

INTERIM REPORT NO. 1

BITUMINOUS MIXES INCORPORATING BLENDED AGGREGATES

by

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and

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Senior Research Scientists

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

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SUMMARY

This report describes the skid performance after four years traffic of several experimental sections containing from 0% to 36% nonpolishing aggregate blended with #10 limestone aggregate. A 1978 installation of an I-2 Modified (30/70) blend employing 30% #68 nonpolishing aggregate and 70% #10 limestone is also discussed. Finally the anticipated 1979 work amounting to approximately 38,000 tons is mentioned.

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INTRODUCTION

The Research Council, in cooperation with the Materials and Maintenance Divisions, is continuously trying to develop economical, skid resistant bituminous surface courses. One of the most successful methods of producing such surfaces in the state's western districts where nonpolishing aggregates are scarce and costly to import has been through the use of blended bituminous mixes, which contain blends of coarse, imported, polish resistant aggregate and fine, locally available, polish susceptible materials. While these mixes have served the Department well as money savers, it is believed they have not been developed to their full potential since the maximum portion of the less expensive local material used in the blends has been about 50%. The mixture containing this percentage of the local materials has been designated an intermediate nonpolishing mix [(I-2(NP))]. If the fraction of the local material could be substantially increased without sacrificing skid resistance, significant savings could be realized.

In 1974 several experimental mixes incorporating from as much as 36% to as little as 0% nonpolishing coarse aggregate were placed in the Staunton and Bristol Districts to determine the minimum fraction of polish resistant aggregate that could be used to provide pavement surfaces with adequate skid resistance.

This report concerns the performance of the 1974 mixes, as well as the 1978 installation of a large experimental section in the Bristol District and some sections planned for installation.

EXPERIMENTAL SITES

1974 Sites

The 1974 work included five sections of roadway surfaces with blended aggregate mixes.⁽¹⁾ Two of the experimental sites are in the Staunton District and the other three in the Bristol District. One of the sites in the Staunton District is on Route 55 east of Front Royal (Warren County) and the other on Route 50 west of

Winchester (Frederick County). The sites in the Bristol District are on Route A-58 east of Dryden (Lee County), Route 19 east of Lebanon in Russell County, and Route A-58 east of St. Paul in Russell County. The Route 19 site was abandoned in 1978 when construction of the adjacent lanes disturbed the experimental site. Schematic drawings of the sites are shown in Figures 1 through 5 appended.

1978 Installation

On the basis of the findings from the 1974 experiments, which are discussed later in the report, it was decided that a test section of mixes employing about 30% of the imported polish resistant aggregate would be placed in 1978. In June 1978 an experimental section requiring approximately 2,690 tons of mix was installed in Smyth County on Route 11 near Chilhowie. Figure 6 shows the layout. The AVD on this section was 8,385 in 1977 and the accumulated annual traffic in each direction is about 1.5 million vehicles.

The special provisions for this section called for an I-2 Modified (30/70 blend) mix, so 30% #68 aggregate (Sylvatus quartzite) was blended with 70% #10 limestone (Washington County Stone Company). Marshall mix data for samples from the paver are given in Table 1.

Table 1

Data for I-2 Modified Mix

Stability	2,525 lb.
Density	146.1 pcf
VMA	18.4%
VFA	68.6%
VTM	5.8%
Asphalt Content	5.2%

Densities on the road averaged slightly below 92% of the maximum theoretical density. The actual percentage of #68 nonpolishing aggregate found from extraction tests on four samples averaged 26% and ranged from 20% to 35%. This variation should not be unexpected because the job mix limits were waived on this project. A change in the 1979 special provisions eliminates the waiving of the job mix limits and hopefully will produce a more uniform range of nonpolishing aggregate.

The price of the I-2 modified mix was \$23.15/ton, which compared favorably with the \$24.90/ton bid price for the alternative I-2(NP) mix. This price savings exceeded the 20% reduction in the #68 nonpolishing aggregate, which cost \$8.00/ton delivered at the plant as compared to the \$3.50/ton for the #10 limestone.

