Low Cost Techniques of Base Stabilization

Construction Report for Iowa Highway Research Board Project HR-312

March, 1989

Highway Division
Iowa Department of Transportation

Construction Report
Iowa Highway Research Board
Project HR-312

LOW COST TECHNIQUES OF BASE STABILIZATION DUBUQUE COUNTY

By
Mark C. Jobgen, P.E.
Dubuque County Engineer
319-557-7283

and
Mark Callahan
Assistant to the Research Engineer
515-239-1382
Office of Materials
Highway Division
Iowa Department of Transportation
Ames, Iowa 50010

March 1989

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DISCLAIMER

The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of Dubuque County or the Iowa Department of Transportation.

ACKNOWLEDGEMENT

Research project HR-312 was sponsored by the Iowa Highway Research Board and the Iowa Department of Transportation. Partial funding for this project was from the Secondary Road Research Fund in the amount of $93,913.

The authors wish to extend appreciation to the Dubuque County Board of Supervisors and the Iowa Department of Transportation for their support in the development and implementation of this project.

We also wish to thank David Leach with Koch Materials Company, Paul Raiford, Jr. with American Consolid, Inc., Bob Randolph with Soil Stabilization Products Company and Steve Spanagel with Contech Construction Products. These gentlemen were invaluable in their assistance with the construction techniques used on this project.

The Dubuque County crewmen who performed the innovative construction techniques also deserve recognition for the extra effort each put forth on the project.

ABSTRACT

Research project HR-312, "Low Cost Techniques of Base Stabilization", was initiated in 1988 to study the effectiveness of four different construction techniques for establishing a stable base on a granular surfaced roadway. The roadway was then seal coated, eliminating dust problems associated with granular surfaced roads. When monies become available, the roadway can now be surfaced with a more permanent structure. A 2.8 mile section of the Horseshoe Road in Dubuque County was divided into four divisions for this study.

This report discusses the procedures used during construction of these different divisions. Problems and possible solutions have been analyzed to better understand the capabilities of the materials and construction techniques used on the project.

INTRODUCTION

There are 68,610 miles of rural granular surfaced secondary roads in Iowa. This represents 76% of the total rural road system. Granular surfaced roads provide the County Engineer with a continuous maintenance problem. Dust, frequent grading, and loose gravel in curves and at approaches to paved roads are a constant hazard.

Granular surfaced roads also increase the travel costs of all types of vehicles in comparison to those same vehicles traveling on hard surfaced roadways. A recent study revealed that for automobiles, pickup trucks and commercial vans the operating cost per mile increased 38 to 40 percent when driving on a granular surfaced road. The cost per mile for a school bus increased by 42 to 45 percent.

The high cost of construction has made it a necessity to look for alternative methods of establishing dustless roadways for low volume secondary roads. Before dustless roads can be established the road base must be sufficiently stable to support a low cost surfacing method.

The Dubuque County Board of Supervisors has made a valiant effort to connect the towns in Dubuque County with a hard surfaced roadway. The high cost of construction has minimized these efforts. The present cost for new paved construction is approximately $155,000 per mile.

PROBLEM STATEMENT

The roadway Dubuque County considered for research was the Horseshoe Road, a 2.8 mile road connecting the cities of Balltown and Rickardsville. The current traffic count on this road is 140 VPD. The road also supplies direct connection to US 52 and IA 3 from Balltown and the Great River Road. The nearest paved parallel route from Balltown to US 52 and IA 3 requires traveling an additional 8.3 miles.

There has not been any dust control placed on this roadway by Dubuque County, resulting in numerous dust complaints from citizens living near the cities of Balltown and Rickardsville. The roadway has rolling hills which present a continuous problem of keeping aggregate from washing into ditches. The road requires regular maintenance to prevent "washboarding".

Therefore, Dubuque County was looking for a method of creating a dustless stabilized roadway that would prove economically feasible. The method would require preparing a stabilized base and then placing a surface maintenance mat such as a seal coat.

This road is an Area Service Road and therefore, to prepare the road for any future paving, it was necessary to establish a roadway top width of 28 feet and design the road for a minimum speed of 40 mph.

Iowa Highway Research Board project HR-312, "Low Cost Techniques of Base Stabilization" was developed by Dubuque County with the assistance of the Iowa Department of Transportation. The project was initiated to compile laboratory data from the field application of four different methods of base stabilization prior to the placement of a permanent pavement structure on the roadway.

OBJECTIVES

The objectives of the research project are:

1. To construct an experimental project consisting of several methods of base stabilization to facilitate surfacing with a low cost sealer which would provide a dustless, stable roadway.
2. To evaluate the field performance of each of these methods.
3. To develop the most cost effective technique of constructing a low volume dustless roadway which could be surfaced with a thin lift asphalt mat in the future.

