ALTERNATIVE FLEXIBLE OVERLAYS

FINAL REPORT
IOWA HIGHWAY RESEARCH BOARD
PROJECT HR-229

March 1988

Highway Division

Iowa Department of Transportation

Final Report
Iowa Highway Research Board
Project HR-229

ALTERNATIVE FLEXIBLE OVERLAYS

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DISCLAIMER

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

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ACKNOWLEDGEMENT

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The authors wish to extend appreciation to the Osceola County Board of Supervisors and the Iowa DOT for their support in developing and conducting this project. We also wish to thank the Rohlin Construction Company for their cooperation during the project. The Osceola County inspection personnel also deserve recognition for the extra effort put forth on the project.

ABSTRACT

The objective of this project was to determine if any of several cutback and emulsified asphalt plant mixed and road mixed overlays had the ability to resist thermal cracking at low temperatures without inducing shoving and/or rutting at high temperatures. A 2.6 mile section of Osceola County road A-34 and a 7.0 mile section of A-46 were divided into 14 test sections of various lengths. After six years, results show an MC-3000 asphalt cutback cold mix can reduce the amount of reflective cracking when compared to an AC-5 hot mix. This can be done without inducing high temperature related problems.

Cold road mixing can be effective in reducing cracking on low volume roads. However, more experience is required if the full benefits of road mixing are to be realized.

INTRODUCTION

Many of the first paved roads in Iowa, particularly in the northwest part of the state, were constructed by using a cutback asphalt mixed with crushed pit run gravel. With low traffic volumes, this type of flexible bituminous pavement has performed well, showing little sign of transverse cracking or deterioration of the asphalt binder. Many of these roads carried traffic over 20 years before needing resurfacing.

With time, the county road departments began constructing paved roads using hot mix that normally contained 85 to 100 penetration asphalts. The mixes were produced at a central plant and laid with an asphalt paver. The result was a smooth, hard, uniform asphalt concrete roadway. Transverse cracking of these pavements has become a costly maintenance problem. One reason for the cracking is the brittle pavement behavior at low temperatures. As degradation occurs at the crack, a depression forms. The result is a reduction in riding quality and a loss of pavement life.

In an attempt to avoid the cracking problem, highway engineers are looking for ways of improving the low temperature characteristics of asphalt pavements with little sacrifice in the moderate to high temperature characteristics. One potential alternative may be to return to a cutback or emulsified asphalt for county roads that carry light traffic. Research project HR-229 was conducted to determine if several flexible bituminous base sections had the ability to resist thermal cracking at low temperatures and resist rutting and shoving at high temperatures.

OBJECTIVE

The objective of the project was to evaluate several bituminous concrete base overlays to determine if any had the potential to reduce future construction and maintenance costs.

PROJECT DESCRIPTION

Two roadways in Osceola County were selected for placement of the experimental overlays. The sections included a 2.6 mile section of county road A-34 and 7.0 mile section of county road A-46 (Figure 1). The existing roadbeds of A-34 and the east four miles of A-46 consisted of a 3" cold laid bituminous concrete base over a 6" gravel base. The west three miles of A-46 were constructed as Iowa Highway Research project HR-18 in 1952 and consisted of various bases with a cold laid bituminous concrete wearing surface. Average daily traffic is 138 to 195 vehicles on A-34 and 135 to 219 vehicles on A-46.

PLAN PREPARATION

The original concept for the project included four bituminous concrete overlay test sections and a control section of Type B asphalt cement concrete overlay to be constructed on two separate roadways. It was later decided to add test sections utilizing cold mix recycling on A-46. Four 1/2 mile test sections were added to the project. The additional sections were to be constructed by

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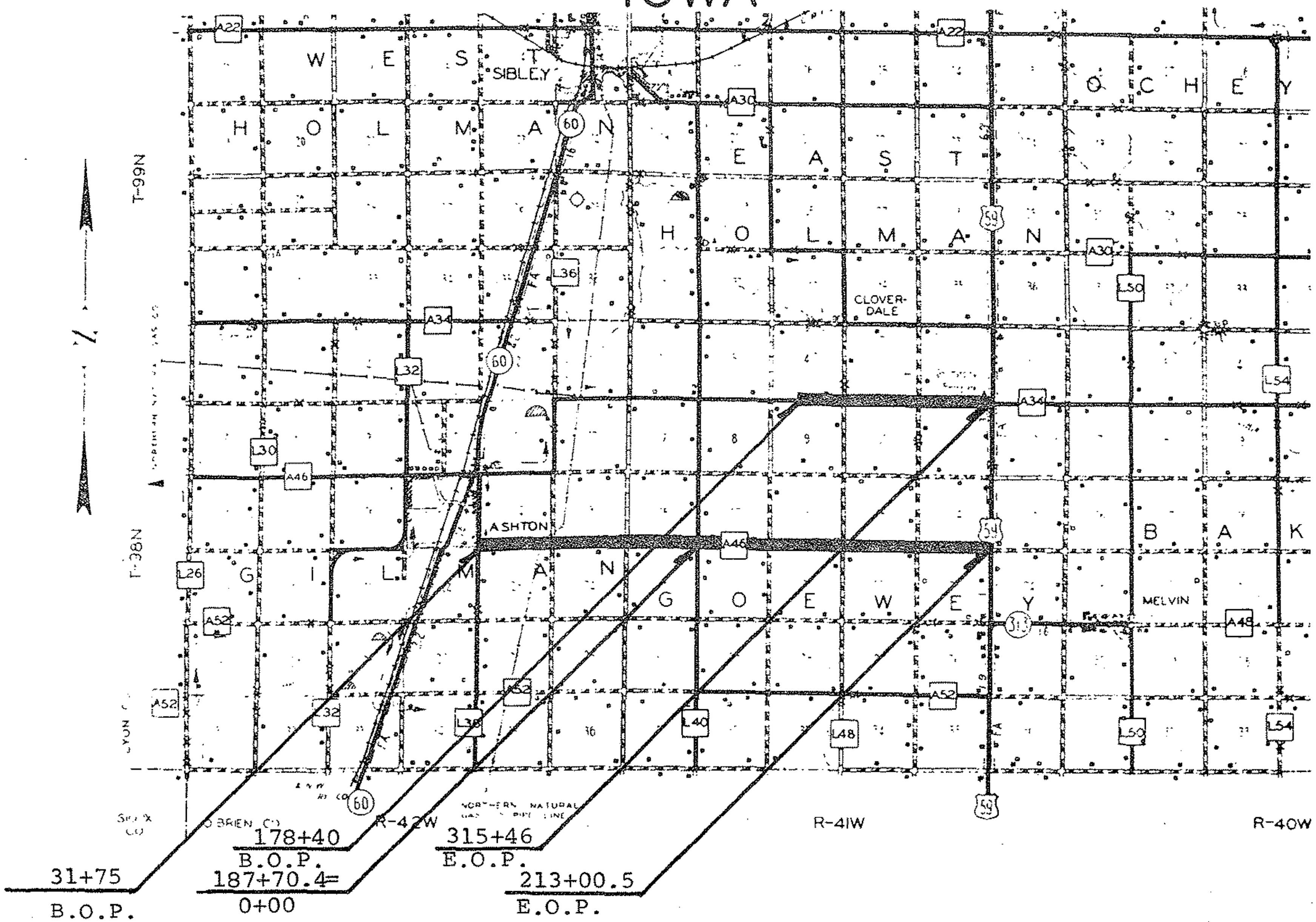


Figure 1
Project Layout

removing 1 1/2" of the existing 3" bituminous pavement, adding new aggregate and bituminous binder, and relaying the mix.

The construction plans and special provisions for A-46 were developed to allow for alternate construction. The first alternative was seven miles of bituminous overlay and the second alternative was five miles of bituminous overlay and two miles of cold mix pavement recycling. Contractor bids for the A-46 project were to be submitted on the first construction alternative only. It was intended that, if determined feasible, alternative 2 would be constructed. Payment for all work in the recycled portion of alternative 2 was to be made on the basis of the contract quantities of alternative 1 for items in that area, with no measurement for payment. Special provisions and contract quantities for both A-34 and A-46 are in Appendix A.

TEST SECTIONS

The various bituminous concrete bases were mixed using the following six bituminous binders from Bituminous Materials of Algona, Iowa:

1. AC-5 grade asphalt cement. Penetration of the asphalt was to be a minimum of 140. The AC-5 asphalt was the control section for comparison.

2. MC-3000 grade cutback asphalt. Residue from the distillation test of this material was to be a minimum of 140 penetration.

3. MC-800 grade cutback asphalt. The MC-800 was added to the project after trial mixes with some of the intended aggregates indicated adequate performance could be achieved with the softer asphalt.

4. SC-800 grade liquid asphalt. ASTM D 2026 was the only requirement specified for this material.

5. HFMS-2 High float anionic emulsified asphalt with a minimum of 5% oil distillate. Again a minimum penetration of 140 was specified for the residue from the distillation test.

6. CSS-1 cationic emulsified asphalt with a minimum of 5% oil distillate.

Gravel aggregate for the bituminous concrete sections, the bituminous recycled sections, and the Type B asphalt concrete control sections was produced by Maudlin Construction Company. Fifteen percent pea gravel (AAT1-532) from Floyd River Sand and Gravel was added to the 3/4" gravel (AAT1-591) for the Type B acc control section on A-46. All other sections were constructed using only Maudlin gravel. See Appendix B for aggregate test reports.

On A-46, ten test sections were constructed 22 feet wide using the bituminous binders. Six of the ten sections were mixed at a central plant with 3/4" gravel aggregate and laid with a paver to a 2" nominal thickness. The other four sections consisted of 67% milled bituminous pavement from the road and 33% virgin aggregate. This blend was mixed on the road with four of the bituminous binders and placed 2 1/4" thick with a motor patrol. The test sections are listed in Table I.

TABLE I
A-46 TEST SECTIONS

Section No.	Binder	Asphalt Added %	Mix Type	Section Length (Ft.)
1	AC-5	6.6	Plant Mix	5940
2	MC-3000	5.7 5.3	Plant Mix	1365 8550
3	HFMS-2	6.4	Plant Mix	2440
4	HFMS-2	4.7	Road Mix	2601
5	CSS-1	4.9	Road Mix	2549
6	CSS-1	6.5	Plant Mix	2880
7	MC-3000	5.5	Plant Mix	2620
8	MC-800	2.9	Road Mix	2594
9	SC-800	2.8	Road Mix	2556
10	SC-800	5.1 4.6	Plant Mix	1600 1085

On A-34, four test sections were constructed 23 feet wide. The sections were mixed at a central plant with 1/2" gravel aggregate and laid with the full width paver. Original plans specified a nominal 3/4" overlay, but due to construction problems, the thickness had to be increased to over one inch. The test sections are listed in Table II.

TABLE II
A-34 TEST SECTIONS

Section No.	Binder	Asphalt %	Thickness (In.)	Section Length (Ft.)
11	HFMS-2	6.4	1 1/2	1520
*12	AC-5	6.4	1 1/4	2740
13	MC-3000	5.2	1 1/8	4570
14	SC-800	5.4	1 1/8	4876

*Constructed in 1982 due to failure of original section.

Plan layouts for the test sections are shown in Appendix C.

MIX DESIGNS

Fourteen mix designs were prepared for the research project. Preparing trial mixes for Marshall testing required some deviation from standard asphalt concrete mix preparation. The MC-3000 and SC-800 mixes with the 3/4" and 1/2" gravels were mixed at 180°F. A curing time of 16 hours at a temperature of 140°F was allowed before molding the Marshall specimens. Marshall testing was done at 77°F.

The 3/4" and 1/2" gravels for mixes with HFMS-2 and CSS-1 were wetted to 5.5 percent moisture prior to mixing. Mixing, curing and molding temperature for the emulsion mixes was 130°F. The cure time before molding specimens was 16 hours and the Marshall testing was done at 77°F.

Mixes for the blend of milled pavement and new aggregate were mixed, cured and compacted at room temperature. The MC-800 and

SC-800 were heated to 160°F prior to mixing, while the HFMS-2 and CSS-1 emulsions were applied at room temperature to the aggregate blend. The mixes were allowed to cure for 20 hours before being compacted and were tested at 77°F. The mix design reports are in Appendix D.

CONSTRUCTION

Rohlin Construction Company of Estherville, Iowa, began construction on September 14, 1981.

Preparation for Road Mixing

The contractor began construction by milling the two miles of pavement on A-46. A 12 foot wide CMI Rotomill was used to remove 1 1/2" of the existing 3" bituminous pavement (Figure 2). The milling was completed in two days. Milling for the sections was done without water to avoid adding excess moisture to the material.

After completion of the milling, virgin gravel was hauled to the road to be mixed at the rate of 1:2 with the milled bituminous material. Both a Seaman Pulverizer and a Bros Pulverizer were used to blend the materials and to further break up the millings. Despite many passes by the pulverizer, very little reduction in maximum particle size was obtained. The asphalt content of the combined materials was 3 percent prior to the addition of new asphalt cement.

