

**COST EFFECTIVE METHODS TO UPGRADE UNPAVED ROADS**

**PHASE I AND PHASE II**

PB2000-102889



**RESEARCH PROJECT No. 91/92-69**

**FINAL REPORT**

**July 1999**

**BY**

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**CONDUCTED BY**

**PENNSYLVANIA DEPARTMENT OF TRANSPORTATION**

**BUREAU OF CONSTRUCTION AND MATERIALS**

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16. Abstract <p>This is the final report on a survey of 511 commercial motor vehicle (CMV) drivers undertaken concurrently with the Driver Fatigue and Alertness Study.</p> <p>Using the same basic methods established in prior studies by other investigators, interviews were conducted at four geographically disparate locations. The demographics of participating drivers were closely matched with those who had participated in previously published research. Care should be taken extrapolating the data reported here to other segments of the CMV driver population. The drivers chosen to participate were driving loaded tractor-trailer combination vehicles (straight trucks were excluded), and who had driven at least 60,000 miles within the last year, been on the road for at least 24 hours at the time of the interview, and had stopped at weigh stations for vehicle inspection or to take a break. Information was gathered on driver demographics, job characteristics, sleeping habits (including episodes of drowsiness while driving), work habits (including length of driving period and activities during breaks), methods and activities for alertness maintenance, and their subjective alertness state at time of the interview.</p> <p>The majority of the drivers drove irregular routes and operated on schedules that varied from day to day. Three-quarters of these drivers using sleeper berths usually took their rests in a single 8-9 hour period. The remainder of the sleeper berth users split their rests and spent fewer hours sleeping than their continuous-rest counterparts. Although the majority of drivers reported no drowsiness and dozing and sleepiness incidents while behind the wheel during the 30 days prior to the interview, an appreciable number did, and drivers with irregular schedules reported significantly more dozing/sleeping incidents.</p> <p>A substantial number of drivers stated they have taken less sleep in order to maintain their schedules. Economic pressures and a lack of availability of suitable parking areas for taking naps or sleeping were cited. Drivers' techniques for maintaining alertness appeared to depend on personal preferences, although most considered maintaining cool cab temperatures, stretching, and listening to the radio to be beneficial.</p>					
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## EXECUTIVE SUMMARY

In the rural areas of Pennsylvania, there are approximately 1,160 miles of unpaved roads that comprise a portion of the current 40,162 mile roadway system that is maintained by the Pennsylvania Department of Transportation. These unpaved road facilities are comprised of either: (1) natural earth, (2) mixtures of aggregates and clay, or (3) thin bituminous surfacing with a crushed stone or gravel base course. (Reference 1) The existing condition of many of these unpaved roads is poor and would require extensive rehabilitation to significantly improve the surface and base course materials.

As a result of House Bill No. 1393 (1991), the Department was allocated \$300,000 to conduct a Demonstration Project for surface upgrading of selected unpaved roads. Again in 1992, the Department was earmarked an additional \$300,000 to extend the studies.

Four (4) counties in western Pennsylvania were selected as candidate counties for the application and evaluation of eleven (11) different treatment methods. The evaluation of the roadways was conducted for three to four years after construction. Road maintenance and repairs were conducted as needed. An estimate of cost for maintenance activities, both before, and after construction, along with performance inspections, provided judgement for these products use in future.

**Metric Conversion Factors\***

To Convert From:	To:	Multiply By:
<b>Length</b>		
foot (ft)	meter (m)	0.3048
inch (in)	millimeter (mm)	25.4
yard (yd)	meter (m)	0.9144
mile (statute)	kilometer (km)	1.609
<b>Area</b>		
square foot (ft <sup>2</sup> )	square meter (m <sup>2</sup> )	0.0929
square inch (in <sup>2</sup> )	square centimeter (cm <sup>2</sup> )	6.451
square yard (yd <sup>2</sup> )	square meter (m <sup>2</sup> )	0.8361
<b>Volume</b>		
cubic foot (ft <sup>3</sup> )	cubic meter (m <sup>3</sup> )	0.02832
cubic yard (yd <sup>3</sup> )	cubic meter (m <sup>3</sup> )	0.00315
gallon (U.S. liquid)	cubic meter (m <sup>3</sup> )	0.004546
ounce (U.S. liquid)	cubic centimeter (cm <sup>3</sup> )	29.57
<b>Mass</b>		
ounce-mass (avdp)	gram (g)	28.35
pound-mass (avdp)	kilogram (kg)	0.4536
ton (metric)	kilogram (kg)	1000
ton (short, 2000 lbm)	kilogram (kg)	907.2
<b>Density</b>		
pound-mass/cubic foot	kilogram/cubic meter (kg/m <sup>3</sup> )	16.02
mass/cubic yard	kilogram/cubic meter (kg/m <sup>3</sup> )	0.5933
pound-mass/gallon(U.S.)**	kilogram/cubic meter (kg/m <sup>3</sup> )	119.8
pound-mass/gallon(Can.)*	kilogram/cubic meter (kg/m <sup>3</sup> )	99.78
<b>Temperature</b>		
deg Celsius (°C)	kelvin (°K)	$t^{\circ}\text{K} = (t^{\circ}\text{C} + 273.15)$
deg Fahrenheit (°F)	kelvin (°K)	$t^{\circ}\text{K} = (t^{\circ}\text{F} + 459.67) / 1.8$
deg Fahrenheit (°F)	deg Celsius (°C)	$t^{\circ}\text{C} = (t^{\circ}\text{F} - 32) / 1.8$

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## 1.0 INTRODUCTION

In the rural areas of Pennsylvania, there are approximately 1,160 miles of unpaved roads that comprise a portion of the current 40,162 mile roadway system that is maintained by the Pennsylvania Department of Transportation. These unpaved road facilities represent important links in the statewide transportation network since they provide access to adjacent land and serve to carry traffic between numerous farms, residences and small villages over relatively short distances. On these roadways, the through traffic is considered local in nature and extent.

The surface of these unpaved roads is comprised of either: (1) natural earth, (2) mixtures of aggregates and clay or (3) thin bituminous surfacing with a crushed stone or gravel base course (REFERENCE 1). These types of surfaces are prone to potholes and road settlement, requiring frequent repairs. It is impossible to make all the needed repairs to the roadways as often as they may need because of time and money constraints.

The existing conditions for many of these facilities would require extensive rehabilitation to significantly improve the surface and base course materials. At many locations, the conditions of the unpaved roads can no longer be significantly improved by routine maintenance operations such as grading and blading, skin patching, pothole patching and the application of seal coats. Scheduled improvements to these unpaved roads require costly expenditures that would represent a sizeable investment and, in turn subsequent increases in the budget requirements of the Department.

Within the past few years, considerable interest has been generated to explore and evaluate various methodologies that will lead to cost-effective and reliable techniques to upgrade and improve these facilities.

As a result of House Bill No. 1393 (1991), the Department was allocated \$300,000 to conduct a Demonstration Project for surface upgrading of selected unpaved roads in

rural-oriented counties, and an additional \$300,000 by the General Assembly for the Fiscal Year 1991-92 to continue this project as Phase II.

## **2.0 OBJECTIVE**

The objective of this Demonstration Project were to evaluate the cost-effectiveness and performance of various experimental treatment methods selected to upgrade designated unpaved roads and to compare the results of the evaluation against a bituminous surface treatment application with and without a primer that was used as the control treatment on rural roadway facilities which have been graded and recompactd.

## **3.0 PROJECT LOCATIONS**

Four counties in western part of the state were selected as candidate counties for this Demonstration Project. Somerset County in Engineering District 9-0, Armstrong County and Butler County in Engineering District 10-0, and Beaver County in Engineering District 11-0 represent the candidate counties.

The project location maps for Phase I and Phase II are located in Appendix A

## **4.0 TREATMENT METHODOLOGIES**

For this Demonstration Project, eleven (11) treatment methods were selected for application and evaluation. The methodologies tried varied from recycled asphalt material (RAP) materials to soil stabilizers, which serve as a base course for seal coats.

Two representative control sections, using standard asphalt emulsion and Asphalt Emulsion Prime (AEP) as the control materials, were used to allow comparison with the performance of the experimental treatment methods selected.

All construction methods and procedures performed on the roadways were performed by Department forces or contracted out by Purchase Order. Most of the detailed construction methods and procedures performed at each site are located in the construction reports for this project.

The following is a list of the eleven (11) treatment methods selected for application and evaluation. The application of each treatment method was placed over the full width of the roadway to utilize the effects of traffic in both directions of travel.

### **PHASE I**

- Primer and a single bituminous surface treatment placed on the existing roadway (Control Section)
- Cold mix in-place recycling with a single bituminous seal coat treatment applied as a wearing surface on the existing roadway (Experimental Section)
- Reclaimed Asphalt Pavement (RAP) with a single bituminous seal coat treatment applied as a wearing surface on the existing roadway (Experimental Section)
- Primer and FB-2 bituminous wearing course treatment applied on the existing roadway (Experimental Section)
- Primer and FB-1 bituminous binder course with a single bituminous seal coat treatment applied as a wearing surface on the existing roadway (Experimental Section)

### **PHASE II**

- Single bituminous surface treatment placed on the existing roadway

(Control Section)

- Cold mix in-place recycling with a single bituminous surface treatment applied as a wearing surface on the existing roadway (Experimental Section)
- FB-1 bituminous leveling course with a single bituminous surface treatment applied as a wearing surface on the existing roadway (Experimental Section)
- Cold mix in-place recycling, FB-1 bituminous leveling course with a single bituminous surface treatment applied as a wearing surface on the existing roadway (Experimental Section)
- FB-2 modified bituminous wearing course applied as a wearing surface on the existing roadway (Experimental Section)
- FB-2 bituminous wearing course with a single bituminous seal coat treatment applied as a wearing surface on the existing roadway (Experimental Section)

The installation of the previous indicated treatment methods was conducted in four (4) counties. A summary of each county's construction performance and maintenance costs for each treatment method is presented in section 4.1 through 4.4.



**4.1 ARMSTRONG COUNTY, MAINTENANCE DISTRICT 10-1**  
**COLD MIX IN-PLACE RECYCLING WITH A SINGLE BITUMINOUS SEAL**  
**COAT TREATMENT APPLIED AS A WEARING SURFACE ON THE**  
**EXISTING SURFACE (EXPERIMENTAL SECTION)**

1. **S.R. 2021, Segment 10/0000 to Segment 60/3084, near Whitesburg (13,939.29).**

**Construction Summary:** Treatment upgrade operations began with the existing roadway pavement structure being milled or crushed to a depth of two (2) to three (3) inches using a Caterpillar RR-250 Road Reclaimer. After milling, two (2) inches of a Reclaimed Asphalt Pavement (RAP) Material was spread over the milled material and mixed in-place by the Road Reclaimer to develop a four (4) to five (5) inch road base. Next, an AASHTO Grade CSS-1h Bituminous Material was spread uniformly over the combined existing roadway material and the RAP material by a distributor truck and this was mixed by the Road Reclaimer. Next, a grader was used to shape and dress the roadway profile. Then, the surface was compacted using a pneumatic-tire roller and a steel wheel tandem roller until compressed to a firm, even surface. Adequate stability and adhesion had been attained and the material was sufficiently cured to prevent distortion, flushing of bituminous material to surface, or loss of aggregate. The surface was then sealed with the application of a single bituminous seal coat treatment. This treatment was achieved by first spreading an E-3 (see Photo 1 in Appendix B). Then, a Type A, AASHTO No.8 Coarse Aggregate was spread uniformly in a single layer using a mechanical spreader. AASHTO No.8 Coarse Aggregate was thoroughly set using a pneumatic-tire roller.

**Performance Summary: S.R. 2021, Segment 10/0000 to Segment 60/3084, near Whitesburg (13,939.29).** The inspection on March 31, 1993 reported that the roadway was in good condition. A year later, it was noted that the overall section was in good condition and the surface treatment placed during 1993 was holding. The worst spot in this section is the uphill section on the right side. Inspection in April 1994 showed that poor areas in the road had been patched (see Photo 2 in Appendix B). The last inspection, June 16, 1995, noted that there was some minor flushing in the wheel paths and edge cracking. Potholes were also noted on the uphill side on Segment 30.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**PRIMER AND SINGLE BITUMINOUS SURFACE TREATMENT PLACED ON  
THE EXISTING ROADWAY (CONTROL SECTION)**

**1. SR 2014, Segment 30/0000 to Segment 70/0957 , near Bowser  
Crossroads (12,408.00 L.F.)**

**Construction Summary:** Initially, the existing roadway surface was graded and shaped to remove surface deformations such as rutting, corrugations, depressions and potholes. Treatment upgrade operations began with the existing roadway surface being primed by the application of an MC-70 Bituminous Material. This material was spread uniformly, at a rate of 0.30 gallons per square yard. After the application of the bituminous material, a dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat. Next, the single bituminous surface treatment was applied.

First, an AC-2.5 (Asphalt Cement) Bituminous Material was spread uniformly, at a rate of 0.30 gallons per square yard, over the roadway surface using a distributor truck. After application of the AC-2.5 material, a Type A, AASHTO No.67 Coarse Aggregate was spread uniformly, in a single layer, at a rate of 35 pounds per square yard, using a mechanical spreader. Next, the AASHTO No.67 Coarse Aggregate was rolled by two (2) pneumatic-tire rollers, as specified in PUB. 408, Section 108.05(c)3.f., with a contact pressure of 40 to 50 pounds per square inch, to set the aggregate. Following the roller operations, a second application of the AC-2.5 material was spread uniformly over the AASHTO No.67 Coarse Aggregate, at a rate of 0.30 gallons per square yard, using a distributor truck.

Then, a Type A, AASHTO No.8 Coarse Aggregate was spread uniformly, in a single layer, at a rate of 25 pounds per square yard, over

the width of the AC-2.5 application through the use of a mechanical spreader. Finally, the AASHTO No.8 Coarse Aggregate was rolled to set the aggregate using two (2) pneumatic-tire rollers.

**Performance Summary: S.R. 2014, Segment 30/0000 to Segment 70/0957.** Road conditions were reported as not very good all three years of the evaluation. Potholes, alligator cracking, loss of aggregate, soft spots, aggregate breaking up, and settlement of roadway were all reported throughout the entire section (see Photos 3 and 4 in Appendix B). In 1994, it was noted in the inspection report to expect additional problems in the future unless the drains are bladed.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

2. SR 4019, Segment 20/0000 to Segment 50/2250 near Limestone Junction (11,616.00 L.F.)

**Construction Summary:** The construction methods and procedures used for the application of the primer and single bituminous surface treatment on this section of S.R. 4019 are the same as used on S.R. 2014, Segment 30/0000 to Segment 70/0957 in Armstrong County.

**Performance Summary:** The inspection on March 31, 1993 revealed that the road had areas where major problems were prevalent. In these areas, loss of aggregate, extensive alligator cracking, rutting, settlement of the road, potholes, and soft spots were noted throughout most of the section. The report from April 13, 1994 noted that there was not much of a change from the previous year's inspection.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**COLD MIX IN-PLACE RECYCLING WITH A BITUMINOUS SURFACE  
TREATMENT APPLIED AS A WEARING SURFACE ON THE EXISTING  
ROADWAY (EXPERIMENTAL SECTION)**

1. **S.R. 2042, Segment 60/1056 to Segment 60/2534, near Shady Plain (1478.4 L.F.)** With Perma-Zyme stabilizer

**Construction Summary:** Treatment upgrade operations began with the scarification of the existing roadway base material, to a depth of six (6) inches, by the use of an RS-500 Road Reclaimer. Before the Road Reclaimer milled the existing roadway surface, a grader began blading the ditch lines to dress them up and to pull the material toward the center of the roadway. Once the roadway was milled, the experimental material called PERMA-ZYME, was added to provide a stabilized base, **at a rate of approximately 1gallon of concentrate for every 5 cubic yards of material** (see Photo 7 in Appendix B).

**Performance Summary:** Only two site inspections were made. On April 12, 1994, it was reported some surfacing has separated and pot holes are developing along the side of the road (see Photo 8 in Appendix B). It also appeared that there was a surface treatment done during the summer of 1993. The overall condition of the road was good. The inspection performed on May 25, 1995 reported that the section has not changed since the last inspection a year before.

**Cost Summary:** This treatment did appear to be cost effective. Maintenance costs after the treatment were less than maintenance costs prior to treatment. Refer to \* at the end of the section on page 49.

**2. S.R. 2043, Segment 10/0000 to Segment 60/2759, near Shady Plain (17899.2 L.F.) With Perma-Zyme stabilizer**

**Construction Summary:** The construction methods and procedures used for the application of the Cold Mix In-Place Recycling with a single Bituminous Surface Treatment on this section of S.R. 2043 are the same as the procedures used at the S.R. 2042 project site in Armstrong County (see Photo 9 in Appendix B).

The cold mix in-place recycling operations require milling the existing roadway surface and the application of Perma-Zyme.

**Performance Summary:** The inspection performed on April 13, 1993 revealed a road in good condition. Potholes and rutting were present but, they were not frequent (see Photo 10 in Appendix B). In Segment 50, the Perma-Zyme and seal coat was noted as not holding up at the bottom of the hill. This was the only major problem reported along the section.

During the inspection on April 12, 1994, small areas of rutting, alligator cracking, and potholes were located in the wheel paths. In the section between 1.70 to 2.60, the surface was in poor condition. There was aggregate loss and the base material was visible. Alligator cracking was also prominent throughout the area. However, the overall road section was in good condition.

The inspection on May 23, 1995, revealed that the road section was still in good condition.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost

effective. Refer to \* at the end of the section on page 49.

**3. S.R. 2049, Segment 20/0000 to Segment 40/0000, near Spring Church (4488.0 L.F.) With Perma-Zyme stabilizer**

**Construction Summary:** The construction methods and procedures used for the application of the Cold Mix In-Place Recycling with a single Bituminous Surface Treatment on this section of the S.R. 2049 are the same as the procedures used at the S.R. 2042 project site in Armstrong County (see Photo 11 in Appendix B).

The cold mix in-place recycling operations require milling the existing roadway surface and the application of Perma-Zyme.

**Performance Summary:** On April 1, 1993 the inspection revealed a road in poor condition with heavy rutting and muddy conditions (see Photo 12 in Appendix B). On the grades, driving was difficult due to soft conditions. The road had to have stone added during the winter to improve the road conditions and stabilization. The inspection on April 12, 1994 revealed that similar problems to the ones encountered the year before. The road was heavily rutted and soft. On May 23, 1995, the final inspection was made on this test section. The road had been repaired since the last inspection.

**Cost Summary:** Maintenance costs after the treatment were less than maintenance costs prior to the treatment. Refer to \* at the end of the section on page 49.



**4.2 BUTLER COUNTY, MAINTENANCE DISTRICT 10-2**  
**RECLAIMED ASPHALT PAVEMENT (RAP) WITH A SINGLE BITUMINOUS**  
**SEAL COAT TREATMENT APPLIED AS A WEARING SURFACE ON THE**  
**EXISTING ROADWAY (EXPERIMENTAL SECTION)**

**1. S.R. 3016, Segment 10/0000 to Segment 10/0880, near  
Callary Boro (897.60 L.F.)**

**Construction Summary:** Initially, the existing roadway profile was reshaped by the addition of PennDOT 2A Coarse Aggregate. This material was placed on the roadway surface and spread and shaped by a grader.

Next, the reshaped roadway surface was primed by the application of an MC-70 (Cut-Back Asphalt) Bituminous Material. This material was spread uniformly, at a rate of 0.30 gallons per square yard, over the roadway surface using a distributor truck.

After the application of the MC-70 Bituminous Material, four (4) inches of the recycled bituminous mixture consisting of Recycled Asphalt Pavement (RAP) material and AASHTO GRADE CSS-1H (Emulsified Asphalt) was placed full width by a mechanical paver and compacted to three (3) inches using a three wheel (steel) roller and a steel wheel tandem roller (see Photo 13 in Appendix B). The recycled mixture was run through a rented Pug Mill prior to placement.

Adequate stability and adhesion had been attained and the material was

sufficiently cured to prevent distortion, flushing of bituminous material to surface, or loss of aggregate. The surface was then sealed with the application of a single bituminous seal coat treatment.

**Performance Summary:** The RAP on S.R. 3016 was not placed through a crusher prior to the pugmill. This majority of the site performed satisfactorily through the 1995 inspection. A short section near the intersection showed initial failures and severe alligator cracking which required removal and replacement (see Photo 14 in Appendix B).

**Cost Summary:** The average maintenance material cost for 4 years after construction was approximately \$3.53 per linear foot. Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 3017, Segment 40/1616 to Segment 70/1198, near Callary Boro  
(6,336.00 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the Reclaimed Asphalt Pavement (RAP) with a single bituminous seal coat treatment on this section of S.R. 3017 are the same as used on S.R. 3016, Segment 10/0000 to Segment 10/0880 in Butler County (see Photo 15 in Appendix B).

**Performance Summary:** This site had some base failures in April of 93 inspection that was patched by the May 1995 inspection (see Photo 16 in Appendix B). Extra heavy traffic was placed on this SR when a large housing development was started along it. The RAP material on SR 3017 was placed through a crusher prior to the pugmill. This method produced a fine mixture, which could explain of the base failure. Other than the initial pavement deterioration this site performed well after patching.

**Cost Summary:** The average maintenance material cost for 4 years after construction was approximately \$0.03 per linear foot. Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**RECYCLED ASPHALT MATERIAL BITUMINOUS WEARING COURSE  
APPLIED AS A WEARING SURFACE ON THE EXISTING ROADWAY  
(EXPERIMENTAL SECTION HEI-WAY RAM)**

**1. S.R. 2011, Segment 20/0000 to Segment 60/0365, near Lardintown  
(12672.0 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the grading and priming of the existing roadway surface by the application of an MC-70 (CutBack Asphalt) Bituminous Material. This material was spread uniformly by a distributor truck.

Then, a AASHTO No.8 Coarse Aggregate was spread uniformly, in a single layer at a rate of 25 pounds per square yard, over the width of the MC-70 Bituminous Material application through the use of a mechanical spreader. The roadway surface was swept after the material had cured.

Next, the FB-2 Modified Bituminous Wearing Course was applied by a mechanical paver, in a single pass and at three (3) different depths (2 inches, 3 inches and 4 inches) in order to evaluate both the handling and placement characteristics of the material. The 2-inch depth was placed from Segment 20/0000 to Segment 20/1230, the 3-inch depth was placed from Segment 30/1102 to Segment 50/0000 and the 4-inch depth was placed from Segment 50/0000 to Segment 60/0416 (see Photo 17 in Appendix B).

The FB-2 Modified Bituminous Wearing Course was mixed at a batch-type Pug Mill located at the HEI-WAY (Heilman) Asphalt Plant on S.R. 0356 around Segment 70/0000.

**Performance Summary: S.R. 2011, Segment 20/0000 to Segment 60/0365.** The 2" section was seal coated because of severe deterioration. It was concluded that the FB-2 Modified be placed at least a 3" depth. Recycled Asphalt Material bituminous wearing course HEI- WAY RAM is found in a special provision under Section 433 (see Photo 18 in Appendix B).

Potholes, loss of aggregate and extensive alligator cracking were reported

in portions of the two (2) inch section on April 7, 1993. The three (3) inch section had some areas where there was loss of aggregate and potholes present. The four (4) inch section was in good condition.

On April 13, 1994, the two (2) inch section was not performing well. Alligator cracking and potholes were evident throughout the section. The three (3) inch section had some alligator cracking in some portions of the roadway, and the four (4) inch section was in good condition with no problems noted.

The last inspections in 1995 revealed that the four (4) and three (3) inch sections were still in very good condition. The two (2) inch section is showing signs patching and worsening.

**Cost Summary:** The average maintenance material cost for 4 years after construction was approximately \$0.01 per linear foot. This treatment did appear to be cost effective. Maintenance costs after the treatment were less than maintenance costs prior to the treatment. Refer to \* at the end of the section on page 49.

**FB-2 BITUMINOUS WEARING COURSE WITH A SINGLE BITUMINOUS SEAL COAT TREATMENT APPLIED AS A WEARING SURFACE ON THE EXISTING ROADWAY (EXPERIMENTAL SECTION)**

- 1. S.R. 3014, Segment 20/0000 to Segment 40/0000, near Callary Boro (3,062.40 L.F.)**

**Construction Summary:** Initially the existing road profile was graded shaped and rolled to remove surface deformations and rutting. Treatment upgrade operations began by priming the existing surface with the application of an MC-70 Bituminous Material.

Next, the FB-2 Bituminous Wearing Course was applied.

The FB-2 Bituminous Wearing Course was applied at a depth of 2 ½ inches at a rate of 225 pounds per square yard over an average width of eight feet.

After the FB-2 Bituminous Wearing Course was spread uniformly, compaction to the proper depth was achieved through the use of a ten ton steel wheel tandem roller.

To complete the paving operations, a layer of fine aggregate blotting material was spread uniformly at a rate of 3 to 5 pounds per square yard while the surface was still tacking and before the roadway was open to traffic.

During the summer of 1993, the single Bituminous Seal Coat Treatment was applied by Department Maintenance forces.

Then, a Type A, AASHTO No.8 Coarse Aggregate was spread uniformly in a single later at a rate of 25 pounds per square yard, over the width of the E-3 application using a mechanical spreader.

To complete the single Bituminous Seal Coat application, the AASHTO No.8 Coarse Aggregate was thoroughly set using a pneumatic-tire roller, with a contact pressure of 40 to 50 pounds per square inch.

**Performance Summary:** The control section contained some initial potholes by the 93 inspection which were patched by the 95 inspection (see Photos 19 and 20 in Appendix B). Except for the potholes it has performed satisfactorily over a 4 year period.

**Cost Summary:** The average maintenance material cost for 4 years after construction was approximately \$0.02 per linear foot. Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**4.3 BEAVER COUNTY, MAINTENANCE DISTRICT 11-2 AND 11-4**  
**PRIMER AND FB-2 BITUMINOUS WEARING TREATMENT APPLIED ON**  
**THE EXISTING ROADWAY (EXPERIMENTAL SECTION)**

- 1. S.R. 3022, Segment 60/0000 to Segment 80/2044, near Green Garden (2,956.80 L.F.)**

**Construction Summary:** Initially, open cracks in the roadway surface were filled and sealed prior to the application of a bituminous bonding material. All unsuitable material was removed and an E-2 (Emulsified Asphalt) Bituminous Material was poured into the cracks

Next, the roadway surface was treated by the application of an AASHTO GRADE CSS-1H (Emulsified Asphalt) Bituminous Material which acted as the bonding agent.

After the application of the AASHTO GRADE CSS-1H Bituminous Material, a dry, fine aggregate blotter material was spread by a dump truck.

After the tack coat application achieved proper cure to allow the water to separate and evaporate, the FB-2 Bituminous Wearing Course was spread uniformly, at a rate of 225 pounds per square yard by a mechanical, bituminous paver. Two (2) passes were required to cover the entire width of roadway.

Following the paver operations, the FB-2 Bituminous Wearing Course was compacted to the required density using a vibratory roller operated in a vibrating mode. Finish rolling was accomplished by a second vibrating roller, which was operated in the static mode.

To complete the paving operations, a layer of fine aggregate was spread uniformly at a rate of three (3) to five (5) pounds per square yard while the surface was still tacky and before the roadway was open to traffic.

**Performance Summary:** This roadway was only inspected twice, once in 1993 and 1995 (see Photos 21 and 22 in Appendix B). Both inspections reported that the roadway and drainage were in good condition, and no problems were observed.

**Cost Summary:** This treatment did appear to be cost effective.



Maintenance costs after the treatment were less than maintenance costs prior to the treatment. Refer to \* at the end of the section on page 49.

**PRIMER AND SINGLE BITUMINOUS SURFACE TREATMENT PLACED ON  
THE EXISTING ROADWAY (CONTROL SECTION)**

**1. S.R. 3023, Segment 100/00000 to Segment 110/3414, near Green  
Garden (4,646.40 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the existing roadway surface being primed by the application of an MC-30 Bituminous Material.

After the application of the bituminous material, a dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat as per Publication 408, Section 461.3 (b) requirements.

Next, the single bituminous surface treatment was applied.

**Performance Summary:** It was reported on April 7, 1993 that the overall condition of the roadway was good (see Photo 1 in Appendix B). Several isolated potholes were observed at random locations, and alligator cracking was observed in the right wheel paths at numerous locations. The roadway was not inspected until 1995. The inspection noted that the roadway had only deteriorated slightly since the last inspection (see Photo 24 in Appendix B).

**Cost Summary :** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**FB-2 BITUMINOUS WEARING COURSE WITH A SINGLE BITUMINOUS SEAL COAT TREATMENT APPLIED AS A WEARING SURFACE ON THE EXISTING ROADWAY (EXPERIMENTAL SECTION)**

**1. S.R. 3010, Segment 40/0000 to Segment 60/2337, near Shafers (7286.4 L.F)**

**Construction Summary:** The construction methods and procedures used for the application of the FB-2 Bituminous Wearing Course on this section of S.R. 3010 are the same as the procedures used at the S.R. 3014 project site in Butler County. (see Photo 25 in Appendix B)

**Performance Summary: S.R. 3010, Segment 40/0000 to Segment 60/2337.** On April 8, 1993, alligator cracking, minor settlement of some areas, and loss of aggregate were all reported during this inspection (see Photo 26 in Appendix B). The majority of the problems are located on the high winds , curve and grade portions of the sections. Poor drainage along the ditch line is the major contributor of the problems.

The last inspection in 1995 revealed alligator cracking and patching throughout the section

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 3014, Segment 10/0000 to Segment 10/1056, near New Sheffield (1056.0 L.F.)**

**Construction Summary:** The construction methods and procedures used for the applications of the FB-2 Bituminous Wearing Course on this section of S.R. 3014 are the same as the procedures used at the S.R. 3010 project site in Beaver County.

**Performance Summary:** The first inspection on April 8, 1993 revealed that the road had no problems with the pavement (see Photos 27 and 28 in Appendix B). The last inspection in 1995 noted that the road had worsened slightly since the previous inspection.

**Cost Summary:** : Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**3. S.R. 3029, Segment 10/0000 to Segment 30/2814, near Mechanicsburg (8659.2 L.F.)**

**Construction Summary:** The construction methods and procedures used for the applications of the FB-2 Bituminous Wearing Course on this section of S.R. 3029 are the same as the procedures used at the S.R. 3010 project site in Beaver County (see Photo 29 in Appendix B).

**Performance Summary:** On April 8, 1993, loss of aggregate in a section of the right wheel path about twelve (12) to fifteen (15) feet was noticed during the inspection. The rest of the road was in good condition. The last inspection in 1995 revealed that crack sealer was placed throughout the project and edge cracking was moderate (see Photo 30 in Appendix B).

**Cost Summary:** : Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

#### 4.4 SOMERSET COUNTY, MAINTENANCE DISTRICT 9-7

#### COLD MIX IN-PLACE RECYCLING WITH A BITUMINOUS SEAL COAT

TREATMENT applied as a wearing surface on the existing roadway (Experimental Section)

#### 1. S.R. 3021, Segment 30/0000 to Segment 40/2275, near Wilson Creek (4,804.80 L.F.)

**Construction Summary:** Treatment upgrade operations began with the existing roadway pavement structure being milled or crushed to a depth of two (2) to three (3) inches using a Caterpillar RR-250 Road Reclaimer.

After the existing pavement structure was milled, two (2) inches of 2A Coarse Aggregate was spread over the milled material and mixed in-place by the Road Reclaimer to develop a four (4) to five (5) inch road base.

Next, an AASHTO GRADE CSS-1H (Emulsified Asphalt) Bituminous Material was spread uniformly over the combined existing roadway material and the 2A Coarse Aggregate by a distributor truck and this was mixed by the Road Reclaimer. This operation was repeated between 3 to 6 times until an application rate of 24.0 gallons per ton of Reclaimed Asphalt Pavement (RAP) was achieved and thoroughly blended.

Next, a grader was used to shape and dress the roadway profile. Then the surface was compacted using a pneumatic-tire roller and a steel wheel tandem roller until compressed to a firm, even surface.

Once adequate stability and adhesion had been attained and the material

was sufficiently cured to prevent distortion, flushing of bituminous material to surface, or loss of aggregate, the surface was then sealed with the application of a single bituminous seal coat treatment.

**Performance Summary:** On April 2, 1993, heavy rutting, settled roadway, potholes, loss of aggregate, and extensive alligator cracking were all observed during the inspection. Repairs were made to the roadway to improve the conditions. A year later, in April 1994, the inspection revealed that the condition of the section had worsened since the previous inspection (see Photos 31 and 32 in Appendix B). The final inspection in 1995 reported that the conditions were the same as the previous inspection except for the development of some potholes near the end of the section.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 4005, Segment 110/0000 to Segment 120/2972, near Allenvale (6,336.00 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the existing roadway pavement structure being milled or crushed to a depth of four (4) to six (6) inches using a Caterpillar RR-250 Road Reclaimer.

After the existing pavement structure was milled, two (2) to three (3) inches of a PennDOT 2A Coarse Aggregate was spread over the milled material and mixed in-place by the Road Reclaimer to develop a six (6) to nine (9) inch road base.

Next, an AASHTO GRADE CSS-1H (Emulsified Asphalt) Bituminous Material was spread uniformly over the combined existing roadway material and the 2A Coarse Aggregate by a distributor truck and this was mixed by the Road Reclaimer.

After the existing material, the 2A and the AASHTO GRADE CSS-1H were blended, an experimental material called **PERMA-ZYME** was added (see Photo 33 in Appendix B).

**Performance Summary:** The first two inspections on April 1, 1993 and April 6, 1994 reported that sections of the road were in poor condition with rutting, loss of aggregate, soft areas, and alligator cracking (see Photo 34 in Appendix B). The inspection in 1995 reported that the patched areas had cracks and the surface was worn in areas.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.



**3. S.R. 2017 Segment 270/0000 to 290/1786, near Fair Hope (21786 feet)**

**Construction Summary:** Placed in October 1992. Same as S.R. 4005 Segment 110/0000 to Segment 120/2972 except for the addition TerraZyme Stabilizing material. TerraZyme was placed at the rate of 1 gallons per 15 cubic yard of material which was used to replaced the Perma-Zyme Stabilizing material.

