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# AN ESTIMATE OF THE COST TO RESURFACE PAVEMENTS AND BRIDGES DAMAGED BY STUDDED TIRES



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**RESEARCH LITERATURE**

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*Includes--"Iowa Studded Tire Survey--1971-72" and "Studded Tire Report"

## SUMMARY

This report contains an estimate of the cost of highway resurfacing necessitated by damage from studded tires. The total is $95,620,000 for the twenty-five years from 1971 to 1996. This total includes $51,937,000 to resurface pavements and bridges on Interstate routes and $43,683,000 for other Primary highways.

The estimate for Interstate routes includes those sections now open to traffic and those planned for completion by November 1974. The estimate for other Primary routes includes rural and municipal sections open to traffic as of November 1970.

The estimate was prepared by computing the cost of expected pavement and bridge resurfacing costs for the twenty-five year period assuming continued use of studded tires, then subtracting from this the expected resurfacing cost for the same period assuming that the use of studded tires is prohibited.

The total figure, $95,620,000, should be regarded as a conservative estimate of the cost which may be avoided by prohibiting the use of studded tires in Iowa. The conservative nature of the estimate may be demonstrated by the following examples of the guidelines used in its preparation.

1. Only mainline pavements were included in the cost estimate for the Interstate routes. The connecting loops, exit ramps and entrance ramps at Interstate interchanges contain many additional miles of pavement subject to wear by studded tires. This pavement was omitted from the estimate because reliable information about the rate of pavement wear at such locations is not available. As a result, the Interstate resurfacing costs are underestimated.

2. Several other costs were also omitted from the estimate because of a lack of sufficient information. These include the cost of repairing damage caused by studded tires to city streets other than those designated as Primary routes, the damage to pavements and bridges on the more-heavily travelled Secondary roads, and the damage to pavement traffic markings on all highway systems.

Experience indicates that portland cement concrete pavements in Iowa have a normal service life of twenty-five years before resurfacing becomes necessary. The service life for asphalt pavements is thirteen years. In making this cost estimate, the need for resurfacing was attributed to wear from studded tires only when the normal service life of the pavement was shortened by that wear. Consequently, this cost estimate does not account for the reduced safety and convenience to Iowa motorists during the time when pavement wear caused by studded tires is significant but less than the critical amount.

## INTRODUCTION

The use of studded tires in Iowa became legal in 1967. Since that time it has become increasingly evident in Iowa, as well as in other states, that studded tires inflict severe damage to highway pavements and bridge floors. Ultimately, the damage reaches the point where resurfacing must be applied in order to maintain the pavements and bridge floors in a serviceable and safe condition.

This report is an estimate of the cost of such resurfacing during the twenty-five years from 1971 to 1996. The costs are shown separately for pavements and bridges and for individual Interstate routes in the tables included in this report.

## FACTORS INCLUDED IN THE COST ESTIMATE

Several of the factors affecting the cost estimate are of sufficient importance to warrant explanation. These are identified as follows and are discussed in succeeding sections of this report.

Vehicles with studded tires
Traffic
Wear of pavements and bridge floors
Resurfacing costs

## VEHICLES WITH STUDDED TIRES

Surveys made by Commission personnel indicate that the number of vehicles equipped with studded tires on Iowa highways has increased at the rate of about 7.5 percent per year for the past two years. The survey made in the winter 1970-71 showed 25.6 percent of the passenger cars on Interstate roads were equipped with studded tires.

In computing the cost estimate, the basic studded tire usage was set at 25.6 percent for 1970-71 with increasing annual rates to a maximum of 60.0 percent in 1975-76 and the years thereafter.

It was assumed that vehicles are equipped with studded tires only on the rear wheels.

## TRAFFIC

The traffic estimates are based on traffic counts made in 1970. They include only passenger cars, pick-up trucks and panel trucks.

Pavement wear due to studded tires occurs only during the months from November to April. The average daily traffic during this period is less than the average annual daily traffic. This seasonal variation in traffic was taken into account in preparing the cost estimate.

Traffic on Interstate and other Primary routes is expected to increase during the twenty-five years of the cost estimate. This increase is reflected in the cost estimate at the following rates:

| | | |
|---|---|---|
| Interstate: | 5.0% of 1970 traffic annually | 1970 to 1980 |
| | 2.5% of 1970 traffic annually | 1981 to 1996 |
| Primary: | 3.0% of 1970 traffic annually | 1970 to 1980 |
| | 1.5% of 1970 traffic annually | 1981 to 1996 |

Traffic volume estimates are generally reported on the basis of two-way traffic. Pavement wear caused by studded tires varies according to the traffic in each lane. For two-lane highways the effective traffic is one-half of the two-way estimate.

On four-lane roads, the traffic in each lane depends upon the total traffic volume. In this estimate, the volume of traffic assigned to one lane on four-lane roads varies from 44 percent for two-way traffic less than 6,000 vehicles per day to 25 percent for traffic of 28,000 vehicles or more.

The maximum amount of traffic carried by any one lane of a six-lane highway was estimated to be 22.5 percent of the total two-way traffic.

## WEAR OF PAVEMENTS AND BRIDGE FLOORS

The wear of pavements and bridge floors caused by studded tires results in depressions or troughs in the wheel paths. These troughs are detrimental to highway safety as described in the following:

1. The troughs interfere with steering control during lane-changing maneuvers.

2. Driver visibility is reduced in wet weather by the splash and spray from water accumulated in the troughs.

3. The water accumulated in the troughs may be sufficient to cause hydroplaning. This occurs when the tires on the front wheels lose contact with the pavement surface because of a wedge of water between the tire and the pavement. The result is partial or complete loss of braking and steering control.

