Supplemental Technical Specification for **May 2, 2008**

Hot Mix Asphalt (HMA) Quality Assurance

SCDOT Designation: SC-M-400V (06/08)

1. SCOPE

Base field acceptance of hot mix asphalt (HMA) mixtures on asphalt binder content, air voids, voids in mineral aggregate (VMA), and in-place mat density of the pavement. Base decisions regarding acceptance, rejection, or acceptance at an adjusted price upon the percentage of the lot that is within the specification limits. Apply all other acceptance criteria documented in the special provisions, supplemental specifications, and sections of the Standard Specifications, except as noted herein. If unable to meet these other acceptance criteria, cease production and take steps necessary to bring the process into compliance with the acceptance criteria.

In general, the contractor performs both *quality control* and *acceptance*. The Department performs *split sample* and *verification* testing on the HMA plant samples and *acceptance* testing for roadway cores.

This specification is comprised of three sections:

- Section 3 – GENERAL **-** Describes what is required to meet the Hot Mix Asphalt (HMA) Quality Assurance (QA) Specification. This section describes requirements, frequency, sampling and testing methods, acceptance and verification, and the party responsible for each item.

- Section 4 – ACCEPTANCE OF MAINLINE PAVING - Describes what mainline production consists of (including shoulders, ramps, and acceleration/deceleration lanes), and the requirements and pay factor calculations for mainline paving on a LOT basis as described in Subsection 4.1.1 and Subsection 4.1.2.1.

- Section 5 – ACCEPTANCE OF LOW TONNAGE PAVING - Describes what low tonnage is, and the requirements and pay factor calculations associated with low tonnage paving. Low tonnage is defined as 2500 tons or less of a specific HMA mixture on a project or when the specific HMA mixture is to be used for non-mainline work, such as patching, non-uniform leveling, widening less than 8-feet, wedging and driveway paving. The pay factor calculations for non-mainline paving will be calculated on a LOT-to-LOT basis as described in Subsection 5.1.1 and Subsection 5.1.2.1.

2. REFERENCED DOCUMENTS

2.1 SCDOT Standard Specifications

2.1.1 Division 300, Division 400

2.2 SCDOT Supplemental Technical Specifications

2.2.1 SC-M-402, SC-M-404, SC-M-405, SC-M-406

2.3 AASHTO Standards

2.3.1 R 11, R 18

2.4 SCDOT Test Methods

2.4.1 SC-T-1, SC-T-2, SC-T-4, SC-T-33, SC-T-62, SC-T-65, SC-T-66, SC-T-68, SC-T-71, SC-T-72, SC-T-75, SC-T-78, SC-T-80, SC-T-83, SC-T-84, SC-T-85, SC-T-86, SC-T-87, SC-T-88, SC-T-92, SC-T-97, SC-T-101

3. GENERAL

3.1 Job Mix Formula

Combine the mineral aggregates and asphalt binder in accordance with **SC-T-80** in such proportions that the finished HMA mixture complies with all applicable requirements specified in the Standard Specifications (including any supplemental specifications) and the special provisions. When allowed by **SC-M-402**, and used in the HMA, liquid anti-stripping additives must be introduced into the mixture and controlled in the field in accordance with **SC-M-406**.

- A Surface course is defined as the following; Surface Types A, B, CM, C, D and E,
- An Intermediate course is defined as the following mix types; Intermediate Types A, B and C,
- Base mixtures are Base Types A, B, C and D,
- Open Graded Friction Course (OGFC) is also referred to in the specification.

If the HMA mixture does not meet the acceptance control limits, submit a revision to the job mix acceptance target values provided the revised job mix meets all of the requirements of the specifications. A job mix revision is only allowed between LOTS. Fax a copy of all job mix revisions to the District Asphalt Manager (**DAM**), the Asphalt Materials Engineer (**AME**), and, if appropriate, the District Materials Laboratory before starting the LOT on which the revised job mix will first be used. Attach all supporting data, including volumetric properties and gradation from previous laboratory tests, to job mix revisions. The Department will accept all revisions as submitted unless the revisions are made outside of the acceptable tolerances and specifications.

Initial job mix formulas are valid for 2 years with a maximum of 3 revisions. If additional revisions are required after the allowable 3 have been made, a new job mix formula is required. Prepare the new job mix formula in accordance with **SC-T-80** or **SC-T-88** and comply with all applicable requirements specified in the Standard Specifications (including any supplemental specifications) and the special provisions.

Job mix formulas are associated with a specific plant, which will be approved for an individual project. Therefore the start of a new project constitutes the beginning of a new set of LOT numbers. A calibration period for either a project or a job mix formula is not permitted. LOT numbers begin immediately with the production of the mixture. If during production of a particular type of mix, a new job mix formula is needed, LOTS run continuously until the project is complete.

3.2 Personnel Requirements

Provide sufficient SCDOT certified personnel trained to perform the required inspections, sampling, testing, verification, and documentation at the plant and on the roadway. A certified Level 2S HMA Technician will prepare mix designs in an SCDOT approved mix design laboratory meeting the requirements outlined in **SC-M-405**. Provide certified Level 1 HMA Technicians at each plant site used to furnish material to the project. Conduct all sampling and testing at the plant by a certified Level 1 HMA Technician or by a candidate for certification

working in the presence and under direct observation of a certified Level 1 HMA Technician. Provide certified Asphalt Roadway Technicians or candidates for certification working in the presence and under direct observation of a certified Roadway Technician to perform the necessary inspection, quality control and quality acceptance (when using a density gauge) testing and documentation on the roadway, however, the certified Level 1 or Roadway Technician is responsible for all testing and reporting. Have a certified Level 3 HMA Quality Control Manager readily available to be on site within an hour and a half, to make necessary process adjustments, make periodic visits to each active plant at a rate of no less than two times per month, review calibration and verification records as needed, be responsible for all quality control activities at each plant they oversee, and monitor mixture production, placement and testing on each project. The Contractor Level 3 QC Manager will provide insight to problems that arise during mix design and production, and therefore should be employed by the company he/she is representing. This person is the Department's primary contact should a problem develop during a project and will be held responsible for all Quality Control / Quality Acceptance testing.

Ensure that technician certifications are in accordance with the Department's HMA Technician Certification Program. Post a current organizational chart, including names, telephone numbers and current certification, of those responsible for the Quality Control program in the laboratory and provide a copy to the **DAM**. Update this chart with appropriate changes, as they become available.

The Department will provide certified Asphalt Roadway Technicians and/or certified Level 1 HMA Technicians or candidates for certification working in the presence and under direct observation of certified personnel to perform the necessary inspection, documentation and testing on either the roadway, in the plant laboratory or in the testing laboratories.

3.3 Field Laboratory Requirements

Provide a laboratory at the plant. The laboratory will be inspected annually by a representative of the **AME** in accordance with **SC-M-404** and approved annually by the **AME**.

Maintain the laboratory and calibrate and verify all equipment in accordance with **AASHTO R 18**. Maintain records of calibration and verification in the laboratory. The **AME** or a District representative will inspect measuring and testing devices to confirm both calibration and condition. If it is determined that the equipment is not within the limits of dimensions or calibration described in the appropriate test method, the **AME**'s representative may stop production until corrective action is taken. If the necessary laboratory equipment is inoperable at the time of a required acceptance test, cease HMA mixture production.

3.4 Quality Control (QC) Program

Provide to the **AME** a QC program that defines all activities, including mix design, process control inspection, sampling, testing, and necessary adjustments in the process that are related to the production and placing of an HMA pavement. At a minimum, conform the QC program to meet the entire specifications and requirements stipulated herein as well as all other acceptance criteria documented in the special provisions, supplemental specifications, and applicable sections of the Standard Specifications. Detail actions that will take place in the absence of a certified Level 3 QC Manager and what steps will take place to ensure all specifications are being met. Document any additional testing that is required by your company to ensure process control, such as obtaining additional check samples to determine whether or not the asphalt plant production shall be ceased before the next quality acceptance sample is obtained. The Department can require production to cease if procedures and requirements stated in the QC program are not followed, until such steps are taken to ensure that all QC program procedures are followed and all requirements are met.

3.5 Required Plant and Roadway QC Tests and Verifications

Perform or have performed the quality control tests specified herein.

3.5.1 Required Plant QC Tests and Verifications

Use the test methods identified in Table 1 to perform QC tests and verifications at a frequency not less than that indicated. All other acceptance criteria documented in the special provisions, supplemental specifications, and sections of the Standard Specifications, except as noted herein, still apply. If unable to meet other acceptance criteria not specifically stated in this specification, cease production and take necessary steps to bring the process into compliance with the acceptance criteria.

Table 1. Required Plant QC Tests and Verifications

Parameter	Minimum Frequency	Sampling Method	Test Method
Maximum Specific Gravity (excluding Base Courses, Surface Type E, and OGFC)	1 per SUBLOT	**SC-T-62, SC-T-101, SC-T-72**	**SC-T-83**
Mixture Gradation	1 per Odd numbered SUBLOT	**SC-T-62, SC-T-101**	**SC-T-76 or SC-T-92**
Lime Rate Verification	2 per LOT	**SC-T-71**	**SC-T-71 or SC-T-78**
Individual Aggregate Stockpile Gradation	1 per 10,000 tons (or min. of 1 per month)	**SC-T-1, SC-T-2**	**SC-T-4**

3.5.2 Required Roadway QC Verifications

Maintain an approved density gauge, on site, during all HMA placing and compaction operations and use the gauge to assist in the quality control of the compaction process. Use the proper number and type of rollers needed to obtain density as determined by **SC-T-65**. When density is used for acceptance, ensure that rollers meet the requirements in Section 401.3 of the Standard Specifications. Maintain roller pattern documentation (SCDOT Form 400.21) on site and perform new roller patterns when there is a change in underlying support, type of asphalt, thickness in mat or other elements (such as different rollers) that might affect the final density. Monitor the roller patterns, mixture placement, and mixture compaction during production on all projects except for driveways and full-depth patching. Verify and document the ambient air temperature and the HMA mix temperature at the roadway, at a frequency not less than that indicated in Table 2. The Department will verify temperatures, calculate and document both the lay down rate for each 200 tons and the cumulative lay down rate (in pounds per square yard), and verify and document the tack rate and type at frequencies not less than those indicated in Table 2.

