NV · SPS-1

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Long-Term Pavement Performance

March 25, 1998
File: 800.12.8.1

Mr. Dale Lindsey
Nevada DOT
1263 S. Stewart Street
Carson City, NV 89712

RE: SPS-1 and SPS-2 Draft Reports

Dear Dale:

Enclosed for your review are the draft construction reports for the SPS-1 and SPS-2 projects constructed near Battle Mountain. We would appreciate it if you would review these reports and provide us with any comments by May 29th.

We are also sending copies of these reports to those persons below, and are requesting their comments by May 29th as well.

Should you have any questions, please do not hesitate to call Doug or myself at 702/329-4955 or e-mail me at *ksenn@nce.reno.nv.us*.

Sincerely,
NICHOLS CONSULTING ENGINEERS, Chtd.

Kevin Senn, P.E.
Agency Coordinator

KS/rkp
Enclosures

cc: John McKenzie, Monte Symons, Shiraz Tayabji, Gonzalo Rada, Bill Bellinger (w/o encl.), John Nichols (w/o encl.)

Nevada Department of Transportation

Materials Sampling, Field Testing and Laboratory Testing Plan

Strategic Highway Research Program

SPS-1 Experimental Projects

Interstate Highway No. I-80

Humboldt & Lander Counties

Nevada

FINAL

March 1998

NICHOLS
CONSULTING
ENGINEERS, Chtd.

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I. INTRODUCTION

The Strategic Highway Research Program (SHRP) SPS-1 (Specific Pavement Study) experiment was designed to study the structural factors involved in flexible pavement design. The objective of this study is to more precisely determine the relative influence of strategic factors that influence the performance of flexible pavements. The primary factors addressed include drainage, base type and thickness, and asphalt surface thickness. The study objective includes a determination of the environmental region and soil type on these factors.

This report covers the construction of the SPS-1 and SPS-2 experimental test sections on I-80 in Humboldt and Lander Counties, Nevada, constructed between May 1995 and August 1995. Section II gives an overall project description. Sections III, IV, and V pertain to the SPS-1 construction, discussing the materials and construction procedures used for each type of material, summarizing the construction activities, and noting key observations. Sections VI, VII, and VIII pertain to the SPS-2 construction following the SPS-1 format.

II. NEVADA SPS-1 PROJECT DESCRIPTION

PHYSICAL ATTRIBUTES

The Nevada SPS-1 project is located in north central Nevada, approximately five miles west of Battle Mountain, in the outer eastbound lane of Interstate 80, as shown in figure 1. The SPS-1 sections extend from station 64+80 to station 158+80 (milepost 226.4).

The construction work on this segment of I-80 consisted of removing the existing asphalt concrete (AC) surfacing, cement treated base, dense graded aggregate base, and embankment. The original subgrade was stabilized with lime and the embankment was replaced. The SHRP structural sections were then placed on top of the embankment.

The terrain surrounding the test sections is generally flat with minimal ground cover.

The elevation of the test sections is 4195 ft with a latitude of 40°42' N, and a longitude of 117°01' W.

CLIMATE

The location of the test site is classified by LTPP to be in the dry-freeze zone. Based upon climatic information collected at a Battle Mountain weather station from 1961 to 1990, the average yearly high temperature was 103°F, the average yearly low temperature was -14°F, and the average yearly precipitation was 8.23 in.

EXISTING SOIL

The soil in this area varied throughout the project.

The Nevada SPS-1 project fills the dry-freeze, coarse subgrade categories in table 1. This table lists the pavement structural combinations for all SPS-1 projects.

TRAFFIC

Traffic data collected at GPS site 323010 near Wells, Nevada, approximately 120 mi east of the NV SPS-1 site is as follows:

Years	Average Annual Truck Volume SHRP Lane	Average Annual ESALs in SHRP Lane	% Truck Volume in SHRP Lane
1990-1992	302,000	799,000	52

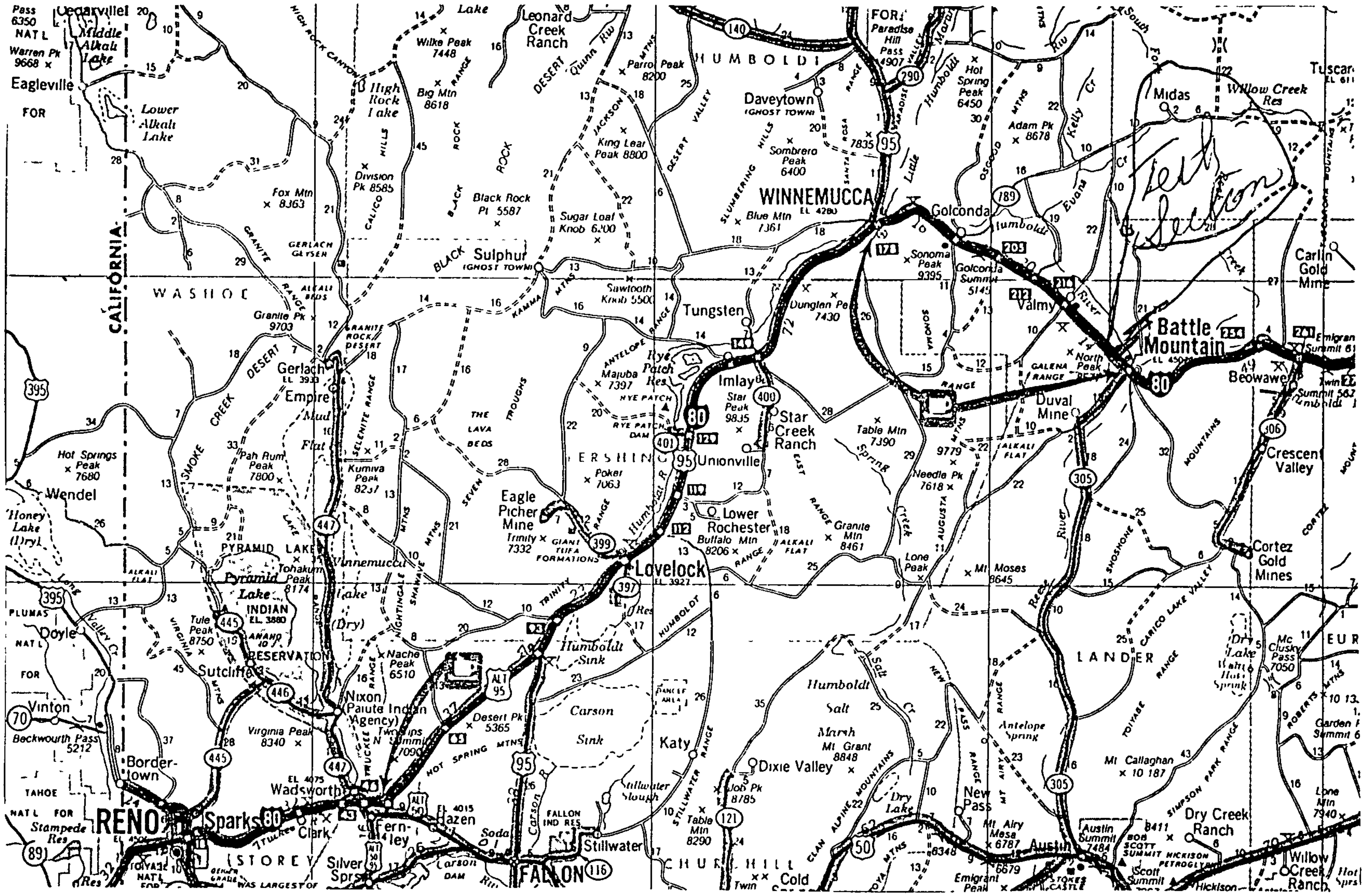


Figure 1. Location of NV SPS-1 project.

Table 1. SPS-1 pavement structural combinations.

Pavement Structure Combinations				Factors for Moisture, Temperature, Subgrade Type, and Location															
				Wet								Dry							
				Freeze				No Freeze				Freeze				No Freeze			
				Fine		Coarse		Fine		Coarse		Fine		Coarse		Fine		Coarse	
Drainage	Base Type	Total Base Thick	Surface Thick	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
No	DGAB	8"	4"		K13		M13		O13		Q13		S13		U13		W13		Y13
			7"	J1		L1		N1		P1		R1		T1		V1		X1	
		12"	4"	J2		L2		N2		P2		R2		T2		V2		X2	
			7"		K14		M14		O14		Q14		S14		U14		W14		Y14
	ATB	8"	4"	J3		L3		N3		P3		R3		T3		V3		X3	
			7"		K15		M15		O15		Q15		S15		U15		W15		Y15
		12"	4"		K16		M16		O16		Q16		S16		U16		W16		Y16
			7"	J4		L4		N4		P4		R4		T4		V4		X4	
	ATB 4" DGAB	8"	4"	J5		L5		N5		P5		R5		T5		V5		X5	
			7"		K17		M17		O17		Q17		S17		U17		W17		Y17
		12"	4"		K18		M18		O18		Q18		S18		U18		W18		Y18
			7"	J6		L6		N6		P6		R6		T6		V6		X6	
Yes	4" PATB DGAB	8"	4"	J7		L7		N7		P7		R7		T7		V7		X7	
			7"		K19		M19		O19		Q19		S19		U19		W19		Y19
		12"	4"		K20		M20		O20		Q20		S20		U20		W20		Y20
			7"	J8		L8		N8		P8		R8		T8		V8		X8	
		8"	4"		K21		M21		O21		Q21		S21		U21		W21		Y21
			7"	J9		L9		N9		P9		R9		T9		V9		X9	
	ATB 4" PATB	12"	4"		K22		M22		O22		Q22		S22		U22		W22		Y22
			7"	J10		L10		N10		P10		R10		T10		V10		X10	
		8"	4"	J11		L11		N11		P11		R11		T11		V11		X11	
			7"		K23		M23		O23		Q23		S23		U23		W23		Y23
		12"	4"	J12		L12		N12		P12		R12		T12		V12		X12	
			7"		K24		M24		O24		Q24		S24		U24		W24		Y24

Nevada SPS-1

BASE CODES:
DGAB = Dense graded untreated aggregate base
ATB = Dense graded asphalt cement treated base
4" PATB = 102 mm (4") thick open graded permeable asphalt cement treated drainage layer
4" DGAB = 102 mm (4") thick dense graded untreated aggregate base layer beneath asphalt treated base

GEOMETRICS

All test sections are situated on a horizontally straight section of I-80. Vertically, the grade varies from a minimum of -0.06 percent to a maximum of -0.3 percent. The transverse slope throughout the project was two percent, sloping to the outer edge.

PROJECT PERSONNEL

Key personnel on the project included John McKenzi, Resident Engineer, and Bill Scott, Assistant Research Engineer, of Nevada DOT, John Maddick, Superintendent, of Maddick Construction Co., and Chuck Hicks and Pete Pradere of Nichols Consulting Engineers representing the Western Regional Office for LTPP.

III. NEVADA SPS-1 CONSTRUCTION

The SHRP SPS-1 experiment consists of the construction of 12 test sections with AC layers and base layers of varying thickness and material type. These are shown as sections 320101 through 320112 in figure 2. For this project, no supplemental state sections were constructed.

SUBGRADE/EMBANKMENT

Materials

As this project was constructed over an existing section of highway, removal of the existing AC layer was necessary. Upon this removal there were problems that will be discussed in the following sections. To correct these problems, a layer of lime stabilized soil was placed, topped by a layer of granular material to produce a suitable subbase for the test sections.

Natural Subgrade, Embankment Soil Classification

Based on laboratory testing, the natural subgrade material varied between a silty sand and a clayey sand. Less than five percent of the material was larger than 2 mm, while the percentage of clay ranged from 1.4 to 16.9.

Equipment and Construction Methods

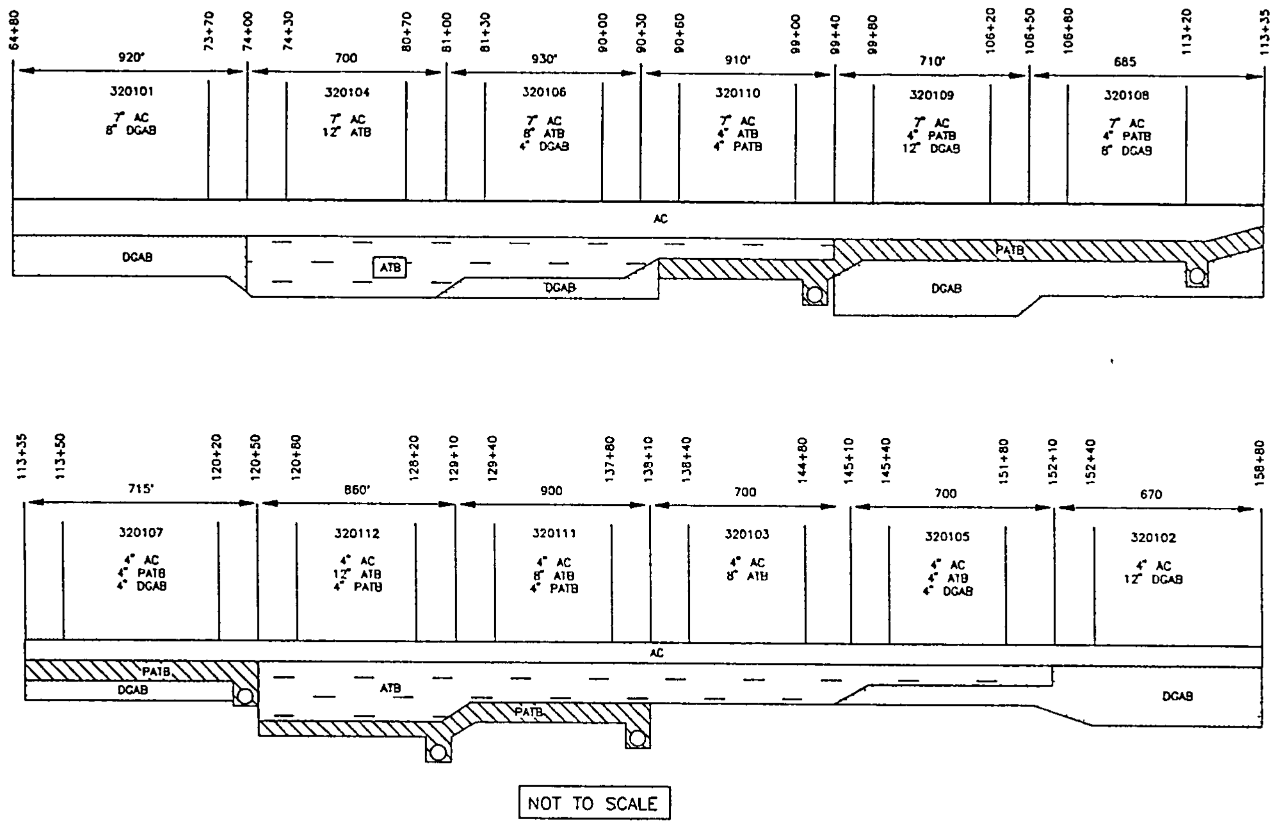
Roadway Excavation

The original AC layer was milled and removed and the millings were placed on the outer shoulder. This took place in May 1995. Following the AC removal, 8 in of cement-treated base and 8 in of dense graded aggregate base were rotomilled and piled on the outer shoulder. Two paddlewheel scrapers were then used to remove the remaining embankment material to a depth of 38 in from new grade. The embankment material was removed from the site.

At this point the subgrade material was determined to be unsuitable, since it did not meet the NDOT specifications for subbase material. NDOT determined that lime soil stabilization would provide a suitable subgrade material and confirmed with LTPP personnel that this would not effect the experiment.

Soil Stabilization

The stabilization operations began on May 31, 1995. Culp Soil Stabilization, Inc. performed the stabilization. Hydrated lime was spread and mixed at three percent by volume of soil, 1 ft deep into the unsuitable material. A 1993 CMI RS-500 Mixer/Pulverizer was used to mix the lime to the depth of 1 ft, operating at a rate of 80 ft/min. Water was added during the mixing process. The lime particle size was 3/8 in, and after the first pass of the mixer, the particles



AC – Asphalt Concrete
PATB – Permeable Asphalt Treated Base
ATB – Asphalt Treated Base
DGAB – Dense Graded Aggregate Base
[O] – Transverse Drain

Figure 2. Layout of experimental test sections, NV SPS-1 Project, I-80.

were not totally dissolved. The mixer made additional passes in order to completely dissolve the lime particles. A motor grader was utilized to finish the subgrade surface to within 1/2 in tolerance. A trimming machine was utilized for finished grade. The right hand (SHRP) lane was excavated 22 ft wide, stabilized, and filled, then the passing lane was excavated, stabilized, and filled.

Fill Operations

Fill operations began on June 6, 1995. The process started with pushing the CTB/DGAB stockpile from the right shoulder into the area that was excavated. The lifts were compacted in 6 in to 8 in thicknesses with a Catepillar 815 equipped with a sheepsfoot roller. Two Catepillar 14G graders and one 140G grader were used to level the fill prior compaction. Water was applied with a 6000 gal water truck periodically during the fill operation.

Borrow was brought to the site using double belly dumps to bring the fill to the finished subgrade line. One Catepillar 14G grader was used for grading. A rubber-tired roller was used for compaction. The borrow was obtained from a stockpile located at the plant. The plant was located at the Negro Pit (NDOT designation 83-6) near Battle Mountain. Moisture content and density tests were performed during the entire fill operation to ensure proper compaction. If sections of fill did not meet compaction or moisture specifications, they were reworked until they met the specifications.

Quality Assurance Sampling and Testing

Prior to soil stabilization, sampling and testing of the natural subgrade was performed as shown in figure A1, appendix A. The results of the density tests are given in table 2. Following placement of the embankment, sampling and testing was performed as shown in figure A2, appendix A. The results of the density tests are given in table 3.

FWD Testing

FWD testing was performed on the lime treated subgrade on May 15-16, 1995, and on the embankment from July 6-11, 1995. Tables 4 and 5 list the midlane and outer wheelpath averages and standard deviations for each section and appendix B shows the midlane and outer wheelpath plots. Figure 3 shows the plot of the average deflections at 4500 lb for both the subgrade and embankment.

The standard deviation of deflections in many of the subgrade sections was high in both the midlane and outer wheelpath. The midlane and outer wheelpath averages followed the same general pattern, with the exception of section 320105, as seen in figure 3. Section 320105 had a standard deviation of 54.8 mils in the outer wheelpath.

The embankment was relatively consistent throughout, with the exception of section 320103 in the midlane. The standard deviation for section 320103 in the midlane was 17.0 mils, while the standard deviation in all of the other sections was below 4.2 mils.

Table 2. Density test results.

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density Wet (pcf)	Average Test Site Density Dry (pcf)	Method	Percent Moisture
5/4/95	320101	6+60	5' from outside shoulder	108.6	96.8	B	12.2
5/5/95	320105	5+50	5' from outside shoulder	122.7	110.4	B	11.1
5/5/95	320106	5+50	5' from outside shoulder	125.8	107.8	B	16.7
5/5/95	320107	5+25	5' from outside shoulder	124.5	105.3	B	18.2
5/5/95	320109	5+50	5' from outside shoulder	117	102.6	B	14
5/5/95	320111	5+50	5' from outside shoulder	129.4	111.8	B	15 8

Table 3. Embankment density

Section	Test No. from Figure E2	In-Situ Dry Density (pcf)	% of Optimum Dry Density	In-Situ Moisture Content
320101	T1	130.0		3.8
320101	T2	130.7		4.6
320101	T3	131.6		5.1
320101	T4	127.0		5.8
320102	T40	130.8		5.3
320102	T41	129.9		5.6
320102	T42	129.4		5.5
320103	T33	132.4		5.3
320103	T34	123.9		4.9
320103	T35	130.0		4.8
320105	T36	131.6		6.4
320105	T37	124.2		6.1
320105	T38	130.7		6.8
320105	T39	118.2		6.2
320106	T8	125.3		5.8
320106	T9	131.4		4.5
320106	T10	127.6		6.2
320106	T11	129.2		5.9
320107	T22	124.7		6.6
320107	T23	130.1		6.2
320107	T24	127.4		6.0
320107	T25	126.4		6.4
320108	T19	131.1		6.6
320108	T20	130.6		6.2
320108	T21	130.2		6.9
320109	T15	131.0		6.4
320109	T16	128.9		6.2
320109	T17	132.4		6.1
320109	T18	128.7		6.4
320110	T12	127.6		5.2
320110	T13	126.3		3.2
320110	T14	128.0		5.0
320111	T29	131.2		4.0
320111	T30	131.8		4.2
320111	T31	130.6		4.6
320111	T32	131.1		4.5
320112	T26	131.8		4.8
320112	T27	130.7		4.6
320112	T28	132.4		4.9

Table 4. SPS-1 lime stabilized subgrade FHWA averages and standard deviations at 4500 lbs, sensor 1.

Section	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviaton (mils)
320101	37.3	39.1	29.0	28.4
320102	21.4	7.2	34.4	31.0
320103	25.4	10.2	30.7	12.2
320104	20.7	11.1	22.1	15.8
320105	27.0	17.7	59 5	54.8
320106	23.4	16.5	16.8	6.6
320107	18.7	6.6	17.9	5.7
320108	13.9	3.8	14.3	3.8
320109	14.9	3.0	16.3	4.9
320110	19.0	5.2	28 2	22.5
320111	18 6	5.1	22.7	8.9
320112	15.3	2.9	16.7	3.5

Table 5. SPS-1 embankment FWD averages and standard deviations at 4500 lbs, sensor 1.