**Performance Summary:** One inspection June 1994 showed TerraZyme was working satisfactorily (see Photos 39 and 40 in Appendix B). Somerset County Manager reported TerraZyme had passed three winters satisfactorily. The project had been resurfaced in 1995 before this researcher could evaluate the site.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**PRIMER AND SINGLE BITUMINOUS SURFACE TREATMENT PLACED ON  
THE EXISTING ROADWAY (CONTROL SECTION)**

**1. S.R. 3021, Segment 10/0000 to Segment 30/0000, near Wilson  
Creek (5,280.00 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the existing roadway surface being primed by the application of an MC-30 Bituminous Material. This material was spread uniformly, at a rate of 0.30 gallons per square yard, over the roadway surface using a distributor truck.

After the application of the bituminous material, a dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat.

Next, the single bituminous surface treatment was applied. First, an E-2 (Emulsified Asphalt) Bituminous Material was spread uniformly at a rate of 0.30 gallons per square yard, over the roadway surface using a distributor truck.

After the application of the E-2 material, a Type A, AASHTO No.67 Coarse Aggregate was spread uniformly, in a single layer, at a rate of 35 pounds per square yard, through the use of a mechanical spreader.

Next, the AASHTO No.67 Coarse Aggregate was rolled by two (2) pneumatic tire rollers.

Following the roller operations, another application of the E-2 material

was spread uniformly over the AASHTO No.67 Coarse Aggregate, at a rate of 0.30 gallons per square yard, using a distributor truck.

Then, a Type A, AASHTO No.8 Coarse Aggregate was spread uniformly, in a single layer, at a rate of 25 pounds per square yard, over the width of the E-2 application through the use of a mechanical spreader.

Finally, the AASHTO No.8 Coarse Aggregate was rolled to set the aggregate using two (2) pneumatic-tire rollers.

**Performance Summary:** During the first two inspections on April 2, 1993 and April 6, 1994, the road was reported in good condition with some minor problems. Some small potholes were identified during both inspections. The second inspection noted that the potholes had grown to about twice the size as reported the previous year, and that there was some loss of aggregate and alligator cracking in one area near the end of the project. No major problems were reported along the section either year. The last inspection on June 15, 1995 reported that the potholes had been patched and that the road appeared to be in the same condition as before.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 4005, Segment 100/0000 to Segment 110/0000, near Allenvale  
(2,798.40 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the primer and single bituminous surface treatment on this section of S.R. 4005 are the same as used on S.R. 3021, Segment 10/0000 to Segment 30/0000 in Somerset County.

**Performance Summary:** A small section, about 100 feet, of roadway was sprayed with EMC<sup>2</sup>, a stabilization enzyme applied during construction.

All three inspections reported alligator cracking throughout the section and the inspection in 1994 reported that there was a loss of ditch lines.

Overall, all three inspections reported that the section remains in good condition

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**3. S.R. 4005, Segment 130/0000 to Segment 130/2530, near Allenvale  
(2,534.40 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the primer and single bituminous surface treatment on this section of S.R. 4005 are the same as used on S.R. 3021, Segment 10/0000 to Segment 30/0000 in Somerset County.

**Performance Summary:** The road section is performing well and no major problems were reported. The ditch lines were noted as filling up and causing some minor problems along the first foot of the width of the road.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**PRIMER AND FB-1 BITUMINOUS BINDER COURSE WITH A SINGLE BITUMINOUS SEAL COAT TREATMENT APPLIED AS A WEARING SURFACE ON THE EXISTING ROADWAY (EXPERIMENTAL SECTION)**

1. **S.R. 4005, Segment 80/0000 to Segment 100/0000, near Allenvale (5,385.60 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the existing roadway surface being primed by the application of an MC-30 (Cut-Back Petroleum Asphalt) Bituminous Material. This material was spread uniformly, at a rate of 0.30 gallons per square yard, over the roadway surface using a distributor truck.

After the application of the Bituminous Material, a dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat as per Publication 408.

Next, an FB-1 Bituminous Binder Course was spread at a depth of three-and-a-half (3-1/2) inches using a mechanical bituminous paver that covered the entire width of roadway in a single pass.

After the FB-1 was properly cured, as per the requirements of Publication 408, Section 439.3(g), compaction was achieved using a three wheel (steel) roller and a steel wheel tandem roller to compress the FB-1 to a firm, even surface. Intermediate rolling with a pneumatic-tire roller was not required.

Finally, the surface was sealed with the application of a single bituminous seal coat.

**Performance Summary:** In April 1993 the road showed signs of alligator cracking. In April of 1994 the same alligator cracks were visible but also accompanied by soft spots.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**SINGLE BITUMINOUS SURFACE TREATMENT PLACED ON THE  
EXISTING ROADWAY (CONTROL SECTION)**

- 1. S.R. 1010, Segment 70/0724 to Segment 90/0000, near Kanter  
(3590.4 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the single Bituminous Surface Treatment on this section of S.R. 1010 are the same as used on S.R. 1010, Segment 40/0920 to Segment 50/0972 in Somerset County.

**Performance Summary:** Inspection of the roadway in April 1994 revealed 3-4 inches of rutting, loss of surface treatment, and alligator cracking on the hill.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.



**2. S.R. 1010, Segment 100/0980 to Segment 110/0690, near Kanter  
(2059.2 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the single Bituminous Surface Treatment on this section of S.R. 1010 are the same as used on S.R. 1010, Segment 40/0920 to Segment 50/0972 in Somerset County.

**Performance Summary:** In April 1992, inspection discovered that the roadway contained small rutting and potholes. The April 1994 inspection showed loss of aggregate and an increase in the number of potholes.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**3. S.R. 3039, Segment 40/0000 to Segment 50/0000, near Trent  
(2851.2 L.F.)**

**Construction Summary:** The placement procedures, materials, and equipment used for the application of the single Bituminous Surface Treatment on this section of S.R. 303 are the same as used for the placement of the Bituminous Surface Treatment on S.R. 1010, Segment 40/0929 to Segment 50/0972, in Somerset County (see Photos 35 and 36 in Appendix B).

**Performance Summary:** The first inspection of the section was on April 2, 1993. Potholes and loss of aggregate were observed in spots throughout the section. The ride through the section was also bumpy.

On April 6, 1994, alligator cracking was observed in several locations. Loss and breakup of aggregate was also noted. The surface treatment is also breaking up in one section which could be attributed to a soft subbase. Overall, the section is in pretty good condition.

The last inspection on June 15, 1995 revealed potholes, rutting, and alligator cracks located throughout the section. Overall, the section was in good condition.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**COLD MIX IN-PLACE RECYCLING WITH A SINGLE BITUMINOUS  
SURFACE TREATMENT APPLIED AS A WEARING SURFACE ON THE  
EXISTING ROADWAY (EXPERIMENTAL SECTION)**

1. **S.R. 1010, Segment 40/0920 to Segment 50/0972, near Kanter  
(Select Granular Material; Perma-Zyme; 3273.6 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the scarification of the existing roadway base material to a depth of two (2) to three (3) inches by a grader using a standard scarifier blade.

Next, two (2) to three (3) inches of Select Granular Material ( PA # 2RC Aggregate) was placed over the scarified base material by a dump truck.

Then, the grader mixed in-place the existing roadway base material and the 2RC Aggregate to provide a base treatment of four (4) to six (6) inches of blended material.

After the material was thoroughly mixed, the grader bladed the four (4) to six (6) inches of the loose, blended material into a windrow.

The next operation involved the addition of an experimental material called **PERMA-ZYME**.

The **PERMA-ZYME** was utilized to help create a dense and permanent base by fusing the inorganic and organic materials in the combined mixture of the existing base material and the 2RC Aggregate through a catalytic bonding process.

**Performance summary:** The inspection performed on April 6, 1993

revealed a very badly worn road. There was extensive rutting, soft areas, and alligator cracking present throughout the road section. The inspection performed a year later, April 7, 1994, revealed almost a new road. The majority of the rutting and soft areas were not as prominent as the previous year.

**Cost Summar :** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 1010, Segment 50/0972 to Segment 70/0724, near Kanter  
(AASHTO GRADE CSS-1H Bituminous Material; 3273.6 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the scarification of the existing roadway base material to a depth of four (4) to six (6) inches by the use of an RS-500 Road Reclaimer.

The depth of the scarification was dependent on the composition of the material encountered.

After the full width of the roadway surface was milled, the surface was treated by the application of an AASHTO GRADE CSS-1H (Emulsified Asphalt) Bituminous Material.

The AASHTO GRADE CSS-1H Bituminous Material was diluted with equal parts of compatible water (50:50 blend) prior to application.

To achieve the 9.70 gallons per linear foot application rate, approximately five (5) passes were required by the distributor truck. If the AASHTO GRADE CSS-1H Bituminous Material were placed in one pass, most of the solution would run off due to the amount of water used.

After each pass by the distributor truck, the Road Reclaimer would immediately follow to mix the AASHTO GRADE CSS-1H Bituminous Material and the previously milled roadway material. Also, part of the work crew would follow the Road Reclaimer, after each pass, to remove rocks in excess of four (4) inches in diameter and other objectionable material.

After the required amount of the AASHTO GRADE CSS-1H Bituminous

Material was mixed with the milled roadway material, the grader shaped and dressed the roadway surface to conform to the required roadway crown.

Then, the surface was compacted by a three-wheel roller and by a steel wheel tandem roller, which removed creases in the surface.

The final activity on this section involved the application of a single Bituminous Surface Treatment.

**Performance Summary:** All the inspections on this road reported that the road was in good condition. The first two inspections, April 6, 1993 and April 7, 1994, revealed some minor rutting and potholes in areas.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**FB-1 BITUMINOUS LEVELING COURSE WITH A SINGLE BITUMINOUS SURFACE TREATMENT (EXPERIMENTAL SECTION)**

**1. S.R. 1010, Segment 90/0000 to Segment 100/0980, near Kanter (3643.2 L.F.)**

**Construction Summary:** The construction methods and procedures used for the application of the FB-1 Bituminous Leveling Course and the single Bituminous Surface Treatment on this section of S.R. 1010 are the same as used on S.R. 3039, Segment 20/0000 to Segment 40/0000 in Somerset County (see Photos 37 and 38 in Appendix B).

**Performance Summary:** All three inspections in 1993, 1994, and 1995 revealed a road in good condition. No problems were noticed during the first two inspections and the last inspection revealed some alligator cracking.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment , which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**2. S.R. 3039, Segment 20/0000 to Segment 40/0000, near Trent  
(6864.00 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the application of an MC-30 (Cut-Back Petroleum Asphalt) Bituminous Material, as a primer, to the existing roadway surface.

After the application of the MC-30 Bituminous Material, a sufficient amount of dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat.

Next, the FB-1 Bituminous Leveling Course was applied at a depth of 2-1/2 inches.

After the FB-1 Bituminous Leveling Course was spread uniformly and the surface became tacky, compaction was achieved through the use of two (2) rollers. First, a three-wheel roller compacted the FB-1 material to the required depth. Then, a steel wheel tandem roller completed the finish rolling of the surface to remove any roller marks.

The final activity on this section of S.R. 3039 involved the application of a single Bituminous Surface Treatment

**Performance Summary:** The inspection on April 2, 1993 revealed that the entire section is in excellent shape with no problems noticed.

On April 6, 1994, the inspection recorded that the section was still in good condition with a smooth surface. Loss of aggregate was noted in isolated sections not covering more than 2 square feet.



The last inspection on June 15, 1995 revealed that the section was still in good condition, but alligator cracking was developing.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**3. S.R. 3039, Segment 50/0000 to Segment 60/3814, near Trent  
(6494.4 L.F.)**

**Construction Summary:** The placement procedures, materials, and equipment used for the application of the FB-1 Bituminous Leveling Course on this section of S.R. 3039 are the same as used for the placement of the FB-1 Bituminous Leveling Course for Segment 20/0000 to Segment 40/0000.

**Performance Summary:** The segment was noted as being in good condition with no problems on the April 2, 1993 inspection.

The inspection on April 6, 1994 showed that the road was still in good overall condition. However, poor drainage in the ditches appears to be the major source of the problems in this area. Problems seen in this section are loss of surface treatment, area becoming bumpy, soft areas, and alligator cracking.

The last inspection on June 15, 1995 showed some cracking, but no major problems throughout the section

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment, which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

**COLD MIX IN-PLACE RECYCLING, FB-1 BITUMINOUS LEVELING  
COURSE WITH A SINGLE BITUMINOUS SURFACE TREATMENT APPLIED  
AS A WEARING SURFACE ON THE EXISTING ROADWAY  
(EXPERIMENTAL SECTION)**

1. **S.R. 3039, Segment 10/0000 to Segment 20/0000, near Trent  
(3590.4 L.F.)**

**Construction Summary:** Treatment upgrade operations began with the scarification of the existing roadway base material to a depth of three (3) inches by the use of the RS-500 Road Reclaimer.

After the roadway base material was milled, the product **PERMA-ZYME** was added, by a distributor truck, to provide a stabilized base.

Once the **PERMA-ZYME**-treated surface was properly cured, an FB-1 Bituminous Leveling Course was placed. First, the surface was primed by the application of an MC-30 (Cut-Back Petroleum Asphalt) Bituminous Material.

After the application of the MC-30 Bituminous Material, a sufficient amount of dry, fine aggregate blotter material was spread by a dump truck to cover and blot up any excess prime coat.

Next, the FB-1 Bituminous Leveling Course was applied at a rate of 125 pounds per square yard and at a depth of two (2) inches.

Since the mechanical paver was not equipped with side extensions, the plant-mixed FB-1 Bituminous Leveling Course had to be spread in two (2)

passes to cover the entire width of roadway.

As the plant-mixed FB-1 material was placed, the surface was compacted, by a three-wheel roller, to the required density to achieve a one-and-a-half (1-1/2) inch depth.

Finish rolling of the surface was completed by a steel wheel tandem roller, which also removed any roller marks.

The final activity on this section of S.R. 3039 involved the application of a single Bituminous Surface Treatment.

**Performance Summary: S.R. 3039, Segment 10/0000 to Segment 20/0000** During construction Perma-Zyme was added to help stabilize the subbase. During the first inspection on April 2, 1993, rutting and soft areas were seen sporadically along the test section. The majority of the rutting and soft areas were observed on or near turns and at the beginning of the test section near a stop sign. Therefore, the cause of the rutting could be attributed to the breaking of traffic at these areas.

The sections that were noted as being problem areas during the previous inspection had been repaired and surface treated before the inspection on April 6, 1994. Alligator cracking was seen developing at some portions of the test section. Overall, the entire section appeared to be in good condition.

The last inspection, June 15, 1995, revealed that there were no changes to the section since the previous inspection. The ruts that were noted in the 1993 inspection were still patched and performing well. The performance of the rest of the section appears to be good.

**Cost Summary:** Maintenance costs prior to treatment were less than maintenance cost after treatment ,which did not appear to be cost effective. Refer to \* at the end of the section on page 49.

*\* No cost data was available except data off the Moris System. This data is set up for an entire S.R., which may be misleading, because often only a segment is under evaluation (See APPENDIX C – COST DATA).*

## **5.0 CONCLUSIONS AND RECOMENDATIONS**

After the completion of construction, site inspections were made once per year to assess field performance, road stability and the effect of freeze-thaw cycles for three winters. Some of the test sections were below the minimum acceptable length for pavements. In general if the test section was at least as good performing as the control section it was approved for future use. Inspection notes, maintenance manager comments, and limited cost data was also used to determine future use by the Department.

### **5.1 METHOD 1: Primer and a Single Bituminous Surface Treatment Placed on the Existing Roadway (Control Section)**

#### **PHASE I**

#### **S.R. 2014 – Segment 30/000 to Segment 70/0957 Armstrong County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.1.

#### **S.R. 4019 - Segment 20/000 to Segment 50/2250 Armstrong County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.1.

#### **S.R. 3023 – Segment 100/0000 to Segment 110/3414 Beaver County.**

The evaluation concluded that this road performed satisfactorily. Costs did appear to be effective.

#### **S.R. 3014 – Segment 20/0000 to Segment 40/0000 Butler County.**

The evaluation concluded that this road performed satisfactorily. Costs were found to be questionable. Refer to Section 4.2.

**S.R. 3021 – Segment 10/0000 to Segment 30/0000 Somerset County.**

The evaluation concluded that this road performed satisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 4005 – Segment 100/0000 to Segment 110/0000 Somerset County.**

The evaluation concluded that this road performed satisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 4005 – Segment 130/0000 to Segment 130/2530 Somerset County.**

The evaluation concluded that this road performed satisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**RECOMMENDATIONS**

The control treatment for Phase I performed satisfactorily for 4 out of 6 roads, there were some minor problems, but the only major problems occurred on S.R. 4019, the coal trucking road. This is a standard maintenance treatment that has an average life between 1 to 3 years. Use of the control treatment is recommended.

**5.2 METHOD 2: Cold Mix In-Place Recycling with a Single Bituminous Seal Coat Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

**PHASE I**

**S.R. 2021 – Segment 10/000 to Segment 60/3084 Armstrong County.**

The evaluation concluded that this road performed good. Costs appeared to be more effective than the control treatment. Refer to Section 4.1.

**S.R. 3021 – Segment 30/0000 to Segment 40/2275 Somerset County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 4005 – Segment 110/0000 to Segment 120/2972 Somerset County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**RECOMMENDATION**

This treatment did not perform well on two of the three test roads which was comparable to our control roads. Some of the poor performing areas on these roads were repaired, but returned to previous condition overtime. Therefore, use of this treatment method on unpaved roads is recommended but placements should be monitored as provisional.

**5.3 METHOD 3 : Reclaimed Asphalt Pavement (RAP) with a Single Bituminous Seal Coat Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

**PHASE I**

**S.R. 3016, Segment 10/0000 to Segment 10/0880 Butler County.**

The evaluation concluded that this road performed satisfactorily. Costs were found to be questionable. Refer to Section 4.2.

**S.R. 3017, Segment 40/1616 to Segment 70/1198 Butler County.**

The evaluation concluded that this road performed questionably. Costs were found to be questionable. Refer to Section 4.2.



## **RECOMMENDATION**

The performance of this treatment method was satisfactory on one road and questionable on one road. Some minor problems were encountered, but no major problems. Therefore, use of this method is recommended.

### **5.4 METHOD 4: Primer and FB-2 Bituminous Wearing Course Treatment Applied on the Existing Roadway (Experimental Section)**

#### **PHASE I**

#### **S.R. 3022 – Segment 60/0000 to Segment 80/2044 Beaver County.**

The evaluation concluded that this road performed good. Costs did appear to be effective. Refer to Section 4.3.

## **RECOMMENDATIONS**

Compared to the control sections, this treatment did well. Therefore, the treatment is recommended for use.

### **5.5 METHOD 5: Primer and FB-1 Bituminous Binder Course with a Single Bituminous Seal Coat Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

#### **PHASE I**

#### **S.R. 4005 – Segment 80/0000 to Segment 100/0000 Somerset County.**

The evaluation concluded that this road performed as satisfactorily for at least two winters. Costs did not appear to be effective. Refer to Section 4.4.

## RECOMMENDATIONS

Most of the minor problems on this road could be eliminated with proper drainage. Even with the poor drainage the roadway performed satisfactorily. The treatment method is recommended.

### 5.6 **METHOD 6 : Single Bituminous Surface Treatment Placed on the Existing Roadway (Control Section)**

#### PHASE II

#### **S.R. 1010 – Segment 70/0724 to Segment 90/0000 Somerset County.**

The evaluation concluded that this road performed marginally. Costs did not appear to be effective. Refer to Section 4.4.

#### **S.R. 1010 – Segment 100/0980 to Segment 110/0690 Somerset County.**

The evaluation concluded that this road performed marginally. Costs did not appear to be effective. Refer to Section 4.4.

#### **S.R. 3039 – Segment 40/0000 to Segment 50/0000 Somerset County.**

The evaluation concluded that this road performed marginally. Costs did appear to be effective. Refer to Section 4.4.

## RECOMMENDATIONS

The overall performance of this control treatment was poor. This is a standard Maintenance treatment that can sometimes show good results but sometimes may need to be resurfaced every spring.

**5.7 METHOD 7 : Cold Mix In-Place Recycling with a Single Bituminous Surface Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

PHASE I

**S.R. 2042 – Segment 60/1056 to Segment 60/2534 Armstrong County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.1.

**S.R. 2043 – Segment 10/0000 to Segment 60/2759 Armstrong County**

The evaluation concluded that this road performed good. Costs were found to be questionable. Refer to Section 4.1.

**S.R. 2049 – Segment 20/0000 to Segment 40/0000 (with Perma-Zyme) Armstrong County**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.1.

PHASE II

**PERMA-ZYME**

**S.R. 1010 – Segment 40/0920 to Segment 50/0972 Somerset County.**

The evaluation concluded that this road performed unsatisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 1010 – Segment 50/0972 to Segment 70/0724 Somerset County.**

The evaluation concluded that this road performed good. Costs did not appear to be effective. Refer to Section 4.4.

**RECOMMENDATIONS**

The Perma-Zyme treated roads performed satisfactorily. The one road had problems the first two years after application, because the Perma-Zyme

application was not applied heavily enough. It is recommended that when the stabilizer is used, that the application is started about 50 feet before the beginning of the road section to allow time for the mixture to reach the prescribed concentration. Therefore this treatment is recommended for provisional use.

#### **TerraZyme**

**S.R. 2017 - Segment 270/000 to Segment 290/1766 Somerset County.**

The evaluation concluded that this road performed satisfactorily. Costs did not appear to be effective. Refer to Section 4.4.

#### **RECOMMENDATIONS**

The section of road applied with TerraZyme performed satisfactorily through three winters when compared to the other roads in the county. Therefore, this treatment method is recommended for provisional use.

#### **5.8 METHOD 8: FB-1 Bituminous Leveling Course with a Single Bituminous Surface Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

##### **PHASE II**

**S.R. 1010 – Segment 90/0000 to Segment 100/0980 Somerset County.**

The evaluation concluded that this road performed good. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 3039 – Segment 20/0000 to Segment 40/00000 Somerset County.**

The evaluation concluded that this road performed good. Costs did not appear to be effective. Refer to Section 4.4.

**S.R. 3039 – Segment 50/0000 to Segment 60/3814 Somerset County.**

The evaluation concluded that this road performed satisfactorily. Costs did appear to be effective. Refer to Section 4.4.

#### **RECOMMENDATIONS**

The road performance during the evaluation was good compared to the control method on Phase II, and there were no major problems reported. Therefore, the use of the treatment is recommended.

**5.9 METHOD 9: Cold Mix In-Place Recycling, FB-1 Bituminous Leveling Course with a Single Bituminous Surface Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

**PHASE II**

**S.R. 3039 – Segment 10/0000 to Segment 20/0000 Somerset County.**

The evaluation concluded that this road performed good. Costs did appear to be effective. Refer to Section 4.4.

#### **RECOMMENDATIONS**

This treatment had good performance and is recommended for future use.

**5.10 METHOD 10 : FB-2 Modified Bituminous Wearing Course Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

**PHASE I**

**S.R. 2011 – 20/0000 to 60/0365 (Heiway RAM) Butler County**

The evaluation concluded that this road performed good. Costs did appear to be effective. Refer to Section 4.2.

## **RECOMMENDATIONS**

This section was divided into three sections with varying depths of the FB-2 modified bituminous wearing course. The depths varied between two (2), three (3), and four (4) inches. The two (2) inch section had problems so it is recommended that at least three (3) inches of this material be placed for future use by the Department.

### **5.11 METHOD 11 : FB-2 Bituminous Wearing Course with a Single Bituminous Seal Coat Treatment Applied as a Wearing Surface on the Existing Roadway (Experimental Section)**

#### **PHASE II**

#### **S.R. 3010 – Segment 40/0000 to Segment 60/2337 Beaver County.**

The evaluation concluded that this road performed questionably Costs did not appear to be effective. Refer to Section 4.3.

#### **S.R. 3014 – Segment 10/0000 to Segment 10/1056 Beaver County.**

The evaluation concluded that this road performed satisfactorily. Costs did appear to be effective. Refer to Section 4.3.

#### **S.R. 3029 – Segment 10/0000 to Segment 30/2814 Beaver County.**

The evaluation concluded that this road performed satisfactorily. Costs did appear to be effective. Refer to Section 4.3.

## **RECOMMENDATIONS**

This treatment method had minor problems reported during the inspection period. The performance of the treatment was good. The use of this treatment method is recommended for future use.

## **SUMMARY OF RECOMMENDATIONS**

To the best of his knowledge the Researcher recommends all the experimental features in

the following order from most reliable performance and cost background information to the least;

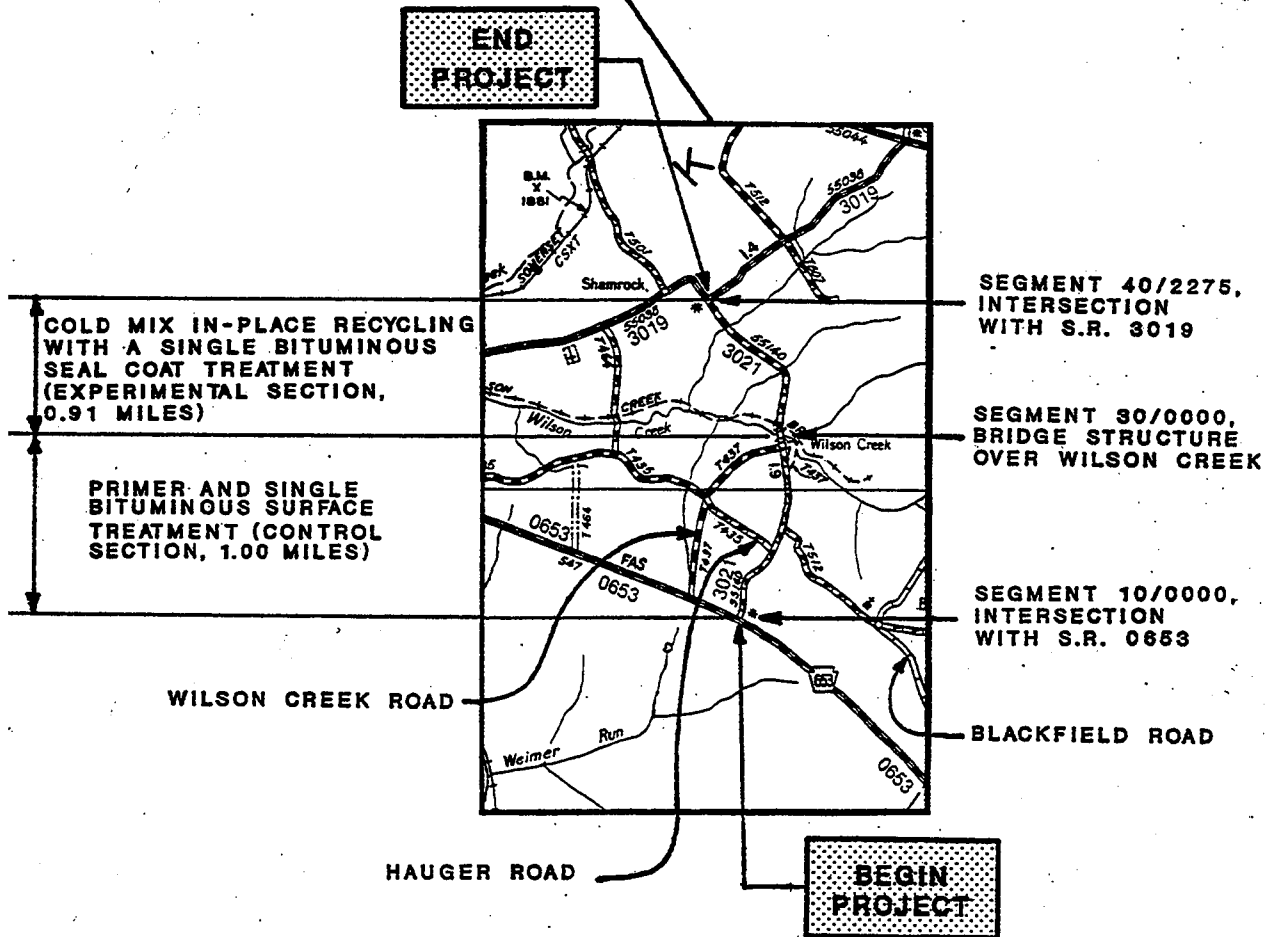
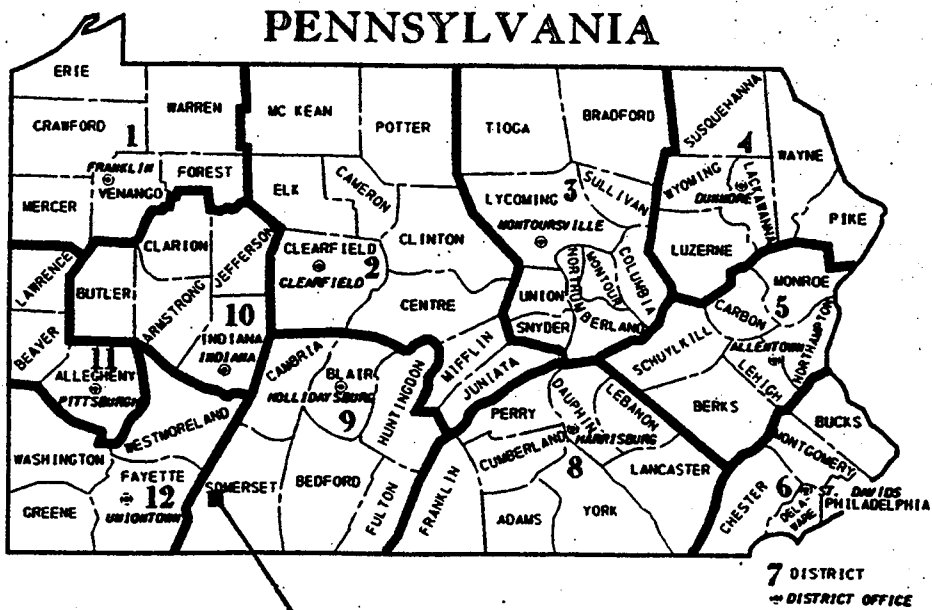
1. Cold Mix in place recycling, FB-1 Bituminous Leveling Course with a Single Bituminous Surface Treatment Applied as a Wearing Surface..
2. Primer and FB-2 Bituminous Wearing Course Treatment with a Single Bituminous Seal Coat Treatment Applied on the Existing Roadway
3. FB-2 Modified Wearing Course Applied as Wearing course (HEI-WAY RAM) at a minimum depth of 3 inches
4. Cold Mix in Place Recycling with a Single Bituminous Surface Treatment as a Wearing Surface applied on an Enzyme Stabilized Roadway Base(such as Permazyme or Terrazyme)
5. Primer and FB-1 Bituminous Binder Course with a Single Bituminous Seal Coat Treatment Applied as Wearing Surface
6. FB-2 Wearing Course with a Single Bituminous Seal Coat Treatment.
7. Primer and FB-1 Binder Course with a Single Bituminous Seal Coat Treatment Applied as a Wearing Surface on the Existing Roadway
8. Cold Mix in place recycling, FB-1 Bituminous Leveling Course with a Single Bituminous Surface Treatment Applied as a Wearing Surface on the existing Roadway
9. Reclaimed Asphalt Pavement (RAP) with a Single Bituminous Seal Coat Treatment

## **6.0 REFERENCES**

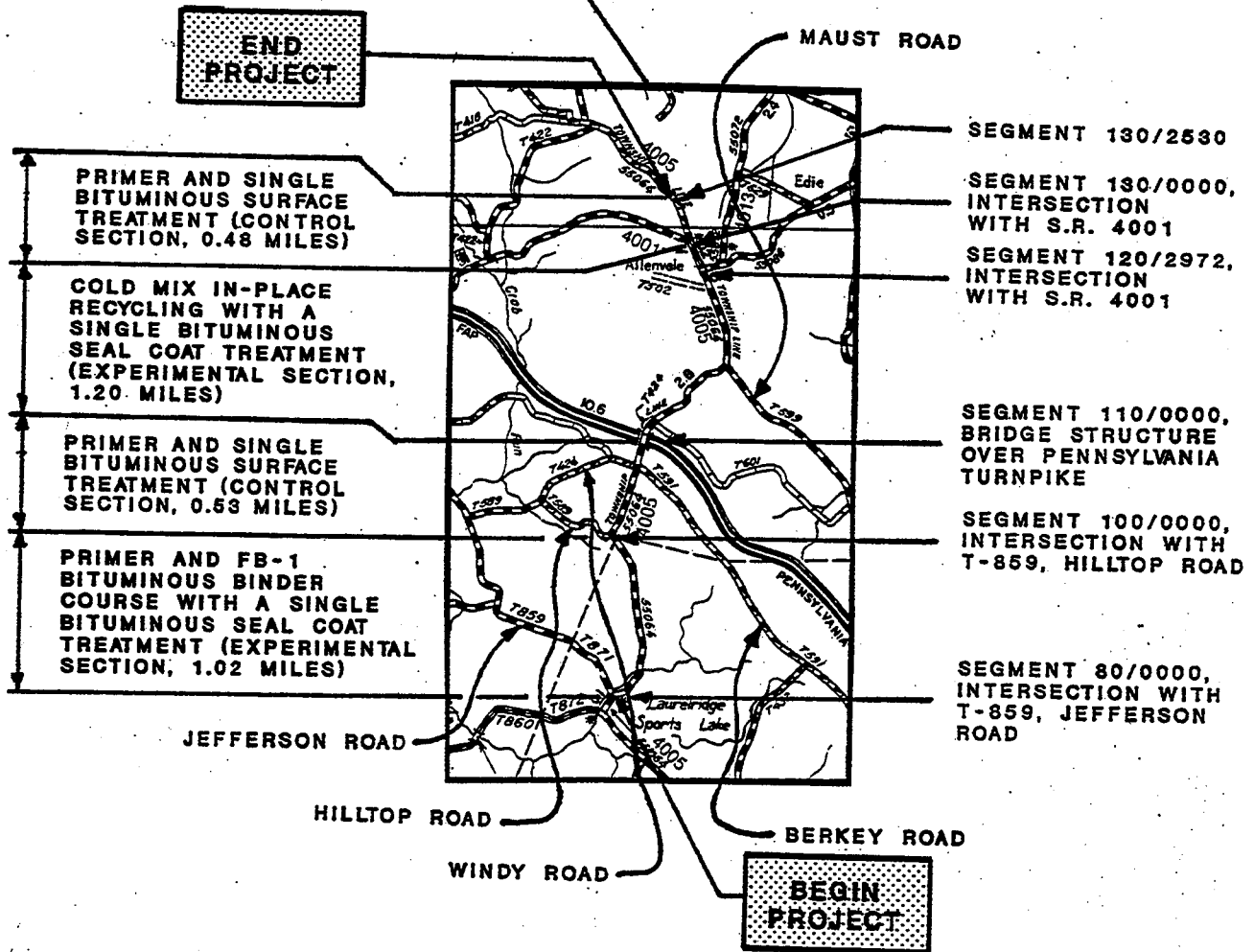
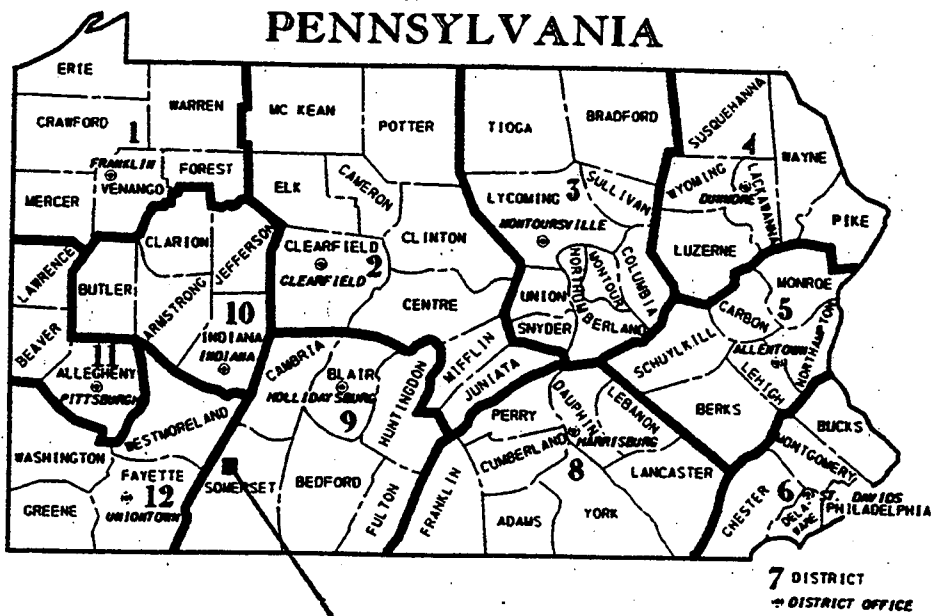
- 1.) Maintenance Manual, Publication 23,  
August 1990 Edition,  
Bureau of Maintenance and Operations,  
Pennsylvania Department of Transportation.





