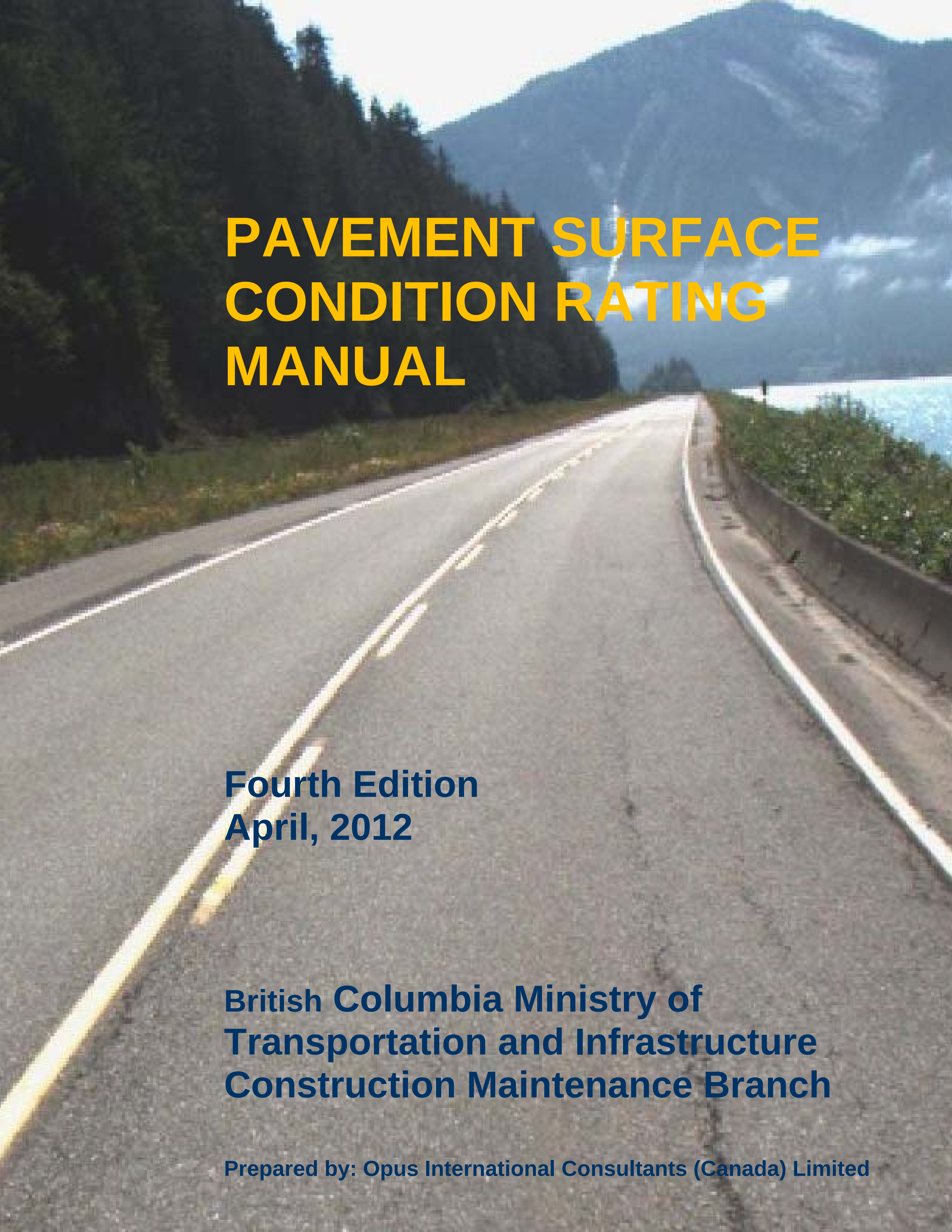

PAVEMENT SURFACE CONDITION RATING MANUAL

Fourth Edition
April, 2012

British Columbia Ministry of Transportation and Infrastructure Construction Maintenance Branch

Prepared by: Opus International Consultants (Canada) Limited

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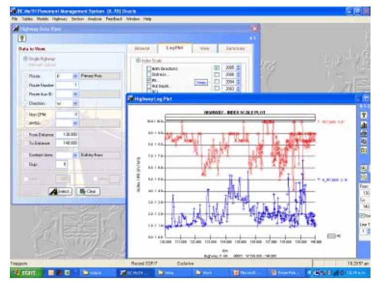
1 Introduction

1.1 Overview

The British Columbia Ministry of Transportation and Infrastructure (BCMoT) has implemented a multifaceted pavement asset management program. It is built around the Roadway Pavement Management System (RPMS) application and supported by data collection procedures and asset management policies.

Pavement surface condition data is a key component of the BCMoT infrastructure asset management program. The information is used across a wide range of business processes. This includes:



- Monitoring the on-going performance of the provincial paved road network;
- Predicting future pavement conditions and assessing long term needs;
- Strategic investment planning to support annual programming and decision making;
- Identifying rehabilitation and maintenance treatment options;
- Project level analyses to investigate causes of pavement deterioration and evaluating specific treatment options;
- Corporate performance measure reporting; and
- Supporting outsourced rehabilitation and maintenance service delivery.

This manual documents the technical specifications that guide the data collection and quality assurance requirements for Ministry high speed network level and manual project level pavement surface condition surveys that encompass the following measures:

- Surface distress;
- Roughness; and
- Rut depths.

The specifications have been field tested over a number of years and continue to evolve with experience and build upon best practices from other agencies including the Transportation Association of Canada.

1.2 Rating Manual Background

The BCMoT Pavement Surface Condition Rating Manual was originally released in 1994. It was developed by a committee comprised of provincial rehabilitation and pavement design personnel.

The manual was subsequently updated in 2002 and 2009 based on field experience and input from data collection contractors capturing improvements to the survey procedures and quality assurance, consolidation of specifications, advancements in surveying technology and a wider application of the manual.

This fourth d release of the Pavement Surface Condition Rating Manual further updates current practices and the application of the rating system to support Ministry asset management needs.

