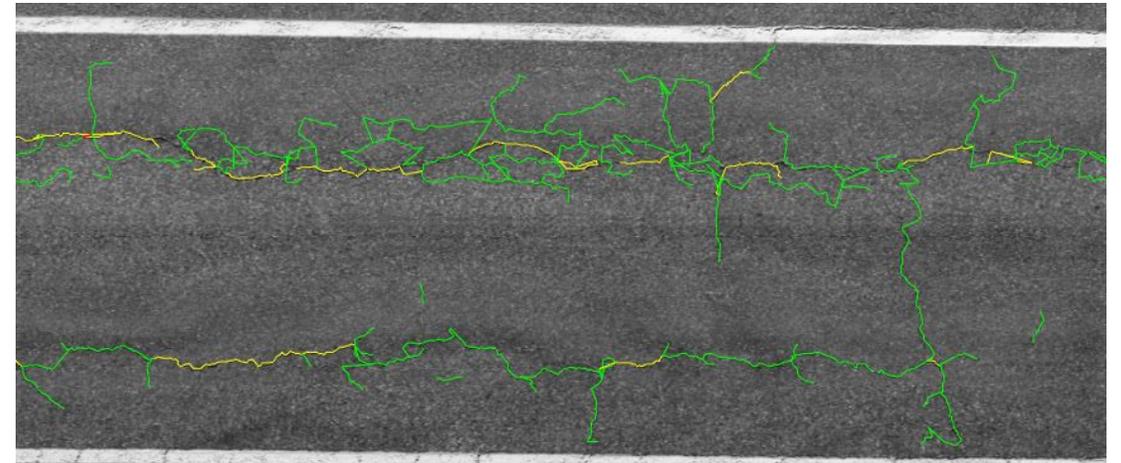# CTDOT's Experiences on DQMP

By

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Connecticut Department of Transportation

Two Main Topics of Presentation

- Data Quality Management Plan (DQMP) Development
- Overview of CTDOT's DQMP

DQMP Development

- Prepared by UConn in cooperation with CTDOT and FHWA

- Funded by State Planning and Research Project, SPR-2309

- A $123,000 effort

- Required by FHWA as part of the National Highway Pavement Performance Data Quality Management Program described in 23CFR§490.319(c)(USG2017)

- Held kick-off meeting on September 13, 2017

DQMP Development – CT Pavement Facts

- 7,738 directional miles (for the 3,719 centerline-mile-state-maintained roadway network) surveyed each year

- Represents 100% of the Interstate, Primary and Secondary system of Connecticut's state highway network

- An additional 328 miles of the local road network surveyed as needed for HPMS program

- 70.5% of CTDOT maintained roadways are flexible pavements, 29.0% are composite pavements, and under 0.5% are rigid pavements

- So, over 99% of these pavements have asphalt surfaces

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DQMP Development – UConn's Methodology