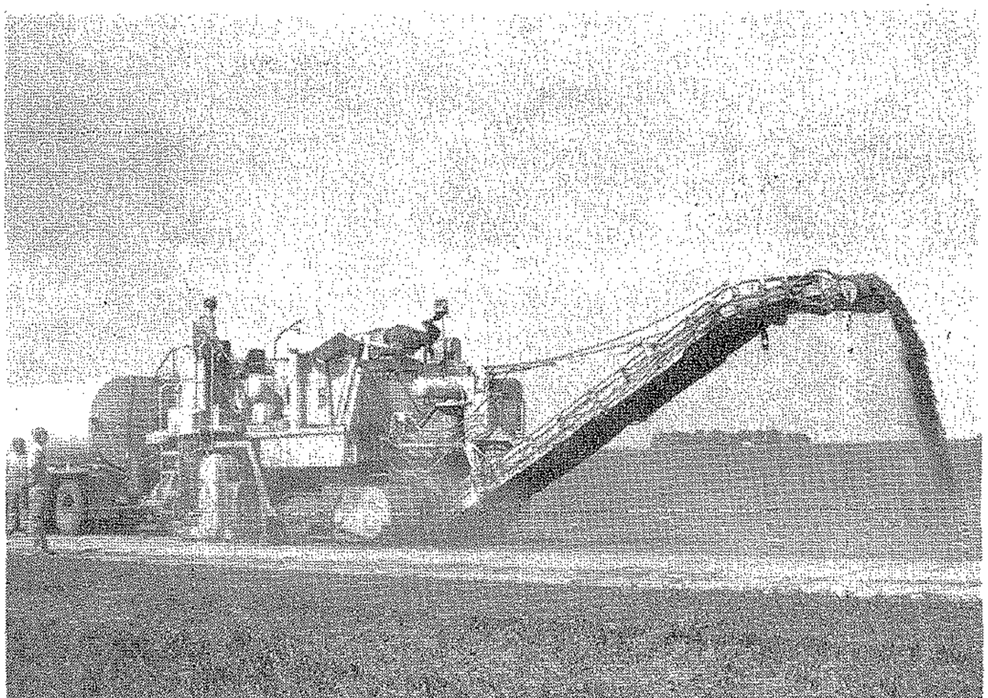


Figure 2. Milling on county road A-46

The combined aggregate and recycled material for the MC-800 and SC-800 sections was spread across the roadway and allowed to dry. The additional drying time was necessary to lower the moisture content below 2% before applying asphalt. To tack the base, the aggregate was windrowed at one side of the road. The opposite side was broomed clean and tacked with MC-70. The material was then bladed onto the tacked surface allowing the other side to be cleaned and tacked.

Road Mixing

In the special provisions, the preferred equipment for mixing and relaying the milled material was a traveling pug and a laydown machine. A traveling pug was not available, so an asphalt distributor and a Seaman or Bros Pulverizer were accepted for asphalt application and mixing. The contractor decided to use a motor patrol to spread the mix rather than an asphalt paver.

Mixing of the milled material and the SC-800 began September 18. The air temperature ranged from 68°F to 74°F. After cleaning and tacking the base, the milled material was spread across the roadwav the width of the distributor bar (Figure 3). The SC-800 asphalt was heated to 170°F prior to application. Unfortunately, the distributor wasn't capable of delivering the specified 2.8 percent asphalt in one pass. Following the initial pass of the distributor, a patrol bladed the mix into a windrow for the pulverizer mixing. The first pass of the pulverizer left the asphalt "balled-up" with the fine portion of the aggregate. The material was again spread across the road and the remaining SC-800 was applied in two additional passes. Blading the mix back and forth and subsequent passes with the pulverizer did break up most of the asphalt balls (Figure 4). As expected, 100 percent coating of the material was not achieved in the cold mix process.

After 96 hours of aeration (Figure 5), the mix was spread across the road to the 1/2" per foot cross slope. Initial compaction was by two rubber tired rollers followed by a large steel vibrating roller (Figure 6). Four days later the surface was rerolled with the rubber tired rollers.

The second section mixed was the MC-800 section. In an attempt to avoid the balling problem experienced on the SC-800 section, the material was split into three windrows and asphalt was added. The MC-800 asphalt was heated to 225°F prior to application. The distributor was then able to apply the 2.9 percent asphalt specified in one pass per windrow. The smaller windrows could also be handled much easier by the patrol and the pulverizer. Despite the change, some balling of the asphalt still occurred. The completed mix was spread and compacted the same as the previous section. Air temperature remained moderate, around 70°F, during mixing and placing of the MC-800.

The HFMS-2 and CSS-1 emulsions were mixed in a similar manner. Percentages of emulsion required in the mixes were 4.7 for the HFMS-2 and 4.9 for the CSS-1. This required six passes of the

Figure 3. First application of SC-800 to road mix

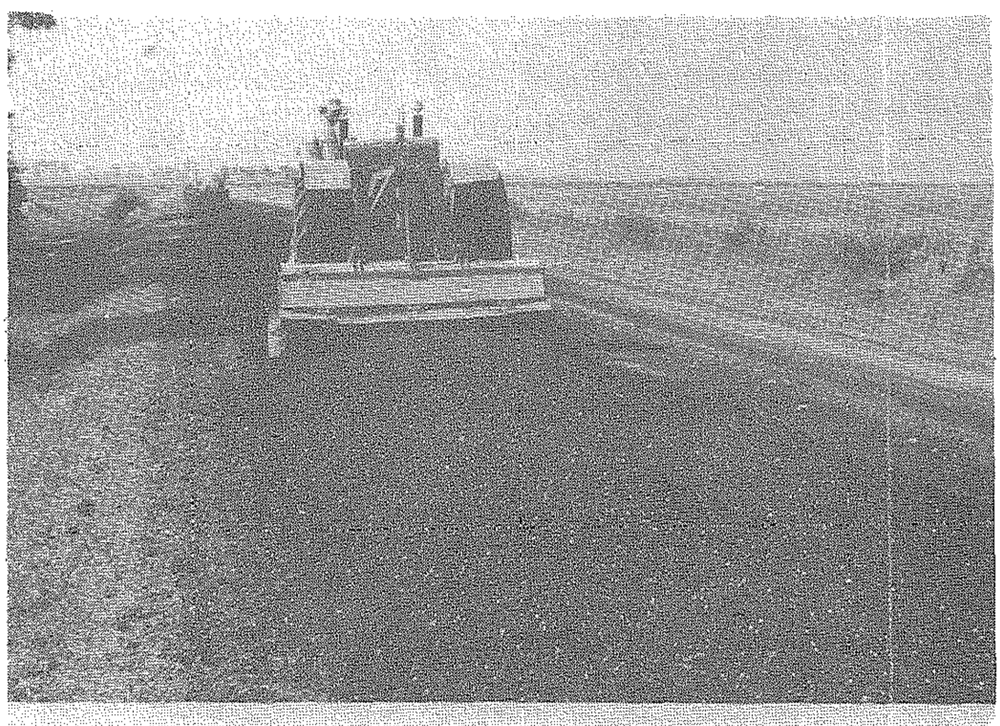


Figure 4. Mixing windrow with a pulverizer

Figure 5. SC-800 road mix left to aerate after mixing.

Figure 6. Compaction of road mix section

distributor on each section. The emulsions caused only minor balling in the mix. Air temperatures during mixing and placing were between 52°F and 65°F. The emulsions were heated to 140°F for application, but quickly cooled because of the air temperature and a strong wind. After several days the compacted surface exhibited a dark brown color and produced dust as traffic passed.

Plant Mixing and Paver Laying

The mixes composed of 3/4" and 1/2" gravel were mixed in a continuous drum mix plant set up one mile south of Ashton. Asphalt temperatures and mix temperatures for the various mixes are shown in Table III.

TABLE III
Temperatures (°F)

Binder	Asphalt Temp. °F	Mix Temp. °F
AC-5	250° to 305°	280° to 350°
SC-800	210°	195° to 200°
MC-3000	230° to 250°	190° to 235°
HFMS-2	150°	180° to 210°
*CSS-1	150° to 175°	140° to 210°

*Mix temperature was raised above 190°F because poor coating and poor laying qualities of the mix resulted at lower temperatures.

The plant mix sections were laid with a Blaw Knox full width paver. To simplify storage of the asphalt binders, the paver was first used on A-34 to lay 1/2" mix with a particular binder and then moved to A-46 to place the 3/4" mix using the same asphalt binder.

Problems began on the SC-800 section of A-34. A 1/2" mix could not be placed 3/4" thick as the plans had specified. The contractor increased the mat thickness to between 1 1/8" and 1 1/2" so that it could be laid without tearing. The problem was the same for each mix on A-34.

Another problem occurred while mixing and placing the CSS-1 material. At a mix temperature of 140°F to 150°F, poor coating of the aggregate was observed. It was difficult to lay the mix at that temperature due to dragging and tearing of the mat even at the increased thickness. At a 190°F mix temperature the problems were reduced. No significant problems arose during the resurfacing of A-46.

Compaction included a vibratory steel roller, followed by a rubber-tired roller and final rolling with a static steel roller. Generally, the rollers were held back from the paver to allow the mats to cool to between 120°F and 140°F in order to gain stability.

CONSTRUCTION COSTS

The construction costs for all plant mix sections were similar to the construction costs for the Type B acc overlay. Using bid prices for the different asphalt binders, and actual quantities used, the cost of binder per ton of mix ranged from $13.53 for the HFMS-2 emulsion to $16.15 for the MC-3000. Binder cost per ton of mix for AC-5 asphalt was $15.31. The cost per ton of mix was $13.74 for CSS-1 emulsion and $14.42 for SC-800. Bid prices for mixing, placing and compacting the bases were the same for each of the plant mixed sections. Due to the bid procedure for the road mixed sections, no bid price cost could be developed.

CONSTRUCTION TESTING

The construction of fourteen different test sections required substantial testing. Samples of each mix were taken from the roadway prior to rolling. Density samples for each section were obtained from the compacted mats.

Plant Mix Testing

From the mix samples obtained, the asphalt binders were extracted and tested for penetration and viscosity (Appendix E). As was expected, the SC-800 was too fluid to test for penetration. The other extreme was the CSS-1 emulsion extracted from the 3/4" and 1/2" mixes as penetrations of 78 and 83 indicated a relatively hard asphalt binder (similar to an AC-10). Penetrations ranging from 108 to 148 for the other three extracted asphalts were generally consistent with project expectations for the plant mixes.

The lab densities, field densities and field voids were determined for each section and are given in Appendix F. No minimum density requirements were specified for the bituminous concrete test sections. Four inch diameter cores were cut from the AC-5 Type B control section and weighed to verify that field densities met the required 94% of Marshall density. The bituminous concrete sections were too soft for cutting cores so a nuclear density gauge was used to obtain field densities.

Road Mix Testing

Bituminous binders extracted from the road mixed sections constructed with 67% reclaimed bituminous pavement had relatively low penetrations except for the SC-800 (Appendix E). This was expected due to the presence of 3% old asphalt cement with a penetration of 40 in the mix. The very soft SC-800 had a dramatic effect on the old asphalt binder and produced a penetration of 140 for the extracted asphalt combination.

The field densities for the road mix sections were obtained by use of the nuclear density gauge. Lab densities, however, were based on modified proctor density rather than Marshall density. Lab densities, field densities and field voids are given in Appendix F.

DISCUSSION

The purpose of the project was to construct flexible bituminous concrete base overlays which have the potential to reduce future maintenance and construction costs. The recycled portions of the project were added as a possible alternative to overlay construction for a deteriorated road.

Plant Mixed Sections

The construction of the plant mixed sections was generally successful using standard asphalt construction equipment and procedures.

One disappointment was the stripping of aggregate on the CSS-1 sections. During trial mixing no special consideration was given to the compatibility of the aggregate and the binder. In the future, more attention should be paid to the electrical charge of both aggregate and emulsion in order to minimize the potential of stripping or premature failure.

Another problem which was not expected was the necessity to increase the thickness of the 1/2" mix to avoid tearing the mat. Common practice for paver laid hot mix is to use a maximum aggregate size which is no larger than 50 percent of the mat thickness. The relatively low mix temperatures may have contributed to the problem.

Road Mixed Sections

The construction of the road mixed sections was somewhat disappointing. Equipment used on the job was not the optimum. The initial problem was how to eliminate oversized pieces of milled pavement. Passes by the pulverizers had only marginal success at reducing the amount of 1" plus chunks. As a result of several passes by the pulverizer, additional fine material was produced.

The other problem encountered was inadequate mixing. Addition of asphalt binder through an asphalt distributor caused the binder to flow on top of the aggregate and cool before the pulverizer could mix the materials.

The mixing equipment used on this project could not adequately mix the recycled pavement and the small amount of binder. An improved procedure would have been to first screen off the oversized pieces of milled pavement (or run the millings through a traveling crusher). A more effective means of mixing the materials would be to use a traveling pug mill or a pulverizer equipped to apply the required percentage of binder directly into the mixing chamber.

