PAVEMENT LIFE RESEARCH PROJECT

Interstate 89 Bolton-Colchester MM 71/50-91/70

Initial Report

Feb. 1980

Reporting On
Work Plan 79-R & B-9

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

Prepared By
Ronald I. Frascoia
Research Specialist

Reviewed By: R. F. Nicholson

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

Date: Feb. 8, 1980

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

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

FROM: R. I. Frascoia, Research Specialist

DATE: February 8, 1980

SUBJECT: Pavement Life Research Project I 89 Bolton-Colchester
Initial Report Feb., 1980

The attached preliminary report is the result of field inspections and approximately three weeks of study on the subject. Preliminary recommendations have been included in the belief that they may prove beneficial in providing a starting point for consideration by management.

Following the review of this information, if either type of hot recycling or the Mendon procedure of cold recycling is selected for use or further consideration, a laboratory testing program would be required to determine:

1. If a softening agent is required.
2. If the presence of the rubber slurry will effect the mix or result in pollution problems.
3. If the stripping characteristics of the coarse aggregate can be corrected when the material is hot or cold recycled.
4. The percent moisture and emulsion required with cold recycling.

RIF/msd
Enclosure
cc: Dir. of Eng. & Const. Gage
Chief Research & Testing Eng. Brown
Chief Concrete & Soils Eng. Armstrong
Bituminous Concrete Supervisor Jerd
Research Specialist Frascoia

PURPOSE OF STUDY

This study was undertaken to determine what rehabilitation method(s) should be specified to correct existing pavement distress and prevent additional failures from occurring on the Bolton-Colchester Interstate overlay project constructed in 1975.

This report includes brief but factual information on the following subjects:

1. Problems which have occurred from the time of construction in 1975 through the present period.
2. Present roadway conditions.
3. Potential corrective treatments.
4. Discussion.
5. Preliminary recommendations.
6. Cost information.

REVIEW OF THE 1975 OVERLAY PROJECT FROM THE TIME OF CONSTRUCTION TO THE PRESENT

The 1975 pavement overlay projects on Interstate Route 89, project Bolton-Williston I 89-2 (23) and Williston-Colchester I 89-3 (51) covered a length of 20.3 miles. The projects included an area composed of all or part of ten initial construction contracts which had been completed 11 to 13 years earlier and had been opened to traffic in November of 1963 and 1964.

The justification for the project was based on a review of field observations and measurements which revealed "considerable rutting, longitudinal and transverse cracking --- wheel path cracking --- pitting and loss of matrix --- surface moisture penetration". The analysis indicated that "the existing pavement is deficient in structural strength for today's traffic and related loads and is inadequate for the projected requirements".

The specification for the 1975 overlay included a strain relieving interlayer (SRI) which had shown conclusive benefits in reducing reflective cracking in pavements following experimental applications on Interstate 91 in Putney (1973) and Derby (1974). The treatment consisted of vulcanized rubber shreds and fine aggregate in an emulsion slurry placed in a 3/8 inch total thickness.

Placement of the rubber slurry began in June of 1975. As the project progressed and the first of two courses of bituminous mix was placed over the SRI, pavement distress in the form of shoving or raveling

was observed at random locations exposed to traffic. During the removal of distressed pavement, observations revealed that the bituminous concrete was experiencing severe stripping problems. A number of adjustments were made in the construction procedure and materials in an attempt to combat the problem. They included increasing the first course of pavement from 1 inch to 1 1/2 inches, changing the asphalt from AC 5 to the more viscous AC 10 grade, switching from Type III to the more stable Type II mix and prohibiting traffic until both courses were in place. The changes appeared to reduce the level of pavement failure but did not totally eliminate the problem. Accordingly, a decision was made to discontinue the use of the rubber slurry on the remaining 12.8 miles of northbound highway from the area of Richmond Interchange to Colchester (MM79/05 - 91/84).