- Perform literature review

- Evaluation existing CTDOT procedures

- Establish data acceptance thresholds

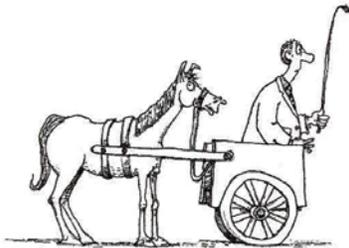- Develop, prepare, and submit DQMP

DQMP Development – Literature Review
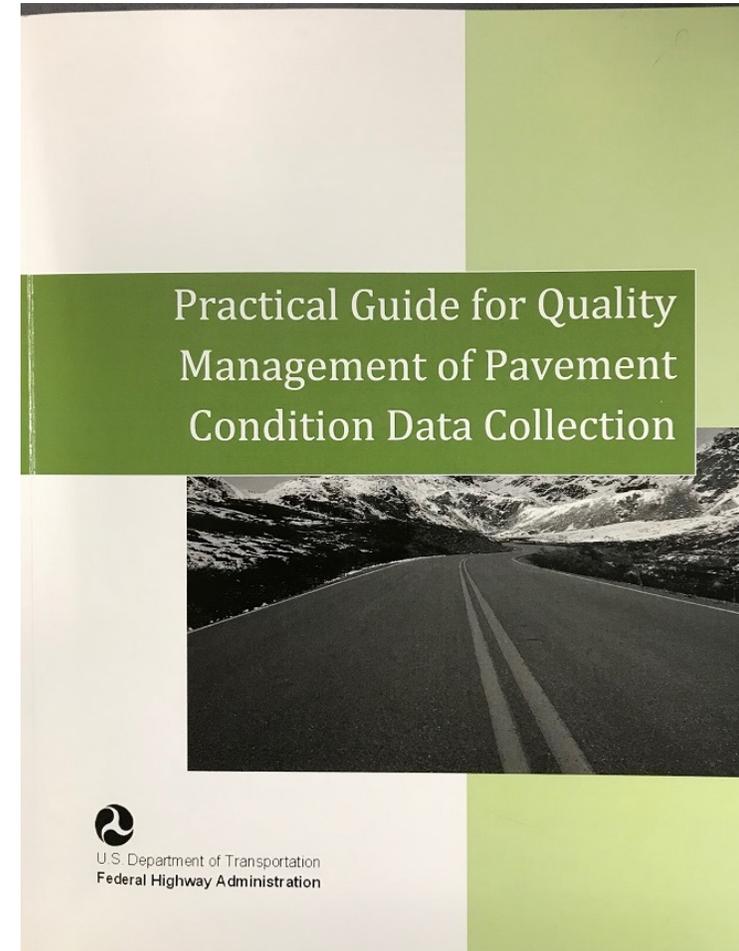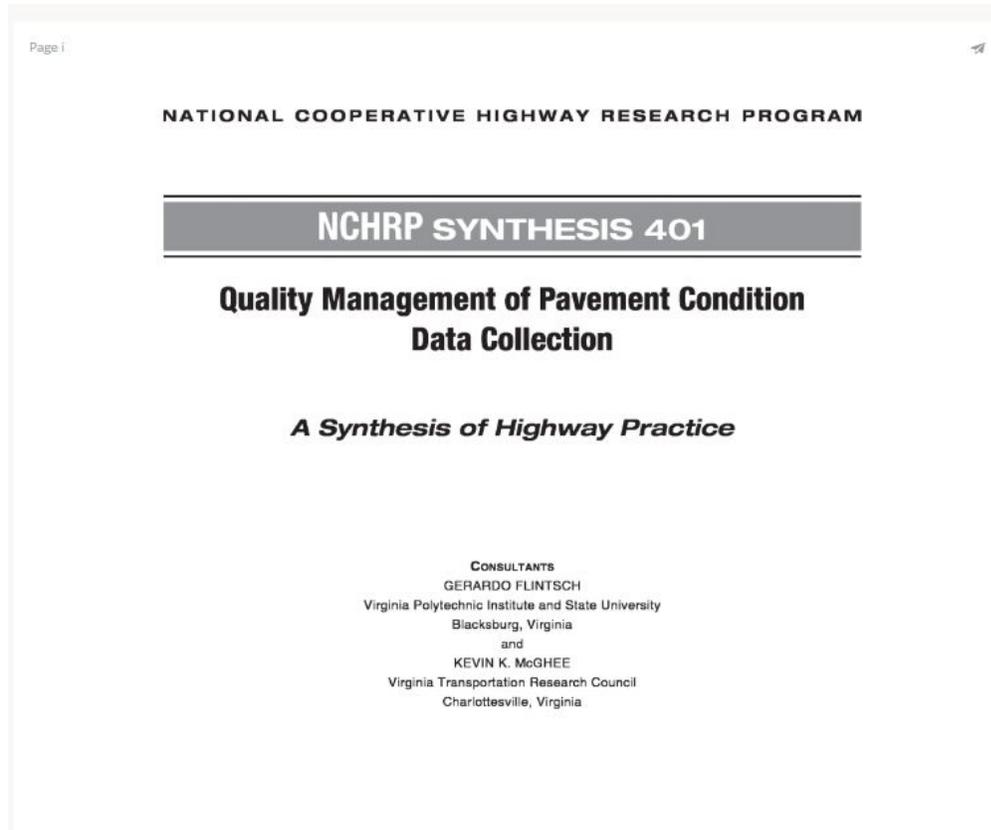
DQMP Development Literature Review

