AN INTEGRATED PAVEMENT DATA MANAGEMENT AND FEEDBACK SYSTEM (PAMS)

A Feasibility Report

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

ABSTRACT

This feasibility study report discusses the present practices followed by the Department to manage some 16,000 miles of highways. The practices were defined through existing policy manuals and discussions with individuals and/or sections who have some responsibility in the pavement management processes. The major thrust towards this feasibility effort was to determine what improvements or enhancements would be necessary to upgrade the existing pavement management system.

The report addresses four major deficiencies in the present system: (1) absence of a common location identifier for linking and merging various data files; (2) pavement distress measurements; (3) axle number and load distribution measurements and projections; and (4) level of maintenance reporting procedures.

The report further stresses that development of the pavement management system can begin by upgrading the existing system without the necessity of starting from scratch. This can be accomplished by implementing a set of recommendations geared towards rectifying the existing deficiencies.

IMPLEMENTATION

The development of an integrated pavement data management system should begin with total implementation of the recommendations enumerated in Chapter 8 of this report.

1. INTRODUCTION

Within the Office of Highways, numerous data, both fiscal and engineering, are generated on a pavement system for various reasons. It is generally assumed that the pavement system data collection is for the primary purpose of providing a tool to the management for decision making and long-range planning. On the other hand, one would ask whether the format and accessibility of such data is conducive to any adequate analysis or evaluation for future planning and designing of the highway system. The answer, today, would in most cases be negative. Although a number of examples can be cited to drive this point home, one deserves particular mention.

One of the top managers of the Louisiana Department of Transportation requested information relative to the state's interstate system. Specifically, he wanted to know what was out there in terms of material types, thicknesses, dimensions, etc., of the different layers on the system. At the time, it seemed an easy task to compile such information since it was felt that any information that would be up-to-date and readily available on a pavement system would have to be on the interstate system. However, much to the dismay of the person entrusted with this data compilation, it took almost three months to compile the data, by which time the data had become outdated for the management's intended purpose. Incidentally, this incident was to provide a driving force towards the development of a pavement management system concept.

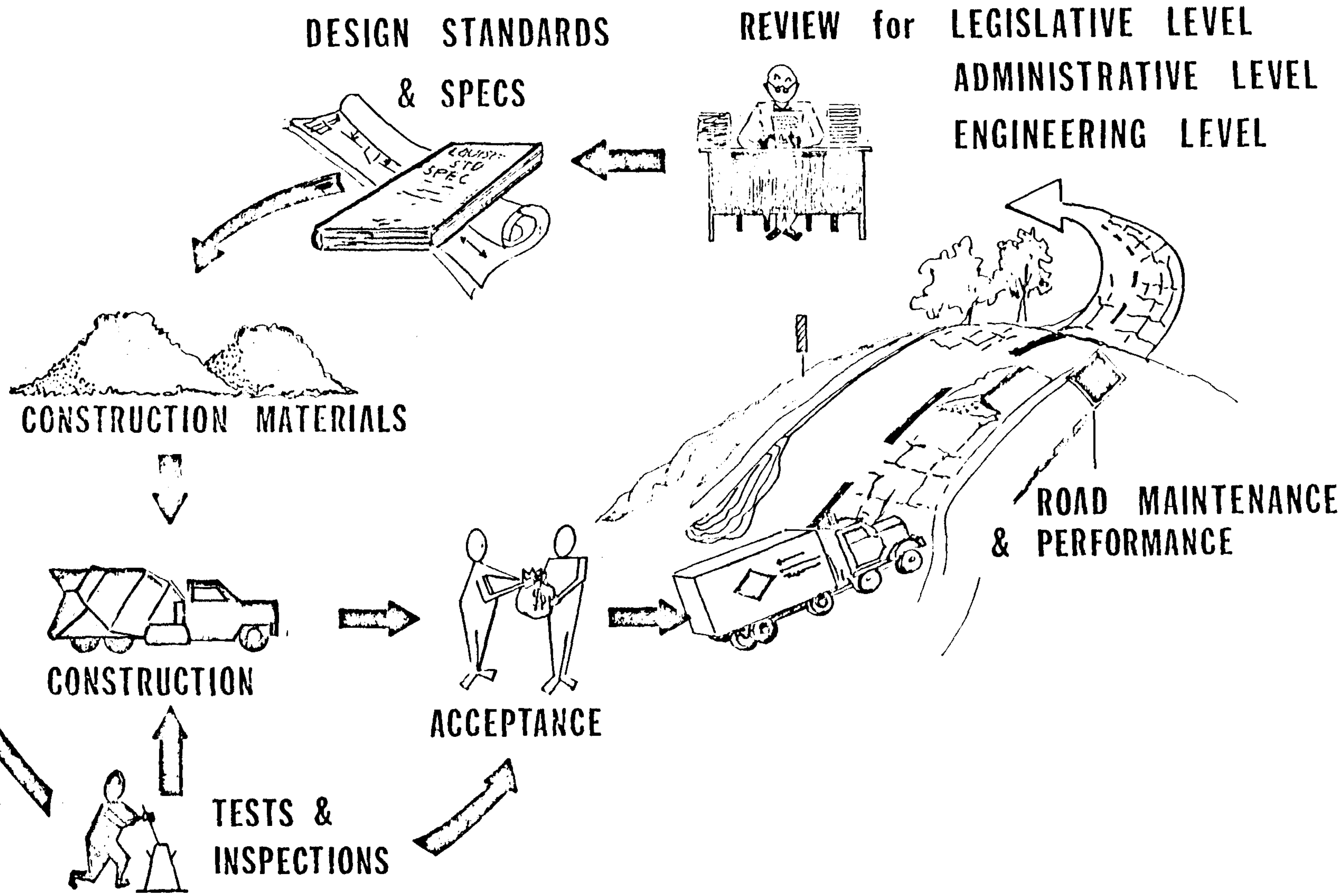
The above example should not be construed to mean that the present system has not served the intended purpose well, but rather because of rapid changes occurring in the total concept in pavement management at various levels of management, the existing system is not geared to provide the ready answers to questions such as:

+ What is out there on a given segment of road?
+ What is its performance level now?

+ What is its maintenance cost now?
+ What is its traffic history, past, present and future?
+ What is the effect of increased load limits on the pavement performance?
+ What is the remaining life of the pavement?
+ What is the best or optimum strategy for road service, maintenance? resurfacing? reconstruction?
+ Why do some roads fail early or outperform other identical ones?
+ Is the road net performance improving or declining?

The above issues or questions can be categorized into three broad levels of interests: legislative, administrative and engineering or technical. A pavement management system should be able to provide answers to all these levels in an integrated manner. Integrated because the management process is a closed-loop system requiring interaction between various divisions of the Department. This is simplistically depicted in Figure 1-1. The review phase of the feedback system encompasses decision processes necessary to provide answers to the three levels of interests mentioned before.

Although Louisiana has a pavement management system of some sort, it lacks the feedback requirements necessary to provide the tools to make equitable decisions at all levels of interests. Furthermore, the system, as it exists today, is a combination of loosely correlated policy-procedures memoranda and computer programs designed to satisfy the needs of the individual section within the agency. To provide a stronger communication and correlation between these various sections in terms of data flow, the Department, in cooperation with the Federal Highway Administration, initiated a study to determine if a need exists to develop an integrated and automated pavement data management system. Furthermore, if a need was indicated through a feasibility study, then to develop such a system. This report is concerned with the findings of the feasibility phase of the study.



Louisiana's Projected Pavement Management and Feedback System

FIGURE 1-1

2. OBJECTIVES

Specifically, the major objectives of this research study are twofold:

1. To determine the feasibility of developing a pavement data management system; and

2. If feasibility is evident, to develop an integrated system that would satisfy the immediate and long-term goals of the Department as enumerated below:

   The immediate goal is directed towards enhancement of the Department's current system of assessment of project needs and priorities in order to provide proper rationale for decision making through acquisition, analysis and evaluation of information compatible with available resources, accepted procedures and use.

   The long-term goals can be focussed to the following two specifics:

   a. To provide a stronger link to efficiently monitor the Department's overall pavement management feedback cycle as defined in Figure 1-1.

   b. To enhance the quality assurance system relative to specification language that could be related to performance.

3. FEASIBILITY STUDY METHODOLOGY

Implementation of a plan to explore the feasibility of developing a pavement management system requires the backing and support of the top managers of the Department. Furthermore, because of the multi-discipline involvement in the overall pavement management "process", it is essential that these various disciplines be given an opportunity to provide input to determine the need to develop such a system. Such an approach tends to maintain a high degree of credibility and support at the start and during the development and implementation of the PAvement Management System or PAMS.

In keeping with this philosophy, the feasibility study phase of the overall research effort was initiated with the formation of a steering committee composed of the following:

+ Maintenance Systems Engineer
+ EDP Engineering Systems Supervisor
+ Traffic and Programs Engineer
+ Soils and Pavement Design Engineer
+ Road Design Engineer
+ Scheduling and Manpower Systems Engineer
+ Highway Needs, Priorities, Programs Engineer
+ Transportation Planning Engineer
+ Materials and Research Engineer
+ Research and Development Engineer

The overall feasibility plan is based upon conclusions derived through discussions with various members, both collectively and individually, and review and analysis of the present system and its associated features.

4. THE PRESENT SYSTEM

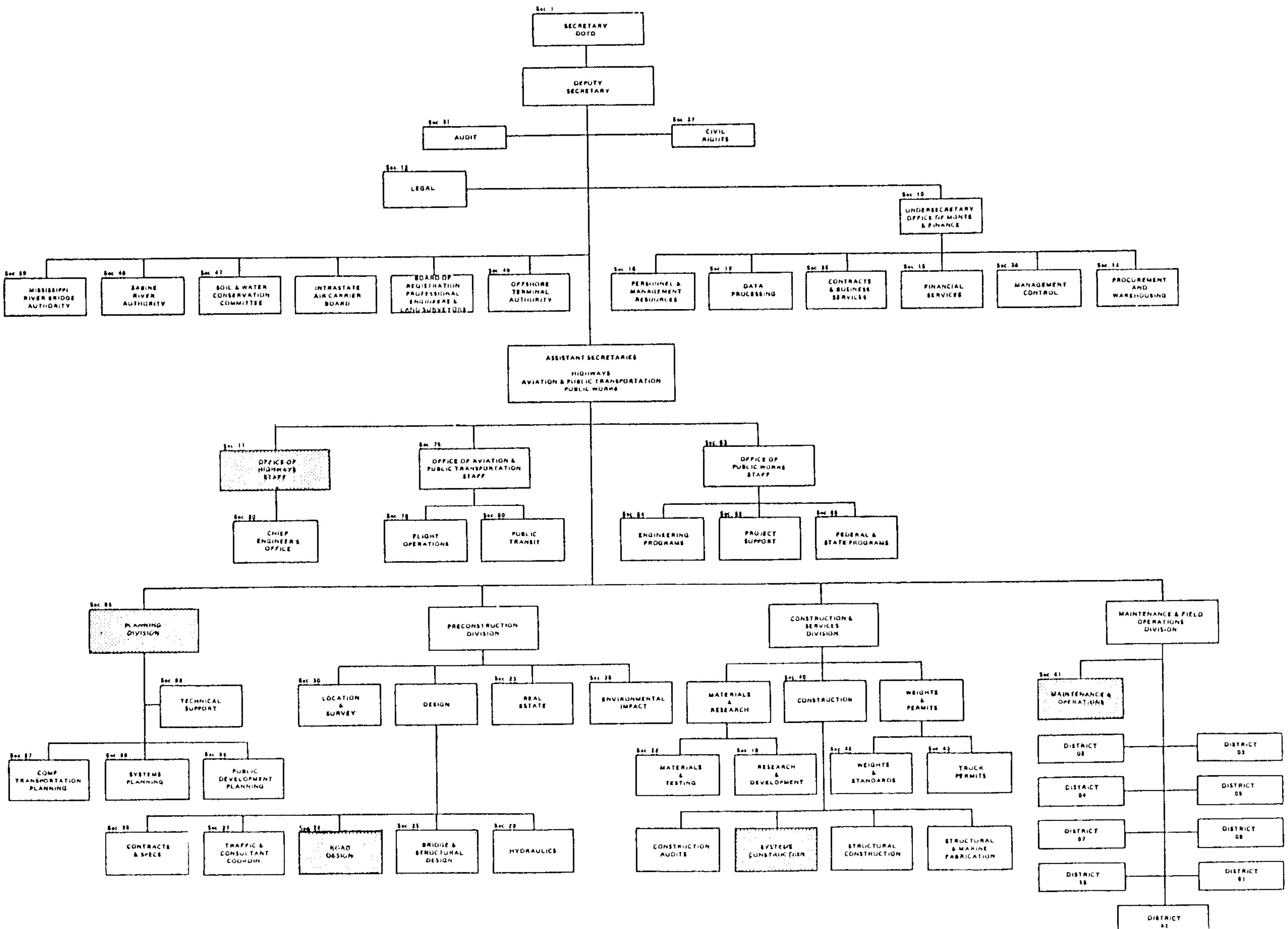
Pavement management is not a new concept. All state highway and transportation agencies make management decisions as a part of normal operations based on some sort of pavement management system. Louisiana is no exception. The central thought or idea behind a pavement management system is to improve the efficiency of decision making at all levels of interests. The management process involves a number of divisions each of which is entrusted with the task of satisfying certain time-, budget-critical responsibilities. Figure 4-1 is an organization chart of the Louisiana DOTD. Although the entire organization is involved, to some extent, in the management of the pavement system, the shaded blocks signify those divisions and/or sections that have direct involvement in the management of the system. This management could be in terms of either direct data input or potential use of the output data. In the following paragraphs, the activity of each block is discussed relative to the pavement data management. In the discussion, emphasis is placed on the extent of automation used by each of the disciplines, the major reports, if any, generated by the system, and the level of communication flow that is maintained by the various units in their decision-making process.

4.1. Traffic and Programs

4.1.a. Statewide Monitoring - Highway Needs Study

This transportation discipline is entrusted with development of the total construction program at both the network and the project level. In this respect, they should be considered the prime user of the system. The central issue facing them is the justification of the construction program to the legislators. A clear, properly supported, objectively based justification is likely to receive a more favorable consideration than a loosely correlated (to other criteria of pavement management) one.

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION & DEVELOPMENT



Louisiana Department of Transportation and Development Organization Chart

FIGURE 4-1

Act 334 passed by the Louisiana Legislature in 1974 requires the DOTD to revise its procedures in the determination of resource allocation and project priority. The essential function of the Office of Highways, Traffic and Programs Section, is compliance with this act (1)*.

The assessment of needs on the state-maintained highway system (urban and rural) consists of an annual inventory and analysis of approximately 16,000 miles of roadway in the system. Needs Study areas have been developed to provide a uniform and efficient procedure for conducting the field phase of the needs evaluation and highway sufficiency rating. The areas, with miles of state highways in each parish, are shown in Figure 4.1-1. The field phase of the Needs Study is conducted annually by qualified engineering teams within each of the nine highway districts. The time required for a full cycle of the program is approximately 18 months. The program is developed at both the network level and the project level. Figure 4.1-2 is a brief overview of the functional steps necessary in developing the Highway Needs Study and Legislative Construction Program. The following paragraphs briefly discuss the needs appraisal concepts, process, and the various data elements collected to develop the overall program.

Appraisal Concepts

Appraising the adequacy of existing facilities involves two major steps, performed in sequence. First, the facility is appraised to see if it meets criteria of tolerability for present traffic. If it does not, it is classified as an existing or "backlog" deficiency. If it is now tolerable, it is then appraised for its ability to meet the same

*Underlined numbers in parentheses refer to list of references.

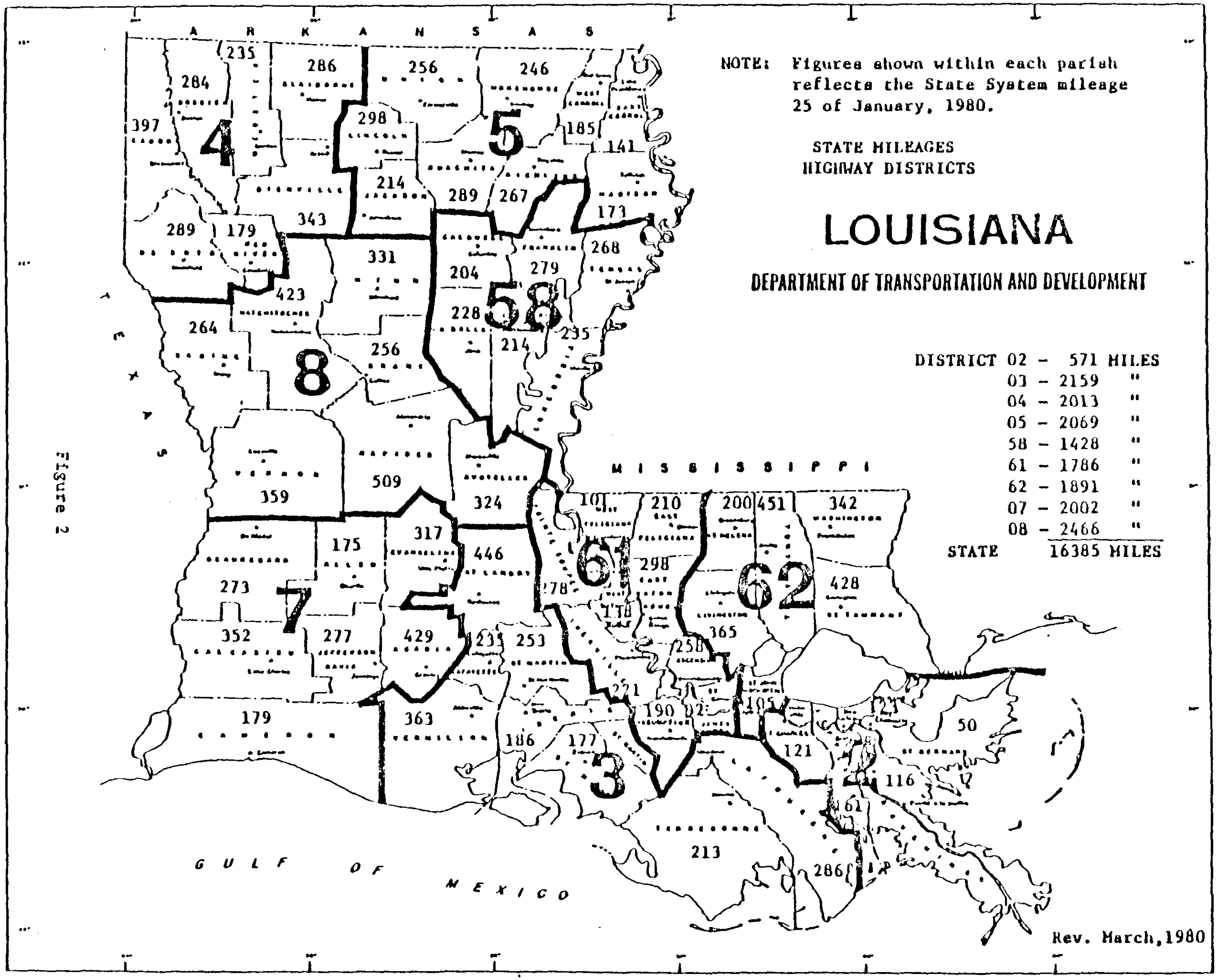
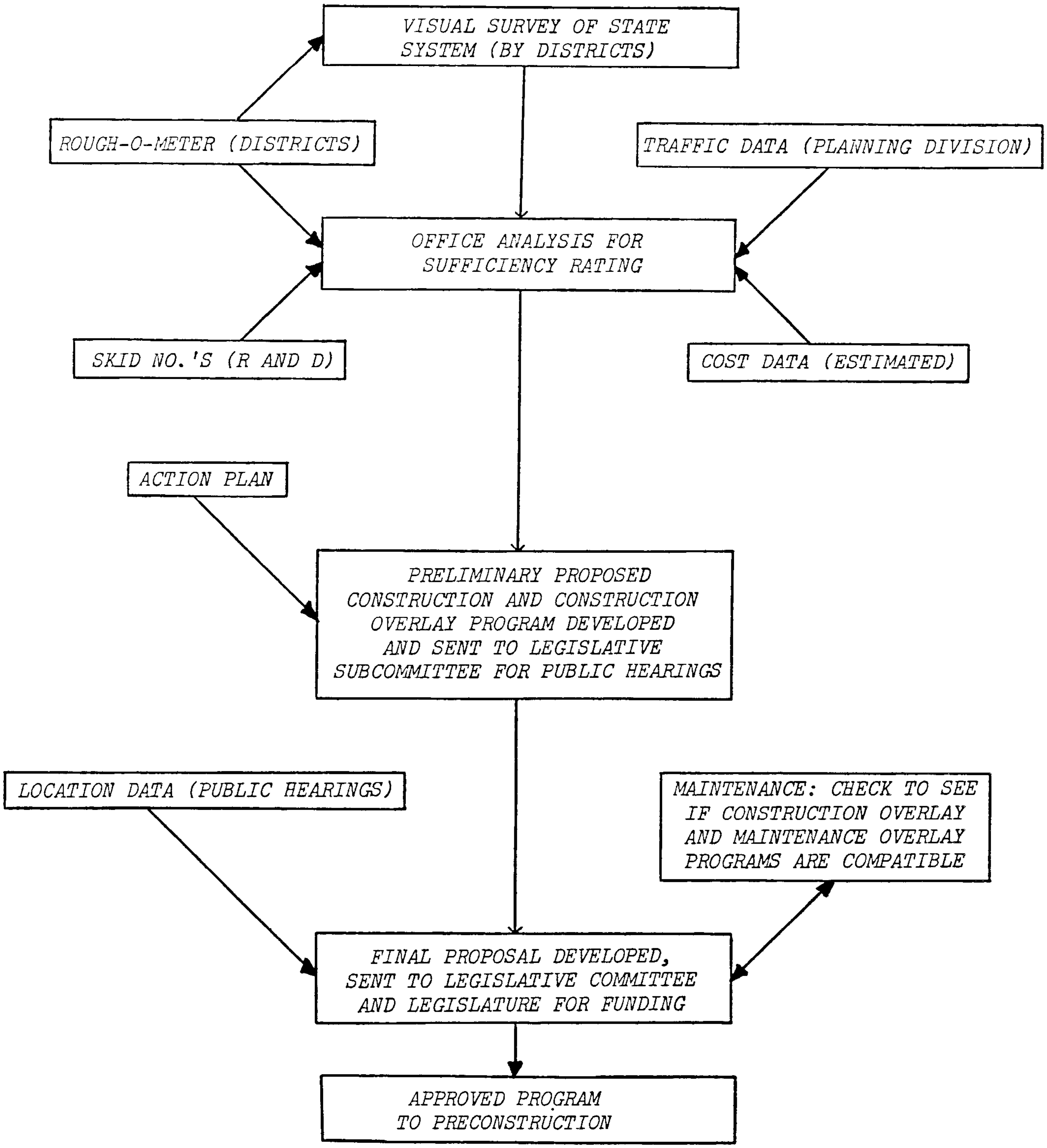


