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16. Abstract

Test roads were constructed near El Paso, Buffalo and Brownsville under Study 2-9-83-347. All test roads were designed as statistical experiments such that analysis of effects due to asphalt-rubber formulation could be determined. Asphalt-rubber was formulated using various rubber concentration, rubber type, digestion conditions, and interlayers were applied at various shot rates. In addition, aggregate grade was varied, and single and double binder applications were studied.

Based on field performance to date, the interlayer which is performing the best in the El Paso Test Road contains 26% rubber and was applied at 0.40 gallons per square yard. The Brownsville Test Road is experiencing bleeding from the interlayer in half of the test sections due to excessive interlayer binder application rates. The Buffalo Test Road is not experiencing any distress at this time.

Long-term monitoring of these test roads will be continued under Study No. 1-10-77-187.

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Asphalt-Rubber Interlayer Field Performance

by

Cindy Adams

and

Jorge Gonzales

Research Study Number 2-9-85-449

Report No. 449-1F

Sponsored by the

State Department of

Highways and Public Transportation

in cooperation

with the

United States Department of Transportation

Federal Highway Administration

Texas Transportation Institute

Texas A&M University

College Station, Texas 77843

June 1987

METRIC CONVERSION FACTORS

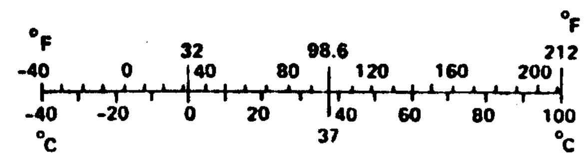
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



SUMMARY

Test roads were constructed near El Paso, Buffalo and Brownsville under Study 2-9-83-347. All test roads were designed as statistical experiments such that analysis of effects due to asphalt-rubber formulation could be determined. Asphalt-rubber was formulated using various rubber concentration, rubber type, digestion conditions, and interlayers were applied at various shot rates. In addition, aggregate grade was varied, and single and double binder applications were studied.

Based on field performance to date, the interlayer which is performing the best in the El Paso Test Road contains 26% rubber and was applied at 0.40 gallons per square yard. The Brownsville Test Road is experiencing bleeding from the interlayer in half of the test sections due to excessive interlayer binder application rates. The Buffalo Test Road is not experiencing any distress at this time.

IMPLEMENTATION STATEMENT

Laboratory test results obtained in Study 2-9-83-347 should provide information necessary to develop a state specification for asphalt-rubber based on performance. Two of the three test roads which have been monitored since construction are beginning to provide useful data concerning the construction of asphalt-rubber interlayers. However, monitoring should be continued until sufficient data is acquired to establish a correlation to laboratory properties.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

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CHAPTER I

INTRODUCTION

History

Ground tire rubber has been used as an additive in various types of asphalt pavement construction in recent years. The use of rubber is an attempt to input additional elasticity to paving materials.

A blend of paving asphalt cement and gound tire rubber is called "asphalt-rubber". Rubber content of this blend is 18 to 26 percent by total weight of the blend (1). The blend is formulated at elevated temperature to promote chemical and physical bonding of the two components. Various petroleum distillates are sometimes added to the blend to reduce viscosity and promote workability.

Asphalt-rubber binders have been used in a number of Civil Engineering applications. Early observations of field installations indicated that asphalt-rubber bound materials reduced the occurance of reflection cracking. Thus, much use of asphalt-rubber has been in pavement rehabilitation systems where the reduction of reflection cracks is desired. An asphalt-rubber seal coat sandwiched between an existing cracked asphalt concrete pavement and new asphalt concrete overlay is called an asphalt-rubber "interlayer" (2). Historically, the design and construction of asphalt-rubber seal coats and interlayers has been identical, although recent research suggests modifications of old techniques are justified (3).

Field observations suggest asphalt-rubber interlayers may reduce reflection cracking in overlays (1,2,4). However, many types of formulations of asphalt and rubber are possible due to a wide assortment of constituents. Evidence suggests certain asphalt-rubber blends may produce undesirable results (5). Although some data is available regarding performance of asphalt-rubber in the laboratory (5,6,7,8,9) a correlation between laboratory data and field performance has not been developed.

Accomplishments in Study 2-9-83-347 (16)

In this study, three experimental test roads containing asphalt-rubber interlayers were constructed. Test pavements were designed as statistical experiments such that future performance analysis could be obtained. Precondition surveys were conducted prior to rehabilitation to provide documentation for future condition surveys.

One test pavement was constructed in the east and westbound travel lanes on Interstate Highway 10 east of El Paso, Texas between FM 34 and the McNary interchange. This pavement will be referred to as the "El Paso Test Road".

The second test pavement was constructed in the northbound travel lane of Interstate Highway 45 from the Leon-Freestone County Line north to the U.S. 84 overpass. This pavement will be referred to as the "Buffalo Test Road".

Test road number three was constructed in the north and southbound lanes of State Highway 4 from the International Bridge north approximately two miles. This pavement will be referred to as the "Brownsville Test Road".

Samples of asphalt-rubber were obtained during field mixing of asphalt and rubber for laboratory characterization. Samples of asphalt and rubber were obtained for mixing in the laboratory. A comparison was made between laboratory test results of field and laboratory prepared asphalt-rubber.

Three new laboratory tests were used to evaluate asphalt-rubber engineering properties. These included force ductility, double ball softening point, and torque fork viscosity.

Results of these laboratory tests indicate engineering properties of field prepared asphalt-rubber can be duplicated by laboratory prepared mixtures. This means future mixtures of asphalt-rubber can be designed in the laboratory prior to construction.

Scope

The purpose of this research was to monitor the performance of these three test roads. Systematic condition surveys were conducted semi-annually at the El Paso, Buffalo, and Brownsville Test Roads following the guideline for pavement evaluation outlined by Epps, et. al. (13). This report documents the field survey data, procedures and performance data based on pavement condition prior to interlayer construction.

CHAPTER II

MATERIALS

El Paso Test Road

Asphalt cements used in the preparation of asphalt-rubber binders and asphalt concrete was obtained from the Chevron refinery in El Paso, Texas. These asphalts meet the Texas State Department of Highways and Public Transportation (SDHPT) specification (12) requirements for AC-10 and AC-20 viscosity graded materials as shown in Table 1.

Three sources of rubber were used to produce asphalt-rubber binders investigated at the El Paso Road. These rubber materials were obtained from the suppliers shown in Table 2. Sieve analysis of rubber was accomplished following a modified ASTM C136 procedure (10). The procedure was changed by lightly rubbing the rubber particles by hand on each sieve to prevent rebound from the sieve surface. Undue force was not applied using this procedure to avoid pushing particles through the sieve.

It was desired to estimate the precision of the modified sieve analysis procedure. Therefore, ten random sieve analyses were performed by the same operator on each of the three rubber types. The percent rubber passing each sieve was measured and confidence intervals have been established for gradation of each rubber type based on average and standard deviation for percent passing each sieve size. Gradations with 95 percent confidence limits appear in Table 3. Average gradation for each rubber type is plotted in Figure 1. Further characterization of each rubber type following ASTM procedure D297 (11) provides data relating to physical and chemical properties as shown in Table 4.

Dolomite mineral aggregates used for construction of interlayer and asphalt concrete were obtained from the Esperanza Pit, Esperanza, Texas. Interlayer aggregates were precoated with approximately one percent Chevron AC-20 and stockpiled prior to application.

Table 1. Asphalt Cement Properties.

Properties	AC-10 Asphalt El Paso	AC-10 Asphalt Buffalo	AC-10 Asphalt Brownsville	AC-10 Spec Min.	AC-10 Spec Max.	AC-20 Asphalt El Paso	AC-20 Asphalt Buffalo	AC-20 Asphalt Brownsville	AC-20 Spec Min.	AC-20 Spec Max.
Viscosity, 140F poises	1048	868	930	1000 ± 200		1860	1755	1792	2000 ± 400	
Viscosity, 275F stokes	2.9	2.8	2.9	1.9	-	3.8	3.5	3.7	2.5	-
Penetration, 77F, 100g, 5 sec	92	150	136	85	-	69	70	88	55	-
Flash Point C.O.C., F	600+	N/A	530	450	-	600+	595	582	450	-
Specific Gravity, 77F	1.010	1.017	1.022	N/A		1.012	1.013	1.024	N/A	
Tests on residues from thin film oven test:										
Viscosity, 140F poises	2257	2445	2228	-	3000	4146	4485	3431	-	6000
Ductility, 77F, 5 cms per min., cms	141+	141+	141+	70	-	141+	141+	141+	50	-

Table 2. Rubber Types.

El Paso Test Road

Rubber	Source	Source Designation	Manufacturers Designation
A	Genstar Conservation Chandler, Arizona	C104	Whole Tire, Vulcanized, Ambient Grind
B	Atlos Manufacturing Los Angeles, CA	TPO 44	Tread Tire, Vulcanized, Ambient Grind
C	Midwest Elastomers Wapokonetta, Ohio	N/A	Whole Tire, Vulcanized, Cryogenic Grind
	Buffalo/Brownsville Test Roads		
D	Genstar Conservation, Chandler, Arizona	C106	Whole Tire, Vulcanized Ambient Grind
E	Baker Rubber, South Bend, Indiana	1MAT-20	High Natural Rubber Content, Vulcanized, Ambient Grind

Table 3. El Paso Rubber Gradations

Sieve	% Passing Rubber A	Rubber B	Rubber C
8	100	100	100
10	100	100	99 ± 0.5
16	65 ± 5.6	38 ± 2.1	67 ± 3.9
30	2 ± 0.3	8 ± 0.6	8 ± 1.1
40	0.5 ± 0.4	4 ± 0.4	3 ± 0.9
50	0	3 ± 0.4	1 ± 0.6
100		0.4 ± 0.5	0.2 ± 0.4
200		0	0

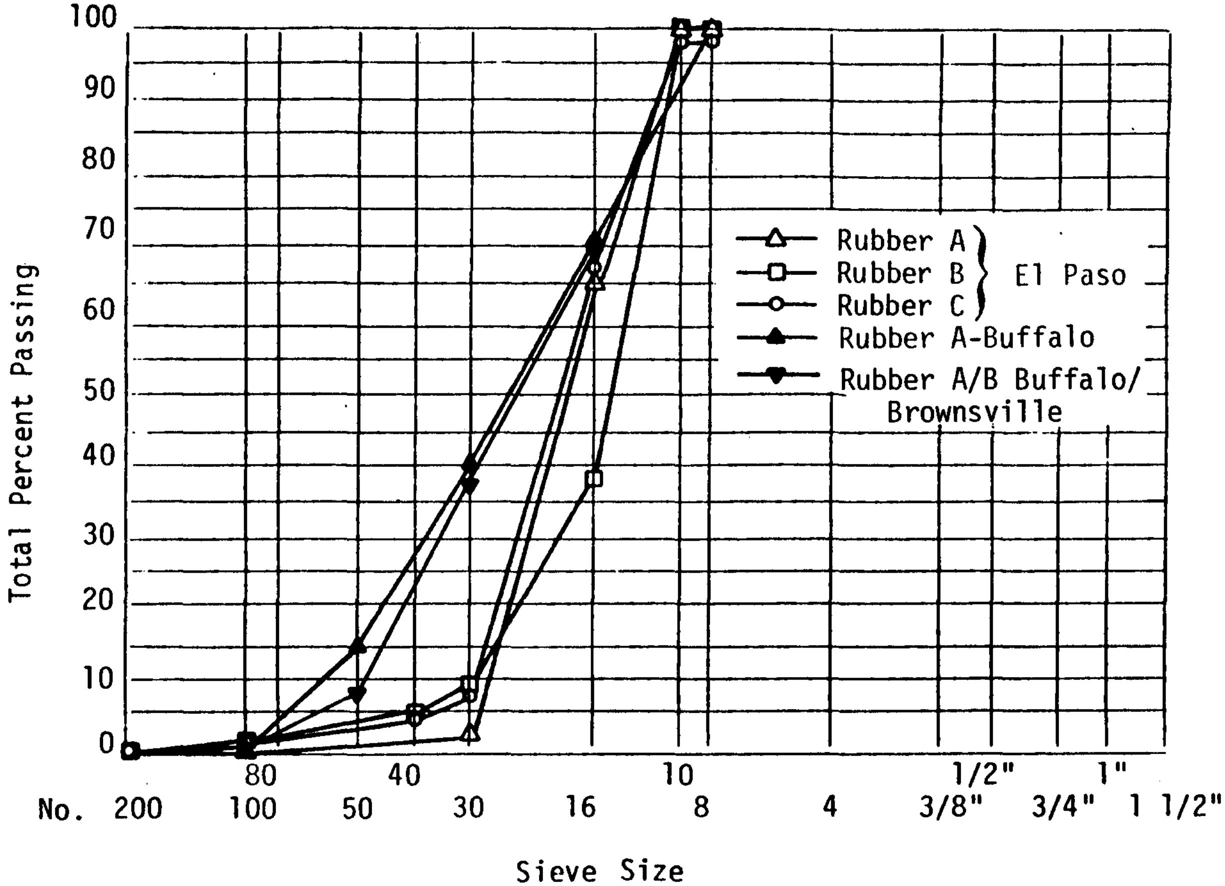


Figure 1. Rubber Gradations

Table 4. Rubber Properties.

	El Paso		
	A	B	C
Specific Gravity	1.165	1.153	1.150
Total Extract, % by weight	15.45	19.47	24.50
Ash, % by weight	5.71	3.49	2.41
Free Carbon, % by weight	29.21	30.75	31.31
Total Sulfur, % by weight	1.17	1.02	1.10
Rubber Polymer:			
Natural Rubber, % by weight	30	20	0
Styrene butadiene, % by weight	60	80	55
Polybutadiene, % by weight	10	0	45
	100	100	100
Rubber Hydrocarbon, % by volume	60.92	55.89	50.76

Table 4. Rubber Properties. (Continued)

	Buffalo		Brownsville
	D	D/E	D/E
Specific Gravity	1.160	1.48	1.15
Total Extract, % by weight	15.41	12.75	13.27
Ash, % by weight	5.68	4.86	5.03
Free Carbon, % by weight	29.00	28.35	28.53
Total Sulfur, % by weight	1.15	1.17	1.18
Rubber Polymer:			
Natural Rubber, % by weight	30	61	54
Styrene butadiene, % by weight	60	35	40
Polybutadiene, % by weight	10	4	6
	100	100	100
Rubber Hydrocarbon, % by volume	61.02	58.46	58.95

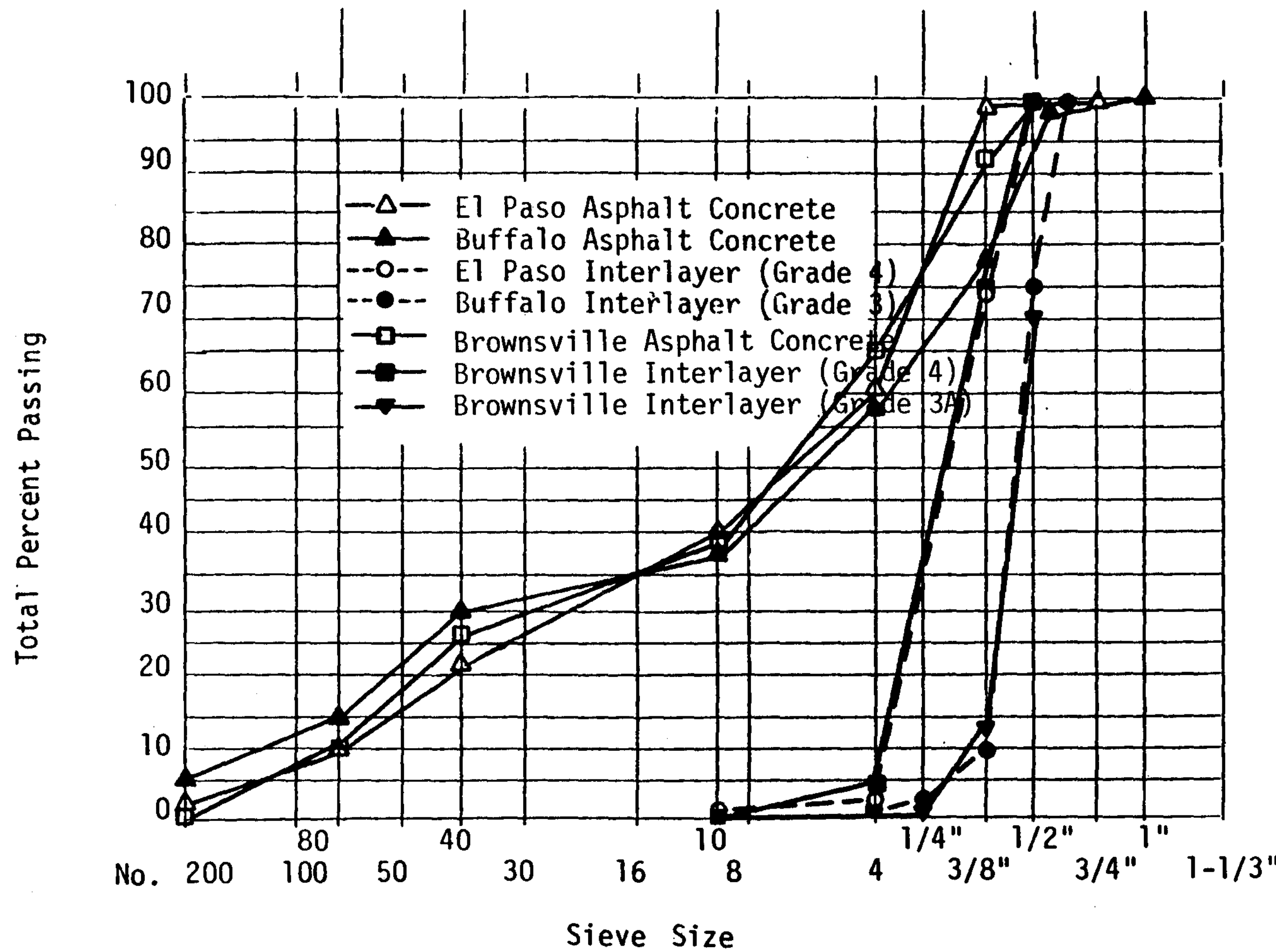


Figure 2. Aggregate Gradations

Particle size gradations of interlayer and asphalt concrete aggregates appear in Figure 2. Both materials conform to Texas SDHPT Item 302 Grade 4 and Item 340 Type D specification limits, respectively. Physical properties of mineral aggregates conform to Texas SDHPT specifications as shown in Table 5.

Samples of the asphalt concrete overlay were obtained by coring each test section approximately two weeks after construction. Characteristics of the overlay asphalt concrete are as shown in Table 6. Figure 3 indicates the variation of asphalt concrete resilient modulus with temperature.

Buffalo Test Road

Asphalt used for asphalt-rubber blending was an AC-10 asphalt cement supplied by Texas Fuel and Asphalt, Corpus Christi, Texas. Asphalt for asphalt concrete production was an AC-20 asphalt cement supplied by Trumbull Asphalt of Houston, Texas. These asphalts meet the Texas SDHPT specification requirements for AC-10 and AC-20 viscosity graded materials as shown in Table 1. A flux oil, Sundex 790, from Sun Oil Corporation, Houston, Texas, was blended with the AC-10 asphalt prior to blending with rubber.

One rubber source was used to produce the asphalt-rubber placed on the Buffalo Test Road. This material is described as Rubber A Designation C106 in Table 2. This rubber has the same chemical properties as Rubber Type A Designation C104 used at the El Paso Test Road. However, particle size gradation differs. Sieve analysis of the rubber is shown in Figure 1. Note the finer size gradation of the Buffalo Type A rubber compared with El Paso Type A.

Limestone mineral aggregates used for construction of interlayer and asphalt concrete were obtained from the Yelberton Pit near Mexia, Texas. Interlayer aggregates were precoated with approximately 0.50 percent AC-20 immediately prior to application.

Particle size gradations of aggregates are shown in Figure 2. Materials conform to Texas SDHPT Grade 3 Item 302 seal coat and Type C

Table 5. Mineral Aggregate Properties

Test	Seal Coat				Asphalt Concrete			
	El Paso Grade 4	Buffalo Grade 3	Brownsville Grades 3 & 4	Spec (12)	El Paso Type D	Buffalo Type C	Brownsville Type D	Spec (12)
Unit Weight, pcf Tex-404A	84.6	81.5	N/A	N/A	91.4	85.2	N/A	35, min
L. A. Abrasion, % Tex-410A	21	33	N/A	35, max	21	33	N/A	40, max
Polish Value, % Tex-438A	35	45	N/A	N/A	35	45	N/A	N/A
Decant., % Tex-217F, II	0.4	0.8	.3	5, max	0.8	0.8	0.5	1, max
Plasticity Index Tex-106E	N/A	N/A	N/A	N/A	3	1	1.5	6, max
Sand Equivalent	N/A	N/A		N/A	N/A	N/A	60	45, min

Table 6. Asphalt Concrete Properties.