- Guidelines for development published on June 15, 2018

- DQMP due data on May 20, 2018

- States collect data for Interstates that conform to the final rule: January 1, 2018

Guidelines for Development and Approval of State Data Quality Management Programs

Introduction

High-quality data is a critical part of performance-based management of highway pavements. Although many States use data quality practices, few have documented or formalized these into standard processes. Because of the importance of pavement performance data to decisions involving the Federal-aid program, the National Performance Management Measures: Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program (PM2) rule established ride (IRI), rutting, faulting, and cracking percent, or present serviceability rating (PSR) (can be used as an alternative to IRI, rutting, faulting, and cracking for NHS routes with speed limits less than 40 mph) as the pavement condition metrics, per 23 CFR 490.309[1] –"Data Requirements." States must collect and report these condition metrics to the Federal Highway Administration (FHWA) Highway Performance Monitoring System (HPMS) in accordance with the HPMS Field Manual[2] for the purpose of determining the condition of 0.1-mile sections and eventually calculating pavement measures in terms of good, fair, and poor per 23 CFR 490.309.

The PM2 rule also requires States to develop Data Quality Management Programs (DQMPs) appropriate for their agency, per 23 CFR 490.319. The DQMP requirement in the PM2 rule is intended to help States improve the accuracy of the pavement condition metrics noted above. A DQMP is a document that defines the acceptable level of data quality and describes how the data collection process will ensure this level of quality in its deliverables and processes.

An effective DQMP should address the critical areas where errors can occur. Even in the best of programs, errors often are made due to data collection equipment malfunction, unintended mistakes by operators, computer glitches, mechanical failures, and other issues that can result in poor data and the need for expensive recollection efforts.

