QUALITY CONTROL OF RECYCLED ASPHALTIC CONCRETE

FINAL REPORT

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ABSTRACT

This study examined the variations found in recycled asphaltic concrete mix based upon plant quality control data and verification testing. The data was collected from four recycled hot-mix projects constructed in 1981. All plant control and acceptance data was statistically analyzed. Samples of recycled hot mix and reclaimed material were tested and analyzed in the research laboratory to resolve possible conflicts in the plant data. The recycled asphaltic concrete variation was examined with respect to that of the state's conventional asphaltic concrete. Additionally, the quality of the recycled mix's asphalt cement as measured by absolute viscosity was examined with respect to a predictive equation. It was found that variations in recycled mixtures were similar to those of conventional hot mix for all control and acceptance testing. The quality of the asphalt cement in the recycled mix was similar to results anticipated by the prediction equation.

METRIC CONVERSION FACTORS*

To Convert from	To	Multiply by
	Length	
foot	meter (m)	0.3048
inch	millimeter (mm)	25.4
yard	meter (m)	0.9144
mile (statute)	kilometer (km)	1.609
	Area	
square foot	square meter (m^2)	0.0929
square inch	square centimeter (cm^2)	6.451
square yard	square meter (m^2)	0.8361
	Volume (Capacity)	
cubic foot	cubic meter (m^3)	0.02832
gallon (U.S. liquid)**	cubic meter (m^3)	0.003785
gallon (Can. liquid)**	cubic meter (m^3)	0.004546
ounce (U.S. liquid)	cubic centimeter (cm^3)	29.57
	Mass	
ounce-mass (avdp)	gram (g)	28.35
pound-mass (avdp)	kilogram (kg)	0.4536
ton (metric)	kilogram (kg)	1000
ton (short, 2000 lbs)	kilogram (kg)	907.2
	Mass per Volume	
pound-mass/cubic foot	kilogram/cubic meter (kg/m^3)	16.02
pound-mass/cubic yard	kilogram/cubic meter (kg/m^3)	0.5933
pound-mass/gallon (U.S.)**	kilogram/cubic meter (kg/m^3)	119.8
pound-mass/gallon (Can.)**	kilogram/cubic meter (kg/m^3)	99.78
	Temperature	
deg Celsius (C)	kelvin (K)	$t_K=(t_C+273.15)$
deg Fahrenheit (F)	kelvin (K)	$t_K=(t_F+459.67)/1.8$
deg Fahrenheit (F)	deg Celsius (C)	$t_C=(t_F-32)/1.8$

*The reference source for information on SI units and more exact conversion factors is "Metric Practice Guide" ASTM E 380.

**One U.S. gallon equals 0.8327 Canadian gallon.

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IMPLEMENTATION STATEMENT

The recommendations of this report call for the Department to accept the use of reclaimed asphaltic concrete in all mixes governed by Section 501 of the Standard Specifications. It is anticipated that specifications incorporating the use of reclaimed materials will be developed. Implementation of such specifications will provide impetus for contractors to include recycling as part of their normal operations.

INTRODUCTION

In 1978 Louisiana constructed two asphaltic concrete recycling projects as part of a study to determine construction feasibility and to evaluate recycled mix quality, economics and energy conservation aspects. The technological feasibility of producing a recycled asphaltic concrete in both a batch and a dryer drum plant was demonstrated. Material test results indicated that recycled mixes had properties similar to conventional mixes. Economic and conservation aspects were favorable. The recommendations of the published report (1)* called for the Department to consider appropriate means to further the development of the recycling concept. It was believed that specifications could be developed which would permit the substitution of a recycled hot mix for a conventional hot mix.

With regard to this recommendation, the Department let four recycling projects in 1981. The intent of these projects was twofold: (1) to promote the recycling concept among the state's contractors, and (2) to document on a broader data base the quality control aspects associated with recycling efforts.

This report describes the research effort to determine the variations in recycled hot mix based upon the quality control data obtained from the state's recycling projects. Data was collected from the Daily Asphaltic Concrete Reports along with samples of recycled mix and reclaimed material from each of the four projects. The mix samples were used to verify mix properties and to examine the viscosity of the asphalt cement. The data was statistically evaluated and compared to data for conventional asphaltic concrete. Based on this comparison, conclusions and recommendations regarding specifications for recycled hot mix are presented.

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*Underlined numbers in parentheses refer to list of references.

SCOPE

The objective of this study was to establish a broad data base of recycled mix properties which could be used to determine control and acceptance limits for recycled mixes. The scope was confined to data collected from four recycling projects constructed in 1981. This data included normal plant sampling and testing and additional verification testing by the research laboratory on both the recycled mix and reclaimed materials.

METHODOLOGY

The Department's normal schedule of control and acceptance testing at the plant and at the roadway was maintained for the duration of each of four recycling projects. Quality control testing included gradation, asphalt cement content and Marshall properties such as air voids and voids filled with asphalt (VFA). Acceptance testing included in this study were Marshall stability, roadway compaction and gradation (No. 4, No. 40, No. 80 sieves). The plant control and acceptance data as collected from the Daily Asphaltic Concrete Inspection Reports are presented in Tables A-1* through A-5. Roadway sample data are found in Tables A-6 through A-10. It should be noted that data from one project (U.S. 90) have been divided into two sets to distinguish between a 30% reclaim/70% virgin mix design (Lots 1-20) and a 20% reclaim/80% virgin mix design (Lots 21-30). The letter designation "A" represents data from the 30/70 mix design.

In addition to on-going production data, one gallon of recycled mix and one gallon of reclaimed material was sampled for every 1,000 tons of production for each of the recycling projects, to be sent to the research laboratory. These samples were used to verify mix properties and to determine whether any variations found in the recycled mix could be attributed to the reclaimed material. The samples were extracted for gradation and asphalt cement content. Also, the asphalt cement was Abson recovered and absolute viscosities were determined. The recycled mix data is presented in Tables A-11 through A-15, and the reclaimed material properties are found in Tables A-16 through A-20.

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*All tables preceded by the letter "A" will be found in Appendix A, Project Data, page 47.

All data generated either at the plant or at the research laboratory was analyzed using the Department's Statistical Analysis System (SAS) computer program. The statistical evaluation was then considered with respect to a similar analysis of conventional hot mix. In order to eliminate bias due to different job mix formulas and sample sizes, a pooled standard deviation was utilized:

$$J_p = \sqrt{\frac{(N_1-1)S_1^2 + (N_2-1)S_2^2 + \ldots(N_k-1)S_k^2}{N_1+N_2 + \ldots N_k-k}}$$

where: k = Number of subgroups

N = Number of observations

S = Variance of population

The absolute viscosity data obtained from the recycled mix and reclaimed material was examined to determine the quality of the asphalt cement in the recycled mix. Reference (2) provides a prediction equation which can be used to approximate the viscosity of the asphalt in the recycled mix as follows:

$$\text{Log Log } V = a + bP$$

where: V = Desired Viscosity (cp)

P = New Asphalt Cement (% of total binder)

a, b = Constants determined by knowing the viscosities of the reclaimed material and the new asphalt cement.

A brief description of the four recycling projects evaluated under this study is presented on the following pages.

La. 01 - Red River Parish Line-Junction La. 175

State Project No.: 53-08-14

Project Length: 10.162 Miles

Contractor: Madden Contracting Co., Inc.

Plant Type: Modified Standard Havens Dryer Drum

Project Design: Cold Milling - 131,650 square yards (14,500 tons; 2-inch average cut)

Recycled Mix - 21,700 tons (2 1.5-inch lifts)

Reconstruct Shoulders - 8,150 tons reclaimed material

Mix Design: 30/70 Reclaim/Virgin Mix

4.9% Total Asphalt Content (3.4% New AC-30)

Job Mix Formula

Sieve Size	Percent Passing
3/4	94-100
1/2	83-100
No. 4	47-61
No. 10	36-48
No. 40	23-33
No. 80	12-20
No. 200	5-9
% AC	4.5-5.3

La. 21 - Bogalusa-Varnado

State Project No.:	30-04-23
Project Length:	6.901 Miles
Contractor:	Boh Brothers Construction Co., Inc.
Plant Type:	Astec Dryer Drum
Project Design:	Cold Milling - 97,150 square yards (11,000 tons; 2-inch average cut)
	Recycled Mix (Roadway) - 22,300 tons (2 2-inch lifts)
	Recycled Mix (Shoulders) - 8,250 tons (2-inch lift)
Mix Design:	25/75 Reclaim/Virgin Mix
	5.4% Total Asphalt Cement (4.2% New AC-30)

Job Mix Formula

Sieve Size	Percent Passing
3/4	91-100
1/2	82-100
No. 4	52-66
No. 10	38-50
No. 40	21-31
No. 80	7-15
No. 200	4-8
% AC	5.0-5.8

U.S. 80 - Simsboro-Ruston

State Project No.:	01-07-21
Project Length:	7.115 Miles
Contractor:	Madden Contracting Co., Inc.
Plant Type:	Modified Standard Havens Dryer Drum
Project Design:	Cold Milling - 100,555 square yards (11,000 tons, 2-inch average cut)
	Recycled Mix - 16,590 tons (2 1.5-inch lifts)
	Reconstruct Shoulders - 5,600 tons reclaimed material
Mix Design:	30/70 Reclaim/Virgin Mix
	5.0% Total Asphalt Cement (3.5% New AC-30)

Job Mix Formula

Sieve Size	Percent Passing
3/4	94-100
1/2	83-100
No. 4	49-63
No. 10	40-52
No. 40	23-33
No. 80	11-19
No. 200	4-8
% AC	4.6-5.4

U.S. 90 - Junction La. 397-Jefferson Davis Parish Line

State Project No.: 03-05-18

Project Length: 7,888 Miles

Contractor: R. E. Heidt Construction Co., Inc.

Plant Type: 3-Ton Modified Batch (Hot Bin Reclaim Entry)

Project Design: Cold Milling

Mile 0-6.1 - 85,700 square yards (10,700 tons; 2.5-inch average cut)

Mile 6.1-7.9 - 23,350 square yards (2,100 tons; 1.5-inch average cut)

Recycled Mix (Roadway)

Mile 0-6.1 - 14,250 tons (2 1.5-inch lifts)

Mile 6.1-7.9 - 4,900 tons (2-inch and 1.5-inch lifts)

Reconstruct Shoulders

Mile 0-6.1 - 5,600 tons reclaim material

Recycled Mix (Shoulders)

Mile 6.1-7.9 - 1,400 tons (1.5-inch lift)

Mix Design: 30/70 Reclaim/Virgin Mix

5.2% Total Asphalt Cement (3.7% New AC-30)

20/80 Reclaim/Virgin Mix

5.2% Total Asphalt Cement (4.2% New AC-30)

Job Mix Formula

Sieve Size	Percent Passing (30/70 Mix)	Percent Passing (20/80 Mix)
3/4	93-100	92-100
1/2	85-100	84-100
No. 4	54-68	54-68
No. 10	42-54	42-54
No. 40	23-33	23-33
No. 80	12-20	12-20
No. 200	6-10	5-9
% AC	4.8-5.6	4.8-5.6

DISCUSSION OF RESULTS

Analysis by Project

La. 01

The statistical analyses of the data for this project and the following projects are found in Appendix B.* Table B-1 provides the analysis of plant and roadway samples based on individual results. This table along with Figure 1 present the mean values determined for each sieve size. The clear areas on the figure show the limits of the job mix formula while the filled-in portions show the minimum and maximum values obtained during plant production. It is observed that the plant produced a mix within the job mix formula (JMF) with the exception of the No. 200 sieve. This sieve was found to be out of control for one extraction during the first day's run. Table B-2, Mean Plant Data by Lot, shows that the lot average was within the JMF.

Marshall properties were generally within specification limits. Marshall stabilities, as shown in Figure 2, were well above the 1200-lb. minimum specified for Type 1 mixes. The mean stability was 1763 with a standard deviation of 171 lbs. It should be noted that the mean air voids for this project was near the lower specification limit and that less than the minimum 3.0 percent air voids was achieved for three lots (Table B-2). Consequently, the VFA percentage was high for these lots. In each case, control was re-established with the following lot.

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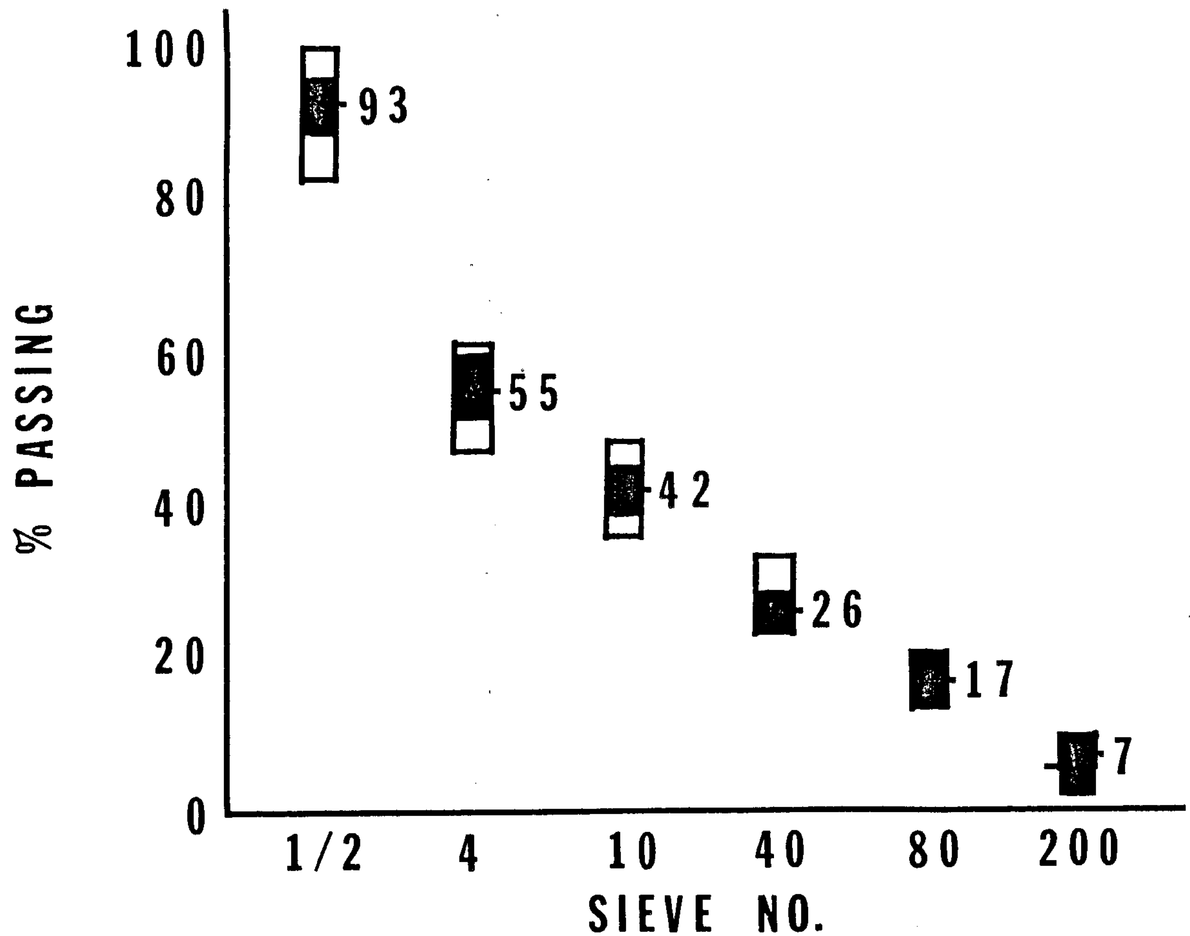
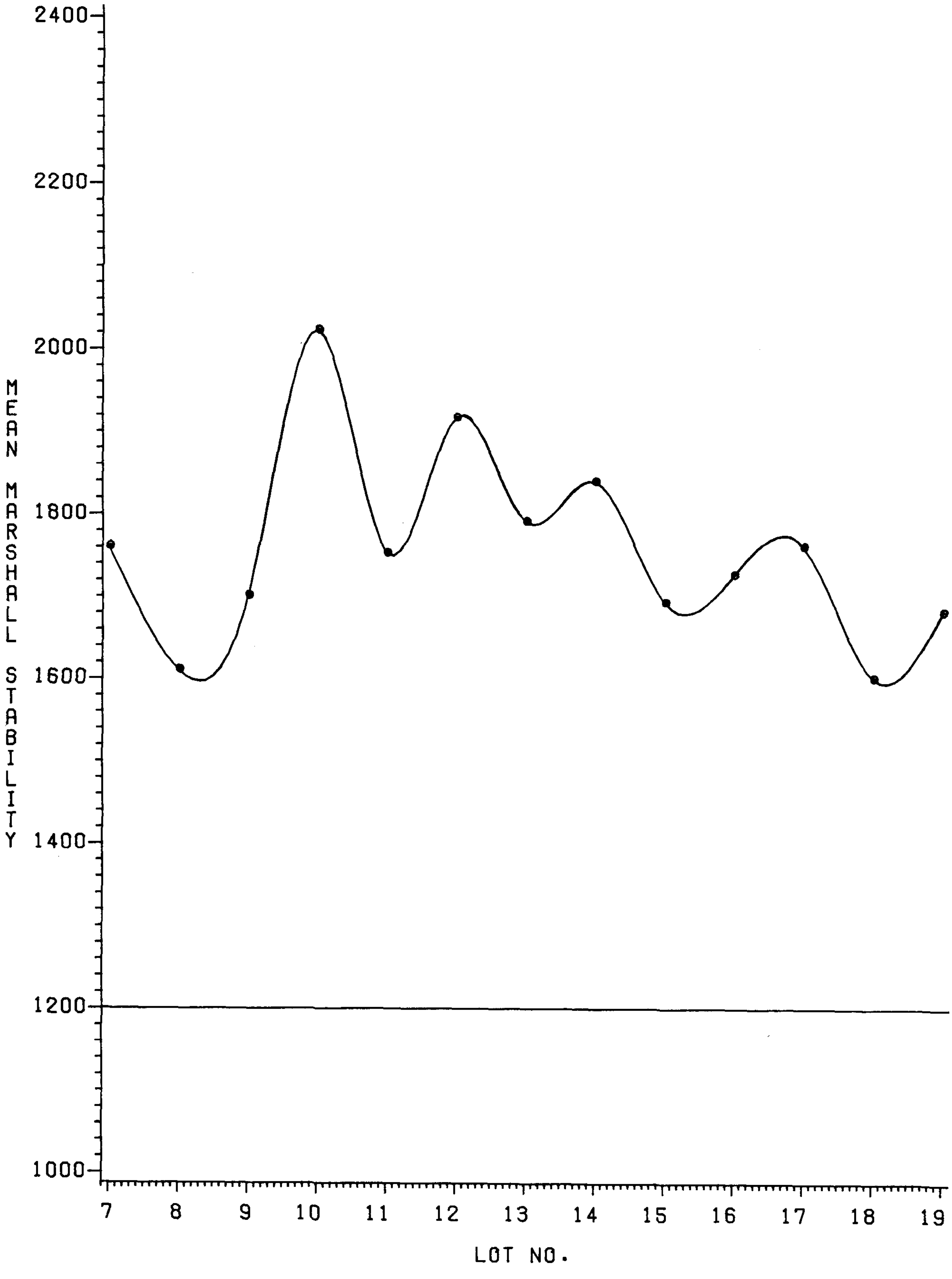
*All tables preceded by the letter "B" will be found in Appendix B, Statistical Analyses, page 67.