	El Paso	Buffalo	Brownsville
Hveem Stability (Texas Method)	33	19	46
Indirect Tensile Modulus, 77F, psi x 10^3	34.9	11.8	10.4
Indirect Tensile Modulus after Lottman Freeze-Thaw, 77F, psi x 10^3	30.2	12.0	12.4
Resilient Modulus, 77F, psi x 10^3	328	266	137
Resilient Modulus after Lottman Freeze-Thaw, psi x 10^3	242	188	155
Asphalt Content, % by weight	5.0	4.9	5.4
Unit Weight, pcf	144.7	139.5	136.9
Absorbed Asphalt, %	1.1	0.9	N/A
Effective Asphalt, %	3.9	4.0	N/A
VMA, %	14.6	19.6	N/A
Air Voids, %	5.5	9.2	9.4

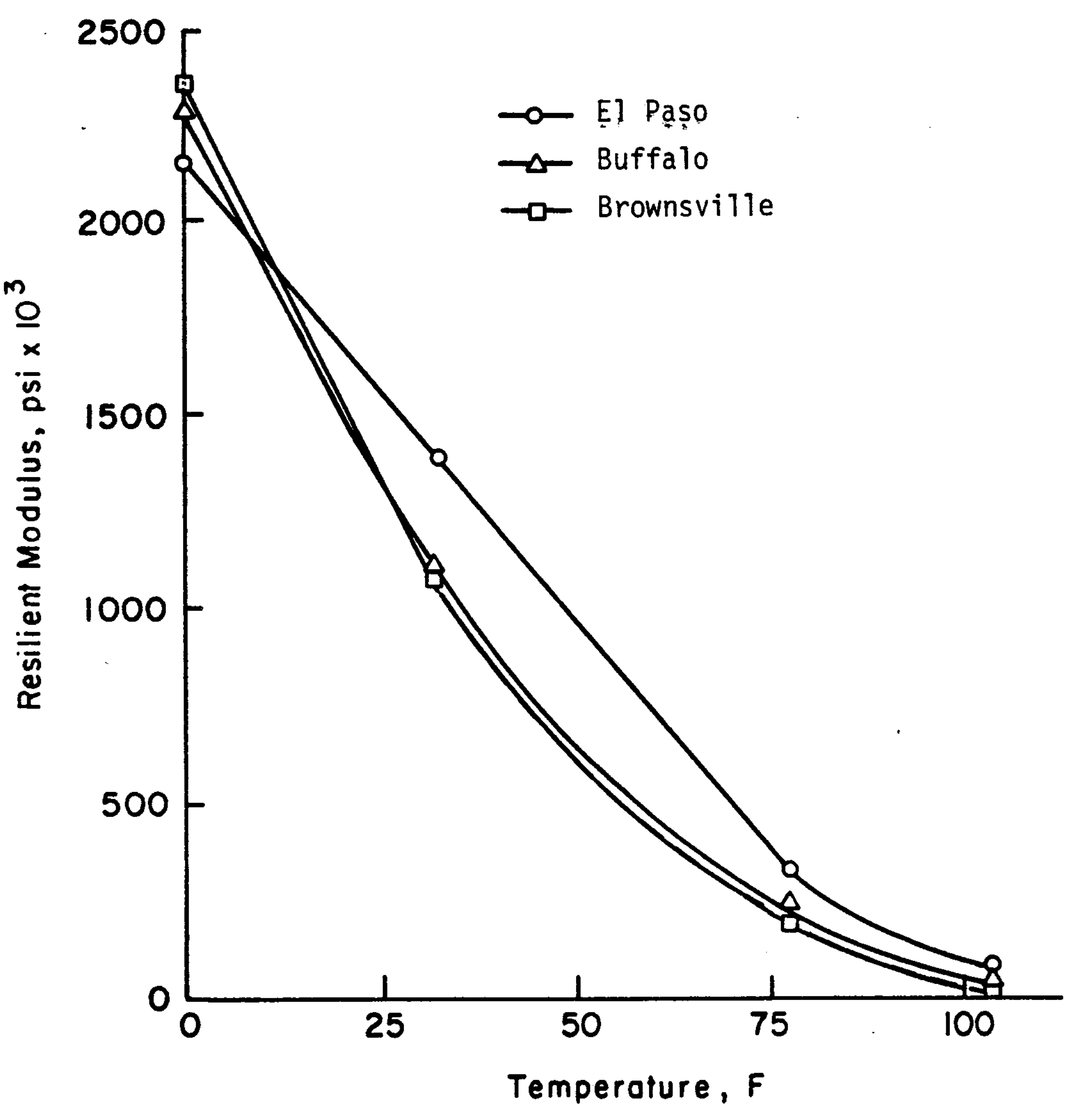


Figure 3. Asphalt Concrete Resilient Modulus

Item 340 asphalt concrete specification limits, respectively, as shown in Table 4. Physical properties of the limestone are shown in Table 5.

Core samples of the asphalt concrete overlay were obtained within each test section approximately two weeks after construction. Laboratory properties of the asphalt concrete are summarized in Table 6 and represented graphically in Figure 3.

Brownsville Test Road

Asphalt used for asphalt-rubber blending was an AC-10 from Texas Fuel and Asphalt, Corpus Christi, Texas. An AC-20 was obtained from the same source for asphalt concrete production. These asphalts meet Texas SDHPT specification requirements as shown in Table 1. Sundex 790 from Sun Oil Corporation was blended with the AC-10 asphalt at 6 percent by volume. Control sections were placed with non-modified AC-10 and polymer modified emulsion, designated HFRS-2, from Texas Emulsions, Austin, Texas.

The rubber used to produce the asphalt-rubber was a blend of 60 percent Type A and 40 percent Type B as shown in Table 2. Properties of the blended rubber appear in Table 4. Sieve analysis of this rubber blend appears in Figure 1.

Mineral aggregates for asphalt concrete were obtained from the San Juan Plant. Seal coat aggregates were sampled from the Fordyce Company, Spaulding Pit. Approximately 1 percent lime from Redland Worth Corporation was added to the asphalt concrete.

Particle size gradation of aggregates appear in Figure 2. Asphalt concrete aggregates conform to Texas SDHPT Type D, and interlayer aggregates conform to Grades 3A and 4, respectively. Physical properties of aggregates appear in Table 5.

Laboratory properties of core samples obtained by District 21 personnel appear in Table 6 and Figure 3.

CHAPTER III

EXPERIMENT DESIGN

The following discussion relates to the statistical design of two experimental test roads. Subscripts within the mathematical models are associated with main factors and replicates.

A major portion of Study 2-9-83-347 was dedicated to establishing statistically designed field and laboratory experiments which could form the basis for future correlations between field performance and laboratory test results.

El Paso Test Road - Field Responses

This experiment was designed as a Latin Square (21) with three samples per treatment. The statistical model for the analysis of this design is formulated as follows:

$$Y_{ijk} = \mu + R_i + C_j + A_k + e_{ijk}$$

where Y_{ijk} = response to ith rubber, jth concentration and kth application rate.

μ = effect on response of the overall mean

R_i = effect on response of the ith rubber, $i = 1,2,3$

C_j = effect on response of the jth concentration, $j = 1,2,3$

A_k = effect on response of the kth application rate, $k = 1,2,3$

e_{ijk} = random error

Note: This Latin Square was designed without replication. Therefore, estimation of interaction effects is not possible as the model above reflects. As a first approximation, this experiment estimates main factor effects only, and assumes no interactions.

Levels of the independent variables are as follows:

I. Rubber Type, R_i

A. Type A (Table 2)

B. Type B (Table 2)

C. Type C (Table 2)

II. Rubber Concentration, %, C_j

A. 22

B. 24

C. 26

III. Application Rate, gsy, A_k

A. 0.35

B. 0.40

C. 0.45

The matrix arrangement shown in Figure 4 depicts all combinations of variables investigated for field response at the El Paso Test Road.

El Paso Test Road - Laboratory Responses

Two experiments were designed for this phase of the research. One deals with asphalt-rubber material prepared in the field and the other deals with asphalt-rubber prepared in the laboratory. Both experiments are full factorial designs with fixed factors and three replicates.

Models for analysis of these respective experiment designs are as follows:

Field Mixed Asphalt-Rubber

$$Y_{ijk} = \mu + R_i + C_j + RC_{ij} + e_{ijk}$$

where terms are as indicated previously and RC_{ij} represents the

Application Rate, A_k	Rubber Concentration, C_j	22	24	26
	35	C Section 2	B Section 9	A Section 8
	40	B Section 4	A Section 1	C Section 6
	45	A Section 5	C Section 7	B Section 3

Rubber Type, R_i

Control (No Interlayer)
Section 10

Figure 4. El Paso Field Response Experiment

		Rubber, R_i		
		A	B	C
Concentration, C_j	22	— — —	— — —	— — —
	24	— — —	— — —	— — —
	26	— — —	— — —	— — —

Figure 5. El Paso Lab Response to Field Mixed Material

interaction effect of the ith rubber and jth concentration. A matrix representation is shown in Figure 5.

Laboratory Mixed Asphalt-Rubber

$$Y_{ijkm} = \mu + R_i + C_j + D_k + RC_{ij} + RD_{ik} + CD_{jk} + RCK_{ijk} + e_{ijkm}$$

where: D_k = effect on response of the k_{th} digestion condition, $k = 1,2,3$

and other terms are as before with interactions occurring for all combinations of main effects. Figure 6 is a matrix representation of this experiment.

Three digestion conditions were produced in the laboratory. These digestion conditions were varied from low to moderate to high to provide a range from which simulation of field digestion could be approximated. The basis for this lab variation was an effort to provide asphalt-rubber lab mixes with properties of field prepared mixes.

Buffalo Test Road - Field Responses

This experiment was designed as a full factorial with two fixed factors and two replications. The model for analysis of this design is as follows:

$$Y_{ijk} = \mu + C_i + D_j + CD_{ij} + e_{ijk}$$

where terms are as before.

Levels of the independent variables are as follows:

I. Concentration of Rubber, C_i

A. 18

B. 22

Rubber, R_i	A			B			C		
Concentration, C_j / Digestion, D_k	22	24	26	22	24	26	22	24	26
Low	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —
Med	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —
High	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —

Figure 6. El Paso Lab Response to Lab Mixed Material

II. Digestion, D_j

A. Low

B. High

In this experiment, rubber type and application rate are held constant. The resulting four treatments are replicated providing eight experimental test sections. Four additional test sections were included as control sections. Two sections were constructed using a conventional asphalt cement as the interlayer binder and the other two sections contain no interlayer.

Buffalo Test Road - Laboratory Responses

This experiment was designed to evaluate laboratory responses of field mixed and laboratory mixed asphalt-rubber materials as in the El Paso experiment. The experiment is a replicated, full factorial with fixed factors analyzed according to the model appearing below:

$$Y_{ijk} = \mu + C_i + D_j + CD_{ij} + e_{ijk}$$

where terms are as previously described. The matrix representation of the field and laboratory experiments for this model appear as shown in Figures 7 and 8.

The model used for analysis of the laboratory response to field prepared asphalt-rubber is shown below:

$$Y_{ijk} = \mu + C_i + D_j + R_k + CD_{ij} + CR_{ik} + DR_{ik} + CDR_{ijk} + \varepsilon_{ijk}$$

where terms are as previously described and,

R_k = effect on response to k^{th} field replicate, k = 1,2

Digestion, D_j		Concentration, C_i, % 18	Concentration, C_i, % 22
	High	1 8	7 12
	Low	9 11	6 10

Controls (AC Binder)
2 5

(No Interlayers)
3 4

Note: Numbers shown are test section numbers noted on Figure 13.

Figure 7. Buffalo Field Response Experiment.

		Concentration, %	
		18	22
Digestion	Low	- - -	- - -
	Med	- - -	- - -
	High	- - -	- - -

Figure 8. Buffalo Lab Response to Lab Mixed Material

This third main effect is added to the model such that judgement regarding replicate batches of field mixed asphalt-rubber is possible. Matrix representation of this experiment is as shown in Figure 9. Field replicates of each treatment were fabricated to judge variability within each material type. For example, test sections 1 and 8 represent two separate batches, or truck loads, of High Digestion, 18 percent, asphalt-rubber. These replicates will allow future comparison of field performance within a given treatment such that variability can be judged between treatment types. In this study, it was desired to see whether laboratory responses differed significantly for replicate materials fabricated in supposedly the same manner.

Brownsville Test Road - Field Responses

The Brownsville Test Road was designed to evaluate field performance of two aggregate grades in single and double applications as interlayers. Asphalt-rubber formulation was not varied in this experiment. Control sections are composed of interlayer binders of polymer modified asphalt and conventional asphalt cement.

All combinations of interlayers applied at the Brownsville Test Road are described in the following table:

Binder Application	Binder Type	Top Aggregate Grade	Bottom Aggregate Grade
Single	A-R	3	N/A
Single	A-R	4	N/A
Single*	A-R	4	4
Double	A-R	3	3
Double	A-R	4	3
Double	A-R	4	4
Double	AC	4	3
Double	Polymer	4	4

*Grade 4 aggregate was applied two layers deep in one application over one appliction of binder.

Field Replicate	1		2	
Concentration, %	**18**	**22**	**18**	**22**
Digestion				
Low	- - -	- - -	- - -	- - -
High	- - -	- - -	- - -	- - -

Figure 9. Buffalo Lab Response to Field Mixed Material.

Brownsville Test Road - Laboratory Response

The asphalt-rubber binder at Brownsville Test Road is composed of the same asphalt and rubber as Buffalo Test Road for the Genstar/Baker blend except Brownsville contains a 60:40 ratio of Genstar to Baker compared with a 50:50 ratio at Buffalo.

The laboratory mixes are compared for low, moderate and high digestion, similarly to El Paso and Buffalo mixes.

CHAPTER IV

SITE SELECTION

Location of field test roads was accomplished in cooperation with the Texas SDHPT. A list of sites was obtained from highway districts planning asphalt-rubber interlayer construction and from this list potential test sites were selected. Criteria used to judge the adequacy of sites are listed in order of importance below:

1. Willingness of district and contractors to participate in experiment.
2. Size of project.
3. Time until next planned rehabilitation.
4. Pavement substructure uniformity.
5. Overlay thickness and uniformity.
6. Distress uniformity.

A contract had been awarded on the project which would become the El Paso Test Road when initial contact with the El Paso Highway District was made. Since significant changes in the original contract were required to accomodate the planned experiments, it was crucial that a cooperative spirit exist between highway department, contractor, and research personnel. Planning the Buffalo Test Road began before there was a contract between the highway department and a contractor. Therefore, requirements of test section construction were included in job specifications and subject to competitive bidding.

A full distributor of asphalt-rubber was desired for use in application of each test section for both test roads. This was desirable for reasons listed below:

1. A more representative blend of asphalt-rubber could be expected compared with partial loads,

2. Test section length of approximately one lane-mile resulted from approximately 4200 gallon distributor loads. These lengths provided transitions before and after the 1500 feet of photologs contained in each

test section. This further enhanced the potential for representative materials placed over photologs.

3. Production rate was not appreciably slowed. This enhanced the desired cooperative spirit between contractor and research personnel.

Project size was an important factor for both test roads since it was desired to place test sections in lanes having consistent traffic volumes and loads. Both projects were of sufficient length to accomodate approximately nine lane miles for the El Paso Test Road and over ten lane miles for the Buffalo Test Road.

El Paso Test Road

The El Paso Test Road is part of Texas Project FR-10-1(168)079 located on Interstate Highway 10 (IH-10) in Hudspeth County, approximately 80 miles east of El Paso between the McNary interchange and FM 34 as shown on Figure 10. Test sections are each approximately 0.90 mile in length in the travel lanes as shown in Figure 11.

Original pavement structure for eastbound lanes was U. S. Highway 80 consisting of a 20 foot wide portland cement concrete pavement constructed in 1932. Conversion of the original highway to the interstate system in 1963 added westbound lanes consisting of 6 inches dense graded asphalt concrete over 6 inches cement treated base and 6 inches cement treated subgrade. An overlay of original portland cement concrete pavement in 1963 consisted of 6 inches dense graded asphalt concrete in which 3 inch by 6 inch Number 10 welded wire fabric was embedded in the lower 1-1/2 inches.

Distress consisted of slight to severe transverse cracking at random intervals, and combinations of longitudial and alligator cracking distributed throughout.

Traffic on the El Paso Test Road consisted of a total traffic volume of 7900 average daily traffic (ADT) in 1983. Truck volume was approximately 25 percent of this value with five axle semi-trucks accounting for approximately 60 percent of all trucks.

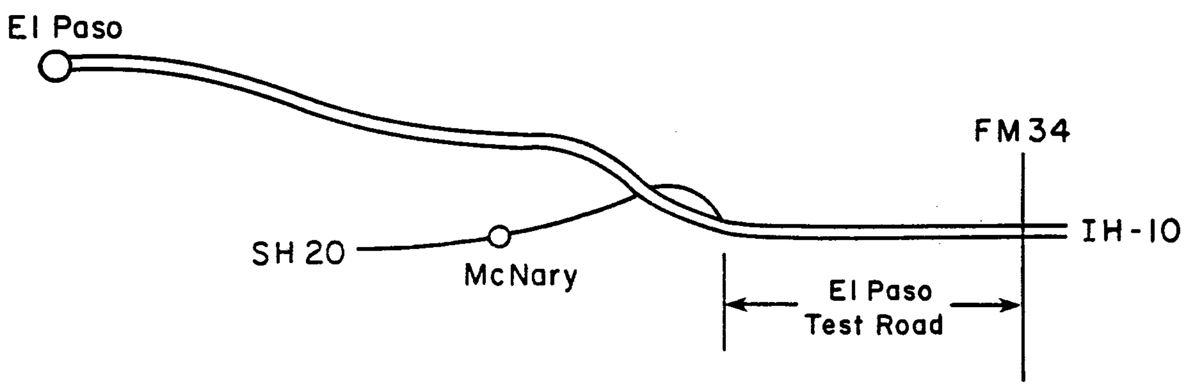


Figure 10. El Paso Test Road Location

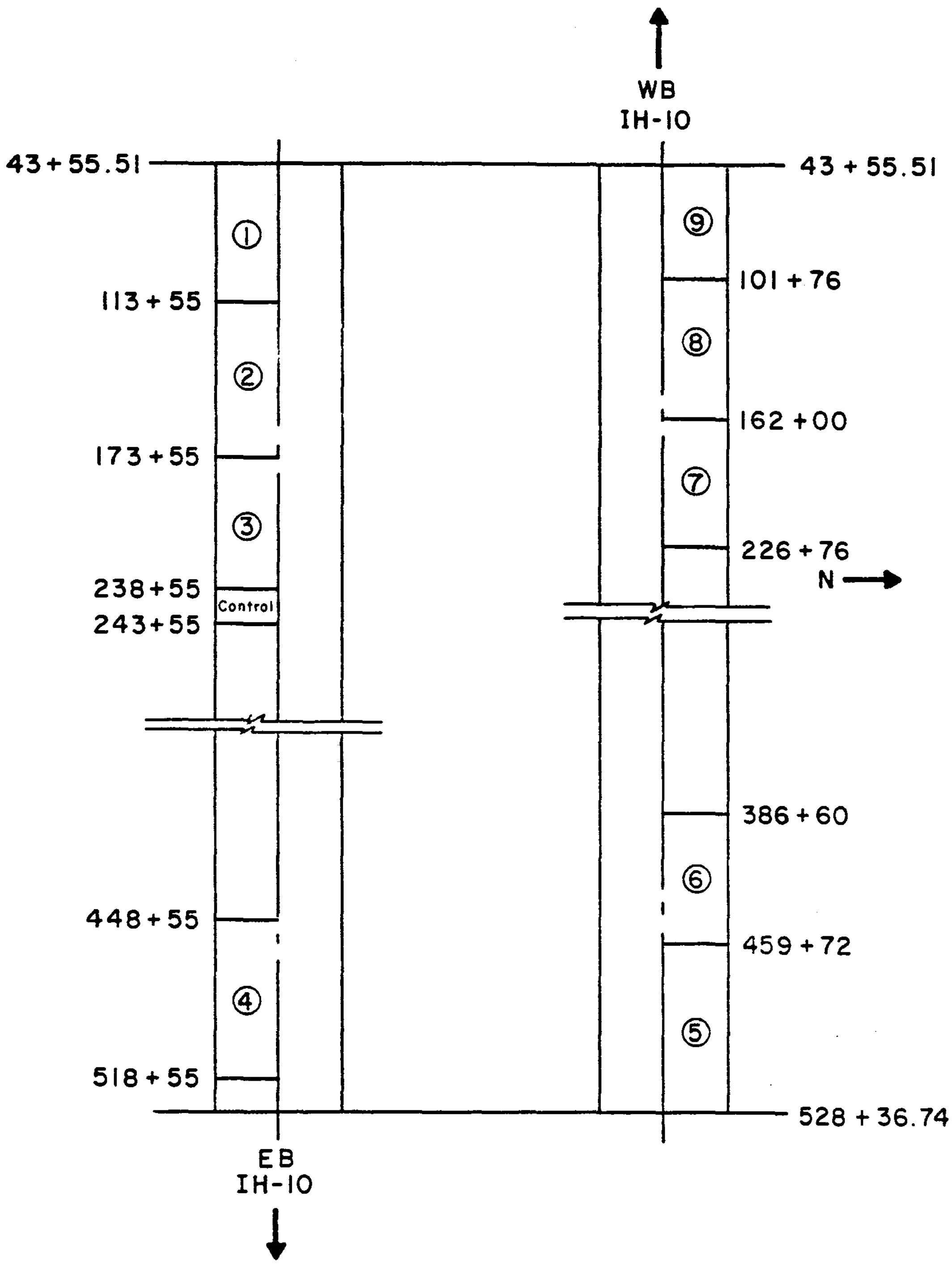


Figure 11. El Paso Test Sections

Subgrade soils on the El Paso Test Road are poorly graded sands and gravels, some containing plastic fines, classified by the Unified Soil Classification System as GP-GC and SP-SC for gravels and sands, respectively.