During the past four years, areas treated with the SRI have required random pavement removal and replacement which has consumed an increasing amount of maintenance funds. In all cases the distress has occurred in the form of raveling of the 1975 overlay with the major cause attributable to stripping of the asphalt from the coarse aggregate. The stripping action is initiated by a number of factors working in different combinations. The SRI is undoubtably the major factor due to its' tendency to act as a moisture barrier or dam which causes surface moisture to be retained in the overlay. This belief is supported by the increased requirement for pavement patching immediately following extended periods of wet weather. The flexibility of the interlayer also tends to reduce the overall stability of the overlay under traffic. The belief that the SRI is a major factor leading to the stripping action is supported

by the fact that the 12.8 miles of Northbound overlay placed without the SRI has not developed any areas of distress. Other contributing factors include the coarse aggregates' basic susceptability to stripping, the asphalt in the bituminous mix, and the traffic volume on the roadway.

PRESENT ROADWAY CONDITION

A detailed survey of the north and southbound lanes was completed on December 27, 1979. The survey revealed a total of 538 patches totaling approximately 4,060 square yards in area or 1 percent of the roadway surface. Approximately 94 percent of the patches are located in the travel lane; presumably due to higher traffic volumes, with the greatest share bordering on either the ten foot shoulder or the center line.

Sixty-three percent of the distress has occurred on the northbound lane where 386 patches totaling 2550 square yards in area amount to 2.4 percent of the roadway surface on the 7.6 mile section. Ninety-six percent of the patched area was noted in the travel lane.

The southbound lane contained 152 patches totaling 1510 sy. in area. The patches amounted to 0.5% of the roadway surface on the 20.3 mile section with 92% of the patched area located in the travel lane. It should be noted that 98% of the patches on the southbound lane were located on the northerly 11.1 miles of the roadway between the Colchester Interchange and a point 1 1/2 miles south of the Williston rest area at MM 80/60. A breakdown of the pavement condition between southbound interchanges is as follows:

Area	Length	# Of Patches	SY Patched Area
Colchester-Williston	7.61 Mi.	70	709
Williston-Richmond	5.80 Mi.	78	790
Richmond-Bolton	6.75 Mi.	4	12

A steady decrease was noted in the rate of pavement failure until the year 1979 when more patching was required than the total for the previous years. A summary of maintenance carried out is as follows:

Southbound	Year	% of Total Patches	SY Patched
	1976	18	270
	1977	23	344
	1978	7	115
	1979	52	783

Northbound	Year	% of Total Patches	SY Patched
	1976	28	714
	1977	15	383
	1978	5	128
	1979	52	1326

Mays Meter readings taken on northbound Bolton-Richmond averaged 36.4 inches of roughness per mile while the southbound from Richmond to Williston averaged 27.9 inches and the Bolton-Richmond area averaged 25.4 inches. In comparison, the southbound from Bolton to Waterbury was 163% rougher with an average of 66.7 inches per mile.

POTENTIAL CORRECTIVE TREATMENTS

Following are descriptions, comments, and advantages/disadvantages on 10 different treatments which could be considered for use on the subject area. The treatments are as follows:

Cold Recycle (Bell & Flynn)

Cold Recycle (Mendon Process)

Hot Recycle (Plant Method)

Hot Recycle (Drum Mixer)

Pavement Maintenance & Bituminous Overlay

Bituminous Concrete Overlay

Open Graded Asphalt Friction Course

Pavement Resurfacing Membrane and Overlay

Stress Absorbing Membrane Interlayer

Asphalt Rubber Surface Treatment

In-place hot recycling was not considered since the process is not capable of penetrating more than 1 1/4"± and, therefore, would not be effective in restabilizing the 2 1/2"± 1975 overlay.

COLD RECYCLE
(USING BELL & FLYNN PAVEMENT RECLAMATION PROCESS)

DESCRIPTION -

STEP A - Pulverize existing pavement to level of base course (5 1/2").

B - Add moisture, shape and compact the pulverized material.

C - Place 1/2" leveling course.

D - Place 1 1/2" wearing course, Type II mix.

