

**Louisiana DOTD  
Pavement Data Quality  
Management Program**

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## List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
DCV	Data Collection Vehicle
DCC	Data Collection Consultant
DMI	Distance Measurement Instrument
DQCVS	District Quality Control Verification Sites
DOTs	Department of Transportations
FWD	Falling Weight Deflectometer
FHWA	Federal Highway Administration
GIS	Geographic Information System
GPS	Global Positioning System
HPMS	Highway Performance Monitoring System
IA	Independent Assurance
IRI	International Roughness Index
LADOTD	Louisiana Department of Transportation and Development
LIDAR	Light Detection and Ranging
LRM	Location Referencing Method
LRS	Location Referencing System
NHS	National Highway System
PCI	Pavement Condition Index
PMS	Pavement Management System
PWL	Percent Within Limits
PSI	Present Serviceability Index
PSR	Present Serviceability Rating
QA/QC	Quality Assurance and Quality Control
QC	Quality Control
QM	Quality Management
ROW	Right-Of-Way
RWD	Rolling Wheel Deflectometer
SQL	Structured Query Language
SOP	Standard Operating Procedures

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# Louisiana DOTD Pavement Data Quality Management Program

## Introduction

This document details the quality control procedures and standards, to meet the requirements identified in the federal legislation below, for pavement management data collection and delivery for Louisiana Department of Transportation and Development (LADOTD).

LADOTD has used a Data Collection Consultant (DCC) for over 20 years which has allowed LADOTD to acquire the most technically advanced pavement data for use in the Pavement Management System (PMS).

**LADOTD a National Leader in Data Quality Management.** LADOTD has been a national leader in Quality Assurance and Quality Control (QA/QC) for pavement distress data collection. In February 2013 the FHWA issued the “Practical Guide for Quality Management of Pavement Condition Data Collection.” The purpose of this guide was to provide transportation agencies with the necessary tools, procedures, and practices for developing, using, and/or modifying a Quality Management (QM) plan for network-level pavement condition data collection. This guide outlined a process for systematically implementing QM practices throughout the data collection effort. It described the roles and responsibilities for successful QM of the data and presents the practices currently in use by transportation agencies. LADOTD was one of the three agencies provided as a “Case Study” example of proper Quality Management.

## **Federal Requirements**

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** Each State DOT shall develop and utilize a Data Quality Management Program, approved by FHWA that addresses the quality of all data collected, regardless of the method of acquisition, to report the pavement condition metrics, discussed in 23 CFR 490.311, and data elements discussed in 23 CFR 490.309(c).

In a Data Quality Management Programs, State DOTs shall include, at a minimum, methods and processes for:

- 1. Data collection equipment calibration and certification;**
- 2. Certification process for persons performing manual data collection;**
- 3. Data quality control measures to be conducted before data collection begins and periodically during the data collection program;**
- 4. Data sampling, review and checking processes; and**
- 5. Error resolution procedures and data acceptance criteria.**

## LADOTD Data Quality Management

The Data Collection Consultant (DCC) is required to deliver road condition data and asset data of the highest quality. This requires quality control to be built-in to every process, ensuring that data errors or exceptions are caught as early as possible and immediately remedied according to pre-defined procedures and rules.

The DCC must comply with the current *LADOTD Distress Identification Protocol General Guidelines for All Pavements*; the current *LADOTD Distress Identification Protocol for Asphalt and Composite Pavements*; and the current *LADOTD Distress Identification Protocol for Jointed and Continuously Reinforced Concrete Pavements*. Links to the aforementioned protocols are listed below:

[LA DOTD Distress Identification Protocols General Guidelines for All Pavements](#)

[LA DOTD Distress Identification Protocols for Asphalt and Composite Pavements](#)

[LA DOTD Distress Identification Protocols for Jointed and Continuously Reinforced Concrete Pavements](#)

The DCC is required to establish and ensure adherence to various Standard Operating Procedures (SOPs) through which the processes used for data collection, processing and reporting are to be well-documented and will form an integral part of the Quality Control Program. DCC developed SOPs must be approved by LADOTD before data is collected.

The DCC shall be aware that new State and Federal laws can require adjustment to new data collection thresholds, adjustments to existing data collection or analysis procedures, or the creation of new procedures altogether. The DCC shall also comply with or exceed appropriate AASHTO Standards, including updated AASHTO Standards as required by LADOTD. These adjustments will be made as necessary by the DCC.

LADOTD has a significant long-term investment in pavement data collection that has resulted in a Pavement Management System (PMS) that contains advance data inventory histories and pavement deterioration curves. It is incumbent upon the DCC to prevent the compromise in any way, or place at risk, this significant investment with insufficient or inferior data or imagery collection, with inadequate data analysis, or with inadequate software. Failure to do so will place the existing data collection contract in danger of cancellation.

LADOTD has always adopted the most advanced data collection technology available when it has proven to be reliable and legitimate. LADOTD acknowledges that data collection technology has continued to evolve in the past 20 years as noted by the recent transitions from 2D to 3D technology.

Any new technologies must also comply with, or exceed, any new Federal or State laws or National Standards addressing pavement data collection and management.

## Scope of Work

### Major Deliverables

The following table represents the number of directional miles of pavement distress data and video logs the DCC will collect and provide to the Louisiana Department of Transportation and Development.

**Table 1 Distress Data Collection Statewide CYCLE 2A (NTP Date – December 31, 2019)**

<b>Task</b>	<b>Item</b>	<b>Analysis Miles</b>
1	Preliminary Activities & Initial Pilot	N/A
2	Interstate – Data Collection (Primary and Secondary Directions)	1,886
3	Interstate – Data Delivery (Primary and Secondary Directions)	1,886
4	Non-Interstate National Highway System (NHS) – Data Collection	3,185
5	Non-Interstate National Highway System (NHS) – Data Delivery	3,185
6	Non-Interstate National Highway System (NHS) – ROW Image Only Collection	1,072
7	Non-Interstate National Highway System (NHS) – ROW Image Only Delivery	1,072
8	Local-National Highway System (NHS) – Data Collection (Primary and Secondary Directions)	212
9	Local-National Highway System (NHS) – Data Delivery (Primary and Secondary Directions)	212
10	Highway Performance Monitoring System (HPMS) – Data Collection (Primary Direction)	853
11	Highway Performance Monitoring System (HPMS) – Data Delivery (Primary Direction)	853
12	State Systems – Data Collection (Primary & Secondary Directions for Divided Highways)	13,787
13	State Systems – Data Delivery (Primary & Secondary Directions for Divided Highways)	13,787
18	Frontage/Service Roads – Data Collection (Primary Direction)	499
19	Frontage/Service Roads – Data Delivery (Primary Direction)	499
22	Skid Testing	1,940

**Table 2 Distress Data Collection Statewide CYCLE 2B (January 1 – December 31, 2020)**

<b>Task</b>	<b>Item</b>	<b>Analysis Miles</b>
1	Preliminary Activities & Initial Pilot	N/A
2	Interstate – Data Collection (Primary and Secondary Directions)	1,886
3	Interstate – Data Delivery (Primary and Secondary Directions)	1,886
4	Non-Interstate National Highway System (NHS) – Data Collection (Primary and Divided Secondary Directions)	3,185
5	Non-Interstate National Highway System (NHS) – Data Delivery (Primary and Divided Secondary Directions)	3,185
6	Non-Interstate National Highway System (NHS) – ROW Image Only Collection (Secondary Direction Direction)	1,072
7	Non-Interstate National Highway System (NHS) – ROW Image Only Delivery (Secondary Direction Direction)	1,072
8	Local – National Highway System (NHS) – Data Collection (Primary and Secondary Directions)	212
9	Local – National Highway System (NHS) – Data Delivery (Primary and Secondary Directions)	212
10	Highway Performance Monitoring System (HPMS) – Data Collection	853
11	Highway Performance Monitoring System (HPMS) – Data Delivery	853
14	State Systems – Image Collection (Secondary Direction)	13,339
15	State Systems – Image Delivery (Secondary Direction)	13,339
16	Ramps – Data Collection	846
17	Ramps – Data Delivery	846
20	Frontage/Service Roads – Image Collection (Secondary Direction)	499
21	Frontage/Service Roads – Image Delivery (Secondary Direction)	499

### **Pavement Condition Measures**

The following tables provide an outline of the current Pavement Condition Measures for both the Pavement Management System (PMS) requirements and the 23 CFR Part 490 Federal pavement condition requirements.

In the table below, the red shaded items are specific to fulfilling the Part 490 requirement only. The unshaded items are measures that will support Pavement Management System or Safety Management efforts but are not relevant to Part 490.

The green shaded items are shared by both the PMS and Part 490 requirements; however, these items may be measured or used in a different manner by the PMS or the Part 490 purposes. For instance, the LADOTD faulting measures are used to identify joints that exceed a threshold of 0.2 inches. When enough joints exceed this threshold, then a joint repair project is authorized for the project level assessment. For the Federal faulting data, an average of the faulting over a 0.100-mile segment is submitted for the network level assessment of condition.

It should also be noted that LADOTD uses a wheelpath of 36 inches in fatigue cracking assessment while the Federal wheelpath for fatigue cracking, reported via HPMS, is 39 inches.