Despite the difficulties during construction, the MC-800 and SC-800 produced a surprisingly good surface. The two emulsion sections, however, appeared very lean on asphalt. Both emulsion sections remained a dark brown color after construction and produced dust as traffic passed.

PERFORMANCE

The late completion date of the paving forced the county to postpone the application of the seal coat surfacing planned for the project. A winter seal was applied only to the surface of the road mix sections before winter.

Performance of Plant Mixed Sections

It was apparent, shortly after construction, that the plant mixed CSS-1 emulsion sections were not performing well. Besides having low penetrations, the sections experienced aggregate loss from the surface. The emulsion may not have been compatible with the gravel aggregate. Eventually the 1/2" mix of CSS-1 on A-34 had to be bladed off with a motor patrol. The CSS-1 sections on A-46 experienced the same problem, but to a much lesser extent. The other plant mixed sections performed satisfactorily with little noticeable difference in appearance.

In early summer of 1982, county road A-46 was used as a haul road for 15 ton aggregate trucks transporting material to a four-mile pcc paving project. The heavy trucks caused some areas of the CSS-1 emulsion section to lose surface aggregate. The surface of the 1/2 mile CSS-1 section was corrected by resurfacing with an asphalt sand mix in July 1982.

Also in July 1982, 1 1/4" of Type B mix of AC-5 and 1/2" gravel was placed on A-34 where the CSS-1 section had earlier been removed. The resurfacing of A-46 and A-34 was completed with a seal coat surface over the test sections. One-half mile of the AC-5 section and 1200 feet of the SC-800 plant mix section on A-46 were left with no seal coat to observe the effects of traffic and weather on the base material. However, these sections were covered when A-46 was seal coated a second time. The east 4 miles were seal coated in 1985 and the west 3 miles in 1986. Specific locations of construction and maintenance, excluding this seal coat, are shown in Appendix G.

At the end of the five year research period, several statements can be made concerning the condition of the pavement. First, rut depth measurements made at the end of the research period show that no significant rutting has taken place throughout the length of any one section. Ten sets of four readings were made in the wheel paths of each section (Appendix H). The largest average rut depth was 0.12 inch in the MC-3000 section on A-34. In general, rutting of the experimental sections on A-34 was slightly greater than those of similar sections on A-46. It should be noted, however, that A-34 had a rutting problem prior to construction and had known subbase problems.

Also, the degree of base degradation at crack locations appears to be minimal since no depressions were noticed upon visual inspection.

TABLE IV
CRACKING AND RUTTING VALUES

Section No.	Average Rut Depth (Inches)	Linear Feet of Transverse Cracks Per Station (12-21-87)
1	0.10	22.6
2	0.10	9.4
3	0.09	95.1
4	0.11	----
5	0.06	----
6	0.08	----
7	0.07	86.9
8	0.22	22.9
9	0.16	29.3
10	0.07	93.0
11	0.11	1.5
12	0.09	4.0
13	0.12	4.1
14	0.10	9.5

Although the paved sections have performed similarly in terms of rutting and crack degradation, it was obvious at the end of the six-year test period the MC-3000 and HFMS-2 sections had outperformed the SC-800 and CSS-1 sections. This conclusion is based on crack surveys taken throughout the research period. Results of the surveys are given in terms of linear feet of transverse cracks per station of pavement (see Appendix I). The better performance of these sections is also directly related to their higher structural ratings as determined with the Road Rater (Appendix J).

Also from available information, the percentage of original cracks which reflected to the surface could be calculated for several sections. From these calculations it became clear the MC-3000 sections had the best performance record of all the paver laid sections.

Performance of Road Mixed Sections

The two emulsion road mixed sections, having a sand seal only, performed better than expected through the winter of 1981-82. Although samples from the roadway contained nearly 7% asphalt, the sections appeared very lean on asphalt. It was evident the emulsions did little to activate the old asphalt.

The following summer (1982) both road mixed emulsion sections required maintenance. A 1300 foot ac surface patch was placed on the HFMS-2 section and the entire one-half mile CSS-1 section was resurfaced with asphalt concrete. The two sections were then seal coated as originally planned. As mentioned previously, these sections were again resurfaced when A-46 was seal coated in 1985.

The incompatibility of the emulsion and aggregate was the expected cause for the failure of the CSS-1 section.

The road mixed SC-800 and MC-800 sections have performed satisfactorily during the research period. The initial construction of these sections was completed by applying a seal coat in July 1982. A 1000 foot segment in both the SC-800 and MC-800 sections was double seal coated in an attempt to correct surface distortions. The double seal coat technique provided a good surface, indicating a double seal coat treatment might be justified on future projects.

Overall, the road mixed sections were superior to the paver laid sections of A-46 in terms of cracking. The HFMS-2 section was especially impressive, averaging only 1 transverse crack every 4 stations. The MC-800 and SC-800 sections averaged nearly 1 crack per station. (Appendix I). Undoubtedly these results were greatly influenced by the additional surface work the road mixes required beyond the seal coats applied in 1982 and 1985-86, especially those of the HFMS-2 section.

Rutting became a more severe problem in the SC-800 and MC-800 sections, with rut measurements averaging 0.16 inch and 0.22 inch, respectively, being taken at the end of the research period. The emulsion sections had little rutting, due to the major resurfacing of these sections (Appendix H).

CONCLUSIONS

From the construction and performance of the paver laid and road mixed sections, several conclusions can be drawn.

Plant Mixed Sections

The success of the MC-3000 mixes in reducing the amount of reflective cracking (especially section 2) shows the paver laying process using a cutback asphalt can result in a pavement equal to hot mixed asphalt in terms of preventing reflective cracking. The lower mix temperature of the cutback mixes apparently resulted in less thermal contraction after placement and during cold weather. The lower mixing temperature and surface seal seemed to keep the asphalt from oxidizing. Also, test results show high temperature effects, such as rutting and shoving, are not a concern under moderate traffic conditions.

The use of cutback asphalts, especially the MC-3000, can be used successfully on low volume roads to reduce the amount of maintenance resulting from cracking of a normal asphalt concrete mix.

Road Mixed Sections

The road mixed sections generally had fewer cracks per station than the plant mixed sections.

Lab and field densities of the road mixed sections were low because of mixing at ambient temperatures. This resulted in a pavement more susceptible to rutting, as evidenced by the higher rutting values of the road mixed MC-800 and SC-800 sections. The unrutted condition of the other road mixed sections was due to the replacement/repair of these sections.

The generally poor results of the road mixed sections were the result of inexperience in both mix design and construction. The contractor was allowed to start too late into the construction season using equipment not suited for road mixing. Future construction involving road mixing must address these problems if more successful results are to be realized.

Appendix A

Contract Quantities and Special Provisions

Contract Quantities   County Road A-34

	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Base, Cleaning & Preparation of	6.817	Miles	100.00	681.70
2	Primer of Tack-Coat Bitumen	5.872	Gals.	.95	5,578.40
3	Base, Type B Class 2 Asphalt Cement Concrete	577	Tons	9.17	5,291.09
4	Base, Bituminous Concrete Class 2	3,381	Tons	9.17	31,003.77
5	Asphalt-Sand Surface Course	160	Tons	30.00	4,800.00
6	Base, Binder Bitumen HFMS-2	27,823	Gals.	.90	25,040.70
7	Base, Binder Bitumen CSS-1	9,966	Gals.	.90	8,969.40
8	Base, Binder Bitumen MC-3000	7,619	Gals.	1.25	9,523.75
9	Base, Binder Bitumen SC-800	6,940	Gals.	1.15	7,981.00
10	Asphalt Cement	50	Tons	232.00	11,600.00
				Grand Total	$110,469.81

Contract Quantities   Co. Rd. A-46

	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	Base, Cleaning & Preparation of	6.988	Miles	100.00	698.80
2.	Primer Or Tack-Coat Bitumen	7,313	Gals	1.00	7,313.00
3.	Base, Type B Class 2 Asphalt Cement Concrete	1,437	Tons	9.07	13,033.59
4.	Base, Bituminous Concrete Class 2	8,483	Tons	9.07	76,940.81
5.	Asphalt-Sand Surface Course	70	Tons	30.00	2,100.00
6.	Asphalt Cement	99	Tons	232.00	22,968.00
7.	Base, Binder Bitumen HFMS-2	70,918	Gals	.90	63,826.20
8.	Base, Binder Bitumen CSS-1	24,439	Gals	.90	21,995.10
9.	Base, Binder Bitumen MC-3000	24,354	Gals	1.25	30,442.50
10.	Base, Binder Bitumen SC-800	17,190	Gals	1.15	19,768.50
			Grand Total		$259,086.50

Alternate Construction Quantities

1.	Base, Cleaning & Preparation of	4.981	Miles
2.	Primer or Tack-Coat Bitumen	7,313	Gals
3.	Base, Type B Class 2 Asphalt Cement Conc.	1,437	Tons
4.	Base, Bituminous Concrete Class 2	5,713	Tons
5.	Asphalt-Sand Surface Course	50	Tons
6.	Asphalt Cement	99	Tons
7.	Base, Binder Bitumen HFMS-2	67,057	Gals
8.	Base, Binder Bitumen CSS-1	20,588	Gals
9.	Base, Binder Bitumen MC-3000	21,367	Gals
10.	Base, Binder Bitumen SC-800	14,491	Gals
11.	Aggregate, For Bituminous Mix	969	Tons
12.	Planing & Milling Existing Base	25,911	Sq. Yds.
13.	Mixing & Relaying Bituminous Concrete Base	25,911	Sq. Yds.

IOWA DEPARTMENT OF TRANSPORTATION
Ames, Iowa

Special Provisions
for

ACC PROJECTS

Osceola County Projects:
FM-72(7)--55-72
SN-69(1)--51-72

May 27, 1981

THE STANDARD SPECIFICATIONS, SERIES OF 1977, ARE AMENDED BY THE FOLLOWING ADDITIONS AND MODIFICATIONS. THESE ARE SPECIAL PROVISIONS AND SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

358.01 GENERAL. The work shall consist of the construction of two Type B asphalt cement concrete base sections and various compacted bituminous concrete base courses as specified on the plans. Section 2203 of the Standard Specifications will apply to Division 1 (Type B ACC base) and Section 2204 of the Standard Specifications will apply to Divisions 2, 3, 4, and 5 (various compacted bituminous concrete base courses) except where modified by these special provisions or other DOT current special provisions. Section 1109.03 of the Standard Specifications shall not apply to asphalt-sand mix, SC-800, or primer or tack coat. All or any part of the work may be eliminated at the discretion of the engineer.

It is intended that some wheel-track distortion be corrected by placing a heavy tack coat, blading a hot asphalt-sand mix into the areas, and rolling it up to six times with a rubber-tired roller. The areas to be corrected, mix designs, and construction procedures will be determined during construction.

It is proposed that two miles of Project RS-69(1) will be milled, mixed, and laid cold, if found feasible. This work may be done before other work is started and therefore need not delay other work. If the alternate is not found feasible, as determined by the engineer, these areas will be constructed according to the original plan; however milled depths other than the proposed 1½ inches will be considered if the contractor and engineer can reach agreement on construction methods and payment.

358.02 MATERIALS.

A. Primer or Tack-Coat Bitumen — MC-70 meeting requirements of Section 4138 shall be used.

B. Division 1 - AC-5 meeting requirements of AASHTO M 226-78, Table 2, shall be used.

C. Division 2 - Anionic high-float emulsified asphalt meeting requirements of ASTM D 977 shall be used. Residue from the distillation test of this material shall be a minimum 140 penetration at 77°F. (25°C.) with 100g. for 5 seconds. The anionic high-float emulsified asphalt shall contain a minimum of 5% oil distillate. HFMS-2 is intended, but the grade will depend on the design and job-mix formula determinations.

D. Division 3 - Cationic emulsified asphalt meeting requirements of AASHTO M 208-72 shall be used. Residue from the distillation test of this material shall be a minimum 140 penetration at 77° F (25°C.) with 100g. for 5 seconds. The cationic emulsified asphalt shall contain a minimum of 5% oil distillate. CSS-1 is intended, but the grade will depend on the design and job-mix formula determinations.

E. Division 4 - Medium curing cut-back asphalt meeting requirements of AASHTO M 82-75 shall be used. Residue from the distillation test of this material shall be a minimum 140 penetration at 77°F. (25°C) with 100g. for 5 seconds. MC-3000 furnished in the upper half of the viscosity range is intended, but the grade will depend on the design and job-mix formula determinations.

F. Division 5 - Slow curing liquid asphalt meeting requirements of ASTM D 2026 shall be used. SC-800 is intended, but the grade will depend on the design and job-mix formula determinations.

G. Aggregate - The aggregate incorporated in the Type B, Class 2 asphalt cement concrete (asphaltic concrete) base and the various types of bituminous concrete bases, including virgin aggregate to be in mixtures for the milled areas, shall meet requirements of Section 4126 and Gradation No. 19, Section 4109, except Paragraph 4126.04C shall be deleted. All pit-run material passing an 8-inch screen shall be crushed and incorporated in the aggregate.

