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THE DEVELOPMENT OF MAINTENANCE MANAGEMENT TOOLS FOR USE BY THE
TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

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Research Report 151-4F

Maintenance Quality, Methods and Ratings

Research Study No. 2-18-71-151

Sponsored by

Texas State Department of Highways and Public Transportation
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Federal Highway Administration

September 1976

Texas Transportation Institute
Texas A&M University
College Station, Texas

PREFACE

This is the final report issued under Research Study 2-18-71-151, "Maintenance Quality, Methods and Ratings". This report presents a review of maintenance management tools developed in this study and suggested for use by the Texas State Department of Highways and Public Transportation. Research efforts sponsored by the Federal Highway Administration and the National Cooperative Highway Research Program contributed information useful in the development of the maintenance rating system.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

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ABSTRACT

Close cooperation among Texas State Department of Highways and Public Transportation district maintenance operational personnel, central office representatives and the Texas Transportation Institute study team together with a review of the literature provided the necessary information to develop selected maintenance management tools. These management tools consist of maintenance performance standards, cost codes and a maintenance rating system which has been implemented in part by the Texas State Department of Highways and Public Transportation.

Key Words: Maintenance methods, cost codes, maintenance rating, management, equipment, materials.

SUMMARY

The basic elements of a maintenance management system have been recognized and defined. These elements include maintenance standards, inventory of maintainable facilities, maintenance work load, budgeting, planning and scheduling and management information systems. This report delineates the development of maintenance standards cost codes and a maintenance rating system by establishing panels consisting of Texas State Department of Highways and Public Transportation district maintenance personnel, central office personnel and members of the Texas Transportation Institute.

The literature reviewed as part of this and associated studies has been instrumental in the development of the management tools developed in this study. Flexible management tools capable of satisfying a large number of needs yet capable of accepting anticipated necessary changes have been developed and are offered for general use by Texas as well as other states.

IMPLEMENTATION STATEMENT

The maintenance management tools developed as part of this study and reported herein are either being implemented or scheduled for implementation.

Implementation of the standardized maintenance methods are widespread, as the methods developed are employed in on-going activities. Implementation of these methods and cost codes are expected to improve efficiency and provide for more uniform maintenance activities throughout the state.

The maintenance rating method has been introduced into all 25 districts and has been utilized in its entirety by one district for a three-year period. Other districts have implemented the visual rating portion of the rating system.

The establishment of permanent review panels composed of district maintenance operational personnel and the establishment of a section within the maintenance operations division (D-18) may be necessary to successfully carry out the task of continued review of the methods, codes and rating system.

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INTRODUCTION

Funding for highway maintenance operations in Texas as well as most states comprises a significant and continually increasing portion of the total highway budget. The increasing public demand for high levels of service constantly widens the gap between funds available for maintenance operations and the funds required to provide the desired level of service. The existence of this situation makes it imperative to develop a system that will assist engineers in short and long range maintenance and rehabilitation planning. Such systems, hereafter referred to as maintenance management systems, have been developed or are being developed in thirty-three states (1) and several cities and counties.

Research Study 2-18-71-151, "Maintenance Quality, Methods and Ratings", a cooperative study between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute responded to this need in Texas by developing selected management tools as outlined by the study objectives given below.

1. Develop a system by which all highway maintenance operations can be coded and placed into functional groups,
2. Develop maintenance quality standards and maintenance methods for various highway classes,
3. Develop a maintenance rating system that can be used as a basis to schedule highway maintenance operations and
4. Implement on a trial basis the maintenance rating system and assess the established quality standards and maintenance methods.

References 2 and 3 describe the development of the maintenance

operation codes, quality standards and maintenance methods. These codes and methods are scheduled for implementation by the Texas State Department of Highways and Public Transportation. Reference 4 describes the maintenance rating system. Implementation of the maintenance rating system together with the establishment of refinements in the system were developed in Research Study 2-18-75-199. This one-year research study was a cooperative study between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute. The primary work items in this study were as follows:

1. Implement the Maintenance Rating System developed in Research Study 2-18-71-151,
2. Conduct a statewide survey on 250 randomly selected roadway sections,
3. Re-evaluate the assigned weighting factors of the various types of observed distress and roadway conditions and
4. Develop an urban visual rating system.

Statewide survey data were collected on the randomly selected roadway sections. The survey consisted of Mays Ride Meter roughness data and visually obtained maintenance rating scores. These data will furnish background comparisons with data of future reports scheduled for Research Study 2-8-75-207.

Weighting factors assigned to the various types of observed distress and roadway conditions were based primarily on experience gained in Districts 7 and 21 together with information published in the literature. Sufficient data from other districts representing other geographical areas were not available prior to the termination of this project to make rational adjustments in the proposed weighting or deduct factors.

Implementation of the Maintenance Rating System and development of an urban rating system which are items 1 and 4 of Research Study 2-18-75-199 work plan are discussed in detail in reference 5.

Texas Transportation Institute staff participation in other research efforts during the conduct of Research Studies 2-18-71-151 and 2-18-75-199 and a research project titled "Pavement Evaluation" sponsored by the Federal Highway Administration afforded the opportunity for Texas Transportation Institute personnel to review 34 pavement rating systems presently utilized by state, county and city agencies (6). This study also utilized data collected under Research Study 2-18-71-151 in Districts 7 and 21 to determine those types of pavement distress which contribute most heavily to the maintenance urgency rating of pavements.

An evaluation of the Transportation Research Board organized and Federal Highway Administration sponsored Workshop on Pavement Rehabilitation was prepared by B. F. McCullough and J. A. Epps (7). This evaluation summarized the four-day meeting attended by representatives from agencies throughout the United States and Canada. The overall objectives of the workshop were to establish a better understanding of pavement rehabilitation concepts, operations and needs so that the framework for a rational pavement rehabilitation design procedure could be formulated and used as a guide for future research and development studies. This workshop was instrumental in defining the needed interaction between maintenance management pavement information and information required for pavement rehabilitation purposes.

C. V. Wootan and J. A. Epps participated in a three-day workshop to develop national highway maintenance research needs (8). The product of this workshop sponsored by the Federal Highway Administration and

organized by the Transportation Research Board was a priority listing of 28 maintenance research study outlines. This conference was instrumental in identifying national and state needs in the area of maintenance research for Texas Transportation Institute personnel. These research project listings have been considered by the Texas State Department of Highways and Public Transportation Area II research committees.

C. V. Wootan and J. A. Epps participated in the development of a National Cooperative Highway Research Program Synthesis titled "Recording and Reporting Methods for Highway Maintenance Expenditures" (9). This synthesis was developed under NCHRP Project 20-5, Topic 7-04 and afforded Texas Transportation Institute personnel the opportunity to obtain detailed information from 11 states concerning their present maintenance recording and reporting systems.

The close cooperation between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute, considered necessary for successful completion of the study and referred to above, was obtained by three means of formal contact.

1. A study contact man representing the maintenance operations division of the Texas State Department of Highways and Public Transportation was appointed to devote approximately one-half time to the study. The same person has served in this capacity for the duration of the project. He has maintained contact with both the study supervisors at the Texas Transportation Institute and district personnel of the Texas State Department of Highways and Public Transportation.

2. Study panels were established to identify maintenance activities, develop maintenance methods, and to define the type of

information that would be useful for maintenance management purposes. These panels were comprised of district supervisory maintenance personnel from each of the twenty-five districts.

3. An advisory group was formed consisting of representatives of the Texas State Department of Highways and Public Transportation concerned with design, materials and tests, research and maintenance, representatives of the Federal Highway Administration and representatives of the Texas Transportation Institute. The purpose of this group was to furnish overall guidance to the project.

Formal meetings, together with informal contacts made while traveling and after meetings, established lines of personal communication between the study supervisors, maintenance operations division contact representative and the district maintenance personnel. Understanding and acceptance of the information developed in the project was thus greatly enhanced.

Study panels, as will be discussed below, formed the working element of these research studies. These panels were responsible for identifying the types of maintenance activities currently performed by the Texas State Department of Highways and Public Transportation for preparing the maintenance methods and for guidance in selecting the appropriate approach to the maintenance evaluation portion of the project.

The report that follows is intended to summarize the maintenance management tools developed by the Texas Transportation Institute and the Texas State Department of Highways and Public Transportation personnel during the conduct of Research Studies 2-18-71-151 and 2-18-75-199. The basic structure of a maintenance management system will be introduced and utilized to provide the framework for the report.

COMPONENTS OF A MAINTENANCE MANAGEMENT SYSTEM

As indicated above, more than thirty-three state, county and city agencies have operating or are developing maintenance management systems. As may be anticipated, the needs of these states, counties and cities vary. A review of Table 1 indicates the magnitude of the maintenance budget, lane miles of highway to maintain, population, climates, etc., for eleven states (9) and points out the wide variation in requirements among states. Thus, no two systems are identical; but, most of the systems have key elements or components which can be recognized. In general, the basic components of these maintenance management systems include the following:

1. Maintenance standards,
2. Inventory of maintainable facilities,
3. Maintenance work load,
4. Budgeting,
5. Planning and scheduling and
6. Management information systems (10).

Maintenance standards are developed to formally establish criteria for determining the need for work, the required quality of work and the resources necessary to achieve that quality and expected productivity rate. Maintenance standards are developed for those maintenance activities which consume a large portion of the maintenance budget. Usually at least 95 percent of maintenance expenditures can be defined by maintenance standards (11).

Three types of maintenance standards can be identified; quality standards, quantity standards and performance standards. Quality

TABLE 1. General Information for Eleven States

State	Annual Maintenance Budget (Dollars)	Lane Miles of Highway	Approximate Cost Per Lane Mile	Population	Motor Vehicles	People Per Vehicle	Maintenance Cost Per Vehicle (\$/year)	Area of State, Square Miles	Range of Annual Average Moisture, Inches	Temperature Extremes, Average Cold Month, °F	Range in Elevation Feet
California	153,000,000	45,000	3,400	20,601,000	13,413,000	1.5	11.40	158,693	4-96	8-16	-282 to 14,494
Hawaii	10,000,000	2,200	4,550	832,000	477,780	1.7	20.90	6,450	10-450	63-5	0 to 13,796
Illinois	79,000,000	38,000	2,100	11,236,000	5,952,000	1.8	13.30	56,400	32-48	14-0	279 to 1,235
Louisiana	86,000,000	36,225	2,400	3,764,000	2,057,000	1.8	41.80	48,523	48-64	36-1	-5 to 536
Minnesota	53,000,000	29,000	1,800	3,897,000	2,452,616	1.5	21.60	84,068	20-32	-8-1	602 to 2,301
Nevada	15,500,000	11,794	1,300	548,000	437,000	1.2	35.50	110,540	4-28	4-10	470 to 13,143
North Dakota	14,350,000	15,160	950	640,000	490,000	1.3	29.30	70,655	14-20	-10-1	750 to 3,505
Pennsylvania	201,000,000	75,569	2,650	11,794,000	6,800,000	1.7	29.50	45,333	36-52	14-1	0 to 3,213
Tennessee	38,485,000	23,500	1,600	4,126,000	2,467,000	1.6	15.40	42,244	40-76	22-1	182 to 6,643
Washington	40,000,000	17,000	2,400	3,429,000	2,370,000	1.4	16.90	68,192	8-120	8-1	0 to 14,410
Wyoming	17,000,000	14,620	1,160	353,000	294,000	1.2	51.00	97,914	8-56	-8-1	3,100 to 13,804

after reference 9.

standards describe the results to be achieved in terms of the resulting conditions of the highway or in terms of a specific frequency of performance. They may also be expressed in terms of the specific amount of work to be done per unit of highway or the thresholds at which certain maintenance activities should be carried out. Quality standards should represent policy decisions by top management regarding the "level of service" to be provided by the highway system. Quality standards are generally thought of as subjective measures; although many, such as mowing height or shoulder drop off standards, are objective in nature.

Quantity standards, sometimes called frequency standards or work load rates, identify by activity the amount of work set as a standard for a given class of highway or type of pavement in order to sustain the facility at a particular level. Quality standards, when stated in terms of work to be performed, become quantity standards. Quantity standards ususally reflect annual resource requirements needed to attain quality standards. These standards are usually set by policy, judgement based on past experience, historical data or a combination of these factors.

Performance standards usually outline methods of performing maintenance activities and the rate at which work is to be accomplished. These standards describe work methods to be used in performing the activity; the optimum crew configuration in terms of the numbers and classification of labor; the types and numbers of equipment units; the amounts of material required per unit of work accomplishment; the unit of measurement to define accomplishment and a standard average productivity rate for the maintenance activity described.

Highway agencies need information to formulate and evaluate policies,

to plan and design highways and to administer the construction, maintenance and operation of the highway facility. Roadway inventories are part of the basic information that is required to accomplish these tasks. Lane miles of highway pavement by type, bridges, drainage facilities, roadside maintenance features, rest stops, buildings, etc., are types of information that are collected. Inventory data should be collected with the end use of the data in mind. One of these end uses is formulation of the maintenance work load.

Work load is determined by the quantity and criticality of maintenance needs and the desired service level to be maintained. Examples of work load values include quantity of paving material to be placed per lane mile of highway and mowing frequency.

The maintenance budget should accurately reflect the proposed maintenance program. A program-oriented or performance budget is expressed in units of work to be accomplished by the various maintenance activities being programmed. The budget is achieved by developing a program of work units to be accomplished by the desired maintenance administrative sub-division and applying the appropriate unit costs to the work unit. Costs are determined from work units by use of performance standards together with standard labor usage rates, standard equipment rental rates, material unit costs and standard production rates. The budget must also include all items to be performed by outside contract as well as those being performed by the maintenance force itself.

The basic tools used in planning and scheduling include the following:

1. Seasonal-schedule of maintenance activities which provides a general planning framework,
2. A yearly schedule of maintenance activities often prepared during budget preparation and

3. Weekly, biweekly and/or monthly crew scheduling performed by the crew leader or foreman, or a maintenance section supervisor.

The establishment of a maintenance information system which provides the basic information required by operating managers for routine decisions and by top management for program control and improvement is a vital element of the maintenance management system. Accurate information must be recorded and assembled for easy and timely interpretation. The basic information required must be recorded at the field level with the individual workman or crew leader usually performing this function. Reports can be quickly assembled and analyzed through the use of data processing equipment. The types of reports generated should fit the end use of the report at a particular management level.

MAINTENANCE STANDARDS

The major accomplishment in the area of maintenance standards performed as a part of Research Study 2-18-71-151 was the development of maintenance performance standards (2). Initial work on this phase of the study identified methods to classify maintenance activities. A review of the literature resulted in Table 2 being developed and reported in reference 2. Subsequent review of eleven state maintenance management systems documented in Appendix A of this report add to this body of information.

Based on Table 2 and discussions with Texas State Department of Highways and Public Transportation Maintenance Operations Division personnel, five major areas were identified for the purpose of establishing study panels. These panels were formed during the first 6 months of the project and were composed of district personnel, repre-

TABLE 2. Classification of Maintenance Operations

Present THD Method (6)	Proposed THD (7)	AASHTO (8)	THD (Proposed) District 2 (9)	NCHRP Report 42 (10)	Arizona (11)	California (12)	Florida (13)	Proposed Idaho (14)	Proposed Iowa (15)
Base & Surface	Subgrade	Routine Roadway	General Section Expense	Routine Roadway Surface Operations	Routine Surface	General Maintenance	Bridges	Traffic Services	Overhead Operations
Shoulders, Side Approaches, Roadside Drainage & Structures	Base	Special Roadway Surface	Regular Roadway	Special Roadway Surface Operations	Shoulders & Sides	Major Slides & Storm Drainage Repair	Tunnels	Traveled Roadway	Routine Surface
Guide Markings, Markers, Signs, Signals, & Lighting	Surface	Shoulders & Side Approaches	Emergency Traffic Services	Shoulders	Roadside & Drainage	Restoration & Traffic Services	Ferries	Shoulders, Side Approaches & Sidewalks	Special Surface
Parks & Plants	Concrete Pavement	Drainage	Traffic Operations Undistributable	Roadside & Drainage	Structures	Maintenance Performed by Cities	Surface & Base	Drainage System	Shoulder & Approach
Row Maintenance (Except Mowing)	Shoulders	Roadside & Landscape	Traffic Directions	Structures	Snow, Ice & Sand Control	Roadside Rests	Roadsides	Bridges & Structures	Roadside & Drainage
Assistance to Traffic, Emergency, Snow & Ice Removal	Bridges	Structures	Traffic Protection	Snow, Ice and Drift Sand	Traffic Services	Buildings & Grounds	Drainage	Roadside	Snow & Ice
Mowing Row	Culverts	Snow & Ice Control	Beautification & Comfort	Traffic Control & Service Facilities	Emergency Maintenance	Landscaping & Functional Planting	Signs	Buildings & Yards	Traffic Service
Rest Areas with Comfort Stations	Pipe	Traffic Control & Motorists Services	Special Maintenance	Other Services	General Functions		Centerline & Pavement Markings	Disaster Repairs	Other
Channel & Embankment	Row Maintenance	Litter Pick-up		Unusual or Disaster			Traffic Signals	Administrative & Miscellaneous Operations	
Substructure	Signs and Safety	River Crossings					Turnouts, Driveways & Crossovers		
Superstructure (Deck)	Pavement Markings	Other Services					Beautification		
Superstructure (Supporting Members)	Erosion Control	Unusual or Disaster					Recreation Facilities		
Railing	Emergency Services	General Supervision					Plaques & Historical Markers		
Painting Except Railing	Rest Areas & Comfort Stations						Emergencies		
Special Jobs	Miscellaneous								

TABLE 2. Classification of Maintenance Operations (Continued)

Louisiana Study (16) (Jorgensen)	Louisiana (17)	Minnesota (18)	Mississippi (19)	Oklahoma (20)	Oregon (21)	Utah Study (Jorgensen) 5	Virginia Maint. Study (22) (Jorgensen)	Washington (23)
Bituminous Surface	Surface	Roadway Surfaces	Routine Roadway Surface Operations	General Highway Maintenance	Safety & Traffic Control	Hard Surface & Hard Shoulder	Surface	Roadway
Concrete Surface	Shoulders, Approaches, Roadside, Drainage	Shoulders, Approaches, Sidewalks	Shoulders, Side Approaches, & Sidewalks	Emergency Actions	Drainage	Non-Hard Surface	Shoulders	Shoulders & Road Approaches
Gravel or Shell Surface	Structures	Roadsides	Drainage & Beautification	Roadway Surfaces	Roadway	Gravel Shoulder	Drainage	Roadside
Shoulder & Approach	Traffic Services	Drainage Facilities	Traffic Service	P.C.C. Surfaces	Shoulders	Vegetation Control	Roadside	Drainage
Roadside & Drainage	Miscellaneous	Bridges & Tunnels	Snow, Ice & Sand Control	Bituminous Surfaces	Roadsides	Roadside	Traffic Services	Major Structures
Structural		Safety & Traffic Control Devices	Structures	Asphaltic Repairs	Snow & Ice	Drainage & Major Structure	Snow & Ice Control	Snow & Ice Control
Traffic Service		Snow Removal, Ice Control, & Drift Prevention	Extraordinary Maintenance	Earth & Gravel Surfaces	Bridges	Traffic	Structures	Traffic Services
		Structures	General Expenses	Drainage	Highway Structures	Snow & Ice		
			Supervision	Shoulders & Approaches	Traffic Services	Extraordinary		
				Major Structures	Roadside Recreational Areas	General		
				Minor & Miscellaneous Structures		Crusher & Stockpiling		
				Roadside				
				Traffic Service				
				Snow & Ice Control & Removal				
				Special Maintenance				

sentatives of the maintenance division and the Texas Transportation Institute. The panels and their respective areas of responsibility were:

PANEL A - Base and Subgrade,

PANEL B - Bituminous Surfaces and Shoulders
and Approaches,

PANEL C - Portland Cement Concrete Surfaces,

PANEL D - Roadside Maintenance and

PANEL E - Structures.

The original members of the panels are shown in Table 3. These panels have remained active during the projects although the composition of the panels have changed due to retirements and promotions.

As noted in Table 3 each district was represented. Meetings were held as required at the various district offices located throughout the state. The first round of panel meetings was held to describe the objectives of the study, to identify existing maintenance operations and to assign responsibility for development of the maintenance methods. Subsequent meetings were held to review the developed methods, assign responsibility for developing additional methods and to initiate action on the development of the maintenance evaluation techniques. A total of 5 rounds of panel meetings have been held to develop in excess of 200 maintenance activities currently performed by Texas Highway Department maintenance forces.

Maintenance Method

A typical example of maintenance method developed by the panel is shown in Figure 1. The major information provided in the method is described below.

TABLE 3. Original Panel Members 1972

<u>PANEL</u>	<u>NAME</u>	<u>MEMBERS</u>
A	BASE AND SUBGRADE	J. M. McDowell, Chairman, Dist. 1 L. S. Thompson, Dist. 10 J. N. Dominick, Dist. 11 J. O'Connell, Dist. 17 R. P. Hudson, Dist. 19
B	BITUMINOUS SURFACES AND SHOULDERS AND APPROACHES	S. G. Cox, Jr., Chairman, Dist. 21 J. L. Wilde, Jr., Dist. 14 W. B. Collier, Dist. 15 W. F. Adams, Dist. 22 R. S. Martin, Jr., Dist. 23
C	PORTLAND CEMENT CONCRETE SURFACES	V. F. Matusick, Chairman, Dist. 13 B. E. Davis, Dist. 2 G. G. Cleveland, Dist. 9 J. H. Doss, Dist. 12 C. H. Brown, Dist. 20
D	ROADSIDE MAINTENANCE	A. L. McKee, Chairman, Dist. 8 F. L. Ragland, Dist. 3 R. C. Liles, Dist. 4 J. W. King, Dist. 5 J. H. Swarbrick, Dist. 25
E	STRUCTURES	J. R. Evans, Chairman, Dist. 7 R. S. Neal, Dist. 6 H. Schneemeyer, Jr., Dist. 16 G. Green, Dist. 18 J. L. Lawrence, Dist. 24

after reference 2.

TABLE 4. Maintenance Quality Standards

Group	Code	Quality Standard
Bit. Surface	Level up ruts	1/2" to 1" allowed before repair
Bit. Surface	Level up waves	1" per 10 ft. section - 50% of roadway
Bit. Surface	Level up corrugations	25% of any 100 foot section
Bit. Surface	Pot holes	1" in depth - 1 ft. in diameter
Bit. Surface	Bleeding	excess of 20 ft. in length
Bit. Surface	Cracks	1/4" in width
P.C.C. Surface	Raveling, pop-outs, scaling	25% of any 100 ft. section
P.C.C. Surface	Spalling	6" in width, 2" in depth
P.C.C. Surface	Blowups	1/2" or greater
P.C.C. Surface	Faulting & Settlement	1/4" or greater
P.C.C. Surface	Cracks	1/4" or greater
Shoulders	Pot Holes	3 inches in depth or greater
Shoulders	Blade	blade once a year
Roadside	Mowing	4" to 6" height allowed
Roadside	Brush Control	no trees larger than 4" diameter within 30 ft.
Structures	Decks	1/2" deep spalling
Structures	Paint Railings stringers	Rust pitting 1/8 inch in depth
Traffic Services	Repair Signs	4 to 5 sq. inches
Traffic Control	Traffic Buttons	50% of buttons missing in any one skip stripe

after reference 12.

TABLE 5. Maintenance Quality Standards

Group	Code	Quality Standard
Bit. Surfaces	Pot Holes	2 inches depth, 24 sq. inches
Bit. Surfaces	Localized	2 inches depth, 6 inches diameter
Bit. Surfaces	Bleeding	One square yard
Traffic Control	Guide Lines	6 lineal ft. missing
Shoulders	Pot Holes	2 inches depth, 12 inches diameter
Shoulders	Localized	2 inch drop off, 6 lineal ft.
Roadside	Mowing	Cut between 6 and 12 inches
Roadside	Litter	10 items of litter in 0.1 mile
Drainage	Reshape	50% of cross section is obstructed
Structures	Culverts	2 inches in depth and 24 sq. inch area
Drainage	Silt Removal	50% of cross section obstructed

after reference 13.

TEXAS HIGHWAY DEPARTMENT ----- MAINTENANCE ACTIVITY		Cost Code 262								
REPAIR OF POT HOLES Temporary										
DEFINITION	The temporary repair of bowl-shaped holes of various sizes in an asphalt pavement.									
METHOD	<p><u>Conditions Favoring Use</u></p> <p>The temporary method of repair should be used any time that the permanent method cannot be, such as adverse weather conditions, traffic too heavy, etc.</p> <p><u>Procedure</u></p> <ol style="list-style-type: none"> 1. Provide adequate traffic control. 2. Remove water and loose material from the hole. 3. Backfill the hole with one of the following types of material: <ol style="list-style-type: none"> a. Base material or crushed gravel. b. Base material and an asphaltic concrete material. c. Asphaltic concrete material. d. In case of a submerged hole, asphaltic concrete material in burlap bag. 4. Compact the patch as well as possible by hand operated equipment or truck wheel. <table border="0"> <tr> <td><u>Men</u></td> <td><u>Equipment</u></td> </tr> <tr> <td>3 Crewmen with capability of operating truck and placing asphaltic concrete material. Flagmen as needed.</td> <td>Truck Signs and Barricades as required</td> </tr> <tr> <td><u>Small Tools</u></td> <td><u>Materials</u></td> </tr> <tr> <td>Asphalt rake Broom Hand Tamp</td> <td>Base material Asphaltic concrete material</td> </tr> </table>		<u>Men</u>	<u>Equipment</u>	3 Crewmen with capability of operating truck and placing asphaltic concrete material. Flagmen as needed.	Truck Signs and Barricades as required	<u>Small Tools</u>	<u>Materials</u>	Asphalt rake Broom Hand Tamp	Base material Asphaltic concrete material
<u>Men</u>	<u>Equipment</u>									
3 Crewmen with capability of operating truck and placing asphaltic concrete material. Flagmen as needed.	Truck Signs and Barricades as required									
<u>Small Tools</u>	<u>Materials</u>									
Asphalt rake Broom Hand Tamp	Base material Asphaltic concrete material									

Figure 1. Typical Maintenance Method

PERFORMANCE DATA, QUANTITATIVE		Unit of Measure -- Cubic Yard
Unit Cost Labor	Unit Cost Traffic Control	
Unit Cost Preparation	Total Unit Cost	
Unit Cost Travel	Labor Required Hours/Unit (Net)	
Unit Cost Equipment	Labor Required Hours/Unit (Gross)	
Unit Cost Materials	Approximate Accomplishment Per Day	
PERFORMANCE QUALITY STANDARD		
Provide a reasonably smooth and safe riding surface until permanent repairs can be completed.		
METHOD OF RATING		
<ol style="list-style-type: none"> 1. Test ride the repaired surface at designated speed limit to insure smoothness. 2. Make a visual inspection to insure that a neat appearing surface which adequately prevents surface water from passing into the base or subgrade is produced. 		
SCHEDULING		
Temporary repairs may be performed at any time as needed.		
COMMENTS		
<ol style="list-style-type: none"> 1. During wet weather cement may be added to the asphalt patching material and around the exposed surfaces of pot holes to add stability to the patch. 2. An infrared heater, butane burner, or other system may be used for drying the hole and patch. 3. An "Ejecto" truck may be useful in this operation. 		
CROSS REFERENCES		

Figure 1. Typical Maintenance Method (Continued)

Activity Code No. _____

Date _____

Method _____ Unit of Measure _____

District _____ Foreman No. _____ County _____

Highway No. _____ Location _____
(Milepost, distance from intersection, etc.)

PERSONNEL DATA

Title	Comp Rate	Hours in Preparation	Hours on Travel	Hours Traffic Control	Hours Performing Activity	
		Indicate number of hours spent in yard preparing equipment, materials, etc. requiring 30 or more minutes, less than 30 show under travel time.	Indicate the number of hours spent on travel from warehouse to work site.	Indicate the number of hours spent on traffic control (setting and removing signs and barricades, flagging, etc.) if 30 minutes or more.	Indicate the number of hours spent doing the method, include time spent on travel or traffic control less than 30 minutes.	

EQUIPMENT DATA

Equip. Number	Rate	Hours or Miles in Preparation	Hours or Miles on Travel	Hours, Miles Traffic Control	Hours, Miles Performing Activity	Description of Equipment
						Indicate type, name, size of equipment used.

Quantity of Material Charged _____

Unit Cost of Material Charged _____

Total Cost of Material Charged _____

Quantity of Work Performed _____ Work Performed per Day _____

Labor Required _____ (Hrs/Unit) Unit Cost _____

Figure 2. Performance Data Gathering Form

Identification. This top portion of the method gives the title and the cost code number.

Definition. This section defines the activity that is described below. The conditions favoring use are stated to provide guidance in terms of traffic, size, extent or other conditions that would favor the use of this method over some other method. The procedure defines a step by step method for accomplishing the maintenance activity together with the necessary men, equipment, materials and small tools necessary for proper performance of the activity.

Performance Data, Quantitative. This section of the method is intended to give the reader an indication of the cost and production that can be expected by use of the method under average conditions. The cost data were obtained from one or more districts by use of a form shown in Figure 2.

Performance Quality Standard and Method of Rating. This item indicates in a very general way the level to which the maintenance activity should be performed and the method to make this evaluation.

Scheduling. This section provides a delineation of the time of year or under what conditions the activity should be performed.

Comments. Alternative types of materials, new equipment and potential problems are often included in the section.

Cross References. The reader is provided with code numbers of other methods that pertain to use of the method being described.

As indicated above the maintenance method or performance standard contained a general quality standard. It is felt that sufficient funds and/or time were not available to quantify the quality standards. Quality standards, however, were obtained from the literature (Tables

4 and 5) (12, 13) and supplied to Texas State Department of Highways and Public Transportation personnel for review and inclusion in the maintenance method where possible.

Definition of quantity standards for particular operations have not been attempted by the Texas State Department of Highways and Public Transportation. In general, it is felt that quantity standards are not required under the present system of budget preparation practiced in Texas.

INVENTORY OF MAINTAINABLE FACILITIES

Selected roadway inventory data are collected and recorded by the Texas State Department of Highways and Public Transportation. These data include miles of highway by pavement type, county, district, highway type; number of bridges; pavement geometric design information; pavement materials and thickness information and certain other selected purposes.

Inventory data in a form and with the degree of detail required for formulation of a maintenance work load presently do not exist within the Texas State Department of Highways and Public Transportation.

MAINTENANCE WORK LOAD

As described above, the maintenance work load is a function of the level of service to be provided and the constraints on the work to be performed. The wide range in climate, traffic and maintenance materials utilized in the state have created difficulties in adopting a system other than that based on historical requirements. Consequently, Texas usually approaches work load and budget from this viewpoint.

BUDGETING

A program-oriented or performance budget is not presently utilized in Texas. The budget is primarily based on historical fiscal requirements of each of the 25 districts in the state. District budget submittals are reviewed by the Maintenance Operations Division and a statewide budget is prepared. The wide range in climate, traffic, maintenance materials and maintenance techniques that exist in the state and the decentralized management system have created difficulties in adopting a system other than that based on historical requirements.

PLANNING AND SCHEDULING

Formalized planning and scheduling tools are being prepared by a number of districts. District 7 (San Angelo) (14) has recently defined a schedule of seasonal maintenance activities which provides a general planning framework (Table 6). In addition, quarterly planning and weekly planning and scheduling forms are utilized in the maintenance sections. Figure 3 shows the Weekly Work Schedule Form utilized by the maintenance foreman to schedule maintenance operation. The job description, job location, men and equipment requirements are listed. In addition, "bad weather" projects are identified for the week. This form has proven to be a valuable tool for field planning purposes.

District 21 was the first district to utilize the maintenance rating system as a planning tool. References 15, 16 and 17 discuss the general use of the visual condition survey, Dynaflect measurements, Mays Ride Meter readings, skid numbers, traffic counts and accident data for planning maintenance activities. Criteria are offered in this paper for determining when and what kind of maintenance actions should be

TABLE 6. Seasonal Maintenance Activities

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Litter Clean Up Crack Pouring Winter Asphalt Work Pruning Painting Complete Center Stripe	Crack Pouring Pruning Complete Litter Pickup Winter Asphalt Complete Painting	Poison Redo Rest Areas for Summer Usage Winter Asphalt Complete Pruning	Seal Shoulders Start Level Work Finish Parks	Level Seal Coats Begin Mowing	Level Mow Asphalt Seals Poison
JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Mow Level Seal Coats Poison	Mow Level Seal Coats Poison	Caliche Begin Center Stripe Mow Linseed Oil on Bridge Decks Complete Summer Asphalt	Mow Caliche Work Center Stripe Begin Winter Edging Painting of Sign Posts, Guard Rails, Islands etc.	Complete Mowing Caliche Work Center Stripe Winter Asphalt Edging Bridge Work Painting	Begin Crack Pouring Center Stripe Winter Asphalt Complete Caliche Work Edging Litter Bridge Work Painting Straighten Sign Delineators after Clean Up Mowing

WEEKLY WORK SCHEDULE				MAINTENANCE FOREMAN
_____, 19__				_____
ITEM	JOB DESCRIPTION & LOCATION	MEN REQ'D.	EQUIPT. REQ'D.	BAD WEATHER PROJECTS
BASE REPAIRS				
PAVEMENT MAINT.				
1. LEVEL				
2. SQUEEGEE				
3. SEAL				
R.O.W. MAINT.				
1. MOWING				
2. PRUNING				
3. TRASH				
SHOULDER WORK				NOTES, REMARKS, ETC:
TRAFFIC MAINT.				
1. SIGNS				
2. STRIPING				
3. PAINTING				
PARK MAINT.				
& UTILITY				
WEED POISON				
VACATION				
MISC.				
WAREHOUSE & OFFICE PERSONNEL				
TOTALS				

Figure 3. Weekly Work Schedule

planned. It should be noted that these criteria are based on field experience and will be improved with additional use of this system.

A yearly schedule of maintenance activities that is prepared during budget preparation is a part of the system developed in District 21. This approach to budgeting should gain acceptance in other areas of the state.

MANAGEMENT INFORMATION SYSTEMS

There appears to be two broad purposes that a maintenance information system could be expected to serve. These are:

1. To improve the internal management of the maintenance function and thereby improve the overall efficiency of the maintenance operation and
2. To provide performance data and cost experience that will guide decision makers in future investment decisions. That is, to provide information needed for objective evaluation of alternative reconstruction, rehabilitation, roadway design and pavement construction options.

The first of these purposes is, of course, totally internal to the maintenance operation. Its basic requirement is to have a data recording and reporting system that will provide the operational detail necessary to answer the question, "How?". How can a given job or function be performed most efficiently, and how can the optimum level of maintenance be performed within a given budget constraint.

The second purpose is geared toward bringing specific activity cost data by specific roadway location to the attention of managers outside the maintenance area. It permits maintenance costs to become one of the

decision elements in a larger decision framework concerning alternative pavement, structural, roadway or geometric design decisions.

Obviously, the detail required for different types of information will vary with the emphasis placed on the purpose of the system. A system designed to serve internal maintenance needs will be more concerned with labor, material and equipment costs, with performance standards and work schedules, and with budgeting, planning and scheduling of maintenance programs. It will be much less concerned with the precise location of these activities within management sub-areas. Precise locational data, on the other hand, are among the basic needs of a system to serve the broader management needs outside the maintenance organization itself.

Since maintenance management systems are relatively new, and since they have been generally developed within the maintenance organization itself, it is perhaps to be expected that they would concentrate on providing data for internal management purposes. As the process matures and experience is gained, it is logical to expect that the maintenance information systems will eventually be broadened to more adequately serve the other purposes. At the present time, however, the maintenance information systems are directed primarily toward providing internal maintenance management information.

Examples of systems utilized in eleven states are outlined in Appendix A. These state summaries were prepared as part of the National Cooperative Research Program Synthesis titled "Recording and Reporting Methods for Highway Maintenance Expenditures" (9) and are included herein to provide background information for the Texas State Department of Highways and Public Transportation committees responsible for revising

the maintenance recording and reporting system currently utilized in Texas. The outline utilized for these "state reports" is as follows:

1. Recording Systems,
2. Collection and Processing of Recorded Data,
3. Reporting Systems,
4. Reliability of Recording and Reporting Systems,
5. Mechanisms for Changing Recording and Reporting Systems and
6. Conclusion, Recommendations, Research Needs.

No two surveyed states had identical recording or identical reporting systems. State maintenance organizational structures differ as do the methods of establishing the location at which the maintenance activity was performed. Two types of recording systems are presently being utilized by states. If a single reporting procedure is utilized for both maintenance management and for payroll and accounting information, a "single recording system" is said to be utilized. If separate reports are filed by field personnel, then the term "parallel recording system" is utilized to describe the reporting system. Of the states surveyed, 5 utilized a single recording system approach while 6 utilized the parallel recording system.

Field data are recorded either by the individual workman or the crew leader for the single reporting system while the crew leader records for the crew as a whole or for the individual workman when parallel reporting systems are utilized. All systems surveyed in the above mentioned study record labor in man-hours and equipment usage in miles or hours. Materials quantities utilized were not recorded for all systems surveyed.

The basic field data reported are normally collected daily. This

information is checked by the immediate supervisor of the individual filing the report and transmitted to the district office or central office for processing and reporting. Delays or lag time between supplying the data and furnishing reports is commonly 20 to 30 days. All reports from the states surveyed except one produced in Tennessee are developed by electronic data processing.

Reports produced by the various states for management purposes are numerous but for convenience can be summarized into eight broad categories as follows:

1. Audit,
2. Inventory,
3. Planning,
4. Equipment Usage,
5. Performance,
6. Budget Control and
7. Special Analytical and Exception Reports.

In the early stages of reporting system development, many states have produced very large numbers of reports utilized by only a few individuals. Upon later evaluation many of these reports have been discontinued. Most states now insist that a real need be defined before a report is prepared as a routine output of the reporting system.

Information system components developed as part of Research Study 2-18-71-151 includes development of codes by which maintenance activities can be identified and placed into functional groups for maintenance recording and reporting purposes. A second major contribution of this research study has been the development of a maintenance rating system. This system has been developed to provide information for both internal

management of maintenance operations and to provide performance data to guide decision makers in future investment decisions. Several reports have been developed which utilize these data for management purposes. The development of cost codes and the maintenance rating system together with reports developed to utilize the results of the maintenance rating system are discussed below.

COST CODES

Coding of the methods for cost accounting purposes was initiated parallel to the development of maintenance methods. Literature such as that summarized in Table 2 was utilized for this development. Results of this study are shown in Appendix B. Seven maintenance categories were established as shown below:

- 100 Base and Subgrade,
- 200 Surface,
- 400 Shoulders and Approaches,
- 500 Roadside Maintenance,
- 600 Structures over 20 feet,
- 700 Traffic Services and
- 800 Extraordinary Maintenance.

Subgroups were defined in each of the seven categories, and the subgroups were further subdivided, as required. For example, item 521 identifies a roadside maintenance activity - "litter pick-up by hand". The first digit indicates a 500 series activity which is reserved for roadside maintenance. The 520 series represents litter pick-up and the particular item 521 indicates that litter is removed by hand. Items 522 and 523 refer to litter pick-up by a "tow-type" of machine and by

a "self-propelled machine with shredder", respectively.

Field use of these codes can be limited to utilization of only the first of the three digits, two of the three digits or all of the digits can be utilized by the district. This versatility will allow costs and performance information to be kept to the degree of accuracy desired by the individual districts. If all three of the digits are utilized to record field performance information, alternative methods of performing the same basic activity such as litter pick-up can be studied. It is anticipated that this type of information will be helpful in establishing the type of maintenance action most suitable for a given set of environmental and traffic conditions.

From the above discussion, it is apparent that the person recording the maintenance operation must select a three digit number from a list of 304 numbers. This task is not expected to be troublesome because of the structure utilized in developing these codes and because a given individual will usually only be concerned with selection of the proper descriptive code from a relatively short list of meaningful alternatives.

The number of maintenance activities defined by other states in some cases is in excess of 500 (9). The number of maintenance activities that are available to be coded in other states is reported in reference 9 and summarized below:

California - 470,

Hawaii - 36,

Illinois - 49,

Louisiana - 124,

Nevada - 72,

North Dakota - 63,

Pennsylvania - 218,

Tennessee - 71,

Washington - 373 and

Wyoming - 46.

The number of activities available for coding is constantly under change in some states. Some activities are deleted and new and more efficient operations are added.

MAINTENANCE RATING SYSTEM

The maintenance rating system was developed to provide information for the following specific purposes:

1. Define the present condition of the roadway,
2. Compare the present condition with the past condition to predict the future condition of the roadway,
3. Determine maintenance needs in terms of materials, equipment, manpower and dollars,
4. Establish maintenance priorities based upon available resources and
5. Identify those maintenance activities which provide the greatest return for the maintenance investment.

The term "roadway" as utilized above includes all features within the right-of-way; therefore, the maintenance rating system by definition should include an evaluation or rating of the following roadway elements:

1. Pavement,
2. Shoulder,
3. Structures,
4. Roadside including drainage features,
5. Traffic services,
6. Off-highway and
7. Special and emergency.

Special and emergency operations are not predictable and were not of sufficient duration to lend themselves to be evaluated for a useful end result.

Off-highway maintenance operations such as building maintenance were considered adequately covered by preventive maintenance activities already practiced by the Texas State Department of Highways and Public Transportation.

Structures are presently evaluated by a detailed bridge rating system required by the Federal Highway Administration. It was felt that this rating could be utilized to predict bridge maintenance requirements. Thus, a bridge rating system was not developed as part of Research Study 2-18-71-151.

Pavement, shoulder, roadside and traffic service elements were further investigated and a maintenance rating system developed. The resulting rating system was developed based on an extensive literature review conducted by Texas Transportation Institute staff personnel and published in references 6 and 7 and summarized below. Reference 6 contains information collected on condition surveys presently utilized by 34 state, county and city agencies. Of the 34 agencies that reported using a rating system, 20 utilized the rating scores in maintenance decisions. A common characteristic of the reviewed rating systems was their general absence of ratings for roadside, drainage and traffic services elements of the roadway.

Literature Review

Reference (18) contains an excellent literature review of techniques and equipment available to evaluate pavements for maintenance and rehabilitation purposes. Existing techniques available to measure pavement behavior and pavement distress as defined in this report are reviewed below.

Methods of Measuring Behavior. Behavior of a pavement can be defined as its immediate response to load. Methods for measuring behavior of pavements due to loads can be conveniently grouped into the following categories:

1. Bearing tests,
2. Deflection tests,
3. Impact tests,
4. Vibration tests and
5. Other methods.

Many of these test methods measure the response of the pavements in terms of deflection, radius of curvature, and/or elastic modulus under conditions that simulate traffic loads in terms of both magnitude and/or frequency of loading. Little attempt has been made to measure behavior due to non-traffic associated loads.

Although soil classification and soil strength index methods do not directly measure response to load, they can be utilized as an index with a structural model to predict load carrying capacity of the pavement. Advantages, disadvantages, speed of operation and information indicating where the various devices have been implemented are contained in Table 7. A brief discussion is presented below describing the various categories of devices.

Bearing Tests. Bearing tests are distinguished by the application of a static or dynamic load to a pavement or soil through a plate. The static plate bearing tests widely utilized for determining modulus of subgrade reaction and deflection is the most common test of the group. The California Bearing Ratio (CBR) and bearing tests developed by North

TABLE 7. Behavior

CATEGORY	METHOD	BEHAVIOR MEASURED	SPEED OF OPERATION (MEASUREMENTS PER DAY)	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Bearing	Static Plate Bearing	*Deflection *Elastic Modulus *Modulus of Sub-grade Reaction	1 to 10	*History of Use and Acceptance	*Slow Test to Perform *Massive Equipment Necessary	*U.S. Navy *Corps of Engineers *U.S. Army *U.S. Air Force (3)	*Development of More Portable Equipment *Increase Speed of Data Collection
	Dynamic Plate Load	*Deflection *Elastic Modulus	1 to 10	*Dynamic Loads Which Simulate Traffic	*Slow Test to Perform *Massive Equipment Necessary	*Research Tool Only (1)	*Development of More Portable Equipment *Increase Speed of Data Collection
	California Bearing Ratio	*Soil Strength Index *Deflection *Elastic Modulus	1 to 5	*History of Use and Acceptance	*Slow Test to Perform *Not Suitable for Stabilized Materials	*U.S. Army *U.S. Air Force *Corps of Engineers (3)	*Increase Speed of Data Collection
	North Dakota Florida? Other	*Soil Strength Index	1 to 5	*Acceptance Within State	*Does Not Measure Deflection or Elastic Modulus But Soil Strength Index Only *Not Suitable for Stabilized Materials	— (1)	*Increase Speed of Data Collection *Determine Relationship Between Measured Data and Behavior
Deflection	Benkleman Beam	*Deflection *Radius of Curvature	300	*History of Use and Acceptance *Realistic Loads *Simple to Perform *Easily Transportable	*Speed of Operation	*Asphalt Institute *U.S.—Oklahoma and Other States *Great Britain R.R.L. *Some South African Provinces *Canada-RTAC (3)	*Reliability of Measurements *Increase Speed of Data Collection
	California Traveling Deflectometer	*Deflection *Radius of Curvature	1800 to 2000	*Speed of Operation *Realistic Loads *Easily Transportable	*Downgrade Measurements Are Not Possible *Measurements on Curves Not Taken Because of Safety	*California (3)	*Determine Reliable Elastic Moduli from Measurements
	Lacroix	*Deflection *Radius of Curvature	5,000	*Speed of Operation *Realistic Loads *Easily Transportable		*France *Great Britain RRL *Some Canadian Provinces *South African NIRR (3)	*Determine Reliable Elastic Moduli from Measurements
Impact	State of Washington	*Deflection	—	*Speed and Simplicity of Operation	*Small Load Applied	(1)	*Determine Relationship Between Measured Data and Behavior
	French	*Deflection	500	*Dynamic Load Which Simulates Traffic *Easily Transportable	*Speed of Operation	*Denmark *France (1)	*Determine Relationship Between Measured Data and Behavior *Increase Speed of Data Collection
	Germany Others	*Deflection	—			(1)	*Determine Relationship Between Measured Data and Behavior
	Shell	*Deflection *Elastic Moduli *Radius of Curvature	5 to 50	*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Small Load Applied *Frequency Range *Speed of Operation	*Research Only (1)	*Increase Speed of Data Collection *Determine Reliable Elastic Moduli from Measurements
	Great Britain RRL	*Elastic Moduli *Deflection	5 to 50	*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Frequency Range *Speed of Operation	*Research Only (1)	*Determine Reliable Elastic Moduli for Various Pavement Layers
	French-LCPC	*Elastic Moduli *Deflection		*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Speed of Operation	*Research Only (1)	*Extend Available Load Magnitude and Frequency for Any Single Device

TABLE 7. Behavior (Cont.)

Road Rater	*Deflection *Radius of Curvature *Elastic Modulus	600-800	*Variable Force *Low Maintenance *Speed of Operation	*Frequency Range *Small Force	*Pennsylvania *California (2)	*Determine Reliable Elastic Moduli from Measurements
Dynalect	*Deflection *Radius of Curvature *Elastic Modulus	400-600	*Variable Force *Low Maintenance *Speed of Operation	*Frequency Range *Magnitude of Load Applied	*Texas *Utah *California *Virginia *Pennsylvania (3)	*Determine Reliable Elastic Moduli from Measurements
Vibratory	Cox	*Deflection *Radius of Curvature *Elastic Modulus	1,000	*Speed of Operation	*Under Development for Contra Costa County, California As Well As Other Agencies (2)	*Determine Reliable Elastic Moduli from Measurements
	U.S. Air Force	*Deflection *Radius of Curvature *Elastic Modulus	300	*Variable Force and Frequency *Large Force *Multipurpose *High Frequency	*Size of Equipment *Slow Test to Perform (2)	*Under Development *Development of More Portable Equipment
	Corps of Engineers	*Deflection *Radius of Curvature *Elastic Modulus	300	*Variable Force and Frequency *Large Force *Multipurpose	*Size of Equipment *Slow Test to Perform (2)	*Under Development *Development of More Portable Equipment
Other Methods	Soil Classification	Soil Support	1 to 5	*History of Use	*Does Not Measure Behavior of Entire Pavement But Only Subgrade *FAA *States Using Group Index Method, etc. (3)	*Determine Relationship Between Measured Data and Behavior
	In-Situ Transducers	*Deflection *Deformation *Load		*Capable of Measuring Behavior Under Actual Pavement Loading Conditions *Measure Coupled Loads Due to Traffic and Environment	*Installation *Reliability and Maintenance *Permanent Installation *Limited Number of Measurements Possible *Research Only (1)	*Develop Method of Measuring Remaining Life of Pavement
	Curvature	*Radius of Curvature	300	*Small *Transportable	*Require a Slow Moving Load *South Africa *California (3)	*Increase Speed of Measurements

RRL - Road Research Laboratory
LCFC - Laboratoire Central Des Ponts Et Chaussées
RTAC - Road and Transport Association of Canada

after reference 7.

Dakota and Florida, although not widely used to measure pavement behavior, have been included. Dynamic plate load tests have been utilized as a research tool, but have not gained widespread implementation.

Deflection. Benkleman beam, California Traveling Deflectometer and Lacroix Deflectometer are examples of deflection measuring devices. These devices are also capable of obtaining the radius of curvature of the deflection basin. The widespread use of these devices together with their ability to apply realistic loads have resulted in widespread utilization of this category of devices throughout the world.

Impact. Impact devices employ a falling weight to impart a shock-wave into the pavement structure which is measured and converted to deflection. Little if any full scale implementation of this category of devices has taken place in the United States.

Vibratory. Vibratory devices have received widespread use as research tools in the last 10 years; additionally, the Dynaflect and the Road Rater have gained widespread acceptance for pavement rehabilitation forecasting. These devices use either a heavy or light vibrator to excite the pavement. Deflection, radius of curvature and elastic moduli can be determined.

Several sophisticated wave propagation devices have been grouped under this heading and are utilized to evaluate airport pavements. Wide frequencies are used to propagate waves into the pavements under relatively heavy loads. The U. S. Air Force and U. S. Army Corps of Engineers are developing such devices.

Other Methods. Soil classification methods including that utilized by the FAA are part of pavement overlay design models.

In-situ transducers, although utilized for research only at this

stage of development, may become important for certain urban facilities. The development of devices of this nature to measure such items as remaining fatigue life and the behavior of pavements subjected to coupled loads appears reasonable with additional research.

Curvature measuring devices have been used in South Africa, California and Texas.

Methods of Measuring Pavement Distress. Roadway distress manifestations result when some limiting response or damage occurs in the roadway. Distress manifestation associated with the pavement is usually in the form of pavement cracking, distortion and disintegration, vehicle and pavement related noise or skid resistance. Numerous methods have been established to measure pavement distress and attempts have been made to establish limiting values of the various forms of distress. Complications associated with establishment of these limiting responses are due, in part, to the inadequacies of distress measuring methods to identify and accurately measure the significant factors. In addition, it should be realized that distress affects not only occupants of the vehicle but also the operation of the vehicle and the people and goods adjacent to the roadway.

The measurement of pavement distress can be obtained from user oriented evaluations or mechanistic evaluations. The output from the somewhat subjective evaluations and the objective mechanistic evaluation measurements taken at any particular time is usually referred to as the level of service. The history of this level of service, or serviceability, with time is a measure of pavement performance.

Mechanistic evaluations are concerned with measuring in quantitative terms such items as pavement cracking, road roughness, skid resistance,

etc.

User oriented evaluations such as the Present Serviceability Rating are often intended to measure only the riding quality provided by the pavement. A measurement at any particular time is the level of service provided to the user. Variations of this level of service, present serviceability, with time is a measure of pavement performance. The best known definitions and procedures for measuring serviceability in North America are those developed utilizing a panel of highway users at the AASHO Road Test and in Canadian pavement evaluation studies. The AASHO terminology for performance rating is Present Serviceability Rating (PSR) while the Canadian equivalent is presently referred to as the Riding Comfort Index (RCI) to more explicitly denote the evaluation only of pavement riding quality.

It is obviously impractical both in terms of the time and expense to evaluate performance serviceability on anything but a limited basis using the rating panel method. Consequently, considerable effort has gone into correlating various mechanical evaluation methods with panel performance evaluations. This effort has led to the development of a number of road roughness measuring devices, as road roughness is generally considered to be of major importance to the user and is thus reflected in his performance evaluations.

In addition to road roughness measuring devices used to correlate with user oriented evaluations, the engineer has been concerned with pavement distress in terms of pavement cracking, pavement distortion, and pavement disintegration. Pavement evaluation methods attempting to measure these forms of distress are referred to as condition surveys. Another group of methods of pavement evaluation are those associated

with measuring pavement behavior. These test methods along with analysis techniques evaluate the structural load carrying capacity of a pavement among other factors. They do not measure mechanistically the pavement structural distress.

Two other forms of pavement related distress are of concern to the engineer and the driving public: (1) Highway noise created largely by the tire pavement interaction and the vehicle; and (2) skid resistance and other safety related measurements.

Table 8 presents a brief summary of the groups of methods utilized to measure pavement distress. It is the function of pavement evaluation methods to periodically measure the above mentioned distress in order to (19):

1. Provide data for checking design predictions and updating them as necessary,
2. Re-schedule rehabilitation measures as indicated by updated predictions,
3. Provide data for upgrading the design models themselves and
4. Provide information for updating network rehabilitation progress.

Pavement evaluation thus serves the planning and design activities of pavement management and is, therefore, a part of the pavement management system thus providing the means for assessing rehabilitation needs on both a project and a network basis.

Pavement roughness evaluation has received considerable attention from most highway and airport agencies as roughness is generally accepted as the primary component of serviceability as viewed by the user. A number of attempts have been made to correlate different rough-

TABLE 8. Pavement Evaluation Methods

Evaluation Group	Examples of Categories	Comments	
Performance	Present Serviceability Index Riding Comfort Index	°User-oriented subjective evaluation of road roughness	mainly of
Roughness	Profilometer Mechanical Vibrometer Precise Level	°Developed Primarily to provide faster and more economical performance evaluations	
Condition	Visual Photographic	°Measurement of type, degree, magnitude and location of pavement distress	
Noise	Sound Recording Equipment	°Measurement of noise associated with tire-pavement interaction and vehicle and the effect of the noise on the driver and adjacent people	
Skid Resistance	Indirect - Surface Texture Direct - Locked-wheel Skid Trailer	°Measurement of accident potential of pavement section	f given
Behavior	Bearing Deflection Impact Vibratory Wave Propagation	°Measurement of the immediate reaction or response of a pavement to load	
Cost	Maintenance Cost per mile Benefit - Cost Index USER Cost	°Measure of maintenance effectiveness of certain maintenance activities mechanistic pavement design models, benefits, feedback to s, etc.	
Traffic	Traffic Volume Capacity	°Measurement of pavements ability to handle present and future traffic	adequately

After reference (7)

ness measuring devices with panel oriented performance ratings. These results are presented in the literature together with descriptions of the numerous devices utilized to measure roughness.

Table 9 has been prepared based on a literature review and the workshop proceedings (19, 10). For convenience, road roughness measuring devices have been grouped into the following categories:

1. Profilometer,
2. Mechanical Vibrometer,
3. Precise Leveling.

Speed of operation, advantages, disadvantages, research needs and agencies that implemented the individual devices have been identified. A brief discussion is presented below briefly describing the operational features of the various categories of devices.

Profilometer

Rolling straight edge measuring equipment was utilized in the United States as early as 1900. Since that time, numerous profile measuring devices identified by such names as Viagraphs, profilograph and profilometers have been developed and utilized by highway and airport agencies.

Correlation of user-oriented performance evaluation with roughness measurements was formalized at the AASHO Road Test. The Chloë Profilometer was utilized, in part, for this correlation.

Surface dynamic profilometers have received increased use in the last 10 years as research tools and for calibration of other roughness measuring equipment. Surface dynamics profilometer equipment promises to be the most desirable method of this category of equipment to measure road profile characterist Its major

TABLE 9. Pavement Mechanistic Evaluation Roughness Evaluation

CATEGORY	METHOD	QUANTITY MEASURED	SPEED OF OPERATION	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Profilometer	Rolling Straight Edge (Calif. U of Michigan, Illinois, French, Others)	Vertical Movement	Slow	*Repeatability	*Operating Speeds *Measurement of Certain Wave Lengths	*California Division of Highways *University of Michigan *Other Agencies (3)	*Increase Speed of Operation and Measurement of Certain Wave Lengths
	CHLOE Profilometer	Slope Variance	Slow	*Repeatability	*Slow Operating Speed *Measurement of Long and Short Wave Lengths *Movement of Towing Vehicle	*AASHO Road Test *General States (3)	*Increase Speed of Operation and Measurement of Certain Wave Lengths
	British - RRL	Vertical Movement (Inches Per Mile)	Slow	*Repeatability *Calibrations of Other Roughness Measuring Devices	*Slow Operating Speed *Measurement of Long Wave Lengths	*Several Canadian Provinces *Canadian Ministry of Transport *British - R.R.L. (3)	*Speed of Operation and Measurement of Long Wave Lengths
	Surface Dynamics Profilometer	Amplitude and Length of all Waves	Moderate	*Repeatability *Calibration of Other Roughness Measuring Devices *Measurement of Long Wave Length	*High Capital and Operating Costs *Highly Skilled Operating Personnel Required for Operation *Data Reduction Costs *Complexity of System *Not a Direct Measure of Vehicle Ride Characteristics	*General Motors *Texas *Michigan (3)	*Transfer Function for Roadway Wave Length and Frequency to User Opinion
Mechanical Vibrometer	VIA-Log	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed			*Developed in 1926 and Utilized in New York State (2)	
	PCA	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed or 50 MPH	*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Wisconsin *Washington *California (3)	
	Mays Ride Meter	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed or 50 MPH	*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment *Continuous Record	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Texas (3)	*Improve Repeatability of Results *Identify Significant Vehicle and Environmental Factors Affecting Roughness Measurement *Improve Data Handling Technique
	Cox and Son	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)		*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment *Continuous Record	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Research Activities (2)	
	BPR Roughometer	Relative Vertical Movement Between Wheel and Mass (Trailer)	20 MPH	*History of Use	*Low Operating Speed *Attenuation of Wave Lengths in the Ride Frequency Range *Repeatability and Constancy Related to Calibration	*Several States (3)	
Precise Leveling	Rod and Level	Amplitude and Length of All Waves	Slow	*Precise Measurement *History of Use	*Slow Operating Speeds *Safety *"Down Time" of Facility *Not a Direct Measure of Vehicle Ride Characteristics	*Agencies Associated with Airfields (3)	*Increase Speed of Operation *Transfer Function for Roadway Wave Length and Frequency to User Opinion
	Traveling Rod and Laser Beam	Amplitude and Length of All Waves	Slow	*Precise Measurement	*Slow Operating Speed *"Down Time" of Facility *Not a Direct Measure of Vehicle Ride Characteristics	*Under Development (2)	

advantages are summarized below.

1. Determination of actual profiles,
2. Capability of handling large amounts of data by automated means,
3. Operating speeds sufficient to cover reasonable amounts of pavement in a reasonable time,
4. Capability of detecting and analyzing longer wave lengths in the pavement,
5. Excellent repeatability and
6. Capability of use for calibration of car road meters.

Mechanical Vibrometer

This category of equipment measures vertical movement between the axle of an automobile or a wheel in the case of trailer devices and the mass automobile or wheel supports. The State of New York developed a device called a "Via-Log" prior to 1926. This device measured the vertical movement between the front axle and the body of the car. Similar devices commonly referred to as the PCA meter, the Mays Ride Meter and the Cox and Son Road Meter have been developed utilizing many of the same principles. The major advantages offered by this newer equipment are in terms of improved measuring and recording equipment, thus allowing higher speeds of operation.

Limited work has been performed on measuring runway and taxiway roughness with instrumented aircraft. Certainly this is an area which deserves further consideration from both a vehicle operational standpoint as well as a passenger standpoint.

In 1941 the Bureau of Public Roads reported the development of

a trailer unit capable of measuring road roughness. This device known as the BPR Roughometer has been widely used and correlated with performance evaluations. Excellent repeatability and possible use as a calibrator for other roughness measuring devices makes its use attractive.

This category of roughness measuring devices does not give a reliable measure of roughness wave length.

Precise Leveling

The precise leveling method has been utilized for a number of years. A survey rod and level have been widely used on airfields and some highways. Research on the application of laser beams together with a traveling rod have been reported which will offer a faster and perhaps more reliable method.

Equipment to measure road roughness would ideally have the following characteristics:

1. Correlate with performance evaluation,
2. Measure wide spectrum of roadway wave lengths,
3. Measure response of typical vehicular traffic on the facility,
4. High speed of operation,
5. Simple and easy to operate,
6. Capable of mass inventory thus capable of measuring, analyzing, storing and retrieving large amounts of data and
7. Easily transportable.

Such equipment has not been developed in a single unit at this point in time. However, the combination of several existing devices will provide the necessary measurement system.

The combination of equipment to meet the desired requirements would consist of a surface dynamics profilometer or precise leveling device for correlation with performance evaluations and for calibration purposes. Car road meters such as the PCA, Mays or Cox would be utilized for the correlation of mass inventory data. Correlation of these car meters with performance evaluations would be maintained through profilometer equipment such as the surface dynamics profilometer device being developed in Texas or precise leveling methods as described above. An alternate method for calibration of car road meters would be through the use of vibration tables or other suitable devices. Repeatable road profiles would be programmed into the vibration table. The road meter response of the automobile excited by this table would be measured at periodic intervals.

As noted most of the devices noted in Table 9 are considered implementable; however, the areas of applicability of various roughness measuring devices are shown in Table 10. In addition it should be noted that roughness measurements can be utilized for construction monitoring, maintenance programming, inventory and network programming and research. Reference 21 defines the use of the Mays Ride Meter in Texas.

Most highway and airport agencies conduct periodic pavement condition surveys on selected sections, or on a mass basis. These surveys are measurements of pavement distress such as cracking, distortion and disintegration and can be defined as any process of identifying, either

TABLE 10. Areas of Applicability for Various
Types of Roughness Measuring Equipment

Type of Facility	Construction Monitoring	Mass Inventory
Expressway or Primary Highway	BPR Roughometer Car Ride Meters Surface Dynamics Profilometer Rolling Straight Edge (British Road Research Laboratory) (CHLOE Profilometer)	Car Ride Meters Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)
Secondary (Rural) Highway	BPR Roughometer Car Ride Meter Rolling Straight Edge (Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)	Car Ride Meters (Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)
Country or Local Rural Highways	BPR Roughometer Car Ride Meters Rolling Straight Edge (Surface Dynamics Profilometer)	Car Ride Meters
Airfields	Car Ride Meters Surface Dynamics Profilometer British Road Research Laboratory (Precise Level)	Car Ride Meters Surface Dynamics Profilometer British Road Research Laboratory (Precise Level)

1. Brackets denote applicability primarily for special purposes or control sections

after reference 7

qualitatively and/or quantitatively, visible manifestations of pavement distress.

Condition surveys are conducted in a variety of fashions and to varying degrees of accuracy, subjectivity, and reliability by the many agencies employing such surveys in the United States and elsewhere. In general, condition surveys are conducted for purposes which are relatively limited in number and which can be briefly summarized as follows:

1. To be used as input to development of a structural rating or index,
2. To aid in projection of budget requirements,
3. To aid in decisions to perform or not to perform maintenance,
4. To act as a diagnostic tool for assessment of design and/or construction procedures,
5. To be used as input to rehabilitation design and
6. To be used as input in determining pavement performance history (22).

As indicated these purposes closely coincide to those given above for the establishment of evaluation methods for pavement distress.

In order to more clearly define the nature of existing conditions surveys a letter was sent to the highway departments in most states, territories and selected Canadian provinces requesting information on their pavement condition rating system currently in use or projections for use in the immediate future.*

* Primarily, this literature review was conducted by the Texas Transportation Institute staff to satisfy research requirements for Federal Highway Administration Contract No. DOT-FH-11-8264. Reference 6 contains details of this survey.

Out of 58 separate agencies contacted, 44 responses were received or had previously been made available. The agencies included not only the states and selected Canadian provinces but also one county in the state of Washington and two city agencies in Texas.

Some of the general items derived from the replies are:

1. Number of agencies using or adopting rating systems - 34,
2. Number of agencies using a composite numerical rating score - 24,
3. Number of agencies using ratings or rating scores in maintenance decisions - 20,
4. Number of agencies using rating systems for flexible pavements - 30 and
5. Number of agencies using rating systems for rigid pavements - 18.

Of the states and agencies for which information was available, a total of sixteen either currently use or plan to use mechanical devices to assist in obtaining pavement ratings. The devices being used and the number of agencies using them are:

1. Roughness measuring devices (PCA Roadmeter, Mays Ride Meter, etc.) - 16,
2. Skid measuring devices - 8,
3. Deflections measured by the Dynaflect - 3 and
4. Deflections measured by the Benkelman Beam - 1.

These mechanical devices are used for rapid surveys and should not be confused with the number of mechanical devices used in design survey procedures. Many agencies use the types of devices shown but do not

necessarily use them in a rating system.

Table 11 is a summary of the 22 agencies for which the salient features of the condition surveys could be determined. There are several important similarities in these rating systems. These are:

1. Over 70 percent of the agencies using numerical rating scores currently or in the near future use their condition rating system in making maintenance decisions,
2. All of the 22 agencies listed have condition rating systems for flexible pavements and approximately 60 percent have systems for rigid pavements,
3. The car ride meter (Mays, Cox, PCA, etc.) is used by more than half the agencies listed in the table for determining roughness. The Dynaflect and various skid devices are used to a lesser extent,
4. Annual inspection frequencies appear to be the most popular and
5. Generally, the overall numerical rating ranges from 100 (best pavements) to 0 (poorest pavements).

The existing pavement condition survey methods can be classified into two broad categories identified as visual and photographic in Table 12. Details of the items measured in condition surveys conducted in Washington, Minnesota, Ohio, Canadian Department of Transport, British Research Laboratory and King County, Washington, are summarized together with advantages and disadvantages of each method in Table 12. All of the visual methods obtain a subjective measure of the type, degree and magnitude of distress in addition to its approximate location.

Nomenclature used by most agencies in describing pavement distress types is somewhat uniform, although the refinement varies among procedures.

TABLE 11.
SUMMARY OF AGENCIES USING NUMERICAL PAVEMENT RATING SCORES

	Does the agency use the rating score in maintenance decisions?	Does the agency use a rating system for flexible pavements?	Does the agency use a rating system for rigid pavements?	Rating Team Composition	Measuring Equipment Used	Rating Frequency	Numerical Rating Range	Is the numerical rating adjusted for traffic?
Arizona	Yes	Yes	Yes	Unk	Unk	Every two years	100 0	Yes
California	Yes	Yes	Yes	5 to 6 Teams, 2 men ea.	Cox Meter	Every two years	0 201	No
Florida	Yes	Yes	No	5 Teams, 2 men ea.	Mays Meter	Annually	100 0	Yes
Georgia	Unk	Yes	No	Unk	Wisc. Roadmeter Dynaflect Skid	Unk	0 100	Yes
Indiana	No	Yes	Yes	2 Teams ea. District, 2 men ea.	None	Annually	100 0	Yes
Kansas	Yes	Yes	Yes	One man	Roughometer	Unk	100 0	No
Louisiana	Yes	Yes	Yes	Unk	Mays Meter Skid	Unk	100 14	Yes
Maine	Unk	Yes	Unk	Unk	None	Unk	5 1	No
Maryland	Unk	Yes	Yes	One man	None	Annually	100 0	No
Minnesota	Yes	Yes	Yes	One team ea. District, 2 men ea.	PCA Meter	Annually	5 0	No
Nebraska	Yes	Yes	Yes	Unk	Neb. Roadmeter Dynaflect Skid	Every two years	100 0	Yes
New Mexico	Yes	Yes	Yes	One man	None	Annually	100 0	Yes
North Dakota	Yes	Yes	No	Unk	None	Unk	0 49	Unk
Tennessee	Yes	Yes	Yes	One team rates entire state	None	Annually	100 0	No
Texas	Yes	Yes	Yes	One team ea. District, 2 men ea.	Mays Meter	Annually	100 0	No
Virginia	Unk	Yes	Yes	Unk	Unk	Unk	Unk	Unk
Washington	Yes	Yes	Yes	Four teams, 2 men ea.	PCA Meter	Every two years	100 0	No
*King County, Washington	Yes	Yes	No	Unk	Cox Meter Benk. Beam Skid	Annually	160 0	No
Oregon	Yes	Yes	Unk	Unk	PCA Meter	Unk	Unk	Yes
Utah	Yes	Yes	Unk	2 Teams, 2 Men ea.	Cox Meter Dynaflect Skid	Annually	NA**	NA
Ontario	Unk	Yes	Unk	Unk	None	Unk	100 0	Unk
Corpus Christi, Texas	Yes	Yes	Unk	Unk	None	Annually	100 60	Unk

* This system is under consideration for adoption.

**Not applicable to date.

After reference (6)

TABLE 12. Pavement Mechanistic Evaluation--Condition Survey (Distress Measurements)

CATEGORY	METHOD	MEASUREMENTS	ITEMS MEASURED	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Visual Evaluation	Washington State (Flexible)	Type, Degree, Magnitude and Location of Distress	*Rutting *Waves, Sags, Humps *Corrugations, Potholes, Raveling, Flushing *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington *California (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Washington State (Rigid)	Type, Degree, Magnitude and Location of Distress	*Cracking *Raveling, Disintegration, Pop Out Sealing *Joint Spalling *Pumping, Blowing *Blowups *Faulting, Curling, Warping, Settlement *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington *California (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Flexible)	Type, Degree, Magnitude and Location of Distress	*Rutting *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Multiple Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Rigid)	Type, Degree, Magnitude and Location of Distress	*Spalled Joints *Faulted Joints *Cracked Panels *Broken Panels *Faulted Panels *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Bituminous Overland)	Type, Degree, Magnitude and Location of Distress	*Longitudinal Cracking *Transverse Cracking *Multiple Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Ohio (Proposed)	Type, Degree, Magnitude and Location of Distress	*Deterioration *Obstruction *Flushing *Stripping	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured *Limited Measures of Degree and Magnitude of Distress	*Ohio (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection
Photographic	Canadian Dept. of Transport (Flexible)	Type, Degree, Magnitude and Location of Distress	*Hair Cracking *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Chicken Wire *Map Cracking *Reflection Cracking *Stripping *Raveling *Rutting *Deformation *Distortion *Subgrade Settlement *Skin Patches *Deep Patches *Localized Reconstruction *Frost Heave	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Canadian Dept. of Transport (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	British Road Research Laboratory	Type, Degree, Magnitude and Location of Distress	*Disintegration, Flushing *Deformation *Texture *General Variability *Overall Condition	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured	*British Road Research Laboratory (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	King County, Washington (Proposed)	Type, Degree, Magnitude and Location of Distress	*Corrugation, Shoving, Slippage *Flushing *Raveling *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Waves, Sags, Humps *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured	*King County (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection
	British Columbia	*Photographs	*Cracking *Some Distortion *Safety Hazards	*History of Use and Acceptance *Speed of Operation *Safety *Combine Several Measurements in Single Operation *Continuous Record	*Subjectivity of Measurements *Speed *Safety *Detail of Pavement Defects	*British Columbia (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Washington State	*Photographs		*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection

after reference 7.

The following major categories of distress are usually recognized by the various methods:

1. Cracking (alligator, longitudinal, transverse, map, reflection),
2. Disintegration (raveling, stripping, spalling, scaling),
3. Permanent Deformation (rutting, faulting, etc.) and
4. Distortion (settlement, heave, etc.).

Details of individual methods are given in Table 12 and reference 6 to give the reader a better understanding of the differences in condition surveys. In addition to the detail associated with types of distress, some agencies require different forms for flexible, rigid and overlaid pavements while others use a single form.

Length of sections surveyed and weighting factors assigned various types of distress by the different agencies also vary among those conducting condition surveys. For example, Table 13 shows the approximate percent of the condition rating score that is determined by pavement distress factors. The percentage range from 17 percent (Arizona) to 100 percent (Maine). No geographical pattern is evident from the distribution of the percentages. On the average, 49 percent of the rating score for flexible pavements and 43 percent for rigid pavements is accounted for by distress factors. Since the remaining percentages account for such items as roughness, traffic, geometry, etc., it is readily apparent that distress considerations are a significant, though highly variable, part of the individual rating systems.

Table 14 shows the percentage of the pavement rating score represented by each of the forms of distress. The distress factors listed are self-explanatory with the exception of the one listed as "General". This category is used to group those forms of distress listed by the various

TABLE 13. Maximum Percent Distress Factors
Influence Overall Rating by Agency*

	<u>Flexible Pavements</u>	<u>Rigid Pavements</u>
1. Arizona	17.0	17.0
2. California	78.3	--
3. Florida	50.0	--
4. Georgia	37.5	--
5. Indiana	22.0	22.0
6. Kansas	44.0	50.0
7. Louisiana	30.0	30.0
8. Maine	100.0	--
9. Maryland	40.0	40.0
10. Minnesota	50.0	50.0
11. Nebraska	40.0	--
12. New Mexico	40.0	40.0
13. North Dakota	75.5	--
14. Tennessee	50.0	50.0
15. Texas	80.4	85.7
16. Virginia	48.0	42.0
17. Washington	50.0	50.0
18. King County, Washington	37.5	--

*In general, the table does not utilize distress measured by ride meters in the computation of percentages.

-- Indicates one of two items: The agency does not use a rating system for rigid pavements or distress factors are not numerically weighted.

TABLE 14. Maximum Percent Individual Distress Factors Influence Overall Rating by Agency

	Flexible Pavements												Rigid Pavements										
	General	Cracking	Rutting	Raveling	Deflection	Corrugations	Patching	Pitting	Distortion	Shoving	Pot holes	Flushing	General	Cracking	Faulting	Patching	Blow ups	Spalling	Undulations	Scaling	Pumping		
Arizona	17.0												17.0										
California		33.2	9.5	11.9		19.0	4.7																
Florida		30.0	13.3				6.7																
Georgia				37.5																			
Indiana	22.0												22.0										
Kansas		4.0	18.0	12.0			10.0							4.0	24.0	4.0		4.0	10.0	4.0			
Louisiana	30.0												30.0										
Maine		9.0	44.0	14.0		5.0		14.0	14.0														
Maryland	40.0												40.0										
Minnesota		27.5	7.5			15.0								15.0	5.0	15.0		12.5		2.5			
Nebraska	20.0			20.0																			
New Mexico	40.0												40.0										
North Dakota		49.0	10.2	4.1					6.1	6.1													
Tennessee	>50												>50										
Texas		27.4	5.9	7.8		7.8	7.8			15.7	7.8			28.6	7.6	3.8	7.6	11.4		11.4	11.4		
Virginia		35.0	5.0	1.0				2.0			5.0			7.0	10.0		25.0						
Washington King County, Washington		18.1	11.1		2.7	4.2		11.1		2.7				9.8	5.9	2.9	2.9	9.8		9.8	8.8		
		12.5	6.3	6.3	3.1			3.1	3.1		3.1												
Avg. Among Agencies Using the Distress Factor	25.8	29.5	9.5	6.2	28.8	7.5	8.1	14.0	7.6	4.6	8.2	5.3	29.0	16.9	6.5	7.2	5.3	12.5	10.0	6.9	10.1		
Avg. Among Agencies Using Flexible (18) or Rigid (12) Rating Systems	12.9	16.4	5.3	1.7	3.2	2.1	2.7	0.8	1.7	0.5	1.4	0.9	16.9	7.0	2.7	1.8	0.9	5.2	0.8	2.3	1.7		

agencies under generalized headings like "structural adequacy".

The amount that individual distress factors influence the overall rating can be examined in two ways. First, by determining the average of only those agencies which use the factor and second, by averaging of all agencies. The latter is considered the more informative, because if an agency does not include a given factor, that is an indication that the factor is considered unimportant.

Based on the latter averaging procedure, the "General" category accounts for an average of 13 percent (flexible) and 17 percent (rigid) of the overall pavement rating score. Of all of the specific types of distress, cracking is the most heavily weighted with 16 percent for flexible and 7 percent for rigid pavements. The next most important forms of distress for flexible pavements are rutting (5%) and patching (3%). For rigid pavements, the next most important forms of distress are spalling (5%) and faulting (3%). Deflections average 3 percent for flexible pavements but are not considered as distress in this analysis.

Photographic methods for conducting condition surveys have been developed in British Columbia and Washington. The British Columbia device not only gives an indication of pavement cracking and distortion but also measures road roughness, pavement cross slope, the presence of roadside hazards and signing needs. Detailed pavement distress cannot be recognized from photographic techniques presently used.

Review of Table 12 and the literature indicates that a number of condition survey methods have been implemented by various agencies; however, certain problem areas have been identified and are given below:

1. Undesirable subjectivity in surveys due to present techniques and/or human factors,

2. Absence of valid, workable statistical sampling procedures for highway surveys,
3. Adequate delineation of established survey areas for repetitive survey purposes,
4. Lack of uniformity in severity weighting techniques for distress types,
5. Inability with current data storage and retrieval methods to achieve a valid and workable inventory of pavement condition and
6. Hazardous and disruptive nature of condition surveys, as currently conducted.

In spite of the above mentioned problems with condition surveys, the condition survey approach was considered as a measuring element in the pavement rating system.

Development of Maintenance Rating System

Based on the literature summarized above and discussions with field and central office maintenance personnel of the Texas State Department of Highways and Public Transportation a maintenance rating system has evolved. The key elements of this system have become a subjective visual roadway condition survey and objective mechanistic tools to measure pavement roughness, skid resistance and pavement structural capacity. The objective measuring systems include the Mays Ride Meter to determine pavement roughness (21), the locked-wheel skid trailer to measure the skid number at 40 m.p.h. and the Dynaflect to measure pavement structural capacity. The subjective roadway condition survey consists of a pavement condition survey and

an itemized evaluation of shoulder, roadside, drainage and traffic services features. Separate forms are utilized for flexible and rigid pavements.

Details describing the roadway condition survey as presently utilized in Texas can be found in reference 4. A brief history of the development of this system follows.

Development of Roadway Condition Survey. As discussed above the maintenance rating system should be capable of determining the present condition of highway elements including the pavement, shoulder, roadside, drainage and traffic services features. An extensive list of maintainable features under each of the above categories was prepared and reviewed by Texas Transportation Institute and Texas State Department of Highways and Public Transportation representatives. The items finally selected for shoulder, roadside, drainage and traffic services features are shown in Figure 4 and listed below:

A. Shoulders

1. Paved Shoulders

- a. Ride
- b. Contrast
- c. Pavement edge
- d. Shoulder edge
- e. Cracks
- f. Raveling or flushing
- g. Vegetation

2. Unpaved Shoulders

- a. Pavement edge
- b. Rutting, corrugations, loose rock

DISTRICT NO. <input type="text"/>		RATERS <input type="text"/>		DATE MONTH <input type="text"/> DAY <input type="text"/> YEAR <input type="text"/>							
LOCATION											
						FOREMAN NO. <input type="text"/>		HIGHWAY CLASS <input type="text"/>		COUNTY NO. <input type="text"/>	
						HIGHWAY NO. <input type="text"/>		CONTROL <input type="text"/>		SECTION <input type="text"/>	
						FROM <input type="text"/>		TO <input type="text"/>		LANE <input type="text"/>	
						MAYS METER					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		RUTTING					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		RAVELING					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		FLUSHING					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		CORRUGATIONS					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		ALLIGATOR CRACKING					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		LONGITUDINAL CRACKING					
SLIGHT MODERATE SEVERE		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		TRANSVERSE CRACKING					
CRACKS (1) SEALED (2) PARTIALLY SEALED (3) NOT SEALED											
GOOD FAIR POOR		<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	<input type="text"/> 01-15 <input type="text"/> 06-30 <input type="text"/> > 30	% AREA		PATCHING					
01-5 2 6-10 3 > 10		FAILURES / MILE									
RIDE CONTRAST PAVEMENT EDGE SHOULDER EDGE CRACKS RAVELING VEGETATION		PAVED									
PAVEMENT EDGE RUTTING, CORRUGATIONS, LOOSE ROCK		UNPAVED									
LITTER MOWING VEGETATION SLOPE EROSION		ROADSIDE AND DRAINAGE									
CULVERTS DITCHES, OUTFALL, CHANNELS ROADSIDE DRAINAGE		TRAFFIC SERVICE									
GUARDRAILS SIGNS DELINEATORS STRIPING AUXILIARY MARKINGS											
OTHER											

Figure 4. Maintenance Rating Form for Flexible Pavements

B. Roadside

1. Litter
2. Mowing
3. Vegetation
4. Slope erosion

C. Drainage

1. Culverts
2. Ditches, outfalls, channels
3. Roadside drainage

D. Traffic Services

1. Guardrails
2. Signs
3. Delineators
4. Striping
5. Auxiliary Marking

The items initially considered for evaluation purposes are shown in Table 15. As noted, a considerable number of items were combined or deleted. For example, items finally selected to identify shoulder maintenance needs are in the two categories of paved and unpaved rather than the four categories of asphalt concrete, surface treatment or seal coat, unpaved and sod as originally considered.

The rating techniques selected for use in evaluating the condition of the shoulder, roadside, drainage and traffic services elements are shown in Table 16. This numerical rating is based on the condition of the element being evaluated and not specifically for its need for maintenance. However, numerical ratings can be utilized to suggest the urgency of required maintenance utilizing the guidelines shown below:

TABLE 15. Roadway Items Originally Considered for
Evaluation as Part of Maintenance Rating System

SHOULDER FEATURES

- A. Asphalt Concrete Shoulders
 - 1. Appearance
 - 2. Distress Types Contained on Pavement Condition Survey
- B. Surface Treatment on Seal Coat Shoulder
 - 1. Appearance
 - 2. Riding Quality
 - 3. Raveling
 - 4. Flushing
 - 5. Cracking
 - 6. Potholes
 - 7. Shoulder Build-up
- C. Unpaved Shoulders (Granular Materials)
 - 1. Appearance
 - 2. Riding Quality
 - 3. Raveled Pavement Edge
 - 4. Pavement Drop-off
 - 5. Potholes
 - 6. Corrugations or Loose Rock
 - 7. Erosion
- D. Sod Shoulders
 - 1. Appearance
 - 2. Riding Quality
 - 3. Raveled Pavement Edge
 - 4. Pavement Drop-off
 - 5. Potholes
 - 6. Corrugations or Loose Rock
 - 7. Erosion

ROADSIDE FEATURES

- A. Litter
- B. Trees
- C. Shrubs and Plantings
- D. Grass
- E. Flowers
- F. Roadside Parks
- G. Fencing
- H. Brush
- I. Vegetation Control
- J. Encroachments
- K. Pest Control

DRAINAGE FEATURES

- A. Drainage Ditches
 - 1. Erosion
 - 2. Silt Removal
 - 3. Vegetation Control
 - 4. Slope Adequacy
 - 5. Vegetation Needs
- B. Slopes
 - 1. Erosion
 - 2. Vegetation Needs
 - 3. Retards - Grass
 - 4. Retards - Concrete
- C. Culverts and Drainage Structures
 - 1. Silting
 - 2. Structure Condition
 - 3. Rip Rap

TRAFFIC SERVICES

- A. Signs
 - 1. Cleanness
 - 2. Supports
 - 3. Location
- B. Delineators
 - 1. Cleanness
 - 2. Supports
 - 3. Location
- C. Median Barriers, Guard Rails, Transition Rails
 - 1. Cleanness
 - 2. Supports
 - 3. Location
- D. Turnouts
 - 1. Mailbox
 - 2. Driveway
 - 3. Mailbox Condition
- E. Intersection Channelization
- F. Striping
- G. Night Visibility

TABLE 16. Rating Scale for Shoulder, Roadside,
Drainage and Traffic Services.

General Description of Condition	Numerical Scale
Very Good	1-2
Good	2-4
Fair	4-6
Poor	6-8
Very Poor	8-9
Item not present on roadway section	0

Evaluation Score

Maintenance Urgency

1 - 2	Maintenance not required in 2 or more years
2 - 4	Maintenance not probable in 2 years but need should be re-evaluated yearly
4 - 6	Possible maintenance in 1 year
6 - 8	Schedule maintenance within 1 year
8 - 9	Schedule maintenance immediately

Development of Flexible Pavement Condition Survey. The pavement condition portion of the maintenance rating system was developed based on the extensive literature review summarized above together with input from personnel from the Texas State Department of Highways and Public Transportation. Two systems for pavement evaluation were seriously considered for adoption by the study staff; the Washington State Method and the method proposed for use in Ohio (13). The Washington Method (Figure 5) appeared to offer more versatility and thus was selected for trial implementation on a maintenance section of District 21. The results of this survey were very encouraging and thus the type of form utilized by Washington was used as a basis for development of the Texas pavement maintenance rating form.

Figure 6 depicts the original maintenance rating form utilized for trial implementation in Districts 7 and 21. All of the roadways in Districts 7 and 21 and approximately 250 pavement sections selected throughout the state were evaluated with this form in 1972-1973. Deduct or negative values assigned to the various degrees and types of pavement distress for the 1973 survey form are shown in Table 17.

A comparison of Figures 5 and 6 illustrates the changes made in the Washington form for use in Texas. These changes are briefly reviewed

*CODE = (1) Unpaved Roadways, (2) Roadways Under Construction
(3) Bridge, (4) Roadway Impassable

HF 33.23
REVISED 3/1/71

Figure 5. Washington Pavement Condition Survey Form

DATE _____		LOCATION		DISTRICT NO.			
				COUNTY NO.			
				HIGHWAY NO.			
				CONTROL			
				SECTION			
				FROM			
				TO			
				LANE NO.			
				RATER NO.			
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				SLIGHT		① 1-15 ② 1-15 ③ 1-15	
				MODERATE		④ 16-30 ⑤ 16-30 ⑥ 16-30	
				SEVERE		⑦ >30 ⑧ >30 ⑨ >30	
				GOOD		① 1-5 ② 1-5 ③ 1-5	
				FAIR		④ 6-15 ⑤ 6-15 ⑥ 6-15	
				POOR		⑦ >16 ⑧ >16 ⑨ >16	
				RIDE			
				CONTRAST			
				PAVEMENT EDGE			
				SHOULDER EDGE			
				CRACKS			
				RAVELING			
				VEGETATION			
				PAVEMENT EDGE			
				RUTTING, CORRUGATIONS, LOOSE ROCK			
				LITTER			
				MOWING			
				VEGETATION			
				SLOPE EROSION			
				ENCROACHMENTS			
				CULVERTS			
				DITCHES, OUTFALL, CHANNELS			
				ROADSIDE DRAINAGE			
				GUARDRAILS			
				SIGNS			
				DELINEATORS			
				STRIPING			
				AUXILIARY MARKINGS			
				SIGNALS			
				ROADWAY MAINTENANCE SCHEDULE			

Figure 6. 1973 Maintenance Rating Form for Flexible Pavements

TABLE 17. 1973 Deduct Table
Flexible Pavement Evaluation

Negative Values to be Assigned to the Various Degrees of Pavement Failures

Type of Distress	Degrees of Distress	Extent or Amount of Distress		
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Waves	Slight	10	15	20
Sags	Moderate	20	25	30
Humps	Severe	30	35	40
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Longitudinal Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Transverse Cracking	Slight	3	5	10
	Moderate	4	7	12
	Severe	5	10	15
Patching	Good	2	5	7
	Fair	5	7	10
	Poor	7	10	15

below.

1. Shoulder, roadside, drainage and traffic service features were added to the form and bituminous and portland cement concrete pavements were placed on separate forms.

2. The headings of rutting, waves, sags, humps, alligator cracking, longitudinal cracking, transverse cracking and patching were transferred from the Washington to the Texas form although the definition of the amount and severity of distress was changed in many cases.

3. Corrugations, raveling and flushing which appears under one heading on the Washington form was separated into three headings on the Texas form.

4. The pavement distress items for portland cement concrete pavement, as will be discussed below, was altered to include an evaluation method for both continuous and jointed concrete pavements.

A comparison of Figures 4 and 6 illustrates refinements in the rating system which occurred after a trial implementation phase. Six changes which occurred are briefly discussed in the following paragraphs.

1. Additional location data were included. Specifically, the foreman, number and highway class were identified on the new form. In addition, the names of those conducting the rating and the date the ratings were performed was included in a form suitable for data processing.

2. The pavement distress items "Waves, Sags, Humps" was removed and replaced with the Serviceability Index as measured by the Mays Meter.

The field trials demonstrated that considerable variation existed in the estimates of "waves, sags, humps". This variability together with the general availability of the Mays Ride Meter indicated that this was a practical change.

3. From a maintenance scheduling standpoint it is necessary to know if the transverse and longitudinal cracks are sealed, partially sealed or not sealed. A column denoting this condition was inserted.

4. A column denoting the number of failures per mile of roadway was inserted into the form. Due to the reduced frequency of needed maintenance pavement failures were expected and have occurred in Texas at an increasing rate. This category of distress is singled out to emphasize the seriousness of the problem.

5. Under the heading of "roadside" the item "encroachments" has been removed. Encroachments were not considered a major problem in most parts of the state. Encroachment problems can now be entered on the form by use of an appropriate number under the columns "other".

6. A three space column was added and titled "other". This portion of the form is to be utilized by the evaluation team to denote unusual conditions that exist along the roadway. Examples of items to be noted by code numbers are encroachments, signals operating improperly and dangerous geometric features including improper speed signing of curves and striping of no passing zones.

Because of the changes in the pavement rating forms, new deduct values were developed and are shown in Table 18. The deduct points for patching were reduced and deduct points were adjusted for longitudinal and transverse crack condition, i.e., sealed or unsealed.

TABLE 18. Deduct Table Flexible Pavement Evaluation

Negative Values to be Assigned to the Various Degrees of Pavement Failures

Type of Distress	Degrees of Distress	Extent or Amount of Distress		
		(1)	(2)	(3)
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20

Deduct Points for Cracking

Longitudinal Cracking

	Sealed			Partially Sealed			Not Sealed		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Slight	2	5	8	3	7	12	5	10	15
Moderate	5	8	10	7	12	15	10	15	20
Severe	8	10	15	12	15	20	15	20	25

Transverse Cracking

Slight	2	5	8	3	7	10	3	7	12
Moderate	5	8	10	7	10	15	7	12	15
Severe	8	10	15	10	15	20	12	15	20

Failures	20	30	40
----------	----	----	----

Deduct points for the Mays Ride Meter were based on Serviceability Index values obtained from the statewide random pavements survey. The distribution of the Serviceability Index values for all pavement sections investigated is shown in Table 19 together with the deduct points presently utilized. Ten deduct points were assigned to the average condition and the other deduct points were arbitrarily assigned as shown. It should be recognized that the vast majority of the pavements surveyed had either asphalt concrete or chip seal surfaces.

Development of Rigid Pavement Condition Survey. The visual rating form for portland cement concrete or rigid pavements is identical to the form for flexible pavements with the exception of the central portion of the form relating to the pavement surface (Figure 7). The development of the form followed a process similar to that utilized for development of the flexible pavement form. The Washington Method was utilized as a general guide and a form for trial implementation developed (Figure 8). This form was utilized to rate pavements in Districts 13 and 17. The results of this trial implementation suggested that certain changes should be made (Figure 7). As will be noted on Figure 7, the pavements portion of the form is divided into three sections. The types of distress observed on both continuously reinforced and jointed pavements are listed first. These distress types include pumping, scaling, raveling, disintegration, pop-outs, spalling, longitudinal cracking, patching and faulting. The other two portions relate to either continuously reinforced concrete or jointed pavements exclusively.

Deduct points utilized with the present rigid pavement form are shown in Table 20.

TABLE 19. Distribution of 1973 Serviceability Index
Values as Obtained from Random Pavement Sections

Serviceability Index	Percent of Pavements Less Than Value	Deduct Points
4.70	0	0
3.70	25	3
3.50	35	5
3.30	50	10
3.10	65	20
2.95	75	30
2.75	85	40
2.40	95	50

DISTRICT NO. <input type="text"/>		RATERS <input type="text"/>		DATE MONTH <input type="text"/> DAY <input type="text"/> YEAR <input type="text"/>	
LOCATION		FOREMAN NO.		HIGHWAY CLASS	
COUNTY NO.		HIGHWAY NO.		CONTROL	
SECTION		FROM		TO	
LANE		MAYS METER		PORTLAND CEMENT CONCRETE PAVEMENTS	
		① SLIGHT ② MODERATE ③ SEVERE PUMPING		ALL PAVEMENTS	
		① 1-5 ② 6-10 ③ >10 FAILURES / MILE		CRACK JOINTED ONLY	
		SLIGHT MODERATE SEVERE		SURFACE DETERIORATION	
		SLIGHT MODERATE SEVERE		SPALLING	
		SLIGHT MODERATE SEVERE		LONGITUDINAL CRACKING	
		GOOD FAIR POOR		PATCHING	
		MODERATE SEVERE		FAULTING	
		CLOSED OPEN		CRACK SPACING	
		MODERATE SEVERE		% INTERSECTING CRACKS	
		SAWED CONSTR.		JOINT SPACING	
		SLIGHT MODERATE SEVERE		TRANSVERSE CRACKING	
		JOINT & CRACK (1) SEALED (2) PARTIALLY (3) NO SEAL		SHOULDER	
		RIDE CONTRAST PAVEMENT EDGE SHOULDER EDGE CRACKS RAVELING VEGETATION		PAVED	
		PAVEMENT EDGE RUTTING, CORRUGATIONS, LOOSE ROCK		UNPAVED	
		LITTER MOWING VEGETATION SLOPE EROSION		ROADSIDE AND DRAINAGE	
		CULVERTS DITCHES, OUTFALL, CHANNELS ROADSIDE DRAINAGE		TRAFFIC SERVICE	
		GUARDRAILS SIGNS DELINEATORS STRIPING AUXILIARY MARKINGS			
		OTHER			

Figure 7. Maintenance Rating Form for Rigid Pavements

DISTRICT NO. COUNTY NO. HIGHWAY NO. CONTROL SECTION FROM TO LANE NO. RATER NO.	LOCATION		DATE _____		JOINTED ONLY	PORTLAND CEMENT CONCRETE PAVEMENT				
							1-25% PANELS	1 1-2	CRACKS > 1/8"	CRACKING
							25-50% PANELS	2 3-5	PER PANEL	
							OVER 50% PANELS	3 5+		
							SAWED CONSTRUCTION	1 < 20' 2 > 20'		JOINT SPACING
							1-15% JOINTS	1 0-1	WIDTH OF SPALL IN INCHES	JOINT SPALLING or TRANSVERSE CRACK SPALLING
							16-50% JOINTS	2 1-3		RAVELLING DISINTEGRATION POP OUT SCALING
							OVER 50% JOINTS	3 3+		PUMPING BLOWING
							1-25% AREA	1 SLIGHT		FAULTING CURLING WARPING
							26-75% AREA	2 MODERATE		
OVER 75% AREA	3 SEVERE									
1-15% SECTIONS	1 < 10%	% SECTION LENGTH		ALL PAVEMENTS	CRCP ONLY					
16-35% SECTIONS	2 10-50%									
OVER 35% SECTIONS	3 > 50%									
1-15% SECTIONS	1 0-1/4"									
16-35% SECTIONS	2 1/4 - 1/2"									
OVER 35% SECTIONS	3 1/2" +									
1-5% SECTIONS	1 1-5%	% AREA PER SECTION	PATCHING							
6-20% SECTIONS	2 6-25%									
OVER 20% SECTIONS	3 25% +									
< 1/16" WIDE	1 5-10'	3 < 2' OR > 15'	TRANSVERSE CRACK SPACING							
> 1/16" WIDE	2 2-5' OR 10-15'									
< 1/8" WIDE	1 0-99'	LINEAL FEET PER STATION	LONGITUDINAL CRACKING							
1/8" - 1/4" WIDE	2 100-199'									
SPALLED	3 200 +									
NO LOOSE PIECES	1 < 10%		% INTERSECTING CRACKS							
LOOSE PIECES	2 > 10%									
RIDE			PAVED							
CONTRAST										
PAVEMENT EDGE										
SHOULDER EDGE			UNPAVED							
CRACKS										
RAVELLING										
VEGETATION			ROADSIDE							
PAVEMENT EDGE										
RUTTING, CORRUGATIONS, LOOSE ROCK										
LITTER			DRAINAGE							
MOWING										
VEGETATION										
SLOPE EROSION			TRAFFIC SERVICES							
ENCROACHMENTS										
CULVERTS										
DITCHES, OUTFALL, CHANNELS										
ROADSIDE DRAINAGE										
GUARDRAILS										
SIGNS										
DELINEATORS										
STRIPING										
AUXILIARY MARKINGS										
SIGNALS										
ROADWAY MAINTENANCE SCHEDULE										

TABLE 20. Deduct Values for Rigid Pavement

Type of Distress	Degrees of Distress	Extent or Amount of Distress (1)	(2)	(3)
Pumping		20	40	60
Failures/Mile		20	30	40
Surface Deterioration	Slight	5	10	20
	Moderate	10	20	30
	Severe	20	40	60
Spalling	Slight	5	10	15
	Moderate	10	15	20
	Severe	20	40	60
Longitudinal Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20
Faulting	Moderate	5	15	
	Severe	15	40	
Crack Spacing	Closed	0	10	
	Open	15	40	
% Intersecting Cracks	Moderate	5	15	
	Severe	15	40	
Joint Spacing	Information Only			
Transverse Cracking				
If Joint Spacing is less than 20 feet.				
	Slight	5	10	20
	Moderate	10	20	30
	Severe	15	30	40
If Joint Spacing is greater than 20 feet.				
	Slight	0	5	10
	Moderate	5	10	20
	Severe	10	15	30
Joints		0	10	20

Use of Maintenance Rating System for Flexible Pavements. The condition survey portion of the maintenance rating system was made available for use by all districts during the conduct of Research Study 2-18-75-199 as described in reference 5. A majority of the 25 districts in Texas have utilized this evaluation tool for a part or all of the pavements in their district. In addition one district, District 21, has made use of the other evaluation tools which are considered a part of the Maintenance Rating System. These tools include the Mays Ride Meter, the skid trailer and the Dynaflect. The use of the information gathered from their survey work is discussed in references 15, 16 and 17. Computer programs developed to assist in the use of these data for maintenance management purposes are described below together with the utilization of the collected data.