1.3 Format of Manual

The manual is structured according to the following chapters:

- Chapter 1 - Introduction
- Chapter 2 - Pavement Surface Condition Surveys;
- Chapter 3 - Flexible Pavement Distresses;
- Chapter 4 - Surface Distress Inspection Guidelines;
- Chapter 5 - Pavement Roughness and Rut Depth Guidelines;
- Chapter 6 - Network Level Surveying Locational Referencing;
- Chapter 7 - Network Level Survey QA Specifications;
- Chapter 8 - Pavement Performance Indices;
- Chapter 9 - Miscellaneous Ratings; and
- Chapter 10 - Manual Pavement Condition Rating Forms.

2 Pavement Condition Surveys

This chapter provides an overview of current practices for the contracted high speed network level surveys, and for manual project level distress surveys. These principles are also applicable to the pavement condition survey requirements of BCMoT concession agreements, but the concession agreement may also contain addition details or requirements in this regard. In the case of any material contradiction between the information contained in this manual, and that required in a concession agreement or network level survey contract, the language in the concession agreement or network level survey contract shall take precedence.

2.1 High Speed Network Level Surveys

The Ministry measures pavement performance according to surface distress and pavement roughness. High speed pavement surface condition surveys are conducted on a cyclical basis for the provincial road network. The surveys capture the severity and density of several surface distress types within each surveyed lane, as well as rut depth and roughness measurements in both wheel paths; and digital images of the right-of-way.

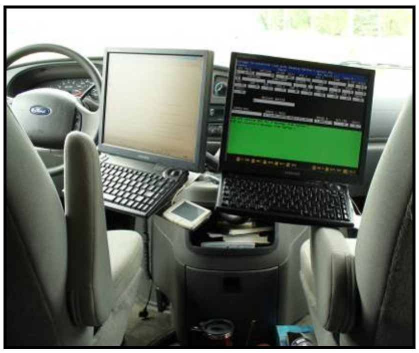
The objective of the high speed network level surveys is to obtain performance data that is sufficiently accurate, representative and consistent to support network level analyses. This involves the survey of the condition of the paved numbered highways and a representative sample of all paved side roads under the Ministry's jurisdiction, to identify pavements that are deficient, according to defined levels of service, and to monitor trends in highway condition. Data is used to ascertain overall pavement rehabilitation needs and assess appropriate investment levels to support strategic asset management planning. This in turn dictates the rating methodology and measuring equipment that are used for the surveys.

Multi-year pavement condition survey contacts are outsourced to contractors with multi-function pavement evaluation vehicles equipped with sophisticated on-board systems and instrumentation. Using third party contractors supports objectivity and consistency throughout the province. The surveys are guided by quality assurance procedures to ensure that collected data is accurate, repeatable, and of consistent quality and integrity from year to year and between contractors.

The high speed network level pavement surface condition surveys are conducted every two years on the primary highway system, either a two or four year basis for secondary highways depending on significance and on a four year cycle for selected paved side roads.

A brief description of the types of data collected and the equipment used to date for the high speed network level surveys follows.

2.1.1 Surface Distress



The rating is performed in accordance with this manual. The rating data is collected continuously and reported at 50 metre intervals.

The distress types included for the high speed network level surveys include:

Cracking	• Longitudinal wheel path cracking • Longitudinal joint cracking • Pavement edge cracking • Transverse cracking • Meandering longitudinal cracking • Alligator cracking
Defects	• Bleeding • Potholes

2.1.2 Rutting

The transverse profile of the travel lane is measured on a continuous basis. Sensor measurements are recorded across the full lane profile and used to calculate the average rut depths for each wheel path and the maximum rut depth in each wheel path. The data is collected continuously and reported at 50 metre intervals.

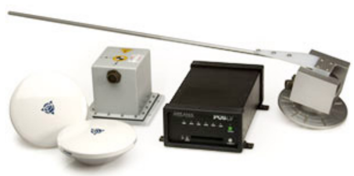
2.1.3 Roughness

Longitudinal profile roughness measurements are collected for each wheel path on a continuous basis using a laser profiler that conforms to the FHWA Class II Profiler Specification. The data is collected continuously, and reported at 50 metre averaged intervals as per the International Roughness Index (IRI) protocols.

2.1.4 Right of Way Digital Images

Digital images are collected during the surveys that show the full right of way view of the roadway, including both the pavement surface, and roadside features such as signs, structures and guard rails. The images are required to be collected using a high resolution progressive scan digital color camera with specific technical specifications are defined within the data collection contracts given the changes in technology.

2.1.5 Spatial Referencing



Spatial referencing of the pavement condition data is provided through a fully integrated differential GPS, inertial positioning, and an orientation system. Both linear and GPS positioning measurements are collected concurrently for each pavement condition record and digital image according to a defined linear referencing system for the highway network (see Chapter 6).

2.2 Project Level Manual Surveys

Manual surface distress surveys are routinely conducted during the detailed evaluations that are carried out for candidate rehabilitation projects. In addition to distress surveys, this can include geotechnical investigations, strength testing, coring, and laboratory testing. The purpose of the project level manual distress surveys is to provide a more accurate and detailed investigation of the pavement deterioration in order to assist in determining appropriate rehabilitation treatments.

The manual surface distress mapping method consists of a person walking the pavement section, identifying and classifying the existing distress features and plotting them on a map.

Marking off the test section in advance at 10 metre intervals assists in the mapping and rating process.

Based on the crack mapping and visual observation, the individual assigns the severity and density ratings for the distress types identified using the rating manual guidelines and photographs as references. Rutting is rated based upon the measured wheel path rut depths. Both the right and left wheel path rut depths are measured according to “ASTM E 1703/E 1703M - Standard Test Method for Measuring Rut-Depth of Pavement Surface using a Straightedge”.

3 Surface Distress Inspection Guidelines

This chapter provides inspection guidelines for conducting both high speed network level and manual, project level surface distress surveys.