PROJECT DESCRIPTION

The project is a 2.8 mile section of the Horseshoe Road in Dubuque County between Balltown and Rickardsville. The project was segmented into four divisions. All construction was performed by the Dubuque County Highway Department.

Division I involved constructing a macadam base that met current Iowa DOT specifications. Dubuque County placed five inches of Spec. 4122.02 Gradation 13 choked with two inches of Spec. 4122.02 Gradation 14 on the roadway. A 320 foot length of Tensar fabric was placed under one section of the macadam to determine the effect this material would have on the performance of the base.

Division II used the Consolid System method of base stabilization. Depending on the natural moisture content of the soil, the Consolid System uses one of two types of soil additives. If the soil is by nature dry, then a combination of two inverted emulsions is used (Consolid 444 + Conservex). If the soil has a high natural moisture content, then a combination of an inverted emulsion and a lime hydrated base powder is used (Consolid 444 + Solidry). The Consolid 444 + Solidry combination was initially used on this project. This method is basically new to Iowa. The procedure requires the soil to be broken up to a depth of ten inches. The soil is blended so as not to contain any particles exceeding three inches in diameter. Using a mobile distribution tank with spray bar, the Consolid 444 inverted emulsion is applied at a rate of 6.25 gallons per 100 square yards of roadway area and mixed thoroughly into the soil. This material is then compacted. The next step involves loosening the top four inches only. Using a distributor truck, the lime hydrated powder (Solidry) is applied at the rate of 4 pounds per square yard and compacted. Eventually the Conservex inverted emulsion was added to the top four inches due to the poor performance of the Solidry.

Division III involved using BIO CAT 300-1, which is a biochemical formulation designed to modify and stabilize soils. This procedure is similar to the Consolid System in that the BIO CAT 300-1 is thoroughly blended with the roadway material. The material was blended into the existing roadway in separate six inch, eight inch

and ten inch deep sections. The BIO CAT 300-1 is applied at a rate of one gallon per 240 cubic feet of material. Once the material was thoroughly mixed, a flat roller was used to compact the treated material.

Division IV involved the mixture of a high float emulsion with the base stone on the roadway. Three inches of Class A granular surfacing were thoroughly mixed with HFE-300 at a rate of 6.0% HFE-300 by volume. Once this material had been thoroughly mixed, it was bladed into shape and rolled with a flat roller.

All four divisions were sealed using a double seal coat. This was done to prevent moisture from penetrating into the base.

CONSTRUCTION

Dubuque County was performing grading work to correct two curves on the roadway which affected Division II and Division III; therefore, the divisions were not constructed in numerical order. Table I provides a description of the project division layout.

Table I
Test Division Layout

Division	Base Material	Stationing From	Stationing To	Length Ft.
I	Macadam	104+00	147+50	4350
II	Consolid	70+00	104+00	3400
III	BIO CAT 300-1	37+00	70+00	3300
IV	HFE-300	0+00	37+00	3700

Construction started with Division IV. Class A granular surfacing was placed on the roadway to a depth of three inches and a width of 28 feet for the length of the division.

On September 7, 1988, the operation of mixing HFE-300 with the Class A stone was begun. A target application rate of 2.26 gallons HFE-300 per square yard was used. The Class A stone was bladed to one edge of the roadway. A motor grader then pulled a small amount of stone to the middle of the road and a distributor having an 8 foot spray bar sprayed the stone with the HFE-300. Another motor grader following the distributor moved the combined material to the other edge of the roadway. This procedure was repeated until the targeted amount of emulsion had been applied to all the stone. Once this was completed, the material was again windrowed to one edge of the roadway.

A similar procedure was used to mix the material. A motor grader pulled a small amount of material from the windrow. A Seaman Travel Mixer was then used to mix the material. A second motor grader moved the mixed material to the opposite edge of the road. The entire windrow was moved from one edge of the road to the other four times before the material was adequately blended.

The Dubuque County crew was able to mix 1500 feet of material the first day. Since it was a first time operation for the crew, the operation took considerably longer than anticipated. Because of the lateness of the day, David Leach of Koch Materials recommended

that shaping and compaction of the roadway be postponed to the next morning. Therefore, the material was left in a windrow overnight.

The following day the stone that had not yet been blended was sprayed with water prior to addition of the HFE-300. This was done because the stone was dry and it was felt the emulsion would start balling up and not mix well. The previous day's mixing procedure was then used to mix the material. Only 900 lineal feet of new material was mixed since the crew had to shape and compact this and the previous day's mixture.

