____%

3. Caltrans-owned fences are generally free of damage and breaks.

   What percentage of sampled unit is as described? _____%

4. Trees are trimmed to maintain clearance, visibility and appearance.

   What percentage of the trees in the sampled unit are maintained as described above? _____%

5. All drainage facilities (ditches, channels, drains, culverts, etc.) are maintained in serviceable condition (clear of debris and repaired).

   What percentage of inspected drainage facilities meet the above description? _____%

6. Underdrains, slotted drains and edge drains are inspected and maintained at least once per year.

   Yes 100% No 0% (circle) _____%
   (May require consultation with Area Superintendent or Area office records)

7. Graffiti is controlled.

   What percentage of flat vertical surfaces (maintained by Caltrans) are graffiti free?

   _____%

Family D - Litter and Debris

1. Are travelled way and paved shoulders kept free of litter (debris, carcasses, spills)?

   Yes 100% No 0% (circle) _____%

2. Does litter accumulation along roadside appear reasonable given local conditions, availability of special programs workers, established litter pickup frequency, traffic volumes, adjacent land use, etc.?

   (General Appearance)
   0 25 50 75 100
   |_____|_____|_____|_____|
   0 100 _____%

Family E - Landscaping

[Note: scale listed under Question #1 may be applied as a general guide to all E Family questions.]

1. Is landscaping maintained adequately to ensure safety devices and sight distances are not impaired?

   (No*) 0% (Somewhat*) 50% (Yes*) 100% _____%
   *(If directional signs obscured, response = 50%; if safety signs obscured, response =0; if no signs obscured, response = 100%)

2. The appearance of landscaped areas could be categorized as poor to excellent considering the health of the plants, existence of weeds, edging, condition of pruning and thinning and expressed as the following percentage:

   _____%.

   (May be necessary to consult with Area Superintendent or Landscape MaintenanceLeadworker for area in question)

3. The condition of the irrigation system is described as unsatisfactory to excellent considering broken lines, inoperative valves, unprogrammed automatic controllers, clogged filters, adjusted nozzles, etc. and qualified as a percentage:

   _____%

   (May be necessary to consult with Area Superintendent or Landscape MaintenanceLeadworker for area in question)

HM-3 Program (H & J Families) Questions

(Note: Percentage scores for HM-3 Program will be calculated by HQ based upon the total number of bridges or structures in the sample segment.)

H Family - Bridges

Procedures

Determine number of bridges in sample survey and type, if possible. Check accompanying inventory to get a "feel" for the type of items to be encountered during the field review. Evaluate each bridge as one "unit" and answer questions accordingly. If there are no bridges in sample segment ignore the H Family questions.

Number of bridges reviewed _____.

1) Number of bridges with deck drainage systems that were not open and operational:

_____

(Check drain grates, discharge locations if accessible and catch basins for debris)

2) Number of bridges that were not clear of drift and debris in all areas:

_____

3) Number of bridges where the bridge railing or approach guardrail were damaged or not functional:

_____

(Check for decay in timber rails and missing bolts in all rail systems)

4) Number of bridges which have deck spalls or potholes that exceed 6" in the maximum dimension and 3/4" in depth:

_____

5) Where applicable, number of bridges where the paint system does not appear to be clean and visually free of developing corrosion:

_____

(Make a casual inspection as viewed from the side at ground level)

6) Where applicable, number of bridges where the streambed is visible, and there are indications of scour exposing the footings or other foundation elements:

_____

J Family - Other Structures

Procedures

Determine number of structures in sample survey and type, if possible. Check accompanying inventory to get a "feel" for the type of items to be encountered during the field review. Evaluate each structure as one "unit" and answer questions accordingly. If there are no structures in sample segment ignore the J Family questions.

Note: Except where directed to specific types of structures, J Family questions apply to all elements in this family.

Number of J Family structures reviewed _____.

1) Number of structures where the lighting system is not fully operational:

_____

(During a walk-thru inspection, test all manual switches)

2) Number of pump plants where there was overgrown vegetation encroaching on stairways and vents:

_____

3) Number of lined tunnels or tubes where the lining was not clean in appearance and in a condition that provides maximum reflectivity:

_____

(A low-speed drive-thru would most likely suffice to provide adequate information.)

4) Number of structures where there are spalls or other structural deterioration exceeding a square foot in area:

_____

5) Number of structures where there was an accumulation of debris or litter:

_____

HM-4 Program (K & M Families) Questions

General procedures for K & M Families

Review the furnished inventory printouts of electrical and traffic guidance items within the sample segment in order to ascertain identity and quantity of K and M Family items. (Note that not all inventory items are addressed by survey questions). On most 2-lane roads with a minimum of inventory (e.g., unlandscaped A/C with unpaved shoulders), it should be possible to combine K and M Family reviews with those for other families (HM-1 and HM-2). However, dependent on the complexity of the sample (location, traffic, quantity of other family inventories, etc.), it may be necessary to drive the sample segment separately for the purpose of evaluating K and M Family inventory. Also, On freeways in metropolitan areas, districts may elect to have K and M Family reviews performed by electrical or special crew superintendents.

Lighting and reflectivity questions will require that portions of the K and M Family reviews be performed at night. As an alternative, data from recent (within the last 90 days), comprehensive night inspections may be used to respond to those questions.

Family K - Electrical

1. Are traffic signal(s) hardware in satisfactory condition (relatively free of loose or missing plates; missing handhole covers; misaligned heads; poles leaning; dents; loose bases; cracked flanges; missing or broken pull box covers, etc.)? (70% = barely acceptable; 100% = free of all defects)

   _____%

2. Are traffic signal loop detector(s) wire exposed in roadway? (1 wire exposed per signalized intersection = 50%; none exposed at any location = 100%)

   _____%

3. Are traffic signal lamps in serviceable condition? (4% of lamps burned out = 70%; all lamps in good condition = 100 %)

   _____%

4. Are ramp meters operating properly during programmed hours? (If 1 in 10 malfunction, rate = 70% if all operate properly, rate = 100%)

   _____%

5. Are lighting poles and pull boxes in good condition (i.e. free of missing hand-hole covers, dents in poles, missing or inoperable pull box covers, etc.)? (70% = barely acceptable; 100% = free of all defects)

   _____%

6. Are the number of highway lights and illuminated sign outages excessive (more than 2% of inventory)? (If 2% are out, rate = 70%; if none are out, rate = 100%)

   _____%

Family M - Traffic Control

1. What is condition of pavement striping and marking? (If reflectivity is at least 50% of "new paint", rate = 70%; if all "new paint" condition, rate = 100%)

   _____%

2. Is permanent restriping of patches meeting guidelines of current statewide policy? (Usually = 70%; always = 100%)

   _____%

3. What percentage of raised markers are in place? (Note: only those markers comprising the present "standard" are to be considered. Do not count superceded portions of the old pattern which may still remain on the pavement at some locations).

   _____%

4. What percentage of the surface-mounted (reflective type) raised markers can be seen at night for distances of 300 ' or more? (Note: this question will not apply when reviewing "inlaid reflective markers").

   _____%

5. What condition are signs? (Note: on rural, 2-lane roads with a minimal amount, the actual number of signs in place and free of defects may be compared with the inventory to arrive at a percentage of the total. On other 5-mile segments with large inventories of signs, it may be necessary to "sample" a portion - e.g., 1 mile which appears average. Alternatively, a subjective evaluation of 70% = barely acceptable to 100% = free of all defects requiring maintenance or replacement may be used.)

   _____%

6. What percentage of guardrails are free of defects (no split posts or blocks, post foundations stable, bolts tight, etc.)?

   _____%

7. What is median barrier condition? (If all median barrier is functional, rate is 70% to 100%; if portions are non-functional in preventing crossovers, etc., rate = 0 to 69%)

   _____%

8. What percentage of vehicle energy attenuators are in operable condition?

   _____%

ROAD MTCE AREAS BY DISTRICT

District	1	2	3	4	5	6	7	8	9	10	11
Areas	620	610	610	611	610	610	611	610	610	630	620
	630	620	630	618	630	620	617	620	620	641	630
	670	630	660	626	640	630	622	630	630	650	650
	680	640	710	641	650	640	631	640		660	720
	690	650	720	648	660	650	638	670		671	730
		660	730	656	690	660	641	710		680	
		670	760	721		670	651	720		690	
			770	727			656	730			
			780	**732**			**662**				
				741			671				
				747			678				
				851			683				
				862			701				
				866			707				
				871			**713**				
				876			733				
				882			741				
							753				
							761				
							768				
							773				
Totals	5	7	9	17	6	7	21	8	3	7	5
No. of Sample Segments	15	21	27	51	18	21	63	24	9	21	15
% of Total (rounded)	5%	7%	9%	18%	6%	7%	22%	8%	3%	7%	5%

Propose utilizing a sample frame of *3 5-mile C/L segments per Area for a total of 285 samples statewide representing approximately 10% of total.

* One Area in District 4 and three Areas in District 7 will have only 2 samples (bold) while Areas in each district will have 4 samples (underlined).

Maintenance Review
Survey Cover Sheet

Date(s): _____

District _____ Route _____ County No. _____ P.M. _____ to P.M. _____

Reviewer _____
Name/Clasification

Time spent → in Field: _____ (hrs) → in Office: _____ (hrs)

Reviewer _____
Name/Classification

Time spent → in Field: _____ (hrs) → in Office: _____ (hrs)

Others: _____ _____
Name/Classification Name/Classification

_____ _____
Name/Classification Name/Classification

Special circumstances/Problems encountered: _____

Suggestions/Comments: _____

Inventory problems: _____

APPENDIX E

CALIFORNIA HIGHWAY MAINTENANCE LEVEL OF SERVICE REVIEW

7.200.00 HIGHWAY MAINTENANCE LEVEL OF SERVICE (LOS) REVIEW

7.210.00 PURPOSE

Highway Maintenance Level of Service (LOS) Review is the method by which Maintenance performance is evaluated. The results of this performance evaluation give maintenance managers at all levels a basis for decisions affecting the way maintenance is to be accomplished. District managers are to use the reports of noncompliance within their district to request reallocation of resources between families [groupings of related activities] and any necessary exceptions to Levels of Service. Headquarters managers use the statewide version of the Highway Maintenance Review Report and other input from the districts in planning the future of the Highway Maintenance program, including budgeting and other legislative action, program changes, and reallocation of resources between HM programs.

7.220.00 PROCESS

The Highway Maintenance LOS review will be conducted once, yearly, by all districts. The review will be conducted in the spring. Analysis of review data will be accomplished by headquarters during May and June. Resultant information and appropriate feedback will be forwarded to districts and other interested parties during July.

All districts will review randomly selected locations to determine the existing condition of facilities maintained. If the conditions found are not satisfactory, the district must determine if the work is being done in accordance with Levels of Service as defined in this manual (Volume 2, Chapter 3). If there is noncompliance with a Level of Service, it must be determined if the condition is due to a lack of resources, an improper Level of Service or ineffective use of resources.

Each district will be furnished with a list of "primary" and "alternate" locations, chosen at random, from among all possible route/county segments within the district. All data reported will be based on review of these locations, as applicable.

7.230.00 PRODUCT

The annual Highway Maintenance LOS review process will culminate in a report which will be used by management to make a number of decisions concerning highway maintenance, including:

- Should a Level of Service be changed?
- Should resources be reallocated within the statewide HM program to regain compliance with Levels of Service?
- Should the maintenance LOS review process be changed?

The report will contain, as a basis for these decisions, an assessment of the following:

- On a statewide basis, the Division's performance in meeting approved Levels of Service,
- In each district, the problems identified in highway maintenance accomplishment and performance.

7.240.00 RESPONSIBILITIES

7.241.00 Headquarters Division of Highway Maintenance

7.242.10 Chief

The Chief of the Division of Highway Maintenance (DHM) is responsible for the overall management of the Highway Maintenance LOS review process. Questions relating to the process will be referred to the appropriate DHM Office Chief(s).

7.242.20 Office Chiefs

Office Chiefs in the DHM have overall responsibility for ensuring that current Maintenance Levels of Service are being met in those maintenance programs (families) assigned to them. From a program management perspective, the Office Chiefs have among their responsibilities for Level of Service compliance:

- Review district performance and accomplishment of prescribed levels of service for assigned families.
- Provide technical information and special interpretations to districts to assist them in applying the Highway Maintenance LOS review process.

The Chief of the Office of Resource Management will be responsible for the analysis of completed review data submitted by the districts. This analysis will include:

- A statewide report by maintenance family and program on the status of maintenance compliance.
- District reports by maintenance family and program on the status of maintenance compliance.
- "Special Interest" reports from the data received as appropriate.
- Reports supporting changes in Levels of Service at both district and statewide levels.

The Chief of the Office of Resource Management will initiate action necessary to provide current information and documentation on the Highway Maintenance LOS review process including:

- Memorandum of instructions for accomplishing the maintenance LOS review
- Listing of randomly chosen sample locations (district, county, route, post-miles) and the inventory items to be found within each location
- Highway Maintenance review questionnaires

APPENDIX F

FLORIDA MAINTENANCE CONDITIONS STANDARDS, PROGRAM INSTRUCTION MANUAL

---INSTRUCTIONS---

DATA COLLECTION

FOR

MAINTENANCE CONDITIONS STANDARDS PROGRAM

Prepared by

Roadway Maintenance and Operations Section

State Maintenance Office

REVISED
1 JULY 1987

MAINTENANCE CONDITIONS STANDARDS PROGRAM

INSTRUCTIONS MANUAL

TABLE OF CHANGES

PAGE NUMBER	CHANGE NUMBER	EFFECTIVE DATE
1	1	1 JULY 1987
4	1	1 JULY 1987
9	1	1 JULY 1987
20	1	1 JULY 1987
23	1	1 JULY 1987
31	1	1 JULY 1987
32	1	1 JULY 1987
34	1	1 JULY 1987
35	1	1 JULY 1987
39	1	1 JULY 1987
41	1	1 JULY 1987
44	1	1 JULY 1987
*45	1	1 NOVEMBER 1987
*46	1	1 NOVEMBER 1987
*50	1	1 NOVEMBER 1987
*51	2	1 NOVEMBER 1987
*51a	ADDED	1 NOVEMBER 1987
56	1	1 JULY 1987
58	1	1 JULY 1987
APPENDIX 1, PAGE 2	1	1 JULY 1987

TABLE OF CHANGES is to be added as the first sheet of the manual. Pages preceded by an * are the current changes and the old pages are to be removed and replaced or added as appropriate.

1 NOVEMBER 1987

CONTENTS

ACKNOWLEDGEMENTS

The development of this program was conducted by the Roadway Maintenance and Operations and the Systems Sections of the State Maintenance Office, Florida Department of Transportation, in cooperation with Maintenance representatives from all Districts within the State. Acknowledgement to: Maintenance Levels-of-Service Guidelines, National Cooperative Highway Research Program Report 223, Transportation Research Board, National Research Council, Washington, D.C., June 1980 for guidelines in developing our Maintenance Conditions Standards Program and in providing some verbiage in this manual. The July 1987 revisions are the result of an in-depth review by the original development committee. Our thanks and appreciation to those members for many long hours of research and study in the continuing development and refinement to this program.

ABSTRACT

The information contained in this manual defines a method of conducting a visual and mechanical evaluation of routine highway maintenance conditions. The purpose of this evaluation is to provide information that may be used to maximize highway user benefits subject to the constraints of available resources (personnel, equipment and materials).

This manual is, primarily, to be used by personnel responsible for conducting the Maintenance Conditions Survey. Training for conducting the survey was provided to initiate the program and additional training will be provided as required. The survey is being conducted on all types of highway facilities. The type of maintenance required determines the classification of a particular facility. The current facility type classifications are as follows:

1. Rural Limited Access
2. Rural Arterial
3. Urban Limited Access
4. Urban Arterial
5. Special Facility

Each of the highway facility types is divided into 5 elements:

1. Pavement
2. Roadside
3. Traffic Services
4. Drainage
5. Vegetation/Aesthetics

Further division of these elements include those features that are characteristic to an individual element. For example, the Roadside element is composed of the following characteristics:

a. Shoulder - Non-Paved
b. Front Slope
c. Turnout
d. Sidewalk
e. Bike Path
f. Fence

The field worksheet/data processing input coding forms list all characteristics that are to be evaluated in the survey. A copy of each form is in the CODING SHEET section of this manual.