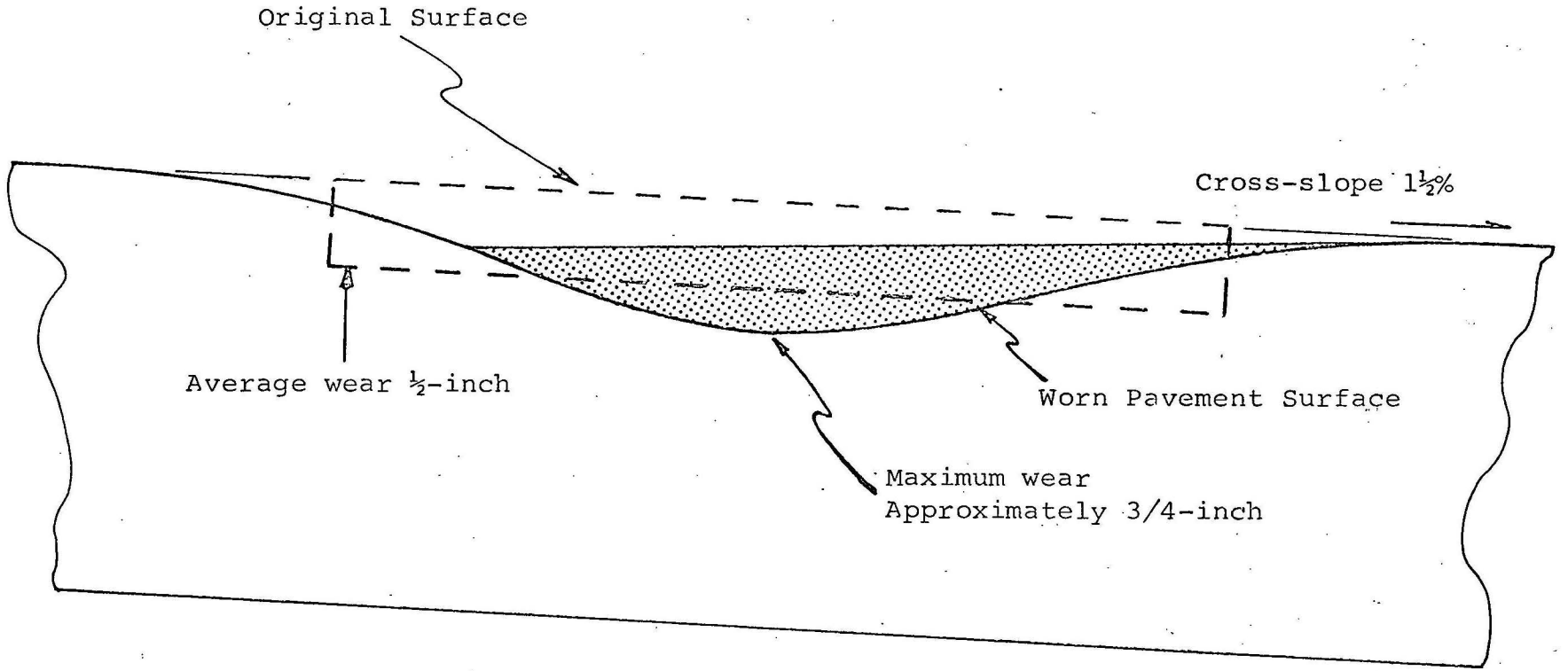
In order to minimize these potential hazards to safe driving, pavements and bridge floors should be resurfaced when the average depth of wear in the wheel paths reaches 0.5 inch. This criterion was used to determine the need for resurfacing. See illustration page 6.

The number of applications of studded tires necessary to produce the critical wear of 0.5 inch is:

Portland cement concrete pavements and bridge floors: 5,400,000

Asphalt pavements and bridge surfaces: 2,800,000

The above figures were obtained from pavement wear studies in Minnesota. Those studies included both accelerated wear tests in a laboratory and the measurements of wear on in-service pavements. Selection of the Minnesota wear rates in making this estimate is justified by the similarity between Iowa and Minnesota pavements.




Possible accumulation of water

ILLUSTRATION OF PAVEMENT CONDITION WHEN RESURFACING IS REQUIRED

## RESURFACING COSTS

Resurfacing costs used in this estimate are as follows:

| | |
|---|---|
| 4-lane Interstate pavement | $48,000 per mile |
| 6-lane Interstate pavement | $68,000 per mile |
| 2-lane Primary pavement | $15,500 per mile |
| 4-lane Primary pavement | $28,800 per mile |
| Bridge floors | $13.50 per sq. yd. |

All costs are based on asphalt resurfacing with the addition of a waterproof membrane on bridge floors.

Where the existing pavement surface is portland cement concrete, the first resurfacing was estimated to be 2.5 in. thick and cost double the rates shown above. The second resurfacing and all thereafter was estimated to be 1.25 in. thick and to cost the amounts shown.

Where the existing pavement surface is asphalt, all resurfacings were estimated at 1.25 in. and at the rates shown above.

TOTAL REPAIR COSTS
DUE TO STUDDED TIRES 1971-96

| | Pavement | Bridges | Total |
|---|---|---|---|
| Interstate | $39,866,487 | $12,070,710 | $51,937,197 |
| Primary | $24,855,908 | $18,826,985 | $43,682,893 |
| Total | $64,722,395 | $30,897,695 | $95,620,090 |

INTERSTATE ROUTES

REPAIR COSTS DUE TO STUDDED TIRES

| Route Number | Cost ($) | | |
|---|---|---|---|
| | Pavements | Bridges | Total |
| I-29 | 3,370,128 | 1,118,806 | 4,488,934 |
| I-35 | 8,516,256 | 1,654,136 | 10,170,392 |
| I-74 | 599,040 | 55,080 | 654,120 |
| I-80 | 19,614,896 | 2,474,268 | 22,089,164 |
| I-80N | 95,616 | 24,064 | 119,680 |
| I-235 | 5,133,815 | 4,468,634 | 9,602,449 |
| I-380 | 2,208,384 | 619,070 | 2,827,454 |
| I-480 | 328,352 | 1,656,652 | 1,985,004 |
| Total | 39,866,487 | 12,070,710 | 51,937,197 |

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| Mo. State Ln. - Ia. 2 (1 mi. S.) | 8.9 | PC | 4 | -0- | -0- | -0- |
| Ia. 2 - FAS 760 (1 mi. S.) | 11.1 | PC | 4 | 159,840 | 9,735 | 169,575 |
| FAS 760 - Mills Co. Ln. | 5.4 | PC | 4 | 184,032 | 61,908 | 245,940 |
| Mills Co. Ln. - US 34 | 6.5 | PC | 4 | 196,560 | 31,487 | 228,047 |
| US 34 - I-80 (East) | 16.1 | PC | 4 | -0- | -0- | -0- |
| I-80 (East) - Ia. 192 | 1.0 | PC | 4 | -0- | -0- | -0- |
| Ia. 192 - I-80 (West) | 2.0 | PC | 4 | 34,560 | 10,314 | 44,874 |
| I-80 (West) - 23rd Ave. (Co. Bluffs) | 0.8 | PC | 4 | 21,120 | 8,237 | 29,357 |
| 23rd Ave. - 9th Ave. | 0.8 | PC | 4 | 28,800 | 23,085 | 51,885 |
| 9th Ave. - I-480 | 0.6 | PC | 4 | 31,680 | 36,231 | 67,911 |

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| I-480 - NCL (Co. Bluffs) | 3.3 | PC | 4 | 82,368 | 69,905 | 152,273 |
| NCL (Co. Bluffs) - I-80N | 14.5 | PC | 4 | 696,00 | 27,216 | 723,216 |
| I-80N - US 30 | 4.5 | PC | 4 | 185,760 | 43,228 | 228,988 |
| US 30 - Ia. 175 | 36.6 | PC | 4 | 228,384 | 43,306 | 271,690 |
| Ia. 175 - Woodbury Co. L. | 14.0 | PC | 4 | 154,560 | 2,263 | 156,823 |
| Woodbury - Salix Int. Co. L. | 7.6 | PC | 4 | 167,808 | -0- | 167,808 |
| Salix Int. - Ia. 378 | 7.2 | PC | 4 | 273,024 | -0- | 273,024 |
| Ia. 378 - US 75 | 2.0 | PC | 4 | 103,680 | 37,215 | 140,895 |
| US 75 - Wall St. (Sioux City) | 4.3 | AC | 4 | 291,024 | 43,767 | 334,791 |
| Wall St. - US 20 (East) | 0.7 | AC | 4 | 103,488 | 593,960 | 697,448 |

