State of Wisconsin



HMA PWL Test Strip **Spreadsheet Instruction** Manual

2025 Edition

1. Disclaimer

This document is to be used as an instructive guide for the HMA PWL Test Strip Spreadsheet and to answer frequently asked questions of Regional Technical Services Section (TSS) and those acting as Department Representatives. It is not a substitute for reading and understanding HMA Pavement Percent Within Limits (PWL) specifications.

If there is a question about dispute resolution or data entry that is not covered in this document, please contact the Regional PWL Representative. If consulting BTS is recommended by this document or the HMA PWL Test Strip Spreadsheet, that contact should be made by TSS Staff.

The HMA PWL Test Strip Spreadsheet is designed to simplify the recording and analysis of contractor Quality Control (QC) and department Quality Verification (QV) data related to pavement density and air voids used for HMA test strip pay adjustment.

The Plans, Standard Specifications, and Special Provisions ALWAYS supersede this document, even in cases where this document may contradict those provisions.

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3. General

- A copy of this instruction manual is available within the PWL Test Strip Spreadsheet on the *Project Info & Instructions* worksheet. Simply double click the button "PWL Test Strip Manual" to access them from within the spreadsheet.
- The PWL Test Strip Spreadsheet should be filled out and completed by the Department Representative.
- The *Project Info & Instructions* worksheet <u>must</u> be filled out first prior to entering test results. Some worksheets will not appear until the required project information has been entered.
- Worksheets tab colors indicate the following:
 - Green Worksheets that require test results to be entered.
 - Red Worksheets that only present results; no data entry is required in these sheets.
- Cells that are canary/yellow colored are data entry fields.
 - It is essential that no blank spaces are entered in or after any of the information entered into the fields.
 - When copy/pasting, only use "Paste Values". If you use the hotkey combination, CTRL+V, values will be pasted automatically.

4. Project Info & Instructions

This is the main entry point for the PWL Test Strip Spreadsheet (Figure 1). It contains fields for information about the project as well as paving information such as the mix design and pavement layer and dimensions.

The canary/yellow fields on the *Project Info and Instructions* worksheet should be filled out completely by the Department Representative prior to beginning construction. Most of the fields in the *Project Info & Instructions* worksheet (i.e.: Contract Unit Price, Lane Width, Nominal Thickness, JMFs, etc.) are required for the worksheet to function correctly. The Test Strip Type (Combined Density and Volumetrics, Density-Only, and Volumetric-Only) must be selected to hide or reveal the correct worksheets for data entry. Project information used in all other worksheets within the spreadsheet are referenced from the *Project Info & Instructions* worksheet and can only be changed from this worksheet.

At the end of the Test Strip, the Department Representative must enter the Test Strip's Final Tonnage (cell C23) and Final Length (ft., cell C24). These final values are used for the pay adjustments.

	Programmer of TRANS	Visconsin Departme of Transportation	ent		PWL Test Strip
evised 4-08-25	ŀ	HMA PWI Test Strin Spreadsh	eet		Spreadsheet
Γ	Combined F	ensity and Volumetrics Test Strip Proj	ect Information		Instructions 2020
Test Strip Type:	 Combined Density and Volumetrics 	O Density-Only	Volumetric-Only		
Date Constructed:		Paving Width(ft):			
Test Strip #:		Lane Width(ft):			
Contract ID:		Nominal Thickness(in):		Calculated Tonnage	
Job No./Project ID:		Estimated Tonnage:		Ŭ	Calculate Tonnage Based On Known Length
Route/Road:		Estimated Stations- Start:	End:	Calculated Length	Stations Decreasing
County:		Estimated Length(ft):			
WisDOT Mix No.:		Test Strip Pavement Layer:			
Mix Gradation:		Underlying Layer:			
Mix Traffic Vol:		Density Lower Spec Limit(%):	Enter Mix and Layer Info		
Asphalt Binder:		Project Leader:	· · ·		Save As with Suggested File
Binder Designation:		Contractor:			Name (Use this to save)
Mix Type:		JMF Gmm:			
Contract Unit Price:		JMF AC %:		From WisDOT 250	Free and All Mondach and a PDF
Final Tonnage:		JMF AC Sp. Gr.:		Report/ Current JMF	Export All Worksheets as PDF
Final Length:		JMF Gse:			
_					Export Field Density
_		Density Zone #1 Center Station:			Worksheets as PDF
Random Stations Locked	Generate Random Stations	Density Zone #2 Center Station:			
		Random Split Sample #1 Tonnage:			
Random Tonnage Locked	Generate Random Tonnage	Random Split Sample #2 Tonnage:			
		Random Split Sample #3 Tonnage:			
Other/Notes:					
Suggested File Name:	PWL-TSCombined				

Figure 1: Project Info & Instructions Interface.

There are several buttons for worksheet functions found on the righthand side of the interface. The buttons perform the following functions:

Save As with Suggested File Name (Use this to save)	 Saves the spreadsheet as a new Excel file (without overwriting old versions) with the suggested file name, including the date and time that the spreadsheet was saved. This is the preferred method of saving the spreadsheet.
Export All Worksheets as PDF	• Exports the entire spreadsheet and its worksheets as a PDF.
Export Field Density Worksheets as PDF	• Exports only the field density worksheets (QC-1, QC-2, QV-1, and QV-2 Density Worksheets) as a PDF. These can be printed and used in the field.

5. Split Sample Comparison

This worksheet only appears when either "Combined Density and Volumetrics" or "Volumetric-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to enter the split samples' Gmm and Gmb results as well as the results of any dispute testing, if required. The split sample comparison is a check for reasonable test result differences between labs.

The Department Representative will enter the following information from the split sample comparison testing (Figure 2):

- QC Gmms
- QV Gmms
- QC Gmbs
- QV Gmbs
- BTS Referee Gmms (if required)
- BTS Referee Gmbs (if required)

