Delaware Department of Transportation

REQUEST FOR PROPOSALS
PROFESSIONAL SERVICES

RFP Number: **2154S**

PAVEMENT MANAGEMENT SUPPORT SERVICES

Submission Due Date/Time: **Thursday November 14, 2024, no later than 2:00 P.M. Local Time**

Three (3) year term with two (2) possible one-year extensions

Agreement Type: On-Call

One (1) agreement may be awarded from this solicitation

Funding: State

The anticipated method of payment is cost plus fixed fee

pursuant to 29 *Del. C.* §6981

PROJECT INFORMATION

This Request for Proposal (RFP) issued by the Delaware Department of Transportation (DelDOT) is for the purpose of acquiring Proposals from qualified firms to provide services to aid with their pavement management system and various tasks associated with DelDOT's pavement management program.

PROJECT DESCRIPTION

DelDOT is seeking consultants to provide support to its Pavement Management program. This program utilizes the AgileAssets Pavement Analyst software to manage, analyze, and optimize a paving program to keep Delaware's road network in a state of good repair. The selected consultant must be familiar with pavement management concepts, pavement distress identification, and automated pavement distress collection, and the AgileAssets pavement analyst tool. The selected consultant must also be familiar with necessary Federal Highway Reporting requirements, such as 23 C.F.R. §515 and the Federal Highway Performance Monitoring System (HPMS). Please refer to **Attachment A**: Pavement Data Dictionary.

CONSULTANT SERVICES REQUIRED

- **Pavement Condition Data Collection Support**
  - Ensure compliance with DelDOT's Data Quality Management Plan (DQMP)
  - Coordination with DelDOT and Data Collection Vendor involving collection process improvements, updates, and documentation.
  - Configuration of pavement management system
  - Field reviews and condition assessments if necessary
- **General Pavement Management and Engineering practice Support**
  - Developing new and updating existing treatments and decision trees
  - Managing and updating treatment unit costs
  - Calibrating existing and developing new performance models and index benefits

- Assist in developing treatment recommendations and project selection criteria.
- Support in the management of the master work plan and its analysis within the pavement management system.
- Support in management of the construction history in the pavement management system.
- Develop and manage optimization scenarios based on varying criteria within the pavement management system to help with condition and budget projections.

- **Support within AgileAssets Pavement Analysis Software**
    - Coordination with software vendor to fix bugs and test and implement upgrades.
    - Performing system calibration to ensure system configuration is working as expected.
    - Possible field validation of analysis scenarios results.
    - Configuring various aspects of software when implementing updates to pavement management practices, including database configuration, system jobs and procedures, data imports, tables, windows, etc. (i.e., implementing necessary changes in the Pavement Management System to reflect updated performance models, treatment, selection, etc.)
    - Linear Referencing System and Inventory data processing and management within the pavement management system.

- **Pavement Management Business Process Support**
    - Support efforts with keeping DelDOT's Pavement Management Business Process updated and relevant.
    - Assist in keeping the program's Standard Operating Procedures document updated as improvements are implemented.
    - Assist with keeping DQMP up to date for federal review and certification, as required by 23 CFR 490.319(c).

- **Federal and State Reporting Support**
    - Ensure compliance with DelDOT's Transportation Asset Management Plan (TAMP) and assist with updates and consistency reviews to confirm compliance with the TAMP.
    - Provide presentations for executive level managers on the Pavement Management Program and PMS initiatives.
    - Developing and updating reports for presenting pavement management data.

- Provide End User training for the Pavement Management System and its different features.

QUESTIONS

Questions must be submitted before the due date identified in the Procurement Schedule for this RFP. All inquiries must be submitted in the Q/A section of the project listing in the Bonfire Procurement Portal.

DelDOT's response to questions will be posted, according to the procurement schedule, under the project listing in Bonfire and to the State of Delaware Bid Solicitation Directory Website: http://www.bids.delaware.gov/.

Direct contact with State of Delaware employees other than DelDOT's Contract Administration staff regarding this RFP is expressly prohibited without prior consent. Firms directly contacting State of Delaware employees risk elimination of their proposal from further consideration. Exceptions exist only for organizations currently doing business in the State who require contact in the normal course of doing that business.

PROCUREMENT SCHEDULE

Action Item	Date	Time
Deadline for Questions to ensure response:	Ten (10) business days prior to the proposal due date	2:00 P.M. Local Time
Final Response to Questions posted by:	Five (5) business days prior to the proposal due date	2:00 P.M. Local Time
Proposals Due no later than:*	**Thursday November 14, 2024**	2:00 P.M. Local Time

NOTE: Only asterisk (*) marked date changes will be communicated (via posted Addendums).

PROPOSAL REQUIREMENTS

Interested firms must submit the material required herein or they may not be considered for the project:

1. Proposals must be received before the Proposal Due Date and Time, as identified in the Procurement Schedule for this RFP. Responses submitted by hard copy, mail, facsimile, or e-mail will not be accepted. Responses received after the Proposal Due Date and Time will not be considered.
2. **Upload your submission at**: https://deldot.bonfirehub.com/portal/

   Important Notes:

   - Logging in and/or uploading the file(s) does not mean the response is submitted. Users must successfully upload all the file(s) and MUST click the submit button before the proposal due date and time.
   - Users will receive an email confirmation receipt with a unique confirmation number once the submission has been finalized. This will confirm that the proposal has been submitted successfully.
   - Each submitted item of Requested Information will only become visible to DelDOT after the proposal due date and time.
   - If the file is mandatory, you will not be able to complete your submission until the requirement is met.
   - Uploading large documents may take significant time depending on the size of the file(s) and your Internet connection speed. The maximum upload file size is 1000 MB.
   - Minimum system requirements: Internet Explorer 11, Microsoft Edge, Google Chrome, or Mozilla Firefox. Java Script must be enabled.

   Need Help? Please contact Bonfire directly at Support@GoBonfire.com for technical questions related to your submission. You can also visit their help forum at https://bonfirehub.zendesk.com/hc.

3. **The Prime Consultant must be Registered,** or submit application for registration, with DelDOT at or before the time of submission in order to be considered. For registration information, click here.

4. **Submit one (1) Original and one (1) Redacted copy** of the Proposal. The original must be a .pdf file of the original signed proposal and should be clearly marked "Original" on the first page of the document. The redacted copy must be a .pdf file of the original signed proposal with any proprietary or confidential information redacted, and this copy should be clearly marked as "Redacted" on the first page of the document. The redacted copy is required even if the submission contains no proprietary or confidential information.

   To determine what information may be considered proprietary or confidential and may be redacted from their Proposal, firms should review Delaware's Freedom of Information Regulations here; http://regulations.delaware.gov/AdminCode/title8/1400.shtml#TopOfPage. Under Delaware FOIA law, 29 Del. C, §10002(l)(2), "Trade secrets and commercial or financial information…which is of a privileged or confidential nature" are "records that shall not be deemed public" and are therefore exempt from disclosure under FOIA.

5. **Architect-Engineer Qualifications**; **GSA SF330:**

   Standard Form 330 - Architect-Engineer Qualifications (gsa.gov)

   Follow instructions for the SF330, and add the following Individual Agency Instructions:

   A. Part I Section C 11, Proposed Team;
      Indicate if the firm is a DBE and provide the approximate percentage of the contract cost they will perform.

   B. Part I Section E, Resumes of Key Personnel Proposed for this Contract;
      Resume information is limited to eight (8) individuals regardless of affiliation.

   C. Part I Section F, Example Projects;
      Example Projects provided are limited to ten (10).

   D. Part I Section H 30, Additional Information;
      (DelDOT recommends formatting this section using Times New Roman, 12 pt. font)
      1) The Prime consultant must indicate the current workload with DelDOT by listing the following in a table format:
         Agreement No.; Agreement Title; Consultant PM; Prime or Sub; Total Dollars paid to date; current number of Tasks issued; and date of contract expiration.
      2) List any DelDOT agreement number your firm has been selected for and not included above.
      3) Firms may include a "Rating Criteria Support Information" Section, limited to four pages, within Section H, that covers any information that directly relates to the firm's ability to meet the specific rating criteria listed in this RFP.

      Note: Letters of Interest should not be included.

6. **Joint venture** submissions will not be considered.

7. DelDOT reserves the right to reject any and all submissions. Submissions become property of DelDOT and shall be retained electronically for a minimum period of three (3) years from the date

of receipt. DelDOT reserves the right to any and all ideas included in this response without incurring any obligations to the responding firms or committing to procurement of the proposed services.

8. **Required Certification Forms.** All firms responding to the RFP must complete and return the submission forms located in 'Appendix A' of this document.

No promotional materials or brochures are to be included as part of the submission.

RATING CRITERIA

#	**Criteria Description**:	**Weight**
1	Project understanding, approach, services required	25 %
2	Firm's experience pertaining to Pavement Management Software	25%
3	Firm's experience on similar projects	20%
4	Key Staff and Project Team qualifications	15%
5	Firm's resources and capability to accomplish proposed work on schedule	15 %
	TOTAL:	**100%**

OVERVIEW OF SELECTION PROCESS

- This is an On-Call agreement utilized for the performance of services for a number of projects under task orders issued on an as-needed basis.
- This is a single-phase solicitation process with the availability for discussions with up to three (3) of the most highly qualified firms. Based upon the listed criteria and evaluation of each firm's submitted proposal, the Selection Committee may decide if a small sample task and/or discussions will be held with the most highly qualified consultants. If discussions are held, they will serve to clarify the technical approach, qualifications, and capabilities provided in response to the RFP, after which the committee will determine the ranking of the candidate firms.
- Selection Committee members will individually score each firm's submitted proposal which determines individual ranking. DelDOT's ranking is the combined ranking of all Committee members. Firms, in order of ranking, will have the opportunity to negotiate an agreement with DelDOT. If DelDOT cannot reach agreement with the highest ranked firm(s), DelDOT terminates negotiations and begins negotiations with the next highest ranked firm, and so on until an agreement is reached. DelDOT notifies via email the awarded firm(s) of the opportunity to enter into an agreement with DelDOT. This notification also includes information on the next steps for the agreement process.
- After the ranking process has been completed, applicable price information will be requested from the successful candidate firm(s), such as; salary rates for various classifications of personnel; and an indirect cost derivation for the most current accounting period.
- Payroll burden and overhead will be computed on direct salary costs only (not including overtime) at the consultant's audited rate, as per Federal Acquisition Regulations Part 31, and DelDOT policies. Computer and CADD costs are not allowable as a direct cost to this project. Rate determination and applicability is subject to audit by DelDOT. Additionally, candidates should be prepared for

DelDOT to work with your current accounting firm to provide information and backup documentation. Full and immediate cooperation is required to avoid delays in execution of an agreement. Failure to cooperate may result in breaking off of negotiations and moving to the next ranked firm.

- Shortlist and Selection Committee membership appointments are confidential. DelDOT's Professional Services Procurement Manual may be viewed here.

INSURANCE REQUIREMENTS

The selected firm(s) must obtain at its own cost and expense and keep in force and effect during the term of the agreement, including all extensions, the minimum coverage limits specified below with a carrier satisfactory to the State.

a. Worker's Compensation and Employer's Liability Insurance in accordance with applicable law.

b. Commercial General Liability - $1,000,000 per occurrence/$3,000,000 per aggregate.

c. Errors and Omissions - $1,000,000 per occurrence/$3,000,000 per aggregate.

d. Automotive Liability Insurance covering all automotive units used in the work (including all units leased from and/or provided by the State to Vendor pursuant to this Agreement as well as all units used by Vendor, regardless of the identity of the registered owner, used by Vendor for completing the Work required by this Agreement to include but not limited to transporting Delaware clients or staff), providing coverage on a primary non-contributory basis with limits of not less than:

   1. $1,000,000 combined single limit each accident, for bodily injury;
   2. $250,000 for property damage to others;
   3. $25,000 per person per accident Uninsured/Underinsured Motorists coverage;
   4. $25,000 per person, $300,000 per accident PIP benefits if carrying any of our clients or employees; and
   5. Comprehensive coverage for all vehicles leased from the State of Delaware Fleet Services which shall cover the replacement cost of the vehicle in the event of collision, damage or other loss.

Certificate of Insurance and/or copies of the insurance policies will be requested at time of award.

In no event shall the State of Delaware be named as an additional insured on any policy required under this agreement.

MISCELLANEOUS

DelDOT is not liable for any cost incurred by the consultant in the preparation or presentation of the Proposal.

Any individual, business, organization, corporation, consortium, partnership, joint venture, or any other entity including subconsultants currently debarred or suspended is ineligible to participate as a candidate for this process. Any entity ineligible to conduct business in the State of Delaware for any reason is ineligible to respond to the RFP.

DelDOT will affirmatively insure individuals and businesses will not be discriminated against on the grounds of race, creed, color, sex, or national origin in consideration for an award. Minority business enterprises will be afforded full opportunity to submit bids/proposals in response to this invitation.

Department of Transportation
State of Delaware
By: Nicole Majeski
Secretary
Dover, DE

Appendix A - REQUIRED FORMS

The following completed forms are required to be returned with each proposal:

- Certification of Eligibility
- Certificate of Non-Collusion

Attachments

Attachment A: Pavement Data Dictionary

CERTIFICATION OF ELIGIBILITY

Delaware Department of Transportation

Request for Proposal 2154S – Pavement Management Support Services

We have read Request for Proposal number **2154S** and fully understand the intent of the RFP as stated, certify that we have adequate personnel and knowledge to fulfill the requirements thereof, and agree to furnish such services in accordance with the contract documents as indicated should we be awarded the contract.

____ hereby certifies that it is not included on the United States Comptroller General's Consolidated List of Persons or Firms Currently Debarred for Violations of Various Public Contracts Incorporating Labor Standard Provisions.

________________________Signature of the Bidder or Offeror's Authorized Official

________________________Name and Title of the Bidder or Offeror's Authorized Official

________________________Date

Sworn and subscribed before me this ___________ day of _____________________________, 20___

_____________________________________ My commission expires: ______ / ______ / 20___

Notary Public Month Day Year

CERTIFICATE OF NON-COLLUSION

By submission of this bid, each bidder and each person signing on behalf of any bidder certifies, and in the case of a joint bid, each party thereto certifies as to its own organization, under penalty of perjury, that to the best of knowledge and belief:

1) The prices in this bid have been arrived at independently without collusion, consultation, communication, or agreement for the purpose of restricting to such prices, with any other bidder or with any competitor;

2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the Bidder and will not knowingly be disclosed by the Bidder prior to opening, directly or indirectly, to any other bidder or to any competitor; and

3) No attempt has been made or will be made by the Bidder to induce any other person, partnership or corporation to submit or not to submit a bid for the purpose of restricting competition.

_________________________Signature of the Bidder or Offeror's Authorized Official

_________________________Name and Title of the Bidder or Offeror's Authorized Official

_________________________Date

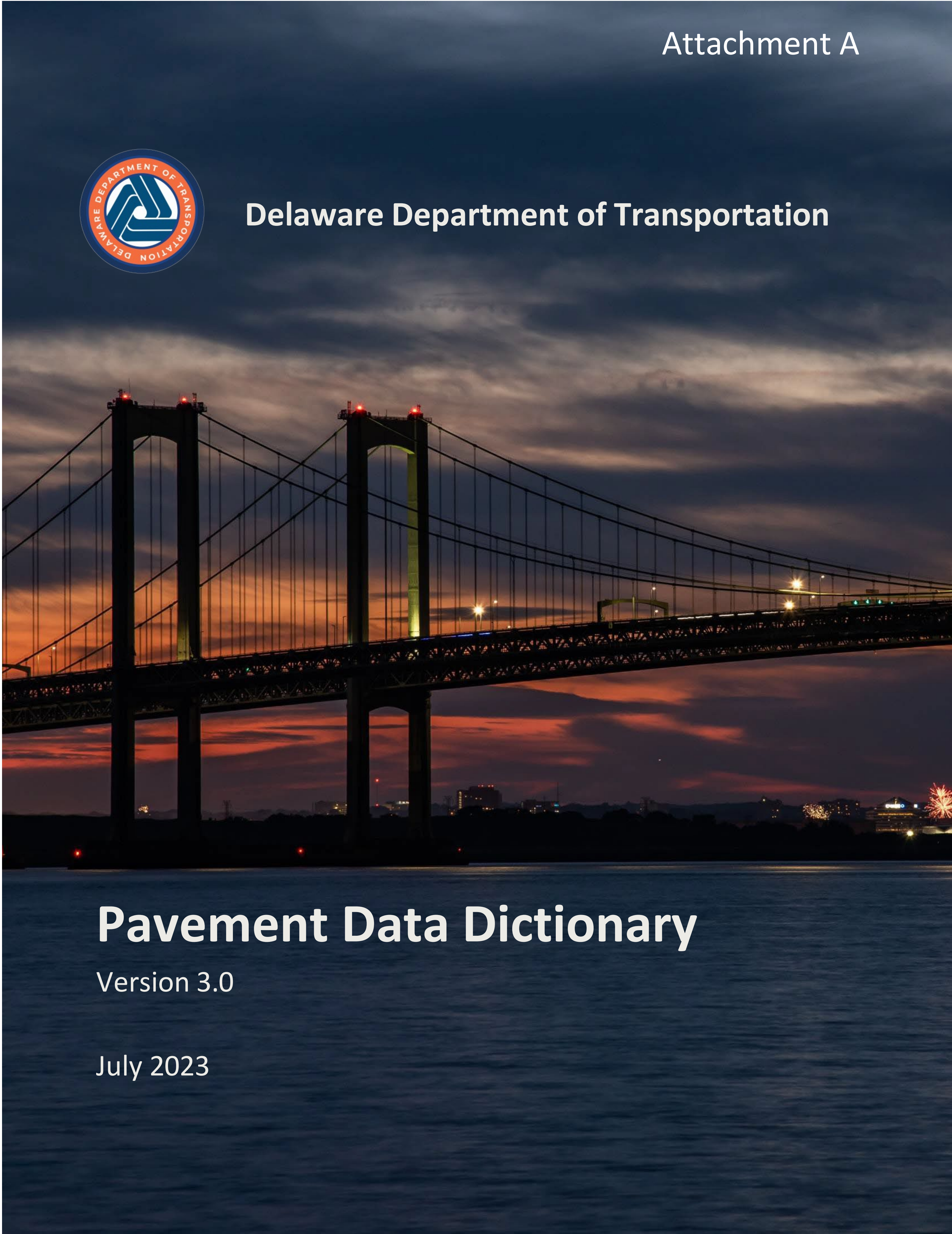
Sworn and subscribed before me this ___________ day of ______________________________, 20___

_______________________________________ My commission expires: ______ / ______ / 20___

Notary Public Month Day Year

Attachment A

Delaware Department of Transportation



Pavement Data Dictionary

Version 3.0

July 2023

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
V1.0	Feb 23, 2017	Mandli Communications/ AECOM	DelDOT Staff		
V 2.0	Dec 27, 2021	The Kercher Group	DelDOT Staff		Block Cracking and Raveling were removed; Units of Measure for Transverse Cracking and Joint Reflective Cracking were changed to Counts only
V 3.0	July 26, 2023	Mott MacDonald	DelDOT Staff		Incorporating ASTM E3303 for cracking measurements

Table of Contents

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INTRODUCTION

This Pavement Data Dictionary will identify all the data items required for input into the pavement management system including distress types, severity levels and methods of measurement for automated road rating data collection for the Delaware Department of Transportation (DelDOT).

This document should be read in conjunction with DelDOT's Data Quality Management Plan (DQMP). The objective for this Data Dictionary document, together with the DQMP, is to ensure that data being delivered to support the Pavement Management program and pavement condition reporting is repeatable across multiple data collection cycles and is as independent as possible of specific vendors that are collecting the data on behalf of DelDOT. Having accurate and repeatable data ensures that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

This Data Dictionary assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used. Depending upon the capabilities of the automated data acquisition system, some of the distress/inventory data items may need to be collected/rated manually to meet the requirements of the current DelDOT distress rating protocol and DQMP.
- Data collection for each cycle shall be completed in a single data collection year.

The distress data is collected for the following pavement types:

- Asphalt Cement (AC) Pavement [Wearing Course ID, WC = 1]
- Jointed Plain Concrete Pavement (JPCP) [WC = 2]
- Composite Pavement (APC) [WC = 3]
- Surface Treated (ST) Pavement [WC = 4]
- Continuously Reinforced Concrete Pavement (CRCP) [WC = 5]

Distinction between Section & Segment Datasets

For the purposes of this document, a data collection ***segment*** refers to a length of roadway, measured in the direction of travel, measuring between 5 and 7 feet. Data collection segment lengths of 1/1000th of a mile, and 2 meters are both acceptable. DelDOT uses a segment length of 6 feet for AC, APC, ST, and CRCP pavements. For JPCP, a slab length is used as a segment length. Data collection segments should be marked for exclusion in the case of bridges, construction, lane deviations, railroads or wherever data may not be valid for any reason.

A data collection ***section*** refers to a length of roadway, measured in the direction of travel, measuring 0.1 mile; a section can be less than 0.1 mile at the end of a roadway. All the Data Elements required for the Highway Performance Monitoring System (HPMS) reporting will be either collected at the section level or collected at the segment but summarized at the section level.

As a result of the distinction above, there will be two distinct datasets delivered based on this data dictionary: a section-level dataset, and a segment-level dataset.

List of Data Items

The data to be collected on each data collection section/segment will include the individual data items listed in Table 1. The data shall be submitted in a file format with one row per data collection section/segment and the data items listed below as columns.

Table 1. Data Elements Collected for Pavement Management

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
ROUTE_ID		x	x	x	x	x		Route, Direction, Lane (From, To – placeholders only)
LANE_DIR		x	x	x	x	x		
LANE_ID		x	x	x	x	x		
DE_GIS_ROADWAY		x	x	x	x	x		GIS Route
FROM_POINT		x	x	x	x	x	NUMBER (*, 4)	From
TO_POINT		x	x	x	x	x	NUMBER (*, 4)	To
SEC_WIDTH		x	x	x	x	x	NUMBER (*,2)	Section Width
LENGTH_DMI	ft.	x	x	x	x	x	NUMBER (*, 2)	Interval Length
LENGTH_SHP	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of road segment
WC_ID		x	x	x	x	x	INTEGER	Wearing Course as identified during rating
VEHICLE_NAME		x	x	x	x	x	STRING	Vehicle Name
DATE_RATED		x	x	x	x	x	DATE	Date Rated
CRCK_LENGTH	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Cracking (including failed/open sealed cracks)
CRCK_LENGTH_S	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Sealed Cracking (excluding failed/open sealed cracks)
INTERVAL_AREA	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of analysis segment | Area of Slab
CRCK_WIDTH	Inch	x	x	x	x	x	NUMBER (*, 4)	Width of Cracking
CRKD	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density (Crack Length / Interval Area)
CRKD_S	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of Sealed Cracks (excluding failed/open sealed cracks)
CRKD_L	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of cracks having width <= 0.25"
CRKD_H	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM	%	x	x	x	x	x	NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) *100 (excluding sealed cracks)
CRCK_LEN_Z1	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Edge / Zone 1 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z1	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 1 (excluding failed/open sealed cracks)
AREA_Z1	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Left Edge / Zone 1
CRCK_WID_Z1	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Left Edge / Zone 1
CRKD_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 1
CRKD_S_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 1 (excluding failed/open sealed cracks)
CRKD_L_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 1
CRKD_H_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z1	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 1 (excluding sealed cracks)
CRCK_LEN_Z2	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 2 (including failed/open sealed cracks)
CRCK_LENGTH_S_Z2	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 2 (excluding failed/open sealed cracks)
AREA_Z2	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Left Wheel Path - Zone 2
CRCK_WID_Z2	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Left Wheel Path / Zone 2
CRKD_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 2
CRKD_S_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 2 (excluding failed/open sealed cracks)
CRKD_L_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 2
CRKD_H_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z2	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 2 (excluding sealed cracks)
CRCK_LEN_Z3	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 3 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z3	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 3 (excluding failed/open sealed cracks)
AREA_Z3	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Center / Zone 3
CRCK_WID_Z3	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Center / Zone 3
CRKD_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 3
CRKD_S_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 3 (excluding failed/open sealed cracks)
CRKD_L_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 3
CRKD_H_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z3	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 3 (excluding sealed cracks)
CRCK_LEN_Z4	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 4 (including failed/open sealed cracks)
CRCK_LENGTH_S_Z4	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 4 (excluding failed/open sealed cracks)
AREA_Z4	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Right Wheel Path / Zone 4
CRCK_WID_Z4	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Right Wheel Path / Zone 4
CRKD_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 4
CRKD_S_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 4 (excluding failed/open sealed cracks)
CRKD_L_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 4
CRKD_H_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z4	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 4 (excluding sealed cracks)
CRCK_LEN_Z5	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 5 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z5	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 5 (excluding failed/open sealed cracks)
AREA_Z5	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Right Edge / Zone 5
CRCK_WID_Z5	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Right Edge / Zone 5
CRKD_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 5
CRKD_S_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 4 (excluding failed/open sealed cracks)
CRKD_L_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 5
CRKD_H_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z5	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 5 (excluding sealed cracks)
DE_BLEEDING_HI_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - High
DE_BLEEDING_LOW_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - Low
DE_BLEEDING_MED_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - Medium
DE_FAULTING_RWP_IN	Inches				x		NUMBER (*, 2)	Average Fault Height - Right Wheel Path
DE_JOINT_DET	Text				x		STRING	"None" if no spalling, otherwise "Low", "Med" or "High" (Starting Joint)
DE_JNT_SEAL_DAMAGE	Text				x		STRING	"None" if no seal damage, otherwise "Low" or "High" (Starting Joint)
DE_PATCH_DET_HI_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - High
DE_PATCH_DET_LOW_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - Low
DE_PATCH_DET_MED_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - Medium
DE_ROUGH_CROWN_LF	Linear ft.			x			NUMBER (*,1)	Length of Crown Slope / Cross Slope
DE_RUT_LWP_AVG_IN	Inches	x	x	x			NUMBER (*, 2)	Average Rutting - Left Wheel Path
DE_RUT_RWP_AVG_IN	Inches	x	x	x			NUMBER (*, 2)	Average Rutting - Right Wheel Path
DE_RUT_LWP_HI_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of High Severity Rutting - Left Wheel Path
DE_RUT_LWP_LOW_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Low Severity Rutting - Left Wheel Path

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
DE_RUT_LWP_MED_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Med Severity Rutting - Left Wheel Path
DE_RUT_LWP_MAX_IN	Inches	x	x	x			NUMBER (*, 2)	Maximum Rutting - Left Wheel Path
DE_RUT_RWP_MAX_IN	Inches	x	x	x			NUMBER (*, 2)	Maximum Rutting - Right Wheel Path
DE_RUT_RWP_HI_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of High Severity Rutting - Right Wheel Path
DE_RUT_RWP_LOW_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Low Severity Rutting - Right Wheel Path
DE_RUT_RWP_MED_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Med Severity Rutting - Right Wheel Path
DE_IRI_LWP_INCH_MILE	Inches/Mile	x	x	x	x	x	NUMBER (*, 2)	Average International Roughness Index - Left Wheel Path
DE_IRI_RWP_INCH_MILE	Inches/Mile	x	x	x	x	x	NUMBER (*, 2)	Average International Roughness Index - Right Wheel Path
DE_JNT_SPACING_LF	Linear ft.				x	x	NUMBER (*,1)	Average Joint Spacing
DE_ASR_CNT	Count				x	x	INTEGER	Count of Map Cracking / Alkali-Silica Reactivity
DE_SLAB_CRACK	Text				x	x	STRING	"None" if no cracking, otherwise "Low", "Med" or "High".
DE_TRAN_CRK_JPCP_YN	Boolean				x		INTEGER	Transverse Cracking on JPCP: 1 if transverse cracking with length > 5ft is present, otherwise 0.
DE_LONG_CRK_CRCP_LF	Linear ft.					x	NUMBER (*,1)	Length of Longitudinal Cracking on CRCP
DE_PUNCHOUT_SF	Sq. ft.					x	NUMBER (*, 2)	Area of Punchouts for CRCP Pavements
BEGIN_LAT	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Latitude at start of segment in decimal degrees (WGS84)
BEGIN_LONG	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Longitude at start of segment in decimal degrees (WGS84)
BEGIN_ALT	Feet	x	x	x	x	x	NUMBER (*,1)	Mean Sea Level (MSL) altitude at start of segment
END_LAT	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Latitude at end of segment in decimal degrees (WGS84)
END_LONG	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Longitude at end of segment in decimal degrees (WGS84)
END_ALT	Feet	x	x	x	x	x	NUMBER (*,1)	Mean Sea Level (MSL) altitude at end of segment
BRIDGE		x	x	x	x	x	INTEGER	
BRIDGE_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Bridge within road segment

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CONSTRUCTION		x	x	x	x	x	INTEGER	
CONSTRUCTION_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Construction within road segment
LANE_DEVIATION		x	x	x	x	x	INTEGER	
LANE_DEVIATION_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Lane Deviation within road segment
RAILROAD		x	x	x	x	x	INTEGER	
RAILROAD_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Railroad within road segment
GRADE_PERCENT	Percentage	x	x	x	x	x	NUMBER(*,1)	Average grade for the road segment
GRADE_CLASS	Text	x	x	x	x	x	STRING	HPMS Grade Classification
CURVE_DEGREE	Decimal Degrees	x	x	x	x	x	NUMBER(*,1)	Degree of curvature per 100ft
CURVE_CLASS	Text	x	x	x	x	x	STRING	HPMS Curvature Classification

DATA ITEMS

In this section, the data elements shown in *Table 1* are explained further.

Inventory Data Items

The following items are applicable to data collected for **both the section and segment level datasets**. They comprise of data items which help in identifying a section/segment. These items shall be reported as follows:

ROUTE_ID

Description: Unique Identifier for each Route

Use: For identifying the section/segment for which data is being reported

Data Type: INTEGER

Detection Method: Populated from shapefile.

LANE_DIR

Description: Indicates the directionality of the event

Use: For identifying the section/segment for which data is being reported

Data Type: INTEGER

Detection Method: Populated from shapefile.

LANE_ID

Description: Unique Lane number numbered according to convention

Use: For identifying the surveyed lane on the section/segment

Data Type: INTEGER

Detection Method: Populated from shapefile.

FROM_POINT

Description: Begin measure of the route

Use: For identifying the section/segment for which data is being reported

Data Type: NUMBER (22,3)

Detection Method: Automated shapefile matching.

TO_POINT

Description: End measure of the route

Use: For identifying the section/segment for which data is being reported

Data Type: NUMBER (22,3)

Detection Method: Automated shapefile matching.

SEC_WIDTH

Description: The measured width in feet of a given section measured from the edge of the pavement to the edge of the pavement.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2)

Detection Method: Automated

LENGTH_DMI

Description: Interval Length - the measured length of segment in feet OR the measured length of section in miles.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2) for segment, Numeric (*, 3) for section.

Unit of Measure: Feet for segment, Mile for Section.

Detection Method: Automated using Distance Measurement Instrument (DMI).

LENGTH_SHP

Description: Length of road segment in feet.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2) for segment, Numeric (*, 3) for section.

Unit of Measure: Feet for segment, Mile for Section.

Detection Method: Automated shapefile matching.

WC_ID

Description: Wearing Course (WC) as identified during rating.

Use: Important Inventory data to identify section/segment. Used in decision matrix.

Data Type: INTEGER

- WC_ID = 1 for AC pavements
- WC_ID = 2 for JPCP pavements
- WC_ID = 3 for APC
- WC_ID = 4 for ST
- WC_ID = 5 for CRCP

Detection Method: Manual/Automated

VEHICLE_NAME

Description: Name of the Vehicle used to collect automated distress data.

Use: To be used during QA/QC of the automated distress data.

Data Type: STRING

Detection Method: Manual/Automated

DATE_RATED

Description: The date on which the data is being collected for reported segment/section.

Use: For identifying the data collection date.

Data Type: Date (MM/DD/YYYY HH24:MI:SS)

Detection Method: Automated

BEGIN_LAT

Description: Latitude at the start of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

BEGIN_LONG

Description: Longitude at the start of segment in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

BEGIN_ALT

Description: Mean Sea Level (MSL) altitude in feet at the start of segment.

Use: For identifying the segment/section for which data is being reported.

Data Type: NUMBER (*,1)

Detection Method: Automated

END_LAT

Description: Latitude at the end of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

END_LONG

Description: Longitude at the end of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

END_ALT

Description: Mean Sea Level (MSL) altitude in feet at the end of segment.

Use: For identifying the segment/section for which data is being reported.

Data Type: NUMBER (*,1)

Detection Method: Automated

BRIDGE

Description: Bridge Flag (Yes/No).

Use: For identifying and marking the segment/section with a bridge for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

BRIDGE_LENGTH

Description: Length of the bridge in feet within a section/segment.

Use: For identifying and marking the segment/section with a bridge for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

CONSTRUCTION

Description: Construction Activity Flag (Yes/No).

Use: For identifying and marking the segment/section with an on-going construction for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

CONSTRUCTION_LENGTH

Description: Length of the on-going construction activity in feet within a section/segment.

Use: For identifying and marking the segment/section with an on-going construction for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

LANE_DEVIATION

Description: Lane Deviation Flag (Yes/No).

Use: For identifying the segment/section where the automated vehicle had to deviate from the lane due to different reasons.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

LANE_DEVIATION_LENGTH

Description: Length of the lane deviation in feet within a section/segment.

Use: For identifying and marking the segment/section with lane deviation for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

RAILROAD

Description: Railroad Crossing Flag (Yes/No).

Use: For identifying and marking the segment/section with a railroad crossing for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

RAILROAD_LENGTH

Description: The length of the railroad crossing in feet within a section/segment.

Use: For identifying and marking the segment/section with a railroad crossing for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

Segment-Level Distress Data Items

The following items are applicable to data collected **only for the segment level dataset**. These items shall be reported as follows:

DE_BLEEDING_LOW_SF

Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glasslike, or reflective surface.

Description: Area of Low Severity Bleeding (*Figure 1*)

Use: To be used in calculating Overall Pavement Index (OPC) and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

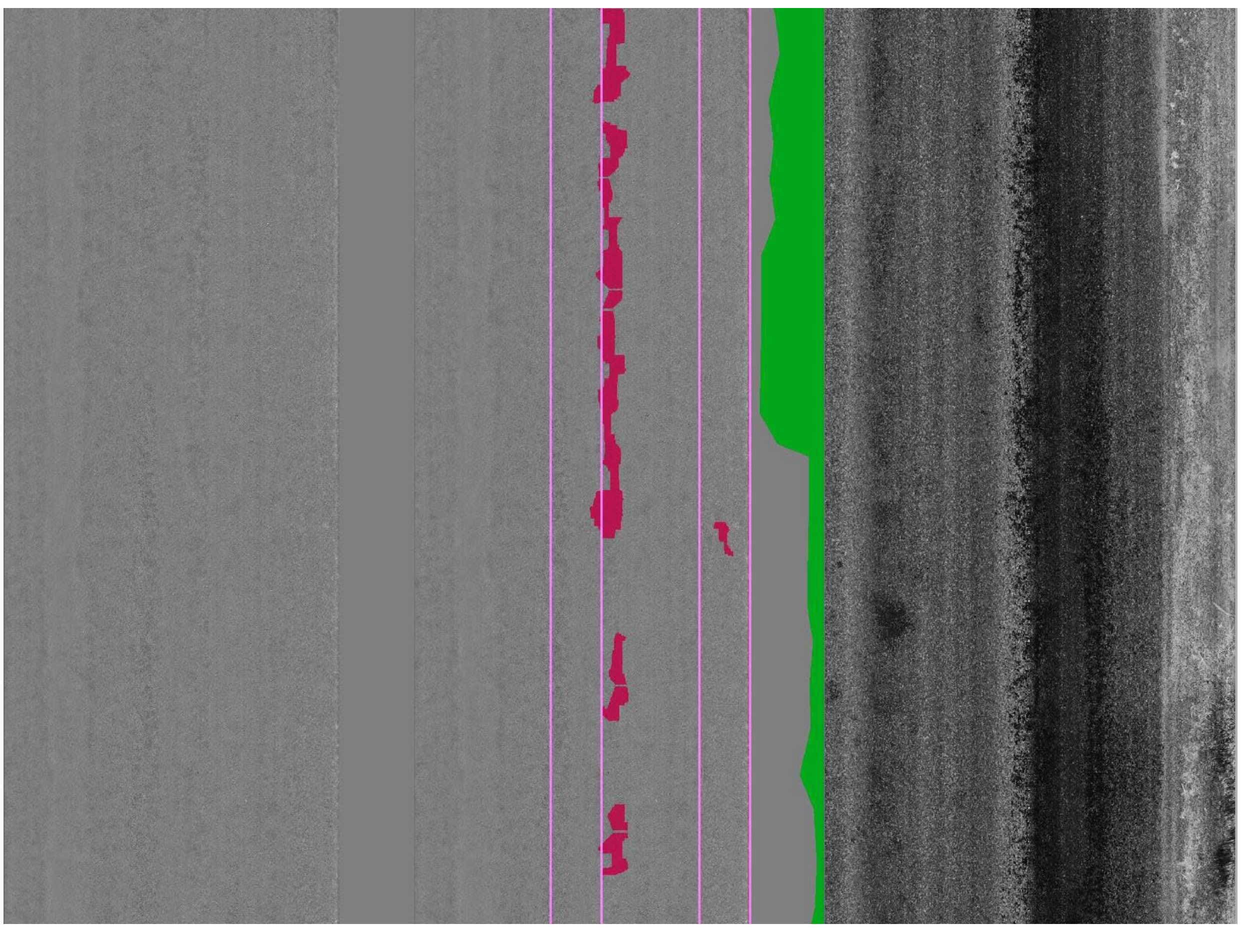

Figure 1. Pavement area discolored by excess asphalt binder.

DE_BLEEDING_MED_SF

Description: Area of Medium Severity Bleeding (*Figure 2*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

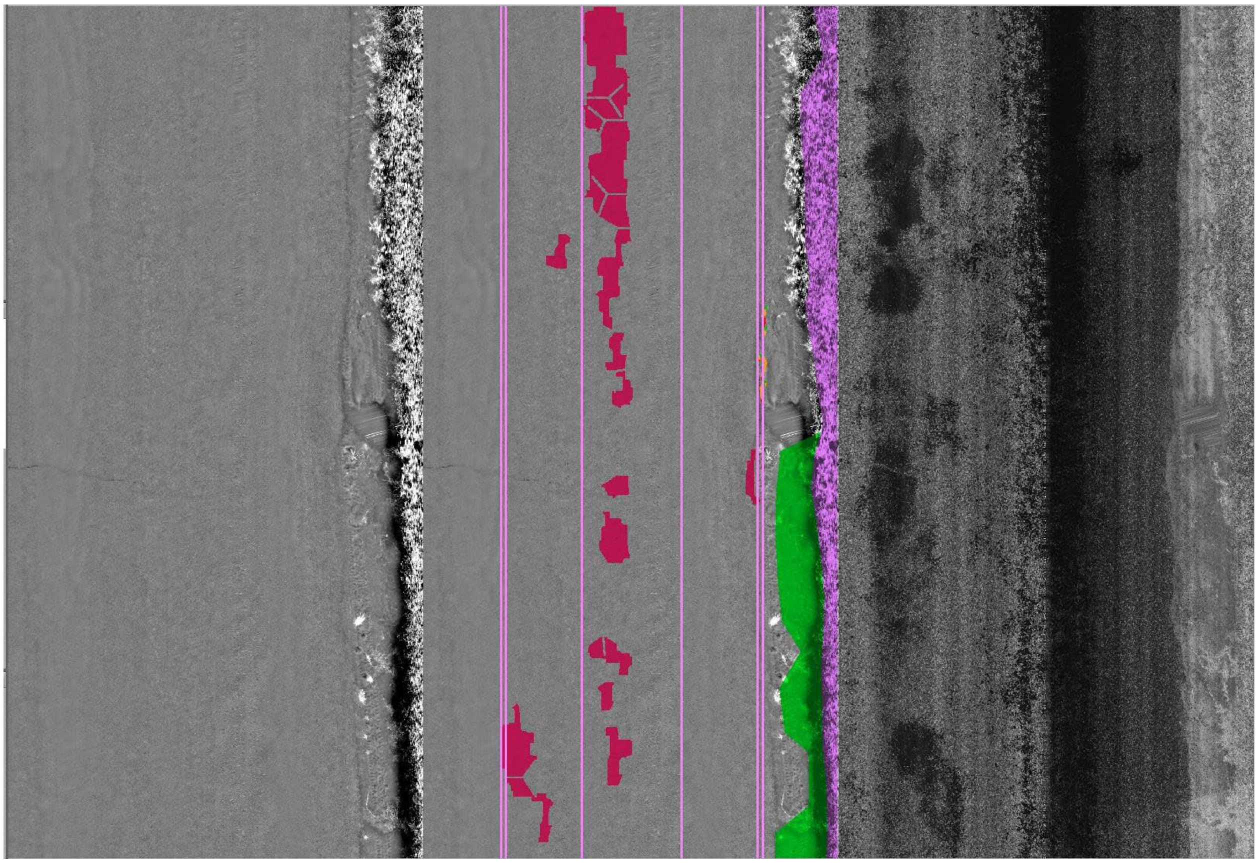

Figure 2. Pavement area begins to lose surface texture due to excessive asphalt binder at the surface.

DE_BLEEDING_HI_SF

Description: Area of Medium Severity Bleeding (*Figure 3*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

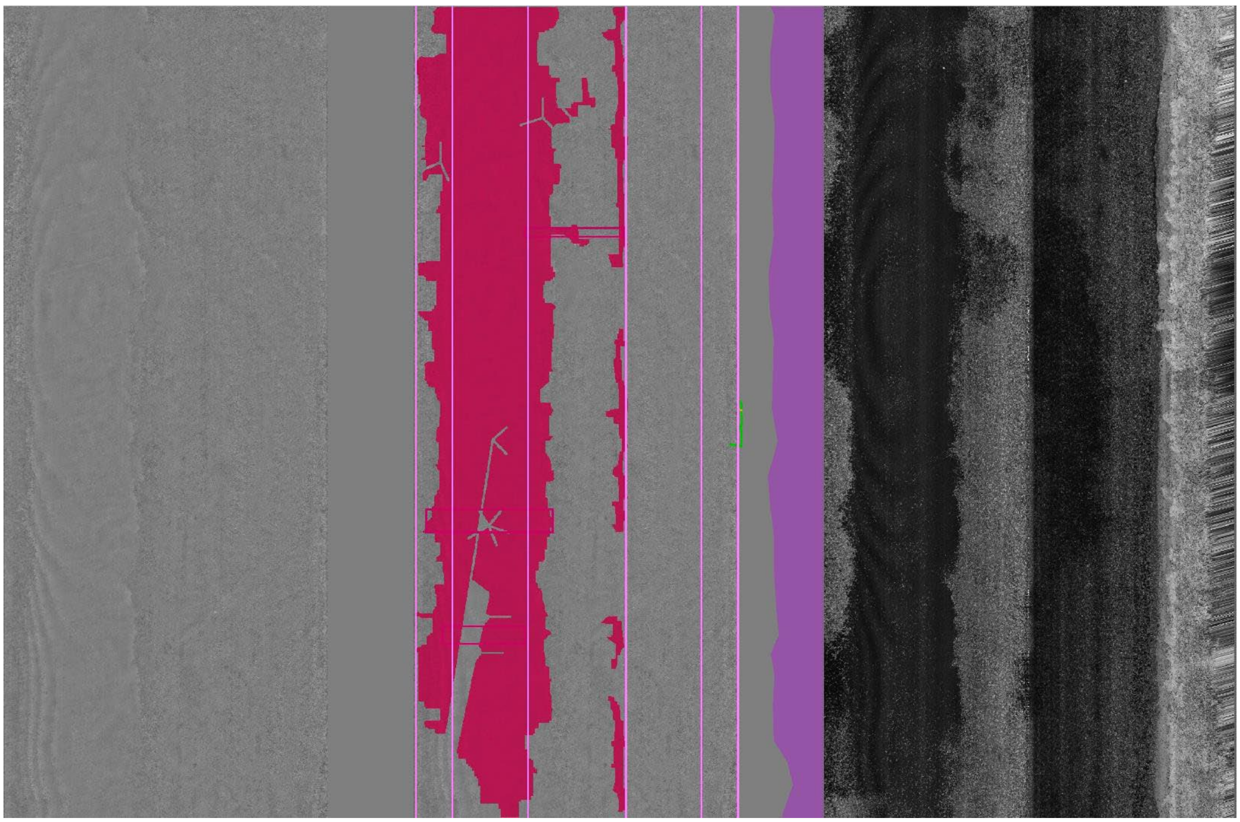

Figure 3. Excessive asphalt cement at the pavement surface conceals aggregates under a shiny surface.

DE_PATCH_DET_LOW_SF

A patch is an area of pavement that has been replaced by a filler material. A patch is considered a defect no matter its condition. All patches are rated at least at a low-severity level. Distresses within the patch are not rated independently. For PCC pavements, any full-width patch is considered a slab and not a patch.

Description: Area of Low Severity Patch Deterioration / Potholes (*Figure 4* & *Figure 5*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

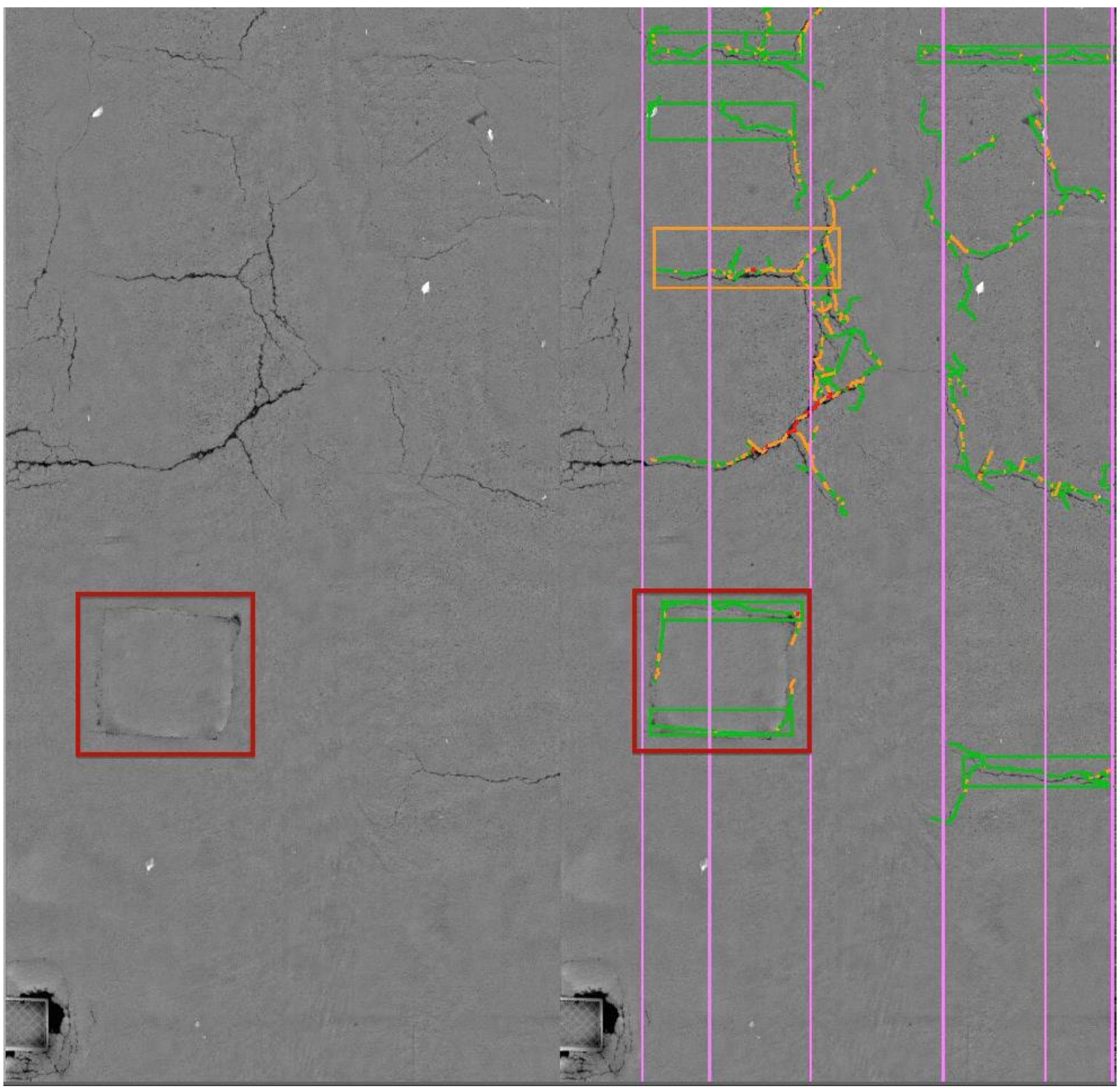

Figure 4. AC – Low Severity Patches show few defects and are usually smooth and new with uniform boundaries.

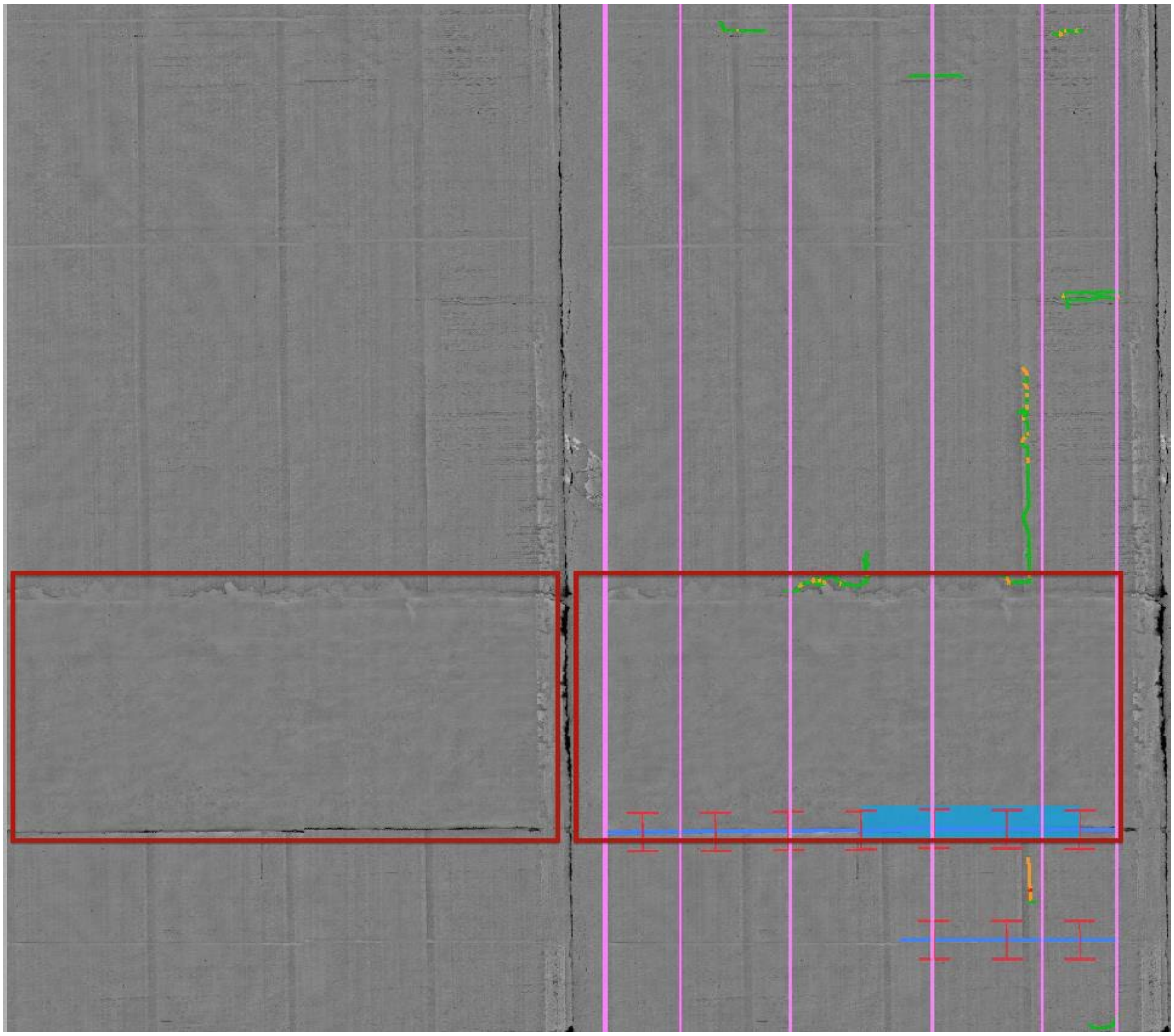

Figure 5. PCC – Low Severity Patches show few defects and are usually smooth and new with uniform boundaries.

DE_PATCH_DET_MED_SF

Description: Area of Medium Severity Patch Deterioration / Potholes (*Figure 6* & *Figure 7*)

Use: To be used in calculating Overall Pavement Index and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

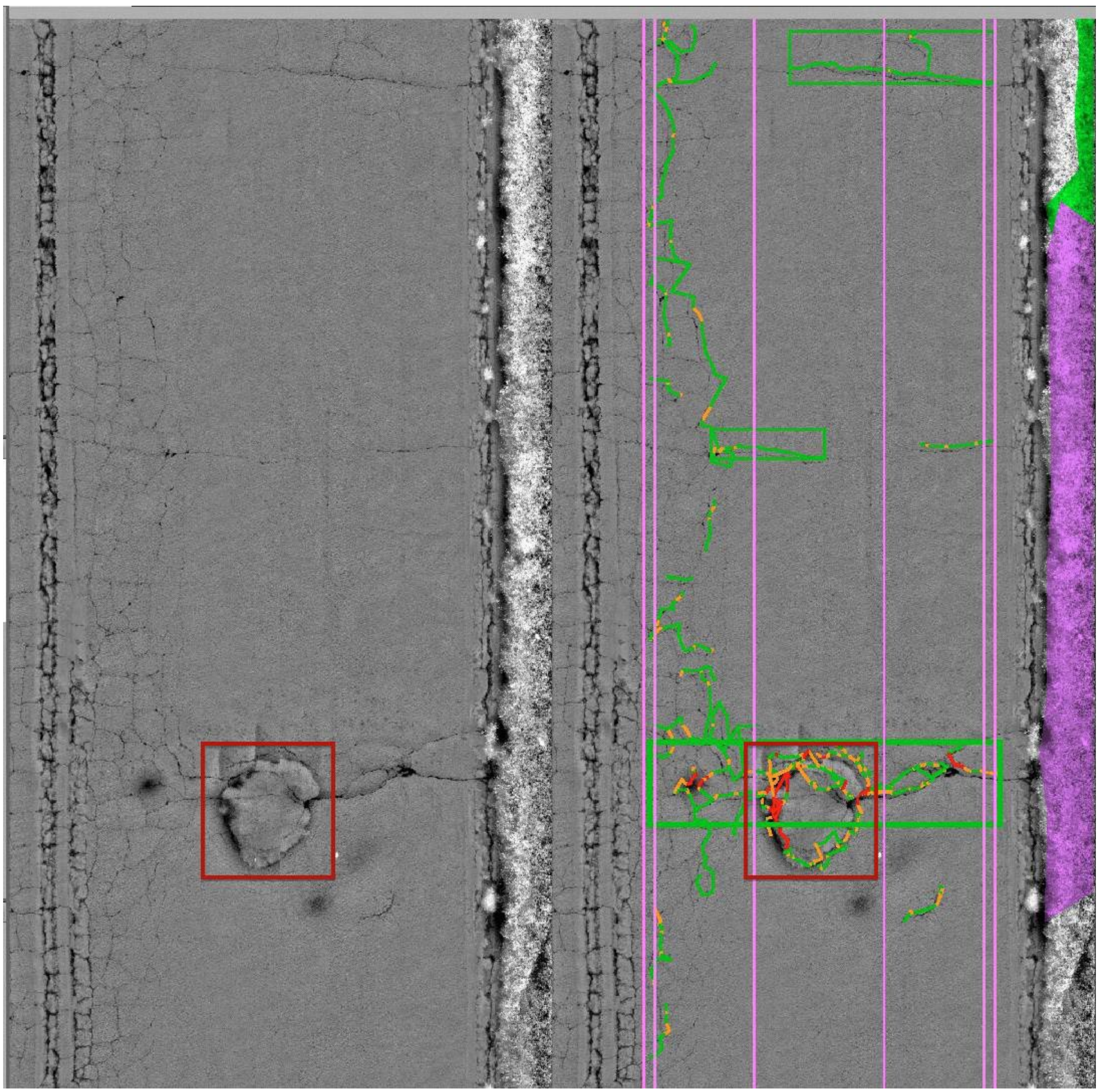

Figure 6. AC – Medium Severity Patches display medium severity defects and may have jagged edges with some distress or cracks present.

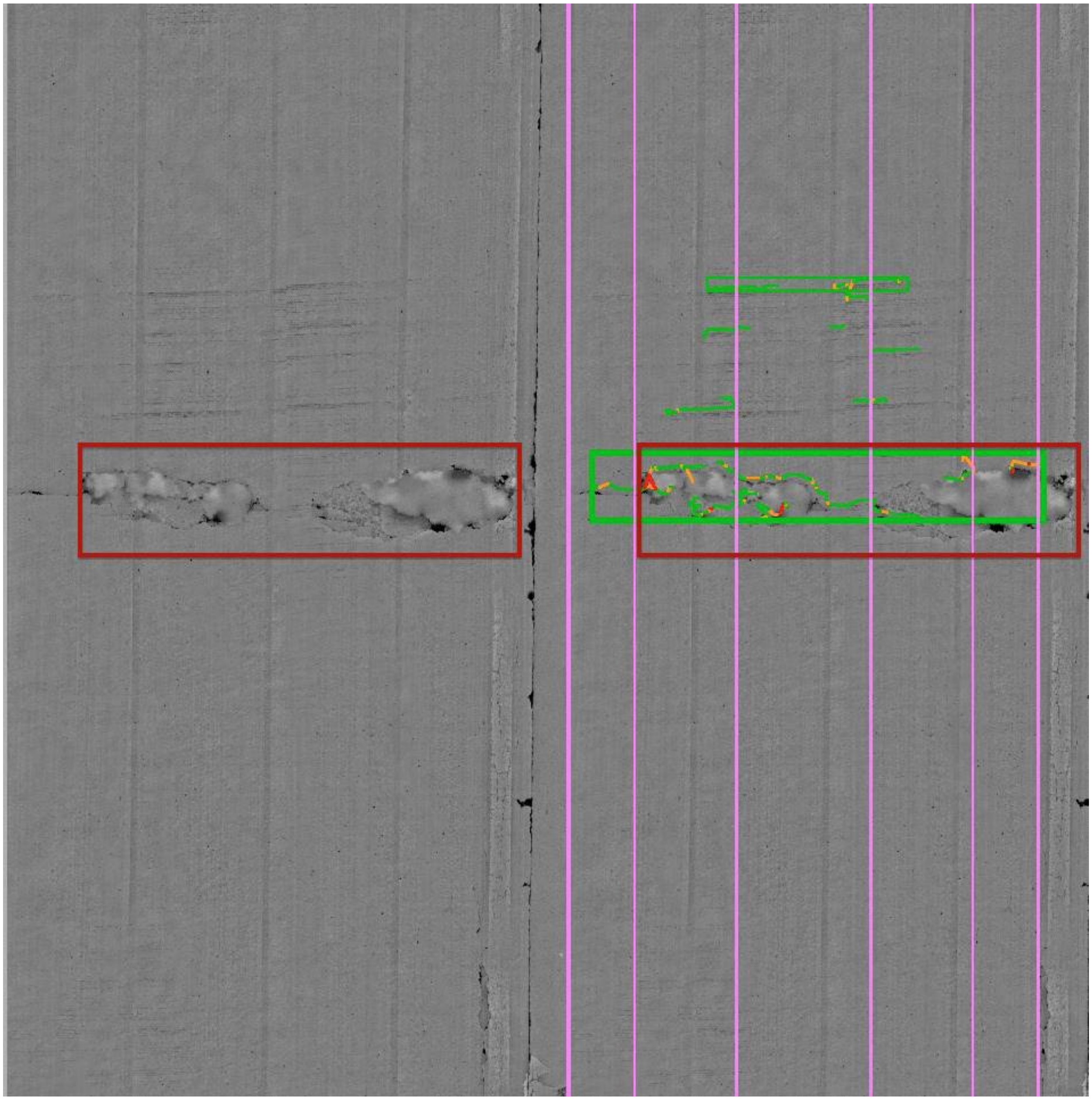

Figure 7. PCC – Medium Severity Patches display medium severity defects and may have jagged edges with some distress or cracks present. Any AC patch found with no defects or low severity defects will be considered a medium severity PCC patch.

DE_PATCH_DET_HI_SF

Description: Area of High Severity Patch Deterioration / Potholes (*Figure 8* & *Figure 9*)

Use: To be used in calculating Overall Pavement Index and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

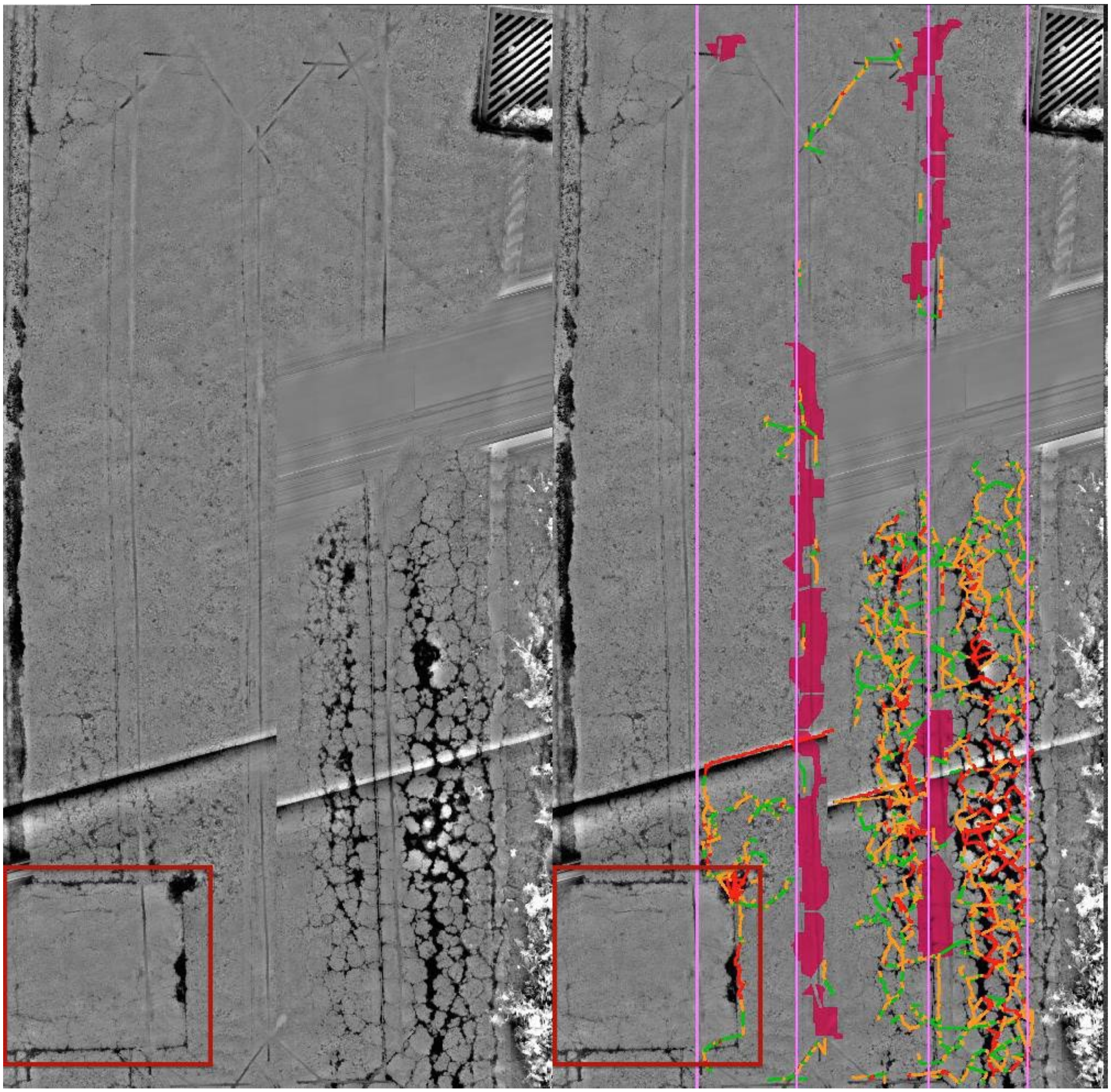

Figure 8. AC - High Severity Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any pothole is considered high severity patch deterioration.