Section	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320101	15.6	1.7	13.8	1.6
320102	15.6	2.0	12 1	1.7
320103	26.9	17.0	14.7	1.7
320104	13.9	3.0	10 5	3.0
320105	17.9	4.1	14.2	1.6
320106	16.5	1.7	11.7	2.1
320107	15.8	1.8	15 0	1.4
320108	10 8	1.4	9.9	1 0
320109	12.8	3.7	9.6	1.2
320110	16.5	1.9	16.0	1.6
320111	11.5	1.6	11.0	1.6
320112	8.6	1.3	5.6	1.0

figure 3

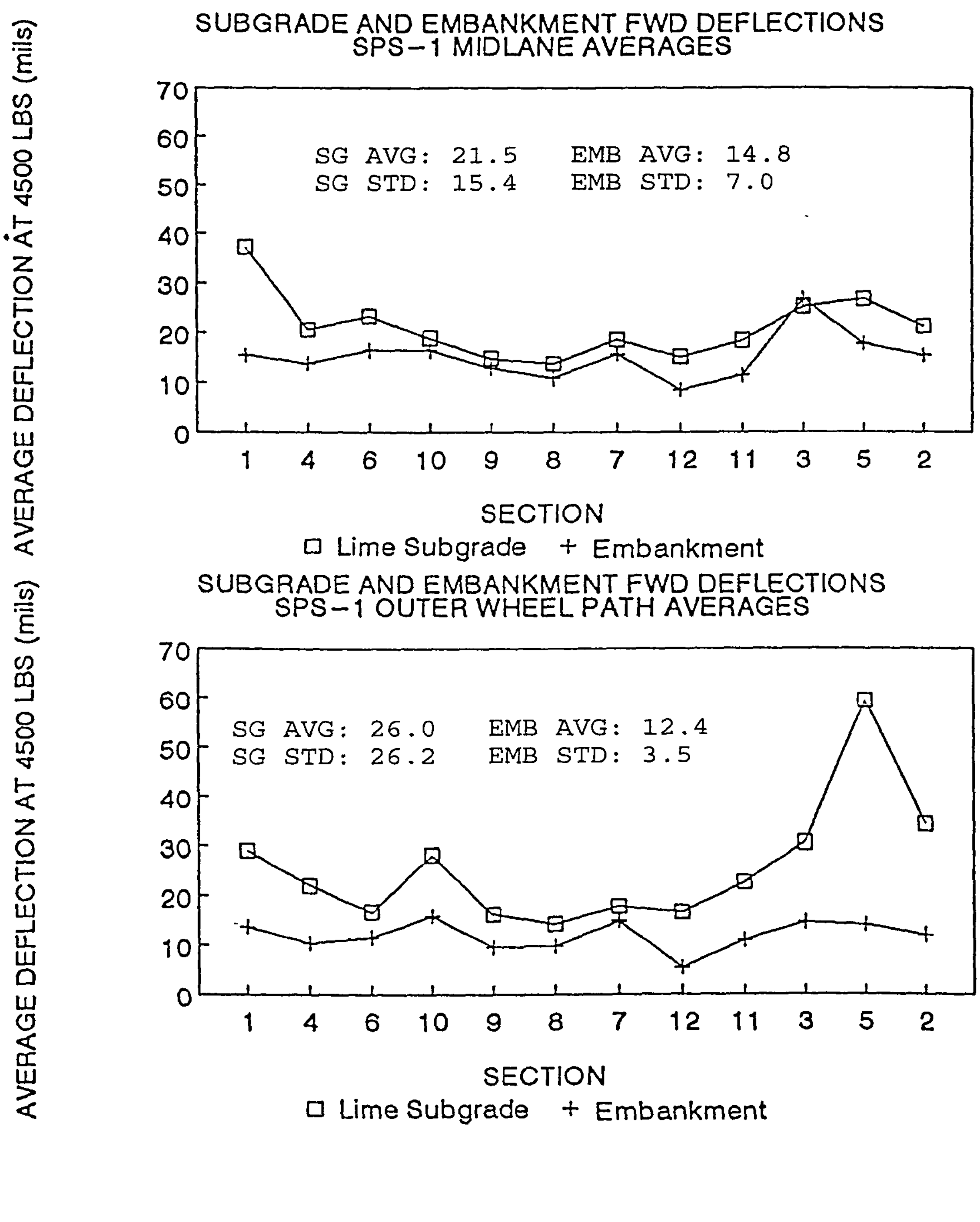


Figure 3. Subgrade and embankment average deflections, midlane and OWP, NV SPS-1.

The FWD plots in appendix B show a high degree of variability. It should be noted that sensor 1 was used for this analysis. To determine the possibility of shearing of the subgrade under the load plate and sensor 1, the defections for all seven sensors were plotted for several of the highly variable sections. The plots for sensors 2 through 6 followed the same general path as sensor 1, indicating that shearing of the lime-treated subgrade was not taking place.

Embankment Thicknesses

Unfortunately, no measurements were taken to determine the thickness of the lime stabilized soil, so it is assumed that it was constructed to the plan thickness of 12 in. Table 6 shows thickness information for the granular embankment material.

DENSE GRADED AGGREGATE BASE

Seven of the test sections, 320101, 320102, 320105, 320106, 320107, 320108, and 320109 received a dense graded aggregate base (DGAB) varying in thickness from 4 to 12 in.

Materials

The aggregate used for the DGAB was a crushed gravel, meeting the Nevada DOT Type 1, Class B specification. The gradation for the DGAB is shown in table 7.

The majority of the crushing operations took place at the Negro Pit (NDOT designation 83-6) where the rocks were crushed in two cones. Some crushing was also performed at pit 83-8.

Equipment and Construction Methods

Placement of the DGAB took place between July 6 and July 20, 1995. The types of equipment included in the operation were:

- 1 Gomaco B500-B trimmer
- 2 Catepillar 14G blades
- 1-2 water trucks
- 1 Catepillar CS-563 single drum vibratory roller
- 1 Bomag BW213 D-2 single drum vibratory roller
- 1 Catepillar 623B scraper
- 7 belly-dump trucks (2 singles, 2 "junior" doubles, 3 full doubles)

The belly dumps hauled DGAB (NDOT Type 1 Class B base) to the sections. The DGAB was dumped in windrows that were usually several truckloads thick before being graded. In "rough grading," the Catepillar 14G graders made 6 to 7 passes in both directions until the base was spread out sufficiently to form a uniform mat about 2.5 in thicker than the target (compacted) thickness. The 4 in sections received one 4 in lift, the 8 in sections two 4 in lifts, and the 12 in sections two 6 in lifts. No automatic elevation control was used at this stage.

Table 6. Granular embankment thicknesses.

Section	Average	Max	Min	StDev
320101	22.8	26.7	20.4	1 5
320102	21.4	23.0	19.7	0.9
320103	24.5	28.3	20.8	1.8
320104	18.4	21.0	16.1	1.0
320105	23.7	26.4	21.5	1 3
320106	18.3	19.7	17.5	0.5
320107	24.6	26.2	23.0	0.8
320108	17.1	18.5	15.2	0.8
320109	14.4	15.2	13.2	0.5
320110	22.5	24.3	20.4	0.8
320111	19.9	21.4	17 6	1.0
320112	15.1	17 0	13.4	1.1

Table 7. DGAB gradation.

Sieve	% Passing
1-1/2	100
1	96
3/4	85
½	67
3/8	59
#4	46
#10	37
#40	24
#80	17
#200	12.4

The rough graded mat was compacted in 6 to 7 passes of the Catepillar CS-563 single drum vibratory roller. After the primary compaction, the base was trimmed to 3/16 in above the target grade and recompacted utilizing a Bomag BW213 D-2 single drum vibratory roller. Trimming was accomplished utilizing either a Catepillar 146 grader with electronic controls with a guide on grade or a Gomaco B500-B trimmer. Water trucks sprayed water on the DGAB throughout the placement operations.

Quality Assurance Sampling and Testing

Bulk samples of the DGAB were taken and density tests performed as shown in figure A3, appendix A. Results of the density testing are shown in table 8.

FWD Testing

FWD testing was performed from July 12-24, 1995. Appendix B shows the deflection plots for the seven sections receiving DGAB. Table 9 lists the midlane and outer wheelpath average deflections and standard deviations, normalized to a 9000 lb load.

Section 320109 had a high standard deviation of 22.9 mils in the midlane. The high midlane average of 39.2 mils is likely a result of poor DGAB placement, since the subgrade and embankment did not show any significant weak areas.

Section 320105 had the highest outer wheelpath deflection average and highest outer wheelpath standard deviation, likely due to the variable lime stabilized subgrade in this section.

PERMEABLE ASPHALT TREATED BASE

Six of the 12 SPS-1 sections received a 4 in permeable asphalt treated base (PATB). The PATB in sections 320107, 320108, and 320109 was placed directly on the DGAB, and directly on the embankment in sections 320110, 320111, and 320112. Transverse interceptor drains and longitudinal drains were placed in all of the sections, prior to PATB placement. PATB paving took place on August 14 and 18, 1995.

Materials

No mix design for PATB was used.

Table 10 gives gradations of samples taken from the cold feed belt during production.

Table 8. DGAB density.

Section	Test No. from Figure E3	In-Situ Dry Density (pcf)	% of Optimum Dry Density	In-Situ Moisture Content
320101	T43	130.0		4.8
320101	T44	135.5		3.9
320101	T45	131.4		4.0
320101	T46	132.3		4 3
320102	T63	130 3		4.0
320102	T64	133.5		4.2
320102	T65	130.6		4.5
320102	T66	130.1		4 3
320105	T60	123.4		5 3
320105	T61	123.5		5.0
320105	T62	122.8		5.6
320106	T47	123.0		5.4
320106	T48	127.0		5.3
320106	T49	132 9		5 6
320107	T57	129.6		4.7
320107	T58	131.4		5.2
320107	T59	128.4		5.1
320108	T54	128.3		4.4
320108	T55	129 3		3.6
320108	T56	129.8		4.4
320109	T50	132.5		4.8
320109	T51	129.0		4 7
320109	T52	127.1		4.6
320109	T53	130.4		4.2

Table 9. SPS-1 DGAB FWD averages and standard deviations at 9000 lbs, sensor 1.

Section	Thickness (in)	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320101	8	25.1	2.5	28.3	1.4
320102	12	22.3	1.9	22.9	4.0
320105	4	23.7	2.9	30.2	5.2
320106	4	27.0	2.0	23.0	2.3
320107	4	14.8	1.3	11.9	1.2
320108	8	24.6	4.2	23.3	4.9
320109	12	39.2	22.9	22.0	3.6

Table 10. Permeable asphalt treated base gradations from cold feed belt, NV SPS-1 (% passing).

	Sieve Size						
Date Sampled	1"	3/4"	1/2"	3/8"	No.4	No.8	No.200
8/11/95	100	93	62	39	9	5	2
	100	94	64	39	9	5	2
	100	91	57	34	7	4	2
	100	95	60	36	8	4	2
	100	91	56	32	7	4	2
	100	90	54	31	6	4	2
Average	100	92.3	58.8	35.2	7.7	4.3	2
Standard Deviation	0	2.0	3.8	3.4	1.2	0.5	0
8/14/95	100	91	59	32	6	3	2
	100	92	50	31	7	4	2
	100	93	57	35	8	5	3
	100	93	58	36	8	5	2
Average	100	92 3	56	33.5	7.3	4.3	2 3
Standard Deviation	0	1.0	4.1	2.4	1.0	1.0	0.5
8/18/95	100	92	58	34	7	4	2
	100	92	59	36	8	5	2
	100	96	56	32	7	4	2
	100	92	55	33	6	4	2
	100	90	56	32	6	4	2
Average	100	92.4	56.8	33.4	6.8	4.2	2
Standard Deviation	0	2.2	1.6	1.7	0.8	0.4	0
Total Average	100	92.3	57.4	34.1	7.3	4.3	2.1
Total Standard Deviation	0	1.7	3.3	2.6	1.0	0.6	0 3
Specification Limits	100	90-100	35-65	20-45	0-10	0-5	0-2

Equipment and Construction Methods

The equipment used in the PATB placement included the following:

- Catepillar AP-1050 paver
- Catepillar Extend-A-Mat 10-20B screed
- Catepillar CB-534 double-drum vibratory roller (13 tons)
- Ford 545A front end loader
- Oil truck for liquid asphalt
- 7 belly dump trucks
- CMI Clarco Cocal loading machine

The operation began with the priming of the sections to be paved with MC-250 liquid asphalt. The MC-250 was then dusted with a fine coat of sand to prevent tracking by construction traffic. The specifications for the MC-250 are given in appendix C.

Asphalt Plant

The asphalt plant was located approximately 5 miles from the project in pit 83-8. It was a CMI drum plant purchased in 1994 and belonged to Honeywell in Winnemucca. The plant could produce a maximum of 375 tons per hour. The asphalt cement was refined at Huntway Refining Company from Benicia, California The refinery produced the AC-20, AC-20P, and AC-30 grades of binder that were used on the project.

Edge Drain Construction

On July 19, 1995, trenching for the edge drains began. A Vermeer V-4150 trenching machine was used. Other equipment included a Catepillar 416 Series II, Catepillar 950 E loaders, and one water truck. Elevations were checked in the trenches behind the trencher.

Next, the geotextile was rolled out into the trenches. The specifications for the geotextile are given in appendix C. About 4 ft extended onto the outer edge of the roadway. Approximately 3 ft of fabric extended from the outer edge of the trench and was tacked down to prevent being picked up by the paver during PATB paving.

On the DGAB sections, a 4 ft piece of fabric was rolled out on the inside edge, to be folded over the PATB following paving. This would prevent fines from contaminating the PATB from the inner edge. On the sections where the PATB would be placed directly on the embankment, the entire grade was covered with geotextile.

Then, approximately 3 in of an open graded rock was placed into the trench. On top of the rock a 4 in diameter Cresline SCH40 Nema TC-2 Rigid PVC slotted pipe was placed. The slots were spaced at 1 in and the pipe was laid with the slots down.

Transverse interceptor drains were placed at the following stations: 99+00, 113+20, 120+20, 128+20, and 137+80.

Edge drain outlets were placed at the following stations: 92+75, 94+90, 97+05, 100+10, 103+20, 105+20, 107+20, 109+20, 111+20, 115+60, 118+03, 122+55, 124+65, 126+75, 131+10, 133+45, and 135+75.

Trenching was completed on August 2nd.

PATB Paving

The PATB was paved in three passes with the inner and outer passes 13 ft wide and the center pass 14 ft wide. The outer pass of all sections and the middle pass of 320110 were paved on August 14, 1995 and the middle and inner passes paved on August 18, 1995. The air temperature during paving was near 70°F in the mornings and near 90°F in the afternoons, with no clouds present.

A line was marked with a stringline and spray paint for the paver to follow horizontally on its first pass. This allowed the paver to make a fairly straight pass of uniform width. Elevation control was accomplished with automatics on the wireline, and skis on the grade. When paving the inner and outer passes, one side of the paver followed the wireline, and the other had a ski to follow the grade. Paving the middle pass, elevation was controlled by utilizing joint matching shoes on each side following the previous passes.

The PATB mix was placed using belly dump trucks, and the Cocal machine distributed the mix into the paver. The paver screed operator had a lot of problems keeping a level mat.

Table 11 lists the PATB mix temperatures at the plant and paver during production.

Table 11. PATB mix temperatures at the plant and paver during production, NV SPS-1.

Date	Average PABT Plant Temperature (°F)	Standard Deviation (°F)	Average PATB Paver Temperature (°F)	Standard Deviation (°F)
08/14/95	252	2.7	252	2.7
08/18/95	265	11.2	262	6.5

Compaction

A catepillar CB534 double drum vibratory (13 ton) roller was utilized in static mode for compaction. The roller waited until the PATB mat had cooled to 170°F prior to beginning compaction. Two complete coverages were made on all six sections. For each width of PATB placed, the compactor made two passes in three overlapping widths, i.e., covering the outer, middle, and inner surface.

Prior to paving other layers, construction traffic driving on the PATB caused rutting which was especially severe near the edge drains.

Quality Assurance Sampling and Testing

The complete materials sampling layout for the PATB layer is shown in appendix A, figure A4.

Loose lift thicknesses were measured during paving and are given in table 12. An elevation survey was used to determine the final layer thicknesses, shown in table 13.

Table 12. Loose life thicknesses, PATB paving, NV SPS-1.

Section	Lift	Avg Thickness (inch)	Standard Deviation (inch)	Min Thickness (inch)	Max Thickness (inch)
320107	1	4.4	0.4	3.4	5.0
320108	1	4.6	0.2	4.1	5 4
320109	1	4.5	0.2	4.0	5.1
320110	1	4.6	0.3	3.9	5.0
320111	1	4.6	0.2	4.1	5.0
320112	1	4.5	0.3	4.0	5 5

Table 13. Final lift thicknesses, PATB layer, NV SPS-1.

Section	Avg Thickness (inch)	Standard Deviation (inch)	Min Thickness (inch)	Max Thickness (inch)
320107	4.1	0.6	2.6	5.5
320108	4.5	0.3	3.6	5 2
320109	4.0	0.4	3.2	4.9
320110	4.4	0 3	3.8	4.9
320111	4.4	0.5	3.5	5.6
320112	4.2	0.3	3.6	5.0

Detailed Construction

Section 320107

Placement of the PATB paving began on August 14, 1995, at 10:55 a.m., in the outer lane going eastbound, and was finished at 11:25 a.m. The inner pass was paved from 11:30 a.m. to 11:45 a.m. on August 18, 1995. The center pass was paved from 3:25 p.m. to 3:55 p.m. on August 18, 1995. The average loose paving thickness was 4.4 in with a 0.4 in standard deviation. The average compacted thickness was 4.1 in, with a standard deviation of 0.6 in, based on an elevation survey.

Section 320108

The outer pass was paved from 11:45 a.m. to 12:10 p.m. on August 14, 1995 and the inner pass from 9:50 a.m. to 10:35 a.m. on August 18, 1995. The average loose laydown thickness was 4.6 in with a standard deviation of 0.2 in. The average compacted thickness was 4.5 in with a standard deviation of 0.3 in, based on an elevation survey.

Section 320109

Paving took place in the outer pass on August 14, 1995 from 12:30 p.m. until 1:00 p.m., the inner pass from 9:15 a.m. to 9:45 a.m., on August 18, 1995, and in the middle pass from 4:55 p.m. until 5:20 p.m. on August 18, 1995. The loose laydown thickness averaged 4.5 in with a standard deviation of 0.2 in. The final compacted thicknesses averaged 4.0 in with a standard deviation of 0.4 in.

Section 320110

Paving began at 1:25 p.m. in the outer lane on August 14, 1995 and finished at 2:00 p.m. The paver turned around and heading east paved the middle pass up to station 5+46 from 2:15 p.m. until 3:25 p.m. There was a plant breakdown at station 2+35 for 52 min. The paver had a full hopper and there was about 100 ft of windrow during the breakdown. The remaining portion of the middle pass was paved on August 18, 1995, from 5:30 p.m. until 5:40 p.m. The inner pass was paved on August 18, 1995 from 8:30 a.m. until 9:00 a.m. The average loose laydown thickness was 4.6 in with a standard deviation of 0.3 in. The final thickness measured 4.4 in with a standard deviation of 0.3 in.

Section 320111

The outer pass was paved on August 14, 1995 from 8:35 a.m. until 9:00 a.m., the middle pass from 2:10 p.m. until 2:40 p.m. on August 18, 1995, and the inner pass from 1:45 p.m. until 2:25 p.m. on August 18. The loose laydown thickness averaged 4.6 in and had a 0.2 in standard deviation. The average compacted thickness measured 4.4 in with a 0.5 in standard deviation.

Section 320112

The outer pass was paved from 9:20 a.m. until 10:15 a.m. on August 14, 1995. The inner pass was paved form 12:20 p.m. until 12:50 p.m. on August 18, 1995, and the middle pass from 2:55 p.m. until 3:20 p.m. on August 18, 1995. The average loose laydown thickness was 4.5 in with a 0.3 in standard deviation The compacted thickness averaged 4.2 in with a standard deviation of 0.3 in.

ASPHALT TREATED BASE

Seven of the 12 SPS-1 sections received an asphalt treated base (ATB). In sections 320103 and 320104, the ATB was placed directly on the embankment. In sections 320105 and 320106, the ATB was placed on dense graded aggregate base. The ATB was placed over the permeable asphalt treated base in sections 320110, 320111, and 320112. Paving of the ATB began on August 4, 1995 in section 320104, and was completed on August 23, 1995 in section 320105.

Materials

Table 14 summarizes the mix design for the ATB mix. The complete mix design is given in appendix D. During production, samples of the aggregate were taken from the cold feed belt. Table 15 lists these gradations.

Table 14. Asphalt treated base mix design summary, NV SPS-1.

Asphalt Type:	AC-20
Asphalt Producer:	Huntway
Admixture Type:	Hydrated Lime, Wet-Cured 48 Hours
Admixture Amount:	1.5%
Hveem Value:	41
Percent Air Voids:	4.9
Percent Asphalt:	5.25

Equipment and Construction Methods

The equipment used in the ATB placement included the following:

- Catepillar AP-1050 paver
- Catepillar Extend-A-Mat 10-20B screed
- Two Catepillar CB-534 double drum vibratory rollers (13 tons)
- Ford 545A front end loader
- Distributor truck for liquid asphalt
- Seven belly dump trucks
- CMI Clarco Cocal loading machine
- Hyster C530A rubber-tired roller (10.2 tons)

The belly dump trucks dumped windrows such that two trucks would dump over the same area. The windrows were therefore two loads thick. The Cocal machine then picked up the ATB material and deposited it in the hopper of the paver. There was a problem with maintaining a consistent amount of material in the hopper. The hopper was consistently too full or too empty, and the loader was used to add or remove material. This was the case in every section. In addition, the belly dump trucks were not keeping up with the paver. Due to these delays, the ATB paving operation was essentially stop and go in all sections. One exception to the delays was when the paver turned around to start a new pass. At this point, the trucks had a chance to accumulate before the paving started again.

The ATB was paved in three passes, with the width varying in each lift to overlap longitudinal joints from previous lifts (see table 16). Depending upon final thicknesses, two, three, or four lifts were placed on respective sections.

Wire lines and a 30 ft ski was utilized for the two outside passes and joint matching shoes were utilized for the center pass until August 22nd. On August 22nd and 23rd, skis were utilized on the outside passes and the wire lines were not utilized.

