EXPERIMENTAL USE OF HOT RECYCLED ASPHALT PAVEMENT ON VERMONT RTE 15

Interim Report 85-4
March 1985

Follow-up To Initial Report 82-3

Reporting On
Category II Work Plan 81-B&R-11
Essex-Jericho-Underhill FR 030-1(11)

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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16. Abstract

An 11.7 mile portion of Vermont Rte 15 in Essex-Jericho-Underhill was paved with a leveling and surface course of recycled bituminous concrete pavement. Nearly 18,000 tons of the mix containing up to 35 percent reclaimed pavement material was produced in a standard batch plant using the heat transfer method. Modifications to the plant were limited to a flowboy-elevator feed system which was wired into the plant's automated scales and controls. The use of the reclaimed bituminous concrete pavement did not significantly reduce the production capability of the 6 ton batch plant or cause problems in producing specification material.

Savings in natural resources obtained with the use of the recycled mix included 4796 tons of new aggregate and 330 tons of asphalt cement.

Savings in energy totaled 86,370 BTU/ton of 30% recycled mix and 112,590 BTU/ton of 35% recycled mix with energy savings for the project totaling 1,536,483,610 BTU.

Field observations made through 40 months of service reveal that the recycled mix has resisted the development of new or reflective cracks and the formation of ruts better than the standard mix. The recycled mix has also maintained higher friction values and has not experienced surface bleeding which has been recorded on the standard mix.

Based upon the performance of the experimental project to date, the use of hot recycling should be encouraged whenever practical on future paving contracts.

17. Key Words	18. Distribution Statement
Recycled bituminous concrete, standard batch plant, heat transfer method, natural resources, energy savings, reflective cracks, ruts, friction values, bleeding.	No restrictions

