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Agreement T4118, Task 29
QA-QC Comparison

STATISTICAL ASSESSMENT OF QUALITY ASSURANCE-QUALITY CONTROL DATA FOR HOT MIX ASPHALT

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16. ABSTRACT

Recent trends in the paving industry have resulted in increased contractor involvement in the design, acceptance, and performance of hot mix asphalt (HMA) pavements. As a result, questions have arisen about whether contractor process control tests, alternatively known as quality control (QC), should be incorporated into the acceptance and pay factor processes that state highway agencies currently use. To examine this issue, various statistical tests were used including F and t-tests to compare QC data to agency-obtained quality assurance (QA) results. The percentage of projects that exhibited statistically significant differences in mean values and variances was calculated and assessed. For projects that had statistically similar QC and QA results, the average difference between the two testing programs was calculated. The results of the statistical analysis were analyzed from both a statistical and engineering perspective.

This report contains data from four state DOTs—California, Minnesota, Texas, and Washington. These states also provided the funding for the study.

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BACKGROUND

In the late 1950s the American Association of State Highway and Transportation Officials (AASHTO—then AASHO) constructed a large-scale experimental paving project to better understand the issues related to pavement design, construction, and life-cycle performance of pavements. A significant result of this study was a realization that flexible pavements exhibited higher variability than expected. This finding led to several refinements in specification systems. One of the refinements was the introduction of statistical measures to better quantify the mean values and variances of layer and material properties with a focus on hot mix asphalt (HMA). A second refinement was the increased use of specification systems that focus on pavement quality rather than on standardized construction practices. Most modern specification systems incorporate one or both of these elements.

To better control HMA quality, most specification systems attempt to balance the risk of poor performance between the state department of transportation (DOT) and the contractor. These systems generally grant greater autonomy to the contractor during the design process and construction. In exchange for increased autonomy, the contractor assumes a portion of the project risk. This provides motivation to the contractor to deliver a quality product, while the autonomy and design involvement encourages efficient and innovative designs and construction practices.

These trends have redirected the emphasis of specification systems toward the delivery of quality, cost-effective pavements, rather than merely focusing on pre-established construction guidelines. In pursuit of these goals and to limit their own testing burden, many state DOTs are beginning to use all available information to better control HMA quality (Hughes, 2005). This practice entails the use of contractor quality control (QC) data as part of the acceptance process. A prerequisite to using the QC data is that they must be validated. Currently, several different methods are available to validate QC results, ranging from simple one-to-one comparisons of split samples to statistical F and t-tests. This project utilized F and t-tests to determine whether there are statistically significant differences between reported QC and quality assurance (QA)

measurements. The QC results are only validated if the mean values are not statistically different at a given significance level. Note that this method of validation is not based upon engineering considerations but merely mathematical criteria. The assumption inherent in this validation procedure is that with a relatively small number of samples, any differences between mean QC and QA values that will adversely affect the behavior of the material will also be detected by the statistical analysis. This is one approach to comparing QA and QC results. Such statistical procedures do not assess which data set is actually more "correct."

In the past, QC data generally have been omitted from the decision making process as the benefits of its inclusion were outweighed by the concern that a contractor would report biased values in comparison to the QA results gathered by the state DOT. This concern has begun to fade. In 1993 an unpublished report entitled *Limits of the Use of Contractor Performed Sampling and Testing* (FHWA, 1993) recommended that contractor quality control data be used in the quality assurance decision for HMA projects. This recommendation was written into law in 1995 with the enactment of 23 CFR 637 (Code of Federal Regulations, 2007). (Appendix E contains the complete text for 23 CFR 637.) This regulation allows for the use of a contractor's QC data in the QA process for all federal-aid highway projects with the conditions that (1) the contractor's technicians and laboratories must be qualified to perform the sampling and tests, (2) verification samples and testing must be done independently of QC to assess the quality of the material, and (3) an independent assurance program is used to assess the QC sampling and testing. The intention of this regulation is to assure the quality of HMA pavements by using all available test data in the acceptance process.

In 2005, the National Cooperative Highway Research Program (NCHRP) published a summary of state quality assurance programs (Hughes, 2005). In the report, Hughes noted that there is significant confusion as to the meaning and proper implementation of the independent assurance (IA) requirement contained in 23 CFR 637. Hughes noted that there are two definitions for this term. The first is that the independent assurance program is meant to validate the contractor's testing procedures and results. In this interpretation, the state DOT and the contractor conduct identical tests on split samples to determine whether there are statistically significant differences between the

test results. This system measures testing variability. The second interpretation of IA is that it is to provide an assessment of the resulting product, rather than the contractor's test results. This requires that the verification samples be taken at separate locations independent of the QC program so that comparisons to the overall quality of the HMA can be determined. According to the report, both interpretations are currently being utilized by state DOTs. Optimal Procedures for Quality Assurance Specifications (FHWA, 2003), or OPQAS, states that the first system should be called "test method verification" and that the second should be termed "process verification" to eliminate confusion.

LITERATURE REVIEW

OVERVIEW

Federal Regulation 23 CFR 637 appears to have increased, rather than decreased, the amount of QA testing that state DOTs perform on many highway projects (Hughes, 2005). In part, this increase in testing is a response to the IA requirements written into the regulation, but it is also motivated by a concern about using potentially biased contractor data as part of the acceptance process. A study recently conducted at Auburn University examined the possibly biased reporting of QC results (Parker and Turochy, 2006). The study concluded that contractor-performed tests should only be used for QC of hot mixed asphalt concrete. This conclusion was based upon statistical analyses of data provided by several state DOTs. The premise of Parker and Turochy's approach was "that contractor-performed tests can be effectively used in quality assurance if they provide the same results as state DOT tests." In addition to determining whether statistical differences occurred between QC and QA measures at both the statewide and project levels, the study examined which measures (QA or QC) provided a smaller standard deviation and was closer to target values. The study concluded that QC measures were more likely to have smaller variations and to be closer to target values. According to the authors, these results indicated a bias on the part of contractors to report more favorable values.

In response to this opinion and to the report's overall conclusions, the National Asphalt Paving Association (NAPA) by letter to the manager of the NCHRP overseeing the Auburn study noted much higher QC testing frequencies and, as a result, greater contractor proficiency in testing and sampling procedures. NAPA noted that as a result of the higher testing frequency, reported variances should be smaller and more accurately reflect the actual variation of the total population (Newcomb, 2007).

The Auburn study largely took the view that if the QC results appear to be biased toward reporting more favorable values than the QA program indicates, QC results should not be used for acceptance purposes. The question becomes what results are

observed by comparing data from the states of California, Minnesota, Texas and Washington. This report will attempt an answer.

In addition to a statewide analysis, the Auburn study (Parker and Turochy, 2006) examined results of QA and QC measurements at a project level for data obtained from Georgia, Florida, Kansas, and California. The analysis was similar to the approach taken by this study. Because state highway agencies make acceptance and pay factor determinations at a project or lot level, comparing data at this level is relevant to the discussion of using QC test data. Another benefit of comparing data at the project level is that the number of samples in the testing populations is small in comparison to those for a statewide analysis. The statistical tests are dependent upon the sample sizes to determine both the t-statistic and the critical t values. As the sample size increases, the t-statistic increases, and the critical t-value decreases. This increases the probability that small differences between mean values will be statistically significant. The magnitude of these significant differences can easily be smaller than the inherent variability of the testing procedure. Thus statistical tests on sample sizes that are much larger than those typically found at the project level may not be relevant to the discussion.

A summary of the Auburn study's project-level analysis is shown in Table 1. The California data indicate that a slightly higher percentage of projects exhibited statistically significant differences between mean values and variances than were found for this study. Overall, however, the two studies produced similar results.

Table 1. Summary of State Data Contained in the Auburn Study (α = 0.01)							
			Number of Projects	Projects with Statistical Differences between Variances		Projects with Statistical Differences between Mean Values	
				# Projects	%	# Projects	%
Georgia	Split Samples	12.3-mm (1/2")	35	2	5.7%	0	0.0%
		75-um (#200)	35	3	8.6%	2	5.7%
		Asphalt Content (%)	41	1	2.4%	1	2.4%
	Independent Samples	12.3-mm (1/2")	114	13	11.4%	10	8.8%
		75-um (#200)	126	15	11.9%	13	10.3%
		Asphalt Content (%)	114	12	10.5%	10	8.8%
Florida	Split Samples	12.3-mm (1/2")	29	3	10.3%	1	3.4%
		9.5-mm (3/8")	29	2	6.9%	0	0.0%
		4.75-mm (#4)	29	4	13.8%	0	0.0%
		2.36-mm (#8)	30	3	10.0%	1	3.3%
		(#16)	29	1	3.4%	1	3.4%
		(#30)	29	0	0.0%	2	6.9%
		600-um (#50)	29	2	6.9%	1	3.4%
		(#100)	29	2	6.9%	1	3.4%
		75-um (#200)	30	6	20.0%	2	6.7%
		Asphalt Content (%)	30	3	10.0%	0	0.0%
	Independent Samples	12.3-mm (1/2")	25	5	20.0%	1	4.0%
		9.5-mm (3/8")	24	3	12.5%	2	8.3%
		4.75-mm (#4)	25	5	20.0%	2	8.0%
		2.36-mm (#8)	25	5	20.0%	1	4.0%
		(#16)	25	1	4.0%	1	4.0%
		(#30)	25	1	4.0%	1	4.0%
		600-um (#50)	25	2	8.0%	1	4.0%
		(#100)	25	1	4.0%	1	4.0%
		75-um (#200)	25	0	0.0%	2	8.0%
		Asphalt Content (%)	26	3	11.5%	2	7.7%

Table 1. Summary of State Data contained in Auburn Study (α = 0.01) continued								
				Number of Projects	Projects with Statistical Differences between Variances		Projects with Statistical Differences between Mean Values	
					# Projects	%	# Projects	%
Kansas	Independent Samples	Air Voids (%)		24	5	20.8%	0	0.0%
		G_{mm}		23	2	8.7%	3	13.0%
		$\%G_{mm}$		24	13	54.2%	11	45.8%
California	Independent Samples	19- or 12.5-mm	(3/4" or 1/2")	77	17	22.1%	18	23.4%
		9.5-mm	(3/8")	86	17	19.8%	19	22.1%
		4.75-mm	(#4)	86	20	23.3%	12	14.0%
		2.36-mm	(#8)	86	23	26.7%	14	16.3%
		600-um	(#30)	86	20	23.3%	13	15.1%
		75-um	(#200)	85	31	36.5%	25	29.4%
		Asphalt Content (%)		82	26	31.7%	26	31.7%

TYPES OF SPECIFICATIONS

Currently, a multitude of specification systems are used throughout the United States that govern the acceptance and construction of HMA pavements. These specification systems vary in their distribution of risk, allowance of contractor autonomy, and in the definition of successful HMA pavements. This section is largely a summary of information in TRB Circular E-C037 (2002). The discussion is included to briefly recap current and past systems.

The oldest specification system is the methods approach. In this system the controlling agency specifies both the materials and the construction processes to be used by the contractor. The contractor is neither rewarded nor encouraged to be creative in the construction process. A successful HMA pavement is defined as one that is constructed according to the specifications, largely independent of actual pavement quality/ performance. The state DOT assumes the vast majority of the risk in this system. The benefit to the state is that it requires only a simple test for acceptance of HMA

pavements. However, a recent survey (Hughes, 2005) revealed that the limitations imposed upon contractors, the simplified definition of success, and the unbalanced risk distribution of this system have result in it being used by only two state highway agencies.

Perhaps the most common specification systems, employed by at least 21 state highway agencies, are quality assurance specifications. These systems are alternatively called QA/QC specifications. These systems divide the responsibility of producing a quality HMA pavement into process control (QC) conducted by the contractor and quality assurance (QA) performed by the SHA. The focus of these systems is usually measurement of material properties such as density, asphalt content, and gradation within certain ranges to control the quality of product. The systems allow the contractor greater autonomy to control and streamline the process by which the HMA is produced. The QA program is used to provide an independent evaluation of both the construction method and of in-situ HMA properties. Statistical analysis of both QA and QC test results are common and allow for both the average and the dispersion of measured parameters. In a QA/QC system risk is shared between the contractor and the SHA (although the risks are not necessarily the same).

The latest specification systems are oriented toward the actual and predicted performance of HMA pavements. These specifications include one or more of three approaches. The first is to require contractors to warranty pavement performance for a set period of time at a specified minimum level of service. This should allow the contractor significant autonomy in the construction process while ensuring a minimal or no rehabilitation cost to the state DOT for a set time period. Warranties also place the short-term risks of poor performance entirely on the contractor, motivating quality workmanship. The second approach is to measure mechanical properties of constructed HMA pavements. These properties are then used in conjunction with anticipated traffic loads to model the deterioration of the pavement over time. Typical mechanical properties of interest are resilient (or dynamic) modulus, creep, and fatigue characteristics. The high cost and time requirements of this system make it generally unappealing at present to both contractors and state DOTs. The final approach is to

predict future performance by using empirical relationships based upon easily obtained properties such as density, asphalt content, pavement thickness, and gradation.

Any specification system that allows QC results to be used in the QA process should provide adequate protection against the possibility of accepting sub-par pavements. In part, this eventuality can be prevented by using statistical F- and t-tests to compare the mean values and variances of QC and QA measurements. These controls can identify relatively small differences between the two testing programs with only a minimal number of state DOT testing requirements.

RESEARCH METHODOLOGY

OVERVIEW

The purpose of this study was to determine the percentage of state DOT projects for which a statistically significant difference exists between the contractor's QC and state's QA test results for HMA pavements. The study tracked average differences between QC and QA test results when statistically significant differences were not found between the two measures. The rationale behind this approach was that QC results could be used for pay factor determination if they were statistically similar to the QA tests. The material parameters analyzed as part of this study included asphalt content, aggregate gradations, air voids, and in-place density. The California, Minnesota, Texas, and Washington State DOTs provided data.

A short review of common statistical terms and concepts follow.

STATISTICAL PROCEDURES

Statistical analysis represents a tool for describing populations that have inherent variations. For this study, a population was defined as the entire HMA production in a given lot or project. Tests are conducted at discrete points within a population to determine parameters such as the mean or standard deviation (or variance). The test results are combined to form a sample set of the overall population. As the testing frequency increases, the number of results in the sample set increases, and the sample more accurately reflects the overall population's true mean and variance values. In the extreme, if every possible test location were tested, the sample set would match the population.

The most common measure used to describe either sample sets or populations is the mean. The mean is the average or expected value and can be used to describe either a sample set or a population. The mean is denoted as $\bar{x}$ and is defined as:

$$\bar{x} = \frac{x_1 + x_2 + \cdots + x_n}{n} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (1)$$

The variance of a sample or population is another commonly used statistic. The variance is a measure of the scatter of individual measurements about the mean value. A small variance is reflected in a tight clustering of values about the mean, whereas a large variance indicates that the values are widely spread. The variance is denoted as s^2. The square root of the variance is the more common measure, termed the standard deviation, and is denoted by s or σ. The definition of the variance is:

$$s^2 = \frac{\sum (x_i - \bar{x})^2}{n-1} \tag{2}$$

The normal distribution is a statistical tool used to model the distribution of continuous variables in a population. The normal distribution is a bell shaped curve that can be characterized fully by two parameters, which are the mean and standard deviation. For HMA pavements, normal distributions are usually used for properties such as density, air voids, and gradations, as they are a reasonable approximation of observed values. The normal distribution is not an exact measure, however, as it predicts both excessively large and even negative values at extremely low probabilities.

The Student's t-test is a statistical procedure for determining whether differences occur between two sample sets at a given significance level. For this study, the Student's t-test was used to detect statistical differences between the means of the QC and QA testing programs. The assumptions involved with the t-test require that both samples be taken from normally distributed populations. These assumptions are appropriate for HMA pavements because the tested parameters can be reasonably approximated with a normal distribution. A significance level of $\alpha = 0.01$ was used for this study's t-tests. At this significance level there is 1.0 percent chance of rejecting a null hypothesis when it is actually true. If the magnitude of the significance level were increased (say $\alpha = 0.05$), the allowable difference between the QC and QA programs would be reduced, and the percentage of projects that exhibited statistical differences would get larger. The null hypothesis for all tests in this study was that the means of the QC and QA tests for each project were equal. The α level was thus a measure of the contractor's or seller's risk. The magnitude of α was chosen to be consistent with current SHA systems that utilize QC data and the Parker and Turochy study. Other α levels could have been used.

The Student's t-test is based upon the t-statistic and can be used with both paired and unpaired sample sets. Paired sample sets (for example) occur in HMA pavements when both a state DOT and a contractor perform tests on split samples. The pair of samples relate to the same material of the total population. Independent or unpaired samples occur when SHA and contractor tests are taken at different locations. Gradations are more likely than density or air-void contents to be composed of paired sampling.

The null hypothesis for this study for unpaired data using a two-sided Student's t-test was that there is no statistical difference between the mean values of QC and QA results. Expressed mathematically this is:

Null Hypothesis $$H_0 : \overline{x_{QC}} - \overline{x_{QA}} = 0 \quad (3)$$

Alternate Hypothesis $$H_1 : \overline{x_{QC}} - \overline{x_{QA}} \neq 0 \quad (4)$$

The t-statistic with unequal sample variances was defined as:

$$t = \frac{\left|\overline{x_{QC}} - \overline{x_{QA}}\right|}{\sqrt{\frac{s_{QC}^2}{n_{QC}} + \frac{s_{QA}^2}{n_{QA}}}} \quad (5)$$

where n_{QC} = # of QC test results

n_{QA} = # of QA test results

The t-statistic with equal sample variances was defined as:

$$t = \frac{\left|\overline{x_{QC}} - \overline{x_{QA}}\right|}{S_p\sqrt{\frac{1}{n_{QC}} + \frac{1}{n_{QA}}}} \quad (6)$$

where S_P = the pooled standard deviation and was defined as:

$$S_P^2 = \frac{s_{QC}^2\left(n_{QC} - 1\right) + s_{QA}^2\left(n_{QA} - 1\right)}{n_{QC} + n_{QA} - 2} \quad (7)$$

The t-test also depended upon the number of both the QC and QA sample sizes. The sample sizes were used to compute a single measure of the number of degrees of freedom of the test, denoted d_f. This is an important concept in that small sample sizes reduce the resolution of the t-test. Thus it was necessary to have a sufficient number of

both QA and QC test results to utilize the t-statistic. The d_f is used to obtain the critical t-statistic value for comparison to the calculated t-statistic.

For unequal sample variances, the degree of freedom was calculated by using Equation 8.

$$d_f = \frac{\left[\left(se_{QC}\right)^2 + \left(se_{QA}\right)^2\right]^2}{\frac{\left(se_{QC}\right)^4}{n_{QC}-1} + \frac{\left(se_{QA}\right)^4}{n_{QA}-1}} \tag{8}$$

where $se_{QC} = \frac{s_{QC}}{\sqrt{n_{QC}}}$

$se_{QA} = \frac{s_{QA}}{\sqrt{n_{QA}}}$

For equal sample variances, the degree of freedom was calculated by using Equation 9.

$$d_f = n_{QC} + n_{QA} - 2 \tag{9}$$

The t-test is then performed by obtaining a critical t-statistic from published tables or by calculations that depend upon the significance level and sample sizes. The dependence of the critical t-statistic on the sample size and significance level is shown in Figure 1.

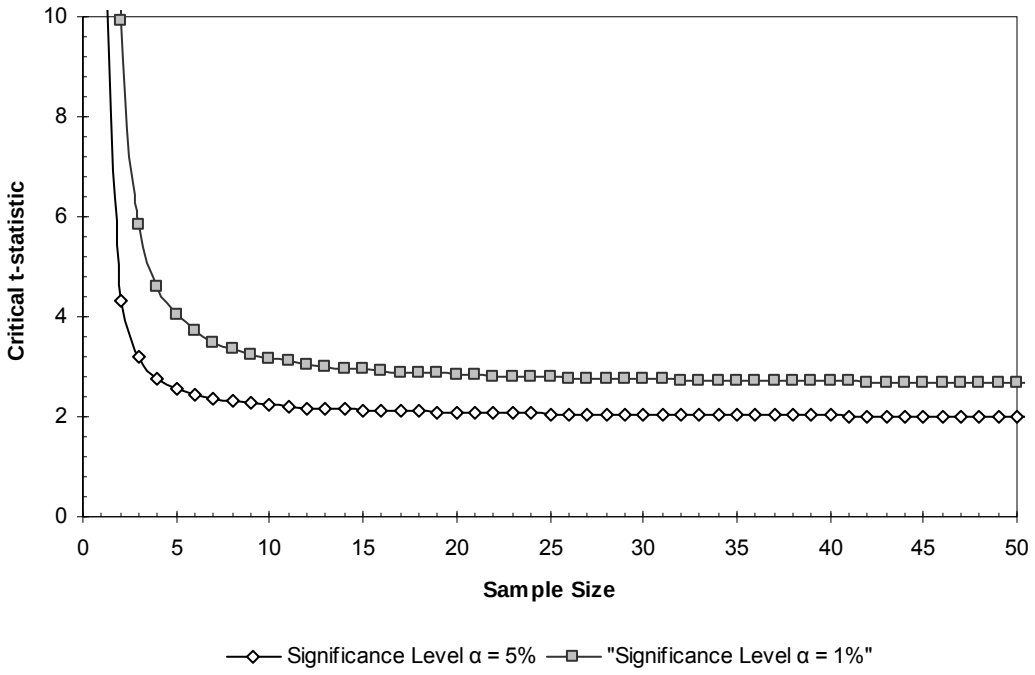

Figure 1. Critical t-Statistics vs Sample Size and Significance Level

If the calculated t-statistic is less than the critical t-statistic (based on the significance level), then the null hypothesis is not disproved (hypothesis testing, by necessity uses somewhat ambiguous language—if the null hypothesis is "accepted" then the official statement is that one fails to reject the null hypothesis). If the calculated t-statistic based on the data examined is larger than the critical t-statistic, then the null hypothesis (H_0) is disproved, and the alternate hypothesis (H_1) that the means are different is accepted.

F-tests can be used to detect statistical differences between the variances of the QC and QA samples. The F-test compares the ratio of the variances of the QC and QA test results. The F-test requires the same assumptions about the underlying population distribution as the t-test (i.e., normal distribution).

The F-statistic can be calculated as:

$$F = \frac{s^2_{QA}}{s^2_{QC}} \tag{10}$$

Null Hypothesis $$H_0 : \overline{s^2_{QC}} = \overline{s^2_{QA}} \tag{11}$$

Alternate Hypothesis $H_1 : \overline{s^2_{QC}} \neq \overline{s^2_{QA}}$ (12)

As with the t-test, the final step is to calculate a critical F value based upon the sample degrees of freedom. If the calculated F-statistic based on test results is greater than the critical F value for a given significance level, the null hypothesis is rejected and the variances are not equal. If the F-statistic is less than the critical F value, the null hypothesis is not disproved, and the variances do not show statistically significant differences at the given confidence level. This test should be run prior to the use of a t-test, as it is necessary to determine how the t-statistic should be calculated.

DATA ANALYSIS

CALIFORNIA DEPARTMENT OF TRANSPORTATION DATA

Caltrans provided data from approximately 30 projects that had been constructed from 2000 to 2006. These projects were constructed according to Caltrans HMA Specification Section 39, presumably reflecting the version of Section 39 in effect at the time of construction. This is noted since Caltrans Section 39 has recently undergone a major revision.

Caltrans organizes the QC and QA information into Excel files that perform statistical tests on mean values and variances for each lot within a project. In addition to the statistical analyses, Caltrans compares the results of tests that exhibit statistical differences to specified allowable testing difference (ATD) criteria to determine whether the differences are not only significant statistically but also significant in comparison to the allowable testing difference. If the test results are verified by statistical or ATD criteria, the QC values are used to compute the project pay factor.

In accordance with 23 CFR 637, the Caltrans standard specification calls for both the QC testing procedures to be verified independently. The validation of the QC sampling procedures (or test method verification) is accomplished by comparing the results of tests on split samples for asphalt contents, gradations, and theoretical maximum densities for a production start up evaluation or test strip. Caltrans also requires that the engineer responsible for QA obtain and test representative samples for in-place density. In this manner, Caltrans satisfies the IA requirements called for in 23 CFR 637.

To verify the contractor gradation, asphalt content, and compaction test results, California requires testing of independent samples (process verification). The mean values of the test results are compared by using the Student's t-test with an α level of 0.01. Note that the Caltrans specification does not require an F-test to be conducted to determine whether the sample variances are equal. The sample variances are assumed to be equal, and the t-statistic is calculated as such. For this analysis, F-tests were performed to determine whether the variances were equal. On the basis of the result of

the F-test, the t-statistic was computed accordingly. Significant differences between variances were detected in lots at rates varying from 11 to 32 percent for the Caltrans data.

The allowable testing difference, or D2S filter, compares the difference between QA and QC test results to predetermined or negotiated testing variations to determine whether they are significantly different. The ATD between test means is calculated as follows:

$$d_{\bar{x}} = 2S_r\left[\frac{1}{n_c}+\frac{1}{n_a}\right]^{1/2} \tag{13}$$

where:

$d_{\bar{x}}$ = allowable testing difference between means

S_r = Precision Index for the test method from Table 2

n_c = number of contractor's quality control tests (minimum of two required)

n_a = number of state quality assurance tests (minimum of one required)

The Precision Index could also be thought of as the recognized standard deviation of the test method.

Table 2. California Precision Indices

			California Test Designation	Precision Index
Gradation (Sieve Size)	19- or 12.5-mm	(3/4" or 1/2")	202	0.90%
	9.5-mm	(3/8")		2.40%
	4.75-mm	(#4)		2.00%
	2.36-mm	(#8)		1.40%
	600-um	(#30)		1.10%
	75-um	(#200)		0.70%
Other Parameters	Asphalt Content		379	0.23%
			382	0.18%
	Sand Equivalent (min.)		217	8
	Hveem Stabilometer Value (min.)		366	6.6
	Percent of Theoretical Maximum Density		375	0.88%
	Theoretical Maximum Density		309	.03 g/cc
	Percent Air Voids		367	1.6

The contractor's QC test results are verified if either the statistical or the ATD test conditions are met. Table 3 is a summary of the available data (a total of 46 individual lots) provided by Caltrans. These data show that a small portion of testing data for the lots was invalidated when both statistical and ATD criteria were applied. Invalidated for this table means that the difference between the QA and QC testing programs was determined to be statistically significant and larger than the ATD.

Table 3. Analysis of California Data (α = 0.01, D2S Filtering)

		# of Lots	Lots with Statistical Differences between Mean Values and ATD Differences	Rate of Occurrence of Invalid QC Results
Gradation (sieve size)	19- or 12.5-mm (3/4" or 1/2")	46	3	6.5%
	9.5-mm (3/8")	46	1	2.2%
	4.75-mm (#4)	46	0	0.0%
	2.36-mm (#8)	46	2	4.3%
	600-um (#30)	46	6	13.0%
	75-um (#200)	46	5	10.9%
Other Parameters	Asphalt Content	44	5	11.4%
	Sand Equivalent	24	0	0.0%
	Stability Value	22	1	4.5%
	Moisture Content	11	0	0.0%
	Relative Compaction	34	4	11.8%

1. All t-tests were calculated assuming equal sample variances.
2. Invalid QC results in last column simple implies a statistical rejection.

As shown above, relative compaction, asphalt content, and percentage passing the No. 30 and 200 sieves were the most likely parameters to be reported with both statistical and D2S differences.

Table 4 shows the percentage of projects that exhibited statistical differences between the mean values or variances. The ATD filter used by Caltrans was not included for these results. The results are for an α significance level of 0.01 and show higher rates of occurrence than the results presented in Table 3.

Table 4. Analysis of California Data (α = 0.01, No ATD Filtering)							
		# of Lots	Lots with Statistical Differences between Mean Values		Lots with Statistical Differences between Variances	
Gradation (Sieve Size)	19- or 12.5-mm (3/4" or 1/2")	46	5	11%	5	11%
	9.5-mm (3/8")	46	8	17%	5	11%
	4.75-mm (#4)	46	4	9%	6	13%
	2.36-mm (#8)	46	5	11%	7	15%
	600-um (#30)	46	9	20%	8	17%
	75-um (#200)	46	5	11%	10	22%
Other Parameters	Asphalt Content	44	11	25%	11	25%
	Sand Equivalent	24	1	4%	3	13%
	Stability Value	22	9	41%	4	18%
	Moisture Content	11	0	0%	0	0%
	Relative Compaction	34	6	18%	11	32%

Despite the overall increase in frequency, the general trends were similar to those observed in Table 3, with increased significant differences being detected for finer gradations, relative compaction, and asphalt content measurements. Note that stability mean values were statistically unequal in 41 percent of the lots.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION DATA

WSDOT provided test results for seven HMA projects that were completed between 2003 and 2007. WSDOT's North Central Region had examined these projects to determine the potential benefits of using QC data. According to information provided by WSDOT, the QC results examined in the study were not subjected to a verification process or used as part of the acceptance decision. There was a 60 to 200 percent increase in the amount of available test information when QC results were submitted to WSDOT. The WSDOT information noted a 50 to 75 percent reduction in agency testing requirements as a result of the additional information.

WSDOT did not use the QC information as part of its acceptance or pay-factor decisions. This fact complicated the comparison of these data to those from Caltrans. A risk associated with using QC data is how the possible economic pressures and potential

biases affect QC testing results. In the WSDOT program the QC tests did not affect the contractor's payment, so these pressures were not present.

The WSDOT data are presented in Table 5.

Table 5. Analysis of WSDOT Data (α = 0.01)

			# of Job Mix Formulas	Job Mix Formulas with Statistical Differences between Mean Values		Job Mix Formulas with Statistical Differences between Variances	
Gradation (Sieve Size) and Asphalt Content (%)	19-mm	(3/4")	10	0	0%	0	0%
	12.5-mm	(1/2")	10	2	20%	1	10%
	9.5-mm	(3/8")	10	3	30%	1	10%
	4.75-mm	(#4)	10	2	20%	2	20%
	2.36-mm	(#8)	10	3	30%	2	20%
	1.18-mm	(#16)	10	2	20%	4	40%
	600-mm	(#30)	10	1	10%	0	0%
	300-um	(#50)	10	3	30%	0	0%
	150-um	(#100)	10	2	20%	0	0%
	75-um	(#200)	10	2	20%	3	30%
	Asphalt Content		10	0	0%	2	20%

The WSDOT project data indicate that significant differences between mean values and variances occurred at rates similar to those observed in the NCHRP report (Hughes, 2005) and in the Caltrans data.

TEXAS DEPARTMENT OF TRANSPORTATION DATA

The Texas DOT provided a large number of test records for five different asphalt mix design types. The data did not delineate between individual projects, so a comparison of QC and QA test results was not possible at the project level. The data were analyzed at the mix design level, and the results are presented in Tables 6 and 7.

Table 6. Analysis of Texas DOT Statistically Significant Differences, (α = 0.01)				
Mix Design		In-Place Air Voids (%)	Absolute Difference from Target Lab Molded Density	Asphalt Content
A	Variance	NSD	NSD	NSD
	Mean Value	NSD	NSD	NSD
B	Variance	SD	NSD	NSD
	Mean Value	SD	SD	SD
C	Variance	NSD	NSD	NSD
	Mean Value	SD	NSD	NSD
D	Variance	NSD	SD	SD
	Mean Value	SD	SD	SD
F	Variance	No Data	NSD	NSD
	Mean Value	No Data	NSD	NSD

*SD: Statistical Difference between testing programs
**NSD: No Statistical Difference between testing programs

These data indicate that statistically significant differences were detected for 60 percent of the mixes for in-place air voids, and 40 percent for absolute difference from target density and for asphalt content measurements.