3.1 Distress Identification

The following are key points with respect to overall distress identification:

- Distress ratings apply only to the traveled lane with the exception of pavement edge and longitudinal joint cracks.
- Transverse crack ratings should not be influenced by the shoulder conditions as some types of pavement rehabilitation (i.e. milling) treat just the main travelled lane.
- Longitudinal joint cracks can occur +/- 300 mm on either side of the centre line.
- If doubt exists as to whether a crack is a longitudinal joint crack or a longitudinal wheel path crack, assign the latter.
- Pavement edge cracks must be within 600 mm of the fog line or where no fog line exists, within 600m of where the fog line would be based on an appropriate lane width for such a road.
- Alligator cracking is a load related distress that is indicative of structural failure in the layer materials and will generally be either longitudinal or defined as isolated blowouts.
- Alligator cracking is double counted where it exists as part of another distress type. For example, alligator cracking in a wheel path would be recorded as severe wheel track cracking and alligator cracking

- The presence of alligator cracking automatically increases the severity of the associated longitudinal or transverse cracking to "SEVERE".
- Potholes are also double counted where they occur as part of another distress type. For example, a pothole in a transverse crack would be recorded as a severe transverse crack and a pothole.

3.2 Rating Severity

The following are key points with respect to rating severity for both, high speed network level and manual, project level surface distress surveys:

- 10 Percent Rule – when trying to assign the severity level for an individual crack, if at least 10% of the crack is in a higher severity level, the higher level is assigned. For example, if a transverse crack is 2.0 metres in length, with 0.25 metres measured at high severity and the remainder at moderate, the crack is assigned a high severity level.

Example of 10% Rule

- Low severity cracks can only consist of single cracks and no spalling.
- Moderate severity cracks can consist of single or multiple cracks with moderate spalling.
- High severity cracks can consist of single or multiple cracks with severe spalling.
- Cracks that are **fully** sealed are rated as low severity. Cracks that are not fully sealed are rated as per the inspection guidelines described in Chapter 4. Please note that for high speed network level surveys, cracks with intact, or fully effective sealant (as discerned at highway speed) are to be rated as low severity. If a crack has not been sealed, or if it has been sealed and it is apparent that the crack sealant is no longer effective, it should be rated as per the inspection guidelines contain in Chapter 4 (refer to Figure 4 for example).
- There are only moderate and high severity levels for alligator cracking, distortion, ravelling and bleeding.
- Rutting is categorized into three severity levels based on an average rut depth range (this applies to both project and high speed network level rating methods).
- Low severity potholes should be **clearly distinguishable** from surface ravelling. Small depressions less than 15 cm in diameter and 25 mm deep are **not** to be rated as potholes.

3.3 Rating Density for High Speed Network Level Surveys

The following are key points with respect to rating density high speed network level surveys:

- Number means the number of transverse cracks or potholes identified within a single 50 metre length of roadway lane.
- Length means the proportionate length of the distress identified within a single 50 metre length of roadway lane.
- Area means the measure area of the surface deterioration in square metres.
- Quantification of distress density is based on evaluation of a single 50 metre length of roadway lane.
- The density calculations for longitudinal wheel path cracking, rutting, shoving and bleeding requires measurement of the surface distress in **each wheel path**. The calculated density if is based on the total length of distress over a single 50 metre length of roadway lane times two (i.e. 50 metre segment: 2 x 50 = 100 metre total wheel path length).
- Table 1 on the next page describes how the density ratings presented in this manual are converted into percentage values for the high speed network level distress surveys when integrated keyboards are used and there is a transition from one severity level to another. For other more accurate data acquisition methods, the actual values can be used.
- Additional examples are provided in Chapter 3 for each distress type and sample files are contained in Chapter 7.

Table 1: Conversion of Density Ratings to Percentage Values

Distress Type	Severity Levels	Density Measure	Basis for Calculation and Acceptable Density Values
Longitudinal Wheel Path Cracking	L-M-H	Linear	Total combined length of cracking measured in each wheel path divided by the segment length x 2 (i.e. 100 m)
Longitudinal Joint Cracking	L-M-H		Total length of crack measured divided by the segment length
Pavement Edge Cracking	L-M-H		Total length of crack measured divided by the segment length
Meandering Longitudinal Cracking	L-M-H		Total length of crack measured divided by the segment length
Bleeding	M-H		Total length of bleeding measured in each wheel path over combined 100 m wheel path length
Transverse Cracking	L-M-H	Number	• 0% - no transverse cracking is present • 5% - few (1-2 cracks) • 35% frequent (3 – 10 cracks) • 90% - throughout (>10 cracks)
Potholes	L-M-H		• 0% - none • 5% - few (1 -2 potholes) • 35% - frequent (3 to 9 potholes) • 90% - throughout (> 10 potholes)
Alligator Cracking	M-H	Area	• 0% - none • 5% - few • 15% - intermittent • 35% - frequent • 65% - extensive • 90% - throughout
Rutting	L-M-H	Segment	• 0% - neither wheel path rut depths are ≥ 3 mm • 35% -only one wheel path rut depths is ≥ 3 mm • 90% - both wheel path rut depths are ≥ 3 mm

Linear Measured Distresses:

- Linear measured density values are calculated based on the proportional length of the distress severity level identified using the data collection vehicle's DMI measurements. If the distress severity level is observed over the entire 50 metre segment, then the density value would be 100 percent. If however, the distress severity level is only observed for a portion of the segment, the density value is to be calculated using a weighted average as shown in the following example:

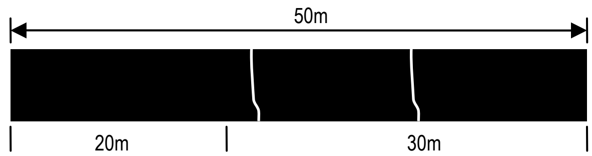
  Example: 18 metres of moderate severity longitudinal meandering cracking would be calculated as 36% (i.e. 18m/50m).

- Within a 50 metre segment, there can be more than one distress severity level rated. The same calculation process as noted previously is followed and the total combined density rating must be equal to or less than 100 percent.

Number Measured Distresses:

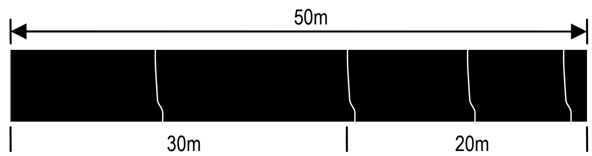
- Calculating the percentage density rating for both transverse cracking and potholes is based on the number of occurrences observed within a 50 metre segment according to the four possible density values (none – 0%, few - 5%, frequent -35% and throughout - 90%). If the same distress severity level is observed for the entire 50 metre segment, then only these values should be applied. If however, the severity level is only observed for a portion of the segment (i.e. transition from no observed distress and starts within a segment), the density value is calculated using a weighted average as shown in the following example:

  Example: Moderate severity transverse cracking rated as intermittent density (i.e. 35%) only begins in the last 30m of the segment, the density percentage is calculated as (20m x 0 + 30m x 35)/50 = 14% and rounded to the nearest 5% to be 15%.



