



**INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS**

**PERCENT WITHIN LIMITS (PWL)
ITM No. 588-26**

1.0 SCOPE.

1.1 This test method covers the procedure to determine the Percent Within Limits (PWL) for HMA, *for QC/QA Performance Validation, and for CAPP Loadout.*

1.2 Rounding of values will be in accordance with 109.01(a).

2.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

3.0 SIGNIFICANCE AND USE. This procedure is used to determine the PWL of:

3.1 *A Lot of HMA. Pay Factors for HMA are determined using PWL values.*

3.2 *A Lot of Performance Validation Test Results for Load Transfer Efficiency (LTE), Friction, or other performance type tests. Pay Factors are determined using PWL values.*

3.3 *Loadout Test Results for Specified CAPP Products. CAPP compliance is determined using PWL values.*

4.0 PROCEDURE. HMA

4.1 Mixture

4.1.1 Determine the average of the lot mixture properties for binder content, air voids at N_{des} , and VMA at N_{des} as follows:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

where:

\bar{x} = average of the lot mixture property values

x_i = subplot mixture property value

n = number of mixture subplot samples in the lot

4.1.2 Determine the standard deviation of the lot mixture property as follows:

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

where:

s = standard deviation of the lot mixture property

x_i = subplot mixture property value

\bar{x} = average of the lot mixture property values

n = number of mixture subplot samples in the lot

4.1.3 Calculate the Upper Quality Index for each mixture property by subtracting the lot average of each mixture property from the Upper Specification Limit and dividing the result by the standard deviation of the lot mixture property as follows:

$$Q_U = \frac{USL - \bar{x}}{s}$$

where:

Q_U = Upper Quality Index

USL = Upper Specification Limit

\bar{x} = average of the lot mixture property values

s = standard deviation of the lot mixture property

4.1.4 Calculate the Lower Quality Index for each mixture property by subtracting the Lower Specification Limit from the lot average of each mixture property and dividing the result by the standard deviation of the lot mixture property as follows:

$$Q_L = \frac{\bar{x} - LSL}{s}$$

where:

Q_L = Lower Quality Index

LSL = Lower Specification Limit

\bar{x} = average of the lot mixture property values

s = standard deviation of the lot mixture property

- 4.1.5** Determine the percentage of material that will fall within the Upper and Lower Specification Limits by entering the table of Quality Index Values (Appendix A) with Q_U or Q_L using the column appropriate to the total number of measurements, n .
- 4.1.6** Determine the percent of material that will fall within the limits for each mixture property by adding the percent within the Upper Specification Limit ($PWLU$) to the percent within the Lower Specification Limit ($PWLL$), and subtracting 100 from the total as follows:

$$\text{Total PWL} = (PWLU + PWLL) - 100$$

4.2 Density

- 4.2.1** Determine the average of the lot density values as follows:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

where:

\bar{x} = average of the lot density values

x_i = core density value

n = number of cores in the lot

- 4.2.2** Determine the standard deviation of the lot density as follows:

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

where:

s = standard deviation of the density of the lot

\bar{x} = average of the lot density values

x_i = core density value

n = number of cores in the lot

- 4.2.3 Calculate the Lower Quality Index for in-place density (% G_{mm}) by subtracting the Lower Specification Limit from the average of the density of the lot and dividing the result by the standard deviation of the density of the lot as follows:

$$Q_L = \frac{\bar{x} - LSL}{s}$$

where:

Q_L = Lower Quality Index

LSL = Lower Specification Limit

\bar{x} = average of the lot density values

s = standard deviation of the density of the lot

- 4.2.4 Determine the PWL for density by entering the table of Quality Index Values (Appendix A) using the column appropriate to the total number of measurements, n.
- 4.2.5 Determine the percent within the lower specification limit (PWL_L) for density as follows:

$$\text{Total PWL} = \text{PWL}_L$$

5.0 REPORT. **HMA**

- 5.1 Binder content, air voids, VMA, and in-place density (%G_{mm}) lot average values will be reported to the nearest 0.01%.
- 5.2 The standard deviation values for binder content, air voids, VMA, and in-place density (%G_{mm}) will be reported to the nearest 0.01.
- 5.3 Binder content, air voids, and VMA Q_U and Q_L values will be reported to the nearest 0.01.
- 5.4 In-place density (%G_{mm}) Q_L values will be reported to the nearest 0.01.

