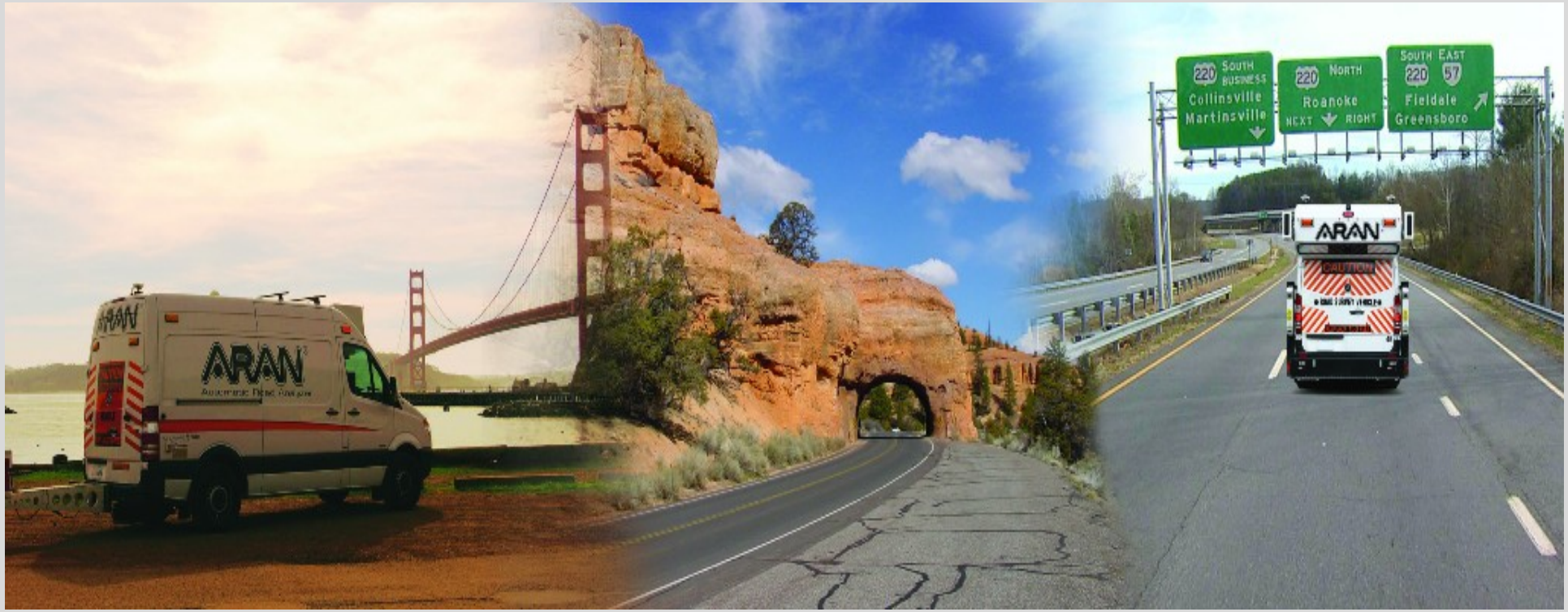


Data Quality Management Programs for the FAST Act

Michael Robson, Asset Management Specialist

DQMP Requirements

DQMP Requirements

‘Living’ +
‘Working’
Document

FAST Act DQMP Requirements

§ 490.319(c) leaves the design to the State DOTs, “as long as it includes the following items:

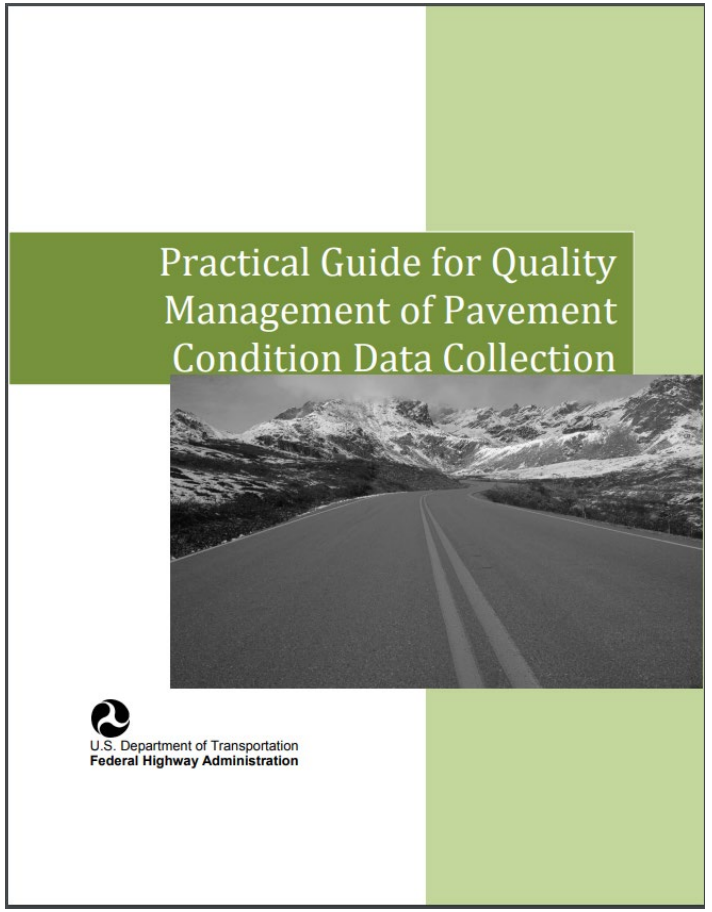
- Data Collection equipment, **calibration**, and **certification**;
- **Certification process** for persons performing manual data collection, if used;
- **Data quality control measures** conducted both before data collection begins and periodically during the data collection program;
- **Data** sampling, review, and checking processes; and
- **Error resolution** procedures and data acceptance criteria.”

DQMP Objectives

- **Evaluation and updates** of data collection, processing, and reporting protocols considering **agency goals and objectives**
- Better **compliance** with data standards and protocols
- **Improved completeness**, accuracy and consistency of data – **April 15th submission**
- Increased **data credibility** within the organization
- **Cost-savings** from more appropriate data-driven treatment recommendations
- **Increased accuracy** of budget need determinations
- **Better integration** with other internal agency data
- **Compliance** with FHWA MAP-21/FAST Act requirements published January 2017 and effective May 2017