Computer Programs. Computer programs were developed to fit the needs of different levels of management within the Texas State Department of Highways and Public Transportation as determined from panel meetings and personal visits to several districts. Several of these programs were prepared to provide one-time needs or for illustration purposes and have not been formally prepared for implementation. Those programs anticipated for use on a broad scale have been documented in references 4 and 24.

Condition survey data reduction and sorting programs have been developed and documented in reference 4. Five rating scores have been defined as follows:

1. Pavement Rating Score (PRS),
2. Shoulder Rating Score (SRS),

3. Roadside Rating Score (RRS),
4. Drainage Rating Score (DRS) and
5. Traffic Services Rating Score (TRS).

Ten sort options exist to summarize these data from low to high Pavement Rating Score, by highway class, by county number, by highway type, by foreman and by several combinations of the above basic categories (Table 21). An example of a typical printout is shown in Figure 9.

A program referred to as the plot program has been developed based on a need to summarize a variety of collected data in graphical form (Figure 10) according to location along the roadway. Information collected and displayed includes:

1. Road roughness as measured by the Mays Ride Meter,
2. Skid number as measured by the ASTM E-17 locked wheel skid trailer,
3. Structural adequacy as measured by the Dynaflect,
4. Location of intersecting roads,
5. Average daily traffic,
6. Equivalent 18,000 lb. single axle load applications for a 20-year design life,
7. Control and section number,
8. Type of surfacing material,
9. Date of last surfacing,
10. Cost per mile for pavement and shoulder maintenance,
11. Cost-benefit ratio based on cost per mile and pavement rating score,
12. Pavement Rating Score,
13. Shoulder Rating Score,

TABLE 21. Sort Options

Option	Sort Order
1	Sort by County: county, highway code, highway number, lane, and from mile.
1A	Sort by County: county, highway code, highway number, from mile, and lane.
2	Sort by Foreman Number: foreman, highway code, highway number, lane, and from mile.
3	Sort by PRS-Entire District: pavement rating score.
4	Sort by PRS - by County: county and pavement rating score.
5	Sort by PRS - by Foreman Number: foreman and pavement rating score.
6	Sort by PRS - by Highway Class: highway class and pavement rating score.
7	Sort by Highway Type - Entire District - Ordered by PRS: highway code and pavement rating score.
8	Sort on Foreman - Arranged by Type - Ordered by PRS: foreman, highway code, and pavement rating score.
9	Sort by Highway Type - Entire District - Ordered by PRS - "SH" Highway Codes Converted to "US": highway code and pavement rating score.
10	Sort by Highway Type - Entire District - Ordered by PRS - "US" Highway Codes Converted to "SH": highway code and pavement rating score.

Notes:

- A. Sort options 9 and 10 may not be requested in the same run.
- B. The conversions of highway codes in options 9 and 10 are internal conversions for the purpose of sorting only. The highway codes will be printed exactly as read from the input cards.

DISTRICT NO. 3 --SORT BY COUNTY

```

*****
*ROADSIDE*****
*AND *TRAFC*
*PAVEMENT* *SHOULDER *DRAINAGE*SERVS*
* * * * C * * L * * * * PAVED *UP* * * *
* * * * O * * O * * * * ***** * * *
* * * * R * * N * T * * * * R * * * *
* * * * R * * A * G * R * * * * U * * * *
* * R * F * U * LC* IC* AC* *F* * T* * DR* U*
* R * A * L * G * LR* TR* NR* *A* * T* * IO* X*
* U * V * U * A * IA* UA* SA* *I* * I* * TA* I*
* T * E * S * T * GC* DC* VC* *L* * N* * .D* L*
*****
* * * * * RATING ***** T * L * H * I * AK* IK* EK* P * *U* PS *PG* S* S* I*
* * * * * SCORES ***** I * I * I * O * TI* NI* RI* A * *R* AH *A * L* OI* A*
* * * * * ***** N * N * N * N * ON* AN* SN* T * *E* VO *VC* .D* TD* D R*
* F * 4 * * * * * * * * * * T * G * G * G * S * RG* LG* EG* C * *S* EU V*EO* VP* FE*G E Y*
* O * 4 * C * I * * * * * * * * * * R * * * * * * * * * * H * * * ML E*MR* EE* A *U L *
* R * A * J * G * * * * * * * * * * P * S * R * D * A * M * M * M * M * M * M * I * *P* CED RG*ER* G *CLD*A ISM*
* E * 7 * U * H * C * S * F * * * S * A * H * O * R * F * O * O * O * O * O * O * N * *E* ONE AE*NU* EE*U.R*R NTA*
* M * * N * W * O * E * R * * * * V * O * A * A * * * SDS*SDS*SDS*SDS*SDS*SDS*SDS* G * *R* NTRCVT*TG*LMTR*L A*D ERR*
* A * 5 * T * A * N * C * O * T * * * H * E * U * D * I * * * LEE*LEE*LEE*LEE*LEE*LEE*LEE* * * T REA* A*IOAD*VCI*RSAIK*
* N * L * Y * Y * T * T * M * O * L * E * M * L * S * N * S * IRV*IRV*IRV*IRV*IRV*IRV*IRV*GFP* *M*RREEALT*ET*TWTS*EHN*AITPI*
* * A * * * R * I * * * * A * T * E * D * I * A * E * GAE*GAE*GAE*GAE*GAE*GAE*GAE*OAO* *I*IADDCI*I*DI*TI*I*RAA*IGOIN*
* N * 5 * N * N * O * O * M * M * N * E * N * E * D * G * R * HTR*HTR*HTR*HTR*HTR*HTR*HTR*OIO* *L*DSGGKNO*GO*ENOD*TN*G*LN*RG*
* O * 5 * O * O * L * N * P * P * E * R * T * R * E * E * * * TEE*TEE*TEE*TEE*TEE*TEE*TEE*DRR* *E*ETEE*SGN*EN*RGNN*S.E*SSSGS*
*****
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*S*3.9* 86* 84* 87* 90*100*1 *2 * * * * *1 * * * *2113121* *2111*111* *
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*R*3.9* 89* 86* 77* 87* 84*3 * * * * * *1 * * * *2111131* *2223*121*3212 *
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*M*4.0* 89* 83* 87* 90*100*1 *1 * * * * *1 * * * *2113131* *2111*111* *
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*L*4.0* 89* 84* 82* 87* 88*3 * * * * * *1 * * * *3111131* *2113*121*2112 *
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*X*3.8* 86* 79* 85* 90* 86* *3 * * * * * * * * *2422122* *2211*111* 2212*
* 5* 3*252*IH 35* 22* 1* 5.2* 9.0*A*3.7* 86* 74* 80* 90* 86* *3 * * * * * * *1 * * *1343223* *2222*111* 2212*
* 5*12*252*US 283* 89* 1* 0.0* 5.2*S*4.0* 80*100*100*100*100* * *1 * * * *1 *2 * * * * * * *
* 5*12*252*US 283* 89* 1* 0.0* 5.2*R*3.9* 65* 71* 75* 80* 60*2 * *2 * * *2 *1 *2 * * * *3526211* *4411*222*14546*
* 5*12*252*US 283* 89* 1* 0.0* 5.2*M*3.8* 79*100*100*100*100* * *1 * * * *1 *2 * * * * * * *
* 5*12*252*US 283* 89* 1* 0.0* 5.2*L*3.5* 71* 80* 75* 80* 60*2 * *1 * * *1 *1 *2 * * * *3223211* *4411*222*14546*
* 5* 1*252*FM 578*1031* 7* 0.0* 4.6*R*3.2* 55* 70* 85* 83* 84* *2 * * * *1 *2 * *1*1 * * * *33*2211*212* 233 *
* 5* 1*252*FM 578*1031* 6* 4.6* 8.2*R*3.0* 42* 70* 87* 87* 84* *3 * * * *1 *1 * *1* * * * *42*1121*112* 233 *
*****

```

Figure 9. Output from Program MRSFP

18 KIP EQUIV. AXLES

Figure 10. Plot Program Output

14. Roadside Rating Score,
15. Drainage Rating Score,
16. Traffic Services Rating Score and
17. Composite Rating Score obtained by multiplying the PRS, SRS, RRS, DRS and TRS by the percent of the total maintenance budget expended for each category.

The type of output shown in Figure 10 has been utilized by two districts at both the district and section management levels. This plot has been an invaluable reference for district maintenance personnel as well as district planning, design and construction groups.

A summary program has been prepared at the request of district engineers to present a concise review of their roadway conditions. Table 22 illustrates the general format of this output which contains information on the highway location, the rating scores, skid numbers (SN), road roughness (SI), structural capacity (SCI), average daily traffic (ADT), surface type (ST) and date of last surfacing. Because little use of this program has been made, it has not been documented.

A series of three budget programs were developed for District 21 in 1974. These programs were developed to illustrate the usefulness of maintenance rating system information for budget preparation and to satisfy, in part, central office requirements for budget justification. Figures 11 and 12 and Table 23 depict the computer printout format utilized to display the data. Figures 11 and 12 depict actual average and desired rating scores by each foreman by highway class. These data were utilized to adjust past years budgets to consider the present condition of the roadways. Table 23 summarizes cost by foreman for each highway class.

*****															*****
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	AST*
*	FROM	TO	*	*	*	*	*	*	*	*	AVG*	AVG*	AVG*	*	JUR.*
* ROAD	MP	MP	*LANE	*CRS	*PRS	*SRS	*RRS	*DRS	*TSS	SN	SI	SCI	ADT	*ST	DATE*
*****															*****
US 281	0.0*	3.0*	*	78*	53*	87*	86*	77*	88*	37.*	3.6*	0.0*	3730*	AC*	969*
US 281	3.0*	11.0*	*	73*	43*	83*	90*	80*	83*	45.*	3.0*	0.0*	3655*	AC*	969*
US 281	11.0*	22.0*	*	87*	75*	86*	92*	93*	92*	42.*	3.8*	0.0*	3580*	AC*	968*
US 281	22.0*	30.0*	*	85*	77*	76*	84*	93*	92*	43.*	3.8*	0.0*	3040*	AC*	968*
SH 285	0.0*	8.0*	*	80*	75*	80*	72*	80*	87*	49.*	3.3*	.82*	910*	ST*	961*
SH 285	8.0*	15.0*	*	78*	68*	75*	68*	80*	88*	52.*	3.4*	.84*	910*	ST*	961*
SH 285	15.0*	22.0*	*	79*	68*	80*	70*	80*	88*	40.*	3.8*	.84*	1380*	AS*	961*
FM 430	0.0*	3.0*	*	85*	70*	85*	90*	90*	93*	41.*	2.6*	0.0*	115*	ST*	967*
FM 754	0.0*	3.0*	*	90*	98*	85*	90*	90*	88*	0.*	2.8*	0.0*	240*	ST*	969*
FM 755	0.0*	7.0*	*	88*	93*	75*	86*	87*	90*	39.*	3.6*	.45*	500*	ST*	970*
FM1418	0.0*	6.0*	*	87*	90*	85*	90*	90*	85*	38.*	2.5*	0.0*	285*	ST*	969*
FM2191	0.0*	6.0*	*	85*	77*	80*	88*	90*	90*	63.*	3.1*	0.0*	760*	AC*	972*
FM2191	6.0*	12.0*	*	86*	72*	83*	92*	97*	92*	39.*	3.2*	0.0*	490*	ST*	966*
FM3066	0.0*	2.0*	*	84*	86*	55*	92*	77*	88*	70.*	3.6*	0.0*		*ST*	966*
*****															*****

TABLE 23. District 21 -- Budget Data

FOREMAN ACCOUNT NO. 7
 LEVEL 2 YEAR 1975
 TOTAL FUNDS AVAILABLE TO FOREMAN 630703.

HWY CLASS	TOTAL MILES	EXPENS DISTRB	COST COST	COST/ MILES MAINTD
10	33.09	9.2	58025	1754.
20	126.11	29.3	184796	1465.
30	26.27	20.7	130556	4970.
31	0.12	0.1	631	5256.
40	4.71	6.4	40365	8570.
50	10.90	2.5	15768	1447.
60	6.26	2.7	17029	2720.
70	14.25	12.3	77576	5444.
71	1.71	0.7	4415	2582.
80	5.85	16.1	101543	17358.
		TOTALS	630702	2751. WEIGHTED AVERAGE

FIGURE 11.

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 4

HWY CLASS	COMPOS SCORE	PAVMT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	75.1	82.6	71.3	74.4	60.0	72.8	3.7	1478.	1402.	18.6	190694.	180929.
20	68.3	65.4	58.8	73.8	60.0	73.0	3.8	839.	862.	12.7	116932.	120076.
30	79.2	88.6	69.6	86.5	65.0	65.7	2.2	4718.	4253.	54.1	4387.	3955.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
OVERALL WEIGHTED AVG	71.6	73.7	64.8	74.1	60.0	72.9	3.8	1159.	1133.	15.7	312013.	304961.
TOTAL (NON-WEIGHTED)												

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 5

HWY CLASS	COMPOS SCORE	PAVMT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	73.9	78.0	70.9	72.4	62.3	71.7	4.1	933.	901.	12.2	117654.	113616.
20	69.7	61.9	59.4	73.6	60.0	76.0	4.5	793.	815.	12.4	43002.	44168.
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	73.8	73.6	70.4	74.4	60.0	74.0	4.9	2695.	2683.	36.3	90105.	89692.
50	76.6	81.8	75.0	80.6	64.5	64.5	2.6	3456.	3341.	43.4	31138.	30102.
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	70.0	68.0	68.0	74.0	60.0	67.0	3.9	16199.	16190.	231.2	65930.	65893.
OVERALL WEIGHTED AVG	72.9	73.5	68.2	73.4	61.5	72.7	4.3	1533.	1514.	21.0	347828.	343472.
TOTAL (NON-WEIGHTED)												

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 6

HWY CLASS	COMPOS SCORE	PAVMT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	63.7	48.8	54.8	75.6	60.3	69.9	3.8	1685.	1806.	29.6	63339.	67885.
20	68.8	67.1	56.2	75.9	58.9	69.4	3.9	1047.	1027.	15.2	151089.	148156.
30	71.0	73.1	68.6	76.0	60.0	64.6	4.0	6020.	5953.	84.2	44183.	43698.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	70.6	66.0	69.0	76.0	60.0	70.0	3.9	4455.	4580.	64.9	28378.	29175.
50	63.9	48.0	57.1	81.7	70.1	63.0	2.6	2582.	2522.	39.8	38032.	37153.
60	72.6	72.4	61.8	80.5	66.8	70.0	2.9	1773.	1706.	25.4	29914.	28784.
70	72.7	63.4	71.3	87.7	66.9	65.6	1.8	2556.	2558.	36.8	25048.	25070.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	70.6	66.0	69.0	76.0	60.0	70.0	3.8	6684.	5940.	84.1	27805.	24710.
OVERALL WEIGHTED AVG	68.2	63.4	58.0	77.0	60.8	68.8	3.7	1691.	1678.	25.2	407789.	404631.
TOTAL (NON-WEIGHTED)												

FIGURE 12. District 21--Budget Data

Foreman Account No. 4

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 22.30 PCT SHOULDERS 22.10 PCT ROADSIDE 36.20 PCT DRAINAGE 1.00 PCT TRAFFIC SERVICES 18.40

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY *					TRAF COST	**** COST/BENEFIT RATIOS ****				TRAF	**** LEVEL OF MAINTENANCE ****				
		SURF COST	SHLD COST	ROAD COST	DRAN COST		SURF		SHDF	ROAD	DRAN	SURF		SHLD	ROAD	DRAN	TRAF	
10	231002	1789.	399	395	648	18	329	5.9	5.8	9.5	0.3	4.8	68.0	68.0	68.0	68.0	68.0	
20	158616	1138.	254	252	412	11	209	3.7	3.7	6.1	0.2	3.1	68.0	68.0	68.0	68.0	68.0	
30	5933	6380.	1423	1410	2310	64	1174	20.3	20.1	33.0	0.9	16.8	70.0	70.0	70.0	70.0	70.0	
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	
40	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	
50	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	
60	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	
70	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	
80	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	75.0	75.0	75.0	75.0	75.0	

Foreman Account No. 5

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 31.30 PCT SHOULDERS 5.60 PCT ROADSIDE 38.30 PCT DRAINAGE 0.30 PCT TRAFFIC SERVICES 24.50

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY *					TRAF COST	**** COST/BENEFIT RATIOS ****				TRAF	****	LEVEL OF MAINTENANCE				*****	
			SURF COST	SHLD COST	ROAD COST	DRAN COST	SURF		SHDF	ROAD	DRAN	SURF			SHLD	ROAD	DRAN	TRAF		
10	154118	1217.	381	68	466	4	298	5.6	1.0	6.9	0.1	4.4	68.0	68.0	68.0	68.0	68.0	68.0		
20	52096	961.	301	54	368	3	235	4.4	0.8	5.4	0.0	3.5	68.0	68.0	68.0	68.0	68.0	68.0		
30	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0		
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0		
40	109402	3273.	1024	183	1253	10	802	14.4	2.6	17.7	0.1	11.3	71.0	71.0	71.0	71.0	71.0	71.0		
50	37770	4356.	1364	244	1668	13	1067	19.2	3.4	23.5	0.2	15.0	71.0	71.0	71.0	71.0	71.0	71.0		
60	868	1277.	400	72	489	4	313	5.6	1.0	6.9	0.1	4.4	71.0	71.0	71.0	71.0	71.0	71.0		
70	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	71.0		
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0	71.0		
80	79881	19627.	6143	1099	7517	59	4809	81.9	14.7	100.2	0.8	64.1	75.0	75.0	75.0	75.0	75.0	75.0		

Foreman Account No. 6

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 26.90 PCT SHOULDERS 15.10 PCT ROADSIDE 30.90 PCT DRAINAGE 0.30 PCT TRAFFIC SERVICES 26.80

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY *					TRAF COST	**** COST/BENEFIT RATIOS ****				TRAF	**** LEVEL OF MAINTENANCE ****				*****	
			SURF COST	SHLD COST	ROAD COST	DRAN COST	SURF		SHDF	ROAD	DRAN	SURF		SHLD	ROAD	DRAN	TRAF		
10	77205	2014.	542	304	622	6	540	7.7	4.3	8.9	0.1	7.7	70.0	70.0	70.0	70.0	70.0		
20	176260	1260.	339	190	389	4	338	4.8	2.7	5.6	0.1	4.8	70.0	70.0	70.0	70.0	70.0		
30	52926	7211.	1940	1089	2228	22	1932	27.7	15.6	31.8	0.3	27.6	70.0	70.0	70.0	70.0	70.0		
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0		
40	33989	5336.	1435	806	1649	16	1430	19.1	10.7	22.0	0.2	19.1	75.0	75.0	75.0	75.0	75.0		
50	44186	2691.	724	406	832	8	721	10.2	5.7	11.7	0.1	10.2	71.0	71.0	71.0	71.0	71.0		
60	37874	2124.	571	321	656	6	569	8.0	4.5	9.2	0.1	8.0	71.0	71.0	71.0	71.0	71.0		
70	29619	3105.	835	469	959	9	832	11.8	6.6	13.5	0.1	11.7	71.0	71.0	71.0	71.0	71.0		
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0		
80	33504	8054.	2166	1216	2489	24	2158	28.9	16.2	33.2	0.3	28.8	75.0	75.0	75.0	75.0	75.0		

Some of the budget programs were utilized for two years by District 21. No other district has expressed an interest in utilizing these programs and therefore refinements have not been made nor has the documentation been prepared.

Additional detail describing the use of the Maintenance Rating System in District 21 can be found in references 15, 16, 17 and 24. Costs of collecting, coding and preparing the information for the "plot program" is given as about 0.5 percent of the maintenance budget.

Use of Maintenance Rating System for Rigid Pavements. The majority of the implementation effort expended in Research Study 2-18-75-199 was devoted to the flexible pavement rating system as there are many more miles of flexible pavements in all classes of highways as opposed to rigid pavements. In addition, the majority of rigid pavements in Texas are located in urban areas which have unique rating problems which are presently under study.

Two interesting observations have been made with the limited data obtained from trial implementation. Figures 13 and 14 illustrate the decrease in Serviceability Index with time for continuously reinforced concrete pavements. In each instance the Serviceability Index showed a significant decline for the first 60 months or five years after construction and then appears to reach a level where little change occurs for the next five to seven years.

A second observation is shown in Figure 15. The annual maintenance costs increased with age as expected; however, a significant increase occurred between the ages of six and ten years, while the Serviceability Index changed very little during this same period. These data support the observed need for a maintenance rating system to consist of more than just a measure of road roughness.

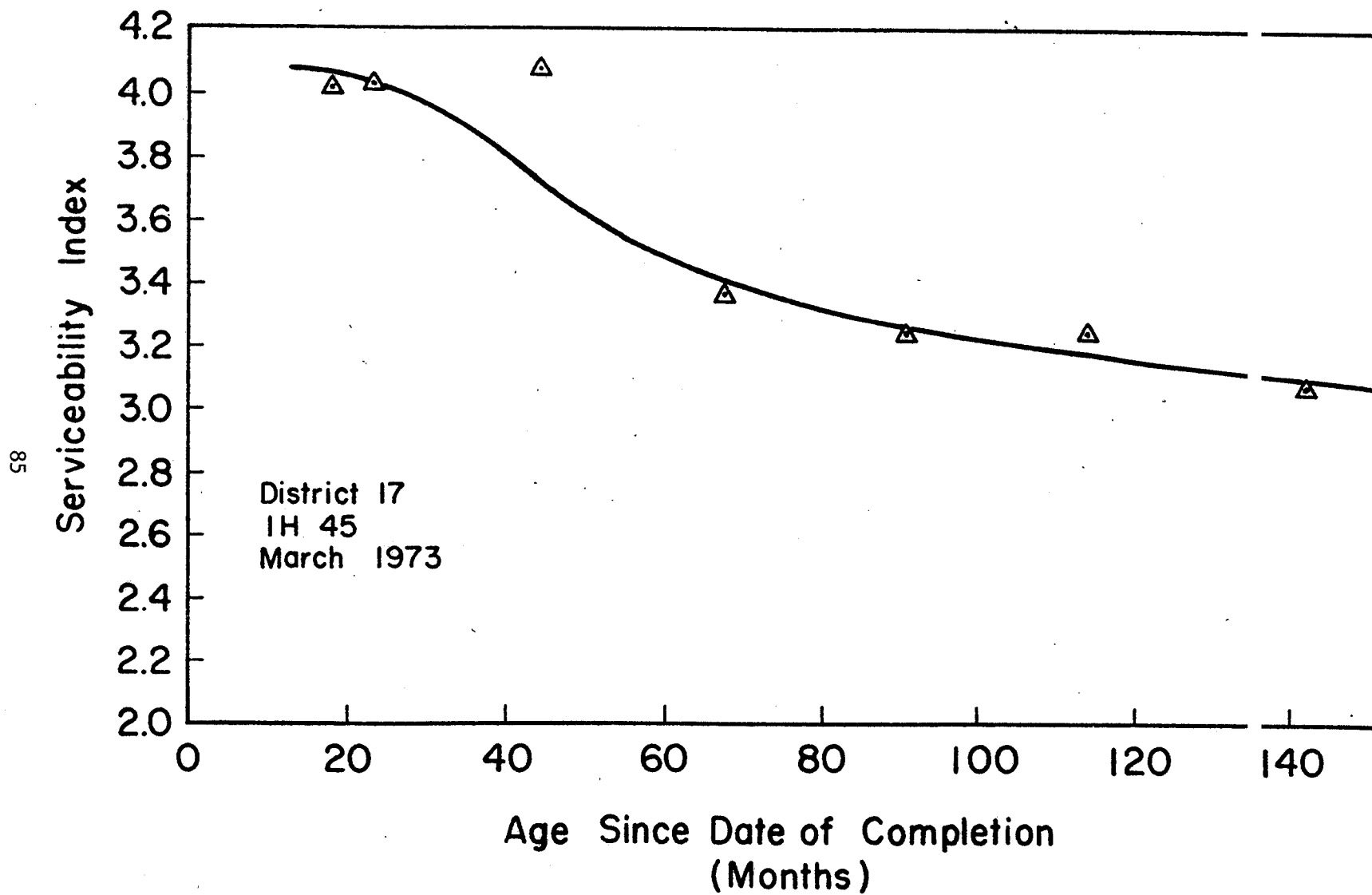


Figure 13. Serviceability Index Versus Age

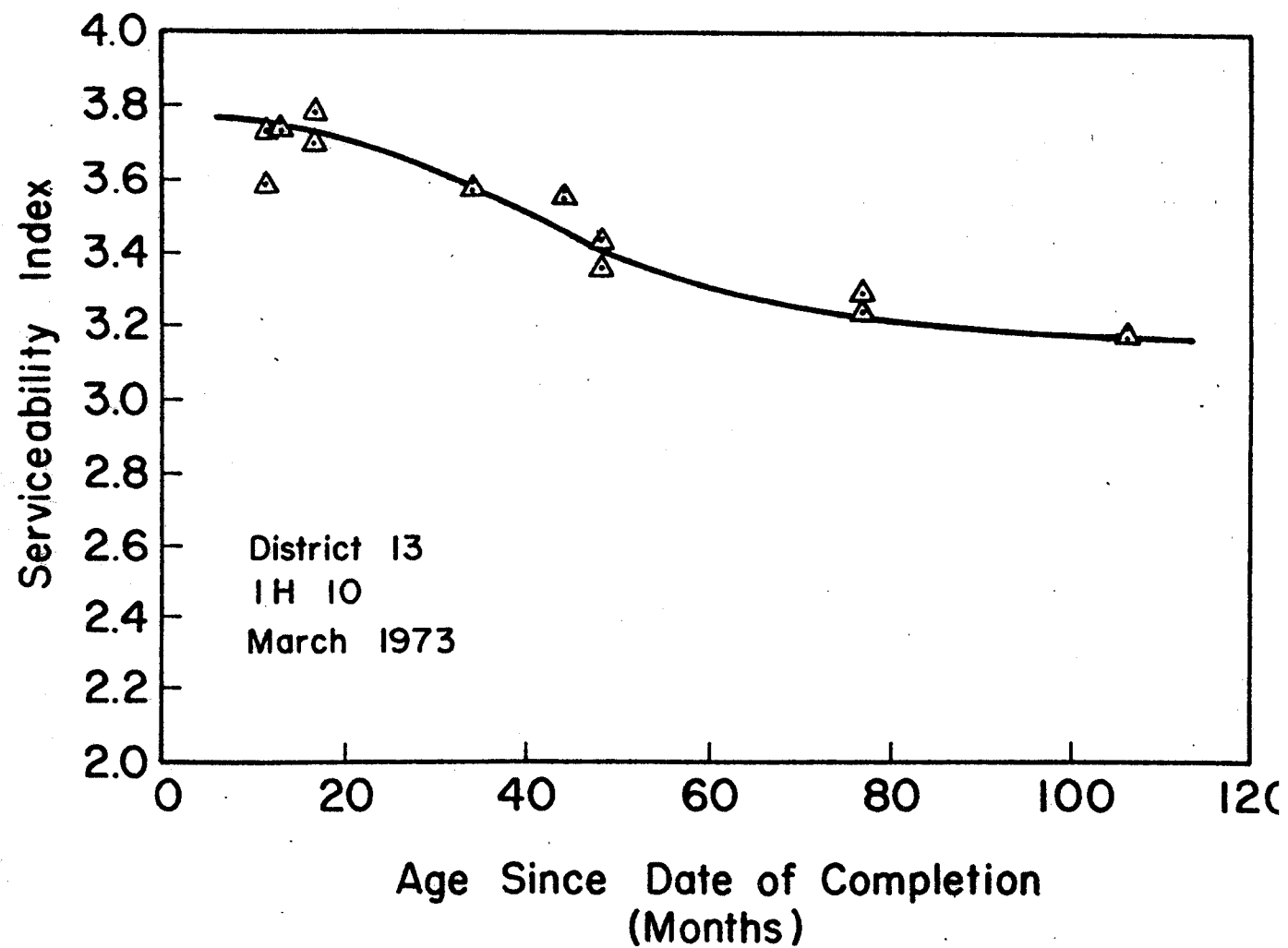


Figure 14. Serviceability Index Versus Age

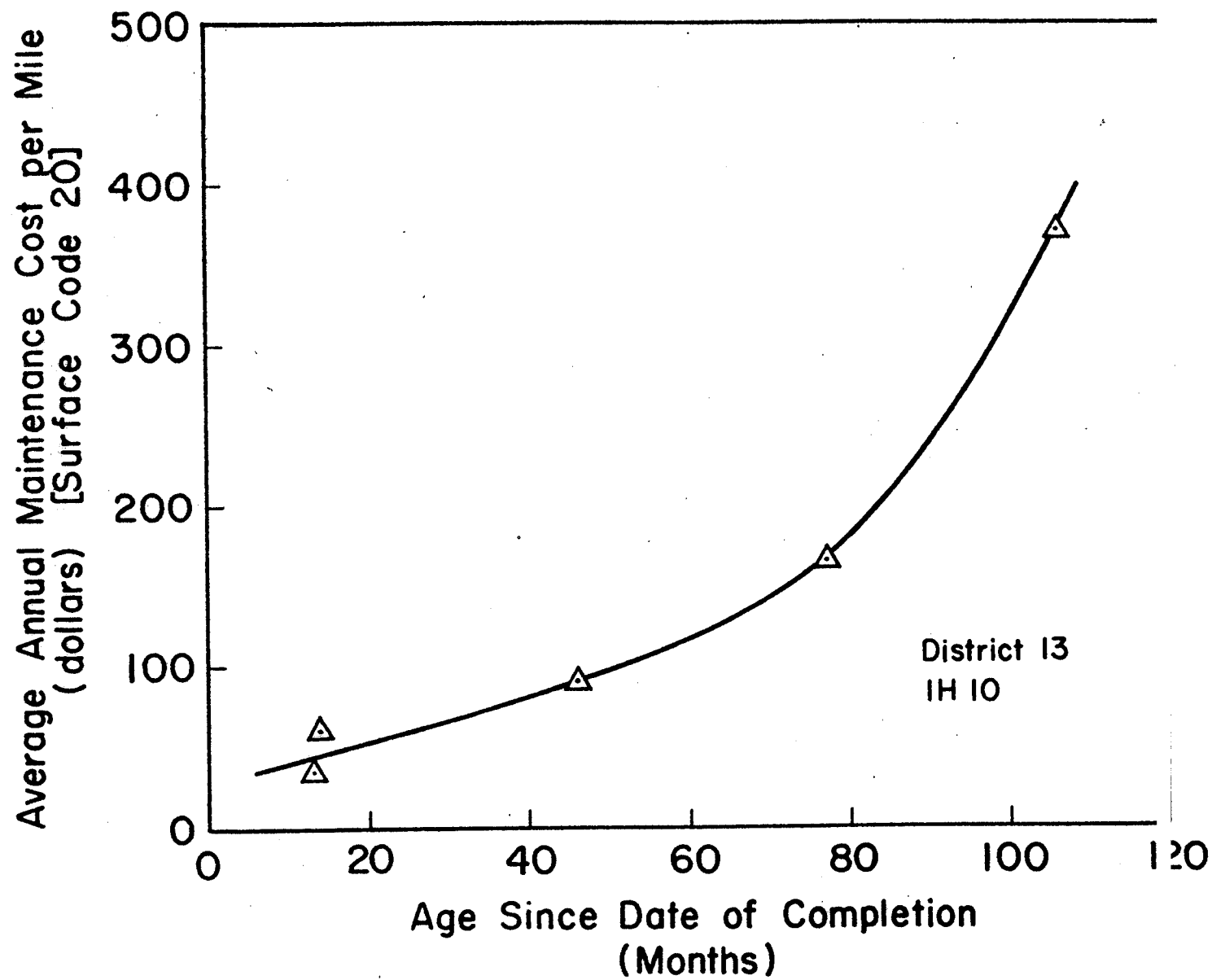


Figure 15. Average Annual Maintenance Cost Versus Age

RANDOM SAMPLE ANALYSIS

The two kinds of flexible pavement survey data presented for treatment are Serviceability Index and the visual rating scores. These data were obtained on approximately 250 randomly selected pavement sections. These sections are located in all 25 State Department of Highways and Public Transportation Districts and were sampled from the three main highway categories: Interstate Highways, U. S. and State Highways and Farm-to-Market Roads.

Each of the randomly sampled pavement sections is approximately two miles in length and collectively represent a one percent sample of the total centerline state maintained rural mileage. These sections were selected by utilizing two-stage cluster sampling theory. This procedure requires the random selection of counties within each highway district followed by a random selection of two-mile pavement sections within the selected counties. The sampling method used allows for efficient gathering of field data on these flexible pavement sections. This sampling method will be treated in more detail in reports being prepared for Research Study 2-8-75-207.

For this report the statistics used to summarize the data are straightforward means and standard deviations. These statistical procedures will allow one to get a "feel" for the kinds of values one might expect for Serviceability Indexes and visual rating scores on pavements around the state of Texas. By utilizing two-stage cluster sampling theory, more sophisticated statistical techniques can be employed to estimate mean and standard error values in any district or for the whole state. Again, a more detailed treatment of the data will be made in later Texas Transportation Institute reports. The formulas

used for the statistical treatment in this report are contained in Appendix C.

The Serviceability Index values and visual rating scores used in this report were obtained primarily in 1974. If 1974 data were missing for a test section, then another year's value was substituted for the missing value. This is a reasonable approximation since the kinds of data being treated for the pavement sections generally change only by small amounts between any two consecutive years.

Referring to Table 24 and considering all of the statewide samples, the Interstate Highways have the highest mean value of Serviceability Index (4.07) and the Farm-to-Market Roads the lowest (2.90) with all "combined" mean Serviceability Index of 3.27. The standard deviations for each highway type tend to increase as the pavements became rougher. This is also shown in Figure 16 which is a plot of Serviceability Index versus standard deviation for the 1974 random section data. The standard deviations in Tables 24 and 25 are weighted values and represent the "average" variation within a given two-mile pavement section for a given highway type. This "within" variation comes about because a Serviceability Index value is obtained every 0.2 mile. Thus, there are about 10 data points within each random section.

The coefficients of variation shown in Table 24 range from 7.3 percent for Interstate Highways to 14.3 percent for Farm-to-Market Roads. These data indicate the amount of variation that can typically be expected in a two-mile pavement section for the different highway types.

Table 25 shows the individual State Department of Highways and Public Transportation Districts listed by alphabetic codes. These

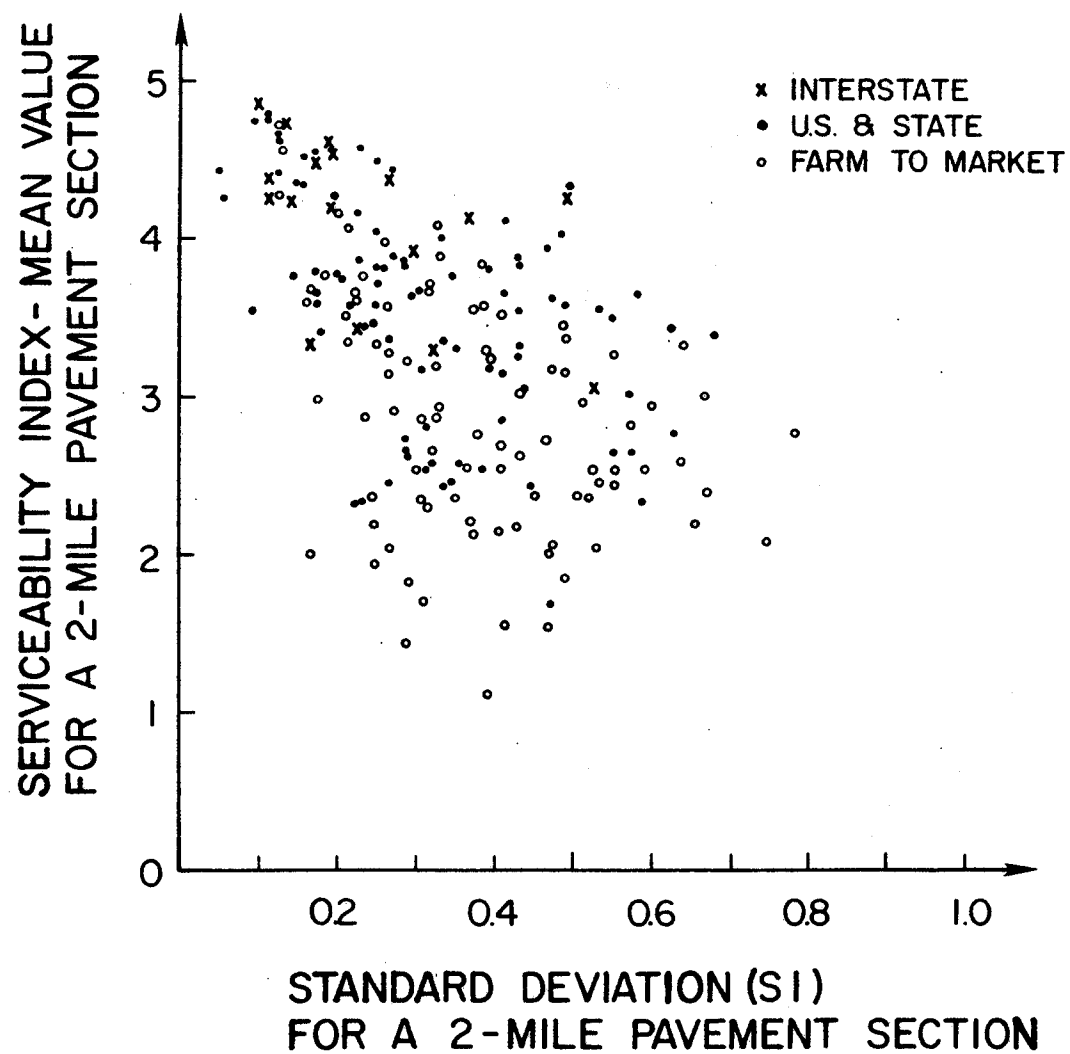


FIGURE 16 . SERVICEABILITY INDEX MEAN AND STANDARD DEVIATIONS FOR RANDOMLY SELECTED 2 MILE SECTIONS OF PAVEMENT IN TEXAS - 1974.

TABLE 24. Statewide Serviceability Index Statistics for
Randomly Located Pavement Sections (~1974)

	Highway Type			
	IH	US & SH	FM	Combined
Mean	4.07	3.54	2.90	3.27
Standard Deviation	0.296	0.349	0.414	0.379
Coeff. of Variation(%)	7.3	9.9	14.3	11.6

TABLE 25. Serviceability Index Statistics for District
Randomly Located Pavement Sections (~1974)

District	Highway Type							
	IH		US & SH		FM		Combined	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
A	3.44	0.230	3.61	0.305	2.36	0.563	2.98	0.444
B	3.06	0.527	3.74	0.274	2.46	0.409	3.02	0.381
C	-----	-----	3.42	0.463	3.11	0.568	3.27	0.515
D	4.49	0.149	3.91	0.407	3.20	0.381	3.77	0.360
E	-----	-----	3.07	0.396	3.15	0.309	3.11	0.357
F	4.34	0.230	4.21	0.171	3.62	0.279	3.95	0.235
G	-----	-----	3.65	0.171	3.21	0.275	3.43	0.229
H	4.58	0.186	2.85	0.417	2.90	0.465	3.13	0.415
I	4.63	0.109	3.84	0.242	2.93	0.388	3.54	0.307
J	-----	-----	2.99	0.405	2.72	0.450	2.79	0.438
K	-----	-----	2.94	0.506	2.11	0.570	2.42	0.547
L	4.18	0.294	4.11	0.193	3.36	0.478	3.78	0.365
M	-----	-----	3.84	0.354	2.53	0.399	3.04	0.382
N	-----	-----	4.04	0.269	2.79	0.368	3.41	0.323
O	3.41	0.435	3.11	0.455	2.96	0.386	3.14	0.426
P	3.79	0.297	3.44	0.394	3.10	0.478	3.33	0.423
Q	-----	-----	3.16	0.326	2.42	0.471	2.74	0.415
R	3.35	0.165	3.81	0.270	2.83	0.336	3.15	0.306
S	-----	-----	3.49	0.442	2.84	0.460	3.12	0.453
T	4.59	0.135	3.64	0.215	3.30	0.506	3.54	0.407
U	-----	-----	3.61	0.243	2.85	0.284	3.30	0.262
V	-----	-----	3.29	0.527	3.33	0.383	3.31	0.463
W	4.28	0.494	3.96	0.294	2.56	0.446	3.39	0.391
X	4.36	0.200	3.74	0.211	2.33	0.342	3.34	0.261
Y	-----	-----	3.08	0.339	3.21	0.241	3.15	0.289

data indicate the kinds of means and standard deviations one may expect within a given district. It has been observed by the Texas Transportation Institute researchers that those Districts which generally have sandy type soils exhibit higher Serviceability Index values than those Districts with expansive clays as subgrade materials.

Figures 17 thru 24 show the Serviceability Index histogram and percentage cumulative distribution plots for the four highway types. The histogram plots reveal how the data are grouped. For example, Figure 17 shows for Interstate Highways in Texas that approximately 36 percent of the 0.2 mile Serviceability Index increments fall between 4.2 and 4.4. Figure 21 for Farm-to-Market Roads indicates that none of the 0.2 mile increments measured falls between 4.2 and 4.4. Figure 18, the percentage cumulative distribution plot for Interstate Highways, reveals that approximately 6 percent of the data points are above a Serviceability Index of 4.8 and 100 percent of the data points are above a Serviceability Index of 2.6. In comparison for Farm-to-Market Roads, Figure 22 shows that approximately 6 percent of the data are above a Serviceability Index of 3.8 and 100 percent of the data are above the value of 1.2.

Collectively, the data presented above indicate that the amount of roughness on Interstate Highway pavement sections is much less than that found on the Farm-to-Market road system. Again, this is as one might expect between the two highway types.

The mean visual rating scores as determined from the randomly selected pavement sections indicate the same basic trends observed for Serviceability Index data. The visual rating scores shown in Table 26 indicate that Interstate Highways are in better "condition" than U. S. and State Highways, and U. S. and State Highways are better than Farm-

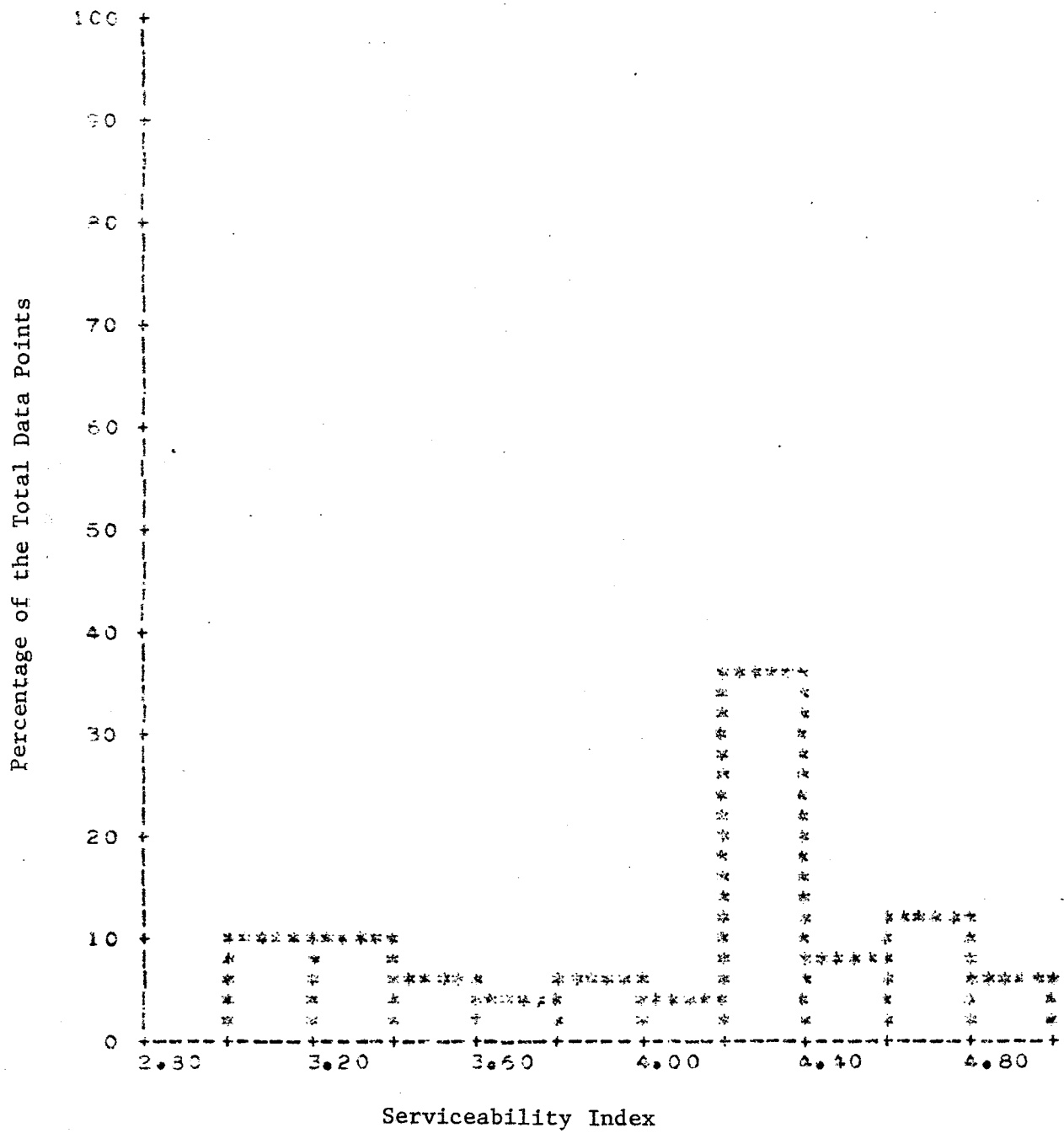


Figure 17. Serviceability Index Histogram for
Statewide Random Sections - Interstate Highways (1974).

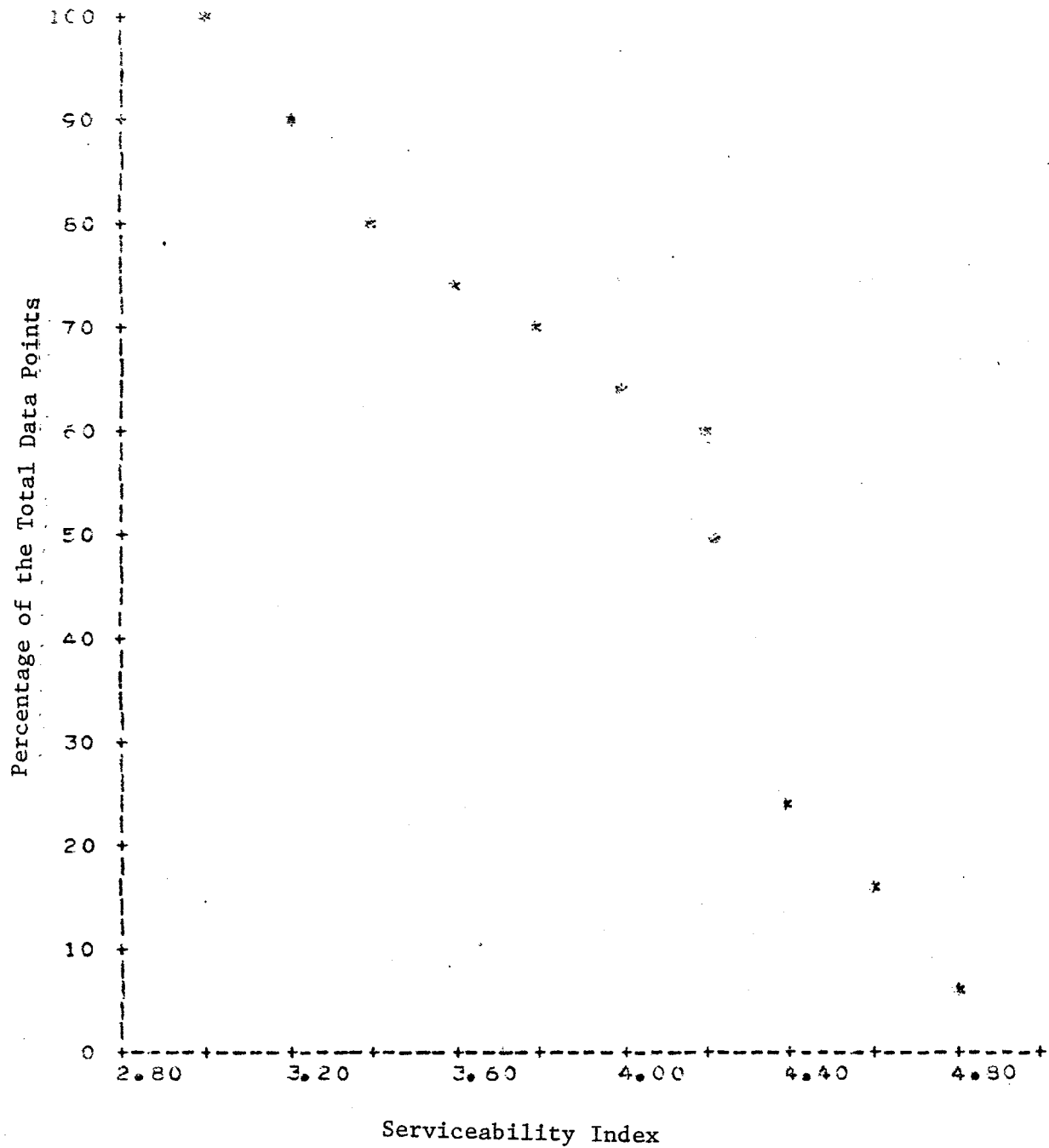


Figure 18. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

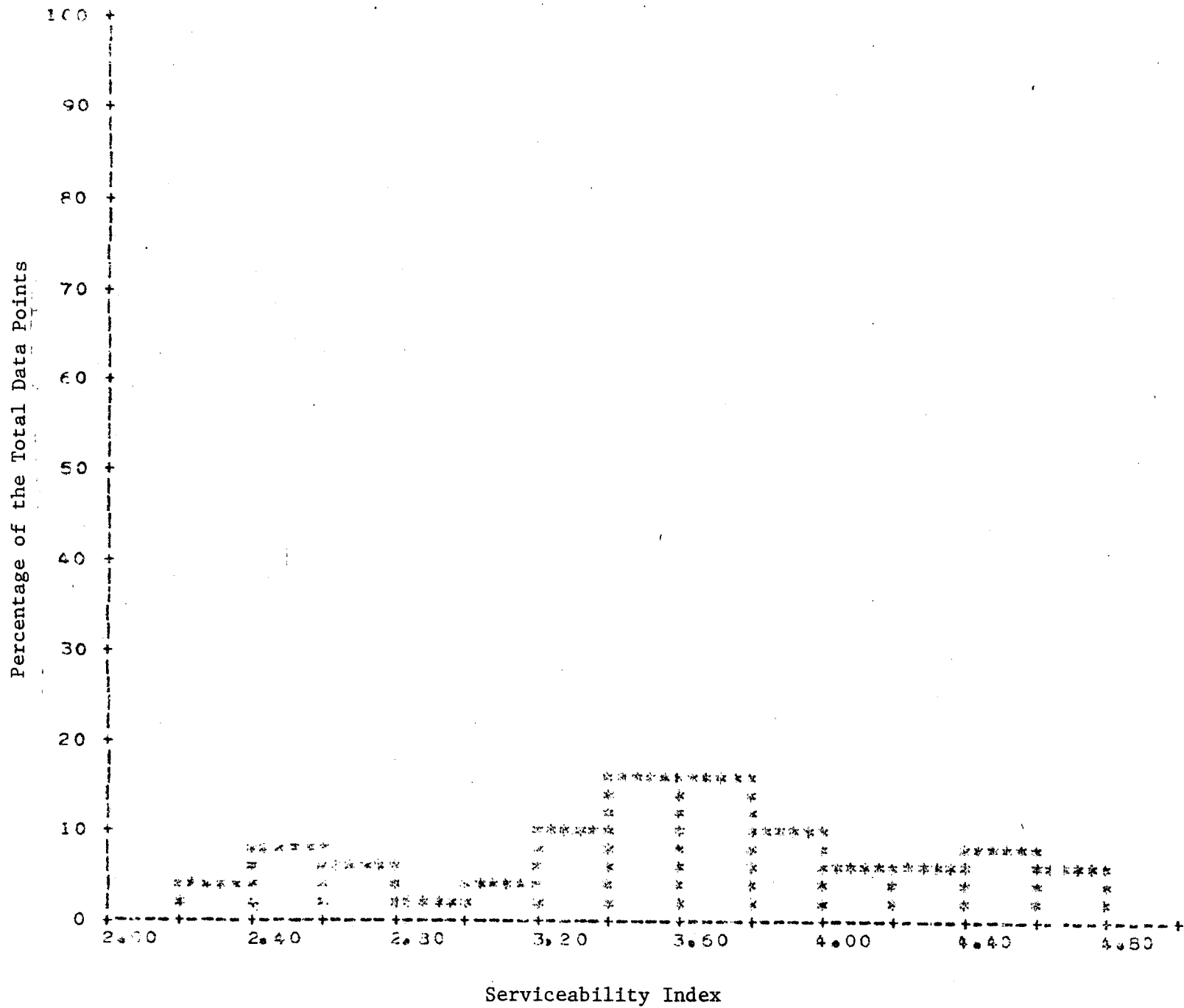


Figure 19. Serviceability Index Histogram for Statewide Random Sections - U.S. & State Highways (1974).

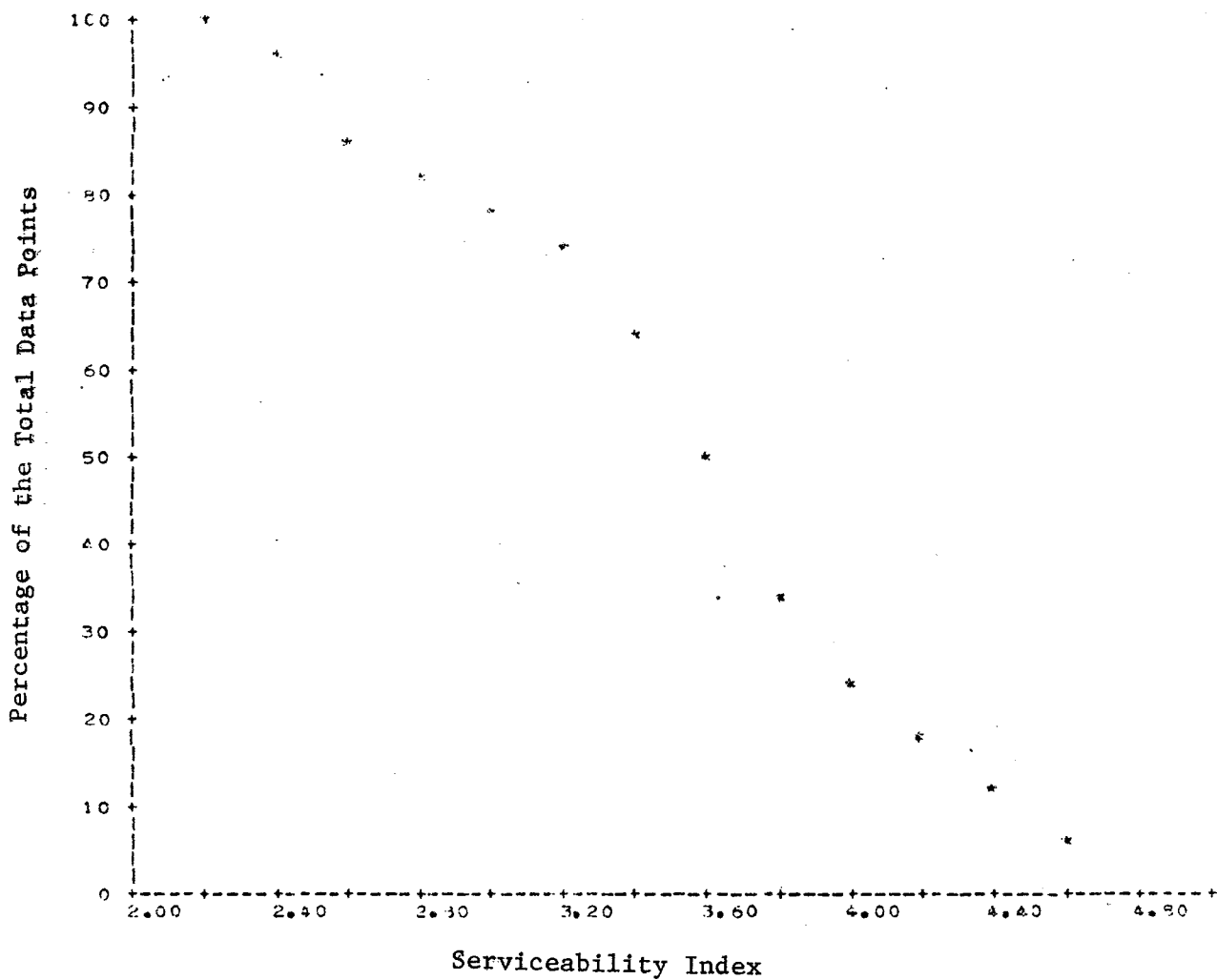


Figure 20. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - U.S. & State Highways (1974).

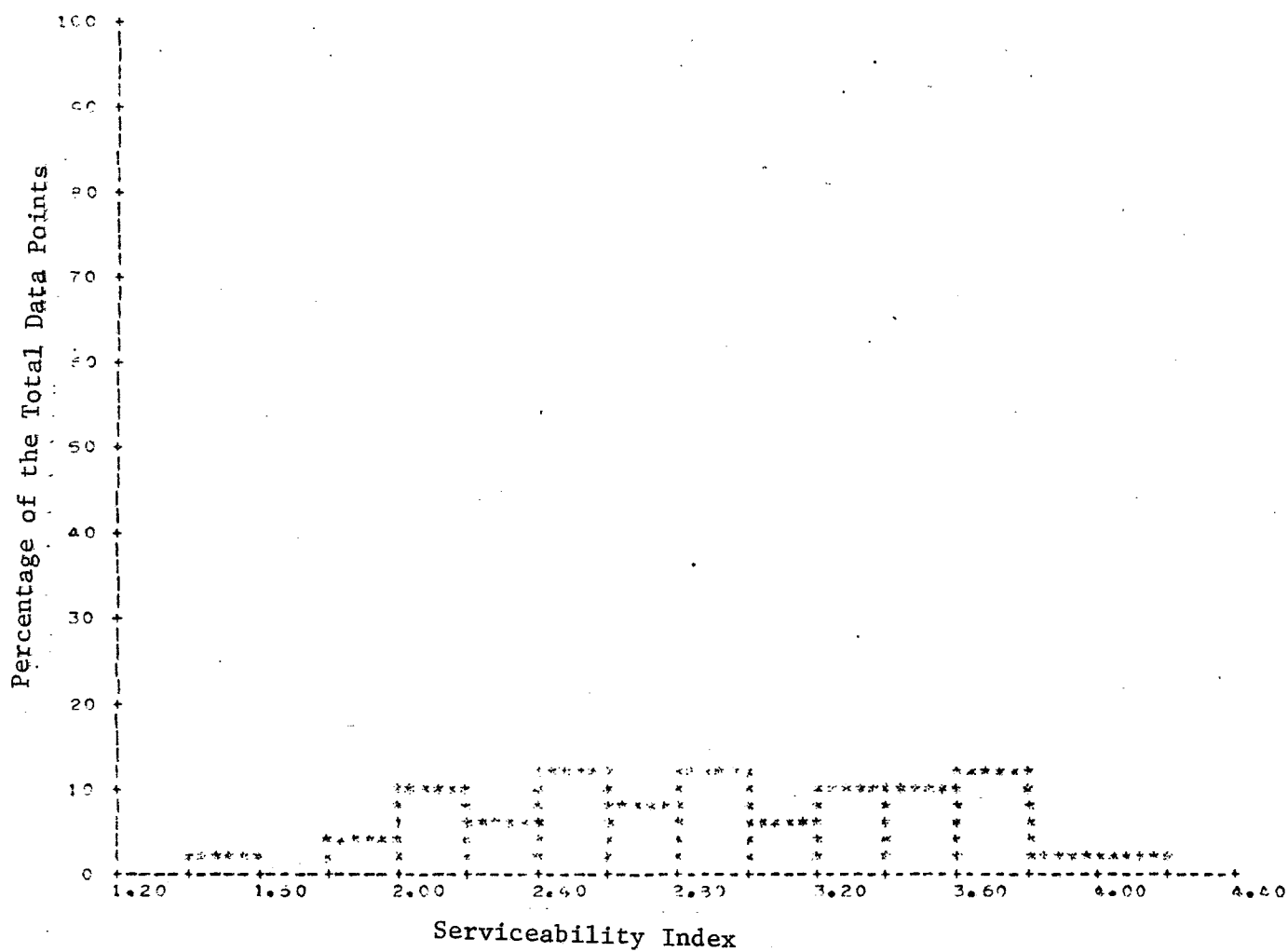


Figure 21. Serviceability Index Histogram for Statewide Random Sections - U.S. & State Highways (1974).

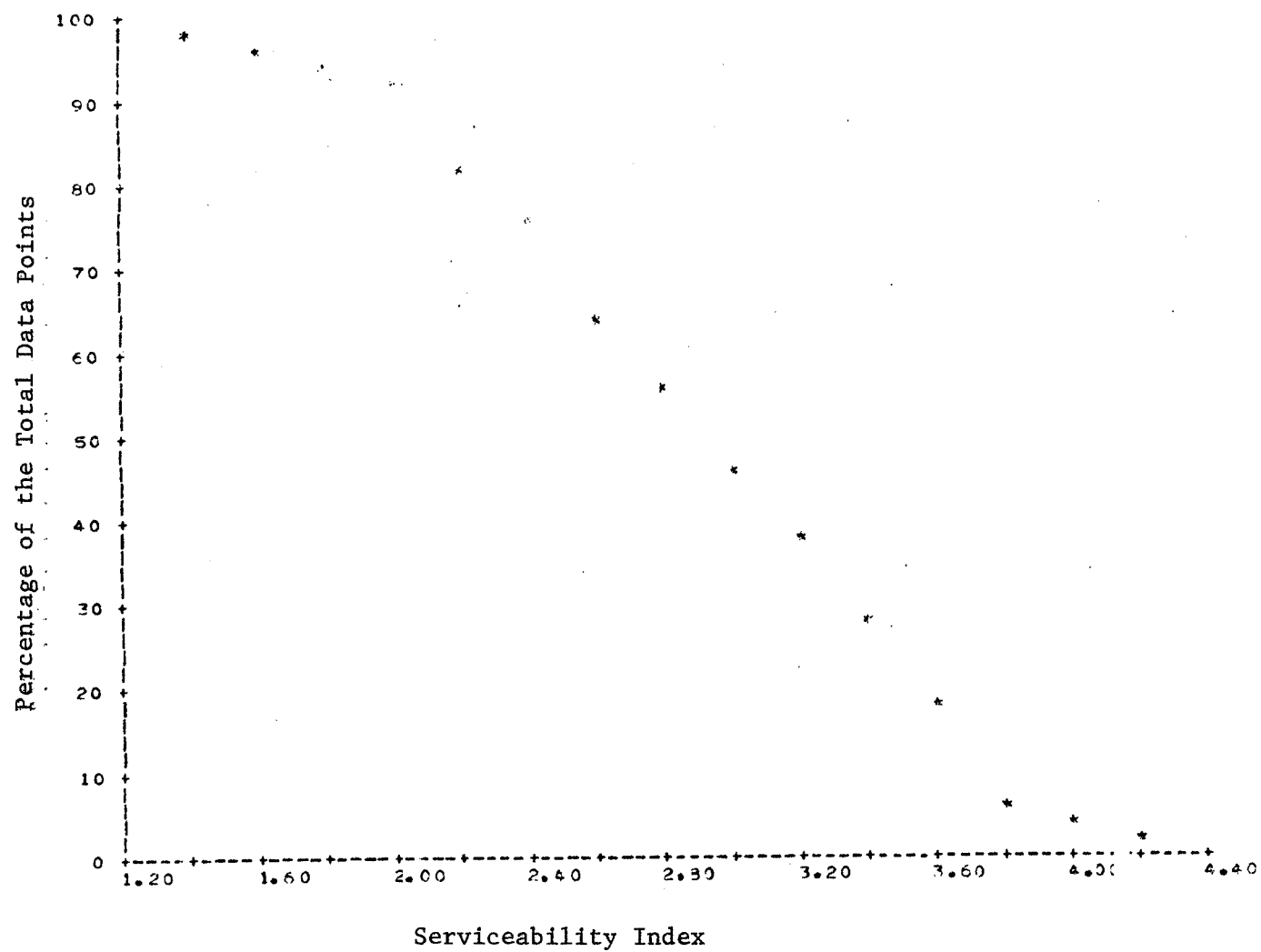


Figure 22. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - U.S. & State Highways (1974).

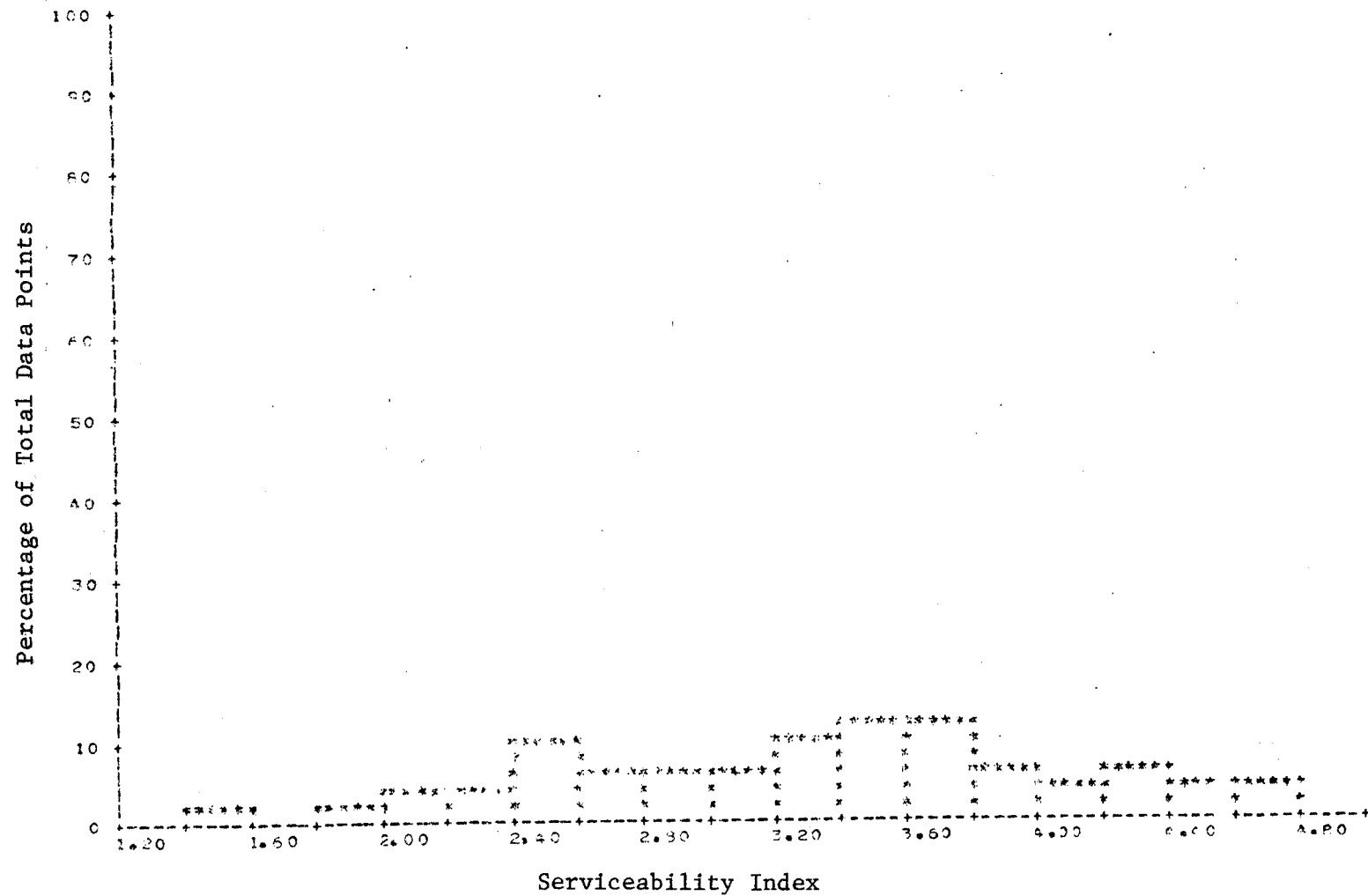


Figure 23. Serviceability Index Histogram for
Statewide Random Sections - F.M. Highways (1974).

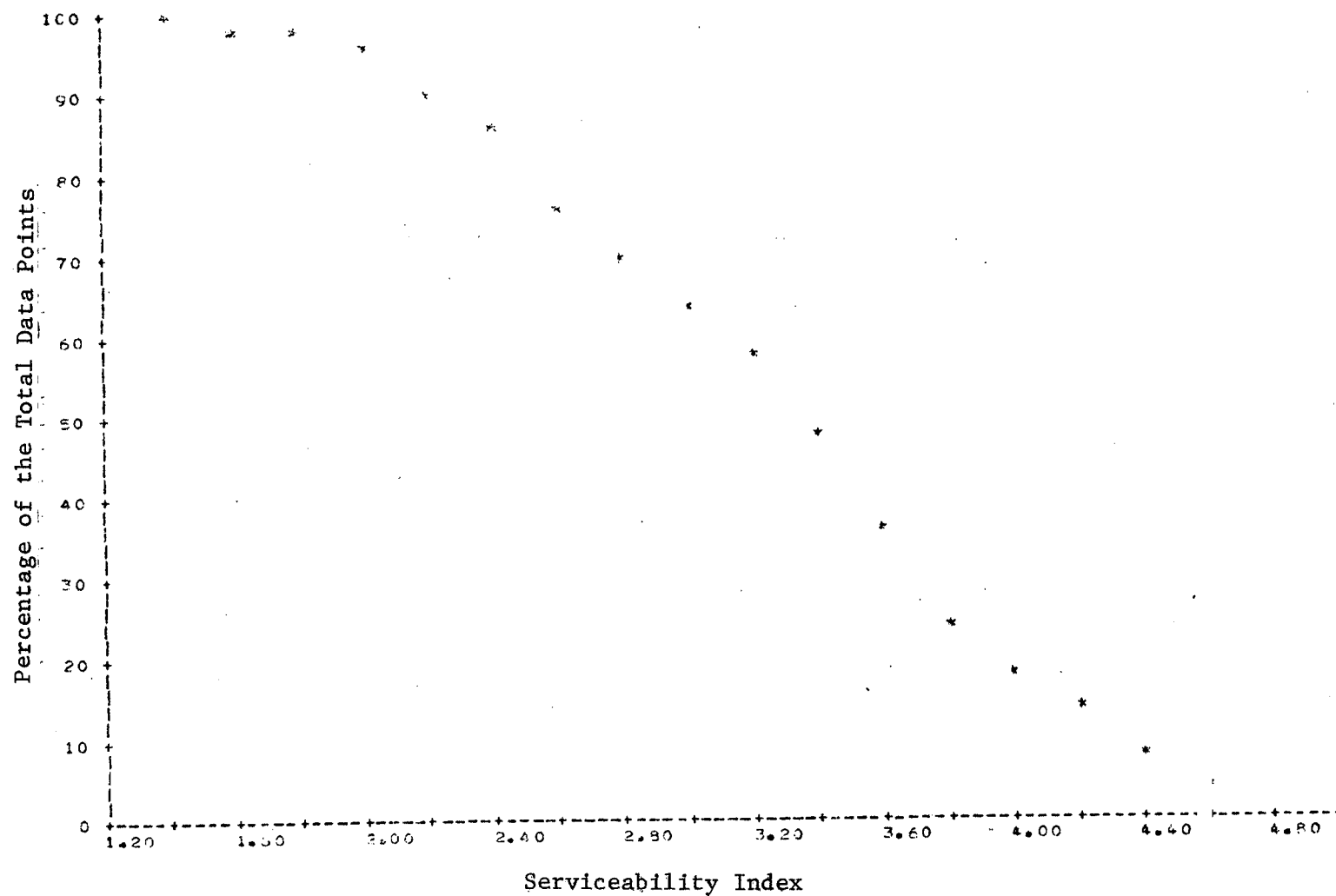


Figure 24. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

TABLE 26. Statewide Visual Evaluation Scores for
Randomly Located Pavement Sections (~1974)

Type of Rating	Mean for Highway Type			
	IH	US & SH	FM	Combined
1. Pavement Rating (w/o MRM Deduct)	92.4	84.4	80.6	83.3
Score (w/MRM Deduct)	87.9	68.5	51.7	61.9
2. Shoulder Rating Score	73.8	69.9	66.2	68.5
3. Roadside Rating Score	78.8	77.4	76.3	77.0
4. Drainage Rating Score	85.0	78.7	76.1	78.0
5. Traffic Services Rating Score	81.6	81.2	81.7	81.5

to-Market Roads. This is a reflection of many factors which affect each highway type such as level of service, age, traffic, maintenance, etc.

The Pavement Rating Scores as shown in Tables 26 through 30 are computed for two cases: one in which the Mays Ride Meter deduction points are not utilized in the calculation of the score and the other in which they are deducted. This is done because some individuals who utilize Pavement Rating Scores prefer to see the score reflect "true" pavement distress, i.e., rutting, flushing, cracking, etc., as opposed to a score which is a composite of both "true" distress and roughness.

In Table 26, the differences between the two computed Pavement Rating Scores for Interstate Highways is small, i.e., 92.4 without Mays Ride Meter deductions versus 87.9 with the deductions. For U. S. and State Highways the two scores are 84.4 and 68.5, respectively. The Farm-to-Market scores are 80.6 and 51.7. It is apparent from these data that the magnitude of roughness deductions is more important for Farm-to-Market Roads than Interstate Highways. As stated in reference 4, a perfect Pavement Rating Score is equal to 100.

It is of interest to note that the Pavement Rating Scores without Mays Ride Meter point deductions are not vastly different between the three highway types. The difference between 92.4 (Interstate) and 80.6 (Farm-to-Market) is not large. Both scores indicate for the sample taken in 1974 that Interstate and Farm-to-Market Roads were in relatively good condition.

The Shoulder, Roadside, and Drainage Rating Scores indicate the same basic trend between highway types as was observed for the Pavement

TABLE 27. District Visual Evaluation Scores for Randomly Located Interstate Highway Pavement Sections (~1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	1	76.0/68.0	77.0	85.0	80.0	82.0
B	1	85.0/65.0	73.0	82.0	90.0	90.0
C	0	-----	----	----	----	----
D	3	100.0/99.0	76.3	79.7	89.0	87.0
E	0	-----	----	----	----	----
F	2	97.5/96.0	72.5	71.0	90.0	83.0
G	0	-----	----	----	----	----
H	2	98.5/98.0	75.0	73.5	90.0	86.0
I	2	95.0/94.5	80.0	86.0	85.0	86.0
J	0	-----	----	----	----	----
K	0	-----	----	----	----	----
L	2	89.5/87.5	64.5	75.0	83.5	74.0
M	0	-----	----	----	----	----
N	0	-----	----	----	----	----
O	3	85.7/73.0	70.3	89.0	82.0	76.0
P	1	98.0/93.0	81.0	82.0	90.0	78.0
Q	0	-----	----	----	----	----
R	1	82.0/74.0	70.0	85.0	90.0	86.0
S	0	-----	----	----	----	----
T	1	100.0/100.0	69.0	57.0	63.0	72.0
U	0	-----	----	----	----	----
V	0	-----	----	----	----	----
W	1	98.0/96.0	67.0	80.0	73.0	82.0
X	1	83.0/82.0	89.0	67.0	90.0	92.0
Y	0	-----	----	----	----	----

TABLE 28. District Visual Evaluation Scores for Randomly
Located State Highway Pavement Sections (~1974)

District No.	No. of Sections	Pavement Rating Score w/oMRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	4	82.0/75.0	64.5	79.0	81.8	82.0
B	3	96.3/91.3	77.7	79.0	79.0	81.3
C	4	91.5/74.2	75.2	81.2	85.0	79.0
D	6	80.8/72.3	70.5	80.5	82.8	82.3
E	8	65.5/42.1	67.1	77.0	74.6	80.8
F	5	93.8/91.8	70.0	73.8	86.0	84.4
G	4	89.8/78.2	58.8	72.8	75.0	79.0
H	4	60.5/28.0	65.0	76.0	81.8	82.0
I	4	88.2/74.2	69.2	75.5	77.5	83.5
J	3	87.7/55.0	62.3	77.0	73.3	78.0
K	4	77.2/30.8	65.8	73.5	77.5	79.0
L	4	89.8/87.2	66.2	78.5	74.2	77.5
M	4	91.0/83.0	67.2	79.8	74.0	82.5
N	4	94.5/92.0	74.8	83.0	80.0	84.0
O	4	85.2/59.2	75.0	89.2	89.2	88.5
P	5	95.0/82.6	73.4	74.2	69.2	80.8
Q	3	83.7/62.3	70.0	75.7	71.3	80.0
R	3	84.7/78.0	74.0	78.0	83.3	82.0
S	4	89.2/44.5	70.5	73.5	70.0	71.5
T	3	79.0/71.7	63.7	61.3	66.7	73.3
U	4	86.8/81.5	75.0	77.2	75.0	80.5
V	4	88.0/71.2	72.8	81.8	84.2	86.0
W	4	87.0/82.0	75.0	76.5	82.5	83.0
X	5	85.4/73.6	68.8	76.4	86.0	81.6
Y	4	77.2/47.2	77.2	80.2	82.5	83.5

TABLE 29. District Visual Evaluation Scores for Randomly
Located Farm-to-Market Road Pavement Sections (1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	6	72.3/29.8	65.0	69.8	75.7	76.7
B	4	85.2/42.4	68.8	67.8	75.0	79.0
C	4	84.2/61.2	78.8	81.0	83.2	86.5
D	5	75.4/56.2	76.0	78.8	75.4	87.6
E	8	79.6/57.2	70.6	76.8	76.1	84.2
F	6	83.2/71.7	65.3	78.8	85.5	87.3
G	4	90.0/75.0	65.0	72.2	73.2	80.0
H	4	68.2/42.8	72.5	73.5	81.5	82.5
I	6	81.2/47.8	56.2	76.3	71.7	82.0
J	7	69.7/37.0	62.9	73.7	74.3	75.1
K	5	61.4/6.0	60.0	77.2	76.0	83.6
L	5	78.2/61.8	62.0	77.8	68.0	79.2
M	6	85.0/50.8	61.7	76.8	74.0	80.0
N	4	90.5/54.8	70.0	81.5	75.8	83.0
O	4	92.2/64.0	75.0	84.2	83.2	86.0

TABLE 29. (Cont.)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
P	4	87.2/67.2	68.8	77.2	70.8	76.5
Q	4	69.8/32.2	53.8	75.5	69.2	79.5
R	7	92.6/64.4	63.4	80.4	81.9	83.7
S	4	81.0/33.8	68.8	70.5	70.8	78.5
T	4	86.2/75.8	57.5	69.0	55.8	76.0
U	3	80.0/44.3	63.3	72.0	70.0	75.3
V	4	84.2/70.0	63.8	77.2	81.8	86.0
W	4	80.2/38.8	68.8	79.8	84.2	84.5
X	3	88.3/50.0	68.3	76.3	87.7	85.3
Y	4	78.5/61.0	78.8	81.2	82.5	83.0

TABLE 30. District Visual Evaluation Scores for Randomly
Located Combined Highway Pavement Sections (1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	11	75.5/49.7	65.9	74.5	78.3	79.1
B	8	89.4/63.5	72.6	73.8	78.4	81.2
C	8	87.9/67.8	77.0	81.1	84.1	82.8
D	14	83.0/72.3	73.7	79.7	81.5	84.1
E	16	72.6/49.7	68.9	76.9	75.4	82.5
F	13	89.5/83.2	68.2	75.7	86.4	85.5
G	8	89.9/76.6	61.9	72.5	74.1	79.5
H	10	71.2/47.9	70.0	74.5	83.3	83.0
I	12	85.8/64.4	64.5	77.7	75.8	83.2
J	10	75.1/42.4	62.7	74.7	74.0	76.0
K	9	68.4/17.0	62.6	75.6	76.7	81.6
L	11	84.5/75.7	64.0	77.5	73.1	77.6
M	10	87.4/63.7	63.9	78.0	74.0	81.0
N	8	92.5/73.4	72.4	82.2	77.9	83.5
O	11	87.9/64.7	73.7	87.4	85.1	84.2

TABLE 30. (Cont.)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
P	10	92.2/77.5	72.3	76.2	71.9	78.8
Q	7	75.7/45.1	60.7	75.6	70.1	79.7
R	11	89.5/69.0	66.9	80.2	83.0	83.5
S	8	85.1/39.1	69.6	72.0	70.4	75.0
T	8	85.2/77.2	61.2	64.6	60.8	74.5
U	7	83.9/65.6	70.0	75.0	72.9	78.3
V	8	86.1/70.6	68.2	79.5	83.0	86.0
W	9	85.2/64.3	71.3	78.3	82.2	83.6
X	9	86.1/66.7	70.9	75.3	87.0	84.0
Y	8	77.9/54.1	78.0	80.8	82.5	83.2

Rating Score. The exception to this is the Traffic Services Rating Score. This score actually increases slightly for Farm-to-Market Roads as compared to the other two highway types. This may be an indicator of the fact that striping, delineators, etc., receive less deterioration on lightly traveled roads as opposed to the heavier traveled highways. It could also be that the Traffic Services Rating items are relatively insensitive to the highway type.

Tables 27 through 30 are averaged summaries of the five different rating scores for all twenty-five State Department of Highways and Public Transportation Districts. Each Table presented treats a different highway type beginning with Interstate Highways in Table 27.

Figures 25 through 72 are histogram and percentage cumulative distribution plots of the five rating scores for each highway type considered. These plots were generated from the scores obtained for all of the statewide randomly selected pavement sections. Although the number of figures containing these data is sizable, it was felt that the information being provided by the figures was particularly worthwhile to the personnel in the field recording and analyzing visual rating data.

An example of the information contained in these plots can be shown by utilizing Figures 25 and 26 which are presentations of Pavement Rating Score data for Interstate Highways. In Figure 25, approximately 48 percent of the data points are shown to lie between the interval of 95 to 100. The percentage cumulative distribution plot, Figure 26, shows that approximately 48 percent of the data points are higher than a Pavement Rating Score of 95. Additionally, this figure indicates that 100 percent of the data points are higher than a Pavement Rating Score of 65.

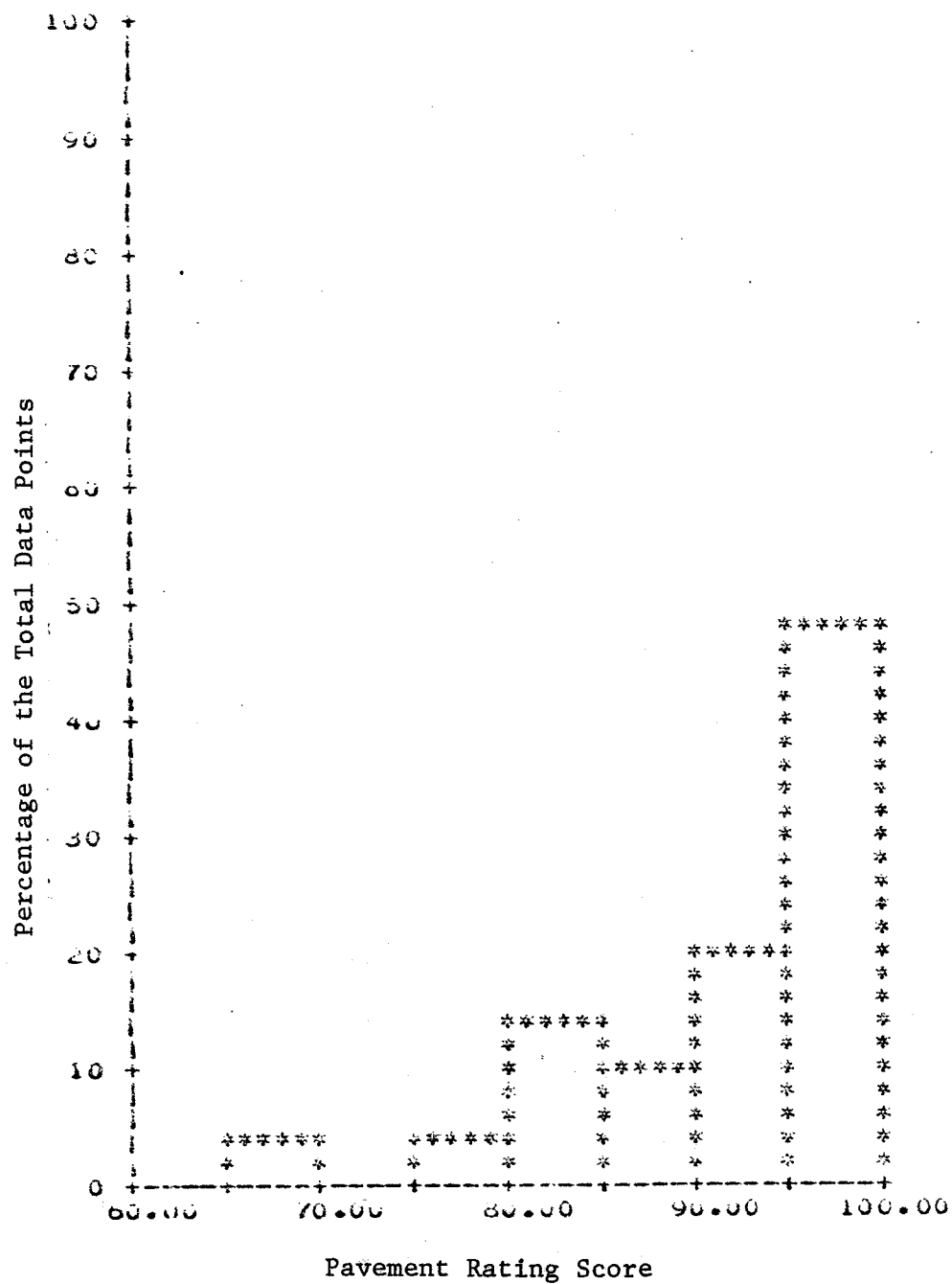


Figure 25. Pavement Rating Score (Without MRM Deductions)
Histogram for Statewide Random Sections -
Interstate Highways (1974).

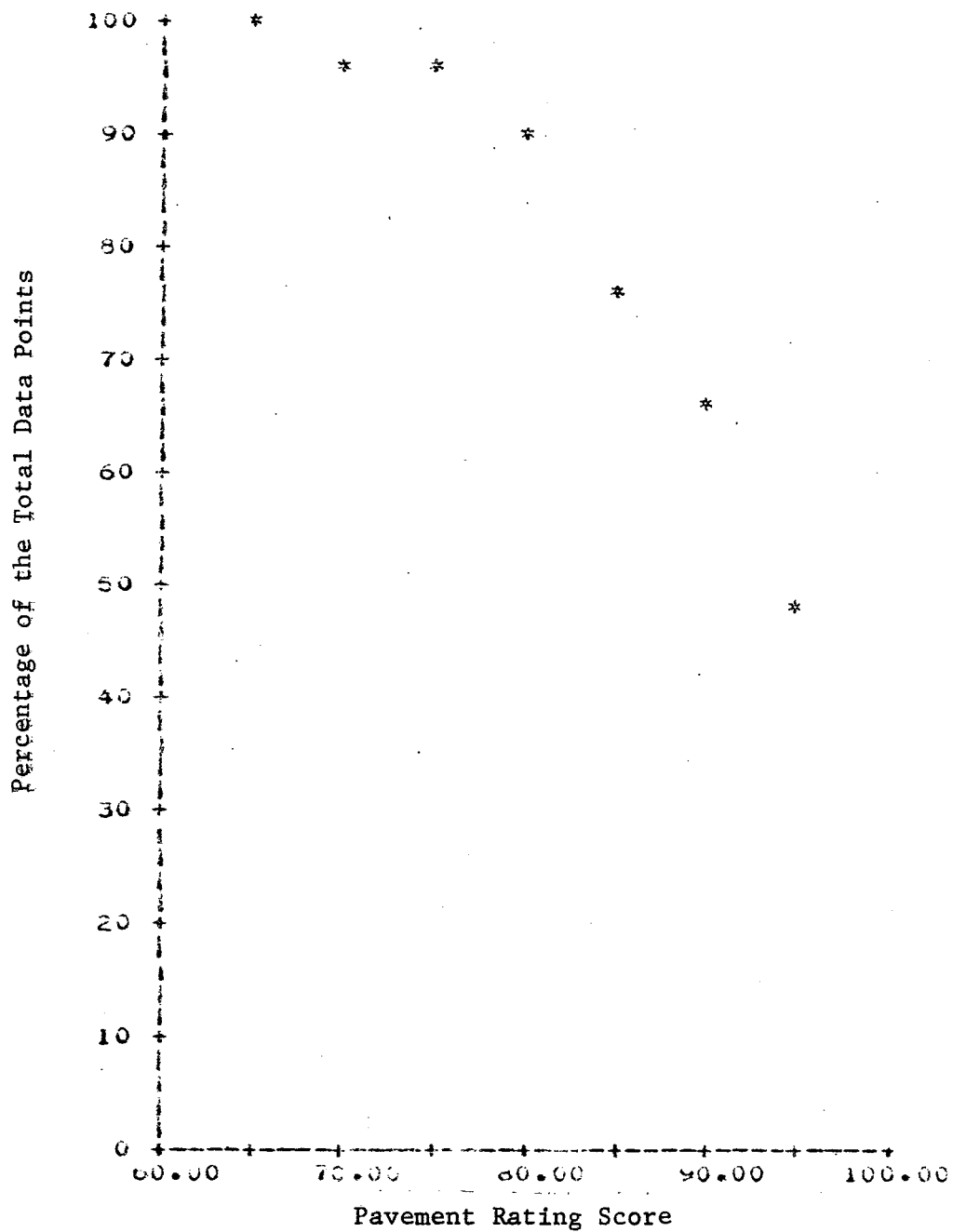


Figure 26. Pavement Rating Score (Without MRM Deductions)
Percentage Cumulative Distribution for Statewide
Random Sections - Interstate Highways (1974).

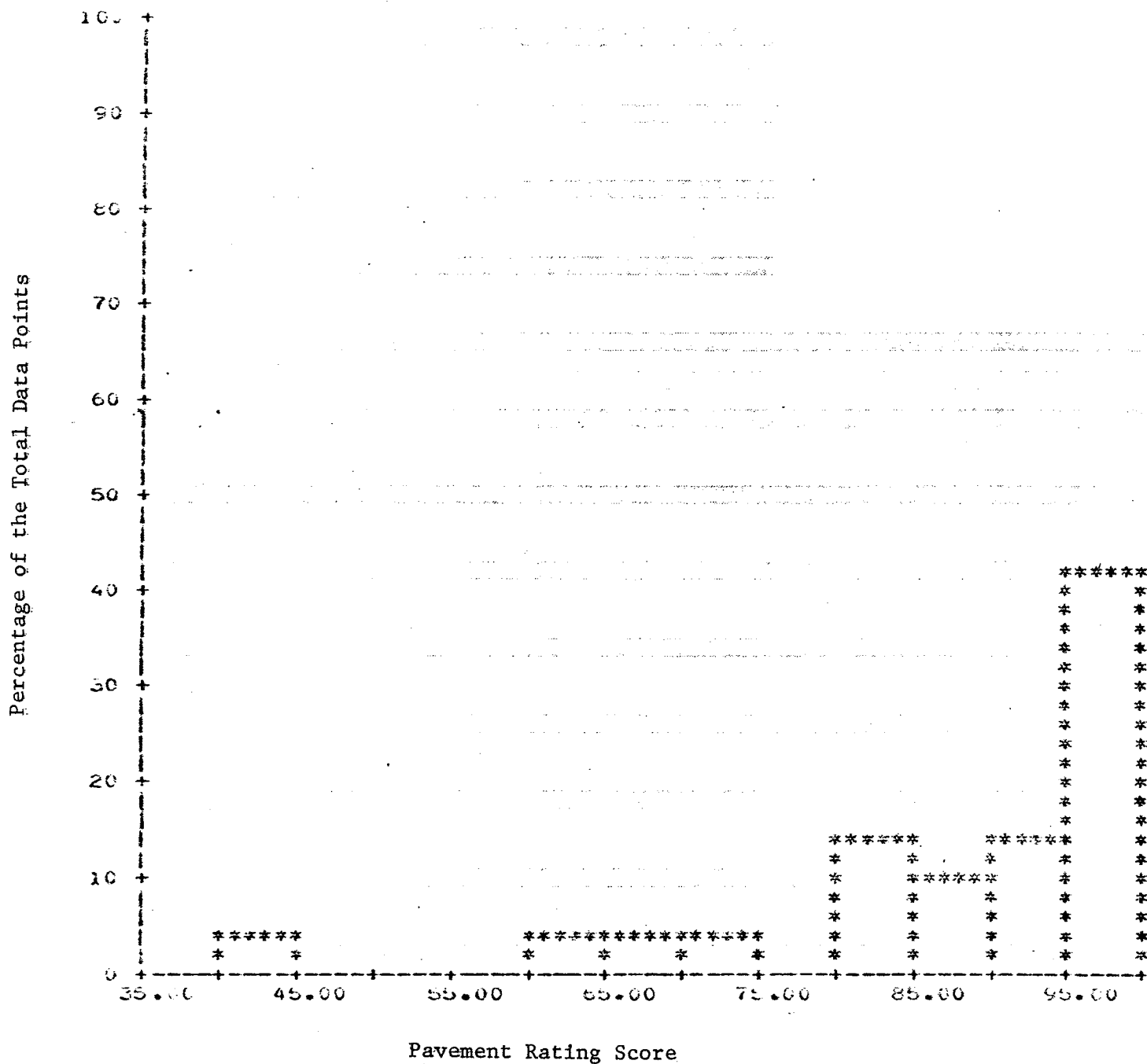


Figure 27. Pavement Rating Score (With MRM Deductions)
Histogram for Statewide Random Sections -
Interstate Highways (1974).