6.0 PROCEDURE . Performance Validation

6.1 LTE and Friction

6.2 Calculate Mean, Standard Deviation, Upper Quality Index, and Lower Quality Index using the formulas in 4.1

6.3 Use Excel or Equivalent Computing Methods to Automate the Process and to Calculate the PWL

	A	F	G	L	M
56	Showing Actual Q_u & Q_L with Example Count, Mean and Std.Dev.				
57	Excel Formulas ITM 588	PV LTE	PV Friction		
58	Lot	5	6		
59	Total PWL	98.0	100.0		
60	QL PWL	98.0	100.0		
61	QL	2.10	2.80		
62	QL LSL	85.0	45.0		Friction Lower Spec Limit Enter Friction LSL of 40.0 if the CMD/DMF was Tested for Laboratory Polishing and was rated as "acceptable" by the Engineer. Otherwise, enter 45.0.
63	Qu PWL	100.0	100.0		
64	Qu	429.86	546.09		
65	Qu USL	1000.0	1000.0		
66	Count	200	200		
67	Mean (Calculated)	89.44	49.88		
68	Std.Dev. (Calculated)	2.12	1.74		

6.4 For single sided PWL calculations, Q_u is set to 1000 as shown above to assure that the spreadsheet calculates PWL correctly.

6.5 The correct Excel formulas with rounding in compliance with this ITM are shown in the example below.

	A	F
56	Showing Actual Q_u & Q_L with Example Count, Mean and Std.Dev. For LTE Example	
57	Excel Formulas ITM 588	=F19
58	Lot	=F20
59	Total PWL	=IF(F61="", "", (F63+F60)-100)
60	QL PWL	=ROUND(100*(1-MAX(0,ROUND(BETADIST(MAX(0,1/2-1/2*F61*F66^0.5/(F66-1)),F66/2-1,F66/2-1,0),5))),0)
61	QL	=IF(F67="", "", ROUND((F67-F62)/F68,2))
62	QL LSL	85
63	Qu PWL	=ROUND(100*(1-MAX(0,ROUND(BETADIST(MAX(0,1/2-1/2*F64*F66^0.5/(F66-1)),F66/2-1,F66/2-1,0),5))),0)
64	Qu	=IF(F67="", "", ROUND((F65-F67)/F68,2))
65	Qu USL	1000
66	Count	=COUNT(F71:F270)
67	Mean (Calculated)	=AVERAGE(F71:F270)
68	Std.Dev. (Calculated)	=STDEV.S(F71:F270)

7.0 PROCEDURE . CAPP**7.1 Loadout Test Results for Specified Products**

7.2 Calculate Mean, Standard Deviation, Upper Quality Index, and Lower Quality Index using the formulas in 4.1

7.3 Use Excel or equivalent computing methods to automate the process and to calculate the PWL on the last 30 tests in accordance with ITM 211-26.

7.4 Example from the INDOT SharePoint Data Collection Worksheet

	K	L
31	Critical Sieve	
32	PWL of Last 30 Tests	92.00
33	QL PWL	95.00
34	QL	1.65
35	QL LCL	42.00
36	Qu PWL	97.00
37	Qu	1.81
38	Qu UCL	62.00
39	Count	30.00
40	Calculated Average	51.55
41	Calculated Standard Deviation	5.78

7.5 The correct Excel formulas with rounding in compliance with this ITM are shown in the example below.

7.6 Q_U , Q_L , and the data for Count, Average, and Standard Deviation are pulled from appropriately referenced cells (not shown).