Split Sa	ample T	esting		oarisor	1				If datasets cor	npare and testing differenc	ces are within testing toleranc	e, QC data is carried i	into the	
•	•								Air Voids Pay	Factor worksheet. If not, E	3TS will conduct referee Gmn	n & Gmb tests and BTS	5	
Date:			1	est Strip #:					data will be us	ed for subsequent calculati	ions.			
Project ID:			F	oute/Road:					If QC and QV datasets do not compare, BTS referee Gmm and Gmb test data needs to be entered in the					
Mix Type:			1	Layer:					BTS Referee (Gmm/Gmb Column.			Gmm	
JMF Gmm:	Enter JM	F Gmm.	1										Xd Mean	
G _{mm}			-							BTS Vs. QC Results		BTS Vs. QV Results	s Tolerance	
Split Sample	Tonnage	QC Gmm	QV Gmm	Difference	X. Mean	Degree	of -1	BTS Referee	Difference	X. Mean	Difference	X. Mean	0.012	
Number				(X _d)		Freedor	n .	Gmm	(X _d)		(X _d)			
1					t-test p-value	Prob. c	0.010	-		t-test p-value		t-test p-value		
2														
					Split Sample	Results:								
G _{mm} Toleranc	e to JWF	00.000	01/ 0	1				DTC Cmm	1					
Split Sample	Tonnage	JMF	JMF					JMF						
Number		Difference	Difference					Difference						
1				1										
2				1									Gmb	
													Only 1	
3]									Xd Mean	
3 G _{mb}										BTS Vs. QC Results		BTS Vs. QV Results	Xd Mean Tolerance	
3 G _{mb} Split Sample Number	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean	Degree Freedor	of -1	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean	Difference (X _d)	BTS Vs. QV Results X _d Mean	Xd Mean Tolerance	
3 G _{mb} Split Sample Number 1	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value	Degree Freedor Prob. c	of -1 0.010	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean t-test p-value	Difference (X _d)	BTS Vs. QV Results X _d Mean t-test p-value	Xd Mean Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value	Degree Freedor Prob. c	of -1 0.010	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean t-lest p-value	Difference (X _d)	BTS Vs. QV Results X _d Mean t-test p-value	Xd Mean Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value Split Sample	Degree Freedor Prob. c Results:	of -1 0.010	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean t-test p-value	Difference (X _d)	BTS Vs. QV Results X _d Mean t-test p-value	Xd Meen Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value Split Sample	Degree Freedor Prob. c Results:	of -1 0.010	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean t-test p-value mm All Within Tolerance-No Refe	Difference (X _d)	BTS Vs. QV Results X _d Mean t-lest p-value	Xd Mean Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3 Note:	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value Split Sample	Degree Freedor Prob. c Results:	of -1 0.010	BTS Referee Gmb	Difference (X _d) ut Xd Mean and G	BTS Vs. QC Results Xg Mean t-test p-value mm All Within Tolerance-No Reference-No Reference-	Difference (X _d)	BTS Vs. QV Results X _d Mean t-test p-value	Xd Mean Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3 Note: This review is a	Tonnage	QC Gmb	QV Gmb	Difference (X _d)	X _d Mean t-test p-value Split Sample bs. Due to the st	Degree / Freedor Prob. c Results: mell sample size, <20	of -1 0.010	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean t-test p-value mm All Within Tolerance-No Refe	Difference (X _a)	BTS Vs. QV Results X _d Mean t-lest p-value	Xd Man Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3 Note: This review is a possible to have Ever such differ	Tonnage	QC Gmb	QV Gmb	Difference (X _d) es between la), but the "fer	X _d Mean t-test p-value Split Sample bs. Due to the sist results are with	Degree i Freedor Prob. c Results: mall sample size, <20 thin testing toleranc	0 -1 0.010	BTS Referee Gmb	Difference (X _d) ut Xd Mean and G	BTS Vs. QC Results X _d Mean L-test p-value mm All Within Tolerance-No Ref	eree Test Needed	BTS Vs. QV Results X _d Mean t-test p-value	Xd Mean Tolerance 0.012	
3 Gmb Split Sample Number 1 2 3 Note: This review is a possible to hav For such differ baced on effert	Tonnage	QC Gmb	QV Gmb	Difference (X _d) es between la a), but the "fer mix production	X _d Mean t-test p-value Split Sample bs. Due to the sr st results are with may resume as	Degree - Freedor Freedor Prob. c Results: mail sample size, <20 thin testing tolerance the test result differe a co within Tolerance	, it is , it is e". nces are to IME	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean I-lest p-value mm All Within Tolerance-No Refe	Interest Needed	BTS Vs. QV Results X _d Mean t-lest p-value % BTS	Xd Man Tolerance 0.012	
3 G _{mb} Split Sample Number 1 2 3 Note: This review is a possible to hav For such differ based on small and both Xdl	Tonnage a check for reas e two sets of da rences, if allowe I sample sizes a en are within t	QC Gmb	QV Gmb asult difference e t-test (p-valu neer, asphalt t testing differe ce QC Gmm a	es between la e), but the "tea mix production ences. In suct	X _d Mean t-test p-value Split Sample I bs. Due to the si st results are win in may resume as in case, if all Gmm.	Degree + Freedor Prob. c Results: mall sample size, <2C thin testing toleranc the test result differe a rewithin Toleranc.	of -1 0.010 , it is e ^r . nces are to JMF he right	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results Xa Mean I-Iest p-value mm All Within Tolerance-No Ref	Difference (X _i) irre Test Needed Air Voids Contractor Department	BTS Vs. QV Results X, Mean t-test p-value % BTS	Xd Mean Tolerance 0.012	
3 Gmb Split Sample Number 1 2 3 Note: This review is a possible to have For such differ based on small and both Xd M	Tonnage a check for reas e two sets of da rences, if allowe I sample sizes a ean are within th	OC Gmb	QV Gmb asult difference e t-test (p-valu neer, asphalt testing differ ce QC Gmm a WL Rep is en	es between la a), but the "tee mix production nnces. In such and Gmb data tered in the bc	X _d Mean t-test p-value Split Sample bs. Due to the sr tresults are win n may resume as n case, if all Gmm will be used for a w below.	Degree Freedor Prob. c Results: mail sample size, <20 thin testing toleranc n are within Toleranc n are within Toleranc), it is e*. nces are e to JMF he right	BTS Referee Gmb	Difference (X _d)	BTS Vs. QC Results X _d Mean I-lest p-value mm All Within Tolerance-No Refi	Difference (X ₂) Irree Test Needed Air Voids Contractor Department	BTS Vs. QV Results X _g Mean I-lest p-value % BTS	Xd Man Tolerance 0.012	
3 Gmb Split Sample Number 1 2 3 Note: This review is a possible to hav For such differ based on small and both Xd M is checked and	Tonnage a check for reas te two sets of da rences, if allowe I sample sizes a ean are within to d the name of th	QC Gmb	QV Gmb esult difference e t-test (p-valu neer, asphalt t testing differr ce QC Gmm a WL Rep is em	es between la e), but the "termix production mix production ences. In such and Gmb data tered in the bo	X _d Mean 1-test p-value Split Sample I bs. Due to the sr st results are with n may resume as to case, if all Gmm will be used for a xx below.	Degree Freedor Freedor Prob. c Results: mail sample size, <22 thin testing toleranc the test result different a rea within Toleranco analysis if the box at the	h -1 0.010 , it is e ^r . nces are a to JMF he right	BTS Referee Gmb	Difference (X _d)	BTS Vs. OC Results X _a Mean - I-test p-value - mm All Within Tolerance-No Refi -	Air Voids Contractor Department	BTS Vs. QV Results X ₄ Mean t-test p-value % BTS	Xd Man Tolerance 0.012	
3 Gmb Split Sample Number 1 2 3 Note: This review is a possible to hav For such differ based on smal and both Xd M is checked and It is also possit	Tonnage a check for reas e two sets of da ences, if allowe I sample sizes a ean are within tu d the name of th bble to have two-s	QC Gmb	QV Gmb asult difference Hest (p-value testing difference ee QC Gmm a WL Rep is en sults that are s	Difference (X _d) es between la es, but the "ter mix production noces. In suc roces. In suc tered in the bc	X ₄ Mean t-test p-value Split Sample bs. Due to the sr tresults are wh in may resume as in case, if all Gmm will be used for a xx below. at the results pass	Degree Freedor Prob. c Results: mail sample size, <22 thin testing toleranc, the test result differ a are within Toleranc, analysis if the box at t is the t-test (p-value), I	h -1 0.010 , it is e". nces are to JMF he right wut the " test	BTS Referee Gmb	Difference (X _d) ut Xd Mean and G	BTS Vs. QC Results X ₄ Mean Hest p-value mm All Within Tolerance-No Refe	Difference (X ₂) tree Test Needed Contractor Department	BTS Vs. QV Results X _g Mean L-lest p-value % BTS	Xd Mean Tolerance 0.012	
3 Gmb Split Sample Number 1 2 3 Note: This review is a possible to hav For such differ based on small and both Xd M is checked and this also possible differences ex	Tonnage a check for reas re two sets of da senses, if allowe I sample sizes a ean are within t the name of th ble to have two-s cceed testing to	QC Gmb	QV Gmb esult difference t-test (p-value neer, asphalt t testing differ ec QC Gmm ew WL Rep is en sults that are te ec cause of th	Difference (X _d) es between la b), but the "ter mix productionences. In suct ences. In suct ences. In suct and Gmb data tered in the bc so variable that is type testing	X _u Mean t-test p-value Split Sample bs. Due to the sr st results are wh in may resume as n case, if all Gmm will be used for a x below.	Degree (Freedor Freedor Prob. c Results: anal sample size, <20 thin testing toleranc the test result differ are within Toleranc analysis if the box at t the t-test (p-value), to be resolved before	h -1 0.010 , it is or, nces are to JMF he right but the 'Yest production	BTS Referee Gmb	Difference (X _d)	BTS Vs. OC Results Xa Mean Hest p-value mm All Within Tolerance-No Refr	Difference (K.) tree Test Needed Air Voids Contractor Department	BTS Vs. QV Results X _s Mean Hest p-value % BTS Revised	X dMan Tolerance 0.012	
3 Gmb Split Sample Number 2 3 Note: This review is a possible to hav For such differ based on small and both Xd M is checked and It is also possit differences ex of mix resumes	Tonnage a check for reas e two sets of da rences, if allowe I sample sizes a ean are within to the the name of th ble to have two-s cceed testing to 5.	QC Gmb	QV Gmb esult difference t-test (p-value t-testing difference QC Gmm WL Rep is en wUL Rep is en sults that are t he cause of th	Difference (X _a) es between la s), but the "te- mix productions ences. In such and Gmb data tered in the bc so variable that is type testing	X _d Mean t-test p-value Split Sample bs. Due to the si st results are wh in may resume as in case, if all Gmm will be used for a ix below. at the results pass variation needs to whether the set of the set of the set of the set of the test of the set of the set of the set of the set of the test of the set of the set of the set of the set of the set of the set of the set of the set of the set of the set of the set of the set of the set of the	Degree i Freedor Prob. c Results: mail sample size, <2C thin testing tolerance are within tolerance are been to be the tolerance to be the tolerance are been to be the tolerance are been to be	f -1 0.010 • . • . • . • . • . • . • . • . • . • .	BTS Referee Gmb	Difference (X _d)	BTS Vs. OC Results Xa Mean Item (Second Second	Contractor Department	BTS Vs. QV Results X ₃ Mean I-lest p-value % BTS Revised	Ad Mean Tolerance 0.012	