The material was shaped with a motor grader and compacted using a sheepsfoot for three passes. A rubber drum roller and a pneumatic tired roller were then used for final compaction. It was difficult to obtain a tightly knit surface, but this did not seem to pose a difficult problem since the surface was to be covered with a double seal coat.

On the third day the final 1,300 feet of HFE-300 treatment was placed using the same methods. The process went well and a considerably better finish was obtained as the crew gained experience.

On September 12, 1988, Division II was scarified from Station 70+00 to Station 80+00. A volume of material 28 feet wide and 10 inches deep was loosened using the Seaman Travel Mixer. On September 15, 1988, the application of the Consolid 444 material was initiated. The material came in 55 gallon drums and was added to a water

tanker. The specifications called for a Consolid 444 concentration of 6.25 gallons per 100 square yards of roadway area be mixed with enough water to bring the soil to optimum moisture. Because the soil was so dry, as a result of the dry summer, the mix proportions used were approximately 60 parts of water to one part Consolid 444. The material was spread on the roadway and blended into the soil using the Seaman Travel Mixer. Although the water tanker had an extended spray bar, three passes were still required to spread the material across the entire 28 feet of the roadway. The material was mixed and compacted in two 5 inch lifts.

In the area which was on a grade, the liquid ran downgrade in the tanker's wheel tracks. This problem was rectified in later applications by following the tanker with a springtooth cultivator pulled by a small track type tractor.

Once the 10 inches were compacted, the top 4 inches were reloosened and mixed with the Solidry material. The Solidry was applied at a rate of 4 pounds per square yard. It was then mixed with the Seaman Travel Mixer and compacted with the sheepsfoot roller.

On Friday, September 16, the remainder of the division was scarified and windrowed for the next week's placement of the materials. Over the weekend three inches of rain fell, reducing the roadway to a quagmire. The next few days were spent trying to dry out the roadway. On September 26, 1988, it was felt the Consolid 444 could be added to the roadway. The material was applied to th

remainder of the division but the crew was unable to apply the Solidry because of high winds. The next day the Solidry was added to the roadway, blended and compacted.

On September 28, 1988, several areas were noticed that did not appear to be adequately compacted. These were small, confined areas. The roadway was primed and it was decided to watch these unstable areas for any further deterioration. The areas remained unstable. The vendor's representative recommended the section be treated with Conservex, which is a chemical mixed with MC-30 asphalt.

On October 6, 1988, the entire division was scarified 4 inches deep. Fifty-three gallons of Conservex were mixed with 1,100 gallons of MC-30 and blended into the roadway material using the travel mixer. The material was recompacted using sheepsfoot and steel vibratory rollers. This improved the overall stability of the roadway considerably. However, there was a 12 inch wide seam approximately 800 feet long in the center of the roadway that did not compact. The problem seemed to be that this material did not get thoroughly blended, as there was not the required percent of MC-30 in this small seam.

On September 28, 1988, construction was started on Division I. This division involved the placement of macadam and chokestone to a width of 28 feet. The plans called for five inches of macadam and two inches of chokestone. The area between Stations 104+00 and 107+50 included the placement of Tensar reinforcement beneath the

macadam. The macadam rock was placed using a jersey type spreader and compacted using a drum roller. The chokestone material was then placed. A motor grader was used to spread the material across the roadway.

The quantity of chokestone used ran considerably more than projected because of the crew's inexperience in placing this material. The county was able to take advantage of this, however, by using the extra material to dress up the surface. The extra material also added to the structural capabilities of the roadway.

On October 4, 1988, construction began on Division III. This division included stabilizing a 28 foot wide road base with a blend of water and a chemical called BIO CAT 300-1. The BIO CAT 300-1 was blended such that the application rate would be one gallon of BIO CAT 300-1 per 240 cubic feet of material. Enough water was added to the BIO CAT 300-1 to bring the soil to optimum moisture.

Division III was divided into three segments of six inch, eight inch, and ten inch depths (see Table II). Construction started with the six inch segment. The roadway was scarified and the BIO CAT/water mix was applied full width using the distributor. The distributor was followed by the springtooth cultivator and Seaman Mixer. Compaction was attempted using a flat drum roller. This did not give adequate compaction, so the sheepsfoot roller was used for initial compaction and the drum roller was used for finish rolling. Soil from the eight and ten inch segments was placed in a

windrow and treated by pulling part of it from the windrow and applying the BIO CAT/water mix. The springtooth cultivator and Seaman Mixer then blended the material. A motor grader then moved the material across the road. This procedure provided better distribution of the BIO CAT 300-1 through the soil compared to the six inch section.