TERMINOLOGY

FACILITY TYPE - Classification determined by the type of maintenance applied to the facility (rural or urban) and the access to and from the facility (e.g., Rural Limited Access).

MAINTENANCE ELEMENT - A part of the highway system that requires maintenance (e.g., pavement, traffic services, aesthetics).

ELEMENT CHARACTERISTIC - A part or parts of a maintenance element that, combined with other characteristics, compose the maintenance element (e.g., Roadside is composed of: shoulder, front slope, turnout, sidewalk and other characteristics).

MAINTENANCE CONDITION - That condition of an element characteristic that requires routine maintenance to prevent deficiencies or that needs to be repaired or corrected (e.g., cracking or rutting - for pavement).

LEVEL-OF-MAINTENANCE - That point at or below the deficiency level of a maintenance condition that should trigger an appropriate maintenance activity (e.g., grass should be mowed when it is 12 inches high).

The Department is responsible for maintaining the highways in a safe and comfortable condition for the users and for protecting the public investment in these facilities. Field supervisors are assisted in maintaining desired conditions by recommended levels of service prepared by maintenance engineers for various highway elements (pavement, roadside, traffic services, drainage, vegetation). These levels of service are influenced by a number of considerations such as safety, protection of investment, comfort, economics, environmental impact, aesthetics and not least of all, constraints on available resources (money, personnel, equipment and materials). The decisions, of which elements should be maintained at a desired level of service and which should be allowed to regress, are generally made informally by maintenance personnel (e.g., field supervisors). Consequently, because of these many and complicated factors, inconsistent decisions are made that result in unintended lower levels of maintenance.

Because of these inconsistencies and resulting lower levels of maintenance, a systematic and formal method of making policy decisions for desired levels of maintenance was developed. This method, called the Maintenance Conditions Standards Program was implemented in April 1985. This program considers those factors talked about previously and allows different levels of service for varying maintenance elements and highway classifications.

This manual does not address the steps involved in the development of the program. Instead, it is produced as guidelines for those responsible for gathering the data needed to implement and maintain the program. This edition of the manual still does not address every situation or answer every question encountered in conducting the survey or maintaining the MCSP, but as experience is gained it will be applied to these instructions for further expansion and refinement. Classroom and on-the-job training will supplement this manual in the continuance of the program.

SURVEY SAMPLE SELECTION

The Maintenance Conditions Standards Program uses the Department's data processing system for input and output of information collected. This data is analyzed and compared to desired levels or conditions of maintenance. Data processing is also used to produce those samples of highways to be surveyed. These samples are selected from the Department's Roadway Characteristics Inventory, by listing all facilities by length and classification (e.g. Urban Limited Access) and then applying a random number generator program to produce mile posts or points to be surveyed. Versatility of the random number generator allows selection by facility type, by county, by maintenance area (yard), by district or on a state-wide level. A sample sheet listing the district, maintenance area, county-section, mile post and pertinent information is explained in detail in the SURVEY SAMPLE LIST section of this manual. The list contains the number of samples required for each facility type selected. Listed again are the highway classifications or facility types used in this program:

1. Rural Limited Access
2. Rural Arterial
3. Urban Limited Access
4. Urban Arterial
5. Special Facility

The number of samples required for the population (population is centerline miles) involved is determined using statistical formulas. The number of samples determined will provide accuracy within 3% at a confidence level of 95%.

An in-house review was begun early this year and with the assistance of Florida State University Statistical Consulting Center an analysis of the program was made relating to the collection and assimilation of data. This analysis is APPENDIX I.

SURVEY SAMPLE LIST/CODING FORM

The Survey Sample List (a sample copy is provided at the end of this section) is a computer print out listing the maintenance area, facility type number, county-section, state road number and mile post. The number of samples for each Maintenance Area will normally, not exceed 120 (30 per facility type). Alternate samples are provided for use when a primary sample is unacceptable. This is explained later in this section of the manual. The maintenance area number is the FLORIDA DEPARTMENT OF TRANSPORTATION designation and is three digits of 1 thru 9. The next column on the list is the facility type number. The county-section number is the FDOT county numbering system of five digits between 00000 and 99999. The state road number is then listed for each sample. The next column on the list is the mile point at the CENTER of the selected sample.

SURVEY FREQUENCY

A listing of samples required to be surveyed will be provided to each District Maintenance Conditions Standards Engineer by the Roadway Maintenance and Operations Section of the State Maintenance Office on the following frequency:

SCHEDULED SAMPLE PERIOD - The Maintenance Conditions Standards Program (MCSP) Engineer will be responsible for completing the survey of those samples in his District not later than the last working day of the scheduled period. The MCSP Engineer will assure that the data is entered in the appropriate place in the Department's data processing system no later than 5 working days after the end of the period.

It is recommended that the data collected be entered into the data processing system on a regular basis. The computer file will provide a safe storage place with means of quick retrieval, if necessary. Statistically, partial data cannot be used until all samples have been completed and entered, however, interim and preliminary reports may be required for planning, current status or interpolated information.

AS REQUIRED - Occasionally, a survey of a particular section of roadway (e.g., a roadway adjacent or leading to a popular tourist attraction) will be requested. Other occasions will require surveys for a particular Facility Type (e.g., URBAN LIMITED ACCESS), by individual section, by a grouping of sections, by county, by maintenance area or any combination of facility types by sections, counties, maintenance areas, districts or statewide. In most instances, priorities and completion dates will be assigned to these additional requests, possibly requiring some adjustment to existing and other workloads.

DATE: 06MAY87
PAGE: 1

DEPARMENT OF TRANSPORTATION
MAINTENANCE CONDITIONS SUVEY
SURVEY POINTS 3RD PERIOD 1986-87

SURVEY TEAM NAMES

DATE MO/DA/YR	CC#	FACIL TYPE	COSEC	SR#	MP	PAVEMENT	ROADSIDE	TRAFFIC SERVICES	DRAINAGE	VEG/AESTHETIC
__/__/__	190	2	10901	160	2.5					
__/__/__	190	2	10901	12	12.1					
__/__/__	190	2	10901	12	12.1					
__/__/__	190	2	10901	12	12.1					
__/__/__	190	2	10901	100	52.1					
__/__/__	190	2	10901	10	52.1					
__/__/__	190	1	10901	15	67.1					
__/__/__	190	1	10901	5	67.1					
__/__/__	190	4	11904	12	12.1					
__/__/__	190	1	11904	10	18.1					
__/__/__	190	1	11904	10	18.1					
__/__/__	190	2	11904	500	19.1					
__/__/__	190	4	11906	12	12.1					
__/__/__	190	4	12704	30	2.9					
__/__/__	190	4	12904	54	2.9					
__/__/__	190	4	12904	12	12.1					
__/__/__	190	4	12904	100	12.9					
__/__/__	190	4	12904	10	12.9					
__/__/__	190	3	12904	165	32.0					
__/__/__	190	4	12906	65	12.0					

DATA COLLECTION

The data must be collected accurately and completely to maintain credibility of the program. Also, ratings may be used by other sections and divisions within the Department, other State of Florida agencies (e.g., Governor's Office) and possibly by other states and federal agencies.

CREW ORGANIZATION AND RESPONSIBILITIES

The Maintenance Conditions Standards survey team will be composed of two persons in each District. These positions are assigned to the District Maintenance Engineer. Each district will be responsible for implementing and maintaining the Maintenance Conditions Standards Program. It is mandatory that the MCSP survey team's first responsibility be the safety of the pedestrian and motoring public and to themselves. (See APPENDIX II for recommended Safety Procedures.) On occasions, it may be necessary to schedule the survey of those samples with high traffic density, during low traffic periods to provide proper safety. It may become necessary to request a safety crew (flagpersons, cones, signs, flashing directional arrow) from the maintenance area in which the survey is taking place. The survey team should walk together as they evaluate each sample, primarily for safety, and to prevent missing any items that might be overlooked by one person.

EQUIPMENT AND SUPPLIES

The following is a list of equipment and supplies required or recommended for the efficient and safe collection of the survey data:

DOT approved safety hats (hardhats) and vests

DOT vehicle with installed Distance Measuring Instrument

Flashing amber lights for vehicle roof (See APPENDIX II)

Straight-line Diagram maps for those sections to be sampled

Legal size writing clipboard

Blank Maintenance Conditions Survey coding sheets

Pocket type calculator

Measuring wheel or long (100' or more) measuring tape

Paper clips

Pencils - preferably mechanical

Pencil erasers

Small measuring rule (6") or small roll-up metal tape

Straightedge (5' to 8') (metal or wood)

Leveling device (carpenter's level or string level)

Stringline - long (100' or more)

Hammer - 20 oz. or larger

Nails - 12D or larger

Heavy duty pry bar for removal of manhole covers and inlet grates

Small box to hold supplies and coding forms

Appropriate size box(s) for measuring litter

Copy of Maintenance Condition Standards

Other publication (e.g., Road Design and Traffic Operations Standards, Uniform Traffic Control Devices Manual)

Some items on the list are required for proper collection of the data. Other items or supplies that will make collection of the survey data safer or more efficient may be included. Straightline Diagrams should be available from the District Planning Section and should also be available in each maintenance area.

CODING SHEET

GENERAL INFORMATION

There are two coding sheets used to record survey data (samples follow this section). The first sheet is a combination SURVEY SAMPLE LIST and CODING SHEET. The top section of the sheet is for survey team names. The body of the form is used to list the characteristics being surveyed and whether or not they meet the Maintenance Conditions Standards. When entering information on the coding sheets, leave blank those columns under characteristics that are not present in the section being surveyed. Pencil entries are recommended so that a rating may be changed if it does not meet desired nighttime conditions. Block type numbers and letters should be used for coding rather than those of a cursive, fancy or rounded type. Keep the sheet clean, neat and clear of stray marks or figures in any coding fields since this data may be entered into the computer by those not familiar with the survey or the coding sheets. The second form is a blank form that may be used if desired. The format is different but the blank form requires the same input data as the precoded one.

CODING INSTRUCTIONS (PRECODED FORM)

SURVEY TEAM - These spaces are for team members names conducting the survey. This information is not entered into the computer, but must be on the coding sheet since these sheets will be considered as "source" documents that could be used for auditing purposes.

DATE OF SURVEY - (card columns 1 thru 8) - This field is used to record the date the actual survey was accomplished for a sample.

COST CENTER NO. (card columns 9 thru 11) - This number is a FDOT cost center number and should be the maintenance area number in which the survey is being taken. This number is precoded.

FACILITY TYPE - This number is the Bureau of Maintenance's classification for the type of maintenance required on the roadway. A brief explanation of each FACILITY TYPE is listed below:

RURAL LIMITED ACCESS - Interstate, toll and other limited access roadways that have adjacent property unimproved, agricultural, low density population, industrial and light commercial development.

RURAL ARTERIAL - All other rural roadways not covered above that have adjacent property unimproved, agricultural, low density population, industrial and light commercial development.

URBAN LIMITED ACCESS - Interstate, toll and other limited access roadways that have adjacent property of high density population, industrial and heavy commercial development.

URBAN ARTERIAL - All other urban roadways not covered above that have adjacent property of high density population, industrial and heavy commercial development.

SPECIAL FACILITY - Can be any of the classifications above. This FACILITY TYPE will be a survey of a special use or special interest roadway. (e.g., Roadways associated with highly popular tourist attraction). Special facility runs must be requested through the Roadway Maintenance and Operations section of the State Maintenance Office.

The above definitions are used to classify the type of maintenance for all roadways currently maintained by the FDOT. Maintenance classification of any roadway shall not change for any section length of less than one mile. For additional information consult the Department of Transportation memorandum, dated October 31, 1984, from the State Maintenance Engineer to District Maintenance Engineers; subject: Roadway Characteristic Inventory of Highway Maintenance Sections.

FACILITY TYPE - (card column 12) - This column is precoded and is the Facility Type (1 thru 5) of the sample being surveyed. Facility Type number assignments are as follows: 1 for RURAL LIMITED ACCESS, 2 for RURAL ARTERIAL, 3 for URBAN LIMITED ACCESS, 4 for URBAN ARTERIAL and 5 for SPECIAL FACILITY.

COUNTY-SECTION NO. (card columns 14 thru 18) - This field is used to record the county and section number as assigned by the FDOT's Bureau of Planning. County-section number is precoded on the Random

Sample Selection List and is the same as used on straightline diagrams and other official FDOT identification of roadways.

STATE ROAD NO. (card columns 20 thru 24) - This number indicates the state road number of the section on which the sample is to be surveyed. This number is precoded beginning to the left and leaves unused columns blank.

MILE POST STATION (card columns 26 thru 28) - This number is precoded on the Random Sample Selection List. A sample is 1/10 mile (528 feet) in length. The mile post station (point) is the middle of the sample and is considered to be at the centerline of roadway or construction. The survey should be conducted in opposite directions along the roadway(s) for 264 feet from the designated center point and includes all area within the FDOT's right-of-way or authorized boundaries.

ELEMENTS/CHARACTERISTICS - The remaining portion of the form lists each element and its associated characteristics. Each characteristic will be coded: Y=YES - meets desired conditions, N=NO - does not meet desired conditions or left blank when the characteristic is not present in the sample.

The MCSP team will be responsible for locating and marking the sample limits. Each sample should be marked in a manner (e.g., paints, reflective tapes) so it can be located at night. The marks should remain in-place for the scheduled sample period. Paint or

tape colors should be changed each sampling period to properly identify current points. The vehicle assigned should have a Distance Measuring Instrument installed to assure accurate location of the selected center point. It is suggested that the team use the straightline diagram to determine the nearest roadway feature (bridge, intersection, side road) with an SLD mile post and proceed to the selected point. Most DMI's will measure stations or miles ascending or descending and will allow programming of a desired station or mile post. If the DMI becomes inoperative or unavailable due to vehicle maintenance, then simple arithmetic may be used to locate the point. Determine the difference between a given SLD mile post and the sample point and travel by vehicle odometer to the sample point. The limits of the sample must be marked on the roadway for future reference.

The Random Sample Program automatically excludes most bridges. Should any part of the sample fall on a bridge, go to the nearest end (abutment) of the bridge and survey 1/10th mile from that end of the bridge. Should a mile point fall on a bridge, select the next alternate point provided on the Survey Sample List. Notify the MCSP Engineer in the Roadway Maintenance and Operations Section of this situation. Include County-Section and mile point of the sample. If a part of a sample falls on a multi-lane facility constructed with individual travelway bridges, it will be necessary to consider both bridges for the proper begin or end bridge point (use abutment) since some structures may be staggered or one may be longer than the other. The Random Sample Program currently does not eliminate

projects let or under construction. Since some samples (see below) in these categories should not be surveyed, select the next available alternate sample point provided. Samples that have a characteristic under construction (e.g., guiderail revision, minor shoulder repair, turnout/turn storage installation, intersection upgrade, utility work*) may be surveyed but omit the portion(s) of the characteristic(s)that is/are affected by construction. If two or more characteristics are under construction simultaneously, throughout the sample, (e.g., resurface, shoulders, crossdrains, sidedrains, guiderail) then select the next available alternate sample provided. Document and mark the alternate point.

*Utility cuts to install buried pipeline, cables and so forth.

NOTE:

Listed below are six characteristics that should be evaluated for all samples.