Table 15. Asphalt treated base gradations from cold feed belt, NV SPS-1 (% passing).

	Sieve Size							
Date Sampled	1"	3/4"	1/2"	3/8"	No.4	No 10	No 40	No.200
8/4/95	100	97	81	69	53	33	17	5
	100	96	85	72	53	34	17	5
	100	97	86	71	53	35	18	6
	100	96	84	68	49	31	16	6
Average	100	96	84	70	52	33.3	17	5.5
Standard Deviation	0	0.6	2.2	1.8	2	1.7	0.8	0.6
8/7/95	100	96	87	74	55	35	16	4
8/9/95	100	99	88	74	53	34	18	7
	100	95	82	69	50	31	16	6
	100	98	84	71	52	32	16	5
	100	96	86	72	53	34	17	6
Average	100	97	85	71	52	33	16.8	6
Standard Deviation	0	1.8	2.6	2.1	1.4	1.5	1.0	0.8
8/11/95	100	96	84	69	51	32	16	6
8/19/95	100	97	81	66	46	30	16	6
	100	96	82	70	51	34	18	6
	100	96	85	72	53	36	18	5
	100	95	82	70	51	35	17	5
Average	100	96	82	69	50.2	33.8	17.2	5.5
Standard Deviation	0	0.8	1.7	2.5	3.0	2.6	1.0	0.6
8/21/95	100	93	81	66	48	32	16	5
	100	95	84	71	51	35	18	5
	100	95	84	71	52	35	17	6
	100	97	82	69	49	32	17	6
	100	98	84	73	55	36	19	7
Average	100	95.6	83	70	51	34	17.4	5.8
Standard Deviation	0	1.9	1.4	2.6	2.7	1.9	1.1	0.8
8/22/95	100	95	83	70	52	34	18	7
	100	98	89	78	57	37	19	7
	100	95	85	73	53	34	18	6
	100	97	87	72	52	34	18	7
	100	96	83	69	52	34	18	7
Average	100	96.2	85.4	72.4	53.2	34.6	18.2	6.8
Standard Deviation	0	1.3	2.6	3.5	2.2	1.3	0.4	0.4
8/23/95	100	97	--	72	54	35	18	7
	100	97	--	70	53	34	17	6
	100	99	--	76	59	36	17	6
Average	100	97.7	--	72.7	55.3	35	17.3	6.3
Standard Deviation	0	1.2	--	3	3.2	1	0.6	0.6
Total Average	100	96.4	84	70.9	52.2	33.9	17.3	5.9
Total Standard Deviation	0	1.4	2.2	2.7	2.6	1.7	0.9	0.8
Specification Limits	100	90-100	None	63-85	45-65	30-44	12-22	3-7

Table 16. Construction sequence of ATB layer, NV SPS-1.

Date	Section Paved	Lift	Approximate Compacted Lift Thickness (inch)	Passes
8/4/95	320104	1	4	All
	320106	1	4	Inner, Outer
8/7/95	320104	2	4	Inner
	320104	2	4	Part of Middle (joint at 78+0)
	320106	1	4	Middle
8/9/95	320104	2	4	Outer
	320104	2	4	Rest of Middle
	320104	3	2	All
	320104	4	2	All
	320106	2	2	All
	320106	3	2	All
8/11/95	320103	1	4	Outer
8/19/95	320103	1	4	Middle
	320110	1	2	Outer, Middle
	320111	1	4	Outer
	320112	1	4	All
	320112	2	4	Outer
8/21/95	320103	1	4	Inner
	320103	2	2	Outer
	320105	1	2	Outer (joint at 150+90)
	320110	1	2	Inner
	320110	2	2	All
	320111	1	4	Inner, Middle
	320111	2	2	Outer
	320112	2	4	Inner, Middle
	320112	3	2	Outer
8/22/95	320103	2	2	Inner, Middle
	320103	3	2	Outer
	320105	1	2	Finish Outer Pass
	320105	1	2	Middle, Inner
	320105	2	2	Outer
	320111	2	2	Middle, Inner
	320111	3	2	Outer
	320112	3	2	Middle, Inner (middle paved in rain, joint at 130+99)
	320112	4	2	Inner, Outer
8/23/95	320103	3	2	Inner, Middle
	320105	2	2	Inner, Middle
	320111	3	2	Inner, Middle
	320112	4	2	Middle

Joints were kept out of the monitoring sections with the exception of one joint in section 320104, at station 3+70 of the second lift, and one joint at station 0-20 in the first lift of section 320106, which fell in the sampling area.

Table 17 lists the temperatures and weather during ATB paving. Table 16 summarizes the construction sequence. Table 18 lists the ATB mix temperatures at the plant and paver during production.

Compaction

Compaction procedures included breakdown, intermediate, and final rolling as follows:

Breakdown. This was accomplished using a Catepillar CB-534 vibrating roller. The roller weight was 13 tons, and vibrated at 350 vibrations/minute. Each mat was covered in three overlapping passes of four coverages each, usually about 5 to 15 minutes after paving. The roller covered the entire mat first, then moved on to the second coverage. Roller coverages were usually 200-300 ft in length.

Intermediate. A 10 ton Hyster C530A pneumatic rubber-tired roller was used. There were four tires in the front and five in the back, each at 60 psi pressure. Each section received six non-overlapping coverages 45 minutes to an hour following paving. Half of the mat received six coverages first, then the other half received six coverages.

Final. The Catepillar CB-534 13 ton vibratory roller was used for this pass, vibrating at 350 vibrations per minute. Compaction was accomplished 90-120 minutes after paving. Approximately four coverages were made with no exact pattern. On several passes, the compaction was done with no vibration.

Compaction tests were performed at various locations throughout the ATB project, and the results are shown in table 19. The average density was 139 pcf, which is 93 percent of the optimum density of 149.5 pcf.

Quality Assurance Sampling and Testing

Figure A5, appendix A shows the materials sampling layout for the ATB layer. Densities taken on the top ATB layer are given in table 20.

Samples of the AC mixture were compacted in the field during production, and in the lab following production. The samples were tested for density, percent air voids, percent asphalt, and Hveem stability in the lab. The results are shown in tables 21 and 22.

FWD Testing

FWD testing was performed from August 15-25, 1995. Section 320106 was not tested.

Table 17. Temperatures and weather during ATB paving, NV SPS-1.

Date	Sections Paved	Low Temp (°F)	High Temp (°F)	Type of Weather
08/04/95	320104, 320106	53	101	Scattered clouds & hot
08/07/95	320104, 320106	55	82	Scattered clouds & warm
08/09/95	320104, 320106	52	94	Scattered clouds, hot & windy
08/11/95	320103	51	63	Clear, cool & windy
08/19/95	320103, 320110, 320112	51	96	Clear & hot
08/21/95	320103, 320105, 320110, 320111, 320112	61	97	Partly cloudy, hot & windy
08/22/95	320103, 320105, 320111, 320112	58	91	Mostly cloudy, hot & some rain in p.m.
08/23/95	320103, 320105, 320111, 320112	59	93	Partly cloudy & hot

Table 18. ATB mix temperatures at the plant and paver during production, NV SPS-1.

Date	Average ATB Plant Temperature (°F)	Standard Deviation (°F)	Average ATB Paver Temperature (°F)	Standard Deviation (°F)
08/04/95	307	4.3	301	4.2
08/07/95	305	0*	301	4.2
08/09/95	298	10.7	298	8 1
08/11/95	300	0*	303	3 5
08/19/95	284	5.8	282	7 5
08/21/95	288	9.8	285	7.2
08/22/95	286	8.8	284	8.1
08/23/95	294	13.4	290	12.2

Table 19. Densities and percent compaction for ATB sections, NV SPS-1.

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density (pcf)	% Relative Compaction
8/4/95	320104	75+50	9' Rt	139	93
	320104	75+50	9' Rt	138	92
	320104	77+25	3.8' Lt	139	93
	320104	79+75	11.5' Rt	140	93
	320106	87+50	2 6' Lt	139	93
8/7/95	320104	79+50	--	137	92
	320104	76+00	--	138	92
	320104	79+75	--	138	92
8/21/95	320103	144+00	2.9' Rt	138	92
	320110	95+00	Outer edge	139	93
	320110	96+50	2.7' Rt	138	92
	320110	97+75	2 8' Rt	140	93
	320110	97+75	10.4' Lt	139	93
	320110	95+75	8 6' Rt	139	93
	320111	132+50	12.3' Lt	138	92
	320111	135+25	5' Rt	138	92
	320112	125+50	9.7' Lt	139	93
	320112	126+75	13.5' Lt	139	93
	320112	126+00	4.2' Rt	138	92
	320112	121+25	8.2' Rt	139	93
8/22/95	320103	141+50	5.4' Rt	139	93
	320103	140+00	11.5' Rt	139	93
	320103	140+50	2 2' Rt	138	92
	320105	149+75	1' Rt	139	93
	320105	148+00	6 5' Rt	139	93
	320105	148+75	8 9' Lt	138	92
	320105	146+75	8.7' Lt	139	93
	320105	151+50	1' Lt	138	92
	320111	136+50	1.6' Rt	139	93
	320111	131+50	6.9' Rt	139	93
	320111	136+50	1' Rt	139	93
	320111	135+50	5.3' Rt	138	92
	320111	129+50	9.8' Lt	139	93
	320112	128+50	4.3' Rt	139	93
	320112	125+50	3.4' Rt	138	92
	320112	125+50	11.9' Rt	138	92
	320112	128+00	11.7' Rt	139	93
	320112	121+55	8.7' Lt	139	93
	320112	128+75	5.8' Lt	139	93

Table 19. Densities and percent compaction for ATB sections, NV SPS-1. (cont'd)

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density (pcf)	% Relative Compaction
8/23/95	320105	147+50	7.9' Lt	138	92
	320105	151+00	8.4' Lt	138	92
	320105	149+25	5.6' Lt	139	93
	320111	137+00	5.8' Lt	138	92
Project Average				139	93
Project Standard Deviation				0.7	0.5

Table 20. ATB density.

Section	Test No. from Figure A5	In-Situ Density (pcf)
320103	T82	132.0
320103	T83	131.1
320103	T84	129.6
320104	T67	129.8
320104	T68	130.3
320104	T69	128.5
320105	T85	129.2
320105	T86	126.3
320105	T87	129.4
320106	T70	131.6
320106	T71	130.6
320106	T72	130.5
320110	T73	131.2
320110	T74	128.2
320110	T75	130.2
320111	T79	133.4
320111	T80	132.1
320111	T81	132.2
320112	T76	132.3
320112	T77	133.9
320112	T78	134.0

Table 21. ATB field compacted sample data during production, NV SPS-1.

Date Sampled	Test Section	Maximum Density (pcf)	Density (pcf)	% Air Voids	% Asphalt
08/04/95	320104	151.1	144.1	4.6	5.5
	320106	150.3	--	--	5 5
08/07/95	320104	147 9	145.5	1.6	5.4
08/09/95	320104	149.9	145.6	2.9	5.4
	320106	149.6	--	--	5 4
08/11/95	320103	149.7	144.9	3.2	5.6
08/19/95	320112	149 4	144 6	3 2	5.6
	320112	149.8	--	--	5 3
08/21/95	320110	149.9	144.7	3.5	5.5
	320111	149.8	--	---	5 3
08/22/95	320105	150.0	144.2	3.9	5.5
	320111	150.6	--	--	5.5
	320103	150.7	--	--	5.4
08/23/95	320111	150.3	--	--	5.4
Average		149 9	144 8	3.3	5.4
Standard Deviation		0 7	0 6	0 9	0.1

Table 22. ATB laboratory compacted sample data during production, NV SPS-1.

Date Sampled	Test Section	Maximum Denisty (pcf)	Density (pcf)	Percent Air Voids	Percent Asphalt	Hveem Value
08/04/95	320105	151.4	143.0	5 5	5 50	41
08/07/95	320104	151 4	142.4	5.9	5.41	40
08/09/95	320104	151.4	143.0	5.5	4.43	44
08/11/95	320103	151.1	141.1	6.4	5.62	42
08/19/95	320112	151.6	143.2	5.5	5.62	41
08/21/95	320110	150.4	143.3	4.7	5.50	40
08/22/95	320105	152.1	144.8	4.8	5.49	40
08/23/95	320111	150.9	144.0	4.6	5.44	40
Average		151.3	143.1	5.4	5.4	41
Standard Deviation		0.5	1.1	0.6	0.4	1.4

Appendix B shows the deflection plots for the sections tested. Table 23 lists the deflection averages and standard deviations for each section.

Loose Paving Thicknesses and Final Layer Thicknesses

Loose lift thicknesses were measured during paving and are given in table 24. An elevation survey was used to determine the final layer thicknesses, shown in table 25.

Detailed Construction

The following sections discuss the detailed ATB construction by test section.

Section 320103 (8 in ATB)

Paving began on August 11, 1995 with paving of the outer pass of lift 1. Paving continued on August 19, 21, 22, and 23, 1995 for an 8 in total thickness. This section was paved in three lifts, the first 4 in and the second and third 2 in. The loose laydown thickness averages for the first, second, and third lifts were 4.8 in, 3.5 in, and 3.1 in, respectively. The final compacted layer thickness averaged 8.6 in with a standard deviation of 0.3 in.

Section 320104 (12 in ATB)

The first lift was paved on August 4, 1995. Paving continued on August 7th and 9th. Four lifts were placed; two 4 in lifts under two 2 in lifts. The loose laydown thicknesses for the second through fourth lifts averaged 5 in, 3 in, and 3.1 in, respectively. The average compacted layer thickness was measured as 12.4 in, with a standard deviation of 0.4 in. A joint was present at station 3+70 of lift two in the middle pass.

Section 320105 (4 in ATB)

This section received a 4 in ATB layer, placed in two 2 in lifts. Paving took place on August 21-22, 1995. The loose laydown thicknesses averaged 3.5 in and 2.9 in for the first and second lifts. The compacted lift thickness was measured as 4.8 in with a standard deviation of 0.2 in. A joint was present at station 4+90 in the outer pass of lift one.

Section 320106 (8 in ATB)

Paving began on August 4, 1995 and continued on August 7th and 9th. Three lifts were placed. Lift one had a 4 in thickness, and lifts two and three had 2 in thicknesses. The loose laydown thicknesses for the three lifts averaged 5.6 in, 2.9 in, and 3.1 in, respectively. The final average measured thickness of 8.8 in was higher than the specified 8 in thickness. The standard deviation was 0.4 in.

Table 23. SPS-1 ATB FWD averages and standard deviations at 9000 lbs, sensor 1.

Section	Thickness (inch)	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320103	8	5.8	0.3	7.0	0.6
320104	12	5.6	0.4	5.0	0.2
320105	4	10.2	0.7	12.4	1.2
320106	8	not tested		not tested	
320110	4	13.5	0.6	12.8	0.7
320111	8	6.3	0.2	7.4	0.3
320112	12	5.6	0.2	6.8	0.2

Table 24. Loose lift thicknesses, ATB paving, NV SPS-1.

Section	Lift	Average Loose Lift Thickness (inch)	Standard Deviation (inch)	LowThickness (inch)	High Thickness (inch)
320103	1	4.8	0.4	3.9	5.5
	2	3.5	0.3	3	4
	3	3.1	0.2	2.9	3.5
320104	1	Unknown	Unknown	Unknown	Unknown
	2	5.0	0.5	4.3	6.0
	3	3.0	0.4	2.3	4.0
	4	3.1	0.1	2.9	3.5
320105	1	3.5	0.2	3.3	3.9
	2	2.9	0.3	2.5	3.5
320106	1	5.6	0.5	4.8	6.6
	2	2.9	0.2	2.4	3.3
	3	3.1	0.1	2.8	3.4
320110	1	2.5	0.2	2.1	2.9
	2	2.9	0.2	2.5	3.3
320111	1	5.3	0.6	4.4	6.8
	2	3.1	0.2	2.6	3.5
	3	3.1	0.2	2.8	3.4
320112	1	5.0	0.3	4.5	5.8
	2	5.0	0.6	4.1	6.0
	3	3.1	0.2	2.5	3.5
	4	3.2	0.2	2.8	3.6

Table 25. Final lift thicknesses, ATB layer, NV SPS-1.

Section	Specified Thickness (inch)	Average Thickness (inch)	Standard Deviation (inch)	Low Thickness (inch)	High Thickness (inch)
320103	8	8.6	0.3	8.2	9.2
320104	12	12.4	0.4	11.8	13 3
320105	4	4.8	0.2	4 4	5.9
320106	8	8.8	0.4	8.0	9.5
320110	4	4.0	0.3	3.4	4.7
320111	8	8.4	0.6	7 1	9.2
320112	12	12.4	0.4	11:0	13 2

Section 320110 (4 in ATB)

Two 2 in thick lifts were paved on August 19 and 21, 1995. The loose laydown thicknesses averaged 2.5 in and 2.9 in for the two lifts. The compacted thicknesses in the section averaged 4 in, which was exactly the specified thickness. The standard deviation was 0.3 in.

Section 320111 (8 in ATB)

Three lifts of ATB were placed: one 4 in lift under two 2 in lifts. The paving took place on August 19, 21, 22, and 23, 1995. The loose laydown thicknesses for the three lifts averaged 5.3 in, 3.1 in, and 3.1 in, respectively. The average depth of the finished ATB in this section was 8.4 in, with a standard deviation of 0.6 in.

Section 320112 (12 in ATB)

Paving was performed on August 19, 21, 22, and 23, 1995 in four lifts. The bottom two lifts had a 4 in thickness, and the top two lifts a 2 in thickness. The loose laydown thickness of the four lifts averaged 5 in, 5 in, 3.1 in, and 3.2 in, respectively. The final compacted thickness measured 12.4 in, with a standard deviation of 0.4 in.

ASPHALT CONCRETE

Six of the test sections, 320102, 320103, 330105, 320107, 320111, and 320112 received a 4 in asphalt surface, and six, 320101, 320104, 320106, 320108, 320109, and 320110 received a 7 in asphalt surface. The paving started on August 25, 1995 and was completed August 30, 1995.

Materials

Table 26 summarizes the mix design for the AC mixture.

Table 26. Asphalt concrete mix design summary.

Asphalt Type:	AC-20P (Polymerized)
Asphalt Producer:	Huntway
Admixture Type:	Hydrated Lime, Wet-Cured 48 Hours
Admixture Amount:	1 5%
Hveem Value:	40
Percent Air Voids:	4.7
Percent Asphalt:	5.25

The complete AC mix design is given in appendix E. During production, samples of the aggregate were taken from the cold feed belt. Table 27 lists these gradations.

Table 27. Asphalt extracted aggregate gradations from cold feed belt, NV SPS-1 (% passing).

	Sieve Size							
Date Sampled	1"	3/4"	1/2"	3/8"	No.4	No.10	No.40	No.200
8/25/95	100	91	75	67	55	37	18	4
	100	93	73	67	54	37	18	5
	100	95	81	71	57	38	19	5
	100	91	68	58	45	31	16	5
Average	100	92	74	66	53	36	18	5
Standard Deviation	0	1.9	5.4	5.5	5.3	3 2	1 3	0 5
8/26/95	100	94	73	64	54	36	16	5
	100	93	79	72	61	40	16	4
	100	93	76	67	55	36	14	3
	100	93	74	64	54	37	15	4
	100	91	73	64	51	34	14	4
Average	100	93	75	66	55	37	15	4
Standard Deviation	0	1 1	2 5	3.5	3.7	2.2	0 9	0 7
8/28/95	100	95	82	73	62	41	15	3
	100	95	80	73	60	41	17	4
	100	92	72	63	50	33	14	4
	100	92	78	71	60	40	15	3
	100	93	75	67	57	37	14	3
Average	100	93	77	69	58	38	15	3
Standard Deviation	0	1.5	4.0	4.3	4.7	3.4	1 2	0.5
8/29/95	100	94	74	67	56	37	15	4
	100	91	75	65	54	37	15	3
	100	94	70	62	50	34	14	4
	100	93	75	68	57	38	15	4
	100	93	76	66	57	39	15	4
Average	100	93	74	66	55	37	15	4
Standard Deviation	0	1.2	2.3	2.3	2.9	1.9	0.4	0.4
8/30/95	100	95	80	73	62	41	16	3
	100	93	78	69	55	37	16	4
	100	91	71	64	52	35	15	4
	100	92	72	62	48	32	13	3
	100	93	72	64	53	36	15	4
Average	100	93	75	66	54	36	15	4
Standard Deviation	0	1.5	4.1	4.5	5.1	3.3	1.2	0.5
Total Average	100	93	75	67	55	37	15	4
Total Standard Deviation	0	1.3	3.6	4.0	4.3	2.7	1.4	0.7
Specification Limits	100	88-95	70-85	60-78	43-60	30-44	12-22	3-7

Equipment and Construction Methods

The equipment used in the AC placement included the following:

- Catepillar AP-1050 paver
- Catepillar Extend-A-Mat 10-20B screed
- Two Catepillar CB-534 double drum vibratory rollers (13 tons)
- Ford 545A front end loader
- Distributor truck for liquid asphalt
- Seven belly dump trucks

- CMI Clarco Cocal loading machine
- Hyster C530A rubber-tired roller (10.2 tons)

The AC paving operation was stop and go as with the ATB paving, due to the hopper being too full or too empty, and also due to the belly dump trucks not being able to keep up with the paver. Table 28 shows the construction sequence for the AC paving. The paver usually made continuous passes of 6 or twelve sections in a row, depending on the lift being paved.

Three passes were made per lift, with the widths of each pass varying by lift in order to overlap the underlying lifts. In the 7 in sections, three lifts were placed; one 3 in nominal lift under two 2 in nominal lifts. In the 4 in sections, two 2 in nominal lifts were placed. The widths of the top pass starting from the outer edge were approximately 10 ft, 12 ft and 16 ft.