31	Critical Sieve	
32	PWL of Last 30 Tests	=IF(L34="", "", (L36+L33)-100)
33	QL PWL	=ROUND(100*(1-MAX(0,ROUND(BETADIST(MAX(0,1/2-1/2*L34*L39^0.5/(L39-1)),L39/2-1,L39/2-1,0,5))),0)
34	QL	=IF(L40="", "", ROUND((L40-L35)/L41,2))
35	QL LCL	=L14
36	Qu PWL	=ROUND(100*(1-MAX(0,ROUND(BETADIST(MAX(0,1/2-1/2*L37*L39^0.5/(L39-1)),L39/2-1,L39/2-1,0,5))),0)
37	Qu	=IF(L40="", "", ROUND((L38-L40)/L41,2))
38	Qu UCL	=L13
39	Count	=COUNT(OFFSET(C2,COUNTA(C:C)-MIN(COUNTA(C:C),30),0,MIN(COUNTA(C:C),30),1))
40	Calculated Average	=AVERAGE(OFFSET(C2,COUNTA(C:C)-MIN(COUNTA(C:C),30),0,MIN(COUNTA(C:C),30),1))
41	Calculated Standard Deviation	=STDEV.S(OFFSET(C2,COUNTA(C:C)-MIN(COUNTA(C:C),30),0,MIN(COUNTA(C:C),30),1))

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
2.30	100	100	100	100	100	100	100	100	100	100	100	100
2.29	100	100	100	100	100	100	100	100	100	100	100	99
2.28	100	100	100	100	100	100	100	100	100	100	100	99
2.27	100	100	100	100	100	100	100	100	100	100	99	99
2.26	100	100	100	100	100	100	100	100	100	100	99	99
2.25	100	100	100	100	100	100	100	100	100	100	99	99
2.24	100	100	100	100	100	100	100	100	100	99	99	99
2.23	100	100	100	100	100	100	100	100	100	99	99	99
2.22	100	100	100	100	100	100	100	100	100	99	99	99
2.21	100	100	100	100	100	100	100	100	99	99	99	99
2.20	100	100	100	100	100	100	100	100	99	99	99	99
2.19	100	100	100	100	100	100	100	100	99	99	99	99
2.18	100	100	100	100	100	100	100	100	99	99	99	99
2.17	100	100	100	100	100	100	100	99	99	99	99	99
2.16	100	100	100	100	100	100	100	99	99	99	99	99
2.15	100	100	100	100	100	100	100	99	99	99	99	99
2.14	100	100	100	100	100	100	100	99	99	99	99	99
2.13	100	100	100	100	100	100	100	99	99	99	99	99
2.12	100	100	100	100	100	100	99	99	99	99	99	99
2.11	100	100	100	100	100	100	99	99	99	99	99	99
2.10	100	100	100	100	100	100	99	99	99	99	99	99
2.09	100	100	100	100	100	100	99	99	99	99	99	99
2.08	100	100	100	100	100	100	99	99	99	99	99	99
2.07	100	100	100	100	100	100	99	99	99	99	99	99
2.06	100	100	100	100	100	99	99	99	99	99	99	99
2.05	100	100	100	100	100	99	99	99	99	99	99	99
2.04	100	100	100	100	100	99	99	99	99	99	99	99
2.03	100	100	100	100	100	99	99	99	99	99	99	99
2.02	100	100	100	100	100	99	99	99	99	99	99	99
2.01	100	100	100	100	100	99	99	99	99	99	99	98
2.00	100	100	100	100	100	99	99	99	99	99	99	98
1.99	100	100	100	100	100	99	99	99	99	99	98	98
1.98	100	100	100	100	99	99	99	99	99	98	98	98
1.97	100	100	100	100	99	99	99	99	99	98	98	98
1.96	100	100	100	100	99	99	99	99	98	98	98	98
1.95	100	100	100	100	99	99	99	99	98	98	98	98
1.94	100	100	100	100	99	99	99	99	98	98	98	98
1.93	100	100	100	100	99	99	99	98	98	98	98	98
1.92	100	100	100	100	99	99	99	98	98	98	98	98
1.91	100	100	100	100	99	99	99	98	98	98	98	98
1.90	100	100	100	100	99	99	98	98	98	98	98	98