**Table 3 Asphalt & Composite Pavement Condition Measures**

<b>Asphalt Pavement Distress Types</b>	<b>Composite Pavement Distress Types</b>	<b>Units of Measure</b>
*DOTD Fatigue (Alligator) Cracking		Sq.Ft. (DOTD Wheelpath)
*HPMS Fatigue Cracking	*HPMS Fatigue Cracking	*Sq.Ft. (HPMS Wheelpath)
Longitudinal Cracking	Longitudinal Cracking	Linear Ft.
Transverse Cracking	Transverse Cracking	Linear Ft.
Patch\Patch Deterioration	Patch\Patch Deterioration	Sq. Ft. & Count
Potholes	Potholes	Sq. Ft. & Count
Rutting	Rutting	Inches
IRI	IRI	Inches / Mile
	Blowups	Sq. Ft. & Count
Fill Quantities	Fill Quantities	Cu. Ft.
High/Low Shoulder	High/Low Shoulder	Inches
Macrottexture	Macrottexture	Inches

\* HPMS Wheelpath = 39"; LADOTD Wheelpath = 36"

**Table 4 Jointed & Continuously Reinforced Concrete Pavement Condition Measures**

<b>Jointed Concrete Pavement Distress Types</b>	<b>Continuously Reinforced Pavement Distress Types</b>	<b>Units of Measure</b>
Longitudinal Cracking	Longitudinal Cracking	Linear Ft.
Transverse Cracking	Transverse Cracking	Linear Ft.
Patch\Patch Deterioration	Patch\Patch Deterioration	Sq. Ft. & Count
Blowups	Blowups	Sq. Ft. & Count
IRI	IRI	Inches / Mile
Faulting		Inches
	Punchouts	Sq. Ft. & Count
High/Low Shoulder	High/Low Shoulder	Inches
Macrottexture	Macrottexture	Inches

**Present Serviceability Rating (PSR)**

Since 2019 the LADOTD has been requiring the DCC to calculate PSR using a combination of collected data specified in the previous section. The LADOTD took key words and descriptions from FHWA’s numerical PSR scale (1-5) ([2016 HPMS Field Manual Table 4.4](#)) and devised a method to calculate it using existing collected data. Federal Goodness rating combined with Cracking, Rutting and Faulting are the measures being utilized to calculate PSR for all Pavement types.

PSR is substituted where there are no IRI readings. In most cases there are inadequate Roughness readings either where the Data Collection vehicle stops or is moving slowly (less than 25 mph). This mostly happens in congested Urban areas where signals are, or just due to the scale of traffic. There are other extenuating circumstances that warrant a PSR reading.

Thresholds for pavement measures with associated PSR are referenced in Table’s 5 thru 8 below.

**Table 5 Asphalt Standards for PSR**

<i>PSR Thresholds for Asphalt (ASP) Pavements</i>				
PSR	RUTTING (Fed Rating)	RUTTING (INCHES)	CRACKING (Fed Rating)	CRACKING (%)
5	GOOD	<0.20	GOOD	<5
4	FAIR	>=0.20 AND <0.40	GOOD	<5
3	GOOD	<0.20	FAIR	>=5 AND <20
3	FAIR	>0.20 AND <0.40	FAIR	>=5 AND <20
3	POOR	>=0.40	GOOD	<5
2	POOR	>0.40	POOR	>=20 AND <=25
2	GOOD	<0.20	POOR	>=20 AND <=25
2	FAIR	>=20 AND <0.40	POOR	>=20 AND <=25
2	POOR	>=0.40	FAIR	>=5 AND <20
1			POOR	>25 AND <=37.5
0.5			POOR	>37.5

**Table 6 Composite Standards for PSR**

<i>PSR Thresholds for Composite (COM) Pavements</i>				
PSR	RUTTING (Fed Rating)	RUTTING (INCHES)	CRACKING (Fed Rating)	CRACKING (%)
5	GOOD	<0.20	GOOD	<5
4	FAIR	>=0.20 AND <0.40	GOOD	<5
3	GOOD	<0.20	FAIR	>=5 AND <15
3	FAIR	>0.20 AND <0.40	FAIR	>=5 AND <15
3	POOR	>=0.40	GOOD	<5
2	POOR	>0.40	POOR	>=20 AND <=25
2	GOOD	<0.20	POOR	>=20 AND <=25
2	FAIR	>=20 AND <0.40	POOR	>=20 AND <=25
2	POOR	>=0.40	FAIR	>=5 AND <20
1			POOR	>25 AND <=37.5
0.5			POOR	>37.5

**Table 7 Jointed Concrete Standards for PSR**

<i>PSR Thresholds for Jointed Concrete Pavements (JCP)</i>				
<b>PSR</b>	<b>CRACKING (Fed Rating)</b>	<b>CRACKING (%)</b>	<b>FAULTING (Fed Rating)</b>	<b>FAULTING (INCHES)</b>
5	GOOD	<5	GOOD	<.1
4	GOOD	<5	FAIR	>=.1 AND <.15
3	FAIR	>=5 AND <10	GOOD	<.1
3	FAIR	>=5 AND <10	FAIR	>=.1 AND <.15
3	GOOD	<5	POOR	>=.15
2	POOR	>=15 AND <=50	POOR	>=.15
2	POOR	>=15 AND <=50	GOOD	<.1
2	POOR	>=15 AND <=50	FAIR	>=.1 AND <.15
2	FAIR	>=5 AND <15	POOR	>=.15
1	POOR	>50 AND <=75		
0.5	POOR	>75		

**Table 8 Continuously Reinforced Concrete Standards for PSR**

<i>PSR Thresholds for Continuously Reinforced Concrete Pavements (CRCP)</i>		
<b>PSR</b>	<b>CRACKING (Fed Rating)</b>	<b>CRACKING (%)</b>
4	GOOD	<5
3	FAIR	>=5 AND <10
2	POOR	>=15 AND <=50
1	POOR	>50 AND <=75
0.5	POOR	>75

## Controls for Project Set Up

At the initiation of a project, or when a change in technology is implemented in a subsequent cycle of the project, the DCC shall evaluate the data shells, data dictionaries, protocols, specifications provided by LADOTD and the deliverables required by LADOTD, to ensure there will be no mismatch between the required data to comply with these items and the capabilities of the proposed technology.

Standard Operating Procedures (SOPs) shall be provided by the DCC for all appropriate procedures, methodologies, processes, etc. SOPs must be approved by LADOTD before data is collected.

The DCC shall participate in a small Pilot Task to finalize and gain acceptance of DCC’s methods, procedures, deliverables, reporting, etc. that will be used for the remainder of the project. This Pilot Task will include roadway systems found in the overall project Tasks so that upon QA/QC acceptance by LADOTD, the Pilot Task deliverables will complete some percentage of those Tasks and as such

would be billable. This Pilot Task will be conducted at the start of each 2-year data collection cycle, or when a change in technology is proposed by the DCC.

Also required, at this time, is an explanation and where appropriate, a demonstration of the DCC's solutions, databases, software, images, methods and procedures that will meet the deliverables of a project. The DCC is required to identify any deliverable that can't be provided, or can't meet the specifications with respect to resolution, accuracy, and repeatability. LADOTD reserves the right to require the DCC to incorporate select 2D technology with 3D technology if it improves the DCC's ability to provide the deliverables. A theoretical example might be to use 2D technology to capture friction data while all other data would be captured with 3D technology.

This will then lead to final project delivery timelines, final selection of appropriate 2D/3D or other advanced technology and the "Final Defined Data Acceptance Criteria" for that 2-year cycle.

Finally, the DCC's Quality Control Plan for the project will be formalized, and signed off on by LADOTD, to ensure success of the project. This Plan will give emphasis to both Quality Assurance and Quality Control (QA/QC) for the duration of the project.

LADOTD reserves the right to require additional procedures, methods, protocols, data items, reporting measures or any reasonably appropriate modifications to the DCC's Quality Control Plan when issues arise during a data cycle that jeopardize successful capture and delivery of the data collection deliverables. This may also occur due to new State or Federal laws, updated National Standards, or when a persistent issue arises that must be addressed.

LADOTD reserves the right to modify the data collection technology in subsequent cycles and require modifications to the DCC's Quality Control Plan as appropriate. This would be necessary if superior technology is introduced during the 6-year project duration.

## **DCC's Data Collection Equipment Calibration and Certification**

*Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements*

*DCC Equipment & Settings Verification*

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

**Data collection equipment calibration and certification**

**DCC Equipment & Settings Verification**

Before mobilization, the DCC will ensure that the Data Collection Vehicle's (DCV) components (equipment and cameras) have been configured to meet both the manufacturer's recommendations regarding calibration/verification of their equipment and the LADOTD project specifications and requirements.

The DCC will capture both sample data and sample images using the specific configuration of the DCV required to meet the project deliverables. The sample data will be evaluated to verify that the data will produce results consistent with the project requirements.

If this evaluation by the DCC is found to not meet the manufacturer's recommendations or the project specifications and requirements, the DCC will make all necessary adjustments, modifications, etc. to the DCV to correct the issue. Mobilization of a DCV shall not occur until all issues are legitimately resolved.

The DCC will continue to ensure that all equipment calibrations and camera maintenance are to be performed in accordance with specific manufacturer recommendations. Equipment calibrations refer to anything that requires proper and regular calibration to ensure that the device is in proper working order and will produce expected, acceptable results.

As part of the SOPs, a regular maintenance and testing program of the equipment and cameras, in accordance with the manufacturer's recommendations, shall be performed and documented by the DCC.

All activities with respect to these verification requirements shall be documented and reported to LADOTD on a monthly basis.

## Data Quality Control Measures

*Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements*

*DCC Primary Baseline Calibration Site Testing*

*Subsystems Included in Primary Baseline Calibration*

*Primary Baseline Calibration Testing Procedures*

*Baseline Calibration Tolerances for Acceptance*

*Baseline Calibration Reporting of Result*

*District Quality Control Verification Sites*

*DCC Final Cycle Report*

*DCC Quality Control in Field Data Collection*

*DCC Quality Control in Image and Data Location*

*DCC Assurance of Data Validity –Internal Analysis*

*Systems Included in DCC Internal Analysis*

*Testing Procedures*

*Tolerances for Acceptance*

*Reporting of Results*

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

**Data quality control measures to be conducted before data collection begins and periodically during the data collection program**

### DCC Primary Baseline Calibration Site Testing

LADOTD will establish Primary Baseline Calibration Sites. Prior to being authorized by LADOTD to collect data, the DCV will be calibrated to a Primary Baseline Calibration Site. Such calibration must be maintained for the duration of subsequent data collection. Calibrations will be repeated as needed, or as defined further in following sections.