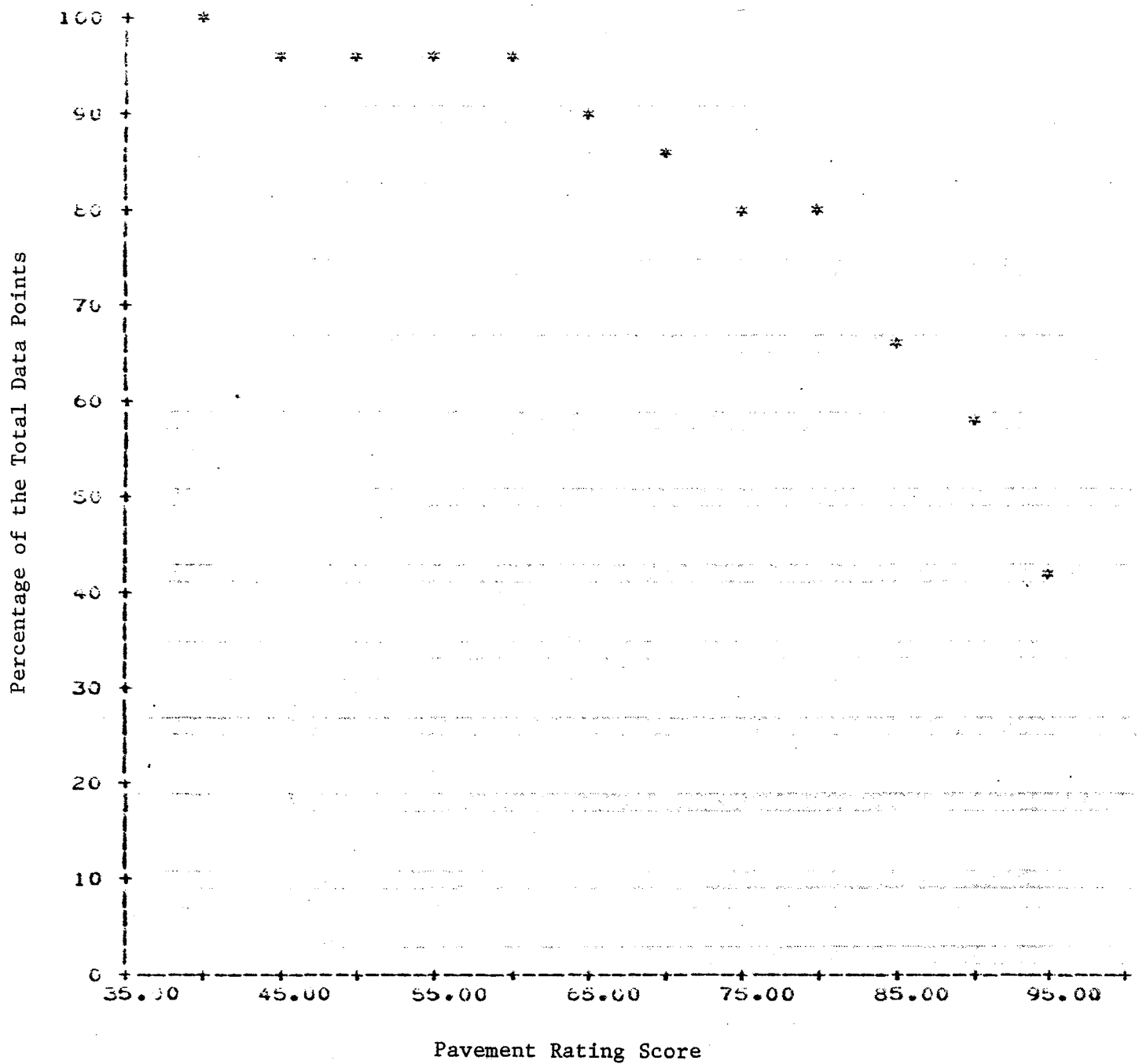


Figure 28. Pavement Rating Score (With MRM Deductions)
Percentage Cumulative Distribution for Statewide
Random Sections - Interstate Highways (1974).

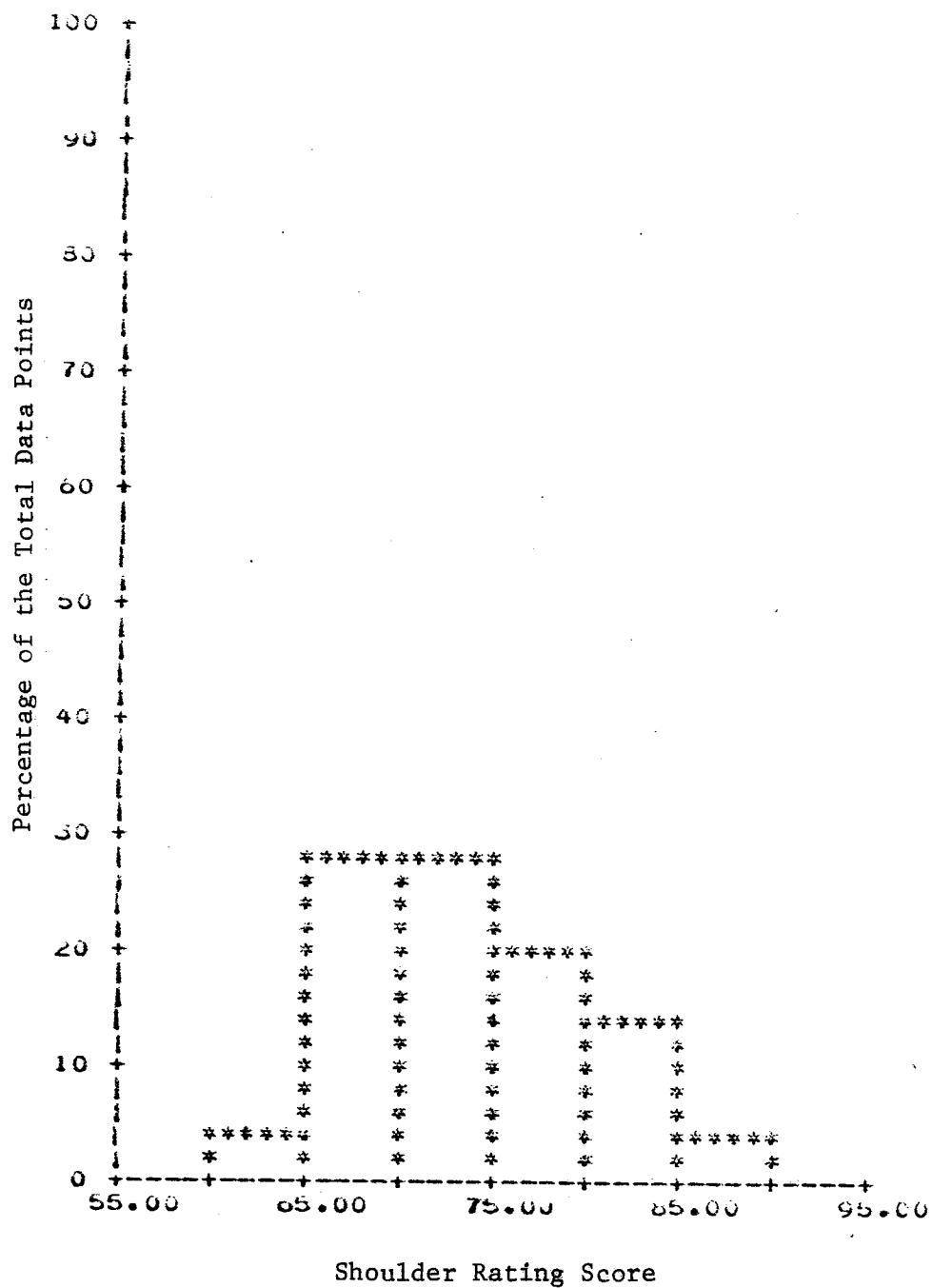


Figure 29. Shoulder Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

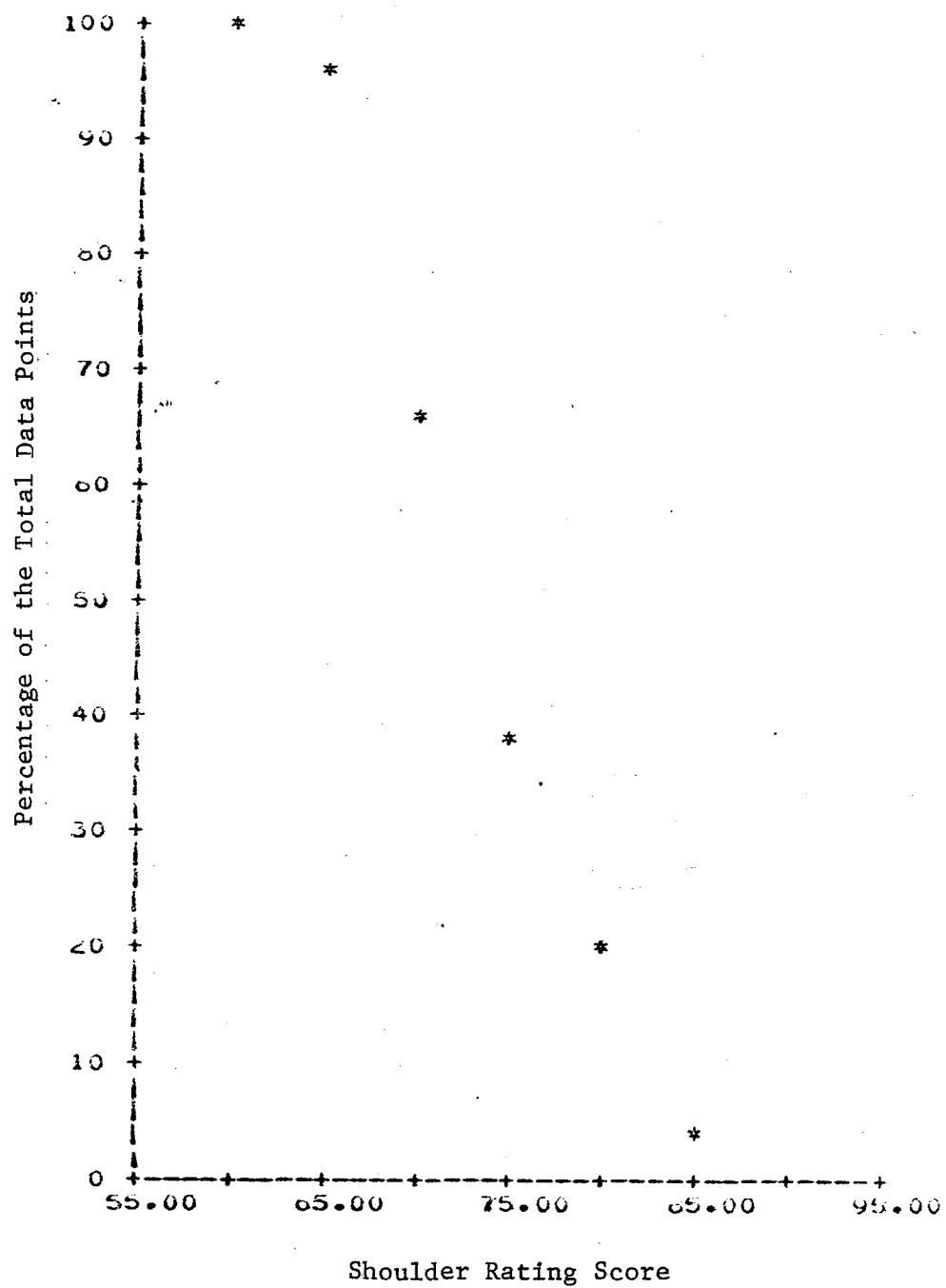


Figure 30. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

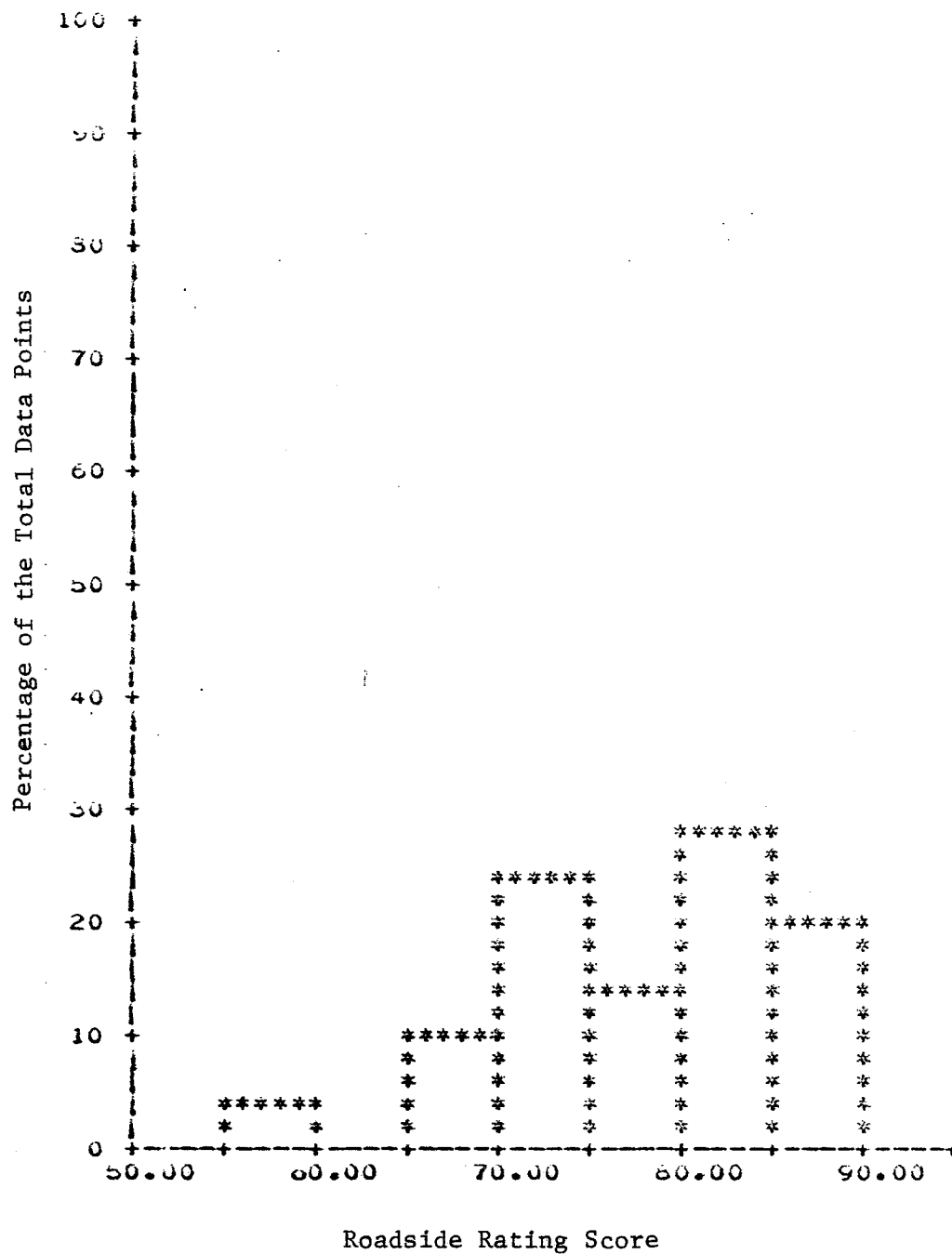


Figure 31. Roadside Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

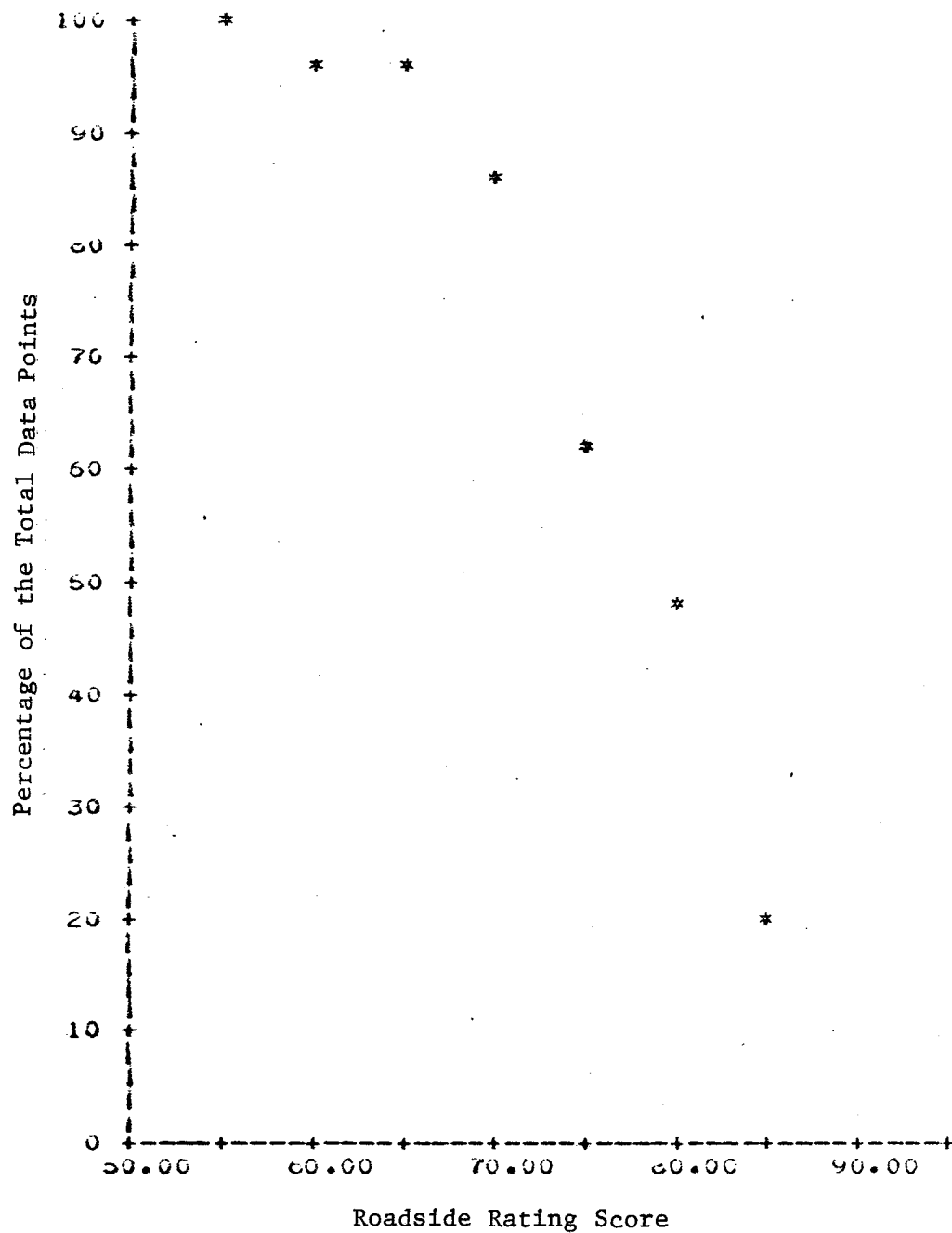


Figure 32. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

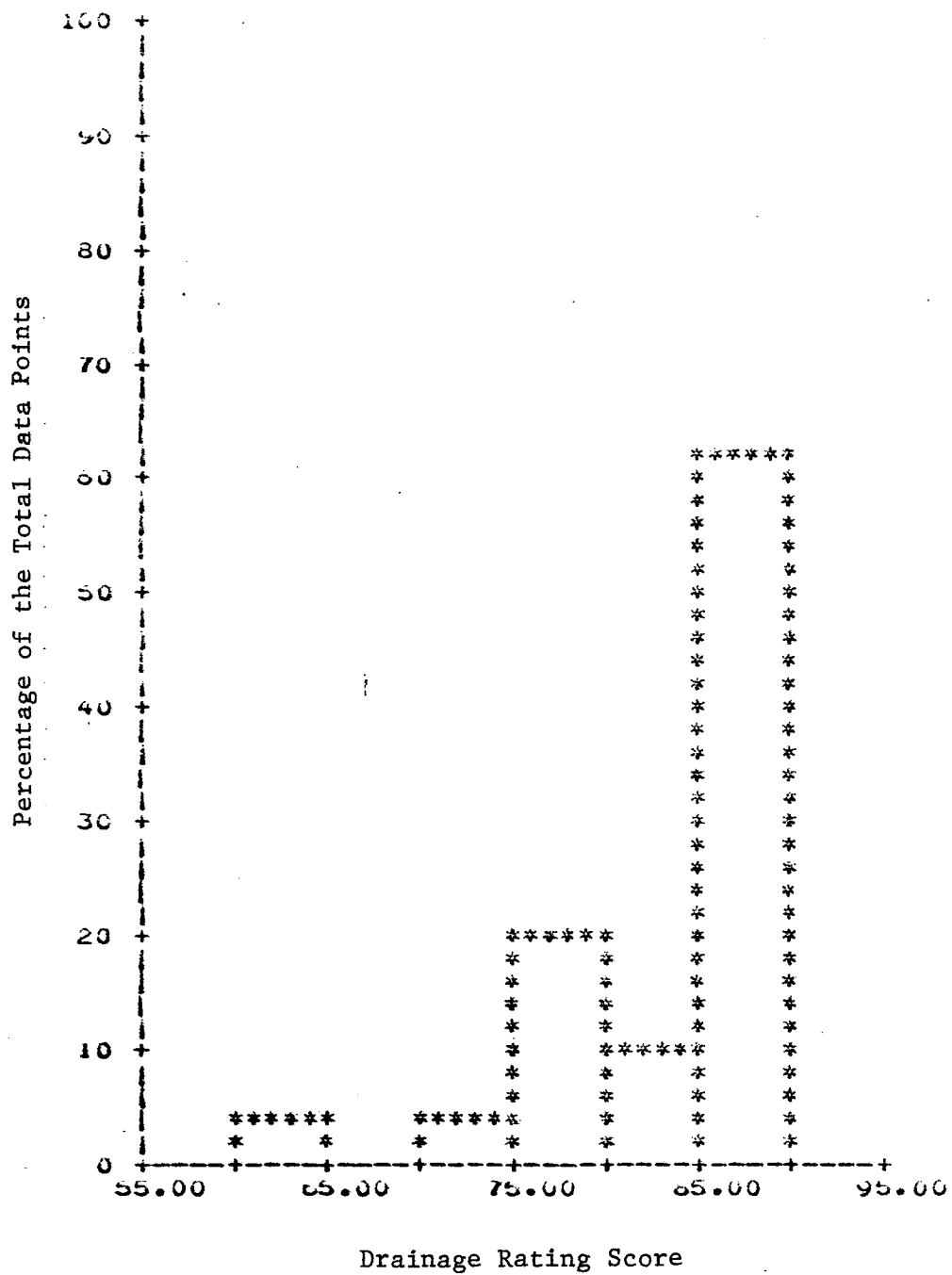


Figure 33. Drainage Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

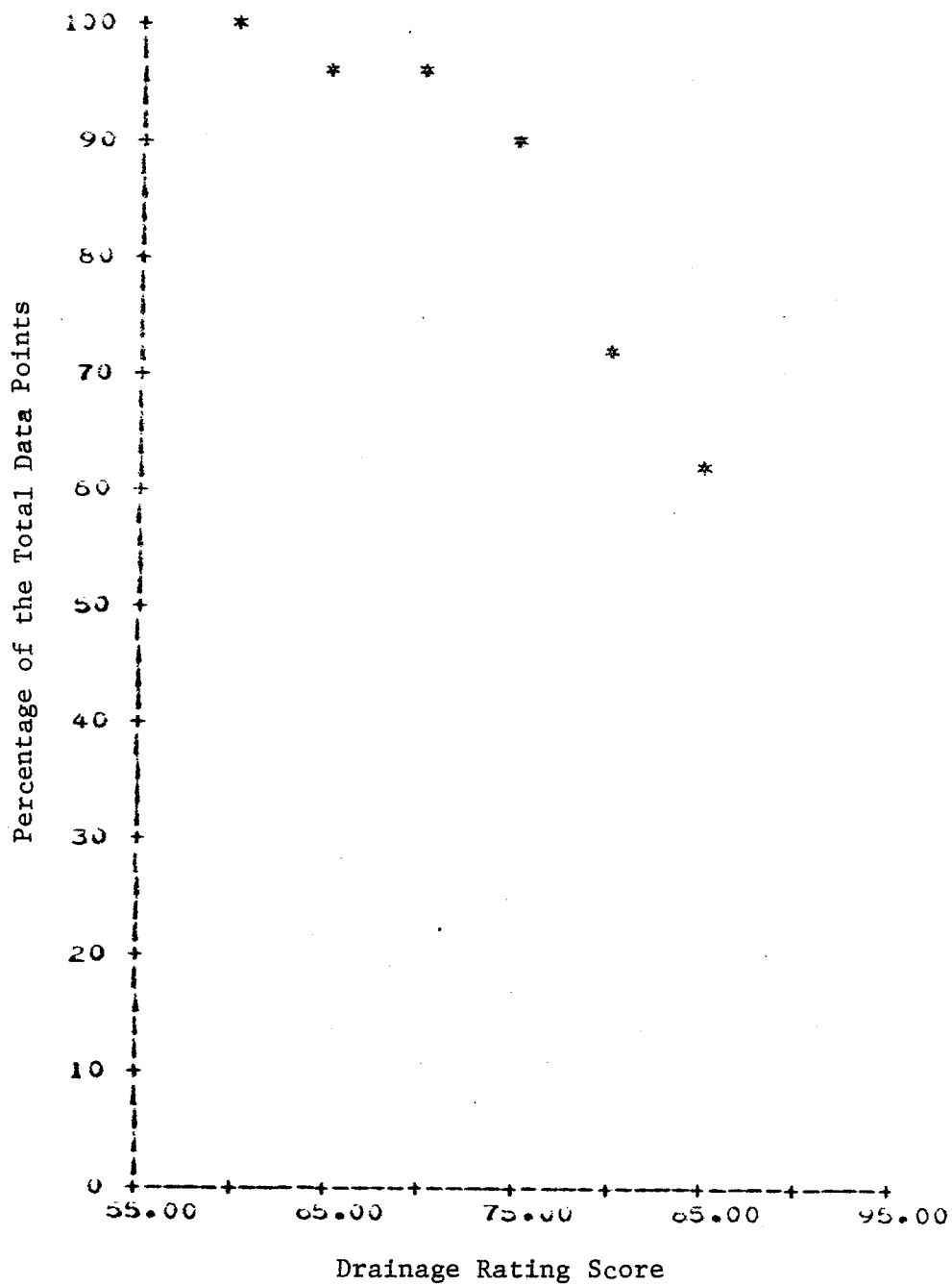


Figure 34. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

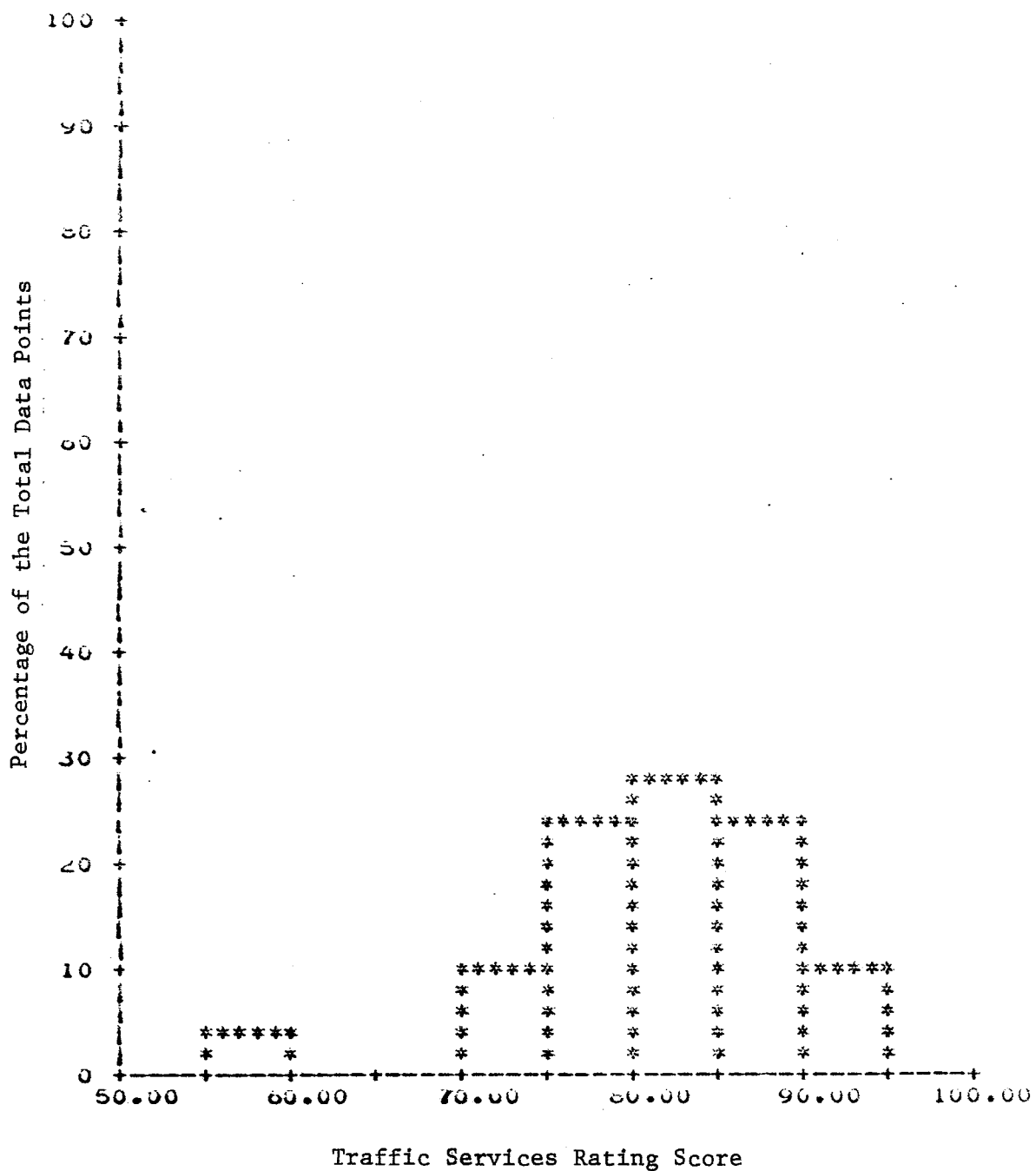


Figure 35. Traffic Services Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

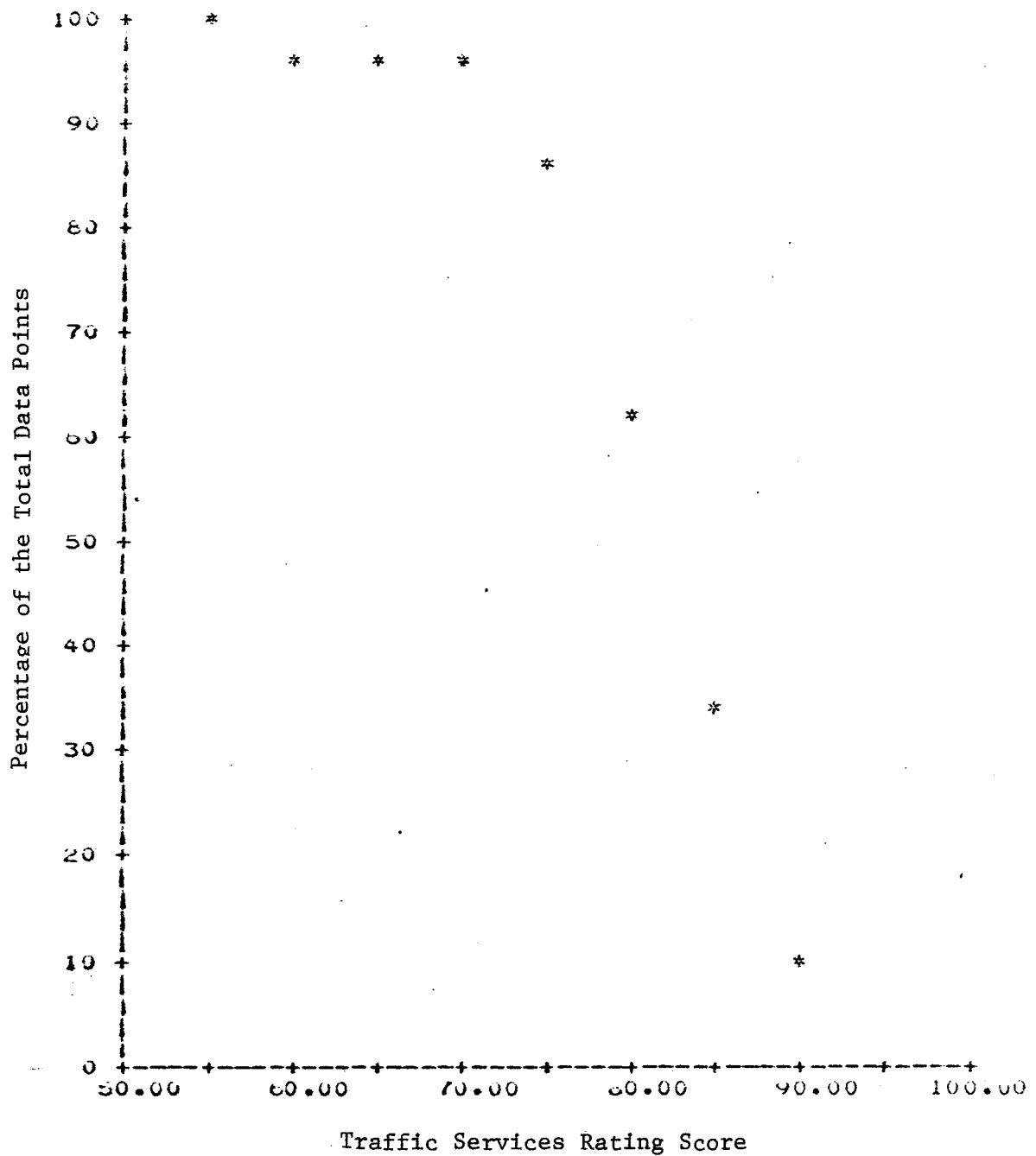


Figure 36. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

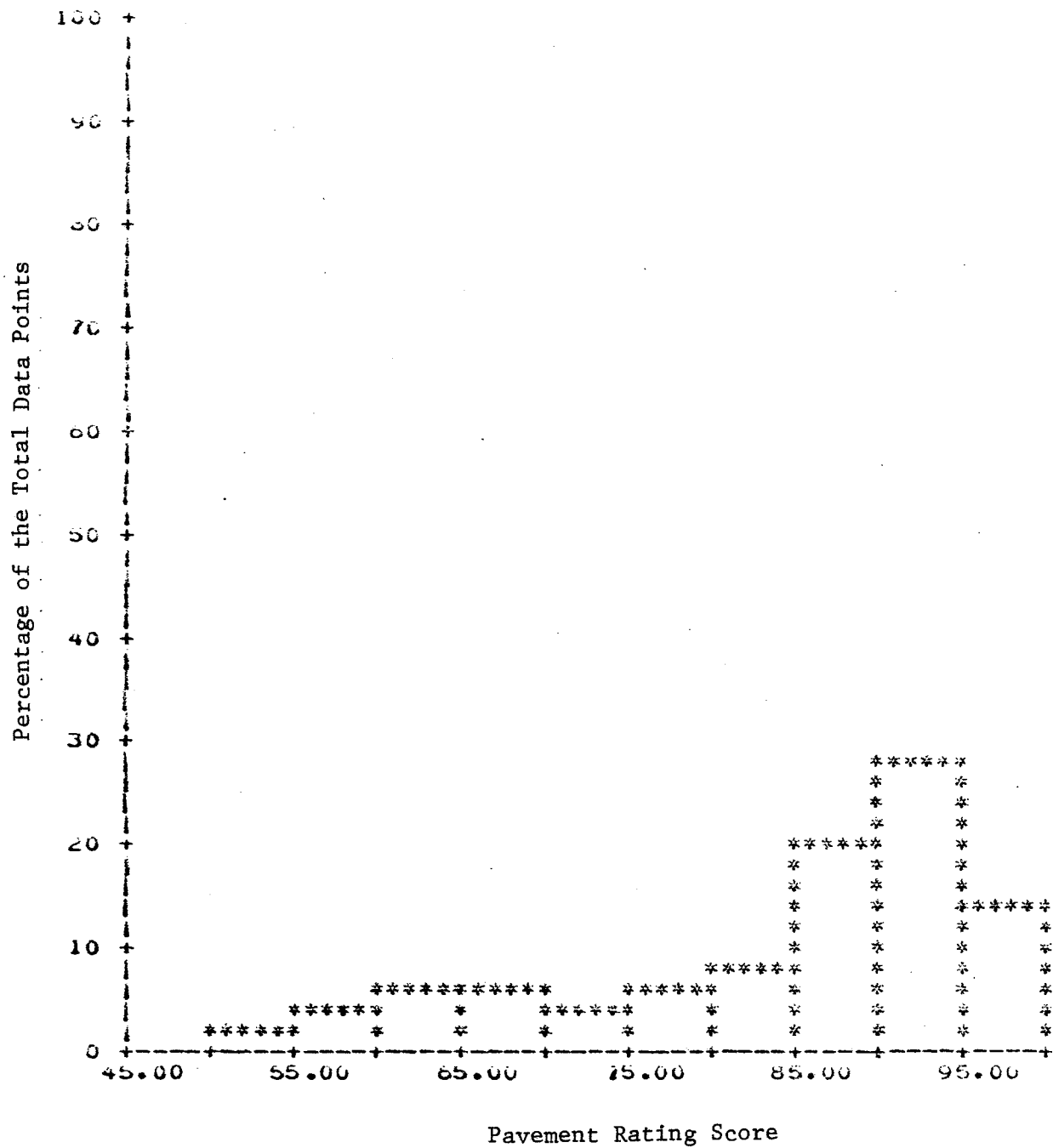


Figure 37. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - U.S. and State Highways (1974).

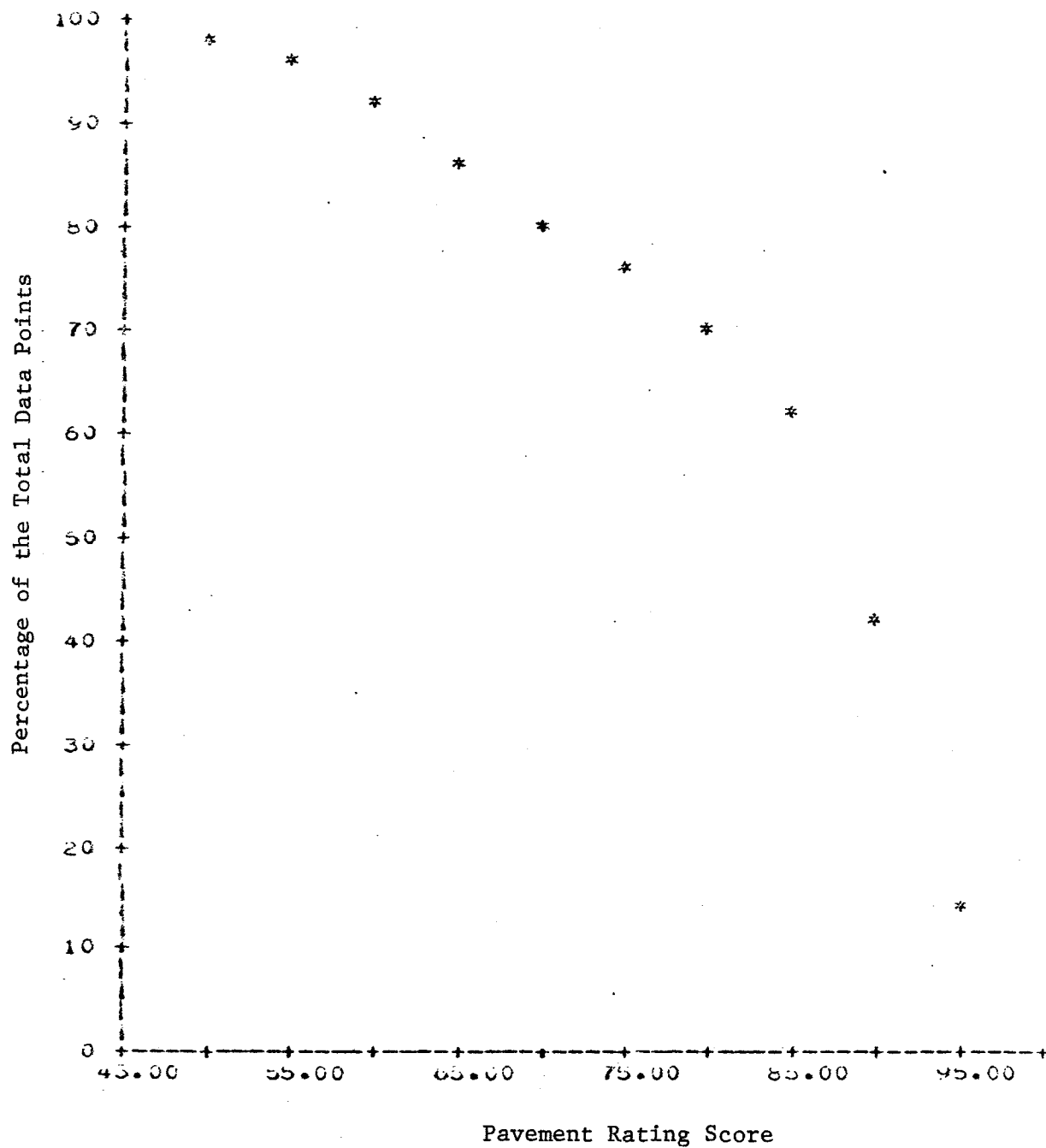


Figure 38. Pavement Rating Score (Without MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

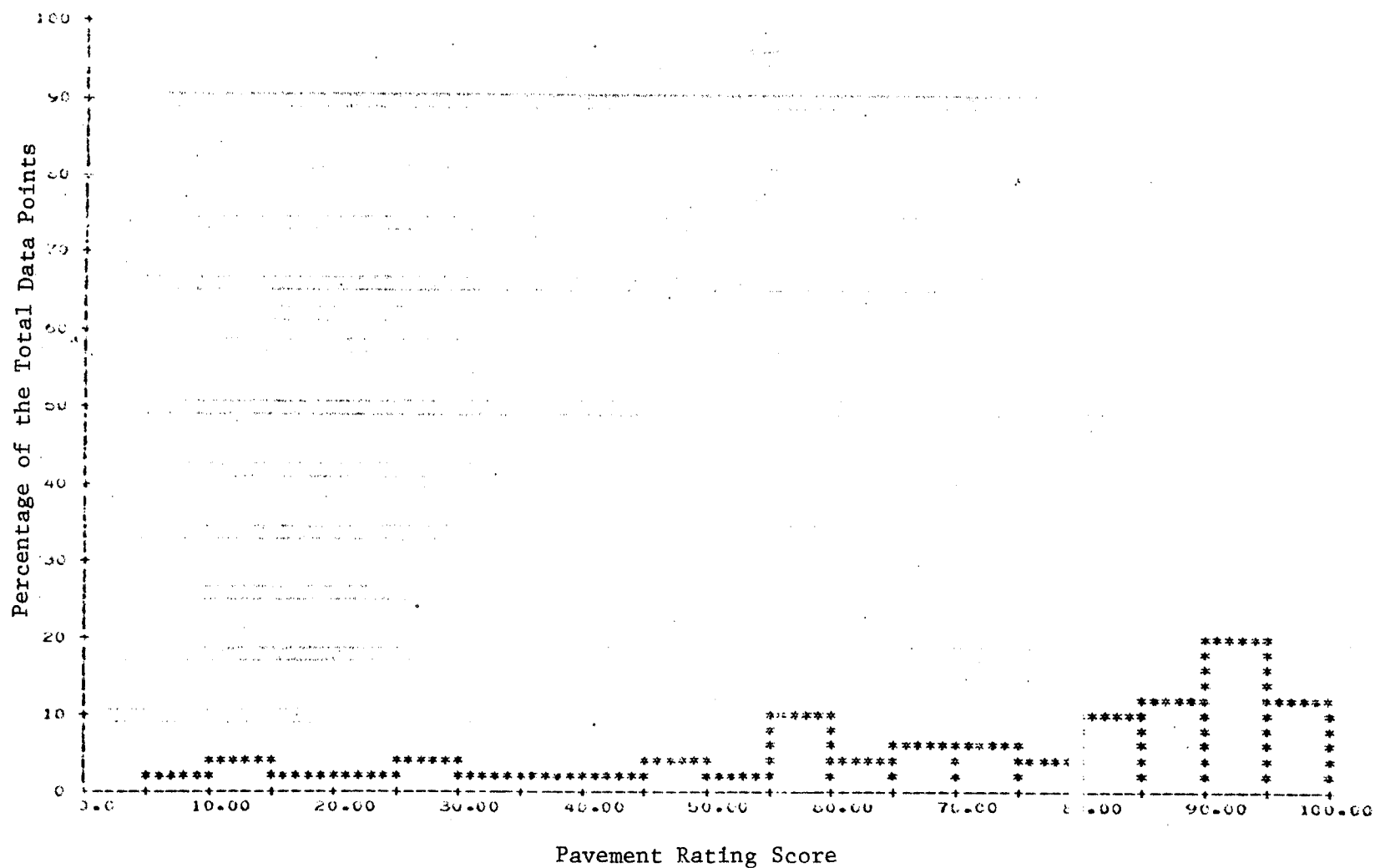


Figure 39. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - U.S. and State Highways (1974).

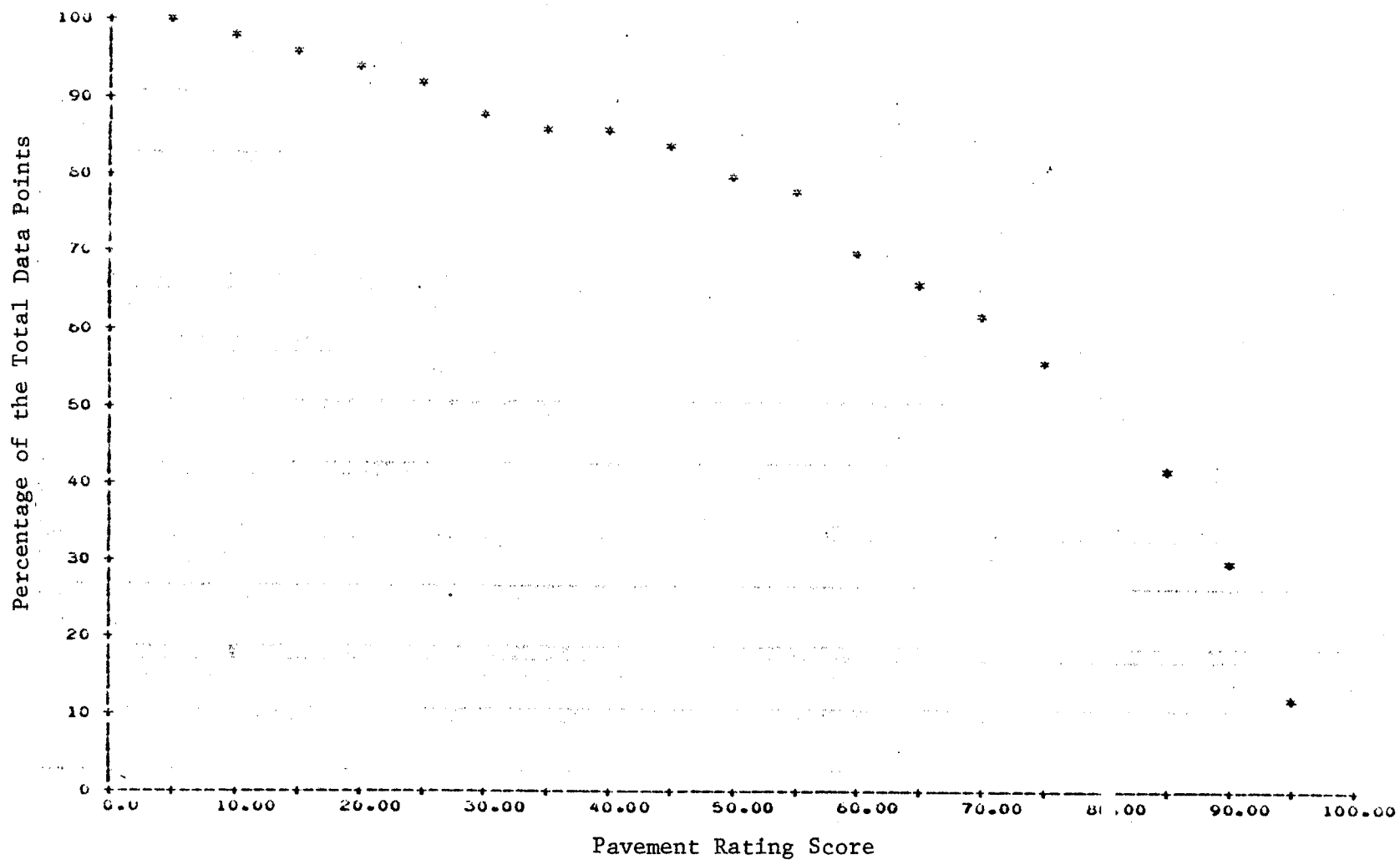


Figure 40. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

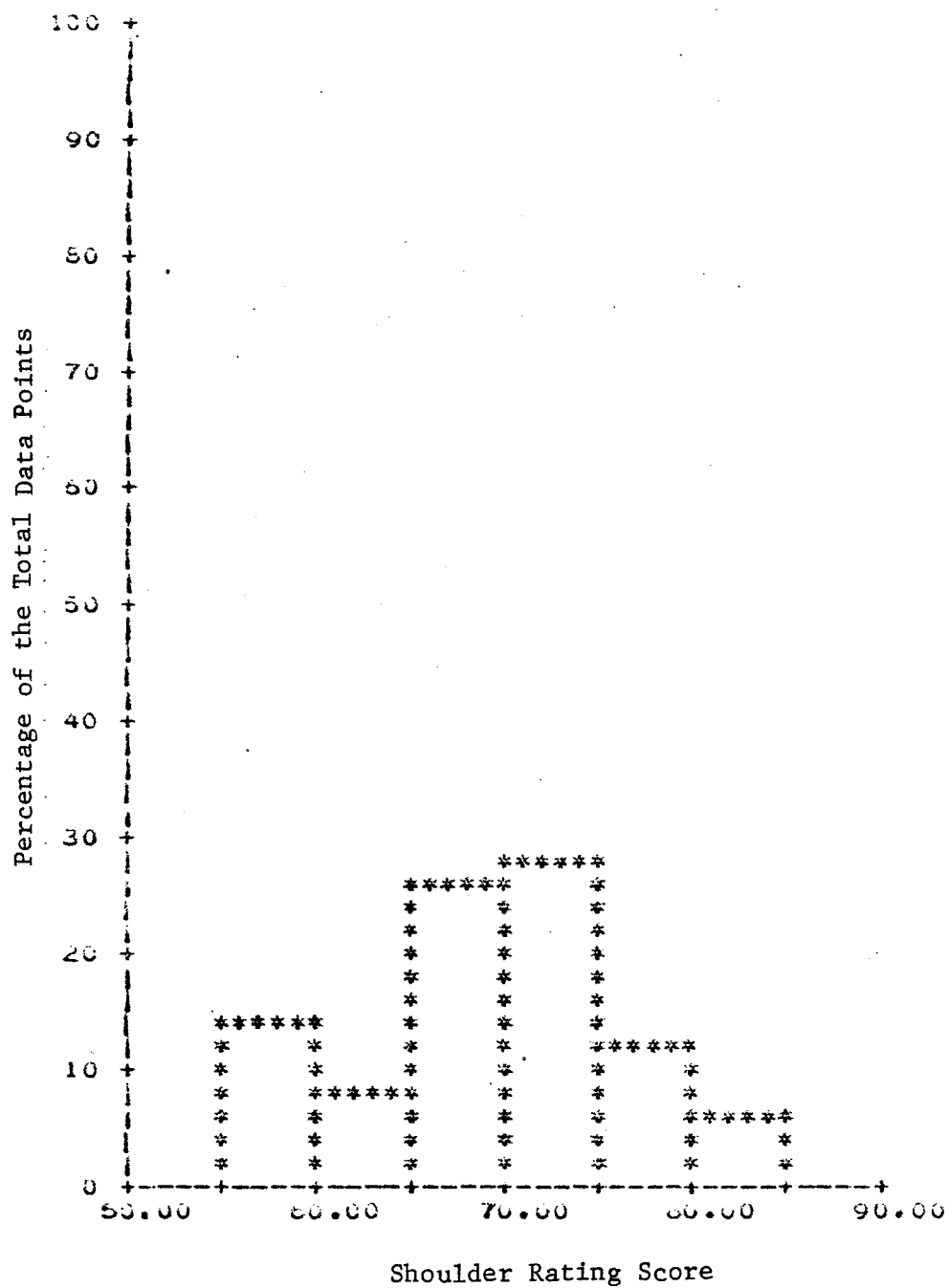


Figure 41. Shoulder Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

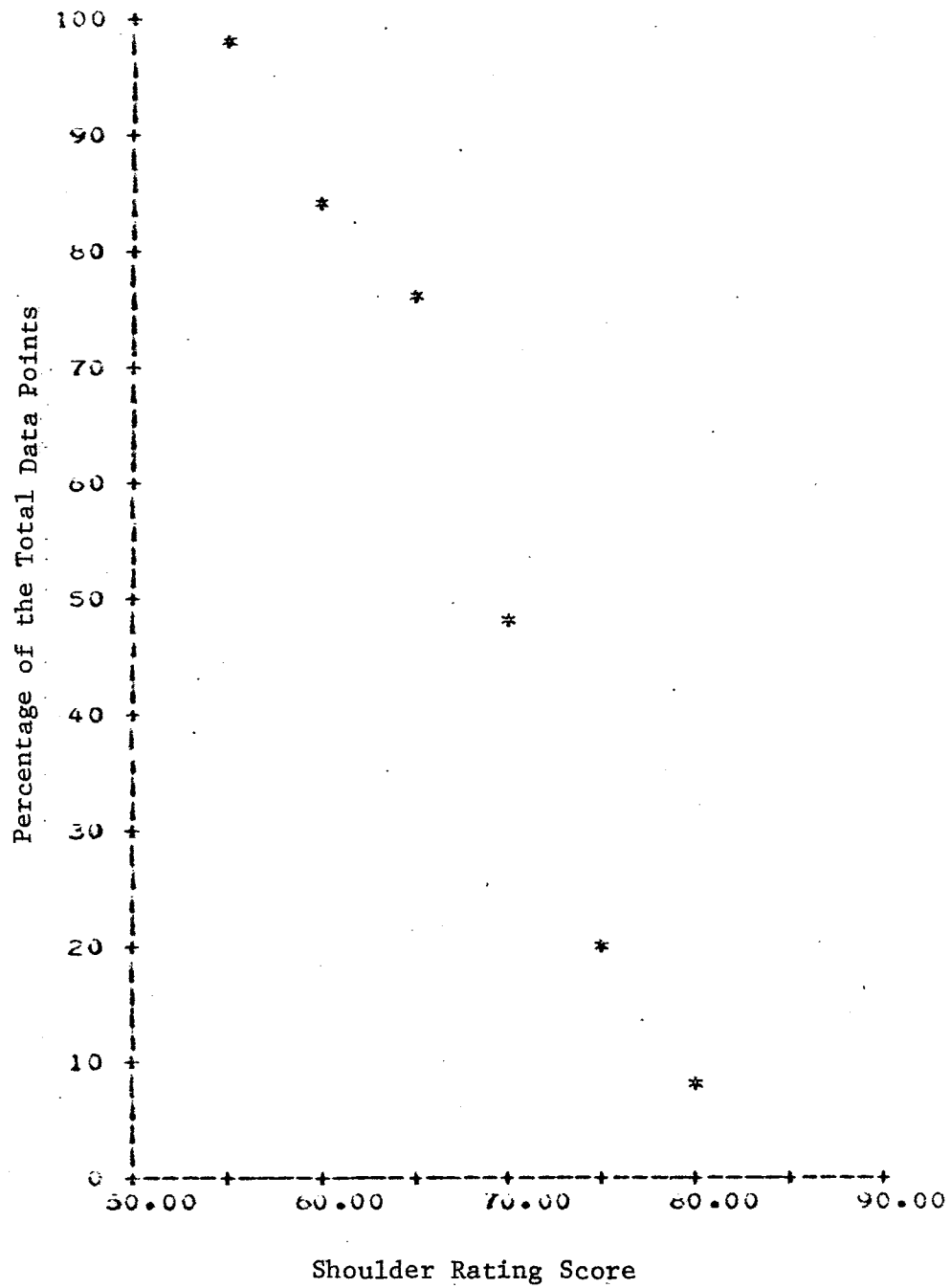


Figure 42. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

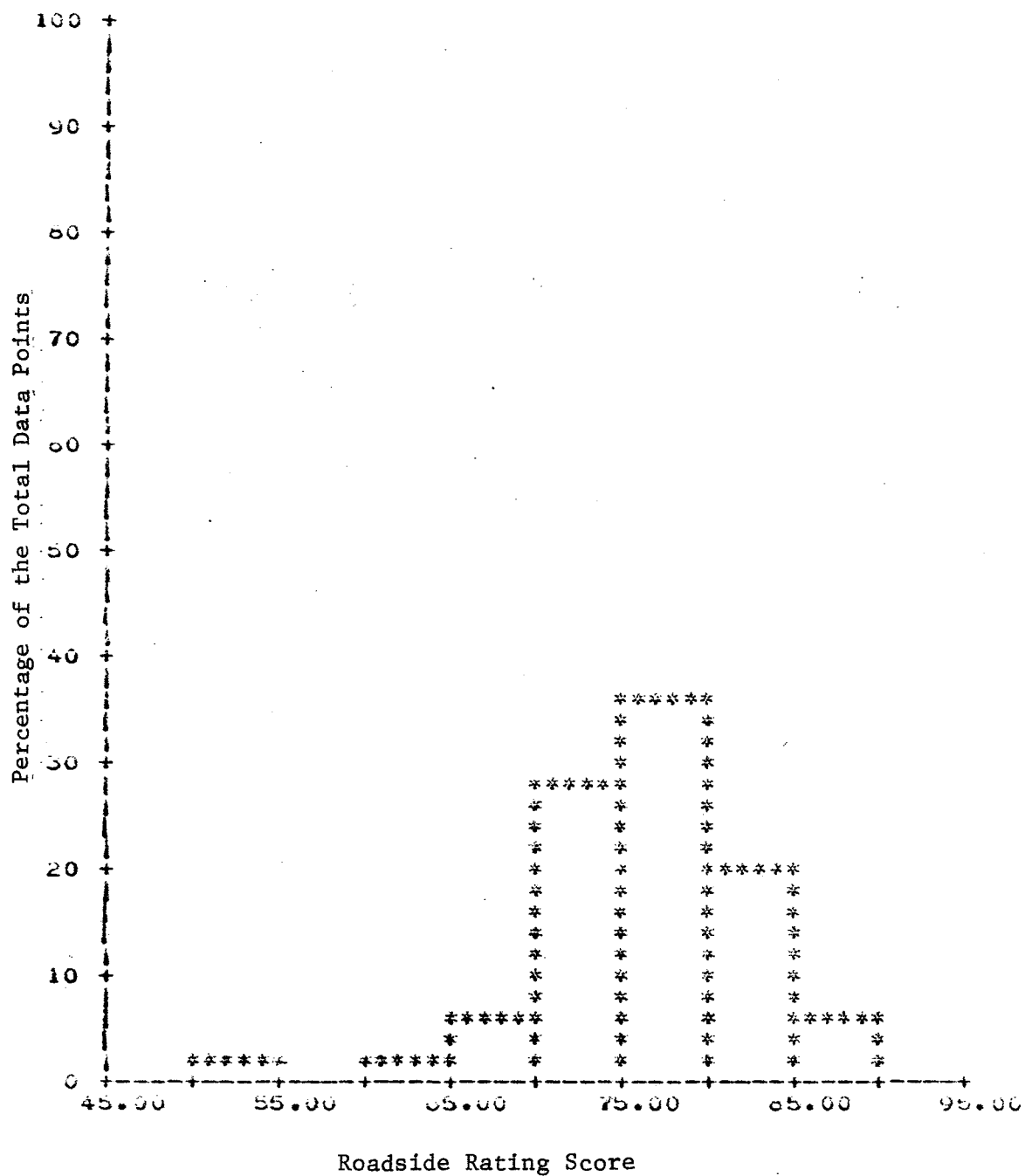


Figure 43. Roadside Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

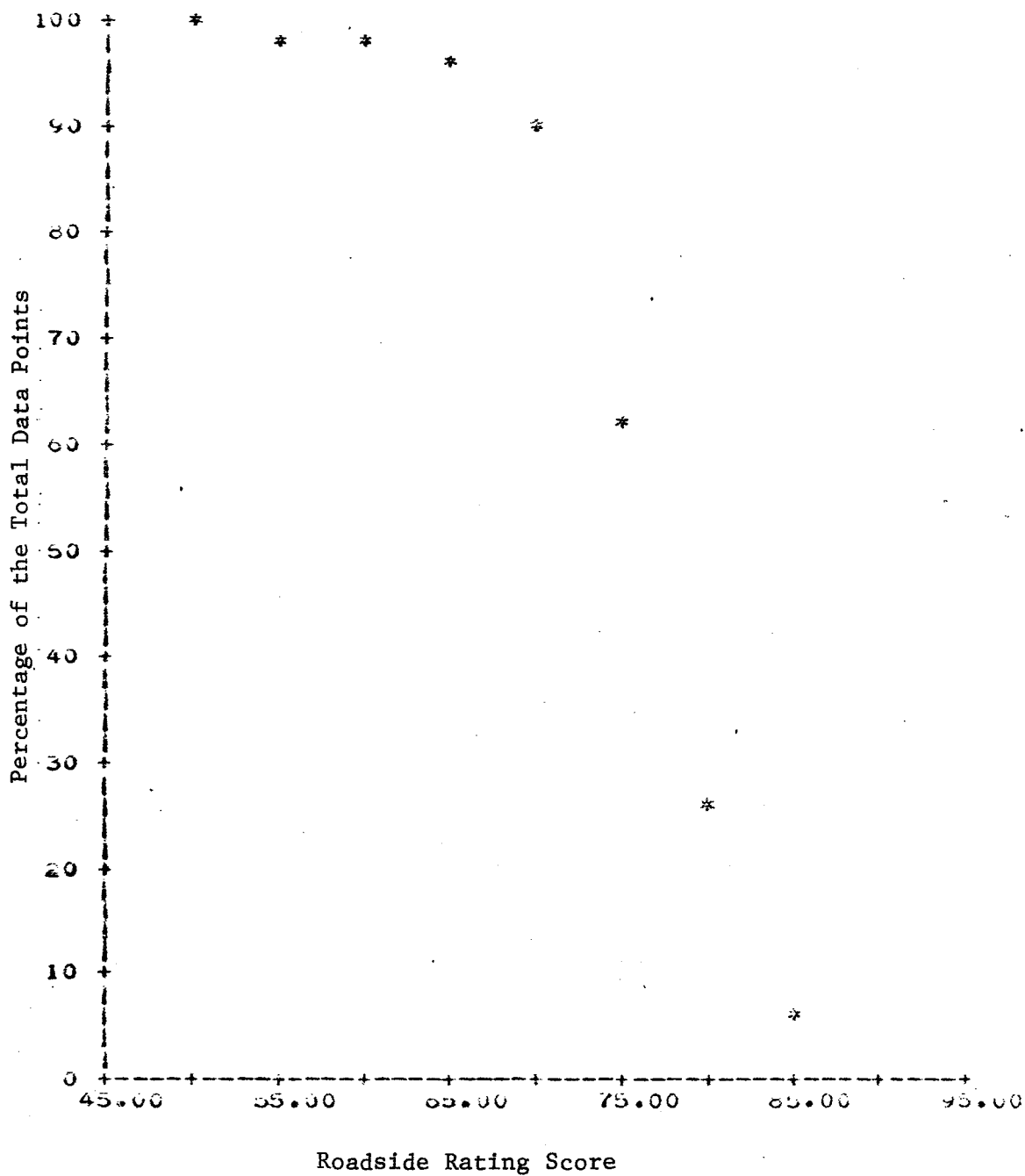


Figure 44. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

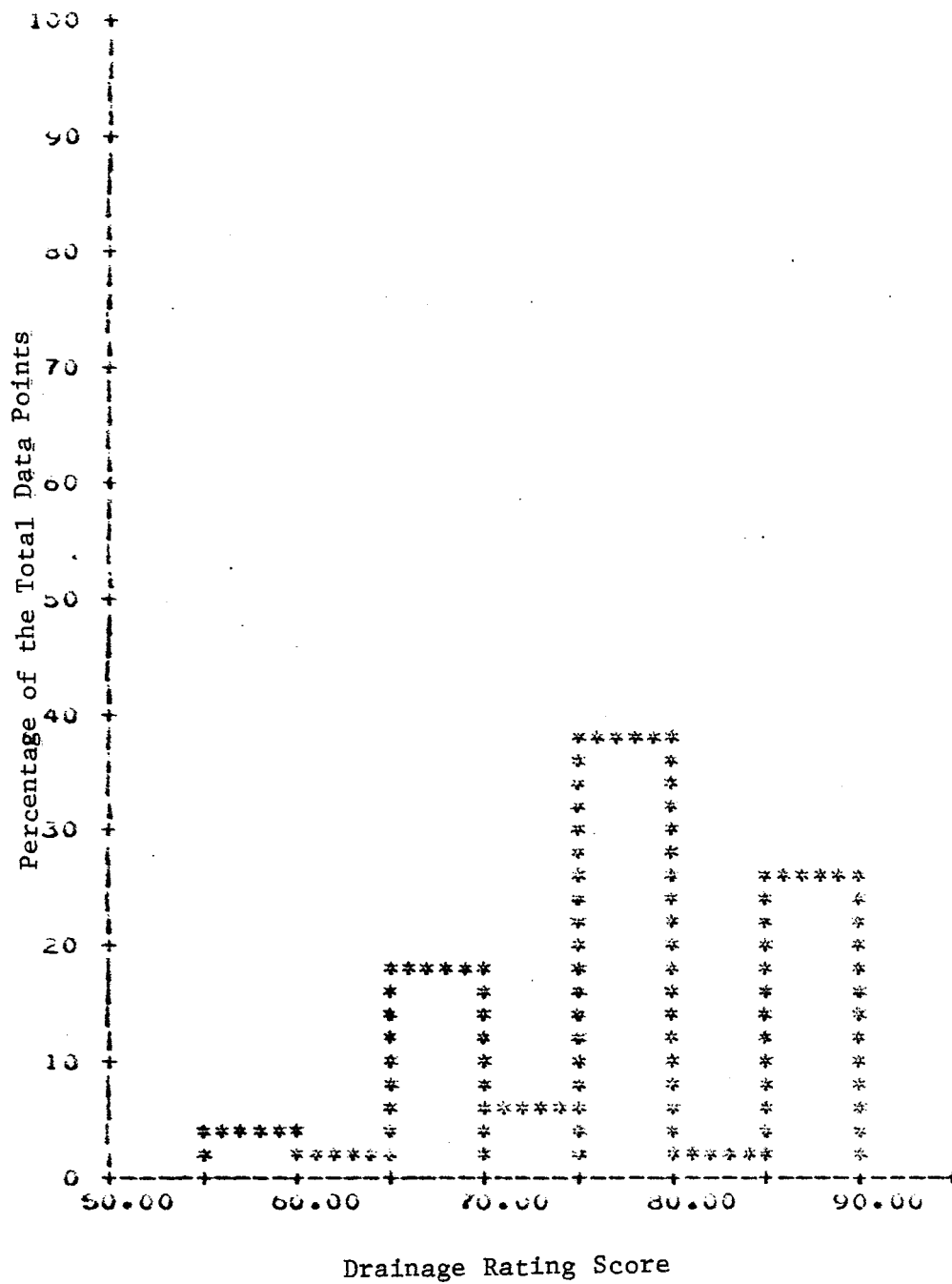


Figure 45. Drainage Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

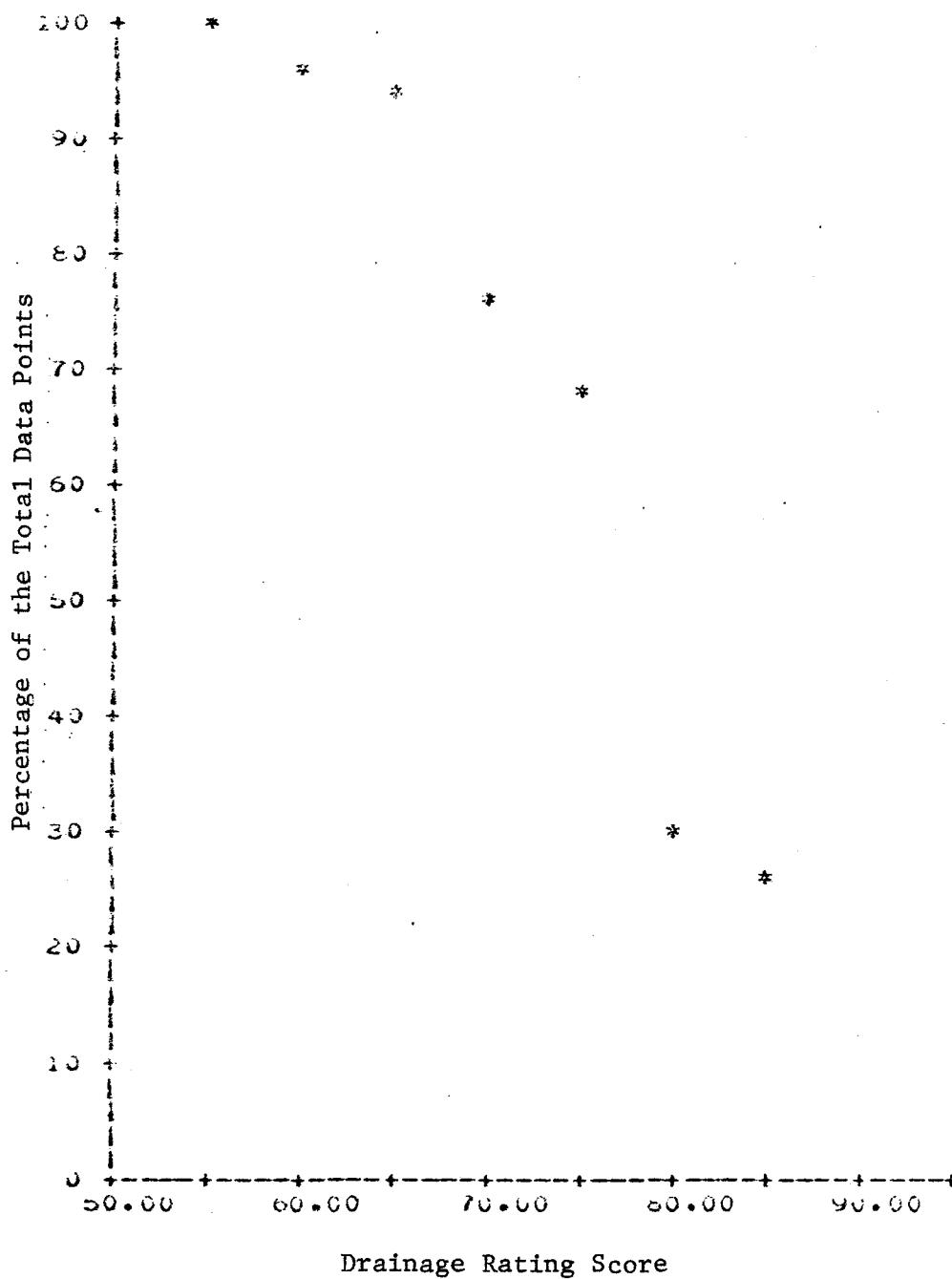


Figure 46. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

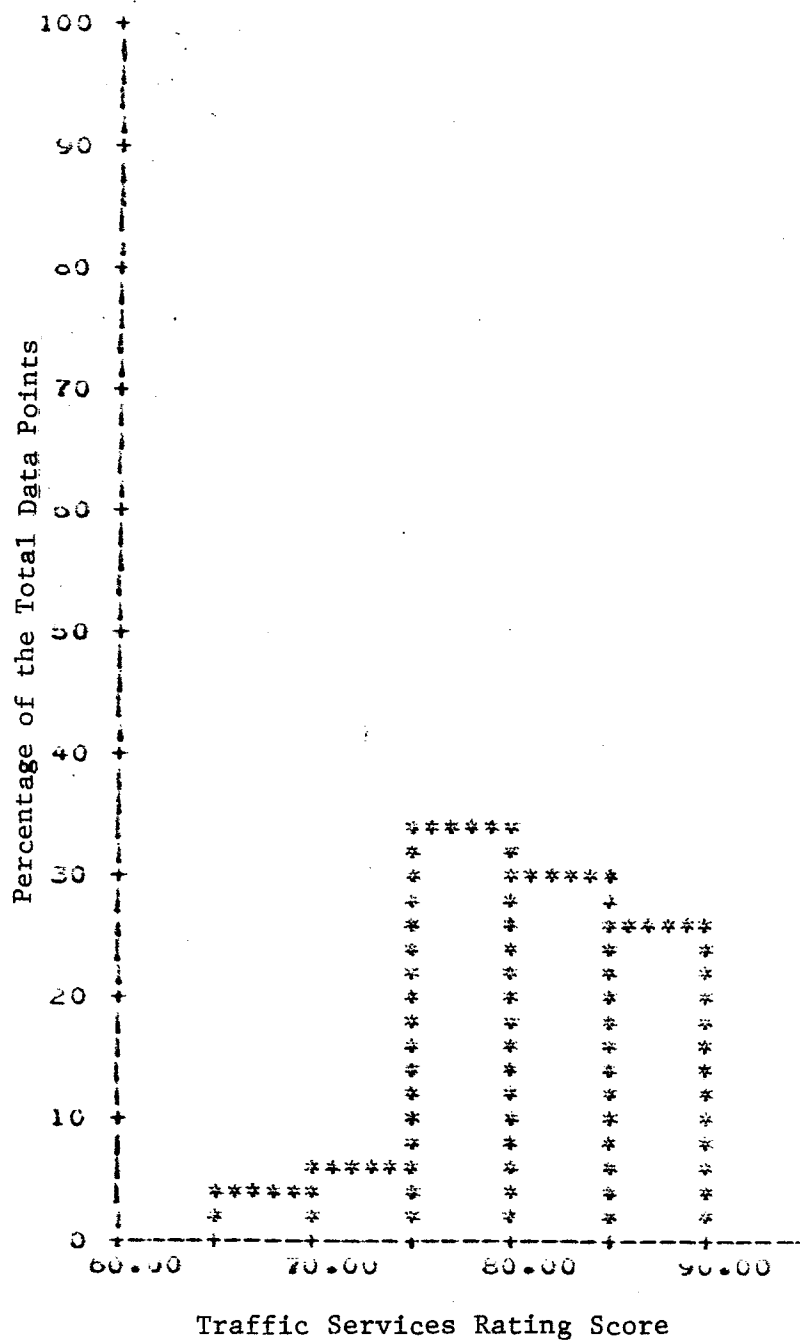


Figure 47. Traffic Services Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

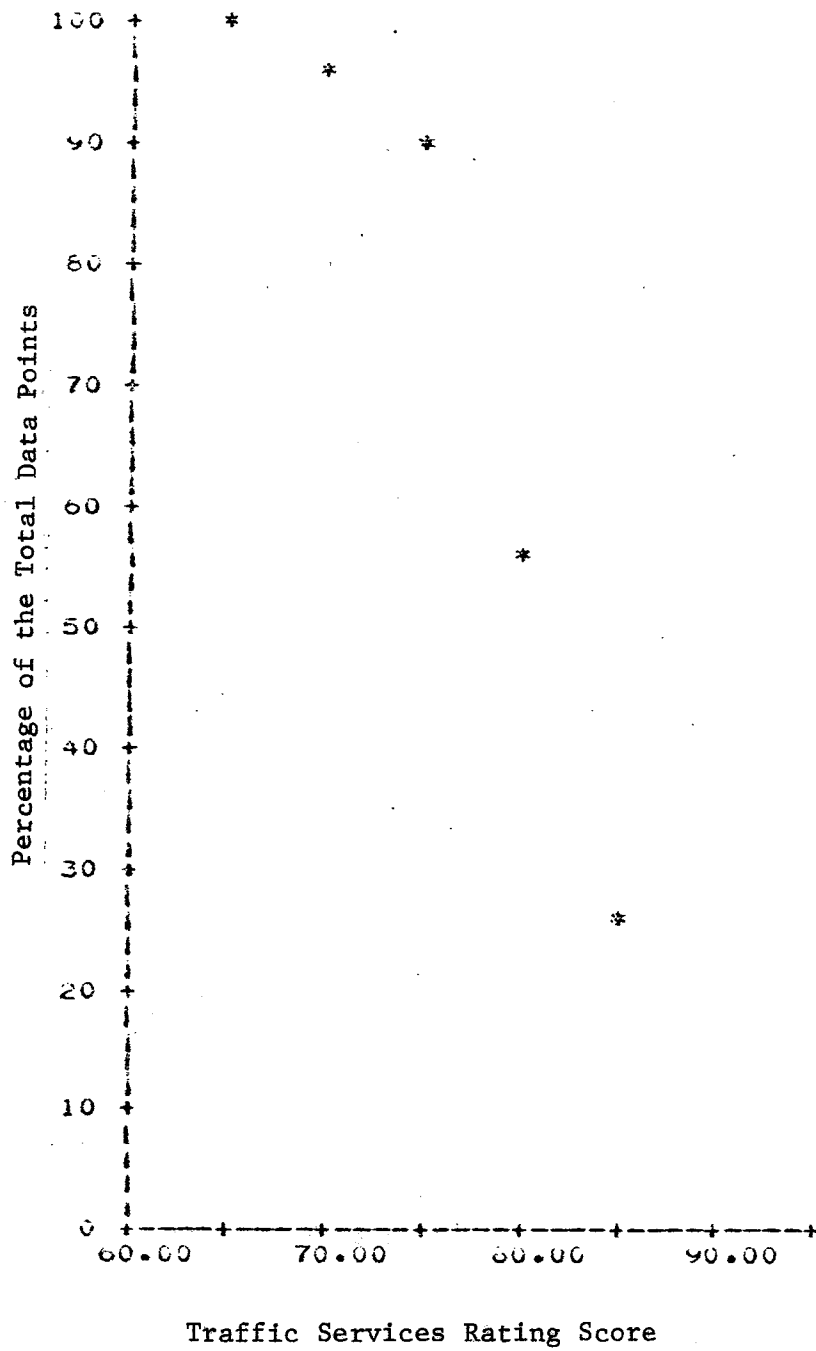


Figure 48. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

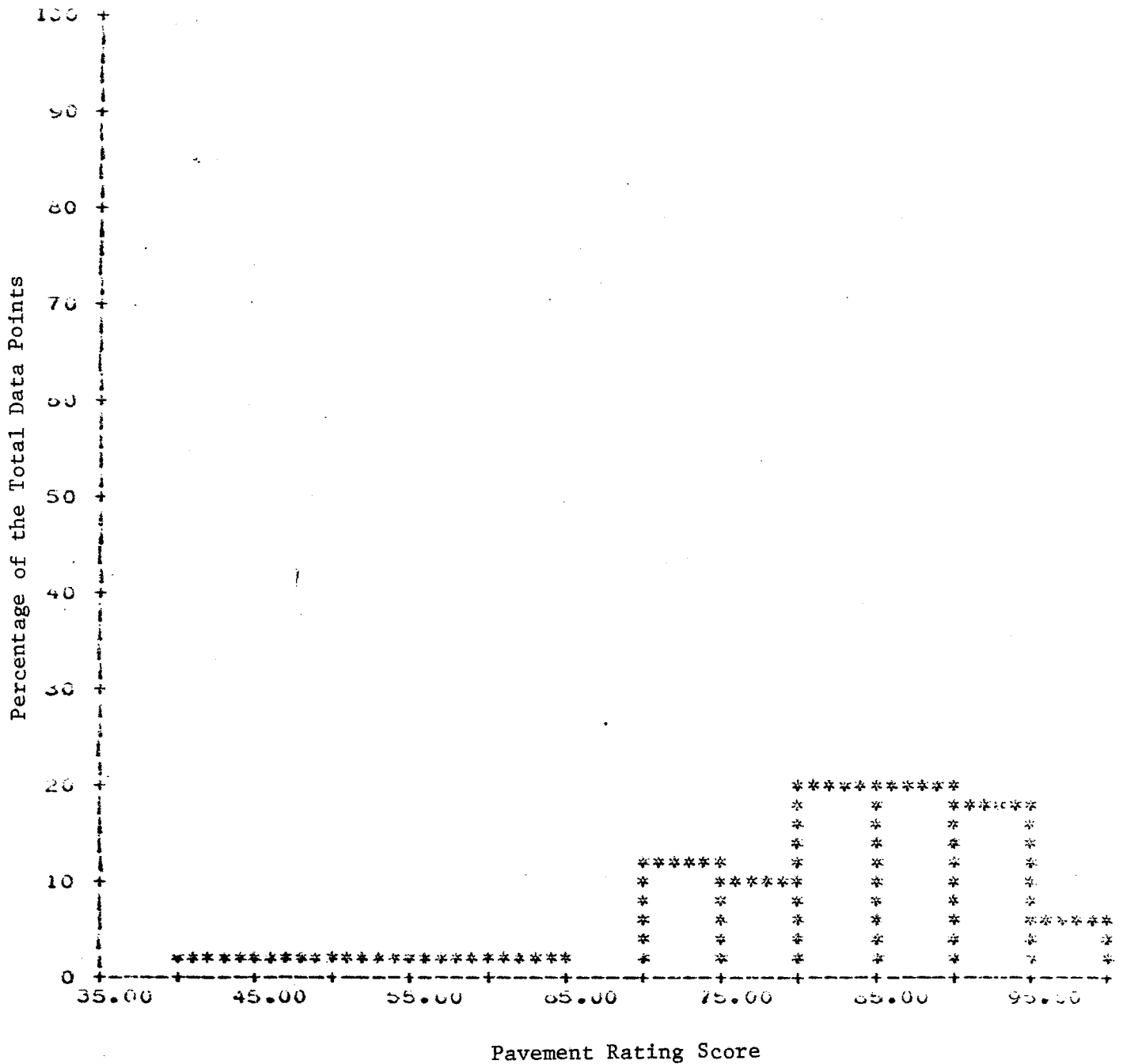


Figure 49. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - F.M. Highways (1974).

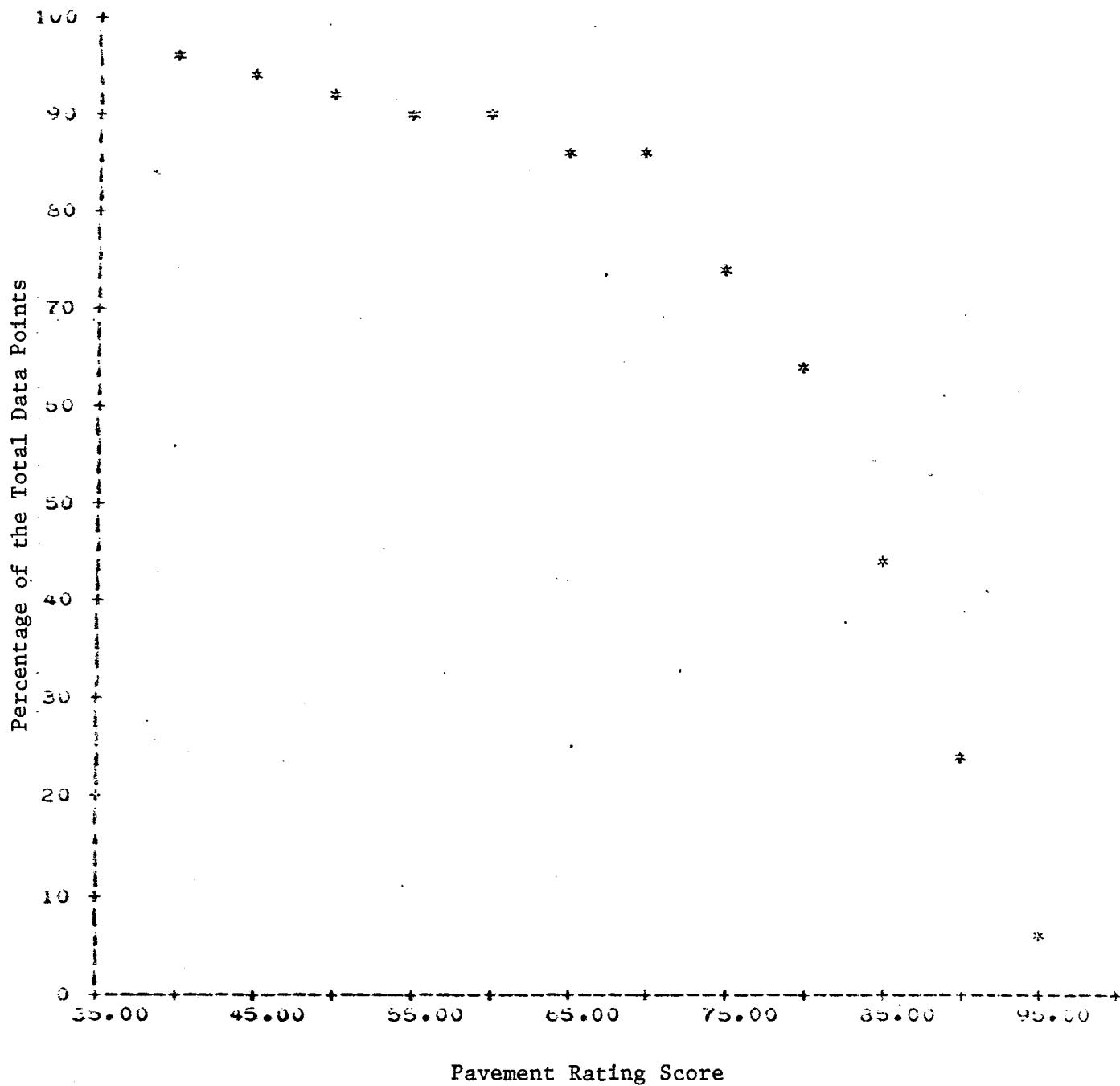


Figure 50. Pavement Rating Score (Without MRM Deductions)
Percentage Cumulative Distribution for State-
wide Random Sections - F.M. Highways (1974).

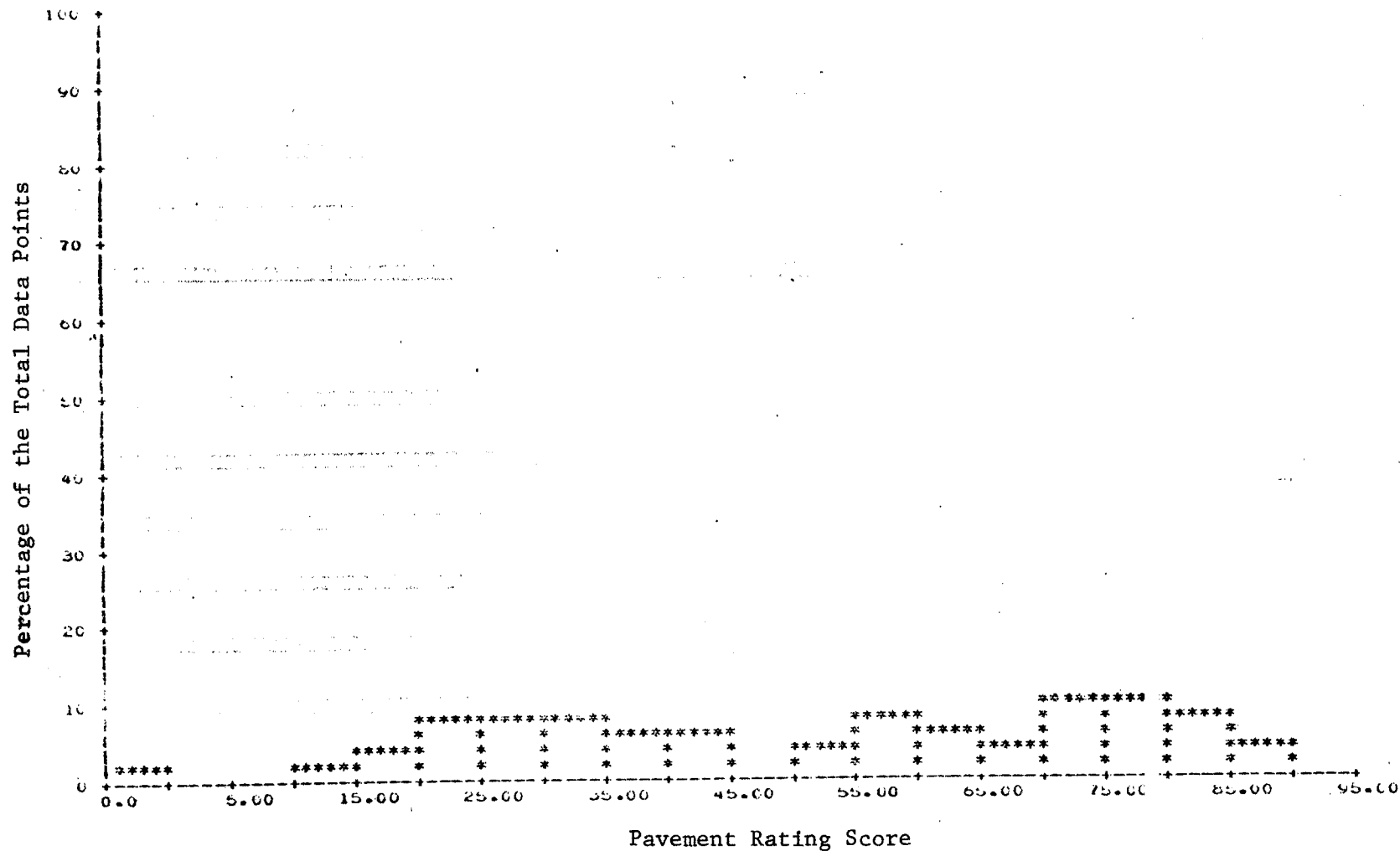


Figure 51. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - F.M. Highways (1974).