PAVEMENT (BOTH TYPES)

1. Pothole
2. Cracking
3. Depression

TRAFFIC SERVICES

4. Raised Pavement Markers
5. Striping

VEGETATION/AESTHETICS

6. Litter Removal

Further, there are characteristics that should be evaluated only for a particular pavement type:

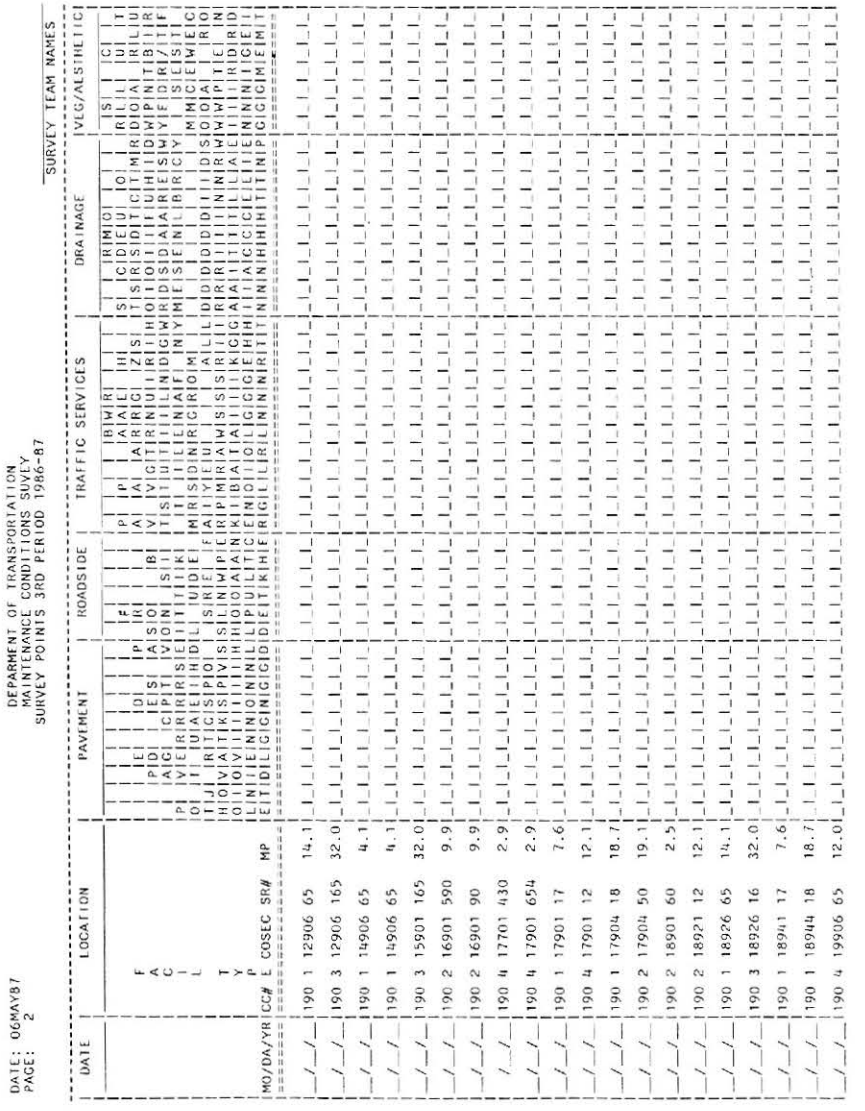
PAVEMENT (RIGID)

1. Joint
2. Pavement Void

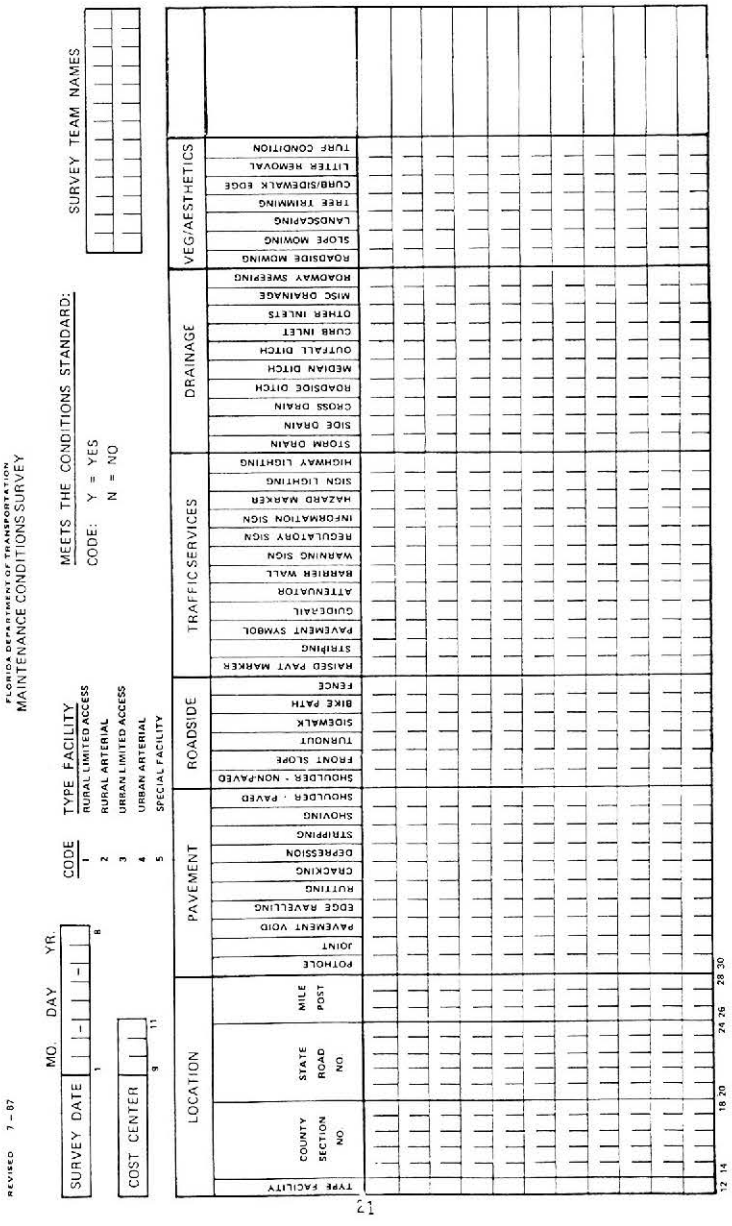
PAVEMENT (FLEXIBLE)

1. Edge Ravelling
2. Rutting
3. Stripping
4. Shoving

As a check, the total of any RIGID PAVEMENT characteristic PLUS the total of any FLEXIBLE PAVEMENT characteristic should be equal to or greater than the total number of points surveyed. To further assure that the mandatory data is coded, a review of coding forms prior to entering the data into the computer should be made.



CHANGE # 1



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MAINTENANCE CONDITION STANDARDS

The following pages list the Maintenance Conditions Standards. Most are written to allow adjustment for multiple considerations (e.g., available resources, safety, user comfort, protection of investment, aesthetics). This method also allows differing levels of service to be established for various road classifications (facility types). Further, this method allows updating if and when new data becomes available. To keep the collection time within reasonable limits the size of the program has been limited to those maintenance conditions that are of practical significance.

ROADWAY ELEMENTS

The Roadway is divided in to five elements; PAVEMENT, ROADSIDE, TRAFFIC SERVICES, DRAINAGE and VEGETATION/AESTHETICS. Each element is further divided into seven or more characteristics of that element. Following are the standards with some suggestions and recommendations that will help in measuring and evaluating most of these characteristics.

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

PAVEMENT

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

POTHOLE	no defect is greater than ½ square foot in area and 1½ inches deep. Pervious base must not be exposed in any hole.
JOINT	85% of the linear feet of transverse and longitudinal joint material appears to function as intended.
PAVEMENT VOID	90% of the slabs exhibit no evidence of pumping.
EDGE RAVELLING	90% of the total pavement edge is ravelled less than 4 inches. No continuous section of edge ravelling 4 inches or wider exceeds 25 feet in length.
RUTTING	rutting areas are not more than 3/4 inch average depth.
CRACKING ASPHALT	no Class III cracking exists.
CONCRETE	90% of roadway slabs have no unsealed cracks wider than 1/8 inch.
DEPRESSION	no measurement exceeds 1/2 inch deep within the initial 10 foot increments or plus 3/8 inch for each additional 10 foot increments. Measurement of each depressed area must be made in both directions.
STRIPPING	95% of pavement surface is free of stripping or delamination.
SHOVING	the shoved area does not exceed a cumulative 25 square feet.
SHOULDER-PAVED	no defects exist as listed for pavement.

NOTE: Many resurfacing projects now include widening of travelways beyond the designed lane width. Generally, any paved area with the same rate of slope as the travelway, four (4) foot or less in width will be considered as pavement UNLESS designated as paved shoulder by the straight line diagram. Do not evaluate edge widening or edge rumble strips installed by maintenance forces.

POTHOLE - Place a straightedge across the defective area, at two or three locations, to determine if any part of the defect is deeper than that listed on the standard. To determine the square foot area of a defect, measure the area as a square or rectangle. A straightedge and a marker to outline the area may be helpful. If BOTH depth and area are greater than the appropriate standard then this characteristic does not meet the desired maintenance condition. Further, if pervious base is exposed in ANY hole then this characteristic does not meet desired conditions.

JOINT (RIGID PAVEMENT) - This standard requires that 85% of the joints appear to function as intended by restricting the intrusion of water and imcompressibles. Determine the linear feet of transverse and longitudinal joint either by computation or actual measurement. Transverse joints are generally 20 feet apart but spot checks should be made to verify this. On multi-lane divided sections, with paved shoulders, BOTH the paved median shoulder and

paved outside shoulder joints are to be evaluated. Generally, it is easier to multiply the total joint length by 0.15(15%) to determine what length is allowed below the desired maintenance condition and then measure those joints that do not function as intended. Cumulative lengths greater than the 15% cause this characteristic to be below the desired maintenance condition.

PAVEMENT VOIDS (RIGID PAVEMENT ONLY) - Determine the number of slabs by counting or measuring a slab length (verify that all slabs are the same length) along the roadway. Divide this length into 528 feet times the number of lanes to determine the number of slabs within the sample. Portions of a slab or slabs that have cracked and depressed areas below the original grade are indicators that a void exists. A vertical difference at any construction joint is also an indication of probable slab movement. Wet or discolored areas on adjacent paved shoulders or depressed paved shoulder at the pavement edge are further indications that slab movement or pumping is taking place. If more than 10% (.10 x no. of slabs) show visible signs of pumping, then this characteristic is below the desired maintenance condition.

EDGE RAVELLING - Two lane roadway (flexible pavement) samples with non-paved shoulders can have a maximum pavement edge of 1056 feet. Multi-lane divided, with non-paved shoulders, will normally have four (4) edges for a total of 2112 feet possible to ravel. The following table may assist in the survey of this characteristic.

NON-PAVED SHOULDER PAVEMENT EDGE

NO. EDGES	LENGTH FT	90%	10%
2	1056	950	106
4	2112	1901	211

At least 90% of the total pavement edge must be free of ravelling less than 4 inches wide or this characteristic will be below the desired condition.

Further, any CONTINUOUS edge ravelling of more than 25 feet in length AND 4 inches or greater in width, causes this characteristic to be below the desired maintenance condition. Also, any individual pavement edge (maximum 528 feet) having more than 25 feet ACCUMULATED ravelling 4 inches wide or greater causes this characteristic to be below the desired maintenance condition.

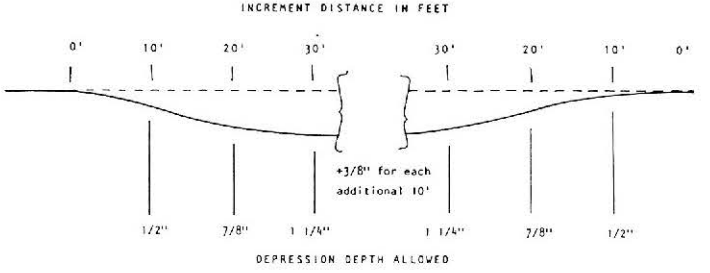
RUTTING - Using a 6 foot straightedge placed across the wheelpath, take measurements at 25 foot intervals along the sample. Determine the average depth of the rutted area by adding the measurement at each interval and dividing by the number of measurements. This number should normally be 22 in a 528 foot sample. If the rutting averages MORE than 3/4 inch then this characteristic does not meet the desired maintenance condition. As a general rule, progressively less rutting occurs when a wheelpath is closer to the centerline or to the median. One exception will be superelevated curves to the left. Observation should be made of all wheelpaths to determine if measurement is required.

ASPHALT CRACKING - The definition of Class III cracking is: 1/4 inch or greater longitudinal or transverse cracks which are opened to the base or underlying material. Also, progressive Class II cracking resulting in severe spalling with chunks of pavement breaking out is considered Class III cracking. Severe ravelling (loss of surface aggregate) is also classified as Class III cracking. This definition is from the Instructions and Procedures for the Flexible Pavement Condition Survey, Florida Department of Transportation, July 1983. If the section being surveyed contains any Class III cracking as outlined above, then it does not meet the desired maintenance condition.

CONCRETE CRACKING - This standard requires 90% of roadway slabs to be free of any unsealed crack (excluding joints) wider than 1/8 inch. A slab is defined as that area within the designed control joints. A method for determining the number of slabs in a sample is given in the PAVEMENT VOIDS (RIGID PAVEMENT ONLY) standard.

DEPRESSION - This measurement may require driving nails into the pavement surface or joints to attach a string line. Since this measurement must be taken in traffic lanes, utilize safety procedures as required. The stringline, marked at 10 foot increments, can be stretched tightly (along the pavement) across the depressed area and the depth of the depression measured at 10 foot increments. Measurement of each depressed area must be made from BOTH ends to insure that no grade change exceeds the rate allowed by

the standard. If any measurement in the first or last increment is GREATER THAN 1/2 inch, then this sample does not meet the desired maintenance condition. If the first and last increments meet desired conditions then measurements of the second and next-to-last increments should be made. If measurement of either of these increments is GREATER THAN 1/2 inch PLUS 3/8 inch, then this characteristic does not meet the desired maintenance conditions. If the measurement of these increment is less than allowed by the standard, then measurements of the defective area should be continued. Remove the nails at the completion of the measurement. The following profile drawing may provide some help.



STRIPPING - Compute the area of travelway in the section being surveyed. Length of section is 528 feet x number of lanes x lane width to give total square feet being surveyed. If more than 5% of the total square feet (0.05 x total square feet) has stripping or delamination, then this characteristic does not meet the desired maintenance condition. The following table lists 5% of total square feet for number of lanes and width combinations.

STRIPPING

Amounts listed are 5% of TOTAL square feet.

Number of Lanes

Lane Width	2	3	4	5	6
10'	528	792	1056	1320	1584
11'	581	871	1162	1452	1742
12'	634	950	1267	1584	1901
14'	739	1109	1478	1848	2218

SHOVING/PUSHING/RIPPLING - This characteristic is the movement of flexible pavement surface, generally on an incline, caused by the acceleration or deceleration of vehicle traffic. Occasionally, shoving (sometimes called rippling) will occur between wheelpaths on level grades. The result is alternating depressed and raised areas in the pavement surface causing a rough or bumpy ride with the possibility of collecting and holding water that could lead to further deterioration of the pavement surface. Severe movement will result in cracking or breaking of the riding surface exposing the underlying pavement course or the base material. If more than 25 square feet of pavement, in a sample, is displaced by pushing, shoving or rippling, then this characteristic does not meet the desired maintenance condition.

SHOULDER (PAVED) - Paved shoulders (does not include pavement widening) shall be evaluated using the PAVEMENT element standards. Any defect (pothole, joint, void, edge ravelling, rutting, cracking, depression, stripping or shoving) in amounts greater than listed causes this characteristic to be below the desired maintenance condition.

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

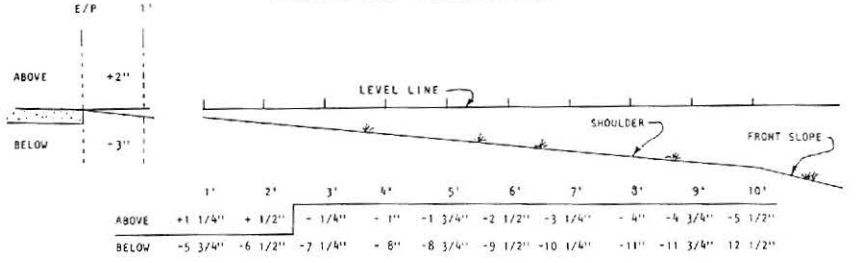
ROADSIDE

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

SHOULDER-UNPAVED	no shoulder drop-off exceeds 3 inches deep within one foot of the pavement edge for 25 continuous feet. No deviations exist greater than 5 inches below or 2 inches above the original design. No washboard areas exist having a total differential greater than 5 inches from the low spot to the high spot.
FRONT SLOPE	no ruts or washouts exist greater than 6 inches in depth.
TURNOUT	Flexible Pavement - no defect is greater than 1/2 square foot in area and 1 1/2 inches deep. No Class III cracks exists. Rigid Pavement - no vertical fracture, horizontal crack or settlement exists greater than 3/4 inch.
SIDEWALK	no vertical fracture, horizontal crack or settlement exist greater than 3/4 inch.
BIKE PATH	no loose material and debris present. No irregularities of more than 1 1/4 inches in size exist within 1 foot of each other.
FENCE	no unrestrained entry is allowed.