Table 2. Required Road QC Tests and Verifications

Parameter	Minimum Frequency	Test Method	Responsible Party
Monitoring of density	Continuous	**SC-T-33** (or AME approved)	Contractor
Temperature: Ambient air	Before paving starts, then 2 per LOT	**SC-T-84**	Department
Mat	4 per LOT	**SC-T-84**	Department
Mixture Temperature Verification	4 per LOT	**SC-T-84**	Department
Calculated Lay Down Rate	1 per 200 tons	**SC-T-85**	Department
Tack Rate, Type	1 per application	**SC-T-86**	Department

3.6 Acceptance Program

Perform or have performed the acceptance tests specified herein.

3.6.1 Plant Calibration

Calibrate the plant so that the mix conforms to the job mix formula and field acceptance criteria prior to production.

3.6.2 Required Plant Acceptance Tests

Use the test methods identified in Table 3 and perform the plant acceptance tests at a frequency not less than that indicated. Carry calculations for the test results for asphalt binder content, air voids, and VMA to the thousandths (0.001) and round to the nearest hundredth (0.01). Carry calculations for the test results for gradation to the hundredths (0.01) and round to the nearest tenth (0.1) except for the No. 200 sieve and dust to asphalt ratio, and carry them to the thousandths (0.001) and round to the nearest hundredth (0.01). Carry calculations for averages to the thousandths (0.001) and round to the nearest hundredth (0.01). Round the calculations in accordance with the **AASHTO R 11** rules of rounding.

Table 3. Required Plant Acceptance Tests

Test Parameter	Typical Frequency	Sampling Method	Test Method
Asphalt Binder Content, %	1 per SUBLOT	**SC-T-101, SC-T-72** and **SC-T-62**	**SC-T-75**
Voids Analysis Air Voids, % VMA, % (excluding Base Courses, Surface Type E and OGFC)	1 per SUBLOT	**SC-T-101, SC-T-62**	**SC-T-66** and **SC-T-68**
Mixture Gradation (Base Courses, Surface Type E, and OGFC only)	1 per SUBLOT	**SC-T-101, SC-T-62**	**SC-T-76, or SC-T-92**

3.6.2.1 Asphalt Binder Content

In accordance with **SC-T-62**, obtain a mixture sample of at least 35 pounds. Separate the sample into 3 approximately equal sized samples in accordance with **SC-T-72**. The 3 samples will be identified as acceptance test sample, split test sample, and referee sample. Bag, label and store the portions of mixture for the Department's split test sample and the referee sample for later testing as required in Subsection 3.8, "Split Sample Program." Retain the split test and referee samples in a dry, protected location for a minimum of 4 production days. A production day is defined as a day that mixture is produced for Department projects. Dispose of split test samples that have not been selected by the Department for testing after 4 production days. For all split samples selected by the Department, retain the corresponding referee sample in a dry, protected location until the verification test result is available and it is determined that no referee testing will be required for the split sample.

Calibrate the ignition oven for each job mix prior to producing mix. Perform oven calibrations and verifications in accordance with **SC-T-75**. Keep all calibrations and verifications along with supporting data in a notebook readily available in the field laboratory. The **DAM** or **AME** may require re-calibration of the ignition oven if the verification test and the referee test do not compare within allowable limits.

3.6.2.2 Voids analysis

Compact the specimens in accordance with **SC-T-66**. Determine the percent air voids and VMA by **SC-T-68**. Compare the bulk specific gravity of the compacted mixture with the maximum mixture specific gravity determined by **SC-T-83** to determine the air voids. Retain compacted specimens in a dry, protected location for a minimum of 4 production days. Dispose of the compacted specimens that have not been selected by the Department after 4 production days. Use the average of a minimum of 2 maximum specific gravity specimens for each SUBLOT when computing air voids. The maximum allowable individual difference for bulk specific gravity and maximum specific gravity specimens are 0.020 and 0.018, respectively. Inform the **DAM** or **AME** immediately if specimens do not compare. Voids analysis will not apply for Base Courses, Surface Type E and OGFC.

3.6.2.3 Gradation (For Base Courses, Surface Type E and OGFC Only)

Perform gradation in accordance with **SC-T-76 or SC-T-92** for each SUBLOT for acceptance purposes for Base Courses, Surface Course Type E, and OGFC. Evaluate each SUBLOT's gradation on an individual basis for pay purposes.

3.6.3 Required In-Place Density Acceptance Tests

3.6.3.1 Intermediate Courses and Surface Courses Type A, B, and CM

Based on Table 4, the SCDOT roadway inspector will identify roadway sampling locations, observe the contractor obtaining the cores, and take possession of the cores once obtained. The Department will compute in-place density on cores obtained from the pavement for Intermediate courses, and Surface courses Type A, B, and CM. The Department will use the test method identified in Table 4 to perform the density acceptance tests at the frequency indicated.

Once the SCDOT roadway inspector has identified the coring location in accordance with SC-T-101, obtain one six-inch (6") core at each randomly selected coring location and immediately give each core to the Department's roadway inspector for marking and possession. Perform all sampling and trimming under the direct observation of an SCDOT inspector.

Provide the Department access to a full set of roadway core density testing equipment located at the HMA plant. This access may be full use of the existing equipment, or a second set of equipment that has been fully installed and calibrated as is required of the original set of equipment. The Department will test roadway cores either at the HMA plant, the Department's Central or District Laboratories, or in a HMA Verification Laboratory.

After testing, the Department will notify the Contractor, before the completion of the following LOT, of the test results and will retain the roadway cores in a dry, protected location for a minimum of 4 production days.

3.6.3.2 Base Courses, and Surface Courses Type C and D

Determine the in-place density for Base courses, and Surface Course Type C and D, by the use of an approved density gauge and procedure. Ensure that the gauge has been approved by the **AME**. Furnish and operate the gauge to determine in-place density results at a frequency not less than that indicated in Table 4. The SCDOT roadway inspector will divide each LOT into equal SUBLOTS corresponding to the number of density values to be obtained and use **SC-T-101** to determine roadway density locations. Under the direct observation of the SCDOT inspector, determine one gauge density value at each randomly selected location within each SUBLOT. Express the in-place density as a percentage of the target density. Under the direct observation of the SCDOT inspector, determine the target density from a control strip constructed in accordance with **SC-T-65**. The Department inspector will document the density readings and carry out calculations for density to the hundredths (0.01) and round to the nearest tenth (0.1) in accordance with **AASHTO R 11** rules of rounding.

Table 4. Required Roadway Acceptance Tests

<table>
<tr><th>Test Parameter</th><th colspan="2">Typical Frequency</th><th>Sampling Method</th><th>Test Method</th></tr>
<tr><td rowspan="2">In-Place Density
(% of Max. Theoretical)
Note: Requirements apply to Intermediate Courses and to Surface Courses Type A, B, and CM</td><td>Surface</td><td>1 per 2,000 foot SUBLOT</td><td rowspan="2">SC-T-101
SC-T-87</td><td rowspan="2">SC-T-87</td></tr>
<tr><td>Intermediate</td><td>1 per 1,500 foot SUBLOT</td></tr>
<tr><td>In-Place Density
(% of Target Gauge Control Strip Density)
Note: Requirements apply for Base and Surface Courses Type C and D</td><td colspan="2">10 per LOT</td><td>SC-T-101</td><td>SC-T-65</td></tr>
</table>

3.6.3.3 Surface Course Type E and Open Graded Friction Course (OGFC)

Surface Type E and OGFC will not have in place density performed. Place these mixes at the proper rate and promptly roll as indicated in the standard specifications.

3.7 Failing Samples and Plant Operations

Obtain another sample, a check sample, when a sample fails to meet the specification limits as outlined in Subsection 4.2.1.1, "Specification Limits," on any one of the following properties: asphalt binder content, air voids, VMA, or fails to meet the job mix formula requirements for gradation, and/or dust to asphalt ratio. Denote the check sample as a check sample and do not use it in calculating pay factors. Only the samples obtained at the predetermined random sample tonnage can be used for computing the daily pay factors. If however, the random sample tonnage falls within the 3-and-hold segment, obtain a sample from the first truckload produced after the 3-and-hold segment and use this sample as the pay factor sample. If no

more truckloads are needed on the project, use only the samples obtained in accordance to **SC-T-101**. Use all other samples taken between random sampling tons for informational purposes only.

Make necessary adjustments, produce 3 truckloads of mix and hold plant production until the test results are obtained from the third truckload when 2 consecutive acceptance samples fail on any one of the following properties: asphalt binder content, air voids, VMA, gradation, and/or dust to asphalt ratio. If this sample fails, discard the mixture in the silo, clean out the plant and resume production only when the mix produced meets the all job mix properties. If at the end of the day the mix still fails to meet specifications, make necessary adjustments or changes before starting the next day's production, produce 3 truckloads and hold plant production until results are obtained from the third truck load. When on 3-and-hold, do not send mix to the project until a sample meets all specification limits. This procedure may be altered when the Resident Construction Engineer (**RCE**) deems necessary.

Immediately inform the **DAM**, or the **DAM**'s appointed Departmental representative when 2 consecutive failing samples occur.

Perform at least one entire series of required plant acceptance tests on the next random sampled following a failing sample as outlined in Tables 1 and 3 for information purposes only to ensure conformity within specifications limits.

3.8 Split Test Sample Program

Department personnel may witness the Contractor quality control and acceptance sampling and testing being performed. If it is observed that the sampling or the quality control or acceptance tests are not being performed in accordance with the applicable test procedures, the Department personnel witnessing the sampling and testing will immediately notify the Contractor and the **DAM** of the observed deficiencies. The **DAM** will investigate the observed deficiencies and, if the deficiencies are not immediately corrected, the **RCE**, **DAM** or the **AME** may stop production until corrective action is taken. The Department representative will document all witnessed samples and tests. The Department representative may elect to obtain samples for testing, separate from the Contractor's sampling and testing process, to augment validation of specification compliance.