Table II
BIO CAT 300-1 Subdivisions

Segment Depth	Stationing From	To	Length Ft.
10"	37+00	48+00	1100
8"	48+00	59+00	1100
6"	59+00	70+00	1100

Some soft areas developed in the roadway during the process. The vendor's representative believed this was due to cool temperatures not permitting the soil to dry adequately. He felt that with time the roadway would improve.

The roadway was then primed and a double seal coat was applied to complete the project.

CORRECTION OF PROBLEMS

Division I - The only problem involved the chokestone being placed in excess of the proposed two inch lift. The lift was slightly more than three inches thick. The crews now understand how to do periodic yield checks that should correct this problem.

Division II - The problem with the Consolid System procedure involved the Solidry. The material is a dry powder and windy conditions caused problems during placement. Upon the vendor's recommendation, Conservex was used to help stabilize the top four inches. This procedure, with the blending of the Consolid 444, would work better in the summer than early fall. The material took too long to dry and considerable time was lost because of rain. The problem with the seam was merely a blending problem and could be alleviated by ensuring the material is thoroughly mixed.

Division III - The compaction problem encountered in the six inch section was corrected by adding the sheepsfoot to the operation. The BIO CAT material should also be added in the summer as the material took a longer than anticipated amount of time to dry. This seemed to hinder compaction.

Division IV - It was determined the material should be bladed, shaped and rolled the same day the emulsion is added. This aids in compaction and enables the material to form a more tightly knit surface.

CONSTRUCTION TESTING

Iowa DOT research personnel performed density testing of the roadway. A Clegg Impact Tester was also used. On November 8, 1988, Road Rater and Roughometer tests were performed on the roadway. Results of these tests are in Appendix A. Testing will continue for five years. Annual Road Rater tests, crack surveys, and rut depth measurements will be taken. Also, visual examinations will be made during testing.

PROJECT COSTS

The total cost for the project was $147,651 including materials, labor and equipment. Division I (macadam) cost $39,225 for the 4,350 feet. Division II (Consolid) cost $29,241 for the 3,400 feet. Division III (BIO CAT) cost $12,909 for the 3,300 feet. Division IV (High Float Emulsion) cost $26,163 for the 3,700 feet.

At first the costs of the divisions may be deceiving because of the distinct variations in construction techniques and the varying lengths of the segments. Because of the diverse construction techniques a cost per mile comparison of each division would not tell the whole story. For instance, in Division II 2,950 cubic yards of material were treated while Division III treated 2,280 cubic yards of material.

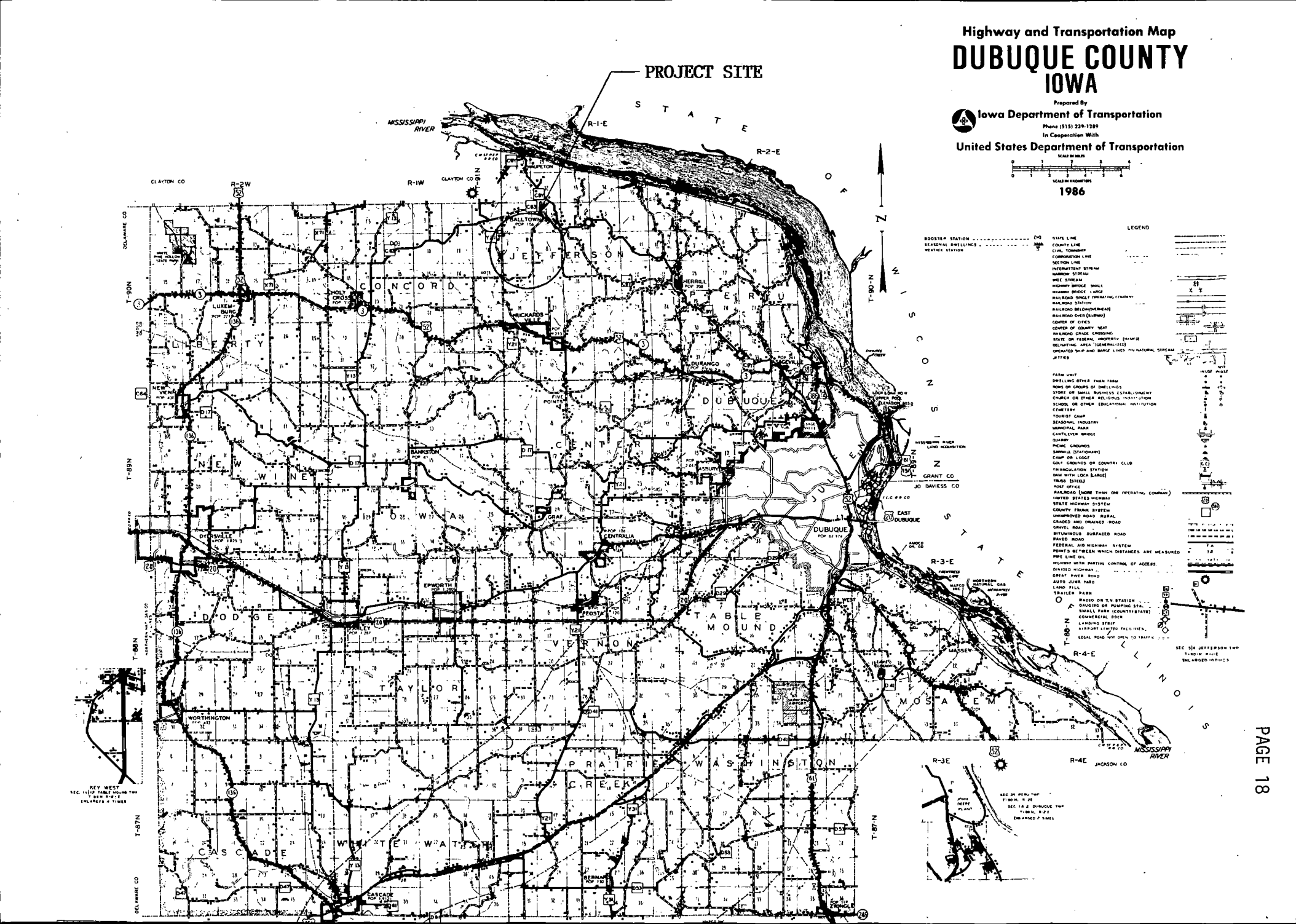
The seal coat for the 2.8 miles cost $40,113. The roadway was sealed for a width of 28 feet the entire length of the project.