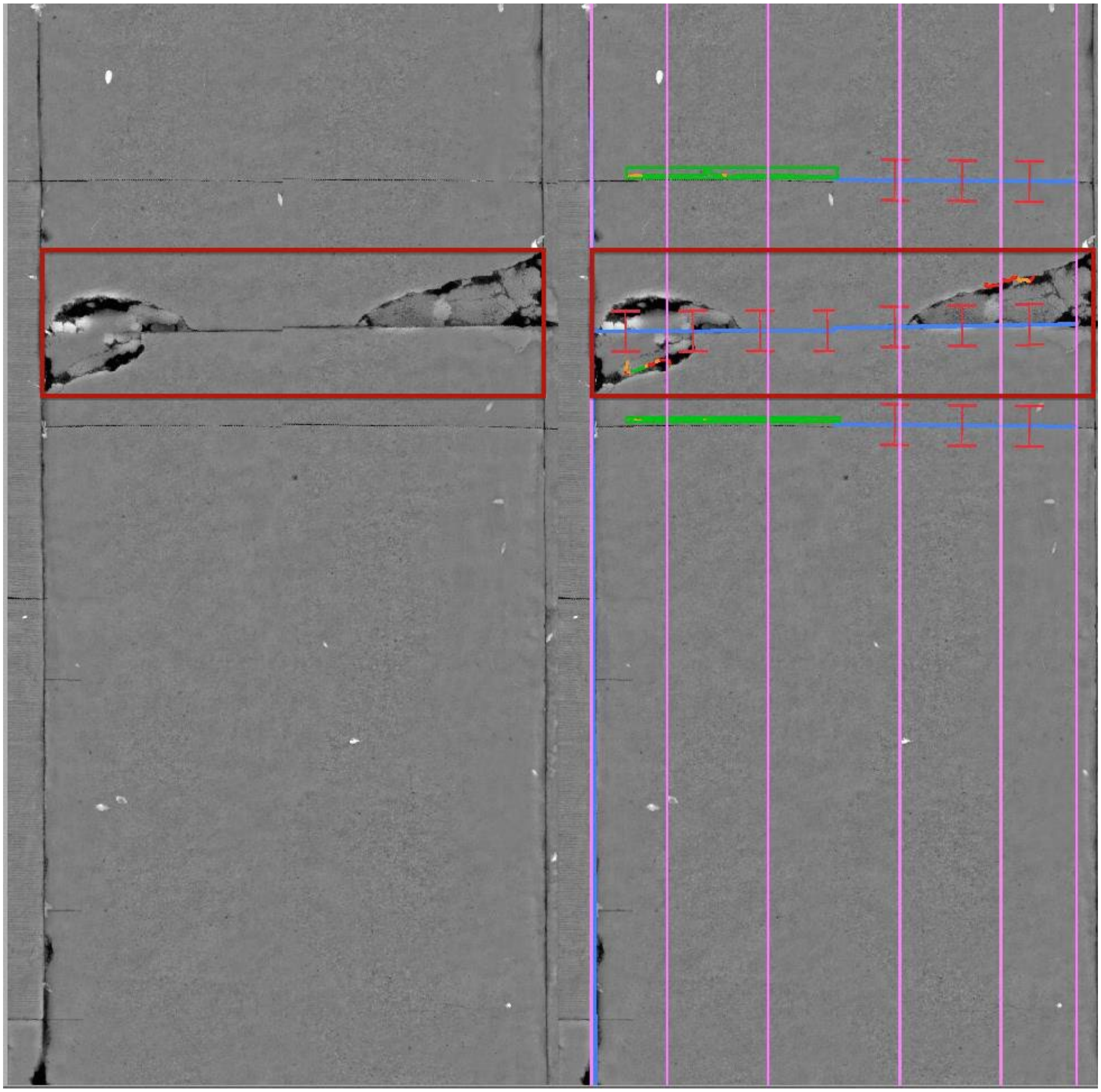

Figure 9. PCC - High Severity Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any AC patch found with medium or high severity distress is considered a high severity PCC patch.

DE_JOINT_DET

Joint Deterioration (Spalling) is the breakdown of a slab adjacent to the joint edge anywhere along the length of the joint. The spall usually does not extend vertically through the slab but intersects the joint at an angle.

Description: Severity of the Deteriorated (Spalled) Starting[1] Joint (*Figure 10*, *Figure 11* & *Figure 12*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, Med, High)

Data Type: STRING

Detection Method: Manual/Automated

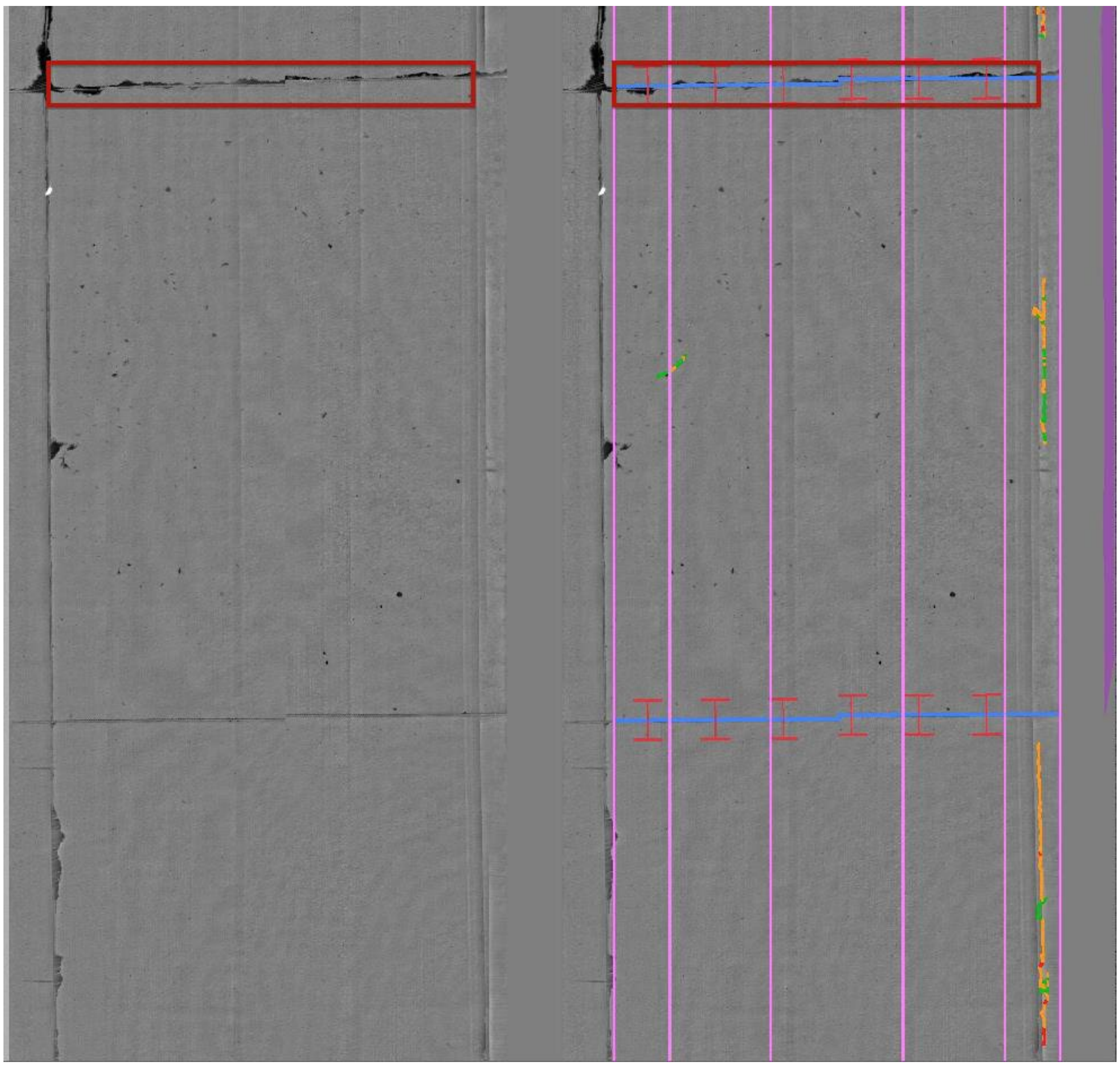

Figure 10. Low-severity joint deterioration is characterized by spalls less than 3 inches wide with no significant loss of material. Single cracks in the corner of the slab will be counted toward cracking.

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[1] Segment level data for PCC pavements is collected for each slab. Approaching or Starting Joint is the 1st of the two joints on a slab in the survey direction.

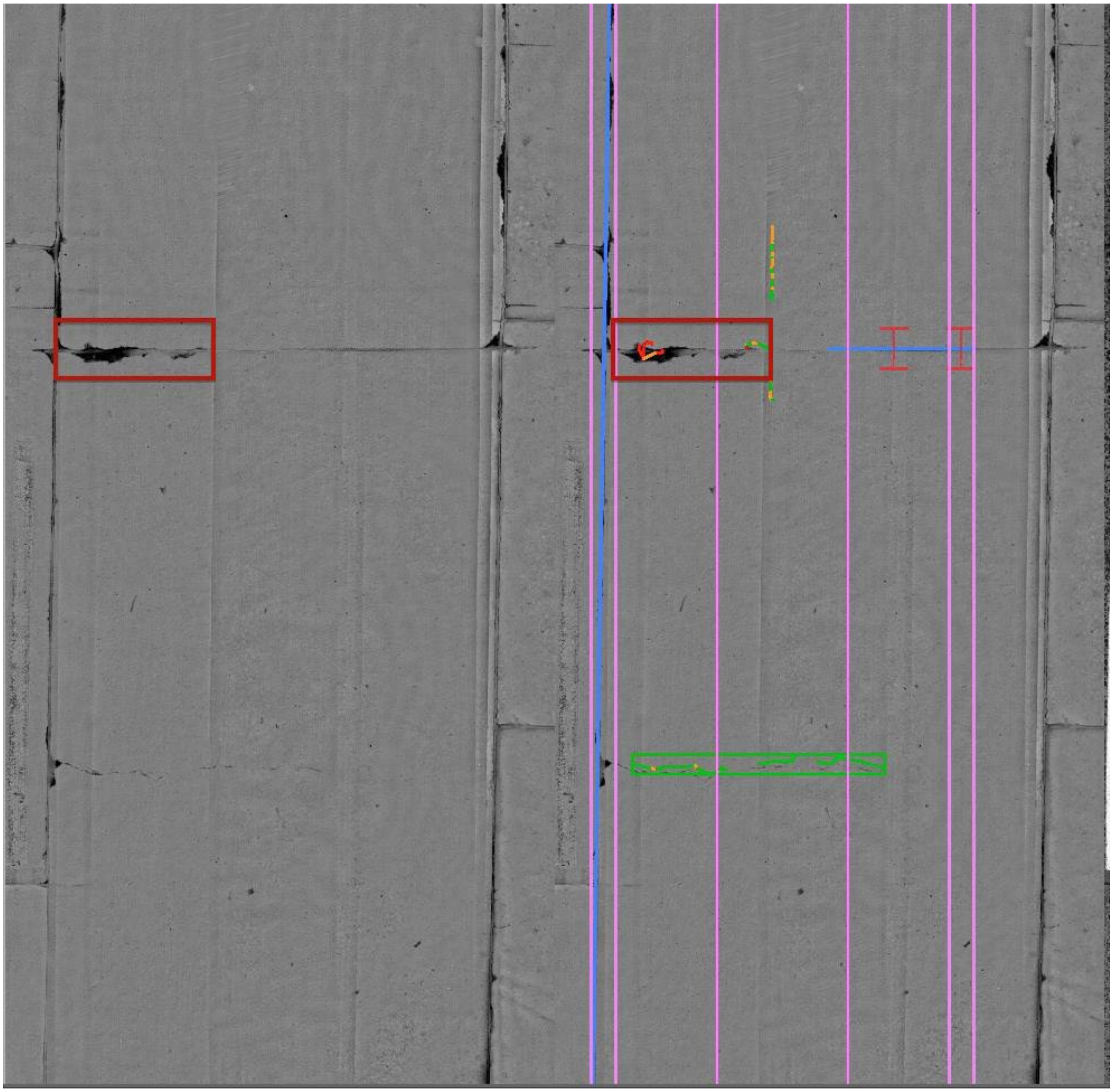

Figure 11. Medium-severity joint deterioration is characterized Spalls 3 to 6 inches wide with a loss of material are evident in medium-severity joint spalling.

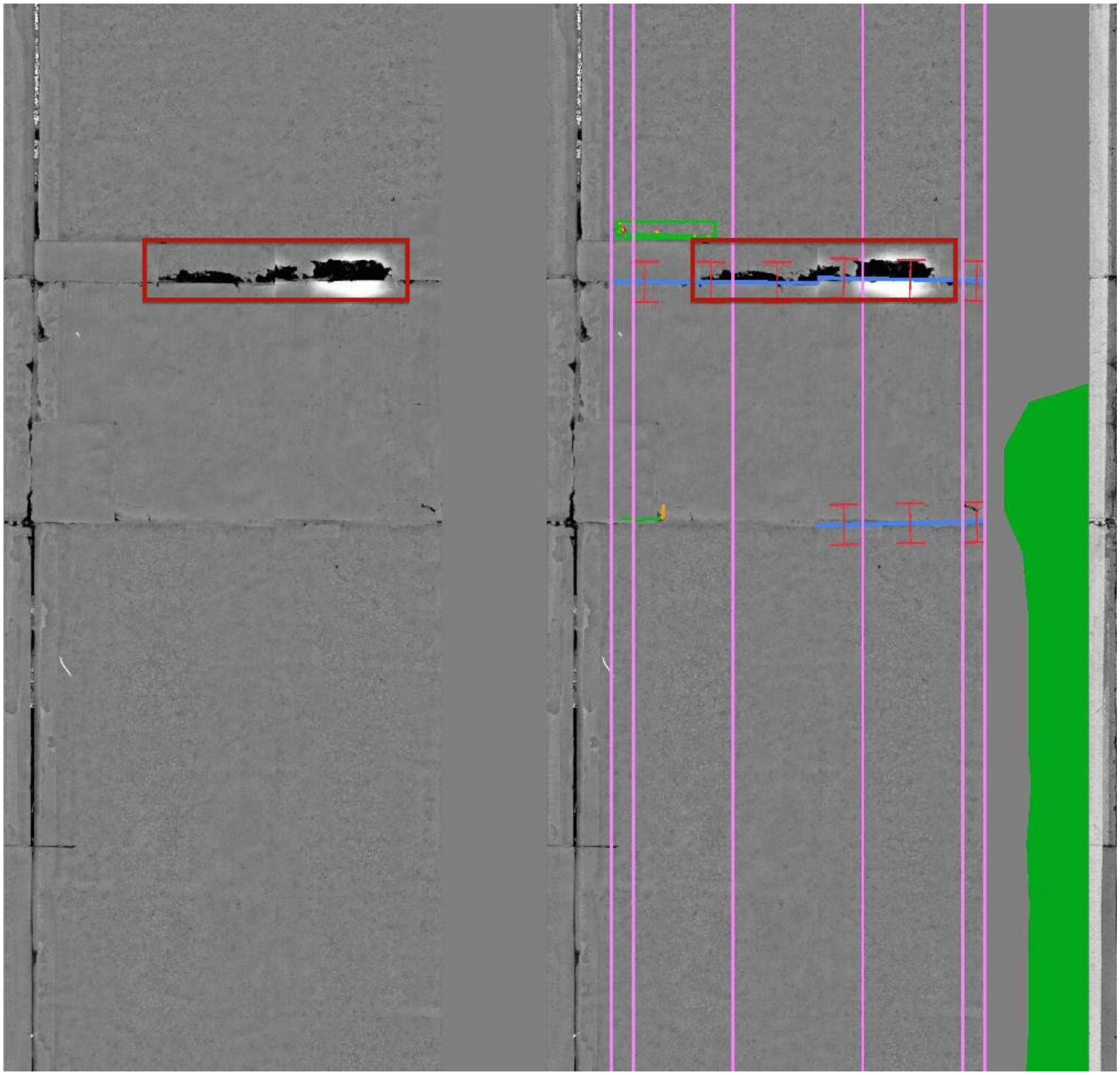

Figure 12. High-severity joint spalls exceed 6 inches wide and show a significant loss of material.

DE_JNT_SEAL_DAMAGE

Joint Seal Damage is any joint seal condition that enables incompressible materials to accumulate in PCC joints and allows water infiltration. Joint seal damage types include joint sealant stripping or extrusion, weed growth, hardening of the filler (oxidation), bond loss, and lack or absence of sealant in the joint.

Description: Severity of the Deteriorated (Spalled) Starting Joint (*Figure 13* & *Figure 14*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, High)

Data Type: STRING

Detection Method: Manual/Automated

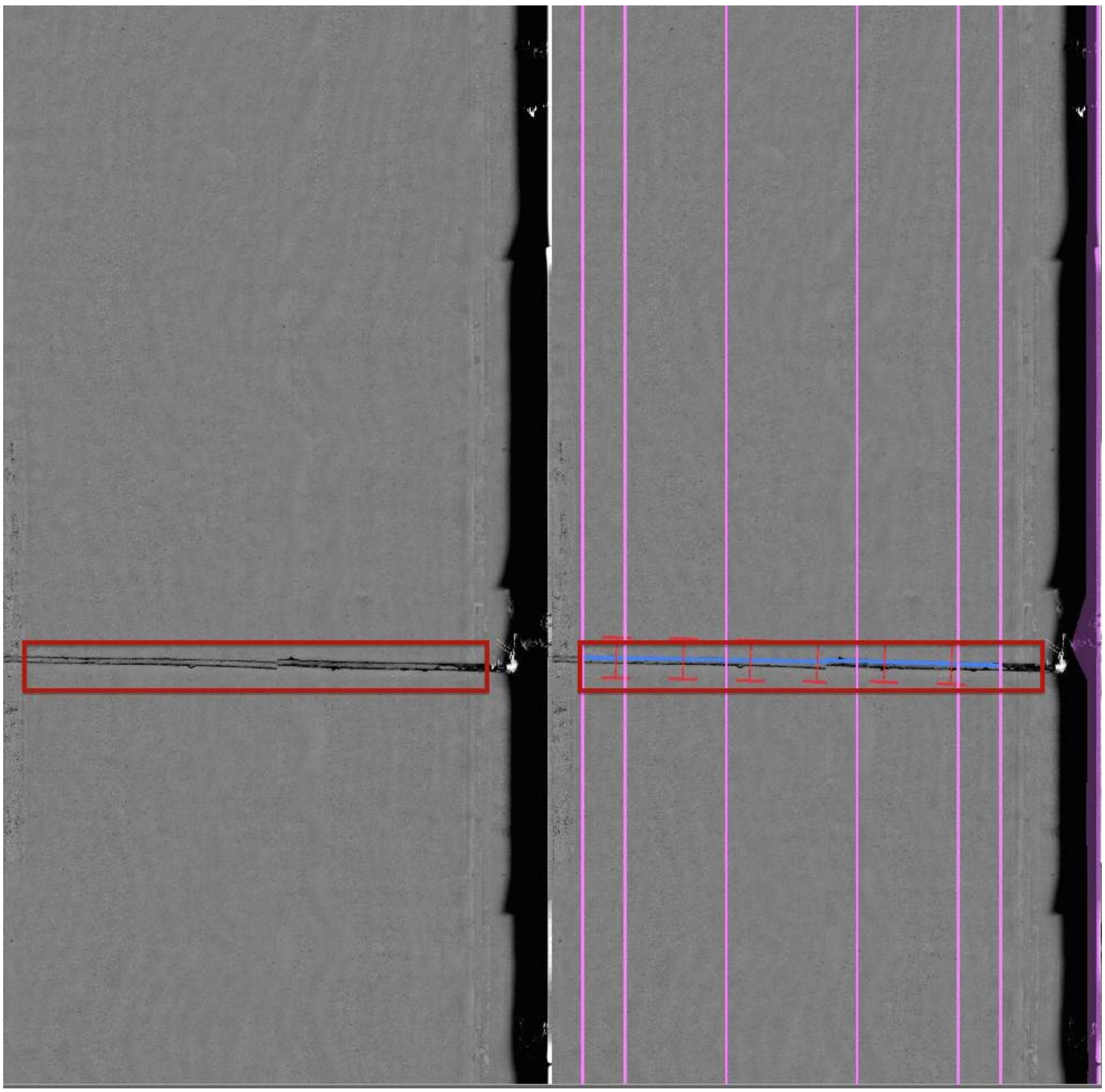

Figure 13. Low-Severity Joint Seal Damage is characterized by less than 10% loss of joint sealant.

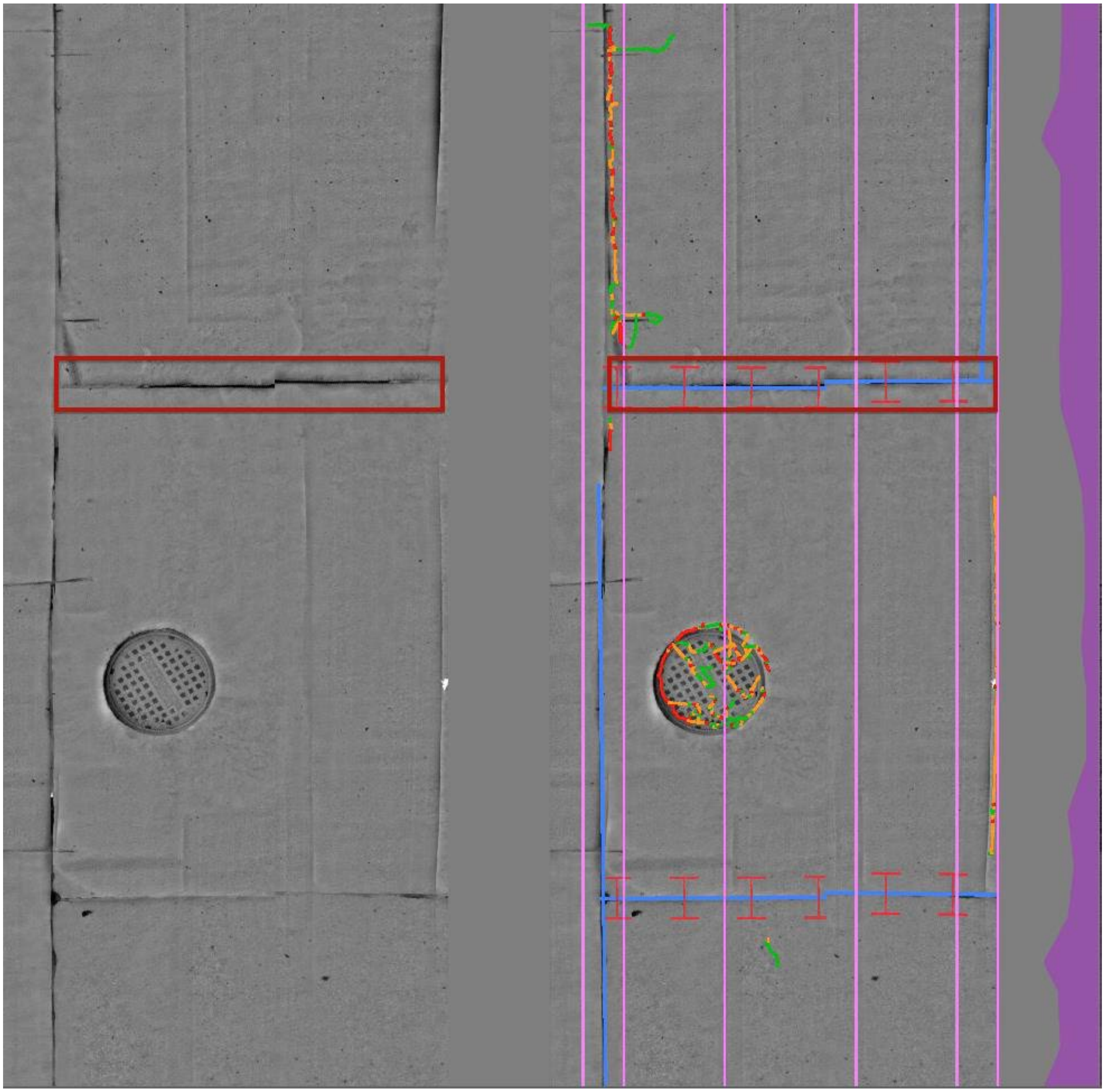

Figure 14. High-Severity Joint Seal Damage is characterized by more than 10% loss of joint sealant.

DE_SLAB_CRACK

Slab cracking encompasses both transverse and longitudinal cracking on PCC slabs. The highest severity crack defines the severity level of the slab. If a slab is broken into three or more pieces, the severity level is increased.

Description: Severity of the Slab Cracking (*Figure 15*, *Figure 16* & *Figure 17*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, Med, High)

Data Type: STRING

Detection Method: Manual/Automated

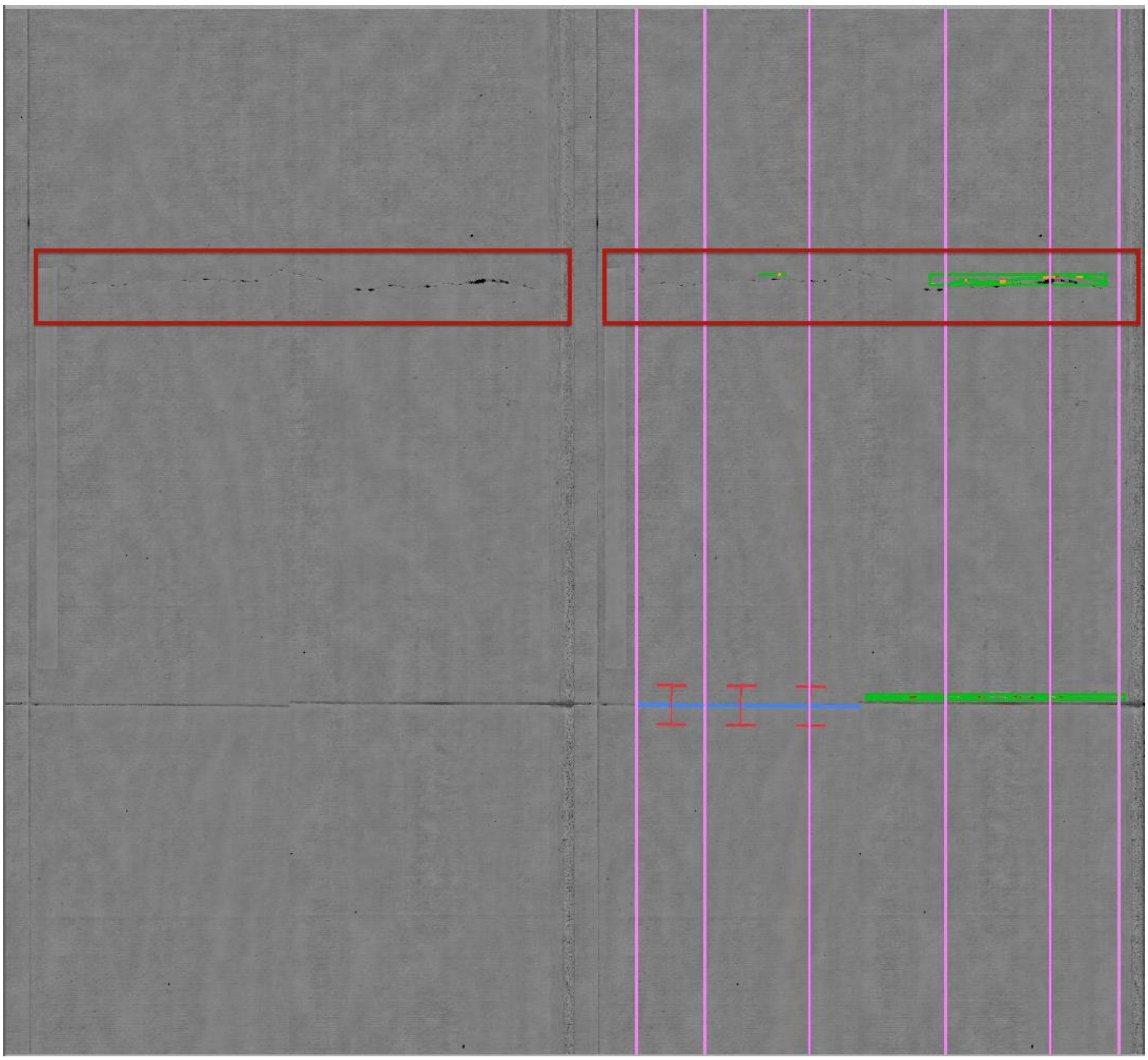

Figure 15. Low-severity slab cracking is characterized by cracks with widths less than ¼-inch or sealed cracks in good condition. If the cracks create three or more pieces, the severity level is increased by one severity level.

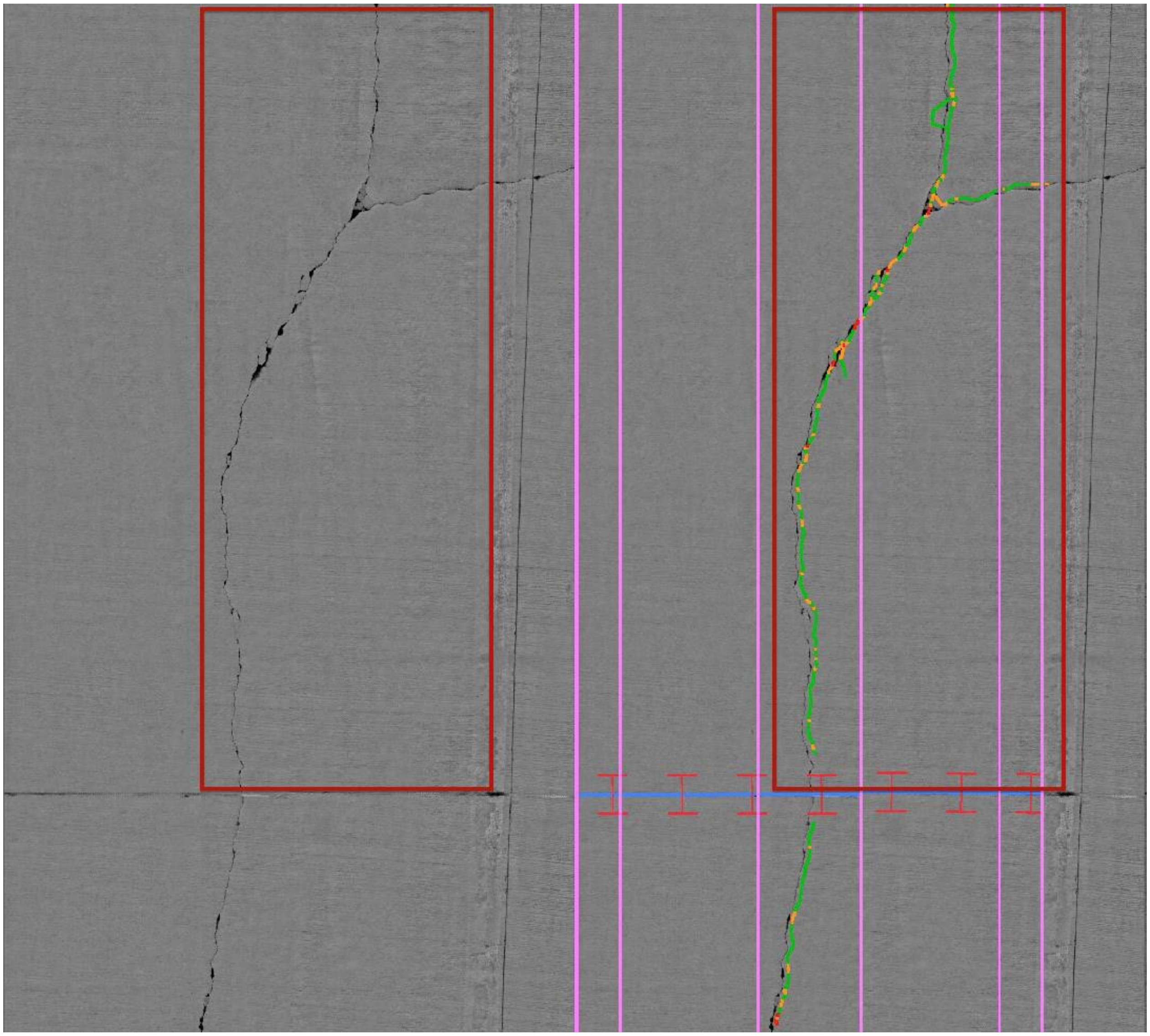

Figure 16. Medium-severity slab cracking is characterized by cracks with widths between ¼-inch and ¾-inch or spalling less than 3 inches wide. If the cracks create three or more pieces, the severity level is increased by one severity level.

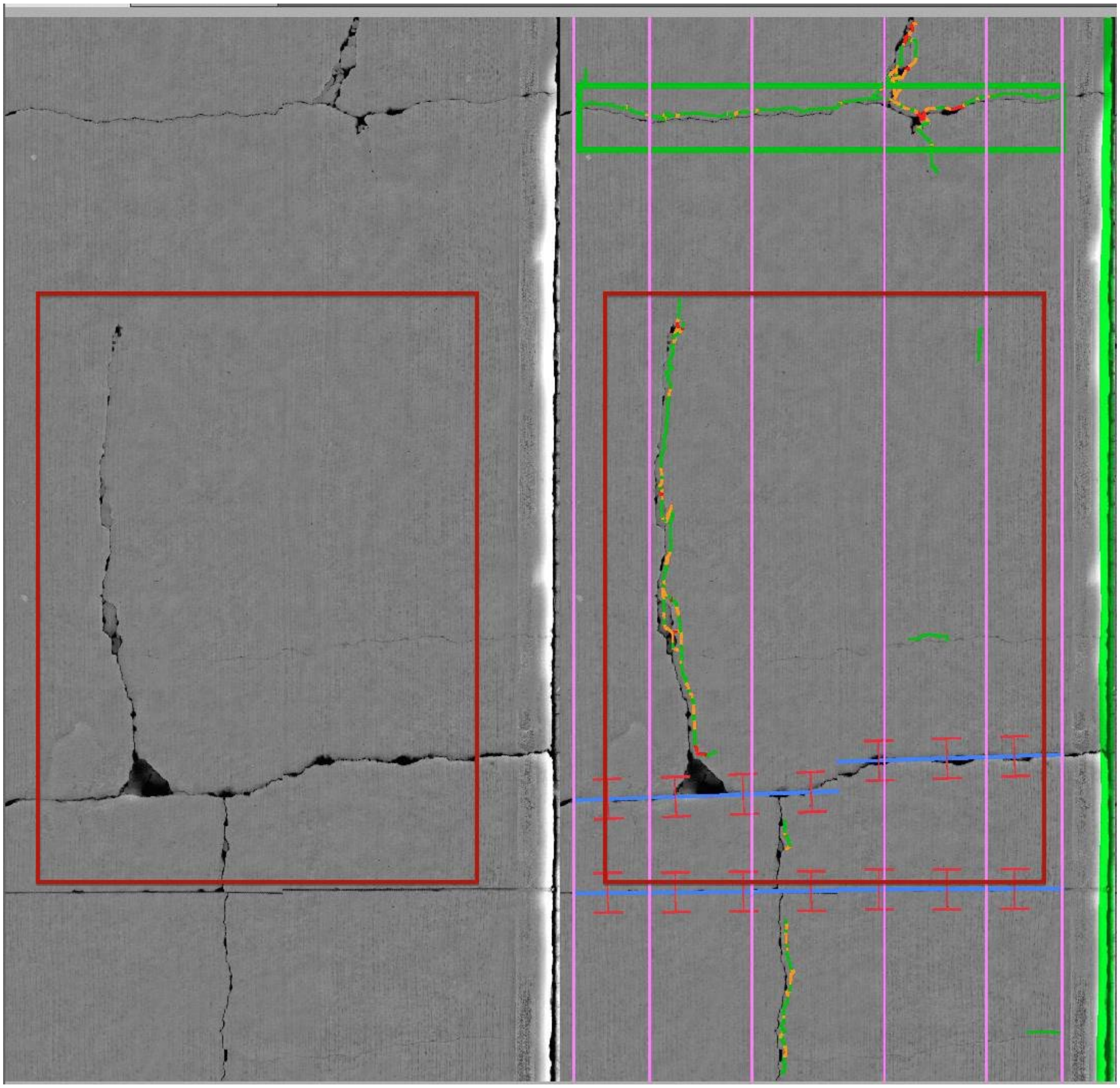

Figure 17. High-severity slab cracking is characterized by cracks with widths exceeding ¾-inch or spalling exceeding 3 inches wide.

DE_ROUGH_CROWN_LF

Cross slopes, provided for water drainage, that are too steep can cause vehicles to drift and skid laterally.

Description: Length of Crown/Cross Slope > 6%

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_ASR_CNT

Alkali-Silica Reactivity (ASR) or Map Cracking refers to a network of shallow, fine, or hairline cracks that extend only through the upper surface of the concrete. Map cracking is caused by concrete over-finishing and may lead to surface scaling, which is the breakdown of the slab surface to a depth of approximately 0.25 to 0.5 inches.

Description: Count of Slabs with Map Cracking /Alkali-Silica Reactivity (*Figure 18*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Count (0 or 1)

Data Type: INTEGER

Detection Method: Manual/Automated

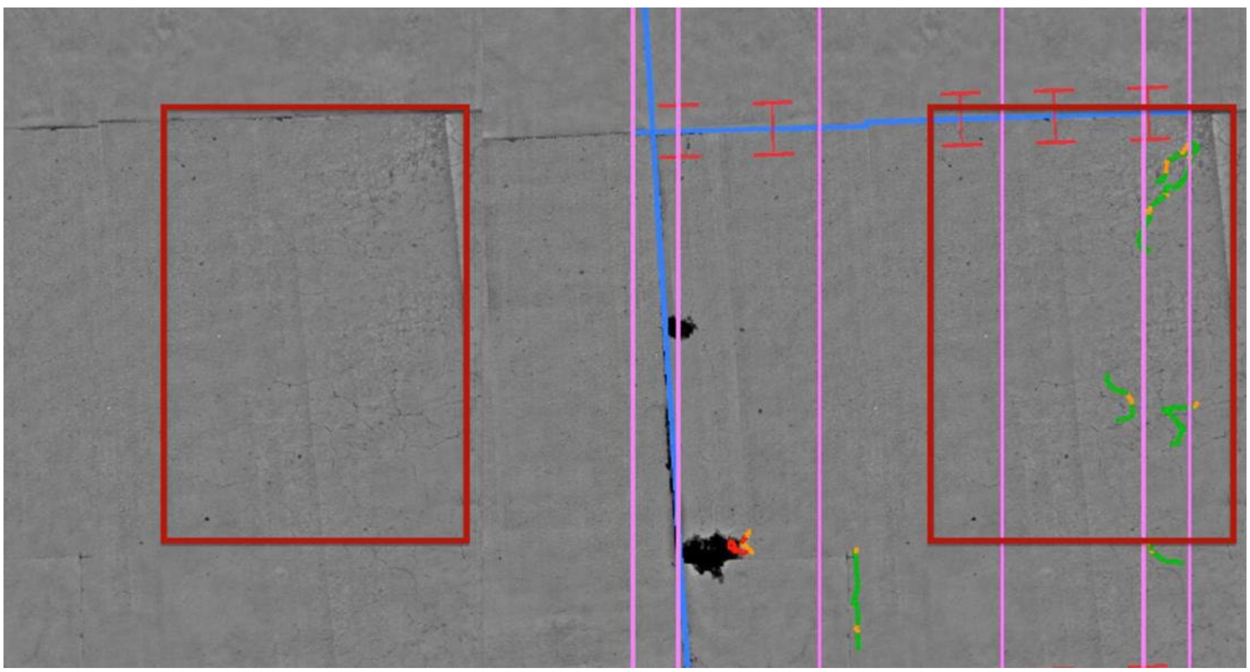

Figure 18. ASR Cracking

Crack Measurements

Cracking is defined as a fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement (HPMS Field Manual). The definition of the zones for cracking reporting are shown in *Figure 19*.

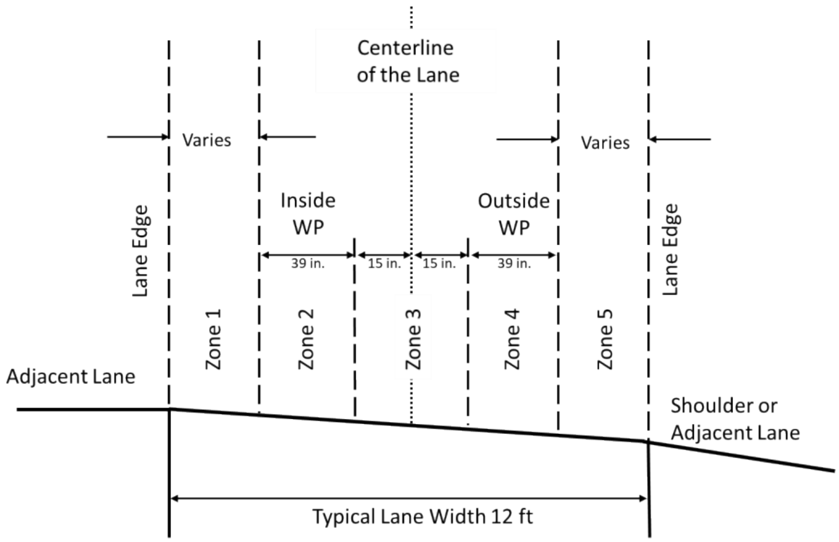

Figure 19. Definition of Transverse Zones (Source: AASHTO R85-18)

CRCK_LENGTH

Description: Length of Cracking (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z1

Description: Length of Cracking - Left Edge / Zone 1[2] (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

[2] Note that Zones are defined under the heading Crack Measurements above.

CRCK_LEN_Z2

Description: Length of Cracking - Left Wheel Path / Zone 2 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z3

Description: Length of Cracking - Center / Zone 3 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z4

Description: Length of Cracking - Right Wheel Path / Zone 4 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z5

Description: Length of Cracking - Right Edge / Zone 5 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S

Description: Length of Sealed Cracking (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z1

Description: Length of Sealed Cracking - Left Edge / Zone 1[3] (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z2

Description: Length of Sealed Cracking - Left Wheel Path / Zone 2 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z3

Description: Length of Sealed Cracking - Center / Zone 3 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

[3] Note that Zones are defined under the heading Crack Measurements on page 34.

CRCK_LENGTH_S_Z4

Description: Length of Sealed Cracking – Right Wheel Path / Zone 4 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z5

Description: Length of Sealed Cracking - Right Edge / Zone 5 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_WIDTH

Description: Weighted Average Width of Cracking

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated/Manual

Guidance: For PCC manually rated open cracks, the crack widths will be assigned as below for PSCM calculation:

Severity	Width (in)
Low	0.15
Med	0.5
High	1

CRCK_WID_Z1

Description: Weighted Average Width of Cracking - Left Edge / Zone 1[4]

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

CRCK_WID_Z2

Description: Weighted Average Width of Cracking - Left Wheel Path / Zone 2

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

CRCK_WID_Z3

Description: Weighted Average Width of Cracking - Center / Zone 3

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

CRCK_WID_Z4

Description: Weighted Average Width of Cracking – Right Wheel Path / Zone 4

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

[4] Note that Zones are defined under the heading Crack Measurements on page 34.

CRCK_WID_Z5

Description: Weighted Average Width of Cracking – Right Edge / Zone 5

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

INTERVAL_AREA

Description: Area of analysis segment | Area of Slab

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z1

Description: Area of analysis segment - Left Edge / Zone 1[5]

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z2

Description: Area of analysis segment - Left Wheel Path / Zone 2

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

---

[5] Note that Zones are defined under the heading Crack Measurements on page 34.

AREA_Z3

Description: Area of analysis segment - Center / Zone 3

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z4

Description: Area of analysis segment – Right Wheel Path / Zone 4

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z5

Description: Area of analysis segment – Right Edge / Zone 5

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

CRKD

Crack Density is the total sum of the crack lengths within the area being analyzed divided by the area being analyzed.

Description: Crack Density (Crack Length / Interval Area)

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z1

Description: Crack Density – Left Edge / Zone 1[6]

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z2

Description: Crack Density – Left Wheel Path / Zone 2

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z3

Description: Crack Density – Center / Zone 3

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z4

Description: Crack Density – Right Wheel Path / Zone 4

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

[6] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_Z5

Description: Crack Density – Right Edge / Zone 5

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_S

Description: Crack Density of Sealed Cracks excluding failed/open sealed cracks - (Sealed Crack Length / Interval Area)

Use: For reporting crack density of the sealed cracks

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_S_Z1

Description: Crack Density of Sealed Cracks – Left Edge / Zone 1

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z2

Description: Crack Density of Sealed Cracks – Left Wheel Path / Zone 2

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z3

Description: Crack Density of Sealed Cracks – Center / Zone 3

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z4

Description: Crack Density of Sealed Cracks – Right Wheel Path / Zone 4

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z5

Description: Crack Density of Sealed Cracks – Right Edge / Zone 5

Use: For reporting cracking density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_L

Description: Crack Density of cracks having width <= 0.25"

Use: To be able to identify narrow cracking

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z1

Description: Crack Density of cracks having width <= 0.25" – Left Edge / Zone 1[7]

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z2

Description: Crack Density of cracks having width <= 0.25" – Left Wheel Path / Zone 2

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z3

Description: Crack Density of cracks having width <= 0.25" – Center / Zone 3

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z4

Description: Crack Density of cracks having width <= 0.25" – Right Wheel Path / Zone 4

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

[7] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_L_Z5

Description: Crack Density of cracks having width <= 0.25" – Right Edge / Zone 5

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H

Description: Crack Density of cracks having width > 0.25"

Use: To be able to identify wide cracking

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z1

Description: Crack Density of cracks having width > 0.25" – Left Edge / Zone 1[8]

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z2

Description: Crack Density of cracks having width > 0.25" – Left Wheel Path / Zone 2

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

---

[8] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_H_Z3

Description: Crack Density of cracks having width > 0.25" – Center / Zone 3

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z4

Description: Crack Density of cracks having width > 0.25" – Right Wheel Path / Zone 4

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z5

Description: Crack Density of cracks having width > 0.25" – Right Edge / Zone 5

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

PSCM

Pavement Surface Cracking Metric (PSCM) is a numerical, dimensionless measure of the pavement cracking defined as area of open fissures within the area being analyzed divided by the total area being analyzed. It is equivalent to crack density multiplied by weighted crack width. It is defined in detail in the A3303 ASTM standard.

Description: ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) *100 (excluding sealed cracks)

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: All

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z1

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Left Edge / Zone 1[9]

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z2

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Left Wheel Path / Zone 2

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z3

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Center / Zone 3

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

---

[9] Note that Zones are defined under the heading Crack Measurements on page 34.

PSCM_Z4

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Right Wheel Path / Zone 4

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z5

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Right Edge / Zone 5

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

Segment- and Section-Level Distress Data Items

The following items are applicable to data collected for **both the section and segment level datasets**. These items shall be reported as follows:

DE_FAULTING_RWP_IN

Faulting is vertical misalignment of PCC pavement joints

Description: Average Absolute Faulting of the Right Wheel Path for the Measured Section

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual). To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_IRI_LWP_INCH_MILE

International Roughness Index (IRI) is a statistic used to estimate the amount of roughness in a measured longitudinal profile. The LWP and RWP IRI are averaged for HPMS reporting.

Description: Average International Roughness Index - Left Wheel Path

Use: For investment requirements modeling to estimate pavement deterioration, section deficiencies, and necessary improvements, in cost allocation studies, in pavement condition trends, and for other analysis purposes including NHS performance. Also, for performance measure calculation for pavement condition on the NHS (HPMS Field Manual).

Pavement Type: ALL

Unit of Measure: Inches/Mile

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_IRI_RWP_INCH_MILE

Description: Average International Roughness Index - Right Wheel Path

Use: For investment requirements modeling to estimate pavement deterioration, section deficiencies, and necessary improvements, in cost allocation studies, in pavement condition trends, and for other analysis purposes including NHS performance. Also, for performance measure calculation for pavement condition on the NHS (HPMS Field Manual).

Pavement Type: ALL

Unit of Measure: Inches/Mile

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_LWP_AVG_IN

A rut is longitudinal surface depressions in the asphalt pavement derived from measurements of a profile transverse to the path of travel on a highway lane. The LWP and RWP Rutting is averaged for HPMS reporting.

Description: Average Rutting Depth - Left Wheel Path

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_RWP_AVG_IN

Description: Average Rutting Depth - Right Wheel Path

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_LWP_LOW_LF

Description: Extent (length) of Low (<0.25") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_MED_LF

Description: Extent (length) of Medium (0.25"-0.75") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_HI_LF

Description: Extent (length) of High (>0.75") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_LOW_LF

Description: Extent (length) of Low (<0.25") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_MED_LF

Description: Extent (length) of Medium (0.25"- 0.75") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_HI_LF

Description: Extent (length) of High (>0.75") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_MAX_IN

Description: Maximum Rutting Depth - Left Wheel Path
Use: Collected for additional Rutting information

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_RWP_MAX_IN

Description: Maximum Rutting Depth - Right Wheel Path
Use: Collected for additional Rutting information

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_TRAN_CRK_JPCP_YN

One or more transverse (predominantly perpendicular to the pavement centerline) cracks of any severity extending for at least 5 ft.

Description: Transverse Cracking - JPCP

Use: To be used in calculating Cracking Percent for HPMS Reporting.

Pavement Type: JPCP

Unit of Measure: Boolean (1/0)

Data Type: INTEGER

Detection Method: Manual/Automated

DE_LONG_CRK_CRCP_LF

Longitudinal Cracks (Cracks that are predominantly parallel to the pavement centerline) of any severity.

Description: Length of Longitudinal Cracking - CRCP.

Use: To be used in calculating Cracking Percent for HPMS Reporting

Pavement Type: CRCP

Unit of Measure: Linear ft.

Data Type: NUMBER (*,1)

Detection Method: Manual/Automated

DE_PUNCHOUT_SF

The area enclosed by two closely spaced (usually < 0.6 m) transverse cracks, a short longitudinal crack, and the edge of the pavement or a longitudinal joint. Also includes "Y" cracks that exhibit spalling, breakup, or faulting. An area that is enclosed by two distressed transverse cracks that are spaced between 0.6 m and 1 m, a short longitudinal crack, and the edge of the pavement or a longitudinal joint is also considered a punchout (LTPP, 2014).

Description: Area of Punchouts - CRCP

Use: To be used in calculating Cracking Percent for HPMS Reporting

Pavement Type: CRCP

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

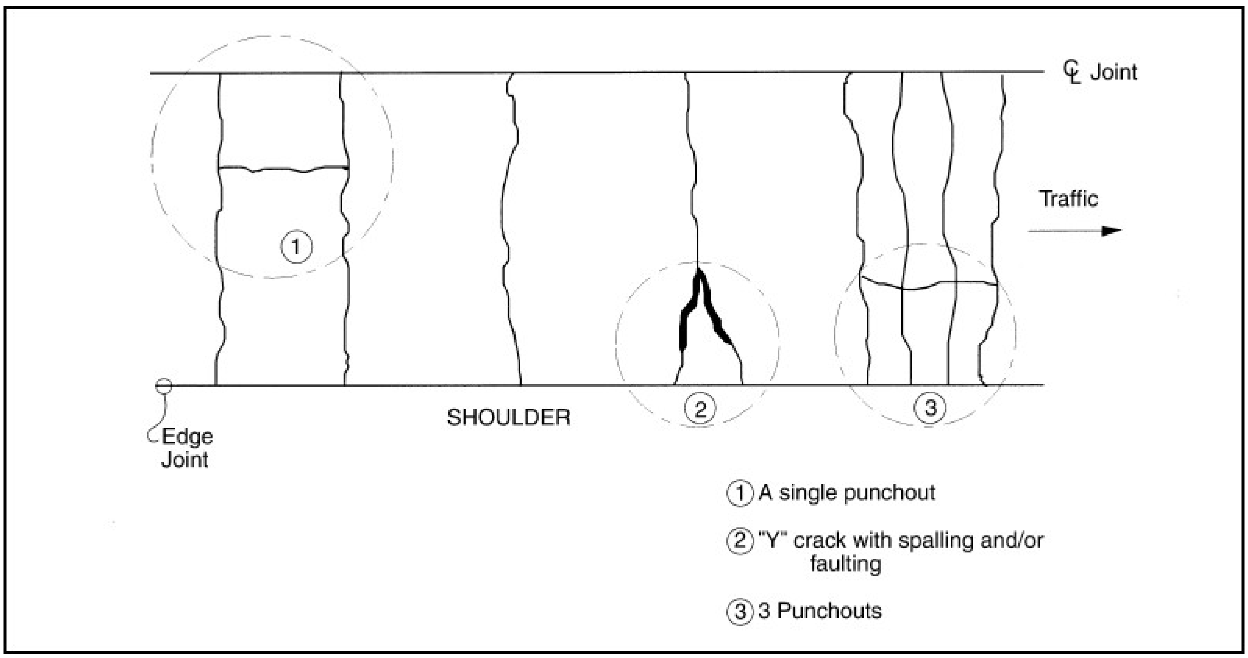

Figure 20. Punchouts (LTPP, 2014)

CRACKING PERCENT

Cracking Percent is calculated for the purpose of HPMS reporting. Cracking Percent is defined as the percentage of pavement surface exhibiting cracking. For Asphalt pavement, it is the total area exhibiting visible fatigue type sealed/unsealed cracking (both longitudinal and/or pattern) for all severity levels in the wheelpaths in each section. For Jointed Plain Concrete Pavements (JPCP), it is the percentage of slabs within the section that exhibit transverse cracking. For Continuously Reinforced Concrete Pavements (CRCP), it is the percentage of the area of the section exhibiting longitudinal cracking, punchouts, and/or patching but excluding Transverse Cracking (HPMS Field Manual). Majority of PCC pavements in DelDOT are JPCP.

Description: Percentage of pavement surface exhibiting cracking.

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: All

Unit of Measure: Percent

Data Type: NUMBER (*,2)

Detection Method: Calculated at Section Level

REFERENCES

Delaware Department of Transportation (DelDOT) Data Quality Management Plan (DQMP) V-2.0. Delaware Department of Transportation.

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Delaware Department of Transportation

Data Quality Management Plan

July 26, 2023

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Revision History

Version	Date	Author	Description
v0.1-0.9x	5/8/18	Kercher Group	Initial Drafts
v1.0	5/8/18	Kercher Group	Initial submittal for FHWA
v1.1	8/27/18	Kercher Group	Updated submittal for FHWA
V1.11		Kercher Group	Repeatability requirements for Crack Length, Faulting, Rutting, and IRI have been changed. Accuracy requirements for Crack Length are changed.
V1.13	11/04/2019	Kercher Group	Requirement of Slab Cracking Length and Patch Deteriorations/Potholes Count is dropped.
V1.2	7/28/2020	Kercher Group	Updated based on QA report
V1.3	12/27/2021	Kercher Group	Block Cracking and Surface Defects are removed. Transverse Cracking, Joint Reflective Cracking, and Slab Cracking will be measured as Counts only; their Accuracy and Reputability criteria were changed. Data Elements with CV < 50% Repeatability Criteria were changed to CV < 30%. Repeatability Criteria for Bleeding, IRI, slab Cracking, and Length were changed. Accuracy limits for Faulting were changed. Patching will be measured in area units only.
V2.0	07/26/2023	Mott MacDonald	Removing/Adding data elements based on the revised Data Dictionary document to use the new standard ASTM E3303.

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Table of Contents

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Introduction

This document defines the Data Quality Management Plan for DelDOT.

Based on §490.319(c) of the Federal Register of January 5, 2015 and the final rule published by the FHWA on January 18, 2017, it is required by the FHWA that "Each State DOT shall develop and utilize a Data Quality Management (QM) Program, approved by the FHWA, that addresses the quality of all data collected, regardless of the method of acquisition, to report the pavement condition metrics, discussed in §490.311, and data elements discussed in §490.309(c)."

These elements are required for target setting according to 23 CFR 490.105 - Establishment of performance targets, 23 CFR 490.307 - National performance management measures for assessing pavement condition, 23 CFR 490.309 - Data requirements, 23 CFR 490.311 - Calculation of pavement metrics, and 23 CFR 490.313 - Calculation of performance management measures. The pavement performance management measures are required on the Interstate System, and the NHS (excluding the Interstate).

Under 23 CFR 490.319(c), the State DOT must develop a DQMP that addresses the following:

A. Data collection equipment calibration and certification;
B. Certification process for persons performing manual data collection;
C. Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
D. Data sampling, review and checking processes; and
E. Error resolution procedures and data acceptance criteria.

These areas are addressed in the following sections with the exception of certification processes for manual data collection since this is not applicable for DelDOT.

In addition to the condition data used for pavement management in the DelDOT pavement management system, this Data Quality Management Plan therefore includes the data elements used to determine pavement condition from the most current HPMS Field Manual[1] specifically identified in 23 CFR 490.311 - Calculation of pavement metrics:

- IRI Rating (IRI)
    - All pavements
- Cracking Percent Value (percent)
    - Asphalt and Composite Pavements: fatigue type cracking for all severity levels in the wheelpath in each section
        - Fatigue Cracking (sq. ft.)
    - Jointed Plain Concrete Pavements: percentage of slabs within the section that exhibit transverse cracking based on
        - Slab Cracking (ft.)
        - Slab Count (count)
    - Continuously Reinforced Concrete Pavements: area of the section exhibiting longitudinal cracking, punchouts, and/or patching (sq. ft.)

[1] Most current HPMS Field Manual: https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/hpms_field_manual_dec2016.pdf

- Rutting value (inches)
    - Asphalt and Composite Pavements only.
- Faulting value (inches)
    - Jointed Plain Concrete Pavements only.

The underlying objective for this document is to create a repeatable process to ensure that data being delivered to support the Pavement Management program and FHWA pavement condition reporting is accurate and repeatable so that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

As noted in the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*, "*An effective pavement management system depends on reliable, accurate, and complete information. Quality pavement condition data is directly linked to the ability of the pavement management system to produce reasonable, timely, and reliable recommendations regarding an agency's pavement network. Increasingly, pavement managers realize that money is wasted and poor decisions are made when data are substandard. Confidence in data is eroded and people within the organization will tend to work around poor-quality data. The savings from using good data comes from more accurate decisions and lower life cycle cost for maintaining the pavements.*"

The approach followed in this Data Quality Management Plan is to define and provide detailed descriptions for all parts of the quality management cycle while not being so prescriptive as to require vendors to change their own quality management processes and procedures that would already result in high quality, accurate and repeatable final data and does not unreasonably regulate source and raw data except where existing AASHTO and ASTM standards are applicable.

The following definition of the Data Quality Management Cycle is quoted from the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*.

Data Quality Management Cycle

Management of data quality is based on many of the same principles as other QM processes, such as Total Quality Management (TQM) and the Deming cycle of "Plan, Do, Check, and Act" for quality enhancement. Wang (1998) identified four phases that are essential in the QM cycle to ensure high quality data: define, measure, analyze, and improve. Expanding these concepts to pavement condition data collection includes (also shown in figure 7):

- **Define data quality** – Identify the acceptable levels of resolution, accuracy, and repeatability.
- **Plan and implement QC** – Develop and implement a set of procedures to produce, check, and ensure data of acceptable quality.
- **Perform acceptance tests and evaluate results** – Perform tests to compare delivered data to acceptability metrics.
- **Take corrective action** – Take steps to re-collect or reprocess data as needed to achieve data acceptance standards.
- **Report on data quality** – Document the data quality standards, protocols, equipment, personnel, collection and processing methods, QC, acceptance tests, and results.
- **Improve the process** – Use the knowledge and experienced gained to modify processes as needed to improve data quality.

It should be noted that the steps in the QM cycle incorporates a feedback process so that the collection team evaluates data quality continually throughout the collection and makes any needed process modifications as soon as it becomes evident.

To address all parts of the Data Quality Cycle, this document divided into the following sections:

- **Introduction**: This gives the purpose and layout of the document.
- **Data Collection**: This section lists the deliverables, including individual data elements, being collected, and the protocols, resolution, accuracy, and repeatability required for each.

- **Quality Control**: This gives the QC activities for each deliverable, and the frequency at which the QC activity should be performed. The section is further divided into sub-sections for pre-collection activities, activities carried out during collection, and post-collection activities.
- **Acceptance**: This section gives a description of acceptance percentage (%) within limits required for each acceptance test, and the action that will be taken if the acceptance test fails.
- **Team Roles and Responsibilities**: This describes each role, the assigned resource, and the quality management responsibilities for that role.
- **Quality Reporting Plan**: The last section details the reporting that will be performed on the quality management activities, including which role is responsible for generating the reporting.

1. Deliverables, Protocols, and Quality Standards

Data Elements

The distresses and individual data elements listed in Table 1 and Table 2 are required to be collected for use in the DelDOT pavement management program. Pavement distresses are considered for four pavement types, namely Asphalt Concrete (AC), Jointed Plain Concrete Pavement (JPCP), Continuously Reinforced Concrete Pavement (CRCP), Composite pavement (AC over PCC, or APC), and Surface Treated (ST) pavements. The data elements in Table 1 shall be collected at 6-ft./slab-length interval in accordance with the *DelDOT Pavement Data Dictionary version 3.0*. The QM process assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used for all ratings.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31 on off years.

Lengths of lane exclusions related to bridges, construction, lane deviations, or railroads should be reported for each route.

Table 1 – Data Elements collected for pavement management for 6-ft./slab-length segments

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Route, Direction, Lane (From, To – placeholders only)	X	X	X	X	X	N/A	ROUTE_ID LANE_DIR LANE_ID OFFSET_FROM OFFSET_TO
GIS Route	X	X	X	X	X	N/A	DE_GIS_ROADWAY
Section/Segment Width	X	X	X	X	X	Width of Lane Rated (ft.)	SEC_WIDTH
From, To	X	X	X	X	X	From, To milepoints based on measured shape file (Miles)	FROM_POINT TO_POINT
Wearing Course	X	X	X	X	X	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	WC_ID
Date Rated	X	X	X	X	X	MM/DD/YYYY	DATE_RATED
Bleeding			X			High, Medium, Low (sq. ft.)	DE_BLEEDING_HI_SF DE_BLEEDING_LOW_SF DE_BLEEDING_MED_SF
Crown / Cross-Slope			X			(Linear ft.)	DE_ROUGH_CROWN_LF

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Faulting				X		Average fault height Right Wheel Path (Inches)	DE_FAULTING_RWP_IN
International Roughness Index (IRI)	X	X	X	X	X	Left Wheel Path, Right Wheel Path (Inches Per Mile)	DE_IRI_LWP_INCH_MILE DE_IRI_RWP_INCH_MILE
Joint Deterioration / Spalling				X		High, Medium, Low, None	DE_JOINT_DET
Joint Seal Damage				X		High, Low	DE_JOINT_SEAL_DAMAGE
Map Cracking / Alkali-Silica Reactivity				X	X	Occurrences (Count)	DE_ASR_CNT
Patch Deterioration / Potholes	X	X	X	X	X	High, Medium, Low (sq. ft.)	DE_PATCH_DET_HI_SF DE_PATCH_DET_LOW_SF DE_PATCH_DET_MED_SF
Rutting	X	X	X			Left Wheel Path, Right Wheel Path; High, Medium, Low (Linear ft.); Average (Inches)	DE_RUT_LWP_HI_LF DE_RUT_LWP_LOW_LF DE_RUT_LWP_MED_LF DE_RUT_RWP_HI_LF DE_RUT_RWP_LOW_LF DE_RUT_RWP_MED_LF DE_RUT_LWP_AVG_IN DE_RUT_RWP_AVG_IN
Slab Cracking				X	X	High, Medium, Low, None	DE_SLAB_CRACK
Transverse Cracking - JPCP				X		1 (Yes), 0 (No)	DE_TRAN_CRK_JPCP_YN
Longitudinal Cracking - CRCP					X	Length (ft)	DE_LONG_CRK_CRCP_LF
Punchouts - CRCP					X	Area (sq. ft)	DE_PUNCHOUT_SF
Interval Length	X	X	X	X	X	Length (ft)	LENGTH
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	X	X	X	X	X	Latitude, Longitude (Degrees), Altitude (ft.)	BEGIN_LAT BEGIN_LONG BEGIN_ALT END_LAT END_LONG END_ALT
Exclusions	X	X	X	X	X	Bridges, Construction, Railroads (Count); Total Length Excluded (Miles)	BRIDGE BRIDGE_LENGTH CONSTRUCTION CONSTRUCTION_LENGTH LANE_DEVIATION LANE_DEVIATION_LENGTH RAILROAD RAILROAD_LENGTH

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Low Severity Crack Density (Width≤0.25 in.)- Zones 1-5	X	X	X	X	X	Crack density (of cracks with width≤ 0.25 in.) measured as crack length per unit area (ft./sq. ft.), Zones for AC, APC, and ST only.	CRKD_L, CRKD_Z1_L, CRKD_Z2_L, CRKD_Z3_L, CRKD_Z4_L, CRKD_Z5_L
High Severity Crack Density (Width>0.25 in.)- Zones 1-5	X	X	X	X	X	Crack density (of cracks with width> 0.25 in.) measured as crack length per unit area (ft./sq. ft.). Zones for AC, APC, and ST only.	CRKD_H, CRKD_Z1_H, CRKD_Z2_H, CRKD_Z3_H, CRKD_Z4_H, CRKD_Z5_H
PSCM	X	X	X	X	X	ASTM E3303 Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area). Zones for AC, APC, and ST only.	PSCM, PSCM_Z1, PSCM_Z2, PSCM_Z3, PSCM_Z4, PSCM_Z5
Crack Length	X	X	X	X	X	Length of Cracking (including failed/open sealed cracks), Length of Sealed Cracking (excluding failed/open sealed cracks) (ft.). Zones for AC, APC, and ST only.	CRCK_LENGTH, CRCK_LEN_Z1, CRCK_LEN_Z2, CRCK_LEN_Z3, CRCK_LEN_Z4, CRCK_LEN_Z5, CRCK_LENGTH_S, CRCK_LENGTH_S_Z1, CRCK_LENGTH_S_Z2, CRCK_LENGTH_S_Z3, CRCK_LENGTH_S_Z4, CRCK_LENGTH_S_Z5
Area	X	X	X	X	X	Area of Analysis | Area of Slab (sq. ft.). Zones for AC, APC, and ST only.	INTERVAL_AREA, AREA_Z1, AREA_Z2, AREA_Z3, AREA_Z4, AREA_Z5
Crack Width	X	X	X	X	X	Weighted Average Width of Cracking (inch). Zones for AC, APC, and ST only.	CRCK_WIDTH, CRCK_WID_Z1, CRCK_WID_Z2, CRCK_WID_Z3, CRCK_WID_Z4, CRCK_WID_Z5
PSCI	X	X	X	X	X	Pavement Surface Cracking Index	PSCI
Ambient/Surface Temperature (°F)	X	X	X	X	X	Temperature recorded during distress collection	

In additional pavement management distresses collected above, the distresses and individual data elements listed in Table 2 are required to be collected for HPMS reporting at 0.1-mile interval. These data elements shall be collected in accordance with the HPMS manual and *DelDOT Pavement Data Dictionary version 3.0* or latest iteration. All non-distress data elements mentioned in Table 1 (e.g., Route, Section Width, From, To, Wearing Course, Date Rated, etc.) will also be reported for 0.1-mile sections.