SHOULDER (UNPAVED) - To measure shoulder drop-off use a straight edge or a stringline. When a shoulder drop-off exceeds 3 inches within one foot of the pavement edge for 25 continuous feet or more then this characteristic does not meet the desired maintenance condition. Deviation of shoulder from design template, including the radius at paved turnouts, must also be considered. Generally, shoulders are sloped 3/4 inch per foot from the edge of pavement, except in superelevated curves. Deviation greater than 5 inches below or 2 inches above the design template causes this characteristic to be below the desired maintenance conditions. See the following FIGURE.

ALLOWED DEVIATION FOR NON-PAVED SHOULDERS



	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
ABOVE	+1 1/4"	+ 1/2"	- 1/4"	- 1"	-1 3/4"	-2 1/2"	-3 1/4"	- 4"	-4 3/4"	-5 1/2"
BELOW	-5 3/4"	-6 1/2"	-7 1/4"	- 8"	-8 3/4"	-9 1/2"	-10 1/4"	-11"	-11 3/4"	12 1/2"

Another condition to be considered is washboarding (ruts, washouts or other defects perpendicular to the pavement edge). A total deviation greater than 5 inches difference between the high and low spot causes this characteristic to be below the desired maintenance condition.

NOTE: Utility strips will be evaluated using the CURB/SIDEWALK EDGING characteristic.

FRONT SLOPE - Front slopes provide a gradual and contoured transition from the shoulder edge to the roadside ditch or toe of slope. Using a long straightedge or stringline, determine the depth of defects compared to the slope template. Any defect greater than 6 inches in depth causes this characteristic to be below the desired maintenance condition.

TURNOUT (PAVED) - Maintenance of turnouts in a highway section (no curb and gutter) shall extend out to five (5) feet from the edge of pavement OR to the limits of paved shoulders.

Maintenance of turnouts in a curb and gutter section shall extend to the front of the sidewalk or projected front edge OR to the right-of-way when no sidewalk is installed.

Flexible pavement turnouts shall contain no potholes greater than 1/2 square foot in area AND 1 1/2 inches deep. No Class III cracks shall be present. If BOTH depth and area are greater than the standard or if Class III cracks exists then this characteristic does not meet the desired maintenance conditions.

Rigid pavement turnouts shall have no vertical fracture, horizontal crack or settlement greater than 3/4 inch. Any defect greater than the above causes the characteristic not to meet the desired condition.

SIDEWALK - Sidewalk is constructed of concrete or asphalt paving. Flexible asphalt sidewalk is subject to fractures caused by growing tree roots, settling or deterioration and is to be surveyed using the standard for rigid concrete sidewalk. Any vertical fracture, horizontal crack or settlement greater than 3/4 inch causes this characteristic to be below the desired maintenance condition. This measure includes the normal sidewalk joint and the sidewalk to curb joint. Sidewalk will be projected across a paved turnout and that area evaluated as sidewalk. There will be locations where the sidewalk is also designated as a bike path. In these cases, the sidewalk shall ALSO be evaluated as a bike path (see BIKE PATHS below).

BIKE PATH - The presence of loose material (sand, gravel, dirt), debris (sticks, limbs, rocks, cans, bottles and so forth) that can cause a bicyclist to lose control causes the pathway to be below the desired maintenance condition. Irregularities (bumps or depressions) of more than 1 1/4 inches in height or depth and closer than 1 foot of each other also cause this characteristic to be below the desired maintenance condition. Do not evaluate bike path as sidewalk when a separate sidewalk facility is within the sample.

FENCE - Any unauthorized opening in a limited access fence line that allows unrestrained access causes this characteristic to be below the desired maintenance condition.

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

TRAFFIC SERVICES

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

RAISED PAVEMENT MARKER	70% of the required markers are functional (reflective). No more than 120 feet of continuous centerline or laneline is without a reflective marker.
STRIPING	70% of the original installation functions as intended.
PAVEMENT SYMBOL	70% of the original installation functions as intended.
GUIDERAIL	90% of an installation functions as intended.
ATTENUATOR	95% of the device functions as intended.
BARRIER WALL	99% of an installation functions as originally intended.
WARNING SIGN	95% of the required signs are present and functioning as intended.
REGULATORY SIGN	95% of the required signs are present and functioning as intended.
INFORMATION SIGN	85% of the required signs are present and functioning as intended.
HAZARD AND GUIDE MARKERS	80% of the required markers are present and functioning as intended.
SIGN LIGHTING	75% of the required installation is functioning as intended.
HIGHWAY LIGHTING	90% of the required installation is functioning as intended.

NOTE 1: The FDOT Manual On Sign Installation and the FDOT Roadway and Traffic Design Standards both provide fundamental concepts of traffic control devices such as application practices, installation, operation and maintenance. A review of these publications prior to beginning the MCSP survey and a periodical review during the survey year can assist in determining whether a traffic control device does or does not meet a desired maintenance condition. Other publications that can provide useful information are the USDOT Manual on Uniform Traffic Control Devices and the Traffic Control Devices Handbook.

NOTE 2: Nighttime reflectivity checks will be conducted using LOW BEAM headlights only. It is recommended that survey vehicle headlights be adjusted with all required supplies and equipment in the vehicle and with fuel tank at 1/2 full. Most DOT vehicle shops should have the required equipment to set headlights.

RAISED PAVEMENT MARKER - Raised pavement markers are reflective white, amber or red. Some markers are designed with a reflector on one side only. They are effective aids for night driving, especially on wet pavement. They are used on ALL FDOT highways to delineate centerline, some curbs, traffic islands and for transition

of roadway or lane width changes. At least 70% of the required markers must be functional (reflective) at a distance of 528 feet. No more than 120 feet of continuous centerline or lane line shall be without a reflective marker. Skip line will be considered as a continuous line. Designed breaks in pavement lines (crossovers, intersections) shall not be included in the 120 continuous feet.

STRIPING - Pavement striping is normally 4 inch wide solid centerline, skipline or solid edgeline and is either paint, thermoplastic or tape. When the observation is being conducted in daylight hours at least 70% of the original installation must function as intended. When this characteristic meets desired daytime conditions, then a nighttime observation will be required. For nighttime, at least 70% of the original installation must function as intended. Periodic nighttime reviews, of a roadway with new or recently installed striping should be made to establish or re-establish a baseline for what is 100% effective.

PAVEMENT SYMBOL - Pavement symbols are used to communicate certain meanings at specific locations. Included in this characteristic are gore area markings, shoulder markings, word and symbols markings, stop lines, crosswalk lines, parking space markings, curb markings, painted medians and others. The publications noted at the beginning of this section can provide guidelines for proper installation and function for most pavement symbols. When the observation is being made in daylight hours then at least 70% of the original

installation must function as intended. When a nighttime observation is required at least 70% of the installation must function as intended. Periodic nighttime reviews of a roadway with new or recently installed pavement symbols should be made to establish or re-establish a baseline for what is 100% effective. Symbols that appear to be abandoned should be verified as such with the area engineer and not be evaluated if determined to be so.

GUIDERAIL - Guiderail is installed to protect the motorist from various hazards in and adjacent to the travelway and, in most cases, where fill slopes exceed 3:1. At least 90% of guiderail, on a single run, must function as intended. The end anchor must be properly installed and adjusted to cause the installation to function as designed in a direct end impact. Proper height must also be part of the observation. Any given installation must be at the correct elevation required by FDOT Road Design Standards. ANY missing panel will cause this characteristic not to meet desired conditions. Installations may vary from roadway to roadway because of design standard changes and should be evaluated using the appropriate design standard. Failure to meet any of the above requirements will cause this characteristic to be below the desired maintenance condition. Evaluation does not include reflective markers.

ATTENUATOR - Vehicle impact attenuators are of various configurations and are designed for different roadway conditions.

They are generally constructed of modules or cells with some containing sand or water. They provide the motorist with a cushioned impact area prior to solid obstructions such as; parapet walls, bridge columns, sign structures and signal poles. Water or liquid type attenuators should be checked for loss of water by evaporation or leakage. Any loss is to be computed as a percent of the design amount. Lids or top covers must be in place and secured as designed. Sand filled attenuators should be checked for consolidation or loss of material and any loss computed as a percent of the design amount. Other conditions that will cause the device not to perform as intended are: an accumulation of trash and debris in and under the devices that prevents proper compression, shear pins not properly installed or missing, the device not properly anchored allowing misalignment or allowing the device to become misaligned when impacted. When an appurtenance has less than 95% of the design components or the device would not function as intended then this characteristic does not meet desired maintenance conditions. Evaluation does not include reflective markers.

BARRIER WALL - Barrier wall is either cast-in-place or precast concrete wall, and is generally constructed in medians to separate vehicular traffic travelling in opposite directions. Occasionally, it is used to separate traffic from roadside construction. Temporary barrier installed and maintained by Department forces is to be included in the survey. When less than 99% of an installation functions as intended this characteristic does not meet desired

conditions. If any condition exists (e.g., section missing, section misaligned creating an obstruction or hazard) causing the installation not to function as intended, then this characteristic does not meet the desired maintenance condition. Evaluation does not include reflective markers.

HIGHWAY SIGNS

NOTE: Many cities and counties install traffic control signs and devices adjacent to or on FDOT right-of-way. Verification of ownership should be determined, if possible. Warning, Regulatory and Information signs and devices installed and maintained by the FDOT will be identified (front or back) as property of the Florida Department of Transportation and will have an installation date painted on or attached to the sign. Evaluate only FDOT signs and devices. As a reference for what is 100% nighttime reflective, a new (small) sign and bracket can be obtained from the warehouse. Periodically, it can be temporarily attached to a post for evaluation reference. Signs with incorrect horizontal or vertical offsets or twisted or leaning beyond design standard do not meet desired conditions. An exception to vertical offset (height) is metric speed signs.

WARNING SIGN - Warning signs are used when it is deemed necessary to warn traffic of existing or potentially hazardous conditions on or adjacent to the travelway. Both day and night observations should

have 95% or more of the required signs present and functioning as intended or this characteristic does not meet the desired maintenance condition.

REGULATORY SIGN - These signs inform highway users of traffic laws or regulations and indicate the applicability of legal requirements that would otherwise not be apparent. Both day and night observations should have 95% or more of the required signs present and functioning as intended or this characteristic does not meet the desired maintenance condition.

INFORMATION SIGN - Information or guide signs are essential to direct the motorist along streets and highways, to inform them of intersecting routes, to direct them to towns and cities or other important destinations and to identify geographical locations. Both day and night observations should have 85% or more of the required signs present and functioning as intended or this characteristic does not meet the desired maintenance condition.

HAZARD AND GUIDE MARKER - Hazard and guide (object) markers are generally of three types: those composed of reflective buttons mounted on a background which may or may not be reflective, reflective sheeting only or those with alternating black with white reflective stripes. These type signs are used to mark an object or to direct traffic around an object. This characteristic will also include: clear or amber "button" type reflectors used on guiderail,

attenuator and barrier wall systems, button or combination button and reflective sheeting markers used at crossovers, those markers used for some ramp delineation, reflective paint used on some curbs and other applications where object or guide marking is used. All installations should be in accordance with FDOT Roadway and Traffic Design Standards. Both day and night observations must have at least 80% of the required markers present and functioning as intended. Post mounted markers installed to prohibit unauthorized traffic movements (off-tracking, median crossing, shoulder parking) will not be evaluated.

NOTE: It is the opinion of the Roadway Design Section, the Traffic Operations Section and the Bureau of Maintenance that permanent hazardous objects WITHIN the Clear Zone (CZ) of any facility type shall continue to be delineated. CZ areas, by facility type, are listed in the current FDOT Roadway and Traffic Design Standards Index # 700.

SIGN LIGHTING - Illumination of overhead roadway signs may be by means of: a light behind the sign illuminating the message thru translucent material, a source that illuminates the entire face of the sign or some other source such as illuminated tubing or incandescent panels that make the message visible at night. Street or highway lighting is not regarded as meeting the requirements for sign illumination. At least 75% of EACH sign structure illumination system should be functioning as intended. Sign

illumination at some locations is no longer required but remains installed. Those locations where lighting is present but non-functioning should be verified as officially out of service. The area engineer can provide this information.

HIGHWAY LIGHTING - All lighting OWNED by the Department is to be included in the survey regardless of who maintains it. A daytime evaluation will be for missing or damaged poles, missing or damaged luminaires and other defects. At least 90% of the required lighting system should be installed and functioning as intended. ANY missing inspection plate or electrical access panel will cause this characteristic not to meet the desired maintenance condition. If this characteristic meets the daytime evaluation, then a nighttime check should be made.

NOTE: Highway lighting inventory and outage reports are available thru District Maintenance Offices.

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

DRAINAGE

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

STORM DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 90 RURAL ARTERIAL - 85 URBAN LIMITED ACCESS - 90 URBAN ARTERIAL - 85
SIDE DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 75 RURAL ARTERIAL - 75 URBAN LIMITED ACCESS - 80 URBAN ARTERIAL - 80
CROSS DRAIN	(varies)% of the cross-sectional area is not obstructed. RURAL LIMITED ACCESS - 80 RURAL ARTERIAL - 80 URBAN LIMITED ACCESS - 85 URBAN ARTERIAL - 85
ROADSIDE DITCH (NON-PAVED)	the ditch bottom is (varies) feet or more below the outside edge of pavement. RURAL LIMITED ACCESS - 3 RURAL ARTERIAL - 3 URBAN LIMITED ACCESS - 2 1/2 URBAN ARTERIAL - 2 1/2
MEDIAN DITCH (NON-PAVED)	the ditch bottom is 2 feet or more below the inside edge of pavement.
OUTFALL DITCH	the ditch bottom is at or within the lower 1/3 of the distance between natural ground and the design flowline.
CURB INLET	90% of the opening is not obstructed.
OTHER INLETS	85% of the openings is not obstructed.
MISC. DRAINAGE STRUCTURE	90% of the installation functions as designed.
ROADWAY SWEEPING	material accumulation is no greater than 3/4 inch deep in the travelled way or 2½ inches deep in the gutter.

DRAINAGE

STORM DRAIN - Current design standards require manhole covers, inlet grates and other means of access to storm drain systems to be welded, chained, bolted or otherwise secured to prevent theft or dislodging. Removal of these access covers may be required to survey the system. If the survey requires opening any secured access then it must be re-sealed. It is recommended that a walk-thru inspection of the system, within the sample, be made to determine if blockage or restriction of any drainage structure exists. If blockage or restriction is evident then no further inspection is required. Some storm drain systems are designed to hold water due to tides, flood control or water management conditions and standing water will not necessarily mean the system is obstructed. When (varies)% of the cross-sectional area of any pipe is clear of obstruction this characteristic meets the desired maintenance condition. A table to assist in measuring the percent of cross-sectional area obstructed is provided following the SIDE DRAIN/CROSS DRAIN section.

SIDE DRAIN/CROSS DRAIN - SIDE DRAIN normally occurs under turnouts. Occasionally, turnouts will be connected by longer sections of pipe with this connection being covered. These connected installations are not considered to be Storm Drain. CROSS DRAIN will normally run under a travelway(s) at a perpendicular angle and spill into an open roadside ditch. Those cross drains in curb and gutter sections,

that tie into a storm drain system shall be considered as a part of that system. A table is provided that lists most diameters of pipe used on the FDOT's roadways and a measurement to determine whether the pipe is obstructed more than the desired maintenance condition. The measurement is in inches and will be taken at the centerline of the pipe, from the obstruction (silt, mud, sand or so forth) to the top inside wall of the pipe (the percent obstruction varies). The required percentage is listed at the top of the table. Determine the pipe diameter, select the diameter in the table and move to the right along that line until under the desired percent obstruction and read that figure. EXAMPLE: Select 18 inch diameter pipe and move right under 10% obstruction and read 15.2 inches. Measure the pipe being surveyed. If the measurement is less than the table value (15.2 inches) then less than 90% of this pipe area is open and does not meet the desired maintenance condition.