The Department will conduct its own tests to validate test results. The validation tests for asphalt binder content and maximum specific gravity will be on split test samples (see Subsection 3.6.2, "Required Plant Acceptance Tests"). The acceptance tests for in-place density will be on the cores (see Subsection 3.6.3, "Required In-Place Density Acceptance Tests"), or based on density gauge readings.

The frequency of the Department's split test samples will in general be equal to or greater than ten percent (10%) of the tests required. The Department will provide the split test sample results within 6 working days of the sample being obtained by the laboratories. Conduct at least one split test sample for asphalt binder content, gradation, in-place density, and voids analysis from the first 2 days of production. Additionally, the Department may select any or all retained samples for further testing. All split test samples testing and data analysis will be performed by or under the supervision of a Certified HMA Level 1 Technician. Inspect measuring and testing devices to confirm both calibration and condition. Calibrate and correlate all testing equipment in accordance with **AASHTO R 18**.

3.8.1 Asphalt Binder Content and Maximum Specific Gravity

For validation of quality acceptance results coming from the Contractor, the average test results for asphalt binder content and maximum specific gravity will be compared to split test samples obtained by the Department. If the differences are within the allowable differences listed in

Table 5, no further testing or analysis will be necessary and the Contractor's test values will be used in the computation of the asphalt binder content LOT pay factor.

When differences between the Contractor's and Department's test results are not within the allowable limits in Table 5, referee testing will be required. When referee testing is required, the Office of Materials and Research (**OMR**) will test the referee sample. If the original verification sample was tested in the **OMR**, then a District Materials Laboratory (**DML**) will test the referee sample. If the difference between the referee sample test result and the Contractor's initial test result is within the allowable limits in Table 5, then the initial Contractor's test result will be used in the computation. If the difference between the referee sample test result and the Contractor's initial test result is not within the allowable limits in Table 5, then the referee sample test result will be used in lieu of the Contractor's test result in the computation.

In the event comparison of the required test results is outside the allowable differences in Table 5, Department split samples fail the specification limits, or a continual trend of difference between Contractor and Department test results is identified, the **DAM** will immediately investigate. The **DAM** may suspend production while the investigation is in progress. The investigation may include testing by the Department of any remaining split samples or a comparison of split sample test results on the mixture currently being produced. The investigation may also include review and observation of the Contractor's technician's performance, testing procedure, and equipment.

Table 5. Allowable Differences Between Contractor Tests and Department Split Tests

Test Parameter		Allowable Difference
Asphalt Binder Content, %		± 0.40
Maximum Specific Gravity		± 0.035
Bulk Specific Gravity of Lab Specimens		± 0.035
Gradation (Base, Surface Type E and OGFC only)	½" and greater	± 7.0
	3/8"	± 6.0
	No. 4	± 6.0
	No. 8	± 5.0
	No. 30	± 4.0
	No. 100	± 3.0

3.8.2 In-Place Density

3.8.2.1 Intermediate Courses and Surface Courses Type A, B, and CM

All roadway densities will be determined by the Department as indicated in 3.6.3.1.

In the event that a problem with density arises, the **DAM** will immediately investigate. The **DAM** may suspend production while the investigation is in progress. The investigation may include testing by the Department of other LOTS. The investigation may also include review and observation of the Contractor's compaction techniques and equipment.

3.8.2.2 Base Courses, Surface Courses Type C and D

The Department will observe the establishment of the target density in accordance to **SC-T-65**. The Contractor, for verification of the established roller pattern, will retain a copy of Form 400.21 on the roadway and forward to the **RCE**.

All roadway densities will be determined by the Department as indicated in 3.6.3.2.

In the event that a problem with density arises, the **DAM** will immediately investigate. The **DAM** may suspend production while the investigation is in progress. The investigation may include testing by the Department of other LOTS. The investigation may also include review and observation of the Contractor's compaction techniques and equipment.

3.8.3 Voids Analysis

For the samples obtained and tested by the Department, the air voids and VMA results will be compared with the average of the Contractor's acceptance test results from the LOT from which the Department obtained the verification sample. The following procedure will be used for making the comparison:

Step 1. For each acceptance property, air voids and VMA, calculate the LOT average, X_a, and sample standard deviation, *s*, for the Contractor's acceptance test results using the equations below:

$$X_a = \frac{\sum_{1}^{n} X_i}{n} \qquad s = \sqrt{\frac{\sum_{1}^{n} (X_i - X_a)^2}{n-1}}$$

Where: *n* is the number of acceptance test results for the LOT.
X_i represents the individual contractor acceptance test results

Step 2. Calculate the difference, *D*, between the Contractor's acceptance test average, X_a, and the Department's independent verification test results, X_v, from the equation below that gives a positive value for *D*:

$D = X_a - X_v$ or $D = X_v - X_a$

Step 3. Depending upon the number of acceptance test results for the LOT, *n*, determine the allowable difference from the appropriate equation below:

If *n* = 3, $D_{allow} = 4.861 \times s$
If *n* = 4, $D_{allow} = 3.544 \times s$
If *n* = 5, $D_{allow} = 2.958 \times s$
If *n* = 6, $D_{allow} = 2.830 \times s$

Step 4. Compare the value of *D* calculated in Step 2 with the value of D_{allow} calculated in Step 3.

If in the event *D* is equal to or less than D_{allow}, no further testing or analysis will be necessary and the Contractor's test values will be used in the computation of the LOT pay factor for Air Voids.

In the event *D* is greater than D_{allow} for Air Voids, Department verification samples fail the specification limits, or a continual trend of difference between Contractor and Department test results is identified, the DAM will immediately investigate. The **DAM** may suspend production while the investigation is in progress. The investigation may include testing by the Department of additional samples, or a comparison of split sample test results on the mixture currently being produced. The investigation may also include review and observation of the Contractor's technician's performance, testing procedure, and equipment.

3.9 Verification Program

The Department's verification tests will be conducted at an SCDOT HMA Verification Laboratory, or at the OMR's Central or District Laboratories. The Department will coordinate verification testing in an effort to minimize the impact on normal quality control and acceptance testing.

Department verification tests will be compared statistically to Contractor acceptance tests following **SC-T-97,** "Method for Verification of Contractor HMA Acceptance Test Results." The Department's HMA Verification Manager will perform this comparison in conjunction with the applicable managers of the Verification Laboratories for this project and the applicable **DAM**. Because a sufficient number of samples are needed for this statistically-based verification process, the contract unit price will be paid on the monthly estimates until the verification process is complete. Projects are not considered complete until the HMA Verification Manager has all data, has performed all analyses required, and has provided the **DAM** the necessary information to complete all payment related functions.

3.10 Documentation

Document all observations, records of inspection, adjustments to the mixture, test results, QC verifications, and corrective actions. Provide legible copies of this documentation to the **RCE** within 30 calendar days of the completion of the hot mix asphalt work on the project. Maintain all permanent records unless the Department is given the permanent records during production of the mixture. Provide Department representatives full access to all QC, acceptance, and verification documentation throughout the progress of the work. Make available at all times these documents, either in paper form or viewable on a computer monitor, to the Department representatives for review.

Continue from contract to contract, charts, records, and testing frequencies for a HMA mixture produced at plant site.

4. ACCEPTANCE OF MAINLINE PAVING

Evaluate all materials used for mainline paving for acceptance by the Department's Acceptance Procedures specified herein. Utilize results from the acceptance testing when determining the acceptability of the materials. In addition, the Department will conduct testing and monitor and observe sampling and testing procedures to verify the data used for acceptance purposes. The Department's data will be compared with data from the acceptance testing program as described in Subsection 3.8, "Split Test Sample Program" and Subsection 3.9, "Verification Program." Conduct acceptance test sampling and testing on a random basis according to frequencies indicated in Subsection 3.6, "Acceptance Program." Determine all sampling tons and roadway locations randomly using **SC-T-101**. Notify the **DAM** at least one day prior to any production in order to make necessary arrangements for verification. Failure to do so could result in no payment for that given day's production.

Record all inspections and test results on approved forms and charts and keep up to date records that are available at all times to the Department during the performance of the work. Utilize only those tests designated in advance as acceptance tests in the computation of pay factors. Record test results on forms provided by the Department. The Department will prepare and distribute uniform forms for reproduction for use as required. Deliver, either by email or fax all test results necessary to calculate payment factors to the **DAM** and to the HMA Verification Manager within one hour of completion of each test, or production can be halted until results are delivered. Provide a copy of each truck ticket printout with the corresponding plant acceptance test results. Submitted test results will be considered preliminary until the LOT pay factor

worksheet, along with the needed documentation is signed and submitted for payment within 3 calendar days of completion of the LOT. If there are any issues with the results after providing them to the Department, provide a written explanation to the **DAM** and HMA Verification Manager within the 3-day period explaining why the results need changing. The **DAM**, in consultation with the **AME**, reserves the right to make the requested change or keep the results as submitted. The **DAM** may halt production until the request has been investigated and a decision made as to the disposition of the test results.

4.1 Mixture

Evaluate the HMA mixture at the plant, with respect to asphalt binder content and to the air voids and VMA of laboratory-compacted samples, on a LOT-to-LOT basis. Test the material for acceptance in accordance with the provisions of these special provisions. Reject any load or loads of mixture, which, in the opinion of the Department's certified roadway technician, are obviously contaminated, segregated, or otherwise unacceptable for use in the work.

4.1.1 Mainline production

Base the acceptance and pay factors for asphalt binder content and the volumetric properties of air voids and VMA on the percentage of the LOT that is within the specification limits based on the Quality Index calculated using the test results from the LOT. A LOT for asphalt binder content and volumetric properties is defined as a day's production with at least 3 SUBLOTS, where a SUBLOT consists of 500 tons of a particular mixture.

