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.

2. Table of Contents

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.

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.
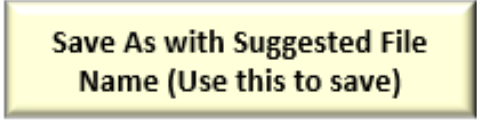
5. Split Sample Comparison

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)

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.
4. 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.

Split Sample Testing Comparison

Date:	8/29/2024		Test Strip #:	1
Project ID:			Route/Road:	USH 51
Mix Type:	4-MT-58-28S		Layer:	Upper
JMF Gmm:	2.445			

If datasets compare and testing differences are within testing tolerance, QC data is carried into the Air Voids Pay Factor worksheet. If not, BTS will conduct referee Gmm & Gmb tests and BTS data will be used for subsequent calculations.
If QC and QV datasets do not compare, BTS referee Gmm and Gmb test data needs to be entered in the BTS Referee Gmm/Gmb Column.

G$_{mm}$

										BTS Vs. QC Results			BTS Vs. QV Results			Gmm Xd Mean Tolerance
Split Sample Number	Tonnage	QC Gmm	QV Gmm	Difference (X$_d$)	X$_d$ Mean	0.007	Degree of Freedom	2	BTS Referee Gmm	Difference (X$_d$)	X$_d$ Mean		Difference (X$_d$)	X$_d$ Mean		0.012
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		
2	338	2.439	2.447	0.008	Test differences within testing tolerance.											
3	680	2.439	2.446	0.007	Split Sample Results:		Do not Compare.									

G$_{mm}$ Tolerance to JMF

Split Sample Number	Tonnage	QC Gmm-JMF Difference	QV Gmm-JMF Difference				BTS Gmm-JMF Difference									Gmb Xd Mean Tolerance
1		0.002	0.004													
2		0.006	0.002													
3		0.006	0.001													

Gmms are within JMF Acceptance Limit.

G$_{mb}$

										BTS Vs. QC Results			BTS Vs. QV Results			
Split Sample Number	Tonnage	QC Gmb	QV Gmb	Difference (X$_d$)	X$_d$ Mean	0.002	Degree of Freedom	2	BTS Referee Gmb	Difference (X$_d$)	X$_d$ Mean		Difference (X$_d$)	X$_d$ Mean		0.012
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		
2		2.368	2.370	0.002	Test differences within testing tolerance.											
3		2.364	2.364	0.000	Split Sample Results:		Datasets Compare.									

☑ Failed t-test but Xd Mean and Gmm All Within Tolerance - No Referee Test Needed.
Regional PWL Rep. Approving Split Sample Data
Bob Seger

Air Voids %		
Contractor	Department	BTS
3.1	3.1	
2.9	3.1	
3.1	3.4	

Note:
This review is a check for reasonable test result differences between labs. Due to the small sample size, <20, it is possible to have two sets of data that fail the t-test (p-value), but the *"test results are within testing tolerance"*. For such differences, if allowed by the engineer, asphalt mix production may resume as the test result differences are based on small sample sizes and consistent testing differences. In such case, if all Gmm are within Tolerance to JMF and both Xd Mean are within testing tolerance QC Gmm and Gmb data will be used for analysis if the box at the right is checked and the name of the Regional PWL Rep is entered in the box below.

It is also possible to have two-sets of test results that are so variable that the results pass the t-test (p-value), but the *"test differences exceed testing tolerance"*. The cause of this type testing variation needs to be resolved before production of mix resumes.

Revised 4-08-25

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)

Core Data

	Date:		Test Strip #:		
	Project ID:		Route/Road:		
	Mix Type:	--	Layer:		**Enter QV Data for Optional QC/QV Core Density Verification.**
	Gmm For Analysis :		LSL:	Enter Mix and Layer Info	
	Gmm Source:	QC	JMF Gmm:	Enter JMF Gmm.	

Contractor Core Density Calculations

Label	Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result
	-01+00							
	-00+50							
	00+00							
	00+50							
	01+00							

	Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result
	-01+00							
	-00+50							
	00+00							
	00+50							
	01+00							

Average:

PWL Rep Suspect Core Review

Note:
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.