Table 2 – Data Elements collected for HPMS collected for 0.1-mile sections specifically for FHWA pavement condition metrics[2]

Data Elements	Pavement Type			Description, Severity Levels and Units	Individual Data Fields
	AC	JPCP	CRCP		
Crack Percentage	X	X	X	Fatigue area for AC, slabs with Transverse Cracks for JPCP, and Longitudinal Cracking, Punchouts, and/or Patching for CRCP.	Captured for 0.1-mile sections or derived from cracking measurement in Table 1
Faulting		X		Average fault height Right Wheel Path (Inches)	Captured for 0.1-mile sections or derived from the slab-length segments data
International Roughness Index (IRI)	X	X	X	Average of Left Wheel Path and Right Wheel Path (Inches Per Mile)	Captured for 0.1-mile sections directly (in additional to collection for 6-ft/Slab-Length segments)
Rutting	X			Average of Left Wheel Path and Right Wheel Path (Inches)	Captured for 0.1-mile sections or derived from 6-ft data

Data Collection Scope

The following is required by DelDOT regarding scope of services by the data collection vendor.

- The vendor shall conduct field surveys on all pavement sections of state-maintained roads and suburban streets to identify:
  - Type of pavement
  - Severity and Extent of some distresses (See Table 1)
  - Crack density and PSCM/PSCI for cracking distresses (See Table 1)
- The vendor will provide data in a comma separated values (.csv) import file. Images shall be in JPG format. The data shall be compatible with the department's Pavement Management System.

[2] 23 CFR 490.311

- The vendor shall provide training for all personnel who perform the field surveys.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31.[3]
- The data collection vendor will be required to provide QA/QC to ensure data is reliable. The QA/QC plan should be submitted to DelDOT prior to collection data. This will be the responsibility of the vendor.

Data Protocol, Resolution, Accuracy and Repeatability

The expected data units and resolution, accuracy and repeatability are identified for each data element in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability below. Following requirements will apply to each individual 6 ft./slab-length longitudinal data collection segment within each calibration site specified in Table 7.

Table 3 – Data Protocols, Resolution, Accuracy and Repeatability for Data Elements collected at 6 ft./slab-length segments

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
Route, Direction, Lane (From, To – placeholders only)	e.g., 1-00001, R, 1	N/A	Exact	Exact
GIS Route	GIS Route ID based on provided measured shape file, e.g., 10928	N/A	Exact	Exact
Section/Segment Width	Total width of 5 AASHTO zones between lane edge or centerline, and	0.1 ft.	± 0.5 ft.	± 0.5 ft.

[3] Note that the August 31 date is for data collection completion – the resulting HPMS data is due to FHWA on April 15 of the following year for Interstates, and June 15 biennially of the following year for Non-Interstate.
[4] See section Calibration Reference Value Data Collection and Review
[5] 10 runs for Initial Calibration, 5 runs for the monthly Calibration Verification

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
	lane edge or shoulder.			
From, To	From, To milepoints based on measured shape file (Miles)	0.00001 Miles	± 0.0001 Miles	± 0.0001 Miles
Wearing Course	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	N/A	Exact	Exact
Date Rated	Date Format: (MM/DD/YYYY)	N/A	Exact	Exact
Bleeding	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*. (for Fatigue Cracking, also	1 sq. ft. (per Severity Level)	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Crown / Cross-Slope		1 ft.	± 0.1 ft.	Std. dev. < 0.05 ft. or CV < 5%
Faulting	AASHTO R36-21[6] (also *HPMS Field Manual*)	0.01 Inches (for Average fault height Right Wheel Path)	0.05 inches	Std. dev. < 0.10 inches Or CV < 5%
International Roughness Index (IRI)	AASHTO R43-13[7] (also *HPMS Field Manual*)	1 inch per mile (for Left Wheel Path, Right Wheel Path)	Maximum (± 25 inches per mile), based on running average of 11 6-ft segments or 5 slab-length segments[8]	Std. dev. < 15 inches per mile or CV (Std. Dev./Mean) < 15%, based on running average of 11 6-ft segments or 5

[6] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics
[7] 23 CFR 490.311(b)(1)(i) Computation of IRI. Note that additional equipment standards required prior to data collection startup such as AASHTO R56-14 are listed in Table 6 – Equipment and Data Collection Protocols and Standards.
[8] This measurement should be the average of the IRI values from the previous 5 segments, the current segment, and the next 5 segments, or as many segments up to 5 that are available at the beginning and end of sections. For JPCP, the measurement should be the average of the IRI values from the previous 2 slabs, the current slab, and the next 2 slabs, or as many slabs up to 2 that are available at the beginning and end of the sections.

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
				slab-length segments
Joint Deterioration / Spalling	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	None (0), Low (1), Medium (2), High (3)	± 0.5	Std. dev. < 0.5
Joint Seal Damage		None (0), Low (1), High (2)	± 0.5	Std. dev. < 0.5
Map Cracking / Alkali-Silica Reactivity		Yes (1), No (0)	± 0.25	Std. dev. < 0.4
Patch Deterioration / Potholes		High, Medium, Low (sq. ft.)	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Rutting	AASHTO R 87[9] (also *HPMS Field Manual*)	1 ft. (for Left Wheel Path, Right Wheel Path; per severity); 0.01 inches (for Average)	± 0.1 ft. ± 0.1 inches	Std. dev. < 0.75 ft. or CV < 5% Std. dev. < 0.05 inches for average or CV < 5%
Slab Cracking	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	None (0), Low (1), Medium (2), High (3)	± 0.5	Std. dev. < 0.5
Transverse Cracking - JPCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	0 (No), Yes (1)	± 0.25	Std. dev. < 0.4
Longitudinal Cracking - CRCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	± 0.1 ft.	± 0.1 ft.	Std. dev. < 0.05 ft. or CV < 5%

[9] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics. Alternatively, for automated rut data capture, the following are applicable:

- Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and
- Quantification of Rut Depth values in accordance with AASHTO Standard RR 87-19, with the modifications specified in the HPMS Field Manual

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
Punchouts - CRCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	± 0.1 sq. ft.	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Interval Length	Length of surveyed segment.	0.1 ft	± 0.1 ft	Std. dev. < 0.05 ft or CV (Std. Dev./Mean) < 5%
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	GPS	0.00000001 degrees	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)
Exclusions	Bridges, Construction, Railroads (Flag); Total Length Excluded (Miles)	Flag (1,0); Length 0.01 Miles	Exact for Flag; No requirement for length.	Exact for Flag; No requirement for length.
Crack length (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 ft.	± 15 Linear ft.	Std. dev. < 4 Linear ft. or CV (Std. Dev./Mean) < 25%
Sealed Crack length (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 ft.	± 15 Linear ft.	Std. dev. < 4 Linear ft. or CV (Std. Dev./Mean) < 25%
Crack Width (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.0001 in.	± 0.05 in.	Std. dev. < 0.1in. or CV (Std. Dev./Mean) < 5%
Area (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 sq. ft.	± 2 sq. ft.	Std. dev. < 1 sq. ft. or CV (Std. Dev./Mean) < 5%
PSCM (Whole width, Zone 2-4, Zone 1 & 5)	ASTM E3303	0.01	±0.1 for the whole width, ±0.25 for Individual zones (1-5)	Std. dev. < 0.1 or CV < 5%. Std. dev. < 0.2 or CV < 5% for Zones 2, 3, & 4.

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
				Std. dev. < 0.5 or CV < 5% for Zones 1 & 5.
Low Severity Crack Density (Width≤0.25 in.)-(Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.5 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%
High Severity Crack Density (Width>0.25 in.)-(Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.1 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%
Crack Density (Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.25 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%

All HPMS data elements (Table 2) will also be collected and reported for 0.1-mile sections. The expected data units and resolution, accuracy and repeatability are identified for each data element in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability below.

Table 4 – Data Protocols, Resolution, Accuracy and Repeatability for HPMS Data Elements

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
Crack Percentage	-	-	(Quality controlled at finer segmentation level. See Table 3)	(Quality controlled at finer segmentation level. See Table 3)
Faulting	AASHTO R36-21[11] (also *HPMS Field Manual*)	1 Count (per Severity Level), 0.01 Inches (for Average fault height	± 5 Count, 0.1 inches	Std. dev. < 5 Count Std. dev. < 0.10 inches Or CV < 10%

[10] 10 runs for Initial Calibration, 5 runs for the monthly Calibration Verification

[11] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
		Right Wheel Path)		
International Roughness Index (IRI)	AASHTO R43-13[12] (also *HPMS Field Manual*)	1 inch per mile (for Left Wheel Path, Right Wheel Path)	Maximum (± 15 inches per mile, ± 10% per mile)	Std. dev. < 5 inches per mile or CV (Std. Dev./Mean) < 10%
Rutting	AASHTO R 87 [13] (also *HPMS Field Manual*)	1 ft (for Left Wheel Path, Right Wheel Path; per severity); 0.01 inches (for Average)	± 50 Ft, ± 0.25 inches	Std. dev. < 20 ft. or CV < 5% Std. dev. < 0.05 inches for average or CV < 5%
Route, Direction, Lane (From, To – placeholders only)	e.g., 1-00001, R, 1	N/A	Exact	Exact
GIS Route	GIS Route ID based on provided measured shape file, e.g., 10928	N/A	Exact	Exact
Section Width	Total width of 5 AASHTO zones between lane edge or centerline, and lane edge or shoulder.	0.1 ft.	± 0.5 ft.	± 0.5 ft.
From, To	From, To milepoints based	0.1 Miles	± 0.02 Miles	± 0.02 Miles

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[12] 23 CFR 490.311(b)(1)(i) Computation of IRI. Note that additional equipment standards required prior to data collection startup such as AASHTO R56-14 are listed in Table 6 – Equipment and Data Collection Protocols and Standards.

[13] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics. Alternatively, for automated rut data capture, the following are applicable:

- Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and
- Quantification of Rut Depth values in accordance with AASHTO Standard R 87-19, with the modifications specified in the HPMS Field Manual

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
	on measured shape file (Miles)			
Wearing Course	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	N/A	Exact	Exact
Date Rated	Date Format: (MM/DD/YYYY)	N/A	Exact	Exact
Interval Length	Length of surveyed segment.	0.1 Miles	± 0.02 Miles	Std. dev. < 0.01 Miles or CV (Std. Dev./Mean) < 10%
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	GPS	0.00000001 degrees	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)
Exclusions	Bridges, Construction, Railroads (Flag); Total Length Excluded (Miles)	Flag (1,0); Length 0.01 Miles	Exact for Flag; No requirement for length.	Exact for Flag; No requirement for length.

2. Quality Assurance and Quality Control

The data collection vendor is required to submit a quality assurance (QA), quality control (QC) plan to the DelDOT as part of their proposal. DelDOT will review and approve the plan to check it has at a minimum the required elements as defined in this document, as well as approve the results of the QC activities defined below in Table 5 – QC Activities.

Quality assurance focuses on procedures and processes to ensure quality. Quality control focuses on the activities that will be performed to check the quality of the data being collected.

Required QC activities are summarized below in Table 5 – QC Activities. The individual activities are then described in more detail in the subsequent sections. The activities and sections are categorized into:

- Activities required prior to the main data collection effort
- Activities required during collection
- Activities required at the end of the data collection prior to final acceptance

Table 5 – QC Activities

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
Certification of DelDOT Personnel	DelDOT Pavement Management Engineer certifies that DelDOT personnel, or their designees are certified to perform QC/QA tasks and approve or certify deliverables.	Memorandum confirming certification of personnel.	Pre-collection
Pre-Approval of Equipment and Methods	Vendor warrants that equipment and methods meet specifications identified in Table 6 and that data elements are collected in accordance with protocols in Table 3.	Review and approval by DelDOT[15] of Vendor Start-up Report	Pre-collection (as part of vendor Startup Report)
Pre-approval of Quality Management Plan	Vendor submits a Quality Management Plan that addresses items including list in section below discussing the Vendor Quality Management Plan	Review and approval by DelDOT of Vendor Quality Management Plan	Pre-collection
Initial Calibration	Data meets acceptance requirements from Table 8 for the	Review and approval by	Pre-collection (as part of

[14] QC activities are summarized here and described in detail in the remainder of this section. The acceptance criteria and corrective actions are described in the following section relating to Acceptance below.
[15] Review and approval by DelDOT denote review by pavement management staff (as noted in section 4. Team Roles and Responsibilities) and approval by the pavement management engineer. This applies for all QC Activities relating to the Startup Report.

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
	designated number of runs for each calibration test site.	DelDOT of Start-up Report	vendor Startup Report)
Calibration Verification	Data meets acceptance requirements from Table 9 for the designated number of runs for each calibration test site.	Approval by DelDOT of Monthly Data Submission Deliverable	Monthly (typically, as part of monthly vendor data submission)
Ongoing Discrepancy Monitoring	Discrepancies and invalid data should be flagged (manually and automatically) and reported by the vendor in a Discrepancy Report according to the Vendor's Quality Management Plan.	Certification by DelDOT that Discrepancies are within Acceptance limits and defined in the vendor QMP	Monthly (as a separate vendor Discrepancy Report)
Independent Bounds and Format Checking	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format. Minimum data checks: **IRI** • 30 < IRI ≤ 500 inch/mile • Left and right IRI values differ ≤ 150 inch/mile for 0.1-mile data set. • Left and right IRI values differ ≤ 200 inch/mile for 6-ft./slab-length data set. **Rutting** • Values ≤ 1.0 inch • Left and right rutting values differ ≤ 0.25 inch • Applicable to both 0.1-mile and 6-ft./slab-length data sets. **Cracking** • 0 ≤ Crack Density ≤ 1.5 ft./sq. ft. for 6-ft./slab-length data set only. **PSCM** • 0 ≤ PSCM ≤ 4% for 6-ft./slab-length data set only. **Faulting** • Values ≤ 1.0 inch	Independent data check by DelDOT to confirm Vendor's discrepancy report findings	Monthly (as part of Independent Quality Report)

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
	• Values > 0 when joints are present • Applicable to both 0.1-mile and 6-ft./slab-length data sets Use database checks to compare with previous year and flag results > 10% different.		
Independent Image Sample Checking	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate.	Independent data check by DelDOT to confirm Vendor's distress ratings.	Monthly (as part of Independent Quality Report)
Independent Distance and Location Verification	Inspect a random sample of 10 sections/segments of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points.	Independent location data check by DelDOT to confirm Vendor's location data.	Monthly (as part of Independent Quality Report)
Final data review	**Scope** • Data coverage (excluding identified occurrences e.g., construction, railroads, etc.) > 99% **Within bounds** • Data within bounds specified in the bounds checks > 98%	Approval by DelDOT of Final Data Submission Deliverable	Prior to Final Acceptance (as part of final Independent Quality Report)

Certification of DelDOT Personnel or Representatives

Personnel from DelDOT (or their representatives) who perform QC/QA processes shall be certified at the start of each data collection cycle. This certification will ensure that personnel are competent to perform the process (or part of the process) for which they are responsible. The certification process will involve the Pavement Management Engineer or, at the discretion of the Pavement Management Engineer, a person who is currently certified or was certified for the previous data collection cycle, assessing the person's competency to perform each task.

Roles and responsibilities for QA/QC personnel are documented in section 4. Team Roles and Responsibilities below.

The following processes or tasks from Table 5 – QC Activities that are performed by personnel other than the Pavement Management Engineer require certification:

- Certification of Vendor Start-up Report
    - Initial Calibration
        - Determination of reference values for use in initial calibration by the vendor
        - Verification that vendor's calculations pertaining to calibration are correct
- Approval of Monthly Data Submission Deliverable
    - Calibration Verification
        - Verification that vendor's calculations pertaining to calibration are correct based on previously defined initial calibration reference values
    - Ongoing Discrepancy Monitoring
    - Independent Bounds and Format Checking
    - Independent Image Sample Checking
    - Independent Distance and Location Verification
- Final data review

The certification shall identify each of the above processes or tasks and the person or persons certified to undertake these.

Pre-Production Activities

A vital part of quality management is to ensure that any vendor awarded a contract has equipment matching the required standards and protocols, as well as sound standard operating procedures and training for their equipment operators.

The data collection vendor must undertake a pavement data collection start-up process annually. The startup process must be finished (including DelDOT review) before production data may be collected.

The results of these pre-collection activities shall be reported by the vendor in a Startup Report.

The start-up process must include the following:

1. The data collection vendor shall provide all pavement data collection start-up work, reported at one time in a Start-up Report.
2. An initial pavement data collection/processing validation, verification and calibration exercise shall be carried out on calibration roadway sections/segments selected by DelDOT based on the number of sites and repetitions defined in Table 7.
3. During this exercise, the vendor will submit data to DelDOT or their representative who will conduct accuracy and precision tests for all data items based on the accuracies and precisions defined in Table 3.
4. In addition, calibration procedures, camera angles and coverage, data calculation methods and standard operating procedures will be verified according to the vendor's quality management plan.

5. The DelDOT Project Manager must approve the Start-up Report and its findings in writing before future work is undertaken.

Vendor Quality Management Plan

It is important that Vendor's maintain a Quality Management Plan, but it is understood that these may cover somewhat different aspects of quality management and be formatted according to the vendor's preferences. Nonetheless, vendors' Quality Management Plans should address, at a minimum, QC areas including but not limited to:

- Image capture methods and QC,
- Automated Crack detection image processing and QC,
- Pavement profile data processing and QC (including block test and bounce test frequency),
- Distance and location measurement QC and exception handling (bridges, construction zones, etc.),
- Handling of multiple vehicles,
- Handling of equipment adjustment and repairs,
- Handling of adverse weather conditions,
- Automated and manual flagging, handling, monitoring and reporting of invalid data,
- Personnel training and certification,
- Vendor quality management roles and responsibilities.

Pre-Approval of Data Collection Vendors using Automated Equipment

For equipment used to collect condition measurements, the data collection vendor shall certify that the protocols for initial certification and ongoing data collection specified in Table 6 are met. Where applicable, these standards and protocols are also specified in Table 3 for ongoing data collection.

For collection of IRI, the vendor shall undertake the certification detailed in AASHTO R56-14 as noted in Table 6 below. While not repeating the full R56 specification here, the vendor shall ensure the test is conducted at an established test site (not necessarily within the state) that meets the criteria as designated in 8.2.1 of the standard and is acceptable to DelDOT. A reference profile shall be collected as defined in 8.2.2 of the standard, and 5 test runs shall be made at a minimum of two speeds as defined in 8.2.3 of the standard. Test data shall be analyzed by the vendor using the ProVAL software and shall result in cross-correlation agreement scores of at least 0.92 and 0.90 for repeatability and accuracy respectively. The full results of the certification with at least the information designated in 8.5 of the standard (including location of the test site, DMI results, and cross-correlation tables for repeatability and accuracy) shall be submitted by the vendor as part of the Startup Report for approval by the DelDOT.

Table 6 – Equipment and Data Collection Protocols and Standards

Pavement Condition Metric	Protocol
IRI[16]	• IRI collection device in accordance with AASHTO Standards M328-14. • Collection of IRI data in accordance with AASHTO Standard R57-14. • Quantification of IRI data in accordance with AASHTO Standard R43-13. • Certification of IRI data in accordance with AASHTO Standard R56-14.
Cracking percent [17]	• For asphalt, collection of pavement surface images in accordance with AASHTO Standard R 86-18, with the modifications specified in the HPMS Field Manual. • Quantification of cracking from asphalt pavement surface images in accordance with AASHTO Standard R 85-18. • Generating Pavement Surface Cracking Indices from Digital Images in accordance with ASTM E3303-21. • Quantification of cracking from jointed and continuously reinforced concrete pavements in accordance with HPMS Field Manual. • Computation of Cracking Percent for each pavement type in accordance with the HPMS Field Manual.
Rutting for asphalt pavements [18]	• Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and • Quantification of Rut Depth values in accordance with AASHTO Standard R 87-18, with the modifications specified in the HPMS Field Manual.
Faulting for jointed concrete pavements [19]	• Faulting computed based on AASHTO Standard R36-21, with the parameters specified in the HPMS Field Manual.

Initial Calibration of Automated Equipment

Calibration Sites and Number of Repetitions per Site

Prior to the start of every data collection effort, a set of initial calibration sites shall be chosen to adequately represent the current pavement types. The number of initial calibration sites shall be at least as many as the number given in Table 7 – Calibration Sites below.

[16] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[17] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[18] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[19] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Table 7 – Calibration Sites and Number of Repetitions per Site

Pavement Type	Approximate CL Length	Number of Sites	Number of Repetitions per Site
Asphalt	0.2 miles	2	10
Composite	0.2 miles	2	10
Surface Treated	0.2 miles	2	10
PCC	0.2 miles	2	10

Sites should be chosen according to the criteria given in Table 8 – Criteria for Selecting Calibration Sites.

Table 8 – Criteria for Selecting Calibration Sites

Criteria for selecting Calibration Sites
Each calibration section should be 0.1-mile long. Each site/location will contain 2-3 calibration sections. Each site will also be divided in 6-ft/slab-length segments.
Try to minimize drive time between calibration sites.
Sites should be in close proximity to DelDOT offices, if possible.
No Interstates.
Avoid bridges and approaches.
Avoid sections with Lane Deviations if possible.
Avoid sections with Stop signs and/or Signals.
Avoid sections with no pavement markings.
No recent construction.
Preferably sections with OPC ranging between 60-80, with representative cross-section within the range. Avoid sections expected to be resurfaced in the near future.
Targeted Distresses - sections that include combinations of low severity fatigue, any severity longitudinal, any severity transverse/joint reflective, and/or any severity block cracking are preferable. This should result in a range of crack density and PSCM/PSCIs across the transverse zones.
Avoid Routes with cul-de-sacs or abrupt ending.
Avoid parked vehicles if possible. Requires review of imagery.
Vendor to provide imagery/photos of vehicle location on each site to provide lateral location for field measurement team.
Consider providing curb and/or drop-off location with location information.

Calibration Reference Value Data Collection and Review

For crack length measurements, the calibration shall be checked as follows:

- Prior to evaluating each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the DelDOT QC/QA designated person checking calibration.

- Using the LCMS images, the actual cracking will be checked against the cracks measured by the LCMS.
- The beginning of the calibration section/segment covered by the LCMS imagery should be found (e.g., using GPS coordinates).
- For each crack location, where there is a discrepancy between the observed cracking on the ground and the cracking marked up in the images, a discrepancy should be recorded with the length of the discrepancy noted. Note that discrepancies where a crack is missed by the LCMS, and also where cracks are wrongly identified by the LCMS, should both be recorded. Crack lengths less than a foot long will not be evaluated. Only discrepancies totaling more than 1 linear foot of cracking should be recorded. Only cracks with width greater than or equal to 1 mm as defined in AASHTO R 85-18 should be considered.
- The total absolute length of the discrepancies defines the reference discrepancy value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
- Repeatability of crack length measurement should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

For distress data elements, the calibration shall be checked as follows:

- Prior to evaluating each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the person checking calibration.
- Using the LCMS images, the actual distress on the ground will be checked against the distress measured by the LCMS.
- The beginning of the calibration section/segment covered by the LCMS imagery should be found (e.g., using GPS coordinates).
- Any distress that is outside of the limit of length and van measured width should not be considered in the physical measurements to the extent reasonably possible.
- For each distress element in the output data set (i.e., each severity of each distress type):
    - For each distress location, where there is a discrepancy between the observed distress on the pavement and the distress identified in the images, the discrepancy should be recorded with the amount of the discrepancy noted. Note that discrepancies where distress is missed by the LCMS, and also where distresses are wrongly identified by the LCMS, should both be recorded. A discrepancy shall be recorded as follows. For each distress:
        - For each distress location identified on the pavement, a discrepancy shall be recorded if the LCMS identified distress does not match the distress identified on the pavement within a tolerance of the relevant value in Table 3 and Table 4.
        - The value of the discrepancy in this case shall be determined based on the unit of measure of the distress. The value shall be noted as the amount of the

pavement distress minus the amount of the distress identified by the LCMS and shall thus be logged as positive where there is more pavement distress and negative where there is more LCMS distress.

- For each gap between distress locations identified on the pavement, a discrepancy shall be recorded if there is LCMS-identified distress the distress identified on the pavement within a tolerance of the relevant value in Table 3 and Table 4.
- A note describing the discrepancy shall be recorded for each entry for reference purposes.
- The approximate location of each discrepancy within the data calibration section/segment shall be recorded for reference.

  - For each calibration site, for each distress element, the total value of the discrepancies shall be added to the quantity obtained for the randomly selected van run to define the reference value. The reference discrepancy shall be obtained by subtracting the average of the multiple van runs from this reference value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
  - Repeatability of distress measurements should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

In the case of IRI, Rutting and Faulting measurements, because it shall be certified that the data collection vehicles have been calibrated for these measurements, the reference value will be assumed to be the average of the repeat runs. As a result, the accuracy for the initial calibration is ‘exact’ (no discrepancy) but for calibration verification, the verification number shall be compared to the initial calibration number.

The reference values obtained should be compared to the previous calibration reference values to check they are within the acceptable limits defined in Table 3.

As an alternate approach to the field visit, software provided by a data collection vendor or any GIS software in conjunction with vendor-provided images can be used to detect discrepancies and determine the reference value.

If on-site calibration is done, the following equipment should be taken to the calibration site:

- Measuring wheel with electronic readout and measuring precision to the 1/10th of a foot. This will be used:
  - To confirm the length of the data section/segment by measuring along the centerline from Begin Milepoint to End Milepoint.
  - To identify the average data capture width and length measured by the data collection van. In cases where striping is present, the width between outer lane lines may be used. For locations without striping, use the measurement from the visible edge of pavement towards the centerline may be used.
  - To measure length and width of each area of distress on the pavement and classify each into appropriate severity definition based on visual inspection.

- Measuring tape as a backup to the measuring wheel.
- Spray paint for marking of begin/end of segments and identified distress extents.
- Smart Level with % cross-slope readout to the 1/10th percent. This is used to measure transverse cross-slope at intervals along the length of surface treated pavements.
- Digital photos may be taken at intervals along the length of the calibration sites to compare against imagery taken from data collection van. Digital photos may also be taken of spot locations of interest.

Iterative Calibration Process

Multiple data collection runs should be made on each calibration section as defined in Table 7 – Calibration Sites. The average and standard deviation of the data collection runs compared to the reference values, as well as whether these meet the accuracy and repeatability requirements defined in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability , should be reported in the Startup Report.

The measurement of cracking distress is a two-stage process: first the LCMS initially measures crack length and width, and then this 'raw' information is translated into distresses. Because the initial step of capturing crack width is independent of the second step, the processing of the crack data into distresses, if the initial cracks are detected properly, it is not necessary to redo this step if there is a problem only with the second step. As a result, once the crack length calibration has verified, it is possible to allow the Vendor to begin data collection, under the assumption that the processing step can be repeated multiple times independently to ensure distress processing calibration. However, data acceptance and payment will be dependent on distress calibration also being approved and not just crack length detection being approved.

Production Activities

Calibration Verification at Calibration Sites

Calibration Verification Site Selection

Calibration verification will take place on all initial calibration sites defined for initial calibration.

Calibration Site Monitoring Process

The data collection vendor will undertake a calibration verification process according to the frequency defined in Table 5 – QC Activities.

It will be required to make 5 repeat runs on each calibration site for calibration verification. The reference values obtained in the initial calibration for each distress on each calibration site will be used for evaluation of accuracy.

The vendor will deliver the results of this calibration verification as part of the monthly data submission. The vendor may continue to collect data prior to approval of the monthly data submission but will do so at risk. If the monthly data submission is not approved, the vendor will be required to follow the acceptance process defined in Table 9 – QC Acceptance Requirements.

Ongoing Monitoring

Vendor Discrepancy Monitoring

The vendor will deliver a Discrepancy Report according to the frequency defined in Table 5 – QC Activities and based on the format defined in section 5 Quality Reporting Plan. This report will list all discrepancies identified in the data for the previous reporting time interval. The discrepancies will contain bounds checks according to the vendor's quality management plan, and at a minimum, identify any data collected outside the bounds defined in Table 5 – QC Activities for independent bound checking.

In addition to bounds checking, the vendor will list all deviations noted in the field where supplied information (such as sections and section limits to be measured) was identified as possibly inaccurate.

Independent Bounds Checking

DelDOT, or its designated representative, will use a database or spreadsheet checking method to check data being delivered based on the bounds and frequency defined in Table 5 – QC Activities for independent bound checking.

Independent Image Sample Checking

DelDOT, or its designated representative, will use a manual method to spot check that data being delivered based on LCMS data remains accurate and that there are no major discrepancies.

Independent Distance and Location Verification

DelDOT, or its designated representative, will use a manual method to spot check that the location information of data being delivered is accurate by spot checking GPS and LRS data by plotting on a GIS map with appropriately accurate layers.

Post-Production Activities

Prior to final acceptance of the data, checks for completeness of overall scope and that all data is within bounds will be conducted by either DelDOT or their designated representative in accordance with the specifications defined in Table 5 – QC Activities.

3. Acceptance

The focus of acceptance is to validate that the deliverables meet the established quality standards. Following is a description of acceptance testing, the frequency to be performed, and corrective actions for items that fail to meet criteria.

Table 9 – QC Acceptance Requirements[20]

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
Pre-approval of Quality Management Plan	N/A	Vendor Quality Management Plan is checked to ensure that, at a minimum, it addresses items required. Certification of Vendor Quality Management Plan.	Deliverable returned with comments for correction.
Pre-Approval of Equipment and Methods	N/A	Vendor warrants that equipment and methods meet specifications identified in Table 6 and that data elements are collected in accordance with protocols in Table 3. Part of Certification of Vendor Start-up Report.	Data collection cannot commence until Acceptance criteria are met.
Initial Calibration	≥90% of data collection sections/segments within all limits as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 3 and Table 4 for the designated number of runs for each calibration test site. Part of Certification of Start-up Report.	Vendor will rerun calibration for any sections that fail. Data collection cannot commence until Acceptance criteria are met. **Exception**: If it is determined that the crack detection in the images is not a problem and that the only problems are due to accuracy

[20] None of these checks should be regarded as in any way superseding the HPMS manual and CFR 490 legislation regarding coverage and quality.
[21] Repeated from *Table 5* – QC Activities above.
[22] Based on values from *Table 5* – QC Activities above.

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
			limits based on processing of the cracking data, the vendor shall be allowed to proceed but must work with DelDOT or their representative to ensure crack processing parameters are determined that result in distress measurements that meet acceptance limits. No data will be accepted for which the full pre- and post-calibration verification has not been approved.
Calibration Verification	≥90% of data collection sections/segments within all limits as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 3 and Table 4 for the designated number of runs for each calibration test site. Part of Approval of Monthly Data Submission Deliverable.	Vendor will rerun calibration for any sections that fail. All data since last approved calibration check to be re-submitted within acceptable limits.
Ongoing Discrepancy Monitoring	≥90% of sections/segments within all bounds as defined in Table 5. No more than 5% failing > 4 bounds criteria.	Discrepancies and invalid data should be flagged (manually and automatically) and reported in a Discrepancy Report according to the Vendor's Quality Management Plan. Part of Approval of Monthly Data Submission Deliverable.	All data since last approved check to be re-submitted within acceptable limits
Independent Bounds and Format Checking	≥90% of sections/segments within all bounds as	Inspect 100% of uploaded data samples to ensure within	All data since last approved check to be re-submitted

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
	defined in Table 3 and Table 4.	normal bounds and in the required format. Part of Approval of Monthly Data Submission Deliverable.	within acceptable limits.
Independent Image Sample Checking	100% of samples free of major problems.	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Independent Distance and Location Verification	100% of sections/segments within all limits relating to distance and location as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Inspect a random sample of 10 sections/segments of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Final data review	Scope • Data coverage (excluding identified occurrences e.g., construction, railroads, etc.) > 99% Within bounds • Data within bounds specified in the bounds checks > 98%	Approval of Final Data Submission Deliverable Part of Final Acceptance.	Vendor to continue work to meet acceptance criteria. Payment withheld until acceptance criteria are met.

4. Team Roles and Responsibilities

The following identifies the quality-related responsibilities of the DelDOT data management team and lists specific quality responsibilities.

Table 10 – Roles and Responsibilities

Team Role	Quality Management Responsibilities
DelDOT Pavement Management Engineer	• Set quality standards, acceptance criteria, and corrective actions. • Assess effectiveness of QM procedures. • Recommend improvements to quality processes. • Certification of resources in other roles.
DelDOT Project Manager	• Manage the contract with the vendor. • Approve each deliverable per quality standards. • Approve resolution of quality issues. • Check vendor Discrepancy Reports.
DelDOT Quality Representative	• Work with the DelDOT Project Manager to identify calibration sites. • Provide calibration reference values for distresses. • Work with vendor to ensure vendor obtained calibration values are within required limits. Iterate with vendor to adjust calibration post processing of the data where necessary to improve data quality. • Evaluate and make approval recommendations to project manager regarding Vendor deliverables (e.g., Startup Report, Quality Management Plan, Data submissions, etc.). • Recommend improvements to quality processes and acceptance limits. • Certification of new resources in this role.
DelDOT Data Expert	• Perform independent checks (e.g., bounds, format, image, location etc.) as called for in Table 5. • Make approval recommendations to project manager based on outcome of checks. • Be available for consultation with other quality roles and the vendor when deliverables fall outside quality limits.
Data Collection Vendor Representative	• Collect and process data. • Submit deliverables as defined in the contract. • Be responsible for ensuring Vendor quality processes and procedures are followed based on approved quality management plan. • Work with DelDOT project manager regarding scheduling and payment issues.

5. Quality Reporting Plan

The following Quality deliverables are defined. Frequency of submission and quality management content should be as defined in Table 3 and the section of this document describing Quality Assurance and Quality Control.

- **Vendor Quality Management Plan** – This should be submitted by the vendor and contain all quality assurance and quality control processes and procedures that the vendor warrants will be undertaken during the project.
- **Vendor Startup Report** – This should be submitted by the vendor and contain a description of the startup process and quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Interim Data Submissions** – The vendor will submit interim data at regular intervals, and include quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Discrepancy Reports** – The vendor will submit reports listing all data discrepancies identified by the vendor (whether by automated or manual checking) at regular intervals as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Independent Quality Report** – These reports will be submitted to the DelDOT project manager by a party independent of the vendor (either by DelDOT internally, or by a DelDOT appointed representative). These reports should be submitted at regular intervals, and include quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.

Pavement Management System Standard Operating Procedure

Delaware Department of Transportation

Submitted by:

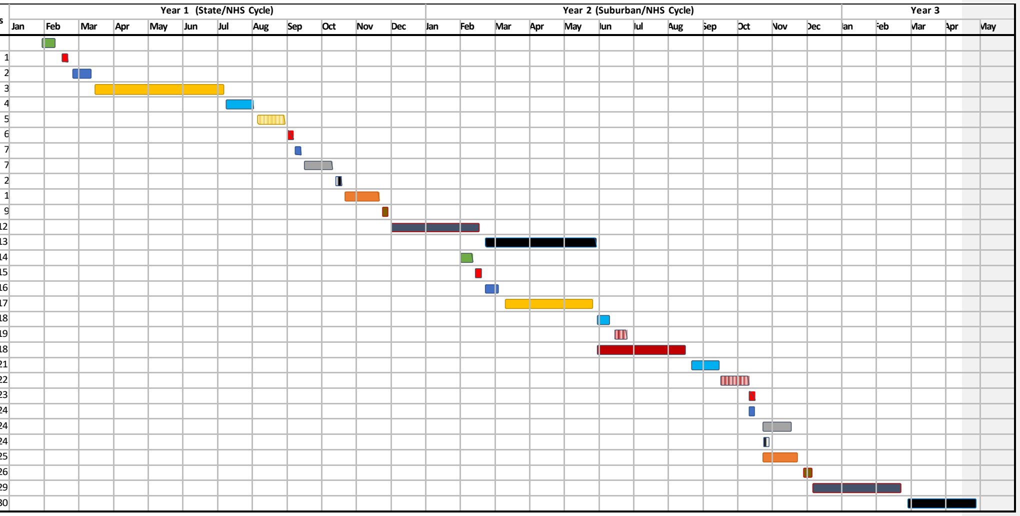
The Kercher Group, Inc.

July 24, 2024

Table of Contents

DelDOT Pavement Management Activity Calendar

Task No.	Tasks	Effort (Weeks)	Start	End	Prerequisites
1	Overall Configuration Review (Year 1)	2	28-Jan	8-Feb	
2	LRS, Inventory and Bridge Location Import in TEST (Year 1)	1	18-Feb	22-Feb	1
3	Pavement Type Update (Pre Data Collection) in TEST (Year 1)	2	25-Feb	8-Mar	2
4	Data Collection State/NHS Routes (Year 1)	16	18-Mar	5-Jul	3
5	Quality Assurance Process State/NHS Routes (Year 1)	4	8-Jul	2-Aug	4
6	State/NHS Route Distress Data Import (Year 1)	4	5-Aug	30-Aug	5
7	LRS, Inventory and Bridge Location Import in PROD (Year 1)	1	2-Sep	6-Sep	6
8	Pavement Type Update (Post Data Collection) in PROD (Year 1)	1	9-Sep	13-Sep	7
9	Construction History Data Update (Year 1)	4	16-Sep	11-Oct	7
10	Traffic Data Updates (Year 1)	1	14-Oct	18-Oct	2
11	Treatment Unit Cost Updates (Year 1)	5	21-Oct	22-Nov	1
12	Build Pavement Management Sections (Year 1)	1	25-Nov	29-Nov	9
13	Project Selection (Year 1)	12	2-Dec	21-Feb	12
14	Bond Bill Submittal and PMG Reporting (Year 1)	14	24-Feb	1-May	13
15	Confirm Overall System Configuration (Year 2)	2	3-Feb	14-Feb	14
16	LRS, Inventory and Bridge Location Import in TEST (Year 2)	1	17-Feb	21-Feb	15
17	Pavement Update Type (Pre Data Collection) in TEST (Year 2)	2	24-Feb	6-Mar	16
18	Data Collection NHS Routes (Year 2)	12	9-Mar	29-May	17
19	Quality Assurance NHS Routes (Year 2)	2	1-Jun	12-Jun	18
20	NHS Route Distress Data Import (Year 2)	2	15-Jun	26-Jun	19
21	Data Collection Suburban Routes (Year 2)	12	1-Jun	21-Aug	18
22	Quality Assurance Suburban Routes (Year 2)	4	24-Aug	18-Sep	21
23	Suburban Route Distress Data Import (Year 2)	4	21-Sep	16-Oct	22
24	LRS, Inventory and Bridge Location Import in PROD (Year 2)	1	19-Oct	23-Oct	23
25	Pavement Type Update (Post Data Collection) in PROD (Year 2)	1	19-Oct	23-Oct	24
26	Construction History Data Update (Year 2)	4	26-Oct	20-Nov	24
27	Traffic Data Updates (Year 2)	1	26-Oct	30-Oct	24
28	Treatment Unit Cost Updates (Year 2)	5	26-Oct	27-Nov	25
29	Build Pavement Management Sections (Year 2)	1	30-Nov	4-Dec	26
30	Project Selection (Year 2)	12	7-Dec	26-Feb	29
31	Bond Bill Submittal and PMG Reporting (Year 2)	9	1-Mar	30-Apr	30



Overall Configuration Review

1. Purpose

The engineering configuration of the overall Pavement Management System should be reviewed regularly to ensure that the decision-making framework is verified and improved as new types of data are made available and as business processes change within the state.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)

Engineering Configuration PMS Configuration Guide (latest version)

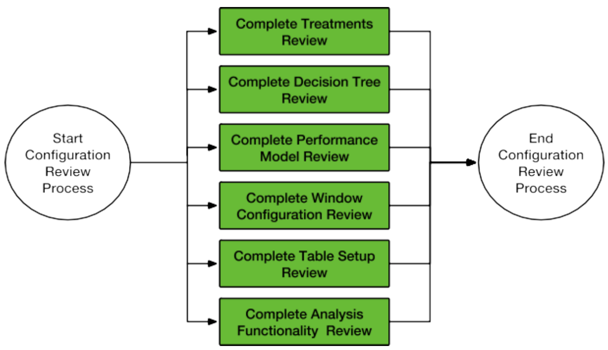
3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.2)

4. Scope

This SOP includes the review of various components of the Pavement Management System. This SOP identifies the components to be reviewed but does not detail the specific steps to complete these key configuration changes within the system. If configuration changed are made, system calibration and testing will be required. This SOP review procedure should be completed annually, however changes to the configuration may delay subsequent processes. Therefore, if configuration changes are required, they should be schedules in advance and completed in a separate development environment of the Pavement Management System to allow for formal system testing.

This review will typically be completed during a review meeting with all involved DelDOT parties (Pavement Management Group, Planning, IT, Key Consultants) but will be lead by the Pavement Management Group.



5. *Prerequisites*

None

6. *Responsibilities*

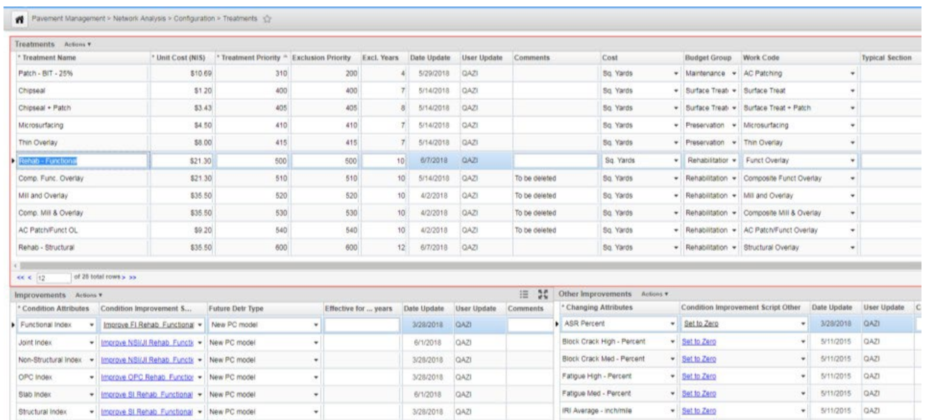
This SOP will be managed by the Pavement Management Group Lead with configuration being completed by asset management implementers experienced in the AgileAssets software.

7. *Procedure*

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

Treatments Review

1. Review the overall Treatment setup in the Treatments window (Pavement Management > Network Analysis > Configuration > Treatments).

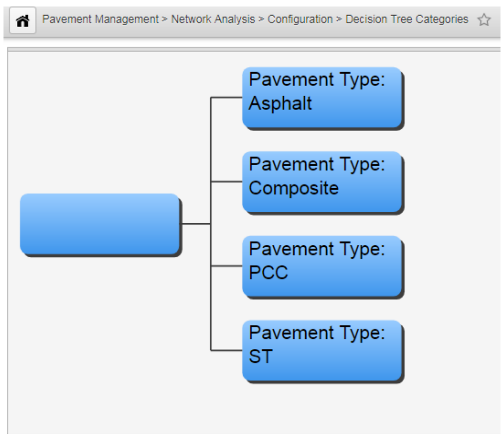


2. Review Treatment list in the window (upper pane) and determine if additional treatments are required.
3. Review the Treatment rules (lower panes) and determine if refinements to the treatment rules are required.
4. If additional treatments are required or if existing treatment rules are to be revised, configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

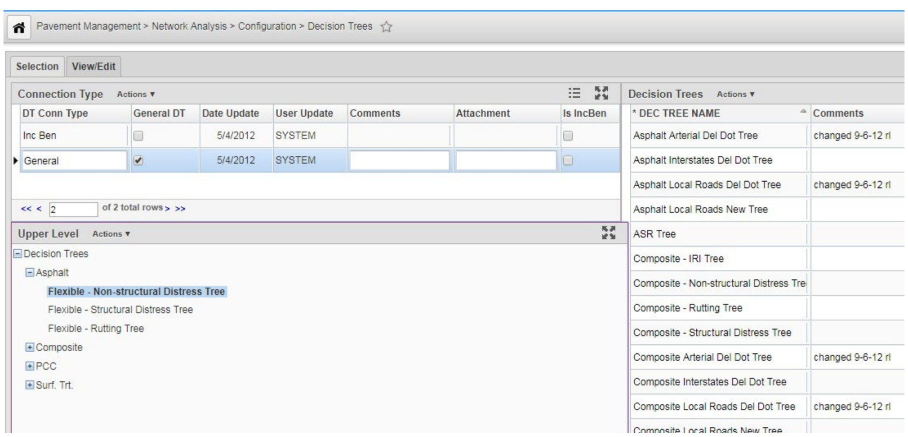
Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Decision Tree Review

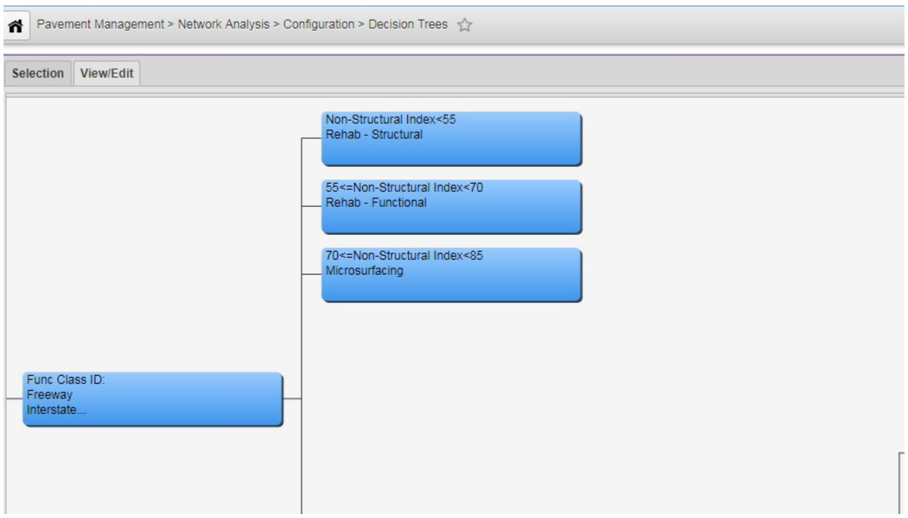
1. Review the overall Decision Tree setup in the **Decision Tree Categories** window (Pavement Management > Network Analysis > Configuration > Decision Tree Categories) and the **Decision Tree** window (Pavement Management > Network Analysis > Configuration > Decision Trees).



Pavement Management > Network Analysis > Configuration > Decision Tree Categories
Pavement Type: Asphalt
Pavement Type: Composite
Pavement Type: PCC
Pavement Type: ST



Pavement Management > Network Analysis > Configuration > Decision Trees
Selection
View/Edit
Connection Type
Actions
DT Conn Type
General DT
Date Update
User Update
Comments
Attachment
Is IncBen
Inc Ben
5/4/2012
SYSTEM
General
5/4/2012
SYSTEM
of 2 total rows
Upper Level
Decision Trees
Asphalt
Flexible - Non-structural Distress Tree
Flexible - Structural Distress Tree
Flexible - Rutting Tree
Composite
PCC
Surf. Trt.
Decision Trees
DEC TREE NAME
Comments
Asphalt Arterial Del Dot Tree
changed 9-6-12 rl
Asphalt Interstates Del Dot Tree
Asphalt Local Roads Del Dot Tree
changed 9-6-12 rl
Asphalt Local Roads New Tree
ASR Tree
Composite - IRI Tree
Composite - Non-structural Distress Tre
Composite - Rutting Tree
Composite - Structural Distress Tree
Composite Arterial Del Dot Tree
changed 9-6-12 rl
Composite Interstates Del Dot Tree
Composite Local Roads Del Dot Tree
changed 9-6-12 rl



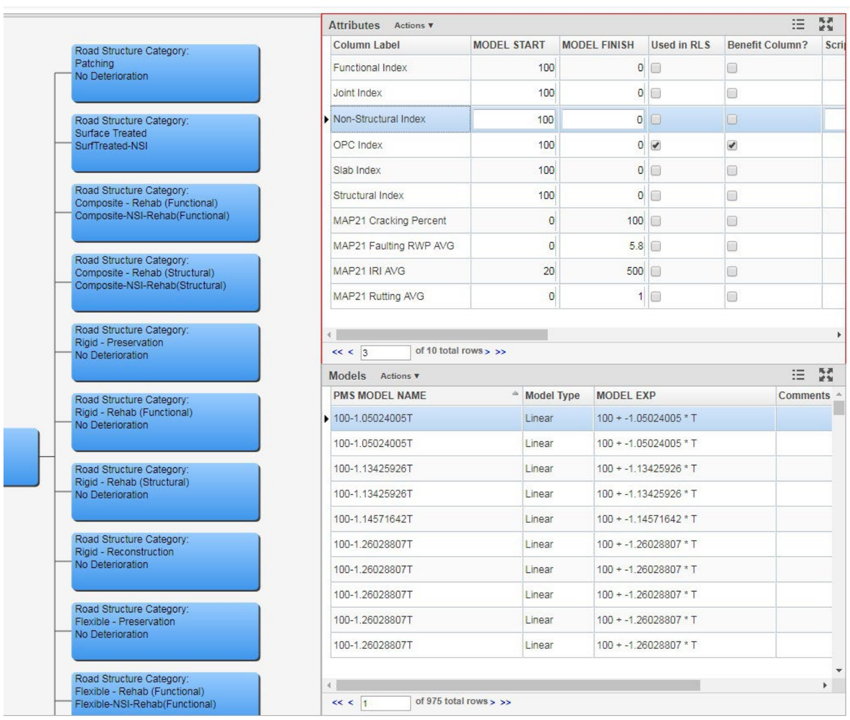
2. Review all Decision Trees and determine if refinement to the decision-making logic is required.

3. If changes to the decision tree configuration is required, the specific configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Performance Model Review

1. Review the overall Performance Model setup in the **Performance Model Tree Structure** window (Pavement Management > Performance Analysis > Performance Models) and other supporting model setup windows.



2. Review all Performance Models and model setup and determine if additional revisions are required.

3. If changes are required, the specific configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Window Configuration Review

1. Review all windows in the system. These may need to be revised if

- The format of data being imported has been revised
- Column changes are required
- Calculation changes are required
- Any other functionality is required within the window

2. If changes to any windows are required, the specific configuration needs should be developed and configuration should be completed in a development environment.

Setup Table Review

1. Review all setup tables in the system. These windows and their reference setup tables may need to be revised if the format of data being imported has been revised or if other configuration changes have been completed. The windows that reference setup tables are located in:

- Pavement Management > Setup > Construction History > …
- Pavement Management > Setup > Database Setup > …

2. If changes to setup tables are required, the specific configuration needs should be developed and configuration should be completed in a development environment.

Analysis Functionality Review

1. Review the overall analysis output needs for running scenarios and reports. These would include:

- Constraints
- Constraint Subdivisions
- Scope Variables
- Any other analysis focused configuration

2. If changes are required, the specific configuration needs should be developed, configuration should be completed in a development environment and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

LRS, Inventory, and Bridge Location Import:

1. *Purpose*

Inventory Data is utilized in DelDOT's AgileAssets Pavement Management System (PMS) to populate various roadway attributes in the system. This data, as configured in the system, is used as PMS variables and for reporting needs. The source data is supplied by DelDOT Road Rating Vendor.

2. *References*

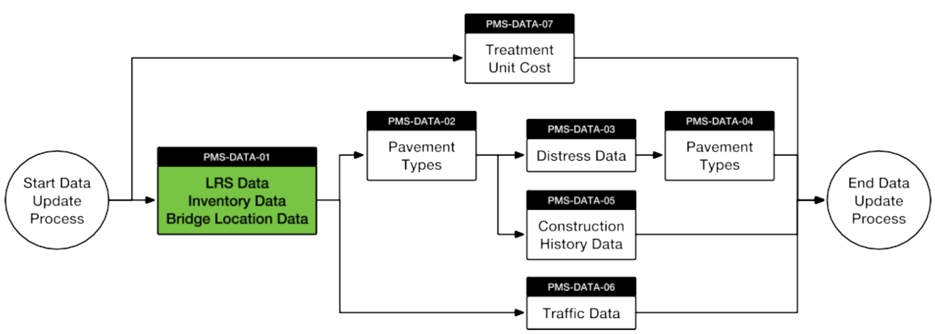
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. *Definitions*

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. *Scope*

This SOP includes the updating of the Inventory Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL**, Confirm Overall System Configuration.

6. Responsibilities

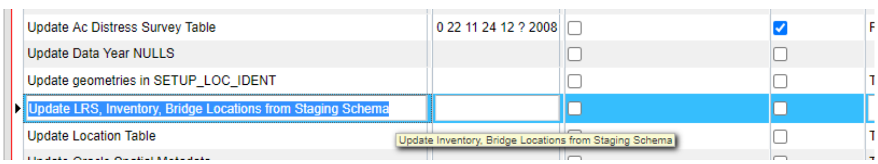
This SOP will be conducted by the Pavement Management Group.

7. Procedure

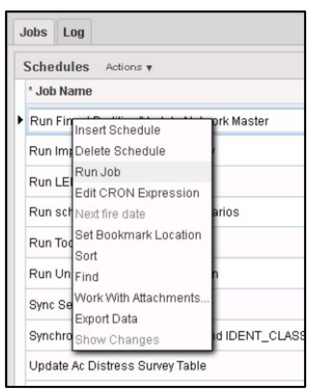
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

The following step are necessary to update the data:

1. Open the **Schedules** window (System > Tools > System Job > Schedules).
2. In the list of schedules, find the **Update LRS, Inventory, Bridge Locations from Staging Schema** schedule.



3. Right-click on the schedule and select **Run Job**. The Finest Partition process is complete.



4. By running this combined system job, the LRS, inventory, and Bridge Location data has been updated based on the latest data.

Pavement Type Update (Pre Data Collection)

1. Purpose

Pavement Type is a key data input utilized in the DelDOT AgileAssets Pavement Management System (PMS). The accurate and updated Pavement Types data is essential for PMS to assign appropriate treatment during the optimization process. During the PMS process, Pavement Type is updated twice; once before data collection is started and once after the data collection is complete.

Within DelDOT, maintaining an accurate pavement type inventory attribute was been a challenge through the years. This 2-step process is an internal systematic approach to correcting the issue.

2. References

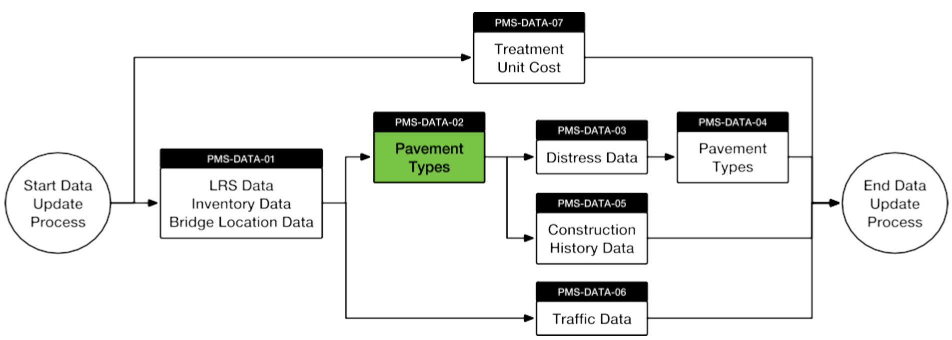
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Pavement Type as part of the overall PMS data update process. This procedure should be completed twice with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedures that are required to be completed before first Pavement Type update are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import

6. Responsibilities

This SOP will be conducted by the Pavement Management Group.

7. Procedure

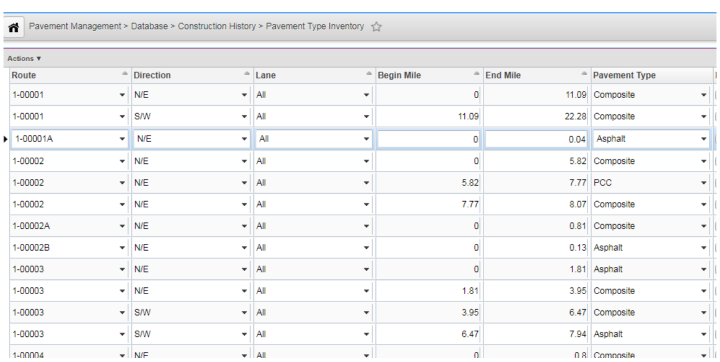
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

<u>Pavement Type Inventory Input</u>

Construction history data is updated regularly per **SOP PMS-DATA-05 (Construction History Data).** From this data, pavement type is updated nightly through a system job. Since, the original source of the Payment Types is a legacy management section table, there is a possibility that there is no construction history associated with some management sections and that the Pavement Type may be incorrect. Therefore, the following step identify process to manually edit the Pavement Type.

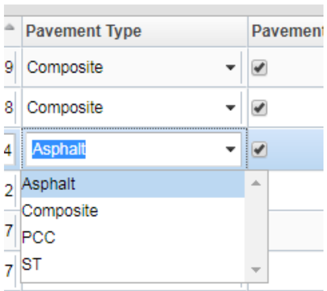
The Pavement Type Inventory window contains information related to the pavement types of all the management sections.

1. Open the **Pavement Type Inventory** window (Pavement Management > Database > Construction History > Pavement Type Inventory).



Route	Direction	Lane	Begin Mile	End Mile	Pavement Type
1-00001	N/E	All	0	11.09	Composite
1-00001	S/W	All	11.09	22.28	Composite
1-00001A	N/E	All	0	0.04	Asphalt
1-00002	N/E	All	0	5.82	Composite
1-00002	N/E	All	5.82	7.77	PCC
1-00002	N/E	All	7.77	8.07	Composite
1-00002A	N/E	All	0	0.81	Composite
1-00002B	N/E	All	0	0.13	Asphalt
1-00003	N/E	All	0	1.81	Asphalt
1-00003	N/E	All	1.81	3.95	Composite
1-00003	S/W	All	3.95	6.47	Composite
1-00003	S/W	All	6.47	7.94	Asphalt
1-00004	N/E	All	0	0.8	Composite

2. Click on the drop-down menu under Pavement Type column and select the pavement type.



3. Press the **Save Data** button in the upper right of the screen when complete.

Note: In addition, the Pavement type is automatically updated when a construction history record is inserted. Refer to **SOP PMS-DATA-05 (Construction History Data)** document to update the construction history.

State and Suburban Route Distress Data Import

1. Purpose

Distress Data is utilized in DelDOT's AgileAssets Pavement Management System (PMS). This data, configured in the system, is the basis for the roadway condition calculations. It is critical that DelDOT conduct a thorough Quality Assurance review of condition data in order ensure that the system results and decisions are defensible. These requirements are included in the Data Quality Management Plan (DQMP).

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)
Data Quality Management Plan (DQMP)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. Scope

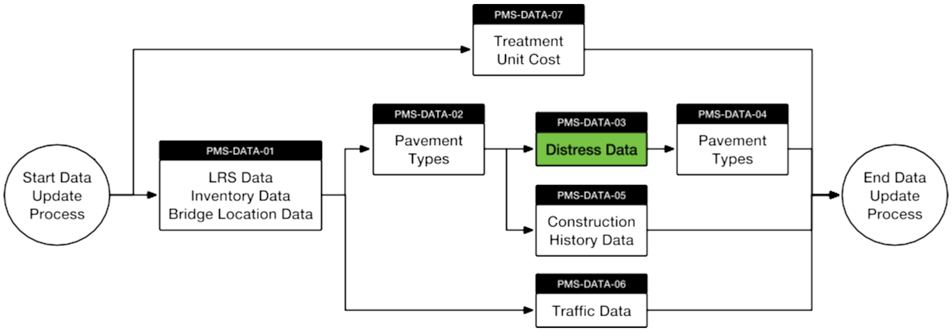
This SOP includes the updating of the Distress Data as part of the overall PMS data update process. This procedure should be completed annually for NHS roadway segments Distress Data updates and every other year for the full roadway segment Distress Data update.

Frequency Note

For years in which the entire network will be surveyed:

- The State Route Distress Data will be imported in August after the State Route Distress Data Quality Assurance process is complete.
- The Suburban Route Distress Data will be imported between September and October after the Suburban Route Distress Data Quality Assurance process is complete.

For years in which only NHS segments will be surveyed, the NHS Route Distress Data will be imported in August after the NHS State Route Distress Data Quality Assurance process is complete.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)

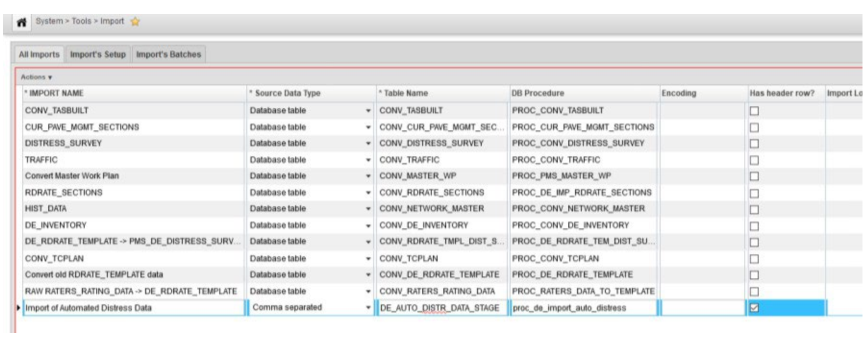
6. *Responsibilities*

This SOP will be managed by the Pavement Management Group Lead. DelDOT EAMS will complete the data import steps.