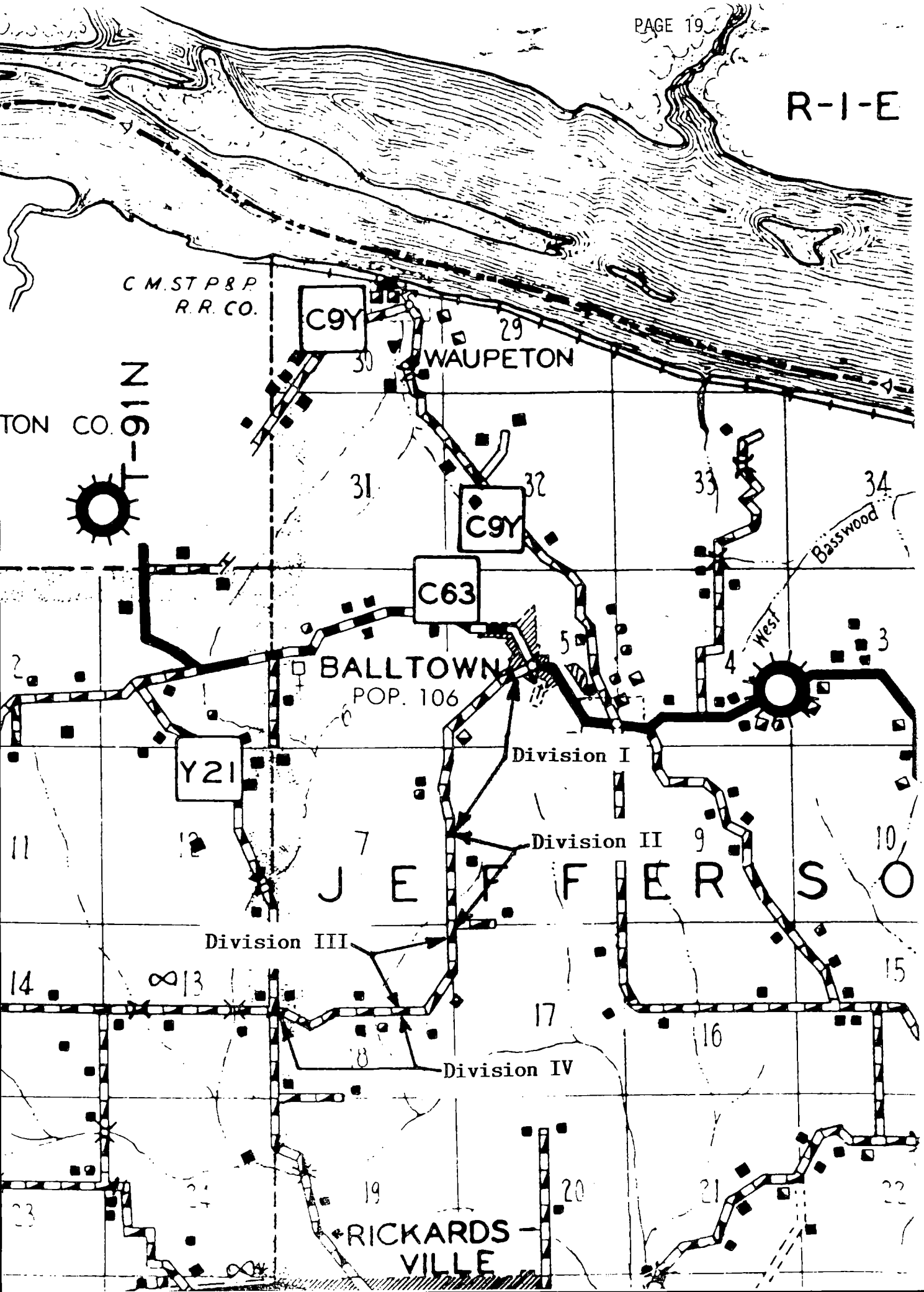
SUMMARY & CONCLUSION

Overall, the project went well. It is recommended these materials be used on roadways during the summer because of the better drying weather. The days were cool and this may have hindered efforts to get compaction.

At first observance the HFE-300 and macadam divisions seem to be performing best. The BIO CAT 300-1 and the Consolid divisions required the addition of water and small pockets of material were difficult to compact. However, it is felt there are not enough of these areas to say the materials were not successful. The winter freeze thaw cycles will give better information as to the durability of these materials.

The BIO CAT and Consolid methods are relatively new methods to this area and, therefore, close contact will be maintained with the vendors to see how these roadway base divisions will function over the next five years.


Highway and Transportation Map
DUBUQUE COUNTY
IOWA
Prepared By
Iowa Department of Transportation
Phone (515) 239-1289
In Cooperation With
United States Department of Transportation
1986
PROJECT SITE
LEGEND
STATE LINE
COUNTY LINE
CIVIL TOWNSHIP
CORPORATION LINE
SECTION LINE
INTERMITTENT STREAM
NARROW STREAM
WIDE STREAM
HIGHWAY BRIDGE SMALL
HIGHWAY BRIDGE LARGE
RAILROAD SINGLE (OPERATING COMPANY)
RAILROAD STATION
RAILROAD DEFUNCT(ABANDONED)
RAILROAD OVER (SUBWAY)
CENTER OF CITIES
CENTER OF COUNTY SEAT
RAILROAD GRADE CROSSING
STATE OR FEDERAL PROPERTY (NAMED)
DELINEATING AREA (GENERALIZED)
OPERATED SHIP AND BARGE LINES ON NATURAL STREAMS
JETTIES
FARM UNIT
DWELLING OTHER THAN FARM
ROWS OR GROUPS OF DWELLINGS
STORE OR SMALL BUSINESS ESTABLISHMENT
CHURCH OR OTHER RELIGIOUS INSTITUTION