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
1.89	100	100	100	100	99	99	98	98	98	98	98	98
1.88	100	100	100	100	99	99	98	98	98	98	98	98
1.87	100	100	100	99	99	98	98	98	98	98	98	98
1.86	100	100	100	99	99	98	98	98	98	98	98	98
1.85	100	100	100	99	99	98	98	98	98	98	98	98
1.84	100	100	100	99	99	98	98	98	98	98	97	97
1.83	100	100	100	99	99	98	98	98	98	98	97	97
1.82	100	100	100	99	99	98	98	98	98	97	97	97
1.81	100	100	100	99	98	98	98	98	97	97	97	97
1.80	100	100	100	99	98	98	98	98	97	97	97	97
1.79	100	100	100	99	98	98	98	97	97	97	97	97
1.78	100	100	100	99	98	98	98	97	97	97	97	97
1.77	100	100	100	99	98	98	97	97	97	97	97	97
1.76	100	100	100	99	98	98	97	97	97	97	97	97
1.75	100	100	100	99	98	98	97	97	97	97	97	97
1.74	100	100	100	98	98	97	97	97	97	97	97	97
1.73	100	100	100	98	98	97	97	97	97	97	97	97
1.72	100	100	100	98	98	97	97	97	97	97	96	96
1.71	100	100	99	98	97	97	97	97	97	96	96	96
1.70	100	100	99	98	97	97	97	97	96	96	96	96
1.69	100	100	99	98	97	97	97	96	96	96	96	96
1.68	100	100	99	98	97	97	97	96	96	96	96	96
1.67	100	100	99	98	97	97	96	96	96	96	96	96
1.66	100	100	99	98	97	97	96	96	96	96	96	96
1.65	100	100	99	97	97	96	96	96	96	96	96	96
1.64	100	100	99	97	97	96	96	96	96	96	96	96
1.63	100	100	98	97	97	96	96	96	96	96	96	95
1.62	100	100	98	97	96	96	96	96	96	95	95	95
1.61	100	100	98	97	96	96	96	96	95	95	95	95
1.60	100	100	98	97	96	96	96	95	95	95	95	95
1.59	100	100	98	97	96	96	95	95	95	95	95	95
1.58	100	100	98	96	96	96	95	95	95	95	95	95
1.57	100	100	97	96	96	95	95	95	95	95	95	95
1.56	100	100	97	96	96	95	95	95	95	95	95	95
1.55	100	100	97	96	95	95	95	95	95	95	95	95
1.54	100	100	97	96	95	95	95	95	95	94	94	94
1.53	100	100	97	96	95	95	95	95	94	94	94	94
1.52	100	100	97	96	95	95	95	94	94	94	94	94
1.51	100	100	96	95	95	95	94	94	94	94	94	94
1.50	100	100	96	95	95	94	94	94	94	94	94	94
1.49	100	100	96	95	95	94	94	94	94	94	94	94