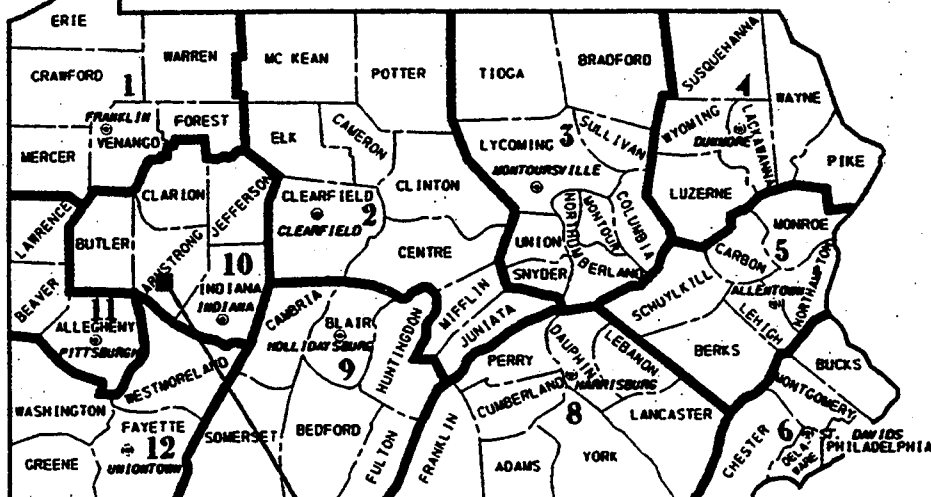


**FIGURE A-1**  
**PROJECT LOCATION MAP**  
**S.R. 3021 NEAR WILSON CREEK**  
**SOMERSET COUNTY, ENGINEERING DISTRICT 9-0**



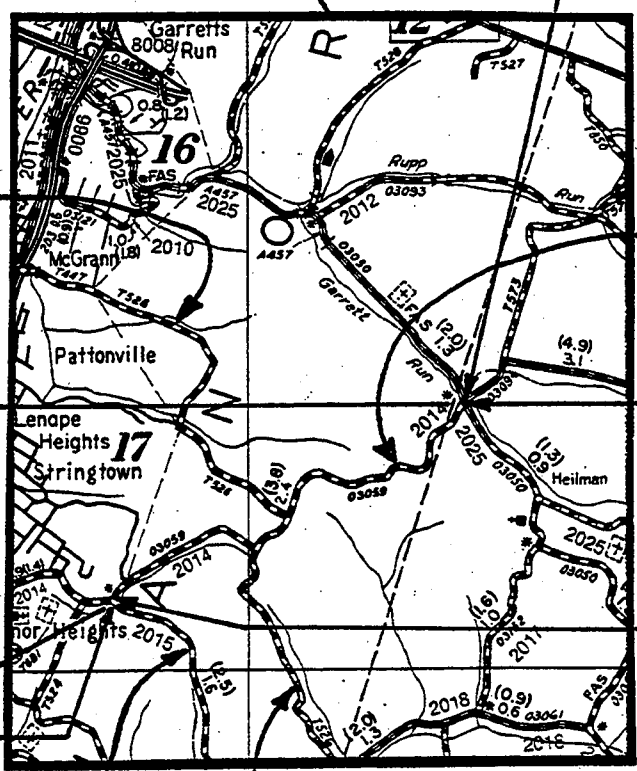
**FIGURE A-2**  
**PROJECT LOCATION MAP**  
**S.R. 4005 NEAR ALLENVALE**  
**SOMERSET COUNTY, ENGINEERING DISTRICT 9-0**

# PENNSYLVANIA



7 DISTRICT  
= DISTRICT OFFICE

**END PROJECT**



STICH HOLLOW ROAD

NUNAMAKER HILL ROAD

SEGMENT 70/0957,  
INTERSECTION  
WITH S.R. 2025

PRIMER AND SINGLE  
BITUMINOUS SURFACE  
TREATMENT (CONTROL  
SECTION, 2.35 MILES)

SEGMENT 30/0000,  
INTERSECTION  
WITH S.R. 2018,  
GREENFIELD DRIVE

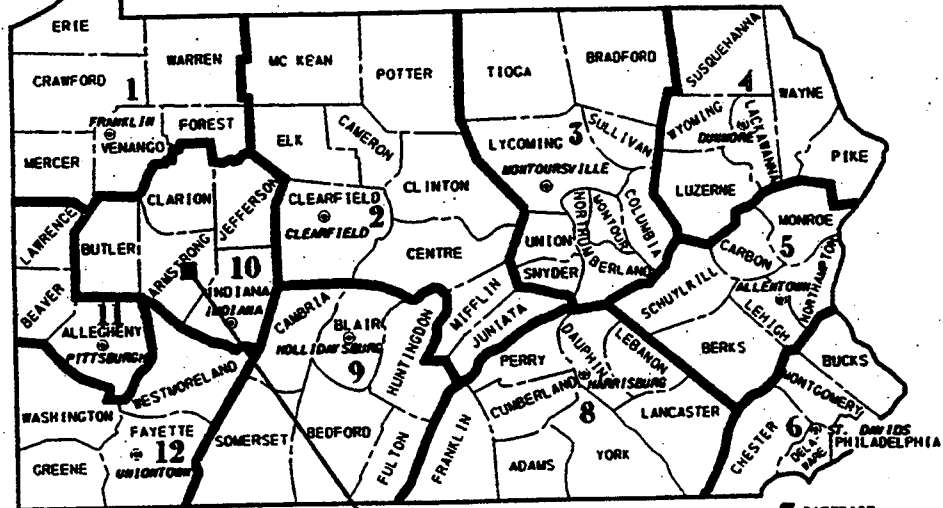
**BEGIN PROJECT**

GREENFIELD DRIVE

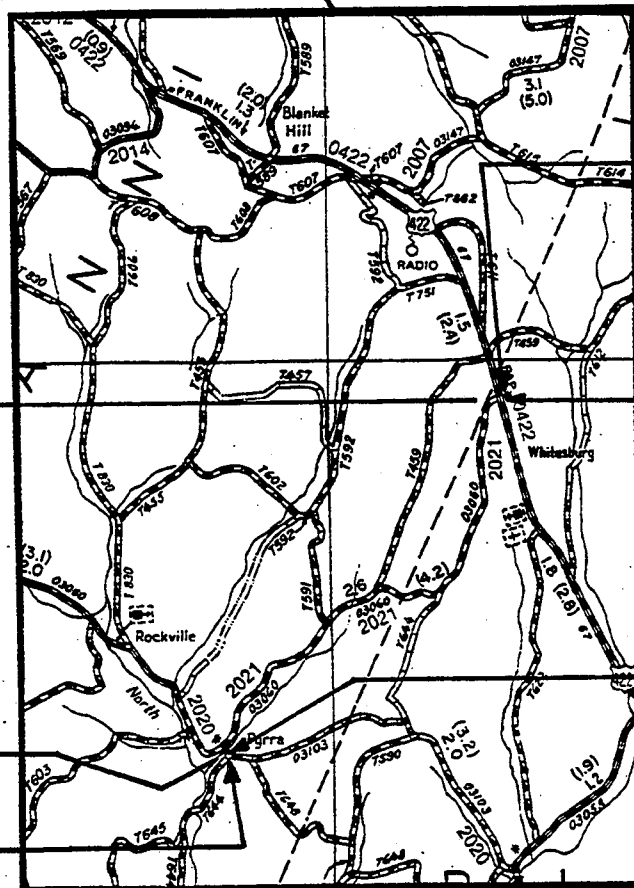
SCHALL HOLLOW ROAD

**FIGURE A-3  
PROJECT LOCATION MAP  
S.R. 2014 NEAR BOWSER CROSSROADS  
ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0**

# PENNSYLVANIA



7 DISTRICT  
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**END PROJECT**

SEGMENT 60/3084,  
INTERSECTION  
WITH S.R. 0422

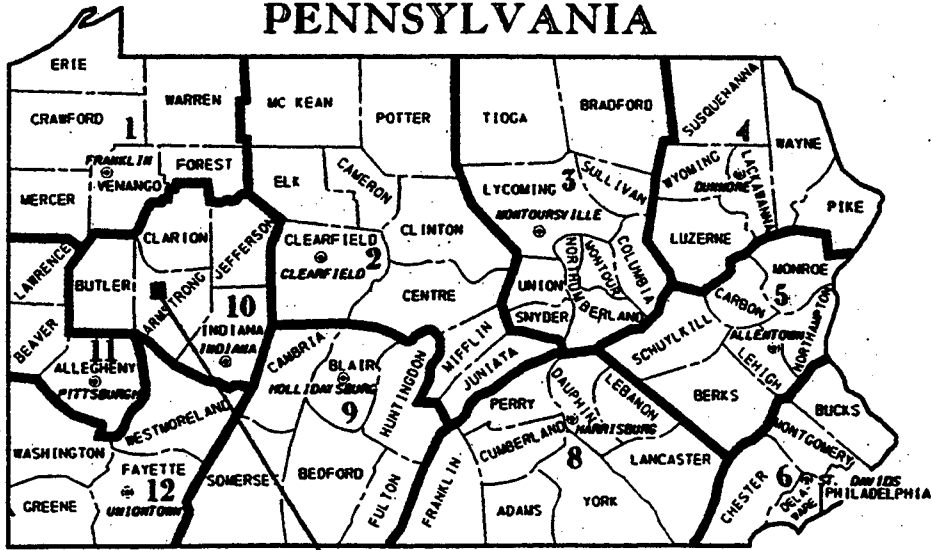
SEGMENT 10/000,  
INTERSECTION  
WITH S.R. 2020

GOLD MIX IN-PLACE  
RECYCLING WITH A  
SINGLE BITUMINOUS  
SEAL COAT TREATMENT  
(EXPERIMENTAL SECTION,  
2.64 MILES)

**BEGIN PROJECT**

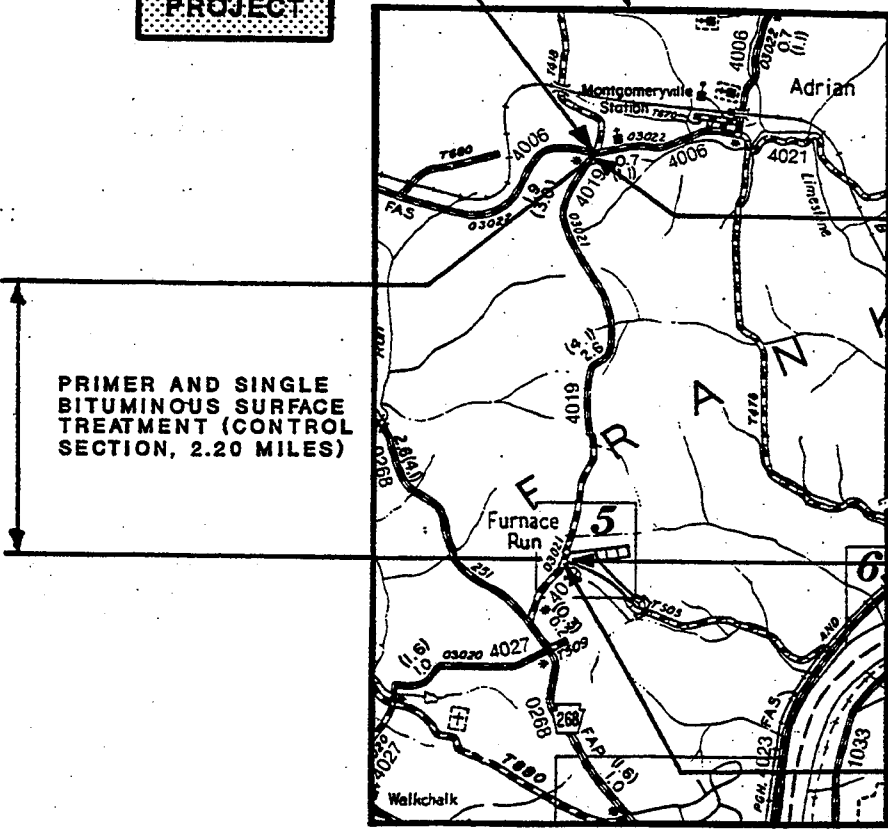
**FIGURE A-4**  
**PROJECT LOCATION MAP**  
**S.R. 2021 NEAR WHITESBURG**  
**ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0**

# PENNSYLVANIA



7 DISTRICT  
 → DISTRICT OFFICE

**END PROJECT**

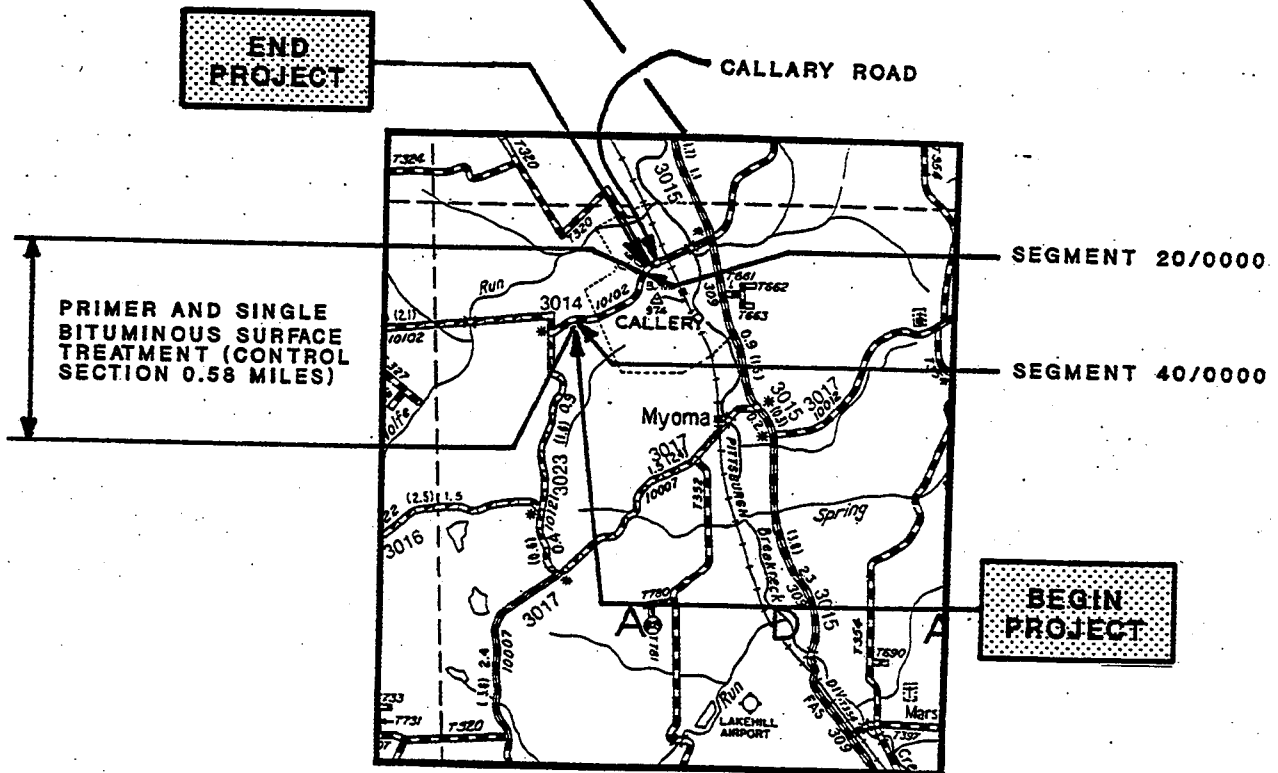
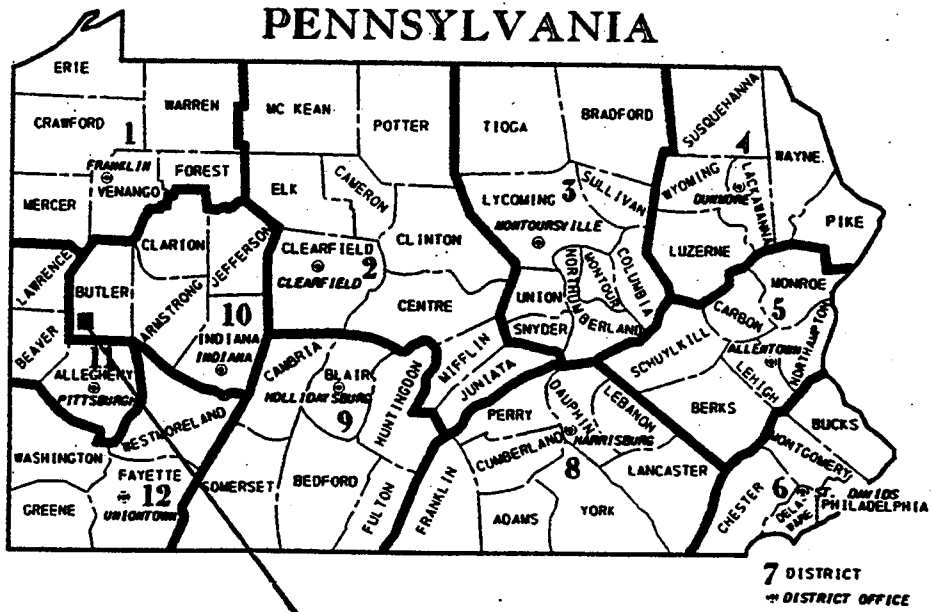


SEGMENT 50/2250,  
 INTERSECTION  
 WITH S.R. 4006

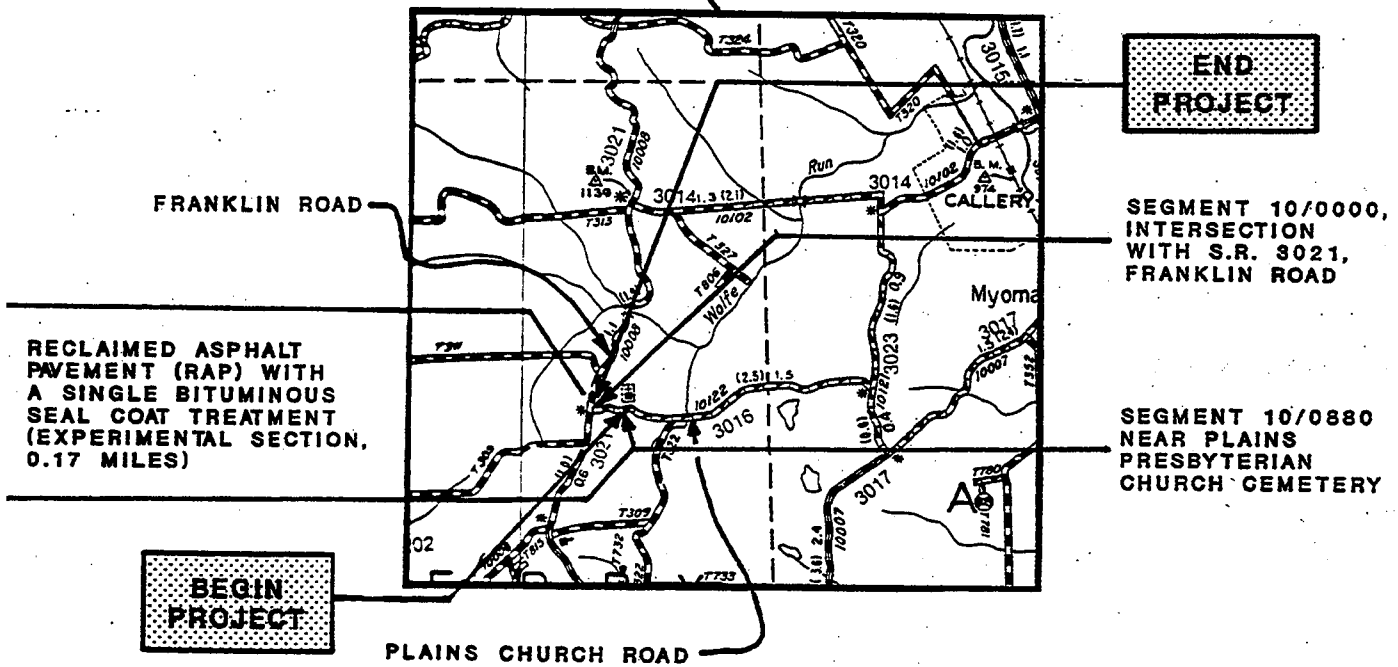
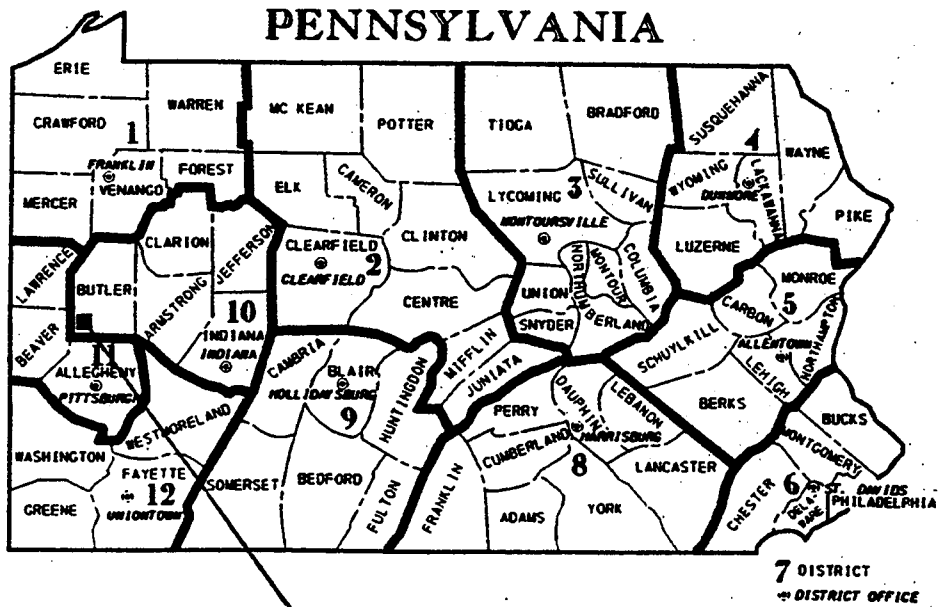
SEGMENT 20/0000,  
 INTERSECTION  
 WITH T-505

**BEGIN PROJECT**

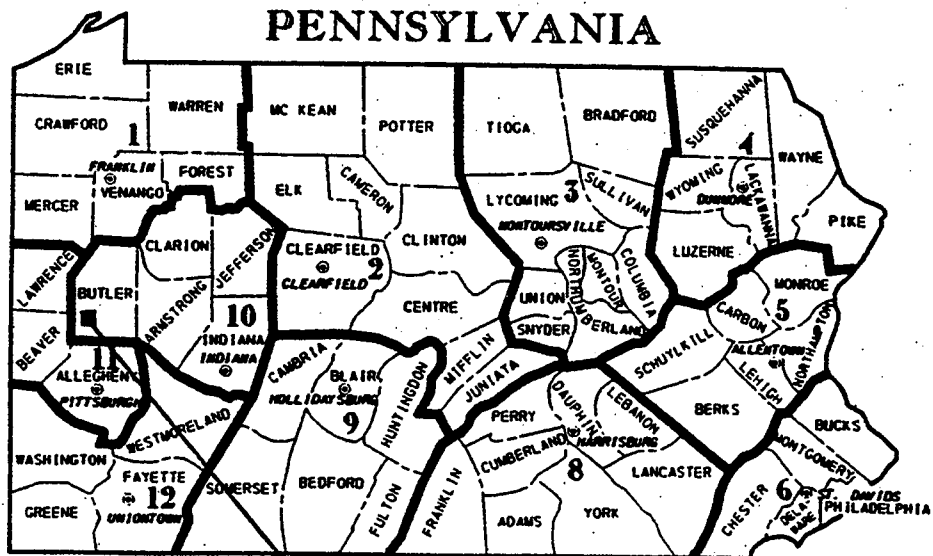
**FIGURE A-5  
 PROJECT LOCATION MAP  
 S.R. 4019 NEAR LIMESTONE JUNCTION  
 ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0**



**FIGURE A-6**  
**PROJECT LOCATION MAP**  
**S.R. 3014 NEAR CALLARY BORO**  
**BUTLER COUNTY, ENGINEERING DISTRICT 10-0**

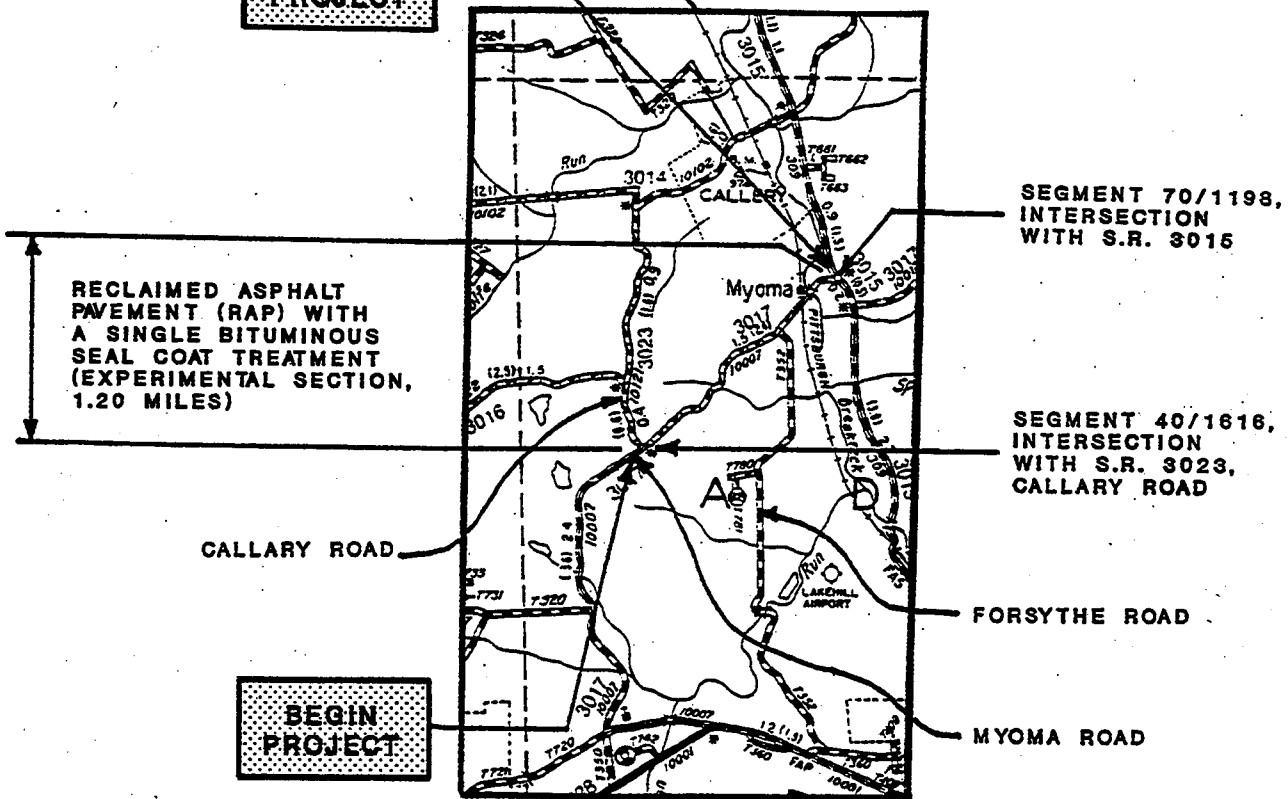


**FIGURE A-7**  
**PROJECT LOCATION MAP**  
**S.R. 3016 NEAR CALLARY BORO**  
**BUTLER COUNTY, ENGINEERING DISTRICT 10-0**



7 DISTRICT  
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**END PROJECT**



RECLAIMED ASPHALT PAVEMENT (RAP) WITH A SINGLE BITUMINOUS SEAL COAT TREATMENT (EXPERIMENTAL SECTION, 1.20 MILES)

SEGMENT 70/1198, INTERSECTION WITH S.R. 3015

SEGMENT 40/1616, INTERSECTION WITH S.R. 3023, CALLARY ROAD

CALLARY ROAD

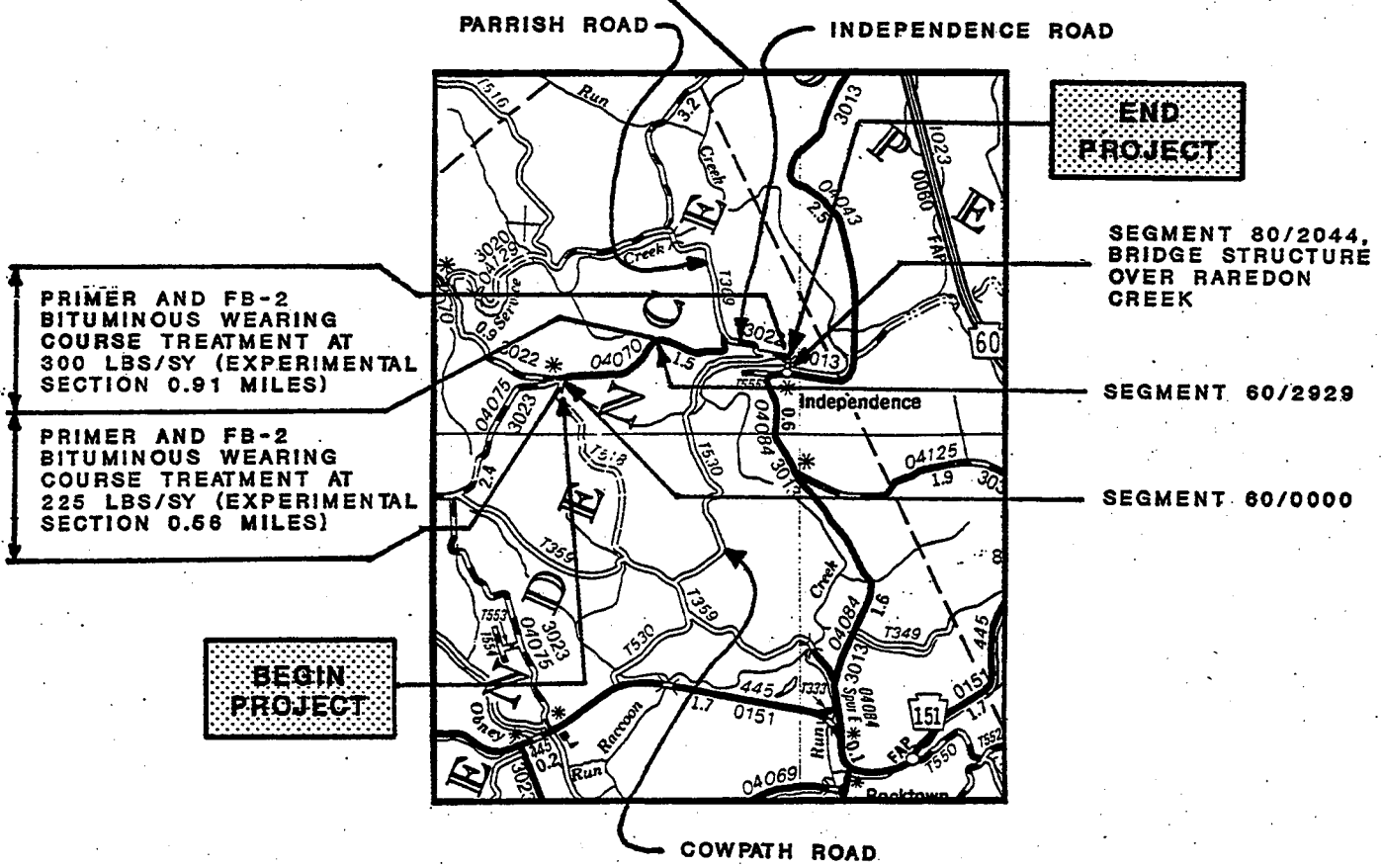
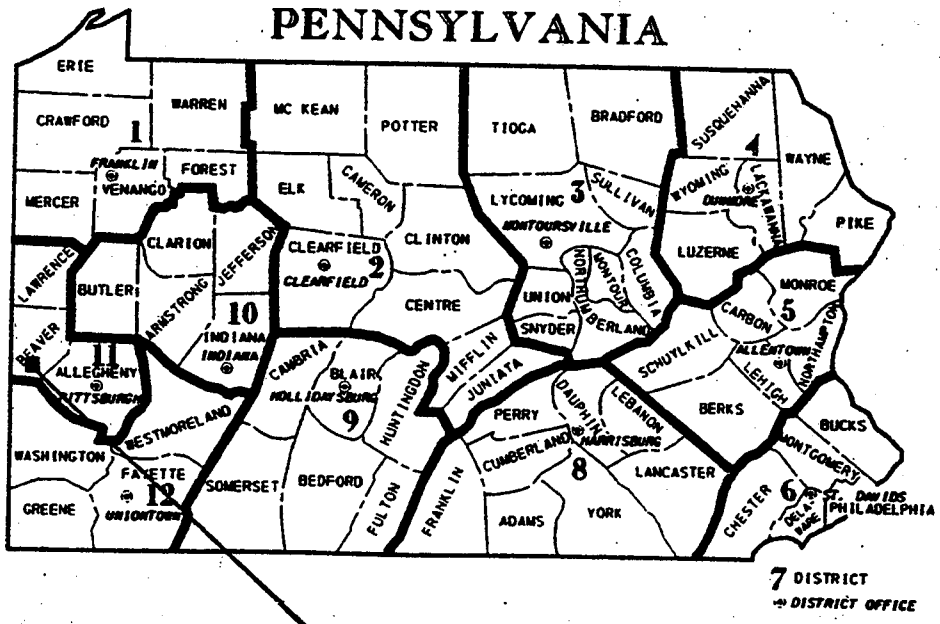
FORSYTHE ROAD