During production, asphalt mix temperatures were taken both at the plant and at the paver. These temperatures are recorded in table 29. The weather during the paving was generally clear and hot. Table 30 lists the air temperatures recorded during paving.

QUALITY ASSURANCE

Quality Assurance Sampling and Testing

Figure A6, appendix A shows the complete materials sampling layout for the AC layer. Density tests taken during construction of the AC layer are given in table 31. Densities taken on the top lift of the AC layer as shown in figure A6 are given in table 32.

Samples of the AC mixture were compacted in the field during production, and in the lab following production. The samples were tested for density, percent air voids, percent asphalt, and Hveem stability (in the lab). The results are shown in tables 33 and 34.

FWD Testing

Table 35 lists the FWD deflection averages and standard deviations for both the midlane and outer wheelpath in each section.

Table 28. Construction sequence of asphalt layer, NV SPS-1.

Date	Section Paved	Lift	Approximate Compacted Lift Thickness (in)	Passes
8/25/95	320101, 320104, 320106, 320108, 320109, 320110	1	3	Outer, Middle
8/26/95	320101, 320104, 320106, 320108, 320109, 320110	1	3	Inner
8/26/95	320101, 320104, 320106, 320108, 320109, 320110	2	2	Outer
8/26/95	320103, 320105, 320107, 320111, 320112	1	2	Outer
8/28/95	320102	1	2	Outer
8/28/95	320102, 320103, 320105, 320107, 320111, 320112	1	2	Middle, Inner
8/28/95	320101, 320104, 320106, 320108, 320109, 320110	2	2	Middle
8/28/95	320108, 320109	2	2	Inner
8/28/95	320110	2	2	Inner (joint at 97+05 in sampling area)
8/29/95	320101, 320104, 320106	2	2	Inner
8/29/95	All	Top	2	Outer
8/29/95	320101, 320104, 320106, 320107, 320108, 320109, 320110, 320112	Top	2	Middle
8/30/95	320102, 320103, 320105, 320111	2	2	Middle
8/30/95	All	Top	2	Inner

Table 29. AC mix temperatures at the plant and paver during production.

Date	Average AC Plant Temperature (°F)	Standard Deviation (°F)	Average AC Paver Temperature (°F)	Standard Deviation (°F)
08/25/95	298	8.8	297	4.5
08/26/95	299	6.4	296	3 0
08/28/95	298	7.8	297	5.0
08/29/95	300	3.0	299	3.6
08/30/95	303	7.2	299	4.7

Table 30. Temperature and weather during asphalt paving.

Date	Sections Paved	Low Temp. (°F)	High Temp. (°F)	Type of Weather
08/25/95	320101, 320104, 320106, 320108, 320109, 320110	52	91	Scattered clouds, hot
08/26/95	All sections except 320102	77	93	Clear and hot
08/28/95	All	50	89	Clear and warm
08/29/95	All	48	93	Clear and hot
08/30/95	All	46	94	Clear and hot

Table 31. Densities and percent compaction for AC sections, NV SPS-1.

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density (pcf)	% Relative Compaction
8/25/95	320101	67+25	6.1' Lt	141	94
	320104	74+50	1' Lt	142	94
	320104	74+75	11.5' Rt	141	94
	320104	79+75	10 4' Rt	141	94
	320108	108+50	11' Lt	141	94
	320110	91+00	12' Lt	141	94
	320110	95+25	6 0' Lt	140	93
	320110	95+25	6.7' Rt	141	94
8/26/95	320101	69+00	5.0' Lt	142	94
	320101	73+00	2.2' Rt	139	93
	320106	82+25	12 8' Rt	138	92
	320106	83+75	2 2' Lt	142	94
	320106	84+00	12.5' Rt	139	93
	320106	89+25	6.0' Lt	141	94
	320108	108+75	12.9' Lt	140	93
	320108	109+50	9.5' Lt	140	93
	320109	105+00	2.8' Rt	139	93
	320110	93+50	4.0' Rt	138	92
8/28/95	320101	65+25	8 9' Rt	142	95
	320101	70+50	4 4' Rt	138	92
	320102	153+00	7 7' Rt	139	93
	320102	155+50	2 4' Lt	140	94
	320102	156+75	9.4' Lt	140	94
	320103	139+50	11.3' Rt	141	94
	320103	143+25	11.3' Lt	141	94
	320105	146+50	10.2' Rt	142	95
	320106	82+75	10.6' Rt	141	94
8/29/95	320107	117+00	12.9' Lt	139	93
	320108	112+00	9.7' Lt	139	93
	320108	112+75	5.5' Rt	140	94
	320109	102+75	7.7' Lt	141	94
	320109	105+50	5.0' Rt	140	94
	320111	136+25	1.0' Rt	140	94
	320111	136+75	8.9' Lt	140	94
	320112	125+50	8.6' Rt	141	94
	320112	127+00	8.9' Lt	139	93

Table 31. Densities and percent compaction for AC sections, NV SPS-1. (cont'd)

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density (pcf)	% Relative Compaction
8/29/95	320101	67+25	9.9' Rt	140	93
	320101	69+00	5.9' Rt	140	93
	320101	72+50	9.8' Rt	141	94
	320101	73+50	11.1' Rt	142	95
	320103	143+25	4.0' Lt	141	94
	320104	74+50	9.4' Rt	140	93
	320104	79+00	6.1' Rt	140	93
	320104	79+00	2 4' Lt	142	95
	320106	88+00	3.1' Rt	140	93
	320107	114+25	5.4' Lt	140	93
	320108	109+75	10.5' Rt	141	94
	320110	95+75	4.1' Lt	141	94
	320111	134+50	12.4' Lt	141	94
	320112	121+00	5.4' Lt	140	93
	320112	128+00	0 5' Lt	142	95
Project Average				140	94
Project Standard Deviation				1.1	0 7

Table 32. AC density.

Section	Test No. from Figure A6	In-Situ Density (pcf)
320101	T88	134.6
320101	T89	134.9
320101	T90	135.1
320102	T121	134.8
320102	T122	134.7
320102	T123	135.7
320103	T115	131.2
320103	T116	134.4
320103	T117	135.6
320104	T91	135.3
320104	T92	134.3
320104	T93	135.4
320105	T118	134.3
320105	T119	134.8
320105	T120	136.7
320106	T94	134.2
320106	T95	132.0
320106	T96	133.8
320107	T106	135.4
320107	T107	133.2
320107	T108	131.4
320108	T103	132.9
320108	T104	132.9
320108	T105	133.4
320109	T100	134.0
320109	T101	129.6
320109	T102	131.2
320110	T97	132.1
320110	T98	130.4
320110	T99	131.0
320111	T112	137.9
320111	T113	136.7
320111	T114	136.0
3230112	T109	136.0
320112	T110	137.4
320112	T111	136.0

Table 33. AC field compacted sample data during production.

Date Sampled	Test Section	Maximum Density (pcf)	Density (pcf)	% Air Voids	% Asphalt
08/25/95	320104	150.3			5.2
08/26/95	320109	150.3	143.3	4.7	5.2
	320102	149.4			5.2
08/28/95	320105	150.4			5.3
	320106	149.7			5.3
08/29/95	320106	149.9	140.8	6.1	5.2
	320107	149.9			5.4
08/30/95	320102	149.9	143.2	4.5	5.3
	320110	149 4			5.2
Average		149.9	142.4	5.1	5.3
Standard Deviation		0.3	1.4	0.9	0.1

Table 34. AC laboratory compacted sample data during production.

Date Sampled	Test Section	Max. Density (pcf)	Density (pcf)	Percent Air Voids	Percent Asphalt	Hveem Value
08/26/95	320109	151.2	142.6	5.7	5.2	43
08/28/95	320102	150.5	141.5	6.0	5 3	45
08/29/95	320106	150.4	141.5	5.9	5.2	43
08/30/95	320102	147.2	142.7	3.1	5.3	45
Average		149.8	142.1	5.2	5.2	44
Standard Deviation		1.8	0.7	1.4	0.1	1.2

Table 35. SPS-1 AC FWD avaerages and standard deviations at 9000 lbs, sensor 1.

Section	Thickness (inch)	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320101	7	8.7	0.4	9.7	0.4
320102	4	15.0	1.2	14.8	0.9
320103	4	7.6	0.2	9.3	0.5
320104	7	3.9	0.1	4.4	0.2
320105	4	10.7	0.5	11.8	0.5
320106	7	4.9	0.2	4.9	0.2
320107	4	10.0	0.5	10.3	0.7
320108	7	7.9	0.3	7.2	0.6
320109	7	7 0	0.7	7.0	0.4
320110	7	6 2	0 3	6 2	0.3
320111	4	7.0	0.2	7.6	0 4
320112	4	5.9	0 2	5.8	0.2

Section 320102, the 4 in AC section on 12 in of DGAB, had the highest deflections and standard deviations in both the midlane and outer wheelpath. Section 320104, the 7 in AC section on 12 in of ATB, had the lowest deflections and standard deviations in both the midlane and outer wheelpath.

Layer Thicknesses

During paving, loose paving thicknesses were measured for each lift. Final compacted layer thicknesses were measured by an elevation survey. Table 36 lists the loose lift thicknesses measured, and table 37 lists the final compacted layer thickness for each section.

Detailed Construction

The following sections discuss the detailed AC construction by test section.

Section 320101

Paving took place on August 25-26 and August 28-30, 1995. Three lifts were placed in loose thicknesses of 3.9 in, 2.6 in, and 2.8 in, or approximate compacted thicknesses of 3 in, 2 in, and 2 in. The average compacted layer thickness was 7.2 in, with a standard deviation of 0.4 in. The mean laydown temperature was 298°F. No problems were noted during the laydown procedures.

Section 320102

Paving began on August 28th, and continued on August 29-30, 1995. Two lifts of 2.8 in loose thicknesses were placed. The average compacted layer thickness was 4.1 in, with a standard deviation of 0.2 in. The mean laydown temperature was 295°F.

Between stations 0-90 and 0-60 on August 29, 1995, some rough finish within 3 to 4 ft of the outside edge was filled and raked by hand prior to compaction. This occurred on the top lift of the outer pass.

Section 320103

This section was paved starting on August 26, 1995 and continued from August 28-30, 1995. Two lifts were placed in loose thicknesses of 2.8 in and 2.6 in. The final measured thickness was 4.2 in, with a standard deviation of 0.1 in. The mean laydown temperature was not recorded. No problems were encountered during the paving of this section.

Section 320104

Paving began on August 25, 1995. Three lifts were placed in loose thicknesses of 3.8 in, 2.6 in, and 2.7 on. Paving continued on August 26 and August 28-30, 1995. On August 30th, on

Table 36. Loose lift thicknesses, AC paving, NV SPS-1.

Section	Lift	Average Loose Lift Thickness (in)	Standard Deviation (in)	Low Thickness (in)	High Thickness (in)
320101	1	3.9	0.2	3.4	4.4
	2	2.6	0.1	2.5	3.0
	3	2.8	0.2	2.3	3.4
320102	1	2.8	0.1	2.5	3.0
	2	2.8	0.2	2.5	3.1
320103	1	2.8	0.1	2.6	3.1
	2.	2 6	0.1	2.4	2.9
320104	1	3 8	0.1	3.5	4.3
	2	2.6	0.1	2.5	2 8
	3	2.7	0.1	2.5	2.9
320105	1	2.8	0 2	2.5	3.3
	2	2.6	0 1	2.4	2.9
320106	1	3 8	0.1	3 5	4 0
	2	2 7	0 1	2 4	2 9
	3	2.8	0.1	2 6	3.0
320107	1	2 9	0.1	2.6	3.3
	2	2 8	0 2	2 5	3 4
320108	1	3.8	0.3	3.4	4.4
	2	2 7	0.1	2 5	2.8
	3	2.9	0.2	2.6	3.9
320109	1	3 8	0.3	3.1	4.3
	2	2 6	0.1	2.4	2.8
	3	2.8	0.2	2.5	3.1
320110	1	3.6	0 2	3.3	4.0
	2	2.5	0.2	2.3	2.8
	3	2.7	0.1	2.5	3.0
320111	1	2.7	0.1	2.5	3.0
	2	2.7	0.1	2.4	3 0
320112	1	2.8	0.1	2.6	3.0
	2	2.7	0 2	2.5	3.1

Table 37. Final lift thicknesses, AC layer, NV SPS-1.

Section	Specified Thickness (inch)	Average Thickness (inch)	Standard Deviation (inch)	Min. Thickness (inch)	Max. Thickness (inch)
320101	7	7.2	0.4	6.1	8.2
310102	4	4.1	0.2	3.6	4.6
320103	4	4.2	0.1	3.8	4.4
320104	7	7.3	0.3	6.3	7.8
320105	4	4.2	0.2	3.6	4.7
320106	7	7.2	0 2	6.8	7.6
320107	4	4.2	0.2	3.7	4.9
320108	7	7.0	0.3	6.6	7.8
320109	7	7.0	0.3	6.4	7.6
320110	7	7.0	0.2	6.5	7.6
320111	4	4.1	0.1	3.8	4.4
320112	4	4.2	0.2	3.7	4.6

the top lift of the inner lane, the paver stopped for 35 minutes at station 3+55 when the rubber tired pneumatic compactor lost a tire.

The final AC layer thickness averaged 7.3 in, with a standard deviation of 0.3 in. The mean laydown temperature was 297°F.

Section 320105

This section received two loose lifts of 2.8 in and 2.6 in. Paving took place on August 26 and August 28-30, 1995.

On August 26th, when paving the first lift of the outer pass, there was a cold joint at station 5+65, which fell near the end of the sampling area.

The average compacted layer thickness measured 4.2 in, with a standard deviation of 0.2 in. The mean laydown temperature was 295°F.

Section 302106

Paving started on August 25, 1995 and continued on August 26 and August 28-30, 1995. Three loose lifts were placed in thicknesses of 3.8 in, 2.7 in and 2.8 in.

On August 29th, while paving the top lift of the outer pass, there were holes in the AC on the outside edge of the pass between stations 0-30 and 0-20, and 0+00 and 0+15. The holes were caused by an auger malfunction, and the rough area was finished by hand prior to compaction.

The average layer thickness was 7.2 in, with a standard deviation of 0.2 in. The mean laydown temperature was 295°F.

Section 320107

Two loose AC lifts of 2.9 in and 2.8 in were placed on August 26 and 28-30, 1995. No paving problems were encountered.

The average layer thickness was 4.2 in, with a standard deviation of 0.2 in. No asphalt laydown temperatures were recorded.

Section 320108

Paving took place on August 25-26 and August 28-30, 1995. Three loose lift thicknesses of 3.8 in, 2.7 in, and 2.9 in were placed.

On August 30th, while paving the top lift of the inner pass, the paver stopped for 52 minutes at station 3+40 due to unacceptable compaction. The problem was corrected and the paver moved on. The only laydown temperature measured was 270°F. Also while paving the top lift of the middle pass on August 30th, a low spot was filled in by hand at station 3+00 and compacted.

The average compacted thickness was 7.0 in, with a standard deviation of 0.3 in. The mean laydown temperature was 298°F.

Section 320109

This section received three lifts, placed in loose thicknesses of 3.8 in, 2.6 in, and 2.8 in. The paving took place on August 25-26 and August 28-30, 1995. On August 25th, trucks waited on the grade for up to 45 minutes while paving the outer pass of the first lift.

The average laydown temperature was 295°F. The average compacted thickness was 7.0 in, with a standard deviation of 0.3 in.

Section 320110

Three lifts of AC were placed on August 25-26 and August 28-30, 1995. The loose thicknesses averaged 3.6 in, 2.5 in, and 2.7 in for the three lifts.

On August 28th, a transverse cold joint was placed at station 5+05, just past the end of the monitoring section.

On August 29th while paving the outer pass of the top lift, the Cocal wheels were caving in the edge of the lift. This occurred between stations 6+00 and 6+50, and was finished by hand prior to compaction. A hole was filled in by hand at station 2+70 of the top lift in the middle pass, and then compacted.

On August 30th, the paver stopped for 25 minutes at station 0-90, while paving the top lift of the inner pass. The compaction at this point was not meeting specifications, and the area was recompacted.

The final layer thickness averaged 7.0 in, with a standard deviation of 0.2 in. The mean laydown temperature was 297°F.

Section 320111

Two lifts were placed with the loose thicknesses measuring 2.7 in. Paving took place on August 26 and August 28-30, 1995. No problems or delays were encountered during paving.

The average layer thickness was 4.1 in, with a standard deviation of 0.1 in. The mean laydown temperature was 296°F.

Section 320112

Two lifts were placed, with paving taking place on August 26 and August 28-30, 1995. The loose lift thicknesses averaged 2.8 in and 2.7 in.

On August 29th, a transverse cold joint was placed at station 5+76, just outside of the sampling area. On August 30th, the paver stopped for 40 minutes at station 5+90, in the transition, due to insufficient compaction.

The average layer thickness was 4.2 in, with a standard deviation of 0.2 in. The mean laydown temperature was 301°F.

IV. SUMMARY - NEVADA SPS-1 CONSTRUCTION

Subgrade/Embankment

Removal of the original AC layer began in May of 1995. Following the AC removal, 8 in of cement treated base and 8 in of dense graded aggregate base were removed and stockpiled. Subgrade material was then removed to a depth of 38 in and taken off the site. At this point, the existing subgrade material did not meet NDOT specifications. Lime was mixed 1 ft deep into the subgrade at a rate of three percent by volume of the soil. A Sheepsfoot compactor then compacted the lime stabilized subgrade.

The excavated material was then placed back into the cut and compacted in 6 to 8 in lifts. A fill material was also added to replace the material removed from the site. Compaction tests were performed on the lifts following compaction. The fill operations began on June 6, 1995. On July 5, 1995 all trimming and compacting was completed, and the embankment was ready for DGAB placement.

Dense Graded Aggregate Base

Placement of the DGAB took place between July 6 and July 20, 1995 on seven of the test sections. The DGAB material was placed in maximum 6 in compacted lifts. The total DGAB layer thicknesses were either 4 in, 8 in, or 12 in.

Permeable Asphalt Treated Base

Six of the twelve SPS-1 sections received a permeable asphalt treated base. The PATB was placed directly on the DGAB in three of the sections, and directly on the embankment in three others. Transverse interceptor drains and longitudinal drains were placed in all of the sections prior to PATB placement.

On DGAB sections, a construction fabric was placed in the drains and extended 4 ft under the PATB. On the embankment sections, the fabric covered the entire roadway under the PATB, as well as the drains. Trenching on the PATB Sections began on July 19th, and was completed on August 2, 1995.

The PATB was paved in one 4 in lift and took place from August 14 through August 18, 1995. The surface under the PATB was primed with an MC-250 liquid asphalt at least 24 hours prior to paving.

Asphalt Treated Base

Seven of the twelve SPS-1 sections received an asphalt treated base, placed either directly on the embankment, on the permeable asphalt treated base, or on the dense graded aggregate base.

The sections received either a 4 in, 8 in, or 12 in ATB layer. Two 2 in lifts were placed on the 4 in sections. The 8 in section had a bottom 4 in lift and two 2 in upper lifts. Each lift was paved in three passes. The 12 in section had two 4 in and two 2 in lifts. The ATB paving began on August 4th, and was completed on August 23, 1995.

Asphalt Concrete

Six of the test sections received a 4 in AC layer and six received a 7 in AC layer. The paving started on August 25th, and was completed on August 30, 1995. In the 7 in sections, three lifts were placed; one 3 in lift under two 2 in lifts. In the 4 in sections two 2 in lifts were placed. Three passes were made per lift.

V. KEY OBSERVATIONS - NEVADA SPS-1

As this project was constructed over an existing section of highway, the removal of the existing pavement structure was required. When this was performed, the subgrade, which varied between a silty sand and a clayey sand, was found to be out of specifications for NDOT subgrade material. This required the lime stabilization of the top 1 ft of subgrade soil.

After this stabilization, embankment material was placed and compacted. FWD testing on the embankment showed that the material was very consistent throughout, with the exception of midlane on section 320103.

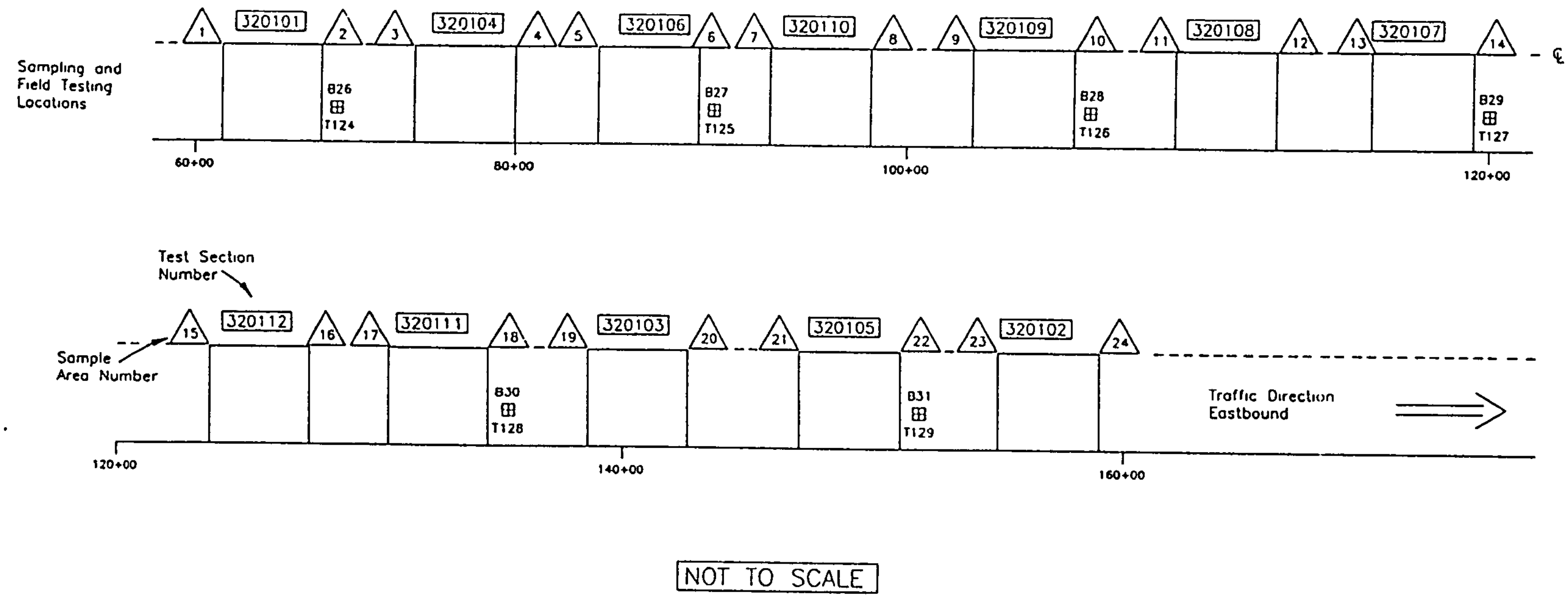
The dense graded aggregate base (DGAB) was placed on seven of the twelve sections. The material was placed in either one or two lifts, depending on the design thickness. Sections 320105 and 320109 were found to have high variations in deflections during FWD testing, while the other five sections were more consistent.