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
1.48	100	99	96	95	94	94	94	94	94	94	94	94
1.47	100	99	96	95	94	94	94	94	94	94	94	93
1.46	100	99	95	94	94	94	94	94	93	93	93	93
1.45	100	98	95	94	94	94	93	93	93	93	93	93
1.44	100	98	95	94	94	93	93	93	93	93	93	93
1.43	100	98	95	94	94	93	93	93	93	93	93	93
1.42	100	97	95	94	93	93	93	93	93	93	93	93
1.41	100	97	94	94	93	93	93	93	93	93	93	93
1.40	100	97	94	93	93	93	93	93	92	92	92	92
1.39	100	96	94	93	93	93	92	92	92	92	92	92
1.38	100	96	94	93	93	92	92	92	92	92	92	92
1.37	100	96	93	93	92	92	92	92	92	92	92	92
1.36	100	95	93	93	92	92	92	92	92	92	92	92
1.35	100	95	93	92	92	92	92	92	92	92	92	92
1.34	100	95	93	92	92	92	92	92	91	91	91	91
1.33	100	94	93	92	92	92	91	91	91	91	91	91
1.32	100	94	92	92	91	91	91	91	91	91	91	91
1.31	100	94	92	92	91	91	91	91	91	91	91	91
1.30	100	93	92	91	91	91	91	91	91	91	91	91
1.29	100	93	92	91	91	91	91	91	91	90	90	90
1.28	100	93	91	91	91	91	90	90	90	90	90	90
1.27	100	92	91	91	90	90	90	90	90	90	90	90
1.26	100	92	91	90	90	90	90	90	90	90	90	90
1.25	100	92	91	90	90	90	90	90	90	90	90	90
1.24	100	91	90	90	90	90	90	90	90	90	90	89
1.23	100	91	90	90	90	89	89	89	89	89	89	89
1.22	100	91	90	89	89	89	89	89	89	89	89	89
1.21	100	90	90	89	89	89	89	89	89	89	89	89
1.20	100	90	89	89	89	89	89	89	89	89	89	89
1.19	100	90	89	89	89	89	89	89	89	88	88	88
1.18	100	89	89	89	88	88	88	88	88	88	88	88
1.17	100	89	88	88	88	88	88	88	88	88	88	88
1.16	100	89	88	88	88	88	88	88	88	88	88	88
1.15	97	88	88	88	88	88	88	88	88	88	88	88
1.14	95	88	88	88	87	87	87	87	87	87	87	87
1.13	93	88	87	87	87	87	87	87	87	87	87	87
1.12	92	87	87	87	87	87	87	87	87	87	87	87
1.11	91	87	87	87	87	87	87	87	87	87	87	87
1.10	90	87	87	87	87	87	87	87	87	87	86	86
1.09	89	86	86	86	86	86	86	86	86	86	86	86
1.08	88	86	86	86	86	86	86	86	86	86	86	86
1.07	88	86	86	86	86	86	86	86	86	86	86	86

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
1.06	87	85	85	85	85	86	86	86	86	86	86	86
1.05	86	85	85	85	85	85	85	85	85	85	85	85
1.04	86	85	85	85	85	85	85	85	85	85	85	85
1.03	85	84	85	85	85	85	85	85	85	85	85	85
1.02	84	84	84	84	84	84	85	85	85	85	85	85
1.01	84	84	84	84	84	84	84	84	84	84	84	84
1.00	83	83	84	84	84	84	84	84	84	84	84	84
0.99	83	83	83	84	84	84	84	84	84	84	84	84
0.98	82	83	83	83	83	83	83	84	84	84	84	84
0.97	82	82	83	83	83	83	83	83	83	83	83	83
0.96	81	82	82	83	83	83	83	83	83	83	83	83
0.95	81	82	82	82	83	83	83	83	83	83	83	83
0.94	80	81	82	82	82	82	82	82	82	82	83	83
0.93	80	81	82	82	82	82	82	82	82	82	82	82
0.92	79	81	81	82	82	82	82	82	82	82	82	82
0.91	79	80	81	81	81	81	82	82	82	82	82	82
0.90	78	80	81	81	81	81	81	81	81	81	81	81
0.89	78	80	80	81	81	81	81	81	81	81	81	81
0.88	78	79	80	80	81	81	81	81	81	81	81	81
0.87	77	79	80	80	80	80	80	80	81	81	81	81
0.86	77	79	79	80	80	80	80	80	80	80	80	80
0.85	76	78	79	79	80	80	80	80	80	80	80	80
0.84	76	78	79	79	79	79	80	80	80	80	80	80
0.83	76	78	78	79	79	79	79	79	79	79	79	79
0.82	75	77	78	79	79	79	79	79	79	79	79	79
0.81	75	77	78	78	78	79	79	79	79	79	79	79
0.80	74	77	77	78	78	78	78	78	78	79	79	79
0.79	74	76	77	78	78	78	78	78	78	78	78	78
0.78	74	76	77	77	77	78	78	78	78	78	78	78
0.77	73	76	77	77	77	77	77	78	78	78	78	78
0.76	73	75	76	77	77	77	77	77	77	77	77	77
0.75	73	75	76	76	77	77	77	77	77	77	77	77
0.74	72	75	76	76	76	76	77	77	77	77	77	77
0.73	72	74	75	76	76	76	76	76	76	76	76	76
0.72	71	74	75	75	76	76	76	76	76	76	76	76
0.71	71	74	75	75	75	75	76	76	76	76	76	76
0.70	71	73	74	75	75	75	75	75	75	75	75	76
0.69	70	73	74	74	75	75	75	75	75	75	75	75
0.68	70	73	74	74	74	74	75	75	75	75	75	75
0.67	70	72	73	74	74	74	74	74	74	74	75	75
0.66	69	72	73	73	74	74	74	74	74	74	74	74