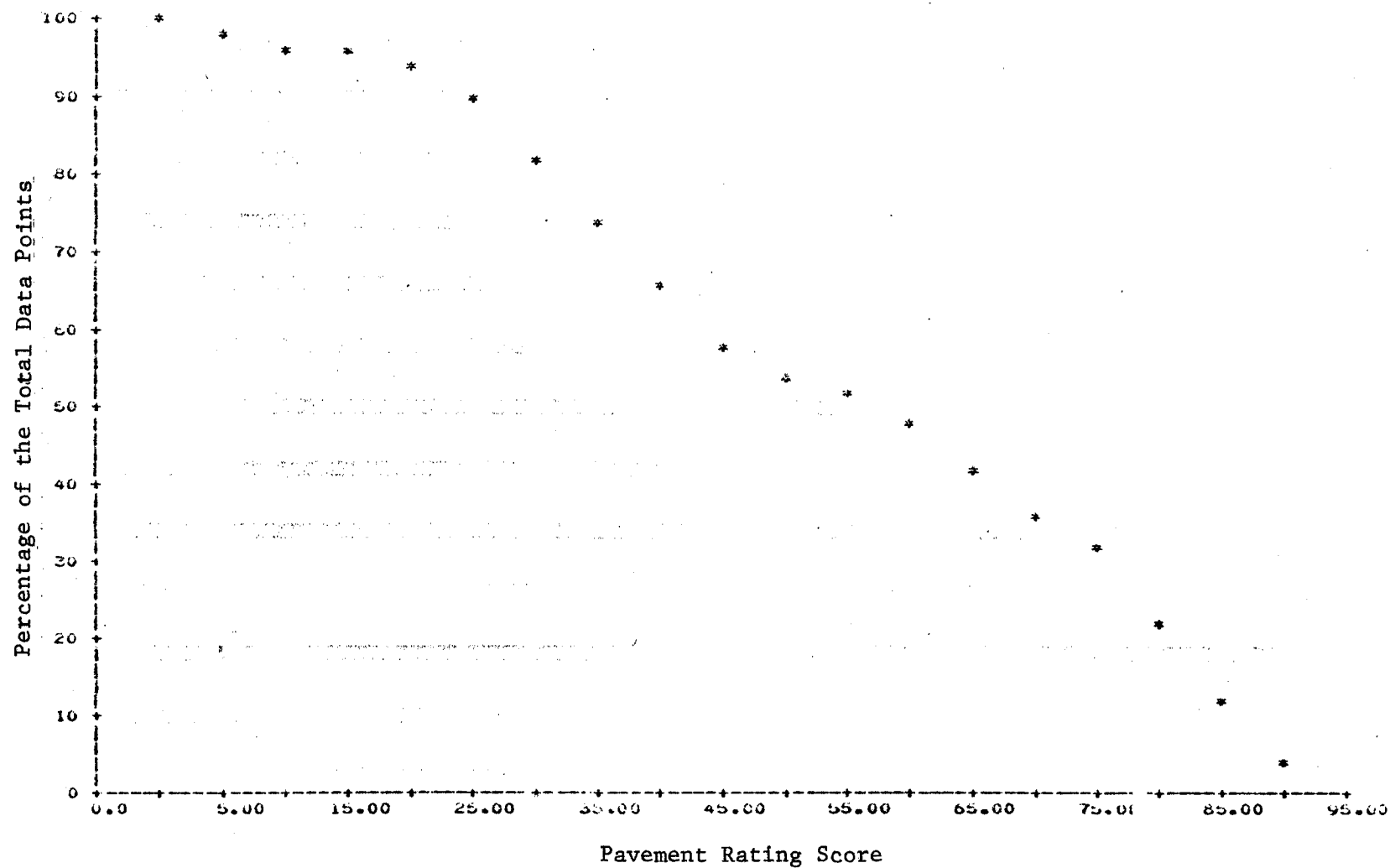


Figure 52. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

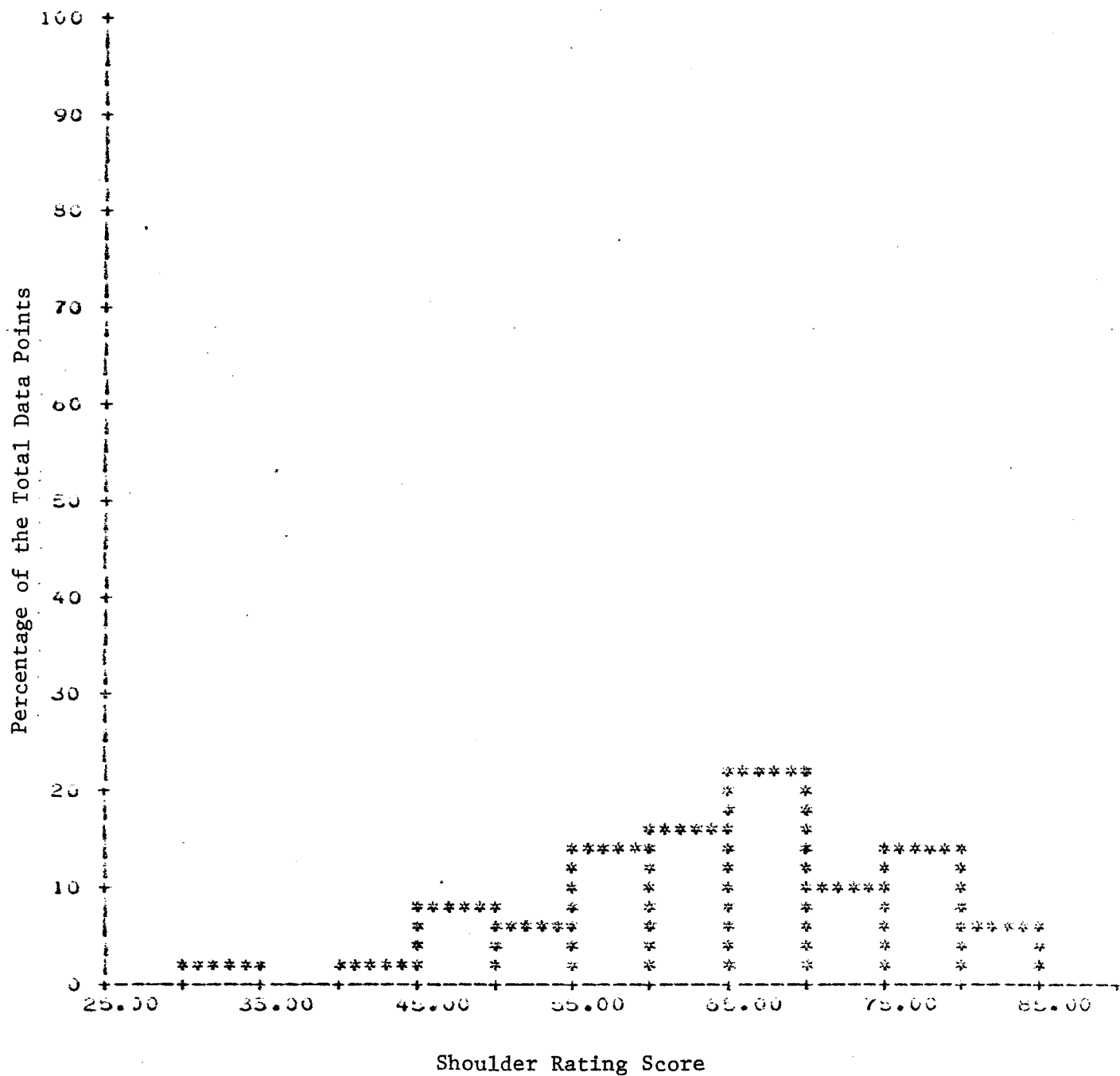


Figure 53. Shoulder Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

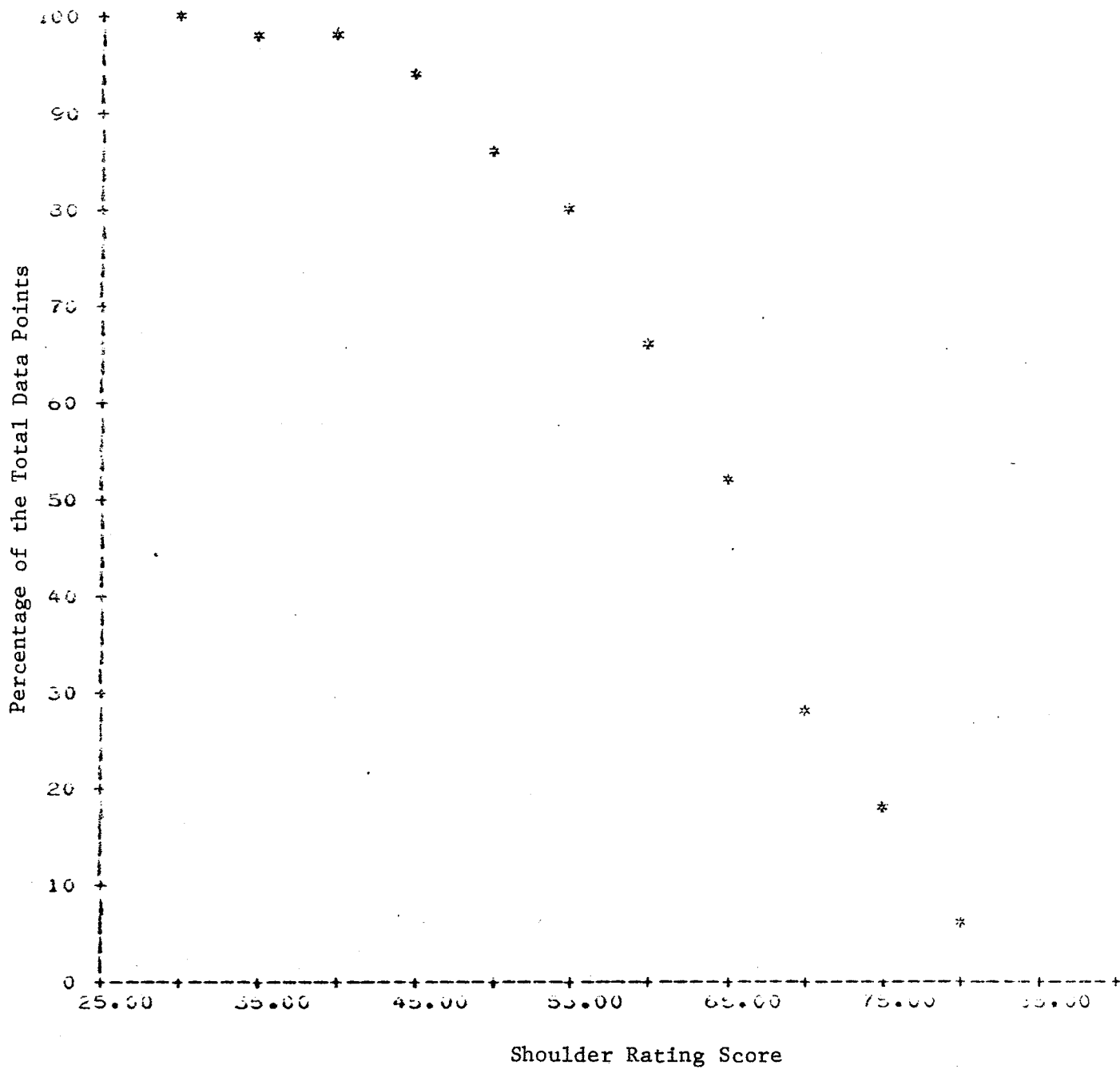


Figure 54. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

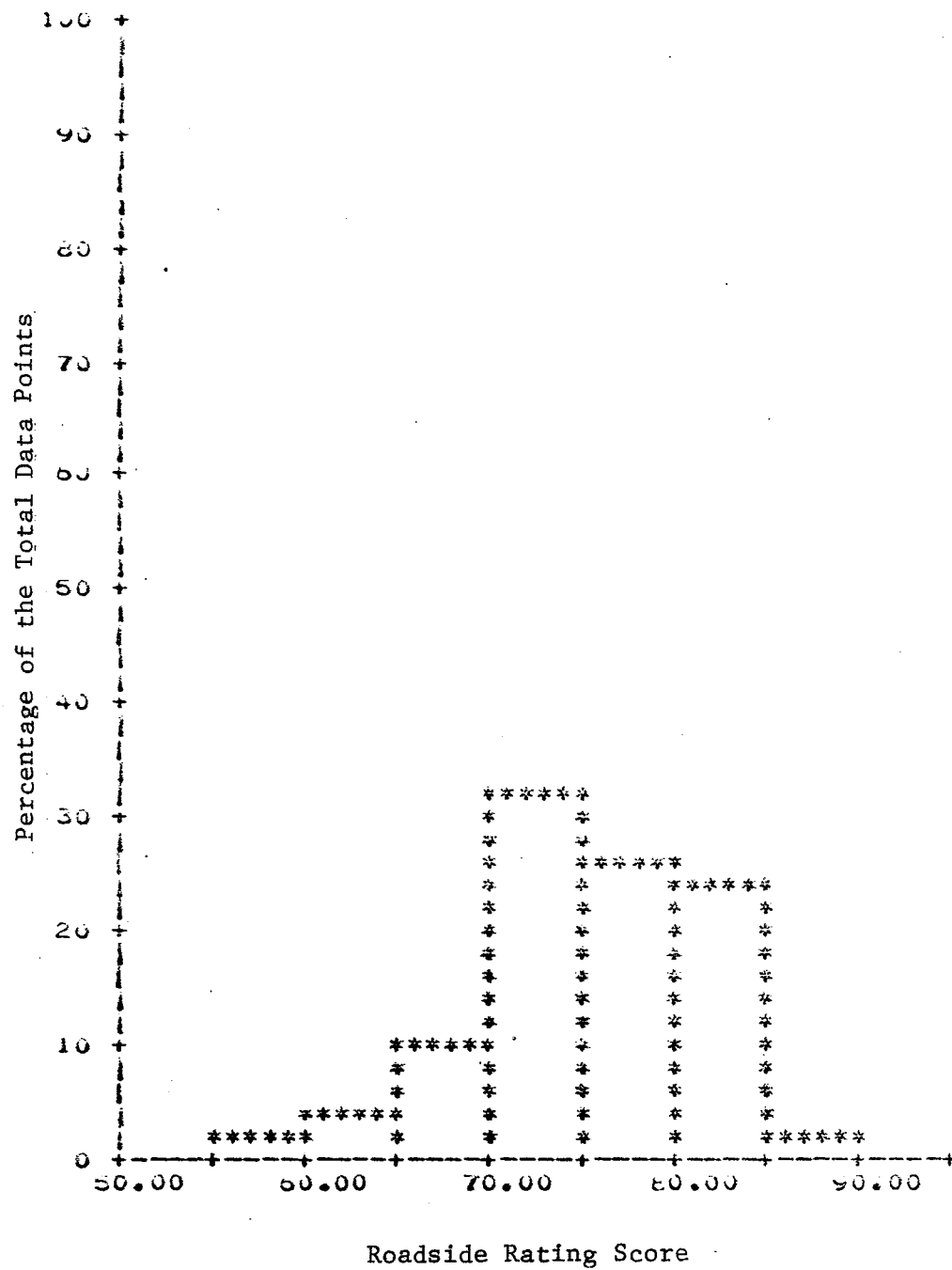


Figure 55. Roadside Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

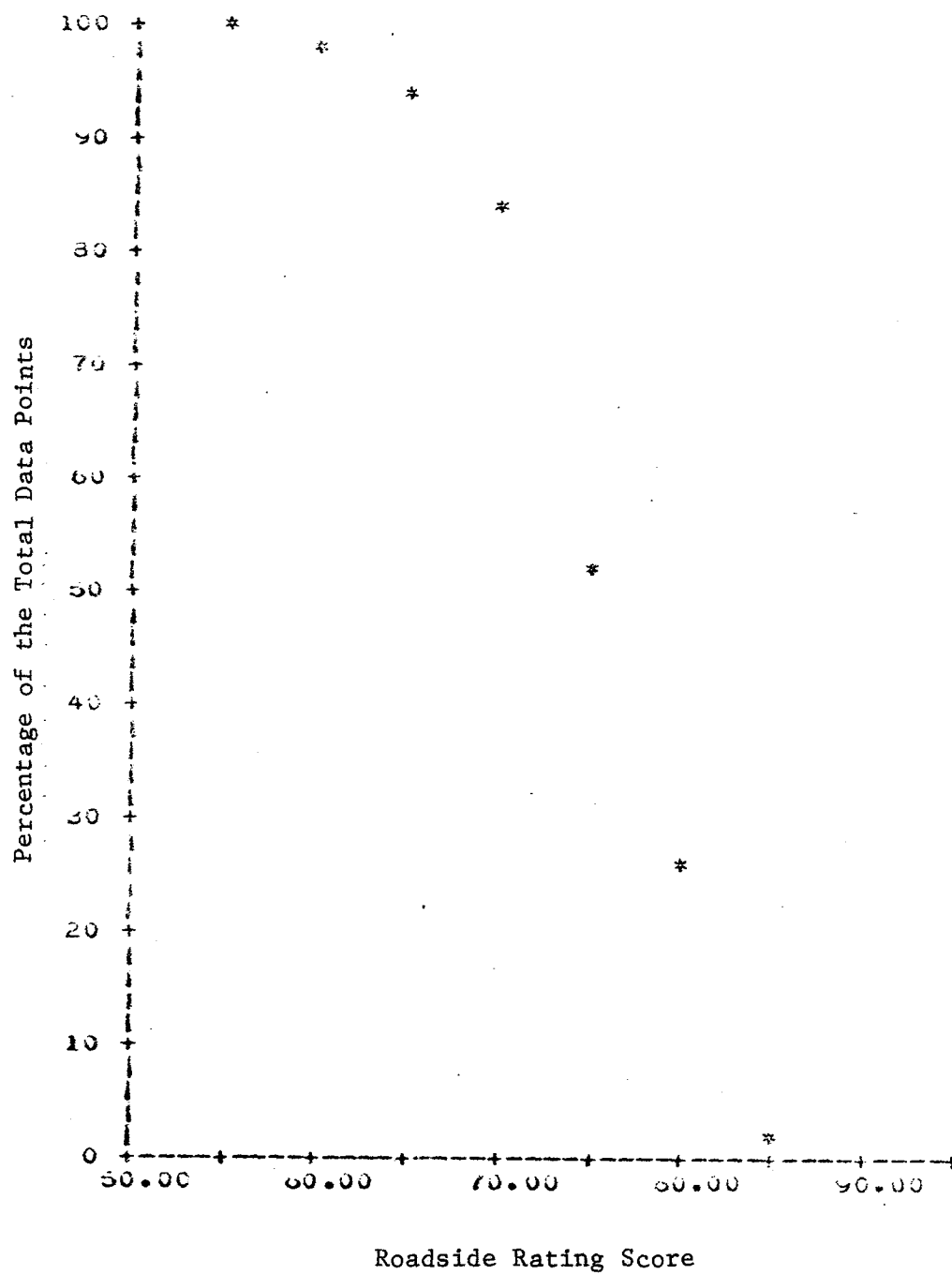


Figure 56. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

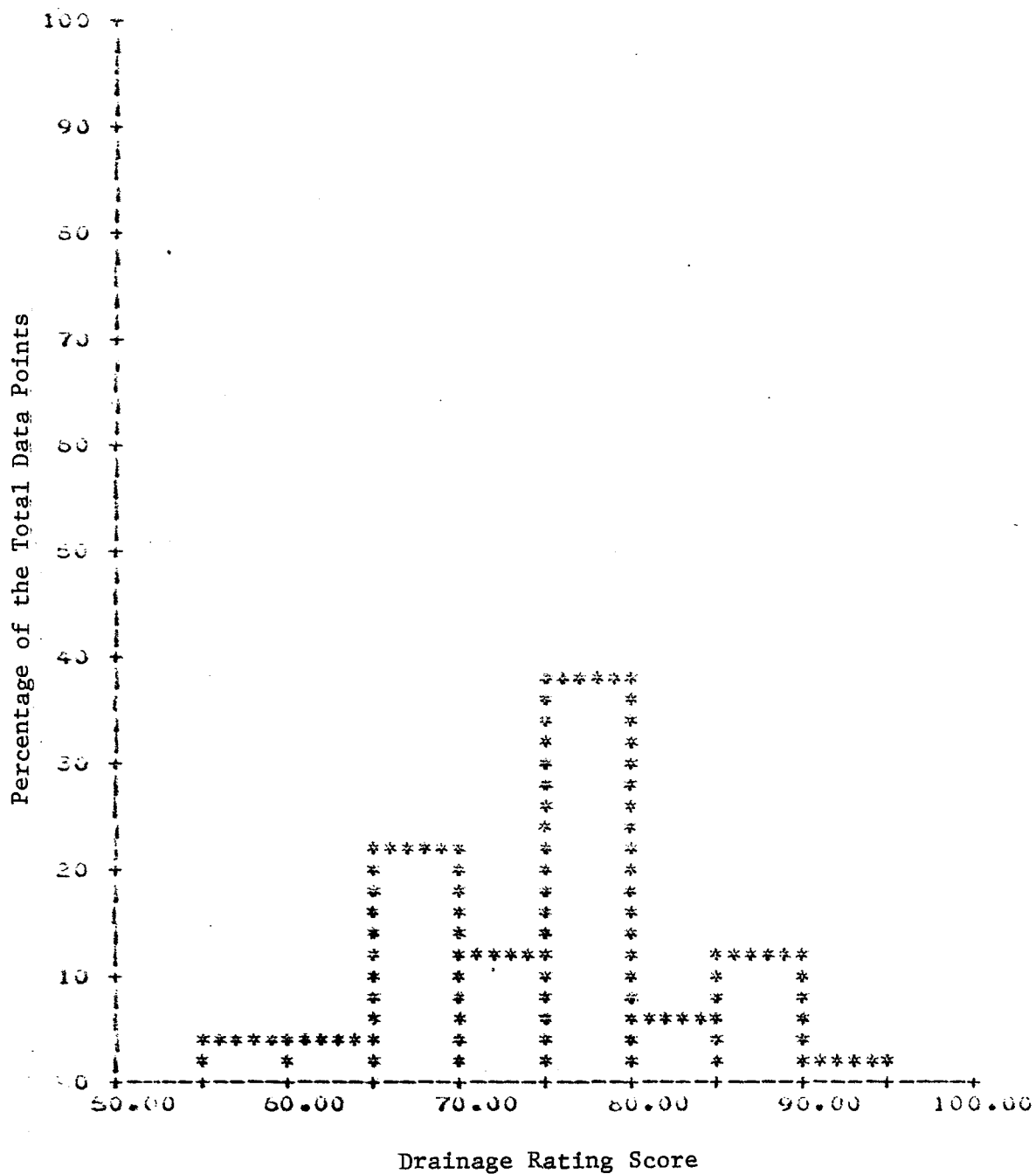


Figure 57. Drainage Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

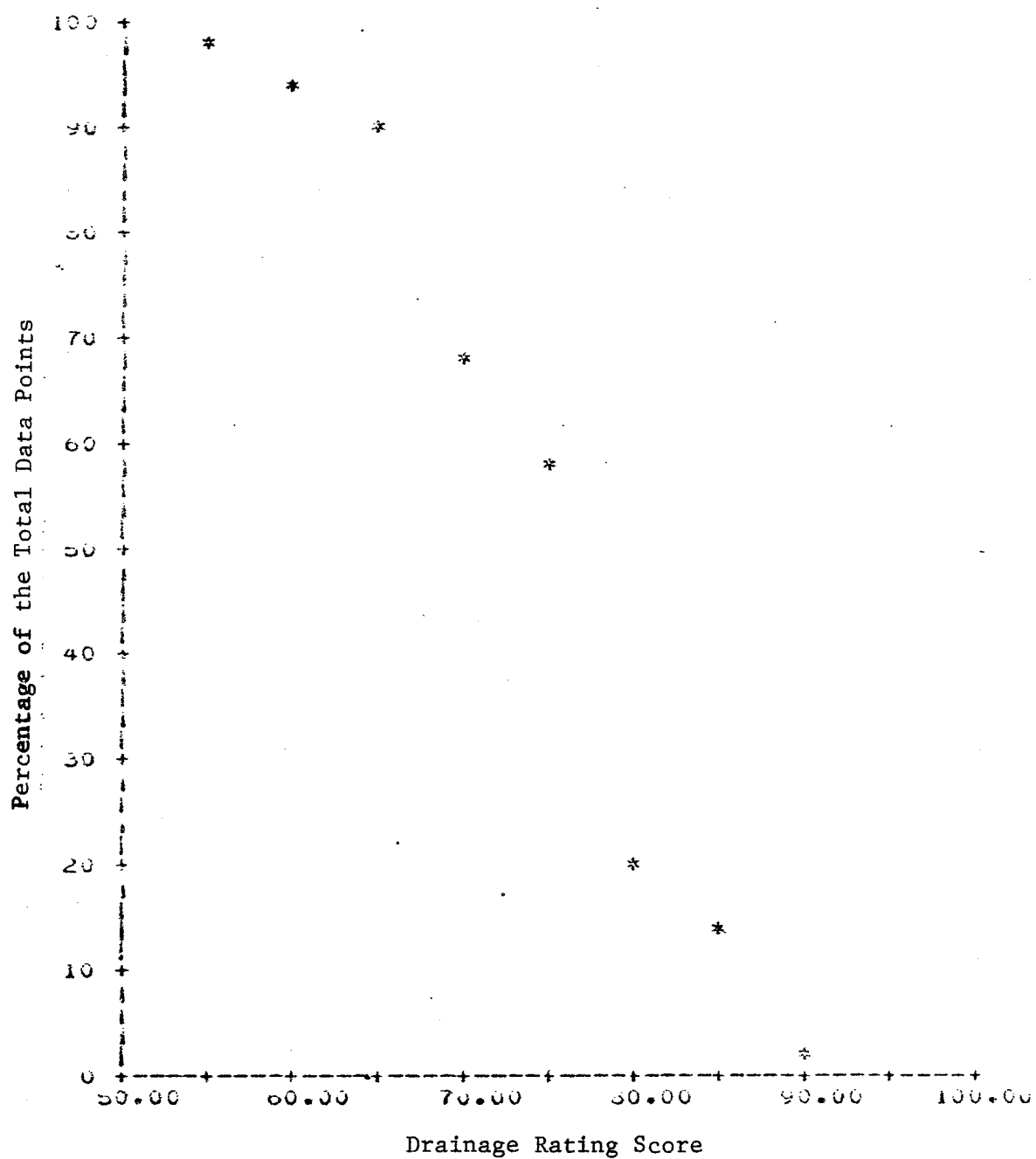


Figure 58. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

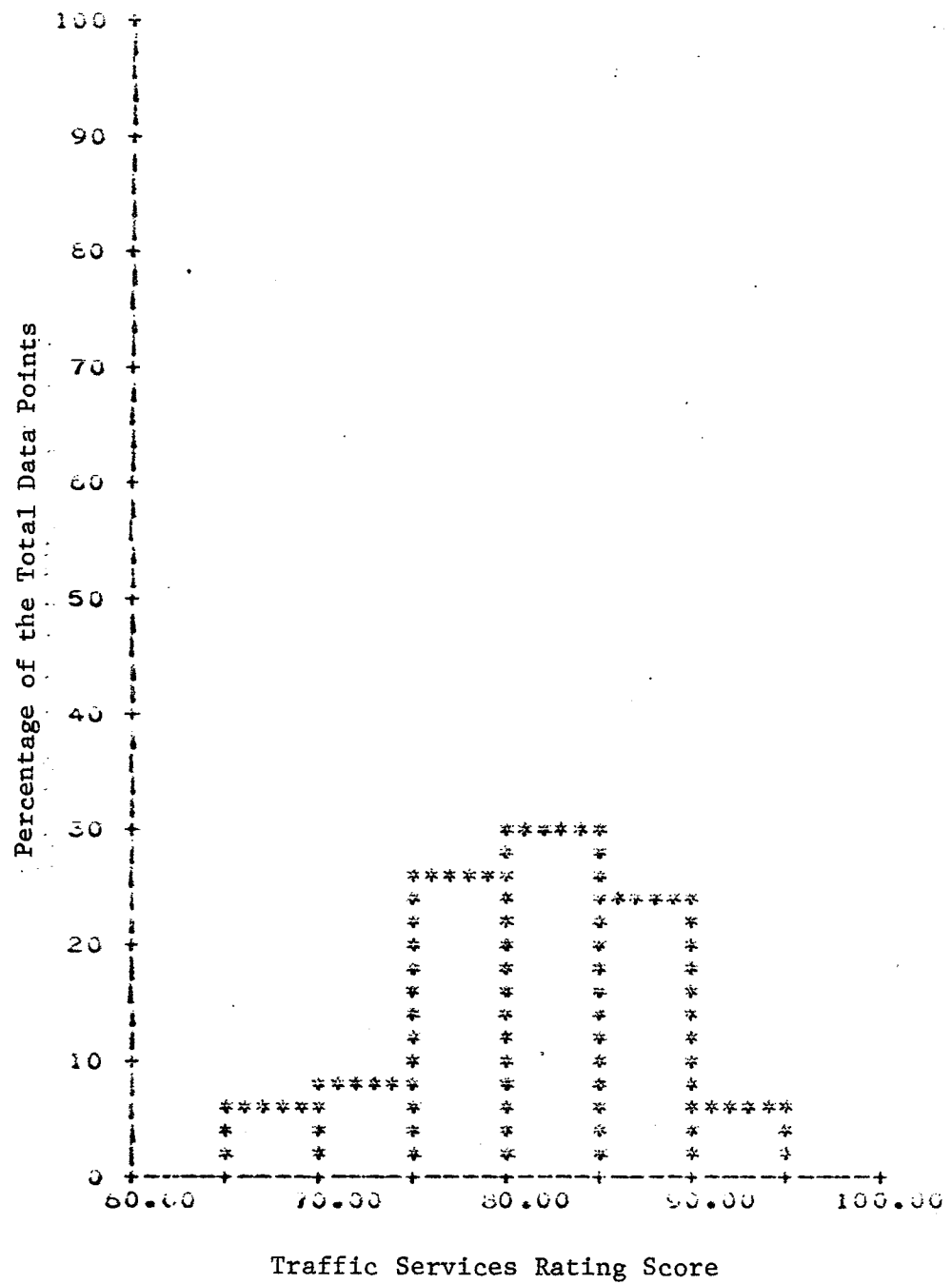


Figure 59. Traffic Services Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

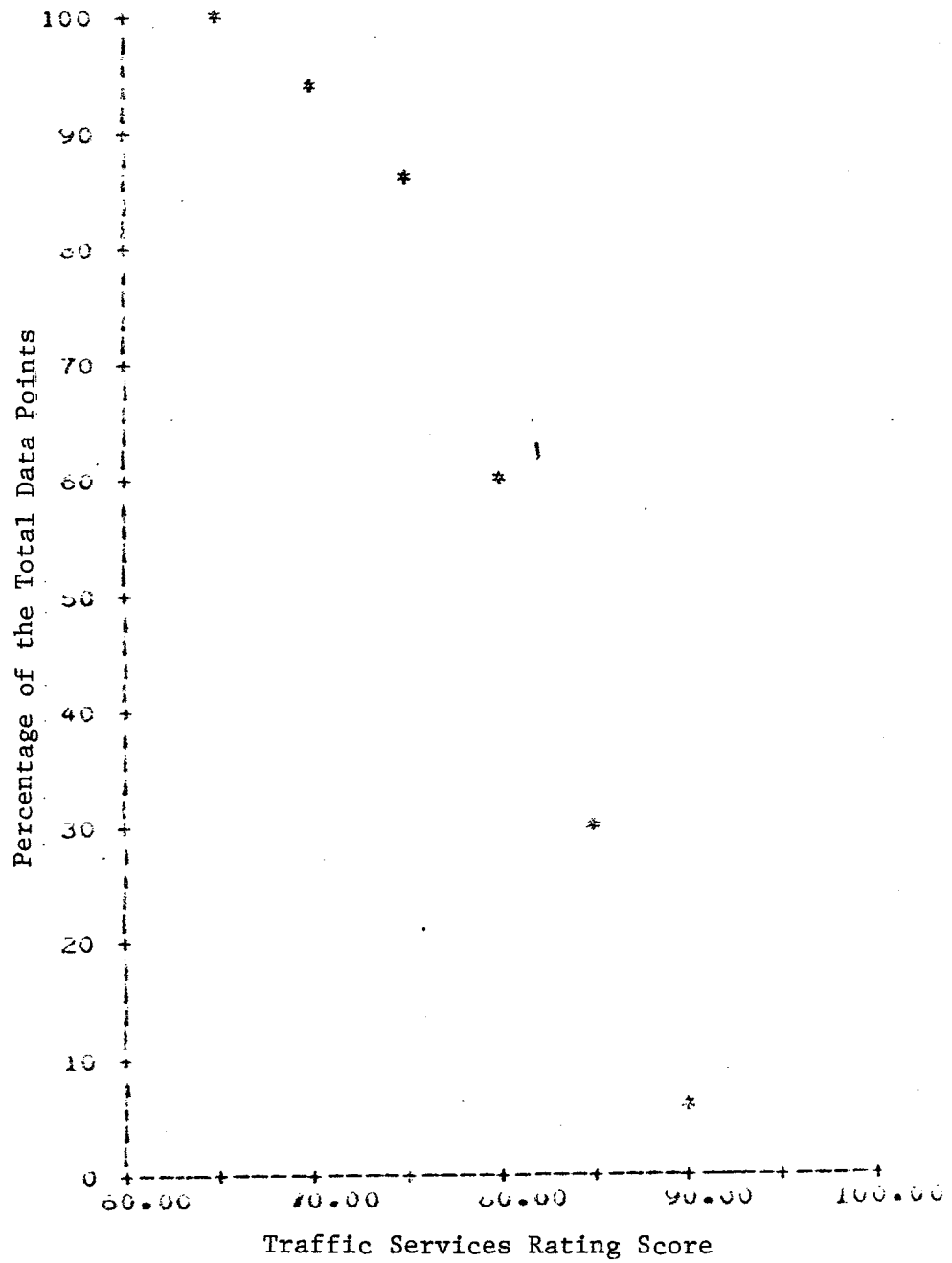


Figure 60. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

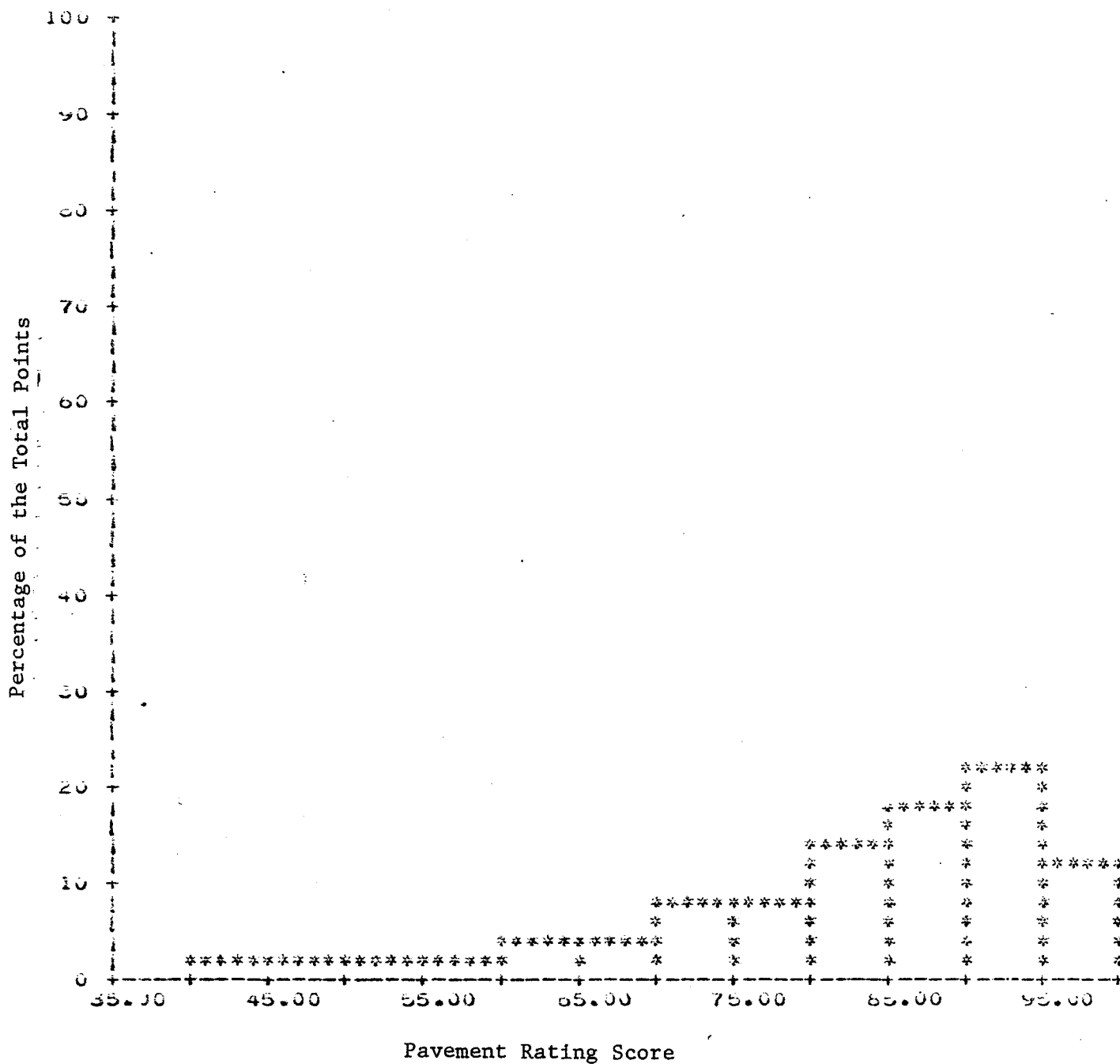


Figure 61. Pavement Rating Score (Without MRM Deductions)
Histogram for Statewide Random Sections - Combined Highways (1974).

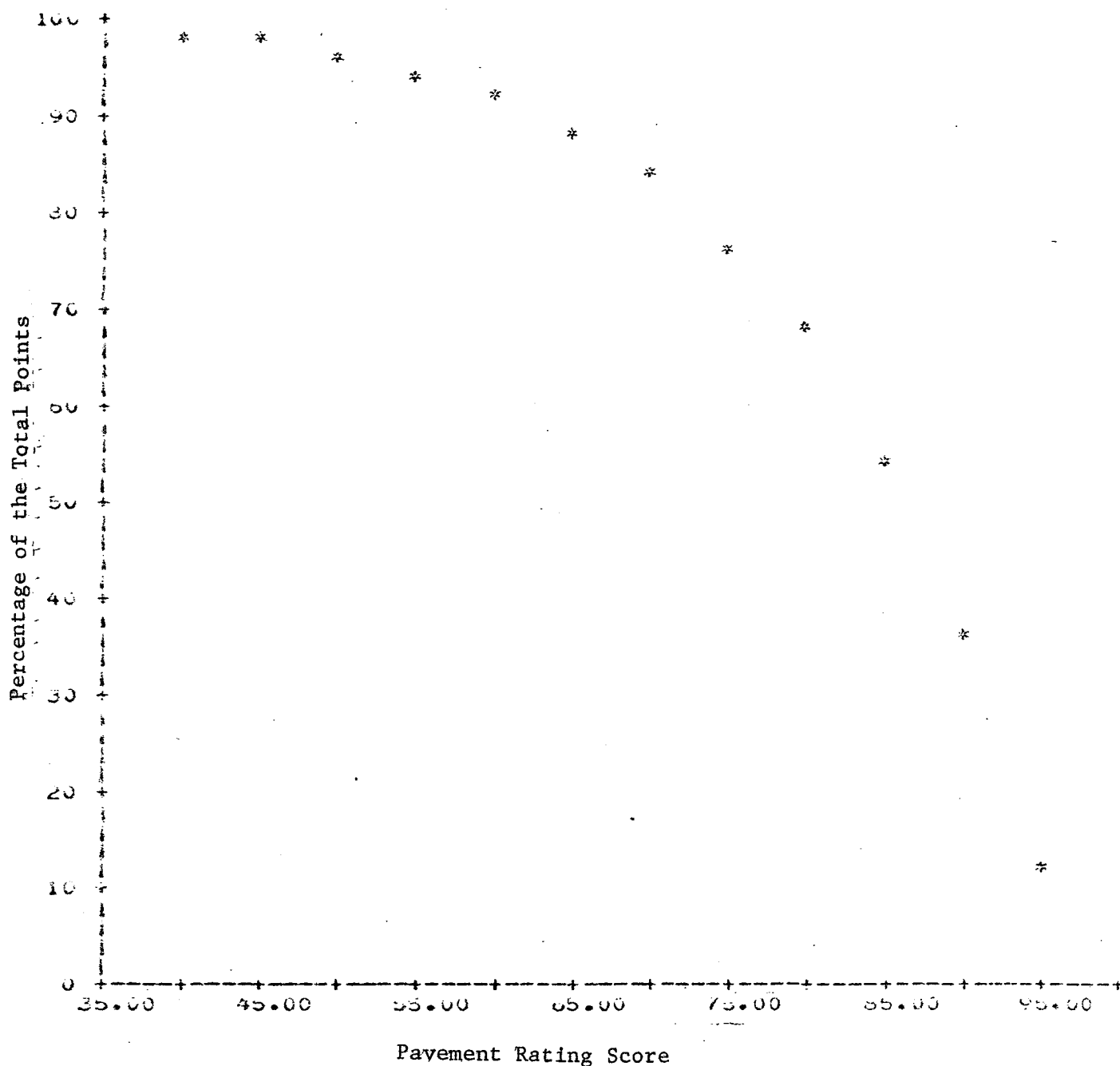


Figure 62. Pavement Rating Score (Without MRM Deductions)
 Percentage Cumulative Distribution for Statewide
 Random Sections - Combined Highways (1974).

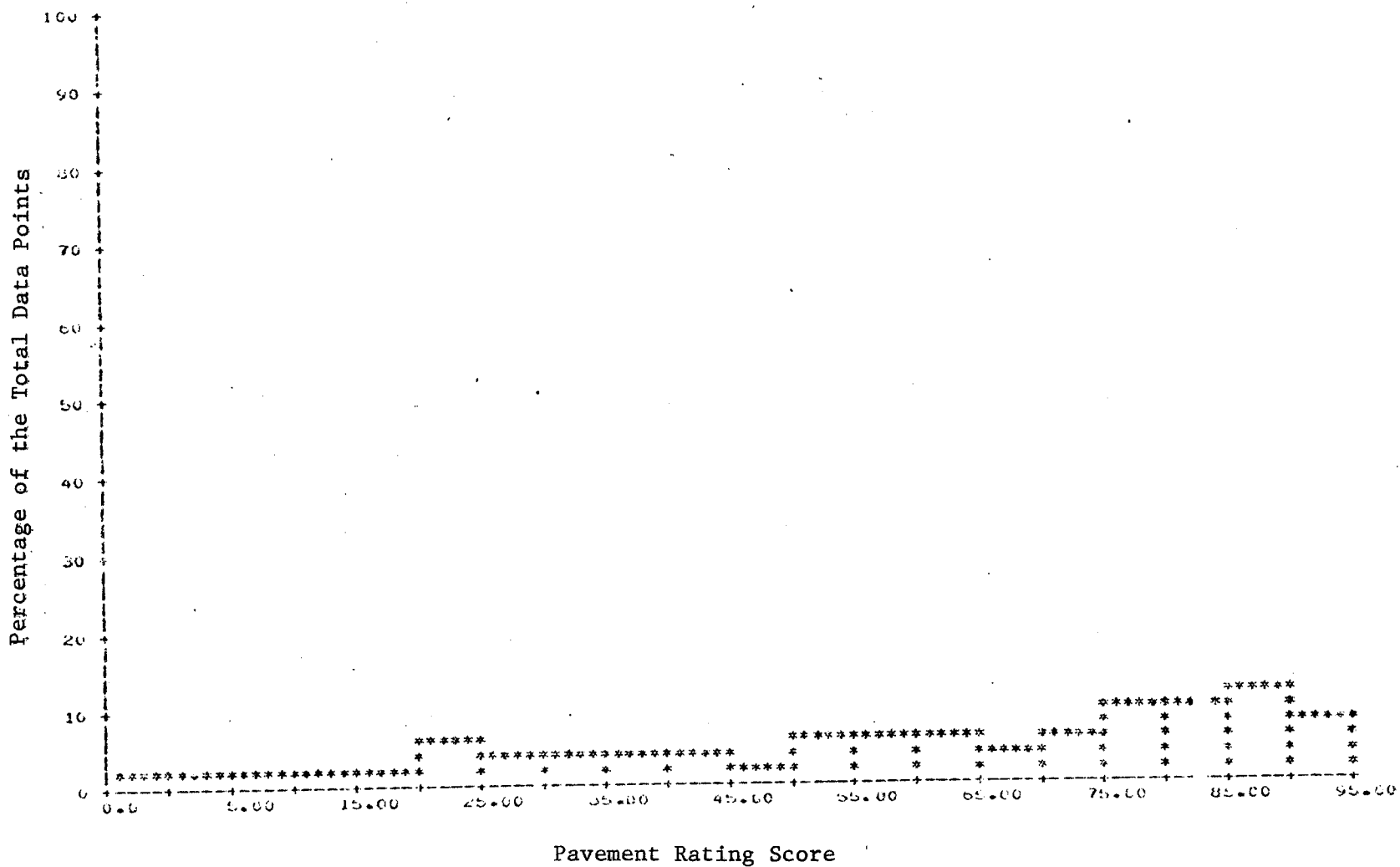


Figure 63. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - Combined Highways (1974).

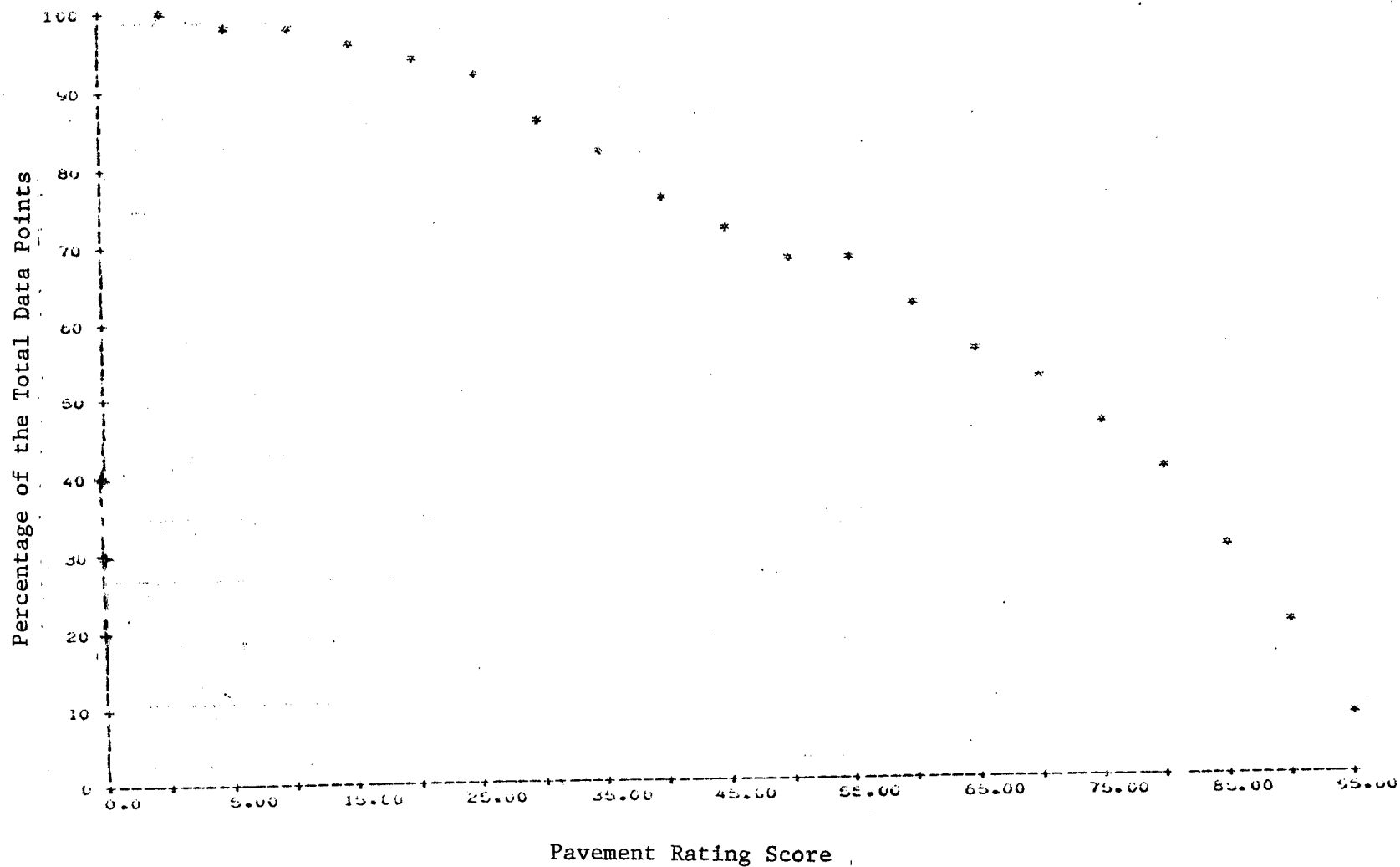


Figure 64. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

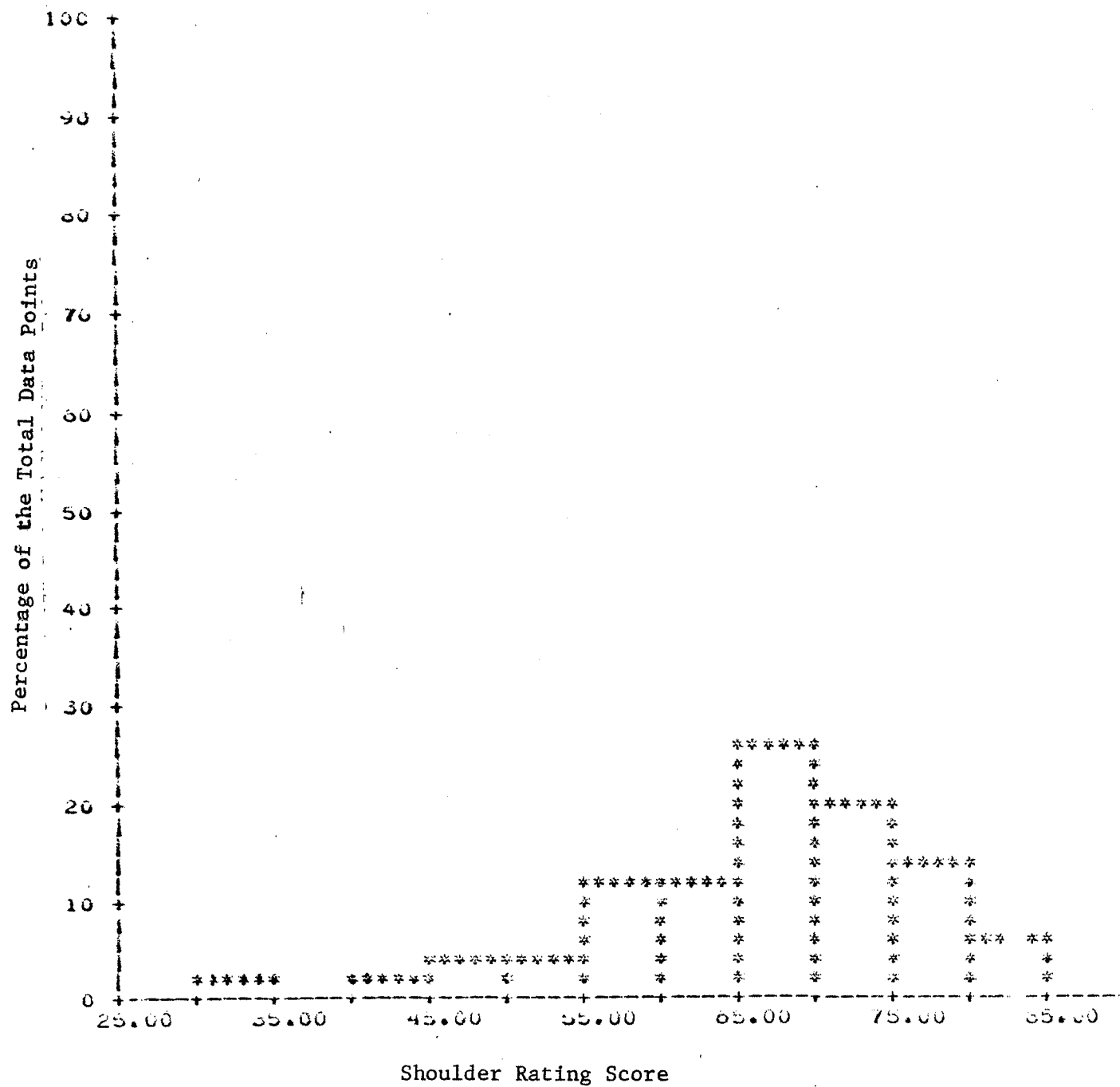


Figure 65. Shoulder Rating Score Histogram for
Statewide Random Sections - Combined Highways (1974).

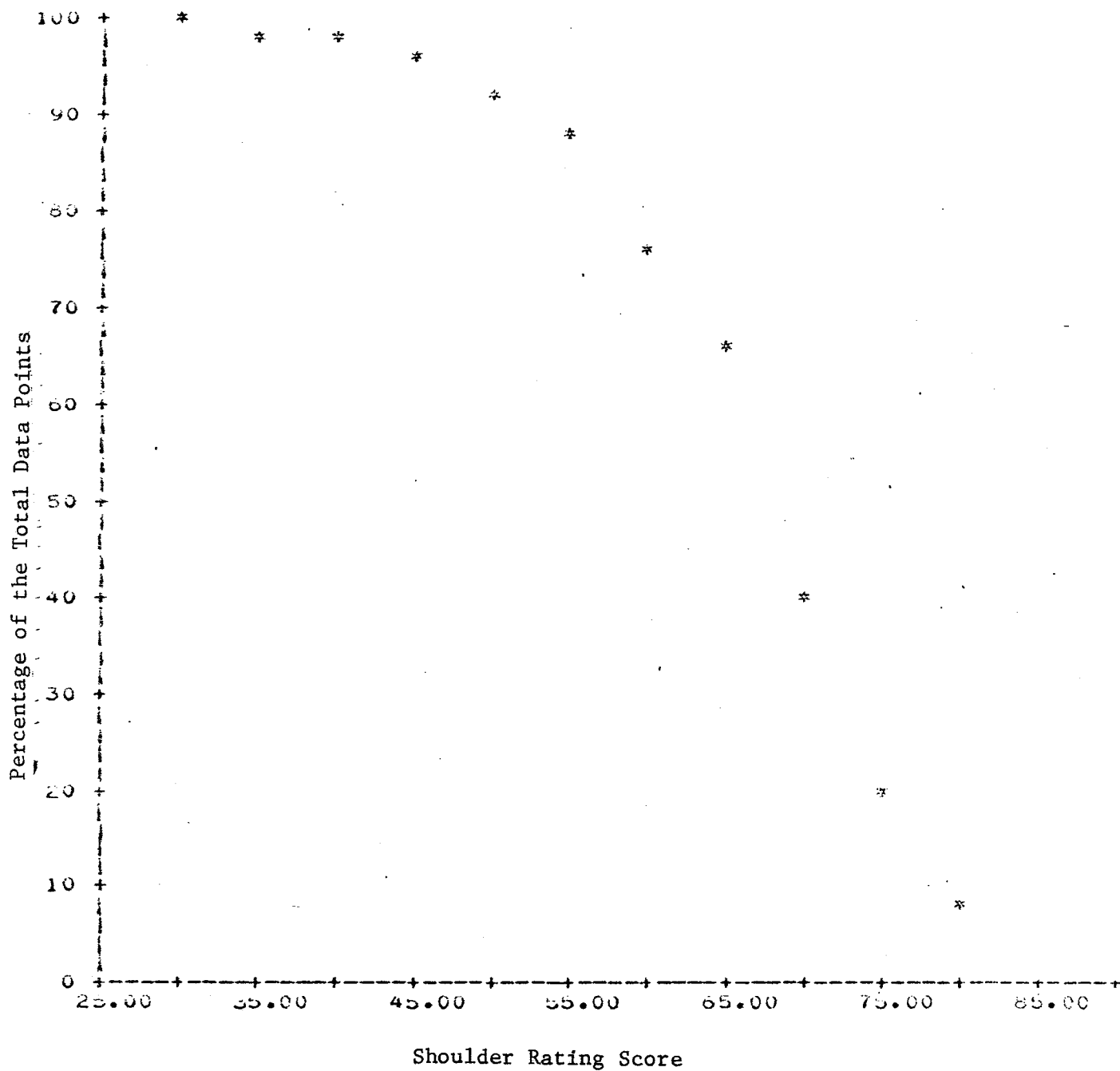


Figure 66. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

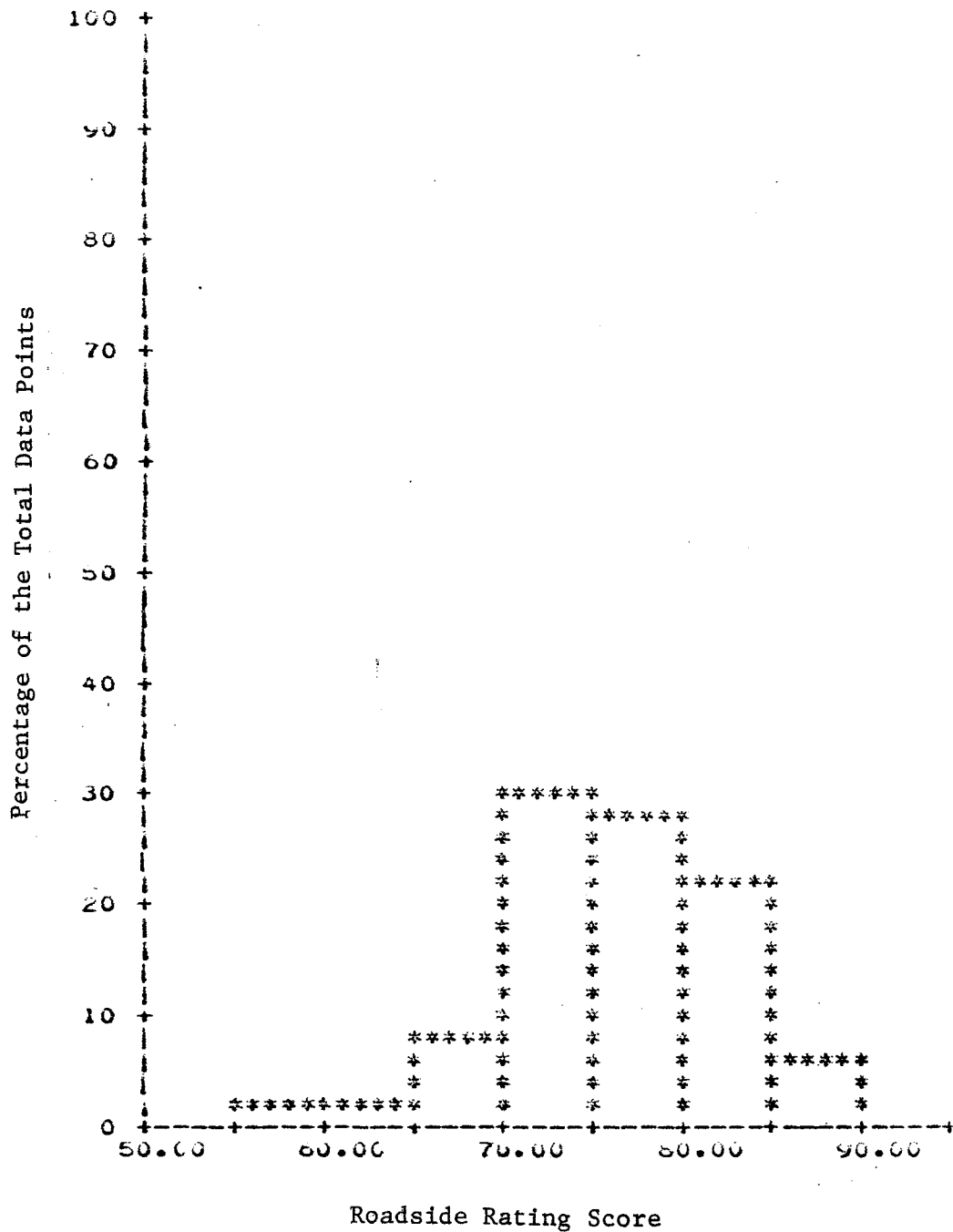


Figure 67. Roadside Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

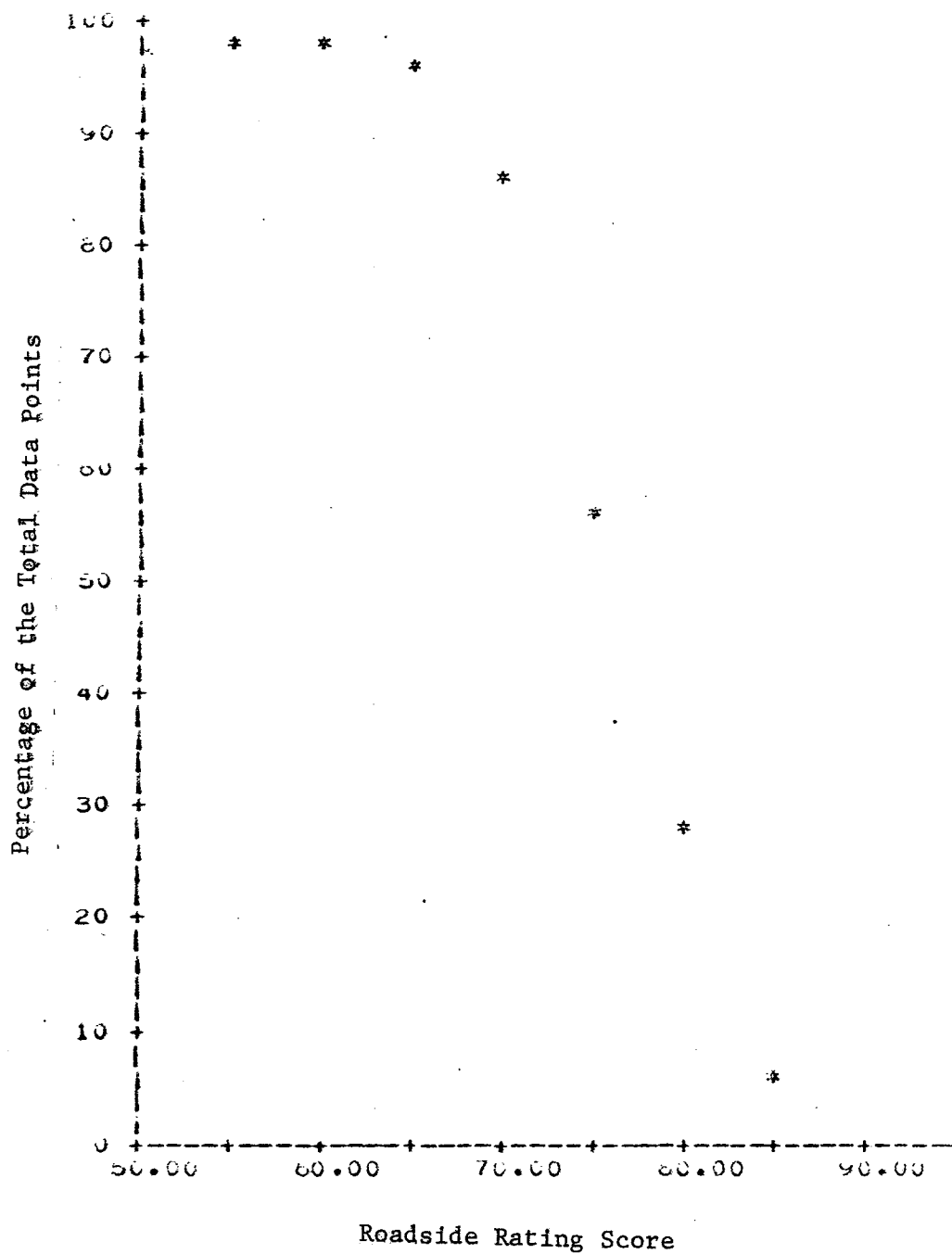


Figure 68. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

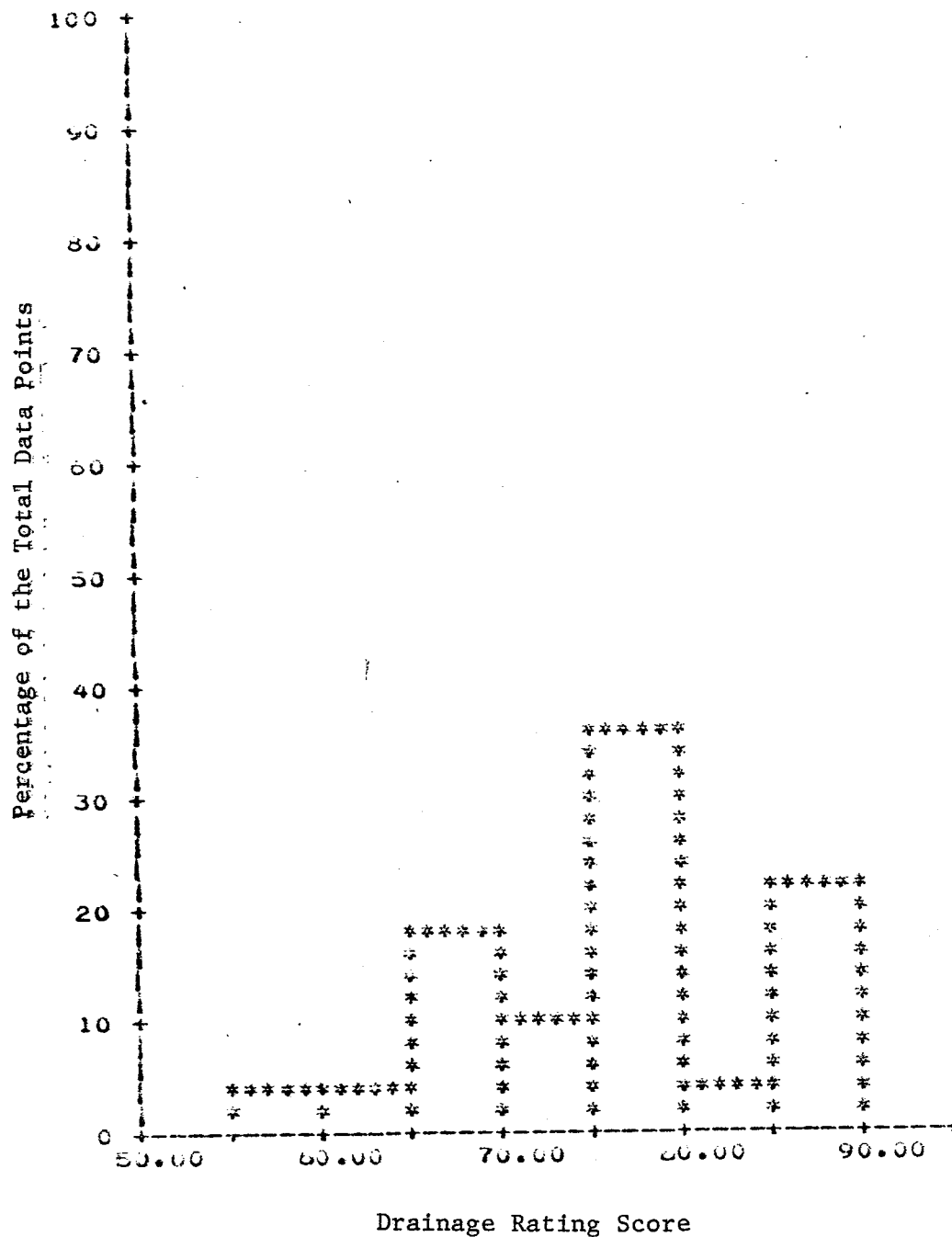


Figure 69. Drainage Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

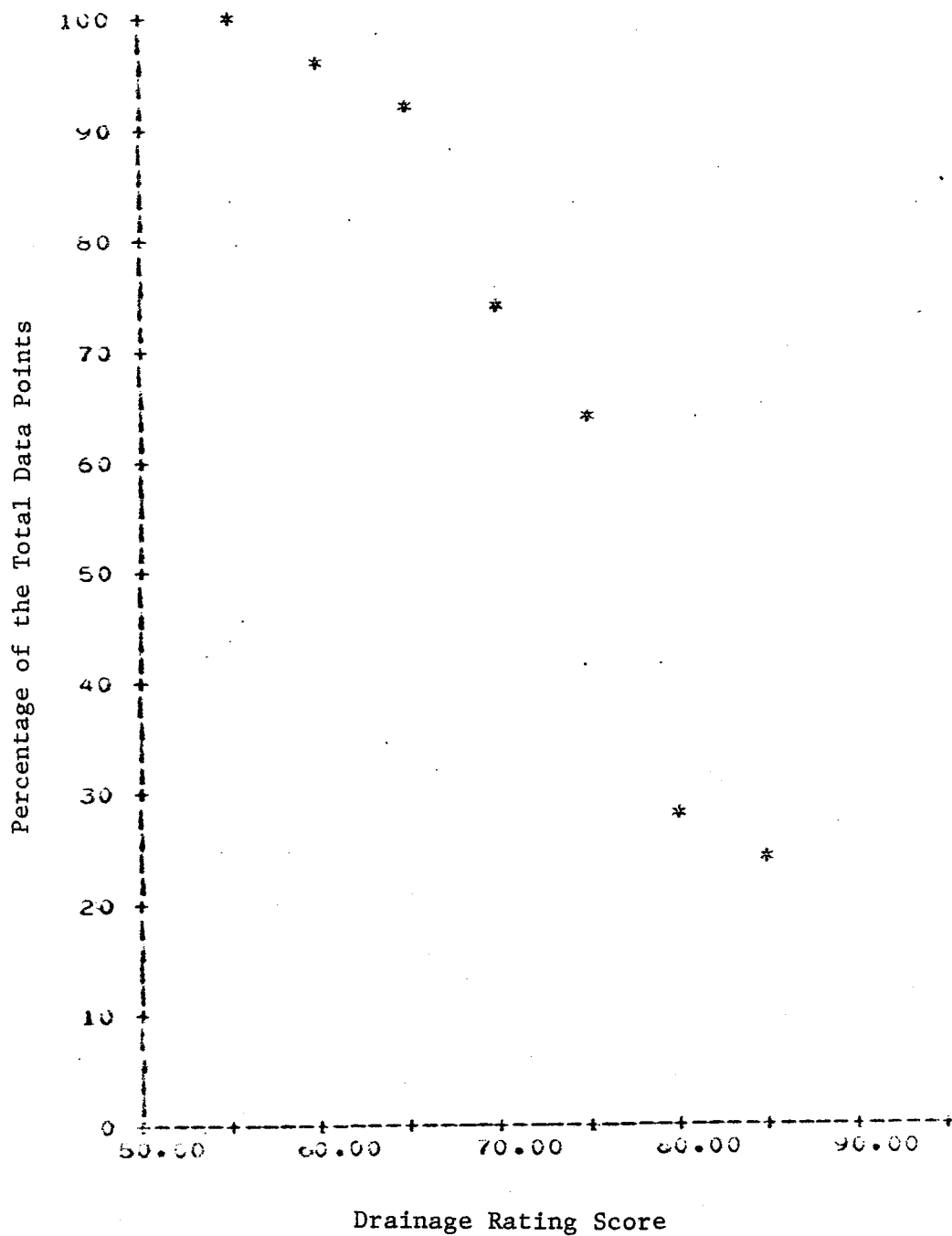


Figure 70. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

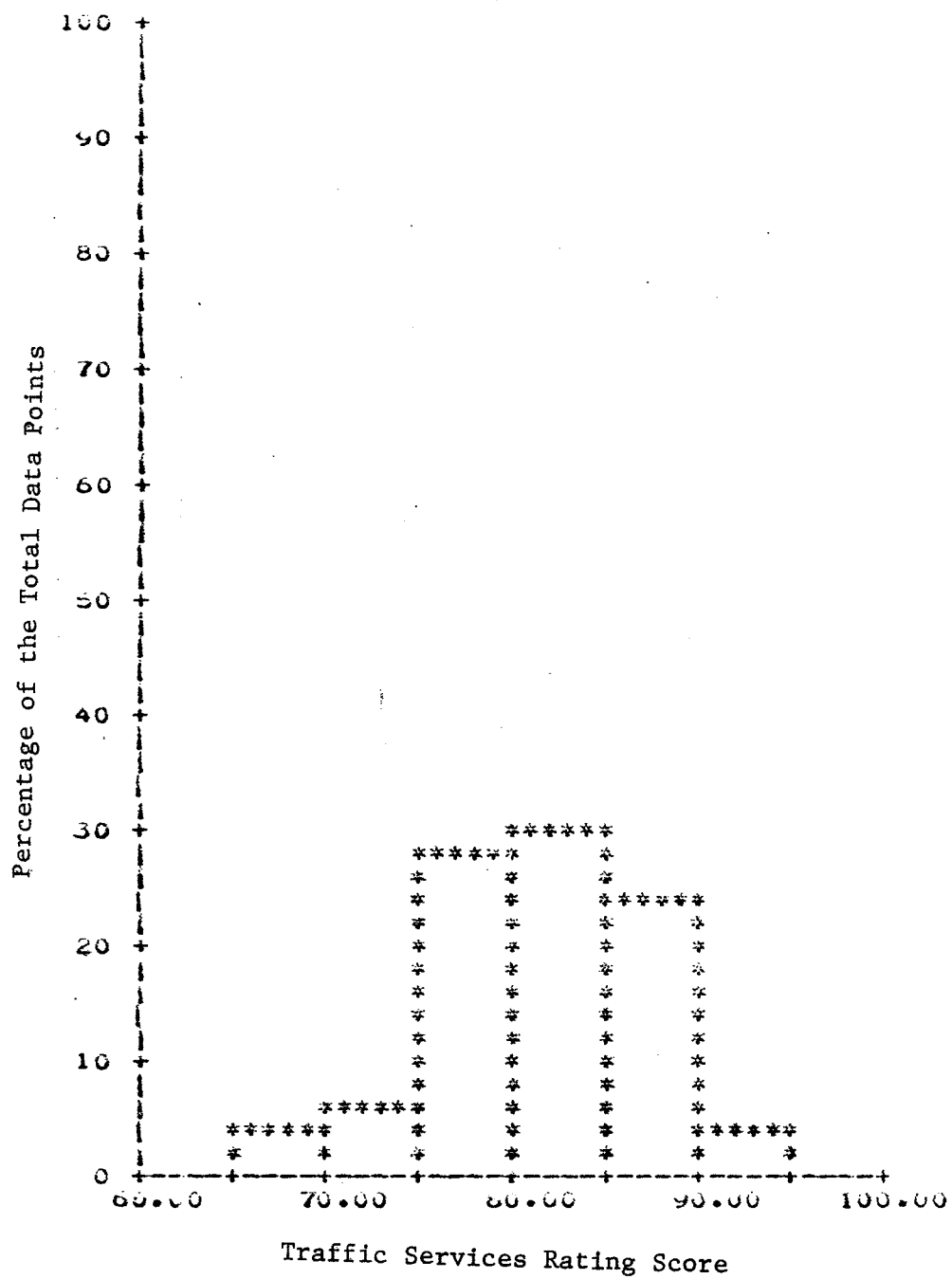


Figure 71. Traffic Services Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

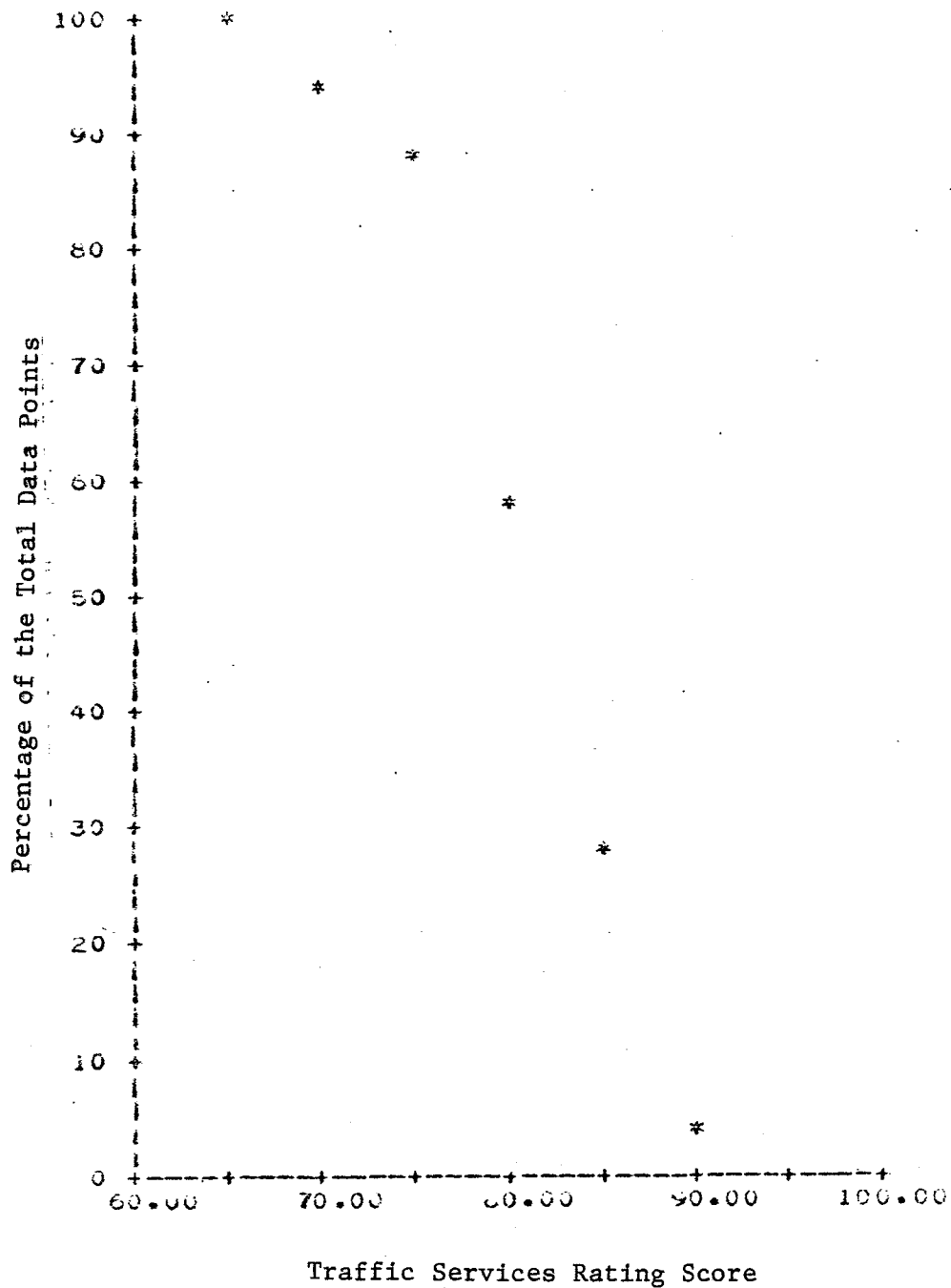


Figure 72. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

CONCLUSIONS

By establishing and maintaining close contact among the researchers and central office and operational personnel of the Texas State Department of Highways and Public Transportation, key elements of a maintenance management system have been developed. The specific items developed include the following:

1. Maintenance Performance Standards,
2. Cost Codes and Maintenance Methods,
3. Maintenance Rating System and
4. Data Reduction and Data Summary Programs.

The maintenance performance standards were developed to outline maintenance methods for use by the State Department of Highways and Public Transportation. These methods specifically include the conditions for which a maintenance method should be used along with cost, production, quality and scheduling information.

The cost codes provide for cost accounting of the maintenance performed. These cost codes are separated into seven maintenance categories as follows: base and subgrades, surfaces, shoulders and approaches, roadside maintenance, structures over 20 feet, traffic services and extraordinary maintenance. Additional subgroups are used in each of the seven major groupings as required to define each maintenance operation.

In conjunction with the maintenance methods and cost codes, the maintenance rating system was developed to provide specific information about the roadway. This system can be used to define the present condition of the road, assist in determining maintenance needs, establish main-

tenance priorities and identify maintenance activities which provide the greatest return. The primary benefits of the rating system are rating scores for the pavement, shoulder, roadside, drainage facilities and traffic services.

Computer programs have been written to treat the maintenance rating system information. This information and other types of pavement data such as skid numbers, Dynaflect deflections, etc., can be analyzed and summarized for mass inventory surveys such as those accomplished in District 21. Additionally, three budget programs were developed to illustrate the usefulness of maintenance rating system information for budget preparation purposes.

Literature reviewed as part of studies sponsored by the Texas State Department of Highways and Public Transportation, Federal Highway Administration and the National Cooperative Research Program have been instrumental in the development of the management tools employed in this study. It has been the intent of the research project to furnish flexible management tools capable of satisfying a large number of needs while being capable of accepting change as necessary.

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A P P E N D I C E S

APPENDIX A

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 20,601,000 residents of California operate 13,413,000 motor vehicles on 164,136 miles of highways of which 16,105 miles are under state control. The state occupies 158,693 square miles from an elevation of -282 feet below sea level to 14,494 feet above sea level. Mean minimum and maximum temperatures are 8 and 116°F with average annual moisture ranging from 4 to 96 inches.

The California Department of Transportation has a \$153,000,000 maintenance budget for 1975. This budget will be used by its 11 districts to maintain 45,000 lane miles of highways (16,000 center line miles).

Eleven districts comprise the California Department of Transportation. Each district is divided into from 4 to 12 territories which are managed by superintendents. Maintenance supervisors are in responsible charge of individual crew operations and report to the superintendents. Superintendents report to the district maintenance engineers. In the smaller districts, the maintenance engineer will report to the District Director of Transportation while in the larger districts the district maintenance engineer may report to the district Deputy Director of Operations and Maintenance.

The administration of the maintenance program by the Department of Transportation, Division of Maintenance and Operations is performed at the central office level by the Office of Maintenance.

The basic maintenance recording and reporting system was developed in 1971. A parallel recording system (Maintenance and Accounting) is being utilized although an effort is being made to develop a single recording system. A manual recording system is utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

California State Department of Transportation Form DMO-M-83, "Maintenance Daily Report" is utilized to collect maintenance work method information (Figure A-1). The type of information obtained on this form includes;

1. Work method or activity performed
2. Location of work performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization (indirectly) and
6. Accomplishments (Production)

Details are presented below.

Location

Each maintenance work method is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A two digit number is utilized to designate the district.
2. Superintendent Territory. Superintendents are responsible for specific areas of the district. The designation "maintenance

section" is often utilized by other states to identify a similar area of responsibility. Three character numeric codes are utilized to identify the supervisor's section within the Superintendent's Territory.

3. Supervisor Crew. A three character numeric code as described above is utilized to describe this basic cost center. This designation is entered under unit on Form DMO-M-83.

4. County and Route. The county and highway route are designated by a 5 character numeric code. This code consists of a two number county designation and a three number route code.

5. Post Mile. Reporting of post mile or mile posts which is the district's prerogative is utilized to specifically pinpoint where certain maintenance activities were performed on the roadway. The post mile is reported to the nearest 0.1 mile. Approximately one-half of all districts currently report work method performance by the post mile.

Information is not recorded which indicates in what lane the maintenance work method was performed. Designation of the maintenance function or work method indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Work Method

Maintenance work methods are defined by a maintenance numbering system. The numbering or coding system is a 5 character numeric code used to designate the program, sub-program, and standard method as shown in the example below:

07 - 022

07 - program (signs)

02 - sub-program (sign maintenance)

2 - standard method (clean signs on two posts
or poles)

Approximately 470 program - methods have been defined in California.
Performance Standards and Scheduling Values for approximately 185
methods have been developed. These work methods have been grouped
into 19 programs as shown below:

1. Roadbed, Flexible
2. Roadbed, Rigid
3. Roadside Maintenance
4. Roadway Litter and Debris
5. Vegetation Control
6. Pavement Delineation
7. Signs
8. Electrical
9. Traffic Safety Devices
10. Snow Removal and Ice Control
11. Roadside Rests
12. Landscape Maintenance
13. Bridge and Pump Maintenance
14. Tube, Tunnel, and Public Service Facility Maintenance
15. Permits
16. Operations
17. Administration and Auxiliary Services
18. Major Damage and Disaster Maintenance
19. Work for Others

It should be noted that there are different programs for the
maintenance of portland cement concrete pavements and for snow
and ice control.

Specific support activities are related to the maintenance work by the addition of a two digit code. Examples of these activities are;

1. travel
2. haul
3. flagging
4. other traffic control
5. delays
6. special equipment preparation
7. additional operated equipment

An example of these codes are shown on Figure A-2 for roadside maintenance activities.

Manpower

Manpower utilization for a particular function is recorded. Labor, equipment and accomplishments are reported by the supervisor for the entire crew.

In recording the labor utilized, three types of entries are made: the total number of man hours actually spent on performing the maintenance activity; the number of work hours spent on support activities such as delays, travel, haul, flagging other traffic control, etc.; and the number of hours required for supervision and administration. Work expended is reported to the nearest 1/2 hour.

Time for vacation, military leave, etc. for the entire crew is obtained from Form HM85 (Figure A-3). A Form HM85 is filled out for the supervisor's crew and is the basic accounting and payroll form. The supervisor is responsible for summerizing vacation time, etc. for his entire crew on Form DMO-M-83.

Form DMO-M-83 is so arranged that five maintenance work methods can be reported on a single form, complete with a designation for manpower and equipment utilization. Total crew hours are summed on this form for a given day.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by a unique equipment number. Equipment use is charged out daily by the hour or by the mile, depending on the type of equipment utilized. Sedans, station wagons and 1/2 ton pickup usage is reported in miles. All other items of equipment are reported in hours of actual usage. For example, if a piece of equipment is at the job site and idle, such as a travel vehicle or a standby vehicle, it is not reported as used for the idle period. Any vehicle with accumulated usage of less than one hour for the day will report one hour of usage. Equipment usage is reported to the nearest one hour.

Downtime either while the equipment is in the shop or field is reported. Downtime is defined as the hours a piece of equipment is unavailable because it is out of service during the working hours of the work day.

Materials

Materials utilized for a particular function are not recorded on the DMO-M-83 but in some cases maybe obtained from the productivity entry. The productivity entry reports the amount of material utilized, in tons, cubic yards, lineal feet, etc. for a particular maintenance work method. Stockpile number, inventory quantities, etc. are a part of a materials management system.

Accomplishments

Accomplishments in terms of productivity units are recorded for certain maintenance work performed. For example, tons or cubic yards of material placed are reported. Productivity for work methods such as inspection of drainage structures, etc., is accounted for in terms of man-hours.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Daily Report Form DMO-M-83 is filled out daily by the maintenance supervisor for his crew. This information is sent to the superintendent's office generally weekly for approval and checking. The information on the daily forms is key punched monthly at the district office and transmitted through the remote computer terminal to the central office monthly. Reports are returned to the supervisors, superintendents, district maintenance engineers, etc. about 10 to 15 days after the end of the month.

It is estimated that about four-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. The crew supervisors each require about one-half hour per day to complete the Maintenance Daily Report.

REPORTS

Several maintenance management reports are produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports:

Comparison Reports. The superintendent comparison report (Figure A-4) presents a performance summary of all work performed under the direction of a superintendent in his area of authority. Data is given for the reporting month and the year to date totals.

Data are sorted by the maintenance program, sub-program and method as previously described for each supervisor under the jurisdiction of the superintendent. Comparison information is presented for the state as a whole, for the district within which the superintendent works and for each supervisor. Information reported includes the following:

1. Completed production in terms of a work method unit of measurement (tons, cubic yards, lineal feet).
2. Production in terms of hours of labor worked performing the maintenance work method.
3. Support in terms of hours of labor worked performing support activities such as travel, haul, flagging, etc.
4. Percent support or the work hours devoted to support activities divided by the work hours devoted to production.
5. Realization or the maintenance performance standard (for example man hours per ton of material placed) divided by the actual performance rate for the maintenance activity.
6. Planned production for the maintenance activity to the reporting data.
7. Crew labor cost per productive unit.

The District comparison report (Figure A-5) displays the same information as the superintendent's comparison report except information is presented by maintenance work method to compare state wide totals, district totals and superintendent totals.

State wide comparison reports are also available using the same reporting format.

Expenditure Analysis Report. Expenditures analysis report includes salary and equipment unit cost per production unit of each

work method performed. This report is being utilized to determine the most economical method to perform a work method. Data displayed on these reports by maintenance method include;

1. Man-years of labor expended for the year to date.
2. Dollars expended for the year to date for salaries (labor), equipment, materials and other items together with the total expenditures.
3. Year to date production and the units for measuring production.
4. Cost for salaries and equipment per unit of production, i.e. dollars per ton.
5. Dollar expenditures for the reported month.

Reports are prepared to provide comparison for the superintendent among the supervisors, for the district among the superintendents and for the state among the districts. Thus, the same sequence of Expenditure Analysis reports are available as is the case with the comparison reports. An example of an expenditure analysis report is shown as Figure A-6.

Information to produce this report must come from both the Maintenance Daily Report and accounting input documents.

Budget Status Reports. Budget status reports present both man-year expenditures and dollar expenditures by maintenance programs such as flexible roadbed maintenance, rigid roadbed maintenance, roadside maintenance, etc. Dollar expenditures are reported for three categories - expenditures by state forces, by city forces charged to the state, and contract maintenance charged to the state. Both expended and planned man-years are reported. Dollar expenditures and man-years are reported in the following format:

1. Reporting month
2. Year to date
3. Target year totals
4. Target adjustments
5. Percent expended fiscal year to date
6. Percent expended for the last fiscal year on a year to date basis
7. Percent expended for the last 4 fiscal years on a year to date basis.

This reporting format is utilized for both district summaries and state wide summaries. An example of a district summary is shown in Figure A-7.

Equipment utilization reports have been recently revised and are produced on a monthly basis. An annual program work plan is developed based on information coded by the supervisor and reports are generated to showing yearly planned programs by the month. This data is used to develop monthly scheduling reports. Examples of these are shown as Figures A-8, A-9, A-10, and A-11.

It should be noted that on the DMO-M-83 "Maintenance Daily Report" man hours are reported for the entire working crew. These hours are transferred to dollar values as shown on the Expenditure Analysis Report and Budget Status Report by use of an average cost per hour for the crew. Man-years planned for work methods are prepared by field personnel on a yearly basis after the quality of service level has been determined. These man-years can be altered during the year.

The various reports are produced monthly with year to date totals. Reports as discussed above are utilized by the district maintenance

engineer, the superintendent, the supervisor as well as central office personnel.

Reports are used for fiscal control, by reviewing expenditures and comparing expended and planned man-year totals; for monitoring of program execution by comparing planned and expended man year totals; for allocation of manpower by reviewing the realization figures and cost per unit of productivity; and for budget preparation as a check to determine productivity figures to be utilized in calculating the budget.

Presently maintenance program work that appear to be contrary to planned budgets due to productivity problems and/or prior planning must be located by a review. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The California Department of Transportation is satisfied with the reliability of the existing system. A manual of instructions has been prepared and are utilized by supervisors to accurately fill out the Maintenance Daily Report. Maintenance management seminars are held annually to discuss the system and improve the reporting accuracy. Spot checks are made on data reported by supervisors.

As pointed out previously data are recorded in the field by the supervisor rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information.

The recording and reporting system can be altered by the direction of the central office maintenance staff as the need arises. Changes usually originate in the field and after field study the needed change can be made. The central office continually works with

the districts through meetings and visitations. Data processing changes do not appear to be a bottleneck as data processing personnel are on the maintenance staff.

Data collected are stored on tape for about a 5-year period. Four year average costs and man-year requirements for maintenance work methods are calculated annually.

References

1. "General Reporting Instructions," California Department of Transportation, Division of Highways.
2. "Maintenance Management System," California Department of Transportation, Office of Maintenance, Planning Section, December, 1975.

California State Department of Transportation MAINTENANCE DAILY REPORT

Figure A-1. Maintenance Daily Report

MO. 1 DAY YR.

CREW 2 RATE

DIST. 3 UNIT

CASH 4 OT

CTO 5 EARNED

VAC 6

7A SELF

7B FAMILY

CTO 8 TAKEN

9A MIL. LEAVE

9B JURY/WIT.

10

TRANSFERRED FROM REPORT HM85

SUPERVISOR'S SIGNATURE

PROGRAM - METHOD

COUNTY - ROUTE

FROM P.M. TO P.M.

CHARGE DISTRICT UNIT

EXPENDITURE AUTH.

SPECIAL DESIGNATION

PRODUCTION UNIT - DESC.

ACCTG. ACTIVITY-MAN HRS.

SUPRV. & ADMIN. (001) HRS.

SUPPORT ACTIVITIES

DELAYS (EA. OCC.)*

TRAVEL (MAN MILES)

HAUL (MAN MILES)

FLAGGING (NO. OF MEN)

OTHER TRAFFIC CONTROL

SPEC. EQUIP. PREP (EA.OCC)

ADDITIONAL EQUIP. (NO.)

(EXPLAIN IN REMARKS)

EQUIPMENT USAGE HRS.

DOWN TIME

ITEM 27

CHC 28

FIELD 29

SHOP 30

USE 31

REMARKS:

WEATHER:

I

II

III

IV

V

Figure A-2.

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std. or Sch. Val.* (Man Hrs.)	/	Unit
03-010	<u>ROADSIDE PATROL</u> Report pumping water off road or storm patrol with graders to this number. Report man miles if appropriate.			Man Miles
-011	<u>RAIN AND WIND PATROL</u> Patrolling of highways during or shortly after storms to check function of drainage facilities, or other potential hazards. Also includes placing and picking up warning devices and cleaning debris from drains or roadway.	.090*		Man Miles
-012	<u>ROCK AND SAND PATROL</u> Patrolling for and blading or removing fallen rock or drifted sand from travel way. Includes warning device control.	.066		Man Miles
03-020	<u>DRAINAGE STRUCTURE CLEANING</u> Cleaning dirt, silt, rock or debris from horizontal drains, underdrains, or slotted drains included in this number. Also report any drainage cleaning with fully operated rented equipment to this number. Also includes flushing down drains.			Each
-021	<u>CULVERT OR OVERSIDE DRAIN OPENINGS - HAND TOOLS</u> Includes cleaning up to 10 Lin. Ft. of adjacent ditch. Count only openings cleaned, do not count openings inspected but not cleaned.	250*		Each Opn
-022	<u>CULVERT OR OVERSIDE DRAIN OPENINGS - MECHANICAL</u> Cleaning ends with loader or backhoe. Includes cleaning up to 30 Lin. Ft. of adjacent ditch. Count only openings cleaned, do not count openings inspected but not cleaned.	750*		Each Opn
03-030	<u>CLEAN DROP INLETS</u> Includes cleaning drop inlets with fully operated rented equipment, or flushing drop inlets.			Cu Yd

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std. cost Sch. Value* (Man Hr.)	/	Unit
03-031	CLEAN DROP INLETS - HAND TOOLS Cleaning drop inlets using various types of hand tools.	1.500*		Cu Yd
-032	CLEAN DROP INLETS - MECHANICAL Cleaning drop inlets using mechanical equipment, such as vacuum type.	1.000*		Cu Yd
03-040	<u>SHOULDER GRADING</u> When grading large areas over 20 Ft. wide, which are generally used for parking, report to this number.			Sho Mi
-041	GRADE SHOULDERS Includes shoulder surface grading or shaping and drop-off repair using <u>existing</u> roadside material. Area graded should be less than 20 Ft. wide.	2.000		Sho Mi
03-050	<u>SHOULDER DROP-OFF REPAIR</u> Report shoulder drop-off repair using a shoulder box and imported material to this number. Shoulder should be wide enough for emergency parking otherwise report to applicable 03-11X number.			Tons
-051	MANUAL REPAIR - IMPORT MATERIAL Shoulder drop-off repair (import material) using hand tools to spread the material.	.800*		Tons
-052	MECHANICAL REPAIR - IMPORT MATERIAL Shoulder drop-off repair (import material) using grader, trucks, tractors etc. to spread material.	.012		Tons
03-060	<u>DITCH CLEANING (INVERT LESS THAN 10 FEET)</u> Cleaning dirt, silt, rock or debris from ditches using clam shell, water truck or other methods not listed below. If shoulders are shaped at the same time ditches are cleaned report to the appropriate 03-06X number all time involved in ditch cleaning and shoulder grading.			Lin Ft

Figure A-2. (Continued)
03 PROGRAM (ROADSIDE MAINTENANCE)

		St l. or Sci. Val.* (Man Hrs.)	/	Unit
03-061	DITCH CLEANING - MANUAL Cleaning material from ditches using hand tools.	013*		Lin Ft
-062	DITCH CLEANING - GRADER, LOADER, OR BOTH Includes cleaning ditches with grader, loader or both. Also includes shoulder grading when done in conjunction with ditch cleaning.	002*		Lin Ft
-063	DITCH CLEANING - BACKHOE Cleaning material from ditches using a backhoe	020*		Lin Ft
03-070	<u>CHANNEL CLEANING (INVERT 10 FEET AND OVER)</u> Cleaning dirt, silt, rock or debris from channels using methods not listed below.			Cu Yd
-071	CHANNEL CLEANING - HEAVY EQUIPMENT Above activity using bulldozer, grader, truck shovel, loader etc.	050*		Cu Yd
03-080	<u>DITCH OR CHANNEL REPAIR</u> Do not use the 03-08X sub program for ditch or channel cleaning, use 03-06X or 07X.			Lin Ft
-081	DITCH REPAIR OR RECONSTRUCTION (INVERT LESS THAN 10 FT) Includes reshaping or reconstruction of unpaved ditches, would also include patching of AC or PCC lined ditches.			Lin Ft
-082	CHANNEL REPAIR OR RECONSTRUCTION (INVERT OVER 10 FT) Includes reshaping or reconstruction of unpaved channels, would also include patching of AC or PCC lined channels.			Lin Ft
03-090	<u>DRAINAGE FACILITY OR STRUCTURE REPAIR OR REPLACEMENT</u> Includes removal of graffiti from rocks or various types of walls.			

A-16

Figure A-2. (Continued)
03 PROGRAM (ROADSIDE MAINTENANCE)

		Std or Sch Val. (Man Hrs.)	/	Unit
03-091	REPAIR OR REPLACEMENT OF DRAINAGE FACILITIES Repair or replacement of culverts, drop inlets, other type drains, wingwalls, headwalls, debris racks etc. included in this number.			Each
-092	REPAIR OR REPLACEMENT OF OTHER STRUCTURES Includes work on retaining walls, bin walls, crib walls, sound walls, PCC or stone curbs and dikes, sidewalks, cattle guards or other structures not defined elsewhere.			Each Rpr
03-100	<u>REPAIR OF RIGHT OF WAY OR OTHER ROADSIDE FENCE</u> Includes repair to rock fence, or roadside fence used only as glare screen. Also includes repair to gates on right of way fences.			Lin Ft
A-17 -101	REPAIR CHAIN LINK FENCE Repair of chain link right of way fence of any height.	.00		Lin Ft
-102	BARBED WIRE FENCE Repair of barbed wire right of way fences.	.26*		Lin Ft
-103	WIRE MESH FENCE, OR MESH AND BARBED WIRE FENCE Repair of wire mesh right of way fence, or combination barbed wire and mesh fence.	.63		Lin Ft
03-110	<u>ROADSIDE SECTION RESTORATION</u> Do not use 03-11X sub program when removing sand from travel-way (use 03-012), to improve drainage (use 03-06X or 07X), and for major damage repair (see 18 program).			Cu Yd
-111	REMOVAL OF DRIFT OR STORM DEPOSITED MATERIAL Removal of drift or storm deposited material by any method.	.67*		Cu Yd

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		St . or Sc . Val.* (Ma Hrs.)	/	Unit
03-112	SLIDE REMOVAL Removal of small slides by any method. If estimated expenditure is over \$1,000 in one location or \$5,000/mile see 18 Program.	034		Cu Yd
-113	MANUAL MATERIAL REPLACEMENT Replacement of roadside material performed with hand tools.	500*		Cu Yd
-114	MECHANICAL MATERIAL REPLACEMENT Replacement of roadside material used graders, loaders, trucks, tractors etc.	040*		Cu Yd
-115	OTHER ROADSIDE SECTION RESTORATION Included in this activity are jobs such as bench cleaning, cut slope grading, removing loose rocks from slopes, and maintaining earth berms. Report cubic yards of material if applicable.			Cu Yd
03-880	<u>SUPV AND ADMIN (ROADSIDE MAINTENANCE PROGRAM)</u> (See Definition 01-880) Do not report support activities to this number.			
03-980	<u>MISCELLANEOUS (ROADSIDE MAINTENANCE PROGRAM)</u>			
-981	CLEANING CULVERT AND OVERSIDE DRAIN INTERIORS Cleaning culvert or overside drain interiors by any method.	2,000*		Cu Yd
-982	SLOPE PROTECTION Such as placement of rock or riprap on slopes for the purpose of slope protection or stabilization. For fertilizing or seeding slopes see 05-984 and 985.			

A-18

DAILY MAINTENANCE PERSONNEL REPORT

DATE

MO.	DAY	YR.