Six sections received a 4 in permeable asphalt treated base (PATB). Edge drains were constructed on these sections utilizing a geotextile and open graded rock placed in trenches. The PATB was paved without any major problems, but after paving had taken place and previous to paving subsequent layers, construction traffic caused rutting of the PATB that was particularly severe near the edge drains.

Seven sections had an asphalt treated base (ATB) placed using belly dump trucks and a pickup machine to deposit the material into the paver's hopper. The hopper was consistently too full or too empty and a loader had to be used to add or remove material. Also, the belly dumps were not keeping up with the paver, which resulted in a stop and go paving operation. These problems occurred throughout ATB paving. FWD testing showed higher deflections on sections 320105 and 320110 than for the other four sections that were tested (section 320106 was not tested).

Paving of the asphalt concrete (AC) was performed in the same fashion as for the ATB, and the same problems that occurred during ATB paving were experienced. In addition, there were some additional problems that were constrained to particular sections. Section 320102 had a rough finish between stations 0-90 and 0-60 that had to be raked by hand. The pneumatic roller had tire problems on section 320104 and stopped for over a half-hour. Section 320106 also had rough areas that had to be raked. Paving halted for almost an hour on section 320108 while problems with compaction were being resolved. FWD testing revealed that section 320102 had the highest deflection and standard deviations, while section 320104 had the lowest deflections and standard deviations.

APPENDIX A
SPS-1 SAMPLING PLAN



□ 2' x 2' bulk sampling location (B26–B31) to 12' below top of subgrade
\+ Location of nuclear moisture-density tests (T124–T129)
△ Sample areas

Figure A1. Overview of material sampling and testing on natural subgrade, NV SPS-1.

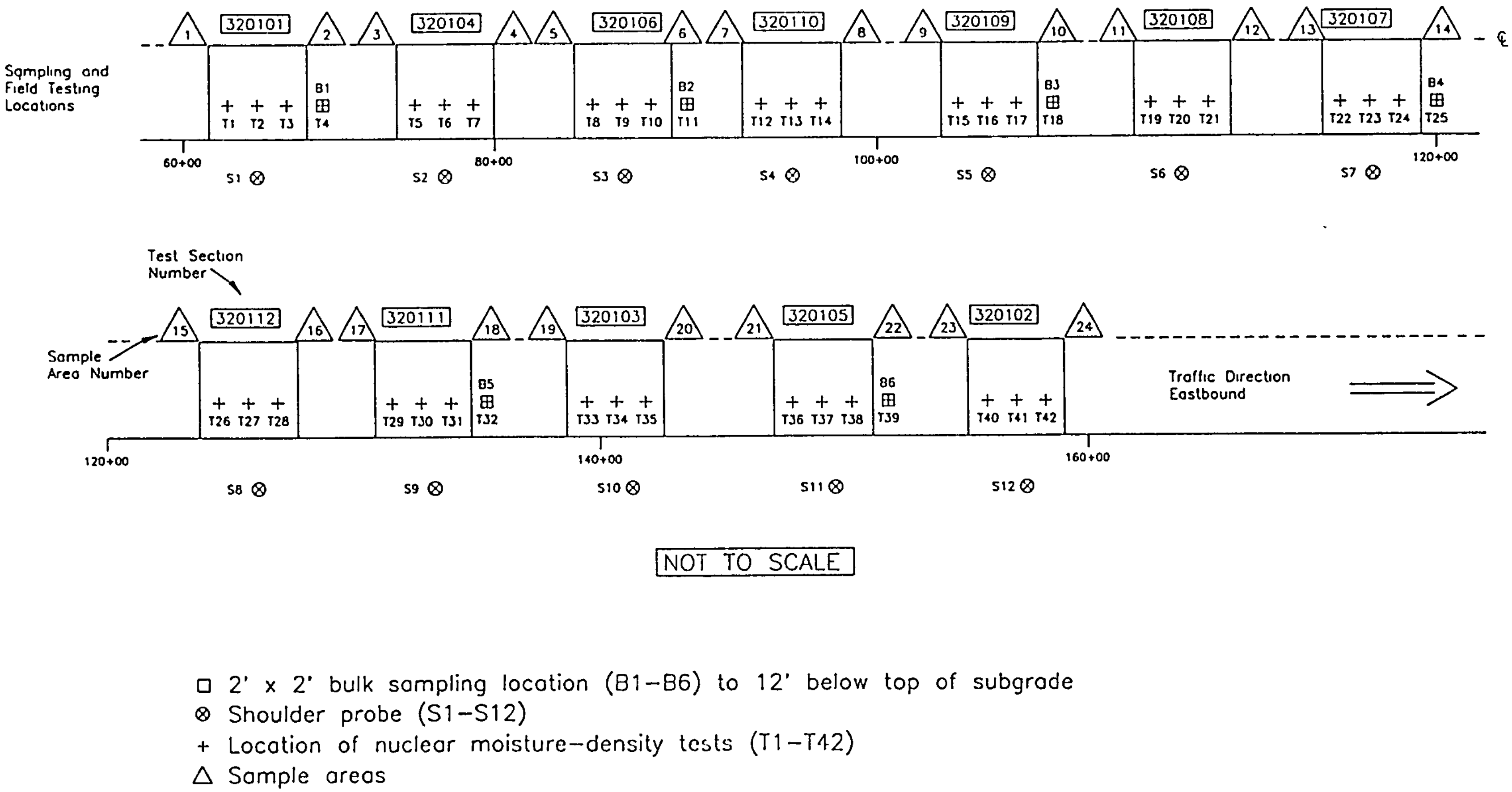
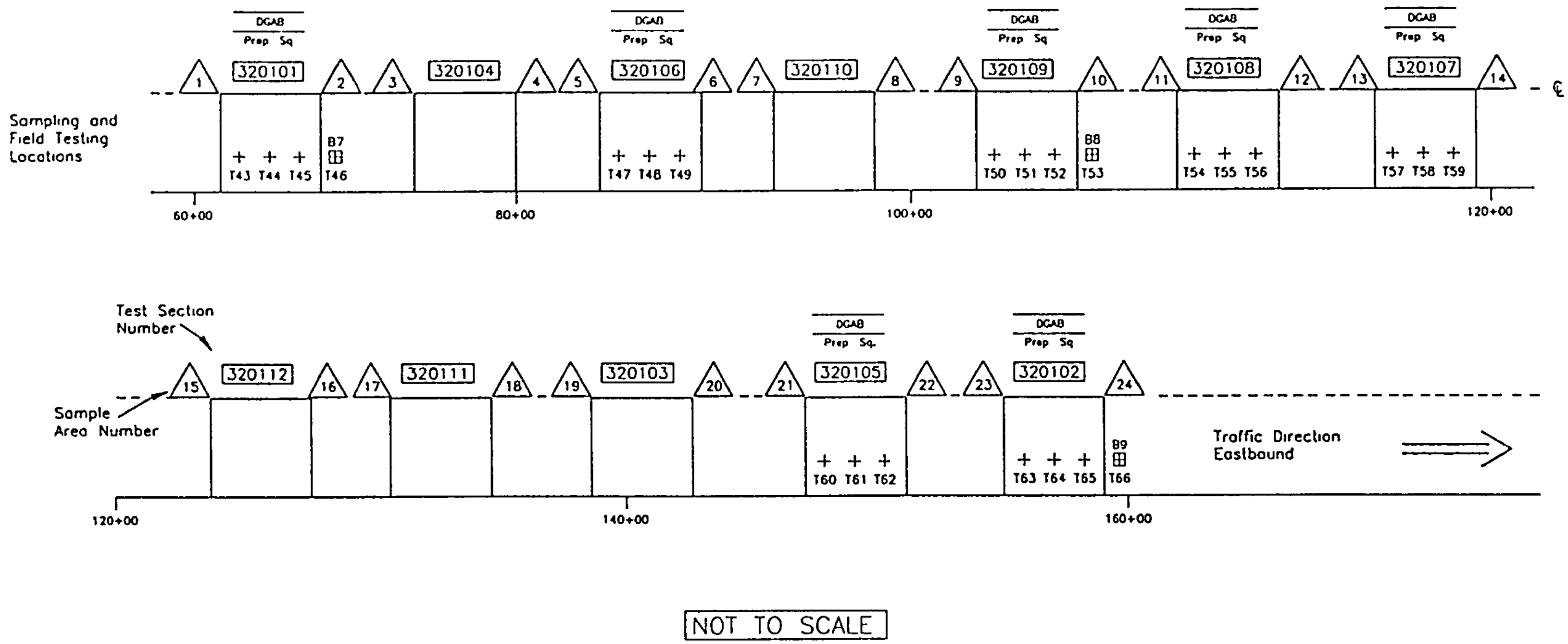


Figure A2. Overview of material sampling and testing on embankment, NV SPS-1.



+ Location of nuclear moisture-density tests (T43–T66)

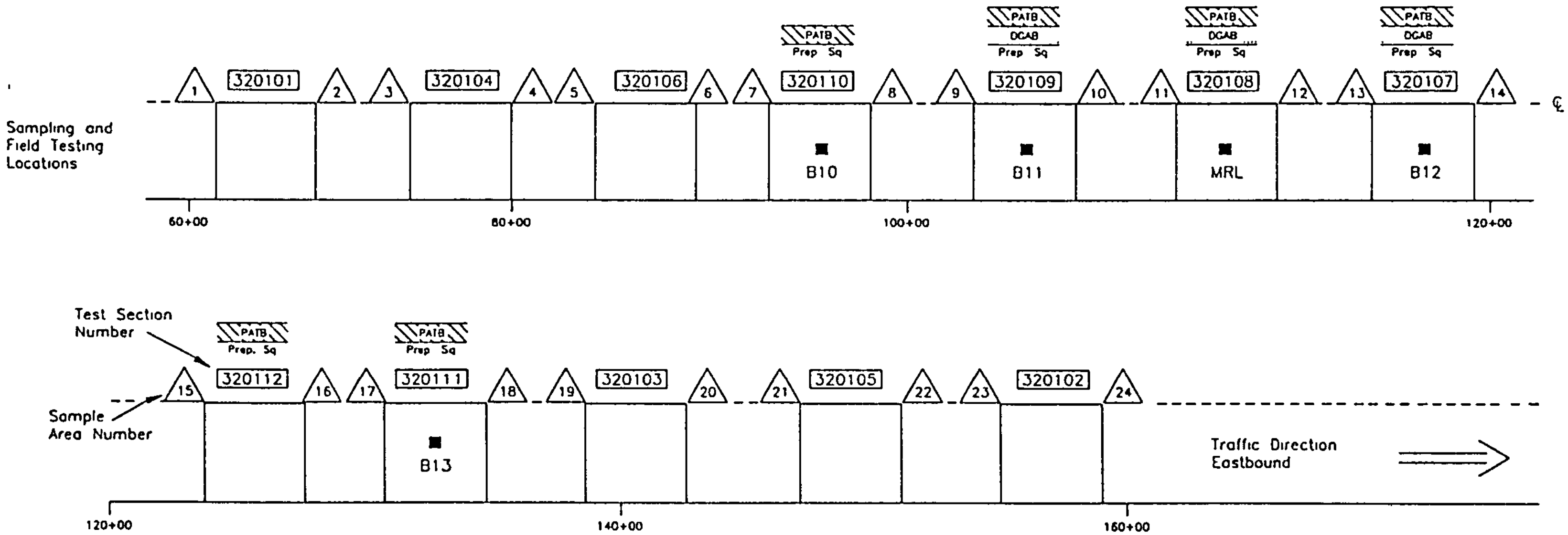
□ Location of bulk sampling (B7–B9)

Prep. Sq. – Prepared Subgrade

DCAB – Dense Graded Aggregate Base

△ Sample areas

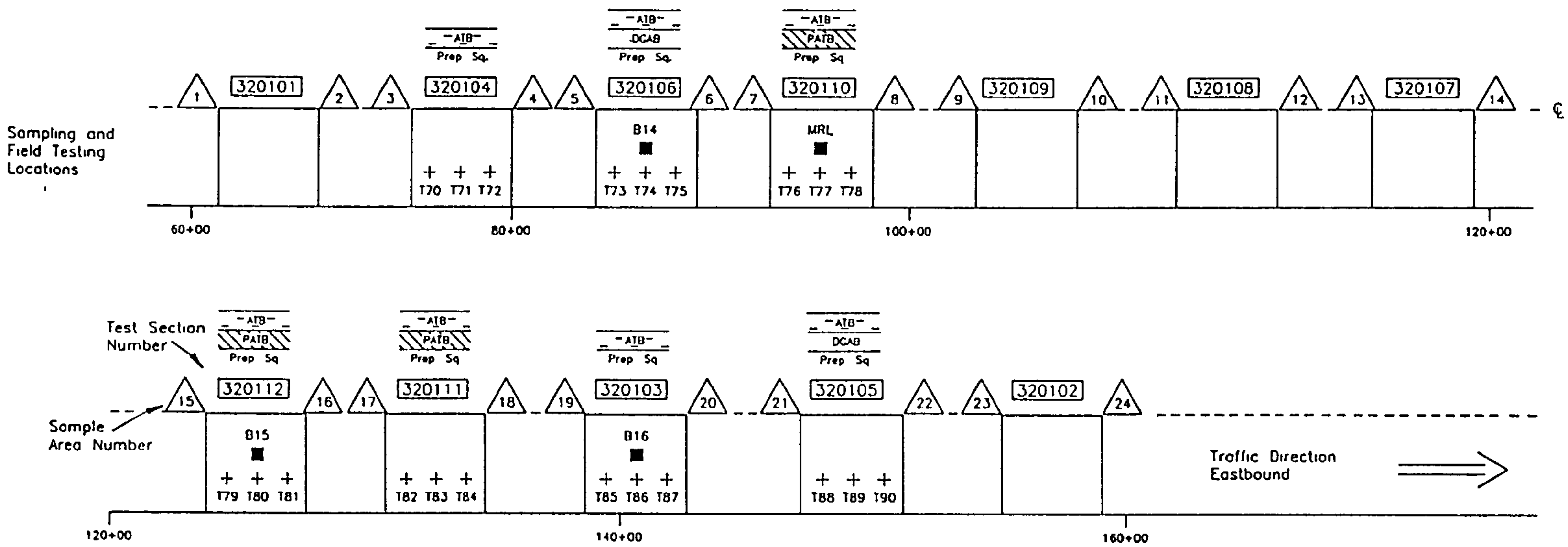
Figure A3. Overview of material sampling and testing on dense graded aggregate base, NV SPS-1.



■ Bulk sample of PATB (B10–B13)
Prep. Sq – Prepared Subgrade
DGAB – Dense Graded Aggregate Base
PATB – Permeable Asphalt Treated Base
MRL Bulk mixture sample
△ Sample areas

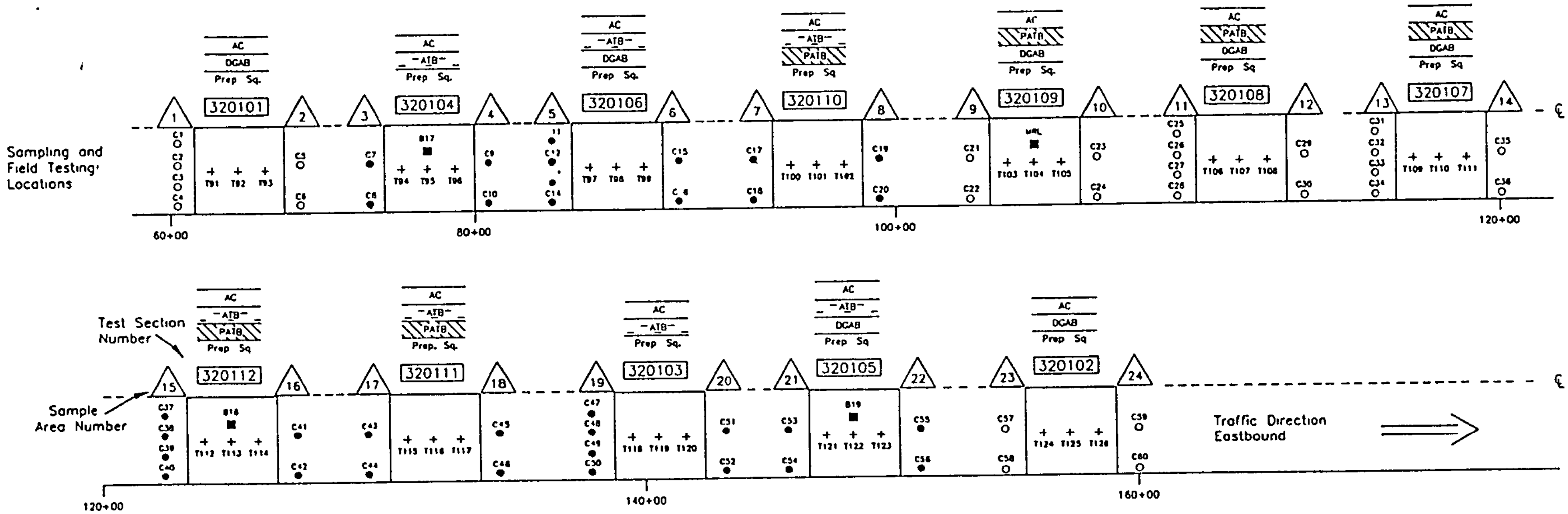
NOT TO SCALE

Figure A4. Overview of material sampling and testing on permeable asphalt treated base, NV SPS-1.



+ Location of nuclear moisture-density tests (T70-T90)
■ Bulk sample of ATB (B14-B16)
Prep. Sq. - Prepared Subgrade
DGAB - Dense Graded Aggregate Base
ATB - Asphalt Treated Base
PATB - Permeable Asphalt Treated Base
△ Sample areas
* Asphalt cement from plant (B20-B22)
MRL Bulk mixture sample

Figure A5. Overview of material sampling and testing on asphalt treated base, NV SPS-1.



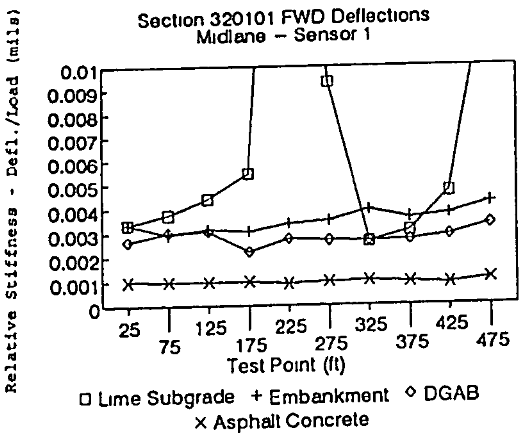
- o 4" OD Core of AC Surface (C1–C6, C21–C36, C57–C60)
- • 4" OD Core of AC Surface and Asphalt Treated Base layers (C7–C20, C37–C56)
- \+ Location of nuclear density tests (T91–T126)
- ■ Location of bulk sampling (B17–B19)

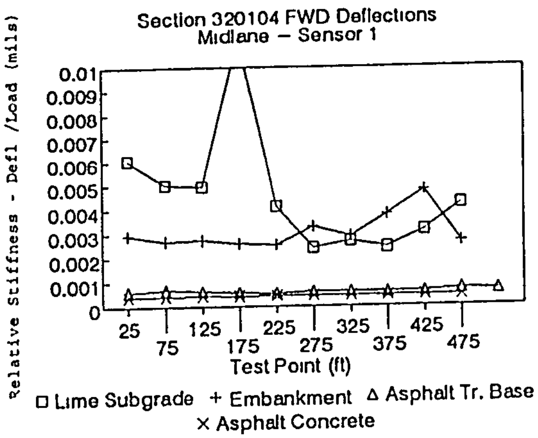
Prep Sq. – Prepared Subgrade
PATB – Permeable Asphalt Treated Base
DGAB – Dense Graded Aggregate Base
AC – Asphalt Concrete Surface
△ Sample areas
MRL Bulk mixture sample
* Asphalt cement samples from plant (B23–B25)

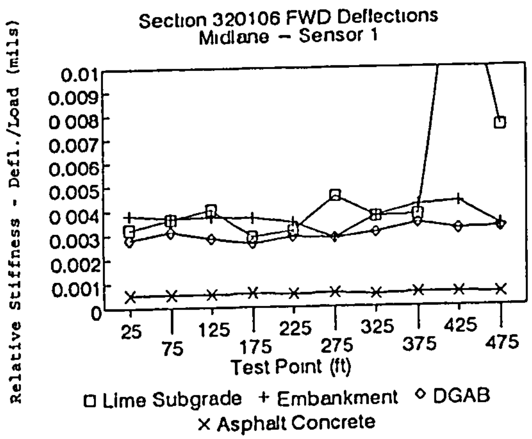
NOT TO SCALE

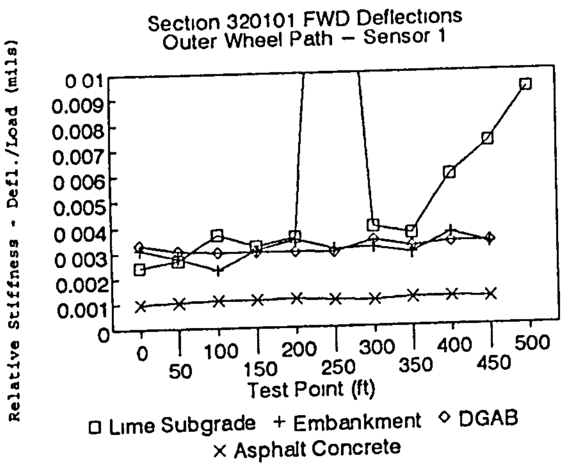
Figure A6. Overview of sampling, testing, and coring plan on asphalt concrete, NV SPS-1.