COMMENTS - This process was used on 2 miles of I 91 in Derby, Vermont in September 1974. The treated area has remained free of cracks or rutting through the present date, a period covering 5 1/2 winter seasons. New Hampshire is using the process with similar success reported. They have 5 such projects scheduled for 1980 using triple R funds. They use $2.50 per s.y. for estimating purposes but are getting bid prices as low as $2.00 per s.y.. Stabilization of the pulverized pavement is achieved without the addition of asphalt resulting in a savings of time, asphalt, and energy. Bell & Flynn can mobilize sufficient equipment to prepare 3 1/2 miles of 24' roadway per week.

ADVANTAGES OF TREATMENT -

1. Eliminates reflective cracking.
2. Utilizes all existing pavement material.
3. Provides 40%± savings in energy over a removal & replacement treatment.
4. Cost 17% less than average of all potential treatments.

DISADVANTAGE OF TREATMENT -

1. Estimated 15% longer period of interruption to roadway users.

COLD RECYCLE
(USING MENDON-SHERBURNE PROCESS)

DESCRIPTION -

STEP A - Pulverize existing pavement to level of base course (5 1/2").

B - Add moisture, asphalt, shape and compact pulverized material.

C - Place 1/2" leveling course.

D - Place 1 1/2" wearing course, Type II mix.

COMMENTS - This process was used on 1.5 miles of U.S. Route 4 in Sherburne, Vermont in October 1978. The treated area remained free of cracks through the first winter season. The process will utilize existing material and thereby conserve aggregate, asphalt, and energy. It may be difficult to pulverize the material placed in 1975 with cold planing equipment since the overlay is not securely bonded to the original pavement surface and will probably separate in fairly large pieces. Selection of this process will require a laboratory testing program to determine the percent moisture and asphalt required.

ADVANTAGES OF TREATMENT -

1. Eliminates reflective cracking.
2. Utilizes all existing pavement material.
3. Provides 35%± savings in energy over a removal & replacement treatment.

DISADVANTAGES OF TREATMENT -

1. Estimated 20% longer period of interruption to roadway users.
2. Cost 48% higher than cold recycling with Bell & Flynn Method and 22% higher than average of all other potential treatments.

HOT RECYCLE
(USING STANDARD BATCH PLANT)

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Size and stockpile the processed material.

C - Produce recycled mix.

D - Place two 1 1/4" lifts of the recycled mix.

E - Place 1" wearing course, Type III mix.

COMMENTS - The process will utilize a portion of the existing material and thereby conserve aggregates and asphalt. Region 15 Demonstration Project funds would be available to Vermont if hot recycling is utilized. Selection of this process would require a laboratory testing program to determine if:

1. A softening agent is required.
2. The presence of the rubber slurry will effect the mix or result in pollution problems.
3. The stripping characteristics of the coarse aggregate can be corrected when the material is hot recycled.

ADVANTAGE OF TREATMENT -

1. Process will utilize 25-50% of the material removed.

DISADVANTAGES OF TREATMENT -

1. Lack of experience with hot recycling increases the risk of problems.
2. Process will not eliminate reflective cracking.
3. Cost 9% higher than average of all other potential treatments.

HOT RECYCLE
(USING A DRUM MIXER)

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Size and stockpile the processed material.

C - Produce recycled mix.

D - Place two 1 1/4" lifts of the recycled mix.

E - Place 1" wearing course, Type III mix.

COMMENTS - The use of a drum mixer could double the amount of allowable recycled material which could be used in a hot recycling process. Maine completed a 19 mile project in 1979 using 100% recycled material at a cost of $16.00 per ton or a $5.00 per ton savings over their average cost for bituminous concrete. Use of a drum mix plant may require an EPA polution variance. Selection of this process could encourage bids by a larger number of contractors. Region 15 Demonstration Project funds would be available to Vermont if hot recycling is utilized. Selection of this process would require a laboratory testing program to determine if:

1. A softening agent is required.
2. The presence of the rubber slurry will effect the mix or result in pollution problems.
3. The stripping characteristics of the coarse aggregate can be corrected when the material is hot recycled.

ADVANTAGES OF TREATMENT -

1. Utilizes a higher % of the existing pavement material.
2. Reduces asphalt requirements.
3. Cost is 10% less than the standard plant method of hot recycling and 2% less than the average of all potential treatments.