Figure 2: Split Sample Comparison data entry fields.

This worksheet checks for four (4) conditions to be met:

- 1. The paired t-test p-value for both Gmm and Gmb must be greater than alpha (0.010).
- 2. The Gmms for all parties must not be more than ± 0.024 from the JMF Gmm.
- 3. The Average Difference (X_d Mean) between both QC and QV Gmms and Gmbs must be less than or equal to 0.012.
- Individual QC and QV air voids tests must meet the acceptance limits (1.5% ≤ Va ≤ 5.0%).

Notes:

- BTS Referee Testing is only required if Condition 1 AND 3 are NOT MET, OR Condition 4 is NOT MET.
 - In the event BTS Referee testing is required, the BTS Referee cells (column K) will change to a canary/yellow color and say "BTS Result". Enter the results of the BTS Referee testing in these cells (Figure 3).
- If Condition 1 is NOT MET but Condition 3 IS MET, then no BTS referee testing is required.
 - In the event this situation occurs. Select the checkbox next to *Failed t-test but Xd* Mean and Gmm All Within Tolerance – No Referee Test Needed and enter the Regional PWL Representative Name that reviewed and approved the results in the field that appears below the check box (Figure 4).



Figure 3: Failed t-test and Xd Mean.

A	В	C	D	E	F	G	Н	I	J	K	L	М	N	0	р	Q	R S	Т
1	Split Sa	mple 1	estino		oarisor)					If datasets con	nare and testing differ	ences are within	n testing tolerand	e OC data is carried	into the		
2			3			-					Air Voids Pav	Factor worksheet. If no	t BTS will cond	uct referee Gmr	n & Gmb tests and BT	s		
3	Date:	8/29/2	2024	1	fest Strip #:	1		1			data will be use	d for subsequent calci	ulations			•		
4	Project ID:			F	oute/Road:	USH 5	51				If QC and QV datasets do not compare. BTS referee Gmm and Gmb test data needs to be entered in the							
5	Mix Type:	4-MT-5	8-28S		Laver:	Uppe	r	1			BTS Referee (mm/Gmb Column					Gmm	1
6	JMF Gmm;	2.4	45		,												Xd Mean	
7	G _{mm}											BTS Vs. QC Results			BTS Vs. QV Result	s	Tolerance	۱
	Split Sample	T	00.0	011.0	Difference	×	0.007	Degree of	0	BTS Referee	Difference	¥		Difference	×		0.040	1
8	Number	Tonnage	QC Gmm	QV Gmm	(X _d)	A _d wean	0.007	Freedom	2	Gmm	(X _d)	A _d mean		(X _d)	A _d mean		0.012	
9	1	198	2.443	2.449	0.006	t-test p-value	0.007	Prob. α	0.010			t-test p-value			t-test p-value			
10	2	338	2.439	2.447	0.008	Test differer	ices withir	n testing tol	erance.									
11	3	680	2.439	2.446	0.007	Split Sample	Results:	Do not C	ompare.									
12	G _{mm} Tolerance	to JMF							1									
	Split Sample	_	QC Gmm-	QV Gmm-						BTS Gmm-								
12	Number	Tonnage	JMF	JMF	Gmn	ns are within J	MF ACCE	ptance Lir	nit.	JMF								
10	1		0.002	0.004					•	Dimerence								
15	2		0.002	0.004					•								Cmb	7
16	3		0.000	0.002					- \								Xd Mean	
17	G _{mb}				1					L		BTS Vs. QC Results			BTS Vs. QV Result	s	Tolerance	•
	Split Sample	T	00.0	OV Cresh	Difference	×	0.000	Degree of		BTS Referee	Difference	¥ M		Difference	×		0.040	-
18	Number	Tonnage	QC Gmb	QV Gmb	(X _d)	A _d wean	0.002	Freedom	2	Gmb	(X _d)	Ad Mean		(X _d)	A _d mean		0.012	
19	1		2.367	2.372	0.005	t-test p-value	0.250	Prob. α	0.010			t-test p-value			t-test p-value			
20	2		2.368	2.370	0.002	Test differer	ices withir	n testing tol	erance.									
21	3		2.364	2.364	0.000	Split Sample	Results:	Datasets	Compare]	
22										Failed t-test b	ut Xd Mean and Gr	nm All Within Tolerance - N	o Referee Test Need	ded.				
23	Note:									Regional PV	/L Rep. Approv	ng Split Sample Data						
24	This review is a	check for reas	sonable test re	esult differenc	es between la	bs. Due to the si	mall sample	e size, <20, i	t is		Bob Seg	ər				7		
25	For such differe	nees if allowe	d by the endi	noor acnhalt	mix production	n may resume as	the test re	sult different	os aro				Contractor	Air Volds	%	-		
27	based on small	sample sizes a	nd consistent	testing differe	ances. In such	n case if all Gmn	are within	Tolerance t	JMF				3.1	3.1	613	1		
28	and both Xd Mean are within testing tolerance QC Gmm and Gmb data will be used for analysis if the box at the r							right				2.9	3.1					
29	is checked and the name of the Regional PWL Rep is entered in the box below.								-				3.1	3.4		1		
30																		
31	It is also possibl	e to have two-	sets of test re	sults that are s	so variable tha	t the results pass	the t-test (p-value), bu	the "test									
32	differences exc	eed testing to	lerance". Th	ne cause of th	is type testing	variation needs	to be resoli	ved before p	roduction						Revise	1 4-08-25		
33	of mix resumes.																	

Figure 4: Failed t-test but Xd Mean and Gmm All Within Tolerance.

6. Core Data

This worksheet only appears when either "Combined Density and Volumetrics" (Figure 5) or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to enter the mainline density test results obtained by cores.