DCVs that leave the State, require repairs, to either the vehicle or data collection equipment, or are out of service for an extended period of time, must be recalibrated on the LADOTD approved Primary Baseline Calibration Sites. DCVs must be recalibrated at least once per month at LADOTD approved Primary Baseline Calibration Sites, or as directed by LADOTD.

#### ***Subsystems Included in Primary Baseline Calibration***

The following subsystems will be tested on the Primary Baseline Calibration Sites:

- Distance Measuring Instrument (DMI)
- Imagery
- IRI

- Rutting
- Faulting
- GPS
- Inertial Navigation

#### ***Primary Baseline Calibration Testing Procedures***

Data acquisition for the calibration of electronic sensor data will require at least three passes on each pavement calibration section. The electronic sensor data will then be evaluated for accuracy as appropriate for the equipment. The data will be compared with the reference standard, and appropriate corrective action will be taken if data is not consistent with the criteria defined for the equipment. The DCC shall provide LADOTD with all results from this calibration effort.

#### ***Baseline Calibration Tolerances for Acceptance***

If the data and/or images do not meet the criteria defined for the equipment, then the DCC shall take appropriate corrective action. This may require recollection of data, by the DCC, with no additional compensation.

#### ***Baseline Calibration Reporting of Results***

All calibrations procedures performed during this project, along with the recorded calibration data, are to be documented (i.e., results from tests are recorded and any corrective action taken shall be explained in detail) and reported to LADOTD on a monthly basis.

#### ***District Quality Control Verification Sites***

During the initial data collection in each district, the DCC shall establish a District Quality Control Verification Sites (DQCVS) on a Linear Referencing System ID. The DCC shall calibrate all DCVs on the LADOTD Primary Baseline Calibration Sites just prior to establishing a DQCVS in a district. The DQCVS will use known low , Rutting, and Faulting values from past data collection cycles to confirm that the current values are valid to use as baseline data. Separate DQCVS sites are required for each district and each district can contain more than one DQCVS site at the DCCs discretion.

For subsequent ongoing data collection, within a particular district, the DQCVS will be collected weekly by each DCV and compared with the baseline data. The DCC will use this comparison data to determine the accuracy of field measurements and to identify needed equipment recalibrations at the Primary Baseline Calibration Sites. All weekly DQCVS data collection shall be documented, both in writing and electronically (digital images with electronic sensor data) and shall be delivered to LADOTD in monthly reports.

#### ***DCC Final Cycle Report***

The DCC shall submit a Final Cycle Report at the end of each (2) two-year cycle. The DCC's Final Report shall contain the results of all calibration procedures, the calibration data that was collected and any corrective action taken shall be explained in detail.

The DCC shall also submit any recommendations for changes the DCC feels would improve or would be beneficial to the overall success of this effort.

## **DCC Quality Control in Field Data Collection**

Detailed Standard Operating Procedures (SOPs) will be established by the DCC and will be rigorously followed for all aspects of DCV operation, equipment and system checks and data collection processes.

The DCC Field Technicians will visually monitor real-time data readouts to ensure that the data being collected falls within reasonable and expected ranges for the pavement being measured. All video monitors will also be watched carefully, to ensure proper lighting, focus, aim, image clarity, and to ensure that no bugs or debris on the camera enclosures are obscuring visibility.

When the collection period for the day is finished, Data Integrity Log files (containing all settings used on the DCV and any error messages generated during collection) and a Section Average Summary (contains all summarized subsystem values) will be generated by the DCC Field Technicians.

The Data Integrity Log files and the Section Average Summary will be reviewed by the DCC Field Technician to check the completeness and validity of the collected data.

On a daily basis, the Data Integrity Log files, the Section Average Summary, samples of collected images and a Daily Contact report will be forwarded by the DCC Field Technician to the DCC Support Team for further review. DCC Data Analysts will confirm the DCC Field Technician review and ensure that nothing was overlooked. If discrepancies or errors are found, the DCC Field Technicians will be given immediate feedback with appropriate corrective action to be taken.

In all cases, if significant errors are detected, the DCC shall contact the LADOTD Project Manager (PM) by phone to discuss the issue resolution and if necessary consult with the LADOTD PM for appropriate corrective action. The DCC will subsequently follow up with emails containing Microsoft Word documents detailing the issue, decision points, and final corrective action for the issue. The document should also include appropriate date and location information. These Microsoft Word documents shall be included in monthly reports and noted in the Final Cycle Report.

## **DCC Quality Control in Image and Data Location**

Equipment configuration and integration, to allow the field collected data, pavement imagery, and forward-facing perspective images and right-facing right-of-way images to be linked, synchronized and georeferenced, is critical to this effort.

All devices and technology, such as real time kinematic Global Positioning System (GPS) technology, inertial measurement units (accelerometers, gyroscopes), distance measuring instruments (DMI), etc. shall be constantly monitored in real time, and checked in post processing, to ensure they are working properly.

The DCC shall verify all data and image are accurately referenced to the GPS, the GIS and the LRS.

## **DCC Assurance of Data Validity –Internal Analysis**

### ***Systems Included in DCC Internal Analysis***

The following subsystems will be tested:

- Distance Measuring Instrument (DMI)
- Imagery
- IRI

- Faulting
- Rutting
- GPS
- Inertial Navigation System

***Testing Procedures***

Upon receipt of a shipment of raw data from the DCC Field Technicians to the DCC Support Team, the DCC Data Analysts will process all data and images collected. It is expected that the DCC shall use automated software to process this data and images, using a standard set of settings that will flag unexpected results for review.

***Tolerances for Acceptance***

If the data and/or images do not meet the “Final Defined Data Acceptance Criteria,” the appropriate corrective action will take place. This may require recalibration on the Primary Baseline Calibration Sites and recollection of data, by the DCC, with no additional compensation.

***Reporting of Results***

The DCC will utilize the QC results in the downstream processing of data. All deviations from the criteria outlined in “Final Defined Data Acceptance Criteria” will be addressed at the time of data delivery. Any outstanding items will be placed on an exceptions list for recapture or other further action. The results of these checks will ensure the final deliveries to the LADOTD are of acceptable quality.

## Rater Certification and Functional Requirements

*Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements*

*DCC Quality Control in Pavement Distress Data*

*DCC Quality Control of Forward Facing Perspective and Right Facing Right-of-Way Images*

*DCC Quality Control of Pavement Images*

*DCC Quality Control in Data Reduction*

*Project Reporting*

*DCC Control of Quality in Highway Asset Inventory*

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

**Certification process for persons performing manual data collection;**

### DCC Quality Control in Pavement Distress Data

Prior to starting network production, the Primary Baseline Calibration Sites will be rated by the DCC QC Analyst. The results will be validated by the DCC Project Manager and the LADOTD Project Manager both procedurally and against historical data. This rating will then be used as a calibration measure to verify the ratings by the DCC Rating Technicians.

Before any DCC Rating Technician will be allowed to proceed with production work on the project, he/she must successfully and consistently rate the Primary Baseline Calibration sites. This process will be conducted to ensure inter-rater consistency among various DCC Rating Technicians with respect to the distress protocols outlined in the various LADOTD Distress Identification Protocols and “Final Defined Data Acceptance Criteria”. The DCC Project Manager will document and validate that every DCC Rating Technicians is producing the valid results, within acceptable limits, prior to beginning production.

At least once a year, the DCC Rating Technicians will rate the Primary Baseline Calibration Sites to ensure that each operator remains consistent and accurate.

For each rating of a batch of raw data by a DCC Rating Technician, the DCC QC Analyst will conduct statistical random sampling of the rated distress data to ensure data meets the requirements detailed in the various LADOTD Distress Identification Protocols and the “Final Defined Data Acceptance Criteria”.

If the rated data does not meet the requirements of the LADOTD Distress Identification Protocols and the “Final Defined Data Acceptance Criteria”, the file will be sent back to the original DCC Rating Technician for rework. The DCC Rating Technician(s) may be instructed to redo the file, redo the entire day or redo the entire batch of data depending on the severity of the issue. This re-rating will then be used to define the level of stringency of data review when the next batch is submitted by that DCC Rating Technician. Follow-up training may be required for the DCC Rating Technician.

The DCC Project Manager or DCC QC Analyst shall use whatever combination of benchmarking, random auditing, and consistency checks among various DCC Rating Technicians that will assure the overall consistency and validity of the distress ratings.

The DCC shall include all details of these base line ratings and any required re-ratings in the Monthly reports.

### **DCC Quality Control of Forward Facing Perspective and Right Facing Right-of-Way Images**

The DCC DCV shall contain only the specified Cameras and Lens Packages authorized by LADOTD. Should replacement Cameras and Lens Packages become unavailable in subsequent data collection cycles, LADOTD has the sole authority to approve the appropriate replacement Cameras and Lens Packages.

The DCC Field Technicians shall perform daily checks to ensure the auto focus and auto iris adjustment capabilities of the camera lens packages are functioning properly.

Daily checks shall be performed to ensure the forward-facing perspective camera shall be sky to pavement ration of sky 45% / pavement 55% and left to right ratio of left 60 % / right 40%.

Daily checks shall be performed to ensure the final LADOTD authorized angle for the right facing right-of-way camera remains the same.

Deviation from these authorized camera positions and alignments will result in re-collection of affected LRS-ID. The DCC shall validate continuous camera alignment in monthly calibration reporting.

The DCC Field Technicians shall clean the camera lens and enclosures as often as necessary to prevent a buildup of road debris and bugs. The temperature control devices, or other means to eliminate fogging and condensation in the camera enclosures, shall be kept in good working condition.