Buffalo Test Road

Buffalo Test Road State project designation is FRI-45-2(68)180 located on Interstate Highway 45 (IH-45) in Freestone County, from the Leon county line to US 84 as shown in Figure 12. Test sections are each approximately 0.80 mile in length in the northbound travel lane as shown in Figure 13.

The Buffalo Test Road is constructed on 8 inches of continuously reinforced concrete pavement over 4 inches of asphalt treated basecourse and 6 inches lime treated subgrade. The original pavement structure was constructed in 1971.

Distress consisted of typical hairline random transverse cracks at 3 to 6 foot intervals, and infrequent punchouts.

Traffic on the Buffalo Test Road was measured by Texas SDHPT in 1983 at approximately 15,000 ADT. The total volume of trucks is approximately 20 percent, Volume by individual truck type has not been measured in this area and is therefore, not available.

Subgrade soil types along the Buffalo Test Road alignment were obtained from recently recorded Soil Conservation Service logs (23). Classification of subgrade soils by the Unified System are as low plasticity clays and silty clays, ML-CL, along much of the alignment with some clays bordering on high plasticity.

Brownsville Test Road

Brownsville Test Road State project designation is MW 017(2) located on State Highway (SH4) in Cameron County from the International Bridge north approximately two miles. Test sections are located in travel and passing lanes both north and southbound as shown in Figure 14.

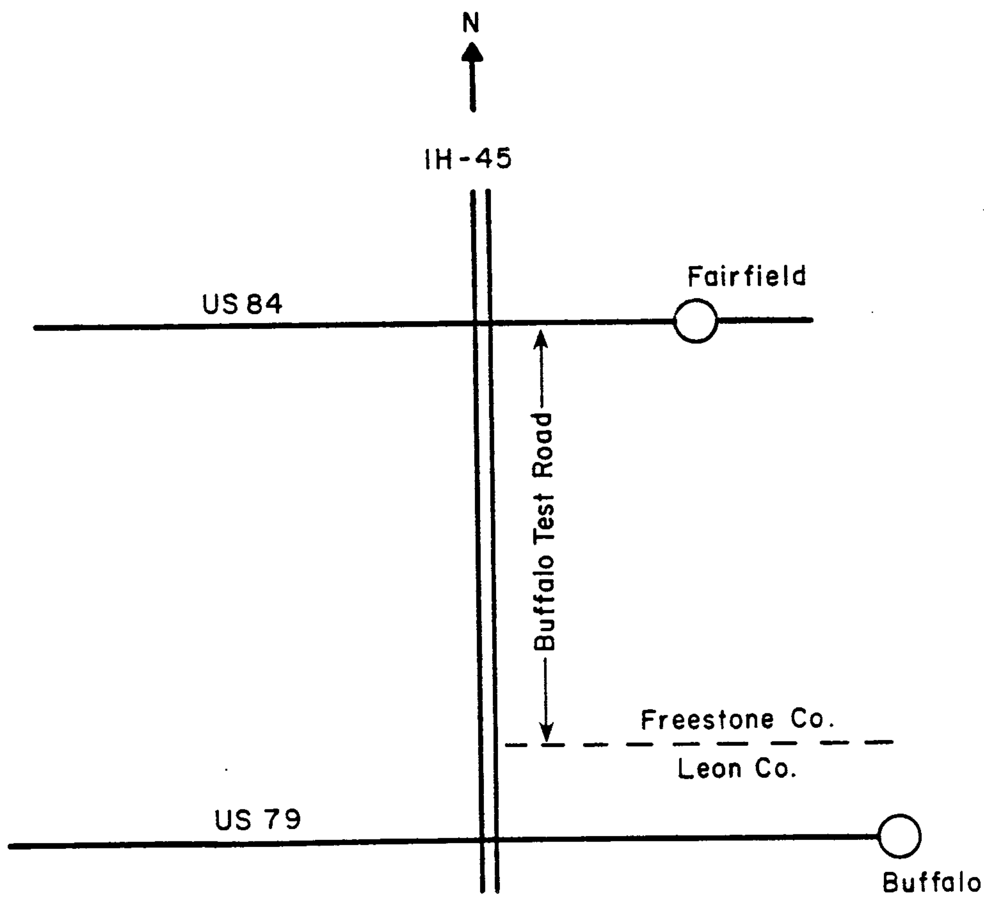


Figure 12. Buffalo Test Road Location

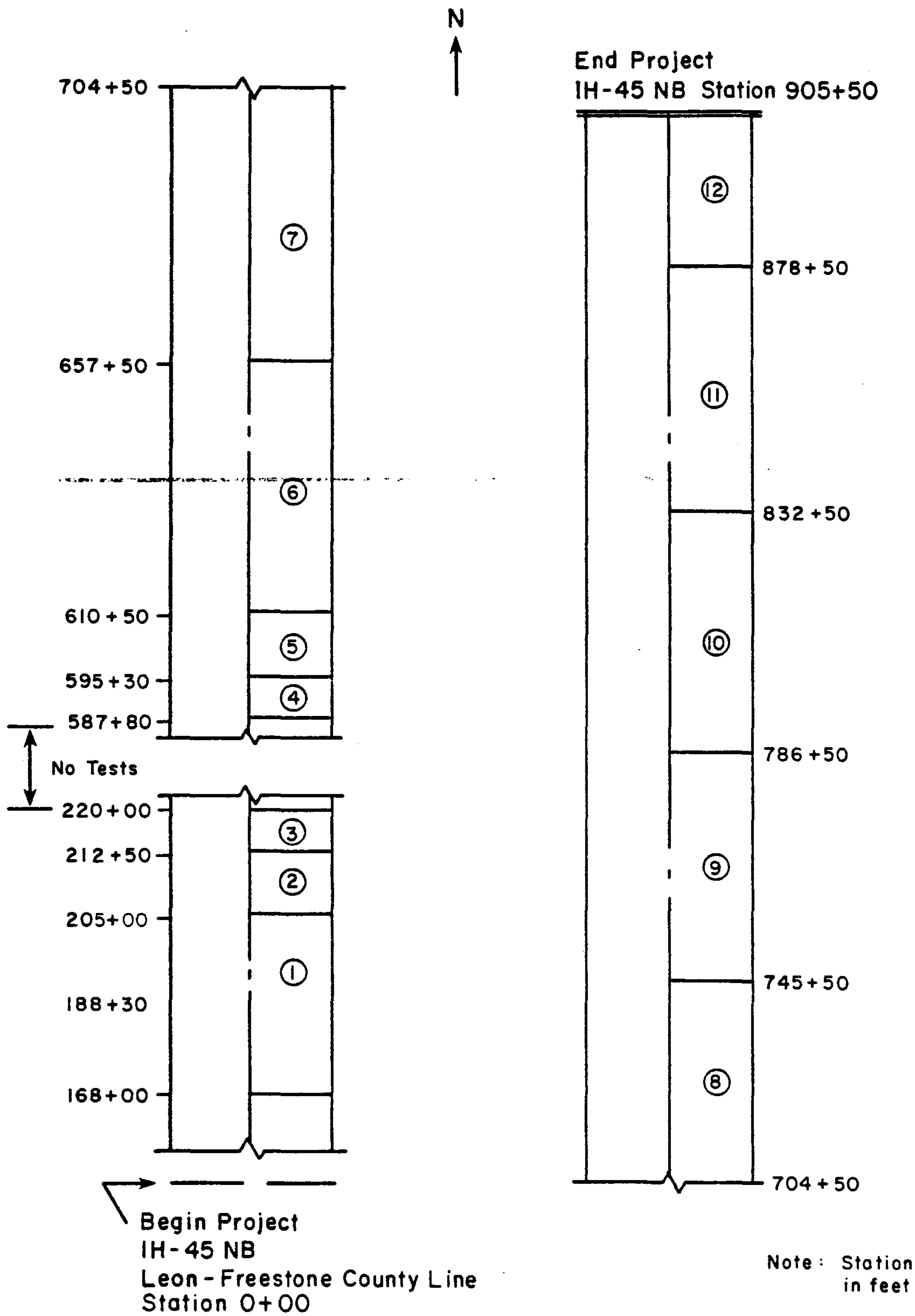


Figure 13. Buffalo Test Sections

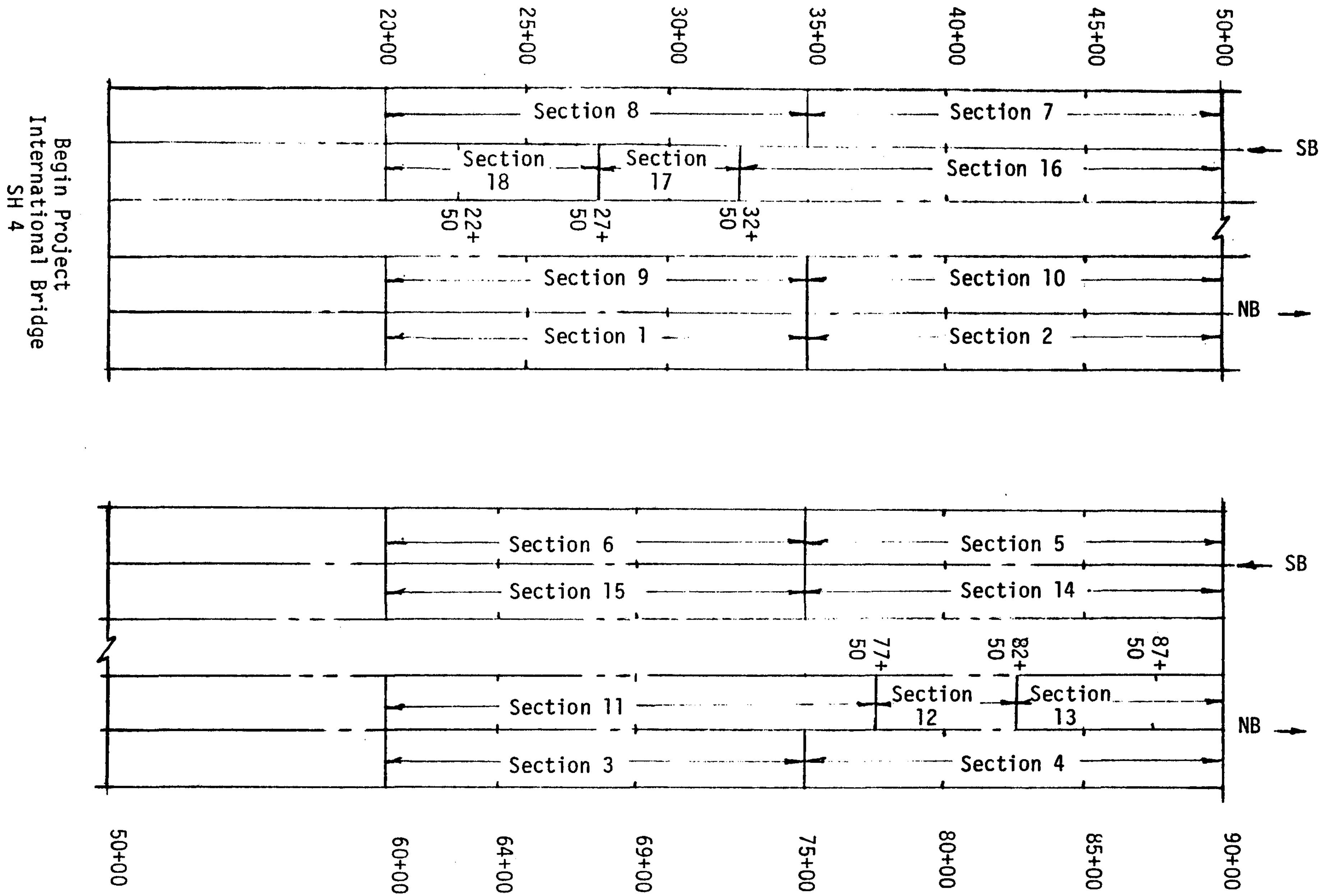


Figure 14. Brownsville Test Road - Test Section Locations

The existing pavement structure prior to rehabilitation consisted of approximately 4 inches of asphalt concrete placed over 8 inches of crushed stone base over 8 inches of soils of ADT river sand.

Traffic on the Brownsville Test Road was measured in 1983 by Texas SDHPT at approximately 23,000 ADT.

Subgrade soil types along the Test Road alignment are classified as CL and ML from Station 15 + 00 to approximately 55 too. Soils become more plastic to the north, classified as CH and MH from Station 75 + 00 to 110 + 00.

CHAPTER V

TEST ROAD CONSTRUCTION

El Paso-Preconstruction

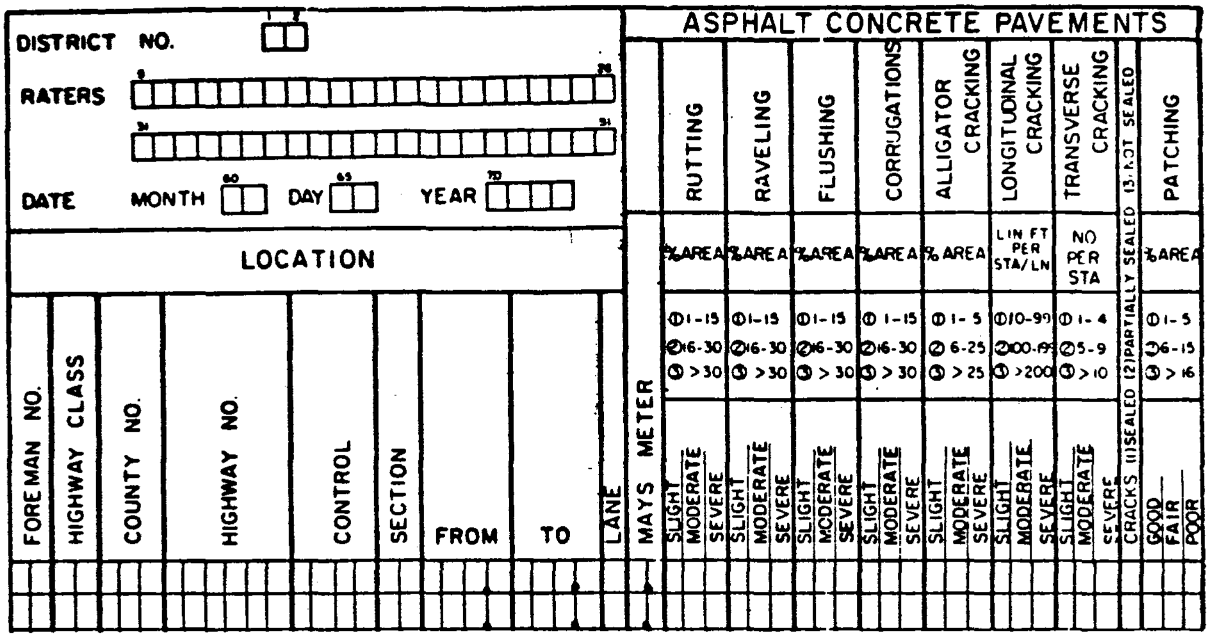
Prior to construction three segments of pavement each 500 feet in length were located within each test section. These sections were surveyed by photographing the 12 foot wide and 500 foot long pavement section prior to rehabilitation. The locations of these photolog segments within each test section are as shown in Table 7.

Photolog equipment consisted of a test vehicle equipped with a motorized 35 mm camera mounted in front of the vehicle in a vertical position over the pavement. The camera and vehicle speed were synchronized such that each photographic frame recorded pavement measuring 8 by 12 feet with a six inch overlap for adjacent segments. All photgraphs are on file at Texas Transportation Institute, College Station, Texas. Each photograph of the test sections was studied to determine the extent of distress present prior to construction. Distress types and levels of severity were recorded for each test section following the criteria described by Epps, et al. (13). Results of the photolog summary appear in Appendix A. An index of pavement condition has been described (14) which quantifies all forms and levels of pavement distress. Based on maintenance costs, this index, or Pavement Rating Score (PRS), allows numerical comparison of pavement condition. A PRS value of 100 describes a pavement with no distress. Progressively lower PRS values describe pavement condition with more severe forms of distress. The form shown in Figure 15 is used to catalog distress observed on the pavement. Deduct values are assigned to each type and level of distress according to Table 8. The sum of deduct values is subtracted from 100 resulting in the pavement ratio score (PRS).

The results of this analysis for the ten El Paso test sections appear in Table 9.

Table 7. El Paso Photolog Locations.

Test Section	Photolog	Station From	Station To
1	1	68+65.5	73+65.5
	2	86+00	91+00
	3	104+00	109+00
2	4	136+00	141+00
	5	145+00	150+00
	6	150+00	155+00
3	7	180+00	185+00
	8	186+00	191+00
	9	191+00	196+00
4	10	485+00	490+00
	11	490+00	495+00
	12	520+00	525+00
5	13	510+00	505+00
	14	490+00	495+00
	15	480+00	475+00
6	16	460+00	455+00
	17	455+00	450+00
	18	450+00	445+00
7	19	180+00	175+00
	20	175+00	170+00
	21	170+00	165+00
8	22	120+00	115+00
	23	115+00	110+00
	24	110+00	105+00
9	25	95+00	90+00
	26	80+00	75+00
	27	75+00	70+00
Control	28	238+55	243+55



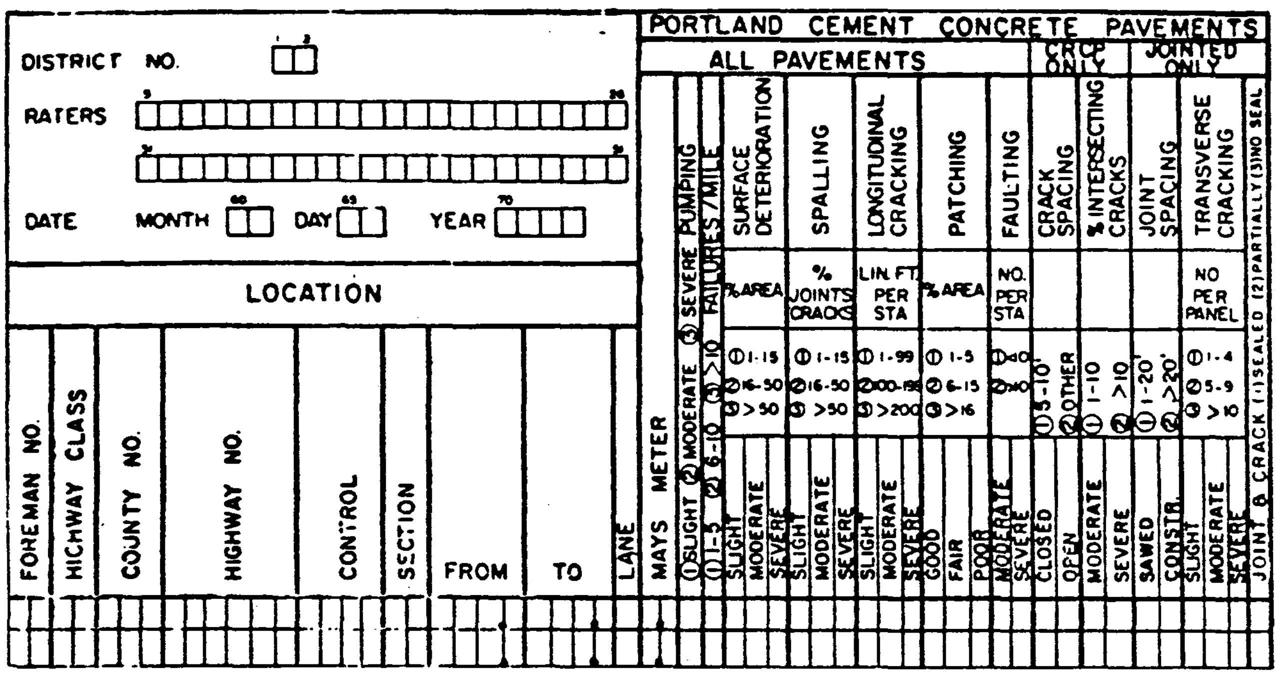


Figure 15. Pavement Rating Forms

Table 8. Pavement Rating Deduct Values.

Type of Distress	Degress of Distress	Extent or Amount of Distress (1)	(2)	(3) *
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20

Deduct Points for Cracking

Longitudinal Cracking

	Sealed (1)	(2)	(3)	Partially Sealed (1)	(2)	(3)	Not Sealed * (1)	(2)	(3)
Slight	2	5	8	3	7	12	5	10	15
Moderate	5	8	10	7	12	15	10	15	20
Severe	8	10	15	12	15	20	15	20	25

Transverse Cracking

	Sealed (1)	(2)	(3)	Partially Sealed (1)	(2)	(3)	Not Sealed * (1)	(2)	(3)
Slight	2	5	8	3	7	10	3	7	12
Moderate	5	8	10	7	10	15	7	12	15
Severe	8	10	15	10	15	20	12	15	20

* Numbers in parentheses refer to quantity of distress observed as indicated on Figure 1.