Therefore, in accordance to Table 3, if 4 tests are obtained from a given LOT, calculate the Quality Index on the results of four tests (n=4). However, when operational conditions are such that fewer than 4 tests are obtained from the production on a given day, follow the procedure in the next paragraph.

If the number of tests obtained from the day's production is three (n=3), compute the Quality Index from the results of the 3 tests and use the corresponding table for n=3. If insufficient tests (n=1 or n=2) are obtained from the day's production, combined these results with the next day's production SUBLOTS until at least 3 tests are obtained. If the next day's production is not within 60 days of the open SUBLOT, combine the open SUBLOT with enough tests from the previous completed LOT to yield 3 tests and calculate the Quality Index and close out the open LOT. If the last LOT on the project has only 1 or 2 tests, combine with enough tests from the previous LOT to yield 3 tests and calculate the Quality Index.

If the first SUBLOT is expected not to reach the random tonnage according to Table 1 of **SC-T-101**, then perform at least one series of Plant Quality Control and Acceptance tests for payment. Provide a random sampling tonnage for such low-production days to the **DAM** prior to production. If production continues, refer to Table 1 of **SC-T-101** for sampling tonnage for the second and following SUBLOTS of the mixture.

4.1.2 In-Place Density

For mainline paving (including shoulders, ramps, and acceleration/deceleration lanes), apply in-place density pay factors as specified herein unless otherwise noted on the plans. The Department's Certified Roadway Technician is responsible for determining the random core locations and providing the information to the contractor for each SUBLOT in accordance to **SC-T-101** once compaction has been completed.

4.1.2.1 Intermediate Courses and Surface Courses Type A, B and CM

Evaluate the in-place density for Intermediate courses and Surface courses Type A, B and CM on a LOT-to-LOT basis, where a LOT is defined as a day's production with at least 3 plant acceptance SUBLOTS. Therefore, if less than 3 plant SUBLOTS are performed for a given day,

combine the roadway cores taken from the first day with the following day(s) until at least 3 plant acceptance SUBLOTS are completed.

In the event that less than 3 roadway cores are obtained, but 3 plant acceptance SUBLOTS are complete, use the entire length of the represented LOT to establish the remaining core(s) to close the LOT.

Express the in-place density as a percentage of the theoretical maximum mix density. Calculate the theoretical maximum density from the maximum specific gravity as determined by **SC-T-83**. Determine the maximum specific gravity by averaging the maximum specific gravity results of the entire LOT. Carry calculations for density to the hundredths (0.01) and round to the nearest tenth (0.1) in accordance with **AASHTO R 11** rules of rounding.

4.1.2.2 Base Courses and Surface Courses Type C and D

Evaluate Base Courses and Surface Courses Type C and D on a LOT-to-LOT basis. Compute the in-place density by comparing density values determined by the use of an approved density gauge to the target density established on control strips constructed in accordance with **SC-T-65**. Construct a control strip at the beginning of work. Construct additional control strips when a change is made in the type or source of materials or compaction equipment, or whenever a significant change occurs in the composition of the underlying pavement structure or the composition of the material being placed from the same source.

4.1.2.3 Surface Course Type E and Open Graded Friction Course

Surface Course Type E and OGFC will not have to have in place density performed. Place these mixtures at the proper rate and promptly roll as required by the standard specifications.

4.2 Acceptance Plan

It is the intent of these specifications that each LOT meets specification requirements at the time of initial evaluation. No re-sampling or re-testing (other than referee testing described in Subsection 3.8, “Split Testing Sample Program”) will be allowed.

Adjust the payment for each LOT on the basis of acceptance test results in accordance with the requirements of these specifications. Keep accurate records of the tonnage of HMA in each LOT. Determine pay factors as indicated below.

4.2.1 Determination of Pay Factor for Mainline Paving

For mainline LOTS, determine pay factors for asphalt binder content, air voids, VMA, and in-place density for Intermediate courses, and Surface Courses Type A, B and CM, based on the estimated PWL determined from the Quality Index and Tables 11 through 19. The Quality Index uses both the average and standard deviation within each LOT to estimate the percentage of the LOT within the specification limits. Remove and replace all material in the LOT that has a TPWL of 20 or less for any one acceptance characteristic, or has a TPWL of 40 or less for any 2 acceptance characteristics, or has a TPWL of 60 or less for any 3 or more acceptance characteristics. For material with a TPWL greater than 60, compute the unit bid price in accordance with Subsection 4.2.1.3, “Pay Factors.”

Base the pay factor for in-place density for Base Courses and Surface Courses Type C and D on the percent of the established target density. Compute the pay factor for in-place density and the unit bid price in accordance with Subsection 4.2.1.3, “Pay Factors.”

Compute only binder content and gradation pay factors for Surface Course Type E and OGFC.

4.2.1.1 Specification Limits

Calculate the specification limits for mixture properties from the allowable tolerances from the job mix formula (JMF) shown in Table 6.

Table 6. Allowable Tolerances from the Job Mix Formula for Mixture Properties

Characteristic	Surface Tolerance	Intermediate Tolerance	Base Tolerance
Asphalt Binder Content, %	0.36	0.43	0.50
Air Voids, %	1.15		---
VMA, %	1.15		---

Compute the specification limits for mixture properties using the tolerances from Table 6 and the following equations:

$$USL = JMF + Tolerance$$

$$LSL = JMF - Tolerance$$

Where:

USL = Upper Specification Limit
LSL = Lower Specification Limit
JMF = Job Mix Formula Target Value
Tolerance = Allowable Tolerance from Table 6.

The in-place mat density specification limits are shown in Table 7.

Table 7. Specification Limits for In-Place Density

	Intermediate Courses and Surface Type A, B and CM			Base Courses and Surface Type C and D		
% of Theoretical Maximum Density	**LSL**	**Target**	**USL**	**LSL**	**Target**	**USL**
* Interstate and Multi-Lift Paving	92.2	94.0	96.0	—	—	—
All Other Paving	91.2	93.0	96.0	—	—	—
% of Control Strip Target Density	—	—	—	98	100	102

* Multi-lift Paving is defined as HMA paving that requires more than one lift of HMA to be placed on any portion of the roadway and applies to all lifts if any portion of the roadway is considered to be multi-lift. However, if only a single lift is to be placed over *non-mainline work* as defined in section 53 of this specification, the multi-lift paving density limits will not apply.

4.2.1.2 Determining Percent Within Limits

Determine the estimated PWL value for each acceptance characteristic, asphalt binder content, air voids, VMA, and in-place density as follows:

Step 1. Calculate the LOT average, X_a, and sample standard deviation, s, using the equations below:

$$X_a = \frac{\sum_{1}^{n} X_i}{n} \qquad s = \sqrt{\frac{\sum_{1}^{n} (X_i - X_a)^2}{n-1}}$$

Where: n is the number of test results for the LOT.
X_i represents the individual contractor acceptance test results

Step 2. Calculate the lower specification limit Quality Index, Q_L, using the equation below:

$$Q_L = \frac{X_a - LSL}{s}$$

Step 3. Calculate the upper specification limit Quality Index, Q_U, using the equation below:

$$Q_U = \frac{USL - X_a}{s}$$

Step 4. Depending upon the value of n, use Q_L to enter the appropriate table (from Tables 12 through 20), to determine the percentage of the LOT that is above the lower specification limit. This will be called the Lower Percent Within Limits (LPWL). If there is no lower specification limit for a material characteristic, then LPWL = 100.0%.

Step 5. Depending upon the value of n, use Q_U to enter the appropriate table (from Tables 12 through 20) to determine the percentage of the LOT that is below the upper specification limit. This will be called the Upper Percent Within Limits (UPWL). If there is no upper specification limit for a material characteristic, then UPWL = 100.0%.

Step 6. Calculate the total percentage of the LOT that is within the specification limits. This will be called the Total Percent Within Limits (TPWL) and is calculated using the equation below:

TPWL = (LPWL + UPWL) – 100

4.2.1.3 Pay Factors

If the TPWL is 20 or less for any one acceptance characteristic, or 40 or less for any 2 acceptance characteristics, or 60 or less for any 3 or more acceptance characteristics remove and replace the mixture representing that LOT.

Determine, by using the equation below, an individual percent pay factor, *PF*, for each of the individual material characteristics if the TPWL for each of the individual material characteristics (asphalt content, air voids, VMA, and in-place density) is appropriate to leave in place, and if no one TPWL is less than 80. **If any one individual material characteristic has a TPWL less than 80, the maximum pay factor for the remaining characteristics cannot be more than 100 percent.** LOTS with TPWL greater than 90 will receive pay factors greater than 100 percent. The maximum pay factor is 105 percent.

PF = 55 + 0.5(TPWL)

For Base Courses and Surface Courses Type C and D, base the pay factor for in-place density on percent of the target density. The payment schedule is shown in Table 8.

Table 8. Pay Factors for In-Place Density for Base and Surface Courses Type C and D

Average Percent of Target Control Strip Density	Pay Factor
Greater than 102.0	97
98.0-102.0	100
96.0 – 97.9	5 × (Percent Density – 78.0)
Less than 96.0	80.0

D

Determine the percent pay factor for the LOT, *LPF*, by multiplying the percent pay factors for asphalt binder content, air voids, VMA, and in-place density by weighted coefficients as shown in the equation below. Carry the percent pay factor for the LOT to the nearest hundredth (0.01) and round to the nearest tenth (0.1). Determine the *LPF* from the following equation:

$$LPF = 0.30(PF_{AC}) + 0.25(PF_{AV}) + 0.10(PF_{VMA}) + 0.35(PF_{Den})$$

Where:

LPF = Percent pay factor for the LOT
PF_{AC} = Percent pay factor for asphalt binder content
PF_{AV} = Percent pay factor for air voids
PF_{VMA} = Percent pay factor for VMA.
PF_{Den} = Percent pay factor for in-place density.

When Base Courses are produced, determine the pay factors by computing a pay factor for asphalt binder content, gradation, and density. Determine the pay for asphalt binder content in accordance to Subsection 4.2.1.2 and the pay factor for gradation by using Table 9.