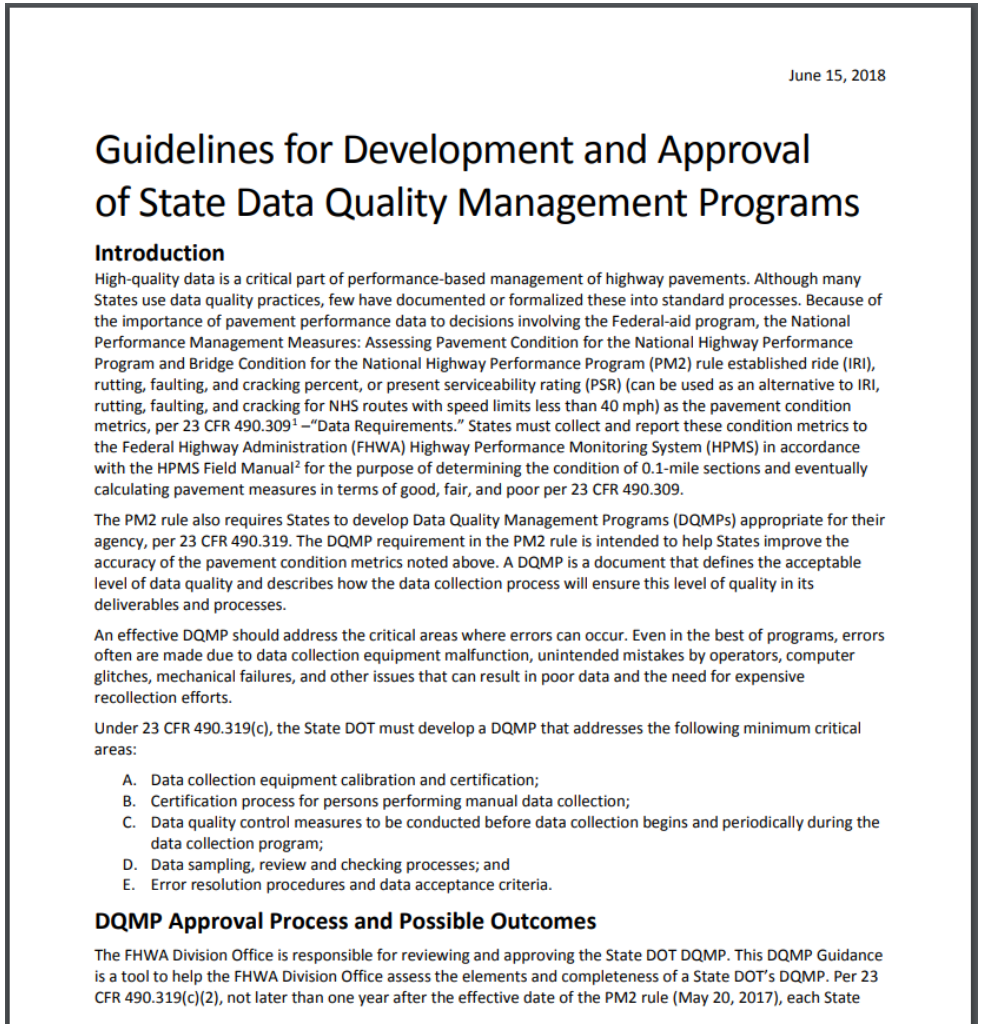
Resources for DQMP

- FHWA DQMP Guide (June2018)
  - Development & Approval Process
- FHWA Practical Guide
  - Guidance on contents
- NCHRP Synthesis 401
  - Data quality approaches
  - The state of the practice
- HPMS materials
  - Guidance on data quality
  - continuous process improvement
- FHWA Website
  - reports & recorded webinars
- **NCHRP Synthesis 20-05/Topic 49-15 - TRB**



Outcome of FHWA DQMP Review

- **Compliance: meets requirements**
- **Substantial Compliance: minor revisions**
- Conditional Compliance: plan for corrective action
- Non-Compliance: **FAIL!**



June 15, 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

Quality Management Approach

- Administered by the DOT
- DQMP sets quality standards, roles and responsibilities
- QC is conducted by Data Collection Contractor
- DOT staff conduct quality acceptance.
- Documentation through the quality reporting plan.
- Process improvements by continuous quality assurance.

Typical Contents of DQMP

- **Data Collection Protocols & Quality Standards**
  - Deliverables, Protocols & Quality Standards
  - Reference or “Ground Truth” Measurement
  - Monthly Control & Weekly Verification Sites
  - Equipment Calibration & Certification Protocols
  - Certification of Equipment & Software Operators
- **Data Quality Control Measures: Contractor or In-House**
  - QC Before Data Collection
  - QC During Data Collection
  - QC After Data Collection
  - Error Tracking & Resolution Procedures
- **Data Quality Acceptance Criteria: DOT**
- **Quality Assurance Plan**
  - Documentation & Training
  - Process Improvement
- **Quality Reporting Plan**
  - QC Log
  - Acceptance Log
- **Roles & Responsibilities**

Deliverables, Protocols and Quality Standards

Example for Pavement Performance Measures

Deliverable	Protocol	Resolution & Reporting	Accuracy (compared to reference)	Repeatability (out of 3 runs)
International Roughness Index (IRI)	Collection of Longitudinal Profile: AASHTO R57-14 Quantification of IRI: AASHTO R43-13	Nearest 1 inch per mile Report MRI (average of left and right IRI)	± 5%	± 5%
Rut Depth	Collection of Transverse Profile: AASHTO R88-18 Quantification of Rut Depth: AASHTO R87-18	Nearest 0.01 inch Report average rut depth of two wheel paths	± 0.08 inches	± 0.08 inches
Faulting	Measurement and Quantification: AASHTO R36-17	Nearest 0.01 inch Report average absolute faulting of all joints in the right wheel path, including zero values	± 0.04 inches	± 0.04 inches
Percent Cracking	Image Collection: AASHTO R86-18 Cracking Estimation: AASHTO R85-18	Nearest 1% Report Percent Cracking	± 10% AC ± 20% PCC	± 10%

Quality Control Measures

Example QC Activities Before Data Collection

Deliverable	Quality Expectations	QC Activity	Frequency
All Pavement Data	Completeness	Plan collection route	Once, prior to data collection.
		Routing QC to match DOT supplied info	Once, prior to data collection.
		Define equipment configuration	Once, prior to data collection.
		Verify equipment configuration	Once, prior to collection. Also conducted after any equipment changes.
	Accuracy and Repeatability	Equipment calibration	Once, prior to collection. Also conducted after any equipment changes.
		DMI calibration	Once, prior to data collection. Also conducted during and after data collection.
		Data collection and data processing personnel certification	Once, prior to data collection.
Distress and Sensor Data	Accuracy and Repeatability	Control sites measurements	Once, prior to data collection. Also conducted during and after data collection.

