

COLD RECYCLING OF ASPHALT PAVEMENTS

Interim Report
Transportation Research Project No. 90

by

Alan Meadors
Materials and Research Division
Arkansas State Highway and Transportation Department

In cooperation with the
U.S. Department of Transportation
Federal Highway Administration

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Arkansas



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The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the Arkansas State Highway and Transportation Department or the Federal Highway Administration.

Introduction

A commonly used method in rehabilitating badly rutted and deteriorated asphalt pavement is milling the old surface before overlay. This method reduces the need for "level up" courses and can be particularly useful in urban areas where curbs and overpasses restrict the overall thickness of the pavement section. The Arkansas State Highway and Transportation Department (AHTD) has purchased two milling machines for this purpose. The pavement millings produced from this rehabilitation technique are often used as patching and shoulder material.

The objective of this project is to evaluate the use of this material in a recycled mix. The recycled mix is limited in composition to pavement millings, water, and a modifier or emulsion. The processing of material is also limited to methods not employing state-of-the-art or specialized equipment.

This report is limited to the design, construction and evaluation of an emulsion recycling mix placed in September, 1986. The tests methods used and modifications employed to allow satisfactory completion of the project are described. Field observations of the performance are also included.

Project Initiation and Design

Test Site Selection

The research project subcommittee began searching for a possible site for a field trial of emulsion recycling soon after it was decided that this first project should utilize material from an existing stockpile. Mr. Ray Woodruff, District 1 Engineer, located a test site in his district for this first field trial. The stockpile of pavement millings for this project was located at the junction of State Highway 42 and Interstate 55 in Crittenden County. The size of the stockpile was estimated at approximately 1900 cubic yards. The overlay site was located on the west frontage road along I-55 approximately 2 miles north of the stockpile. The site is approximately 3200 feet in length with very light traffic. The location of this project is shown in Figure 1.

Project Development

There were several options available to the subcommittee for constructing a recycled test site for this project. These alternatives were:

1. Let a contract to pulverize the stockpile, mix the material, and place it on the roadway.
2. Purchase a traveling pugmill capable of producing the mix needed.
3. Rent a pugmill for use in this project.
4. Let a contract for a portion of the work.

Several equipment companies and manufacturers were contacted to determine the cost of purchasing and/or renting a pugmill for use. It was found that a traveling pugmill suitable for this type of recycling may cost from \$100,000 to \$200,000. A used traveling pugmill was found at a local equipment company