The 20% reduction in the amount of the nonpolishing aggregate used in the I-2 Modified as compared to the I-2(NP) should result in a price reduction of about 4%. This savings was realized in that the reduction in the cost per ton of mix was about 7%.

PERFORMANCE OF THE 1974 INSTALLATIONS

As judged by visual inspections the experimental sections placed in 1974 have performed very well; no excessive cracking has taken place. The traffic volumes have not been exceedingly high; the accumulated traffic for the various sites has been between 3.0 and 4.5 million vehicles in about 4½ years.

The characteristic of primary interest, the skid resistance as measured by a locked wheel skid test trailer at a test speed of 40 mph as specified by ASTM Standard test method E-274-77 and reported as skid number at 40 mph (SN_{40}), has varied from year to year but has shown no trend. Thus the average SN_{40} for the 4 years appeared to be the best estimate of skid resistance for each site as the dependent variable when correlated with percent nonpolishing aggregate.

In order to determine the relationship between the average 4-year SN_{40} and the percentage nonpolishing aggregate in the mix, Figure 7 was plotted. A linear correlation of this relationship considering only the test sections is shown on the figure. The correlation is fairly good with a correlation coefficient of .76 and a standard error of 3.5 (SN_{40}). The single data point at 15% nonpolishing aggregate and an SN_{40} of 38 is for the Route 58 Lee County site and is the main reason that the correlation is not substantially better. However, no logical reason could be found for this relatively low result.

All aggregates in Figure 7 were either #8 or #78 stone and there does not appear that one aggregate is substantially better than another due to size only.

According to the relationship in Figure 7, an average of 30% nonpolishing aggregate would produce an average SN_{40} of approximately 54. Based on the assumption that there may be a 10% fluctuation around the average, the minimum amount of nonpolishing material at any location on the pavement is approximately 20%. For such a location, a skid number of 50 would still be provided.

Thus it appears that a conservative estimate of the minimum amount of nonpolishing material needed to provide a good skid resistant surface is about 30%. As more information is obtained on typical plant variations, it may be possible to reduce the percentage of nonpolishing material below the 30% level.

ANTICIPATED 1979 WORK

In an attempt to save additional maintenance funds and to extend the experience in the use of blended mixes, several maintenance overlay schedules were advertised in the Bristol, Salem, and Staunton Districts this year. The blended mix (I-2 Modified) was advertised as an alternative to the normally specified I-2 (NP) mix. Of 10 schedules advertised, the blended mix was low on 8 involving a total of 37,904 tons of mix and a savings over the I-2 (NP) of \$44,794, or \$1.18/ton. While this average savings is less than that indicated in the 1978 work, it still satisfies the 4% guideline, which indicates that some of the contractors are passing an equitable portion of the savings on to the state.

It is anticipated that the alternative bid next year will include a note allowing the state to choose the mix that is most economical and to ensure that all contractors meet the above guidelines.

ACKNOWLEDGEMENT

The blended mixes were designed and controlled by the materials personnel in the Staunton and Bristol Districts.

REFERENCE

- 1 Hughes, C. S., and D. C. Mahone, "Installation Report - Blended Aggregate Bituminous Mixes," VH&TRC 75-R39, 1975.