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| US 20 (East) - US 20, US 77 | 0.5 | AC | 4 | 97,920 | -0- | 97,920 |
| US 20, US 77 - Isabella | 0.5 | AC | 4 | 85,920 | -0- | 85,920 |
| Isabella - Riverside (Ia. 12) | 2.0 | AC | 4 | 223,680 | 39,315 | 262,995 |
| Riverside (Ia. 12) - Mo. River Bridge | 0.5 | AC | 4 | 19,920 | 37,634 | 57,554 |
| TOTAL | 151.4 | | | 3,370,128 | 1,118,806 | 4,488,934 |

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Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| Mo. Line - Ia. 2 | 12.8 | PC | 4 | -0- | -0- | -0- |
| Ia. 2 - US 34 | 20.4 | PC | 4 | -0- | -0- | -0- |
| US 34 - Warren Co. Line | 9.7 | AC | 4 | 60,528 | 2,276 | 62,804 |
| Warren Co. Line - Ia. 5 | 25.5 | AC | 4 | 269,280 | 7,156 | 276,436 |
| Ia. 5 - I-80 (South) | 4.7 | PC | 4 | 160,176 | 95,612 | 255,788 |
| I-80 (South) - Douglas Avenue | 2.5 | PC | 4 | 270,000 | 110,187 | 380,187 |
| Douglas Ave. - Ia. 401 | 5.2 | PC | 4 | 436,800 | 63,619 | 500,419 |
| Ia. 401 - I-80 (North) | 6.7 | PC | 4 | 749,328 | 626,234 | 1,375,562 |
| I-80 (North) - Polk Co. F 32 | 5.2 | PC | 4 | 534,144 | 36,979 | 571,123 |
| Polk Co. F 32 - US 30 | 19.4 | PC | 4 | 1,126,752 | 109,772 | 1,236,524 |
| US 30 - US 20 | 32.1 | PC | 4 | 493,056 | 48,892 | 541,948 |

I-35

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| US 20 - Ia. 106 | 48.6 | PC | 4 | 2,566,080 | 255,663 | 2,821,743 |
| Ia. 106 - Ia. 9 | 10.5 | PC | 4 | 841,680 | 278,396 | 1,120,076 |
| Ia. 9 - Minn. Line | 14.9 | PC | 4 | 1,008,432 | 19,350 | 1,027,782 |
| TOTAL | 218.2 | | | 8,516,256 | 1,654,136 | 10,170,392 |

I-80

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| Missouri River - I-29 | 0.8 | PC | 4 | 15,744 | 45,693 | 61,437 |
| I-29 - I-80N | 23.8 | PC | 4 | 205,632 | 108,947 | 314,579 |
| I-80N - US 59 | 13.2 | PC | 4 | 709,632 | 97,665 | 807,297 |
| US 59 - US 71 | 20.0 | PC | 4 | 1,161,600 | 127,293 | 1,288,893 |
| US 71 - Adair Co. Line | 12.7 | PC | 4 | 597,408 | 125,802 | 723,210 |
| Adair Co. Line - Ia. 25 | 13.0 | AC | 4 | 848,640 | 69,676 | 918,316 |
| Ia. 25 - US 6 | 14.1 | AC | 4 | 1,015,200 | -0- | 1,015,200 |
| US 6 - I-35 (South) | 22.7 | PC | 4 | 1,492,752 | 227,760 | 1,720,512 |
| I-35 (North) - US 65 | 4.5 | PC | 6 | 669,600 | 216,497 | 886,097 |
| US 65 - US 6 | 16.9 | PC | 4 | 1,541,280 | 199,956 | 1,741,236 |
| US 6 - Ia. 14 | 5.2 | PC | 4 | 476,736 | 89,159 | 565,895 |
| Ia. 14 - Jasper Co. T22 | 9.3 | PC | 4 | 763,344 | 28,933 | 792,277 |

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Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| Jasper Co. T22 - Ia. 146 | 9.3 | AC | 4 | 1,004,400 | 193,868 | 1,198,268 |
| Ia. 146 - Ia. Co. W21 (1 mi. East) | 43.3 | PC | 4 | 3,450,144 | 266,988 | 3,717,132 |
| Ia. Co. W21 (1 mile East) - US 218 | 14.8 | AC | 4 | 1,314,240 | 204,413 | 1,518,653 |
| US 218 - Ia. 1 | 5.7 | PC | 4 | 487,008 | 102,921 | 589,929 |
| Ia. 1 - 2 mi. W of West Liberty Int. | 11.2 | PC | 4 | 819,776 | 23,103 | 842,879 |
| West Liberty Int. - Cedar River Br. | 8.1 | AC | 4 | 692,064 | 139,004 | 831,068 |
| Cedar River Br. - US 61 | 29.6 | PC | 4 | 1,633,920 | 24,478 | 1,658,398 |
| US 61 - I-74 | 2.3 | PC | 4 | 183,264 | 31,165 | 214,429 |
| I-74 - Mississippi R. | 8.6 | PC | 4 | 532,512 | 150,947 | 683,459 |
| TOTAL | 289.1 | | | 19,614,896 | 2,474,268 | 22,089,164 |

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Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| I-35 & I-80 - 63rd St. | 3.8 | PC | 4 | 747,840 | 619,514 | 1,367,354 |
| 63rd St. - 31st St. | 2.3 | PC | 6 | 1,359,111 | 495,955 | 1,855,066 |
| 31st - Cottage Grove | 0.6 | PC | 6 | 392,496 | 249,351 | 641,847 |
| Cottage Grove - Keoway | 0.6 | PC | 6 | 376,584 | 143,296 | 519,880 |
| Keoway - Penn Ave. | 1.3 | PC | 6 | 740,792 | 1,748,601 | 2,489,393 |
| Penn Ave. - Ia. 163 | 1.2 | PC | 6 | 703,392 | 97,855 | 801,247 |
| Ia. 163 - Easton Ave. | 0.5 | PC | 4 | 126,960 | 623,762 | 750,722 |
| Easton Ave. - Euclid | 1.6 | PC | 4 | 385,536 | 219,876 | 605,412 |
| Euclid - I-35 & I-80 | 1.7 | PC | 4 | 301,104 | 270,424 | 571,528 |
| Total | 13.6 | | | 5,133,815 | 4,468,634 | 9,602,449 |