The Department Representative will enter the following information from the core density testing:

- Contractor Dry Weight (g)
- Contractor SSD Weight (g)
- Contractor Submerged Weight (g)
- Department Dry Weight (g) (if performed)
- Department SSD Weight (g) (if performed)
- Department Submerged Weight (g) (if performed)
- QC or QV Core Data Used For Analysis (option available when Department enters optional core verification results)
- Suspect Core Removal (if needed)
- Daily Average Gmm for Density-Only Test Strip Analysis (Density-Only Test Strip, Figure 6)
- PWL Production Gmm OR Non-Random Dept. Gmm collected during Density-Only Test Strip (Density-Only Test Strip, Figure 6)

	А	В	С	D	E	F	G	Н		К	V
	Core Data										
1	Core Dala										
2											
3					_						
4	Date:				Test Strip #:						
5	Project ID:				Route/Road:						
6	Mix Type:				Layer:			Ente	r QV Data for		
7	Gmm For Analysis :				LSL:	Enter Mix an	d Layer Info	Option	nal OC/OV Core		
8	Gmm Source:		QC		JMF Gmm:	Enter JM	F Gmm.	Densi	ty Verification		
9				Contracto	r Core Density	Calculations		Densi	ty vermeation.		
		Random	Offset	Drav	SSD	Submorged	QC Core	QC Density	Location Comparison		
10	Label	Station	from CL	Diy	330	Submergeu	Density	% of Gmm	Result		
11		-01+00									
12		-00+50									
13		00+00									
14		00+50									
15		01+00									
							OC Coro				
		Random	Offset	Dry	SSD	Submerged	Bulk	QC Density	Location Comparison		
18		Station	from CL	Diy	335	Jubilieigeu	Density	% of Gmm	Result		
19		-01+00									
20		-00+50									
21		00+00									
22		00+50									
23		01+00									
24						Average:					
25	Note:								DM/L Dam		
26	The Location Compar	ison Result r	eferences va	alues on the Ga	auge-Core Var	iability workshe	eet comparing	g the core	PWLKep		
27	density data with each	adjusted nu	iclear densit	y gauge readir	ng at each test	location. "Susp	ect Core" is	displayed	Suspect Core		
28	may be damaged. Co	arison Resul	nional PWI	Ion Compariso	m average is ≥ when a "Susn	1.0 01 ≤ -1.0 t ect Core" is id	antified here	a core triat	Review		
29	density values are con	nsidered aue	stionable. O	NLY THE REG	IONAL PWL R	EPRESENTAT	IVE CAN RE	MOVE A			
30	CORE FROM ANALY	SIS.									
31											
32											
33	Other/Notes:										
34											
36									D : 1400.05		
37									Revised 4-08-25		
38											

Figure 5: Core Data Fields for a Combined Volumetric and Density Test Strip.

	А	В	С	D	E	F	G	Н	I	K V
1	Core Data			Daily Av	verage Gmm	for Density-C	Only Test St	rip Analysis:		
2	PWI Produ	uction Gmm	OR Non-F	andom Dent	- t. Gmm.colle	cted during	Donsity-On	ly Tost Strip:		1
2	T WE TOOL				. Onin cone	cieu uuring i	Density-On	iy rest strip.		
3	Date:				Test Strin #•			1		
5	Project ID:				Route/Road:					
6	Mix Type:				Layer:			Ento	r OV Data for	
7	Gmm For Analysis :	Enter Gr	nm Running /	Avg. Above	LSL:	Enter Mix and	d Layer Info	Ontion		
8	Gmm Source:		QC	-	JMF Gmm:	Enter JM	F Gmm.	Option	hai QC/QV Core	
9				Contracto	r Core Density	Calculations		Densi	ty verification.	
10	Label	Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result	
11		-01+00						Enter Gmm.		
12		-00+50						Enter Gmm.		
13		00+00						Enter Gmm.		
14		00+50						Enter Gmm.		
15		01+00						Enter Gmm.		
18		Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result	
19		-01+00					,	Enter Gmm.		
20		-00+50						Enter Gmm.		
21		00+00						Enter Gmm.		
22		00+50						Enter Gmm.		
23		01+00						Enter Gmm.		
24	Noto					Average:				
26 27 28 29 30 31 32	The Location Comparison Result references values on the Gauge-Core Variability worksheet comparing the core density data with each adjusted nuclear density gauge reading at each test location. "Suspect Core" is displayed under Location Comparison Result if the Location Comparison average is ≥ 1.0 or ≤ -1.0 this indicates a core that may be damaged. Contact the Regional PWL Representative when a "Suspect Core" is identified here or when core density values are considered questionable. ONLY THE REGIONAL PWL REPRESENTATIVE CAN REMOVE A CORE FROM ANALYSIS.									
33	Other/Notes:									
34	,									
35										
36										
37									Revised 4-08-25	
38										

Figure 6: Core Data Fields for a Density-Only Test Strip.

The department may decide to perform optional density verification of the contractor's results. If the department performs this testing, the results can be entered by pressing the

Enter QV Data for
Optional QC/QV Core
Density Verification.

button to reveal the data entry fields (Figure 7). Additionally, the Department Representative, at their discretion, can select which data set, QC or QV, to use for acceptance, pay adjustment, and nuclear gauge correlation.

Notes:

• It is recommended to use QV results for analysis if the *Difference in Average % Density* (cell U24) is more than 0.5%.

	Α	В	с	D	E	F	G	н	1	к	L	м	N	0	Р	Q	R	S	T	U	v
1	Core Data																				
2	eere butu																				
2													-								
4	Date:		8/29/2024		Test Strip #:	1			.		Hide C	C/OV Core	e		QC or Q	Core Data	0.00	~			
5	Project ID:				Route/Road:	USH	51		4		Density	Verificatio	on.		Used Fo	Analysis?	Ŏ qv				
6	Mix Type:		4-MT-58-28	IS	Layer:	Upp	ier	Ente	r QV Data for												
7	Gmm For Analysis :				LSL:	93.	0	Option	al QC/QV Core												
8	Gmm Source:		BTS Refere	e	JMF Gmm:	2.4	45	Densi	ty Verification.			_									
9				Contracto	r Core Density	Calculations	OC Cara					Department	Core Density C	alculations		Dep	partment Minu	us Contractor I	Density Dat	8	1
10	Label	Random Station	Offset from CL	Dry	SSD	Submerged	Bulk Density	QC Density % of Gmm	Location Comparison Result		Dry	SSD	Submerged	Bulk Density	QV Density % of Gmm	Dry	SSD	Submerged	Core Bulk Density	Density %	
11	UL-1	786+45	1.5	2,021.3	2,022.6	1,151.8	2.321														
12	UL-2	786+95	3.5	1,672.1	1,673.6	949.0	2.308														
13	UL-3	787+45	6.0	1,963.0	1,963.9	1,129.8	2.353														
14	UL-4	787+95	8.5	2,028.0	2,028.8	1,166.8	2.353														
	01-3	700145	10.5	1,735.2	1,740.3	502.0	2.2.54														1
18		Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result		Dry	SSD	Submerged	QV Core Bulk Density	QV Density % of Gmm	Dry	SSD	Submerged	Core Bulk Density	Density %	
19	UL-6	808+30	1.5	1,796.2	1,797.8	1,006.8	2.271														
20	UL-7	808+80	3.5	1,592.3	1,593.3	917.2	2.355														
21	UL-8	809+30	6.0	1,999.3	2,000.3	1,150.4	2.352														
22	UL-9	809+80	8.5	1,981.3	1,982.5	1,133.8	2.335														
23	01-10	810+30	10.5	1,928.5	1,929.9	1,091.5 Average:	2.300			I L			Average:				Differe	ence in Average	- % Density:		
25	Note:																				1
26	The Location Compar	son Result n	eferences va	lues on the G	auge-Core Var	iability workshe	et comparin	g the core	PWL Rep		If the differen	ce between th	ne QC and QV a	verage dens	ities is greate	r than 0.5%, co	onsider using Q	V core densitie	es in place o	f QC core	
27	density data with eacl	adjusted nu	clear densit	y gauge readin	ng at each test	location. "Susp	ect Core" is	displayed	Suspect Core		densities.										
28	may be damaged. Co	arison Result stact the Rec	t if the Locat	ion Compariso Renresentative	on average is ≥ when a "Susn	1.0 or ≤ -1.0 t ect Core" is id	nis indicates entified here	a core that or when core	Review												
29	density values are con	isidered que	stionable. Ol	NLY THE REG	IONAL PWL R	EPRESENTAT	IVE CAN RE	MOVE A													
30	CORE FROM ANALY	SIS.																			
32																					
33	Other/Notes:																				
34																					
35																					
36																					
37									Revised 4-08-25												
38																					

Figure 7: Optional Department Verification of Cores.