4 miles ECL Front Royal

Approximately
M.P. 1.3

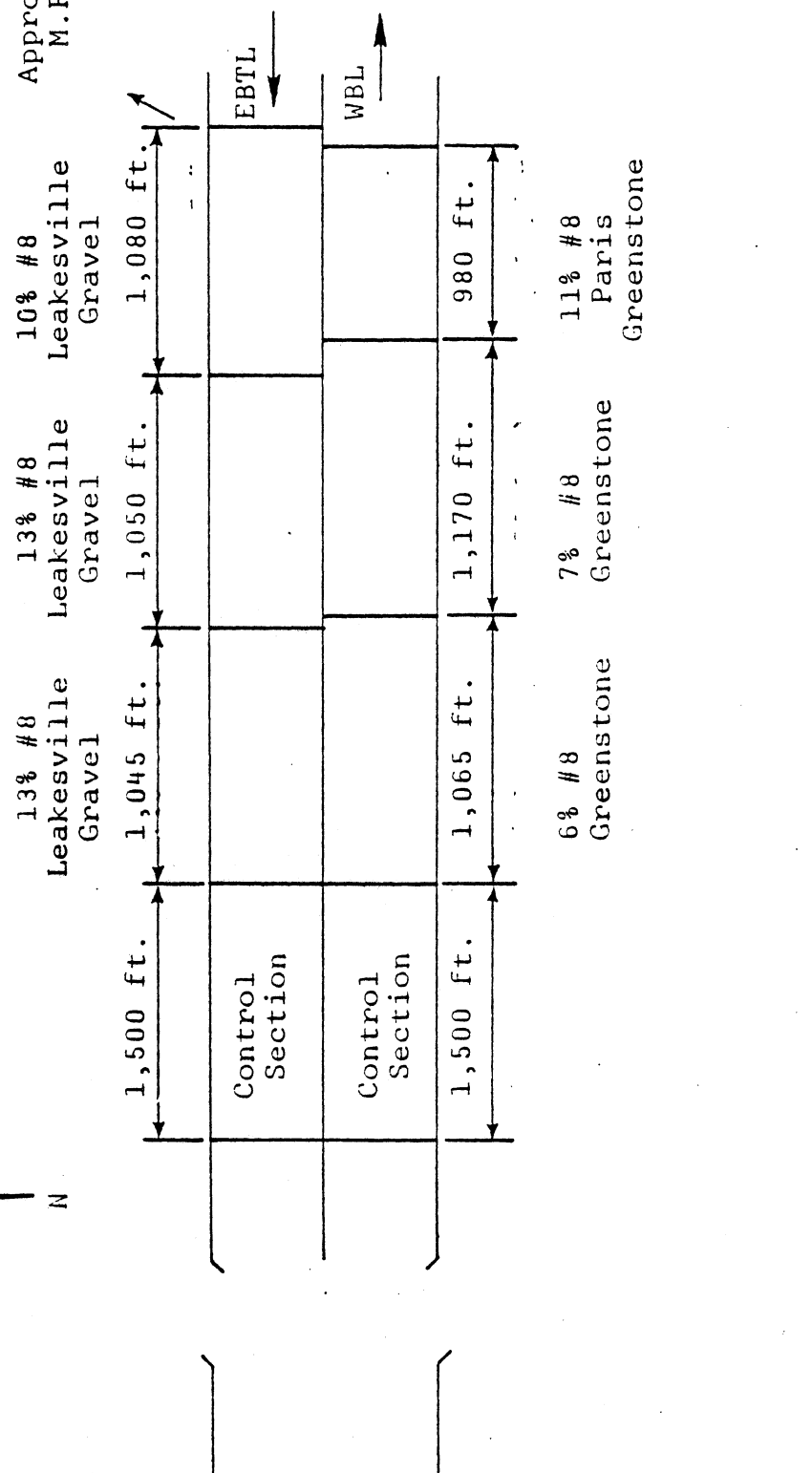
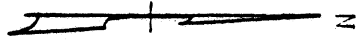


Figure 1. Route 55 - Warren County.
(1 foot = .304 m)
(1 mile = 1.6 km)