Other/Notes:

Revised 4-08-25

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

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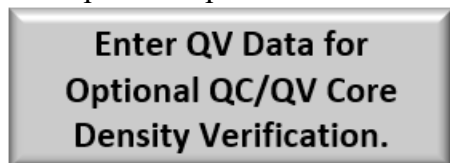
Enter QV Data for Optional QC/QV Core Density Verification. button to reveal the data entry fields (Figure 7). Additionally, the Department Representative, at their discretion, can select which data set, QC or QV, to use for acceptance, pay adjustment, and nuclear gauge correlation.

Notes:

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

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.

Core Data

	Date:	8/6/2024			Test Strip #:	1	
	Project ID:				Route/Road:	STH 33	
	Mix Type:	3-MT-58-28S			Layer:	Lower	
	Gmm For Analysis :	2.573			LSL:	91.0	
	Gmm Source:	QC			JMF Gmm:	2.567	

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

Contractor Core Density Calculations

Label	Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result	Remove Core Data From Analysis?
LL-1	10+38	1.5	941.0	941.7	548.6	2.394	93.0	Suspect Core (1.1%)	☐ Remove Core 1
LL-2	10+88	3.5	1,330.5	1,331.7	783.7	2.428	94.4		☐ Remove Core 2
LL-3	11+38	6.0	1,245.9	1,246.7	738.3	2.451	95.3		☐ Remove Core 3
LL-4	11+88	8.5	993.9	994.7	588.1	2.444	95.0		☐ Remove Core 4
LL-5	12+38	10.5	1,336.4	1,338.6	780.9	2.396	93.1		☐ Remove Core 5

Label	Random Station	Offset from CL	Dry	SSD	Submerged	QC Core Bulk Density	QC Density % of Gmm	Location Comparison Result	Remove Core Data From Analysis?
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
LL-7	25+61	3.5	1,199.3	1,199.8	699.3	2.396	93.1	Suspect Core (-1.8%)	☐ Remove Core 7
LL-8	26+11	6.0	1,183.3	1,184.2	698.8	2.438	94.8		☐ Remove Core 8
LL-9	26+61	8.5	1,146.8	1,147.8	671.4	2.407	93.5		☐ Remove Core 9
LL-10	27+11	10.5	1,110.7	1,111.7	645.7	2.383	92.6		☐ Remove Core 10
					Average:	2.412	93.7		

PWL Rep Suspect Core Review

Hide Core Review

Note:
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.

Other/Notes:

Revised 4-08-25

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%
- QV AC%
- 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)
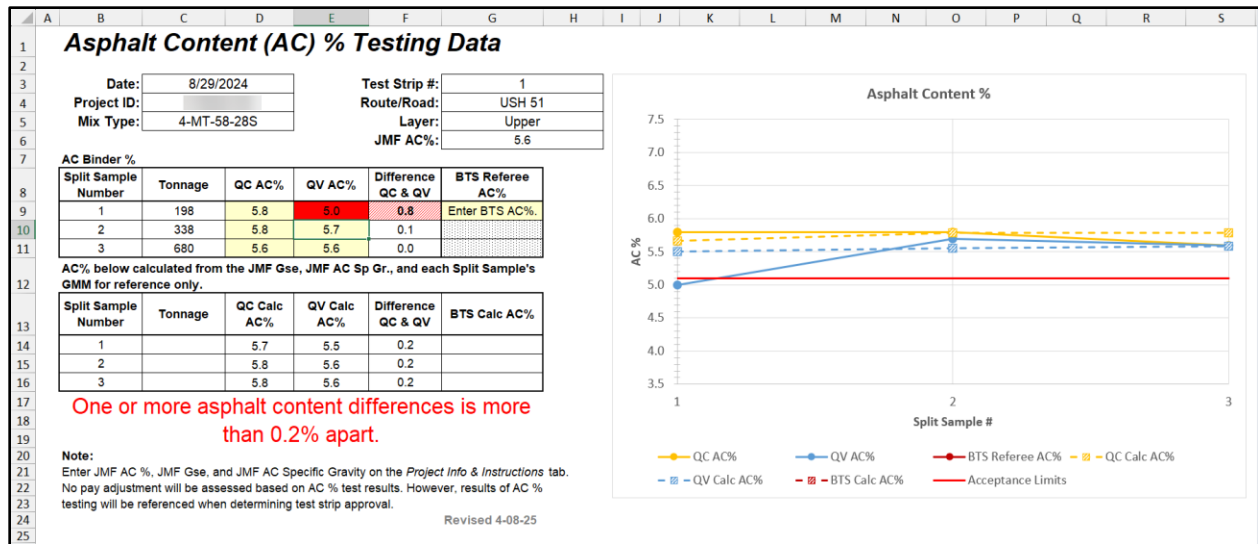
Figure 10: Individual Unacceptable Asphalt Contents.
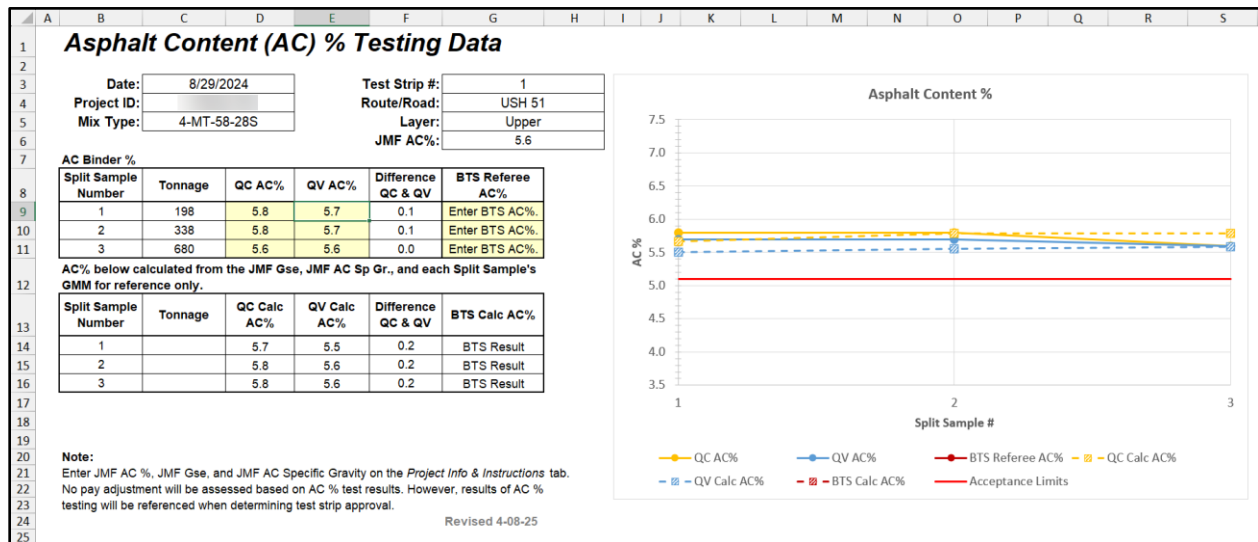
Figure 11: Split Sample Comparison Requires BTS Referee Testing.

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:

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

$$G_{se,JMF} = JMF\ Effective\ Stone\ Specific\ Gravity$$

$$G_{mm,x} = Measured\ Gmm\ for\ Split\ Sample\ X\ (QC\ or\ QV)$$

13

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).

The spreadsheet contains the following content:

Mix Acceptance Results

Test strip HMA mixture shall conform to the following limits based on individual QC and QV test results (tolerances based on most recent JMF):

Confirm that the mixture conforms to acceptance limits by checking the boxes below.

Split Sample

Item % passing given Sieve:	Acceptance Limits	1	2	3
		Check All	Check All	Check All
37.5-mm	+/- 8.0	☑	☑	☑
25.0-mm	+/- 8.0	☑	☑	☑
19.0-mm	+/- 7.5	☑	☑	☑
12.5-mm	+/- 7.5	☑	☑	☑
9.5-mm	+/- 7.5	☑	☑	☑
2.36-mm	+/- 7.0	☑	☑	☑
75-μm	+/- 3.0	☑	☑	☑
VMA in Percent[1]	-1.0	☑	☐	☑
Test Result		PASS	FAIL	PASS

Clear All

[1] VMA limits based on minimum requirement for mix design nominal maximum aggregate size in table 460-1.

Revised 4-08-25

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).

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
    - PWL.
- Air Voids
    - 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.