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EXPERIMENTAL USE OF HOT RECYCLED ASPHALT PAVEMENT ON VERMONT RTE 15

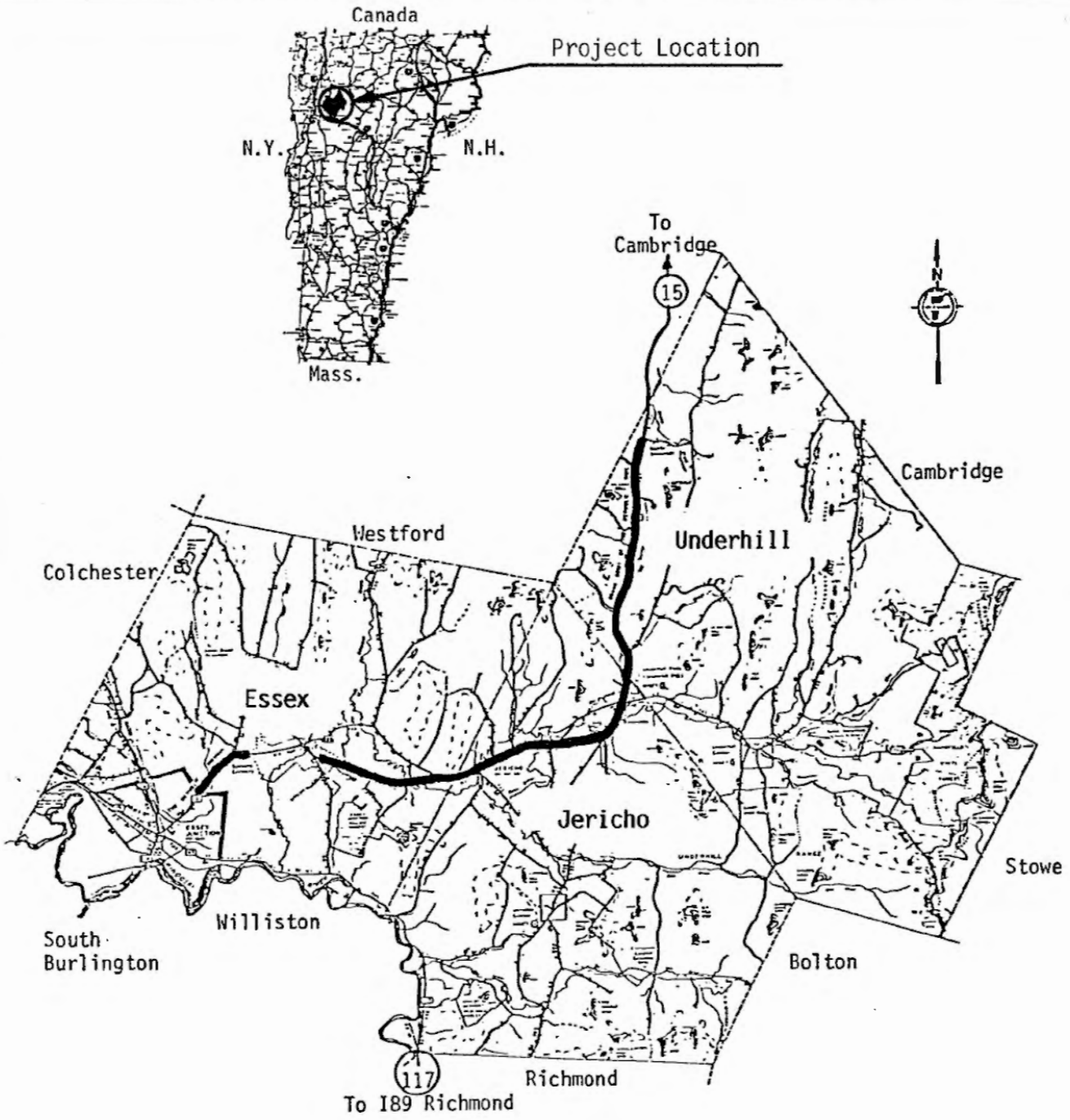
INTRODUCTION

In July, 1981, an 11.7 mile portion of Vermont Rte 15 in Essex-Jericho-Underhill was paved with a leveling and surface course of recycled bituminous concrete pavement. Nearly 18,000 tons of the mix containing up to 35 percent reclaimed pavement material was produced in a standard batch plant using the heat transfer method. Modifications to the plant were limited to the addition of a flowboy-elevator feed system which was wired into the plant's automated scales and controls. The use of the reclaimed bituminous concrete pavement did not significantly reduce the production capability of the 6 ton batch plant or cause problems in producing specification material. Production of the recycled mix did not significantly reduce air quality at the plant site. Penetration values of the recycled mix were considered satisfactory without adding a rejuvenating agent or specifying a higher penetration grade of asphalt. The recycled mix did not present any problems with placement although it was somewhat stiffer than virgin mix making handwork more difficult. Heating requirements for plant production were the same for the recycled and standard mixes averaging 1.58 gallons of No. 4 fuel oil per ton of mix. The use of reclaimed material reduced the quantity of asphalt and new aggregate required thus resulting in energy savings of 86,370 BTU per ton of 30 percent recycled mix and 112,590 BTU per ton of 35 percent recycled mix.

Energy savings for the project totaled 1,536,483,610 BTU. The use of reclaimed pavement in the mix resulted in the conservation of 3063 tons of coarse aggregate, 1733 tons of fine aggregate and 330 tons of asphalt cement. The experiences gained on this project suggest that the bid prices will result in cost savings to the State on future hot recycle contracts.

The entire project has been visually observed twice each year since construction. Observations and tests have concentrated on reflective cracking, pavement rutting, bleeding, distress, riding quality, friction values and maintenance requirements during the reporting period. Detailed recordings have generally been confined to test sections paved with the standard and recycled mix in adjacent lanes. Such areas include test sections 7, 8 and 9 plus an area extending six tenths of a mile easterly from test section number 8.

This report discusses the condition and performance of the recycled and standard mixes through 40 months of service. For detailed information on the construction phase of the experimental project, refer to Initial Report 82-3 published in February, 1982.



PROJECT LOCATION - VT RTE 15 IN CHITTENDEN COUNTY

CLIMATOLOGICAL AND TRAFFIC CONDITIONS

Weather conditions during the 40 month period of exposure have generally fallen within the norm for the geographical area. Namely, a freezing index of 1186, 74 freeze-thaw cycles and 73 inches of snowfall. Frost penetration within the roadway cross section is believed to have reached the 50 to 60 inch depth. The highest air temperatures reached the mid 90's while pavement surface temperatures would have been expected to reach the 130°F range.

The average daily traffic volume on the project varied with the proximity to the greater Burlington urban area. The volume on the westerly portion in Essex ranged from 9213 vehicles in 1981 to 13,030 vehicles in 1984. The traffic on the area east of Underhill began with 2274 in 1981 and increased to a maximum of 3360 vehicles in 1984. The area of Essex and Jericho where the test sections have been closely monitored has varied from 6032 vehicles in 1981 to a high of 8180 vehicles in 1984. Total vehicle passes average 4.2 million per lane on the test sections. Truck traffic was estimated at eight percent on the section east of Underhill Village and five percent at all other locations.