STORM DRAIN/SIDE DRAIN/CROSS DRAIN

PIPE I.D.	% OF OPEN AREA* 90%	85%	80%	75%
12	10.1	9.5	9.0	8.4
15	12.7	11.9	11.2	10.5
18	15.2	14.3	13.4	12.6
21	17.7	16.7	15.7	14.7
24	20.3	19.3	17.9	16.8
27	22.8	21.4	20.1	19.0
30	25.3	23.8	22.4	21.1
36	30.4	28.5	26.9	25.3
42	35.4	33.3	31.3	29.5
48	40.5	38.1	35.8	33.7
54	45.6	42.8	40.3	37.9
60	50.6	47.6	44.8	42.1
66	55.7	52.3	49.2	46.3
72	60.8	57.1	53.7	50.5

*Based on Inside Diameter

ROADSIDE DITCH (NON-PAVED) - In general, a standard roadside ditch (not to include ditch paving) is designed to a minimum depth below the roadway although there will occur special ditches or exceptions on some older roadways. A roadside ditch must have a front slope and at least a 6 inch back slope to be considered a ditch. Some

roadside canals serve as roadside ditch and have a flat berm on one or both sides. For purposes of this survey, these flat areas will be considered to be front/back slopes. Observation of the ditches throughout the section should provide insight as to the original design of the ditches . If all ditches are the same elevation and provide proper drainage then they probably were designed at that elevation. A check of construction plans will provide an answer when a field determination is not possible. The elevation of the outside edge of pavement (not paved shoulder) will be used to determine the depth of the ditch. A surveyor's hand-held level and folding carpenter's rule or stringline level can be used to make measurements along the sample. If any standard ditch bottom is less than (varies) feet below the edge of the pavement or less than original construction, then this characteristic does not meet the desired maintenance condition.

MEDIAN DITCH (NON-PAVED) - The standard median ditch (not to include ditch paving) design calls for a minimum depth of two feet below the roadway. Variations in roadway typical sections result in many deviations from this standard. One example is a two-lane facility that has been upgraded to a multi-lane divided. Many times the new roadway is constructed at a higher or lower elevation than the existing. In this situation, the two foot standard generally applies only to the inside pavement edge (not paved shoulder edge) of the higher roadway. Another situation where the standard two foot minimum does not apply is the transition from standard ditch

grade to meet paved crossover grades. There are also "special" ditch grades that do not conform to the standard. A review of construction plans will provide information concerning the designed elevation of these exceptional situations. Measurement can be made with a hand-held surveyor's level, or a stringline level. If any standard median ditch grade is less than 2 feet below the inside edge of pavement elevation or any "Special" median ditch grade is less than original design then this characteristic does not meet the desired maintenance condition.

OUTFALL DITCH - Initial observation of the ditch system, as a whole, can provide an answer as to whether actual measurements of the ditch bottom elevation shall be made. If the ditch grade appears to be higher than original construction then actual measurements should be made. Structures included and adjacent to the ditch or construction plans can be used to determine design flowline. After determination of designed ditch elevation, a distance from that elevation to natural ground can be calculated. If any part of the ditch grade is above the bottom 1/3 of the calculated distance, then this characteristic does not meet the desired maintenance condition.

CURB INLET - At least 90% of the slotted inlet area must be open for this characteristic to meet the desired maintenance condition. Gutter grates or gutter cover plates are installed as cleaning or maintenance access and are not to be considered as part of the

opening area. Covers or grates shall be attached according to current design standards or by an acceptable method or this characteristic does not meet desired maintenance conditions. A measurement of the opening length times the opening height (6" for most curb inlets) will give the area to be considered. A table is provided that converts the percent obstruction to linear inches for opening heights of 6 inches. To use the table, read the opening length at the left and move right to the 10% (OBSTRUCTION) column. If the obstructed area is equal to or greater than the inches in that column then this characteristic does not meet the desired maintenance condition. Inlet sizes not included in the table can be computed or interpolated from the table.

CURB INLET OBSTRUCTION TABLE

OPENING		
LENGTH	HEIGHT	10%
8'	6"	10"
9'	6"	11"
10'	6"	12"
11'	6"	13 1/4"
12'	6"	14 1/2"
13'	6"	15 3/4"
14'	6"	16 3/4"
15'	6"	18"

OTHER INLETS - This characteristic includes all inlets and enclosed junction boxes (manholes) other than slotted curb type. These

inlets may be found in a ditch with or without paving, in valley gutter and at other locations designed to collect water runoff. Covers or grates shall be attached according to current design standards or by an acceptable method or this characteristic does not meet desired maintenance conditions. Measure the opening to determine the opening area. When the inlet structure is unslotted then the grate is the collection area to be measured. When at least 85% of the opening is clear of obstructions then this characteristic meets the desired condition.

MISCELLANEOUS DRAINAGE STRUCTURE - This characteristic includes ditch paving, valley gutter, flume, spillway, French drain, retention/detention pond, siltation device and other miscellaneous drainage structures that are used to enhance or control the flow of runoff or storm drain water. Covers or grates shall be attached according to current design standards or by an acceptable method or this characteristic does not meet desired maintenance conditions. These structures must function at 90% or more of original design to meet the desired maintenance condition. See APPENDIX III for additional information.

ROADWAY SWEEPING - This characteristic applies ONLY to; Urban Limited Access Roadways, any curb and gutter, any valley gutter, intersections of state roads and barrier wall gutter. This characteristic does not meet the desired maintenance condition if undesirable material accumulation is greater than 3/4 inch deep in

CHANGE # 2

the travelway or more than 2 1/4 inches deep in the gutter of curb and gutter, valley gutter or barrier wall gutter.

ADDED

FLORIDA DEPARTMENT OF TRANSPORTATION

MAINTENANCE CONDITIONS STANDARDS

VEGETATION AND AESTHETICS

THE FOLLOWING CHARACTERISTICS MEET THE DESIRED CONDITIONS STANDARDS WHEN:

ROADSIDE MOWING	not more than 1% of vegetation exceeds (varies) inches high. This excludes bahia seed stalks and decorative flowers allowed to remain for aesthetics. The area shall be maintained in accordance with the mowing guide. RURAL LIMITED ACCESS - 24 RURAL ARTERIAL - 18 URBAN LIMITED ACCESS - 13 URBAN ARTERIAL - 12
SLOPE MOWING	not more than 1% of vegetation exceeds 24 inches high. This excludes bahia seed stalks and decorative flowers allowed to remain for aesthetics. The area shall be maintained in accordance with the mowing guide.
LANDSCAPING	vegetation is maintained in a healthy, attractive condition.
TREE TRIMMING	there is no encroachment of trees, tree limbs or vegetation in or over travelway or clear zone, lower than 14½ feet or lower than 10 feet over sidewalks.
CURB/SIDEWALK EDGE	there is no encroachment of grass and debris of more than 6 inches onto the curb or sidewalk or no build up of more than 4 inches above or 2 inches below the top of curb or sidewalk.
LITTER REMOVAL	the volume of litter does not exceed 6 cubic feet per acre excluding all roadway pavement.
TURF CONDITION	turf is in a relatively healthy condition and the mowing area is 90% free of undesired grass and broad-leaf weeds.

ROADSIDE MOWING - This characteristic is the control of planted or natural grasses and vegetation for safety and aesthetic purposes. Areas mowed by private resident or commercial establishment will not be evaluated for minimum mowing height. Vegetation should not obscure vision and should be maintained in accordance with the FDOT A Guide to Roadside Mowing. Measurements with a rule or stick marked at the appropriate heights should be made throughout the sample. If more than 1% of vegetation, EXCLUDING bahia seed stalks and decorative flowers which have been allowed to remain for aesthetics, exceeds (varies) inches, then this characteristic does not meet the desired maintenance condition.

SLOPE MOWING - This characteristic is the control of planted or natural grasses and vegetation for safety and aesthetic purposes. Areas mowed by private resident or commercial establishment will not be evaluated for minimum mowing height. Vegetation should not obscure vision and should be maintained in accordance with FDOT A Guide To Roadside Mowing. Measurements should be made throughout the sample. If more than 1% of vegetation, EXCLUDING bahia seed stalks and decorative flowers allowed to remain for aesthetics, exceeds 24 inches, then this characteristic does not meet desired conditions.

LANDSCAPING - Landscaping is performed in those areas that have been changed by the placing of ornamental bushes, shrubs, flowers or plants and that require maintenance such as weeding, mulching, trimming, pruning, replacing, fertilizing, insect spraying or edging. The presence of mulch materials (pine straw, wood chips) and evidence of pruning or trimming are indicators that a landscape area is probably being maintained. Planting that are not pruned and that appear unhealthy or unattractive due to apparent lack of maintenance cause this characteristic to be below the desired maintenance condition.

TREE TRIMMING - This characteristic is the encroachment control of tree limbs or brush into or over travelway, shoulder, clear zone and sidewalk. The FDOT Roadway and Traffic Design Standards (Index-700) defines the limits of Clear Zone Area (CZ), by facility type.* If encroachment is lower than 14 1/2 feet over travelway or Clear Zone or lower than 10 feet over a sidewalk, then this characteristic does not meet the desired maintenance condition. If there is dead or dying vegetation next to or over a travelway or Clear Zone that could fall or otherwise present a hazard to pedestrian or vehicular traffic, then this characteristic does not meet the desired maintenance condition.

*CZ for undivided highways with design speeds of 50 mph or greater and projected (20 year) ADT less than 1600 will be the same as comparable highways with ADT greater than 1600.

CURB/SIDEWALK EDGING - Curb and sidewalk edging, including median curb, is performed for aesthetic and safety reasons. Edging control may be accomplished by mechanical control (cutting or trimming by machine) or by chemical control. Dead or dying vegetation at a curb or sidewalk edge is probably an indicator that a chemical control program is the method being used for control. In this case, an evaluation must be made to determine if the soil remaining, after the vegetation is gone, will still cause an encroachment. Grass and debris on sidewalks could cause a hazard to pedestrian and authorized traffic (bicycle, tricycle, baby carriage and so forth). If there is encroachment of more than 6 inches onto the sidewalk or curb, then this characteristic does not meet the desired maintenance condition. Also included in this characteristic is the maintenance of non-paved utility strips and curb and gutter medians. A utility strip is generally considered to be that unpaved area between the back of a curb and a sidewalk. If utility strip or curb and gutter median soil has a build-up of more than 4 inches above or is more than 2 inches below the top of curb or sidewalk, this characteristic does not meet the desired maintenance condition.

LITTER REMOVAL - Removal of litter from roadside areas is performed for aesthetic and safety reasons. It is desired to present a pleasing appearance to the motoring and pedestrian traffic, but it is more important to provide safety. Litter on roadsides during mowing operations presents an increased possibility of hazard to the motorist, pedestrian and mower operator. The area to be evaluated

will normally be the right-of-way width excluding THRU traffic lanes. An exception will be that portion of the right-of-way that is continually under water. This characteristic does not meet the desired maintenance condition if more than 6 cubic feet of litter per acre is present in the sample or if ANY litter exists that creates a hazard to motorist or pedestrian traffic.

TURF CONDITION - Turf condition will normally be evaluated within the established mowing limits. Occasionally, mowing limits are changed and areas are left to regenerate. These areas, in the first stages of regeneration, will appear to be within mowing limits and probably will contain undesirable vegetation. When mowing limits have been extended, due to adjoining property improvement or new development, a transition period is required to establish desirable turf conditions. Consideration should be given when these situations are encountered. Properly maintained and desired vegetation provides a pleasing appearance but primarily, it presents less chance of shoulder and slope defects (ruts, washouts, washboarding) thereby providing a safe recovery area for motorist traffic. Turf should be in a relatively healthy condition and the mowing area should be 90% free of undesired grasses and broad-leaf weeds. Turf that is not healthy, sparse or contains more than 10% of undesirable competitive- noxious grasses and broadleaf weeds and not maintained in accordance with the FDOT's Mowing and Non-paved Shoulder Maintenance guidelines does not meet the desired maintenance conditions.

CHANGE # 1

DATA COLLECTION

Data may be entered on either of the Maintenance Conditions Survey input forms as explained in the CODING SHEET section in this manual.

DATA INPUT

It will be the responsibility of the MCSP Engineer to ensure the collected data is entered into the data processing system accurately and as soon as feasible. All data should be checked for accuracy prior to the end of the input session. Procedures to enter the data are on the next page. If arrangements are made to have others enter the data, then it will be the responsibility of the MCSP Engineer to instruct these persons in the proper procedures.

1. Logon to TSO using standard logon procedures.

2. Type %MAINT and press ENTER.
   When the screen returns to ready.

3. Type %SURVEY and press ENTER.
   You will receive the following message.
   DATA SET 'userid.SURVEY.DATA' EXISTS (RECORDS WILL BE ADDED)

   Press ENTER and the Panel below will be displayed

```
============== MAINTENANCE CONDITIONS STANDARDS PROGRAM ================
                        INPUT PROCEDURE
COMMAND ===>
            DATE OF SURVEY=> __/__/__     MO/DA/YR
            COST CENTER NO=> ___
             TYPE FACILITY=> _
            COUNTY SECTION=> _____
             STATE ROAD NO=> _____
                 MILE POST=> __._

       AFTER ENTERING DATA ON THIS PANEL
       PRESS  ENTER  KEY TO DISPLAY PANEL FOR INPUTTING RATINGS
       PRESS  PF3    KEY TO END
```

   Below is the Panel for inputting the ratings.

```
COUNTY SECTION=> _____        STATE ROAD NO=> _____       MILE POST=> ___
Y=YES   N=NO
------------ PAVEMENT ----------------------------------------------------
   POTHOLES=> _         JOINTS=> _     PAVT VOIDS=> _       EDGE RAVEL=> _
    RUTTING=> _      CRACKING=> _    DEPRESSIONS=> _        STRIPPING=> _
    SHOVING=> _  PAVED SHLDRS=> _
------------ ROADSIDE ----------------------------------------------------
  SHOULDERS=> _      FT SLOPES=> _       TURNOUTS=> _       SIDEWALKS=> _
 BIKE PATHS=> _         FENCES=> _
------------ TRAFFIC SERVICES --------------------------------------------
PVT MARKERS=> _       STRIPING=> _     PVT SYMBOLS=> _      GUIDERAILS=> _
ATTENUATORS=> _  BARRIER WALLS=> _  WARNING SIGNS=> _       REG SIGNS=> _
 INFO SIGNS=> _    HAZARD MKRS=> _  SIGN LIGHTING=> _     HWY LIGHTING=> _
------------ DRAINAGE ----------------------------------------------------
STORM SEWER=> _    SIDE DRAINS=> _   CROSS DRAINS=> _     RSIDE DITCH=> _
MEDIAN DTCH=> _   OUTFALL DTCH=> _    CURB INLETS=> _    OTHER INLETS=> _
 MISC DRAIN=> _     RDWY SWEEP=> _
------------ VEGETATION/AESTHESTICS --------------------------------------
ROAD MOWING=> _   SLOPE MOWING=> _    LANDSCAPING=> _   TREE TRIMMING=> _
CURB/SW EDG=> _   LITTER REMOV=> _     TURF COND.=> _

     AFTER ENTERING RATINGS ON THIS PANEL
     PRESS  ENTER  KEY TO WRITE A RECORD AND RETURN FOR NEXT RECORD
```

4. After you have completed entering of records and you wish to visually
   inspect the records.
   Enter QED 'userid.SURVEY.DATA'

OUTPUT REPORT

Following is a sample report listing maintenance conditions for URBAN LIMITED ACCESS on a District survey. The report lists the 5 elements, each with its associated characteristics. Each characteristics shows the number (#) of samples surveyed, the number of characteristics that meet (YES) the desired maintenance condition and what percent (*) that number is of the total surveyed. The report then lists the LEVEL OF MAINTENANCE for each of the 5 elements. This value is computed using predetermined numerical values for each characteristic. A final computation shows the LEVEL OF MAINTENANCE overall for the Type Facility surveyed. Reports may be produced by facility type for a maintenance area, a district or on a statewide level.