The average difference between the QA and QC values are presented in Table 7 for all analyzed mix designs. The values highlighted in gray are properties for which statistical differences were detected between mean values with an α level of 0.01.

These results indicate that when statistically significant differences were not detected, the difference between the mean values of the QA and QC measurements was close to zero.

Note that the inverse of this statement is not necessarily true. This can be seen by comparing the results of the Molded Density readings for Mix Designs A and D. Mix D exhibited a smaller difference between QA and QC testing programs, but unlike Mix A the results were determined to be statistically different. The primary reason for this is that Mix A exhibited standard deviations that were approximately 10 percent larger than those found for Mix D. The larger standard deviations reduced the calculated t-statistic. Secondly, the critical t-statistic for Mix A was calculated with 91 degrees of freedom. Mix D had 560 degrees of freedom. This resulted in the critical t-statistic for Mix A

being 2 percent larger than the value computed for Mix D. The combination of these two factors resulted in Mix D producing statistically significant results while Mix A did not.

Table 7. Summary of Texas DOT Data (α = 0.01)

Mix Design		In-Place Air Voids (%)		Molded Densities (%)		Asphalt Contents (%)	
		QA	QC	QA	QC	QA	QC
A	Mean Difference between QA and QC (QA-QC)	0.05		-0.05		0.01	
	Std. Dev	1.34	1.34	0.37	0.34	0.20	0.19
	Count	66	34	68	25	70	69
B	Mean Difference between QA and QC (QA-QC)	0.62		0.09		0.08	
	Std. Dev	1.42	0.99	0.40	0.37	0.45	0.44
	Count	699	33	699	356	645	706
C	Mean Difference between QA and QC (QA-QC)	0.28		0.03		0.02	
	Std. Dev	1.22	1.20	0.34	0.33	0.33	0.33
	Count	1531	143	1726	657	1632	1780
D	Mean Difference between QA and QC (QA-QC)	1.22		-0.04		0.03	
	Std. Dev	1.23	1.16	0.30	0.34	0.39	0.32
	Count	1635	21	1895	430	1490	1934
F	Mean Difference between QA and QC (QA-QC)	-		0.03		0.09	
	Std. Dev	0.81	-	0.31	0.32	0.27	0.31
	Count	41	0	60	9	56	66

Note: Shaded areas show significant differences between QA and QC mean test results.

MINNESOTA DEPARTMENT OF TRANSPORTATION DATA

Between 2003 and 2004 the Minnesota Department of Transportation (MnDOT) gathered QA and QC data to study the relationship between asphalt content, voids in the mineral aggregate (VMA), and asphalt film thicknesses (AFT) for HMA projects. The goal of the study was to implement a specification system to better control asphalt contents across different HMA aggregate gradations. The AFT parameter is dependent

upon asphalt content, percentage of aggregate in the mix, and the surface area of aggregate of a HMA pavement.

The AFT parameter (microns) is calculated as:

$$AFT = \frac{P_{be} * 4870}{100 * P_s * SA} \quad (13)$$

where P_{be} = effective asphalt content as a percentage of the total mixture

P_s = percentage of aggregate in the mixture

SA = calculated aggregate surface area in ft^2/lb

The SA is calculated according to the following equation:

$$SA = 2 + 0.02a + 0.04b + 0.08c + 0.14d + 0.30e + 0.60f + 1.60g \quad (14)$$

where a, b, c, d, e, f and g are the percentage passing sieves #4, 8, 16, 30, 50, 100, 200

Minnesota allows QC results to be used as part of pay factor determinations. QC tests are validated by one-to-one comparisons of test results on split samples for each lot. If the difference between the QC and QA tests is within a given tolerance, the average of the two tests is used to compute the pay adjustment. If the tolerance is exceeded, the contractor tests an additional sample from the lot, and the average is computed on the basis of the results of this test and the original QA test. The use of split samples represents a test method verification IA procedure as defined by OPQAS.

The results of the statistical analysis of the Minnesota data are presented in Table 8.

The results of the Minnesota data exhibit several differences in comparison to the previous analyses. The most notable difference between the Minnesota data and the other states is that for the #4, 8, and 16 sieves, less than 2 percent of projects exhibited statistically significant differences. The California and Washington data exhibited rates of approximately 10 and 30 percent, respectively. The reason behind this is that the Minnesota data exhibited, on average, much higher variances for these three sieves than either California or Washington. Note also that the Minnesota data had a higher rate of occurrence of statistically different mean values for the #200 sieve. Both Washington and California exhibited differences in approximately 20 percent of projects. Because the AFT calculation is dependent upon the surface area of the HMA aggregate, the #200

sieve's high rate of statistically significant differences was carried through to the AFT tests.

Table 8. Analysis of Minnesota Data (α = 0.01)

			Number of Projects	Projects with Statistical Differences between Mean Values		Projects with Statistical Differences between Variances	
Gradation (sieve size)	4.75-mm	(#4)	274	4	1.5%	7	2.6%
	2.36-mm	(#8)	274	1	0.4%	11	4.0%
	1.18-mm	(#16)	274	1	0.4%	9	3.3%
	600-um	(#30)	273	20	7.3%	9	3.3%
	300-um	(#50)	272	58	21.3%	11	4.0%
	150-um	(#100)	264	96	36.4%	11	4.2%
	75-um	(#200)	275	102	37.1%	17	6.2%
Other Parameters	Asphalt Content		275	22	8.0%	22	8.0%
	Surface Area (ft^2/lb)		275	86	31.3%	13	4.7%
	VMA		275	17	6.2%	12	4.4%
	AFT (microns)		275	101	36.7%	11	4.0%

Minnesota also made HMA field core data available. Communication with Curt Turgeon of MnDOT (Turgeon, 2007) provided the following background on field density determination:

- A day's HMA production is divided into lots. Within each lot, two locations are randomly selected.
- The Contractor tests one core for the each location and MnDOT tests the companion core for the first location. If the difference between the MnDOT and Contractor cores is less than 0.030 G_{mb}, then the Contractor's core is verified and the average of the Contractor's cores for the two locations are averaged for pay. If the difference is exceeded, then the average of the MnDOT and Contractor cores at the second location are used to determine pay.

- The current practice (as of December 2007) is to cut two cores at each location thereby the Contractor does not know which location is to be used for verification, i.e., meeting the 0.030 G_{mb} requirement.

Table 9 is used to summarize MnDOT and Contractor G_{mb} core results. Data was made available for 1999, 2000, 2001, 2003 and 2006.

Table 9. Summary of MnDOT Core Data

	1999	2000	2001	2003	2006
Average difference in G_{mb} (QC-QA)	0.007	0.005	0.004	0.003	0.003
Number of Sets of Cores in the averages	738	4526	510	582	2989

The average differences in core G_{mb} have declined over a span of about eight years.

Additional data was provided by MnDOT which allows us to view Contractor and agency results from field split samples of HMA. The results follow in Table 10.

Table 10. Summary of MnDOT Split Sample Data

Project Year	No. of Split Samples	Statistic	Contractor Test Results					MnDOT Test Results				
			P_b	G_{mm}	G_{mb}	Va	VMA	P_b	G_{mm}	G_{mb}	Va	VMA
2001	246	Mean	--	2.495	2.406	3.5	14.8	--	2.495	2.410	3.4	14.5
		Std Dev	--	0.034	0.036	0.8	1.0	--	0.032	0.036	0.9	1.2
2003	132	Mean	5.4	2.489	2.398	3.7	14.6	5.3	2.486	2.405	3.3	14.3
		Std Dev	0.6	0.051	0.047	0.6	0.8	0.6	0.053	0.046	0.8	0.9
2004	117	Mean	5.5	2.491	2.403	3.5	14.8	5.6	2.495	2.403	3.7	14.8
		Std Dev	0.3	0.039	0.037	0.4	0.6	0.3	0.040	0.038	0.6	0.7

The data in Table 10 represent large sample sizes (in effect a population measure) and allow a quick view of differences in Contractor and MnDOT results for binder content, theoretical maximum density, bulk density, air voids, and voids in mineral aggregate. Bulk density results are of special interest and MnDOT results are either the same or slightly higher than Contractor results.

DISCUSSION OF DATA

CALTRANS DATA

The Caltrans HMA specification includes a test of whether the data are not only statistically significant but also significant in comparison to allowable testing variations.

Table 11 summarizes the average differences between statistically similar QA and QC results for these projects and also expresses these differences as a percentage of average target values. The intent of expressing the percentage of the average differences between statistically similar QA and QC values and average target values is to provide a reference frame from which the results can be interpreted.

Table 11. Summary of Caltrans QC Utilization Program

			Number of Lots	Average Difference between Statistically Similar QA and QC values (QA-QC)	Average Target Value	Difference expressed as a Percentage of Target Value
Gradation (Sieve Size)	19- or 12.5-mm	(3/4" or 1/2")	46	0.15	98	0.15%
	9.5-mm	(3/8")	46	-0.33	71	-0.46%
	4.75-mm	(#4)	46	0.20	49	0.41%
	2.36-mm	(#8)	46	0.05	35	0.15%
	600-um	(#30)	46	-0.11	19	-0.58%
	75-um	(#200)	46	-0.12	4.9	-2.48%
Other Parameters	Asphalt Content		44	0.04	5.1	0.70%
	Sand Equivalent		24	-0.81	46	-1.76%
	Stability Value		22	-0.30	37	-0.81%
	Moisture Content		11	0.00	0	0.00%
	Relative Compaction		34	0.16	96	0.17%

Caltrans' specification system does not allow QC data to be used for acceptance or pay factor determinations when they fail both the statistical and the ATD criteria. Thus, there is little risk that the program might result in egregious pay or acceptance discrepancies in relation to traditional systems. Note also that Caltrans' assumption of equal sample variances (though not always true) usually has a minimal effect on the

calculated t-statistic. Nevertheless, this assumption should be proved for an equivalent significance level for each parameter (i.e. a F-test should be performed).

WSDOT DATA

The results of the WSDOT analysis exhibited trends similar to those observed in the Caltrans data and the Parker and Turochy study. The average differences between statistically similar QC and QA results are shown in Table 12.

Table 12. Summary of WSDOT Data (α = 0.01)

			Average Difference between Statistically Similar QA and QC values (QA-QC)	Typical Target Value	Difference expressed as a Percentage of Target Value
Gradation (Sieve Size) and Asphalt Content (%)	19-mm	(3/4")	0.00	100	0.00%
	12.5-mm	(1/2")	0.15	95	0.16%
	9.5-mm	(3/8")	0.07	79	0.09%
	4.75-mm	(#4)	0.74	48	1.54%
	2.36-mm	(#8)	-0.09	32	-0.29%
	1.18-mm	(#16)	0.20	22	0.91%
	600-mm	(#30)	0.18	16	1.11%
	300-um	(#50)	0.06	10	0.60%
	150-um	(#100)	0.16	7	2.36%
	75-um	(#200)	0.08	4.8	1.59%
	Asphalt Content		0.03	5.3	0.57%

This information illustrates that when QC results are not statistically different from the QA data; the average differences are relatively small. The magnitude of the WSDOT differences was up to 2.4 percent of target values, which is similar to the trends observed in the Caltrans data. The WSDOT data also suggest that, on average, statistically similar results occur in approximately 80 percent of reported parameters.

Unlike the Caltrans and Parker and Turochy studies, the WSDOT data (refer back to Table 5) did not exhibit significant differences between the mean values of asphalt content for any of the Job Mix Formulas (JMF). On the basis of a sample set containing only seven projects with ten JMFs, it is difficult to extrapolate from these data to form a conclusion about the agreement between QC and QA testing program.

TEXAS DOT DATA

The Texas data exhibited several interesting trends. The first is that, given the large sample sizes, statistical differences were only detected in half of the measured parameters. For mix designs B, C, and D the average number of degrees of freedom was 2000. T-tests for sample sizes of these magnitudes are sensitive to any difference between mean values.

Analyzing the Texas data on a mix design level was useful in that it demonstrated that; overall, the QC and QA testing programs produce similar results. With sample sizes in the thousands, it can be reasonably assumed that these samples adequately represent the total QC and QA populations with only a minimal amount of difference. Unfortunately, when so many test results are compared, the usefulness of validating QC results with statistical F- and t-tests is questionable. The statistical tests can invalidate results that are separated by only extremely small margins. These margins may not be significant when viewed from an engineering perspective. These differences can also be smaller than natural variations due to the materials or testing inaccuracies.

MINNESOTA DOT DATA

The Minnesota data are summarized in Table 13.

Comparatively, the California and WSDOT data exhibited larger asphalt content average differences of 0.7 percent and 0.6 percent (as compared to 0.3 percent for MnDOT). Otherwise, the differences between Caltrans, Minnesota, and Washington are rather modest with the exception of the No. 50, 100, and 200 sieves.

Minnesota cores results (Table 9) show that the Contractor's bulk density from cores was slightly greater that the Minnesota DOT data, but the differences are all within the testing variance for bulk density. The decrease in bulk density differences over time (1999 to 2006) between the Contractor and DOT core data is noted. The split sample results (Table 10) show that the Contractor and DOT test results (average and standard deviations) for theoretical and bulk density, percent binder, air voids, and VMA are all similar.

Table 13. Summary of Minnesota Data (α = 0.01)					
			Average Difference between Statistically Similar QA and QC values (QA-QC)	Average QA Values	Difference expressed as a Percentage of Average QA Values
Gradation (sieve size)	4.75-mm	(#4)	0.08	68	0.12%
	2.36-mm	(#8)	0.42	54	0.77%
	1.18-mm	(#16)	0.19	42	0.45%
	600-mm	(#30)	0.83	30	2.75%
	300-um	(#50)	0.73	17	4.29%
	150-um	(#100)	0.62	8	7.77%
	75-um	(#200)	0.61	5	12.24%
Other Parameters	Asphalt Content		0.02	6	0.30%
	Surface Area (ft^2/lb)		1.64	32	5.12%
	VMA		-0.21	15	-1.38%
	AFT (microns)		-0.65	8	-8.07%

CONCLUSIONS

STATISTICAL VALIDATION MEASURES

The results of this study indicate that F- and t-tests can be used to validate QC results for use in acceptance and pay factor decisions. This should be no surprise because numerous road agencies have used these statistical measures for some time to compare agency and contractor results. The statistical tests provide an adequate level of resolution when differences are sought between the two testing programs over a range of sample sizes. This study used an α value of 0.01 for the F- and t-tests to establish filter criteria that produce significant results, and that level seems reasonable. These tests may lose relevance if the number of samples in the QC and QA program becomes large. If results are analyzed at a statewide level, the statistical tests are much too discriminating to be used.

STATE DATA COMPARISON

The data from the four contributing state DOTs exhibited similar trends in terms of the average number of projects and parameters that produce statistically significant differences. Given differences in state independent assurance programs and even the use of contractor QC data, these similar trends are reassuring.

Between the states, different parameters (such as asphalt content, gradation sizes, etc.) had the larger number of statistically significant differences—there are no consistent trends.

The average differences for the various parameters for statistically similar QA and QC results are quite similar for the state data. This should not be a surprise given standard test methods, tester training programs, etc.

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APPENDIX A

WSDOT HMA QA/QC STUDY

WSDOT HMA QA/QC Study

WSDOT Test Data

Project #	Job Mix Formula		19-mm (3/4")	12.5-mm (1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	1.18-mm (#16)	600-mm (#30)	300-um (#50)	150-um (#100)	75-um (#200)	Asphalt Content
1	1	Average	100.00	96.54	82.46	51.62	34.54	24.00	17.08	11.77	7.92	5.70	5.61
		Std. Dev	0.00	0.75	1.55	1.60	1.28	0.78	0.62	0.42	0.27	0.11	0.16
		Count	13	13	13	13	13	13	13	13	13	13	13
	2	Average	100.00	96.50	80.75	49.75	33.50	23.25	16.25	11.00	7.75	5.48	5.75
		Std. Dev	0.00	1.12	0.83	0.83	0.50	0.43	0.43	0.00	0.43	0.23	0.23
		Count	4	4	4	4	4	4	4	4	4	4	4
2	1	Average	100.00	93.73	83.36	54.18	34.91	23.00	16.09	11.91	8.73	6.34	5.07
		Std. Dev	0.00	1.27	2.34	2.09	1.38	1.00	0.70	0.54	0.47	0.27	0.09
		Count	11	11	11	11	11	11	11	11	11	11	11
3	1	Average	100.00	91.33	79.22	52.61	35.11	24.39	17.44	12.78	8.78	5.98	5.04
		Std. Dev	0.00	1.67	2.25	1.60	1.20	0.89	0.68	0.53	0.53	0.32	0.14
		Count	18	18	18	18	18	18	18	18	18	18	18
4	1	Average	100.00	97.75	88.25	59.25	40.25	26.00	17.00	11.75	7.75	4.90	5.85
		Std. Dev	0.00	0.83	1.92	2.05	1.48	0.71	0.00	0.43	0.83	0.07	0.05
		Count	4	4	4	4	4	4	4	4	4	4	4
	2	Average	100.00	97.73	86.18	57.45	38.82	25.27	16.82	11.18	7.27	4.75	5.80
		Std. Dev	0.00	0.45	1.75	2.50	1.75	1.29	0.72	0.57	0.45	0.31	0.12
		Count	11	11	11	11	11	11	11	11	11	11	11

WSDOT HMA QA/QC Study

Contractor Test Data

Project #	Job Mix Formula		19-mm (3/4")	12.5-mm (1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	1.18-mm (#16)	600-mm (#30)	300-um (#50)	150-um (#100)	75-um (#200)	Asphalt Content
1	1	Average	100.00	97.50	86.00	56.25	37.75	24.50	17.00	11.00	7.00	4.75	5.70
		Std. Dev	0.00	0.58	1.15	1.50	0.96	0.58	0.00	0.00	0.00	0.06	0.00
		Count	4	4	4	4	4	4	4	4	4	4	4
	2	Average	100.00	96.43	80.71	47.86	33.86	23.57	17.00	11.57	8.00	5.60	5.66
		Std. Dev	0.00	0.98	1.50	7.78	2.04	1.81	1.41	1.13	1.00	0.77	0.17
		Count	7	7	7	7	7	7	7	7	7	7	7
2	1	Average	100.00	93.43	83.10	54.67	36.14	22.67	15.86	11.81	8.38	6.04	5.20
		Std. Dev	0.00	1.16	2.00	2.48	6.44	1.46	1.06	0.98	0.74	0.55	0.28
		Count	21	21	21	21	21	21	21	21	21	21	21
3	1	Average	100.00	90.73	78.85	51.50	33.50	22.15	16.62	11.96	8.50	5.84	5.01
		Std. Dev	0.00	0.78	1.16	1.30	0.99	0.67	0.57	0.82	0.58	0.28	0.13
		Count	26	26	26	26	26	26	26	26	26	26	26
4	1	Average	100.00	97.00	84.90	56.40	36.30	23.10	15.60	9.90	6.80	4.50	5.64
		Std. Dev	0.00	0.94	1.66	1.65	1.83	1.29	0.97	0.74	0.42	0.38	0.13
		Count	10	10	10	10	10	10	10	10	10	10	10
	2	Average	100.00	96.86	85.41	56.14	37.73	24.14	16.50	10.82	7.00	4.54	5.74
		Std. Dev	0.00	0.83	1.53	2.40	1.42	0.71	0.51	0.39	0.00	0.67	0.14
		Count	22	22	22	22	22	22	22	22	22	22	21

WSDOT HMA QA/QC Study

WSDOT Test Data

Project #	Job Mix Formula		19-mm (3/4")	12.5-mm (1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	1.18-mm (#16)	600-mm (#30)	300-um (#50)	150-um (#100)	75-um (#200)	Asphalt Content
5	1	Average	100.00	97.76	85.41	51.24	30.84	19.94	14.10	10.47	8.08	5.93	6.00
		Std. Dev	0.00	0.79	1.86	2.07	1.38	1.69	1.08	0.84	0.67	0.57	0.19
		Count	51	51	51	51	51	49	49	49	49	51	51
6	1	Average	100.00	94.92	78.16	42.24	29.80	22.96	16.24	10.16	6.76	4.40	4.90
		Std. Dev	0.00	1.38	3.17	2.83	1.66	1.14	0.78	0.47	0.44	0.16	0.14
		Count	25	25	25	25	25	25	25	25	25	25	25
7	1	Average	100.00	95.00	82.40	52.80	34.80	24.70	18.50	12.90	7.70	4.07	5.26
		Std. Dev	0.00	1.56	2.32	3.43	3.01	1.70	1.27	0.88	0.67	0.32	0.31
		Count	10	10	10	10	10	10	10	10	10	10	10
	2	Average	100.00	94.78	82.00	50.44	32.00	22.11	16.22	11.44	6.89	3.84	5.32
		Std. Dev	0.00	1.92	3.81	4.10	3.08	2.62	2.11	1.42	1.05	0.45	0.33
		Count	9	9	9	9	9	9	9	9	9	9	9

WSDOT HMA QA/QC Study

Contractor Test Data

Project #	Job Mix Formula		19-mm (3/4")	12.5-mm (1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	1.18-mm (#16)	600-mm (#30)	300-um (#50)	150-um (#100)	75-um (#200)	Asphalt Content
5	1	Average	100.00	97.69	86.44	52.29	31.28	19.97	14.08	10.41	7.99	5.87	5.93
		Std. Dev	0.00	0.86	1.77	1.72	1.37	1.26	1.07	0.93	0.75	0.54	0.16
		Count	101	101	101	101	101	101	101	101	101	101	101
6	1	Average	100.00	93.98	78.41	42.35	29.94	22.63	16.29	9.96	6.69	4.54	4.93
		Std. Dev	0.00	1.33	2.72	2.66	1.76	1.36	0.96	0.64	0.58	0.25	0.14
		Count	49	48	48	48	48	48	48	48	48	48	48
7	1	Average	100.00	94.37	82.05	51.37	34.47	23.68	17.74	12.37	7.42	3.81	5.16
		Std. Dev	0.00	1.30	2.17	2.48	1.98	0.95	0.81	1.01	0.61	0.30	0.25
		Count	19	19	19	19	19	19	19	19	19	19	19
	2	Average	100.00	94.76	82.82	51.06	32.18	22.06	16.47	11.53	7.00	3.78	5.34
		Std. Dev	0.00	1.20	2.04	1.64	1.63	1.09	1.33	1.07	0.61	0.41	0.14
		Count	17	17	17	17	17	17	17	17	17	17	17

Appendix B
Texas Dot HMA QA/QC Study

Texas DOT HMA QA/QC Study				
Texas DOT Test Data				
Mix Design		In-Place Air Voids (%)	Molded Densities (%)	Asphalt Contents (%)
A	Average	6.42	0.54	4.09
	Std. Dev	1.34	0.37	0.20
	Count	66	68	70
B	Average	6.77	0.57	4.56
	Std. Dev	1.42	0.40	0.45
	Count	699	699	645
C	Average	6.86	0.42	4.58
	Std. Dev	1.22	0.34	0.33
	Count	1531	1726	1632
D	Average	7.31	0.38	5.01
	Std. Dev	1.23	0.30	0.39
	Count	1635	1895	1490
F	Average	7.10	0.41	5.68
	Std. Dev	0.81	0.31	0.27
	Count	41	60	56

Texas DOT HMA QA/QC Study				
Contractor Test Data				
Mix Design		In-Place Air Voids (%)	Molded Densities (%)	Asphalt Contents (%)
A	Average	6.37	0.59	4.08
	Std. Dev	1.34	0.34	0.19
	Count	34	25	69
B	Average	6.16	0.49	4.49
	Std. Dev	0.99	0.37	0.44
	Count	33	356	706
C	Average	6.58	0.39	4.56
	Std. Dev	1.20	0.33	0.33
	Count	143	657	1780
D	Average	6.09	0.43	4.98
	Std. Dev	1.16	0.34	0.32
	Count	21	430	1934
F	Average	-	0.38	5.59
	Std. Dev	-	0.32	0.31
	Count	0	9	66

Appendix C

Caltrans HMA QA/QC Study

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
1	1	Average	99.00	72.00	51.00	39.50	19.00	5.85	5.40				
		Std Dev	0.00	1.41	1.41	0.71	0.00	0.21	0.00				
		Count	2	2	2	2	2	2	2				
	2	Average	97.67	85.00	58.67	43.00	20.00	6.27	5.60				
		Std Dev	0.58	1.73	0.58	1.00	1.00	0.40	0.00				
		Count	3	3	3	3	3	3	3				
2	1	Average	96.20	71.80	49.20	38.00	21.40	5.52	5.20	0.00	42.20	0.00	97.08
		Std Dev	0.84	2.39	1.30	1.41	0.89	0.19	0.19	0.00	0.84	0.00	1.05
		Count	9	9	9	9	9	9	9	9	9	9	10
	2	Average	97.13	72.38	51.50	39.25	22.25	6.00	4.91	0.00	44.00		97.61
		Std Dev	0.99	1.30	1.93	2.05	1.67	0.76	0.22	0.00	2.65		1.02
		Count	16	16	16	16	16	16	16	16	16		16
3	1	Average	99.00	75.50	53.00	35.50	16.75	6.08	5.93				95.60
		Std Dev	0.00	2.89	1.83	1.00	0.96	0.43	0.10				0.00
		Count	4	4	4	4	4	4	4				4
	2	Average	98.81	71.56	51.69	33.75	15.81	4.91	6.17				97.14
		Std Dev	0.40	1.67	1.70	1.77	1.28	0.55	0.09				0.59
		Count	16	16	16	16	16	16	12				11
	3	Average	98.80	74.60	52.80	37.40	17.00	5.90	6.04				
		Std Dev	0.45	1.14	1.10	0.89	0.71	0.19	0.15				
		Count	5	5	5	5	5	5	5				

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
1	1	Average	98.83	69.00	49.00	37.33	17.50	5.57	5.23				
		Std Dev	0.41	2.00	1.90	1.75	0.84	0.41	0.06				
		Count	6	6	6	6	6	6	6				
	2	Average	97.20	83.60	57.80	42.60	19.40	6.26	5.34				
		Std Dev	0.45	1.67	1.10	1.14	0.55	0.46	0.12				
		Count	5	5	5	5	5	5	5				
2	1	Average	96.51	71.36	49.73	39.22	21.58	5.63	5.42	68.00	48.00	0.00	96.91
		Std Dev	0.69	1.42	1.21	0.95	0.92	0.33	0.17	0.00	1.26	0.00	0.35
		Count	50	50	50	50	50	50	50	50	50	50	47
	2	Average	96.82	72.32	50.70	39.80	21.09	5.70	5.08	68.00	46.86	0.00	96.76
		Std Dev	0.72	1.34	1.25	1.11	1.29	0.35	0.17	0.00	3.98	0.01	0.51
		Count	56	56	56	56	56	56	56	56	56	56	56
3	1	Average	98.78	74.61	52.67	35.39	16.06	5.19	6.05				96.68
		Std Dev	0.43	1.75	1.46	1.46	0.94	0.38	0.12				0.00
		Count	18	18	18	18	18	18	18				18
	2	Average	98.86	72.40	51.60	35.48	16.38	5.03	6.12		38.33		97.77
		Std Dev	0.45	1.26	1.40	1.63	1.21	0.51	0.17		2.31		0.48
		Count	50	50	50	50	50	50	50		3		49
	3	Average	98.44	71.78	50.28	35.72	15.78	4.87	6.14				
		Std Dev	0.62	2.41	2.30	2.16	1.17	0.51	0.16				
		Count	18	18	18	18	18	18	18				

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
4	1	Average	98.93	72.29	52.71	38.00	18.86	4.96	5.63				96.99
		Std Dev	1.21	1.59	2.20	1.47	1.03	0.66	0.36				0.80
		Count	15	15	15	15	15	15	15				15
	2	Average	99.38	73.15	51.31	37.69	18.92	4.82	5.37				96.70
		Std Dev	0.51	2.08	2.18	1.55	1.19	0.49	0.26				0.67
		Count	18	18	18	18	18	18	18				18
5	1	Average	98.25	73.75	51.39	36.75	19.89	6.10	4.95	73.18	45.36	0.00	97.43
		Std Dev	1.32	1.78	1.71	2.07	1.97	0.85	0.16	6.76	2.04	0.00	1.20
		Count	28	28	28	28	28	28	28	11	28	8	28
	2	Average	99.00	72.82	51.65	36.71	18.94	6.00	4.92		46.88		97.41
		Std Dev	0.94	0.81	2.64	1.40	1.09	0.57	0.14		2.20		0.54
		Count	17	17	17	17	17	17	17		17		17
	3	Average	99.00	72.50	49.25	36.50	20.50	6.25					
		Std Dev	0.00	0.58	0.96	2.38	1.29	0.50					
		Count	4	4	4	4	4	4					
	4	Average	99.38	74.00	49.63	35.38	21.50	6.38	5.07				96.73
		Std Dev	0.52	1.93	2.45	1.41	1.07	0.52	0.17				1.31
		Count	8	8	8	8	8	8	8				8
6	1	Average	98.60	71.40	48.00	34.80	19.40	5.08	5.02	72.80	45.00		98.97
		Std Dev	0.55	1.95	1.41	1.10	0.89	0.61	0.04	1.64	0.00		0.86
		Count	5	5	5	5	5	5	5	5	1		6
7	1	Average	97.67	74.33	52.67	34.00	18.00	5.00	5.48	66.33			
		Std Dev	0.58	0.58	2.08	1.00	2.00	0.00	0.23	1.53			
		Count	3	3	3	3	3	3	3	3			
8	1	Average	97.75	73.50	52.75	34.25	17.00	4.75	5.51	65.00			98.05
		Std Dev	0.50	1.73	1.71	0.96	2.58	0.50	0.20	2.94			0.99
		Count	4	4	4	4	4	4	4	4			4

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
4	1	Average	99.18	72.45	52.44	37.96	17.76	4.84	5.66				97.71
		Std Dev	0.51	1.05	1.03	0.77	0.90	0.34	0.15				0.66
		Count	55	55	55	55	55	55	55				55
	2	Average	99.04	72.91	51.67	38.05	18.01	4.70	5.35				97.03
		Std Dev	0.19	1.31	1.08	0.95	0.99	0.43	0.10				0.39
		Count	79	79	79	79	79	79	79				79
5	1	Average	98.75	73.59	51.34	37.35	21.16	6.26	4.94	66.91	40.91	0.00	97.50
		Std Dev	0.56	1.77	1.64	1.79	1.16	0.50	0.12	5.85	2.39	0.00	0.36
		Count	99	99	99	99	99	99	99	22	11	99	99
	2	Average	99.71	72.85	50.37	37.28	21.34	6.10	4.84	73.35	39.60	0.00	97.29
		Std Dev	0.46	1.09	1.05	1.56	1.56	0.52	0.10	3.50	2.07	0.00	0.48
		Count	93	93	93	93	93	93	93	20	5	93	93
	3	Average	98.80	73.20	50.00	35.80	20.40	5.86	4.92				95.34
		Std Dev	0.45	0.45	0.71	1.79	1.52	0.49	0.19				1.08
		Count	5	5	5	5	5	5	5				5
	4	Average	99.44	73.90	50.08	36.58	22.14	6.38	4.88				96.96
		Std Dev	0.50	1.79	2.45	1.74	1.49	0.52	0.14				0.33
		Count	72	72	72	72	72	72	72				72
6	1	Average	98.96	71.80	49.84	37.60	21.46	5.32	4.79	72.08	39.86	0.01	97.98
		Std Dev	0.35	1.74	1.28	1.51	1.15	0.32	0.16	2.43	1.68	0.01	0.50
		Count	50	50	50	50	50		51	13	7	22	51
7	1	Average	97.31	74.15	53.54	35.00	17.62	4.60	5.61	58.31	39.50	0.20	
		Std Dev	0.75	1.99	1.98	1.73	2.33	0.41	0.33	4.61	0.55	0.04	
		Count	13	13	13	13	13	13	13	13	6	13	
8	1	Average	97.33	71.13	53.54	36.67	18.38	3.69	5.69	63.25	40.36	0.16	98.32
		Std Dev	0.70	1.65	1.86	2.43	2.52	0.62	0.28	5.01	0.50	0.04	0.53
		Count	24	24	24	24	24	24	24	24	11	23	24