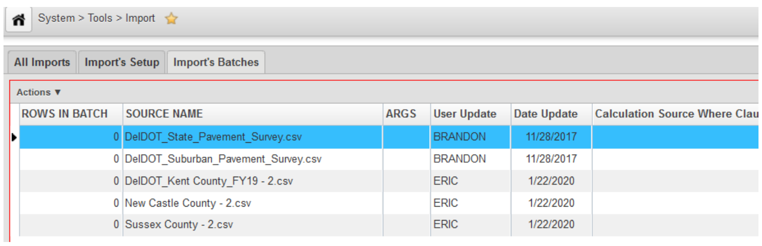
7. *Procedure*

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

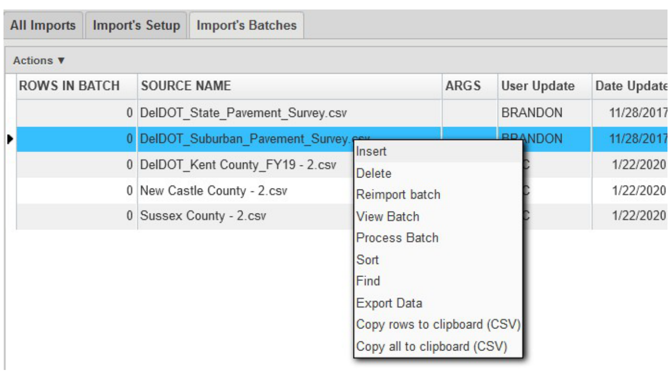
1. Open the **Import** window (System > Tools > Import).



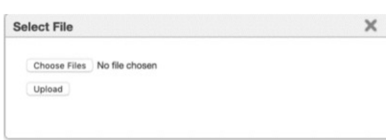
2. In the list of imports, highlight **Import of Automated Distress Data** import and then select the **Import's Batches** tab.



3. Right-click and select **Insert**.

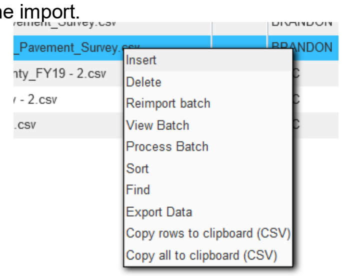


4. Select **Upload** and select the source file containing the Distress Data. Select **OK** to close the window.

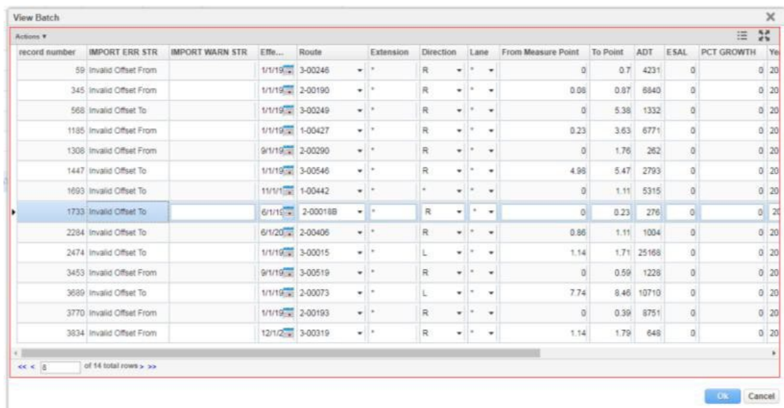


5. A new row in the Import window should identify the source data selected in the previous step. **ROWS IN BATCH** column shows the total number of rows in the import batch.

Right-click on this new row and select **Process Batch**. The **ROWS IN BATCH** column will change to identify the number of errors for the import.



6. Right-click on the new row again and select **View Batch**. Review all import errors and resolve as required based on DelDOT Quality Assurance processes.



1. Once all errors are reviewed and accepted, the Distress Data Import process is complete. A value of 0 in **ROWS IN BATCH** column would indicate successful import of the whole batch.

Pavement Type Update (Post Data Collection)

1. Purpose

Pavement Type is a key data input utilized in the DelDOT AgileAssets Pavement Management System (PMS). The accurate and updated Pavement Types data is essential for PMS to assign appropriate treatment during the optimization process. During the PMS process, Pavement Type is updated twice; once before data collection is started and once after the data collection is complete.

Within DelDOT, maintaining an accurate pavement type inventory attribute was been a challenge through the years. This 2-step process is an internal systematic approach to correcting the issue.

2. References

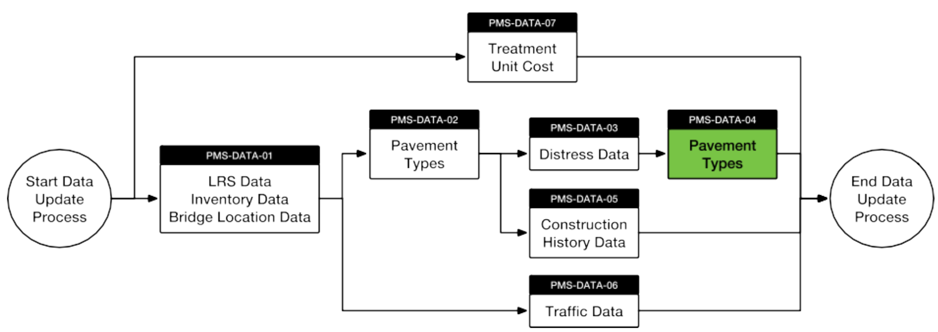
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Pavement Type as part of the overall PMS data update process. This procedure should be completed twice with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedures that are required to be completed before first Pavement Type update are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import

6. Responsibilities

This SOP will be conducted by the Pavement Management Group.

7. Procedure

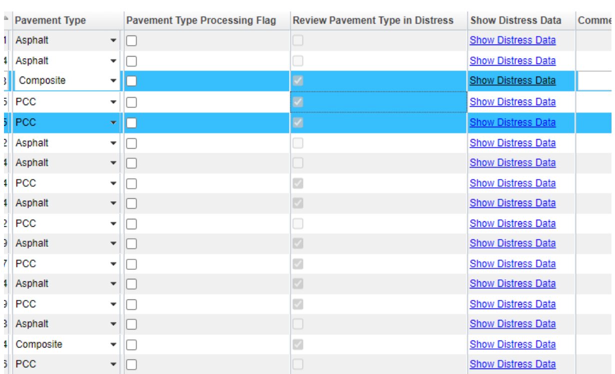
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

The source information for this effort will be a subset of the distress survey data, specifically the segments that the rater found conflicting pavement type information.

Pavement Type Inventory Input

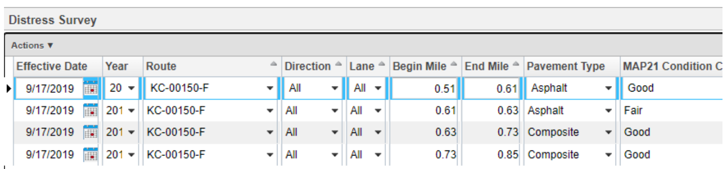
The Pavement Type Inventory window contains information related to the pavement types of all the management sections.

1. Open the **Pavement Type Inventory** window (Pavement Management > Database > Construction History > Pavement Type Inventory).
2. Under the column **Review Pavement Type in Distress**, locate the checked records. A checked record shows discrepancy in Pavement type between Pavement Type Inventory and Distress Data.

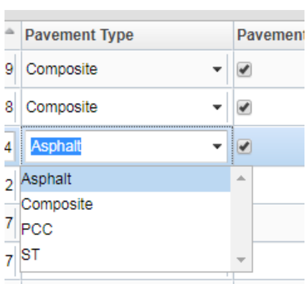


Pavement Type	Pavement Type Processing Flag	Review Pavement Type in Distress	Show Distress Data	Comme
Asphalt	☐	☐	Show Distress Data	
Asphalt	☐	☐	Show Distress Data	
Composite	☐	☑	Show Distress Data	
PCC	☐	☑	Show Distress Data	
PCC	☐	☑	Show Distress Data	
Asphalt	☐	☐	Show Distress Data	
Asphalt	☐	☐	Show Distress Data	
PCC	☐	☑	Show Distress Data	
Asphalt	☐	☑	Show Distress Data	
PCC	☐	☐	Show Distress Data	
Asphalt	☐	☑	Show Distress Data	
PCC	☐	☑	Show Distress Data	
Asphalt	☐	☑	Show Distress Data	
PCC	☐	☑	Show Distress Data	
Asphalt	☐	☐	Show Distress Data	
Composite	☐	☑	Show Distress Data	
PCC	☐	☐	Show Distress Data	

3. For each checked record, click on Show Distress Data hyperlink under **Show Distress Data** column to review the distress data causing conflicting pavement types. Close the window.



4. In **Pavement Type Inventory** window, click on the drop-down menu under Pavement Type column and select the appropriate pavement type.



5. Press the **Save Data** button in the upper right of the screen when complete.
6. In addition, the Pavement type is automatically updated when a construction history record is inserted. Refer to **SOP PMS-DATA-05 (Construction History Data)** document to update the construction history.

Construction History Data Updates

1. Purpose

Construction History Data is utilized in the DelDOT AgileAssets Pavement Management System (PMS). This data, configured in the system, enables the recording of pavement construction and rehabilitation work.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
PCC & HM Pavement Project Reporting, PMG Training Document (Version 1.1)
Engineering Configuration PMS Configuration Guide (latest version)

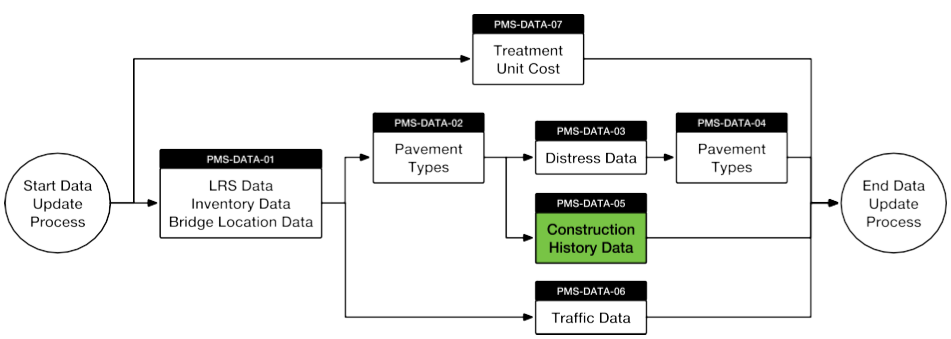
3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Construction Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.

The Construction History section enables the recording of pavement construction and rehabilitation work. You can view, insert, edit, and/or modify data related to work performed on pavements. Data is recorded in these windows by the limits of the work as it was performed on the road. The limits for a project do not have to coincide with the limits of any pavement management sections.



5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)

In addition, a Quality Assurance review of the source condition data is required.

5. Responsibilities

This SOP will be conducted by the Pavement Management Group.

7. Procedure

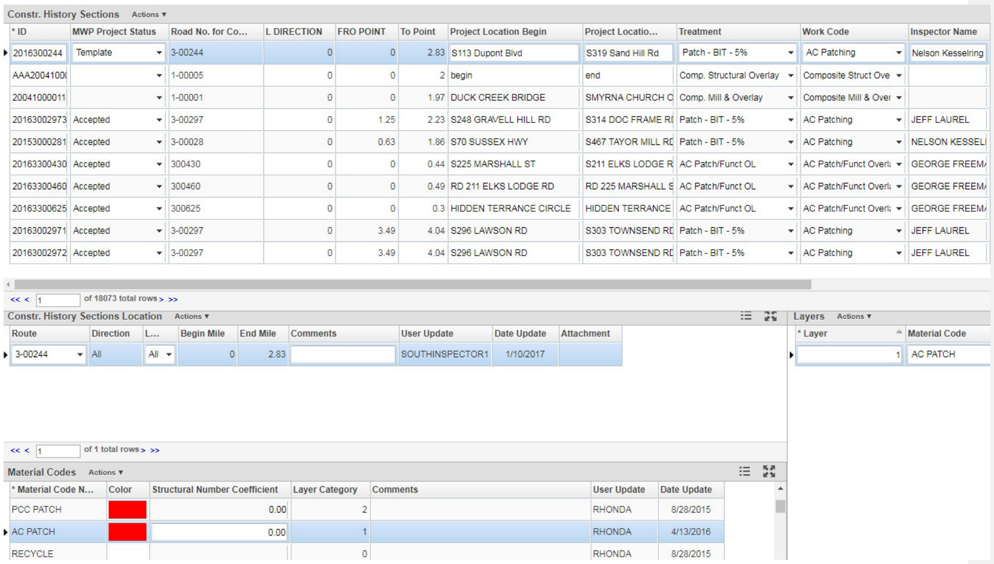
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

This SOP identifies the step for the Pavement Management Group to insert and insert details into the Construction history window. There is a reference process that allows for projects to be inserted into the Contraction History window directly through the Work Plan window. The corresponding details and setup related to that process are identified in the **PCC & HM Pavement Project Reporting, PMG Training Document (Version 1.1)**. By this reference, that process enhances and is considered part of the overall process identified in this SOP.

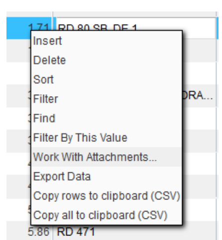
Contract Information Data Input

The Contract Information pane contains information related to the work performed as a whole, specifically Contract level details. Fill in as many of these fields as are applicable to the work performed.

1. Open the **Contracts and Layers Data** window (Pavement Management > Database > Construction History > Contracts and Layers Data).



2. Right-click in the top **Constr. History Sections** pane and then click **Insert**. A Contract record is inserted.



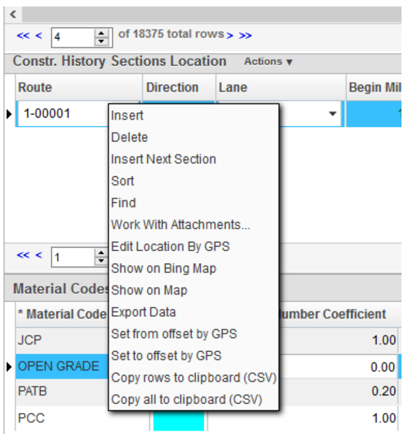
3. Enter data into the new row, filling in each of the main portions of the form with appropriate values.

4. Press the **Save Data** button in the upper right of the screen when complete.

<u>Location Information Data Input</u>

The **Constr. History Sections Location** pane contains location information, such as Route, Direction, Lane, Begin Mile, and End Mile attributes.

5. Select a Contract in the top pane. Right-click in the **Constr. History Sections Location** pane and select **Insert**. A new record is inserted.



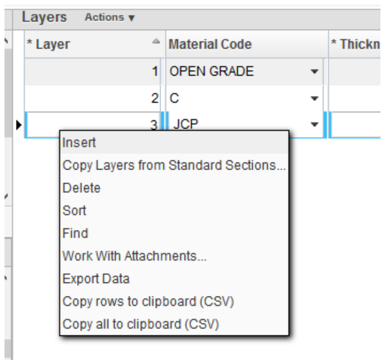
6. Enter location data into the new row, filling in each of the main portions of the form with appropriate values. Set column **Direction** to All for all the records unless the construction is done in one direction only; in that case it should be S/W.

7. When all location data is entered, click **Save Data** in the upper right of the screen.

Layer Information Input

The **Layer** pane allows you to enter information relating to pavement layer details.

1. Select a Contract in the top pane. Right-click in the **Layer** pane and select **Insert**. A new record is inserted.



2. Enter mainline pavement layer data into the new row, filling in each of the columns of the row with appropriate values.

3. When all layers are entered, click **Save Data** in the upper right of the screen.

Traffic Data Updates

1. Purpose

Traffic Data is utilized in the DelDOT AgileAssets Pavement Management System (PMS) as an additional attribute in the system.

2. References

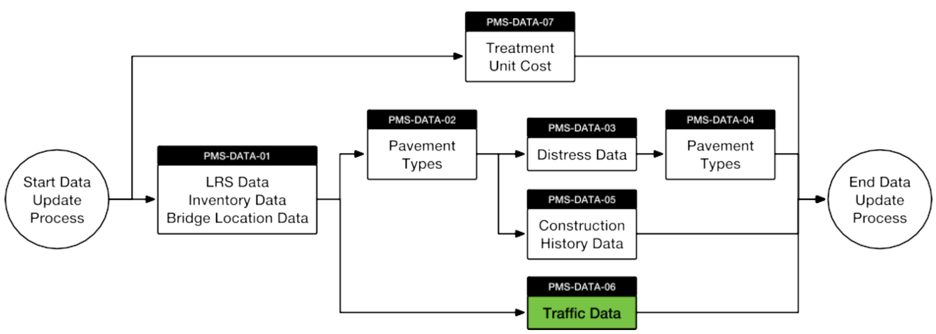
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Traffic Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import

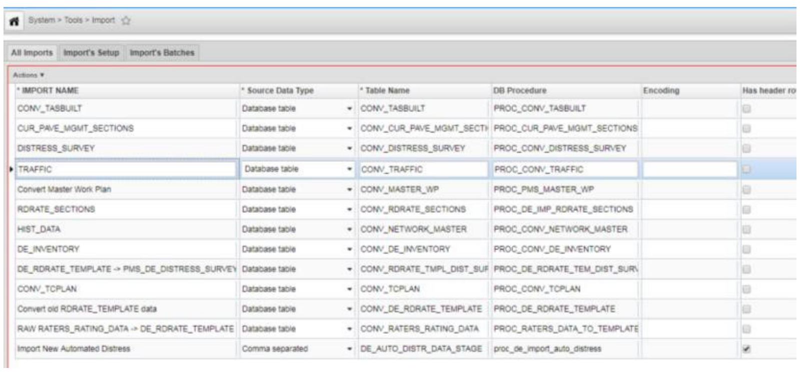
6. Responsibilities

This SOP will be managed by the Pavement Management Group Lead. DelDOT EAMS will complete the data import steps.

7. Procedure

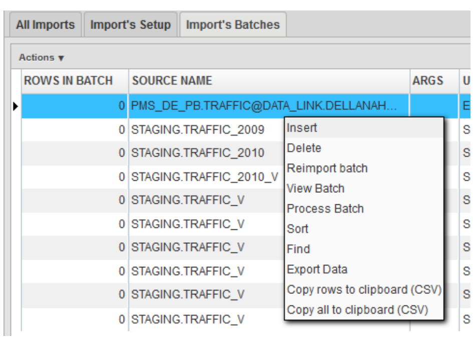
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

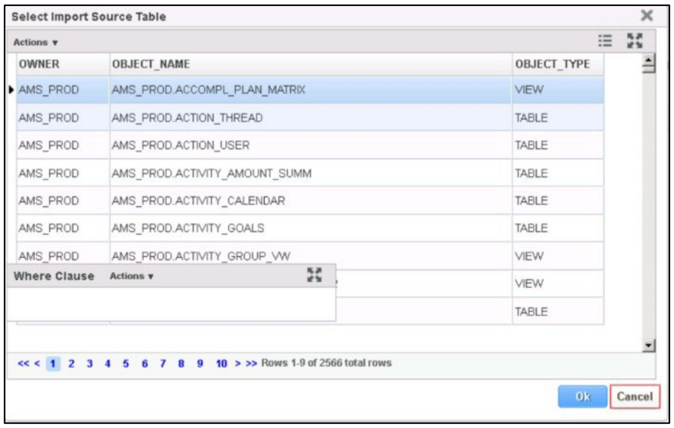
1. Open the **Import** window (System > Tools > Import).



2. In the list of imports, highlight **STAGING.TRAFFIC_V** import and then select the **Import's Batches** tab.

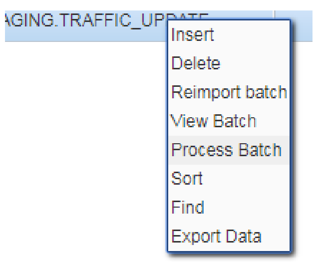
3. Right-click and select **Insert**. Select the source table containing the Inventory Data. This data will be supplied from DelDOT's Planning Group. Select **OK** to close the window.

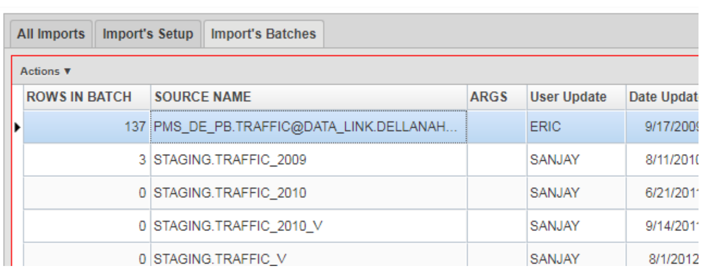




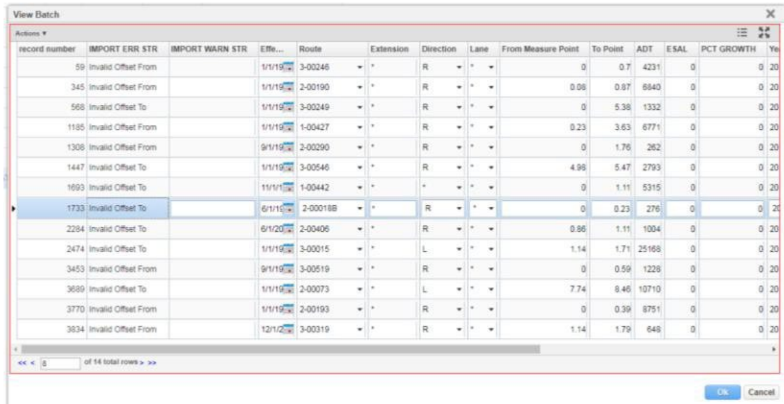
4. A new row in the Import window should identify the source data selected in the previous step.

5. Right-click on this new row and select **Process Batch**. The **ROW IN BATCH** column will change to identify the number of errors for the import.





6. Right-click on the new row again and select **View Batch**. Review all import errors and resolve as required based on DelDOT Quality Assurance processes.



View Batch

Actions ▾

record number	IMPORT ERR STR	IMPORT WARN STR	Effe...	Route	Extension	Direction	Lane	From Measure Point	To Point	ADT	ESAL	PCT GROWTH	Ye
59	Invalid Offset From		1/1/19	3-00246	*	R	*	0	0.7	4231	0	0	20
345	Invalid Offset From		1/1/19	2-00190	*	R	*	0.06	0.87	6840	0	0	20
568	Invalid Offset To		1/1/19	3-00249	*	R	*	0	5.38	1332	0	0	20
1185	Invalid Offset From		1/1/19	1-00427	*	R	*	0.23	3.63	6771	0	0	20
1308	Invalid Offset From		9/1/19	2-00290	*	R	*	0	1.76	262	0	0	20
1447	Invalid Offset To		1/1/19	3-00546	*	R	*	4.96	5.47	2793	0	0	20
1693	Invalid Offset To		11/1/1	1-00442	*	*	*	0	1.11	5315	0	0	20
1733	Invalid Offset To		6/1/1	2-00018B	*	R	*	0	0.23	276	0	0	20
2284	Invalid Offset To		6/1/20	2-00406	*	R	*	0.86	1.11	1004	0	0	20
2474	Invalid Offset To		1/1/19	3-00015	*	L	*	1.14	1.71	25168	0	0	20
3453	Invalid Offset From		9/1/19	3-00519	*	R	*	0	0.59	1228	0	0	20
3689	Invalid Offset To		1/1/19	2-00073	*	L	*	7.74	8.46	10710	0	0	20
3770	Invalid Offset From		1/1/19	2-00193	*	R	*	0	0.39	8751	0	0	20
3834	Invalid Offset From		12/1/2	3-00319	*	R	*	1.14	1.79	648	0	0	20

<< < 8 of 14 total rows > >>

Ok Cancel

7. Once all errors are reviewed and accepted, the Traffic Data Import process is complete.

Treatment Unit Cost Updates

1. Purpose

Treatment Unit Costs and Unit Cost Factors are utilized in the DelDOT's AgileAssets Pavement Management System (PMS). This data, configured in the system, is very important and sensitive decision variables for all analyses. It is critical that DelDOT conduct a thorough and detailed review of construction cost data in order to finalize the data that will utilized in the following steps.

2. References

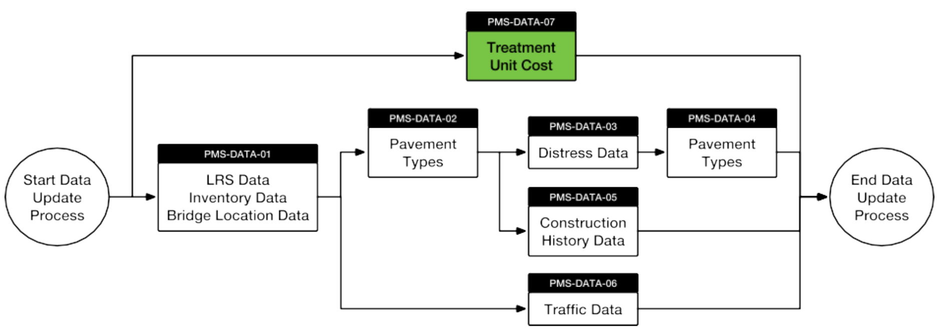
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of both the Treatment Unit Costs and Unit Cost Factors as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedure that is required to be completed is SOP No. **PMS-GENERAL-01**, Overall Configuration Review.

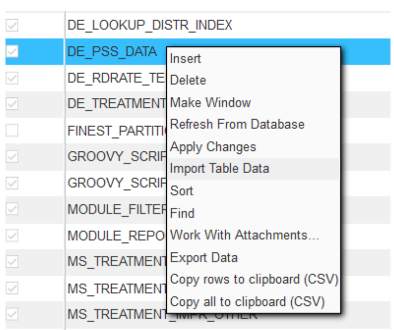
6. Responsibilities

This SOP will be conducted by the Pavement Management Group. The Pavement Management Group may request support from District Pavement Management Leads during the Treatment Unit Cost development, but the input of the data will be conducted by the Pavement Management Group.

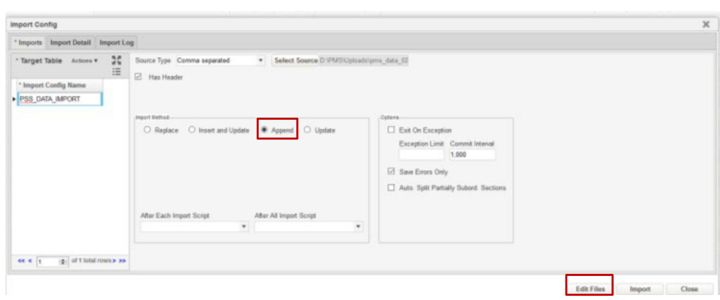
7. Procedure

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

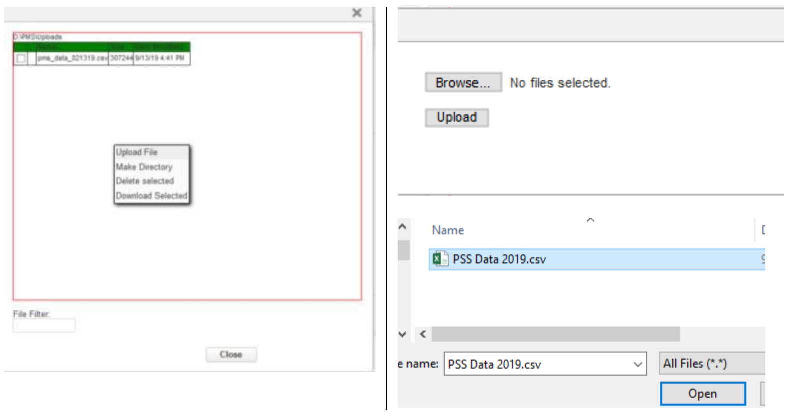
1. Import the actual project costs for the last four years for State Routes and two years for Suburban Routes from DelDOT's PSS project estimating database.
2. Open the **Tables** window (System > Utilities > Tables). Right-click on the table DE_PSS_DATA and select Import Data Table.



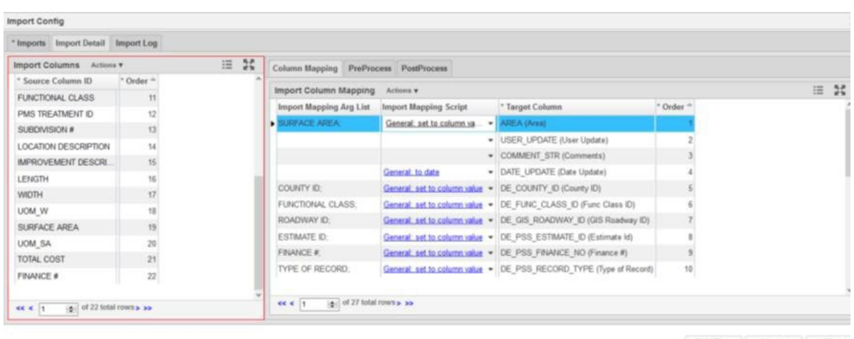
3. Select PSS_DATA_IMPORT under Import Configuration in **Import Config** window. Choose Append under Import Method. Select *Comma separated* as Source Type.



4. Press Edit File, select Upload file in the right-click menu. Select Browse in the new pop-up window. Locate the latest PSS data file on computer and press Open. Select Upload. Select Close.



5. Press Select Source on the **Import Config** window and choose the latest uploaded file.
6. Press Import Detail tab in the **Import Config** window. In the left pane, Import Columns, select Refresh Source Column on the right-click menu. In Import Column Mapping pane, select Refresh Target Column on the right-click menu.
7. Press Import. The latest PSS data will be imported.



8. Open **PSS Data** window (Pavement Management > Database > PSS Data). Select Update Target Table on the right-click menu. Select Pavement Type (the only updatable column in the table) and press OK.
9. Open **Treatment Unit Cost** window (Pavement Management > Database > Treatment Unit Cost). Select Update Target Table on the right-click menu. Select all the columns and press OK.

Select Data Columns

Data Columns Actions ▾

Select	Column Label	View Type	Calculation Source SQL
☑	Sample Size	R-Number	SELECT b.TKG_SAMPLE_SIZE from DE_T
☑	Treatment Unit Cost - Average	R-Number	SELECT b.DE_TRT_UNIT_COST_AVG from
☑	Treatment Unit Cost - Maximum	R-Number	SELECT b.DE_TRT_UNIT_COST_MAX from
☑	Treatment Unit Cost - Minimum	R-Number	SELECT b.DE_TRT_UNIT_COST_MIN from

10. Open **Treatments** window (Pavement Management > Network Analysis > Configuration > Treatments). Select any treatment under Treatment Name column, press Unit Costs tab in the bottom pane. It will show average, maximum, and minimum unit costs calculated based on the latest PSS data. Please note that the calculated costs are just for the reference purposes, the actual column used in optimization analysis is **Treatment Cost**. Treatment Cost is an editable column to be populated by user. Click the Save Data button after making any edits to the Treatment Cost.

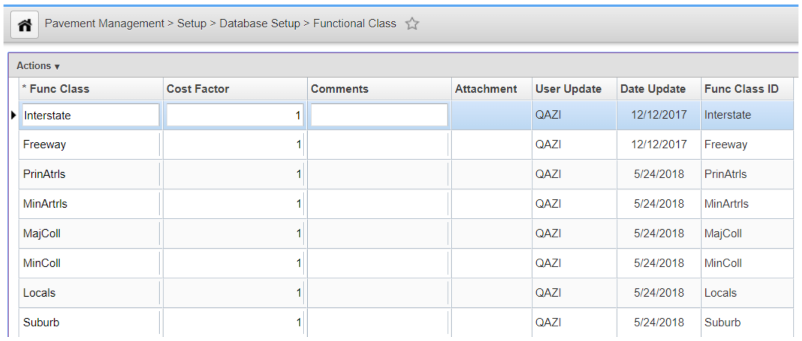
Treatment Unit Cost - Average	Treatment Unit Cost - Maximum	Treatment Unit Cost - Minimum	Treatment Cost	S
0.59	58.04	0.04	21.3	
			21.3	
45.71	242.35	0.73	21.3	
0.14	0.16	0.13	21.3	

11. If it is determined that Treatment Unit Cost Factors updates are required, proceed with the following steps.

<u>Treatment Unit Cost Factor Updates (Functional Class)</u>

There are two Unit Cost Factors configured in the PMS. These factors allow for variation in cost based on various system attributes. These factors can be adjusted as follows:

1. Open the **Functional Class** window (Pavement Management > Setup > Database Setup > Functional Class). Select the value in the **Cost Factor** column corresponding to the Functional Class requiring updating. Revise the factor as required.

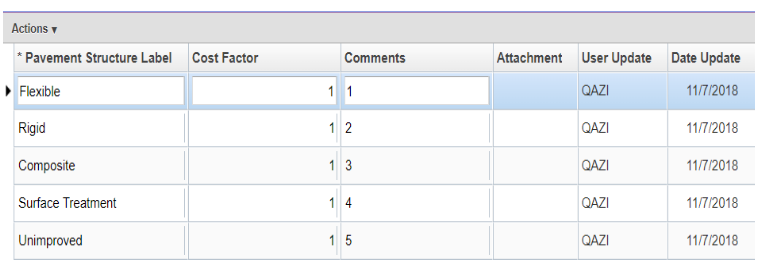


* Func Class	Cost Factor	Comments	Attachment	User Update	Date Update	Func Class ID
Interstate	1			QAZI	12/12/2017	Interstate
Freeway	1			QAZI	12/12/2017	Freeway
PrinAtrls	1			QAZI	5/24/2018	PrinAtrls
MinArtrls	1			QAZI	5/24/2018	MinArtrls
MajColl	1			QAZI	5/24/2018	MajColl
MinColl	1			QAZI	5/24/2018	MinColl
Locals	1			QAZI	5/24/2018	Locals
Suburb	1			QAZI	5/24/2018	Suburb

2. Continue update the factors for other Functional Classes as necessary and then click the **Save Data** button in the top right corner of the window.

<u>Treatment Unit Cost Factor Updates (Pavement Type)</u>

1. Open the **Pavement Type** window (Pavement Management > Setup > Database Setup > Pavement Type). Select the value in the **Cost Factor** column corresponding to the Pavement Type under column Pavement Structure Label requiring updating. Revise the factor as required.



* Pavement Structure Label	Cost Factor	Comments	Attachment	User Update	Date Update
Flexible	1	1		QAZI	11/7/2018
Rigid	1	2		QAZI	11/7/2018
Composite	1	3		QAZI	11/7/2018
Surface Treatment	1	4		QAZI	11/7/2018
Unimproved	1	5		QAZI	11/7/2018

2. Continue update the factors for other Pavement Types as necessary and then click the **Save Data** button in the top right corner of the window.

3. All Treatment Unit Costs and Unit Cost Factors have now been updated in the PMS.

Build Pavement Management Sections

1. *Purpose*

Management Sections in DelDOT's AgileAssets Pavement Management System are utilized as sections of roadway that reflect, as closely as possible, typical project limits. In order for these Management Sections to be utilized, they need to be created based on rules determined by DelDOT.

2. *References*

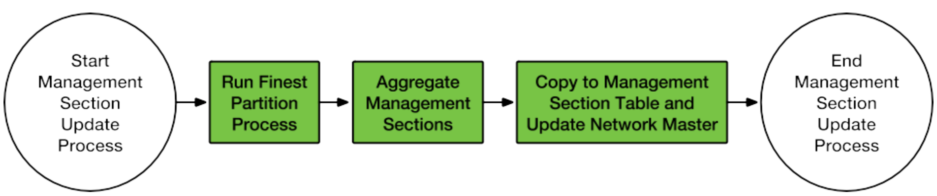
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. *Definitions*

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. *Scope*

This SOP includes the processes involved in updating of the Management Sections as well as the Network Master which utilizes the Management Sections. This procedure should be completed annually when new system data is available and prior to any analyses being completed for that year.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import
- SOP No. **PMS-DATA-04**, Pavement Type Update (Post Data Collection)
- SOP No. **PMS-DATA-05**, Construction History Data Update

6. *Responsibilities*

This SOP will be conducted by the Pavement Management Group Lead.

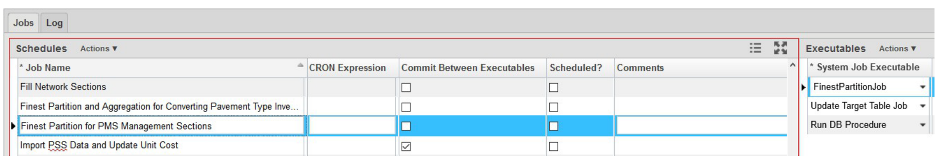
7. *Procedure*

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

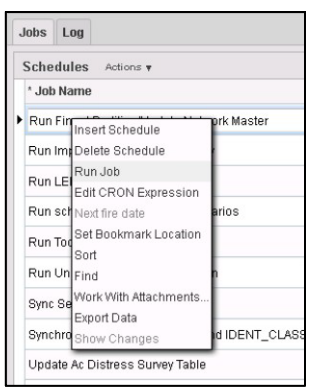
The following step are necessary to update the Pavement Management Sections.

Run Finest Partition Process

1. Open the **Schedules** window (System > Tools > System Job > Schedules).
2. In the list of schedules, find the **Finest Partition for PMS Management Sections** schedule.



3. Right-click on the schedule and select **Run Job**. The Finest Partition process is complete.



4. To verify data process and manually adjust data, open the **Finest Partition For Mgmt Sections** window (Pavement Management > Database > Inventory Data > Management Sections Creation > Finest Partition For Mgmt Sections) and view the data shown in the window. For any data that

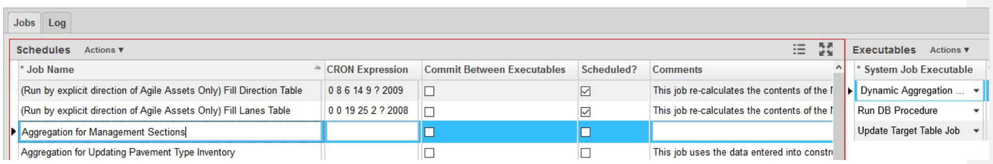
is a forced split is required, select the record and select the box in the **Section Must Split Y/N** column.

5. Select **Save** in the upper right of the screen when all selections are made.

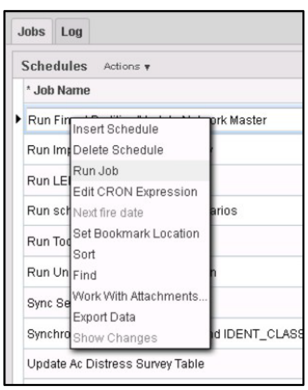
<u>Aggregate Management Sections</u>

6. Open the **Schedules** window (System > Tools > System Job > Schedules).

7. In the list of schedules, find the **Aggregation for Management Sections** schedule.

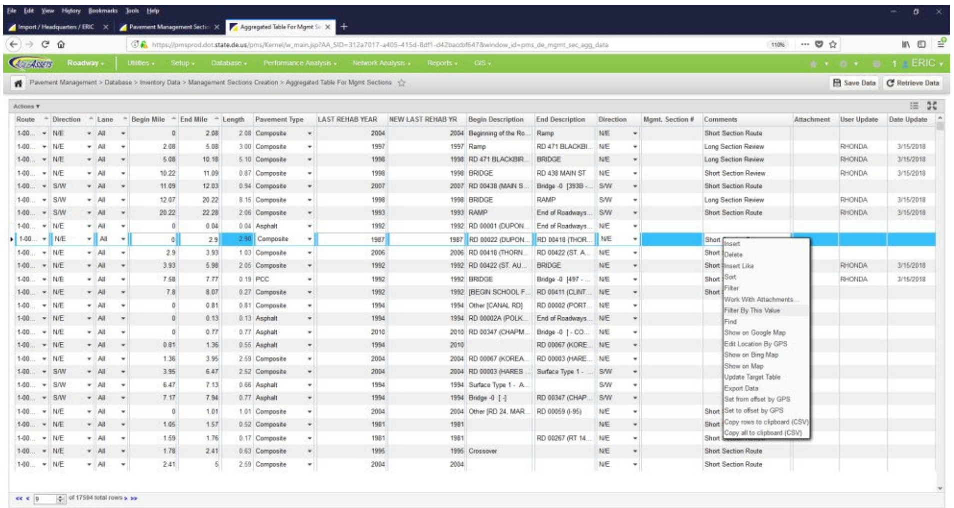


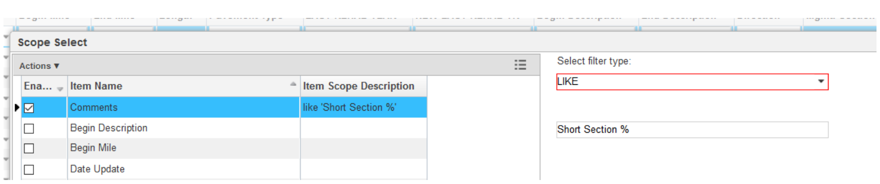
8. Right-click on the schedule and select **Run Job**. The aggregation process for the management sections is now complete.



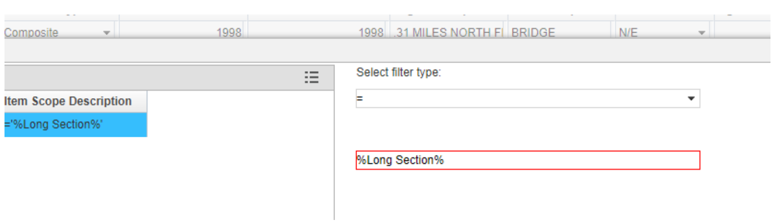
9. To verify the data process and manually adjust data, open the **Aggregated Table For Mgmt Sections** window (Pavement Management > Database > Inventory Data > Management Sections Creation > Aggregated Table For Mgmt Sections) and view the data shown in the window. Data in this window can be manually adjusted, if necessary, after review.
10. In order to identify and review the short sections, right click on the **Comment** column and select **Filter by this Value**. In the Scope Select window, Select **Filter Type:** as LIKE and write “Short Section %” in the textbox. The Sections commented as “Short Section Review” are the actual short sections with length <0.5 mile. The sections commented as “Short Section Route” are other

sections on those routes that contain a short section. DelDOT staff can review and edit the short sections by merging them into their neighbors if desired.





11. To identify and review the long sections, right click on the **Comment** column and select **Filter by this Value**. In the Scope Select window, Select **Filter Type:** as LIKE and write "% Long Section %" in the textbox. The long sections are the sections with length > 5 miles. These sections will be reviewed and split if deemed necessary.

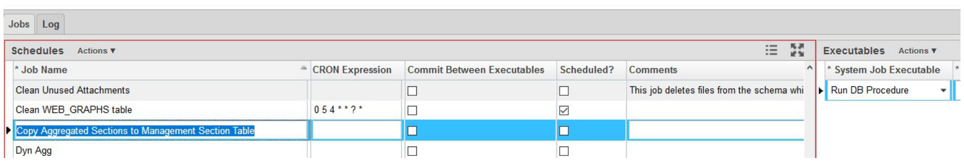


Note: It is important to note that any manual modification will be overwritten the next time the Build Pavement Management Sections process is completed (annually). If there are a significant number of manual refinements, either note all refinements so that they can be reconsidered next year or consider a fully manual Section Development Process.

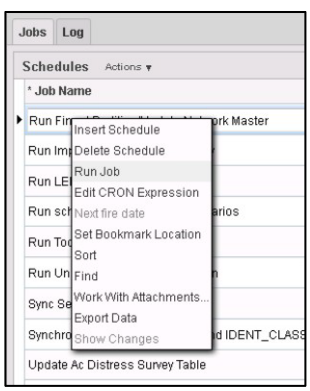
Copy to Management Section Table

12. Open the **Schedules** window (System > Tools > System Job > Schedules).

13. In the list of schedules, find the **Copy Aggregated Sections to Management Section Table** schedule.



14. Right-click on the schedule and select **Run Job**. The aggregated sections have been copied to the Management Section table and table columns have been updated.

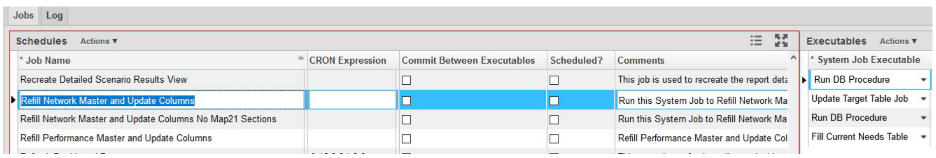


15. To verify the data process and manually adjust data, open the **Current Pavement Management Sections** window (Pavement Management > Database > Inventory Data > Current Pavement Management Sections) and view the data shown in the window. Data in this window can be manually adjusted, if necessary, after review.

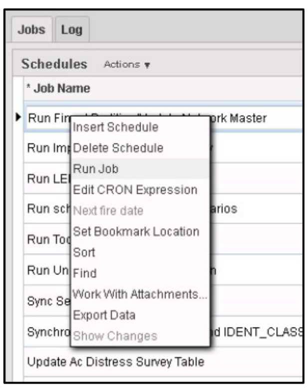
Update Network Master

16. Open the **Schedules** window (System > Tools > System Job > Schedules).

17. In the list of schedules, find the **Refill Network Master and Update Columns** schedule.



18. Right-click on the schedule and select **Run Job**. The network master has been updated and all columns have been recomputed utilizing all latest data.



19. To verify the data process, open the **Network Master** window (Pavement Management > Network Analysis > Network Master) and review the data shown in the window. Data in this window cannot be manually adjusted. If issues are identified, review the source data and processes.

Project Selection

1. Purpose

DelDOT's AgileAssets Pavement Management System allows for the development of optimized work plans identifying the best cost-effective project to complete each year. It is important to stay as close as possible to the optimized solution while understanding that project-level issues may create the need to deviate from the plan. The purpose of this SOP is to aid in developing the final work plan of projects.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

Work Plan – Programmed project developed either through an optimization analysis or manually created.
LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. Scope

This SOP includes the steps involved in developing the 6-year projects list. This procedure should be completed annually.

5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import
- SOP No. **PMS-DATA-04**, Pavement Type Update (Post Data Collection)
- SOP No. **PMS-DATA-05**, Construction History Data Update
- SOP No. **PMS-DATA-06**, Traffic Data Update
- SOP No. **PMS-DATA-07**, Treatment Unit Cost Update
- SOP No. **PMS-SECTION-01**, Build Pavement Management Sections

6. *Responsibilities*

This SOP will be conducted by the Pavement Management Group (PMG).

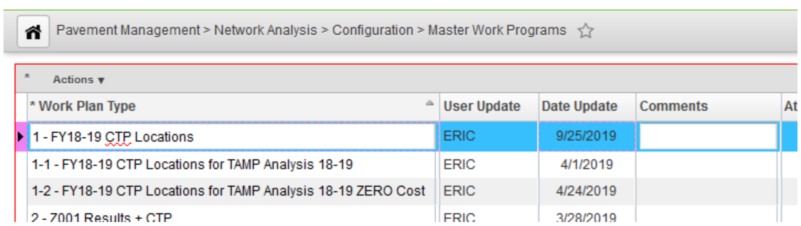
7. *Procedure – State Optimization Analysis*

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

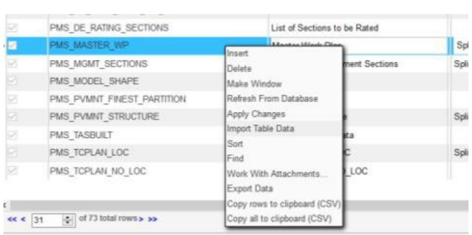
The following steps are necessary to complete the project selection process.

Import CTP locations to the MWP

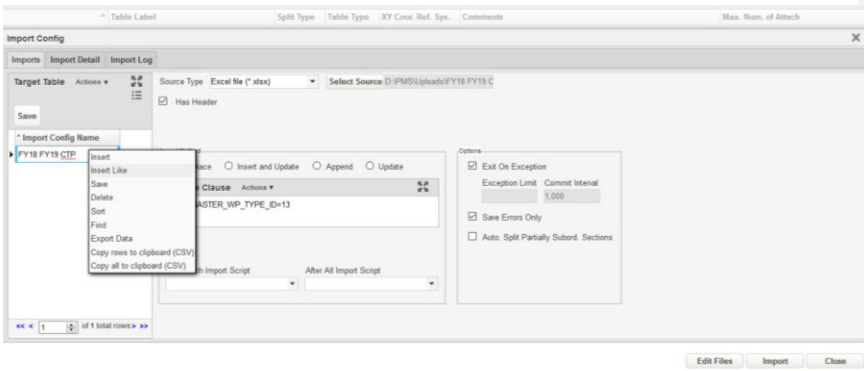
1. Open **Master Work Programs** window (Pavement Management > Network Analysis > Configuration > Master Work Programs).
2. Insert a new Work Plan Type "FY18-19 - 1 - CTP Locations". 1 indicates the Step/Scenario number which will use this work plan. This is explained further in this section.

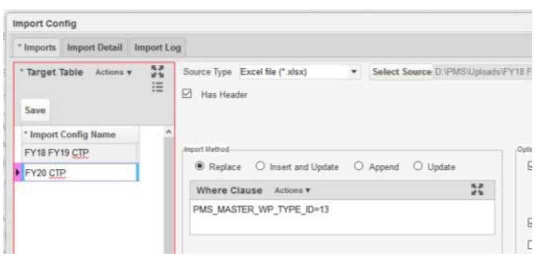


3. Similarly, insert two more Work Plan Types, "FY18-19 - 2 - Z001 Results + CTP" and "FY18-19 – 3 - Z001 Results+STP Results+CTP".
4. Open **Work Plan Data** (Pavement Management > Network Analysis > Work Plan Data) and Select "FY18-19 - 1 - CTP Locations" from the dropdown menu **Select WP Type**.
5. Populate the Work Plan by importing the projects using a work plan spreadsheet. The spreadsheet must be in a readily importable excel file format.
   a. Open **Tables** window (System > Utilities > Tables). Right Click on Table PMS_MASTER_WP and select Import Table Data.



b. In the **Import Config** window, right-click on the existing Import and select Insert Like. Name it according to Year of MWP.





c. Press Edit Files button and upload the importable spreadsheet containing MWP data. Refresh the source and target columns and edit where needed. Press Import.

Create Optimization Analysis Scenarios

DelDOT's annual Capital Transportation Program (CTP) partially relies on Federal funds. The annual CTP budget on Project Authorization Schedule sheet is divided into three categories, Federal - NHS (Z001) budget, Surface Transportation Program (STP) Federal Eligible Budget, and State budget, as shown in Table 1 below.

Table 1: CTP Budget – Project Authorization Schedule

Paving Program	Current CTP Plan			
	State		Federal - NHS (Z001)	Federal - STP
	Maintenance Funds	Remaining Funds		

FY20 Program	13,500,000	$65,000,000	$11,144,658	$7,455,342
FY21 Program	19,500,000	$55,200,000	$5,800,000	$9,000,000
FY22 Program	7,700,000	$36,200,000	-	-
FY23 Program	7,700,000	$36,200,000	-	-
FY24 Program	7,700,000	$36,200,000	-	-
FY25 Program	7,700,000	$36,200,000	-	-
FY26 Program	7,700,000	$36,200,000	-	-
FY27 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000
FY28 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000
FY29 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000

Commented [QA1]: Sarah will have to look at these funding and correct them..

Patch Funding to Districts is subtracted off the top from the State fund. The CTP budget is further divided following the NHS, STP-Fed, and State funding allocation rules. Three sets of additional constraint subdivisions, based on County, NHS Code, Functional Class, and Budget Groups, are used to build the State funding scenario (Table 2 and Table 3). Table 3 shows the budget constraints for year 1 of the analysis. This process is repeated for each year of the analysis. The excel spreadsheet used to determine the budget breakdown is attached. Right click on the Object, Select Work Sheet Object ➔ Open to see the calculations. Once opened, create a copy (file -> save as) of the file in order to use the file for calculation. Select the **Title Page** tab before closing the spreadsheet.

State Funding Calculation Spreadsheet

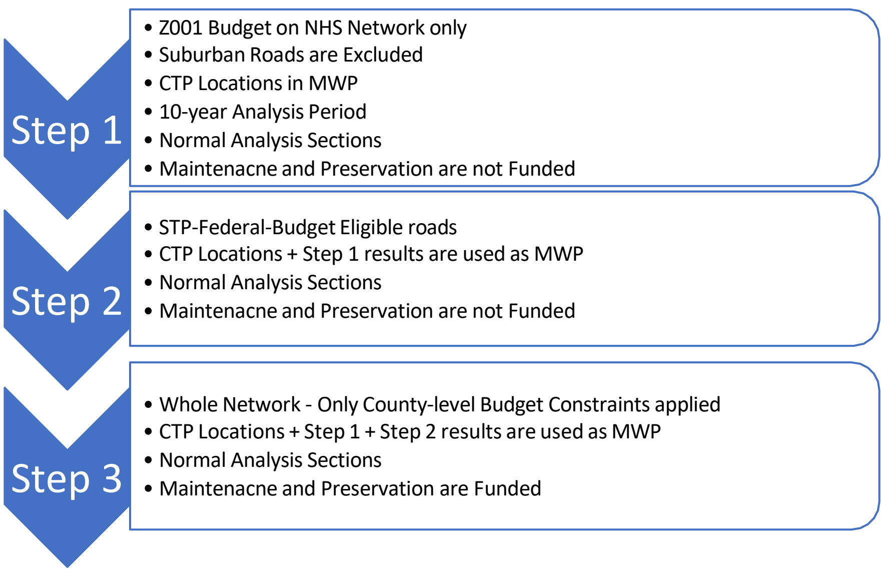
Table 2: Budget Breakdown

County Breakdown %	County	% Lane Miles Managed	STP	Z001
	Kent	25%	20%	10%
	NCC	30%	50%	70%
	Sussex	45%	30%	20%
Treatment Breakdown %	Treatment	% Lane Miles Managed	STP	Z001
	Maint/ST	-	0%	0%
	Preservation	-	0%	0%
	Regab/Recon	-	100%	100%

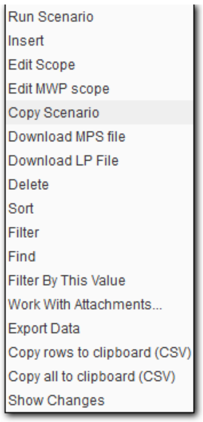
Table 3: Budget Constraints for Optimization Analysis for 1 year

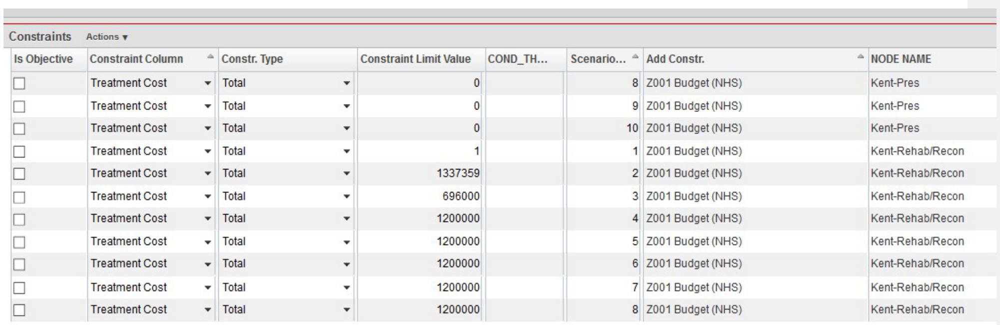
Constraint Column	Constraint Limit Value	Add Constr.	Node Name	Comments
Treatment Cost	20,900,000	By County	Kent	The Sum of these budgets by County is equal to the total budget by Fiscal Year (STATE + FEDERAL) on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County is by % Lane Miles Managed.
	25,080,000		New Castle	
	37,620,000		Sussex	
	0	STP Fed Eligible	Kent-Maint/ST	The Sum of these budgets is equal to the total FEDERAL budget by Fiscal Year + the 20% STATE Match Budget on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County and Budget Group is user defined.
	0		Kent-Pres	
	4,464,000		Kent-Rehab/Recon	
	0		NCC-Maint/ST	
	0		NCC-Pres	
	11,160,000		NCC-Rehab/Recon	
	0		Sussex-Maint/ST	
	0		Sussex-Pres	
	6,696,000		Sussex-Rehab/Recon	
	0	Z001 Budget (NHS)	Kent-Maint/ST	The Sum of these budgets is equal to ((the total Z001 line item/the total FEDERAL budget) * 20% STATE Match Budget) + the total Z001 Budget on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County and Budget Group is user defined.
	0		Kent-Pres	
	1,337,359		Kent-Rehab/Recon	
	0		NCC-Maint/ST	
	0		NCC-Pres	
	9,361,513		NCC-Rehab/Recon	
	0		Sussex-Maint/ST	
	0		Sussex-Pres	
	2,674,718		Sussex-Rehab/Recon	

The three-step process followed to run Statewide optimization results is illustrated in the figure below. In the first step, scope of analysis is limited to NHS network and Normal Analysis Sections (with variable length). Suburban roads are excluded. Only Z001 Budget (NHS) funds are used to run the analysis for a 10-year analysis period. Master work Plan is included in the analysis if available. Maintenance and Preservation activities are not funded under this scenario.
The second step includes running the optimization analysis only on STP-Federal-Budget Eligible road sections which essentially exclude minor collectors, locals, and suburban roads from the analysis. Maintenance and Preservation activities are not funded under this scenario. The results from Step 1 are used as work plan in Step 2.
Step 3 involves running the optimization analysis on the whole network (but suburban roads), only the county specific Budget constraints are applied. The results from Step 2 are used as work plan in this step.



6. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), copy an existing template Scenario (FY20-25 State Optimization Analysis - Step 1 - Z001) with **Z001 Budgets** as additional constraint. That is, only Z001 portion of the funding (Table 3) is applied to select the projects in the first step.

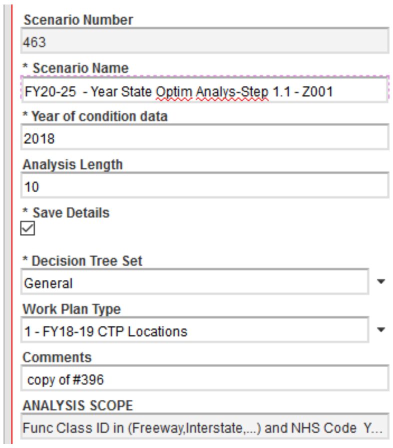




Constraints Actions ▾

Is Objective	Constraint Column	Constr. Type	Constraint Limit Value	COND_TH...	Scenario...	Add Constr.	NODE NAME
☐	Treatment Cost	Total	0		8	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	0		9	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	0		10	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	1		1	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1337359		2	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	696000		3	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		4	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		5	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		6	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		7	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		8	Z001 Budget (NHS)	Kent-Rehab/Recon

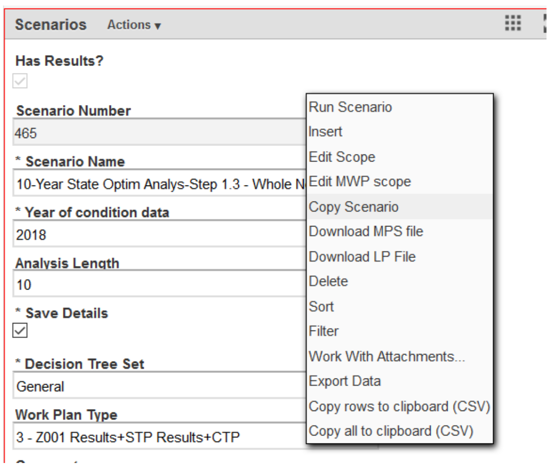
a. Select the *FY18-19 - 1 - CTP Locations* in Work Plan Type.
b. Analysis Length: 10
c. Year of Condition Data: 2019
d. Analysis scope:
    i. NHS Code: Yes
    ii. Functional Class: **All but Suburban**
    iii. Management Section: **Normal Analysis Sections**.
e. Analysis Type: **Multi-constraint**
f. Update the budgets
g. Run the analysis.



7. Populate the work plan “FY18-19 - 2 - Z001 Results + CTP” with CTP projects from “FY18-19 – 1 - CTP Locations” and the 1st scenario (Z001 Funding) analysis results.
8. In the Multi-Constraint Optimization window, copy an existing template (FY20-25 State Optimization Analysis - Step 1.2 - STP) of Step 2 with **STP Budgets** as the only additional constraint. Change the FY accordingly.
   a. Select FY18-19 - 2 - Z001 Results + CTP in Work Plan Type.
   b. Analysis Length: 10 (TAMP requires 4 years)
   c. Analysis scope:
      i. Functional Class: **All but Suburban**
      ii. Management Section: **Normal Analysis Sections**
   d. Analysis Type: **Multi-constraint**
   e. Run the analysis.
9. Populate the work plan “FY18-19 - 3 - Z001 Results+STP Results+CTP” with the projects obtained from the 2nd Scenario analysis results.
10. In the Multi-Constraint Optimization window, copy an existing template (FY20-25 - State Optim Analys- Step 1.3 - Whole Network) of Step 3 with the **county-level budgets** as the only additional constraint.
    a. Select the FY18-19 - 3 - Z001 Results+STP Results+CTP in Work Plan Type.
    b. Analysis Length: 10 (TAMP requires 4 years)
    c. Analysis scope:
       iii. Functional Class: **All but Suburban**
       iv. Management Section: **Normal Analysis Sections**
    d. Analysis Type: **Multi-constraint**
    e. Run the analysis.
11. See the results in Report Tab of the Multi-constrained Optimization window. Export the Report Tab as an excel file and analyze the results.
12. Field validate the projects selected by the optimization process.

In order to set and analyze targets for Federal reporting required under MAP-21/FAST Act, an extra step is added to the State Optimization Analysis procedure (See Section 8).

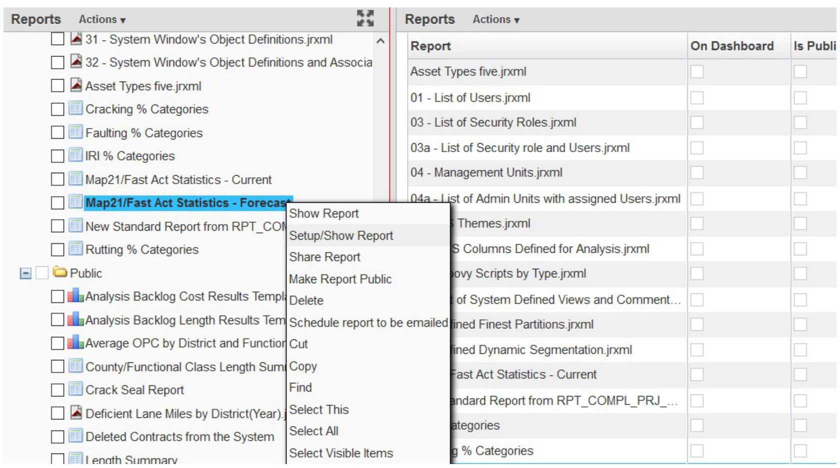
1. After running the 3rd Scenario of State Optimization Analysis (Section 8), create a new work plan comprising of projects obtained from the Step 3 of 3rd Scenario analysis results. Name it appropriately e.g. “FY18-19 - 4 - Whole Network used for MAP-21”.
2. In the Multi-Constraint Optimization window, copy the 3rd scenario (created in Section 8) to create a 4th and Final Scenario. It can be named as FY20-25 State Optim Analys- Step 2 - Whole Network



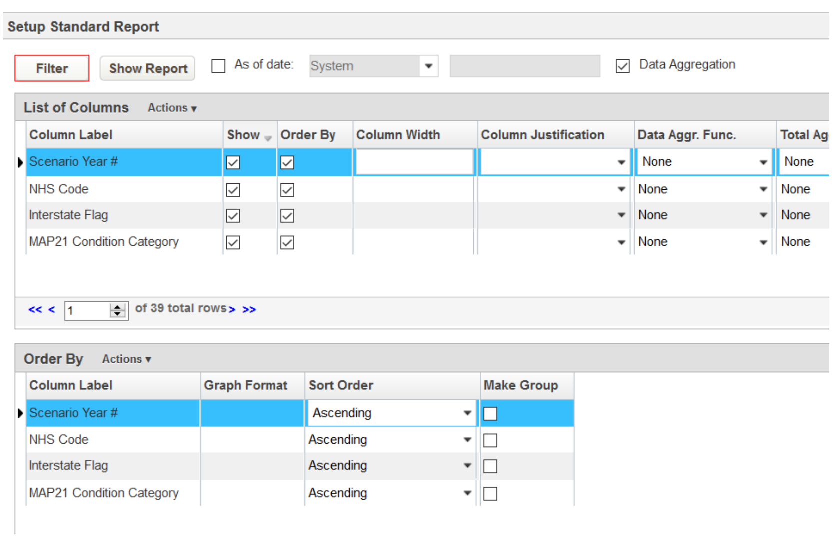
Make following changes in the new scenario:

a. Select the Whole Network - for MAP-21 Analysis in Work Plan Type
b. Analysis Length: 10 (TAMP requires 4 years)
c. Analysis scope:
   v. Functional Class: **All but Suburban**
   vi. Management Section: **HPMS/MAP21 Analysis Sections**
d. Analysis Type: **Estimate MWP Influence**
e. Run the analysis.