The forward-facing perspective and right facing right-of-way camera images shall be collected at DMI intervals sufficient to provide the optimum image, and image quality, for asset image identification and collection. The images are each expected to represent approximately 0.004 miles (21.12 feet) segment length. These images shall be delivered in a JPEG format.

All image locations shall be identified to the nearest thousandth (0.001) mile increment (5.28 feet) or better in the data submittals. All image locations shall also be identified by their GPS coordinates in the data submittals. All JPEG images shall also be either geocoded or geotagged with GPS coordinates. The resolution of the collected images shall not be less than 1920 pixels x 1080 pixels or as approved by LADOTD.

Upon approval and acceptance of images by LADOTD, the DCC shall then add "Header Information" to the final JPEG image submittals identifying the district, the parish, the LRS-ID, the direction of travel, the route, the direction of travel chainage, the primary direction chainage, the vehicle speed, the collection date and the current LADOTD Logo for image source reference. The "Header Information" will represent, except for the data collection date, the QA/QC approved final data, not the raw data collected in the field.

### **DCC Quality Control of Pavement Images**

The DCC shall verify these images are synchronized, properly overlapped and fused or stitched together into one uninterrupted continuous pavement JPEG image for the section length of approximately 0.004 miles (21.12 feet). The imaging system shall be configured to allow for the optimum contrast and visibility of transverse and longitudinal cracks via laser lighting to eliminate

shadows and variations in ambient lighting. Note laser lighting is required while strobe lighting is prohibited.

The system shall capture clear, high resolution digital pavement images, in JPEG format, that represent the width of transverse road section, including the shoulder/pavement edge for high/low shoulder measures. Pavement Images shall not be collected during times when the visibility of cracking and other distress forms are continuously obstructed by road conditions. This includes, but is not limited to, water on the pavement surface and either sand or mud on the pavement surface, etc. Locations with unacceptable pavement image quality shall be collected again at no additional cost to LADOTD. The DCC shall identify locations with foreign material on the pavement surface to the LADOTD Project Manager as soon as possible for possible removal by district forces.

The resolution of pavement images should be sufficient, under optimal conditions, to identify crack widths meeting the “Final Defined Data Acceptance Criteria” in both the transverse and longitudinal directions when traveling at survey speeds. The DCC shall use a semi-automated solution to quantify pavement cracking, or rate the pavement distresses, with manual assistance as necessary, per the LADOTD Distress Identification Protocols. This shall include color coded digital line work and grids representing the various distress types and severity. This rating shall be indicated on the stitched pavement images identified in this section which will be used for QA/QC purposes. Pavement images shall be used to measure line work, grids, etc., so they must be of sufficient quality to allow this to occur. LADOTD will have final approval over size, shape, color, patterns, etc. for this line work.

For QA/QC purposes, all pavement distress data and pavement management index data shall be synchronized and linked to the pavement images, forward facing perspective images and right facing right-of-way images for viewing and data analysis purposes, via the Software Viewing Tool. The DCC shall furnish the stitched and rated images on external hard drives (USB 2.0) or on other pre-approved storage media. All image start locations shall be identified to the nearest thousandth (0.001) mile increment (5.28 feet) or better and also include GPS coordinates. All pavement JPEG images should also be either geocoded or geotagged with GPS coordinates.

### **DCC Quality Control in Data Reduction**

“Raw Data Files” will contain data at increments relative to the capabilities of the data collection technology, which will be generally termed “Raw Data”. The Raw Data Files are expected to be the original data source for both the “Electronic Data Files” and the “Summary Data Files” and will provide LADOTD with the opportunity to look at a more detailed level of data than the summary provided in the Electronic Data Files.

The Electronic Data Files will generally summarize the raw data to 0.004 mile (21.21 foot) lengths. The Summary Data Files will generally summarize the raw data to 0.100 mile (528 foot) lengths. Additional Data Files, as noted via various data dictionaries, will be delivered as per the details outlined for those data dictionaries.

The following “Standard quality checks” to be performed during data summarization will include, but are not limited to:

- Check the quantity of data before and after summarization to ensure that no data is missing.
- Note and correct any errors resulting from summarization.

- Perform a preliminary comparison between the collected (unedited) data and the LRS-ID table, checking for section length discrepancies, as well as to ensure that all sections have been collected.

The following “Standard quality checks” to be performed during Reporting will include, but are not limited to:

- Ensure that all processed data matches the criteria detailed in the “Final Defined Data Acceptance Criteria”.
- Ensure that the data has not been included in any previous delivery.
- Compare current data to previous year(s) of data when previous data is available.

## **Project Reporting**

The data at this point is expected to match the requirements of LADOTD and will be provided in an approved LADOTD format as required in the Contract. Queries will be run to ensure that all expected and intended data for submission to the LADOTD is present.

## **DCC Control of Quality in Highway Asset Inventory**

LADOTD will work with the DCC to establish Asset Calibration Sites for non-pavement fixed assets. Prior to starting network production, appropriate assets on the Asset Calibration Sites will be captured, thoroughly inspected for quality and validated for accuracy by the DCC Project Manager or DCC Asset Inventory Analyst. The results will be used as an asset calibration benchmark to verify the asset inventory work of the DCC Asset Inventory Technicians.

Prior to starting network production, each DCC Asset Inventory Technicians will then complete an asset inventory for the Asset Calibration Sites. The data capture results, for each DCC Asset Inventory Technician, must match (+/-) 1% of the assets in the asset calibration benchmark.

The DCC Asset Inventory Analyst shall perform the following ongoing quality testing, on the Asset Inventory Technician data submittals, to ensure asset accuracy and consistency over the course of the entire project:

- An initial visual check for completeness and accuracy will be performed daily on each DCC Asset Inventory Technician’s submitted data files.
- A check of a minimum of 10% of each DCC Asset Inventory Technician’s daily asset inventory data for quality based on the SOP and requirement of the Scope of Work. Any file with poor quality will be failed and sent back to the DCC Asset Inventory Technician to rework.
- Failure to meet the criteria for a given day will result in the DCC Asset Inventory Technician re-working their production for that entire day to eliminate similar errors.
- A random sampling of the non-pavement fixed assets will be done to ensure that they meet the requirements detailed in the Scope of Work.
- A series of logic checks and spatial queries will also be performed. Examples of queries include, chainage offset, side of road offset, consistency checks on spelling, and the presence of text where required.

## Error Resolution Procedures

*Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements – Error Resolution Procedures*

*DCC Highway Asset Inventory Submittals*

*LADOTD Identified Data Issues*

*Data Acceptance Criteria*

*Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements – Data Acceptance Criteria*

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

### [Error resolution procedures](#)

## DCC Highway Asset Inventory Submittals

The Asset Inventory Data will be provided to the LADOTD via an ESRI Geodatabase.

## LADOTD Identified Data Issues

If for any reason, the integrity of data delivered to the LADOTD is found to be questionable or unsatisfactory, to ensure proper communication the following steps will be taken by the LADOTD.

- 1) An email will be sent to the DCC Project Manager, with a cc: to the DCC QC Analyst outlining:
  - a) A clear description of the issue(s)
  - b) LADOTD's network locators e.g. District, LRS-ID, etc.
  - c) File Name (if possible)
  - d) Chainage
  - e) Direction
  - f) Length
- 2) The email will define the Time Allotted to the DCC to investigate and verify the issue.

While phone calls often occur during issue investigation and resolution, the discussion points and decisions shall be documented via email by both parties for resolution tracking.

In the event a shipment to the DCC is required, shipping and delivery information will to be sent to the DCC Project Manager via email. The LADOTD staff member shipping the item will also place a phone call to the DCC Project Manager when shipment is being sent.

## Data Acceptance Criteria

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

### [Data acceptance criteria](#)

## **Detailed Quality Control by (DCC) Data Collection Consultant**

*Data Collection Consultant Personnel Training/Certification*

*On-vehicle real-time checks*

*Periodic diagnostics/data checks*

*Incoming data and video checks*

*DCC recommends subsystems and equipment for data collection and proper calibration*

*DCC is responsible for the collection, processing and delivery*

*Standardization of operation procedures*

*Develop quality check program*

*Equipment/method validation using calibration sites*

*Pilot data should be delivered in a timely manner*

*DCC should ensure that a control section is ready for data collection*

*DCC ensures that control sections are collected correctly*

*Data should be validated at the end of the day (including, but not limited to)*

*Calibration Sites and Verification of Calibration*

*Exceptions*

*Final Reports*

### **Data Collection Consultant Personnel Training/Certification**

- 1) Inter-rater training is completed by the DCC and submitted to LADOTD for review
  - a) Rater exhibits understanding of LADOTD Distress Identification Protocols by correct distress identification and classification.
  - b) Consistency of rating distresses across multiple raters.
- 2) Train DCC Field Technicians in correct method of collection of control sections.
  - a) Primary to primary direction collection.
  - b) Opposite to opposite direction collection.
- 3) Key personnel are identified.
- 4) DCC discloses all certifications/achievements in their proposal.
  - a) Education of key personnel.
  - b) Achievements of key personnel.
- 5) Cite current and past clients for references.

### **On-vehicle real-time checks**

- 1) DCC Field Technicians monitor systems to ensure that erroneous data/images is not being collected (including, but not limited to):
  - a) Distance Measuring Instrument (DMI)
  - b) Imagery
  - c) IRI
  - d) Rutting
  - e) Faulting
  - f) GPS
  - g) Inertial Navigation
- 2) Images are observed/checked during collection, and after a day's collections, to prevent/minimize re-runs.
  - a) Pavement images:
    - i) Clarity
    - ii) Minimal missed/skipped images
    - iii) Proper lighting
    - iv) Correct stitching of pavement images
  - b) Right of way images:
    - i) Clarity
    - ii) Minimal missed/skipped images
    - iii) Proper lighting

### **Periodic diagnostics/data checks**

- 1) DCC Field Technicians reviews data to ensure that it is within tolerance.
- 2) Sample data is sent to main office for verification.
- 3) Data Collection Vehicle (DCV) is checked daily for proper calibration, operation and maintenance.
  - a) All calibration, operation and maintenance should be performed as per the manufacturer recommendations, or as outlined in the standard operating procedures of the equipment/device.
  - b) All calibrations/maintenance should be document as performed and reported to LADOTD.

