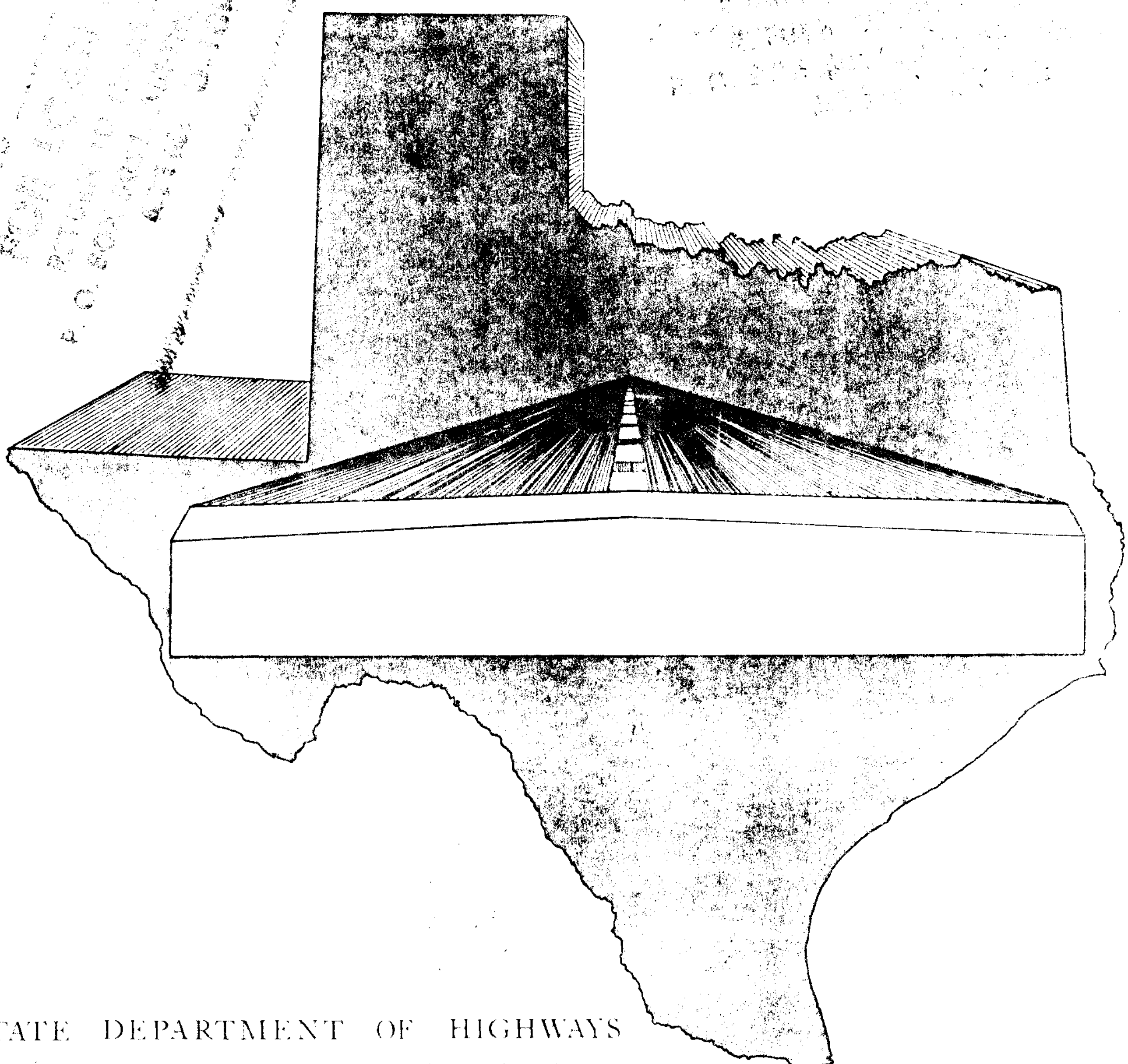
PAVEMENT DAMAGE DUE TO HEAVY LOADS IN TEXAS: AN AREA STUDY



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

July 1978

PAVEMENT DAMAGE DUE TO HEAVY LOADS IN TEXAS: AN AREA STUDY

Prepared by the

State Department of Highways and Public Transportation

Austin, Texas

July, 1978

SUMMARY & CONCLUSIONS

In recent years, extensive pavement damage to the state highway system by overweight trucks has been of increasing concern to the State Department of Highways and Public Transportation. Highway damages are not localized, but occur to various degrees statewide. In order to evaluate the magnitude of the heavy load problem, selected highways in the area west of Houston were analyzed in July, 1978, since pavement deterioration in that region was a good representation of statewide problems.

Although the damage identified by this study can generally be attributed to a predominance of gravel trucks, other heavy vehicles carrying grain, brick, lumber and specialized equipment cause similar problems in this area as well as statewide.

Based on the finding of this study, it is apparent that heavy loads are resulting in costly repairs and inconvenience to the public at an increasing rate. Hazards resulting from damages to the highway system present continuing potential threats to life and health.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

A safe, convenient and rapid transportation network for all our citizens is the objective of our highways. Design, construction and maintenance of the highway system are activities which are closely interrelated when a highway facility is instituted. Optimum utilization of our tax dollars to construct highways must consider the balanced application of funds to these activities to faithfully discharge the obligation of providing highways to the traveling public.

When design loads to highways are exceeded, destruction of pavement occurs. As overloads increase in weight and frequency, destruction of the highway system occurs at a vastly accelerated rate to quickly jeopardize not only the investment in a needed facility but directly affects the safety of every motorist. An illustration of the damages caused by these vehicles may be found in a newspaper article by the Houston Post located in Appendix A.