Table 9. El Paso Preconstruction Pavement Rating Scores.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	1	85	90	65	40
	2	82	97	85	59
	3	76	97	100	68
2	4	77	80	85	40
	5	90	97	100	82
	6	93	97	100	85
3	7	81	97	80	43
	8	76	97	80	48
	9	93	97	95	78
4	10	79	92	60	-1
	11	86	98	100	84
	12	90	92	70	32
5	13	90	97	60	33
	14	88	97	80	60
	15	90	97	80	57
6	16	92	92	65	35
	17	86	97	80	51
	18	90	92	80	49
7	19	97	92	85	49
	20	97	98	100	85
	21	93	97	90	68
8	22	93	98	95	76
	23	92	100	95	79
	24	98	97	95	80
9	25	90	97	85	67
	26	98	91	80	57
	27	76	97	85	43
10	28	90	85	85	37

Table 9 contains the PRS values obtained by measuring all combined forms of distress present in each test section. PRS values are also shown which were obtained by measuring individual types of cracking. These cracking PRS ratings are presented such that a more precise comparison may be made between test sections for crack related distress. The asphalt-rubber interlayer is intended to reduce the rate at which cracks in the underlying pavement propagate the new asphalt concrete overlay. The "cracking PRS" values, therefore, will provide a basis for which future condition surveys can be compared. By comparing PRS values for transverse, longitudiual and alligator cracks, a measure of interlayer performance within and between test sections can be obtained based on percent original PRS.

El Paso-Construction

Asphalt-rubber interlayers were placed on June 23, 24 and 27, 1983 by International Surfacing, Inc., Phoenix, Arizona. Sections 5 to 9 were placed June 23, 1983, followed by sections 1 to 3 on June 24, 1983. Section 4 was placed June 27, 1983. Environmental conditions during construction were favorable with early morning temperatures of approximately 70F and afternoon temperatures of 100F.

Observations and tests made during construction included the following:

I. Asphalt-rubber mixing

A. Assuring desired rubber types were used in asphalt-rubber to be placed over selected test section locations.

B. Proportion of asphalt and rubber.

C. Blending time.

D. Blending temperature.

E. Viscosity prior to application.

F. Sampling of asphalt and rubber.

II. Asphalt-rubber application.

A. Asphalt-rubber spray rate.

B. Aggregate spread rate.

C. Asphalt-rubber cooling rate.

D. Sampling of asphalt-rubber.

Considerable coordination was necessary during construction to assure that the desired asphalt-rubber combinations and application rates, as shown in Figure 4, were placed over photolog locations appearing in Table 7. This required adjusting distributor volumes such that materials could be placed contiguously with minimum disruption to construction procedures.

Asphalt arrived at the mixing site by highway transport where it was pumped into a storage container. Granulated rubber was shipped from the three manufacturers in 50 or 60 pound bags.

Blending of the asphalt and rubber required two pieces of equipment. Initial mixing of asphalt and rubber occurred in a pre-blending device which combines asphalt and rubber in the approximate pre-blend proportions desired. After the asphalt and rubber are pre-blended, the material is pumped to the asphalt distributor. The flow of blended asphalt and rubber are continuous from pre-blender to distributor in the approximate proportions desired. Final proportioning is accomplished after all of the rubber is in the distributor by adding additional asphalt.

A sample calculation follows which describes how the number of bags of rubber and gallons of asphalt cement are determined to achieve a blend containing 22 percent rubber by weight of blend.

Assumption:

Distributor volume	4500 gallons
Rubber Bag Weight	50 pounds
Unit Weight Asphalt Cement @ 350F	7.54 pounds/gallon
Unit Weight Asphalt-Rubber @ 350F	7.54 pounds/gallon

Find: Number of bags of rubber and gallons of asphalt cement to yield a 4500 gallon asphalt-rubber blend at 22% rubber by weight of blend.

Rubber: $\frac{4500 \times 7.54 \times .22}{50} = 149.3$ bags

Asphalt Cement: $\frac{4500 \times 7.54 \times .78}{7.54} = 3510$ gallons

Specific gravity of asphalt-rubber was measured at various temperatures in the laboratory following procedures described by ASTM D70 (25). Weight to volume conversions were done with a high boiling point oil such that specific gravity could be measured above 212F. The graph shown in Figure 16 of asphalt-rubber specific gravity was used in the calculation above for the required volume to weight conversion. Note the difference in asphalt-rubber specific gravity as measured and that calculated from cubical coefficient of expansion data. A 95 percent confidence limit on measured values encompasses calculated values. This seems to indicate volume change in asphalt-rubber is due to combined thermal expansion of the constituents. The large variation in specific gravity results shown in Figure 16 indicates this test is probably of limited use for quality control unless more precise results can be achieved.

Results of observations and tests performed during mixing of the asphalt-rubber appear in Table 10. Note that the field viscosity of the asphalt-rubber blend appears to depend on rubber content as shown in Table 10 and plotted in Figure 17. Note that the type of rubber affects the viscosity of the blend as shown in Figure 17. Viscosity tests were performed using a portable Haake rotational viscometer on samples of asphalt-rubber obtained directly from the distributor truck approximately 50 minutes after all rubber had been added to the truck.

Rubber Type C in addition to generating the lowest asphalt-rubber viscosity relationship, also caused a considerable volume increase in the blend as mixing progressed. This was manifested in overflows of asphalt-rubber from the top hatch of the 4500 gallon distributor truck

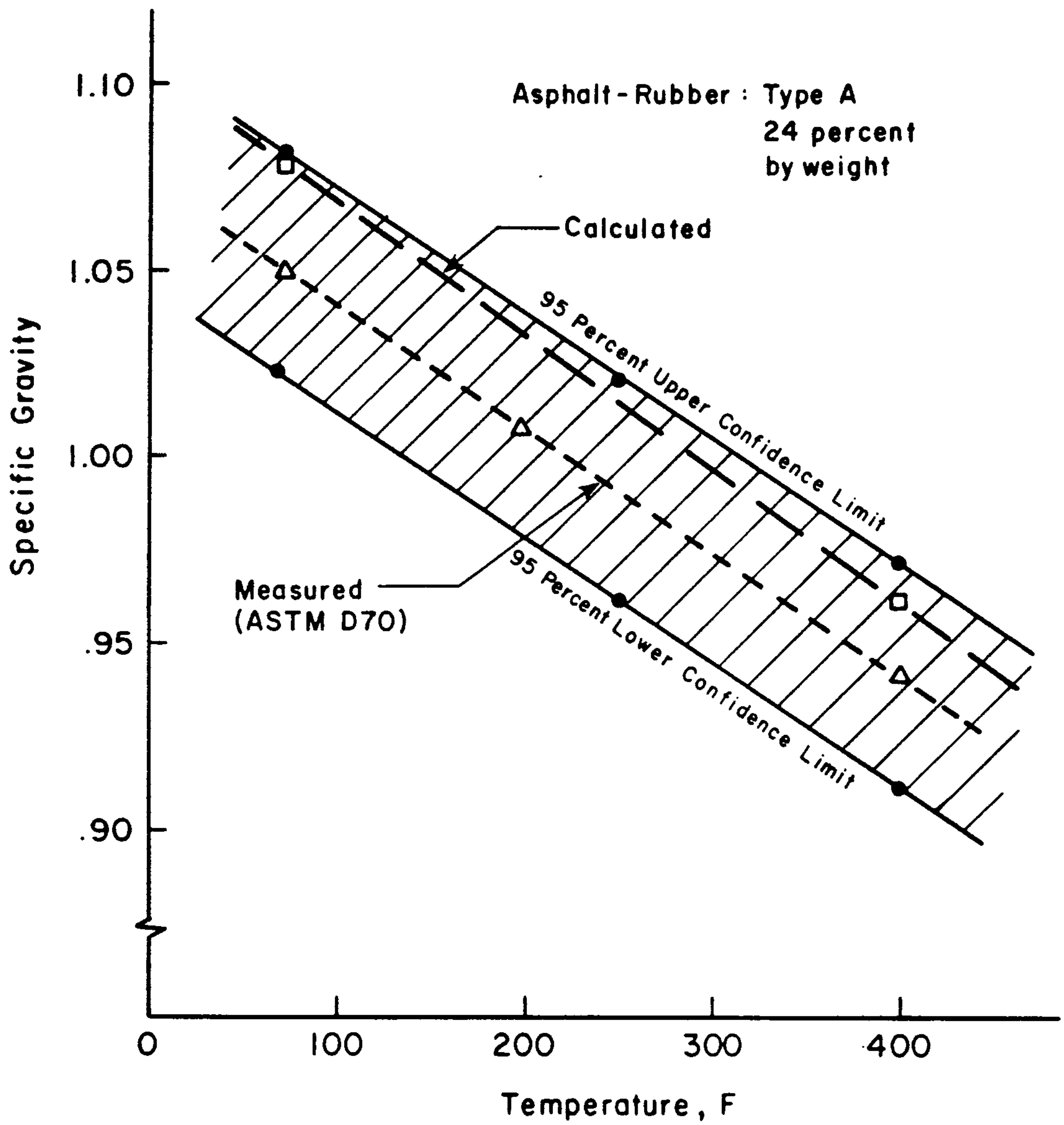
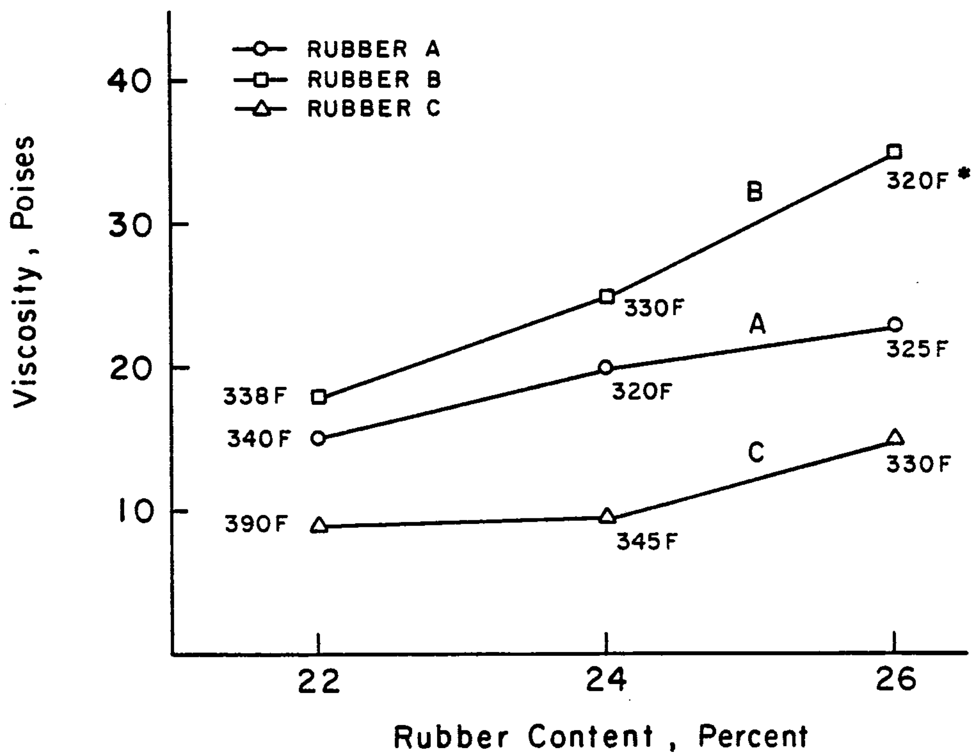


Figure 16. Asphalt - Rubber Specific Gravity

Table 10. El Paso Mixing Observations and Test Results.

Test Section	Beginning Date	Beginning Time	Time Req'd to Fill Truck w/ Blend, min.	Time Between Full Truck & Application, min.	Temp. Prior to Application	Viscosity Prior to Application, poises	Rubber Type	Rubber Content, %
1	6/24/83	4:35am	40	105	320	20	A	24
2	6/24/83	5:20am	40	95	390	9	C	22
3	6/24/83	6:02am	53	90	320	35	B	26
4	6/27/83	11:40am	35	110	338	18	B	22
5	6/23/83	5:25am	55	85	340	15	A	22
6	6/23/83	6:25am	55	90	330	15	C	26
7	6/23/83	11:20am	30	160	345	10	C	24
8	6/23/83	1:15pm	30	135	325	23	A	26
9	6/23/83	1:50pm	30	125	330	25	B	24



* TEMPERATURES SHOWN ARE VALUES CORRESPONDING TO VISCOSITY MEASUREMENTS

Figure 17. El Paso Asphalt - Rubber Viscosity

for test section mixes 6 and 7. The overflows occurred during routine pumping of the blend after approximately 2300 gallons had been loaded. Overflow was avoided for the third blend containing Rubber C by loading the first half of the blend at a slower rate. Moisture contained in the rubber is thought to be the cause of this adverse reaction and may be related to the cryogenic processing technique.

Asphalt-rubber temperature measurements were obtained to determine the rate at which the binder loses heat prior to aggregate application. Temperatures were measured using a Fluke digital thermometer under varying ambient temperature conditions. These data are plotted on Figure 18 with calculated theoretical values (15).

Temperature loss in the asphalt-rubber binder is rapid as shown by Figure 18. Binder temperature decreases to near the initial pavement temperature in approximately 90 seconds under the conditions of the test.

Verification of binder aggregate application quantities was accomplished by Texas SDHPT personnel. During construction, measurement of the application quantity was accomplished at approximately 1000 to 3500 foot intervals until the proper application rate was achieved. Measurement of application rate was accomplished using calibrated metering rods accompanying each distributor truck. Measurement of aggregate spread quantity was accomplished at similar intervals by volume of aggregate. Rates of binder and aggregate within each test section are shown in Table 11.

Research binders as shown in Figure 4 were applied over photologs in appropriate test sections at the rates shown in Table 11. However, the distributor truck emptied its contents before reaching photolog 12 in Test Section 4 and therefore, no research binder is present over photolog 12.

Placement of overlay asphalt concrete began July 18, 1983, approximately four weeks after asphalt-rubber application. Core specimens were obtained from each test section to determine overlay thickness and provide samples for evaluation of physical properties as reported in Tables 6 and Figure 3. Results of thickness measurements are shown in Table 12.

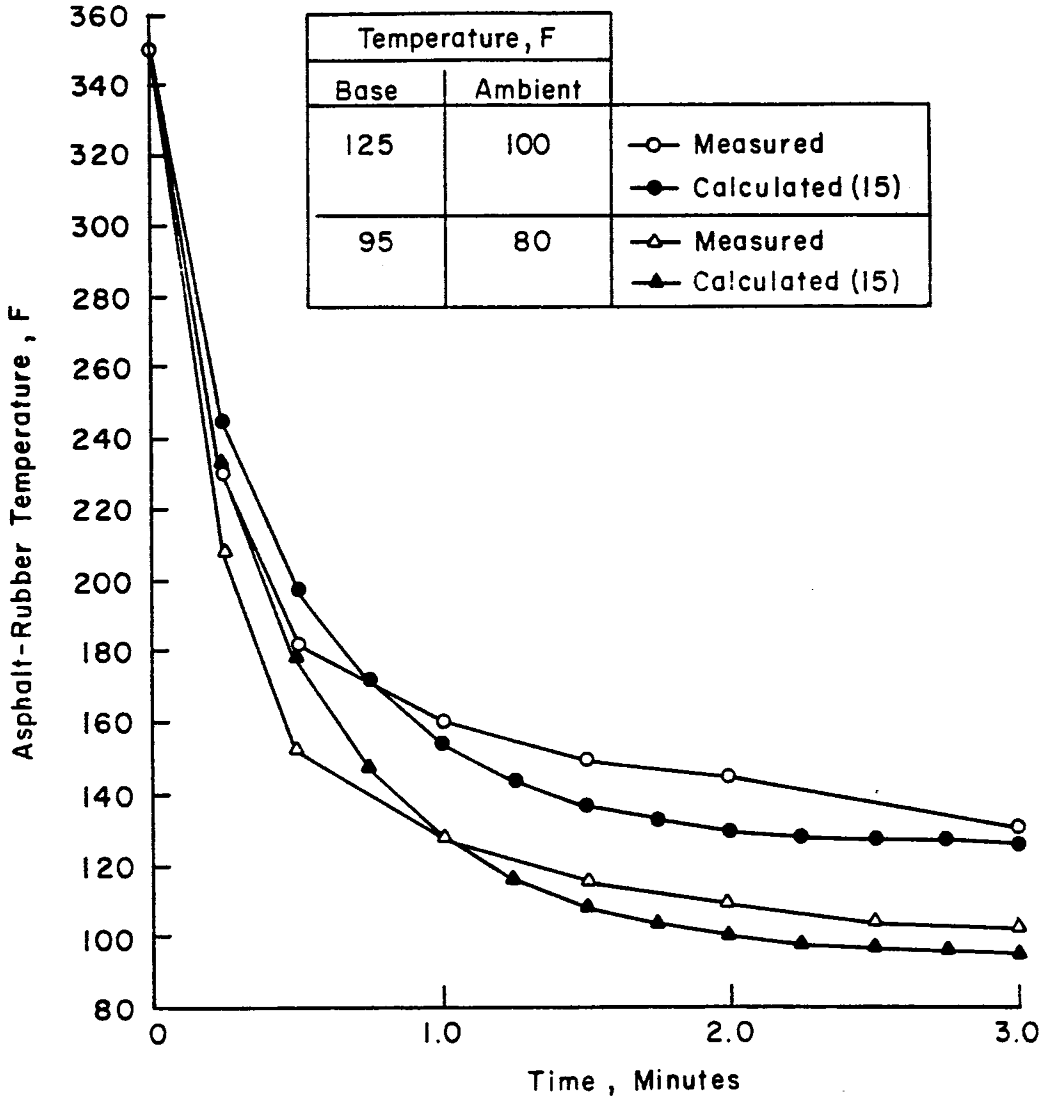


Figure 18. El Paso Asphalt-Rubber Temperature Loss

Table 11. El Paso Application Quantities.

Test Section	Photolog	Measured Asphalt Rubber Rate, gsy	Desired
1	1	.36	.40
	2	.41	
	3	.41	
2	4	.35	.35
	5	.38	
	6	.38	
3	7	.45	.45
	8	.45	
	9	.45	
4	10	.38	.40
	11	.38	
	12	*	
5	13	.44	.45
	14	.44	
	15	.44	
6	16	.41	.40
	17	.41	
	18	.41	
7	19	.44	.45
	20	.44	
	21	.44	
8	22	.36	.35
	23	.36	
	24	.36	
9	25	.36	.35
	26	.36	
	27	.35	
Control	28	0	0

* Distributor truck emptied before reaching photolog No. 12.

Note: Aggregate spread quantities were uniform throughout project ranging from 116 sq.yd./cu.yd. to 117 sq.yd./cu.yd. (19.5 to 19.7 lb./sq.yd.).

Table 12. El Paso Overlay Thicknesses.

Test Section	Photolog	Overlay Thickness, in.
1	1	1.75
	2	1.25
	3	1.25
2	4	1.25
	5	1.25
	6	1.25
3	7	1.50
	8	1.50
	9	1.25
4	10	1.75
	11	2.25
	12	*
5	13	1.75
	14	2.75
	15	2.00
6	16	0.75
	17	0.75
	18	0.50
7	19	1.75
	20	1.50
	21	1.25
8	22	1.50
	23	1.50
	24	1.50
9	25	1.50
	26	1.50
	27	1.25
Control	28	1.50

* Photologged, but no research binder in this area.

Locations of test sections were preserved after construction for future reference. Monuments consisting of 4 inch by 4 inch by 8 feet cedar posts were located at the beginning of each test section along the highway right-of-way. Posts were painted white and contain black lettering denoting stationing shown on Figure 11 of specific locations of test section boundaries. Location of photologs within test sections for future condition surveys will be simplified by reference to these monuments.

Buffalo-Preconstruction

Eight sections of pavement each approximately 0.80 lane mile in length were selected to receive the various asphalt-rubber blends shown in Figure 7. Four additional pavement sections, each 750 feet in length, were selected as control sections. Three segments of pavement each 500 feet in length were selected in each of the eight test sections for photolog surveys as previously described for El Paso Test Road. The entire length of the control sections were photologged. Locations of photologs are as shown on Table 13. Photolog equipment was as used on the El Paso Test Road.

Condition surveys on site were combined with cracking data obtained from photologs to provide PRS values for test and control sections. Table 14 contains PRS values obtained after completing the condition survey and photolog interpretation. All photographs obtained during surveys are on file at Texas Transportation Institute, College Station, Texas.

Buffalo-Construction

Asphalt-rubber was placed over test sections August 20, 21 and 22, 1984 by Arizona Refining Company, Phoenix, Arizona. Environmental conditions during construction were favorable with early morning temperatures of approximately 70F and afternoon temperatures approaching 100F.

Table 13. Buffalo Photolog Locations.