Recycled Mix Gradation Control - La. 01

FIGURE 1

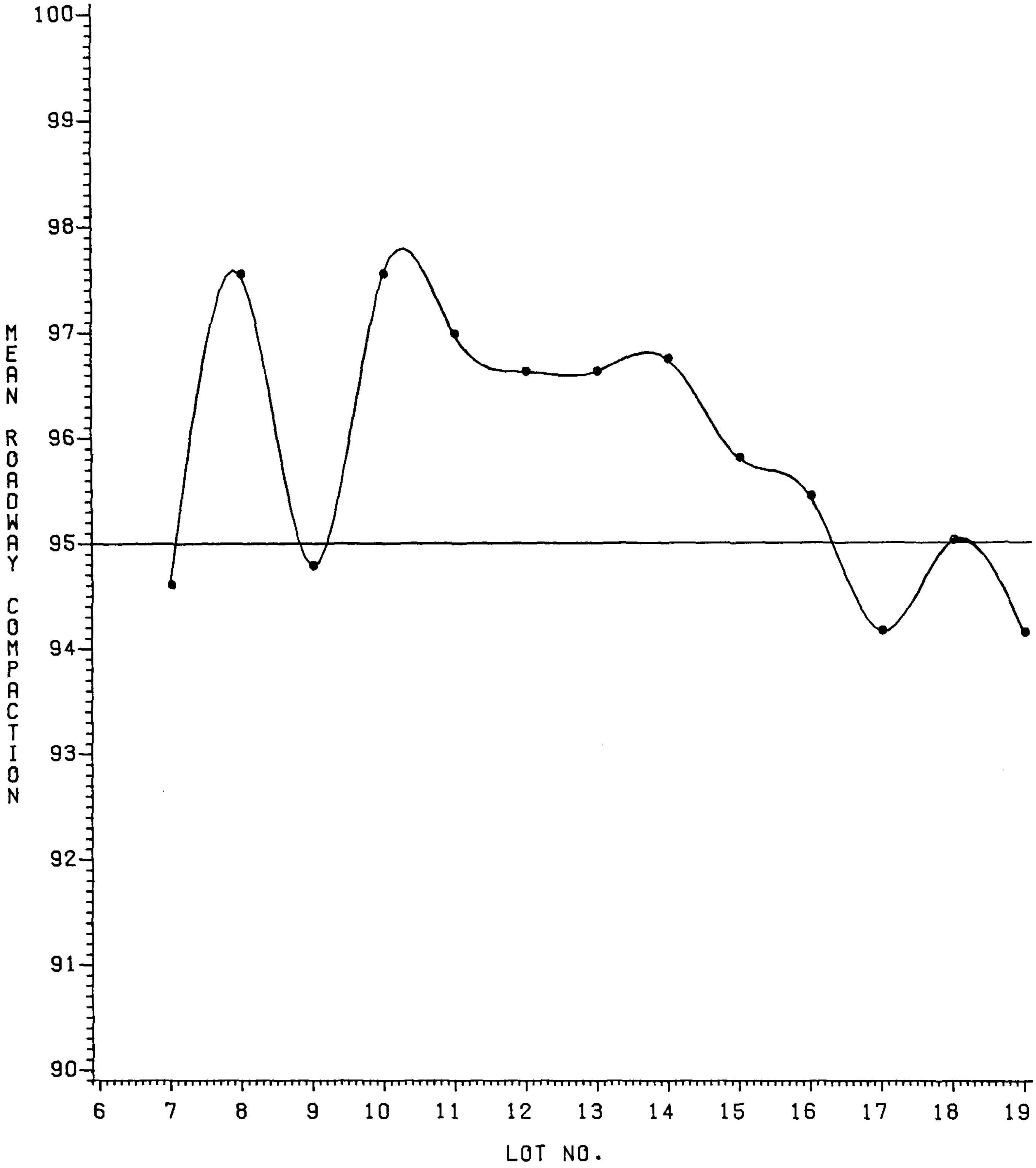


Mean Marshall Stabilities - La. 01

FIGURE 2

Figure 3 shows the compactive effort attained for the project. While the mean percent compaction of 95.8 is above the 95 percent specification, it is apparent that four lots (Nos. 7, 9, 17 and 19) fell below that limit. Discussions with the district laboratory and project engineers indicated that base support was the probable cause for the low compaction for lots 9 and 17. The low compaction on lot 19 may be related to mix problems associated with a low specific gravity on a plant briquette for that lot.

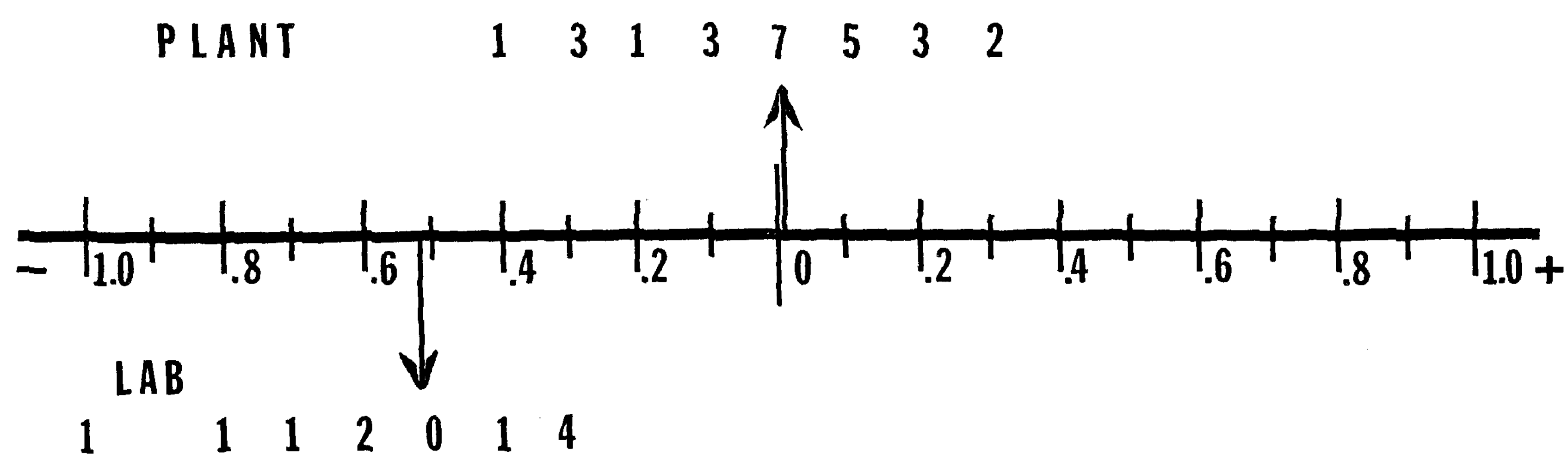
Asphalt cement content appeared to be maintained in excellent control during operations as a mean plant-extracted value of 4.9 percent was the design asphalt content. Figure 4 provides a graphic presentation of the distribution of plant-extracted asphalt contents. This figure depicts the frequency of asphalt contents above or below the design content in increments of ± 0.1. It should be noted from the figure that seven of the twenty-five plant extraction results had asphalt contents of 4.9%. In fact, all of the plant values were within the job mix formula tolerance limits of ± 0.4 and were normally distributed. Also shown on this figure are the frequencies for the recycled mix samples examined at the research laboratory. The mean of 4.4 percent, which is provided in Table B-3, certainly does not agree with the plant data. Upon investigation, two factors were found to have influenced the mix's asphalt content: ash correction and reclaimed material asphalt content. The plant personnel used an ash correction consistent with their conventional production. Samples of solvent from the centrifuge examined at the district laboratory, however, showed that a higher ash correction was necessary for the recycled mix. Use of this value would have lowered all plant asphalt contents by 0.3 percent, thereby reducing the plant mean to 4.6 percent. That this value was lower than design was a direct consequence of the reclaimed material's asphalt content. The difference between the mean of 4.1 percent (Table B-4) found in the reclaimed material at the research laboratory and the 5.0 percent assumed during production, at a 30 percent reclaim feed rate, would effectively reduce the recycled mix asphalt content by 0.3 percent.



Mean Roadway Compaction - La. 01

FIGURE 3

LA 01
ASPHALT CONTENT CONTROL
(4.9)



La. 01 - Asphalt Content Control

FIGURE 4

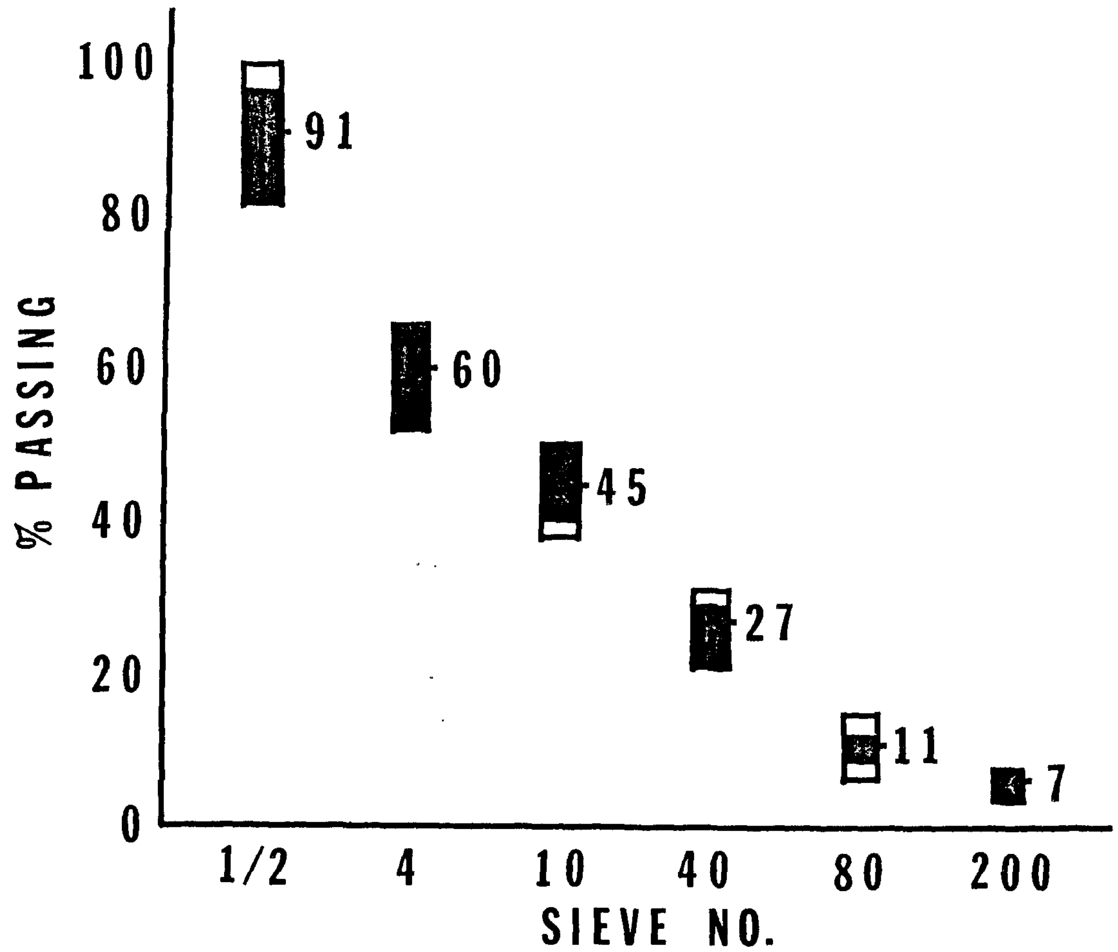
La. 21

Figure 5 presents graphically the gradation data given in Table B-5 for this project. While the minimum and maximum values for most of the sieve sizes reached the tolerance limits, none were found to exceed those limits. Table B-6 shows very little variation in between-lot averages.

Marshall properties were well within specification limits and demonstrated small standard deviations. A discrepancy was discovered in briquette stabilities between the plant and verification samples tested at the district laboratory. The proving ring on the Marshall apparatus at the plant was replaced beginning with lot 9. As such, the Marshall stability values were divided into two different sets to eliminate bias. The mean Marshall stabilities are presented in Figures 6 and 7. Mean and standard deviations for lots 1-8 (Figure 6) were 2,020 lbs. and 232 lbs., respectively. Figure 7, lots 9-20 had a mean stability of 1,822 and a standard deviation of 169. The larger deviation for lots 1-8 may be due to the faulty proving ring.

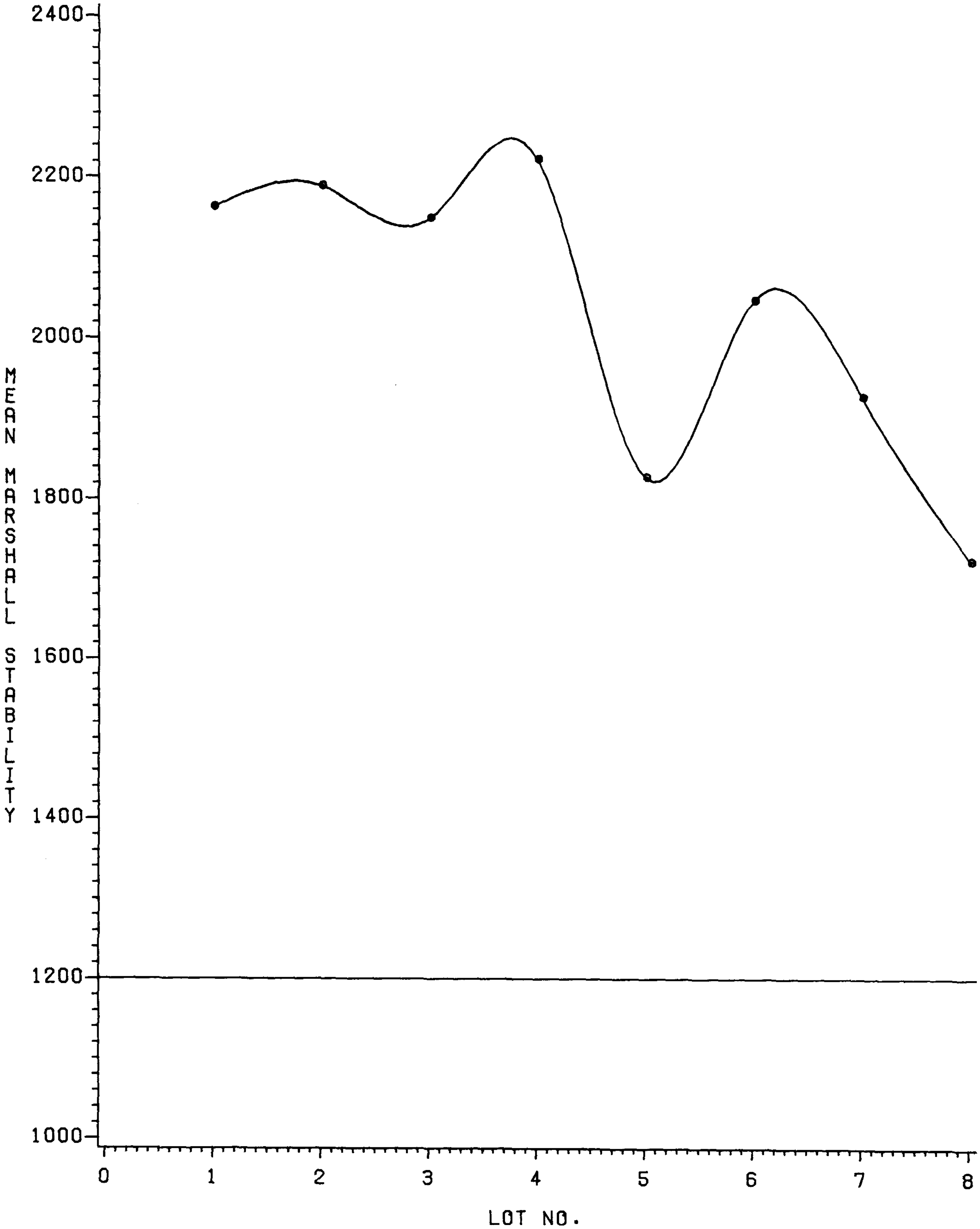
The compactive effort is presented in Figure 8. The consistency of the compaction achieved can be observed and is readily verified by a low standard deviation of 1.24 (Table B-5).

Tables B-7 and B-8 present the analysis data obtained from recycled mix and reclaimed material by the research laboratory. The recycled mix analysis conforms to that of the plant with the exception of the asphalt cement content. The mean plant content was 5.1 (Table B-5) as opposed to the 5.6 mean obtained in the research analysis. Concern over asphalt content control was expressed during plant operations. While extractions showed low asphalt contents, totalizing meters on the asphalt feed line indicated that sufficient quantities were being fed. Verification samples at the district laboratory extracted by reflux showed a mean content of 5.4 percent, the targeted design.