Figure 2

State Mileage by District and Parish

FIGURE 4.1-1



Functional Steps for Development of Yearly Construction Program

FIGURE 4.1-2

tolerability criteria based on projected future traffic. If it does not, it is classified as a future deficiency. Structural deterioration of the pavement is also considered in evaluating future deficiencies.

The broad categories of deficiency are traffic capacity, alignment, widths, and structural (pavement) and drainage condition. The first three of these categories, broadly labeled "geometric", are developed objectively and consistently, in the sense of being readily subject to numerically quantifiable values.

Structural and drainage adequacy require judgmental evaluation. Drainage adequacy, for example, is evaluated in terms of cross-sectional character (ditches, slopes, curbs, etc.) and height of grade line. These elements provide guidance, as to whether improvement is feasible or whether reconstruction is a more practical alternative. In the determination of structural adequacy, rough-o-meter and skid resistance studies are used to supplement engineering judgment. These are the only two measured performance-related criteria considered in the deficiency assessment process. Upgrading of this particular area of monitoring is discussed in detail in Chapter 6.

The type of deficiency is a key to the type of needed improvement, e.g., resurfacing, widening or reconstruction. Cost estimate is prepared on a major cost item basis, e.g., right-of-way, surface and base, grading and drainage, etc. These are developed on an item cost-per-mile basis and can be aggregated to provide an overall cost-per-mile value for a given section or segment of roadway. Costs are based on the standard required to meet forecast year rather than present traffic.

Appraisal Process - Data Input

Basically, the appraisal process of the total network system is accomplished through the following steps:

+ Identifying study sections and subsections.
+ Describing existing conditions.
+ Determining the character and degree of deficiencies.
+ Estimating improvements needed to overcome deficiencies.
+ Estimating costs of needed improvements.

The data necessary to accomplish the above steps is generated in the field and/or office and transferred on the forms such as the one shown as Figure 4.1-3 for rural systems. These forms are computer generated with all pertinent information prefilled from the most recently available data on computer files. The field personnel enter the necessary changes in the data blocks, if such is indicated from their field survey. Discussion of the above appraisal steps and the data elements on the form follow:

Identification of Sections

Identification of sections within the system is accomplished by the use of a control-section system. This system primarily consists of a series of numbered controls superimposed over the state-route system. These controls are subdivided into sections in order to localize statistical data and facilitate the filing of records.

Sections of the control are further divided into subsections. Each subsection represents a length of road or street that is relatively homogeneous in geometrics, traffic volume, and cross section, and long enough to be a logical section for needs appraisal. Locations within the subsection are specified by a log mile identification from the beginning of the control section. Items 1 through 9 in Figure 4.1-3 contain data relative to section identification. The items are self-explanatory.

FORM NO. 106

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

HIGHWAY NEEDS STUDY

RURAL INVENTORY FORM

CARD 1

IDENTIFICATION

		Column
1. Parish	0 7	1-2
2. Route Number	0 0 0 9	3-7
3. Control	0 9 9	8-10
4. Section	0 4	11-12
5. Subsection	0 2	13-14
6. Length (00.00 mile)	0 7 5 4	15-18
7. Con. Sect. Log Mile (00.00 mile) (Beg. of Subsection)	0 6 8 6	19-22
8. Functional Classification	0 4	23-24

Code	Functional System
01	Interstate
02	Other Principal Arterial
03	Minor Arterial
04	Collector
05	Local
06	Other

9. Federal Aid System — 2 — 25
   1 FAP, Including Interstate
   2 FAS
   3 Non FA

EXISTING CONDITIONS

		Column
10. Year	8 0	26-27
Geometrics		
11. Access Control (Full 1 / Partial 2 / None 3)	3	28
12. Surface Width (ft.)	2 0	29-30
13. Number of Lanes	0 2	31-32
14. Shoulder Width (ft.) ___Rt.	0 0 0 5	33-34
15. Terrain: (Flat 1 / Rolling 2)	2	35
16. Percent of Length with Intolerable Safe Speed	0 0	36-37
17. Percent of Length with Sight Distance ≥ 1500 Ft.	0 2	38-39
18. Median Width (ft.)	0 0	40-41
19. Average Highway Speed (mph)	6 0	42-43
20. Number of Signals	0 0	44-45
21. Type of Development (Rural 1 / Dense 2)	1	46
22. Apparent Right-of-Way ___(ft.)	1 0 0	47-49
Traffic		
23. ADT	0 0 7 3 7	50-54
24. Percent Trucks (2 AXLE-6 TIRE)	1 5	55-56
25. Total Trucks (INCL. P/U & VANS)	4 0	57-61
26. K-Factor	1 0	62-63
27. Directional Factor	5 5	64-65
28. Capacity (hourly)	0 9 7 6	66-69
29. Operating Speed (mph)	5 4	70-71
Structural — V/C = 0.07		
30. Surface Type — EALA = 6456	7	72

2	Graded and Drained
4	Gravel, Shell or Stone
7	Bituminous
8	Bituminous Concrete
9	Concrete
0	Brick

		Column
31. Pavement Section ('SN Known 1 / 'D' Known 2 / Heavy 3 / Medium 4 / Light 5)	5	73
32. Pavement Condition (PSR 0.0)	1 2	74-75
33. Shoulder Type (Surfaced 1 / Stabilized 2 / Earth 3)	2	76
34. Drainage Adequacy (Good 1 / Fair 2 / Poor 3)	1	77
CARD NUMBER	1	78

REMARKS:

CARD 2

ANALYSIS OF DEFICIENCIES

		Column
1-7 Identification (Repeat Card 1)		1-22
35. Design Year	0 0	23-24
36. Design Year ADT	0 0 0 8 1 4	25-30
37. Avg. Annual Traffic Growth___%	0 5	31-32
38. Percent of Length with Intolerable Safe Speed (Design Year)	0 0	33-34
39. Time of Pavement Condition Deficiency (Now 1 / 1-5 2 / 6-10 3 / 11-15 4 / 16-20 5 / 20+ 6)	1	35

40. Deficiencies:

	Code	Now	1-5	6-10	11-15	16-20	20+
Operating Speed	1						X
Land or Rdway Width	2						X
Safe Speed	3						X
Pavement Type or Cond.	4	X					
Shoulders	5						X
None	6						

		Column
41. Initial Deficiency Code	4	36
42. Secondary Deficiency Code	6	37
43. Period Section Becomes Deficient (Now 1 / 1-5 2 / 6-10 3 / 11-15 4 / 16-20 5 / 20+ 6)	1	38

DESCRIPTION OF IMPROVEMENT

		Column
44. Year of Improvement	8 0	39-40
45. ADT 1st. Yr. after Improvement	0 0 0 7 4 1	41-46
46. Type of Improvement	0 7	47-48

0	No Improvement
1	New Location
2	Reconstruction
3	Isolated Reconstruction
4	Major Widening
5	Minor Widening
6	Resurfacing & Shoulder Improvement
7	Resurfacing
8	Structures Only

		Column
47. Design Standard Number	2 5	49-50
48. Access Control (Full 1 / Partial 2 / None 3)	3	51
49. Number of Lanes	0 2	52-53

RAILROAD CROSSINGS

Number of RR Crossings with:

		Column
50. No Protective Devices	0	54
51. Cross Bucks	0	55-56
52. Flashing Lights	0	57-58
53. Flashing Lights & Gates	0	59-60
54. Grade Separations	0	61-62

STRUCTURES

		Column
55. Number of Structures (Present)	0 2	63-64
Number of Deficiencies (Existing Structures):		
56. Width	0 0	65-66
57. Vertical Clearance	0 0	67-68
58. Loading	0 0	69-70
59. Other	0 0	71-72
60. Number of Structures Needed	0 0	73-74
61. Time of Structure Needs (Now 1 / 1-5 2 / 6-10 3 / 11-15 4 / 16-20 5 / 20+ 6)	6	75
CARD NUMBER	2	76

CARD 3

COSTS, Thousands

		Column
1-7 Identification (Repeat Card 1)		1-22
62. Right-of-Way	0 0 0 0 0 0	23-28
63. Grading & Drainage	0 0 0 0 0 0	29-34
64. Surface & Base	0 0 0 3 9 9	35-40
65. Engr. & Cont.	0 0 0 0 7 2	41-46
66. Structures (Incl. RR Grade Sep.)	0 0 0 0 0 0	47-52
67. Other	0 0 0 0 9 0	53-58
68. Total	0 0 0 5 5 1	59-64
69. Cost Area	0 3	65-66
70. Expansion Factor (00.000)		67-71
CARD NUMBER	3	80

Rural Inventory and Monitoring Data Input Form

FIGURE 4.1-3

Describe Existing Conditions

Definitions of the existing conditions on each study section, to the extent possible, are performed as an office operation making use of the most up-to-date inventory and condition data available, and supplemented by an annual on-site inspection which recognizes and adjusts to changes for deterioration, improvements, land use, additions to or deletions from the state-maintained system, etc.

The definition of existing conditions, defined by items 10 through 34 in Figure 4.1-3, form the basis for subsequent determination and analysis of deficiencies. The data on these items are categorized according to geometrics, traffic and pavement section. Two items, 31 and 32 on the form, deserve explanation.

Item 31, Pavement Section, is coded through data provided in Table 4.1-1. "SN" is the structural number for flexible pavements and "D" is the slab thickness for rigid pavements. If SN or D is not known, the codes 3, 4 or 5 can be coded according to the heavy, medium or light rating of the combined depth.

TABLE 4.1-1

Pavement Section Guide

Code	Type of section	Flexible pavement					Rigid pavement
		"SN" range	Surface type & thickness	Base type & thickness	Subbase type & thickness	Combined depth 1/	Range in pavement thickness "D"
3	Heavy	4.6 - 6.0	4" asphaltic concrete	9" crushed stone to PC concrete	4" gravel 2/	> 12"	9.1 - 11.0" (8" if continuously reinforced)
4	Medium	3.1 - 4.5	3" asphaltic concrete	8" gravel to penetration macadam	4" gravel	11-12"	7.1 - 9.0" (6" if continuously reinforced)
5	Light	1.0 - 3.0	Surface treatment to 2" asphaltic concrete	6" gravel or crushed stone	2" gravel or sand	10"	6.0 - 7.0"

1/ To be used as a guide where only the total depth is known or estimated.

2/ Subbase course not necessary under portland cement concrete base.

Item 32, Pavement Condition, is a PSI rating as determined by the Mays Ride Meter. In addition to this measure of pavement condition rating, subjective examination is also accomplished for components of pavement section. This is discussed under a separate section following this one.

Analysis of Deficiencies

After present conditions on each section have been determined, they are compared with minimum tolerable conditions to judge present and future adequacy of the section. Such minimum tolerable conditions for rural arterials and collectors are given in Table 4.1-2.

Initially each study section is compared to the minimum tolerable condition using present traffic volumes and conditions. Those sections not meeting these conditions are identified. Furthermore, deficient sections are also delineated on the basis of both structural adequacy and geometric or operational elements; or combinations of elements which do not meet these minimum tolerable conditions. Examples of conditions which place a highway in the critically deficient class are as follows:

1. Peak hour traffic volumes resulting in operating speeds lower or volume/capacity ratios higher than the minimum tolerable conditions.
2. Lane widths narrower than the minimum tolerable width specified.
3. Curves, grades, and sight distance restrictions not meeting the minimum tolerable conditions which result in unsafe conditions.
4. Pavement condition below the minimum tolerable specified.
5. Pavement type below the minimum tolerable specified.

TABLE 4.1-2

Minimum Tolerable Conditions for Rural Arterials and Collectors

Functional Systems	Rural Principal Arterials		Rural Minor Arterials						Rural Collectors							
Current Average Daily Traffic	-All-		Over 6,000		6,000-1,501		1,500 or less		6,000-1,501 1/		1,500-751		750-301		300 or less	
1. Terrain	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R
2. Operating Speed (Peak Hour)	55	50	50	45	50	45	40	40	-	-	-	-	-	-	-	-
3. Surface Type	High 9/		High 9/		Intermediate 8/						Low 7/		Low 7/		Gravel	
4. Lane Width	11		11		11		11		11		10		9		22' Rdway	
5. Shoulder Type 6/	Stab.		Stab.		Stab.		Earth		Earth		Earth		Earth		-	-
6. Graded Right Shoulder (ft.)	8	8	8	8	6	6	6	6	4	4	4	4	2	2	-	-
7. Safe Speed (Design Speed) 2/	65	55	60	50	60	50	60	50	50	45	50	40	50	40	40	35
8. Stopping Sight Distance	550	415	475	350	475	350	475	350	350	315	350	275	350	275	-	-
9. Maximum Curvature	5°	6°	5°	8°	5°30'	8°	5°30'	8°	8°	10°	8°	13°	8°	13°	-	-
10. Maximum Gradient 3/	4°	4°	4°	4°	5°	5°	5°	5°	5°	5.5°	5°	6°	6°	6°	-	-
11. Number of Lanes	4/		4/		2		2		2 1/		2		2		-	-
12. Pavt. Cond. (PSR or Equiv.) 10/	2.6		2.6		2.1		2.1		2.1		2.1		2.1		-	-
13. Railroad Crossing Protection	Refer to Table 5															
14. Structures:																
a. Width (ft.) 5/	Approach Pavement +6 ft.		+4 ft.		+4 ft.		+4 ft.		Approach Pavement +2 ft.		+2 ft.		20'	20'	18'	18'
b. Vertical Clearance (ft.)	14		14		14		14		14		14		14		14	
c. Loading	H-20		H-20		H-15		H-15		H-15		H-15		H-15		H-15	

1/Rural Collectors with present ADT above 6,000 should be multilane where necessary to maintain peak hour operating speeds of 40 and 35 in flat and rolling terrain respectively.

2/Approximate speed on which minimum tolerable stopping sight distance, curvature, and gradients are based.

3/Steeper grades may be considered tolerable if lengths are relatively short or climbing lanes are provided.

4/As necessary to maintain the operating speed specified.

5/For bridges over 250 ft. in length, widths 4 ft. less than shown, but in no case less than the width of the approach traveled way, will be considered tolerable.

6/Stabilized indicates Gravel or other granular material, with or without admixture.

7/Bituminous Surface Treatment.

8/Bituminous Concrete, with a combined - surface and base - thickness less than 7 inches.

9/Bituminous Concrete, Portland Cement Concrete, or brick, with a combined - surf. & Base - thickness over 7 inches.

10/Value of 2.6 or 2.1 indicates appropriate table (B-1 thru B-4) for EALA comparison.

The sections which presently are tolerable are further examined for their future adequacy by expanding traffic in five-year increments to the forecast year.