Test Strip Summary

Contract:		
Job No./Project ID:		
WisDOT Mix No.:	0-250-0152-2024	
Mix Type:	4-MT-58-28S	
File Name:	_STH 96_4-MT-58-28S_Upper_PWL-TS-1-C	

Test Strip #:	1
Route/Road:	STH 96
Test Strip Layer:	Upper
Underlying Layer:	Existing HMA
Test Strip Type:	Combined Density and Volumetrics Test Strip

Paving Width(ft):	16.0
Lane Width(ft):	11.0
Nominal Thickness(in):	2.00
Contract Unit Price:	$73.40

Overall Test Strip Approval and Material Acceptance

Test Strip	Approved; However, consult Regional PWL Rep. & BTS prior to proceeding with production.
Material	Conforming, Test Strip Material May Remain in Place.

Save with Suggested File Name and send a copy of the completed Test Strip Excel file to the Regional PWL Rep. and BTS ( ).

Save As with Suggested File Name and Email to BTS for Review

Export All Worksheets as PDF

Export Test Strip Summary as PDF

Split Sample Comparison

Gmm Split Sample t-test Results	Datasets Compare.
Gmm Test Differences Within Tolerance?	Test differences within testing tolerance.
Gmm Within Tolerance to JMF?	Gmms are within JMF Acceptance Limit.
Gmb Split Sample t-test Results	Datasets Compare.
Gmb Test Differences Within Tolerance?	Test differences within testing tolerance.
Pass	

Density

Density Test Strip Tonnage	497.5
PWL	100.00
Pay Factor	104.00
Density Net Pay Adjustment	$646.69
Non-Random Gmm Test Result (Density Only Test Strip)	Not Applicable.
Pass	

460.2005 Incentive Density PWL HMA Pavement

Air Voids

Air Voids Test Strip Tonnage	769.66
PWL	100.00
Pay Factor	104.00
Air Voids Net Pay Adjustment	$1,000.56
Pass	

460.2010 Incentive Air Voids HMA Pavement

AC % and Mix Acceptance Results

AC %	Acceptable, but consult BTS for QC-QV differences more than 0.2%.
Mix Acceptance	Pass

Nuclear Density Gauge Correlation (Info from QC/QV Density, Correlation, and Gauge-Core Variability Worksheets)

Gauge ID	NUCDENSITYTEC	Gauge Serial #	Core Spread (%)	Gauge Spread (%)	Gauge Comp. Avg.	Correlation R²	Gauge Recommendation	Gauge Offset
QC-1		8969		2.5	0.7	2.28%	Secondary QC	0.8
QC-2		8058	1.4	1.8	0.6	2.61%	Primary QC	0.4
QV-1		30869		2.1	0.4	66.06%	Primary QV	0.3
QV-2		30961		1.7	0.4	30.46%	Secondary QV	0.6

Resolutions:

Revised 4-08-25

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.