II Heavy Loads

Pavement distress was studied on ten highways in Austin, Colorado, Fort Bend, Matagorda, and Wharton Counties. The highways were specially selected to show the damage caused by heavily loaded trucks. The types of distress shown are typical of the damage caused by all types of heavy truck loads found throughout the state. This type of damage can be expected on highways as cumulative truck loading accrues or as individual truck weights increase. The trucks using the selected highways are generally loaded with sand and gravel. Figure 1 illustrates the concentration of numerous aggregate sources in the area. Aggregate from any given source may be shipped in any direction from that source. However, the majority of material is shipped to Houston with some sources providing aggregate to a large construction project near Bay City. Therefore, the study was composed of a comparison of the lanes carrying the loaded trucks to Houston or Bay City--with the lanes carrying the returning empty trucks. Additionally, the costs of maintaining a highway in good condition and the cost of upgrading a damaged highway were studied. Note that Figure 1 also shows the locations of the highway segments studied and reported herein.

A. Results of Study

Table I shows the ratios of distress of loaded lanes compared with the return lanes.

1. The study indicated the lanes which carry the loaded trucks have rut depths 2.34 times greater than the lanes carrying the returning empty trucks. Rut depths from 3/4-inch to 1-inch can easily be found on the loaded lanes of most of the highways studied as shown in Pictures 5, 8, and 11. Shear failures (where the pavement material is shoved vertically each side of the wheel path) occur frequently on the loaded lanes particularly on the Farm-to-Market roads (see Pictures 5, 8,and 9). Some shear failures were noted on US 90A near the center line and it is estimated that over one mile (of a 7.6 mile study length) has previously been repaired because of this shear-type failure.

TABLE I

Loaded Lanes/Return Lanes = Ratio of Distress

Location	Rut Depth (inches)	Visible Repair Areas (feet/mi)	Pavement Roughness (inches/mi) *
FM-109 Colorado Co.	.31/.21 = 1.48	277/106 = 2.61	95/83 = 1.14
FM-2614 Colorado Co.	.145/.05 = 2.90	359/59 = 6.08	180/101 = 1.78
FM-2614 Wharton Co.	.215/.08 = 2.69	1526/675 = 2.26	126/95 = 1.33
US-90A Colorado and Wharton Co.	.665/.22 = 3.02	49/43 = 1.14	78/52 = 1.50
FM 3013 Colorado Co.	.70/.225 = 3.11	None	57/37 = 1.54
SH-159 Austin Co.	.28/.13 = 2.15	645/423 = 1.52	73/85 = 0.86
FM-109 Austin Co.	.17/.10 = 1.70	27/16 = 1.69	112/104 = 1.08
FM-2977 Ft. Bend Co.	1.23/.65 = 1.89	151/181 = 0.83	91/84 = 1.08
SH-60 Matagorda Co.	.10/.05 = 2.00	32/13 = 2.42	35/33 = 1.06
FM-2668 Matagorda Co.	.39/.16 = 2.44	9/2 = 4.50	149/136 = 1.10
SH-71 Matagorda Co.	N/A	2713/1797 = 1.51	478/256 = 1.87
Average	2.34	2.46	1.30

* A smooth surface generally ranges from 20 to 40 inches/mile.

2. Pavement repairs required on the lanes carrying the loaded trucks are 2.46 times greater on the average as compared to the lanes carrying the empty trucks. Examples of pavement repair are the patches shown in Pictures 1,5, and 9.

3. The lanes carrying loaded trucks have a measured roughness of about 1.30 times greater than the lanes carrying empty trucks. On some highway sections excessive rutting was found although the roughness values showed a relatively smooth longitudinal profile.

4. Truck traffic on the highways studied was found to be as much as three times the usual volume with a high of 33.8 percent of the total traffic. The truck stops and intersections along the highways have an appearance similar to a beehive, particularly during the "first load" period in the morning hours.

5. The large number of pavement repairs in the lanes carrying loaded trucks indicates about 71 percent of the pavement repair maintenance efforts are used on the loaded lanes. The percentage values are based on the measured repair areas reported above. The pavement maintenance costs were found to range from $295 to $23,540 per mile each year. By comparison, the pavement maintenance cost of a typical low volume highway carrying normal truck traffic will be about $200 per mile per year. The detailed costs for each highway studied may be found in Appendix B.

With pavement repairs required on the loaded lanes in the range of 2 to 3 times the amount required on the return lanes, a similar relationship may be expected with major reconstruction of the roadways. It may be reasoned that the loaded lanes are failing 2 or 3 times faster than the return lanes. It follows that highways carrying large volumes of heavy loads will wear out faster and fail, and require rehabilitation and reconstruction at 2 to 3 times the rate expected for highways carrying a normal traffic load. Or, the highways having the large volumes of heavy loads will need an improved structure requiring considerable additional funding.

B. Example of Resurfacing Costs

FM-3013 was one of the highways analyzed in this study. The section of highway from Eagle Lake to the San Bernard River was orginally constructed in 1975. Presently, the pavement carries about 2500 vehicles per day with approximately 33 percent trucks. The majority of trucks contain aggregate material. The trucks are loaded in the northbound lanes and return empty in the southbound lanes. The major pavement distress is extreme rutting in the northbound lanes. The possibility of a safety hazard exists because of hydroplaning during periods of rainfall. Also standing water can migrate through the asphaltic surface, softening the subbase and subgrade leading to rapid deterioration of the pavement structure. Because of these conditions the pavement requires a level-up and resurfacing after only three years of service. The cost for this resurfacing is estimated to be $262,936.55 (a 7.2 mile length or $36,518.97/mile).