**BEGIN PROJECT**

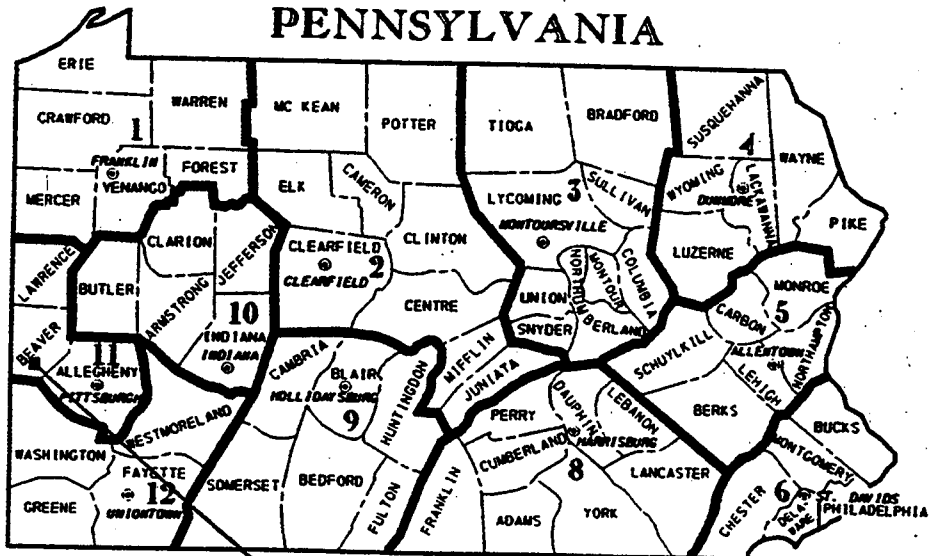
MYOMA ROAD

**FIGURE A-8**  
**PROJECT LOCATION MAP**  
**S.R. 3017 NEAR CALLARY BORO**  
**BUTLER COUNTY, ENGINEERING DISTRICT 10-0**

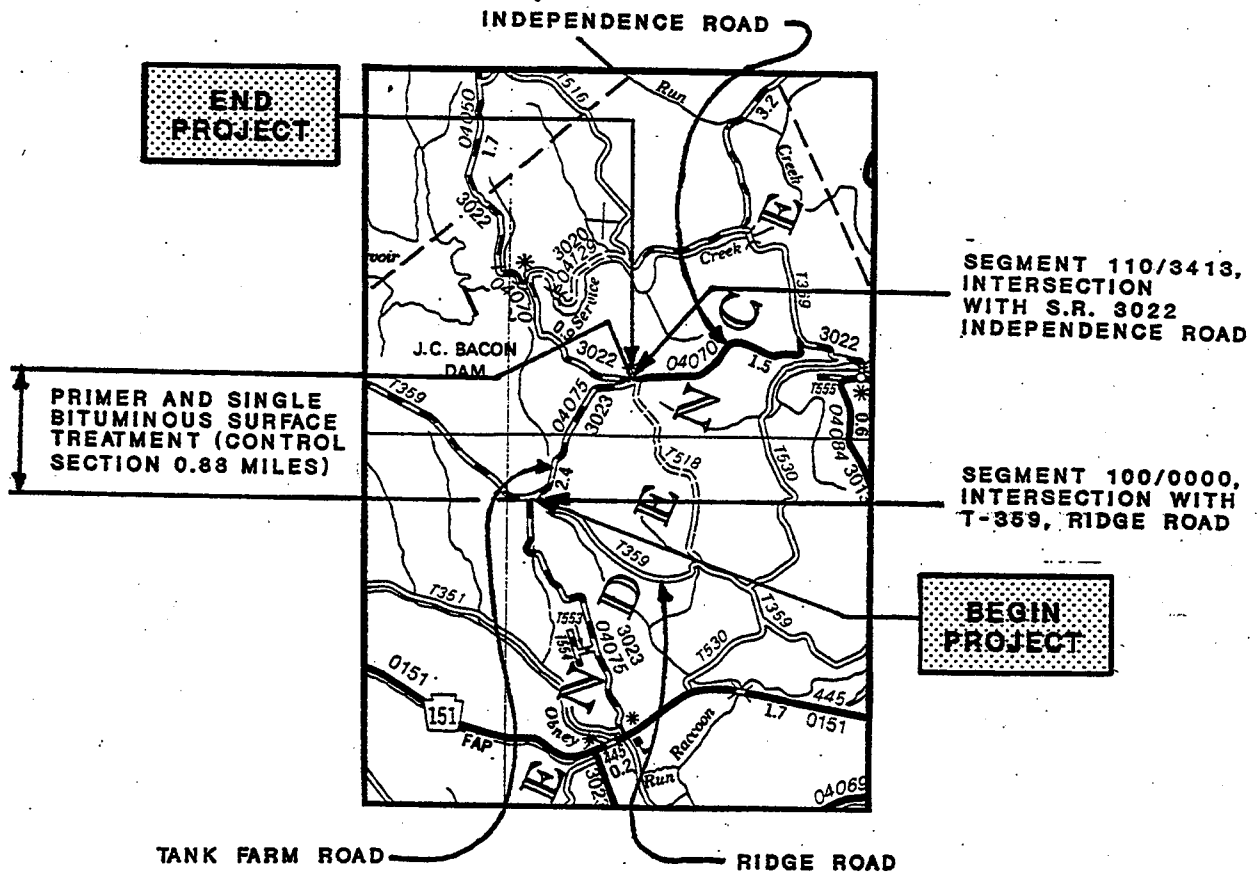




**FIGURE A-9**  
**PROJECT LOCATION MAP**  
**S.R. 3022 NEAR GREEN GARDEN**  
**BEAVER COUNTY, ENGINEERING DISTRICT 11-0**

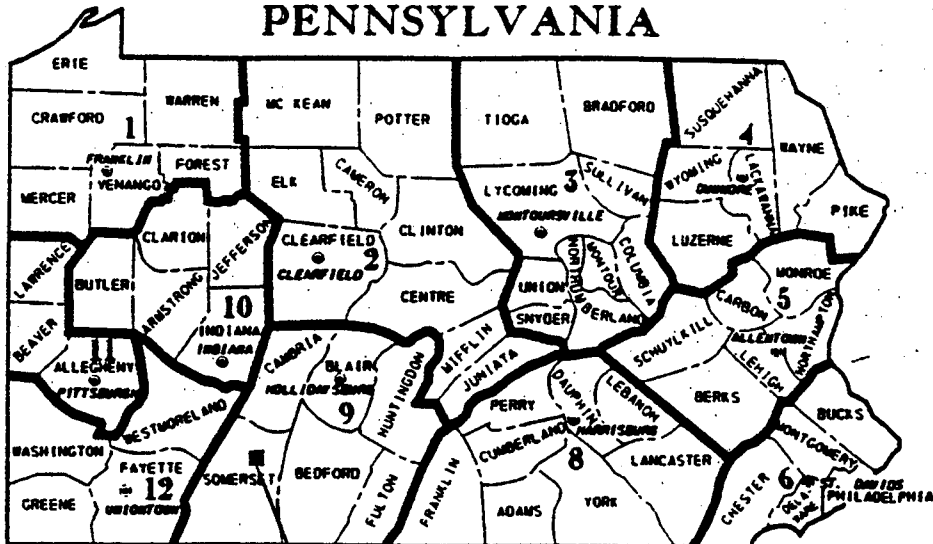


7 DISTRICT  
 = DISTRICT OFFICE



**FIGURE A-10**  
**PROJECT LOCATION MAP**  
**S.R. 3023 NEAR GREEN GARDEN**  
**BEAVER COUNTY, ENGINEERING DISTRICT 11-0**

# PENNSYLVANIA



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COLD MIX IN-PLACE  
RECYCLING WITH A  
SINGLE BITUMINOUS  
SURFACE TREATMENT  
(EXPERIMENTAL SECTION,  
0.62 MILES)

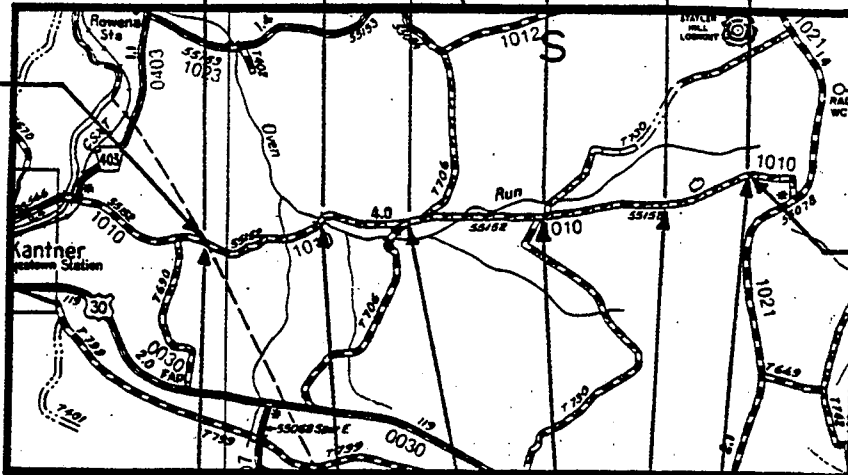
SINGLE BITUMINOUS  
SURFACE TREATMENT  
(CONTROL SECTION,  
0.68 MILES)

FB-1 BITUMINOUS LEVELING  
COURSE WITH A SINGLE  
BITUMINOUS SURFACE  
TREATMENT (EXPERIMENTAL  
SECTION, 0.69 MILES)

GOLD MIX IN-PLACE  
RECYCLING WITH A  
SINGLE BITUMINOUS  
SURFACE TREATMENT  
(EXPERIMENTAL SECTION,  
0.62 MILES)

SINGLE BITUMINOUS  
SURFACE TREATMENT  
(CONTROL SECTION,  
0.39 MILES)

**BEGIN  
PROJECT**



**END  
PROJECT**

SEGMENT 40/0920, AT  
BOUNDARY LINE BETWEEN  
QUEMAHONING AND SHADE  
TOWNSHIP

SEGMENT 110/0690

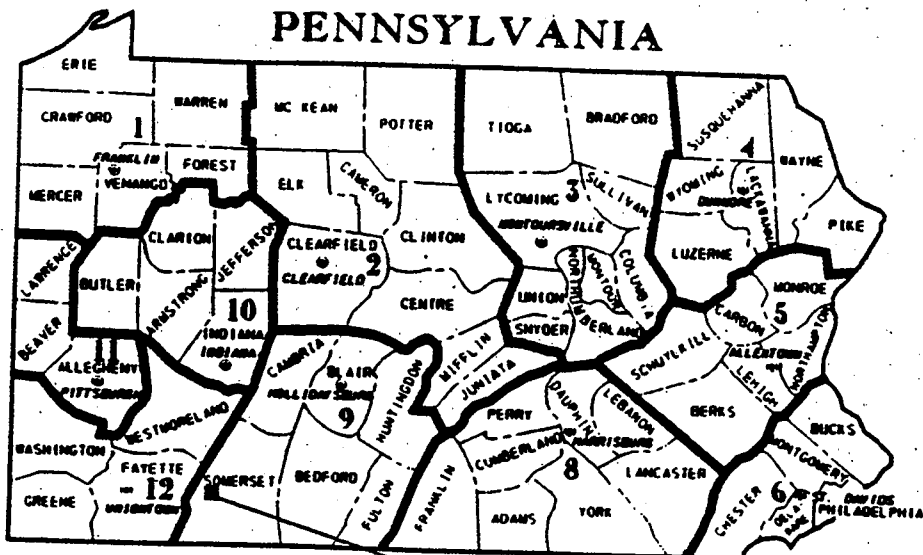
SEGMENT 100/0980

SEGMENT 50/0972, BRIDGE  
STRUCTURE OVER OVEN RUN

SEGMENT 90/0000

SEGMENT 70/0724

FIGURE A-11  
PROJECT LOCATION MAP  
S.R. 1010 NEAR KANTNER  
SOMERSET COUNTY, ENGINEERING DISTRICT 9-0



7 DISTRICT  
- DISTRICT OFFICE

SEGMENT 80/0000,  
BRIDGE STRUCTURE  
OVER ALLEN CREEK  
NEAR INTERSECTION  
WITH TOWNSHIP ROAD  
T-548, PRITTS  
DISTILLERY ROAD

SEGMENT 80/3814,  
INTERSECTION WITH  
S.R. 3029

FB-1 BITUMINOUS LEVEL-  
ING COURSE WITH A  
SINGLE BITUMINOUS  
SURFACE TREATMENT  
(EXPERIMENTAL SECTION,  
1.23 MILES)

**END  
PROJECT**

SEGMENT 40/0000,  
BRIDGE STRUCTURE  
OVER ALLEN CREEK

PRITTS DISTILLERY ROAD

SEGMENT 20/0000,  
BRIDGE STRUCTURE  
OVER LAUREL HILL  
CREEK

**BEGIN  
PROJECT**

SEGMENT 10/0000,  
INTERSECTION WITH  
S.R. 3033

SINGLE BITUMINOUS  
SURFACE TREATMENT  
(CONTROL SECTION,  
0.54 MILES)

FB-1 BITUMINOUS LEVEL-  
ING COURSE WITH A  
SINGLE BITUMINOUS  
SURFACE TREATMENT  
(EXPERIMENTAL SECTION,  
1.30 MILES)

COLD MIX IN-PLACE  
RECYCLING, FB-1  
BITUMINOUS LEVELING  
COURSE WITH A SINGLE  
BITUMINOUS SURFACE  
TREATMENT (EXPERIMENTAL  
SECTION, 0.68 MILES)

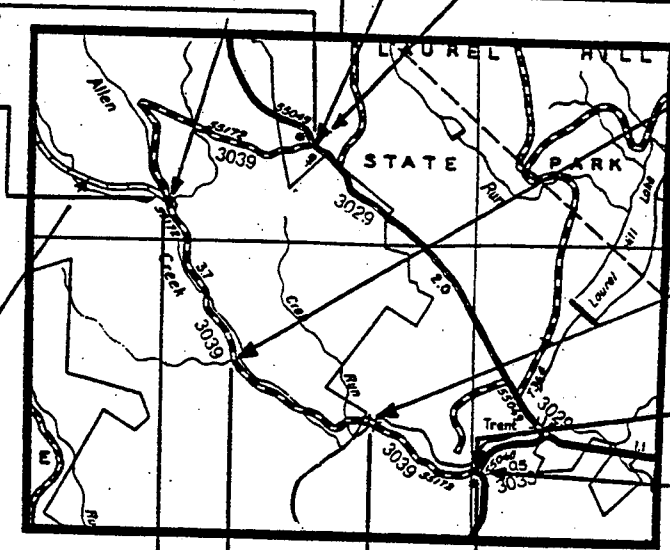
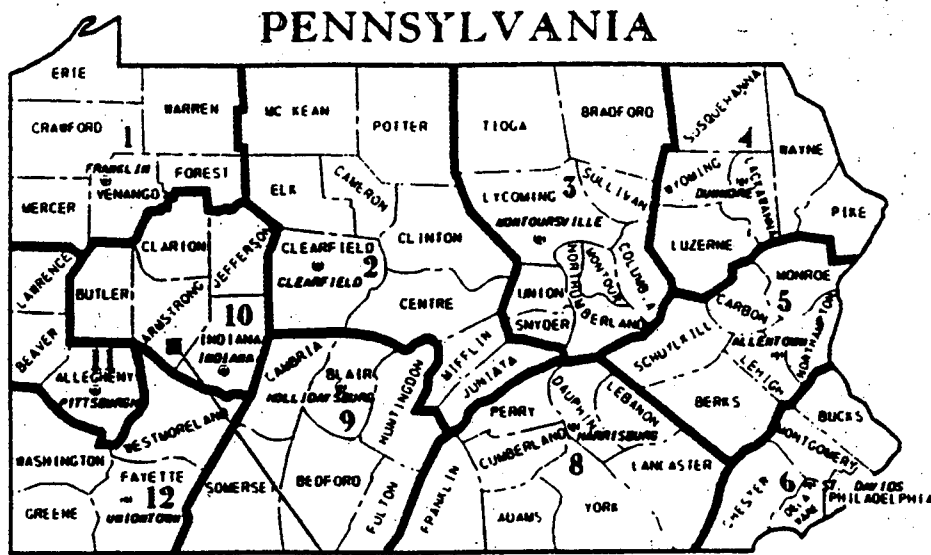


FIGURE A-12  
PROJECT LOCATION MAP  
S.R. 3039 NEAR TRENT  
SOMERSET COUNTY, ENGINEERING DISTRICT 9-0



7 DISTRICT  
 -- DISTRICT OFFICE

SEGMENT 60/2759,  
 INTERSECTION WITH  
 S.R. 0056

**END  
 PROJECT**

BLACKS HOLLOW ROAD

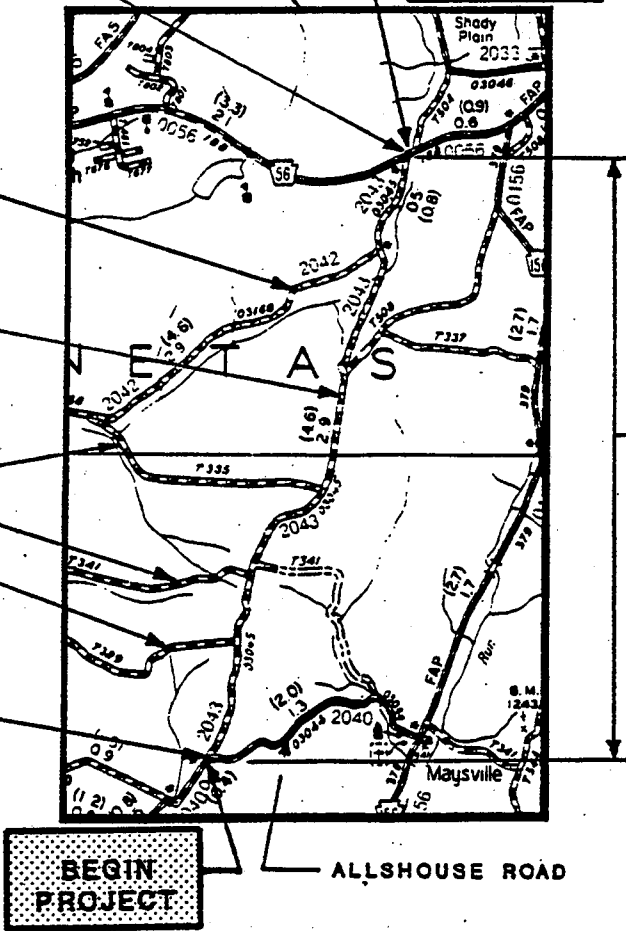
FLAT ROCK ROAD

RUMBAUGH ROAD

MARTIN ROAD

ROSS ROAD

SEGMENT 10/0000,  
 INTERSECTION WITH  
 S.R. 2040, ALLSHOUSE  
 ROAD

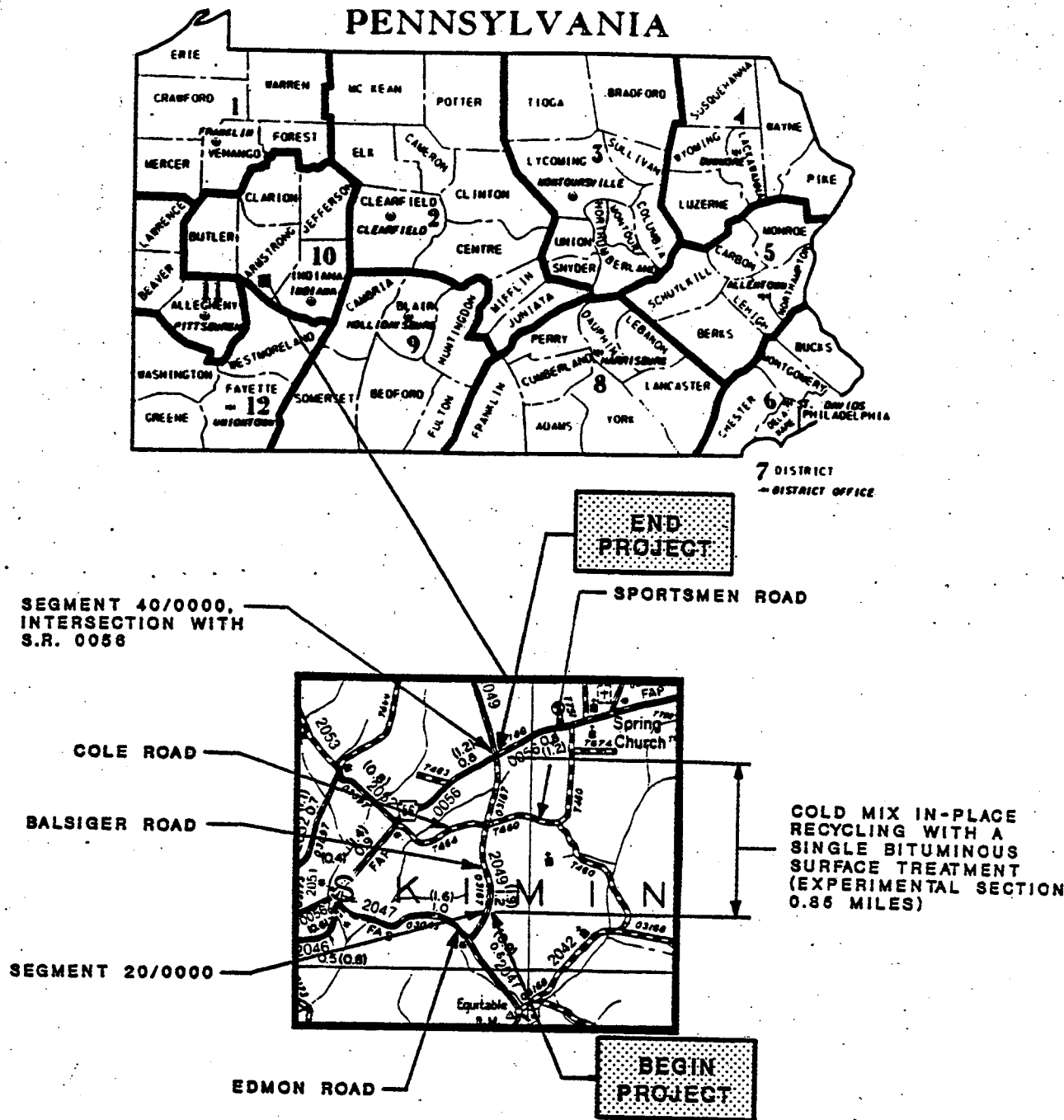


COLD MIX IN-PLACE  
 RECYCLING WITH A  
 SINGLE BITUMINOUS  
 SURFACE TREATMENT  
 (EXPERIMENTAL SECTION,  
 3.39 MILES)

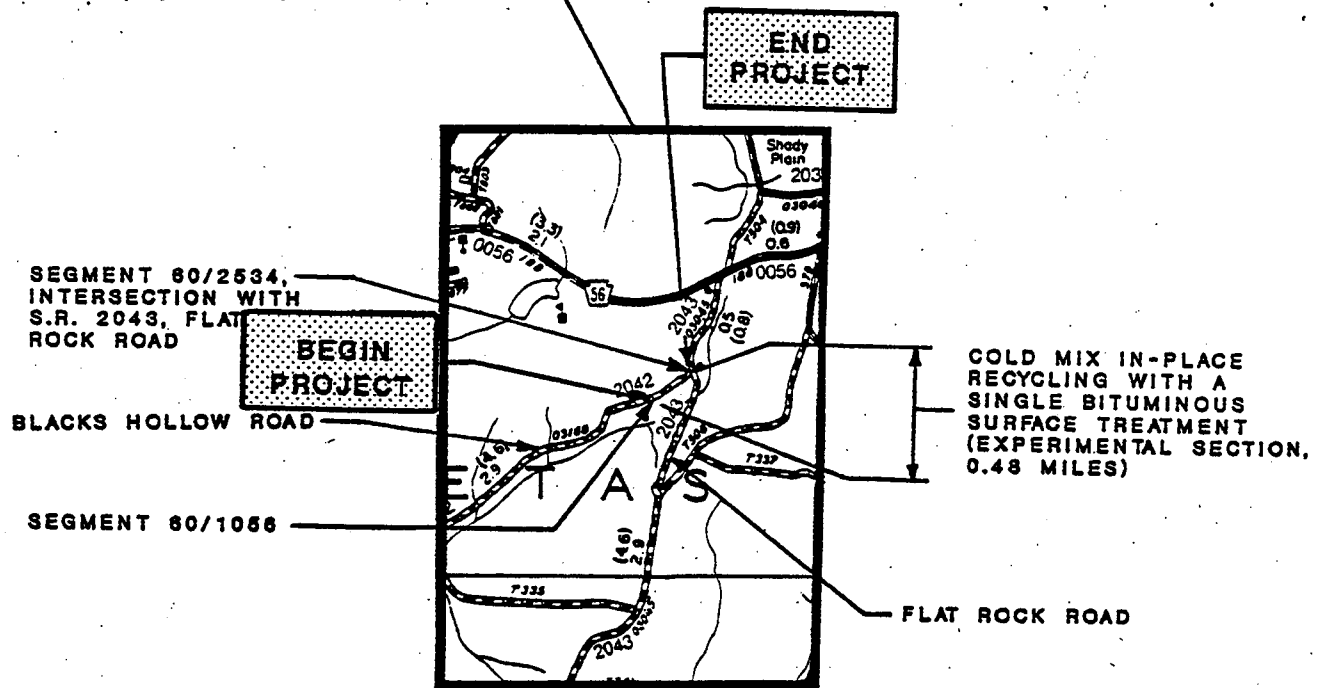
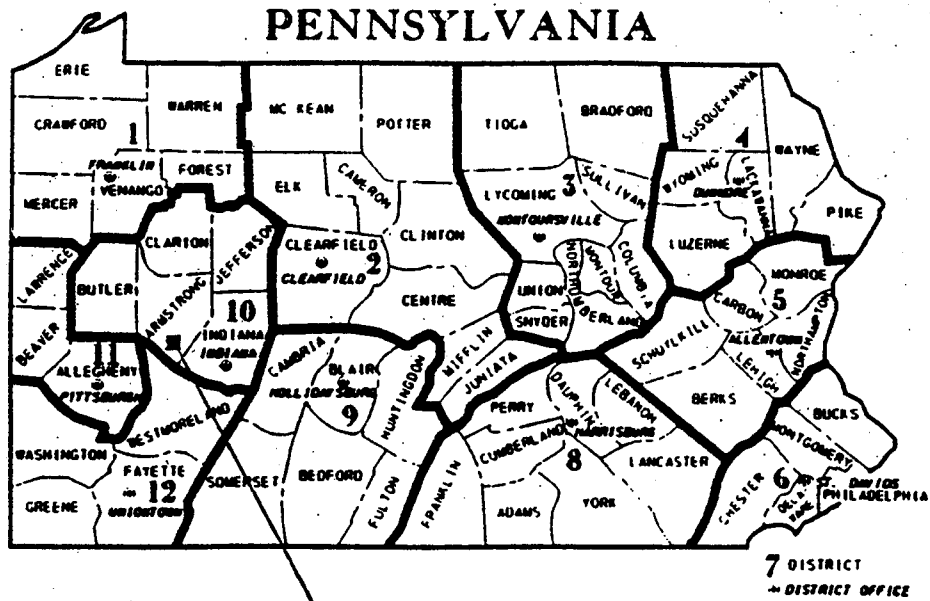
**BEGIN  
 PROJECT**

ALLSHOUSE ROAD

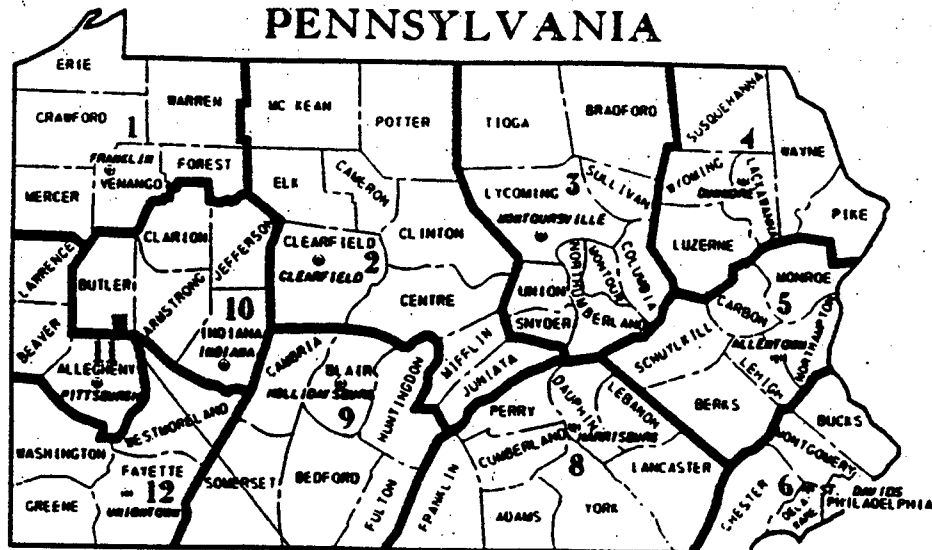
FIGURE A-13  
 PROJECT LOCATION MAP  
 S.R. 2043 NEAR SHADY PLAIN  
 ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0



**FIGURE A-14**  
**PROJECT LOCATION MAP**  
**S.R. 2049 NEAR SPRING CHURCH**  
**ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0**



**FIGURE A-15**  
**PROJECT LOCATION MAP**  
**S.R. 2042 NEAR SHADY PLAIN**  
**ARMSTRONG COUNTY, ENGINEERING DISTRICT 10-0**