Table 9. Pay Factor for Gradations
(Base Courses, Surface Type E, and OGFC only)

Number of out of tolerance gradations per LOT	Pay Factor (PF_{GRAD})
0	100
1	90
2	75
3 or more	50

$$LPF = 0.30(PF_{AC}) + 0.35(PF_{GRAD}) + 0.35(PF_{Den})$$

Where:

PF_{GRAD} = Percent pay factor for Gradation (see Table 9)

When Surface Course Type E and Open Graded Friction Courses are produced, compute the pay factors by using a pay factor for asphalt binder content, and gradation. Determine the pay for asphalt binder content by Subsection 4.2.1.2 and the pay factor for gradation by using Table 9.

$$LPF = 0.50(PF_{AC}) + 0.50(PF_{GRAD})$$

Base any reductions or increases in payment that are necessary on the original contract unit bid price per ton of asphalt concrete mixture. The total amount of any reduction or increase in payment will be in the form of a lump sum deducted from or added to the monies due.

5. Acceptance of Low Tonnage Paving

Use this acceptance procedure when there are 2500 tons or less of a specific HMA mixture on a project or when the specific HMA mixture is to be used for non-mainline work, such as patching, non-uniform leveling, widening less than 8-foot, wedging and driveway paving. Evaluate all materials used for low tonnage paving for acceptance by the Department's Acceptance Procedures specified herein. The Department will utilize results from the Contractor's acceptance testing when determining the acceptability of the materials. In addition, the Department will conduct testing, monitor and observe the Contractor's sampling and testing procedures to verify the data used for acceptance purposes. The Department's data will be compared with data from the Contractor's acceptance testing program as described in Subsection 3.8, “Split Test Sample Program” and Subsection 3.9, “Verification Program.” Conduct acceptance test sampling and testing on a random basis according to frequencies indicated in Subsection 3.6, “Acceptance Program.”

Base the acceptance and pay factors for low tonnage for asphalt binder content and the volumetric properties of air voids and VMA on the difference from the target value for each acceptance characteristic. Perform at least one series of required plant acceptance tests in accordance to Table 3 per LOT where a LOT is defined as a day’s production. Notify the Department at least one day prior to any production in order to make necessary arrangements for verification. Failure to do so could result in no payment for that given day’s production.

Record all inspections and test results on approved forms and charts and keep up to date records that are available at all times to the Department during the performance of the work. Utilize only those tests designated in advance as acceptance tests in the computation of pay factors. Record test results on forms provided by the Department. The Department will prepare and distribute uniform forms for reproduction for use as required. Deliver by email or fax all test results necessary to calculate payment factors to the **DAM** and the HMA Verification Manager immediately as they become available, or production may be halted by the **DAM** until results are delivered. Provide a copy of each truck ticket printout with the corresponding plant acceptance test results. Submitted test results are treated as preliminary until the LOT pay factor worksheet, along with the needed documentation is signed and submitted for payment within 3 calendar days of completion of the LOT as indicated in Section 4.

5.1 Mixture

Evaluate the HMA mixture at the plant, with respect to asphalt binder content and to the air voids, VMA and/or in-place density, on a LOT-to-LOT basis. Test the material for acceptance in accordance with the provisions of these special provisions. Reject any load or loads of mixture, which, in the opinion of the Department’s certified roadway technician, are obviously contaminated, segregated, or otherwise unacceptable for use in the work.

5.1.1 Low-tonnage production

Base the acceptance and pay factors for asphalt binder content and the volumetric properties of air voids and VMA on the percentage of the LOT that is within the specification limits based on the Quality Index calculated using the test results from the LOT when more than 3 SUBLOTS are produced in a day. If less than 3 SUBLOTS are produced in a day, base the acceptance and pay factors for asphalt binder content and the volumetric properties of air voids and VMA on the absolute average difference (AAD) from the target value for each acceptance characteristic.

Therefore, in accordance to Table 3, if 3 or more (n=3 or more) tests are obtained from a given LOT, calculate the Quality Index on the results of the tests in accordance with Subsection 4.2.1.2, “Determining Percent Within Limits” and use Subsection 4.2.1.3 “Pay Factors” to calculate payment. However, when operational conditions are such that fewer than 3 tests are obtained from the production on a given day, follow the procedure in the next paragraph.

If the number of tests obtained from the day's production is less than 3 (n=1 or n=2), determine pay factors for asphalt binder content, air voids, and VMA based on the average absolute difference (*AAD*) between the acceptance test results from the LOT and the acceptance target values in accordance to Subsection 5.2.1 "Determining Average Absolute Difference," and compute the pay factor in accordance with Subsection 5.2.2, "Pay Factors" and Table 10.

Perform at least one series of required plant acceptance tests per LOT no matter how many tons of a particular mixture is produced in a day and follow the requirements according to the sampling and test methods in Table 3.

5.1.2 In-Place Density

5.1.2.1 Intermediate Courses and Surface Courses Type A, B and CM

Evaluate the in-place density for Intermediate courses and for Surface courses Type A, B and CM on a LOT-to-LOT basis. If the number of linear feet in the LOT is less than 1,500, no cores are required. Compute the LOT payment in accordance with Subsection 5.2.2.2. If the number of linear feet is greater than 1500, subdivide the LOT into 3 separate SUBLOTS and obtain cores in accordance to **SC-T-101**. Compute the payment in accordance with Subsection 5.2.2.1.

Express the in-place density as a percentage of the theoretical maximum mix density. Calculate the theoretical maximum density from the maximum specific gravity as determined by **SC-T-83**. The maximum specific gravity used shall be the average of the maximum specific gravity results of the LOT using Contractor data. Carry calculations for density to the hundredths (0.01) and round to the nearest tenth (0.1) in accordance with **AASHTO R 11** rules of rounding.

5.1.2.2 Base Courses and Surface Courses Type C and D

Evaluate Base Courses and Surface Courses Type C and D on a LOT-to-LOT basis. The in-place density shall be based on density values determined by the use of an approved density gauge, and on a target density established on control strips constructed in accordance with **SC-T-65**. One control strip shall be constructed at the beginning of work on each roadway or shoulder course, and on each lift of each course. An additional control strip shall be constructed when a change is made in the type or source of materials or compaction equipment, or whenever a significant change occurs in the composition of the underlying pavement structure or the composition of the material being placed from the same source.

5.1.2.3 Surface Course Type E and Open Graded Friction Course

Surface Course Type E and OGFC will not have in-place density performed. Place these mixtures at the proper rate and promptly roll with at least 2 passes of a tandem steel wheel roller. Cease rolling as soon as the mixture is properly seated to the underlying surface.

5.1.2.4 Acceptance Plan

It is the intent of these specifications that each LOT meets specification requirements at the time of initial evaluation. No re-sampling or retesting (other than referee testing described in Subsection 3.6, "Verification Program") will be allowed.

Adjust the payment for each LOT on the basis of acceptance test results in accordance with the requirements of these specifications. Keep accurate records of the tonnage of HMA in each LOT. Determine pay factors as indicated below.

5.2.1 Determining Average Absolute Difference

Determine the *AAD* from the target value for each acceptance characteristic, asphalt binder content, air voids, and VMA, as follows:

Step 1. For each acceptance property, calculate the absolute difference, D_i, between each Contractor acceptance test result, X_i, and the target value, T, from the equation below that gives a positive value for D_i:

$$D_i = X_i - T \qquad \text{or} \qquad D_i = T - X_i$$

Step 2. For each acceptance property, calculate the average absolute difference, AAD_j, using the absolute differences, D_i, calculated in Step 1, from the following equation:

$$AAD_j = \frac{\sum_{1}^{n} D_i}{n}$$

Where: n is the number of test results for the LOT.

5.2.2 Pay Factors

Determine an individual pay factor, *PF*, for each acceptance property, asphalt binder content, air voids, and VMA in accordance to Subsection 5.1 "Mixture." Use Table 10 to compute the individual PF and the equations found in Subsection 5.2.2.1 to compute the LFP. Remove and replace any mixture having a property pay factor below 80 percent.

Table 10. Pay Factors for Non Mainline Paving LOTS

Property		PF	Average Absolute Difference from Target Number of Tests	
			1	2
Binder Content	Surface	100	0.00-0.36	0.00-0.28
		95	0.37-0.44	0.29-0.36
		90	0.45-0.55	0.37-0.43
		80	0.56-0.66	0.44-0.51
	Intermediate	100	0.00-0.43	0.00-0.33
		95	0.44-0.52	0.34-0.42
		90	0.53-0.65	0.43-0.51
		80	0.66-0.78	0.52-0.60
	Base	100	0.00-0.50	0.00-0.38
		95	0.51-0.65	0.39-0.49
		90	0.66-0.75	0.50-0.59
		80	0.76-0.90	0.60-0.69
Air Voids & VMA	Surface & Intermediate	100	0.00-1.15	0.00-0.89
		95	1.16-1.40	0.90-1.14
		90	1.41-1.75	1.15-1.36
		80	1.76-2.10	1.37-1.61

5.2.2.1 Density LOTS

Determine the percent pay factor for the LOT, *LPF*, by multiplying the percent pay factors for asphalt binder content, air voids, VMA, and in-place density by weighted coefficients as shown in the equation below. Carry the percent pay factor for the LOT to the nearest hundredth (0.01) and round to the nearest tenth (0.1). Use the following equation to determine the *LPF*:

$$LPF = 0.30(PF_{AC}) + 0.25(PF_{AV}) + 0.10(PF_{VMA}) + 0.35(PF_{Den})$$

Where:

LPF	= Percent pay factor for the LOT
PF_{AC}	= Percent pay factor for asphalt binder content
PF_{AV}	= Percent pay factor for air voids
PF_{VMA}	= Percent pay factor for VMA.
PF_{Den}	= Percent pay factor for Density.