C. Study Locations

The highways selected for study were as follows:

District 12

US-71, Matagorda County, From SH-35 to Wharton County Line

SH-60, Matagorda County, From FM-2668 to FM-521

SH-159, Austin County, From Fayette County Line to FM-109 in Industry

FM-109, Austin County, From Colorado County Line to SH-159 in Industry

FM-2668, Matagorda County, From FM-3057 to FM-521

FM-2977, Fort Bend County, From FM-762 to FM 361

District 13

US-90A, Colorado and Wharton County, From Eagle Lake to the West San Bernard River

FM-109, Colorado County, From 5 miles north of SH-71 to SH-71

FM-2614, Colorado County, From FM-950 to FM-102

FM-3013, Colorado County, From US-90A at Eagle Lake to the San Bernard River

FM-2614 was divided into two study sections since an aggregate source was found near the county line and about midway between the limits noted above. Visible distress was noted in the westbound lanes from the aggregate source west (to FM-950). However, the pavement damage was more pronounced in the eastbound lanes from the aggregate source east (to FM-102).

Figure 1 shows the highways studied and Appendix B offers a summary of data collected along with pictures of the present condition.

D. Overweight Loads

The maximum legal gross load is 80,000 pounds with up to 20,000 pounds permitted on a single axle and 34,000 pounds on a tandem axle. Overweight loads are common in Texas and based upon the information in Appendix A, overloads are common in other states also. Typical overweight loads contain green or wet grain, brick, gravel and lumber as well as specialized equipment. The timber industry ships logs which cantilever over the end of a trailer causing heavy loads on the rear axle.

The Department of Public Safety indicates some 33,600 citations were issued in 1977 for gross weight overloads. Among these but possibly in addition were 1,022 citations for weights exceeding 20,000 pounds on a single axle

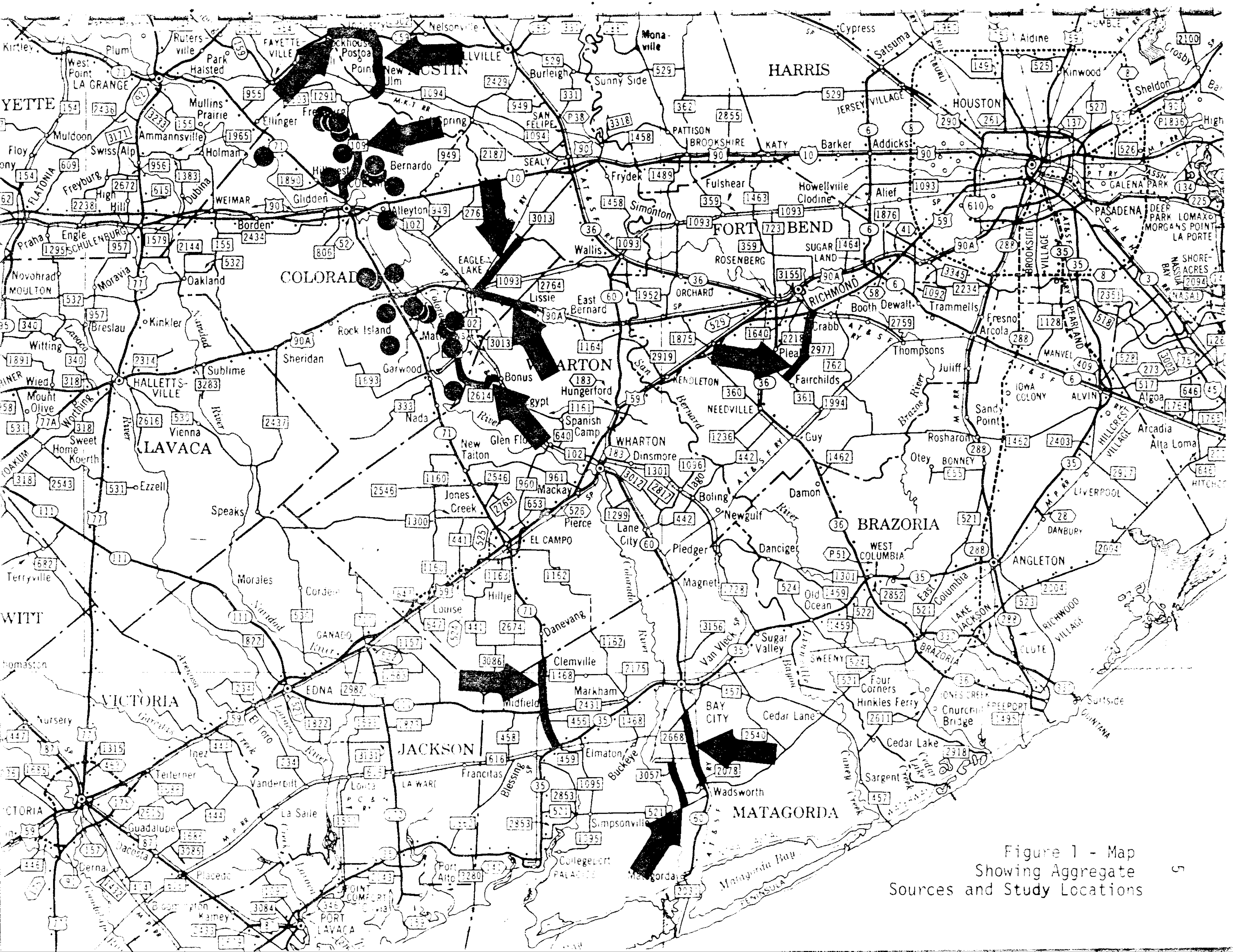


Figure 1 - Map Showing Aggregate Sources and Study Locations

and 5,988 citations for weights exceeding 34,000 on a dual axle. Also 66,611 warning tickets were given for overload violations. Thus a total of over 100,000 overloads were recognized by the Department of Public Safety. No overweight information is readily available for the loads in the study area.