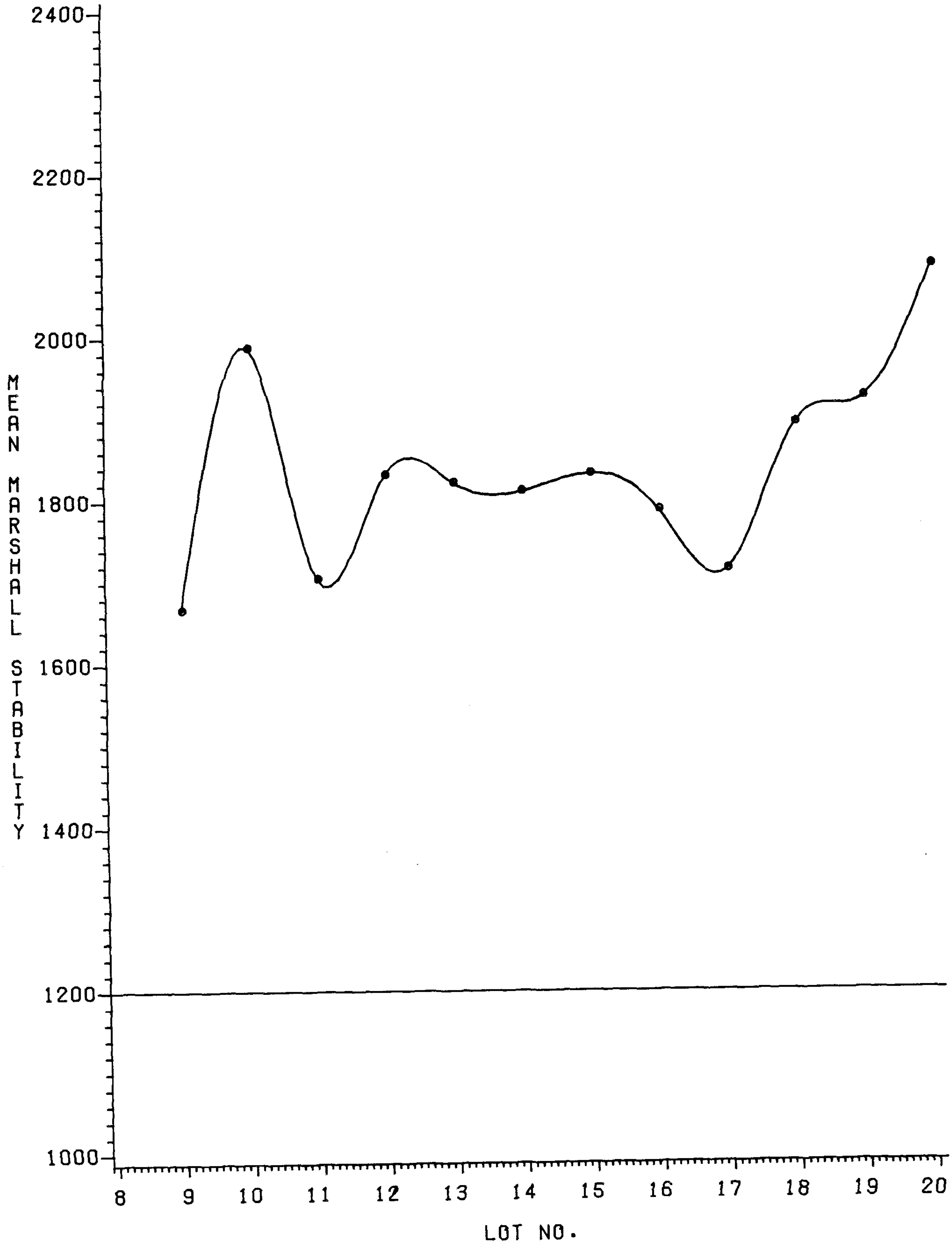
Recycled Mix Gradation Control - La. 21

FIGURE 5



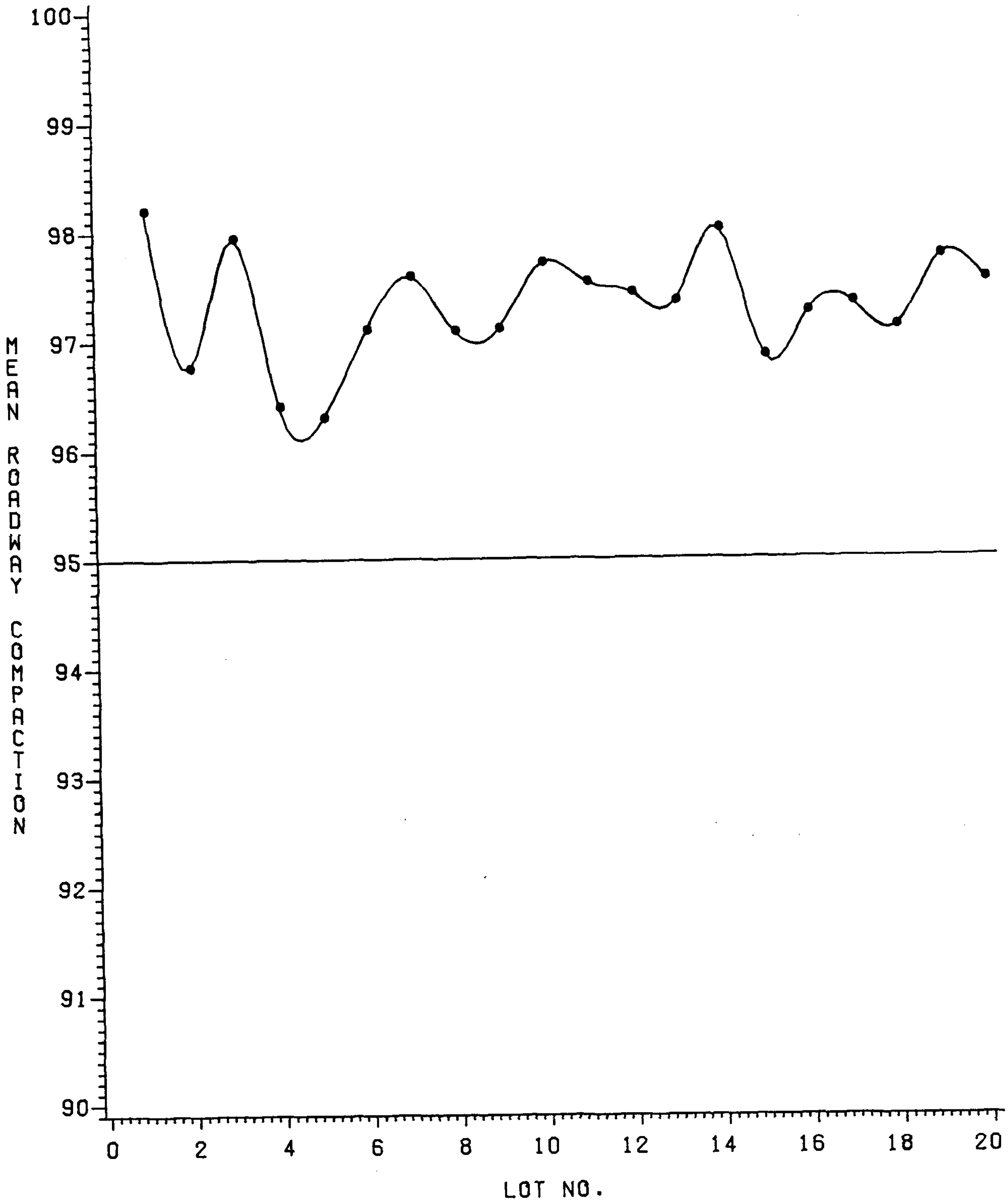
Mean Marshall Stabilities - La. 21A

FIGURE 6



Mean Marshall Stabilities - La. 21

FIGURE 7



Mean Roadway Compaction - La. 21

FIGURE 8

In addition, the research laboratory examined the asphalt content using a volumetric method which concurred with the district laboratory's reflux findings. It was believed then that error was being introduced by the ash correction as several ash contents were determined during operations, each one widely varying from the previous one. Figure 9 depicts the asphalt control exhibited on both the plant and the research samples. The frequencies of both the plant and the lab samples are normally distributed about their respective means. Tables B-5 and B-7 show that their standard deviations are close. A truer ash correction for either or both sets of samples would shift the data so that the means would approach a common value.

U.S. 80

The gradation data for this project as shown in Figure 10 was derived from Table B-9. Sieve No. 40 was outside the tolerance limits for one sample in lot 1. The average for this lot as well as the other lots for all sieve sizes was well within the control limits (Table B-10).

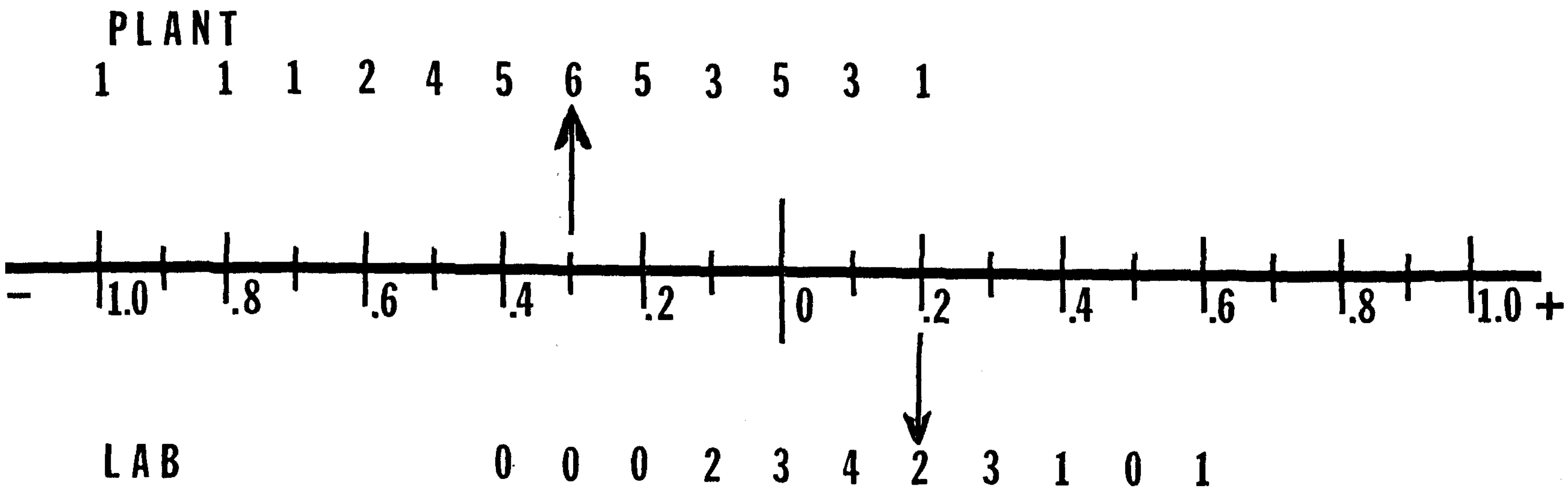
Mean Marshall stabilities and roadway compaction are presented in Figures 11 and 12. In both cases consistent control can be observed. This is substanted by the means and standard deviations (1719, 163; 96.6, 1.31) found in Table B-9. Average void content and VFA's (Table B-10) were out of control on two lots but control in each case was restored in the following lots.

Gradation and asphalt cement data for the recycled mix and reclaimed materials examined by the research laboratory are presented in Tables B-11 and B-12. The mean and standard deviation of gradations and asphalt content agree well with those of the plant extractions. Figure 13 shows that the asphalt content obtained by research is slightly higher than that of the plant and that the distribution of values is similar.

LA 21

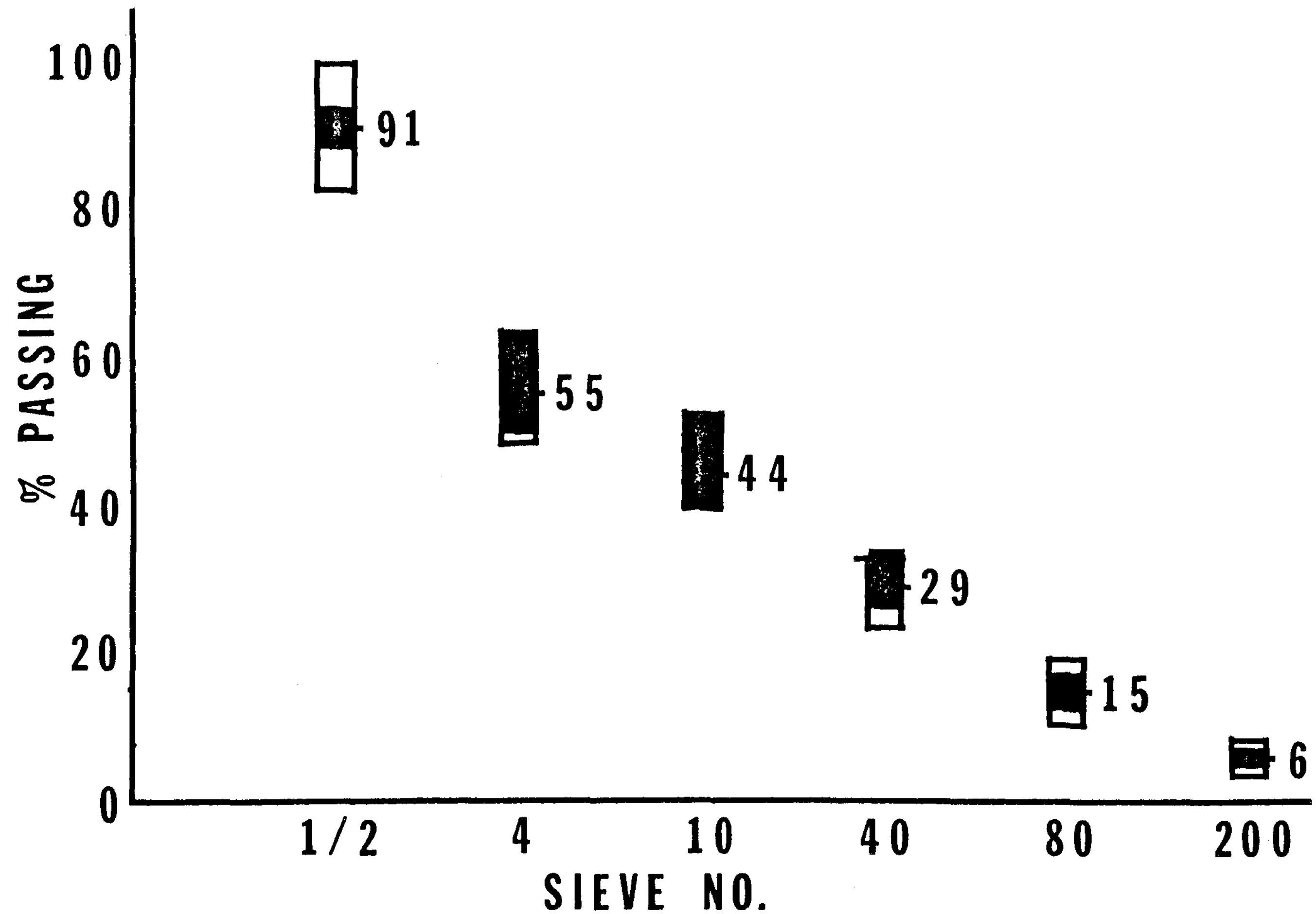
ASPHALT CONTENT CONTROL

(5.4)



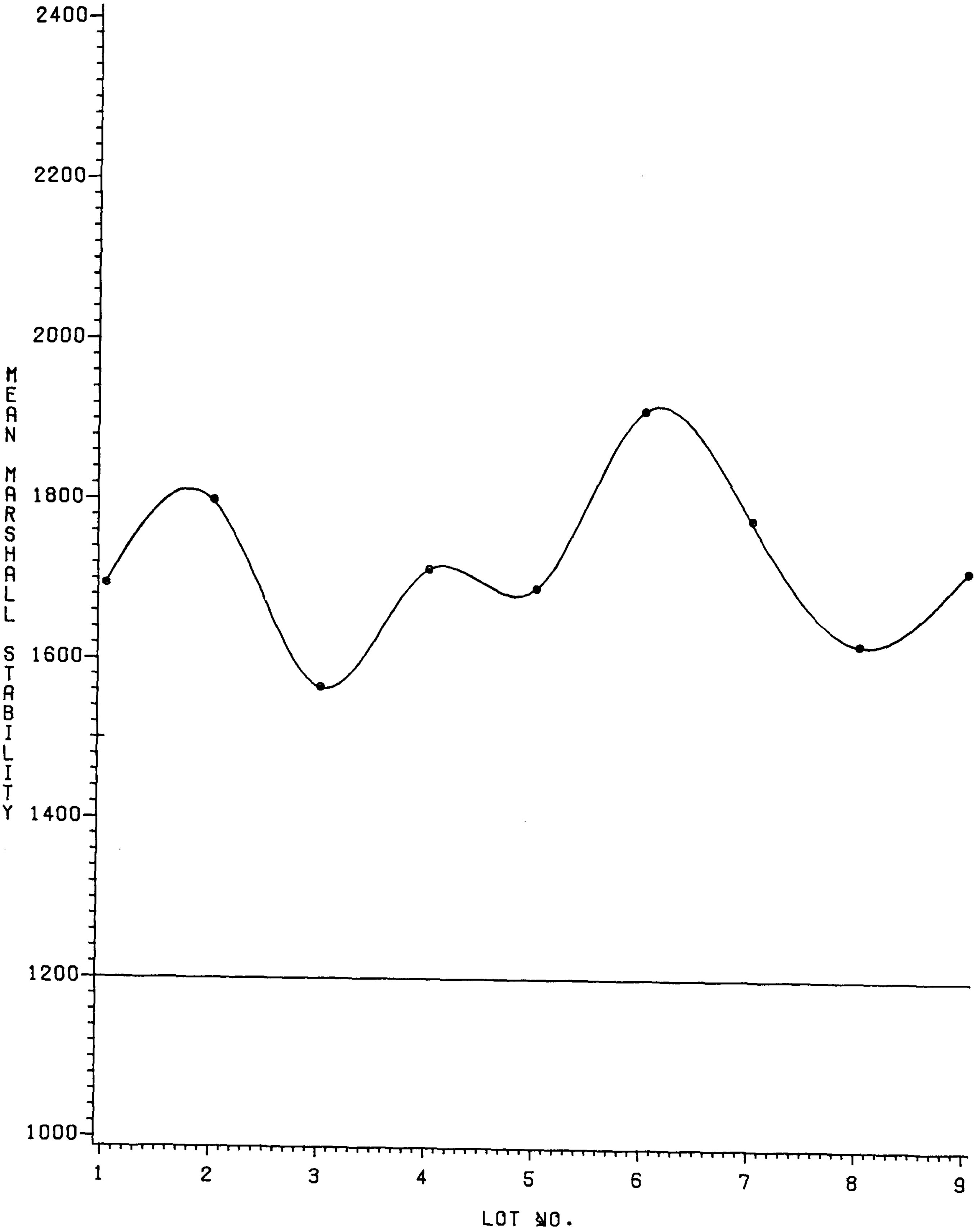
La. 21 - Asphalt Content Control

FIGURE 9



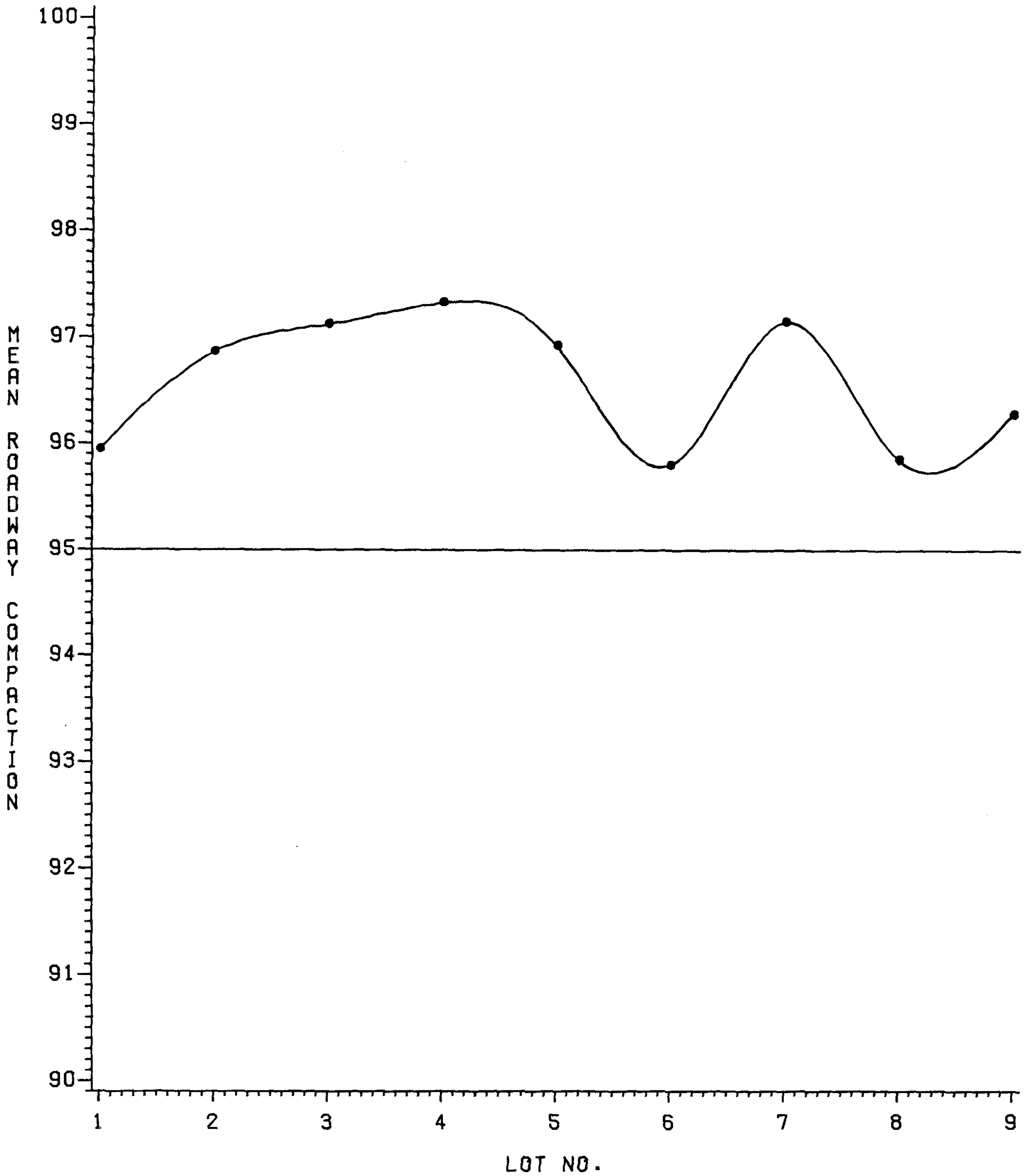
Recycled Mix Gradation Control - U.S. 80