I-74 I-80N I-380 I-480

Repair Costs Due to Studded Tires 1971-96

| Section (From-To) | Length (Mi) | Pavement Surface Type | Number Of Lanes | Additional Repair Costs Due to Studded Tires ($) | | |
|---|---|---|---|---|---|---|
| | | | | Pavement | Bridges | Total |
| I-74 | 5.2 | PC | 4 | 599,040 | 55,080 | 654,120 |
| I-80N | 16.6 | PC | 4 | 95,616 | 24,064 | 119,680 |
| I-380 | 14.2 | PC | 4 | 2,208,384 | 619,070 | 2,827,454 |
| I-480 | 0.8 | PC | 6-8 | 328,352 | 1,656,652 | 1,985,004 |

STUDDED TIRE REPORT
February, 1972

The following is a comparative analysis of three reports on studded tire wear which were released by Iowa, Pennsylvania and Wisconsin. The objectives of all three reports was to: (1) Estimate added maintenance costs as a result of the use of studded snow tires; (2) Re-emphasize the findings of the Minnesota Study (3) And to make concluding remarks on the future use of studded snow tires.

The three states estimated the following twenty-five year added maintenance costs precipitated solely by the use of studded snow tires:

| | | |
|---|---|---|
| Iowa | - | $ 95,620,000 |
| Wisconsin | - | $ 306,000,000 |
| Pennsylvania | - | $ 1,041,759,000 |

The following evaluation is concerned primarily with explaining the estimated cost differiential between the three reports. The analysis will compare the respective methodology, travel characteristics and limitation of all three reports.

1. Maximum Studded Tire Application Rate:

| | | |
|---|---|---|
| Iowa | - | 60% usage |
| Wisconsin | - | 60% usage |
| Pennsylvania | - | 50% usage |

2. Traffic Growth - (% increase/year)

| | | |
|---|---|---|
| Iowa | - | 3 & 1.5% Primary<br>5 & 2.5% Interstate |
| Wisconsin | - | 7% |
| Pennsylvania | - | 4% |

3. Studded Tire Year

| | | |
|---|---|---|
| Iowa | - | 150 days |
| Wisconsin | - | 180 days |
| Pennsylvania | - | 180 days |

4. Seasonal Traffic Adjustment Factor - It appears that Iowa was the only state to use a seasonal adjustment factor. Mr. Dave Lieford of the Wisconsin Highway Material Department, indicated in a phone conversation, that Wisconsin did not use a traffic adjustment factor. Contact with Pennsylvania was not made, but the report mentions no use of a seasonal factor. On the basis of our own factors, this discrepency, by itself, would make the Iowa cost-estimate as much as 15% lower.

5. Construction Costs - For a 1.25-1.00 inch overlay, the states released the following per mile costs:

| | Iowa | Wisconsin | Pennsylvania |
|---|---|---|---|
| 2 Lane A.C.,P.C.C. - | $15,500 | $12,923 | $12,672 |
| 4 Lane A.C.,P.C.C. - | 28,800 | 28,271 | 25,344 (Est.) |
| 4 Lane Interstate - | 48,000 | 28,271 | 25,344 (Est.) |
| 6 Lane Interstate - | 68,000 | 38,345 | 38,016 (Est.) |

The Wisconsin and Pennsylvania construction costs are estimated because their report documentation is limited. It should be noted that Iowa's costs reflect shoulder repair in addition to the roadway resurfacing. So do Wisconsin's

The above cost figures reflect resurfacing costs on both A.C. and P.C.C. Should the existing pavement surface be P.C.C., the first resurfacing, (2.5"), would be double the indicated rates.

The total cost figures for Iowa and Wisconsin include structure repair costs, but Pennsylvania's do not.

Also noteworthy is that Pennsylvania and Wisconsin used an inflation factor in their costs, while Iowa did not. Pennsylvania compounded their costs for the 25 year study period at a rate of 5%. Wisconsin increased its structure costs at a unspecified rate.

6. Number of Passes - Each report incorporated the Minnesota guideline for determining pavement wear, that being the number of studded tire passes needed to wear a ½" trough in the existing pavement. The following figures were used:

| | (Millions) | | |
|---|---|---|---|
| | Iowa | Wisc. | Penn. |
| A.C. | 2.8 | 3.3 | 3.4 |
| P.C.C. | 5.4 | 4.6 | 4.6 |

7. Condition of existing pavement at the start of the study period:

Both Wisconsin and Pennsylvania indicated that they assumed all pavement to be new at the beginning of their respective study years. Iowa assumed primary mileage as new, but Interstate sections were analyzed using as base, the actual construction year. The assumption made by Iowa would lower the Interstate costs significantly.

8. Critical Pavement Wear - all three reports agreed that ½" wear indicated the need for resurfacing.

9. By far, the most significant factor attributable to the large difference in projected damage figures, is the "affected miles of pavement". The "affected miles" are those sections of road which would deteriorate at a rate exceeding the normal wear, (i.e. 13 years for A.C. and 25 years for P.C.C.). This additional wear is computed by the number of passes over a section of pavement.

Most significant is that Iowa's estimate of pavement damage is much lower. This low estimate can be attributed to some of the preceeding differences, (i.e., seasonal factors, construction costs, etc.) but the most telling statistic is the "natural" traffic volume for each state. The following is a table of 1969 vehicle miles;