Test Section	Photolog	Station From	To
1	1 to 3	188+30	201+24
2	4 to 5	205+00	212+50
3	6 to 7	212+50	220+00
4	8 to 9	587+80	595+30
5	10 to 11	595+30	604+40
6	12 to 14	631+20	645+50
7	15 to 17	683+00	698+50
8	18 to 20	714+15	729+50
9	21 to 23	755+60	770+70
10	24 to 26	810+00	825+00
11	27 to 29	860+00	875+00
12	30 to 32	889+00	904+00

Table 14. Buffalo Preconstruction Pavement Rating Scores.

Test Section	Photolog	Overall PRS
1	1	90
	2	90
	3	90
2	4	90
	5	100
3	6	100
	7	90
4	8	90
	9	100
5	10	100
	11	100
6	12	100
	13	100
	14	90
7	15	90
	16	90
	17	90
8	18	90
	19	90
	20	90
9	21	90
	22	100
	23	90
10	24	80
	25	90
	26	90
11	27	90
	28	100
	29	100
12	30	100
	31	90
	32	100

Note: Much of the distress on Buffalo Test Road consisted of random transverse cracks at less than 5 foot intervals. In most cases cracks were closed and not "working" significantly. This results in a deduct score of 10. Deduct scores of 0 resulted from closed cracks occurring at between 5 and 10 intervals.

Observations and tests made during construction were identical to those for the El Paso Test Road. Similar coordination was required of contracting efforts such that asphalt-rubber combinations desired as shown in Figure 7 were placed in appropriate locations over photologs as shown in Table 13. Distributor volumes were adjusted as for El Paso such that the desired asphalt-rubber mixes were placed at appropriate locations on test sections.

Blending of asphalt and Sundex 790 at 6 percent Sundex by blend volume was accomplished prior to blending with rubber. Pre-blending of asphalt-rubber was accomplished as on the El Paso project prior to pumping the blend into distributor trucks. Here the asphalt-rubber blend remained in the trucks for the desired digestion period prior to application.

Digestion was varied as a control variable in this experiment as explained previously for laboratory prepared mixes. Two levels of digestion were achieved. "Low" digestion describes blends of 2 to 2 3/4 hours. "High" digestion describes blends of 16 to 16 1/2 hours.

Rubber concentrations of 18 and 22 percent by weight of the blend were used.

Results of observations and tests performed during mixing of the asphalt-rubber appear in Table 15. Viscosity and rubber content appear to be directly proportional as occurred for El Paso blends. However, viscosity appears to be inversely proportional to digestion period. The results of these tests are plotted in Figure 19.

Temperature loss of the asphalt-rubber was measured as for the El Paso Test Road. Results of these tests are shown on Figure 20. Results are similar to those observed at El Paso. Texas SDHPT personnel verified binder and aggregate quantities as part of routine quality control procedures. However, unlike El Paso, binder quantities were determined by weight rather than volume. Each asphalt-rubber distributor was weighed prior to, and after application. The difference in weight was converted to volume and the corresponding application rate determined for the measured pavement area covered. Therefore, application rates shown in Table 16 reflect averages throughout each test section.

Table 15. Buffalo Mixing Observations and Test Results.

Test Section	Beginning Date	Beginning Time of Day	Time Req'd to Fill Truck w/ Blend, min.	Time Between Full Truck & Application, hrs-min.	Temp, F Prior to Application	Viscosity Prior to Application, poises	Rubber Type	Rubber Content, Percent	Digestion Time
1	8/22/84	5:30pm	50	15-40	390	11	A	18	High
6	8/21/84	7:05am	35	2-55	400	48	A	22	Low
7	8/20/84	7:07pm	45	15-53	400	21	A	22	High
8	8/20/84	8:21pm	40	15-14	400	6.50	A	18	High
9	8/20/84	11:45am	45	2-5	400	14	A	18	Low
10	8/21/84	1:00pm	105	2-5	390	45	A	22	Low
11	8/21/84	:45pm	35	2-10	380	13	A	18	Low
12	8/21/84	6:30pm	40	15-50	390	19	A	22	High

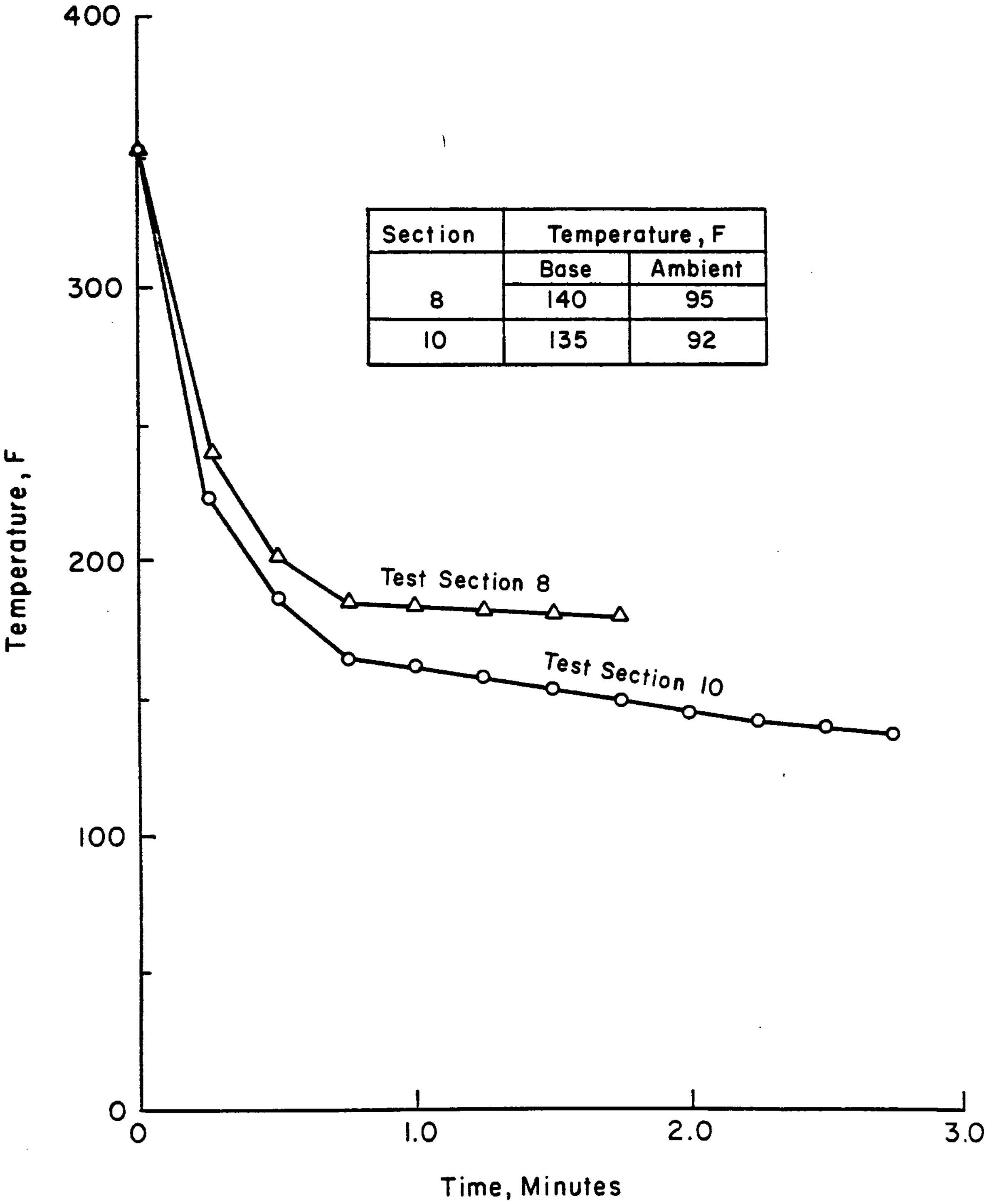


Figure 20. Buffalo Asphalt-Rubber Temperature Loss

Table 16 - Buffalo Application Quantities

Test Section	Binder Rate, gsy	Aggregate Rate, sy/cy
1	.58	95
2	.57	90
3	No Binder	No Aggregate
4	No Binder	No Aggregate
5	.55	80
6	.57	77
7	.56	79
8	.57	77
9	.52	75
10	.59	80
11	.54	78
12	.56	79

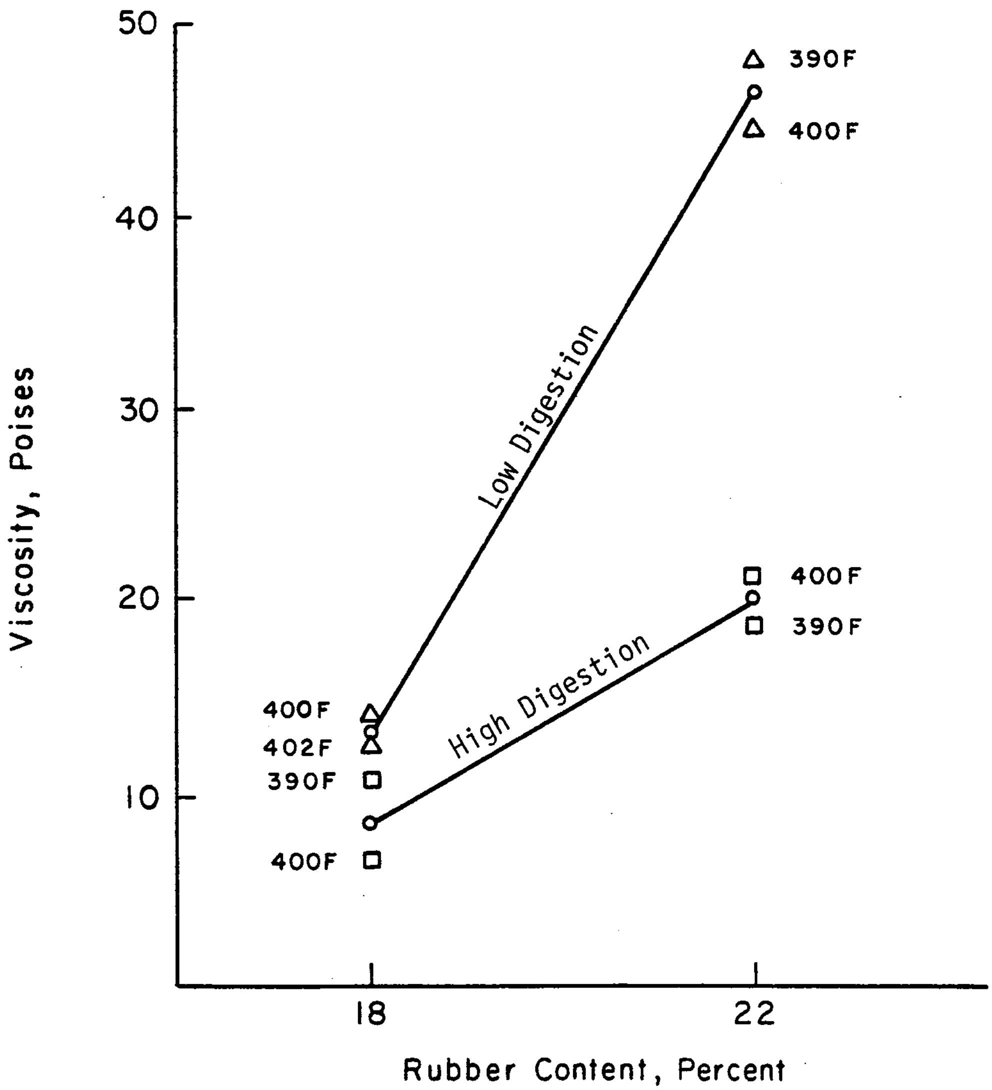


Figure 19 . Buffalo Asphalt-Rubber Viscosity

Buffalo overlay asphalt concrete consists of a Texas Type C leveling course and a one-inch Texas Type D surface course. Placement of the levelling course began September 10, 1984 and was completed November 16, 1984. Each test section was sampled by coring to obtain laboratory specimens and to verify overlay thickness. Physical properties of the asphalt concrete are reported in Table 6 and Figure 3. Results of thickness measurements of core samples are shown in Table 17.

Locations of photologs within test sections are permanently marked using raised reflective pavement buttons positioned on the right shoulder of the northbound lane. Precise location of photologs for future condition surveys is therefore possible by reference to these pavement markers.

Brownsville - Preconstruction

Twelve pavement sections were selected to receive asphalt-rubber and various combinations of aggregates. The asphalt-rubber binder formulation was held constant for this experiment. Rubber was blended at 60 percent Type D and 40 percent Type E as described in Tables 2 and 4. Six additional sections were selected as controls. Control sections consisted of: 1) no treatment, 2) asphalt cement interlayer, 3) polymer asphalt interlayer. All sections were replicated to provide a statistical bsis for later analysis of performance betwen sections. A description of all materials used is shown in Table 18.

A 500 foot photolog was recorded in each test section. Locations of photologs are as shown in Table 19. Photolog equipment and technique was used at Buffalo and El Paso.

Condition surveys on site were combined with cracking data from photologs to provide PRS values. Table 20 contains these PRS data.

Brownsville - Construction

Asphalt-rubber was first placed over non-experimental pavement sections such that binder shot rate and aggregate spread rates could be

Table 17. Buffalo Overlay Thickness.

Test Section	Photolog	Overlay Thickness, in
1	1	2.4
	2	2.5
	3	2.3
2	4	2.5
	5	2.6
3	6	2.6
	7	3.3
4	8	3.5
	9	3.8
5	10	3.8
	11	3.8
6	12	3.8
	13	3.5
	14	3.3
7	15	3.4
	16	3.5
	17	3.5
8	18	3.3
	19	3.3
	20	3.1
9	21	3.4
	22	3.5
	23	3.8
10	24	3.4
	25	3.4
	26	3.4
11	27	3
	28	3.1
	29	3.1
12	30	4
	31	4
	32	4

Table 18. Brownsville Test Section Materials

Test Section	Binder	Aggregate Application	Aggregate Size Bottom/Top	Overlay Thickness,in
1	A-R	Double	Grade 3/Grade 3	N/A
2	A-R	Single	Grade 3	N/A
3	A-R	Double	Grade 3/Grade 4	N/A
4	AC	Double	Grade 3/Grade 4	N/A
5	A-R	Double	Grade 3/Grade 3	1.4
6	A-R	Single	Grade 3	1.2
7	A-R	Double	Grade 3/Grade 4	1.1
8	AC	Double	Grade 3/Grade 4	1.3
9	A-R	Double	Grade 4/Grade 4	1.3
10	A-R	Single	Grade 4	1.0
11	A-R	Single	Grade 4 Two deep	1.1
12	None	None	N/A	1.2
13	Polymer	Double	Grade 4/Grade 4	1.6
14	A-R	Double	Grade 4/Grade 4	N/A
15	A-R	Single	Grade 4	N/A
16	A-R	Single	Grade 4 Two deep	N/A
17	None	None	N/A	N/A
18	Polymer	Double	Grade 4/Grade 4	N/A

Table 19. Brownsville Photolog Locations

Test Section/Photolog	Location
1	25+00 to 30+00
2	40+00 to 45+00
3	64+00 to 69+00
4	80+00 to 85+00
5	85+00 to 80+00
6	69+00 to 64+00
7	45+00 to 40+00
8	30+00 to 25+00
9	25+00 to 30+00
10	40+00 to 45+00
11	64+00 to 69+00
12	77+50 to 82+50
13	82+50 to 87+50
14	85+00 to 80+00
15	69+00 to 64+00
16	45+00 to 40+00
17	32+50 to 27+50
18	27+50 to 22+50

Note: Stations are south to north.

Table 20. Brownsville Preconstruction Pavement Rating Scores.

Test Section	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	97	97	85	79
2	97	97	95	89
3	97	95	95	87
4	97	95	100	92
5	93	95	95	83
6	97	95	95	87
7	97	97	95	89
8	98	97	85	80
9	97	95	100	92
10	97	95	100	92
11	97	95	100	92
12	97	85	100	82
13	97	95	100	92
14	97	95	100	92
15	100	95	100	95
16	97	95	100	92
17	97	95	100	92
18	97	95	100	92

adjusted. After calibration was completed, test section construction began. Asphalt-rubber was placed on all test sections by October 12, 1984 by Arizona Refining Company, Phoenix, Arizona. Control sections were placed by SDHPT personnel by October 26, 1984.

Observations and tests made during construction were identical to those for the El Paso and Buffalo Test Roads. Similar coordination was required of contracting efforts such that asphalt-rubber seal coat combinations desired were placed in appropriate locations over photologs.

Blending of asphalt and Sundex 790 at 6% Sundex by blend volume was accomplished prior to blending with rubber. Pre-blending of asphalt-rubber was accomplished as on the El Paso and Buffalo projects prior to pumping the blend into distributor trucks. Here the asphalt-rubber blend remained in the trucks during digestion prior to application.

Digestion remained constant in this experiment. Rubber and asphalt were blended for approximately 1 hour after all rubber was added to the blend for each test section.

Rubber concentration remained constant at 18 percent by weight of the asphalt-rubber blend. Texas SDHPT personnel verified binder and aggregate quantities as part of routine quality control procedures. At the beginning of the project, binder quantities were intended to be determined by volume. However, the trucks supplied by the asphalt-rubber contractor had not been calibrated, and some difficulty was experienced while attempting calibration on the job site. Therefore, shot rates were determined by weight. Each asphalt-rubber distributor was weighed prior to, and after application. The difference in weight was converted to volume and the corresponding application rate determined for the measured pavement area covered. Therefore, application rates shown in Table 21 reflect averages throughout each test section.

Brownsville overlay asphalt concrete consists of approximately 1 1/4 inches Texas Type D asphalt concrete. Placement of the overlay began after asphalt-rubber and control section seal coats had been in service at least one week. Each test section was core drilled to obtain labora-

Table 21. Brownsville Test Road Aggregate and Binder Application Rates.

Test Section	Design Aggregate Rate, sy/cy	Measured Aggregate Rate, sy/cy	Design Binder Rate, gsy	Measured Binder Rate, gsy	Measured Embedment Depth, %	Comments
1	80/80	56/56	0.71/0.69	0.77/0.85	38/40	Severe Flushing
2	80	56	0.69	0.78	-	Severe Flushing
3	115/80	83/56	0.53/0.69	0.48/0.71	-/52	Slight Flushing
4	115/80	56	0.27/0.36	0.60	-	Severe Flushing
5	80/80	56/56	0.71/0.69	0.67/0.65	14/43	No Distress
6	80	56	0.69	0.76	48	Slight Flushing
7	115/80	80/56	0.58/0.69	0.59/0.71	26/48	Severe Flushing
8	115/80	80/56	0.27/0.36	0.45/0.58	-	Severe Flushing
9	115/115	83/83	0.53/0.69	0.49/0.51	-/51	Severe Flushing
10	115	83	0.51	0.58	50	Severe Flushing
11	57	80	0.51	0.65	70	Severe Flushing
12	None	None	None	None	-	
13	115/115	83 *	0.27/0.25	0.48 *	-	Severe Flushing
14	115/115	83/80	0.53/0.51	0.56/0.52	24/47	Slight Flushing
15	115	83	0.51	0.56	53	Severe Flushing
16	57	80	0.51	0.66	50	No Distress
17	None	None	None	None	-	
18	115/115	83	0.27/0.25	0.53 *	-	Severe Flushing

tory specimens and to verify overlay thickness. Physical properties of the asphalt concrete are reported in Table 6 and Figure 3.

Locations of photologs are permanently marked using raised reflective pavement buttons position on the right shoulder. Precise location of photologs for future condition surveys is therefore possible by reference to these pavement markers.

CHAPTER 6

FIELD SURVEY DATA

Each of the three test roads were surveyed annually as a minimum to evaluate field performance. Types of distress and levels of severity were recorded for each test section following the criteria described by Epps, et al (13). Results for each test road are presented in the Appendices. All forms and levels of pavement distress were quantified using the Pavement Rating Score (PRS). Based on maintenance costs, this index, or PRS, allows numerical comparison of pavement condition. A PRS value of 100 describes a pavement with no distress. Progressively lower PRS values describe pavement conditions with more severe form of distress. The form shown in Figure 21 is used to catalog distress observed on the pavement. Deduct values are assigned to each type and level of distress according to Table 22. The sum of deduct values is subtracted from 100 resulting in the PRS.

El Paso Test Road

The El Paso Test Road was constructed in July of 1983. Pavement condition surveys were conducted on the following dates:

February, 1984
May, 1984
July, 1985
October, 1985
May, 1986

The data from these surveys as well as pre-construction data are documented in Appendix A.

Cracking began to appear in all sections by the time of the first survey in February of 1984. Some of these cracks healed during the following summer. By the next year maintenance crews had sealed the cracks; however, the cracks were open again by October, 1985.