The aggregate incorporated in the asphaltic-sand mix shall meet requirements of Specification 4129 and Gradation No. 22, Section 4109.

H. Final Mixture - Refer to general notes on plans.

358.03 EQUIPMENT.

A. Divisions 2, 3, 4, and 5 - Article 2001.19 of the Standard Specifications shall apply where the material is paver laid.

358.04 CONSTRUCTION

A. Divisions 2, 3, 4, and 5 - It is intended the various bituminous concrete base courses shall be paver laid with the option to spread with motor patrols, if so approved by the engineer. Articles 2203.09, 2203.10, 2203.11, 2203.13, and 2203.15 of the Standard Specifications shall apply where the material is paver laid, except the second paragraph of 2203.10 shall not apply. Article 2204.07 will not apply.

B. Additional Construction Work on Project RS-69(1). The following additional construction work is intended on this project.

Milling - This work shall include all labor and equipment for milling or planing 25,911 square yards, 1½ inch in depth, of the existing bituminous concrete base on Project RS-69(1). Intended areas to be milled are from station 26+50, Division 2, to station 79+50, Division 3, and from station 133+00, Division 4, to station 186+00, Division 5. Over 95% of this milled material must pass a 1-inch sieve; large pieces not incorporated in the mix will be loaded on county trucks.

Mixing and Relaying - This work shall include all labor and equipment for mixing and relaying the milled bituminous concrete base. This work shall include adding a virgin aggregate to the milled material so that a 2¼-inch lift will be re-laid by tacking the milled surface, adding asphalt to the combined mix, and re-laying and compacting the mix on the same areas. It is preferred that a traveling pug be used for mixing and that a laydown machine be used for laying; however other methods producing acceptable results may be used, if acceptable to the engineer.

This additional work and the revised quantities within this area are identified on the plans as alternate construction. Payment for all work in this area, if constructed as intended, will be made on the basis of the contract quantities for items identified on the plans as quoted construction, with no measurement for payment, as noted on the plans. This payment will be full compensation for furnishing all equipment, labor, and materials necessary to do this additional construction work within the area designated.

Appendix B

Aggregate Test Reports

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - BITUMINOUS MATERIALS
LAB LOCATION AMES

MATERIAL PEA ROCK — LAB NO. AAT1-532

INTENDED USE 10-15% ADDED TO #4126 AGGREGATE

COUNTY OSCEOLA — PROJ NO. SN-29(3), FM-72(7)

DESIGN — CONTRACT NO. 18620, 18619, 18618

PRODUCER FLOYD RIVER SAND & GRAVEL — CONTRACTOR ROHLIN CONST.

SOURCE

UNIT OF MATERIAL 3 SACKS FROM STOCKPILE 2,500 TON

SAMPLED BY BOB FREY — SENDER'S NO. BF-5

DATE SAMPLED 8-14-81 — REC'D 8-17-81 — REPORTED 9-25-81

SIEVE ANALYSIS - PER CENT PASSING

1 1/2"	
1"	
3/4"	
1/2"	
3/8"	100
NO. 4	22
NO. 8	1.5
NO. 16	1.0
NO. 30	0.9
NO. 50	0.8
NO. 100	0.7
NO. 200	0.7

% PSG. NO. 8 AFTER 16 CYCLES F & T, WATER-ALCO. SOL.
% PSG. NO. 8 AFTER 25 CYCLES F & T, WATER SOLUTION
% OF WEAR, LOS ANGELES ABRASION, GRADING

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX

COPIES:
BIT. AGG.
J. BUMP
PAUL SCHWARTING
L. ZEARLEY
PROJECTS LISTED ABOVE

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - BITUMINOUS MATERIALS
LAB LOCATION AMES

MATERIAL 3/4" CRUSHED AGGREGATE LAB NO. AAT1-591

INTENDED USE TYPE B CLASS 2 & BIT. CONC. BASE

COUNTY OSCEOLA PROJ NO. SN-69(3) SN-29(3)

DESIGN CONTRACT NO.

PRODUCER MAUDLIN CONST. CONTRACTOR ROHLIN CONST.

SOURCE NE-1/4 28-98-42 OSCEOLA CO.

UNIT OF MATERIAL 2 SACKS 18,000 T.

SAMPLED BY BOB FREY SENDER'S NO. 7/31-1 A&B

DATE SAMPLED 7-31-81 REC'D 9-1-81 REPORTED 9-25-81

SIEVE ANALYSIS - PER CENT PASSING

1 1/2"	
1"	
3/4"	100
1/2"	95
3/8"	87
NO. 4	71
NO. 8	58
NO. 16	45
NO. 30	29
NO. 50	14
NO. 100	8.2
NO. 200	6.5

% PSG. NO. 8 AFTER 16 CYCLES F & T, WATER-ALCO. SOL.
% PSG. NO. 8 AFTER 25 CYCLES F & T, WATER SOLUTION
% OF WEAR, LOS ANGELES ABRASION, GRADING

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX

COPIES:
BIT. AGG.
J. BUMP
P. SCHWARTING
L. ZEARLEY
PROJECTS LISTED ABOVE

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - BITUMINOUS MATERIALS
LAB LOCATION AMES

MATERIAL 1/2" CRUSHED AGGREGATE LAB NO. AAT1-592

INTENDED USE BIT. CONC. BASE OVERLAY

COUNTY OSCEOLA PROJ NO. FM-72(7)

DESIGN CONTRACT NO.

PRODUCER MAUDLIN CONST. CONTRACTOR ROHLIN CONST.

SOURCE NE-1/4 28-98-42, OSCEOLA CO.

UNIT OF MATERIAL 4 SACKS 4,000 T.

SAMPLED BY BOB FREY SENDER'S NO. 7/31-2

DATE SAMPLED 7-31-81 REC'D 9-1-81 REPORTED 9-25-81

SIEVE ANALYSIS - PER CENT PASSING

1 1/2"	
1"	
3/4"	100
1/2"	98
3/8"	90
NO. 4	69
NO. 8	56
NO. 16	42
NO. 30	26
NO. 50	14
NO. 100	8.7
NO. 200	7.7

% PSG. NO. 8 AFTER 16 CYCLES F & T, WATER-ALCO. SOL.
% PSG. NO. 8 AFTER 25 CYCLES F & T, WATER SOLUTION
% OF WEAR, LOS ANGELES ABRASION, GRADING

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX

COPIES:
BIT. AGG
J. BUMP
P. SCHWARTING
L. ZEARLEY
FM-72(7), OSCEOLA

DISPOSITION:

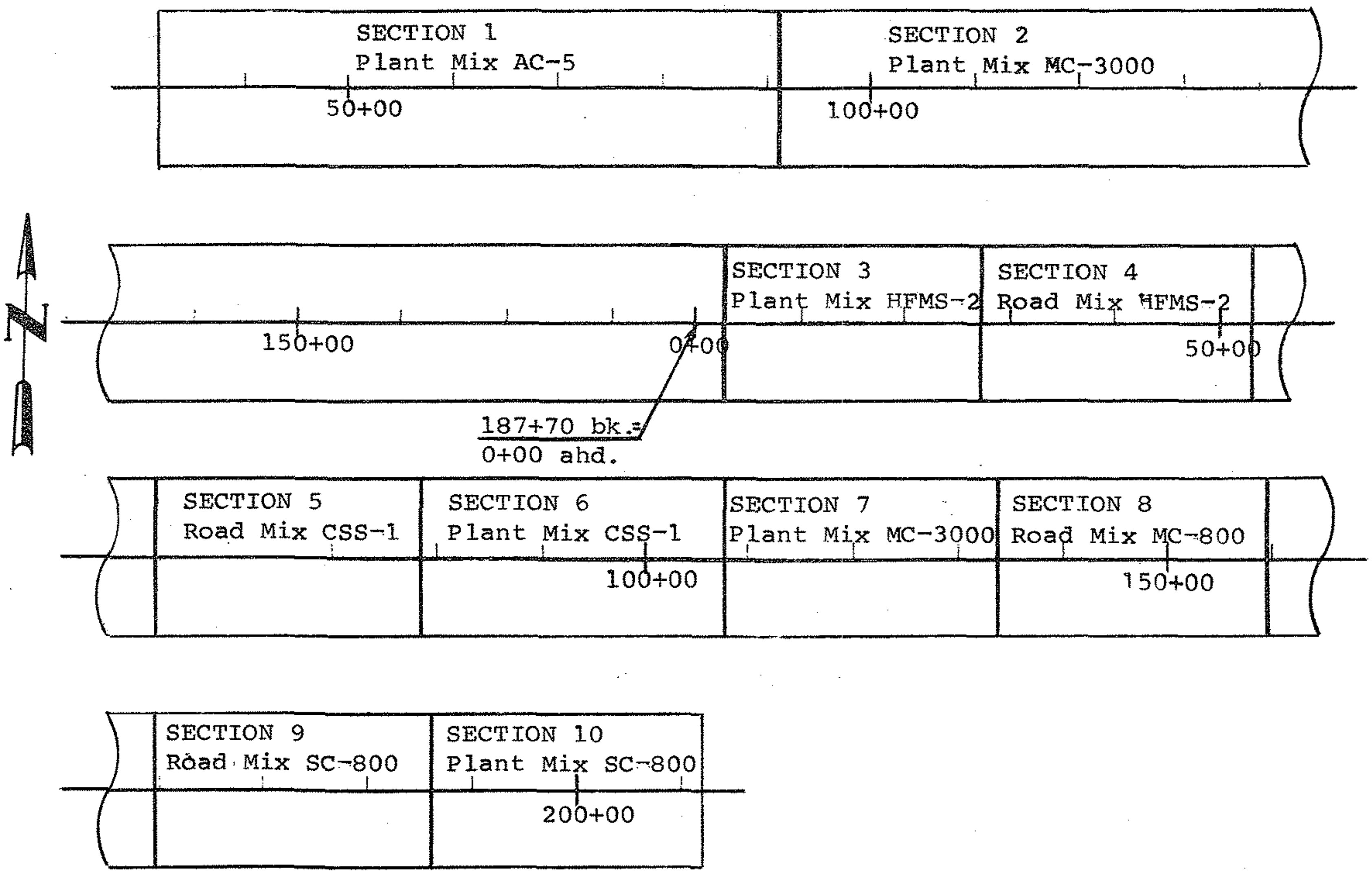
SIGNED: BERNARD C. BROWN

Appendix C

Test Section Layout

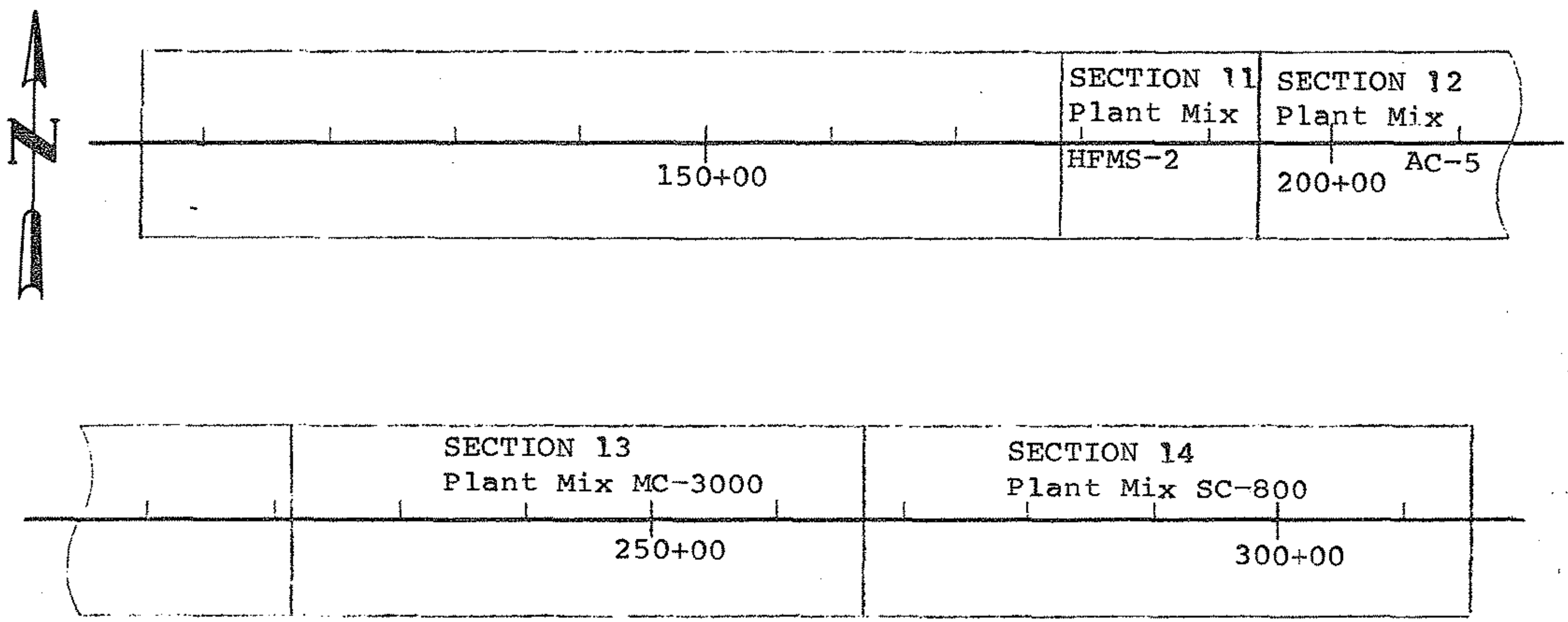
Test Section Layout

A-46



Test Section Layout

A-34



Appendix D

Mix Design Reports

IOWA DEPARTMEN OF TRANSPORTATION
OFFICE OI MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION   AMES

MIX, TYPE AND CLASS: TYPE B CLASS I   LAB NO. ABD1-140

INTENDED USE. AC-5

SIZE 3/4"   SPEC. NO.   DATE REPORTED 9/15/81

COUNTY OSCEOLA   PROJECT SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72