FIGURE 10



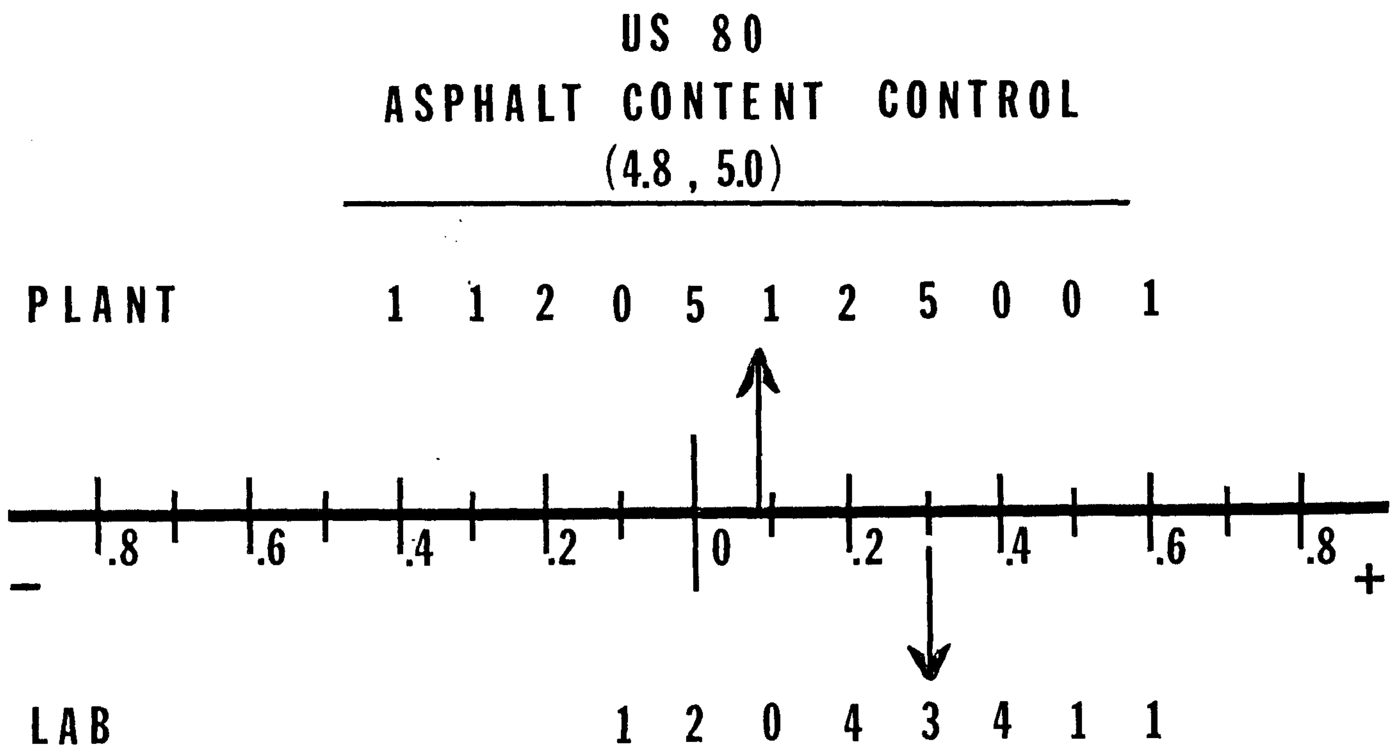
Mean Marshall Stabilities - U.S. 80

FIGURE 11



Mean Roadway Compaction - U.S. 80

FIGURE 12



U.S. 80 - Asphalt Content Control

FIGURE 13

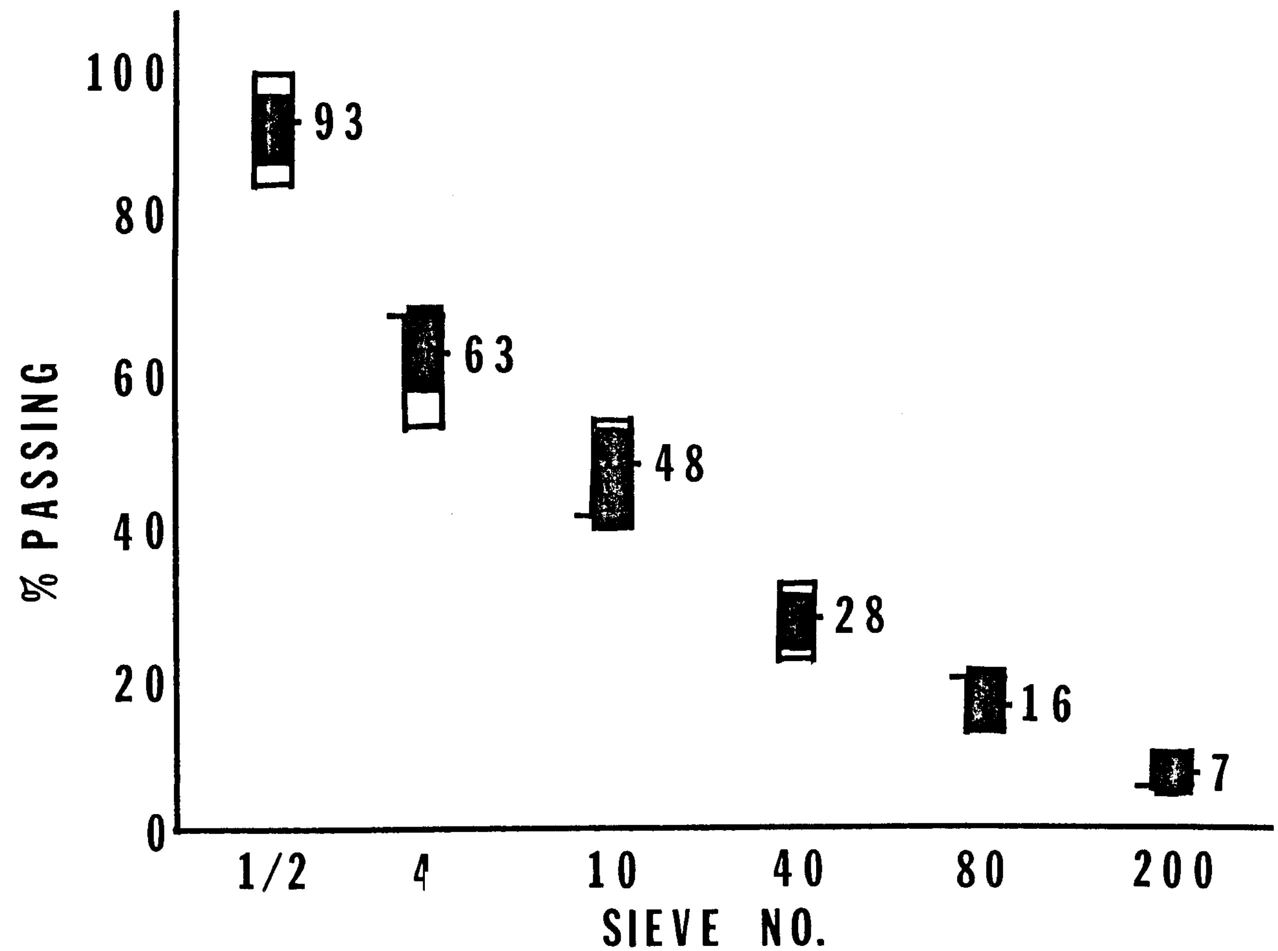
U.S. 90

Tables B-13 and B-14 present the analysis of plant and roadway data for each of the two sets of reclaim/virgin ratios used on the project. The "A" assignment was used to designate the 30/70 recycling ratio. The gradation analysis shows that the change in the reclaim feed did not have an effect on the mean values for the various sieve sizes. As such, Figure 14 combines the data. It is seen that minimum and maximum values exceeded the job mix formula limits on sieves No. 4, No. 10, No. 80 and No. 200. Tables B-15 and B-16 which present the average data by lot show that only lot 24 had significant problems with gradation control. However, it is noted that those results were based on only one sample.

As expected, the higher ratio reclaim/virgin mix produced a higher mean Marshall stability. This is evidenced in Figures 15 and 16. However, it is seen that the higher proportion of oxidized asphalt cement in the 30/70 blend does not affect any of the other Marshall properties. Both air voids and VFA's are observed to be similar with respect to the different mix designs. Figure 16 does show that the average stability for lot 21 is below the minimum specification limit. Table B-16 reports that all Marshall properties for this lot were out of control. It is known that a poor quality sand material caused this situation. A shift to the original sand eliminated the problem.

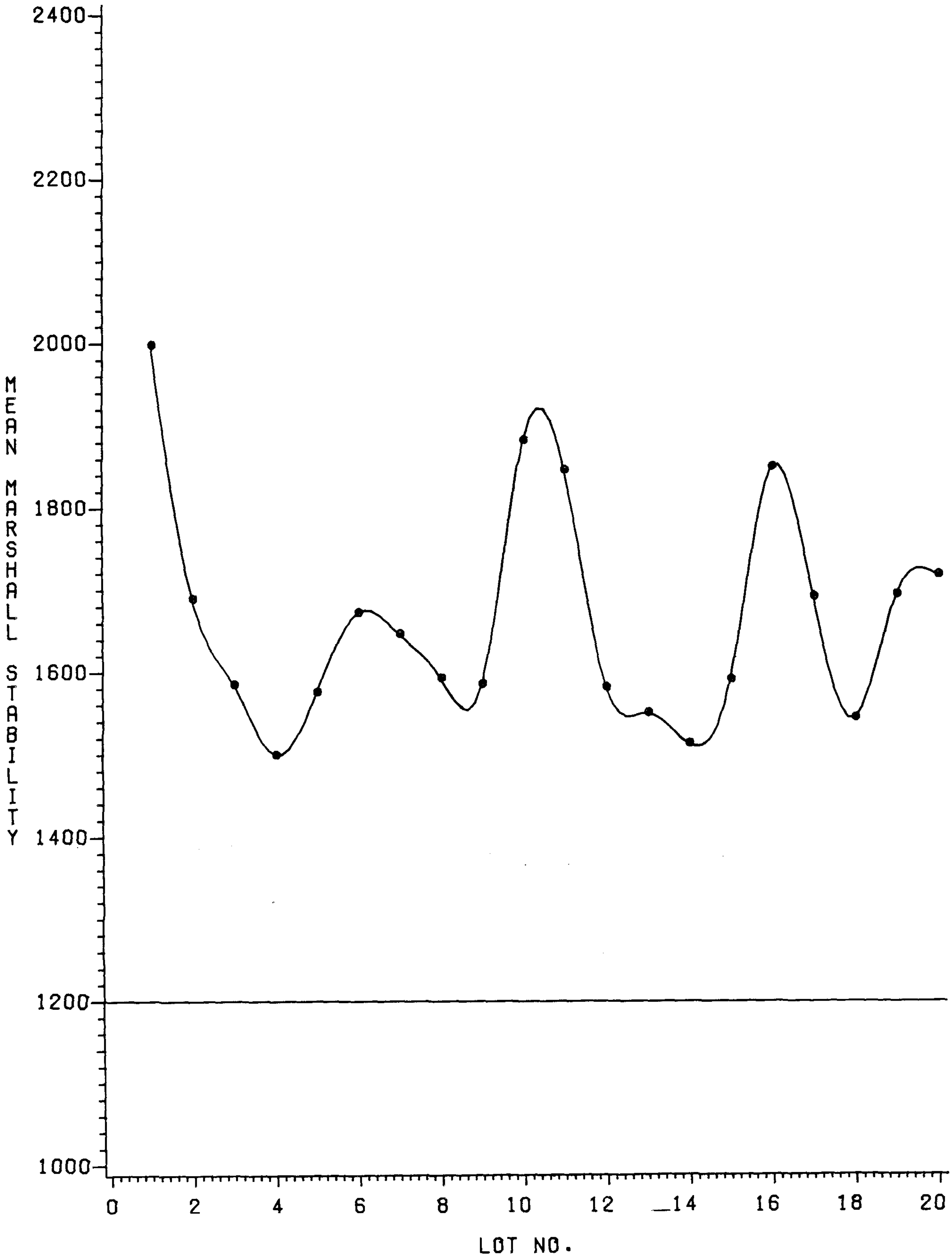
Figures 17 and 18 show that a similar pattern developed in roadway compaction, wherein the higher reclaimed proportioned mix maintained a higher mean compaction. The standard deviations were virtually the same. The lower than specification compaction achieved in lot 19 was due to the very low value of one core sample.

Tables B-17 and B-20 provide the analysis of recycled mix and reclaimed material performed by the research lab. The analysis shows identical results to those of the plant with respect to gradation.



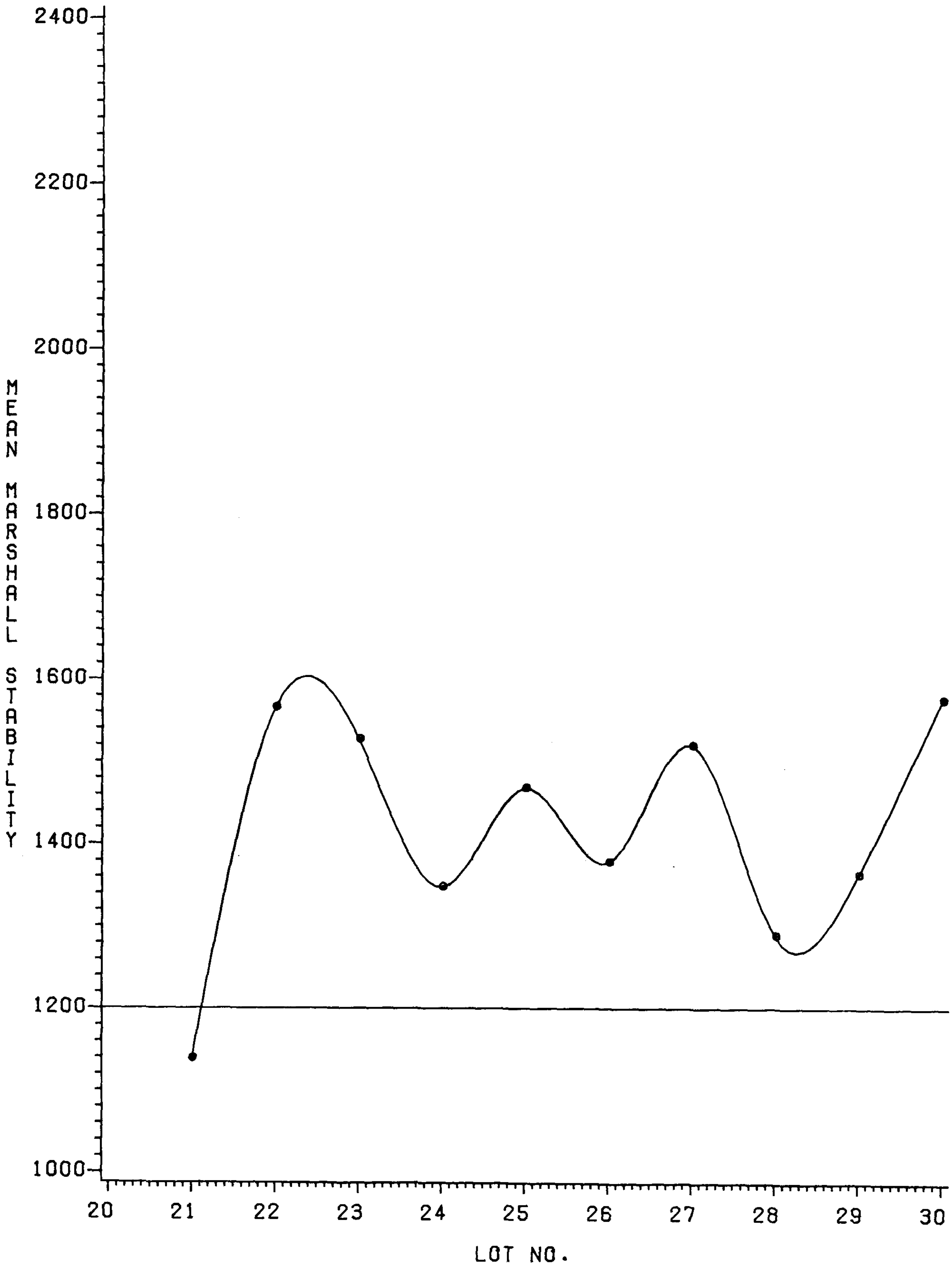
Recycled Mix Gradation Control - U.S. 90