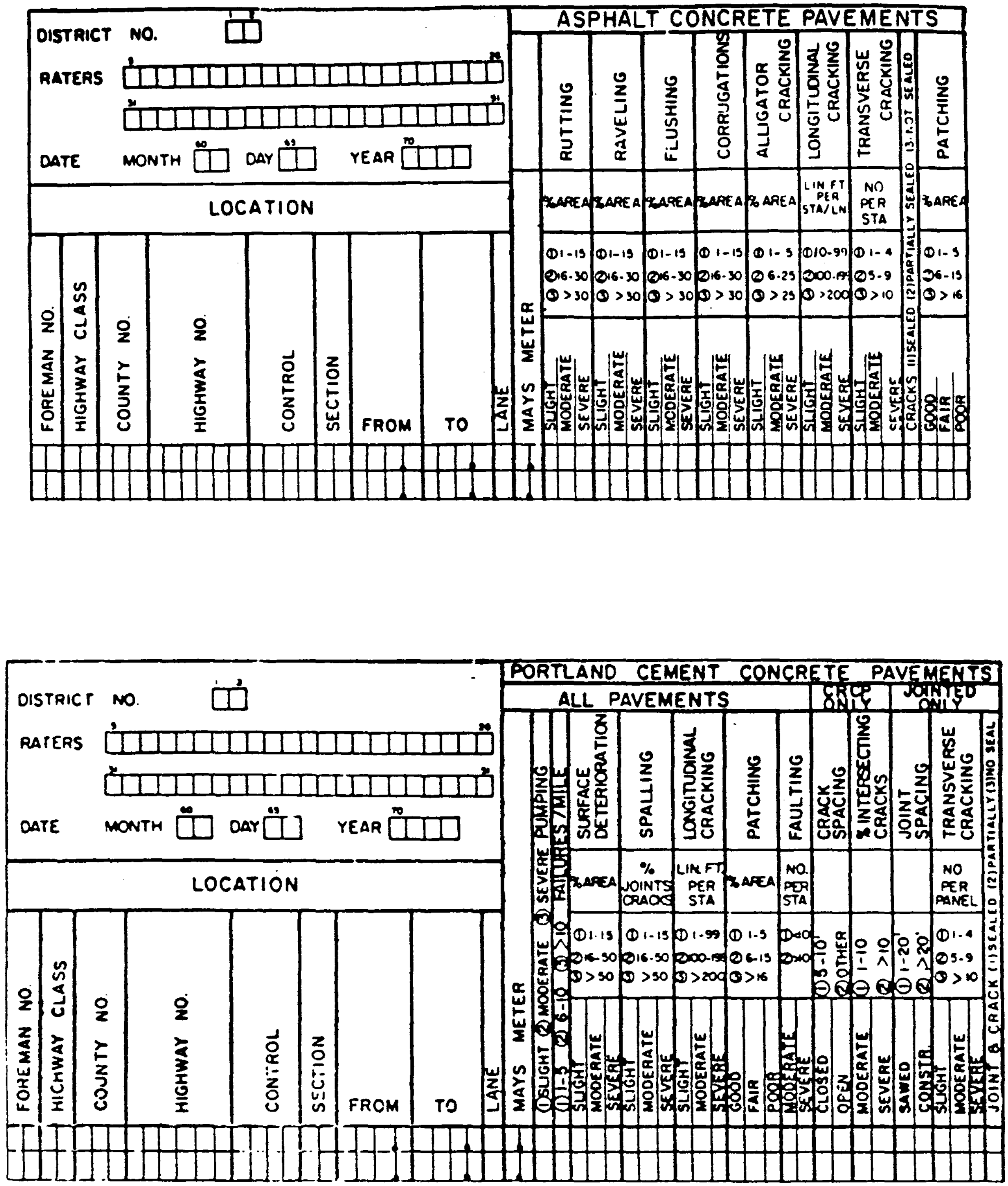


Figure 21. Pavement Rating Forms

Table 22. Pavement Rating Deduct Values.

Type of Distress	Degress of Distress	Extent or Amount of Distress (1)	(2)	(3) *
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20

Deduct Points for Cracking

Longitudinal Cracking

	Sealed (1)	(2)	(3)	Partially Sealed (1)	(2)	(3)	Not Sealed * (1)	(2)	(3)
Slight	2	5	8	3	7	12	5	10	15
Moderate	5	8	10	7	12	15	10	15	20
Severe	8	10	15	12	15	20	15	20	25

Transverse Cracking

	Sealed (1)	(2)	(3)	Partially Sealed (1)	(2)	(3)	Not Sealed * (1)	(2)	(3)
Slight	2	5	8	3	7	10	3	7	12
Moderate	5	8	10	7	10	15	7	12	15
Severe	8	10	15	10	15	20	12	15	20

* Numbers in parentheses refer to quantity of distress observed as indicated on Figure 1.

The predominant type of distress was transverse cracking and the second main type of distress was longitudinal cracking. Pavement Rating Scores (PRS) are presented in Tables 23 through 27 for each survey conducted. The asphalt rubber interlayer is intended to reduce the rate at which cracks in the underlying pavement propagate the new asphalt concrete overlay. "Cracking PRS" values are presented so that a more precise comparison may be made between test sections for crack related distress.

Even though there is a substantial amount of cracking that is now being exhibited in the El Paso Test Road, the PRS still reflects that the pavement is in reasonably good condition. Most of the photologs had a PRS above 90. The scores in the 60's and 70's are due to "pumping" that was observed in some of the transverse cracks. Since all of the cracking PRS's were 93 or above, differences between the performance of the sections based on PRS could not be detected. For example, a photolog could have anywhere from 60 to 240 linear feet of transverse cracking and still have a PRS of 97. Therefore, actual linear feet of cracking observed was compared with the linear feet of cracking prior to construction. These data are presented in Table 28.

Figures 22 and 23 show the data in Table 28 graphically. The extent of transverse cracking is shown in Figure 22. Transverse cracking was the predominant distress and was most useful in the analysis of performance. The bold line in Figure 22 is the control section, 100 percent of the cracks in the underlying pavement have reflected to the surface while most of the sections with the asphalt-rubber interlayer have less than 50 percent of original cracking. Also, between February and May of 1984, many of the asphalt-rubber sections exhibited "crack healing"; whereas, this was not observed in the control section.

Brownsville Test Road

The Brownsville Test Road was constructed by October of 1984. This test road was designed to evaluate field performance of two aggregate grades in single and double applications as interlayers. Control

Table 23. El Paso Pavement Rating Scores for February, 1984.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	1	97	100	100	97
	2	97	100	100	77
	3	97	100	100	77
2	4	97	100	100	97
	5	100	100	100	100
	6	97	100	100	97
3	7	100	100	100	100
	8	100	100	100	100
	9	97	100	100	97
4	10	100	100	95	95
	11	100	100	100	100
	12	100	100	95	95
5	13	100	95	100	95
	14	100	100	100	100
	15	97	100	100	97
6	16	100	100	100	100
	17	100	100	100	100
	18	100	100	100	100
7	19	100	100	100	100
	20	97	100	100	97
	21	97	95	100	92
8	22	97	100	100	97
	23	100	100	100	100
	24	97	100	100	97
9	25	97	100	100	97
	26	97	95	100	92
	27	97	95	100	92
10	28	100	100	100	100

Table 24. El Paso Pavement Rating Scores for May, 1984.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	1	97	100	100	97
	2	90	100	100	70
	3	90	100	100	70
2	4	100	100	100	100
	5	100	100	100	100
	6	100	100	100	100
3	7	100	100	100	100
	8	100	100	100	100
	9	97	100	100	100
4	10	100	100	100	100
	11	100	100	100	100
	12	100	100	100	100
5	13	100	100	100	100
	14	100	100	100	100
	15	100	100	100	100
6	16	100	100	100	100
	17	100	100	100	100
	18	100	100	100	100
7	19	100	100	100	100
	20	97	100	100	97
	21	97	95	100	92
8	22	100	100	100	95
	23	100	100	100	100
	24	100	100	100	100
9	25	100	100	100	100
	26	97	100	100	97
	27	100	100	100	100
10	28	100	100	100	100

Table 25. El Paso Pavement Rating Scores for July, 1985.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
	1	97	100	100	92
1	2	97	100	100	77
	3	93	100	100	73
	4	97	100	100	97
2	5	97	100	100	97
	6	97	100	100	97
	7	100	100	100	100
3	8	100	100	100	100
	9				
	10	100	100	100	100
4	11				
	12	100	100	100	100
	13	100	100	100	100
5	14	100	100	100	100
	15	100	100	100	100
	16	100	100	95	95
6	17	100	100	100	100
	18	97	100	100	97
	19	100	100	100	100
7	20	100	100	100	100
	21	97	100	100	97
	22	100	100	100	100
8	23	100	100	100	100
	24	100	100	100	100
	25	97	100	100	97
9	26	97	100	100	97
	27	100	100	100	100
10	28	97	100	100	97

Table 26. El Paso Pavement Rating Scores for October, 1985.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
	1	97	100	100	97
1	2	97	100	100	77
	3	93	100	100	73
	4	97	100	100	97
2	5	97	100	100	97
	6	97	100	100	97
	7	100	100	100	100
3	8	97	100	100	97
	9	97	100	100	97
	10	100	100	100	100
4	11	100	100	100	100
	12	100	100	100	100
	13	97	95	100	92
5	14	100	100	100	100
	15	97	100	100	97
	16	100	100	100	100
6	17	100	100	100	100
	18	100	100	100	100
	19	100	100	100	100
7	20	97	100	100	97
	21	97	95	100	92
	22	97	100	100	97
8	23	97	100	100	97
	24	100	100	100	100
	25	97	100	100	97
9	26	97	100	100	97
	27	97	100	100	97
10	28	97	100	100	97

Table 27. El Paso Pavement Rating Scores for May, 1986.

Test Section	Photolog	Cracking PRS			Overall PRS
		Trans.	Long.	Allig.	
1	1	97	100	100	97
	2	97	95	100	72
	3	93	100	100	73
2	4	97	95	100	72
	5	97	100	100	77
	6	97	100	100	77
3	7	97	100	100	97
	8	97	100	100	97
	9	97	100	100	77
4	10	97	95	100	72
	11	97	100	100	77
	12	100	100	100	100
5	13	97	95	95	67
	14	100	100	100	100
	15	97	100	100	97
6	16	97	100	100	97
	17	97	100	100	77
	18	97	100	100	97
7	19	97	100	100	97
	20	97	100	100	97
	21	97	95	100	92
8	22	97	100	100	97
	23	97	100	100	97
	24	97	100	100	97
9	25	97	100	100	97
	26	97	95	100	92
	27	97	100	97	77
10	28	97	100	100	100

Table 28. Extent of Overlay Cracking Expressed as a Percentage of Cracking in the Original Pavement for the El Paso Test Road.

Test Section	Photolog	% of Original Cracking														
		Feb., 1984			May, 1984			July, 1985			Oct., 1985			May, 1986		
		Trans.	Long.	Allig.	Trans.	Long.	Allig.	Trans.	Long.	Allig.	Trans.	Long.	Allig.	Trans.	Long.	Allig.
1	1	37	24	0	41	36	0	59	6	0	57	0	0	105	0	0
	2	30	0	0	24	0	0	56	0	5	34	0	0	43	95	0
	3	30	0	0	37	7	0	83	7	0	51	0	0	61	16	0
2	4	8	0	0	8	0	0	13	12	0	17	12	0	22	29	0
	5	7	0	0	6	0	0	34	0	0	42	29	0	57	73	0
	6	26	0	0	16	0	0	32	0	0	41	0	0	48	0	0
3	7	2	0	0	2	0	0	1	0	0	13	0	0	16	17	0
	8	3	0	0	3	4	0	2	4	0	21	12	0	30	38	0
	9	13	0	0	16	0	0	15	0	0	33	0	0	30	0	0
4	10	0	5	6	0	5	3	0	4	2	5	4	0	13	34	0
	11	1	0	600	0	0	0	6	0	0	10	0	0	23	102	0
	12	3	0	12	0	0	0	0	0	0	8	0	0	8	31	0
5	13	20	75	0	21	3	0	19	16	0	38	100	0	51	126	11
	14	8	0	0	0	0	0	0	0	0	8	0	0	8	0	0
	15	31	0	0	0	0	0	7	0	0	14	6	0	24	7	0
6	16	5	0	0	13	0	1	10	0	8	8	11	0	24	23	0
	17	3	7	0	0	0	0	14	13	2	2	13	0	9	21	0
	18	3	0	0	0	6	0	21	16	0	13	4	0	19	5	0
7	19	8	6	0	3	0	9	2	0	0	19	1	0	21	3	0
	20	36	7	0	27	9	0	25	9	0	37	0	0	37	0	0
	21	28	89	0	23	103	0	27	13	0	46	112	0	56	121	0
8	22	26	0	0	6	0	0	5	0	0	16	0	0	36	0	0
	23	18	0	0	2	0	0	4	0	0	33	0	0	46	12	0
	24	48	0	0	6	0	0	14	0	0	15	0	0	66	0	0
9	25	56	0	0	30	0	0	41	0	0	38	7	0	52	7	0
	26	79	11	0	33	7	0	25	0	0	56	7	0	78	16	0
	27	19	17	0	13	0	0	1	0	0	22	5	0	32	13	0
10	28	30	0	0	45	0	0	90	0	0	100	0	0	106	0	0

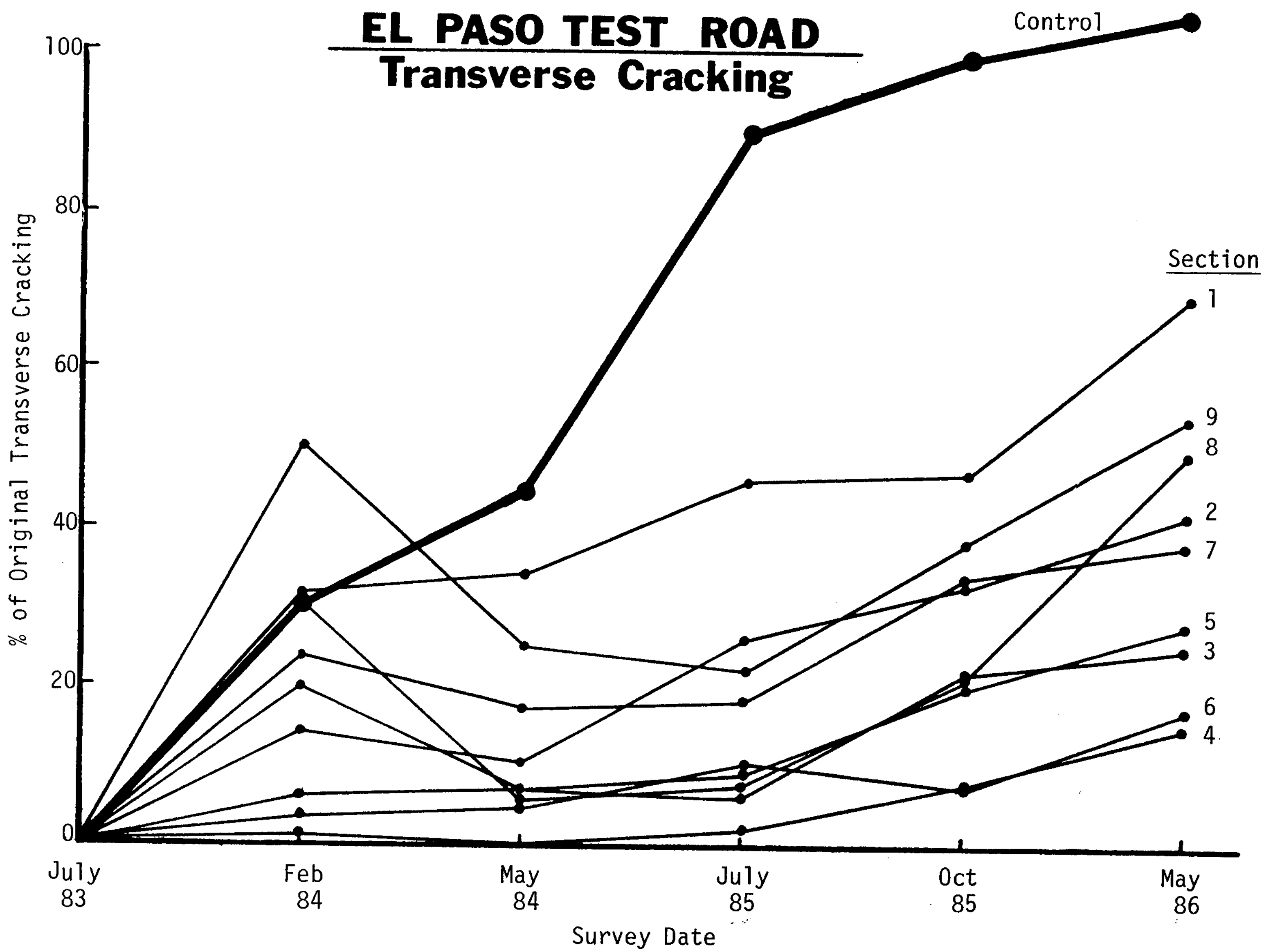


Figure 22. El Paso Transverse Cracking Versus Survey Date.

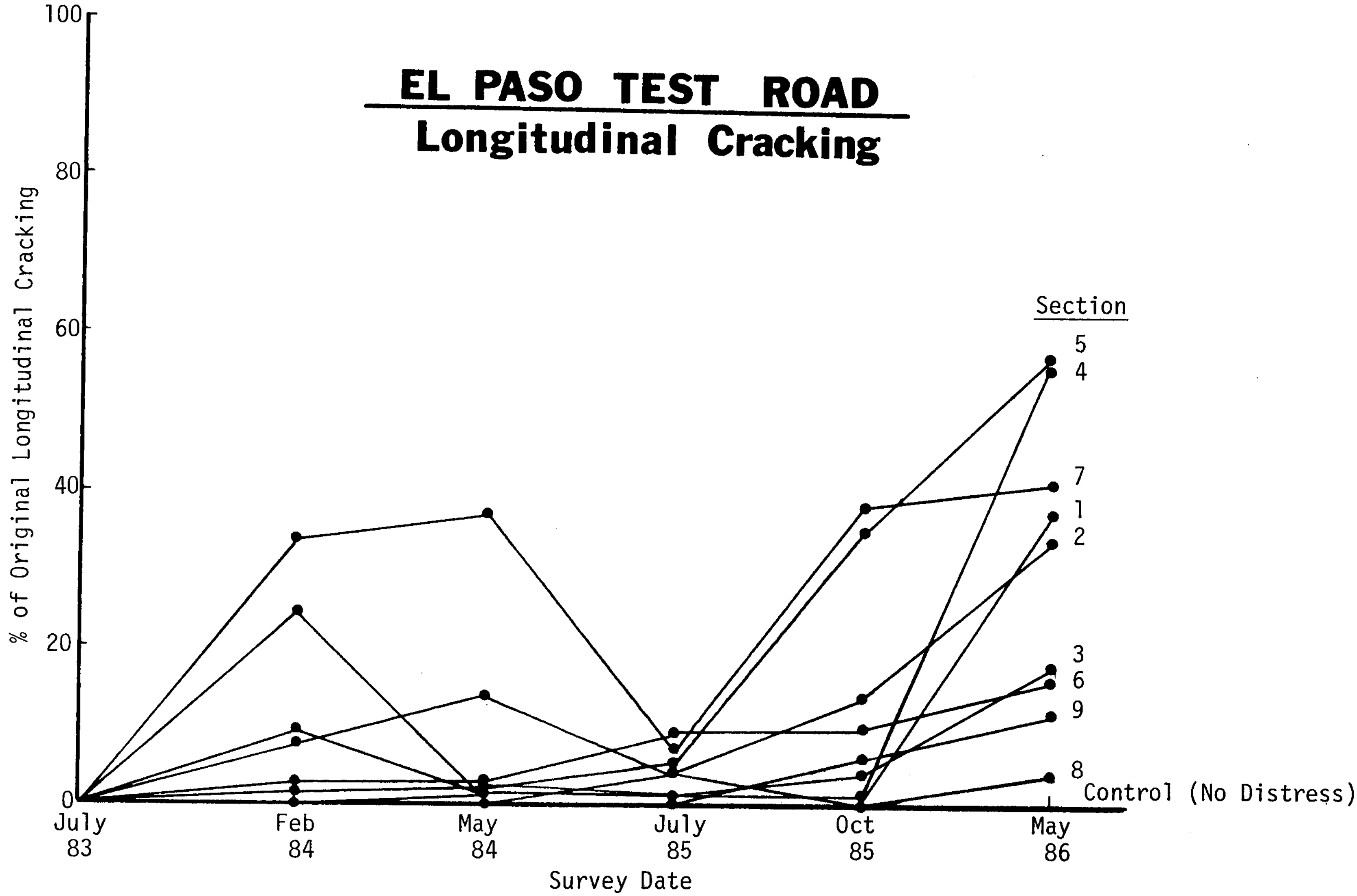


Figure 23. El Paso Longitudinal Cracking Versus Survey Date.

sections consisted of: 1) no treatment, 2) asphalt cement interlayers, and 3) polymer asphalt interlayer.

The pavement was surveyed in November of 1985 and May of 1986. PRS values for each survey are shown in Tables 29 and 30. This test road is exhibiting very little cracking; however, the predominant type of distress is bleeding. This accounts for the relatively low overall PRS values in Table 30. The extent of cracking expressed as a percentage of cracking in the original pavement is shown in Table 31. These data are presented graphically in Figures 24 and 25. A bar graph showing the amount of bleeding in each section is given in Figure 26. It appears that the bleeding occurs once a crack has developed and the binder from the interlayer comes up through the crack; however, this is difficult to determine because the crack is completely obscured by the bleeding.