7 DISTRICT  
 -- DISTRICT OFFICE

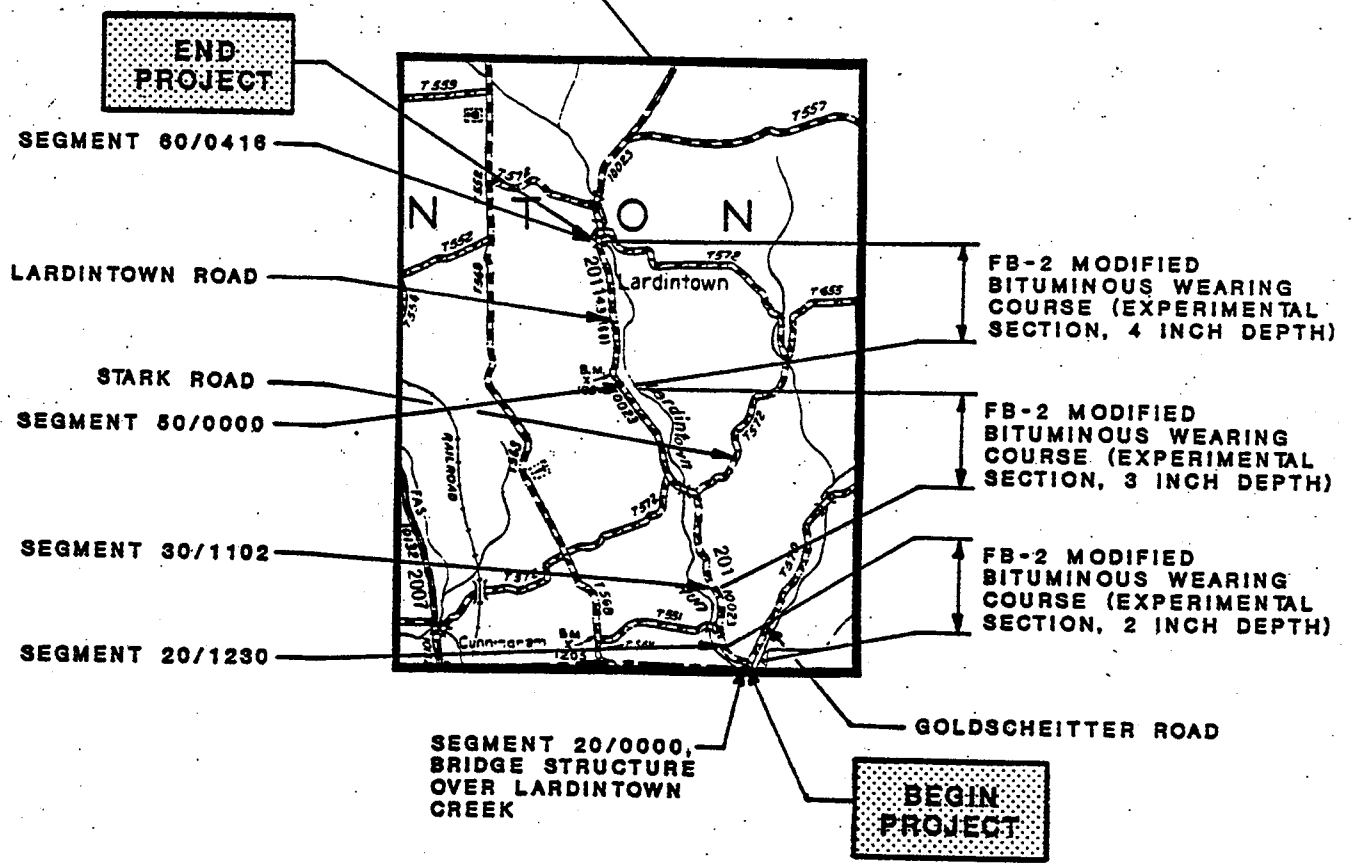
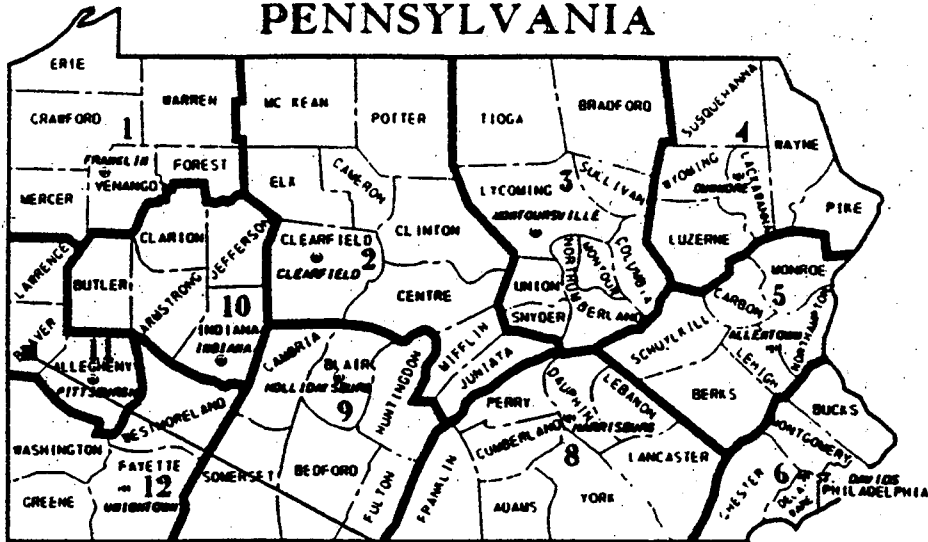


FIGURE A-16  
 PROJECT LOCATION MAP  
 S.R. 2011 NEAR LARDINTOWN  
 BUTLER COUNTY, ENGINEERING DISTRICT 10-0



# PENNSYLVANIA



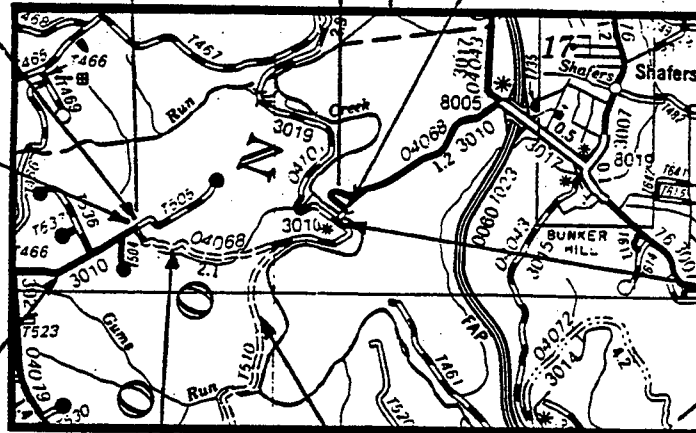
7 DISTRICT  
- DISTRICT OFFICE

FB-2 BITUMINOUS WEARING COURSE WITH A SINGLE BITUMINOUS SEAL COAT TREATMENT (EXPERIMENTAL SECTION, 1.38 MILES)

SEGMENT 80/2337, BRIDGE STRUCTURE OVER RACCOON CREEK

**BEGIN PROJECT**

SEGMENT 40/0000, INTERSECTION WITH HOLT ROAD (PART OF S.R. 3010)



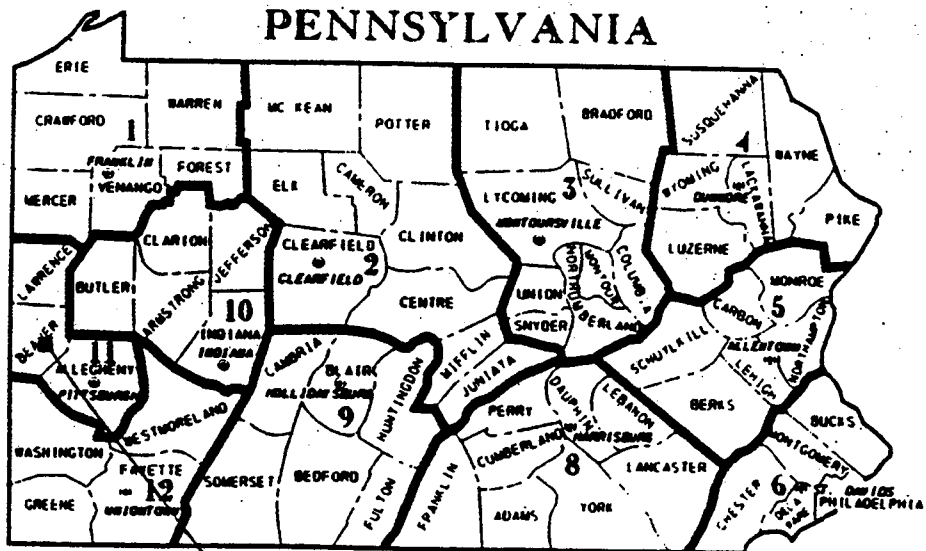
**END PROJECT**

HOLT ROAD

MOFFET MILL ROAD

GUMS RUN ROAD

FIGURE A-17  
PROJECT LOCATION MAP  
S.R. 3010 NEAR SHAFERS  
BEAVER COUNTY, ENGINEERING DISTRICT 11-0



7 DISTRICT  
 → DISTRICT OFFICE

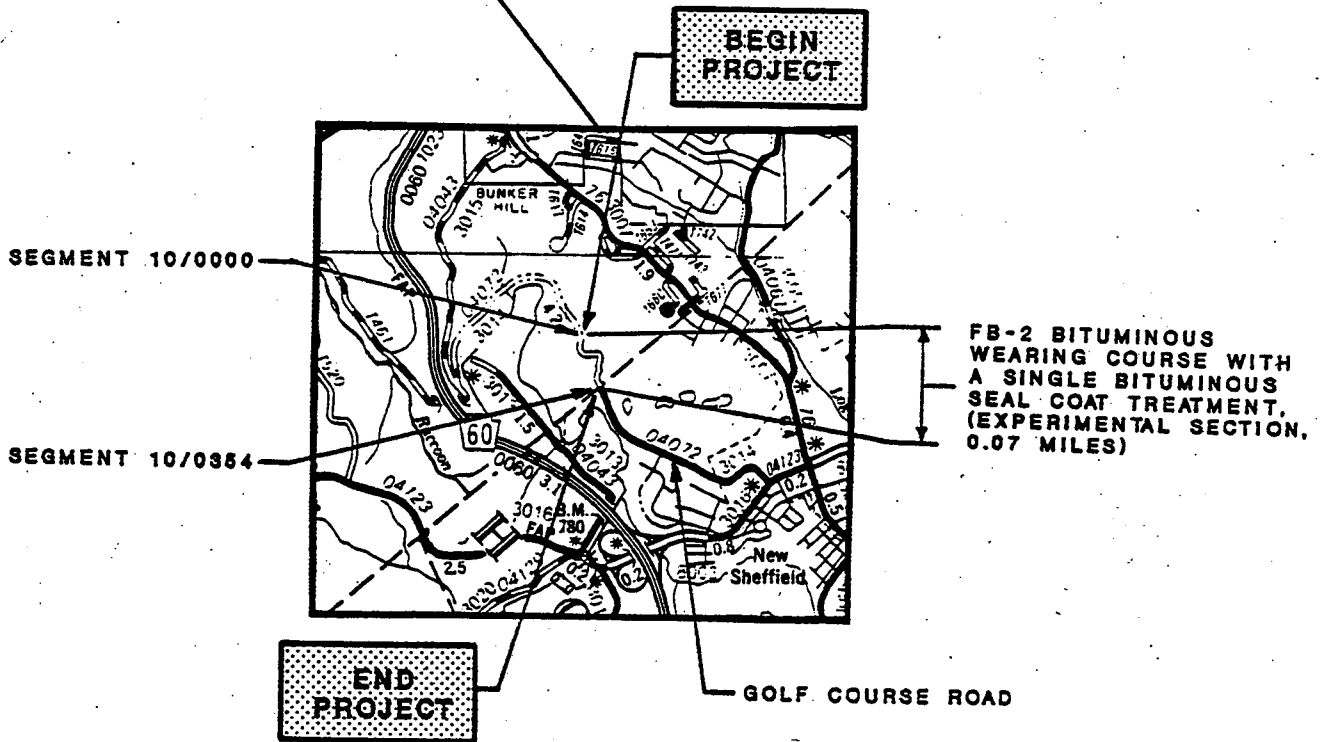
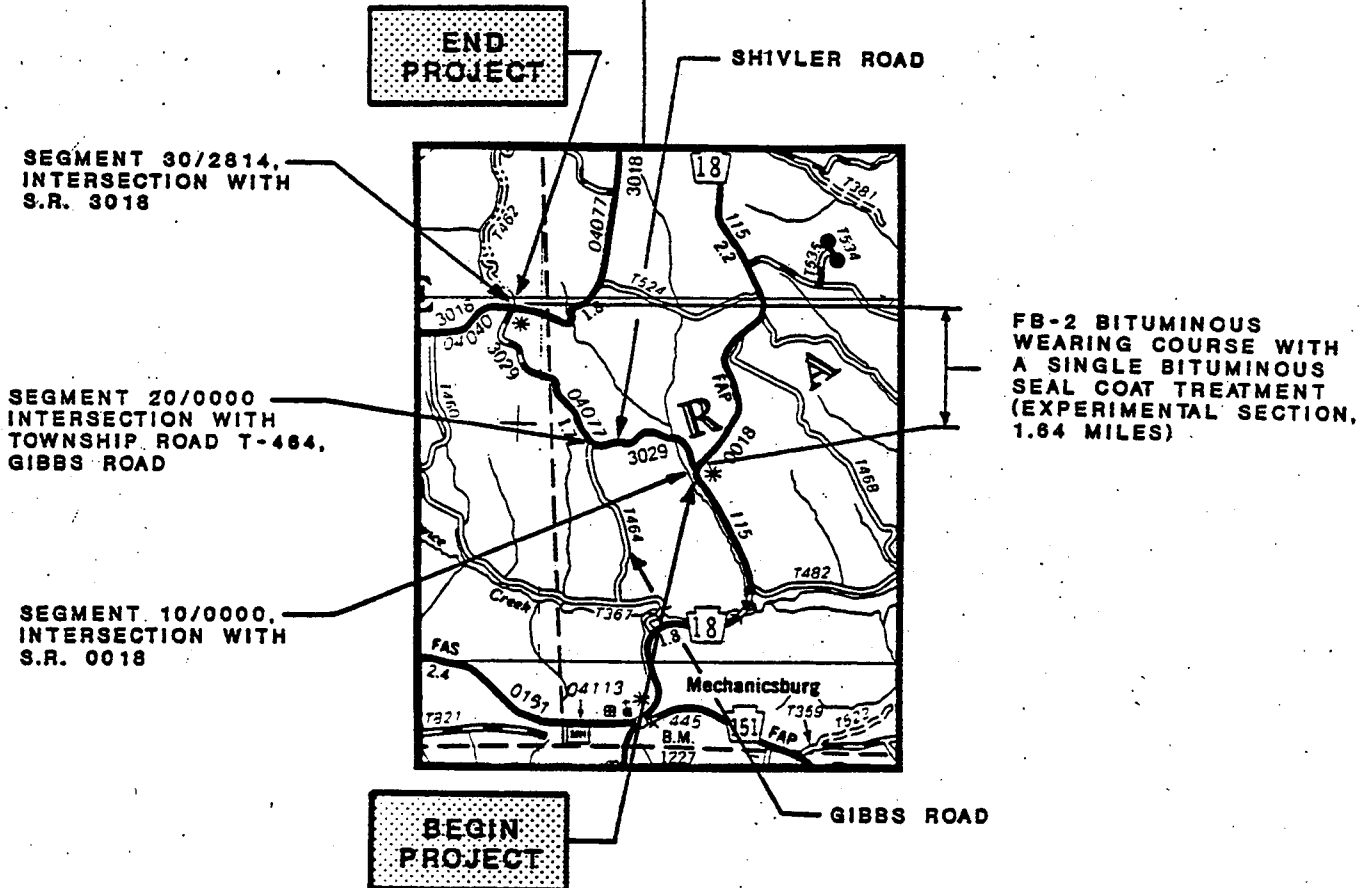
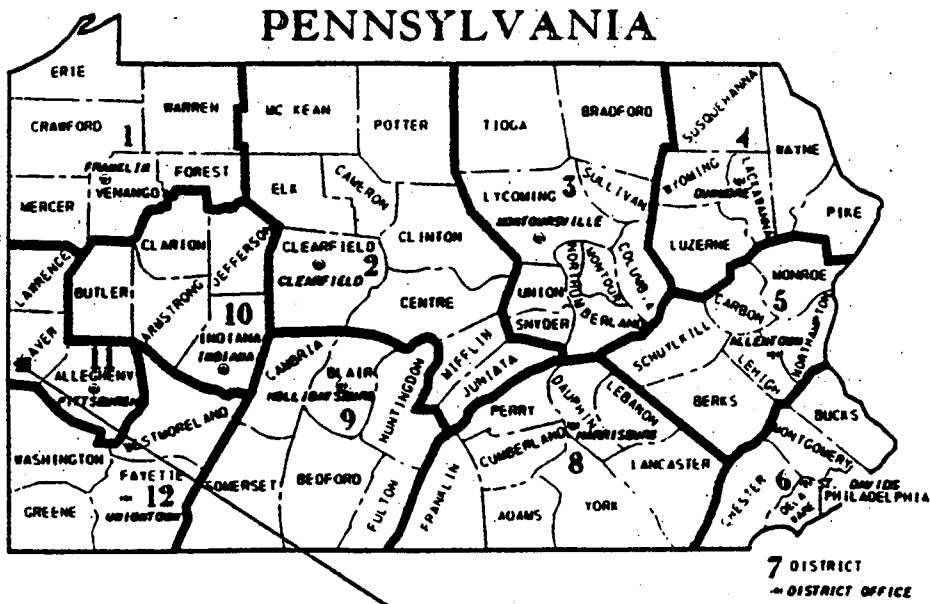
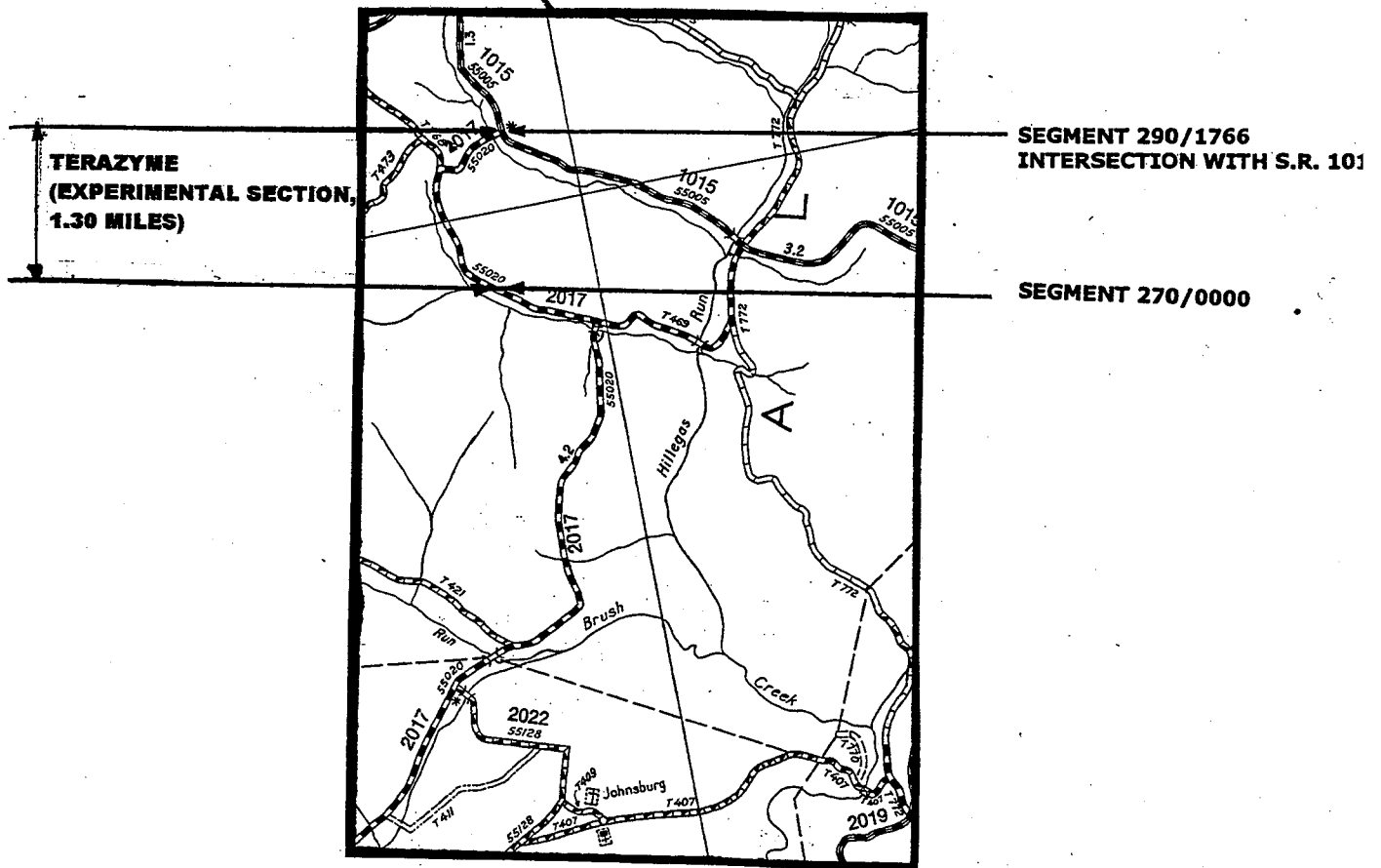
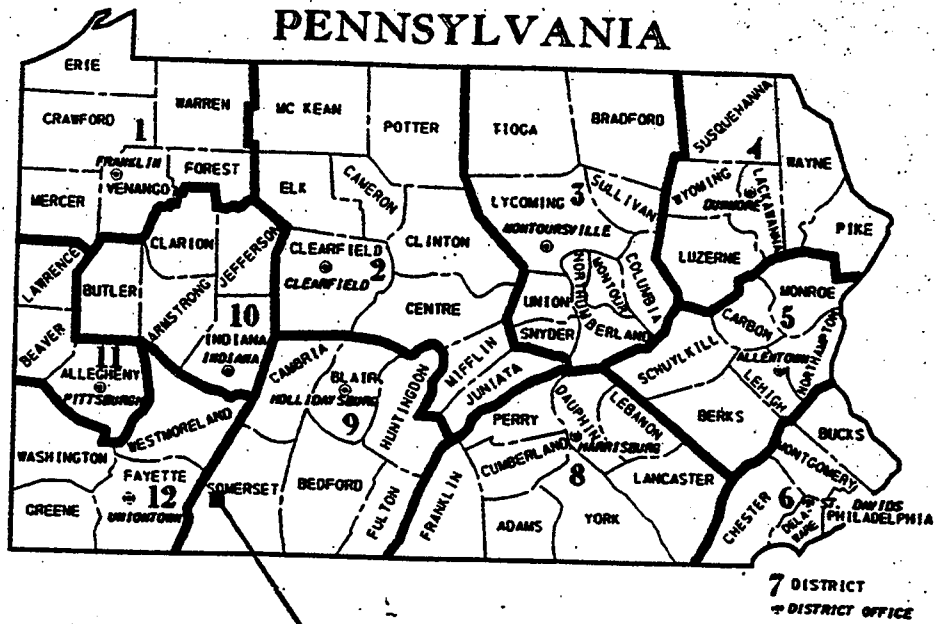


FIGURE A-18  
 PROJECT LOCATION MAP  
 S.R. 3014 NEAR NEW SHEFFIELD  
 BEAVER COUNTY, ENGINEERING DISTRICT 11-0



**FIGURE A-19**  
**PROJECT LOCATION MAP**  
**S.R. 3029 NEAR MECHANICSBURG**  
**BEAVER COUNTY, ENGINEERING DISTRICT 11-0**



**FIGURE A-20**  
**PROJECT LOCATION MAP**  
**S.R. 2017**  
**SOMERSET COUNTY, ENGINEERING DISTRICT 9-0**

**APPENDIX B**  
**PHOTOGRAPHS**



Armstrong County  
S.R. 2021



**Photo 1** – Construction Photo taken June 1991.



**Photo 2** – Inspection Photo taken April 1994 shows a patched area.

S.R. 2014



**Photo 3** – Inspection Photo taken March 1993.



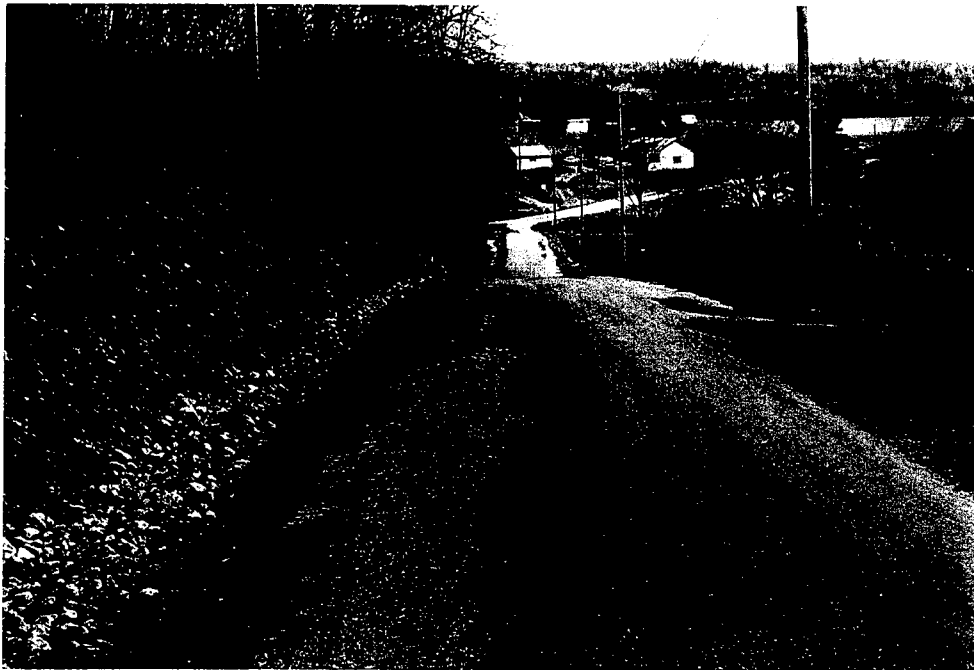
**Photo 4** – Inspection Photo taken March 1993.



S.R. 4019



**Photo 5** – Inspection Photo taken March 1993.



**Photo 6** – Inspection Photo taken April 1994 showing alligator cracking.

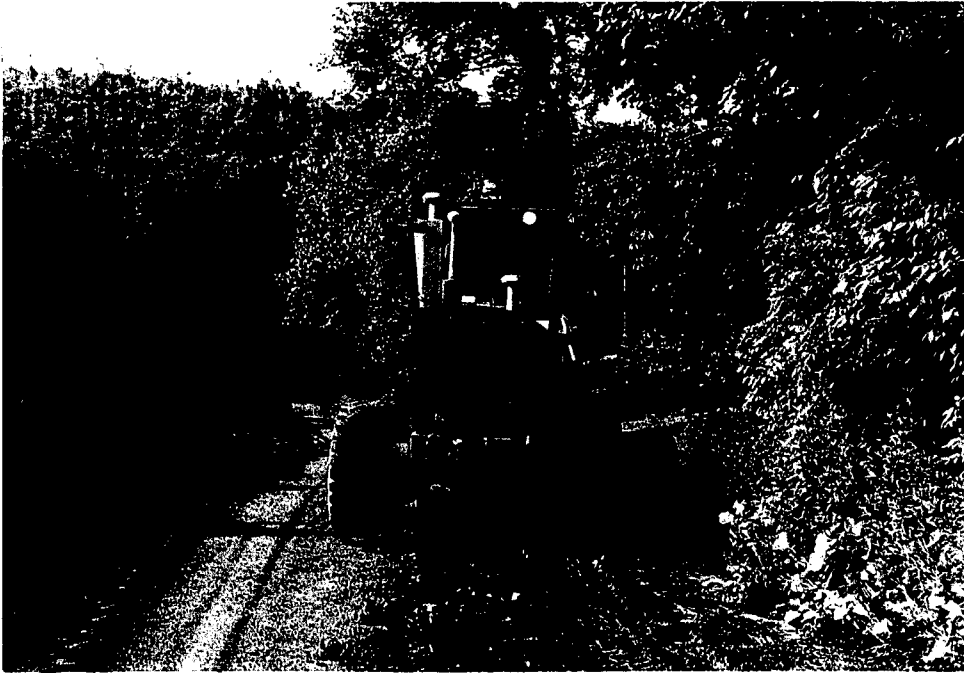


Photo 7 – Inspection Photo taken July 1992 after placement of PermaZyme.



Photo 8 – Inspection Photo taken April 1994 showing potholes.

S.R. 2043



**Photo 9** – Construction Photo taken July 1992.

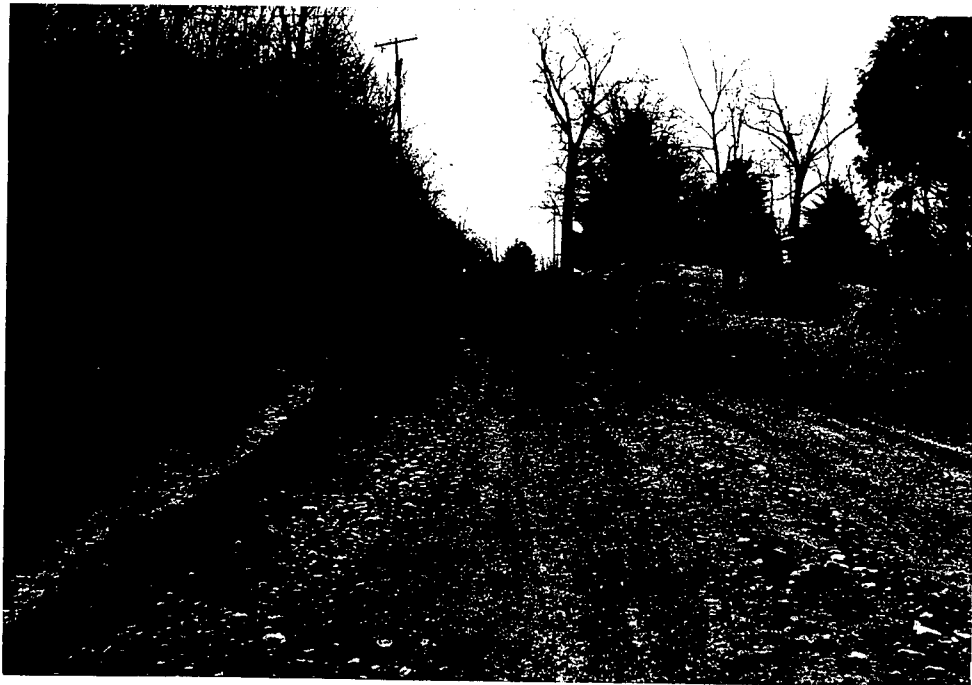


**Photo 10** – Inspection Photo taken April 1993 shows potholes.

S.R. 2049



**Photo 11** – Construction Photo taken July 1992.



**Photo 12** – Inspection Photo taken April 1993 shows loss of aggregate.

**Butler County**  
**S.R. 3016**



**Photo 13 – Construction Photo taken May 1991.**



**Photo 14 – Inspection Photo taken April 1993 showing alligator cracking.**

S.R. 3017

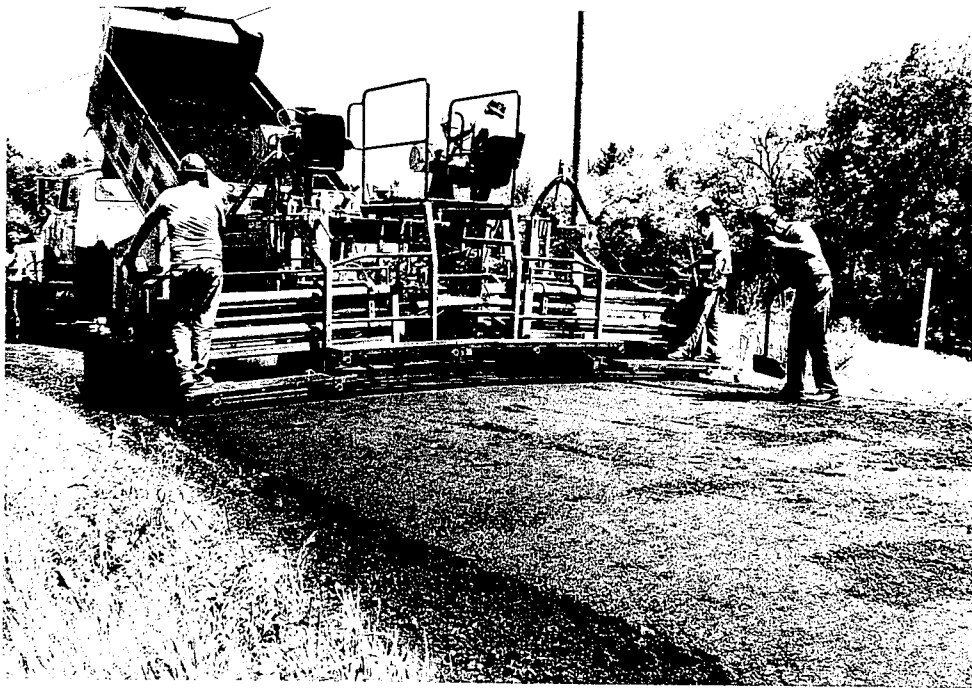


Photo 15 – Construction Photo taken May 1991.



Photo 16 – Inspection Photo taken May 1995.



Photo 17 – Construction Photo taken September 1992.

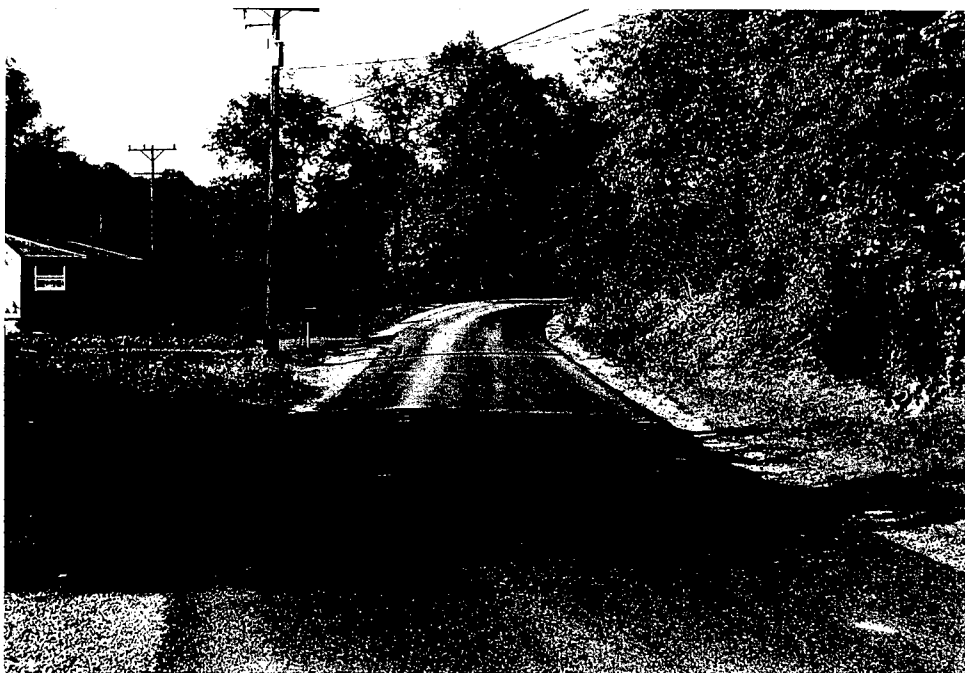


Photo 18 – Inspection Photo taken October 1992.