Notes regarding the testing can be entered at the bottom of the worksheet in the provided field found in the range of cells (B33:I36).

After this worksheet and the QC and QV density worksheets have been filled out, the *Gauge-Core Variability* worksheet may flag some cores as suspect (further discussed in section 12. Gauge-Core Variability). In the event cores have been flagged suspect, the *Location Comparison Result* next to the applicable core will say "Suspect Core (X.X%)" (where X.X will be the average location comparison result). The Department Representative may remove suspect cores



from the analysis by clicking the button. This will reveal the options to remove the suspect cores (Figure 8). Simply click the checkbox next to the suspect cores to remove them from the analysis.

Notes:

• Remove suspect cores starting with the core with the largest *Location Comparison Average*. Sometimes not all the cores that were originally flagged will remain flagged once the core with the largest *Location Comparison Average* is removed. This information will also appear in a pop-up when the PWL Rep Suspect Core Review button is pressed.

	А	В	C	D	E	F	G	Н	I	J	К	V
1	Core Data									Р.		
1	oore Data											
2												
3	D -1[0/6/2024					1				
4	Date:		8/6/2024		Test Strip #:	1 CTU	22					
5	Mix Type:		3-MT-58-28	35	laver:		oo Jer	E.e.		1		
7	Gmm For Analysis :		2.573	55	ISI:	91.	.0	Ente	r QV Data for			
8	Gmm Source:		QC		JMF Gmm:	2.5	57	Option	hal QC/QV Core			
9				Contracto	r Core Density	Calculations		Densi	ty Verification.			
							QC Core					
		Station	from Cl	Dry	SSD	Submerged	Bulk	QC Density	Location Comparison	From Analysis?		
10	Label	Station	nomee				Density	70 OI GIIIII	Result	FIOIT Analysis:		
11	LL-1	10+38	1.5	941.0	941.7	548.6	2.394	93.0	Suspect Core (1.1%)	Remove Core 1		
12	LL-2	10+88	3.5	1,330.5	1,331.7	783.7	2.428	94.4		Remove Core 2		
13	LL-3	11+38	0.0	1,245.9	1,246.7	738.3	2.451	95.3		Remove Core 3		
14	11-5	12+38	0.5 10.5	1 336 4	1 338 6	780.0	2.444	93.0		Remove Core 5		
=:		12150	10.5	1,550.4	1,550.0	700.5	2.000	55.1				
		Random	Offset				QC Core	OC Density	Location Comparison	Remove Core Data		
		Station	from CL	Dry	SSD	Submerged	Bulk	% of Gmm	Result	From Analysis?		
18							Density			,		
19	LL-6	25+11	1.5	1,331.3	1,332.7	773.2	2.379	92.5	Suspect Core (-1.6%)	Remove Core 6		
20	LL-7	25+01	3.5	1,199.3	1,199.8	609.3	2.390	95.1	Suspect Core (-1.8%)	Remove Core 7		
21	11-9	26+61	8.5	1,105.5	1,104.2	671.4	2.407	93.5		Remove Core 9		
23	LL-10	27+11	10.5	1,110.7	1,111.7	645.7	2.383	92.6		Remove Core 10		
24						Average:	2.412	93.7				
25	Note:								D141 D			
26	The Location Compari	son Result r	eferences va	alues on the Ga	auge-Core Var	iability workshe	eet comparin	g the core	PWL Rep	Hide Core		
27	density data with each	adjusted nu	iclear densit	y gauge readir	ng at each test	location. "Susp	bect Core" is	displayed	Suspect Core	Review		
28	may be damaged. Con	anson Resul	nional PWI	Representative	when a "Susp	1.0 0r ≤ -1.0 t ect Core" is id	entified here	or when core	Review			
29	density values are cor	sidered que	stionable. O	NLY THE REG	IONAL PWL R	EPRESENTAT	IVE CAN RE	MOVE A				
30	CORE FROM ANALYS	SIS.										
31												
32	Other/Notes									1		
34	other/notes.											
35												
36												
37									Revised 4-08-25			
38												

Figure 8: Suspect Core Review Interface.

7. AC % Data

This worksheet only appears when either "Combined Density and Volumetrics" or "Volumetric-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to enter the results of the asphalt content testing.

The Department Representative will enter the following information from the asphalt content testing ():

- QC AC%
- QVAC%
- BTS Referee AC% (if required)



Figure 9: AC% Data Fields.

In the event there are unacceptable individual asphalt contents, then the corresponding BTS Referee AC% cell(s) will turn canary/yellow and will say "Enter BTS AC%." Enter the results of the BTS Referee Testing in the corresponding cell(s). (Figure 10)

In the event the *Split Sample Comparison* requires BTS Referee Testing, all of the BTS Referee AC% cells will turn canary/yellow and will say "Enter BTS AC%." Enter the results of the BTS Referee Testing in the corresponding cells. (Figure 11)



Figure 10: Individual Unacceptable Asphalt Contents.



Figure 11: Split Sample Comparison Requires BTS Referee Testing.

Additionally, the table below the data entry table shows calculated asphalt contents that are calculated using each party's Gmm in the following equation:

Calculated AC (%) =
$$100 * \frac{G_{AC,JMF}}{G_{mm,x}} * \frac{G_{se,JMF} - G_{mm,x}}{G_{se,JMF} - G_{AC,JMF}}$$

Where:

$$G_{AC,JMF} = Asphalt \ Cement \ JMF \ Specific \ Gravity$$

 $G_{se,JMF} = JMF \ Effective \ Stone \ Specific \ Gravity$
 $G_{mm,x} = Measured \ Gmm \ for \ Split \ Sample \ X \ (QC \ or \ QV)$

Individually measured asphalt contents and calculated asphalted contents for both parties as well as the acceptance limits are drawn on the chart to the right of the data entry fields. Measured values are shown in solid-colored lines and markers, where QC values are yellow, QV values are blue, and BTS Referee values are Red. Calculated values for each party are also plotted using the same colors as measured values but using dashed lines and hashed markers instead.

8. Mix Acceptance

This worksheet only appears when either "Combined Density and Volumetrics" or "Volumetric-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to accept the mixture split sample gradations and VMAs.

The Department Representative will check the box for each measured property that meets the acceptance limits for each split sample (Figure 12).



Figure 12: Mix Acceptance Checklist

Notes:

- The checklist applies to QC and QV/BTS results. If any party does not meet the acceptance limit for a property in the list, the checkbox should not be marked.
 - QV/BTS may optionally test the gradation.

If any of the requirements are not met, the split sample not meeting the requirement will be flagged with "Fail", otherwise it will be flagged with "Pass" (Figure 13).

	AB	С	D	E	F	G	Н	I		
1	Mix Acceptance Resu	ılts	Confirm that the mixture							
2	Test strip HMA mixture shall conform	to the following	conforms to acceptance limits							
3	limits based on individual QC and C	V test results	by	[,] checkir	ig the bo	xes belo	W.			
4	(tolerances based on most rec	ent JMF):								
5				S	plit Samp	le				
6				1	2	3				
7	ltem	Acceptance		Check	Check	Check				
8	% passing given Sieve:	Limits								
9	37.5-mm	+/- 8.0			v	v				
10	25.0-mm	+/- 8.0			✓	✓				
11	19.0-mm	+/- 7.5			✓	✓				
12	12.5-mm	+/- 7.5			✓	✓				
13	9.5-mm	+/- 7.5			✓	✓				
14	2.36-mm	+/- 7.0			✓	✓				
15	75-µm	+/- 3.0			✓	✓				
16	VMA in Percent ^[1]	-1.0		✓		✓				
17										
18		Test Result		PASS	FAIL	PASS				
19										
20	^[1] VMA limits based on minimum re	quirement for mix			Clear All					
21	design nominal maximum aggregate	size in table 460-1.								
22				_						
23				Re	vised 4-08	-25				
24										

Figure 13: Passing/Failing Mixture Properties.