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
0.65	69	72	73	73	73	74	74	74	74	74	74	74
0.64	69	71	72	73	73	73	73	73	73	74	74	74
0.63	68	71	72	72	73	73	73	73	73	73	73	73
0.62	68	71	72	72	72	73	73	73	73	73	73	73
0.61	68	70	71	72	72	72	72	72	72	73	73	73
0.60	67	70	71	71	72	72	72	72	72	72	72	72
0.59	67	70	71	71	71	72	72	72	72	72	72	72
0.58	67	69	70	71	71	71	71	71	71	72	72	72
0.57	66	69	70	70	71	71	71	71	71	71	71	71
0.56	66	69	70	70	70	71	71	71	71	71	71	71
0.55	66	68	69	70	70	70	70	70	70	70	71	71
0.54	65	68	69	69	70	70	70	70	70	70	70	70
0.53	65	68	69	69	69	69	70	70	70	70	70	70
0.52	65	67	68	69	69	69	69	69	69	69	69	70
0.51	65	67	68	68	69	69	69	69	69	69	69	69
0.50	64	67	68	68	68	68	69	69	69	69	69	69
0.49	64	66	67	68	68	68	68	68	68	68	68	68
0.48	64	66	67	67	68	68	68	68	68	68	68	68
0.47	63	66	67	67	67	67	67	68	68	68	68	68
0.46	63	65	66	67	67	67	67	67	67	67	67	67
0.45	63	65	66	66	67	67	67	67	67	67	67	67
0.44	62	65	65	66	66	66	66	67	67	67	67	67
0.43	62	64	65	66	66	66	66	66	66	66	66	66
0.42	62	64	65	65	65	66	66	66	66	66	66	66
0.41	62	64	64	65	65	65	65	65	65	66	66	66
0.40	61	63	64	65	65	65	65	65	65	65	65	65
0.39	61	63	64	64	64	65	65	65	65	65	65	65
0.38	61	63	63	64	64	64	64	64	64	64	64	65
0.37	60	62	63	63	64	64	64	64	64	64	64	64
0.36	60	62	63	63	63	63	64	64	64	64	64	64
0.35	60	62	62	63	63	63	63	63	63	63	63	63
0.34	60	61	62	62	63	63	63	63	63	63	63	63
0.33	59	61	62	62	62	62	62	63	63	63	63	63
0.32	59	61	61	62	62	62	62	62	62	62	62	62
0.31	59	60	61	61	61	62	62	62	62	62	62	62
0.30	58	60	61	61	61	61	61	61	61	61	62	62
0.29	58	60	60	61	61	61	61	61	61	61	61	61
0.28	58	59	60	60	60	61	61	61	61	61	61	61
0.27	58	59	60	60	60	60	60	60	60	60	60	60
0.26	57	59	59	60	60	60	60	60	60	60	60	60
0.25	57	58	59	59	59	59	59	60	60	60	60	60