PROJECT CONDITION AND PERFORMANCE

Reflective Cracking

Nearly all full width transverse cracks reflected through both the recycled and standard mix during the first winter season. Reflection of short transverse cracks and the more prevalent longitudinal cracks have been slow to occur. Presently, only four percent of the original cracks have reflected up through the recycled material and 22 percent reflection has occurred in the standard pavement.

A performance breakdown can be seen in the following table.

Type Mix	*Test Section No. and Lane	Original LF of Cracks	% Reflective Cracking 1/82	10/83	10/84
Recycled	7 WB	89	13	13	13
	8 EB	333	4	4	4
	9 WB	167	0	0	0
Standard	7 EB	128	9	13	22
	8 WB	309	6	11	18
	9 EB	107	0	34	35

*Test sections are 150 feet in length by 12 feet in width.

Pavement Rutting

In general, pavement wheel path rutting has been insignificant on both the recycled and standard mix to date. The average readings for individual test sections are the same except for test section 8 where rutting is 1/16 inch greater on the standard mix. When all readings taken in October 1984 are considered, the rut values on the standard mix exceed those recorded on

the recycled mix by an average of 1/16 inch. A summary of the values can be seen in the following table:

Type Mix	Test Section No. and Lane	Rutting Measurement in Inches: Original Range	Average Orig. Value	10/81	10/83	10/84
Recycled	7 WB	1/16 - 6/16	4/16	1/16	2/16	2/16
	8 EB	2/16 - 20/16	8/16	1/16	2/16	2/16
	9 WB	3/16 - 10/16	7/16	1/16	3/16	3/16
Standard	7 EB	1/16 - 5/16	3/16	1/16	2/16	2/16
	8 WB	3/16 - 18/16	7/16	2/16	3/16	3/16
	9 EB	3/16 - 7/16	5/16	2/16	3/16	3/16

Riding Quality

The riding quality of the pavement has been monitored with a Mays Ride Meter. The surface tolerance in inches of roughness per mile was excellent following construction and has remained good through the evaluation period. There are no significant differences in roughness between areas paved with recycled or standard mix. The project averages and values for a 0.6 mile test section can be seen in the following table:

Test Section	10/81	10/82	10/83	10/84
Eastbound Lane	15	25	30	46
Westbound Lane	18	26	29	48
Recycled-Essex MM6.80 - 7.40EB	-	-	40	47
Standard-Essex MM6.80 - 7.40WB	-	-	32	53

Friction Values

Pavement friction values have been obtained using a locked wheel friction trailer. The measurements have been taken in the left wheel path at a speed of 40 miles per hour. As shown in the following table, the recycled mix has provided slightly higher friction values throughout the project life.

Test Section	Average Friction Value 10/81	10/82	10/83	10/84
Project Average	37.2	-	-	41.9
Recycled - Essex MM6.80 - 7.40 EB	-	38.0	35.3	40.1
Standard - Essex MM6.80 - 7.40 WB	-	36.1	33.6	35.9

Pavement Bleeding

Pavement surface bleeding was observed in the standard mix on test sections 7, 8 and 9. Bleeding was not noted in the recycled mix in the adjacent lane. The bleeding, noted as individual spots in both left and right wheelpaths, totaled approximately 75 linear feet within the 450 feet of test area. The level of bleeding appears to be on the increase since the condition was not noted during the 1983 inspection.

Pavement Distress

There has been no significant increase in the area of distress which occurred approximately 2 1/2 weeks after paving was completed in the Village of Jericho at mile marker 0063±.

The distress in the form of slippage or shoving of the recycled mix occurred in an area where at least a portion of the asphalt emulsion tack coat was washed away by a rain shower prior to the placement of the overlay.

Maintenance Requirements

There have been no maintenance requirements on the experimental project. With the possible exception of the distressed area on the westbound lane in the Village of Jericho at milemarker 0063±, no maintenance requirements are anticipated in the near future.

SUMMARY OF PROJECT CONDITION AND PERFORMANCE

Reflective Cracking

The recycled mix has resisted the development of new or reflective cracks better than the standard mix.

Pavement Rutting

The average rutting on the recycled mix is 1/16 inch less than that recorded on the standard mix.