DATE 21MAY87 FLORIDA DEPARTMENT OF TRANSPORTATION
MAINTENANCE CONDITIONS STANDARDS REPORT

UNIT NAME: ALL COST CENTER NO.: ALL
TYPE MAINTENANCE PROGRAM: URBAN LIMITED ACCESS
GEOGRAPHIC AREA: DISTRICT MILAGE EVALUATED: 52.7
EVALUATION PERIOD : JUL THRU OCT 1986-1987

PAVEMENT

	#	YES	*
POTHOLES	27	26	96
JOINTS	13	8	62
PAVT VOIDS	13	13	100
EDGE RAVEL	7	7	100
RUTTING	17	17	100
CRACKING	27	5	19
DEPRESSIONS	27	26	96
STRIPPING	17	17	100
SHOVING	17	14	82
PAVED SHLDRS	25	4	16

ROADSIDE

	#	YES	*
SHOULDER SOIL	26	3	12
FRONT SLOPES	26	13	50
TURNOUTS	1	1	100
SIDEWALKS	1	0	0
BIKE PATHS	0	0	0
FENCES	26	16	62

VEGETATION - AESTHETICS

	#	YES	*
ROADSIDE MOW	27	0	0
SLOPE MOWING	6	0	0
LANDSCAPING	7	0	0
TREE TRIMMING	27	17	63
CURB/SW EDGE	4	0	0
LITTER REMOVE	27	12	44
TURF CONDITION	27	0	0

TRAFFIC SERVICES

	#	YES	*
RAISED MARKER	27	0	0
STRIPING	27	10	37
PAVT SYMBOLS	9	6	67
GUIDERAILS	16	14	88
ATTENUATORS	0	0	0
BARRIER WALLS	2	2	100
WARNING SIGNS	8	5	63
REGULAR SIGNS	12	10	83
INFO SIGNS	17	13	76
HAZARD MARKER	22	6	27
SIGN LIGHTING	3	3	100
HWY LIGHTING	15	7	47

DRAINAGE

	#	YES	*
STORM DRAINS	2	1	50
SIDE DRAINS	1	1	100
ROADSIDE DITCH	24	13	54
MEDIAN DITCH	23	21	91
OUTFALL DITCH	1	0	0
CURB INLETS	8	6	75
OTHER INLETS	19	9	47
MISC DRAIN ST	12	3	25
RDWY SWEEPING	27	21	78

LEVEL OF MAINTENANCE ON EACH ELEMENT :

PAVEMENT	74
ROADSIDE	39
TRAFFIC SERVICES	48
DRAINAGE	64
VEGETATION - AESTHETICS	23

LEVEL OF MAINTENANCE:

URBAN LIMITED ACCESS	54

APPENDIX I

Statistical Analysis of MCSP Rating Procedure

This is an analysis of the Maintenance Conditions Standards Program (MCSP), relating to the current collection and assimilation of data. There had been questions raised as to the statistical validity of the ratings generated by the use of this program and whether they were representative of the roadways found throughout the state, district, and each individual maintenance yard's area of responsibility. This report attempts to answer that question, answering not only if the ratings are representative, but why they are representative.

Through the use of the Florida State University Statistical Consulting Center, and its Director, Dr. Duane Meeter, the statistical mechanics of the MCSP were found to be valid, with a couple of minor exceptions and additions that expand the area of analysis.

The sampling of the various milepost stations for each maintenance yard was found to be sound, provided the samples were selected in a true random fashion, which is the current method of selecting samples within the MCSP.

A question had been raised as to the differences in sample size among the different characteristics by maintenance yard. This had been a concern to the facilitators of the MCSP, but it was found to be alright if the amount of samples by characteristic adequately represented these characteristics in the population. In other words, if the proportion of the characteristics in the sample matched the proportion of characteristics in the population.

If a sample milepost station is deleted because it falls on a bridge or an area under construction, the milepost station next to it should not be selected because that means those segments next to bridges and construction have two chances of being sampled, which defeats the concept of a simple random sample. To circumvent this problem, the sample size should be made slightly larger (say, 35 or 40) than the 30 now selected for each facility type per maintenance yard. When a sample is deleted because it falls on a bridge, the 31st sample can be substituted in its place for a replacement, thus preserving the concept of simple random sampling. If none of the first 30 random samples fall on a bridge or on a segment under construction, only use those first 30 random samples.*

When it is time for an MCSP rating to be calculated for each maintenance, district, and statewide areas, a small change in the current method of analysis needs to be made. Instead of the "numerical level of importance" of each characteristic being multiplied by the "percent meeting standards" of each respective characteristic, the "numerical level of importance" of each characteristic needs to be

*Adopted effective July 1, 1987.

multiplied by the number of each respective characteristic meeting standards. This will enable a small amount of skewness to be eliminated from the data. This step is done on the facility type/maintenance area level.

On the facility type/maintenance area level, each milepost station sampled should have its own MCSP rating. This is done by multiplying each "yes-meets standards" by its individual "numerical level of importance" and totalling these numbers for each individual milepost station. Next, take the "no-does not meet standards" and multiply them by their individual "numerical level of importance" and add them to the total of the "yes-meets standards' that was already computed. Divide the number obtained when adding "yes-meets standards" by the number obtained when adding the "yes-meets standards" and "no-does not meet standards." An example is the best way to show this procedure:

Level of importance: 10 8 8 6 8 7 8 7 8 7 7 6 5---7 8 8 7 9 9 9 9 8 7 7 7 6
"yes" or "no": Y - - - Y Y Y Y Y N Y Y---Y N Y - - - - - - - - - -

Level of importance: 6 6 7 6 6 6 6 6 5 5 5 6 5 6 5 4 5 4 5 5
"yes" or "no": - - Y Y - - - - - - - Y - N - - Y - Y N

Points "yes": 110 110/136 = 80.9 MCSP Rating for
Total Points "yes" and "no": 136 this milepost station.

These changes are made to enable an analysis to be taken based on the variability of the data. The variability of the data is easier to compute if each milepost station has its individual ratings computed and examined.*

Two of the most important statistical characteristics of any distribution of observations (such as the 30 individual ratings of a maintenance area's Rural Limited Access facility type), are its measures of central tendancy and variability. Measures of central tendency give information about the "center" of a group of scores, such as the mean or "average" of a group of scores.

To obtain information about the differences that exist among the scores, measures of variability are used. Two measures of variability to be used in the analysis of MCSP ratings are the standard deviation and standard error. The term "standard deviation" means that if a group of milepost stations are grouped by facility type and are each given an MCSP rating, assuming their distribution is normal, approximately two-thirds of the ratings will fall less than one standard deviation on either side of the mean.

The term "standard error" is actually the standard deviation of an infinite group of means. For example, if a random sample of 30 observations was drawn from the parent population and a mean (X), or average was found for these 30 samples, and this process was repeated an infinite number of times, each time having a new mean computed, it would be found that the mean of this infinite sampling distribution would be the true rating and the standard deviation of this infinite sampling distribution would be the standard error that was computed earlier from only one sampling distribution.

What all of this means is that a confidence interval can be computed, using statistical tables, that will give a range where the actual MCSP rating will be found. This confidence interval can be computed on any level of the MCSP study.

Many statistical studies use a 95% confidence interval and that is what will be used in this analysis. The confidence interval can be computed using the mean, standard deviation, standard error, and sample size of a particular distribution; whether it be on a maintenance area, district, or statewide level. When the confidence interval is computed, it gives with 95% certainty, a range that the true MCSP rating will fall in between.

After an MCSP rating is computed for each facility type per maintenance area (the mean of the distribution of scores for that individual facility type), all the facility types for each individual maintenance area are multiplied by their respective "1 to 100" levels of importance. The results are then added, giving us an MCSP rating for each individual maintenance area.

If it is determined by the MCSP facilitators that the "1 to 100" levels of importance are no longer valid, then the MCSP ratings by facility type can be averaged for each individual maintenance yard and this can be used as the MCSP rating for that particular maintenance yard. Another way would be to add the number of yesses and divide it by the number of possible yesses to get a rating by individual maintenance yard.

Whichever way is chosen to select the rating for the individual maintenance yard, it should be followed in computing the rating for the district and statewide levels. The best way would be to use the individual milepost stations' ratings as a distribution, so that a precise analysis could be made. An analysis of variance lets the reader know where his maintenance area, district, or statewide rating stands in comparison with other ratings from the past or present.

An example using the analysis of variance is attached. This example shows how an MCSP rating would be computed for a Rural Limited Access facility type, for the first period, 1986-87. It gives the actual rating (71.3) and the 95% confidence interval (68.71 to 73.89), which is the range that the true MCSP rating most probably lies in. The standard deviation of the example (6.961) gives a measure of dispersion of the sample scores, indicating that 66% of the scores lie within one standard deviation on either side of the mean (71.3).

*Adopted effective July 1, 1987.

Individual Sample Method
First Period 1986-87

Mile Post Station	#Yes/#No	MCSP Rating
34.0	108/134	80.6
33.3	114/134	85.1
32.7	123/165	74.5
31.5	147/215	68.4
31.4	160/211	75.8
29.7	102/140	72.9
25.9	107/166	64.5
25.2	121/141	85.8
23.7	101/134	75.4
21.6	113/134	84.3
21.4	91/128	71.1
19.3	119/162	73.5
19.2	109/147	74.1
14.1	110/155	71.0
14.0	102/162	63.0
13.9	108/142	76.1
13.8	100/134	74.6
12.7	88/134	65.7
12.1	88/154	57.1
10.9	129/194	66.5
08.5	118/163	72.4
07.7	82/123	66.7
06.4	85/136	62.5
05.8	100/140	71.4
05.1	97/161	60.2
04.2	88/134	65.7
02.2	102/141	72.3
01.7	116/169	68.6
01.2	147/216	68.1
00.8	146/204	71.6

Mean (average) MCSP Rating: $\bar{X} = 71.3$

Range (highest rating minus lowest rating): 85.8 - 57.1 = 28.7

Variance = $\frac{\Sigma x^2}{n - 1}$ = $\frac{\text{Sum of squares}}{\text{Degrees of freedom}}$ = $\frac{1405.37}{29}$ = 48.46

s^2 represents variance.

Standard deviation = $\sqrt{48.46}$ = 6.961

s represents standard deviation.

Standard error = $\frac{6.961}{\sqrt{30}}$ = 1.27

$s_{\bar{x}}$ represents standard error.

The .95 confidence interval is $\bar{X} \pm t(s_{\bar{x}})$, where t = 2.04.

Our confidence interval is

$71.3 \pm (2.04)(1.27)$, or
68.71 to 73.89

The true MCSP rating for the Rural Limited Access facility type probably lies between 68.7 and 73.9. If more precision is needed, a larger sample is required.

Florida Department of Transportation

BOB MARTINEZ
GOVERNOR

Haydon Burns Building, 605 Suwannee Street, Tallahassee, Florida 32301-8064, Telephone (904) 488-8541

KAYE N. HENDERSON
SECRETARY

March 3, 1987

M E M O R A N D U M

TO: District Maintenance Engineers

FROM: J. W. Roberts, State Maintenance Engineer

SUBJECT: Safety Procedures for Maintenance Conditions Standard Program (MCSP) Survey Personnel

The attached procedures were recently approved by B. G. Morris, State Safety Engineer and DAS William F. Ventry for Traffic Count and Vehicle Classification field personnel. Because the MCSP teams are exposed to these same hazards your MCSP personnel should incorporate those procedures in carrying out their activity. Some exceptions have been made as noted.

Please address questions related to this matter to John Anthamatten.

JWR/Am

cc: MCSP Engineers
B. G. Morris, State Safety Engineer

APPENDIX II

TRAFFIC COUNTING AND VEHICLE CLASSIFICATION PROCEDURES

All new traffic technicians will be provided a minimum of 2 weeks training by accompanying an experienced field technician who is collecting traffic data. Furthermore, the supervisor shall go over these job procedures with new personnel before they are allowed in the field. All field personnel will be provided training in first aid techniques.

All FDOT vehicles used to collect traffic data will be equipped with the following equipment:

1. Four way flashing lights
2. A minimum of 2 yellow strobes mounted on a light bar, positioned at the vehicle's mid-section.
3. Two-way radios to facilitate safety and operationsl communications.
4. Triangular safety signs mounted inside rear doors, so they are visible when the doors are open.*
5. First aid kit
6. Fire extinguisher

* Optional

All FDOT personnel who gather traffic count/vehicle classification data will follow these job safety procedures:

Seat Belts will be worn during the operation of all D.O.T. vehicles.

Orange Safety Vests and U.L. approved safety glasses* or safety prescription glasses will also be worn during field operations.

Reflectorized Safety Vests will be worn during low visibility situations.

Vehicle Lights will be used in the following manner:

Turn signal and yellow roof mounted strobe lights will be activated as the traffic count vehicle approaches the work site, usually 500'-1000' in advance of the site. Four way flashers will be activated at work site and remain activated until work is completed. The proper turn signal will be activated when leaving the work site. Strobe lights will also remain activated as vehicle leaves work site and re-enters traffic flow. After safely re-entering traffic flow, strobe lights will be turned off.

Vehicles will be parked wherever, in technician's judgement, there is the most room to safely park the vehicle. The vehicle will be parked a minimum of four feet from the edge of the pavement.

When setting or retrieving hoses, never stand in travel lanes. When placing equipment, observe traffic in both directions on undivided highways. Face on-coming traffic on divided highways.

* Optional

When crossing roadway, technician should wait for a safe break in traffic. Never try to "beat" traffic. Be patient and be safe when crossing the roadway.

Never attempt to stop or divert traffic.

Field technicians shall use discretion regarding their safety in hazardous situations due to dense fog, heavy rains, and lightning prevalent conditions. If the technician considers himself in danger by these conditions, he shall discontinue work, seek safe shelter and notify the supervisor as soon as possible.

Technician shall advise supervisor when there is a need for a two-person operation to safely set equipment. The supervisor shall investigate any such report, and make a final decision about the site before the operation is undertaken.*

Nighttime operations will be conducted with a two-person team. This will provide an additional person for safety and security, as well as to light the work area. Reflectorized safety vests will be worn. Lighting will be provided by a handheld flourescent lamp, which will cast a non-directional, non-glare light

* MCSP team omit.

Disciplinary action will be taken against anyone not following safety procedures specified for this type work. These disciplinary actions will be in accordance with DOT disciplinary standards, and range in severity from a written reprimand to dismissal.

APPENDIX III

RETENTION AREAS - A retention area is designed to collect large volumes of storm water runoff at a certain point and retain it there to be dispersed by evaporation and percolation. A review of the construction plans will be required to determine original cross section. Measurements from a given elevation (e.g. retaining wall, berm, dam) can be taken to determine the current volume of the area. Siltation of more than 10% of the design capacity causes this characteristic to be below the desired maintenance condition.

DETENTION AREA - A detention area is designed to temporarily detain large volumes of storm water runoff so suspended solids can settle before the water is allowed to spill into natural waterbodies. A review of the original construction plans will be required to determine original cross section or capacity. Measurements can be made the same as RETENTION AREA. Siltation of more than 10% of the design capacity causes this characteristic to be below the desired maintenance condition.

SILTATION DEVICE - The siltation device or silt basin is intended to trap silt and sand washed into storm sewer systems. They are of various design and size but normally are constructed at the end of a piped outfall or storm drain system. Basically, they are composed of four sidewalls with a flow line lower than the outfall to allow sediment or silt to settle before the water is allowed to continue to a natural waterbody. They may also be constructed with debris fence, oil skimmers and weirs. Measure the length, width and design depth to determine the original volume. Siltation of more than 10% of the design capacity or any damage that allows the device not to perform its design function causes this characteristic to be below the desired maintenance condition.