Quality Control Measures

Example QC Activities During Data Collection

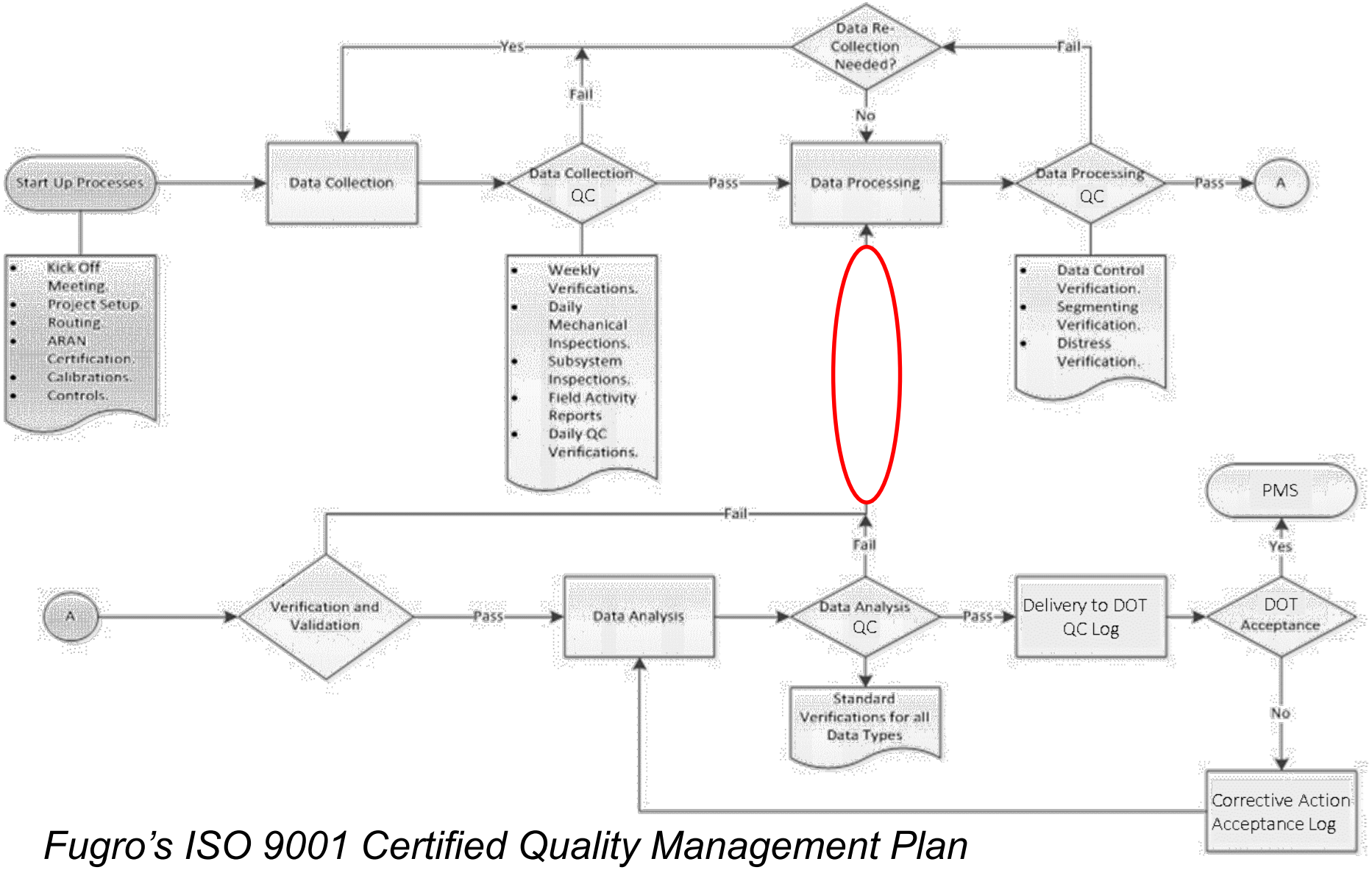
Deliverable	Quality Expectations	QC Activity	Frequency
All Pavement Data	Safety/ Efficiency	Mechanical inspection	Daily
		Preventative maintenance program	According to program
	Completeness	Field activity report including the collection location info	Daily
	Accuracy	Subsystem checks (sensors, computers, software)	Daily
		Real-time quality monitoring (monitor images and data streams during collection)	Daily
		End of day verification (review sample of data and images from day's collection)	Daily
		DMI calibration	Monthly
		Check environmental conditions (dry pavement surface, temperature within equipment operating range)	Daily
Distress and Sensor Data	Accuracy and Repeatability	Control sites	Monthly
		Verifications sites	Weekly