Riding Quality

There are no significant differences in roughness between areas paved with the recycled and standard mix.

Friction Values

The recycled mix has maintained friction values approximately two points or more above those recorded on the standard mix.

Pavement Bleeding

Surface bleeding has been recorded on the standard mix but has not been observed on the recycled mix.

Pavement Distress

Pavement distress has been limited to the area initially reported in the Village of Jericho.

Maintenance Requirements

There have been no maintenance requirements on the experimental project and none are anticipated in the near future.

SUMMARY AND CONCLUSIONS

Vermont's first hot recycling project has been successful from the standpoint of production, construction and performance. In general, research on this project supports the following conclusions:

1) Relatively few plant modifications were required to produce recycled bituminous mix with a conventional batch plant.

2) Mixes utilizing up to 30 percent reclaimed pavement millings were produced within the specification without difficulty.

3) Production of the recycled mix, although somewhat slower than standard mix, often exceeded 1000 tons per day and was always sufficient to meet the needs of the paving crew.

4) The recycled mix did notpresent any problems with placement although it was somewhat stiffer than virgin mix making handwork more difficult.

5) Heating requirements for plant production were the same for the recycled and standard mixes averaging 1.58 gallons of No. 4 fuel oil per ton of mix.

6) The use of reclaimed material resulted in energy savings of 86,370 BTU per ton of 30 percent recycled mix and 112,590 BTU per ton of 35 percent recycled mix. Energy savings for the project totaled 1,536,483,610 BTU.

7) The use of reclaimed pavement in the mix resulted in the conservation of 3063 tons of coarse aggregate, 1733 tons of fine aggregate and 330 tons of asphalt cement.

8) Production of the recycled mix did not significantly reduce air quality at the plant site.

9) The recycled mix has resisted the development of new or reflective cracks better than the standard mix.

10) The recycled mix has resisted the formation of ruts better than the standard mix.

11) The recycled mix has consistently maintained friction values above those recorded on the standard mix.

12) Surface bleeding has been experienced on the standard mix but has not been recorded on the recycled mix.

RECOMMENDATIONS

Based upon the performance of the experimental project to date, the use of hot recycling should be encouraged whenever practical on future paving contracts.

Monitoring should continue on this experimental project with emphasis on a comparison of the performance and aging characteristics of the recycled and standard mixes.

Condition of old pavement - Test Section #4 July, 1981

Location as noted above - October, 1984

Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

Location & Route Essex-Jericho-Underdhill Rte 15 Job Number FR 030-1(11)
Experimental Feature Hot Recycle Width of Roadway 23'±

Code for Crack Type

Type A = Transverse from shoulder to centerline
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 6/30/81	1/28/82	10/21/83	10/4/84	/ /	/ /	/ /	/ /
Section #7EB				Standard Mix				
Type A	12	12	12	12				
Type B	3	0	2	7				
Type C	99	0	3	9				
Type D	14	0	0	0				
Total	128	12	17	28				
Avg./100' of roadway	85							
Section #7WB				Recycled Mix				
Type A	12	12	12	12				
Type B	18	0	0	0				
Type C	58	0	0	0				
Type D	1	0	0	0				
Total	89	12	12	12				
Avg./100' of roadway	59							
Section #8WB				Standard Mix				
Type A	12	12	12	12				
Type B	4	0	6	6				
Type C	285	7	16	38				
Type D	8	0	0	0				
Total	309	19	34	56				
Avg./100' of roadway	206							
Section #8EB				Recycled Mix				
Type A	12	12	12	12				
Type B	4	0	0	0				
Type C	317	0	0	0				
Type D	0	0	0	0				
Total	333	12	12	12				
Avg./100' of roadway	222							

Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

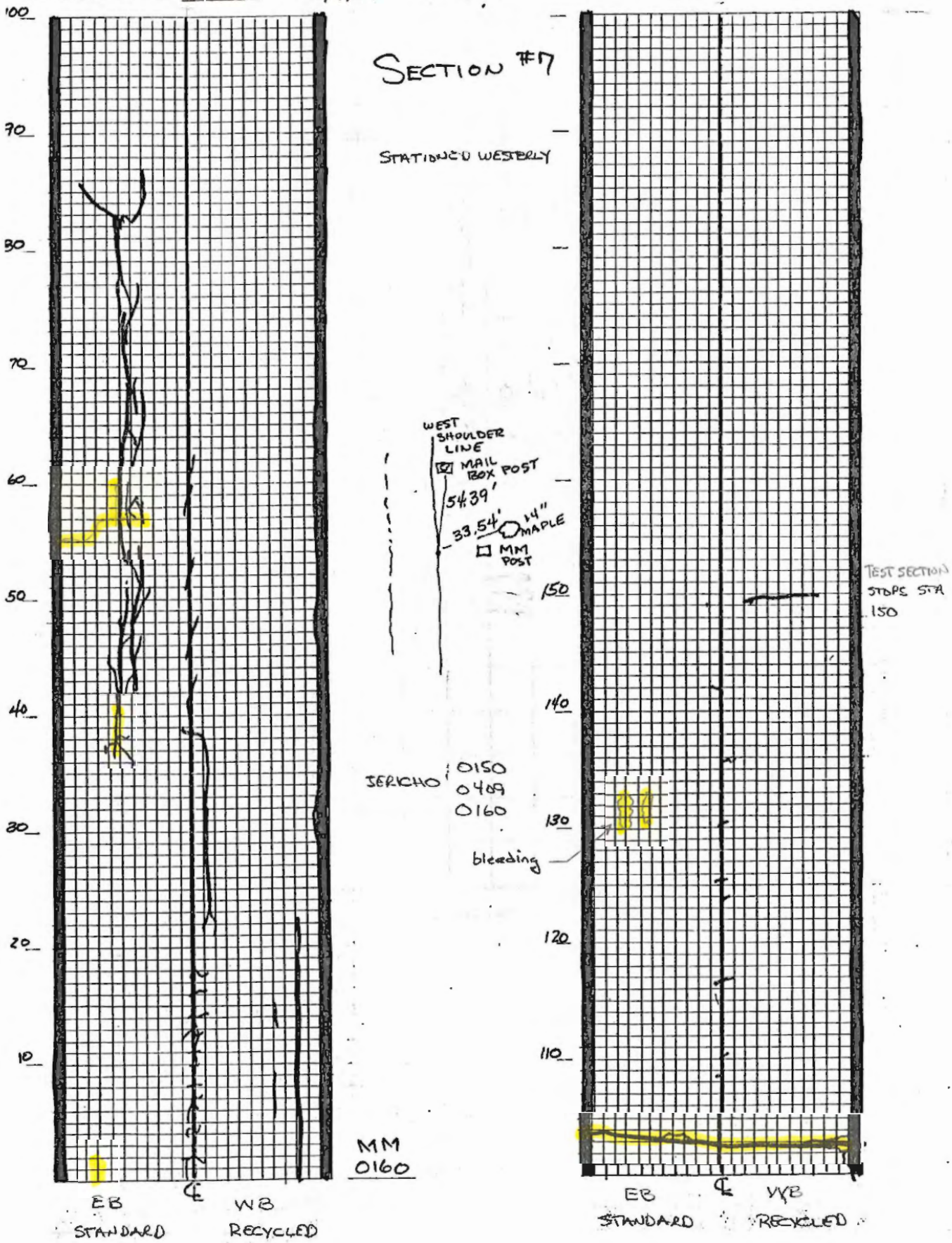
Location & Route Essex-Jericho-Underhill Rte 15 Job Number FR 030-1(11)
Experimental Feature Hot Recycle Width of Roadway 23'±

Code for Crack Type

Type A = Transverse from shoulder to centerline
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 6/31/81	1/28/82	10/21/83	10/4/84	/ /	/ /	/ /	/ /
Section #9 EB					Standard Mix			
Type A	0	0	0	0				
Type B	8	0	0	0				
Type C	99	0	36	37				
Type D	0	0	0	0				
Total	107	0	36	37				
Avg./100' of roadway	71							
Section #9 WB					Recycled Mix			
Type A	0	0	0	0				
Type B	4	0	0	0				
Type C	163	0	0	0				
Type D	0	0	0	0				
Total	167	0	0	0				
Avg./100' of roadway	111							
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								

ORIG. SURVLY BY PC & BM DATE 6/30/81 PAVEMENT CONDITION SURVEY SHEET 1 OF 1
RE-SURVEYED BY NH & RF DATE 6/4/84 PROJECT ESSEX - JERICHO - UNDERHILL FR 030-1(11)