FIGURE 14



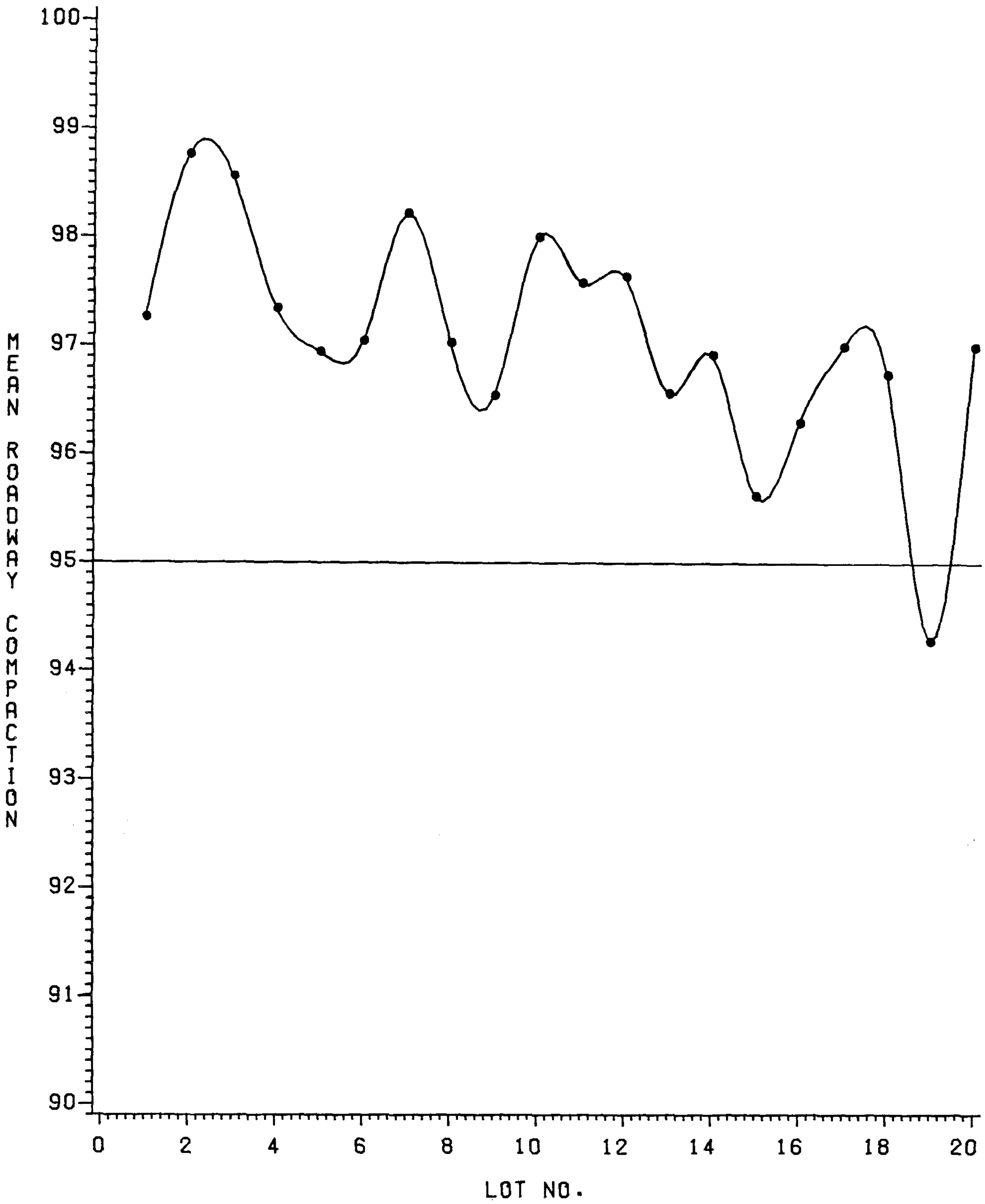
Mean Marshall Stabilities - U.S. 90A

FIGURE 15



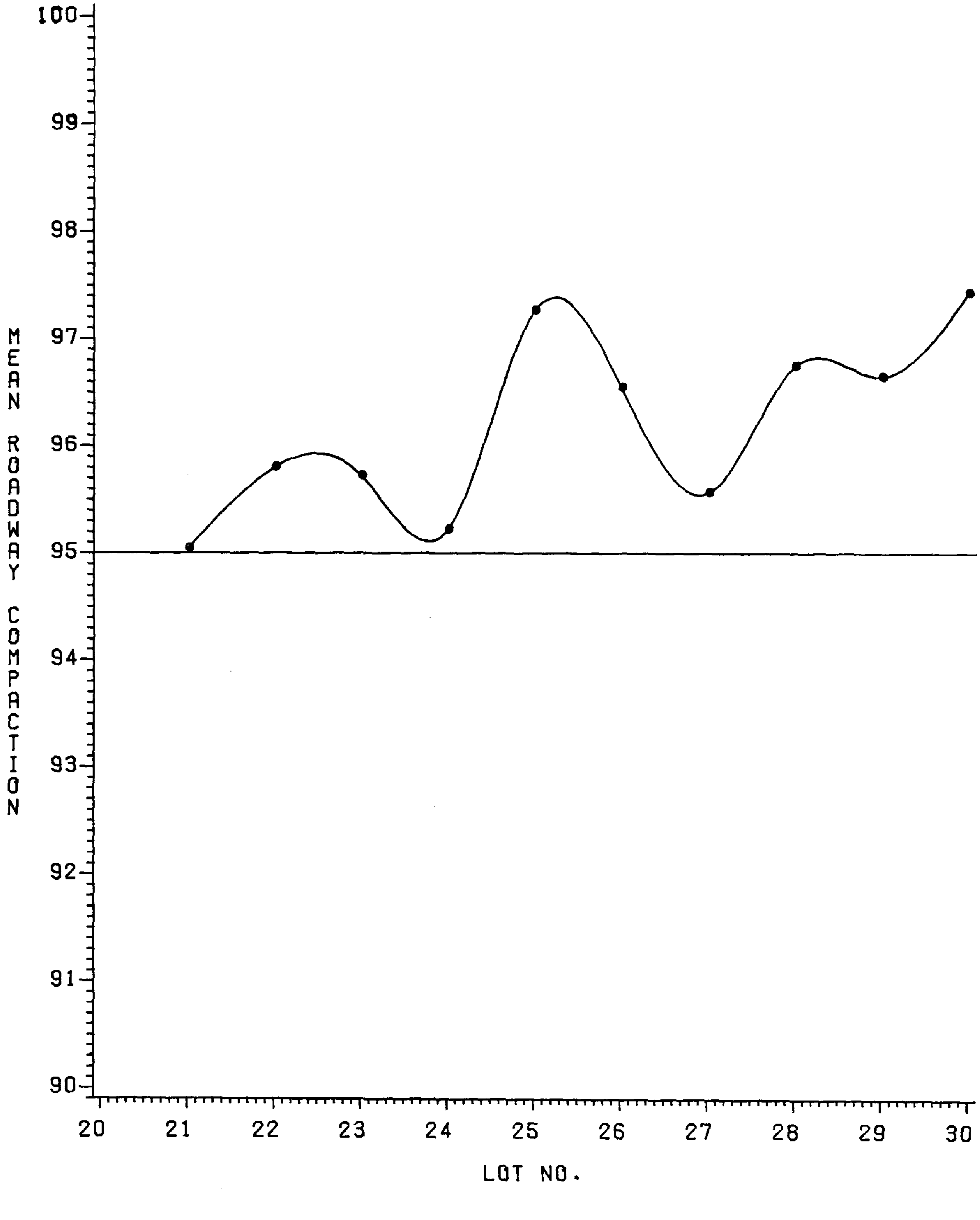
Mean Marshall Stabilities - U.S. 90

FIGURE 16



Mean Roadway Compaction - U.S. 90A

FIGURE 17



Mean Roadway Compaction - U.S. 90

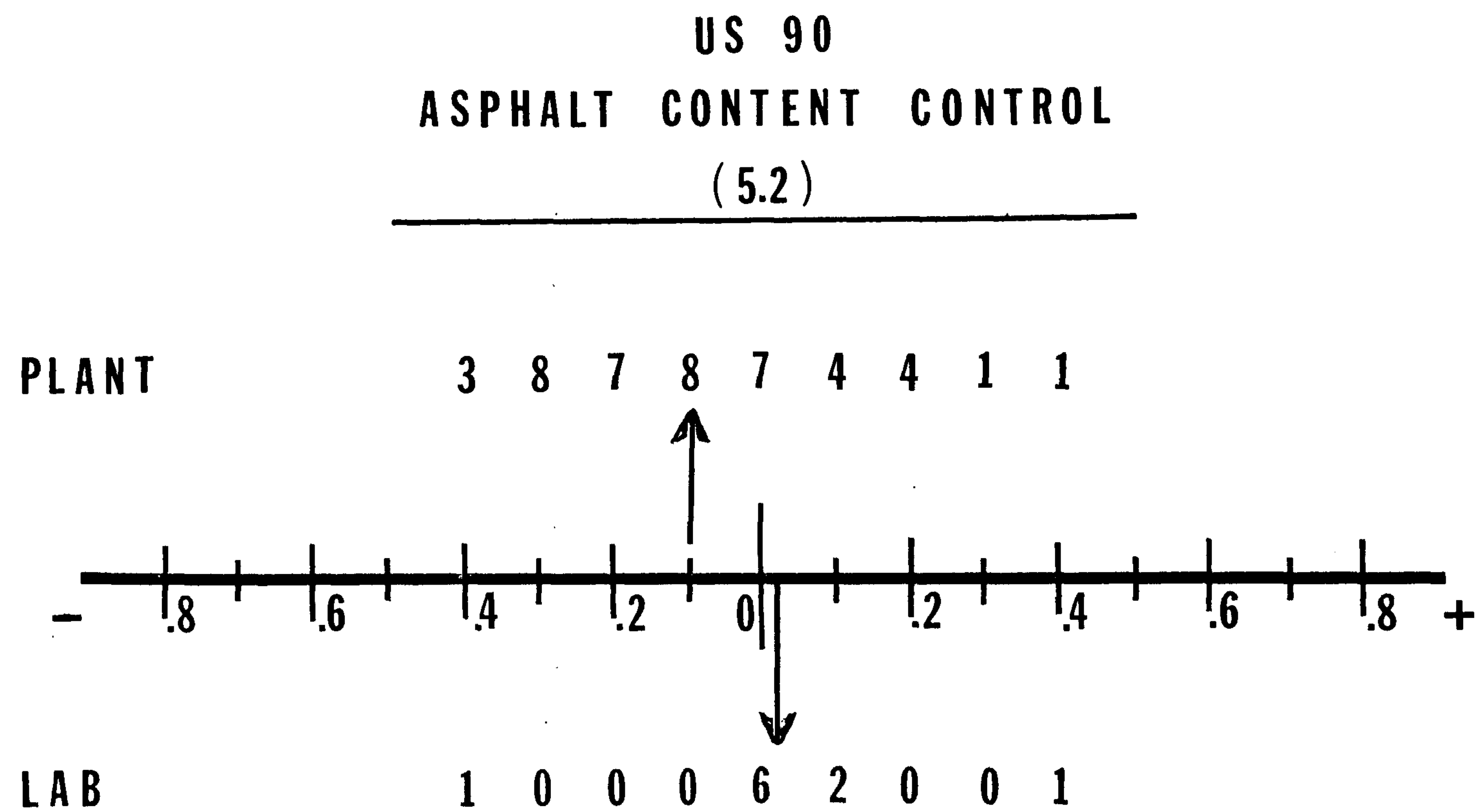
FIGURE 18

Also, Figure 19 demonstrates that asphalt cement content control was accurate and precise at both the plant and the research lab.

Asphalt Cement Quality Analysis

The quality of asphalt cement in bituminous mix is not directly tested as part of a normal control and acceptance testing program. However, as the asphalt cement quality is considered to play a great role in the durability and therefore longevity of bituminous mix, the initial quality is monitored by a biannual plant certification test. As a measure of quality, the Abson recovered asphalt cement is tested for absolute viscosity at 140°F (AASHTO T 202-14). The value obtained cannot be greater than 2,000 poises above the viscosity of the original asphalt after thin film oven aging with a maximum of 12,000 poises as an upper limit of acceptability. The imposition of this maximum limit (4 times the original viscosity) will reduce the possibility of placing pre-aged or less durable mix. It was believed that the quality of recycled mix should also be examined with this in mind.

The absolute viscosities of samples of recycled mix and reclaimed material are reported in the tables for each project in Appendix B and are presented in Table 1. A prediction equation based on a previous study, as presented in the Methodology section of this report, was used to develop the values shown in the table. Three of the projects closely approximated the predicted viscosities, while the recycled mix on U.S. 80 exceeded its prediction by a factor of 1.6. Three possibilities exist which could explain this greater than anticipated value. First, the equation is predicated on a blending of two asphalt cements, each at some different viscosity, at some level of proportioning. The prediction is not inclusive of any plant aging effect. Most plants in Louisiana generally age the asphalt during production at rates of about 1.2 through 2.75. The second factor to consider is the viscosity of the reclaimed material.



U.S. 90 - Asphalt Content Control

FIGURE 19

TABLE 1

RECYCLED ASPHALT CEMENT VISCOSITIES*

	La. 01	La. 21	U.S. 80	U.S. 90
Reclaimed Material	173,598	294,141	434,240	351,828
Recycled Mix	9,241	8,473	18,096	13,684
Prediction Equation	9,020	8,292	11,264	10,712

*Recovered absolute viscosities @ 140°F (poises).

The viscosity test procedure states that the test method is only applicable for viscosities under 200,000 poises. The accuracy of values obtained for the reclaimed material (especially for U.S. 80 and possibly for U.S. 90) may then be considered suspect. A final factor is related to the source of asphalt cement. Reference 3 concludes that asphalt source plays a significant role in the accuracy of recovered asphalt viscosity. Any one or all of these factors may be influencing the value of the asphalt viscosity in the final recycled mix.

With respect to the 12,000-poise maximum limit on viscosity of asphalt cement in new mixes, it would seem that the use of a rejuvenator, a lower viscosity asphalt cement or the reduction of the reclaim-to-virgin ratio could have been specified. However, as a result of the capability associated with the prediction equation, these choices could be simplified. Table 2 has been developed to facilitate an acceptable design of subsequent recycling projects. Estimated viscosities in this table suggest the following two points:

1. Regardless of the viscosity of the reclaimed material, the use of more than 25 percent of this material with new AC-30 asphalt cement will result in a harder binder than is presently acceptable; and,

2. The use of AC-10 asphalt cement (1,000 poises) in recycled mixes containing 25 to 50 percent old material would, in nearly every case, provide binder properties preferable to those of a mix using AC-30 at the 25 percent reclaimed level.

Although it would seem feasible from Table 2 to use AC-10 with a 50 percent reclaim addition level (11,022 poises), this rate may not produce a desirable mix. The three factors indicated above (plant aging, reclaim viscosity above test procedure limits, and asphalt source) might increase the final asphalt cement viscosity above the

TABLE 2

PREDICTED RECYCLED MIX VISCOSITIES

Vis. of New AC (poises)	Vis. of Reclaimed AC (poises)	% of Reclaim in Final Mix	Predicted Vis. (poises), Before Plant Aging
3,000	30,000	25	5,138
"	"	40	7,178
"	"	50	8,992
"	100,000	25	6,664
"	"	40	11,022
"	"	50	15,543
"	200,000	25	7,686
"	"	40	13,954
"	"	50	21,092
1,000	30,000	25	2,155
"	"	40	3,497
"	"	50	4,881
"	100,000	25	2,746
"	"	40	5,249
"	"	50	8,234
"	200,000	25	3,138
"	"	40	6,562
"	"	50	11,022

12,000-poise criteria. Whether or not such a final viscosity is tolerable would depend on the economics of recycling versus conventional designs and the possibility of reduced pavement life. Until such time as the performance of recycled pavements is evaluated this question seems moot.

Variation of Recycled Mixes

For purposes of this study variability was measured using sample standard deviations obtained by dividing the sum of squared deviations by the number of degrees of freedom, N-1. These deviations can then be assumed to be an unbiased estimate of population standard deviation. The sample standard deviations for gradation, asphalt content, stability and percent compaction for each project are recompiled from Appendix B and presented in Table 3. The pooling equation reported in the Methodology section was applied to each quantity, and the pooled results are provided in Table 4. Also shown in Table 4 are the standard deviations for conventional Type 1 mix produced by the same plants in 1981. Additionally, the table contains the tolerance limits which are used in current specifications. These limits were developed in Reference 4.

It can be observed in Table 4 that the pooled standard deviations of the recycled mix gradation are lower on each sieve size than those of the conventional hot mix produced by the same plants. A variation of 2σ in the recycled hot mix would still remain within the specification tolerance limits. This indicates that for control purposes, less than 2.5 percent on either side of the limits would be cast off in normal probability. As such, the variation in recycled mixes is comparable or better than the conventional hot mix variation.

The gradation acceptance criteria are based on the average percent deviation from tolerance limits per lot on the Nos. 4, 40 and 80 sieves. The project analysis presented earlier stated that gradation

TABLE 3

SAMPLE STANDARD DEVIATIONS FOR RECYCLED PROJECTS

	Project									
	La. 01		La. 21		U.S. 80		U.S. 90A		U.S. 90	
Quantity	N	σ	N	σ	N	σ	N	σ	N	σ
3/4	26	0.00	37	0.36	18	0.59	31	0.90	18	0.00
1/2	26	2.11	37	2.87	18	1.91	31	2.02	18	3.16
No. 4	26	2.23	37	3.70	18	2.65	31	3.04	18	3.61
No. 10	26	1.66	37	2.68	18	2.66	31	2.29	18	2.94
No. 40	26	1.30	37	1.61	18	1.79	31	1.86	18	2.20
No. 80	26	1.16	37	0.81	18	1.02	31	1.87	18	2.09
No. 200	26	1.39	37	0.83	18	0.51	31	1.20	18	1.04
% AC	25	0.19	37	0.27	18	0.27	31	0.20	18	0.22
Stab.	41	171	72	220	34	163	52	165	33	173
% Comp.	65	1.70	100	1.24	45	1.31	100	1.51	50	1.55

TABLE 4

POOLED STANDARD DEVIATIONS

Quantity	Recycled Hot Mix (4 Projects)	Conventional Hot Mix (Same Plants)	Specification Tolerance Limits
3/4	.53	.62	± 6
1/2	2.47	3.27	± 9
No. 4	3.14	4.00	± 7
No. 10	2.45	4.17	± 6
No. 40	1.73	2.67	± 5
No. 80	1.43	2.42	± 4
No. 200	1.05	1.29	± 2
% AC	.23	.24	± .4
Stability	186	175	
% Compaction	1.46	1.30	

control problems were limited to only one lot of the U.S. 90 project. Application of the acceptance criteria shows that no pay adjustments would have been made to this lot or any other lot of the recycled hot mix.

Table 4 shows that the variation in asphalt cement content is similar between the conventional and recycled hot mixes. Both of these values compare favorably with a historical standard deviation of 0.25 (4). While the variation of asphalt content is acceptable, the accuracy is found to be dependent on the ash correction and accuracy of the reclaimed material's asphalt content. It should be noted that errors in the asphalt content of the reclaimed material would produce proportionate errors in recycled mixes using higher levels of reclaimed material.

The Marshall stability variation found with the recycled hot mix is virtually the same as that obtained with the conventional mix. Also, there is no difference between these values and the 190-lb. standard deviation associated with historical data (4). The mean stabilities for the recycled projects were high for Type 1 mixes. It is believed that this is principally due to the increased viscosity of the binder in the recycled mix. Consequently, mixes with higher levels of reclaimed materials may have increased stabilities; such increase, then, should not necessarily be considered indicative of a better project. The increased stability with increased reclaim ratio can be observed in the U.S. 90 data.

Roadway compaction pooled standard deviations as presented in Table 4 show more variability for the recycled mix than for the conventional mix. Data generated during the implementation of the state's statistically oriented end-result type specifications reported a pooled standard deviation of 1.41 (5). As such, variation of the compactive effort for the recycled projects compares favorably.

CONCLUSIONS

The following conclusions are drawn from the data generated in this study and, as such, are constrained by the number of projects examined and the addition rates of reclaimed materials utilized in those projects.

1. The variations found in recycled mixtures are similar to those of conventional hot mix for all control and acceptance testing including gradation, asphalt cement content, Marshall properties and roadway compaction.

2. The accuracy of asphalt cement content in a recycled mix is dependent on the correction due to ash content; the ash correction for a recycled mix tends to be greater than for a conventional hot mix.

3. Asphalt cement content accuracy is dependent on a knowledge of the reclaimed material's asphalt content and the rate at which reclaimed material is blended with virgin materials; the dependency is increased for higher reclaim/virgin ratios.