Warren-Faquier County Line

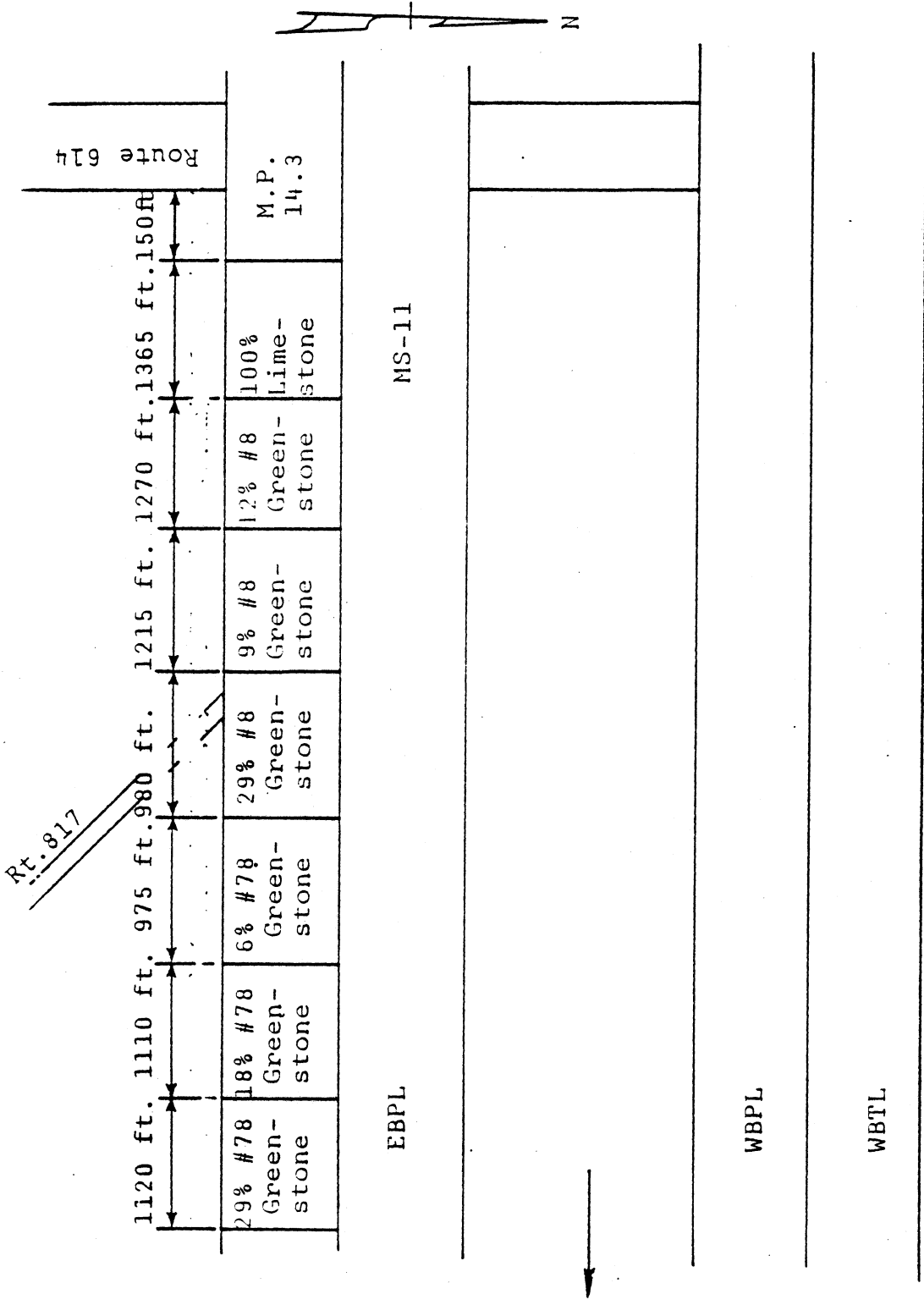


Figure 2. Route 50 - Frederick County.
 (1 foot = .304 m).
 (1 mile = 1.6 km)