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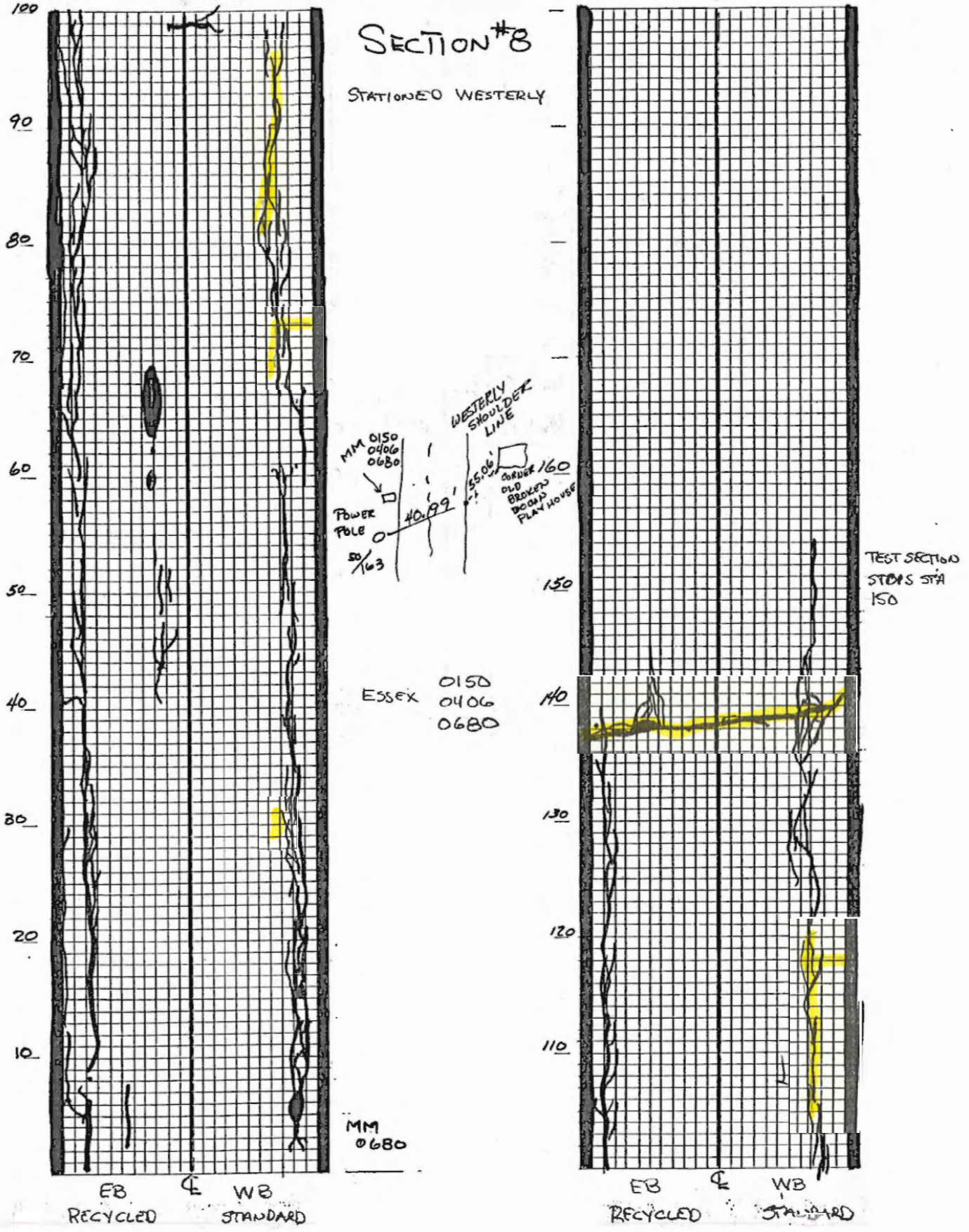