4. Asphalt cement quality as measured by absolute viscosity is a constraint which limits the reclaim/virgin ratio that can be utilized when employing an AC-30 grade of asphalt cement as the new binder; the use of a less consistent asphalt cement or a rejuvenating agent would allow for higher reclaim/virgin ratios.

5. A prediction equation exists which provides a good approximation of the asphalt cement viscosity to be expected in a recycled mix.

RECOMMENDATIONS

Currently, recycling projects are under construction using Special Provisions. Based on the findings of this study it is recommended that supplemental specifications be approved which would incorporate the special provisions now in use and the following specific recommendations:

1. Allow the use of reclaimed asphaltic concrete materials in any mix included in Section 501 of the Standard Specifications; such a mix should be governed by all provisions of Section 501.

2. The Department should permit the contractor to use whatever percentage of milled material he elects, up to a maximum of 40 percent. Conditional would be the specification of virgin AC-30 grade asphalt cement for mixes containing less than 25 percent reclaimed material or AC-10 grade for mixes containing 25 percent or greater.

It is further recommended that evaluations should be initiated on the four projects covered by this report to examine recycled asphaltic concrete pavements in relation to conventional hot mix pavements in the performance mode. Accomplishment of these performance evaluations could aid in the refinement of both road and mix design.

It is finally recommended that appropriate ash corrections be used for each recycling project. Inherent in this recommendation would be an evaluation of the suitability of the Department's current ash procedure (TR-314) when used in conjunction with recycled mixes.

LIST OF REFERENCES

1. Carey, D. E., and Paul, H. R., Hot Plant Recycling of Asphaltic Concrete, Louisiana Department of Transportation and Development, Research Report No. 143, May 1980.

2. Carey, D. E., and Paul, H. R., Effects of Asphalt Cement Rejuvenating Agents, Louisiana Department of Transportation and Development, Research Report No. 146, August 1980.

3. Carey, D. E., and Paul, H. R., Evaluation of Asphalt Cement Extraction and Recovery Methods, Louisiana Department of Transportation and Development, Research Report No. 157, July 1982.

4. Shah, S. C., Quality Control Analysis Part I - Asphaltic Concrete, Louisiana Department of Highways, Research Report No. 15, November 1964.

5. Shah, S. C., and Yoches, Veto, Quality Control Analysis Part V, Louisiana Department of Highways, Research Report No. 94, December 1975.

APPENDIX A

PROJECT DATA

LIST OF TABLES

Table No. Page No.

TABLE A-1

PLANT CONTROL AND ACCEPTANCE DATA - LA. 01

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
7	1678	2.37	2.5	82	100	93	55	43	24	14	2	5.2
7	1308	2.39	1.6	88	100	89	51	40	26	18	9	.
7	1795	2.38	2.1	85	.	.	.	.	.	.	.	.
8	1588	2.36	3.7	75	100	93	58	45	28	19	7	5.0
8	1632	2.37	3.3	77	100	91	51	40	27	17	6	4.9
9	1851	2.36	3.7	75	100	92	54	41	25	16	6	4.6
9	1558	2.36	3.7	75	100	90	55	44	28	15	7	5.1
9	1693	2.38	2.9	79	.	.	.	.	.	.	.	.
10	1853	2.36	3.7	75	100	96	57	43	26	16	6	5.2
10	2082	2.37	3.3	77	100	95	58	44	26	16	6	4.9
10	2131	2.38	2.9	79	.	.	.	.	.	.	.	.
11	1730	2.32	5.3	69	100	94	57	44	27	18	7	4.9
11	1769	2.36	3.7	75	100	92	54	41	27	18	8	4.9
11	1758	2.37	3.3	77	.	.	.	.	.	.	.	.
12	2021	2.38	2.9	80	100	96	57	43	26	17	7	4.9
12	1823	2.36	3.7	75	100	92	52	39	23	15	6	4.7
12	1899	2.37	3.3	77	.	.	.	.	.	.	.	.
12	1922	2.37	3.3	77	.	.	.	.	.	.	.	.
13	1796	2.38	2.9	80	100	94	56	44	28	18	9	5.0
13	1785	2.36	3.7	75	100	90	53	40	24	15	6	4.6
14	1882	2.39	2.4	83	100	90	54	40	24	16	7	4.8
14	1901	2.39	2.4	83	100	95	59	44	26	17	7	5.1
14	1720	2.37	3.3	77	.	.	.	.	.	.	.	.
14	1853	2.38	2.9	80	.	.	.	.	.	.	.	.
15	1678	2.37	3.3	77	100	92	54	42	26	17	7	5.0
15	1606	2.37	3.3	77	100	95	59	43	26	17	8	4.5
15	1793	2.37	3.3	77	.	.	.	.	.	.	.	.
16	1588	2.38	2.9	80	100	93	53	41	27	17	8	4.8
16	1639	2.38	2.9	80	100	92	54	42	27	17	9	4.8
16	1951	2.38	2.9	80	.	.	.	.	.	.	.	.
17	1915	2.36	3.7	75	100	95	55	41	25	16	7	4.9
17	1743	2.37	3.3	77	100	96	57	44	27	17	7	4.9
17	1623	2.38	2.9	80	.	.	.	.	.	.	.	.
17	1761	2.38	2.9	80	.	.	.	.	.	.	.	.
18	1877	2.36	3.7	75	100	94	55	42	26	18	7	4.6
18	1239	2.39	2.4	83	100	94	54	41	26	16	7	5.1
18	1732	2.38	2.9	80	.	.	.	.	.	.	.	.
18	1555	2.34	4.5	71	.	.	.	.	.	.	.	.
19	1807	2.38	2.9	80	100	90	54	41	25	16	8	5.0
19	1369	2.32	5.3	68	100	91	54	41	26	17	8	5.0
19	1867	2.37	3.3	77	.	.	.	.	.	.	.	.

TABLE A-2

PLANT CONTROL AND ACCEPTANCE DATA - LA. 21

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
1	2165	2.34	3.7	77	98	87	58	43	26	11	7	5.1
1	2346	2.32	4.5	73	100	92	59	43	24	11	8	5.4
1	2129	2.34	3.7	77	.	.	.	.	.	.	.	.
1	2007	2.32	4.5	73	.	.	.	.	.	.	.	.
2	2018	2.34	3.7	77	100	90	58	43	25	10	6	5.1
2	2381	2.34	3.7	77	100	94	58	43	26	10	6	5.1
2	2152	2.33	4.1	75	.	.	.	.	.	.	.	.
2	2196	2.33	4.1	75	.	.	.	.	.	.	.	.
3	2063	2.33	4.1	75	100	93	58	45	27	11	6	5.5
3	2230	2.33	4.1	75	.	.	.	.	.	.	.	.
4	1844	2.32	4.5	73	100	90	60	46	27	10	6	5.2
4	2412	2.34	3.7	77	100	93	61	46	26	10	6	5.2
4	2358	2.32	4.5	73	.	.	.	.	.	.	.	.
4	2263	2.33	4.1	75	.	.	.	.	.	.	.	.
5	1962	2.34	3.7	77	100	89	57	44	26	10	6	5.4
5	1789	2.33	4.1	75	100	91	62	46	27	10	6	5.3
5	1736	2.32	4.5	73	.	.	.	.	.	.	.	.
5	1811	2.32	4.5	73	.	.	.	.	.	.	.	.
6	2079	2.33	4.1	75	100	93	59	45	26	11	7	5.1
6	1962	2.34	3.7	77	100	85	53	40	24	10	6	4.7
6	2207	2.34	3.7	77	.	.	.	.	.	.	.	.
6	1929	2.34	3.7	77	.	.	.	.	.	.	.	.
7	1855	2.31	4.9	71	100	89	54	40	22	9	5	4.6
7	2015	2.33	4.1	75	100	95	66	50	29	12	7	4.8
7	1982	2.33	4.1	75	.	.	.	.	.	.	.	.
7	1844	2.33	4.1	75	.	.	.	.	.	.	.	.
8	1617	2.33	4.1	75	100	90	57	43	25	10	6	5.0
8	2002	2.33	4.1	75	100	93	61	48	27	11	7	4.4
8	1417	2.30	5.3	69	.	.	.	.	.	.	.	.
8	1842	2.33	4.1	75	.	.	.	.	.	.	.	.

TABLE A-2 (CONTINUED)

PLANT CONTROL AND ACCEPTANCE DATA - LA. 21

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
9	1817	2.34	3.7	77	100	92	63	46	25	10	6	5.4
9	1522	2.32	4.5	73	100	90	53	41	25	9	6	4.9
9	1717	2.33	4.1	75	.	.	.	.	.	.	.	.
9	1611	2.34	3.7	77	.	.	.	.	.	.	.	.
10	1994	2.33	4.1	75	100	91	65	49	29	12	7	5.6
10	1982	2.33	4.1	75	.	.	.	.	.	.	.	.
11	1685	2.33	4.1	75	100	92	64	48	28	11	7	5.3
11	1697	2.34	3.7	77	100	94	63	47	28	11	7	5.4
11	1732	2.33	4.1	75	.	.	.	.	.	.	.	.
12	1986	2.33	4.1	75	100	89	58	45	27	11	7	4.9
12	1823	2.33	4.1	75	100	91	66	50	29	11	7	5.5
12	1945	2.33	4.1	75	.	.	.	.	.	.	.	.
12	1574	2.34	3.7	77	.	.	.	.	.	.	.	.
13	1678	2.31	4.9	71	100	94	61	45	26	10	7	4.8
13	1888	2.31	4.9	71	100	91	59	45	27	11	7	4.9
13	2065	2.32	4.5	73	.	.	.	.	.	.	.	.
13	1659	2.31	4.9	71	.	.	.	.	.	.	.	.
14	1769	2.31	4.9	71	100	94	65	48	28	12	8	5.4
14	1890	2.32	4.5	73	100	93	62	45	26	10	6	4.9
14	1630	2.30	5.3	69	.	.	.	.	.	.	.	.
14	1960	2.32	4.5	73	.	.	.	.	.	.	.	.
15	1991	2.32	4.5	73	100	93	59	46	28	11	7	5.0
15	1871	2.32	4.5	73	100	93	58	45	28	11	7	5.0
15	1861	2.32	4.5	73	.	.	.	.	.	.	.	.
15	1611	2.31	4.9	71	.	.	.	.	.	.	.	.
16	1519	2.31	4.9	71	100	94	65	48	28	11	7	5.2
16	1968	2.32	4.5	73	100	89	56	43	26	11	7	5.0
16	1833	2.33	4.1	75	.	.	.	.	.	.	.	.
16	1815	2.33	4.1	75	.	.	.	.	.	.	.	.
17	1745	2.32	4.5	73	100	97	64	48	29	12	8	5.3
17	1667	2.32	4.5	73	100	92	60	43	26	12	8	5.0
17	1814	2.32	4.5	73	.	.	.	.	.	.	.	.
17	1638	2.32	4.5	73	.	.	.	.	.	.	.	.
18	2056	2.32	4.5	73	100	91	59	44	26	11	7	5.2
18	1787	2.33	4.1	75	100	94	61	46	27	12	7	5.1
18	1843	2.33	4.1	75	.	.	.	.	.	.	.	.
19	2139	2.33	4.1	75	100	88	55	41	25	10	4	5.2
19	1968	2.32	4.5	73	99	82	52	40	29	10	6	5.1
19	1746	2.32	4.5	73	.	.	.	.	.	.	.	.
19	1852	2.31	4.9	71	.	.	.	.	.	.	.	.
20	2262	2.33	4.1	75	100	91	61	45	26	11	7	5.5
20	1914	2.33	4.1	75	.	.	.	.	.	.	.	.

TABLE A-3

PLANT CONTROL AND ACCEPTANCE DATA - U.S. 80

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
1	1633	2.35	3.7	76	100	91	62	52	34	17	6	5.2
1	1829	2.37	2.9	80	100	90	56	45	29	15	6	5.2
1	1669	2.38	2.5	82	.	.	.	.	.	.	.	.
1	1643	2.37	2.9	80	.	.	.	.	.	.	.	.
2	1490	2.36	3.3	77	99	89	54	43	28	15	6	5.1
2	1791	2.36	3.3	77	99	90	55	44	28	15	5	5.0
2	1938	2.37	2.5	82	.	.	.	.	.	.	.	.
2	1971	2.35	3.3	78	.	.	.	.	.	.	.	.
3	1604	2.35	3.3	78	100	92	54	44	30	16	7	5.0
3	1386	2.36	2.9	80	100	90	51	40	26	14	6	4.8
3	1540	2.35	3.3	78	.	.	.	.	.	.	.	.
3	1725	2.37	2.5	82	.	.	.	.	.	.	.	.
4	1448	2.37	2.5	82	100	89	50	40	26	13	5	4.6
4	1833	2.37	2.5	82	100	93	58	47	30	15	6	5.3
4	1953	2.36	2.9	80	.	.	.	.	.	.	.	.
4	1614	2.36	2.9	80	.	.	.	.	.	.	.	.
5	1717	2.34	4.1	73	100	90	54	44	29	16	5	4.6
5	1602	2.36	3.3	77	100	93	56	46	29	16	6	5.1
5	1801	2.35	3.7	75	.	.	.	.	.	.	.	.
5	1632	2.36	3.3	77	.	.	.	.	.	.	.	.
6	1691	2.35	3.7	75	100	93	54	44	27	14	5	4.8
6	1897	2.36	2.9	80	100	90	55	44	28	14	6	4.7
6	1960	2.32	4.5	72	.	.	.	.	.	.	.	.
6	2094	2.36	2.9	80	.	.	.	.	.	.	.	.
7	1760	2.36	2.9	80	100	89	55	44	28	15	6	5.3
7	1673	2.36	2.9	80	100	89	53	43	28	14	6	5.0
7	1939	2.35	3.3	78	.	.	.	.	.	.	.	.
7	1725	2.35	3.3	78	.	.	.	.	.	.	.	.
8	1705	2.36	2.9	80	100	88	54	43	28	14	6	5.3
8	1568	2.37	2.5	82	99	93	57	45	28	14	6	5.0
8	1540	2.36	2.9	80	.	.	.	.	.	.	.	.
8	1663	2.36	2.9	80	.	.	.	.	.	.	.	.
9	1740	2.35	3.3	78	99	88	54	45	29	14	6	5.6
9	1682	2.36	2.9	80	98	94	57	47	30	14	6	5.1

TABLE A-4

PLANT CONTROL AND ACCEPTANCE DATA - U.S. 90A

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
1	1982	2.33	4.1	74	97	92	65	50	31	21	10	5.2
1	2013	2.35	3.3	78	.	.	.	.	.	.	.	.
2	1612	2.35	3.3	78	100	93	61	48	28	17	8	5.3
2	1586	2.35	3.3	78	100	94	61	47	25	14	6	4.9
2	1870	2.36	2.9	80	.	.	.	.	.	.	.	.
3	1604	2.35	3.3	78	100	92	59	45	24	14	6	5.5
3	1686	2.35	3.3	78	100	94	62	48	27	16	7	5.4
3	1464	2.35	3.3	78	.	.	.	.	.	.	.	.
4	1510	2.33	4.1	74	100	92	62	48	27	16	7	5.1
4	1494	2.34	3.7	76	100	92	63	50	28	19	6	5.3
4	1495	2.33	4.1	74	.	.	.	.	.	.	.	.
5	1677	2.34	3.7	76	100	94	61	48	28	17	6	5.1
5	1525	2.32	4.5	72	97	90	58	45	26	17	6	5.4
5	1525	2.31	4.9	70	.	.	.	.	.	.	.	.
6	1815	2.34	3.7	76	100	92	62	47	26	17	5	4.9
6	1557	2.34	3.7	76	100	91	62	47	26	16	8	5.0
6	1647	2.35	3.3	78	.	.	.	.	.	.	.	.
7	1647	2.35	3.3	78	100	93	60	45	24	14	6	5.0
7	1647	2.35	3.3	78	.	.	.	.	.	.	.	.
8	1556	2.34	3.7	76	100	93	63	47	25	14	6	5.4
8	1631	2.33	4.1	74	.	.	.	.	.	.	.	.
9	1586	2.32	4.5	72	100	94	59	45	26	16	7	4.9
10	1891	2.33	4.1	74	100	92	61	46	26	16	6	4.9
10	1970	2.33	4.1	74	100	95	67	50	27	16	7	5.0
10	1790	2.33	4.1	74	.	.	.	.	.	.	.	.
11	1847	2.31	4.9	70	100	94	62	48	29	18	7	4.8
12	1891	2.33	4.1	74	100	95	67	51	28	15	6	5.1
12	1525	2.31	4.9	70	100	94	66	50	28	14	7	4.8
12	1388	2.31	4.9	70	.	.	.	.	.	.	.	.
12	1525	2.35	3.3	78	.	.	.	.	.	.	.	.
13	1292	2.31	4.9	70	100	94	64	49	27	13	5	5.3
13	1833	2.34	3.7	76	100	95	67	52	30	16	7	5.0
13	1459	2.33	4.1	74	.	.	.	.	.	.	.	.
13	1620	2.33	4.1	74	.	.	.	.	.	.	.	.
14	1541	2.33	4.1	74	100	96	69	52	29	15	6	5.4
14	1568	2.32	4.5	72	100	95	65	49	27	14	5	5.1
14	1433	2.32	4.5	72	.	.	.	.	.	.	.	.
15	1433	2.33	4.1	74	100	94	59	45	26	16	7	4.9
15	1740	2.33	4.1	74	100	94	68	53	30	16	6	5.1
15	1525	2.30	5.0	69	.	.	.	.	.	.	.	.
15	1671	2.32	4.5	72	.	.	.	.	.	.	.	.
16	1847	2.32	4.5	72	100	90	65	50	29	15	6	4.8
16	1920	2.33	4.1	74	.	.	.	.	.	.	.	.
16	1788	2.34	3.7	76	.	.	.	.	.	.	.	.
17	1693	2.32	4.5	72	100	97	67	50	29	16	6	5.3
18	1474	2.32	4.5	72	100	91	63	49	28	16	7	5.1
18	1621	2.33	4.2	74	97	92	65	50	31	21	10	5.2
18	1540	2.33	4.2	74	.	.	.	.	.	.	.	.
19	1761	2.34	3.7	76	100	88	60	45	26	15	6	5.0
19	1631	2.33	4.1	74	.	.	.	.	.	.	.	.
20	1731	2.33	4.1	74	100	97	67	49	29	17	8	5.1
20	1708	2.33	4.1	74	.	.	.	.	.	.	.	.