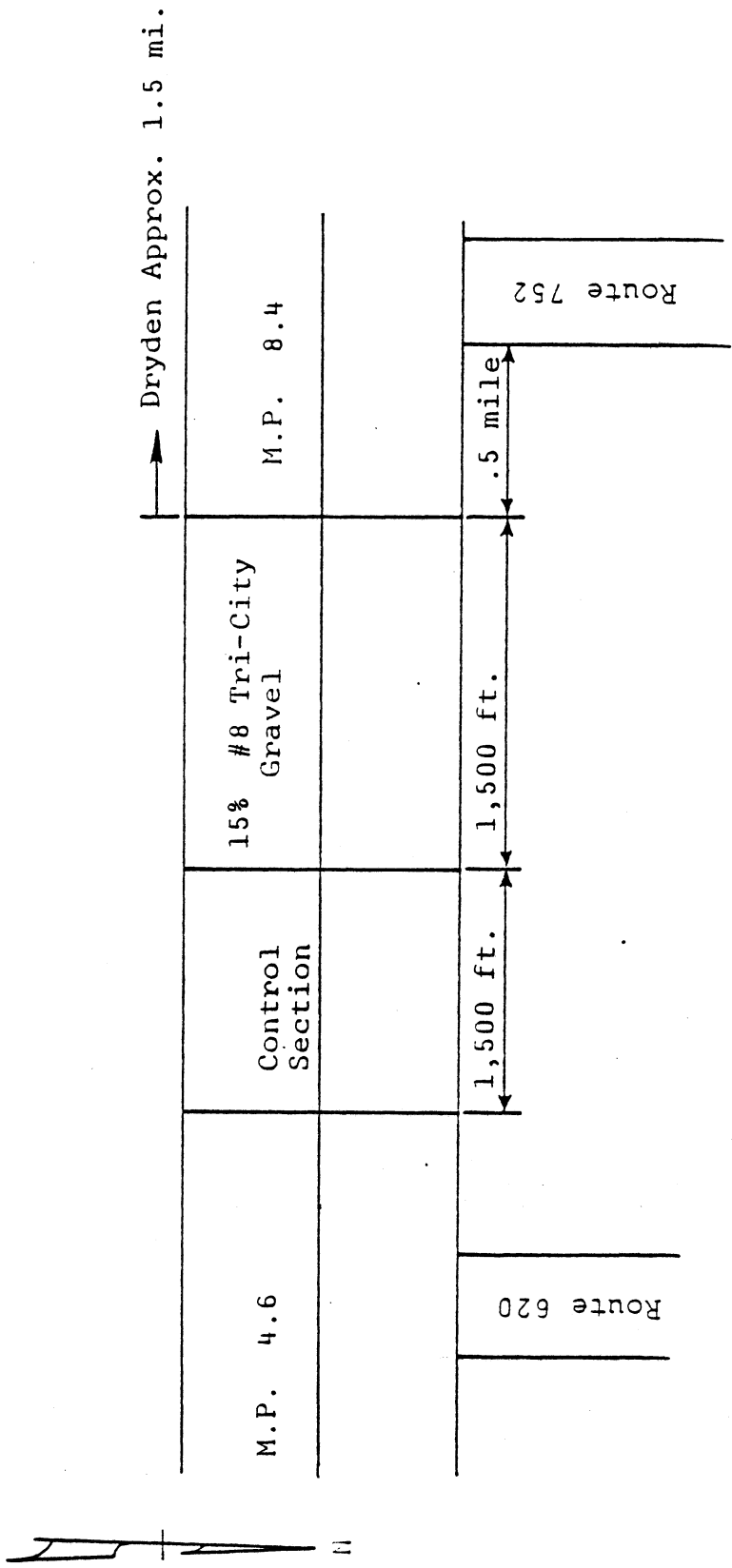


Figure 3. Route A-58 -- Lee County.
 (1 foot = .304 m).
 (1 mile = 1.6 km)