SCHOOL OR OTHER EDUCATIONAL INSTITUTION
CEMETERY
TOURIST CAMP
SEASONAL INDUSTRY
MUNICIPAL PARK
CANTILEVER BRIDGE
QUARRY
PICNIC GROUNDS
SAWMILL (STATIONARY)
CAMP OR LODGE
GOLF GROUNDS OR COUNTRY CLUB
TRIANGULATION STATION
DAM WITH LOCK (LARGE)
TRUSS (STEEL)
POST OFFICE
RAILROAD (MORE THAN ONE OPERATING COMPANY)
UNITED STATES HIGHWAY
STATE HIGHWAY SYSTEM
COUNTY TRUNK SYSTEM
UNIMPROVED ROAD RURAL
GRADED AND DRAINED ROAD
GRAVEL ROAD
BITUMINOUS SURFACED ROAD
PAVED ROAD
FEDERAL AID HIGHWAY SYSTEM
POINTS BETWEEN WHICH DISTANCES ARE MEASURED
PIPE LINE OIL
HIGHWAY WITH PARTIAL CONTROL OF ACCESS
DIVIDED HIGHWAY
GREAT RIVER ROAD
AUTO JUNK YARD
LAND FILL
TRAILER PARK
RADIO OR T.V. STATION
GAUGING OR PUMPING STA.
SMALL PARK (COUNTY OR STATE)
COMMERCIAL DOCK
LANDING STRIP
AIRPORT LIMITED FACILITIES
LEGAL ROAD NOT OPEN TO TRAFFIC
BOOSTER STATION
SEASONAL DWELLINGS
WEATHER STATION
MISSISSIPPI RIVER
STATE OF WISCONSIN
STATE OF ILLINOIS
CLAYTON CO
DELAWARE CO
GRANT CO
JO DAVIESS CO
JACKSON CO
JEFFERSON
CONCORD
LIBERTY
NEW WINE
DODGE
TAYLOR
CASCADE
PRAIRIE
WASHINGTON
CREEK
WHITEWATER
TABLE MOUND
VERNON
MOSALEM
PERU
DUBUQUE
CENTER
T-91N
T-90N
T-89N
T-88N
T-87N
R-1W
R-1E
R-2W
R-2E
R-3E
R-4E
GUTTENBERG
DUBUQUE
EAST DUBUQUE
DURANGO
HERRALL
LUXEMBURG
HOLY CROSS
RICKARDS
BANKSTON
ASBURY
FIVE POINTS
CENTRALIA
DYERSVILLE
EPWORTH
FROST
WORTHINGTON
CASCADE
BERNARD
ZWINGLE
MASSEY
KEY WEST
JOHN DEERE PLANT
NORTHERN NATURAL GAS METERING STA.
SEC. 5 & 8 JEFFERSON TWP T-90 N R-1 E ENLARGED 4 TIMES
SEC. 31 PERU TWP T-90 N R 2E
SEC. 1 & 2 DUBUQUE TWP T-89 N, R 2 E
ENLARGED 4 TIMES
SEC. 13 & 24 TABLE MOUND TWP T-88 N R-1 E
SEC. 19 & 30 MOSALEM TWP T-88 N R-2 E
ENLARGED 4 TIMES