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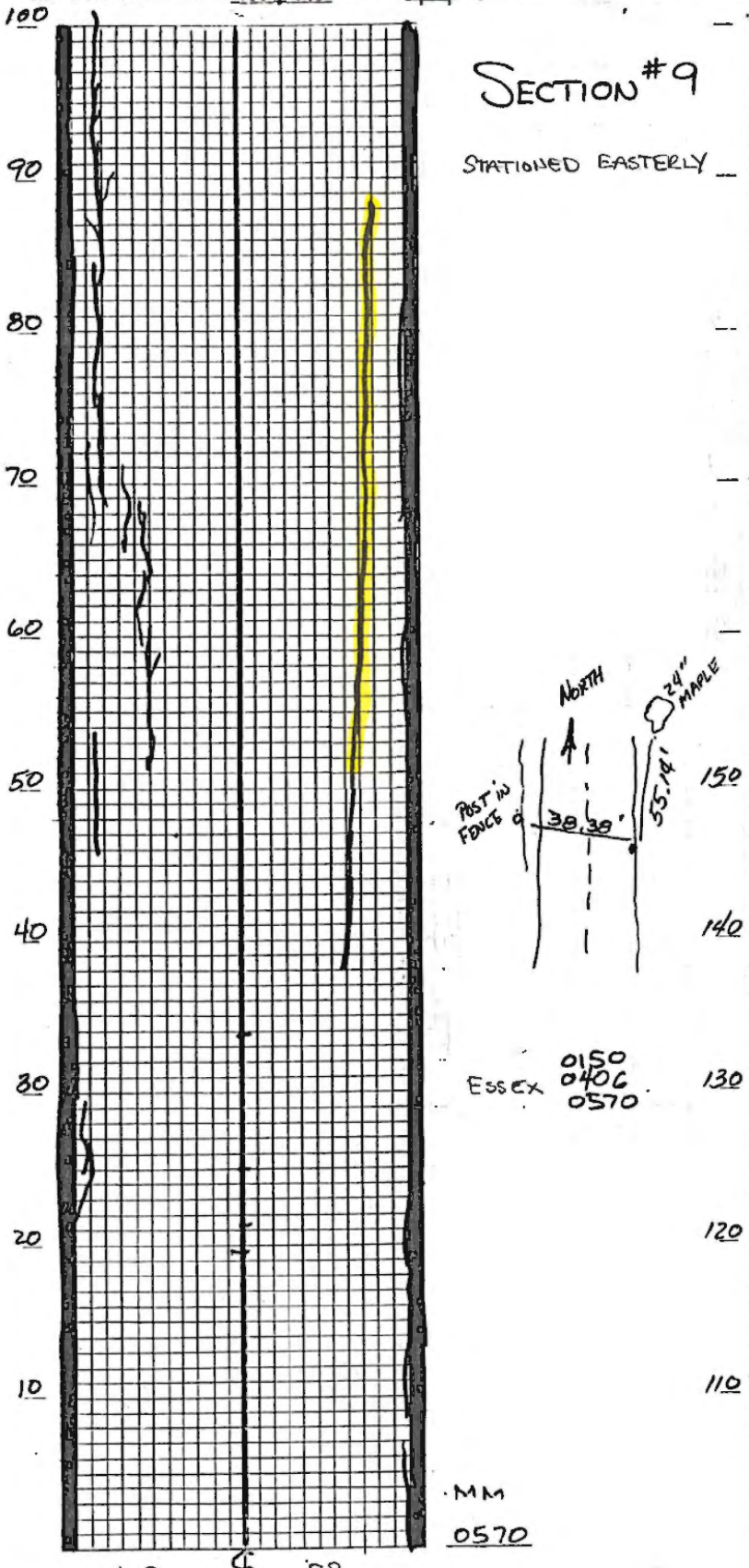
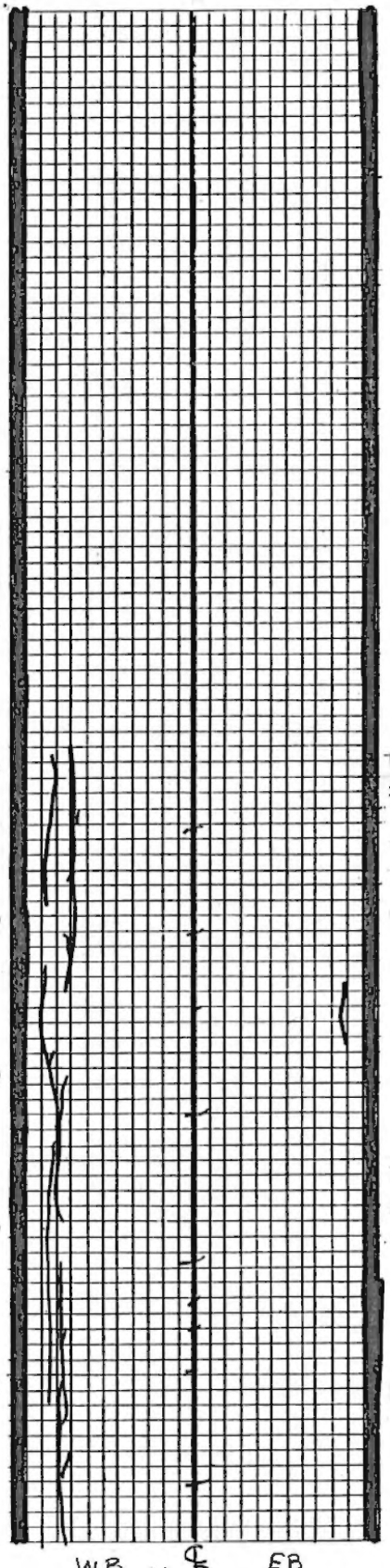
SECTION #9