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
9	2	Average	97.33	69.67	49.33	36.67	20.67	2.73	5.25				96.75
		Std Dev	0.58	0.58	1.15	1.15	1.15	0.67	0.10				0.92
		Count	27	27	27	27	27	27	27				3
	5	Average	97.67	70.52	48.38	34.95	19.62	3.80	5.41				97.49
		Std Dev	0.80	1.36	2.27	1.63	1.07	0.66	0.15				0.98
		Count	27	27	27	27	27	27	27				16
10	2	Average	97.08	72.62	45.54	33.23	18.15	3.50	5.39	67.23	40.29	0.00	98.22
		Std Dev	0.64	1.19	0.78	1.24	2.34	0.23	0.17	4.11	1.82	0.00	0.53
		Count	13	13	13	13	13	13	14	13	14	17	11
	2	Average	97.43	73.57	45.36	33.07	18.14	3.54	5.42	67.07	40.38	0.00	
		Std Dev	0.76	1.70	0.74	1.64	2.11	0.26	0.16	2.64	1.30	0.00	
		Count	14	14	14	14	14	14	8	14	8	9	
11	1	Average	98.46	69.85	46.15	35.08	20.31	3.92	5.69	67.00	44.00		97.67
		Std Dev	0.66	1.07	1.14	1.66	1.65	0.49	0.22	1.15	1.80		1.17
		Count	13	13	13	13	13	13	24	10	22		19
12	1	Average	94.00	73.50	44.00	34.50	18.50	3.90	4.70				96.70
		Std Dev	1.41	3.54	1.41	0.71	6.36	0.85	0.14				0.85
		Count	2	2	2	2	2	2	2				2
13	1	Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		Count	0	0	0	0	0	0	0	0	0	0	

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
9	2	Average	96.71	72.00	49.86	38.00	21.71	3.90	5.40				97.46
		Std Dev	0.46	0.82	1.46	1.63	1.50	0.64	0.13				0.47
		Count	27	27	27	27	27	27	27				22
	5	Average	97.83	70.98	49.25	36.66	20.94	4.07	5.40				97.88
		Std Dev	0.83	1.15	2.21	1.56	1.90	0.72	0.20				1.23
		Count	115	115	115	115	115	115	115				144
10	2	Average	97.43	73.88	46.06	32.97	17.71	3.63	5.50	63.92	40.00		98.17
		Std Dev	0.58	1.17	0.72	0.85	1.19	0.35	0.14	3.79	1.58		0.52
		Count	90	90	90	90	90	90	90	26	9	87	90
	2	Average	97.36	74.27	46.03	33.34	17.83	3.56	5.52	65.17	40.63	0.00	96.00
		Std Dev	0.68	1.49	0.82	1.09	1.34	0.33	0.15	3.65	0.52	0.00	0.00
		Count	64	64	64	64	64	64	64	18	8	64	64
11	1	Average	96.85	69.05	44.56	34.63	19.15	4.06	5.64	68.41	40.17	0.12	97.53
		Std Dev	0.65	0.86	0.90	1.44	2.07	0.57	0.16	3.36	1.47	0.04	0.77
		Count	41	41	41	41	41	41	41	17	6	41	41
12	1	Average	95.83	71.00	54.00	36.17	20.33	2.86	5.00				96.94
		Std Dev	2.59	1.86	5.39	2.08	2.57	0.63	0.33				0.39
		Count	12	12	12	12	12	12	12				12
13	1	Average	97.78	68.78	44.06	30.00	17.78	3.79	5.17	0.00	0.00	0.00	96.87
		Std Dev	0.81	1.22	1.47	1.71	1.56	0.68	0.17	0.00	0.00	0.00	0.32
		Count	18	18	18	18	18	18	18	0	0	0	18

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
14	1	Average	92.25	66.50	48.00	33.75	18.00	5.45	5.01				
		Std Dev	1.26	1.91	1.41	2.06	1.41	1.05	0.08				
		Count	4	4	4	4	4	4	4				
	2	Average	93.09	63.64	45.18	31.09	17.18	5.82	4.65				98.06
		Std Dev	2.47	4.23	4.53	3.42	2.36	0.75	0.36				0.42
		Count	11	11	11	11	11	11	9				7
	3	Average	97.00	67.00	48.00	33.00	16.00	3.80	4.80	0.00	0.00	0.00	
		Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		Count	1	1	1	1	1	1	1	0	0	0	
	4	Average	96.00	70.50	49.50	34.50	19.50	6.70	4.88				97.00
		Std Dev	0.00	0.71	3.54	3.54	2.12	0.14	0.18				0.57
		Count	2	2	2	2	2	2	2				2
15	1	Average	99.11	71.00	45.89	35.33	18.22	4.09	4.68		46.44		97.00
		Std Dev	0.60	1.87	3.10	2.29	1.30	0.84	0.24		2.07		0.90
		Count	9	9	9	9	9	9	9		9		9
16	1	Average	95.67	66.83	48.67	34.83	19.00	4.33	5.18	58.00	50.78	0.98	96.42
		Std Dev	1.03	0.75	1.37	1.33	1.26	0.45	0.18	1.90	2.73	0.02	0.22
		Count	6	6	6	6	6	6	6	6	9	3	8
	2	Average	95.71	66.86	48.57	35.29	19.29	5.21		55.33	47.75		
		Std Dev	0.76	2.54	2.15	1.98	1.38	0.45		2.52	2.22		
		Count	7	7	7	7	7	7		3	7		
17	1	Average	99.50	66.70	46.90	34.40	18.30	5.17	4.64				97.64
		Std Dev	0.53	2.00	1.85	2.55	1.70	0.83	0.20				0.83
		Count	10	10	10	10	10	10	10				10
18	1	Average	99.70	66.05	45.75	32.51	18.20	5.34	4.62	62.20	47.83	0.53	97.40
		Std Dev	0.57	2.14	1.80	7.24	2.26	1.10	0.21	5.93	2.59	0.50	1.19
		Count	20	20	20	20	20	20	30	20	30	4	27

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
14	1	Average	94.32	68.11	46.64	32.96	17.89	5.29	4.80				
		Std Dev	1.56	1.85	1.93	1.48	1.10	0.48	0.24				
		Count	28	28	28	28	28	28	28				
	2	Average	95.13	68.19	47.64	32.96	18.09	5.32	4.86				97.11
		Std Dev	1.13	1.33	1.25	1.12	0.97	0.40	0.20				0.62
		Count	67	67	67	67	67	67	67				67
	3	Average	94.17	67.75	46.58	32.67	18.00	5.48	4.66	0.00	0.00	0.00	97.18
		Std Dev	0.72	1.36	1.88	1.78	1.35	0.46	0.19	0.00	0.00	0.00	0.65
		Count	12	12	12	12	12	12	12	0	0	0	12
	4	Average	95.36	68.27	46.73	33.36	18.55	5.79	4.75				97.74
		Std Dev	1.43	1.95	1.62	1.21	1.04	0.43	0.13				0.89
		Count	12	12	12	12	12	12	12				12
15	1	Average	99.20	71.20	45.02	35.05	17.51	4.28	5.00	70.56	39.76	0.00	96.91
		Std Dev	0.60	1.52	1.19	1.50	1.10	0.50	0.10	5.15	1.43	0.00	0.55
		Count	41	41	41	41	41	41	41	41	41	41	41
16	1	Average	96.20	68.68	49.07	35.23	19.34	4.93	5.28	55.10	39.02	0.97	96.69
		Std Dev	1.02	2.11	1.77	1.82	1.43	0.61	0.20	2.79	0.01	0.02	0.50
		Count	44	44	44	44	44	44	44	41	4	4	46
	2	Average	96.53	67.72	49.00	34.84	19.16	4.93	5.25	54.03	40.80		
		Std Dev	1.11	1.87	1.61	1.53	1.25	0.41	0.24	1.77	1.10		
		Count	32	32	32	32	32	32	32	32	5		
17	1	Average	99.13	66.64	47.22	33.23	17.05	4.76	4.60				97.95
		Std Dev	0.54	2.34	1.70	2.11	1.50	0.51	0.14				0.84
		Count	91	91	91	91	91	91	91				91
18	1	Average	99.64	67.62	46.21	32.36	17.28	4.76	4.65	62.44	48.17	0.53	97.48
		Std Dev	0.51	1.92	1.80	1.51	1.27	0.44	0.13	5.03	2.93	0.48	0.65
		Count	146	146	146	146	146	146	146	9	6	6	146

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
19	1	Average	99.72	65.61	45.61	34.39	19.06	6.04	4.86	68.00	47.60		97.89
		Std Dev	0.46	2.17	1.91	1.61	1.06	0.42	0.37	0.00	4.28		0.74
		Count	18	18	18	18	18	18	27	1	5		25
20	1	Average	99.79	62.16	41.53	31.63	17.32	5.75	5.00	56.78	44.67		98.15
		Std Dev	0.42	1.80	1.43	1.46	1.11	0.80	0.33	7.92	5.50		0.99
		Count	19	19	19	19	19	19	19	18	18		15
21	1	Average	100.00	72.00	45.14	31.29	17.43	4.50	5.05	79.71	46.67		97.27
		Std Dev	0.00	0.82	0.69	1.50	0.98	0.45	0.24	3.09	1.51		0.58
		Count	7	7	7	7	7	7	7	7	6		6
	2	Average	100.00	71.13	47.63	33.13	18.75	4.21	4.47	79.00	48.38	0.10	97.39
		Std Dev	0.00	2.23	2.07	2.70	2.82	0.27	0.19	0.00	1.60	0.01	0.57
		Count	8	8	8	8	8	8	8	2	8	2	8
	3	Average	100.00	73.18	47.18	32.84	18.00	4.38	4.91	80.67			
		Std Dev	0.00	1.43	1.70	2.29	1.48	0.51	0.24	1.53			
		Count	45	45	45	45	45	45	39	3			
22	1	Average	98.50	62.75	45.75	33.75	17.50	4.58	4.73				95.90
		Std Dev	0.58	0.50	2.06	2.22	1.29	0.38	0.06				1.32
		Count	4	4	4	4	4	4	4				4
23	1	Average	95.67	70.67	49.00	34.67	18.67	5.37	4.82	57.00	49.67		
		Std Dev	0.58	0.58	1.73	0.58	1.53	0.71	0.20	5.57	2.08		
		Count	3	3	3	3	3	3	3	3	3		
24	1	Average	98.75	78.25	47.50	36.50	21.00	2.88	4.88				96.25
		Std Dev	0.50	1.26	1.29	1.29	2.45	0.15	0.15				0.50
		Count	4	4	4	4	4	4	4				4

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
19	1	Average	99.16	63.16	44.03	33.31	18.03	5.88	4.78	56.60	40.75	0.10	98.02
		Std Dev	0.47	2.36	2.09	1.79	1.07	0.47	0.16	6.58	1.22	0.05	1.00
		Count	128	128	128	128	128	128	128	5	12	128	128
20	1	Average	99.41	61.56	42.26	32.05	16.79	5.54	4.74	61.75	42.00	0.05	97.18
		Std Dev	0.49	2.32	2.16	1.73	1.43	0.51	0.18	2.82	2.10	0.07	0.55
		Count	121	121	121	121	121	121	121	8	11	121	121
21	1	Average	100.00	71.65	46.40	32.45	18.00	4.26	5.00	79.86	40.00	0.11	97.16
		Std Dev	0.00	0.99	1.14	0.94	0.56	0.19	0.18	0.90	N/A	0.05	0.53
		Count	20	20	20	20	20	20	20	7	1	20	20
	2	Average	100.00	69.87	45.79	31.87	17.63	4.13	4.56	80.82	42.86	0.09	97.10
		Std Dev	0.00	2.02	2.07	1.82	1.20	0.31	0.20	1.83	3.24	0.02	0.52
		Count	38	38	38	38	38	38	38	11	7	38	38
	3	Average	100.00	73.00	47.28	32.90	17.85	3.77	4.94	79.79	43.00	0.10	
		Std Dev	0.00	1.99	2.09	1.51	0.92	0.45	0.17	1.14	3.46	0.03	
		Count	71	71	71	71	71	71	71	24	6	71	
22	1	Average	98.67	66.12	47.07	32.70	16.60	4.42	4.73				97.74
		Std Dev	0.64	2.77	1.55	1.66	1.22	0.45	0.10				0.43
		Count	43	43	43	43	43	43	43				43
23	1	Average	96.73	71.00	49.69	36.54	19.12	5.70	5.00	53.55	49.75	0.20	
		Std Dev	0.83	1.57	1.89	1.53	0.71	0.40	0.18	3.22	1.71	0.08	
		Count	26	26	26	26	26	26	26	20	4	4	
24	1	Average	98.54	78.62	48.31	36.00	20.23	3.20	4.85				97.31
		Std Dev	0.52	1.98	2.53	2.08	1.92	0.85	0.12				1.32
		Count	13.00	13.00	13.00	13.00	13.00	13.00	13.00				13.00

Caltrans HMA QA/QC Study

Caltrans Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
25	1	Average	98.80	88.60	52.60	39.00	22.80	4.02	4.92		36.50		96.43
		Std Dev	0.45	1.67	2.61	2.12	2.59	0.58	0.13		2.12		1.29
		Count	5	5	5	5	5	5	5		2		4
26	3	Average	97.40	71.20	51.00	36.60	17.40	5.68	4.92	0.00			96.96
		Std Dev	1.67	3.11	2.45	2.88	1.82	0.46	0.11	0.00			1.46
		Count	5	5	5	5	5	5	5	5			5
27	1	Average	95.50	70.00	46.75	33.25	17.50	4.00	5.30	0.00			97.75
		Std Dev	0.58	1.41	1.26	0.96	0.58	1.02	0.44	0.00			2.25
		Count	4	4	4	4	4	4	4	4			4
28	1	Average	98.50	69.75	52.00	36.75	16.75	5.50	5.01				98.55
		Std Dev	0.58	2.06	1.63	0.96	0.50	1.00	0.23				2.30
		Count	4	4	4	4	4	4	4				4
29	1	Average	97.50	72.50	51.50	36.50	20.00	5.30	4.96	73.00	38.50	0.02	97.85
		Std Dev	0.71	2.12	0.71	0.71	0.00	0.71	0.14	0.00	2.12	0.01	1.63
		Count	2	2	2	2	2	2	2	1	2	2	2

Caltrans HMA QA/QC Study

Contractor Test Data

Project #	Lot #		Percentage Passing (Sieve Size)						Other Parameters				
			19- or 12.5-mm (3/4" or 1/2")	9.5-mm (3/8")	4.75-mm (#4)	2.36-mm (#8)	600-um (#30)	75-um (#200)	Asphalt Content	Sand Equivalent	Stability Value	Moisture Content	Relative Compaction
25	1	Average	97.95	87.56	52.41	39.74	24.03	3.77	5.07	68.69	42.08	0.00	96.97
		Std Dev	0.69	1.57	1.90	1.19	1.46	0.45	0.16	2.25	4.10	0.01	0.54
		Count	39	39	39	39	39	39	39	39	12	39	39
26	3	Average	97.68	70.77	50.52	36.59	17.07	5.53	5.19				97.78
		Std Dev	1.19	3.00	2.40	1.93	1.25	0.67	0.22				0.77
		Count	56	56	56	56	56	56	56				56
27	1	Average	96.08	69.54	46.71	33.33	17.75	3.84	5.43				98.02
		Std Dev	1.06	1.32	1.99	1.05	1.62	0.70	0.15				1.16
		Count	24	24	24	24	24	24	24				24
28	1	Average	98.24	69.97	51.62	36.93	17.10	5.36	5.15				98.11
		Std Dev	0.74	1.76	1.35	1.71	1.40	0.61	0.18				1.00
		Count	31	31	31	31	31	31	31				31
29	1	Average	97.70	72.25	51.60	36.95	20.85	4.38	5.02	65.14	41.00	0.08	96.95
		Std Dev	1.26	1.89	2.66	1.28	2.13	0.86	0.14	2.73	4.36	0.04	0.76
		Count	20	20	20	20	20	20	20	7	7	20	20

Appendix D

MINNESOTA DOT ASPHALT FILM THICKNESS STUDY
QA/QC TESTING RESULTS

2003 ASPHALT FILM THICKNESS STUDY

MnDOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
0901-72	Average	5.50	4.69	4.96	6.60	10.86	20.43	31.57	43.71	56.43	70.57	36.79	6.57	14.46
	Std Dev	0.29	0.25	0.28	0.35	0.69	0.98	1.13	0.95	1.51	2.07	1.43	0.27	0.26
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
3605-37	Average	5.20	4.70	4.96	7.35	9.50	12.50	17.00	21.00	27.00	38.50	29.12	8.31	14.40
	Std Dev	0.00	0.14	0.15	0.78	0.71	0.71	1.41	1.41	1.41	2.12	2.29	0.40	0.42
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
3605-37	Average	5.62	4.88	5.17	7.55	9.67	13.17	17.67	23.17	31.50	49.83	30.41	8.30	14.70
	Std Dev	0.17	0.12	0.13	0.45	0.52	0.75	1.03	1.17	1.87	2.32	1.50	0.44	0.44
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6

2003 ASPHALT FILM THICKNESS STUDY

Contractor Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
0901-72	Average	5.68	4.96	5.26	5.81	9.67	19.58	31.00	42.92	54.67	68.75	34.30	7.51	14.50
	Std Dev	0.23	0.21	0.24	0.52	0.98	1.98	2.37	2.97	3.45	3.82	2.64	0.73	0.22
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
3605-37	Average	5.14	4.76	5.02	6.14	8.00	11.60	16.40	21.00	27.20	39.20	25.95	9.43	14.40
	Std Dev	0.13	0.17	0.18	0.47	0.71	0.55	0.89	1.58	2.28	2.95	1.59	0.41	0.45
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
3605-37	Average	5.45	4.85	5.13	6.62	8.36	12.00	17.09	22.64	30.73	47.64	27.59	9.06	14.67
	Std Dev	0.22	0.25	0.28	0.52	0.67	0.77	1.14	1.50	2.24	2.73	1.78	0.43	0.41
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
0416-27	Average	4.83	4.33	4.54	5.95	8.75	16.50	29.00	40.50	54.50	72.00	32.64	6.84	13.90
	Std Dev	0.17	0.15	0.16	1.25	1.71	1.00	0.82	1.91	2.38	2.94	3.08	0.82	1.50
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
1102-59	Average	4.39	4.03	4.22	4.94	7.25	11.35	17.15	23.65	32.80	46.35	24.19	8.50	13.81
	Std Dev	0.21	0.20	0.22	0.39	0.55	0.81	1.14	1.60	2.48	3.28	1.52	0.40	0.35
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
1119-32	Average	5.25	4.28	4.52	5.85	8.67	15.00	27.83	40.17	54.33	70.33	31.75	7.07	14.02
	Std Dev	0.15	0.22	0.24	1.08	1.63	2.37	2.99	3.82	5.35	3.78	4.38	1.26	0.29
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
1504-10	Average	6.06	5.06	5.39	4.36	6.00	12.40	27.60	43.60	59.20	73.20	27.48	9.54	15.72
	Std Dev	0.17	0.25	0.27	0.11	0.00	0.55	1.14	1.67	2.77	3.70	0.76	0.26	0.51
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
3509-19	Average	6.10	5.32	5.67	4.69	9.00	28.10	40.00	48.80	58.70	68.90	36.56	7.57	15.26
	Std Dev	0.09	0.16	0.18	0.33	1.63	2.92	1.56	1.32	1.42	2.02	2.30	0.43	0.26
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
3509-19	Average	6.05	5.20	5.53	4.99	8.80	29.93	41.07	50.20	60.73	72.40	37.88	7.13	15.37
	Std Dev	0.20	0.18	0.20	0.47	0.86	1.49	1.75	1.47	1.28	1.24	1.70	0.39	0.37
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
4501-36	Average	4.77	4.20	4.41	5.83	8.33	19.00	30.00	40.33	53.33	67.67	32.95	6.53	13.90
	Std Dev	0.21	0.10	0.11	0.32	0.58	1.73	2.65	4.04	4.93	5.51	2.37	0.33	0.78
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
4508-23	Average	5.77	4.79	5.08	5.16	9.33	25.89	41.44	48.89	58.11	70.78	37.07	6.68	14.20
	Std Dev	0.15	0.16	0.18	0.13	0.50	1.27	1.74	1.96	2.47	2.22	1.09	0.11	0.54
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9

2003 ASPHALT FILM THICKNESS STUDY

Contractor Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
0416-27	Average	5.00	4.28	4.51	5.67	8.67	15.83	28.00	40.17	53.50	71.33	31.72	6.99	13.78
	Std Dev	0.17	0.13	0.15	1.24	1.51	1.47	1.10	1.17	1.52	2.16	3.39	0.75	1.19
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
1102-59	Average	4.47	4.10	4.29	4.76	7.09	11.19	16.56	23.35	32.23	44.49	23.60	8.88	13.77
	Std Dev	0.21	0.18	0.19	0.32	0.61	0.82	1.50	1.66	2.55	4.22	1.41	0.42	0.34
	Count	43	43	43	43	43	43	43	43	43	43	43	43	43
1119-32	Average	5.13	4.20	4.43	5.42	8.61	14.96	27.22	41.22	55.00	71.04	31.05	7.04	14.00
	Std Dev	0.20	0.24	0.26	0.83	1.27	2.16	2.71	4.10	3.84	3.28	3.51	0.94	0.20
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
1504-10	Average	5.89	5.05	5.37	4.45	6.08	12.15	26.31	43.31	57.92	71.92	27.32	9.58	15.58
	Std Dev	0.05	0.09	0.09	0.20	0.28	0.55	1.44	1.55	1.85	1.98	0.81	0.24	0.34
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
3509-19	Average	6.10	5.20	5.54	4.88	7.79	28.16	39.32	49.00	58.79	69.84	36.11	7.48	15.38
	Std Dev	0.08	0.11	0.12	0.38	0.79	1.89	2.00	1.70	1.47	1.83	1.52	0.30	0.29
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
3509-19	Average	6.01	5.10	5.42	4.88	7.96	29.00	40.32	49.96	59.86	71.61	36.76	7.20	15.45
	Std Dev	0.13	0.10	0.11	0.64	0.92	1.74	2.31	2.12	1.98	1.87	1.93	0.36	0.36
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28
4501-36	Average	4.80	4.40	4.62	5.35	8.33	18.50	29.83	41.33	54.33	69.00	32.15	7.00	13.97
	Std Dev	0.09	0.14	0.15	0.21	0.52	0.55	1.33	1.86	2.50	2.90	0.81	0.26	0.45
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
4508-23	Average	5.64	4.68	4.95	5.30	8.83	25.42	40.92	48.67	57.17	72.25	36.76	6.58	14.35
	Std Dev	0.15	0.15	0.16	0.56	1.03	2.50	2.71	2.61	1.47	3.93	2.11	0.43	0.34
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

SP		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5401-30	Average	5.64	4.65	4.92	5.42	8.09	19.27	32.27	45.45	60.91	75.09	33.40	7.20	14.45
	Std Dev	0.21	0.15	0.17	0.37	0.54	2.00	2.72	2.46	2.43	2.63	2.10	0.49	0.34
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
5410-17	Average	5.26	4.72	4.98	4.75	8.40	17.70	31.10	43.00	55.60	69.80	31.36	7.75	13.85
	Std Dev	0.18	0.08	0.09	0.30	0.52	0.95	1.60	1.94	1.90	2.04	1.26	0.34	0.58
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
5703-39	Average	5.07	4.50	4.74	5.90	8.33	18.67	30.33	42.00	57.00	71.67	33.36	6.92	14.33
	Std Dev	0.25	0.30	0.33	0.30	0.58	0.58	1.15	1.00	1.73	1.53	1.22	0.43	0.15
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
6004-17	Average	5.03	4.36	4.59	5.67	7.26	10.17	14.13	18.43	24.83	36.39	23.65	9.49	13.38
	Std Dev	0.19	0.18	0.20	0.46	0.62	0.98	1.39	1.78	2.52	3.41	1.82	0.63	0.69
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
6004-17	Average	5.98	5.38	5.72	4.68	7.31	21.31	37.38	49.85	60.23	69.38	33.28	8.38	14.92
	Std Dev	0.17	0.17	0.19	0.21	0.48	1.25	3.55	2.85	3.00	3.04	1.58	0.40	0.80
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
6008-14	Average	4.89	4.20	4.42	6.05	8.95	15.90	25.81	38.81	55.05	69.33	32.13	6.70	12.31
	Std Dev	0.31	0.25	0.28	0.53	0.67	1.04	1.89	3.06	4.58	3.90	1.61	0.42	4.14
	Count	21	21	21	21	21	21	21	21	21	21	21	21	21
6013-12	Average	5.80	4.75	5.04	4.95	7.83	14.50	26.17	44.00	58.00	68.67	29.85	8.23	14.22
	Std Dev	0.20	0.15	0.17	0.14	0.41	0.84	0.75	1.26	2.00	1.97	0.77	0.31	0.24
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
15-603-10	Average	6.08	4.98	5.30	4.82	7.25	16.00	29.42	43.58	59.42	73.67	30.31	8.51	13.96
	Std Dev	0.28	0.30	0.34	0.27	0.45	1.28	3.34	2.27	3.92	3.85	1.41	0.26	0.57
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12

2003 ASPHALT FILM THICKNESS STUDY

Contractor Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5401-30	Average	5.62	4.66	4.94	5.48	7.72	19.04	31.84	46.32	61.36	75.68	33.24	7.27	14.64
	Std Dev	0.17	0.12	0.14	0.36	0.84	2.01	2.54	3.15	2.29	2.63	1.93	0.51	0.32
	Count	25	25	25	25	25	25	25	25	25	25	25	25	25
5410-17	Average	5.27	4.62	4.88	4.80	8.05	17.23	30.36	42.73	54.95	69.41	30.92	7.68	14.35
	Std Dev	0.07	0.07	0.07	0.33	0.38	0.75	1.33	1.64	1.81	1.97	1.06	0.22	0.27
	Count	22	22	22	22	22	22	22	22	22	22	22	22	22
5703-39	Average	4.93	4.60	4.84	5.47	8.17	17.83	29.67	42.17	56.17	71.67	32.20	7.33	14.27
	Std Dev	0.27	0.13	0.14	0.34	0.41	0.75	1.21	2.14	1.94	2.88	1.33	0.28	0.34
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
6004-17	Average	5.21	4.36	4.60	5.63	7.00	9.74	13.65	17.88	24.35	36.44	23.17	9.70	14.07
	Std Dev	0.18	0.17	0.19	0.51	0.49	0.71	0.98	1.37	1.92	2.54	1.48	0.66	0.57
	Count	34	34	34	34	34	34	34	34	34	34	34	34	34
6004-17	Average	6.08	5.31	5.66	4.96	7.35	20.47	36.88	49.41	59.41	68.59	33.35	8.29	15.38
	Std Dev	0.21	0.16	0.18	0.65	0.70	1.37	2.37	2.40	2.55	2.79	1.93	0.60	0.56
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
6008-14	Average	4.91	4.23	4.45	5.72	8.84	15.52	25.48	38.68	55.77	69.58	31.39	6.93	14.10
	Std Dev	0.23	0.23	0.25	0.62	0.82	1.21	1.55	2.52	4.02	3.40	1.90	0.59	0.48
	Count	31	31	31	31	31	31	31	31	31	31	31	31	31
6013-12	Average	5.74	4.68	4.96	4.76	7.35	14.24	26.06	44.41	59.24	70.12	29.27	8.26	14.71
	Std Dev	0.12	0.13	0.14	0.34	0.49	0.83	1.14	1.28	1.68	2.26	1.15	0.34	0.19
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
15-603-10	Average	5.90	4.92	5.23	4.89	7.45	15.40	29.80	44.50	59.30	73.20	30.48	8.37	14.25
	Std Dev	0.13	0.16	0.18	0.38	0.60	1.19	1.77	2.78	3.45	3.75	1.76	0.37	0.45
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
35-612-04	Average	5.88	4.98	5.29	4.98	6.50	10.25	19.00	33.75	55.25	71.75	25.94	9.94	14.03
	Std Dev	0.17	0.17	0.19	0.41	0.58	0.50	0.82	0.96	0.96	2.22	1.27	0.52	0.24
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
63-612-06	Average	6.11	5.04	5.37	5.43	8.13	15.50	28.25	47.13	62.88	75.38	31.95	8.19	14.40
	Std Dev	0.20	0.18	0.21	0.31	0.64	1.20	2.38	3.60	4.26	4.17	1.85	0.39	0.63
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
68-606-09	Average	6.14	5.13	5.46	3.97	5.86	18.43	33.14	44.00	56.57	69.57	29.21	9.13	14.86
	Std Dev	0.16	0.15	0.17	0.42	0.90	0.79	1.35	1.41	1.62	1.62	1.36	0.54	0.40
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2003 ASPHALT FILM THICKNESS STUDY

Contractor Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
35-612-04	Average	6.16	5.06	5.39	5.05	6.33	10.33	18.58	33.17	55.25	73.00	25.91	10.15	14.83
	Std Dev	0.12	0.11	0.12	0.37	0.49	0.65	1.08	1.47	2.09	1.86	1.10	0.44	0.17
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
63-612-06	Average	5.98	5.01	5.33	4.93	7.67	14.75	28.00	45.92	61.92	75.25	30.48	8.54	14.74
	Std Dev	0.15	0.16	0.17	0.49	0.78	1.29	3.59	2.84	3.06	2.86	1.94	0.51	0.30
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
68-606-09	Average	6.04	5.23	5.56	3.96	5.79	18.11	33.53	44.00	57.26	71.47	29.17	9.30	15.13
	Std Dev	0.11	0.09	0.10	0.40	0.79	0.74	1.26	1.11	1.24	1.35	1.39	0.43	0.20
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
1805-63	Average	6.08	4.78	5.09	4.18	6.81	14.75	30.75	49.13	64.06	76.50	29.52	8.43	14.28
	Std Dev	0.37	0.19	0.20	0.37	0.66	1.13	2.32	2.83	3.55	3.76	1.95	0.67	0.60
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
1805-63	Average	4.88	4.19	4.41	7.08	10.85	18.92	30.92	44.77	59.31	76.46	37.32	5.76	14.06
	Std Dev	0.16	0.13	0.15	0.29	0.55	0.95	1.04	1.59	1.89	2.03	1.26	0.25	0.39
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
11-604-12	Average	5.58	4.78	5.06	4.44	7.00	13.80	28.80	43.80	55.00	64.80	28.48	8.66	14.46
	Std Dev	0.08	0.13	0.14	0.21	0.00	0.45	0.84	0.84	1.00	1.10	0.53	0.37	0.47
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
1118-119	Average	6.20	5.30	5.65	4.20	6.00	12.00	28.00	46.33	58.00	67.67	27.22	10.10	15.93
	Std Dev	0.36	0.46	0.51	0.30	0.00	0.00	1.00	2.52	3.00	3.51	1.01	0.56	0.78
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
1118-119	Average	5.58	4.93	5.23	5.03	7.33	12.67	27.67	45.17	57.83	70.83	29.47	8.65	15.35
	Std Dev	0.19	0.23	0.25	0.64	0.82	1.21	1.21	2.23	2.86	2.40	2.03	0.37	0.59
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
1809-55	Average	5.32	4.66	4.92	5.10	7.40	14.20	27.70	42.30	55.00	69.40	29.71	8.08	13.83
	Std Dev	0.18	0.13	0.15	0.22	0.52	0.63	1.34	1.64	1.89	1.78	1.14	0.45	0.26
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
1809-55	Average	5.26	4.44	4.69	5.56	8.44	15.89	27.67	40.78	55.67	71.44	31.51	7.27	14.56
	Std Dev	0.19	0.19	0.21	0.39	0.53	1.27	2.35	3.11	2.96	2.60	1.61	0.53	0.92
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
1809-55	Average	5.63	4.91	5.20	4.93	7.08	13.33	25.25	38.00	49.25	62.50	27.94	9.08	14.56
	Std Dev	0.17	0.16	0.17	0.28	0.51	0.78	1.48	2.09	2.63	3.12	1.40	0.44	0.56
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12