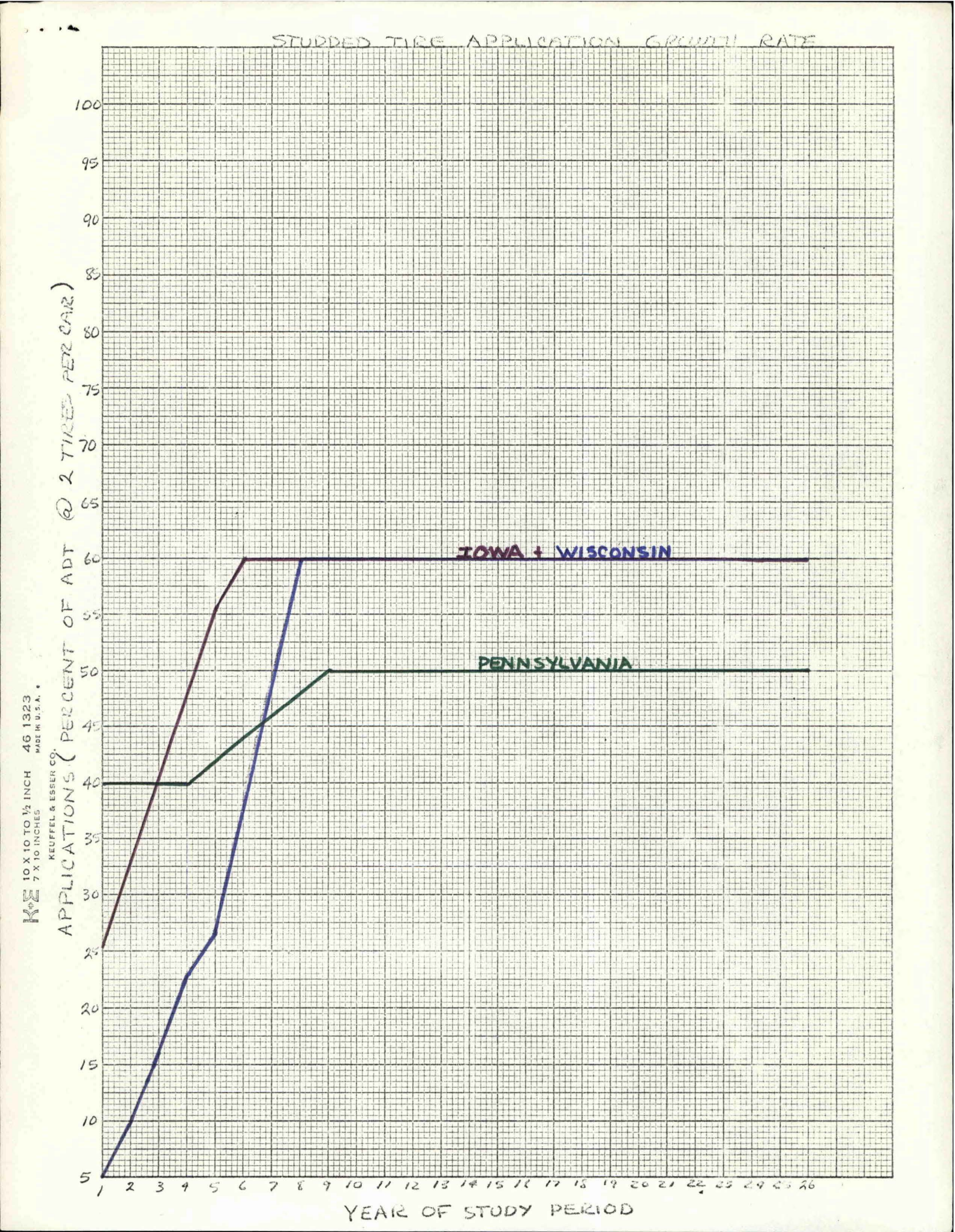
| | Iowa | Wisc. | Penn. |
|---|---|---|---|
| 1969 V.M. | 15,426 | 23,885 | 55,148 |

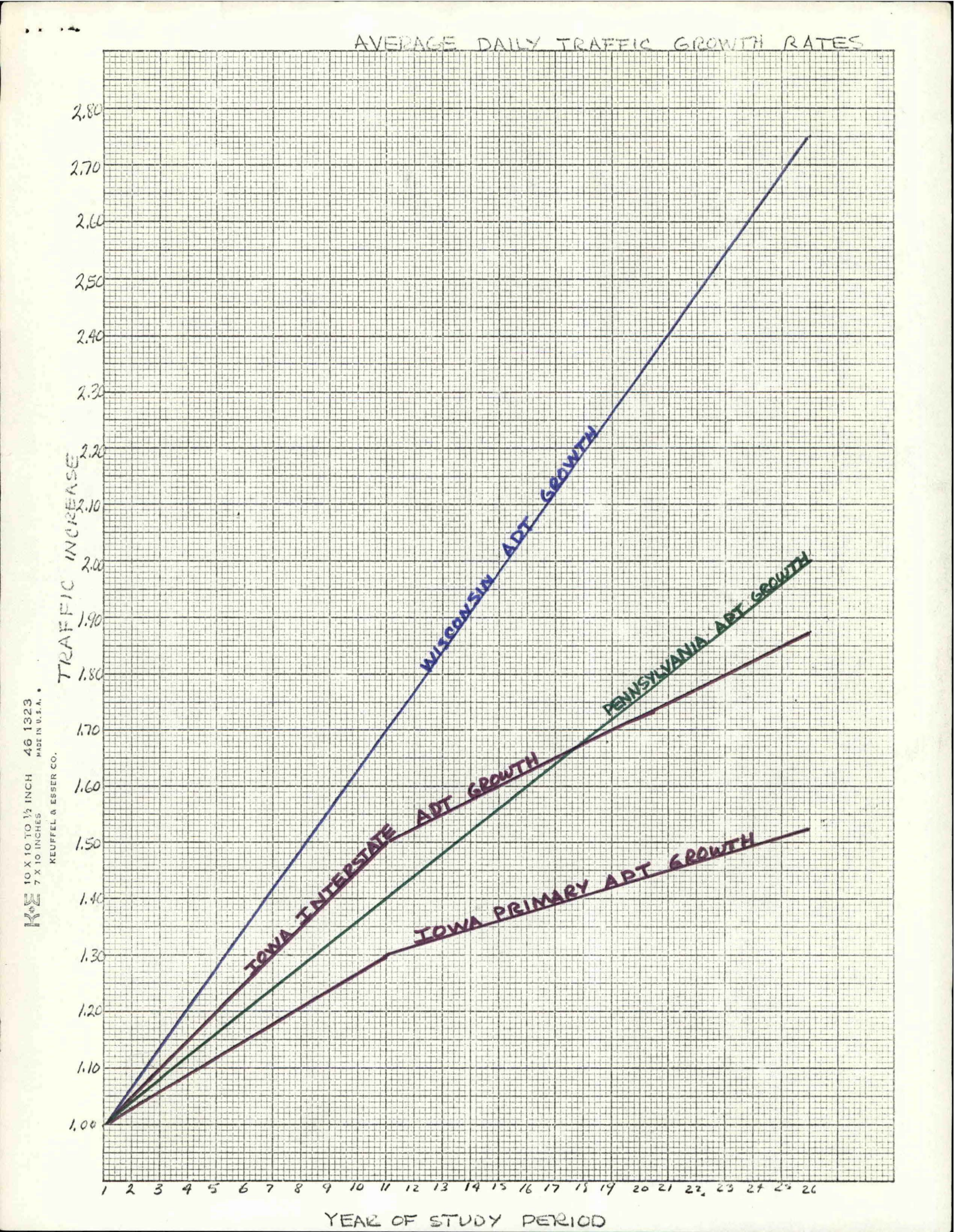
In each report, the affected pavement mileage was broken down by traffic volumes. A comparison of this table, in large part, explains the cost estimate differential.