Quality Control Measures

Example QC Activities After Data Collection

- **Completeness Checks**
  - Network Coverage
  - Section Coverage
  - Fields in Each Table (Data Type, Blanks, Duplicates)
  - Tables in Relational Database
- **Range Checks**
  - Acceptable Range
- **Accuracy &Repeatability**
  - Control Sites: Entry, Monthly, Exit
  - Verification Sites: Weekly
- **Logic**
  - Distresses individually & sum to match section length or area
  - Distress data matching pavement surface type
- **Reasonableness**
  - Year-to-Year Analysis: deterioration trends

Example Quality Control Plan



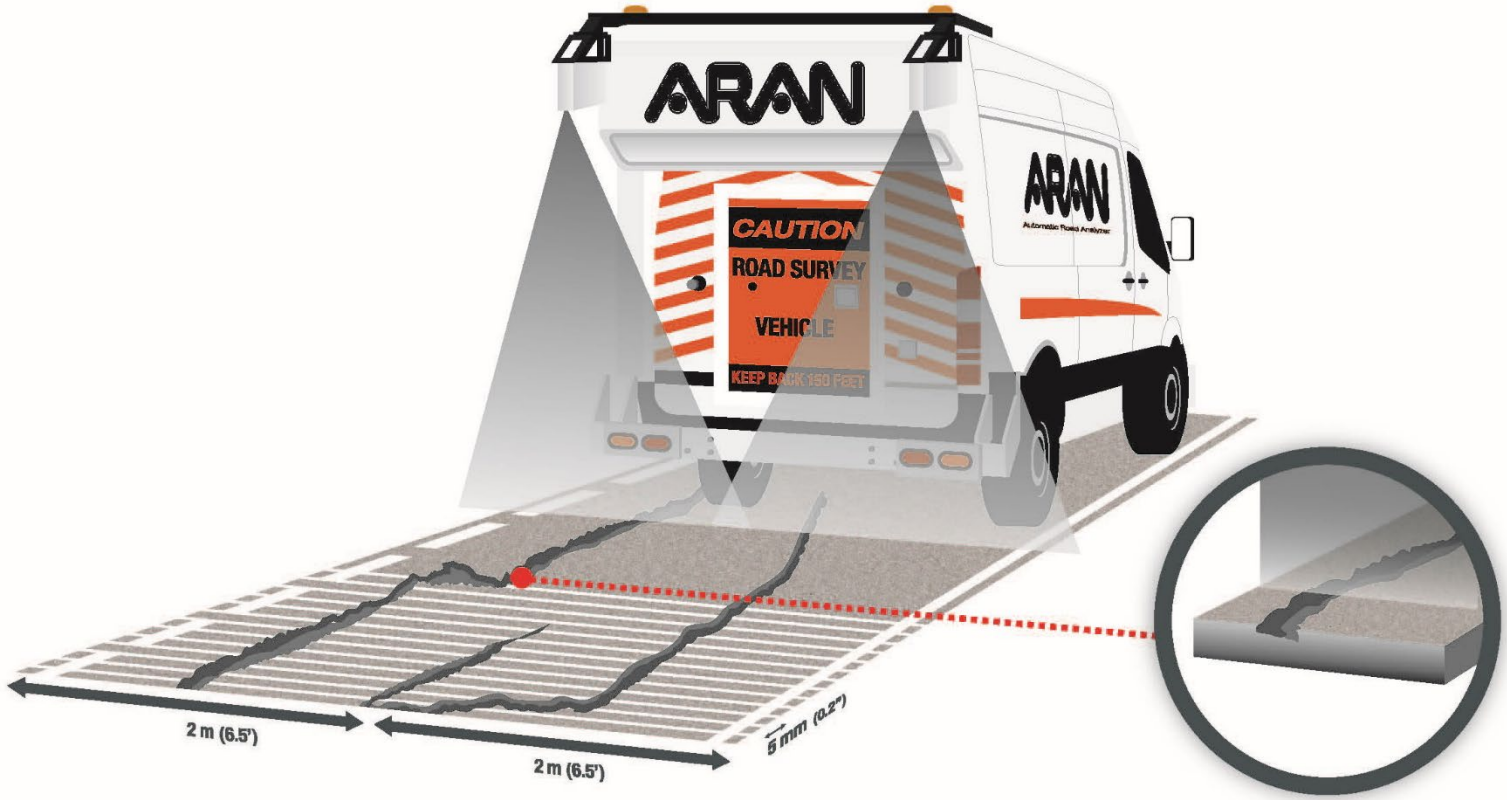
Fugro's ISO 9001 Certified Quality Management Plan