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

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
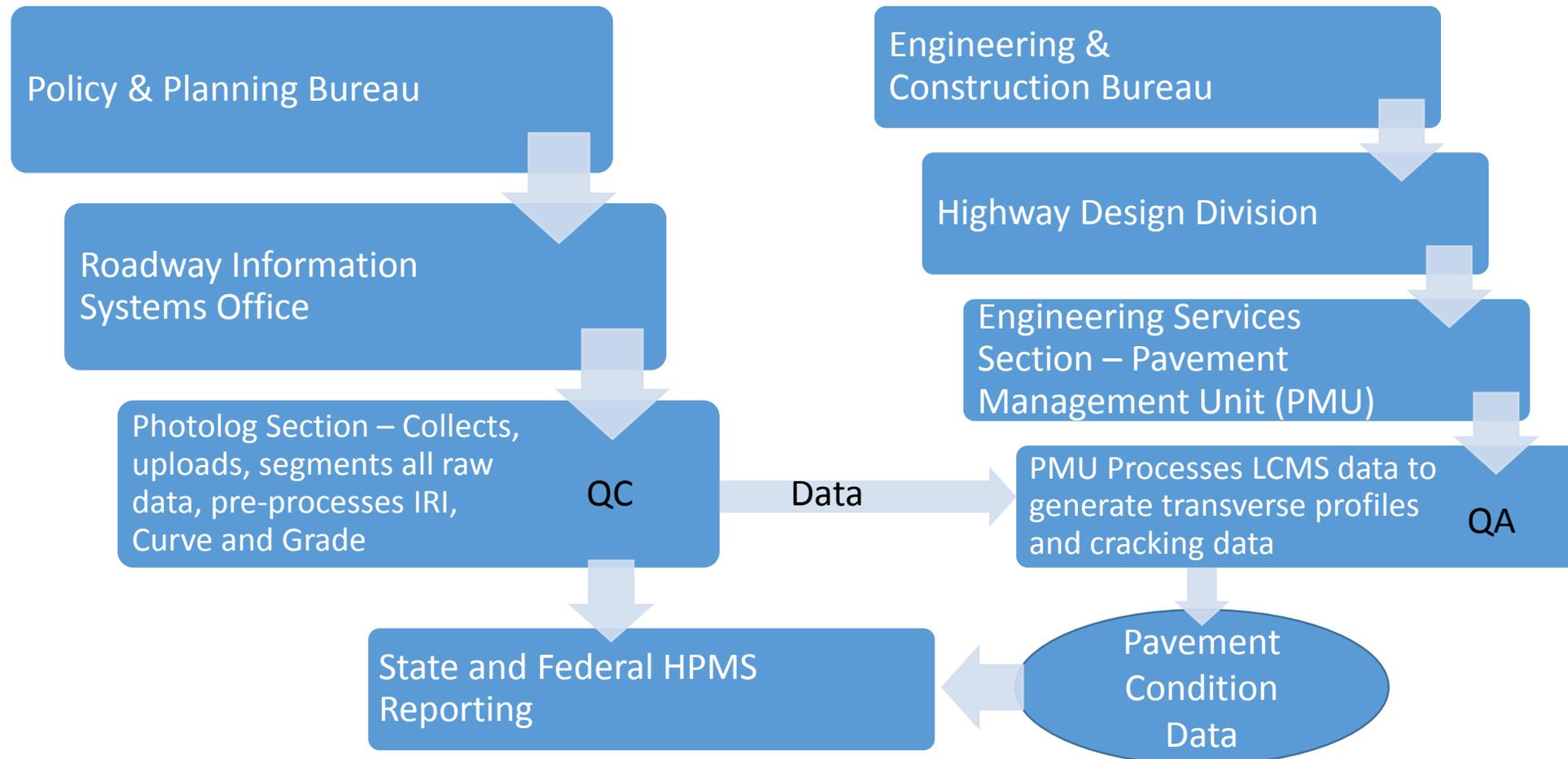E. Error resolution procedures and data acceptance criteria.

DQMP Approval Process and Possible Outcomes

The FHWA Division Office is responsible for reviewing and approving the State DOT DQMP. This DQMP Guidance is a tool to help the FHWA Division Office assess the elements and completeness of a State DOT's DQMP. Per 23 CFR 490.319(c)(2), not later than one year after the effective date of the PM2 rule (May 20, 2017), each State

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[1] National Performance Management Measures: Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program (PM2) rule under 23 CFR part 490: https://www.federalregister.gov/documents/2017/01/18/2017-00550/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway
[2] Highway Performance Monitoring System (HPMS) Field Manual: https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/ . The Field Manual is incorporated by reference in 23 CFR 490.111.

DQMP Development – Existing Procedures

Policy & Planning Bureau

Roadway Information Systems Office

Photolog Section – Collects, uploads, segments all raw data, pre-processes IRI, Curve and Grade

QC

Data

State and Federal HPMS Reporting

Engineering & Construction Bureau

Highway Design Division

Engineering Services Section – Pavement Management Unit (PMU)