- Similarly, within a 50 metre segment, there can be a transition between density levels. The same calculation process as noted previously is followed.

  Example: The first 30m of a segment exhibits low severity transverse cracking with a "few" density level (i.e. 5%) and the last 20m is rated at a "frequent" density (35%), the overall segment density percentage would be (30m x 5 + 20m x 35)/50 = 17% and rounded to 15% (i.e. nearest 5%)



- Within a 50 metre segment, there can be more than one distress severity level rated. The same calculation process as noted previously is followed and the total combined density rating must be equal to or less than 100 percent.

Area Measured Distresses:

- Calculating the percentage density rating for alligator cracking is performed the same way as that noted above for transverse cracking and potholes. It is based however, on the number of occurrences observed within a 50 metre segment according to the six possible density levels (none – 0%, few - 5%, intermittent – 15%, frequent -35%, extensive – 65% and throughout - 90%).

- If the distress severity level is observed for the entire 50 metre segment, then only these values should be applied. If however, the distress severity level is observed for a portion of the segment or there is a transition within the segment between the two defined severity levels, the density values are calculated by taking a weighted average as noted above.

3.4 High Speed Network Level Distress Survey Requirements

The following additional surface distress inspection guidelines are to be applied when conducting high speed surveys:

- Surveys are performed according to the distress rating definitions contained within this manual for the following 8 distress types:
  - a) Longitudinal wheel path cracking;
  - b) Longitudinal joint cracking;
  - c) Pavement edge cracking;
  - d) Transverse cracking;
  - e) Meandering longitudinal cracking;
  - f) Alligator cracking;
  - g) Potholes; and
  - h) Bleeding.
- Hours of operation apply for conducting high speed network level distress surveys that require visual rating of the distress features and / or digital image data collection:
  - o Surveys are conducted between sunrise and one hour prior to sunset;
  - o From sunrise until 12:00 noon, surveys are only conducted in northerly and easterly directions; and
  - o From 12:00 noon to one hour prior to sunset, surveys are only conducted in southerly and westerly directions.
- The above hours of operations may not apply for high speed surface distress surveys that employ more advanced technology such as laser lighting systems. Such an assessment will be based on the Contractor’s equipment.
- Hours of operations for windshield surface distress surveys performed at low speeds are sunrise to sunset and all provincial regulations and traffic control requirements must be followed.
- Surveys are not to be conducted when raining.
- Distress ratings are conducted on a continuous basis with results reported at 50 metres intervals by lane specified.

3.5 Manual Walking Survey Inspections

The following additional surface distress inspection guidelines are to be applied when conducting manual (i.e. walking), project level surveys:

- Rating segments can be 20 to 50 metres in length and one lane wide for manual project level surveys
- The rating individual is advised to mark out the test segments in advance using a tape measure to assist in the distress mapping. Forms to be used for the distress mapping are provided in this manual.
- All provincial regulations and traffic control requirements must be followed.
- Each test segment should be evaluated separately, with the distress types and severity/extent ratings assigned while on the site. Ensure distresses that occur in the transition between segments are assigned correctly and not duplicated on adjacent segments.
- For distress mapping purposes, abbreviations for the distress types are used with the severity level identified on the map. For example, TC-M denotes a transverse crack of moderate severity. Cracks that have been fully sealed are denoted with a subscript "s" (i.e. TC_s).
- Any features that cannot be drawn on the distress mapping form should be noted in the comments section.
- Both the left and right wheel path rut depths should be measured at 5 metre intervals. The highest rut depth measurement identified within the test segment is used as the criteria for assigning the severity.
- Following the manual rating of all the test segments, the individual should walk the entire site a few times to ensure that the severity and density ratings have been consistently applied.
- The relative angle of the sun and the roadway surface viewing direction can have a significant impact on visual observations. When conducting manual surveys, make sure to view the pavement from more than one direction.

4 Flexible Pavement Distress Rating

The rating methodology has been designed to be suitable for both high speed network level surface distress surveys that are conducted for the Ministry's high speed network level and project level surveys.

The rating system includes 12 distress types within the following categories:

Category	Distress Type	Abbreviation
Cracking	• Longitudinal Wheel Path Cracking	LWP
	• Longitudinal Joint Cracking	LJC
	• Pavement Edge Cracking	PEC
	• Transverse Cracking	TC
	• Meandering Longitudinal Cracking	MLC
	• Alligator Cracking	AC
Surface Deformation	• Rutting[1]	RUT
	• Shoving[1]	SHV
	• Distortion[1]	DST
Surface Defects	• Bleeding	BLD
	• Potholes	POT
	• Ravelling[1]	RAV

(1) Note: Not included in high speed network level pavement surface conditions distress surveys.

The distress types selected for the rating system represent the most predominant distress manifestations observed in British Columbia, focusing on those that progressively affect the pavement's ability to support traffic loads.

Each distress type is classified and rated according to its severity and density. In most cases, there are three levels of severity that describes the condition of the distress with definitions for each level – low, moderate and high. There are five ranges of density that indicates the portion of the road surface affected by a specific distress type. Photographs and drawings of distress types are provided as a reference for assessing severity and general mechanisms of failure listed.

4.1 Longitudinal Wheel Path Cracking (LWP)

Description: Cracks which follow a course predominantly parallel to the pavement centre line and are located at or near the centre of the wheel path.

Possible Causes: Heavy traffic during spring thaw when pavements are weak.