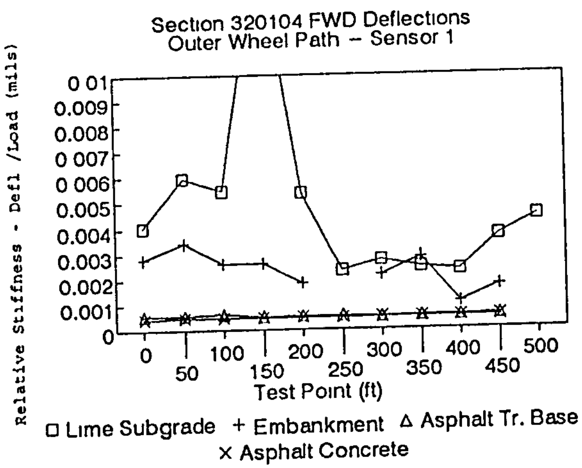
APPENDIX B
SPS-1 FWD DEFLECTION PLOTS

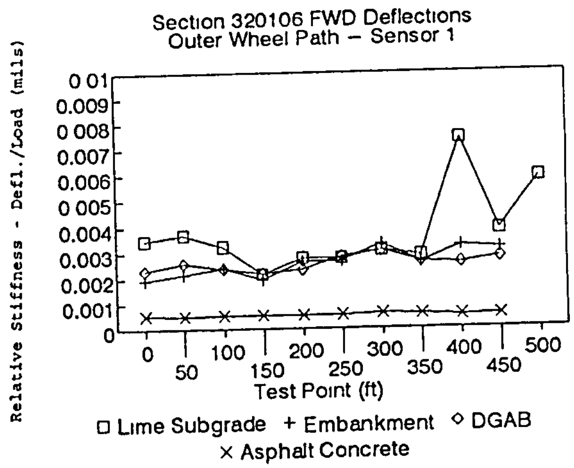

Section 320101 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

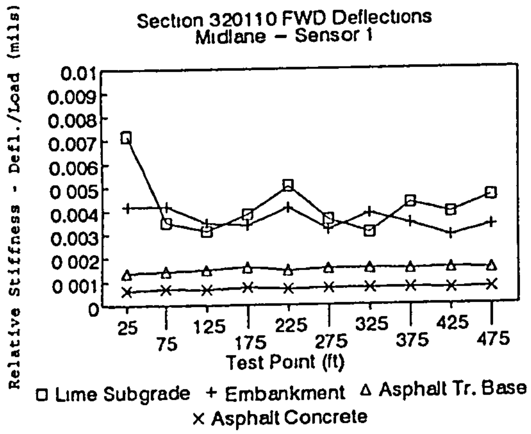

Section 320104 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete

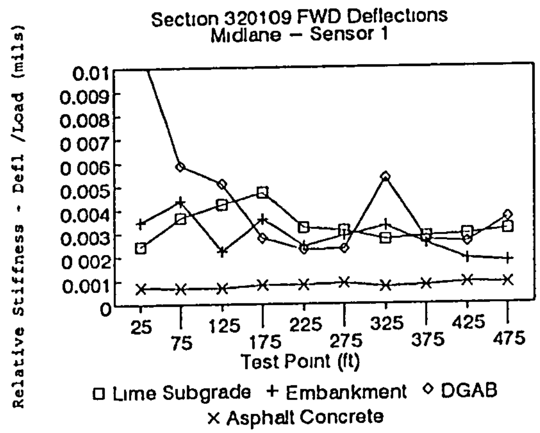

Section 320106 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

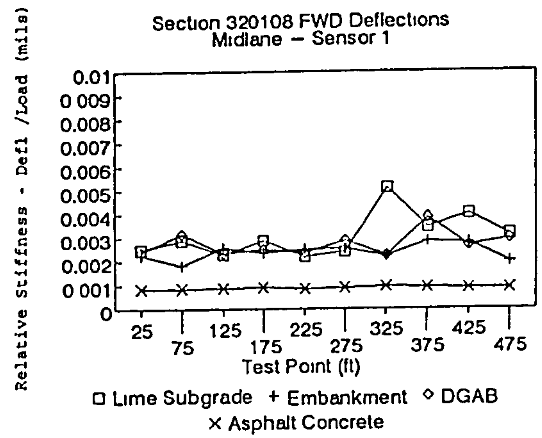

Section 320101 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete


Section 320104 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete


Section 320106 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete


Section 320110 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete


Section 320109 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete


Section 320108 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
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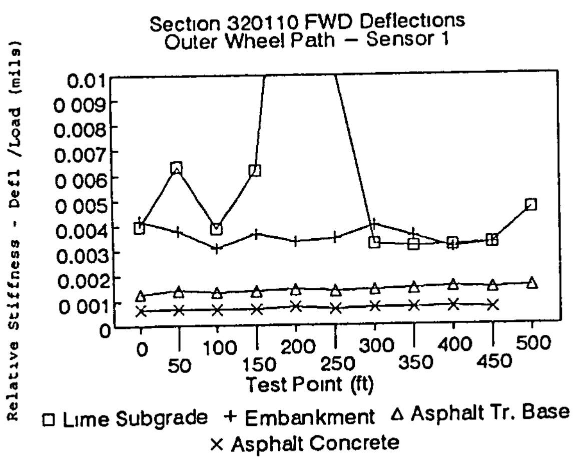
× Asphalt Concrete


Section 320110 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
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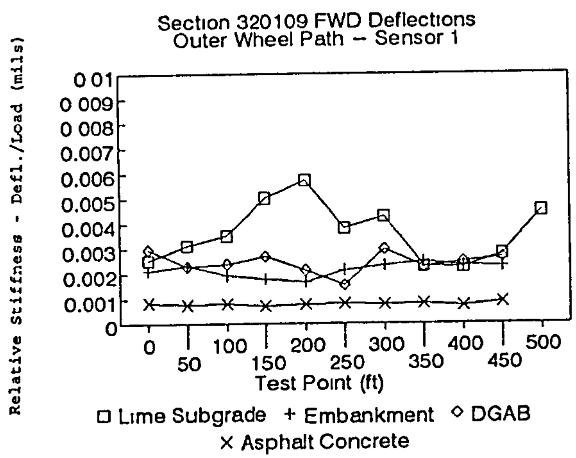
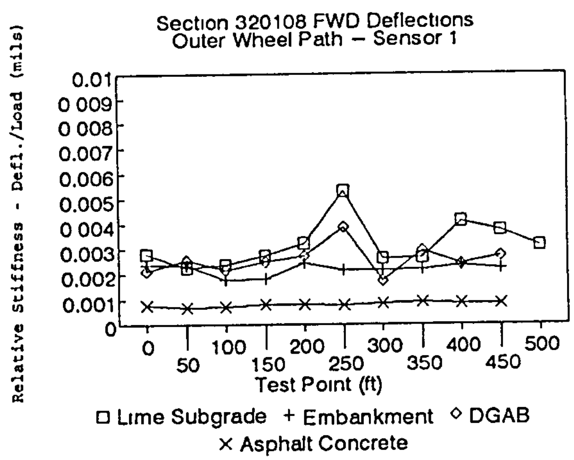
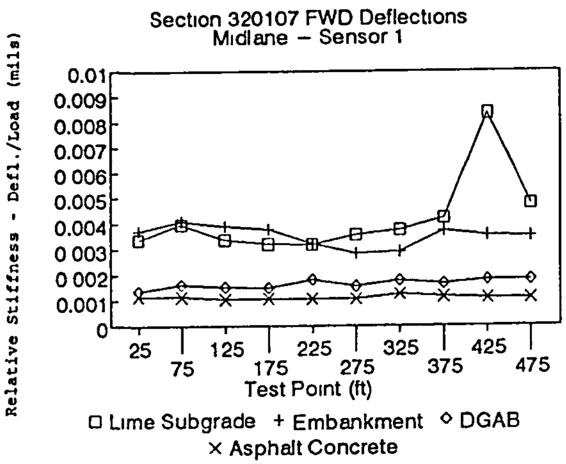
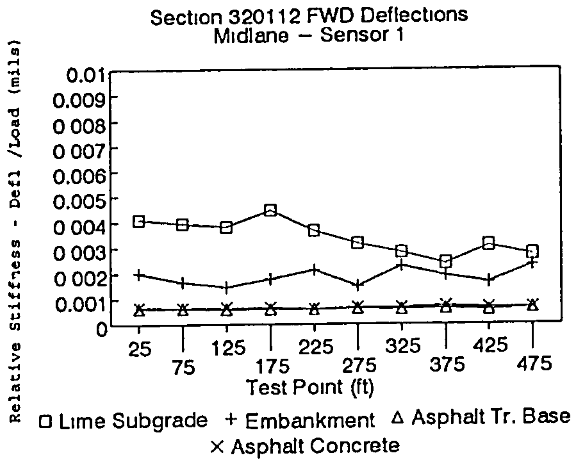
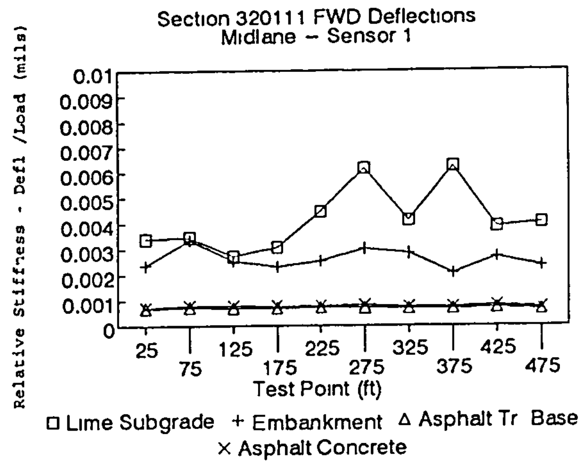
× Asphalt Concrete

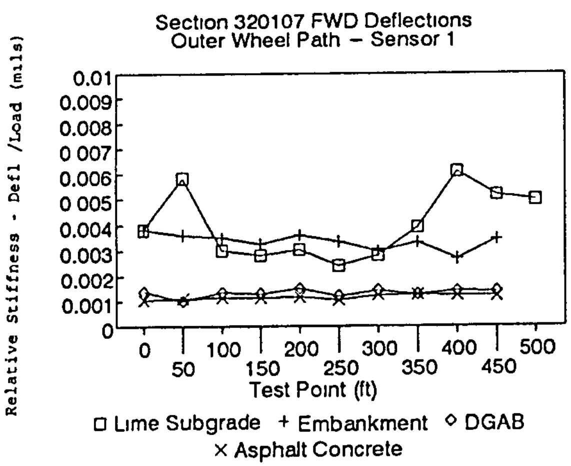

Section 320109 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

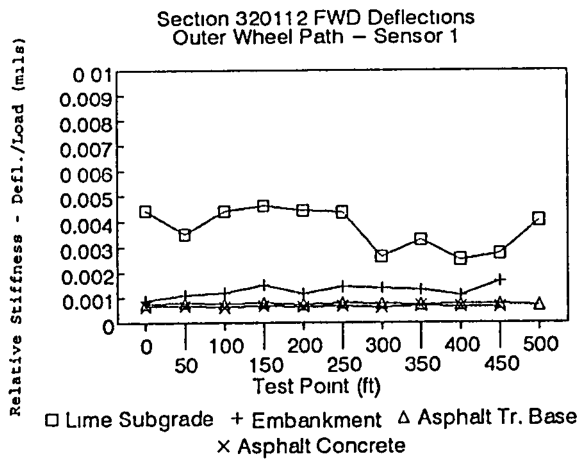

Section 320108 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

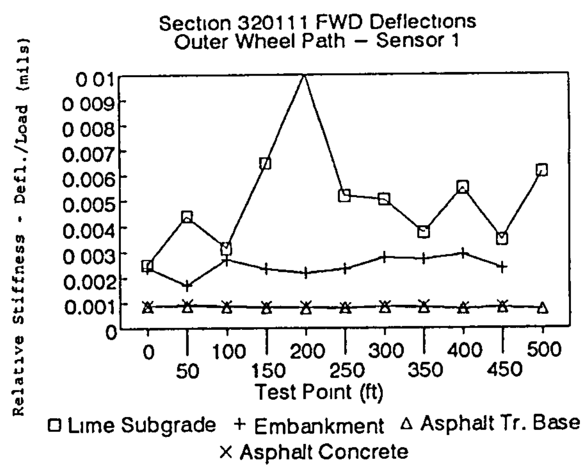

Section 320107 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

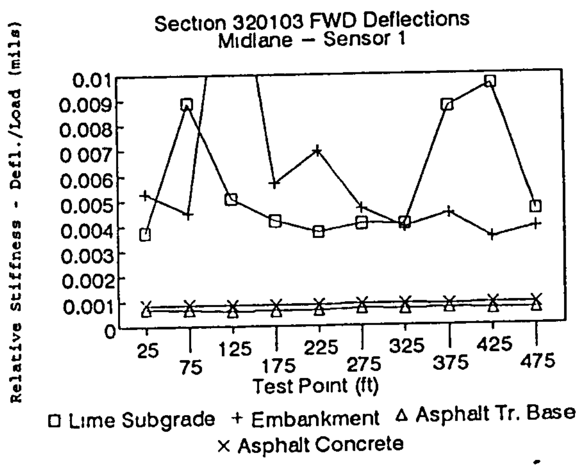

Section 320112 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete

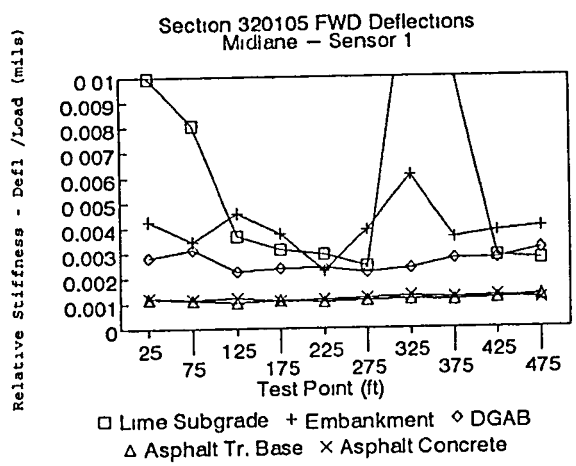

Section 320111 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr Base
× Asphalt Concrete

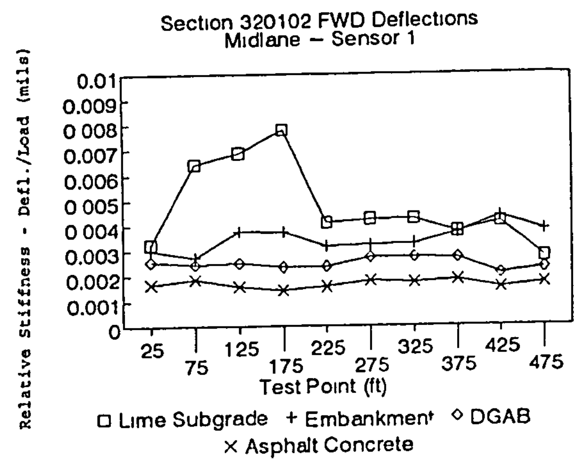

Section 320107 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

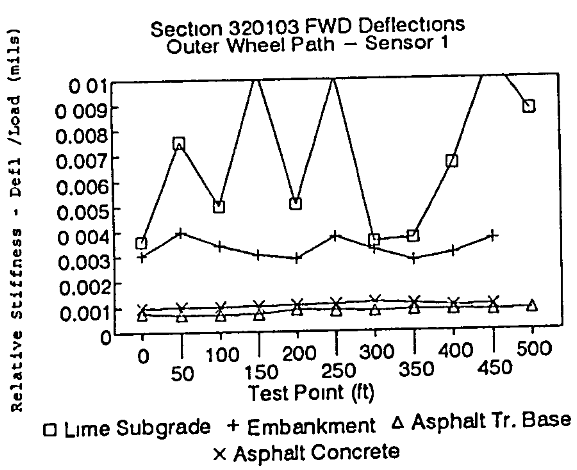

Section 320112 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete

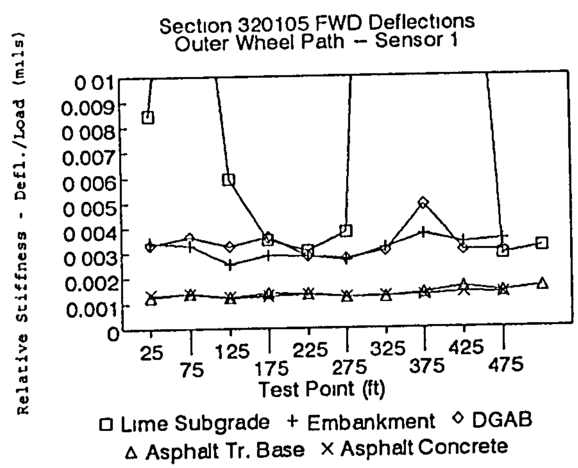

Section 320111 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete

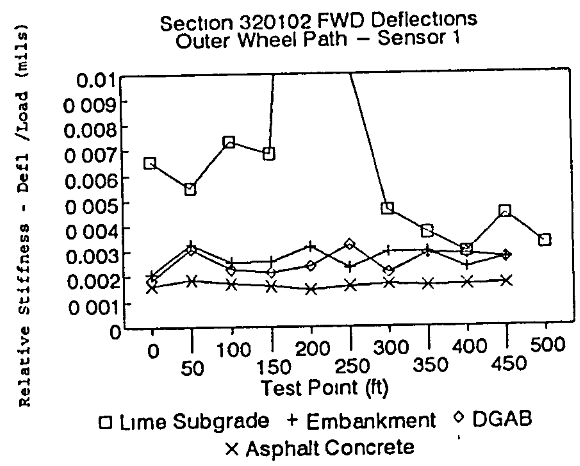

Section 320103 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete


Section 320105 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
△ Asphalt Tr. Base × Asphalt Concrete


Section 320102 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete


Section 320103 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment △ Asphalt Tr. Base
× Asphalt Concrete


Section 320105 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
△ Asphalt Tr. Base × Asphalt Concrete


Section 320102 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB
× Asphalt Concrete

APPENDIX C
PRIME COAT TESTS - DGAB

PRIME ON DGAB
SPS-1

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
1263 S. Stewart, C.C., Nv. 89712

Lab Test# CCBL-96-00

SEP 1995

REPORT OF TESTS OF BITUMINOUS LIQUIDS

Date Reported 09/14/95
Nevada Specification, MC-250
Manufacturer PETRO SOURCE
Shipping Point EAGLE SPRINGS
Contractor MATICH
Sampled By DRIVER
Observed By ROBERT J. PETU
Tests By DY
Date Sampled 09/01/95
Date Received 09/08/95

SEP 21 1995

Cont. No. 2591
Project No.* I-80-3(12)
County LANDER
Field Number 2
APO Number
Wt Ticket No. 110772
Refinery No. 141107
Truck/trailer (112)/999999
Quantity 23.46
Date Tested 09/12/95

TESTS PERFORMED	TEST RESULTS	SPECIFICATIONS
Flash Point, °F (T48) or (T79)		(°C) Minimum 150°F
Original Viscosity 60°C(140°F), cSt (T201)	(379) 379	(mm²/s) 250-500 cSt
Water Mass % (T55)		Maximum 0.2 %
Distillation: % of Total Distillate (T78)		
To 218°C (424°F)	0.0	Maximum 10.0 %
To 252°C (486°F)	19.8	15.0-55.0 %
To 307°C (585°F)	81.5	60.0-87.0 %
Percent Residue By Distillation To 351°C (664°F) (T78)	79.8	Minimum 67 %
% Total Distillate To 351°C(664°F) (T78)		- %
Residue Visc. 60°C(140°F), Poises (T202)	(41) 405	(Pa·s) 300-1200 Poises
Residue Viscosity 60°C(140°F), cSt (T201)		(mm²/s) - cSt

REMARKS AND RECOMMENDATIONS: MATERIAL CONFORMS TO NEVADA SPECIFICATION

APPENDIX D
ATB MIX DESIGN

ATB

MAR 27 1995

MAR 29 1995

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
1263 S. STEWART ST. CARSON CITY, NV 89712

BITUMINOUS MIX DESIGN

LAB NUMBER:	BF95-145	*BITUMEN RATIO:*	5.25 AC-20
CONTRACT NUMBER:	2591		
COUNTY:	HUMBOLDT & LANDER		
PRIMARY CONTRACTOR:	MATICH CORPORATION		
DATE SAMPLED:	03/08/95		
DATE RECEIVED:	03/10/95		
DATE REPORTED:	03/27/95		
SAMPLED BY:	BOGGS & BOWLEN		
CHECKED BY:	WFM & MSB		
TYPE MATERIAL:	TYPE 2 PLANTMIX AGGREGATE		
SOURCE OF SAMPLE(S):	HU 83-08 & HU 83-06		
MINERAL FILLER:	1.5% HYDRATED LIME WET-CURED (MARINATED) 48 HOURS		
TYPE ASPHALT:	AC-20		
ASPHALT PRODUCER:	HUNTWAY		
SAND EQUIVALENT:	42		
SPECIFIC GRAVITY:	2 61		
SURFACE AREA m²/kg (ft²/lb):	5 76 (28 1)		
PROJECT NUMBER(S):	LTPP-080-3(44)218 & SPI-080-3(12)		