DISADVANTAGES OF TREATMENT -

1. Lack of experience with hot recycling increases the risk of problems.
2. Does not reduce reflective cracking.

PAVEMENT MAINTENANCE & OVERLAY

DESCRIPTION -

STEP A - Patch existing pavement as required.

B - Apply tack coat.

C - Place 1 1/2" binder course, Type II mix.

D - Place 1" wearing course, Type III mix.

COMMENTS - This treatment could be considered on the southerly 9 miles of the southbound roadway where patching has been required on only 25 square yards of surface area.

ADVANTAGES OF TREATMENT -

1. Shortest period of interruption to users.
2. Reduces the use of energy.
3. Cost 32% lower than average of all potential treatments.

DISADVANTAGES OF TREATMENT -

1. Potential for failure great if maintenance procedure fails to remove all unstable pavement areas.
2. Does not reduce reflective cracking.

BITUMINOUS CONCRETE OVERLAY

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Apply tack coat.

C - Place 1/2" leveling course.

D - Place 1 1/2" binder course, Type II mix.

E - Place 1" wearing course, Type III mix.

COMMENTS - The utilization of a standard overlay procedure reduces the risk of unanticipated problems which often occur with experimental treatments.

ADVANTAGES OF TREATMENT -

1. Provides the lowest risk of premature failure.
2. Cost 6% less than average of all potential treatments.

DISADVANTAGE OF TREATMENT -

1. Does not utilize existing pavement material.
2. Does not reduce reflective cracking.

OPEN GRADED ASPHALT FRICTION COURSE

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Apply tack coat.

C - Place 1/2" leveling course.

*D - Place 2" binder course, Type II mix.

E - Place 3/4" Open graded asphalt friction course.

*May require 1/2" additional material to meet existing shoulder grades.

COMMENTS - This treatment would offer a high probability of success based upon the performance of friction courses placed in Norwich-Fairlee and Royalton-Randolph. The surface provided is safer and quieter and might be expected to reduce winter maintenance costs.

ADVANTAGES OF TREATMENT -

1. Provides safe, quiet riding surface.
2. Cost equal to average of all potential treatments.

DISADVANTAGES OF TREATMENT -

1. Does not utilize existing pavement material.
2. Does not reduce reflective cracking.

PAVEMENT RESURFACING MEMBRANE

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Place 1/2" leveling course.

C - Place pavement resurfacing membrane (fabric).

D - Place 1 1/2" binder course, Type II mix.

E - Place 1" wearing course, Type III mix.

COMMENTS - The four more commonly used fabrics installed on a 1200 lineal foot section of Route 15 in Colchester have not reduced reflective cracking in the 1 1/2" bituminous concrete overlay. However, information from other States including New Hampshire indicates the fabrics can reduce the level of reflective cracking when they are placed beneath overlays of 2 1/2" or greater thickness. Maine reports that the fabrics have reduced reflective cracking by 25% on a section overlaid with 3 to 3 1/2" of pavement. They also reported that a chip seal interlayer provided equal performance.

ADVANTAGE OF TREATMENT -

1. May reduce the rate of reflective cracking.

DISADVANTAGES OF TREATMENT -

1. Does not utilize existing pavement material.
2. Consumes more asphalt, aggregate and energy than other treatments.
3. Cost 19% higher than average of all potential treatments.

STRESS ABSORBING MEMBRANE INTERLAYER

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Apply tack coat.

C - Place 1/2" leveling course.

D - Place Stress Absorbing Membrane Interlayer.

*E - Place 1 1/2" wearing course, Type II mix.

*May require 1/2" to 3/4" additional material.

COMMENTS - The one mile section of asphalt rubber stress absorbing membrane interlayer placed on I 91 in Springfield did not prevent reflection cracks from occurring in a 1" bituminous concrete overlay.

ADVANTAGES OF TREATMENT -

1. Cracks in the bituminous overlay may heal during warm weather.

DISADVANTAGES OF TREATMENT -

1. Does not utilize existing pavement material.
2. May consume more asphalt, aggregate, and energy than the standard overlay treatment.
3. Will not eliminate reflective cracking.
4. Estimated 5% longer period of interruption to roadway users.