S.R. 3014



Photo 19 – Inspection Photo taken April 1993 showing loss of aggregate and potholes.

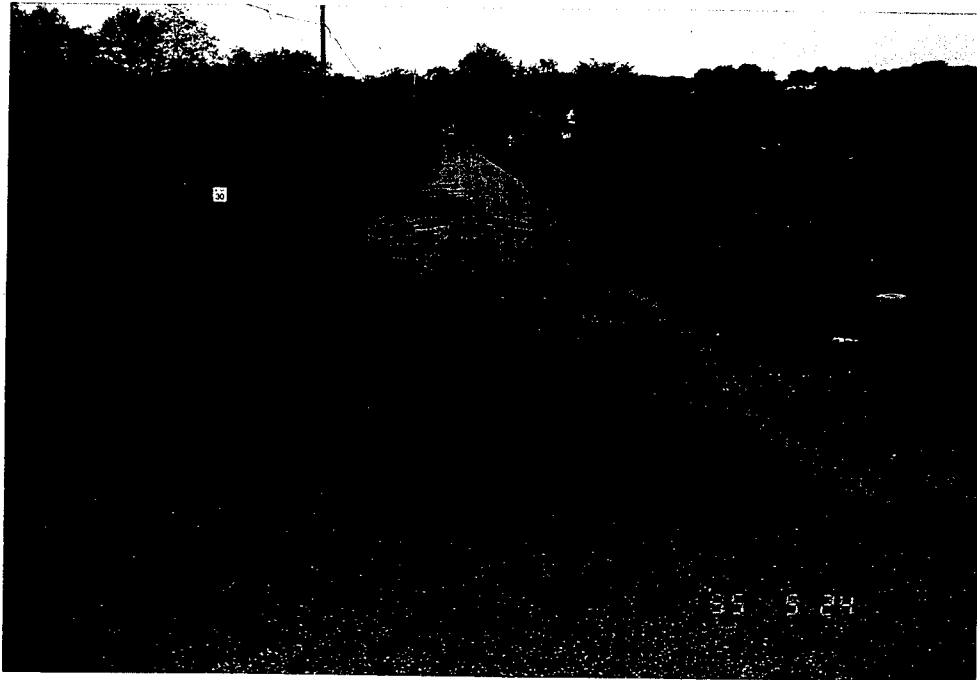


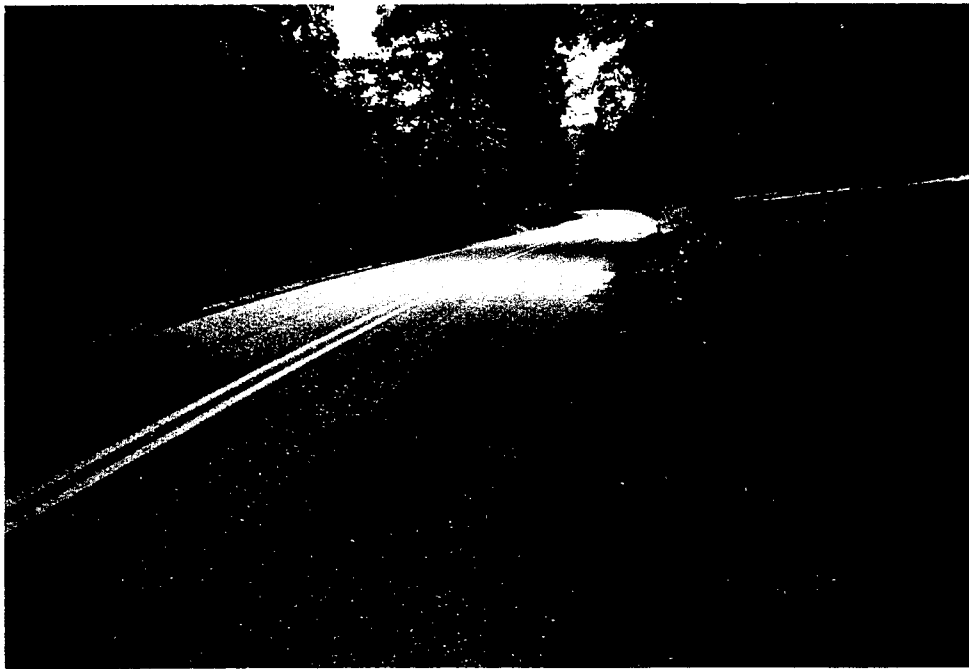
Photo 20 – Inspection Photo taken in May 1995 showing filled potholes.



**Beaver County**  
**S.R. 3022**



**Photo 21** – Inspection Photo taken June 1995 showing that the pavement is performing satisfactorily.



**Photo 22** – Inspection Photo taken June 1995 showing that the pavement is performing satisfactorily.

S.R. 3023



Photo 23 – Inspection Photo taken April 1993.



Photo 24 – Inspection photo taken June 1995.

S.R. 3010



Photo 25 – Construction Photo taken July 1992.



Photo 26 – Inspection Photo taken in April 1993 shows alligator cracking.

S.R. 3014



Photo 27 – Inspection Photo taken April 1993.

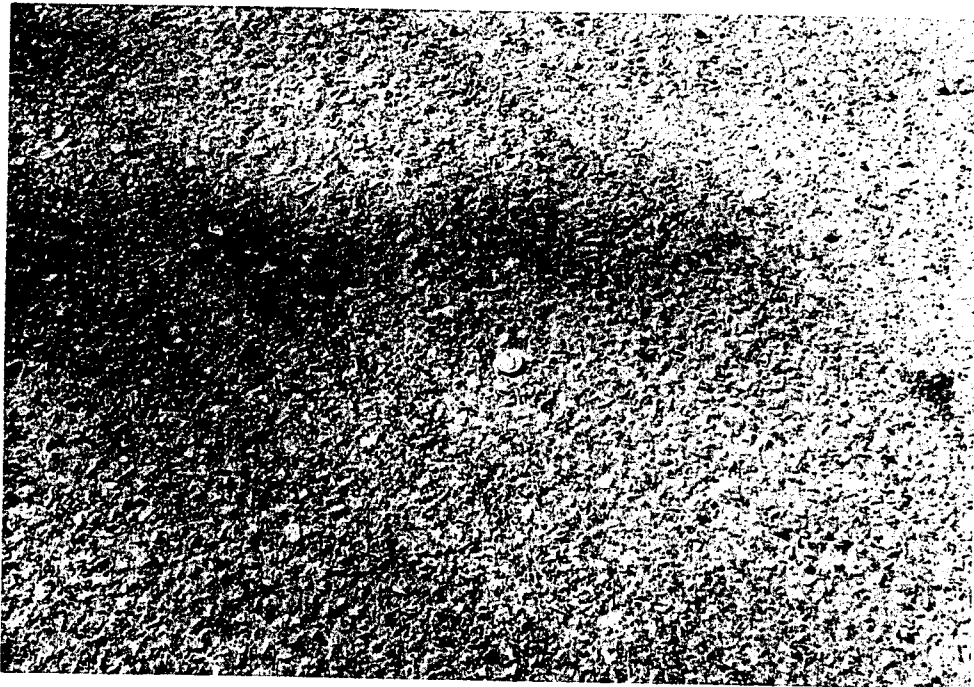


Photo 28 – Inspection Photo taken April 1993.

S.R. 3029

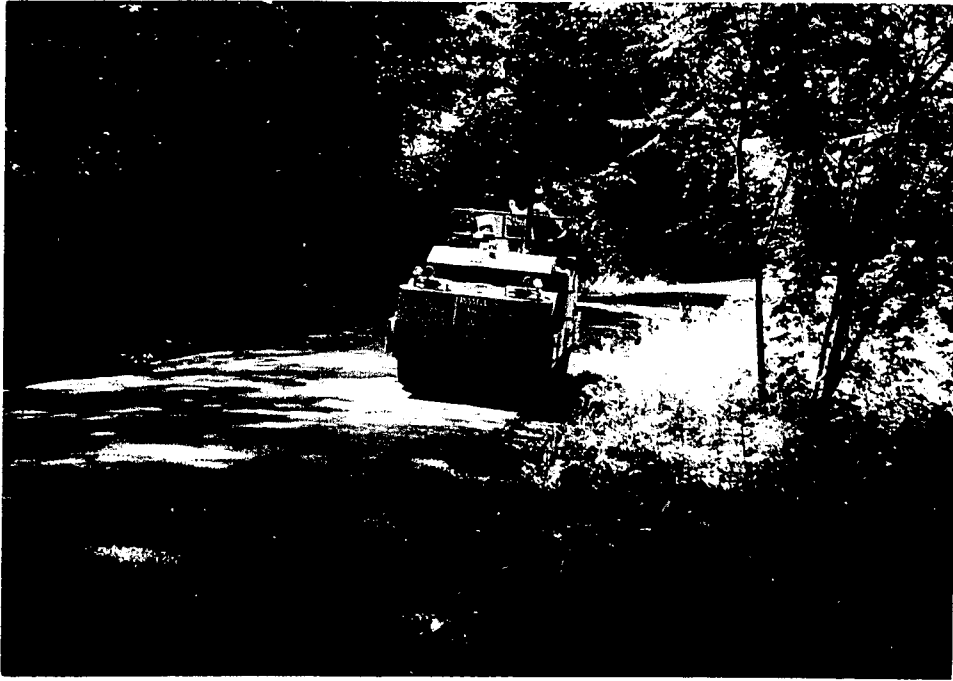


Photo 29 – Construction Photo taken July 1992.



Photo 30 – Inspection Photo taken June 1995.

Somerset County  
S.R. 3021



Photo 31 – Inspection Photo taken April 1994 showing potholes.

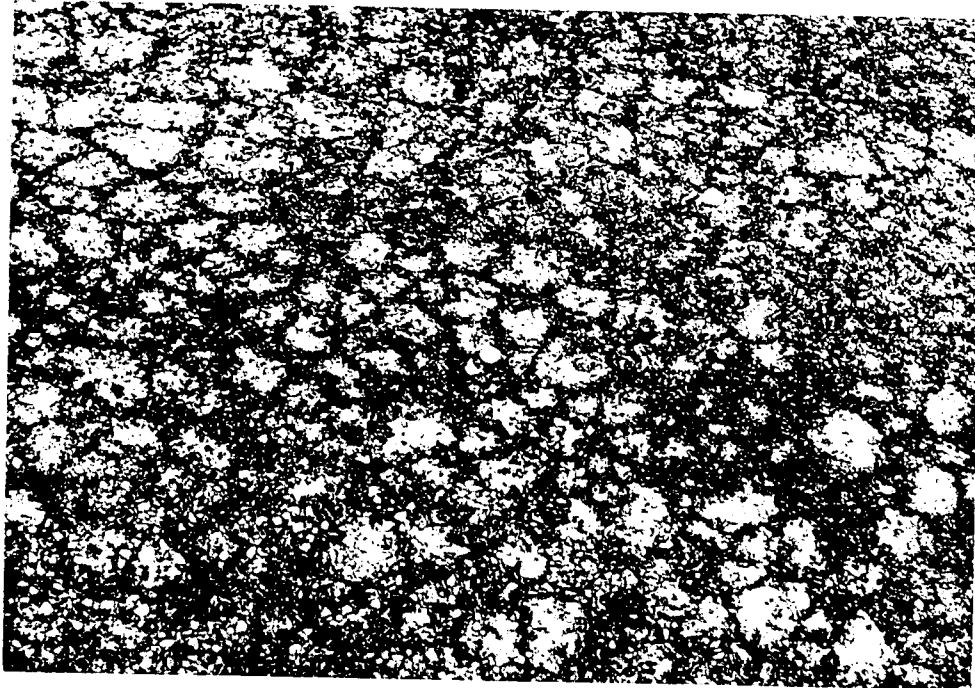


Photo 32 – Inspection Photo taken April 1994 showing alligator cracking.

S.R. 4005



Photo 33 – Construction Photo taken June 1991.



Photo 34 – Inspection photo taken April 1994

S.R. 3039



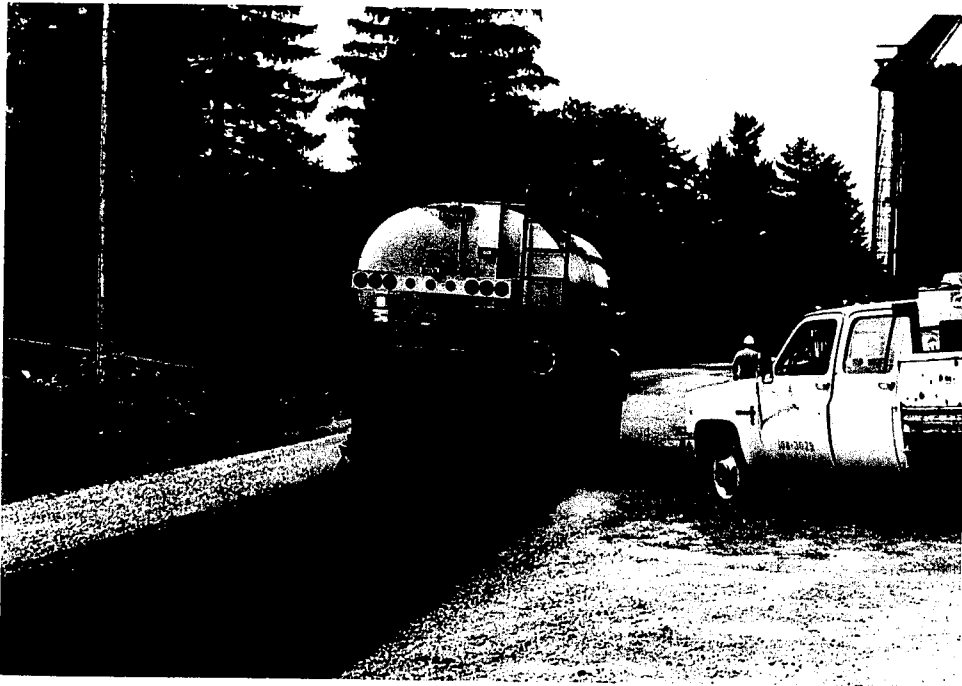
Photo 35 – Construction Photo taken September 1992.



Photo 36 – Inspection Photo taken October 1992.



S.R. 1010



**Photo 37** – Construction Photo taken September 1992.



**Photo 38** – Inspection Photo taken October 1992.



**APPENDIX C**  
**COST DATA**

SR	YEAR	SHAPING	DUST PALLIATIVE	MANUAL PATCH	SURFACE TRMT	RECYCLE MECH	BASE REPAIR	SCRATCH COAT	BITUMINOUS SURFACE	LIQUID PATCH	TOTALS
2014	88-89	\$3,675.65		\$3,339.15	\$10,396.00						\$17,410.80
	89-90	\$4,243.32		\$1,321.12							\$5,564.44
	90-91	\$4,342.69	\$8,209.28	\$3,401.78	\$20,628.57						\$36,582.32
	91-92			\$1,910.04							\$1,910.04
	92-93			\$8,161.83	\$11,173.80		\$16,499.84				\$35,835.47
	93-94			\$15,093.75	\$13,024.00			\$59,511.23		\$2,700.00	\$28,117.75
94-95			\$11,403.76				\$59,511.23		\$2,700.00	\$73,614.99	
<b>TOTALS</b>		<b>\$12,261.66</b>	<b>\$8,209.28</b>	<b>\$44,631.43</b>	<b>\$55,222.37</b>	<b>\$0.00</b>	<b>\$16,499.84</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$2,700.00</b>	<b>\$199,835.81</b>
2021	88-89	\$3,007.35	\$5,040.00								\$8,047.35
	89-90	\$2,652.08	\$3,817.80	\$45,203.57							\$51,673.45
	90-91	\$789.58	\$403.20	\$827.46		\$68,319.04					\$70,339.28
	91-92			\$2,546.72	\$9,642.50						\$12,189.22
	92-93				\$9,490.80						\$9,490.80
	93-94			\$1,610.00	\$12,901.16						\$14,511.16
	94-95			\$805.35							\$805.35
<b>TOTALS</b>		<b>\$6,449.01</b>	<b>\$9,261.00</b>	<b>\$50,993.10</b>	<b>\$32,034.46</b>	<b>\$68,319.04</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$2,700.00</b>	<b>\$3,505.35</b>
2042	88-89	\$3,174.43	\$104.00	\$3,669.40		\$15,840.00					\$22,787.83
	89-90	\$1,944.86	\$1,418.76	\$400.34	\$4,995.00						\$8,768.96
	90-91	\$3,355.72	\$537.60		\$4,192.00						\$8,085.32
	91-92	\$400.81	\$1,125.30								\$1,526.11
	92-93	\$1,398.98	\$736.00		\$4,884.00						\$7,018.98
	93-94	\$1,262.22	\$3,500.64		\$1,924.00						\$6,686.86
	94-95	\$2,419.41									\$2,419.41
<b>TOTALS</b>		<b>\$13,956.43</b>	<b>\$7,422.30</b>	<b>\$4,069.74</b>	<b>\$15,995.00</b>	<b>\$15,840.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$57,283.47</b>
2043	88-89	\$7,351.30	\$5,316.00								\$12,667.30
	89-90	\$5,304.15	\$16,097.55								\$21,401.70
	90-91	\$10,264.54	\$11,750.40								\$22,014.94
	91-92	\$835.03	\$12,896.40								\$13,731.43
	92-93	\$12,046.76	\$7,205.90		\$30,197.64						\$49,450.30
	93-94		\$2,244.00	\$4,427.50	\$16,370.28		\$17,097.08				\$40,138.86
	94-95		\$3,740.00	\$1,932.84	\$16,794.00		\$14,123.16				\$36,590.00
<b>TOTALS</b>		<b>\$35,801.78</b>	<b>\$59,250.25</b>	<b>\$6,360.34</b>	<b>\$63,361.92</b>	<b>\$0.00</b>	<b>\$31,220.24</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$185,954.53</b>
2049	88-89	\$2,673.20	\$788.00	\$1,834.70		\$31,194.24			\$669.76		\$37,159.90
	89-90	\$1,237.64	\$4,555.53	\$3,803.23	\$9,357.88					\$1,340.00	\$20,294.28
	90-91	\$1,697.60	\$2,246.40	\$919.40	\$8,051.26						\$12,914.66
	91-92	\$267.21	\$4,356.00	\$636.68						\$3,451.44	\$8,711.33
	92-93	\$2,331.63	\$1,610.00		\$7,741.80						\$11,683.43
	93-94	\$315.56		\$8,875.13							\$9,190.69
	94-95	\$691.26		\$1,288.56							\$1,979.82
<b>TOTALS</b>		<b>\$9,214.10</b>	<b>\$13,555.93</b>	<b>\$17,357.70</b>	<b>\$25,150.94</b>	<b>\$31,194.24</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$669.76</b>	<b>\$4,791.44</b>	<b>\$101,334.11</b>
4019	88-89	\$6,181.78	\$1,800.00								\$7,981.78
	89-90	\$3,212.91	\$3,654.00	\$800.68							\$7,667.59
	90-91	\$10,146.10	\$16,964.16	\$1,011.34	\$22,640.73						\$50,762.33
	91-92		\$383.41	\$16,569.60	\$7.98					\$58.40	\$17,019.39
	92-93			\$868.28	\$11,630.52	\$771.90					\$13,270.70
	93-94			\$20,326.25	\$10,382.20						\$30,708.45
	94-95			\$3,382.47	\$12,372.00						\$15,754.47
<b>TOTALS</b>		<b>\$19,540.79</b>	<b>\$22,801.57</b>	<b>\$42,958.62</b>	<b>\$57,033.43</b>	<b>\$771.90</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$58.40</b>	<b>\$143,164.71</b>

ARMSTRONG COUNTY TOTAL: \$867,169.24

SR	YEAR	SHAPING	RESTALLI- ZATION	DUST PALLIATIVE	MANUAL PATCH	SURFACE TRMT	BASE REPAIR	SCRATCH COAT	BITUMINOUS SURFACE	LIQUID PATCH	TOTALS	
3010	88-89		\$8,809.71	\$7,965.18	\$4,198.25		\$12,264.70				\$33,237.84	
	89-90	\$2,223.81	\$2,996.40	\$4,496.40	\$916.25					\$7,809.00	\$18,441.86	
	90-91	\$947.73	\$3,150.60	\$2,772.48	\$379.54						\$7,250.35	
	91-92										\$0.00	
	92-93				\$12,206.77	\$8,063.79	\$16,040.37				\$36,310.93	
3014	93-94				\$5,418.75	\$7,175.35				\$97.50	\$12,691.60	
	94-95				\$4,224.54		\$46,024.93				\$50,249.46	
	TOTALS	\$3,174.54	\$14,956.71	\$15,234.06	\$27,344.09	\$15,239.14	\$74,330.00	\$0.00	\$0.00	\$7,906.50	\$158,182.04	
	88-89				\$1,007.58						\$1,007.58	
	89-90	\$988.36			\$549.75					\$5,388.21	\$6,926.32	
3022	90-91	\$135.39									\$135.39	
	91-92										\$0.00	
	92-93										\$0.00	
	93-94										\$0.00	
	94-95				\$1,207.01	\$0.00	\$0.00	\$0.00	\$0.00	\$5,388.21	\$1,207.01	
TOTALS	\$1,123.75	\$0.00	\$0.00	\$2,764.34	\$0.00	\$0.00	\$0.00	\$0.00	\$5,388.21	\$9,275.30		
3023	88-89	\$724.00	\$5,034.12	\$4,314.96	\$1,259.48		\$19,051.20			\$6,364.00	\$36,747.76	
	89-90	\$3,459.26	\$9,765.60	\$3,020.70						\$6,850.00	\$23,095.56	
	90-91	\$4,941.74	\$4,639.20	\$4,012.16	\$2,277.24		\$15,243.36	\$21,145.28	\$867.50	\$10,101.24	\$63,227.72	
	91-92										\$0.00	
	92-93				\$3,294.18	\$11,884.89					\$15,179.07	
3029	93-94				\$850.00	\$17,553.34	\$13,421.30				\$31,824.64	
	94-95				\$1,120.80		\$3,378.54		\$4,788.33		\$9,287.67	
	TOTALS	\$9,125.00	\$19,438.92	\$11,347.82	\$8,801.69	\$29,438.23	\$51,094.40	\$21,145.28	\$5,655.83	\$23,315.24	\$179,362.41	
	88-89	\$1,488.00			\$5,289.80					\$4,947.64	\$11,725.44	
	89-90				\$733.00						\$733.00	
3029	90-91	\$1,353.90		\$948.96	\$2,296.22	\$15,776.08	\$10,046.76				\$30,421.92	
	91-92										\$0.00	
	92-93				\$366.02	\$14,763.34			\$978.57	\$26.00	\$16,107.93	
	93-94				\$1,593.75						\$1,619.75	
	94-95				\$344.86	\$3,942.00	\$10,046.76	\$0.00	\$1,592.25		\$5,879.11	
TOTALS	\$2,841.90	\$0.00	\$948.96	\$10,623.64	\$34,481.42	\$34,481.42	\$10,046.76	\$2,570.82	\$4,973.64	\$55,437.14		
3029	88-89		\$6,497.19								\$6,497.19	
	89-90	\$988.36			\$6,230.50						\$7,218.86	
	90-91		\$4,215.80								\$4,215.80	
	91-92										\$0.00	
	92-93										\$0.00	
3029	93-94					\$6,801.62			\$4,770.96		\$6,801.62	
	94-95						\$0.00	\$0.00	\$4,770.96	\$0.00	\$4,770.96	
	TOTALS	\$988.36	\$10,712.99	\$0.00	\$6,230.50	\$6,801.62	\$6,801.62	\$0.00	\$4,770.96	\$0.00	\$29,504.43	
	<b>BEAVER COUNTY TOTAL:</b>											<b>\$442,812.32</b>

COST SUMMARY

BUTLER COUNTY

1988-1995

SR	YEAR	SHAPING	DUST PALLIATIVE	RESTALLI-ZATION	MANUAL PATCH	SURFACE TRMT	RECYCLE MECH	BASE REPAIR	SCRATCH COAT	BITUMINOUS SURFACE	LIQUID PATCH	TOTALS
2011	88-89	\$7,707.04	\$4,986.65		\$13,193.39					\$1,062.40		\$26,949.48
	89-90	\$5,192.99	\$1,727.99		\$17,757.35	\$7,926.08				\$3,675.24	\$10,050.81	\$46,330.47
	90-91	\$5,143.53	\$175.00		\$6,115.93						\$23,683.90	\$35,118.36
	91-92	\$6,332.28	\$1,776.00		\$7,943.31	\$13,054.15						\$29,105.74
	92-93	\$4,814.81	\$1,995.00		\$16,672.65		\$27,760.00		\$2,980.18			\$54,222.64
93-94	\$874.64	\$1,254.00		\$2,838.54								\$4,967.18
94-95				\$4,528.65	\$31,737.00			\$23,384.32		\$1,568.16		\$61,218.13
<b>TOTALS</b>		<b>\$30,065.29</b>	<b>\$11,914.65</b>	<b>\$0.00</b>	<b>\$69,049.82</b>	<b>\$52,717.23</b>	<b>\$27,760.00</b>	<b>\$0.00</b>	<b>\$26,364.50</b>	<b>\$6,305.80</b>	<b>\$33,734.71</b>	<b>\$357,912.00</b>
3014	88-89	\$647.65	\$366.66		\$4,980.41							\$5,994.72
	89-90		\$1,090.00		\$7,755.47							\$8,845.47
	90-91	\$2,351.33	\$2,768.50		\$6,780.71	\$6,552.00						\$18,452.53
	91-92			\$560.00	\$1,482.52	\$2,967.15			\$32,799.00			\$35,766.15
	92-93	\$1,062.09			\$4,691.80	\$2,980.00			\$5,963.40			\$16,561.61
93-94				\$9,057.30	\$10,281.00							\$7,671.80
94-95				\$34,748.21	\$30,273.75		\$12,492.00		\$2,700.00	\$0.00	\$2,700.00	\$34,530.30
<b>TOTALS</b>		<b>\$4,061.07</b>	<b>\$4,225.16</b>	<b>\$560.00</b>	<b>\$34,748.21</b>	<b>\$30,273.75</b>	<b>\$0.00</b>	<b>\$12,492.00</b>	<b>\$38,762.40</b>	<b>\$0.00</b>	<b>\$2,700.00</b>	<b>\$127,822.58</b>
3016	88-89		\$4,299.98		\$281.91							\$4,581.89
	89-90	\$3,115.79	\$1,435.00									\$4,550.79
	90-91	\$1,102.19	\$2,490.10		\$2,127.28						\$875,550.00	\$881,269.57
	91-92	\$3,166.14	\$2,174.55									\$5,340.69
	92-93	\$3,540.30	\$2,572.90									\$6,113.20
93-94	\$1,749.28	\$3,961.00			\$1,192.00						\$6,902.28	
94-95	\$1,444.83		\$9,478.19									\$10,923.02
<b>TOTALS</b>		<b>\$14,118.53</b>	<b>\$16,933.53</b>	<b>\$9,478.19</b>	<b>\$2,409.19</b>	<b>\$1,192.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$875,550.00</b>	<b>\$919,681.44</b>
3017	88-89	\$3,238.25	\$1,833.33		\$3,119.80							\$8,191.38
	89-90	\$733.13	\$1,405.40		\$9,199.59	\$8,568.00					\$5,097.12	\$25,003.24
	90-91	\$1,836.98	\$1,190.00		\$9,040.94						\$58,370.00	\$70,437.92
	91-92				\$15,988.14	\$16,768.00					\$16,502.35	\$49,258.49
	92-93		\$1,192.25		\$17,334.08	\$14,146.20		\$14,295.38				\$46,967.91
93-94				\$29,644.90	\$6,407.00		\$2,841.60	\$22,965.25				\$61,858.76
94-95				\$21,306.22	\$25,181.00		\$832.80					\$47,320.02
<b>TOTALS</b>		<b>\$5,808.35</b>	<b>\$5,620.97</b>	<b>\$0.00</b>	<b>\$105,633.68</b>	<b>\$71,070.20</b>	<b>\$0.00</b>	<b>\$17,969.78</b>	<b>\$22,965.25</b>	<b>\$0.00</b>	<b>\$79,969.47</b>	<b>\$309,037.70</b>
<b>BUTLER COUNTY TOTAL:</b>											<b>\$1,614,453.72</b>	

SR	YEAR	SHAPING	DUST PALLIATIVE	RESTALLI-ZATION	MANUAL PATCH	SURFACE TRMT	BASE REPAIR	SCRATCH COAT	LIQUID PATCH	TOTALS
1010	88-89		\$1,522.50		\$2,830.46					\$4,352.96
	89-90	\$6,301.10	\$4,497.74	\$20,465.28	\$2,750.75					\$34,014.87
	90-91	\$1,273.13	\$3,798.00							\$5,071.13
	91-92		\$3,850.00	\$2,392.10	\$375.34	\$26,805.02		\$18,874.76		\$2,392.10
	92-93	\$2,379.74		\$9,590.40				\$26,123.96		\$61,875.26
	93-94	\$2,363.19		\$5,785.00				\$44,998.72		\$4,772.77
94-95	\$4,905.60		\$38,232.78		\$5,956.55	\$26,805.02	\$2,409.58	\$0.00		\$36,814.56
<b>TOTALS</b>	<b>\$17,222.76</b>		<b>\$13,668.24</b>		<b>\$5,956.55</b>	<b>\$26,805.02</b>	<b>\$2,409.58</b>	<b>\$44,998.72</b>	<b>\$0.00</b>	<b>\$149,293.65</b>
3021	88-89									\$0.00
	89-90	\$4,556.18	\$3,037.50	\$4,742.64	\$880.24					\$13,216.56
	90-91	\$653.77	\$558.00	\$3,762.00	\$190.66					\$5,164.43
	91-92				\$2,365.74					\$2,365.74
	92-93	\$5,701.47			\$8,926.57	\$15,265.28		\$14,000.25		\$20,966.75
	93-94					\$7,667.05				\$22,926.32
94-95					\$22,932.33	\$0.00	\$14,000.25	\$0.00		\$7,667.05
<b>TOTALS</b>	<b>\$10,911.42</b>		<b>\$3,595.50</b>	<b>\$8,504.64</b>	<b>\$12,363.21</b>	<b>\$22,932.33</b>	<b>\$0.00</b>	<b>\$14,000.25</b>	<b>\$0.00</b>	<b>\$72,387.35</b>
3039	88-89	\$2,953.35	\$1,890.00	\$420.00						\$5,263.35
	89-90	\$1,793.39		\$2,076.00	\$1,430.39		\$2,438.10			\$7,737.88
	90-91	\$1,273.13		\$2,200.00	\$3,241.22					\$6,714.35
	91-92	\$1,302.68	\$405.00	\$7,910.65						\$9,618.33
	92-93		\$700.00	\$3,839.94	\$9,781.45					\$39,983.30
	93-94									\$9,781.45
94-95									\$0.00	
<b>TOTALS</b>	<b>\$7,322.55</b>		<b>\$2,995.00</b>	<b>\$16,446.59</b>	<b>\$14,453.06</b>	<b>\$35,443.36</b>	<b>\$2,438.10</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$79,088.96</b>
4005	88-89	\$5,906.70	\$630.00	\$8,848.00	\$1,095.66					\$16,480.36
	89-90	\$14,783.35	\$5,008.25	\$22,275.60	\$2,860.78		\$812.70			\$45,740.68
	90-91	\$688.18	\$3,286.80		\$762.64	\$8,814.10				\$13,551.72
	91-92	\$4,637.52			\$9,226.39		\$6,585.82	\$3,087.92	\$5,180.00	\$28,717.65
	92-93		\$784.00	\$8,898.12				\$52,107.72		\$106,931.53
	93-94									\$0.00
94-95					\$14,984.33			\$14,200.20		\$29,184.53
<b>TOTALS</b>	<b>\$26,015.75</b>		<b>\$9,709.05</b>	<b>\$40,021.72</b>	<b>\$28,929.79</b>	<b>\$53,955.79</b>	<b>\$7,398.52</b>	<b>\$55,195.64</b>	<b>\$19,380.20</b>	<b>\$240,605.46</b>
2017	88-89	\$2,185.48	\$892.50	\$0.00	\$3,232.20	\$25,502.55	\$0.00	\$24,672.18	\$0.00	\$56,484.91
	89-90	\$0.00	\$213.72	\$0.00	\$2,200.60	\$8,974.50	\$0.00	\$0.00	\$0.00	\$11,388.82
	90-91	\$0.00	\$4,530.06	\$7,040.00	\$3,260.29	\$0.00	\$0.00	\$0.00	\$2,160.00	\$16,990.35
	91-92	\$0.00	\$0.00	\$0.00	\$25,258.82	\$0.00	\$0.00	\$3,194.40	\$24,921.40	\$53,374.62
	92-93	\$2,280.59	\$6,163.10	\$1,728.00	\$1,595.20	\$36,396.55	\$0.00	\$0.00	\$0.00	\$48,183.43
	93-94	\$0.00	\$0.00	\$0.00	\$15,308.37	\$0.00	\$0.00	\$0.00	\$0.00	\$15,308.37
94-95	\$0.00	\$2,688.00	\$0.00	\$126,238.05	\$0.00	\$0.00	\$52,079.74	\$489.13	\$181,494.92	
<b>TOTALS</b>	<b>\$4,466.07</b>		<b>\$14,507.38</b>	<b>\$8,768.00</b>	<b>\$177,093.52</b>	<b>\$70,873.60</b>	<b>\$0.00</b>	<b>\$79,946.32</b>	<b>\$27,670.53</b>	<b>\$383,225.42</b>
<b>SOMERSET COUNTY TOTAL:</b>										<b>\$924,531.54</b>

**APPENDIX D**  
**LIQUID TREATED BASE COURSE FOR STABILIZATION OF UNPAVED**  
**ROADS DRAFT SPECIFICATION**



This office is currently evaluating the performance of various experimental treatment methods to improve unpaved roadways under Research Projects 91-069 (PHASE I) and 92-069 (PHASE II). The funding for this evaluation was the result of House Bill No. 1393, which allocated the Department \$300,000 per phase to conduct a Demonstration Program for surface upgrading of selected unpaved roads in rural-oriented counties. The participating Counties are Armstrong, Beaver, Butler and Somerset.