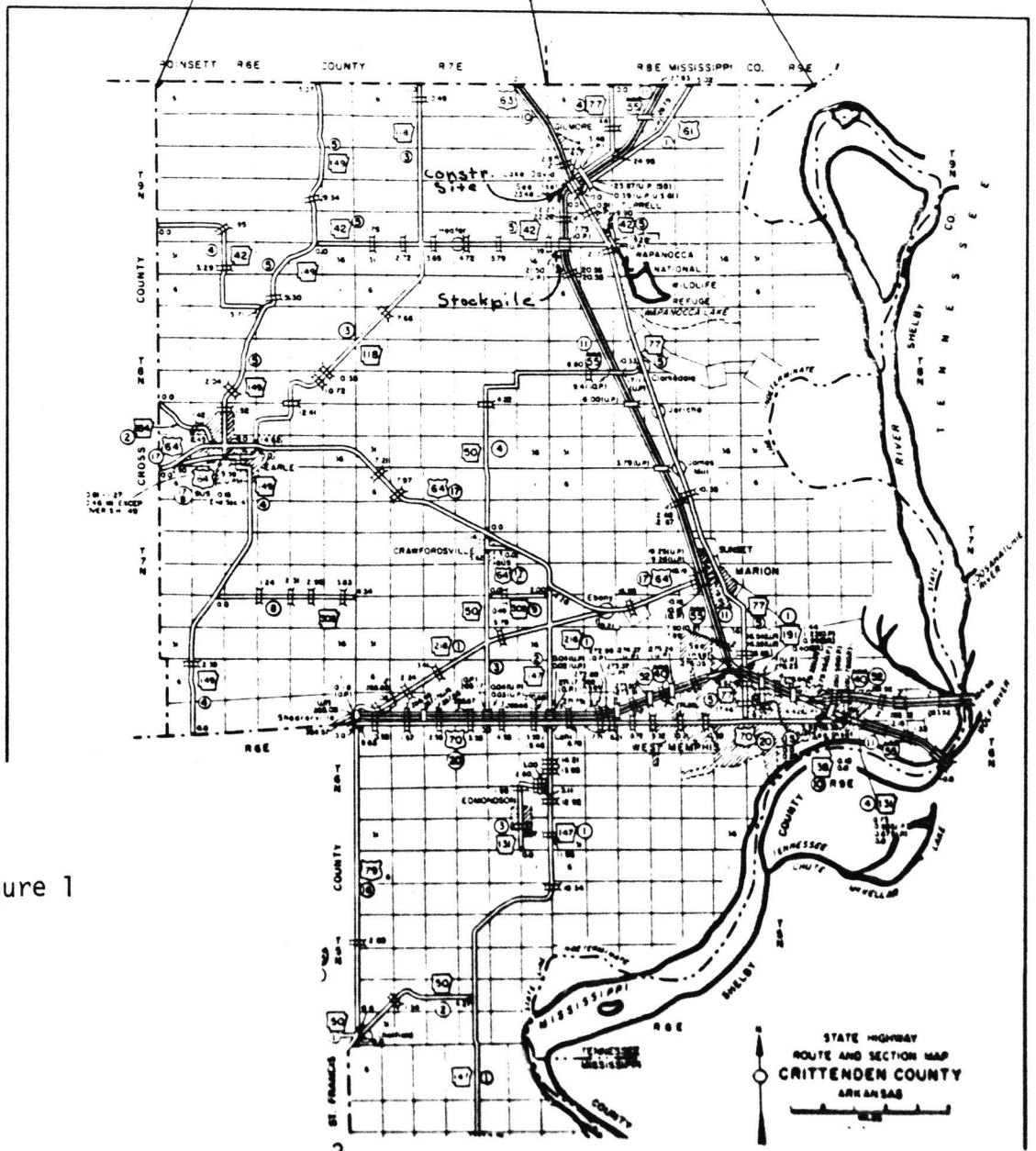
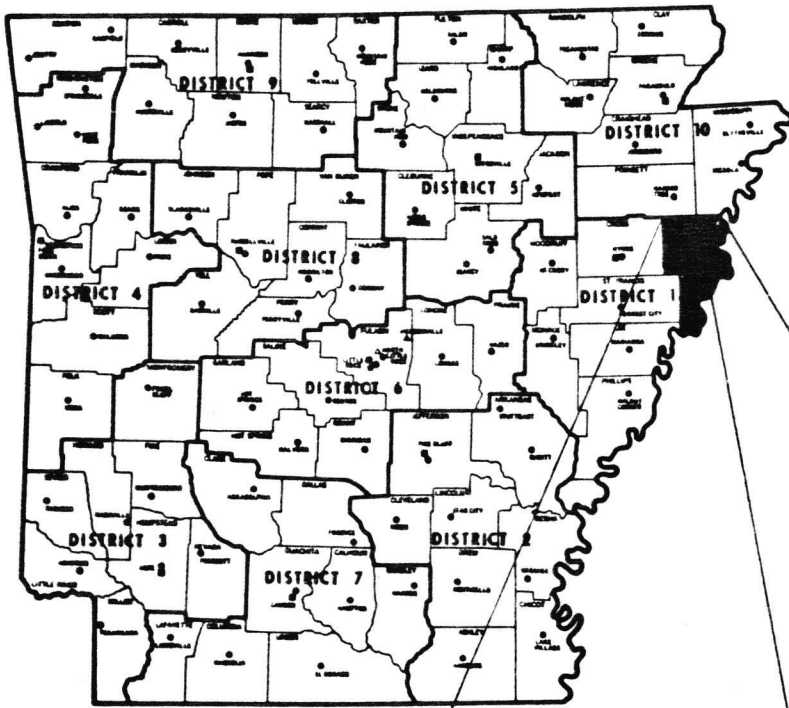


Figure 1

that could be purchased for \$55,000. This same used pugmill could be rented for approximately \$20,000. No other companies were interested in renting a pugmill.

Since the cost of renting and/or purchasing the equipment was termed excessive for a research project, it was decided to pursue the contract option. To minimize the cost, the contractor's portion of work was reduced to pulverizing the stockpile, mixing water and emulsion to the pavement milling and discharging into the dump trucks. The hauling, placing and compacting was left for state maintenance forces. An invitation for bid and specification was released in August and the bid was awarded September 2, 1986. A copy of the bid and specification is included in Appendix A.