PMU Processes LCMS data to generate transverse profiles and cracking data

QA

Pavement Condition Data

30 years on the Road To Progressively Better Data
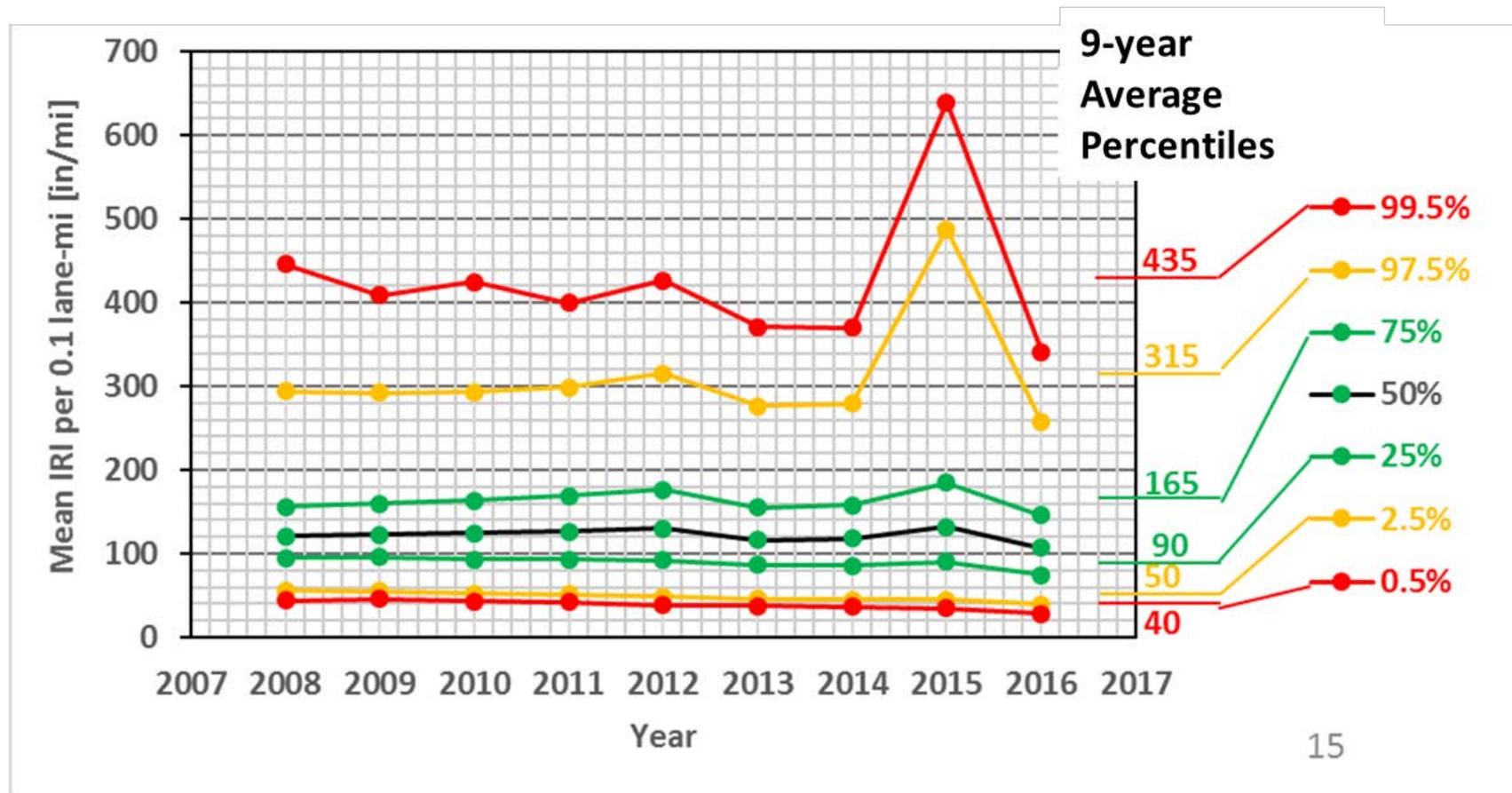
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DQMP Development – Existing Equipment

FUGRO 9000 Series ARANs

- Pave3D Pavemetrics Laser Crack Measurement System (LCMS)