When Base courses are produced, determine pay factors by computing a pay factor for asphalt binder content, gradation and density. Use Subsection 5.1 “Mixture” to determine the pay for asphalt binder content and Table 9 to determine the pay factor for gradation.

$$LPF = 0.35(PF_{AC}) + 0.30(PF_{GRAD}) + 0.35(PF_{Den})$$

Where:

PF_{GRAD}	= Percent pay factor for Gradation (see Table 9)

Base any reductions or increases in payment that are necessary on the original contract unit bid price per ton of asphalt concrete mixture. The total amount of any reduction or increase in payment will be in the form of a lump sum deducted from or added to the monies due.

5.2.2.2 Non-Density LOTS

Determine the percent pay factor for the LOT, *LPF*, by multiplying the percent pay factors for asphalt binder content, air voids, and VMA by weighted coefficients as shown in the equation below. Carry the percent pay factor for the LOT to the nearest hundredth (0.01) and round to the nearest tenth (0.1). Use the following equation to determine the *LPF*:

$$LPF = 0.45(PF_{AC}) + 0.45(PF_{AV}) + 0.10(PF_{VMA})$$

When Base Courses, Surface Course Type E, and/or Open Graded Friction Courses are produced, determine the LPF by computing a pay factor for asphalt binder content and gradation. Use Subsection 5.1 “Mixture” to determine the pay for asphalt binder content and Table 9 to determine the pay factor for gradation.

$$LPF = 0.50(PF_{AC}) + 0.50(PF_{GRAD})$$

Base any reductions or increases in payment that are necessary on the original contract unit bid price per ton of asphalt concrete mixture. The total amount of any reduction or increase in payment will be in the form of a lump sum deducted from or added to the monies due.

Table 11. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 3.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
1.152 or More	100	-0.039 to 0.000	50
1.149 to 1.151	99	-0.069 to -0.040	49
1.145 to 1.148	98	-0.109 to -0.070	48
1.141 to 1.144	97	-0.139 to -0.110	47
1.138 to 1.140	96	-0.179 to -0.140	46
1.134 to 1.137	95	-0.219 to -0.180	45
1.127 to 1.133	94	-0.249 to -0.220	44
1.118 to 1.126	93	-0.289 to -0.250	43
1.111 to 1.117	92	-0.319 to -0.290	42
1.101 to 1.110	91	-0.359 to -0.320	41
1.091 to 1.100	90	-0.389 to -0.360	40
1.071 to 1.090	89	-0.429 to -0.390	39
1.061 to 1.070	88	-0.459 to -0.430	38
1.041 to 1.060	87	-0.489 to -0.460	37
1.031 to 1.040	86	-0.519 to -0.490	36
1.011 to 1.030	85	-0.559 to -0.520	35
1.001 to 1.010	84	-0.589 to -0.560	34
0.971 to 1.000	83	-0.619 to -0.590	33
0.961 to 0.970	82	-0.649 to -0.620	32
0.931 to 0.960	81	-0.679 to -0.650	31
0.911 to 0.930	80	-0.709 to -0.680	30
0.891 to 0.910	79	-0.739 to -0.710	29
0.871 to 0.890	78	-0.759 to -0.740	28
0.841 to 0.870	77	-0.789 to -0.760	27
0.821 to 0.840	76	-0.819 to -0.790	26
0.791 to 0.820	75	-0.839 to -0.820	25
0.761 to 0.790	74	-0.869 to -0.840	24
0.741 to 0.760	73	-0.889 to -0.870	23
0.711 to 0.740	72	-0.909 to -0.890	22
0.681 to 0.710	71	-0.929 to -0.910	21
0.651 to 0.680	70	-0.959 to -0.930	20
0.621 to 0.650	69	-0.969 to -0.960	19
0.591 to 0.620	68	-0.999 to -0.970	18
0.561 to 0.590	67	-1.009 to -1.000	17
0.521 to 0.560	66	-1.029 to -1.010	16
0.491 to 0.520	65	-1.039 to -1.030	15
0.461 to 0.490	64	-1.059 to -1.040	14
0.431 to 0.460	63	-1.069 to -1.060	13
0.391 to 0.430	62	-1.089 to -1.070	12
0.361 to 0.390	61	-1.099 to -1.090	11
0.321 to 0.360	60	-1.109 to -1.100	10
0.291 to 0.320	59	-1.116 to -1.110	9
0.251 to 0.290	58	-1.125 to -1.117	8
0.221 to 0.250	57	-1.132 to -1.126	7
0.181 to 0.220	56	-1.136 to -1.133	6
0.141 to 0.180	55	-1.139 to -1.137	5
0.111 to 0.140	54	-1.143 to -1.140	4
0.071 to 0.110	53	-1.147 to -1.144	3
0.041 to 0.070	52	-1.150 to -1.148	2
0.001 to 0.040	51	-1.159 to -1.151	1
-0.039 to 0.000	50	-1.160 or Less	0

Table 12. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 4.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
1.471 or More	100	-0.029 to 0.000	50
1.441 to 1.470	99	-0.059 to -0.030	49
1.411 to 1.440	98	-0.089 to -0.060	48
1.381 to 1.410	97	-0.119 to -0.090	47
1.351 to 1.380	96	-0.149 to -0.120	46
1.321 to 1.350	95	-0.179 to -0.150	45
1.291 to 1.320	94	-0.209 to -0.180	44
1.261 to 1.290	93	-0.239 to -0.210	43
1.231 to 1.260	92	-0.269 to -0.240	42
1.201 to 1.230	91	-0.299 to -0.270	41
1.171 to 1.200	90	-0.329 to -0.300	40
1.141 to 1.170	89	-0.359 to -0.330	39
1.111 to 1.140	88	-0.389 to -0.360	38
1.081 to 1.110	87	-0.419 to -0.390	37
1.051 to 1.080	86	-0.449 to -0.420	36
1.021 to 1.050	85	-0.479 to -0.450	35
0.991 to 1.020	84	-0.509 to -0.480	34
0.961 to 0.990	83	-0.539 to -0.510	33
0.931 to 0.960	82	-0.569 to -0.540	32
0.901 to 0.930	81	-0.599 to -0.570	31
0.871 to 0.900	80	-0.629 to -0.600	30
0.841 to 0.870	79	-0.659 to -0.630	29
0.811 to 0.840	78	-0.689 to -0.660	28
0.781 to 0.810	77	-0.719 to -0.690	27
0.751 to 0.780	76	-0.749 to -0.720	26
0.721 to 0.750	75	-0.779 to -0.750	25
0.691 to 0.720	74	-0.809 to -0.780	24
0.661 to 0.690	73	-0.839 to -0.810	23
0.631 to 0.660	72	-0.869 to -0.840	22
0.601 to 0.630	71	-0.899 to -0.870	21
0.571 to 0.600	70	-0.929 to -0.900	20
0.541 to 0.570	69	-0.959 to -0.930	19
0.511 to 0.540	68	-0.989 to -0.960	18
0.481 to 0.510	67	-1.019 to -0.990	17
0.451 to 0.480	66	-1.049 to -1.020	16
0.421 to 0.450	65	-1.079 to -1.050	15
0.391 to 0.420	64	-1.109 to -1.080	14
0.361 to 0.390	63	-1.139 to -1.110	13
0.331 to 0.360	62	-1.169 to -1.140	12
0.301 to 0.330	61	-1.199 to -1.170	11
0.271 to 0.300	60	-1.229 to -1.200	10
0.241 to 0.270	59	-1.259 to -1.230	9
0.211 to 0.240	58	-1.289 to -1.260	8
0.181 to 0.210	57	-1.319 to -1.290	7
0.151 to 0.180	56	-1.349 to -1.320	6
0.121 to 0.150	55	-1.379 to -1.350	5
0.091 to 0.120	54	-1.409 to -1.380	4
0.061 to 0.090	53	-1.439 to -1.410	3
0.031 to 0.060	52	-1.469 to -1.440	2
0.001 to 0.030	51	-1.499 to -1.470	1
-0.029 to 0.000	50	-1.500 or Less	0

Table 13. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 5.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
1.671 or More	100	-0.029 to 0.000	50
1.601 to 1.670	99	-0.059 to -0.030	49
1.541 to 1.600	98	-0.079 to -0.060	48
1.491 to 1.540	97	-0.109 to -0.080	47
1.441 to 1.490	96	-0.139 to -0.110	46
1.391 to 1.440	95	-0.159 to -0.140	45
1.351 to 1.390	94	-0.199 to -0.160	44
1.311 to 1.350	93	-0.229 to -0.200	43
1.271 to 1.310	92	-0.249 to -0.230	42
1.231 to 1.270	91	-0.279 to -0.250	41
1.191 to 1.230	90	-0.309 to -0.280	40
1.151 to 1.190	89	-0.339 to -0.310	39
1.121 to 1.150	88	-0.369 to -0.340	38
1.081 to 1.120	87	-0.399 to -0.370	37
1.051 to 1.080	86	-0.429 to -0.400	36
1.011 to 1.050	85	-0.449 to -0.430	35
0.981 to 1.010	84	-0.469 to -0.450	34
0.951 to 0.980	83	-0.509 to -0.470	33
0.911 to 0.950	82	-0.539 to -0.510	32
0.881 to 0.910	81	-0.569 to -0.540	31
0.851 to 0.880	80	-0.599 to -0.570	30
0.821 to 0.850	79	-0.629 to -0.600	29
0.781 to 0.820	78	-0.659 to -0.630	28
0.751 to 0.780	77	-0.689 to -0.660	27
0.721 to 0.750	76	-0.719 to -0.690	26
0.691 to 0.720	75	-0.749 to -0.720	25
0.661 to 0.690	74	-0.779 to -0.750	24
0.631 to 0.660	73	-0.819 to -0.780	23
0.601 to 0.630	72	-0.849 to -0.820	22
0.571 to 0.600	71	-0.879 to -0.850	21
0.541 to 0.570	70	-0.909 to -0.880	20
0.511 to 0.540	69	-0.949 to -0.910	19
0.471 to 0.510	68	-0.979 to -0.950	18
0.451 to 0.470	67	-1.009 to -0.980	17
0.431 to 0.450	66	-1.049 to -1.010	16
0.401 to 0.430	65	-1.079 to -1.050	15
0.371 to 0.400	64	-1.119 to -1.080	14
0.341 to 0.370	63	-1.149 to -1.120	13
0.311 to 0.340	62	-1.189 to -1.150	12
0.281 to 0.310	61	-1.229 to -1.190	11
0.251 to 0.280	60	-1.269 to -1.230	10
0.231 to 0.250	59	-1.309 to -1.270	9
0.201 to 0.230	58	-1.349 to -1.310	8
0.161 to 0.200	57	-1.389 to -1.350	7
0.141 to 0.160	56	-1.439 to -1.390	6
0.111 to 0.140	55	-1.489 to -1.440	5
0.081 to 0.110	54	-1.539 to -1.490	4
0.061 to 0.080	53	-1.599 to -1.540	3
0.031 to 0.060	52	-1.669 to -1.600	2
0.001 to 0.030	51	-1.789 to -1.670	1
-0.029 to 0.000	50	-1.790 or Less	0