Design and Specifications

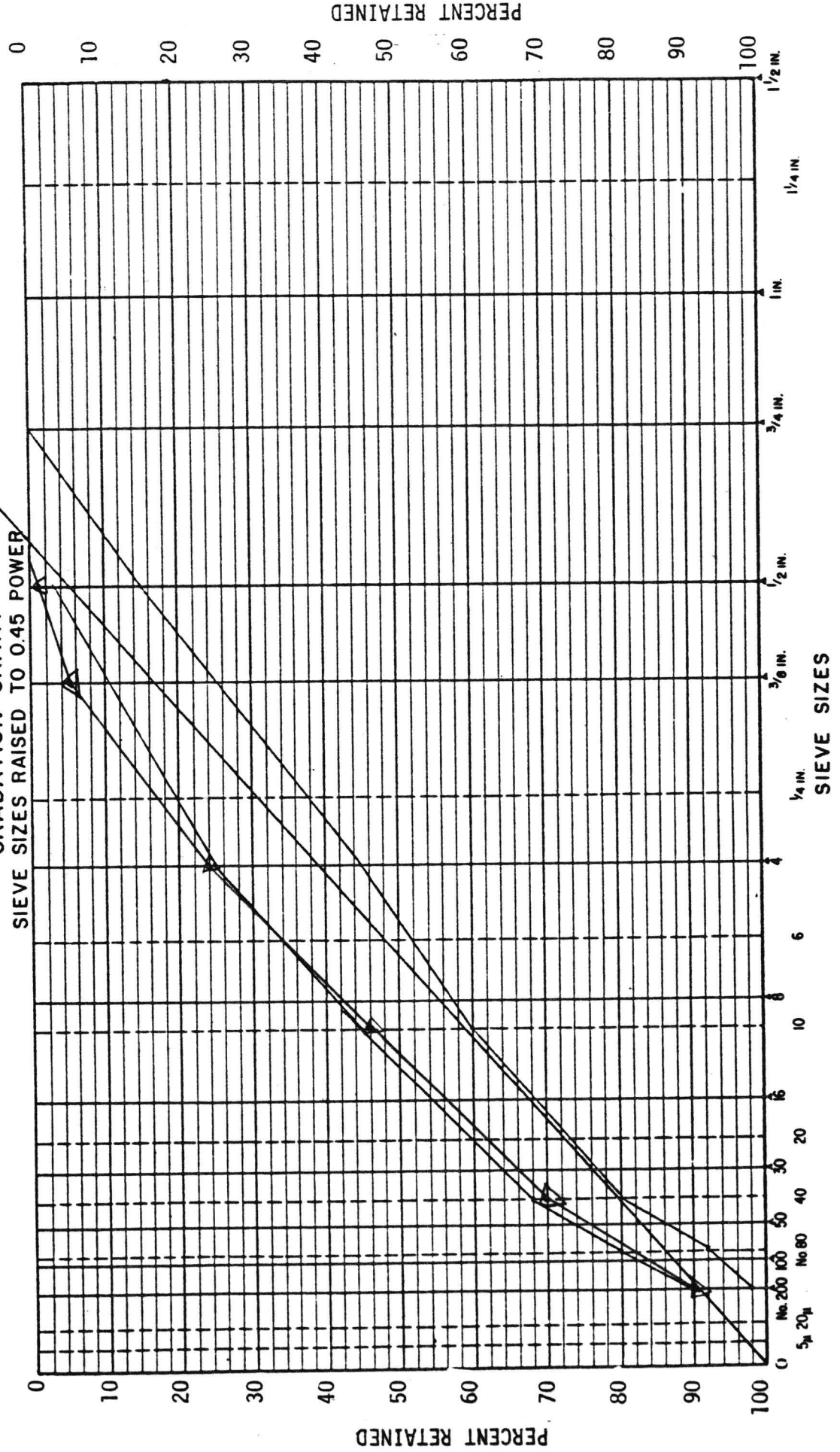
Samples of the stockpile were secured and taken to the central laboratory for analysis. The samples were found to contain less than 1% moisture and approximately 5.7% asphalt content. The gradation analysis of the aggregate showed it to be finer than the AHTD's normal surface course but maintains a fairly uniform gradation distribution. The gradation of the material is shown in Figure 2.