CONTRACTOR ROHLIN

PROJ. LOCATION

AGG. SOURCES 3/4" GRAVEL - ASHTON PIT - OSCEOLA CO.;
PEA GRAVEL - FLOYD RIVER SAND & GRAVEL
JOB MIX FORMULA AGGREGATE PROPORTIONS: 85% AAT1-482, 15% AAT1-532

JOB MIX FORMULA - COMBINED GRADATION

	1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	96	89	64	50	38	25	12	7.1	5.6	
TOLERANCE:	98/100		7	7	6		5				3	

75 BLOW MARSHALL DENSITY		2.32	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 537 POISES		
PLASTICITY INDEX	N. P.		
% ASPH. IN MIX	5.0	6.0	7.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS	1933	1817	2047
FLOW - 0.01 IN.	7	7	8
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.25	2.29	2.32
BULK SP. GR. COMB. DRY AGG.	2.634	2.634	2.634
SP. GR. ASPH. @ 77 F.	1.022	1.022	1.022
CALC. SOLID SP.GR.	2.48	2.44	2.41
% VOIDS - CALC.	9.3	6.3	3.6
RICE SP. GR	2.47	2.43	2.39
% VOIDS - RICE	8.8	5.8	3.0
% WATER ABSORPTION - AGGREGATE	1.38	1.38	1.38
% VOIDS IN THE MINERAL AGGREGATE	18.8	18.3	18.1
% V.M.A. FILLED WITH ASPHALT	50.7	65.6	79.8
CALCULATED ASPH.FILM THICKNESS(MICRONS)	7.7	9.6	11.5
FILLER/BITUMEN RATIO		0.9	

A CONTENT OF 6.50% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:
ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
J. PUMP
P. SCHWARTING
D. JORDISON
R. SHELQUIST
L. ZEARLEY
ROHLIN
C. JONES

SIGNED: BERNARD C. BROWN

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX. TYPE AND CLASS: TYPE B CLASS 2 LAB NO. ABD1-131

INTENDED USE: AC-5

SIZE 1/2" SPEC. NO. DATE REPORTED 9/15/81

COUNTY OSCEOLA PROJECT SN-29(3)--51-72 ~~SN~~-69(3)--51-72 FM-72(7)--55-72

CONTRACTOR ROHLIN

PROJ. LOCATION

AGG. SOURCES 1/2" GRAVEL - ASHTON PIT - OSCEOLA CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT1-509

JOB MIX FORMULA - COMBINED GRADATION

	1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	98	90	69	56	42	26	14	8.7	7.3
TOLERANCE:				98/100	7		6		5			3

75 BLOW MARSHALL DENSITY		2.29	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 572 POISES		
PLASTICITY INDEX	2		
% ASPH. IN MIX	5.0	6.0	7.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	2072	2043	1907
FLOW - 0.01 IN.	8	8	8
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.26	2.28	2.29
BULK SP. GR. COMB. DRY AGG.	2.641	2.641	2.641
SP. GR. ASPH. @ 77 F.	1.022	1.022	1.022
CALC. SOLID SP.GR.	2.48	2.45	2.41
% VOIDS - CALC.	9.0	6.9	5.1
RICE SP. GR.	2.48	2.42	2.36
% VOIDS - RICE	8.9	5.7	3.1
% WATER ABSORPTION - AGGREGATE	1.32	1.32	1.32
% VOIDS IN THE MINERAL AGGREGATE	18.7	18.8	19.4
% V.M.A. FILLED WITH ASPHALT	51.6	63.6	73.8
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.6	8.2	9.8
FILLER/BITUMEN RATIO		1.1	

A CONTENT OF 6.75% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:
ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
J. BUMP
P. SCHWARTING
D. JORDISON
R. SHELQUIST
L. ZEARLEY
ROHLIN
C. JONES

Asph. Mix Design
Projects Listed Below
J. Bump
P. Schwarting
D. Jordison
R. Shelquist
L. Zearley

Form 956
1-75

Rohlin
C. Jones

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-157

Intended Use: SC-800 Cold Mix Spec. No. Date Reported 9/28/81

County: Osceola Proj. No. SN-29(3)--51-72 / SN-69(3)--51-72 / FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 3/4" Gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-591

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	95	87	71	58	45	29	14	8.2	6.5
Tolerance											

Asphalt Source and Approximate Viscosity	Algona	
% Asph. In Mix	5.0	6.0
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2242	2300
Flow - 0.01 In.	8	9
Sp. Gr. By Displacement (Lab Dens.)	2.26	2.27
Bulk Sp. Gr. Comb. Dry Agg.	2.634	2.634
Sp. Gr. Asph. @ 77 F.	0.9744	0.9744
Calc. Solid Sp. Gr.	2.43	2.39
% Voids - Calc.	6.9	5.0
Rice Sp. Gr.		
% Voids - Rice		
% Water Absorption - Aggregate	--	--
% Voids in the Mineral Aggregate	18.5	19.0
% V.M.A. Filled with Asphalt	62.7	73.6
Calculated Asph. Film Thickness (Microns)	7.8	9.4

Mixing Temp. 180° F.
Cure - 16 hrs. @ 140° F.
Molding Temp. 140° F.
Testing Temp. 77° F.

A content of 5.50% SC-800 is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Form 956
1-75

Rohlin Constr.
C. Jones

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
MATERIALS DEPARTMENT
ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
Projects Listed Below
J. Bump
P. Schwarting
D. Jordison
R. Shelquist
L. Zearley

Mix, Type and Class: Type B Class 2 Size 1/2" Lab. No. ABD1-159

Intended Use: SC-800 Cold Mix Spec. No. Date Reported 9/28/81

County: Osceola Proj. No. SN-29(3)--51-72 / ~~SN~~-69(3)--51-72 / FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 1/2" Gravel 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT-592

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	98	90	69	56	42	26	14	8.7	7.3
Tolerance											

Asphalt Source and Approximate Viscosity	Algona - SC-800	
% Asph. In Mix	5.0	6.0
Number of Marshall blows	50	50
Marshall Stability - Lbs.	1940	1960
Flow - 0.01 In.	8	10
Sp. Gr. By Displacement (Lab Dens.)	2.24	2.25
Bulk Sp. Gr. Comb. Dry Agg.	2.641	2.641
Sp. Gr. Asph. @ 77 F.	0.9744	0.9744
Calc. Solid Sp. Gr.	2.43	2.40
% Voids - Calc.	7.9	6.1
Rice Sp. Gr.	Mixing Temp. 180° F. Cure - 16 Hrs. 140° F.	
% Voids - Rice	Molding Temp. 140° F. Testing Temp. 77° F.	
% Water Absorption - Aggregate	--	--
% Voids in the Mineral Aggregate	19.4	19.9
% V.M.A. Filled with Asphalt	59.2	69.6
Calculated Asph. Film Thickness (Microns)	7.6	9.2

A Content of 5.25% SC-800 is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Asph. Mix Design
SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72, Osceola
J. Bump, Schwarting
D. Jordison, R. Shelquist
L. Zearley, Rohlin

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-156

Intended Use: MC-3000 Cold Mix Spec. No. Date Reported 9-28--81

County Osceola Proj. No. SN-29(3)--51-72 SN-69(3)--51-72 FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 3/4" Gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-591

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	95	87	71	58	45	29	14	8.2	6.5
Tolerance											

Asphalt Source and Approximate Viscosity	Algona MC-3000 93.7% Residue	
% Asph. In Mix	5.0	6.0
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2955	3450
Flow - 0.01 In.	13	17
Sp. Gr. By Displacement (Lab Dens.)	2.10	2.14
Bulk Sp. Gr. Comb. Dry Agg.	2.634	2.634
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.44	2.41
% Voids - Calc.	14.0	11.0
Rice Sp. Gr.	Mixing temp. 180°F. Cure-16 hrs. @ 140°F.	
% Voids - Rice	Molding Temp. 140°F. Testing Temp. 77°F.	
% Water Absorption - Aggregate	--	--
% Voids in the Mineral Aggregate	24.3	23.6
% V.M.A. Filled with Asphalt	42.4	53.3
Calculated Asph. Film Thickness (Microns)	7.8	9.4

A Content of 5.5% MC-3000 is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Rohlin Constr. Co.
C. Jones

Asph. Mix Design
Projects listed below
J. Bump
P. Schwarting
D. Jordison
R. Shelquist
L. Zearley

Mix, Type and Class: Type B Class 2 Size 1/2" Lab. No. ABD1-158

Intended Use: MC-3000 Cold Mix Spec. No. Date Reported 9/28/81

County: Osceola Proj. No. SN-29(3)--51-72, ~~SN~~-69(3)--51-72, FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 1/2" Gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-592

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	98	90	69	56	42	26	14	8.7	7.3
Tolerance											

Asphalt Source and Approximate Viscosity	Algona - MC-3000	
% Asph. In Mix	5.0	6.0
Number of Marshall blows	50	50
Marshall Stability - Lbs.	3180	3480
Flow - 0.01 In.	10	14
Sp. Gr. By Displacement (Lab Dens.)	2.10	2.11
Bulk Sp. Gr. Comb. Dry Agg.	2.641	2.641
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.45	2.41
% Voids - Calc.	14.2	12.5
Rice Sp. Gr.	Mixing Temp. 180° F. Cure - 16 Hr. @ 140° F.	
% Voids - Rice	Molding Temp. 140° F. Testing Temp. 77° F.	
% Water Absorption -Aggregate	--	--
% Voids in the Mineral Aggregate	24.5	24.9
% V.M.A. Filled with Asphalt	42.1	49.8
Calculated Asph. Film Thickness (Microns)	7.6	9.2

A Content of 5.25% MC-3000 is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72, Osceola
J. Bump, Schwarting
D. Jordison, R. Shelquist
L. Zearley, Rohlin

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-160

Intended Use: HFMS-2 Cold Mix Spec. No. Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72, SN-69(3)--51-72, FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 3/4" Gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-591

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	95	87	71	58	45	29	14	8.2	6.5
Tolerance											

Asphalt Source and Approximate Viscosity	Algona HFMS-2 (65.6% Residue)	
% Total Emulsion in Mix ~~% Asph. in Mix~~	5.5	6.5
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2175	2470
Flow - 0.01 In.	12	11
Sp. Gr. By Displacement (Lab Dens.)	2.07	2.08
Bulk Sp. Gr. Comb. Dry Agg.	2.634	2.634
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.42	2.39
% Voids - Calc.	14.6	12.9
Rice Sp. Gr.	5.5% water added to agg. before mixing Mixing temp. 130°F.	
% Voids - Rice	Cured 16 hrs. @ 130°F. Molding temp. 130°F.	
% Water Absorption - Aggregate	Testing temp. 77°F. --	--
% Voids in the Mineral Aggregate	25.7	26.2
% V.M.A. Filled with Asphalt	43.4	50.7
Calculated Asph. Film Thickness (Microns)	8.6	10.3

A content of 7.0 HFMS-2 emulsion is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
SN-29(3)--51-72
~~SN~~ 69(3)--51-72
FM-72(7)--55-72, Osceola
J. Bump
Schwarting, D. Jordison
R. Shelquist, L. Zearley
Rohlin

Mix, Type and Class: Type B Class 2 Size 1/2" Lab. No. ABD1-163

Intended Use: HFMS-2 Cold Mix Spec. No. Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72 SN-69(3)--51-72 FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 1/2" gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-592

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	98	90	69	56	42	26	14	8.7	7.3
Tolerance											

Asphalt Source and Approximate Viscosity	Algona - HFMS-2 (65.6% residue)	
% Total Emulsion in Mix	5.5	6.50
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2060	2362
Flow - 0.01 In.	11	11
Sp. Gr. By Displacement (Lab Dens.)	2.04	2.09
Bulk Sp. Gr. Comb. Dry Agg.	2.641	2.641
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.43	2.39
% Voids - Calc.	16.0	12.7
Rice Sp. Gr.	5.5% water added to Agg. before mixing	
% Voids - Rice	Mixing Temp. 130°F Cured 16 hrs. @ 130°F	
% Water Absorption - Aggregate	Molding temp. 130°F Testing Temp. 77°F	--
% Voids in the Mineral Aggregate	27.0	26.0
% V.M.A. Filled with Asphalt	40.7	51.2
Calculated Asph. Film Thickness (Microns)	8.4	10.0

A content of 7.0% HFMS-2 emulsion is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72, Osceola
J. Bump, Schwarting
D. Jordison, R. Shelquist
L. Zearley, Rohlin

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-161

Intended Use: CSS-1 Cold Mix Spec. No. Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72 SN-69(3)--51-72 FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 3/4" Gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-591

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	95	87	71	58	45	29	14	8.2	6.5
Tolerance											

Asphalt Source and Approximate Viscosity	Algona - CSS-1 (67.3% Residue)	
% Total Emulsion in Mix	5.5	6.5
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2320	2825
Flow - 0.01 In.	16	15
Sp. Gr. By Displacement (Lab Dens.)	2.03	2.07
Bulk Sp. Gr. Comb. Dry Agg.	2.634	2.634
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.42	2.39
% Voids - Calc.	16.2	13.3
Rice Sp. Gr.	5.5% water added to agg. before testing; mixing Temp. 130°F.	
% Voids - Rice	Cured 16 hrs. @ 130°F. Molding Temp. 130°F. Testing temp. 77°F.	
% Water Absorption - Aggregate	--	--
% Voids in the Mineral Aggregate	27.2	26.5
% V.M.A. Filled with Asphalt	40.3	49.7
Calculated Asph. Film Thickness (Microns)	8.6	10.3

A Content of 7.0% CSS-1 emulsion is recommended to start the job.