APPENDIX A

Newspaper Article

Post/commentary

Roadruiners

The United States has a magnificent highway system that, as it nears completion, is already pocked with holes on the most traveled sections. A highway trade organization estimates that there are 116 million potholes across the country, in addition to cracks, fractures, worn shoulders, rough rural roads and thousands of defective, even dangerous, bridges.

The damage was worsened by the snow and ice of an unusually harsh winter. Accidents are happening, cars being damaged, because of the chuckholes and fractures. Several hundred truckers staged a slowdown in Pennsylvania to protest broken springs and ruined tires that they blame on the bad surface of Interstate 70. Meanwhile, various federal and state agencies blame part of the highway deterioration on overloaded trucks. The Federal Highway Administration estimates that the interstate highways are wearing out 50 percent faster than they are being repaired. The federal government has censured 14 states for failure to enforce weight limits and warned another 12 to be more accurate in their weight inspections.

Congress has raised the weight limit from 73,280 pounds in 1974 to 80,000 pounds. But seven states right down the center of the country refuse to go along. Indiana's State Highway Commission says heavier trucks would cost the state an extra $14 million a year in highway repair and it is already $80 million short in keeping up with maintenance as it is.

Congress raised the limit in hopes of reducing the number of trips and thereby saving fuel. Unfortunately, many trucks ignore the limit. The Illinois Department of Transportation estimates that a tractor-trailer only 5 percent above the legal weight does as much highway damage as 10,000 cars. Other studies show that a truck overloaded by 20 percent does twice the damage of a legal load. Checking at random 1,792 truckloads of coal delivered to Tennessee Valley Authority power plants, Tennessee found that 1,367 were overweight — some as much as 25,000 pounds. Massachusetts found some trucks carrying up to 140,000 pounds; truckers have now agreed to hold their weights down to 100,000 in Massachusetts — still 20,000 above the federal limit.

The federal government is committed to financing 90 percent of the interstate system construction. The states are to supply the other 10 percent and maintenance. Now states say they cannot afford the repairs. The 55 mph speed limit has reduced fuel use, thereby lowering the total of gasoline taxes paid to states by $2.3 billion. Transportation Secretary Brock Adams proposes to wind up construction on the system quickly and shift spending to road repair. This would leave the states to finish the missing segments, some of them controversial. "One thing I want to avoid," Adams says, "is letting the existing highway system collapse." To many a Houstonian, the interstate system is essential simply to get from home to work and back. It must be preserved.

APPENDIX B

Pictures and Data of the Study
Locations Related to Heavy Loads

Picture 1.

SH-71 Matagorda County From: SH-35
9.43 Miles, Control 266-7 To: Wharton County Line

History

Concrete pavement originally placed in 1931. A small section has been overlaid with asphaltic concrete.

Traffic

Average Daily Traffic	=	2520
13 hour count July, 1978	=	1899
Truck count July, 1978	=	482
% Trucks July, 1978	=	25.3

Present Condition			Ratio
Rut Depth, Not Applicable			
Repair Areas,	Loaded Lanes	2713 ft/mi	1.51
	Return Lanes	1797 ft/mi	
Roughness,	Loaded Lanes	478 in/mi	1.87
	Return Lanes	256 in/mi	

Pavement Repair Costs

1975-76	=	$ 3,095.43/mi
1976-77	=	15,685.22/mi
1977-78 (9 months)	=	23,540.61/mi

Picture shows some of the repair areas which are dominant on the Southbound or loaded lane. The concrete slabs have faulted. The surface is uneven and rough. Traffic must slow down and trucks are straddling the centerline or traveling with the right wheels on the shoulder as shown in Picture 2. Maintenance costs have increased by a factor of seven in three years.

Picture 1

Picture 2

Section 3.

SH-60 Matagorda County, From: FM 2668
7.55 Miles, Control 241-4 To: FM 521

History

Concrete pavement originally placed in 1932. Widened from 18-feet to 24-feet and resurfaced with asphalt in 1967. Overlaid with 1-inch asphalt in 1970.

Traffic

Average Daily Traffic	=	3280
13 hour count July, 1978	=	3082
Truck count July, 1978	=	79
% Trucks July, 1978	=	2.6

Present Condition			Ratio
Rut Depth,	Loaded Lanes -	0.10 inches	2.0
	Return Lanes -	0.05 inches	
Repair Areas,	Loaded Lanes -	32 ft/mi	2.42
	Return Lanes -	13 ft/mi	
Roughness,	Loaded Lanes -	35 in/mi	1.06
	Return Lanes -	33 in/mi	

Pavement Repair Costs

1975-76	=	$ 2,252.76/mi
1976-77	=	1,744.80/mi
1977-78 (9 months)	=	1,567.44/mi

Picture not available

Picture 4

FM-2668	Matagorda County,	From:	FM-3057
	5.15 Miles, Control 2697-1	To:	FM 521

History

Flexible pavement and asphaltic surface originally placed in 1964. Resurfaced in 1968 and 1977.

Traffic

Average Daily Traffic	=	1310
13 hour count July, 1978	=	1224
Truck count July, 1978	=	81
% Trucks July, 1978	=	6.6

Present Condition			Ratio
Rut Depth,	Loaded Lanes -	0.39 inches	2.44
	Return Lanes -	0.16 inches	
Repair Areas,	Loaded Lanes -	9 ft/mi	4.50
	Return Lanes -	2 ft/mi	
Roughness,	Loaded Lanes -	149 in/mi	1.10
	Return Lanes -	136 in/mi	

Pavement Repair Costs

1974-75	=	$ 3,525.23
1975-76	=	2,984.18 *
1976-77	=	4,423.37

*Resurfacing Contract Completed in 1976 = $157,793.90

The picture shows a surface which is flushed in the loaded lanes. The return lanes have minor flushing. The surface was sealed in 1976. This seal hides much of the prior distress.