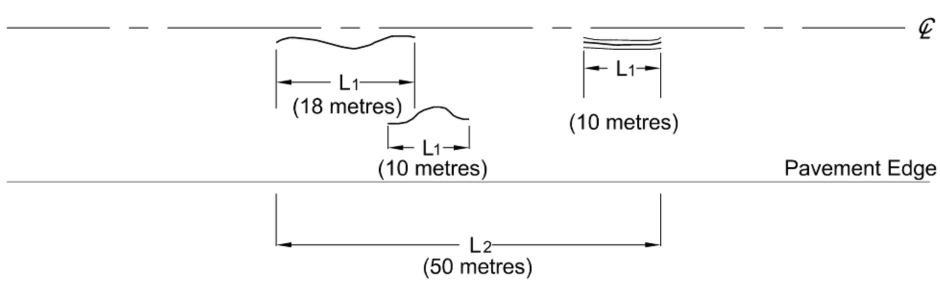
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{2 \times L_2} \times 100\,\% = \frac{(18+10+10)}{2 \times 50} \times 100\% = 38\% = L3$$

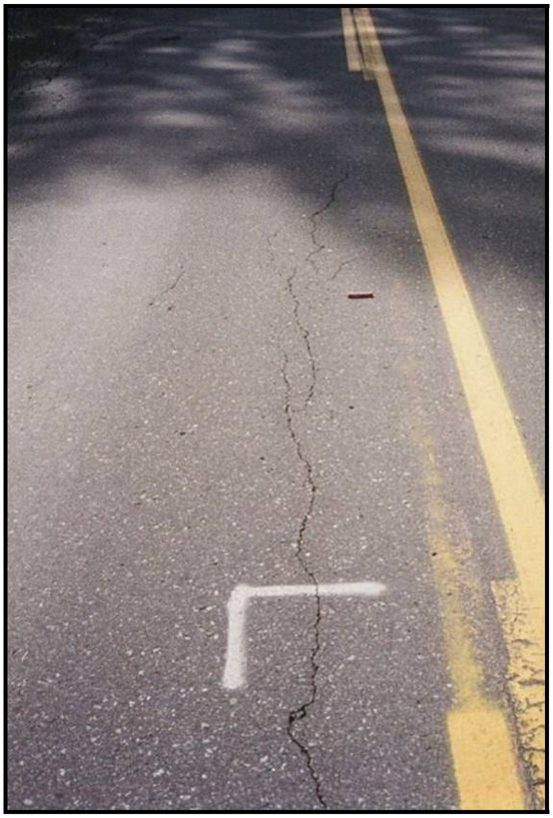


Figure 1 - Low Severity LWP

Figure 2 - Moderate Severity LWP

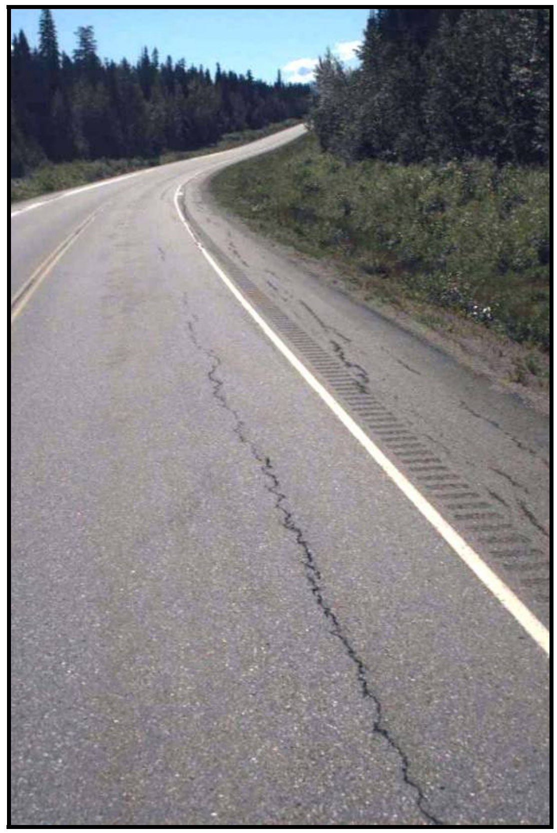


Figure 3 - High Severity LWP (multiple cracks)

Figure 4 - High Severity LWP

4.2 Longitudinal Joint Cracking (LJC)

Description: Cracks which occur along or in the immediate adjacent vicinity of the longitudinal centre or lane line pavement joint.

Possible Causes:

- Poor construction of longitudinal joint.
- Frost action on adjacent lanes with variable granular depths. Differential frost heave along the centre line caused by the insulating value of snow along pavement edges.
- Moisture changes resulting in swelling and shrinkage

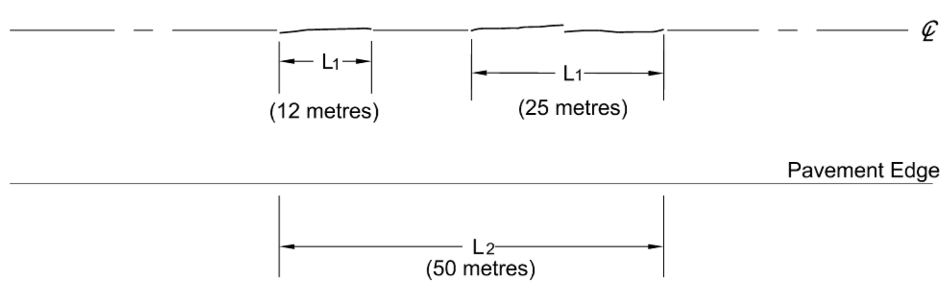
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{L_2} \times 100\% = \frac{(12 + 25)}{50} \times 100\% = 74\% = L4$$

Figure 5 - Low Severity LJC

Figure 6 - Moderate Severity LJC

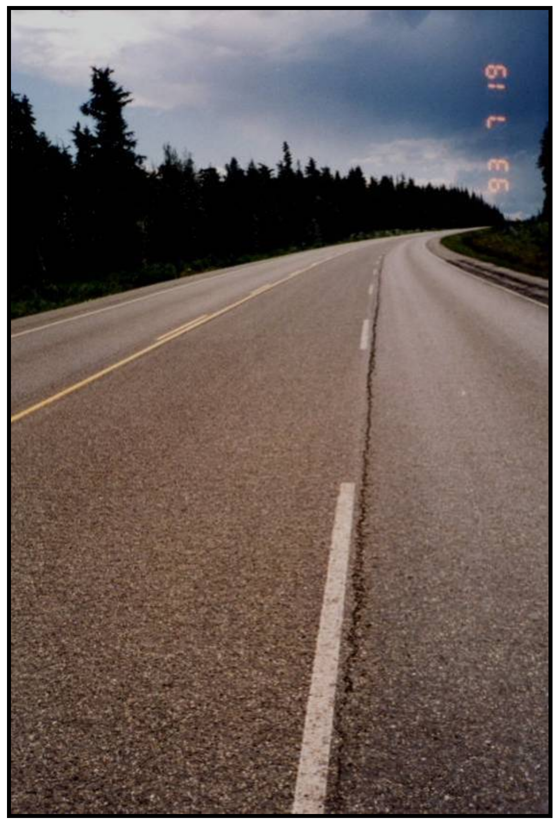


Figure 7 - High Severity LJC (multiple cracks)

Figure 8 - High Severity LJC (single crack)

4.3 Pavement Edge Cracking (PEC)

Description: Cracks which occur parallel to and within 0.6 metres of the inside and/or outside of the fog line. Cracks may be crescent shaped cracks or other fairly consistent cracks which intersect the pavement edge.