STATIONED EASTERLY



ESSEX 0150
0406
0570

MM
0570



STANDARD MIX STOPS STA 200

TEST SECTION STOPS STA 150

Prepared by: R. I. Frascoia

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

WORK PLAN FOR CATEGORY III EXPERIMENTAL PROJECT

RECYCLING ASPHALT PAVEMENTS (REGION 15-DEMONSTRATION PROJECT NO. 39) WORK PLAN 81-B&R-11

OBJECT OF EXPERIMENT

To utilize pulverized bituminous pavement as a portion of a new bituminous concrete mix and to compare the design, manufacturing process, cost, energy consumption, environmental features and performance of the recycled material with a standard bituminous concrete mix.

PROJECT

Essex - Jericho - Underhill FR 030-1(11)

PROJECT LOCATION

Section I - Beginning on Vt. 15 in the Town of Essex, at the Essex Junction East Village limits, and extending northeasterly 1.27 miles to the intersection with TH 702.

Section II - Beginning on Vt. 15 in the Town of Essex, 600 feet east of the Sand Hill Road intersection, and extending northeasterly through the Town of Jericho into the Town of Underhill, a distance of 10.52 miles, ending at the TH 9 intersection at MM 4.35.

EXPERIMENTAL WORK LOCATION

For the full length of the project, a distance of 11.79 miles which shall include a control section.

CONSTRUCTION PROCEDURE

The process shall include mixing the pulverized pavement with new aggregate and asphalt cement in a suitable mixing plant, and placing the recycled mixture and a control section of standard bituminous concrete mix.

INVESTIGATION PROCEDURE

The investigation will include the following steps:

1) Obtain initial design, construction and maintenance records on the section of highway which is to be overlaid.

2) Visually inspect and document the condition of the existing pavement.

3) Analyze samples of the pulverized pavement to determine the properties of the recoverable materials. Document the design test results and analysis of the properties of the recycled design mix and the individual components of the mix.

4) Observe the recycling process and document pertinent information on the equipment modifications required, method of production and production rates, mix temperatures, compaction effort required and achieved, weather conditions, and other related information.

5) Document field tests taken during the construction of the project and obtain core samples of the recycled pavement for lab analysis.

6) Determine if the recycling process provides significant environmental benefits such as elimination of disposal problems, conservation of quality aggregates, etc.

7) Compare differences in energy consumption between the recycled mix and the standard bituminous concrete mix placed on the control section.

8) Compare the cost of the recycled pavement with that of the standard pavement placed on the control section.

9) Compare the performance of the recycled pavement with that of the standard pavement placed on the control section.

CONTROL SECTION

A control section approximately 0.25 miles in length shall be included on the project with the control treatment consisting of a standard bituminous concrete mix placed as a 1/2 inch leveling course and a 1 1/2 inch wearing course. Sufficient data will be gathered on the control section to make the desired comparisons with the recycled pavement section.

COST

The in place cost of the recycled bituminous mix shall be $31.90 per ton.

DATE OF CONSTRUCTION

The experimental treatment shall be completed prior to September 1, 1981.

DURATION OF STUDY

The experimental project will be evaluated for a minimum of three years following completion of construction.

SURVEILLANCE

The experimental and control treatments shall be monitored during construction and at least once each winter and spring for the duration of the study. Evaluations shall include documentation of the condition of both experimental and control treatments.

REPORTS

An initial report covering the basic data collected, construction experiences, test results and initial observations shall be submitted within 90 days after project completion. Interim reports shall be made on an annual basis. A final report shall include recommendations for use in developing future recycling projects.

Reviewed by:

R. F. Nicholson

R. F. Nicholson, P.E.
Materials & Research Engineer

Date: 6/23/81

Vermont Agency of Transportation
Materials & Research Division
June 22, 1981