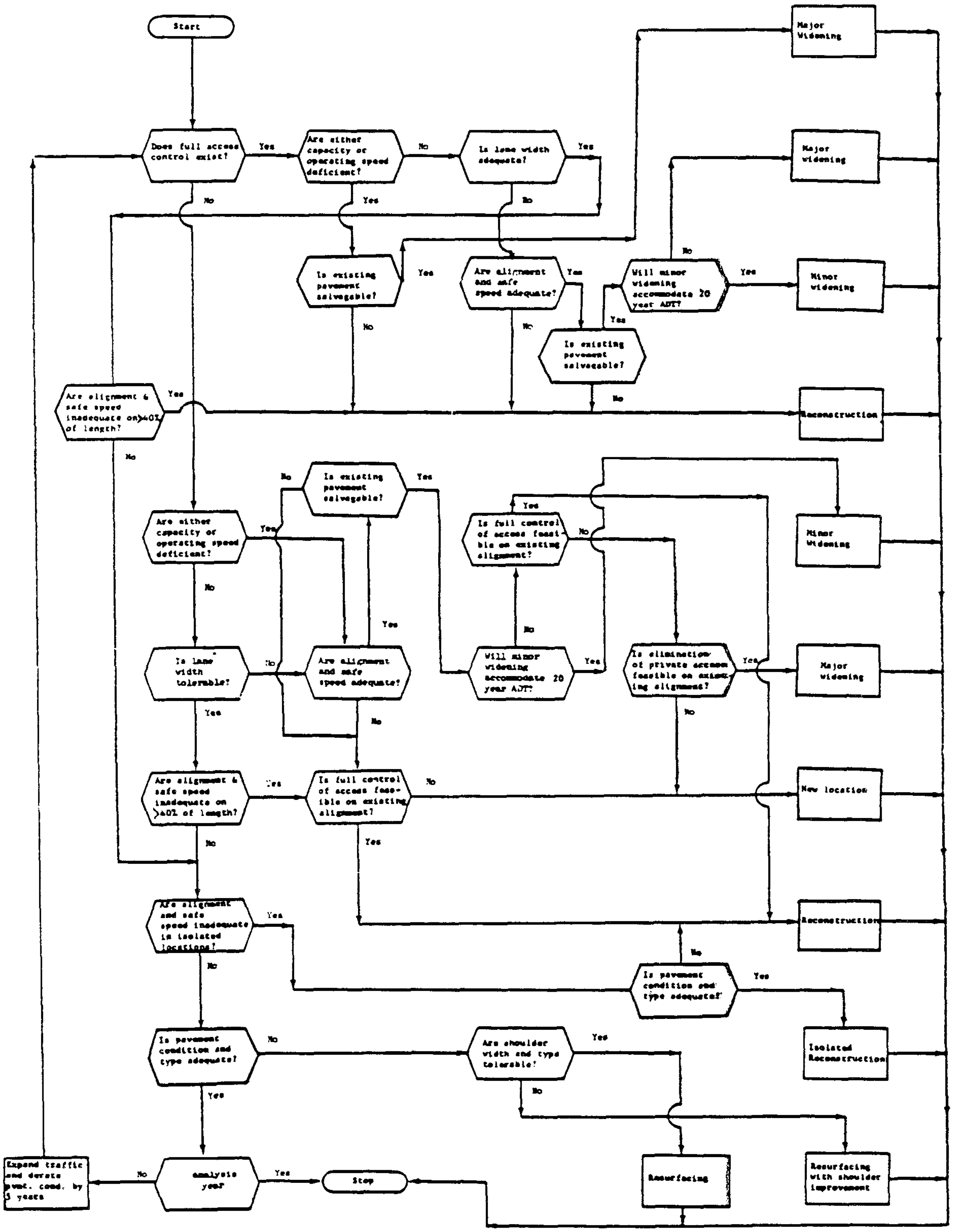
Description of Improvements

Information about the type of existing or future deficiencies provides the key to improvements necessary for the study sections. Flow charts such as Figure 4.1-4, for rural principal arterials, indicate the type of improvement appropriate to a certain set of deficiency conditions. While the chart appears complex, it merely portrays the analytical logic used to develop a consistent appraisal of needs.

Use of such flow charts depends on inventory and traffic information obtained from existing inventory data discussed in the preceding section.

As an example, if all items on a section are presently tolerable except pavement condition, the flow chart suggests resurfacing. Before resurfacing is established as the need to be reported, the analyst is required to assure that the section will not have a capacity deficiency, which would make widening or reconstruction more appropriate.

Two categories of improvements result from the needs analysis: (1) those necessary to overcome present deficiencies or "backlog needs," and (2) those necessary to correct "future deficiencies" between now and the forecast year. Previous statewide needs studies have shown that a substantial portion of total needs falls in the "backlog needs" category. Due to limited resources, it is practical to assume that corrective action on some "backlog needs" (also called "now needs") will be deferred.



Improvement Analysis Guide for Rural Principal Arterials

FIGURE 4.1-4

The above analysis, using the evaluation worksheets and flow charts, provides the basis for determining needs on existing facilities. However, most facilities on new location, identified during the functional classification process, are not susceptible to similar analysis. Needs for these new facilities are based on functional classification, future traffic volumes, and design standards.

Estimation of Costs of Needed Improvements

The total cost of each needed improvement is composed of the following costs:

1. Right-of-way and utility adjustments.
2. Grading and drainage.
3. Surface and base.
4. Other - traffic devices, roadside improvements, etc.
5. Structure cost.

Since construction costs vary by terrain, soil type, climate, density of development, etc., the above component costs have been categorized according to cost areas in the state. The three cost areas are shown in Figure 4.1-5. Thus for each major cost category mentioned above, an average cost per mile is determined as a combined function of:

1. Functional class of road to be improved.
2. Type of improvement.
3. Design standard.
4. Location of project by cost area.

4.1.b. Statewide Monitoring - Sufficiency Rating

In order to provide logical highway programming for improvement of existing roads, the Department annually assigns numerical sufficiency ratings to all state highways. The information is defined on the rating form shown as Figure 4.1-6. The rating form contains measurements relative to roughness and skid

Delineation of Cost Areas for Construction Cost Development
FIGURE 4.1-5

FORM NO. 108

LA DEPT OF TRANSPORTATION AND DEVELOPMENT

HIGHWAY NEEDS STUDY
SUFFICIENCY RATINGS
RURAL CODE SHEET

DATE 9-3-90
BY B. Moorehead D. Sullivan

1 PARISH 07 2. ROUTE 00091 3 CONTROL 089 4 SECTION 04 5. SUBSECTION 012

6. LENGTH 07.54 7. C.S. LOG MILE 0686 8. FUNCTIONAL CLASS 04

9. ROUGH-O-METER 231 10. SKID NUMBER 26

RATINGS - PAR 100
CONDITION - PAR 50

PRELIM SURFACE 05 BASE-SUBBASE 04 DRAINAGE 5 SUBGRADE 3

Surface		Base-Subbase		Drainage		Subgrade	
Very Good	20	Very Good	10	Very Good	8	Very Good	4
Good	15	Good	7	Good	5	Good	3
Fair	10	Fair	4	Fair	3	Fair	2
Poor	5	Poor	1	Poor	1	Poor	1

-4 -1 -2

FINAL 11. SURFACE 00 12. BASE-SUBBASE 02 13. DRAINAGE 5 14. SUBGRADE 3

15. ROUGH-O-METER (Apply to 11 and 12 above) 1
16. REMAINING YEARS SERVICE 1
17. TOTAL CONDITION (Sum 11—16) 12

SERVICE - PAR 30

18. VOLUME/CAPACITY (V/C) RATIO 30

SAFETY - PAR 20

19. SHOULDER WIDTH ~~3~~ 5
20. SURFACE WIDTH 5
21. ALIGNMENT 5
22. SKID NUMBER RATING (Apply to 11 above) 3
23. TOTAL SAFETY (Sum 19—22) ~~16~~ 18
24. TOTAL RATING (Sum 17 + 18 + 23) ~~058~~ 060

SIGHT DISTANCE > 1500 C.S. LOGGED MILES		
IN	OUT	TOTAL IN
.19	.44	.25
1.22	1.33	.11
2.72	2.80	.08
4.33	4.43	.10
4.72	4.95	.23
5.19	5.29	.10
5.61	5.73	.12
5.90	6.20	.30
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
TOTAL MILES IN =		1.29
% OF LENGTH IN =		17

CALCULATION OF AVERAGE HIGHWAY SPEED

DEGREE OF CURVATURE	DESIGN SPEED (MPH)	NUMBER OF CURVES	TRAVEL TIME (TABLE C-1)
28.0 – 43.0	25		
19.5 – 28.0	30		
14.0 – 19.5	35		
11.0 – 14.0	40		
8.5 – 11.0	45		
7.0 – 8.5	50	~~||||~~ ||	1.26
5.5 – 7.0	55	|	.16
4.75 – 5.5	60	~~||||~~	.75
4.0 – 4.75	65	|||	.42
	TOTALS	16	2.59
	Tangent Travel Time =		4.42
	TOTAL TRAVEL TIME =		7.01

Section Length 7.54 Mile

Total Curve Length 2.40 Mile (From Table C-2)

Tangent Length 5.14 Mile

x 0.86 Min./Mile

Tangent Travel Time 4.42 Min.

AHS = Section Length / Total Travel Time = 7.54 / 7.01 x 60 Minutes = 64.5 MPH 60

Remarks:

Sufficiency Rating Input Form for Rural System

FIGURE 4.1-6

resistance of pavement surfaces. The surface, base, drainage, and subgrade ratings are subjective, although for surface and base, PSI values are used as guidelines for rating assignment. Subgrade rating is assigned on the basis of knowledge of the subgrade material.

The final total rating, item 24 in Figure 4.1-6, determines the existing condition of the pavement section. The higher the number the better the condition. A surface condition rating of zero would categorize the pavement as "now need" or requiring improvement within one year.

4.1.c. Sampling Rate Frequency

The data discussed in Figures 4.1-3 and 4.1-6 are generated every year during the same period, August through October. The entire network (16,000 miles) is monitored during this period by the nine districts.

4.1.d. Data Storage

The data generated by the districts is stored on-line through the Department's terminal network. Once the construction program for the year is developed, the on-line files are purged for off-line storage on tapes. Figure 4.1-7 is a screen image of the forms discussed in Figures 4.1-3 and 4.1-6.

4.1.e. Output Reports

The input data of Figure 4.1-7 is used to generate the yearly construction program for the entire network by system classification. The projects listing within each classification is a prioritized list based on total sufficiency rating number. Specifically, the following outputs are generated for development of yearly highway construction program for use by the Department's top management and legislative bodies:

```
NSR1              ***RURAL NEEDS STUDY SCREEN 1 ***          ACTION CODE : I
                                                         DATE UPDATED: 03-30-79
PARISH: 40   ROUTE: 0071    CONTROL: 008   SECTION: 09    SUBSECTION : 01
 LENGTH              : 0207              ***EXISTING CONDITIONS CONTINUED***
 CON.SECT.LOG MILE : 0000                  K-FACTOR                 : 10
 FUNTIONAL CLASS   : 2                     DIRECTIONAL FACTOR       : 55
 FEDERAL AID SYSTEM: 1                     CAPACITY (HOURLY)        : 3560
***EXISTING CONDITIONS***                  OPERATING SPEED(MPH)     : 63
 YEAR                : 79                  SURFACE TYPE             : 8
 ACCESS CONTROL      : 3                   PAVEMENT KNOWN OR TYPE : 3
 SURFACE WIDTH(FT.) : 48                   PAVEMENT (SN) OR (D)     : 00
 NUMBER OF LANES     : 04                  PAVEMENT COND(PSR-0.0) : 48
 SHOULDER WIDTH   RT: 10  LT: 04           SHOULDER TYPE            : 1
  TERRAIN                      : 1         DRAINAGE ADEQUACY        : 1
  % LGTH W INTOL SAFE SPEED : 00        *****ANALYSIS OF DEFICIENCIES****
  % LGTH W SIGHT DIST.>1500 : 10           DESIGN YEAR                   : 99
  MEDIAN WIDTH                 : 44        DESIGN YEAR ADT              : 012289
  AVERAGE SPEED (MPH)          : 70        AVG. ANNUAL TRAFFIC GROWTH %: 20
  NUMBER OF SIGNALS            : 00        % LENG INTOL SAFE SP. DESIGN YR: 00
  TYPE OF DEVELOPMENT          : 1         TIME OF PAVEMENT COND.DEF.   : 6
  APPARENT RIGHT-OF-WAY        : 240       INITIAL DEFICIENCY CODE       : 6
  AVERAGE DAILY TRAFFIC        : 08270     SECONDARY DEFICIENCY CODE     : 6
  PERCENT TRUCKS               : 12        PERIOD SECTION BECOMES DEF. : 6

NSR2              ***RURAL NEEDS STUDY SCREEN 2 ***          ACTION CODE : I
                                                         DATE UPDATED: 03-30-79
PARISH: 40   ROUTE: 0071    CONTROL: 008   SECTION: 09    SUBSECTION : 01
**DESCRIPTION OF IMPROVEMENT ***                    ***COSTS,THOUSANDS***
YEAR OF IMPROVEMENT      : 99              RIGHT-OF-WAY         : 000000
ADT 1ST YR. AFTER IMPR : 012537            GRADING&DRAINAGE     : 000000
TYPE OF IMPROVEMENT      : 0               SURFACE&BASE         : 000000
DESIGN STANDARD NO.      : XX              PRELIMINARY ENGR. : 000000
ACCESS CONTROL           : 3               STRUCTURES           : 000000
NUMBER OF LANES          : 04              OTHER                : 000000
***RAILROAD CROSSINGS***                   TOTAL                : 000000
 NO PROTECTIVE DEV.: 0                     COST AREA            : 03
 CROSS BUCKS         : 0                   EXPANSION FACTOR     :
 FLASHING LIGHTS     : 1           ROUGH-O-METER : 043   SKID NUMBER : 36
 FLASHING LTS&GATES: 0              ****** SUFFICIENCY RATINGS *******
 GRADE SEPARATIONS : 0          ****CONDITION(50)*SERVICE(30)***SAFETY(20)****
****STRUCTURES****                SURFACE      : 20 V/C RATIO: 30 SHOULDER WIDTH: 5
 NO.OF STRS PRESENT: 00           BASE&SUBBASE: 10                SURFACE WIDTH : 5
 WIDTH    : 00                    DRAINAGE     : 6                ALIGNMENT      : 5
 VERTICAL CLEARANCE: 00           SUBGRADE     : 4                SKID NO.RATING: 5
 LOADING : 00                     ROUGH-O-METER: 5                TOTAL SAFETY : 20
 OTHER    : 00                    REMAIN YRS SR: 5                TOTAL RATING: 100
 NO. OF STRS NEEDED: 00           TOTAL COND. : 50
 TIME OF STR NEEDS : 0           REMARKS:
```

Terminal Screen Image of Input for Rural Inventory and Monitoring Data

FIGURE 4.1-7

+ Rural and urban construction program listing for:

    - Principal arterial (P.A.)
    - Minor arterial (M.A.)
    - Collectors

+ Rural and urban overlay program listing for:

    - P.A.
    - M.A.
    - Collector

Figures 4.1-8 and 4.1-9 are examples of prioritized construction and overlay project listing, respectively, for rural principal arterial.

The stored data from needs evaluation is also used to generate Highway Needs summary report for each of the nine districts. Figure 4.1-10 is an example of this summary for a control section in a district. The summary log reflects the highway section graphically and summarizes pertinent data relative to the specific section of the roadway and programmed improvement. This summary is available for use by the design, districts, legislative committee and needs study personnel. The extent of use varies depending on functional needs.

Based on information obtained in the public hearings, comments from the Legislative Committee on Transportation, Highways and Public Works and comments from the Department District Engineers, a proposed highway improvement program is prepared and submitted to the Legislature for approval and funding. The proposed improvement program is submitted to the Legislature 90 days prior to the date it convenes. Approval by the Legislature finalizes the highway improvement program for the next fiscal year. This approved program is then submitted to the Preconstruction Section for further handling as discussed in the next section.

DATE 04/28/81

LOUISIANA DEPARTMENT OF HIGHWAYS
RURAL CONSTRUCTION PRIORITY LISTING

TAN07014 PAGE 1

FUNCTIONAL CLASSIFICATION: PRINCIPAL ARTERIAL STATE TOTALS

PARISH	ROUTE NO.	CONTROL SECTION	SUB-SECT.	BEG. C-S LOG MILE	LENGTH	RECOMMENDED IMPROVEMENT	EST. COST	CUM. COST	FED. SYS.	TOTAL RATING	STATE RANK
VERNON	0008	29-02	1	0.00	9.27	RECONSTRUCTION	3800	3800	FAP	64	1
CALCASIEU	0171	24-02	0	0.00	7.24	MAJOR WIDENING	8172	11972	FAP	70	2
RAPIDES	0071	53-01	4	3.65	8.24	MAJOR WIDENING	9156	21128	FAP	71	3
GRANT	0165	15-03	1	0.00	5.93	MAJOR WIDENING	6880	28008	FAP	74	4
MOREHOUSE	0165	16-03	1	0.00	5.42	MAJOR WIDENING	6290	34298	FAP	74	5
VERNON	0171	25-01	3	2.01	5.04	MAJOR WIDENING	6090	40388	FAP	78	6
OUACHITA	0165	16-02	0	0.00	3.08	MAJOR WIDENING	3553	43941	FAP	78	7
NATCHITOCHES	0071	53-04	2	8.80	2.12	MAJOR WIDENING	2427	46368	FAP	82	8
RAPIDES	0165	14-06	1	0.00	11.49	MAJOR WIDENING	16456	62824	FAP	82	9
CALDWELL	0165	15-07	3	0.28	2.61	MAJOR WIDENING	2901	65725	FAP	83	10
CONCORDIA	0084	22-07	3	9.22	3.89	MAJOR WIDENING	5585	71310	FAP	84	11
EAST BATON ROUGE	0061	19-02	6	12.12	0.50	MAJOR WIDENING	432	71742	FAP	93	12
CATAHOULA	0084	22-06	3	10.97	2.17	MAJOR WIDENING	2482	74224	FAP	96	13

Prioritized Listing of Construction Projects for Rural Principal Arterials

FIGURE 4.1-8

LOUISIANA DEPARTMENT OF HIGHWAYS
RURAL OVERLAY PRIORITY LISTING

DATE 04/28/81 — TAND7924 — PAGE 1

FUNCTIONAL CLASSIFICATION: PRINCIPAL ARTERIAL — STATE TOTALS

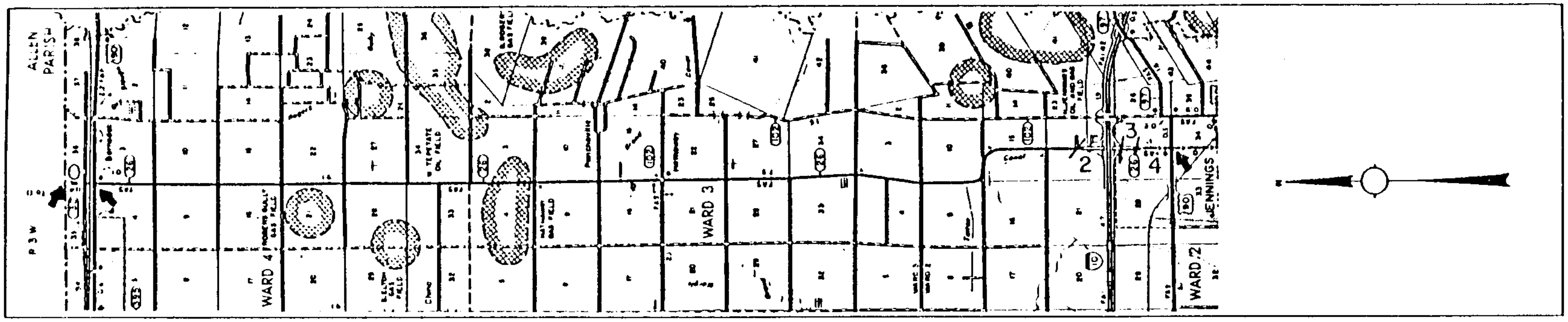
PARISH	ROUTE NO.	CONTROL SECTION	SUB-SECT.	REG. C-S LOG MILE	LENGTH	RECOMMENDED IMPROVEMENT	EST. COST	CUM. COST	FED. SYS.	S R	SURF. COND.	STATE RANK
CLAIBORNE	0079	27-06	7	13.57	0.24	RESURFACING ONLY	25	25	FAP	3	7	1
CADDO	0071	11-04	0	0.00	13.92	RESURFACING ONLY	1771	1796	FAP	3	7	2
CALCASIEU	1010	450-91	4	24.55	1.95	RESURFACING ONLY	647	2443	FAP	5	8	3
RAPIDES	0028	74-02	2	6.71	4.70	RESURFACING ONLY	857	3300	FAP	5	8	4
NATCHITOCHES	0001	53-03	1	0.00	3.63	RESURFACING ONLY	691	3991	FAP	5	8	5
ST. LANDRY	0071	8-06	0	0.00	10.91	RESURFACING ONLY	1505	5496	FAP	5	8	6
SABINE	0171	25-03	6	12.93	2.60	RESURFACING ONLY	319	5815	FAP	5	8	7
GRANT	0167	23-02	0	0.00	11.98	RESURFACING ONLY	1523	7338	FAP	5	8	8
CALCASIEU	1010	450-91	3	19.81	4.74	RESURFACING ONLY	2069	9407	FAP	5	9	9
POINTE COUPEE	0190	8-02	0	0.00	8.74	RESURFACING ONLY	2579	11986	FAP	5	9	10
RED RIVER	0084	53-07	1	0.00	8.05	RESURFACING ONLY	1334	13320	FAP	3	11	11
TERREBONNE	0090	5-03	1	0.00	3.33	RESURFACING ONLY	446	13766	FAP	3	12	12
CLAIBORNE	0079	27-05	3	10.87	0.38	RESURFACING ONLY	55	13821	FAP	3	12	13
LINCOLN	0167	23-10	6	2.63	3.37	RESURFACING ONLY	401	14222	FAP	3	12	14
VERNON	0008	373-01	4	3.38	3.94	RESURFACING ONLY	501	14723	FAP	3	12	15
CALCASIEU	0171	24-01	6	2.77	0.62	RESURFACING ONLY	184	14907	FAP	3	12	16
CLAIBORNE	0079	27-05	4	11.25	0.18	RESURFACING ONLY	54	14961	FAP	3	12	17
WEST FELICIANA	0061	19-04	2	6.09	0.34	RESURFACING ONLY	116	15077	FAP	3	12	19
RAPIDES	0071	9-01	18	7.46	0.16	RESURFACING ONLY	30	15107	FAP	5	13	19
ASSUMPTION	0090	5-02	2	0.69	2.90	RESURFACING ONLY	541	15648	FAP	5	13	20
CLAIBORNE	0079	27-05	2	6.44	4.43	RESURFACING ONLY	659	16307	FAP	5	13	21
WINN	0167	23-04	2	9.38	0.30	RESURFACING ONLY	36	16343	FAP	5	13	22