There are several buttons for worksheet functions found above each split sample and below the results of the analysis. The buttons perform the following functions:

Check All	• Checks all properties as passing for the split sample below the button.
Clear All	• Clears all checkboxes (Resets the worksheet).

9. Air Voids Pay Factor

This worksheet only appears when either "Combined Density and Volumetrics" or "Volumetric-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to review the test strip's air voids results and the associated pay adjustments (Figure 14).

No information is to be entered into this worksheet.

Depending on the results of the t- and Xd Mean testing performed on the *Split Sample Comparison* worksheet, the QC or BTS test results will be used to calculate the air voids used to calculate the PWL_{VA} and Air Voids Pay Adjustment. Additionally, that party's Gmm values will be used to calculate the Average Gmm (cell D11) used to calculate the Target Max Density (PCF) for the density portion of the test strip. The party whose results are used for the analysis is identified by the Gmm Source (cell D12).

1	A	B	С	D	E	F	G	н	1	M	Q	R	S	T	U	V W X Y
1		Air V	oids P	ay Facto	r											
2		Date:	8/2	9/2024	Test Strip #:	1						Target _{va} :	3.0			D11 ()
з	Pr	ject ID:			Route/Road:	USH	51					LSL _{va} :	2.0			Default Contract
4	M	x Type:	4-MT	-58-28S	Layer:	Upp	ber					USL _{va} :	4.3			Unit Price
5									Air Voie	is						
6	Lot	Split Sample No.	Date	Gmm	Gmb	Air Voids	Standard Deviation	Mean	Number of Tests in Lot	PWLUL	PWLLL	PWL _{Va}	PF _{Va}	Lot Size (Ton)	Air Voids Pay Adjustment	\$ 65.00 \$ 71.45
7		1		2.443	2.367	3.1										
8	TS-1	2	8/29/2024	2.439	2.368	2.9										
9		3		2.439	2.364	3.1	0.107	3.0	3	100.00	100.00	100.00	104.00	844.88	\$ 1,098.34	460.2010 Incentive Air Voids HMA Pavement
10		Δ	erane Gmm		2 440		1									
12		G	imm Source:		QC		1									
13	Accepta	ole Gmm	& Gmb value	es carried in as	determined from	the Split Sampl	e Comparison	worksheet.								Revised 4-08-25

Figure 14: Air Voids Pay Adjustment Example.

10. Density Pay Factor

This worksheet only appears when either "Combined Density and Volumetrics" or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to review the test strip's density results and the associated pay adjustments (Figure 15).

No information is to be entered into this worksheet.

Notes:

- For a Combined Volumetric and Density Test Strip, depending on the results of the split sample comparison testing, the QC or BTS test results will be used for the Average Gmm (cell D19) for the Target Max Density (PCF) of the cores and nuclear gauge readings.
- For a Density-Only Test Strip, the Daily Average Gmm for the Density-Only Test Strip Analysis (cell I1 in *Core Data*), will be used as the Average Gmm (cell D19) to calculate density.
- The Gmm source is identified in cell D20.
- The Department Representative will determine which party's core density results will be used for acceptance, pay adjustment, and nuclear gauge correlation on the *Core Data* worksheet if verification testing is performed (otherwise the default is QC). The source of the data selected by the representative is identified in cell D21.



Figure 15: Density Pay Adjustment Example.

11. Test Strip Summary

This worksheet is used to display the acceptance results of the Test Strip as well as the Nuclear Density Gauge Correlation, if performed (Figure 16). The Nuclear Density Gauge Correlation will only appear when either "Combined Density and Volumetrics" or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet.

Each portion of the test strip is broken down into the various acceptance requirements:

- Split Sample Comparison
 - Gmm/Gmb t-test comparison.
 - Gmm within tolerance of JMF.
 - Test differences between parties are within tolerance.
- Density
 - o PWL.
 - Air Voids
 - o PWL.
- AC % and Mix
 - Acceptable asphalt contents.
 - Acceptable Gradation and VMA.

Any agreed upon resolutions to any issues that occurred during the test strip should be entered in the Resolutions space at the bottom of this worksheet (range C46:H51). Examples of resolutions include, but are not limited to:

- Test Strip left in place but required the construction of another test strip prior to continuing to production.
- Test Strip removed and replaced.
- Contractor will make an adjustment to some process to bring some parameter back into acceptable limits.
- Contractor will reheat mixture during production to account for testing differences between parties.
- Etc.

This worksheet will decide based on the results of the test strip whether the material is acceptable (shown in ranges C9:H9 and C10:H10). It also determines the following outcomes of the test strip:

- Approved, proceed with production.
- Approved; However, consult Regional PWL Rep. & BTS prior to proceeding with production.
- Not approved. Consult Regional PWL Rep. & BTS.

В	C D	E F	G	Н	I	J	К
Tost Strin	Summary						
Contract	Summary	Teet Strip #-		1	Paving Width(ft):	16.0	
h No /Project ID:		Route/Road:	ST	1 96	Lane Width(ft):	11.0	
	0-250-0152-2024	Test Strin Laver:		ner	Nominal Thickness(in):	2 00	
Mix Type:	4-MT-58-28S	Underlying Layer:	Fristin		Contract Unit Price:	\$73.40	-
File Name:	STH 96 4-MT-58-28S Upper PWL-TS-1-C	Test Strip Type:	Combined Density and	Volumetrics Test Strip		\$10.40	
			,		-		
	Overall Test Strip Approval	and Material Acc	ceptance		Save with Suggested F	ile Name and send a copy	
Test Strip	Approved; However, consult Regional PW	L Rep. & BTS prio	or to proceeding wi	th production.	of the completed Te	st Strin Excel file to the	
Material	Conforming, Test Strip	Material May Ren	nain in Place.		Regional PM	/I Ren and RTS	
	Split Sample C	omparicon			incgional P vi	i i i i	
	Cmm Split Sample t-test Results	ompanson	Datacete Compar	•		- 7.	
	Cmm Test Differences Within Telerance2	Test differ	oncos within tostir	c. In tolorance	Save As with Suggested	File Name	
	Cmm Within Tolorance to IME2	Cmmc ar	within IME Accor	ig tolerance.	and Email to BTS for	Review	
	Gmb Split Sample Ltost Booults	Ginnis are	Datagete Compar				
	Cmb Test Differences Within Telerance2	Tost diffor	onces within testir	e. In tolerance	Export All Worksheet	s as PDF	
	Gind rest differences within Tolerance?	rest differ	ences within testir	ig tolerance.			
	Fass						
	Densi	ty			Export Test Strip Summ	ary as PDF	
	Density Test Strip Tonnage		497.5				
	PWL		100.00				
	Pay Factor		104.00				
	Density Net Pay Adjustment		\$646.69		460.2005 Incentive Densit	y PWL HMA Pavement	
Non-Rando	om Gmm Test Result (Density Only Test Strip)		Not Applicable.				
	Pass	i					
	Air Voi	ds					
	Air Voids Test Strip Tonnage		769.66				
	PWL		100.00				
	Pay Factor		104.00				
	Air Voids Net Pay Adjustment		\$1.000.56		460 2010 Incentive Air Voi	ids HMA Pavement	
	Pass		+ 1,2 2 2 2 2				
1	AC I/ and Mix Assa	ménunga Denvilée			1		
	AC % and Mix Acce	ptance Results		reneas more than 0.2%			
	AC % and Mix Acce AC %	ptance Results Acceptable, but cons	sult BTS for QC-QV diffe	rences more than 0.2%.			
	AC % and Mix Acce AC % Mix Acceptance	ptance Results Acceptable, but cons	sult BTS for QC-QV diffe Pass	rences more than 0.2%.			
	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug	eptance Results Acceptable, but cons Correlation (Inf	o from QC/QV Density.	rences more than 0.2%. Correlation, and Gauce	e-Core Variability Workshe	ets)	
Gauge ID	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial #	e Correlation (Inf Core Spread (%)	o from QC/QV diffe	rences more than 0.2%. Correlation, and Gauge Gauge Comp. Avg.	e-Core Variability Workshe	ets) Gauge Recommendation	Gauge Offset
Gauge ID I	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8969	Ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%)	o from QC/QV Density, Gauge Spread (%) 2.5	rences more than 0.2%. Correlation, and Gauge Gauge Comp. Avg. 0.7	e-Core Variability Workshe Correlation R ² 2.28%	ets) Gauge Recommendation Secondary QC	Gauge Offset
Gauge ID I QC-1 QC-2	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8969 8055	Ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%)	o from QC/QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8	rences more than 0.2%. Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6	e-Core Variability Workshe Correlation R ² 2.28% 2.61%	ets) Gauge Recommendation Secondary QC Primary QC	Gauge Offset 0.8 0.4
Gauge ID 1 QC-1 QC-2 QV-1	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8969 8058 30869	e Correlation (Inf Core Spread (%)	o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4	e-Core Variability Workshe Correlation R ² 2.28% 2.61% 60.06%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV	Gauge Offset 0.8 0.4 0.3
Gauge ID 1 QC-1 QC-2 QV-1 QV-2	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8969 80668 300609 30061	e Correlation (Inf Core Spread (%)	o from QC/QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4 0.4	-Core Variability Workshe Correlation R ² 2.28% 2.61% 60.06% 30.46%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6
Gauge ID I QC-1 QC-2 QV-1 QV-2	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gauge NUCDENSITYTEC Gauge Serial # 8969 8058 300699 30961	ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%) 1.4	o from QC-QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4 0.4	-Core Variability Workshe Correlation R ² 2.28% 2.61% 66.06% 30.46%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6
Gauge ID I QC-1 QC-2 QV-1 QV-2 Resolutions: I	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8069 8069 300809 300961	ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%) 1.4	o from QC/QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4 0.4	e-Core Variability Workshe Correlation R ² 2.28% 2.61% 66.08% 30.46%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6
Gauge ID I QC-1 QC-2 QV-1 QV-2 Resolutions:	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 8969 8055 30069 30061	ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%) 1.4	ault BTS for QC-QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4 0.4	e-Core Variability Workshe Correlation R ² 2.28% 2.61% 60.00% 30.46%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6
Gauge ID I QC-1 QC-2 QV-2 I Resolutions: I	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gauge NUCDENSITYTEC Gauge Serial # 8069 80658 300869 300961	ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%) 1.4	sult BTS for QC-QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.6 0.4 0.4 0.4	-Core Variability Workshe Correlation R ² 2.28% 2.61% 68.06% 30.46%	ets) Gauge Recommendation Secondary QC Primary QV Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6
Gauge ID I QC-1 QC-2 QV-1 QV-2 Resolutions: I	AC % and Mix Acce AC % Mix Acceptance Nuclear Density Gaug NUCDENSITYTEC Gauge Serial # 80069 80058 300809 300901	ptance Results Acceptable, but cons e Correlation (Inf Core Spread (%) 1.4	suit BTS for QC-QV diffe Pass o from QC/QV Density, Gauge Spread (%) 2.5 1.8 2.1 1.7	Correlation, and Gauge Gauge Comp. Avg. 0.7 0.8 0.4 0.4 0.4	e-Core Variability Workshe Correlation R ² 2.81% 66.06% 30.46%	ets) Gauge Recommendation Secondary QC Primary QC Primary QV Secondary QV	Gauge Offset 0.8 0.4 0.3 0.6