TABLE A-5

PLANT CONTROL AND ACCEPTANCE DATA - U.S. 90

LOT	STAB	SPGR	VOIDS	VFA	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC
21	1248	2.31	5.3	69	100	93	65	50	31	17	6	5.0
21	1052	2.30	5.7	67	100	92	65	48	29	14	6	4.9
21	1113	2.31	5.3	69	.	.	.	.	.	.	.	.
22	1525	2.34	4.1	74	100	95	61	46	28	16	6	5.0
22	1553	2.34	4.1	74	100	93	66	51	30	19	7	5.2
22	1657	2.35	3.7	76	.	.	.	.	.	.	.	.
22	1525	2.34	4.1	74	.	.	.	.	.	.	.	.
23	1623	2.34	4.1	74	100	90	58	44	27	16	6	5.2
23	1429	2.33	4.5	72	.	.	.	.	.	.	.	.
24	1261	2.34	4.5	.	100	63	53	40	24	12	4	4.9
24	1433	2.34	4.5	.	.	.	.	.	.	.	.	.
25	1311	2.33	4.1	72	100	97	67	52	34	21	8	5.7
25	1305	2.33	4.1	72	100	93	64	48	30	17	7	5.4
25	1786	2.34	4.1	74	.	.	.	.	.	.	.	.
26	1449	2.33	4.5	72	100	90	60	46	29	16	6	5.0
26	1422	2.33	4.5	72	100	95	65	49	30	16	7	5.2
26	1173	2.31	5.3	69	.	.	.	.	.	.	.	.
26	1466	2.33	4.5	72	.	.	.	.	.	.	.	.
27	1693	2.34	4.1	74	100	92	63	48	29	15	6	5.2
27	1466	2.33	4.5	72	100	97	69	53	32	17	8	5.6
27	1362	2.32	4.9	70	.	.	.	.	.	.	.	.
27	1555	2.33	4.5	72	.	.	.	.	.	.	.	.
28	1220	2.32	4.9	.	100	91	62	48	29	15	6	5.3
28	1418	2.33	4.5	.	100	94	63	48	30	16	6	5.2
28	1174	2.31	5.3	.	.	.	.	.	.	.	.	.
28	1342	2.33	4.5	.	.	.	.	.	.	.	.	.
29	1357	2.32	4.9	.	100	95	61	47	30	16	6	5.1
29	1296	2.32	4.9	.	100	92	62	47	26	16	8	5.0
29	1349	2.32	4.9	.	.	.	.	.	.	.	.	.
29	1449	2.33	4.5	.	.	.	.	.	.	.	.	.
30	1510	2.31	5.3	71	100	93	63	49	29	20	7	5.3
30	1628	2.33	4.5	75	100	94	65	49	28	18	8	5.2
30	1586	2.32	4.9	73	.	.	.	.	.	.	.	.

TABLE A-6

ROADWAY CORE DATA - LA. 01

LOT	SPGR	COMP
7	2.23	93.7
7	2.30	96.6
7	2.21	92.9
7	2.26	94.9
7	2.26	94.9
8	2.34	99.2
8	2.29	97.0
8	2.32	98.3
8	2.25	95.3
8	2.31	97.9
9	2.20	92.8
9	2.23	94.1
9	2.26	95.4
9	2.26	95.4
9	2.28	96.2
10	2.29	96.6
10	2.31	97.5
10	2.28	96.2
10	2.34	98.7
10	2.34	98.7
11	2.27	96.7
11	2.26	95.8
11	2.32	98.3
11	2.31	97.9
11	2.27	96.2
12	2.33	98.3
12	2.29	96.6
12	2.25	94.9
12	2.27	95.8
12	2.31	97.5
13	2.30	97.0
13	2.31	97.5
13	2.23	94.1
13	2.31	97.5
13	2.30	97.0
14	2.29	96.2
14	2.32	97.5
14	2.31	97.1
14	2.32	97.5
14	2.27	95.4
15	2.31	97.5
15	2.26	95.4
15	2.28	96.2
15	2.26	95.4
15	2.24	94.5
16	2.29	96.2
16	2.23	93.2
16	2.29	96.2
16	2.28	95.8
16	2.28	95.8
17	2.19	92.4
17	2.24	94.5
17	2.25	94.9
17	2.27	95.8
17	2.21	93.2
18	2.24	94.5
18	2.24	94.5
18	2.31	97.5
18	2.23	94.1
18	2.24	94.5
19	2.21	93.6
19	2.22	94.1
19	2.16	91.5
19	2.24	94.9
19	2.28	96.6

TABLE A-7

ROADWAY CORE DATA - LA. 21

LOT	SPGR	COMP
1	2.32	99.6
1	2.26	97.0
1	2.29	98.3
1	2.33	00.0
1	2.24	96.1
2	2.28	97.4
2	2.24	95.7
2	2.28	97.4
2	2.25	96.7
2	2.26	96.6
3	2.26	97.0
3	2.29	98.3
3	2.30	98.7
3	2.29	98.3
3	2.27	97.4
4	2.25	96.6
4	2.24	96.1
4	2.26	97.0
4	2.22	95.3
4	2.26	97.0
5	2.24	96.1
5	2.25	96.6
5	2.28	97.4
5	2.25	96.6
5	2.21	94.8
6	2.28	97.4
6	2.26	96.6
6	2.28	97.4
6	2.29	97.9
6	2.25	96.2
7	2.31	99.1
7	2.24	96.1
7	2.25	96.6
7	2.30	98.7
7	2.27	97.4
8	2.28	98.3
8	2.26	97.4
8	2.26	97.4
8	2.22	95.7
8	2.24	96.6

TABLE A-7 (CONTINUED)

ROADWAY CORE DATA - LA. 21

LOT	SPGR	COMP
9	2.18	93.6
9	2.30	98.7
9	2.32	99.6
9	2.29	98.3
9	2.27	95.3
10	2.26	97.0
10	2.28	97.9
10	2.25	96.6
10	2.29	98.3
10	2.30	98.7
11	2.30	98.7
11	2.28	97.9
11	2.26	97.0
11	2.28	97.9
11	2.24	96.1
12	2.31	99.1
12	2.29	98.3
12	2.26	97.0
12	2.25	96.6
12	2.24	96.1
13	2.21	95.7
13	2.24	97.0
13	2.27	98.3
13	2.28	98.7
13	2.24	97.0
14	2.27	98.3
14	2.26	97.8
14	2.28	98.7
14	2.26	97.8
14	2.25	97.4
15	2.23	96.1
15	2.23	96.1
15	2.22	95.7
15	2.26	97.4
15	2.29	98.9
16	2.28	98.3
16	2.31	99.6
16	2.27	97.8
16	2.16	93.1
16	2.26	97.4
17	2.21	95.3
17	2.27	97.8
17	2.27	97.8
17	2.29	98.7
17	2.25	97.0
18	2.28	97.9
18	2.22	95.3
18	2.29	98.3
18	2.28	97.9
18	2.24	96.1
19	2.27	97.8
19	2.29	98.7
19	2.26	97.4
19	2.26	97.4
19	2.26	97.4
20	2.28	97.9
20	2.24	96.1
20	2.26	97.0
20	2.28	97.9
20	2.30	98.7

TABLE A-8

ROADWAY CORE DATA - U.S. 80

LOT	SPGR	COMP
1	2.30	97.0
1	2.27	95.8
1	2.31	97.5
1	2.30	97.0
1	2.19	92.4
2	2.26	95.8
2	2.29	97.0
2	2.29	97.0
2	2.30	97.5
2	2.29	97.0
3	2.34	99.2
3	2.29	97.0
3	2.28	96.6
3	2.29	97.0
3	2.26	95.8
4	2.30	97.5
4	2.34	99.2
4	2.30	97.5
4	2.28	96.6
4	2.26	95.8
5	2.25	95.7
5	2.31	98.3
5	2.32	98.7
5	2.26	96.2
5	2.25	95.7
6	2.21	94.0
6	2.31	98.3
6	2.28	97.0
6	2.21	94.0
6	2.25	95.7
7	2.28	96.6
7	2.30	97.5
7	2.30	97.5
7	2.30	97.5
7	2.28	96.6
8	2.26	95.8
8	2.27	96.2
8	2.27	96.2
8	2.24	94.9
8	2.27	96.2
9	2.26	95.8
9	2.25	95.3
9	2.31	97.9
9	2.28	96.6
9	2.26	95.8

TABLE A-9

ROADWAY CORE DATA - U.S. 90A

LOT	SPGR	COMP
1	2.29	97.9
1	2.24	95.7
1	2.26	96.6
1	2.28	97.4
1	2.31	98.7
2	2.34	99.6
2	2.26	96.2
2	2.33	99.2
2	2.34	99.6
2	2.33	99.2
3	2.35	00.0
3	2.32	98.7
3	2.30	97.9
3	2.30	97.9
3	2.31	98.3
4	2.29	98.3
4	2.24	96.1
4	2.29	98.3
4	2.26	97.0
4	2.26	97.0
5	2.26	97.4
5	2.24	96.5
5	2.30	99.1
5	2.21	95.2
5	2.24	96.5
6	2.25	96.2
6	2.29	97.9
6	2.29	97.9
6	2.27	97.0
6	2.25	96.2
7	2.33	99.2
7	2.30	97.9
7	2.27	97.4
7	2.30	97.9
7	2.32	98.7
8	2.27	97.0
8	2.23	95.3
8	2.30	98.3
8	2.29	97.9
8	2.26	96.6
9	2.27	97.8
9	2.16	93.1
9	2.28	98.3
9	2.20	94.8
9	2.29	98.7
10	2.29	98.3
10	2.29	98.3
10	2.28	97.8
10	2.28	97.8
10	2.28	97.8
11	2.28	98.7
11	2.26	97.8
11	2.27	98.3
11	2.22	96.1

TABLE A-9 (CONTINUED)

ROADWAY CORE DATA - U.S. 90A

LOT	SPGR	COMP
11	2.24	97.0
12	2.24	96.5
12	2.28	98.3
12	2.25	96.9
12	2.27	97.8
12	2.29	98.7
13	2.27	97.4
13	2.25	96.6
13	2.26	97.0
13	2.26	97.0
13	2.21	94.8
14	2.25	97.0
14	2.24	96.6
14	2.23	96.1
14	2.24	96.6
14	2.28	98.3
15	2.25	97.0
15	2.25	97.0
15	2.15	92.7
15	2.21	95.3
15	2.23	96.1
16	2.23	95.7
16	2.27	97.4
16	2.22	95.3
16	2.24	96.1
16	2.26	97.0
17	2.28	98.3
17	2.22	95.3
17	2.29	98.7
17	2.23	96.1
17	2.24	96.6
18	2.26	97.0
18	2.27	97.4
18	2.26	97.0
18	2.26	97.0
18	2.22	95.3
19	2.25	96.2
19	2.11	90.2
19	2.20	94.0
19	2.24	95.7
19	2.23	95.3
20	2.27	97.4
20	2.26	97.0
20	2.28	97.9
20	2.24	96.1
20	2.25	96.6

TABLE A-10

ROADWAY CORE DATA - U.S. 90

LOT	SPGR	COMP
21	2.20	95.2
21	2.18	94.4
21	2.11	91.3
21	2.23	96.5
21	2.26	97.8
22	2.23	95.3
22	2.24	95.7
22	2.26	96.6
22	2.24	95.7
22	2.24	95.7
23	2.23	95.3
23	2.27	97.0
23	2.23	95.3
23	2.24	95.7
23	2.23	95.3
24	2.23	95.3
24	2.21	94.4
24	2.22	94.9
24	2.26	96.6
24	2.22	94.9
25	2.29	98.3
25	2.23	95.7
25	2.27	97.4
25	2.25	96.6
25	2.29	98.3
26	2.15	92.7
26	2.27	97.8
26	2.22	95.7
26	2.29	98.7
26	2.27	97.8
27	2.24	96.1
27	2.24	96.1
27	2.23	95.7
27	2.15	92.3
27	2.26	97.6
28	2.21	95.3
28	2.25	97.0
28	2.25	97.0
28	2.25	97.0
28	2.26	97.4
29	2.24	96.6
29	2.26	97.4
29	2.26	97.4
29	2.26	97.4
29	2.19	94.4
30	2.27	97.8
30	2.24	96.6
30	2.24	96.6
30	2.27	97.8
30	2.28	98.3

TABLE A-11

RESEARCH LAB RECYCLE MIX DATA - LA. 01

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
8	1	94	57	45	29	19	8	4.6	10989
8	.	.	.	.	.	.	.	4.6	.
10	1	90	50	38	24	16	7	3.9	8745
10	.	.	.	.	.	.	.	4.6	.
12	1	92	58	44	26	17	9	4.3	8956
12	.	.	.	.	.	.	.	4.6	.
14	1	92	59	45	28	18	9	4.5	8032
14	.	.	.	.	.	.	.	4.1	.
16	1	89	54	42	26	17	9	4.2	9483
16	.	.	.	.	.	.	.	4.3	.

TABLE A-12

RESEARCH LAB RECYCLE MIX DATA - LA. 21

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
1	1.00	91	59	43	24	10	6	5.4	16341
1	0.97	86	56	41	23	10	6	5.3	20795
2	1.00	92	58	44	26	10	6	5.6	12766
4	1.00	94	64	48	27	10	6	5.6	9036
9	1.00	87	55	43	25	11	7	5.4	8585
10	1.00	92	62	47	27	11	7	5.7	6501
11	1.00	93	64	48	27	11	7	5.7	5714
12	1.00	92	61	46	27	11	7	5.7	5476
13	1.00	89	55	42	24	10	7	5.5	5388
14	1.00	90	61	45	24	9	6	5.4	5510
15	1.00	88	57	44	26	10	6	5.5	6058
16	1.00	88	54	43	27	11	7	5.5	5521
17	1.00	87	58	45	26	10	6	5.3	7071
18	1.00	91	59	44	25	11	7	5.5	5916
19	1.00	95	66	48	27	11	7	6.0	7905
20	1.00	92	60	45	26	11	7	5.8	6981

TABLE A-13

RESEARCH LAB RECYCLE MIX DATA - U.S. 80

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
1	1	95	61	49	31	16	5.4	4.9	38217
2	1	92	58	46	30	16	6.8	5.0	16491
2	1	94	57	45	30	16	6.3	5.3	12000
3	1	96	58	46	30	16	6.6	5.4	21323
3	1	93	58	46	30	17	6.9	5.3	12287
3	1	94	55	44	28	15	5.7	5.4	14725
4	1	91	54	43	28	14	5.8	5.2	15300
4	1	90	54	43	28	14	5.5	5.2	16261
5	1	89	53	44	28	14	5.2	5.3	7926
5	1	91	55	44	27	14	5.4	4.7	24023
6	1	93	58	46	28	14	5.5	5.6	13717
6	1	93	54	42	26	13	5.2	6.2	15657
7	1	92	56	45	28	14	5.6	5.4	11882
8	1	91	53	43	27	14	5.4	5.3	32578
8	1	94	55	44	27	14	5.8	5.0	22076
9	1	93	57	46	28	14	5.7	5.4	16074

TABLE A-14

RESEARCH LAB RECYCLE MIX DATA - U.S. 90A

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
1	1	95	66	50	32	22	10.0	5.2	15288
2	1	90	63	48	28	17	8.0	5.3	14298
3	1	87	52	40	23	13	6.0	4.8	14028
4	1	89	62	48	29	17	7.0	5.2	13857
5	1	96	67	52	30	18	5.0	5.6	11182
6	1	95	69	51	29	18	7.0	5.3	12561
7	1	92	61	47	27	15	6.3	5.2	14577

TABLE A-15

RESEARCH LAB RECYCLE MIX DATA - U.S. 90

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
22	1	93	63	47	30	17	7	5.2	14176
27	1	94	63	48	30	16	7	5.2	13220
30	1	92	63	48	30	20	8	5.2	12614

TABLE A-16

RESEARCH LAB RECLAIM MIX DATA - LA. 01

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
7	.	.	.	.	.	.	.	4.1	.
8	1	96	65	46	26	15	9	3.6	292560
9	.	.	.	.	.	.	.	4.2	.
10	1	96	66	50	28	16	9	4.0	123991
11	.	.	.	.	.	.	.	3.9	.
12	1	96	65	49	28	16	9	4.2	225903
13	.	.	.	.	.	.	.	4.0	.
14	1	96	64	49	28	15	8	4.7	97873
15	.	.	.	.	.	.	.	4.2	.
16	1	96	68	51	29	16	9	4.5	127662
17	.	.	.	.	.	.	.	3.4	.

TABLE A-17

RESEARCH LAB RECLAIM MIX DATA - LA. 21

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
1	1	96	62	49	32	14	8	4.1	.
1	1	98	64	49	31	14	9	4.3	.
2	1	95	60	46	30	12	7	4.4	.
4	.	.	.	.	.	.	.	3.8	.
9	1	98	64	52	33	14	8	4.2	279330
10	.	.	.	.	.	.	.	4.2	.
11	.	.	.	.	.	.	.	4.9	.
12	1	94	59	49	32	14	9	4.8	308952
13	.	.	.	.	.	.	.	3.9	.
14	.	.	.	.	.	.	.	4.2	.
15	.	.	.	.	.	.	.	4.3	.
16	1	98	68	55	34	15	9	4.7	.
17	.	.	.	.	.	.	.	4.4	.
18	.	.	.	.	.	.	.	4.9	.
19	1	96	63	50	32	14	9	4.5	.
20	.	.	.	.	.	.	.	4.4	.
21	.	.	.	.	.	.	.	4.1	.
22	.	.	.	.	.	.	.	4.2	.
23	.	.	.	.	.	.	.	4.7	.
24	.	.	.	.	.	.	.	4.1	.
26	.	.	.	.	.	.	.	4.1	.
27	.	.	.	.	.	.	.	4.1	.
28	.	.	.	.	.	.	.	4.0	.
29	.	.	.	.	.	.	.	3.8	.

TABLE A-18

RESEARCH LAB RECLAIM MIX DATA - U.S. 80

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
2	1.00	94	64	52	37	19	8.9	5.0	321082
4	0.98	90	61	51	36	18	8.7	5.2	547397
6	1.00	95	63	53	38	20	9.1	4.4	
9	1.00	89	56	46	33	17	8.5	4.2	

TABLE A-19

RESEARCH LAB RECLAIM MIX DATA - U.S. 90A

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
1	1	98	72	58	34	18	10	4.7	.
2	1	97	69	56	34	18	10	4.9	.

TABLE A-20

RESEARCH LAB RECLAIM MIX DATA - U.S. 90

LOT	GRTF	GROH	NO4	NO10	NO40	NO80	NO200	AC	VISC
22	1	96	69	56	31	17	9	4.7	.
27	1	97	70	57	34	19	10	4.7	.
30	1	99	68	52	30	18	10	4.7	.