A mix design in the asphalt laboratory was attempted. All trials resulted in unsatisfactory results. In general, differences of as much as $\frac{1}{2}\%$ asphalt could not be detected in design. Therefore, another method of determining asphalt content using gradation, surface area, and film thickness was investigated. From this analysis it was found that the maximum asphalt content was 7.0%. This gave a maximum of 1.3% asphalt that could be added to the material.

Since a preliminary review of the literature showed that, in general, maximum compaction can be obtained in a cold recycled mixture if the total

GRADATION CHART

SIEVE SIZES RAISED TO 0.45 POWER



Identification of gradations: \triangle — Gradation of Stockpile
ACHMSC - Type Z 50 BLOW MARSHALL

Figure 2

liquid content (asphalt and water) is maintained between 5% and 7% of the weight of the recycled material. A design was approved calling for an emulsion content range from 1% to 1½% by weight of the total mix and the water added to range from 3% to 4%.

The specification for this project was written to allow some modification as experience is gained on this research project while establishing some minimum acceptable standards. A minimum degree of pulverization was specified to insure that less than 5% of the material mixed with the emulsion and water is less than 2 inches in diameter. A minimum production rate of 75 tons/hour was specified to give an adequate rate for the maintenance personnel hauling and placing the material. A seasonal limitation was added prohibiting this work after September 30 or when the air temperature is below 75°. This was added to give the pavement some summer like weather to allow evaporation of the excess water that was used to aid in compaction.

Construction

The contractor moved his equipment onto the job site on September 9, 1986. The contractor immediately had considerable problems pulverizing the stockpile with a front end loader into small enough particles to pass through a 2 inch scalping screen. The contractor worked on pulverizing the stockpile all day on September 10th. At the end of the second day District maintenance trucks were employed to make some trial batches for calibration purposes. Samples of pulverized millings from the stockpile were tested for moisture and asphalt content. These samples showed that as much as 5% moisture existed in portions of the stockpile while the asphalt content was found to vary between 4.8 and 5.4 percent of the mix. Since the moisture and asphalt content varied widely, it was decided to allow field adjustments outside the specification limits originally prescribed.

The first day of production and placement of the cold recycling mix was Thursday, September 11th. The production was steady during the morning hours. Maintenance crews placed a 3 inch lift of the material starting in the northbound lane. Several clumps that refused to break up during mixing caused tearing the mat during placement. Therefore, much raking and spreading was required behind the screed.

The first 1000 feet placed consisted of 1% CMS emulsion and 1% extra water. The job foreman suggested that the emulsion content be increased to 2% to aid in workability. Therefore, the contractor doubled his emulsion content and shut off the free water to maintain the target liquid content. The weather during the morning hours reached the mid eighties and was sunny. This seemed to help in obtaining a better looking job. However, after lunch

it clouded up and rained on the job site. Therefore, work was suspended until Monday since State Maintenance forces do not work on Fridays. This suspension of work worked out well with the contractor since the amount of pulverized material was almost nonexistent when work was suspended. The contractor worked during the weekend to pulverize the stockpile into a finer gradation. Work was scheduled to start on Monday, September 15th. However, problems with the pugmill forced suspension of this day's activities.

On Tuesday, September 16, work proceeded at a good pace. Segregation was noticed on the roadway and was traced back to the discharging of the pugmill into the trucks. The forward momentum of the mix from the mixing paddles seemed to sling the larger clumps of material to the far side of the truck bed. This was confirmed by reversing the direction of the trucks during loading. This reversal switched the segregation from one side of the mat to the other. Later the same day, a further increase in emulsion content was tried. Approximately 3% emulsion was used. No problems were encountered that could be traced to the increase in emulsion content. The mix was not observed to be particularly rich or tender during placement and compaction.

The construction of the cold recycled pavement was completed on Wednesday, September 17th. No construction problems were noted. Some of the previous day's run was compacted with the newly placed pavement. Even though there was a good bit of warm weather during construction, the moisture in the mix used to aid compaction did not seem to readily evaporate. The first day's run still seemed a little tender one week after construction. However, the light traffic on the road had not rutted or shoved the pavement during this time and seemed to be holding up well. Photographs showing the construction are found in the Appendix B.