Figure 16: Test Strip Summary Example.

There are several buttons for worksheet functions found on the righthand side of the interface. The buttons perform the following functions:

Save As with Suggested File Name and Email to BTS for Review	 Saves the spreadsheet as a new Excel file (without overwriting old versions) with the suggested file name, including the date and time that the spreadsheet was saved. Creates a new email to send the test strip file to BTS. (Note: This function only works with Outlook.) You will be able to edit the email before it sends.
Export All Worksheets as PDF	• Exports the entire spreadsheet and its worksheets as a PDF.
Export Test Strip Summary as PDF	• Exports only the Test Strip Summary worksheet.

12. Gauge-Core Variability

This worksheet only appears when either "Combined Density and Volumetrics" or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instruction* worksheet. This worksheet is used to review the Location Comparison Averages and the Gauge Comparison for nuclear gauge correlation portion of the test strip (Figure 17).

No information is to be entered into this worksheet.

The tables on the left half of the worksheet reflect the comparisons which may or may not have suspect cores removed from the analysis. The tables on the right half of the worksheet reflect the comparisons using all of the original data with no removed suspect cores.

Notes:

- The Location Comparison table is used to determine whether a core is deemed suspect. A core is deemed suspect when the Average of the Adjusted Differences (cells G12-G21) from all the gauges is either greater than or equal to 1.0 or less than or equal to 1.0 for a specific core. Suspect cores will be flagged in the table automatically with a red background Location Comparison Average and "Suspect Core" appearing in the third column (Figure 18). Cores deemed suspect may only be removed from the analysis by the Department Representative. Removing cores can be done in the *Core Data* worksheet. Refer to section 6 Core Data for additional information on removing cores (Figure 19).
- The Gauge Comparison table is used to determine whether a nuclear gauge is deemed suspect. A nuclear gauge is deemed suspect when the Average Absolute Adjusted Difference (Cells B36, C36, D36, and E36) for a particular gauge is greater than or equal to 1.0%. Suspect gauges will be flagged in the table automatically with a red background showing on the testing party, gauge ID, and Gauge Comparison Average (Figure 18). Gauges deemed suspect should be removed from the project and further diagnostics should be performed in coordination with the WisDOT Radiation Safety Officer.



Figure 17: Gauge-Core Variability Tables







Figure 19: Removed Suspect Cores Example.

13. QC-X / QV-X Density Worksheets

These worksheets only appears when either "Combined Density and Volumetrics" or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instructions* worksheet. These are the field density worksheets that should be used for the test strip by the density technicians. These worksheets can be saved as PDFs and printed from the *Project Info & Instructions* worksheet if desired. These worksheets must be filled out to complete the nuclear gauge correlation.

The Department Representative will enter the following information into the worksheet received from the density technicians:

- Density and Moisture Standards
- Gauge Serial Number
- QC/QV Technician Name
- M Counts / D Counts for Reading 1
- Wet Density 1 (PCF)
- M Counts / D Counts for Reading 2
- Wet Density 2 (PCF)
- M Counts / D Counts for Reading 3 (if required)
- Wet Density 3 (PCF) (if required)
- Test Remarks