JOB DESCRIPTION:

ON I-80 FROM 1 8 MILES EAST OF VALMY INTERCHANGE TO 3.2 MILES EAST OF HUMBOLDT / LANDER COUNTY LINE

		SPECIFICATIONS·
+#4 WATER ABSORPTION:	0 8	***4% MAX***
SS SOUNDNESS COARSE:	1 6	***12% MAX***
SS SOUNDNESS FINES:	3 5	***15% MAX***
LIQUID LIMIT:	INTERMEDIATE 1/2" 30, CRUSHER FINES 17	***35 MAX***
PLASTICITY INDEX:	INTERMEDIATE 1/2" 15, CRUSHER FINES NP (NON-PLASTIC)	
PLASTICITY INDEX:	COMPOSITE PI AFTER 48 HOUR MARINATION· NP	***NP (3 MAX)***
LA ABRASION:	22.9	***45% MAX***
FRACTURE FACE COUNT:	99 3	***60% MIN***
VMA:	16.0	***12 - 22***
SPLIT TENSILE, kPa (PSI):	949 4 (137 7)	***448 kPa (65 PSI) MIN***
% RETAINED STRENGTH:	94 8	***70% MIN***

REMARKS:

FOR THE MATERIAL REPRESENTED BY THE SUBMITTED SAMPLES WITH THE ABOVE GRADINGS, LABORATORY TESTS INDICATE A BITUMEN RATIO OF 5 25 AC-20 FOR TYPE 2 PLANTMIX AGGREGATE TREATED WITH 1.5% HYDRATED LIME AND WET-CURED (MARINATED) 48 HOURS

BIN PERCENTAGES
10% COARSE 3/4"
40% INTERMEDIATE 1/2"
50% CRUSHER FINES

DISTRIBUTION:

- 1 *DISTRICT ENGINEER*
- 1 *RESIDENT ENGINEER*
- 1 *CONSTRUCTION ENG.*
- 1 *LAB FILES*
- 3 *BITUMINOUS LAB*
- 1 *ASPHALT LAB*
- 1 *DEAN WEITZEL*

NOTE· CHANGES FROM THE RECOMMENDED PERCENT OF ASPHALT WILL BE DISCUSSED WITH THE MATERIALS DIVISION

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
1263 S. STEWART ST. CARSON CITY, NV 89712

BITUMINOUS MIX DESIGN

BF95-145

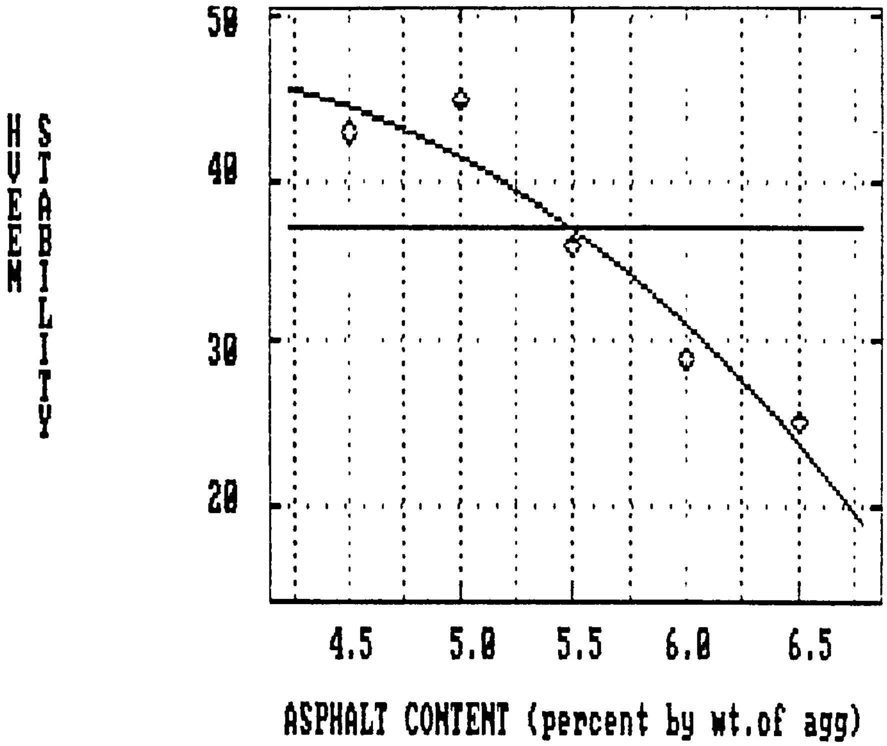
STABILITY TESTS:

						TYPE 2 SPECS:
AX. DENSITY, Mg/m³ (PCF):			2.416 (150.8)			
g/m³ (PCF):	2.264 (141.3)	2.279 (142.2)	2.335 (145.7)	2.342 (146.1)	2.348 (146.5)	
ITUMEN RATIO:	4.5	5.0	5.5	6.0	6.5	
VEEM VALUE:	43	45	36	29	25	37 MIN
AIR VOIDS:	7.5	6.3	3.4	2.4	1.5	3 – 6
0 BLOW MARSHALL DENSITIES (AVG)			2.282 (142.4)			

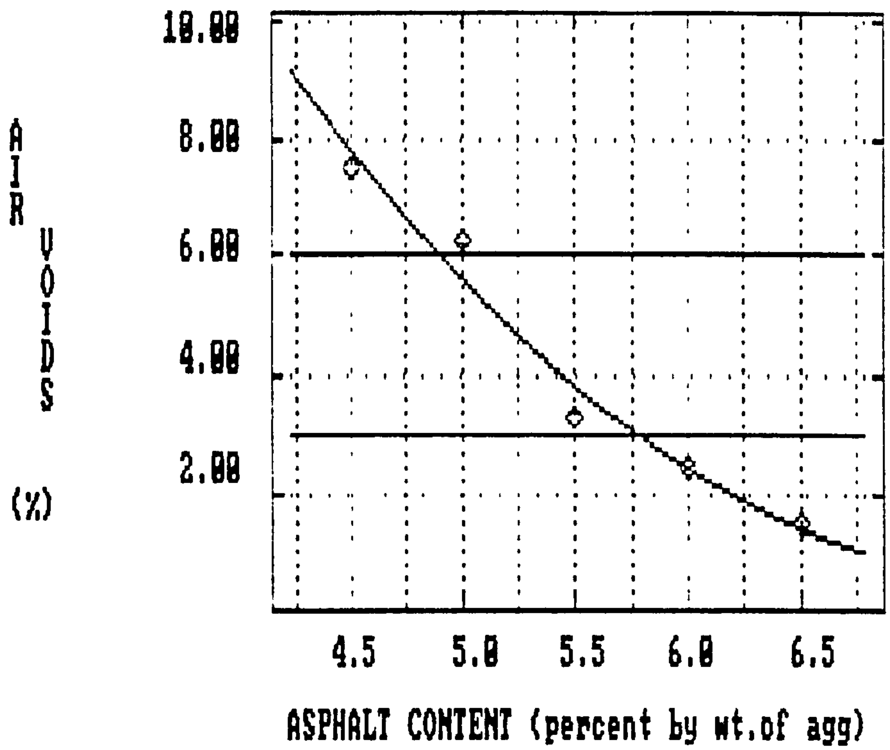
GRADATION TESTS:
(PERCENT PASSING)

SIEVE SIZE:	COARSE 3/4":	INTERMEDIATE 1/2":	CRUSHER FINES:	* AS COMBINED AND TESTED:	TYPE 2 SPECS:
37.5 mm (1½"):					
25 mm (1"):	100.0			100.0	100
19 mm (3/4"):	67.3	100.0		96.7	90 – 100
12.5 mm (1/2"):	11.4	83.3		84.4	
9.5 mm (3/8"):	3.3	44.5	100.0	68.1	63 – 85
4.75 mm (NO. 4):	1.7	5.9	96.4	50.7	45 – 63
2.36 mm (NO. 8):	1.5	3.3	68.3	35.6	
2.00 mm (NO. 10):	1.5	3.2	61.1	32.0	30 – 44
1.18 mm (NO. 16):	1.4	2.9	46.3	24.5	
600 µm (NO. 30):	1.3	2.7	33.7	18.1	
425 µm (NO. 40):	1.3	2.6	28.5	15.4	12 – 22
300 µm (NO. 50):	1.3	2.5	23.7	13.0	
150 µm (NO. 100):	1.1	2.2	15.2	8.6	
75 µm (NO. 200):	1.0	2.0	10.9	6.3	3 – 7

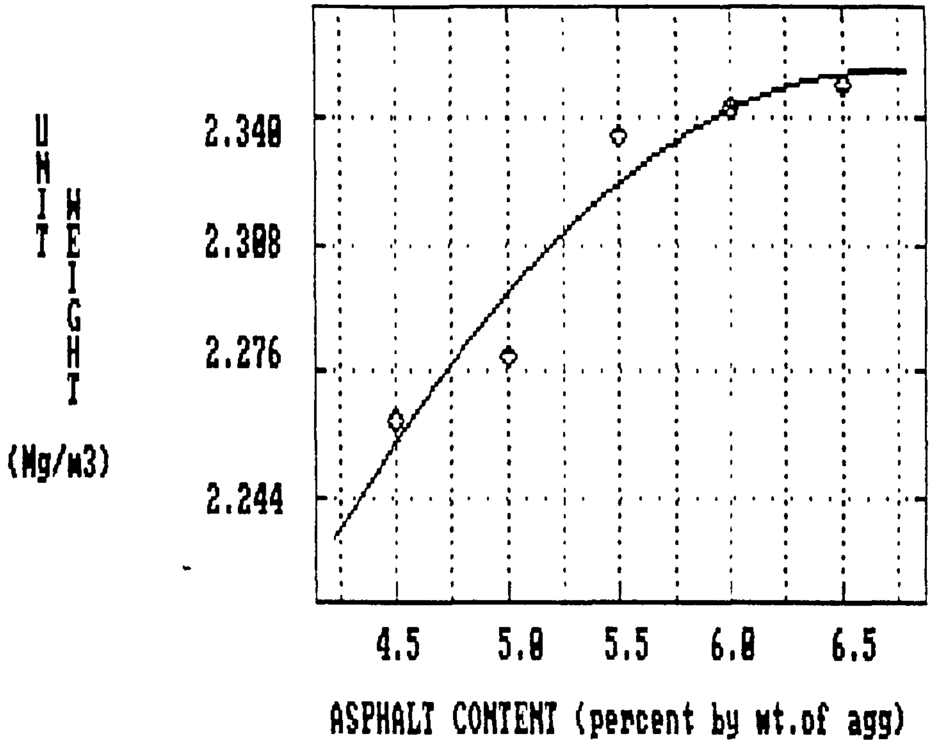
37.5 mm (1½"):		
25 mm (1"):		
19 mm (3/4"):		
12.5 mm (1/2"):		
9.5 mm (3/8"):		
4.75 mm (NO. 4):		
2.36 mm (NO. 8):		
2.00 mm (NO. 10):		
1.18 mm (NO. 16):		
600 µm (NO. 30):		
425 µm (NO. 40):		
300 µm (NO. 50):		
150 µm (NO. 100):		
75 µm (NO. 200):		



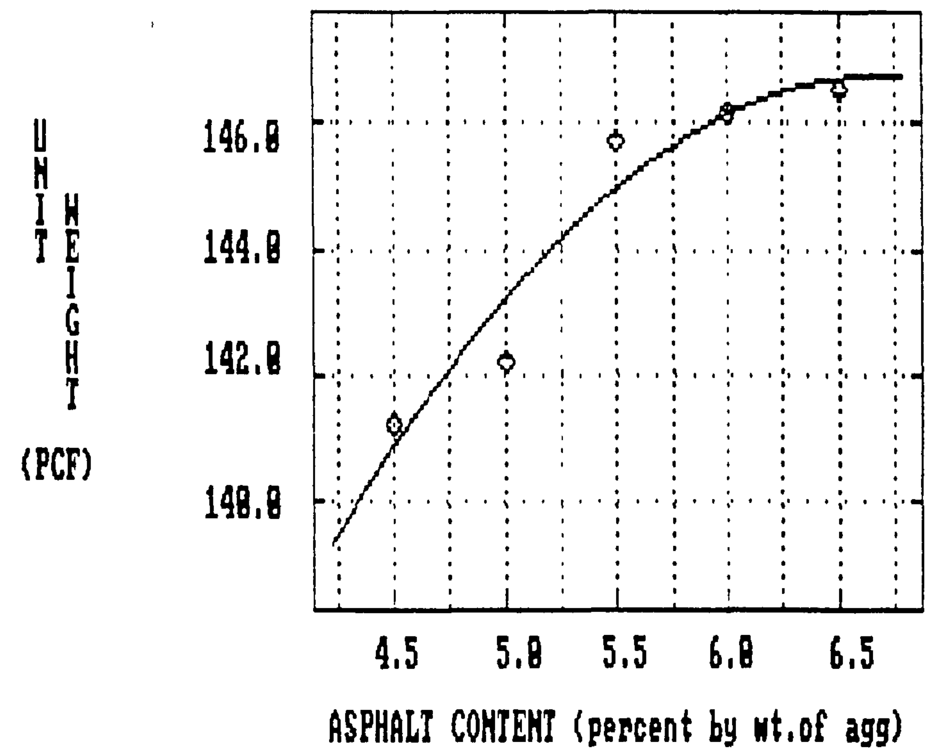
BF95-145 (2591) TYPE 2 AC-20 HUNTWAY



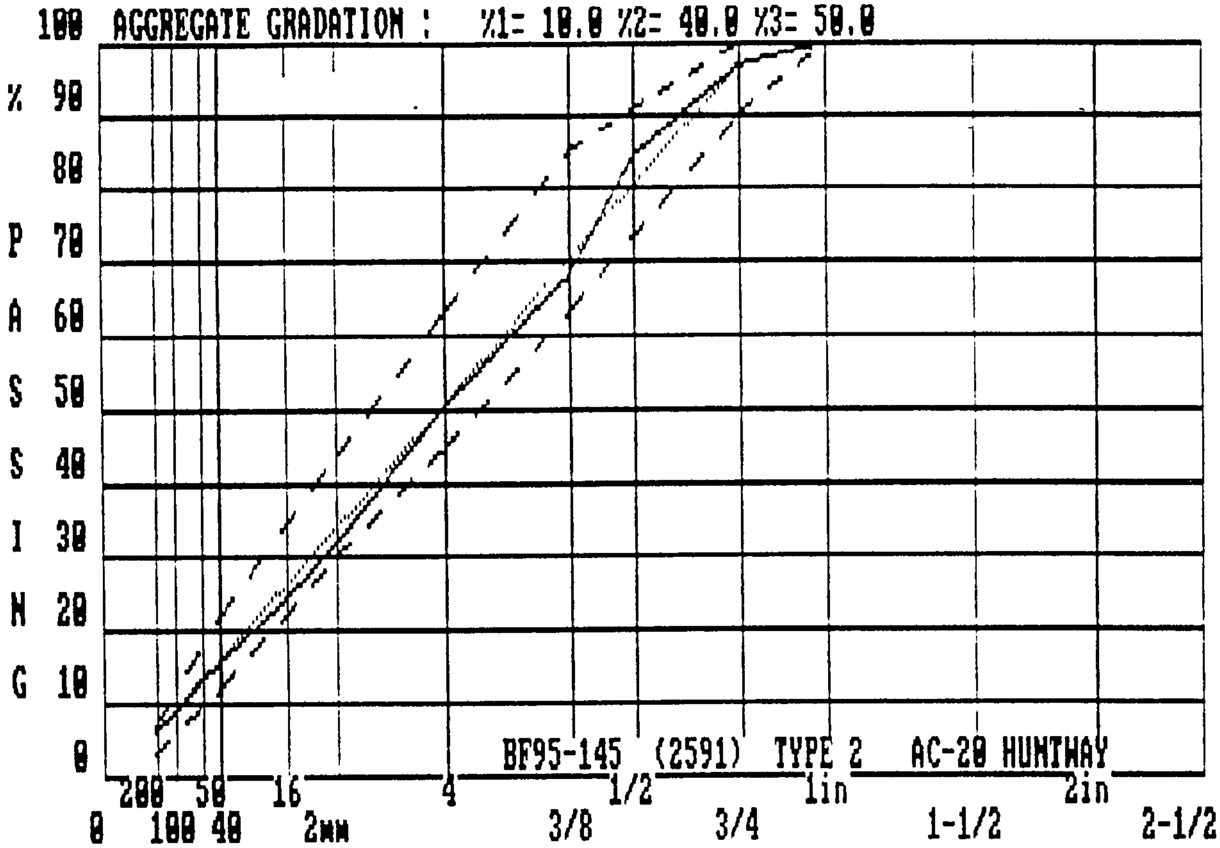
BF95-145 (2591) TYPE 2 AC-20 HUNTWAY

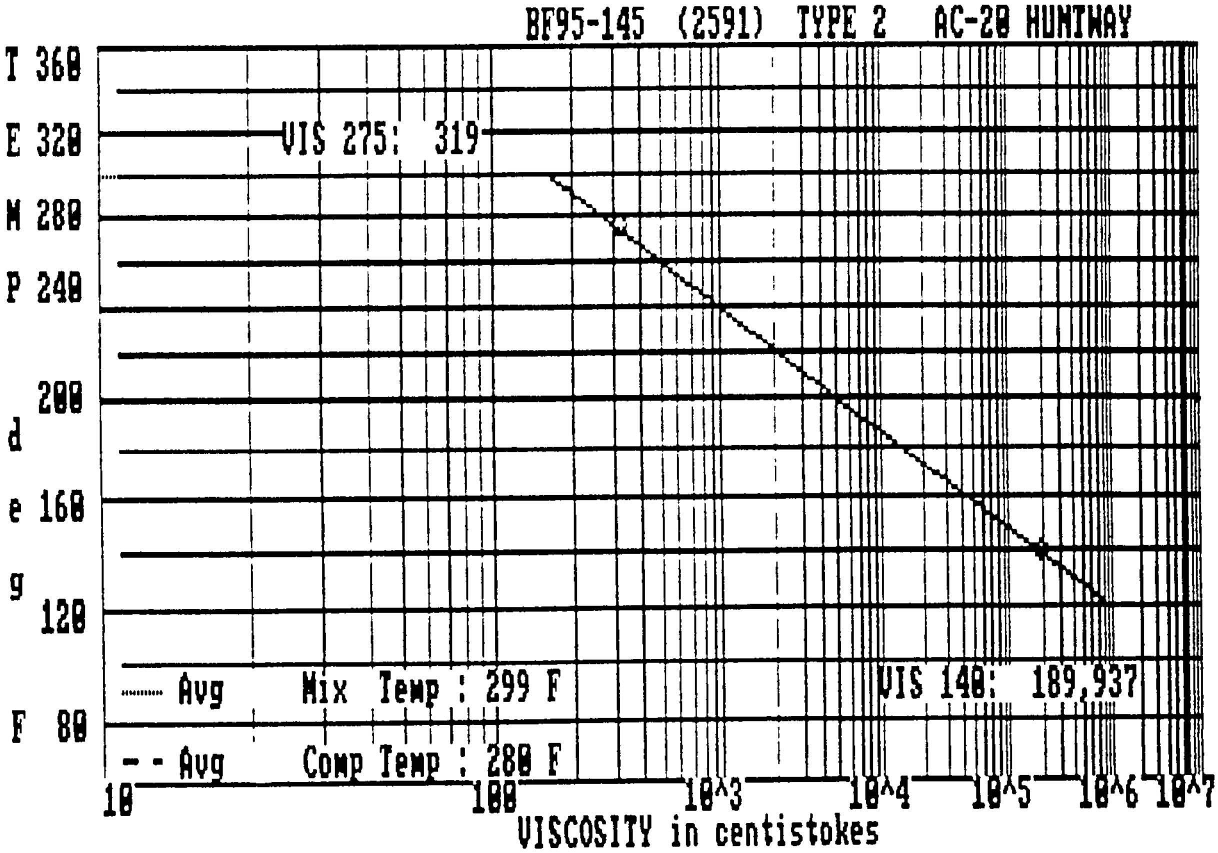


BF95-145 (2591) TYPE 2 AC-20 HUNTWAY



BF95-145 (2591) TYPE 2 AC-20 HUNTWAY


100 AGGREGATE GRADATION : %1= 10.0 %2= 40.0 %3= 50.0
% PASSING
90
80
70
60
50
40
30
20
10
0
BF95-145 (2591) TYPE 2 AC-20 HUNTWAY
200 50 16 4 1/2 1in 2in
0 100 40 2mm 3/8 3/4 1-1/2 2-1/2


BF95-145 (2591) TYPE 2 AC-20 HUNTWAY
TEMP deg F
360
320
280
240
200
160
120
80
VIS 275: 319
VIS 140: 189,937
Avg Mix Temp : 299 F
- - Avg Comp Temp : 280 F
10 100 10^3 10^4 10^5 10^6 10^7
VISCOSITY in centistokes

SHRP Plantmix Agg P.I HU-83-6

MATICH CORPORATION
NDOT Contract #2591
1 1/2" Maximum

	Coarse Combo Only			Specific Gravity	Absorption
	53	33	3/4" Aggregate, %	2 593	1 06
	47	29	1 1/2" Aggregate, %	2 568	0.80
	0	38	Negro Sand	2.51	2 53