ASPHALT RUBBER SURFACE TREATMENT

DESCRIPTION -

STEP A - Remove 1975 overlay.

B - Apply tack coat.

C - Place 1/2" leveling course.

*D - Place 1 1/2" course, Type II mix.

E - Place A.R.S.T.

*May require 1/2" to 3/4" additional material to meet existing shoulder grades.

COMMENTS - Our limited experience with an A.R.S.T. on I 91 in Springfield and on I 89 in Richmond indicates the treatment is susceptible to the loss of cover stone and can not prevent underlying cracks from reflecting up through the surface treatment.

ADVANTAGES OF TREATMENT -

1. Surface cracks may heal during warm weather.

DISADVANTAGES OF TREATMENT -

1. Greater risk of failure than with other potential treatments.
2. Does not utilize existing pavement material.
3. May consume more asphalt, aggregate, and energy than the standard overlay treatment.
4. Will not eliminate reflective cracking.
5. Estimated 5% longer period of interruption to roadway users.

DISCUSSION

The selection of a treatment for correcting the problems on the Bolton-Colchester section of Interstate 89 should be based upon the following objectives or values:

1. Cost Effectiveness
    - A. Potential for premature failure.
    - B. Initial cost vs. performance life.
        1. Reduce reflective cracking.

2. User Comfort and Safety
    - A. Surface ride.
    - B. Friction values.
    - C. Noise Levels.

3. Energy Conservation
    - A. Energy required to produce product.
    - B. Energy required for equipment.

4. Conservation of Resources
    - A. Utilization of existing roadway material.
    - B. Asphalt required.

5. Roadway Interruption Time
    - A. Inconvenience and cost to user.
    - B. Safety.

PRELIMINARY RECOMMENDATIONS

Based upon the condition of the existing roadway and the potential rehabilitative treatments available to the Agency, corrective treatment is recommended as follows:

1. Specify Cold Recycling using the Bell & Flynn pavement reclamation process on the 7.6 mile northbound section.

2. Specify pavement removal and a standard bituminous concrete overlay on the northerly 11 mile section of the southbound lane.

3. Postpone treatment of the southerly 9 mile section of the southbound lane until surface conditions require rehabilitative treatment.

A secondary recommendation would be to consider hot recycling on the northerly 11 mile section of the southbound lane. The choice for the northbound section and the southerly segment of the southbound would remain as stated above.

COST SUMMARY

Treatment	Cost/S.Y.	Cost/Mile
Cold Recycle (Bell & Flynn)	$ 6.30	$ 88,660
Cold Recycle (Mendon Process)	$ 9.30	$ 130,900
Hot Recycle - Plant Method	$ 8.33	$ 117,260
Hot Recycle - Drum Mixer	$ 7.49	$ 105,400
Pavement Maintenance & Bituminous Overlay	$ 5.19	$ 73,012
Bituminous Concrete Overlay	$ 7.17	$ 100,922
Open Graded Asphalt Friction Course	$ 7.60	$ 107,072
Pavement Resurfacing Membrane and Overlay	$ 9.06	$ 127,600
Stress Absorbing Membrane Interlayer	$ 7.48	$ 105,322
Asphalt Rubber Surface Treatment	$ 7.48	$ 105,322
Average =	$ 7.54/s.y.	$ 106,147/Mi.

P. Gori
2/6/30

Cost Info.
Bolton-Colchester I-89

Cold Recycle (Bell & Flynn)

A. & B. Pulverize & Shape (5½"-24') 2.50/SY = $35,200/mile
C. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile
D. 1½" Bituminous (24'+taper) 1386 tons/mile @ $30.00/ton = $41,580/mile
Total cost per mile $88,660

Cold Recycle

A, B, C Pulverize, Stabilize, Shape (5½"-24') $5.50/SY = $77,440/mile
D. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile
E. 1½" Bituminous (24'+taper) 1386 tons/mile @ $30.00/ton = 41,580/mile
Total cost per mile $130,900