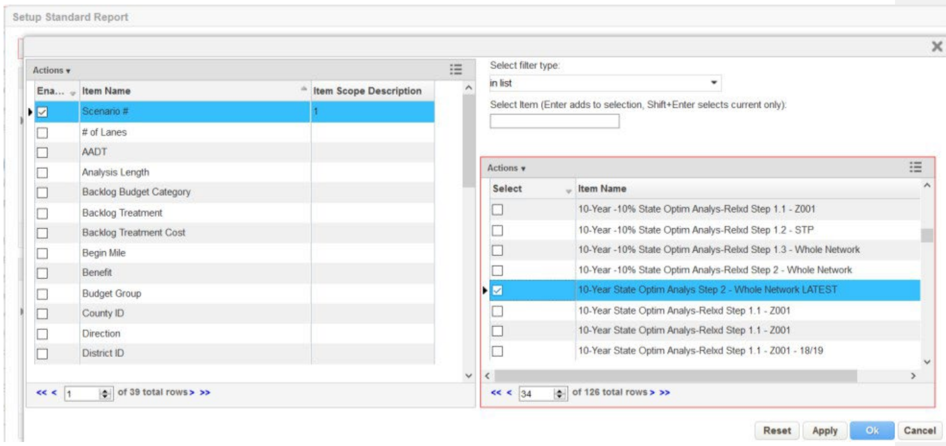
1. Export the Report Tab of the Multi-constrained Optimization window as an excel file and analyze the results.
2. In the Report Window (Pavement Management > Reports > Reports), right click on the report **Map21/Fast Act Statistics – Forecast.** Select Setup/Show Report on the right-click menu.



3. Press Filter in the Setup Standard Report pop-up window.



4. Select the appropriate Scenario and press OK.

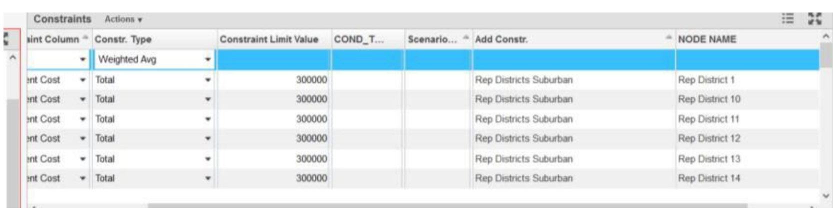


5. Select Show Report. The generated report can be downloaded in excel/csv files format to produce graphics.

9. Procedure – Suburban Streets Optimization Analysis

The Suburban Street optimization analysis is conducted in two steps. The first step involves running the analysis using Representative Districts funding for an analysis period of 10 years.

1. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), create a Scenario with **Rep Districts Suburban** as additional constraint.

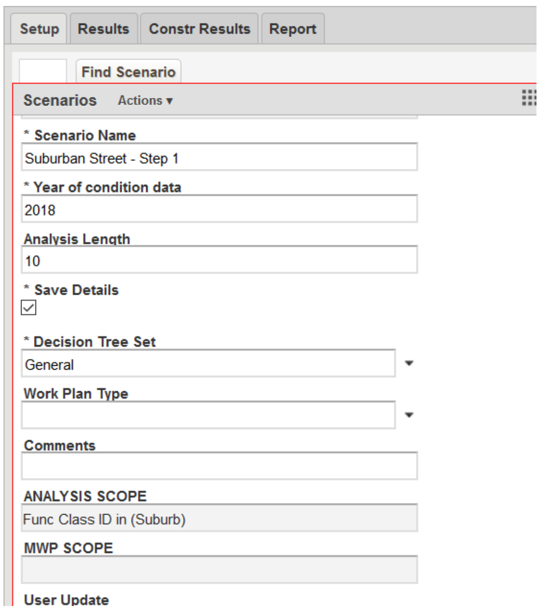


2. Allocate 300,000 to each of the 41 Representative Districts.
3. In the **Scenarios** pane, set:
    a. Analysis Length: 10
    b. Analysis scope:
        i. Functional Class: **Suburban only**

   ii. Management Section: **Normal Analysis Sections**.

  c. Analysis Type: **Multi-constraint**

4. Run the analysis.



5. Open **Master Work Programs** window (Pavement Management > Network Analysis > Configuration > Master Work Programs).
6. Insert a Work Plan Type "MWP_Rep Districts".
7. Open **Work Plan Data** (Pavement Management > Network Analysis > Work Plan Data) and Select "MWP_Rep Districts" from the dropdown menu **Select WP Type**.
8. Populate the Work Plan with the projects obtained in Step 1, using **Copy from the Analysis WP** in the right-click menu.
9. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), create another Scenario with **Senate Districts Suburban** as additional constraint.
10. Allocate 300,000 to each of the 21 Senate Districts.
11. In the **Scenarios** pane, set:

  d. Analysis Length: **10**

  e. Work Plan Type: **MWP_Rep Districts**

f. Analysis scope:
   i. Functional Class: **Suburban only**
   ii. Management Section: **Normal Analysis Sections**.
g. Analysis Type: **Multi-constraint**
h. Run the analysis.

12. See the results in Report Tab of the Multi-constrained Optimization window. Export the Report Tab as an excel file and analyze the results.

Attachment A

Delaware Department of Transportation

Pavement Data Dictionary

Version 3.0

July 2023

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
V1.0	Feb 23, 2017	Mandli Communications/ AECOM	DelDOT Staff		
V 2.0	Dec 27, 2021	The Kercher Group	DelDOT Staff		Block Cracking and Raveling were removed; Units of Measure for Transverse Cracking and Joint Reflective Cracking were changed to Counts only
V 3.0	July 26, 2023	Mott MacDonald	DelDOT Staff		Incorporating ASTM E3303 for cracking measurements

Table of Contents

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INTRODUCTION

This Pavement Data Dictionary will identify all the data items required for input into the pavement management system including distress types, severity levels and methods of measurement for automated road rating data collection for the Delaware Department of Transportation (DelDOT).

This document should be read in conjunction with DelDOT's Data Quality Management Plan (DQMP). The objective for this Data Dictionary document, together with the DQMP, is to ensure that data being delivered to support the Pavement Management program and pavement condition reporting is repeatable across multiple data collection cycles and is as independent as possible of specific vendors that are collecting the data on behalf of DelDOT. Having accurate and repeatable data ensures that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

This Data Dictionary assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used. Depending upon the capabilities of the automated data acquisition system, some of the distress/inventory data items may need to be collected/rated manually to meet the requirements of the current DelDOT distress rating protocol and DQMP.
- Data collection for each cycle shall be completed in a single data collection year.

The distress data is collected for the following pavement types:

- Asphalt Cement (AC) Pavement [Wearing Course ID, WC = 1]
- Jointed Plain Concrete Pavement (JPCP) [WC = 2]
- Composite Pavement (APC) [WC = 3]
- Surface Treated (ST) Pavement [WC = 4]
- Continuously Reinforced Concrete Pavement (CRCP) [WC = 5]

Distinction between Section & Segment Datasets

For the purposes of this document, a data collection ***segment*** refers to a length of roadway, measured in the direction of travel, measuring between 5 and 7 feet. Data collection segment lengths of 1/1000th of a mile, and 2 meters are both acceptable. DelDOT uses a segment length of 6 feet for AC, APC, ST, and CRCP pavements. For JPCP, a slab length is used as a segment length. Data collection segments should be marked for exclusion in the case of bridges, construction, lane deviations, railroads or wherever data may not be valid for any reason.

A data collection ***section*** refers to a length of roadway, measured in the direction of travel, measuring 0.1 mile; a section can be less than 0.1 mile at the end of a roadway. All the Data Elements required for the Highway Performance Monitoring System (HPMS) reporting will be either collected at the section level or collected at the segment but summarized at the section level.

As a result of the distinction above, there will be two distinct datasets delivered based on this data dictionary: a section-level dataset, and a segment-level dataset.

List of Data Items

The data to be collected on each data collection section/segment will include the individual data items listed in Table 1. The data shall be submitted in a file format with one row per data collection section/segment and the data items listed below as columns.

Table 1. Data Elements Collected for Pavement Management

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
ROUTE_ID		x	x	x	x	x		Route, Direction, Lane (From, To – placeholders only)
LANE_DIR		x	x	x	x	x		
LANE_ID		x	x	x	x	x		
DE_GIS_ROADWAY		x	x	x	x	x		GIS Route
FROM_POINT		x	x	x	x	x	NUMBER (*, 4)	From
TO_POINT		x	x	x	x	x	NUMBER (*, 4)	To
SEC_WIDTH		x	x	x	x	x	NUMBER (*,2)	Section Width
LENGTH_DMI	ft.	x	x	x	x	x	NUMBER (*, 2)	Interval Length
LENGTH_SHP	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of road segment
WC_ID		x	x	x	x	x	INTEGER	Wearing Course as identified during rating
VEHICLE_NAME		x	x	x	x	x	STRING	Vehicle Name
DATE_RATED		x	x	x	x	x	DATE	Date Rated
CRCK_LENGTH	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Cracking (including failed/open sealed cracks)
CRCK_LENGTH_S	ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Sealed Cracking (excluding failed/open sealed cracks)
INTERVAL_AREA	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of analysis segment | Area of Slab
CRCK_WIDTH	Inch	x	x	x	x	x	NUMBER (*, 4)	Width of Cracking
CRKD	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density (Crack Length / Interval Area)
CRKD_S	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of Sealed Cracks (excluding failed/open sealed cracks)
CRKD_L	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of cracks having width <= 0.25"
CRKD_H	ft. / Sq. ft.	x	x	x	x	x	NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM	%	x	x	x	x	x	NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) *100 (excluding sealed cracks)
CRCK_LEN_Z1	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Edge / Zone 1 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z1	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 1 (excluding failed/open sealed cracks)
AREA_Z1	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Left Edge / Zone 1
CRCK_WID_Z1	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Left Edge / Zone 1
CRKD_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 1
CRKD_S_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 1 (excluding failed/open sealed cracks)
CRKD_L_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 1
CRKD_H_Z1	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z1	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 1 (excluding sealed cracks)
CRCK_LEN_Z2	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 2 (including failed/open sealed cracks)
CRCK_LENGTH_S_Z2	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 2 (excluding failed/open sealed cracks)
AREA_Z2	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Left Wheel Path - Zone 2
CRCK_WID_Z2	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Left Wheel Path / Zone 2
CRKD_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 2
CRKD_S_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 2 (excluding failed/open sealed cracks)
CRKD_L_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 2
CRKD_H_Z2	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z2	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 2 (excluding sealed cracks)
CRCK_LEN_Z3	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 3 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z3	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 3 (excluding failed/open sealed cracks)
AREA_Z3	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Center / Zone 3
CRCK_WID_Z3	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Center / Zone 3
CRKD_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 3
CRKD_S_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 3 (excluding failed/open sealed cracks)
CRKD_L_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 3
CRKD_H_Z3	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z3	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 3 (excluding sealed cracks)
CRCK_LEN_Z4	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 4 (including failed/open sealed cracks)
CRCK_LENGTH_S_Z4	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 4 (excluding failed/open sealed cracks)
AREA_Z4	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Right Wheel Path / Zone 4
CRCK_WID_Z4	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Right Wheel Path / Zone 4
CRKD_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 4
CRKD_S_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 4 (excluding failed/open sealed cracks)
CRKD_L_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 4
CRKD_H_Z4	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z4	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 4 (excluding sealed cracks)
CRCK_LEN_Z5	ft.	x	x	x			NUMBER (*, 2)	Length of Cracking - Left Wheel Path / Zone 5 (including failed/open sealed cracks)

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CRCK_LENGTH_S_Z5	ft.	x	x	x			NUMBER (*, 2)	Length of Sealed Cracking - Zone 5 (excluding failed/open sealed cracks)
AREA_Z5	Sq. ft.	x	x	x			NUMBER (*, 2)	Area of Analysis - Right Edge / Zone 5
CRCK_WID_Z5	Inch	x	x	x			NUMBER (*, 4)	Weighted Average Width of Cracking - Right Edge / Zone 5
CRKD_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density (Crack Length / Interval Area) - Zone 5
CRKD_S_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of Sealed Cracks - Zone 4 (excluding failed/open sealed cracks)
CRKD_L_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width <= 0.25" - Zone 5
CRKD_H_Z5	ft. / Sq. ft.	x	x	x			NUMBER (*, 4)	Crack Density of cracks having width > 0.25"
PSCM_Z5	%	x	x	x			NUMBER (*, 2)	ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) - Zone 5 (excluding sealed cracks)
DE_BLEEDING_HI_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - High
DE_BLEEDING_LOW_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - Low
DE_BLEEDING_MED_SF	Sq. ft.			x			NUMBER (*, 2)	Area of Bleeding - Medium
DE_FAULTING_RWP_IN	Inches				x		NUMBER (*, 2)	Average Fault Height - Right Wheel Path
DE_JOINT_DET	Text				x		STRING	"None" if no spalling, otherwise "Low", "Med" or "High" (Starting Joint)
DE_JNT_SEAL_DAMAGE	Text				x		STRING	"None" if no seal damage, otherwise "Low" or "High" (Starting Joint)
DE_PATCH_DET_HI_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - High
DE_PATCH_DET_LOW_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - Low
DE_PATCH_DET_MED_SF	Sq. ft.	x	x	x	x	x	NUMBER (*, 2)	Area of Patch Deterioration / Potholes - Medium
DE_ROUGH_CROWN_LF	Linear ft.			x			NUMBER (*,1)	Length of Crown Slope / Cross Slope
DE_RUT_LWP_AVG_IN	Inches	x	x	x			NUMBER (*, 2)	Average Rutting - Left Wheel Path
DE_RUT_RWP_AVG_IN	Inches	x	x	x			NUMBER (*, 2)	Average Rutting - Right Wheel Path
DE_RUT_LWP_HI_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of High Severity Rutting - Left Wheel Path
DE_RUT_LWP_LOW_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Low Severity Rutting - Left Wheel Path

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
DE_RUT_LWP_MED_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Med Severity Rutting - Left Wheel Path
DE_RUT_LWP_MAX_IN	Inches	x	x	x			NUMBER (*, 2)	Maximum Rutting - Left Wheel Path
DE_RUT_RWP_MAX_IN	Inches	x	x	x			NUMBER (*, 2)	Maximum Rutting - Right Wheel Path
DE_RUT_RWP_HI_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of High Severity Rutting - Right Wheel Path
DE_RUT_RWP_LOW_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Low Severity Rutting - Right Wheel Path
DE_RUT_RWP_MED_LF	Linear ft.	x	x	x			NUMBER (*,1)	Extent of Med Severity Rutting - Right Wheel Path
DE_IRI_LWP_INCH_MILE	Inches/Mile	x	x	x	x	x	NUMBER (*, 2)	Average International Roughness Index - Left Wheel Path
DE_IRI_RWP_INCH_MILE	Inches/Mile	x	x	x	x	x	NUMBER (*, 2)	Average International Roughness Index - Right Wheel Path
DE_JNT_SPACING_LF	Linear ft.				x	x	NUMBER (*,1)	Average Joint Spacing
DE_ASR_CNT	Count				x	x	INTEGER	Count of Map Cracking / Alkali-Silica Reactivity
DE_SLAB_CRACK	Text				x	x	STRING	"None" if no cracking, otherwise "Low", "Med" or "High".
DE_TRAN_CRK_JPCP_YN	Boolean				x		INTEGER	Transverse Cracking on JPCP: 1 if transverse cracking with length > 5ft is present, otherwise 0.
DE_LONG_CRK_CRCP_LF	Linear ft.					x	NUMBER (*,1)	Length of Longitudinal Cracking on CRCP
DE_PUNCHOUT_SF	Sq. ft.					x	NUMBER (*, 2)	Area of Punchouts for CRCP Pavements
BEGIN_LAT	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Latitude at start of segment in decimal degrees (WGS84)
BEGIN_LONG	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Longitude at start of segment in decimal degrees (WGS84)
BEGIN_ALT	Feet	x	x	x	x	x	NUMBER (*,1)	Mean Sea Level (MSL) altitude at start of segment
END_LAT	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Latitude at end of segment in decimal degrees (WGS84)
END_LONG	Decimal Degrees	x	x	x	x	x	NUMBER (12,8)	Longitude at end of segment in decimal degrees (WGS84)
END_ALT	Feet	x	x	x	x	x	NUMBER (*,1)	Mean Sea Level (MSL) altitude at end of segment
BRIDGE		x	x	x	x	x	INTEGER	
BRIDGE_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Bridge within road segment

Field Name	Units	Pavement Type					Data Type	Description
		AC	APC	ST	JPCP	CRCP		
CONSTRUCTION		x	x	x	x	x	INTEGER	
CONSTRUCTION_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Construction within road segment
LANE_DEVIATION		x	x	x	x	x	INTEGER	
LANE_DEVIATION_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Lane Deviation within road segment
RAILROAD		x	x	x	x	x	INTEGER	
RAILROAD_LENGTH	Linear ft.	x	x	x	x	x	NUMBER (*, 2)	Length of Railroad within road segment
GRADE_PERCENT	Percentage	x	x	x	x	x	NUMBER(*,1)	Average grade for the road segment
GRADE_CLASS	Text	x	x	x	x	x	STRING	HPMS Grade Classification
CURVE_DEGREE	Decimal Degrees	x	x	x	x	x	NUMBER(*,1)	Degree of curvature per 100ft
CURVE_CLASS	Text	x	x	x	x	x	STRING	HPMS Curvature Classification

DATA ITEMS

In this section, the data elements shown in *Table 1* are explained further.

Inventory Data Items

The following items are applicable to data collected for **both the section and segment level datasets**. They comprise of data items which help in identifying a section/segment. These items shall be reported as follows:

ROUTE_ID

Description: Unique Identifier for each Route

Use: For identifying the section/segment for which data is being reported

Data Type: INTEGER

Detection Method: Populated from shapefile.

LANE_DIR

Description: Indicates the directionality of the event

Use: For identifying the section/segment for which data is being reported

Data Type: INTEGER

Detection Method: Populated from shapefile.

LANE_ID

Description: Unique Lane number numbered according to convention

Use: For identifying the surveyed lane on the section/segment

Data Type: INTEGER

Detection Method: Populated from shapefile.

FROM_POINT

Description: Begin measure of the route

Use: For identifying the section/segment for which data is being reported

Data Type: NUMBER (22,3)

Detection Method: Automated shapefile matching.

TO_POINT

Description: End measure of the route

Use: For identifying the section/segment for which data is being reported

Data Type: NUMBER (22,3)

Detection Method: Automated shapefile matching.

SEC_WIDTH

Description: The measured width in feet of a given section measured from the edge of the pavement to the edge of the pavement.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2)

Detection Method: Automated

LENGTH_DMI

Description: Interval Length - the measured length of segment in feet OR the measured length of section in miles.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2) for segment, Numeric (*, 3) for section.

Unit of Measure: Feet for segment, Mile for Section.

Detection Method: Automated using Distance Measurement Instrument (DMI).

LENGTH_SHP

Description: Length of road segment in feet.

Use: For use in treatment cost calculation and pavement analysis.

Data Type: Numeric (*, 2) for segment, Numeric (*, 3) for section.

Unit of Measure: Feet for segment, Mile for Section.

Detection Method: Automated shapefile matching.

WC_ID

Description: Wearing Course (WC) as identified during rating.

Use: Important Inventory data to identify section/segment. Used in decision matrix.

Data Type: INTEGER

- WC_ID = 1 for AC pavements
- WC_ID = 2 for JPCP pavements
- WC_ID = 3 for APC
- WC_ID = 4 for ST
- WC_ID = 5 for CRCP

Detection Method: Manual/Automated

VEHICLE_NAME

Description: Name of the Vehicle used to collect automated distress data.

Use: To be used during QA/QC of the automated distress data.

Data Type: STRING

Detection Method: Manual/Automated

DATE_RATED

Description: The date on which the data is being collected for reported segment/section.

Use: For identifying the data collection date.

Data Type: Date (MM/DD/YYYY HH24:MI:SS)

Detection Method: Automated

BEGIN_LAT

Description: Latitude at the start of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

BEGIN_LONG

Description: Longitude at the start of segment in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

BEGIN_ALT

Description: Mean Sea Level (MSL) altitude in feet at the start of segment.

Use: For identifying the segment/section for which data is being reported.

Data Type: NUMBER (*,1)

Detection Method: Automated

END_LAT

Description: Latitude at the end of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

END_LONG

Description: Longitude at the end of segment/section in decimal degrees (WGS84)

Use: For accurately identifying the segment/section for which data is being reported.

Data Type: NUMBER (12,8)

Detection Method: Automated

END_ALT

Description: Mean Sea Level (MSL) altitude in feet at the end of segment.

Use: For identifying the segment/section for which data is being reported.

Data Type: NUMBER (*,1)

Detection Method: Automated

BRIDGE

Description: Bridge Flag (Yes/No).

Use: For identifying and marking the segment/section with a bridge for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

BRIDGE_LENGTH

Description: Length of the bridge in feet within a section/segment.

Use: For identifying and marking the segment/section with a bridge for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

CONSTRUCTION

Description: Construction Activity Flag (Yes/No).

Use: For identifying and marking the segment/section with an on-going construction for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

CONSTRUCTION_LENGTH

Description: Length of the on-going construction activity in feet within a section/segment.

Use: For identifying and marking the segment/section with an on-going construction for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

LANE_DEVIATION

Description: Lane Deviation Flag (Yes/No).

Use: For identifying the segment/section where the automated vehicle had to deviate from the lane due to different reasons.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

LANE_DEVIATION_LENGTH

Description: Length of the lane deviation in feet within a section/segment.

Use: For identifying and marking the segment/section with lane deviation for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

RAILROAD

Description: Railroad Crossing Flag (Yes/No).

Use: For identifying and marking the segment/section with a railroad crossing for exclusion.

Data Type: INTEGER (1/0)

Detection Method: Manual/Automated

RAILROAD_LENGTH

Description: The length of the railroad crossing in feet within a section/segment.

Use: For identifying and marking the segment/section with a railroad crossing for exclusion.

Data Type: NUMBER (*,2)

Detection Method: Automated

Segment-Level Distress Data Items

The following items are applicable to data collected **only for the segment level dataset**. These items shall be reported as follows:

DE_BLEEDING_LOW_SF

Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glasslike, or reflective surface.

Description: Area of Low Severity Bleeding (*Figure 1*)

Use: To be used in calculating Overall Pavement Index (OPC) and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

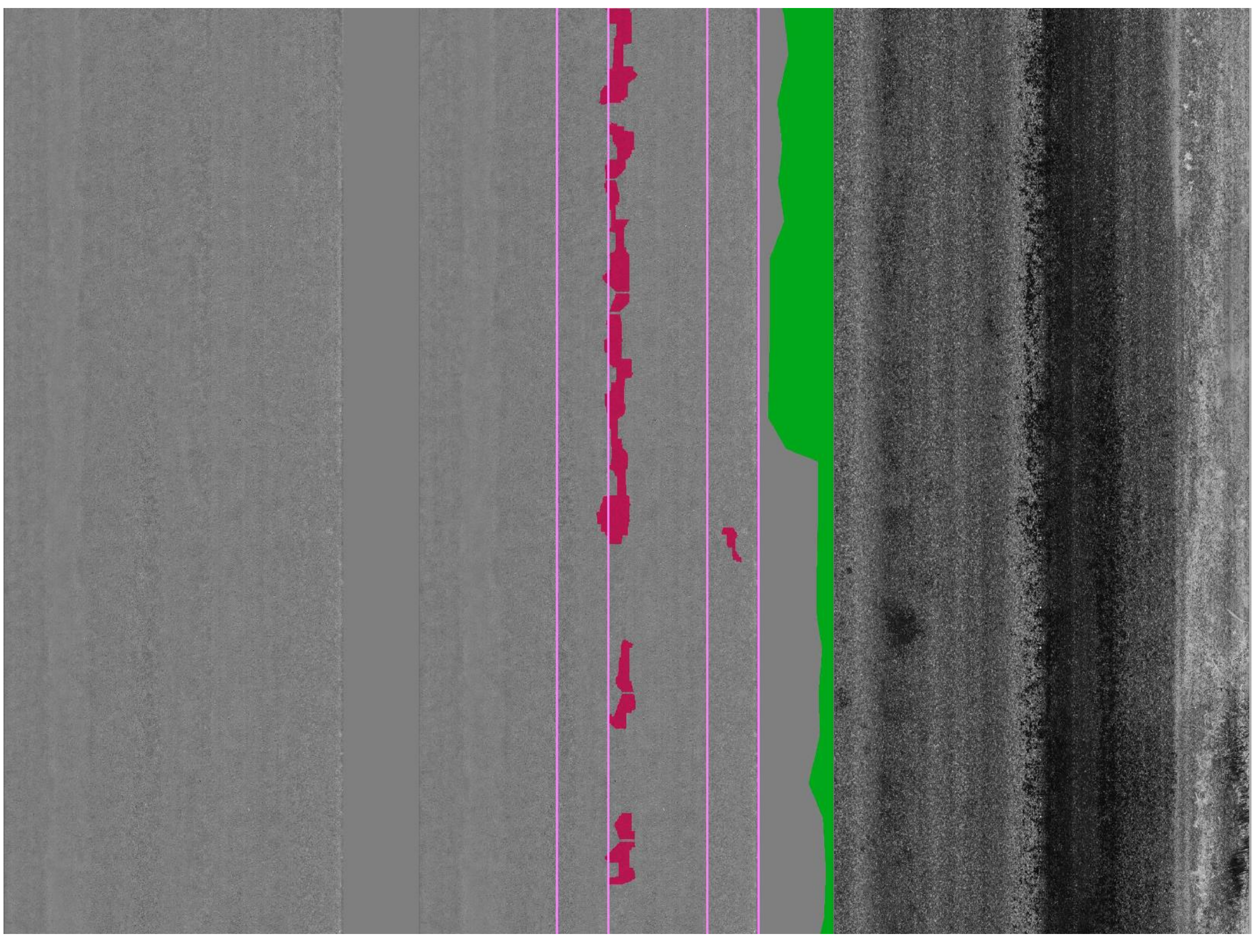

Figure 1. Pavement area discolored by excess asphalt binder.

DE_BLEEDING_MED_SF

Description: Area of Medium Severity Bleeding (*Figure 2*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

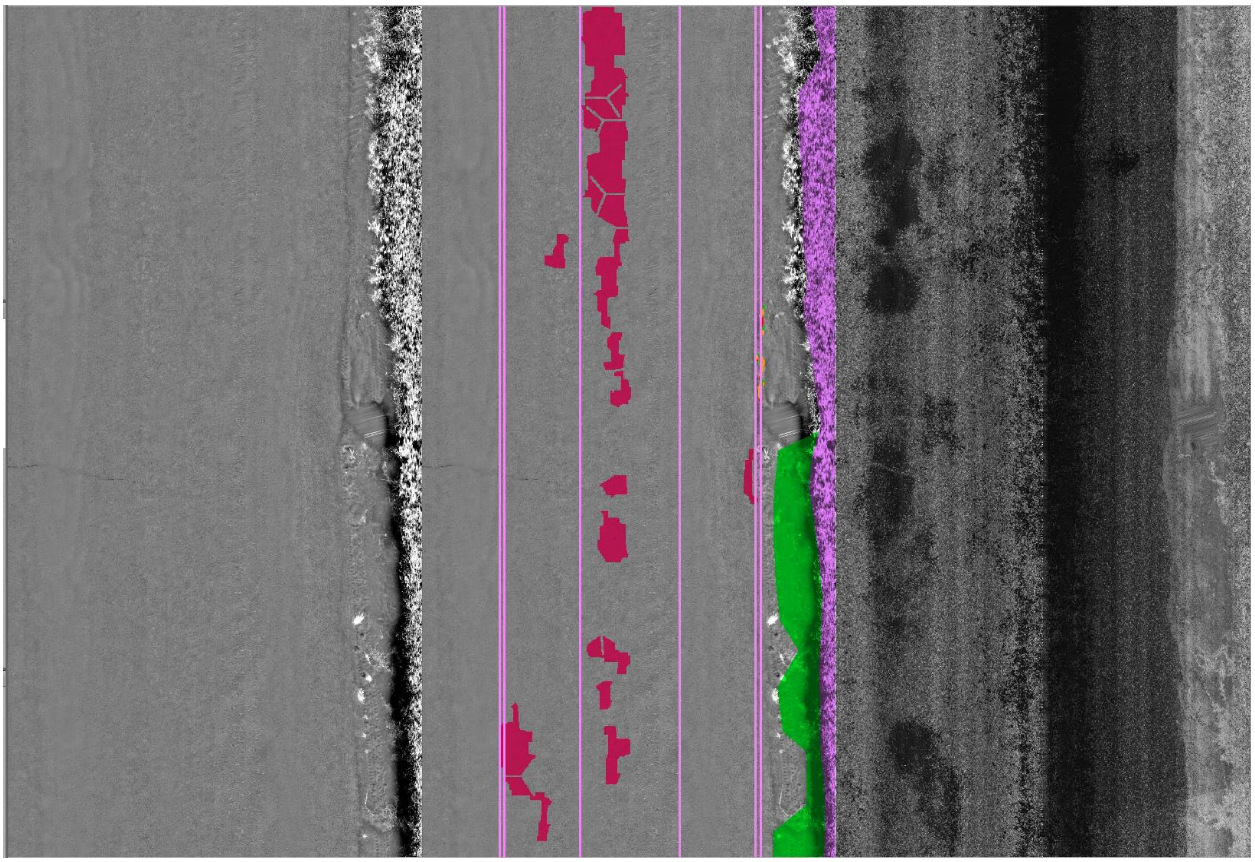

Figure 2. Pavement area begins to lose surface texture due to excessive asphalt binder at the surface.

DE_BLEEDING_HI_SF

Description: Area of Medium Severity Bleeding (*Figure 3*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

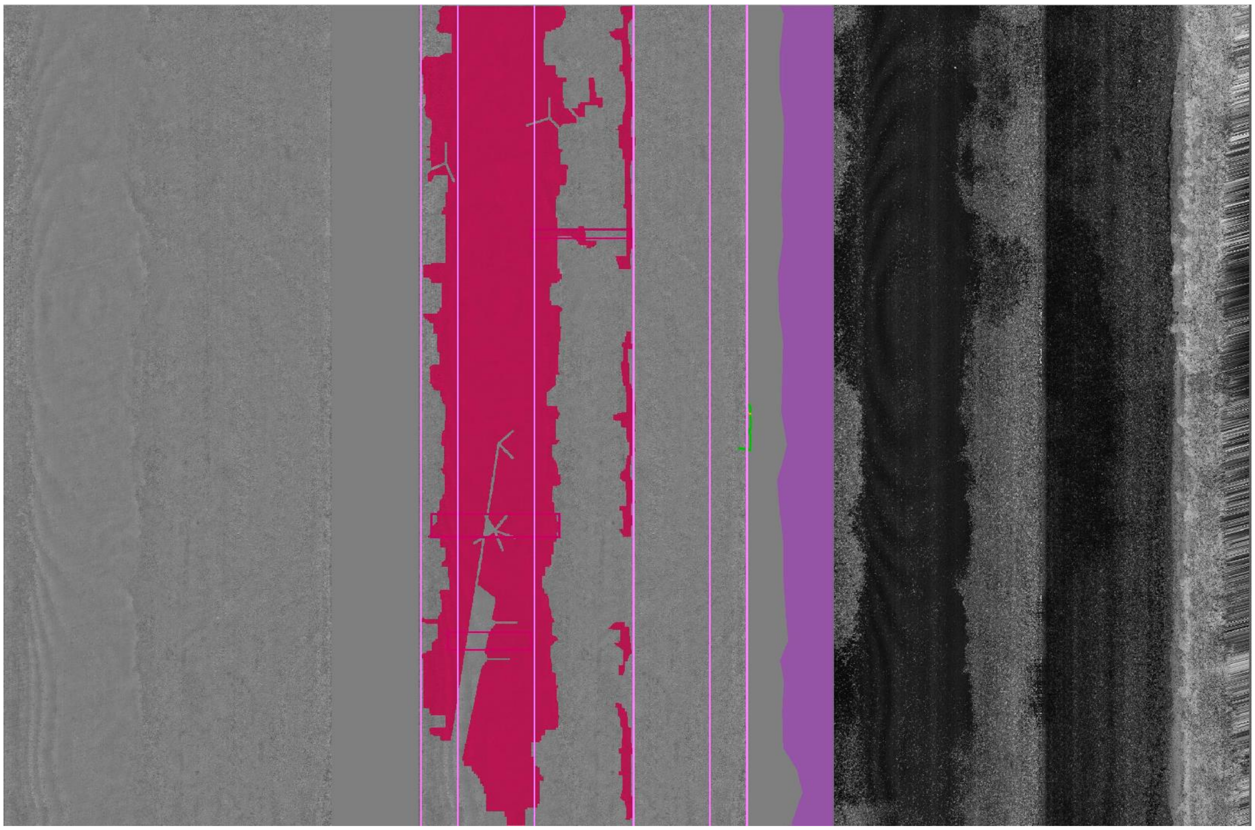

Figure 3. Excessive asphalt cement at the pavement surface conceals aggregates under a shiny surface.

DE_PATCH_DET_LOW_SF

A patch is an area of pavement that has been replaced by a filler material. A patch is considered a defect no matter its condition. All patches are rated at least at a low-severity level. Distresses within the patch are not rated independently. For PCC pavements, any full-width patch is considered a slab and not a patch.

Description: Area of Low Severity Patch Deterioration / Potholes (*Figure 4* & *Figure 5*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

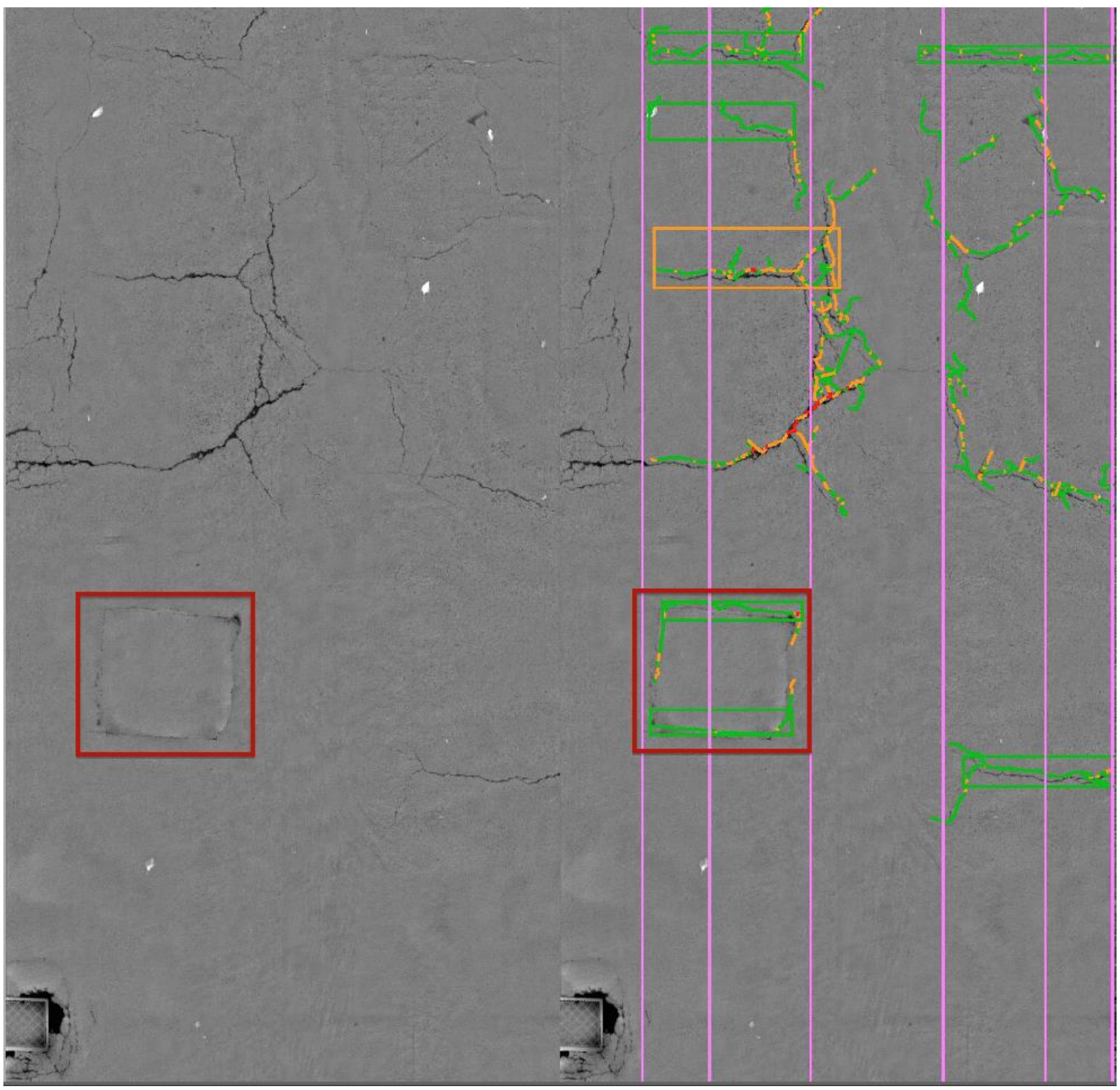

Figure 4. AC – Low Severity Patches show few defects and are usually smooth and new with uniform boundaries.

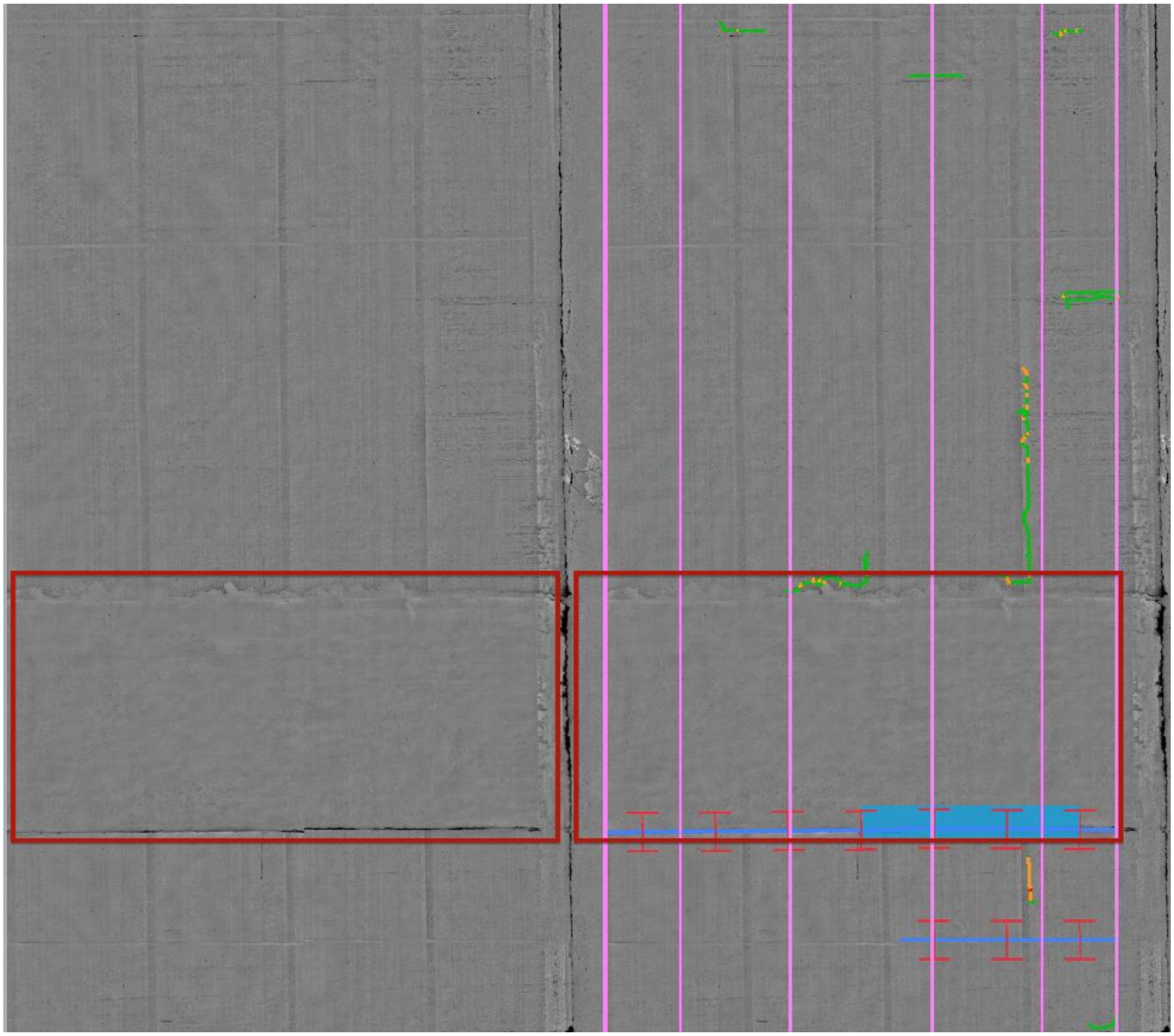

Figure 5. PCC – Low Severity Patches show few defects and are usually smooth and new with uniform boundaries.

DE_PATCH_DET_MED_SF

Description: Area of Medium Severity Patch Deterioration / Potholes (*Figure 6* & *Figure 7*)

Use: To be used in calculating Overall Pavement Index and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

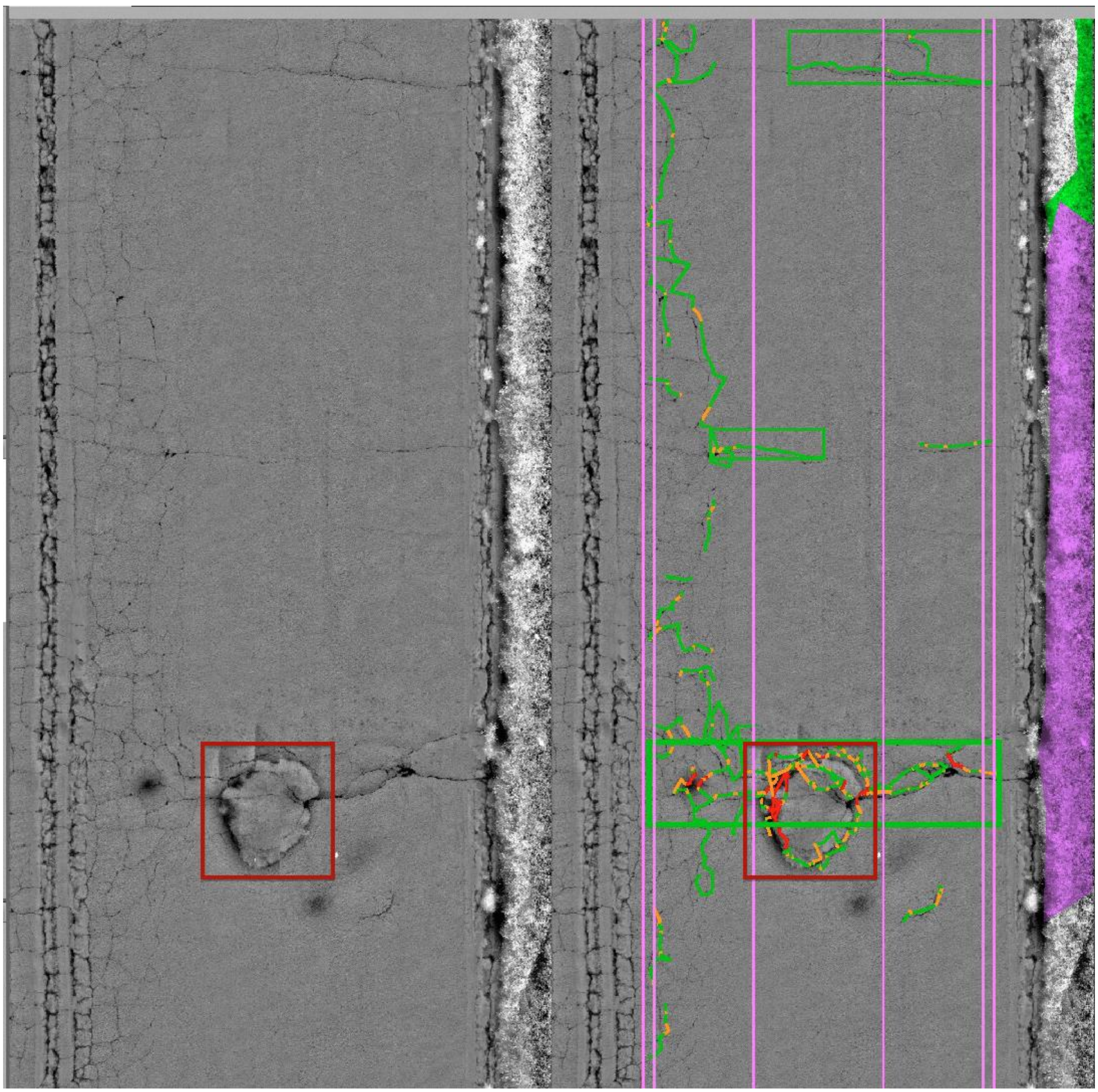

Figure 6. AC – Medium Severity Patches display medium severity defects and may have jagged edges with some distress or cracks present.

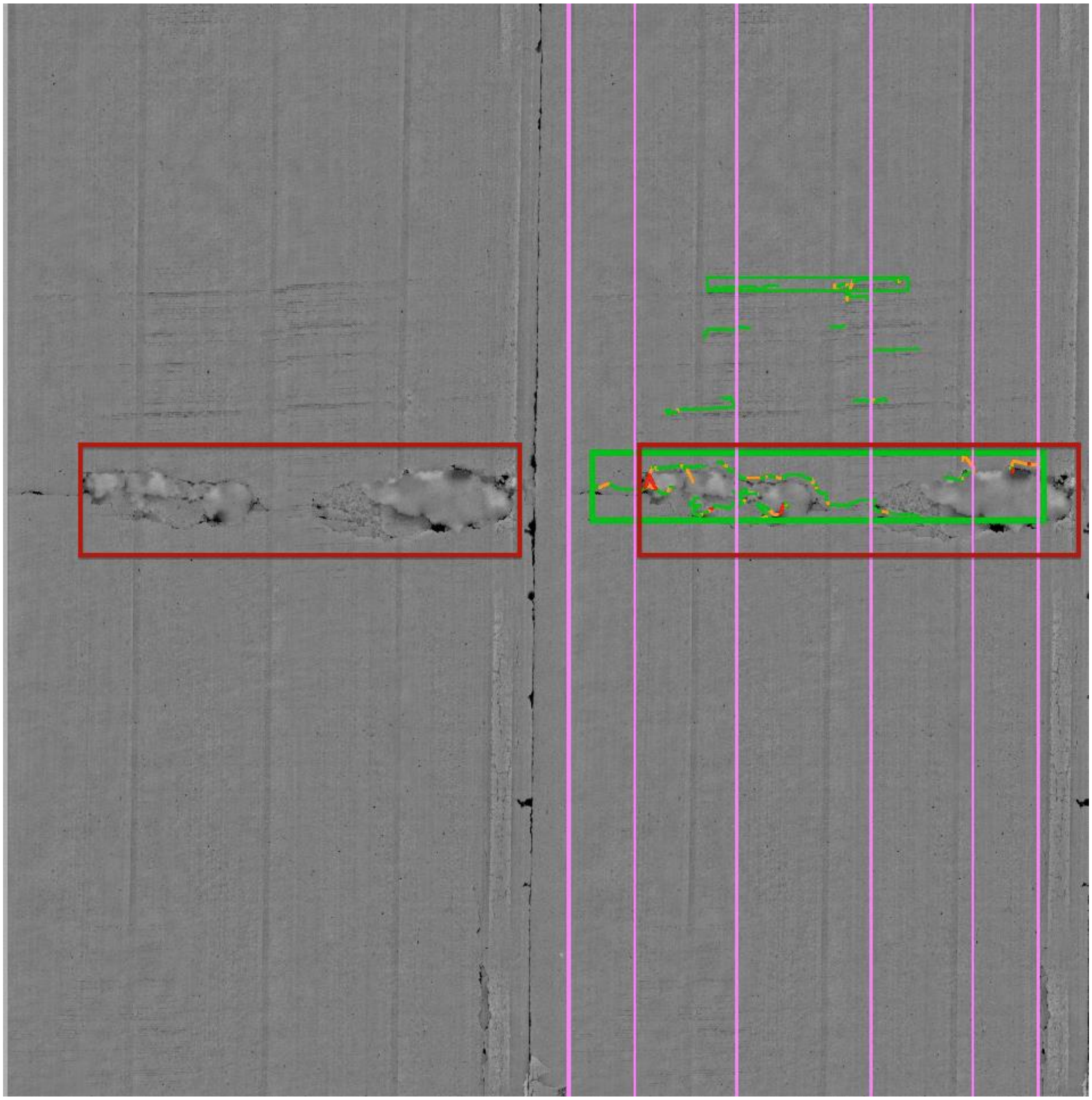

Figure 7. PCC – Medium Severity Patches display medium severity defects and may have jagged edges with some distress or cracks present. Any AC patch found with no defects or low severity defects will be considered a medium severity PCC patch.

DE_PATCH_DET_HI_SF

Description: Area of High Severity Patch Deterioration / Potholes (*Figure 8* & *Figure 9*)

Use: To be used in calculating Overall Pavement Index and treatment selection.

Pavement Type: All

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

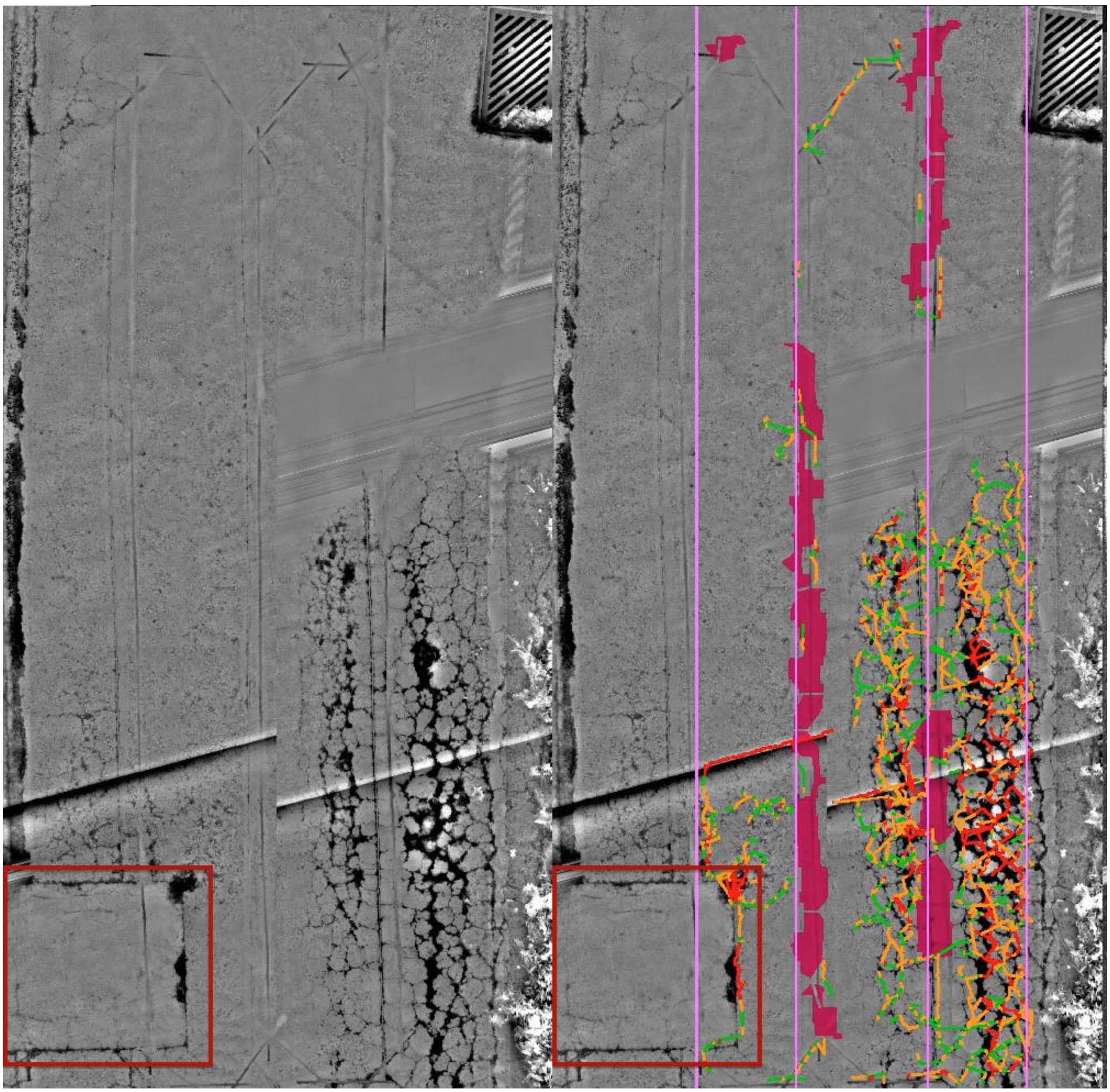

Figure 8. AC - High Severity Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any pothole is considered high severity patch deterioration.

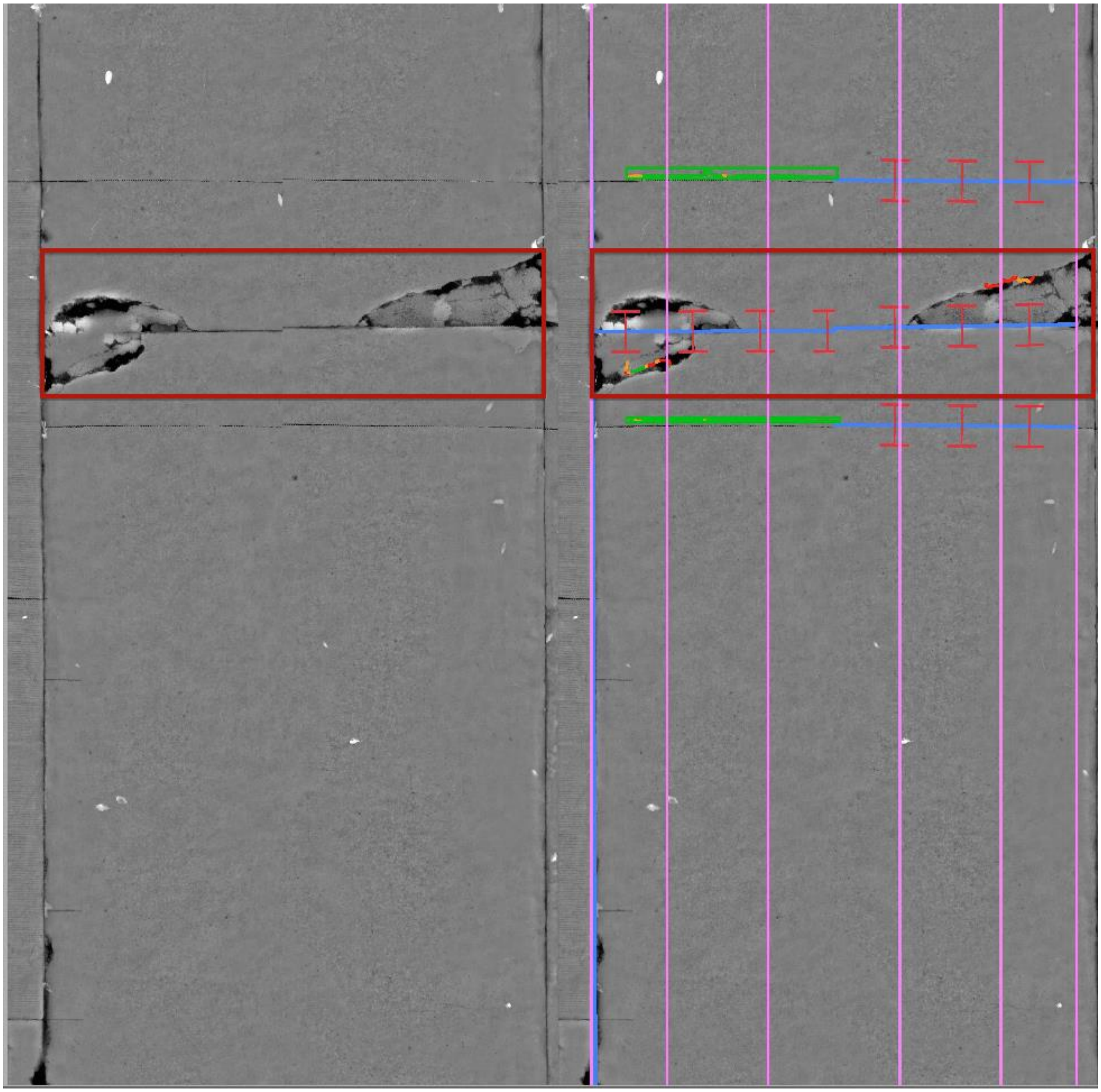

Figure 9. PCC - High Severity Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any AC patch found with medium or high severity distress is considered a high severity PCC patch.

DE_JOINT_DET

Joint Deterioration (Spalling) is the breakdown of a slab adjacent to the joint edge anywhere along the length of the joint. The spall usually does not extend vertically through the slab but intersects the joint at an angle.

Description: Severity of the Deteriorated (Spalled) Starting[1] Joint (*Figure 10*, *Figure 11* & *Figure 12*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, Med, High)

Data Type: STRING

Detection Method: Manual/Automated

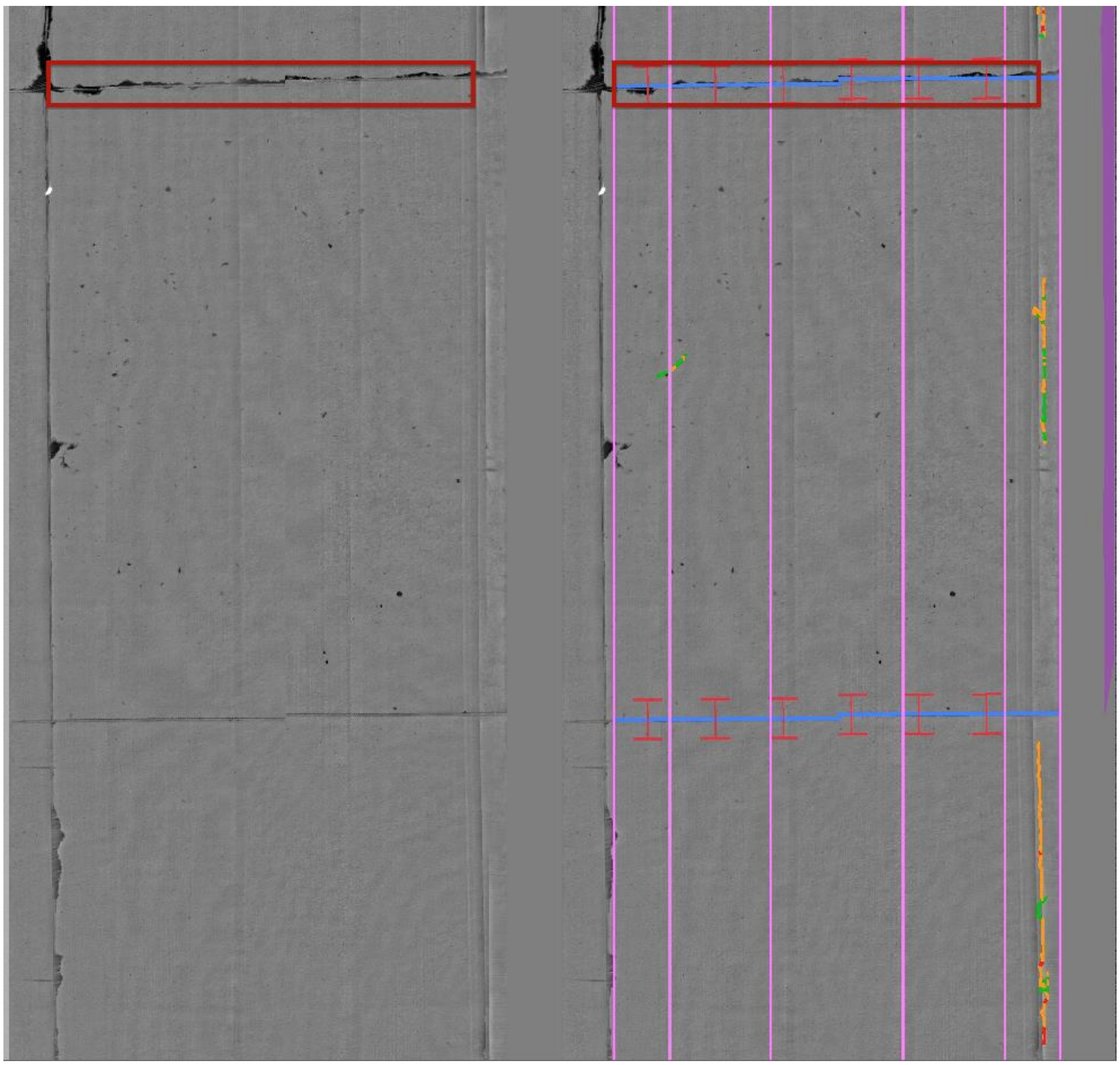

Figure 10. Low-severity joint deterioration is characterized by spalls less than 3 inches wide with no significant loss of material. Single cracks in the corner of the slab will be counted toward cracking.

[1] Segment level data for PCC pavements is collected for each slab. Approaching or Starting Joint is the 1st of the two joints on a slab in the survey direction.

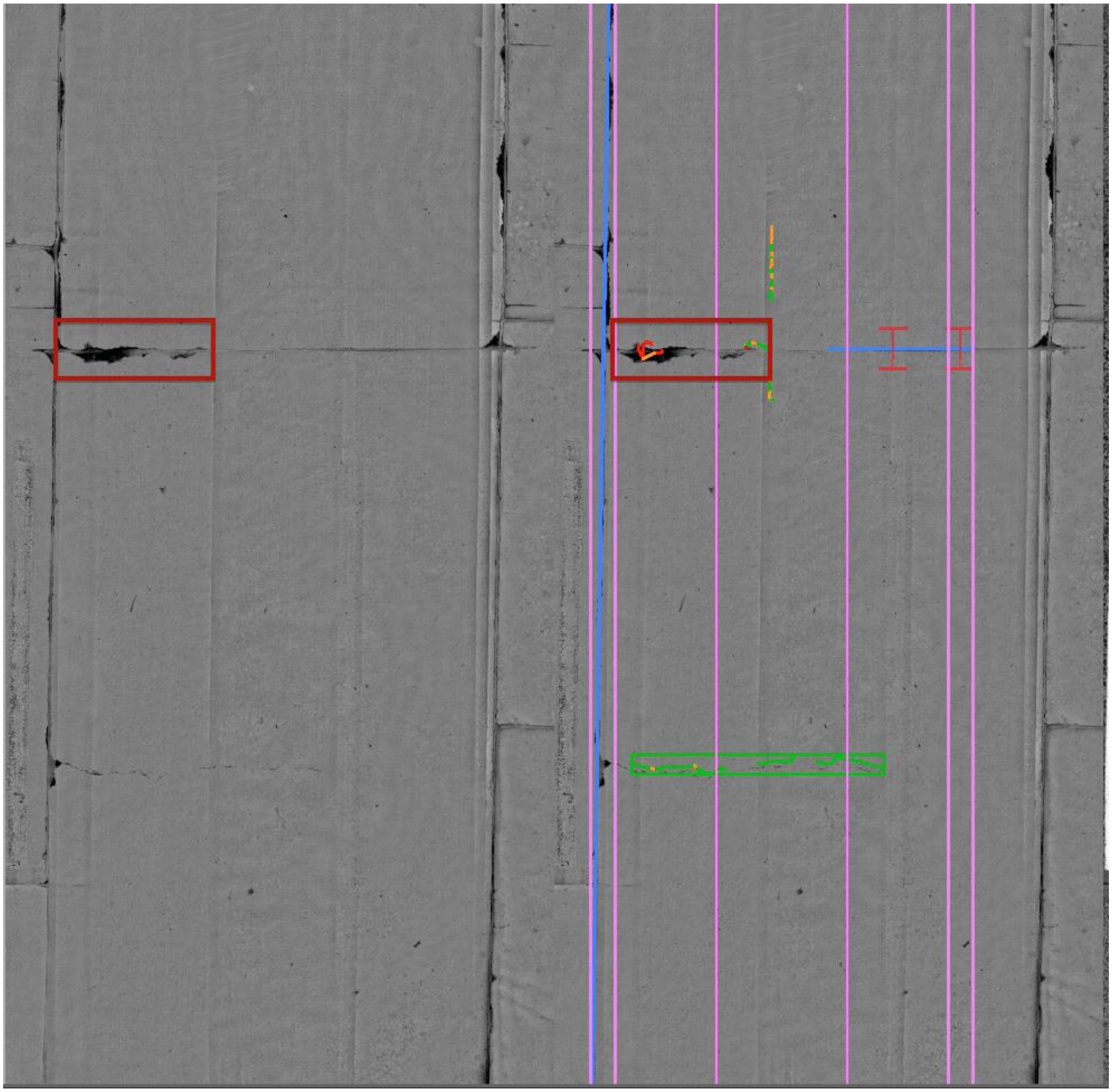

Figure 11. Medium-severity joint deterioration is characterized Spalls 3 to 6 inches wide with a loss of material are evident in medium-severity joint spalling.