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
0.24	57	58	59	59	59	59	59	59	59	59	59	59
0.23	56	58	58	58	59	59	59	59	59	59	59	59
0.22	56	57	58	58	58	58	58	58	58	58	58	59
0.21	56	57	57	58	58	58	58	58	58	58	58	58
0.20	56	57	57	57	57	58	58	58	58	58	58	58
0.19	55	56	57	57	57	57	57	57	57	57	57	57
0.18	55	56	56	57	57	57	57	57	57	57	57	57
0.17	55	56	56	56	56	56	56	57	57	57	57	57
0.16	54	55	56	56	56	56	56	56	56	56	56	56
0.15	54	55	55	56	56	56	56	56	56	56	56	56
0.14	54	55	55	55	55	55	55	55	55	55	55	55
0.13	54	54	55	55	55	55	55	55	55	55	55	55
0.12	53	54	54	54	54	55	55	55	55	55	55	55
0.11	53	54	54	54	54	54	54	54	54	54	54	54
0.10	53	53	54	54	54	54	54	54	54	54	54	54
0.09	52	53	53	53	53	53	53	53	53	53	53	54
0.08	52	53	53	53	53	53	53	53	53	53	53	53
0.07	52	52	52	53	53	53	53	53	53	53	53	53
0.06	52	52	52	52	52	52	52	52	52	52	52	52
0.05	51	52	52	52	52	52	52	52	52	52	52	52
0.04	51	51	51	51	51	52	52	52	52	52	52	52
0.03	51	51	51	51	51	51	51	51	51	51	51	51
0.02	51	51	51	51	51	51	51	51	51	51	51	51
0.01	50	50	50	50	50	50	50	50	50	50	50	50
0.00	50	50	50	50	50	50	50	50	50	50	50	50
-0.01	50	50	50	50	50	50	50	50	50	50	50	50
-0.02	49	49	49	49	49	49	49	49	49	49	49	49
-0.03	49	49	49	49	49	49	49	49	49	49	49	49
-0.04	49	49	49	49	49	48	48	48	48	48	48	48
-0.05	49	48	48	48	48	48	48	48	48	48	48	48
-0.06	48	48	48	48	48	48	48	48	48	48	48	48
-0.07	48	48	48	47	47	47	47	47	47	47	47	47
-0.08	48	47	47	47	47	47	47	47	47	47	47	47
-0.09	48	47	47	47	47	47	47	47	47	47	47	46
-0.10	47	47	46	46	46	46	46	46	46	46	46	46
-0.11	47	46	46	46	46	46	46	46	46	46	46	46
-0.12	47	46	46	46	46	45	45	45	45	45	45	45
-0.13	46	46	45	45	45	45	45	45	45	45	45	45
-0.14	46	45	45	45	45	45	45	45	45	45	45	45
-0.15	46	45	45	44	44	44	44	44	44	44	44	44
-0.16	46	45	44	44	44	44	44	44	44	44	44	44

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
-0.17	45	44	44	44	44	44	44	43	43	43	43	43
-0.18	45	44	44	43	43	43	43	43	43	43	43	43
-0.19	45	44	43	43	43	43	43	43	43	43	43	43
-0.20	44	43	43	43	43	42	42	42	42	42	42	42
-0.21	44	43	43	42	42	42	42	42	42	42	42	42
-0.22	44	43	42	42	42	42	42	42	42	42	42	
-0.23	44	42	42	42								
-0.24	43	42										
-0.25	43	42										
-0.26	43											
-0.27	42											
-0.28	42											
-0.29	42											
-0.30	42											