Quality Acceptance Criteria

Example Quality Acceptance Procedures and Criteria

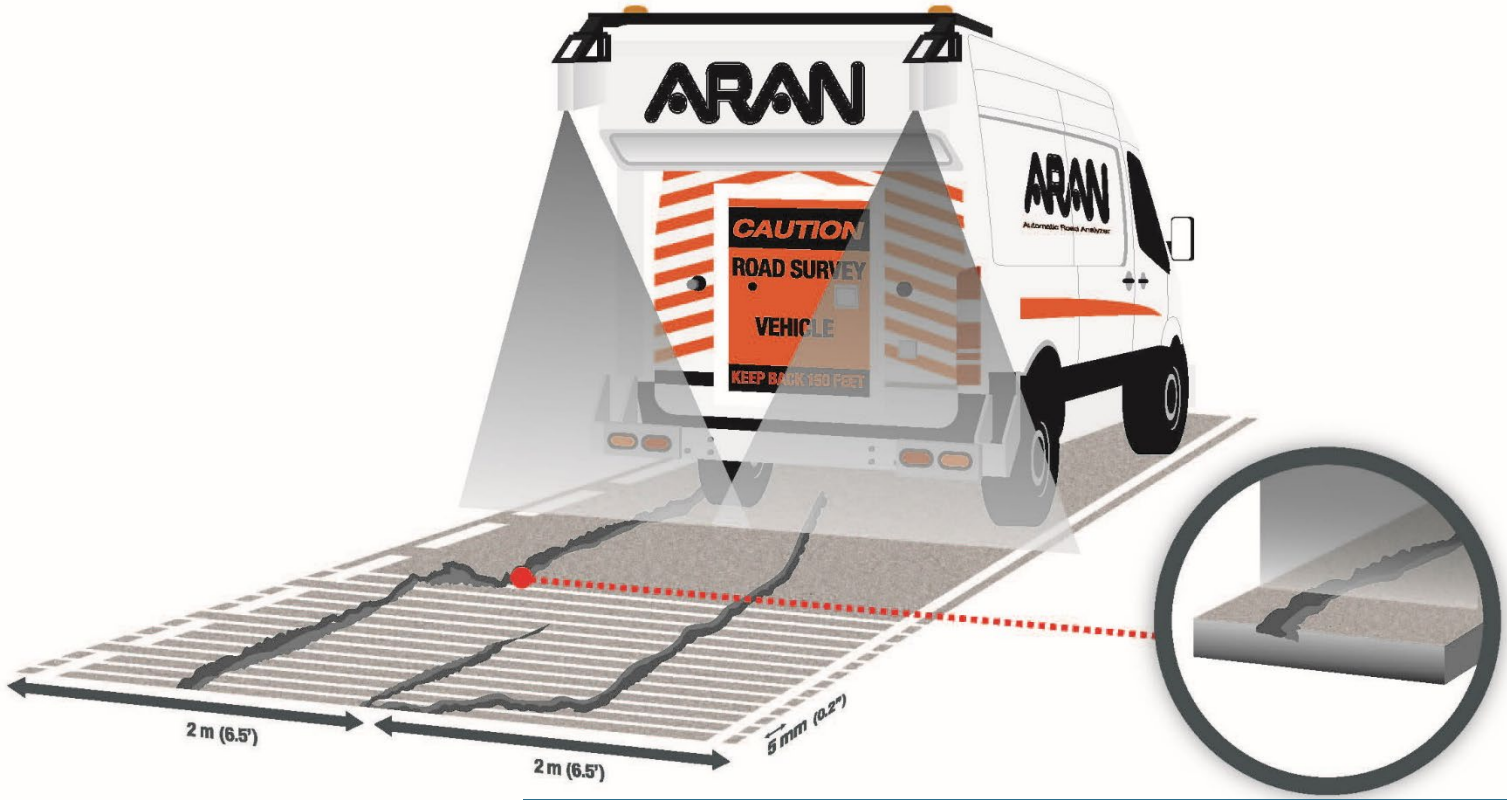
Quality Expectation	Acceptance (Percent within the Limits)	Acceptance Testing	Action if Criteria Not Met
Correct data type and format	100%	Data type (integer, string, etc.) and format check according to data dictionary	Correction
Accurate location information	98%	GPS coordinates within acceptable accuracy compared to ARDOT values for each section; unique GPS coordinates for each data record; data alignment check	Re-Collection
Correct data according to surface type	98%	Collected pavement type matching DOT supplied type (e.g. no faulting on flexible pavements, etc.)	Correction or Re-Process
Individual data within acceptable range	98%	Check individual data values to be within acceptable range established by DOT	Re-Collection Re-Process
Reasonable IRI Data	98%	Flag 5-m data with the following ➢ Collection Speed < 40 mph ➢ IRI zero or null values ➢ IRI > 400 in./mi. ➢ IRI < 30 in./mi. ➢ IRI value difference > 30% from left to right wheel path	Review and if not justified, send for Re-Collection or Re-Process