COST CENTER			
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FOREMAN

FORM 85 (REV 1 72)

1. Outlined Totals to be posted on HM-83.
2. Total Hours Present must equal Total Crew Hours on HM-83.

<----- CURRENT MONTH -----> <----- FISCAL YEAR 0 DATE ----->

PROGRAM METHOD	COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPORT HOURS	REAL- IZATION	PCT SUPP	PLANNED PROD UNIT	COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPO T HOUR	REAL- IZATION	PCT SUPP	CREW RATE BARE \$/ PROD
01-880 SUPV & ADMIN						MHRS						
STATE	16	13,013	4			112,052	32	120,280	4			
DIST 02		1,353				9,589		10,351				
SUPT		191				2,133		1,730				
FORE 612		6				310		104				
FORE 613		36				294		175				
FORE 614		10				528		116				
FORE 615		64				222		396				
FORE 616		37				285		421				
FORE 617		38				494		518				
01-031 DIGOUT & REPLACE						MHRS	TON					
STATE	1,644	718	1,385		193	7,263	7,922	4,272	6,111		155	9.37
DIST 02						109	43	31	18		316	20.88
SUPT						109						
FORE 615						109						
01-032 GRADER DIGOUT						0.410* MHRS PER TON	TON	TON				
STATE	734	331	883	91	267	15,698	14,367	5,196	13,14	113	262	8.87
DIST 02	101	36	106	115	294	2,448	809	335	09	99	212	8.99
SUPT	38	17	60	92	353	200	86	42	46	84	349	15.26
FORE 615	38	17	60	92	353		39	19	68	84	358	15.53
FORE 616						113	15	12	42	51	350	25.06
FORE 617						87	32	11	36	119	332	10.33
01-033 GRADER/KHO-LDRR DIGOUT						0.360* MHRS PER TON	TON	TON				
STATE	3,003	1,344	3,133	80	233	49,785	31,307	11,931	25,53	94	210	8.07
DIST 02	413	158	320	94	203	965	3,403	1,078	2,52	114	218	7.02
SUPT	21	9	32	84	356	153	126	70	91	65	273	14.36
FORE 612						153						
FORE 614							98	57	16	62	232	13.35
FORE 615	21	9	32	84	356		28	13	43	78	331	13.92
FORE 616												
01-034 MANUAL DIGOUT						3.450* MHRS PER TON	TON	TON				
STATE	162	309	336	181	109	2,600	1,623	5,447	4,144	103	74	40.12
DIST 02		2	2		100	88	146	381	51	132	92	34.90
SUPT												
FORE 614												

Figure A-5.
MAINTENANCE BRANCH
DISTRICT PERFORMANCE SUMMARY

RUN DATE: 04 19/76
BUS DATE:

MARCH 1976

< --- CURRENT MONTH --- >

< --- FISCAL YEAR TO DATE --- >

PROGRAM
METHOD

COMPLETED PRODUCTION SUPPORT REAL- PCT
PROD UNIT HOURS HOURS IZATION SUPP
PLANNED COMPLETED PRODUCTION SU PORT REAL- PCT
PROD UNIT PROD UNIT HOURS H URS IZATION SUPP CREW PAT
BARE \$/ PR

01-880

SUPV & ADMIN

STATE	16	13,013	4	MHRS	112,052	32	120,280	54
DIST 02		1,353		9,589			10,351	
SUPT 601		92					280	
SUPT 610		191		2,133			1,730	
SUPT 620		216		1,148			2,339	
SUPT 630		412		1,669			2,261	
SUPT 650		62		1,704			1,082	
SUPT 660		208		1,680			1,659	
SUPT 670		160		1,255			986	
SUPT 690		12					12	

01-030

BASE & SURFACE REPAIR

STATE	1	9	5	56	MHRS	88	TON	13	68	48	71	61
DIST 02							9		26	41	158	51
SUPT 620							9		26	41	158	51

01-031

DIGOUT & REPLACE

STATE	1,644	718	1,385	193	MHRS	7,263	TON	7,922	4,272	1,611	155	9
DIST 02						109	43		31	98	316	20
SUPT 610					109							
SUPT 660							11		21	73	348	56
SUPT 670							32		10	25	250	7

01-032

GRADER DIGOUT

STATE	734	331	883	91	267	TON	15,698	TON	14,367	5,196	1,614	113	262	8
DIST 02	101	36	106	115	294		2,448		809	335	709	99	212	8
SUPT 610	38	17	60	92	353	200	86	42	146	84	349	15		
SUPT 620						81	300	54	129	228	239	4		
SUPT 630							73	40	119	75	299	15		
SUPT 650						177	61	20	42	125	205	7		
SUPT 660						400	92	53	77	71	145	9		
SUPT 670	63	19	46	136	242	1,590	197	126	195	64	155	11		

01-033

GRDR&BKHO-LDRR DIGOUT (0.360* MHRS PER TON)

STATE	3,003	1,344	3,133	80	233	TON	49,785	TON	31,307	11,931	2,053	94	210	8
DIST 02	413	158	320	94	203		965		3,403	1,078	2,352	114	218	7
SUPT 610	21	9	32	84	356	153	126	70	191	65	273	14		
SUPT 620						1,062	808	211	367	138	174	4		
SUPT 630						3,384	1,350	369	928	132	251	6		
SUPT 650						30	177	39	108	163	275	5		
SUPT 660	392	149	288	95	193	499	688	269	556	92	207	8		
SUPT 670						675	253	119	201	77	169	8		

Figure A-6.

MMS303-EA-D

STATEWIDE
(DIST 01-11)MAINTENANCE BRANCH
EXPENDITURE ANALYSISRUN DATE: APRIL 1, 1976
FOR FY 1975-76 (JULY THRU MARCH)

PAGE 1

PGM-MTHD	MAN YRS @ 1800 HR/YR	DOLLARS EXPENDED YEAR TO DATE					YTD PRODUCTION		SAL-EQP	\$ THIS
		SALARIES	EQUIP	MATLS	OTHER	TOTAL	QUANTITY	UNIT	UNT-CST	MONTH
01-000 ROADBED FLEXIBLE										
DIST 02					4,163	4,163				101
DIST 04		37	6	929		973				
DIST 06					8	8				
DIST 07			57			57				1
TOTAL		37	64	929	4,172	5,202				103
01-880 SUPV & ADMIN										
DIST 01	3.82	62,508	3,775		1	66,284				8,273
DIST 02	5.74	95,963	1,905		94	97,962				13,018
DIST 03	6.62	112,459	4,004		7	117,461				12,310
DIST 04	11.19	183,773	9,205	10		192,988				19,844
DIST 05	4.55	74,152	2,701	8		76,863				10,678
DIST 06	5.72	90,845	1,988		405	93,238				10,828
DIST 07	6.71	108,160	7,815			115,975				13,261
DIST 08	6.79	112,321	4,361		1,558	118,241				11,534
DIST 09	3.01	49,669	2,725			52,394				8,177
DIST 10	6.32	103,011	3,715	85		106,812				5,115
DIST 11	6.35	102,006	8,147	33	170	110,358				12,561
TOTAL	66.82	1,094,873	50,834	137	2,237	1,148,083				125,603
01-981 SPECIAL STUDY										
DIST 04	.01	176	69			246				246
01-030 PASE & SURFACE REPAIR										
DIST 02	.04	623	138	17	160	939	9	TON	84.63	
DIST 04	.01	148	43	442	285	920				
DIST 05	.01	127	29	259		416	1	TON	157.12	157
DIST 06					4,760	4,760				595
DIST 07	.01	171	21			192	3	TON	64.20	
DIST 10					2	2				
TOTAL	.06	1,071	232	719	5,208	7,231	13	TON	100.27	752
01-034 DIGOUT										
DIST 02	.07	1,200	525	47	13	1,786	43	TON	39.68	60
DIST 03	.11	1,785	669	275		2,730	137	TON	17.92	
DIST 04	4.53	73,567	46,444	64,518	2,847	187,377	6,798	TON	17.65	33,967
DIST 05	.21	3,286	2,570	1,184	695	7,838	267	TON	22.31	1,065
DIST 06	.09	1,458	468	177		2,104	107	TON	17.93	962
DIST 07	.86	13,881	4,122	5,640	2	23,656	422	TON	42.59	5,342
DIST 08		18	14	98		131				
DIST 10	.09	1,534	817	473	534	3,360	61	TON	38.24	835
DIST 11	.08	1,325	470	124		1,920	84	TON	21.39	
TOTAL	6.05	98,158	56,104	72,549	4,093	230,905	7,922	TON	19.47	42,234

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Figure A-7.

MMS303-BS-D

STATEWIDE
(DIST 01-11)MAINTENANCE BRANCH
BUDGET STATUSRUN DATE: MAY
FOR FY 1975-76 (3, 1976
JUL THRU APRIL)

PAGE 1

PROGRAM	MAN-YEARS EXPND	MAN-YEARS PLANNED	\$ BY MAINT	\$ BY CITIES	\$ BY CONTRACT	\$ REIMB	\$ TOTAL BUDGET	\$ OTHER DEPT-STAFF	\$ TOTAL EXPENDED
01 ROADBED FLEXIBLE (GL 93X)									
THIS MONTH	66.47	58.12	3,037,965	24,969		136-	3,062 797	3,318	3,066,115
FISCAL YEAR TO DATE	502.68	525.40	17,398,143	21,789		2,826-	17,417 107	16,190	17,433,297
TARGET FY TOTAL		656.62	28,891,400	261,300		20,000-	29,132 700	8,200	29,140,900
TARGET ADJUSTMENTS		5.63-	32,000				32 000		32,000
PERCENT FYTD	77%	80%	60%	8%		14%	60%	197%	60%
PERCENT LAST FY	80%		79%	69%	100%	97%	79%	82%	79%
PERCENT LAST 4 FY	78%		73%	51%	53%	77%	73%	78%	73%
02 ROADBED RIGID (GL 93X)									
THIS MONTH	14.13	13.13	416,878			560-	416 317	631	416,948
FISCAL YEAR TO DATE	117.91	131.92	3,073,594			3,020-	3,070 574	6,523	3,077,097
TARGET FY TOTAL		158.01	4,218,800		112,800	6,700-	4,324 900	2,700	4,327,600
TARGET ADJUSTMENTS		13.64-	1,326,000-				1,326 000-		1,326,000-
PERCENT FYTD	75%	83%	73%			45%	71%	242%	71%
PERCENT LAST FY	83%		83%		47%	97%	81%	67%	81%
PERCENT LAST 4 FY	82%		79%		47%	119%	78%	67%	78%
03 ROADSIDE MAINTENANCE (GL 93X)									
THIS MONTH	49.78	46.60	1,484,140	18,532		23,661-	1,479 011	382	1,479,393
FISCAL YEAR TO DATE	438.50	474.09	10,973,968	52,318	16,053	292,447-	10,749 893	2,718	10,752,611
TARGET FY TOTAL		525.56	13,094,400	82,200	112,800	190,100-	13,099 300	9,300	13,108,600
TARGET ADJUSTMENTS		2.33	577,000-				577 000-		577,000-
PERCENT FYTD	83%	90%	84%	64%	14%	154%	82%	29%	82%
PERCENT LAST FY	89%		89%	60%	97%	82%	89%	98%	89%
PERCENT LAST 4 FY	89%		88%	58%	53%	85%	87%	95%	87%
04 ROADWAY LITTER & DEBRIS (GL 93X)									
THIS MONTH	25.34	24.03	668,457	92,892		10,833-	750 516		750,516
FISCAL YEAR TO DATE	246.07	238.02	5,625,149	521,809		120,988-	6,025 971	357	6,026,328
TARGET FY TOTAL		283.98	6,472,400	1,015,400		116,100-	7,371 700	2,400	7,374,100
TARGET ADJUSTMENTS		5.15-	7,000				7 000		7,000
PERCENT FYTD	87%	84%	87%	51%		104%	82%	15%	82%
PERCENT LAST FY	82%		83%	49%		80%	79%	100%	79%
PERCENT LAST 4 FY	84%		84%	49%		78%	79%	98%	79%
05 VEGETATION CONTROL (GL 93X)									
THIS MONTH	14.53	27.42	429,691	48,241		97	478 030		478,030
FISCAL YEAR TO DATE	205.40	198.93	5,133,072	83,237		1,249-	5,215 061	379	5,215,441
TARGET FY TOTAL		250.42	6,634,400	39,700		5,800-	6,668 300	2,700	6,671,000
TARGET ADJUSTMENTS		23.67	811,300				811 300		811,300
PERCENT FYTD	82%	79%	77%	210%		22%	78%	14%	78%
PERCENT LAST FY	78%		79%	46%		95%	78%	80%	78%
PERCENT LAST 4 FY	79%		78%	63%		78%	78%	61%	78%

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Figure A-8.

MMS404-A

DISTRICT = 01

MAINTENANCE BRANCH

RUN DATE = 04/08/76

* VEHICLE NOT ASSIGNED TO USER

DISTRICT EQUIPMENT REPORT

BUSINESS DATE = 12-75 PAGE 99

<----- THIS MONTH -----> <----- FISCAL YEAR TO DATE ----->

ITEM-CHC NUMBER	DESCRIPTION	DOWN-TIME FIELD	DOWN-TIME SHOP	ACTUAL USE	NON USE	AVER USE	\$COST NON-USE	DOWN-TIME FIELD	DOWN-TIME SHOP	ACTUAL USE	NON USE	\$COST NON-USE	\$COST REPAIRS	\$COST OPER	DATE-IN SERVICE
006.00-1561	PICKUP														04-72
	SUPT 01-650	0	0	910				0	30	5223					
	TOTAL FOR CHC-NO.	00	00	910	00	1150	00	00	30	5223	00	00	00	00	
006.00-1563	PICKUP														04-72
	*SUPT 01-620	0	0	211				0	0	211					
	TOTAL FOR CHC-NO.	00	00	211	00	1150	00	00	00	211	00	00	357	231	
006.00-1564	PICKUP														04-72
	*SUPT 01-650	0	0	0				0	0	158					
	TOTAL FOR CHC-NO.	00	00	00	00	1150	00	00	00	158	00	00	00	133	
006.00-1573	PICKUP														04-72
	*SUPT 01-620	0	0	71				0	0	71					
	*SUPT 01-650	0	0	817				0	0	817					
	TOTAL FOR CHC-NO.	00	00	888	00	1150	00	00	00	888	00	00	00	00	
006.00-1830	PICKUP														05-72
	*SUPT 01-650	0	0	0				0	0	446					
	TOTAL FOR CHC-NO.	00	00	00	00	1150	00	00	00	446	00	00	132	58	
006.00-1834	PICKUP														07-72
	*SUPT 01-650	0	0	300				0	0	300					
	TOTAL FOR CHC-NO.	00	00	300	00	1150	00	00	00	300	00	00	449	497	
006.00-1842	PICKUP														05-72
	*SUPT 01-650	0	0	150				0	0	150					
	TOTAL FOR CHC-NO.	00	00	150	00	1150	00	00	00	150	00	00	186	363	
006.07-2488	PICKUP W/AIR COND.														04-73
	SUPT 01-640	0	0	1254				0	8	7299					
	*SUPT 01-650	0	0	0				0	0	310					
	TOTAL FOR CHC-NO.	00	00	1254	00	1150	00	00	08	7609	00	00	00	00	
006.30-0943	UTILITY BODY														08-71
	*SUPT 01-610	0	0	0				0	0	219					
	TOTAL FOR CHC-NO.	00	00	00	00	113	00	00	00	219	00	00	00	00	
006.30-0950	UTILITY BODY														07-71
	SUPT 01-610	0	0	118				0	8	744					
	TOTAL FOR CHC-NO.	00	00	118	05-	113	02-	00	08	744	74-	36-	00	00	

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Figure A-9.

MMS018-A		MAINTENANCE BRANCH FOREMAN (LEVEL I) PROGRAM WORK PLAN - DETAIL FISCAL YEAR 1974-75														07/01/74	PAGE 1
DISTRICT	03																
SUPT	610																
FOREMAN	612																
PROG-																	
METHOD DESCRIPTION	CO RTE	TOTAL PRODUCTION QUANT * UNIT	M A N H O U R S												M-HR PER PROD, UNIT		
01 880 SUPV & ADMIN		731 MAN-HRS	731	61	61	61	61	61	61	61	61	0	61	61	61	1.00	
TOTAL PGM-METHOD			731	61	61	61	61	61	61	61	61	0	61	61	61		
034 MANUAL DIGOUT	YOL 084	19 TON	152		40								72		40	8.04	
TOTAL PGM-METHOD			152		40								72		40		
031 HAND PLACED SURFACING	YOL 016	58 TON	296		26	41	66		20	31	0		51		41	5.10	
031 HAND PLACED SURFACING	YOL 084	191 TON	976		92		174	102	77	36	2	4	163	128		5.10	
TOTAL PGM-METHOD			1272		118	41	240	102	97	67	2	4	163	179	41		
025 SERVICE CONTRACT SURF	YOL 016	388 MAN-HRS	388	388												1.00	
025 SERVICE CONTRACT SURF	YOL 084	205 MAN-HRS	205	74	131											1.00	
TOTAL PGM-METHOD			593	462	131												
052 ROCK SEAL 8"SPREAD	YOL 016	112 TON	276		175										101	2.46	
052 ROCK SEAL 8"SPREAD	YOL 084	81 TON	199												27 172	2.46	

* MONTHLY PLANNED UNITS DIDNOT EQUAL TOTAL PLANNED UNITS AND WAS NOT CORRECTED. DIFFERENCE LISTE ON ERROR LIST (MMS017-A1).

DEPARTMENT OF TRANSPORTATION
OFFICE OF MAINTENANCE
PROGRAM WORK PLAN

PREF RED BY J. Smith

01 PROGRAM

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DNO-M-99.

Figure A-11.

MAINTENANCE MONTHLY WORKLOAD PLAN
 BY COST-CENTER
 MONTH OF DECEMBER 1976

PAGE 3

DISTRICT 02

SUPT. 629 QUINCY

CREW 637 DOYLE CREW

PREPARED BY

John Peters

DATE 11-21-76

PROGRAM METHOD	DESCRIPTION	CO. RTE.	UNITS OR HRS OF MEAS.	UNIT PLANNED MAN-HRS.	1	2	3	4	5	REMARKS MATERIAL & EQUIPMENT
01-880 SUPV & ADMIN		*	20 MAN-HRS	20	I	X	I	X	I	
01-041 PETROL FILL CORNUCOPIA		LAS 395	40 100#CTN	187	I	X	I	I	I	KATTLE Fm CC-626
03-880 SUPV & ADMIN		*	5 MAN-HRS	5	I		I	X	I	
03-063 DITCH CLEAN BACKHOE		LAS 395	876 LIN FT	24	I		I	X	I	
03-102 BARBED WIRE FENCE		SIE 395	570 LIN FT	20	I		I	X	I	
03-071 Chw clw. Hvy Equip		LAS 395	200 cu yd			X				Return H/c To Shop CAT To be delivered 12-4-76
04-880 SUPV & ADMIN		*	4 MAN-HRS	4	I		I	I	X	I
04-011 LITTER/FREWAY PATROL		*	390 MAN MI	30	I	X	I	X	I	X
07-880 SUPV & ADMIN		*	3 MAN-HRS	3	I	X	I		I	I
10-880 SUPV & ADMIN		*	60 MAN-HRS	60	I		I	I	X	I
10-030 SNOW SEASON PREP		*	50 MAN-HRS	50	I		I	X	I	X
10-011 TRUCK PLOWING		* 395	1,427 VEH MI	140	I		I	I	X	I
10-012 GRADER PLOWING		* 395	167 VEH MI	30	I		I	I	X	I
10-021 SNOW & ICE COVER		LAS 395	2,056 VEH MI	219	I		I	X	I	X
		SIE 395	280 VEH MI	30	I		I	X	I	I
17-880 SUPV & ADMIN		*	4 MAN-HRS	4	I	X	I		I	I
17-054 TRAINING SAFETY		*	5 MAN-HRS	5	I	X	I		I	I
17-061 SUPERVISORS MEETING		*	4 MAN-HRS	4	I		I		I	X

Supts of File

APPENDIX B

ILLINOIS DEPARTMENT OF TRANSPORTATION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 11,236,000 residents of Illinois operate 5,952,000 motor vehicles on 129,942 miles of highway of which 16,780 miles are under state control. The state occupies 56,400 square miles from an elevation of 279 feet to 1,235 feet above sea level. Mean minimum and maximum temperatures are 14 and 90°F with average annual moisture ranging from 32 to 48 inches.

The Illinois Department of Transportation has a \$79,000,000 maintenance budget for fiscal year 1976. This budget will be used by its 9 districts to maintain 38,000 lane miles of highways (16,800 center line miles).

Nine districts comprise the Illinois Department of Transportation Maintenance Management System. Each district is divided into "Maintenance Team Sections" resulting in a total of 104 Maintenance Team Sections.

The Highway Maintenance Lead Workers 02 or Section Supervisors are in charge at the Maintenance Team Sections with assistance from Highway Maintenance Lead Workers 01 often referred to as crew leaders. Highway Maintenance Lead Workers 02 report to Maintenance Field Engineers who are in responsible charge of several Maintenance Team Sections. The Maintenance Field Engineers report to the District Maintenance Engineer who reports to the District Engineer.

The administration of the maintenance program by the Director of the Illinois Division of Highways is performed at the central office level by the Engineer of Maintenance.

The basic maintenance recording and reporting system was developed in 1966 and 1967. Significant changes in the system were made in 1970 and 1971. A single reporting system is utilized to satisfy both the accounting and maintenance management function. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Illinois Department of Transportation Form BFM-884, "Maintenance and Traffic Time Card" is utilized to collect maintenance obtained on this form includes:

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Accomplishments
6. Foreman's designation

The forms are prepared for each employee daily and cover a bi-monthly payroll period. In some areas individual workmen fill out the cards while in other areas the Highway Maintenance Lead Worker 01 may fill out the forms for the employee. Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording

the following information:

1. District. A number from 1 to 9 is utilized to designate the district.
2. Maintenance Team Section. One hundred four Maintenance Team Sections are designated by 3 digit numbers. The first number of the code refers to the district, the second number refers to the Maintenance Field Engineer in charge of the Maintenance Team Section and the last digit refers to the particular one of the several Team Sections under his control. Thus, a code of 712 refers to District 7, Maintenance Field Engineer 10 and the second area under Field Engineer 10.
3. Maintenance Sub-Section. Maintenance Sub-Sections are specific segments of highways. A Sub-Section is based on a continuous route through a Maintenance Team Section.

The cost reporting units within a Maintenance Team Section are the "Sub-Sections." A Maintenance Team Section is composed of one or more Sub-Sections. Sub-Sections are assigned 3-digit numbers.

A Sub-Section is based on a continuous route through a Maintenance Team Section and may be modified by pavement width or traffic lanes.

If all the pavement on a route within a Team Section is of uniform width, said route shall constitute one Sub-Section. If a portion of the pavement on a route within a Team Section is under 22 ft. in width and the remainder is 22 ft., or greater in width, a separate Sub-Section shall be established for each portion. A separate Sub-Section shall also be established whenever there is a change in the number of traffic lanes on a route within a Team Section.

Sub-Section numbers are based on the following basic criteria:

- | | |
|---------------------------------|------------|
| 1. Marked Interstate Routes and | |
| Primary Routes | 010 to 799 |
| 2. Special Bridge Structures | 800 to 819 |
| 3. City Street Maintenance | 820 to 849 |
| 4. 50-50 Financed Roads | 850 to 859 |
| 5. River Bridges Maintained | |
| with Adjoining States | 860 to 869 |

For example, sub-sections for U. S. Route 30 could be numbered 300, 301, 302.

Little attempt has been made to establish maintenance section limits based on type of pavement and/or time of construction except for some special study sections.

Special job authorizations are filled out by the employee under the direction of the State Maintenance Engineer, the District Maintenance Engineer or the Maintenance Field Engineer. All other times the column on the Maintenance and Traffic Time card is not filled in.

4. Milepost. A milepost or milepoint system is not utilized as a part of the maintenance management system.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder, roadside, etc.

Activity

Maintenance Work Function Codes are utilized to designate the maintenance activity performed (Table B-1). Forty-nine maintenance

codes are presently utilized and are divided into the following major groups:

1. Roadway Surface Operations
2. Shoulder and Side Approaches
3. Roadside and Drainage
4. Bridge Structures
5. Snow and Ice Control
6. Traffic Services and Facilities
7. Maintenance General Functions
8. Equipment Maintenance
9. Traffic Signing
10. Miscellaneous and
11. "Time Off" Codes

It should be noted that a special function code does not exist for maintenance on portland cement concrete pavements. Some special codes exist for snow and ice removal.

Function codes were developed and have been revised based on input from the districts. These function codes can be expected to be altered in the future.

Manpower

Manpower utilization is assigned to a particular study and location on the individual time sheet. The employee's name, position, and social security number are recorded together with the start and stop time for each working day. If the workman performed more than one maintenance activity and/or worked on more than one sub-section for a given day, two or more lines of dates must be filled out for that day indicating the working hours for each

activity and/or sub-section. Regular, over-time and time-off hours are recorded on this form. All time-off hour entries must be accompanied by the appropriate function code as shown in Table B-1.

The report is intended to cover a bi-monthly payroll period ending on the 15th and 31st of the month. The time worked is reported to the nearest one-half hour.

Equipment

Equipment utilized by a particular individual and for a particular maintenance activity and/or sub-section is recorded. Equipment is designated by an equipment code. This code rather than individual equipment numbers are entered on the Maintenance and Traffic Time Card. The equipment usage hours are not just the hours that the equipment was actually in operation, but rather the number of hours that the equipment was assigned to the job and unavailable for other uses. Equipment time is recorded to the nearest half hour.

The Highway Maintenance Lead Worker 01 should be certain that no equipment is omitted or duplicated in reporting. If more than one type of equipment is used, the hours of usage of each type of equipment should be recorded on the time card of the man responsible for its operation that day. For equipment used fully among the entire crew, each type can be recorded on a separate man's time card until all equipment used by the crew is accounted for. If one man must report two or more types of equipment, additional lines should be used, with careful checking that no equipment is omitted or listed twice. It is important that the day's date, work location and work function code be given for each piece of equipment.

Materials

The district collects all materials bills and codes these costs such that the cost of materials is assigned to the Maintenance Team Sections and sub-section as appropriate. The type of material is identified by the work function code shown in Table B-1.

Accomplishments

The accomplishment data entered on the time card are the measure of the amount of work performed at a particular location for a particular work function. If the work is performed by the entire crew, the accomplishments are entered on only one time card which is usually the Lead Worker. The Lead Worker is responsible to insure that a work accomplishment value has been recorded. The units of accomplishment are reported in units assigned to the function code for which the accomplishment is being recorded.

Inventory

A Maintenance Roadway Inventory Record is maintained in each district by Maintenance Team Section and Sub-Section. Information collected and reported on this inventory includes;

1. District designation
2. Maintenance Team Section Number
3. Sub-Section numbers
4. Route numbers
5. Location of road (municipal or rural)
6. County
7. City
8. Average width of R.O.W.
9. Average daily traffic

10. Topography
11. Surface type
12. Width of pavement
13. Lane miles of pavement
14. Lane miles of ramps
15. Access control
16. Feet of curbs and/or gutters
17. Drainage structures
18. Historical markers
19. Frontage roads, lane miles
20. Storm sewers
21. Ditches
22. Shoulders
23. Culverts
24. Entrances and side approaches
25. Bridge structures
26. Acres of mowing
27. Right-of-way fence
28. Field engineers jurisdiction
29. Rest areas
30. Weight stations
31. Pump houses
32. Walls, cribbing, rip-rap, and
33. Highway class

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance and Traffic Time Card is filled out daily by the workman or the Highway Maintenance Lead Worker. At the

end of the bi-monthly pay period the Highway Maintenance Section Lead Worker or Field Engineer checks the card and approves with his signature. The cards are sent to the district for checking and key punching within three days after close of pay period. Processing is completed by the districts in 15 calendar days. These data are then transmitted to the central office for editing, checking and processing which may be 1 to 2 weeks.

It is estimated that about 0.6 percent of the maintenance budget is expended on recording and reporting maintenance activities. Sixty-six thousand dollars for computer charges were expended in 1974. Approximately 5 to 7 minutes per day are required per workman to fill out the time card and approximately one-half per day is required of the lead worker. Key punching in the district office amounts to about 1 to 2 days per pay period and about 1 man day is required at the district office to correct time card entries per pay period.

A one month turn around time is the goal of the reporting system.

REPORTS

Several reports are produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports.

Roadway Inventories Listings and Summaries. Roadway inventory reports summarize the information obtained on the Maintenance Roadway Inventory Record. These reports are printed upon request and show data by Maintenance Sub-Section, Maintenance Team Sections, Field Engineers areas of responsibility, Districts and State Totals. An example of this report is shown on Figure B-2 for Maintenance Team Section 712 and Sub-Sections 128, 129, 140, 185, 186 and 370.

Work Accomplishment Reports. Work Accomplishment Reports

summarize work crew performance and develop labor hours per unit and unit costs from direct labor and equipment usage charged to the various work functions. Only direct labor and equipment usage costs are used in this report. These reports are issued monthly and annually for Lead Workers, Maintenance Team Sections, Field Engineers' areas, Districts and State totals. Special Project Accomplishment Reports are produced monthly. Reports can be printed for each foreman as well as for special projects.

An example of a monthly work accomplishment report for District 7 is shown on Figure B-3. It should be noted that sub totals are given for maintenance function groups such as roadway surface, shoulder and side approach, roadside and drainage, etc. Salaried and hourly labor are separated as are charges for regular and over-time hours.

Direct Cost Summary for Major Work Functions. These reports summarize by District, Maintenance Team Section charges to individual maintenance functions (Figure B-4). Information reported includes; units accomplished, unit costs for labor and equipment, direct costs per lane mile and percent of direct costs. Seventeen of the forty-nine maintenance functions are shown on this report. The 17 functions normally account for about 70 percent of total maintenance expenditures. These reports are issued monthly and annually. A similar report is prepared to compare districts and contains a state wide total.

Equipment Usage Reports. These reports show equipment usage costs which are computed from the usage hours reported multiplied by established hourly rates. Usage hours are not meter hours or hours of actual operations; but as discussed previously, are the work hours

during which the equipment is on a specific job and unavailable for any other use. The reports are issued monthly and annually and are prepared for Field Engineers' Areas, Districts and State totals.

An annual report issued under the cost series reports lists every sub-section in the state by Maintenance Team Section and District and gives the sub-section lane miles or bridge lineal feet and the cost per lane mile for the sub-section or cost per lineal foot if the sub-section is for a special bridge.

Cost Reports. These reports show all costs charged to the maintenance function. They show the costs assigned to the various maintenance functions plus non-production labor, all overhead costs, etc. Material costs are also included in these reports which are printed quarterly and annually. Reports are prepared for each Maintenance Team Section, Field Engineers' area, District and State total. Annual reports are also broken-down for interstate, regular highway and Chicago Expressways.

It should be noted that sub totals are given for maintenance function groups such as roadway surface, shoulder and side approach, roadside and drainage, etc.

Special Sub-Section Reports. As discussed previously each district has been instructed to establish special sub-sections for detailed study. Special reports are issued annually for these roadway and bridge special sub-sections. Costs per lane mile for mainline surface functions are reported for the pavement types within the sub-sections together with costs per lineal foot of bridge length for the various bridge sections under study.

Other reports in the maintenance management system are for error listings and control.

Reports are utilized for fiscal control by reviewing expenditure information. Budget information does not appear in these reports. Comparison of accomplishment units for specific maintenance functions among districts can be utilized to determine access productivity and to allocate manpower. Exception reports are presently not a part of the reporting system. The reports are utilized for budget preparation.

OTHER ITEMS

The Illinois Department of Transportation is not completely satisfied with the accuracy of the reports. Field data collection needs to be improved. Training programs have been utilized in an attempt to improve this accuracy.

The recording and reporting system can be altered by direction of the central office. Field input is normally obtained prior to any changes. Certain changes are contemplated.

A maintenance work standard committee has been formed and is composed of central office staff members, district engineers, field engineers, foremen, and equipment operators.

Recorded data are stored on tape and can be stored for a prolonged period of time.

Reference

1. "Maintenance System," informal report prepared by the State of Illinois, Department of Transportation.

Figure B-1. Field Recording Form

MO. DAY YEAR	EMP. NAME	DISTRICT	RESP.
PAY PERIOD ENDING DATE	POSITION	CARD OF CARDS	PAYROLL NO.
	SOC. SEC. NO.		SUBMITTED BY

ILLINOIS DEPT. OF TRANSPORTATION-MAINTENANCE & TRAFFIC TIME CARD

LINE NO.	DAYS DATE	AUTHORIZATION	WORK LOCATION		WORK FUNCTION CODE	LABOR						EQUIPMENT		COM- PLI- MENTS	TRAFFIC MATERIAL		FORE- MANS NO.	
		A & B, RP & L OR SPEC. PROJ. NO.	MAINT. TEAM SECTION	SUB SECTION		HOURLY RATE	START TIME	STOP TIME	HOURS			EQUIPMENT CODE	HOURS USED		Q UANTITY	CODE		QUANT.
			COUNTY	ROUTE					REGULAR	OVERTIME	TIME OFF							
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		

APPROVED BY _____
BFM-884 (REV. 10-72)

OFFICE USE ONLY

Table 1 on reverse side of card

Table 3-1.

BPM 004 (REV. 12-73)

TRAFFIC

MAINTENANCE

WORK FUNCTION CODES			
CATEGORY	FUNCTION CODE	WORK ITEMS	ACCOMP. UNITS
SIGN ERECTION	510	New, Interstate	EACH
	511	New, All Others	EACH
	512	Maintenance, Interstate	EACH
	513	Maintenance, All Others	EACH
	514	Temporary, Interstate	EACH
	515	Temporary, All Others	EACH
	516	Sign Erection and Sign Maintenance of Rest Areas and Truck Weigh Stations, Interstate	EACH
517	Sign Erection and Sign Maintenance of Rest Areas and Truck Weigh Stations, All Others	EACH	
DELINEATORS	518	New, Interstate	EACH
	519	New, All Others	EACH
	520	Maintenance, Interstate	EACH
	521	Maintenance All Others	EACH
BARRICADES	522	New and Maintenance	EACH
PAYEMENT STRIPING	525	Linealene, Interstate	MILES
	526	Linealene, Multilane, Non-Interstate	MILES
	527	Centerline, Undivided, Multilane, Non-Interstate	MILES
	528	Centerline, Two Lane	MILES
	529	Edgeline, Interstate	MILES
	530	Edgeline, Divided, Multilane, Non-Interstate	MILES
	531	Edgeline, Undivided, Multilane Non-Interstate	MILES
	532	Edgeline, Two Lane	MILES
	533	Edgeline, Interstate Ramps	MILES
	534	Edgeline, Non-Interstate Ramps	MILES
	535	Yellow, Zero Marking, Two Lane	MILES
SPECIAL PAYMENT MARKING	545	Core, Interstate	EACH
	546	Core, Non-Interstate	EACH
	547	Railroad Crossings	EACH
	548	Rest Areas and Truck Weigh Stations, Interstate	EACH
	549	Rest Areas and Truck Weigh Stations, Non-Interstate	EACH
	550	Stop Lines, Cross Walks	EACH
	551	Channelization Striping	EACH
	552	Messages and Symbols	EACH
553	Curb Marking	LIN. FT.	
554	Hazard and Other Miscellaneous Marking	EACH	
555	Pavement Marking Removal	LIN. FT.	
TRAFFIC CONTROL SIGNALS AND ROADWAY LIGHTING	560	Replacement of Traffic Signals	EACH
	561	Maintenance of Traffic Signals	EACH
	562	Maintenance of Roadway Lighting Units	EACH
	563	Replacement of Roadway Lighting Units	EACH
SIGN SHOP	570	Stripping and Sign Cleaning	EACH
	571	Sign Painting	EACH
	572	Sheeting Applications	EACH
	573	Silk Screening	EACH
	574	Sign Assembly Fabrication	EACH
GENERAL FUNCTIONS	580	General Duties	-----
	581	Lost Time	-----
	582	Low Cost Traffic Improvement	-----
	583	Experimental, Test and Special Projects	-----
EQUIPMENT MAINTENANCE	584	Emergency Patrol	NO. ASSISTS
	585	Material Handling	-----
HIGHWAY MAINTENANCE	590	Trucks	-----
	591	Other Equipment	-----
SIGN WASHING	594	Disaster Maintenance	-----
	595	Highway Maintenance Activities	-----
MISCELLANEOUS	596	Interstate	EACH
	597	Non-Interstate	EACH
	598	Supervisor, Traffic	-----
599	Office Personnel, Storekeepers, etc.	-----	

WORK FUNCTION CODES			
CATEGORY	FUNCTION CODE	WORK ITEMS	UNITS
ROADWAY SURFACE OPERATIONS	410	Bituminous Surface Patching	TONS
	411	Permanent Patching	SQ. YD.
	412	Crack Filling	GAL
	413	Bump, Barring and Joint Cutting	LIN. FT.
	414	Mud Jacking and Undersealing	SQ. YD.
	415	Sealing	SQ. YD.
	430	Sealing	SQ. YD.
	431	Patching (Hand Method)	TON
	432	Patching (Machine Method)	TON
	433	Cutting High Shoulders	CU. YD.
SHOULDER AND SIDE APPROACHES	434	Blading and Dragging	MILES
	435	Filling Edge Joint	MILES
	440	Repairing Slopes	CU. YD.
441	Ditches (Hand Method)	-----	
442	Ditches (Machine Method)	CU. YD.	
443	Clean and Repair Sewers, etc.	-----	
444	Wells, Cribbing and Riprap	SQ. YD.	
ROADSIDE AND DRAINAGE	445	Care and Removal of Trees and Plants	-----
	446	Mowing (Hand Method)	-----
	447	Mowing (Machine Method)	ACRE
	448	Reseeding and Resodding	ACRE
	449	Wood Spraying	ACRE
	450	Cleaning Dirt and Debris (Hand)	LANE MILES
	451	Cleaning Dirt and Debris (Equip.)	MILES
	460	Repair and Maintain Bridges	-----
	461	Cleaning Bridges	LIN. FT.
	462	Operation of Movable Span Bridges & Ferries	-----
SNOW AND ICE CONTROL	465	Snow Removal	OPER. HR.
	466	Preparation for Snow Control	-----
TRAFFIC SERVICES AND FACILITIES	470	Guard Rail Maintenance	LIN. FT.
	471	Right of Way Fence Maintenance	LIN. FT.
	472	Maintenance of Rest Areas and Historical Markers	EACH
	473	Weigh Station Maintenance	EACH
	474	Subway Pumping (Includes Cleaning)	EACH
	475	Disaster Maintenance	-----
MAINTENANCE GENERAL FUNCTIONS	480	General Duties	-----
	481	Lost Time	-----
	482	Advertising Sign Removal	EACH
EQUIPMENT MAINTENANCE	*490	Trucks	-----
	*491	Other Equipment	-----
TRAFFIC SIGNING	495	Sign Maintenance	-----
MISCELLANEOUS	*498	Supervisor, Maintenance	-----
	*499	Office Personnel, Storekeeper, etc.	-----

*THIS FUNCTION DOES NOT REQUIRE A SUBSECTION NUMBER

EQUIP. CODE	EQUIPMENT	EQUIP. CODE	EQUIPMENT
010	Asphalt Kettle	420	Sprayers (paint)
070	Air Compressor - up to and including 150 cu. ft.	432	Sprayers (wood)
072	Air Compressor - over 150 cu. ft.	440	Sprayers - rock, asphalt
100	Asphalt Distributor	460	Street Sweeper - self propelled
171	Pull Type Graders	500	Tractor with various attachments
172	Motor Grader - up to 60 h.p.	540	Sewer Cleaners
173	Motor Grader - over 60 h.p.	541	Catch Basin Cleaner
221	End Loader - up to and including 1 cu. yd.	542	Landscaping Equipment, Seeders, etc.
222	End Loader - over 1 cu. yd.	820	Hydra Seeder
223	Crawler Type Loader	900	Brush Chippers
224	Force Feed Loaders	911	Pickup and Carryall Trucks
230	Mixers, concrete and bituminous	912	1-1/2 Ton Trucks
260	Mudjacks	913	2-1/2 Ton Trucks
311	Cranes and Attachments	914	4 Ton Trucks, 2 Wheel Drive
312	Gradiols	915	Tandem Axle Trucks
340	Rollers, Tandem	916	4 Wheel Drive Trucks
341	Rollers - Patching Type	917	3 Ton Trucks
		920	Rotary Snow Plow

REMARKS				

"TIME OFF" CODES		
FUNCTION CODE	REASON FOR TIME OFF	
100	Time Off Without Pay	
124	Vacation	
125	Sick Leave	
126	Holidays	
127	Personal or Other Leave (Explain)	
130	Military Leave	

Figure B-2. Roadway Inventory

DISTRICT 7
PAGE 01

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HIGHWAY INVENTORY SUMMARY TEST SECTION REPORT SECTION 712						
	SUB SECTION	SUB SECTION	SUB SECTION	SUB SECTION	SUB SECTION	SUB SECTION
	128	129	140	185	186	370
SPECIAL SUBSECTION CODE			N	N		
ROUTE NUMBER	S12800	S12900	S14000	S18500	S18500	S03700
MUNICIPAL OR RURAL CODE	R	R	R	R	R	R
COUNTY	FAYETTE	FAYETTE	FAYETTE	FAYETTE	FAYETTE	FAYETTE
CITY						
AVERAGE WIDTH OF RIGHT OF WAY-Feet	80	80	60	80	80	80
AVERAGE DAILY TRAFFIC - 100	12	0	10	9	14	6
TOPOLOGY CODE	1	2	2	1	1	1
SURFACE CODE	2	1	2	1	3	2
AVERAGE WIDTH OF PAVEMENT - Feet	24	18	20	18	20	24
LANE MILES - 8 FOOT WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES - 9 FOOT WIDTH	0.0	20.5	11.4	37.1	0.0	0.0
LANE MILES - 10 FOOT WIDTH	0.0	0.0	5.4	0.0	17.7	0.0
LANE MILES - 11 FOOT WIDTH	0.0	0.0	0.3	0.8	0.0	0.0
LANE MILES - 12 FOOT WIDTH	5.3	0.0	0.0	1.4	0.0	13.8
LANE MILES-13&14 FOOT WIDTHS	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES-15 FOOT WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES - VARIABLE WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES OF RAMPS	0.0	0.0	0.0	0.0	0.0	0.0
CURBS, CURBS/GUTTERS, GUTTERS-100/FT	0	248	117	300	45	55
DRAINAGE STRUCTURES	0	61	4	63	27	39
HISTORICAL MARKERS	0	0	0	0	0	0
FULL ACCESS CONTROL	N	N	N	N	N	N
LANE MILES OF FRONTAGE ROADS	0.0	0.0	0.0	0.0	0.0	0.0
SEWERS - UP TO 36 INCH DIAM.-10/FT	0	0	39	47	0	189
SEWERS - OVER 36 INCH DIAM.-10/FT	0	0	0	0	0	0
DITCHES - PAVED - 100/FT	0	1	1	10	0	4
DITCHES - SOIL - MILES	5	16	16	34	17	12
SHLDRS - SURFACED, HIGH - MILES	0	0	0	1	0	0
SHLDRS-SURFACED, HIGH-AVG WIDTH-FT	0	0	0	10	0	0
SHLDRS - SURFACED, LOW - MILES	0	0	0	0	0	0
SHLDRS - SURFACED, LOW-AVG WIDTH-FT	0	0	0	0	0	0
SHLDRS - AGGREGATE - MILES	0	0	0	0	0	0
SHLDRS - AGGREGATE - AVG WIDTH-FT	0	0	0	0	0	0
SHLDRS - TURF - MILES	5	16	16	36	17	12
SHLDRS - TURF - AVG WIDTH - Feet	5	8	6	11	11	8
CULVERTS - CROSSROADS	8	32	23	53	25	27
CULVERTS - SIDE APPROACHES	20	76	95	244	11	51
ENTRANCES & SIDE APPROACHES	9	67	66	116	36	77

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Figure B-2. (Continued)

DISTRICT 7
PAGE 01
CONTINUED

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HIGHWAY INVENTORY SUMMARY
TEAM SECTION REPORT
SECTION 712

	SUB SECTION 128	SUB SECTION 129	SUB SECTION 140	SUB SECTION 135	SUB SECTION 186	SUB SECTION 370
STRUCTURES - LINEAL FEET	0	251	227	326	192	107
NO. OF STRUCTURES - UNDER 100 FEET	0	4	2	5	1	0
NO. OF STRUCTURES - OVER 100 FEET	0	1	1	0	1	1
SPECIAL STRUCTURES - TYPE	0	0	0	0	0	0
SPECIAL STRUCTURES - AGE IN YEARS	0	0	0	0	0	0
SPECIAL STRUCTURES - LINEAL FEET	0	0	0	0	0	0
GUARD RAIL - STEEL PLATE - 10/FT	0	150	185	165	355	275
GUARD RAIL - CABLE GUARD - 10/FT	0	0	0	0	0	0
GUARD RAIL - WOOD - 10/FT	0	0	0	0	0	0
FIELD ENGINEERS NUMBER	10	10	10	10	10	10
SUPERVISORS NUMBER	12	12	12	12	12	12
LANDSCAPING - INDIVIDUAL PLANTING	0	64	273	83	5	83
LANDSCAPING - MASS PLANTING-SQ YDS	0	37375	0	0	0	49860
LANDSCAPING - ACRES OF TIMBER	0	0	0	0	0	0
TURF ACRES	16	72	37	42	39	41
RIGHT OF WAY FENCE - MILES	0.0	0.0	0.0	0.0	0.0	0.0
REST AREAS - FLUSH	0	0	0	0	0	0
REST AREAS - PIT	0	0	0	0	0	0
REST AREAS - MINOR	0	0	0	0	0	0
WEIGH AND INSPECTION FACILITIES	0	0	0	0	0	0
PUMP HOUSE	0	0	0	0	0	0
WALLS, CRIBBING, AND RIPRAP-10/FT	0	0	0	0	0	0
EXPRESSWAY/INTERSTATE CODE	0	0	0	0	0	0

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Figure B-3. Monthly Accomplishment Reports

DISTRICT

7

MONTHLY WORK ACCOMPLISHMENTS
DISTRICT REPORT
MARCH 1976

PAGE 1 OF 2

* WORK * * FUNCTION *		* ACCOMPLISHMENT FACTORS *			* LABOR - COST *				* BREAKDOWN *		
* WORK ACCOMPLISHMENT *		* HOURS *	* LABOR * * PER * * UNIT *	* COST * * AND * * EQUIPMENT *	* REGULAR *	* SALARIED * * LABOR *	* OVERTIME *	* HOURLY * * LABOR *	* EQUIPMENT * * USAGE * * COST *		
* UNITS *	* UNIT *	* PER * * HOUR *	* AND * * EQUIPMENT *	* EQUIPMENT *	* HR *	* \$ *	* HR *	* \$ *	* HR *	* \$ *	
BITUMIN PATCH	414.50 TONS	2.58	19.84	1052.0	5935.59	16.0	89.24	.0	.00	2196.85	
PERF PATCHING	103.50 SQ YDS	4.66	39.88	452.0	2662.76	.0	.00	32.0	233.60	1230.80	
CRACK FILLING	5088.50 GALS	.23	1.78	1182.0	6737.44	.0	.00	.0	.00	2303.00	
BUMP BRN&JT CUT	192.00 LIN FT	.65	5.14	124.0	696.76	.0	.00	.0	.00	290.40	
MUDJACK&NDSEAL	.00 CU YDS	.00	.00	.0	.00	.0	.00	.0	.00	.00	
SEALING	279.00 SQ YDS	.43	3.46	120.0	674.08	.0	.00	.0	.00	290.40	
ROADWAY SURFACE TOTALS				2930.0	16706.63	16.0	89.24	32.0	233.60	6311.45	
SEALING	.00 SQ YDS	.00	.00	.0	.00	.0	.00	.0	.00	.00	
PATCH-HAND	927.50 TONS	1.30	10.53	1209.0	6621.35	.0	.00	.0	.00	3144.00	
PATCH-MACHINE	195.00 TONS	.67	6.74	130.0	756.54	.0	.00	.0	.00	558.20	
CUT HIGH SHOULDR	30.00 CU YDS	.53	4.70	16.0	84.96	.0	.00	.0	.00	56.00	
BLADE AND DRAG	640.00 MILES	1.95	17.43	1248.0	6926.76	.0	.00	.0	.00	4226.80	
FILL EDGE JOINT	7.00 MILES	1.14	10.64	8.0	42.48	.0	.00	.0	.00	32.00	
SHOULDER AND SIDE APPRC. TOTALS				2611.0	14432.09	.0	.00	.0	.00	8017.00	
SLOPES	158.00 CU YDS	.61	5.06	96.0	549.08	.0	.00	.0	.00	250.40	
DITCHES-HAND	412.00 LB HRS	.00	.00	412.0	2316.88	.0	.00	.0	.00	747.60	
DITCHES-MACHINE	7135.00 CU YDS	.44	3.88	3152.0	17572.83	.0	.00	.0	.00	10115.20	
REP SEWERS, ETC.	1306.00 LB HRS	.00	.00	1306.0	7396.67	.0	.00	.0	.00	2740.60	
WALLS, CRIB, RIPR	2223.00 SQ YDS	.13	1.03	288.0	1672.88	.0	.00	.0	.00	626.40	
TREES&PLANT CARE	2380.30 LB HRS	.00	.00	2380.3	13471.91	.0	.00	.0	.00	4843.00	
MOWING-HAND	8.00 LB HRS	.00	.00	8.0	41.24	.0	.00	.0	.00	16.00	
MOWING-MACHINE	.00 ACRES	.00	.00	.0	.00	.0	.00	.0	.00	.00	
RESEED&RESODDING	.00 ACRES	.00	.00	.0	.00	.0	.00	.0	.00	.00	
WEED SPRAYING	64.25 ACRES	7.14	51.74	459.0	2611.29	.0	.00	.0	.00	712.90	
DIRT&DEB-MANUAL	2292.70 LN MI	3.94	28.94	9012.0	49672.45	12.0	63.04	.0	.00	16611.90	
DIRT&DEB-MACHINE	40.00 MILES	1.80	17.23	72.0	418.08	.0	.00	.0	.00	271.20	
ROADSIDE AND DRAINAGE TOTALS				17185.3	95723.31	12.0	63.04	.0	.00	36935.20	

Figure B-3. (Continued)

DISTRICT		7		MONTHLY		WORK		ACCOMPLISHMENTS		DISTRICT REPORT		MARCH		1976		PAGE 2 OF 2			
* WORK	* ACCOMPLISHMENT FACTORS	* LABOR UNIT COST	* SALARIED LABOR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	* REGULAR	* OVERTIME	
* FUNCTION	* UNITS	* PER AND	* UNIT EQUIPMENT	* HR	* \$	* HR	* \$	* HR	* \$	* HR	* \$	* HR	* \$	* HR	* \$	* HR	* \$	* HR	* \$
BRIDGE REPAIR	1342.50 LB HRS	.00	.00	1341.0	7409.18	1.5	8.21	.0	.00	.00	3705.80	.0	.00	.00	.00	.00	.00	.00	.00
BRIDGE CLEANING	26849.00 LIN FT	.02	.15	520.0	2852.26	.0	.00	.0	.00	.00	1051.20	.0	.00	.00	.00	.00	.00	.00	.00
BRIDGES & FERRIE	.00 S EACH	.00	.00	.0	.00	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
STRUCTURES TOTALS				1861.0	10261.44	1.5	8.21	.0	.00	.00	4757.00	.0	.00	.00	.00	.00	.00	.00	.00
SNOW REMOVAL	383.50 OPER HR	1.44	16.39	390.0	2069.22	162.5	843.06	.0	.00	.00	3374.00	.0	.00	.00	.00	.00	.00	.00	.00
PREP SNOW CNTRL	.00 LB HRS	.00	.00	22.0	123.30	2.0	13.54	.0	.00	.00	55.00	.0	.00	.00	.00	.00	.00	.00	.00
SNOW AND ICE CONTROL TOTALS				412.0	2192.52	164.5	856.60	.0	.00	.00	3429.00	.0	.00	.00	.00	.00	.00	.00	.00
GUARD RAIL	1661.00 LIN FT	.51	4.30	854.0	4865.24	.0	.00	.0	.00	.00	2282.00	.0	.00	.00	.00	.00	.00	.00	.00
ROW FENCE	1000.00 LIN FT	.05	.36	52.0	276.48	.0	.00	.0	.00	.00	79.20	.0	.00	.00	.00	.00	.00	.00	.00
REST AREAS ETC.	185.00 EACH	7.98	61.46	1476.0	8533.00	.0	.00	.0	.00	.00	2836.20	.0	.00	.00	.00	.00	.00	.00	.00
WEIGH STATIONS	2.00 EACH	8.00	54.48	16.0	84.96	.0	.00	.0	.00	.00	24.00	.0	.00	.00	.00	.00	.00	.00	.00
SURWAY PUMPING	.00 EACH	.00	.00	.0	.00	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
DISASTER MAINT	.00 LB HRS	.00	.00	.0	.00	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
TRAFFIC SERVICES TOTALS				2398.0	13759.68	.0	.00	.0	.00	.00	5222.00	.0	.00	.00	.00	.00	.00	.00	.00
GENERAL DUTIES	1391.00 LB HRS	.00	.00	1383.0	7688.21	8.0	44.32	.0	.00	.00	2719.30	.0	.00	.00	.00	.00	.00	.00	.00
LOST TIME	110.00 LB HRS	.00	.00	110.0	604.98	.0	.00	.0	.00	.00	312.00	.0	.00	.00	.00	.00	.00	.00	.00
BILLBOARD REMOVA	10.00 L EACH	.00	.00	150.0	828.82	.0	.00	.0	.00	.00	238.40	.0	.00	.00	.00	.00	.00	.00	.00
GENERAL FUNCTIONS TOTALS				1643.0	9122.01	8.0	44.32	.0	.00	.00	3269.70	.0	.00	.00	.00	.00	.00	.00	.00
TRUCKS	952.00 LB HRS	.00	.00	940.0	5103.40	12.0	60.00	.0	.00	.00	1011.60	.0	.00	.00	.00	.00	.00	.00	.00
OTHER EQUIPMENT	1472.00 LB HRS	.00	.00	1472.0	8151.10	.0	.00	.0	.00	.00	1154.80	.0	.00	.00	.00	.00	.00	.00	.00
EQUIPMENT MAINTENANCE TOTALS				2412.0	13254.50	12.0	60.00	.0	.00	.00	2166.40	.0	.00	.00	.00	.00	.00	.00	.00
SIGN MAINTENANCE	60.00 LB HRS	.00	.00	60.0	344.40	.0	.00	.0	.00	.00	123.60	.0	.00	.00	.00	.00	.00	.00	.00
TRAFFIC SIGNING TOTALS				60.0	344.40	.0	.00	.0	.00	.00	123.60	.0	.00	.00	.00	.00	.00	.00	.00
SUPERVISOR	.00 LB HRS	.00	.00	.0	.00	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
OFFC. PERSONL., ETC	176.00 LB HRS	.00	.00	176.0	869.10	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
MISCELLANEOUS TOTALS				176.0	869.10	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
ERRORS	.00 LB HRS	.00	.00	.0	11.48	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
ERRONEOUS DATA TOTALS				.0	11.48	.0	.00	.0	.00	.00	.00	.0	.00	.00	.00	.00	.00	.00	.00
GRAND TOTALS				31688.3	176677.16	214.0	1121.41	32.0	233.60	70231.95									

Figure B-3. (Continued)

PAGE 1 OF 1

EQUIPMENT USAGE REPORT
DISTRICT NO. 7
MARCH 1976

EQUIPMENT	* CODE *	HOURS USED	* RATE PER HOUR *	COS
ASPHALT KETTLE	* 010 *	436.0	2.20	59.20
AIR COMPRESSORS TO 150 CU FT	* 070 *	136.0	3.50	76.00
AIR COMPRESSORS OVER 150 CU FT	* 072 *	112.0	5.00	60.00
ASPHALT DISTRIBUTOR	* 100 *	.0	3.00	.00
PULL TYPE GRADERS	* 171 *	60.0	.50	30.00
MOTOR GRADER TO 60 HORSEPOWER	* 172 *	452.0	3.00	1356.00
MOTOR GRADER OVER 60 H.P.	* 173 *	60.0	6.00	360.00
END LOADER TO 1 CUBIC YARD	* 221 *	16.0	3.80	60.80
END LOADER OVER 1 CU YD	* 222 *	155.0	8.50	1317.50
CRAWLER TYPE LOADER	* 223 *	.0	12.00	.00
FORCE FEED LOADER	* 224 *	.0	12.00	.00
MIXERS, CONCRETE AND BITUMINOUS	* 230 *	.0	3.50	.00
MUDJACKS	* 260 *	.0	8.00	.00
CRANES & ATTACHMENTS	* 311 *	184.0	6.80	1251.20
GRADALL	* 312 *	136.0	8.80	1196.80
ROLLERS, TANDEM	* 340 *	.0	8.30	.00
ROLLERS-PATCHING TYPE	* 341 *	.0	2.70	.00
SPRAYERS-PAINT	* 420 *	.0	1.20	.00
SPRAYERS-WEED	* 432 *	.0	2.00	.00
SPREADERS-ROCK, ASPHALT	* 440 *	.0	2.30	.00
STREET SWEEPER-SELF PROPULLED	* 460 *	.0	12.00	.00
TRACTOR WITH ATTACHMENTS	* 500 *	908.0	4.00	3632.00
SEWER CLEANERS	* 540 *	.0	2.00	.00
CATCH BASIN CLEANER	* 541 *	.0	10.00	.00
LANDSCAPING EQUIPMENT, ETC.	* 542 *	.0	1.20	.00
HYDRO SEEDER	* 820 *	.0	5.40	.00
BRUSH CHIPPERS	* 900 *	.0	3.00	.00
PICKUP AND CARRYALL TRUCKS	* 911 *	4917.5	1.90	343.25
1-1/2 TON TRUCKS	* 912 *	1149.5	3.00	448.50
1-1/2 TON TRUCKS, WINTER USAGE	* 912 *	8.0	5.00	40.00
2-1/2 TON TRUCKS	* 913 *	1861.0	3.00	583.00
2-1/2 TON TRUCKS, WINTER USAGE	* 913 *	35.0	5.00	175.00
4 TON TRUCKS	* 914 *	.0	4.00	.00
4 TON TRUCKS, WINTER USAGE	* 914 *	.0	7.00	.00
TANDEM AXLE TRUCK	* 915 *	52.0	8.00	416.00
TANDEM AXLE TRUCK, WINTER USAGE	* 915 *	46.5	11.80	548.70
4 WHEEL DRIVE TRUCKS	* 916 *	.0	22.00	.00
4 WHEEL DRIVE TRUCKS, WINTER USE	* 916 *	.0	27.00	.00
3 TON TRUCK	* 917 *	9253.5	4.00	37014.00
3 TON TRUCK, WINTER USAGE	* 917 *	352.0	7.00	2464.00
ROTARY SNOW PLOW, TRUCK TYPE	* 920 *	.0	40.00	.00
ERRORS	* 999 *	.0	.00	.00

TOTAL

20330.0

10231.95

Figure B-3. (Continued)

MONTHLY MAINTENANCE DIRECT COST SUMMARY
FOR MAJOR WORK FUNCTIONS
(DIRECT LABOR & EQUIP. USAGE COSTS ONLY)

DISTRICT NO. 7

MARCH 1976
PAGE NO. 1

TEAM SEC. NO.	LANE MILES	BITUMINOUS PATCHING (410) - TONS				PERMANENT PATCHING (411) - SQ. YDS.				RACK FILLING (412) - GALS.			
		UNITS ACCOMP.	UNIT COST LBR. & EQ.	DIRECT COST PER LANE MI.	% OF DIRECT COST	UNITS ACCOMP.	UNIT COST LBR. & EQ.	DIRECT COST PER LANE MI.	% OF DIRECT COST	UNITS ACCOMP.	UNIT COST LBR. & EQ.	DIRECT COST PER LANE MI.	% OF DIRECT COST
7XX *****		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
712	374.2	21.00	95.46	5.35	7.52	.00	873.28	2.33	3.27	1355.00	1.38	5.01	7.03
713	517.9	12.00	92.78	2.14	2.48	99.00	24.11	4.60	5.31	3613.50	1.92	13.43	15.45
722	303.5	16.50	61.18	3.32	3.37	.00	.00	.00	.00	120.00	1.74	.68	.70
723	294.3	13.00	31.08	1.42	1.63	.00	.00	.00	.00	.00	.00	.00	.00
731	336.8	104.50	21.32	6.61	9.00	.00	70.88	.21	.29	.00	.00	.00	.00
732	362.6	54.50	10.63	1.59	1.64	4.50	176.84	2.19	2.25	.00	.00	.00	.00
741	412.1	19.50	13.68	.64	.82	.00	.00	.00	.00	.00	.00	.00	.00
742	312.9	173.50	3.54	1.96	2.19	.00	.00	.00	.00	.00	.00	.00	.00
DIST. 7	2904.0	414.50	19.83	2.83	3.31	103.50	39.87	1.42	1.66	5081.50	1.77	3.11	3.64
TOT.													

Figure B-3. (Continued)

PAGE 1 OF 1

NON-PRODUCTIVE LABOR REPORT						
DISTRICT NO. 7						
PARC 1976						
JOB FUNCTION	* CODE *	TECHNICAL		NON-TECHNICAL		
		HOURS	COST	HOURS	COST	
NOT PAID						
TIME OFF	* 100 *	.0	.00	332.0	.00	
SUB-TOTAL		.0	.00	332.0	.00	
PAID						
VACATION	* 124 *	255.0	2412.54	480.0	26 0.59	
SICK LEAVE	* 125 *	95.5	698.49	1340.0	74 2.64	
HOLIDAYS	* 126 *	.0	.00	.0	.00	
PERSONAL OR OTHER LEAVE	* 127 *	16.0	117.68	464.0	25 2.64	
MILITARY LEAVE	* 150 *	.0	.00	.0	.00	
SUB-TOTAL		366.5	3228.71	2284.0	126 5.87	
TOTAL		366.5	3228.71	2616.0	126 5.87	

B-01

Figure B-3. (Continued)

PAGE 1 OF 1

OVERHEAD LABOR REPORT				
DISTRICT NO. 7				
MARCH 1976				
JOB FUNCTION	* CODE *	HOURS *	COST *	
TECH-NON TECH	*			
SUPERVISOR	* 498 *	.0		.00
OFFICE PERSONNEL, ETC	* 499 *	176.0		869.10
SUB-TOTAL		176.0		869.10
TECH-NON TECH	*			
CLERICAL, ENGINEERS-MAINT	* 990 *	2092.0		16527.83
SUB-TOTAL		2092.0		16527.83
TOTAL		2268.0		17396.93

Figure B-3. (Continued)

PAGE 1 OF 1

REPORT ON WORK PERFORMED IN DISTRICT
BY WORKERS FROM OTHER DISTRICTS FOR
DISTRICT NO. 7
MARCH 1976

WORKERS HOME DISTRICT	*	REGULAR HOURS	*	COST	*	OVERTIME HOURS	*	COST	*
01	*	.0		.00		.0		.00	
02	*	.0		.00		.0		.00	
03	*	.0		.00		.0		.00	
04	*	.0		.00		.0		.00	
05	*	.0		.00		.0		.00	
06	*	.0		.00		.0		.00	
07	*	.0		.00		.0		.00	
08	*	.0		.00		.0		.00	
09	*	.0		.00		.0		.00	
ERRORS	*	.0		.00		.0		.00	
TOTALS	*	.0		.00		.0		.00	

Figure B-4. Quarterly Cost Reports and Annual Cost Per Mile Reports

DISTRICT 7

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
DISTRICT MAINTENANCE COST REPORT
TOTAL COST 1ST QUARTER 1976

PAGE 1 OF 2

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000

* WORK FUNCTIONS	* LABOR COSTS	* MATERIALS AND SERVICES	* TOTAL	* PERCENTAGE
	* REGULAR * OVERTIME	* CONTRACT	* ACCRUED	
	* DIRECTED * PRORATED	* DIRECTED * PRORATED * MAINT.	* COSTS	
*****	*****	*****	*****	*****
BITUMINOUS SURFACE PATCH	410* 32701.51 .00 113.36	2346.64 .00 .00	35161.51	3.07
PERMANENT PATCHING	411* 8523.02 .00 41.83	4.50 69.00 .00	8638.35	.75
CRACK FILLING	412* 38522.37 .00 .00	438.56 14096.24 .00	53107.17	4.63
BUMP BURNING & JOINT CUTTING	413* 8962.00 .00 .00	176.50 .00 .00	9138.50	.80
MUDJACKING & UNDERSEALING	414* .00 .00 .00	.00 .00 .00	.00	.00
SEALING	415* 7821.74 .00 41.64	211.35 .00 .00	8074.73	.70
ROADWAY SURFACE TOTALS	* 96530.64 .00 196.82	3227.55 14165.24 .00	114120.26	9.95
SEALING	430* .00 .00 .00	.00 .00 .00	.00	.00
PATCHING - HAND METHOD	431* 20427.26 .00 .00	5044.10 .00 .00	25471.36	2.22
PATCHING - MACHINE METHOD	432* 825.06 .00 .00	63.88 .00 .00	888.94	.08
CUTTING HIGH SHOULDERS	433* 619.36 .00 .00	.00 .00 .00	619.36	.05
BLADING AND DRAGGING	434* 12971.40 .00 .00	105.52 .00 .00	13076.92	1.14
FILLING EDGE JOINTS	435* 337.04 .00 .00	.00 .00 .00	337.04	.03
SHOULDERS & SIDE APPRO. TOTALS	* 35180.12 .00 .00	5213.50 .00 .00	40393.62	3.52
REPAIRING SLOPES	440* 638.24 .00 .00	.00 .00 .00	638.24	.06
DITCHES - HAND METHOD	441* 10105.83 .00 19.86	.00 .00 .00	10125.69	.88
DITCHES - MACHINE METHOD	442* 31233.56 .00 .00	.00 .00 .00	31233.56	2.73
CLEAN. & REPAIR. SEWERS, ETC	443* 14550.85 .00 .00	288.10 850.75 .00	15689.70	1.37
WALLS, CRIBBING, & RIPRAP	444* 4370.00 .00 .00	.00 .00 .00	4370.00	.38
CARE & REM. OF TREES & PLANTS	445* 60330.47 .00 6.73	.00 .00 .00	60337.20	5.27
MOWING - HAND METHOD	446* 41.24 .00 .00	.00 .00 .00	41.24	.00
MOWING - MACHINE METHOD	447* .00 .00 .00	.00 .00 .00	.00	.00
RESEEDING & RESODDING	448* 140.44 .00 .00	.00 54.00 .00	194.44	.02
WEED SPRAYING	449* 2611.29 .00 .00	.00 3400.80 .00	6012.09	.52
CLEANING DIRT & DEBRIS - HAND	450* 81198.11 .00 188.07	.00 .00 .00	81386.18	7.10
CLEANING DIRT & DEBRIS - EQUIP.	451* 441.80 .00 85.52	.00 .00 .00	527.32	.05
ROADSIDE & DRAINAGE TOTALS	* 205661.83 .00 300.18	288.10 4305.55 .00	210555.66	18.38
REPAIRING & MAINTAINING BRIDGES	460* 17352.86 .00 40.28	339.70 1008.70 .00	18742.54	1.64
CLEANING BRIDGES	461* 5709.04 .00 .00	.00 .00 .00	5709.04	.50
BRIDGES & FERRIES	462* .00 .00 .00	.00 .00 .00	.00	.00
BRIDGE STRUCTURES TOTALS	* 23062.90 .00 40.28	339.70 1008.70 .00	24451.58	2.14
SNOW REMOVAL	465* 49800.57 .00 27484.55	69.53 91948.04 .00	169302.73	14.78
PREPARATION FOR SNOW CONTROL	466* 8193.18 .00 1428.44	.00 .00 .00	9621.62	.84
SNOW & ICE CONTROL TOTALS	* 57993.75 .00 28913.02	69.53 91948.04 .00	178924.35	15.62
GUARD RAILS MAINTENANCE	470* 6139.71 .00 .00	.00 .00 .00	6139.71	.54
R.O.W. FENCE MAINTENANCE	471* 458.84 .00 .00	.00 107.29 .00	566.13	.05
MAINT. REST AREAS & HIST. MARKERS	472* 28480.53 .00 650.94	306.08 322.69 .00	29760.24	2.60
WEIGH STATION MAINTENANCE	473* 84.96 .00 .00	2242.22 13.54 .00	2340.72	.20
SURWAY PUMPING	474* 25.76 .00 .00	22.38 .00 .00	48.14	.00
DISASTER MAINTENANCE	475* 51.68 .00 .00	.00 .00 .00	51.68	.00
TRAFFIC SERVICES TOTALS	* 35241.48 .00 650.94	2570.68 443.52 .00	38906.62	3.39

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Figure B-4. (Continued)

DISTRICT 7

 STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
 DISTRICT MAINTENANCE COST REPORT
 TOTAL COST 1ST QUARTER 1976

PAGE 2 OF 2

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* * * * *****	* * * * *****	* * * * *****				* * * * *****			* * * * *****	* * * * *****
		LABOR COSTS				MATERIALS AND SERVICES				
		REGULAR	OVERTIME	DIRECTED	PRORATED	CONTRACT	PRORATED	MAINT.		
GENERAL DUTIES	480*	28346.50	93.12	368.47	112.36	.00	.00	28920.45	2.52	
LOST TIME	481*	3188.16	27.40	.00	.00	.00	.00	3215.56	.28	
BILLBOARD REMOVAL	482*	2244.48	.00	.00	.00	.00	.00	2244.48	.20	
MAINTENANCE - GENRL FUNCTION TOTALS*		33779.14	120.52	368.47	112.36	.00	.00	34380.49	3.00	
TRUCKS	490*	26155.24	.00	93.24	10.82	9569.69	.00	35828.99	3.13	
OTHER EQUIPMENT	491*	23002.88	49.00	108.56	.00	.00	.00	23160.44	2.02	
EQUIPMENT MAINTENANCE TOTALS	*	49158.12	49.00	201.80	10.82	9569.69	.00	58989.43	5.15	
SIGN MAINTENANCE	495*	703.24	.00	.00	.00	.00	.00	703.24	.06	
SUPERVISOR	498*	.00	.00	.00	.00	.00	.00	.00	.00	
OFFICE PERSONNEL, STOREKEEPER ETC.	499*	.00	2425.76	.00	.00	.00	.00	2425.76	.21	
MISCELLANEOUS TOTALS	*	.00	2425.76	.00	.00	.00	.00	2425.76	.21	
GAS & OIL	*	.00	.00	.00	19.90	71861.39	.00	71881.29	6.27	
CITY MAINTENANCE BY AGREEMENT	*	.00	.00	.00	.00	.00	140.64	140.64	.01	
TRAVEL	*	.00	.00	.00	.00	1163.19	.00	1163.19	.10	
TELECOMMUNICATION	*	.00	.00	.00	.00	18734.97	.00	18734.97	1.64	
LABOR CODE ERRORS-MISC MATL-SERV CONT. SERV.	000*	.00	5302.65	.00	160.66	98456.26	593.41	104512.98	9.12	
ALL WORK FUNCTIONS TOTALS	*	537311.22	7897.93	30671.53	12012.80	311656.55	734.05	900284.08	78.56	
TIME OFF WITH PAY-OTHER 124-127 & 150*		65615.70	16077.73					81693.43	7.13	
DISTRICT/REGION	990*	.00	53916.33					53916.33	4.71	
BUREAU	990*	.00	10053.92					10053.92	.88	
ADMINISTRATION & SUPERVISION TOTALS*		.00	63970.25					63970.25	5.59	
REGULAR LABOR COSTS TOTALS	*	602926.92	87945.91					.00	.00	
EQUIPMENT PURCHASES								25292.60	2.21	
MAINTENANCE CONTRIBUTION TO S.E.R. & SOCIAL SECURITY								74614.23	6.51	
TOTAL ACCRUED COSTS								1145854.59	100.00	
CREDITS ACCRUING TO STATE										
TOTAL ACTUAL COST TO STATE								1145854.59		

B-2C

Figure B-4. (Continued)
 STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
 SUBSECTION COST PER LANE MILE REPORT
 YEAR OF 1975.

DISTRICT	SECTION	SUBSECTION	ROADWAY CLASS	SUBSECTION CATEGORY	SPECIAL BR & RD SUBSECTION TYPE CODE	LANE MILES-RD LINEAL FEET-BR	COST P R LANE MIL -RD LINEAL FO T-BR
7	712	128	P	N		5.3	\$ 523 22
7	712	129	P	N		20.5	\$ 1,115 93
7	712	140	P	N		17.1	\$ 1,089 28
7	712	185	P	N		39.3	\$ 1,761 12
7	712	186	P	N		17.7	\$ 958 18
7	712	370	P	N		13.8	\$ 883 33
7	712	400	P	N		52.0	\$ 1,801 23
7	712	510	P	N		55.5	\$ 1,536 86
7	712	570	I	N		36.1	\$ 818 76
7	712	700	I	N		104.3	\$ 1,662 50
7	712	800	I	B	0	105.0	\$ 0 04
7	712	801	I	B	2	113.0	\$ 0 04
7	712	802	I	B	9	1,095.0	\$ 0 00
7	712	803	I	B	8	475.0	\$ 0 00
7	712	820	P	O		2.3	\$ 322 51
7	712	821	P	O		1.7	\$ 323 30
7	712	951	P	U		1.8	\$ 334 98
7	712	952	P	U		1.9	\$ 323 00
7	712	953	P	U		2.8	\$ 322 22
7	712	954	P	U		2.1	\$ 322 35
7	713	128	P	N		1.9	\$ 1,242 75
7	713	130	P	N		41.5	\$ 1,678 17
7	713	320	P	N		7.4	\$ 963 07
7	713	330	P	N		44.7	\$ 1,624 58
7	713	331	P	N		54.6	\$ 834 67
7	713	370	P	N		17.4	\$ 1,091 07
7	713	371	P	N		9.0	\$ 952 10
7	713	400	P	N		36.4	\$ 1,176 14
7	713	401	P	N		10.2	\$ 1,538 15
7	713	450	P	N		17.0	\$ 1,271 07
7	713	451	P	N		25.6	\$ 1,104 15
7	713	490	P	N		25.3	\$ 1,182 00
7	713	570	I	N		86.9	\$ 1,523 11
7	713	700	I	N		78.5	\$ 2,570 15
7	713	800	I	B	4	156.0	\$ 5 5
7	713	801	I	B	5	422.0	\$ 7 8
7	713	802	I	B	6	121.0	\$ 6 9
7	713	820	P	O		2.3	\$ 313 1
7	713	821	P	O		.1	\$ 5,451 0
7	713	822	P	O		2.3	\$ 313 0
7	713	823	P	O		3.0	\$ 313 9
7	713	824	P	O		1.7	\$ 2,710 7
7	713	825	P	O		1.6	\$ 314 4
7	713	850	P	O		.2	\$ 334 0
7	713	908	P	U		9.9	\$ 1,038 9
7	713	909	P	U		15.1	\$ 833 5
7	713	922	P	U		1.0	\$ 316 4
7	713	923	P	U		1.2	\$ 827 0
7	713	925	P	U		2.5	\$ 352 0
7	713	926	P	U		20.6	\$ 822 7

Figure B-4. (Continued)

LCS-R043

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
ANNUAL COST PER LANE MILE REPORT
SPECIAL ROADWAY SUBSECTIONS - MAIN LINE SURFACE COSTS ONLY
YEAR OF 1975

PAGE 01

SURFACE TYPE CODE	NO. SUBSECTIONS	TOTAL LANE MILES	TOTAL COST	COST PER LANE MILE
0	4	349.3	\$ 23,875.23	\$ 68.35
1	6	390.5	\$ 51,519.93	\$ 131.93
				\$ 0.00
3	5	383.1	\$ 69,512.78	\$ 181.44
4	2	92.0	\$ 26,069.43	\$ 283.36
5	1	132.0	\$ 59,000.98	\$ 446.97
6	3	58.4	\$ 3,280.39	\$ 56.17
				\$ 0.00
8	3	81.7	\$ 3,207.21	\$ 39.25
9	1	13.3	\$ 389.44	\$ 29.28

Figure B-4. (Continued)

LCS-R044

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
ANNUAL COST PER LINEAL FT. REPORT

PAGE 01

SPECIAL BRIDGES
YEAR OF 1975

BRIDGE TYPE CODE	NO SUBSECTIONS	TOTAL LINEAL FEET	TOTAL COST	COST PER LINEAL FOOT
INTERSTATE AND EXPRESSWAY				
0	3	850.0	\$ 450.79	\$ 0.53
1	2	259.0	\$ 50.36	\$ 0.19
2	10	3,697.0	\$ 386.20	\$ 0.10
3	9	5,705.0	\$ 59,493.68	\$ 10.42
4	11	2,881.0	\$ 1,359.73	\$ 0.47
5	12	3,283.0	\$ 7,649.38	\$ 0.32
6	10	3,185.0	\$ 2,444.36	\$ 0.76
7	5	900.0	\$ 732.82	\$ 0.81
8	9	4,224.0	\$ 3,655.73	\$ 0.86
9	6	10,504.0	\$ 9,901.19	\$ 0.94
J	4	23,839.0	\$ 12,299.90	\$ 0.51
PRIMARY				
0	9	993.0	\$ 341.02	\$ 0.34
1	8	1,463.0	\$ 5,989.31	\$ 0.09
2	7	2,688.0	\$ 1,948.63	\$ 0.72
3	11	2,696.0	\$ 2,559.02	\$ 0.94
4	7	1,757.0	\$ 147.33	\$ 0.08
5	10	3,250.0	\$ 878.00	\$ 0.27
6	7	1,661.0	\$ 22.10	\$ 0.01
7	1	270.0	\$ 12,885.63	\$ 4.72
8	10	4,309.0	\$ 7,269.00	\$ 0.68
9	8	13,254.0	\$ 21,931.94	\$ 0.65
J	21	25,445.0	\$ 1,413,140.21	\$ 5.53

Figure B-4. (Continued)

LCS-R045

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
ANNUAL COST PER LANE MILE REPORT
BY SYSTEMS
YEAR OF 1975

PAGE 01

	DISTRICT	LANE MILES	TOTAL COST	COST PER LANE MILE
REGULAR SYSTEM				
	1	3,060.3	\$ 6,730,227.94	\$ 2,199.20
	2	3,886.2	\$ 6,147,253.09	\$ 1,581.81
	3	3,483.6	\$ 5,102,779.41	\$ 1,464.80
	4	2,620.7	\$ 4,327,023.31	\$ 1,651.09
	5	3,730.2	\$ 5,194,946.10	\$ 1,392.67
	6	3,678.0	\$ 5,318,415.85	\$ 1,446.00
	7	2,240.1	\$ 3,344,872.46	\$ 1,493.17
	8	3,115.1	\$ 5,178,696.70	\$ 1,662.44
	9	2,136.3	\$ 3,488,799.57	\$ 1,633.10
	0	3,693.0	\$ 7,992,654.20	\$ 2,137.00
	TOTAL	31,648.5	\$ 52,735,668.63	\$ 1,666.29
INTERSTATE SYSTEM				
	1	400.5	\$ 1,288,933.42	\$ 3,218.31
	2	471.5	\$ 783,698.48	\$ 1,672.74
	3	921.9	\$ 1,600,478.98	\$ 1,736.06
	4	345.2	\$ 711,334.98	\$ 2,060.64
	5	803.9	\$ 1,145,606.66	\$ 1,425.06
	6	401.8	\$ 657,018.12	\$ 1,635.18
	7	681.6	\$ 873,355.66	\$ 1,281.33
	8	571.7	\$ 1,001,857.41	\$ 1,752.41
	9	396.5	\$ 614,695.04	\$ 1,550.30
	TOTAL	4,994.6	\$ 8,681,978.75	\$ 1,738.27
URBAN EXPRESSWAY SYSTEM				
	1	944.6	\$ 9,180,397.50	\$ 9,718.82
	TOTAL	944.6	\$ 9,180,397.50	\$ 9,718.82

ERROR LINE COSTS FROM THE COST REPORT ARE INCLUDED

APPENDIX C

LOUISIANA DEPARTMENT OF HIGHWAYS

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,764,000 residents of Louisiana operate 2,057,000 motor vehicles on 52,845 miles of highways of which 16,500 miles are under state control. The state occupies 48,523 square miles from 5 feet below sea level to 535 feet above sea level. Mean minimum and maximum temperatures are 36 and 94°F with average annual moisture from 48 to 64 inches.

The Louisiana Department of Highways has a 86,000,000 dollar maintenance budget for fiscal year 1975-1976. This budget will be used by its 9 districts to maintain 36,225 lane miles (16,554 center line miles) which consist of 515 Interstate highway lane miles, 4,283 primary highway lane miles, 4,275 secondary highway lane miles, 6,988 Farm-to-Market lane miles and 492 frontage road lane miles.

Nine districts comprise the Louisiana Department of Highways. Each district is divided into parish gangs resulting in a total of 62 parish gangs state wide. Sixty-four parishes exist in Louisiana. Two to 3 foremen operate crews within each parish gang. State wide crews for bridge repair and accident damage crews exist. District wide crews are often involved in maintenance betterment activities and activities such as seal coats, placing hot mix, structures repair, mud jacking and certain traffic service activities. Three thousand seven hundred sixteen (3,716) maintenance employees in the state are

distributed as follows: central office - 184, district administrative staff - 324, district wide crews - 894, river crossing staffs - 542, parish gangs - 1,772. Typically parish gangs have about 60 percent of their employees as equipment operators and 40 percent laborers.

Superintendents are in responsible charge of the parish gangs with assistance from the crew leaders or foreman. Superintendents report to maintenance specialists at the district level. Maintenance specialists report to the District Maintenance Engineer and the Assistant District Engineer for Maintenance who in turn report to the District Engineer. The administration of the maintenance program by the Director of the Louisiana Department of Highways is performed at the central office level by the Chief Construction and Maintenance Engineer.

The basic maintenance recording and reporting system was implemented in 1969. A single recording system is being utilized. These data are utilized to produce separate maintenance management and fiscal reports. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Louisiana Department of Highway Form LDH-03-41-4058 "Daily Work Report" and LDH-03-15-4125 "Biweekly Activity Report" are utilized to collect maintenance activity information (Figures C-1 and C-2). The Daily Work Report is filled out daily by the foreman. The Biweekly Activity report is filled out by the parish gang clerk based on information obtained from the Daily Work Reports. The

types of information obtained on this form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information.

1. District. A two digit code is utilized to identify the district. The entry can either be for the district or section number of the gang foreman responsible for preparing the daily report.
2. Parish Gang. A three digit code is utilized to identify the gang whose foreman is preparing the daily report.
3. Parish. A two digit numerical code from 01 to 64 is utilized to identify the parish in which the work was performed. If the function is not chargeable to a single parish, the appropriate Districts (90 thru 98) or State-wide (99) Parish Code is used.
4. System. Entries for system codes are utilized to identify and determine the distribution of expenditures into the following categories:
 - 1.- Interstate
 - 2 - Primary
 - 3 - Secondary
 - 4 - Farm-to-Market

- 5 - Buildings and Grounds
- 6 - Overhead and Undistributed Expense
- 7 - Parish Road
- 8 - City Street and
- 9 - Parking Lot, Driveway, etc.

5. Structures. A single digit code (1 through 5) identifies the type of structure on which the work is performed. The codes are shown below.

- | | |
|-------------|---------------------|
| 1. Timber | 4. Elevated Roadway |
| 2. Concrete | 5. Pontoon Bridge |
| 3. Steel | |

In addition a ten digit numerical code is utilized to designate a particular structure. This code is composed of a 5 digit control section number followed by a five digit structure identifying code.

6. Control Unit. A five digit numeric code is utilized to identify a specific segment of highway on which maintenance was performed. The control unit is utilized only with activities involving surface and shoulder maintenance.

A seven digit project number can be assigned to a specific maintenance project. This unique number which consists of the control unit and a two digit project number is recorded in the space titled "Project Number."

7. Milepost. Milepost designations are not utilized to designate maintenance activity location.

Information is not recorded which indicates the lane in which a maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed

on the pavement shoulder, roadside, traffic services, etc.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Figure C-3). One hundred twenty-four function codes are presently utilized and are divided into the following major groups:

1. Bituminous Surface
2. Concrete Surface
3. Gravel or Shell Surface
4. Shoulder Maintenance
5. Roadside and Drainage
6. Structure Maintenance
7. Traffic Services
8. River Crossing Operation
9. Unusual or Disaster Maintenance
10. State Force Construction
11. Maintenance Overhead
12. Service Centers and Clearing Accounts and
13. Administration

A written description of the work is also required for those codes whose last digit is 9. For example, other bituminous maintenance, other concrete surface maintenance, etc.

It should be noted that special function codes exist for bituminous, portland cement concrete and unsurfaced roadways. Designation of the maintenance function on the reporting form is under the heading "Function Number."

Manpower

Manpower utilization for a particular function is recorded by the foreman for each individual. The employee's name is given along with the identifying employee number. The regular hours worked and the over-time worked is recorded to the nearest half-hour. This time is assigned to a specific maintenance function and foreman as described above. Hours taken for annual leave, sick leave, compensatory time off, etc. are recorded on the Daily Work Report and the Biweekly Activity Report.

The recording system allows men borrowed from other gangs to be properly charged. Miscellaneous and overhead labor charges can be properly assigned by the use of function codes.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment number. A six digit numeric code is utilized. The first three digits refer to an equipment class and the last three digits refer to a particular item of equipment within that class. Equipment usage is reported either in terms of miles or hours. Miles is the reporting unit for smaller pieces of equipment.

All equipment used on a job site must be charged to a function. For example, if a gradall was used only two hours at a job site, but remained there all day, it is charged out as being used 8 hours. Equipment hours or mileage including travel to the job site, materials haul, etc. must be charged to the proper maintenance function.

Materials

Materials utilized for a particular function are recorded daily. A description of each type of material used such as asphalt cement, base material, hot mix, etc. and the location from which the material was obtained is noted on the form. The amount of material and the unit of measure for each material is also recorded. Stockpile and materials eight digit codes are recorded on the Biweekly Activity Report.

Accomplishments

Work performance is reported for most of the maintenance functions involving maintenance activities performed on the roadway. Accomplishments are usually measured in quantities of weight or volume materials, lengths and area of surfaces and in numbers of items. The units of measure used for accomplishments are shown for each function code on Figure C-3.

As mentioned above the Biweekly Activity Report is filled out daily by the parish clerk based on input from the foreman's Daily Work Report. A separate Biweekly Activity Report must be filled out for such maintenance function. Daily labor, equipment and material entries are totaled over a two week period. These bi-weekly totals are reported for data processing purposes.

COLLECTION AND PROCESSING OF RECORDED DATA

The Daily Work Report is filled out daily by the foreman of the individual crew or gang for each employee in the gang. The parish clerk transfers these data to the Biweekly Activity Report on a daily basis. Totals are obtained biweekly on Biweekly Activity

Reports by the parish clerk. These forms are then transmitted biweekly to the district office for key punching and transmission through a remote terminal to the central office for processing and reporting. Errors recognized by the central computer are referred to the district for correction.

It is estimated that about four-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Sixty-two parish clerks require approximately two hours per day to prepare the Biweekly Activity Reports at a cost of approximately \$115,000 per year. Foreman costs associated with data recording amounts to about \$80,000 annually. District lane charges are probably of the order of \$20,000 annually for key punching and data transmission. Central office data processing charges are \$100,000 annually which includes programming and systems design.

A computerized auditing procedure is utilized to identify certain errors such as employee name and number, equipment numbers, accomplishment units, etc. In addition if certain productivity or accomplishments are reported outside a predetermined range of variance (say $\pm 20\%$ of the work standard) an error message or exception note is returned to the district. This auditing procedure, in addition to that performed at the parish level, improves the accuracy of the reported data.

REPORTS

Several reports are produced for use by management. These reports include a maintenance performance report, a quantity report, a

productivity report and an accounting report. The Performance Report is a quarterly report for each manager which emphasizes amounts of work accomplished. The productivity analysis report is an annual summary organized to help review performance on individual work functions. This report shows the number of organizations which achieve standard productivity and those which do not achieve standard productivity. The quantity analysis report is produced annually for evaluation of the amounts of work performed. This report was designed to verify and update standards and to initiate further research where needed. A brief discussion is presented below indicating the types of data contained on these reports.

Maintenance Performance Report. The Maintenance Performance Report is issued quarterly about one month after the end of the reporting period (Figure C-4). The report list planned and actual accomplishment quantities, planned and actual hours, planned and actual total, planned and actual unit cost and planned and actual man hour rates per quantity of material utilized for each maintenance function. The percent of actual to planned quantities are reported for labor, total cost, etc. This report can be furnished for individual districts as well as for statewide totals.

Productivity Analysis Report. This report is produced annually and displays material quantities, labor hours, total costs, unit costs and productivity rates together with the percent of costs for labor, equipment, and material functions (Figure C-5). The report is prepared such that individual maintenance crews or parish gangs can be compared for a particular maintenance function.

Actual and planned quantities are displayed for parish gangs. Cost distribution of work is also monitored, i.e. labor, equipment, material, and percent.

Quantity Analysis Report. This report is produced annually and illustrates the annual quantity of material placed by maintenance function on interstate, primary, secondary and farm-to-market roads. This report is prepared to assist in the revision of standards.

Maintenance planning reports are prepared. These reports become the basis of the planned quantities reported on the maintenance performance report and productivity analysis report. Planning quantities are based on historical quantities required to perform the various maintenance activities. A preliminary budget report is prepared for the district and parish gang by the central office (Figure C-6). This budget is reviewed by the district staff. A field worksheet can and has been utilized to supply field input to develop the budget information. This form is shown in Figure C-7.

As described above, monthly, quarterly, and annual reports are produced depending on the use of the reports. Reports are returned to the district approximately one month after the end of the reporting period.

Reports are utilized for fiscal control, for monitoring program execution, for allocation of manpower and equipment and for budget preparation and planned work units. The majority of the reports are utilized at the central office and district office level.

Maintenance function activities that appear contrary to planned budgets due to productivity problems or poor planning must be located

by a detailed review of maintenance reports. The auditing procedure described above does, however, identify productivity rates in excess of or below certain standard levels. Other types of exception reports are presently not a part of the reporting system, but are being developed.

OTHER ITEMS

The Louisiana Department of Highways is satisfied with the reliability of the existing system although improvements can be made. It is estimated that data input is 90 percent or more reliable.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises. The central office continually works with the districts through district engineering meetings and other meetings to assess the usefulness of the recorded and reported information.

A maintenance standard committee exists which is responsible for revision of the work standards. Meetings are held quarterly.

Changes in the maintenance management system are directed by the central office with changes usually occurring at the beginning of the fiscal year.

Data collected since 1967 have been stored on tapes and therefore can be retained for an extended period of time.

References

Crawford, F. E. and M. Jackson, "Implementing Findings from the Louisiana Maintenance Research Project," Highway Research Board, Special Report 100, 1968.

DAILY WORK REPORT

[illegible]

11-15

C-13

Figure C-3. Function Codes

Louisiana Department of Highways
FUNCTION CODES FOR MAINTENANCE WORK REPORTING

July 1, 1975

SURFACE MAINTENANCE										
BITUMINOUS SURFACE	CONCRETE SURFACE	GRAVEL OR SHELL SURFACE	SHOULDER MAINTENANCE	ROADSIDE AND DRAINAGE	STRUCTURE MAINTENANCE (OVER 20' SPAN)	TRAFFIC SERVICE	RIVER CROSSING OPERATION	UNUSUAL OR DISASTER MAINTENANCE	STATE FORCE CONSTRUCTION	MISCELLANEOUS
411* Surface Tr. Patching (*C. Y. Aggr.)	421* Patching Surface (*C. Y. Aggr.)	431* Patching Surface (*C. Y. Aggr.)	441* Patching Non-Paved Shoulders (*C. Y. Material)	461 Erosion Control and Repair	481* Painting Structures (*Gal. Paint)	511 Snow & Ice Control	561 Operation of Ferries	601 Storm Damage	621 Earthwork & Grading	M. TENANCE OVERHEAD 651 Field Maintenance Supervision 652 Material Handling & Stockpiling 654 Sales Tax 655 Field Maintenance Standby Time 660 Maintenance Units 661 Small Tools, Minor Equipment & Protective Clothing 662 Testing of Maintenance Materials 663 Radio Communications System 664 Minor Electrical Maintenance 665 Training 666 Travel (Change in Work Location) 680 City Streets & Traffic Signals 690 Severance Tax 691 Detached Services 692 Other Maintenance Overhead Functions
412* Premix Patching (*Tons Premix)	422* Premix Patching (*Tons Premix)	432* Reshaping Surface (*Miles Bladed)	442* Reshaping Non-Paved Shoulders (*Miles Bladed)	462 Clean and Rep. Drain Structures	482 Foundation Repair	531* (Sect. 45 Only) Pavement Striping (*Miles Painted)	563 Operation of Bridges	602 Accident Damage	622 Drainage	
413* Patching Base (*C. Y. Material)	425* Joint Repair (*100 L. F. Joint)	433* Restoring Surface (*C. Y. Material)	443* Restoring Non-Paved Shoulders (*C. Y. Material)	463* Clean and Reshape Ditches (*Miles Cleaned)	483 Structural Repair	532* Electric Signals (*Install. Serv.)	564 Operation Tunnels		623 Base & Surface	
415* Seal Coat (*Miles Sealed)	429 Other Conc. Surface Maintenance	439 Other Gravel or Shell Maintenance	451* Surface Tr. Patching Shoulders (*C. Y. Aggr.)	464* Machining Ditches (*Miles Machined)	484 Deck and Rail Repair	533* Signs/Guide Posts, & Delineators (*Install. Serv.)			624 Shoulder Improvement	
416* Premix Leveling (*Tons Premix)			452* Premix Patching Shoulders (*Tons Premix)	470* Mowing (*Acres Mowed)	485 Repair & Maintain Mechanism for Movable Spans	534 Guard Rails			625 Roadside Development	S. ICE CENTERS & CLEARING ACCOUNTS 70 Automotive, Road & Marine Equipment 70 Office Furniture & Equipment 70 Shop Equipment 70 Miscellaneous Equipment 70 Land & Improvements 70 Buildings & Improvements 72 Operating & Maintaining Leased or Rented Auto., Rd. & Marine Equipment 73 Equipment Repair Shop Overhead 73 Fabr. Auto., Rd. & Marine Equipment 73 Repr. or Serv. Auto., Rd. & Mar. Equip. 73 Sales Tax on Purchase of Equipment 73 Service Charges on Parts Contracts for Automotive, Rd. & Marine Equip. 74 Small Tools Rental 74 Equip. Serv. & Insps. (Sect. 45 only) 76 Inventory 76 Inventory - Finished Signs (Sect. 45 only) 77 Fabr. & Recond. Signs (Sect. 45 only) 77 Reclaiming Aluminum (Sect. 45 only) 77 Sign Shop Overhead (Sect. 45 only) 77 Fabr. Signs (Dist. & Sect. other than Sect. 45) 77 Transf. of Fabr. Signs to Inventory (Credit) 77 Transf. to Dist., Sect., Cont. Unit or Proj., etc. (Credit)
417* Spot Surface Replacement (*Tons Premix)			455* Slurry Seal (*Miles Sealed)	471 Cutting Brush	486 Channel Repair and Protection	535 (Sect. 45 Only) Recondition Signal Parts			626 Structures (Over 20' Span)	
418* Slurry Seal (*Miles Sealed)			459 Other Shoulder Maintenance	472 Landscape Maintenance	487 Tunnel Repair	538 Hand Striping			627* Sign Installations (*Install. Serv.)	
419 Other Bit. Surface Maintenance				473* Litter Cleaning Roadside (*C. Y. Hauled)	488 Ferry Ramp Repair	540* ReflectORIZED Pavement Markers (*Markers Plcd)			628* Signal Installations (*Install. Serv.)	
				474* Servicing Litter Barrels (*Barrels Serv.)	489 Bailey Bridges	541* Hot Plastic Marking (*Lbs. Material)			629 Traffic Service Betterments	A. NISTRATION 811 Annual Leave Taken 812 Sick Leave Taken 813 Compensatory Leave Taken 814 Other Leave Taken 820 Admin. & Gen. Office Overhead 823 Compensatory Leave Paid 824 Annual Leave Paid (Terminal Leave Only) 883 Custodial Services 884 Grounds Maintenance 885 Building Maintenance 910 Administrative Engineering
				476* Herbicide Application (*Acres Sprayed)	490 Inspection of Structures and Bridges	555 Operation of Pit Scales			630 (Sect. 45 Only) Signal Fabrication	
				479 Other Roadside & Drainage Maintenance	491 Payment to Others for Maintaining Ferries & Bridges	557 Operation of Rest Areas			631 Minor Betterments	
					499 Other Structure Maintenance	559 Other Traffic Services			632* Hot Mix in Place (*Tons Placed) 633* Plant Mix Seal (*Tons Placed)	

Report Work Accomplishment With These Work Functions

Figure C-4. Maintenance performance report.