2003 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
1805-63	Average	6.04	4.81	5.12	4.08	6.47	14.29	30.24	48.18	62.24	74.59	28.77	8.70	14.12
	Std Dev	0.19	0.17	0.19	0.44	0.80	1.26	2.22	3.17	3.07	3.50	2.08	0.69	0.55
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
1805-63	Average	4.84	4.21	4.42	6.45	10.40	18.20	30.20	43.85	57.65	74.65	35.56	6.06	14.08
	Std Dev	0.18	0.15	0.17	0.40	1.10	0.77	1.01	1.42	2.11	2.16	1.22	0.30	0.28
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
11-604-12	Average	5.74	5.01	5.32	4.22	7.00	13.90	29.90	44.00	55.30	65.20	28.34	9.13	14.91
	Std Dev	0.22	0.28	0.31	0.19	0.00	0.32	0.57	1.15	1.42	1.69	0.34	0.54	0.44
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
1118-119	Average	6.03	5.46	5.81	3.80	5.29	11.00	26.71	45.43	56.43	66.14	25.51	11.09	16.01
	Std Dev	0.19	0.24	0.26	0.18	0.49	0.58	1.11	1.27	1.72	2.04	0.99	0.44	0.47
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
1118-119	Average	5.66	5.08	5.39	4.45	6.31	12.06	27.13	45.38	57.88	71.50	27.70	9.49	15.54
	Std Dev	0.19	0.19	0.21	0.44	0.48	0.85	1.31	1.93	2.06	2.25	1.35	0.62	0.49
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
1809-55	Average	5.49	4.78	5.05	5.60	7.33	13.86	27.48	41.24	54.00	67.76	30.18	8.17	14.11
	Std Dev	0.21	0.17	0.19	0.56	0.48	0.85	1.66	1.81	2.24	2.55	1.66	0.46	0.30
	Count	21	21	21	21	21	21	21	21	21	21	21	21	21
1809-55	Average	5.24	4.54	4.80	6.31	8.44	15.25	27.31	39.50	54.13	69.06	32.27	7.27	14.51
	Std Dev	0.18	0.15	0.17	0.61	0.89	1.24	2.02	2.42	2.60	2.79	2.05	0.57	0.66
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
1809-55	Average	5.51	4.90	5.19	5.70	7.37	13.37	25.95	38.26	49.79	63.00	29.50	8.58	14.68
	Std Dev	0.18	0.20	0.22	0.54	0.76	0.90	1.31	2.05	2.62	3.51	1.78	0.42	0.37
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
11-602-06	Average	5.86	5.29	5.54	3.60	5.80	13.70	30.50	44.10	53.20	62.90	26.53	10.16	15.16
	Std Dev	0.40	0.38	0.46	0.24	0.42	0.82	2.07	3.03	4.08	4.48	1.41	0.58	0.80
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10

2003 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
11-602-06	Average	6.04	5.50	5.85	3.34	5.08	13.00	30.23	42.15	50.92	60.08	25.13	11.35	15.70
	Std Dev	0.28	0.34	0.38	0.14	0.28	1.00	1.96	2.70	3.15	3.64	1.08	0.59	0.63
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2610-10+	Average	6.01	4.81	5.12	5.64	7.75	13.50	27.63	43.50	59.63	72.88	30.91	8.14	14.05
	Std Dev	0.17	0.12	0.14	0.70	0.89	1.60	2.83	4.00	4.69	4.19	2.97	0.88	0.67
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
7503-31	Average	5.77	4.66	4.94	6.16	7.86	13.29	25.71	39.29	53.71	68.29	30.81	7.83	14.39
	Std Dev	0.29	0.29	0.33	0.30	0.38	0.76	1.60	1.98	1.70	1.80	1.28	0.62	0.48
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
2101-20	Average	5.65	4.71	4.99	6.82	9.67	18.87	35.07	47.93	61.40	72.73	37.03	6.57	14.67
	Std Dev	0.16	0.22	0.24	0.44	0.62	0.74	1.67	2.43	2.92	3.01	1.60	0.30	0.73
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
4401-16	Average	5.63	4.77	5.05	5.00	7.25	14.92	30.58	45.50	58.58	69.83	30.49	8.09	14.59
	Std Dev	0.26	0.29	0.32	0.29	0.45	0.90	1.68	1.98	2.64	3.24	1.26	0.71	0.73
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
4401-16	Average	5.36	4.50	4.76	5.63	8.17	16.25	31.33	44.92	57.50	69.08	32.44	7.15	14.12
	Std Dev	0.23	0.23	0.26	0.45	0.72	1.14	1.97	2.43	2.43	2.84	1.84	0.44	0.36
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
6111-21+	Average	5.90	4.68	4.98	5.78	7.67	14.00	28.00	42.83	57.33	71.00	31.11	7.85	14.33
	Std Dev	0.28	0.25	0.28	0.80	1.21	1.26	1.41	1.47	1.21	2.00	2.55	0.92	0.76
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
6111-21	Average	6.80	5.77	6.19	5.20	7.00	13.67	29.67	46.33	65.67	87.00	30.85	9.78	17.20
	Std Dev	0.30	0.32	0.36	0.20	0.00	0.58	1.53	2.08	3.21	3.46	1.01	0.76	0.53
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
7802-30	Average	5.85	4.64	4.93	6.71	9.08	16.62	28.85	43.00	59.00	71.38	34.43	6.98	14.47
	Std Dev	0.44	0.25	0.27	0.47	0.64	1.45	1.63	1.47	1.96	2.02	1.67	0.52	0.49
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2003 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2610-10+	Average	6.02	4.83	5.14	4.62	6.65	12.15	24.80	41.80	57.60	71.30	27.57	9.14	14.25
	Std Dev	0.15	0.17	0.19	0.61	0.93	1.35	1.99	2.76	3.36	4.58	2.32	0.85	0.38
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
7503-31	Average	5.94	4.83	5.13	4.98	6.63	12.25	24.00	39.13	54.63	68.88	27.66	9.05	14.53
	Std Dev	0.17	0.15	0.17	0.37	0.52	1.04	1.69	1.55	2.20	1.89	1.31	0.55	0.34
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
2101-20	Average	5.78	4.78	5.08	5.85	8.06	17.06	33.18	47.82	61.18	74.18	33.71	7.34	14.84
	Std Dev	0.21	0.22	0.24	0.53	0.56	1.20	1.51	2.19	2.65	2.96	1.55	0.41	0.66
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
4401-16	Average	5.80	4.85	5.15	4.22	6.33	13.87	29.20	45.47	58.60	71.20	28.21	8.91	14.49
	Std Dev	0.18	0.17	0.19	0.43	0.49	0.92	1.74	1.68	1.99	2.24	1.23	0.62	0.42
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
4401-16	Average	5.64	4.63	4.91	4.08	6.50	14.19	29.44	44.81	58.00	70.94	28.13	8.51	14.48
	Std Dev	0.15	0.15	0.17	0.26	0.52	0.98	1.46	1.56	1.67	1.73	1.19	0.41	0.27
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
6111-21+	Average	5.97	4.89	5.20	4.90	6.71	12.93	25.21	40.71	56.00	70.29	28.18	9.03	14.63
	Std Dev	0.14	0.23	0.25	0.49	0.61	1.73	1.76	2.43	2.48	2.13	1.91	0.76	0.49
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
6111-21	Average	6.80	6.05	6.49	4.30	6.50	12.50	25.50	45.00	65.00	87.50	28.05	11.26	17.25
	Std Dev	0.28	0.49	0.55	0.14	0.71	0.71	0.71	0.00	0.00	0.71	0.75	0.66	0.21
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
7802-30	Average	6.01	4.82	5.13	5.32	7.41	15.35	27.82	43.29	59.00	72.53	30.74	8.15	14.71
	Std Dev	0.29	0.25	0.28	0.46	0.71	1.87	2.01	2.08	2.32	2.43	2.12	0.48	0.45
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
7408-39	Average	6.00	5.15	5.48	6.75	11.00	20.50	34.00	47.00	61.00	74.50	38.00	7.03	13.65
	Std Dev	0.71	0.07	0.12	0.49	0.00	0.71	1.41	1.41	1.41	2.12	1.41	0.41	0.21
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
2401-36	Average	6.65	5.30	5.68	5.00	7.00	13.50	25.00	37.00	57.00	71.00	28.41	9.73	15.35
	Std Dev	0.07	0.00	0.00	0.00	0.00	0.71	1.41	1.41	1.41	1.41	0.61	0.22	0.49
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2003 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
7408-39	Average	5.98	4.90	5.21	5.90	10.40	20.40	34.20	48.40	61.40	74.40	36.40	7.00	14.38
	Std Dev	0.25	0.10	0.12	0.91	0.89	0.89	1.30	1.82	2.07	2.70	2.25	0.49	1.06
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
2401-36	Average	6.27	5.33	5.69	3.90	6.17	12.50	22.50	36.17	54.83	70.67	25.34	10.96	15.75
	Std Dev	0.15	0.14	0.15	0.28	0.75	1.05	1.76	2.14	1.47	1.03	1.45	0.54	0.31
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6

2003 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
4011-22	Average	5.58	4.67	4.94	5.28	7.67	13.33	27.00	42.33	55.33	70.00	29.83	8.08	14.70
	Std Dev	0.25	0.25	0.28	0.41	0.52	0.82	0.89	0.82	1.03	1.10	1.32	0.58	0.41
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
0703-16	Average	5.93	4.89	5.19	5.76	8.90	17.33	31.38	45.52	58.29	69.81	33.52	7.57	14.87
	Std Dev	0.18	0.19	0.21	0.45	0.77	1.59	2.04	2.02	2.87	3.63	1.81	0.49	0.68
	Count	21	21	21	21	21	21	21	21	21	21	21	21	21
8304-29	Average	6.70	5.25	5.63	3.50	5.00	10.00	21.00	32.00	50.00	66.00	22.42	12.22	15.00
	Std Dev	0.28	0.35	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.14
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
0801-30	Average	6.00	5.06	5.38	5.32	8.40	17.80	32.20	45.00	56.40	65.00	32.56	8.06	15.30
	Std Dev	0.21	0.25	0.28	0.16	0.55	0.45	0.45	0.71	0.89	0.71	0.72	0.46	0.27
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
1703-66	Average	6.45	5.50	5.88	5.40	8.50	18.50	33.00	45.50	57.00	65.00	33.13	8.65	15.30
	Std Dev	0.07	0.00	0.00	0.00	0.71	0.71	1.41	2.12	1.41	1.41	1.09	0.29	0.85
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2003 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	ACeff (By Mix)	ACeff (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
4011-22	Average	5.66	4.84	5.14	4.97	7.44	13.00	27.22	42.56	56.11	70.89	29.19	8.57	14.73
	Std Dev	0.18	0.27	0.29	0.22	0.53	0.71	0.97	1.33	1.62	1.69	0.96	0.50	0.30
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
0703-16	Average	5.89	4.97	5.28	5.28	8.43	16.95	31.48	46.41	59.75	71.52	32.53	7.93	14.98
	Std Dev	0.17	0.25	0.27	0.35	0.66	1.85	2.30	2.02	2.15	2.36	1.66	0.53	0.58
	Count	44	44	44	44	44	44	44	44	44	44	44	44	44
8304-29	Average	6.55	5.15	5.51	3.00	5.00	10.00	20.50	32.50	50.00	68.50	21.64	12.40	15.80
	Std Dev	0.35	0.49	0.55	0.14	0.00	0.00	0.71	0.71	1.41	2.12	0.37	1.03	0.14
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
0801-30	Average	6.14	5.15	5.49	4.38	7.13	16.50	31.38	45.63	57.25	67.50	29.91	8.95	15.58
	Std Dev	0.18	0.12	0.13	0.37	0.83	0.93	2.20	1.85	1.58	2.20	1.48	0.40	0.43
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
1703-66	Average	6.47	5.33	5.70	4.50	7.33	16.33	32.00	46.67	58.33	66.67	30.38	9.21	15.57
	Std Dev	0.21	0.12	0.13	0.56	1.15	2.89	3.46	1.15	0.58	0.58	2.97	1.11	0.50
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
0901-72	Average	5.45	4.67	4.94	6.53	10.67	21.20	32.87	44.53	56.40	69.67	37.03	6.49	14.91
	Std Dev	0.26	0.18	0.20	0.47	0.62	1.82	2.85	2.83	2.75	3.09	1.37	0.19	0.86
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
0901-73	Average	5.73	4.69	4.98	5.58	8.91	17.64	29.36	41.45	52.73	65.27	32.41	7.51	14.47
	Std Dev	0.18	0.21	0.23	0.57	1.14	1.57	1.69	2.02	2.33	2.28	2.41	0.64	0.65
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
0906-42	Average	5.14	4.27	4.50	6.70	9.33	15.00	23.67	37.67	55.67	73.00	31.96	6.86	14.03
	Std Dev	0.05	0.06	0.06	0.17	0.58	1.00	1.15	1.15	2.08	1.73	1.22	0.35	0.46
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
0906-42	Average	5.00	4.03	4.24	5.83	8.00	11.75	17.00	24.25	34.25	47.75	25.98	7.94	13.23
	Std Dev	0.45	0.40	0.44	0.55	0.82	0.96	1.83	2.99	4.79	5.85	2.35	0.17	0.73
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
3108-55	Average	4.75	4.24	4.45	4.94	7.00	11.00	18.00	26.75	36.63	50.00	24.53	8.85	13.94
	Std Dev	0.21	0.17	0.18	0.39	0.53	0.53	0.76	1.16	1.51	2.51	1.22	0.48	0.23
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
3108-55	Average	5.24	4.64	4.90	5.34	8.00	14.20	26.40	41.40	56.60	71.20	30.30	7.89	15.46
	Std Dev	0.11	0.11	0.12	0.39	0.71	1.30	2.30	3.13	2.30	2.17	2.02	0.49	0.67
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
6915-122	Average	4.99	4.24	4.47	6.82	9.33	15.06	23.28	34.39	48.44	64.28	29.58	7.38	14.94
	Std Dev	0.30	0.39	0.42	0.61	0.59	1.11	1.49	2.28	3.40	3.59	1.78	0.79	0.81
	Count	18	18	18	18	18	18	18	18	18	18	18	18	18
6920-37	Average	5.10	4.70	4.95	7.55	11.00	19.00	31.00	43.00	56.50	73.00	36.85	6.55	14.15
	Std Dev	0.14	0.28	0.31	0.21	0.00	0.00	0.00	0.00	0.71	1.41	0.39	0.47	0.21
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
0901-72	Average	5.61	4.89	5.18	5.66	9.71	20.39	31.93	43.54	55.21	68.71	34.55	7.32	14.59
	Std Dev	0.20	0.20	0.22	0.41	0.76	1.99	2.57	2.83	3.24	3.43	2.15	0.56	0.57
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28
0901-73	Average	5.44	4.65	4.92	5.46	8.73	17.55	29.36	41.00	52.36	64.36	32.01	7.53	14.54
	Std Dev	0.21	0.26	0.28	0.73	0.90	1.63	2.01	2.28	2.62	3.01	2.64	0.68	0.45
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
0906-42	Average	5.43	4.38	4.63	6.18	9.00	14.50	23.75	36.25	55.00	72.50	30.66	7.35	13.85
	Std Dev	0.22	0.26	0.29	0.26	0.00	0.58	0.50	0.50	0.82	1.91	0.64	0.42	0.37
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
0906-42	Average	4.89	3.89	4.09	4.77	6.71	10.57	16.00	22.14	31.57	43.86	22.72	8.88	13.86
	Std Dev	0.28	0.26	0.29	0.75	0.95	1.51	2.45	3.63	5.19	6.47	3.18	1.17	1.21
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
3108-55	Average	4.46	4.22	4.42	4.39	6.43	10.71	17.71	25.86	35.43	48.43	23.03	9.36	13.54
	Std Dev	0.16	0.13	0.14	0.20	0.51	0.47	0.61	0.77	1.34	2.31	0.83	0.53	0.27
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
3108-55	Average	5.33	4.77	5.04	4.98	7.70	14.00	26.20	40.40	56.10	70.80	29.35	8.38	15.19
	Std Dev	0.15	0.22	0.24	0.37	0.48	1.15	2.20	2.41	2.23	2.10	1.68	0.49	0.38
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
6915-122	Average	4.84	4.31	4.53	6.14	9.69	14.66	22.90	33.28	47.48	63.72	28.49	7.76	14.72
	Std Dev	0.17	0.27	0.29	0.44	0.76	1.04	1.35	2.31	2.34	2.52	1.62	0.60	0.55
	Count	29	29	29	29	29	29	29	29	29	29	29	29	29
6920-37	Average	5.40	4.90	5.18	6.87	12.00	18.33	30.00	42.67	56.00	72.00	35.98	7.01	14.93
	Std Dev	0.10	0.10	0.11	0.06	0.00	0.58	0.00	0.58	1.00	1.00	0.25	0.16	0.21
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
36-646-02	Average	5.15	4.78	5.04	6.28	8.67	18.50	31.83	41.00	50.50	63.50	33.83	7.29	14.30
	Std Dev	0.23	0.31	0.33	0.55	0.82	1.87	3.43	4.15	5.17	5.17	3.00	0.51	0.74
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
38-602-24	Average	6.43	4.73	5.05	5.95	8.50	13.50	23.25	37.50	53.50	69.38	30.45	8.12	15.50
	Std Dev	0.20	0.18	0.20	0.66	0.76	1.60	1.67	1.41	1.60	2.20	2.16	0.74	0.92
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
0406-52	Average	4.61	3.87	4.06	5.98	7.80	11.10	14.90	18.50	23.60	32.30	24.73	8.01	13.58
	Std Dev	0.27	0.30	0.32	0.46	0.63	0.99	1.10	1.35	2.01	3.13	1.78	0.61	0.82
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
1411-16	Average	5.34	4.97	5.25	5.95	8.45	16.82	33.64	48.00	58.82	68.73	33.92	7.55	15.46
	Std Dev	0.25	0.30	0.33	0.41	0.52	0.87	1.69	3.10	3.76	8.90	1.72	0.50	0.98
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
0416-31	Average	5.68	4.92	5.22	4.44	6.60	15.80	32.60	49.00	63.80	76.80	30.38	8.45	15.62
	Std Dev	0.58	0.64	0.71	0.61	1.14	2.77	2.07	2.35	3.56	4.44	3.06	1.58	0.86
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
0416-39	Average	6.08	4.90	5.22	5.58	8.00	17.50	33.75	47.50	60.25	75.25	33.41	7.61	14.93
	Std Dev	0.22	0.18	0.21	0.31	0.00	1.29	2.06	1.29	1.50	2.22	0.40	0.33	0.59
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
1118-20	Average	6.36	5.48	5.85	4.98	7.00	16.80	35.80	51.80	63.00	72.40	32.33	8.81	16.42
	Std Dev	0.26	0.34	0.38	0.26	0.00	0.45	1.48	2.77	3.08	3.05	0.75	0.47	1.22
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
1118-20	Average	5.95	5.02	5.34	4.80	6.90	16.10	34.80	50.50	62.40	73.10	31.52	8.25	16.01
	Std Dev	0.36	0.33	0.37	0.30	0.32	0.88	2.04	3.37	3.47	2.56	1.16	0.51	0.89
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
36-646-02	Average	5.06	4.67	4.92	5.46	7.78	17.22	31.89	41.22	50.33	62.67	31.59	7.61	14.53
	Std Dev	0.05	0.09	0.09	0.49	0.67	1.48	2.89	3.53	4.00	4.06	2.31	0.48	0.32
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
38-602-24	Average	6.62	5.02	5.38	5.15	7.48	12.67	22.86	36.62	52.71	68.19	28.12	9.36	15.35
	Std Dev	0.19	0.18	0.20	0.48	0.75	1.46	2.15	2.38	1.74	2.02	2.01	0.79	0.63
	Count	21	21	21	21	21	21	21	21	21	21	21	21	21
0406-52	Average	4.69	3.94	4.14	5.47	7.48	10.78	14.26	18.17	23.78	33.57	23.55	8.63	13.84
	Std Dev	0.18	0.30	0.32	0.63	0.90	1.17	1.48	1.75	2.70	4.26	2.28	1.01	0.81
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
1411-16	Average	5.19	4.92	5.18	5.74	8.25	16.35	33.80	48.35	58.95	71.15	33.41	7.57	15.82
	Std Dev	0.23	0.27	0.30	0.54	0.64	1.04	1.82	2.78	3.91	4.87	1.98	0.45	0.86
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
0416-31	Average	5.88	5.19	5.52	3.67	5.89	14.67	31.22	47.78	61.44	75.56	27.96	9.66	15.47
	Std Dev	0.51	0.50	0.56	0.46	0.78	1.94	1.86	2.33	2.70	4.30	2.12	1.29	0.80
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
0416-39	Average	6.05	5.02	5.34	4.68	7.17	16.00	33.00	46.50	58.83	74.00	30.77	8.48	15.30
	Std Dev	0.14	0.13	0.15	0.71	0.98	1.55	3.03	2.43	1.83	2.97	2.11	0.60	0.43
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
1118-20	Average	6.22	5.59	5.96	4.65	6.73	15.82	34.82	49.36	60.82	69.82	30.87	9.40	16.32
	Std Dev	0.33	0.36	0.40	0.22	0.47	0.87	1.66	2.69	2.79	3.19	1.26	0.38	0.86
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
1118-20	Average	5.93	5.16	5.48	4.68	6.86	15.77	34.32	49.45	61.91	72.41	31.02	8.63	15.90
	Std Dev	0.29	0.30	0.34	0.34	0.56	0.97	3.48	3.14	3.44	3.50	1.60	0.65	0.83
	Count	22	22	22	22	22	22	22	22	22	22	22	22	22