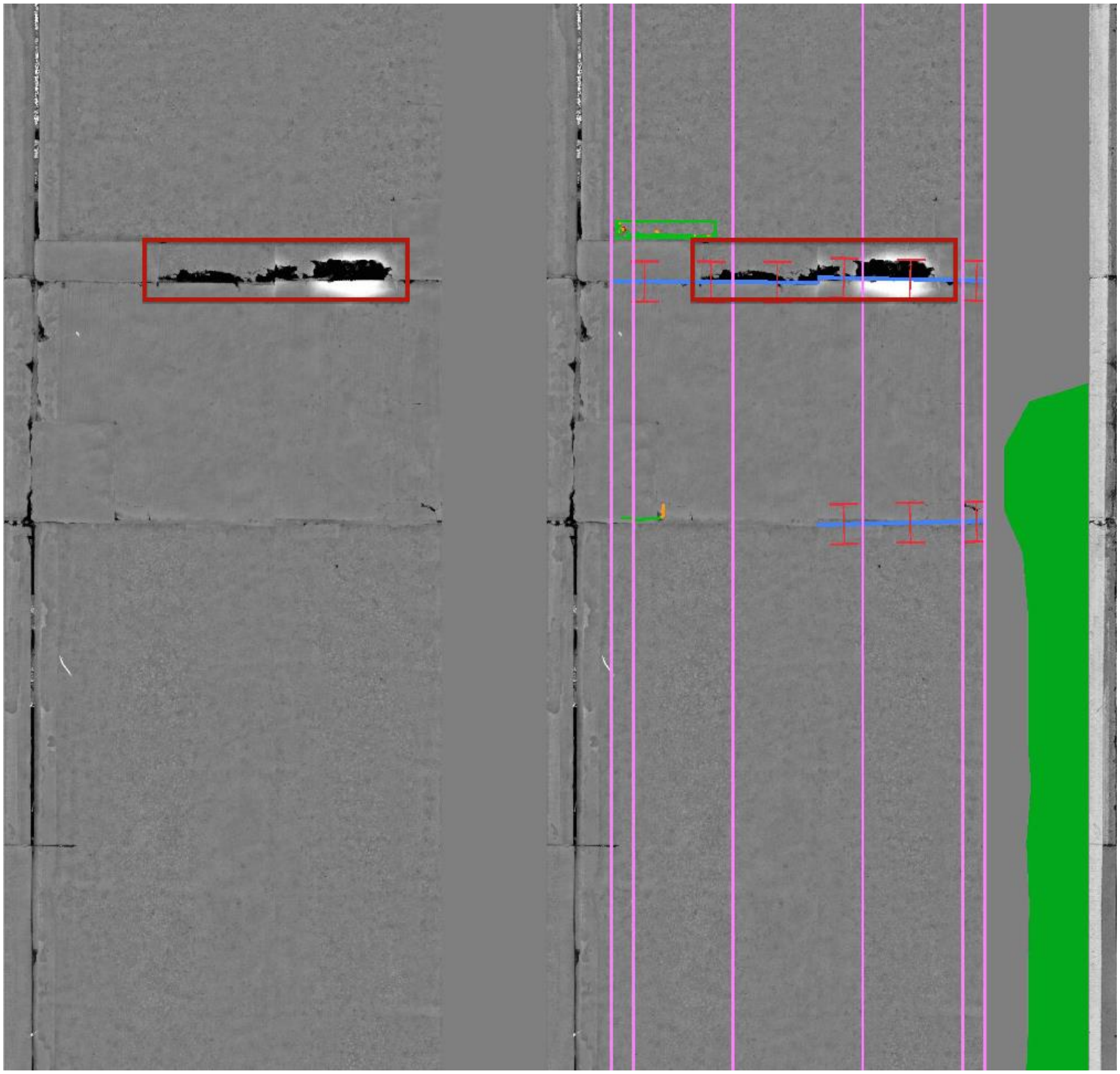

Figure 12. High-severity joint spalls exceed 6 inches wide and show a significant loss of material.

DE_JNT_SEAL_DAMAGE

Joint Seal Damage is any joint seal condition that enables incompressible materials to accumulate in PCC joints and allows water infiltration. Joint seal damage types include joint sealant stripping or extrusion, weed growth, hardening of the filler (oxidation), bond loss, and lack or absence of sealant in the joint.

Description: Severity of the Deteriorated (Spalled) Starting Joint (*Figure 13* & *Figure 14*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, High)

Data Type: STRING

Detection Method: Manual/Automated

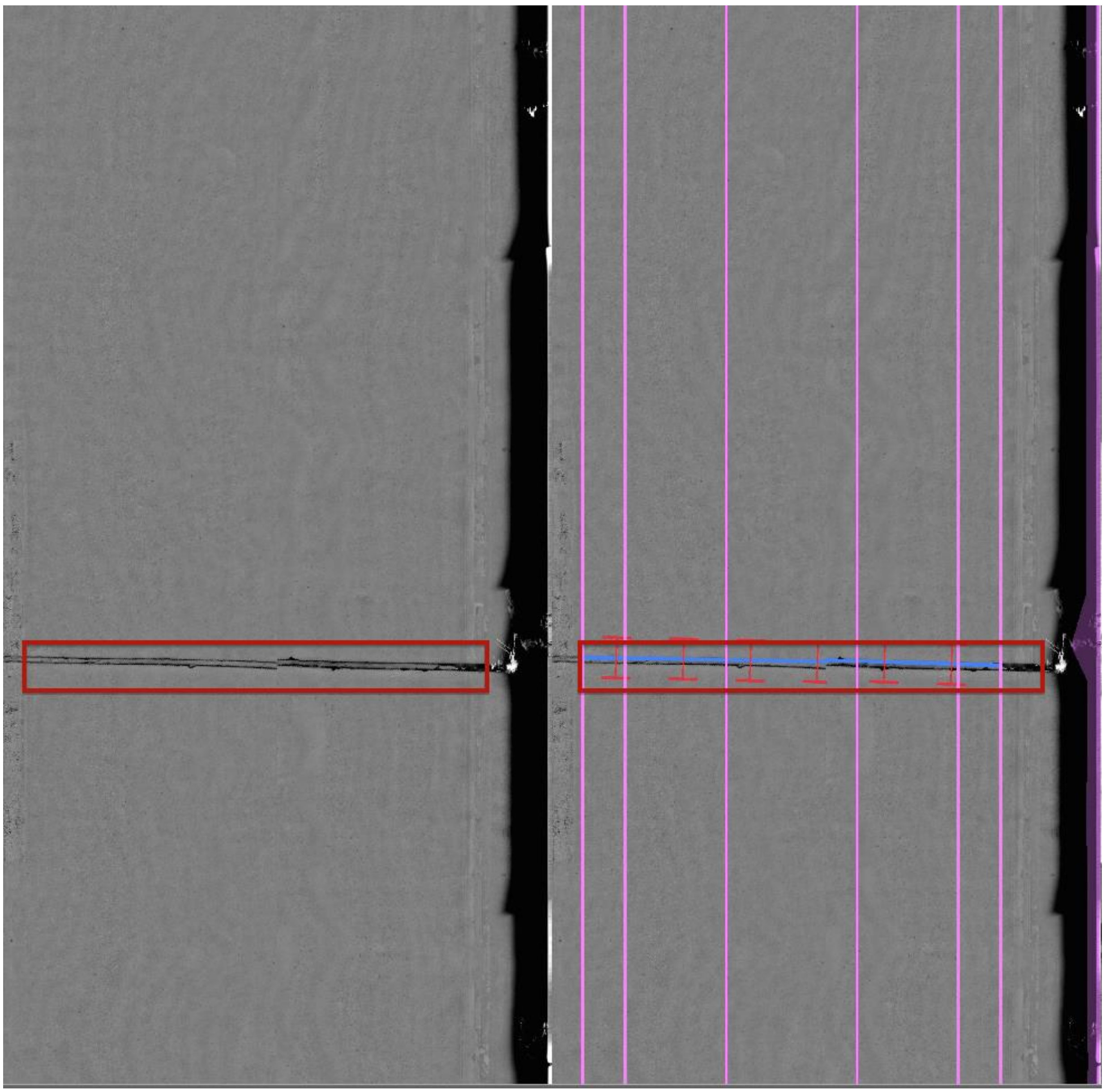

Figure 13. Low-Severity Joint Seal Damage is characterized by less than 10% loss of joint sealant.

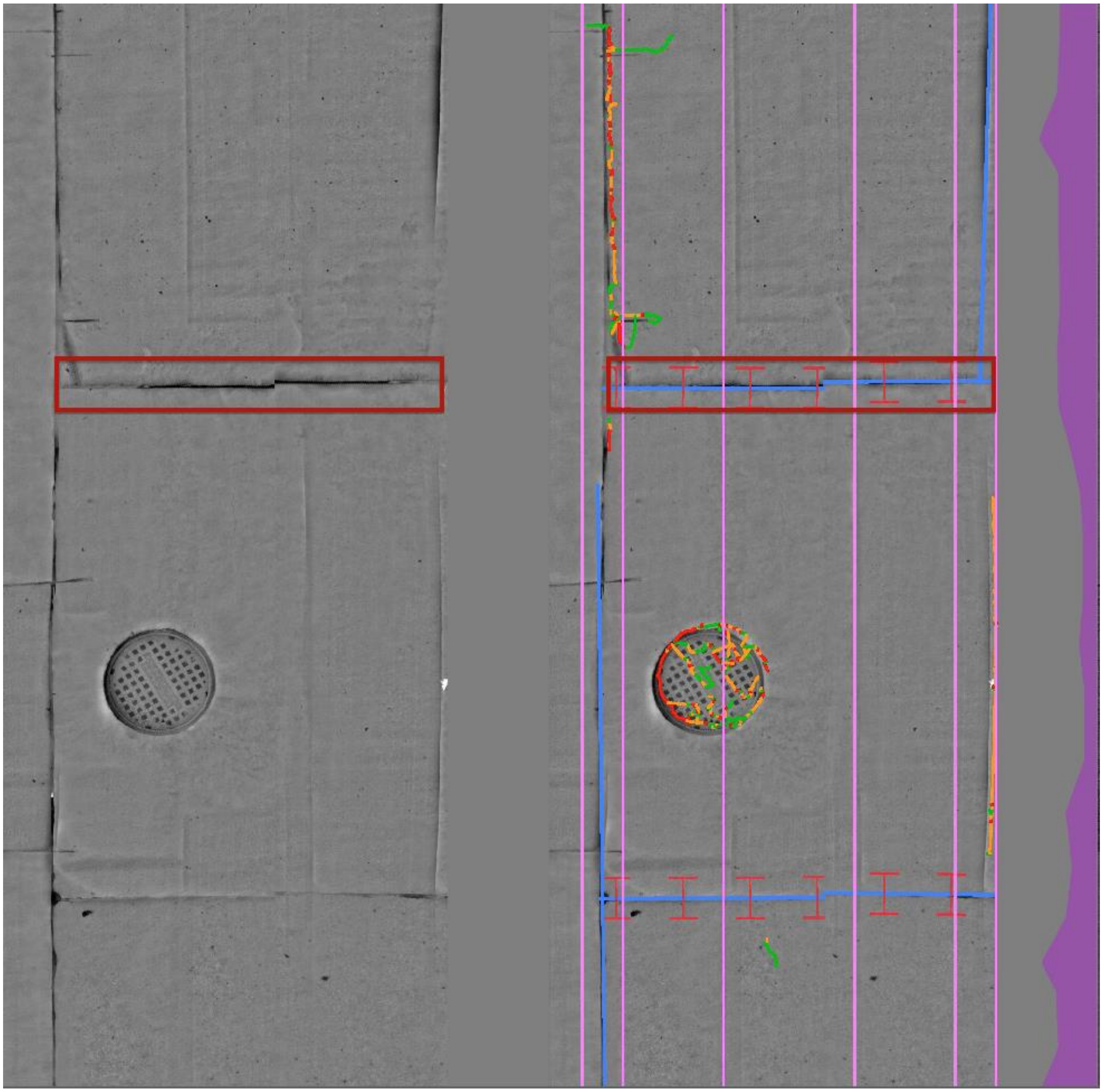

Figure 14. High-Severity Joint Seal Damage is characterized by more than 10% loss of joint sealant.

DE_SLAB_CRACK

Slab cracking encompasses both transverse and longitudinal cracking on PCC slabs. The highest severity crack defines the severity level of the slab. If a slab is broken into three or more pieces, the severity level is increased.

Description: Severity of the Slab Cracking (*Figure 15*, *Figure 16* & *Figure 17*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Text (None, Low, Med, High)

Data Type: STRING

Detection Method: Manual/Automated

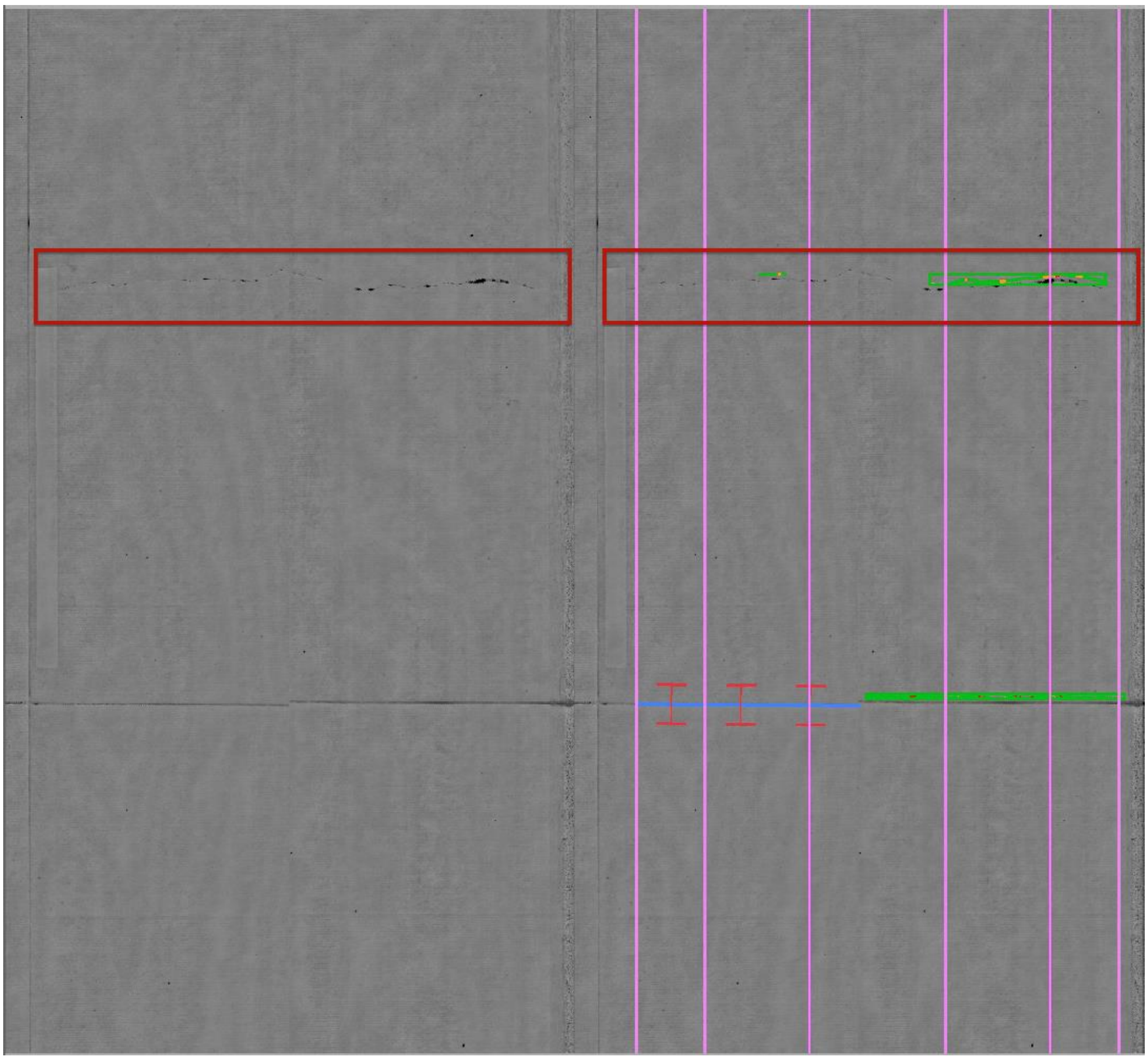

Figure 15. Low-severity slab cracking is characterized by cracks with widths less than ¼-inch or sealed cracks in good condition. If the cracks create three or more pieces, the severity level is increased by one severity level.

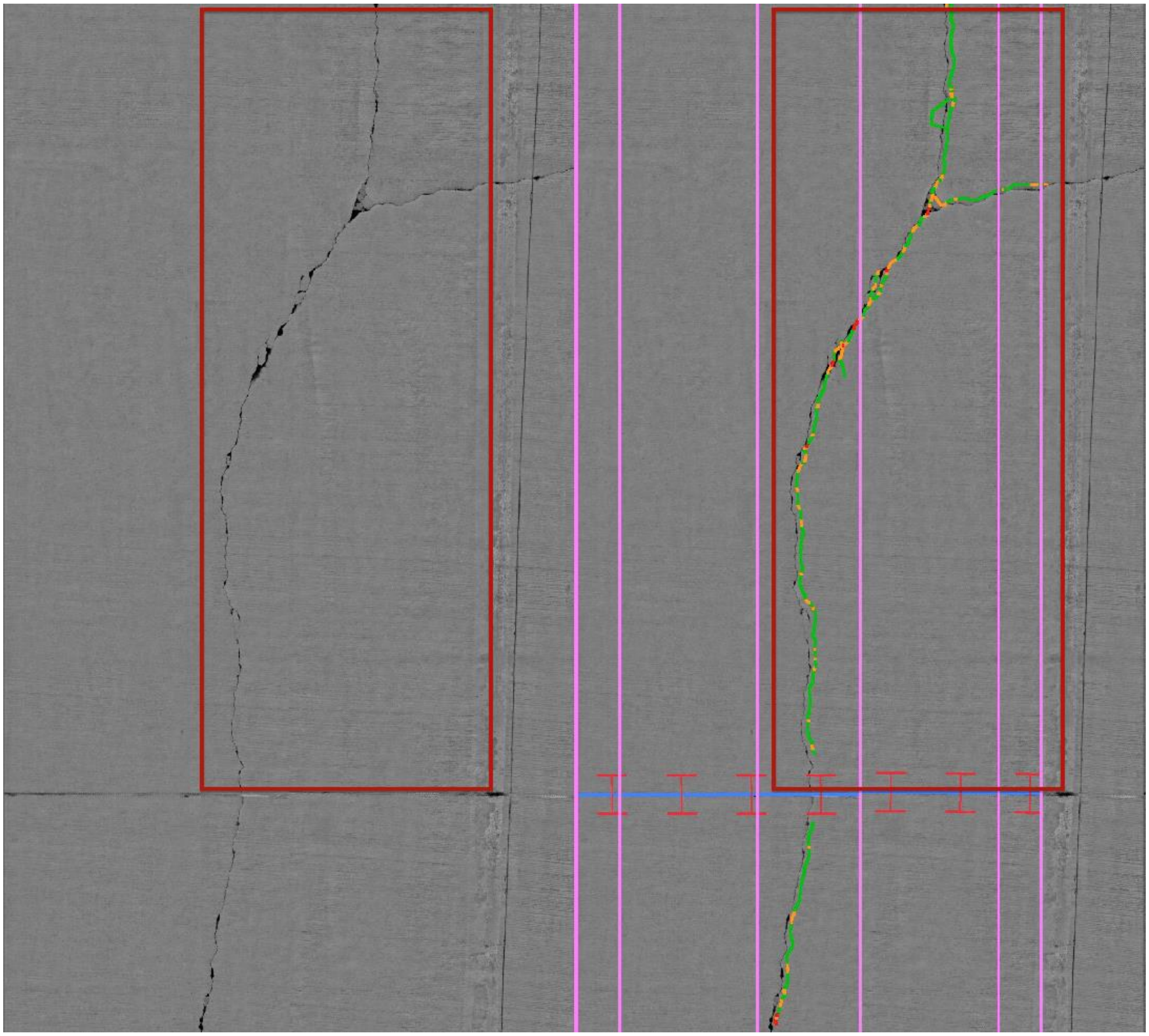

Figure 16. Medium-severity slab cracking is characterized by cracks with widths between ¼-inch and ¾-inch or spalling less than 3 inches wide. If the cracks create three or more pieces, the severity level is increased by one severity level.

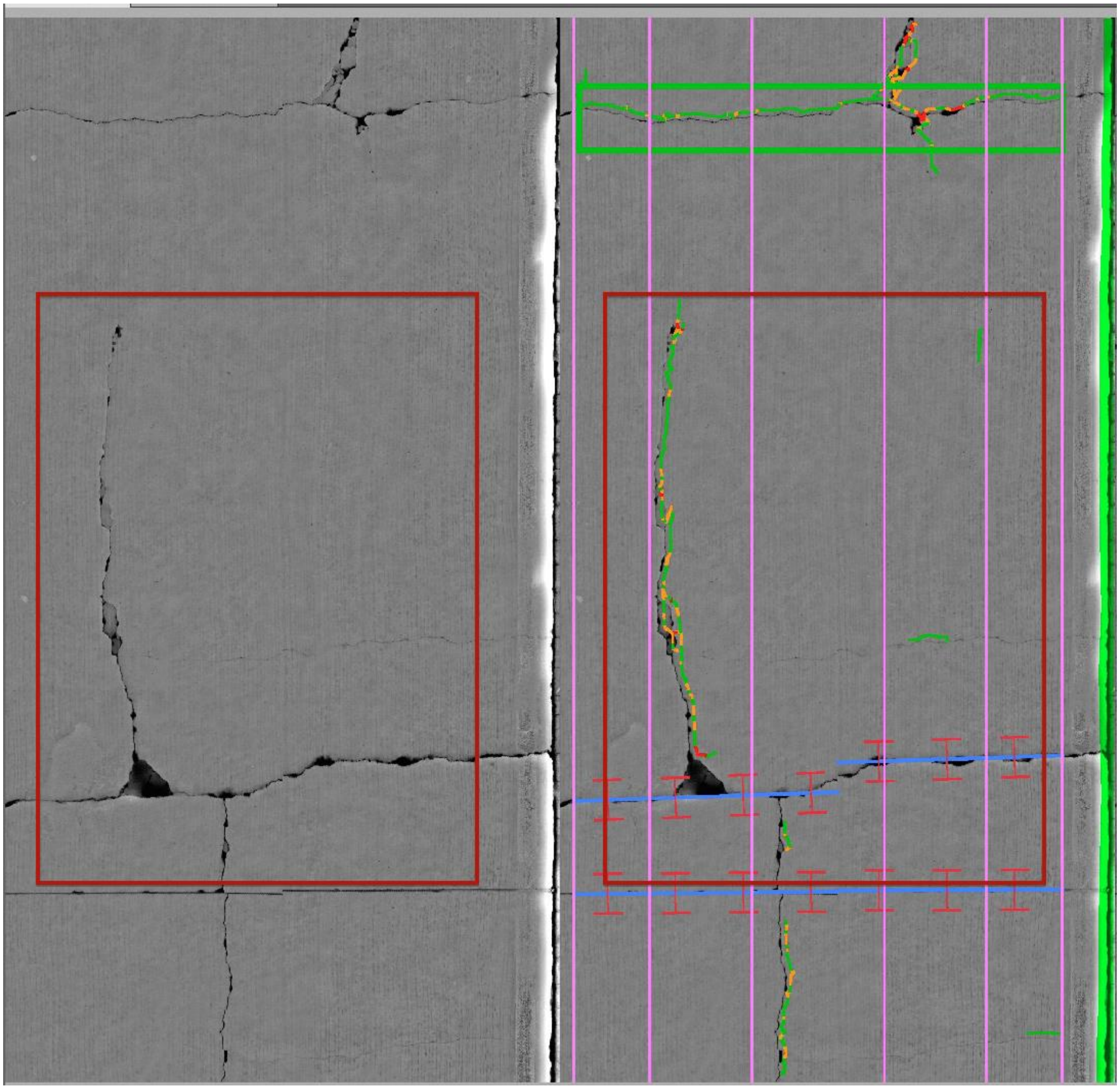

Figure 17. High-severity slab cracking is characterized by cracks with widths exceeding ¾-inch or spalling exceeding 3 inches wide.

DE_ROUGH_CROWN_LF

Cross slopes, provided for water drainage, that are too steep can cause vehicles to drift and skid laterally.

Description: Length of Crown/Cross Slope > 6%

Use: To be used in calculating OPC and treatment selection.

Pavement Type: Surface Treated

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_ASR_CNT

Alkali-Silica Reactivity (ASR) or Map Cracking refers to a network of shallow, fine, or hairline cracks that extend only through the upper surface of the concrete. Map cracking is caused by concrete over-finishing and may lead to surface scaling, which is the breakdown of the slab surface to a depth of approximately 0.25 to 0.5 inches.

Description: Count of Slabs with Map Cracking /Alkali-Silica Reactivity (*Figure 18*)

Use: To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Count (0 or 1)

Data Type: INTEGER

Detection Method: Manual/Automated

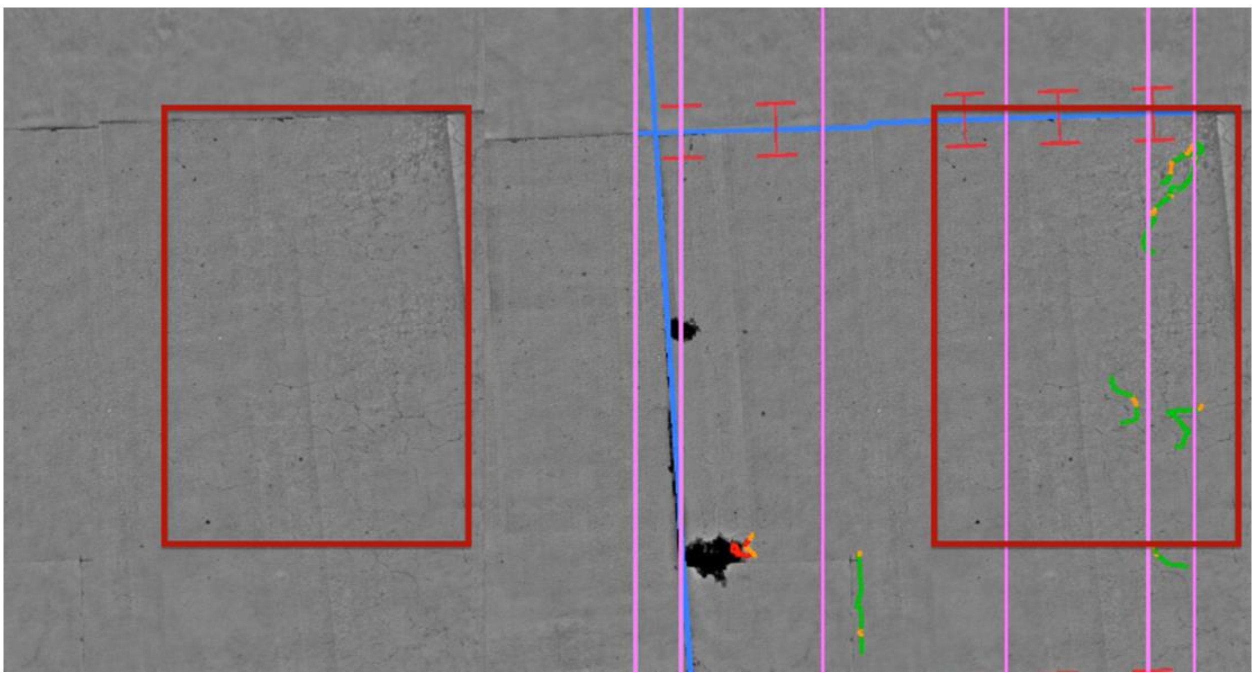

Figure 18. ASR Cracking

Crack Measurements

Cracking is defined as a fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement (HPMS Field Manual). The definition of the zones for cracking reporting are shown in *Figure 19*.

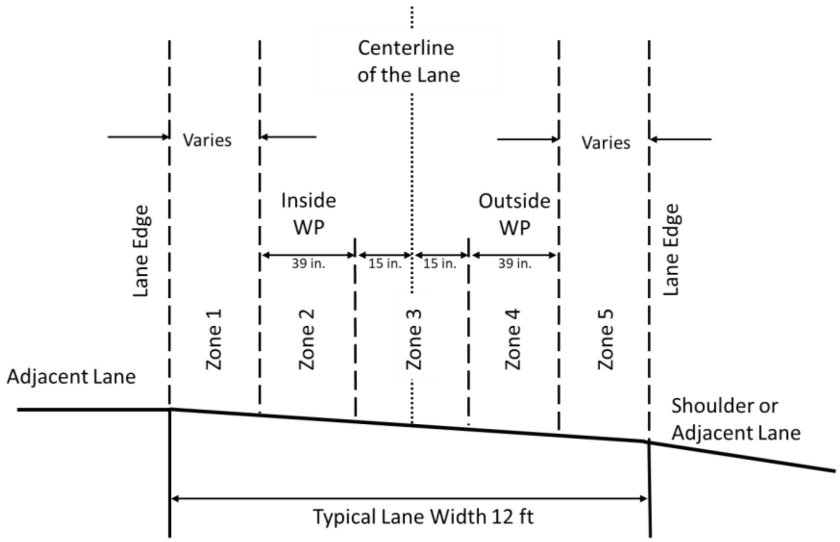

Figure 19. Definition of Transverse Zones (Source: AASHTO R85-18)

CRCK_LENGTH

Description: Length of Cracking (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z1

Description: Length of Cracking - Left Edge / Zone 1[2] (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

[2] Note that Zones are defined under the heading Crack Measurements above.

CRCK_LEN_Z2

Description: Length of Cracking - Left Wheel Path / Zone 2 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z3

Description: Length of Cracking - Center / Zone 3 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z4

Description: Length of Cracking - Right Wheel Path / Zone 4 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LEN_Z5

Description: Length of Cracking - Right Edge / Zone 5 (including failed/open sealed cracks)

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S

Description: Length of Sealed Cracking (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z1

Description: Length of Sealed Cracking - Left Edge / Zone 1[3] (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z2

Description: Length of Sealed Cracking - Left Wheel Path / Zone 2 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z3

Description: Length of Sealed Cracking - Center / Zone 3 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

[3] Note that Zones are defined under the heading Crack Measurements on page 34.

CRCK_LENGTH_S_Z4

Description: Length of Sealed Cracking – Right Wheel Path / Zone 4 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_LENGTH_S_Z5

Description: Length of Sealed Cracking - Right Edge / Zone 5 (excluding failed/open sealed cracks)

Use: For calculating Sealed Crack Density

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

CRCK_WIDTH

Description: Weighted Average Width of Cracking

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated/Manual

Guidance: For PCC manually rated open cracks, the crack widths will be assigned as below for PSCM calculation:

Severity	Width (in)
Low	0.15
Med	0.5
High	1

CRCK_WID_Z1

Description: Weighted Average Width of Cracking - Left Edge / Zone 1[4]

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

CRCK_WID_Z2

Description: Weighted Average Width of Cracking - Left Wheel Path / Zone 2

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

CRCK_WID_Z3

Description: Weighted Average Width of Cracking - Center / Zone 3

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

CRCK_WID_Z4

Description: Weighted Average Width of Cracking – Right Wheel Path / Zone 4

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

[4] Note that Zones are defined under the heading Crack Measurements on page 34.

CRCK_WID_Z5

Description: Weighted Average Width of Cracking – Right Edge / Zone 5

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,4)

Detection Method: Automated

INTERVAL_AREA

Description: Area of analysis segment | Area of Slab

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z1

Description: Area of analysis segment - Left Edge / Zone 1[5]

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z2

Description: Area of analysis segment - Left Wheel Path / Zone 2

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

[5] Note that Zones are defined under the heading Crack Measurements on page 34.

AREA_Z3

Description: Area of analysis segment - Center / Zone 3

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z4

Description: Area of analysis segment – Right Wheel Path / Zone 4

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

AREA_Z5

Description: Area of analysis segment – Right Edge / Zone 5

Use: For calculating Crack Density and Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: Square Feet (ft^2)

Data Type: NUMBER (*,2)

Detection Method: Automated

CRKD

Crack Density is the total sum of the crack lengths within the area being analyzed divided by the area being analyzed.

Description: Crack Density (Crack Length / Interval Area)

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z1

Description: Crack Density – Left Edge / Zone 1[6]

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z2

Description: Crack Density – Left Wheel Path / Zone 2

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z3

Description: Crack Density – Center / Zone 3

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_Z4

Description: Crack Density – Right Wheel Path / Zone 4

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

---

[6] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_Z5

Description: Crack Density – Right Edge / Zone 5

Use: For calculating Pavement Surface Cracking Metric (PSCM)

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_S

Description: Crack Density of Sealed Cracks excluding failed/open sealed cracks - (Sealed Crack Length / Interval Area)

Use: For reporting crack density of the sealed cracks

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_S_Z1

Description: Crack Density of Sealed Cracks – Left Edge / Zone 1

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z2

Description: Crack Density of Sealed Cracks – Left Wheel Path / Zone 2

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z3

Description: Crack Density of Sealed Cracks – Center / Zone 3

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z4

Description: Crack Density of Sealed Cracks – Right Wheel Path / Zone 4

Use: For reporting crack density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_S_Z5

Description: Crack Density of Sealed Cracks – Right Edge / Zone 5

Use: For reporting cracking density of the sealed cracks

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Manual/Automated

CRKD_L

Description: Crack Density of cracks having width <= 0.25"

Use: To be able to identify narrow cracking

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z1

Description: Crack Density of cracks having width <= 0.25" – Left Edge / Zone 1[7]

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z2

Description: Crack Density of cracks having width <= 0.25" – Left Wheel Path / Zone 2

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z3

Description: Crack Density of cracks having width <= 0.25" – Center / Zone 3

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_L_Z4

Description: Crack Density of cracks having width <= 0.25" – Right Wheel Path / Zone 4

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

[7] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_L_Z5

Description: Crack Density of cracks having width <= 0.25" – Right Edge / Zone 5

Use: To be able to identify narrow cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H

Description: Crack Density of cracks having width > 0.25"

Use: To be able to identify wide cracking

Pavement Type: All

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z1

Description: Crack Density of cracks having width > 0.25" – Left Edge / Zone 1[8]

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z2

Description: Crack Density of cracks having width > 0.25" – Left Wheel Path / Zone 2

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

---

[8] Note that Zones are defined under the heading Crack Measurements on page 34.

CRKD_H_Z3

Description: Crack Density of cracks having width > 0.25" – Center / Zone 3

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z4

Description: Crack Density of cracks having width > 0.25" – Right Wheel Path / Zone 4

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

CRKD_H_Z5

Description: Crack Density of cracks having width > 0.25" – Right Edge / Zone 5

Use: To be able to identify wide cracking

Pavement Type: AC, ST, APC

Unit of Measure: feet per square feet (ft/ft^2)

Data Type: NUMBER (*,4)

Detection Method: Automated

PSCM

Pavement Surface Cracking Metric (PSCM) is a numerical, dimensionless measure of the pavement cracking defined as area of open fissures within the area being analyzed divided by the total area being analyzed. It is equivalent to crack density multiplied by weighted crack width. It is defined in detail in the A3303 ASTM standard.

Description: ASTM Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area) *100 (excluding sealed cracks)

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: All

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z1

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Left Edge / Zone 1[9]

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z2

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Left Wheel Path / Zone 2

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z3

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Center / Zone 3

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

---

[9] Note that Zones are defined under the heading Crack Measurements on page 34.

PSCM_Z4

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Right Wheel Path / Zone 4

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

PSCM_Z5

Description: Pavement Surface Cracking Metric (excluding sealed cracks) - Right Edge / Zone 5

Use: For characterizing the severity and extent of pavement cracking and calculating Pavement Surface Cracking Index (PSCI).

Pavement Type: AC, ST, APC

Unit of Measure: Percent (%)

Data Type: NUMBER (*,2)

Detection Method: Automated

Segment- and Section-Level Distress Data Items

The following items are applicable to data collected for **both the section and segment level datasets**. These items shall be reported as follows:

DE_FAULTING_RWP_IN

Faulting is vertical misalignment of PCC pavement joints

Description: Average Absolute Faulting of the Right Wheel Path for the Measured Section

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual). To be used in calculating OPC and treatment selection.

Pavement Type: PCC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_IRI_LWP_INCH_MILE

International Roughness Index (IRI) is a statistic used to estimate the amount of roughness in a measured longitudinal profile. The LWP and RWP IRI are averaged for HPMS reporting.

Description: Average International Roughness Index - Left Wheel Path

Use: For investment requirements modeling to estimate pavement deterioration, section deficiencies, and necessary improvements, in cost allocation studies, in pavement condition trends, and for other analysis purposes including NHS performance. Also, for performance measure calculation for pavement condition on the NHS (HPMS Field Manual).

Pavement Type: ALL

Unit of Measure: Inches/Mile

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_IRI_RWP_INCH_MILE

Description: Average International Roughness Index - Right Wheel Path

Use: For investment requirements modeling to estimate pavement deterioration, section deficiencies, and necessary improvements, in cost allocation studies, in pavement condition trends, and for other analysis purposes including NHS performance. Also, for performance measure calculation for pavement condition on the NHS (HPMS Field Manual).

Pavement Type: ALL

Unit of Measure: Inches/Mile

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_LWP_AVG_IN

A rut is longitudinal surface depressions in the asphalt pavement derived from measurements of a profile transverse to the path of travel on a highway lane. The LWP and RWP Rutting is averaged for HPMS reporting.

Description: Average Rutting Depth - Left Wheel Path

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_RWP_AVG_IN

Description: Average Rutting Depth - Right Wheel Path

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_LWP_LOW_LF

Description: Extent (length) of Low (<0.25") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_MED_LF

Description: Extent (length) of Medium (0.25"-0.75") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_HI_LF
Description: Extent (length) of High (>0.75") Severity Rutting - Left Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_LOW_LF
Description: Extent (length) of Low (<0.25") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_MED_LF
Description: Extent (length) of Medium (0.25"- 0.75") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_RWP_HI_LF
Description: Extent (length) of High (>0.75") Severity Rutting - Right Wheel Path

Use: To be used in calculating OPC and treatment selection.

Pavement Type: AC, ST, APC

Unit of Measure: Linear Feet

Data Type: NUMBER (*,1)

DE_RUT_LWP_MAX_IN
Description: Maximum Rutting Depth - Left Wheel Path
Use: Collected for additional Rutting information

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_RUT_RWP_MAX_IN

Description: Maximum Rutting Depth - Right Wheel Path
Use: Collected for additional Rutting information

Pavement Type: AC, ST, APC

Unit of Measure: Inches

Data Type: NUMBER (*,2)

Detection Method: Automated

DE_TRAN_CRK_JPCP_YN

One or more transverse (predominantly perpendicular to the pavement centerline) cracks of any severity extending for at least 5 ft.

Description: Transverse Cracking - JPCP

Use: To be used in calculating Cracking Percent for HPMS Reporting.

Pavement Type: JPCP

Unit of Measure: Boolean (1/0)

Data Type: INTEGER

Detection Method: Manual/Automated

DE_LONG_CRK_CRCP_LF

Longitudinal Cracks (Cracks that are predominantly parallel to the pavement centerline) of any severity.

Description: Length of Longitudinal Cracking - CRCP.

Use: To be used in calculating Cracking Percent for HPMS Reporting

Pavement Type: CRCP

Unit of Measure: Linear ft.

Data Type: NUMBER (*,1)

Detection Method: Manual/Automated

DE_PUNCHOUT_SF

The area enclosed by two closely spaced (usually < 0.6 m) transverse cracks, a short longitudinal crack, and the edge of the pavement or a longitudinal joint. Also includes "Y" cracks that exhibit spalling, breakup, or faulting. An area that is enclosed by two distressed transverse cracks that are spaced between 0.6 m and 1 m, a short longitudinal crack, and the edge of the pavement or a longitudinal joint is also considered a punchout (LTPP, 2014).

Description: Area of Punchouts - CRCP

Use: To be used in calculating Cracking Percent for HPMS Reporting

Pavement Type: CRCP

Unit of Measure: Sq. Ft.

Data Type: NUMBER (*,2)

Detection Method: Manual/Automated

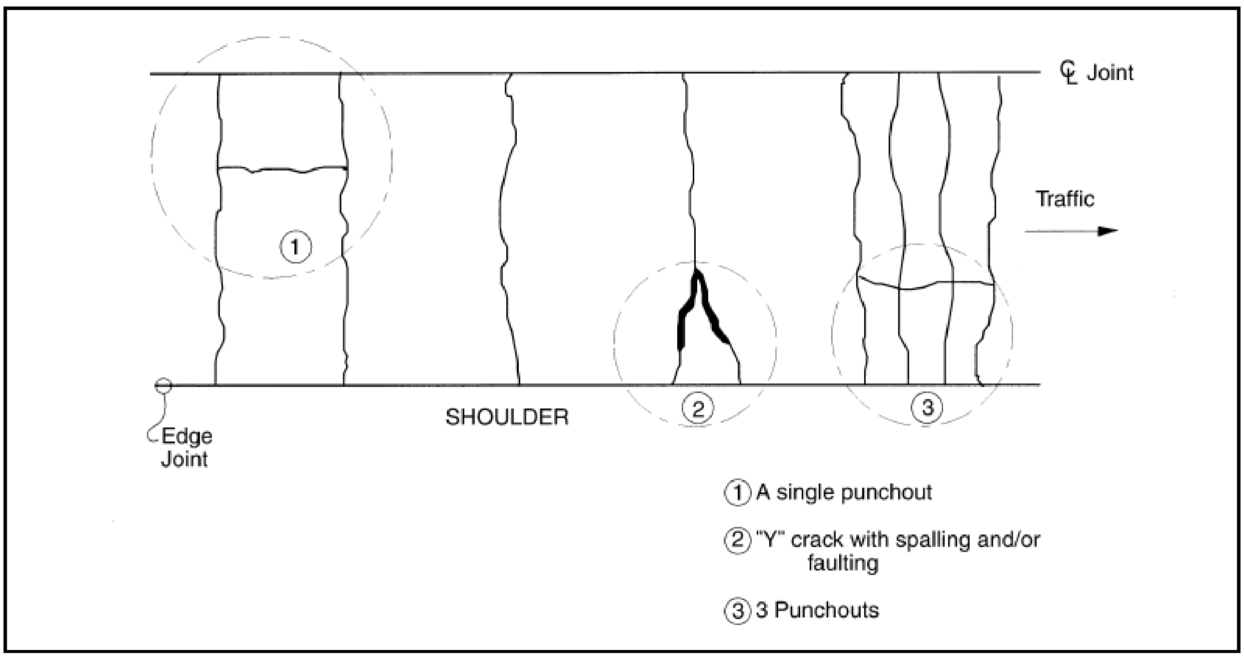

Figure 20. Punchouts (LTPP, 2014)

CRACKING PERCENT

Cracking Percent is calculated for the purpose of HPMS reporting. Cracking Percent is defined as the percentage of pavement surface exhibiting cracking. For Asphalt pavement, it is the total area exhibiting visible fatigue type sealed/unsealed cracking (both longitudinal and/or pattern) for all severity levels in the wheelpaths in each section. For Jointed Plain Concrete Pavements (JPCP), it is the percentage of slabs within the section that exhibit transverse cracking. For Continuously Reinforced Concrete Pavements (CRCP), it is the percentage of the area of the section exhibiting longitudinal cracking, punchouts, and/or patching but excluding Transverse Cracking (HPMS Field Manual). Majority of PCC pavements in DelDOT are JPCP.

Description: Percentage of pavement surface exhibiting cracking.

Use: For pavement modeling purposes and pavement condition performance metric rating (HPMS Field Manual).

Pavement Type: All

Unit of Measure: Percent

Data Type: NUMBER (*,2)

Detection Method: Calculated at Section Level

REFERENCES

Delaware Department of Transportation (DelDOT) Data Quality Management Plan (DQMP) V-2.0. Delaware Department of Transportation.

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ASTM E3303 – Standard Practice for Generating Pavement Surface Cracking Indices from Digital Images – ASTM International, 2021. DOI: 10.1520/E3303-21. https://www.astm.org/e3303-21.html

LTPP, Distress Identification Manual for The Long-Term Pavement Performance Program (Fifth Revised Edition), Federal Highway Administration (FHWA), FHWA-HRT-13-092, May 2014.
https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/13092/13092.pdf

DelDOT

Delaware Department of Transportation

Data Quality Management Plan

July 26, 2023

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Revision History

Version	Date	Author	Description
v0.1-0.9x	5/8/18	Kercher Group	Initial Drafts
v1.0	5/8/18	Kercher Group	Initial submittal for FHWA
v1.1	8/27/18	Kercher Group	Updated submittal for FHWA
V1.11		Kercher Group	Repeatability requirements for Crack Length, Faulting, Rutting, and IRI have been changed. Accuracy requirements for Crack Length are changed.
V1.13	11/04/2019	Kercher Group	Requirement of Slab Cracking Length and Patch Deteriorations/Potholes Count is dropped.
V1.2	7/28/2020	Kercher Group	Updated based on QA report
V1.3	12/27/2021	Kercher Group	Block Cracking and Surface Defects are removed. Transverse Cracking, Joint Reflective Cracking, and Slab Cracking will be measured as Counts only; their Accuracy and Reputability criteria were changed. Data Elements with CV < 50% Repeatability Criteria were changed to CV < 30%. Repeatability Criteria for Bleeding, IRI, slab Cracking, and Length were changed. Accuracy limits for Faulting were changed. Patching will be measured in area units only.
V2.0	07/26/2023	Mott MacDonald	Removing/Adding data elements based on the revised Data Dictionary document to use the new standard ASTM E3303.

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Table of Contents

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Introduction

This document defines the Data Quality Management Plan for DelDOT.

Based on §490.319(c) of the Federal Register of January 5, 2015 and the final rule published by the FHWA on January 18, 2017, it is required by the FHWA that "Each State DOT shall develop and utilize a Data Quality Management (QM) Program, approved by the FHWA, that addresses the quality of all data collected, regardless of the method of acquisition, to report the pavement condition metrics, discussed in §490.311, and data elements discussed in §490.309(c)."

These elements are required for target setting according to 23 CFR 490.105 - Establishment of performance targets, 23 CFR 490.307 - National performance management measures for assessing pavement condition, 23 CFR 490.309 - Data requirements, 23 CFR 490.311 - Calculation of pavement metrics, and 23 CFR 490.313 - Calculation of performance management measures. The pavement performance management measures are required on the Interstate System, and the NHS (excluding the Interstate).

Under 23 CFR 490.319(c), the State DOT must develop a DQMP that addresses the following:

A. Data collection equipment calibration and certification;
B. Certification process for persons performing manual data collection;
C. Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
D. Data sampling, review and checking processes; and
E. Error resolution procedures and data acceptance criteria.

These areas are addressed in the following sections with the exception of certification processes for manual data collection since this is not applicable for DelDOT.

In addition to the condition data used for pavement management in the DelDOT pavement management system, this Data Quality Management Plan therefore includes the data elements used to determine pavement condition from the most current HPMS Field Manual[1] specifically identified in 23 CFR 490.311 - Calculation of pavement metrics:

- IRI Rating (IRI)
    - All pavements
- Cracking Percent Value (percent)
    - Asphalt and Composite Pavements: fatigue type cracking for all severity levels in the wheelpath in each section
        - Fatigue Cracking (sq. ft.)
    - Jointed Plain Concrete Pavements: percentage of slabs within the section that exhibit transverse cracking based on
        - Slab Cracking (ft.)
        - Slab Count (count)
    - Continuously Reinforced Concrete Pavements: area of the section exhibiting longitudinal cracking, punchouts, and/or patching (sq. ft.)

[1] Most current HPMS Field Manual: https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/hpms_field_manual_dec2016.pdf

- Rutting value (inches)
    - Asphalt and Composite Pavements only.
- Faulting value (inches)
    - Jointed Plain Concrete Pavements only.

The underlying objective for this document is to create a repeatable process to ensure that data being delivered to support the Pavement Management program and FHWA pavement condition reporting is accurate and repeatable so that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

As noted in the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*, "*An effective pavement management system depends on reliable, accurate, and complete information. Quality pavement condition data is directly linked to the ability of the pavement management system to produce reasonable, timely, and reliable recommendations regarding an agency's pavement network. Increasingly, pavement managers realize that money is wasted and poor decisions are made when data are substandard. Confidence in data is eroded and people within the organization will tend to work around poor-quality data. The savings from using good data comes from more accurate decisions and lower life cycle cost for maintaining the pavements."*

The approach followed in this Data Quality Management Plan is to define and provide detailed descriptions for all parts of the quality management cycle while not being so prescriptive as to require vendors to change their own quality management processes and procedures that would already result in high quality, accurate and repeatable final data and does not unreasonably regulate source and raw data except where existing AASHTO and ASTM standards are applicable.

The following definition of the Data Quality Management Cycle is quoted from the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*.

Data Quality Management Cycle

Management of data quality is based on many of the same principles as other QM processes, such as Total Quality Management (TQM) and the Deming cycle of "Plan, Do, Check, and Act" for quality enhancement. Wang (1998) identified four phases that are essential in the QM cycle to ensure high quality data: define, measure, analyze, and improve. Expanding these concepts to pavement condition data collection includes (also shown in figure 7):

- **Define data quality** – Identify the acceptable levels of resolution, accuracy, and repeatability.
- **Plan and implement QC** – Develop and implement a set of procedures to produce, check, and ensure data of acceptable quality.
- **Perform acceptance tests and evaluate results** – Perform tests to compare delivered data to acceptability metrics.
- **Take corrective action** – Take steps to re-collect or reprocess data as needed to achieve data acceptance standards.
- **Report on data quality** – Document the data quality standards, protocols, equipment, personnel, collection and processing methods, QC, acceptance tests, and results.
- **Improve the process** – Use the knowledge and experienced gained to modify processes as needed to improve data quality.

It should be noted that the steps in the QM cycle incorporates a feedback process so that the collection team evaluates data quality continually throughout the collection and makes any needed process modifications as soon as it becomes evident.

To address all parts of the Data Quality Cycle, this document divided into the following sections:

- **Introduction**: This gives the purpose and layout of the document.
- **Data Collection**: This section lists the deliverables, including individual data elements, being collected, and the protocols, resolution, accuracy, and repeatability required for each.

- **Quality Control**: This gives the QC activities for each deliverable, and the frequency at which the QC activity should be performed. The section is further divided into sub-sections for pre-collection activities, activities carried out during collection, and post-collection activities.
- **Acceptance**: This section gives a description of acceptance percentage (%) within limits required for each acceptance test, and the action that will be taken if the acceptance test fails.
- **Team Roles and Responsibilities**: This describes each role, the assigned resource, and the quality management responsibilities for that role.
- **Quality Reporting Plan**: The last section details the reporting that will be performed on the quality management activities, including which role is responsible for generating the reporting.

1. Deliverables, Protocols, and Quality Standards

Data Elements

The distresses and individual data elements listed in Table 1 and Table 2 are required to be collected for use in the DelDOT pavement management program. Pavement distresses are considered for four pavement types, namely Asphalt Concrete (AC), Jointed Plain Concrete Pavement (JPCP), Continuously Reinforced Concrete Pavement (CRCP), Composite pavement (AC over PCC, or APC), and Surface Treated (ST) pavements. The data elements in Table 1 shall be collected at 6-ft./slab-length interval in accordance with the *DelDOT Pavement Data Dictionary version 3.0*. The QM process assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used for all ratings.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31 on off years.

Lengths of lane exclusions related to bridges, construction, lane deviations, or railroads should be reported for each route.

Table 1 – Data Elements collected for pavement management for 6-ft./slab-length segments

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Route, Direction, Lane (From, To – placeholders only)	X	X	X	X	X	N/A	ROUTE_ID LANE_DIR LANE_ID OFFSET_FROM OFFSET_TO
GIS Route	X	X	X	X	X	N/A	DE_GIS_ROADWAY
Section/Segment Width	X	X	X	X	X	Width of Lane Rated (ft.)	SEC_WIDTH
From, To	X	X	X	X	X	From, To milepoints based on measured shape file (Miles)	FROM_POINT TO_POINT
Wearing Course	X	X	X	X	X	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	WC_ID
Date Rated	X	X	X	X	X	MM/DD/YYYY	DATE_RATED
Bleeding			X			High, Medium, Low (sq. ft.)	DE_BLEEDING_HI_SF DE_BLEEDING_LOW_SF DE_BLEEDING_MED_SF
Crown / Cross-Slope			X			(Linear ft.)	DE_ROUGH_CROWN_LF

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Faulting				X		Average fault height Right Wheel Path (Inches)	DE_FAULTING_RWP_IN
International Roughness Index (IRI)	X	X	X	X	X	Left Wheel Path, Right Wheel Path (Inches Per Mile)	DE_IRI_LWP_INCH_MILE DE_IRI_RWP_INCH_MILE
Joint Deterioration / Spalling				X		High, Medium, Low, None	DE_JOINT_DET
Joint Seal Damage				X		High, Low	DE_JOINT_SEAL_DAMAGE
Map Cracking / Alkali-Silica Reactivity				X	X	Occurrences (Count)	DE_ASR_CNT
Patch Deterioration / Potholes	X	X	X	X	X	High, Medium, Low (sq. ft.)	DE_PATCH_DET_HI_SF DE_PATCH_DET_LOW_SF DE_PATCH_DET_MED_SF
Rutting	X	X	X			Left Wheel Path, Right Wheel Path; High, Medium, Low (Linear ft.); Average (Inches)	DE_RUT_LWP_HI_LF DE_RUT_LWP_LOW_LF DE_RUT_LWP_MED_LF DE_RUT_RWP_HI_LF DE_RUT_RWP_LOW_LF DE_RUT_RWP_MED_LF DE_RUT_LWP_AVG_IN DE_RUT_RWP_AVG_IN
Slab Cracking				X	X	High, Medium, Low, None	DE_SLAB_CRACK
Transverse Cracking - JPCP				X		1 (Yes), 0 (No)	DE_TRAN_CRK_JPCP_YN
Longitudinal Cracking - CRCP					X	Length (ft)	DE_LONG_CRK_CRCP_LF
Punchouts - CRCP					X	Area (sq. ft)	DE_PUNCHOUT_SF
Interval Length	X	X	X	X	X	Length (ft)	LENGTH
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	X	X	X	X	X	Latitude, Longitude (Degrees), Altitude (ft.)	BEGIN_LAT BEGIN_LONG BEGIN_ALT END_LAT END_LONG END_ALT
Exclusions	X	X	X	X	X	Bridges, Construction, Railroads (Count); Total Length Excluded (Miles)	BRIDGE BRIDGE_LENGTH CONSTRUCTION CONSTRUCTION_LENGTH LANE_DEVIATION LANE_DEVIATION_LENGTH RAILROAD RAILROAD_LENGTH

Data Elements	Pavement Type					Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	JPCP	CRCP		
Low Severity Crack Density (Width≤0.25 in.)-Zones 1-5	X	X	X	X	X	Crack density (of cracks with width≤ 0.25 in.) measured as crack length per unit area (ft./sq. ft.), Zones for AC, APC, and ST only.	CRKD_L, CRKD_Z1_L, CRKD_Z2_L, CRKD_Z3_L, CRKD_Z4_L, CRKD_Z5_L
High Severity Crack Density (Width>0.25 in.)-Zones 1-5	X	X	X	X	X	Crack density (of cracks with width> 0.25 in.) measured as crack length per unit area (ft./sq. ft.). Zones for AC, APC, and ST only.	CRKD_H, CRKD_Z1_H, CRKD_Z2_H, CRKD_Z3_H, CRKD_Z4_H, CRKD_Z5_H
PSCM	X	X	X	X	X	ASTM E3303 Pavement Surface Cracking Metric (Crack Length * Crack Width / Interval Area). Zones for AC, APC, and ST only.	PSCM, PSCM_Z1, PSCM_Z2, PSCM_Z3, PSCM_Z4, PSCM_Z5
Crack Length	X	X	X	X	X	Length of Cracking (including failed/open sealed cracks), Length of Sealed Cracking (excluding failed/open sealed cracks) (ft.). Zones for AC, APC, and ST only.	CRCK_LENGTH, CRCK_LEN_Z1, CRCK_LEN_Z2, CRCK_LEN_Z3, CRCK_LEN_Z4, CRCK_LEN_Z5, CRCK_LENGTH_S, CRCK_LENGTH_S_Z1, CRCK_LENGTH_S_Z2, CRCK_LENGTH_S_Z3, CRCK_LENGTH_S_Z4, CRCK_LENGTH_S_Z5
Area	X	X	X	X	X	Area of Analysis | Area of Slab (sq. ft.). Zones for AC, APC, and ST only.	INTERVAL_AREA, AREA_Z1, AREA_Z2, AREA_Z3, AREA_Z4, AREA_Z5
Crack Width	X	X	X	X	X	Weighted Average Width of Cracking (inch). Zones for AC, APC, and ST only.	CRCK_WIDTH, CRCK_WID_Z1, CRCK_WID_Z2, CRCK_WID_Z3, CRCK_WID_Z4, CRCK_WID_Z5
PSCI	X	X	X	X	X	Pavement Surface Cracking Index	PSCI
Ambient/Surface Temperature (°F)	X	X	X	X	X	Temperature recorded during distress collection	

In additional pavement management distresses collected above, the distresses and individual data elements listed in Table 2 are required to be collected for HPMS reporting at 0.1-mile interval. These data elements shall be collected in accordance with the HPMS manual and *DelDOT Pavement Data Dictionary version 3.0* or latest iteration. All non-distress data elements mentioned in Table 1 (e.g., Route, Section Width, From, To, Wearing Course, Date Rated, etc.) will also be reported for 0.1-mile sections.

Table 2 – Data Elements collected for HPMS collected for 0.1-mile sections specifically for FHWA pavement condition metrics[2]

Data Elements	Pavement Type			Description, Severity Levels and Units	Individual Data Fields
	AC	JPCP	CRCP		
Crack Percentage	X	X	X	Fatigue area for AC, slabs with Transverse Cracks for JPCP, and Longitudinal Cracking, Punchouts, and/or Patching for CRCP.	Captured for 0.1-mile sections or derived from cracking measurement in Table 1
Faulting		X		Average fault height Right Wheel Path (Inches)	Captured for 0.1-mile sections or derived from the slab-length segments data
International Roughness Index (IRI)	X	X	X	Average of Left Wheel Path and Right Wheel Path (Inches Per Mile)	Captured for 0.1-mile sections directly (in additional to collection for 6-ft/Slab-Length segments)
Rutting	X			Average of Left Wheel Path and Right Wheel Path (Inches)	Captured for 0.1-mile sections or derived from 6-ft data

Data Collection Scope

The following is required by DelDOT regarding scope of services by the data collection vendor.

- The vendor shall conduct field surveys on all pavement sections of state-maintained roads and suburban streets to identify:
    - Type of pavement
    - Severity and Extent of some distresses (See Table 1)
    - Crack density and PSCM/PSCI for cracking distresses (See Table 1)
- The vendor will provide data in a comma separated values (.csv) import file. Images shall be in JPG format. The data shall be compatible with the department's Pavement Management System.

[2] 23 CFR 490.311

- The vendor shall provide training for all personnel who perform the field surveys.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31.[3]
- The data collection vendor will be required to provide QA/QC to ensure data is reliable. The QA/QC plan should be submitted to DelDOT prior to collection data. This will be the responsibility of the vendor.

Data Protocol, Resolution, Accuracy and Repeatability

The expected data units and resolution, accuracy and repeatability are identified for each data element in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability below. Following requirements will apply to each individual 6 ft./slab-length longitudinal data collection segment within each calibration site specified in Table 7.

Table 3 – Data Protocols, Resolution, Accuracy and Repeatability for Data Elements collected at 6 ft./slab-length segments

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
Route, Direction, Lane (From, To – placeholders only)	e.g., 1-00001, R, 1	N/A	Exact	Exact
GIS Route	GIS Route ID based on provided measured shape file, e.g., 10928	N/A	Exact	Exact
Section/Segment Width	Total width of 5 AASHTO zones between lane edge or centerline, and	0.1 ft.	± 0.5 ft.	± 0.5 ft.

[3] Note that the August 31 date is for data collection completion – the resulting HPMS data is due to FHWA on April 15 of the following year for Interstates, and June 15 biennially of the following year for Non-Interstate.
[4] See section Calibration Reference Value Data Collection and Review
[5] 10 runs for Initial Calibration, 5 runs for the monthly Calibration Verification

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
	lane edge or shoulder.			
From, To	From, To milepoints based on measured shape file (Miles)	0.00001 Miles	± 0.0001 Miles	± 0.0001 Miles
Wearing Course	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	N/A	Exact	Exact
Date Rated	Date Format: (MM/DD/YYYY)	N/A	Exact	Exact
Bleeding	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*. (for Fatigue Cracking, also	1 sq. ft. (per Severity Level)	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Crown / Cross-Slope		1 ft.	± 0.1 ft.	Std. dev. < 0.05 ft. or CV < 5%
Faulting	AASHTO R36-21[6] (also *HPMS Field Manual*)	0.01 Inches (for Average fault height Right Wheel Path)	0.05 inches	Std. dev. < 0.10 inches Or CV < 5%
International Roughness Index (IRI)	AASHTO R43-13[7] (also *HPMS Field Manual*)	1 inch per mile (for Left Wheel Path, Right Wheel Path)	Maximum (± 25 inches per mile), based on running average of 11 6-ft segments or 5 slab-length segments[8]	Std. dev. < 15 inches per mile or CV (Std. Dev./Mean) < 15%, based on running average of 11 6-ft segments or 5

[6] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics
[7] 23 CFR 490.311(b)(1)(i) Computation of IRI. Note that additional equipment standards required prior to data collection startup such as AASHTO R56-14 are listed in Table 6 – Equipment and Data Collection Protocols and Standards.
[8] This measurement should be the average of the IRI values from the previous 5 segments, the current segment, and the next 5 segments, or as many segments up to 5 that are available at the beginning and end of sections. For JPCP, the measurement should be the average of the IRI values from the previous 2 slabs, the current slab, and the next 2 slabs, or as many slabs up to 2 that are available at the beginning and end of the sections.

