

REPORT AND RECOMMENDATIONS TO THE VIRGINIA DEPARTMENT OF
HIGHWAYS AND TRANSPORTATION ON THE USE OF STUDDED
TIRES IN VIRGINIA

by

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(The opinions, findings, and conclusions expressed in this
report are those of the author and not necessarily those of
the sponsoring agencies.)

Virginia Highway and Transportation Research Council
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BACKGROUND

Since the introduction of studded tires in the United States in the early sixties, the Virginia Highway and Transportation Research Council has stayed abreast of the research and information on their use through literature reviews, participation in the activities of national committees, and personal contacts with people working in the highway field and in related industries. Surveys have been conducted in Northern Virginia, the Valley, and the Richmond and Norfolk areas to determine the extent to which studded tires have been used in these localities and the degree of wear sustained by selected pavements. Since the winter of 1965-66, the Council has submitted biennial reports to the Department setting forth its findings and recommendations on the use of studded tires. (1,2,3,4,5,6)

In 1968, the state legalized the use of studded tires for two years, and reenacted this legislation for additional two-year periods in 1970, 1972, 1974, and 1976. Now the General Assembly is considering legislation that would permit the use of studded tires on a permanent basis. A copy of the proposed legislation, House Bill No. 48, is attached as Appendix A to this report.

Since the last report by the Council, (6) submitted in October 1975, there has been little change in the technology or knowledge used in evaluating studded tires, and the synthesis on the effects of studded tires (7) issued in that year under the sponsorship of the National Cooperative Highway Research Program thoroughly documents the state of knowledge on the effects of studded tires. Consequently, this present Council report cites the findings of the above mentioned synthesis and attempts to briefly put into perspective the few considerations which need to be taken into account in deciding upon the desirability of legalizing the use of studded tires on a permanent basis.

FACTORS TO BE CONSIDERED

There has been, and will continue to be, much controversy on the value of studded tires in those regions of the world where vehicular travel through snow and ice entails difficulty. Some people argue that studs provide safety and that they reduce accidents; others contend that they create hazardous conditions by erasing pavement markings and wearing ruts into the pavement to

the extent that water puddles and causes accidents. No one has been able to substantiate either of these claims. A coupling of the interactions among the large number of factors that can cause accidents and the fact that relatively few accidents occur under a given set of circumstances, including those that happen on ice and/or hard packed snow, renders it nearly impossible to isolate a single factor as the one cause of an accident.

Since no one has proved that studded tires provide safety or create hazardous conditions, the decision as to whether their use should be made legal must be based on other criteria. The author feels that the following claims⁽⁷⁾ are less controversial and should form a basis for the decision.

1. Studded tires sometimes make the difference between "go-no go" on ice and hard packed snow.
2. When used on a sufficient number of vehicles, studded tires inflict great damage upon pavement surfaces.
3. If such tires are used on the front wheels as well as the rear wheels of a vehicle, cornering ability is improved on ice and hard packed snow.
4. Studded tires improve stopping ability on ice and hard packed snow, even when used only on the rear wheels.
5. On wet and dry pavement, studded tires reduce the stopping capability of a vehicle.
6. The studs used at present do from 30% to 50% less damage to pavements than did the first generation ones introduced in this country in the early sixties.
7. The presently used studs are also about 15% less effective in providing cornering, traction, and stopping ability than the ones used earlier.

These seven claims, if taken as valid, lead one to conclude that studs can enhance the performance capability of a vehicle on ice and hard packed snow, but reduce vehicle stopping ability to some degree on wet and dry pavements. In addition, if employed on a sufficient number of vehicles, studded tires can inflict great damage on pavement surfaces. In fact, this damage has been so severe in some of the northern states and Canadian Provinces that they have had to outlaw the use of studded tires completely.^(8,9)

Thus since studs can provide better traction and stopping ability when used on the rear wheels and better cornering capability when used on the front, or steering, wheels on ice and hard packed snow, a major question that must be considered is, If studs are legalized on a permanent basis, will enough people equip their vehicles with them to cause great damage to the pavements? Data available for Virginia do not provide an answer, because they were collected over the past ten years, a period during which studded tires were legal on only a temporary basis and activities promoting their sale and use in the state were minimal. These data, which are given in Appendix B, indicate that the accumulated pavement wear over the past seven years has been less than $\frac{1}{4}$ inch on any of the sites tested. This amount of wear is insignificant and probably does not reflect studded tire wear but rather normal pavement wear.