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
1507-23	Average	5.31	4.54	4.80	6.31	9.78	20.22	36.00	49.22	61.89	74.11	36.97	6.32	13.93
	Std Dev	0.23	0.24	0.26	0.29	0.44	0.67	1.22	1.64	2.26	2.85	1.00	0.28	0.52
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
3107-42	Average	5.33	4.42	4.67	6.21	10.94	21.88	36.75	50.44	60.75	69.94	38.06	5.97	14.58
	Std Dev	0.15	0.17	0.19	0.32	0.44	1.15	1.95	2.66	2.54	2.41	1.10	0.24	0.68
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
5702-42	Average	5.85	4.75	5.05	5.70	9.00	20.50	36.00	48.50	60.00	73.00	35.45	6.93	14.60
	Std Dev	0.35	0.35	0.39	0.28	0.00	0.71	1.41	2.12	1.41	0.00	0.18	0.58	0.99
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
6002-63	Average	5.67	4.90	5.19	2.90	6.00	23.33	34.67	45.00	58.00	70.67	29.43	8.61	15.97
	Std Dev	0.12	0.10	0.11	0.17	0.00	1.15	3.21	3.61	3.00	1.15	0.94	0.46	0.85
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
6005-53	Average	5.56	4.92	5.21	6.26	8.36	14.79	28.43	46.50	60.93	72.93	33.07	7.68	15.24
	Std Dev	0.31	0.30	0.33	0.45	0.63	0.89	1.50	3.08	4.51	5.18	1.87	0.25	0.95
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
6005-53	Average	5.80	5.03	5.34	6.19	7.86	13.14	27.00	45.14	59.57	72.57	31.78	8.19	15.16
	Std Dev	0.39	0.35	0.40	0.33	0.38	0.69	1.00	1.86	2.64	3.36	1.33	0.66	0.45
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
6006-21	Average	5.65	4.35	4.61	5.95	8.00	20.00	32.50	46.00	61.50	78.00	34.57	6.53	14.40
	Std Dev	0.21	0.07	0.06	0.78	1.41	1.41	2.12	2.83	4.95	7.07	3.38	0.73	0.57
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
6804-21	Average	5.56	4.72	5.00	4.07	5.89	16.07	30.50	41.89	53.39	64.68	27.92	8.72	15.24
	Std Dev	0.17	0.20	0.21	0.17	0.31	0.90	1.11	1.29	1.73	2.07	0.65	0.28	0.47
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
1507-23	Average	5.33	4.58	4.84	5.67	8.67	18.78	35.04	48.11	60.93	73.44	34.56	6.82	14.42
	Std Dev	0.17	0.16	0.18	0.28	0.55	0.80	0.85	1.22	1.24	1.40	1.01	0.27	0.34
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
3107-42	Average	5.29	4.53	4.79	5.93	10.73	21.42	36.52	50.27	60.91	70.03	37.32	6.25	14.58
	Std Dev	0.18	0.19	0.21	0.43	0.63	0.97	1.52	1.96	2.08	2.13	1.44	0.33	0.60
	Count	33	33	33	33	33	33	33	33	33	33	33	33	33
5702-42	Average	5.60	4.83	5.11	5.65	8.50	21.00	36.50	49.75	61.50	74.50	35.48	7.02	14.85
	Std Dev	0.29	0.26	0.29	0.19	0.58	0.82	1.73	1.89	1.73	1.29	0.83	0.49	0.64
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
6002-63	Average	5.60	4.90	5.19	3.30	6.50	23.00	33.50	44.50	57.50	71.00	30.05	8.41	15.50
	Std Dev	0.28	0.14	0.17	0.71	0.71	1.41	2.12	3.54	2.12	0.00	0.47	0.14	1.13
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
6005-53	Average	5.57	4.92	5.21	6.07	8.29	14.29	27.66	46.03	59.57	71.29	32.34	7.85	15.27
	Std Dev	0.20	0.24	0.26	0.40	0.52	0.75	1.21	2.39	3.20	3.50	1.48	0.37	0.70
	Count	35	35	35	35	35	35	35	35	35	35	35	35	35
6005-53	Average	5.76	5.04	5.34	5.92	8.00	13.00	26.82	45.09	58.64	71.36	31.30	8.33	14.98
	Std Dev	0.20	0.27	0.29	0.51	0.63	1.10	1.78	2.43	3.23	3.72	1.86	0.49	0.71
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
6006-21	Average	5.30	4.17	4.40	6.27	8.67	20.33	33.00	46.67	62.00	78.67	35.73	6.01	13.73
	Std Dev	0.10	0.06	0.06	0.49	0.58	0.58	1.00	1.53	2.65	4.04	1.67	0.34	0.25
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
6804-21	Average	5.41	4.78	5.05	3.73	5.39	15.14	30.18	41.96	53.64	65.50	26.78	9.21	15.29
	Std Dev	0.14	0.21	0.23	0.32	0.57	0.85	1.28	1.48	1.83	2.47	1.19	0.56	0.45
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
44-601-18	Average	5.00	4.30	4.53	6.30	10.67	22.00	36.00	48.33	61.67	74.33	37.94	5.82	13.80
	Std Dev	0.44	0.17	0.20	0.20	0.58	1.00	2.00	2.08	1.53	1.15	0.86	0.39	0.46
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
57-610-09	Average	6.20	5.23	5.57	3.29	5.88	19.67	30.79	43.13	56.96	70.04	28.13	9.72	14.98
	Std Dev	0.22	0.20	0.22	0.72	0.99	1.49	2.60	1.85	2.18	3.37	2.24	1.02	0.52
	Count	24	24	24	24	24	24	24	24	24	24	24	24	24
57-625-03	Average	5.52	4.58	4.85	5.82	9.20	18.40	31.00	46.00	60.80	75.00	34.30	6.90	13.70
	Std Dev	0.15	0.18	0.20	0.29	0.84	1.14	1.87	2.55	1.79	1.87	1.48	0.51	0.60
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
60-601-53	Average	6.11	5.08	5.41	6.93	8.75	15.63	33.13	46.63	59.75	74.13	35.26	7.47	14.29
	Std Dev	0.16	0.22	0.24	0.44	0.71	0.52	1.13	2.26	3.20	3.64	1.45	0.29	0.66
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
60-609-19	Average	5.39	4.74	5.02	4.89	8.33	20.33	33.56	46.78	60.11	80.00	33.37	7.35	13.88
	Std Dev	0.18	0.26	0.28	0.52	1.00	1.66	4.33	2.17	2.37	2.29	2.60	0.66	0.47
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
60-609-19	Average	5.72	4.92	5.22	4.83	8.11	17.89	31.33	43.44	57.44	82.78	31.78	8.00	14.21
	Std Dev	0.15	0.13	0.15	0.25	0.33	0.60	1.00	1.01	1.59	1.64	0.80	0.19	0.30
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
60-609-20	Average	5.75	4.73	5.01	5.83	9.00	20.25	36.50	50.25	65.25	80.75	36.15	6.75	14.48
	Std Dev	0.24	0.33	0.36	0.05	0.00	1.26	2.38	2.63	2.22	1.71	0.99	0.37	0.78
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
60-609-20	Average	6.18	5.80	6.18	5.73	9.25	20.75	35.50	47.75	59.25	71.50	35.53	8.50	16.48
	Std Dev	0.13	0.12	0.13	1.07	0.96	0.50	1.00	1.50	1.50	2.38	1.91	0.56	0.24
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
44-601-18	Average	5.14	4.49	4.73	5.59	10.33	22.11	35.78	47.89	60.67	73.89	36.52	6.33	14.08
	Std Dev	0.13	0.18	0.19	0.38	0.71	1.62	2.54	2.85	2.50	2.52	1.80	0.41	0.49
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
57-610-09	Average	6.05	5.16	5.49	3.65	6.48	19.94	31.64	44.15	57.88	70.73	29.40	9.17	14.98
	Std Dev	0.17	0.18	0.20	0.68	1.09	1.62	1.93	1.87	2.12	3.47	2.26	0.91	0.50
	Count	33	33	33	33	33	33	33	33	33	33	33	33	33
57-625-03	Average	5.50	4.69	4.96	5.11	8.30	17.10	29.50	44.40	59.40	73.40	31.81	7.62	13.81
	Std Dev	0.18	0.20	0.22	0.61	0.67	1.10	1.65	1.84	1.58	1.07	1.90	0.58	0.26
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
60-601-53	Average	6.19	5.19	5.53	6.37	8.42	14.74	32.74	46.63	59.26	73.79	33.82	7.98	14.96
	Std Dev	0.25	0.24	0.26	0.61	0.77	0.87	1.63	2.69	3.43	3.87	1.91	0.38	0.45
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
60-609-19	Average	5.42	4.84	5.12	4.77	8.77	20.08	34.46	46.46	59.15	79.08	33.40	7.48	14.15
	Std Dev	0.13	0.24	0.26	0.54	1.09	1.80	1.90	1.71	1.82	1.71	2.31	0.48	0.23
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
60-609-19	Average	5.83	5.02	5.33	4.55	8.13	17.60	30.93	43.53	56.87	82.47	31.18	8.34	14.39
	Std Dev	0.07	0.08	0.09	0.33	0.52	1.12	1.16	1.30	1.55	1.60	1.25	0.37	0.20
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
60-609-20	Average	6.03	5.01	5.33	5.40	8.00	19.56	34.67	48.78	63.22	79.78	34.19	7.61	14.54
	Std Dev	0.18	0.16	0.18	0.25	0.00	1.51	2.50	3.15	3.03	2.49	1.28	0.39	0.41
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
60-609-20	Average	6.48	6.08	6.50	5.94	9.13	21.00	35.25	48.63	60.63	74.38	36.01	8.79	16.79
	Std Dev	0.29	0.26	0.30	0.28	0.35	1.07	1.98	2.33	2.20	1.85	1.39	0.37	0.61
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
68-607-14	Average	6.00	5.02	5.34	2.49	4.30	26.50	35.90	42.60	52.70	64.10	28.34	9.21	15.14
	Std Dev	0.17	0.17	0.19	0.38	0.67	1.78	2.28	2.72	2.95	3.41	1.96	0.64	0.58
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
Fosston	Average	5.24	4.24	4.47	6.14	9.60	19.20	31.80	46.20	62.60	77.80	35.55	6.13	14.02
	Std Dev	0.25	0.23	0.25	0.35	0.55	0.84	1.10	1.48	2.51	2.77	1.14	0.25	0.43
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
0206-49	Average	5.35	4.83	5.10	5.28	9.50	19.50	35.25	46.75	56.75	69.50	34.33	7.23	14.93
	Std Dev	0.17	0.15	0.16	0.26	0.58	0.58	0.96	0.96	1.26	2.38	0.79	0.13	0.31
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
1103-24	Average	5.28	4.28	4.51	5.39	9.42	18.75	32.83	45.08	56.17	68.58	33.72	6.53	13.78
	Std Dev	0.22	0.26	0.28	0.48	0.67	1.22	1.95	2.84	3.81	4.93	2.16	0.45	0.70
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
1113-15	Average	5.45	4.69	4.96	6.31	9.81	17.00	30.44	44.00	55.75	68.69	34.47	7.01	13.85
	Std Dev	0.14	0.16	0.17	0.49	0.75	0.89	1.63	1.93	1.98	2.41	1.37	0.34	0.50
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
1809-66	Average	5.48	4.74	5.02	5.30	8.11	15.56	28.22	44.00	58.22	72.33	31.26	7.87	15.32
	Std Dev	0.20	0.17	0.19	0.52	0.93	1.67	2.17	2.74	3.73	3.74	2.45	0.70	0.90
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
1810-88	Average	5.57	4.87	5.16	5.07	7.86	14.86	27.43	43.71	58.71	72.86	30.43	8.29	15.57
	Std Dev	0.21	0.15	0.17	0.47	0.90	1.35	2.37	3.35	4.82	4.67	2.48	0.54	0.85
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
3002-09	Average	5.65	4.65	4.93	5.00	7.75	15.75	29.50	41.75	52.75	64.50	30.25	7.94	14.85
	Std Dev	0.13	0.19	0.21	0.16	0.50	0.96	1.91	2.75	3.50	4.20	1.16	0.31	0.81
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
68-607-14	Average	5.97	5.19	5.52	2.44	4.03	26.06	35.64	42.55	52.67	64.06	27.92	9.65	15.15
	Std Dev	0.25	0.25	0.28	0.39	0.47	1.97	2.40	2.50	2.61	3.09	1.74	0.70	0.72
	Count	33	33	33	33	33	33	33	33	33	33	33	33	33
Fosston	Average	5.14	4.48	4.72	5.83	9.63	18.00	30.63	44.88	61.38	76.00	34.35	6.69	13.98
	Std Dev	0.17	0.16	0.17	0.18	0.52	0.76	0.92	1.25	1.51	1.20	0.92	0.29	0.25
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
0206-49	Average	5.30	5.00	5.28	5.20	9.00	18.00	34.00	45.50	55.50	69.50	33.13	7.76	14.90
	Std Dev	0.28	0.42	0.46	0.14	0.00	0.00	0.00	0.71	0.71	0.71	0.33	0.61	0.14
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
1103-24	Average	5.29	4.38	4.62	4.84	8.68	18.53	32.71	45.89	56.55	69.03	32.41	6.95	14.20
	Std Dev	0.17	0.21	0.23	0.34	0.57	0.95	1.14	1.86	2.33	2.56	1.20	0.43	0.26
	Count	38	38	38	38	38	38	38	38	38	38	38	38	38
1113-15	Average	5.42	4.74	5.01	5.75	8.90	17.00	30.38	44.10	55.41	67.97	33.00	7.40	13.95
	Std Dev	0.13	0.15	0.16	0.34	0.49	1.00	1.72	1.90	1.97	2.29	1.04	0.29	0.48
	Count	29	29	29	29	29	29	29	29	29	29	29	29	29
1809-66	Average	5.40	4.87	5.14	4.90	7.42	14.58	27.33	43.33	57.33	70.33	29.66	8.50	15.32
	Std Dev	0.21	0.23	0.25	0.46	0.90	1.51	2.39	2.74	3.47	4.01	2.21	0.88	0.76
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
1810-88	Average	5.50	4.89	5.18	4.76	7.31	14.38	26.00	41.62	56.38	69.54	28.93	8.81	15.27
	Std Dev	0.16	0.23	0.25	0.91	1.03	1.85	2.52	3.25	4.09	4.91	3.28	0.98	0.55
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
3002-09	Average	5.60	4.69	4.97	4.63	7.11	14.11	28.78	41.22	52.33	64.56	28.62	8.45	14.72
	Std Dev	0.21	0.25	0.28	0.44	0.60	1.05	1.09	1.39	1.32	1.81	1.27	0.32	0.49
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
3005-11	Average	5.15	4.28	4.51	5.68	9.00	17.82	31.32	43.50	54.95	69.41	33.28	6.61	14.30
	Std Dev	0.22	0.24	0.26	0.33	0.62	0.91	1.49	2.22	2.63	2.58	1.31	0.45	0.73
	Count	22	22	22	22	22	22	22	22	22	22	22	22	22
4319-19	Average	5.30	4.53	4.78	5.80	8.75	16.50	31.50	44.00	54.25	66.00	32.90	7.08	13.80
	Std Dev	0.00	0.10	0.10	0.59	0.96	0.58	1.73	2.58	2.63	3.16	1.18	0.22	1.12
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
4903-64	Average	5.05	4.30	4.53	5.82	9.69	17.77	29.15	40.08	52.85	69.38	33.25	6.64	13.64
	Std Dev	0.18	0.20	0.21	0.28	0.48	0.83	0.99	1.38	1.57	2.18	1.02	0.41	0.39
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
7305-86	Average	5.50	4.55	4.81	6.45	9.50	17.00	30.50	46.00	60.00	74.00	34.95	6.72	14.40
	Std Dev	0.14	0.07	0.08	0.35	0.71	1.41	2.12	2.83	2.83	2.83	2.11	0.29	0.00
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
7305-86	Average	5.08	4.53	4.77	5.75	8.75	16.25	29.25	43.25	58.25	73.00	32.67	7.12	13.75
	Std Dev	0.34	0.33	0.36	0.19	0.50	0.96	1.71	1.50	2.63	2.00	1.01	0.66	0.47
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
7305-86	Average	5.57	4.81	5.10	5.90	8.86	16.29	28.57	42.86	58.00	70.86	32.81	7.61	15.06
	Std Dev	0.39	0.35	0.39	0.61	1.07	1.80	3.21	4.06	4.32	5.08	2.97	0.70	0.96
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
7316-11	Average	5.54	4.82	5.10	5.26	7.20	11.80	22.20	36.80	49.80	63.20	27.58	9.03	14.50
	Std Dev	0.18	0.18	0.20	0.40	0.84	0.84	1.30	2.28	3.77	4.21	1.35	0.60	0.96
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
7316-11	Average	5.23	4.51	4.76	5.96	8.75	14.25	24.13	36.50	51.25	69.75	30.81	7.53	14.28
	Std Dev	0.17	0.20	0.21	0.26	0.46	0.46	0.64	1.31	2.25	2.43	0.91	0.35	0.50
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
3005-11	Average	5.15	4.39	4.63	4.79	7.66	15.91	30.69	42.43	53.77	68.57	30.24	7.47	14.34
	Std Dev	0.26	0.25	0.27	0.41	0.59	1.15	1.83	2.20	2.57	2.38	1.57	0.55	0.64
	Count	35	35	35	35	35	35	35	35	35	35	35	35	35
4319-19	Average	5.26	4.54	4.79	5.44	8.00	19.40	30.40	42.40	53.00	65.20	32.40	7.22	14.00
	Std Dev	0.25	0.15	0.16	0.88	0.71	5.59	1.95	2.07	1.73	2.59	2.08	0.34	0.84
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
4903-64	Average	5.26	4.43	4.67	5.96	9.14	17.40	29.49	40.09	52.69	68.77	33.05	6.94	14.28
	Std Dev	0.14	0.20	0.21	0.83	1.24	1.42	1.70	2.24	3.01	3.37	2.61	0.73	0.39
	Count	35	35	35	35	35	35	35	35	35	35	35	35	35
7305-86	Average	5.30	4.57	4.82	5.97	9.00	16.00	29.67	43.33	57.00	70.00	33.05	7.15	14.17
	Std Dev	0.10	0.25	0.27	0.81	1.00	2.00	1.53	1.15	1.73	1.00	2.86	0.87	0.12
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
7305-86	Average	5.31	4.76	5.03	4.79	7.29	14.71	28.57	42.57	56.29	70.71	29.51	8.29	13.86
	Std Dev	0.41	0.42	0.46	0.48	0.76	1.38	1.72	2.07	3.04	3.30	1.97	0.38	0.39
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
7305-86	Average	5.54	4.83	5.12	5.16	7.75	14.67	27.25	40.75	55.67	68.67	29.98	8.36	14.84
	Std Dev	0.38	0.35	0.40	0.66	0.87	1.44	2.22	2.73	3.23	4.44	2.47	0.87	0.79
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
7316-11	Average	5.52	4.77	5.05	4.57	6.22	10.44	21.67	36.44	51.78	65.11	25.50	9.72	14.69
	Std Dev	0.19	0.28	0.30	0.66	0.67	1.01	1.73	2.51	3.11	3.41	2.04	1.24	0.84
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
7316-11	Average	5.15	4.55	4.80	5.36	7.69	12.88	22.75	35.06	50.75	68.63	28.44	8.23	14.39
	Std Dev	0.22	0.17	0.19	0.34	0.70	0.89	1.29	1.73	2.52	2.66	1.51	0.41	0.42
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
7701-34	Average	5.79	4.81	5.11	5.53	8.29	17.43	33.43	46.86	59.71	73.43	33.33	7.47	14.76
	Std Dev	0.20	0.22	0.23	0.27	0.49	0.53	0.53	0.69	0.76	1.40	0.95	0.46	0.28
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
01-602-12	Average	6.43	5.00	5.34	4.37	6.14	11.00	23.14	44.57	60.00	71.71	26.62	9.79	15.13
	Std Dev	0.18	0.18	0.20	0.45	0.38	1.15	1.21	1.62	2.16	2.69	1.47	0.49	0.39
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
01-602-12	Average	6.50	5.00	5.35	4.54	6.40	10.80	23.80	44.40	60.00	72.40	27.08	9.62	14.82
	Std Dev	0.21	0.19	0.21	0.15	0.55	0.45	0.84	1.14	1.58	1.52	0.55	0.43	0.75
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
05-604-20	Average	5.65	5.10	5.41	5.60	8.00	16.00	33.00	49.50	60.00	69.50	32.93	7.99	14.35
	Std Dev	0.21	0.28	0.31	0.14	0.00	0.00	1.41	2.12	2.83	3.54	0.78	0.27	0.64
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
11-596-02	Average	5.57	4.90	5.19	4.87	8.67	18.00	33.67	46.33	58.00	71.00	32.55	7.78	14.83
	Std Dev	0.12	0.17	0.19	0.45	0.58	1.00	0.58	1.15	1.00	1.73	1.57	0.51	0.21
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
11-606-07	Average	5.94	5.39	5.73	4.57	7.14	14.29	29.57	45.57	58.14	70.43	29.41	9.50	16.50
	Std Dev	0.28	0.24	0.27	0.22	0.38	0.76	1.90	3.41	4.26	4.47	1.37	0.63	0.90
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
11-613-02	Average	5.80	5.09	5.41	3.98	6.42	13.33	29.33	45.75	57.00	67.00	27.60	9.54	15.50
	Std Dev	0.26	0.33	0.36	0.35	0.51	0.78	1.61	2.77	3.52	3.88	1.26	0.55	0.72
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
18-601-16	Average	5.92	5.00	5.31	5.72	10.33	21.50	37.00	49.67	60.33	72.67	36.82	7.04	15.27
	Std Dev	0.08	0.06	0.07	0.45	0.52	0.84	1.26	1.75	2.42	3.27	1.70	0.29	0.37
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
7701-34	Average	5.51	4.89	5.17	5.01	7.29	16.57	32.29	46.00	58.00	71.57	31.32	8.06	15.04
	Std Dev	0.17	0.23	0.25	0.38	0.49	1.13	1.11	1.91	2.45	2.23	1.32	0.58	0.46
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
01-602-12	Average	6.26	5.08	5.42	4.45	5.94	10.71	23.06	44.35	59.12	71.76	26.48	9.98	14.94
	Std Dev	0.14	0.15	0.16	0.33	0.43	0.92	0.97	1.58	1.69	1.99	1.12	0.38	0.38
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
01-602-12	Average	6.29	5.13	5.48	4.35	5.92	10.85	24.31	45.54	60.54	73.15	26.70	9.99	15.17
	Std Dev	0.18	0.19	0.21	0.25	0.28	0.38	1.25	1.45	1.56	1.63	0.89	0.40	0.39
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
05-604-20	Average	5.80	5.36	5.69	5.03	7.71	15.43	32.86	49.29	60.14	70.29	31.66	8.78	15.00
	Std Dev	0.24	0.24	0.27	0.65	0.95	0.79	1.21	1.89	2.19	2.36	2.01	0.77	0.46
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
11-596-02	Average	5.63	4.88	5.17	4.48	7.63	17.00	32.75	45.88	56.88	69.25	30.75	8.22	15.01
	Std Dev	0.30	0.29	0.32	0.70	1.06	1.31	1.67	2.17	2.03	2.38	2.49	0.70	0.45
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
11-606-07	Average	5.77	5.40	5.73	4.25	6.45	13.91	29.64	44.18	56.36	67.55	28.14	9.96	16.11
	Std Dev	0.20	0.27	0.30	0.25	0.69	1.58	2.20	2.79	5.46	3.80	1.78	0.85	0.70
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
11-613-02	Average	5.77	5.21	5.53	3.81	5.81	13.31	29.88	45.31	56.69	66.38	26.97	9.99	15.47
	Std Dev	0.31	0.31	0.34	0.29	0.40	0.60	1.41	2.44	3.09	3.30	1.12	0.57	0.63
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
18-601-16	Average	6.05	5.03	5.36	5.24	10.06	22.00	37.38	50.69	61.44	73.44	36.24	7.21	15.59
	Std Dev	0.13	0.12	0.13	0.42	0.68	0.73	1.02	1.54	2.03	2.19	1.36	0.35	0.33
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
18-620-08	Average	5.90	5.03	5.34	4.60	8.00	17.25	31.50	47.50	60.25	72.50	31.41	8.34	15.63
	Std Dev	0.24	0.17	0.19	0.85	1.41	3.10	3.87	4.20	4.27	5.20	3.66	0.71	0.46
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
18-620-08	Average	5.43	4.60	4.86	5.47	8.67	16.33	32.00	46.00	56.67	67.67	32.63	7.27	14.73
	Std Dev	0.06	0.20	0.21	0.21	0.58	0.58	1.73	2.65	3.21	4.04	1.33	0.41	0.76
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
30-604-17	Average	5.64	4.68	4.95	4.91	7.88	16.38	31.88	45.00	56.00	67.75	31.16	7.80	14.09
	Std Dev	0.32	0.17	0.18	0.64	1.36	2.26	3.76	3.25	2.39	2.38	2.89	0.76	0.45
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
33-606-20	Average	5.13	4.33	4.56	6.05	9.50	18.25	31.50	43.50	55.00	68.25	34.31	6.47	14.28
	Std Dev	0.30	0.35	0.38	0.66	1.00	0.50	0.58	1.29	1.83	2.06	1.89	0.38	0.69
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
33-608-13	Average	5.40	4.80	5.07	5.64	8.60	16.60	30.00	43.60	56.20	68.00	32.46	7.62	13.66
	Std Dev	0.16	0.12	0.14	0.55	0.55	0.55	1.58	1.82	1.92	1.87	0.94	0.35	0.59
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
33-617-08	Average	5.43	4.75	5.02	5.73	9.00	17.50	31.00	43.00	54.25	67.25	33.11	7.39	14.23
	Std Dev	0.22	0.24	0.26	0.29	0.00	0.58	0.82	1.41	1.71	2.50	0.82	0.48	0.61
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
33-617-08	Average	5.23	4.40	4.64	6.33	9.67	18.33	31.33	42.67	54.00	67.67	34.75	6.51	13.53
	Std Dev	0.12	0.10	0.11	0.25	0.58	0.58	0.58	0.58	1.00	1.53	0.96	0.33	0.35
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
49-649-06	Average	5.86	5.13	5.45	5.32	8.47	16.07	31.07	45.93	59.07	71.60	32.23	8.25	14.79
	Std Dev	0.27	0.35	0.39	0.43	0.74	1.79	2.52	2.94	4.18	5.69	1.98	0.61	0.88
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
18-620-08	Average	5.77	5.12	5.44	4.60	7.89	18.22	32.78	48.22	61.44	73.22	31.93	8.36	15.69
	Std Dev	0.26	0.19	0.21	0.67	1.17	2.77	3.80	3.93	3.68	4.06	3.21	0.75	0.46
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
18-620-08	Average	5.34	4.67	4.94	5.19	7.86	16.57	31.86	45.86	56.43	67.57	31.72	7.58	14.76
	Std Dev	0.17	0.27	0.29	0.25	0.38	0.98	1.46	2.19	2.64	2.37	1.25	0.36	0.49
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
30-604-17	Average	5.38	4.70	4.97	5.23	8.50	16.00	29.50	41.50	53.75	67.75	31.22	7.77	14.20
	Std Dev	0.38	0.56	0.61	0.31	0.58	0.82	0.58	0.58	0.50	1.26	1.01	1.08	0.41
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
33-606-20	Average	5.26	4.63	4.88	5.81	9.63	18.13	32.00	43.38	54.38	67.75	33.99	7.03	14.44
	Std Dev	0.30	0.28	0.30	0.44	2.26	1.64	1.31	1.30	1.19	1.58	2.23	0.70	0.20
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
33-608-13	Average	5.68	4.94	5.24	5.68	8.00	16.60	30.80	44.20	57.40	69.20	32.40	7.89	14.60
	Std Dev	0.13	0.09	0.10	0.83	0.71	0.55	1.10	0.84	1.14	1.10	1.62	0.47	0.67
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
33-617-08	Average	5.62	5.05	5.36	5.43	8.55	17.09	31.27	43.09	54.18	67.09	32.27	8.09	14.89
	Std Dev	0.17	0.27	0.30	0.40	0.69	0.83	0.65	1.14	1.40	1.70	1.31	0.56	0.40
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
33-617-08	Average	5.21	4.60	4.85	5.64	9.40	17.90	31.20	42.50	53.30	66.60	33.27	7.14	14.16
	Std Dev	0.27	0.26	0.29	0.47	2.07	1.60	1.75	1.84	2.11	2.46	2.41	0.74	0.39
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
49-649-06	Average	5.94	5.18	5.50	5.08	7.69	16.06	30.44	44.94	57.56	69.38	31.11	8.64	15.14
	Std Dev	0.21	0.30	0.34	0.77	0.79	1.81	2.78	1.98	3.65	6.96	2.24	0.63	0.87
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
73-601-41	Average	5.52	4.82	5.10	5.80	8.60	15.40	30.40	44.00	55.40	68.40	32.42	7.70	14.08
	Std Dev	0.28	0.19	0.21	0.60	0.89	1.34	1.52	2.92	3.29	3.97	2.18	0.74	0.74
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
73-607-27	Average	5.57	4.93	5.22	4.97	7.67	15.00	31.33	46.67	58.00	67.67	30.84	8.25	15.30
	Std Dev	0.32	0.21	0.24	0.23	0.58	1.00	1.53	1.53	2.65	3.21	1.47	0.17	0.40
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
73-617-30	Average	5.28	4.67	4.93	5.38	7.83	12.17	22.33	34.50	48.83	64.17	28.09	8.59	14.08
	Std Dev	0.04	0.18	0.19	0.52	0.75	1.17	1.51	2.26	3.97	5.19	1.95	0.81	0.88
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
73-617-30	Average	5.40	4.73	5.00	4.93	7.00	10.33	17.50	27.83	40.50	56.33	24.62	9.93	14.05
	Std Dev	0.23	0.26	0.28	0.34	0.63	1.03	1.05	1.72	3.02	4.50	1.35	0.90	0.55
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
86-603-15	Average	6.26	5.09	5.43	5.35	7.38	12.50	25.00	41.38	59.25	77.38	29.46	8.98	14.81
	Std Dev	0.18	0.16	0.17	0.43	0.52	0.76	1.41	2.39	3.11	3.89	1.29	0.32	0.68
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
86-603-15	Average	5.79	4.71	5.00	4.97	6.89	12.00	26.22	42.33	58.11	73.11	28.52	8.53	14.20
	Std Dev	0.27	0.28	0.31	0.23	0.33	0.50	1.48	2.29	2.26	2.15	1.00	0.33	0.42
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
80-609-17	Average	5.65	4.85	5.14	6.00	9.25	18.00	32.75	45.50	56.00	65.50	34.33	7.30	13.25
	Std Dev	0.13	0.19	0.20	0.42	0.50	0.00	1.26	1.29	1.63	1.00	1.04	0.43	0.26
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
86-103-04	Average	6.18	5.55	5.92	5.75	9.00	18.00	33.75	47.00	58.25	68.50	34.19	8.46	15.00
	Std Dev	0.22	0.13	0.15	0.50	0.82	1.41	2.22	2.45	2.63	2.89	2.17	0.66	0.57
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
73-601-41	Average	5.68	4.92	5.21	5.42	7.83	15.17	30.17	43.67	54.33	67.50	31.16	8.19	14.65
	Std Dev	0.27	0.17	0.19	0.73	1.17	1.47	1.17	2.07	2.42	2.66	2.33	0.76	0.62
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
73-607-27	Average	5.56	5.30	5.61	4.60	7.20	14.20	31.60	47.00	58.60	68.60	29.84	9.18	15.38
	Std Dev	0.11	0.21	0.23	0.48	0.45	1.10	2.19	3.08	3.36	2.97	1.93	0.61	0.43
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
73-617-30	Average	5.50	4.76	5.04	4.85	6.91	11.27	21.64	33.82	47.27	62.27	26.17	9.43	14.43
	Std Dev	0.24	0.28	0.31	0.56	0.70	1.10	1.57	1.66	2.24	2.69	2.00	0.88	0.51
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
73-617-30	Average	5.35	4.82	5.09	4.23	6.33	9.67	17.83	28.33	41.83	58.00	23.07	10.78	14.80
	Std Dev	0.26	0.22	0.25	0.38	0.52	0.82	1.94	3.14	3.66	4.52	1.40	0.84	0.68
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
86-603-15	Average	6.19	5.17	5.52	5.08	6.91	11.83	24.61	41.17	57.74	74.91	28.37	9.48	15.00
	Std Dev	0.14	0.15	0.16	0.34	0.51	0.72	1.47	2.53	3.36	3.67	1.32	0.41	0.55
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
86-603-15	Average	5.72	4.86	5.15	4.45	5.96	11.27	25.58	42.12	56.73	71.23	26.72	9.42	14.51
	Std Dev	0.19	0.17	0.19	0.38	0.45	0.83	2.06	2.88	3.48	3.46	1.58	0.56	0.49
	Count	26	26	26	26	26	26	26	26	26	26	26	26	26
80-609-17	Average	5.73	4.76	5.05	6.28	8.40	17.10	32.70	44.80	55.40	65.40	33.90	7.27	14.03
	Std Dev	0.11	0.12	0.12	0.68	0.70	0.74	1.34	1.62	1.51	1.71	1.47	0.38	0.25
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
86-103-04	Average	5.96	5.34	5.68	5.57	8.29	17.29	32.57	45.29	56.29	66.86	32.84	8.43	15.27
	Std Dev	0.23	0.13	0.15	0.34	0.49	0.95	1.51	1.50	1.80	1.68	1.43	0.26	0.42
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
86-103-04	Average	6.55	5.73	6.13	5.88	9.00	18.25	34.75	49.50	61.75	74.75	35.07	8.51	15.95
	Std Dev	0.19	0.22	0.25	0.15	0.00	0.50	1.71	3.11	3.59	3.10	0.72	0.40	0.93
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
86-134-043	Average	6.03	5.20	5.53	5.68	9.00	18.00	35.00	50.25	63.00	73.75	34.80	7.74	15.30
	Std Dev	0.21	0.16	0.18	0.15	0.00	0.00	0.82	1.26	1.63	1.71	0.39	0.23	0.57
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
86-134-043	Average	6.27	5.50	5.87	5.97	9.67	17.67	32.33	47.33	62.00	75.00	34.94	8.18	15.70
	Std Dev	0.23	0.26	0.30	0.15	0.58	0.58	2.08	3.06	4.58	5.57	1.55	0.06	1.22
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
86-630-19	Average	5.90	5.10	5.42	5.53	8.67	18.00	34.00	48.67	61.00	71.67	33.98	7.78	15.37
	Std Dev	0.00	0.17	0.18	0.21	0.58	0.00	1.00	2.08	2.65	2.89	0.94	0.46	0.55
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
86-630-19	Average	6.08	5.28	5.62	5.60	9.00	17.00	30.75	44.75	59.50	72.50	33.18	8.24	15.35
	Std Dev	0.15	0.10	0.11	0.22	0.00	0.00	0.96	1.50	2.52	2.52	0.13	0.16	0.78
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
141-03-28	Average	5.73	4.87	5.16	5.87	8.00	14.00	28.33	40.67	53.67	66.67	31.09	8.13	13.50
	Std Dev	0.06	0.12	0.13	0.65	1.00	1.00	1.15	1.53	2.52	3.06	2.36	0.82	0.26
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
141-03-28	Average	5.68	4.60	4.88	6.30	8.75	15.00	29.00	41.75	55.50	70.00	32.85	7.23	13.68
	Std Dev	0.29	0.32	0.35	0.41	0.96	0.82	1.41	1.26	1.73	1.41	1.73	0.34	0.35
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
0303-60	Average	5.36	4.25	4.50	5.85	8.23	15.31	29.31	43.23	56.92	69.23	32.11	6.84	13.99
	Std Dev	0.25	0.26	0.28	0.71	1.17	1.11	2.06	3.11	3.73	3.61	2.12	0.53	1.30
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
86-103-04	Average	6.31	5.56	5.94	5.84	8.88	17.75	34.25	48.50	61.00	73.63	34.58	8.37	16.36
	Std Dev	0.17	0.11	0.12	0.31	0.35	0.46	1.39	1.77	2.51	1.92	1.02	0.27	0.51
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
86-134-043	Average	5.86	5.31	5.64	5.73	8.25	17.50	34.13	48.63	61.13	71.63	33.91	8.11	15.44
	Std Dev	0.17	0.15	0.16	0.38	0.46	0.53	0.83	1.06	1.46	1.41	0.90	0.32	0.41
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
86-134-043	Average	6.08	5.43	5.78	6.18	9.00	17.75	31.75	45.75	59.50	72.50	34.54	8.14	15.95
	Std Dev	0.22	0.22	0.25	0.15	0.00	0.50	1.89	3.30	4.51	5.92	0.90	0.16	0.98
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
86-630-19	Average	5.67	5.03	5.34	5.40	8.00	16.83	32.83	46.17	57.83	68.50	32.46	8.01	15.17
	Std Dev	0.16	0.10	0.12	0.27	0.00	0.75	1.33	2.40	3.25	3.67	1.00	0.15	0.74
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
86-630-19	Average	6.02	5.45	5.80	5.92	8.75	17.33	31.08	45.00	59.67	73.08	33.72	8.38	16.18
	Std Dev	0.17	0.12	0.14	0.33	0.45	0.89	1.51	2.13	2.96	3.78	1.34	0.30	0.64
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
141-03-28	Average	5.54	4.78	5.06	6.20	7.88	13.63	28.38	41.50	55.13	67.88	31.59	7.83	14.34
	Std Dev	0.11	0.17	0.18	0.80	0.64	1.06	1.60	2.88	3.18	3.60	2.13	0.71	0.59
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
141-03-28	Average	5.71	4.76	5.05	6.04	8.09	14.91	30.45	42.09	55.00	69.45	32.21	7.65	14.30
	Std Dev	0.27	0.21	0.23	0.60	0.70	1.22	2.21	1.87	1.95	2.02	1.76	0.45	0.54
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
0303-60	Average	5.53	4.47	4.74	4.45	6.63	13.37	27.42	42.89	56.68	70.37	28.06	8.29	14.39
	Std Dev	0.22	0.19	0.21	0.78	1.07	1.61	2.76	4.20	3.51	3.29	2.84	0.85	0.84
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2102-50	Average	6.16	4.90	5.22	5.34	7.40	14.00	29.20	44.20	59.80	73.20	30.66	8.30	15.18
	Std Dev	0.18	0.25	0.28	0.44	0.55	1.22	1.79	1.92	2.28	3.56	1.80	0.41	0.37
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
2108-04	Average	5.76	5.09	5.40	5.44	8.39	16.09	30.70	45.87	58.22	69.78	32.25	8.17	15.21
	Std Dev	0.19	0.19	0.21	0.39	0.66	1.08	3.34	3.32	3.07	3.34	1.94	0.36	0.53
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
2180-92	Average	5.68	4.71	4.99	7.35	10.38	16.75	26.63	37.19	53.44	70.75	35.27	6.90	14.28
	Std Dev	0.18	0.16	0.17	0.38	0.50	0.68	1.50	2.17	2.87	2.77	1.34	0.27	0.36
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
2609-30	Average	6.20	4.93	5.25	5.50	7.57	14.43	28.86	43.86	59.43	73.14	31.06	8.25	14.91
	Std Dev	0.23	0.20	0.22	0.37	0.53	1.40	2.04	1.68	1.51	1.86	1.57	0.37	0.52
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
5617-28	Average	5.41	4.43	4.69	5.88	8.42	17.21	33.21	47.32	60.42	72.05	33.91	6.74	14.55
	Std Dev	0.18	0.19	0.21	0.42	0.51	1.03	1.58	2.00	2.12	2.76	1.41	0.36	0.51
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
5617-28	Average	6.09	5.01	5.34	5.55	8.00	16.38	32.00	46.13	59.50	70.88	32.56	8.01	14.14
	Std Dev	0.34	0.48	0.53	0.58	0.76	1.51	3.12	4.05	3.82	4.02	1.99	0.86	1.30
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
2509-19	Average	5.80	4.43	4.71	4.43	7.00	14.00	29.00	41.00	50.33	62.33	28.09	8.15	13.63
	Std Dev	0.26	0.45	0.49	0.21	0.00	0.00	1.00	2.65	3.21	2.31	0.82	0.61	0.35
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
2801-64	Average	5.77	4.50	4.78	5.20	8.33	20.00	38.67	45.33	51.00	62.00	33.64	6.95	14.50
	Std Dev	0.47	0.26	0.31	0.75	1.53	2.00	1.53	2.08	2.65	2.65	3.21	0.71	0.62
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2102-50	Average	6.13	4.87	5.19	4.23	6.17	12.83	26.83	42.83	57.67	71.67	27.25	9.28	15.02
	Std Dev	0.23	0.30	0.33	0.25	0.41	0.41	1.47	1.72	3.01	3.39	0.77	0.69	0.46
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
2108-04	Average	5.79	5.18	5.49	4.70	7.13	14.53	28.82	44.03	56.68	69.95	29.38	9.14	15.62
	Std Dev	0.08	0.09	0.10	0.44	0.66	0.98	1.56	1.94	2.24	2.16	1.72	0.53	0.26
	Count	38	38	38	38	38	38	38	38	38	38	38	38	38
2180-92	Average	5.45	4.63	4.89	6.24	9.05	15.21	24.42	35.95	51.79	72.53	31.79	7.50	14.29
	Std Dev	0.20	0.17	0.19	0.26	0.40	0.79	1.57	2.37	3.10	3.29	1.07	0.37	0.30
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
2609-30	Average	6.00	4.91	5.22	4.71	6.82	13.27	26.27	42.36	57.55	72.36	28.42	8.96	14.95
	Std Dev	0.13	0.22	0.24	0.36	0.60	0.90	1.19	1.29	1.81	2.01	1.35	0.47	0.40
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
5617-28	Average	5.55	4.56	4.82	5.13	7.70	16.13	31.65	46.78	59.30	72.48	31.65	7.44	14.60
	Std Dev	0.13	0.15	0.16	0.54	0.70	0.97	1.43	1.65	1.55	1.81	1.54	0.45	0.37
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
5617-28	Average	6.13	5.09	5.42	5.02	7.56	15.67	31.00	46.11	60.56	72.11	31.16	8.51	14.86
	Std Dev	0.29	0.40	0.44	0.77	1.51	1.50	2.06	2.52	3.43	2.80	2.16	0.91	0.98
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
2509-19	Average	5.70	4.61	4.89	4.77	7.10	14.70	31.00	44.00	54.30	66.80	29.67	8.03	14.11
	Std Dev	0.25	0.28	0.31	0.26	0.32	0.67	2.00	2.75	3.56	3.99	1.36	0.50	0.61
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
2801-64	Average	5.71	4.75	5.04	4.86	7.60	18.30	37.80	44.70	50.40	61.70	31.94	7.72	14.37
	Std Dev	0.13	0.15	0.17	0.85	1.07	1.42	1.14	1.34	1.43	1.57	2.69	0.61	0.34
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2801-64	Average	5.35	4.43	4.68	5.10	8.50	21.50	39.50	45.50	51.75	63.00	34.21	6.66	14.60
	Std Dev	0.19	0.15	0.17	0.29	0.58	0.58	0.58	0.58	0.50	0.00	0.71	0.38	0.28
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5502-85	Average	5.74	4.96	5.26	5.51	9.47	23.20	37.53	44.93	52.20	65.33	35.71	7.24	15.16
	Std Dev	0.22	0.23	0.25	0.84	1.06	2.68	3.11	2.52	1.66	1.54	3.14	0.83	0.85
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
5502-85	Average	5.90	5.38	5.71	5.58	9.50	25.25	41.25	49.25	58.00	69.50	37.62	7.40	16.18
	Std Dev	0.14	0.33	0.36	0.68	0.58	2.87	4.35	4.11	3.37	4.20	2.66	0.31	1.28
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5502-85	Average	5.58	5.03	5.32	5.30	9.50	22.25	35.75	44.00	55.25	73.00	35.05	7.40	14.33
	Std Dev	0.13	0.10	0.11	0.24	1.00	1.26	0.50	0.82	1.26	1.83	1.07	0.23	0.84
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5502-85	Average	5.63	4.60	4.87	5.35	9.75	16.75	24.25	32.25	47.50	71.25	30.74	7.75	14.80
	Std Dev	0.05	0.22	0.23	0.30	0.96	1.50	1.26	1.26	1.00	0.96	1.69	0.73	0.72
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5502-85	Average	5.61	5.03	5.32	6.00	10.75	25.13	38.00	46.88	56.50	69.75	38.31	6.80	15.58
	Std Dev	0.15	0.23	0.24	0.83	1.16	1.81	3.55	2.36	2.39	2.55	2.83	0.55	0.54
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
5509-69	Average	5.64	5.04	5.34	5.26	9.20	22.40	34.00	44.40	56.00	73.20	34.67	7.50	14.60
	Std Dev	0.17	0.11	0.13	0.23	0.45	1.14	3.94	1.14	1.00	1.30	0.34	0.22	0.77
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
5509-69	Average	5.61	4.64	4.92	4.84	10.00	17.14	25.71	33.86	48.57	70.14	30.55	7.87	14.69
	Std Dev	0.11	0.21	0.23	0.56	1.00	1.57	2.21	2.48	2.37	1.86	1.93	0.56	0.51
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
2801-64	Average	5.70	4.76	5.05	4.08	7.00	18.55	39.00	45.73	52.00	63.73	30.77	8.01	14.91
	Std Dev	0.12	0.12	0.13	0.34	0.45	0.82	1.41	1.68	2.05	2.57	1.29	0.39	0.48
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
5502-85	Average	5.71	5.03	5.33	5.32	8.18	22.04	35.79	43.11	50.61	63.86	33.79	7.72	15.03
	Std Dev	0.19	0.21	0.23	0.68	0.94	2.46	3.19	2.79	2.63	2.38	2.66	0.61	0.73
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28
5502-85	Average	5.86	5.34	5.67	5.08	8.20	22.80	37.80	47.00	56.00	68.20	34.54	8.00	15.84
	Std Dev	0.15	0.36	0.39	0.52	0.84	3.03	4.60	4.06	3.74	5.31	2.27	0.25	1.36
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
5502-85	Average	5.52	5.02	5.31	4.36	7.40	19.80	32.20	40.20	52.00	68.80	30.54	8.49	14.40
	Std Dev	0.11	0.25	0.27	0.64	0.55	1.30	1.30	1.30	2.00	2.49	1.38	0.67	0.54
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
5502-85	Average	5.68	4.72	5.00	4.12	6.80	13.60	21.20	29.60	45.80	70.00	25.32	9.70	14.66
	Std Dev	0.04	0.08	0.09	0.74	0.84	1.52	1.92	2.30	2.86	1.87	2.32	1.00	0.45
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
5502-85	Average	5.63	5.11	5.42	4.98	8.30	22.80	37.40	45.10	55.10	68.60	34.21	7.73	15.84
	Std Dev	0.16	0.19	0.21	0.60	0.95	1.48	1.78	2.02	2.51	2.22	1.99	0.41	0.58
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
5509-69	Average	5.69	5.14	5.45	4.41	7.77	20.77	33.62	42.46	54.69	71.15	31.66	8.39	14.88
	Std Dev	0.17	0.19	0.21	0.39	0.44	1.17	1.50	2.07	2.59	2.54	1.27	0.41	0.52
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
5509-69	Average	5.63	4.68	4.96	4.15	7.31	14.77	23.08	32.08	48.62	70.77	26.61	9.14	14.61
	Std Dev	0.09	0.15	0.16	0.53	0.75	1.54	2.25	2.96	3.62	2.68	2.07	0.86	0.33
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5509-69	Average	5.90	4.70	4.99	4.85	6.50	14.50	31.00	43.50	53.50	66.00	29.29	8.31	14.00
	Std Dev	0.14	0.00	0.01	0.21	0.71	0.71	1.41	0.71	0.71	1.41	1.06	0.31	0.42
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
5509-69	Average	5.64	4.97	5.27	6.00	10.71	25.29	38.57	45.71	54.86	69.29	38.25	6.71	14.90
	Std Dev	0.19	0.20	0.21	0.29	0.49	0.95	0.98	1.38	1.86	1.98	1.02	0.17	0.57
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
5617-28	Average	5.41	4.43	4.69	5.88	8.42	17.21	33.21	47.32	60.42	72.05	33.91	6.74	14.55
	Std Dev	0.18	0.19	0.21	0.42	0.51	1.03	1.58	2.00	2.12	2.76	1.41	0.36	0.51
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
5617-28	Average	6.09	5.01	5.34	5.55	8.00	16.38	32.00	46.13	59.50	70.88	32.56	8.01	14.14
	Std Dev	0.34	0.48	0.53	0.58	0.76	1.51	3.12	4.05	3.82	4.02	1.99	0.86	1.30
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
7901-41	Average	5.44	4.68	4.95	5.05	9.45	19.18	31.91	41.18	54.45	72.36	32.89	7.39	14.83
	Std Dev	0.14	0.22	0.24	0.83	1.21	3.22	2.88	2.82	3.47	3.50	3.49	0.73	0.37
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
7901-41	Average	6.01	4.75	5.05	4.70	9.64	19.82	30.27	38.82	51.64	72.09	32.10	7.70	14.74
	Std Dev	0.25	0.19	0.21	0.91	1.03	1.33	1.68	1.99	2.62	3.96	2.76	0.60	0.36
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
66-623-08	Average	5.00	4.13	4.34	4.83	6.75	12.00	21.25	32.25	48.00	63.25	26.11	8.11	14.50
	Std Dev	0.00	0.10	0.10	0.19	0.50	0.82	1.50	1.71	1.83	2.06	1.10	0.49	0.08
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
66-623-08	Average	6.30	5.40	5.76	4.27	5.67	9.33	20.33	38.00	57.67	75.00	24.72	11.39	15.83
	Std Dev	0.20	0.17	0.20	0.59	0.58	0.58	0.58	0.00	0.58	1.00	1.42	0.94	0.49
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5509-69	Average	6.00	4.87	5.18	4.39	6.14	13.86	30.43	43.00	53.29	66.00	28.01	9.02	14.54
	Std Dev	0.32	0.14	0.16	0.49	0.69	0.69	0.98	1.83	2.21	2.38	1.33	0.29	0.55
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
5509-69	Average	5.69	5.13	5.44	5.02	8.47	23.07	36.87	45.20	54.33	67.93	34.34	7.74	15.56
	Std Dev	0.07	0.17	0.18	0.49	0.64	1.49	1.25	1.42	1.45	2.94	1.80	0.45	0.25
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
5617-28	Average	5.55	4.56	4.82	5.13	7.70	16.13	31.65	46.78	59.30	72.48	31.65	7.44	14.60
	Std Dev	0.13	0.15	0.16	0.54	0.70	0.97	1.43	1.65	1.55	1.81	1.54	0.45	0.37
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
5617-28	Average	6.13	5.09	5.42	5.02	7.56	15.67	31.00	46.11	60.56	72.11	31.16	8.51	14.86
	Std Dev	0.29	0.40	0.44	0.77	1.51	1.50	2.06	2.52	3.43	2.80	2.16	0.91	0.98
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
7901-41	Average	5.47	4.71	4.99	4.27	7.50	16.94	29.81	39.81	52.88	71.75	29.32	8.33	14.83
	Std Dev	0.12	0.17	0.18	0.87	0.89	1.57	1.60	2.14	2.68	3.02	2.59	0.70	0.37
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
7901-41	Average	5.99	4.69	4.99	3.85	7.33	17.00	28.47	37.63	50.73	72.73	28.13	8.72	14.66
	Std Dev	0.39	0.28	0.32	0.79	1.09	1.51	1.87	2.03	2.60	3.73	2.73	0.94	0.57
	Count	30	30	30	30	30	30	30	30	30	30	30	30	30
66-623-08	Average	5.03	4.27	4.50	4.85	6.45	11.36	19.91	32.91	48.18	63.73	25.66	8.57	14.15
	Std Dev	0.09	0.18	0.20	0.37	0.52	0.81	1.45	1.70	2.23	2.69	1.33	0.69	0.28
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
66-623-08	Average	6.27	5.41	5.77	3.72	4.84	9.53	20.32	38.74	57.89	74.05	23.45	12.02	15.94
	Std Dev	0.21	0.18	0.20	0.37	0.50	0.96	1.73	1.66	2.31	2.50	1.10	0.74	0.52
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Dodge Co.	Average	5.67	5.10	5.41	5.83	9.67	24.00	38.67	47.00	56.33	71.33	37.19	7.09	14.73
	Std Dev	0.06	0.20	0.21	0.40	0.58	1.00	1.53	2.00	2.08	2.52	1.67	0.41	0.15
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Dodge Co.	Average	6.00	5.30	5.64	6.00	10.50	26.00	43.00	51.50	58.50	71.00	39.60	6.94	15.50
	Std Dev	0.14	0.14	0.14	0.14	0.71	1.41	0.00	0.71	2.12	1.41	0.91	0.33	0.42
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Fillmore Co.	Average	5.85	5.10	5.42	2.50	5.00	18.00	36.00	45.50	52.50	64.00	26.46	9.99	16.25
	Std Dev	0.07	0.00	0.00	0.57	0.00	0.00	1.41	3.54	2.12	0.00	1.47	0.56	0.49
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Goodhue Co.	Average	5.25	4.50	4.75	4.60	7.50	12.50	21.50	32.00	47.50	67.00	26.42	8.75	14.55
	Std Dev	0.07	0.00	0.00	0.57	0.71	0.71	0.71	1.41	0.71	0.00	0.03	0.00	0.07
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Goodhue Co.	Average	5.58	4.93	5.22	5.14	8.13	14.63	25.50	37.50	53.38	71.88	29.63	8.61	14.93
	Std Dev	0.26	0.28	0.31	0.68	0.83	0.74	1.31	1.93	2.72	3.27	1.92	0.79	0.55
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Goodhue Co.	Average	5.33	4.67	4.93	4.37	7.00	15.33	29.67	41.67	53.33	67.00	28.75	8.35	14.47
	Std Dev	0.12	0.12	0.13	0.31	0.00	0.58	1.15	1.15	1.53	2.65	0.33	0.19	0.35
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Houston Co.	Average	5.78	4.63	4.92	3.58	7.00	20.83	32.83	37.67	46.17	70.17	29.04	8.37	13.70
	Std Dev	0.15	0.16	0.18	0.93	1.41	2.56	2.64	2.88	2.71	1.83	3.30	1.33	0.42
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Houston Co.	Average	5.60	4.37	4.63	4.23	7.43	19.71	30.00	33.29	39.71	58.00	28.75	7.99	12.46
	Std Dev	0.32	0.30	0.33	1.11	1.40	3.20	3.37	2.75	2.50	2.00	4.21	1.35	0.51
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Dodge Co.	Average	5.71	5.14	5.45	4.80	7.91	22.00	36.64	45.55	55.00	71.45	33.43	7.95	15.65
	Std Dev	0.05	0.09	0.10	0.49	0.54	1.41	1.43	1.51	3.22	1.37	1.76	0.39	0.22
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
Dodge Co.	Average	5.90	5.33	5.66	5.17	8.43	25.29	42.71	51.71	59.29	71.29	36.83	7.50	15.80
	Std Dev	0.12	0.13	0.14	0.35	0.79	1.70	0.95	1.38	2.06	1.70	1.45	0.39	0.52
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Fillmore Co.	Average	5.83	5.20	5.52	3.48	5.25	17.75	34.00	44.00	51.00	63.25	27.62	9.74	15.90
	Std Dev	0.15	0.23	0.25	0.26	0.50	0.50	1.41	2.00	2.00	1.89	0.51	0.48	0.47
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Goodhue Co.	Average	5.26	4.67	4.93	4.52	6.15	10.92	19.23	30.85	46.54	67.92	24.59	9.85	14.67
	Std Dev	0.09	0.12	0.13	0.63	0.99	1.44	2.24	2.58	3.15	3.66	2.43	1.01	0.44
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
Goodhue Co.	Average	5.53	4.93	5.22	4.49	6.63	13.63	24.11	36.42	52.26	72.11	27.07	9.47	15.21
	Std Dev	0.19	0.29	0.31	0.76	1.07	1.16	1.70	2.61	2.75	2.98	2.51	1.11	0.69
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
Goodhue Co.	Average	5.52	4.68	4.95	4.01	6.33	14.56	29.11	41.67	53.11	67.00	27.46	8.79	14.37
	Std Dev	0.32	0.26	0.29	0.25	0.50	0.73	1.17	1.00	1.27	1.50	0.66	0.61	0.37
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Houston Co.	Average	5.85	4.85	5.15	2.91	5.29	18.86	31.14	35.71	44.64	68.93	25.87	9.79	14.93
	Std Dev	0.11	0.18	0.19	0.51	0.99	1.75	2.57	2.87	3.05	3.27	2.38	1.17	0.42
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
Houston Co.	Average	5.52	4.54	4.80	3.28	5.89	17.74	28.11	31.63	39.05	57.68	25.29	9.37	13.44
	Std Dev	0.28	0.22	0.25	0.63	1.05	2.56	2.62	2.81	3.08	3.09	2.75	1.23	0.47
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Winona Co.	Average	5.53	4.47	4.73	3.77	6.00	12.67	31.00	42.33	49.67	63.00	26.40	8.73	13.53
	Std Dev	0.06	0.12	0.12	0.06	0.00	0.58	2.65	3.79	3.21	1.00	1.08	0.30	0.72
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Winona Co.	Average	6.00	4.98	5.30	4.52	7.20	12.00	35.00	49.60	54.80	65.80	29.53	8.76	15.44
	Std Dev	0.25	0.28	0.31	0.78	1.10	1.00	2.24	3.21	4.76	4.21	2.36	0.56	0.83
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
0804-73	Average	5.87	5.03	5.34	5.39	8.57	18.00	35.00	44.29	50.00	56.14	32.73	7.96	14.57
	Std Dev	0.36	0.23	0.26	0.64	0.98	0.58	1.91	2.21	3.27	4.02	2.26	0.27	0.45
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
0804-73	Average	5.75	5.22	5.54	6.15	9.17	19.50	35.83	47.50	54.67	61.50	35.42	7.63	15.55
	Std Dev	0.24	0.22	0.25	0.48	0.98	1.38	2.14	2.43	2.34	5.47	2.31	0.45	0.53
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
0804-73	Average	6.00	5.23	5.57	5.40	8.67	17.67	33.00	42.67	48.00	55.00	32.19	8.43	14.30
	Std Dev	0.26	0.15	0.18	0.75	0.58	0.58	1.00	0.58	1.00	1.00	1.50	0.23	0.66
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
0804-73	Average	5.88	5.26	5.58	6.02	8.78	18.44	34.11	45.78	53.22	62.33	34.25	7.95	14.70
	Std Dev	0.19	0.15	0.17	0.29	0.44	0.73	1.69	1.09	1.56	2.00	1.10	0.40	0.47
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
3280-107	Average	5.43	4.97	5.25	4.82	6.83	11.50	17.50	23.33	30.50	48.50	23.76	10.77	14.88
	Std Dev	0.20	0.16	0.18	0.23	0.41	0.55	0.55	0.52	1.22	1.64	0.80	0.52	0.55
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
4604-29	Average	6.25	5.35	5.71	5.20	8.00	17.00	32.50	44.00	52.00	61.50	31.60	8.80	16.10
	Std Dev	0.21	0.21	0.24	0.28	0.00	1.41	0.71	1.41	1.41	2.12	0.76	0.58	0.28
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Winona Co.	Average	5.89	4.61	4.90	3.37	5.00	11.29	30.43	41.43	49.14	63.00	24.58	9.74	14.07
	Std Dev	0.23	0.23	0.25	0.66	1.00	0.76	1.90	2.64	2.27	2.38	1.65	0.61	0.60
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Winona Co.	Average	5.85	5.11	5.43	3.93	5.91	10.18	34.27	47.64	53.09	64.55	26.91	9.87	15.36
	Std Dev	0.09	0.18	0.19	0.55	0.83	0.98	1.74	2.54	2.84	2.50	1.99	0.77	0.56
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
0804-73	Average	5.88	5.00	5.31	4.34	7.33	16.67	35.22	45.22	51.67	58.67	30.14	8.61	14.97
	Std Dev	0.15	0.22	0.24	0.63	0.71	1.12	2.54	2.73	3.12	3.61	2.21	0.50	0.47
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
0804-73	Average	5.66	5.15	5.46	6.02	9.40	19.00	36.10	48.20	55.90	64.40	35.41	7.51	15.43
	Std Dev	0.22	0.18	0.20	0.23	0.52	0.94	2.08	2.39	2.51	2.55	1.43	0.24	0.49
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
0804-73	Average	6.27	4.93	5.26	4.43	7.17	15.50	32.00	42.00	48.00	54.33	28.89	8.94	14.53
	Std Dev	0.10	0.22	0.23	0.98	1.17	1.05	1.79	2.10	2.37	2.66	2.76	0.91	0.45
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
0804-73	Average	5.60	5.16	5.47	6.03	9.00	18.20	34.75	46.75	54.55	64.45	34.58	7.71	14.81
	Std Dev	0.18	0.17	0.19	0.45	0.65	1.01	1.37	1.71	1.99	2.63	1.54	0.38	0.41
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
3280-107	Average	5.29	4.94	5.22	4.84	6.80	11.20	17.50	23.10	30.60	49.40	23.69	10.74	14.87
	Std Dev	0.26	0.19	0.21	0.30	0.42	0.42	0.53	0.57	0.52	1.17	0.82	0.73	0.49
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
4604-29	Average	5.71	5.17	5.48	5.82	8.67	17.89	34.56	47.11	55.33	65.33	34.01	7.85	15.53
	Std Dev	0.20	0.14	0.16	0.37	0.71	1.05	1.42	1.36	1.32	1.73	1.41	0.26	0.36
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5202-44	Average	6.23	5.63	6.00	6.43	9.75	19.50	35.25	46.50	55.50	66.50	36.19	8.08	15.98
	Std Dev	0.15	0.05	0.06	0.21	0.50	0.58	0.50	0.58	0.58	0.58	0.70	0.18	0.40
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5202-44	Average	5.66	5.08	5.38	5.95	9.14	18.79	34.57	46.14	54.57	64.36	34.64	7.58	15.09
	Std Dev	0.16	0.14	0.15	0.33	0.53	0.97	1.45	1.66	1.91	2.13	1.43	0.26	0.34
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
5212-24	Average	5.93	4.85	5.16	5.65	8.75	21.00	35.25	49.00	62.75	74.25	35.44	7.12	15.58
	Std Dev	0.19	0.25	0.28	0.51	0.96	1.41	2.22	2.58	3.10	3.59	2.49	0.80	0.68
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
5212-24	Average	5.57	4.70	4.98	5.25	9.17	19.33	30.00	41.33	55.33	66.83	32.76	7.40	14.25
	Std Dev	0.27	0.28	0.31	0.23	0.75	1.03	1.26	1.75	1.75	2.93	1.44	0.40	0.38
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
5380-88	Average	5.54	5.04	5.34	5.33	10.00	25.00	36.86	45.86	55.71	64.57	36.37	7.17	15.43
	Std Dev	0.18	0.19	0.21	0.38	0.82	2.38	2.61	3.24	3.25	3.91	2.52	0.37	0.57
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
8301-24	Average	6.10	5.30	5.64	5.66	8.40	17.80	33.00	44.40	52.40	62.20	32.95	8.35	15.60
	Std Dev	0.20	0.17	0.20	0.15	0.55	0.84	1.22	2.07	2.41	2.95	1.07	0.38	0.63
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
8304-28	Average	6.16	5.58	5.94	6.63	9.88	19.13	34.00	46.13	54.50	64.50	36.18	8.01	15.61
	Std Dev	0.26	0.18	0.21	0.45	0.64	0.64	1.20	1.55	1.85	2.45	1.41	0.49	0.45
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
8304-28	Average	5.83	5.22	5.54	5.88	9.00	18.33	34.67	46.33	54.83	65.33	34.37	7.86	15.40
	Std Dev	0.33	0.31	0.34	0.54	0.89	1.21	2.07	2.80	3.37	4.03	2.34	0.35	0.68
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
5202-44	Average	5.88	5.50	5.84	6.20	9.50	18.67	34.33	46.67	55.33	66.00	35.29	8.07	15.83
	Std Dev	0.18	0.11	0.13	0.18	0.55	0.52	0.52	0.82	1.03	0.89	0.63	0.22	0.38
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
5202-44	Average	5.50	5.08	5.37	5.89	9.06	18.06	34.25	46.25	54.66	64.88	34.26	7.66	15.29
	Std Dev	0.14	0.14	0.15	0.49	0.72	1.22	1.68	1.87	2.13	2.12	1.93	0.44	0.39
	Count	32	32	32	32	32	32	32	32	32	32	32	32	32
5212-24	Average	5.79	4.80	5.10	5.89	9.56	21.44	34.56	47.22	59.78	70.67	36.01	6.91	15.12
	Std Dev	0.20	0.21	0.23	0.31	0.53	1.24	2.65	3.99	5.24	5.57	1.93	0.45	0.87
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
5212-24	Average	5.19	4.45	4.70	5.56	10.50	20.47	31.47	42.60	55.63	66.40	34.71	6.61	14.33
	Std Dev	0.15	0.19	0.20	0.45	0.94	1.17	1.63	2.13	2.80	2.95	1.88	0.43	0.52
	Count	30	30	30	30	30	30	30	30	30	30	30	30	30
5380-88	Average	5.66	5.09	5.40	6.07	11.00	24.29	36.14	44.50	55.14	63.71	37.70	7.03	15.36
	Std Dev	0.14	0.13	0.15	0.45	1.71	2.79	3.18	2.98	3.11	3.36	3.29	0.67	0.57
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
8301-24	Average	5.60	5.03	5.33	5.69	8.81	17.69	33.75	46.25	54.75	64.94	33.62	7.73	15.40
	Std Dev	0.19	0.19	0.21	0.26	0.40	0.95	1.69	1.95	2.29	2.14	1.28	0.30	0.43
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
8304-28	Average	5.93	5.53	5.87	6.28	9.67	18.33	33.67	46.00	54.58	64.67	35.21	8.13	15.67
	Std Dev	0.21	0.22	0.25	0.34	0.49	0.78	1.44	1.65	1.93	1.92	1.21	0.46	0.48
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
8304-28	Average	5.69	5.15	5.46	5.55	8.54	17.54	33.85	46.15	54.54	64.85	33.18	8.02	15.45
	Std Dev	0.35	0.26	0.30	0.54	0.78	1.05	1.41	2.23	2.60	2.91	1.90	0.46	0.72
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
3408-14	Average	6.10	5.21	5.55	5.72	9.50	20.27	34.50	48.05	62.09	73.82	35.57	7.62	15.11
	Std Dev	0.25	0.22	0.25	0.34	1.34	1.80	1.97	2.42	2.64	2.72	2.11	0.41	0.46
	Count	22	22	22	22	22	22	22	22	22	22	22	22	22
3408-14	Average	6.21	5.31	5.66	5.64	9.82	21.94	36.41	49.71	61.82	73.29	36.51	7.57	14.84
	Std Dev	0.31	0.19	0.21	0.40	0.95	1.71	2.00	2.31	2.51	2.47	2.06	0.48	0.39
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
3408-14	Average	6.18	5.25	5.60	5.05	8.88	20.50	36.25	49.25	61.38	73.13	34.49	7.91	16.09
	Std Dev	0.21	0.21	0.23	0.31	0.83	1.41	1.58	1.49	1.69	1.73	1.35	0.39	0.65
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
3408-14	Average	5.91	5.18	5.50	5.39	9.75	20.21	34.71	48.33	62.08	73.63	35.22	7.63	15.54
	Std Dev	0.22	0.22	0.24	0.51	1.42	1.84	1.94	2.12	2.38	2.46	2.18	0.45	0.62
	Count	24	24	24	24	24	24	24	24	24	24	24	24	24
3408-14	Average	5.91	5.16	5.49	5.39	9.29	20.29	35.00	47.93	60.21	71.79	34.85	7.70	14.51
	Std Dev	0.24	0.26	0.29	0.48	1.14	2.67	2.99	3.32	3.60	3.33	2.89	0.48	0.81
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
3708-13	Average	5.91	4.84	5.14	6.45	8.63	15.63	28.75	42.63	56.25	70.63	33.28	7.54	15.48
	Std Dev	0.23	0.25	0.28	0.47	0.52	0.52	0.89	1.41	2.05	1.30	1.12	0.55	0.67
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
5107-12	Average	5.91	4.97	5.28	5.21	7.00	12.57	27.00	40.57	54.57	70.00	28.92	8.91	15.10
	Std Dev	0.27	0.24	0.26	0.54	0.58	0.79	1.29	1.40	1.90	1.91	1.53	0.45	0.65
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
26-621-07	Average	6.00	4.60	4.90	5.55	8.00	16.00	29.50	44.50	64.00	77.00	32.27	7.37	13.35
	Std Dev	0.42	0.57	0.62	0.21	0.00	1.41	3.54	4.95	1.41	0.00	1.60	0.58	1.34
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
3408-14	Average	5.92	5.18	5.50	5.22	8.47	18.43	33.30	47.27	60.60	72.53	33.28	8.07	15.04
	Std Dev	0.18	0.20	0.22	0.36	0.57	1.04	1.62	1.95	2.28	2.65	1.51	0.44	0.36
	Count	30	30	30	30	30	30	30	30	30	30	30	30	30
3408-14	Average	6.22	5.32	5.67	5.00	8.50	19.38	34.91	48.85	60.65	72.26	33.59	8.25	14.89
	Std Dev	0.26	0.27	0.30	0.52	0.93	1.99	2.43	2.55	2.63	2.59	2.32	0.56	0.47
	Count	34	34	34	34	34	34	34	34	34	34	34	34	34
3408-14	Average	6.19	5.29	5.64	4.58	8.00	18.50	35.20	48.50	60.50	71.90	32.34	8.51	15.91
	Std Dev	0.22	0.23	0.26	0.32	0.67	1.78	2.49	3.21	3.78	3.73	1.87	0.44	0.59
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
3408-14	Average	5.91	5.21	5.54	4.89	8.23	18.69	34.10	48.21	61.18	72.54	32.89	8.23	15.47
	Std Dev	0.28	0.30	0.33	0.55	0.93	2.04	2.43	2.86	3.43	3.50	2.50	0.63	0.74
	Count	39	39	39	39	39	39	39	39	39	39	39	39	39
3408-14	Average	5.87	5.11	5.43	5.00	8.30	18.48	34.15	47.85	59.52	71.22	32.94	8.05	14.50
	Std Dev	0.21	0.25	0.28	0.44	0.87	2.12	2.67	2.74	2.74	2.79	2.14	0.54	0.59
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
3708-13	Average	5.97	5.02	5.33	5.81	7.58	14.68	28.63	42.42	57.37	71.63	31.38	8.31	15.47
	Std Dev	0.10	0.17	0.18	0.44	0.84	1.11	1.30	1.80	1.61	2.27	1.58	0.64	0.59
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
5107-12	Average	5.65	4.88	5.17	4.65	5.92	12.31	25.15	40.00	54.62	69.77	26.98	9.35	14.90
	Std Dev	0.15	0.16	0.18	0.44	0.49	1.03	1.46	1.68	1.56	1.96	1.40	0.57	0.45
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
26-621-07	Average	6.20	5.20	5.54	5.30	7.43	14.14	28.57	45.43	59.14	73.14	30.64	8.84	14.69
	Std Dev	0.12	0.22	0.24	0.47	0.79	0.90	1.27	0.79	1.07	1.07	1.65	0.74	0.53
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
26-621-07	Average	7.00	5.67	6.09	4.73	7.00	15.33	29.67	47.33	63.33	76.67	30.38	9.77	15.07
	Std Dev	0.26	0.23	0.26	0.51	1.00	0.58	0.58	1.15	1.53	2.08	1.42	0.39	1.31
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
37-600-02	Average	6.05	5.15	5.48	6.20	9.50	14.00	27.50	43.50	55.50	68.50	32.74	8.16	13.90
	Std Dev	0.21	0.07	0.06	0.42	0.71	0.00	2.12	3.54	3.54	3.54	0.54	0.23	0.71
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
37-600-02	Average	6.15	5.00	5.33	6.00	9.00	14.50	28.50	43.50	55.50	70.00	32.44	8.00	13.55
	Std Dev	0.07	0.00	0.00	0.14	0.00	0.71	0.71	0.71	2.12	1.41	0.25	0.07	0.35
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
37-612-13	Average	6.23	4.88	5.20	5.60	9.25	18.25	30.00	40.25	53.25	69.00	34.18	7.43	13.53
	Std Dev	0.10	0.10	0.10	0.37	0.50	1.50	1.83	1.26	1.26	1.63	1.71	0.49	0.22
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
37-612-13	Average	6.54	4.74	5.07	5.20	8.60	20.40	33.80	44.80	58.20	74.40	35.51	6.97	13.54
	Std Dev	0.13	0.18	0.20	0.32	0.55	1.34	0.84	1.10	1.30	1.14	1.53	0.55	0.42
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
42-606-09	Average	6.19	5.16	5.50	6.48	8.67	13.83	28.00	44.92	58.92	71.33	33.01	8.15	15.86
	Std Dev	0.22	0.12	0.13	0.78	0.89	1.11	2.52	2.39	2.23	1.72	2.40	0.59	0.66
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
42-613-23	Average	5.95	5.00	5.32	6.70	9.17	14.67	28.00	44.17	59.83	73.17	33.93	7.64	15.25
	Std Dev	0.25	0.18	0.20	0.51	0.75	0.82	1.67	3.06	1.94	1.33	1.22	0.34	0.88
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
51-603-15	Average	6.08	4.88	5.19	5.00	7.18	13.39	20.86	32.82	54.46	73.43	27.52	9.23	14.29
	Std Dev	0.17	0.16	0.18	0.38	0.77	1.75	2.19	2.37	3.33	3.37	2.03	0.63	0.67
	Count	28	28	28	28	28	28	28	28	28	28	28	28	28