3/4" Aggregate	1 1/2" Aggregate	Sand	#67 Aggregate Specs	#4 Aggregate Specs	Sand Specs	sieve size	Coarse Spec % passing	Project Spec. % passing	Coarse Combo Only	
100	100	100	100	100	100	2"	100	100	100 0	100 0
100	100	100	100	90-100	100	1 1/2"	-	87-100	100 0	100 0
100	55	100	100	20-55	100	1"	-	65-90	78 9	87 0
95	15	100	90-100	0-15	100	3/4"	35-70	48-82	57.4	73.7
55	1.1	100	-	-	100	1/2"	-	-	29.7	56.5
32	0 6	100	20-55	0-5	100	3/8"	10-30	39-57	17 2	48 7
3	0 4	96 7	0-10	-	95-100	4	0-5	30-45	1 8	37.9
1	0 3	84	<5		-	8	-	23-38	0 7	32.3
		68			45-80	16	-	15-33	0 0	25 8
		52			-	30	-	8-24	0.0	19 8
		25			10-35	50	-	4-13	0 0	9 5
		6			2-12	100	-	1-5	0 0	2.3
		2.5			0-5	200	-	0-3	0 0	1 0

APPENDIX E
BITUMINOUS MIX DESIGN

AC

LAB NO: BF-108-95 JAN 25 1995
REPORT DATE: 01/25/95
DATE SAMPLED: 10/20/95
DATE RECEIVED: 01/06/95
CHECKED BY: BM/MB
TYPE MATERIAL: TYPE 2C PLANTMIX AGGREGATE
SAMPLED BY: JIM BOWLEN
SOURCE OF SAMPLE: HU 83-06, HU 83-08, NEGRO PIT

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
1263 S. STEWART ST. CARSON CITY, NV 89712
BITUMINOUS MIX DESIGN

CONT/EA NO: 2591
COUNTY: HUMBOLDT AND LANDER
CONTRACTOR: MATICH CORPORATION
JOB DESCR.: ON I-80 FROM 1.8 MILES EAST OF VALMY INTER. TO 3.2 MILES EAST OF HUMBOLDT/LANDER COUNTY LINE

PROJECT NO: SPI-080-3(12)
TYPE ASPHALT: AC-20P
ASPHALT PRODUCER: HUNTWAY

BIT. RATIO DENSE GRADED: 5.25 AC-20P olymer
BIT. RATIO DENSE GRADED:
BIT. RATIO OPEN GRADED:

JAN 31 1995

		SPECS:
SPECIFIC GRAVITY:	2.59 (2.59)	
SURFACE AREA(FT²/LB)(M²/kg):	26.4 (5.41)	
PLUS NO. 4 WATER ABSORPTION:	1.1	4% MAX
SAND EQUIVALENT:	46	
L.A. ABRASION, % LOSS:	33.4	45 MAX
LIQUID LIMIT:	23	35 MAX
PLASTIC INDEX:	NP	NP (0-3)
VMA:	15.9	12-22
% FRAC. FACE COUNT:	96.3	60 MIN

		SPECS:
SS SOUNDNESS COARSE:	6.70	12.00 MAX
SS SOUNDNESS FINES:	8.20	15.00 MAX

			SPECS:
SPLIT TENSILE, PSI (kPa):	80.2	(553.0)	65 MIN (448.2 kPa)
S.T.% RET.AFTER LOTT.:	118.8		70 MIN

GRADING TESTS (WASH METHOD)

Percent by Weight Passing Seive

Sieve Size	COARSE (Hu-83-8)	INTER-MEDIATE (Hu 83-8)	CRUSHER FINES (80% 83-8 20% 83-6)	NATURAL FINES (Negro)	* AS COMBINED AND TESTED	TYPE 2C SPECS:
1 1/2						
1	100				100	100
3/4	71	100			93	88-90
1/2	14	75			74	70-85
3/8	3	45	100	100	65	63-78
NO 4	1	7	95	95	54	43-60
NO 8	1	2	74	75	41	
NO 10	1	2	68	70	39	30-44
NO 16	1	2	57	56	32	
NO 30	1	2	43	39	23	
NO 40	1	1	38	28	19	12-22
NO 50	1	1	30	16	14	
NO 100	1	1	17	3	7	
NO 200	1	1	12	1	5	3-7

STABILITY TESTS

TYPE MINERAL FILLER OR ADDITIVE
1.5% HYDRATED LIME WET-CURED 48 HOURS

						(Mg/m³)
RICE MAX. DENS.					149.5 (2.396)	
LBS PER CU FT	139.6 (2.237)	140.0 (2.244)	141.9 (2.274)		144.1 (2.309)	144.7 (2.319)
BITUMEN RATIO	4.00	4.50	5.00		5.50	6.00
HVEEM VALUE	45	44	43	40	37	32
% AIR VOIDS	8.5	7.6	5.7	4.7	3.6	2.6
% DURABIL LOSS			2.0		1.5	1.0

REMARKS

FOR THE MATERIAL REPRESENTED BY THE SUBMITTED SAMPLES WITH THE ABOVE GRADINGS, LABORATORY TESTS INDICATE A BITUMEN RATIO OF 5.25 AC-20P FOR TYPE 2C PLANTMIX AGGREGATE TREATED WITH 1.5% HYDRATED LIME AND WET-CURED (MARINATED) 48 HOURS. HVEEM VALUE SPECS. FOR THIS PROJECT IS 37 MINIMUM, % AIR VOID SPECS. ARE 3-6, DURABILITY SPECS. ARE 25% MAXIMUM LOSS.

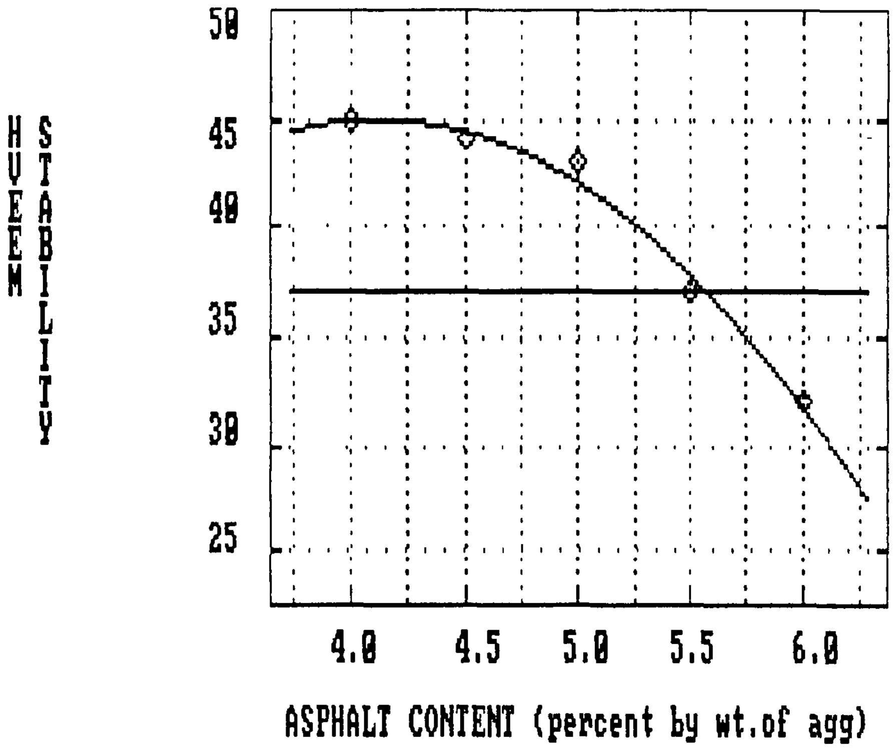
* COMBINED 24% COARSE, 21% INTERMEDIATE, 35% CRUSHER FINES AND 20% NATURAL FINES AS PER TRANSMITTALS.

NOTE: CHANGES FROM THE RECOMMENDED PERCENT OF ASPHALT WILL BE DISCUSSED WITH THE MATERIALS DIVISION.

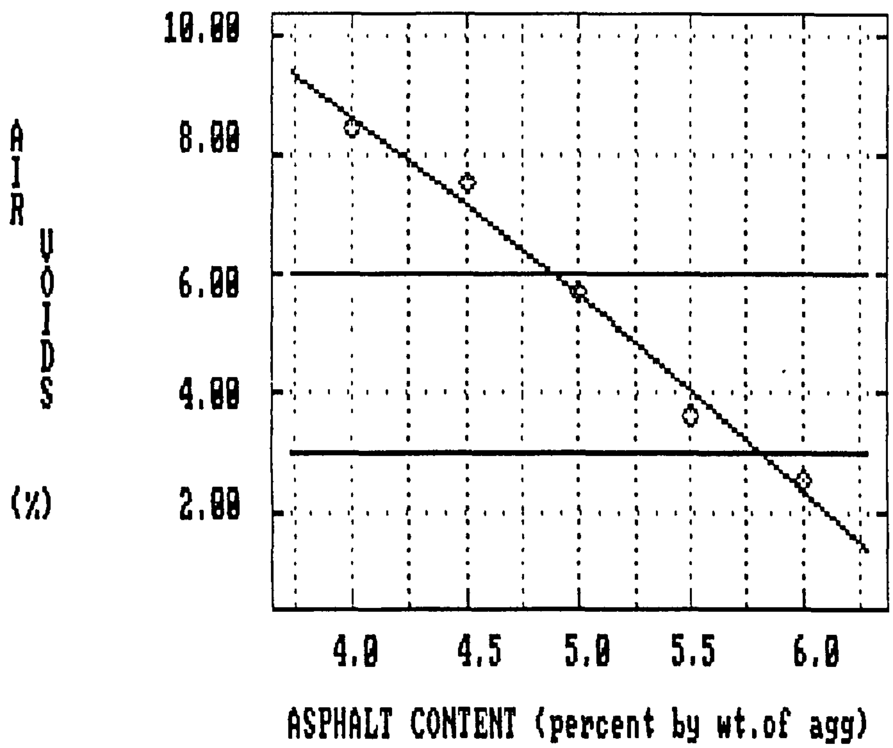
Crusher Fines Combined 80% Hu 83 8 20% Hu 83 6

DISTRIBUTION:
- DISTRICT ENGINEER
- RESIDENT ENGINEER
- CONSTRUCTION ENG.
- LAB FILES
- BITUMINOUS LAB
- ASPHALT LAB
- DEAN WEITZEL

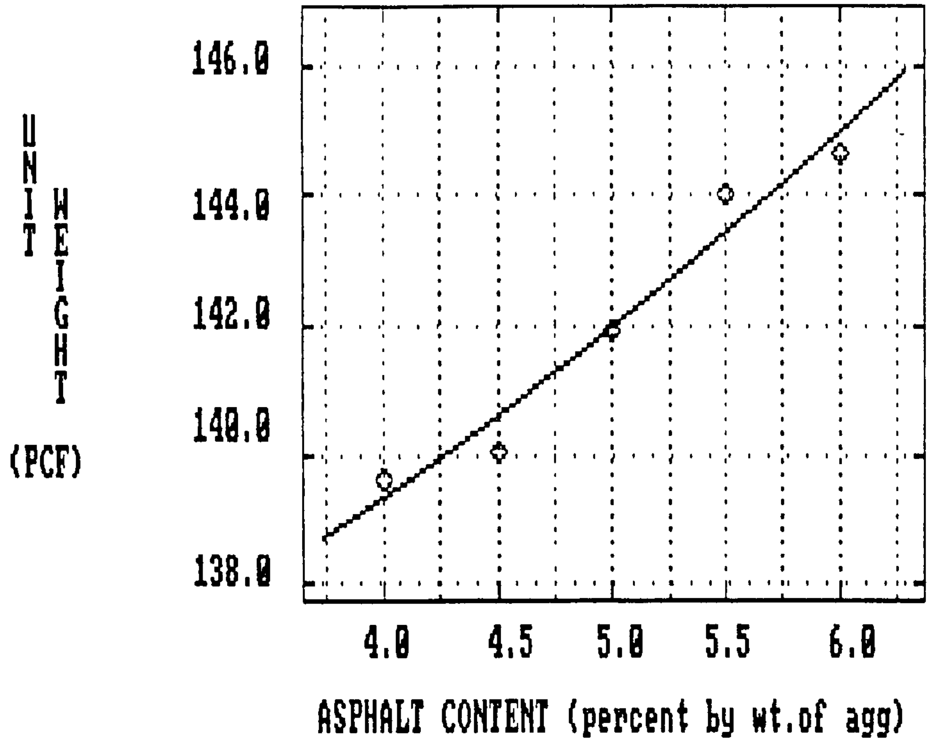
BF-108-95



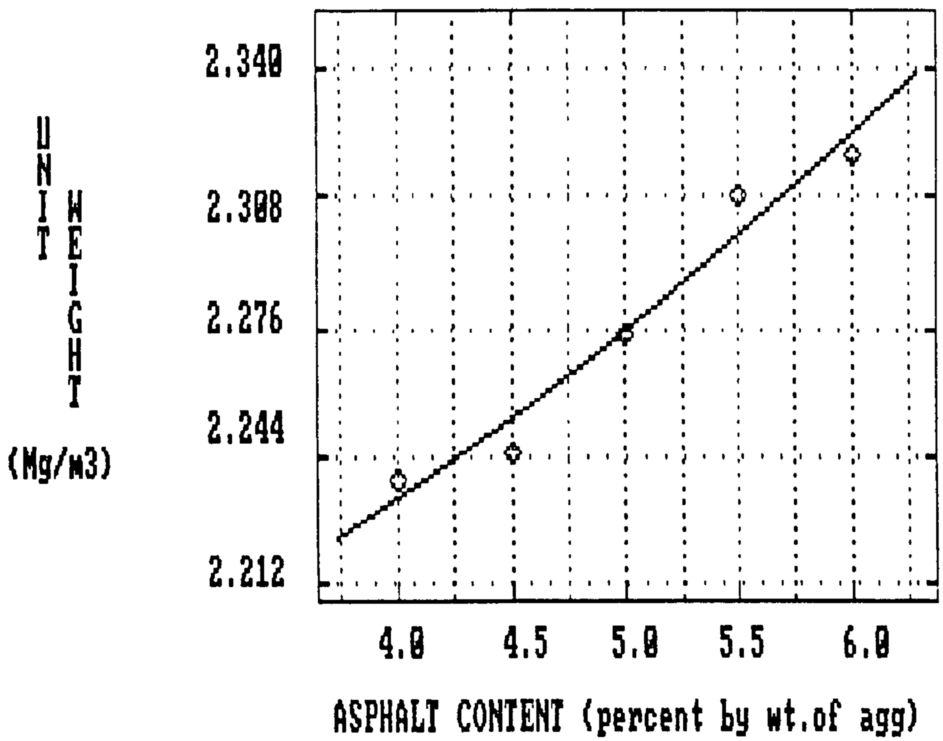
BF-108-95 (2591) T-2C AC-20P HUNTWAY



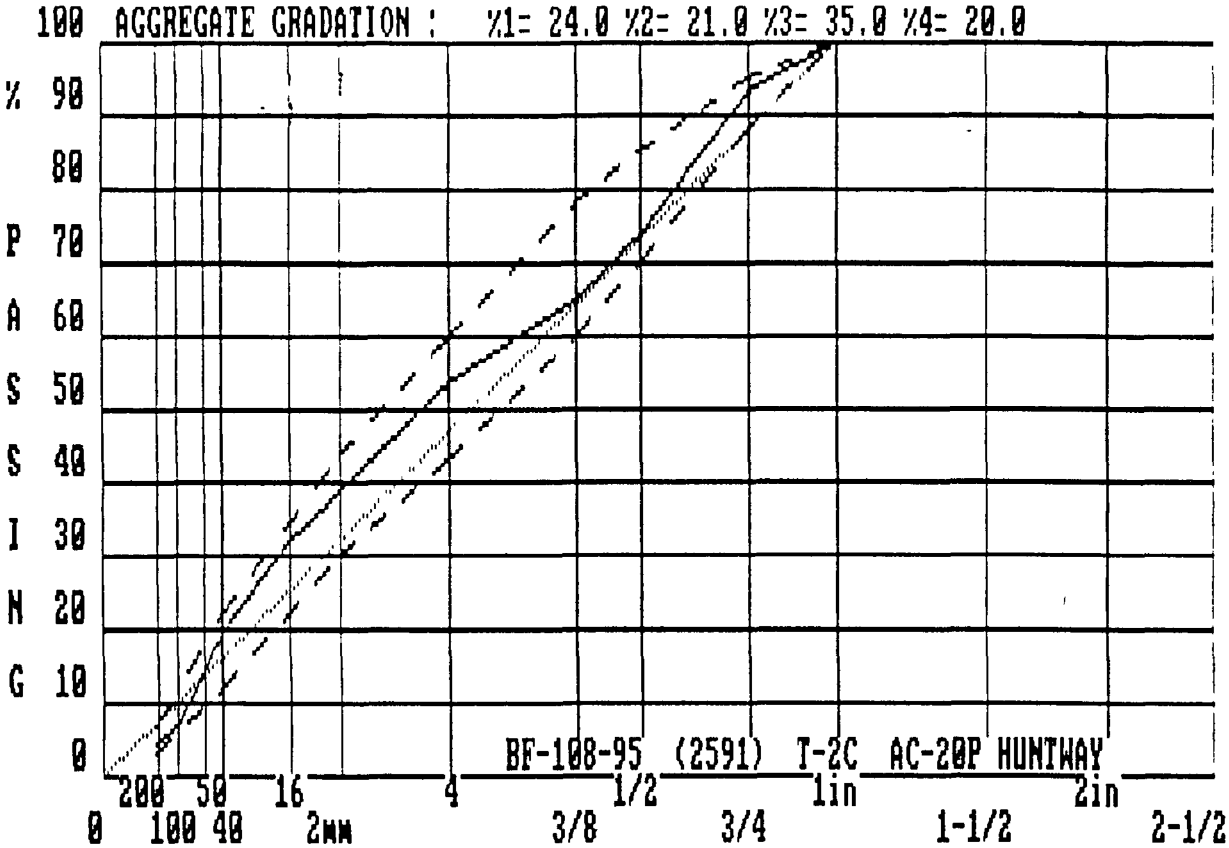
BF-108-95 (2591) T-2C AC-20P HUNTWAY



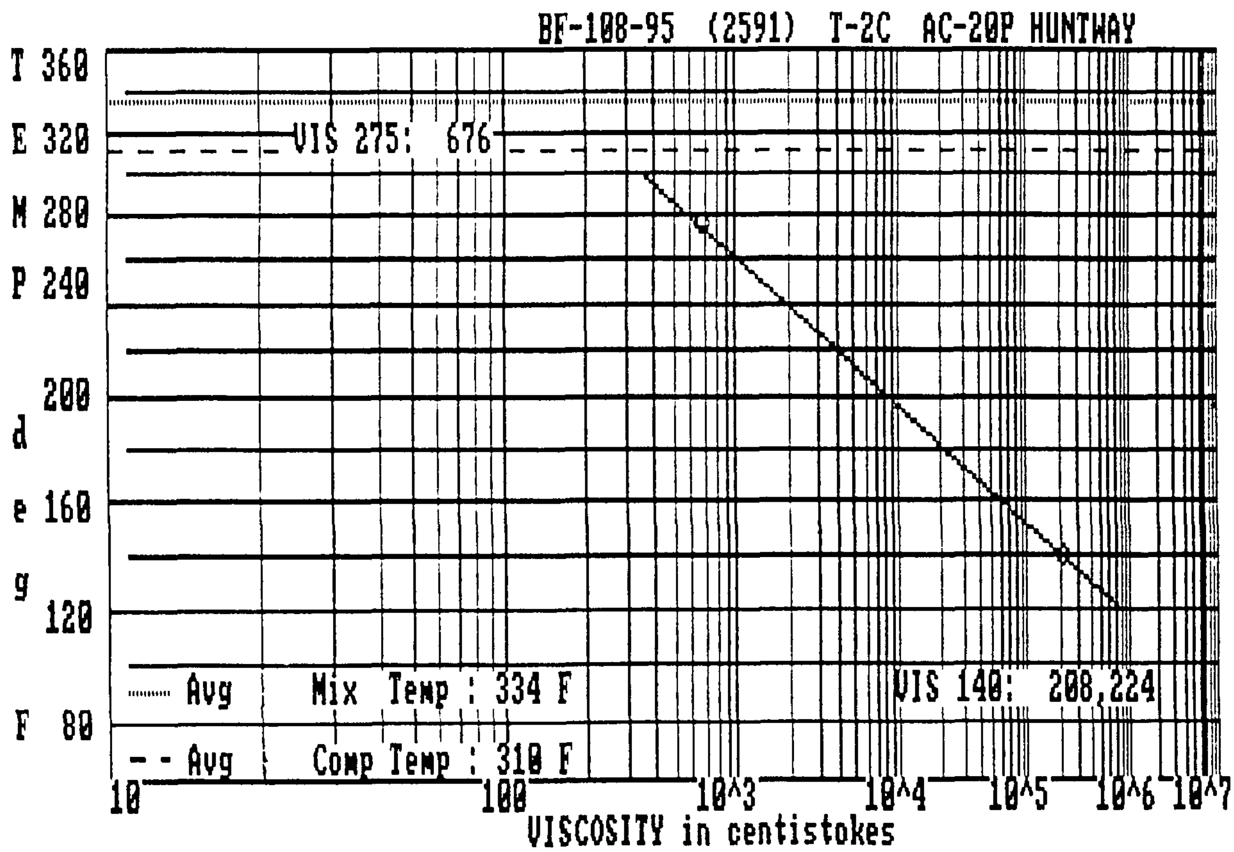
BF-108-95 (2591) T-2C AC-20P HUNTWAY



BF-108-95 (2591) T-2C AC-20P HUNTWAY



AGGREGATE GRADATION : %1= 24.0 %2= 21.0 %3= 35.0 %4= 20.0
% PASSING
100
90
80
70
60
50
40
30
20
10
0
BF-108-95 (2591) T-2C AC-20P HUNTWAY
200 50 16 4 1/2 1in 2in
0 100 40 2mm 3/8 3/4 1-1/2 2-1/2



BF-108-95 (2591) T-2C AC-20P HUNTWAY
TEMP deg F
360
320
280
240
200
160
120
80
VIS 275: 676
Avg Mix Temp : 334 F
- - Avg Comp Temp : 310 F
VIS 140: 208,224
10
100
10^3
10^4
10^5
10^6
10^7
VISCOSITY in centistokes