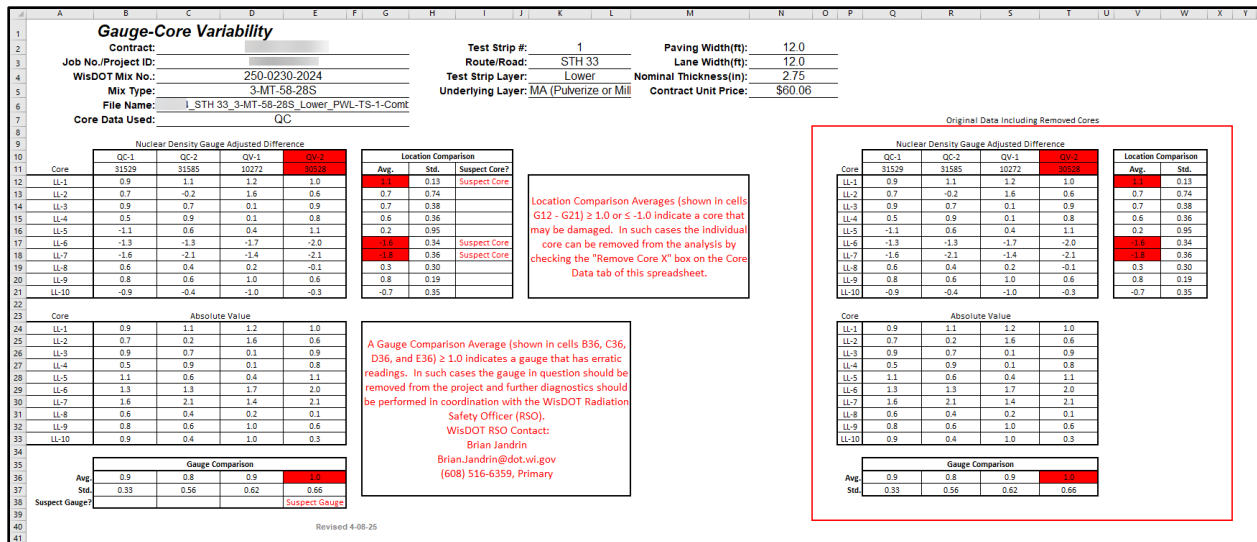

Figure 17:Gauge-Core Variability Tables

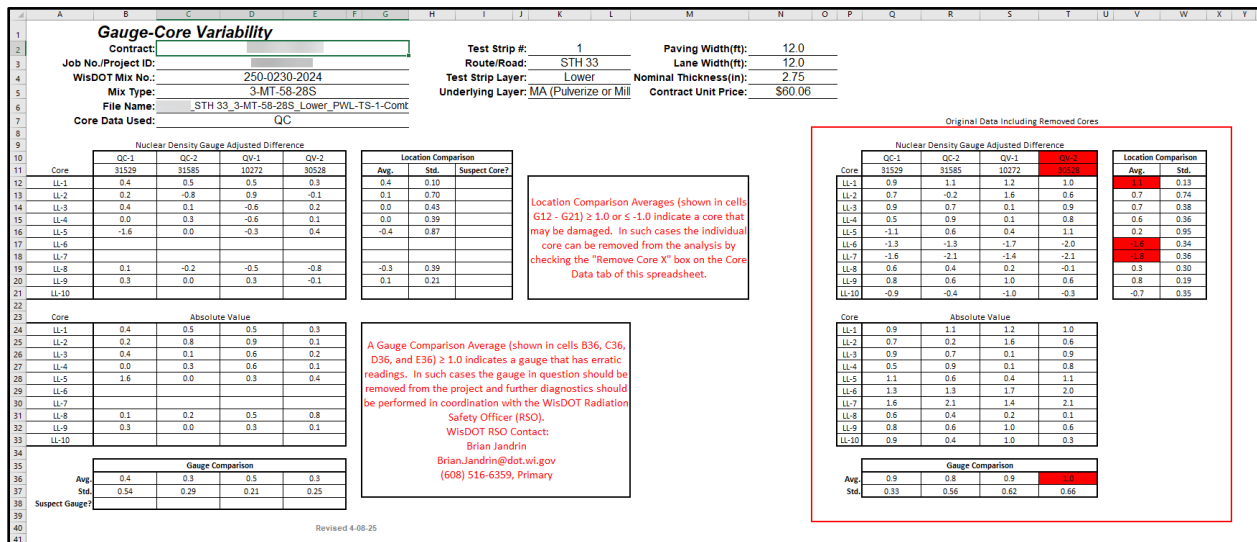*Figure 18: Suspect Cores/Gauges Example.*

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

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.