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
26-621-07	Average	6.86	5.68	6.10	4.56	6.60	13.60	29.00	48.60	63.80	76.40	29.36	10.18	16.02
	Std Dev	0.17	0.28	0.31	0.92	1.52	1.52	1.73	3.05	1.92	2.30	3.17	0.94	0.51
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
37-600-02	Average	5.98	5.08	5.40	6.48	8.00	13.00	27.20	43.60	55.80	67.80	31.95	8.24	14.62
	Std Dev	0.13	0.16	0.18	0.18	0.71	0.71	2.05	2.51	3.27	3.77	0.93	0.32	0.60
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
37-600-02	Average	6.10	4.85	5.17	7.03	8.25	13.75	28.50	44.25	56.75	71.25	33.54	7.50	14.50
	Std Dev	0.14	0.10	0.11	0.36	0.50	0.50	0.58	0.96	0.96	0.50	1.08	0.27	0.28
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
37-612-13	Average	6.18	4.85	5.17	5.75	7.87	15.33	28.40	38.40	51.67	67.47	32.18	7.85	14.05
	Std Dev	0.20	0.27	0.29	0.61	0.83	1.18	1.30	1.80	2.44	2.90	2.08	0.64	0.36
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
37-612-13	Average	6.49	4.75	5.08	5.26	7.47	17.53	32.40	42.60	55.40	70.73	33.38	7.42	14.11
	Std Dev	0.11	0.16	0.17	0.55	0.64	1.19	1.80	2.06	2.44	2.89	1.59	0.34	0.37
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
42-606-09	Average	6.12	5.18	5.52	5.58	7.41	13.09	27.14	45.50	59.14	70.91	30.53	8.82	15.55
	Std Dev	0.18	0.15	0.17	0.52	0.67	0.87	2.32	2.43	2.27	2.39	1.65	0.56	0.80
	Count	22	22	22	22	22	22	22	22	22	22	22	22	22
42-613-23	Average	6.09	5.11	5.44	6.01	8.10	13.90	25.80	43.10	58.60	71.40	31.48	8.42	14.84
	Std Dev	0.23	0.19	0.22	0.25	0.32	0.57	1.81	3.00	2.88	2.50	0.52	0.33	0.88
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
51-603-15	Average	5.99	4.99	5.31	4.40	6.41	12.48	19.95	32.24	53.32	71.36	25.57	10.16	14.37
	Std Dev	0.12	0.13	0.14	0.40	0.68	1.50	1.93	2.37	2.88	3.28	1.88	0.72	0.43
	Count	66	66	66	66	66	66	66	66	66	66	66	66	66