Pavement Performance

The performance of the pavement was monitored periodically throughout the fall and winter by District and Research personnel. The performance of the recycled mix is adequate to date. However, very little traffic exists on this roadway. Traffic has increased lately with construction activity in the area. Therefore, the performance will be monitored closely over the next few months. The site may be sealed if the pavement shows any signs of increased distress.

Conclusions and Recommendations

Since the cold recycled pavement is only 5 months old no definite conclusions can be drawn. However, this project has demonstrated that pavement millings can be pulverized, mixed, and placed on the roadway with little or no specialized equipment. There are some construction problems that have been realized during this project that must be overcome to insure optimum performance. These problems include:

1. The stockpile should be processed thoroughly to insure adequate breakup of material.
2. The pugmill should be modified to stop segregation when discharging into the trucks.
3. Preliminary testing should be increased to insure that limits of the variability of stockpiled millings are known.

The following recommendations are given based upon the experience gained from the first cold recycling project:

1. The age of the stockpile should be a consideration when selecting possible sites. It is believed that a fresh stockpile would not cause the pulverization problems that the test project did.
2. Any emulsion recycling work should be flexible enough in mix design to allow field modification as long as the maximum asphalt content and total liquid content is not exceeded.
3. Future test sites should be constructed during the heat of July and August. It is believed that the free water could be evaporated quicker and compaction would be easier during hot weather.

APPENDIX A

INVITATION, BID AND AWARD

BID/JOB No.

DATE:

F.O.B. As designated below

By: M. D. Head

Item No.	DESCRIPTION	Quantity	Unit	Unit Price	Amount
1.	<p style="text-align: center;">Emulsion Recycling</p> <p>Deliver and setup a pugmill capable of mixing a minimum of 75 tons of material per hour with the CMS-2 emulsion and water needed to accomplish the mixing. The percentage of emulsion required for mixing will range from 1% to 1.5% by weight of the total mix. Likewise, the percentage of water required will range from 3% to 4% by weight of the total mix.</p> <p>The emulsion, water and pugmill shall be delivered to the mixing site of the job located near the stockpile of asphalt pavement millings at the southwest quadrant of the I-55-Hwy 42 Interchange in Crittenden County.</p> <p>The successful bidder will be required to begin within 10 days after notice to begin from the District Engineer and complete within 15 working days after project has begun.</p>	6000	gal.		

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB

EMULSION RECYCLING

DESCRIPTION: This item shall consist of supplying the equipment and materials necessary to produce a recycled mixture utilizing stockpiled asphalt pavement millings in accordance with these specifications.

MATERIALS: The emulsion used in recycling for this project shall meet all the requirements for CMS-2 emulsion given in Section 403 of the Standard Specifications for Highway Construction, Edition of 1978.

Water supplied to aid in mixing shall conform to the provisions set forth in Section 802 of the Standard Specifications.

EQUIPMENT: The pugmill shall be capable of adequately mixing the recycled asphalt pavement millings with water and emulsion and maintain a production rate of 75 tons/hour.

The pugmill shall be equipped with a scalping screen to insure that no more than 5% of the recycled pavement millings introduced into the mixer is larger than 2 inches in diameter.

The pugmill shall also be equipped with a dispensing system capable of adding a prescribed amount of both water and emulsion to the mixer prior to or during mixing.

A storage container with sufficient capacity to supply the required amount of water to the pugmill for one complete working day shall be supplied.

CONSTRUCTION METHODS: The pugmill shall be set up at the job site in such a manner that the mixer can be charged and dosed, and material discharged into trucks in an efficient manner. The Contractor will be responsible for the calibration, operation, and maintenance of the pugmill and dispensing system. The Contractor shall also be responsible for charging the pugmill using the stockpile of recycled asphalt pavement millings furnished at the job site. The stockpile shall be processed by the Contractor before charging the pugmill to insure that the material is relatively free of large clumps that may overload the scalping screen and affect the production rate. The Contractor will also be responsible for insuring that an adequate amount of water is available for mixing at the start of each working day.

SEASONAL LIMITATIONS: No emulsion recycling will be permitted after September 30 nor when ambient air temperature is less than 75° except by written permission of the District Engineer.

METHOD OF MEASUREMENT: Material recycled in accordance with these specifications will be measured by the gallon as provided in Section 109 of the Standard Specifications.