R-1-E
C M.ST P&P R.R. CO.
C9Y
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30
WAUPETON
TON CO.
T-91 N
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C9Y
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C63
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RICKARDS-
VILLE

Appendix B

Field Testing

NUCLEAR DENSITY

DATE	STATION	LOCATION	DEPTH	DENSITY
DIVISION II			(inches)	
9-29-88	72+00	6'R	6	116.95
			4	114.00
		5'L	6	116.05
			4	112.75
	74+00	CL	6	116.30
			4	113.00
		11'R	6	109.80
			4	109.40
		11'L	6	111.75
			4	110.60
	76+00	6'L	6	112.50
			4	105.50
		6'R	6	133.00
			4	114.00
	80+00	6'L	6	119.15
			4	117.40
		11'R	6	116.10
			4	114.35
	84+00	CL	6	121.25
			4	120.20
		6'L	6	120.80
			4	119.35
		4'R	6	123.55
			4	121.10
	86+00	8'R	6	113.05
			4	112.50
		11'L	6	119.95
			4	116.80
	88+00	6'R	6	114.00
			4	113.55
		6'L	6	121.25
			4	118.45
10-03-88	92+00	6'R	6	117.25
			4	118.75
		10'L	6	103.50
			4	106.50
	94+00	6'L	6	112.45
			4	106.45
		6'R	6	122.45
			4	122.40
	96+00	9'L	6	114.20
			4	111.70
		11'R	6	117.20
			4	115.00

NUCLEAR DENSITY

DATE	STATION	LOCATION	DEPTH	DENSITY
DIVISION II			(inches)	
10-07-88	92+00	7'R	6	122.30
			4	117.50
		CL	6	127.50
			4	122.80
		7'L	6	123.80
			4	119.30
	94+00	9'R	6	122.00
			4	120.30
		CL	6	132.40
			4	128.30
		10'L	6	120.20
			4	117.50
	96+00	7'R	6	128.30
			4	122.70
		CL	6	131.70
			4	126.90
		7'L	6	131.70
			4	127.80
	98+00	7'R	6	115.50
			4	112.00
		LL	6	115.30
			4	107.80
		7'L	6	116.40
			4	116.10
	100+00	7'R	6	118.80
			4	118.70
		CL	6	120.10
			4	116.70
		7'L	6	119.20
			4	115.50
	102+00	9'R	6	125.20
			4	122.90
		CL	6	119.70
			4	112.60
		9'L	6	126.10
			4	122.00

NUCLEAR DENSITY

DATE	STATION	LOCATION	DEPTH (inches)	DENSITY
DIVISION III				
10-05-88	50+00	7'R	6	122.50
			4	122.75
		CL	6	119.00
			4	117.50
		7'L	6	114.75
			4	114.50
	52+00	8'R	6	115.75
			4	116.50
		CL	6	115.50
			4	115.50
		8'L	6	116.00
			4	118.75
	54+00	7'R	6	119.25
			4	121.00
		CL	6	116.50
			4	117.75
		7'L	6	114.25
			4	112.25
	56+00	10'R	6	118.50
			4	118.25
		CL	6	115.75
			4	113.75
			6	118.50
			4	118.25
	58+00	7'R	6	116.75
			4	118.00
		CL	6	121.25
			4	121.75
		7'L	6	121.25
			4	123.50
	60+00	5'R	6	131.50
			4	130.50
		CL	6	128.50
			4	129.50
		6'L	6	129.25
			4	130.50
	62+00	10'R	6	120.75
			4	118.75
		CL	6	132.25
			4	130.75
		10'L	6	122.25
			4	122.75