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
				slab-length segments
Joint Deterioration / Spalling	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	None (0), Low (1), Medium (2), High (3)	± 0.5	Std. dev. < 0.5
Joint Seal Damage		None (0), Low (1), High (2)	± 0.5	Std. dev. < 0.5
Map Cracking / Alkali-Silica Reactivity		Yes (1), No (0)	± 0.25	Std. dev. < 0.4
Patch Deterioration / Potholes		High, Medium, Low (sq. ft.)	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Rutting	AASHTO R 87[9] (also *HPMS Field Manual*)	1 ft. (for Left Wheel Path, Right Wheel Path; per severity); 0.01 inches (for Average)	± 0.1 ft. ± 0.1 inches	Std. dev. < 0.75 ft. or CV < 5% Std. dev. < 0.05 inches for average or CV < 5%
Slab Cracking	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	None (0), Low (1), Medium (2), High (3)	± 0.5	Std. dev. < 0.5
Transverse Cracking - JPCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	0 (No), Yes (1)	± 0.25	Std. dev. < 0.4
Longitudinal Cracking - CRCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	± 0.1 ft.	± 0.1 ft.	Std. dev. < 0.05 ft. or CV < 5%

[9] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics. Alternatively, for automated rut data capture, the following are applicable:

- Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and
- Quantification of Rut Depth values in accordance with AASHTO Standard RR 87-19, with the modifications specified in the HPMS Field Manual

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
Punchouts - CRCP	*DelDOT Pavement Data Dictionary version 3.0 or latest iteration*	± 0.1 sq. ft.	Mean within ± 2 sq. ft. of reference value (10 replicate runs)	Std. dev. < 2 sq. ft. or CV < 5%
Interval Length	Length of surveyed segment.	0.1 ft	± 0.1 ft	Std. dev. < 0.05 ft or CV (Std. Dev./Mean) < 5%
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	GPS	0.00000001 degrees	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)
Exclusions	Bridges, Construction, Railroads (Flag); Total Length Excluded (Miles)	Flag (1,0); Length 0.01 Miles	Exact for Flag; No requirement for length.	Exact for Flag; No requirement for length.
Crack length (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 ft.	± 15 Linear ft.	Std. dev. < 4 Linear ft. or CV (Std. Dev./Mean) < 25%
Sealed Crack length (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 ft.	± 15 Linear ft.	Std. dev. < 4 Linear ft. or CV (Std. Dev./Mean) < 25%
Crack Width (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.0001 in.	± 0.05 in.	Std. dev. < 0.1in. or CV (Std. Dev./Mean) < 5%
Area (Whole width, Zone 1-5)	DelDOT Pavement Data Dictionary version 3.0 or latest iteration	0.1 sq. ft.	± 2 sq. ft.	Std. dev. < 1 sq. ft. or CV (Std. Dev./Mean) < 5%
PSCM (Whole width, Zone 2-4, Zone 1 & 5)	ASTM E3303	0.01	±0.1 for the whole width, ±0.25 for Individual zones (1-5)	Std. dev. < 0.1 or CV < 5%. Std. dev. < 0.2 or CV < 5% for Zones 2, 3, & 4.

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference[4] value)	Repeatability (for 10/5[5] replicate runs)
				Std. dev. < 0.5 or CV < 5% for Zones 1 & 5.
Low Severity Crack Density (Width≤0.25 in.)-(Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.5 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%
High Severity Crack Density (Width>0.25 in.)-(Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.1 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%
Crack Density (Whole width, Zones 1-5)	ASTM E3303	0.001 ft./sq. ft.	±0.25 ft./sq. ft. of reference value (initial calibration mean)	SD ≤ 0.25 ft./sq. ft. or CV ≤ 5%

All HPMS data elements (Table 2) will also be collected and reported for 0.1-mile sections. The expected data units and resolution, accuracy and repeatability are identified for each data element in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability below.

Table 4 – Data Protocols, Resolution, Accuracy and Repeatability for HPMS Data Elements

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
Crack Percentage	-	-	(Quality controlled at finer segmentation level. See Table 3)	(Quality controlled at finer segmentation level. See Table 3)
Faulting	AASHTO R36-21[11] (also *HPMS Field Manual*)	1 Count (per Severity Level), 0.01 Inches (for Average fault height	± 5 Count, 0.1 inches	Std. dev. < 5 Count Std. dev. < 0.10 inches Or CV < 10%

[10] 10 runs for Initial Calibration, 5 runs for the monthly Calibration Verification
[11] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
		Right Wheel Path)		
International Roughness Index (IRI)	AASHTO R43-13[12] (also *HPMS Field Manual*)	1 inch per mile (for Left Wheel Path, Right Wheel Path)	Maximum (± 15 inches per mile, ± 10% per mile)	Std. dev. < 5 inches per mile or CV (Std. Dev./Mean) < 10%
Rutting	AASHTO R 87 [13] (also *HPMS Field Manual*)	1 ft (for Left Wheel Path, Right Wheel Path; per severity); 0.01 inches (for Average)	± 50 Ft, ± 0.25 inches	Std. dev. < 20 ft. or CV < 5% Std. dev. < 0.05 inches for average or CV < 5%
Route, Direction, Lane (From, To – placeholders only)	e.g., 1-00001, R, 1	N/A	Exact	Exact
GIS Route	GIS Route ID based on provided measured shape file, e.g., 10928	N/A	Exact	Exact
Section Width	Total width of 5 AASHTO zones between lane edge or centerline, and lane edge or shoulder.	0.1 ft.	± 0.5 ft.	± 0.5 ft.
From, To	From, To milepoints based	0.1 Miles	± 0.02 Miles	± 0.02 Miles

[12] 23 CFR 490.311(b)(1)(i) Computation of IRI. Note that additional equipment standards required prior to data collection startup such as AASHTO R56-14 are listed in Table 6 – Equipment and Data Collection Protocols and Standards.

[13] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics. Alternatively, for automated rut data capture, the following are applicable:

- Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and
- Quantification of Rut Depth values in accordance with AASHTO Standard R 87-19, with the modifications specified in the HPMS Field Manual

Data Elements	Protocol	Resolution	Accuracy (mean over 5runs compared to reference value)	Repeatability (for 10/5[10] replicate runs)
	on measured shape file (Miles)			
Wearing Course	Wearing Course ID (1=AC, 2=JPCP, 3=APC, 4=ST, 5=CRCP, 6=OTHERS)	N/A	Exact	Exact
Date Rated	Date Format: (MM/DD/YYYY)	N/A	Exact	Exact
Interval Length	Length of surveyed segment.	0.1 Miles	± 0.02 Miles	Std. dev. < 0.01 Miles or CV (Std. Dev./Mean) < 10%
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	GPS	0.00000001 degrees	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)	± 15 ft. (0.00004 degrees latitude; 0.00005 degrees longitude)
Exclusions	Bridges, Construction, Railroads (Flag); Total Length Excluded (Miles)	Flag (1,0); Length 0.01 Miles	Exact for Flag; No requirement for length.	Exact for Flag; No requirement for length.

2. Quality Assurance and Quality Control

The data collection vendor is required to submit a quality assurance (QA), quality control (QC) plan to the DelDOT as part of their proposal. DelDOT will review and approve the plan to check it has at a minimum the required elements as defined in this document, as well as approve the results of the QC activities defined below in Table 5 – QC Activities.

Quality assurance focuses on procedures and processes to ensure quality. Quality control focuses on the activities that will be performed to check the quality of the data being collected.

Required QC activities are summarized below in Table 5 – QC Activities. The individual activities are then described in more detail in the subsequent sections. The activities and sections are categorized into:

- Activities required prior to the main data collection effort
- Activities required during collection
- Activities required at the end of the data collection prior to final acceptance

Table 5 – QC Activities

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
Certification of DelDOT Personnel	DelDOT Pavement Management Engineer certifies that DelDOT personnel, or their designees are certified to perform QC/QA tasks and approve or certify deliverables.	Memorandum confirming certification of personnel.	Pre-collection
Pre-Approval of Equipment and Methods	Vendor warrants that equipment and methods meet specifications identified in Table 6 and that data elements are collected in accordance with protocols in Table 3.	Review and approval by DelDOT[15] of Vendor Start-up Report	Pre-collection (as part of vendor Startup Report)
Pre-approval of Quality Management Plan	Vendor submits a Quality Management Plan that addresses items including list in section below discussing the Vendor Quality Management Plan	Review and approval by DelDOT of Vendor Quality Management Plan	Pre-collection
Initial Calibration	Data meets acceptance requirements from Table 8 for the	Review and approval by	Pre-collection (as part of

[14] QC activities are summarized here and described in detail in the remainder of this section. The acceptance criteria and corrective actions are described in the following section relating to Acceptance below.

[15] Review and approval by DelDOT denote review by pavement management staff (as noted in section 4. Team Roles and Responsibilities) and approval by the pavement management engineer. This applies for all QC Activities relating to the Startup Report.

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
	designated number of runs for each calibration test site.	DelDOT of Start-up Report	vendor Startup Report)
Calibration Verification	Data meets acceptance requirements from Table 9 for the designated number of runs for each calibration test site.	Approval by DelDOT of Monthly Data Submission Deliverable	Monthly (typically, as part of monthly vendor data submission)
Ongoing Discrepancy Monitoring	Discrepancies and invalid data should be flagged (manually and automatically) and reported by the vendor in a Discrepancy Report according to the Vendor's Quality Management Plan.	Certification by DelDOT that Discrepancies are within Acceptance limits and defined in the vendor QMP	Monthly (as a separate vendor Discrepancy Report)
Independent Bounds and Format Checking	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format. Minimum data checks: **IRI** • 30 < IRI ≤ 500 inch/mile • Left and right IRI values differ ≤ 150 inch/mile for 0.1-mile data set. • Left and right IRI values differ ≤ 200 inch/mile for 6-ft./slab-length data set. **Rutting** • Values ≤ 1.0 inch • Left and right rutting values differ ≤ 0.25 inch • Applicable to both 0.1-mile and 6-ft./slab-length data sets. **Cracking** • 0 ≤ Crack Density ≤ 1.5 ft./sq. ft. for 6-ft./slab-length data set only. **PSCM** • 0 ≤ PSCM ≤ 4% for 6-ft./slab-length data set only. **Faulting** • Values ≤ 1.0 inch	Independent data check by DelDOT to confirm Vendor's discrepancy report findings	Monthly (as part of Independent Quality Report)

Activity[14]	Quality Expectation	QC Check and Responsibility	Frequency
	• Values > 0 when joints are present • Applicable to both 0.1-mile and 6-ft./slab-length data sets Use database checks to compare with previous year and flag results > 10% different.		
Independent Image Sample Checking	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate.	Independent data check by DelDOT to confirm Vendor's distress ratings.	Monthly (as part of Independent Quality Report)
Independent Distance and Location Verification	Inspect a random sample of 10 sections/segments of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points.	Independent location data check by DelDOT to confirm Vendor's location data.	Monthly (as part of Independent Quality Report)
Final data review	**Scope** • Data coverage (excluding identified occurrences e.g., construction, railroads, etc.) > 99% **Within bounds** • Data within bounds specified in the bounds checks > 98%	Approval by DelDOT of Final Data Submission Deliverable	Prior to Final Acceptance (as part of final Independent Quality Report)

Certification of DelDOT Personnel or Representatives

Personnel from DelDOT (or their representatives) who perform QC/QA processes shall be certified at the start of each data collection cycle. This certification will ensure that personnel are competent to perform the process (or part of the process) for which they are responsible. The certification process will involve the Pavement Management Engineer or, at the discretion of the Pavement Management Engineer, a person who is currently certified or was certified for the previous data collection cycle, assessing the person's competency to perform each task.

Roles and responsibilities for QA/QC personnel are documented in section 4. Team Roles and Responsibilities below.

The following processes or tasks from Table 5 – QC Activities that are performed by personnel other than the Pavement Management Engineer require certification:

- Certification of Vendor Start-up Report
    - Initial Calibration
        - Determination of reference values for use in initial calibration by the vendor
        - Verification that vendor's calculations pertaining to calibration are correct
- Approval of Monthly Data Submission Deliverable
    - Calibration Verification
        - Verification that vendor's calculations pertaining to calibration are correct based on previously defined initial calibration reference values
    - Ongoing Discrepancy Monitoring
    - Independent Bounds and Format Checking
    - Independent Image Sample Checking
    - Independent Distance and Location Verification
- Final data review

The certification shall identify each of the above processes or tasks and the person or persons certified to undertake these.

Pre-Production Activities

A vital part of quality management is to ensure that any vendor awarded a contract has equipment matching the required standards and protocols, as well as sound standard operating procedures and training for their equipment operators.

The data collection vendor must undertake a pavement data collection start-up process annually. The startup process must be finished (including DelDOT review) before production data may be collected.

The results of these pre-collection activities shall be reported by the vendor in a Startup Report.

The start-up process must include the following:

1. The data collection vendor shall provide all pavement data collection start-up work, reported at one time in a Start-up Report.
2. An initial pavement data collection/processing validation, verification and calibration exercise shall be carried out on calibration roadway sections/segments selected by DelDOT based on the number of sites and repetitions defined in Table 7.
3. During this exercise, the vendor will submit data to DelDOT or their representative who will conduct accuracy and precision tests for all data items based on the accuracies and precisions defined in Table 3.
4. In addition, calibration procedures, camera angles and coverage, data calculation methods and standard operating procedures will be verified according to the vendor's quality management plan.

5. The DelDOT Project Manager must approve the Start-up Report and its findings in writing before future work is undertaken.

Vendor Quality Management Plan

It is important that Vendor's maintain a Quality Management Plan, but it is understood that these may cover somewhat different aspects of quality management and be formatted according to the vendor's preferences. Nonetheless, vendors' Quality Management Plans should address, at a minimum, QC areas including but not limited to:

- Image capture methods and QC,
- Automated Crack detection image processing and QC,
- Pavement profile data processing and QC (including block test and bounce test frequency),
- Distance and location measurement QC and exception handling (bridges, construction zones, etc.),
- Handling of multiple vehicles,
- Handling of equipment adjustment and repairs,
- Handling of adverse weather conditions,
- Automated and manual flagging, handling, monitoring and reporting of invalid data,
- Personnel training and certification,
- Vendor quality management roles and responsibilities.

Pre-Approval of Data Collection Vendors using Automated Equipment

For equipment used to collect condition measurements, the data collection vendor shall certify that the protocols for initial certification and ongoing data collection specified in Table 6 are met. Where applicable, these standards and protocols are also specified in Table 3 for ongoing data collection.

For collection of IRI, the vendor shall undertake the certification detailed in AASHTO R56-14 as noted in Table 6 below. While not repeating the full R56 specification here, the vendor shall ensure the test is conducted at an established test site (not necessarily within the state) that meets the criteria as designated in 8.2.1 of the standard and is acceptable to DelDOT. A reference profile shall be collected as defined in 8.2.2 of the standard, and 5 test runs shall be made at a minimum of two speeds as defined in 8.2.3 of the standard. Test data shall be analyzed by the vendor using the ProVAL software and shall result in cross-correlation agreement scores of at least 0.92 and 0.90 for repeatability and accuracy respectively. The full results of the certification with at least the information designated in 8.5 of the standard (including location of the test site, DMI results, and cross-correlation tables for repeatability and accuracy) shall be submitted by the vendor as part of the Startup Report for approval by the DelDOT.

Table 6 – Equipment and Data Collection Protocols and Standards

Pavement Condition Metric	Protocol
IRI[16]	• IRI collection device in accordance with AASHTO Standards M328-14. • Collection of IRI data in accordance with AASHTO Standard R57-14. • Quantification of IRI data in accordance with AASHTO Standard R43-13. • Certification of IRI data in accordance with AASHTO Standard R56-14.
Cracking percent [17]	• For asphalt, collection of pavement surface images in accordance with AASHTO Standard R 86-18, with the modifications specified in the HPMS Field Manual. • Quantification of cracking from asphalt pavement surface images in accordance with AASHTO Standard R 85-18. • Generating Pavement Surface Cracking Indices from Digital Images in accordance with ASTM E3303-21. • Quantification of cracking from jointed and continuously reinforced concrete pavements in accordance with HPMS Field Manual. • Computation of Cracking Percent for each pavement type in accordance with the HPMS Field Manual.
Rutting for asphalt pavements [18]	• Collection of transverse pavement profiles in accordance with AASHTO Standard R 88-18 and • Quantification of Rut Depth values in accordance with AASHTO Standard R 87-18, with the modifications specified in the HPMS Field Manual.
Faulting for jointed concrete pavements [19]	• Faulting computed based on AASHTO Standard R36-21, with the parameters specified in the HPMS Field Manual.

Initial Calibration of Automated Equipment

Calibration Sites and Number of Repetitions per Site

Prior to the start of every data collection effort, a set of initial calibration sites shall be chosen to adequately represent the current pavement types. The number of initial calibration sites shall be at least as many as the number given in Table 7 – Calibration Sites below.

[16] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[17] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[18] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[19] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Table 7 – Calibration Sites and Number of Repetitions per Site

Pavement Type	Approximate CL Length	Number of Sites	Number of Repetitions per Site
Asphalt	0.2 miles	2	10
Composite	0.2 miles	2	10
Surface Treated	0.2 miles	2	10
PCC	0.2 miles	2	10

Sites should be chosen according to the criteria given in Table 8 – Criteria for Selecting Calibration Sites.

Table 8 – Criteria for Selecting Calibration Sites

Criteria for selecting Calibration Sites
Each calibration section should be 0.1-mile long. Each site/location will contain 2-3 calibration sections. Each site will also be divided in 6-ft/slab-length segments.
Try to minimize drive time between calibration sites.
Sites should be in close proximity to DelDOT offices, if possible.
No Interstates.
Avoid bridges and approaches.
Avoid sections with Lane Deviations if possible.
Avoid sections with Stop signs and/or Signals.
Avoid sections with no pavement markings.
No recent construction.
Preferably sections with OPC ranging between 60-80, with representative cross-section within the range. Avoid sections expected to be resurfaced in the near future.
Targeted Distresses - sections that include combinations of low severity fatigue, any severity longitudinal, any severity transverse/joint reflective, and/or any severity block cracking are preferable. This should result in a range of crack density and PSCM/PSCIs across the transverse zones.
Avoid Routes with cul-de-sacs or abrupt ending.
Avoid parked vehicles if possible. Requires review of imagery.
Vendor to provide imagery/photos of vehicle location on each site to provide lateral location for field measurement team.
Consider providing curb and/or drop-off location with location information.

Calibration Reference Value Data Collection and Review

For crack length measurements, the calibration shall be checked as follows:

- Prior to evaluating each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the DelDOT QC/QA designated person checking calibration.

- Using the LCMS images, the actual cracking will be checked against the cracks measured by the LCMS.
- The beginning of the calibration section/segment covered by the LCMS imagery should be found (e.g., using GPS coordinates).
- For each crack location, where there is a discrepancy between the observed cracking on the ground and the cracking marked up in the images, a discrepancy should be recorded with the length of the discrepancy noted. Note that discrepancies where a crack is missed by the LCMS, and also where cracks are wrongly identified by the LCMS, should both be recorded. Crack lengths less than a foot long will not be evaluated. Only discrepancies totaling more than 1 linear foot of cracking should be recorded. Only cracks with width greater than or equal to 1 mm as defined in AASHTO R 85-18 should be considered.
- The total absolute length of the discrepancies defines the reference discrepancy value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
- Repeatability of crack length measurement should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

For distress data elements, the calibration shall be checked as follows:

- Prior to evaluating each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the person checking calibration.
- Using the LCMS images, the actual distress on the ground will be checked against the distress measured by the LCMS.
- The beginning of the calibration section/segment covered by the LCMS imagery should be found (e.g., using GPS coordinates).
- Any distress that is outside of the limit of length and van measured width should not be considered in the physical measurements to the extent reasonably possible.
- For each distress element in the output data set (i.e., each severity of each distress type):
    - For each distress location, where there is a discrepancy between the observed distress on the pavement and the distress identified in the images, the discrepancy should be recorded with the amount of the discrepancy noted. Note that discrepancies where distress is missed by the LCMS, and also where distresses are wrongly identified by the LCMS, should both be recorded. A discrepancy shall be recorded as follows. For each distress:
        - For each distress location identified on the pavement, a discrepancy shall be recorded if the LCMS identified distress does not match the distress identified on the pavement within a tolerance of the relevant value in Table 3 and Table 4.
        - The value of the discrepancy in this case shall be determined based on the unit of measure of the distress. The value shall be noted as the amount of the

pavement distress minus the amount of the distress identified by the LCMS and shall thus be logged as positive where there is more pavement distress and negative where there is more LCMS distress.

- For each gap between distress locations identified on the pavement, a discrepancy shall be recorded if there is LCMS-identified distress the distress identified on the pavement within a tolerance of the relevant value in Table 3 and Table 4.
- A note describing the discrepancy shall be recorded for each entry for reference purposes.
- The approximate location of each discrepancy within the data calibration section/segment shall be recorded for reference.

- For each calibration site, for each distress element, the total value of the discrepancies shall be added to the quantity obtained for the randomly selected van run to define the reference value. The reference discrepancy shall be obtained by subtracting the average of the multiple van runs from this reference value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
- Repeatability of distress measurements should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

In the case of IRI, Rutting and Faulting measurements, because it shall be certified that the data collection vehicles have been calibrated for these measurements, the reference value will be assumed to be the average of the repeat runs. As a result, the accuracy for the initial calibration is 'exact' (no discrepancy) but for calibration verification, the verification number shall be compared to the initial calibration number.

The reference values obtained should be compared to the previous calibration reference values to check they are within the acceptable limits defined in Table 3.

As an alternate approach to the field visit, software provided by a data collection vendor or any GIS software in conjunction with vendor-provided images can be used to detect discrepancies and determine the reference value.

If on-site calibration is done, the following equipment should be taken to the calibration site:

- Measuring wheel with electronic readout and measuring precision to the 1/10th of a foot. This will be used:
    - To confirm the length of the data section/segment by measuring along the centerline from Begin Milepoint to End Milepoint.
    - To identify the average data capture width and length measured by the data collection van. In cases where striping is present, the width between outer lane lines may be used. For locations without striping, use the measurement from the visible edge of pavement towards the centerline may be used.
    - To measure length and width of each area of distress on the pavement and classify each into appropriate severity definition based on visual inspection.

- Measuring tape as a backup to the measuring wheel.
- Spray paint for marking of begin/end of segments and identified distress extents.
- Smart Level with % cross-slope readout to the 1/10th percent. This is used to measure transverse cross-slope at intervals along the length of surface treated pavements.
- Digital photos may be taken at intervals along the length of the calibration sites to compare against imagery taken from data collection van. Digital photos may also be taken of spot locations of interest.

Iterative Calibration Process

Multiple data collection runs should be made on each calibration section as defined in Table 7 – Calibration Sites. The average and standard deviation of the data collection runs compared to the reference values, as well as whether these meet the accuracy and repeatability requirements defined in Table 3 – Data Protocols, Resolution, Accuracy and Repeatability , should be reported in the Startup Report.

The measurement of cracking distress is a two-stage process: first the LCMS initially measures crack length and width, and then this 'raw' information is translated into distresses. Because the initial step of capturing crack width is independent of the second step, the processing of the crack data into distresses, if the initial cracks are detected properly, it is not necessary to redo this step if there is a problem only with the second step. As a result, once the crack length calibration has verified, it is possible to allow the Vendor to begin data collection, under the assumption that the processing step can be repeated multiple times independently to ensure distress processing calibration. However, data acceptance and payment will be dependent on distress calibration also being approved and not just crack length detection being approved.

Production Activities

Calibration Verification at Calibration Sites

Calibration Verification Site Selection

Calibration verification will take place on all initial calibration sites defined for initial calibration.

Calibration Site Monitoring Process

The data collection vendor will undertake a calibration verification process according to the frequency defined in Table 5 – QC Activities.

It will be required to make 5 repeat runs on each calibration site for calibration verification. The reference values obtained in the initial calibration for each distress on each calibration site will be used for evaluation of accuracy.

The vendor will deliver the results of this calibration verification as part of the monthly data submission. The vendor may continue to collect data prior to approval of the monthly data submission but will do so at risk. If the monthly data submission is not approved, the vendor will be required to follow the acceptance process defined in Table 9 – QC Acceptance Requirements.

Ongoing Monitoring

Vendor Discrepancy Monitoring

The vendor will deliver a Discrepancy Report according to the frequency defined in Table 5 – QC Activities and based on the format defined in section 5 Quality Reporting Plan. This report will list all discrepancies identified in the data for the previous reporting time interval. The discrepancies will contain bounds checks according to the vendor's quality management plan, and at a minimum, identify any data collected outside the bounds defined in Table 5 – QC Activities for independent bound checking.

In addition to bounds checking, the vendor will list all deviations noted in the field where supplied information (such as sections and section limits to be measured) was identified as possibly inaccurate.

Independent Bounds Checking

DelDOT, or its designated representative, will use a database or spreadsheet checking method to check data being delivered based on the bounds and frequency defined in Table 5 – QC Activities for independent bound checking.

Independent Image Sample Checking

DelDOT, or its designated representative, will use a manual method to spot check that data being delivered based on LCMS data remains accurate and that there are no major discrepancies.

Independent Distance and Location Verification

DelDOT, or its designated representative, will use a manual method to spot check that the location information of data being delivered is accurate by spot checking GPS and LRS data by plotting on a GIS map with appropriately accurate layers.

Post-Production Activities

Prior to final acceptance of the data, checks for completeness of overall scope and that all data is within bounds will be conducted by either DelDOT or their designated representative in accordance with the specifications defined in Table 5 – QC Activities.

3. Acceptance

The focus of acceptance is to validate that the deliverables meet the established quality standards. Following is a description of acceptance testing, the frequency to be performed, and corrective actions for items that fail to meet criteria.

Table 9 – QC Acceptance Requirements[20]

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
Pre-approval of Quality Management Plan	N/A	Vendor Quality Management Plan is checked to ensure that, at a minimum, it addresses items required. Certification of Vendor Quality Management Plan.	Deliverable returned with comments for correction.
Pre-Approval of Equipment and Methods	N/A	Vendor warrants that equipment and methods meet specifications identified in Table 6 and that data elements are collected in accordance with protocols in Table 3. Part of Certification of Vendor Start-up Report.	Data collection cannot commence until Acceptance criteria are met.
Initial Calibration	≥90% of data collection sections/segments within all limits as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 3 and Table 4 for the designated number of runs for each calibration test site. Part of Certification of Start-up Report.	Vendor will rerun calibration for any sections that fail. Data collection cannot commence until Acceptance criteria are met. **Exception**: If it is determined that the crack detection in the images is not a problem and that the only problems are due to accuracy

[20] None of these checks should be regarded as in any way superseding the HPMS manual and CFR 490 legislation regarding coverage and quality.
[21] Repeated from *Table 5* – QC Activities above.
[22] Based on values from *Table 5* – QC Activities above.

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
			limits based on processing of the cracking data, the vendor shall be allowed to proceed but must work with DelDOT or their representative to ensure crack processing parameters are determined that result in distress measurements that meet acceptance limits. No data will be accepted for which the full pre- and post-calibration verification has not been approved.
Calibration Verification	≥90% of data collection sections/segments within all limits as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 3 and Table 4 for the designated number of runs for each calibration test site. Part of Approval of Monthly Data Submission Deliverable.	Vendor will rerun calibration for any sections that fail. All data since last approved calibration check to be re-submitted within acceptable limits.
Ongoing Discrepancy Monitoring	≥90% of sections/segments within all bounds as defined in Table 5. No more than 5% failing > 4 bounds criteria.	Discrepancies and invalid data should be flagged (manually and automatically) and reported in a Discrepancy Report according to the Vendor's Quality Management Plan. Part of Approval of Monthly Data Submission Deliverable.	All data since last approved check to be re-submitted within acceptable limits
Independent Bounds and Format Checking	≥90% of sections/segments within all bounds as	Inspect 100% of uploaded data samples to ensure within	All data since last approved check to be re-submitted

QC Activity [21]	Acceptance (percent within limits) [22]	Acceptance Testing and Frequency	Action if Criteria not Met
	defined in Table 3 and Table 4.	normal bounds and in the required format. Part of Approval of Monthly Data Submission Deliverable.	within acceptable limits.
Independent Image Sample Checking	100% of samples free of major problems.	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Independent Distance and Location Verification	100% of sections/segments within all limits relating to distance and location as defined in Table 3 and Table 4. No more than 5% failing > 4 acceptance criteria.	Inspect a random sample of 10 sections/segments of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Final data review	Scope • Data coverage (excluding identified occurrences e.g., construction, railroads, etc.) > 99% Within bounds • Data within bounds specified in the bounds checks > 98%	Approval of Final Data Submission Deliverable Part of Final Acceptance.	Vendor to continue work to meet acceptance criteria. Payment withheld until acceptance criteria are met.

4. Team Roles and Responsibilities

The following identifies the quality-related responsibilities of the DelDOT data management team and lists specific quality responsibilities.

Table 10 – Roles and Responsibilities

Team Role	Quality Management Responsibilities
DelDOT Pavement Management Engineer	• Set quality standards, acceptance criteria, and corrective actions. • Assess effectiveness of QM procedures. • Recommend improvements to quality processes. • Certification of resources in other roles.
DelDOT Project Manager	• Manage the contract with the vendor. • Approve each deliverable per quality standards. • Approve resolution of quality issues. • Check vendor Discrepancy Reports.
DelDOT Quality Representative	• Work with the DelDOT Project Manager to identify calibration sites. • Provide calibration reference values for distresses. • Work with vendor to ensure vendor obtained calibration values are within required limits. Iterate with vendor to adjust calibration post processing of the data where necessary to improve data quality. • Evaluate and make approval recommendations to project manager regarding Vendor deliverables (e.g., Startup Report, Quality Management Plan, Data submissions, etc.). • Recommend improvements to quality processes and acceptance limits. • Certification of new resources in this role.
DelDOT Data Expert	• Perform independent checks (e.g., bounds, format, image, location etc.) as called for in Table 5. • Make approval recommendations to project manager based on outcome of checks. • Be available for consultation with other quality roles and the vendor when deliverables fall outside quality limits.
Data Collection Vendor Representative	• Collect and process data. • Submit deliverables as defined in the contract. • Be responsible for ensuring Vendor quality processes and procedures are followed based on approved quality management plan. • Work with DelDOT project manager regarding scheduling and payment issues.

5. Quality Reporting Plan

The following Quality deliverables are defined. Frequency of submission and quality management content should be as defined in Table 3 and the section of this document describing Quality Assurance and Quality Control.

- **Vendor Quality Management Plan** – This should be submitted by the vendor and contain all quality assurance and quality control processes and procedures that the vendor warrants will be undertaken during the project.
- **Vendor Startup Report** – This should be submitted by the vendor and contain a description of the startup process and quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Interim Data Submissions** – The vendor will submit interim data at regular intervals, and include quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Discrepancy Reports** – The vendor will submit reports listing all data discrepancies identified by the vendor (whether by automated or manual checking) at regular intervals as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.
- **Independent Quality Report** – These reports will be submitted to the DelDOT project manager by a party independent of the vendor (either by DelDOT internally, or by a DelDOT appointed representative). These reports should be submitted at regular intervals, and include quality information as defined in Table 5 and the section of this document describing Quality Assurance and Quality Control.

Pavement Management System Standard Operating Procedure

Delaware Department of Transportation

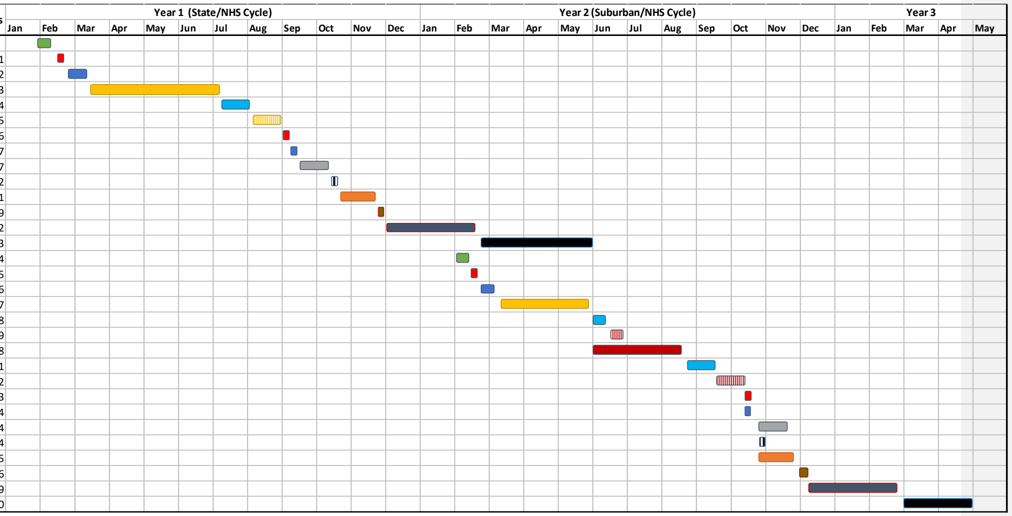
Submitted by:
The Kercher Group, Inc.

July 24, 2024

Table of Contents

DelDOT Pavement Management Activity Calendar

Task No.	Tasks	Effort (Weeks)	Start	End	Prerequisites
1	Overall Configuration Review (Year 1)	2	28-Jan	8-Feb	
2	LRS, Inventory and Bridge Location Import in TEST (Year 1)	1	18-Feb	22-Feb	1
3	Pavement Type Update (Pre Data Collection) in TEST (Year 1)	2	25-Feb	8-Mar	2
4	Data Collection State/NHS Routes (Year 1)	16	18-Mar	5-Jul	3
5	Quality Assurance Process State/NHS Routes (Year 1)	4	8-Jul	2-Aug	4
6	State/NHS Route Distress Data Import (Year 1)	4	5-Aug	30-Aug	5
7	LRS, Inventory and Bridge Location Import in PROD (Year 1)	1	2-Sep	6-Sep	6
8	Pavement Type Update (Post Data Collection) in PROD (Year 1)	1	9-Sep	13-Sep	7
9	Construction History Data Update (Year 1)	4	16-Sep	11-Oct	7
10	Traffic Data Updates (Year 1)	1	14-Oct	18-Oct	2
11	Treatment Unit Cost Updates (Year 1)	5	21-Oct	22-Nov	1
12	Build Pavement Management Sections (Year 1)	1	25-Nov	29-Nov	9
13	Project Selection (Year 1)	12	2-Dec	21-Feb	12
14	Bond Bill Submittal and PMG Reporting (Year 1)	14	24-Feb	1-May	13
15	Confirm Overall System Configuration (Year 2)	2	3-Feb	14-Feb	14
16	LRS, Inventory and Bridge Location Import in TEST (Year 2)	1	17-Feb	21-Feb	15
17	Pavement Update Type (Pre Data Collection) in TEST (Year 2)	2	24-Feb	6-Mar	16
18	Data Collection NHS Routes (Year 2)	12	9-Mar	29-May	17
19	Quality Assurance NHS Routes (Year 2)	2	1-Jun	12-Jun	18
20	NHS Route Distress Data Import (Year 2)	2	15-Jun	26-Jun	19
21	Data Collection Suburban Routes (Year 2)	12	1-Jun	21-Aug	18
22	Quality Assurance Suburban Routes (Year 2)	4	24-Aug	18-Sep	21
23	Suburban Route Distress Data Import (Year 2)	4	21-Sep	16-Oct	22
24	LRS, Inventory and Bridge Location Import in PROD (Year 2)	1	19-Oct	23-Oct	23
25	Pavement Type Update (Post Data Collection) in PROD (Year 2)	1	19-Oct	23-Oct	24
26	Construction History Data Update (Year 2)	4	26-Oct	20-Nov	24
27	Traffic Data Updates (Year 2)	1	26-Oct	30-Oct	24
28	Treatment Unit Cost Updates (Year 2)	5	26-Oct	27-Nov	25
29	Build Pavement Management Sections (Year 2)	1	30-Nov	4-Dec	26
30	Project Selection (Year 2)	12	7-Dec	26-Feb	29
31	Bond Bill Submittal and PMG Reporting (Year 2)	9	1-Mar	30-Apr	30



Overall Configuration Review

1. Purpose

The engineering configuration of the overall Pavement Management System should be reviewed regularly to ensure that the decision-making framework is verified and improved as new types of data are made available and as business processes change within the state.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)

Engineering Configuration PMS Configuration Guide (latest version)

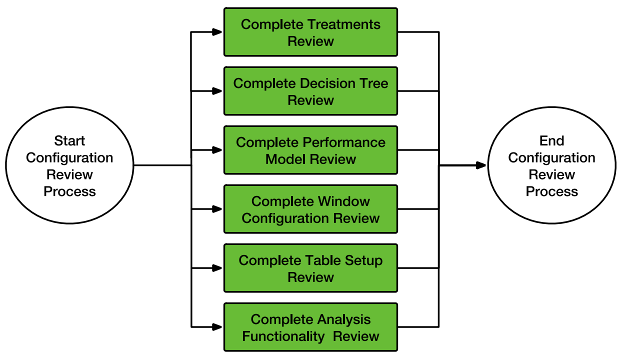
3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.2)

4. Scope

This SOP includes the review of various components of the Pavement Management System. This SOP identifies the components to be reviewed but does not detail the specific steps to complete these key configuration changes within the system. If configuration changed are made, system calibration and testing will be required. This SOP review procedure should be completed annually, however changes to the configuration may delay subsequent processes. Therefore, if configuration changes are required, they should be schedules in advance and completed in a separate development environment of the Pavement Management System to allow for formal system testing.

This review will typically be completed during a review meeting with all involved DelDOT parties (Pavement Management Group, Planning, IT, Key Consultants) but will be lead by the Pavement Management Group.



5. Prerequisites

None

6. Responsibilities

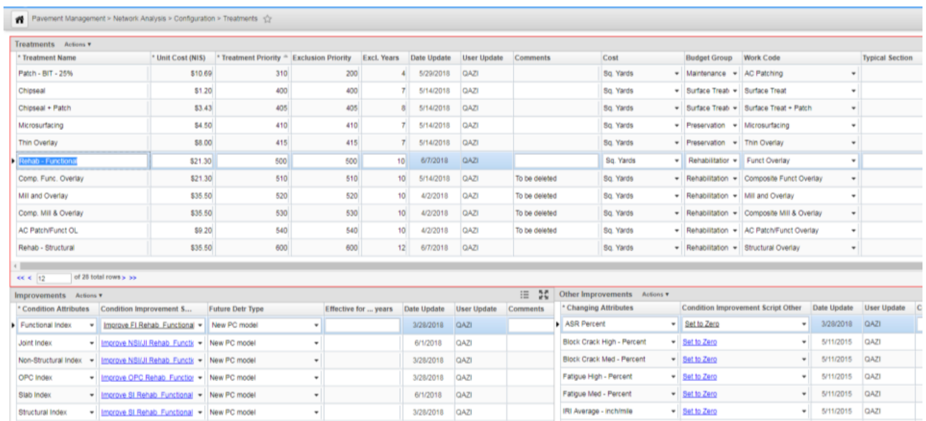
This SOP will be managed by the Pavement Management Group Lead with configuration being completed by asset management implementers experienced in the AgileAssets software.

7. Procedure

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

Treatments Review

1. Review the overall Treatment setup in the Treatments window (Pavement Management > Network Analysis > Configuration > Treatments).

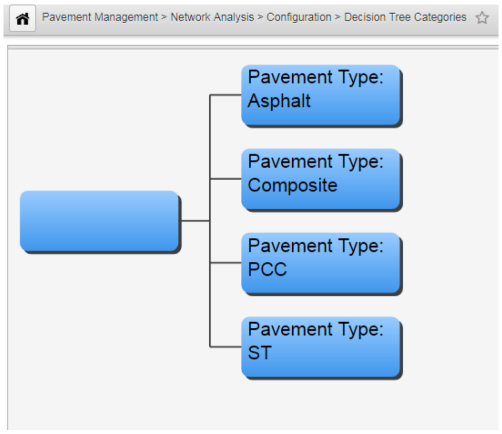


2. Review Treatment list in the window (upper pane) and determine if additional treatments are required.
3. Review the Treatment rules (lower panes) and determine if refinements to the treatment rules are required.
4. If additional treatments are required or if existing treatment rules are to be revised, configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

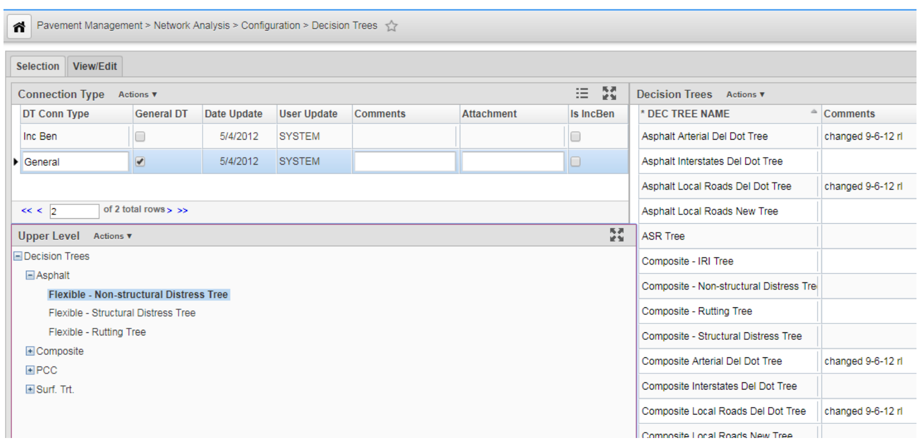
Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Decision Tree Review

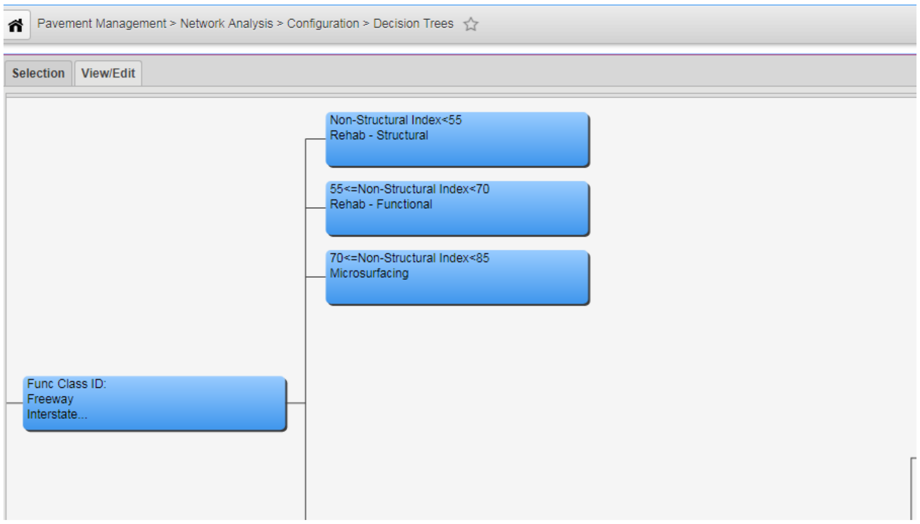
1. Review the overall Decision Tree setup in the **Decision Tree Categories** window (Pavement Management > Network Analysis > Configuration > Decision Tree Categories) and the **Decision Tree** window (Pavement Management > Network Analysis > Configuration > Decision Trees).



Pavement Management > Network Analysis > Configuration > Decision Tree Categories
Pavement Type: Asphalt
Pavement Type: Composite
Pavement Type: PCC
Pavement Type: ST



Pavement Management > Network Analysis > Configuration > Decision Trees
Selection
View/Edit
Connection Type
Actions
DT Conn Type
General DT
Date Update
User Update
Comments
Attachment
Is IncBen
Inc Ben
5/4/2012
SYSTEM
General
5/4/2012
SYSTEM
of 2 total rows
Upper Level
Actions
Decision Trees
Asphalt
Flexible - Non-structural Distress Tree
Flexible - Structural Distress Tree
Flexible - Rutting Tree
Composite
PCC
Surf. Trt.
Decision Trees
Actions
* DEC TREE NAME
Comments
Asphalt Arterial Del Dot Tree
changed 9-6-12 rl
Asphalt Interstates Del Dot Tree
Asphalt Local Roads Del Dot Tree
changed 9-6-12 rl
Asphalt Local Roads New Tree
ASR Tree
Composite - IRI Tree
Composite - Rutting Tree
Composite - Structural Distress Tree
Composite Arterial Del Dot Tree
changed 9-6-12 rl
Composite Interstates Del Dot Tree
Composite Local Roads Del Dot Tree
changed 9-6-12 rl



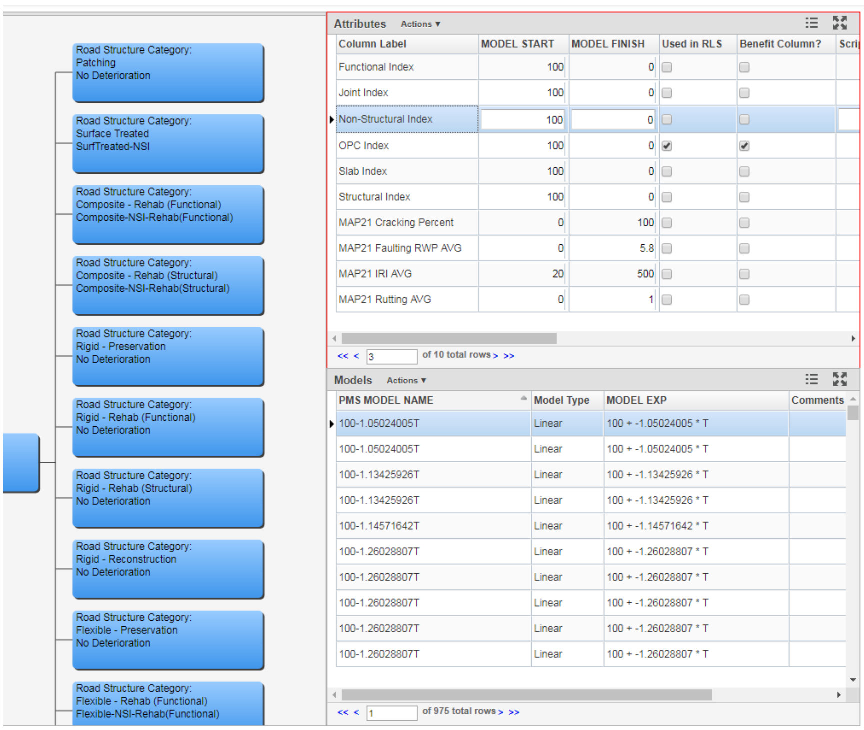
2. Review all Decision Trees and determine if refinement to the decision-making logic is required.

3. If changes to the decision tree configuration is required, the specific configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Performance Model Review

1. Review the overall Performance Model setup in the **Performance Model Tree Structure** window (Pavement Management > Performance Analysis > Performance Models) and other supporting model setup windows.



2. Review all Performance Models and model setup and determine if additional revisions are required.

3. If changes are required, the specific configuration needs should be developed, configuration should be completed in a development environment, and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

Window Configuration Review

1. Review all windows in the system. These may need to be revised if

- The format of data being imported has been revised
- Column changes are required
- Calculation changes are required
- Any other functionality is required within the window

2. If changes to any windows are required, the specific configuration needs should be developed and configuration should be completed in a development environment.

Setup Table Review

1. Review all setup tables in the system. These windows and their reference setup tables may need to be revised if the format of data being imported has been revised or if other configuration changes have been completed. The windows that reference setup tables are located in:

- Pavement Management > Setup > Construction History > …
- Pavement Management > Setup > Database Setup > …

2. If changes to setup tables are required, the specific configuration needs should be developed and configuration should be completed in a development environment.

Analysis Functionality Review

1. Review the overall analysis output needs for running scenarios and reports. These would include:

- Constraints
- Constraint Subdivisions
- Scope Variables
- Any other analysis focused configuration

2. If changes are required, the specific configuration needs should be developed, configuration should be completed in a development environment and system calibration should be completed.

Utilize the latest version of the AgileAssets PMS Engineering Configuration Document for an understanding of the system configuration.

LRS, Inventory, and Bridge Location Import:

1. *Purpose*

Inventory Data is utilized in DelDOT's AgileAssets Pavement Management System (PMS) to populate various roadway attributes in the system. This data, as configured in the system, is used as PMS variables and for reporting needs. The source data is supplied by DelDOT Road Rating Vendor.

2. *References*

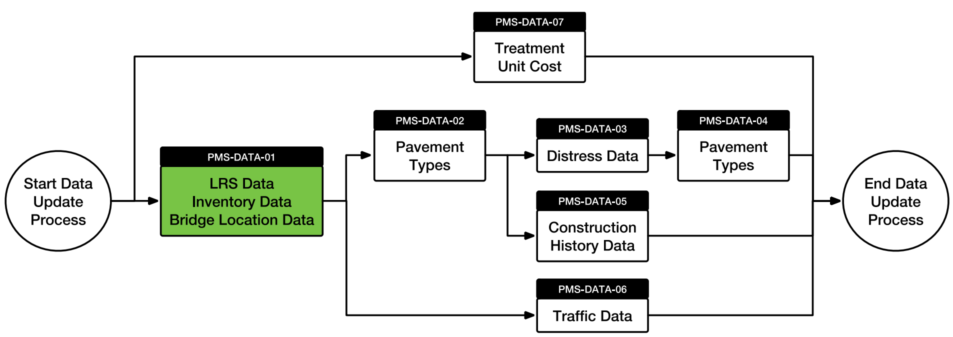
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. *Definitions*

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. *Scope*

This SOP includes the updating of the Inventory Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL**, Confirm Overall System Configuration.

6. Responsibilities

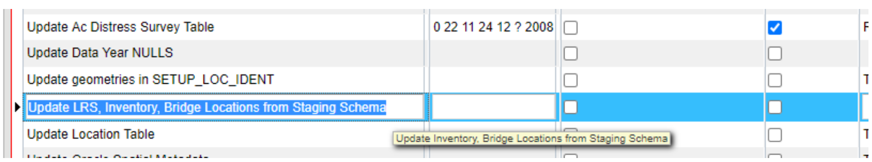
This SOP will be conducted by the Pavement Management Group.

7. Procedure

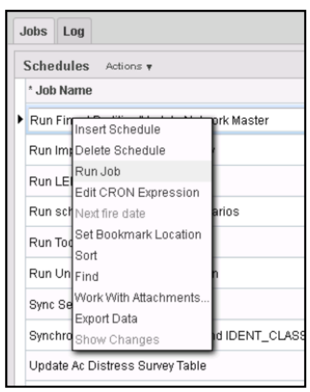
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

The following step are necessary to update the data:

1. Open the **Schedules** window (System > Tools > System Job > Schedules).
2. In the list of schedules, find the **Update LRS, Inventory, Bridge Locations from Staging Schema** schedule.



3. Right-click on the schedule and select **Run Job**. The Finest Partition process is complete.



4. By running this combined system job, the LRS, inventory, and Bridge Location data has been updated based on the latest data.

Pavement Type Update (Pre Data Collection)

1. Purpose

Pavement Type is a key data input utilized in the DelDOT AgileAssets Pavement Management System (PMS). The accurate and updated Pavement Types data is essential for PMS to assign appropriate treatment during the optimization process. During the PMS process, Pavement Type is updated twice; once before data collection is started and once after the data collection is complete.

Within DelDOT, maintaining an accurate pavement type inventory attribute was been a challenge through the years. This 2-step process is an internal systematic approach to correcting the issue.

2. References

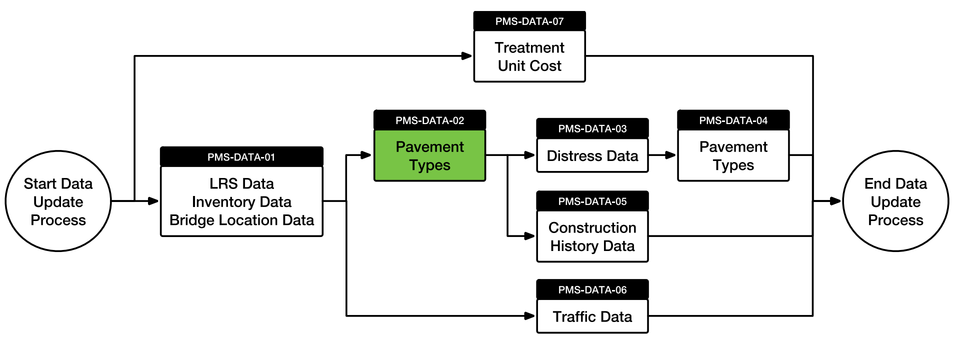
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Pavement Type as part of the overall PMS data update process. This procedure should be completed twice with specific timing based on the prerequisites identified below.



5. *Prerequisites*

The prerequisite procedures that are required to be completed before first Pavement Type update are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import

6. *Responsibilities*

This SOP will be conducted by the Pavement Management Group.

7. *Procedure*

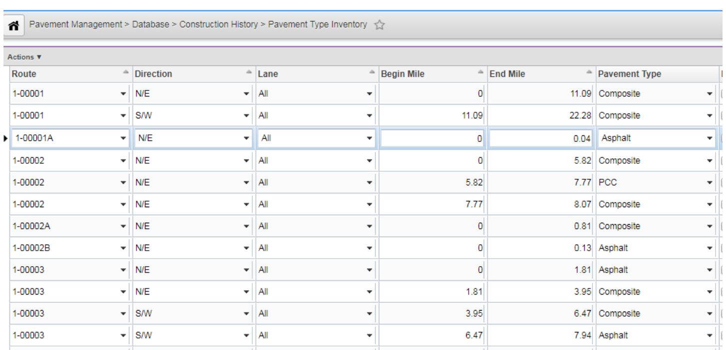
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

<u>Pavement Type Inventory Input</u>

Construction history data is updated regularly per **SOP PMS-DATA-05 (Construction History Data).** From this data, pavement type is updated nightly through a system job. Since, the original source of the Payment Types is a legacy management section table, there is a possibility that there is no construction history associated with some management sections and that the Pavement Type may be incorrect. Therefore, the following step identify process to manually edit the Pavement Type.

The Pavement Type Inventory window contains information related to the pavement types of all the management sections.

1. Open the **Pavement Type Inventory** window (Pavement Management > Database > Construction History > Pavement Type Inventory).

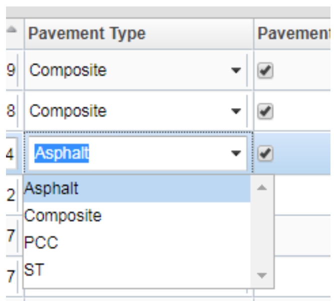


Pavement Management > Database > Construction History > Pavement Type Inventory

Actions ▾

Route	Direction	Lane	Begin Mile	End Mile	Pavement Type
1-00001	N/E	All	0	11.09	Composite
1-00001	S/W	All	11.09	22.28	Composite
1-00001A	N/E	All	0	0.04	Asphalt
1-00002	N/E	All	0	5.82	Composite
1-00002	N/E	All	5.82	7.77	PCC
1-00002	N/E	All	7.77	8.07	Composite
1-00002A	N/E	All	0	0.81	Composite
1-00002B	N/E	All	0	0.13	Asphalt
1-00003	N/E	All	0	1.81	Asphalt
1-00003	N/E	All	1.81	3.95	Composite
1-00003	S/W	All	3.95	6.47	Composite
1-00003	S/W	All	6.47	7.94	Asphalt
1-00004	N/E	All	0	0.8	Composite

2. Click on the drop-down menu under Pavement Type column and select the pavement type.



3. Press the **Save Data** button in the upper right of the screen when complete.

Note: In addition, the Pavement type is automatically updated when a construction history record is inserted. Refer to **SOP PMS-DATA-05 (Construction History Data)** document to update the construction history.

State and Suburban Route Distress Data Import

1. Purpose

Distress Data is utilized in DelDOT's AgileAssets Pavement Management System (PMS). This data, configured in the system, is the basis for the roadway condition calculations. It is critical that DelDOT conduct a thorough Quality Assurance review of condition data in order ensure that the system results and decisions are defensible. These requirements are included in the Data Quality Management Plan (DQMP).

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)
Data Quality Management Plan (DQMP)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. Scope

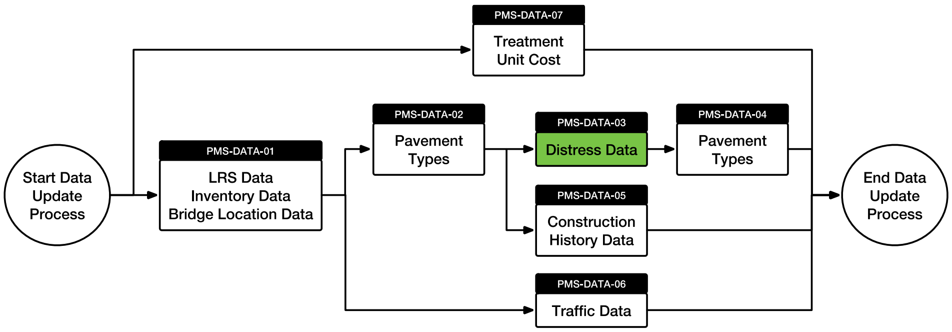
This SOP includes the updating of the Distress Data as part of the overall PMS data update process. This procedure should be completed annually for NHS roadway segments Distress Data updates and every other year for the full roadway segment Distress Data update.

Frequency Note

For years in which the entire network will be surveyed:

- The State Route Distress Data will be imported in August after the State Route Distress Data Quality Assurance process is complete.
- The Suburban Route Distress Data will be imported between September and October after the Suburban Route Distress Data Quality Assurance process is complete.

For years in which only NHS segments will be surveyed, the NHS Route Distress Data will be imported in August after the NHS State Route Distress Data Quality Assurance process is complete.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)

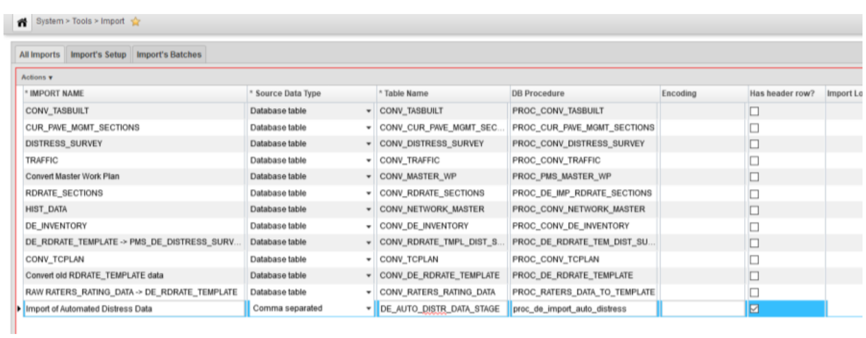
6. *Responsibilities*

This SOP will be managed by the Pavement Management Group Lead. DelDOT EAMS will complete the data import steps.

7. *Procedure*

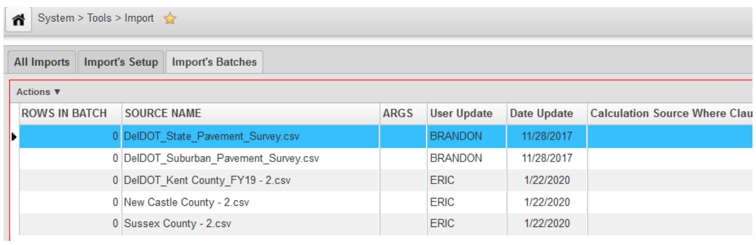
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

1. Open the **Import** window (System > Tools > Import).

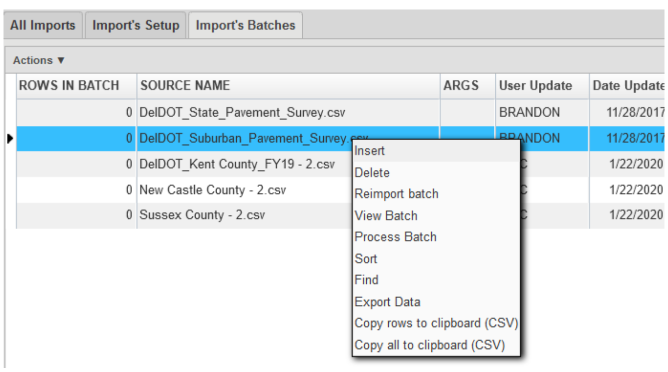


* IMPORT NAME	* Source Data Type	* Table Name	DB Procedure	Encoding	Has header row?	Import Lo
CONV_TASBUILT	Database table	CONV_TASBUILT	PROC_CONV_TASBUILT		☐	
CUR_PAVE_MGMT_SECTIONS	Database table	CONV_CUR_PAVE_MGMT_SEC...	PROC_CUR_PAVE_MGMT_SECTIONS		☐	
DISTRESS_SURVEY	Database table	CONV_DISTRESS_SURVEY	PROC_CONV_DISTRESS_SURVEY		☐	
TRAFFIC	Database table	CONV_TRAFFIC	PROC_CONV_TRAFFIC		☐	
Convert Master Work Plan	Database table	CONV_MASTER_WP	PROC_PMS_MASTER_WP		☐	
RDRATE_SECTIONS	Database table	CONV_RDRATE_SECTIONS	PROC_DE_IMP_RDRATE_SECTIONS		☐	
HIST_DATA	Database table	CONV_NETWORK_MASTER	PROC_CONV_NETWORK_MASTER		☐	
DE_INVENTORY	Database table	CONV_DE_INVENTORY	PROC_CONV_DE_INVENTORY		☐	
DE_RDRATE_TEMPLATE -> PMS_DE_DISTRESS_SURV...	Database table	CONV_RDRATE_TMPL_DIST_S...	PROC_DE_RDRATE_TEM_DIST_SU...		☐	
CONV_TCPLAN	Database table	CONV_TCPLAN	PROC_CONV_TCPLAN		☐	
Convert old RDRATE_TEMPLATE data	Database table	CONV_DE_RDRATE_TEMPLATE	PROC_DE_RDRATE_TEMPLATE		☐	
RAW RATERS_RATING_DATA -> DE_RDRATE_TEMPLATE	Database table	CONV_RATERS_RATING_DATA	PROC_RATERS_DATA_TO_TEMPLATE		☐	
Import of Automated Distress Data	Comma separated	DE_AUTO_DISTR_DATA_STAGE	proc_de_import_auto_distress		☑	

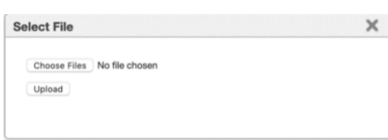
2. In the list of imports, highlight **Import of Automated Distress Data** import and then select the **Import's Batches** tab.



3. Right-click and select **Insert**.

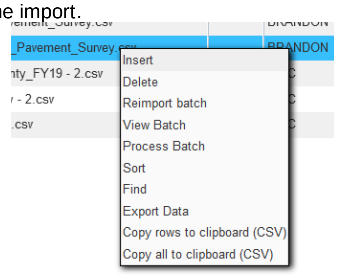


4. Select **Upload** and select the source file containing the Distress Data. Select **OK** to close the window.

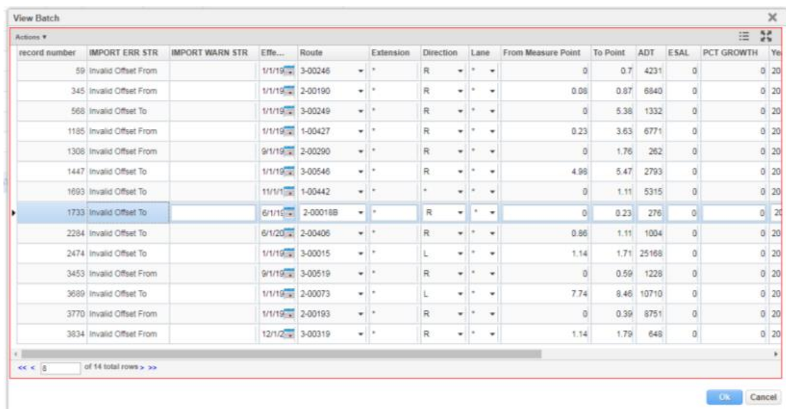


5. A new row in the Import window should identify the source data selected in the previous step. **ROWS IN BATCH** column shows the total number of rows in the import batch.

Right-click on this new row and select **Process Batch**. The **ROWS IN BATCH** column will change to identify the number of errors for the import.



6. Right-click on the new row again and select **View Batch**. Review all import errors and resolve as required based on DelDOT Quality Assurance processes.



1. Once all errors are reviewed and accepted, the Distress Data Import process is complete. A value of 0 in **ROWS IN BATCH** column would indicate successful import of the whole batch.

Pavement Type Update (Post Data Collection)

1. *Purpose*

Pavement Type is a key data input utilized in the DelDOT AgileAssets Pavement Management System (PMS). The accurate and updated Pavement Types data is essential for PMS to assign appropriate treatment during the optimization process. During the PMS process, Pavement Type is updated twice; once before data collection is started and once after the data collection is complete.

Within DelDOT, maintaining an accurate pavement type inventory attribute was been a challenge through the years. This 2-step process is an internal systematic approach to correcting the issue.

2. *References*

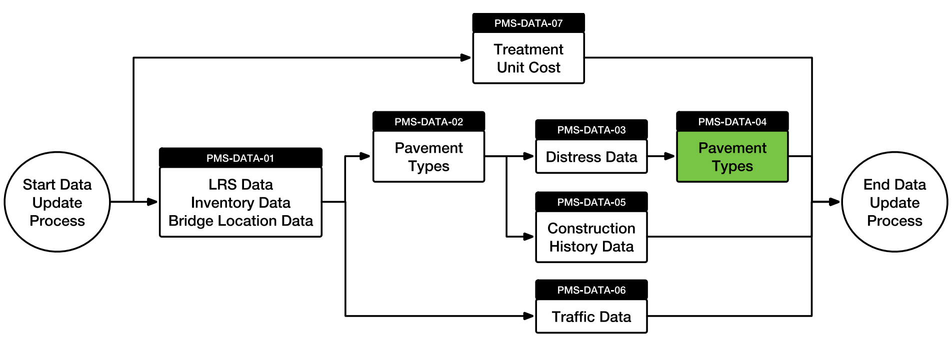
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. *Definitions*

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. *Scope*

This SOP includes the updating of the Pavement Type as part of the overall PMS data update process. This procedure should be completed twice with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedures that are required to be completed before first Pavement Type update are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import

6. Responsibilities

This SOP will be conducted by the Pavement Management Group.