Fiscal Year 1967-68
Period From 07.01.67 To 09.30.67

District No 08

Parish NATCHITOCHES

Parish Supt. Gang No. 085

FUNCTION		ACCOMPLISHMENT UNIT	QUANTITY			LABOR HOURS			TOTAL COST			UNIT COST			RATE—MM G		
NAME	NO		PLAN	ACTUAL	%	PLAN	ACTUAL	%	PLAN	ACTUAL	%	PLAN	ACTUAL	%	PLAN	ACTUAL	%
BITUMINOUS SURFACE																	
SURFACE TREAT PATCH	411	CY AGGR	1212	124	10	2424	1607	66	16968	5792	34	1400	4671334		20	130648	
PREMIX PATCHING	412	TONS MIX	1084	525	48	3252	1847	57	21680	9283	43	2000	1770.88		30	35117	
PATCHING BASE	413	CY MAT	509	434	85	1019	688	68	3565	2152	61	700	497.71		50	15.79	
CRACK REPAIR	414	GAL FILL										180			5		
SEAL COAT	415	50 YD		54068			344			4792			9				
CONCRETE SURFACE																	
PATCHING SURFACE	421	CY CONC	89			443			2655			3000			50		
PREMIX PATCHING	422	TONS MIX	50			150			1000			2000			30		
PATCHING BASE	423	CY MAT	90			180	7	4	630	20	3	700			20		
CRACK REPAIR	424	GAL FILL										180			5		
JOINT REPAIR	425	100 LN FT										270			9		
GRAVEL-SHELL SURFACE																	
PATCHING SURFACE	431	CY AGGR	18	79	439	12	117	975	105	564	537	600	713119		7	15212	
RESHAPE SURFACE	432	ROAD MI	219	72	33	350	220	63	1313	974	74	600	1353226		10	31191	
SHOULDER + APPROACH																	
PATCH NON-PAV SHOUL	441	CY MAT	175	373	213	175	667	381	628	2246	358	358	602168		10	15174	
RESHAPE NON-PAV SHOUL	442	SHOUL MI	473	97	21	710	444	63	3607	1946	54	762	2007263		15	46305	
PATCHING BASE	443	CY MAT					6			13							
ROADSIDE + DRAINAGE																	
CLEAN-REP DRAIN STR	462						482		1059								
CLEAN-RESHAPE DITCH	463	DITCH MI	2			360	120	33	1080	297	27	60000			000		
MOWING	470	ACRES	7294	2996	41	7294	3783	52	25529	12670	50	350	424121		10	13126	
LITTER CLEANING	473	LOADS	53	15	28	1066	322	30	2399	715	30	4500	4764106		200	215107	
HEAVY LITTER BARRELS	474	BARRELS		403			219			569			191			5	
TRAFFIC SERVICE																	
SIGN MAINTENANCE	533						240			464							
DISASTER MAINT																	
ACCIDENT DAMAGE	602						132			375							
MAINT OVERHEAD																	
OTHER GENERAL FUNCT	699						2638			6369							
TOTAL PLANNED MAINT						17435	14083	81	81159	50334	62						
STATE FORCE CONSTR							4286			29891							
LEAVE							4496			8933							
ADMIN AND OVERHEAD							2984			6669							
TOTAL STATE HIGHWAY							25769			95826							
DEF SYSTEM WORK							84			417							
TOTAL							25853			96243							

Figure C-5. Productivity analysis.

Fiscal Year 1967-68.
Period From 06-28-67 To 07-25-67

District No. 08		Function SURFACE TREAT PATCH			Function No. 411		Accomplishment CY AGGR				
PARISH & PERMANENT LOCATION	GANG NO.	QUANTITY	LAYS IN HOURLY	TOTAL COST	PERCENT OF COST				UNIT COST	RATE PER H. D.	
					LABOR	EQUIP.	MAT.	CONTR.			
ALEXANDRIA	210	9	54	220	44	22	34		2443	60	
ALEXANDRIA	211	78	736	2994	48	26	26		3539	74	
ACTUAL		87	790	3214	48	25	26		3594	91	
PLAN		816	1532	11424	29	15	56		1400	20	
HESPER	120	160	800	2893	53	20	27		2693	80	
HESPER	220	12	194	433	54	19	27		3356	87	
HESPER	221	27	312	915	65	13	22		3388	116	
ACTUAL		139	1216	4211	56	10	25		3079	67	
PLAN		703	1286	10062	29	15	56		1400	20	
MARY	130	98	440	2010	45	22	33		2751	45	
MARY	230	116	498	2107	38	19	43		1550	30	
ACTUAL		224	942	4118	41	21	38		1780	35	
PLAN		870	1740	12180	29	15	56		1400	20	
LEESVILLE	140	137	464	2413	37	21	42		1761	34	
LEESVILLE	240	79	416	1840	45	21	34		2358	53	
LEESVILLE	241	125	464	2129	36	21	43		1847	37	
ACTUAL		341	1244	6989	39	21	40		1930	39	
PLAN		639	1677	11739	29	15	56		1400	20	
HATCHITOGUES	550	412	1215	7362	33	19	48		1714	29	
ACTUAL		412	1215	7362	33	19	48		1714	29	
PLAN		1212	2424	16758	29	15	56		1400	20	
WILFIELD	260	137	520	2537	39	23	38		1852	38	
WILFIELD	261	26	100	690	45	23	32		2463	57	
ACTUAL		165	680	3227	41	23	36		1956	41	
PLAN		1029	2098	14406	29	15	56		1400	20	
DRY POND	170	24	60	305	39	18	43		1605	33	
DRY POND	270	274	548	3816	28	18	54		1393	20	
DRY POND	271	30	100	630	45	22	33		2101	53	
ACTUAL		328	788	4182	31	19	50		1473	24	
PLAN		650	1320	9240	29	15	56		1400	20	
DISTRICT ACTUAL		1706	6881	33242	40	20	40		1949	40	
DISTRICT PLAN		6269	12417	86919	29	15	56		1400	20	

Figure C-6. Maintenance planning summary

Fiscal Year	1968 69	District No	07	Parish No	891	Parish Supt. Cong No.	SEASONAL DIST %												
LOCATION	NAME	ACCOMPLISH UNIT	QUANTITY	LABOR HOURS	LEAD	COST	MATERIAL	CONTR	TOTAL	UNIT COST	DATE	BY	SEASONAL DIST %						
													10	15	20	25			
BITUMINOUS SURFACE	411 CY ABSR		560	1136	2991	1303	3374		7668	13.50				2.0	30	20	10	40	
	412 TONS MIX		753	2227	5023	1674	5100		12477	17.10				3.0	50	20	15	15	
	413 CY MAT		693	1788	3477	2033	1320		7770	8.70				2.0	35	5	30	33	
	414 GAL FILL		495	216	465	349	42		892	1.70				1.5	30	50	50	50	
	415 TONS MIX		1420	1604	3353	1371	10973		15988	11.20				1.5	30	20	15	15	
CONCRETE SURFACE	417 TONS MIX		403	1332	2551	1133	3644		7921	16.40				2.0	50	20	15	15	
	421 CY CONC		650	3500	6523	3374	12593		22490	34.60				4.0	30	50	20	20	
	422 TONS MIX		84	232	511	197	658		1436	17.10				3.0	30	50	20	20	
	423 CY MAT		835	1670	3270	2760	1235		7285	8.70				2.0	30	50	20	20	
	424 GAL FILL		835	418	732	556	72		1420	1.70				1.5	30	50	50	50	
GRAVEL-SHELL SURFACE	425 100 LN FT		1040	1437	2923	770	153		3048	3.70				1.4	50	50	50	50	
	431 CY AGGR		160	192	362	312	722		1416	8.95				1.2	5	45	30	20	
	432 ROAD MI		308	616	1244	1421			2763	7.20				1.6	15	25	35	25	
	433 CY AGGR		648	338	749	499	2012		9160	6.50				6	5	65	30	20	
	441 CY MAT		899	599	1178	683	684		2945	3.90				1.2	5	75	10	10	
SHOULDER & APPROACH	442 SLODN MI		330	832	1832	2056			3740	6.80				1.5	20	15	10	15	
	443 CY MAT		1007	785	1417	702	1277		3726	3.70				1.7	5	75	10	10	
	444 CY AGGR		275	963	1974	790	2172		4935	17.95				3.5	30	20	10	10	
	445 TONS MIX		51	153	333	156	373		837	17.00				3.0	50	20	15	15	
	446 CY MAT		44	56	108	159	71		416	6.71				2.0	35	5	50	50	
ROADSIDE & DRAINAGE	462 DITCH MI		2796	2796	5595	836			6431	2.30				1.0	15	20	15	30	
	463 DITCH MI		69	552	1416	1509			3424	836.06				240.0	20	40	20	20	
	464 DITCH MI		69	552	1416	1509			3424	34.00				8.0	20	40	20	20	
	470 ACRES		10432	10432	35773	23049			56422	3.20				1.0	50	20	20	20	
	473 LOADS		256	5120	10295	1404			11699	45.70				20.0	10	30	40	20	
TOTAL PLANNED MAINT										198074				35	27	14	24		

APPENDIX D

MINNESOTA DEPARTMENT OF HIGHWAYS Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,897,000 residents of Minnesota operate 2,452,616 motor vehicles on 127,742 miles of highway of which 13,472 miles are under state control. The state occupies 84,068 square miles from an elevation of 602 feet to 2,301 feet above sea level. Mean minimum and maximum temperatures are -8 and 88°F with average annual moisture ranging from 20 to 32 inches.

The Minnesota Department of Highways has a \$53,000,000 maintenance budget for fiscal year 1975. This budget will be used by its 16 maintenance areas to maintain 29,000 lane miles of highways.

Nine construction districts comprise the Minnesota Department of Highways. Seven of the construction districts are divided into two maintenance areas each. The two metropolitan districts are also the maintenance areas. Hence, a total of 16 maintenance areas exist. Maintenance areas are divided into from 3 to 13 subareas. Seventy-six subareas have been established.

Foremen are in responsible charge of individual subareas. Foremen report to a highway superintendent which is in charge of several subareas. The superintendent reports to the maintenance area engineer who reports to the district engineer.

The existing Maintenance Cost Accounting (MCA) was developed in the late 1950's and data were processed manually. In the 1960's the system was computerized; however, system problems existed because of the detail required to be recorded and the resulting poor accuracy.

A single recording system is being utilized. A manual recording system is being utilized in the field with electronic data processing being utilized to compile and produce the reports.

RECORDING SYSTEM

Minnesota Department of Highways Form 1949, "Uniform Time and Cost Report," Form 1701, "Time Report," and Form 1702, "Requisition and Distribution Sheet," are the main forms utilized to collect maintenance activity information (Figures D-1 to D-3). The Uniform Time and Cost Report (Form 1949) is the official time report used for monthly employees, hourly laborers, intermittent (extra pay) and state equipment. The Time Report (Form 1701) is used to report time charged by hired equipment, both for owner-operated agreements and those under Tabulation of Bids and is filled out usually by the maintenance area engineer or central office. The Requisition and Distribution Sheet (Form 1702) is a multi-use form used primarily for requesting and issuing all stock through the stock room. Form 1702 is also used as a face sheet for schedules, distributing credits and charges, etc. by the area offices. A stockman normally fills the form out.

The type of information obtained on the form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization

The forms are prepared by each employee for every two-week payroll period. The basic information is recorded in columns titled

A, B, C, and D. The entry in each of these columns depends on the type of charges being made, what the charge is to be made to, etc. Column A is utilized to enter the Maintenance Account Number. Two digit Account Numbers are used for all charges not made directly to a control section or a maintenance area code number. Examples of items that have account numbers include;

1. Gravel and Bituminous Stockpiles (69*)
2. Central Office Expenses (70*)
3. Field Expenses (71*)
4. Road Equipment Purchases and Betterments (72*)
5. Accounts Receivable from within Highway Department (98*)
6. Accounts Receivable from outside the Highway Department (99*)
7. Building Construction and Betterments (84*)
8. Equipment Charges, etc. (75*).

A detailed list is shown on Table D-1.

Some accounts are subdivided into commodities to differentiate items included within an account. The most common commodity breakdown is Labor (01), Material (02), and Equipment (03). Examples of Commodities for Account Number 92, "Miscellaneous Field Materials (Inventory)," are seen on Table D-2. Two digit numbers are utilized to distinguish commodities. These numbers are recorded in column D.

It should be reemphasize that all field maintenance operation charges made to Interstate control sections, typical segments or Maintenance Area Code Numbers do not have an Account Number and therefore an X is placed in column A of the reporting form.

*Refers to account number.

Maintenance operations which fall into this category are routine maintenance operations, special maintenance operations, extraordinary maintenance operations, and betterment programs. Detailed discussions of these activities are presented later.

Column B indicates the organization numbers to which the labor, equipment, and/or material is to be charged. For example, if the equipment utilized is to be charged to the organization for which it is assigned, an X is placed in column B. If the equipment is to be charged to a different maintenance area the appropriate maintenance area designation is utilized. Organizational numbers are three digit numerical codes and are shown in Table D-3. The purpose of establishing the organization numbers is to identify transactions between highway department divisions, districts, and areas as well as counties, other state departments and governmental agencies.

Column B is also utilized to indicate the surface type and location code for surface and shoulder repair Maintenance Operations performed on typical segments and interstate control sections. Codes are shown in Table D-4.

Column C is utilized to designate where the field maintenance operation is performed, the equipment number if the work is to be charged to a piece of equipment, a Building Number if the work is to be charged to a building or a Maintenance Job Number if the work is to be charged to a specific job assigned by the area office.

For all field maintenance operations, column C is utilized to record interstate control sections, typical highway segments or Maintenance Area Code Numbers. The state trunk highway system has

been divided into road sections with fixed termini. A four digit number is utilized to identify a road section. The first two digits represent the county number and the last two digits the section within the county. Interstate highways are assigned section numbers in the 80 or 90 series. In establishing the length of the Control Sections consideration was given to the practical limits for survey, for construction projects and maintenance operations. No attempt was made to make the lengths of the Control Sections into lengths to fit the present type of road surface. Detailed maintenance costs are kept for surface repairs and shoulder and approach repairs on typical segments of certain control sections. In addition, maintenance operations involving special roadway maintenance, extra-ordinary maintenance and betterments on all trunk highways are chargeable to control section numbers. Routine maintenance operations on noninterstate and routine surface and shoulder maintenance on nontypical segments are not charged to control sections but rather to maintenance area code numbers.

Column D is utilized to define the activity performed by the field maintenance operation or the Commodity Number if an Account Number is utilized for charges that are not made directly to a control section, or a maintenance area code number. Field maintenance activities are designated by Maintenance Operation Numbers (Table D-5). Six groups of numbers exist. Detailed descriptions of their operations can be found in reference D-1.

Accomplishment Numbers more explicitly defining certain maintenance operations are utilized together with Maintenance

Operation Numbers for special roadway and betterment maintenance activities. Accomplishment numbers are shown on Table D-6. Units of measure are designated for each accomplishment.

From the above discussion it is apparent that a considerable number of codes are utilized to record the various maintenance activities performed. These codes consist of the following:

1. Maintenance Account Numbers are utilized to code activities normally associated with other than field maintenance operations (Table D-1).
2. Commodity Numbers are used to designate subdivisions of Maintenance Account Numbers (Table D-2).
3. Organization Numbers are codes utilized to identify organization for charging purposes (Table D-3).
4. Surface Type and Location Codes are utilized for the types of surfaces on which the repair was performed and the location of the repair (main lanes, service lanes, ramps, surface, shoulder, etc.) (Table D-4).
5. Control Section Numbers are codes which identify specific sections of highways.
6. Typical Segment codes are utilized to identify special study segments of roadways on which detailed maintenance activity information is desired.
7. Maintenance Area Code Numbers are codes used to identify one of the 16 Maintenance Areas within the State.
8. Equipment Numbers are codes used to identify state highway mobile equipment.

9. Building Numbers are codes utilized to identify state owned buildings.

10. Maintenance Job Numbers are codes for special jobs normally associated with Account Numbers 68 (Undistributed Shop Jobs), 98 (Accounts Receivable from within highway department), and 99 (Accounts Receivable from outside the highway department).

11. Maintenance Operation Numbers are codes utilized to designate the type of activity performed (Table D-5).

12. Accomplishment Numbers are codes which more explicitly define certain maintenance operations for special roadway and betterment maintenance activities (Table D-6).

These codes are utilized in columns A, B, C, and D as described above by the individual maintenance employee. A review of the above information is presented below in a format consistent with those utilized to summarize other states recording and reporting systems.

Location

Each field maintenance operation as defined in Table D-5 is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. The district is designated by the use of an Organization Number (Table D-3) to which the maintenance workman is assigned. The district number is the last number of a three digit numeric code. The Organization Number will also appear in the general information part of Form 1949 and may appear in column C.

Another method of identifying the district is by use of the Maintenance Area Code Number found in column C. This four digit

number designates one of the 16 maintenance areas formed in the state. The last digit of this code designates the district.

2. Maintenance Area. The maintenance area is designated by the use of an Organization Number (Table D-3) to which the maintenance workman is assigned or by one of the Maintenance Area Code found in column C as described above.

3. Maintenance Subareas. The maintenance subareas are not directly identified on the recording form. By association with employees, names, Control Section Numbers, Typical Segments, Equipment Numbers, etc., maintenance subarea charges may somewhat be identified.

4. Maintenance Roadway Segments. Segments of roadways are designated by Control Section Numbers. Maintenance activity information is collected by Control Section Numbers for all Interstate Highways. Typical Segments Numbers are utilized to designate special study sections on other parts of the highway system.

5. Milepost. Mileposts or milepoints are not recorded for any maintenance activities.

Maintenance performed on bridges is assigned to a particular bridge by use of a Bridge Number. The bridge number is placed under the remarks column.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance operations number indicates if the maintenance action was performed on the pavement, shoulder and approaches, roadside, etc. Use of the Surface Type and Location Codes identifies service, roads, ramps, loops, etc. for certain maintenance activities.

Activity

Maintenance Operation Numbers, Accomplishment Numbers, Maintenance Account Numbers and Commodity Numbers are utilized to define the type of maintenance activities performed (Table D-1, D-2, D-5, and D-6). Forty-three Maintenance Operation Codes exist, 41 Accomplishment Numbers, 43 Account Numbers and numerous Commodity Numbers associated with the Account Numbers.

Maintenance Operation Numbers are those normally associated with routine maintenance operations and are divided into the following major groups:

1. Roadway Surface,
2. Shoulder and Approaches,
3. Roadside and Drainage,
4. Traffic Service,
5. Snow and Ice Control,
6. Structures,
7. Special Roadway Maintenance,
8. Extra-ordinary Maintenance and
9. Betterments.

It should be noted that roadway surface repair has only two operation numbers; 01-surface repair and 02-crackfilling. However, items in Maintenance Operation Group 6, Special Roadway Maintenance, contain many items which are often under function code groupings for roadway surface.

Maintenance Operation Numbers are presently under review to be reduced in number.

Manpower

Manpower utilization is assigned to a particular activity by the individual. When the employee changes activities such that columns A, B, C, or D are changed he must fill in another line of data. Time is reported to the nearest hour by field crews and to the nearest 0.1 hour by shop personnel daily. Time is summed for a two week period ending on a Tuesday. Form 1949 is turned into central offices on Wednesday and the individual is paid 10 days later. Payrolls are developed by exception reporting as items such as holidays, vacation, sick leave and compensatory time taken are reported.

Equipment

Equipment utilized for a particular Maintenance Operation on Account Number is recorded. Each item of equipment has an assigned Equipment Unit Number. In order to facilitate the assignment of rental rates, equipment units are grouped into classes depending on equipment type, size and relative operating, maintenance, depreciation and initial purchase costs. An Equipment Class Number is assigned to this grouping. A rental rate is computed on a cost per mile, hour, day or year depending on the equipments functions. This rental rate reflects the average operating maintenance, storage, and depreciation cost. The rates are reviewed every year by the Maintenance Division and are adjusted accordingly to reflect fluctuations in the costs of owning and operating the equipment.

Equipment Unit Numbers are recorded on Form 1949 while charges are determined based on Equipment Class Numbers and their associated

Rental Rates. Five character numerical codes designates equipment numbers.

Materials

Materials utilized for a particular maintenance operation are not recorded on Form 1949. Form 1702, Requisition and Distribution Shop is utilized for material and parts items obtained from central warehouses. All material transfers are recorded as such utilizing this form. Average costs for materials are determined by inventory purchase information. Materials stockpiles do not have a unique number assigned to them.

Accomplishments

An accomplishment report is not a part of the Minnesota Department of Highways recording system.

COLLECTION AND PROCESSING OF RECORDED DATA

The forms 1949, 1701, and 1702 are filled out daily and summed every two weeks by the individual maintenance employee. Foremen are responsible for the data accuracy. These forms are then transmitted every two weeks to the central office computer cards and punched and reports prepared monthly in the central office. The monthly reports are presently complete about 6 weeks after the data are transferred to the central office. Secretarial type employees are not utilized at the subarea level to handle these data.

It is estimated that about one-half of one percent of the maintenance budget is expended on recording and reporting maintenance

activities. About \$60,000 were required for key punching and computer use in 1974. It is estimated that about 1 hour per individual is required to record the data every two weeks.

REPORTS

Nineteen reports are available from the Minnesota Maintenance Cost Accounting system. Report numbers and a brief description of these reports are seen in Table D-7. A brief discussion of the more important reports from a roadway maintenance management standpoint is presented below indicating the types of data contained on these reports:

MCA-2. Maintenance Cost Accounting report 2 is a presentation of charges to control sections within a particular district. The report is issued monthly and contains a monthly summary of charges as well as a year to date summary. Two different formats are utilized to present these data. Figure D-4 is the reporting format utilized to present a summary for a district by control sections (CS). However, control section has a broad connotation as utilized on this report. The control section may be one of the following;

1. Control Section designating an Interstate Highway segment,
2. Typical Segment designating a special study section on a highway other than Interstate,
3. Maintenance Area Code designating one of the 16 maintenance areas,
4. Control Section numbers of highways where special roadway maintenance, extra-ordinary maintenance and betterment programs are performed.

The column designated OP on the report refers to Maintenance Operation Number (Table D-5). Thus, field maintenance operations including routine maintenance, special roadway maintenance, extraordinary maintenance and betterment projects are the only activities reported on this form. Activities defined by Account Numbers and Commodity Numbers are reported on MCA-26.

The column designated ST on the report refers to Surface Type and Location Code (Table D-4). This information is recorded in columns B of Form 1949 and reported for Maintenance Operations in Group 0 (Roadway Surface), Group 6 (Special Roadway) and Group 7 (Extra-ordinary Maintenance) and Group 8 (Betterments). The information gathered in the Surface Type and Location Code column was used to determine maintenance costs for certain types of roadway. Data were collected for a ten-year period ending in 1972. These data are no longer collected.

The column designated ACP on the report refers to the Accomplishment Number which are codes to more explicitly define certain maintenance operations for special roadway and betterment maintenance activities (Table D-6).

The column Labor is the hourly pay rate times 1.38 (38%) for fringe benefits. The column Material is the actual cost of the material taken from Form 1702, "Requisition on Distribution Sheet," and is the average dollar cost from aterial invoices. The column Equipment is the summation of equipment hours using established rental rates. The column Agreement is charges which originate from Form 1701, "Time Report (Hired Equipment)."

The column total, including overhead, is the summation of the columns Labor, Material and Equipment times 1.19 (19% for overhead).

The second format of MCA-2 is shown on Figure D-5. A summary of labor material and equipment costs are presented by Maintenance Operation Numbers for a given District. Monthly and year to date totals are shown on this report.

MCA-4. Maintenance Cost Accounting report 4 compares present year expenditures with past years expenditures both in terms of the reported month and the year to date for specific district totals (Figure D-6). Expenditures are listed by Maintenance Operation Number, summed for Maintenance Operation groups and totaled for the district. For example, expenditures are summed for roadside and drainage maintenance, special roadway, betterments, etc.

MCA-5. Maintenance Cost Accounting report 5 delineates special maintenance and betterment charges for the reporting month and year to date. The report is presented by district, control section as defined in MCA-2 report, and by Maintenance Operation and Accomplishment Number. This report is utilized within the highway department to formulate other internal reports including the "Construction Project Log Record."

MCA-6. Maintenance Cost Accounting report 6 is titled "Maintenance and Betterment Costs for Counties." This is not an accurate description of the report because cost data are not collected by county. Maintenance costs reported is all maintenance except routine maintenance (Table D-5). Routine maintenance typically amounts to the bulk of the money expended on maintenance.

Costs are separated by county. Costs per mile expenditures are reported. This report is generated about twice per year with a summary for the calendar year report.

MCA-7. Maintenance Cost Accounting report 7 details maintenance expenditures for bridges. Labor, material and equipment charges are reported for the report's month and the year to date. The data are presented by district bridge number, control sections and Maintenance Operation Number.

MCA-10. Maintenance Cost Accounting report indicates maintenance expenditures over a number of years for a particular maintenance section in terms of cost per mile. Separate costs are reported for the Maintenance Operation Number groupings.

MCA-26. Maintenance Cost Accounting report 26 contains all charges not assigned to field maintenance activities. These charges as discussed above are made against Maintenance Account Numbers (Table D-1) and Commodity Numbers (Table D-2). Data are grouped by district, Account Number, Organization Number, Special Job Number and Commodity Number. Data are reported for the current month and year to date.

MCA-27. Maintenance Cost Accounting report 27 is an equipment listing and acts as an inventory master file.

MCA-29. Maintenance Cost Accounting report 29 is a listing of overhead charges for the various districts. These charges are reflected on MCA-2 as overhead charges.

MCA-32. Maintenance Cost Accounting reports 32A, 32B, 32C, and 32D are equipment reports indicating fuel, parts, etc. utilized by

various pieces of equipment. These data are utilized to develop rental rates for equipment classes. These are monthly and quarterly reports.

The majority of the reports described above (Table D-7) are prepared monthly with year to date totals. MCA-2 report is the primary maintenance management report. Costs are separated only to the maintenance area level, thus the present reporting system will not be particularly useful at the subareas level. Reports are presently transmitted to the district about 6 weeks after the end of the month.

Reports are utilized for fiscal control and budget preparation. Productivity rates cannot be presently determined from the reported data. The budget is presently budgeted by labor, equipment and materials cost and not by maintenance operation or activity.

OTHER ITEMS

The Minnesota Department of Highways have recently reviewed the Maintenance Cost Accounting program (D-2). The problems with the existing system were defined and given below:

1. The output reports cannot be used by the maintenance people to manage their business.
2. The output reports do not show units of accomplishments and unit costs.
3. The output reports show costs for maintenance activities by maintenance area and not subarea
4. The output reports do not show costs on a trunk highway within a subarea.

5. The output reports do not show budgeted versus actual amounts used per activity in a cost center.

6. The turn around time, recording and reporting the data is too long (six weeks).

7. The input to the MCA system is cumbersome. Some workmen fill out four or more time sheets each day because a separate sheet is required for straight time, shift differential, equipment differentials and equipment used.

8. An accounting manual does not exist.

9. Account and commodity numbers can originate in the districts without central office control.

10. Input to the MCA system from Forms 1949, 1701, and 1702 are presently not transmitted by remote computer terminals.

Reliability of this recording and reporting system is questionable because of the large number of codes that must be utilized, the selective use of the codes in reporting certain types of charges and due to the fact that individual workmen report the data. It is difficult to differentiate between routine and special maintenance.

The concept of the Typical Segment to record maintenance activities for specific types and designs of pavement has merit if properly conducted. This type of data has the potential for use in a pavement data management system.

Committees composed of district representatives make suggestions for altering maintenance operation activities. These recommendations are reviewed and either accepted or rejected by the central office staff. Committees that are formed include the following:

1. Snow and Ice Control,
2. Traffic Services,
3. Equipment,
4. Personnel and
5. Bridge.

These committees normally meet about four times per year. Changes are affected by directive, manual change, or by engineering memorandum.

The Maintenance Cost Accounting system was developed because of legislative pressure and is presently a cost accounting system. Certain changes are contemplated in the system, some of which are being implemented on a trial basis.

Snow removal requires about 27 percent of the annual maintenance budget and hence the distribution of expenses for snow and ice control is of interest to the administration.

References

- D-1 "Maintenance Manual," State of Minnesota, Department of Highways, July 1, 1971.
- D-2 Glasow, T. A., "Evaluation of the Maintenance Cost Accounting System," an internal report of Minnesota Department of Highways.
- D-3 Katz, J. S., "Performance Standards as a Tool in Preparing the Maintenance Program Budget," Highway Research Record No. 347, 1971.

Table D-1

ACCOUNT NUMBERS - MAINTENANCE

ACCOUNT NUMBERS	USED BY			DESCRIPTION	ACCOUNT NUMBERS	USED BY			DESCRIPTION
	M.A.	C.S.	C.O.M.			M.A.	C.S.	C.O.M.	
1-30				Not Assigned	73			X	Reserve for Motor Pool
31		X		Maint. Area 1B - Virginia - 321	74	X	X		Field Labor Equip. Maint.
32		X		Maint. Area 1A - Duluth - 301	75	X	X	X	Equipment charges (State Unit)
33		X		Maint. Area 2A - Bemidji - 302	76	X	X	X	Repairs Parts and Supplies (Inventory)
34		X		Maint. Area 3A - Brainerd - 303	77	X	X	X	Shop Overhead
35		X		Maint. Area 2B - Crookston - 322	78	X	X		Shop Tools
36		X		Maint. Area 4A - Detroit Lakes - 304	79	X	X	X	Build. Maint.
37		X		Maint. Area 3B - St. Cloud - 323	80	X		X	Rental Reserve (State Units)
38		X		Maint. Area 4B - Morris - 324	81	X	X	X	Error Correction
39		X		Maint. Area 5A - Golden Valley - 305	82			X	Depreciation Road Equipment
40		X		Maint. Area 8A - Willmar - 308	83				Not Assigned
41		X		Maint. Area 9A - St. Paul Park - 309	84			X	Building Construction and Betterments
42		X		Maint. Area 6A - Rochester - 306	85			X	Miscellaneous Cash Credits
43		X		Maint. Area 6B - Owatonna - 326	86	X			Accounts Payable
44		X		Maint. Area 7A - Mankato - 307	87	X		X	Reserve for Maint. Overhead (District)
45		X		Maint. Area 8B - Marshall - 328	88	X		X	Reserve for Leave with Pay
46		X		Maint. Area 7B - Windom - 327	89				Not Assigned
47-61				Not Assigned	90				Not Assigned
					91			X	Depreciation Building (State Owned)
62				Not Assigned	92	X			Miscellaneous Field Materials (Inventory)
63				Sign Shop (Det. Lakes)	93			X	Asset Account, Road Equipment
64				Not Assigned	94				Not Assigned
65-61				Not Assigned	95				Not Assigned
					96			X	Asset Account, Buildings
					97				Not Assigned
68	X	X		Undistributed Shop Jobs (Better- ments or "B" Jobs)	98	X	X	X	Accounts Receivable from within Highway Dept. (Maintenance Areas Construction Districts, Central Office Stations)
69	X			Gravel and bituminous Stock Piles (Stock Inventory)	99	X	X	X	Accounts Receivable from out- side the Highway Dept. (Govern- mental Agencies, Firms and Individuals)
70			X	Central Office Expense					
71				Field Expense					
72			X	Road Equipment Purchases and Betterments					

M.A. = Maintenance Areas

C.S. = Central Shop

C.O.M. = Central Office Maintenance Division

Table D-2. Commodity Numbers for Account Number 92,
Miscellaneous Field Material (Inventory).

40	Calcium Chloride
41	Salt
42	Crack Filler
43	Bituminous Material (includes tar, road oil, powdered asphalt and bituminous additives)
44	Miscellaneous Field Tools and Supplies
45	Posts, Wood and Steel
46	Culverts, Gutters, Tile, etc.
47	Signs, Flags, Plates and Related Supplies
48	Paint
49	Lumber
50	Bridge and Structural Steel
51	Bridge Supplies

Table D-3
ORGANIZATION NUMBERS

<u>Administration</u>		<u>Counties</u>	
110	Office of the Commissioner	801	Aitkin
120	Office of Public Information	802	Anoka
132	Office of Personnel (& Training)	803	Becker
133	Office of Data Processing	804	Beltrami
134	Office of Administrative Management (Management Services)	805	Benton
135	Office of Financial Administration	806	Big Stone
137	Administrative Services Section (Stores)	807	Blue Earth
138	Electronic Communications Section	808	Brown
139	Audit Section	809	Carlton
<u>Safety</u>		810	Carver
201	Office of Safety	811	Cass
202	Office of Highway Patrol	812	Chippewa
203	Office of Driver License Section	813	Chicago
204	Office of Safety Information Section	814	Clay
205	Office of Drivers Training Section	815	Clearwater
206	Office of Traffic Safety Research	816	Cook
207	Office of Vehicle Safety Inspection	817	Cottonwood
<u>Districts</u>		818	Crow Wing
311 (1)	Duluth	819	Dakota
312 (2)	Bemidji	820	Dodge
313 (3)	Brainerd	821	Douglas
314 (4)	Detroit Lakes	822	Farzibault
315 (5)	Golden Valley	823	Fillmore
316 (6)	Rochester	824	Freeborn
317 (7)	Mankato	825	Goodhue
318 (8)	Willmar	826	Grant
319 (9)	St. Paul	827	Hennepin
301 (A)	Duluth	828	Houston
302 (A)	Bemidji	829	Hubbard
303 (A)	Brainerd	830	Istanti
304 (A)	Detroit Lakes	831	Itasca
305 (A)	Golden Valley	832	Jackson
306 (A)	Rochester	833	Kanabec
307 (A)	Mankato	834	Kandiyohi
308 (A)	Willmar	835	Kittson
309 (A)	St. Paul Park	836	Knochiwing
321 (B)	Virginia	837	Lac qui Parle
322 (B)	Crookston	838	Lake
323 (B)	St. Cloud	839	Lake of the Woods
324 (B)	Morris	840	Le Sueur
326 (B)	Owatonna	841	Lincoln
327 (B)	Windom	842	Lyon
328 (B)	Marshall	843	McLeod
<u>Maintenance Areas</u>		844	Mahnomen
321 (B)	Virginia	845	Marshall
322 (B)	Crookston	846	Martin
323 (B)	St. Cloud	847	Meeker
324 (B)	Morris	848	Mille Lacs
326 (B)	Owatonna	849	Morrison
327 (B)	Windom	850	Mower
328 (B)	Marshall	851	Murray
<u>Operations</u>		852	Nicollet
330	Office of Road Design	853	Nobles
340	Office of Bridge Design	854	Norman
350	Office of Materials	855	Olmsted
360	Office of Right of Way & Utilities	856	Otter Tail
370	Office of Traffic Engineering	857	Pennington
380	Office of Contract Administration	858	Pine
381	Central Shop	859	Pipestone
382	Central Office Maintenance Operations	860	Polk
388	Environmental Services Section	861	Pope
<u>RESEARCH AND STANDARDS</u>		862	Ramsey
601	Research Coordination	863	Red Lake
602	Right of Way Standards	864	Redwood
604	Design Standards	865	Renville
605	Construction Standards	866	Rice
606	Maintenance Standards	867	Rock
607	Research and Standards Division Headquarters	868	Roseau
<u>STATE AID</u>		869	St. Louis
608	Office of State Aid	870	Scott
<u>TRANSPORTATION AND TRANSIT PLANNING AND PROGRAMMING</u>		871	Shorburne
701	Office of Programming	872	Sibley
702	Office of Transportation Planning	873	Stearns
<u>HIGHWAY LEGAL DIVISION</u>		874	Steele
801	Legal Division	875	Stevens
		876	Swift
		877	Todd
		878	Traverse
		879	Wabasha
		880	Wadena
		881	Waseca
		882	Washington
		883	Watsonwan
		884	Wilkin
		885	Winona
		886	Wright
		887	Yellow Medicine
		<u>State of Minnesota Departments</u>	
		901	Administration
		902	Natural Resources
		903	Education
		904	Adjutant General (A.G.O.)
		905	Secretary of State (Motor Vehicle)
		906	Attorney General
		907	Veterans Affairs
		908	Governor's Office
		909	Human Rights Commission
		910	State Retirement System (MSRS)
		911	Public Welfare
		912	Civil Defense
		913	Civil Service
		914	University of Minnesota
		915	Health
		916	Historical Society
		917	Horticultural Society (State Fair)
		918	Agriculture
		919	Economic Development
		920	Aeronautics
		921	Legislature - House
		922	Legislature - Senate
		923	Taxation
		924	Industry and Labor
		925	Employment & Security
		926	State Treasurer
		927	
		928	State Auditor
		929	Public Service Department
		930	Iron Range Resources Comm.
		931	Department of Corrections
		932	Municipal Commission
		933	Archives Commission
		934	State Planning Agency
		935	Comm. of Insurance & Banking
		936	Upper Great Lakes Regional Comm.
		937	Pollution Control
		938	Minnesota Geological Surveys
		939	Junior College Board - Minn.
		940	State College Board - Minn.
		941	Water Resources Board
		942	Veterans Home
		943	Zoological Board
		944	Safety Department
		945	Arts Council
		946	Minnesota Resource Commission
		947	Revisor of Statutes
		948	State Soil & Water Conservation Comm.
		<u>U.S. Government Departments</u>	
		951	Transportation (B.P.R.)
		952	U. S. Engineers
		953	Postal Services
		954	Treasury (Customs)
		955	Interior (Parks)
		956	Agriculture
		957	Defense - Air Force, Army, Navy
		958	Customs

Table D-4
SURFACE TYPE AND LOCATION CODES

Location		Surface Type	Location and Surface Type Code	Possible Maintenance Operations Chargeable (See Listing Below)
General	Specific			
Main Roadway	Surface	Bituminous	13	List I
		Concrete	14	
	Shoulders and Approaches	Gravel	22	List II
		Bituminous	23	
		Concrete	24	
Service Lane	Surface	Bituminous	53	List I
		Concrete	54	
	Shoulders and Approaches	Gravel	62	List II
		Bituminous	63	
		Concrete	64	
Interchanges Ramp, Loop and Crossovers	Surface	Bituminous	73	List I
		Concrete	74	
	Shoulders	Gravel	82	List II
		Bituminous	83	
		Concrete	84	

Maintenance Operation List I
Maintenance Operation List II

01, 02, 61, 63, 64, 65, 66, 71, 83, 85
14, 62, 63, 65, 66, 71, 83, 85, 86

Table D-5

MAINTENANCE OPERATION NUMBERS

	OPERATION NO.	OPERATION DESCRIPTION	PROGRAM BUDGET ACTIVITY NUMBER
ROUTINE MAINTENANCE	GROUP 0	ROADWAY SURFACE	
	01	Surface Repair	3212
	02	Crackfilling	3212
	GROUP 1	SHOULDERS AND APPROACHES	
	14	Shoulder and Side Approach Repairs	3220
	GROUP 2	ROADSIDE AND DRAINAGE	
	21	Roadside Repair	3233
	22	Drainage	3232
	23	Vegetation Control	3234
	24	Wayside Rest Areas	3235
ROUTINE MAINTENANCE	25	Clear Debris	3236
	26	R/W Fence and Marker	3237
	27	Plant Material Maintenance	3249
	GROUP 3	TRAFFIC SERVICE	
	31	Signs and Markers	3340
	32	Pavement Markings	3310
	33	Guard Rail & Traffic Barriers	3338
	34	Dust Control	
		Surface	3212
		Shoulders & Approaches	3220
ROUTINE MAINTENANCE	35	Lighting	3320
	36	Traffic Signals	3330
	37	Opening Bridges	3260
	38	Detours	3239
	39	Routine Agreements and Contracts	3282
	GROUP 4	SNOW AND ICE CONTROL	
	41	Snow Fence	3250
	44	Snow and Ice Control	3250
	GROUP 5	STRUCTURES	
	52	Bridge Repainting	3260
	53	Bridge Repair	3260
SPECIAL ROADWAY	GROUP 6	SPECIAL ROADWAY MAINTENANCE	
	61	Joint and Crack Sealing	3213
	62	Restore Aggregate to Surface	3212
		Shoulders & Approaches	3220
	63	Bituminous Surface Repairs	3212
	64	Mudjacking and Pavement Repair	3214
	65	Light Reshaping, Grade Lifts & Swamp Fill	3212
	66	Seal Coat with Aggregate	3212
	67	Replacement of Drainage Structure	3232
	68	Special Agreements and Contracts	3282
EXTRA ORDINARY	GROUP 7	EXTRAORDINARY MAINTENANCE	
	71	Damage Prevention and Repairs	
	72	Signals and Traffic Control	3340
BETTERMENTS	GROUP 8	BETTERMENTS	
	80	Engineering Preliminary, Construction	
	81	Roadway and Drainage Grading & Earthwork	3212
	82	Drainage Structures & Roadway Earthwork Protective Structures	3232
	83	Base Construction	3212
	84	Untreated Aggregate to Roadway Courses	3212
	85	Bituminous Wearing Courses	3212
	86	Improved Shoulders and Approach Surfacing	3220
	87	Bridges, Viaducts, Grade Separation Structures and Tunnels	3260
	88	Traffic and Pedestrian Service and Miscellaneous Facilities	
	89	Roadside Development	3239

* use appropriate program budget activity number depending on type of work done within operation.

Table D-6
ACCOMPLISHMENT NUMBERS

ACCOMPLISHMENT NUMBER	WORK ITEM	UNIT OF MEASURE
07	MAINTENANCE REIMBURSEMENT AGREEMENTS	
08	TRAFFIC SERVICE, Includes flagging	LUMP SUM
09	SUPERVISION, Includes checker	LUMP SUM
10	MAINTENANCE AND RESTORATION OF HAUL ROAD (Includes all equipment hours and all regravelling quantities to maintain haul road and restore to original condition)	MILE
16	GRAVEL OR CRUSHED ROCK IN PLACE, Includes regravelling (Includes load, haul, spread, etc.)	TON
19	SALVAGED BITUMINOUS MIXTURE IN PLACE	TON
23	BINDER SOIL IN PLACE	C. Y.
31	PREPARATION OF SUBGRADE (Scarifying, blading, shaping and compacting of the subgrade prior to construction of a base or a surface from existing roadway for use in the new base or surface.)	MILE
42	BASE CONSTRUCTION (Base or Sub-Base; Sand, Gravel, Soil Stabilized Gravel, Crushed Rock or Bituminous Stabilized Base) (All operations on the road of stabilizing, mixing, spreading, shaping and compacting the base) Includes Water. Includes all operation for production of gravel material including cost of material.	TON
51	BITUMINOUS MATERIAL (Including Application)	GALLON
52	BITUMINOUS SURFACE (Includes all operations on the road such as sweeping, windrow- ing, drying, mixing, spreading and rolling) Includes Aggregate and all operations of gravel production, load, haul, etc.)	TON
54	BITUMINOUS MIXTURE IN PLACE, Includes delivery (Purchased from vendor or const. contract)	TON
57	SPECIAL BITUMINOUS SURFACE REPAIR (Heater, Planer, etc.)	SQUARE YARD
59	SEAL COAT AGGREGATE IN PLACE (All operations) (FA-1, FA-2, FA-3, FA-4 and FA-5)	C. Y.
61	CLEARING AND CRUBBING	ACRE
62	SLOPING	STATION
63	EXCAVATION	C. Y.
66	TOPSOIL IN PLACE	C. Y.
67	EMBANKMENT IN PLACE	C. Y.
68	REMOVE PAVEMENT	SQUARE YARD
69	REMOVE PORTABLE CULVERTS	LIN. FEET

Table D-6 (continued)

ACCOMPLISHMENT NUMBERS (Cont'd.)

ACCOMPLISHMENT NUMBER	WORK ITEM	UNIT OF MEASURE
70	REMOVE MISCELLANEOUS STRUCTURES	C. Y.
71	METAL DAMS, CRIB WALLS, etc. (Area of completed dam)	SQUARE FEET
72	CONCRETE IN PLACE (In culverts, drains and miscellaneous structures. Includes all reinforcement)	C. Y.
73	MASONRY IN PLACE	C. Y.
74	RIPRAP IN PLACE	C. Y.
75	CONCRETE PAVEMENT (OR BASE) REPAIR (REPLACEMENT OR REPAIR OF EXISTING PAVEMENT OR BASE WITH NEW CONCRETE PAVEMENT OR BASE) (Does not include replacement or repair of concrete pavement with bituminous mixture) (Includes all reinforcement)	SQUARE YARD
76	FURNISH AND INSTALL PORTABLE CULVERTS (Size and type must be shown on accomplishment report)	LIN. FEET
77	PREFABRICATED SURFACE DRAINS IN PLACE	LIN. FEET
78	SUB-SURFACE DRAINS IN PLACE (Includes tile drains)	LIN. FEET
79	MANHOLES AND CATCH BASINS IN PLACE (Includes castings) (Adjustments of less than 1 foot in existing manholes and catch basins is considered to be construction of one lineal ft.)	LIN. FEET
80	CURB, CURB AND GUTTER, IN PLACE (Concrete, masonry or bituminous)	LIN. FEET
82	SEEDING	ACRE
83	SODDING	SQUARE YARD
84	GUARD RAIL IN PLACE	LIN. FEET
85	CLEANING AND SEALING JOINTS IN CONCRETE PAVEMENT	MILE
86	MUDJACKING (Use field com. 01, 02 & 03 for oper. no.)	SQUARE YARD
96	TEMP. PILE DRIVING	
97	TIMBER PLACEMENT	
98	STEEL ERECTION	
99	(FIELD COMMODITY 4) To clear from Special Account agreed amount to be billed against report to show full charges by accomplishment numbers - show credit received from Governmental Agency as a separate item. In preparing the accomplishment report, list the reimbursement credit and the overhead credit as a separate item.	

Table D-7. Maintenance Cost Accounting Reports

Report No.	Description
MCA-2*	Changes to Control Sections in District
MCA-4	Comparative Monthly Maintenance Expenditures
MCA-5	Special Maintenance and Betterments
MCA-6	Cost for Counties by Trunk Highway
MCA-7	Bridge Maintenance Costs
MCA-10	Comparative Costs for 10 Year Period
MCA-26	Account Report
MCA-27	Equipment List
MCA-29	Overhead Report
MCA-30	End of Year Account Adjusting and Closing Entries
MCA-32A	Equipment Costs
MCA-32B	Equipment Costs
MCA-32C	Equipment Costs
MCA-32D	Equipment Costs
MCA-33	Area Inventory of Units
MCA-35	Class Inventory of Units
MCA-40A	Control Section Error Listing
MCA-40B	Equipment Error Listing
MCA-52	Control Section Listing

* MCA = Maintenance Cost Accounting

2. Column B

- a. Enter "X" for charges to "home" organization.
- b. Enter three digit organization number (Ref. 5-791.715) for charges to be interdivision billed.
- c. Or make entry as instructed by office or foreman.

3. Column C

- a. Enter five digit Equipment Unit Number if work is to be charged to a piece of equipment.
- b. Enter five digit Building Number if work is to be charged to a building.
- c. Enter assigned Maintenance Job Number if work is to be charged to a job. The Job Numbers are assigned by the area office.
- d. If roadway or roadside work is charged to Account 98 (Accounts Receivable from within the Highway Department) in column A, i.e., interdivision billing, and the work is chargeable to a highway, enter the typical segment number, interstate control section number or Maintenance Area Code Number in column C.
- e. If none of the above apply, enter an "X" or as instructed by the office.

4. Column D

- a. For work chargeable to Account Nos. in column A, enter the appropriate Commodity Number in column D.
- b. The most common Commodity Numbers are:

01	Labor
02	Material
03	Equipment
04	Contract and Special Agreements

c. Certain accounts, such as Account 87, Reserve for Overhead (District), and Account 75, Equipment charges (State Units), are subdivided into different commodities. Refer to 5-791.735 or contact the area office manager for complete listings. Commodity listings are given in various manuals such as Stockroom Procedures (5-794), etc. and office memorandums and bulletins.

H. Examples of coding in columns A, B, C and D are shown in Fig. C 5-791.710.

I. Inasmuch as certain information is keypunched for electronic data processing transposed directly from Forms, 1701, 1702 and 1949, it is very important that all entries are legible. This is particularly true for the codes entered in columns A, B, C and D.

J. The general rule is that each line on the forms must have either a code number or an "X" in each of the columns A, B, C and D. If a column is left blank, the keypunch operator will repeat the code listed on the previous line. In other words, a blank means "repeat". Indiscriminate use of code letters, "X"s or blanks will cause errors in the data processing analysis printouts.

K. Charges on Form 1949 for personal services should be compatible (the same) as charges on Form 1949 equipment usage on any job on a particular day.

Figure D-1. FORM 1949 - Uniform Time and Cost Report

Figure D-2. FORM 1701: Time Report (Hired Equipment)

JULY 1, 1971

MAINTENANCE MANUAL

Fig. A 5-791.710 (2)

[illegible]

Figure D-3. FORM 1702 - Requisition and Distribution Sheet

Figure D-4. MCA-2 Report
MCA 2
MINNESOTA HIGHWAY DEPARTMENT

MAINTENANCE COST ACCOUNTING

CHARGES TO CONTROL SECTIONS IN DISTRICT 27

SEPTEMBER 1968

CURRENT MONTH					CAL YEAR TO DATE				
CS	UP	ST	ACP		LABOR	MATERIAL	EQUIP	AGREEMENT	TOT INCL OH
0702	61	8			11.55		16.17		30.49
	61	85			26.95		3.50		33.50
					38.50		19.67		63.99
0704	14	14						2007.37	2208.11
	61	8			50.05		4.51		60.02
	61	85			147.73	21.60	176.42		300.33
					197.78	21.60	180.93	2007.37	2640.45
0705	63	8			80.85		12.64		102.84
	63	9			128.75		20.08		163.71
	63	51			207.90		99.00		337.59
	63	52			1035.36		602.00		1089.19
					1432.86		613.72		2493.24
0706	63	8			69.30				76.23
	63	9			75.05		11.84		96.66
	63	51			69.30		45.50		126.28
	63	52			302.57	1586.20	185.50		2281.70
	64	86			141.35	17.05	35.52		213.31
					141.35	1591.20	35.52		1944.88
					658.37	1603.25	278.36		2793.98
0707	61	85					102.98		113.28
	63	9			15.49		2.00		21.11
	63	9			15.45		5.28		22.90
	63	51			23.10		13.00		39.71
	63	52			109.73		122.00		256.90
					168.68		246.14		450.80

Figure D-5. MCA-2 Report

DISTRICT 27

OPERATION SUMMARY

SEPTEMBER 1968

1	8210.65	8663.06	4753.69	23790.14	160057.08	73048.11	74574.08	332441.20
2	15.50	34.00		54.56	34872.09	6010.71	7507.73	53229.58
14	26514.56	9975.09	16939.17	58776.10	112192.34	70787.16	78100.17	312570.60
21					967.49	22.75	548.30	1672.30
22	7737.14	2595.50	3613.24	15341.13	47153.92	9580.77	24842.60	89735.24
23	16521.16	1759.38	11145.53	32368.68	101379.31	16312.35	52177.02	187471.55
24	1850.66	461.02	712.54	3378.90	11921.31	1410.84	2861.98	17890.54
25	11213.71	22.45	16593.49	30613.13	82674.93	795.46	41634.99	137615.97
26	23.40		5.00	31.24	1840.20	195.77	190.67	2431.70
27	109.20	168.82	7.86	314.47	5316.13	1578.00	728.07	2384.42
31	7568.86	7226.69	1553.54	18753.45	89166.38	32726.54	16258.79	151266.88
32	3204.91	6408.45	1638.31	12376.94	16376.97	42455.29	7966.54	73378.46
33	4054.77	424.74	1153.33	6196.12	17493.69	1715.90	3835.51	25449.50
34	15.60		20.00	39.16	117.46	202.89	61.50	427.04
35		91.40		100.54	188.65	1020.35		1323.20
36		111.09		122.20	522.53	1081.47		1764.40
37						.50		.55
38	51.77		12.50	70.70	225.02	7612.00	55.00	9269.58
39						4662.00		5124.20
41					13490.67	36.74	3363.87	18580.41
42	19.50	91.67	45.00	171.79	25327.05	1213.51	17396.83	49232.13
43	372.74	4183.71	145.90	7659.59	13598.13	59457.56	35116.63	232454.41
52	616.50	140.12	76.96		916.24	3054.23	306.16	3973.83
53	7684.63	672.30	937.62		10224.01	36711.09	2193.84	48513.87
61	6467.97	9123.30	3080.00		20472.40	37862.92	14916.04	74221.78
62					2161.41		13022.16	16791.13
63		13630.87	13.50CR		14979.11	14100.37	24643.32	55027.74
64	1753.98	414.13	208.70		2614.49	2675.31	578.34	3871.34
66						2333.39	797.45	77042.10
69							6.75	7.43
80		15.00	13.50		31.35	788.43	897.00	2446.15
	104000.33	66916.80	62641.88	7659.59	265340.46	887499.12	430533.22	2007921.54

Figure D-6. MCA-4 Report
MINNESOTA HIGHWAY DEPARTMENT
MAINTENANCE COST ACCOUNTING

MCA-4
10

COMPARATIVE MONTHLY MAINTENANCE EXPENDITURES DISTRICT 1

SEPTEMBER 1964

EXPENDITURE	SEPTEMBER 1968	SEPTEMBER 1967	1968 TO DATE	1967 TO DATE
ROUTINE MAINTENANCE				
21 PATCH REPAIR GRADE SCARP	64,166.60	53,376.35	440,680.73	335,031.00
22 FILL AND 1 IN. GRADE JOINTS	6,600.00	7,331.17	50,241.76	95,416.31
REPAIR ROADWAY SURFACE TOTAL	60,203.08	7,257.52	490,922.49	430,447.31
14 PATCH CRACK FILLING RUTS ETC	29,043.75	25,307.69	106,234.09	102,433.04
SPROUTS AND APPROACH TOTAL	29,043.75	25,307.69	106,234.09	102,433.04
21 LEANER CUT FILL SLOPES SLIDES	865.66	1,095.62	33,545.74	24,136.28
22 TRAP DRAINAGE STRUCTURES CULV	16,779.10	16,675.13	109,611.20	88,590.06
23 CUTTING CLEARING VEGETATION	23,014.16	8,129.37	106,508.77	106,201.07
24 DAYSIDE REST AND CAMP AREAS	5,636.21	5,237.58	21,268.56	31,801.60
25 CLEANS TREES	4,523.30	4,644.51	64,276.51	53,571.04
26 RIGHT OF WAY FENCE AND MARKERS	.00	136.27	66.27	5,001.45
27 PLANTING TREES AND SEEDING	689.04	2,667.96	7,347.62	15,760.59
ROADSIDE AND LEAKAGE TOTAL	50,281.35	31,605.16	471,508.63	335,117.75
31 SIGNS AND MARKERS	20,777.57	24,436.00	113,216.87	145,226.66
32 TRAFFIC VIO GUIDE LINES	16,174.03	23,245.83	80,276.47	101,355.87
33 GUARD RAIL MAINTENANCE	4,566.44	2,567.26	21,706.64	19,230.03
34 APPLICATION DUST PAULIIVES	26.22	374.66	2,927.31	1,800.54
35 LIGHTING	2,226.17	187.75	7,248.44	7,481.77
36 SIGNALS AND DEVICES	99.66	61.66	747.93	651.62
37 INTERSTATE SIGNS AND MARKERS	.00	202.40	43,617.47	4,342.01
38 OTHER MAINTENANCE	1,175.01	.78	73,036.07	10,673.36
40 ROUTINE MAINTENANCE AGMT	.00	.00	350,605.76	303,019.70
TRAFFIC SERVICE TOTAL	43,024.90	50,650.96	1,542,553.53	6,095.14
41 SNOW PLOW BARRELING	63.81	.00	206,072.10	398,337.53
42 REMOVAL OF SNOW AND ICE	7.15	30.39	251,706.31	264,076.03
43 SNOW AND CHEMICAL APPLICATION	6,860.96	16,081.52	506,523.00	655,576.79
SUM. ALL ICE CONTROL TOTAL	9,991.92	16,112.11	22,400.33	15,536.02
52 REPAIRING	3,034.50	2,279.76	63,150.14	57,126.05
53 SUPPLY	3,263.09	6,199.16	66,156.51	75,262.97
SUM. SUPPLY TOTAL	12,098.69	10,478.96	127,306.65	132,389.02

APPENDIX E

NEVADA DEPARTMENT OF HIGHWAY'S Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 548,000 residents of Nevada operate 437,000 motor vehicles on 49,704 miles of highways of which 6,366 miles are under state control. The state occupies 110,540 square miles from an elevation of 470 feet to 13,143 feet above sea level. Mean minimum and maximum temperatures are 4 and 110°F with average annual moisture ranging from 4 to 28 inches.

The Nevada Department of Highways has a \$15,500,000 annual maintenance budget. This budget will be used by its 6 districts to maintain 11,794 lane miles of highway (5,486 center line miles of highway are maintained by the state).

Six districts comprise the Nevada Department Highways. Each district is divided into maintenance stations resulting in about 70 maintenance crews state wide.

Foremen are in responsible charge at the maintenance station with assistance from lead men. Foremen report to a supervisor who is often responsible for the activities of several foremen. The supervisor may or may not reside at the location of the district office. Maintenance supervisors report to the superintendent who works out of the district office. The superintendent reports to the Assistant District Engineer for maintenance who in turn reports to the District Engineer. The administration of the maintenance program for the State Highway Engineer of the Nevada Department of Highways is performed at the

central office level by the Maintenance Engineer and his staff.

The basic maintenance recording and reporting system was developed in the 1972 to 1974 period with the assistance of a consultant (Byrd, Tallamy, MacDonald and Lewis). A parallel recording system is being utilized. Manual recording of data is practiced in the field with electronic data processing utilized to compile and produce reports. Two years of reliable maintenance cost data are now available from the recording and reporting system.

RECORDING SYSTEM

Nevada Department of Highways Form NHD-034-012-10-72, "Activity Report" is utilized to collect maintenance activity information (Figure E-1). The type of information obtained on this form includes:

1. Activity performed,
2. Location activity performed,
3. Manpower utilization,
4. Equipment utilization,
5. Material utilization and
6. Accomplishments.

Information is coded daily on the Activity Report by the foreman for the maintenance crew. Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A number from 1 to 6 is utilized to designate the district. This number is the first number of the three character numeric code for "Division Code" as shown on the Activity Report.

2. Maintenance Station. Approximately 70 maintenance stations designate an area of responsibility which is headed by a foreman. Foremen numbers, which are the last two numbers of the Division Code, are used to identify the maintenance stations.

3. County. The county is identified by use of the county designation shown on milepost markers. County abbreviations are utilized. For example, EL designates Elko County.

4. Highway. The highway is designated by five character alphanumeric code. The first two characters designate the highway system (IR-Interstate, SR-State Route). The final three characters designate the highway number. For example, Interstate Route 80 would be recorded as IR 080.

These data are recorded in the columns marked "System and Route or Special Facility." Special Facility Numbers are utilized for such items as rest areas.

5. Milepost. Begin and end mileposts which designate the boundaries within which the maintenance activity was performed are recorded. Items such as structures and inter-change are located by a single milepost entry. Mileposts can be reported to the nearest 0.01 mile.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance activity indicates if the maintenance action was performed on the

pavement or shoulder for portland cement concrete pavements only, however, activities performed on the pavement can be separated from roadside activities, snow and ice control, etc.

Activity

"Maintenance activity codes" are utilized to designate the maintenance activity performed (Table E-1). Seventy-two maintenance activities are presently utilized and are divided into the following programs:

1. Planning and Scheduling
2. Flexible Pavement
3. Rigid Pavement
4. Repairing Miscellaneous Concrete Appurtenances
5. Roadside Maintenance
6. Roadside Cleanups
7. Roadside Facilities
8. Roadside Appurtenances
9. Traffic Service
10. Snow and Ice Control
11. Structure Maintenance
12. Betterments
13. Stockpile

The activities codes are five character numeric codes with the first three numbers indicating the program number and the last two numbers indicating the activity number.

It should be noted that special activity codes are utilized for maintenance on portland cement concrete pavements. Special codes also exist for snow and ice removal.

Manpower

Manpower utilization for a particular function is recorded to the nearest full hour for the entire crew by the foreman. The Division Code identifies the foreman. In recording the labor utilized, three entries are made in the columns headed, N, R, and OVT on the Activity Report as follows:

N Record the number of men working on the job during the day.

R Record the regular hours worked by each employee.

OVT Record the over-time hours worked by each employee.

A typical entry on the Activity Report would be 481 indicating 4 men each worked 8 regular hours and each worked 1 over-time hour. If 4 men worked 8 regular hours and 3 of the men worked 2 over-time hours with 1 man working 1 over-time hour, a double entry would be made. The first entry would be 382 with the second entry 181.

Special codes are utilized for supervisory personnel.

Equipment

Equipment utilized for a particular function is recorded. Equipment is identified by class and the number of hours or miles operated is recorded depending upon the type of equipment. Fifty-three equipment class codes can be utilized. Examples of some of the class codes are shown on Table E-2.

Total mileage for those items of equipment requiring daily mileage reports is placed in the "mileage" column on the Activity Report. Coupes, sedans, stationwagons, and survey wagons are in this category of equipment.

Reporting Equipment Usage

All equipment which is at the job site must be charged for the entire time it is required at the site regardless of how much it was actually used.

EXAMPLE: A loader is required to be at a job site for 8 hours to load a truck intermittently throughout the day. Only 4 or 5 loads were loaded and the actual usage time was only 30 minutes but the loader would be charged for the full 8 hours it was at the site.

If aggregates or other material hauled is involved in the performance of the maintenance activity, the one way haul distance is recorded in the "haul" column of the Activity Report. Mileage is reported to the nearest mile and hourly usage to the nearest full hour.

Materials

The quantity and material class is reported for all materials utilized to perform a maintenance activity. A partial list of material classes is shown on Table E-3. Quantity is reported to the nearest whole unit as designated on the material class list. If a material is not assigned to a specific material class the code 99 is utilized.

Material stockpiling activities have activity codes. Stockpiles can be assigned a coding number and material purchases can be identified for certain materials by the use of activity codes (Table E-1).

Accomplishments

Accomplishments are reported for all maintenance activities in the units assigned to the specific activity (cubic yards, man hours, square feet, tons, etc.). Accomplishments are recorded to the nearest whole unit.

COLLECTION AND PROCESSING OF RECORDED DATA

The Activity Report is filled out daily by the foreman for the crew for the work week and submitted weekly to the Foreman's Supervisor. The Supervisor edits the Activity Reports and mails them to the Headquarters Maintenance Office where they are subjected to another manual edit then a final machine edit. The computer edit includes date, system, route, county, M.P. location, accomplishment, labor, equipment and material. Headquarters Maintenance Management Coordinators discuss apparent errors with the District Maintenance Superintendent prior to making corrections to the Activity Report. A corrected copy of the Activity Report is then returned to the Foreman thru the district chain of command. Secretarial type employees are not utilized at the station level to record the data.

It is estimated that about two-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Nine thousand dollars for computer charges was expended in 1975-1976 fiscal year. The foreman requires about 10 minutes per day to record the information. The district superintendent requires about 2 hours per week and the central office staff requires about 8 to 10 hours per week to review and edit the recorded data.

Monthly reports are returned to the district by the 20th of the month following data collection.

REPORTS

A total of 37 maintenance management reports have been prepared. A listing of the programs according to the function they perform is shown below:

1. Eleven programs list inventory information, control files and edit errors.
2. Four budget-related programs
3. Three programs on organization and performance
4. One control program
5. Three informational summary programs
6. One exception report program
7. Two analysis detail programs
8. Five file creation programs
9. Seven support or housekeeping programs

Nineteen management reports are produced which fall into the following six categories:

1. Budget Reports
2. Performance Reports
3. Control Reports
4. Summary Reports
5. Exception Reports
6. Analysis Reports

A brief discussion is presented below which indicates the types of data reported for selected reports.

Productivity and Unit Cost Reports. The District Productivity and Unit Cost Report compares an individual foreman's crew productivity to the district weighted average productivity and the crew's

unit cost to the district weighted average cost for every maintenance activity reported by the foreman (Figure E-2). The district weighted average is the yardstick that enables the foreman to evaluate the crew's productivity and unit cost. Percent productivity is the crew productivity measured in terms of units produced per man-hour divided by the district productivity. The report is produced monthly with monthly and year to date values and is supplied to the foreman.

State Productivity Report. The state productivity report compares productivity among districts. The standard productivity obtained from work standards and the computed state weighted average productivity for the reported year are displayed on the report. Information is presented by maintenance activity. Figure E-3 is an example of the report which is prepared annually and distributed to the central office staff. This report is similar to the State Unit Cost Report.

Productivity/Unit Cost Exception. This report summarizes the productivity and costs which vary widely from district means. This exception report identifies those items which fall outside two standard deviations of the mean productivity value for a given activity. Figure E-4 is an example of such a report. This report is prepared monthly and distributed to the district engineer.

District and State Operations Reports. These reports display district totals from processed activity reports compared to accounting report totals. Administrative, overhead and all other accounting charges against the district budget are presented for the reporting month and the year to date. Totals are presented for the district by foreman's division. Figure E-5 is an example of the District

Operations Report. This report is prepared monthly and distributed to the district engineer. Labor, equipment, and material costs are presented. The State Operations Report is reported in basically the same format.

Man-Hour Utilization Reports. The District Man-Hour Utilization Report displays the district man-hours expended for each month of the year. Figure E-6 is an example of this report which is prepared annually for district office utilization. The State Man-Hour Distribution Report has an identical format and is prepared annually for central office use.

State Unit Cost Report. This report displays the standard unit cost, the state weighted average unit cost and the weighted average unit cost achieved by each district for each maintenance activity on a yearly basis. Figure E-7 is an example of this report which is prepared annually for district office utilization.

Summary of Equipment Hours and Material Quantity. Two reports, one for equipment and one for materials are generated for each district and for the state as a whole. Monthly material quantities coded by material class and equipment usage coded by equipment class are displayed by the month and totaled for the year. Figure E-8 and E-9 are statewide reports for materials and equipment respectively. These reports are issued annually for the central office and district staff.

System - Activity Summary. This report permits information to be requested in total or limited to district, activity division, route, specific location on route or other specific data. Labor, equipment, and material costs are reported together with accomplishment units.

Figure E-10 is an example of this report which is produced upon request.

Location Analysis Report. This report summarizes information on specific units within requested milepost limits for a specified period of time. Maintenance activities, units accomplished, labor costs, equipment costs and material costs are reported. Figure E-11 is an example of this report which is produced upon request.

Activity Analysis Report. This report summarizes information on a specific maintenance activity for a particular section, district or statewide. Items reported include location at which the activity was performed together with labor, equipment, and material costs, net productivity and net unit cost. Figure E-12 is an example of this report which is produced upon request.

District Performance Report. This report ranks district productivity and composite costs for a given month. High and low productivity and unit costs are reported on this report by maintenance activity. This summary is a form of an exception report. Figure E-13 is an example of this report which is produced upon request.

Work Accomplishment Report. The work accomplishment report (Figure E-14) compares the units of work completed and dollars expended to the units of work scheduled and dollar budget. This comparison is made by maintenance activity and maintenance program for the current month and year to date.

Planned quantities and budget amounts shown on this report are obtained from an established planning and scheduling program. Preceding year man-hour efforts and costs are supplied to the districts by the central office in the form of management reports.

District estimates of man-hour requirements by the month by activity (Figure E-15) are based on the data supplied by the district office and by the use of a road evaluation program. Man-hours are adjusted by the month to reflect available man-hours and a tentative budget is formulated. A report is generated delineating this tentative budget by activity. Man-hours, work load and costs are reported (Figure E-16).

A detailed inventory system is also a part of the maintenance management system. Details of the inventory as well as the budget preparation program can be found in the attached references.

It should be noted that man-hours are reported for the entire working crew. These hours are transferred to dollar values by use of an average cost per hour for an individual in the crew. The standard productivity rates are obtained from the maintenance work standard.

Reports are utilized to perform the following function:

1. Establish staffing levels for crews and the district,
2. Fiscal control,
3. Identify economic maintenance activity methods,
4. Compare station and district costs and
5. Budget preparation.

Exception reports are described above as part of the reporting system.

OTHER ITEMS

The Nevada Department of Highways is satisfied with the reliability of the existing system. The recording system utilizes foreman to

record information rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information. Training programs were an integral part of implementing the maintenance management system. Conferences were held with individual foremen as well as follow-up reviews after implementation of the program.

The recording and reporting system is under constant review by central office staff with input from the districts and stations. Changes in the system originate from the central office with input from the field.

A standing maintenance standard committee does not exist although maintenance standard committees were utilized to formulate the maintenance work standards.

Data collected can be stored on tape indefinitely under the present system.

References

Davis, K. J., "Examples of Use of a Maintenance Management System," presented to the Transportation Research Board, Maintenance Management Workshop Las Vegas, Nevada, July, 1975.

"Final Report on the Development and Implementation of a Maintenance Management System," prepared by Byrd, Tallamy, McDonald and Lewis, for the Nevada Department of Highways, July, 1974.

"Maintenance Management System Manual of Instruction," State of Nevada, Department of Highways, July, 1973.

TABLE E-1. MAINTENANCE ACTIVITIES

NEVADA DEPARTMENT OF HIGHWAYS

LIST OF ACTIVITIES

6.1.0 Work Programs

<u>PROGRAM NUMBER</u>	<u>ACTIVITY NUMBER</u>		<u>ACCOMPLISHMENT UNIT</u>
		<u>MAINTENANCE</u>	
100.00	100.01	PLANNING & SCHEDULING PROGRAM Planning & Scheduling	Man Hours
101.00		FLEXIBLE PAVEMENT PROGRAM	
	101.01	Base and Surface Repair	Cu. Yds.
	101.02	Surface Patching - Premix (Hand)	Cu. Yds.
	101.03	Surface Patching - Premix (Machine)	Cu. Yds.
	101.04	Surface Patching - Spot Seal	Sq. Yds.
	101.05	Seal Coat - Sand	Sq. Yds.
	101.06	Seal Coat - Flush	Sq. Yds.
	101.07	Crack Filling	Lbs. Filler Material
	101.08	Heater Planing	Sq. Yds.
	101.09	Seal Coat - Chips	Sq. Yds.
111.00		RIGID PAVEMENT PROGRAM (P.C.C.)	
	111.01	Temporary Patching of P.C.C. Pavements	Cu. Yds.
	111.02	Permanent Patching of P.C.C. Pavements	Cu. Yds.
	111.03	Paved Shoulder Repair (Premix)	Cu. Yds.
	111.04	Paved Shoulder Seal - Sand	Sq. Yds.
	111.05	Joint Sealing	Lbs. Filler Material
	111.06	Expansion Joint Repair	Lin. Ft.
112.00		REPAIRING MISC. CONCRETE APPURTENANCE PROGRAM	
	112.01	Repairing Miscellaneous Concrete Appurtenances	Cu. Ft.
131.00		ROADSIDE MAINTENANCE PROGRAM	
	131.01	Cleaning Culverts	Each
	131.02	Cleaning Culvert Openings & Drop Inlets	Each
	131.03	Dressing and Shaping Ditches	Lin. Ft.
	131.04	Cleaning Ditches	Cu. Yds.
	131.05	Culvert Repair and Replacement	Lin. Ft.
	131.06	Fill Slope Repair	Cu. Yds.
	131.07	Unpaved Shoulder Slope Maintenance (Blading)	Shoulder Miles
	131.08	Vegetation Control (Mowing, Flailing, Burnings, Etc.)	Shoulder Miles
	131.09	Vegetation Control (Chemical Weed Spray)	Shoulder Miles
	131.10	Vegetation Control (Hand Weeding)	Man Hours
133.00		ROADSIDE CLEANUP PROGRAM	
	133.01	Remove Debris, Litter, Trash	Shoulder Miles
	133.02	Empty Litter Barrels	Each
	133.03	Sweeping: Traveled Way, Shoulders & Gutters	Sweeping Miles
	133.04	Remove Roadway Debris	Traveled Miles
134.00		MAINTENANCE OF ROADSIDE FACILITIES PROGRAM	
	134.01	Maintenance of Rest Stops	Man Hours
	134.02	Maintenance of Roadside Parks	Man Hours
	134.03	Maintenance of Landscape Areas, with Turf	Man Hours
	134.04	Maintenance of Landscaped Areas without Turf	Man Hours
135.00		MAINTENANCE OF ROADSIDE APPURTENANCES PROGRAM	
	135.01	Repair of Right-of-Way Fences and Gates	Lin. Ft.
	135.02	Cattle Guards and Wings	Each
	135.03	Removal of Encroachments (Advertising Signs, etc.)	Each
	135.04	Inspection of Right of Way Fences and Gates	Fence Miles

TABLE E-1. (CONTINUED)

NEVADA DEPARTMENT OF HIGHWAYS

LIST OF ACTIVITIES

<u>PROGRAM NUMBER</u>	<u>ACTIVITY NUMBER</u>		<u>ACCOMPLISHMENT UNIT</u>
141.00		TRAFFIC SERVICE PROGRAM	
	141.01	Maintenance of Directional, Route and Warning Signs	Sq. Ft.
	141.02	Guardrail - Repair and Replacement	Lin. Ft.
	141.03	Guardrail - Painting	Lin. Ft.
	141.04	Guardrail - Cleaning	Lin. Ft.
	141.05	Pavement Striping - Dashed and Solid	Striping Miles
	141.06	Raised Pavement Markers	Each
	141.07	Pilot Lining	Pilot Line
	141.08	Pavement Markings and Painted Cattle Guards	Sq. Ft.
	141.09	Roadway Lighting Operations: Highway Lighting, Bridge and Approach Lighting	Man Hours
	141.10	Patrolling for Protection of Public Traffic	Traveled Miles
	141.11	Maintenance of Guideposts, R/W Markers, and Milepost Markers	Each
151.00		SNOW AND ICE CONTROL PROGRAM	
	151.01	Snow Removal, Plowing, Blading, Application of Abrasives, Chemicals	Man Hours
	151.02	Plowing with Rotary Snowplow	Man Hours
	151.03	Patrolling for Snow and Ice Control	Man Hours
	151.04	Installation or Removal of Snow Markers	Each
161.00		STRUCTURE MAINTENANCE PROGRAM	
	161.01	Maintenance and Repair of Structures	Man Hours
	161.02	Inspection of Structures (Bridges and Culverts)	Each
		<u>BETTERMENTS</u>	
254.00		A & B GRADING PROGRAM	
	254.01	Roadway Grade Improvement	Cu. Yds.
	254.02	Flood Control and Drainage Grading	Cu. Yds.
	254.03	Install Drainage Structures	Lin. Ft.
256.00		A & B SURFACE TREATMENT PROGRAM	
	256.01	No Activity Assigned	
	256.02	Bituminous Surface Treatment	Cu. Yds.
261.00		A & B TRAFFIC SERVICE PROGRAM	
	261.01	Erection of Route, Safety and Direction Signs	Sq. Ft.
	261.02	No Activity Assigned	
	261.03	Construct Cattle Guards	Each
	261.04	Construct Guardrail	Lin. Ft.
		<u>STOCKPILE</u>	
270.00		MATERIALS PRODUCTION PROGRAM	
	270.01	Aggregate Production	Cu. Yds.
	270.02	Premix Production	Cu. Yds.
	270.03	Mixing Salt and Sand	Cu. Yds.
	270.04	Hauling Materials	Cu. Yds.
	270.05	Chip Production	Cu. Yds.
280.00		MATERIALS PURCHASE PROGRAM	
	280.01	Purchase Aggregate	Cu. Yds.
	280.02	Purchase Premix	Cu. Yds.
	280.03	Purchase Plantmix	Tons
	280.05	Purchase Chips	Cu. Yds.

TABLE E-2. EQUIPMENT CLASS CODES

NEVADA MAINTENANCE MANAGEMENT SYSTEM

6.3.0 MOBILE EQUIPMENT CLASSIFICATION CODES

<u>CLASS CODE</u>	<u>DESCRIPTION</u>
(Mile-age)	Coupes, Sedans and Station Wagons
(Mile-age)	Survey Wagons, Units w/spc. Bodies
(Mile-age)	Pickups and Scouts
11	9,000 GVW Trucks (Garbage Trucks)
12	Trucks Dump Single Axle
13	Trucks Dump Tandem Axle
14	Trucks; Tractor
15	Trucks; All Wheel Drive
16	Trucks: Flatrack
17	Trucks; Service (Includes Lube, Sign Service, Boom, Mechanic Truck, Concrete Drill, Guardrail Washer, Sterilant, Spray Truck, etc.).
21	Line Striper
23	Traction Broom
24	Street Sweeper (Self-propelled)
25	Street Flusher - Semi-Mount
26	Compressors
27	Cranes and Fork Lifts (does not include truck-mounted cranes)
28	Distributors (truck or semi-mounted)
30	Maintenance Distributors (pot type to 600 gal., usually used for small patch operations (including petrolastic pots)).
31	Motor Graders
33	Pulvimixer (Includes self-propelled and towed-type).
34	Chip Spreader Box and Windrow Sizer (towed)
35	Loaders (except Industrial Style Tractors)
37	Conveyors
38	Conveyor w/Screens or Feeder
39	Concrete Mixers
40	Patcheaters (towed)
41	Mowers, Rockpickers, Roto Shreaders, Maintainer (If mower is towed, a class 54 tractor should also be coded.)
42	Rotary Plows
44	Rollers Pulled
45	Rollers, Steel Wheel (includes vibratory)
47	Rollers, Pneumatic Tired
48	Shovel & Backhoe Combination, Truck Mounted
50	Welders, Trailer Mounted
51	Electric Plants
53	Water Tanks, Trailer Mounted
54	Tractors Industrial w/Attachments (Includes Sickle Mower, Loader, Auger, etc.)

TABLE E-3. MATERIAL CLASS CODES

NEVADA MAINTENANCE MANAGEMENT SYSTEM

6.2.0 MATERIALS CLASSIFICATION CODES

CLASS CODE	DESCRIPTION	UNITS	CLASS CODE	DESCRIPTION	UNITS
1	AGGREGATE - This class includes gravels, sand, concrete aggregate.	Cu.Yd.	19	PROPANE - This class includes only the propane purchased for filling trailer-mounted L.P.G. Trailer Tanks.	Gallons
2	CHIPS - This class includes only those that meet gradation requirements of screenings. (See Standard Specifications for Road and Bridge Construction)	Cu.Yd.	20	GUIDE POSTS - This class includes only the physical metal posts and does not include the sign plate or panel.	Each
5	PREMIX - This class includes premix produced by state or commercial sources. (Produced with a liquid asphalt such as SC 800).	Cu.Yd.	21	SIGHT PLATES - This class will include snow delineators (1-1/2" x 4"), sight plates (4" x 2" with silver or yellow scotchlite), and guard rail delineators (3" x 14").	Each
6	CHLORIDES (Salt)	Cu.Yd.	22	MARKER PLATES - This class will include milepost panels and hazard marker plates.	Each
7	SALT AND SAND - This class includes all salt and sand mix used for snow and ice control.	Cu.Yd.	23	SNOW POLES - This class includes manufactured snow poles which are installed on guide posts.	Each
8	PLANTMIX - This class includes all plantmix purchased from a commercial source that is directly applied to the road surface. (Produced with an Asphalt Cement).	Ton	24	SIGNS - All signs will be included in this class.	Sq. Ft.
9	EXPANSION JOINT FILLER MATERIAL	Lin.Ft.	25	WHITE PAINT - This class includes paint used on traffic lines, pavement markings or guardrail.	Gals.
10	CEMENT	Sack	26	GLASS BEADS	Pounds
11	CONCRETE - This class is limited to ready mixed concrete from a batch plant or commercial source.	Cu.Yd.	27	YELLOW PAINT - This class includes paint used on traffic lines and pavement markings.	Gallons
12	LIQUID ASPHALT - This class includes liquid asphalts, asphalt cements, emulsions, etc.	Gals.	28	PAINT THINNER	Gallons
13	CRACK AND JOINT FILLER	Pounds	29	SIGN POSTS - This class includes only 1", 2" and 3" pipe used in the replacement or original installation of signs.	Lin.Ft.
14	FERTILIZER	Pounds	30	FENCE POSTS - This class includes metal and wood fence posts.	Each
15	FERTILIZER	Gallons	31	BARBED WIRE FENCING - This class includes only barbed wire.	Lin.Ft.
16	INSECTICIDES AND HERBICIDES	Pounds	32	STEEL GUARDRAIL - This class will include all panels and hardware necessary for erection of guard rail.	Lin.Ft.
17	INSECTICIDES AND HERBICIDES	Gallons	33	STEEL CATTLEGUARD - This class will include only prefabricated portions of cattleguards. When portions of cattleguards are constructed, the materials incorporated in the work would be coded (concrete, cement, aggregate, etc.).	Lin.Ft.
18	PROPANE CYLINDERS - This class includes only the propane purchased in cylinder containers having 100 lb. capacity.	Each	34	CULVERT PIPE - Includes 18" culvert pipe and excludes end sections or headwalls.	Lin.Ft.
			35	CULVERT PIPE - Includes 24" culvert pipe and excludes end sections or headwalls.	Lin.Ft.