BASIS OF PAYMENT: Work performed and accepted under this item will be paid for as follows:

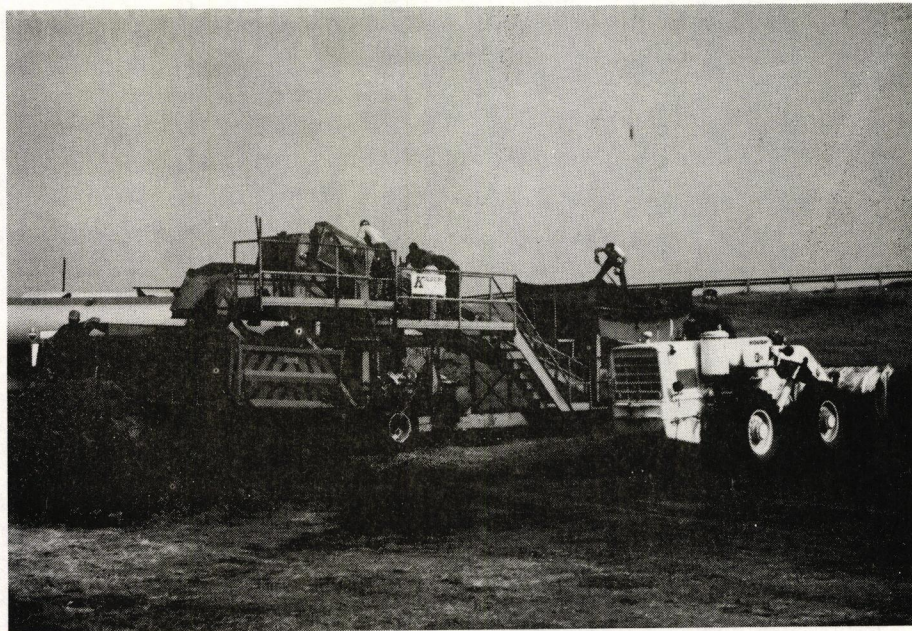
<u>Pay Item</u>	<u>Pay Unit</u>
Emulsion Recycling	gallons