Prioritized Listing of Overlay Projects for Rural Principal Arterials
FIGURE 4.1-9

NEEDS EVALUATION SUMMARY LOG

Jefferson Davis
CONTROL-SECTION C.S. 54-03 ; 54-04

ROUTE NUMBER La 26



	C.S. 54-03		C.S. 54-04							
FUNCTIONAL CLASSIFICATION	COLL.	MA	MA	PA	PA					
STATE ROUTE NUMBER	26	26	26	26	26					
FEDERAL AID SYSTEM	FAS	FAP	FAP	FAP	FAP					
AREA TYPE	RURAL	RURAL	RURAL	URBAN	URBAN					
LENGTH (MILES)	0.47	16.20	0.42	0.43	0.58					
RIGHT-OF-WAY WIDTH	80	80	200	200	60					
ACCESS CONTROL	NONE	NONE	NONE	NONE	NONE					
LANES AND WIDTH	2-20	2-24	4-48	4-48	4-48					
SURFACE TYPE	BITCO.	BITCO.	CONC.	CONC.	BITCO.					
SHOULDER TYPE	STAB.	STAB.	SURF.	SURF.	CURB					
SHOULDER WIDTH	08	08	10	10	00					
A.A.D.T.	1060	1750	2950	10710	10710					
A.A.D.T. DESIGN YEAR	1428	3161	5328	19342	19342					
AVERAGE HIGHWAY SPEED (M.P.H.)	70	70	70	45(P)	45(P)					
K FACTOR	10	10	10	10	10					
OPERATING SPEED (PEAK HOUR)	67	64	67	45	45					
LEVEL OF SERVICE (PEAK HOUR)	A	A	A	A	A					
V/C RATIO (PEAK HOUR)	-	-	-	.30	.35					
TIME PERIOD DEFICIENCY OCCURS:										
OPERATING SPEED OR V/C RATIO	20+	20+	20+	20+	20+					
LANE OR ROADWAY WIDTH	20+	20+	20+	20+	20+					
SAFE SPEED	20+	20+	20+	20+	20+					
PAVEMENT TYPE AND/OR CONDITION	6-10	16-20	20+	16-20	1-5					
SHOULDERS	20+	20+	20+	-	-					
CROSS SECTION AND DRAINAGE	-	-	-	20+	20+					
TYPE OF IMPROVEMENT	RESURF.	RESURF.	NONE	NONE	RESURF.					
RECOMMENDED WIDTH	20	24	48	48	48					
TIME PERIOD	6-10	16-20	20+	20+	1-5					
TOTAL CONSTRUCTION COST	37.	1493.	00	00	122.					
SUB. SECTION NO.	00	01	02	03	04					

Highway Needs Summary Report

FIGURE 4.1-10

4.2 Road Design

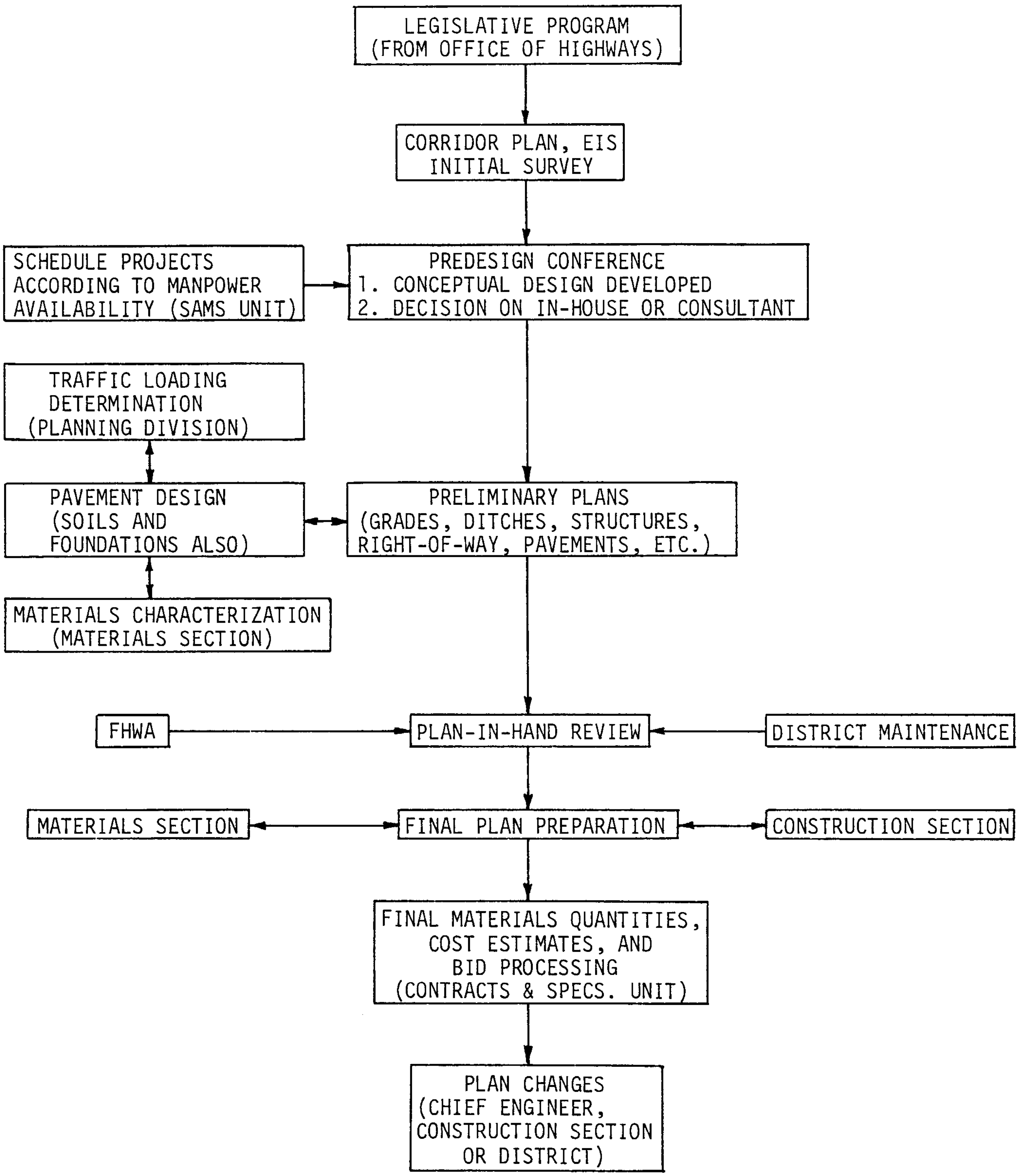
After receiving the approved construction program from the Legislature, the Road Design Section begins work on project construction plans. A chart of the Section's activities is presented in Figure 4.2-1.

The process begins with a preliminary site inspection if the project involves a new location. Currently, most projects involve improvements along existing roadways, and records, previous plans and prior knowledge are used by the Road Design Section in lieu of the formal preliminary site inspection.

A predesign conference is then initiated to develop a conceptual design. The Department's relatively new Scheduling and Manpower Section (SAMS) would coordinate with the Road Design Section to provide the latter with time schedules and staffing levels to complete the design task.

When the project design concept is approved, the Road Design Section prepares preliminary plans which include items such as grades, ditches, rights-of-way and pavements. The Traffic and Planning and the Materials and Research Divisions provide input for these plans. (In particular, the Materials Section's Soils Design Engineer directs the structural design of pavements using the Louisiana/AASHTO design procedure.)

Representatives of the Road Design Section, the District maintenance office and, on federal-aid projects, the FHWA compare preliminary plans with on-site conditions in a "plan-in-hand" review. This review provides further familiarity with the project and an opportunity to determine any need for design changes. For example, the District maintenance personnel can advise if geometrics might interfere with future maintenance functions.



Functional Steps for Design of Construction Projects

FIGURE 4.2-1

After the plan-in-hand review, the Road Design Section prepares final plans and sends them to the Contracts and Specifications Unit for finalizing quantities, preparing estimates and processing bid proposals for contract letting. Most plan changes made after the contract is awarded are made within the construction chain-of-command; however, some changes are forwarded back to the Road Design Section for handling.

There is considerable interaction between the Design Section and other sections of the Department before final plans are prepared for contract letting. However, the interaction is more due to necessity rather than for optimization of the design procedures and/or methods. To generate alternative pavement design strategies, a historical look at past performance of similar sections is a must. The objectives established for design should be primarily related to performance, safety and economy.

Costs are a vital part of information needed for design. The major cost categories, both present and future, are materials, construction, maintenance, and user costs.

Material characterization, either in terms of fundamental properties or as presently evaluated in terms of quality indicators, provides important input to design alternatives and analytical procedures. Perhaps the most direct interaction between design and construction is the materials specifications and standards which provide a direct design input into construction.

One of the major changes that will have to be incorporated (if pavement management were to be developed and implemented) into the present design plans is the identification of the boundaries of the proposed construction project. Currently this is identified in terms of station numbers which serve little purpose upon completion of the project. This identification, it is anticipated, will be in terms of control section log miles or highway route number log mile. Such key identifiers for all construction projects (in addition to station numbers) will facilitate cross-referencing of design standards with other phases of pavement management (highway needs, construction, maintenance, etc.).

Currently, the Department has automated its design activity in the determination of grades, earthwork and cross sections. It also applies the computer in the areas of geometrics, hydraulics and erosion control. In a related area, unit bid item costs are available in computer files for cost index determination (2). However, use of this file for estimation of total contract cost determination has not, as yet, reached its full potential.

Enhancement of the management process relative to this (design) activity can be accomplished through upgrading of data accessibility with respect to:

+ Maintenance cost
+ Pavement performance and service life
+ Distress measurements of roadway
+ Materials and construction quality levels achieved and attainable
+ Specification effectiveness
+ As-built data (cost, etc.)

4.3. Traffic

Presently, traffic data is gathered for geometric design, pavement structural design and environmental assessment of construction projects. The data requirements for the above three categories are satisfied by five basic programs of data collection. These are:

1. Permanent Station Counts

Prior to 1964 the Department maintained fifty-two permanent traffic recorder stations. As the interstate highway system was completed, stations were added on this system to parallel existing stations. The current number of stations is fifty-six. Of these stations, ten are in urban locations and forty-six are in rural locations. These stations are distributed between interstate, principal arterials, minor arterials, and major collectors.

The data from these stations are received in the central office weekly on paper tape and transferred on IBM cards for data processing. An edit is prepared showing possible data errors. These possible errors are investigated for validity, needed corrections made, and a weekly report prepared. At the end of each month, a monthly report is prepared. At the end of the year, an annual report is prepared and included in the Annual Traffic Report.

The above data is used in estimating statewide traffic trends and in obtaining seasonal variation factors for converting twenty-four-hour counts to estimates of the Annual Average Daily Traffic Volume.

2. Routine Station Counts

Prior to 1968, counts were made at 2,080 locations twice per year six months apart and averaged to obtain estimates of Annual Daily Traffic Volumes at these locations. In 1968 procedures provided by the Federal Highway Administration for obtaining statistical estimates of Annual Daily Traffic Volumes were adopted. An expansion of this counting program to approximately 5,000 annual locations was made at this time.

The data from this program is used for obtaining current traffic data for construction projects, for preparation of the Annual Traffic Map, for estimates of vehicular travel on Louisiana's highways, and for providing traffic information to interested individuals or organizations.

3. Blanket or Coverage Counts

This program obtains traffic counts at approximately 31,000 locations on local parish roads and at additional locations on state-maintained highways. Each parish is counted on a cycle of approximately seven years.

4. Vehicle Classification Counts

This program was instituted in late 1977 for the purpose of obtaining vehicle classification data on a continuing basis. Prior to this time classification counts were only obtained for special studies. Since the introduction of this program, counts have been obtained at approximately 400 locations. Counts are made for a 4-hour period during the hours of 7-11 a.m. or 1-5 p.m. This data is tabulated and the percentage of each vehicle type for the maximum hour and the total count period computed. This data is used to provide a vehicle type breakdown of design data for pavement design.

This area of data collection is one of particular concern, since the composition of vehicular traffic is more critical to pavement design volume. The question centers around the accuracy of data collected for only a 4-hour period, and also as to the most desirable hours of data collection. Another area of concern is related to the number and types of vehicle classification necessary for accurate traffic assignment. Ideally, the classification counts should be obtained on each highway project prior to preparation of traffic assignments. These counts could be scheduled using the Highway Construction Program sequencing of projects as developed by the Needs Study Program (Figure 4.1-8).

5. Truck Weight Studies

On a bi-annual basis, trucks are weighed at thirteen locations throughout the state, in compliance with Federal Highway Administration requirements. The data from this study is presently edited for coding errors and submitted to the FHWA for further processing and preparing reports (W4 Tables).

The data obtained in this program is questionable because of the infrequency of data collection, the small number of data collection stations, and data bias introduced because of data being collected once every two years at the same season each year.

All in all, there is much to be accomplished in this system of pavement management. Traffic loading variations comprise one of the most difficult and frustating classes of variables confronting the pavement design engineer. The actual values can vary markedly from questionable design projections resulting in observed performance significantly different from the original predictions.

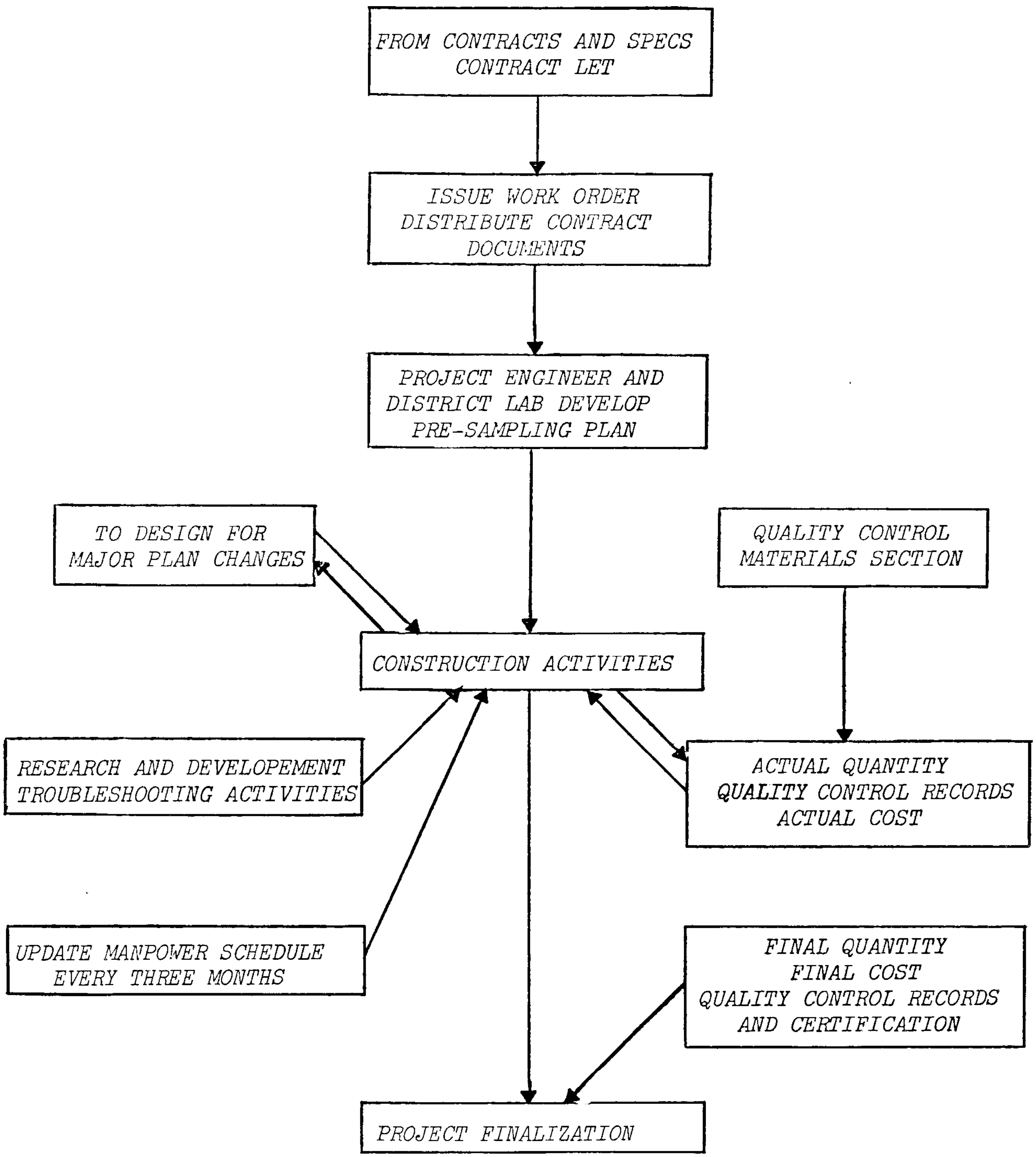
The 1980 report by the Department's Traffic Program Evaluation Committee (3) had concluded that while ADT volumes are important input to the geometric design of pavements, the more critical area of concern is in the projection of the number of heavy trucks, which directly affect roadway condition and rate of deterioration. It was further pointed out in this report that the truck weight data for determination of (truck-induced) damage to the pavements was minimal.