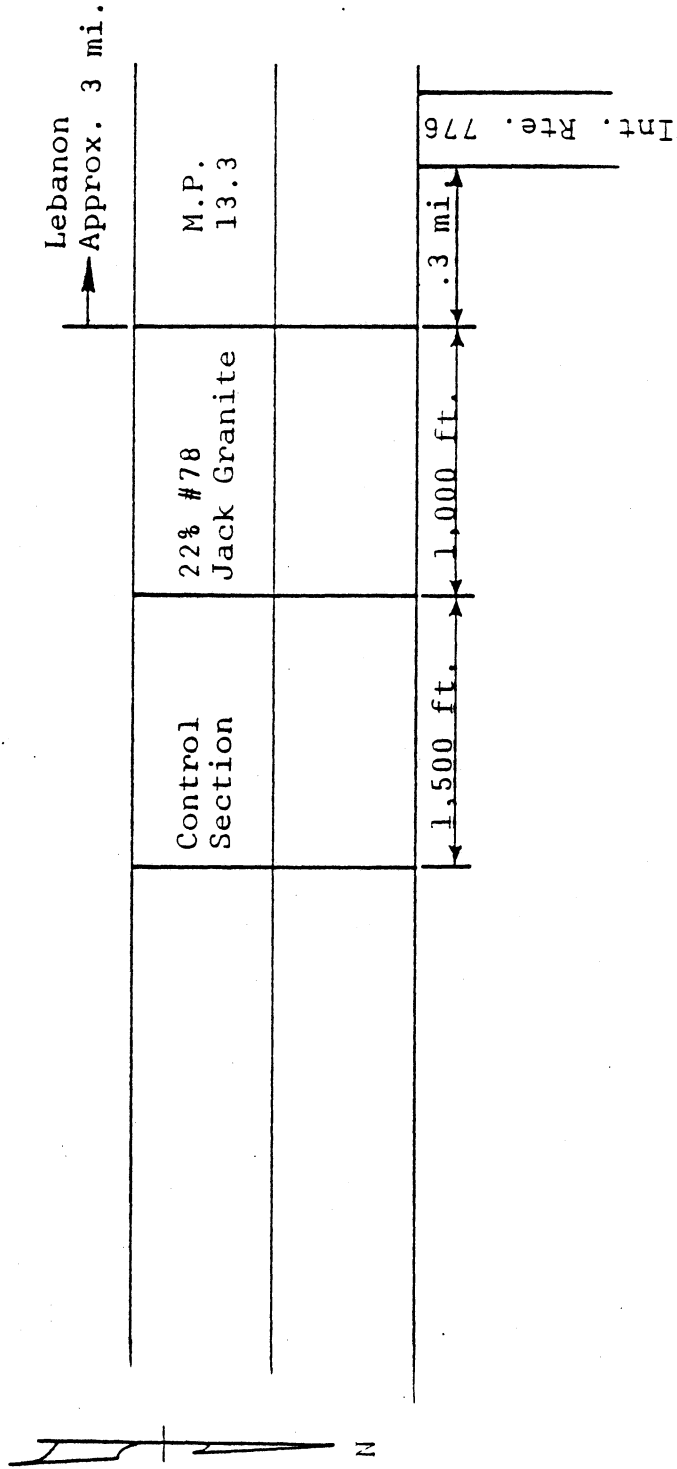


Figure 4. Route 19 — Russell County.
 (1 foot = .304 m)
 (1 mile = 1.6 km)