### **Incoming data and video checks**

- 1) Images are sent to Data Collection Consultant's (DCC) home office for further processing.
- 2) Suspect data is verified and appropriate sections are re-collected if necessary.

**DCC recommends subsystems and equipment for data collection and proper calibration**

- 1) All equipment is calibrated according to the manufacturer's recommendations.
- 2) DMI is calibrated on segments with a known/surveyed length.

**DCC is responsible for the collection, processing and delivery**

- 1) Images delivered.
- 2) Quantified data delivered.
- 3) Data shell correctly filled in.

**Standardization of operation procedures**

- 1) DCC is responsible for all operating procedures pertaining to data collection.
- 2) DCC should seek the opinion of LADOTD when necessary.

**Develop quality check program**

- 1) DCC is responsible for checking all data/images prior to delivery to LADOTD.
- 2) DCC rectifies all issues discovered by LADOTD.

**Equipment/method validation using calibration sites.**

- 1) DCC collects calibration sites multiple times to prove repeatability of the electronic measurements.
- 2) Electronic data is compared to previous year's data collection to ensure consistency and validity of data.

**Pilot data should be delivered in a timely manner.**

- 1) Highlights strengths and weaknesses of data collection/quantification.
- 2) DCC should use LADOTD's feedback to refine the weak areas.

**DCC should ensure that a control section is ready for data collection.**

- 1) A control section should not be collected if the data collection vehicle is forced to collect the majority of the data while traveling towards the sun.
- 2) Control section should not have excessive water on the roadway.
- 3) Control section should not be collected during inclement weather.
- 4) Control section should only be collected during daytime hours and when there is enough day light to collect it in its entirety.

**DCC ensures that control sections are collected correctly.**

- 1) Start at the correct beginning location.
- 2) Ensure data collection vehicle follows correct path of control section.

- 3) End at the correct ending location.

**Data should be validated at the end of the day (including, but not limited to):**

- 1) Distance Measuring Instrument (DMI)
- 2) Imagery
- 3) IRI
- 4) Rutting
- 5) Faulting
- 6) GPS
- 7) Inertial Navigation
- 8) Suspect data should be thoroughly investigated

**Calibration Sites and Verification of Calibration**

- 1) Primary Baseline Calibration Sites are collected each time the DCC starts a new district.
- 2) Primary Baseline Calibration Sites are collected each time the data collection vehicle leaves the state.
- 3) DCC is mandated to re-collect a control section from the previous week's collection to verify that equipment is in calibration.

**Exceptions**

- 1) All exceptions must be approved by LADOTD.
- 2) Exceptions will not be allowed due to poor data/image quality, except when the cause is out of (DCC) Data Collection Consultant's control (e.g., construction, roadway damage, etc.).
- 3) Poor/missing data/images may constitute a re-collection.
- 4) All approved exceptions should be document and submitted to LADOTD.

**Final reports**

- 1) The Final Report is the last item to be delivered to LADOTD.
- 2) Should encompass the entire data collection effort (including, but not limited to):
- 3) Includes all reports
  - a) Inter-rater consistency
  - b) Data collection vehicle equipment checks
  - c) Control/calibration/verification site results
  - d) Data collection vehicle calibration documentation
- 4) Include all correspondences relating to the project

- 5) Explanations of abnormal calibrations
- 6) Data collection schedule adherence/changes
- 7) (DCC) Data Collection Consultant's key project personnel
- 8) Project related issues
- 9) Recommendations for improvements

## Detailed Quality Review and Acceptance by LADOTD

**Federal Requirement. 23 CFR Part 490.319 (c) Other Requirements.** State DOTs shall include, at a minimum, methods and processes for:

[Data sampling, review and checking processes](#)

### Right of way images QA/QC

*Check Image Quality*

*Image clarity*

*Image brightness/darkness*

*Pavement should be dry*

*Images should play in correct order and direction*

*Missing images*

*Check for correct Control Section/HPMS-NHS Section/Frontage Road Section collection*

*Image Coverages*

*Image Location*

*Pavement distress data and pavement images QA/QC*

*Database Checks*

### Check Image Quality

#### ***Image clarity***

- 1) All images should be clear and one should be able to easily read highway signs.
- 2) There should be minimal, or no, debris on the cameras' viewing path (inclusive of the camera lens and protective glass).
- 3) Most highway distresses should be evident in all views.

#### ***Image brightness/darkness***

- 1) The images are not to be collected during hours when it is too dark.
- 2) The rule of thumb is that if street lights/security lighting is lit, then it is too dark.
- 3) It has been found that during poor lighting conditions, the images become very grainy and seem to be out of focus at times ("black out") which can cause a control section to be rejected.
- 4) If the data collection vehicle is collecting just before a rain storm, the dark clouds may not allow the proper amount of light to enter the camera and the subsequent image(s) will be of poor quality; during overcast conditions, this should be paid extra attention to.
- 5) Data collection should be halted during a rain storm; if rain drops are allowed to accumulate on the protective glass, then the images will be of poor quality due to the lack of clarity and sharpness.

- 6) Although some sections may cause the data collection vehicle to temporarily travel in a direction that causes the light to lessen, this may not cause the current control section to be rejected.

***Pavement should be dry***

- 1) The control section should not have any standing water.
- 2) If the control section has any standing water on it or most of the control section is wet, then it should be rejected.

***Images should play in correct order and direction***

- 1) Data collection vehicle should give the impression that it is traveling in a forward direction.
- 2) Images should play sequentially and in the correct order.

***Missing images***

- 1) There should be minimal or no missing images.
- 2) Any control section that contains substitute images should be rejected.

**Check for correct Control Section/HPMS-NHS Section/Frontage Road Section collection**

***Image Coverages***

- 1) The right of way images are to be recorded for 100% of the current section that is being collected; the control section manual, or approved equivalent, contains beginning and ending descriptions for all control sections, and also indicates the length and route number.

***Image Location***

- 2) When checking the right of way views, the beginning description, ending description and route number should be confirmed; many tools are available to aid in the checking of the right of way to determine if the data collection vehicle tested the correct control section. From the LADOTD intranet home page (<http://ladotnet/>), a link, "Project/Highway Information" can be found.
  - a) After left clicking on this link, the "LADOTD Project and Highway Information" web page (<http://engrapps/hwyinfo/home.aspx>) opens; there are two links that can be selected to aid the checking process: "Agile Assets Control-Section Manual" and "Highway Geographic Features".
  - b) The Agile Assets Control-Section Manual contains the control section number, District, Parish Number, Length, Route, Sys Cd, Limit From and Limit To.
    - i) Find a control section by Parish, District, Statewide, or by typing in the specific control section that is to be checked.
    - ii) To find a specific control section, simply enter it into the field at the end of "Select Control-Sections beginning with:" and press the "Submit" button.
  - c) The Highway Geographic Features contains control section, log mile, Route, Mile Point, Parish, District and Feature.
    - i) Find a control section by parish, district, control section or route.
    - ii) To find a specific control section, simply enter it into the field at the end of "Select Single Control-Section:" and press the "Submit" button, located to the right of where the control section is entered.

- 3) Control Section Manual (hard copy) can be consulted for verification of the begin and end descriptions, length and route numbers.
- 4) Maps (hard copy) can be consulted to verify beginning and ending descriptions and intersecting state highways and interstates.
- 5) There are a number of internet-based map solutions that can prove to be a very resourceful tool; before using this tool, the beginning and ending of the control section should already be known.
  - a) Zoom in to the general area where the control section is located until the local roads start to show up.
  - b) Note the local roads that intersect the control section and check the right of way images to see if those roads can be found.
- 6) If all else fails, then seek advice from LADOTD Staff or peers.
- 7) All sections should be sampled
  - a) The beginning of the control section is checked to ensure that the data collection vehicle started at the correct location; if the beginning of the control section that was found by the (DCC) Data Collection Consultant is determined to be incorrect, then the control section should be rejected.
  - b) The images for the first tenth mile should be played to ensure that the images play in the proper sequence.
    - (1) The images should play such that the data collection vehicle is moving forward.
    - (2) The tenth mile sections should be in consecutive order; this can be verified by reviewing the images and the grid with the from and to log miles.
  - ii) The images should be sampled throughout the entire control section; with exception to the beginning and ending of a control sections, check a maximum of one image per mile (if an error is discovered, a more thorough review may be required); the checker should be observing the images during the entire time that a control section's right of way images are being checked.
  - iii) The lengths, as determined by the control section manual and the (DCC) Data Collection Consultant, should coincide to within a certain degree.
    - (1) The difference should be less than 5%.
    - (2) If the difference is more than this, then the control section should be carefully reviewed to ensure that the data collection vehicle tested the correct control section in its entirety.
    - (3) If the control section is found to have been collected correctly and the DMI appears to working correctly, then the control section should not be rejected.
  - iv) The images at the end of the control section should be carefully reviewed to ensure that the data collection vehicle is ending at the correct location; if the ending of the control section that was found by the (DCC) Data Collection Consultant is determined to be incorrect, then the control section should be rejected.
- 8) Lead in and Lead outs (when appropriate)