SIGNED: [signature]
(TESTING ENGINEER)

Asph. Mix Design
SN-29(3)--51-72
SN-69(3)--51-72
FM-72(7)--55-72, Osceola
J. Bump, Schwarting
D. Jordison, R. Shelquist
L. Zearley, Rohlin

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Mix, Type and Class: Type B Class 2 Size 1/2" Lab. No. ABD1-162

Intended Use: CSS-1 Cold Mix Spec. No. ___ Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72, SN-69(3)--51-72, FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: 1/2" gravel - 28-98-42 Osceola Co.

Job Mix Formula Aggregate Proportions: 100% AAT1-592

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	98	90	69	56	42	26	14	8.7	7.3
Tolerance											

Asphalt Source and Approximate Viscosity	Algona - CSS-1	(67.3% Residue)
% Asph. In Mix	5.5	6.5
Number of Marshall blows	50	50
Marshall Stability - Lbs.	2190	2392
Flow - 0.01 In.	17	22
Sp. Gr. By Displacement (Lab Dens.)	2.03	2.03
Bulk Sp. Gr. Comb. Dry Agg.	2.641	2.641
Sp. Gr. Asph. @ 77 F.	1.020	1.020
Calc. Solid Sp. Gr.	2.43	2.39
% Voids - Calc.	16.4	15.2
Rice Sp. Gr.	5.5% water added to agg. before mixing	
% Voids - Rice	Mixing Temp. 130°F. Cured 16 hrs. @ 130° F.	
% Water Absorption - Aggregate	Molding Temp. 130°F. Testing Temp. 77°F. --	---
% Voids in the Mineral Aggregate	27.4	28.1
% V.M.A. Filled with Asphalt	40.0	46.0
Calculated Asph. Film Thickness (Microns)	8.4	10.0

A Content of 7.0% CSS-1 emulsion is recommended to start the job.

SIGNED: ________________
(TESTING ENGINEER)

Form 955
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72; Osceola
J. Bump, Schwarting
R. Shelquist, D. Jordison
L. Zearley, Rohlin

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-165B

Intended Use: Cold-Mix Spec. No. Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72 SN-69(3)--51-72 FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: Aggregate From roadway after milling and addition of new aggregate

Job Mix Formula Aggregate Proportions: 100% ABC1-293 (Contains 3.0% Asphalt)

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	94	86	66	50	38	26	15	11	9.2
Tolerance											

Asphalt Source and Approximate Viscosity	CSS1-H Emulsion		
% Asph. In Mix	6.5	7.2	7.9
Total Emulsion Added	5.0	6.0	7.0
Number of Marshall blows	50	50	50
Marshall Stability - Lbs.	680	650	540
Flow - 0.01 In.	21	19	19
Sp. Gr. By Displacement (Lab Dens.)	2.11	2.10	2.12
Bulk Sp. Gr. Comb. Dry Agg.	2.65	2.65	2.65
Sp. Gr. Asph. @ 77 F.	1.02	1.02	1.02
Calc. Solid Sp. Gr.	2.39	2.37	2.34
% Voids - Calc.	11.8	11.3	9.6
Rice Sp. Gr.			
% Voids - Rice			
% Water Absorption - Aggregate	--	--	--
% Voids in the Mineral Aggregate	25.5	26.5	26.3
% V.M.A. Filled with Asphalt	53.7	57.1	63.6
Calculated Asph. Film Thickness (Microns)	9.0	10.0	11.0

Emulsion & Agg. mixed at room temp. - Mixture Cured 20 hrs. at room Temp. and compacted at room Temp.

SIGNED: (TESTING ENGINEER)

Form 956
1-75

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
(MATERIALS DEPARTMENT)

ASPHALT CONCRETE MIX DESIGN
AMES LABORATORY

Asph. Mix Design
SN-29(3)--51-72
~~SN~~-69(3)--51-72
FM-72(7)--55-72; Osceola
J. Bump, Schwarting
D. Jordison, R. Shelquist
L. Zearley, Rohlin

Mix, Type and Class: Type B Class 2 Size 3/4" Lab. No. ABD1-165A

Intended Use: Cold-Mix Spec. No. Date Reported 9-28-81

County: Osceola Proj. No. SN-29(3)--51-72, SN-69(3)--51-72, FM-72(7)--55-72 Contractor Rohlin

Proj. Location:

Agg. Sources: Aggregate from roadway after milling and addition of new aggregate

Job Mix Formula Aggregate Proportions: 100% ABC1-293 (Contains 3.0% Asphalt)

JOB MIX FORMULA - COMBINED GRADATION

1½"	1"	3/4"	½"	3/8"	#4	#8	#16	#30	#50	#100	#200
		100	94	86	66	50	38	26	15	11	9.2
Tolerance											

Asphalt Source and Approximate Viscosity	MC-800		SC-800		HFMS-2 Emulsion	
% Asph. In Mix	4.9	5.25	5.5	6.0	6.5	7.2
Total Emulsion or cutback Added	2.5	3.0	2.5	3.0	5.0	6.0
Number of Marshall blows	50	50	50	50		
Marshall Stability - Lbs.	680	515	650	640	540	460
Flow - 0.01 In.	21	23	20	19	19	19
Sp. Gr. By Displacement (Lab Dens.)	2.02	2.08	2.06	2.07	2.14	2.15
Bulk Sp. Gr. Comb. Dry Agg.	2.65	2.65	2.65	2.65	2.65	2.65
Sp. Gr. Asph. @ 77 F.	1.00	1.00	1.00	1.00	1.02	1.02
Calc. Solid Sp. Gr.	2.45	2.44	2.43	2.41	2.39	2.37
% Voids - Calc.	17.6	14.7	15.2	14.2	10.6	9.2
Rice Sp. Gr.						
% Voids - Rice						
% Water Absorption - Aggregate	--	--	--	--	--	--
% Voids in the Mineral Aggregate	27.5	25.6	26.5	26.6	24.5	24.7
% V.M.A. Filled with Asphalt	35.9	42.6	42.7	46.7	56.8	62.6
Calculated Asph. Film Thickness (Microns)	6.6	7.1	7.5	8.2	9.0	10.0

Cutbacks heated to 160°F before mixing with Agg. @ room Temp. Emulsion & agg. mixed at toom tem. - mixture cured 20 hrs. at room temp and compacted @ room temp.

SIGNED: (TESTING ENGINEER)

Appendix E

Asphalt Penetrations and Viscosities

PENETRATION/VISCOSITY TEST RESULTS

Extracted Binder From 3/4" Mixes

Asphalt	Penetration	Absolute Viscosity
AC-5	126	891
MC-3000	148	763
SC-800	-*	-*
HFMS-2	133	767
CSS-1	78	1610

Extracted Binder from 1/2" Mixes

Asphalt	Penetration	Absolute Viscosity
MC-3000	139	777
SC-800	-*	-*
HFMS-2	108	1050
CSS-1	83	1490

Extracted Binder from Road Mix

Asphalt	Penetration	Absolute Viscosity
Existing Asphalt	40	11,630
MC-800	68	2,840
SC-800	145	682
HFMS-2	64	3,640
CSS-1	56	3,860

*To soft to test

Note: Penetration at 77°F. .100 gms., 5 sec.

Absolute Viscosity at 140°F., 300 mm. HG(Poises)

Appendix F

Density Test Results

Section No.	Binder	Lab Density[1]	Field Density[2]	Percent Field Voids
1	AC-5	2.39	2.26	7.4
2	MC-3000	2.22	2.07	16.6
3	HFMS-2	2.22	2.06	17.6
4	HFMS-2	2.11	2.09	13.0
5	CSS-1	2.11	2.03	15.3
6	CSS-1	2.21	1.96	22.2
7	MC-3000	2.24	2.06	16.6
8	MC-800	2.00	1.90	21.6
9	SC-800	2.03	1.93	20.2
10	SC-800	2.29	2.09	15.1
11	HFMS-2	2.25	2.07	18.3
12	AC-5	-	-	-
13	MC-3000	2.22	2.16	13.6
14	SC-800	2.36	2.22	11.3

1. Lab densities for section 4, 5, 8 and 9 by Modified Proctor.
2. Field densities for section 1 by cores.

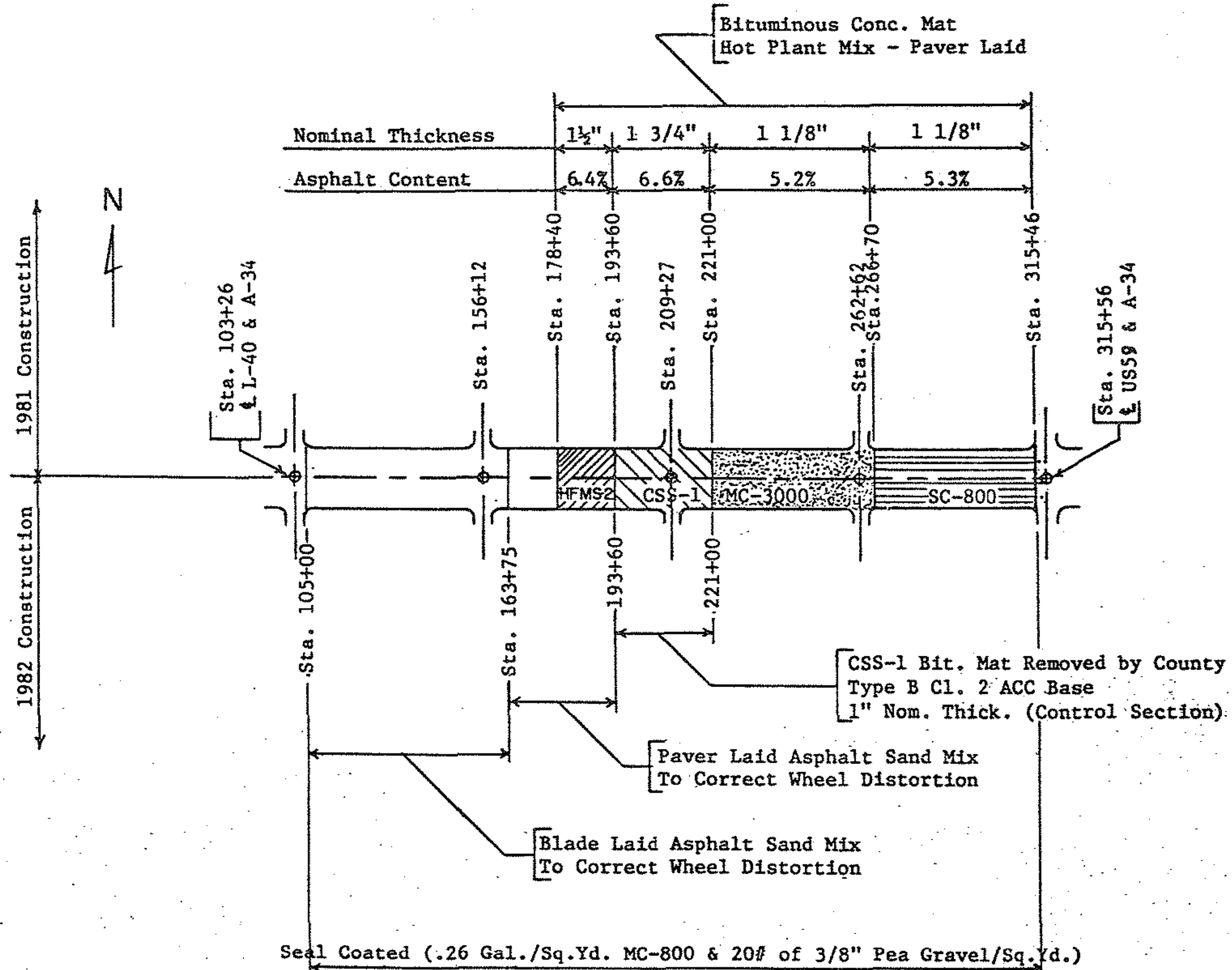
   Field densities for other section by nuclear gauge.