One of the treatment methods selected for evaluation involves cold mix in-place recycling of an existing roadway. Where soft spots are prevalent due to the lack of proper drainage or stabilizing material, the application of several experimental, liquid stabilizers that are either chemically-derived or plant-derived (organic), have been used. Listed below are the liquid stabilizers currently being evaluated:

1. **PERMA-ZYME**  
National Perma-Zyme  
16400 Deer Lake Road  
Derwood, Maryland 20855  
Representatives: Murt and Marilyn Murdock
  
2. **TerraZyme**  
TerraZyme Company  
24 Crescent Street, Suite 1  
Stamford, Connecticut 06906  
Representative: Colin Stauffer
  
3. **EMC<sup>2</sup>**  
Soil Stabilization Products Co., Inc.  
806 W. 22nd Street  
Merced, California 95344  
Representative: Bob Randolph
  
4. **BASE-SEAL**  
Nita Chemical Company  
P.O. Box 99  
Cypress, Texas 77429-0099  
Representative: Joan Mitchell

Based on site inspections to assess field performance, satisfactory results have been recorded with the liquid stabilizers.

Therefore, the attached "DRAFT" Specifications have been developed for review and comment.

**SECTION XXX - LIQUID-TREATED BASE COURSE FOR  
STABILIZATION OF UNPAVED ROADS**

**XXX.1. DESCRIPTION** - This work is the construction of a stabilized soil or roadbed. The work shall consist of furnishing and placing a stabilizing material on a prepared subgrade soil; mixing suitable material and stabilizer solution; and compacting to the lines, grades and dimensions as shown on the drawings.

**XXX.2. MATERIAL -**

(a) **Liquid Stabilizer.** Provide a stabilization material that is water soluble, non-petroleum, non-hazardous, non-toxic, non-flammable, non-corrosive and that has demonstrated, by certified field and laboratory results, successful use in similar soil and weather conditions. Acceptable as listed in Bulletin 15 (Publication 35); and approved by the Engineer; and meeting the following specifications:

**1. CHEMICAL DESCRIPTION:**

Total Solids, %, Minimum	30.0
pH Of 10% Solution (Normal)	5.0 To 6.0

**2. PHYSICAL PROPERTIES:**

**a. General.**

Specific Gravity (Liquid), 59°F (15°C) To 77°F (25°C)	1.05 To 1.35
Gallon Weight, Lbs.	9.15 To 11.35
Viscosity, cp At 77°F (25°C)	Not Greater Than 800
Solubility In Water	Dilutable

**b. Certification.** Section 106.03(b)3.

**(b) Existing Subgrade Soil.**

**1. Gradation.** Do not use for soils having less than 20 percent passing a No. 200 sieve.

**2. Testing Requirements.** Submit randomly sampled in-place soils, under the direction of the Engineer, to the Materials and Testing Division for testing and approval, prior to use.

**(c) Water.** Section 720.

**XXX.3. CONSTRUCTION -**

(a) **Applicability** - Use for subgrade soils approved by the Department.

(b) **Application Rate** - As per manufacturer's recommendations or as directed by the Engineer.

(c) **Weather Limitations** - Do not mix or place material when the ambient temperature is below 50°F (10°C) ; or when the temperature may fall below 32°F (0°C) within 24 hours of placement; or if precipitation is predicted within 48 hours of placement, during placement or 72 hours following placement. Do not place treated material on frozen subgrade. Application shall not be made after September 15, unless approved by the Engineer.

(d) **Placement** - Use a grader or milling machine to loosen or scarify the subgrade soil, to the indicated depth, and spread to the full width at a uniform thickness. After mixing pre-measured containers of stabilizing material with water, use a distributor, as specified in Section 460.3(b), to apply stabilizing material uniformly to achieve specified application rate. Thoroughly mix until the treated material is uniform in appearance, texture, moisture content and free from pockets of segregated aggregates. Grade the treated material to the full width and uniform thickness, as indicated on the drawings, to obtain the required compacted thickness. Blade material that becomes too wet to bring the optimum moisture content to the manufacturer's recommended specifications or as directed by the Engineer. Add water to the treated material when needed to bring the material to the required optimum moisture content for compaction and performance. The mixed material may be bladed into a windrow at the edge of the roadway and allowed to cure a minimum of 14 hours before spreading over the subgrade to the required lines and grades.

(e) **Compaction** - Use sufficient pneumatic-tire rollers, with a contact pressure of 40 to 50 psi, or steel wheel tandem rollers, as specified in Section 108.05(c)3. or 4. Longitudinally roll for the full width with each pass overlapping the preceding pass by at least one-half the width of the roller. Do not allow the moisture in the treated material to fall below or two percentage points above the optimum moisture content, as determined in the laboratory, unless otherwise directed by the Engineer. Continue compaction operations until a density no less than 95% of the specified dry density weight has been achieved. Rolling shall be in the static mode to prevent fracturing of the material. No re-grading or re-rolling shall be permitted, unless directed by the Engineer.

(f) **Requirements For Compacted Layers -**

- |   |                |
|---|----------------|
| ● CBR, Minimum                          | 10             |
| ● Density, Minimum At Optimum Moisture  | 100 To 105 Pcf |
| ● Maximum Thickness Of Compacting Layer | 8 Inches       |

(g) **Curing.** Allow the stabilized base course to cure for at least 72 hours following final compaction. Allow access over the compacted surface provided material pickup does not occur and surface is completely and strongly bound together.

(h) **Additional Surfacing.** Apply additional surfacing after a minimum 3-day curing period. Moisten surface with a mixture of 1 part liquid stabilizer to 1000 parts water prior to placement of additional surfacing.

**XXX.4. MEASUREMENT AND PAYMENT - Cubic Yard Of Material.**

APPENDIX E  
SPECIFICATION REQUIREMENTS FOR  
FLEXIBLE PAVEMENTS

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# SECTION 400

## FLEXIBLE PAVEMENTS

### SECTION 401 — PLANT-MIXED BITUMINOUS CONCRETE COURSES

**401.1 DESCRIPTION** — This work is construction of plant-mixed bituminous concrete courses on a prepared surface.

**401.2 MATERIAL** —

(a) **Bituminous Material.** Type and class of bituminous material required, as specified in Section 702, at the point of delivery and at the bituminous concrete plant.

(b) **Aggregates.** From currently accepted sources listed in Bulletin 14, meeting the final gradation specified in Table A.

Having the SRL designation as indicated in the bid proposal, and supplied from acceptable sources for use in wearing courses. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50 percent by weight and mixed by an approved method.

Aggregates may be obtained from separate acceptable sources. However, unless otherwise permitted, use aggregates or blends of aggregates from sources indicated in the job-mix formula.

If it is desired to produce a mix using material from two or more isolated plants simultaneously, the use of different sources in the job-mix formula may be permitted.

(c) **Filler.** When required, as specified in Section 703.1(c)1.

(d) **Composition of Mixtures.** Size, uniformly grade, and combine aggregate fractions in such proportions that the total aggregate and the bitumen in the job-mix formula conform to the composition's by weight percentages specified in Table A. Except for FB mixes, produce the bituminous mix within the job mix formula tolerances specified in Table B. Produce the FB mixes within the ranges specified in Table A.

Test the materials, proportions, and the mixture at the bituminous concrete plant laboratory under the direction of the Engineer. When required, tests will be made at the MTD, upon submission of necessary samples.

**1. Review of Quality Control Plan and Job-Mix Formula.** Prepare a quality control plan, as specified in Section 106, and submit it for review at the start of the project and at least annually thereafter. Do not start actual work until the quality control plan and the job-mix formula have been reviewed.

**TABLE A**  
**COMPOSITION — BITUMINOUS SURFACE COURSES**

SURFACE COURSE	TOTAL PERCENT BY WEIGHT (PASSING SQUARE OPENINGS, LAB SIEVE TESTS)											BITUMEN % BY WEIGHT		
	1 1/2"	1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200	STONE or GRAVEL	SLAG
ID-2 W.C.	—	—	—	100	80-100	45-80	30-60	20-45	10-35	5-25	4-14	3-6	** 4.5-8.0	** 7.0-10.5
ID-2 B.C.	100	90-100	—	40-75	—	20-47	15-37	10-30	5-24	4-17	3-10	2-5	** 4.0-7.0	** 5.5-9.0
FJ-1 W.C.	—	—	—	—	100	90-100	60-100	40-80	20-60	10-40	7-25	3-15	6.0-12.0	
FJ-1C W.C.	—	—	—	—	100	80-100	60-80	40-60	20-40	10-35	7-25	3-15	6.0-12.0	
FJ-4 W.C.	—	—	—	—	100	90-100	60-100	40-80	20-60	10-40	7-25	3-15	6.0-12.0	
ID-3 W.C.	—	100	90-100	—	60-80	40-65	25-50	20-40	12-28	5-25	4-14	3-6	4.2-7.5	6.2-9.7
FB-2 W.C.	—	—	—	100	85-100	20-40	4-20	—	—	—	—	—	4.2*	5.7*
FB-2 B.C.	100	90-100	—	40-65	—	5-20	4-16	—	—	—	—	—	3.0*	3.5*
FB-1 W.C.	—	—	—	100	85-100	20-30	0-10	—	—	—	—	—	4.0*	5.7*
FB-1 B.C.	100	95-100	—	40-60	—	0-10	0-5	—	—	—	—	—	3.0*	3.5*

\*MINIMUM RESIDUE

\*\*AS PER DESIGN (BULLETIN 27)



If a reviewed master mix design is not on file, submit the proposed job-mix formula for review at least 3 weeks prior to scheduled start of work. Include test results, composition of mixtures, and combined aggregate gradation curves proposed for use in producing the required mix.

At the start of work, make a continuous series of bitumen content and gradation tests so actual production of the plant can be plotted and the job-mix formula verified.

If a change in sources of materials is made, submit a revised job-mix formula for review before using new material. When unsatisfactory results or other conditions make it necessary, a new job-mix formula may be required.

**2. Uniformity.** Perform tests for bitumen content and aggregate gradation, as required in the quality control plan, in accordance with PTM No. 1. If the water absorption (PTM No. 506) of a coarse aggregate used in the bituminous paving mixture exceeds 2.0%, determine the apparent moisture content in the mix by PTM No. 749 in accordance with the approved quality control plan. Perform more tests when directed by the Engineer. The apparent moisture content in the mixture is not to exceed 0.5%.

Printed tickets, from plants equipped with automatic weighing and data recording devices, may be used in place of the test for determining bitumen content of the completed mix. When using this method, request an evaluation of plant operation and the quality control program. Also, establish the print-out and batch controls are consistently operating within prescribed tolerances, in accordance with the applicable requirements of Bulletin 27. Maintain a bitumen content tolerance within  $\pm 0.2\%$  of the job-mix formula for at least 90% of the batches.

As a check, to retain job control on aggregate gradation, test at least daily or, as required in the quality control plan, either of the following:

- The completed mix, in accordance with PTM No. 702 and PTM No. 739, to determine if the reviewed job-mix formula is within tolerances set forth in Table B.
- Hot bin samples, in accordance with PTM No. 743, to determine if the reviewed job-mix formula is within tolerances set forth in Table C.

**TABLE B**  
**JOB-MIX TOLERANCE REQUIREMENTS OF COMPLETED MIX**

	Single Sample (n = 1)	Multiple Samples (n = 3 to n = 7)
Passing No. 4 and Larger Sieves	$\pm 8\%$	—
Passing No. 8 to No. 100 Sieves (Inclusive)	$\pm 6\%$	—
Passing No. 200 Sieve	$\pm 3.0\%$	$\pm 2.0\%$
Bitumen—		
Wearing	$\pm 0.7\%$	$\pm 0.4\%$
Binder	$\pm 0.8\%$	$\pm 0.5\%$
Temperature of Mixture	Within limits of the bituminous material supplier's Bill of Lading	

Send a copy of the bill of lading to the project from the plant, at the beginning of paving, and whenever a change in temperature range occurs.

**TABLE C**  
**JOB-MIX FORMULA TOLERANCES OF AGGREGATE**  
**PASSING SIEVES FOR COMBINED HOT BIN GRADATIONS**

Sieve Size	Percent	
	Wearing	Binder
1"	—	±5
1/2"	—	±13
3/8"	±6	—
#4	±8	±8
#8	±6	±6
#16	±5	±4
#30	±5	±3
#50	±4	±3
#100	±3	±3
#200	±3	±3

In addition to bitumen content tests and sieve analyses, test Marshall specimens, as required in the quality control plan. Make tests on samples of the completed mixture taken at the plant. Obtain each sample for testing, in accordance with PTM No. 1, with each test consisting of the average of three or more specimens prepared from the same sample and tested, in accordance with PTM No. 705.

Perform the test specified in PTM No. 740, daily until no problems are evident; then testing may be reduced to once a week. Base the percentage of unfilled voids on the maximum specific gravity of the mix. Provide the project with the running average of the last five consecutive values. Show this value on the density sample identification form submitted from the project. Use the maximum specific gravity value to calculate the theoretical density of the paving mixtures.

Control all operations in design, preparation, mixing, placement, and compaction of bituminous mixtures to comply with the following Marshall values when tested in accordance with PTM No. 705:

- Stability at 140F, not less than 1200 pounds for binder course and wearing course, unless otherwise specified,
- Flow value not less than 6 nor more than 16, and
- Percentage of unfilled voids not less than 3.0%, nor more than 5.0% for the reviewed job-mix formula for ID-2 wearing and binder courses and ID-3 wearing course. Voids in plant compacted Marshall specimens within ± 2% voids established in the reviewed job-mix formula, with a permissible range of tolerance not to exceed the master range of 2.0% to 6.0% voids.

Provide minimum percent VMA (Voids in Mineral Aggregate) for wearing course of 15.0 and binder course of 12.0. Determine VMA from the Marshall

specimen testing described above. VMA will be considered acceptable if 90 percent of the determinations per project meet the stated minimums.

Compact three additional Marshall specimens daily when approved steel slag, coarse or fine aggregates, is used in wearing courses. Determine average volume (PTM No. 715) and then immerse specimens in 160F, water bath for 48 hours. Cool specimens to ambient temperature, observe for cracks and/or pop outs, re-determine average volume. Test for Marshall stability and flow at 140F. Water-bath conditioned specimens are acceptable if:

- No cracks
- No pop-outs
- Increase in volume after conditioning not to exceed 1%
- Retained Marshall stability not less than 75%

**3. Acceptance of the Mixture.** Obtain material certification from the material producer. Send certification to the Inspector-in-Charge immediately following quality control tests for bitumen determination, sieve analysis, and Marshall test of mixture.

**3.a Scratch or Leveling Courses.** Scratch or leveling course material will be accepted by certification, as specified in Section 106.03(b)3. Certify, using a Department form. If, at any time during the course of work, any of these requirements are not being met, take necessary steps to bring the mix into compliance with the specified job-mix formula or stop operation. Any changes in the job-mix formula and material sources will require immediate review.

**3.b Binder and Wearing Courses.** Mixtures will be accepted by certification at the plant when not more than one test value deviates from the job-mix formula

The acceptance values will be:

- asphalt percent by weight,
- percent passing the No. 8 sieve,
- percent passing the No. 200 sieve,
- stability,
- flow, and
- voids.

If at any time during the course of the work the same test value deviates in consecutive tests, immediately make necessary changes in the materials and/or equipment to comply with the job-mix formula. If the material cannot be brought into compliance within 150 tons of production, suspend operations and notify the Inspector-in-Charge.

If the asphalt content (bitumen) or the percent passing the No. 200 sieve deviates from the tolerances specified in Table B, the affected area will be considered defective work and acceptance will be determined as specified in Section 401.3(p).

(e) **Bituminous Tack Coat.** Section 460.2

**401.3 CONSTRUCTION —**

(a) **Weather Limitations.** Do not place bituminous paving mixtures between October 31 and April 1, unless otherwise permitted in writing by the District Engineer. Do not place bituminous paving mixtures when surfaces are wet or when the temperature of either the air or the surface on which the mixture is to be placed is 40F or lower. When work is halted because of weather conditions, limited tonnage en route to the project may be placed, if permitted.

(b) **Bituminous Mixing Plant.** Obtain bituminous mixtures from a plant meeting the requirements of Chapter 1, Bulletin 27. Plant requirements are only guidelines for maintaining uniformity in the finished product.

Provide qualified plant technicians instructed and trained to perform all necessary tests and to control the plant operation so that the completed mixture complies with the specified requirements. The Department may assign personnel similarly instructed and trained to verify tests necessary to control, to accept the mixtures, and to work in close cooperation with the technicians.

(c) **Hauling Equipment.** Haul bituminous paving mixtures in tightly sealed vehicles free of petroleum oils, solvents, or other materials which adversely affect bituminous concrete. Provide adequate covers of sufficient size and quality to protect the entire load, under all conditions. Deliver mixture at correct laying temperature, free from lumps of chilled material. Provide proper insulation for the hauling vehicle when the air temperature is below 50F between October 1 and May 1. Dispatch vehicles so material delivered is placed and rolled during daylight hours, unless otherwise permitted.

(d) **Bituminous Pavers.** Use self-contained, power-propelled units, with activated screeds or strike-off assemblies, that produce a finished surface of required evenness and texture. Provide a unit that does not tear, shove, or gouge the mixture. Use a unit that is heated, if necessary, and capable of spreading and finishing bituminous plant mix material to widths and depths indicated. Use pavers capable of being operated at forward speeds consistent with satisfactory laying of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and with distribution systems that place the mixture uniformly in front of the screeds.

Hydraulic or other type extensions may be used against abutting lanes or longitudinal joints if the extensions are fed and activated by the same method as the main screed. On the outside edge of pavement, for pavement widths that cannot be uniformly placed, a nonactivated extension may be used.

Do not use equipment that causes tracks, leaves indented areas not corrected by later scheduled operations, produces flushing or other permanent blemishes, or fails to produce a satisfactory surface. Do not use blade graders or drags.

(e) **Rollers.** Use steel-wheel and pneumatic-tire rollers, as specified in Section 108.05(c)3.

(f) **Preparation of Existing Surface.**

1. **Conditioning of Existing Surface.** Remove and dispose of unsuitable material from the surface of existing pavement. Also remove and dispose of excess joint sealer and crack filler.

Prior to the arrival of the bituminous mixture, clean the base of loose and foreign materials.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with bituminous mixtures with a uniform coating of bituminous material, Class E-1, E-6, E-8, or of class and type designated for the bituminous course.

Prior to resurfacing existing wearing courses, apply a tack coat, as specified in Section 460.3, unless otherwise indicated. Also, apply a tack coat to the bituminous base or binder course when, in the opinion of the Engineer, the surface is not satisfactory for direct placement of paving.

2. **Scratch and Leveling Courses.** When indicated, place scratch or leveling courses separately, ahead of resurfacing operations. Use the scratch course to fill wheel ruts and other local, small depressions to the level of surrounding pavement. Use the leveling course to provide a relatively uniform working platform for placing binder or wearing course.

(g) **Spreading and Finishing.** Lay bituminous paving mixtures when the temperature is not more than 15F below the minimum temperature shown on the bituminous material supplier's bill of lading and when not exceeding the maximum specified temperature.

When unforeseen delays in paving are encountered, limited tonnage may be placed, if mixture temperature at the time is not more than 25F below the minimum indicated on the material supplier's bill of lading and if samples of the compacted pavement meet required density, as specified in Section 401.3(i)2.

Spread and strike off the mixture, using mechanical equipment for the entire lane width or as much lane as may be practical. Adjust screed assemblies to provide the required cross section and depth.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structure, place the wearing course mixture uniformly higher so, when compacted, it will be slightly above the edge of the abutting structure.

When wearing course is placed adjacent to curbs to form a bituminous gutter, seal with hot bituminous material of the class and type designated for the wearing course, extending to 12 inches from the curb, applied evenly. The use of Class E-1, E-6, or E-8 emulsified asphalt will be permitted in place of hot bituminous material. Prior to sealing, clean and free harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and

provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two applications. Remove excess bituminous material.

**(h) Compaction.** Compact by rolling to specified density. Roll the surface when the mixture is in proper condition and when rolling will not cause undue displacement, cracking, or shoving. Use suitable rollers, combination of rollers, and rolling patterns to provide required density, as needed for the characteristics of the surface to be covered. However, in the rolling operation, use a vibratory roller operated in vibrating mode or a pneumatic-tire roller. Continuously roll until the specified density is obtained and roller marks are eliminated. Unless otherwise directed, start rolling longitudinally at the sides and progress gradually toward the center of the pavement. On superelevated curves, begin rolling on the low side and progress to the high side, overlapping on successive trips by at least half the width of pneumatic-tire rollers and tandem rollers. Uniformly lap each preceding track or cover the entire surface with rear wheels when using three-wheel rollers. Operate rollers slowly enough to avoid displacement of hot mixture and satisfactorily correct displacement resulting from reversing roller directions or from other causes. When adjoining lanes are placed, follow the same rolling procedure but only after compaction of the fresh mix directly behind the paver at the longitudinal joint:

Finish rolling with a second vibratory roller in the static mode or with a tandem roller. In high production work, it may be necessary to use two or more vibratory rollers in place of a vibratory and tandem roller. On other than normal paving operations, such as ramps, driveways, intersections, or short length of pavement, or other similar areas, where crowded conditions exist, a single vibratory roller may be used. Use pneumatic rollers for scratch course.

Keep wheels of steel-wheel rollers moist and clean to prevent adhesion of fresh material, but do not use excess water. Keep pneumatic-tire roller wheels clean by suitable methods.

Immediately after placing the bituminous material, round or bevel the exposed outer edges to avoid a sharp, ragged, open, or unfinished appearance and to prevent edge breakdown. Immediately repair edge breakdowns.

Remedy irregularities in the binder course before placing the wearing course. If practical, do not permit traffic on the binder course. Satisfactorily clean and treat binder becoming coated with any foreign material, as specified in Section 401.3(f). If the binder course cannot be satisfactorily cleaned, remove and replace.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or otherwise defective, or that show an excess or deficiency of bituminous material. Replace with fresh hot mixture and compact to conform to the surrounding area.

**(i) Density Acceptance.**

**1. Scratch or Leveling Courses.** No density testing is required for scratch or leveling courses.

**2. Bituminous Concrete Base, Binder, and Wearing Courses.** For the daily placement of each material course, drill three 6-inch diameter cores from the compacted surface courses as directed and under the Inspector's supervision; as soon as possible but no later than the day following placement; for testing in accordance with PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. Do not compress, bend, or distort samples during cutting, handling, transporting, or storing. If damage occurs, obtain replacement samples immediately within 1 foot of the original sample location, as directed by the Inspector. Within 24 hours after drilling, backfill holes, resulting from sampling, with the same pavement course material, compact, and seal.

The Inspector will select sample locations in accordance with PTM No. 1 and PTM No. 729 as specified. Those areas outlined in PTM No. 729 (2 feet from an unsupported edge, 1 foot from a longitudinal paving joint, or 1 foot from the edge of obstructions to normal paving such as manhole covers and inlets) are considered nontestable areas. A lot consists of the daily placement of each material course. Each lot will be divided into 3 equal sublots. Sample locations for each material course will be selected independently. Identify the samples, deliver them to the Inspector immediately, and package them for submittal to the MTD for testing. The Inspector will handle samples in accordance with PTM No. 729, Section 7.3, and deliver them to the shipping point within 3 days. Furnish sample containers of sufficient strength to prevent cores from being damaged during transport. When possible, submit samples representing one lot in one container.

Acceptance, with respect to field density, will be determined in accordance with Table D.

Overlays less than 1 inch in thickness; shoulders, areas of pavement widening, or areas of base patching less than 4 feet in width or too narrow to prevent bridging of the compaction area by approved compaction equipment; and small quantities of material (material courses placed in quantities less than 50 tons per day or less than 250 tons per project) are waived from the coring requirement. Instead, acceptance will be determined based on the establishment of an optimum rolling pattern by a licensed nuclear gage operator, as witnessed by the Inspector, utilizing the following procedure:

- Use one of the following nuclear gages or approved equal:  
Troxler Electronics, Model 3411B  
Campbell Pacific Nuclear, Model MC-2  
Seaman Nuclear, Model C-200
- Use nuclear gage calibrated in accordance with AASHTO test method T 238-86. Submit certification of annual calibration of gages and documentation of licensed operator's training to the Inspector. Recalibrate any gage which is damaged and/or repaired.
- Use the control strip technique specified in PTM No. 402, Section 7.2.3, to determine the optimum rolling pattern for each material course. Record all counts, and plot the rolling pattern growth curve on Form TR 4276-B.

The Inspector will ensure the entire area is compacted in accordance with the established optimum rolling pattern.

**(j) Joints.**

**1. Longitudinal Joints.** Offset the longitudinal joint in one layer from the joint in the layer immediately below by approximately 6 inches. However, align the joint in the top layer at the approximate pavement centerline, if the roadway is two-lanes wide; or at approximate lane lines, if the roadway is more than two lanes wide.

Paint the edge of the lane with a very thin coating of bituminous material, Class E-1, E-6, E-8, or of class and type designated for the surface course, prior to placing abutting lanes. When the lane edge is distorted during the day's work, by traffic or other cause, carefully saw the edge of lane to line, as required, prior to painting.

Overlap material in abutting lanes against the vertical face of previously placed lanes. Operate the paver so that, in spreading, the material overlaps the edge of the lane previously placed by approximately 3 inches. To assure a true line, closely follow lines or makings placed for this purpose. Keep the depth of the uncompacted mixture being placed adjacent to a previously compacted lane uniformly high to provide for finished grade after compaction. Keep the depth of overlapped material uniform, so rolling will not result in an irregular, rough joint. Before rolling, carefully broom or lute the coarse aggregate in the material overlapping the joint onto the surface of the unrolled lane, leaving behind only the fine portion of the mixture. Tightly press this material into the compacted lane when the joint is rolled. Broom or lute immediately after the material has been spread by the paver. Immediately compact fresh mix directly behind the paver at the longitudinal joint.

When compacting the joint, shift the steel-wheel roller onto the previously placed lane so only 1 or 2 inches of the drive wheel extends over the uncompacted material. Continue to roll along this line, shifting position gradually across the joint until the joint has been rolled with the entire width of the drive wheel. If the vibratory roller is used for breakdown rolling, shift the roller on uncompacted material 1 or 2 inches across the joint onto the previously placed lane. Make the first pass in the vibratory mode. Roll with steel-wheel and pneumatic-tire rollers until a thoroughly compacted neat joint is obtained.

Where practical, leave only short lane sections, normally less than 25 feet in length, where the abutting lane is not placed the same day.

**2. Transverse Joints.** For wearing and binder courses, construct the paving notch and/or transverse joints on a 6:1 skew and compact to provide a smooth riding surface. For other courses, construct joints perpendicular. Joints may be sawed. Straightedge joints to assure smoothness. If a bulkhead is used, install it straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new material, locate the line of joint back of the rounded edge a sufficient distance and trim to provide a true surface and cross section. In either case, paint the joint face with a very thin coating of bituminous material, Class E-1, E-6, E-8, or of class and type designated for the surface, be-



fore placing fresh material against it. If required, cross roll to obtain thorough compaction of joints.

**3. Other Joints.** When wearing course is placed adjacent to existing pavement at locations such as paving notches, lane additions or utility openings, seal joint with hot, bituminous material of the class and type designated for the wearing course. Apply sealant evenly and extend 6 inches in both directions from joint. Class E-1, E-6 or E-8 emulsified asphalt will be permitted in lieu of hot bituminous material. Prior to sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, apply emulsified asphalt, in two applications. Remove excess bituminous material. Immediately cover with a light application of acceptable dry sand.

**(k) Surface Tolerance.** Test the finished surface with a 10-foot straightedge whenever the Engineer suspects an area is deficient or irregular. Use the straightedge at transverse joints and paving notches. Hold the straightedge in successive positions parallel to the road centerline, in contact with the surface, and check the whole area from one side to the other, as necessary. Advance along the pavement in stages of not more than one-half the length of the straightedge. Correct irregularities of more than  $\frac{3}{16}$ -inch. For irregularities which develop before completion of rolling, correct by loosening surface mixture and removing or adding material, as required. If irregularities or defects that cannot be corrected remain after final compaction, the affected area will be considered defective.

**(m) Tests for Depth: Binder and Wearing Courses.** Control the depth of courses by the weight per square yard, together with a correlation of loose and compacted depth checks. The Inspector will calculate the weight per square yard of each material course for verification of yield. On the basis of the following combined tests, adjust the quantity of material being placed:

- Immediately after the paver screed has struck off the course being constructed, make preliminary loose depth tests, as an aid for controlling depth, by inserting a measuring device through the material to the top of the lower course or base. Take one measurement or more, if directed, for each 200 square yards.
- At the start of the operation, make a minimum of three random depth checks through the compacted course being constructed to the top of the lower course or base, to correlate preliminary loose depth tests with required compacted depth. Additional tests may be required if any change in materials, equipment or operation, is made.

After final compaction, if directed, drill a series of three 6-inch diameter cores through the surface to the top of the base, for each 1,000 square yards of pavement or less. Drill the first series, one at the center and one near each edge; drill the second series, one at the center and one at each quarter point. Alternate the series and continue through the length of project.

The Inspector will measure the depth. Pavement more than 1/4-inch deficient in depth and which cannot be satisfactorily corrected, will be considered defective.

When tests show that the pavement is uniformly deficient by more than 1/8-inch depth in three or more adjoining sections and the deficiency cannot be satisfactorily corrected, the affected area will be considered defective work.

Backfill, compact, and seal test holes with acceptable material after depth measurements have been completed. Additional test holes may be required to determine the extent of the deficient areas.

Start the immediate correction of sections which are deficient in depth at the point of the determined deficiency and proceed longitudinally and transversely until the depth meets the requirements.

**(n) Protection of Courses.** Unless public safety or convenience is restricted, do not permit vehicular traffic or loads on the newly completed course until adequate stability and adhesion have been attained and the material has cooled to 140F or less.

Maintain the course, as specified in Sections 105.13, 107.15 and 901.

**(p) Defective Work.** Unless otherwise directed in writing by the District Engineer, remove and replace pavement deficient in surface tolerance as specified in Section 401.3(k) or Section 305.3(k), or deficient in depth as specified in Section 401.3(m) or Section 305.3(m). For pavement defective in asphalt content and/or percent passing the No. 200 sieve, as specified in Section 401.2(d)3.b, and/or field density, as specified in Section 401.3(i)2., the payment factor percentage from Table D will be applied.

**(q) Verification Samples.** Under the direction and supervision of the Inspector, obtain 3 verification samples of each type of material except scratch and leveling courses, consisting of loose material from the uncompacted mix directly behind the paver, for testing in accordance with PTM No. 702 to determine the percent bitumen and PTM No. 739 to determine the percent passing the No. 200 sieve. The Inspector will select sample locations in accordance with PTM No. 1 and PTM No. 746. Identify each sample by increment and material type, deliver to the Inspector immediately, and package for submittal to the MTD. The Inspector will deliver each sample to the shipping point within 3 days. Furnish cardboard boxes, sized approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches, for loose samples.

Verification samples and quality assurance samples obtained by the quality assurance teams from the Bureau of Construction and Materials will be used only to evaluate the status of the plant certification acceptance of the mixture. If samples meet Condition 1 of Table D, continued use of the plant certification for acceptance of the mixture will be permitted. When a sample meets either Condition 2 or Condition 3 of Table D, a statistical evaluation of plant production will be conducted by the Quality Assurance Support Unit of the Bureau of Construction and Materials for asphalt content and percent passing the No. 200 sieve. Unless the average ( $\bar{X}$ ) of the samples evaluated falls within the tolerances specified in Table B for multiple test samples and at least 90 percent within limits (PWL) is deter-

mined, submit loose box samples to the MTD immediately upon notification, at the same rate as density samples (3 per day per material type), for acceptance in lieu of plant certification, until otherwise directed. Fifteen consecutive lots (days) meeting Condition 1 of Table D are required before a return to plant certification will be allowed.

When plant certification is suspended, acceptance samples (3 per day per material type) will continue to be evaluated individually by the single sample tolerances ( $n=1$ ) specified in Table D. The payment factor percentage for daily acceptance will be based on the most variant sample.

(r) **Retesting.** A request may be made to the Department to retest the entire lot because of dissatisfaction with the test results. The retest will be performed by and at the MTD. Have a representative witness the retest. No retest for compaction will be provided for cores that have been coated with paraffin wax, in accordance with PTM No. 716. The analysis of both the original test values and the retest values will be performed in accordance with PTM No. 5.