Pave3D: LASER CRACK MEASUREMENT SYSTEM



- Crack Detection >2mm
- 1 mm (0.04”) Resolution
- 4160 point Rutting
  - 3D & 2D Data:

Pave3D - 2: LASER CRACK MEASUREMENT SYSTEM



- @ twice data rate
- Crack Detection >1mm
- >12. 000 point Rutting

DQMP Challenges

- **Equipment Certification**
  - Entity to certify? Universities have turned it into a research project
  - Lack of standard certification protocol for cracking, rutting, and faulting
- **Operator Certification**
  - Rare for vehicle operators
  - Lack of experienced manual distress raters
- **Reference or “Ground Truth”**
  - Needed for measuring accuracy
  - Subjective and expensive
  - Some use past data collection cycles
- **Reproducibility**
  - vehicle to vehicle comparison is a concern
- **Resolution**
  - Most equipment cannot meet 0.01 inch resolution for faulting
- **Resources**
  - Limited DOT staff available for DQMP process
  - Outside help might involve conflict of interest

DQMP Challenges

- **Equipment Certification**

Cost Type	Description	Cost	Unit	Unit	Days	Total
ARAN	TTI Certification Cost	$ 4,000.00	ARAN / Test	7	1	$ 28,000.00
ARAN	Operator Certification Cost	$ 400.00	ARAN	2	1	$ 800.00
ARAN	Cost of Not collection	$ 5,000.00	ARAN / Day	0	1	$ -
ARAN	Crew Overhead (hotels, per diem)	$ 500.00	ARAN / Day	1	1	$ 500.00
Raters	TxDOT Training Cost	$ -	Distress Rater			
Raters	Training Overhead (hotels, per diem)	$ 250.00	Distress Rater / Day	12	5	$ 15,000.00
Raters	Cost of Not Working	$ 650.00	Distress Rater / Day	0	5	$ -
						$ 44,300.00

DQMP Challenges

- **Equipment Certification**
  - Entity to certify? Universities have turned it into a research project
  - Lack of standard certification protocol for cracking, rutting, and faulting

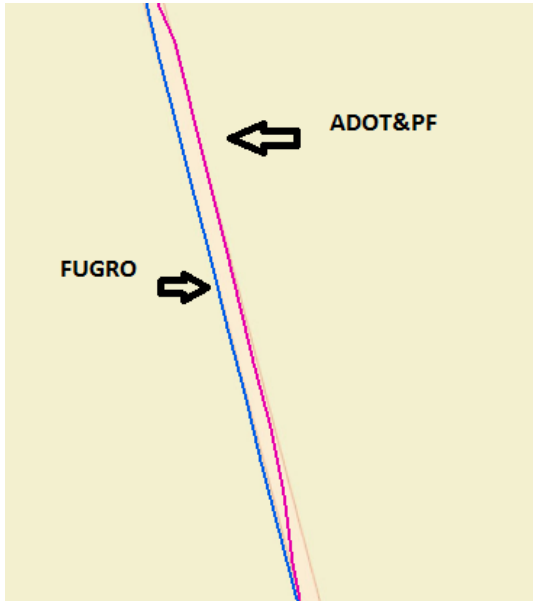
- **Operator Certification**
  - Rare for vehicle operators
  - Lack of experienced manual distress raters
  - A REQUIREMENT NOW