Appendix G

Maintenance Work and Seal Coat Construction

PROJECT FM-72(7)--55-72
RESEARCH PROJECT NO. HR229
COUNTY ROUTE NO. A-34

Note: The Type B and Bituminous Mats are ½" Gravel Mixes.

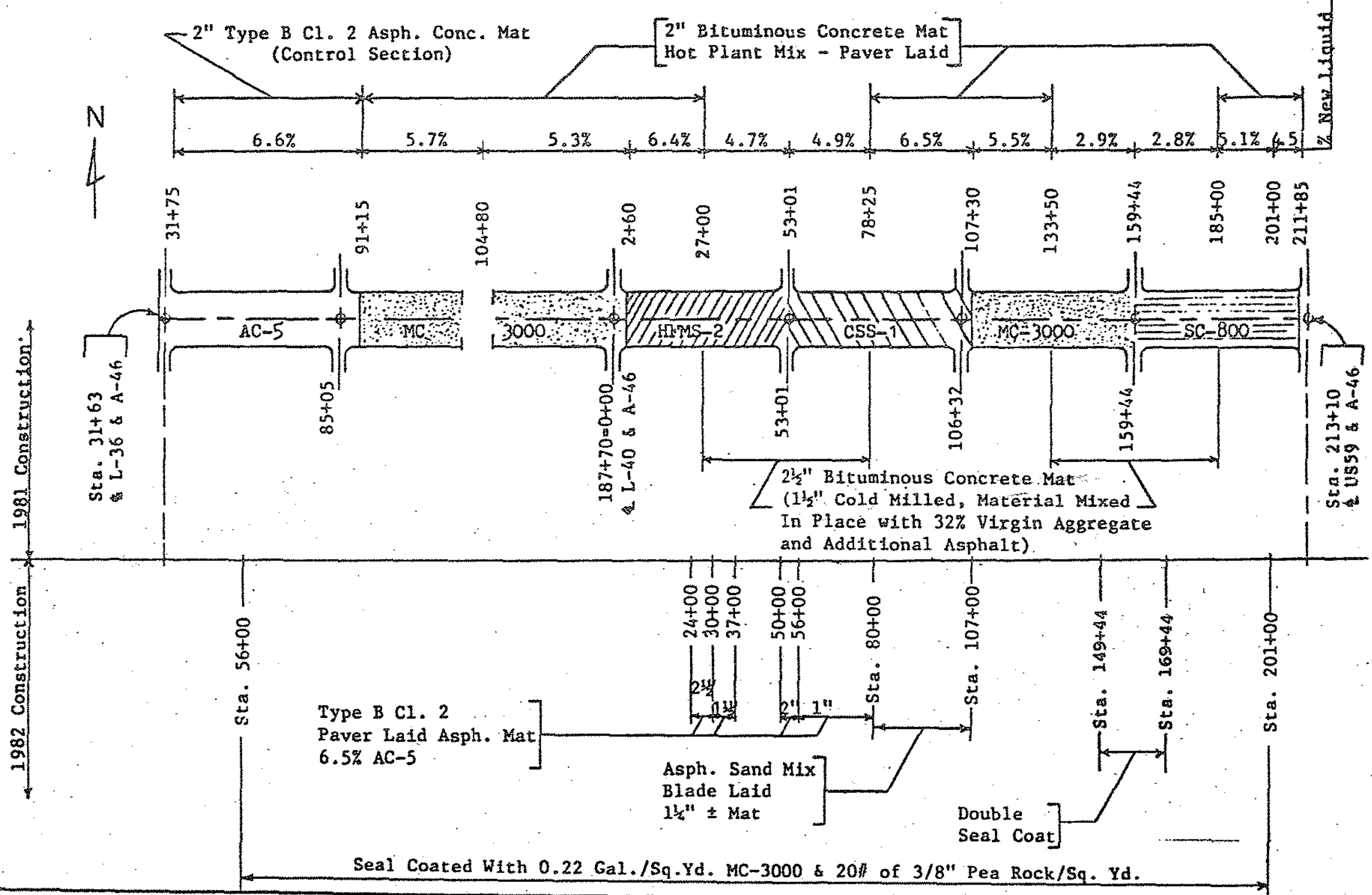


PROJECT SN-69(3)--51-72

RESEARCH PROJECT NO. HR229

COUNTY ROUTE NO. A-46

Note: The Type B and Bituminous Concrete Materials are 3/4" Gravel Mixes.



Appendix H

Rut Depth Measurements

Appendix H

Average Rut Depths

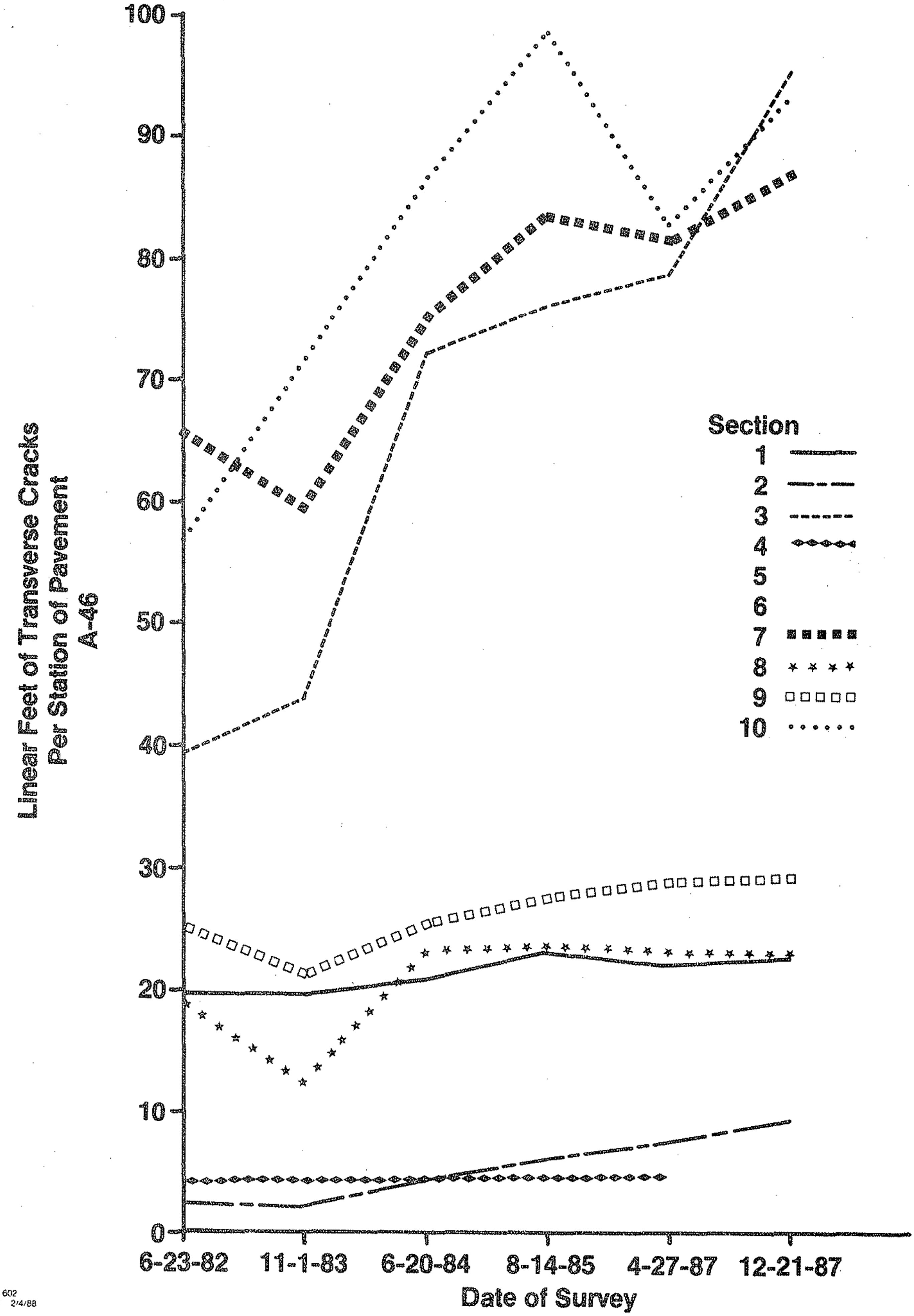
Section	W.O.	W.I.	E.I.	E.O.	AVE.
1	0.11	0.11	0.13	0.07	0.10
2	0.08	0.09	0.14	0.08	0.10
3	0.07	0.10	0.11	0.08	0.09
4	0.08	0.06	0.11	0.19	0.11
5	0.06	0.06	0.06	0.07	0.06
6	0.10	0.06	0.10	0.08	0.08
7	0.08	0.08	0.09	0.05	0.07
8	0.16	0.23	0.20	0.32	0.22
9	0.16	0.19	0.12	0.16	0.16
10	0.06	0.09	0.09	0.06	0.07
11	0.08	0.15	0.14	0.09	0.11
12	0.11	0.10	0.09	0.06	0.09
13	0.10	0.13	0.16	0.12	0.12
14	0.06	0.08	0.16	0.12	0.10

W.O. = Westbound, outside wheelpath
W.I. = Westbound, inside wheelpath
E.I. = Eastbound, inside wheelpath
E.O. = Eastbound, outside wheelpath