4.4. Construction

Figure 4.4-1 is a functional chart of the Construction Section. As in most highway-oriented agencies, there are two levels of management responsible for management of construction projects. These are districts and central. At the central or head office level, management of construction for the total network is involved. The primary concerns are progress, including completion, and expenditures for the total construction program. This level of management has direct concern with the integration of construction with overall pavement management needs (design objectives, standards and specifications, etc.).

The field or project engineer is in charge of the actual construction site. Upon receipt of the work order, he prepares a presampling plan according to the Department's Standard Sampling Manual. This is done in cooperation with the District Laboratory Engineer. From there on the basic mission of the project engineer is to monitor the construction schedule, to control quality and costs, and to document quality, quantity and costs of materials, construction and tests. The project engineer provides most of the basic construction information on the pavement network. In other words, they are the prime source of input of the "as-built" information. It is this initial or zero-age information of the pavement that forms the basis for subsequent evaluation of pavement performance. In addition, these records provide a useful assistance in selecting the initial location of pavement sections for periodic evaluations.

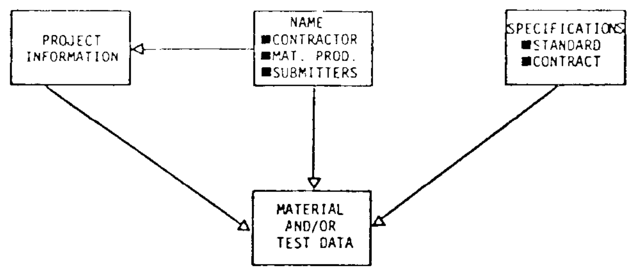
Louisiana has had an automated on-line system that is capable of providing such feedback information on as-built construction data. The system identified as the MATT System, an acronym for MATerial Test System, has been operational since



Functional Steps for Monitoring of Construction Projects

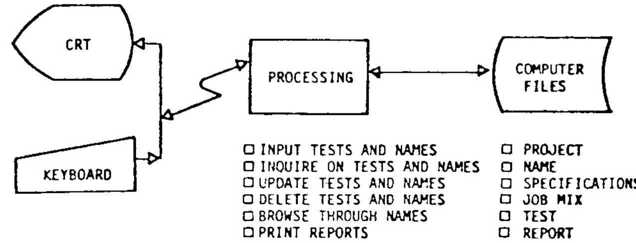
FIGURE 4.4-1

the middle of 1978 (4). The composition of the MATT System is shown in Figure 4.4-2. The three subsystems--project, specification, and name--provide support to the total system and are basic to the material subsystem. Figure 4.4-3 depicts the on-line capabilities of the system. The test files contain



Composition of the MATT System

FIGURE 4.4-2



On-line Capabilities of the MATT System

FIGURE 4.4-3

processed data, including pass-fail flags of all construction materials and tests. There are thirteen material subsystems in all. The project file contains data pertinent to the project and related cross sections of the roadway. It includes information such as project location, route number, length, cost, type of surface, base and shoulder, and related dimensions. This file is the nucleus of the as-built information file, mentioned in the previous paragraph, for identification of sections for future evaluation of performance. Figures 4.4-4 and 4.4-5 are examples of the forms used for input of the as-built information. The MATT System provides daily reports (through the terminals) for project monitoring and a project certification report, upon completion, for final project disposition. Additionally, special analysis and evaluation reports are provided upon user requests.

The MATT System was developed with a view towards easy integration into the pavement management system. However, indexing of construction projects is by project numbers, whereas the indexing used by other systems employs the control section number which is an integral part of the project number. (The first two blocks in the project number represent the control section number of the needs study and maintenance system.) Furthermore, the terminal points of the project are identified in terms of station numbers that have no relativity to other phases of pavement management system. This points to the need to identify the construction project in terms of a common index that could be cross referenced to other systems. This boundary identification will have to be provided on the plans by the Road Design Section in addition to the station numbers.

If the needed enhancements are accomplished, the system is anticipated to provide key input to planning, design and maintenance relative to the following:

MTPI/PROJ NO/ACTION CODE

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PROJECT INFORMATION

Project No.* ____

F. A. P. No.* ____

Associated Projects* 1. ____
2. ____

Route No.* ____

District ____ Parish ____

Project Engineer ____ Contractor ____

Project Engineer Code ____ Contractor Code ____

Name of Highway (From-To)* ____

Begin Control-Section Log Mile ____ End Control-Section Log Mile ____

Beginning Point* ____

Ending Point* ____

System Code ____ Location* ____ (U=Urban, R=Rural)

Work Order Date ____ Bid Cost ____

Acceptance Date ____ Final Cost ____

Contract Days Allocated ____ Contracted Days Used ____

Construction Type Code ____

Number of Lanes ____ One Lane Width, ft. ____

Total Project Length, mi. ____ Average Daily Traffic ____

Median Type* ____ (Barrier, Sod, Paved, Gravel)

Approved By: ____

As-built Project Information Input Form for MATT System

FIGURE 4.4-4

MTRC/PROJ NO/ACTION CODE

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

ROADWAY CROSS-SECTION

Project No.* |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Misc. Info.* |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Roadway Surface* |_|_|_|_|_|

(AST=Asphaltic Surface Treatment,
CRCP=Continuous Reinforced Concrete Pavement,
HMAC=Hot Mix Asphaltic Concrete,
ACWFC=Asphaltic Concrete with Friction Course
PCCP=Portland Cement Concrete Pavement,
ACFC=Asphaltic Concrete Friction Course
OTHER=Any Material Not Listed)

Thickness,in. |_|_|_|•|_|_|
(for ACWFC enter the Hot Mix Thickness only)

Joint Interval,ft. |_|_|_|•|_|_|

If PCCP* |_|
(R=Reinforced, U=Unreinforced)

Load Transfer Device* |_|_|
(DB=Dowel Bar, SL=Starlug)

Construction Type* |_|
(N=New, O=Overlay)

Existing Surface* |_|_|_|_|_|
(Same as Roadway Surface above)

Original Surface as Constructed* |_|_|_|_|_|
(Same as Roadway Surface above)

Base* |_|_|_|_|_|
(BLACK=Black Base,
GRAN=Granular,
SS= Sand Shell,
STSS=Stab. Sand Shell,
SCG= Sand Clay Gravel,
STSCG=Stab. Sand Clay Gravel,
SC= Soil Cement,
OTHER=Any Material Not Listed)

Thickness,in. |_|_|_|•|_|_|

Subbase* |_|_|_|_|_|
(Same as Base above plus LIME=Lime Treated)

Thickness,in. |_|_|_|•|_|_|

Subgrade Soil Classification* |_|_|_|_|_|

Shoulder: Surface* |_|_|_|_|_|
(Same as Surface above)

Width,ft. |_|_|_|•|_|
(Outside Shoulder)

Base* |_|_|_|_|_|
(Same as Base above)

Thickness,in. |_|_|_|•|_|_|
(Surface + Base)

Approved By: ______________________

As-built Roadway Cross-Section Input Form

FIGURE 4.4-5

+ Updating estimates and schedules.
+ Optimizing design models.
+ Quality assurance of sampling, testing, inspection, and specifications.

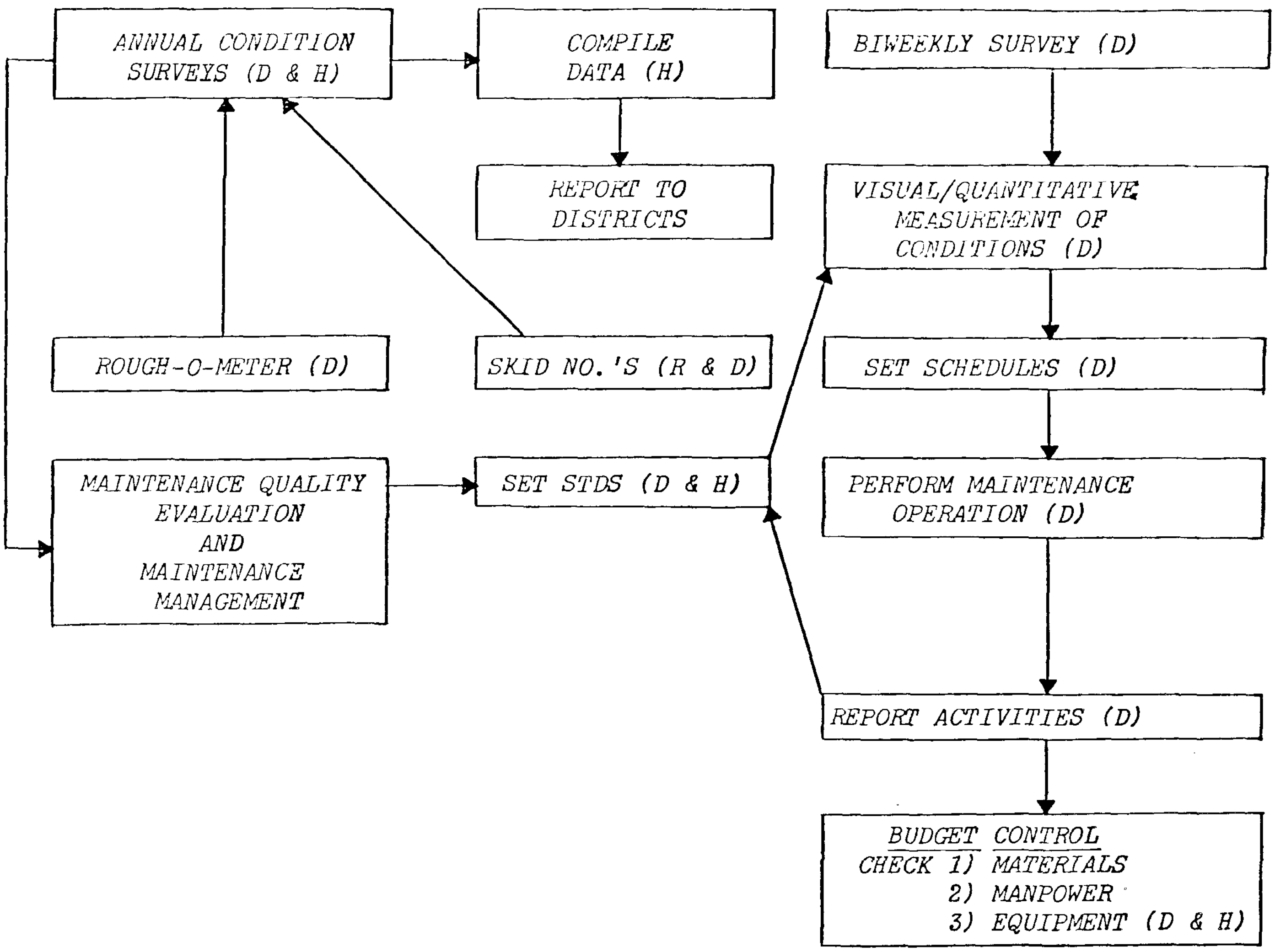
4.5. Maintenance

The flow diagram for the Maintenance Division is shown as Figure 4.5-1. The activities shown in the figure are a result of the implementation of the maintenance management system since 1968. The system is geared towards providing improved methods and procedures for manpower utilization through optimum staffing and equipment assignments. Accurate reporting procedures on a routine basis have provided data base relative to cost of accomplishing maintenance activities and developing performance standards.

As shown in Figure 4.5-1, the state system is surveyed on several separate occasions by the maintenance forces. One survey is the biweekly survey conducted by the parish maintenance superintendent for scheduling of routine maintenance activities. The superintendent makes a selection of projects and estimates quantities and manpower as well as project priority. As the maintenance is performed, a Daily Work Report is completed. The report includes manpower, equipment, and materials used for that day. These reports are compiled and reported as a Biweekly Activity Report (BAR). The BAR contains information on a control section basis.

The data from the Daily Work Report is used to compile the MaiNtenance Reporting System or MNRS file. This file contains accomplishments by functions and authorization. This file is currently used to prepare a performance report for the districts.

MAINTENACE DIVISION



Functional Steps to Accomplish Maintenance Activities

FIGURE 4.5-1

Two other surveys are conducted annually by headquarters and/or district personnel. One of the surveys provides information to determine road quality index values, while the other provides data to develop the hot mix maintenance overlay program.

Figure 4.5-2 is the Road Inspection and Maintenance Inventory form used annually by Department headquarters personnel to gather data on maintenance needs. The information so gathered is translated into maintenance man-hours needed. A comparison of man-hours so needed to man-hours planned for a segment of road is calculated and termed the road quality index. The index values are reported in tabular form by control section, function, activity, class, district and state network. Management can use the road quality index to review maintenance strengths and weaknesses and thus to properly utilize its resources.

The third survey, which is subjective, generates a priority ranking for the maintenance overlay program within the district. However, the final distribution of overlay funds is made on the basis of a statewide relative priority ranking of all projects submitted by the various districts. This statewide ranking is determined by the formula shown in Figure 4.5-3. The input variables for determination of this relative priority are provided by the districts as shown in Figure 4.5-4. The computed numerical value of the relative priority determines the statewide ranking of the project for the maintenance overlay program. The higher this numerical value, the higher will be the project on the ranking scale. Note that in Figure 4.5-4 the district priority of 1 was offset by the statewide ranking of 35 because of the lower numerical value of 28.5 for relative priority. This survey is reinforced by photographs of the surveyed segments.

Rev. 10/81

ROAD INSPECTION AND MAINTENANCE INVENTORY

Date________________

Dist.	Gang	Parish	Route No.	Cont. Sect.	Beginning Mile	MRM (PSI)	C.S. Length	Direction
- -	- - -	- -	- - - -	- - - - -	- -	- . - -	- - . - -	-

INSPECTORS: ____________________ ____________________ *RECORD NOTES ON BACK OF FORM

(FOR 1 UNIT WRITE "001" IN BLANK)

Function	MILES: 001 Unit =	1	2	3	4	5	6	7	8	9	10	11	12	13	14	*NOTE #
		X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	
412 Pothole Patching	1 Ton															
414 Hand Leveling	1 Ton															
415 Seal Coat	1 Mile															
416 Machine Leveling	10 Tons															
417 Surface Replacement	1 Ton															
418 Cutting/ Burning Bumps	1 Location															
421 Patching Surface	1 Cubic Yard															
422 Premix Patching	1 Ton															
424 Roadway Jt. Repair	100 Linear Feet															
425 Expansion Jt. Repair	1 Linear Foot															
432 Reshaping Surface	1 Mile															
433 Restoring Surface	10 Cubic Yards															
441 Patching Nonpaved	1 Cubic Yard															
442 Reshaping Nonpaved	1/10 Mile															
443 Restoring Nonpaved	10 Cubic Yards															
444 Cutting/ Hauling	1/10 Mile															
452 Premix Patching	1 Ton															
455 Sealing	1 Mile															
463 Clean Ditches	1/10 Mile															
464 Machining Ditches	1/10 Mile															
471 Brush Cutting	1/10 Mile															
473 Litter Cleaning	1 Cubic Yard															
531 Pavement Striping	1 Mile															
533 Signs, Guide Posts, Delineators	1 Location															
534 Servicing Guardrails	1 Location															
542 Service Crash Protection	1 Location															
632 Overlay	100 Linear Feet															

FIGURE 4.5-2

Road Inspection and Maintenance Inventory Form

$$\text{RELATIVE PRIORITY} = 25\left[\frac{\Sigma(S^2 \text{ X } D)}{875}\right] + 15\left[\frac{\Sigma(S^2 \text{ X } D)}{250}\right] + 20\,[(1 - 0.476\,(PSI))]$$

CRACK/RAVEL/PATCH FACTOR — RUT/DISTORTION FACTOR — MEASURED DISTORTION FACTOR

$$+\ 20\,[0.0008\,(ADT)] + 5\,[(1 - 0.02857\,(SN))]$$

AVERAGE DAILY TRAFFIC FACTOR — SKID FACTOR

WHERE: S = Severity of condition
D = Density or extent of condition within project area
PSI = 0 - 2.1 (Maximum)
ADT = 0 - 1250 (Maximum)
SN = 0 - 35 (Maximum)

Formula for Statewide Ranking of Projects for Hot Mix Rehabilitation

FIGURE 4.5-3

District		02
District Priority		1
Computed Priority		28.5
Statewide Rank		35
Control Section		450-43-55
Beginning Mile		3.35
Ending Mile		4.70
Length		1.35
Visible Defects		
Rutting	Severity	2
	Density	2
Distortion	Severity	4
	Density	3
Longitudinal	Severity	2
	Density	3
Transverse	Severity	1
	Density	2
Random	Severity	2
	Density	2
Alligator	Severity	2
	Density	2
Patching	Density	2
Present Serviceability Index		1.8
Skid No.		--
Maintenance Cost Trend		--
Traffic A.D.T.		11,406
Thickness		2 in.
Quantity		2265 Ton
Cost Estimate		$67,950
Date Inspected		3/26/79

Input Variables for Determination of Ranking of Projects for Hot Mix Rehabilitation

FIGURE 4.5-4

Generally, the maintenance overlay program is confined to segments less than three miles in length. In a sense, the whole program is geared towards providing a stopgap and cosmetic measure of rehabilitation. The terminal points of the segments are determined by the district as well as the thickness of the overlay segment, which is arbitrarily set at 1.5 to 2 inches.

The maintenance management system is a stand-alone system, and communication with other sections/divisions is minimal although some information is drawn from other systems (psi and skid numbers, for example). The biweekly reporting system is a computerized on-line system. Various reports are generated for use by the maintenance planning unit for policy decisions. An example of a special report is shown in Figure 4.5-5. A routine report is also distributed to the various districts on a monthly basis. The report provides performance information according to various maintenance functions. An example of this report is shown as Figure 4.5-6.

One of the primary drawbacks of the present system of maintenance reporting is its inability to relate maintenance cost to individual segments of the functional system. This lack of information is reflected in Figure 4.5-4 wherein the maintenance cost trend for prioritization of overlay programs is missing. Cost of major activities relative to leveling, resealing spot surface and slab replacement, etc., are reported on the total control section rather than the terminal points of the segment receiving the maintenance. Furthermore, no attempt is made to identify the roadway lane receiving the maintenance.