Picture 4

Picture 5

FM-2977 Fort Bend County — From: FM-762
7.89 Miles, Control 3048-1 — To: FM-361

History

Flexible base with asphalt surface originally placed in 1968 (additional 2 miles placed in 1971). Resurfaced in 1975.

Traffic

Average Daily Traffic	=	840
13 hour count July, 1978	=	932
Truck count July, 1978	=	48
% Trucks July, 1978	=	5.2

Present Condition			Ratio
Rut Depth,	Loaded Lanes - 1.23 inches		1.89
	Return Lanes - 0.65 inches		
Repair Areas,	Loaded Lanes - 151 ft/mi		0.83
	Return Lanes - 181 ft/mi		
Roughness,	Loaded Lanes - 91 in/mi		1.08
	Return Lanes - 84 in/mi		

Pavement Repair Costs

1974-75	=	$ 1,068.81 *
1975-76	=	1,716.44
1976-77	=	10,768.13

* Resurfacing Contract Completed in 1975 $127,085.46

Picture shows loss of original cross-section particularly on loaded lanes. On this roadway almost every conceivable type of distress may be noted - patches, rutting, shear failures, extensive alligator cracking and excessive roughness. These types of failure are associated with heavy loads. Note the resurfacing in 1975 has helped to reduce repair costs in 1975-76 but the repair costs are increasing in 1976-77.

Picture 5

Picture 6

SH-159, Austin County, From: Fayette County Line
To: FM 109 in Industry
4.85 miles Control 408-2

History

Flexible base with asphalt surface originally placed in 1936. Approximately 2.4 miles reconstructed in 1941. Reconstructed in 1949. Resurfaced in 1954 and 1961.

Traffic

Average Daily Traffic	=	870
13 hour count July, 1978	=	674
Truck count July, 1978	=	19
% Trucks July, 1978	=	2.8

Present Condition				Ratio
Rut Depth,	Loaded Lanes	=	0.28 inches	2.15
	Return Lanes	=	0.13 inches	
Repair Areas,	Loaded Lanes	=	645 ft/mi	1.52
	Return Lanes	=	423 ft/mi	
Roughness,	Loaded Lanes	=	73 in/mi	0.86
	Return Lanes	=	85 in/mi	

Pavement Repair Costs

1975-76	=	$7,042.21
1976-77	=	9,758.64
1977-78 (9 months)	=	7,854.54

Picture shows a load oriented longitudinal crack in right wheel path of loaded lanes along with spalling and minor pot holes. Typically a longitudinal crack will occur in the left wheel path; ladder or block cracking will occur; and the blocks will loosen and be whipped out by traffic.

Picture 6

Picture 7

FM-109, Austin County, From: Colorado County Line
To: SH 159 in Industry
6.96 miles Control 716-1

History

Flexible base with base preservative originally placed in 1948. Another base preservative placed in 1953. Resurfaced in 1953, 1960, 1966 and 1972.

Traffic

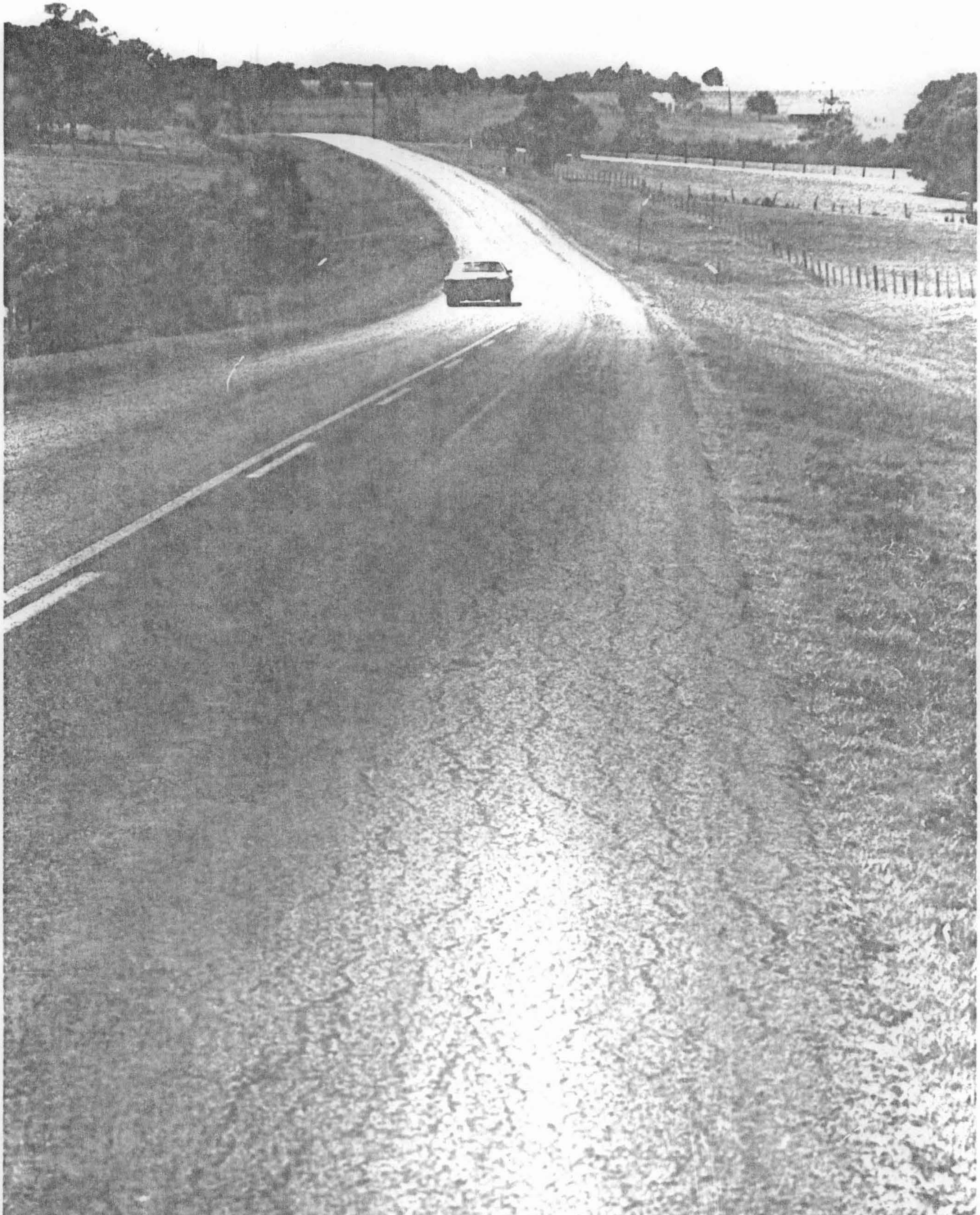
Average Daily Traffic	=	860
13 hour count July, 1978	=	769
Truck count July, 1978	=	142
% Trucks July, 1978	=	18.5