## ESTIMATED AFFECTED MILES

| | Iowa | Wisconsin | Pennsylvania |
|---|---|---|---|
| 5000 A.D.T. | | | |
| 2 Lane | | | |
| A.C. | 16 | 364 | 0 |
| P.C.C. | 0 | 0 | 541 |
| 4 Lane | | | |
| A.C. | 8 | 0 | 0 |
| P.C.C. | 4 | 0 | 115 |
| 10,000 A.D.T. | | | |
| 2 Lane | | | |
| A.C. | 267 | 698 | 2842 |
| P.C.C. | 43 | 540 | 2196 |
| 4 Lane | | | |
| A.C. | 184 | 146 | 109 |
| P.C.C. | 565 | 789 | 1130 |
| 20,000 A.D.T. | | | |
| 2 Lane | | | |
| A.C. | 15 | 270 | 2337 |
| P.C.C. | 12 | 280 | 1980 |
| 4 Lane | | | |
| A.C. | 94 | 218 | 1973 |
| P.C.C. | 320 | 1389 | 3140 |
| 20,000+ A.D.T. | | | |
| 2 Lane | | | |
| A.C. | 0 | 20 | 434 |
| P.C.C. | 0 | 0 | 271 |
| 4 Lane | | | |
| A.C. | 4 | 234 | 1479 |
| P.C.C. | 53 | 739 | 1550 |
| Total | 1581 | 5687 | 20025 |

As explained previously there are some differences in methodology between the three reports but a comparison of the above table indicates that the significant difference lies in the "natural" traffic patterns of each state. The three state systems are in no way comparable to one another.


STUDDED TIRE APPLICATION GROWTH RATE
APPLICATIONS (PERCENT OF ADT @ 2 TIRES PER CAR)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
IOWA + WISCONSIN
PENNSYLVANIA
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
YEAR OF STUDY PERIOD
KE 10 X 10 TO ½ INCH 46 1323
7 X 10 INCHES
KEUFFEL & ESSER CO.
MADE IN U.S.A.



# IOWA STUDDED TIRE SURVEY
## 1971-72

In late December 1971, Iowa Highway Commission field personnel were requested to make a survey that would determine the percent of vehicles with studded tires in Iowa. At the same time the Highway Planning Surveys Department conducted a related study on the interstate system. Similar surveys, though less extensive, were conducted in late December 1970 and January 1971.

### Parked Vehicles

As a practical means of determining the percent of vehicles with studded tires, it was decided to survey parking lots and other areas where large concentrations of vehicles could be found. The first step was to divide the state into survey areas. This was done along county lines beginning with the six counties (Polk, Linn, Scott, Black Hawk, Woodbury and Pottawattamie) having the largest number of vehicle registrations. These six counties are considered unique in that each is dominated by a large city. The remaining areas were selected with some expectation that there would be a certain homogeneity and that the size would at least approach the smallest of the first six counties. Geographical arrangement was not always as compact as had been hoped.

Each area was sampled by obtaining at least 2,400 observations. Only cities large enough to readily yield a reasonable number (150 or more) of observations were included for survey. Further selection was based on an attempt to cover geographically the survey area. Total count requested in a given city was determined as follows:

$$\text{Observations in City A} = \frac{\text{Vehicle registrations in county where City A is located}}{\text{Vehicle registrations in all counties observed}} (2{,}400)$$

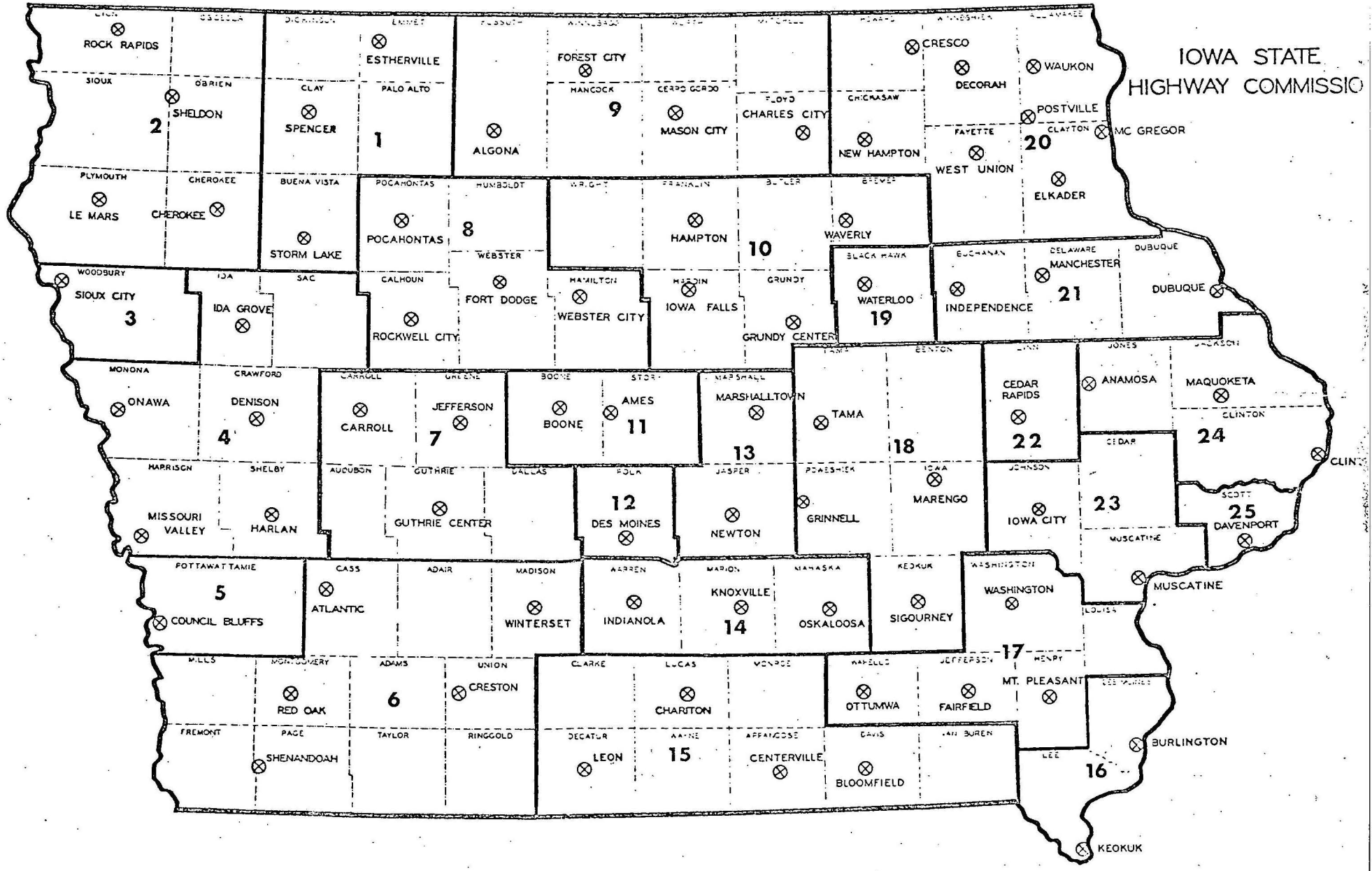
Field personnel were asked to make observations from at least three different locations in each city to minimize sampling error. Assuming a uniform distribution of vehicles with studded tires within any survey area, the results obtained may be stated to be correct to $\pm$ 2% at the 5% level of significance.