The impact of the development of PAMS will be a major one on this division because of the change in the reporting system that will have to be effected if realistic costs are to be made available on a segmental basis. The current reporting procedure, in terms of control section only, will have to be reinforced

MNRS2602 D I S T R I C T P E R F O R M A N C E R E P O R T RUN DATE 06/18/80
STATE MAINTENANCE RECAP FISCAL YEAR 1979-80 MAINT TOTALS ST-SMR
ABBRVTN KEY-- PL = PLANNED DATA FOR YEAR; TD = TO DATE FOR YEAR TD PERIOD AS OF 05-25-80 ELAPSED TIME: 90%

FUNC	QUAN-TITY	PCT %%%	UNIT MEAS	MAN HOURS	PCT %%%	MH/Q %%%	SALARIES	OVER TIMES	TRAVEL$	SUPPLIES$ (CAPITL OUTLYS$)	OPTG SERV$	FRNG BENS & OTHERS$	EQUIP$	TOTAL$ (INX = INDEX)	PCT
PL 429	40,153		M-H	40,153			210,010	0	0	32,080	8,410	0	147.031	397,531	
TD 429	21,420	53%	M-H	21,420	53%	100%	111,212	1,787	5,657	28,333	0	44,181	54.586	245,756	62%
CONCRETE SURFACE SUB TOTAL															
PL	54,915			97,664			459,883	0	0	229,463	8,410	0	241.028	938,785	
TD	41,085	75%		93,151	95%	127%	529,828	13,871	39,613	262,514	0	209.442	284.589	1.339.857	143%
PL 431	4,655		CY-A	5,582			15,883	0	0	29,203	0	0	14.358	59,444	
TD 431	2,687	58%	CY-A	2,347	42%	73%	13,217	157	214	26,477	0	5.162	7.652	52,879	89%
PL 432	7,584		MI	12,133			65,018	0	0	0	0	0	77.485	142,498	
TD 432	4,907	65%	MI	7,510	62%	96%	48,477	44	28	9,743	0	19.123	54.496	131,911	93%
PL 433	9,893		CY	5,934			37,958	0	0	109,247	0	0	25.416	172,627	
TD 433	8,253	83%	CY	5,250	88%	106%	28,785	147	598	83,682	0	11,239	18.372	142,823	83%
PL 439	6,284		M-H	6,284			34,730	0	0	30,520	485	0	21.314	87,045	
TD 439	12,594	200%	M-H	12,594	200%	100%	68,000	8,390	354	82,209	0	26,834	57.206	242,993	279%
GRAVEL OR SHELL SURFACE SUB TOTAL															
PL	28,416			29,933			153,589	0	0	168,970	485	0	138,573	461,614	
TD	28,441	100%		27,701	93%	92%	158,479	8,738	1,194	202,111	0	62,358	137.726	570,606	124%
PL 441	51,207		CY	61,448			240,950	0	0	239,478	0	0	200.577	681,004	
TD 441	57,073	111%	CY	80,683	131%	118%	415,885	71	3,115	489,829	0	164,808	182.932	1.256.640	185%
PL 442	26,424		MI	47,563			217,148	0	0	0	0	0	258.774	475,926	
TD 442	21,442	81%	MI	39,463	83%	102%	246,452	87	1,490	485	0	97,677	261.616	607,807	128%
PL 443	97,452		CY	68,227			736,642	0	0	1,274,430	0	0	379.836	2.390,905	
TD 443	133,791	137%	CY	106,504	156%	114%	599,208	1,261	17,119	884,516	0	236,595	368.812	2.107,511	88%
PL 444	831		MI	8,971			15,440	0	0	0	0	0	15.034	30,474	
TD 444	411	49%	MI	10,409	116%	235%	56,142	0	699	0	0	21,772	41.139	119,752	393%
PL 452	3,135		TONS	9,404			39,063	0	0	47,197	0	0	15.038	101,289	
TD 452	5,364	171%	TONS	16,090	171%	100%	84,824	12	140	104,811	0	34,143	36.620	260,550	257%
PL 455	634		MI	27,830			95,577	0	0	792,209	35,045	0	198.594	1.121,423	
TD 455	0	%	MI	160	1%	%	984	0	140	1,514	0	419	707	3,764	0%
PL 459	74,917		M-H	74,917			300,186	0	0	35,029	9,178	0	82.550	426,937	
TD 459	73,431	98%	M-H	73,431	98%	100%	382,732	516	6,584	168,024	2	151,921	154.509	864,288	202%

Maintenance Cost Report for Functions by Districts (Special Report)
FIGURE 4.5-5

9/13/79 MAINTENANCE COST REPORT PAGE

FISCAL YEAR 1978-79

SORT ; DIST GANG AUTH FUNCTION

DISTRICT	GANG	FUNCTION	AUTH	LABHRS	QUANT	LAB$	C/S$	EQ$	MATL$
02	550	495	009	.0	1.0	.00	.00	.00	.00
02	550	496	009	.0	5.0	.00	.00	.00	.00
02	550	566	009	128.0	.0	729.00	.00	137.00	208.00
AUTH TOTAL				128.0	6.0	729.00	.00	137.00	208.00
02	550	463	452	176.0	.0	975.00	.00	244.00	.00
AUTH TOTAL				176.0	.0	975.00	.00	244.00	.00
02	550	412	454	20.0	29.0	96.00	.00	.00	.00
02	550	443	454	42.0	375.0	298.00	.00	.00	.00
02	550	462	454	99.0	.0	495.00	.00	134.00	.00
02	550	463	454	126.0	.0	880.00	.00	1,087.00	.00
02	550	470	454	120.0	501.0	494.00	.00	.00	.00
02	550	471	454	84.0	4.0	347.00	.00	.00	.00
02	550	492	454	16.0	.0	92.00	.00	79.00	.00
02	550	653	454	8.0	.0	59.00	.00	.00	.00
02	550	656	454	24.0	.0	99.00	.00	.00	.00
AUTH TOTAL				539.0	909.0	2,860.00	.00	1,300.00	.00
02	550	412	455	12.0	39.0	80.00	.00	12.00	.00
02	550	419	455	100.0	.0	546.00	.00	209.00	75.00
02	550	421	455	125.0	17.0	688.00	.00	241.00	688.00
02	550	422	455	28.0	9.0	131.00	.00	31.00	113.00
02	550	423	455	78.0	10.0	474.00	.00	193.00	114.00
02	550	429	455	170.0	.0	878.00	.00	394.00	38.00
02	550	431	455	38.0	25.0	172.00	.00	50.00	198.00
02	550	432	455	.0	20.0	.00	.00	.00	.00
02	550	433	455	60.0	90.0	280.00	.00	143.00	707.00
02	550	441	455	326.0	95.0	1,662.00	.00	495.00	2,744.00
02	550	442	455	247.0	162.0	1,580.00	.00	1,594.00	.00
02	550	443	455	232.0	5,946.0	1,458.00	.00	620.00	2,602.00
02	550	452	455	60.0	12.0	298.00	.00	93.00	426.00
02	550	461	455	.0	2.0	.00	.00	.00	.00
02	550	462	455	8.0	21.0	54.00	.00	15.00	.00
02	550	463	455	.0	3.0	.00	.00	.00	.00
02	550	470	455	1,087.0	724.0	6,158.00	.00	6,799.00	.00
02	550	471	455	148.0	10.0	807.00	.00	250.00	.00
02	550	472	455	72.0	25.0	362.00	.00	91.00	.00
02	550	479	455	16.0	.0	78.00	.00	25.00	25.00
02	550	559	455	274.0	.0	1,555.00	.00	326.00	79.00
02	550	564	455	.0	.0	.00	.00	.00	12.00
02	550	651	455	1,425.0	.0	9,628.00	.00	1,348.00	202.00
02	550	653	455	46.0	.0	278.00	.00	52.00	.00

Statewide Maintenance Performance Recapitulation

FIGURE 4.5-6

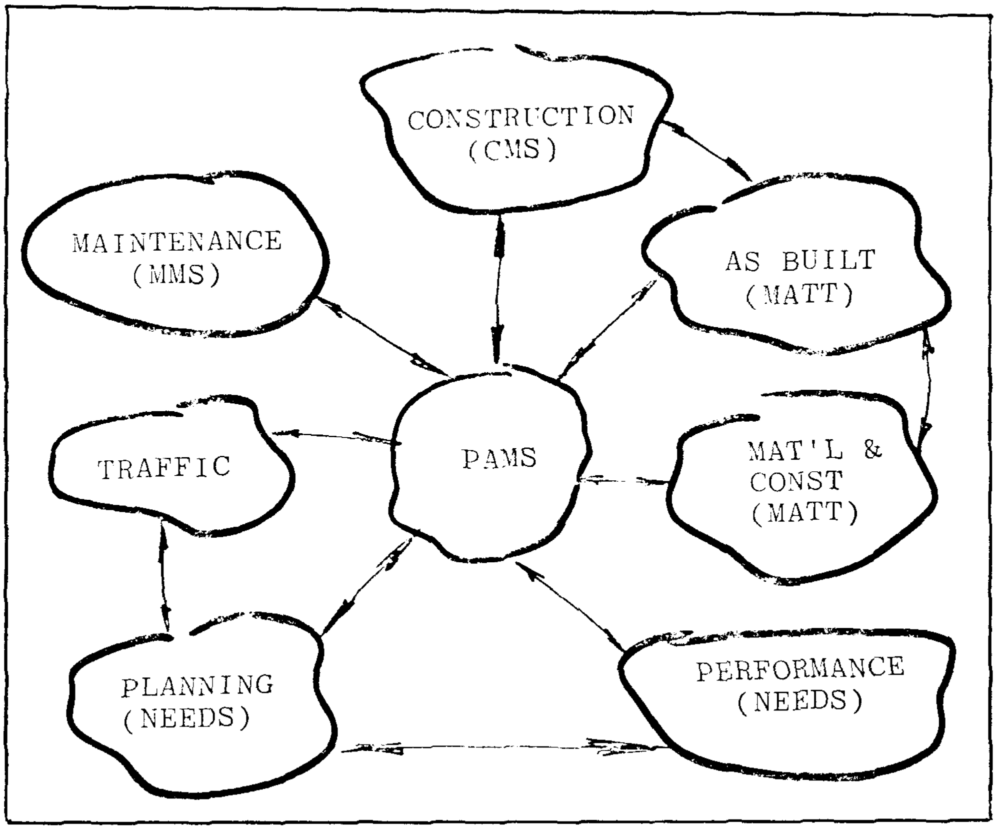
with the log mile identifier(s) for the maintenance location. Such enhancement of the reporting procedure will provide cross referencing to other data systems for analysis and evaluation of:

+ Quality of specifications, construction methods and materials and inspection procedures.
+ Effectiveness of design strategy used: pavement thickness, materials, etc.
+ Inaccurate traffic projections.
+ Rehabilitation models for prioritization and optimization.

5. THE NEW SYSTEM

The previous chapter attempted to discuss the various disciplines generally concerned with generating data that would satisfy their basic requirements (for operation) of "managing" their portion of the pavement system. To that end, the various individual systems have served well. However, the basic and fundamental purpose, that of providing integrated feedback information to the various disciplines, is lacking. It is not the purpose of this study to scratch the existing systems and start afresh. The purpose is rather to enhance the system through additional data input that would serve as a more equitable foundation to decision making by the user/managers of the system. The basic philosophy governing the enhancement of the existing system is that a working system can be developed and instituted in the near future rather than a grandiose one which may be too far out in the future or even nonexistent. As knowledge is gained, the system can be updated to reflect changes.

As envisioned from the existing system, Louisiana's PAMS should take the format shown in Figure 5-1. The central idea depicted in the figure is the ability to get into various files and link (merge) them for desired information retrieval. The arrows between individual systems signify the present capability of linking the files. The traffic, planning and performance files are truly contained in one single file and, therefore, linking is redundant. (Figure 4.1-7 shows the information relative to traffic and performance.) Linking or merging is only possible through a record key that would be common to all files. For example, to link and merge construction management system files to as-built and material and construction system files, the common key would be the project number. However, linking between planning or maintenance files and as-built or material and construction files is not possible because of the absence of a common control key in these files. This absence is one of the key deficiencies in the present system. Therefore, the primary enhancement requirement would be to identify the existing files by means of a common location indexing system that would enable the user to properly link the various files.



Projected Data Base for Louisiana's PAMS

FIGURE 5-1

Although several methods are available to accomplish this change, the method that is foremost on this list (geographical coordinates, control section log mile, route number mile post) is the control section log mile. The primary thrust towards selection of this parameter as the common index is its present usage in the needs file (item 7 in Figure 4.1-3) and its familiarity by users of other files (MATT file). The as-built file in the MATT System has provision for entry of this field for defining boundaries of construction projects (Figure 4.4-4).

With this basic thrust in mind, it is now necessary to define that portion of the existing system needing upgrading to satisfy the pavement management needs of the Department. The enhancements are discussed in the next two chapters. Chapter 6 discusses the identification of needed data elements to upgrade existing files, and Chapter 7 discusses data files, management, retrieval and uses.

6. IDENTIFICATION OF NEEDED DATA ELEMENTS

6.1. Needs Study

Figure 1-1 presented Louisiana's projected pavement management and feedback system. The DOTD's annual Highway Needs and Priorities Study would fall in the upper right-hand portion of the closed loop as the review for the legislative, administrative and engineering levels. That position in the loop sets Highway Needs apart from Maintenance, which addresses stopgap and cosmetic needs. Similarly, Highway Needs and Design occupy separate positions on the loop. Although the Needs Study provides conceptual guidance to Design through decision trees such as the one shown in Figure 4.1-4, specific design work is left to a separate engineering staff. Hence, the Highway Needs function is a unique one. It identifies non-routine maintenance (i.e., rehabilitation) needs relative to minimum tolerable design standards and establishes priorities within highway functional classes.

The field evaluation phase of the Needs Study is intense at the network level and cursory at the project level. In general, nine teams inspect 16,000 centerline miles in three months. This evaluation yields a "first cut" of projects which deserve attention the most.

One immediate goal of the proposed pavement management system will be to enhance the Department's current system of determining highway needs and priorities. Since the current system of first cuts represents in essence the only cuts based on engineering criteria, the goal of enhancement becomes a serious and challenging one.

A review of Figure 4.1-6, the Highway Needs Study Sufficiency Ratings Rural Code Sheet, reveals that the total sufficiency rating is comprised of three general elements. Roadway Condition can earn up to 50 points, traffic capacity-related Service can earn up to 30 points, and roadway Safety can earn up to 20 points for a maximum score of 100.

Roadway Condition score is a summary of subjective ratings of surface (20 points), base-subbase (10 points), subgrade (4 points), and drainage (6 points); mechanistic rating of road roughness (5 points); and analytical rating of remaining years of service life using AASHTO pavement design-analysis methods (5 points). All six of these roadway condition sub-elements are based upon or at least related to pavement distress and ride.

A direct and disciplined (although cursory) measurement of pavement distress and ride would make the Condition rating more relevant than it currently is. These direct measurements would also lend themselves better to analyses of pavement performance, where such performance is defined as a change in pavement condition with time. Ideally, a data bank so established would provide performance-type feedback relative to specifications and translate the Department's materials-oriented quality assurance system into a more desirable performance assurance system. The latter accomplishment would fulfill a long-term goal of the research study.

6.1.a. Literature Review

A literature review has been made of pavement distress types identified by various other agencies. Figures 6.1-1 through 6.1-3 are lists of distress types for asphalt concrete pavements, jointed portland cement concrete pavements, and continuously reinforced portland cement concrete pavements.

TYPE	AGENCY								
	U OF IL	US ARMY	ONT	WA	FL	CA	TX	OH	AR
ALLIGATOR/FATIGUE WHEEL PATH CRACKS	X	X	X	X		X	X	X	X
BLEEDING	X	X	X	X			X	X	
BLOCK CRACKING	X	X	X			X		X	
BUMPS AND SAGS		X	X	X				X	
CORRUGATION	X	X	X	X				X	
DEPRESSION	X	X							X
EDGE CRACKING		X	X					X	
JOINT REFLECTION CRACKING	X	X							
LANE/SHOULDER DROP/HEAVE	X	X							
LANE/SHOULDER SEPARATION	X								
LONG AND TRANSV CRACKING	X	X	X	X	X	X	X	X	X
PATCHING	X	X	X	X	X	X		X	X
POLISHED AGGREGATE	X	X							
POTHOLES	X	X					X	X	
PUMPING/WATER BLEEDING	X								X
RAILROAD CROSSING		X							
RAVELING/WEATHERING	X	X	X	X		X	X	X	
RUTTING	X	X	X	X	X	X	X	X	X
SHOVING		X	X						
SLIPPAGE CRACKING	X	X	X						
SWELL	X	X							X

Asphalt Concrete Pavement Distress Types
As Identified by Various Agencies

FIGURE 6.1-1

TYPE	AGENCY					
	U OF IL	US ARMY	CA	WA	OH	AR
BLOW-UP	X	X		X	X	
CORNER BREAK	X	X			X	X
DEPRESSION	X				X	X
DIVIDED SLAB		X	X	X		
DURABILITY "D" CRACKING	X	X				
FAULTING(TRANSV JOINTS,CRACKS)	X	X	X	X	X	X
JOINT LOAD TRANSFER DISTRESS	X					
JOINT SEAL DAMAGE	X	X			X	
LANE/SHOULDER DROP OFF/HEAVE	X	X	X			
LANE/SHOULDER JOINT SEPARATION	X		X			
LONGITUDINAL CRACKS	X	X	X	X	X	X
LONGITUDINAL JOINT FAULTING	X	X				
PATCHING	X	X	X	X	X	X
PATCH-ADJACENT DISTRESS	X					
POLISHED AGGREGATE		X				
POPOUTS	X	X		X	X	
PUMPING/WATER BLEEDING	X	X		X	X	X
PUNCHOUTS		X				
REACTIVE AGGREGATE DISTRESS	X					
RAILROAD CROSSING		X				
SCALING/MAP CRACKING/CRAZING	X	X				
SHRINKAGE CRACKS		X				
SPALLING AT JOINTS	X	X		X	X	X
SPALLING AT CORNERS	X	X				
SWELL	X					X
TRANSVERSE/DIAGONAL CRACKS	X		X	X	X	X

Jointed Portland Cement Concrete Pavement Distress Types
As Identified by Various Agencies

FIGURE 6.1-2

TYPE	AGENCY		
	U OF IL	OH	AR
ASPHALT PATCH DETERIORATION	X	X	X
BLOW-UP	X	X	
CONCRETE PATCH DETERIORATION	X	X	X
CONSTRUCTION JOINT DISTRESS	X		
DEPRESSION	X	X	X
DURIBILITY "D" CRACKING	X		
EDGE PUNCHOUT	X	X	X
LANE/SHOULDER DROP OFF/HEAVE	X		
LANE/SHOULDER JOINT SEPARATION	X		
LOCALIZED DISTRESS	X		X
LONGITUDINAL CRACKING	X	X	X
LONGITUDINAL JOINT FAULTING	X		X
PATCH-ADJACENT DISTRESS	X		
POPOUTS	X	X	
PUMPING/WATER BLEEDING	X	X	X
REACTIVE AGGREGATE DISTRESS	X		
SCALING/MAP CRACKING/CRAZING	X	X	
SPALLING	X	X	X
SWELL	X		X
TRANSVERSE CRACKING	X	X	X
SETTLEMENT/WAVES		X	

Continuously Reinforced Portland Cement Concrete Pavement
Distress Types as Identified by Various Agencies

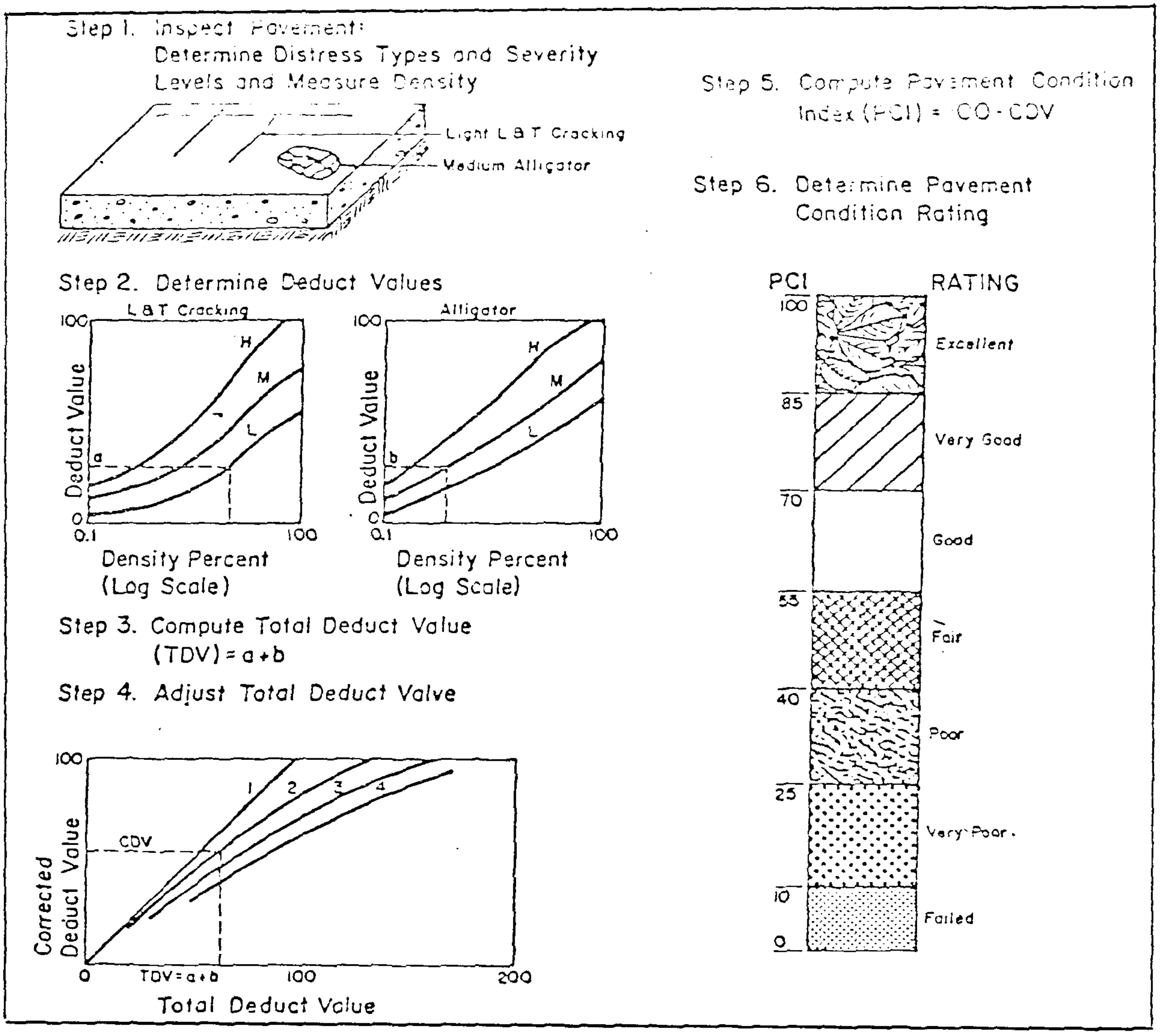
FIGURE 6.1-3

The lists vary in length according to agency and pavement type. For example, in Figure 6.1-1 the U.S. Army Corps of Engineers' Construction Engineering Research Laboratory (CERL) recognizes 19 distress types for flexible pavement. Conversely, in its flexible pavement distress surveys the State of Florida concentrates on the three distress types of cracking, patching and rutting utilized at the AASHO Road Test.