DIVISION CODE

WEEK ENDING _____, 19____

[illegible]

NHD
 034-017
 10-73
 REVISED 2 73

793

Figure E-1. Activity report

STATE OF NEVADA										
DEPARTMENT OF HIGHWAYS										
MAINTENANCE MANAGEMENT SYSTEM										
PRODUCTIVITY AND UNIT COST REPORT										MMS RPT 0-1
FOR DECEMBER										RUN 01/22/75
FOREMAN: GARRISON (451)										
ACTIVITY	DESCRIPTION	UNIT	MAN HOURS CREW	DIST	UNIT/MNHRS CREW	DIST	% PRCD.	UNIT COST CREW	DIST	% COST
100.01	PLANNING & SCHEDULING	MN HR	31	69	1.00	1.00	100	9.31	9.35	96
	YTD TOTALS:		73	347	1.00	1.00	100	8.88	8.07	100
101.01	BASE & SURFACE REPAIR	CU YD								
	YTD TOTALS:		114	305	2.36	1.47	169	5.51	10.37	51
101.02	SURF PATCH PREMIX HAND	CU YD	10	13	.13	.13	100	70.11	70.11	100
	YTD TOTALS:		617	1,095	.13	.13	77	115.87	85.46	130
101.03	SURF PATCH PREMIX MACH	CU YD								
	YTD TOTALS:		959	3,779	1.47	1.20	123	19.14	23.21	82
101.04	SURF PATCH SPOT SEAL	SQ YD	164	264	508.30	415.72	122	.76	.37	86
	YTD TOTALS:		164	284	508.30	375.50	135	.06	.07	86
101.02	CLEAN CULVRT OPEN & DT EACH									
	YTD TOTALS:		34	34	1.21	1.21	100	6.94	6.94	100
101.03	DRESS & SHAPE DITCHES	LN FT	131	147	720.46	661.78	109	.02	.02	100
	YTD TOTALS:		131	147	720.46	661.78	109	.02	.02	100
101.04	CLEANING DITCHES	CU YD	60	242	6.70	3.42	80	2.09	1.41	148
	YTD TOTALS:		192	519	4.63	6.55	71	2.71	1.84	147
101.06	ROAD SECTION RESTORE	CU YD	117	682	3.75	5.20	72	3.44	2.65	130
	YTD TOTALS:		145	1,367	5.34	5.33	100	2.32	2.53	92
101.09	VEGETATION CONTROL MOW SH MI			408		.53			22.50	
	YTD TOTALS:		154	1,900	.96	.61	119	15.69	17.12	92
101.10	VEGETATION CONTROL MND MN HR			93		1.17			7.47	
	YTD TOTALS:		111	665	1.02	1.09	94	3.31	7.86	106

** ACTIVITY 100.01 HAS BEEN PHASED

Figure E-2. Productivity and unit cost report

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM

STATE PRODUCTIVITY REPORT
JULY 1974 THRU OCTOBER 1974

MMS RPI U-J
RUR 12/C3/74

ACTIVITY DESCRIPTION	ACCOMPLISHMENT UNITS	STANDARD UNIT/HR	STATE	DIST. ONE	DIST. TWO	DIST. THREE	DIST. FOUR	DIST. FIVE	DIST. SIX
101.01 B & S REPR	CU YD	1.200	1.219	1.039	1.118	1.126	1.461	2.762	
101.02 SUR PACH H	CU YD	.125	.139	.294	.120	.241	.139	.077	.075
101.03 SUR PACH M	CU YD	1.700	1.293	.650	1.909	1.248	1.267	.828	.934
101.04 SUR PACH S	SQ YD	155.000	113.148	133.333	6,522	112.357		115.518	101.885
101.05 SEAL COT S	SQ YD	480.000	351.513	331.401	575.931	592.325	389.320	216.849	257.556
101.06 SEAL CUT F	SQ YD	725.005				136.912		538.933	
101.07 CRACK FILL	LB	45.000	50.337	23.895				107.130	
101.08 HEAT PLAN	SQ YD	55.000	52.892		59.205	32.095			
101.09 SL CUT CHP	SQ YD	374.995	288.127					295.648	
111.01 PAT SPAL T	CU YD	.111							
111.02 P & FO PAT	CU YD	.035							
111.03 PV SH HA P	CU YD	1.000							
111.04 PV SH SL S	SQ YD	480.000							
111.05 JOINT SEAL	LB	10.000							
111.06 EXP JNT RP	LN FT	1.600	7.312	7.312					
112.01 RPR CON AP	CU FT	6.000	.857	.100	.200	1.778			
131.01 CLEAN CULV	EACH	.225	.313	.819	.201		.714	.063	.083
131.02 CLN CO U:	EACH	1.000	.929	.990	.935	.797	.933	.755	.756

Figure E-3. State productivity report

DISTRICT NO. 1			FOR DECEMBER		RUN 01/22/75	
STATION	ACTIVITY	DESCRIPTION	PRODUCTIVITY EXCEPTIONS	DISTRICT MEAN PROD.	COST EXCEPTIONS	DISTRICT MEAN COST
123	133.04	REMOVE ROADWAY DEBRIS			43.80 TR MI	1.02
126	133.02	EMPTY LITTER BARRELS			6.62 EACH	3.16
128	133.02	EMPTY LITTEN BARRELS	6.75 EACH /MAN HR.	3.00		
129	131.02	CLEAN CULVRT OPEN & DI			234.24 EACH	5.69
152	141.11	MAINTAIN POSTS-MARKERS			13.91 EACH	4.87

Figure E-4. Productivity/unit cost exception

DISTRICT OPERATIONS REPORT FOR THE PERIOD 3-18 THRU 4-15						MMS RPT 0-4 RUN 06/03/75				
DISTRICT: 5						YEAR TO DATE				
MAINTENANCE, STOCKPILES, BETTERMENT EXPENSES:	HOURS	LABOR COSTS	EQUIPMENT COSTS	MATERIAL COSTS	TOTAL COSTS	HOURS	LABOR COSTS	EQUIPMENT COSTS	MATERIAL COSTS	TOTAL COSTS
ACTIVITY REPORT TOTAL	6,270	43,436	41,187	8,012	92,635	61,916	433,329	364,064	288,676	1,086,070
ACCOUNTING TOTALS	6,125	36,256	40,164	7,482	83,902	59,864	396,919	318,671	372,971	1,088,562
CONST SERVICES										
MAINT ACTIVITIES	6,125	36,256	40,164	7,482	83,902	59,864	396,919	318,671	372,971	1,088,562
OPERATIONAL EXPENSES:										
ADMINISTRATION	1,011	8,534	1,057	1,092	10,685	9,749	95,541	12,009	7,962	115,513
MAINTENANCE STATIONS	644	3,935	716	9,086	13,739	6,066	42,043	6,237	61,284	109,565
EQUIPMENT SERVICE	551	3,230	496		3,727	4,857	32,519	5,250	63	37,833
NON RENT EQUIP	16	80		498	578	16	80		498	578
OTHER AGENCIES										
MISCELLANEOUS	155	1,196	392	421	2,010	2,704	21,791	4,856	12,450	39,598
PURCHASED STOCK (INVENTORY CREDITS)				2,537	2,537				22,583	22,583
ACTUAL DISTRICT TOTALS:	8,502	53,234	42,828	21,117	117,180	83,490	590,392	347,207	311,304	1,248,903
OPERATIONAL EXPENSES CREW ANALYSIS										
STATION: 501										
MAINTENANCE STATION	88	589	120	150	859	856	6,457	1,161	3,795	11,414
EQUIPMENT REPAIR						16	120			120
NON RENT EQUIP						94	660	12		672
OTHER AGENCIES										
MISCELLANEOUS	1,148	9,595	1,308	1,233	12,137	11,280	109,146	14,990	8,834	132,971
STATION: 521										
MAINTENANCE STATION				1,187	1,187				7,898	7,898
EQUIPMENT REPAIR										
NON RENT EQUIP				33	33				33	33
OTHER AGENCIES										
MISCELLANEOUS				88	88				6,958	6,958
STATION: 522										
MAINTENANCE STATION	58	398		1,440	1,838	325	2,120	97	8,587	10,805
EQUIPMENT REPAIR	52	269			269	599	3,802	528		4,330
NON RENT EQUIP	16	80			80	16	80			80
OTHER AGENCIES										
MISCELLANEOUS						57	325		1,027	1,353

Figure E-5. District operations report

MAN-HOUR UTILIZATION REPORT FOR 1973													MMS RPT 0-13 RUN 07/29/74	
DISTRICT: ONE														
ACTIVITY DESCRIPTION	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL	
135.02 MAINT CATTLE GUARDS	17	20		6	4			42	4	12	6		111	
135.03 REMOVE ENCRDACHMENTS	5			16					75	3	4	4	107	
135.04 INSPECT RW FENCES GATE	24		7	32	33	55	36	42	16	64	32	32	372	
141.01 MAINT ROUTE-WARN SIGNS	435	402	395	394	437	387	417	403	206	306	376	473	4,631	
141.02 GUARDRAIL REPAIR	240	75	71	54	85	193	76	86	55	56	24	48	1,063	
141.02 GUARDRAIL PAINTING	136	28	472	250	146				16				1,056	
141.04 GUARDRAIL CLEANING						5							5	
141.05 PAVEMENT STRIPE DASHED	203	228	135	21	284	264	144	174	101	180	104	272	2,190	
141.06 PAVEMENT STRIPE SOLID	48	164	164			76		237	210	250	32	56	1,237	
141.07 PILOT LINING	452			120		96	8		32	24	22	96	850	
141.08 PAVEMENT MARKINGS	384	305	274	444	306	165	321	186	155	264	532	324	3,666	
141.09 ROW LIGHTING SYSTEM														
141.10 PATROLLING	18		25	10		47	63	59	101	120	80	32	555	
141.11 MAINTAIN POSTS-MARKERS	246	426	366	267	334	425	375	344	169	277	249	266	3,764	
151.01 SNOW REMOVAL						123	55	1,027	30	133	10		1,378	
151.02 SNOW PLOW ROTARY PLOW														
151.03 SNOW & ICE PATROLLING							9	76	6		14		105	
151.04 INST/REM SNOW MARKERS					44	44					30		118	

Figure E-6. District man-hour utilization report

STATE UNIT COST REPORT										MMS RPT D-9	
JULY 1974 THRU OCTOBER 1974										RUM 12/03/74	
ACTIVITY DESCRIPTION	ACCOMPLISHMENT UNITS	STANDARD UNIT COST	STATE	DIST. ONE	DIST. TWO	DIST. THREE	DIST. FOUR	DIST. FIVE	DIST. SIX		
100.01 PLAN & ICD	NU HR	6.96	7.49	7.99	7.28	7.49	9.47	7.09	7.06		
101.01 B & S REPR	CU YD	19.02	14.09	17.06	14.75	20.73	10.77	8.95			
101.02 SUR PACH M	CU YD	98.12	79.06	40.97	89.48	50.49	83.01	138.00	136.38		
101.03 SUR PACH M	CU YD	18.08	20.58	29.80	16.52	20.49	22.73	26.15	26.08		
101.04 SUR PACH S	SQ YD	.13	.18	.15	2.09	.18		.18	.21		
101.05 SEAL CUT S	SQ YD	.08	.11	.13	.09	.07	.10	.12	.16		
101.06 SEAL CUT F	SQ YD	.03	.05	.06	.04	.16	.04	.06	.03		
101.07 CRACK FILL	LB	.30	.29	.52				.19			
101.08 HEAT PLAN	SQ YD	.29	.31		.28	.51					
101.09 SL COY CHP	SQ YD	.22	.22					.22			
111.01 PAT SPAL T	CU YD	89.08									
111.02 P & FO PAT	CU YD	224.98									
111.03 PV SH HA P	CU YD	21.62									
111.04 PV SH SL S	SQ YD	.09									
111.05 JOINT SEAL	LB	1.07									
111.06 EXP JNT RP	LN FY	6.07	3.57	3.17							
112.01 RPK CON AD	CU FT	2.48	13.80	72.27	44.82	9.24					

** ACTIVITY 100.01 HAS BEEN PRORATED

Figure E-7. State unit cost report

MATERIAL CLASS	SUMMARY OF EQUIPMENT HOURS AND MATERIAL QUANTITIES STATE WIDE												TOTAL
	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	
1 AGGREGATE	39,478	47,719	21,212	9,999	9,295	5,529	5,644	1,447	2,123	3,166	8,645	28,363	182,620
2 SCREENINGS	2,700	1,288	65	3,859	46	257	714	434			533	1,256	11,152
5 PREMIX	34,064	45,765	17,305	4,615	284	274	430	450	596	1,329	1,312	17,000	123,414
6 SALT				574	2,043	1,280	764	134	187		4		4,986
7 SALT-SAND				74	5,825	6,193	7,934	3,050	2,172	919	39		28,206
8 PLANTMIX		125	4,851	269						13	1	638	5,497
10 CEMENT	5	15	32	46	56	42	69	60	20	56	44	69	514
11 CONCRETE	6		9		14	3			9	3	8		52
12 LOD ASPH	1,001,497	1,198,535	645,341	271,534	17,622	30,812	20,626	24,232	20,648	65,496	333,413	762,785	4,392,541
13 CRACK FILL		170	400		7,600	52,100	73,900	76,800	60,200	27,500	3,523		302,193
14 FERTILIZER	1,773	1,215	460	80	80			2,293	39	1,470	140	1,340	8,921

Figure E-8. Material quantity summary report

EQUIP. CLASS	SUMMARY OF EQUIPMENT HOURS AND MATERIAL QUANTITIES STATE WIDE												TOTAL
	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	
24 ST SWEEPER	447	443	469	454	334	327	405	426	538	428	615	504	5,195
25 ST FLUSHER	48	114	161	59	43	53	8	37	89	172	218	320	1,322
26 COMPRESSOR	82	75	95	109	96	230	119	131	228	223	98	62	1,568
28 DISTRIB	469	641	689	295	118	96	170	240	225	157	134	307	3,541
30 MAINT DIST	1,248	1,467	996	869	272	918	1,279	1,607	1,307	1,309	421	643	12,036
31 GRADERS	4,990	5,560	3,314	2,588	1,728	1,738	1,281	1,518	2,234	2,875	3,449	4,000	35,275
33 PULVIMIXER	970	837	451	127		8				24	92	680	3,189
34 CHIP SPAD	664	903	385	161	44			6	32	95	94	574	2,460
35 LOADERS	4,798	4,984	3,975	3,697	4,033	3,668	3,616	2,942	4,042	4,352	4,495	5,009	49,611
37 CONVEYORS	1,182	902	909	1,269	1,143	1,040	952	884	636	1,140	854	362	11,273
38 CONVEY W/S	350	238	160	134	296	240	376	360	272	349	206	94	2,975

Figure E-9. Equipment usage summary report

SYSTEM ROUTE-ACTIVITY SUMMARY											MMS RPT 0-14 RUN 12/06/74	
SYSTEM ROUTE	FROM DATE	TO DATE	DIST	CTY	FROM MILEPOST	TO MILEPOST	ACTIVITY	ACCOMPL. UNITS	TOTAL LABOR	TOTAL EQUIP.	TOTAL MAT'L	TOTAL COSTS
FA 534	7- 1	6-30	1				141.05	35	1,037	503	1,439	2,979
FA 538	7- 1	6-30	1				141.05	26	362	177	3,825	4,364
FA 806	7- 1	6-30	1				141.05	13	295	163	453	911
FA 812	7- 1	6-30	1				141.05	9	108	48	198	354
FA 815	7- 1	6-30	1				141.05		43	25	50	118
FR 403	7- 1	6-30	1				141.05	4	108	49	91	248
FR 406	7- 1	6-30	1				141.05	1	43	23	52	118
FR 407	7- 1	6-30	1				141.05	5	135	71	94	300
FR 416	7- 1	6-30	1				141.05	1	41	23	45	109
FR 419	7- 1	6-30	1				141.05	1	108	44	25	177
FR 420	7- 1	6-30	1				141.05		22	11	440	473
IR 015	7- 1	6-30	1				141.05	232	2,904	1,326	3,797	6,027
RP 808	7- 1	6-30	1				141.05		22	11	6	39
SR 035	7- 1	6-30	1				141.05	22	421	233	478	1,132
SR 007	7- 1	6-30	1				141.05	1	65	53	27	145
SR 012	7- 1	6-30	1				141.05	30	584	391	543	1,518
SR 029	7- 1	6-30	1				141.05	37	756	472	593	1,821
SR 039	7- 1	6-30	1				141.05	4	173	111	102	386
SR 041	7- 1	6-30	1				141.05	19	471	216	384	1,021
SR 060	7- 1	6-30	1				141.05	14	173	123	267	563
SR 068	7- 1	6-30	1				141.05	19	226	135	229	590

Figure E-10. System route activity summary

LOCATION ANALYSIS REPORT										MMS RPT 0-11 RUN 12/11/74	
ROUTE: SR 027 WA FROM: 14.00 TO: 26.53 FROM: 7-1 TO: 10-30											
ACTIVITY	UNITS ACCOMPLISHED	NET MAN HRS	NET LABOR COSTS	NET EQUIP. COSTS	MATL. COSTS	TRAVEL TIME	AVE. HAUL DISTRICT	NET PROD.	NET UNIT COSTS		
101.02 SUR PACH H CU YD	8	77	535	172	81	2.14		.104	98.65		
131.07 SH SLP MNT SH MI	10	165	1,133	956		6.24		.061	209.00		
133.03 SWEEPING SW MI	48	14	101	107		.77		3.429	4.34		
135.03 RMV ENCIRRM EACH	24	4	27	5		1.84		6.000	1.38		
141.01 MNT SIGNS SQ FT	248	13	87	45	93	3.35		19.077	.91		
141.11 MNT MARKER EACH	137	62	434	206	156	5.42		2.210	5.82		
151.01 SNOW REMOV MN HR	28	28	265	231		2.58		1.000	17.74		
151.04 SNOW MARK EACH	520	27	191	74		1.14		19.259	.51		

Figure E-11. Location analysis report

ACTIVITY ANALYSIS REPORT

MMS RPT 0-12

RUN 08/22/74

REQUESTED ACTIVITY 141-07 PILOT LINING

REQUESTED DIVISION 127

REQUESTED MONTH 10

DATE	LOCATION	UNITS ACCOMPLISHED	NET LABOR HOURS	NET LABOR COSTS	NET EQUIP COSTS	MATERIAL COSTS	TRAVEL TIME	HAUL DISTANCE	NET PRODUCTIVITY	NET UNIT COST
6-17	SR 068 CL	.00 1.50	1 32	216	24		1.12		.03	240.32
6-18	SR 068 CL	1.50 3.00	2 32	216	24		1.02		.06	120.22
6-19	SR 068 CL	3.00 5.60	2 32	216	20		.90		.06	118.54
6-20	SR 068 CL	6.40 10.30	4 32	216	18		.68		.13	58.58
6-21	SR 068 CL	10.30 14.20	4 32	216	18		.46		.13	58.58
6-24	SR 068 CL	14.20 18.60	4 32	216	18		.22		.13	58.58
6-25	SR 068 CL	1.90 5.00	3 32	216	18		.96		.09	78.11
6-26	SR 068 CL	5.10 9.20	4 32	216	10		.74		.13	58.58

Figure E-12. Activity analysis report

DISTRICT PERFORMANCE REPORT
FOR DECEMBER

MMS RPT 0-6

RUN 01/22/75

DISTRICT NO.	COMPOSITE PRODUCTIVITY RATING %	DISTRICT NO.	COMPOSITE UNIT COST RATING %
6	127	6	89
3	124	3	95
2	119	5	97
5	114	2	99
1	97	1	107
4	96	4	114

MAX-MIN PRODUCTIVITY/UNIT COST

ACTIVITY	PRODUCTIVITY		UNIT COST	
	HIGH STATION	LOW STATION	HIGH STATION	LOW STATION
101.01 B & S REPR	128	234	398.75	128
101.02 SUR PACH H	350	234	208.39	123
101.03 SUR PACH M	253	350	29.72	253
101.04 SUR PACH S	451	429	1.92	451
101.05 SEAL COT S	623	623	.14	623
101.06 SEAL COT F				
101.07 CRACK FILL	351	227	.87	351
101.08 HEAT PLAN	650	650	.24	650

Figure E-13. District performance report

DISTRICT: SIX
MONTH: DECEMBER

WORK ACCOMPLISHMENT REPORT

MMS RPT 0-3

RUN 01/22/75

ACTIVITY	MONTHLY				YEAR TO DATE			
	UNITS COMPL	UNITS SCHED	DOLLARS EXPENDED	DOLLARS BUDGETED	UNITS COMPL	UNITS SCHED	DOLLARS EXPENDED	DOLLARS BUDGETED
100.01 PLANNING & SCHEDULING	33	65	223	485	262	390	1,823	2,910
101.01 BASE & SURFACE REPAIR			223*	485*			1,378*	2,910*
101.02 SURF PATCH PREPARE HAND						192		2,908
101.03 SURF PATCH PREPARE MACH			4,192	3,592	84	203	12,808	19,159
101.04 SURF PATCH SPOT SEAL				1,773	1,082	1,360	20,462	22,744
101.05 SEAL COAT SAND		15,500			7,654	31,000	1,801	3,546
101.06 SEAL COAT FLUSH	2,351		438		341,444	384,006	55,583	26,984
101.07 CRACK FILLING	4,744	27,000	3,325	7,798	351,205	652,535	12,000	32,685
101.08 HEATER PLANING	29,122		7,781		11,593	54,600	8,520	15,595
101.09 SEAL COAT-CHIPS					33,194	11,000	8,971	2,874
			15,736*	13,163*			277	
111.01 PATCH SPALL AREAS TEMP							128,422*	126,695*
111.02 PART 4 FULL DEPTH PATCH								
111.03 PAVED SHO MAINTENANCE P								
111.04 PAVED SHO SEAL SAND								
111.05 JOINT SEALING								
111.06 EXPANSION JOINT REPAIR								
112.01 REPAIR MISC CONC APURT						150		390
131.01 CLEANING CULVERTS								390*
131.02 CLEAN CULVERT OPEN & DI						22	241	1,136
131.03 DRESS & SHAPE DITCHES	12	30	176	344	111	160	2,206	2,064
131.04 CLEANING DITCHES					2,525	60,000	403	2,576
131.05 CULVERT REPAIR REPLACE		262		648	14,569	2,351	5,100	5,832
131.06 ROAD SECTION RESTORE	2	8	96		2	24	96	
131.07 SHOULDER SLOPE MAINT ROAD	4,387	3,375	7,917	6,241	9,891	15,525	24,737	28,709
131.08 VEGETATION CONTROL MOW	7		298		26	80	1,973	4,745
131.09 VEGETATION CONTROL SPR	32	165	416	4,260	1,052	880	24,816	22,720
131.10 VEGETATION CONTROL MOW	87	100	1,406	2,352	372	200	6,601	4,764
131.11 VEGETATION CONTROL MOW					8	50	94	
131.01 REMOVE DENNIS LITTER			10,309*	13,045*			66,327*	72,486*
131.02 REMOVE LITTER HANDS	10		350		85	240	7,127	5,370
131.03 REMOVE LITTER HANDS	217	150	775	442	1,791	1,400	5,106	4,420
131.04 REMOVE LITTER HANDS	27	80	344	705	333	400	6,528	4,230
					9,477	6,079	12,794	7,944

Figure E-14. Work accomplishment report

MMS RPT B-2
RUN 05/02/74

DISTRICT NO. 6 BUDGET INPUT REPORT

ACT. NUMBER	ACTIVITY DESCRIPTION	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL EST MN HRS	TOTAL BUDGET MN HRS	CREN DAYS	CREW SIZE	UNITS /MN HRS	CHILL /22.1 RATIO
100.01	PLAN & SCD	65	65	65	65	65	65	65	65	65	65	65	65	780	1020	128	1	1.000	7.4
101.01	B & S REPR			80	80				80	80				320	71	1	2	1.000	15.7
101.02	SUR PACH H	100	100	100	500	500	300	300	300	500	500	200	100	3500	5470	171	4	.113	11.5
101.03	SUR PACH M	200	300	200	100							100	100	1000	3215	80	5	1.541	28.6
101.04	SUR PACH S					100	100	100	100	100	100	100		700	320	13	3	141.991	17.7
101.05	SEAL COT S	400	300	100								500	800	2100	3223	40	10	435.765	33.7
101.06	SEAL COT F	400	400	100								200	600	1700	3533	63	7	657.647	36.7
101.07	CRACK FILL				200	400	600	1000	1000	1000	500			4700	2033	71	5	40.326	12.5
101.08	HEAT PLAN				200							300		400	859	21	5	50.066	14.3
101.09	SL COT CHP													0	1207	11	14	342.735	76.7
111.01	PAT SPAL T													0					
111.02	P & FO PAT													0					
111.03	PV SH MA P													0					
111.04	PV SH SL S													0					
111.05	JOINT SEAL													0					
111.06	EXP JMT RP													0					
112.01	RPR CON AP	5	5	5	5	5					5	5	5	40	72	5	7	5.750	15.7
131.01	CLEAN CULV				50	50				50	50			200	325	14	3	.197	11.5

E-37

Figure E-15. Budget input report

MMS RPT B-1
RUN 05/02/74

PRELIMINARY COMPUTED DISTRICT
MAINTENANCE BUDGET

ACTIVITY	MAN HOURS	WOPK LOAD	COSTS	ACTIVITY	MAN HOURS	WOPK LOAD	COSTS
100.01	PLANNING & SCHEDULING	1,020	7,619	134.01	MAINTENANCE REST STOPS	416	2,496
101.01	BASE & SURFACE REPAIR	71	1,290	134.02	MAINT OF ROADSIDE PARK	2,496	2496
101.02	SURF PATCH PREMIX HAND	5,470	617	134.03	MAINT LANDSCAP AREA WT		
101.03	SURF PATCH PREMIX MACH	3,215	4,954	134.04	MAINT LANDSCAP AREA WOT		
101.04	SURF PATCH SPOT SEAL	320	4,543				
101.05	SEAL COAT SAND	3,223	140,470	135.01	REPAIR RR FENCE GATES	200	4,012
101.06	SEAL COAT FLUSH	3,528	232,675	135.02	MAINT CATTLE GUARDS	915	52
101.07	CRACK FILLING	2,833	115,659	135.03	REMOVE ENCROACHMENTS	233	107
101.08	HEATER PLANTING	459	43,007	135.04	INSPECT RR FENCES GATE	72	401
101.09	SEAL COAT-CHIPS	1,207	41,307				
111.01	PATCH SPALL AREAS TEMP	20,736	543,706	141.01	MAINT ROUTE-MARKING SIGNS	2,052	13,270
111.02	PART & FULL DEPTH PATCH			141.02	GUARDRAIL REPAIR	478	1272
111.03	PAVD SHO MAINTENANCE P			141.03	GUARDRAIL PAINTING	670	23,401
111.04	PAVD SHO SEAL SAND			141.04	GUARDRAIL CLEANING	321	95,647
111.05	JOINT SEALING			141.05	PAVEMENT STRIPE DASHED	1,480	814
111.06	EXPANSION JOINT REPAIR			141.06	PAVEMENT STRIPE SOLID	739	404
112.01	REPAIR MISC CONC APURT	72	414	141.07	PILOT LINING	567	67
131.01	CLEANING CULVERTS	325	64	141.08	PAVEMENT MARKINGS	1,044	40,770
131.02	CLEAN CULVERT OPEN & DI	649	584	141.09	PAVEMENT LIGHTING SYSTEM	107	167
131.03	DRESS & SHAPE DITCHES	3,100	840,390	141.10	PATROLLING	249	4,273
131.04	CLEANING DITCHES	2,908	13,804	141.11	MAINTAIN POSTS-MARKERS	4,712	10,696
131.05	REMOVE SAND DRIFT						
131.06	ROAD SECTION RESTORE	2,799	17,811	151.01	SNOW REMOVAL	4,182	67,876
131.07	SLOPE SLOPE MAINT BLAD	769	134	151.02	SNOW PLOW ROTARY PLOW	281	263
131.08	VEGETATION CONTROL MOW	7,533	3743	151.03	SNOW & ICE PATROLLING	689	3431
131.09	VEGETATION CONTROL SPR	516	469	151.04	INST/REM SNOW MARKERS	970	8,402
131.10	CULVERT REPAIR REPLACE						
133.01	REMOVE DEBRIS LITTER	18,594	251,984	161.01	MAINT REPAIR STRUCTURE	281	263
133.02	EMPTY LITTER BARRELS	3,334	29,856	161.02	INSPECT STRUCTURES	689	3431
133.03	SNOWING TRVLO HW & SH	1,012	2746				
133.04	REMOVE ROADWAY DEBRIS	613	979				
		3,130	21,147				
		8,109	75,374				

Figure E-16. Preliminary maintenance budget

APPENDIX F

NORTH DAKOTA HIGHWAY DEPARTMENT'S Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 640,000 residents of North Dakota operate 490,000 motor vehicles on 106,897 miles of highways of which 6,950 miles are under state control. The state occupies 70,655 square miles from an elevation of 750 feet to 3,506 feet above sea level. Mean minimum and maximum temperatures are -10 and 88°F with average annual moisture ranging from 14 to 20 inches.

The North Dakota Highway Department has a \$28,743,453 maintenance budget for 1975-1977 biennium. This budget will be used by its 8 districts to maintain 15,160 lane miles of highways.

Eight districts comprise the North Dakota Highway Department. Each district is divided into maintenance sections resulting in a total of 71 maintenance sections state wide. The location of the maintenance sections was originally based upon snow and ice control needs and the amount of unsurfaced roads to be maintained.

Lead men are in responsible charge at the maintenance section with some assistance from crew leaders. Lead men report to the district maintenance engineer who in turn reports to the district engineer. Some of the smaller districts in the state may have one employee acting as the maintenance engineer in addition to certain other duties. The administration of the maintenance program by the Chief Engineer of the North Dakota Highway Department is performed at the central office level by the Maintenance Engineer.

The basic maintenance recording and reporting system was developed in the 1970 to 1971 period. The maintenance management system makes use of information collected for accounting purposes thus a single recording system is utilized. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports. About four years of reliable maintenance cost data are now available from the recording and reporting system.

RECORDING SYSTEM

North Dakota Highway Department, "Maintenance Time Card" (Form 22-3-1) (Figure F-1) is the source document used for posting employees time and expenses to a time sheet and for recording of vehicle usage. The Maintenance Time Card is completed by the employee, reviewed and approved by the immediate supervisor which is often the lead man and mailed daily to the district office. A secretarial type person at the district level fills out an "Employee Time Distribution Sheet" (Form 22-1-1) (Figure F-2) and "Vehicle Use Report" (Form 15-0-1) (Figure F-3) based on information obtained from the "Maintenance Time Card." A fourth form is utilized to transfer inventory. This form called the "Disposal Report" (Form 8-4-1) (Figure F-4) is normally filled out by district warehouse employees. Information recorded on each of these forms is discussed below.

Information recorded on the "Maintenance Time Card" and transferred to the "Employee Time Distribution Sheet" and "Vehicle Use Report" includes the following;

1. Employee's name and Social Security number
2. Activity performed
3. Location activity performed
4. Man-hours, equipment hours, equipment miles
5. Equipment utilization
6. Per Diem charges if eligible

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A number from 1 to 8 is utilized to designate the district. On certain recording forms a 6 must precede the district number designation.
2. Maintenance Section. The 71 maintenance sections do not have a unique code and thus costs can only be collected indirectly for maintenance sections. Buildings, storage tanks, and certain items of equipment can be recognized as under the control of certain districts. Sections of roadways are designated by district and not by Maintenance Section.
3. Section. Specific highway segments are assigned highway section numbers and designated by a five digit alpha numeric code which includes the district number and the highway number. These codes are recorded in the column "charge-to." An example of such a code is shown below;

H1 - 094

- H - indicates that the "charge-to" is a highway section
- 1 - district number one and
- 094 - designates the highway number (Interstate Highway 94).

Control and sections set-up by construction contracts were utilized at one time but became a bookkeeping problem and have been discarded. A mile marker system or mile post system is used to designate locations of bridges, signs, stockpiles, rest areas, etc. However, the mile marker system is utilized for inventory control and not to designate the location at which maintenance activities are performed. These data help the lead men manage their sections.

Individual maintenance sections monitor the use of some items such as road ice, blade mix, chips, deicing chemicals, etc. for their own management use. This, however, is not widely done and it must be done without the aid of the computer.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Table F-1). Sixty-three maintenance codes are presently utilized and are directed into the following major groups;

1. General Maintenance
2. Additions and Betterments
3. General Maintenance Other Than Roadway
4. Traffic Services
5. Snow and Ice

6. Structures and Extraordinary Maintenance
7. Shop and Building Expense
8. Costs Not Chargeable to Other Maintenance Functions
9. Accounts Receivable
10. Purchase of Equipment, Buildings and Land
11. Other Capitalization Costs
12. Inventory
13. Equipment Expense.

It should be noted that a special function code, "Maintenance of Concrete Surfacing," is utilized for maintenance on portland cement concrete pavements. A special code exists for snow and ice removal.

Manpower

As discussed above, the "Maintenance Time Card" is filled out by the individual workman. It is on this recording form that the hours worked on a particular maintenance activity for a particular highway section or segment are recorded to the nearest hour. Start and quit times are recorded on this form as well as the hours utilized to operate equipment. The total time worked by the individual workman is summed for the day to the nearest hour.

The information supplied by the individual employee on the "Maintenance Time Card" is transferred to the "Employee Time Distribution Sheet" (Figure 2) at the district office daily. The Employee Time Distribution Sheet is a monthly summary record and includes a record of regular time, over-time, vacation, sick leave, jury leave, military leave, etc. All time is assigned to a function and a "charge-to" highway section or segment, building, rest area,

equipment unit, etc. The objective code is also filled out on the Employee Time Distribution Sheet to assign items of expense such as meals, lodging, commercial airfare, taxi, etc. to the proper code.

The following is a partial list of objective codes:

- 123 - Vacation
- 124 - Sick Leave
- 125 - Holiday Pay
- 126 - Jury Leave
- 127 - Military Leave
- 128 - Other Leave
- 241 - In-State Mileage
- 242 - Out-of-State Mileage
- 243 - Commercial Airfare
- 244 - Taxi and Other Transportation
- 245 - In-State Meals
- 246 - Out-of-State Meals
- 247 - In-State Lodging
- 248 - Out-of-State Lodging
- 310 - Oil Mix
- 311 - Gravel Oil Mix
- 313 - Sand
- 314 - Chips
- 332 - Gasoline

Basically the "Objective Code" is a more detailed breakdown of the Function Code.

Employees are paid monthly by two checks as described on page F-8.

Equipment

Equipment utilized by a particular individual is recorded on the "Maintenance Time Card." The equipment unit number is recorded together with the miles driven or motor time depending on the equipment unit. Four digit numbers are utilized for equipment codes. For equipment units designated by 8000 series, the operator reports miles driven. For units designated other than 8000 series, only motor time is recorded. Rental equipment is handled by special function

codes. Equipment use time is recorded to the nearest hour and equipment mileage to the nearest mile. Equipment use is assigned to a particular activity on a particular section of roadway where possible.

The "Vehicle Use Report (Form 15-0-1) shown on Figure F-3 is a monthly summary for a particular vehicle obtained from the Maintenance Time Card. The Vehicle Use Report is filled out at the district level and may contain information from more than one individual's Maintenance Time Card. The Vehicle Use Card can also be utilized to report productivity and the individual operating the vehicle. For example, the number of acres mowed on a daily basis may be recorded for function 450 (mowing) on the form together with the employees name who operated the piece of equipment. Equipment classes have been established to simplify equipment use charges.

Materials

Materials utilized for a particular maintenance activity are recorded daily on the "Disposal Report" (Figure F-4) by employees assigned to material warehouses. This form includes a description of the material by a function and objective code as well as by a word description, the quantity of the material, the unit price of the material and the total cost. Material usage is charged to vehicles for such items as gasoline and to highway section or segment for such items as road oil, sand, chips, oil mix, etc. utilized to perform specific maintenance functions (Debit Column). Inventories are transferred from material stockpile by "crediting" the proper account on this form. The report is prepared for specific districts.

Accomplishments

Accomplishments can be recorded for specific functions on the Maintenance Time Card under the column remarks. This information is then transferred to the Vehicle Use Report.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Time Card is filled out daily by the maintenance employee and approved by the lead man of the maintenance section. The Maintenance Time Card is mailed daily to the district office where the information is transferred to the Employee Time Distribution Sheet and to a Vehicle Use Report. This data transfer is performed daily. The Disposal Report is filled out daily by the district warehouse employees. Information on these three forms is transmitted by mail to the central office on a monthly basis by the third working day of the month. Key punching is done at a centralized data processing center. The source documents do not leave the district.

Employee checks as described above are issued in two stages. The first check is paid on the first of the month and reflects payment on a monthly basis. A second check is issued about the 10th of the month which includes travel expenses and over-time.

Maintenance management reports obtain their source information from the accounting reports as discussed above. Maintenance management reports are back to the district by the 20th of the month.

It is estimated that about one percent of the maintenance budget is expended on recording and reporting maintenance activities. Annual computer costs are about \$10,000 to produce the maintenance

management reports. Individual employees require about 10 minutes per day to fill out the Maintenance Time Card. Three to four hours is required by the district clerical staff daily to transfer the Maintenance Time Card information to the Employee Time Distribution Sheet and Vehicle Use Report. It should be pointed out, however, that these data are required by accounting and a single reporting system is utilized to satisfy both the accounting and maintenance management function.

REPORTS

Two years ago over 28 maintenance reports were given to the districts by the central office. The number of reports has since been reduced to three. A brief discussion is presented below indicating the types of data contained on these reports:

HW1-820-AA. Maintenance Report HW1-820-AA is a report delineating the expected expenditures for maintenance activities by month and a total for the year for all functions the districts expect to perform. The lead men of the section together with the district maintenance engineers are responsible for making these estimates. The estimates are made during March and April or the spring thaw period, by mile marker and highway route. Standard forms are used to record the data collected in the budgetary process. Manpower requirements and availability are primarily responsible for fixing material and equipment quantities for budget preparation.

Two formats are utilized for this report. The report which summarizes district budget amounts by function (Figure F-5) includes

the following information by the month and a yearly total;

1. Planned quantities,
2. Planned hours,
3. Budget amount,
4. Standard unit cost rate and
5. Standard production rates.

The report which summarizes the state budget amounts by function does not include the standard unit cost rate or production rate as it varies by district. It should be noted that costs are not summed for maintenance function or activity groups.

HW1-830-BB. Maintenance Report HW1-830-BB delineates costs for each maintenance function for each district on both a monthly and year to date basis (Figure F-6). All maintenance functions plus overhead costs are shown. The report gives the following information for each function:

1. Function description
2. Function number
3. Unit of measure
4. Planned quantity
5. Actual quantity
6. Planned labor-hours
7. Actual labor-hours
8. Budget
9. Total cost
10. Labor cost
11. Material cost
12. Equipment rental cost
13. Other costs that do not fall in labor, material and equipment rental
14. Standard unit cost
15. Actual unit cost
16. Standard production rate
17. Actual production rate

District total costs are also presented for all functions. Separate print-outs in the same format are provided for monthly and year to

date expenditures. HW1-830-AA Maintenance Report HW1-830-AA summarizes the costs shown on report HW1-830-BB in format to compare district performance. These comparisons are presented on both a monthly and year to date basis for individual maintenance functions. The report includes the following items for each district and each function;

1. Actual quantity
2. Actual hours
3. Total cost
4. Actual unit cost
5. Standard unit cost
6. Actual performance rate
7. Standard performance rate

District total costs are also presented for all functions. Separate print-outs in the same format are provided for monthly and year to date expenditures.

All information with the exception of standard unit costs and standard performance rates are obtained from the information recorded as described above. Standard unit costs and performance rates are based on historical information unique to individual districts.

Reports are utilized at the central office and district level for fiscal control, by reviewing budgeted and actual expenditures; for monitoring of program execution by comparing planned and accomplished man-hours and material quantities; for allocation of manpower by reviewing standard unit costs and productivity rates against actual costs and productivity rates; and for budget pre-

paration to revise productivity rates, etc. based on actual field productivity and unit cost rates.

Presently maintenance functions that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of the reports. Exception reports are presently not a part of the reporting system although their development is under consideration.

OTHER ITEMS

The North Dakota Highway Department is satisfied with the reliability of the existing recording and reporting system although they feel improvements can be made. Basic information is recorded on the Maintenance Time Card and transferred by the district clerical staff to the Employee Time Distribution Sheet and Vehicle Use Report. Material usage is reported by the district warehouse on a Disposal Report. It is believed that this approach improves the reliability of the information in that the workman's time sheet is reviewed by the lead man and district personnel and thus more reliable information is obtained.

The recording and reporting system can be altered by direction of the central office maintenance staff. Prior to any changes in the system operating staff in the districts are consulted. Data processing changes and/or changes involving the accounting system require considerable lead time.

Function codes were developed with the assistance of the district maintenance engineers. A standing standards committee does not exist nor does a format committee exist to review and revise the

recording and reporting system.

The lag time between the reporting of the information by the districts and reporting of the information will probably not be reduced until computer terminals are placed in the district. A new equipment management system is presently being implemented. District productivity standards are being revised as information becomes available.

References

"Maintenance Manual," North Dakota State Highway Department.

"Accounting Manual," North Dakota State Highway Department:
July 1, 1975.

Table F-1. Maintenance Function Codes

General Maintenance

- 410 Routine Roadway Surface Operations
- 411 Hand Patching
- 412 Spot Sealing
- 413 Maintenance of Concrete Surfacing
- 414 Crack Pouring
- 415 Maintenance of Expansion Joints
- 416 Blading Gravel Roads and Shoulders
- 419 Other Surface Maintenance Operations
- 420 Regraveling
- 421 Blade Patching and Leveling
- 422 Resealing - State Forces
- 423 Slab Jacking
- 424 Light Reseals
- 425 Contract Reseals

Additions and Betterments (No mile number needed)

- 428 Service Roads
- 429 Other Additions and Betterments

General Maintenance Other Than Roadway

- 431 Patching and Leveling Shoulders and Side Approaches
- 433 Shoulder Sealing with Aggregate Cover
- 435 Shoulder Sealing Without Aggregate Cover
- 440 Roadside and Drainage
- 441 Right-of-Way Fences and Markers
- 445 Maintenance of Special Roadside Development Projects
- 450 Mowing
- 451 Control of Vegetation
- 455 Removal of Debris
- 461 Guard Rails, Detours and Delineators

Traffic Services

- 462 Centerline Striping
- 463 Signal Equipment
- 464 Signs on Interstate Highways
- 465 Rest Area Maintenance
- 466 Highway Lighting
- 467 Signs on other than Interstate Highways
- 468 Other Pavement Markings
- 469 Edgeline Striping

Snow and Ice

- 480 Snow, Ice and Sand Control and Removal

Table F-1. Continued

Structures and Extraordinary Maintenance

- 490 Extraordinary Maintenance
- 510 Structures - Routine Maintenance
- 511 Structures - Major Maintenance
- 520 Structures - Special Drainage

Shop and Building Expense

- 590 Operating Expense of Shop
- 595 Maintenance of Buildings and Grounds

Costs Not Chargeable to other Maintenance Functions

- 601 Stores Expense
- 612 Sign Shop Expense
- 614 Holiday Pay
- 615 Radio Rental
- 616 Overhead Charges
- 617 Non-Classified Maintenance Costs
- 619 Maintenance Research

Accounts Receivable

- 621 Accounts Receivable from Outside Sources

Purchase of Equipment, Buildings and Land

- 640 Purchase of Major Equipment (licensed)
- 642 Purchase of Buildings and Land
- 643 Purchase of Rest Area Sites
- 645 Purchase of Major Tools and Shop Equipment
- 646 Purchase of Minor Equipment

Other Capitalization Costs - Equipment, Buildings and Land

- 647 Major Equipment - Other Capitalized Costs
- 648 Buildings and Land - Other Capitalized Costs
- 649 Minor Equipment - Other Capitalized Costs

Inventory

- 650 Equipment Parts Inventory
- 655 Petroleum Products Inventory
- 670 Road Materials Inventory
- 690 Central Supply Inventory

Equipment Expense

- 700 Equipment Maintenance Expense
- 701 Equipment Maintenance Expense (Field Personnel)

DATE:		19		NAME:		EMP. NO.	
UNIT No.	MILES				A. M.	P. M.	LODGED AT:
					START		
					QUIT		HOURS WORKED:
NATURE OF WORK				UNIT No.	SECTION	MILE	FUNCTION
MR.				WORKED WITH ME	OPRAT'G UNITS		
REMARKS:							
FORM 20 (10M BKS. 2-65)				"BUY NORTH DAKOTA PRODUCTS"		THE PIERCE CO., FARGO	

Figure F-1. Maintenance Time Card.

E-17

Employee Signature

UN * NUMBER 9833
DISTRICT TO WHICH
UNIT IS ATTACHED 105

NORTH DAKOTA STATE HIGHWAY DEPARTMENT

Figure F-3. VEHICLE USE REPORT

[illegible]

Rev. (9/1/72)
Form 15-0-1

Name of Driver

Year Posted	Month of Operation	Approved
1975	August	H34

MILEAGE DATA:
MILES THIS MONTH: 972
ENDING LAST MONTH: 84,892
MILEAGE TO DATE: 82,864

NORTH DAKOTA STATE HIGHWAY DEPARTMENT
Figure F-4. DISPOSAL REPORT

							Central R f. No.		District Ref. No.			
									0 - 0059			
	DEBIT			CREDIT								
DESCRIPTION	Dist. Dr.	Unit, Hwy., Lot., Bldg., Tank, Project, Inv., Allot., Rest Area, Clm. No.	FUNCT.	Dist. Cr.	Unit, Hwy., Lot., Bldg., Tank, Project, Inv., Allot., Rest Area, Clm. No.	FUNCT.	OBJ.	Q Y.	UNIT PRICE		TOTAL	
Oil Mix	61	I1 J001 06 011	670				310	63		9 15+	5765	31
Gravel O.M.				61	I1 J002 06 011	670	311	(63)		2 57	(1619	10
Road Oil				61	I1 H460 67700	670	302	(12 89)		2320-	(4146	21
Road Oil	61	H1 041	421	61	I1 H460 67600	670	302		5	3065	22	95
Road Oil	61	H1 200	421	61	I1 H460 67600	670	302	3 0		3065	107	25
Oil Mix	61	H1 200	421	61	I1 J001 00 226	670	310		5	10 71	696	15
Sand	61	H1 049	412	61	I1 J004 94 108	670	313		55	5 81	203	3
Oil Mix	61	I1 J001 49 102	670				310	6 10		7 32	4398	45
Gravel O.M.				61	I1 J002 49 102	670	311	(6 10)		1 99	(1194	00
Road Oil				61	I1 H460 67700	670	302	(10 97)		3193	13204	45
Road Oil	61	H1 049	431	61	I1 H460 67600	670	302	1 00		3441	584	9
Oil Mix	61	H1 049	431	61	I1 J001 94 108	670	310		40	8 65	346	00
Road Oil	61	H1 021	412	61	I1 H460 67600	670	302		75	3649	209	82
Chips	61	H1 021	412	61	I1 J005 21 076	670	314		37	6 49	240	1
Sand	61	H1 021	412	61	I1 J004 21 076	670	313		48	4 80	230	40
Oil Mix	61	H1 021	411	61	I1 J001 21 076	670	310		2	13 60	27	2

Prepared By Jacob Paul Date Sept 12 197 5

PAGE TOTALS 157 DEBIT 12,832 00
26 43 CREDIT TOTAL AMOU

HW1-820-AA

01/29/74

1

FUNCTION JULY AUG

Figure F-5. Maintenance Management Report HW1-820-AA.

AL

410 RDWY.SUR.OPER.RTN.

PLAN QTY-												
PLAN HRS-	400	400	500	100	70	50			30	400	400	2,420
BUDGET	3,716		2,763		650					3,720		22,429
		3,711		929		464			2,76		3,715	
STANDARD UNIT COST RATE			.60									
STANDARD PRODUCTION RATE			.00									

411 HAND PATCH ON ROAD

PLAN QTY-	50	100	60	25	25				5	50	38	398
PLAN HRS-	350	700	420	175	175				35	350	266	2,766
BUDGET	2,000		2,400		1,000					2,000		15,920
		4,000							2,00		1,520	
STANDARD UNIT COST RATE			40.00									
STANDARD PRODUCTION RATE			7.00									

412 SPOT SEALING

PLAN QTY-	33,000	170,000	70,000					9,000	30,00	50,000	40,000	402,000
PLAN HRS-	350	1,700	700					90	30	500	400	4,020
BUDGET	9,900		21,000					2,700		15,000		120,600
		51,000							9,00		12,000	
STANDARD UNIT COST RATE			.30									
STANDARD PRODUCTION RATE			.01									

414 TAM.CLN.JTHR.CRACK

PLAN QTY-				20,000	30,000	40,000						90,000
PLAN HRS-				3,000	4,500	6,000						13,500
BUDGET				27,000		54,000						121,500
					40,500							
STANDARD UNIT COST RATE			1.35									
STANDARD PRODUCTION RATE			.15									

416 BLADING GRAVEL R.D.C SHLD

PLAN QTY-	60	60	40	40	40	40	40	40	84	8	60	60	644
PLAN HRS-	18	18	12	12	12	12	12	12	25	2	18	18	193
BUDGET	240		160		160		160		336		240		2,576
		240		160		160		160		32		240	
STANDARD UNIT COST RATE			4.00										
STANDARD PRODUCTION RATE			.30										

421 BLADE PATCH & LEVEL

PLAN QTY-	1,200	1,200	500	200						32	500	1,200	5,120
PLAN HRS-	900	900	375	150						24	375	900	3,640
BUDGET	24,000		10,000								10,000		102,400
		24,000		4,000						6,40		24,000	
STANDARD UNIT COST RATE			20.00										
STANDARD PRODUCTION RATE			.75										

422 BITUMINOUS RESEAL

PLAN QTY-	25												25
PLAN HRS-	1,631												1,631
BUDGET	87,850												87,850
STANDARD UNIT COST RATE		3,500.00											
STANDARD PRODUCTION RATE		65.00											

Figure F-6. Maintenance Management Report HWL 830-BB.

HWL-830-BB JUNE, 1974

GE 1

FUNCTION DESC.		QUANTITY	HOURS	***	COST	DISTRIBUTION	**	COST	PROD. RATE
OVERTIME TEMPORARY	HRS	PLAN ACTUAL	127	BUDGET TOT CST	333	LAB MAT	333 EQT OTH	STAND. ACTUAL	2.62
EMPLOYEE SALARIES	HRS	PLAN ACTUAL	142,708	BUDGET TOT CST	689,567	LAB MAT	689,567 EQT OTH	STAND. ACTUAL	4.83
OVERTIME PERMANENT	HRS	PLAN ACTUAL	4,208	BUDGET TOT CST	18,185	LAB MAT	18,185 EQT OTH	STAND. ACTUAL	4.32
TEMPORARY SALARIES	HRS	PLAN ACTUAL	9,008	BUDGET TOT CST	22,897	LAB MAT	22,897 EQT OTH	STAND. ACTUAL	2.54
COMPENSATORY TIME	HRS	PLAN ACTUAL	3,043	BUDGET TOT CST	13,402	LAB MAT	13,402 EQT OTH	STAND. ACTUAL	4.40
RDWY.SUR.OPER.RTN. 410		PLAN ACTUAL		BUDGET TOT CST	13,038 18,695	LAB MAT	8,637 3,948	EQT OTH	6.10 STAND. ACTUAL 9.37 9.83
HAND PATCH ON ROAD 411	CU YD	PLAN ACTUAL	180 337	BUDGET TOT CST	7,740 15,248	LAB MAT	9,459 3,096	EQT OTH	2.63 STAND. ACTUAL 43.00 45.24
SPOT SEALING 412	SQ YD	PLAN ACTUAL	147,500 333,134	BUDGET TOT CST	30,975 81,228	LAB MAT	23,810 41,413	EQT OTH	15.87 1.8 STAND. ACTUAL .21 .24
MTCE CONCRETE SURFACE 413		PLAN ACTUAL		BUDGET TOT CST	5,516 9,565	LAB MAT	5,806 1,934	EQT OTH	1.88 7 STAND. ACTUAL 9.04 7.25
TRM.CLN.OTHR.CRACK 414	GAL	PLAN ACTUAL	150,000 37,580	BUDGET TOT CST	112,500 29,211	LAB MAT	16,414 6,455	EQT OTH	6.32 STAND. ACTUAL .75 .77
BLADING GRAVEL RD.& 416	SHLD P/MIL	PLAN ACTUAL	6,000 3,459	BUDGET TOT CST	24,000 12,753	LAB MAT	4,816	EQT OTH	7.67 STAND. ACTUAL 4.00 3.68
SPC.SURF.MTC.OPER. 419		PLAN ACTUAL		BUDGET TOT CST	2,271	LAB MAT	1,322	EQT OTH	5.54 STAND. ACTUAL 6.77
BLADE PATCH & LEVL 421	CU YD	PLAN ACTUAL	7,640 11,166	BUDGET TOT CST	114,600 160,187	LAB MAT	33,020 97,789	EQT OTH	29.38 STAND. ACTUAL 15.00 14.34
BITUMINOUS RESEAL 422	MILES	PLAN ACTUAL	90 64	BUDGET TOT CST	270,000 132,669	LAB MAT	14,380 106,043	EQT OTH	11.49 1.7 STAND. ACTUAL 3000.00 2089.26
SLABJACKING 423		PLAN ACTUAL		BUDGET TOT CST	3,780 6,577	LAB MAT	4,094 510	EQT OTH	1.53 STAND. ACTUAL 6.30 6.53
CONTRACT RESEALS 425		PLAN ACTUAL		BUDGET TOT CST	4	LAB MAT		EQT OTH	4 STAND. ACTUAL
ADDTNS.& BETTERMTS 429		PLAN ACTUAL		BUDGET TOT CST	4,613	LAB MAT	2,869 82	EQT OTH	1.02 STAND. ACTUAL 7.70
PTH&LEV.SHLDREAPPR 431	CU YD	PLAN ACTUAL	400 500	BUDGET TOT CST	8,000 7,606	LAB MAT	2,303 3,512	EQT OTH	1.71 STAND. ACTUAL 20.00 15.21
SHLD.SEALNG W/ AGG COVER 433	SQ YD	PLAN ACTUAL	150,000 110,750	BUDGET TOT CST	24,000 13,065	LAB MAT	1,871 9,455	EQT OTH	1.79 0 STAND. ACTUAL .16 .11
SHDLR.VEG.CONTROL 434		PLAN ACTUAL		BUDGET TOT CST	6,088 7,119	LAB MAT	6,286 58	EQT OTH	7.5 STAND. ACTUAL 8.01 4.87
SHLD.SEALNG W/D AGG COVER 435	SQ YD	PLAN ACTUAL	25,107	BUDGET TOT CST	1,489	LAB MAT	90 1,331	EQT OTH	.8 STAND. ACTUAL .05
RD.SIDE & DRAINAGE 440		PLAN ACTUAL		BUDGET TOT CST	38,913 80,490	LAB MAT	51,069 3,592	EQT OTH	24.59 6.0 STAND. ACTUAL 7.14 7.06
R/W FENCE & MARKER 441		PLAN ACTUAL		BUDGET TOT CST	3,977 10,192	LAB MAT	8,393 549	EQT OTH	1.20 STAND. ACTUAL 4.85 5.47
SPEC.ROADSIDE DEVL 445		PLAN ACTUAL		BUDGET TOT CST	28,365 25,915	LAB MAT	17,996 3,247	EQT OTH	4.51 1.1 STAND. ACTUAL 4.65 5.01
MOWING 450	ACRES	PLAN ACTUAL	16,000 15,638	BUDGET TOT CST	73,280 63,934	LAB MAT	25,199	EQT OTH	38.15 STAND. ACTUAL 4.58 4.08

FUNCTION

Figure F-7. Maintenance Management Report HW1-830-AA.

HIGHWAY
TOTALS

411 HAND PATCH ON ROAD

CU YD

ACTUAL QUANTITY	337	611	1,744	624	361	516	3	3	93	4,609
ACTUAL HOURS	2,143	2,796	9,313	3,093	1,535	6,782	1.4	0	1,485	28,577
TOTAL COST	15,248	27,089	81,326	27,614	14,106	46,659	10.8	6	8,712	231,570
UNIT COST-ACTUAL	45.24	44.37	46.64	44.25	39.07	90.42	33.3	3	93.38	50.25
-STAND.	43.00	50.00	33.00	50.00	38.00	45.00	40.0	0	42.00	4.62
PROD.RATE-ACTUAL	6.35	4.57	5.34	4.95	4.25	13.14	4.3	3	15.91	6.20
-STAND.	6.50	8.00	5.00	6.00	5.00	8.00	5.0	0	4.00	5.93

412 SPOT SEALING

SQ YD

ACTUAL QUANTITY	333,134	273,039	281,164	194,022	591,944	73,119	215.8	8	17,210	1,979,480
ACTUAL HOURS	5,412	5,175	3,518	3,518	4,538	1,649	4.4	7	320	28,537
TOTAL COST	81,227	71,798	51,203	49,154	103,216	19,752	55.0	1	3,990	436,271
UNIT COST-ACTUAL	.24	.26	.18	.25	.17	.27	.5	5	.23	.22
-STAND.	.21	.25	.18	.20	.15	.20	.2	2	.25	.20
PROD.RATE-ACTUAL	.01	.01	.01	.01	.02	.02	.2	2	.01	.01
-STAND.	.01	.01	.01	.01	.01	.01	.1	1	.01	.01

414 TRM.CLN.OTHR.CRACK

GAL

ACTUAL QUANTITY	37,580	19,870	40,400	13,550	25,999	6,050	34.9	0	20,020	198,399
ACTUAL HOURS	3,672	2,949	4,924	2,577	2,858	1,937	4.0	3	2,661	25,611
TOTAL COST	29,211	24,351	36,579	19,127	24,576	13,720	35.3	6	22,288	205,188
UNIT COST-ACTUAL	.77	1.22	.90	1.41	.94	2.26	1.1	1	1.11	1.03
-STAND.	.75	1.00	.90	1.10	.85	1.00	.5	5	1.30	.96
PROD.RATE-ACTUAL	.09	.14	.12	.19	.10	.32	.1	1	.13	.12
-STAND.	.10	.13	.13	.13	.11	.25	.1	1	.30	.15

416 BLADING GRAVEL RD. & SHLD P/MIL

ACTUAL QUANTITY	3,459	2,399	2,334	4,071	1,132	1,342	9	7	1,546	17,230
ACTUAL HOURS	1,011	579	460	1,317	173	394	2	9	508	4,721
TOTAL COST	12,753	7,511	5,296	17,604	1,556	5,048	3.6	9	6,826	60,213
UNIT COST-ACTUAL	3.68	3.13	2.26	4.32	1.37	3.76	3.2	2	4.41	3.49
-STAND.	4.00	4.00	3.80	4.20	2.50	4.25	4.5	5	4.00	3.77
PROD.RATE-ACTUAL	.29	.24	.19	.32	.15	.29	.9	9	.32	.27
-STAND.	.25	.25	.22	.30	.20	.33	.0	0	.30	.26

421 BLADE PATCH & LEVL

CU YD

ACTUAL QUANTITY	11,166	5,565	5,032	4,998	9,048	6,189	8.3	6	12,527	62,881
ACTUAL HOURS	7,393	3,826	3,990	4,937	4,511	6,613	8.1	0	7,409	56,263
TOTAL COST	160,186	92,974	91,003	99,400	151,200	98,814	146.5	0	6,443	45,813
UNIT COST-ACTUAL	14.34	16.70	18.08	19.89	16.71	15.96	17.3	3	12,490	901,567
-STAND.	15.00	20.00	17.00	18.00	17.00	19.00	19.0	0	15.30	17.25
PROD.RATE-ACTUAL	.66	.68	.79	.98	.49	1.06	.5	5	1.463	1.78
-STAND.	.60	.90	.70	.75	.65	.90	.0	0	.81	.75

422 BITUMINOUS RESEAL

MILES

ACTUAL QUANTITY	64	1	41	61	44	13	5	5	183,281	1,023,388
ACTUAL HOURS	3,378	733	2,714	4,460	2,602	1,521	2.4	0	9	289
TOTAL COST	132,668	4,074	94,589	147,835	100,089	21,682	93.5	3	130	594,629
UNIT COST-ACTUAL	2,089.26	3,133.83	2,301.41	2,423.51	2,274.75	1,667.87	1,430.8	8	2,058.29	2,058.29
-STAND.	3,000.00	3,000.00	2,500.00	2,575.00	2,000.00	2,500.00	2,500.0	0	2,582.14	2,582.14
PROD.RATE-ACTUAL	53.19	563.84	66.03	73.11	59.13	117.00	38.3	3	61.98	61.98
-STAND.	55.00	70.00	70.00	60.00	55.00	70.00	70.0	0	64.28	64.28

424 LIGHT RESEAL

MILES

ACTUAL QUANTITY					3				50	59
ACTUAL HOURS					112				3,323	3,435
TOTAL COST					4,298				68,659	72,457
UNIT COST-ACTUAL					1,432.63				1,232.66	1,242.88
-STAND.									850.00	850.00
PROD.RATE-ACTUAL					37.33				54.65	58.51
-STAND.									33.00	33.00

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APPENDIX G

TENNESSEE BUREAU OF HIGHWAYS'

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 4,126,000 residents of Tennessee operate 2,467,000 motor vehicles on 78,666 miles of highways of which 9,832 are under state control. The state occupies 42,244 square miles from an elevation of 182 feet to 6,643 feet above sea level. Mean minimum and maximum temperatures are 22 and 92°F with average annual moisture ranging from 40 to 76 inches.

The Tennessee Bureau of Highways has a \$38,485,000 maintenance budget. This budget will be utilized by its 4 Regions and 23 Maintenance Districts to maintain 23,500 lane miles of highway. Each maintenance district is divided into county maintenance units for a total of 95 county units state wide. Maintenance supervisors are in responsible charge of the county maintenance units with assistance from crew leaders. Supervisors report to the District Maintenance Engineer who in turn reports to the Assistant Regional Maintenance Engineer, the Regional Maintenance Engineer and the Regional Engineer. The administration of the maintenance program for the Director of the Bureau of Highways is performed at the central office level by the Maintenance Engineer.

The basic maintenance recording and reporting system was developed in 1971 by Roy Jorgensen and Associates. A parallel recording system is being utilized. The recording system is a

manual system used in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

The Tennessee Bureau of Highways Form MM-1, "Crew Day Card" (Figure G-1) and Form MM-5, "Maintenance Activity Summary" (Figure G-2) are utilized to collect maintenance activity information. The types of information obtained on these forms includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

The Crew Day Card is filled out by the crew leader who usually has a title of foreman. These cards are color coded and pre-printed (as possible) based on programmed activity levels with information including crew size, system, region, maintenance activity and equipment and accomplishment units. The color code is briefly described below:

Red. The red Crew Day Card is filled out for routine maintenance activities that normally stay within the planned maintenance program levels. Such items as painting centerline, sign replacement, sign cleaning, grading shoulders, clean culverts, etc. are within this category referred to as Routine Limited Maintenance (RL).

Blue. The blue Crew Day Card is filled out for routine maintenance activities that are often in excess or less than the planned maintenance programs. These items are dependent to a large extent upon environmental conditions such as rainfall. Crack pouring, surface replacement, concrete patching, clean and reshape ditches, etc. are maintenance activities within this general category referred to as Routine Variable maintenance (RV).

Green. The green Crew Day Card is filled out for emergency maintenance such as bridge repair, excessive spot premix patching, accident cleanup, etc. This general category of maintenance is identified as Routine Unlimited (RU).

Orange. The orange Crew Day Card is filled out for overhead items such as bridge inspection, stockpiling, ferry operation, road patrol, etc. This general category of maintenance is identified as Overhead (O).

Yellow. The yellow Crew Day Card is filled out for special maintenance authorizations that are originated by the Regional Maintenance Engineer. Resurfacing and seal coat operations are usually included in this category. This general category of maintenance is identified as Special Authority maintenance (SA).

White. The white Crew Day Card is filled out when the supply of preprinted cards has been depleted.

The Crew Day Cards are filled out daily and sent to the district office where a clerk transfers the data biweekly to the Maintenance Activity Summary.

Details of these reporting forms are presented below:

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A two digit numeric code from 11 to 16, 21 to 25, 31 to 37, and 41 to 45 is utilized to designate the district by regions. The district numbers can be assigned to regions as required.

2. County. The maintenance unit operating in a county is coded by a two digit numeric code from 1 to 95. The county code can be utilized as assigned to specific districts and regions.

3. System. The highway system is identified by a two digit code. This code is utilized to identify Interstate Highways from other types of highways.

4. Crew. The crew leader's name is recorded on the Crew Day Card but not on the Maintenance Activity Summary. These data cannot be reported for specific crews unless special codes are assigned and recorded.

5. Segments. Particular segments of highways on which the maintenance activity was performed are not presently recorded.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder, roadside, etc.

Activity

Maintenance activity numbers are utilized to designate the

maintenance activity performed (Table G-1). Seventy-one maintenance activity numbers are presently utilized and are divided into district activities and regional activities. Regional activities account for about 30 to 35 percent of the maintenance expenditures and about 25 percent of maintenance activity codes. The codes are further sub-divided into categories for reporting programs on the Crew Day Card as described above. These categories are;

1. Special Authority (SA)
2. Overhead (O)
3. Routine Variable (RV)
4. Routine Limited (RL)
5. Routine Unlimited (RU)

Manpower

Manpower utilization for a particular maintenance activity is recorded. The individual employee is indicated by name and the regular and over-time is recorded to the hour on the Crew Day Card. Manpower is not reported by the individual employee on the Maintenance Activity Summary. Man-hours are reported by the day for standard crew sizes and nonstandard crew sizes by maintenance activity. Man-hour totals are reported for the biweekly report period.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by a 6 digit equipment code. Equipment use is charged out daily by the hour or mile, depending on the type of equipment. A written description of the equipment is also entered.

Materials

Materials utilized for a particular function are recorded daily. A written description of the material is entered together with the units of measurement and the amount of material utilized. Materials utilized are reported to the nearest 0.1 unit. Material codes are utilized to describe materials on the Maintenance Activity Summary. This code is a five digit code.

Accomplishments

Accomplishments are reported in terms of work units as defined by work standards. Tons, man-hours, and lineal feet are commonly used work units. Accomplishments are reported for the entire crew and are recorded to the nearest 0.1 unit. Accomplishments are reported for both standard and nonstandard crew sizes on the Maintenance Activity Summary.

COLLECTION AND PROCESSING OF RECORDED DATA

The Crew Day Card is filled out daily by the crew leader or foreman for his crew. The recorded information is checked by the Foreman II (county supervisor) and sent to the district office where the data are transferred to the Maintenance Activity Summary by a district clerk. Two copies of the Maintenance Activity Summary are sent to the central office, one copy to the Regional Office and one copy is retained in the district. Key punching of data is performed in the central office. Reports are prepared from these data at the district level by a manual process and from the central office by the use of electronic data processing equipment.

An estimate of the recording and reporting expenses was not obtained. However, it was estimated that the crew leader requires about 10 minutes per day to report the daily work activities.

REPORTS

Five reports are produced from the collected data. The Work Performance Report is prepared manually. All other reports are prepared at the central office by electronic data processing equipment. A brief discussion is presented below indicating the types of data contained on these reports.

Work Performance Report. This report is compiled by hand every two weeks by the district clerk at the end of the reporting period (Figure G-3). A copy of the district reports are sent to the regional office where the region report is completed by hand to include regional statistics. The regional compilation takes about 1 week. The 4 regional reports are compiled into a state summary manually requiring about an additional 7 to 10 days. This report is primarily utilized at the District level or Regional level.

For each maintenance activity the work quantities, man-hours and man-hours per unit of accomplishment are recorded for each county maintenance unit together with district totals for the activity. Work quantities and man-hours are reported for the current reporting period, year-to-date totals and the annual programmed quantities. Man-hours per unit of accomplishment are reported for year-to-date together with the work standard for the activity.

Cost Distribution Report. This report summarizes labor, equipment and material costs together with total costs by activity (Figure G-4). These reports are calculated for the county maintenance units, districts, regions and for state wide totals. Interstate costs are separated from other "types of highways" costs. The reports are prepared monthly and reflect year-to-date costs. These reports are utilized mainly at the state level.

Materials are costed at the time of use on the roadway. Inventory accounts are utilized for stockpiles.

Evaluation of Work Load Plan. This report is the basic management report and it is compiled to reflect County, District, Region and State quantities (Figure G-5). The report is printed quarterly and prepared by the highway system (Interstate and other) and by Maintenance Activity Group (Routine Variable RV), Routine Limited (RL), Routine Unlimited (RU), etc. Annual planned and year-to-date quantities are reported for crew days, man-hours, and accomplishments. Man-hour per unit of accomplishment and daily productivity quantities are reported on a year-to-date basis together with the standard quantities. The percent standard achieved is the actual accomplishment divided by the standard accomplishment. This report is distributed to the Districts and Regions for evaluation.

Crew Usage and Performance Report. This report is prepared quarterly and distributed to the District and Region to evaluate crew size and performance against standards (Figure G-6). The report is prepared for a specific district with county unit totals displayed by maintenance activity. Standard crew size performance

is compared to nonstandard crew and both are compared to the work standard. The report is prepared by District and Maintenance Activity Group.

Annual Work Quantity and Planning Value Analyses. This report is prepared annually to evaluate this year's planned activities and to adjust planning values for next year (Figure G-7). Districts are regions receive copies of these reports.

The reports are prepared by regions, by highway system, and by Maintenance Activity Group. The report is printed by maintenance activities for each District within the Region.

The following information is displayed:

1. Planned and Accomplished work units together with the percent or ratio of accomplished to planned units,
2. Inventory units for each District,
3. Standard and actual work units accomplished for each work unit,
4. Planned and actual man-hours together with the percent or ratio of actual to accomplished man-hours, and
5. Standard versus actual man-hours per accomplishment unit.

Reports are utilized for fiscal control, by reviewing expenditures to date on the Cost Distribution Report; for monitoring program execution by comparing annual planned and accomplished work units to date on the Evaluation of Workload Plan Report; for allocation of manpower by reviewing the standard and actual productivity measurements; and for budget preparation by reviewing data contained on the Annual Work Quantity and Planning Value Analysis Report.

Presently maintenance activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of the reports. Exception reports are presently not a part of the reporting system.

OTHER ITEM

The Tennessee Bureau of Highways is satisfied with the reliability of the existing system although improvements can be made. The recording system utilizes crew leaders to record information rather than the individual maintenance employee. These data are then transferred to the Maintenance Activity Summary by a district clerk which should improve data accuracy. It is believed that this approach to recording data improves the reliability of the information.

The recording and reporting system can be altered by direction of the central office staff as the need arises. An annual meeting is held by the central office staff with district and county maintenance personnel to obtain feedback on the performance of the system. Changes in the management system are directed by the central office.

Data collected are stored for about an 18-month period within the central office; then it is stored on film for an indefinite period of time.

Figure G-4. Cost Distribution Report.

EGAD 279

STATE OF TENNESSEE
DEPARTMENT OF HIGHWAYS
COST DISTRIBUTION BY WORK ACTIVITY
PERIOD FROM 03-01-74 TO 03-31-74
REGION NASHVILLE 7 DISTRICT 27

PAGE 371

SYSTEM INTERSTATE		COST DISTRIBUTION BY WORK ACTIVITY					PAGE 371	
.....ACTIVITY.....		EXPENDITURES -- DOLLARS.....						
NO.	DESCRIPTION	TOTAL WORK QUANTITY	WORK UNIT	LABOR	EQUIPMENT	MATERIAL	TOTAL	
420	SPOT PREMIX PATCHING	3.4	TCNS-MIX	104.64	9.03	27.20	140.87	
429	OTHER SHOULDER	120.0	MAN HRS.	392.40	260.48	.00	652.88	
430	CLEAN/RESHAPE DITCH	825.0	LF CLEAN	183.12	212.87	.00	395.99	
431	CLEAN CULVERTS/PIPES	14.0	NO CLEAN	52.32	6.42	.00	58.74	
434	OTHER DRAINAGE	264.0	MAN HRS.	863.28	264.79	.00	1,128.07	
435	MACHINE MOWING	398.2	ACRES	1,373.40	748.35	.00	2,121.75	
436	SLOPE MOWING	80.0	MAN HRS.	261.60	39.14	.00	300.74	
437	CHEMICAL CONTROL-VEG	2,650.0	GAL CHEM	627.84	143.33	2,199.50	2,970.67	
438	BRUSH CUTTING	88.0	MAN HRS.	287.76	21.73	.00	309.49	
439	MAINT-LANDSCAPED ARS	512.0	MAN HRS.	1,674.24	165.43	.00	1,839.67	
441	ROADSIDE CLEANUP	178.5	R/W P-MI	2,158.20	101.68	.00	2,259.88	
442	SERV. LITTER BARRELS	617.0	NO SERV.	2,145.12	766.66	.00	2,911.78	
443	CLEANUP ROADSIDE PARKS	14.0	NO CLEAN	366.24	32.41	.00	398.65	
445	FENCE REPAIR	1,230.0	LF-FEN.	497.04	20.80	87.65	605.49	
447	MAN. ROWAY SWEEPING	56.0	MAN HRS.	183.12	3.91	.00	187.03	
449	OTHER ROADSIDE	56.0	MAN HRS.	183.12	12.49	.00	195.61	
450	CLEANING BRIDGE	21.0	NO CLEAN	235.44	11.54	.00	246.98	
461	SPREAD CHEMICALS	160.0	MAN HRS.	523.20	100.38	560.00	1,183.58	
469	OTHER SNOW AND ICE	502.0	MAN HRS.	1,641.54	161.72	.00	1,803.26	
472	MINOR SIGN REPAIR	20.0	NO SIGNS	52.32	6.95	10.11	69.38	
473	SIGN REPLACEMENT	6.0	NO SIGNS	206.01	99.94	4,080.00	4,385.95	
475	REPAIR SE-GUARDRAIL	62.5	NO FEET	104.64	1.76	.00	106.40	
476	REPAIR GUIDE POSTS	252.0	NO REPRD	444.72	33.96	57.06	535.74	
479	OTH TRAFFIC SERVICES	68.0	MAN HRS.	222.36	54.44	.00	276.80	
480	SLICE REMOVAL	80.0	MAN HRS.	261.60	226.64	.00	488.24	
491	INTERST EMERG PATROL	6,368.0	MAN HRS.	20,823.36	9,515.23	.00	30,338.59	
497	BRIDGE INSPECTION	362.0	MAN HRS.	1,781.04	326.24	.00	2,107.28	
498	INCLEMENT WEATHER	543.0	MAN HRS.	1,775.61	39.88	.00	1,815.49	
TOTAL ALL ACTIVITIES				39,425.28	13,388.20	7,021.52	59,835.00	

Figure G-5. Evaluation of Work Load Plan.

TENNESSEE FINANCE MANAGEMENT
EVALUATION OF WORKLOAD PLAN
PERIOD FROM 07-01-73 TO 12-31-73

4285

ACTIVITY GROUP- VARIABLE		SYSTEM-		STATE		REGION 1 KNOXVILLE		DISTRICT 15		PAGE 149	
.....ACTIVITY.....		...CREW DAYS...		...MAN-HOURS....	ACCOMPLISHMENT.....	P I/ACCOMP.....		..DAILY PROD...	
NO.	DESCRIPTION	ANNUAL TO PLAN	DATE PCT	ANNUAL TO PLAN	DATE PCT	ANNUAL PLAN	UNITS	TO DATE PCT	DATE STD	STD	STD
402	CRACK POURING										
	BLOUNT 05	9	1 11	504	56 11	906	GAL-SEAL	200 22	.03	.56	50 100
	KNOX 47	22	10 45	1232	646 52	2129	GAL-SEAL	1050 49	.02	.56	111 100
	MONROE 62	7	0 00	392	0 00	716	GAL-SEAL	0 00	.00	.56	00 100
	DISTRICT TOTAL	38	11 29	2128	702 33	3751	GAL-SEAL	1250 33	.05	.56	100 100
* 403	CONT PREMIX PATCHING										
	BLOUNT 05	5	5 100	600	442 74	680	TONS-MIX	435 64	1.02	.80	128 150
	KNOX 47	11	8 73	1320	777 59	1597	TONS-MIX	972 61	.00	.80	100 150
	MONROE 62	4	4 100	480	450 94	537	TONS-MIX	2017 376	.02	.80	28 150
	DISTRICT TOTAL	20	17 85	2400	1669 70	2814	TONS-MIX	3424 122	.09	.80	61 150
** 406	SURFACE REPLACEMENT										
	BLOUNT 05	12	0 00	672	0 00	227	TONS-MAT	0 00	.00	2.80	00 20
	KNOX 47	27	4 15	1512	208 14	532	TONS-MAT	65 12	3.02	2.80	115 20
	MONROE 62	9	5 56	504	264 52	179	TONS-MAT	88 49	3.02	2.80	108 20
	DISTRICT TOTAL	48	9 19	2688	472 18	938	TONS-MAT	152 16	3.00	2.80	111 20
411	CONCRETE PATCHING										
	KNOX 47	2	0 00	128	0 00	18	CY-PCC	0 00	.00	7.11	00 9
	DISTRICT TOTAL	2	0 00	128	0 00	18	CY-PCC	0 00	.00	7.11	00 9
412	JOINT REPAIR										
	KNOX 47	1	0 00	48	0 00	120	GAL-SEAL	0 00	.00	.38	00 125
	DISTRICT TOTAL	1	0 00	48	0 00	120	GAL-SEAL	0 00	.00	.38	00 125
* 419	OTHER SURFACE										
	BLOUNT 05	19	0 00	456	0 00	449	MAN HRS.	0 00	.00	1.00	00 0
	KNOX 47	46	19 41	1104	920 83	1093	MAN HRS.	920 84	1.00	1.00	100 0
	MONROE 62	15	3 20	360	96 27	358	MAN HRS.	96 27	1.00	1.00	100 0
	DISTRICT TOTAL	80	22 28	1920	1016 53	1900	MAN HRS.	1016 53	1.00	1.00	100 0
421	CONT PREMIX PATCHING										
	BLOUNT 05	0	0 00	0	0 00	16	TONS-MIX	0 00	.00	.77	00 125
	KNOX 47	1	0 00	96	0 00	82	TONS-MIX	0 00	.00	.77	00 125
	MONROE 62	0	0 00	0	0 00	10	TONS-MIX	0 00	.00	.77	00 125
	DISTRICT TOTAL	1	0 00	96	0 00	108	TONS-MIX	0 00	.00	.77	00 125
* 426	RESHAPE SHO/DITCH										
	BLOUNT 05	20	20 100	1440	1816 126	39	SHLD MTS	49 126	37.6	36.00	103 2
	KNOX 47	25	15 60	1800	1016 56	49	SHLD MTS	59 120	17.2	36.00	48 2
	MONROE 62	19	11 58	1368	984 72	38	SHLD MTS	52 137	18.2	36.00	53 2
	DISTRICT TOTAL	64	46 72	4608	3816 83	126	SHLD MTS	160 127	23.5	36.00	66 2
* 427	PATCH GRAVEL SHLDRS.										
	BLOUNT 05	13	6 46	728	320 44	1947	TONS-AGG	167 09	1.02	.37	519 150
	KNOX 47	16	0 00	896	0 00	2310	TONS-AGG	0 00	.00	.37	00 150
	MONROE 62	15	0 00	840	0 00	2153	TONS-AGG	0 00	.00	.37	00 150
	DISTRICT TOTAL	44	6 46	2464	320 44	4410	TONS-AGG	167 03	1.02	.37	519 150

Figure G-6. Crew Usage and Performance Report.

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM
CREW USAGE AND PERFORMANCE REPORT
PERIOD FROM 07-01-71 TO 07-31-71

EGAD4287 SAMPLE

ACTIVITY GROUP- UNLIMITED

DISTRICT 11

REGION 1 KNOXVILLE

PAGE 1

.....STANDARD CREW SIZE.....				NON-STANDARD CREW SIZE..					COMBINED MH/ACC		
NO.	DESCRIPTION	NO. DAYS	MAN HOURS	ACCOMPL.	MH/ACC	NO. DAYS	MAN HOURS	ACCOMPL.	MH/ACC	TO DATE	STANDARD	PCT
** 401 SPOT PREMIX PATCHING												
	CARTER	4	184	26	7.08	2	64	8	8.00	7.29	1.00	729
	JOHNSON	0	0	0	.00	1	40	6	6.67	6.67	1.00	667
	SULLIVAN	1	48	6	8.73	4	224	22	10.32	10.00	1.00	00
	UNICOI	4	168	32	5.25	2	80	12	6.67	5.64	1.00	564
	DISTRICT TOTAL	9	400	64	6.30	9	408	48	8.55	7.27	1.00	727
420 SPOT PREMIX PATCHING												
	JOHNSON	0	0	0	.00	2	136	16	8.50	8.50	1.00	850
	DISTRICT TOTAL	0	0	0	.00	2	136	16	8.50	8.50	1.00	850
* 473 REPAIR SB-GUARDRAIL												
	SULLIVAN	1	40	107	.37	0	0	0	.00	.37	1.00	37
	DISTRICT TOTAL	1	40	107	.37	0	0	0	.00	.37	1.00	37
476 REPAIR GUIDE POSTS												
	CARTER	0	0	0	.00	2	64	55	1.16	1.16	1.00	116
	DISTRICT TOTAL	0	0	0	.00	2	64	55	1.16	1.16	1.00	116

G-16

Table G-1. Maintenance Activity Numbers

DISTRICT ACTIVITIES	DISTRICT ACTIVITIES	REG ON ACTIVITIES
401 Spot Premix Patching (RU)	451 Minor Repair of Bridge (RU)	400 Maintenance Improvement (O)
402 Crack Pouring (RV)	452 Replace Expansion Seal (RV)	403 Continuous Premix Patching (RV)
406 Surface Replacement (RV)	459 Other Bridge Maintenance (RV)	404 Resurfacing (SA)
410 Spot Premix Patching (RU)	460 Plow Snow (RU)	416 Seal Coating (SA)
411 Concrete Patching (RV)	461 Spread Chemicals (RU)	421 Continuous Premix Patching (RV)
412 Joint Repair (RV)	462 Stockpile and Load Snow	422 Seal Coating (SA)
415 Surface Treatment Patching (RU)	Removal Materials (RU)	437 Chemical Control of
419 Other Surface Maintenance (RV)	469 Other Snow and Ice (RU)	Vegetation (RL)
420 Spot Premix Patching (RU)	472 Minor Sign Repair (RU)	439 Maintenance of Landscaped
425 Grade Shoulders (RL)	474 Clean Traffic Signs (RL)	Areas (RL)
426 Reshaping Shoulders and	475 Repair Steel Beam	440 Reseeding and Mulching (RV)
Pulling Ditches (RV)	Guardrail (RU)	453 Paint Bridge (RL)
427 Patch Gravel Shoulders (RV)	476 Repair Guideposts (RU)	454 Major Repair of Bridge (SA)
429 Other Shoulder Maintenance (RV)	477 Paint Guardrails and	470 Paint Centerlines (RL)
430 Clean and Reshape Ditches (RV)	Posts (RL)	471 Paint Edgelines (RL)
431 Clean Culverts & Pipes (RL)	479 Other Traffic Services (RV)	473 Sign Replacement (RL)
432 Repair Minor Drainage (RV)	482 Accident Cleanup (RU)	480 Slide Removal (RU)
433 Clean Catch Basins (RL)	489 Other Extraordinary	481 Major Settlements (RU)
434 Other Drainage Maintenance (RV)	Maintenance (RU)	483 Emergency Bridge Repair (RU)
435 Machine Mowing (RL)	492 Ferry Operation (O)	490 Rest Area Attendants (Q)
436 Slope Mowing (RL)	493 Stockpiling Material (O)	491 Interstate Emergency Patrol (O)
438 Brush Cutting (RV)	494 Building and Grounds	497 Bridge Inspection (O)
441 Roadside Cleanup (RL)	Maintenance (O)	
442 Service Litter Barrels (RL)	495 Road Patrol (O)	
443 Clean Up Roadside Parks (RL)	496 Field Maintenance	
444 Rest Area and Weigh Station	Supervision (O)	
Maintenance (RL)	498 Inclement Weather and	
445 Fence Repair (RU)	Standby (O)	
446 Mechanical Roadway		
Sweeping (RL)		
447 Manual Roadway Sweeping (RL)		
449 Other Roadside Maintenance (RV)		
450 Clean Bridges (RL)		

Figure G-8.

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM
CREW USAGE AND PERFORMANCE REPORT
PERIOD FROM 07-01-75 TO 12-31-75

ACTIVITY GROUP- LIMITED

DISTRICT 15

REGION 1 KNOXVILLE

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.....ACTIVITY.....				STANDARD CREW SIZE.....			NON-STANDARD CREW SIZE.....			COMBINED MH/ACC.....		
NO.	DESCRIPTION	NO. DAYS	MAN HOURS	ACCOMPL.	MH/ACC	NO. DAYS	MAN HOURS	ACCOMPL.	MH/ACC	TO DATE	STANDARD	PCT			
* 425 GRADE SHOULDERS															
	BLOUNT	13	208	81	2.57	2	48	18	2.67	2.59	2.14	121			
	KNOX	5	80	33	2.42	0	0	0	.00	2.42	2.14	113			
	MONROE	21	336	109	3.08	0	0	0	.00	3.08	2.14	144			
	DISTRICT TOTAL	39	624	223	2.80	2	48	18	2.67	2.79	2.14	130			
* 431 CLEAN CULVERTS/PIPES															
	BLOUNT	4	64	41	1.56	3	80	51	1.57	1.57	1.11	141			
	KNOX	75	1,200	1,612	.74	39	608	766	.79	.76	1.11	68			
	MONROE	34	392	304	1.29	6	72	66	1.09	1.25	1.11	113			
	DISTRICT TOTAL	113	1,656	1,957	.85	48	760	883	.86	.85	1.11	77			
433 CLEAN CATCH BASINS															
	BLOUNT	1	16	12	1.33	1	24	5	4.80	2.35	.90	261			
	KNOX	27	432	570	.76	15	264	368	.72	.74	.90	82			
	MONROE	2	24	17	1.41	0	0	0	.00	1.41	.90	157			
	DISTRICT TOTAL	30	472	599	.79	16	288	373	.77	.78	.90	87			
** 435 MACHINE MOWING															
	BLOUNT	79	1,896	1,159	1.64	42	1,208	788	1.53	1.59	1.60	99			
	KNOX	168	4,000	1,766	2.26	120	3,178	1,381	2.30	2.28	1.60	143			
	MONROE	66	1,772	541	3.28	43	1,344	373	3.60	3.41	1.60	213			
	DISTRICT TOTAL	313	7,668	3,466	2.21	205	5,730	2,542	2.25	2.23	1.60	139			
437 CHEMICAL CONTROL-VEG															
	BLOUNT	3	72	441	.16	0	0	0	.00	.16	.08	200			
	KNOX	3	88	275	.32	2	40	185	.22	.28	.08	350			
	DISTRICT TOTAL	6	160	716	.22	2	40	185	.22	.22	.08	275			
** 441 ROADSIDE CLEANUP															
	BLOUNT	57	1,364	357	3.82	9	144	44	3.27	3.76	4.12	91			
	KNOX	162	3,848	1,014	3.79	101	1,388	522	2.66	3.41	4.12	83			
	MONROE	38	900	116	7.76	56	812	182	4.46	5.74	4.12	139			
	DISTRICT TOTAL	257	6,112	1,487	4.11	166	2,344	748	3.13	3.78	4.12	92			
* 442 SERV. LITTER BARRELS															
	BLOUNT	25	416	397	1.05	41	984	611	1.61	1.39	.55	253			
	KNOX	48	368	407	.90	4	40	46	.87	.90	.55	164			
	MONROE	45	712	1,087	.66	14	112	350	.32	.57	.55	104			
	DISTRICT TOTAL	118	1,496	1,891	.79	59	1,136	1,007	1.13	.91	.55	165			
* 443 CLEANUP ROADSIDE PARKS															
	BLOUNT	2	32	20	1.60	6	152	26	5.85	4.00	4.27	94			
	KNOX	35	552	114	4.84	0	0	0	.00	4.84	4.27	113			
	MONROE	4	64	9	7.11	0	0	0	.00	7.11	4.27	167			
	DISTRICT TOTAL	41	648	143	4.53	6	152	26	5.85	4.73	4.27	111			
446 MECH. ROWAY SWEEPING															
	BLOUNT	1	16	8	2.00	0	0	0	.00	2.00	2.14	121			

Figure G-9.

STATE OF TENNESSEE
DEPARTMENT OF HIGHWAYS
COST DISTRIBUTION BY WORK ACTIVITY
PERIOD FROM 07-01-75 TO 03-31-76

SYSTEM INTERSTATE

REGION NASHVILLE

DISTRICT 34

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.....A C T I V I T Y.....			E X P E N D I T U R E S -- D O L L A R S.....			
NO.	DESCRIPTION	TOTAL WORK QUANTITY	WORK UNIT	LABOR	EQUIPMENT	MATERIAL	TOTAL
401	SPOT PREMIX PATCHING	41.9	TONS-MIX	1,455.12	419.31	502.80	2,377.23
419	OTHER SURFACE	56.0	MAN HRS.	216.72	20.41	.00	237.13
420	SPOT PREMIX PATCHING	29.7	TONS-MIX	681.12	105.76	356.40	1,143.28
429	OTHER SHOULDER	506.0	MAN HRS.	1,958.22	860.97	167.40	2,986.59
430	CLEAN/RESHAPE DITCH	2,500.0	LF CLEAN	185.76	113.78	.00	299.54
431	CLEAN CULVERTS/PIPES	89.0	NO CLEAN	340.56	44.98	.00	385.54
433	CLEAN CATCH BASINS	250.0	NO CLEAN	464.40	122.80	.00	587.20
434	OTHER DRAINAGE	472.0	MAN HRS.	1,826.64	400.94	.00	2,227.58
435	MACHINE MOWING	2,213.6	ACRES	8,599.14	7,425.80	.00	16,024.94
437	CHEMICAL CONTROL-VEG	31,059.0	GAL CHEM	832.05	755.09	6,522.39	8,109.53
438	BRUSH CUTTING	1,026.0	MAN HRS.	3,970.62	471.21	.00	4,441.83
439	MAINT-LANDSCAPED ARS	376.0	MAN HRS.	1,455.12	180.67	.00	1,635.79
441	ROADSIDE CLEANUP	146.7	R/W P-MI	3,722.94	567.65	.00	4,290.59
442	SERV. LITTER BARRELS	886.0	NO SERV.	1,718.28	588.63	.00	2,306.91
443	CLEANUP RDSIDE PARKS	19.0	NO CLEAN	750.78	164.13	.00	914.91
445	FENCE REPAIR	1,097.0	LF-FEN.	1,068.12	185.39	.00	1,253.51
446	MECH. RDWAY SWEEPING	32.0	MI-SWEPT	61.92	125.96	.00	187.88
447	MAN. RDWAY SWEEPING	72.0	MAN HRS.	278.64	32.03	.00	310.67
449	OTHER ROADSIDE	308.0	MAN HRS.	1,191.96	286.59	24.00	1,502.55
451	MINOR BRIDGE REPAIR	2,251.0	MAN HRS.	8,711.37	6,270.40	32,95.71	47,877.48
461	SPREAD CHEMICALS	446.0	MAN HRS.	1,726.02	562.26	5,52.75	7,641.03
462	STKPILING SNOW CHEM.	13.0	MAN HRS.	50.31	123.54	.00	173.85
469	OTHER SNOW AND ICE	95.0	MAN HRS.	367.65	26.18	.00	393.83
470	PAINT CENTERLINES	130.9	MI PAINT	1,501.56	1,332.07	5,53.05	8,786.68
471	PAINT EDGELINE	217.8	MI PAINT	2,027.88	1,910.47	20,13.75	24,152.10
472	MINOR SIGN REPAIR	112.0	NO SIGNS	402.48	73.37	.00	475.85
473	SIGN REPLACEMENT	28.0	NO SIGNS	437.31	86.76	72.10	1,496.17
475	REPAIR SB-GUARDRAIL	618.5	NO FEET	1,609.92	785.23	28.18	2,723.33
476	REPAIR GUIDE POSTS	681.0	NO REPRD	1,486.08	249.79	.00	1,735.87
479	OTH TRAFFIC SERVICES	115.0	MAN HRS.	445.05	143.13	.00	588.18
482	ACCIDENT CLEANUP	8.0	MAN HRS.	30.96	9.15	.00	40.11
489	OTHER EXTRAORD MAINT	56.0	MAN HRS.	216.72	86.75	.00	303.47
496	FIELD MTC SUPRVISION	8.0	MAN HRS.	37.68	11.06	.00	48.74
497	BRIDGE INSPECTION	1,014.0	MAN HRS.	5,881.20	419.82	.00	6,301.02
498	INCLEMENT WEATHER	16.0	MAN HRS.	61.92	62.07	.00	123.99
499	NON-SYSTEM MAINT.	16.0	MAN HRS.	61.92	26.74	.00	88.66
TOTAL ALL ACTIVITIES				55,834.14	25,050.89	73,88.53	154,173.56

APPENDIX H

WASHINGTON DEPARTMENT OF HIGHWAY'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,429,000 residents of Washington operate 2,370,000 motor vehicles on 75,098 miles of highway of which 11,800 are under state control. The state occupies 68,192 square miles from an elevation of 14,410 feet above sea level to sea level. Mean minimum and maximum temperatures are 8 and 92°F with average annual moisture ranging from 8 to 120 inches.

The Washington Department of Highways has a \$40,000,000 yearly maintenance budget. This budget will be used by its 6 districts to maintain 17,000 lane miles of highways (7,000 center line miles are under state maintenance).

Six districts comprise the Washington Department of Highways. Each district is divided into Maintenance Divisions resulting in a total of 31 Maintenance Divisions state wide. Maintenance Divisions are further divided into Maintenance Sections resulting in a total of 134 Maintenance Sections, in the state.

Supervisors are in responsible charge at the Maintenance Section with assistance from Maintenance Lead Technicians. Supervisors report to the Maintenance Division Superintendent who in turn reports to the District Maintenance and Operations Engineer who is responsible to the District Engineer. The overall administration of the maintenance program in the Washington Department of Highways

has been delegated by the Director of Highways to the Assistant Director of Maintenance.

Development of a management information system was initiated in 1964 with the assistance of a consultant. In the 1967 period the highway department developed a Maintenance Control System, a subsystem to the management information system with the consultant acting as a member of the research and development team. The developed system was tried on a trial basis in 4 divisions with the majority of the system implemented in 1968. A performance budget was first prepared for the 1969-1970 biennium based on data collected as part of the maintenance management system. The management system has remained under development with further changes anticipated in the future.

A combination of manual field data input is coupled with electronic data processing to compile and produce the reports. The compilation of field data is duplicated for independent use for payroll and accounting purposes. The duplicated data are being utilized for the Maintenance Control System. Each basic recording document is filled out by the individual maintenance employee. Eight years of reliable performance data have been collected. Performance data for the last three years of record are supplied to the district to aid in plan and budget preparation.

RECORDING SYSTEM

Washington Department of Highways Form 174-036, "Maintenance and Shop Labor Reporting Form" is utilized to collect maintenance

activity information (Figure H-1). The type of information recorded on this form includes;

1. Activity performed,
2. Location activity performed,
3. Manpower utilization,
4. Equipment utilization,
5. Material utilization indirectly, and
6. Accomplishments.

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated on the Maintenance and Shop Labor Reporting Record by designating the highway control section number together with the district, division and crew designation. The organization code is a six digit number denoting the Department's organizational element within which the employee is assigned to work. This code can be utilized to determine the district, and division in which the workman was assigned. Specific information is recorded to denote the location of the work as follows:

1. District. A number from 1 to 6 is utilized to designate district.

2. Maintenance Division. A one digit number is utilized to designate the Maintenance Division. District and Maintenance Division designation is coded in the column identified as Job Number. For example the code M51 would indicate the following:

M - Maintenance Operation (C utilized for Construction
and P utilized for general supervision and planning)

5 - District 5

1 - Maintenance Division 1.

If the labor reported on this form is for a nonmaintenance job, the proper engineering, administrative, etc. job number should be entered under Job Number.

3. Maintenance Section. The maintenance section can be identified by the crew designation. The crew designation is a letter code normally entered after the Maintenance Operation Code. For example, 2113B entered under "function" would designate crew B.

4. Control Section. Control sections identify a specific highway segment. Six digit numeric codes are utilized to identify control sections. If the workmen performed a maintenance activity on the highway a control section is identified in the column titled "Control Section or Equipment Worked on." In the case of shop personnel, the equipment number worked on is indicated in this column. Flexibility in the coding format exists to allow for an increase in the number of maintenance sections as required in the future.

5. Milepost. The state has a milepost system, however, it is not utilized to report the location of maintenance activities. Attempts are presently being made to make use of the milepost system to report the location of the maintenance activity.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Activity

Highway Maintenance Operation Codes are utilized to designate the maintenance activity performed. A four digit numeric code is utilized to identify the Highway Maintenance Operation. The first two digits of the code reveal the specific accounting functions as shown below:

1. Physical Maintenance
2. Traffic Control and Service Facilities
3. Snow and Ice Control
4. Repair of Damages Caused by Traveling Public
5. Suspense Accounts
6. General Functions

The first two digits as a unit also identify the functional class. A list of the 37 functional classes are shown on Table H-1.

The last two digits of the Highway Maintenance Operation Code as a unit are utilized to identify specific activity codes. Table H-2 shows an example of the codes and units utilized for activities associated with maintenance of drainage facilities. Engineering and flagging activities associated with specific functional classes are among the 373 Highway Maintenance Operations. It should be noted that special operation codes do not exist for portland cement concrete pavement as opposed to asphalt concrete surfaced pavements. Special codes exist for snow and ice removal. Maintenance standards exist for many of the operation codes. Usually about 40 to 60 of the maintenance operation codes are widely used.

Manpower

The individual filling out the Maintenance and Shop Labor Reporting Record supplies his name, social security number, organization code, the starting and ending time of his shift, the hours worked, the type of activity performed, the location of the activity and the equipment utilized. Both regular and over-time are reported. Working time is reported to the nearest 0.1 hour. Separate Highway Maintenance Operation codes are utilized for supervision personnel and for delay time due to equipment breakdown. These codes are in the 6,000 series.

As discussed above the entry under Job Number and maintenance crew identify the working unit to which the employee is assigned.

Equipment

Equipment utilized for a particular maintenance operation is recorded by the individuals operating the equipment. Equipment usage is reported by the mile or hour, depending upon the type of equipment. Time is reported to the nearest half-hour and mileage to the nearest mile.

Each item of equipment is designated by an equipment alpha-numeric code. An example of such a designation is shown below:

6A5 - 27

6 - indicates the equipment class

A - indicates the district (District 1)

5 - indicates the equipment sub-class and

27 - indicates the sequential number of the vehicle
in the sub-class within the district.

The vehicle described above is a diesel powered dump truck in the 19,000 to 24,000 gross vehicle weight category. For each vehicle sub-class a rental category and depreciation schedule are assigned. Costs per mile or hour operated and cost per hour assigned are also calculated for each vehicle sub-class. Twenty-four vehicle classes have been identified.

Materials

Materials utilized for a particular maintenance operation are not recorded. Individual measurements of materials can be obtained by utilization of the reported "work units" and the work standards. The inclusion of material usage on the Maintenance and Shop Labor Reporting Record is under study. A special maintenance operation code does exist for material haul.

Accomplishments

Accomplishments are reported by the individual under the heading "Work Units." The units reported are those designated on the maintenance operation code summaries (Table H-2). For example, accomplishments reported for maintenance operation 1135 (patch pot holes - hand spread and compact with truck) are in units of tons. For those operations requiring a crew to perform, only one time card would report accomplishments in the column work units.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance and Shop Labor Reporting Record is filled out daily by the maintenance employee. The section leader will audit the entries for correct coding, total numbers of hours, and the breakdown of the over-time hours. Secretaries are not responsible for individual time reports. These daily records are transmitted

to the division office weekly. The district office will key punch the daily time sheets and combine the data monthly for transmission through the remote computer terminal in the district to the HQ office. The HQ office computer and staff are responsible for the reports. Monthly reports are returned to the district by the 15th of the following month. Yearly reports are returned within 6 weeks after the close of the fiscal year.

It is estimated that about three-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. About 80,000 dollars of computer charges are utilized annually.

REPORTS

Several reports are produced from the collected data. A brief discussion of the more important reports from a maintenance management standpoint are presented below.

Accomplishment Reports. Accomplishment reports are prepared for the state as a whole, the District, Maintenance Divisions, Maintenance Sections and maintenance crews. Year to date totals and current month work units accomplished and costs are reported by Maintenance Operation Number. A District Accomplishment Report is shown on Figure H-2. Information displayed on this report is summarized below.

1. Accomplishments for the year to date reported in terms of the standard unit (tons, lineal feet, etc.) for the maintenance operation.

2. Percent of scheduled work units complete for the year to date.

3. Remaining amount of work units to be completed during the remainder of the year.

4. Hours of labor expended for the year to date.

5. Actual cost and standard cost of the labor for the year to date. The standard cost of labor, equipment and material is obtained from the work standards, man-hour per unit of accomplishment standard, and an estimate of the average cost of labor to perform the given maintenance operation.

6. Labor performance percent or ratio of the standard labor cost to the actual labor cost.

7. Equipment standard and actual cost.

8. Equipment performance percent or the ratio of the standard equipment cost to the actual equipment cost.

9. Material standard and actual cost both of which are obtained by use of the work standard.

10. Total actual and standard cost.

11. Total unit cost or the ratio of the actual costs to the number of work units accomplished.

12. Cost ratio or the ratio of the actual costs to the standard cost.

13. Work units and costs are given for the reported month.

Planning Reports. Several planning reports are prepared from information collected on the Maintenance Yearly Planning Sheet (Figure H-3) and the work standards information. These sheets are developed from input from the crew leadman and section supervisor. Distribution of the work units is made on a monthly basis in

accordance with the direction given in reference H-1. The following reports are obtained from this information;

1. Monthly Man-hour Distribution for:
 - a. Sections (Report No. 8031)
 - b. Divisions (Report No. 8032)
 - c. Districts (Report No. 8033)
 - d. State-wide (Report No. 8034) (Figure H-4)
2. Budget-Aging reports showing monthly cost distributions for:
 - a. Divisions (Report No. 8035)
 - b. Districts (Report No. 8036)
 - c. State-wide (Report No. 8037) (Figure H-5)
3. Workman skill requirement reports for:
 - a. Divisions (Report No. 8039)
 - b. District (Report No. 8040)
 - c. State-wide (Report No. 8041) (Figure H-6)
4. Fund Requirement Reports

The reports described above are prepared before the beginning of each fiscal year. The yearly work plans in some cases are prepared 2 to 3 years in advance. Thus, it is not desirable to compare scheduled or planned activities with performed activities on the Accomplishment reports.

Reports are utilized for fiscal control, by reviewing cost to date in the Accomplished Report; for monitoring of program execution by reviewing the percent completion column of the Accomplishment Report; for allocation of manpower and equipment, by review of the performance percent for labor and equipment costs and by utilizing the Planning Reports; and for budget preparation.

as a check to determine productivity figures to be utilized in calculating the budget. The reports are also utilized to justify budget to state legislation and have been utilized to relocate section boundaries.

Presently maintenance operations that appear to be contrary to planned productivity and budgets must be located by a detailed review. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The Washington Department of Highways is very happy with the reliability of the reported data. HQ office checking is performed selectively.

The recording and reporting system can be altered by direction of the HQ office maintenance staff as the need arises. The HQ office continually works with the districts to assess the usefulness of the recorded and reported information.

A standing maintenance standards committee does not exist. Standards are revised as necessary.

Changes have been made in the reporting format since 1968. These changes are made from the HQ office usually after consultation with field personnel. The maintenance management system has been developed and altered by the Department of Highways with assistance from consultants.

Data can be stored for an extended period of time. The last three years of data are routinely supplied to the districts.

References

- H-1 "Maintenance Control System, Maintenance Yearly Planning Procedures Manual," Washington Department of Highways, September, 1971.
- H-2 "Equipment Information and Reporting System User Manual," State of Washington, Department of Highways, Accounting Division Manual.
- H-3 Dorsey, V. L., "State of Washington Reporting System," Highway Research Record No. 347, 1971.
- H-4 "Quality Standards for Highway Maintenance," Washington Department of Highways, May, 1968.
- H-5 "Highway Maintenance Operations," Washington Department of Highways, July 1, 1975.
- H-6 "Uniform Equipment Rental Rates," Washington Department of Highways, September 1, 1975.
- H-7 "Maintenance Work Control System, Time Standard Manual," Washington Department of Highways, March, 1973.
- H-8 Anderson, D. R., "Maintenance Work Control System, Highway Signal and Lighting Preventive Maintenance and Repair Manual," Washington Department of Highways, December, 1971.

Table H-1. Functional Classes of Highway Maintenance Operation.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

HIGHWAY MAINTENANCE OPERATIONS

OPERATION NUMBER FROM TO		CHART OF ACCOUNTS		PAGE
1100	1199	M2110	ROADWAY SURFACE	1
1200	1299	M2121	ROADSIDE REPAIRS	2
1300	1399	M2122	CLEANING - DRAINAGE FACILITIES	4
1400	1499	M2123	MOWING AND BURNING GRASS - WEEDS (Excluding rest and landscape areas)	6
1500	1599	M2124	MAINTENANCE OF LANDSCAPED AREAS (Other than roadside rest areas)	7
1600	1699	M2125	BRUSH AND TREE GROWTH ALONG RIGHT OF WAY (Excluding rest or landscape areas)	9
1700	1799	M2126	WEED CONTROL (Excluding rest and landscape areas)	10
1800	1899	M2130	SHOULDERS AND SIDE APPROACHES	11
1900	1999	M2140	STRUCTURES	13
2000	2099	M2210	PATHS AND TRAILS	15
2100	2199	M2510	SNOW AND ICE CONTROL	16
2200	2299	M2221	TRAFFIC SIGNS, DIRECTION MARKERS, AND OTHER TRAFFIC DEVICES	18
2300	2399	M2222	PAINTING OF STRIPES AND PAVEMENT MARKINGS	20
2400	2499	M2223	REPAIRING AND MAINTAINING GUARDRAILS	22
2500	2599	M2224	REPAIRING, MAINTAINING, AND OPERATING ELECTRICAL SIGNAL EQUIPMENT	23
2600	2699	M2224	ELECTRONIC MAINTENANCE AND REPAIR	25
2700	2799	M2225	REPAIRING, MAINTAINING, AND OPERATING HIGHWAY LIGHTING SYSTEM	26
2800	2879	M2226	REPAIR AND MAINTENANCE OF ROADSIDE REST AREAS	27
2880	2889	M2240	OPERATION OF DRAWBRIDGES AND FERRIES	29
2890	2899	M2250	OTHER SERVICES	29
2900	2999	M2260	ROADSIDE CLEANING	30
3000	3999	M2310	REPAIR OF DAMAGES CAUSED BY TRAVELING PUBLIC	31
4000	4099	M2400	DISASTER MAINTENANCE	32
5012	5012	M2800	DORMITORY AND DINING ROOM - SUSPENSE	32
5013	5013	M2900	SIGN MANUFACTURE - SUSPENSE	32
5311	5319	M2700	TRAFFIC STRIPING - SUSPENSE	32
6011	6016	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6017	6017	M2690	MAINTENANCE - TRAINING	33
6018	6023	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6024	6025	M2610	MAINTENANCE - GENERAL FUNCTIONS - RADIO OPERATIONS	33
6026	6027	M2620	MAINTENANCE - GENERAL FUNCTIONS - ADMINISTRATION	33
6028	6099	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6500	6530	M2630	MAINTENANCE - PERMIT FUNCTIONS	34
6610	6610	M2150	MAINTENANCE - CETA - SUPERVISION/PHYSICAL MAINTENANCE	35
* 6620	6620	M2150	MAINTENANCE - CETA - PHYSICAL MAINTENANCE	35
6630	6630	M2270	MAINTENANCE - CETA - SUPERVISION/TRAFFIC SERVICES	35
* 6640	6640	M2270	MAINTENANCE - CETA - TRAFFIC SERVICES	35

Table H-2. Highway Maintenance Operation Codes - Example.

NUMBER	UNIT	OPERATION DESCRIPTION
<u>FUNCTION 1300 MAINTENANCE OF DRAINAGE FACILITIES</u>		
<u>MAJOR JOB 1310 CLEANING DITCHES AND CHANNELS</u>		
1311	100 Linear Ft.	Motor grader and front-end loader (may include use of trucks)
1312	100 Linear Ft.	Front-end loader only
1313	100 Linear Ft.	Front-end loader with trucks
1314	100 Linear Ft.	Motor grader(s) - (includes distributing material on shoulder if suitable)
1315	100 Linear Ft.	Motor grader with belt loader with trucks
1316	100 Linear Ft.	Power shovel or clam/dragline (with or without trucks)
1318	100 Linear Ft.	Hydraulic shovel with trucks (includes backhoe type attachments on other equipment)
1329	None	Channel cleanup and other methods of ditch or channel cleaning
<u>MAJOR JOB 1330 CLEANING CULVERTS AND CROSS DRAINS</u>		
(Run out ditches cleaned mechanically to be included under 1310 series)		
1331	Each	Manual shovel - (brushing & inspection included)
1333	Each	Painting culvert marks
1339	None	Other - includes mechanical cleaning methods
<u>MAJOR JOB 1340 CLEANING MANHOLES AND CATCH BASIN</u>		
1341	Each	Manual shovel
1342	Each	Mechanical cleaning - (Vac-All, Eductor, etc.)
1349	None	Other methods

H-15

STATE OF WASHINGTON[illegible]

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

MAINTENANCE ACCOMPLISHMENT REPORT FOR MONTH OF NOVEMBER 75
MAINTENANCE DISTRICT 51

PAGE 142
DATE OF RUN 12/11/75
-----* CURR. MO.