Moving Vehicles

Generally it may be said that the interstate system carries a higher volume of traffic and more out-of-state vehicles than other highways. In an effort to determine the extent of studded tires on the interstates, a 16-hour moving vehicle survey was conducted at each of 14 locations. These observations were made by personnel of the Highway Planning

Surveys Department in January 1972. Though results of this survey would not necessarily correspond to the parked vehicle findings, the percents were comparable at 19.2 and 21.5 respectively.

The following pages include (1) a map showing the 25 parked vehicle survey areas, (2) a sample sheet illustrating the method for calculating results for a survey area, (3) area by area parked vehicle survey results, and (4) results from the interstate moving vehicle surveys.


IOWA STATE
HIGHWAY COMMISSIO
ROCK RAPIDS
ESTHERVILLE
FOREST CITY
CRESCO
WAUKON
DECORAH
POSTVILLE
SHELDON
SPENCER
ALGONA
MASON CITY
CHARLES CITY
NEW HAMPTON
MC GREGOR
WEST UNION
ELKADER
LE MARS
CHEROKEE
STORM LAKE
POCAHONTAS
HAMPTON
WAVERLY
SIOUX CITY
IDA GROVE
FORT DODGE
WEBSTER CITY
IOWA FALLS
GRUNDY CENTER
WATERLOO
INDEPENDENCE
MANCHESTER
DUBUQUE
ROCKWELL CITY
ONAWA
DENISON
CARROLL
JEFFERSON
BOONE
AMES
MARSHALLTOWN
TAMA
CEDAR RAPIDS
ANAMOSA
MAQUOKETA
MISSOURI VALLEY
HARLAN
GUTHRIE CENTER
DES MOINES
NEWTON
GRINNELL
MARENGO
IOWA CITY
DAVENPORT
COUNCIL BLUFFS
ATLANTIC
WINTERSET
INDIANOLA
KNOXVILLE
OSKALOOSA
SIGOURNEY
WASHINGTON
MUSCATINE
RED OAK
CRESTON
CHARITON
OTTUMWA
FAIRFIELD
MT. PLEASANT
SHENANDOAH
LEON
CENTERVILLE
BLOOMFIELD
BURLINGTON
KEOKUK
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Sample Calculation of Percent of Studded Tires
in a Survey Unit

| City | County | Survey Data | | | Sampling Unit Result | | |
|---|---|---|---|---|---|---|---|
| | | Vehicles w/Studded Tires | Total Vehicles Surveyed | % Studded Tires | % Studded Tires | Vehicle Registrations | No. Vehicles w/Studded Tires |
| Tama | Tama | 151 | 701 | 21.5 | | 9,570 | |
| Grinnell | Poweshiek | 199 | 770 | 25.8 | | 9,033 | |
| Marengo | Iowa | 143 | 517 | 27.7 | | 7,644 | |
| Sigourney | Keokuk | 64 | 501 | 12.8 | | 6,847 | |
| | Benton | -- | -- | -- | | 10,807 | |
| | | 557 | 2,489 | | 22.4 | 43,901 | 9,834 |

| 1970-71 % Studded Tires | City | 1971-72 Survey Date: Vehicles w/ Studded Tires | 1971-72 Survey Date: Total Vehicles Surveyed | 1971-72 Survey Date: % Studded Tires | Area Number | 1971-72 Sampling Area Result: % Studded Tires | 1971-72 Sampling Area Result: Vehicle Registrations | 1971-72 Sampling Area Result: No. Vehicles w/ Studded Tires |
|---|---|---|---|---|---|---|---|---|
| | Storm Lake | 159 | 660 | 24.1 | | | | |
| 22.1 | Spencer | 135 | 1,212 | 11.1 | 1 | | | |
| | Estherville | 64 | 817 | 7.8 | | | | |
| | | | | | | 13.3 | 40,845 | 5,432 |
| | Sheldon | 188 | 514 | 36.6 | | | | |
| | LeMars | 183 | 747 | 24.5 | 2 | | | |
| 29.6 | Cherokee | 180 | 560 | 32.1 | | | | |
| | Rock Rapids | 251 | 689 | 36.6 | | | | |
| | | | | | | 32.0 | 52,476 | 16,792 |
| 35.7 | Sioux City | 676 | 2,446 | 27.6 | 3 | | | |
| | | | | | | 27.6 | 48,537 | 13,396 |
| | Ida Grove | 90 | 377 | 23.9 | | | | |
| | Onawa | 69 | 416 | 16.6 | | | | |
| | Denison | 210 | 647 | 32.5 | 4 | | | |
| | Mo. Valley | 80 | 576 | 13.9 | | | | |
| | Harlan | 234 | 515 | 45.4 | | | | |
| | | | | | | 27.2 | 42,590 | 11,584 |
| 34.4 | Council Bluffs | 896 | 4,297 | 20.9 | 5 | | | |
| | | | | | | 20.9 | 42,028 | 8,784 |
| 29.5 | Atlantic | 192 | 579 | 33.2 | | | | |
| | Red Oak | 123 | 453 | 27.2 | | | | |
| 22.5 | Shenandoah | 101 | 600 | 16.8 | 6 | | | |
| 20.4 | Creston | 115 | 483 | 23.8 | | | | |
| | Winterset | 89 | 476 | 18.7 | | | | |
| | | | | | | 24.1 | 63,991 | 15,422 |

| 1970-71 % Studded Tires | City | 1971-72 Survey Date | | | Area Number | 1971-72 Sampling Area Result | | |
|---|---|---|---|---|---|---|---|---|
| | | Vehicles w/ Studded Tires | Total Vehicles Surveyed | % Studded Tires | | % Studded Tires | Vehicle Registrations | No. Vehicles w/ Studded Tires |
| 33.8 | Carroll | 243 | 1,136 | 21.4 | 7 | | | |
| | Jefferson | 332 | 1,087 | 30.5 | | | | |
| | Guthrie Center | 104 | 608 | 17.1 | | | | |
| | | | | | | 23.0 | 41,956 | 9,650 |
| | Pocahontas | 84 | 372 | 22.6 | 8 | | | |
| | Rockwell City | 51 | 360 | 14.2 | | | | |
| 31.8 | Ft. Dodge | 465 | 1,762 | 26.4 | | | | |
| | Webster City | 146 | 731 | 20.0 | | | | |
| | | | | | | 22.7 | 53,757 | 12,203 |
| 25.0 | Algona | 209 | 624 | 33.5 | 9 | | | |
| | Forest City | 151 | 317 | 47.6 | | | | |
| 22.8 | Mason City | 565 | 2,006 | 28.2 | | | | |
| | Charles City | 225 | 571 | 39.4 | | | | |
| | | | | | | 33.8 | 70,988 | 23,991 |
| | Hampton | 157 | 467 | 33.6 | 10 | | | |
| | Waverly | 273 | 813 | 33.6 | | | | |
| | Iowa Falls | 120 | 873 | 13.7 | | | | |
| | Grundy Center | 151 | 519 | 29.1 | | | | |
| | | | | | | 26.5 | 53,638 | 14,214 |
| 21.0 | Ames | 234 | 1,614 | 14.5 | 11 | | | |
| | Boone | 142 | 800 | 17.8 | | | | |
| | | | | | | 15.6 | 39,583 | 6,174 |