- a) Most control sections should have a tenth mile lead in and lead out; the right of way images are the only requirements for the lead in and lead out (no rating or electronic data collection is required); this will help the checker determine if the data collection vehicle began and ended at the correct beginning and ending locations; below are some exceptions to this rule.
  - i) If the current control section begins where another control section ends, consecutively; this is not an exception where state boundaries and District boundaries exist between consecutive control sections.
  - ii) If the current control section ends and another control section begins, consecutively; this is not an exception where state boundaries and District boundaries exist between consecutive control sections.
- b) With exception to sections that are delivered/viewed through iVision/Vision, all sections that are to be collected should have a lead in/lead out.
  - i) District control sections.
  - ii) HPMS and NHS sections.
  - iii) Frontage road section.
- 9) Results from checking the right of way images, for the Frontage Roads, NHS-HPMS and District Control Sections, are documented in the QA/QC form.
  - a) All control sections (LRS ID's) that are checked shall be either accepted or rejected during the QA/QC process.
    - i) Sections that are accepted will have the checker's name and a time/date stamp.
      - (1) Each section that is checked shall be entered into the QA/QC form after it has been checked.
      - (2) All sections that are checked during the work day shall be entered into the QA/QC form prior to the end of the work day.
      - (3) There is only one field that can be filled: Other Remarks – this field is provided to document any event/circumstance that is noteworthy. It is not mandatory for this field to be completed.
      - (4) The checker can drop down the selection box beside "Please Enter Your Name:" and select his/her name to complete this form.
    - ii) Sections that are rejected will have the checker's name, a time/date stamp, and documentation for rejecting the section.
      - (1) Each section that is checked shall be entered into the QA/QC form after it has been checked.
      - (2) All sections that are checked during the work day shall be entered into the QA/QC form prior to the end of the work day.
      - (3) Several fields are provided to document the reason(s) why a section was rejected. It is mandatory that at least one of the fields be completed.
        - (a) Check boxes:

- (i) Right of Way Unsubmitted – this check box should be checked if the section was supposed to be delivered, but was not.
  - (ii) Images Play Backwards/Out of Order – this check box should be checked if the section’s images, or any part of the section, does not play in the correct, logical order.
  - (iii) Right of Way Images Collected in Wrong Direction – this check box should be checked if the section, or any part of the section, was collected in the wrong direction.
- (b) Fill-in fields:
- (i) No Video – this field is used to detail the specific location/images that are missing.
  - (ii) Wrong Road – this field is used to detail the specific segments(s) of a section that was collected, but does not belong to that section.
  - (iii) Unclear Images – this field is used to detail the specific segment(s) of a section where the right of way images are of poor quality.
  - (iv) Wrong Beginning/Ending – this field is used to document that the data collection vehicle either started or ended incorrectly. Sufficient details are provided to the DCC so that it can be correctly fixed.
  - (v) Other Remarks/Comments – this field is used to document any reason, or additional information, regarding a section being rejected.
- (c) The checker can drop down the selection box beside “Please Enter Your Name:” and select his/her name to complete this form.

## **Pavement distress data and pavement images QA/QC**

- 1) Thoroughly read the LADOTD Distress Identification Protocols.
- 2) Check image quality
  - a) Image clarity
    - i) All images should be clear and one should be able to easily identify the type and severity of distresses.
    - ii) There should be minimal or no debris on the cameras’ viewing path (inclusive of the camera lens and protective housing).
    - iii) No images shall be distorted.
  - b) Image brightness/darkness
    - i) The images should have minimal, or no, shadows.
    - ii) The camera(s) shall have the ability to quickly adjust to varying lighting conditions.
      - (1) When the data collection vehicle is on an asphalt road and has crossed a concrete bridge, the camera(s) may “white out” from the higher degree of light reflection from the concrete as compared to the amount of light reflection from the asphalt.

- (2) When the data collection vehicle exits a concrete bridge, onto an asphalt pavement, the camera(s) may “black out” due to the lack of light reflection from the asphalt road compared to the amount of light reflection from the concrete.
  - c) Pavement images should be synchronized with right of way images
    - i) The images are played ensuring that they play in the proper sequence; the images should play such that the data collection vehicle is moving forward.
    - ii) The images should play in the correct order and, if two or more cameras are used, be “seamless” both transversely and longitudinally.
    - iii) The pavement type and texture should correspond to the pavement type and texture that is shown in the right of way view.
    - iv) Pavement images are not required to be collected during the collection of a lead in or lead out for any control section.
  - d) Ability to see all rated distresses:
    - i) Cracking
    - ii) Patching
    - iii) Punch outs
    - iv) Blow ups
  - e) Missing images
    - i) There should be minimal or no missing images.
    - ii) Pavement images should be collected and rated if certain conditions are met.
      - (1) All primary directions.
      - (2) The section is multilane and divided, for at least 0.3 miles, in the secondary direction.
      - (3) The section is a LTRC or Truck section (truck sections only exist in District 62).
      - (4) The section has been specifically requested to be collected in both directions.
  - f) Some items should not be rated:
    - i) Cross drains and manhole covers
    - ii) Sensor loops for traffic signals
    - iii) Sawed and sealed joints
    - iv) Blowups (this is only true on asphalt pavements); however, regardless of pavement type, any distresses that are found within a blow up are to be rated.
- 3) All sections should be sampled and ensure that the rating is appropriate to severity/type.
- a) More than 5 consecutively missed distresses of any type or severity, within a specific segment, may cause the control section to be rejected.
  - b) More than 1 missed distress of any type, and is of high severity, may cause a control section to be rejected.

- c) Any distresses that may exist on an elevated section of highway or bridge does not have to be rated; however, if the section is rated, it should not be rejected.
- d) To make the process as efficient and accurate as possible, the pavement images are sampled; if a problem is found, then a more thorough review may be necessary to discover where most of the errors exist if any images are missing, then the control section should be rejected.
  - i) The ratings utilize three different colors to represent the three different severity levels: orange (no severity), green (low severity), yellow (medium severity) and red (high severity).
  - ii) Different markings represent different distresses: transverse (a single, solid line that travels from the left side to the right side), longitudinal (a single, solid line that travels from the bottom to the top), alligator, and patch (an area drawn marked, using a cross hatch pattern); for a more detailed description of the distress types and severities, please reference the current LADOTD Distress Identification Protocols.
    - (1) Transverse cracking is counted by the linear foot.
    - (2) Longitudinal cracking is counted by the linear foot.
    - (3) Alligator cracking is calculated by the square foot.
    - (4) Patching is calculated by the square foot.
    - (5) Different methods can be used to detect whether a control section was completely rated
      - (a) The checker can open a grid with the quantified data; this will allow the checker to view the numerical amount of a specific distress.
      - (b) The checker can write a SQL statement in the “Where” field to query the database; for instance, if some transverse and longitudinal cracking is observed, then the following “Where” state will make the checker aware of where there is no quantified data: “(RNDM\_L < 1) AND (RNDM\_M < 1) AND (RNDM\_H < 1)”; the checker can then review the filtered segments and review the ratings.
      - (c) The Distress Table can be opened and will show all distresses that were rated within a specific segment.
      - (d) Random sampling throughout the control section is the quickest and most efficient process for checking the ratings; using this method, the checker can determine if the distresses were identified correctly, especially where distress type and severity are concerned.
        - (i) The sample rate is approximately 5% of the control section; please see the below table for the sample frequency.
        - (ii) If any errors are found, then the checker should perform a more thorough review of the ratings so that most or all of the errors can be found and reported back to the Data Collection Consultant (DCC).

Table 5 – Quality Control Required Miles to be Checked

Control Section Length (in miles)	Sample Frequency (tenth miles to be checked)
<=1	2
>1 and <=5	3
>5 and <=10	5
>10 and <=15	8
>15 and <=30	13
>30	5% of Control Section Length

- 4) Results from checking the pavement distress data and pavement images, for the Frontage Roads, NHS-HPMS and District Control Sections, are documented in the QA/QC form.
- a) All control sections (LRS ID’s) that are checked shall be either accepted or rejected during the QA/QC process.
    - i) Sections that are accepted will have the checker’s name and a time/date stamp.
      - (1) Each section that is checked shall be entered into the QA/QC form after it has been checked.
      - (2) All sections that are checked during the work day shall be entered into the QA/QC form prior to the end of the work day.
      - (3) There is only one field that can be filled: Other Remarks – this field is provided to document any event/circumstance that is noteworthy. It is not mandatory for this field to be completed.
      - (4) The checker can drop down the selection box beside “Please Enter Your Name:” and select his/her name to complete this form.
    - ii) Sections that are rejected will have the checker’s name, a time/date stamp, and documentation for rejecting the section.
      - (1) Each section that is checked shall be entered into the QA/QC form after it has been checked.
      - (2) All sections that are checked during the work day shall be entered into the QA/QC form prior to the end of the work day.
      - (3) Several fields are provided to document the reason(s) why a section was rejected. It is mandatory that at least one of the fields be completed.
        - (a) There is only one check box: Pavement/Data Unsubmitted – this check box should be checked if the section was supposed to be delivered, but was not.
        - (b) Fill-in fields:
          - (i) No Video Detail – this field is used to detail the specific location/images that are missing.

- (ii) Unclear Images Detail – this field is used to detail the specific segment(s) of a section where the pavement images are of poor quality.
  - (iii) Missed Crack(s) Detail – this field is used to document the specific location/quantity of cracking that was not rated.
  - (iv) Missed Patching Detail – this field is used to document the specific location/quantity of patching that was not rated.
  - (v) Wrong Rating Detail – this field is used to document where pavement distresses were incorrectly rated with regard to type or severity.
  - (vi) Other Remarks/Comments – this field is used to document any reason, or additional information, regarding a section being rejected.
- (c) The checker can drop down the selection box beside “Please Enter Your Name:” and select his/her name to complete this form.