Possible Causes:

- Frost action.
- Inadequate pavement structural support at the pavement edge and/or excessive traffic loading.
- Poor drainage at the pavement edge and shoulder.
- Inadequate pavement width forces traffic too close to the pavement edge.

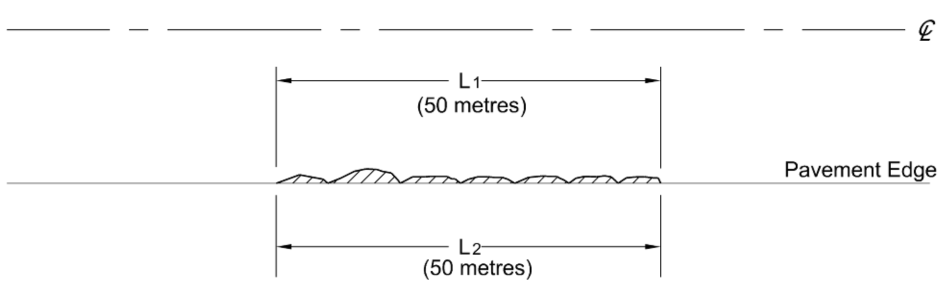
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{L_2} \times 100\% = \frac{50}{50} \times 100\% = 100\% = L5$$

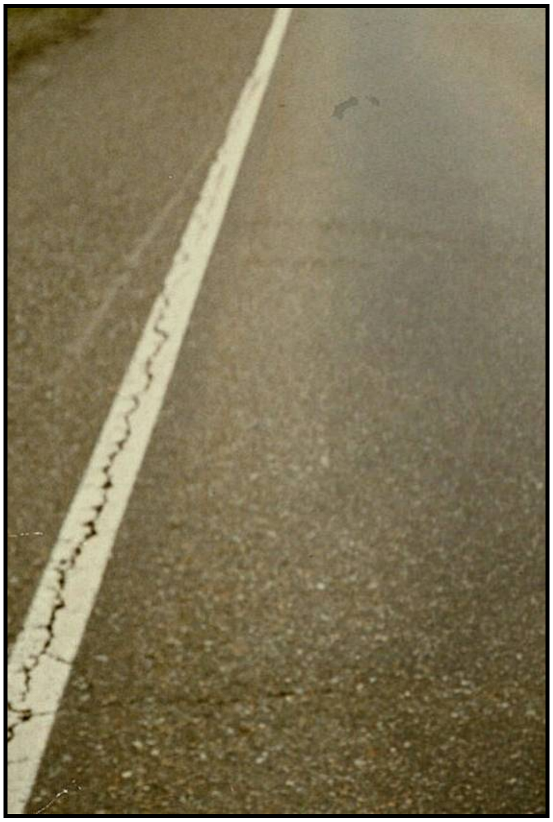


Figure 9 - Low Severity PEC

Figure 10 - Moderate Severity PEC

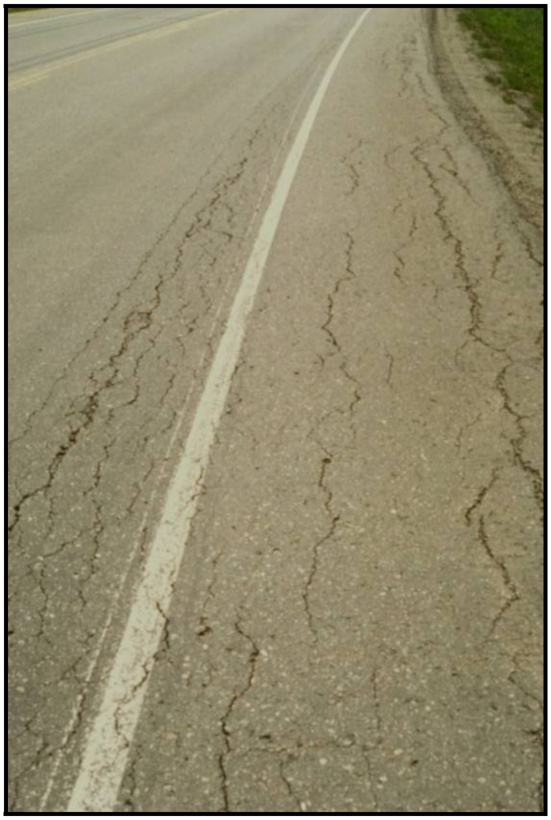


Figure 11 - High Severity PEC (paved shoulder)

Figure 12 - High Severity PEC

4.4 Transverse Cracking (TC)

Description: Cracks that are predominantly perpendicular to the pavement centre line and may extend fully or partially across the roadway.

Possible Causes:

- Surface shrinkage caused by low temperatures.
- High temperature susceptibility of the asphalt cement binder in asphalt mixes.
- Frost action.
- Reflection cracks.

Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Manual Survey		High Speed Survey	
		# Cracks per 50m	% Length Affected	# Cracks per 50m	% Length Affected*
0	None	0	0%	0	0%
1	Few	1-2	< 10%	1-2	5%
2	Intermittent	3-4	10 - 20%		
3	Frequent	5-7	20 - 50%	3-10	35%
4	Extensive	8-10	50 - 80%		
5	Throughout	>10	80 - 100%	>10	90%

Note: High speed surveys only include None, Few, Frequent and Throughout.