APPENDIX B

STATISTICAL ANALYSIS

LIST OF TABLES

TABLE B-1

PLANT AND ROADWAY SAMPLE ANALYSIS - LA. 01

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
STAB	41	1762.71	171.38	1239.00	2131.00
SPGR	41	2.37	0.02	2.32	2.39
VOIDS	41	3.24	0.71	1.60	5.30
VFA	41	77.85	3.88	68.00	88.00
GRTF	26	100.00	0.00	100.00	100.00
GROH	26	92.85	2.11	89.00	96.00
NO4	26	55.00	2.23	51.00	59.00
NO10	26	42.04	1.66	39.00	45.00
NO40	26	26.00	1.30	23.00	28.00
NO80	26	16.65	1.16	14.00	19.00
NO200	26	7.00	1.39	2.00	9.00
AC	25	4.90	0.19	4.50	5.20
RDSPGR	65	2.27	0.04	2.16	2.34
% COMP	65	95.84	1.70	91.50	99.20

TABLE B-2

MEAN PLANT DATA BY LOT - LA. 01

LOT	MNSTAB	MNSPGR	MNVOIDS	MNVFA	MNGRTF	MNGROH	MNNO4	MNNO10	MNNO40	MNNO80	MNNO200	MNAC
7	1760.33	2.38000	2.06667	85.0000	100	91.0	53.0	41.5	25.0	16.0	5.5	5.20
8	1610.00	2.36500	3.50000	76.0000	100	92.0	54.5	42.5	27.5	18.0	6.5	4.95
9	1700.67	2.36667	3.43333	76.3333	100	91.0	54.5	42.5	26.5	15.5	6.5	4.85
10	2022.00	2.37000	3.30000	77.0000	100	95.5	57.5	43.5	26.0	16.0	6.0	5.05
11	1752.33	2.35000	4.10000	73.6667	100	93.0	55.5	42.5	27.0	18.0	7.5	4.90
12	1916.25	2.37000	3.30000	77.2500	100	94.0	54.5	41.0	24.5	16.0	6.5	4.80
13	1790.50	2.37000	3.30000	77.5000	100	92.0	54.5	42.0	26.0	16.5	7.5	4.80
14	1839.00	2.38250	2.75000	80.7500	100	92.5	56.5	42.0	25.0	16.5	7.0	4.95
15	1692.33	2.37000	3.30000	77.0000	100	93.5	56.5	42.5	26.0	17.0	7.5	4.75
16	1726.00	2.38000	2.90000	80.0000	100	92.5	53.5	41.5	27.0	17.0	8.5	4.80
17	1760.50	2.37250	3.20000	78.0000	100	95.5	56.0	42.5	26.0	16.5	7.0	4.90
18	1600.75	2.36750	3.37500	77.2500	100	94.0	54.5	41.5	26.0	17.0	7.0	4.85
19	1681.00	2.35667	3.83333	75.0000	100	90.5	54.0	41.0	25.5	16.5	8.0	5.00

TABLE B-3

RECYCLED MIX SAMPLE ANALYSIS - LA. 01

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	5	100.00	0.00	100.00	100.00
GROH	5	91.40	1.95	89.00	94.00
NO4	5	55.60	3.65	50.00	59.00
NO10	5	42.80	2.95	38.00	45.00
NO40	5	26.60	1.95	24.00	29.00
NO80	5	17.40	1.14	16.00	19.00
NO200	5	8.40	0.89	7.00	9.00
AC	10	4.37	0.25	3.90	4.60
VISC	5	9241	1107	8032	10989

TABLE B-4

RECLAIM MIX SAMPLE ANALYSIS - LA. 01

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	5	100.00	0.00	100.00	100.00
GROH	5	96.00	0.00	96.00	96.00
NO4	5	65.60	1.52	64.00	68.00
NO10	5	49.00	1.87	46.00	51.00
NO40	5	27.80	1.10	26.00	29.00
NO80	5	15.60	0.55	15.00	16.00
NO200	5	8.80	0.45	8.00	9.00
AC	11	4.07	0.37	3.40	4.70
VISC	5	173598	82452	97873	292560

TABLE B-5

PLANT AND ROADWAY SAMPLE ANALYSIS - LA. 21

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
STAB	72	1904.96	219.63	1417.00	2412.00
SPGR	72	2.33	0.01	2.30	2.34
VOIDS	72	4.27	0.40	3.70	5.30
VFA	72	74.17	2.01	69.00	77.00
GRTF	37	99.92	0.36	98.00	100.00
GROH	37	91.32	2.87	82.00	97.00
NO4	37	59.73	3.70	52.00	66.00
NO10	37	44.95	2.68	40.00	50.00
NO40	37	26.57	1.61	22.00	29.00
NO80	37	10.70	0.81	9.00	12.00
NO200	37	6.62	0.83	4.00	8.00
AC	37	5.12	0.27	4.40	5.60
RDSPGR	100	2.26	0.03	2.16	2.33
% COMP	100	97.31	1.24	93.10	100.00

TABLE B-6

MEAN PLANT DATA BY LOT - LA. 21

LOT	MNSTAB	MNSPGR	MNVOIDS	MNVFA	MNGRTF	MNGROH	MNNO4	MNNO10	MNNO40	MNNO80	MNNO200	MNAC
1	2161.75	2.33000	4.10000	75.0000	99.0	89.5	58.5	43.0	25.0	11.0	7.5	5.25
2	2186.75	2.33500	3.90000	76.0000	100.0	92.0	58.0	43.0	25.5	10.0	6.0	5.10
3	2146.50	2.33000	4.10000	75.0000	100.0	93.0	58.0	45.0	27.0	11.0	6.0	5.50
4	2219.25	2.32750	4.20000	74.5000	100.0	91.5	60.5	46.0	26.5	10.0	6.0	5.20
5	1824.50	2.32750	4.20000	74.5000	100.0	90.0	59.5	45.0	26.5	10.0	6.0	5.35
6	2044.25	2.33750	3.80000	76.5000	100.0	89.0	56.0	42.5	25.0	10.5	6.5	4.90
7	1924.00	2.32500	4.30000	74.0000	100.0	92.0	60.0	45.0	25.5	10.5	6.0	4.70
8	1719.50	2.32250	4.40000	73.5000	100.0	91.5	59.0	45.5	26.0	10.5	6.5	4.70
9	1666.75	2.33250	4.00000	75.5000	100.0	91.0	58.0	43.5	25.0	9.5	6.0	5.15
10	1988.00	2.33000	4.10000	75.0000	100.0	91.0	65.0	49.0	29.0	12.0	7.0	5.60
11	1704.67	2.33333	3.96667	75.6667	100.0	93.0	63.5	47.5	28.0	11.0	7.0	5.35
12	1832.00	2.33250	4.00000	75.5000	100.0	90.0	62.0	47.5	28.0	11.0	7.0	5.20
13	1822.50	2.31250	4.80000	71.5000	100.0	92.5	60.0	45.0	26.5	10.5	7.0	4.85
14	1812.25	2.31250	4.80000	71.5000	100.0	93.5	63.5	46.5	27.0	11.0	7.0	5.15
15	1833.50	2.31750	4.60000	72.5000	100.0	93.0	58.5	45.5	28.0	11.0	7.0	5.00
16	1788.75	2.32250	4.40000	73.5000	100.0	91.5	60.5	45.5	27.0	11.0	7.0	5.10
17	1716.00	2.32000	4.50000	73.0000	100.0	94.5	62.0	45.5	27.5	12.0	8.0	5.15
18	1895.33	2.32667	4.23333	74.3333	100.0	92.5	60.0	45.0	26.5	11.5	7.0	5.15
19	1926.25	2.32000	4.50000	73.0000	99.5	85.0	53.5	40.5	27.0	10.0	5.0	5.15
20	2088.00	2.33000	4.10000	75.0000	100.0	91.0	61.0	45.0	26.0	11.0	7.0	5.50

TABLE B-7

RECYCLED MIX SAMPLE ANALYSIS - LA. 21

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	16	99.81	0.75	97.00	100.00
GROH	16	90.44	2.68	86.00	95.00
NO4	16	59.31	3.53	54.00	66.00
NO10	16	44.75	2.18	41.00	48.00
NO40	16	25.69	1.35	23.00	27.00
NO80	16	10.44	0.63	9.00	11.00
NO200	16	6.56	0.51	6.00	7.00
AC	16	5.56	0.19	5.30	6.00
VISC	16	8473	4449	5388	20795

TABLE B-8

RECLAIM MIX SAMPLE ANALYSIS - LA. 21

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	7	100.00	0.00	100.00	100.00
GROH	7	96.43	1.62	94.00	98.00
NO4	7	62.86	2.97	59.00	68.00
NO10	7	50.00	2.83	46.00	55.00
NO40	7	32.00	1.29	30.00	34.00
NO80	7	13.86	0.90	12.00	15.00
NO200	7	8.43	0.79	7.00	9.00
AC	24	4.30	0.32	3.80	4.90
VISC	2	294141	20946	279330	308952

TABLE B-9

PLANT AND ROADWAY SAMPLE ANALYSIS - U.S. 80

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
STAB	34	1719.29	162.99	1386.00	2094.00
SPGR	34	2.36	0.01	2.32	2.38
VOIDS	34	3.10	0.46	2.50	4.50
VFA	34	78.79	2.54	72.00	82.00
GRTF	18	99.67	0.59	98.00	100.00
GROH	18	90.61	1.91	88.00	94.00
NO4	18	54.94	2.65	50.00	62.00
NO10	18	44.44	2.66	40.00	52.00
NO40	18	28.61	1.79	26.00	34.00
NO80	18	14.72	1.02	13.00	17.00
NO200	18	5.83	0.51	5.00	7.00
AC	18	5.04	0.27	4.60	5.60
RDSPGR	45	2.28	0.03	2.19	2.34
% COMP	45	96.58	1.31	92.40	99.20

TABLE B-10

MEAN PLANT DATA BY LOT - U.S. 80

LOT	MNSTAB	MNSPGR	MNVOIDS	MNVFA	MNGRTF	MNGROH	MNNO4	MNNO10	MNNO40	MNNO80	MNNO200	MNAC
1	1693.50	2.3675	3.0	79.50	100.0	90.5	59.0	48.5	31.5	16.0	6.0	5.20
2	1797.50	2.3600	3.1	78.50	99.0	89.5	54.5	43.5	28.0	15.0	5.5	5.05
3	1563.75	2.3575	3.0	79.50	100.0	91.0	52.5	42.0	28.0	15.0	6.5	4.90
4	1712.00	2.3650	2.7	81.00	100.0	91.0	54.0	43.5	28.0	14.0	5.5	4.95
5	1688.00	2.3525	3.6	75.50	100.0	91.5	55.0	45.0	29.0	16.0	5.5	4.85
6	1910.50	2.3475	3.5	76.75	100.0	91.5	54.5	44.0	27.5	14.0	5.5	4.75
7	1774.25	2.3550	3.1	79.00	100.0	89.0	54.0	43.5	28.0	14.5	6.0	5.15
8	1619.00	2.3625	2.8	80.50	99.5	90.5	55.5	44.0	28.0	14.0	6.0	5.15
9	1711.00	2.3550	3.1	79.00	98.5	91.0	55.5	46.0	29.5	14.0	6.0	5.35

TABLE B-11

RECYCLED MIX SAMPLE ANALYSIS - U.S. 80

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	16	100.00	0.00	100.00	100.00
GROH	16	92.56	1.86	89.00	96.00
NO4	16	56.00	2.25	53.00	61.00
NO10	16	44.75	1.73	42.00	49.00
NO40	16	28.38	1.41	26.00	31.00
NO80	16	14.69	1.14	13.00	17.00
NO200	16	5.81	0.57	5.20	6.90
AC	15	5.23	0.23	4.70	5.60
VISC	16	18159	7930	7926	38217

TABLE B-12

RECLAIM MIX SAMPLE ANALYSIS - U.S. 80

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	4	99.50	1.00	98.00	100.00
GROH	4	92.00	2.94	89.00	95.00
NO4	4	61.00	3.56	56.00	64.00
NO10	4	50.50	3.11	46.00	53.00
NO40	4	36.00	2.16	33.00	38.00
NO80	4	18.50	1.29	17.00	20.00
NO200	4	8.80	0.26	8.50	9.10
AC	4	4.70	0.48	4.20	5.20
VISC	2	434240	160029	321082	547397

TABLE B-13

PLANT AND ROADWAY SAMPLE ANALYSIS - U.S. 90A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
STAB	52	1649.71	165.39	1292.00	2013.00
SPGR	52	2.33	0.01	2.30	2.36
VOIDS	52	4.03	0.54	2.90	5.30
VFA	52	74.40	2.64	69.00	80.00
GRTF	31	99.71	0.90	97.00	100.00
GROH	31	93.19	2.02	88.00	97.00
NO4	31	63.23	3.04	58.00	69.00
NO10	31	48.32	2.29	45.00	53.00
NO40	31	27.42	1.86	24.00	31.00
NO80	31	15.03	1.87	13.00	21.00
NO200	31	6.65	1.20	5.00	10.00
AC	31	5.11	0.20	4.80	5.50
RDSPGR	100	2.26	0.04	2.11	2.35
% COMP	100	97.07	1.51	90.20	100.00

TABLE B-14

PLANT AND ROADWAY SAMPLE ANALYSIS - U.S. 90

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
STAB	33	1416.24	172.61	1052.00	1786.00
SPGR	33	2.33	0.01	2.30	2.35
VOIDS	33	4.61	0.47	3.70	5.70
VFA	23	72.13	2.20	67.00	76.00
GRTF	18	100.00	0.00	100.00	100.00
GROH	18	92.72	3.16	83.00	97.00
NO4	18	62.89	3.61	53.00	69.00
NO10	18	47.94	2.94	40.00	53.00
NO40	18	29.17	2.20	24.00	34.00
NO80	18	16.50	2.09	12.00	21.00
NO200	18	6.56	1.04	4.00	8.00
AC	18	5.19	0.22	4.90	5.70
RDSPGR	50	2.24	0.04	2.11	2.29
% COMP	50	96.19	1.55	91.30	98.70

TABLE B-15

MEAN PLANT DATA BY LOT - U.S. 90A

LOT	MNSTAB	MNSPGR	MNVOIDS	MNVFA	MNGRTF	MNGROH	MNNO4	MNNO10	MNNO40	MNNO80	MNNO200	MNAC
1	1997.50	2.34000	3.70000	76.0000	97.0	92.0	65.0	50.0	31.0	21.0	10.0	5.20
2	1689.33	2.35333	3.16667	78.6667	100.0	93.5	61.0	47.5	26.5	15.5	7.0	5.10
3	1584.67	2.35000	3.30000	78.0000	100.0	93.0	60.5	46.5	25.5	15.0	6.5	5.45
4	1499.67	2.33333	3.96667	74.6667	100.0	92.0	62.5	49.0	27.5	17.5	6.5	5.20
5	1575.67	2.32333	4.36667	72.6667	98.5	92.0	59.5	46.5	27.0	17.0	6.0	5.25
6	1673.00	2.34333	3.56667	76.6667	100.0	91.5	62.0	47.0	26.0	16.5	6.5	4.95
7	1647.00	2.35000	3.30000	78.0000	100.0	93.0	60.0	45.0	24.0	14.0	6.0	5.00
8	1593.50	2.33500	3.90000	75.0000	100.0	93.0	63.0	47.0	25.0	14.0	6.0	5.40
9	1586.00	2.32000	4.50000	72.0000	100.0	94.0	59.0	45.0	26.0	16.0	7.0	4.90
10	1883.67	2.33000	4.10000	74.0000	100.0	93.5	64.0	48.0	26.5	16.0	6.5	4.95
11	1847.00	2.31000	4.90000	70.0000	100.0	94.0	62.0	48.0	29.0	18.0	7.0	4.80
12	1582.25	2.32500	4.30000	73.0000	100.0	94.5	66.5	50.5	28.0	14.5	6.5	4.95
13	1551.00	2.32750	4.20000	73.5000	100.0	94.5	65.5	50.5	28.5	14.5	6.0	5.15
14	1514.00	2.32333	4.36667	72.6667	100.0	95.5	67.0	50.5	28.0	14.5	5.5	5.25
15	1592.25	2.32000	4.50000	72.2500	100.0	94.0	63.5	49.0	28.0	16.0	6.5	5.00
16	1851.67	2.33000	4.10000	74.0000	100.0	90.0	65.0	50.0	29.0	15.0	6.0	4.80
17	1693.00	2.32000	4.50000	72.0000	100.0	97.0	67.0	50.0	29.0	16.0	6.0	5.30
18	1545.00	2.32667	4.30000	73.3333	98.5	91.5	64.0	49.5	29.5	18.5	8.5	5.15
19	1696.00	2.33500	3.90000	75.0000	100.0	88.0	60.0	45.0	26.0	15.0	6.0	5.00
20	1719.50	2.33000	4.10000	74.0000	100.0	97.0	67.0	49.0	29.0	17.0	8.0	5.10

TABLE B-16

MEAN PLANT DATA BY LOT - U.S. 90

LOT	MNSTAB	MNSPGR	MNVOIDS	MNVFA	MNGRTF	MNGROH	MNNO4	MNNO10	MNNO40	MNNO80	MNNO200	MNAC
21	1137.67	2.30667	5.43333	68.3333	100	92.5	65.0	49.0	30.0	15.5	6.0	4.95
22	1565.00	2.34250	4.00000	74.5000	100	94.0	63.5	48.5	29.0	17.5	6.5	5.10
23	1526.00	2.33500	4.30000	73.0000	100	90.0	58.0	44.0	27.0	16.0	6.0	5.20
24	1347.00	2.34000	4.50000	.	100	83.0	53.0	40.0	24.0	12.0	4.0	4.90
25	1467.33	2.33333	4.10000	72.6667	100	95.0	65.5	50.0	32.0	19.0	7.5	5.55
26	1377.50	2.32500	4.70000	71.2500	100	92.5	62.5	47.5	29.5	16.0	6.5	5.10
27	1519.00	2.33000	4.50000	72.0000	100	94.5	66.0	50.5	30.5	16.0	7.0	5.40
28	1288.50	2.32250	4.80000	.	100	92.5	62.5	48.0	29.5	15.5	6.0	5.25
29	1362.75	2.32250	4.80000	.	100	93.5	61.5	47.0	28.0	16.0	7.0	5.05
30	1574.67	2.32000	4.90000	73.0000	100	93.5	64.0	49.0	28.5	19.0	7.5	5.25

TABLE B-17

RECYCLED MIX SAMPLE ANALYSIS - U.S. 90A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	7	100.00	0.00	100.00	100.00
GROH	7	92.00	3.46	87.00	96.00
NO4	7	62.71	5.41	52.00	68.00
NO10	7	48.00	3.96	40.00	52.00
NO40	7	28.29	2.81	23.00	32.00
NO80	7	17.14	2.79	13.00	22.00
NO200	7	7.04	1.61	5.00	10.00
AC	7	5.23	0.24	4.80	5.60
VISC	7	13684	1379	11182	15288

TABLE B-18

RECYCLED MIX SAMPLE ANALYSIS - U.S. 90

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	3	100.00	0.00	100.00	100.00
GROH	3	93.00	1.00	92.00	94.00
NO4	3	63.00	0.00	63.00	63.00
NO10	3	47.67	0.58	47.00	48.00
NO40	3	30.00	0.00	30.00	30.00
NO80	3	17.67	2.08	16.00	20.00
NO200	3	7.33	0.58	7.00	8.00
AC	3	5.20	0.00	5.20	5.20
VISC	3	13337	788	12614	14176

TABLE B-19

RECLAIM MIX SAMPLE ANALYSIS - U.S. 90A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	2	100.00	0.00	100.00	100.00
GROH	2	97.50	0.71	97.00	98.00
NO4	2	70.50	2.12	69.00	72.00
NO10	2	57.00	1.41	56.00	58.00
NO40	2	34.00	0.00	34.00	34.00
NO80	2	18.00	0.00	18.00	18.00
NO200	2	10.00	0.00	10.00	10.00
AC	2	4.80	0.14	4.70	4.90
VISC	0	.	.	.	.

TABLE B-20

RECLAIM MIX SAMPLE ANALYSIS - U.S. 90

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
GRTF	3	100.00	0.00	100.00	100.00
GROH	3	97.33	1.53	96.00	99.00
NO4	3	69.00	1.00	68.00	70.00
NO10	3	55.00	2.65	52.00	57.00
NO40	3	31.67	2.08	30.00	34.00
NO80	3	18.00	1.00	17.00	19.00
NO200	3	9.67	0.58	9.00	10.00
AC	3	4.70	0.00	4.70	4.70
VISC	0	.	.	.	.