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
65-608-11	Average	5.67	4.77	5.05	6.00	9.33	18.00	31.33	43.67	56.00	67.67	34.07	7.23	13.50
	Std Dev	0.12	0.06	0.06	0.20	0.58	1.00	1.53	2.08	2.65	2.89	1.48	0.30	0.26
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
76-617-08	Average	6.29	5.20	5.55	5.58	7.38	13.25	29.63	44.38	57.63	72.13	30.77	8.79	14.88
	Std Dev	0.24	0.19	0.21	0.21	0.52	0.71	1.19	1.77	2.26	2.80	1.09	0.29	0.37
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
76-617-08	Average	6.63	5.50	5.89	3.88	5.25	10.50	26.25	42.00	55.00	68.00	25.10	11.43	16.20
	Std Dev	0.15	0.18	0.20	0.33	0.50	0.58	0.96	2.16	3.56	5.48	0.82	0.35	0.59
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Com'l #2	Average	5.40	5.01	5.30	4.00	6.13	11.00	19.75	29.50	41.50	56.75	23.30	11.16	15.63
	Std Dev	0.35	0.34	0.38	0.56	0.83	1.31	3.28	4.99	4.84	3.49	2.60	1.02	1.03
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #2	Average	5.50	4.63	4.90	5.00	7.57	12.71	20.86	30.00	42.14	55.43	26.47	9.03	14.41
	Std Dev	0.22	0.28	0.30	0.67	0.79	0.49	2.73	3.96	4.60	5.19	1.60	0.63	0.84
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #2	Average	5.34	4.69	4.95	4.90	7.86	13.29	21.29	32.14	47.14	64.43	27.27	8.86	14.61
	Std Dev	0.33	0.32	0.35	0.34	0.69	0.49	2.87	3.18	4.22	4.24	1.23	0.79	1.11
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #2	Average	5.93	5.19	5.52	5.06	7.13	13.00	26.63	39.00	49.50	59.38	28.29	9.50	14.60
	Std Dev	0.32	0.33	0.37	0.27	0.64	0.76	2.39	3.51	4.66	5.42	1.29	0.52	0.91
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #2	Average	5.30	4.65	4.91	4.80	8.00	14.00	27.50	39.50	51.00	63.00	28.99	8.24	14.60
	Std Dev	0.57	0.49	0.55	0.00	0.00	1.41	4.95	6.36	5.66	2.83	1.91	0.38	0.42
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
65-608-11	Average	5.63	4.56	4.83	6.33	8.67	16.56	30.78	43.44	55.78	67.44	33.66	7.00	14.34
	Std Dev	0.07	0.12	0.13	0.59	0.71	0.73	1.20	1.13	1.20	1.81	1.77	0.42	0.38
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
76-617-08	Average	6.21	5.26	5.61	4.93	6.13	10.52	28.13	43.35	57.57	72.35	27.88	9.82	14.92
	Std Dev	0.06	0.08	0.09	0.34	0.46	0.90	1.94	1.90	1.44	1.87	1.25	0.50	0.31
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
76-617-08	Average	6.23	5.55	5.92	4.53	5.25	8.75	28.00	42.38	56.25	69.63	25.97	11.11	15.89
	Std Dev	0.05	0.15	0.16	0.25	0.46	0.89	2.83	1.85	2.76	3.38	1.03	0.45	0.43
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #2	Average	5.46	5.15	5.44	3.70	6.00	10.45	19.09	28.55	41.00	55.91	22.37	11.89	15.42
	Std Dev	0.29	0.25	0.28	0.33	0.45	1.21	2.39	3.08	4.07	3.86	1.49	0.89	0.89
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
Com'l #2	Average	5.52	4.76	5.03	4.13	6.56	11.56	20.33	30.11	42.56	54.22	24.06	10.23	14.08
	Std Dev	0.24	0.32	0.35	0.59	0.88	0.88	2.78	4.51	5.41	5.63	1.95	0.77	0.65
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Com'l #2	Average	5.30	4.63	4.88	4.44	7.13	11.88	19.25	29.75	43.56	60.50	24.98	9.55	14.28
	Std Dev	0.20	0.29	0.32	0.47	0.72	1.36	2.72	2.86	4.16	5.40	1.80	0.56	0.89
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
Com'l #2	Average	5.88	5.21	5.54	4.55	6.38	12.13	25.88	38.75	49.13	59.00	26.61	10.15	14.60
	Std Dev	0.26	0.32	0.35	0.36	0.52	0.83	2.17	3.65	4.39	4.96	1.65	0.54	1.09
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #2	Average	5.73	5.00	5.30	4.36	7.00	13.71	28.14	41.00	53.00	66.00	27.95	9.25	14.99
	Std Dev	0.23	0.31	0.34	0.22	0.58	0.76	2.12	2.58	2.65	2.65	1.31	0.51	0.75
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Com'l #2	Average	5.40	4.60	4.86	5.40	9.00	14.00	23.00	33.00	46.00	58.00	29.10	8.14	13.70
	Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Count	1	1	1	1	1	1	1	1	1	1	1	1	1
Com'l #2	Average	5.68	4.72	5.00	4.68	7.40	14.00	28.80	41.60	53.00	65.00	28.91	8.46	15.36
	Std Dev	0.22	0.23	0.25	0.80	1.14	1.00	1.92	3.78	4.85	4.80	1.66	0.72	1.19
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #2	Average	5.74	4.83	5.12	4.36	6.38	13.13	28.50	41.25	52.63	64.00	27.42	9.13	14.93
	Std Dev	0.31	0.18	0.20	0.40	0.74	0.99	2.73	3.58	3.85	4.44	1.82	0.78	1.07
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #3	Average	5.58	5.05	5.35	5.13	7.33	13.83	28.67	42.33	53.33	63.67	29.57	8.82	15.20
	Std Dev	0.12	0.10	0.12	0.43	0.52	0.75	1.03	1.37	1.37	1.75	1.34	0.46	0.35
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Com'l #3	Average	5.22	4.72	4.98	4.84	7.60	14.00	23.80	33.60	46.40	64.60	27.67	8.76	15.02
	Std Dev	0.18	0.35	0.38	0.13	0.55	0.71	4.09	5.27	4.83	1.95	1.10	0.39	0.33
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #3	Average	5.52	4.68	4.95	4.56	7.00	14.20	28.60	40.40	51.00	65.60	28.34	8.54	15.42
	Std Dev	0.31	0.36	0.39	0.60	0.71	0.84	2.07	2.61	3.46	3.65	1.26	0.90	0.50
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #3	Average	5.50	4.73	5.01	4.97	7.33	14.33	28.33	39.00	49.67	62.33	28.97	8.43	15.07
	Std Dev	0.10	0.12	0.12	0.40	0.58	0.58	1.53	2.00	3.51	4.04	1.64	0.40	0.87
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Com'l #4	Average	5.20	4.53	4.78	4.83	8.67	15.67	27.00	37.33	49.00	62.33	29.61	7.87	13.47
	Std Dev	0.26	0.21	0.23	0.40	0.58	1.15	2.65	3.21	3.46	4.16	1.99	0.25	0.57
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Com'l #2	Average	5.65	4.80	5.09	5.20	8.00	14.00	24.50	37.00	49.00	62.00	28.91	8.57	13.30
	Std Dev	0.07	0.00	0.00	0.14	0.00	0.00	0.71	1.41	0.00	1.41	0.41	0.13	0.71
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Com'l #2	Average	5.55	4.72	5.00	4.18	6.71	13.21	28.43	42.21	54.07	67.07	27.54	8.89	14.76
	Std Dev	0.24	0.19	0.21	0.65	0.91	1.05	1.22	1.89	2.46	2.62	1.91	0.90	0.66
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
Com'l #2	Average	5.50	4.76	5.04	4.11	6.05	12.71	28.57	41.76	52.57	63.33	26.74	9.26	14.33
	Std Dev	0.34	0.24	0.27	0.62	1.12	1.31	2.68	3.78	3.85	3.89	2.39	1.03	0.64
	Count	21	21	21	21	21	21	21	21	21	21	21	21	21
Com'l #3	Average	5.83	5.21	5.53	4.69	6.50	13.00	27.88	42.63	53.75	63.38	28.03	9.64	15.56
	Std Dev	0.18	0.16	0.17	0.53	0.53	0.76	1.55	1.51	2.49	2.88	1.68	0.50	0.37
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Com'l #3	Average	5.32	4.92	5.20	4.34	7.00	14.40	23.80	34.40	46.00	64.00	26.67	9.50	14.80
	Std Dev	0.16	0.23	0.24	0.27	0.00	3.21	3.56	4.51	3.39	1.22	1.41	0.48	0.36
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #3	Average	5.58	4.82	5.10	3.97	6.00	13.17	27.50	39.83	51.83	64.17	26.29	9.45	15.22
	Std Dev	0.15	0.26	0.28	0.21	0.00	0.75	1.64	1.94	3.06	3.06	0.72	0.41	0.50
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Com'l #3	Average	5.35	4.66	4.92	4.04	6.08	13.00	26.67	38.50	49.08	61.75	26.03	9.23	14.16
	Std Dev	0.27	0.27	0.30	0.43	0.67	1.04	2.06	3.09	4.06	4.27	1.96	0.45	0.52
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
Com'l #4	Average	5.11	4.61	4.86	3.25	6.00	12.38	23.88	34.75	46.25	59.25	23.67	10.05	13.80
	Std Dev	0.11	0.25	0.27	0.43	0.76	1.30	1.73	2.71	3.96	6.16	2.15	0.72	0.29
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Com'l #4	Average	5.74	5.02	5.33	5.38	8.00	16.40	32.20	43.60	54.00	65.80	31.80	8.17	14.64
	Std Dev	0.15	0.13	0.14	0.46	0.71	0.89	0.45	0.55	1.00	1.10	1.45	0.34	0.40
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #4	Average	5.30	4.57	4.82	3.93	6.33	11.33	20.33	30.00	42.33	56.00	23.55	9.99	14.53
	Std Dev	0.20	0.25	0.28	0.42	0.58	0.58	2.31	2.65	2.52	2.00	1.83	0.44	0.60
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Com'l #4	Average	5.51	4.76	5.04	4.83	8.00	16.10	30.40	41.20	52.10	66.60	30.33	8.09	15.25
	Std Dev	0.32	0.24	0.27	0.23	0.47	0.57	1.35	1.69	2.18	2.63	1.06	0.37	0.45
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
Com'l #4	Average	5.39	4.75	5.02	4.05	6.54	12.08	21.54	31.54	44.46	54.46	24.43	10.02	14.19
	Std Dev	0.25	0.26	0.28	0.28	0.52	0.76	0.97	0.97	1.27	2.50	1.11	0.72	0.39
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
Com'l #4	Average	5.15	4.63	4.88	4.64	7.70	13.60	22.40	32.25	46.25	63.85	26.96	8.83	14.98
	Std Dev	0.15	0.20	0.22	0.22	0.47	0.60	1.47	1.94	2.02	2.32	1.07	0.41	0.47
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
Com'l #4	Average	5.10	4.44	4.68	4.58	7.71	13.57	22.00	31.50	46.00	64.50	26.76	8.54	14.78
	Std Dev	0.22	0.20	0.22	0.25	0.47	0.65	1.30	1.65	2.57	3.11	1.10	0.60	0.57
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
Com'l #5	Average	5.35	4.47	4.72	4.11	6.60	12.60	22.73	33.13	46.40	59.40	25.20	9.13	14.73
	Std Dev	0.28	0.27	0.30	0.19	0.51	0.51	1.03	1.73	2.75	3.20	1.00	0.68	0.53
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
Com'l #5	Average	5.40	4.60	4.86	4.96	7.90	15.20	26.50	36.40	48.10	62.60	29.03	8.15	14.01
	Std Dev	0.33	0.37	0.40	0.30	0.57	0.79	1.72	2.67	3.45	4.30	1.50	0.44	0.53
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Com'l #4	Average	5.49	4.91	5.20	4.25	6.65	14.94	30.59	43.00	53.47	65.35	28.44	8.91	14.26
	Std Dev	0.21	0.25	0.27	0.33	0.49	0.75	1.18	1.54	1.87	2.06	1.13	0.52	0.47
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
Com'l #4	Average	5.20	4.62	4.87	3.65	5.67	11.00	20.67	30.67	43.67	57.83	22.79	10.43	14.40
	Std Dev	0.15	0.22	0.24	0.35	0.52	0.89	1.63	2.66	2.94	2.86	1.58	0.46	0.37
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Com'l #4	Average	5.43	4.83	5.11	4.06	6.75	14.91	29.28	40.84	52.00	65.94	27.78	8.97	14.82
	Std Dev	0.23	0.24	0.26	0.37	0.67	0.96	1.69	2.29	2.79	2.75	1.59	0.57	0.48
	Count	32	32	32	32	32	32	32	32	32	32	32	32	32
Com'l #4	Average	5.08	4.77	5.03	3.38	5.47	10.76	20.24	30.65	43.29	52.82	22.00	11.15	14.06
	Std Dev	0.26	0.23	0.25	0.28	0.51	0.66	1.03	1.46	1.83	2.53	1.11	0.63	0.45
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17
Com'l #4	Average	5.26	4.80	5.06	4.07	6.96	12.81	21.67	32.07	46.37	63.74	25.26	9.78	15.13
	Std Dev	0.19	0.22	0.24	0.29	0.52	0.74	1.39	1.96	2.36	2.86	1.26	0.52	0.49
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
Com'l #4	Average	5.20	4.63	4.89	4.19	7.00	12.74	21.30	31.56	45.85	64.07	25.35	9.45	14.78
	Std Dev	0.19	0.21	0.23	0.71	0.92	1.10	1.49	2.01	2.89	3.41	2.44	0.76	0.44
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
Com'l #5	Average	5.20	4.55	4.80	3.59	6.00	11.85	22.15	33.33	47.19	59.04	23.74	9.86	14.36
	Std Dev	0.27	0.23	0.25	0.28	0.78	0.86	1.32	2.25	3.00	3.67	1.43	0.64	0.57
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
Com'l #5	Average	5.60	4.82	5.11	3.80	6.15	13.15	24.15	33.77	45.23	57.62	24.76	10.10	14.13
	Std Dev	0.20	0.30	0.33	0.49	0.99	1.46	1.99	2.71	3.63	3.66	2.35	0.78	0.52
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Com'l #5	Average	5.60	4.68	4.96	4.67	7.83	14.33	24.17	33.50	45.83	64.67	27.66	8.73	15.17
	Std Dev	0.38	0.34	0.38	0.26	0.41	1.03	1.83	2.51	3.25	4.63	0.99	0.50	0.41
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Com'l #5	Average	5.07	4.37	4.60	4.60	7.85	14.05	23.20	33.10	47.35	64.95	27.37	8.20	14.68
	Std Dev	0.20	0.22	0.24	0.31	0.49	0.76	1.24	1.92	2.83	3.90	1.28	0.40	0.65
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
Com'l #5	Average	5.83	4.84	5.14	4.96	8.14	15.43	26.43	37.43	51.43	64.86	29.49	8.49	14.90
	Std Dev	0.30	0.26	0.29	0.19	0.38	0.53	0.53	1.40	3.10	3.80	0.76	0.42	0.73
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #5	Average	5.80	4.77	5.06	4.50	7.11	12.67	21.67	32.00	46.00	58.11	25.86	9.53	15.72
	Std Dev	0.19	0.27	0.29	0.27	0.33	0.71	1.00	1.94	2.92	3.48	1.01	0.54	0.59
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Com'l #5	Average	5.77	4.77	5.06	4.96	8.57	15.29	24.86	35.43	49.00	67.86	29.29	8.43	15.33
	Std Dev	0.37	0.24	0.27	0.43	0.79	0.95	2.48	1.62	2.45	4.49	1.52	0.39	1.01
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #5	Average	5.13	4.37	4.60	5.70	10.33	18.67	28.33	38.00	51.33	67.33	33.33	6.74	14.13
	Std Dev	0.15	0.06	0.07	0.36	0.58	1.15	1.53	1.73	2.52	3.06	1.73	0.29	0.50
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Com'l #5	Average	5.55	4.95	5.24	4.70	8.00	18.50	32.50	43.50	55.00	71.00	31.52	8.10	15.35
	Std Dev	0.21	0.21	0.24	0.00	0.00	0.71	0.71	2.12	2.83	4.24	0.68	0.19	0.78
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Com'l #5	Average	5.40	4.73	5.00	4.67	7.33	17.00	33.33	45.67	57.00	69.67	30.96	7.88	14.63
	Std Dev	0.20	0.25	0.28	0.12	0.58	1.00	0.58	0.58	1.00	2.08	0.50	0.57	0.40
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State		TOTAL	AC_{eff}	AC_{eff}	PERCENTAGE PASSING SIEVE							SA	AFT	
Project		AC	(By Mix)	(By Agg)	#200	#100	#50	#30	#16	#8	#4	(SF/Lb)	(Microns)	VMA
Com'l #5	Average	5.92	5.05	5.37	3.68	6.50	13.00	22.83	32.00	45.00	63.00	24.51	10.67	15.03
	Std Dev	0.38	0.36	0.40	0.27	0.55	0.89	1.60	2.19	3.16	4.82	1.18	0.71	0.58
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Com'l #5	Average	5.12	4.45	4.69	3.87	6.74	12.87	21.84	32.00	46.68	63.10	24.85	9.21	14.17
	Std Dev	0.24	0.21	0.23	0.27	0.51	0.67	0.97	1.46	2.44	3.51	1.09	0.54	0.45
	Count	31	31	31	31	31	31	31	31	31	31	31	31	31
Com'l #5	Average	5.55	4.85	5.14	3.93	6.80	13.80	24.50	35.60	49.30	62.10	26.00	9.63	14.28
	Std Dev	0.23	0.21	0.23	0.30	0.42	0.79	1.08	1.58	2.71	3.41	1.17	0.39	0.43
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
Com'l #5	Average	5.82	4.93	5.23	3.84	6.14	11.57	20.64	31.36	45.00	55.14	23.61	10.82	15.07
	Std Dev	0.34	0.26	0.29	0.36	0.53	0.65	1.39	2.06	3.35	3.30	1.43	0.60	0.50
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
Com'l #5	Average	5.69	4.97	5.27	3.69	6.60	13.10	22.90	32.90	45.70	62.70	24.71	10.40	15.13
	Std Dev	0.26	0.20	0.22	0.49	0.70	0.74	1.10	1.85	2.91	4.37	1.26	0.54	0.98
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
Com'l #5	Average	5.40	4.66	4.93	4.56	8.40	17.60	27.60	38.20	52.80	68.00	30.01	8.00	14.38
	Std Dev	0.16	0.09	0.10	0.19	0.55	0.55	0.55	0.45	0.84	1.41	0.76	0.17	0.33
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #5	Average	6.00	5.32	5.66	3.72	6.80	16.40	30.00	41.40	53.20	68.80	27.97	9.86	15.48
	Std Dev	0.10	0.08	0.09	0.19	0.45	0.89	0.71	0.89	1.79	1.64	0.88	0.17	0.28
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #5	Average	5.62	5.01	5.31	4.02	6.44	15.33	31.56	44.56	55.78	66.44	28.44	9.10	14.83
	Std Dev	0.23	0.19	0.21	0.19	0.53	0.87	1.33	1.33	1.48	1.74	0.71	0.44	0.29
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Com'l #5	Average	5.55	4.75	5.03	4.47	7.23	15.00	29.69	41.69	52.23	65.23	28.88	8.48	15.25
	Std Dev	0.36	0.33	0.37	0.25	0.44	1.00	1.44	1.97	2.49	1.92	1.15	0.50	0.58
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13
Com'l #6	Average	5.25	4.67	4.93	5.04	8.36	16.91	30.73	41.45	52.45	69.36	31.25	7.69	14.95
	Std Dev	0.29	0.21	0.23	0.40	0.67	0.83	1.10	1.86	2.34	2.77	1.30	0.36	0.44
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
Com'l #6	Average	6.03	4.93	5.25	5.40	9.33	18.33	33.00	43.67	54.33	68.33	33.39	7.66	15.20
	Std Dev	0.23	0.21	0.21	0.61	0.58	0.58	1.73	3.21	4.73	5.51	0.70	0.46	1.22
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Com'l #7	Average	6.07	5.17	5.50	4.80	8.33	16.67	30.33	42.00	53.00	70.33	30.81	8.71	15.50
	Std Dev	0.12	0.15	0.16	0.53	1.15	1.53	1.53	1.73	2.00	2.08	2.21	0.42	1.04
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Com'l #7	Average	5.35	4.50	4.75	4.43	6.50	12.00	21.75	31.50	44.50	59.25	25.11	9.24	14.48
	Std Dev	0.17	0.14	0.16	0.30	0.58	1.15	0.96	1.73	2.38	2.06	1.51	0.54	0.19
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Com'l #7	Average	5.27	4.51	4.77	4.33	8.43	18.86	31.57	41.43	50.57	63.29	30.66	7.60	14.63
	Std Dev	0.20	0.24	0.25	0.18	0.53	2.48	2.23	2.30	2.23	2.75	1.56	0.76	0.76
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #7	Average	5.51	4.73	5.01	3.82	7.11	17.11	32.78	44.00	53.56	63.33	29.03	8.41	14.26
	Std Dev	0.28	0.45	0.49	0.22	0.60	0.78	1.48	2.40	2.46	1.73	0.98	0.77	0.42
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Com'l #9	Average	5.00	4.40	4.63	3.77	6.00	12.33	22.00	32.00	44.33	57.00	23.88	9.45	14.63
	Std Dev	0.10	0.10	0.11	0.06	0.00	1.15	1.00	2.00	2.52	4.00	0.78	0.24	0.32
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Com'l #5	Average	5.49	4.89	5.17	3.67	6.03	13.31	28.03	40.17	50.56	63.06	25.90	9.74	15.11
	Std Dev	0.23	0.22	0.24	0.30	0.56	0.82	2.09	2.68	3.48	3.90	1.41	0.38	0.51
	Count	36	36	36	36	36	36	36	36	36	36	36	36	36
Com'l #6	Average	5.46	4.90	5.19	4.33	7.37	16.26	30.56	42.48	53.85	71.26	29.48	8.59	14.84
	Std Dev	0.20	0.17	0.18	0.49	0.79	1.13	1.69	2.21	2.80	3.01	1.83	0.49	0.57
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
Com'l #6	Average	6.19	5.13	5.47	4.54	8.00	17.43	32.43	44.57	55.71	70.00	31.03	8.59	15.16
	Std Dev	0.41	0.41	0.46	0.57	0.82	0.79	2.51	4.28	5.68	5.86	1.72	0.59	1.21
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Com'l #7	Average	6.08	5.30	5.64	4.10	7.25	16.00	30.75	43.00	54.25	71.75	29.06	9.47	15.65
	Std Dev	0.21	0.14	0.15	0.50	0.96	1.15	1.26	1.83	2.22	2.06	1.69	0.38	0.62
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Com'l #7	Average	5.35	4.58	4.84	3.47	5.08	10.75	20.75	31.50	45.42	60.25	22.27	10.60	15.13
	Std Dev	0.12	0.12	0.13	0.23	0.29	0.45	0.62	0.80	1.44	2.05	0.68	0.52	0.35
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12
Com'l #7	Average	5.35	4.73	4.99	3.64	7.00	17.52	31.37	40.93	49.96	62.22	28.18	8.68	14.29
	Std Dev	0.38	0.26	0.29	0.29	0.62	1.97	2.13	2.04	2.10	2.61	1.73	0.89	0.49
	Count	27	27	27	27	27	27	27	27	27	27	27	27	27
Com'l #7	Average	5.61	4.91	5.20	3.35	6.29	16.00	31.74	43.71	52.77	62.03	27.23	9.31	14.31
	Std Dev	0.29	0.31	0.34	0.43	0.64	0.97	1.55	2.36	2.67	2.85	1.58	0.56	0.44
	Count	31	31	31	31	31	31	31	31	31	31	31	31	31
Com'l #9	Average	5.20	4.78	5.04	3.28	5.40	11.80	22.40	33.00	46.00	60.00	22.84	10.78	14.60
	Std Dev	0.31	0.33	0.36	0.51	0.55	0.84	1.34	1.87	2.92	3.74	1.60	0.81	0.43
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Com'l #10	Average	5.70	4.85	5.14	4.20	6.50	12.50	23.50	35.00	49.00	59.00	25.60	9.80	14.95
	Std Dev	0.14	0.21	0.23	0.00	0.71	0.71	0.71	1.41	1.41	1.41	0.93	0.80	0.21
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Com'l #11	Average	5.20	4.70	4.96	4.15	7.00	12.50	21.50	31.00	47.50	63.50	25.25	9.57	16.10
	Std Dev	0.14	0.14	0.16	0.21	0.00	0.71	0.71	0.00	2.12	0.71	0.35	0.44	0.71
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
Com'l #11	Average	5.55	4.55	4.82	4.75	8.00	14.00	24.00	36.00	50.00	62.50	28.09	8.36	14.65
	Std Dev	0.21	0.07	0.09	0.21	0.00	0.00	1.41	2.83	4.24	6.36	1.06	0.17	1.06
	Count	2	2	2	2	2	2	2	2	2	2	2	2	2
CSM #2	Average	5.34	4.61	4.87	5.76	9.00	17.11	31.33	45.00	58.33	70.89	33.48	7.09	13.84
	Std Dev	0.32	0.33	0.36	0.37	0.71	1.27	2.40	2.96	2.60	2.57	1.69	0.35	0.42
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
CSM #2	Average	5.58	4.74	5.02	6.14	9.90	16.10	25.20	35.70	50.80	65.80	32.33	7.56	14.47
	Std Dev	0.23	0.36	0.40	0.29	0.57	0.99	1.03	1.16	1.48	2.04	1.30	0.52	0.44
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
CSM #2	Average	5.39	4.61	4.87	6.53	10.50	17.58	29.73	41.92	56.46	72.62	35.24	6.76	14.32
	Std Dev	0.25	0.26	0.29	0.79	0.99	1.42	2.41	3.12	3.67	4.10	2.79	0.47	0.57
	Count	26	26	26	26	26	26	26	26	26	26	26	26	26
CSM #2	Average	5.26	4.45	4.69	5.30	8.53	13.93	21.73	30.60	44.40	60.40	28.25	8.11	13.69
	Std Dev	0.19	0.16	0.17	0.32	0.52	0.80	1.62	2.67	3.79	4.34	1.41	0.47	0.56
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
CSM #2	Average	5.29	4.58	4.83	5.42	8.75	15.00	24.38	35.63	52.00	67.56	30.11	7.82	14.28
	Std Dev	0.32	0.28	0.31	0.28	0.58	0.52	1.02	1.75	2.80	3.83	1.09	0.55	0.82
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Com'l #10	Average	5.36	4.60	4.86	3.34	5.40	11.20	22.20	33.60	46.20	55.20	22.69	10.46	14.18
	Std Dev	0.29	0.19	0.21	0.54	0.55	0.84	0.84	1.52	2.59	1.64	1.70	0.67	0.48
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Com'l #11	Average	5.03	4.78	5.03	4.08	6.50	11.50	19.75	30.50	45.50	61.00	24.12	10.18	14.63
	Std Dev	0.10	0.15	0.16	0.69	0.58	0.58	0.50	1.29	1.91	3.37	1.37	0.70	0.42
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Com'l #11	Average	5.70	4.92	5.22	4.04	6.60	12.40	22.80	35.40	49.40	62.40	25.39	10.02	14.52
	Std Dev	0.22	0.11	0.13	0.30	0.55	0.55	0.84	1.67	2.07	1.82	1.14	0.52	0.41
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
CSM #2	Average	5.44	4.69	4.96	5.17	7.35	15.30	31.50	45.45	58.40	71.20	31.07	7.79	14.15
	Std Dev	0.26	0.27	0.30	0.54	0.75	1.03	1.54	1.64	1.50	1.47	1.59	0.68	0.58
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
CSM #2	Average	5.47	4.56	4.83	5.16	7.57	14.36	24.86	36.14	51.07	66.86	28.86	8.16	14.48
	Std Dev	0.29	0.30	0.33	0.37	0.65	0.93	1.79	2.60	2.37	2.63	1.31	0.60	0.34
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
CSM #2	Average	5.48	4.58	4.84	5.71	8.34	15.59	28.97	41.56	55.81	73.03	31.89	7.41	14.58
	Std Dev	0.25	0.25	0.27	0.56	0.79	1.24	2.10	2.93	3.12	2.97	2.20	0.48	0.58
	Count	32	32	32	32	32	32	32	32	32	32	32	32	32
CSM #2	Average	5.15	4.43	4.67	4.35	6.60	12.13	21.07	31.00	44.93	61.87	25.02	9.11	13.65
	Std Dev	0.27	0.23	0.25	0.37	0.51	0.83	1.75	2.90	3.86	4.87	1.53	0.44	0.62
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
CSM #2	Average	5.41	4.56	4.82	4.98	7.29	13.88	24.41	36.24	52.76	69.65	28.33	8.29	14.54
	Std Dev	0.24	0.27	0.30	0.24	0.47	0.70	1.00	1.71	2.44	3.41	0.88	0.47	0.80
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
CSM #2	Average	5.81	4.94	5.24	5.65	9.00	15.13	24.56	35.75	51.63	65.56	30.65	8.33	14.27
	Std Dev	0.21	0.17	0.19	0.21	0.37	0.50	0.81	1.13	1.54	2.03	0.71	0.37	0.33
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
Bauerly #4	Average	5.54	4.84	5.12	7.04	11.40	23.60	41.20	51.80	60.40	70.00	40.91	6.10	14.34
	Std Dev	0.23	0.13	0.15	0.44	0.55	1.34	2.28	2.68	2.79	3.32	1.74	0.17	0.83
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
Bauerly #4	Average	4.79	4.27	4.48	5.49	9.33	18.22	30.56	41.78	55.11	71.00	33.09	6.60	14.73
	Std Dev	0.18	0.23	0.25	0.28	0.50	0.83	1.42	1.99	2.80	2.45	1.21	0.38	0.57
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Bauerly #4	Average	5.18	4.63	4.89	5.50	9.33	18.83	34.17	45.83	56.17	67.50	34.10	6.98	14.02
	Std Dev	0.35	0.42	0.46	0.44	1.03	1.72	2.99	3.97	4.62	4.42	2.75	0.30	0.91
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Bit Rdwys #2	Average	5.58	4.50	4.77	5.64	8.50	17.00	30.13	40.50	51.63	65.75	32.06	7.26	14.51
	Std Dev	0.31	0.24	0.27	0.49	0.93	1.31	2.70	3.96	4.53	4.98	1.89	0.54	0.82
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
Bit Rdwys #2	Average	5.76	4.76	5.05	4.49	7.33	15.07	27.27	36.67	48.40	66.07	28.11	8.77	14.64
	Std Dev	0.29	0.29	0.32	0.45	0.62	1.39	2.60	3.52	4.12	5.43	1.70	0.63	0.74
	Count	15	15	15	15	15	15	15	15	15	15	15	15	15
Bit Rdwys #2	Average	5.30	4.47	4.72	5.05	7.50	15.50	29.50	40.83	50.50	62.17	29.89	7.69	14.35
	Std Dev	0.25	0.24	0.27	0.43	0.55	0.55	2.07	2.71	3.02	2.48	1.33	0.26	0.61
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Bit Rdwys #2	Average	5.22	4.42	4.66	5.07	8.38	14.38	20.85	28.69	41.69	63.77	27.61	8.23	14.91
	Std Dev	0.22	0.32	0.35	0.39	0.65	0.65	1.34	1.49	2.06	3.92	0.95	0.76	0.66
	Count	13	13	13	13	13	13	13	13	13	13	13	13	13