Example:

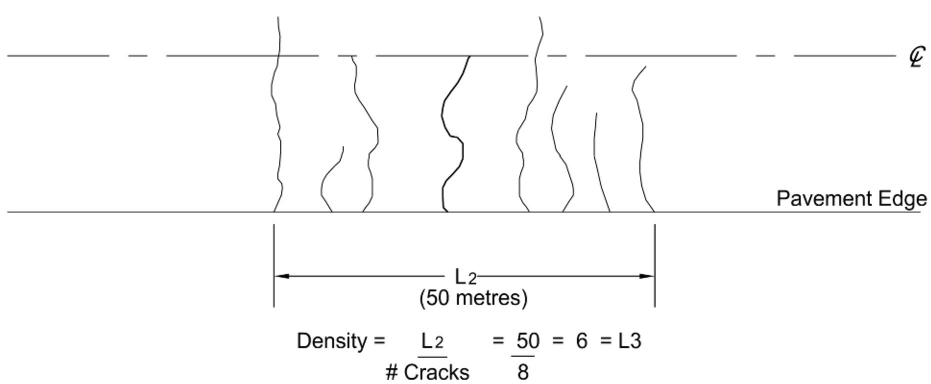
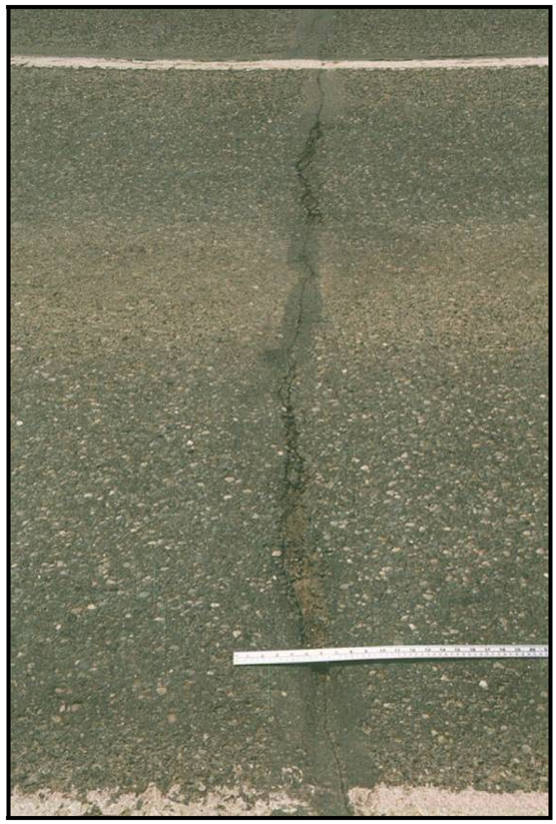


Figure 13 - Low Severity TC

Figure 14 - Moderate Severity TC

Figure 15 - High Severity TC (multiple cracking and spalling)

Figure 16 - High Severity TC



4.5 Meandering Longitudinal Cracking (MLC)

Description: Cracks which wander from edge to edge of the pavement or run parallel to the centre line, situated near the middle of the lane. Meandering longitudinal cracks are usually single cracks, but secondary cracks can develop in areas where transverse thermal cracks also exist.

Possible Causes:

- Frost action with greater heave at the pavement centre than at the edges. This is more prevalent in mixes where asphalt stripping is extensive.
- Faulty construction equipment can cause weak planes in the mix, which can fail from thermal shrinkage

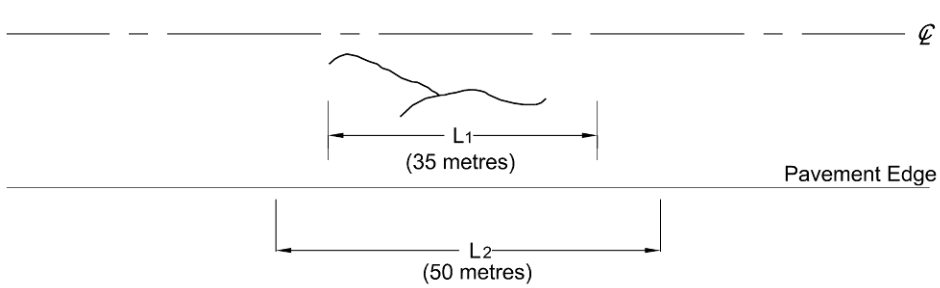
Severity:

Level	Description
Low	Single cracks with no spalling; mean unsealed crack width < 5mm
Moderate	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm
High	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm, alligator

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{L_2} \times 100\% = \frac{35}{50} \times 100\% = 70\% = L4$$

Figure 17- Low Severity MLC

Figure 18 - Moderate Severity MLC

Figure 19 - High Severity MLC
(multiple and alligator cracking)

Figure 20 - High Severity MLC

4.6 Alligator Cracking (AC)

Description: Cracks which form a network of multi-sided blocks resembling the skin of an alligator. Block size can range in size which indicates the depth of failure taking place. The pattern of cracking is usually longitudinal, originating in the wheel paths, but can occur transversely due to frost heaves or settlement and also along the centre line on narrow two lane roads.

Possible Causes:

- Usually areas subjected to repeated traffic loadings.
- Insufficient bearing support due to poor quality base materials or saturated base with poor drainage.
- Stiff or brittle asphalt mixes at cold temperatures.

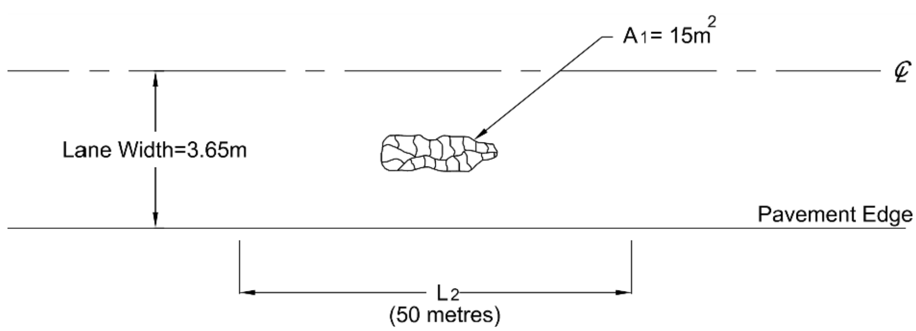
Severity:

Level	Description
Moderate	Interconnected cracks forming a complete block pattern; slight spalling and no pumping
High	Interconnected cracks forming a complete block pattern, moderate to severe spalling, pieces may move and pumping may exist

Density:

Level	Description	Percent Surface Area Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma A_1}{A_2} \times 100\% = \frac{15}{(50 \times 3.65\text{m})} \times 100\% = 8\% = L1$$

Figure 21 - Moderate Severity AC
(progressed from multiple cracks)

Figure 22 - Moderate Severity AC (localized failure)

Figure 23 - High Severity AC (spalling and throughout density)

Figure 24 - High Severity AC with break up and pumping

4.7 Rutting (RUT)

Description: Longitudinal depressions left in the wheel paths after repeated loadings, combined with sideways shoving of the pavement material.