- South Dakota Profiler RoLine – 4" Footprint Line Laser

- SONY HD Camera with 90 Degree Field of View Lens

DQMP Development –
Data Acceptance Thresholds

DQMP Development – Timeline to Prepare and Submit DQMP

- March 7, 2018 – UConn sends 1st draft to CTDOT for review

- May 17, 2018 – UConn sends revised DQMP for FHWA submission

- May 18, 2018 – DQMP submitted to FHWA for approval

- May 20, 2018 – DOT deadline to submit DQMP to FHWA Division Offices

- June 21, 2018 – Met with FHWA CT Division Office to be briefed on their comments

- August 22, 2018 – Final revised DQMP submitted to FHWA

- August 22, 2018 – Received FHWA approval

Fun Fact: Connecticut Shade Tobacco Considered the Finest in the World for Making Cigar Wrappers

Route 191, Enfield

Connecticut River Valley, South Windsor

Overview of CTDOT's DQMP

1. Roles and responsibilities
   - Photolog Unit
   - Pavement Management Unit
2. Certifications for persons performing manual data collection
3. Equipment Calibration/Certification
   - ARANs
   - Walking Profiler (Reference Profiler)
4. Quality Control (QC)
5. Deliverables, Protocols & Quality Standards
6. Data acceptance and error resolution

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Roles and Responsibilities

- Agency Managers
- Quality Control Supervisor
  - QC Lead
  - Field Crew Lead
  - Data Lead (Photolog Unit)
- Quality Assurance Supervisor
  - Data Lead (Pavement Management Unit)

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Certifications/Qualifications of Staff Performing Manual Ratings

- Process required for persons performing manual rating of data according to Federal regulations
- CTDOT uses manual ratings for validation sites and reference checks for crack detection
  - A lead rater was identified
    - 17 years' experience
    - CTDOT subject matter expert
    - Serves on NCHRP 01-57A, *Standard Definitions for Comparable Pavement Cracking Data*
  - Adopting LTPP Distress ID Manual and HPMS Field Manuals
- CTDOT performs network surveys in-house with owned equipment
- CTDOT uses manual collections with walking profilers

Crack Detection Evaluation Report

- Knowledge of LTPP Distress ID Manual
- Knowledge of metrics identified in HPMS Field Manual
- Ability to apply knowledge during manual ratings

Check		
Pass	**Fail**	
☐	☐	**Candidate demonstrates thorough knowledge and understanding of the pavement condition rating methodology contained in the Distress Identification Manual for the Long-Term Pavement Performance Program.**
☐	☐	Distresses for AC Surfaces — Comments:
☐	☐	Distress for Jointed PCC Surfaces: — Comments:
☐	☐	**Candidate demonstrates thorough knowledge and understanding of the pavement condition metrics identified in the December 2016 HPMS Field Manual.**
☐	☐	IRI — Comments:
☐	☐	Rutting — Comments:
☐	☐	Cracking Percent (AC Pavements) — Comments:
☐	☐	Cracking Percent (Jointed PCC Pavements) — Comments:
☐	☐	**Candidate demonstrates the ability to apply above knowledge and understanding during manual pavement ratings.**

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Walking Profiler Evaluation Report

- Knowledge of setup and calibration of SSI Walking Profiler
- Demonstrates ability to operate and effectively collect profile data with equipment

Operator:		Evaluator:		Date:	Evaluation Score Pass / Fail
Check		**Description**			**Comments**
Pass	Fail				
☐	☐	**Candidate demonstrates thorough knowledge and understanding of setup and calibration of SSI CS8800 Walking Profiler**			
☐	☐	Software Understanding	Comments:		
☐	☐	Profiler Components			
☐	☐	Setup, Activation and Charging			
☐	☐	Calibration procedures			
☐	☐	**Candidate demonstrates thorough knowledge and understanding of use and effective collection data of SSI CS8800 Walking Profiler**			
☐	☐	Startup procedures	Comments:		
☐	☐	Collection Procedures			
☐	☐	Performed successful collection			