	* P\	NL DENS	ITY DAT	A FORM (LANI	E FOOT)	Revised 4-08-25	G	8	1	,	×	ı	м	н о
	Nucl	ear HMA	Density	QC/QV Testing	Records	TEST STRIP #1	QC-1	LAYER:	Lo	wer		Density Standard:		4012
	Station De	creasing:	FALSE									Moisture Standard		997
ż	Project ID:				Road Name:	STH 3	3	Contractor:				Gauge Serial #:		31529
į	Project Leader:				County:	Colum	pia	QC NUCDENSITYTEC:				WisDOT Mix #:	:	250-0230-2024
,			TE	ST STRIP - Fiel	d Density Works	heet		QV NUCDENSITYTEC:		N/A		Mix Type:		3-MT-58-28S
,	• Offsets are	e nredet	ermined	according to	the test strin lav	out in WisDOT's I	Manual of	Start:	02+74	End:	39+27	Target Gmm:		2.573
	Test Proced	ures WT	FP H-002		me est serip ing			Length (ft):		3,653		Target Max Density (PCF):		160.1
,	 Gauge off The Targe 	set is sel t Max Gi	t to ZER(mm is th	D since offsets e average fro	s will be determin m the 3 split sam	ed from the test : ples, except for a	strip. density only	Lane Width (ft):		12.0		Required Density %:		91.0
11	test strip, ti	hen it is i I ner Wie	the daily	raverage Gmi Manual of Test	m from productio	n. VI T355		Nominal Thickness(in):		2.75		Date Placed:		8/6/2024
	- calculatet	i per un	300131	-	critice unes with	11555.		Gauge Offset		ZERO		Date Tested:		8/6/2024
12	Gauge/Core S	pacing (ft)	50		Reading 1		R	eading 2 (rotate 180))	Reading 3	(if needed, ori	ginal orientation)		Final Density
13	Lot / Sub Lot ID	Station	Offset from CL	M Count / D Count	₩et Density 1	% Max Density 1	M Count / D Count	₩et Density 2	% Max Density 2	M Count / D Count	₩et Density 3	% Max Density 3	Average PCF	% Max Density
14	LL-1	09+94	1.5	203/1976	146.2	91.3%	201/1968	146.7	91.6%				146.5	91.5%
15	LL-2	10+44	3.5	189/1929	148.8	92.9%	206/1918	149.4	93.3%				149.1	93.1%
"	LL-3	10+94	6.0	207/1897	150.5	94.0%	197/1912	149.7	93.5%				150.1	93.8%
17	LL-4	11+44	8.5	187/1892	150.8	94.2%	195/1909	149.9	93.6%				150.4	93.9%
8	LL-5	11+94	10.5	192/1910	149.8	93.6%	192/1975	146.3	91.4%	188/1912	149.7	93.5%	149.8	93.6%
21	LL-6	30+75	1.5	193/1915	149.5	93.4%	201/1927	148.9	93.0%				149.2	93.2%
21	LL-7	31+25	3.5	206/1899	150.4	93.9%	199/1889	151.0	94.3%				150.7	94.1%
22	LL-8	31+75	6.0	196/1905	150.1	93.8%	200/1913	149.7	93.5%				149.9	93.6%
23	LL-9	32+25	8.5	204/1958	147.2	91.9%	204/1911	149.8	93.6%	200/1950	147.6	92.2%	147.4	92.1%
24	LL-10	32+75	10.5	193/1937	148.3	92.6%	201/1922	149.2	93.2%				148.8	92.9%
25 26	Target Max De	nsity = Gmr	m x 62.24					Test Remarks						
27 28														
**														
32														
34														

Figure 20: QC-X/QV-X Field Density Worksheet Example.

14. QC-X / QV-X Correlation

These worksheets only appears when either "Combined Density and Volumetrics" or "Density-Only" is selected as the Test Strip Type on the *Project Info & Instructions* worksheet. These worksheets are used to review the correlation of each nuclear gauge.

No information is to be entered into this worksheet.

	A B	C D E	F G H	1	J K L	M N	O F	Q I	R S	T U V
1	B L J	Wiscon	sin Departmer	nt	95.5		y = 0.7277x + 2 R ² = 0.51	16.419 L	•	
3 4 5	AT TRANSPORT	of Tr	ansportation		95.0					
6	Revised 4-08-2	5			Ê 945					
7 8		Nuclear / Cor	e Correlation Works	heet	(% Gmn			-		
9	Date:	8/6/2024	Test Strip #:	1	A: 94.0					
10	Contract:		Layer:	Lower	e De					
11	JOD NO.: Poute:	STH 33	Mixture Type: 3	-M1-58-285	ğ 93.5					
13	Underlying Matl.:	:led HMA (Pulverize or Mill and R	Layer Thickness:	2.75						
14	WisDOT Mix No.:	250-0230-2024	Gmm:	2.573	93.0				•	
15	Mix Type:	3-MT-58-28S	Core Diameter:	6 inches						
16	Test Strip Type:	Combined Density	and Volumetrics Test Strip)						
17	NUCDENSITYTEC:				92.5	91.5	92.0 92.5	93.0	93.5 94	0 945
19	Gauge No.:	31529					Gauge R	ading (% Gmm)		
20	-		-				-			
21	ZONE 1									
22	Static	on (@ center of Zone):	10+94		C	ALCULATIONS			R-Square	d: 51.10%
23 24 25 26 27 28 29	Reading 1 (pcf) Ll-1 146.2 LL-2 148.8 Ll-3 150.5 Ll-4 150.8 Ll-5 149.8	Reading 2 (pcf) Difference (pcf) 146.7 0.5 149.4 0.6 149.7 0.8 149.9 0.9 146.3 3.5	Reading 3* (pcf) 111111111111111111111111111111111111	Ave Nuclear (pcf) 146.5 149.1 150.1 150.4 149.8	Core Gmb A 2.394 2.428 2.451 2.444 2.396 2.396	ve Nuclear (%) 91.5 93.1 93.8 93.9 93.6	Core Density (%) 93.0 94.4 95.3 95.0 93.1	Difference (%) 1.5 1.3 1.5 1.1 -0.5	Adjusted Nuc. (%) 92.6 94.2 94.9 95.0 94.7	Adj. Diff. (%) 0.4 0.2 0.4 0.0 -1.6
31	ZONE 2									
32	Static	on (@ center of Zone):	31+75							
33										
34 35 36 37 38 39 40	Reading 1 (pcf) LL-6 149.5 LL-7 150.4 LL-8 150.1 LL-9 147.2 LL-10 148.3	Reading 2 Difference (pcf) 148.9 0.6 151.0 0.6 149.7 0.4 149.8 2.6 149.2 0.9	Reading 3* (pcf) 1111 1111 1111 1111 1111 1111	Ave Nuclear (pcf) 149.2 150.7 149.9 147.4 148.8	Core Gmb A 2.438 2.407	ve Nuclear (%) 93.6 92.1	Core Density (%) 94.8 93.5	Difference (%) 1.2 1.4	Adjusted Nuc. (%) 94.7 93.2	Adj. Diff. (%) 0.1 0.3
41					Spread (%):	2.4	2.3		OFFSE	T: 1.1
									OFFSE	T: 0.6
42 43								(includir	ng removed core	(s) 0.0

Figure 21: QC-X/QV-X Correlation Example.

Notes:

• Cores that were removed from the analysis on the *Core Data* worksheet will not appear in the tables nor will they affect the correlation.

15. Appendix

15.1 t-Testing

The spreadsheet adheres to the specifications for determining whether QC and QV data compare by conducting paired t-tests on *Split Sample Comparison* data.

The t-tests during the test strip use an alpha value of 0.01. The alpha value determines the likelihood of a "false flag" or a failed comparison due to factors other than an actual difference in the population (or material source). Using an alpha value of 0.01, the t-test will fail 1 in 10 times (or about 10% of the time) when the two datasets are actually from the same population. The t-tests "pass" or compare when the p-value from either test is greater than alpha.

15.2 Enabling Macros (Red Banner)

As of February 23, 2023, Microsoft has blocked macros by default from spreadsheets downloaded from the internet (i.e.: Pantry) to provide additional protection from malicious macros. When this occurs, you will see an error like this at the top of the spreadsheet:



When this error is presented, you will be unable to enable macros using old methods where you could simply click the button in the banner to enable macros. Additional steps are required to enable the macros. Perform the following steps to enable macros:

Guidance on allowing VBA macros to run in files you trust

Remove Mark of the Web from a file

For an individual file, such as a file downloaded from an internet location or an email attachment the user has saved to their local device, the simplest way to unblock macros is to remove Mark of the Web. To remove, right-click on the file, choose **Properties**, and then select the **Unblock** checkbox on the **General** tab.

eneral Secu	rity Details Previous Vers	ions		
w	TestDocument.docm			
Type of file:	Microsoft Word Macro-Enabl	ed Document (.docm)	_	
Opens with:	Word	Change		
Location:	C:\Users\			
Size:	13.5 KB (13,850 bytes)			
Size on disk:	20.0 KB (20.480 bytes)			
Created:	Monday, January 24, 2022, 11	1:33:42	_	
Modified:	Monday, January 24, 2022, 11	1:33:42		
Accessed:	Today, January 24, 2022, 11:	33:43		
Attributes:	Read-only Hidden	Advanced.		
Security:	This file came from another c and might be blocked to help this computer.	omputer protect Unblock		

Additional information about this change can be found on Microsoft's website at: https://learn.microsoft.com/en-us/deployoffice/security/internet-macros-blocked