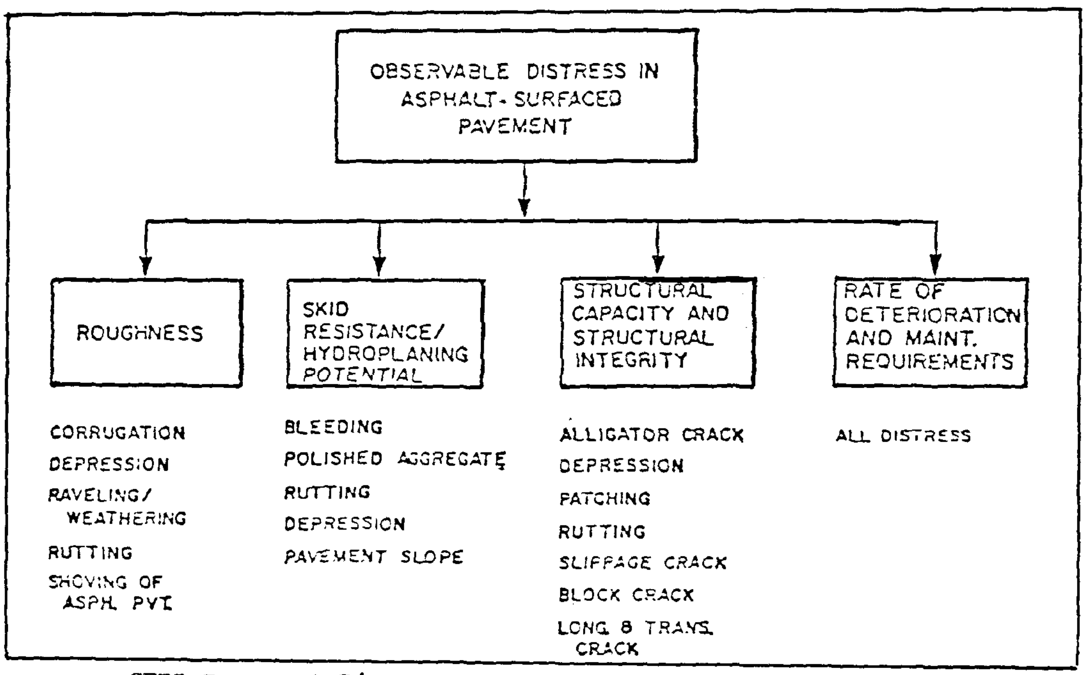
The literature review also covered pavement condition methods used by other agencies. The common theme of these methods is the identification of pavement distress types and a measure of the severity and extent of these types. A brief description of pavement condition rating methods from three of these agencies follows.

Figure 6.1-4 presents the pavement condition rating method developed by CERL (6). The inspector identifies existing pavement distress types and makes quantitative measurements of severity/extent levels of each of 19 possible distress types. He applies severity (low, medium, or high) and extent (density) measurements to "deduct curves" and derives deduct values attributable to each distress type. These raw deduct values are summed for the various distress types observed, an adjustment in the sum is made when multiple distress type/severity levels are observed, and a corrected total deduct value is obtained. The corrected deduct value is subtracted from 100 to yield a Pavement Condition Index. The CERL thus purports to derive an indication of roughness, skid resistance, structural adequacy, and rate of deterioration from pavement distress measurements (Figure 6.1-5).

The State of Florida likewise uses severity and/or extent levels for cracking, patching, and rutting distress types in developing its pavement rating (7). Defect rating (deduct) points are assigned to the various distress levels observed in a small



CERL Pavement Rating Procedure
FIGURE 6.1-4



CERL Pavement Distress - Pavement Condition Relationships
FIGURE 6.1-5

sample of the pavement being evaluated. The sum of defect rating points is subtracted from 100 to derive a defect rating score DR. Road roughness is measured by Mays Ride Meters and is reported on a scale of 0 to 100 as ride rating RR. A pavement rating PR is then calculated as $PR = \sqrt{DR \times RR}$, ranging from 0 to 100. The pavement rating is adjusted for traffic. Skid resistance measurements are obtained through a separate program for identifying such needs.

Washington State (7) utilizes a structural rating S_R and a ride score R_S to develop its pavement condition rating. Six two-man teams evaluate basically each of the 7,000 miles in the highway network every two years. Washington has categorized distress into seven general categories for flexible pavement and eight general categories for rigid pavement. Defect values are assigned to the various severity/extent combinations of these distress types. The structural rating S_R results by subtracting the sum of defect values from 100. Ride score R_S is obtained from a modified PCA Road Meter and is expressed on a scale of from zero (very smooth) to nine (very rough). The final pavement condition rating is expressed as $S_R \left[1 - \frac{R_S}{10} \right]^{\frac{1}{2}}$. Figure 6.1-6 is a copy of Washington State's "Pavement Condition Rating" form. As shown in Figure 6.1-6, these forms are annotated with the previous survey inventory data. This pre-coding lends consistency to the condition ratings with time and thus enhances the validity and usefulness of the pavement performance data base. Incidentally, Washington State has a skid resistance testing program, and results therefrom impact the prioritization of highway needs but are reported separately from the above-described pavement condition rating.

STATE OF WASHINGTON
DEPARTMENT OF TRANSPORTATION

PAVEMENT CONDITION RATING

DATE | RATER | SHEET 1 OF 1

District No	State Route	Funct Class	Control Section	Control Section Seq.	Ending Control Section Milepost for Rated Section	Pavement Type "A"-"B"-"C"	* Pavement Exemption	Multilane (L) (R) (B)	Rutting Pavt Wear **	Corrugation, Waves, Sags, Humps	Alligator Cracking	Raveling or Flushing	Longitudinal Cracking	Transverse Cracking	Patching (Bituminous)	Cracking (PCC)	Raveling, Disintegration, Pop Out, Scaling	Joint Spalling	Pumping, Blowing	Blowups	Faulting, Curling, Warping, Settlement	Patching (PCC)	Pavt Wear **	Roadmeter Counts per Mile
2	002	1	406	110	800	A	2	L	N	1	N	1 R	N	2	N									377
					883	A	2	L	N	N	N	1 R	N	N	N									576
					900	A	3	L	N	N	N	1 R	N	N	N									265
					910	A	2	L	N	N	N	1 R	N	N	N									280
					983	A	2	L	N	1	N	1 R	N	N	N									621

DUPLICATE COLUMNS 3 THRU 17

O | SR | FC | C.S. No. | C.S.S. | ENDING CSMP | TY | EX | LRB | BITUMINOUS PAVEMENTS | PORTLAND CEMENT CONCRETE | ROADMETER COUNTS PER MILE

* CODE: (1) Unpaved Roadways, (2) Roadways under Construction, (3) Bridge, (4) Road Impassable, (5) Other

** Rutting - Pavt. Wear (1) 1/4" to 1/2" (2) 1/2" to 3/4"

REMARKS:

DOT 177-016 REV 1-81

Washington Pavement Condition Rating Form

FIGURE 6.1-6

6.1.b. Proposed Condition Rating Method

The authors are challenged and constrained at this point to propose a condition rating method for incorporation into the DOTD's Highway Needs Study, as follows:

1. The challenge is to technically enhance the Condition portion of the Highway Needs inventory (Figure 4.1-6, page 21) by concentrating on pavement distress and ride as explained in the last part of Section 6.1. The authors are convinced that such concentration will add relevancy to the Condition score, and the national state of the art seems to confirm this (7).

2. The constraint is to recommend a practical condition rating method, with considerations as follows:

    a. The method must recognize that the intent of the Highway Needs inventory is to provide a valid first cut of projects with the greatest needs. The inventory is neither research- nor maintenance-oriented.

    b. The method must not burden the Highway Needs inspectors and office analysts so as to prevent this staff from performing its job within the allocated time.

The proposed condition rating would replace the 50 par point "Condition" portion of the present Highway Needs inventory for rural roads (Figure 4.1-6). This condition rating would be the sum of the pavement distress rating (25 points par, or maximum) and the ride rating (25 points par). For urban roads the proposed condition rating would replace the 40 par point "Condition" portion of the present Highway Needs inventory. The condition rating would be the sum of the pavement distress rating (20 points par) and the ride rating (20 points par).

During the first year of rating under the proposed scheme, the entire network should be surveyed on a sample basis for ride. However, only that 27% (4,368 centerline miles) of the network classified as principal and minor arterials would also be surveyed on a sample basis for pavement distress. The "Condition" score developed for the collector roads during the previous year's survey would serve on a prorated basis (half the score) as the pavement distress score for this group of roads for the first survey. During the second year's rating session the entire network would again be surveyed on a sample basis for ride. However, only that 73% (12,012 centerline miles) of the network classified as collectors would also be surveyed on a sample basis for pavement distress. Pavement distress data would thus be collected every other year on a given project. Each year the Highway Needs inventory form would be pre-coded with condition rating data from the previous survey for reference.

Ride Rating

Road roughness or ride would be measured by means of the Mays Ride Meter (MRM). The DOTD has been using the MRM for more than ten years. Each of the nine transportation districts owns a MRM housed in a sedan, and the R&D Section has one mounted on a trailer.

In Construction and Maintenance (C&M) Memorandum No. I-1690 dated March 1, 1976, the Department's Chief C&M Engineer requested each District Engineer to use the MRM in his individual pavement management program, specifically for construction, maintenance, and planning activities. MRM test results were to be reported in terms of Present Serviceability Index (PSI) ranging from zero (very poor) to five (very good).

In the proposed Highway Needs condition rating scheme, the inspectors would determine PSI values for each subsection in accordance with DOTD standard MRM operation procedures. This testing would be done by the Highway Needs inspectors (now maintenance forces), although general calibration and control of the MRM would remain the responsibility of the District Laboratory personnel. The Highway Needs inspector should select a short section (0.5 mile or less in length) generally centered upon the midpoint of each subsection and determine the PSI. The PSI value would be multiplied by a factor of four or five to incorporate it into the appropriate par point scheme for ride score for urban and rural roads, respectively.

Pavement Distress Rating

Pavement distress rating would involve identification of standardized distress types and subjective estimation of severity and extent levels thereof. The Highway Needs inspector would stop at several points within each subsection. At each point he would inspect the pavement for 50 feet in each direction to make his identifications and estimations. Significant distress found outside the station-length areas so inspected would be noted. The inspector then would determine a single rating for the subsection based upon his notes and observations.

Pavement distress types for the proposed condition rating scheme have been selected based partly on the survey of the national state of the art as related in Figures 6.1-1 through 6.1-3. Knowledge of distress types observed in Louisiana tempered the selection. Application of the data within the context of the Highway Needs objectives served to constrain the depth of the pavement distress survey.

The following types of pavement distress should be recognized in the condition rating:

Jointed PCC Pavement Distress	Unjointed CRC Pavement Distress	Asphalt-Surfaced Pavement Distress
Blowup	Edge Punchout	Bleeding
Corner Break	Patching	Block and Transverse Cracking
Faulting	Popouts	Corrugations
Joint Seal Damage	Pumping	Longitudinal Joint Cracking
Joint Spalling	Scaling, Map Cracking, Crazing	Edge Cracking
Longitudinal Cracking	Settlement and Waves	Patching
Patching	Spalling	Potholes
Popouts	Transverse Cracking	Random Cracking
Pumping		Raveling
Scaling, Map Cracking, Crazing		Rutting
Settlement		Settlement
Transverse/Diagonal Cracking		Wheel Path Cracking

The Pavement Distress Rating method is taken from one developed for and in use by the Ohio Department of Transportation (8). The end point of the method as modified is a number ranging from 0 to 25 for rural roads and from 0 to 20 for urban roads. Such a number is required for input into the Highway Needs Sufficiency Rating.

The following steps are taken in developing the Pavement Distress Rating for a segment of pavement:

Step 1 - Inspect the Pavement

Identify the distress types from the lists given in a preceding paragraph. Subjectively estimate the severity (low, medium, or high) and extent (occasional, frequent, or extensive) levels of each distress type observed.

Step 2 - Determine Deduct Points

Annotate with a circle the distress type-severity-extent weight factors on the condition rating form as appropriate. These weight factors are presented in Figures 6.1-7 through 6.1-9 for asphaltic concrete, jointed concrete, and continuously reinforced concrete pavements. Multiplication of the weight factors for distress type, severity and extent yields the deduct points for a given distress type.

Step 3 - Determine the Total Deduct Points

Do this by adding the deduct points for each distress type.

Step 4 - Determine the Raw Pavement Distress Rating

Subtract the total deduct points from 100 to derive this raw rating.

Step 5 - Determine the Final Pavement Distress Rating

Divide the raw rating by a factor of four for rural roads and five for urban roads for incorporation into the Highway Needs Sufficiency Rating scheme.

Overall Pavement Condition Rating Per Subsection

Figures 6.1-10 through 6.1-12 present the condition rating forms for the three pavement types. These worksheet-type forms document the final Ride Rating and Pavement Distress Rating and their sum--the Pavement Condition Rating.

DISTRESS	DISTRESS WEIGHT	SEVERITY WEIGHT* L	SEVERITY WEIGHT* M	SEVERITY WEIGHT* H	EXTENT WEIGHT** O	EXTENT WEIGHT** F	EXTENT WEIGHT** E
BLEEDING	5	.8	.8	1.0	.6	.9	1.0
BLOCK/TRANSVERSE CRACKING	10	.4	.7	1.0	.5	.7	1.0
CORRUGATIONS	10	.4	.8	1.0	.5	.8	1.0
EDGE CRACKING	5	.4	.7	1.0	.5	.7	1.0
LONGITUDINAL JOINT CRACKING	5	.4	.7	1.0	.5	.7	1.0
PATCHING	5	.3	.6	1.0	.6	.8	1.0
POTHOLES	10	.4	.7	1.0	.5	.8	1.0
RANDOM CRACKING	5	.4	.7	1.0	.5	.7	1.0
RAVELING	10	.3	.6	1.0	.5	.8	1.0
RUTTING	10	.3	.7	1.0	.6	.8	1.0
SETTLEMENT	10	.5	.7	1.0	.5	.8	1.0
WHEEL PATH CRACKING	15	.4	.7	1.0	.5	.7	1.0

* L = LOW, M = MEDIUM, H = HIGH
** O = OCCASIONAL, F = FREQUENT, E = EXTENSIVE

Asphalt Concrete Pavement Distress Weight Factors

FIGURE 6.1-7

DISTRESS	DISTRESS WEIGHT	SEVERITY WEIGHT* L	SEVERITY WEIGHT* M	SEVERITY WEIGHT* H	EXTENT WEIGHT** O	EXTENT WEIGHT** F	EXTENT WEIGHT** E
BLOW-UP	10	1.0	1.0	1.0	.5	.8	1.0
CORNER BREAK	10	.4	.5	1.0	.5	.8	1.0
FAULTING	10	.4	.7	1.0	.5	.8	1.0
JOINT SEAL DAMAGE	5	1.0	1.0	1.0	.5	.8	1.0
JOINT SPALLING	15	.4	.7	1.0	.5	.8	1.0
LONGITUDINAL CRACKING	5	.5	.7	1.0	.4	.9	1.0
PATCHING	5	.4	.7	1.0	.5	.8	1.0
POPOUTS	5	1.0	1.0	1.0	.4	.6	1.0
PUMPING	15	.7	.7	1.0	.3	.7	1.0
SCALING,CRAZING, MAP CRACKING	5	.4	.7	1.0	.6	.8	1.0
SETTLEMENT	5	.4	.7	1.0	.5	.8	1.0
TRANSVERSE/DIAGONAL CRACKING	10	.3	.8	1.0	.4	.8	1.0

* L = LOW, M = MEDIUM, H = HIGH
** O = OCCASIONAL, F = FREQUENT, E = EXTENSIVE

Jointed Concrete Pavement Distress Weight Factors

FIGURE 6.1-8

DISTRESS	DISTRESS WEIGHT	SEVERITY WEIGHT* L	SEVERITY WEIGHT* M	SEVERITY WEIGHT* H	EXTENT WEIGHT** O	EXTENT WEIGHT** F	EXTENT WEIGHT** E
BLOW-UP	10	1.0	1.0	1.0	.7	.9	1.0
LONGITUDINAL CRACKING	10	.4	.8	1.0	.5	.8	1.0
EDGE PUNCHOUT	15	.6	.8	1.0	.6	.9	1.0
PATCHING	10	.4	.7	1.0	.5	.8	1.0
POPOUTS	5	1.0	1.0	1.0	.4	.6	1.0
PUMPING	15	.7	.7	1.0	.3	.7	1.0
SCALING,CRAZING, MAP CRACKING	5	.4	.7	1.0	.5	.8	1.0
SETTLEMENT & WAVES	10	.3	.7	1.0	.4	.7	1.0
SPALLING	15	.3	.6	1.0	.5	.8	1.0
TRANSVERSE CRACKING	5	.4	.7	1.0	.4	.8	1.0