NUCLEAR DENSITY

DATE	STATION	LOCATION	DEPTH (inches)	DENSITY
DIVISION III				
10-05-88	64+00	7'R	6	117.00
			4	116.50
		CL	6	122.00
			4	123.00
		7'L	6	125.25
			4	124.50
	66+00	10'R	6	117.50
			4	119.00
		CL	6	123.50
			4	122.00
		10'L	6	125.00
			4	125.00
		7'R	6	119.00
			4	121.50
		CL	6	125.50
			4	124.00
		7'L	6	121.75
			4	121.50

NUCLEAR DENSITY

DATE	STATION	LOCATION	DEPTH	DENSITY
DIVISION IV			(inches)	
9-09-88	2+00	7'R	BS	132.50
	2+40	L-edge	BS	114.90
	6+00	L-edge	BS	122.60
	8+00	CL	BS	128.20
	12+00	R-edge	BS	112.80
	14+00	7'L	BS	139.70
	15+00	CL	BS	136.50
	18+00	R-edge	BS	120.90
	18+00	L-edge	BS	117.40
	20+00	CL	BS	142.50
	22+00	7'L	BS	131.30
	22+00	7'R	BS	136.70
9-14-88	2+00	7'R	2	127.10
			2	124.70
	6+00	L-edge	2	129.00
		7'L	2	135.30
	10+00	R-edge	2	127.70
		7'R	2	141.70
	14+00	7'L	2	142.00
		CL	2	136.30
	18+00	7'R	2	142.50
		CL	2	138.10
	22+00	L-edge	2	143.80
		7'L	2	145.50
	26+00	R-edge	2	130.50
		7'R	2	149.00
	30+00	L-edge	2	139.50
		7'L	2	147.00
	34+00	7'R	2	149.30
		CL	2	145.20

CLEGG IMPACT TESTING

DATE	STATION	LOCATION	DENSITY	CLEGG IMPACT VALUES		
				1	2	3
9-15-88	2+00	7'R	127.10	84	84	104
		R-edge	124.70	48	54	59
	6+00	L-edge	129.00	36	44	51
		7'L	135.50	104	96	107
	10+00	R-edge	127.70	73	86	92
		7'R	141.70	114	116	113
	14+00	7'L	142.00	126	108	121
		CL	136.30	98	92	104
	18+00	7'R	142.50	112	112	112
		CL	138.10	82	77	91
	22+00	L-edge	143.80	118	93	97
		7'L	145.50	94	108	100
	26+00	R-edge	130.50	69	73	57
		7'R	149.00	91	76	74
	30+00	L-edge	139.50	92	99	92
		7'L	147.00	128	138	133
	34+00	7'R	149.30	120	118	126
		CL	145.20	102	114	140
10-03-88	96+00	9'L	114.20	35	37	44
		11'R	117.20	48	51	52
	94+00	6'L	112.45	29	32	36
		6'R	122.45	52	58	53
	92+00	10'L	103.50	34	36	37
		6'R	117.25	30	39	34
10-05-88	60+00	5'R		51	45	49
		CL		43	46	46
		6'L		34	33	40
	62+00	10'R		26	30	28
		CL		24	28	31
		10'L		29	28	32
	64+00	7'R		31	37	38
		CL		37	34	35
		7'L		32	23	25
	66+00	10'R		21	20	27
		CL		42	51	43

ROAD RATER STRUCTURAL RATING
TEST RESULTS

DATE	DIVISION	DESCRIPTION	80% SR	SOIL K
11-08-88	I	3 inch High Float Emulsion	1.55	172
	II A	10 inch BIO-CAT	1.15	170
	II B	8 inch BIO-CAT	1.22	127
	II C	6 inch BIO-CAT	1.23	172
	III	Conservex	1.39	170
	IV A	Macadam w/Fabric	1.5	161
	IV B	Macadam	2.01	222

BPR ROUGHMETER

DATE	DIVISION	REVOLUTIONS	ROUGHNESS	ROUGHNESS* IN/MI
11-08-88				
EASTBOUND LANE	I	511	90	132
	II	465	104	168
	III	483	111	172
	IV	627	131	157
11-08-88				
WESTBOUND LANE	I	508	94	139
	II	463	101	164
	III	497	112	169
	IV	617	123	150

*Roughness, (IN/MI) = $\frac{\text{Section Roughness} \times 750}{\text{No. Revolutions}}$