## Database Checks

- 1) Database is checked for errors (including, but not limited to):
  - a) Missing data
  - b) Data out of tolerance
  - c) Current data compared to previous collected data
  - d) Areas where pavement condition indicates acute improvement/deterioration are investigated
    - i) IRI improved
    - ii) Rutting improved
    - iii) Faulting improved
    - iv) Distress quantities are validated
      - (1) Checked for acute increase/decrease in longitudinal/transverse cracking
      - (2) Checked for acute increase/decrease in fatigue cracking
      - (3) Checked for acute increase/decrease in patching quantities
- 2) Database is imported into pavement management software. If any errors are found, the database is sent back to the (DCC) Data Collection Consultant for correction, and resubmitted to LADOTD.
- 3) Issues are documented and reported to Data Collection Consultant (DCC).
- 4) GPS data is plotted on GIS map for comparison to existing, accepted GPS data.

<b>Frequency of Quality Control Activities</b>	
<b>Quality Control Activity</b>	<b>Frequency</b>
DCC Primary Baseline Calibration Site Testing	<p>On a monthly basis – Regular Control sites in Central District. Includes: DMI, GPS, elevation, sensor data and post processed data sets (rutting, cross-fall and cracking)</p> <p>On a weekly basis – Local sites within active collection Districts, Verification Control sites (DMI and Sensor data)</p>
DCC Quality Control in Field Data Collection	<p>The DCC Field Technicians will visually monitor real-time data readouts to ensure that the data being collected falls within reasonable and expected ranges for the pavement being measured.</p> <p>On a daily basis, the Data Integrity Log files, the Section Average Summary, samples of collected images and a Daily Contact report will be forwarded by the DCC Field Technician to the DCC Support Team for further review.</p>
DCC Quality Control in Image and Data Location	Constantly monitored in real time, and checked in post processing, to ensure they are working properly.
DCC Quality Control in Pavement Distress Data	On a continual basis during data collection. Sample data report will be forwarded by the DCC Field Technician to the DCC Support Team for further review on a daily basis.
DCC Quality Control of Forward Facing Perspective and Right Facing Right-of-Way Images	The DCC Field Technicians shall perform daily and continuous checks to ensure the auto focus and auto iris adjustment capabilities of the camera lens packages are functioning properly. Sample images will be forwarded by the DCC Field Technician to the DCC Support Team for further review on a daily basis.
DCC Quality Control of Pavement Images	On a continual basis during data collection. Sample images will be forwarded by the DCC Field Technician to the DCC Support Team for further review on a daily basis.
DCC Quality Control in Data Reduction	Continuously reviewed in batches after the data has been collected.
DCC Control of Quality in Highway Asset Inventory	On a monthly basis
LADOTD Right of way images QA/QC and Check for correct Control Section/HPMS-NHS Section/Frontage Road Section collection	On a continual basis during the contract as data and images are delivered by the DCC.
Pavement distress data and pavement images QA/QC	On a continual basis during the contract as data and images are delivered by the DCC.
Database Checks	Continuously reviewed in batches after the data has been delivered.

<b>Roles and Responsibilities between LADOTD and Data Collection Consultant</b>	
<b>LADOTD Project Manager and Staff</b>	<b>Data Collection Consultant (DCC) Project Manager and Staff</b>
Coordination with DCC and Support Staff	Coordination with LADOTD and Support Staff
Communication with DCC (Meetings, emails, etc.)	Communication with LADOTD (Meetings, emails, etc.)
Ensure Clarification between LADOTD and DCC	Ensure Clarification between DCC and LADOTD
Address Necessary Corrections and Revisions	Address Necessary Corrections and Revisions
Project Tracking	Project Tracking
Verification and QA/QC of Deliverables	Data Collection
Acceptance of Final Delivery	Post Processing and Verification of Data
Payment of Invoices	Submittal of Deliverables
	Invoice Submittal

<b>Data Sampling, Review and Checking Process</b>	
<p>All sections should be sampled.</p>	<p>The beginning of the control section is checked to ensure that the data collection vehicle started at the correct location if incorrect, the control section should be rejected.</p> <p>The images for the first tenth mile should be played to ensure that the images play in the proper sequence.</p> <p>The images should be sampled throughout the entire control section</p> <ul style="list-style-type: none"> <li>a) The lengths, as determined by the control section manual and the (DCC) Data Collection Consultant, should coincide with a difference less than 5%.</li> <li>b) If the difference is more than 5%, then the control section should be carefully reviewed to ensure that the data collection vehicle tested the correct control section in its entirety.</li> <li>c) If the control section is found to have been collected correctly and the Distance Measurement Instrument (DMI) appears to working correctly, then the control section should not be rejected.</li> </ul> <p>The images at the end of the control section should be carefully reviewed to ensure that the data collection vehicle is ending at the correct location; if incorrect, the control section should be rejected.</p>

<p>Checking the right of way images, for the Frontage Roads, NHS-HPMS and District Control Sections</p>	<p>All control sections (LRS ID's) that are checked shall be either accepted or rejected during the QA/QC process.</p> <ul style="list-style-type: none"> <li>a) Each section that is checked and <u>accepted</u> shall be entered into the QA/QC form after it has been checked and remarks are entered into the "Other Remarks" field to document the event/circumstance that is noteworthy.</li> <li>b) Sections that are checked and <u>rejected</u> must have the documented reason(s) why a section was rejected. One of the following reasons should be indicated: Right of Way Unsubmitted, Images Play Backwards/Out of Order, Right of Way Images Collected in Wrong Direction, No Video, Wrong Road, Unclear Images, Wrong Beginning/Ending, or Other Remarks/Comments.</li> </ul>
<p>Pavement distress data and pavement images QA/QC</p>	<ol style="list-style-type: none"> <li>1. Check Image Quality (image clarity, brightness/darkness), pavement images should be synchronized with right of way images, ability to see all rated distresses, there should be minimal or no missing images.</li> <li>2. All sections should be sampled and ensure that the rating is appropriate to severity/type.</li> <li>3. Results from checking the pavement distress data and pavement images, for the Frontage Roads, NHS-HPMS and District Control Sections, must be documented on the QA/QC form.</li> </ol>

## GLOSSARY OF TERMS

**AASHTO:** American Association of State Highway and Transportation Officials.

**American Society for Testing and Materials (ASTM):** An international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. ASTM is currently referred to as ASTM, International.

**Acceptance testing:** The activities required to determine the degree of compliance of the pavement data collected with contract requirements. (Flintsch and McGhee 2009)

**Acceptance:** The process whereby all factors used by the agency (i.e., sampling, testing, and inspection) are evaluated to determine the degree of compliance with contract requirements and to determine the corresponding value for a given product. (AASHTO 2011)

**Accuracy:** The degree to which a measurement, or the mean of a distribution of measurements, tends to coincide with the true population mean. (AASHTO 2011)

**Asset Calibration Sites:** LADOTD shall establish sites with appropriate non-pavement assets such as signs, guard rails, etc. that can be inventoried. Prior to starting network production data capture, Asset Calibration Sites will be captured, thoroughly inspected for quality and validated for accuracy and completeness.

**Automated Data Collection:** the process of collecting pavement condition data by the use of imaging technologies or other sensor equipment (McGhee 2004).

**Automated Data Processing:** The reduction of pavement condition (surface distresses, such as cracking and patching, or pavement condition indices, such as IRI) from images or other sensors. The process is considered fully automated if the pavement condition (e.g., distress) is identified and quantified through techniques that require either no or very minimal human intervention (e.g., using digital recognition software capable of recognizing and quantifying cracks on a pavement surface) (McGhee 2004).

**Bias:** An error, constant in direction, that causes a measurement, or the mean of a distribution of measurements, to be offset from the true population mean (AASHTO 2011).

**Calibration** – A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or between values represented by a material measure or a reference material, and the corresponding values realized by standards (AASHTO 2011).

**Certified technician:** a technician certified by some agency as proficient in performing certain duties (AASHTO 2011).

**Corrective Action:** Adjustments to equipment or procedural changes taken to eliminate causes of non-conformities or other undesirable situations.

**Data Collection Vehicle (DCV):** The Data Collection Contractor's vehicle configured with all appropriate equipment to accurately capture the required data to meet the deliverables of the data collection contract.

**Data Collection Consultant (DCC):** the entity required to acquire and deliver road condition data and asset data for use in the Pavement Management system of the Louisiana Department of Transportation and Development.

**Data Processing:** Covers all of the activities that are conducted to convert the raw data collected in the field surveys to useful information (Flintsch and McGhee 2009).

**Distance Measurement Instrument (DMI):** A transducer, or similar device, used to determine the longitudinal distance that the Data Collection Vehicle has traveled.

**Distress Rating:** Measurement of the extent and severity of distress (e.g., cracking, patching, faulting, and rut depth) present on a roadway surface.

**District Quality Control Verification Sites (DQCVS):** The DCC shall establish at least one DQCVS in each district and more than one DQCVS site in each district can be established at the DCCs discretion. The DCC shall calibrate all DCVs on the LADOTD Primary Baseline Calibration Sites just prior to establishing a DQCVS in a district. The DQCVS will use known IRI, Rutting, and Faulting values from past data collection cycles to confirm that the current values are valid to use as baseline data. For subsequent ongoing data collection, within a particular district, the DQCVS will be collected weekly by each DCV and compared with the baseline data.

**DOTs:** Department of Transportations

**ESRI:** An international supplier of geographic information system (GIS) software, web GIS and geodatabase management applications.

**Falling Weight Deflectometer (FWD):** An impact load device used to deliver a transient impulse load to the pavement surface and measure the resultant pavement response (its deflection) by a series of sensors. See ASTM D4694, *Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device*.

**Federal Highway Administration (FHWA):** The division of the U.S. Department of Transportation that provides guidance, management rules and funding for the National Highways of Significance (NHS) pavements. The FHWA definition of NHS includes Interstates.

**Geographic Information System (GIS):** System designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. For LADOTD this is an ESRI solution.

**Global Positioning System (GPS):** Satellite-based navigation system. Compliance with the Louisiana Transportation Research Center's Final Report 539, "LADOTD Standards for GPS Data Collection Accuracy" found at [https://www.ltrc.lsu.edu/pdf/2015/FR\\_539.pdf](https://www.ltrc.lsu.edu/pdf/2015/FR_539.pdf), is required.