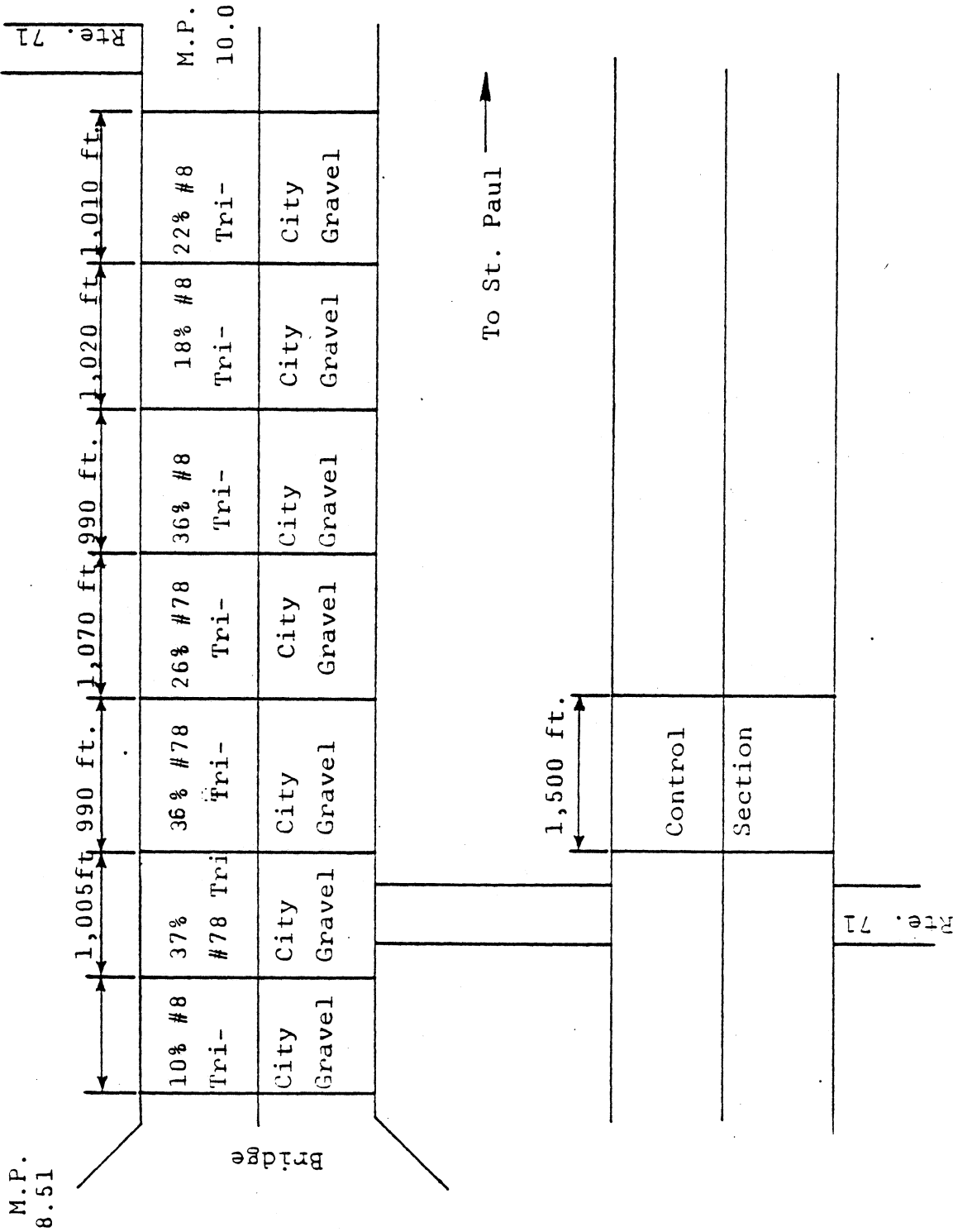


Figure 5. Route A-58 - Russell County.
 (1 foot = .304 m)
 (1 mile = 1.6 km)

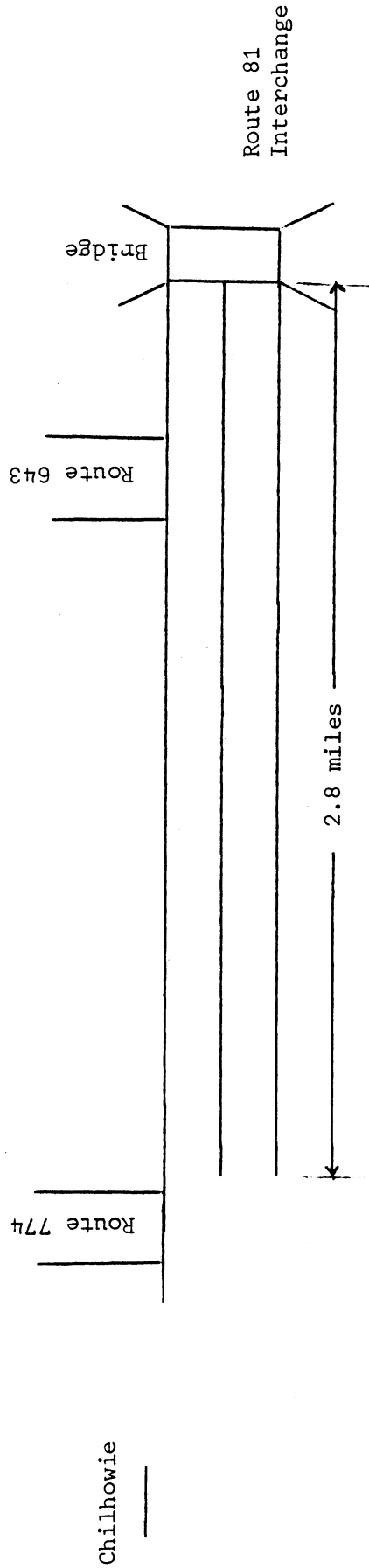


Figure 6. Route 11 -- Smyth County
(1 foot = .304 miles)
(1 mile = 1.6 km)