Open Graded Asphalt Fiction Course

A. Pavement Removal (24') 14080 sy/mile @ $2.00/sy = $28,160/mile
B. Tack coat 89.8 cwt/mile @ $16.50/cwt = $1,482/mile
C. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile
D. 2" Bituminous (24') 1584 tons/mile @ 30.00/ton = $47,520/mile
E. ¾" Friction Course (26') 601 tons/mile @ $30.00/ton = $18,030/mile
Total cost per mile 107,072/mile

Pavement Resurfacing Membrane and Overlay

A. Pavement Removal (24') 14080 sy/mile @ $2.00/sy = $28,160/mile
B. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile

C. Tack coat & Membrane 14080 sy/mile @ $2.00/sy 28,160/mile
D. 1½" Bituminous (24') 1188 tons/mile @ $30.00/ton = $35,640/mile
E. 1" Bituminous (24') 792 tons/mile @ $30.00/ton = $23,760/mile
Total cost per mile $127,600

COST INFO.
BOLTON - COLCHESTER

P. CORTI
2/6/80

ASPHALT RUBBER SURFACE TREATMENT

A. PAVEMENT REMOVAL (24')	14080 SY/MILE @ $2.00/SY =	$28,160/MILE
B. TACK COAT (24')	89.8 CWT/MILE @ $16.50/CWT =	1,482/MILE
C. ½" LEVELING (24')	396 TONS/MILE @ $30.00/TON =	11,880/MILE
D. 1½ BITUMINOUS (24')	1188 TONS/MILE @ $30.00/TON =	35,640/MILE
E A.R.S.T.	14080 SY/MILE @ $2.00/SY	28,160/MILE
	TOTAL COST PER MILE	$105,322

PAVEMENT MAINTENANCE & BITUMINOUS OVERLAY

A. PATCH AREAS REQUIRED		$ 1,000/MILE
B. TACK COAT (24')	89.8 CWT/MILE @ $16.50/CWT =	1,482/MILE
C. 1½" BITUMINOUS (24')	1188 TONS/MILE @ $30.00/TON =	35,640/MILE
D. 1" BITUMINOUS (24' + TAPER)	1163 TON/MILE @ $30.00/TON =	34,890/MILE
	TOTAL COST PER MILE	$73,012

HOT RECYCLE - DRUM MIXER

A. PAVEMENT REMOVAL (24')	14080 SY/MILE @ $2.00/SY =	$28,160/MILES
B, C, D CRUSH, MIX, AND PAVE 2-1¼" LIFTS =	1980 TONS/MILE @ $25.00/TON =	$49,500/MILE
E. 1" BITUMINOUS (24' + TAPER)	858 TONS/MILE @ $30.00/TON. =	$ 27,740/MILE
	TOTAL COST PER MILE	$105,400

Cost Info
Bolton - Colchester

P. Corti
2/6/80

Hot Recycle - Plant Method

A. Pavement Removal (24') 14080 sy/mile @ $2.00/sy = $28,160/mile

B,C,D Crush, Mix, and Pave 2-1¼" Lifts = 1980 tons/mile @ $32.00/ton = $63,360/mile

E. 1" Bituminous (24' + taper) 858 tons/mile @ $30.00/ton = $27,740/mile

Total cost per mile $117,260

Bituminous Concrete Overlay

A. Pavement Removal (24') 14080 sy/mile @ $2.00/sy = $28,160/mile

B. Tack coat (24') 89.8 cwt/mile @ $16.50/cwt = $1,482/mile

C. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile

D. 1½ Bituminous (24') 1188 tons/mile @ $30.00/ton $35,640/mile

E. 1" Bituminous (24') 792 tons/mile @ $30.00/ton $23,760/mile

Total cost per mile $100,922

Stress Absorbing Membrane Interlayer

A Pavement Removal (24') 14080 sy/mile @ $2.00/sy = $28,160/mile

B. Tack coat (24') 89.8 cwt/mile @ $16.50/cwt = $1,482/mile

C. ½" Leveling (24') 396 tons/mile @ $30.00/ton = $11,880/mile

D. SAMI (24') 14080 sy/mile @ $2.00/sy = $28,160/mile

E. 1½ Bituminous (24') 1188 tons/mile @ $30.00/ton = 35,640/mile

Total cost per mile $105,322