APPENDIX B

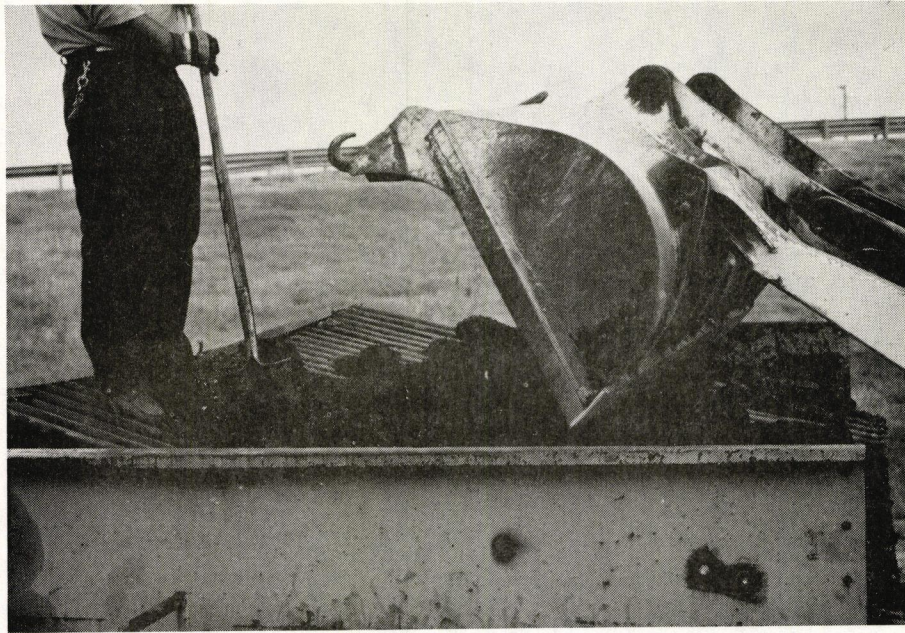
PHOTOGRAPHS



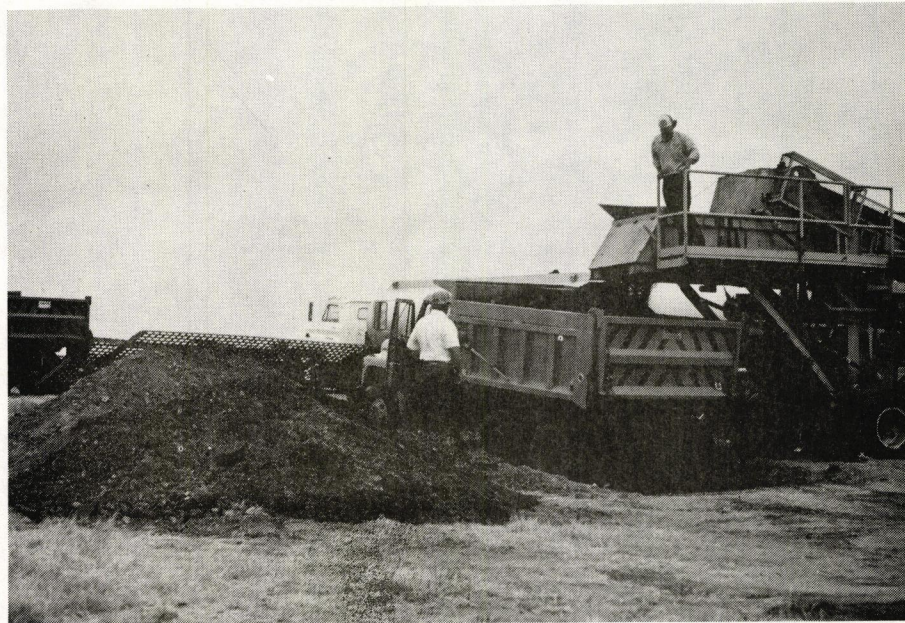
The pavement millings were stockpiled several years ago and had consolidated into one hard mass. The contractor used a track backhoe to shell off the material and a front end loader to charge the hopper.



The traveling pugmill was equipped with a charging hopper and rigged to dose water on the mix at the belt and dose emulsion at the entrance of the mix into the pugmill. The tanks in the background contain emulsion and water.



At first large clumps of material hampered charging of the hopper. The contractor increased his efforts to pulverize the material with some success.



Calibration of the pugmill was accomplished by relating the weight of material through the pugmill with belt speed and time.



Field adjustments were made in the amount of water and emulsion added as necessary due to stockpile variability.



Large clumps in the mix caused some tearing in the mat. Constant hand raking was required to repair the mat.



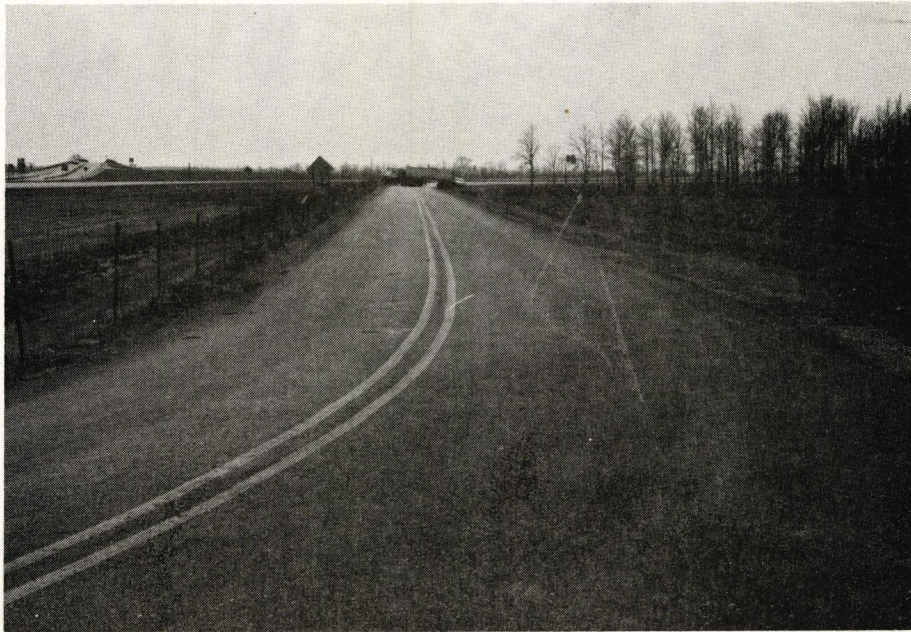
Samples of the mix were taken in the field to monitor moisture content and asphalt content.



The freshly rolled mat seemed fairly tight with only a few segregated spots showing.



Construction directly off the frontage road has caused truck traffic to increase substantially.



The truck seen backing into the side road in the top photo caused the damage shown below by turning his steering axle while stationary.