Table 14. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 6.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
1.801 or More	100	-0.029 to 0.000	50
1.701 to 1.800	99	-0.049 to -0.030	49
1.621 to 1.700	98	-0.079 to -0.050	48
1.551 to 1.620	97	-0.109 to -0.080	47
1.491 to 1.550	96	-0.129 to -0.110	46
1.431 to 1.490	95	-0.159 to -0.130	45
1.381 to 1.430	94	-0.189 to -0.160	44
1.331 to 1.380	93	-0.219 to -0.190	43
1.291 to 1.330	92	-0.249 to -0.220	42
1.241 to 1.290	91	-0.269 to -0.250	41
1.201 to 1.240	90	-0.299 to -0.270	40
1.161 to 1.200	89	-0.329 to -0.300	39
1.121 to 1.160	88	-0.359 to -0.330	38
1.081 to 1.120	87	-0.389 to -0.360	37
1.041 to 1.080	86	-0.409 to -0.390	36
1.011 to 1.040	85	-0.439 to -0.410	35
0.971 to 1.010	84	-0.469 to -0.440	34
0.941 to 0.970	83	-0.499 to -0.470	33
0.901 to 0.940	82	-0.529 to -0.500	32
0.871 to 0.900	81	-0.559 to -0.530	31
0.841 to 0.870	80	-0.589 to -0.560	30
0.801 to 0.840	79	-0.619 to -0.590	29
0.771 to 0.800	78	-0.649 to -0.620	28
0.741 to 0.770	77	-0.679 to -0.650	27
0.711 to 0.740	76	-0.709 to -0.680	26
0.681 to 0.710	75	-0.739 to -0.710	25
0.651 to 0.680	74	-0.769 to -0.740	24
0.621 to 0.650	73	-0.799 to -0.770	23
0.591 to 0.620	72	-0.839 to -0.800	22
0.561 to 0.590	71	-0.869 to -0.840	21
0.531 to 0.560	70	-0.899 to -0.870	20
0.501 to 0.530	69	-0.939 to -0.900	19
0.471 to 0.500	68	-0.969 to -0.940	18
0.441 to 0.470	67	-1.009 to -0.970	17
0.411 to 0.440	66	-1.039 to -1.010	16
0.391 to 0.410	65	-1.079 to -1.040	15
0.361 to 0.390	64	-1.119 to -1.080	14
0.331 to 0.360	63	-1.159 to -1.120	13
0.301 to 0.330	62	-1.199 to -1.160	12
0.271 to 0.300	61	-1.239 to -1.200	11
0.251 to 0.270	60	-1.289 to -1.240	10
0.221 to 0.250	59	-1.329 to -1.290	9
0.191 to 0.220	58	-1.379 to -1.330	8
0.161 to 0.190	57	-1.429 to -1.380	7
0.131 to 0.160	56	-1.489 to -1.430	6
0.111 to 0.130	55	-1.549 to -1.490	5
0.081 to 0.110	54	-1.619 to -1.550	4
0.051 to 0.080	53	-1.699 to -1.620	3
0.031 to 0.050	52	-1.799 to -1.700	2
0.001 to 0.030	51	-2.029 to -1.800	1
-0.029 to 0.000	50	-2.030 or Less	0

Table 15. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 7.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
1.891 or More	100	-0.029 to 0.000	50
1.761 to 1.890	99	-0.049 to -0.030	49
1.671 to 1.760	98	-0.079 to -0.050	48
1.591 to 1.670	97	-0.109 to -0.080	47
1.521 to 1.590	96	-0.129 to -0.110	46
1.461 to 1.520	95	-0.159 to -0.130	45
1.401 to 1.460	94	-0.189 to -0.160	44
1.351 to 1.400	93	-0.209 to -0.190	43
1.301 to 1.350	92	-0.239 to -0.210	42
1.251 to 1.300	91	-0.269 to -0.240	41
1.201 to 1.250	90	-0.299 to -0.270	40
1.161 to 1.200	89	-0.319 to -0.300	39
1.121 to 1.160	88	-0.349 to -0.320	38
1.081 to 1.120	87	-0.379 to -0.350	37
1.041 to 1.080	86	-0.409 to -0.380	36
1.001 to 1.040	85	-0.439 to -0.410	35
0.961 to 1.000	84	-0.459 to -0.440	34
0.931 to 0.960	83	-0.489 to -0.460	33
0.901 to 0.930	82	-0.519 to -0.490	32
0.861 to 0.900	81	-0.549 to -0.520	31
0.831 to 0.860	80	-0.579 to -0.550	30
0.801 to 0.830	79	-0.609 to -0.580	29
0.761 to 0.800	78	-0.639 to -0.610	28
0.731 to 0.760	77	-0.669 to -0.640	27
0.701 to 0.730	76	-0.699 to -0.670	26
0.671 to 0.700	75	-0.729 to -0.700	25
0.641 to 0.670	74	-0.759 to -0.730	24
0.611 to 0.640	73	-0.799 to -0.760	23
0.581 to 0.610	72	-0.829 to -0.800	22
0.551 to 0.580	71	-0.859 to -0.830	21
0.521 to 0.550	70	-0.899 to -0.860	20
0.491 to 0.520	69	-0.929 to -0.900	19
0.461 to 0.490	68	-0.959 to -0.930	18
0.441 to 0.460	67	-0.999 to -0.960	17
0.411 to 0.440	66	-1.039 to -1.000	16
0.381 to 0.410	65	-1.079 to -1.040	15
0.351 to 0.380	64	-1.119 to -1.080	14
0.321 to 0.350	63	-1.159 to -1.120	13
0.301 to 0.320	62	-1.199 to -1.160	12
0.271 to 0.300	61	-1.249 to -1.200	11
0.241 to 0.270	60	-1.299 to -1.250	10
0.211 to 0.240	59	-1.349 to -1.300	9
0.191 to 0.210	58	-1.399 to -1.350	8
0.161 to 0.190	57	-1.459 to -1.400	7
0.131 to 0.160	56	-1.519 to -1.460	6
0.111 to 0.130	55	-1.589 to -1.520	5
0.081 to 0.110	54	-1.669 to -1.590	4
0.051 to 0.080	53	-1.759 to -1.670	3
0.031 to 0.050	52	-1.889 to -1.760	2
0.001 to 0.030	51	-2.229 to -1.890	1
-0.029 to 0.000	50	-2.230 or Less	0

Table 16. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 8.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
I.951 or More	100	-0.029 to 0.000	50
1.811 to 1.950	99	-0.049 to -0.030	49
1.701 to 1.810	98	-0.079 to -0.050	48
1.611 to 1.700	97	-0.099 to -0.080	47
1.541 to 1.610	96	-0.129 to -0.100	46
1.471 to 1.540	95	-0.159 to -0.130	45
1.411 to 1.470	94	-0.189 to -0.160	44
1.361 to 1.410	93	-0.209 to -0.190	43
1.301 to 1.360	92	-0.239 to -0.210	42
1.251 to 1.300	91	-0.269 to -0.240	41
1.211 to 1.250	90	-0.289 to -0.270	40
1.161 to 1.210	89	-0.319 to -0.290	39
1.121 to 1.160	88	-0.349 to -0.320	38
1.081 to 1.120	87	-0.379 to -0.350	37
1.041 to 1.080	86	-0.399 to -0.380	36
1.001 to 1.040	85	-0.429 to -0.400	35
0.961 to 1.000	84	-0.459 to -0.430	34
0.931 to 0.960	83	-0.489 to -0.460	33
0.891 to 0.930	82	-0.519 to -0.490	32
0.861 to 0.890	81	-0.549 to -0.520	31
0.821 to 0.860	80	-0.569 to -0.550	30
0.791 to 0.820	79	-0.599 to -0.570	29
0.761 to 0.790	78	-0.629 to -0.600	28
0.731 to 0.760	77	-0.659 to -0.630	27
0.701 to 0.730	76	-0.699 to -0.660	26
0.661 to 0.700	75	-0.729 to -0.700	25
0.631 to 0.660	74	-0.759 to -0.730	24
0.601 to 0.630	73	-0.789 to -0.760	23
0.571 to 0.600	72	-0.819 to -0.790	22
0.551 to 0.570	71	-0.859 to -0.820	21
0.521 to 0.550	70	-0.889 to -0.860	20
0.491 to 0.520	69	-0.929 to -0.890	19
0.461 to 0.490	68	-0.959 to -0.930	18
0.431 to 0.460	67	-0.999 to -0.960	17
0.401 to 0.430	66	-1.039 to -1.000	16
0.381 to 0.400	65	-1.079 to -1.040	15
0.351 to 0.380	64	-1.119 to -1.080	14
0.321 to 0.350	63	-1.159 to -1.120	13
0.291 to 0.320	62	-1.209 to -1.160	12
0.271 to 0.290	61	-1.249 to -1.210	11
0.241 to 0.270	60	-1.299 to -1.250	10
0.211 to 0.240	59	-1.359 to -1.300	9
0.191 to 0.210	58	-1.409 to -1.360	8
0.161 to 0.190	57	-1.469 to -1.410	7
0.131 to 0.160	56	-1.539 to -1.470	6
0.101 to 0.130	55	-1.609 to -1.540	5
0.081 to 0.100	54	-1.699 to -1.610	4
0.051 to 0.080	53	-1.809 to -1.700	3
0.031 to 0.050	52	-1.949 to -1.810	2
0.001 to 0.030	51	-2.389 to -1.950	1
-0.029 to 0.000	50	-2.390 or Less	0