Present Condition				Ratio
Rut Depth,	Loaded Lanes	=	0.17 inches	1.70
	Return Lanes	=	0.10 inches	
Repair Areas,	Loaded Lanes	=	27 ft/mi	1.69
	Return Lanes	=	16 ft/mi	
Roughness,	Loaded Lanes	=	112 in/mi	1.08
	Return Lanes	=	104 in/mi	

Pavement Repair Costs

1975-76	=	$3,492.78
1976-77	=	2,500.20
1977-78 (9 months)	=	1,994.13

Picture shows excessive rutting and alligator cracking typical of the loaded lanes. This type of distress is associated with heavy loads.



Picture 7

Picture 8

US-90A, Colorado and Wharton Counties
From: FM 3013 in Eagle Lake
To: West San Bernard River
7.60 miles Control 27-3 and 27-4

History

Flexible base and asphalt surface originally placed in 1923 (Wharton Co.) and 1928 (Colorado Co.). Reconstructed in 1953 (Colorado Co.) and 1955 (Wharton Co.). Colorado Co. resurfaced in 1957, 1969. Wharton Co. resurfaced in 1958, 1961, 1971. Total length resurfaced in 1975-76.

Traffic

Average Daily Tarffic	=	4020
13 hour count July, 1978	=	4232
Truck county July, 1978	=	792
% Trucks July, 1978	=	18.7

Present Condition				Ratio
Rut Depth,	Loaded Lanes	=	0.665 inches	3.02
	Return Lanes	=	0.22 inches	
Repair Areas,	Loaded Lanes	=	49 ft/mi	1.14
	Return Lanes	=	43 ft/mi	
Roughness,	Loaded Lanes	=	78 in/mi	1.50
	Return Lanes	=	52 in/mi	

Pavement Repair Costs

1975-76	=	$1,582.00 *
1976-77	=	944.00
1977-78	=	534.00 (9 months)

* Major rehabilitation in 1974-75 - $76,476/mi

Picture shows misalignment of edgeline on the loaded Eastbound lane toward Houston. Misalignment has been caused by pavement material shoved out by the shearing action of heavy loads. Rutting in the wheel paths may also be noted. Note major rehabilitation in 1974-75 has helped reduce repair costs in 1976-78.

Picture 8

Picture 9

FM-2614 - Colorado and Wharton Counties, From: FM 950
To: FM 102
6.61 miles Control 2599-1 and 2599-2.

History

Flexible base and asphalt surface originally placed in 1962. Aside from minor maintenance reconstruction, the highway was resurfaced in 1974.

Traffic	Wharton County	Colorado County
Average Daily Traffic	980	1,450
13 Hour Count, July, 1978	726	581
Truck Count, July, 1978	104	72
% Trucks, July, 1978	14.3	12.4

Present Condition	Eastbound Wharton County		Westbound Colorado County	
Rut Depth - Loaded Lanes	.215 in.	2.69	.145 in.	2.90
Return Lanes	.08. in.		.05 in.	
Repair Areas-Loaded Lanes	1526 ft/mi	2.26	359 ft/mi	6.08
Return Lanes	675 ft/mi		59 ft/mi	
Roughness - Loaded Lanes	126 in/mi	1.33	180 in/mi	1.78
Return Lanes	95 in/mi		101 in/mi	

Pavement Repair Costs 1975-76 = $6,923.00
1976-77 = 693.00
1977-78 = 507.00 (9 months)

Picture shows shear failures, cracking and repair areas typical of the loaded lanes. The condition of this pavement is a good example of damage caused by loading. An aggregate source is located near the county line of Colorado and Wharton Counties. The loaded lanes eastbound in Wharton County show more distress than the return lanes. However, the westbound lanes carry the loaded trucks in Colorado County and the westbound lanes have more distressed areas than the eastbound lanes. Note major maintenarce occurred during 1975-76 which reduced repair costs in following years.

Picture 9

Picture 10

FM 109 - Colorado County, From: 5 miles north SH-71
To: SH-71
5.0 Miles, Control 716-2

History

Flexible base and asphalt surface originally placed in 1938. A 2.8 mile length from Brushy Creek South was reconstructed in 1959. Resurfaced in 1972.