Buffalo Test Road

The Buffalo Test Road was constructed in August of 1984. Rubber concentration and digestion time were the independent variables in this experiment. Control sections consisted of: 1) no treatment, and 2) asphalt cement interlayer.

The pavement was surveyed in October of 1985 and May of 1986 at which times no distress was observed in any of the sections. This is also reflected in the PRS shown in Tables 32 and 33.

Table 29. Brownsville Pavement Rating Scores for November, 1985.

Test Section	Cracking PRS Trans.	Cracking PRS Long	Cracking PRS Allig.	Overall PRS
1	100	100	100	100
2	100	100	100	100
3	100	100	100	95
4	100	95	100	90
5	100	100	100	100
6	100	100	100	100
7	100	100	100	90
8	100	100	100	90
9	100	100	100	100
10	100	100	100	100
11	100	100	100	100
12	100	100	100	100
13	100	100	100	100
14	100	100	100	100
15	100	100	100	100
16	100	100	100	100
17	100	100	100	100
18	100	100	100	100

Table 30. Brownsville Pavement Rating Scores for May, 1986.

Test Section	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	100	100	100	100
2	93	90	100	75
3	100	90	100	80
4	100	90	100	80
5	100	100	100	100
6	100	100	100	100
7	100	90	100	80
8	100	100	100	88
9	100	100	100	100
10	100	100	100	100
11	100	100	100	90
12	100	100	100	100
13	100	100	100	100
14	100	100	100	100
15	100	100	100	100
16	100	100	100	100
17	97	95	100	92
18	97	100	100	97

Table 31. Extent of Overlay Cracking Expressed as a Percentage of Cracking in the Original Pavement for the Brownsville Test Road.

Test Section	% of Cracking					
	November, 1985			May, 1986		
	Trans.	Long.	Allig.	Trans.	Long.	Allig.
1	1	2	0	1	4	0
2	0	11	0	33	84	0
3	0	22	0	10	47	8
4	0	43	0	13	113	100
5	0	0	0	0	0	8
6	10	0	0	10	8	7
7	0	0	0	10	22	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	13	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	100	0	0	120	0	0
16	0	0	0	20	0	0
17	0	0	0	58	300	0
18	0	0	0	87	14	100

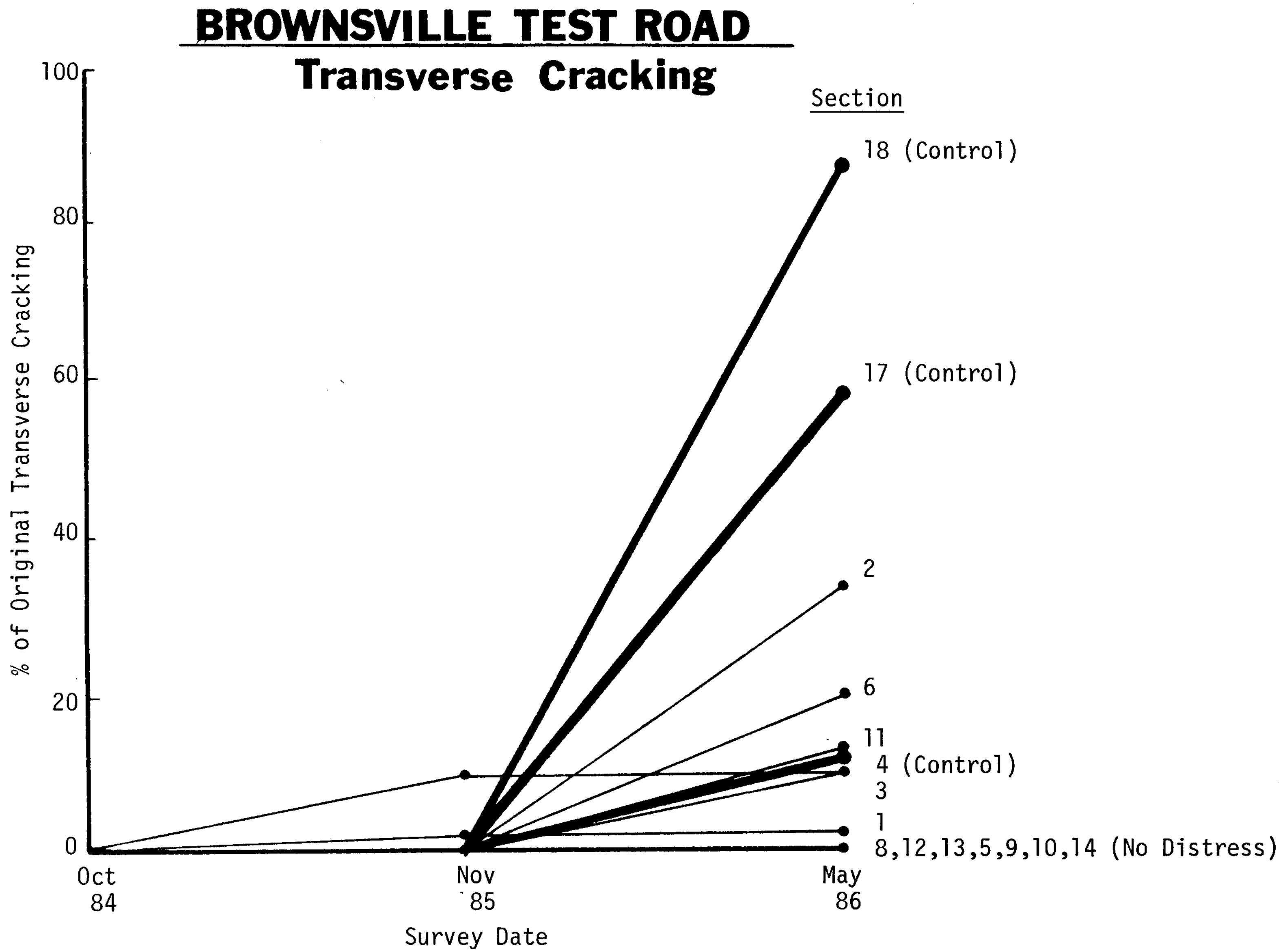


Figure 24. Brownsville Transverse Cracking Versus Survey Date.

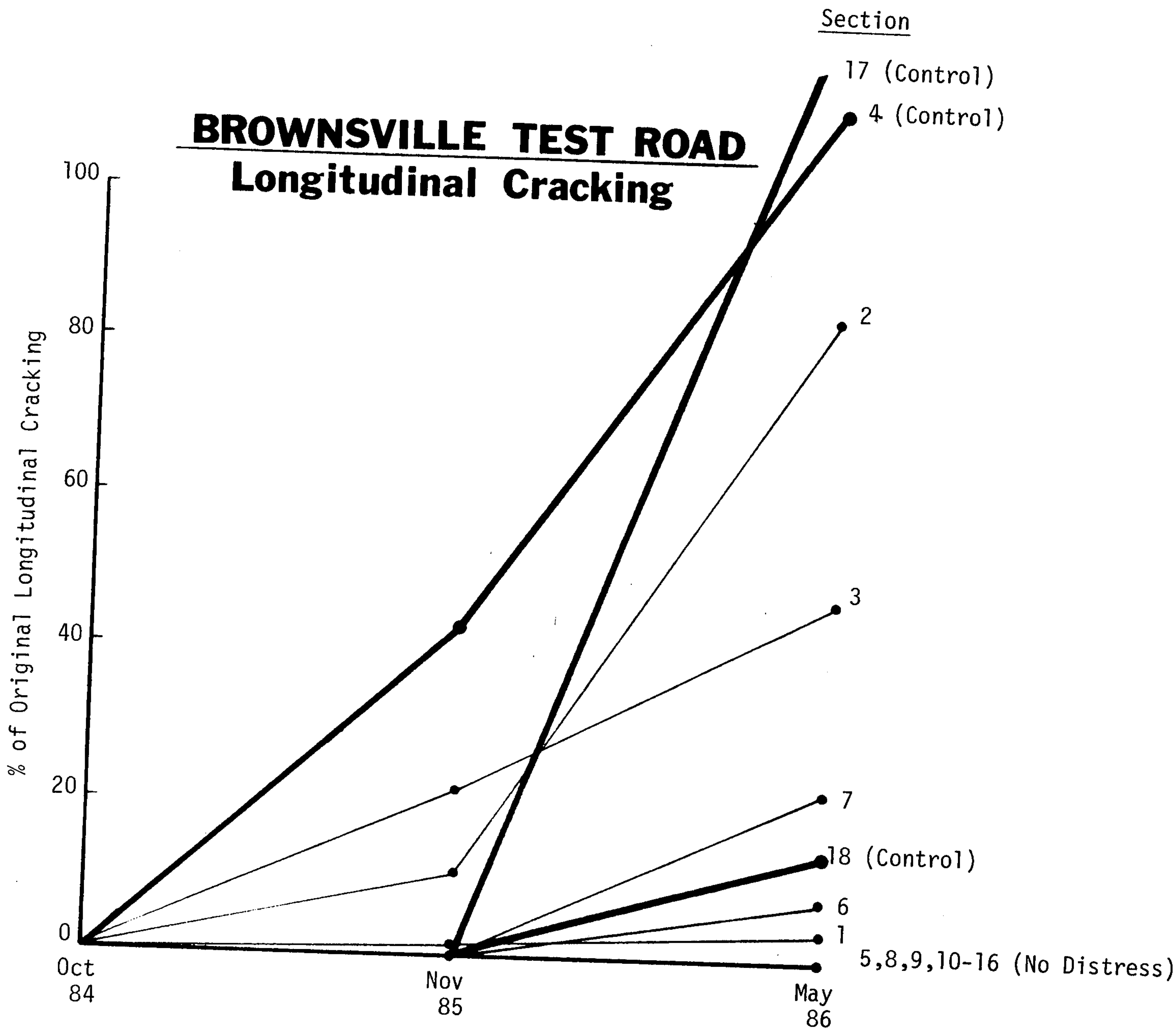


Figure 25. Brownsville Longitudinal Cracking Versus Survey Date.

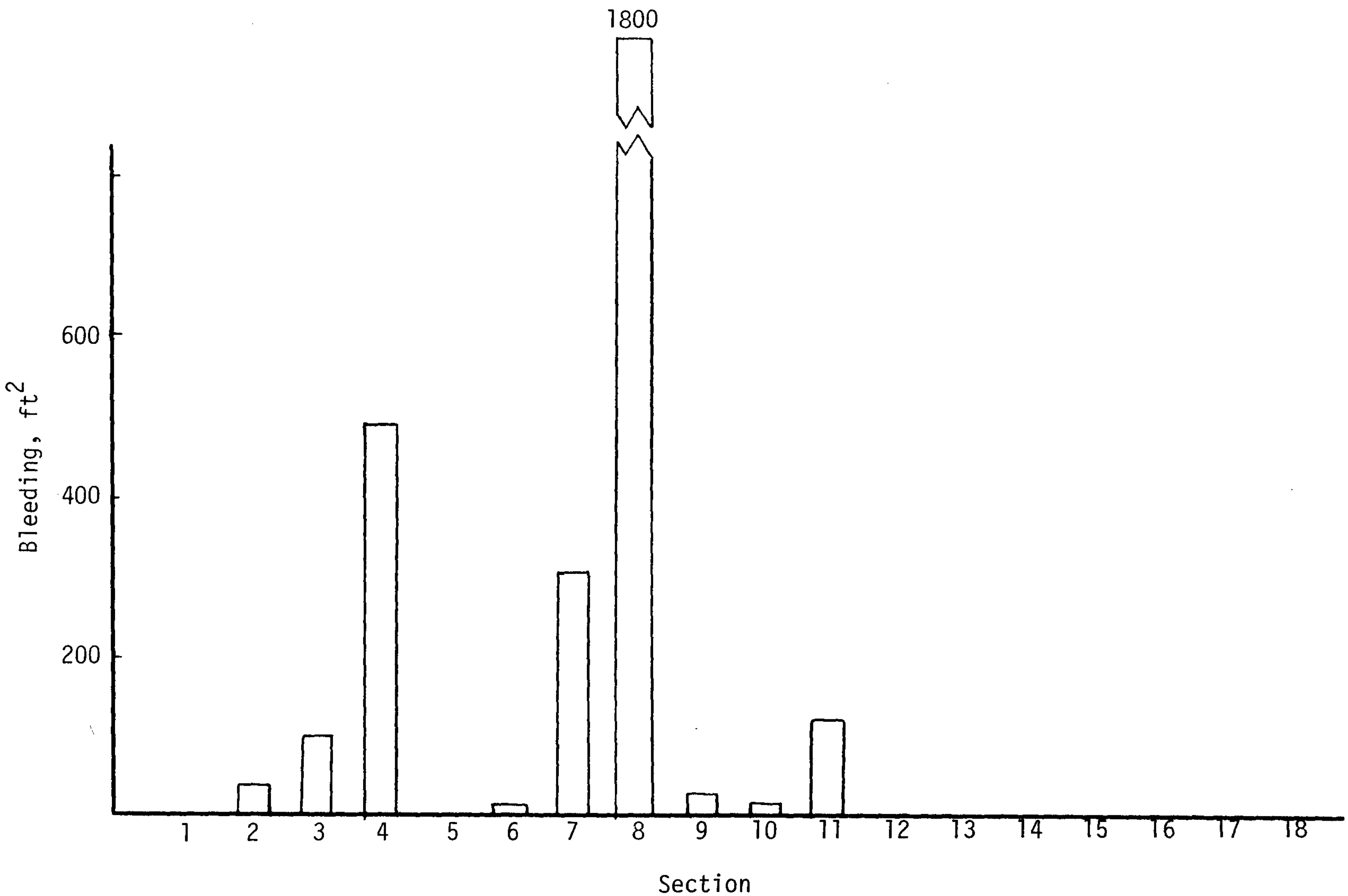


Figure 26. Brownsville Test Road - Area of Bleeding Distress.

Table 32. Buffalo Pavement Rating Scores for October, 1985.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
1	1	100	100	100	100
	2	100	100	100	100
	3	100	100	100	100
2	4	100	100	100	100
	5	100	100	100	100
3	6	100	100	100	100
	7	100	100	100	100
4	8	100	100	100	100
	9	100	100	100	100
5	10	100	100	100	100
	11	100	100	100	100
6	12	100	100	100	100
	13	100	100	100	100
	14	100	100	100	100
7	15	100	100	100	100
	16	100	100	100	100
	17	100	100	100	100
8	18	100	100	100	100
	19	100	100	100	100
	20	100	100	100	100
9	21	100	100	100	100
	22	100	100	100	100
	23	100	100	100	100
10	24	100	100	100	100
	25	100	100	100	100
	26	100	100	100	100
11	27	100	100	100	100
	28	100	100	100	100
	29	100	100	100	100
12	30	100	100	100	100
	31	100	100	100	100
	32	100	100	100	100

Table 33. Buffalo Pavement Rating Scores for May, 1986.

Test Section	Photolog	Cracking PRS Trans.	Cracking PRS Long.	Cracking PRS Allig.	Overall PRS
	1	100	100	100	100
1	2	100	100	100	100
	3	100	100	100	100
2	4	100	100	100	100
	5	100	100	100	100
3	6	100	100	100	100
	7	100	100	100	100
4	8	100	100	100	100
	9	100	100	100	100
5	10	100	100	100	100
	11	100	100	100	100
	12	100	100	100	100
6	13	100	100	100	100
	14	100	100	100	100
	15	100	100	100	100
7	16	100	100	100	100
	17	100	100	100	100
	18	100	100	100	100
8	19	100	100	100	100
	20	100	100	100	100
	21	100	100	100	100
9	22	100	100	100	100
	23	100	100	100	100
	24	100	100	100	100
10	25	100	100	100	100
	26	100	100	100	100
	27	100	100	100	100
11	28	100	100	100	100
	29	100	100	100	100
	30	100	100	100	100
12	31	100	100	100	100
	32	100	100	100	100

CHAPTER 7

ANALYSIS

El Paso Test Road - Statistical Analysis of Field Responses

The purpose of this section is to present the results from the statistical analysis of data obtained from the El Paso Test Road regarding the field performance of asphalt-rubber interlayers. The responses of interest are the following types of distress: transverse cracking, longitudinal cracking and alligator cracking. Each distress type was further classified according to the degree of severity. However, for the purposes of this analysis, a combined measure of types of distress and all degrees of severity was used.

The original experimental design model consisted of a Latin Square with rubber type, concentration of rubber and binder application rate as factors. Mathematically, the model can be written as follows:

$$Y_{ijk} = \mu + R_i + C_j + A_k + \varepsilon_{ijk}$$

where: Y_{ijk} = response to i^{th} rubber, j^{th} concentration and k^{th} application rate

μ = effect on response of the overall mean

R_i = effect on response of the i^{th} rubber

C_j = effect on response of the j^{th} concentration

A_k = effect on response of the k^{th} application rate

ε_{ijk} = random error

Three levels of each factor were considered:

1. rubber types - A, B and C.
2. concentrations - 22 percent, 24 percent and 26 percent.
3. application rates - 0.35, 0.40 and 0.45 gallon/square yard.

Even though the application rates were not exactly as planned, they were sufficiently close to be considered equal to the specified rates.

Distress data were collected for each of three different photologs within each of nine different test sections. Since the same treatment was used within the same section, the responses of the three photologs were considered as independent samples. Since the application rate and thickness for photolog 12 were not available, they were estimated as 0.4 and 2.0 (average of thicknesses for section 4), respectively.

Distress data were collected for five time periods after the application of the asphalt-rubber binder and overlay. The analysis was made independently for each time period.

Two other factors were later included in the model since they were thought to have a significant effect on the response. They were the original distress of the photolog before the application of the treatment and the overlay thickness. Since these factors were not controllable by the experimenter, a new analysis of covariance model, having overlay thickness and original distress as covariates, was constructed.

Since no significant occurrence of alligator cracking was found, only transverse and longitudinal cracking were included in the analysis.

Preliminary analyses indicated that the rubber-type factor was not significant in most cases. In addition, it was of interest to investigate the effect of interaction between concentration and application rate. Consequently, a modified model disregarding rubber type was used. The new model was a 3^2 factorial, which is shown in Figure 27, with original cracking and overlay thickness as covariates.

		Concentration		
		22	24	26
Application rate	0.35	Section 2	9	8
	0.40	4	1	6
	0.45	5	7	3

Figure 27. Modified Factorial Model.

The new model allowed the analysis of interaction between concentration and application rate. It also allowed more degrees of freedom for the error, increasing the accurancy of the analysis at the expense of dropping one factor. Mathematically, the new analysis of covariance model was:

$$Y_{ijk} = \mu + C_i + A_j + CA_{ij} + \beta 1(X_{ijk}-X) + \beta 2(T_{ijk}-\overline{T}) + \varepsilon_{ijk}$$

where: Y_{ijk} = response to i^{th} concentration, j^{th} application rate, k^{th} original distress and kth overlay thickness

μ = effect on response of the overall mean

C_i = effect on response of the i^{th} concentration

A_j = effect on response of the j^{th} application rate

CA_{ij} = effect on response of the interaction of the i^{th} concentration and the j^{th} application rate

β_1 = true linear regression coefficient between response and original distress

β_2 = true linear regression coefficient between response and overlay thickness

X_{ijk} = original distress of photolog k

X = mean of original distress

T_{ijk} = overlay thickness of photolog k

$\overline{T}$ = mean of overlay thickness

ε_{ijk} = random error.

Assuming a significance level of 10 percent, all transverse cracking models were highly significant. From the least squares mean estimates, the concentration appears to be the most significant factor, with higher concentrations tending to perform better. Also, there is a significant interaction between concentration and application rate. It appears that, for the highest concentration, the application rate equal to 0.40 gave the best results.

Even though the results for the longitudinal cracking data were not as consistent as the ones for transverse cracking, the highest concentration rate appears to perform better as in the transverse cracking case. In the only case where interaction was significant, it appears that, for the highest concentration rate, the application rate equal to 0.40 performs better.

Brownsville Test Road

After construction of the interlayers, the test road was opened to traffic before being overlayed. During that time period, almost all of the seal coat interlayers were exhibiting flushing, as noted in Table 21. This distress was hoped to be insignificant since the pavement would be overlayed; however, this was not the case since the pavement is exhibiting bleeding. The fact that the interlayers were too rich in binder was also thought to have a positive effect on retarding crack propagation.

Overall, there is little cracking occuring in the test sections; however, there is an unacceptable level of bleeding being exhibited. It appears that most of the bleeding is coming from the interlayer through the cracks.

There is insufficient cracking in the test sections to do a detailed analysis and to draw any conclusions at this time on the performance of the test sections in terms of reflective cracking. Even though only half of the test sections are flushing at this time, it appears that the interlayer binder rates (Table 21) were excessive in all test sections. It is expected that as the amount of cracking increases in the pavement, bleeding will progress to extreme levels.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

Test roads containing asphalt-rubber interlayers were constructed near El Paso, Buffalo and Brownsville. All test roads were designed as statistical experiments such that analysis of effects due to asphalt-rubber formulation could be determined. Asphalt-rubber was formulated using various rubber concentration, rubber type, digestion conditions, and interlayers were applied at various shot rates. In addition, aggregate grade was varied, and single and double binder applications were studied. Based on field performance to date the following conclusions were made.