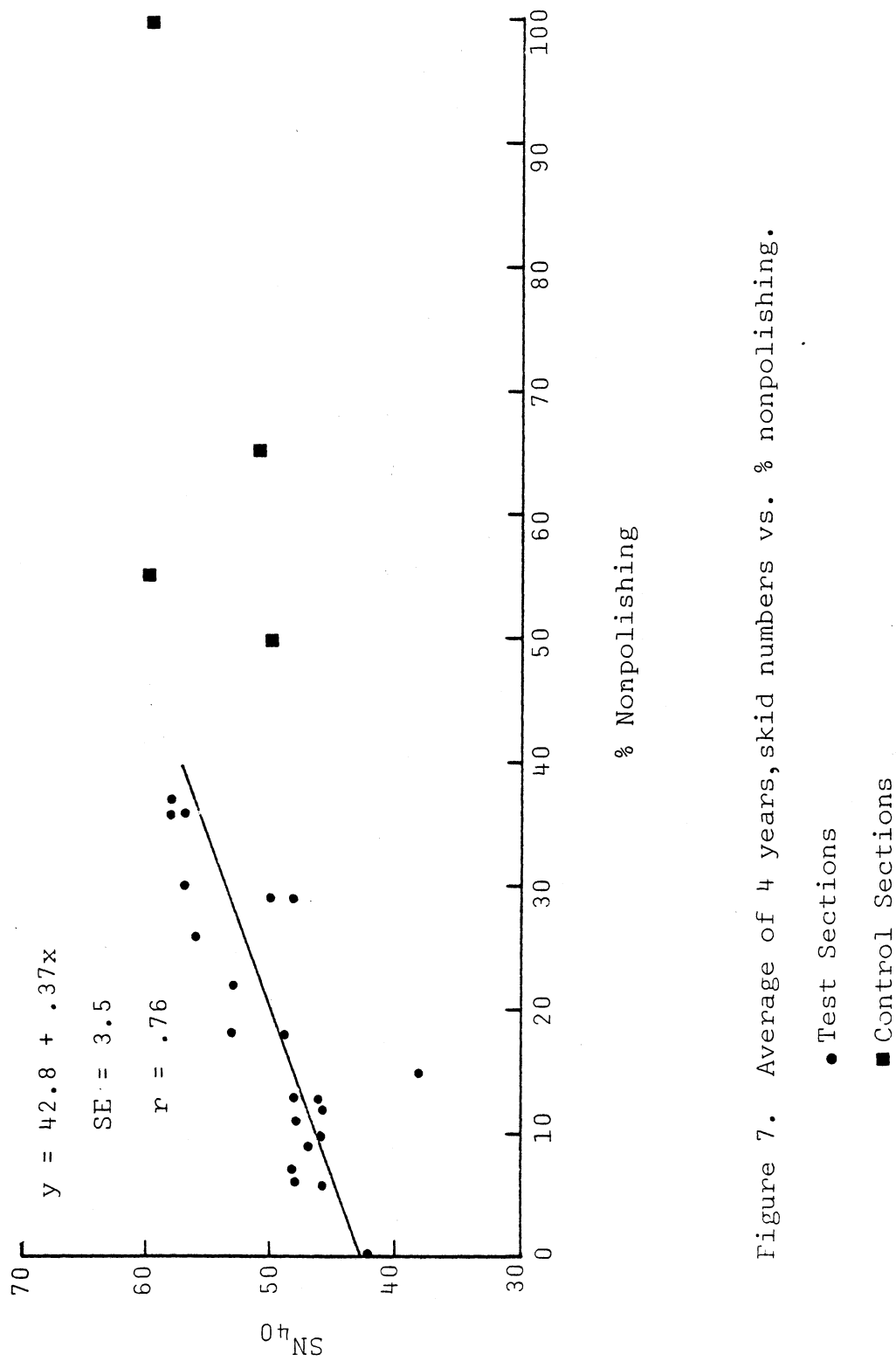


Figure 7. Average of 4 years, skid numbers vs. % nonpolishing.