APPENDIX G

LOUISIANA INSTRUCTIONS FOR ANNUAL ROAD INSPECTION

STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

INTRADEPARTMENTAL CORRESPONDENCE

(504) 379-1501
October 8, 1986

REFERRED TO

_____ REFERRED FOR ACTION
_____ ANSWER FOR MY SIGNATURE
_____ FOR FILE
_____ FOR YOUR INFORMATION
_____ FOR SIGNATURE
_____ RETURN TO ME
_____ PLEASE SEE ME
_____ PLEASE TELEPHONE ME
_____ FOR APPROVAL
_____ PLEASE ADVISE ME

BY _____ DATE _____
BY _____ DATE _____
BY _____ DATE _____
BY _____ DATE _____

IN REPLY PLEASE REFER TO FILE NO.

ANNUAL ROAD INSPECTION
AND MAINTENANCE INVENTORY

MEMORANDUM TO:

EACH DISTRICT ADMINISTRATOR
ATTENTION: DISTRICT MAINTENANCE ENGINEER

Attached are instructions and inspection forms for the Annual Road Inspection. Additional forms are available from the Maintenance Planning Unit upon request.

Completed inspection forms should be forwarded to the District Business Office for transmission. There should be no transmission delay waiting for the entire District Inspection report since the data for each parish gang can be transmitted immediately following the parish inspection.

District Business Managers are requested to notify the Planning Unit when the Inspection data transmission is completed for each gang. All Inspection data should be transmitted using transaction MNRI by December 31, 1986. Forms should be returned to the District Maintenance Engineer.

Please advise if further information is needed.

Very truly yours,

VERDI ADAM, P.E.
DIRECTOR, CONST. & MAINT. DIVISION

VA:jhh
Attachments

cc: Mr. E. P. Waguespack w/atts.
Mr. John Melancon w/atts.
Mr. L. N. Hunsinger w/atts.
Mr. Sam Whitthorne w/atts.
Mr. Jorge J. Ribas w/atts.
Mr. S. C. Shah w/atts.
Each District Business Manager w/atts.

RECOMMENDED FOR APPROVAL _____ DATE _____

RECOMMENDED FOR APPROVAL _____ DATE _____

RECOMMENDED FOR APPROVAL _____ DATE _____

APPROVED _____ DATE _____

M2-a1-1

Attachment 1

INSTRUCTIONS FOR
ANNUAL ROAD INSPECTION

Rev. 9/85

I. General

1. Quantities to be reported on the Annual Road Inspection are the amounts of material or units of work that are required to repair conditions found at the time of inspection. Do not anticipate future needs.

2. Standards published in Maintenance Standards Manual determine when a road condition requires repair and the extent of repair.

3. When road conditions are such that needed repairs exceed the capabilities of the Parish or District Wide Gang and should be repaired by Construction Contract, the quantities for those repairs should be listed by special note and not within a maintenance function, except for Function 632 which is expected to be by contract.

4. Attachment A lists functions, conditions and units for the inspection.

5. Multiple forms for a control section will be required if:
   (a) Length exceeds 14 miles
   (b) Roadways of divided or multi-lane highways are inspected separately.
   (c) Frontage roads are inspected separately.

6. If a control section needs no maintenance, fill in only the heading and ENTER FUNCTION 000 FOR TRANSMISSION ON THE TERMINAL.

7. Right justify and Zero pack all fields used.

   Example: (a) Control section "six-one" must be written "00601".
   (b) Ten tons of hot mix in function 412 must be written "010".

8. For any additional information contact John Melancon (linc 425-1544) or Jorge Ribas (linc 425-1562) in Baton Rouge.

II. Inspection Form

1. Use only Inspection Form revised 9/82. (Example attached)

2. Show District, Gang, Parish, Route and Control Section on each form.

3. Roadway: Use A for two-lane, D for divided and multi-lane, F for frontage roads and O for others . (See Note)

4. Direction: Show direction of Travel when making the inspection (N S E or W). This may not agree with the direction of the Control Section as defined by the Control Section Manual. (See Note)

5. Beginning Mile: For this field, use the beginning of the control section as defined by the Control Section Manual (regardless of the direction of the inspection). For Control Sections up to 14 miles the Beginning Mile of the form is always 01. For control Sections longer than 14 miles and not more than 28 miles, a second form will be required on which the beginning will be 15, etc.

NOTE: Roadway, Direction, and Beginning Mile are required to uniquely identify each report.

6. MRM (Mays Ride Meter) data to be entered when available.

7. C.S. Length: Should be the length defined in the Control Section Manual for each Control Section.

8. Functions: As shown on the Form. There is space at the bottom for an additional function if required. Circle or underline the functions used on each form.

9. Units: Observe very carefully how the unit is defined. For example, the unit for function 416 is 10 tons. If 200 tons are required in a mile then it must be reported as "020" not "200". (If reported as "200" it will be 200x10 = 2000 tons). The same care must be taken when the units are 1/10th mile, 100 linear feet or 10 cubic yards.

10. Miles: Each form covers only 14 miles. If the control section is longer than that, use additional forms but remember to write the correct beginning mile 01-15-29...Right justify and zero pack all fields used.

11. For any special comment about a function, write notes up to 50 letters (including spaces between letters) on the back of the form. To avoid error write the notes in numerical order corresponding to the numbers already written in the front of the form. These notes can then be entered on the screen with the function.

III. Reporting Inspection Results

1. Districts will enter information directly into terminals using transaction MNRI.

2. Notify Baton Rouge when all data is entered for a gang so that summary reports can be prepared.

Attachment A
ANNUAL ROAD INSPECTION
SUMMARY OF RECORDABLE CONDITIONS

FUNCTION		CONDITION	ONE UNIT COUNT FOR EACH
		BITUMINOUS SURFACE	
412	Pothole Patching	Severe depressions and distortions. Potholes, edge rutting.	1 Ton
414	Hand Leveling	Medium-size areas of severe depression, distortion.	1 Ton
415	Seal Coat	Extensive areas of raveled, pitted of oxidized surface. Restoration to improve skid resistance.	1 Mile
416	Machine Leveling	Extensive surf. irregularities such as depressions, distortions and rutting.	10 Tons
417	Surface Replace.	Isolated areas of broken & severely cracked pavement. Limited base failures. Replacement of bituminous concrete surface after base repair.	1 Ton
418	Cutting/ Burning Bumps	Bumps or humps on bituminous surfaced roadways.	1 Location
		CONCRETE SURFACE	
421	Patching Surface	Broken slabs. Final Repair of blowups. Edge punch outs on CRCP.	1 Cu. Yd.
422	Premix Patching	Severe spalls. Surface irregularities. Edge punch outs on CRCP.	1 Ton
424	Roadway Jt. Rpr.	Lifeless jt. material. Non-compressible material. Water penetrating joints. Minor spalls along joints.	100 L. Ft.
425	Expansion Jt. Repr.	Bridge end joint closed to 3 in. or less.	1 Ln. Ft.
		SHOULDER	
441	Patching Nonpaved	Rutting at driveways, mail boxes & intersections. Edge ruts.	1 Cu. Yd.
442	Reshaping Nonpaved	Minor edge ruts. High shoulders. Loss of shoulder slope.	1/10 Mile
443	Restoring Nonpaved	Rutting on shoulder. Restore to original grade & cross-slope.	10 Cu. Yd.

MWRM-G-1

444	Cutting/ Hauling	High shoulders.	1/10 Mile
445	Premix Patching N.P.	Rutting at driveways, mail boxes & intersections. Edge ruts.	1 Ton
452	Premix Patching	Potholes. Breaks or settlement.	1 Ton
455	Sealing	Deteriorated conditions. Raveling, oxidation & light alligator crack.	1 Mile
		ROADSIDE AND DRAINAGE	
463	Clean Ditches	Vegetation blocking ditches. Silt changing flowline.	1/10 Mile
464	Machining Ditches	Partially filled ditches.	1/10 Mile
471	Brush Cutting	Brush at curves, bridges, fences, intersections and signs.	1/10 Mile
473	Litter Cleaning	Debris on roadside.	1 Cu. Yd.
		TRAFFIC SERVICES	
531	Pavement Striping	No pavement markings. Worn or faded markings (more than 50% worn).	1 Mile
533	Signs, Guide-posts Delineators	Replacement, repair, alterations, repainting, resetting or cleaning.	1 Location
534	Servicing Guard-rails	Damaged guardrail or median barrier.	1 Location
542	Service Crash Protection	Crash attenuators need servicing or repair.	1 Location
		MAJOR WORK	
632	Overlay	Surface deteriorated beyond normal maintenance capability.	100 Ln.Ft.

Date_____ ROAD INSPECTION AND MAINTENANCE INVENTORY Rev. 9/82

Dist. Gang Parish Route No. Cont. Sect. Roadway Direction Beg.Mile MRM (PSI) C.S. Length

-- --- -- ---- ----- - - -- --.--- ---.---

INSPECTORS: *RECORD NOTES ON BACK OF FORM

(FOR 1 UNIT WRITE "001" IN BLANK)

	Function	001 Unit =	MILES: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	*NOTE #
			X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	
BITUMINOUS	412 Pothole Patching	1 Ton															
	414 Hand Leveling	1 Ton															
	415 Seal Coat	1 Mile															
	416 Machine Leveling	10 Tons															
	417 Surface Replacement	1 Ton															
	418 Cutting/ Burning Bumps	1 Location															
CONCRETE	421 Patching Surface	1 Cubic Yard															
	422 Premix Patching	1 Ton															
	424 Roadway Jt. Repair	100 Linear Feet															
	425 Expansion Jt. Repair	1 Linear Foot															
SHOULDER	441 Patching Nonpaved Sh.	1 Cubic Yard															
	442 Reshaping Nonpaved	1/10 Mile															
	443 Restoring Nonpaved	10 Cubic Yards															
	444 Cutting/ Hauling	1/10 Mile															
	445 Premix Patch, N.P.	1 Ton															
	452 Premix Patch, Paved	1 Ton															
	455 Sealing Shoulder	1 Mile															
ROADSIDE	463 Clean Ditches	1/10 Mile															
	464 Machining Ditches	1/10 Mile															
	471 Brush Cutting	1/10 Mile															
	473 Litter Cleaning	1 Cubic Yard															
TRAFFSER	531 Pavement Striping	1 Mile															
	533 Signs, Guide Posts, Delin.	1 Location															
	534 Servicing Guardrails	1 Location															
	542 Service/Crash Protection	1 Location															
	632 Overlay	100 Linear Feet															
OTHER FUNC.																	

S-1

APPENDIX H

OHIO RECORDABLE CONDITION MANUAL

September 1980

(Replaces Appendix B of the *Study of Highway Maintenance Quality Levels in Ohio* manual, December 31, 1970.)

RECORDABLE CONDITION MANUAL

INTRODUCTION

This manual describes highway conditions which are referred to as "Recordable Conditions."

The recordable conditions are not necessarily maintenance deficiencies. Only a sample of the highway system will be surveyed so it is important to follow the procedures outlined in the manual closely.

The purpose of the recordable condition survey is to develop numerical data from observations and measurements using a sample of the Ohio highway system.

The procedure followed in making a recordable condition survey varies for the different highway elements. This is necessary because certain conditions occur with a greater frequency than others.

SAMPLES

The sample sections designated for the recordable condition survey are a random selection of highway segments which encompass all highway types and all counties throughout the State highway system. The starting milepost location and the limits of the section are specified for each identified sample section.

A list of the sample sections to be surveyed will be provided by the central office. The list will identify each section by district, county, route type, route number and starting milepost.

The measurements for each of the recordable conditions are designed to be full units of the condition. The definitions specify what the applicable unit will be for each condition. For example, assume that a unit of recordable condition is defined as 100 lineal feet of the condition and 260 feet of the condition is observed. The correct number of units to be noted for this recordable condition is three (3) units.

Condition: Pavement Deterioration

Description: Any Deterioration Which Exceeds Two Inches in Depth and 24 Square Inches in Area or Exposes the Base or Reinforcing Steel.

Scope of Observation: All of the pavement surface in the sample section including the edge line.

One Unit of Count: Each two square yards of the condition; isolated potholes 2 ft x 2 ft dimension or 4 ft^2.

Notes: Any deterioration of the pavement surface requiring immediate repair is a recordable condition.

A two-man team is required, one driving, one recording, and both observing. When a recordable pavement deterioration is encountered, it will be necessary to stop the survey vehicle and personally examine the location to secure an accurate measure of the units present.

Condition: Pavement Obstruction

Description: Any Object Which Cannot Be Safely Driven Through or Over. Glass Containers, Blow Ups, Culvert Sags, and Objects 3 Inches or More in Height Are Obstructions. A Blow Up Extending Into Two Lanes is Two Units of Deterioration. Hard Objects of Any Size and Soft Objects Larger than 3" x 6" are Considered Obstructions.

Scope of Observation: All of the Pavement Surface of the Sample Section.

One Unit of Count: Each Spot Location Where One or More Obstructions are Present

Notes: A pavement obstruction is a condition associated with the pavement surface which adversely affects user safety. Two tires in close proximity in one lane represent one unit whereas two tires in each of the two lanes represent two units of obstruction. Other examples of pavement obstructions include dead animals, trash and pavement blow ups.

Pavement obstructions should be recorded for all lanes of pavement, driving at 40 mph. A two-man team is required, one driving, one recording, and both observing.

Condition: Pavement Flushing (Bleeding)

Description: Any Pavement Flushing Exceeding One Square Yard in Area

Scope of Observation: All of the Pavement Surface of the Sample Section.

One Unit of Count: Each 100 Lineal Feet of the Condition in Each Lane.

Notes: Pavement flushing causes slipperiness due to a reduction in skid resistance caused by the presence of excess bitumen on the pavement surface. Any condition that requires treatment should be considered.

Pavement flushing can be observed for two lanes of pavement driving at 40 mph. A two-man team is required, one driving, one recording, and both observing. An adequate estimate of the number of units present can be established by slowing to 10 mph when a slippery condition is encountered.

Condition: Pavement Striping Deterioration

Description: Striping in Excess of 20 Lineal Feet is Faded, Missing or Does Not Delineate the Pavement Edge or Center

Scope of Observation: All of the Pavement Surface of the Sample Section

One Unit of Count: Each 528 Feet of Edge or Center Strip

Notes: Pavement edge line is required on any pavement which exceeds 20 feet in width. Pavement striping should be checked both during daylight and during night time. Where lack of striping is extensive, estimate the percent of the total survey section which requires each edge and center strip. Multiply the percent of each edge and center line times the total mileage. The resulting mileage should be multiplied by ten to get the units.

Maximum Deterioration:

2 Lane:	60
4 Lane Divided:	120
6 Lane Divided:	160

Condition: Pavement Auxiliary Marking Deterioration

Description: Markings are Missing or Do Not Delineate

Scope of Observation: All of the Pavement Surface, Curb and Dividers of the sample section.

One Unit of Count: Each Location Where Markings are Insufficient

Notes: Auziliary markings will be found in school zones, at railroad crossings, interchange gore areas, and other miscellaneous roadway areas where special markings improve user safety. The markings should be checked both during daylight and during night time.

6

Condition: Shoulder Dropoff

Description: Any Dropoff Between Pavement and Shoulder Exceeding 2 Inches in Depth and 6 Lineal Feet in Length.

Scope of Observation: The Entire Edge of One Shoulder on the Sample Section. For Divided Highways, Rate Both Shoulders in the Direction of the Survey.

One Unit of Count: Each 100 Lineal Feet of the Condition.

Notes: A dropoff between the shoulder and the pavement edge exceeding two inches and which measures more than 6 lineal feet should be classified as one unit of shoulder dropoff.

Shoulder dropoff should be recorded driving at 20 mph. A two-man team is required, one driving, one recording, and both observing.

7

Condition: Shoulder Obstruction

Description: Any Obstruction or Hole Which Exceeds Two Inches in Depth and Twelve Inches in Diameter, or Exposes the Base or Reinforcing Steel. Obstructions Include Any Object Which Cannot be Safely Driven Through or Over. Glass Containers, Blow-Ups, Culvert Sags, and Objects 3 Inches or More in Height are Obstructions. Hard Objects of Any Size and Soft Objects Larger than 3" x 6" are Considered Obstructions.