On the other hand, the use of studded tires is very limited, as can be seen in Appendix C. Of the 16,471 vehicles sampled in 1978, only 442 employed studded tires on the rear wheels. Thus, the data show that only 2.7% of the sampled vehicles used the tires. Only one vehicle was found with the studded tires on the front wheels, which indicates that in Virginia cornering capability is not being improved through the use of such tires. The following items concerning the use of studded tires in Virginia are also worth noting.

1. The usage of studded tires has been on the decline in all the areas sampled except Bristol, where in the past year their use increased from 9.8% to 12.1%.
2. The greatest decline has been in Verona, where their use has dropped from 17.3% in 1972 to 4.1% in 1978.
3. The use of studded tires is much greater in the northern and western portions of the state than in the southern and eastern portions, where Bristol is considered as being in the western rather than the southern portion.

Additionally, it should be noted here that although studded tires induce more rapid gross wear on bituminous concrete pavements than on portland cement concrete pavements, the wear on the latter is much more critical. This is so because a great deal of effort is expended in providing a harsh texture to portland cement concrete pavement surfaces to provide skid resistance potential. Thus although the wear of these surfaces is slower, it would be more damaging because the skid resistance potential would be prematurely lost. The relevance of this point is that the area that has the most pavements of this type also presently has the lowest studded tire usage.

If the legalization of studded tires on a permanent basis does not significantly increase their usage, there is no reason for concern. However, if the usage increases greatly, then surely the damage inflicted on the pavements will necessitate a change in the law. In other words if use is a function of need, there is little to worry about, because those people who feel they really need studded tires employ them at present; but if use is a function of advertisement and promotional activities, then the change from temporary to permanent legalization of the tires may increase their use to the danger point.

Finally, it should be remembered that studded tires are not effective on new snow; they improve traction only on ice and very hard packed snow. Therefore, they provide benefit a very small portion of the time. Because much of the benefit comes from being able to move or accelerate on ice or hard packed snow, it is even possible that studs provide the ability to move under unsafe conditions; thus they may make a bad situation even more hazardous.

RECOMMENDATION

It is the writer's belief that the limited use of studded tires in the state is attributable in part to the past practice of legalizing the use of the tires on a temporary basis, an arrangement under which those people who have felt they really needed them could purchase them. For this reason, and

because of the possibility that permanent legalization may bring about a promotional effort by studded tire producers and marketers that will greatly increase use of the tires in Virginia and thus increase pavement wear, it is recommended that the law not be made permanent but be extended for another two-year period.

APPENDIX I

HOUSE BILL 48

APPENDIX II

PAVEMENT WEAR DATA

Results of Pavement Wear Measurements Taken at 1-foot
Intervals From Edge of Pavement, Values Given in Thirty-Seconds of Inch

NORTHERN VIRGINIA

Site 1

Rt. 1 to Alexandria from I-495, Concrete Mix, No AVD

| <u>DATE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1968 | 0 | 0 | 4 | 7 | 6 | 4 | 5 | 4 |
| Dec. 1969 | 0 | 5 | 5 | 7 | 5 | 2 | 1 | 1 |
| Mar. 1971 | 0 | 1 | 3 | 5 | 5 | 4 | 4 | 3 |
| Dec. 1971 | 0 | 0 | 2 | 3 | 5 | 4 | 1 | 2 |
| Jan. 1973 | 1 | 2 | 3 | 5 | 6 | 5 | 5 | 3 |
| Jan. 1974 | 0 | 4 | 6 | 6 | 5 | 3 | 3 | 3 |
| Jan. 1975 | 0 | 6 | 6 | 5 | 5 | 3 | 1 | 3 |
| Jan. 1976 | 0 | 6 | 5 | 5 | 5 | 4 | 4 | 1 |
| Feb. 1977 | 2 | 3 | 3 | 2 | 3 | 4 | 4 | 4 |
| Jan. 1978 | 0 | 1 | 3 | 3 | 4 | 2 | 1 | 1 |