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ARAN Driver and Operator Training

- Knowledge of condition and geometric data

- Knowledge of ARAN equipment, systems, operation and calibration

- Knowledge of safety, environmental conditions, mechanical checklist

- Able to effectively collect pavement condition data

Operator:		Evaluator:		Date:	Evaluation Score Pass / Fail
Check		Description		Comments	
Pass	Fail				
☐	☐	Candidate demonstrates thorough knowledge and understanding of pavement condition and geometric data			
☐	☐	Transverse Profile	Comments:		
☐	☐	Longitudinal Profile			
☐	☐	IRI			
☐	☐	Faulting			
☐	☐	Cracking			
☐	☐	Curve			
☐	☐	Grade			
☐	☐	Candidate demonstrates thorough knowledge of ARAN Van equipment, systems and operation and can locate and describe each.			
☐	☐	Rights of Way Video	Comments:		
☐	☐	GPS Positioning (GPS)			
☐	☐	Pave3D LCMS System			
☐	☐	Roughness System (IRI)			
☐	☐	Position & Orientation System (POS-LV)			
☐	☐	Distance Measuring Unit (DMI)			
☐	☐	Grade Sensors			
☐	☐	Candidate demonstrates through knowledge and understanding with successful equipment calibration			
☐	☐	Bounce Test	Comments:		
☐	☐	DMI Calibration			
☐	☐	Block Test			
☐	☐	Bucket Test			
☐	☐	LCMS Laser Height Check			
☐	☐	Candidate demonstrates thorough knowledge and understanding of operational standards and ability to correctly navigate vehicle during collection operations	Comments:		
☐	☐	Candidate demonstrates thorough knowledge and understanding of ARAN Van Safety (Operational Practices, equipment	Comments:		
☐	☐	Candidate demonstrates thorough knowledge and understanding of acceptable environmental conditions for collection	Comments:		
☐	☐	Candidate demonstrates effective use of Photolog Daily Mechanical Inspection Check List	Comments:		
☐	☐	Candidate demonstrates effective operation of ARAN Vehicle Systems and performed successful collection of data	Comments:		

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Equipment Calibration

- FUGRO 9000 Series Vans
  - Annual preventive maintenance and calibration by FUGRO
- Monthly calibration by trained Photolog staff
- SSI CS8800 Walking Profiler
  - Calibrated prior to each use by Photolog staff according to specifications

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Quality Control Section of DQMP

- Identifies major deliverables tested for quality level
  - IRI, Rutting, Faulting, Cracking, Cross Slope, Grade, ROW Imagery
- Identifies expectation for the deliverables
- Identifies QC activities that need to be executed to control and monitor quality of deliverable
- Defines frequency of activities

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Daily Collection QC Measures

Specific QC Procedure	Action Performed	Frequency	Quantity
Preventive maintenance and calibration of ARAN equipment	Perform height sensor bounce tests, laser calibration block tests, accelerometer calibration checks, distance calibration, sample IRI calculation and other checks,	Annually, or as specified by manufacturer	As prescribed by manufacturer
Testing of reference validation sites	Perform at least five runs each on designated sections for IRI, cracking, transverse profile, rutting and faulting	Start of season and following equipment upgrades or calibrations	~50 (5 runs on ~10 sections (or the number of sections designated))
Verification testing of reference validation sites during production	Collect same data with both ARAN vans	Monthly	Run all verification sites

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Specific QC Procedures

Deliverable	Quality Expectation	QC Activity	Frequency/ Interval
Vehicle Configuration	• Inspect and clean laser apertures, windshield, and camera lenses • Inspect hardware and mountings • Check tire pressure • Collect small sample route	Check	Prior to daily collection
	• Bounce and block tests, crack measurement system height check	Validation	Monthly

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Deliverables, Protocols and Quality Standards