**Ground Truth:** See reference value.

**Highway Performance Monitoring System (HPMS):** A national-level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the nation's highways. The HPMS contains administrative and extent of system information on all public roads, while information on other characteristics is represented in HPMS as a mix of universe and sample data for arterial and collector functional systems. Limited information on travel and paved miles is included in summary form for the lowest functional systems (FHWA HPMS website – <http://www.fhwa.dot.gov/policyinformation/hpms.cfm>).

**Independent Assurance (IA):** Activities that are an unbiased and independent evaluation of all the sampling and testing (or inspection) procedures used in the quality assurance program (AASHTO 2011).

**Inertial Navigation System:** Includes all devices and technology such as real time kinematic Global Positioning System (GPS) technology, inertial measurement instruments (accelerometers, gyroscopes), distance measuring instruments, etc. required to provide roadway geometry (cross slope, super elevation(slope), grade, vertical curve, etc.), pavement elevations, stationing and latitude/longitude coordinates for pavement images, forward facing perspective images, right facing right-of-way images, pavement distress measures, etc.

**International Roughness Index (IRI):** A statistic used to estimate the amount of roughness in a measured longitudinal profile. The IRI is computed from a single longitudinal profile using a quarter-car simulation. See ASTM E1926, *Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements*.

**Inter-Rater Reliability:** Competent raters using the same protocols on the same roadway sections, get the same results. It is also known as cross-rater reliability.

**LIDAR:** A surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target.

**Louisiana Department of Transportation and Development (LADOTD):** a Louisiana state government organization in charge of maintaining public transportation, roadways, bridges, canals, select levees, floodplain management, port facilities, commercial vehicles, and aviation.

**Location Referencing Method (LRM):** A location reference method consists of a mechanism to find and state the address of a point by referencing it to a known point. Its purpose is to communicate the location of a point through an address (TRB 1974).

**Location Referencing System (LRS):** The total set of procedures for determining and retaining a record of specific points along a roadway. The system includes the location referencing method(s), together with the procedures for storing, maintaining, and retrieving location information about points and segments on the highways (TRB 1974).

**Logic Check:** Consistency between the rated distress type and the pavement type (i.e., assuring that the rated distress matches the pavement type).

**Macrotexture:** A surface texture defined by wavelengths of 0.02 to 2 in (0.5 to 50 mm) and vertical amplitudes between 0.005 and 0.8 in (0.13 to 20 mm). Defined by mixture properties (shape, size, and aggregate gradation) of an asphalt paving material and finishing/texture (depth, width, spacing, and direction of tining/grooving) of a concrete pavement material.

**Manual Data Collection:** Pavement condition data collection through processes where people are directly involved in the observation or measurement of pavement properties without the benefit of automated equipment (e.g., visual surveys and fault meters) (McGhee 2004).

**Microtexture:** A surface texture defined by wavelengths less than 0.02 in (0.5 mm) and vertical amplitudes between 0.04 and 20 mils. Defined by the surface properties of the aggregate particles.

**National Highway System (NHS):** Consists of roadways important to the nation's economy, defense, and mobility (FHWA NHS website – [http://www.fhwa.dot.gov/planning/national\\_highway\\_system/](http://www.fhwa.dot.gov/planning/national_highway_system/)).

**Network-Level Data:** Data supporting pavement management decisions on a roadway network or system basis (Flintsch and McGhee 2009).

**Pavement Condition Index (PCI):** A numerical rating resulting from a pavement condition survey that represents the severity of surface distresses. See ASTM D6433, *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*.

**Pavement Condition Indicator:** A measure of the condition of an existing pavement section at a particular point in time. This indicator may be a specific measure of a pavement condition characteristic (e.g., smoothness or cracking severity and/or extent) or an index defined for a single distress (e.g., cracking), for multiple distresses (e.g., PCI), or for the overall pavement condition (Flintsch and McGhee 2009).

**Pavement Condition:** An evaluation of the degree of deterioration and/or quality of service of an existing pavement section at a particular point in time, either from an engineering or user (driver) perspective. The condition as it is perceived by the user is often referred to as functional condition. The estimated ability of the pavement to carry the load is referred to as structural condition (Flintsch and McGhee 2009).

**Pavement Management System (PMS):** A program for improving the quality and performance of pavements through collecting, analyzing, maintaining, and reporting pavement data, to assist the decision makers in finding optimum strategies for maintaining pavements and minimizing costs through good management practices.

**Pavement Performance:** The history of pavement condition indicators over time or with increasing axle load applications (TRB 2002).

**Percent Within Limits (PWL):** The percentage of the lot falling above the lower specification limit (LSL), beneath the upper specification limit (USL), or between the USL and LSL (AASHTO 2011).

**Precision:** The degree of agreement among a randomly selected series of measurements; or the degree to which tests or measurements on identical samples tend to produce the same results (AASHTO 2011).

**Present Serviceability Index (PSI):** An index derived by formula for estimating the serviceability rating from measurements of physical features of the pavement.

**Present Serviceability Rating (PSR):** A definition of pavement serviceability based on individual observations.

**Primary Baseline Calibration Sites:** LADOTD will establish Primary Baseline Calibration Sites whose pavement condition data and the length of pavement will serve as a reference value or “ground truth” and vehicle calibration location. The following calibration requirements could be included on these sites, Distance Measuring Instrument (DMI), Imagery, IRI, Rutting, Faulting, GPS and Inertial Navigation.

**Project-Level Data:** Data supporting pavement management decisions on a discrete project or roadway segment basis (Flintsch and McGhee 2009).

**Project Manager:** The engineer at the Louisiana Department of Transportation and Development responsible for coordinating with the Data Collection Consultant and is in charge of the planning and execution of the pavement management project.

**Quality Assurance and Quality Control (QA/QC):** The process used to measure and assure the quality of a product, while ensuring products and services meet consumer expectations.

**Quality Audits:** The process of systematic examination of a quality system carried out by an internal or external quality auditor or an audit team. It is a key element in the ISO quality system standard to verify that the institution has clearly defined internal quality monitoring procedures linked to effective action (Flintsch and McGhee 2009).

**Quality Control (QC):** The system used by a contractor to monitor, assess, and adjust its production or placement processes to ensure that the final product will meet the specified level of quality. Quality control includes sampling, testing, inspection and corrective action (where required) to maintain continuous control of a production or placement process (AASHTO 2011).

**Quality Control Plan:** A document that describes the process to be followed for delivering the level of pavement condition data quality required. This plan typically includes data quality objectives (precision, accuracy, completeness, etc.), organization and responsibility, sampling procedures, equipment requirements (calibration, verification, etc.), processing of the QC data, statistical analysis to be conducted, reporting, documentation of potential problems, and remedial solutions (Flintsch and McGhee 2009).

**Quality Management (QM) Plan:** A document that specifies the quality management procedures and resources that will be used and how the process will be implemented and assessed for effectiveness (adapted from ISO 2000).

**Quality System:** The organizational structure, procedures, processes, and resources needed to implement QM to meet the quality objectives (Flintsch and McGhee 2009).

**Quality:** The degree of excellence of a product or service; the degree to which a product or service satisfies the needs of a specific customer; or the degree to which a product or service conforms with a given requirement (AASHTO 2011).

**Random Sample:** sample in which each increment in the lot has an equal probability of being chosen (AASHTO 2011).

**Reference Value:** A value that serves as an agreed-upon reference for comparison, and which is derived as a theoretical or established value, based on scientific principles, an assigned or certified value, based on experimental work of some national or international organization, or a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or engineering group (AASHTO 2011). Reference value is also known as ground truth.

**Repeatability:** Degree of variation among the results obtained by the same operator repeating a test on the same material. The term repeatability is therefore used to designate test precision under a single operator (AASHTO 2011).

**Reproducibility:** Degree of variation among the test results obtained by different operators performing the same test on the same material (AASHTO 2011).

**Resolution:** The smallest change in a quantity being measured that causes a perceptible change in the corresponding indication (ICO 2008).

**Right-Of-Way (ROW) Image:** Forward Facing Right of Way Images are optimized to view the entire roadway, shoulders and overhead roadway signs and Right Facing Right of Way Images are angled to optimize roadside asset inventory collection.

**Rolling Wheel Deflectometer (RWD):** A specially equipped vehicle that exerts a predetermined amount of downward force on the pavement surface at a specific point. The vehicle utilizes a series of displacement lasers to detect the amount of deflection between the point of the applied force and the point where no downward force is being applied.

**Semi-Automated Data Collection/Processing:** Process of collecting pavement condition data using imaging technologies or other sensor equipment but involving significant human input during the processing and/or recording of the data (Flintsch and McGhee 2009).

**Structured Query Language (SQL):** SQL is used to communicate with a database. According to ANSI (American National Standards Institute), it is the standard language for relational database management systems.

**Standard Operating Procedures (SOP):** A set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations. SOPs aim to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

**Stratified Sampling:** A sampling procedure whereby samples are randomly obtained from each subplot (AASHTO 2011). When subpopulations within an overall population vary, it is advantageous to sample each subpopulation (stratum) independently. Stratification is the process of dividing members of the population into homogeneous subgroups before sampling.

**Systematic Sampling:** Statistical method involving the selection of elements from an ordered sampling frame. The most common form of systematic sampling is an equal-probability method. In this approach, progression through the list is treated circularly, with a return to the top once the end of the list is passed.

**Time-History:** A set of successive periodic measurements of pavement condition over time on the same roadway sections. This time-history can be used to determine pavement performance (Flintsch and McGhee 2009).

**Validation:** The mathematical comparison of two independently obtained sets of data (e.g., agency acceptance data vs. contractor data) to determine whether it can be assumed they came from the same population (AASHTO 2011).

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