Site 2

I-95 Ramp to Springfield, Bituminous Mix, No AVD

| <u>DATE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1968 | 3 | 3 | 4 | 7 | 5 | 4 | 1 | 1 |
| Dec. 1969 | 0 | 3 | 3 | 4 | 5 | 3 | 2 | 2 |
| Mar. 1971 | 3 | 3 | 2 | 4 | 5 | 4 | 1 | 1 |
| Dec. 1971 | 2 | 1 | 3 | 5 | 4 | 3 | 1 | 1 |
| Jan. 1973 | 3 | 3 | 3 | 4 | 4 | 3 | 2 | 2 |
| Jan. 1974 | 1 | 4 | 4 | 6 | 6 | 2 | 3 | 2 |
| Jan. 1975 | 1 | 3 | 3 | 5 | 6 | 4 | 3 | 3 |
| Jan. 1976 | 1 | 4 | 4 | 5 | 6 | 2 | 3 | 4 |
| Feb. 1977 | 4 | 3 | 4 | 6 | 5 | 4 | 4 | 3 |
| Jan. 1978 | 4 | 6 | 7 | 8 | 8 | 7 | 6 | 6 |

Site 3

Ramp to I-95 from Springfield, Bituminous Mix, No AVD

| <u>DATE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1968 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 3 |
| Dec. 1969 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 1 |
| Mar. 1971 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 3 |
| Jan. 1973 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 3 |
| Jan. 1974 | 4 | 2 | 1 | 2 | 3 | 3 | 3 | 1 |
| Jan. 1975 | 4 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| Jan. 1976 | 4 | 2 | 1 | 3 | 4 | 4 | 3 | 1 |
| Feb. 1977 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 5 |
| Jan. 1978 | 5 | 5 | 6 | 7 | 7 | 7 | 6 | 7 |

VALLEY LOCATIONS

2083

Site 4

Verona Rt. 11, Bituminous Mix, 1976 AVD 12,090
 From: Int. Rt. 11 and 857 to 0.3 mi. S. of Rt. 275

| <u>DATE</u> | <u>LANE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1971 | NBTL | 1 | 2 | 3 | 2 | 2 | 0 | 1 | 2 |
| | SBTL | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 2 |
| Jan. 1973 | NBTL | 5 | 5 | 3 | 7 | 10 | 11 | 8 | 3 |
| | SBTL | 12 | 5 | 3 | 4 | 5 | 8 | 5 | 2 |
| Jan. 1974 | NBTL | 11 | 7 | 7 | 10 | 11 | 12 | 9 | 5 |
| | SBTL | 13 | 7 | 4 | 6 | 6 | 10 | 6 | 3 |
| Jan. 1975 | NBTL | 6 | 5 | 2 | 3 | 4 | 4 | 3 | 2 |
| | SBTL | 6 | 4 | 2 | 3 | 5 | 5 | 2 | 3 |
| Jan. 1976 | NBTL | 6 | 5 | 4 | 3 | 6 | 4 | 3 | 3 |
| | SBTL | 5 | 4 | 4 | 4 | 7 | 6 | 3 | 6 |
| Feb. 1977 | NBTL | 8 | 4 | 3 | 4 | 7 | 7 | 4 | 2 |
| | SBTL | 8 | 4 | 3 | 3 | 9 | 6 | 3 | 5 |
| Jan. 1978 | NBTL | 10 | 8 | 4 | 5 | 7 | 7 | 4 | 5 |
| | SBTL | 10 | 7 | 4 | 4 | 7 | 6 | 3 | 6 |

Site 5

Salem Rt. 419, Bituminous Mix, 1976 AVD 20,630
 From: 0.6 mi. south of Rt. 11 and 460 to 0.5 mi. north of Rt. 11