Conclusions

1. Based on field performance to date, the interlayer which is performing the best in the El Paso Test Road contains 26% rubber and was applied at 0.40 gallons per square yard.
2. The Brownsville Test Road has insufficient cracking to draw conclusions on field performance of the test sections in terms of reflective cracking.
3. The Brownsville Test Road is experiencing bleeding from the interlayer in half of the test sections due to excessive interlayer binder application rates.
4. The Buffalo Test Road is not experiencing any distress at this time.

Recommendations

1. These three test roads are already producing valuable information about asphalt-rubber interlayers. Monitoring should be continued until sufficient data is obtained to correlate field performance to laboratory properties.

APPENDIX A

Photolog Summaries - El Paso

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El Paso

Preconstruction Survey

Preconstruction Photolog 1. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	27	106	6	21		74
Long., ft.	9	59	33	11		10
Allig., $ft.^2$		358		322		56

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 2. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	94	78	83		22	240
Long., ft.	134	23	4			
Allig., $ft.^2$		86		90		4

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$	362		
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 3. El Paso.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	155	130	90	3	4	196
Long., ft.	80	27				
Allig., $ft.^2$		8		10		

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$	793		
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 4. El Paso.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	112	16	332	41	72	194
Long., ft.	36	56	47		9	30
Allig., $ft.^2$		278		129		

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$	806		
Pumping, ft.			

Preconstruction Photolog 5. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
	F	**N**	**F**	**N**	**F**	**N**
Transv., ft.	265	8	52			11
Long., ft.	56	11				
Allig., ft.^{2}		15				
Flushing, ft.^{2}	494					
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 6. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	195	155				
Long., ft.	89	21				
Allig., ft.^{2}		31				
Flushing, ft.^{2}	197					
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 7. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	203	107	20			60
Long., ft.	61	31	2			
Allig., ft.^{2}		1149		232		
Flushing, ft.^{2}	1120					
Patching, ft.^{2}	378		318			
Pumping, ft.						

Preconstruction Photolog 8. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	235	125	103			35
Long., ft.	29	52	2			
Allig., ft.^{2}		763		91		
Flushing, ft.^{2}	667		27			
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 9. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	301	106	20			9
Long., ft.	49	35				
Allig., ft.^{2}		84				
Flushing, ft.^{2}	260					
Patching, ft.^{2}	378					
Pumping, ft.						

Preconstruction Photolog 10. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	76	128	287	4	21	43
Long., ft.	109	69	84	8	31	
Allig., ft.^{2}		178		704		496
Flushing, ft.^{2}	422		46		35	
Patching, ft.^{2}	624					
Pumping, ft.						

Preconstruction Photolog 11. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	137	174	61	79		
Long., ft.	37					
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 12. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	70	76	112	39	4	24
Long., ft.	35	10	68	4	2	
Allig., ft.^{2}		255		218		225
Flushing, ft.^{2}	584		202			
Patching, ft.^{2}			200			
Pumping, ft.						

Preconstruction Photolog 13. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	143	45	39	19	31	
Long., ft.	102	13	11		4	
Allig., ft.^{2}		302		363		113
Flushing, ft.^{2}	333					
Patching, ft.^{2}	419		40			
Pumping, ft.						

Preconstruction Photolog 14. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	202	157	89			
Long., ft.	119	23	9	5		
Allig., ft.^{2}		213		403		25
Flushing, ft.^{2}	268					
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 15. El Paso.

Distress	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	394	31	60			
Long., ft.	286	37	30			
Allig., $ft.^2$		744		136		
Flushing, $ft.^2$	342					
Patching, $ft.^2$	963					
Pumping, ft.						

Preconstruction Photolog 16. El Paso.

Distress	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	112	93	110	6		
Long., ft.	67	14	38			
Allig., $ft.^2$		122		779		194
Flushing, $ft.^2$	260		14			
Patching, $ft.^2$	820		725			
Pumping, ft.						

Severity: Slight, Moderate, Severe; Filled, F; Not, N. (Flushing, patching and pumping entries are printed in a single cell spanning each severity level.)

Preconstruction Photolog 17. El Paso.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	153	187	37	6		
Long., ft.	134	17				
Allig., ft.^{2}		542		188		
Flushing, ft.^{2}	175					
Patching, ft.^{2}	428		212			
Pumping, ft.						

Preconstruction Photolog 18. El Paso.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	109	74	169	31		
Long., ft.	76	35	87			
Allig., ft.^{2}		331		149		
Flushing, ft.^{2}	1039					
Patching, ft.^{2}	127		134			
Pumping, ft.						

Preconstruction Photolog 19. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	86	179				8
Long., ft.	184	30	153	7		
Allig., ft.^{2}		71		38		
Flushing, ft.^{2}	1219		119			
Patching, ft.^{2}	335		109			
Pumping, ft.						

Preconstruction Photolog 20. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	200	26	25			
Long., ft.	283	11	8			
Allig., ft.^{2}		2				
Flushing, ft.^{2}	242					
Patching, ft.^{2}	155		265			
Pumping, ft.						

Preconstruction Photolog 21. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	191	155	13			
Long., ft.	103	18				
Allig., $ft.^2$		447				
Flushing, $ft.^2$	261					
Patching, $ft.^2$			683			
Pumping, ft.						

Preconstruction Photolog 22. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	274	71	14			
Long., ft.	80	5				
Allig., $ft.^2$		134				
Flushing, $ft.^2$	219					
Patching, $ft.^2$	70		72			
Pumping, ft.						

Preconstruction Photolog 23. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	131	68	57			4
Long., ft.	26	7				
Allig., ft.^{2}		130				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}	1028		
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 24. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	145	2	4			
Long., ft.	32	11				
Allig., ft.^{2}		333				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}	372		
Patching, ft.^{2}	178	140	
Pumping, ft.			

Preconstruction Photolog 25. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	81	49	117	17	14	
Long., ft.	38	30	10			
Allig., $ft.^2$		213		59		

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$	578		
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 26. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	224	16	5			
Long., ft.	326	10	129	18	14	
Allig., $ft.^2$		458		197		

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$	301		
Patching, $ft.^2$	11	680	
Pumping, ft.			

Preconstruction Photolog 27. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	302	78	64	4		51
Long., ft.	282	36	19			
Allig., ft.^{2}		314		57		
Flushing, ft.^{2}	1021		15			
Patching, ft.^{2}	323		385			
Pumping, ft.						

Preconstruction Photolog 28. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	24	18	54	12	12	
Long., ft.		304		128		
Allig., ft.^{2}		185		75		
Flushing, ft.^{2}	1274		540			
Patching, ft.^{2}	30		120			
Pumping, ft.						

El Paso

February, 1984 Survey

Survey Date 2/84 **Photolog** 1. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		87				
Long., ft.		30				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 Photolog 2. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		160				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	6		

Survey Date 2/84 **Photolog** 3. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		178				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	36		

Survey Date 2/84 **Photolog** 4. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		61				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 **Photolog** 5. El Paso.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		26				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 6 . El Paso.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		93				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 7. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		8				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 8. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		15				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 9. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		60				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 10. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		0				
Long., ft.		18				
Allig., ft.^{2}		88				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 11. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		6				
Long., ft.		6				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 Photolog 12 . El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		12				
Long., ft.						
Allig., ft.^{2}		84				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 13. El Paso.

Distress \ Severity, Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		48				
Long., ft.		98				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 Photolog 14. El Paso.

Distress \ Severity, Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		36				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 15. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		151				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 **Photolog** 16. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		18				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 **Photolog** 17. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		12				
Long., ft.		12				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 **Photolog** 18 . El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		12				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 2/84 **Photolog** 19. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		24				
Long., ft.		26				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 Photolog 20 . El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		92				
Long., ft.		24				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 21. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		103				
Long., ft.		108				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 2/84 **Photolog** 22. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		96				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 2/84 **Photolog** 23. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		47				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 24. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		73				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 25. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		158				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 26. El Paso

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		194				
Long., ft.		58				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 27. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		97				
Long., ft.		58				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 2/84 **Photolog** 28. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		36				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

El Paso

May, 1984 Survey

Survey Date 5/84 **Photolog** 1. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		84		12		
Long., ft.		44				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 5/84 **Photolog** 2. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		75		50		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.		26	12

Survey Date 5/84 **Photolog** 3. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		40		177		
Long., ft.		8				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.			38		12	

Survey Date 5/84 Photolog 4. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		54		12		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 5. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		22				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 Photolog 6. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		56				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 7. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 8. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 9. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		72				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 Photolog 10. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		2				
Long., ft.		18				
Allig., $ft.^2$		44				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 **Photolog** 11. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 Photolog 12. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 13. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		22		28		
Long., ft.		4				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 Photolog 14. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 **Photolog** 15. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 Photolog 16. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		43				
Long., ft.						
Allig., ft.^{2}		16				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 17. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 Photolog 18. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.				12		
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 **Photolog** 19. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		9				
Long., ft.						
Allig., $ft.^2$		10				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 Photolog 20. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		69				
Long., ft.		30				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 **Photolog** 21. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		88				
Long., ft.		125				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 Photolog 22. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		24				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$	100					
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/84 **Photolog** 23. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		6				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 Photolog 24. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		10				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 25. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		49		36		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 Photolog 26. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		83				
Long., ft.		35				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 27. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		57		8		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/84 **Photolog** 28 Control. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		43		12		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

El Paso

July, 1985 Survey

Survey Date 7/85 **Photolog** 1. El Paso.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		139				
Long., ft.		8				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		400	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 7/85 **Photolog** 2. El Paso.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	56	200		37		
Long., ft.						
Allig., ft.^{2}		10				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	41		

Survey Date 7/85 **Photolog** 3. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	271	195	12	6		
Long., ft.		8				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.	6					

Survey Date 7/85 **Photolog** 4. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	18	71		12		
Long., ft.		22				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 7/85 **Photolog** 5. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		116				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 7/85 Photolog 6. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		112				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 7/85 **Photolog** 7. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		4				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 Photolog 8. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		6		6		
Long., ft.		4				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 9. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		36		30		
Long., ft.						
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.	6		

Survey Date 7/85 Photolog 10. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.		15				
Allig., $ft.^2$		40				

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Survey Date 7/85 **Photolog 11.** El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		30				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	6		

Survey Date 7/85 Photolog 12. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 7/85 **Photolog** 13. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		32		12		
Long., ft.		22				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 14. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 15. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		18		16		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 7/85 Photolog 16. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		34				
Long., ft.						
Allig., ft.^{2}		90				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 7/85 **Photolog** 19. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		7				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 20. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		53		12		
Long., ft.		30				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 21. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		98				
Long., ft.		16				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 22. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		18				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 17. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		54				
Long., ft.		20				
Allig., ft.^{2}		20				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 Photolog 18. El Paso.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		83				
Long., ft.		32				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 23. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		12				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 Photolog 24. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		22				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 25. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		102		12		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 26. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		62				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 27. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		7				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 7/85 **Photolog** 28 Control. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		108				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

El Paso

October, 1985 Survey

Survey Date 10/85 **Photolog 1.** El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		134				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog 2.** El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		177				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.	50					

Survey Date 10/85 Photolog 3. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		298				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	10		

Survey Date 10/85 Photolog 4. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		131				
Long., ft.		22				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 10/85 **Photolog** 5. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		142				
Long., ft.		20				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 Photolog 6. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		144				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 7. El Paso.

Distress \ Severity \ Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		52				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 Photolog 8. El Paso.

Distress \ Severity \ Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		108				
Long., ft.		10				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 9. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		147				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 Photolog 10. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		32				
Long., ft.		14				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 **Photolog** 11. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		46				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 Photolog 12. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		28				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 13. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		90				
Long., ft.		130				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 10/85 Photolog 14. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		36				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 10/85 **Photolog** 15. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		70				
Long., ft.		22				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 10/85 Photolog 16. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		26				
Long., ft.		14				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 10/85 **Photolog** 17. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		8				
Long., ft.		20				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 Photolog 18. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		50				
Long., ft.		8				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 **Photolog** 19. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		52				
Long., ft.		6				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 20. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		94				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 21. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		168				
Long., ft.		136				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 Photolog 22. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		59				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 23. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		88				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 Photolog 24. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		24				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 25. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		108				
Long., ft.		6				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 Photolog 26. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		138				
Long., ft.		36				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 10/85 **Photolog** 27. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		114				
Long., ft.		18				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 10/85 **Photolog** 28 Control. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

El Paso

May, 1986 Survey

Survey Date 5/86 **Photolog** 1. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		247				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date 5/86 Photolog 2. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		226				
Long., ft.		153				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	120		

Survey Date 5/86 **Photolog 3.** El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		357				
Long., ft.		18				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	90		

Survey Date 5/86 Photolog 4. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		168				
Long., ft.		52				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	28		

Survey Date 5/86 **Photolog** 5. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		192				
Long., ft.		36				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.	12					

Survey Date 5/86 Photolog 6. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		168				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.	26					

Survey Date 5/86 **Photolog** 7. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		66				
Long., ft.		16				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 8. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		152				
Long., ft.		32				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 9. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		132				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	32		

Survey Date 5/86 **Photolog** 10. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		74				
Long., ft.		103				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	95		

Survey Date 5/86 **Photolog** 11. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		106				
Long., ft.		38				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.	30					

Survey Date 5/86 Photolog 12. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		22				
Long., ft.		38				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 13. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.		165				
Allig., $ft.^2$		90				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.	50					

Survey Date 5/86 **Photolog** 14. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		36				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/86 **Photolog** 15. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		118				
Long., ft.		26				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 16. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		78				
Long., ft.		28				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 17. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		38				
Long., ft.		32				
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.	4		

Survey Date 5/86 Photolog 18. El Paso.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		74				
Long., ft.		10				
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Survey Date 5/86 **Photolog** 19. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		60				
Long., ft.		14				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 Photolog 20. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		69		24		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 21. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		203				
Long., ft.		147				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/86 Photolog 22. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		130				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date 5/86 **Photolog** 23. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		122				
Long., ft.		4				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 24. El Paso.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		101				
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 25. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		146				
Long., ft.		6				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 Photolog 26. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		192				
Long., ft.		80				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 25. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		146				
Long., ft.		6				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 26. El Paso.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		192				
Long., ft.		80				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date 5/86 **Photolog** 27. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		163				
Long., ft.		44				
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.	26					

Survey Date 5/86 Photolog 28. El Paso.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		128				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

APPENDIX B

Photolog Summaries - Buffalo

Buffalo

Preconstruction Survey

Preconstruction Photolog 1. Buffalo.

Distress \ Severity, Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1912		192		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 2. Buffalo.

Distress \ Severity, Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1954		63		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 3. Buffalo.

Distress \ Severity; Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1849		127		
Long., ft.						
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 4. Buffalo.

Distress \ Severity; Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1819		41		
Long., ft.						
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Preconstruction Photolog 5. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		793		5		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 6. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		775		17		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 7. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1518		49		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 8. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1452		58		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 9. Buffalo.

Distress \ Severity; Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		575		37		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 10. Buffalo.

Distress \ Severity; Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		592		51		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 11. Buffalo.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1156		41		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 12. Buffalo.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		917		37		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 13. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		997		95		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 14. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1192		99		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 15. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1092		180		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 16. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1232		144		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 17. Buffalo.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1339		55		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 18. Buffalo.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1257		33		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 19. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1279		54		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 20. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1540		53		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 21. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1181		47		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 22. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1158		22		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 23. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1210		8		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 24. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		943		62		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.	17					

Preconstruction Photolog 25. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1223		19		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 26. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1159		62		
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 27. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1251		12		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 28. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1063		5		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 29. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1118		6		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}	5					
Pumping, ft.						

Preconstruction Photolog 30. Buffalo.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		1038		28		
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 31. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		1258		7		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.	2		

Preconstruction Photolog 32. Buffalo.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		780		5		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Buffalo

October, 1985 Survey

There was no distress in the Buffalo Test Road in October, 1985.

Buffalo

April, 1986 Survey

There was no distress in the Buffalo Test Road in April, 1986.

APPENDIX C

Photolog Summaries - Brownsville

Brownsville

Preconstruction Survey

Preconstruction Photolog 1. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	60	120				
Long., ft.	25	85		10		
Allig., $ft.^2$		60		60		
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 2. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.	30	210		30		
Allig., $ft.^2$		180				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 3. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.		115		20		
Allig., ft.^{2}		60				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 4. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.		105				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 5. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		300				
Long., ft.		420		5		
Allig., $ft.^2$		60				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 6. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		120				
Long., ft.		300		15		
Allig., $ft.^2$		60				
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 7. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	60	60				
Long., ft.	205	210		30		
Allig., ft.^{2}		180				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 8. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.	240					
Long., ft.	155	25		10		
Allig., ft.^{2}		1620				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 9. Brownsville.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		180				
Long., ft.	25	395		10		
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 10. Brownsville.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.	60	60				
Long., ft.	10	205				
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Preconstruction Photolog 11. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		60				
Long., ft.		170				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 12. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		60				
Long., ft.		110		40		
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 13. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		60				
Long., ft.		85		5		
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 14. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		60				
Long., ft.	20	165		5		
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 15. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.		55				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 16. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		60				
Long., ft.		45				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Preconstruction Photolog 17. Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		60				
Long., ft.		75		5		
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Preconstruction Photolog 18. Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		60				
Long., ft.		180		30		
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Brownsville

November, 1985 Survey

Survey Date Nov. 1985 Photolog 1 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		2				
Long., ft.		2				
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$			
Patching, $ft.^2$			
Pumping, ft.			

Survey Date Nov. 1985 Photolog 2 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.		30				
Allig., $ft.^2$						

Distress	Slight	Moderate	Severe
Flushing, $ft.^2$	12		
Patching, $ft.^2$			
Pumping, ft.			

Survey Date Nov. 1985 Photolog 3 Brownsville.

Distress \ Severity (Filled, F; Not, N)	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.		30				
Allig., $ft.^2$						
Flushing, $ft.^2$	60					
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 4 Brownsville.

Distress \ Severity (Filled, F; Not, N)	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.		45				
Allig., $ft.^2$						
Flushing, $ft.^2$	290					
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 5 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 6 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		12				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$	12					
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 7 Brownsville.

Distress \ Severity \ Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}			150			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 8 Brownsville.

Distress \ Severity \ Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}			900			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 9 Brownsville.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 10 Brownsville.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 11 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 12 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 13 Brownsville.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 14 Brownsville.

Distress / Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 15 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		12				
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 16 Brownsville.

Distress / Filled, F; Not, N / Severity	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 17 Brownsville.

Severity / Filled, F; Not, N / Distress	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date Nov. 1985 Photolog 18 Brownsville.

Severity / Filled, F; Not, N / Distress	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Brownsville

May, 1986 Survey

Survey Date May, 1986 Photolog 1. Brownsville.

Distress \ Severity	Slight		Moderate		Severe	
Filled, F; Not, N	F	N	F	N	F	N
Transv., ft.				2		
Long., ft.				5		
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}	3		
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 2. Brownsville.

Distress \ Severity	Slight		Moderate		Severe	
Filled, F; Not, N	F	N	F	N	F	N
Transv., ft.				39		
Long., ft.				226		
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		38	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 3. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.		12				
Long., ft.				64		
Allig., ft.^{2}		5				
Flushing, ft.^{2}	15		80			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date May, 1986 Photolog 4. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.				16		
Long., ft.				119		
Allig., ft.^{2}		25				
Flushing, ft.^{2}			485			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date May, 1986 Photolog 5. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}		5				

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 6. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.				12		
Long., ft.				25		
Allig., ft.^{2}						4

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		12	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 7. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.				12		
Long., ft.				100		
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		310	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 8. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		1800	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 9. Brownsville.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}			28			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date May, 1986 Photolog 10. Brownsville.

Distress \ Severity; Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						
Flushing, ft.^{2}			12			
Patching, ft.^{2}						
Pumping, ft.						

Survey Date May, 1986 Photolog 11. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.				8		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		120	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 12. Brownsville.

Distress \ Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.						
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 13. Brownsville.

Distress \ Severity, Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date May, 1986 Photolog 14. Brownsville.

Distress \ Severity, Filled, F; Not, N	Slight		Moderate		Severe	
	F	N	F	N	F	N
Transv., ft.						
Long., ft.						
Allig., $ft.^2$						
Flushing, $ft.^2$						
Patching, $ft.^2$						
Pumping, ft.						

Survey Date May, 1986 Photolog 15. Brownsville.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.				12		
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}		8	
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 16. Brownsville.

Distress \ Severity (Filled, F; Not, N)	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		12				
Long., ft.						
Allig., ft.^{2}						

Distress	Slight	Moderate	Severe
Flushing, ft.^{2}			
Patching, ft.^{2}			
Pumping, ft.			

Survey Date May, 1986 Photolog 17. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		35				
Long., ft.		240				
Allig., ft.^{2}						
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						

Survey Date May, 1986 Photolog 18. Brownsville.

Distress / Severity / Filled, F; Not, N	Slight F	Slight N	Moderate F	Moderate N	Severe F	Severe N
Transv., ft.		52				
Long., ft.		30				
Allig., ft.^{2}		6				
Flushing, ft.^{2}						
Patching, ft.^{2}						
Pumping, ft.						