Traffic

Average Daily Traffic	= 1210
13 Hour Count, July, 1978	= 1612
Truck Count, July, 1978	= 172
% Trucks, July, 1978	= 10.7

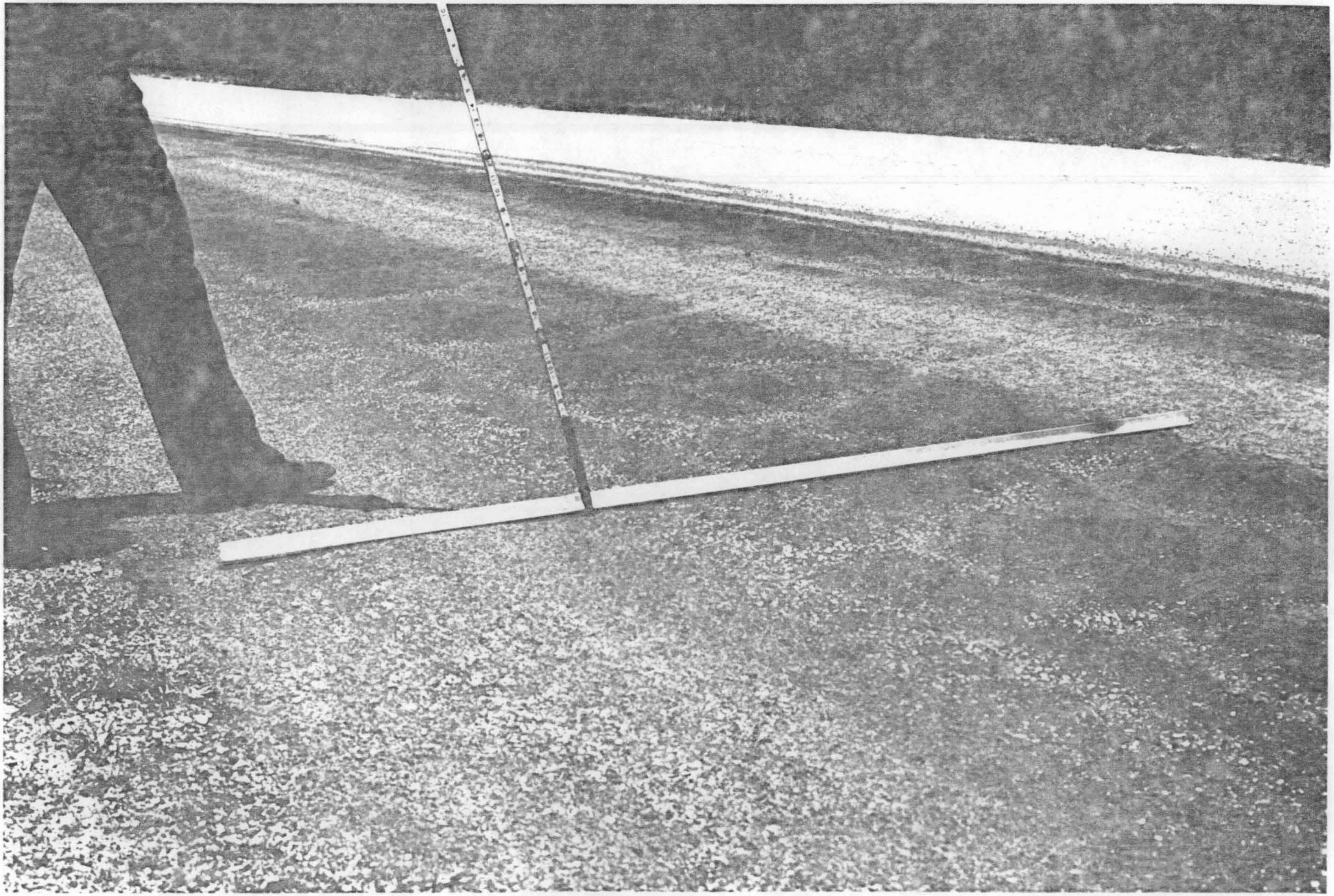
Present Condition

			Ratio
Rut Depth,	Loaded Lanes =	.31 in.	1.48
	Return Lanes =	.21 in.	
Repair Areas,	Loaded Lanes =	277 ft/mi	2.61
	Return Lanes =	106 ft/mi	
Roughness,	Loaded Lanes =	95 in/mi	1.14
	Return Lanes =	83 in/mi	

Pavement Repair Costs

1975-76 =	$5,151.00
1976=77 =	417.00
1977-78 =	293.00 (9 months)

Picture shows load oriented alligator and ladder cracking with the surface broken into small blocks. The blocks have vaulted and the surface has become misshapen. A seal coat or crack sealing has been placed over the cracked area in an attempt to hold the blocks in place and prevent the entry of rain water which would soften the base and subgrade. The cracks are beginning to open again. There is little or no distress on the northbound return lanes in this area. Note major maintenance occurred during 1975-76 which reduced repair costs in the following years.



Picture 10

Picture 11

FM 3013, Colorado County, From: US-90A at Eagle Lake
To: San Bernard River
7.17 mile length Control 3205-2

History

Flexible base, asphalt stabilized base and a asphaltic concrete surface originally placed in 1973. No re-construction or resurfacing since that time even though pavement revision is planned.