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
CSM #2	Average	5.93	5.00	5.31	4.97	7.52	13.83	24.26	35.96	51.91	67.26	28.30	9.16	14.45
	Std Dev	0.27	0.27	0.30	0.39	0.90	1.07	1.05	1.30	1.78	2.58	1.57	0.61	0.41
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
Bauerly #4	Average	5.41	4.94	5.22	6.05	10.36	21.29	41.36	52.57	60.93	70.71	38.13	6.68	14.26
	Std Dev	0.18	0.19	0.21	0.41	0.74	2.40	3.00	2.50	2.27	2.20	2.27	0.43	0.70
	Count	14	14	14	14	14	14	14	14	14	14	14	14	14
Bauerly #4	Average	4.95	4.43	4.66	5.21	8.80	17.20	30.50	41.90	54.30	70.20	31.97	7.13	14.45
	Std Dev	0.22	0.22	0.24	0.53	0.92	1.55	2.27	2.69	3.02	3.49	2.43	0.56	0.60
	Count	10	10	10	10	10	10	10	10	10	10	10	10	10
Bauerly #4	Average	5.33	4.94	5.22	4.83	7.89	16.67	32.89	44.78	54.56	65.22	31.14	8.19	14.23
	Std Dev	0.23	0.36	0.39	0.50	0.78	1.58	2.47	3.07	3.54	3.60	2.46	0.60	0.66
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Bit Rdwys #2	Average	5.44	4.61	4.83	4.65	6.80	13.51	24.68	33.19	42.41	54.24	24.63	7.62	12.67
	Std Dev	2.01	1.94	1.94	1.92	2.15	4.50	9.72	13.93	18.33	24.19	9.60	2.43	4.35
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
Bit Rdwys #2	Average	5.76	4.84	5.13	3.60	6.20	13.80	26.10	35.50	46.85	63.75	25.26	9.92	14.43
	Std Dev	0.31	0.29	0.32	0.50	0.70	0.95	2.38	3.12	3.69	4.25	1.79	0.75	0.68
	Count	20	20	20	20	20	20	20	20	20	20	20	20	20
Bit Rdwys #2	Average	5.28	4.53	4.79	4.03	6.00	13.67	28.17	39.17	48.83	60.00	26.38	8.86	14.27
	Std Dev	0.25	0.20	0.22	0.44	0.63	1.21	2.48	3.49	3.76	3.85	1.94	0.60	0.73
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Bit Rdwys #2	Average	5.39	4.51	4.76	4.16	7.12	13.29	20.59	28.12	41.24	62.65	24.96	9.31	14.46
	Std Dev	0.25	0.33	0.36	0.44	0.60	0.69	1.66	2.12	2.95	4.01	1.45	0.74	0.53
	Count	17	17	17	17	17	17	17	17	17	17	17	17	17

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Bit Rdwys #2	Average	6.16	5.71	6.09	9.11	11.43	12.86	14.00	15.00	18.14	29.29	31.77	9.49	17.17
	Std Dev	0.13	0.13	0.15	1.37	1.72	1.68	1.83	1.83	2.12	2.43	4.20	1.35	1.63
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Bit Rdwys #2	Average	5.80	4.72	5.01	5.75	8.83	18.50	33.83	44.83	55.83	70.17	34.01	7.18	14.37
	Std Dev	0.23	0.27	0.30	0.42	0.41	0.55	1.17	1.33	1.17	1.83	1.02	0.58	0.82
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
McNamara	Average	5.13	4.47	4.71	4.70	7.33	13.67	23.67	34.33	49.67	65.00	27.37	8.39	15.50
	Std Dev	0.21	0.15	0.17	0.26	0.58	0.58	1.15	2.31	4.73	6.56	0.87	0.45	1.77
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
McNamara	Average	5.79	4.98	5.28	5.42	8.33	14.67	25.33	37.44	53.89	69.00	30.15	8.55	15.60
	Std Dev	0.23	0.31	0.34	0.38	0.50	1.00	1.41	2.65	4.04	3.67	1.68	0.63	0.55
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
McNamara	Average	5.93	5.07	5.39	5.47	7.00	14.00	29.00	42.67	55.67	68.33	30.21	8.68	15.03
	Std Dev	0.06	0.06	0.06	0.25	0.00	0.00	1.00	1.53	2.31	2.89	0.36	0.19	0.45
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Midwest #1	Average	6.37	5.23	5.59	5.68	10.00	21.00	37.33	48.83	60.50	76.67	36.48	7.48	15.82
	Std Dev	0.16	0.27	0.30	0.57	0.89	1.10	2.07	2.14	1.87	1.21	1.90	0.62	0.90
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Midwest #1	Average	6.18	5.10	5.44	5.90	9.44	20.33	36.56	48.22	58.67	70.33	35.94	7.38	14.67
	Std Dev	0.18	0.18	0.20	0.58	0.73	1.12	1.94	1.86	1.58	2.40	1.82	0.42	0.81
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Midwest #1	Average	5.92	4.84	5.14	5.86	9.20	20.40	37.20	48.60	58.80	70.00	35.86	6.99	14.48
	Std Dev	0.11	0.15	0.16	0.36	0.45	0.55	0.45	1.14	1.48	1.58	0.89	0.30	0.61
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
Bit Rdwys #2	Average	6.24	5.73	6.11	8.49	10.71	12.57	13.57	15.00	17.86	28.29	30.16	10.06	17.13
	Std Dev	0.28	0.29	0.33	1.20	1.70	1.90	2.30	2.31	2.19	2.21	4.10	1.69	1.36
	Count	7	7	7	7	7	7	7	7	7	7	7	7	7
Bit Rdwys #2	Average	6.04	4.91	5.23	4.88	7.88	17.00	33.50	44.88	56.50	71.25	31.59	8.08	14.35
	Std Dev	0.34	0.32	0.36	0.56	0.64	0.76	2.07	2.23	2.27	2.66	1.36	0.67	0.85
	Count	8	8	8	8	8	8	8	8	8	8	8	8	8
McNamara	Average	5.20	4.43	4.68	4.38	6.67	12.17	22.00	34.17	49.17	64.00	25.72	8.86	14.68
	Std Dev	0.21	0.25	0.27	0.25	0.52	0.75	1.26	1.83	2.64	4.00	1.30	0.51	1.12
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
McNamara	Average	5.54	4.71	4.99	4.95	7.25	12.88	23.19	36.44	52.56	68.00	27.76	8.78	14.98
	Std Dev	0.21	0.21	0.23	0.51	0.68	0.89	1.17	1.41	1.90	2.73	1.64	0.69	0.62
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16
McNamara	Average	5.82	5.10	5.42	4.88	6.33	11.67	26.67	41.50	54.83	67.17	27.70	9.52	15.00
	Std Dev	0.12	0.14	0.16	0.12	0.52	0.52	0.52	1.22	0.75	1.17	0.33	0.36	0.23
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Midwest #1	Average	6.10	5.30	5.64	4.20	8.44	18.56	35.11	48.11	59.44	74.89	31.99	8.61	15.82
	Std Dev	0.14	0.21	0.22	0.40	1.01	1.24	1.96	2.15	1.59	1.54	1.62	0.58	0.61
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Midwest #1	Average	6.01	5.17	5.50	4.14	7.28	17.33	34.50	47.00	57.44	68.89	30.45	8.82	15.01
	Std Dev	0.17	0.20	0.21	0.51	0.67	0.91	1.42	1.78	1.69	1.81	1.31	0.54	0.51
	Count	18	18	18	18	18	18	18	18	18	18	18	18	18
Midwest #1	Average	5.80	4.95	5.25	4.41	7.83	17.92	34.58	47.08	57.83	70.17	31.45	8.16	14.79
	Std Dev	0.10	0.20	0.21	0.44	0.72	0.90	1.62	1.73	1.40	2.12	1.40	0.68	0.50
	Count	12	12	12	12	12	12	12	12	12	12	12	12	12

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Tower	Average	5.38	4.45	4.70	6.80	9.50	14.75	23.75	33.00	48.00	71.25	30.95	7.40	14.75
	Std Dev	0.21	0.19	0.21	0.26	0.58	0.96	1.71	1.63	1.63	1.26	1.39	0.08	0.72
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Tower	Average	5.20	4.52	4.77	5.92	8.89	15.67	26.33	36.00	50.00	70.89	30.27	7.68	15.54
	Std Dev	0.25	0.30	0.32	0.53	0.60	1.22	2.29	2.65	3.00	3.89	1.35	0.45	0.83
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
Tower	Average	5.81	5.21	5.53	6.15	10.13	22.30	39.52	51.48	61.43	71.57	37.38	7.21	16.08
	Std Dev	0.26	0.28	0.31	0.37	0.63	1.02	1.81	2.17	2.57	2.89	1.62	0.34	0.52
	Count	23	23	23	23	23	23	23	23	23	23	23	23	23
Tower	Average	5.42	4.79	5.07	6.85	11.00	21.84	37.42	48.95	61.05	75.79	39.23	6.30	15.28
	Std Dev	0.22	0.23	0.25	0.27	0.47	0.90	1.61	2.30	2.59	3.17	1.25	0.28	0.64
	Count	19	19	19	19	19	19	19	19	19	19	19	19	19
Tower	Average	5.27	4.63	4.89	6.37	10.00	20.00	34.67	45.67	57.33	72.33	36.43	6.54	14.37
	Std Dev	0.25	0.29	0.32	0.86	1.00	1.00	1.53	3.06	4.16	4.04	1.98	0.39	1.42
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
Tower	Average	5.70	4.90	5.20	6.07	8.67	12.00	18.33	26.00	38.33	60.33	26.65	9.55	15.53
	Std Dev	0.17	0.17	0.19	0.68	0.58	1.00	2.31	4.36	5.86	7.51	2.14	1.07	0.75
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
RiverCity #3	Average	5.83	5.08	5.39	4.85	7.00	13.75	24.75	39.50	50.25	61.50	27.95	9.47	15.28
	Std Dev	0.22	0.17	0.18	0.31	0.82	3.77	7.27	4.43	3.40	3.11	3.43	0.86	0.46
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
RiverCity #3	Average	5.52	4.51	4.78	5.18	7.63	14.81	28.00	40.13	51.13	64.31	29.76	7.89	13.96
	Std Dev	0.42	0.44	0.49	0.64	0.89	1.42	2.31	2.33	3.07	2.96	2.50	1.21	0.71
	Count	16	16	16	16	16	16	16	16	16	16	16	16	16

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE #200	#100	#50	#30	#16	#8	#4	SA (SF/Lb)	AFT (Microns)	VMA
Tower	Average	5.43	4.48	4.73	5.63	8.25	13.75	21.75	32.00	47.25	72.00	27.78	8.31	14.60
	Std Dev	0.26	0.17	0.19	0.43	0.96	0.96	2.06	2.31	3.20	3.56	2.05	0.37	0.36
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
Tower	Average	5.29	4.64	4.90	5.52	8.39	15.06	24.89	35.00	48.67	69.78	28.85	8.30	15.05
	Std Dev	0.28	0.24	0.26	0.50	0.61	1.00	1.60	2.03	2.22	2.84	1.36	0.59	0.60
	Count	18	18	18	18	18	18	18	18	18	18	18	18	18
Tower	Average	5.67	5.29	5.61	5.75	9.62	22.18	39.13	50.87	60.95	71.03	36.28	7.53	16.01
	Std Dev	0.19	0.22	0.23	0.35	0.63	1.00	1.52	1.76	1.92	2.31	1.41	0.37	0.45
	Count	39	39	39	39	39	39	39	39	39	39	39	39	39
Tower	Average	5.44	4.90	5.18	6.30	10.33	21.48	36.25	48.03	59.90	74.35	37.52	6.73	15.31
	Std Dev	0.17	0.14	0.16	0.29	0.47	0.64	1.32	1.86	2.15	2.38	1.04	0.26	0.47
	Count	40	40	40	40	40	40	40	40	40	40	40	40	40
Tower	Average	5.30	4.72	4.98	5.82	9.33	19.50	33.50	44.17	55.83	70.17	34.62	7.02	14.25
	Std Dev	0.23	0.19	0.21	0.58	1.03	1.05	1.87	2.71	3.43	4.40	2.00	0.37	0.64
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
Tower	Average	5.57	4.80	5.08	5.81	8.18	12.73	19.09	27.18	40.82	64.09	26.54	9.35	15.42
	Std Dev	0.21	0.13	0.14	0.30	0.60	0.79	1.22	2.04	3.06	4.44	1.17	0.59	0.50
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11
RiverCity #3	Average	5.90	5.18	5.51	4.57	6.67	13.33	24.33	39.67	50.67	62.50	27.16	10.00	14.97
	Std Dev	0.37	0.24	0.27	0.39	0.82	3.67	6.25	3.61	2.73	3.08	3.20	1.40	0.64
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
RiverCity #3	Average	5.56	4.72	5.00	4.39	6.60	13.83	28.07	40.90	52.33	65.10	27.73	8.81	14.44
	Std Dev	0.35	0.37	0.41	0.37	0.72	1.05	1.86	2.20	2.72	2.92	1.55	0.95	0.61
	Count	30	30	30	30	30	30	30	30	30	30	30	30	30

2004 ASPHALT FILM THICKNESS STUDY

Mn/DOT Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
RiverCity #3	Average	5.80	4.30	4.57	4.83	8.00	13.67	22.00	31.00	47.00	72.33	27.52	8.13	15.50
	Std Dev	0.35	0.36	0.40	0.42	1.00	1.53	2.00	2.00	2.00	1.53	2.24	1.12	0.56
	Count	3	3	3	3	3	3	3	3	3	3	3	3	3
RiverCity #3	Average	5.93	4.55	4.84	5.37	8.17	14.83	22.17	31.33	47.00	72.50	28.88	8.22	15.02
	Std Dev	0.15	0.14	0.15	0.75	1.33	1.17	1.17	1.37	1.90	3.27	2.46	0.92	0.88
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
RiverCity #3	Average	5.83	4.90	5.20	4.75	7.75	15.75	30.75	43.50	56.75	72.25	30.48	8.31	14.90
	Std Dev	0.29	0.26	0.29	0.30	0.50	0.50	1.26	2.65	2.87	3.77	1.04	0.28	0.55
	Count	4	4	4	4	4	4	4	4	4	4	4	4	4
RiverCity #3	Average	5.50	5.02	5.31	5.68	10.08	19.58	30.73	40.46	54.23	75.27	34.22	7.58	16.08
	Std Dev	0.20	0.31	0.33	0.46	0.80	1.30	1.80	2.00	1.88	3.28	1.70	0.70	0.64
	Count	26	26	26	26	26	26	26	26	26	26	26	26	26
RiverCity #3	Average	5.93	5.42	5.76	5.60	8.17	19.50	35.83	47.67	57.67	68.33	34.21	8.21	16.18
	Std Dev	0.26	0.29	0.33	0.85	0.75	2.07	2.93	2.58	3.39	3.50	2.32	0.35	0.44
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
RiverCity #3	Average	5.67	5.15	5.46	5.25	8.09	18.36	34.45	47.00	58.27	70.73	33.09	8.03	15.94
	Std Dev	0.33	0.39	0.43	0.38	0.54	1.57	2.62	3.49	4.24	4.45	1.99	0.47	0.80
	Count	11	11	11	11	11	11	11	11	11	11	11	11	11

2004 ASPHALT FILM THICKNESS STUDY

Contractor Test Data

(Based on Production Data)

State Project		TOTAL AC	AC_{eff} (By Mix)	AC_{eff} (By Agg)	PERCENTAGE PASSING SIEVE							SA (SF/Lb)	AFT (Microns)	VMA
					#200	#100	#50	#30	#16	#8	#4			
RiverCity #3	Average	5.88	4.58	4.87	4.40	7.17	13.00	21.00	30.83	46.50	71.83	25.94	9.19	14.95
	Std Dev	0.24	0.15	0.17	0.36	0.98	1.55	1.55	1.47	1.22	1.83	1.90	0.84	0.53
	Count	6	6	6	6	6	6	6	6	6	6	6	6	6
RiverCity #3	Average	5.78	4.61	4.89	4.48	7.22	13.33	20.67	29.89	44.44	68.89	25.94	9.24	14.90
	Std Dev	0.25	0.19	0.21	0.75	0.97	0.87	0.87	0.78	1.67	2.37	2.15	0.78	0.69
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
RiverCity #3	Average	5.70	4.90	5.20	3.88	6.40	14.80	30.00	44.00	57.20	72.60	27.95	9.06	14.60
	Std Dev	0.16	0.19	0.20	0.29	0.55	0.45	0.71	1.22	1.30	1.67	0.75	0.50	0.41
	Count	5	5	5	5	5	5	5	5	5	5	5	5	5
RiverCity #3	Average	5.61	5.15	5.46	4.94	8.81	17.73	29.17	39.65	53.88	74.79	31.41	8.48	16.08
	Std Dev	0.22	0.36	0.39	0.34	0.73	1.36	1.88	1.88	1.73	2.74	1.52	0.75	0.71
	Count	48	48	48	48	48	48	48	48	48	48	48	48	48
RiverCity #3	Average	5.78	5.50	5.84	4.81	7.33	18.33	34.33	46.44	55.00	65.33	31.63	9.01	15.99
	Std Dev	0.22	0.28	0.31	0.28	0.50	2.45	3.35	2.55	2.55	2.92	1.98	0.62	0.43
	Count	9	9	9	9	9	9	9	9	9	9	9	9	9
RiverCity #3	Average	5.68	5.24	5.56	4.96	7.56	17.67	33.67	46.72	57.83	69.83	31.92	8.50	16.01
	Std Dev	0.33	0.34	0.37	0.18	0.62	1.85	2.33	2.08	2.23	2.48	1.52	0.62	0.73
	Count	18	18	18	18	18	18	18	18	18	18	18	18	18

Note: Additional data provided by MnDOT was used in the main body of this report. That data is about comparisons of agency and contractor cores and tests on split samples. The amount of data is quite large and, as such, the detailed data is not included in an appendix. The report authors can be contacted if interested.

APPENDIX E
Code of Federal Regulations (CFR): 23 CFR 637

"Construction Inspection and Approval"
"Subpart B: Quality Assurance Procedures for Construction"

637.201 Purpose.

To prescribe policies, procedures, and guidelines to assure the quality of materials and construction in all Federal-aid highway projects on the National Highway System.

637.203 Definitions.

Acceptance program. All factors that comprise the State transportation department's (STD) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

Independent assurance program. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program which are performed in the STD's central laboratory would not be covered by an independent assurance program.

Proficiency samples. Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

Qualified laboratories. Laboratories that are capable as defined by appropriate programs established by each STD. As a minimum, the qualification program shall include provisions for checking test equipment and the laboratory shall keep records of calibration checks.

Qualified sampling and testing personnel. Personnel who are capable as defined by appropriate programs established by each STD.

Quality assurance. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

Quality control. All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements.

Random sample. A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen.

Vendor. A supplier of project-produced material that is not the contractor.

Verification sampling and testing. Sampling and testing performed to validate the quality of the product.

637.205 Policy.

(a) *Quality assurance program.* Each STD shall develop a quality assurance program which will assure that the materials and workmanship incorporated into each Federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in §637.207 and be approved by the FHWA.

(b) *STD capabilities.* The STD shall maintain an adequate, qualified staff to administer its quality assurance program. The State shall also maintain a central laboratory. The State's central laboratory shall meet the requirements in §637.209(a)(2).

(c) *Independent assurance program.* Independent assurance samples and tests or other procedures shall be performed by qualified sampling and testing personnel employed by the STD or its designated agent.

(d) *Verification sampling and testing.* The verification sampling and testing are to be performed by qualified testing personnel employed by the STD or its designated agent, excluding the contractor and vendor.

(e) *Random samples.* All samples used for quality control and verification sampling and testing shall be random samples.

637.207 Quality assurance program.

(a) Each STD's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of the following:

(1) Acceptance program.

(i) Each STD's acceptance program shall consist of the following:

(A) Frequency guide schedules for verification sampling and testing which will give general guidance to personnel responsible for the program and allow adaptation to specific project conditions and needs.

(B) Identification of the specific location in the construction or production operation at which verification sampling and testing is to be accomplished.

(C) Identification of the specific attributes to be inspected which reflect the quality of the finished product.

(ii) Quality control sampling and testing results may be used as part of the acceptance decision provided that:

(A) The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.

(B) The quality of the material has been validated by the verification sampling and testing. The verification testing shall be performed on samples that are taken independently of the quality control samples.

(C) The quality control sampling and testing is evaluated by an IA program.

(iii) If the results from the quality control sampling and testing are used in the acceptance program, the STD shall establish a dispute resolution system. The dispute resolution system shall address the resolution of discrepancies occurring between the verification sampling and testing and the quality control sampling and testing. The dispute resolution system may be administered entirely within the STD.

(iv) In the case of a design-build project on the National Highway System, warranties may be used where appropriate. See 23 CFR 635.413(e) for specific requirements.

(2) The IA program shall evaluate the qualified sampling and testing personnel and the testing equipment. The program shall cover sampling procedures, testing procedures, and testing equipment. Each IA program shall include a schedule of frequency for IA evaluation. The schedule may be established based on either a project basis or a system basis. The frequency can be based on either a unit of production or on a unit of time.

(i) The testing equipment shall be evaluated by using one or more of the following: Calibration checks, split samples, or proficiency samples.

(ii) Testing personnel shall be evaluated by observations and split samples or proficiency samples.

(iii) A prompt comparison and documentation shall be made of test results obtained by the tester being evaluated and the IA tester. The STD shall develop guidelines including tolerance limits for the comparison of test results.

(iv) If the STD uses the system approach to the IA program, the STD shall provide an annual report to the FHWA summarizing the results of the IA program.

(3) The preparation of a materials certification, conforming in substance to Appendix A of this subpart, shall be submitted to the FHWA Division Administrator for each construction project which is subject to FHWA construction oversight activities.

(b) In the case of a design-build project funded under title 23, U.S. Code, the STD's quality assurance program should consider the specific contractual needs of the design-build project. All provisions of paragraph (a) of this section are applicable to design-build projects. In addition, the quality assurance program may include the following:

(1) Reliance on a combination of contractual provisions and acceptance methods;

(2) Reliance on quality control sampling and testing as part of the acceptance decision, provided that adequate verification of the design-builder's quality control sampling and testing is performed to ensure that the design-builder is providing the quality of materials and construction required by the contract documents.

(3) Contractual provisions which require the operation of the completed facility for a specific time period.

[60 FR 33717, June 29, 1995, as amended at 67 FR 75934, Dec. 10, 2002]

637.209 Laboratory and sampling and testing personnel qualifications.

(a) Laboratories.

(1) After June 29, 2000, all contractor, vendor, and STD testing used in the acceptance decision shall be performed by qualified laboratories.

(2) After June 30, 1997, each STD shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(3) After June 29, 2000, any non-STD designated laboratory which performs IA sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(4) After June 29, 2000, any non-STD laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

(5) After September 24, 2009, laboratories that perform crash testing for acceptance of roadside hardware by the FHWA shall be accredited by a laboratory accreditation body that is recognized by the National Cooperation for Laboratory Accreditation (NACLA), is a signatory to the Asia Pacific Laboratory Accreditation Cooperation (APLAC) Mutual

Recognition Arrangement (MRA), is a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA), or another accreditation body acceptable to FHWA.

(b) Sampling and testing personnel. After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the IA program shall be executed by qualified sampling and testing personnel.

(c) Conflict of interest. In order to avoid an appearance of a conflict of interest, any qualified non-STD laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

[60 FR 33717, June 29, 1995, as amended at 72 FR 54212, Sept. 24, 2007]

[Source for 23 CFR 637: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=b64f282660e0a323b33aab7067e97f6f;rgn=div5;view=text;node=23%3A1.0.1.7.25;idno=23;cc=ecfr]

APPENDIX F
Terminology Associated with Precision Statements

Precision statements for various hot mix tests are of interest in this study and report. Thus, a few definitions are in order (from American Society for Testing and Materials (ASTM) C 670 and E 177):

- "The precision of a measurement process…is a generic concept related to the closeness of agreement between tests results obtained under prescribed like conditions from the measurement process being evaluated. … The greater the dispersion or scatter of the test results, the poorer the precision."
- "One-sigma limit (1S)—the fundamental statistic underlying all indexes of precision is the standard deviation of the population of measurements characteristic of the method when the latter is applied under specifically prescribed conditions (a given system of causes). The terminology 'one-sigma limit' is used in Recommended Practice E 177 to denote the estimate of the standard deviation or sigma that is characteristic of the total statistical population."
- "Single operator one-sigma limit—the one-sigma limit for single operator precision is a quantitative estimate of the variability of a large group of individual test results when the tests have been made on the same material by a single operator using the same apparatus in the same laboratory over a relatively short period of time."
- "Multi-laboratory one-sigma limit—the one-sigma limit for multi-laboratory precision is a quantitative estimate of the variability of a large group of individual test results when each test has been made to make the test portions of the material as nearly identical as possible. Under normal circumstances the estimates of one-sigma limit for multi-laboratory precision are larger than those for single operator precision, because different operators and different apparatus are being used in different laboratories for which the environment may be different."
- "Field versus laboratory tests—precision indexes for ASTM methods are normally based on results obtained in laboratories by competent operators using well-controlled equipment on test portions of materials for which precautions have been taken to assure that they are as nearly alike as possible. Such precautions and the same level of competence may not be practicable for the usual quality control or routine acceptance testing. Therefore, the normal testing variation among laboratories engaged in quality control and acceptance testing of commercial materials may be larger than indicated by the relationship derived from the one-sigma limit for multilaboratory precision. In this case it is recommended that studies be made to determine the one-sigma limit for tests made under field conditions and realistic adjustments in specification tolerances be made accordingly."

- "Two Standard Deviation Limits (2s) – Approximately 95% of *individual* test results from laboratories similar to those in an interlaboratory study can be expected to differ in absolute value from their average value by less than 1.960 s (about 2 s). [This index is known as repeatability.]"
  - "Difference Two Standard Deviation Limit (d2s) – Approximately 95% of *all pairs* of test results from laboratories similar to those in the study can be expected to differ in absolute value by less than $1.960\sqrt{2}$ s (about $2\sqrt{2}$ s) = 2.77 s (or about 2.8 s). This index is also known as the 95% limit on the difference between two test results [or reproducibility]."