| <u>DATE</u> | <u>LANE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1971 | NBTL | 2 | 1 | 2 | 2 | 1 | 0 | 1 | 2 |
| | SBTL | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 3 |
| Jan. 1973 | NBTL | 1 | 4 | 3 | 8 | 4 | 4 | 9 | 3 |
| | SBTL | 4 | 7 | 2 | 4 | 6 | 7 | 6 | 5 |
| Jan. 1974 | NBTL | 6 | 5 | 4 | 5 | 2 | 2 | 1 | 5 |
| | SBTL | 4 | 8 | 4 | 6 | 7 | 8 | 7 | 7 |
| Jan. 1975 | NBTL | 4 | 3 | 4 | 5 | 5 | 6 | 5 | 3 |
| | SBTL | 5 | 4 | 3 | 4 | 4 | 5 | 5 | 4 |
| Jan. 1976 | NBTL | 5 | 4 | 3 | 3 | 4 | 6 | 4 | 4 |
| | SBTL | 4 | 3 | 3 | 4 | 4 | 5 | 5 | 3 |
| Feb. 1977 | NBTL | 4 | 3 | 3 | 3 | 5 | 6 | 4 | 3 |
| | SBTL | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 4 |
| Jan. 1978 | NBTL | 5 | 4 | 4 | 5 | 5 | 6 | 5 | 2 |
| | SBTL | 5 | 5 | 4 | 5 | 5 | 6 | 5 | 5 |

VALLEY LOCATIONS Cont'd

2085

Site 6

Bristol Rt. 11, Bituminous Mix, 1976 AVD 9,835
 From: 0.5 mi. south of I-81 to Rt. 1712

| <u>DATE</u> | <u>LANE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1971 | NBTL | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 2 |
| | SBTL | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 2 |
| Jan. 1973 | NBTL | 1 | 5 | 3 | 3 | 1 | 2 | 2 | 3 |
| | SBTL | 4 | 5 | 3 | 4 | 6 | 1 | 6 | 2 |
| Jan. 1974 | NBTL | 5 | 3 | 2 | 0 | 1 | 3 | 2 | 4 |
| | SBTL | 2 | 7 | 4 | 5 | 7 | 2 | 5 | 4 |
| Jan. 1975 | NBTL | 6 | 2 | 2 | 3 | 4 | 7 | 4 | 1 |
| | SBTL | 5 | 3 | 3 | 3 | 5 | 6 | 4 | 1 |
| Jan. 1976 | NBTL | 5 | 3 | 3 | 4 | 6 | 7 | 3 | 2 |
| | SBTL | 5 | 4 | 3 | 2 | 6 | 8 | 4 | 2 |
| Feb. 1977 | NBTL | 7 | 3 | 2 | 2 | 5 | 7 | 4 | 1 |
| | SBTL | 7 | 4 | 3 | 2 | 3 | 6 | 4 | 2 |
| Jan. 1978 | NBTL | 6 | 5 | 2 | 2 | 5 | 7 | 6 | 2 |
| | SBTL | 8 | 5 | 3 | 2 | 5 | 7 | 7 | 3 |

Site 7

Winchester Rt. 11, Bituminous Mix, 1976 AVD 7,015
 From: 0.3 mi. North of Rt. 706 to Int. 649 & Rt. 11

| <u>DATE</u> | <u>LANE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1971 | NBTL | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 3 |
| | SBTL | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 |
| Jan. 1973 | NBTL | 4 | 2 | 3 | 2 | 4 | 6 | 5 | 1 |
| | SBTL | 2 | 2 | 3 | 2 | 5 | 6 | 5 | 2 |
| Jan. 1974 | NBTL | 6 | 7 | 4 | 3 | 5 | 6 | 6 | 3 |
| | SBTL | 5 | 4 | 3 | 5 | 5 | 8 | 5 | 3 |
| Jan. 1975 | NBTL | 7 | 6 | 4 | 4 | 6 | 7 | 5 | 4 |
| | SBTL | 5 | 3 | 4 | 5 | 5 | 7 | 5 | 3 |
| Jan. 1976 | NBTL | 6 | 5 | 3 | 4 | 5 | 6 | 5 | 3 |
| | SBTL | 7 | 6 | 4 | 5 | 6 | 7 | 6 | 3 |
| Feb. 1977 | NBTL | 10 | 7 | 4 | 2 | 5 | 7 | 6 | 3 |
| | SBTL | 7 | 4 | 3 | 5 | 7 | 7 | 4 | 2 |
| Jan. 1978 | NBTL | 12 | 8 | 5 | 4 | 6 | 9 | 6 | 3 |
| | SBTL | 9 | 4 | 4 | 5 | 7 | 8 | 6 | 3 |