Deliverable	Reference Protocols/ Standards	Required Meas. Res.	Required Accuracy Limits (compared to reference values)	Required Reprod. Limits (between CTDOT vehicles)	Required Repeatability Limits (for five consecutive runs)
IRI (left, right, and MRI average over 0.1-mi sections)	AASHTO R 43-13 AASHTO R 56-14 AASHTO R 57-14 AASHTO M328-14 ASTM E1926-98 HPMS Field Manual	1 in/mi	± 8 percent	Absolute Difference in IRI <10 in/mi (95% PWL****)	Each run within ± 5 percent of the mean of five runs (95% PWL****)
Rut depth (average of right and left wheelpath over 0.1-mi sections)	AASHTO R 48-10 AASHTO PP 70-14 AASHTO PP 69-14 HPMS Field Manual (2016)	≤0.04 in.	± 0.08 in.	Absolute Difference in rut depth <0.06 in (95% PWL)	Within ± 0.06 in. Standard Deviation from mean of five runs (95%PWL)

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Deliverables, Protocols and Quality Standards

Deliverable	Criteria* for Data Checks (Routine 0.10 mile CTDOT Network Sections)	Criteria** for Data Checks (HPMS 0.1 mile Sections)
IRI (left, right, and MRI average per section)	40-450 in./mile (99%****)	• Min. 30 in/mi. • Max. 400 in/mi.
Rut Depth (average of right and left wheelpath per section)	≤0.5 in. (99%)	Max. - 1.00 in.
Faulting (average of right wheel path per section for faults greater than 0.2 in)	≤0.5 in. (90%)	Max. - 1.00 in.

Data Acceptance and Error Resolution

- Documents data sampling, review, and checking processes to verify
  - Proper data format
  - Completeness (including checks for missing data)
  - Consistency, and
  - Range
- Documents an error resolution procedure and acceptance criteria
- Documents that error logs will be maintained throughout the entire process:
  - Data collection
  - Quality Control, and
  - Post-Processing

Data Acceptance and Error Resolution

Deliverable	Acceptance Testing & Frequency	Corrective Action
IRI, rut depth, faulting, cracking, cross slope, longitudinal grade	1. Monthly (min.) verification using validation sites 2. Global database check for range, consistency, logic, and completeness 3. Inspection of all suspect data	1. Re-calibration of vehicle equipment 2. Reject deliverable; data must be re-collected 3. Determine reason for suspect data; or reject deliverable, data must be re-collected

Data Acceptance and Error Resolution

Acceptance Procedures	Action Performed	Frequency	Quantity
Checks of Periodic testing of known validation sites during production	Review QC findings	As needed	50%
Checks of Cross Measurements for reproducibility	Review QC findings	As needed	50%

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Global Database Checks

Acceptance Procedure	Action Performed	Frequency	Quantity
Missing Routes	Check for missing routes	Annually	100%
Data exists for all road segments	Check for missing data by segment	Annually	100%
Data file structure	Check format of file structure	As needed	As needed
Start and end boundaries for all road segments	Find and list segments containing incorrect boundaries; investigate	Annually	100%
Null and negative values	Find and list out of tolerance data, investigate, edit as necessary	As needed	As needed

Quality Management Reporting

- Annual quality management report to summarize the following:
  - Quality Control
  - Acceptance, and
  - Procedural issues

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Quality Control Report - Documentation

- Equipment and Personnel

- Calibration/checks/maintenance

- Schedule adherence and reasons for any changes

- Collection procedures and protocols, incl. any changes

- Applicable guidance documents

- Validation site testing and results

- Log of issues

- Summary of annual review of all QC processes performed

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Acceptance and Quality Management Report

- Quality standards and acceptance criteria
- Validation sites and reference values used
- Analysis of validation site testing results
- Global database checks performed, and the results

- Sampling checks and results
- Acceptance checks and results
- Log of all quality issues through acceptance checks and corrective actions taken
- Summary of annual review
- Recommendations for improvements

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Thank You

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