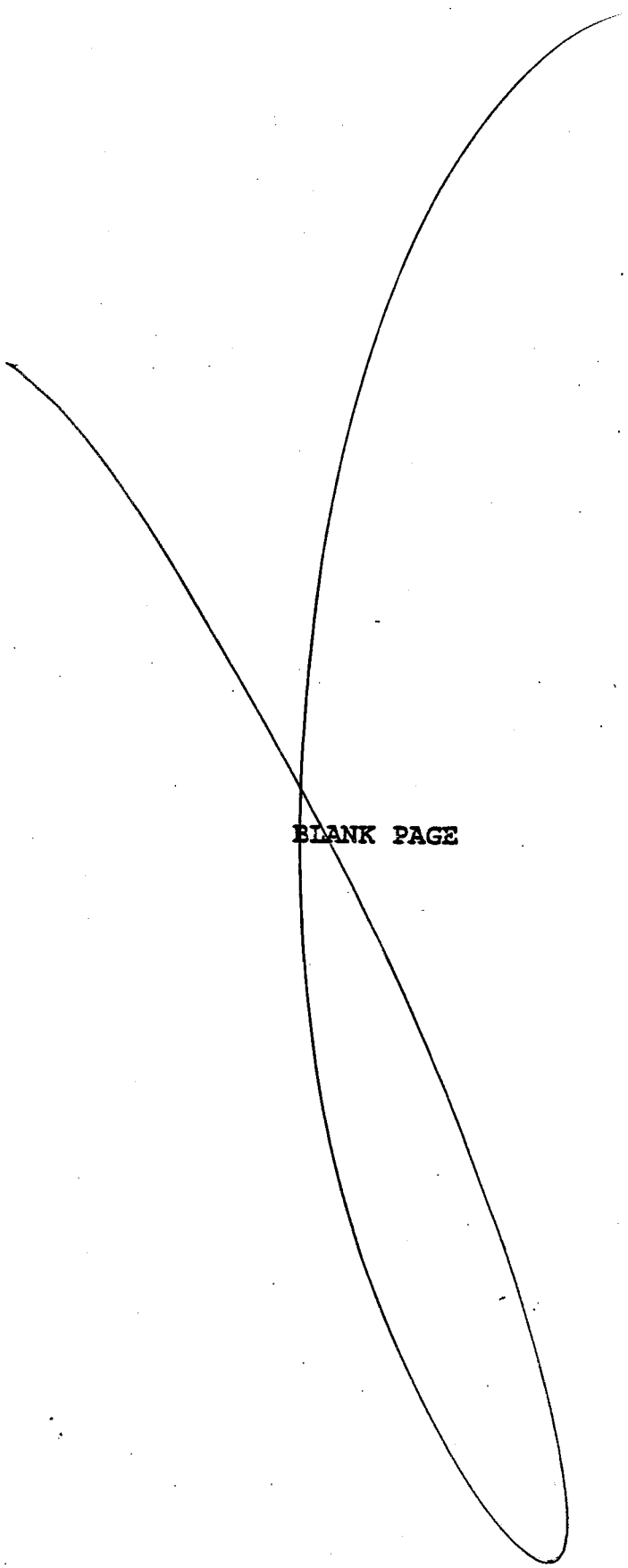
In the event of a retest, the entire lot will be based on the following test values:

- The original test values will be used if repetition is established.
- The retest values will be used if lack of repetition is established.

#### **401.4 MEASUREMENT AND PAYMENT —**

(a) **Plant-Mixed Bituminous Concrete Courses.** As specified in applicable sections.

(b) **Bituminous Tack Coat.** Square Yard or Gallon, as specified in Section 460.4.



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APPENDIX F  
SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS BINDER COURSE FB-1

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## SECTION 440 - BITUMINOUS BINDER COURSE FB-1

440.1 DESCRIPTION - This work is construction of a binder course of plant mixed bituminous concrete on a prepared surface.

440.2 MATERIAL - Section 439.2.

440.3 CONSTRUCTION - Section 439.3, except that the modifications to Section 401.3(k) specified in Section 439.3(k), do not apply.

440.4 MEASUREMENT AND PAYMENT -

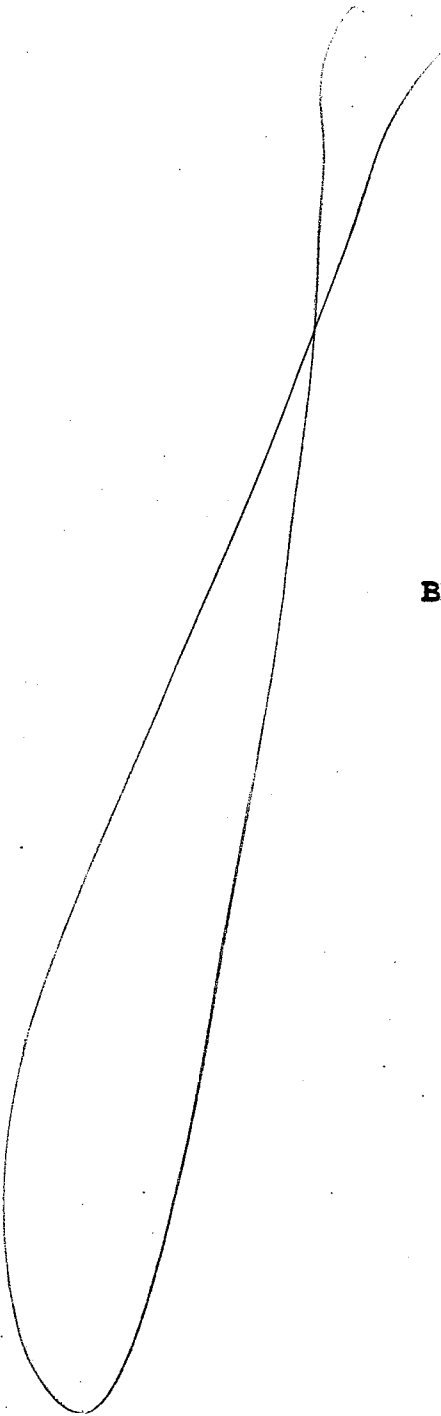
(a) Bituminous Binder Course FB-1.

1. Area Basis. Square Yard.
2. Weight Basis. Ton.
3. Material Used Basis.
  - 3.a Aggregate. Square Yard or Ton.
  - 3.b Bituminous Material. Gallon.

(b) Scratch Course.

1. Weight Basis. Ton.
2. Material Used Basis.
  - 2.a Aggregate. Ton.
  - 2.b Bituminous Material. Gallon.

(c) Leveling Course. Section 440.4(b).



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**APPENDIX G**

**SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS SEAL COAT**

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## SECTION 470 - BITUMINOUS SEAL COAT

**470.1 DESCRIPTION** - This work is an application of bituminous material, immediately followed by an application of coarse aggregate.

### 470.2 MATERIAL -

(a) **Bituminous Material.** One of the following as specified in Section 702:

<u>CLASS OF MATERIAL</u>	<u>TYPE OF MATERIAL</u>	<u>APPLICATION TEMPERATURE F</u>	
		<u>MINIMUM</u>	<u>MAXIMUM</u>
E-2	Emulsified Asphalt	140	175
E-3	Cationic Emulsified Asphalt	140	175
AC-2.5*	Asphalt Cement	240	300

\*AC-2.5 Asphalt Cement is approved for shoulder use only.

(b) **Coarse Aggregate.** Type A, No. 8 - Section 703.2. Having the SRL designation as indicated in the bid proposal and supplied from acceptable sources for use in wearing courses. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50% by weight and mixed by an approved method.

**470.3 CONSTRUCTION** - At least 2 weeks before beginning work, submit a seal coat design for review. Use the method in Appendix E of Bulletin 27 (Pennsylvania Design Method for Seal Coats and Surface Treatments). If source of gradation of aggregate or type of bitumen is changed, submit a new design.

(a) **Conditioning Existing Surface.** Prepare existing surface by removing and disposing of all fatty and unsuitable material. When specified, seal open cracks as specified in Section 469.

(b) **Application of Bituminous Material.** Do not apply bituminous material unless entire surface is in condition to permit satisfactory penetration and adhesion, and unless air, surface, and aggregate temperatures are 60F. Do not apply emulsified asphalt if, in the Engineer's opinion, rain is imminent or if freezing temperatures are expected within 24 hours after application. Also, do not apply from September 15 to May 1 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon and Schuylkill Counties only); and from October 1 to May 1 in Districts 6-0, 8-0, and 5-0 (Berks, Lehigh, Northampton Counties only).

Do not use wet aggregates. Damp aggregates may be used with emulsified asphalt.

Use a distributor as specified in Section 460.3(b). Apply bituminous material at a rate of 0.20 to 0.50 gallon per square yard. Use a rate of application within + or - 10% of the design rate. Determine the distributor application rate in the field in accordance with PTM No. 747.

For inaccessible areas, spread the bituminous material uniformly over the surface, using portable pressure units. Gage quantity of material placed at one time, according to facilities for handling, spreading, and rolling coarse aggregate, as well as the temperature of the surface and the bituminous material.

Insure uniformity at the junction of two applications.

**(c) Spreading and Rolling Coarse Aggregate.** Prior to spreading aggregate, calibrate the spreader using a method acceptable to the Inspector-in-Charge.

Determine the proper rate of application of coarse aggregate, in accordance with the design, and immediately following the application of bituminous material, use a mechanical spreader to uniformly spread 15 to 25 pounds of coarse aggregate per square yard, in a single layer.

Use a sufficient number of pneumatic-tire rollers, as specified in Section 108.05(c)3.f, to cover the width of stone spread during the first pass. Use a contact pressure of 40-50 psi.

**(d) Protection of Surface.** Do not allow vehicular traffic or loads on the newly completed surface until adequate stability and adhesion has been attained and the material is sufficiently cured to prevent distortion, flushing of bituminous material to surface, or loss of aggregate.

Provide sufficient flaggers and/or pilot vehicles to move traffic through the work zone or over the completed work so as to limit traffic speeds and aggregate distortion or pick-up. If directed, sweep the surface with a power broom, removing loose chips before and after the road is opened to traffic.

#### **470.4 MEASUREMENT AND PAYMENT -**

**(a) Area Basis. Square Yard.**

**(b) Material Used Basis.**

**1. Coarse Aggregate. Square Yard.**

**2. Bituminous Material. Gallon.**

**(c) Crack Filling and Sealing. Section 469.4.**

**APPENDIX H**

**SPECIFICATION REQUIREMENTS FOR  
RECYCLED PLANT-MIXED BITUMINOUS  
CONCRETE COURSES**

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## **SECTION 403 - RECYCLED PLANT-MIXED BITUMINOUS CONCRETE COURSES**

**403.1 DESCRIPTION** - This work is the construction of Bituminous Wearing Course ID-2, Bituminous Binder Course ID-2, or Bituminous Concrete Base Course using a combination of virgin and/or reclaimed aggregate material (RAM), and reclaimed asphalt pavement (RAP) materials. Use at least 11 percent of RAP material consisting of cold milled or crushed hot-mix bituminous mixture. Construct these recycled courses, as specified in Sections 401, 402, 420, 421 and 305 of the Specifications, except as modified or supplemented as follows. Obtain guidelines for hot mix recycling from the MTD, if needed.

### **403.2 MATERIAL -**

**(a) Bituminous Materials.** After evaluation by the MTD of the asphalt cement in the pavement core and/or RAP material, the MTD will determine the class (grade) of asphalt cement and/or recycling agent to be used.

**(b) Reclaimed Asphalt Pavement (RAP) Material.** Include a description of the plan to control RAP in the quality control plan. Keep all processed material free of foreign materials. Minimize segregation. Process the RAP material needed so that the final mix complies with Section 401.2(d), Table A. Process any RAP material that cannot be readily broken down in the mixing process and/or affects the paving operation prior to mixing with the virgin materials (at least 95% passing through a 2-inch sieve).

**(c) Reclaimed Aggregate Material (RAM).** If used, have the RAM meet the applicable quality requirements of Section 703.2, Table B.

**(d) Composition of Mixtures.** As required by Section 401 and as follows, the recycled bituminous mixture consists of the RAP material, virgin aggregate(s), RAM, and asphalt cement. For recycled Bituminous Wearing Course ID-2, provide aggregate and RAP meeting the specified SRL requirements. Analyze the mix composition (asphalt content and gradation) of the RAP material stockpile. Obtain at least 10 samples from the stockpile at different locations and extract them to determine the average RAP mix composition. Determine the average stock gradations of virgin aggregate(s) and/or RAM to be blended with the RAP material. Determine the proportions of the reclaimed and virgin materials to meet the mix composition requirements of Section 420 for Bituminous Wearing Course ID-2, Section 421 for Bituminous Binder Course ID-2, and Section 305 for Bituminous Concrete Base Course. Also substitute Table 1 for Table B.

TABLE 1

JOB-MIX FORMULA TOLERANCE REQUIREMENTS ON COMPLETED MIX

	<u>SINGLE TEST</u>	<u>AVERAGE OF 3 TO 5 TESTS</u>
Passing No. 4 And larger Sieves	<u>+ 10%</u>	<u>+ 6%</u>
Passing No. 8 To 100 Sieves (Inclusive)	<u>+ 7%</u>	<u>+ 4%</u>
Passing No. 200 Sieve	<u>+ 3.0%</u>	<u>+ 2.0%</u>
Bitumen - Wearing Binder	<u>+ 0.7%</u> <u>+ 0.8%</u>	<u>+ 0.4%</u> <u>+ 0.5%</u>
Temperature Of Mixture	260 TO 300 F	---

Furnish the mixed material within the master ranges specified in Table A, Section 305 for Bituminous Concrete Base Course, except that the percent bitumen will be maintained with the tolerance for Binder in Table I above.

403.3 CONSTRUCTION -

(a) Bituminous Mixing Plant. In accordance with Section 401.3 or 305.3 and as follows:

1. Batch Plant. Modify the batch plant to allow weighing the reclaimed asphalt pavement (RAP) material prior to incorporation into the pug mill. Design the cold feed bin, conveyor system and the special bin adjacent to the weigh box, if used, to avoid segregation and sticking of the RAP material. Dry the virgin aggregate and/or RAM and heat to a suitable temperature so that on combining with the RAP material at ambient temperature the resulting mix temperature is within 260-300F. Insure that the virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

2. Drum Mixer Plant. Modify the drum mixer plant to prevent direct contact of the RAP material with the burner flame and/or overheating of the RAP material in the process.

(b) Density Acceptance.

1. Conventional Specifications. Section 401.3(i) or Section 305.3(i).



**2. Restricted Performance Specifications.** Obtain acceptance samples in accordance with Section 402.3(s) except only Type II (6-inch diameter cores) samples will be obtained and tested at the MTD.

Partially completed lots and retesting will be in accordance with Sections 402.3(t) and 401.3(r) respectively, for pavement cores.

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APPENDIX I  
SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS TACK COAT

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## SECTION 460 - BITUMINOUS TACK COAT

**460.1 DESCRIPTION** - This work is the conditioning and treating of an existing surface with an application of bituminous bonding material.

### 460.2 MATERIAL -

(a) **Bituminous Material.** One of the following, as specified in Section 702:

<u>CLASS OF MATERIAL</u>	<u>TYPE OF MATERIAL</u>	<u>APPLICATION TEMPERATURE F</u>	
		<u>MINIMUM</u>	<u>MAXIMUM</u>
E-6	Emulsified Asphalt	70	150
E-8	Emulsified Asphalt	70	150

(b) **Fine Aggregate (For Blotting).** Section 703.1.

### 460.3 CONSTRUCTION -

(a) **Conditioning Existing Surface.** Section 401.3(f). Bituminous painting of existing surfaces is not required.

(b) **Application of Bituminous Material.** Use a distributor designed, equipped, calibrated, maintained, and operated so material may be applied uniformly, on variable widths of surface up to 15 feet, at readily determined and controlled rates, as specified, capable of uniform distributing pressure, and with an allowable variation from any specified rate not exceeding 0.02 gallon per square yard. Provide a distributor equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars adjustable laterally and vertically. Determine the distributor application rate in the field, in accordance with PTM No. 747. Small area inaccessible to the distributor may be applied with hand-spraying equipment.

Dilute the emulsified asphalt with equal parts of compatible water (50:50 blend). Apply diluted emulsified asphalt, at a rate approved by the Engineer, to leave a uniform asphalt residue from 0.02 to 0.07 gallon per square yard on the treated surface, as directed. Avoid targeting application for maximum rate. Submit a certificate to the Engineer indicating the dilution ratio and asphalt residue content in the material being used.

Apply the tack coat only when the air temperature is 40F and rising. Do not apply after sunset, to a wet surface, or during wet weather.

Insure uniformity at the junction of two applications.

Satisfactorily correct all uncoated or lightly coated areas. As directed, correct all areas showing an excess of bituminous material, by covering with sufficient dry fine aggregate to blot up or remove excess tack coat.

Following application and prior to succeeding construction, allow the tack coat to cure, without being disturbed, until the water has completely separated and evaporated, as determined by the Inspector-in-Charge.

**(c) Protection of Treated Surface.** Maintain and protect the treated surface against damage. Satisfactorily repair damaged areas prior to placing succeeding construction.

#### **460.4 MEASUREMENT AND PAYMENT -**

**(a) Area Basis.** Square Yard.

**(b) Material Used Basis.** Gallon.

**APPENDIX J**

**SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS WEARING COURSE FB-2**

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**SECTION 430 - BITUMINOUS WEARING  
COURSE FB-2**

**430.1 DESCRIPTION** - This work is construction of a wearing course of plant-mixed bituminous concrete on a prepared surface.

**430.2 MATERIAL** - Section 401.2, and as follows:

(a) **Bituminous Material.** One of the following, at the mixing temperatures shown:

<u>CLASS OF MATERIAL</u>	<u>TYPE OF MATERIAL</u>	<u>MIXING TEMPERATURE, F</u>	
		<u>MINIMUM</u>	<u>MAXIMUM</u>
AC-20	Asphalt Cement	240	300
AC-10	Asphalt Cement	240	300
AC-5	Asphalt Cement	240	300
AC-2.5	Asphalt Cement	240	300
E-4	Emulsified Asphalt	100	160
E-5	Cationic Emulsified Asphalt	100	160
E-6	Emulsified Asphalt	70	150
E-11	Emulsified Asphalt	140	175

(b) **Aggregate.**

\* Fine Aggregate - Section 703.1.

\* Coarse Aggregate, Type A - Section 703.2.

(d) **Composition of Mixtures.** Add the following:

When asphalt cement is used, provide a completed bituminous mixture range from 200F to 250F.

**430.3 CONSTRUCTION** - Section 401.3, except as follows:

(b) **Bituminous Mixing Plant.**

1. **Plant Requirements.** Equipment for developing the design and control tests, in accordance with the Department's modified Marshall method, is not required.

**2. Preparation of Mixture.** Thoroughly coat the aggregate with bituminous material, forming a film of sufficient thickness to provide the required binding properties. Add to the mixture 6% to 12%, by weight, of fine aggregate, within the range directed. Use dry-heated coarse aggregate with asphalt cement.

Dry the aggregate, as necessary, when using other bituminous materials, prior to mixing at a temperature not exceeding 110F. Damp aggregate may be used with emulsified asphalt. Heat the bituminous material to the temperatures specified in Section 430.2(a). Mixing-time requirements and requirements for determining the percentage of the aggregate coated, specified in Chapter 1, Bulletin 27, do not apply. Instead, add the required quantities of aggregate and bituminous material to the mixer. Then, unless otherwise specified, mix the material to obtain a uniform coating of particles and a thorough distribution of bituminous material.

**(f) Preparation of Existing Surface.** Tack coat requirements apply only when designated in the contract.

**(g) Spreading and Finishing.** When spreading with emulsified asphalt, do not strip asphalt from the aggregate. Do not place the wearing course until the binder course is satisfactorily cured and in no case within 24 hours after placing the binder course. When using asphalt cement, the 24-hour requirement is waived.

**(h) Compaction.** After the course has been spread uniformly, allow the mixture to cure, as specified in Section 430.3(g) or until the surface becomes tacky. Compact with a power roller until the mixture is compressed to a firm, even surface. Intermediate rolling with a pneumatic-tire roller is not required.

**(i) Density Acceptance.** Density acceptance will be determined based on non-movement of material under compaction equipment.

#### **430.4 MEASUREMENT AND PAYMENT -**

**(a) Bituminous Wearing Course FB-2.** Square Yard or Ton.

**(b) Scratch Course.** Ton.

**(c) Leveling Course.** Ton.

APPENDIX K

SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS PRIME COAT

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## SECTION 461 - BITUMINOUS PRIME COAT

**461.1 DESCRIPTION** - This work is the conditioning and treating of an absorbent, non-bituminous base course or absorbent existing surface, with an application of bituminous material and, if required, a blotter material.

### 461.2 MATERIAL -

(a) **Bituminous Material.** One of the following, as specified in Section 702:

<u>CLASS OF MATERIAL</u>	<u>TYPE OF MATERIAL</u>	<u>APPLICATION TEMPERATURE F</u>	
		<u>MINIMUM</u>	<u>MAXIMUM</u>
MC-30	Cut-back Petroleum Asphalt	70	120
MC-70	Cut-back Petroleum Asphalt	100	150

(b) **Fine Aggregate (for Blotting).** Section 703.1.

### 461.3 CONSTRUCTION -

(a) **Conditioning Existing Surface.** Section 401.3(f).  
Bituminous painting of existing surfaces and the application of a tack coat are not required.

(b) **Application of Bituminous Material.** Use a distributor, as specified in Section 460.3(b). Apply at a rate of 0.20 to 0.50 gallon per square yard, within specified temperature range.

Insure uniformity at the junction of two applications.

Following application, do not disturb the prime coat. Allow the bituminous material to penetrate, and be absorbed by, the treated surface, until the bituminous material is completely cured, as determined by the Inspector-in-Charge.

Satisfactorily correct uncoated or lightly coated areas with an application of additional bituminous material.

Twenty-four hours after the application of bituminous material, for areas showing an excess of such material, cover with sufficient dry fine aggregate to blot up or remove excess prime coat material, as directed.

(c) **Protection of Treated Surface.** Maintain and protect treated surface against damage. Satisfactorily repair damaged areas before placing succeeding construction.

### 461.4 MEASUREMENT AND PAYMENT - Square Yard.



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APPENDIX L  
SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS SURFACE TREATMENT

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## **SECTION 480 - BITUMINOUS SURFACE TREATMENT**

**480.1 DESCRIPTION** - This work is two applications of bituminous material, each immediately followed by an application of coarse aggregate.

### **480.2 MATERIAL -**

**(a) Bituminous Material.** Section 470.2(a).

**(b) Coarse Aggregate.** Type A, No. 8 and No. 67, Section 703.2. Having the SRL designation as indicated in the bid proposal and supplied from acceptable sources for use in wearing courses. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50% by weight and mixed by an approved method.

**480.3 CONSTRUCTION** - At least two weeks before beginning work, submit a surface treatment design for review. Use the method in Appendix E of Bulletin 27 (Pennsylvania Design Method for Seal Coats and Surface Treatments).

**(a) Conditioning Existing Surface.** Section 470.3(a).

**(b) Application of Bituminous Material and Coarse Aggregate.** Section 470.3(b), except apply at the rates and place in the sequence, as-follows:

#### **FIRST APPLICATION**

Apply bituminous material at a rate of 0.25 to 0.50 gallon per square yard. Use a mechanical spreader and spread 25 to 45 pounds of No. 67 coarse aggregate per square yard, then roll thoroughly to set the aggregate. Sweep off loose material.

#### **SECOND APPLICATION**

Apply bituminous material at a rate of 0.25 to 0.50 gallon per square yard. Use a mechanical spreader and spread 15 to 30 pounds of No. 8 coarse aggregate per square yard, then roll thoroughly to set the aggregate. Do not apply the second application until bituminous material in the first application is sufficiently cured.

**(c) Rolling.** Use sufficient pneumatic-tire rollers, as specified in Section 108.05(c)3.f, with contact pressure of 40-50 psi, to cover the width of stone spread during the first pass. Allow the surface to cure until it becomes tacky, then backroll with a pneumatic-tire roller or steel-wheel tandem roller until good adhesion is attained. If directed, eliminate back rolling. Rolling in the vibratory mode will not be permitted.

(d) Protection of Surface. Section 470.3(d).

480.4 MEASUREMENT AND PAYMENT -

(a) Area Basis. Square Yard.

(b) Material Used Basis.

1. Coarse Aggregate. Square Yard.

2. Bituminous Material. Gallon.

(c) Crack Filling and Sealing. Section 469.4.

**APPENDIX M**

**SPECIFICATION REQUIREMENTS FOR  
BITUMINOUS SEAL COAT**

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# SECTION 470 - BITUMINOUS SEAL COAT

**470.1 DESCRIPTION** - This work is an application of bituminous material, immediately followed by an application of coarse aggregate.

**470.2 MATERIAL -**

(a) **Bituminous Material.** One of the following as specified in Section 702:

<u>CLASS OF MATERIAL</u>	<u>TYPE OF MATERIAL</u>	<u>APPLICATION TEMPERATURE F</u>	
		<u>MINIMUM</u>	<u>MAXIMUM</u>
E-2	Emulsified Asphalt	140	175
E-3	Cationic Emulsified Asphalt	140	175
AC-2.5*	Asphalt Cement	240	300

\*AC-2.5 Asphalt Cement is approved for shoulder use only.

(b) **Coarse Aggregate.** Type A, No. 8 - Section 703.2. Having the SRL designation as indicated in the bid proposal and supplied from acceptable sources for use in wearing courses. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50% by weight and mixed by an approved method.

**470.3 CONSTRUCTION** - At least 2 weeks before beginning work, submit a seal coat design for review. Use the method in Appendix E of Bulletin 27 (Pennsylvania Design Method for Seal Coats and Surface Treatments). If source of gradation of aggregate or type of bitumen is changed, submit a new design.

(a) **Conditioning Existing Surface.** Prepare existing surface by removing and disposing of all fatty and unsuitable material. When specified, seal open cracks as specified in Section 469.

(b) **Application of Bituminous Material.** Do not apply bituminous material unless entire surface is in condition to permit satisfactory penetration and adhesion, and unless air, surface, and aggregate temperatures are 60F. Do not apply emulsified asphalt if, in the Engineer's opinion, rain is imminent or if freezing temperatures are expected within 24 hours after application. Also, do not apply from September 15 to May 1 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon and Schuylkill Counties only); and from October 1 to May 1 in Districts 6-0, 8-0, and 5-0 (Berks, Lehigh, Northampton Counties only).

Do not use wet aggregates. Damp aggregates may be used with emulsified asphalt.

Use a distributor as specified in Section 460.3(b). Apply bituminous material at a rate of 0.20 to 0.50 gallon per square yard. Use a rate of application within + or - 10% of the design rate. Determine the distributor application rate in the field in accordance with PTM No. 747.

For inaccessible areas, spread the bituminous material uniformly over the surface, using portable pressure units. Gage quantity of material placed at one time, according to facilities for handling, spreading, and rolling coarse aggregate, as well as the temperature of the surface and the bituminous material.

Insure uniformity at the junction of two applications.

**(c) Spreading and Rolling Coarse Aggregate.** Prior to spreading aggregate, calibrate the spreader using a method acceptable to the Inspector-in-Charge.

Determine the proper rate of application of coarse aggregate, in accordance with the design, and immediately following the application of bituminous material, use a mechanical spreader to uniformly spread 15 to 25 pounds of coarse aggregate per square yard, in a single layer.

Use a sufficient number of pneumatic-tire rollers, as specified in Section 108.05(c)3.f, to cover the width of stone spread during the first pass. Use a contact pressure of 40-50 psi.

**(d) Protection of Surface.** Do not allow vehicular traffic or loads on the newly completed surface until adequate stability and adhesion has been attained and the material is sufficiently cured to prevent distortion, flushing of bituminous material to surface, or loss of aggregate.

Provide sufficient flaggers and/or pilot vehicles to move traffic through the work zone or over the completed work so as to limit traffic speeds and aggregate distortion or pick-up. If directed, sweep the surface with a power broom, removing loose chips before and after the road is opened to traffic.

#### **470.4 MEASUREMENT AND PAYMENT -**

**(a) Area Basis.** Square Yard.

**(b) Material Used Basis.**

1. **Coarse Aggregate.** Square Yard.

2. **Bituminous Material.** Gallon.

**(c) Crack Filling and Sealing.** Section 469.4.

**APPENDIX O**

**SPECIFICATION REQUIREMENTS FOR  
COLD RECYCLED BITUMINOUS BASE COURSE**

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## SECTION 341 - COLD RECYCLED BITUMINOUS BASE COURSE

**341.1 DESCRIPTION** - This work is the construction of a cold recycled bituminous base course, using reclaimed asphalt pavement (RAP) material and/or reclaimed aggregate material (RAM) combined with virgin aggregates and/or bituminous material.

Do not place cold recycled bituminous base course from September 1 to April 15 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon and Schuylkill Counties only); and from September 15 to April 15 in Districts 6-0, 8-0, and 5-0 (Berks, Lehigh and Northampton Counties only).

### 341.2 MATERIAL -

(a) **Reclaimed Material.** Ninety-five percent of the material is required to pass through a 2-inch sieve.

1. **Reclaimed Aggregate Material.** Aggregate Material which has been removed, hereinafter called (RAM).

2. **Reclaimed Asphalt Pavement.** Processed paving material containing bitumen and aggregates, hereinafter called (RAP).

(b) **Bituminous Material.** Add to the mix the type and quantity of bituminous material as determined by the Engineer. Use bituminous material conforming to the applicable requirements of Bulletin 25. Use one of the following:

\* **Emulsified Asphalt - E-4, E-5, E-6 and E-8**

\* **Asphalt Cement - AC-2.5**

(c) **Aggregate.** Section 703.2, Nos. 8, 57, and 67 (Type A); No. 2A (Type C or better). Add the gradation and quantity to the mix as required and/or directed.

(d) **Testing.** Supply representative samples of the RAP material or 6-inch diameter pavement cores, bituminous materials, and virgin aggregate to the MTD for preliminary testing to determine the optimum moisture content, type of bituminous material, and mix proportions. Obtain guidelines on sampling procedures from the MTD.

(e) **Mixture.** Combine the reclaimed material, aggregates, and bitumen, meeting the requirements specified, in such proportions that the total aggregate and bitumen in the base course conform to the composition accepted by the Engineer. Make field

adjustments to the MTD recommended moisture content and mix proportions, under the guidance of the Engineer, to obtain a satisfactory recycled mixture.

**(f) Stockpiling.** In the event the reclaimed material is stockpiled, store the material in an acceptable manner so as to preserve its quality and suitability.

### **341.3 CONSTRUCTION -**

**(a) Equipment.** Use any equipment which will produce the completed base course and as follows:

1. Use only mechanical mixers, travel mixers, or central mix plants for mixing the base course materials.
2. Use equipment capable of automatically metering liquids with a variation of not more than plus or minus 0.5% from the specified percentage.
3. Maintain all equipment in a satisfactory operating condition as specified in Section 108.05(c).

**(b) Mixing.** Maintain a proper moisture content to assure thorough mixing of the reclaimed material and aggregate with the emulsified asphalt and AC-2.5 asphalt cement. Determine the total moisture content in the field using PTM No. 503. Perform at least 3 tests during each day's operation.

**1. Central Plant Mixing.** For central plant mixing, mix the materials in an acceptable continuous flow or batch-type mixer equipped with batching or metering devices designed to measure the specified quantities of the respective materials. Continue mixing until a thorough and uniform mixture is obtained without stripping of the bituminous material.

Transport the mixture from central mix plants in clean, tight vehicles. Deposit the mix on the prepared area by means of acceptable mechanical spreaders in a uniform loose condition for the full depth of layer being placed. Protective covers for the vehicles may be required by the Engineer.

**2. In-Place Mixing.** For in-place mixing, spread the required quantity of reclaimed material, and aggregate if required, on the prepared area in a uniform loose layer to obtain the specified compacted depth. Adjust the travel speed and/ or the number of passes of the mixer to obtain a thorough and uniform mixture.

If a continuous milling - mixing and placement operation is used, insure that positive discharge pumps accurately meter the bituminous material and the cutting drum of the milling machine mixes it thoroughly with the RAP materials.

**3. Mobile Mixing Plant.** Use a mobile plant equipped to mix, spread, and strike-off the surface; having the capacity to assure a constant supply and proper proportioning of materials; capable of mixing the materials until a uniform coating of the particles and a thorough distribution of the bituminous material throughout is secured; and having a positive-driven feed to proportion the material from the bins and a positive pump to proportion the bituminous material from the tank. Synchronize the feeder and pump to discharge materials in the desired proportions for mixing. Calibrate the plant prior to actual use.

**(c) Compaction.** Construct the base course in approximately equal depth layers. Provide a compacted layer depth of not less than 3 inches nor more than 5 inches. After each course has been uniformly spread, allow that course to cure as necessary prior to rolling. Roll with rollers meeting the requirements of Section 108.05(c).

Commence rolling at the low side of the course; except, leave 3 to 6 inches from any unsupported edge or edges unrolled initially to prevent distortion. Determine in-place density requirements for each course by the construction of at least one control strip for each course under the guidance of a nuclear gauge operator. After each pass of the compaction equipment, take a nuclear density reading following PTM No. 402. Continue compaction with each piece of equipment until no appreciable increase in density is obtained by additional passes. Upon completion of compaction, a minimum of 10 tests will be made at random locations to determine the average in-place density of the control strip. Compact each layer or course of the recycled mixture to a target density of at least 96 percent of the average control strip density. The in place density of each compacted course will be determined in accordance with PTM No. 402.

**(d) Finishing.** Complete the finishing operation during daylight hours.

**(e) Protection.** Protect any finished portion of the base course upon which construction equipment is required to travel to prevent marring, distortion, or damage of any kind.

Immediately and satisfactorily correct any such damage.

**(f) Surface Tolerance.** Test the surface smoothness transversely with acceptable templates and longitudinally with straightedges in accordance with the requirements of Section 401.3(k). Satisfactorily correct any surface irregularity that exceeds 1/2-inch under a template or straightedge.

**(g) Tests for Depth of Finished Base Course.** As directed, cut or drill holes to the full depth of the completed base course. One depth measurement will be made for each 3,000 square yards, or less, of completed base course. Remove and satisfactorily replace any section deficient 1/2-inch or more from the specified depth at no expense to the Department.

Start the immediate correction of sections of base course which are deficient in depth at the point of the determined deficiency and proceed longitudinally and transversely until the base course is found to meet specifications.

Cut or drill all test holes, backfill with similar and/or acceptable material, and satisfactorily compact at no expense to the Department. This operation will be under the supervision of the Engineer who will check the depth for record purposes.

**(h) Maintenance and Traffic.** Maintain the completed base course and control traffic as specified in Section 401.3(n). Use a pilot car for speed control if damage to the completed base course, such as ravening, is likely to occur.

**(i) Curing.** Allow the recycled base course to cure for at least one week before placing the wearing course.

#### **341.4 MEASUREMENT AND PAYMENT -**

**(a) Cold Recycled Bituminous Base Course.** Square Yard.

**(b) Aggregate.** Ton.

**(c) Bituminous Material.** Gallon.