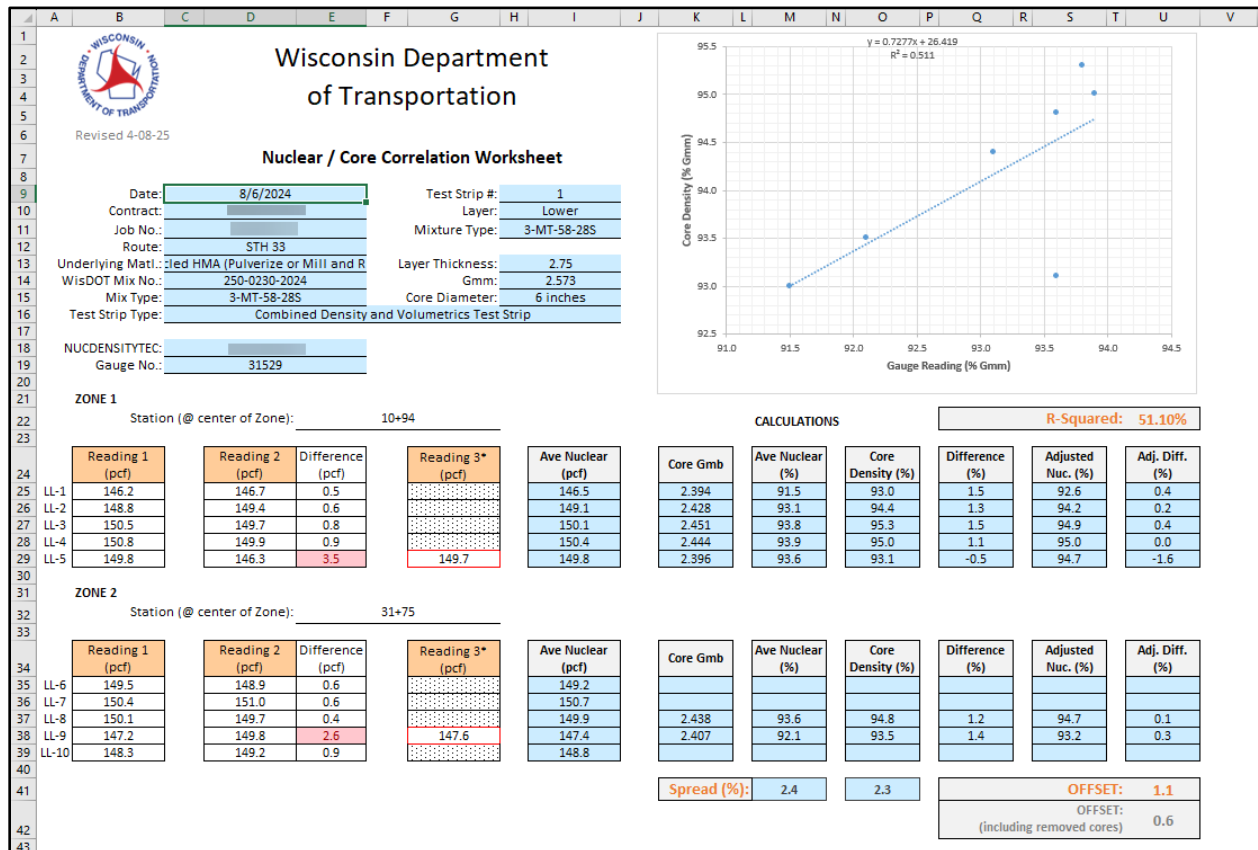No information is to be entered into this worksheet.

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:
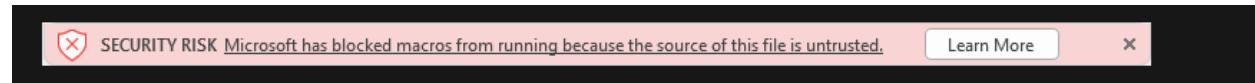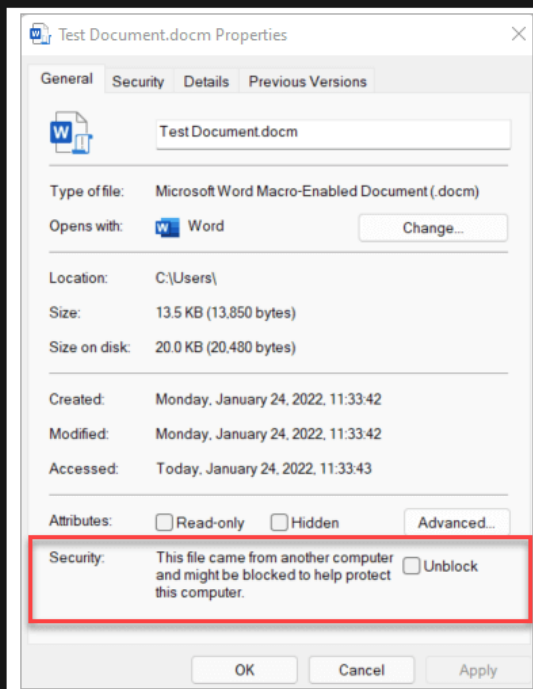

When this error is presented, you will be unable to enable macros using old methods where you could simply click the button in the banner to enable macros. Additional steps are required to enable the macros. Perform the following steps to enable macros:

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