* L = LOW, M = MEDIUM, H = HIGH
** O = OCCASIONAL, F = FREQUENT, E = EXTENSIVE

Continuously Reinforced Concrete Pavement Distress Weight Factors

FIGURE 6.1-9

ASPHALT-SURFACED PAVEMENT CONDITION RATING FORM

DISTRICT	__________
PARISH	__________
ROUTE	__________
CONTROL	__________
SECTION	__________
SUBSECTION	__________
LENGTH	__________
C.S.LOG MILE	__________
FUNCT. CLASS	__________

DATE __________
RATED BY __________

DISTRESS		SEVERITY LEVEL			EXTENT LEVEL			DEDUCT POINTS*
TYPE	WEIGHT FACTOR	LOW	MEDIUM	HIGH	OCC	FREQ	EXT	
		SEVERITY WEIGHT FACTOR			EXTENT WEIGHT FACTOR			
BLEEDING	5	N/A .8	AGG/BIT .8	FREE BIT 1.0	<10%A .6	10%-30% .9	>30% 1.0	______
BLOCK/TRANSVERSE CRACKING	10	<1/8"W .4	1/8"-1" .7	>1" 1.0	<20%L .5	20%-50% .7	>50% 1.0	______
CORRUGATIONS	10	NOTICEABLE RIDE .4	DIS- COMFORT .8	SEVERE VIBRA. 1.0	<10%L .5	10%-30% .8	>30% 1.0	______
EDGE CRACKING	5	<1/4"W .4	>1/4" .7	MULT. >1/4" 1.0	<20%L .5	20%-50% .7	>50% 1.0	______
LONGITUDINAL JOINT CRACKING	5	SINGLE <1/8"W .4	MULT. <1/8" SINGLE >1/8" .7	MULT. CRACKING W/SPALL 1.0	<20%L .5	20%-50% .7	>50% 1.0	______
PATCH	5	SLIGHT DETER. .3	NOTC. RIDE .6	REPLACE 1.0	<10%L .6	10%-30% .8	>30% 1.0	______
POTHOLES	10	<6"W OR >6"W & <1"D .4	>6"W & 1"-2"D .7	>6"W & >2"D 1.0	<20%L .5	20%-50% .8	>50% 1.0	______
RANDOM CRACKING	5	<1/8"W .4	1/8"-1" .7	>1" 1.0	<20%L .5	20%-50% .7	>50% 1.0	______
RAVELING	10	—AGGREGATE LOSS— SLIGHT .3	MOD. .6	SEVERE 1.0	<20%A .5	20%-50% .8	>50% 1.0	______
RUTTING	10	<1/4"D .3	1/4-1" .7	>1" 1.0	<20%L .6	20%-50% .8	>50% 1.0	______
SETTLEMENT	10	NOTICEABLE RIDE .5	DIS- COMFORT .7	DIP>6" 1.0	1/MI .5	2-4/MI .8	>4/MI 1.0	______
WHEEL PATH CRACKING	15	SINGLE/ INTMULT. <1/8"W .4	MULT/ INTALLG >1/8" .7	ALLIG. >1/4" 1.0	<20% WPL .5	20%-50% .7	>50% 1.0	______

*DEDUCT POINTS = DISTRESS WT. FACTOR X SEVERITY WT. FACTOR X EXTENT WT. FACTOR

TOTAL DEDUCT POINTS = ______
100 - TOTAL DEDUCT POINTS = ______

RURAL ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 4 = ______

MAYS RIDE RATING = (MAYS P S I) X 5 = ______

URBAN ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 5 = ______

MAYS RIDE RATING = (MAYS P S I) X 4 = ______

PAVEMENT CONDITION RATING = P D R + R R = ______

REMARKS : ____

Asphalt-Surfaced Pavement Condition Rating Form

FIGURE 6.1-10

JOINTED CONCRETE PAVEMENT
CONDITION RATING FORM

DISTRICT ________ DATE ________
PARISH ________ RATED BY ________
ROUTE ________
CONTROL ________
SECTION ________
SUBSECTION ________
LENGTH ________
C.S.LOG MILE ________
FUNCT. CLASS ________

DISTRESS TYPE	WEIGHT FACTOR	SEVERITY LEVEL LOW	MEDIUM	HIGH	EXTENT LEVEL OCC	FREQ	EXT	DEDUCT POINTS*
		SEVERITY WEIGHT FACTOR			EXTENT WEIGHT FACTOR			
		NOT CONSIDERED			<1/MI	1-3/MI	>3/MI	
BLOW-UP	10	1.0	1.0	1.0	.5	.8	1.0	______
		<1/4"W	1/4-1"	>1"	<1/MI	1-3/MI	>3/MI	
CORNER BREAK	10	.4	.8	1.0	.5	.8	1.0	______
		<1/4"	1/4-1/2"	>1/2"	<20%L	20%-50%	>50%	
FAULTING	10	.4	.7	1.0	.5	.8	1.0	______
		NOT CONSIDERED			<20%	20%-50%	>50%	
JOINT SEAL DAMAGE	5	1.0	1.0	1.0	.5	.8	1.0	______
		<2"W	2"-4"	>4"	<20%	20%-50%	>50%	
JOINT SPALLING	15	.4	.7	1.0	.5	.8	1.0	______
		TIGHT	1/4"-1"W	>1"	<5% SLBS	5%-20%	>20%	
LONGITUDINAL CRACKING	5	.5	.7	1.0	.4	.9	1.0	______
		SLIGHT DETER	NOTC. RIDE	REPLACE	<5% SLBS	5%-20%	>20%	
PATCH	5	.4	.7	1.0	.5	.8	1.0	______
		NOT CONSIDERED			<20%L	20%-50%	>50%	
POPOUTS	5	1.0	1.0	1.0	.4	.6	1.0	______
		STAIN	STAIN	FAULT	<10%L	10%-25%	>25%	
PUMPING	15	.7	.7	1.0	.3	.7	1.0	______
		<1/4"D	1/4"-3/4"	>3/4"	<20%A	20%-50%	>50%	
SCALING,CRAZING MAP CRACKING	5	.4	.7	1.0	.6	.8	1.0	______
		NOTC. RIDE	DIS-COMFORT	DIP>6"	1/MI	2-4/MI	>4/MI	
SETTLEMENT	5	.4	.7	1.0	.5	.8	1.0	______
		TIGHT	1/4-1"W	>1"	CS>15'	10'-15'	<10'	
TRANSVERSE/DIAGONAL CRACKING	10	.3	.8	1.0	.4	.8	1.0	______

*DEDUCT POINTS = DISTRESS WT. FACTOR X SEVERITY WT. FACTOR X EXTENT WT. FACTOR

TOTAL DEDUCT POINTS = ______
100 - TOTAL DEDUCT POINTS = ______

RURAL ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 4 = ______

MAYS RIDE RATING = (MAYS P S I) X 5 = ______

URBAN ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 5 = ______

MAYS RIDE RATING = (MAYS P S I) X 4 = ______

PAVEMENT CONDITION RATING = P D R + R R = ______

REMARKS : ______________________________

Jointed Concrete Pavement
Condition Rating Form

FIGURE 6.1-11

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT CONDITION RATING FORM

DISTRICT ________ DATE ________
PARISH ________ RATED BY ________
ROUTE ________
CONTROL ________
SECTION ________
SUBSECTION ________
LENGTH ________
C.S.LOG MILE ________
FUNCT. CLASS ________

DISTRESS TYPE	WEIGHT FACTOR	SEVERITY LEVEL LOW	MEDIUM	HIGH	EXTENT LEVEL OCC	FREQ	EXT	DEDUCT POINTS*
		SEVERITY WEIGHT FACTOR			EXTENT WEIGHT FACTOR			
BLOW-UP	10	NOT CONSIDERED			<1/MI	1-3/MI	>3/MI	
		1.0	1.0	1.0	.7	.9	1.0	
EDGE PUNCHOUT	15	CRACK <1/4"W	CRACK ≥1/4"	CRACK>1/4" DIP>1/2"	<2/MI	2-5/MI	≥5/MI	
		.6	.8	1.0	.6	.9	1.0	
LONGITUDINAL CRACKING	10	HAIRLINE	1/4-1"	>1"	<5%	5%-15%	>15%	
		.4	.8	1.0	.5	.8	1.0	
PATCH	10	SLIGHT DETER	NOTC. RIDE	REPLACE	<5/MI	5-15/MI	15/MI	
		.4	.7	1.0	.5	.8	1.0	
POPOUTS	5	NOT CONSIDERED			<20%L	20%-50%	>50%	
		1.0	1.0	1.0	.4	.6	1.0	
PUMPING	15	STAIN	STAIN	FAULT	<10%L	10%-25%	>25%	
		.7	.7	1.0	.3	.7	1.0	
SCALING,CRAZING MAP CRACKING	5	<1/4"D	1/4-3/4"	>3/4"	<20%A	20%-50%	>50%	
		.4	.7	1.0	.5	.8	1.0	
SETTLEMENT AND WAVES	10	NOTICEABLE RIDE	DIS-COMFORT	DIP>6"	<1/MI	2-4/MI	>4/MI	
		.3	.7	1.0	.4	.7	1.0	
SPALLING	15	SLIGHT	<1"W	>1"	<20%	20%-50%	>50%	
		.3	.6	1.0	.5	.8	1.0	
TRANSVERSE CRACKING	5	CS 3'-5' OR ≥8'	<3'	<3', INTERSECT	<20%L	20%-50%	>50%	
		.4	.7	1.0	.4	.8	1.0	

*DEDUCT POINTS = DISTRESS WT. FACTOR X SEVERITY WT. FACTOR X EXTENT WT. FACTOR

TOTAL DEDUCT POINTS = ______
100 - TOTAL DEDUCT POINTS = ______

RURAL ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 4 = ______

MAYS RIDE RATING = (MAYS P S I) X 5 = ______

URBAN ROADS

PAVEMENT DISTRESS RATING = (100 - TOTAL DEDUCT POINTS) / 5 = ______

MAYS RIDE RATING = (MAYS P S I) X 4 = ______

PAVEMENT CONDITION RATING = P D R + R R = ______

REMARKS : ________________________________

Continuously Reinforced Concrete Pavement Condition Rating Form

FIGURE 6.1-12

6.2. Road Design

The Design Section does not generate any mass of data that is used by other disciplines. Rather it relies on data generated by other sections/divisions for design purposes. This was discussed in Section 4.2 of Chapter 4. However, there is a primary need for identification of the boundaries of the construction project for cross referencing to other files. The present stationing scheme serves the purpose of location identification during the life of the construction operation. After this operation is over, the station numbers serve little, if any, as location identifiers. Based on existing indexing schemes used by needs file, it is envisioned that a similar scheme, namely control section log mile, could be adopted to identify boundaries of construction or improvement projects on the plans or contract. This would be in addition to the station number location.

As an example, the first segment (subsection 01) of Figure 4.1-10, which is programmed for resurfacing, would be shown on the plans as starting at 0.00 log mile and terminating at log 8.61 miles. However, if the first two subsections 01 and 02 were programmed to be let as a single construction project for resurfacing, then the terminal location of the project would be identified at 8.61+0.57 = 9.18 log miles.

In adopting this approach, the following will have to be resolved:

- Stationing scheme - must necessarily increase in the direction of log mile.
- Controls that traverse other controls.
- New alignment.

6.3. Traffic

Many of the deficiencies in the existing traffic count program addressed in the previous chapter can be rectified by upgrading:

- The traffic data gathering system hardware.
- Vehicle classification counts at locations identified in needs study project program listings.
- Classification count period.
- Procedure for prediction of changes in truck weights over time.

It is felt that upgrading of the traffic data gathering system hardware will necessarily take care of the other deficiencies in classification and truck weight data collection. Three different types of automated traffic equipment are available for possible upgrading by the Traffic Section. These are:

- Weigh-In-Motion (WIM) truck weighing system.
- Telac traffic monitoring system.
- Traficomp traffic surveillance system

The WIM system is a dynamic system designed to provide accurate vehicle weight and dimension information without requiring vehicles to stop for measurement on conventional platform or portable scales. The system basically includes a series of load cells and detector loops installed in the roadway and an instrumented trailer containing electronic measuring and recording equipment. In addition to measuring and recording the wheel weight, axle weight and gross weight of vehicles passing over roadway transducers at normal highway speeds, the WIM system also measures and records vehicle speed, number of axles, axle spacing, and vehicle length automatically.

Presently, the Department has one WIM system installation exclusively used for monitoring truck weights on a federally funded research study.

The Telac 505A is a solid state traffic recorder and the field unit for the Telac telephone traffic data system. It monitors the highway traffic and accumulates and stores hourly traffic volumes in its solid state memory. Once a day, upon interrogation, the 505A transmits its data to a central polling station. The standard Telac can monitor the traffic on up to four lanes. A total of up to eight lanes can be monitored by using optional external loop detectors. The 505A Telac records data for 32 hours, beginning at midnight. When called between midnight and 9 a.m., the data for the previous day is transmitted, allowing a full eight hours for data retrieval. After 9 a.m. and until midnight, the data for the last 24 hours is transmitted.

According to its manufacturer, the Traficomp Traffic Surveillance System is designed to monitor and record a wide variety of traffic-related data including volume count, velocity classification, vehicle length classification, and vehicle type classification. The Traficomp "recorder" unit can be used to count and classify up to eight lanes of traffic through the use of internal and external detectors. This unit can determine and record the traffic count on a 5-, 15-, 30-, or 60-minute basis by lane, direction, or total volume. Velocity classification involves monitoring over a range of six standard categories, which can be divided into any desired speed range (45 mph, 45-50 mph, etc.). Vehicle length classification is provided in four categories. A typical size range is: under 16 feet, 16-24 feet, 24-36 feet, and over 36 feet. Vehicle type classification includes six categories: automobiles, automobiles with trailers, trucks (long wheel base), trucks with three axles, trucks with four axles, and trucks with five or more axles.

6.4. Construction

The MATT System is the prime data file for construction and material test data, in addition to the relative as-built information on construction projects. Although project construction data is recorded by station numbers, cross referencing to other files (performance, maintenance, etc.) can be easily accomplished through control section log mile identifier recorded for each project's boundaries (Figure 4.4-4). The MATT System is dynamic and data elements can be added as deemed necessary.

6.5. Maintenance

With respect to the PAMS, the key data element need is to assign an indexing scheme for identification of maintenance location. Specific maintenance location is necessary for major activities such as surface replacement, joint repair, etc. Likewise, slow-moving operation (pot hole patching) needs to be identified in terms of the control section log mile boundaries of the patching operation (longitudinal) and the roadway lane (transverse).

Implementation of the pavement monitoring system in terms of pavement distress measurements, as discussed in Section 6.1, will provide the Maintenance Division a better tool with which to develop and prioritize their overall maintenance overlay program. Presently, this condition survey is conducted subjectively annually to generate a priority ranking of the overlay program. It is anticipated that a <u>single pavement performance monitoring program will minimize duplication of effort coupled with detailed and equitable data base upon which to base decisions for rehabilitation of pavements</u>.

7. DATA FILES, MANAGEMENT, RETRIEVAL AND USES

7.1. Data Files

Theoretically, the as-built data file should be considered the prime file since monitoring for performance begins after the improvement. If the record control key is standardized, as mentioned in the preceding sections, then files can be developed as stand-alone files (rather than change the existing data files) with the common record control key for linking. For example, the performance measurement file will be a separate file of the needs study files with the header information repeated. Such an approach provides uninterrupted management of existing data files. Furthermore, the system tends to grow without the necessity of expending valuable resources for total restructuring of existing files.

7.2 Data Management

Although data management can be accomplished in manual mode, the pavement management system of the magnitude envisioned in this section must necessarily rely on automation. The Department's existing computer hardware should be capable of handling multiple files in a single sweep. However, management of various files to generate the desired output necessitates availability of softwares (programs) capable of editing, storage, updating, analysis and retrieval. Writing individual programs would be a monumental, if not impossible, task. Fortunately, the Department's present software data management and analysis package, identified as SAS, will fill this void in more ways than one. SAS, an acronym for Statistical Analysis System, is a commercially available computer software system for total data management in one easy-to-use system (5). It provides all the tools needed for data analysis:

- Information storage and retrieval
- Data modification and programming
- Report writing
- Statistical analysis
- File handling

The system is capable of handling (merging) up to 50 separate files using a common variable for matching purposes (control section log mile for PAMS). There is no limit to the number of observations that a SAS data set may contain. The maximum number of variables in a SAS set is 4,000. Statistical analysis capability of this system ranges from simple descriptive statistics to complex multivariable techniques and graphics.

The major thrust towards enumerating the capability of the above software system is to emphasize the importance of such a system in the overall development and implementation of a pavement management system. Certainly, the agency's resources would be exhausted if separate programs were to be written to satisfy each individual request.

7.3. Data Retrieval and Uses

No attempt can be made, at this stage of the study, to define the user needs and the type of data retrieval for these users. However, it is anticipated that such retrieval can consist of either a periodic, standard output report or special type reports as deemed by the user. In the first category would be the report presently generated by the needs system (Figures 4.1-8 and 4.1-9) for the yearly construction program. Such reports are information oriented. On the other hand, reports that generate data for feedback to either design, construction or maintenance are special type reports. Surface finish or surface material type and skid number history (on these surfaces) with time is an example of this type of report for specification feedback purposes.

8. SUMMARY AND RECOMMENDATIONS

In the preceding chapters an attempt was made to discuss the present practices followed by the Department to manage some 16,000 miles of highways. These present practices were defined through existing policy manuals and discussion with individuals and/or sections who have some responsibility in the pavement management processes. The major thrust towards this effort was to determine what improvements or enhancements would be necessary to upgrade the existing system. In this respect, it is a feasibility report. The following comments are based on the preceding discussions and are anticipated to pave the way for development of a total pavement management system.

1. There is a need to develop an integrated and automated pavement data management system. The Department's existing pavement management system does not have the full potential of providing the feedback of information necessary to make equitable decisions for planning, programming, design, construction, performance monitoring and prediction, and maintenance of the highway system.

2. This lack of feedback capability can be attributed to the following four major deficiencies in the existing system:

    - Absence of common location identifier (record control key) for linking and merging various data files.
    - Pavement distress measurements.
    - Axle number and load distribution measurements and projections.
    - Level of maintenance reporting procedures.

3. Enhancement of the existing system can be accomplished by implementing the following recommendations:

    a. Use of a common location identification scheme in all existing and future pavement-related files. This common location identifier should be the control section odometer log mile.

b. The present pavement performance rating procedure used in the sufficiency rating survey should be expanded to include a more disciplined approach in terms of distress types and the associated severity and extent of these types as discussed in Chapter 6. Such a disciplined measurement program would minimize duplication of the rating program presently conducted on four separate occasions (Highway Needs, predesign inspection, maintenance inventory and rehabilitation).

c. All construction and/or rehabilitation project boundaries should be identified by beginning and ending control section log miles in addition to station numbers.

d. Upgrading of the traffic data gathering system in general and the vehicle classification and truck weight count system in particular. Furthermore, the classification count should be obtained on each highway project prior to traffic assignments for pavement design.

e. The maintenance reporting system should be revised to reflect level of maintenance by specific location, both longitudinally by control section log mile and transversely by roadway.

f. The existing files (VSAM or sequential) should be left intact. Additional needed data for existing or new files can be "hooked on" through the record control key and other header information. An example of this would be the pavement distress measurement file hooked on to the needs data file. Softwares are available to link and merge various files through a common key.

g. The development of the pavement management system should begin with implementation of the above recommendations.

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