Traffic

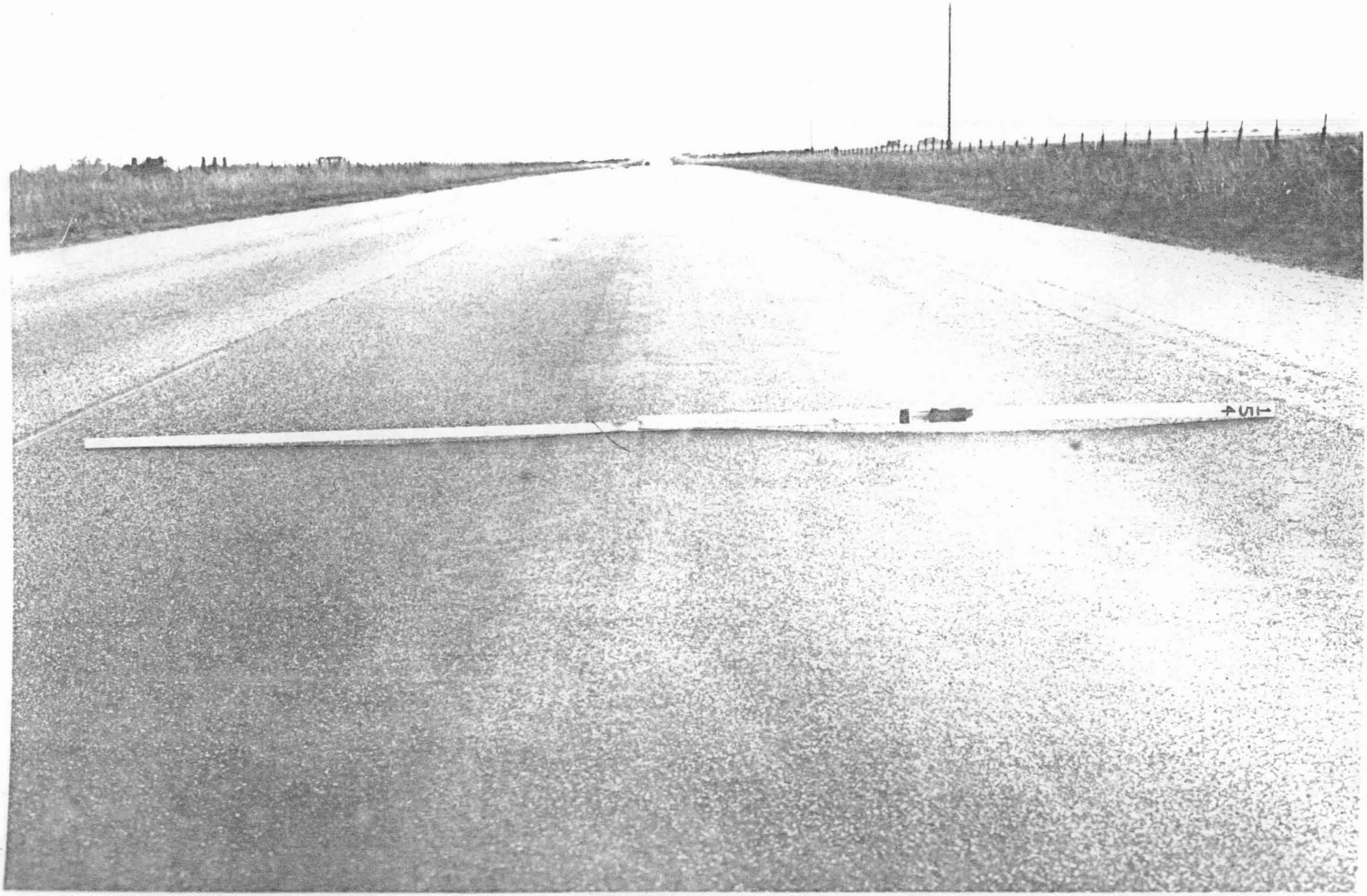
Average Daily Traffic	=	2,520
13 Hour Count, July 14, 1978	=	2,763
Truck Count July 14, 1978	=	906
% Trucks July 14, 1978	=	33.8%

Present Condition			Ratio
Rut Depth, Loaded Lanes	=	0.70-in.	3.11
Return Lanes	=	0.23-in.	
Repair Areas, Loaded Lanes	=	1 ft/mi	N/A
Return Lanes	=	None	
Roughness, Loaded Lanes	=	57 in/mi	1.54
Return Lanes	=	37 in/mi	

Pavement Repair Costs			
1975-76 =	$	402.00	
1976-77 =		958.00	
1977-78 =		36,814.00	* (9 months)

*Current contract for asphaltic concrete overlay - to be performed soon.

Picture shows extreme rut depths in loaded lanes. Since the highway is relatively new, the repair areas are few and the surface is smooth. The highway is nice with an excellent geometric layout - dark surface and contrasting white shoulders. The highway will carry high speed traffic and hydroplaning will be a problem during periods of rainfall because of the excessive water depths in the rutted wheel paths. Where water can accumulate to depths of 0.1-inch, hydroplaning can readily occur at speeds of approximately 50 mph. Even at lower speeds partial loss of control is a serious problem which must be considered.



Picture 11

APPENDIX C

Description of Measurements
and
Traffic Counts

Description of Measurements
and Traffic Counts

Measurements

The measurements obtained were of three types as follows:

1. Pavement Roughness - Obtained with a Mays Road Meter (MRM)

   The resulting values are given in terms of roughness in inches per mile. This measurement is obtained with a calibrated trailer towed by an automobile at 50 mph. The measurement collected is the cumulative bounce or vertical movement between the axle and body of the trailer. A zero value would be extremely smooth and values of 100 to 200 inches per mile are found on very rough pavements.

2. Visible Repair Areas - A Manual Count and an Estimated Length of Pavement Repair which is 12-foot in Width

   Repair areas less than 12-feet in width were extrapolated to an equivalent 12-foot width. The repairs included were made since the last surfacing. Some repairs made prior to the last surfacing were visible but were not included. Generally, repairs appeared to be patches made by sealing or light overlays. Pot holes up to 2-feet in diameter were counted separately but not used in the report.

3. Rut Depth

   Obtained by using a straight edge placed transversely to the pavement and measuring a vertical (rut) depth in the wheel path area. Measurements were collected in both the left and right wheel paths and averaged for final summaries.

Traffic Counts

Traffic counts were obtained during the period of July 14, 1978, through July 26, 1978. The counts were obtained visually throughout a 13-hour period (generally during daylight hours). A summary of the counts may be found in Appendix B. Note the "ADT" column may be considered an annual average daily traffic but the "13 hour" column is the count during this time period (the count was not extrapolated to a 24 hour basis).