VALLEY LOCATIONS Cont'd

Site 8

Radford Arsenal Rt. 114, Bituminous Mix, 1976 AVD 7,280
 From: 0.1 mi. South of New River Bridge to Rt. 659 North

| <u>DATE</u> | <u>LANE</u> | <u>7 ft.</u> | <u>6 ft.</u> | <u>5 ft.</u> | <u>4 ft.</u> | <u>3 ft.</u> | <u>2 ft.</u> | <u>1 ft.</u> | <u>0</u> |
|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| Dec. 1971 | NBTL | 3 | 5 | 3 | 4 | 3 | 4 | 5 | 2 |
| | SBTL | 2 | 5 | 3 | 3 | 5 | 4 | 5 | 3 |
| Jan. 1973 | NBTL | 2 | 5 | 2 | 4 | 5 | 5 | 4 | 2 |
| | SBTL | 4 | 2 | 2 | 3 | 4 | 5 | 4 | 3 |
| Jan. 1974 | NBTL | 4 | 3 | 4 | 5 | 5 | 7 | 6 | 3 |
| | SBTL | 3 | 4 | 3 | 4 | 5 | 3 | 4 | 3 |
| Jan. 1975 | NBTL | 5 | 3 | 3 | 4 | 5 | 6 | 4 | 2 |
| | SBTL | 4 | 4 | 3 | 5 | 6 | 5 | 6 | 3 |
| Jan. 1976 | NBTL | 4 | 4 | 2 | 2 | 3 | 4 | 4 | 2 |
| | SBTL | 3 | 4 | 3 | 3 | 2 | 4 | 3 | 1 |
| Feb. 1977 | NBTL | 3 | 2 | 1 | 1 | 2 | 4 | 3 | 1 |
| | SBTL | 3 | 1 | 1 | 2 | 4 | 6 | 3 | 1 |
| Jan. 1978 | NBTL | 5 | 4 | 3 | 4 | 5 | 6 | 4 | 2 |
| | SBTL | 7 | 5 | 3 | 5 | 8 | 9 | 6 | 3 |

APPENDIX III

STUDED TIRE USE IN VIRGINIA

STUDED TIRE USE IN VIRGINIA

2091

| <u>LOCATION</u> | <u>DATE</u> | <u>NO. CARS SURVEYED</u> | <u>NO. CARS WITH STUDS</u> | <u>% CARS WITH STUDS</u> |
|------------------------------------|-------------|------------------------------|--------------------------------|------------------------------|
| Pentagon | Feb. 1969 | 4466 | 105 | 2.3 |
| (area includes sites 1, 2, & 3) | Feb. 1970 | 4337 | 180 | 4.1 |
| | Feb. 1971 | 4582 | 354 | 7.7 |
| | Dec. 1971 | 4315 | 288 | 6.7 |
| | Jan. 1973 | 4374 | 270 | 6.1 |
| | Jan. 1974 | 4314 | 205 | 4.8 |
| | Jan. 1975 | 4023 | 150 | 3.7 |
| | Jan. 1976 | 4032 | 116 | 2.9 |
| | Feb. 1977 | 4394 | 74 | 1.7 |
| | Jan. 1978 | 4375 | 75 | 1.7 |
| Bristol | 1972 | 1008 | 95 | 9.4 |
| (area includes site 6) | Jan. 1973 | 1010 | 92 | 9.1 |
| | Jan. 1974 | 1080 | 97 | 8.9 |
| | Jan. 1975 | 1080 | 88 | 8.2 |
| | Jan. 1976 | 1036 | 47 | 4.5 |
| | Feb. 1977 | 1004 | 98 | 9.8 |
| | Jan. 1978 | 1008 | 122 | 12.1 |
| Salem | 1972 | 1008 | 95 | 9.4 |
| (area includes site 5) | Jan. 1973 | 1010 | 92 | 9.1 |
| | Jan. 1974 | 1080 | 95 | 8.8 |
| | Jan. 1975 | 1066 | 76 | 7.1 |
| | Jan. 1976 | 1036 | 69 | 6.7 |
| | Feb. 1977 | 1008 | 61 | 6.0 |
| | Jan. 1978 | 1008 | 61 | 6.0 |
| Radford Arsenal | 1972 | 966 | 140 | 14.1 |
| (area includes site 8) | Jan. 1973 | 1016 | 125 | 12.3 |
| | Jan. 1974 | 1058 | 25 | 7.1 |
| | Jan. 1975 | 1080 | 87 | 8.1 |
| | Jan. 1976 | 1036 | 63 | 6.1 |
| | Feb. 1977 | 1007 | 39 | 3.9 |
| | Jan. 1978 | 1008 | 35 | 3.5 |