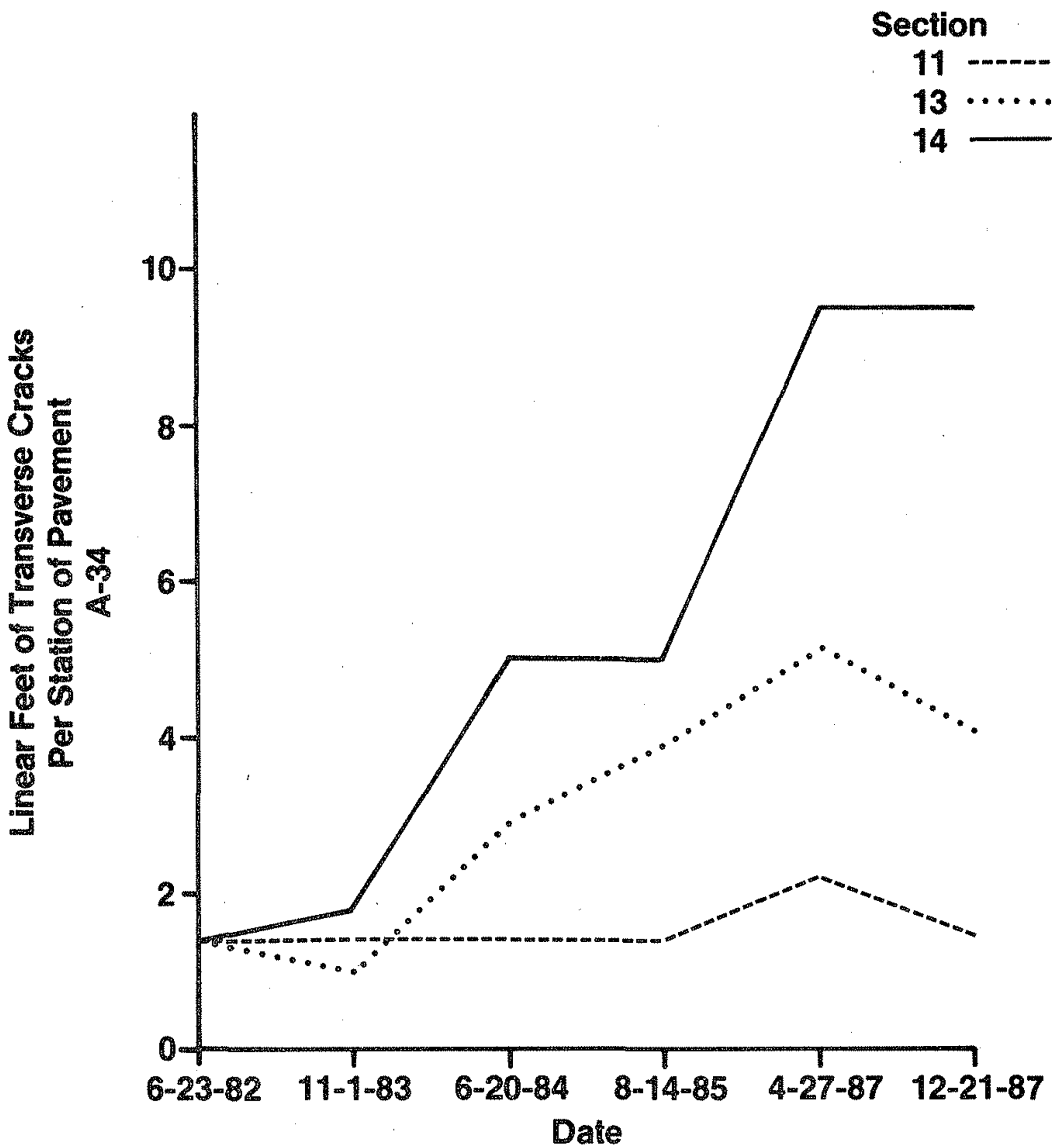
Measurements taken 12-21-87

Appendix I

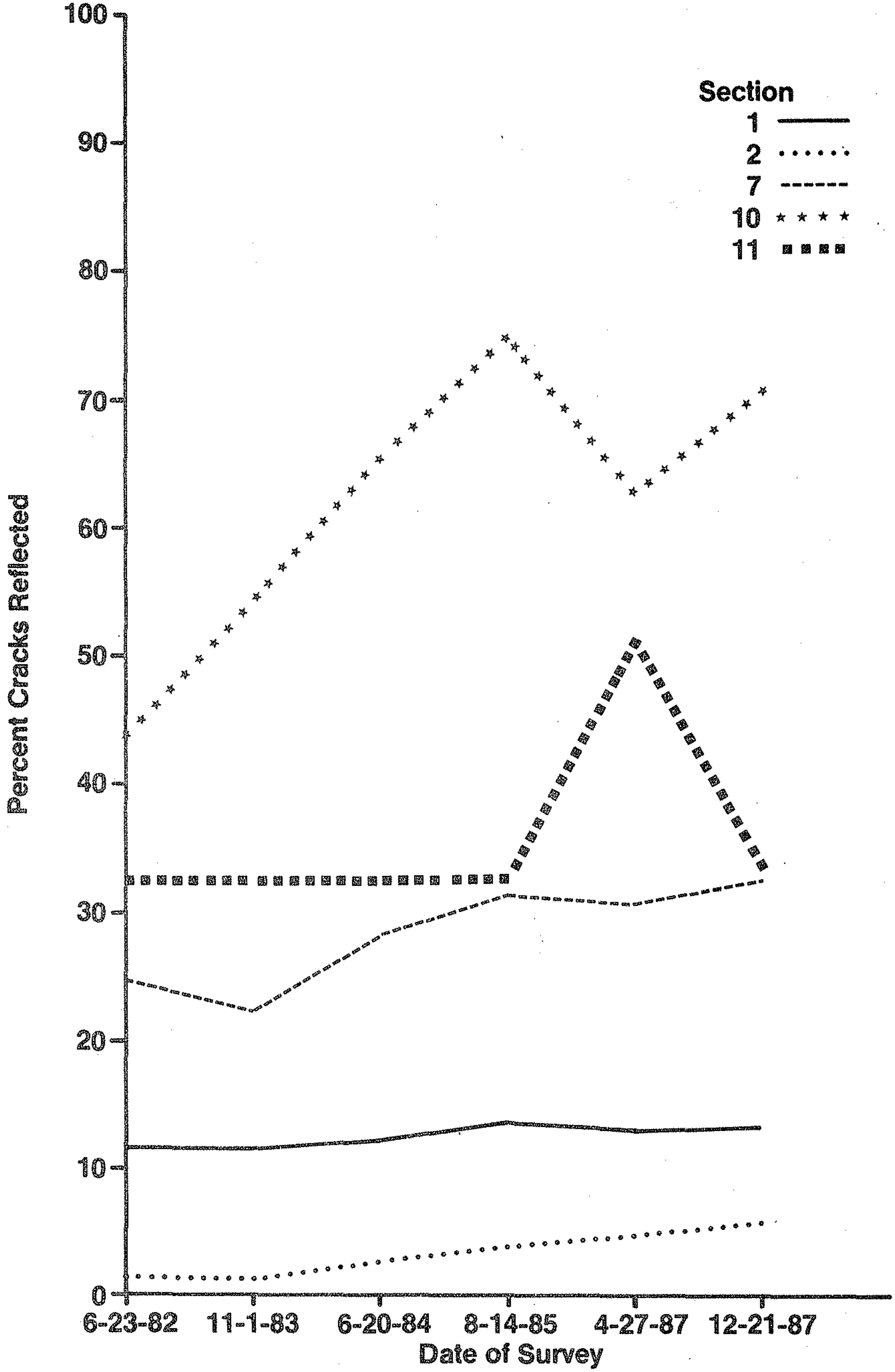
Crack Survey Results



Gra 602
5601 2/4/88


Section
11
13
14
10
8
6
4
2
0
Linear Feet of Transverse Cracks
Per Station of Pavement
A-34
6-23-82
11-1-83
6-20-84
8-14-85
4-27-87
12-21-87
Date

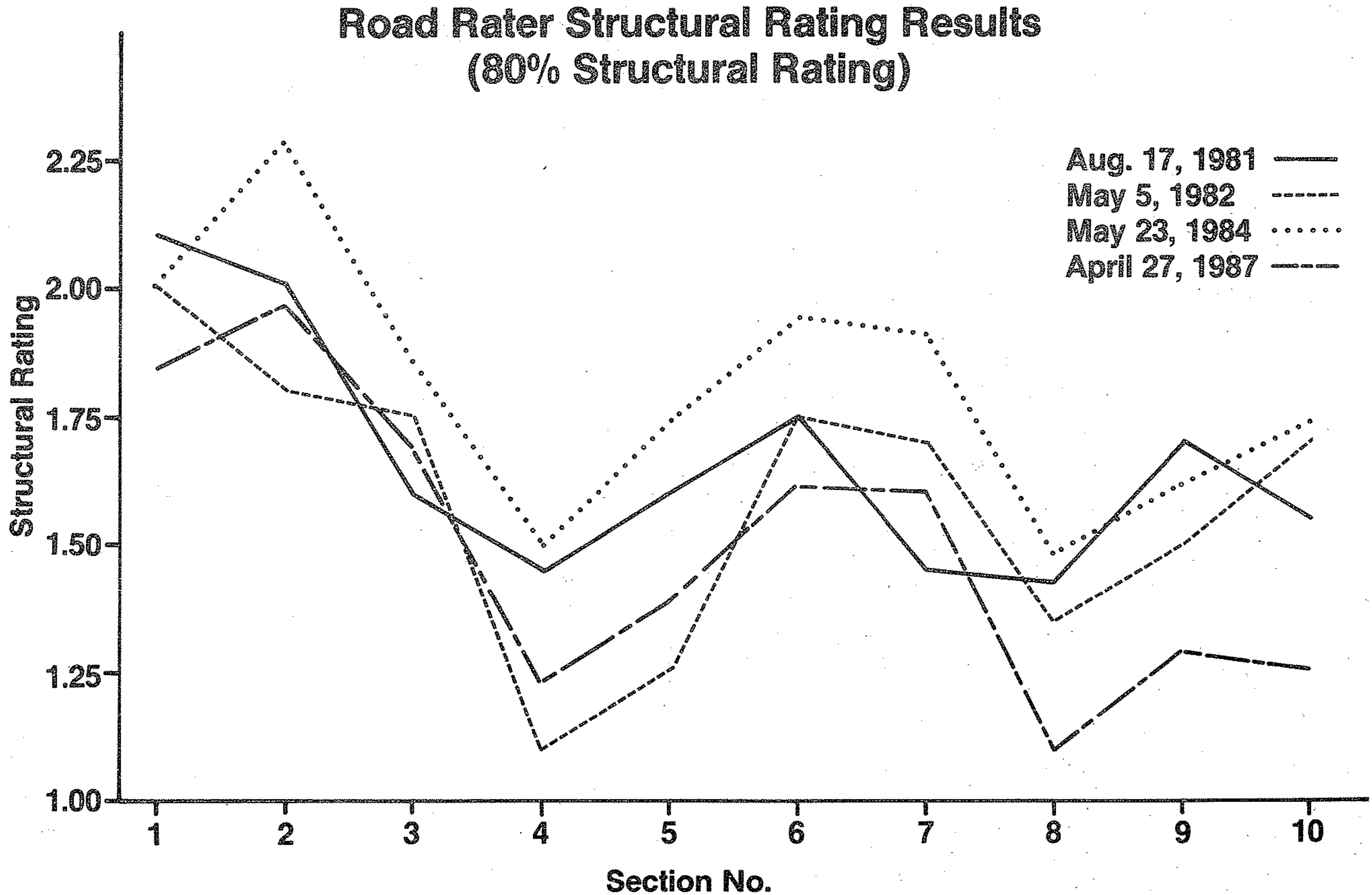
Gra. 602



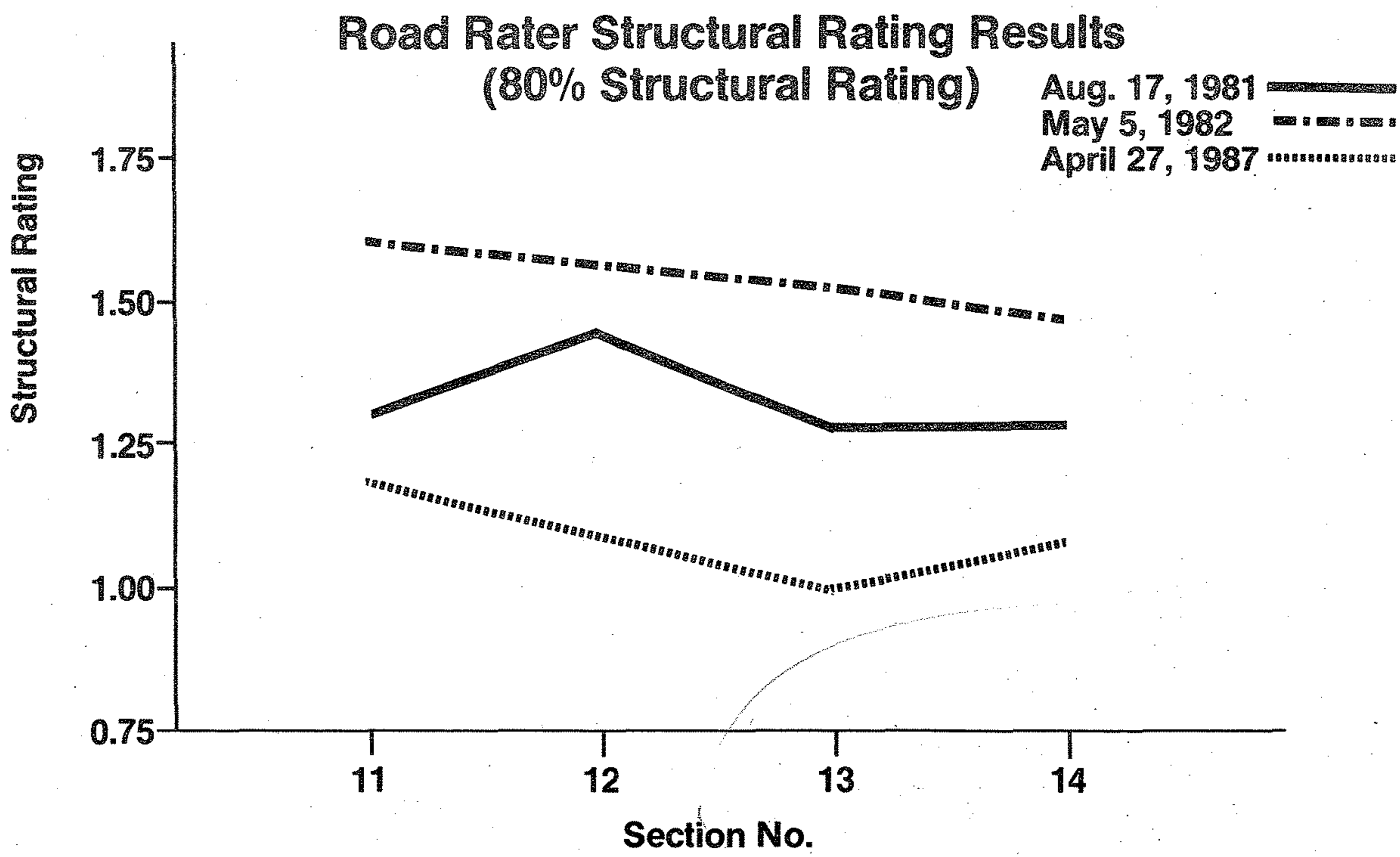
Gra. 602
5601 2/4/88

Appendix J

Road Rater Results



Gra. 602
5601 2/4/88


Road Rater Structural Rating Results
(80% Structural Rating)
Aug. 17, 1981
May 5, 1982
April 27, 1987
Structural Rating
1.75
1.50
1.25
1.00
0.75
11
12
13
14
Section No.