7. Procedure

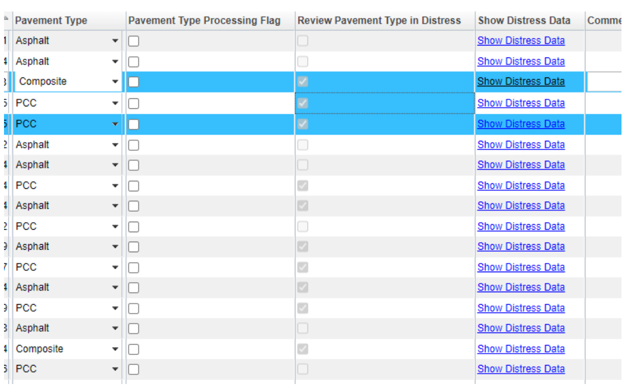
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

The source information for this effort will be a subset of the distress survey data, specifically the segments that the rater found conflicting pavement type information.

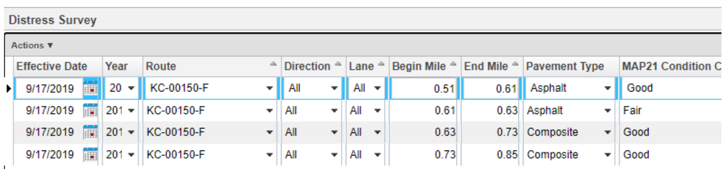
Pavement Type Inventory Input

The Pavement Type Inventory window contains information related to the pavement types of all the management sections.

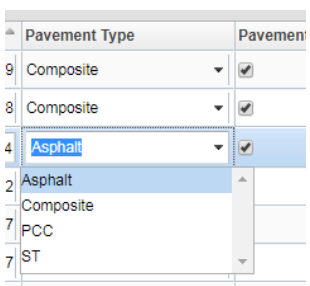
1. Open the **Pavement Type Inventory** window (Pavement Management > Database > Construction History > Pavement Type Inventory).
2. Under the column **Review Pavement Type in Distress**, locate the checked records. A checked record shows discrepancy in Pavement type between Pavement Type Inventory and Distress Data.



3. For each checked record, click on Show Distress Data hyperlink under **Show Distress Data** column to review the distress data causing conflicting pavement types. Close the window.



4. In **Pavement Type Inventory** window, click on the drop-down menu under Pavement Type column and select the appropriate pavement type.



5. Press the **Save Data** button in the upper right of the screen when complete.
6. In addition, the Pavement type is automatically updated when a construction history record is inserted. Refer to **SOP PMS-DATA-05 (Construction History Data)** document to update the construction history.

Construction History Data Updates

1. Purpose

Construction History Data is utilized in the DelDOT AgileAssets Pavement Management System (PMS). This data, configured in the system, enables the recording of pavement construction and rehabilitation work.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
PCC & HM Pavement Project Reporting, PMG Training Document (Version 1.1)
Engineering Configuration PMS Configuration Guide (latest version)

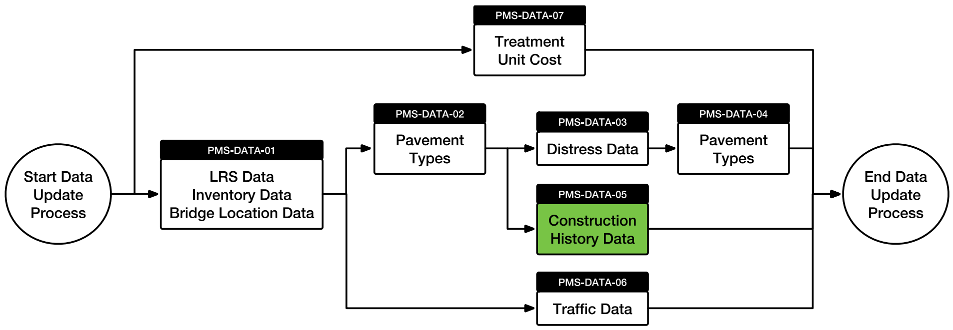
3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Construction Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.

The Construction History section enables the recording of pavement construction and rehabilitation work. You can view, insert, edit, and/or modify data related to work performed on pavements. Data is recorded in these windows by the limits of the work as it was performed on the road. The limits for a project do not have to coincide with the limits of any pavement management sections.



5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)

In addition, a Quality Assurance review of the source condition data is required.

5. Responsibilities

This SOP will be conducted by the Pavement Management Group.

7. Procedure

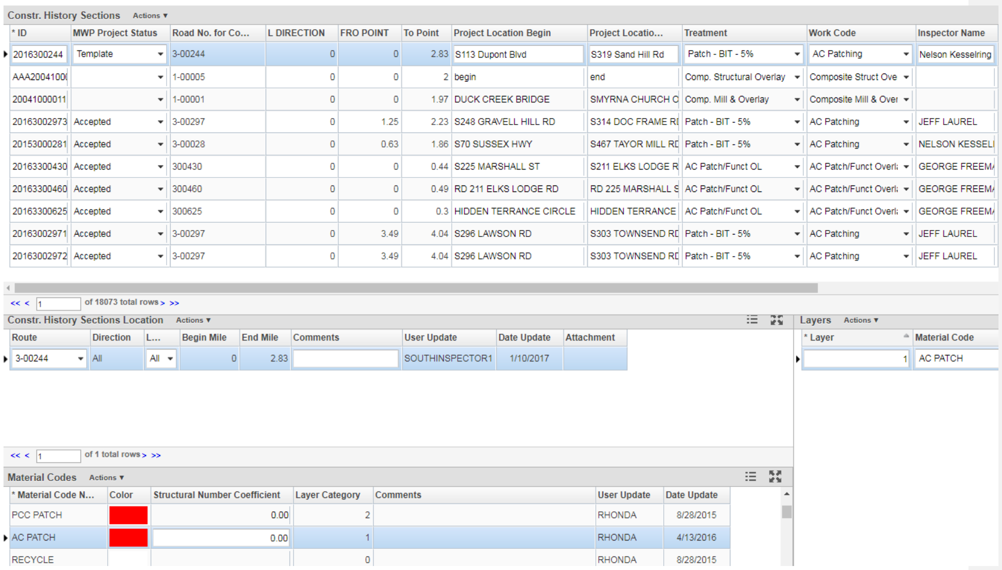
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

This SOP identifies the step for the Pavement Management Group to insert and insert details into the Construction history window. There is a reference process that allows for projects to be inserted into the Contraction History window directly through the Work Plan window. The corresponding details and setup related to that process are identified in the **PCC & HM Pavement Project Reporting, PMG Training Document (Version 1.1)**. By this reference, that process enhances and is considered part of the overall process identified in this SOP.

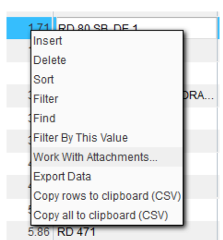
<u>Contract Information Data Input</u>

The Contract Information pane contains information related to the work performed as a whole, specifically Contract level details. Fill in as many of these fields as are applicable to the work performed.

1. Open the **Contracts and Layers Data** window (Pavement Management > Database > Construction History > Contracts and Layers Data).



2. Right-click in the top **Constr. History Sections** pane and then click **Insert**. A Contract record is inserted.



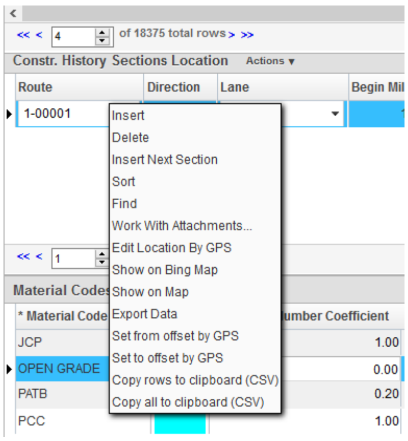
3. Enter data into the new row, filling in each of the main portions of the form with appropriate values.

4. Press the **Save Data** button in the upper right of the screen when complete.

Location Information Data Input

The **Constr. History Sections Location** pane contains location information, such as Route, Direction, Lane, Begin Mile, and End Mile attributes.

5. Select a Contract in the top pane. Right-click in the **Constr. History Sections Location** pane and select **Insert**. A new record is inserted.



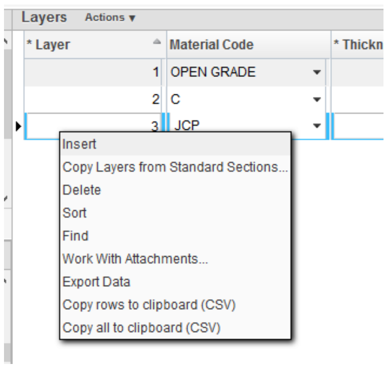
6. Enter location data into the new row, filling in each of the main portions of the form with appropriate values. Set column **Direction** to All for all the records unless the construction is done in one direction only; in that case it should be S/W.

7. When all location data is entered, click **Save Data** in the upper right of the screen.

Layer Information Input

The **Layer** pane allows you to enter information relating to pavement layer details.

1. Select a Contract in the top pane. Right-click in the **Layer** pane and select **Insert**. A new record is inserted.



2. Enter mainline pavement layer data into the new row, filling in each of the columns of the row with appropriate values.

3. When all layers are entered, click **Save Data** in the upper right of the screen.

Traffic Data Updates

1. Purpose

Traffic Data is utilized in the DelDOT AgileAssets Pavement Management System (PMS) as an additional attribute in the system.

2. References

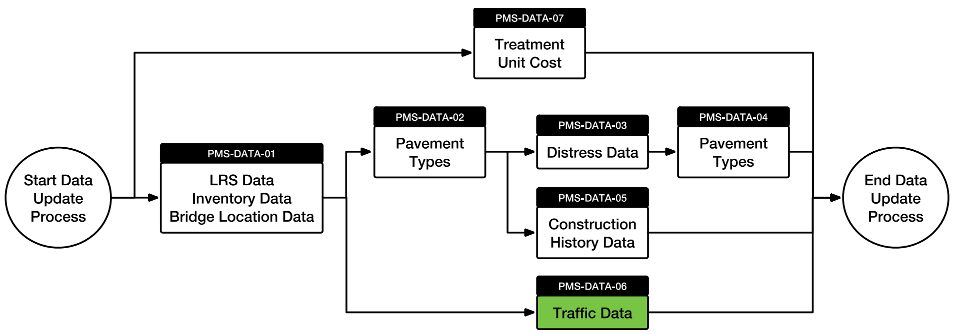
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of the Traffic Data as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import

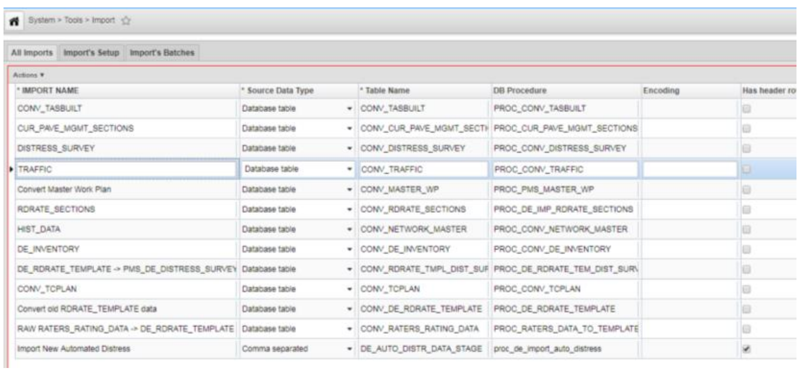
6. Responsibilities

This SOP will be managed by the Pavement Management Group Lead. DelDOT EAMS will complete the data import steps.

7. Procedure

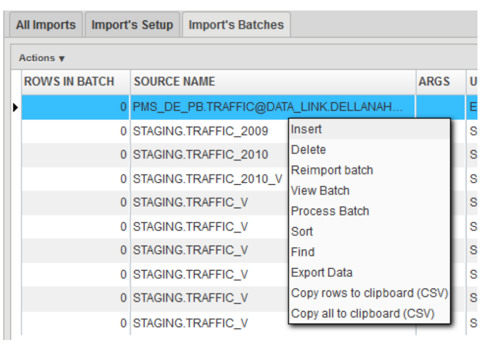
Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

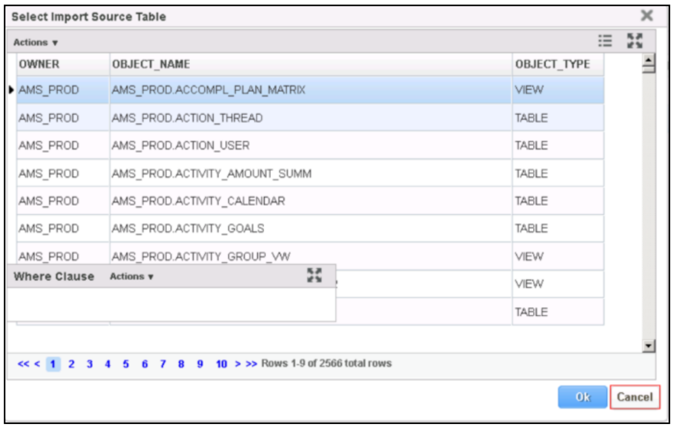
1. Open the **Import** window (System > Tools > Import).



2. In the list of imports, highlight **STAGING.TRAFFIC_V** import and then select the **Import's Batches** tab.

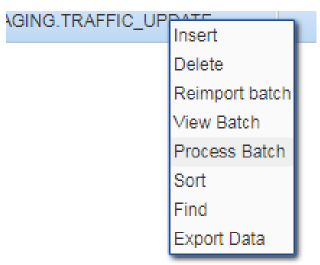
3. Right-click and select **Insert**. Select the source table containing the Inventory Data. This data will be supplied from DelDOT's Planning Group. Select **OK** to close the window.

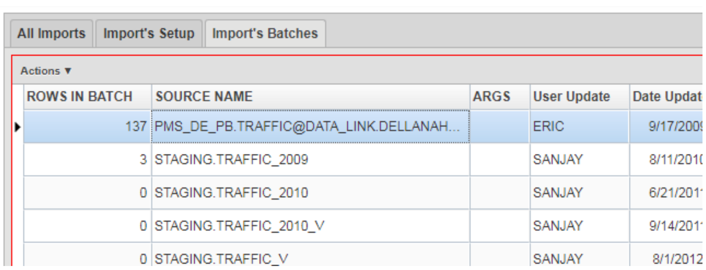




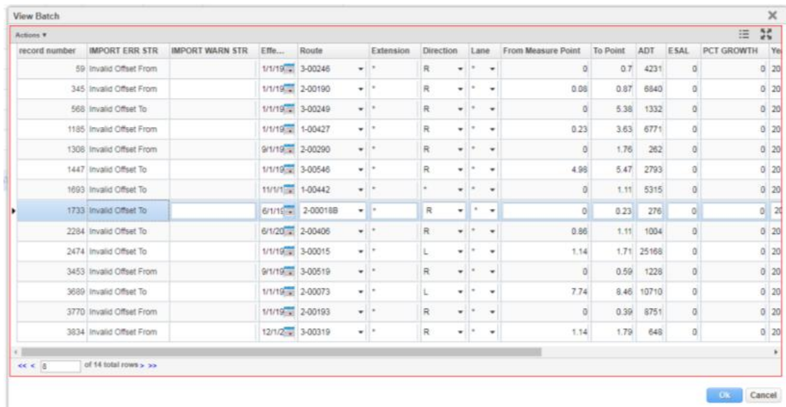
4. A new row in the Import window should identify the source data selected in the previous step.

5. Right-click on this new row and select **Process Batch**. The **ROW IN BATCH** column will change to identify the number of errors for the import.





6. Right-click on the new row again and select **View Batch**. Review all import errors and resolve as required based on DelDOT Quality Assurance processes.



View Batch

Actions ▾

record number	IMPORT ERR STR	IMPORT WARN STR	Effe...	Route	Extension	Direction	Lane	From Measure Point	To Point	ADT	ESAL	PCT GROWTH	Ye
59	Invalid Offset From		1/1/19	3-00246	*	R	*	0	0.7	4231	0	0	20
345	Invalid Offset From		1/1/19	2-00190	*	R	*	0.08	0.87	6840	0	0	20
568	Invalid Offset To		1/1/19	3-00249	*	R	*	0	5.38	1332	0	0	20
1185	Invalid Offset From		1/1/19	1-00427	*	R	*	0.23	3.63	6771	0	0	20
1308	Invalid Offset From		9/1/19	2-00290	*	R	*	0	1.76	262	0	0	20
1447	Invalid Offset To		1/1/19	3-00546	*	R	*	4.98	5.47	2793	0	0	20
1693	Invalid Offset To		11/1/1	1-00442	*	*	*	0	1.11	5315	0	0	20
1733	Invalid Offset To		6/1/1	2-00018B	*	R	*	0	0.23	276	0	0	20
2284	Invalid Offset To		6/1/20	2-00406	*	R	*	0.86	1.11	1004	0	0	20
2474	Invalid Offset To		1/1/19	3-00015	*	L	*	1.14	1.71	25168	0	0	20
3453	Invalid Offset From		9/1/19	3-00519	*	R	*	0	0.59	1228	0	0	20
3689	Invalid Offset To		1/1/19	2-00073	*	L	*	7.74	8.46	10710	0	0	20
3770	Invalid Offset From		1/1/19	2-00193	*	R	*	0	0.39	8751	0	0	20
3834	Invalid Offset From		12/1/2	3-00319	*	R	*	1.14	1.79	648	0	0	20

<< < 8 of 14 total rows > >>

Ok Cancel

7. Once all errors are reviewed and accepted, the Traffic Data Import process is complete.

Treatment Unit Cost Updates

1. Purpose

Treatment Unit Costs and Unit Cost Factors are utilized in the DelDOT's AgileAssets Pavement Management System (PMS). This data, configured in the system, is very important and sensitive decision variables for all analyses. It is critical that DelDOT conduct a thorough and detailed review of construction cost data in order to finalize the data that will utilized in the following steps.

2. References

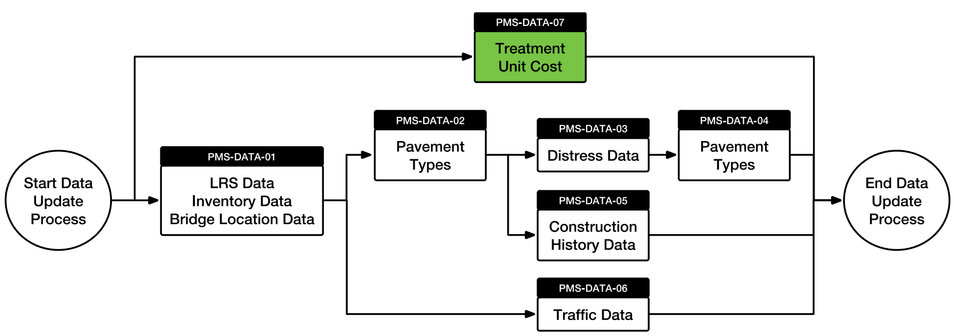
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)

4. Scope

This SOP includes the updating of both the Treatment Unit Costs and Unit Cost Factors as part of the overall PMS data update process. This procedure should be completed annually with specific timing based on the prerequisites identified below.



5. Prerequisites

The prerequisite procedure that is required to be completed is SOP No. **PMS-GENERAL-01**, Overall Configuration Review.

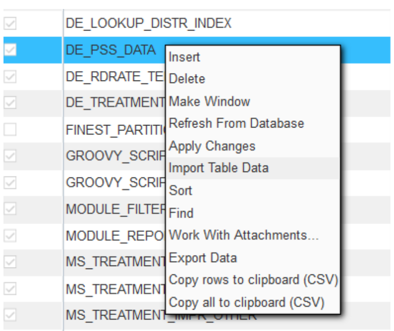
6. Responsibilities

This SOP will be conducted by the Pavement Management Group. The Pavement Management Group may request support from District Pavement Management Leads during the Treatment Unit Cost development, but the input of the data will be conducted by the Pavement Management Group.

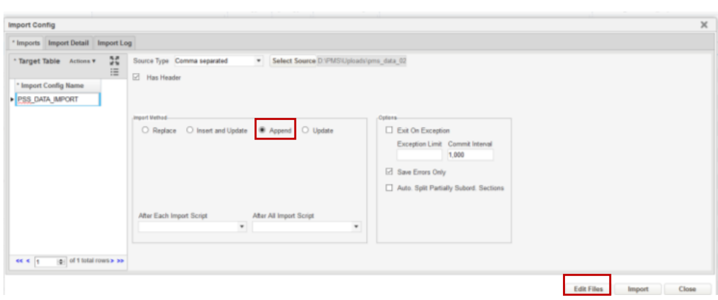
7. Procedure

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

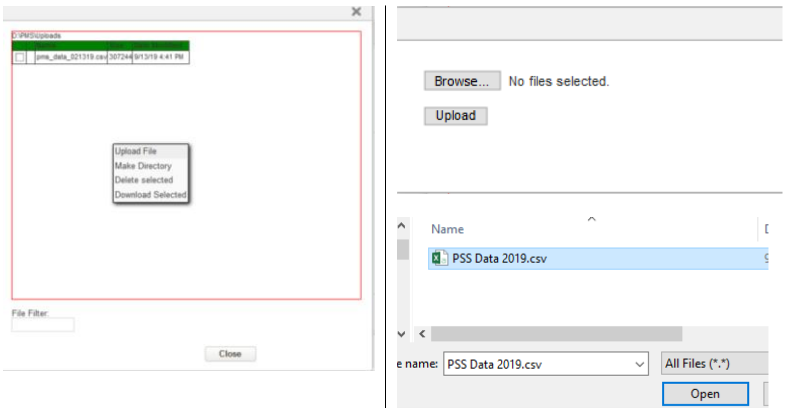
1. Import the actual project costs for the last four years for State Routes and two years for Suburban Routes from DelDOT's PSS project estimating database.
2. Open the **Tables** window (System > Utilities > Tables). Right-click on the table DE_PSS_DATA and select Import Data Table.



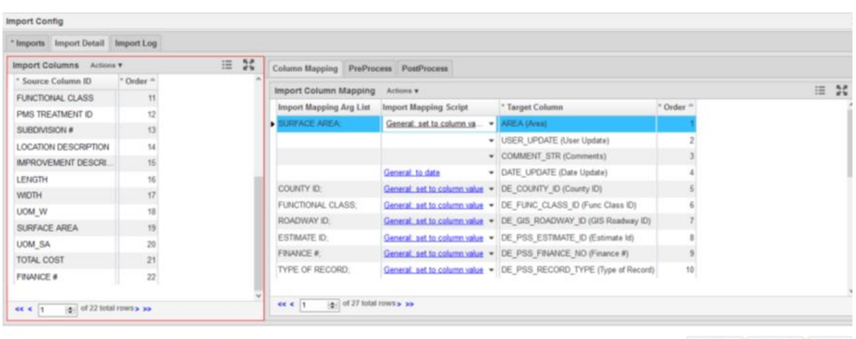
3. Select PSS_DATA_IMPORT under Import Configuration in **Import Config** window. Choose Append under Import Method. Select *Comma separated* as Source Type.



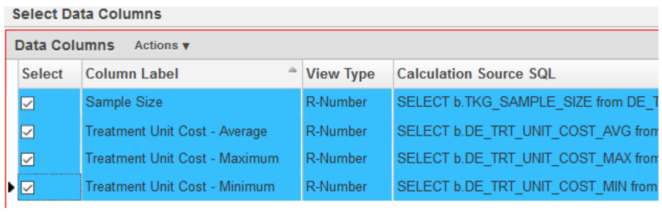
4. Press Edit File, select Upload file in the right-click menu. Select Browse in the new pop-up window. Locate the latest PSS data file on computer and press Open. Select Upload. Select Close.



5. Press Select Source on the **Import Config** window and choose the latest uploaded file.
6. Press Import Detail tab in the **Import Config** window. In the left pane, Import Columns, select Refresh Source Column on the right-click menu. In Import Column Mapping pane, select Refresh Target Column on the right-click menu.
7. Press Import. The latest PSS data will be imported.



8. Open **PSS Data** window (Pavement Management > Database > PSS Data). Select Update Target Table on the right-click menu. Select Pavement Type (the only updatable column in the table) and press OK.
9. Open **Treatment Unit Cost** window (Pavement Management > Database > Treatment Unit Cost). Select Update Target Table on the right-click menu. Select all the columns and press OK.

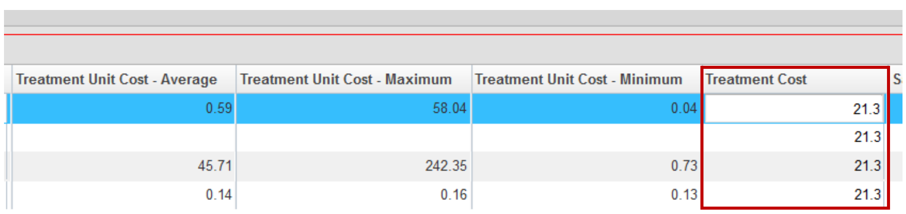


Select Data Columns

Data Columns Actions ▾

Select	Column Label	View Type	Calculation Source SQL
☑	Sample Size	R-Number	SELECT b.TKG_SAMPLE_SIZE from DE_T
☑	Treatment Unit Cost - Average	R-Number	SELECT b.DE_TRT_UNIT_COST_AVG from
☑	Treatment Unit Cost - Maximum	R-Number	SELECT b.DE_TRT_UNIT_COST_MAX from
☑	Treatment Unit Cost - Minimum	R-Number	SELECT b.DE_TRT_UNIT_COST_MIN from

10. Open **Treatments** window (Pavement Management > Network Analysis > Configuration > Treatments). Select any treatment under Treatment Name column, press Unit Costs tab in the bottom pane. It will show average, maximum, and minimum unit costs calculated based on the latest PSS data. Please note that the calculated costs are just for the reference purposes, the actual column used in optimization analysis is **Treatment Cost**. Treatment Cost is an editable column to be populated by user. Click the Save Data button after making any edits to the Treatment Cost.



Treatment Unit Cost - Average	Treatment Unit Cost - Maximum	Treatment Unit Cost - Minimum	Treatment Cost
0.59	58.04	0.04	21.3
			21.3
45.71	242.35	0.73	21.3
0.14	0.16	0.13	21.3

11. If it is determined that Treatment Unit Cost Factors updates are required, proceed with the following steps.

Treatment Unit Cost Factor Updates (Functional Class)

There are two Unit Cost Factors configured in the PMS. These factors allow for variation in cost based on various system attributes. These factors can be adjusted as follows:

1. Open the **Functional Class** window (Pavement Management > Setup > Database Setup > Functional Class). Select the value in the **Cost Factor** column corresponding to the Functional Class requiring updating. Revise the factor as required.

Pavement Management > Setup > Database Setup > Functional Class

Actions ▾

* Func Class	Cost Factor	Comments	Attachment	User Update	Date Update	Func Class ID
Interstate	1			QAZI	12/12/2017	Interstate
Freeway	1			QAZI	12/12/2017	Freeway
PrinAtrls	1			QAZI	5/24/2018	PrinAtrls
MinArtrls	1			QAZI	5/24/2018	MinArtrls
MajColl	1			QAZI	5/24/2018	MajColl
MinColl	1			QAZI	5/24/2018	MinColl
Locals	1			QAZI	5/24/2018	Locals
Suburb	1			QAZI	5/24/2018	Suburb

2. Continue update the factors for other Functional Classes as necessary and then click the **Save Data** button in the top right corner of the window.

Treatment Unit Cost Factor Updates (Pavement Type)

1. Open the **Pavement Type** window (Pavement Management > Setup > Database Setup > Pavement Type). Select the value in the **Cost Factor** column corresponding to the Pavement Type under column Pavement Structure Label requiring updating. Revise the factor as required.

Actions ▾

* Pavement Structure Label	Cost Factor	Comments	Attachment	User Update	Date Update
Flexible	1	1		QAZI	11/7/2018
Rigid	1	2		QAZI	11/7/2018
Composite	1	3		QAZI	11/7/2018
Surface Treatment	1	4		QAZI	11/7/2018
Unimproved	1	5		QAZI	11/7/2018

2. Continue update the factors for other Pavement Types as necessary and then click the **Save Data** button in the top right corner of the window.

3. All Treatment Unit Costs and Unit Cost Factors have now been updated in the PMS.

Build Pavement Management Sections

1. *Purpose*

Management Sections in DelDOT's AgileAssets Pavement Management System are utilized as sections of roadway that reflect, as closely as possible, typical project limits. In order for these Management Sections to be utilized, they need to be created based on rules determined by DelDOT.

2. *References*

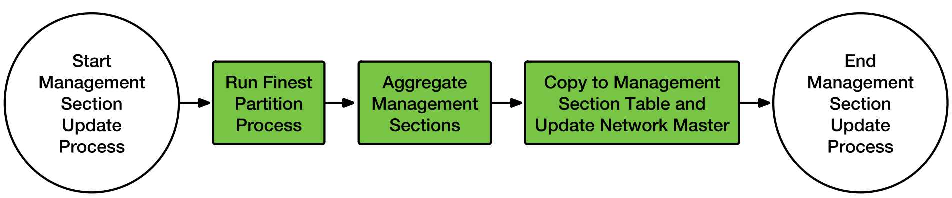
AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. *Definitions*

LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. *Scope*

This SOP includes the processes involved in updating of the Management Sections as well as the Network Master which utilizes the Management Sections. This procedure should be completed annually when new system data is available and prior to any analyses being completed for that year.



5. *Prerequisites*

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import
- SOP No. **PMS-DATA-04**, Pavement Type Update (Post Data Collection)
- SOP No. **PMS-DATA-05**, Construction History Data Update

6. Responsibilities

This SOP will be conducted by the Pavement Management Group Lead.

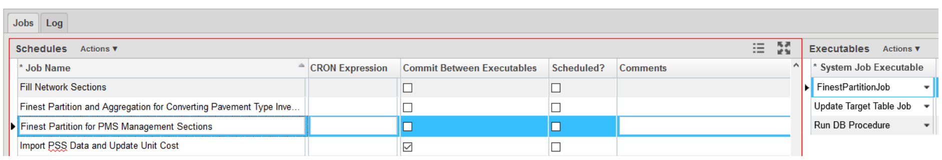
7. Procedure

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

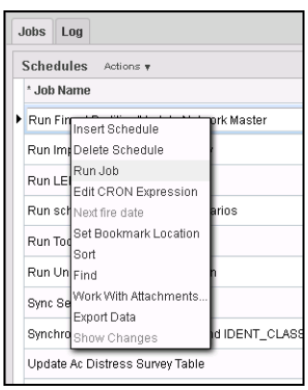
The following step are necessary to update the Pavement Management Sections.

<u>Run Finest Partition Process</u>

1. Open the **Schedules** window (System > Tools > System Job > Schedules).
2. In the list of schedules, find the **Finest Partition for PMS Management Sections** schedule.



3. Right-click on the schedule and select **Run Job**. The Finest Partition process is complete.



4. To verify data process and manually adjust data, open the **Finest Partition For Mgmt Sections** window (Pavement Management > Database > Inventory Data > Management Sections Creation > Finest Partition For Mgmt Sections) and view the data shown in the window. For any data that

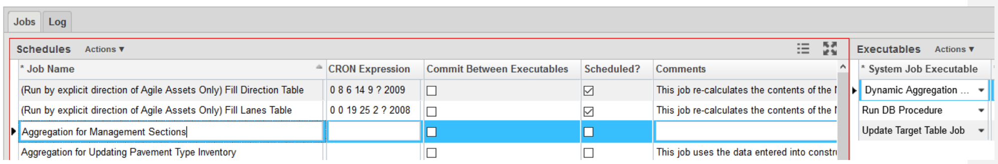
is a forced split is required, select the record and select the box in the **Section Must Split Y/N** column.

5. Select **Save** in the upper right of the screen when all selections are made.

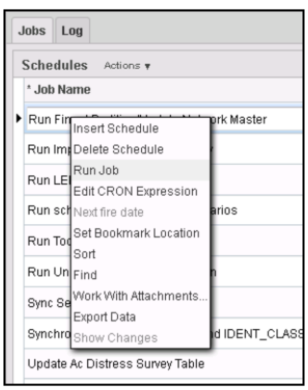
Aggregate Management Sections

6. Open the **Schedules** window (System > Tools > System Job > Schedules).

7. In the list of schedules, find the **Aggregation for Management Sections** schedule.

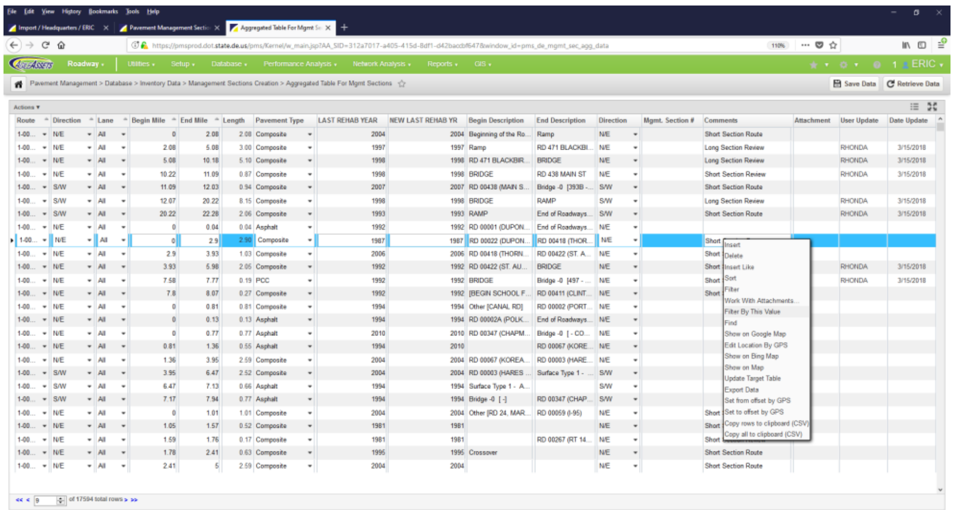


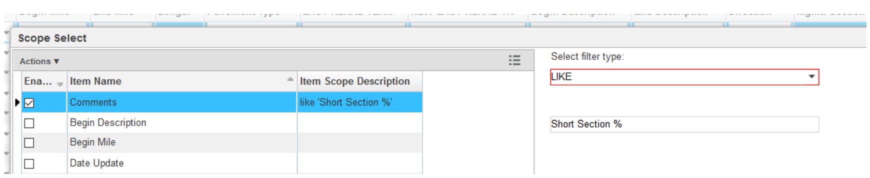
8. Right-click on the schedule and select **Run Job**. The aggregation process for the management sections is now complete.



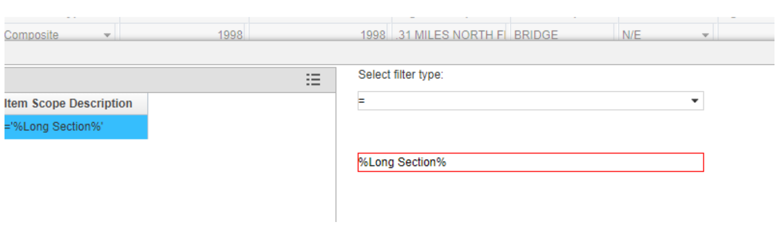
9. To verify the data process and manually adjust data, open the **Aggregated Table For Mgmt Sections** window (Pavement Management > Database > Inventory Data > Management Sections Creation > Aggregated Table For Mgmt Sections) and view the data shown in the window. Data in this window can be manually adjusted, if necessary, after review.
10. In order to identify and review the short sections, right click on the **Comment** column and select **Filter by this Value**. In the Scope Select window, Select **Filter Type:** as LIKE and write “Short Section %” in the textbox. The Sections commented as “Short Section Review” are the actual short sections with length <0.5 mile. The sections commented as “Short Section Route” are other

sections on those routes that contain a short section. DelDOT staff can review and edit the short sections by merging them into their neighbors if desired.





11. To identify and review the long sections, right click on the **Comment** column and select **Filter by this Value**. In the Scope Select window, Select **Filter Type:** as LIKE and write "% Long Section %" in the textbox. The long sections are the sections with length > 5 miles. These sections will be reviewed and split if deemed necessary.

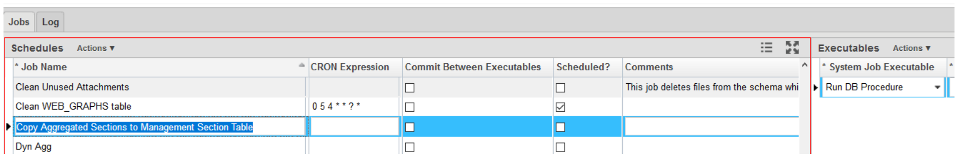


Note: It is important to note that any manual modification will be overwritten the next time the Build Pavement Management Sections process is completed (annually). If there are a significant number of manual refinements, either note all refinements so that they can be reconsidered next year or consider a fully manual Section Development Process.

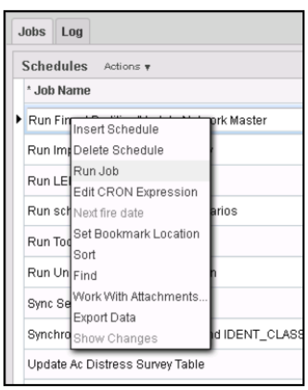
Copy to Management Section Table

12. Open the **Schedules** window (System > Tools > System Job > Schedules).

13. In the list of schedules, find the **Copy Aggregated Sections to Management Section Table** schedule.



14. Right-click on the schedule and select **Run Job**. The aggregated sections have been copied to the Management Section table and table columns have been updated.

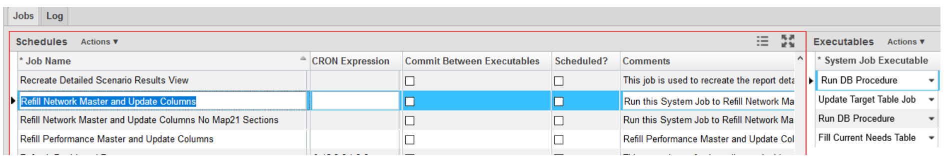


15. To verify the data process and manually adjust data, open the **Current Pavement Management Sections** window (Pavement Management > Database > Inventory Data > Current Pavement Management Sections) and view the data shown in the window. Data in this window can be manually adjusted, if necessary, after review.

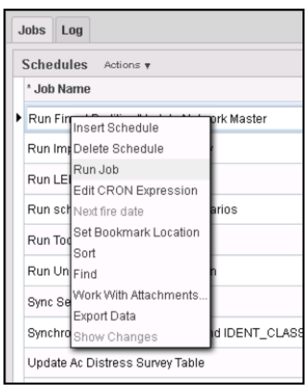
Update Network Master

16. Open the **Schedules** window (System > Tools > System Job > Schedules).

17. In the list of schedules, find the **Refill Network Master and Update Columns** schedule.



18. Right-click on the schedule and select **Run Job**. The network master has been updated and all columns have been recomputed utilizing all latest data.



19. To verify the data process, open the **Network Master** window (Pavement Management > Network Analysis > Network Master) and review the data shown in the window. Data in this window cannot be manually adjusted. If issues are identified, review the source data and processes.

Project Selection

1. Purpose

DelDOT's AgileAssets Pavement Management System allows for the development of optimized work plans identifying the best cost-effective project to complete each year. It is important to stay as close as possible to the optimized solution while understanding that project-level issues may create the need to deviate from the plan. The purpose of this SOP is to aid in developing the final work plan of projects.

2. References

AgileAssets On-line Tutorial (www.docs.agileassets.com)
Engineering Configuration PMS Configuration Guide (latest version)

3. Definitions

Work Plan – Programmed project developed either through an optimization analysis or manually created.
LRS – Linear Referencing System
PMS – Pavement Management System (AgileAssets Pavement Analyst, Version 7.0)
Management Section - Sections of roadway that reflect, as closely as possible, typical project limits.
Network Master – A core system window that consolidates all required analysis related data.

4. Scope

This SOP includes the steps involved in developing the 6-year projects list. This procedure should be completed annually.

5. Prerequisites

The prerequisite procedures that are required to be completed are:

- SOP No. **PMS-GENERAL-01**, Overall Configuration Review
- SOP No. **PMS-DATA-01**, LRS, Inventory and Bridge Location Import
- SOP No. **PMS-DATA-02**, Pavement Type Update (Pre Data Collection)
- SOP No. **PMS-DATA-03**, State and Suburban Route Distress Data Import
- SOP No. **PMS-DATA-04**, Pavement Type Update (Post Data Collection)
- SOP No. **PMS-DATA-05**, Construction History Data Update
- SOP No. **PMS-DATA-06**, Traffic Data Update
- SOP No. **PMS-DATA-07**, Treatment Unit Cost Update
- SOP No. **PMS-SECTION-01**, Build Pavement Management Sections

6. Responsibilities

This SOP will be conducted by the Pavement Management Group (PMG).

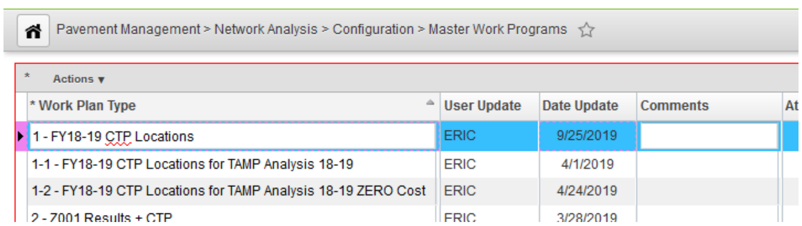
7. Procedure – State Optimization Analysis

Security Note: This procedure required log in access using the **System Role** Profile within the PMS.

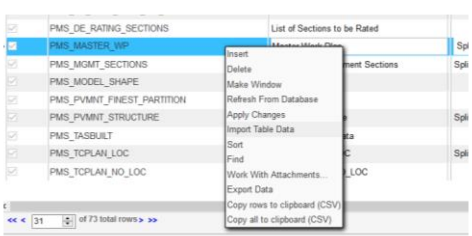
The following steps are necessary to complete the project selection process.

<u>Import CTP locations to the MWP</u>

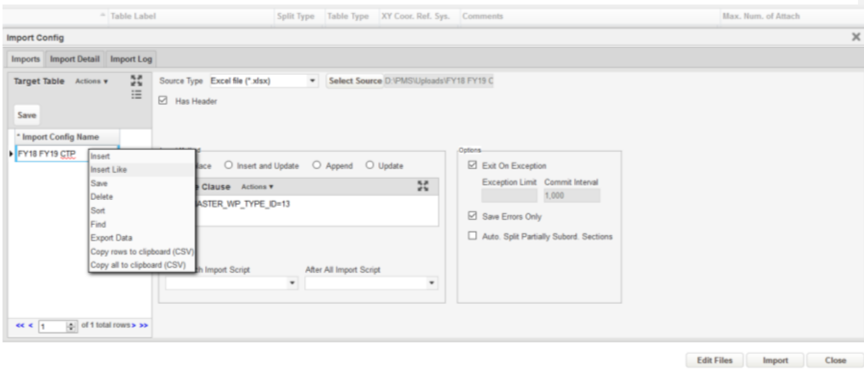
1. Open **Master Work Programs** window (Pavement Management > Network Analysis > Configuration > Master Work Programs).
2. Insert a new Work Plan Type "FY18-19 - 1 - CTP Locations". 1 indicates the Step/Scenario number which will use this work plan. This is explained further in this section.

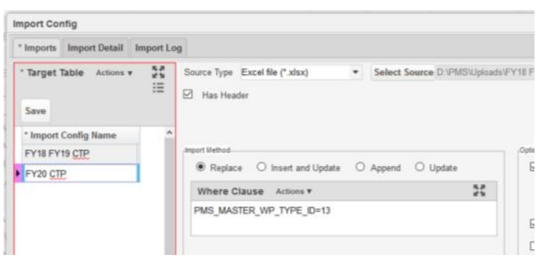


3. Similarly, insert two more Work Plan Types, "FY18-19 - 2 - Z001 Results + CTP" and "FY18-19 – 3 - Z001 Results+STP Results+CTP".
4. Open **Work Plan Data** (Pavement Management > Network Analysis > Work Plan Data) and Select "FY18-19 - 1 - CTP Locations" from the dropdown menu **Select WP Type**.
5. Populate the Work Plan by importing the projects using a work plan spreadsheet. The spreadsheet must be in a readily importable excel file format.
   a. Open **Tables** window (System > Utilities > Tables). Right Click on Table PMS_MASTER_WP and select Import Table Data.



b. In the **Import Config** window, right-click on the existing Import and select Insert Like. Name it according to Year of MWP.





c. Press Edit Files button and upload the importable spreadsheet containing MWP data. Refresh the source and target columns and edit where needed. Press Import.

Create Optimization Analysis Scenarios

DelDOT's annual Capital Transportation Program (CTP) partially relies on Federal funds. The annual CTP budget on Project Authorization Schedule sheet is divided into three categories, Federal - NHS (Z001) budget, Surface Transportation Program (STP) Federal Eligible Budget, and State budget, as shown in Table 1 below.

Table 1: CTP Budget – Project Authorization Schedule

Paving Program	Current CTP Plan			
	State		Federal - NHS (Z001)	Federal - STP
	Maintenance Funds	Remaining Funds		

FY20 Program	13,500,000	$65,000,000	$11,144,658	$7,455,342
FY21 Program	19,500,000	$55,200,000	$5,800,000	$9,000,000
FY22 Program	7,700,000	$36,200,000	-	-
FY23 Program	7,700,000	$36,200,000	-	-
FY24 Program	7,700,000	$36,200,000	-	-
FY25 Program	7,700,000	$36,200,000	-	-
FY26 Program	7,700,000	$36,200,000	-	-
FY27 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000
FY28 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000
FY29 Program	7,700,000	$36,200,000	$10,000,000	$14,800,000

Commented [QA1]: Sarah will have to look at these funding and correct them..

Patch Funding to Districts is subtracted off the top from the State fund. The CTP budget is further divided following the NHS, STP-Fed, and State funding allocation rules. Three sets of additional constraint subdivisions, based on County, NHS Code, Functional Class, and Budget Groups, are used to build the State funding scenario (Table 2 and Table 3). Table 3 shows the budget constraints for year 1 of the analysis. This process is repeated for each year of the analysis. The excel spreadsheet used to determine the budget breakdown is attached. Right click on the Object, Select Work Sheet Object → Open to see the calculations. Once opened, create a copy (file -> save as) of the file in order to use the file for calculation. Select the **Title Page** tab before closing the spreadsheet.

State Funding
Calculation
Spreadsheet

Table 2: Budget Breakdown

County Breakdown %	County	% Lane Miles Managed	STP	Z001
	Kent	25%	20%	10%
	NCC	30%	50%	70%
	Sussex	45%	30%	20%
Treatment Breakdown %	Treatment	% Lane Miles Managed	STP	Z001
	Maint/ST	-	0%	0%
	Preservation	-	0%	0%
	Regab/Recon	-	100%	100%

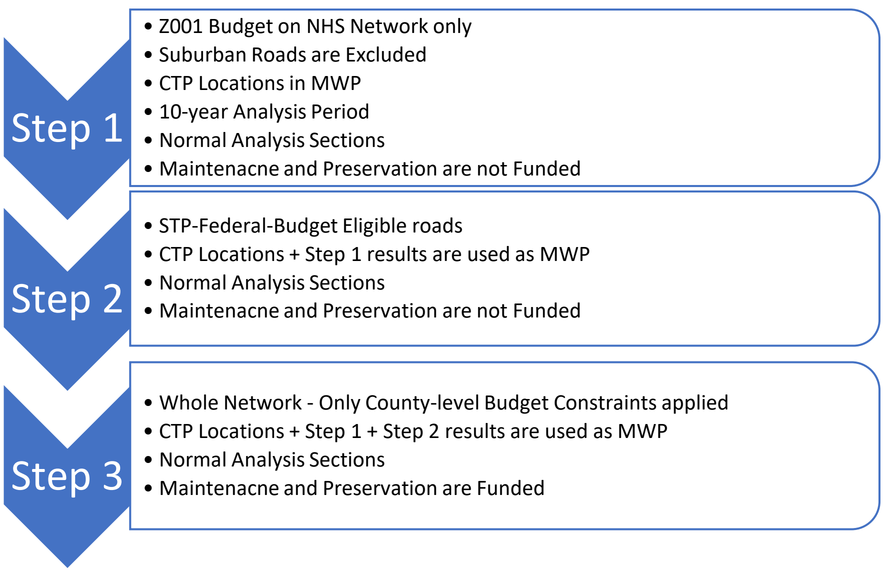
Table 3: Budget Constraints for Optimization Analysis for 1 year

Constraint Column	Constraint Limit Value	Add Constr.	Node Name	Comments
Treatment Cost	20,900,000	By County	Kent	The Sum of these budgets by County is equal to the total budget by Fiscal Year (STATE + FEDERAL) on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County is by % Lane Miles Managed.
	25,080,000		New Castle	
	37,620,000		Sussex	
	0	STP Fed Eligible	Kent-Maint/ST	The Sum of these budgets is equal to the total FEDERAL budget by Fiscal Year + the 20% STATE Match Budget on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County and Budget Group is user defined.
	0		Kent-Pres	
	4,464,000		Kent-Rehab/Recon	
	0		NCC-Maint/ST	
	0		NCC-Pres	
	11,160,000		NCC-Rehab/Recon	
	0		Sussex-Maint/ST	
	0		Sussex-Pres	
	6,696,000		Sussex-Rehab/Recon	
	0	Z001 Budget (NHS)	Kent-Maint/ST	The Sum of these budgets is equal to ((the total Z001 line item/the total FEDERAL budget) * 20% STATE Match Budget) + the total Z001 Budget on the Project Authorization Schedule sheet provided by DelDOT. The split in budget by County and Budget Group is user defined.
	0		Kent-Pres	
	1,337,359		Kent-Rehab/Recon	
	0		NCC-Maint/ST	
	0		NCC-Pres	
	9,361,513		NCC-Rehab/Recon	
	0		Sussex-Maint/ST	
	0		Sussex-Pres	
	2,674,718		Sussex-Rehab/Recon	

The three-step process followed to run Statewide optimization results is illustrated in the figure below. In the first step, scope of analysis is limited to NHS network and Normal Analysis Sections (with variable length). Suburban roads are excluded. Only Z001 Budget (NHS) funds are used to run the analysis for a 10-year analysis period. Master work Plan is included in the analysis if available. Maintenance and Preservation activities are not funded under this scenario.

The second step includes running the optimization analysis only on STP-Federal-Budget Eligible road sections which essentially exclude minor collectors, locals, and suburban roads from the analysis. Maintenance and Preservation activities are not funded under this scenario. The results from Step 1 are used as work plan in Step 2.

Step 3 involves running the optimization analysis on the whole network (but suburban roads), only the county specific Budget constraints are applied. The results from Step 2 are used as work plan in this step.



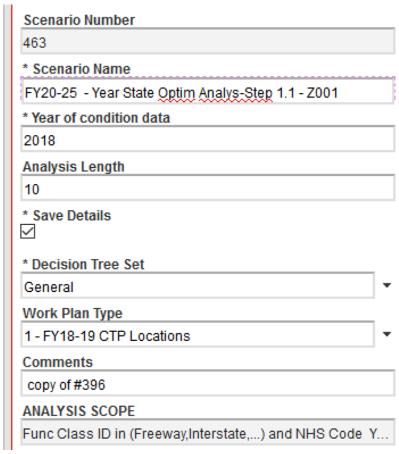
6. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), copy an existing template Scenario (FY20-25 State Optimization Analysis - Step 1 - Z001) with **Z001 Budgets** as additional constraint. That is, only Z001 portion of the funding (Table 3) is applied to select the projects in the first step.

Run Scenario
Insert
Edit Scope
Edit MWP scope
Copy Scenario
Download MPS file
Download LP File
Delete
Sort
Filter
Find
Filter By This Value
Work With Attachments...
Export Data
Copy rows to clipboard (CSV)
Copy all to clipboard (CSV)
Show Changes

Constraints Actions ▾

Is Objective	Constraint Column	Constr. Type	Constraint Limit Value	COND_TH...	Scenario...	Add Constr.	NODE NAME
☐	Treatment Cost	Total	0		8	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	0		9	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	0		10	Z001 Budget (NHS)	Kent-Pres
☐	Treatment Cost	Total	1		1	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1337359		2	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	696000		3	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		4	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		5	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		6	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		7	Z001 Budget (NHS)	Kent-Rehab/Recon
☐	Treatment Cost	Total	1200000		8	Z001 Budget (NHS)	Kent-Rehab/Recon

a. Select the *FY18-19 - 1 - CTP Locations* in Work Plan Type.
b. Analysis Length: 10
c. Year of Condition Data: 2019
d. Analysis scope:
   i. NHS Code: Yes
   ii. Functional Class: **All but Suburban**
   iii. Management Section: **Normal Analysis Sections**.
e. Analysis Type: **Multi-constraint**
f. Update the budgets
g. Run the analysis.

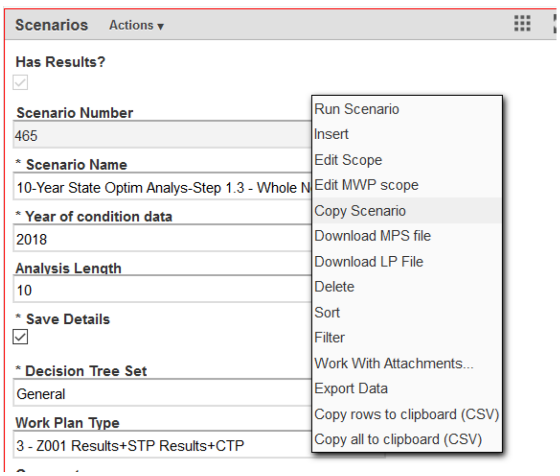


7. Populate the work plan “FY18-19 - 2 - Z001 Results + CTP” with CTP projects from “FY18-19 – 1 - CTP Locations” and the 1st scenario (Z001 Funding) analysis results.
8. In the Multi-Constraint Optimization window, copy an existing template (FY20-25 State Optimization Analysis - Step 1.2 - STP) of Step 2 with **STP Budgets** as the only additional constraint. Change the FY accordingly.
    a. Select FY18-19 - 2 - Z001 Results + CTP in Work Plan Type.
    b. Analysis Length: 10 (TAMP requires 4 years)
    c. Analysis scope:
        i. Functional Class: **All but Suburban**
        ii. Management Section: **Normal Analysis Sections**
    d. Analysis Type: **Multi-constraint**
    e. Run the analysis.
9. Populate the work plan “FY18-19 - 3 - Z001 Results+STP Results+CTP” with the projects obtained from the 2nd Scenario analysis results.
10. In the Multi-Constraint Optimization window, copy an existing template (FY20-25 - State Optim Analys- Step 1.3 - Whole Network) of Step 3 with the **county-level budgets** as the only additional constraint.
    a. Select the FY18-19 - 3 - Z001 Results+STP Results+CTP in Work Plan Type.
    b. Analysis Length: 10 (TAMP requires 4 years)
    c. Analysis scope:
        iii. Functional Class: **All but Suburban**
        iv. Management Section: **Normal Analysis Sections**
    d. Analysis Type: **Multi-constraint**
    e. Run the analysis.
11. See the results in Report Tab of the Multi-constrained Optimization window. Export the Report Tab as an excel file and analyze the results.
12. Field validate the projects selected by the optimization process.

8. Procedure – State Optimization Analysis for Transportation Asset Management Plan (TAMP) Reporting

In order to set and analyze targets for Federal reporting required under MAP-21/FAST Act, an extra step is added to the State Optimization Analysis procedure (See Section 8).

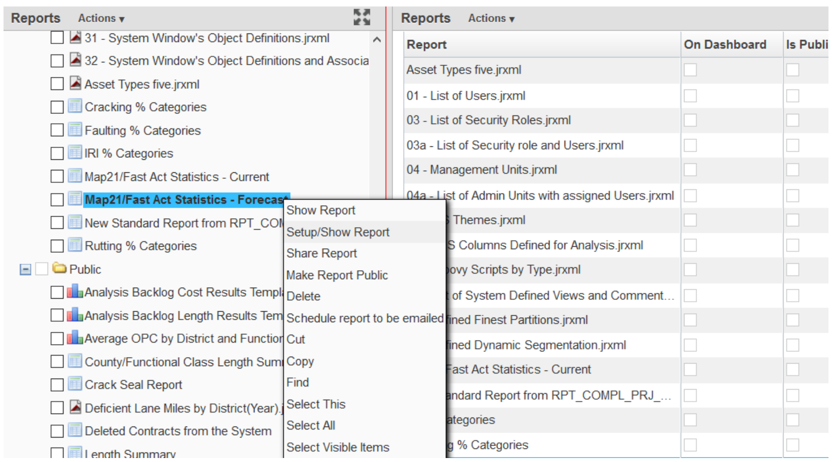
1. After running the 3rd Scenario of State Optimization Analysis (Section 8), create a new work plan comprising of projects obtained from the Step 3 of 3rd Scenario analysis results. Name it appropriately e.g. “FY18-19 - 4 - Whole Network used for MAP-21”.
2. In the Multi-Constraint Optimization window, copy the 3rd scenario (created in Section 8) to create a 4th and Final Scenario. It can be named as FY20-25 State Optim Analys- Step 2 - Whole Network



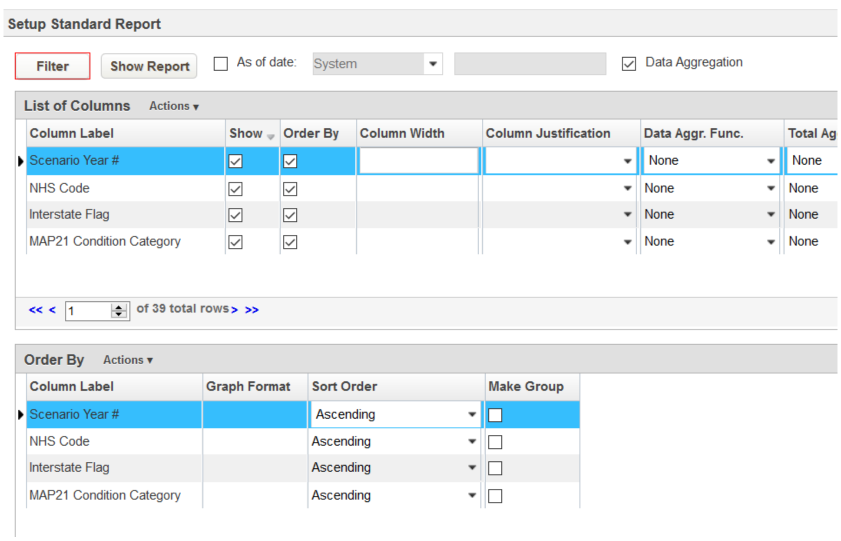
Make following changes in the new scenario:

a. Select the Whole Network - for MAP-21 Analysis in Work Plan Type
b. Analysis Length: 10 (TAMP requires 4 years)
c. Analysis scope:
    v. Functional Class: **All but Suburban**
    vi. Management Section: **HPMS/MAP21 Analysis Sections**
d. Analysis Type: **Estimate MWP Influence**
e. Run the analysis.

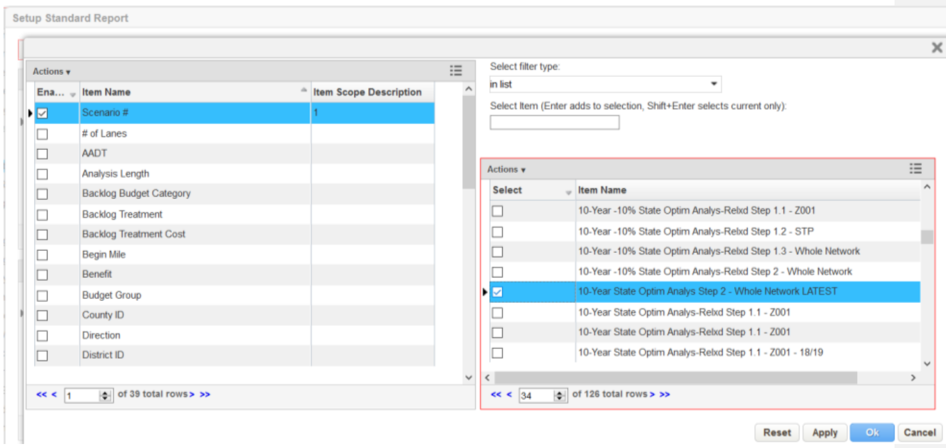
1. Export the Report Tab of the Multi-constrained Optimization window as an excel file and analyze the results.
2. In the Report Window (Pavement Management > Reports > Reports), right click on the report **Map21/Fast Act Statistics – Forecast.** Select Setup/Show Report on the right-click menu.



3. Press Filter in the Setup Standard Report pop-up window.



4. Select the appropriate Scenario and press OK.

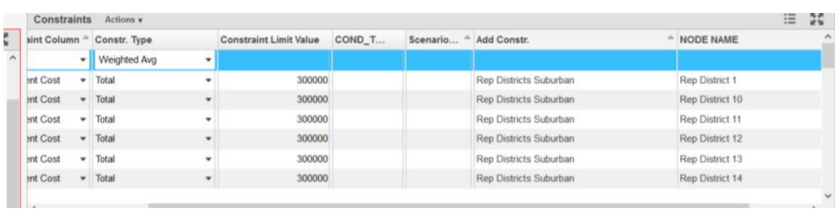


5. Select Show Report. The generated report can be downloaded in excel/csv files format to produce graphics.

9. *Procedure – Suburban Streets Optimization Analysis*

The Suburban Street optimization analysis is conducted in two steps. The first step involves running the analysis using Representative Districts funding for an analysis period of 10 years.

1. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), create a Scenario with **Rep Districts Suburban** as additional constraint.

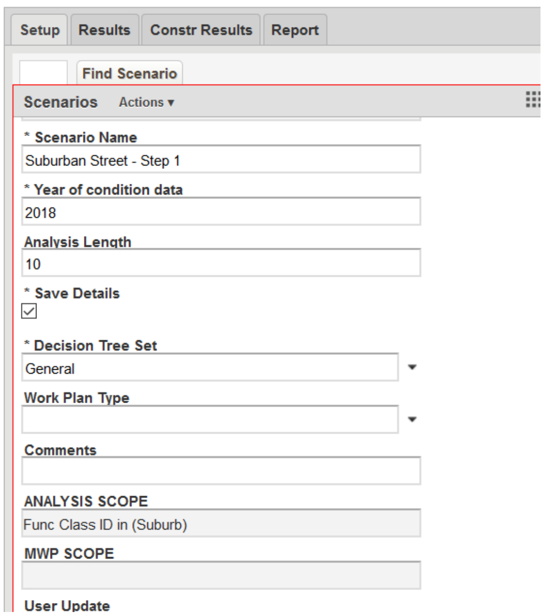


2. Allocate 300,000 to each of the 41 Representative Districts.
3. In the **Scenarios** pane, set:
    a. Analysis Length: 10
    b. Analysis scope:
        i. Functional Class: **Suburban only**

ii. Management Section: **Normal Analysis Sections**.

c. Analysis Type: **Multi-constraint**

4. Run the analysis.



5. Open **Master Work Programs** window (Pavement Management > Network Analysis > Configuration > Master Work Programs).
6. Insert a Work Plan Type "MWP_Rep Districts".
7. Open **Work Plan Data** (Pavement Management > Network Analysis > Work Plan Data) and Select "MWP_Rep Districts" from the dropdown menu **Select WP Type**.
8. Populate the Work Plan with the projects obtained in Step 1, using **Copy from the Analysis WP** in the right-click menu.
9. In the **Multi-Constraint Optimization window** (Pavement Management > Network Analysis > Multi-Constraint Optimization), create another Scenario with **Senate Districts Suburban** as additional constraint.
10. Allocate 300,000 to each of the 21 Senate Districts.
11. In the **Scenarios** pane, set:

d. Analysis Length: **10**

e. Work Plan Type: **MWP_Rep Districts**

f. Analysis scope:
   i. Functional Class: **Suburban only**
   ii. Management Section: **Normal Analysis Sections**.
g. Analysis Type: **Multi-constraint**
h. Run the analysis.

12. See the results in Report Tab of the Multi-constrained Optimization window. Export the Report Tab as an excel file and analyze the results.