CPRC. NO.	HW TO-DATE	J CCMP	K PCT	U REMAIN	I T	S V	LABOR			MATERIAL			T			T A			COST PAT.	UNITS	COST WORK	MO.
							HOURS TO-PAT	PER. PCT.	ACTUAL COST	STD. COST	PER. PCT.	ACTUAL COST	STD. COST	PER. PCT.	ACTUAL COST	STD. COST	PER. PCT.	ACTUAL COST				
11111	MECH MIX PATCH	5114	31	11415	TCN	15c7	65	12907	8400	135	5739	7540	60358	60353	79004	7	404	15.45	1.03			
11121	HAUL FOR PATCH	90033	32	48073	CU MI	3316	79	49296	39073	90	31236	26291			80592	6	364	.59	1.20	1289	950	
11221	MANUAL MIX SPET	545	38	904	TCN	1370	104	11044	11505	135	5491	7416	6650	6650	23185	2	571	42.54	.91	4	331	
11201	MACH MIX GENT	19012	>	5209-	TCN	5937	174	47641	82954	182	18900	34561	228122	228122	294669	34	637	15.50	.85	224	3563	
11331	PATCH PCCW/PCC#	121	57	4	SC FT	38		154			36				190			1.57		37	141	
11341	PATCH APH 4/APH	1503	15	7370	SC FT	157	36	1332	1141	95	644	614	360	360	2336		115	1.55	1.10			
11351	PATCH PCT FOLDS	421	20	1076	TCN	1426	106	11101	11716	141	3105	4387	4807	4807	19013	2	910	45.16	.91	145	6076	
11361	PREP RD MIX		*	200	CU YD																	
11411	MAINT GRAVEL RD	28	>	3-	LN MI	46	58	400	232	56	505	235			905		527	32.32	1.72			
11471	SEAL COAT ROAD	544	>	472-	100CL	357	77	7417	5741	111	2771	3062	29471	29471	39659	3	274	72.90	1.04		73	
11431	HAUL FOR	1147	>	7422-	CU MI	522	125	4400	5503	190	2012	3985			6413		1483	.76	.68			
11531	FOG SEALS	13	>	10-	100CL	21		319			319				638			35.44				
11541	PATCH-SURG-APP#	51	5	1103	SC YD	67	31	593	182	35	412	142	85	35	1090		409	18.79	2.67			
11551	SHVELY PATCHING	295	3	6503	GAL	60	37	340	202	120	107	123	163	163	810		493	2.75	1.64			

Figure H-3. MAINTENANCE YEARLY PLANNING SHEET

Add - 1
Delete - 2
Replace - 3

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

MAINTENANCE YEARLY WORK PLAN

FISCAL YEAR

1 REPORT NO 8034

STATEWIDE

PAGE NO 2
DATE RUN 03/03/71

MONTHLY MANHOUR DISTRIBUTION

DIST	WPK UNITS	MAN HOURS	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL COSTS	% LBR	% EQP	% MAT
1170 SPCL MNT & RPR																		
1	4	242	151					45		45				1	1977	65.5	15.8	18.7
3	10	724	80	44	49	76	55	37	40	37	37	178	67	78	8379	48.9	21.1	30.0
4		172	14	12									188		2542	42.3	10.1	47.6
5	289	939	33	52	259	436	32						104	23	10327	44.7	26.9	28.4
6		710	177	226	129							26	19	133	6695	56.6	10.9	32.5
7		250			48	101							101		1625	82.0	18.0	
TOTAL	303	3117	401	334	485	613	87	82	40	82	37	204	457	235	31945	51.3	19.6	29.1
1160 CLN RUBY SURFCE																		
1	2000	1517	22	103	123	142	81	29	5	91	77	445	313	86	20723	36.0	82.0	
2	1655	4267	127	212	2						1221	1233	616	856	40601	54.1	45.9	
3	4173	4024	273	288	309	265	226	212	218	235	766	563	400	269	47576	43.8	56.2	
4	351	593	15	3	58	114	18	1	9		142	154	78	1	7713	39.6	60.4	
5	2925	2247	190	423	249	90	18				355	559	257	98	29624	38.9	61.1	
6	2529	2877			222	655					556	441	502	461	33019	44.8	55.2	
7	176	856	3	1	353	4	3	4	3	4	120	354	3	4	8818	49.4	50.6	
TOTAL	14151	10361	658	1030	1316	1250	346	248	235	330	3237	3749	2229	1775	168274	44.9	55.1	
1195 FLAGGING																		
1		6873	1110	984	596	466	172	64	30	166	166	639	449	2031	41360	91.3	8.7	
2	288	8162	801	963	420						1072	935	2339	1732	45131	99.3	.7	
3		11767	1159	1269	1636	953	565	513	510	535	958	1089	1448	1092	62356	97.6	2.4	
4		7232	1055	1243	801	698	248	156	119	226	255	903	1031	697	40216	96.8	3.2	
5		7775	1145	1300	515	879	306	50	46	138	566	993	883	956	41516	97.3	2.7	
6		7591	772	1555	1492	198	111		22	89	301	1411	832	808	38385	98.4	1.6	
7		1058	79	131	174	123	80	31	11	71	69	91	69	109	7431	75.8	24.2	
TOTAL	286	45928	6041	6945	5432	3317	1462	814	738	1225	3387	6061	7091	7425	276398	96.3	3.7	

Figure H-4. Monthly Man-Hour Distribution Report.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

PROGRAM 4 BUDGET-AGING

FISCAL YEAR 71 REPORT NO 8037

STATEWIDE

PAGE NO 2
DATE RUN 03/03/71

ACTIVITY	QUANTITY	MAN	COST DISTRIBUTION							TOTAL	LABOR	EQUIPMEN	MATERIAL
DIST	WORK UNITS	HOURS	* JUL JAN	AUG FEB	SEP MAR	OCT APR	NOV MAY	DEC JUN					
1160 CRACK&JNT SEAL													
2	24	326 *			1106	1539				2645	1666	635	344
3	243	4682 *	1576 2271	70 2252	7594 2952	11494 86	4399 2051	2201 70		37020	23699	8200	5121
4	23	322 *				919 265	1266			2450	1617	514	319
5	457	5396 *	1121		4263	31756	12775			49909	32077	11392	6440
6	116	1624 *			278	10448	54 1582			12362	8159	2595	1608
7	70	980 *	1456	3704	1414		548	548		7672	4913	1764	995
TOTAL	156	1015 *	4157 2271	2207 2252	20306 2961	58959 353	18494 4131	2201 1545		125887	80978	28288	16621
1170 SPEC MNT & RPR													
1	4	242 *	1156		407			407 7		1979	1295	314	370
2	10	784 *	754 460	520 426	573 426	706 1971	624 765	426 727		8378	4097	1766	2515
4		192 *	176	155			2111			2442	1031	248	1163
5	289	939 *	236	354	2968	5538	232 1345	155		10828	4848	2908	3072
6		710 *	1372	2373	1381	186	139	1244		6695	3791	730	2174

Figure H-5. Statewide Budget-Aging Report.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
YEARLY WORK PLAN - SKILL REQUIREMENTS
DISTRICT 10000

PAGE NO 1
REPORT NO 8041
DATE 02/26/71

		MONTHLY SKILL REQUIREMENTS (MANHOURS)															
SKILL TITLE	SALARY RANGE	ACTIVITY	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	AY	JUN	TOTAL		
HWY MT. MAN 1	12A	041	9099	8187	12413	15467	11550	5921	3795	9146	12238	10698	11	16	11255	121335	
HWY MT. MAN 11	20A	041	1145	1154	1154	1580	835	197	44	437	516	1495	1	16	1431	11435	
HWY MT. LEADMAN	22A	041	623	613	807	447	200	378	209	607	835	607	1	25	1023	743	
BRIDGE MT. MAN	20A	041	441	404	988	591	906	275	285	574	1470	1489	1	62	5057	14352	
BRIDGE MT. SPFC	24A	041	121	114	276	139	240	72	74	150	410	358		02	1345	3731	
HWY ECP TPR 11	22A	041	443	548	906	2053	1186	978	396	896	1519	1018		64	874	11785	
HWY ECP TPR 111	24A	041			86	466	426	71	2	42	163	151		13	13	1533	
ACT TOTAL			12077	11020	14632	20743	15443	7792	4805	11852	17201	15826	17	98	21153	171742	
ELECTRICIAN	21A	042	226	216	134	146	217	218	206	219	169	150		72	138	2316	
HWY MT. MAN 1	12A	042	6060	6328	8389	8350	10550	10982	12501	9713	7219	8607	10	12	7768	106788	
HWY MT. MAN 11	20A	042	8	9	20	27				3	42	60		51	29	249	
HWY MT. SPFC	21A	042	433	554	624	310	282	182	195	222	302	447		69	706	5123	
HWY MT. LEADMAN	22A	042	41	77	24						6	13		82	25	263	
HWY MT. FOREMAN	24A	042	1	2	1						1	1		1	4	11	
BRIDGE TENDER	16A	042	1606	1656	1606	1656	1606	1696	1696	1696	1908	1908	1	08	1503	21200	
TRAF SIG TECH 1	19A	042	388	261	290	263	251	158	212	292	229	311		11	345	3251	
TRAF SIG TECH 11	25A	042	435	300	331	283	302	248	215	335	265	337		26	369	3645	
ELECT TECH 1	12A	042	14	14	13	12	15	13	12	14	13	12		14	13	150	
ELECT TECH 11	24A	042	14	14	13	12	15	13	12	14	13	12		14	13	150	
ELECT TECH 111	25A	042	14	14	13	12	15	13	12	14	13	12		14	13	150	
HWY ECP TPR 11	22A	042	151	406	479	461	453	419	555	455	504	454		24	387	5224	
HWY ECP TPR 111	24A	042	151	406	479	461	453	419	555	455	504	454		24	387	5224	
COOKS TPR 11	22A	042	151	406	479	461	453	419	555	455	504	454		24	387	5224	
COOKS TPR 111	24A	042	151	406	479	461	453	419	555	455	504	454		24	387	5224	
CARETAKER	16	042	155	160	160	160	160	403	403	403	443	200		60	160	2970	
ACT TOTAL			10324	10299	12389	11892	14461	15555	17892	14782	12068	13234	14	60	12075	159631	
ELECTRICIAN	21A	043	29	19	19	61	17	27	49	27	17	59		17	32	393	

Figure H-6. District Skill Requirement Report.

APPENDIX I

WYOMING STATE HIGHWAY DEPARTMENT'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 353,000 residents of Wyoming operate 294,000 motor vehicles on 40,636 miles of highways of which 6,000 miles are under state control. The state occupies 97,914 square miles from an elevation of 3,100 feet to 13,804 feet above sea level. Mean minimum and maximum temperatures are -8 and 92°F with average annual moisture ranging from 8 to 56 inches.

The Wyoming State Highway Department has a \$15,000,000 maintenance budget for fiscal year 1975-1976. This budget will be used by its 5 districts to maintain 14,620 lane miles of highways (6,000 center line miles) which consist of 3,820 Interstate highway lane miles, 6,160 primary highway lane miles and 4,640 secondary highway lane miles.

Five districts comprise the Wyoming State Highway Department. Each district is divided into maintenance stations resulting in a total of 55 maintenance stations state wide.

Foremen are in responsible charge at the maintenance station with assistance from crew leaders or lead men at certain larger stations. Foremen report to the district maintenance engineer who in turn reports to the district engineer. The administration of the maintenance program by the Superintendent and Chief Engineer of the Wyoming State Highway Department is performed at the central

office level by the Construction and Maintenance Branch through the Operations Division.

The basic maintenance recording and reporting system was developed in the 1970 to 1971 period at the same time the accounting system was being revised. A parallel recording system is being utilized although an effort is being made to develop a single recording system. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports. About one year of reliable maintenance cost data is now available from the recording and reporting system.

RECORDING SYSTEM

Wyoming State Highway Department Form M-17, "Maintenance Activity Record" is utilized to collect maintenance activity information (Figure I-1). The type of information obtained on this form includes;

1. Activity performed,
2. Location activity performed,
3. Manpower utilization
4. Equipment utilization,
5. Material utilization,
6. Accomplishments and,
7. Planned accomplishments.

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording

the following information:

1. District. A number from 1 to 5 is utilized to designate the district.
2. Maintenance Station. Fifty-five maintenance stations designate an area of responsibility which is headed by a foreman. Maintenance stations are designated by 4-letter codes designating the town nearest the maintenance station.
3. Maintenance Section. Maintenance sections identify a specific highway segment. A total of 409 maintenance sections are identified by a 5 character alpha-numeric code. This code consists of a two-letter county designation, a two number route number code and a letter code indicating if the section is in a rural or urban location. Subsections are designated with A, B, or C, depending on the number of sections in rural areas and X, Y, or Z for urban sections. Limits of the sections are established primarily based on snow removal considerations. Little attempt has been made to establish maintenance section limits based on type of pavement and/or time of construction. Flexibility in the coding format exists to allow for an increase in the number of maintenance sections as required in the future.

The space assigned to designate the maintenance section may also be utilized to designate special maintenance projects with unique job numbers and work performed on stockpiles such as an oil mix process, stockpile transfer, or addition of salt performed under function 920. Thus either a maintenance section or job number may be utilized depending on the type of work.

4. Milepost. Begin and end milepost which designate the boundaries within which a maintenance activity was performed must be recorded for the following maintenance functions:

- 412 - Equipment Leveling,
- 422 - Black Seal,
- 423 - Sand - Gravel Seal,
- 424 - Plant Mix Seal and,
- 441 - Shoulder Seal.
- 461 - Slides (at Geology's request)
- 481 - Structures

Mileposts which are recorded to the nearest 0.01 miles may be designated for other maintenance functions. However, it is the usual practice to designate only maintenance sections. In some cases only the begin milepost need be designated. For example, maintenance performed at a bridge can be adequately located by designating the begin milepost location.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Table I-1). Forty-six maintenance codes are presently utilized and are divided into the following major groups:

1. Surface maintenance,
2. Shoulder and side approaches,
3. Roadside and landscape,
4. Drainage,
5. Structures,
6. Snow, ice, and sand control and removal,
7. Traffic services,
8. Rest areas and parks,
9. Maintenance houses and
10. General (Function 920, work in process)

It should be noted that a special function code, concrete paving repair, is utilized for maintenance on portland cement concrete pavements. Some special codes exist for snow and ice removal.

Function codes were developed with reference to the AASHO guides and expanded to include those activities that were a significant portion of the maintenance budget. These maintenance function accounts have been altered and can be expected to be further revised in the future.

Manpower

Manpower utilization for a particular function is recorded. Each crew has a three digit designation. Crews which work under the supervision of a maintenance station are designated as regular (R) while district special crews such as those associated with chip sealing, equipment overlays are designated as district (D).

In recording the labor utilized, two types of entries are made; the total number of men used and the number of hours worked

for monthly and hourly employees. The report is designed to be a weekly report except for those months that end on any day other than Friday. The total time worked is reported to the nearest hour daily and summed for the weekly reporting period.

Separate codes are utilized in the crew designation for administrative personnel such as district maintenance engineers and central office personnel. These data are not transmitted on Form M-17, but through accounting using function 401-405.

(Administrative budgets are not reported by activity.)

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment number which is either the Wyoming license plate number or an assigned equipment number. This number is unique to the piece of equipment for its life. A 6-character alpha-numeric code is utilized for the equipment number always beginning with "H" if the equipment has a Wyoming license plate. Equipment use is charged out daily by the hour or mile, depending on the type of equipment utilized. For example, pickups are charged by the mile while graders and other items of equipment are charged by the hour of actual use. If a piece of equipment was on the job for 8 hours but was actually used 3 1/2 hours, 4 hours would be recorded. The total hours or miles each piece of equipment was utilized during the week is summed from the daily record.

Rental equipment utilized for a particular maintenance function can be recorded by designating that the equipment is rented by placing "RENTAL" in the equipment number entry, and by indicating its

rental rate by the hour or mile and by recording the hours or miles of use daily.

Materials

Materials utilized for a particular function are recorded daily and totaled weekly. Material stockpiles have a unique number assigned to them. If the material in a stockpile is improved by the addition of oil, salt, etc., it is assigned a new stockpile number. All stockpiles are tied to a specific maintenance station. The site of the stockpile is recorded by the 4-letter code used to designate the maintenance station. The inventory number of the material is a 6-character alpha-numeric code which can be obtained from accounting code manuals together with the unit of measure. For example, Inventory number 10-2910 designates salt and the unit of measure is tons. SP4011 refers to a stockpile number 4011 in District 4.

Items recorded under materials designate the source of the material. The location of the use of the material is designated by the location information as discussed above and is charged against the maintenance function only as it is utilized.

Accomplishments

All maintenance functions do not require the reporting of accomplishments. Those functions requiring a report on Accomplishments designate the units such as tons per day, man-hours per day, etc. These units are recorded on the form together with the daily accomplishments. Daily accomplishments are summed weekly.

It is common practice to move materials from one stockpile to another with or without an improvement in the specific material,

The stockpile from which the material was removed is designated by codes in the material used section of the Maintenance Activity Record. The site of the new stockpile is recorded under accomplishments together with the new stockpile identification number and the unit of measurement.

For all maintenance functions that require a measurement of accomplishments, the planned accomplishments part of the form must be filled out. Utilization of this part of the form forces pre-planning. The unit of measure is recorded as obtained from the function code together with the anticipated daily and weekly planned accomplishments.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Activity Record is filled out daily by the lead man for his crew and summed weekly. The foreman is responsible for checking the work of the lead man.

These forms are then transported to the district and checked at the district level prior to electronic transmission to the central office for processing and reporting. Secretarial type employees are not utilized at the station level to handle these data. Data are transmitted weekly to the central office and reported monthly to the districts.

It is estimated that about one-half of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Twenty-four thousand dollars for computer charges was expended in 1974. The lead men and station foremen each require

about 1 hour per week to complete the Maintenance Activity Record with an additional 2 man-hours required at the district level for checking input data. Thus, the average district expends approximately 25 man-hours per week or 100 man-hours per month to collect maintenance activity information.

REPORTS

Seven reports are being produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports:

MR-1. Maintenance Report 1 is a copy of the data transmitted from the Maintenance Activity Record by the district.

MR-2. Maintenance Report 2 indicates the errors that occur on the transmitted Maintenance Activity Record. It is utilized to locate and correct errors associated with the field report and thus may be considered a type of audit or exception report.

MR-3. Maintenance Report 3 has a format similar to MR-5 shown in Figure I-2 except it is prepared for special maintenance projects and other activities associated with stockpile beneficiation or moving. Selected function accounts can also be displayed on this report.

MR-4. Maintenance Report 4 summarizes holding accounts, district overhead accounts, supervising accounts, special work items, function activity 920 and other items not budgeted as regular maintenance.

MR-5. Maintenance Report 5 is a popular report and is shown on Figure I-2. The report is organized by district, maintenance

station and crew number, maintenance section, and maintenance function account. For each function account number the following information is displayed:

1. man-hours for the year to date
2. man-hours per unit of work
 - a. actually performed for the year.
 - b. expected standard obtained from maintenance function standard
3. work units
 - a. accomplished for the year to date
 - b. planned for the year
4. cost per unit of work
 - a. actual for the year to date
 - b. planned for the year based on the maintenance function standard
5. Expenditures
 - a. for the month reported
 - b. for the fiscal year to date
6. budgeted amount for the year
7. balance remaining for the year.

Year to date totals for man-hours, expenditures for the month, year to date expenditures, budget amounts and balance amounts are summed for groups of maintenance activities such as surface maintenance, shoulder and side approach maintenance, roadside and landscape maintenance, etc. The same information is summed by highway section and maintenance crews.

MR-6A. Maintenance Report 6A is a summary report organized by district, maintenance station and crew number. For each crew number the annual budget is displayed together with expenditures for the reporting month, expenditures for the year to date, remaining balance for the year to date and the percent expended to date. In addition the report presents separate summaries on a district-wide basis for interstate, primary and secondary highway snow removal. This report is shown on Figure I-3.

MR-6B. Maintenance Report 6B is a summary report for the entire state organized into four categories, namely; expenditures other than snow and ice control, interstate highway snow and ice control, primary highway snow and ice control and secondary highway snow and ice control. For each district the annual budget is displayed together with expenditures for the reporting month, expenditures for the year to date, remaining balance for the year to date and the percent expended to date.

Snow removal requires about 23 percent of the annual maintenance budget and hence the distribution of expenses for snow and ice control is of interest to the administration. Other types of reports are being considered by the Wyoming State Highway Department.

Inventory control reports are prepared by the accounting branch. These reports contain inventory amounts, the location of the items and the dollar amounts. Equipment reports are also produced. Equipment use rates are determined in the central office by the equipment engineer based on depreciation, operating and repair costs together with historical information.

It should be noted that man-hours are reported for the entire working crew. These hours are transferred to dollar values by use of an average cost per hour for an individual in the crew which is calculated by the central office. The standard man-hour per unit of accomplishment is obtained from the maintenance function standard. Work units planned are prepared by field personnel on a yearly basis at budget preparation time. Planned costs per unit are determined by use of the standard man-hour per unit of productivity and the average labor cost per man for the crew. Budget amounts are obtained by multiplying units planned by costs per unit planned.

The various reports are prepared monthly with year to date totals. The MR-5 report is utilized by the district maintenance engineer and the maintenance station foreman. The MR-6A and MR-6B reports are prepared monthly with year to date totals and are utilized mainly by the central office and the district maintenance engineer. The Maintenance Activity Record is utilized by the foreman and district maintenance engineer to monitor weekly progress and productivity. Reports are transmitted to the district 2 weeks after the end of the month.

Reports are utilized for fiscal control, by reviewing the budget, expenditures and balance columns of the report; for monitoring of program execution by comparing planned and accomplished work units; for allocation of manpower by reviewing productivity quantities such as man-hours per unit of work and cost per unit of production; and for budget preparation as a check to determine productivity figures to be utilized in calculating the budget.

Presently maintenance function activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of MR-5. Exception reports are presently not a part of the reporting system although their development is under consideration.

OTHER ITEMS

The Wyoming State Highway Department is satisfied with the reliability of the existing system although improvements can be made. The recording system utilized lead men and foremen to record information rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information. It is generally believed that more reliable data must be obtained if the information is to be utilized as feedback information to design.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises. The central office continually works with the districts through district engineers meetings and other meetings to assess the usefulness of the recorded and reported information.

A maintenance standard committee exists which is responsible for revision of the standards. Meetings are held as necessary. Productivity rates which were originally based on time and motion studies plus a review of the literature have not been changed as sufficient information has not been collected to warrant a change.

Equipment use charges are reviewed quarterly and revised as necessary.

Changes in the maintenance management system are directed by the state construction and maintenance engineer. Changes usually occur at the beginning of the fiscal year or at the beginning of the month. Few changes have been made to date as it will be necessary to firmly establish the system prior to making refinements. Data processing changes often require considerable lead time to change.

Data collected are stored in the MR-5 format presently for a fiscal year period. A Mark IV data system is used and allows access to data for a prolonged period of time.

References:

1. "Instructions for Maintenance Reporting System, M-17," Wyoming State Highway Department, Revised March 1, 1973.
2. "Maintenance Standards (Guide for Uniform Service)," Wyoming Highway Department, April 1, 1974.

Table I-1.

WYOMING HIGHWAY DEPARTMENT MAINTENANCE FUNCTION ACCOUNTS

January 1, 1974

SURFACE MAINTENANCE

411 Hand Patching

All charges including labor, equipment and materials used in repairing asphalt roadway surfaces. Includes patching pot-holes, raveled edges, etc., when done by hand.

412 Equipment Patching

All charges including labor, equipment and materials used in repairing asphaltic roadway surfaces. To include all patching utilizing laydown machine, motor grader or other approved equipment to patch small isolated failures up to one-quarter in length.

413 Equipment Leveling

All charges including labor, equipment and materials used in leveling and resurfacing asphaltic roadway surfaces. To include all work utilizing laydown machine, motor grader or other approved equipment to level or resurface continuous areas of one-quarter mile length or greater.

417 Concrete Paving Repair

All charges including labor, equipment and materials used in repair of concrete paving. To include mudjacking, undersealing and repair of concrete median and concrete curb and gutter.

418 Crack Sealing

All charges including labor, equipment and materials used in filling or sealing roadway surface cracks.

421 Oil Surface Modification

All charges including labor, equipment and materials used in re-conditioning asphaltic surfaces. To include repaving operations, deslicking, discing, scarifying, tear-up, reprocessing and re-laying.

422 Black Seal

All charges including labor, equipment and materials used in applying a black seal to the roadway surface. The term "black seal" refers to work in which a cover aggregate is not used. Any approved asphaltic or speciality product may be used.

423 Aggregate Seal

All charges including labor, equipment and materials used in applying an aggregate seal. To include cover aggregates such as sand-gravel, chips, sand and scoria.

424 Plant Mix Seal

All charges including labor, equipment and materials used in applying a plant mix seal.

425 Base Repair

All charges including labor, equipment and materials used in repairing the base. To include stabilizing bases by additives, rebase or grade raising and realignment, digging out and replacing large areas of base or subbase failures using equipment.

429 Other

All charges including labor, equipment, and materials used in cleaning railroad crossings, reshaping gravel surfaces, side-walk repair and any other work that pertains to the roadway surface not chargeable to another function.

SHOULDERS & SIDE APPROACHES

441 Shoulder Seal

All charges including labor, equipment and materials used in applying a seal to the edge of the mat or the roadway shoulder.

442 Shoulders

All charges including labor, equipment and materials used in maintaining and widening shoulders. To include blading, shaping and widening new or existing shoulders.

443 Approaches

All charges including labor, equipment and materials used in removing, repairing and constructing approaches, nail box turn-outs, median crossovers and other specialized widening, (i.e. scenic turnouts, snowmobile widening).

ROADSIDE AND LANDSCAPE

451 Mechanical Vegetation Control

All charges including labor and equipment used in mechanical mowing. Does not include cutting of trees and brush or the removal of tree stumps.

453 Chemical Vegetation Control

All charges including labor, equipment and materials used in the chemical control of vegetation.

455 Litter Control

All charges including labor, equipment and materials used in gathering litter and trash from the R/W and road surface to include: removing dead stock, removing and cleaning wrecks, removing weeds from R/W fence, cutting brush or trees, removal of tree stumps or brush from the R/W and cleaning curbs and gutters on urban roadway sections (outside corporate limits, towns over 1,500 population).

457 Fences

All charges including labor, equipment and materials used in removal, replacement and repair of fences.

DRAINAGE

461 Slides

All charges including labor, equipment and materials used in slide removal and correction. Removal of loose rock from the roadway.

462 Irrigation and Drainage

All charges including labor, equipment and materials used in constructing, cleaning and maintaining roadside ditches, drainage and irrigation channels. The maintenance of all structures not considered a bridge, excluding stock structures. To include cleaning, repairing, replacing, thawing, and new installations of underdrains, siphons, pipe and box culverts.

464 Miscellaneous Structures

All charges including labor, equipment and materials used in maintaining miscellaneous structures, to include stockpiles, cattleguards, headgates, diversion boxes, cribbing, binwalls and other structures of similar nature.

468 Erosion Repair and Control

All charges including labor, equipment and materials used in erosion repair or control. To include repair, replacing or constructing dikes, runways, embankment protectors, rip-rap, jute mesh and other erosion controlling devices.

STRUCTURES

481 Structures

All charges including labor, equipment and materials used in the repair, maintenance and operation of structures. To include bridges, overhead sign structures, pedestrian crossing, overhead grade separations and other structures that are considered a bridge and do not fall under "Miscellaneous Structures".

482 Tunnels

All charges including labor, equipment and materials incurred in the physical maintenance of tunnels portal to portal, excluding lighting, signals or electric warning systems.

SNOW, ICE, SAND CONTROL AND REMOVAL

512 Snow, ice and Sand Control

All charges including labor, equipment and materials used in snow, ice and sand removal. To include removal of snow and ice, snow and ice removal to open waterways and snow and ice sanding.

513 Snow Fence Maintenance

All charges including labor, equipment and materials used in the erection, removal and replacement of snow fence, or facilities for the prevention of the accumulation of snow, ice or sand on the roadway.

514 Avalanche Control

All charges including labor, equipment and materials used to induce controlled snow slides. Includes firing of the howitzer and reporting. Does not include snow removal or clearing operations created by firing operations.

515 Road Closure

All charges including labor, equipment and materials used in setting up, manning and removing roadblocks.

TRAFFIC SERVICES

531 Traffic Lane and Guide Line Holding Account

All charges including labor, equipment and materials, to report stripping costs which are not readily charged to a maintenance section, a construction project, a work order, an A/E, an A/S or an S/M. In addition, this account will be used to report ALL PERSONAL EXPENSES incurred in the maintenance stripping work under account 531. No personal expenses that are incurred when stripping work is done on a construction project, A/E, etc., will be charged to account 531. (When reporting time, equipment, materials and personal expense charges to account 531, county-route and mileposts do not need to be shown.)

533 Traffic Lane and Guide Line Painting

All charges including labor, equipment and materials to report all maintenance stripping costs, except personal expenses, that can readily be charged to county-route and mileposts. Stripping work done on construction projects, work orders, A/E's, A/S's and S/M's are not to be charged to account 531. (When reporting time, equipment and material charges to account 531, county-route and mileposts are to be shown.)

541 New Signs

All charges including labor, equipment and materials used for placing any new signs and posts. This account is to be used for original installation and not replacement.

542 Sign Replacement

All charges including labor, equipment and materials used for replacing signs due to normal wear and tear, vandalism, damage by motor vehicles, snow plows, etc.

545 Delineators

All charges including labor, equipment and materials used for setting, removing, replacing old or new posts and placing, removing or rejuvenating old or new delineator tails or buttons. This also includes snow pole maintenance.

546 Guardrail

All charges including labor, equipment and materials used for removing, resetting, repairing guardrails and posts or installing new guardrail. To include repairing or replacing barrier fence.

547 Lighting

All charges including labor, equipment, materials and power used for highway and tunnel lighting. To include electric warning systems.

548 Traffic Signals and Flashing Beacons

All charges including labor, equipment, materials and power used for traffic signals and flashing beacons.

549 Special Signage and Delineating Materials

All charges for the following materials ONLY at the time of purchase to include: conduit, delineators, sign bolts, nuts and washers, thermoplastic tape.

REST AREAS AND PARKS

557 Lighting

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials. To include electric warning systems.

558 Traffic Signals and Flashing Beacons

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials.

571 Roadside Parks

All charges including labor, equipment and materials for the cleaning, repair and general maintenance of the grounds and structures of roadside parks, rest areas and other landscaped areas.

572 Rest Areas and Parks

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials for the cleaning, repair and general maintenance of the grounds and structures of roadside parks, rest areas and other landscaped areas.

MAINTENANCE HOUSES

591 Operation and Repair to Maintenance Houses

All charges including labor, equipment and materials used in the operation or repair of houses owned by the Department at various maintenance stations. (Charges are to be divided between the Road Sections maintained by the Crew occupying the houses at the station.)

GENERAL

920 Oil Mix Processing

The processing and mixing of aggregates and bituminous materials by any method.

920 Screening Aggregate

All charges including labor, equipment and royalty when screening materials.

920 Material Stockpile Transfer

All labor and equipment charges incurred when hauling material with equipment to include: moving material from one stockpile to another, laying material and stockpiling at new locations, etc.

920 Salt, Chloride and Aggregate Mixing

The processing and mixing of aggregates and salt and/or chlorides by any method.

Figure I-1. WYOMING STATE HIGHWAY DEPARTMENT
MAINTENANCE ACTIVITY RECORD

DISTRICT _____ MAINTENANCE STATION _____

CREW		D (DISTRICT) R (REGULAR)	FUNCTION	JOB NO. MAINT. SECTION	BEGIN MILEPOST	END MILEPOST	LAST DATE REPORTED		
							THI	SHEET	
							MO.	YR.	YR.
1	0								

LABOR USED

[illegible]

EQUIPMENT USED

[illegible]

30

MATERIAL USED

<u>MATERIAL USED</u>			<u>SAT.</u>	<u>SUN.</u>	<u>MON.</u>	<u>TUE.</u>	<u>WED.</u>	<u>THU.</u>	<u>FRI.</u>		
<u>SITE</u>	<u>INVENTORY NO.</u>	<u>UNIT</u>	<u>QUANTITY</u>							<u>TOTAL</u>	<u>REMARKS</u>
. ●	
. ●	-
. ●	
. ●	

PREPARED BY:

4.0

RECORD OF
ACCOMPLISHMENT

UNIT OF MEASUREMENT	QUANTITY							TOTAL	SITE	RECEIVING	S.P.	UNIT	
										S	P	T	N
										S	P	T	N

CERTIFIED CORRECT BY

5.0

PLANNED	ACCOMPLISHMENT
1. Review and approve the proposed project plan.	1. Review and approve the proposed project plan.
2. Obtain necessary approvals from the steering committee.	2. Obtain necessary approvals from the steering committee.
3. Develop a detailed project schedule.	3. Develop a detailed project schedule.
4. Assign resources and responsibilities to team members.	4. Assign resources and responsibilities to team members.
5. Monitor project progress and report to the steering committee.	5. Monitor project progress and report to the steering committee.
6. Identify and mitigate risks to the project.	6. Identify and mitigate risks to the project.
7. Communicate project status to stakeholders.	7. Communicate project status to stakeholders.
8. Review project performance and adjust as needed.	8. Review project performance and adjust as needed.
9. Complete the project and deliver the final results.	9. Complete the project and deliver the final results.
10. Conduct a post-project review and document lessons learned.	10. Conduct a post-project review and document lessons learned.

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Figure I-2. Maintenance Report MR-5.

WYOMING HIGHWAY DEPARTMENT		* * * CONSTRUCTION AND MAINTENANCE DIVISION * * *							REPORT NO. MR- 5		DATE 03/25/75	
DISTRICT 5		MAINTENANCE EXPENDITURES									PAGE 5-256	
CREW = 532 LCC = DUBC		PERIOD JUL 1, 1974 TRL FEE 28, 1975										
SECT. FCT	DESCRIPTION	MAN HRS	MAN-HR/UNIT ACT.	STO.	WCRK UNITS ACCOMP PLAN	COST PER UNIT ACTUAL	PLANNED	EXPENDITURES		BUDGET	BALANCE	
								02/01/75	07/01/75			
02/28/75 02/28/75												
* * * * * COUNTY ROUTE = FRO3 FROM MILEPOST 26.75 TO MILEPOST 98.86 = 72.10 CL-MILES * * * * *												
FRO3A 411	PAND PATCHING	24	2.40	4.00	10.0	280	\$35.60	\$55.000	\$0	\$55.00	\$15,400	\$15,044
412	EQUIPMENT PATCHING	286	0.46	0.62	620.0	1300	\$15.97	\$18.750	\$0	\$9,875	\$24,375	\$14,471
413	EQUIPMENT LEVELING	556	0.33	0.25	3012.9	900	\$14.80	\$13.126	\$0	\$44,500	\$11,813	\$32,777
423	AGGREGATE SEAL	1486	3.36	2.00	442.6	227	\$143.40	\$116.115	\$0	\$63,401	\$26,358	\$37,113
429	OTHER	0	0.00	1.00	0.0	110	\$0.00	\$10.000	\$0	\$0.00	\$1,100	\$1,100
TOTAL SURFACE MAINTENANCE		2,752	<						\$0	\$118,876	\$75,046	\$39,275
FRO3A 441	SHOULDER SEAL	72	4.09	2.24	17.6	0	\$134.72	\$0.000	\$0	\$2,391	\$0	\$2,371
442	SHOULDER	484	1.01	1.00	480.0	350	\$10.26	\$15.000	\$0	\$4,923	\$5,250	\$327
TOTAL SHOULDER & SIDE APPROACH		556	<						\$0	\$7,314	\$5,250	\$2,064
FRO3A 451	MECH. VEG. CONTROL	144	1.06	0.55	136.3	400	\$12.85	\$7.500	\$0	\$1,802	\$3,000	\$1,198
453	CHEM. VEG. CONTROL	0	0.00	0.45	0.0	32	\$0.00	\$42.000	\$0	\$0.00	\$1,344	\$812
455	LITTER CONTROL	488	1.00	1.00	488.0	265	\$7.63	\$8.498	\$0	\$3,702	\$2,252	\$1,450
457	FENCES	226	0.92	1.00	246.0	17	\$8.54	\$47.118	\$833	\$2,101	\$801	\$1,300
TOTAL ROADSIDE AND LANDSCAPE		658	<						\$833	\$8,105	\$7,397	\$708
FRO3A 461	SLIDES	8	1.00	1.00	8.0	800	\$18.00	\$9.500	\$0	\$14.00	\$7,600	\$7,456
462	IRRIGATION AND DRAINAGE	256	1.00	1.00	256.0	516	\$13.71	\$10.500	\$0	\$4,007	\$5,418	\$1,411
464	MISCELLANEOUS STRUCTURES	0	0.00	1.00	0.0	71	\$0.00	\$10.507	\$0	\$0.00	\$746	\$746
468	EROSION REPAIR & CONTROL	0	0.00	1.00	0.0	47	\$0.00	\$11.511	\$0	\$0.00	\$541	\$541
TOTAL DRAINAGE		304	<						\$0	\$4,214	\$14,305	\$10,091
FRO3A 481	STRUCTURES	16	1.00	1.00	16.0	140	\$9.69	\$11.500	\$0	\$15.00	\$1,610	\$1,455
TOTAL STRUCTURES		16	<						\$0	\$15.00	\$1,610	\$1,455
FRO3A 533	LANE & GUIDE PAINTING	356	1.00	1.00	356.0	72	\$13.78	\$72.931	\$0	\$4,506	\$5,251	\$345
541	NEW SIGNS	0	0.00	0.00	0.0	6	\$0.00	\$100.000	\$0	\$0.00	\$600	\$300
542	SIGN REPLACEMENT	16	16.00	0.00	1.0	28	\$137.00	\$50.000	\$98	\$17.00	\$1,400	\$1,262
545	DELINTEATORS	48	0.41	0.15	116.0	800	\$3.92	\$1.500	\$0	\$4.50	\$1,200	\$745
546	GUARDRAIL	0	0.00	0.24	0.0	100	\$0.00	\$2.500	\$0	\$0.00	\$250	\$250
TOTAL TRAFFIC SERVICES		420	<						\$98	\$5,708	\$8,701	\$2,933
FRO3A 571	ROADSIDE PARKS	0	0.00	1.00	0.0	40	\$0.00	\$47.000	\$0	\$1,000	\$1,880	\$880

Figure I-2. Continued

WYOMING HIGHWAY DEPARTMENT
DISTRICT 5*** CONSTRUCTION AND MAINTENANCE DIVISION ***
MAINTENANCE EXPENDITURESREPORT NO. HR-5 DATE 03/25/75
PAGE 5-297

CREW = 532 LCC = CUBC

PERIOD JUL 1, 1974 THRU FEB 28, 1975

SECT. FCT	DESCRIPTION	MAN HRS	MAN-HR/UNIT ACT. STD.	WORK UNITS ACCCMP PLAN	COST PER UNIT ACTUAL PLANNED	EXPENDITURES		BUDGET	BALANCE
						02/01/75 02/28/75	07/01/75 02/28/75		
TOTAL REST AREAS AND PARKS						00<	00<		
FR03A	SECTION TOTALS	4,946<				\$0	\$1,00	\$1,880	\$880
*** COUNTY ROUTE = TE03 FROM MILEPOST 2.20 TO MILEPOST 26.75 = 24.55 CL-MILES ***									
TE03	411 HAND PATCHING	24	3.00 4.00	8.0	145 \$42.50 \$55.000	\$0	\$40	\$7,575	\$7,635
	412 EQUIPMENT PATCHING	224	0.72 0.62	310.0	350 \$16.80 \$18.751	\$0	\$5,08	\$6,563	\$1,355
	429 CTRER	0	0.00 1.00	0.0	40 \$0.00 \$10.000	\$0	\$0	\$400	\$400
	TOTAL SURFACE MAINTENANCE	248<				\$0	\$5,48	\$14,538	\$9,390
TE03	441 SHOULDER SEAL	20	0.71 2.24	28.2	0 \$91.03 \$0.000	\$0	\$2,57	\$0	\$2,567
	TOTAL SHOULDER & SIDE APPROACH	20<				\$0	\$2,57	\$0	\$2,567
TE03	453 CHEM. VEG. CONTROL	0	0.00 0.45	0.0	8 \$0.00 \$42.000	\$0	\$17	\$336	\$199
	455 LITTER CONTROL	0	0.00 1.00	0.0	28 \$0.00 \$8.500	\$0	\$0	\$238	\$238
	457 FENCES	371	1.01 1.00	368.0	5 \$7.26 \$50.400	\$0	\$2,03	\$252	\$2,421
	TOTAL ROADSIDE AND LANDSCAPE	371<				\$0	\$2,00	\$826	\$1,584
TE03	461 SLIDES	90	0.94 1.00	96.0	1000 \$12.36 \$9.500	\$0	\$1,17	\$9,500	\$8,313
	462 IRRIGATION AND DRAINAGE	380	1.01 1.00	376.0	70 \$10.83 \$10.500	\$0	\$4,01	\$735	\$3,336
	468 EROSION REPAIR & CONTROL	16	1.00 1.00	16.0	16 \$16.63 \$11.500	\$0	\$2,66	\$184	\$82
	TOTAL DRAINAGE	466<				\$0	\$5,84	\$10,415	\$4,855
TE03	533 LANE & GUIDE PAINTING	60	1.00 1.00	60.0	24 \$31.65 \$74.708	\$0	\$1,19	\$1,793	\$106
	541 NEW SIGNS	16	4.00 0.00	4.0	2 \$61.50 \$100.000	\$0	\$2,6	\$200	\$46
	542 SIGN REPLACEMENT	48	16.00 0.00	3.0	12 \$159.33 \$50.000	\$0	\$4,8	\$600	\$122
	545 DELINEATORS	0	0.00 0.15	0.0	160 \$0.00 \$1.500	\$0	\$0	\$240	\$240
	TOTAL TRAFFIC SERVICES	124<				\$0	\$2,63	\$2,833	\$210
TE03	SECTION TOTALS	1,249<				\$0	\$19,02	\$29,016	\$9,544
DUBO CREW NO. 532 TOTALS									
		6,195<				\$931	\$163,58	\$147,205	\$16,743

Figure I-3. Maintenance Report MR-6A.

WYOMING HIGHWAY DEPARTMENT
DISTRICT 5

* * * CONSTRUCTION AND MAINTENANCE DIVISION * * *
MAINTENANCE EXPENDITURES

REPORT NO. MR-6A DATE 03/25/75
PAGE 5

PERIOD JUL 1, 1974 THRU FEB 28, 1975

MAINT. STA.	BUDGET	EXPENDITURES		BALANCE	% EXPEND
		02/01/75 02/28/75	07/01/74 02/28/75		
BASI CREW NO. 530	\$146,978	\$3,053	\$67,979	\$78,999	46.2%
CCCY CREW NO. 531	\$171,182	\$2,151	\$108,223	\$62,959	63.2%
DUEO CREW NO. 532	\$147,205	\$931	\$163,548	\$16,743-	111.3%
LAND CREW NO. 533	\$211,626	\$7,832	\$167,306	\$44,320	79.0%
LCVE CREW NO. 534	\$205,863	\$5,305	\$98,041	\$107,822	47.6%
MEET CREW NO. 535	\$44,909	\$4,493	\$46,966	\$2,057-	104.5%
SHCS CREW NO. 536	\$166,160	\$5,410	\$85,053	\$81,107	51.1%
SOFA CREW NO. 537	\$64,442	\$400	\$74,292	\$9,850-	115.2%
TENS CREW NO. 538	\$70,326	\$1,453	\$41,178	\$29,148	58.5%
THER CREW NO. 539	\$128,574	\$3,582	\$51,535	\$87,039	37.1%
WCRL CREW NO. 540	\$117,834	\$4,867	\$111,645	\$6,189	94.7%
SUB TOTAL	\$1,465,099	\$39,477	\$1,016,166	\$468,933	68.4%
INT1	\$0	\$0	\$0	\$0	0.0%
PR12	\$0	\$30,810	\$150,564	\$150,564-	0.0%
SEC2	\$0	\$25,192	\$84,686	\$84,686-	0.0%
SUB TOTAL	\$0	\$56,002	\$235,250	\$235,250-	0.0%
TOTAL	\$1,465,099	\$95,479	\$1,251,416	\$233,683	84.2%

Figure I-4. Maintenance Report MR-6B.

WYOMING HIGHWAY DEPARTMENT
STATE* * * CONSTRUCTION AND MAINTENANCE DIVISION * * *
MAINTENANCE EXPENDITURES

REPORT NO MR-6B

DATE 03/25/75

PAGE - 1

PERIOD JUL 1, 1974 THRU FEB 28, 1975

DIST	BUDGET	EXPENDITURES		BALANCE	%
		02/01/75 02/28/75	07/01/74 02/28/75		
1	\$2,026,300	\$94,745	\$1,259,666	\$726,614	64.1%
2	\$2,166,057	\$48,903	\$1,107,943	\$1,058,114	51.1%
3	\$1,951,530	\$26,162	\$1,212,125	\$779,405	60.8%
4	\$1,585,139	\$37,198	\$1,058,132	\$487,007	69.2%
5	\$1,465,055	\$39,477	\$1,016,166	\$468,933	68.4%
SUB TOTAL	\$9,254,125	\$246,485	\$5,734,052	\$3,520,073	61.9%
INTL SNOW REMOVAL AND CONTROL					
1	\$0	\$33,545	\$151,367	\$151,367-	0.0%
2	\$0	\$15,250	\$71,565	\$71,565-	0.0%
3	\$0	\$51,217	\$167,144	\$167,144-	0.0%
4	\$0	\$15,128	\$64,700	\$64,700-	0.0%
SUB TOTAL	\$0	\$115,144	\$455,176	\$455,176-	0.0%
PR12 SNOW REMOVAL AND CONTROL					
1	\$0	\$14,262	\$48,991	\$48,991-	0.0%
2	\$0	\$25,581	\$117,256	\$117,256-	0.0%
3	\$0	\$48,979	\$205,544	\$205,544-	0.0%
4	\$0	\$19,124	\$81,254	\$81,254-	0.0%
5	\$0	\$30,810	\$150,564	\$150,564-	0.0%
SUB TOTAL	\$0	\$138,756	\$603,609	\$603,609-	0.0%
SEC2 SNOW REMOVAL AND CONTROL					
1	\$0	\$42,212	\$121,487	\$121,487-	0.0%
2	\$0	\$8,125	\$25,410	\$25,410-	0.0%
3	\$0	\$19,458	\$52,519	\$52,519-	0.0%
4	\$0	\$15,686	\$68,601	\$68,601-	0.0%
5	\$0	\$25,192	\$84,686	\$84,686-	0.0%
SUB TOTAL	\$0	\$110,675	\$352,703	\$352,703-	0.0%
TOTAL	\$9,254,125	\$611,064	\$7,185,540	\$2,068,585	77.6%

Figure I-4. Continued

WYOMING HIGHWAY DEPARTMENT * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * REPORT NO. MR-6B DATE 03/20/75
STATE MAINTENANCE EXPENDITURES PAGE 2

PERIOD JUL 1, 1974 THRU FEB 28, 1975

DIST	BUDGET	EXPENDITURES		BALANCE	% EXPEND
		02/01/75 02/28/75	07/01/74 02/28/75		
SAND AND ICE CONTROL CHARGED TO MAINTENANCE SECTIONS					
TOTAL 1	\$627,935	\$121,196	\$353,781	\$274,154	56.3%
TOTAL 2	\$61,890	\$31,277	\$65,881	\$23,991-	138.7%
TOTAL 3	\$94,160	\$4,526	\$51,422	\$42,738	54.6%
TOTAL 4	\$54,400	\$17,502	\$76,433	\$22,033-	140.5%
TOTAL 5	\$2,640	\$17	\$889	\$1,751	33.6%
TOTAL	\$841,025	\$174,518	\$568,406	\$272,619	67.5%

APPENDIX J

HAWAII HIGHWAYS DIVISION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 832,000 residents of Hawaii operate 477,780 motor vehicles on 3,530 miles of highways of which 880 miles are under state control. The state occupies 6,450 square miles from sea level to an elevation of 13,796 feet above sea level. Mean minimum and maximum temperatures are 63 and 86°F with average annual moisture from 10 to 450 inches.

The Hawaii Highways Division has a \$10,000,000 maintenance budget. This budget will be used by its 4 districts to maintain 883 center line miles. The Oahu District, which is the largest district, has a district maintenance engineer and a maintenance superintendent at the district level. Foremen act as crew supervisors. In the remaining three districts a maintenance superintendent is in responsible charge of maintenance. In general foremen report to the district maintenance engineer or the superintendent who in turn reports to the district engineer. The administration of the maintenance program by the Chief of the Hawaii Highways Division is performed at the central office level by the Assistant Chief for Construction and Maintenance.

The basic maintenance recording and reporting system was implemented in 1969. A parallel recording system is being utilized although plans have been made to extensively revise the maintenance

management system. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Hawaii Highways Division Form DOT.4-127, "Daily Maintenance Report" is utilized to collect maintenance activity information (Figure J-1). The type of information obtained on this form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. The location is identified by a charge code assigned to the road maintenance section. The charge code also can be utilized to indicate a particular project, piece of equipment, or administrative activity. The charge code is recorded on the Daily Maintenance Report.

Activity

Maintenance function codes are utilized to designate the activity performed. These 36 cost codes were obtained from the AASHO Maintenance Guide. Groups of these function codes include roadway, roadside, structures, traffic services, landscaping and others (storm damage, vehicle damage, trench repairs and engineering services).

To amplify function codes, object codes are utilized. Examples of these object codes are shown below;

- 2975 - Redistributed Labor Cost
- 3252 - Gas or Vehicle Fuel
- 4111 - Private Car Mileage
- 4209 - Freight and Delivery Charges
- 4530 - Rental - Motor Vehicles, etc.

Maintenance function codes and object codes are utilized to assign costs for labor, equipment and materials.

Basically the functional code indicates the purpose for which the expenditure is made and the specific activity or type of work performed to accomplish this purpose, while the object code refers to the commodity or service obtained from a specific expenditure. It indicates what kind of expense is being incurred (i.e., salaries, materials, contractual services, etc.). The object codes are grouped by character of expenditure.

It should be noted that a special function code exists for portland cement concrete repair as opposed to bituminous surfaced roadways.

Manpower

Manpower utilized for a particular function is recorded by the crew foreman for the entire crew. The employee's name is recorded together with the hours worked on a particular function. Employees on temporary assignment, employees on leave and overtime work is recorded on the Daily Maintenance Report. The total time worked is reported to the nearest hour daily.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment charge code. The operator's name is recorded together with the mileage or hours utilized depending upon the type of equipment. Each piece of equipment has a unique number. Mileage of hours of equipment usage are reported to the nearest mile or hour.

Rental equipment is designated by the charge code.

Materials

Materials utilized for a particular function and charge code are recorded. The material utilized is designated by name and not code. Established standard material usage quantities are designated and quantities are recorded in these units.

Accomplishments

Accomplishments are reported indirectly by recording the materials utilized.

COLLECTION AND PROCESSING OF RECORDED DATA

The Daily Maintenance Report is filled out daily by the foreman of the crew and submitted by the foreman daily to the maintenance superintendent. Every two weeks these forms are submitted to the central office. Monthly reports are prepared and are returned to the district about 2 months after the end of the reporting period.

REPORTS

Several reports are produced from the collected data.

Expense Summary. The expense summary report is a basic management report. Expenses for the reporting month and year-to-date

expenses are reported by district for each charge, function, and object code. An example of this report is shown on Figure J-2.

Another expense summary report is produced for each road maintenance section identified by charge code and listing expenditure by functions.

Both reports show the expenses for the reporting month and year-to-date expenses.

Planned and accomplished programs are compared on this report by control and section and function code. The planned program is developed by the foremen with assistance from the superintendent.

Reports are utilized for fiscal control, for monitoring program execution by comparing planned and accomplished work units and for budget preparation.

Presently maintenance function activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by detailed review of the reports. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The Hawaii Highways Division is satisfied with the accuracy of the reporting system with the exception of equipment data. The recording system utilizes foreman to record information rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises.

The central office staff meets with the district superintendent every 4 months to review problems with the management system. The state is presently considering extensive revision in their maintenance management program. Maintenance crews remain together to perform all types of maintenance activities.

Figure J-1: Daily Maintenance Report

DOT 8-127
11/11/68

STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

DAILY MAINTENANCE REPORT

District _____

Date Nov. 10, 1972

LABOR	Charge Code	5170				
NAME OF EMPLOYEE	Func.	HOURS	HOURS	HOURS	HOURS	HOURS
<u>C. B. J. J.</u>	<u>5413</u>	<u>2</u>				
<u>M. B. J.</u>		<u>8</u>				
<u>J. J. J.</u>		<u>8</u>				
<u>D. W. J.</u>		<u>8</u>				
<u>K. S. J.</u>		<u>8</u>				
<u>K. C. J.</u>		<u>8</u>				
<u>D. H. J.</u>		<u>8</u>				

EQUIPMENT USED		Charge Code	5170						
EQUIPMENT CHARGE CODE	OPERATOR	BEGIN MILEAGE	Function	5413	M/D	M/D	M/D	M/D	M/D
			END MILEAGE						
<u>7438</u>	<u>B. J. J.</u>	<u>12455</u>	<u>12465</u>	<u>20</u>					
<u>7243</u>	<u>S. J. J.</u>	<u>7845</u>	<u>7855</u>	<u>8</u>					
<u>7453</u>	<u>G. J. J.</u>	<u>7456</u>	<u>7466</u>	<u>8</u>					
<u>7212</u>	<u>C. J. J.</u>	<u>5005</u>	<u>5015</u>	<u>6</u>					
<u>7238</u>	<u>B. J. J.</u>	<u>8411</u>	<u>8421</u>	<u>6</u>					

MATERIALS		Charge Code	5170								
LIST OF ITEMS	UNIT PRICE	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
<u>3.99 Tons of 55 mil</u>	<u>3.99</u>										
<u>10 gal 55 mil</u>	<u>10</u>										

*Attach outside purchase and warehouse issue tags to time sheets.

TEMPORARY ASSIGNMENT				
EMPLOYEE ON TEMPORARY ASSIGNMENT	EMPLOYEE ON LEAVE	EQUIP. USED (IF ANY)	HOURS	REASON FOR TEMPORARY ASSIGNMENT
	<u>None</u>			

USE BACK OF SHEET FOR REMARKS

C. B. J. J.
Foreman

G. R. J.
Mtnce. Supt.

Figure J-2.

REPORT NO. HWY-250 PREP. 09/16/74

EXPENSE SUMMARY - FUNCTION BY OBJECT

JUNE 1974

P. 17

FUNC CODE	OBJ CODE	DESCRIPTION	THIS MONTH	YEAR TO-DATE	
2410	2875	REDISTRIBUTED LABOR COST-DR	.00	4.79	
		FUNCTION TOTAL	.00	4.79	*
411		BITUMINOUS SURFACL TREATMENT			
	2875	REDISTRIBUTED LABOR COST-DR	.00	6,891.14	
	3340	HWY CON & MAINT MATRLS & SUPP	.00	1,511.92	
	5505	EQUIPMENT USE CHARGE-DEBIT	.00	2,420.32	
		FUNCTION TOTAL	.00	10,823.38	*
412		ASPHALT MACADAM			
	2875	REDISTRIBUTED LABOR COST-DR	2,690.62	59,261.93	
	3340	HWY CON & MAINT MATRLS & SUPP	3,208.53	19,482.21	
	5505	EQUIPMENT USE CHARGE-DEBIT	440.90	14,773.15	
		FUNCTION TOTAL	6,340.05	93,517.29	*
413		ASPHALT CONCRETE			
	2875	REDISTRIBUTED LABOR COST-DR	7,493.96	113,992.77	
	3252	GASOL VEHICLE FUEL	.00	1.94	
	3270	FUEL, OIL & LUBS (EXCEPT M/V)	.00	1.24	
	3340	HWY CON & MAINT MATRLS & SUPP	6,012.37	89,020.05	
	4111	PRIVATE CAR MILEAGE	.00	3.12	
	4209	FREIGHT & DELIVERY CHARGES	.00	3.15	
	4530	RENTAL-MOTORVEHICLES&MNEUPT	.00	3,726.24	
	5505	EQUIPMENT USE CHARGE-DEBIT	1,831.54	27,828.55	
		FUNCTION TOTAL	15,337.87	234,577.00	*
414		PORTLAND CEMENT CONCRETE			
	2875	REDISTRIBUTED LABOR COST-DR	.00	25.52	
		FUNCTION TOTAL	.00	25.52	*
415					
	2875	REDISTRIBUTED LABOR COST-DR	.00	49.44	
	3340	HWY CON & MAINT MATRLS & SUPP	.00	298.80	
		FUNCTION TOTAL	.00	348.24	*
418					
	2875	REDISTRIBUTED LABOR COST-DR	.00	48.11	
		FUNCTION TOTAL	.00	48.11	*
419		OTHERS			
	2875	REDISTRIBUTED LABOR COST-DR	.00	346.60	

APPENDIX K

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION'S Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 11,793,909 residents of Pennsylvania operate 6,800,000 motor vehicles on 115,167 miles of highways of which 44,700 miles (75,559 lane miles) are under state control. The state occupies 45,333 square miles from sea level to an elevation of 3,213 feet above sea level. Mean minimum and maximum temperatures are 14 and 88°F with average annual moisture ranging from 36 to 52 inches.

The Pennsylvania Department of Transportation has a 201,000,000 maintenance budget for 1976-1977. This budget will be utilized by its 67 maintenance districts to maintain 75,559 lane miles of highway. These maintenance districts are located within counties. (The state utilizes a system of 11 engineering districts to administer its construction program.)

Superintendents are in responsible charge of the maintenance district. Assistant superintendents, foreman and laborers comprise the remaining members of the district personnel. The eleven engineering district's maintenance staff review operations and provide direction to the 67 maintenance districts. The engineering districts play an important role in implementing management policies.

The present recording and reporting system was developed in-house with the assistance of an outside consultant. The present system was described in a prepared manual in 1972. Presently this

system is about 50 percent implemented. The maintenance management system makes use of information collected for accounting purposes, thus a single recording system is utilized. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Pennsylvania's "Crew Daily Project Time Record for Direct Labor Production and Equipment Distribution" (Form C-65C) and "Individual Daily Project Time Record for Direct Labor Production and Equipment Distribution" are the major source documents for posting employees time and expenses to a time sheet and for recording of vehicle usage (Figures K-1 and K-2). The foreman completes the "Crew Daily Project Time Record" for all members of his crew that are not specifically assigned to a piece of equipment. Individual equipment operators fill out the "Individual Daily Project Time Record." All recording forms are reviewed by the foreman and the superintendent or assistant superintendent. The information recorded on these forms is coded onto a tape cassette the day following the recording of the information and transmitted to the central office (i.e., work performed Monday is coded onto tape Tuesday and transmitted Tuesday night). Error messages, if any, will be received by the maintenance district office on the morning after transmission.

Information recorded on the Individual and Crew Daily Project Time Record includes the following:

1. Employee's name and Social Security number
2. Activity performed
3. District, County and Foreman number
4. Man-hours, equipment hours and/or equipment miles
5. Equipment designation and
6. Productivity

The report on work and equipment does not indicate the highway route or segment of roadway where the work was performed. Man-hours are recorded by activity to the nearest 0.5 hours. Two hundred eighteen maintenance activities are identified by a 8 digit numeric code. Special codes exist for portland cement concrete pavement repair.

Productivity is reported in untis such as tons, feet, man-hours, etc. depending on the activity. When reporting production the production hours (referred to as Produciton Activity Hours by Penn DOT) are equal to the Project Hours minus the Support Hours. Support Hours include time devoted to items such as travel, safety, equipment breakdown, hauling of material, etc.

Equipment usage is recorded by individual piece of equipment and assigned to a specific activity. Entries for shop and field repair can be made directly on the Crew and Individual Daily Project Time Record.

Materials reports are handled through a separate reporting system. A teletype terminal transmits data from the district to the central office. Materials are not accounted for by route or other identification point on the output reports.

REPORTS

Reports that are produced contain information desired by the districts. This system does not provide specific maintenance cost information for a particular segment or section of roadway.

Reports produced include the following:

1. Highway Feature Inventory
2. Production Planning Worksheet
3. Budget Generation Worksheet
4. Annual Work Plan Worksheet
5. Department Force Program
6. Maintenance Program Summary
7. Specialized Crews Work Program
8. District Efficiency Report
9. Performance Exception Report
10. Detailed Performance Report
11. Production Performance Report - Activity
12. Expenditure Analysis Report

The reports identified by the number 1 to 7 above are basically planning and scheduling reports. The remaining reports are utilized to monitor program execution.

District Efficiency Report. This report presents information delineating the percent of plan completed, the man-hour productivity and the average unit costs for each maintenance activity by maintenance district. The current month and year-to-date totals are presented (Figure K-3).

Performance Exception Report. This report delineates the ten major productivity deviations for a given month for the 10 major activities

performed by the district maintenance crews (Figure K-4).

Detailed Performance Report. Productivity and support units for each maintenance activity are reported on a current month and fiscal year-to-date basis. These units are compared with maintenance standards (Figure K-5).

Production Performance Report. Planned and completed production units for each activity are reported for the current month and the year-to-date. Year-to-date totals are also reported for production hours, support hours and performance hours for each maintenance activity (Figure K-6).

Expenditure Analysis Report. Dollars expended are reported for manpower, materials and equipment by maintenance district and maintenance activity. Production units and unit costs for the county and the state average are also presented for each activity. Both current month and fiscal year-to-date expenditures are reported (Figure K-7).

Reports are utilized at the central office and district level for fiscal control, by reviewing budgeted and actual expenditures; for monitoring of program execution by comparing planned and accomplished production, man-hours and material quantities; for allocation of manpower by reviewing standard unit costs and productivity rates against actual costs and productivity rates; and for budget preparation to revise productivity rates, etc. based on more extensive field productivity and unit cost rates. As noted above exception reports are an integral part of the reporting system.

References

"Foremans Manual," Pennsylvania Department of Transportation,
Bureau of Maintenance, Publication No. 113, January, 1975.



Figure K-1

CREW
DAILY PROJECT TIME RECORD
DIRECT LABOR PRODUCTION AND EQUIPMENT DISTRIBUTION

ID 65	ORGN	MO.	DAY	YR	Foreman Number	PAGE	OF	PAGES
TC								

NO	NAME	SOC. SECURITY NUMBER	PAY CODE	HOURS WORKED					HOURS WORKED	LEAVE TAKEN							Total Hours
				PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5		ANN. LV	SICK LV	HOLI. DAY	Other LV	LW OP	Comp. Time Taken		
1																	
2																	
3																	
4																	
5																	
6																	
7																	
TOTAL										TOTAL							

NO	STATE PROJECT NUMBER										Work Prog	Pt	Meth	Chkd Foreman No.	M F C	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	PRODUCTION			TRAVEL			Safety	Other						
	Sys	WO or LR	Sp	Ph	Sec.	Orgn	Allot	Func	Cd	od											Activity Hours	UNITS	DESCRIPTION	Cd.	Hrs	Miles	Hrs	Hrs	DESCRIPTION					
1																																		
2																																		
3																																		
4																																		
5																																		
TOTAL																																		

2 d u	DEPT. EQUIP. SERV. OR REP. [EQUIP. NO.]	SHOP REP.	FIELD REP.	ID-72 Dept. Equip. Operated [Equip. No.]	ID-67 Outside Equip. Rented [Agree. No.]	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	TOTAL UNITS	REMARKS:
1												I hereby certify that the data on this report is a true and correct record of time, equipment, and service incurred or furnished for the Department of Transportation in acco cord with the agreement entered into by the parties. Any overtime is hereby approved. Foreman: _____ Supt. _____ Asst. Supt. _____
2												
3												
4												
5												
6												
7												
TOTAL												

Figure K-2

**INDIVIDUAL
DAILY PROJECT TIME RECORD
DIRECT LABOR PRODUCTION AND EQUIPMENT DISTRIBUTION**

C-65-1 (11-74)



ID 65	ORGN	MO.	DAY	YR.	Foreman Number	PAGE	OF	PAGES
----------	------	-----	-----	-----	-------------------	------	----	-------

NO.	NAME	SOC. SECURITY NUMBER	PAY CODE	HOURS WORKED					HOURS WORKED	LEAVE TAKEN					TOTAL HOURS	REMARKS:
				PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5		ANN. LV	SICK LV	HOLI. DAY	OTHER LV	LW OP		
1																

PROJ. NO.	STATE PROJECT NUMBER						WORK PROG.		PT. CD.	METHOD	Chgd. Foreman No.	M C	HOURS WORKED					Activity Hours	PRODUCTION		TRAVEL		Safety		OTHER DESCRIPTION	Hauling Hours	Field Approval		
	SYS	WO	or	LR	SP	Ph	SEC.	ORGN					ALLOT	FUNC.	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3		PROJ. NO. 4	PROJ. NO. 5	UNITS	DESCRIPTION	Cd.	Hrs.				Miles	Hrs.
1																													
2																													
3																													
4																													
5																													
TOTAL																													

EQUIP. NO.	DEPT. EQUIP. SERV. OR REP. (EQUIP. NO.)	SHOP REP.	FIELD REP.	ID 72 EQUIP. OPERATED (EQUIP. NO.)	DEPT. EQUIP. RENTED (EQUIP. NO.)	ID 67 OUTSIDE EQUIP. RENTED (AGREEMENT NO.)	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	TOTAL UNITS	CROSS OUT AM or PM NOT APPLICABLE			HRS.	PERSONAL STATEMENT OF WORK PERFORMED
													START	STOP			
1													AM		AM		
2													PM		PM		
3													AM		AM		
4													PM		PM		
5													AM		AM		
6													PM		PM		
7													AM		AM		
													PM		PM		
TOTAL																	

I hereby certify that the data on this report is a true and correct record of time, equipment, and service incurred or furnished for the Department of Transportation in accordance with the agreement entered into by the parties. Any overtime is hereby approved.	EMPLOYEE SIGNATURE:	FOREMAN:	SUPT. OR ASST	SUPT:
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Figure K-3 (continued)

PROGRAM GEN/0870350

H.V.M.S DISTRICT EFFICIENCY REPORT

MONTH MARCH PAGE 42

ACTIVITY	UNIT	DESCRIPTION		DISTRICT 05	MAN HR						PRODUCTIVITY		
					COUNTY 05-1	COUNTY 05-2	COUNTY 05-3	COUNTY 05-4	COUNTY 05-5	COUNTY 05-6	COUNTY	COUNTY	COUNTY
711-122	TONS	ROADS-FLEX BASE	CUR	5.00	.000	.000	.000	.000	5.000	.000			
		PATCHING-NECH	YTD	.68	.667	.000	.000	.253	.693	1.280			
711-12-	GALS	ROADS-FLEX BASE	CUR	.11	.000	.000	.106	.137	.168	.180			
		SURF TREAT-LIG BI	YTD	.03	.031	.014	.040	.024	.016	.045			
711-125	TONS	ROADS-FLEX BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		SURF TREAT-PL MIX	YTD	.25	.151	.307	.352	.246	.135	.319			
711-126	TONS	ROADS-FLEX BASE	CUR	.53	.000	.000	1.397	.467	.000	.000			
		BASE REPAIR	YTD	.61	2.750	.467	1.408	.484	6.000	3.583			
711-129	MAN HRS	ROADS-FLEX BASE	CUR	1.00	.000	.000	.000	1.000	.000	.000			
		OT-EP	YTD	1.01	1.017	1.000	1.000	1.015	1.065	.000			
711-131	TONS	ROADS-RIG BASE	CUR	4.49	3.021	3.824	4.666	6.600	3.893	6.492			
		PATCHING-PAVICAL	YTD	7.13	3.695	6.045	7.345	6.934	3.722	9.226			
711-132	TONS	ROADS-RIG BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		PATCHING-NECH	YTD	.96	.000	.965	.000	1.399	.751	1.007			
711-134	GALS	ROADS-RIG BASE	CUR	.12	.000	.000	.000	.120	.000	.000			
		SURF TREAT-LIG BI	YTD	.10	.000	.017	.405	.094	.000	.299			
711-135	TONS	ROADS-RIG BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		SURF TREAT-PL MIX	YTD	.33	.000	.335	.000	.000	.000	.334			
711-136	TONS	ROADS-RIG BASE	CUR	5.50	.000	.000	.000	.000	.000	5.500			
		BASE/SUBBASE REP	YTD	5.82	6.900	4.375	5.500	4.280	13.062	8.584			
711-137	GALS	ROADS-RIG BASE	CUR	.24	.000	.000	.000	.000	.218	.260			
		CRACK SEALING	YTD	.25	.480	.280	.000	.183	.204	.251			
711-139	MAN HRS	ROADS-RIG BASE	CUR	1.00	.000	.000	.000	1.000	.000	.000			
		OT-EP	YTD	1.00	1.000	1.000	1.000	1.000	1.000	1.000			
711-141	TONS	ROADS-RIG PAVEMENT	CUR	6.09	8.333	3.607	4.400	10.500	3.933	.000			
		PATCH-PAVICAL	YTD	5.46	4.520	5.031	9.161	7.150	2.919	11.318			

K-10

Figure K-3 (continued)

PROGRAM GEN/0670370 H.M.M.S. DISTRICT EFFICIENCY REPORT MONTH MARCH PAGE 41

AVERAGE UNIT COST										
ACTIVITY	UNIT	DESCRIPTION		DISTRICT 05	COUNTY 05-1	COUNTY 05-2	COUNTY 05-3	COUNTY 05-4	COUNTY 05-5	COUNTY 05-6
711-111	TONS	ROADS-UNPAVED PATCHING	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$2323.00	\$ 0.00	\$ 0.00	\$86.00	\$ 0.00	\$ 0.00	\$ 0.00
711-112	MILES	ROADS-UNPAVED SHAPING	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
711-113	SG YDS	ROADS-UNPAVED RE-STABILIZATION	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
711-114	SG YDS	ROADS-UNPAVED DUST PALLIATIVE	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
711-119	MAN HRS	ROADS-UNPAVED OTHER	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
711-121	TONS	ROADS-FLEX BASE PATCHING-MANUAL	CUR	\$79.70	\$59.10	\$104.58	\$54.35	\$66.96	\$49.43	\$679.12
			YTD	\$48.65	\$44.01	\$37.16	\$44.42	\$34.62	\$43.60	\$91.15
711-122	TONS	ROADS-FLEX BASE PATCHING-MECH	CUR	\$45.50	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.25	\$ 0.00
			YTD	\$17.79	\$20.46	\$ 0.00	\$ 0.00	\$11.46	\$24.14	\$9.10
711-124	GALS	ROADS-FLEX BASE SURF TREAT-LIQ BI	CUR	\$1.01	\$ 0.00	\$ 0.00	\$ 0.91	\$ 0.56	\$1.14	\$9.10
			YTD	\$ 0.81	\$ 0.79	\$ 0.93	\$ 0.77	\$ 0.92	\$ 0.57	\$ 0.00
711-125	TONS	ROADS-FLEX BASE SURF TREAT-PL MIX	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$16.83	\$18.15	\$152.83	\$18.06	\$14.64	\$13.03	\$10.90
711-126	TONS	ROADS-FLEX BASE BASE REPAIR	CUR	\$16.09	\$ 0.00	\$ 0.00	\$65.37	\$11.82	\$ 0.00	\$ 0.00
			YTD	\$7.82	\$34.21	\$ 0.00	\$16.03	\$12.46	\$113.75	\$208.90
711-129	MAN HRS	ROADS-FLEX BASE OTHER	CUR	\$8.40	\$ 0.00	\$ 0.00	\$ 0.00	\$6.48	\$ 0.00	\$ 0.00
			YTD	\$12.59	\$15.93	\$ 0.51	\$11.05	\$10.32	\$15.87	\$ 0.00
711-131	TONS	ROADS-RIG BASE PATCHING-MANUAL	CUR	\$143.18	\$51.19	\$65.89	\$381.00	\$343.60	\$44.15	\$196.00
			YTD	\$79.47	\$33.13	\$32.74	\$89.92	\$84.64	\$46.25	\$110.70
711-132	TONS	ROADS-RIG BASE PATCHING-MECH	CUR	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00
			YTD	\$9.01	\$ 0.00	\$6.64	\$ 0.00	\$40.45	\$16.37	\$12.30

Figure K-4. PERFORMANCE EXCEPTION REPORT

COUNTY LEHIGH							DISTRICT 053					
[-----TEN MAJOR ACTIVITIES YEAR - TO - DATE-----]							[-----TEN MAJOR DEVIATIONS THIS MONTH-----]					
		[CURRENT MO]		[YEAR-TO-DATE]				[PRODUCTION]		[PERFORMANCE]		
ACTIVITY	DESCRIPTION	[UNITS]	[HOURS	Σ]	[HOURS	Σ]	ACTIVITY	DESCRIPTION	[UNITS]	[HOURS]	[HOURS	Σ]
711-121	ROADS-FLEX BASE PATCHING-MANUAL	TONS	3035	94	8398	80	711-415	BRIDGE MAINT/REPR SUBSTRUCTURE	1 SITES	28	28	928
711-124	ROADS-FLEX BASE SURF TREAT-LIO BI	GALS	1853	39	5868	42	714-716	VEG MONT-TREE REM 6 INCHES	5 EACH	10	10	389
712-522	SNOW/ICE CONTROL APPLY ASKID/CHEM	MILES	444	107	5640	79	711-321	DRAIN REP/REPL INLET/ENDWALL	5 EACH	59	59	305
719-119	MAINT ADH-OTHER	MAN HRS	682		5595		712-523	SNOW ICE CONTROL SIMUL PLOW-SPREAD	14.9 MILES	144	144	259
711-215	SHOULDERS-UNPAVED CUTTING	MILES	676	84	4756	64	711-126	ROADS-FLEX BASE BASE REPAIR	3 TONS	113	113	201
712-519	SNOW SEASON PREP OTHER	MAN HRS	141		4383		713-821	SIGNS-CONST, DETOUR/VERP	2 SITES	188	188	17
711-312	DRAIN CLEAN-DITCH/ DRAIN CHAN	FEET	81	53	3605	28	712-524	SNOW ICE CONTROL CLEAN UP/NOISE	5.4 MILES	184	60	180
713-624	SIGNS-INSTALL/REPL ALL OTHER	SITES	390	82	3542	67	713-832	GUARDRAIL-PAYNT	6.0 FEET	35	35	28
714-715	VEG MONT-BRUSH/4 SELECT TRM/TON	ACRES			3532	214	711-322	DRAIN REP/REPL DITCH/DRAIN CHAN	7 FEET	35	35	34
711-311	DRAIN CLEAN-INLET / ENDWALL	EACH	113	78	2823	50	711-323	DRAIN REP/REPL PIPE UNDER 36"	3.0 FEET	395	395	37

Figure K-5. DETAILED PERFORMANCE REPORT

COUNTY LEHIGH		ORG: 053							
COST CENTER	ACTIVITY	DESCRIPTION	[-----CURRENT MONTH-----] (PROD OR SUPPORT ACT-HRS STD-HRS)		[-----FISCAL YEAR TO DATE-----] (PROD OR SUPPORT ACT-HRS STD-HRS)		Z		
31	711-121-01	ROADS-FLEX BASE PATCHING-MANUAL COLD MIX	194 TONS	660	720	289 TONS	1225	1072	88
		SAFETY		9			28		
		TRAVEL	502 MILES	23		952 MILES	42		
	711-124-02	ROADS-FLEX BASE SURF TREAT-LIQ BIT MECHANIZED				108220 GALS	1398	1039	74
		HAULING					555		
		OTHER					149		
		SAFETY					13		
		TRAVEL				3272 MILES	117		
	711-126-01	ROADS-FLEX BASE BASE REPAIR MECHANIZED				34 TONS	95	99	104
		HAULING					5		
		OTHER					4		
		SAFETY					1		
		TRAVEL				64 MILES	3		
	711-212-01	SHOULDERS-UNPAVED GRADING MECHANIZED	1 MILES	3	9	8 MILES	100	72	72
		SAFETY					24		
		TRAVEL	13 MILES	1		153 MILES	10		

Figure K-6. PRODUCTION PERFORMANCE REPORT - ACTIVITY

NORTHAMPTON

DISTRICT 055

Activity	Description	Units	[---CURRENT PERIOD---]			[---TOTAL---]		[---YEAR ---]			[---DATE-----]					
			[PRODUCTION UNITS]			[UNITS]		[PRODUCTION UNITS]			[TOT P OD]					
			[PLANNED]	[COMPLETED]	[%]	[PLANNED]	[COMPLETED]	[PLANNED]	[COMPLETED]	[%]	[HOUR]	[SUPPORT]	[PERFORMANCE]			
711-121	ROADS-FLEX BASE PATCHING-MANUAL	TONS	660	481	73	4125	2640	2121	80	8	62	2939	35	8362	93	
711-122	ROADS-FLEX BASE PATCHING-MECH	TONS		12		4644	3714	515	14		58	236	66	358	63	
711-124	ROADS-FLEX BASE SURF TREAT-LIO BI	GALS		1950		55932	55932	21060	91		59	517	60	859	69	
711-125	ROADS-FLEX BASE SURF TREAT-PL MIX	TONS				6059	5454	7240	133		79	168	17	979	185	
711-126	ROADS-FLEX BASE BASE REPAIR	TONS	35			322	210	6	4		48	37	77	48	48	
711-129	ROADS-FLEX BASE OTHER	HAN HRS	UNAVAIL			UNAVAIL	UNAVAIL	45			49	49	100			
711-120	**TOTAL SUBPROGRAM										10	55	3946	37	10606	98
711-131	ROADS-RIG BASE PATCHING-MANUAL	TONS	189	47	25	1180	754	393	52	-1	63	655	45	1463	98	
711-132	ROADS-RIG BASE PATCHING-MECH	TONS				1180	944	161	17		21	79	65	121	60	
711-136	ROADS-RIG BASE BASE/SUBBASE REP	TONS	32			295	192	16	8		09	107	51	209	25	
711-137	ROADS-RIG BASE CRACK SEALING	GALS		972		1180	1180	2132	183		37	251	57	437	122	
711-139	ROADS-RIG BASE OTHER	HAN HRS	UNAVAIL			UNAVAIL	UNAVAIL	16			18	5	28			

Figure K-7.

EXPENDITURE ANALYSIS REPORT

COUNTY CARBON

ORG 052

PROGRAMS AND ACTIVITIES		***** DOLLARS EXPENDED *****						PRODUCTION	UNIT COSTS	
DESCRIPTION		PERSONNEL	CONTRACTS	MATERIAL	EQUIPMENT	TOTAL		UNITS	COUNTY	STATE
		& SERVICES			RENTED	DEPT.				AVERAGE
711-111	ROADS-UNPAVED	MONTH	21	-	-	-	21	0 TONS	.00	
	PATCHING	FYTD	21	-	2058	-	2059	0 TONS	.00	15.21
711-119	ROADS-UNPAVED	MONTH	-	52	-	-	52	0 MAN HRS	.00	
	OTHER	FYTD	315	52	1897	-	2313	0 MAN HRS	.00	16.51
711-121	ROADS-FLEX BASE	MONTH	13602	53	-	3108	16837	161 TONS	104.58	
	PATCHING-MANUAL	FYTD	28994	53	-	7069	36116	972 TONS	37.16	45.61
711-122	ROADS-FLEX BASE	MONTH	9-	-	-	-	9-	0 TONS	.00	
	PATCHING-MECH	FYTD	87	-	44	-	131	0 TONS	.00	19.61
711-124	ROADS-FLEX BASE	MONTH	-	-	-	-	-	0 GALS	.00	
	SURF TREAT-LIQ B1	FYTD	6000	-	38304	-	6023	16146 GALS	.93	1.05
711-125	ROADS-FLEX BASE	MONTH	-	-	2812	-	2812	0 TONS	.00	
	SURF TREAT-PL MIX	FYTD	3025	-	68726	-	996	476 TONS	152.63	16.31
711-126	ROADS-FLEX BASE	MONTH	-	-	-	-	-	0 TONS	.00	
	BASE REPAIR	FYTD	-	-	-	-	-	1511 TONS	.00	10.05
711-129	ROADS-FLEX BASE	MONTH	-	-	-	-	-	0 MAN HRS	.00	
	OTHER	FYTD	15	-	50	-	65	128 MAN HRS	.51	10.64
711-131	ROADS-RIG BASE	MONTH	4105	-	-	-	4105	74 TONS	65.89	
	PATCHING-MANUAL	FYTD	10121	-	-	-	3770	394 TONS	32.74	53.91
711-132	ROADS-RIG BASE	MONTH	-	-	-	-	-	0 TONS	.00	
	PATCHING-MECH	FYTD	4633	-	-	-	3145	1171 TONS	6.64	21.61
711-134	ROADS-RIG BASE	MONTH	-	-	-	-	-	0 GALS	.00	
	SURF TREAT-LIQ B1	FYTD	1068	-	-	-	536	4651 GALS	.35	1.35
711-135	ROADS-RIG BASE	MONTH	-	-	-	-	-	0 TONS	.00	
	SURF TREAT-PL MIX	FYTD	4103	-	22869	-	3736	1295 TONS	23.71	17.52

K-15

APPENDIX L

MAINTENANCE ACTIVITY COST CODES

100 Base and Subgrade

110 Removal of Base and/or Subgrade

120 In Place Repair - No Stabilizer

130 In Place Repair - Stabilizers (Maintainer)

131 In Place Repair Existing Base and/or Subgrade - Add Lime

132 In Place Repair Existing Base and/or Subgrade - Add Cement

133 In Place Repair Existing Base and/or Subgrade - Add Asphalt

134 In Place Repair Existing Base and/or Subgrade - Add Sand

135 In Place Repair Existing Asphalt Stabilized Base - Add Sand

140 In Place Repair - Stabilizers (Maintainer and Mixing Machine)

141 In Place Repair Existing Base and/or Subgrade - Add Lime

142 In Place Repair Existing Base and/or Subgrade - Add Cement

143 In Place Repair Existing Base and/or Subgrade - Add Asphalt

144 In Place Repair Existing Base and/or Subgrade - Add Sand

145 In Place Repair Existing Asphalt Stabilized Base - Add Sand

150 Repair Existing Base and/or Subgrade Other Than In Place

160 Install and/or Maintain Sub-drains - All Types

200 Surfaces

210 Seal Coat

- 211 Aggregate Seal Coat
- 212 Strip or Spot Seal Coat - Major
- 213 Strip or Spot Seal Coat - Minor
- 214 Fog or Sheet Sealing

220 Leveling or Overlay

- 221 Spot Leveling - Blade Spread
- 222 Spot Leveling - Hand
- 223 Spot Leveling - Hot Box
- 224 Level-up Blade - Sections
- 225 Level-up Blade - Continuous
- 226 Overlay - Major
- 227 Overlay - Minor
- 228 Underseal

230 Improve Texture

- 231 Treat Bleeding Pavement - Add Aggregate
- 232 Treat Bleeding Pavement - Heating Aggregate
- 233 Treat Bleeding Pavement - Heating Pavement
- 234 Heater Planer Work
- 235 Grooving (ACP)
- 236 Grooving (Concrete Pavement)
- 237 Improve Pavement Texture - Basic (CRCP)
- 238 Improve Pavement Texture - Basic (RCP)

240 Rutting and Shoving

- 241 Repair Rutting and Shoving - Basic
- 242 Repair Rutting and Shoving - Trim and Overlay

250 Cracks and Joints

- 251 Seal Cracks and/or Joints - Major
- 252 Seal Cracks and/or Joints - Minor
- 253 Seal Cracks - Squeegee
- 254 Seal Cracks - Major Operation (CRCP)
- 255 Seal Cracks - Minor Operation (CRCP)
- 256 Seal Cracks - Hot Rubber (CRCP)
- 257 Seal Cracks - Major Operation (RCP)
- 258 Seal Cracks - Minor Operation (RCP)
- 259 Seal Cracks - Hot Rubber (RCP)

260 Potholes and Spalling

- 261 Repair Potholes - Permanent
- 262 Repair Potholes - Temporary
- 263 Repair Potholes - Hot Box
- 264 Repair Spalling - Basic (Epoxy-CRCP)
- 265 Repair Spalling - Asphaltic Concrete (CRCP)
- 266 Repair Spalling - Basic (Epoxy-RCP)
- 267 Repair Spalling - Asphaltic Concrete (RCP)

270 Edge Repairs

- 271 Edge Repairs - Basic
- 272 Edge Repairs - Box
- 273 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-CRCP)
- 274 Seal Joint Between Pavement and Shoulder - Cutback (CRCP)
- 275 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-RCP)
- 276 Seal Joint Between Pavement and Shoulder - Cutback (RCP)

280 Remove and Replace Concrete Pavement

- 281 Removing and Replacing - Basic (CRCP)
- 282 Removing and Replacing - Fast Set Cement (CRCP)
- 283 Removing and Replacing - Stabilized Base (CRCP)
- 284 Removing and Replacing - Normal Portland Cement (Minor Repairs-CRCP)
- 285 Removing and Replacing - Basic (RCP)
- 286 Removing and Replacing - Fast Set Cement (RCP)
- 287 Removing and Replacing - Stabilized Base (RCP)
- 288 Removing and Replacing - Normal Portland Cement (Minor Repairs-RCP)

290 Blow-ups, Joint and Stress Relief

- 291 Repair Blow-up - Permanent (RCP)
- 292 Repair Blow-up - Temporary (RCP)
- 293 Seal Contraction and Expansion Joints - Basic (RCP)
- 294 Seal Contraction and Expansion Joints - Emulsion with Latex (RCP)
- 295 Seal Contraction and Expansion Joints - Hot Rubber (RCP)
- 296 Stress Relief - CRCP
- 297 Stress Relief - RCP

400 Shoulders and Approaches

410 Seal Coat Shoulders

- 411 Aggregate Seal Coat Shoulders
- 412 Strip or Spot Seal Coat Shoulders - Major
- 413 Strip or Spot Seal Coat Shoulders - Minor
- 414 Fog or Sheet Sealing Shoulders

420 Leveling or Overlay Shoulders

- 421 Spot Leveling Shoulders - Blade Spread
- 422 Spot Leveling Shoulders - Hand
- 423 Spot Leveling Shoulders - Hot Box
- 424 Level-up Shoulders - Blade, Sections
- 425 Level-up Shoulders - Blade, Continuous
- 426 Overlay Shoulders - Major
- 427 Overlay Shoulders - Minor

430 Treat Bleeding, Rutting and Shoving Shoulders

- 431 Treat Bleeding Shoulders - Add Aggregate
- 432 Treat Bleeding Shoulders - Heating Aggregate
- 433 Treat Bleeding Shoulders - Heating Paved Shoulder
- 434 Heater Planer Work Shoulders
- 435 Repair Rutting and Shoving Shoulders - Basic
- 436 Repair Rutting and Shoving Shoulders - Trim and Overlay

440 Cracks and Joints, Shoulders

- 441 Seal Cracks and/or Joints, Shoulders - Major
- 442 Seal Cracks and/or Joints, Shoulders - Minor
- 443 Seal Cracks, Shoulders - Squeegee

450 Potholes and Edge Repairs, Shoulders

- 451 Repair Potholes, Shoulders - Permanent
- 452 Repair Potholes, Shoulders - Temporary
- 453 Repair Potholes, Shoulders - Hot Box
- 454 Edge Repairs, Shoulder - Basic
- 455 Edge Repairs, Shoulder - Box

460 Repair Existing Base and/or Subgrade Other Than In Place, Shoulders

- 461 Removal of Base and/or Subgrade, Shoulders
- 462 Replacement of Removed Base and/or Subgrade, Shoulders - Stabilized Material
- 463 Replacement of Removed Base and/or Subgrade, Shoulders - Non-Stabilized Material

470 In Place Repair Existing Base and/or Subgrade, Shoulders

- 471 In Place Repair Shoulders - No Stabilizer
- 472 In Place Repair Shoulders - Add Lime (Maintainer)
- 473 In Place Repair Shoulders - Add Cement (Maintainer)
- 474 In Place Repair Shoulders - Add Asphalt
- 475 In Place Repair Shoulders - Add Sand (Maintainer)
- 476 In Place Repair Shoulders - Add Lime (Maintainer and Mixing Machine)
- 477 In Place Repair Shoulders - Add Cement (Maintainer and Mixing Machine)
- 478 In Place Repair Shoulders - Add Asphalt (Maintainer and Mixing Machine)
- 479 In Place Repair Shoulders - Add Sand (Maintainer and Mixing Machine)

480 Unpaved Shoulders

- 481 Recondition Sod Shoulders
- 482 Blade Flexible Shoulders - Maintainer and Pneumatic Roller
- 483 Blade Flexible Shoulders - Two Machines
- 484 Blade Flexible Shoulders - One Machine Kickoff Blade
- 485 Blade Flexible Shoulders - Maintainer

490 Approaches, Driveways, Turnouts

- 491 Public Side Road Approaches
- 492 Driveways - Valley and Pipe Type
- 493 Driveways - Safety Island

500 Roadside Maintenance

510 Mowing

- 511 State Owned Mowers
- 512 Leased Mowers
- 513 Full Width Mowing - State Owned Mowers
- 514 Full Width Mowing - Leased Mowers
- 515 Specialized Mowers
- 516 Hand Clean-up

520 Litter

- 521 Litter Pick-up - Hand
- 522 Litter Pick-up - Machine (Tow Type)
- 523 Litter Pick-up - Machine (Self-propelled with Shredder)
- 524 Street Sweeping
- 525 Maintain Litter Barrel

530 Rest Area Maintenance

- 531 Maintain Rest Areas - Comfort Stations
- 532 Maintain Rest Areas

540 Chemical Vegetation Control

- 541 Chemical Vegetation Control - Basic
- 542 Chemical Vegetation Control - Shoulder Edges
- 543 Chemical Vegetation Control - Spray Mesquite
- 544 Chemical Vegetation Control - Channels

550 Establish and Maintain Vegetation

- 551 Establish Vegetation - Basic
- 552 Establish Vegetation - Mulch Sodding
- 553 Establish Vegetation - Asphalt Mulch
- 554 Establish Vegetation - Small Hand Operation
- 555 Establish Vegetation - Disk or Drill
- 556 Maintain Sprinkler System Urban Areas

560 Pruning and Planting

- 561 Pruning and Brush Control - Minor
- 562 Pruning and Brush Control - Major
- 563 Pruning and Brush Control - Chipper
- 564 Planting - Large
- 565 Planting - Small

570 Silt and Erosion

- 571 Silt Removal - Basic
- 572 Silt Removal - Hydraulic Telescopic Boom Type Excavating Machine
- 573 Reshape Ditch and Slope - Basic
- 574 Ditch Retards - Grass
- 575 Ditch Retards - Concrete
- 576 Ditch Retards - Other
- 577 Ditch Liners - Jute
- 578 Ditch Liners - Concrete

580 Remove Silt From Culverts

- 581 Up to 36"
- 582 36" to 6' x 6'
- 583 6' x 6' to Bridge Class

600 Structures Over 20 Feet

601 Inspection Cost

610 Bridge Decks

- 611 Repair of Bridge Deck Spalling and Delamination - Portland Cement
- 612 Repair of Bridge Deck Spalling and Delamination - Epoxy
- 613 Repair of Bridge Deck Spalling and Delamination - Quick Setting Cements
- 614 Armor Joint Repair
- 615 Clean Bridge Deck - Mechanical
- 616 Clean Bridge Deck - Hand

620 Substructure - Concrete

- 621 Substructure Crack Repair
- 622 Substructure Crack Repair - Pressure Grouting
- 623 Repair of Badly Cracked or Spalled Substructure
- 624 Repair of Badly Cracked or Spalled Substructure - Collar
- 625 Repair of Badly Cracked or Spalled Substructure - Guniting
- 626 Repair Bearing Plates - Replace Lead Sheeting (Concrete Beams)
- 627 Substructure Waterproofing
- 628 Substructure Waterproofing - Epoxy Coating

630 Substructure Steel

- 631 Repair of Steel Substructure
- 632 Repair of Steel Substructure - Asphalt

640 Substructure - Timber

- 641 Repair of Timber Substructures
- 642 Removal of Timber Substructures

650 Railing

- 651 Paint Railing - Spray (Hand Cleaning)
- 652 Paint Railing - Hand
- 653 Paint Railing - Spray (Sandblast Cleaning)
- 654 Paint Railing - Touch-up
- 655 Metal Bridge Railing Repair
- 656 Concrete Bridge Railing Repair

660 Paint Bridges

- 661 Brush-off Blast
- 662 Near White
- 663 Touch-up

670 Channels and Riprap

- 671 Maintain Channels
- 672 Maintain Channels - Remove Drift
- 673 Repair and/or Replace Concrete Riprap
- 674 Remove Silt From Culverts

680 Linseed Oil

- 681 Linseed Oil Treatment of Bridge Decks

- 691 Biennial Safety Inspection
- 692 Damage Inspection

700 Traffic Services

710 Guide Markings

- 711 Center Stripe
- 712 Edgelining
- 713 Painting Traffic Medians and Islands
- 714 Zone and Pavement Markings
- 715 Install Traffic Buttons
- 716 Maintain Traffic Buttons

720 Delineation and Railing

- 721 Erect and Maintain Guard Fence and Railing
- 722 Maintain Concrete Median Barrier
- 723 Erect Delineators
- 724 Replace Damaged Delineators
- 725 Clean Delineators

730 Signs

- 731 Special Sign Studies
- 732 Install New Signs
- 733 Replace Signs
- 734 Repair Signs
- 735 Replace or Repair Traffic Damaged Signs
- 736 Replace or Repair Vandalized Signs
- 737 Wash Signs
- 738 Wash Vandalized Signs
- 739 Sign Clear Coating

740 Signals and Illumination

- 741 Install Signals
- 742 Install Illumination
- 743 Maintain Signals
- 744 Maintain Illumination
- 745 Replace or Repair Traffic Damaged or Vandalized Signals
- 746 Replace or Repair Traffic Damaged or Vandalized Illumination
- 747 Sign Illumination
- 748 Safety Lighting

750 Reimbursement to Railroad Companies (D-18 Use Only)

800 Extraordinary Maintenance

801 Emergency Repairs Due to Flooding

802 Emergency Repairs Due to Hurricanes

803 Emergency Repairs Due to Tornadoes

804 Emergency Repairs Due to Other Causes

810 Assistance to Traffic Other Than Caused by Snow and Ice

811 Assistance Needed Due to Floods or Flooding

812 Assistance Needed Due to Hurricanes

813 Assistance Needed Due to Tornadoes

814 Assistance Needed Due to Accident

815 Operation of Nail Picker

816 Removal of Sand Drifts

820 Assistance to Traffic - Snow and Ice

821 Assistance Needed Due to Snow and Ice

822 Plow Snow or Ice

823 Sand Bridges

824 Sand Roadway

825 Deicing Agents

826 Remove Sand, etc., - Mechanical

827 Remove Sand, etc., - Hand

APPENDIX M

APPENDIX M

The means and standard deviations presented in Tables A and B are weighted values. This was done because the number of 0.2 mile Serviceability Index values obtained for the various randomly selected pavement sections were not necessarily a constant value. This occurred because the length of some of the pavement sections had to be decreased to achieve a uniform construction section.

The equation for calculation of means is as follows:

$$\bar{x} = \frac{n_1 \bar{x}_1 + n_2 \bar{x}_2 + \dots + n_k \bar{x}_k}{n_1 + n_2 + \dots + n_k} \quad (1)$$

where \bar{x} = mean for a district for a particular highway type

\bar{x}_1 = mean for the first pavement section in a particular State Department of Highways and Public Transportation District and highway type

\bar{x}_k = mean for the last pavement section in a particular State Department of Highways and Public Transportation District and highway type

n = number of 0.2 mile Serviceability Indexes for a pavement section.

The variances and resulting standard deviations for Serviceability Indexes were also obtained by a weighting process. The equation is:

$$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 + \dots + (n_k - 1)s_k^2}{(n_1 - 1) + (n_2 - 1) + \dots + (n_k - 1)} \quad (2)$$

where s^2 = weighted variance for each State Department of Highways and Public Transportation District and highway type

s_1^2 = variance for the first pavement section in a particular State Department of Highways and Public Transportation District and highway type

s_k^2 = variance for the last pavement section in a particular State Department of Highways and Public Transportation District and highway type

n = same as for Equation 1

$n - 1$ = degrees of freedom

The standard deviation was obtained by taking the square root of the weighted variance.

Means for the visual rating scores were unweighted averages. This was done because only one rating score was obtained for each pavement section.