Scope of Observation: One Entire Shoulder Area of the Section. The Shoulder Width for a Two Lane Road is the Width of a Car or the Break in the Slope Whichever is Less. On Divided Highways With Interstate Type Paved Shoulders, Only the Paved Areas in One Direction of Travel Shall be Observed.

One Unit of Count: Each Spot Location Where One or More Obstructions are Present.

Notes: Any obstruction associated with the shoulder surface which adversely affects user safety. One unit of obstruction is a single item or group of items in one location. Examples include old tires, dead animals, shoulder material and drop-offs less than 6 lineal feet in length. Drop-offs should be observed on both sides of the pavement; for divided highways rate both sides in direction of survey.

The shoulder obstructions should be recorded for the shoulder surface adjacent to the driving lane travelling at 20 mph. A two-man team is required, one driving, one recording, and both observing.

(8)

Condition: Guardrail Appearance

Description: Any Rusting or Paint Discoloration Which Detracts from the Appearance of the Guardrail. Also any Damaged Guardrail Outside the Sample Section for Guardrail Deterioration Should be Rated as Guardrail Appearance.

Scope of Observation: All Guardrail on the Sample Section.

One Unit of Count: Each 100 Lineal Feet Where the Condition Exists

Notes: The rusting or discoloration qualify as a recordable condition if they noticeably detract from the appearance of the guardrail. This must be a detraction which the motorist would observe.

Any runs of guardrail on either side of the roadway should be examined, driving at 40 mph. A two-man team is required, one driving, one recording, and both observing.

(9)

Condition: Guardrail Deterioration

Description: Any Guardrail Which Does Not Properly Function as a Safety Barrier, Due to Damage or Deterioration of the Post, Hardware or Element.

Scope of Observation: The First Six Runs of Guardrail on the Sample Section

One Unit of Count: Each 100 Lineal Feet Section of Guardrail Where the Condition Exists.

Note: Mileage must be logged on recordable condition report from beginning of section to end of sixth run of guardrail.

Guardrail deterioration includes rotten posts, bent rail, and post instability. One unit of the condition includes up to 100 lineal feet of the condition. Each run of guardrail must be personally inspected to insure its proper functioning. Particular attention should be given to the stability of the posts.

(10)

Condition: Sign Deterioration

Description: Any Sign or Signal Which Does Not Properly Function

Scope of Observation: All Signs Within the Sample Section

One Unit of Count: Each Sign Which Does Not Properly Function

Notes: Sign deterioration includes loss of message or any part thereof, damaged or twisted posts or supports, and any loss in reflectivity which prevents the sign from being clearly read either during daylight or darkness. Appropriate distances should be marked on the pavement surface so that the readibility of the sign can be checked at specified speeds. If the sign cannot be clearly read at a specified speed before the distance mark on the pavement is reached, one unit of sign functional failure should be noted.

(11)

Condition: Vegetation Appearance

Description: Any Deviation From Policy Including:

A. Growth Cut Less Than 6 Inches
B. Mowing Beyond Ditch
C. Mowing Three Feet Beyond Slope Break
D. Growth Exceeding 12 Inches

Scope of Observation: All Roadway and Median on Sample Section

One Unit of Count: Each One-Fifth of a Mile Where Deviation Occurs

	Maximum Units
2 Lane	20
Divided Rural	40
Divided Residential	30

Notes: During the recordable condition survey, the mowed area will be examined to determine if mowing practices have deviated from standard policy.

The entire mowed area should be examined and deviations from policy noted as a general condition. Isolated deviations are not a recordable condition unless an obstruction is hidden, i.e. guardrail. Each unit of recordable condition should prevail for 1/5 of a mile. Only two classes of deviation can exist in a fifth of a mile. (1) The grass will be too long or too short, and (2) the mowing can be too extensive.

Mowing shall be rated from the pay periods that include May 15 thru October 15 of each year.

Mowing in violation of the current directive such as wheel tracks in the ditch line is to be counted.

No deduction will be made for overmowing when done by an adjacent property owner.

(12)

Condition: Litter Appearance

Description: Any Tenth Mile Segment of Section Where the Countable Litter Items Exceeds Ten

Scope of Observation: Both Sides and Median Area of the Sample Section

One Unit of Count: Each Tenth Mile Segment Where Condition Exists.

Notes: Drive at 40 mph and count every observable piece of litter that can be detected from the vehicle. A two-man team is required, one driving, one recording, and both observing opposite sides of the roadway. A recordable condition occurs every time the count exceeds ten items on a tenth of a mile highway section. After two or three tenth mile sections have been checked it should be possible to establish the number of recordable conditions for the entire survey section by general inspection alone.

Maximum Units

2 Lane	20
Divided	30

(13)

Condition: Drainage Ditch Obstruction

Description: Any Ditch Where 50 Percent of the Cross Section is Obstructed.

Scope of Observation: All Ditches on the Sample Section

One Unit of Count: Each 100 Lineal Feet of Ditch Where Condition Exists.

Notes: A drainage ditch obstruction creates a functional failure of the ditch. All ditches should be surveyed for the entire sample section. The ditches can be examined traveling at 40 mph. A two-man team is required, one driving, one recording, and each observing opposite cross-sections of drainage ditch.

(14)

Condition: Culvert Obstruction

Description: Any Culvert Having Over 50 Percent of its Section Obstructed

Scope of Observation: The First Six Culverts on the Sample Section

One Unit of Count: Each Culvert Where the Condition Exists

Notes: Mileage must be logged on recordable condition report from beginning of section to the sixth culvert.

A culvert obstruction creates a functional failure when the original drainage section is reduced in excess of 50 percent as a result of erosion, slides, sediment, or deterioration or damage to any pipe or culvert.

In the areas of suspected drainage facilities the observer should drive slowly and stop at intervals to check for culvert pipe. The shoulder should be walked if necessary because most failures will be associated with the smallest pipes which normally go unnoticed.

(15)

Condition: Culvert Deterioration

Description: Any Deterioration Exceeding Two Inches in Depth and 24 Square Inches in Area That Requires Repair. Comparable Deterioration of Pipe Culverts Includes Rusting, Corrosion, and collapsed or broken sections.

Scope of Observation: The First Six Culverts on the Sample Section

One Unit of Count: Each Two Square Yards of the Condition or Section of Collapsed Pipe

Notes: Mileage must be logged on recordable condition report from beginning of section to the sixth culvert.

Culvert deterioration exists when repairs are required to insure the future functioning of the structure.

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STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
RECORDABLE CONDITION REPORT

DATE 3 Mo. Day Yr. 9 18 ROUTE 12 SECTION NUMBER
OBSERVERS ---

	CONDITION	ONE UNIT COUNT FOR EACH	UNITS	TOTAL
PAVEMENT	SURFACE Deterioration	2 sq. Yd	19	
	Obstruction	Location	22	
	Flushing	100 Lin. Ft	25	
	STRIPING Deterioration	1/10 Mile	28	
	AUXILIARY MARKING Deterioration	Location	31	
SHOULDERS	SURFACE Drop Off	100 Lin. Ft	34	
	Obstruction	Location	37	
APPURTENANCES	GUARDRAIL Appearance	100 Lin. Ft	40	
	Deterioration	100 Lin. Ft	43	
	SIGNING Deterioration	Sign	46	
ROADWAY	APPEARANCE Vegetation	1/5 Mile	49	
	Litter	1/10 Mile	52	
DRAINAGE	OBSTRUCTIONS Ditches	100 Lin. Ft	55	
	Structures	Structure	58	
CUL	Deterioration	2 Sq. Yd	61	

ODOMETER		Count	Mileage	
	Beginning			64
	Guardrail (End of 6th Run)			68
	Drainage (6th Structure)			72
	Ending			76

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STATE OF OHIO
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APPENDIX I

INDICATORS OF QUALITY IN MAINTENANCE USED BY OTHERS

Support for maintenance programs is influenced in part by the perception of others of the quality of maintenance—their indicators of quality. Questions 7 through 10 of the Survey of Current Practice asked what the maintenance engineers' perception of the indicators of quality used by others is and their reaction to them. Although a number of agencies stated that the others identified in the questions did not have any indicators of quality, the reply from Kansas is the most realistic: "Opinions, like noses, are possessed by everyone."

Representative agency explanations follow the questions below (some agencies did not comment):

7. Do levels of management in your agency above the maintenance organization use indicators of quality to rate the maintenance program? (These might be official or unofficial, fair or unfair, and might be explained by anecdotes.)

Agencies Answering—48 (yes, 23; no, 25)

California

Deputy Director and above levels of management in Caltrans assess the quality of the maintenance program not only by means of internally generated management reports but by means of public comment and communication with the legislature. Comments from these letter sources normally are in reference to the quality of snow removal, litter pickup, and roadway maintenance.

Connecticut

All at one time or another have requested information as to how we account for personnel, services, equipment and material used in our Maintenance Operations.

Georgia

Upper management uses comments from the news media and general public as a barometer to how well the maintenance organization is functioning or performing.

Kansas

Opinions, like noses, are possessed by everyone. Each of the layers of management, government, as well as the media and traveling public has comments from time to time which may or may not be relevant.

Kentucky

This occurs mostly in the area of traffic services, i.e., snow and ice, mowing, rest areas, noxious weeds, and is based on personal observations of personnel in those areas as well as third party input via complaints or casual comments. Comments are very subjective and frequently unfair—comparison from one road to another is often the basis.

Mississippi

The only indication most observers outside the maintenance organization have is the general appearance of the highway. With limited resources, cosmetic maintenance (litter pickup, mowing, etc.) has to be delayed so that maintenance of the roadway facility itself can be done in a timely manner. Much of this rating is unfair because the observers do not know the overall plan for maintenance.

Missouri

Subjective comments, based upon visual observation.

Montana

MMS budget component is used by districts to develop work plans based on available funding and condition inventory. Top management requires performance at, say, 90 percent of approved work plan and all work must be accomplished within budget.

New Hampshire

Yes, subjective also. Once upon a time back in the early fifties, our Department CEO, a former general, was en route to an out-of-state airport and radioed headquarters to arrange repair of a large pothole as soon as possible. Crew checked route and found nothing. The CEO returned quite disturbed, indicating that the hole had not been patched. Upon further investigation, the hole was located in the adjoining state by a considerable distance. The fact was conveyed to the CEO with the suggestion that the neighboring state should be contacted. The CEO pounded on his desk and said "I don't give a good ———- where it's located, when I say patch it, I mean patch it." And so it was.

TABLE I-1

RESPONSES TO SURVEY QUESTIONS 7 THROUGH 10

Question Number	Total Responses	Yes	No
7	48	23	25
8	47	15	32
9	48	12	36
10	50	19	31

Note: The CEO's reaction in the New Hampshire anecdote was representative of many incidents in the author's experience. Higher-level administrators and governmental executives outside the highway department often rate the maintenance organization by its responsiveness to their requests, regardless of policy.

Oregon

Administrators periodically travel through the state for various reasons and will occasionally comment on deficient maintenance.

Pennsylvania

Each maintenance district is accredited annually through evaluation, using many parameters. Scores of field reviews of maintenance activities account for 50 percent of the accreditation score.

South Carolina

The levels of management above the maintenance organization use the number and type of complaints they receive to rate the maintenance program.

Virginia

At the present time, top management use personal observations and citizen complaints to judge the quality of maintenance.

Ontario

We have a study under way to develop "Key Business Measurements" for senior and middle-level managers. The current situation is that "informal" measures are utilized in the absence of suitable measures.

Oakland County (Michigan)

Levels of management above the maintenance organization use the reports generated by the management system as well as citizen complaints and public opinion (news media) to evaluate the maintenance program.

8. Do executive levels of government outside your agency use indicators of quality to rate the maintenance program (official or unofficial, fair or unfair)?

Agencies answering—47 (yes, 15; no, 32)

California

Executive levels of government outside of Caltrans rate the maintenance program, using public input and reports of accomplishments (budgeted vs. actual expenditures).

Connecticut

See remarks to Question 7.

Kansas

See remarks to Question 7.

Kentucky

Same as 7, only these tend to be more unfair and based more on false pretense.

Mississippi

See the remarks to Question 7.

Montana

See the remarks to Question 7.

New Hampshire

Subjective.

South Carolina

Same as Question 7.

Virginia

Same indicators as mentioned in Question 7.

Ontario

Ad Hoc Central Audits and very general results measures are reported to our "central agencies."

Oakland County (Michigan)

Executive levels of government within the county rate our maintenance program by public opinions, which are expressed to them through their constituents and also through the news media.

9. Does your legislative body express an interest in your maintenance program using indicators of quality of its own?

Agencies answering—48 (yes, 12; no, 36) California

See remarks to Question 7 above.

Colorado

We need better maintenance, more trash removal, better snow and ice removal, etc.

Connecticut

See remarks to Question 7 above.

Delaware

Our funding is dependent on the annual passage of a Bond Bill and an Appropriated Operating Budget. Consequently, all year long, and especially at Budget presentation time, the Legislators make you aware that both the quality and quantity of the Department's operation are under continuous informal scrutiny. Delaware, being a small state, may be under more scrutiny from this source than a larger state.

Iowa

Our legislative body does have an interest in highway maintenance in that they annually review and authorize our maintenance budget and they review and approve rules that are developed to implement laws passed by their legislative action.

Kansas

See the remarks to Question 7.

Kentucky

Yes, again, mostly in the area of traffic sources. These are frequently more subtle than those from the executive branch.

Mississippi

See the remarks to Question 7.

Montana

See the remarks to Question 7.

Nevada

Interest—yes; indicators—no. Periodically, legislature performs audit (performance) and reviews overall Maintenance Program.

New Hampshire

Yes, but again, it's personal observations and opinions and we have 429 legislators.

South Carolina

Same as Question 7.

Virginia

The legislature in the past has not shown a great interest in maintenance quality. Their interest has been primarily in the budget. Individually, legislators are sometimes interested in maintenance quality on specific roads.

10. Do you evaluate media commentary as an indicator of the quality of your maintenance program?

Agencies answering—50 (yes, 19; no, 31)

California

See the remarks to Question 7.

Connecticut

See the remarks to Question 7.

Delaware

Almost any phase of our involvement is subject to scrutiny by the news media. I think that every level of management recognizes the impact this coverage can have on our image and, therefore, take note of the content.

The Department's Public Information office attempts to ensure all managers are aware of coverage involving their section.

Georgia

See remarks to Question 7.

Illinois

The Districts and Central Bureau of Maintenance maintain a file and distribute articles which present commentary on the quality of work by maintenance.

Iowa

The agency is responsive to media commentary and both favorable and unfavorable media coverage is reviewed and evaluated. Media commentary does not, however, establish policy or change programs that we have determined to be appropriate.

Kansas

See the remarks to Question 7.

Maryland

No, but we investigate and respond when appropriate.

Michigan

No, we would review the commentary for facts and possible improvement in service.

Montana

Media commentary is considered but not formally evaluated.

New Hampshire

Yes, but only as an indicator.

New York

Review newspaper articles.

South Dakota

When media points out problem areas, even when condition may be isolated, we do evaluate quality on a statewide basis and make changes if deemed necessary.

Virginia

Letters to the editor and articles from state newspapers are monitored for comments on maintenance quality.

West Virginia

No, the WVOOH strives to maintain a healthy relationship with the media.

Ontario

In a very informal, ad hoc way.

District of Columbia

Local papers periodically publish articles on roadway and street conditions. Also, local paper publishes a column, "Dr. Gridlock," on highway conditions.

Oakland County (Michigan)

News media commentary tends to stress or be attentive only to any negative aspects of the maintenance program. It is difficult to use these as a true indication of the value of a maintenance program as a whole.

Nameless (for obvious reasons)

No (Those idiots don't know much).

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TRANSPORTATION RESEARCH BOARD
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

ADDRESS CORRECTION REQUESTED

000019X022
RICHARD L MCREYNOLDS
ENGINEER OF RESEARCH
KANSAS DEPT OF TRANS
MATERIALS AND RESEARCH CENTER
2300 VAN BUREN
TOPEKA KS 66611