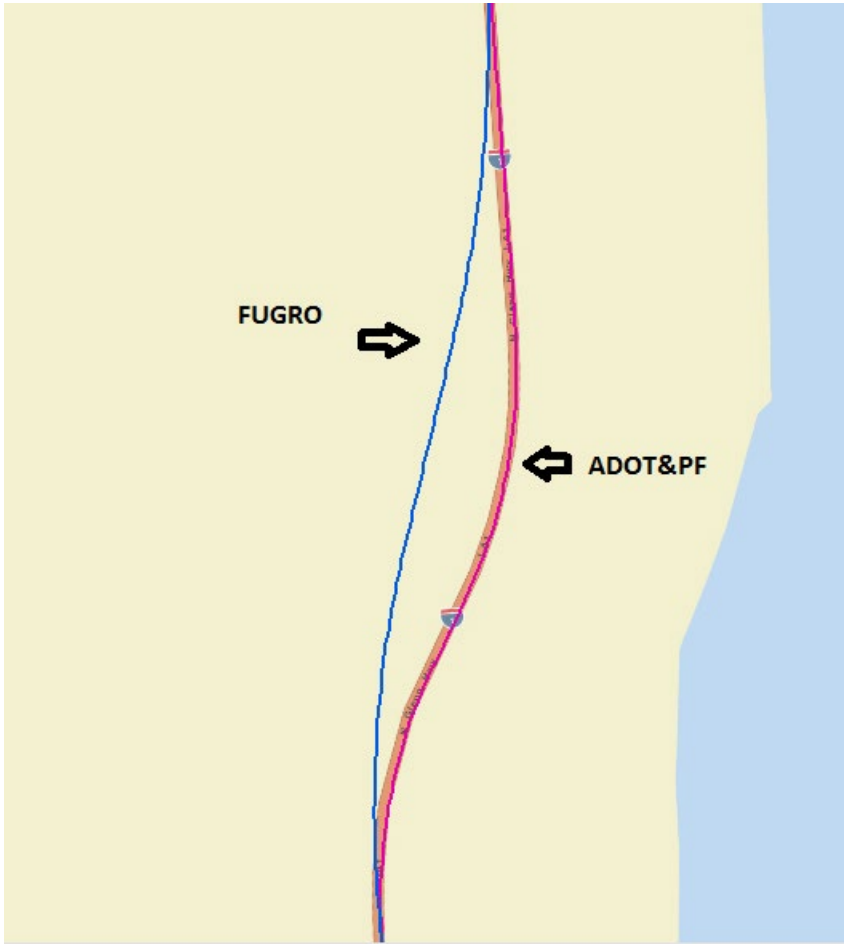
Cost Type	Description	Cost	Unit	Unit	Days	Total
ARAN	TTI Certification Cost	$ 4,000.00	ARAN / Test	7	1	$ 28,000.00
ARAN	Operator Certification Cost	$ 400.00	ARAN	2	1	$ 800.00
ARAN	Cost of Not collection	$ 5,000.00	ARAN / Day	7	1	$ 35,000.00
ARAN	Crew Overhead (hotels, per diem)	$ 500.00	ARAN / Day	1	1	$ 500.00
Raters	TxDOT Training Cost	$ -	Distress Rater			
Raters	Training Overhead (hotels, per diem)	$ 250.00	Distress Rater / Day	12	5	$ 15,000.00
Raters	Cost of Not Working	$ 650.00	Distress Rater / Day	12	5	$ 39,000.00
						$ 118,300.00

LESSONS LEARNED HPMS - LRS CENTERLINE DEVIATIONS

3 LRS Centerline Lane Deviations found along Highway

3 Small Deviations found along Palmer-Fishhook Road.





LESSONS LEARNED - LRS CENTERLINE DEVIATIONS

3 LRS Centerline Lane Deviations found along Glenn Highway

DATA COLLECTION ADVANCEMENTS

- LCMS 2
- Laser
  - Point versus Line
  - Full Profile use
- Single Operator
  - Potential for error
  - Fatigue
- Portable Units
  - In a BOX?
  - Pick up POD
- LED
  - Research
- Machine Learning
- Remains in research
- Technology
  - Map21 -2012
  - I-phone is 10 years old


ARAN
220 South Business
Collinsville
Martinsville
220 North
Roanoke
NEXT RIGHT
South East
220 57
Fieldale
Greensboro
ARAN

Questions?