Table 17. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 9.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
2.001 or More	100	-0.029 to 0.000	50
1.841 to 2.000	99	-0.049 to -0.030	49
1.721 to 1.840	98	-0.079 to -0.050	48
1.631 to 1.720	97	-0.099 to -0.080	47
1.551 to 1.630	96	-0.129 to -0.100	46
1.481 to 1.550	95	-0.159 to -0.130	45
1.421 to 1.480	94	-0.179 to -0.160	44
1.361 to 1.420	93	-0.209 to -0.180	43
1.311 to 1.360	92	-0.239 to -0.210	42
1.261 to 1.310	91	-0.259 to -0.240	41
1.211 to 1.260	90	-0.289 to -0.260	40
1.171 to 1.210	89	-0.319 to -0.290	39
1.121 to 1.170	88	-0.349 to -0.320	38
1.081 to 1.120	87	-0.369 to -0.350	37
1.041 to 1.080	86	-0.399 to -0.370	36
1.001 to 1.040	85	-0.429 to -0.400	35
0.961 to 1.000	84	-0.459 to -0.430	34
0.931 to 0.960	83	-0.479 to -0.460	33
0.891 to 0.930	82	-0.509 to -0.480	32
0.861 to 0.890	81	-0.539 to -0.510	31
0.821 to 0.860	80	-0.569 to -0.540	30
0.791 to 0.820	79	-0.599 to -0.570	29
0.761 to 0.790	78	-0.629 to -0.600	28
0.721 to 0.760	77	-0.659 to -0.630	27
0.691 to 0.720	76	-0.689 to -0.660	26
0.661 to 0.690	75	-0.719 to -0.690	25
0.631 to 0.660	74	-0.759 to -0.720	24
0.601 to 0.630	73	-0.789 to -0.760	23
0.571 to 0.600	72	-0.819 to -0.790	22
0.541 to 0.570	71	-0.859 to -0.820	21
0.511 to 0.540	70	-0.889 to -0.860	20
0.481 to 0.510	69	-0.929 to -0.890	19
0.461 to 0.480	68	-0.959 to -0.930	18
0.431 to 0.460	67	-0.999 to -0.960	17
0.401 to 0.430	66	-1.039 to -1.000	16
0.371 to 0.400	65	-1.079 to -1.040	15
0.351 to 0.370	64	-1.119 to -1.080	14
0.321 to 0.350	63	-1.169 to -1.120	13
0.291 to 0.320	62	-1.209 to -1.170	12
0.261 to 0.290	61	-1.259 to -1.210	11
0.241 to 0.260	60	-1.309 to -1.260	10
0.211 to 0.240	59	-1.359 to -1.310	9
0.181 to 0.210	58	-1.419 to -1.360	8
0.161 to 0.180	57	-1.479 to -1.420	7
0.131 to 0.160	56	-1.549 to -1.480	6
0.101 to 0.130	55	-1.629 to -1.550	5
0.081 to 0.100	54	-1.719 to -1.630	4
0.051 to 0.080	53	-1.839 to -1.720	3
0.031 to 0.050	52	-1.999 to -1.840	2
0.001 to 0.030	51	-2.529 to -2.000	1
-0.029 to 0.000	50	-2.530 or Less	0

Table 18. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 10 to 11.

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
2.041 or More	100	-0.029 to 0.000	50
1.861 to 2.040	99	-0.049 to -0.030	49
1.741 to 1.860	98	-0.079 to -0.050	48
1.651 to 1.740	97	-0.099 to -0.080	47
1.561 to 1.650	96	-0.129 to -0.100	46
1.491 to 1.560	95	-0.159 to -0.130	45
1.431 to 1.490	94	-0.179 to -0.160	44
1.361 to 1.430	93	-0.209 to -0.180	43
1.311 to 1.360	92	-0.239 to -0.210	42
1.261 to 1.310	91	-0.259 to -0.240	41
1.211 to 1.260	90	-0.289 to -0.260	40
1.171 to 1.210	89	-0.319 to -0.290	39
1.121 to 1.170	88	-0.339 to -0.320	38
1.081 to 1.120	87	-0.369 to -0.340	37
1.041 to 1.080	86	-0.399 to -0.370	36
1.001 to 1.040	85	-0.429 to -0.400	35
0.961 to 1.000	84	-0.449 to -0.430	34
0.921 to 0.960	83	-0.479 to -0.450	33
0.891 to 0.920	82	-0.509 to -0.480	32
0.851 to 0.890	81	-0.539 to -0.510	31
0.821 to 0.850	80	-0.569 to -0.540	30
0.791 to 0.820	79	-0.599 to -0.570	29
0.751 to 0.790	78	-0.629 to -0.600	28
0.721 to 0.750	77	-0.659 to -0.630	27
0.691 to 0.720	76	-0.689 to -0.660	26
0.661 to 0.690	75	-0.719 to -0.690	25
0.631 to 0.660	74	-0.749 to -0.720	24
0.601 to 0.630	73	-0.789 to -0.750	23
0.571 to 0.600	72	-0.819 to -0.790	22
0.541 to 0.570	71	-0.849 to -0.820	21
0.511 to 0.540	70	-0.889 to -0.850	20
0.481 to 0.510	69	-0.919 to -0.890	19
0.451 to 0.480	68	-0.959 to -0.920	18
0.431 to 0.450	67	-0.999 to -0.960	17
0.401 to 0.430	66	-1.039 to -1.000	16
0.371 to 0.400	65	-1.079 to -1.040	15
0.341 to 0.370	64	-1.119 to -1.080	14
0.321 to 0.340	63	-1.169 to -1.120	13
0.291 to 0.320	62	-1.209 to -1.170	12
0.261 to 0.290	61	-1.259 to -1.210	11
0.241 to 0.260	60	-1.309 to -1.260	10
0.211 to 0.240	59	-1.359 to -1.310	9
0.181 to 0.210	58	-1.429 to -1.360	8
0.161 to 0.180	57	-1.489 to -1.430	7
0.131 to 0.160	56	-1.559 to -1.490	6
0.101 to 0.130	55	-1.649 to -1.560	5
0.081 to 0.100	54	-1.739 to -1.650	4
0.051 to 0.080	53	-1.859 to -1.740	3
0.031 to 0.050	52	-2.039 to -1.860	2
0.001 to 0.030	51	-2.649 to -2.040	1
-0.029 to 0.000	50	-2.650 or Less	0

Table 19. Estimate of LPWL or UPWL Using Q_L or Q_U for n = 12 or more

Q_L or Q_U	LPWL or UPWL	Q_L or Q_U	LPWL or UPWL
2.091 or More	100	-0.029 to 0.000	50
1.911 to 2.090	99	-0.049 to -0.030	49
1.771 to 1.910	98	-0.079 to -0.050	48
1.671 to 1.770	97	-0.099 to -0.080	47
1.581 to 1.670	96	-0.129 to -0.100	46
1.501 to 1.580	95	-0.159 to -0.130	45
1.441 to 1.500	94	-0.179 to -0.160	44
1.371 to 1.440	93	-0.209 to -0.180	43
1.321 to 1.370	92	-0.229 to -0.210	42
1.261 to 1.320	91	-0.259 to -0.230	41
1.211 to 1.260	90	-0.289 to -0.260	40
1.171 to 1.210	89	-0.309 to -0.290	39
1.121 to 1.170	88	-0.339 to -0.310	38
1.081 to 1.120	87	-0.369 to -0.340	37
1.041 to 1.080	86	-0.399 to -0.370	36
1.001 to 1.040	85	-0.419 to -0.400	35
0.961 to 1.000	84	-0.449 to -0.420	34
0.921 to 0.960	83	-0.479 to -0.450	33
0.891 to 0.920	82	-0.509 to -0.480	32
0.851 to 0.890	81	-0.539 to -0.510	31
0.821 to 0.850	80	-0.569 to -0.540	30
0.781 to 0.820	79	-0.589 to -0.570	29
0.751 to 0.780	78	-0.619 to -0.590	28
0.721 to 0.750	77	-0.659 to -0.620	27
0.691 to 0.720	76	-0.689 to -0.660	26
0.661 to 0.690	75	-0.719 to -0.690	25
0.621 to 0.660	74	-0.749 to -0.720	24
0.591 to 0.620	73	-0.779 to -0.750	23
0.571 to 0.590	72	-0.819 to -0.780	22
0.541 to 0.570	71	-0.849 to -0.820	21
0.511 to 0.540	70	-0.889 to -0.850	20
0.481 to 0.510	69	-0.919 to -0.890	19
0.451 to 0.480	68	-0.959 to -0.920	18
0.421 to 0.450	67	-0.999 to -0.960	17
0.401 to 0.420	66	-1.039 to -1.000	16
0.371 to 0.400	65	-1.079 to -1.040	15
0.341 to 0.370	64	-1.119 to -1.080	14
0.311 to 0.340	63	-1.169 to -1.120	13
0.291 to 0.310	62	-1.209 to -1.170	12
0.261 to 0.290	61	-1.259 to -1.210	11
0.231 to 0.260	60	-1.319 to -1.260	10
0.211 to 0.230	59	-1.369 to -1.320	9
0.181 to 0.210	58	-1.439 to -1.370	8
0.161 to 0.180	57	-1.499 to -1.440	7
0.131 to 0.160	56	-1.579 to -1.500	6
0.101 to 0.130	55	-1.669 to -1.580	5
0.081 to 0.100	54	-1.769 to -1.670	4
0.051 to 0.080	53	-1.909 to -1.770	3
0.031 to 0.050	52	-2.089 to -1.910	2
0.001 to 0.030	51	-2.829 to -2.090	1
-0.029 to 0.000	50	-2.830 or Less	0