| <u>LOCATION</u> | <u>DATE</u> | <u>NO. CARS SURVEYED</u> | <u>NO. CARS WITH STUDS</u> | <u>% CARS WITH STUDS</u> |
|----------------------------------|-------------|------------------------------|--------------------------------|------------------------------|
| Verona | 1972 | 1034 | 180 | 17.3 |
| (area includes site 4) | Jan. 1973 | 1019 | 149 | 14.6 |
| | Jan. 1974 | 1082 | 130 | 12.0 |
| | Jan. 1975 | 1081 | 137 | 12.7 |
| | Jan. 1976 | 1036 | 110 | 10.6 |
| | Feb. 1977 | 1008 | 21 | 2.0 |
| | Jan. 1978 | 1008 | 41 | 4.1 |
| Winchester | 1972 | 1008 | 150 | 14.8 |
| (area includes site 7) | Jan. 1973 | 1016 | 135 | 7.5 |
| | Jan. 1974 | 1067 | 60 | 5.6 |
| | Jan. 1975 | 1082 | 66 | 6.1 |
| | Jan. 1976 | 1036 | 43 | 4.2 |
| | Feb. 1977 | 1008 | 28 | 2.8 |
| | Jan. 1978 | 1008 | 35 | 3.5 |
| Lynchburg | Jan. 1975 | 1079 | 51 | 5.0 |
| | Jan. 1976 | 1036 | 19 | 1.8 |
| | Feb. 1977 | 1008 | 22 | 2.0 |
| | Jan. 1978 | 1008 | 21 | 2.1 |
| Danville #1 (Dan River Mills) | Jan. 1975 | 1080 | 33 | 3.1 |
| | Jan. 1976 | 1036 | 2 | 0.2 |
| | Feb. 1977 | 1008 | 5 | 0.5 |
| | Jan. 1978 | 1008 | 12 | 1.2 |
| Danville #2 | Jan. 1975 | 1026 | 42 | 4.1 |
| | Jan. 1976 | 10.36 | 9 | 0.9 |
| | Feb. 1977 | 1007 | 7 | 0.7 |
| | Jan. 1978 | 1008 | 14 | 1.4 |
| Norfolk #1 (Naval Ship Yard) | Jan. 1975 | 1083 | 7 | 0.2 |
| | Jan. 1976 | 1036 | 1 | 0.1 |
| | Feb. 1977 | 1008 | 1 | 0.1 |
| | Jan. 1978 | 1008 | 2 | 0.2 |

| <u>LOCATION</u> | <u>DATE</u> | <u>NO. CARS SURVEYED</u> | <u>NO. CARS WITH STUDS</u> | <u>% CARS WITH STUDS</u> |
|-------------------------------------|-------------|------------------------------|--------------------------------|------------------------------|
| Norfolk #2 | Jan. 1975 | 1080 | 2 | 0.2 |
| | Jan. 1976 | 1036 | 0 | 0.0 |
| | Feb. 1977 | 1008 | 6 | 0.6 |
| | Jan. 1978 | 1008 | 2 | 0.2 |
| Richmond #1 (Reynolds Metal Co.) | Jan. 1975 | 1060 | 10 | 0.9 |
| | Jan. 1976 | 1036 | 6 | 0.6 |
| | Feb. 1977 | 1010 | 4 | 0.4 |
| | Jan. 1978 | 1008 | 2 | 0.2 |
| Richmond #2 (Dupont) | Jan. 1975 | 1080 | 7 | 0.6 |
| | Jan. 1976 | 1036 | 4 | 0.4 |
| | Feb. 1977 | 1008 | 7 | 0.7 |
| | Jan. 1978 | 1008 | 20 | 2.0 |

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