| 1970-71 % Studded Tires | City | 1971-72 Survey Date: Vehicles w/ Studded Tires | 1971-72 Survey Date: Total Vehicles Surveyed | 1971-72 Survey Date: % Studded Tires | Area Number | 1971-72 Sampling Area Result: % Studded Tires | 1971-72 Sampling Area Result: Vehicle Registrations | 1971-72 Sampling Area Result: No. Vehicles w/ Studded Tires |
|---|---|---|---|---|---|---|---|---|
| 20.7 | Des Moines | 618 | 2,520 | 24.5 | 12 | 24.5 | 145,328 | 35,605 |
| 27.1 | Marshalltown | 289 | 1,345 | 21.5 | 13 | | | |
| | Newton | 317 | 1,168 | 27.1 | | 23.0 | 38,606 | 8,879 |
| | Indianola | 172 | 884 | 19.5 | 14 | | | |
| | Knoxville | 203 | 904 | 22.5 | | | | |
| 13.1 | Oskaloosa | 79 | 815 | 9.7 | | 17.5 | 36,451 | 6,386 |
| | Leon | 132 | 544 | 24.3 | | | | |
| 19.2 | Chariton | 131 | 659 | 19.9 | 15 | | | |
| | Centerville | 200 | 889 | 22.5 | | | | |
| | Bloomfield | 74 | 462 | 16.0 | | 20.9 | 37,144 | 7,763 |
| 7.1 | Keokuk | 70 | 1,206 | 5.8 | 16 | | | |
| 6.3 | Burlington | 142 | 1,967 | 7.2 | | 6.5 | 45,669 | 2,986 |
| | Washington | 52 | 669 | 7.8 | | | | |
| 9.5 | Ottumwa | 178 | 1,097 | 16.2 | 17 | | | |
| | Fairfield | 29 | 480 | 6.0 | | | | |
| | Mt. Pleasant | 40 | 548 | 7.3 | | 11.1 | 51,719 | 5,741 |

| 1970-71 % Studded Tires | City | 1971-72 Survey Date | | | Area Number | 1971-72 Sampling Area Result | | |
|---|---|---|---|---|---|---|---|---|
| | | Vehicles w/ Studded Tires | Total Vehicles Surveyed | % Studded Tires | | % Studded Tires | Vehicle Registrations | No. Vehicles w/ Studded Tires |
| | Tama | 151 | 701 | 21.5 | | | | |
| | Grinnell | 199 | 770 | 25.8 | 18 | | | |
| | Marengo | 143 | 517 | 27.7 | | | | |
| | Sigourney | 64 | 501 | 12.8 | | | | |
| | | | | | | 22.4 | 43,901 | 9,834 |
| 20.5 | Waterloo | 519 | 2,483 | 21.0 | 19 | | | |
| | | | | | | 21.0 | 64,063 | 13,453 |
| | Cresco | 134 | 335 | 40.0 | | | | |
| 35.8 | Decorah | 243 | 647 | 37.6 | | | | |
| | Waukon | 153 | 277 | 55.2 | | | | |
| | Postville | 56 | 156 | 35.9 | | | | |
| | West Union | 182 | 506 | 36.0 | 20 | | | |
| | New Hampton | 191 | 468 | 40.8 | | | | |
| | Elkader | 124 | 309 | 40.1 | | | | |
| | McGregor | 78 | 162 | 48.1 | | | | |
| | | | | | | 40.4 | 50,527 | 20,395 |
| | Independence | 126 | 485 | 26.0 | | | | |
| 23.4 | Manchester | 88 | 414 | 21.3 | 21 | | | |
| 38.6 | Dubuque | 925 | 2,785 | 33.2 | | | | |
| | | | | | | 30.2 | 54,312 | 16,389 |
| 22.5 | Cedar Rapids | 261 | 2,400 | 10.9 | 22 | | | |
| | | | | | | 10.9 | 81,360 | 8,868 |

| 1970-71 % Studded Tires | City | 1971-72 Survey Date: Vehicles w/ Studded Tires | 1971-72 Survey Date: Total Vehicles Surveyed | 1971-72 Survey Date: % Studded Tires | Area Number | 1971-72 Sampling Area Result: % Studded Tires | 1971-72 Sampling Area Result: Vehicle Registrations | 1971-72 Sampling Area Result: No. Vehicles w/ Studded Tires |
|---|---|---|---|---|---|---|---|---|
| | Iowa City | 258 | 1,542 | 16.7 | 23 | | | |
| | Muscatine | 84 | 903 | 9.3 | | | | |
| | | | | | | 13.9 | 56,685 | 7,879 |
| | Anamosa | 76 | 519 | 14.6 | 24 | | | |
| 22.0 | Maquoketa | 120 | 514 | 23.3 | | | | |
| | Clinton | 127 | 1,417 | 9.0 | | 13.0 | 46,225 | 6,013 |
| 14.4 | Davenport | 241 | 2,458 | 9.8 | 25 | | | |
| | | | | | | 9.8 | 71,852 | 7,041 |
| | | | | | | 21.5 | 1,374,231 | 294,874 |

SURVEY OF MOVING VEHICLES

ON IOWA INTERSTATE HIGHWAYS

| Location | 1970-71* % Studs | 1971-72** % Studs |
|---|---|---|
| I-74 Davenport | 19.9 | 20.8 |
| I-80 West of Williamsburg | 19.6 | 25.3 |
| I-80 West of Marengo | 19.0 | 21.1 |
| I-80 East of Menlo | 32.0 | 17.4 |
| I-80 West of Menlo | 31.2 | 16.7 |
| I-80 Minden | 30.9 | 23.5 |
| I-80 Neola | 28.1 | 21.9 |
| I-29 North of Onawa | 21.6 | 21.8 |
| I-29 North of Sioux City Airport | 26.7 | 26.0 |
| I-35 South of Osceola | 28.4 | 17.0 |
| I-35 North of Cumming | 21.1 | 12.6 |
| I-35 South of 520 | 23.7 | 21.5 |
| I-35-80 East of Merle Hay | 28.6 | 16.3 |
| I-35-80 South of Rider Corner | 24.8 | 17.6 |
| Total | 25.6 | 19.2 |

* Cars and station wagons

** Cars, station wagons, pickups, and vans