Possible Causes:

- Poorly compacted structural layers.
- Heavy loadings of saturated unstable granular bases/sub-bases during spring thaw periods.
- Unstable asphalt mixes due to high temperature or low binder viscosity.
- Inadequate lateral support from unstable shoulder materials.
- Permanent deformation of an overstressed subgrade.

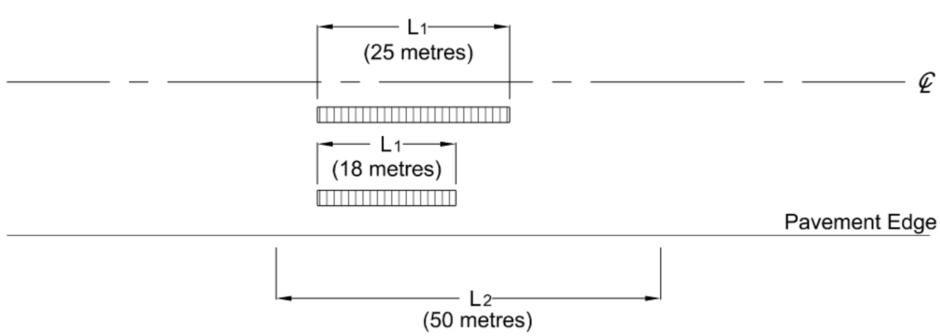
Severity:

Level	Description
Low	Rut depth is less than 10 mm
Moderate	Rut depth is in the range of 10 to 20 mm
High	Rut depth is greater than 20 mm

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{2xL_2} \times 100\% = \frac{(18 + 25)}{2 \times 50} \times 100\% = 43\% = L3$$

Figure 25 - Low Severity RUT

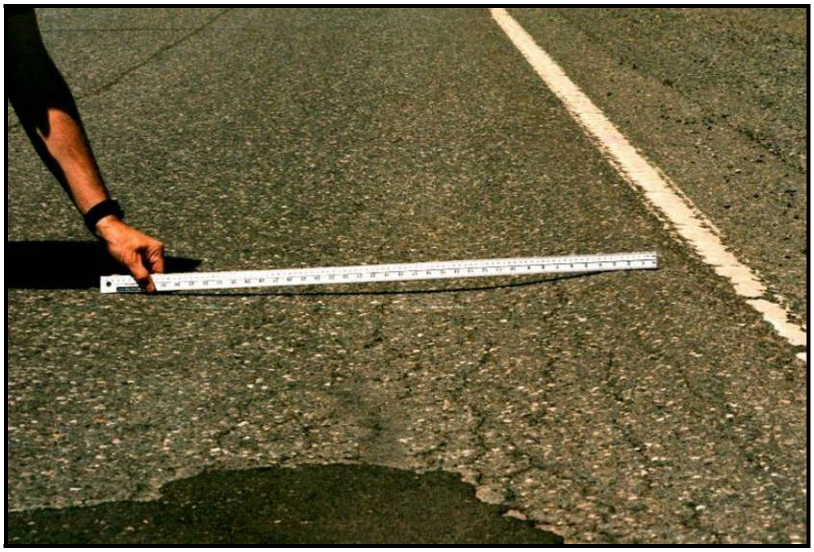


Figure 26 - Moderate Severity RUT

Figure 27 - High Severity RUT with transverse displacement

Figure 28 - High Severity RUT

4.8 Shoving (SHV)

Description: Longitudinal displacement of a localized area of the pavement surface generally caused by braking or accelerating vehicles and usually located on hills, curves or intersections.

Possible Causes:

- Stop and start of vehicles at intersections.
- Heavy traffic on steep downgrades or upgrades.
- Low stability asphalt mix.
- Lack of bond in asphalt surface and underlying layer
- Unstable granular base

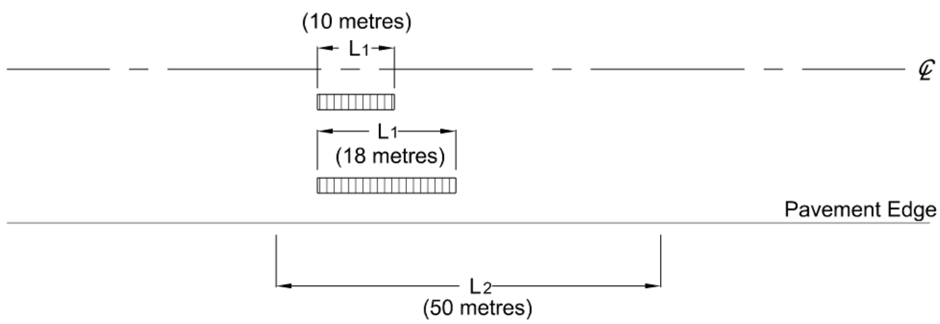
Severity:

Level	Description
Low	Barely noticeable to noticeable
Moderate	Rough ride
High	Very rough ride

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{2xL_2} \times 100\% = \frac{(10 + 18)}{2 \times 50} \times 100\% = 28\% = L3$$

Figure 29 - Typical case at downgrade intersection with heavy loadings

Figure 30 - High Severity SHV (defined by relative effect on ride quality)

4.9 Distortion (DST)

Description: Any deviation of the pavement surface from its original shape other than that described for shoving and rutting. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes and to frost heaving, and from residual effects of frost heaving accumulating after each season.

Possible Causes:

- Differential frost heaves in poorly drained cuts, transitions and at pavement edges or centre.
- Reverse differential frost heave at culverts.
- Differential settlement of subgrade or base materials.
- Lack of subgrade support.
- Embankment slope failure

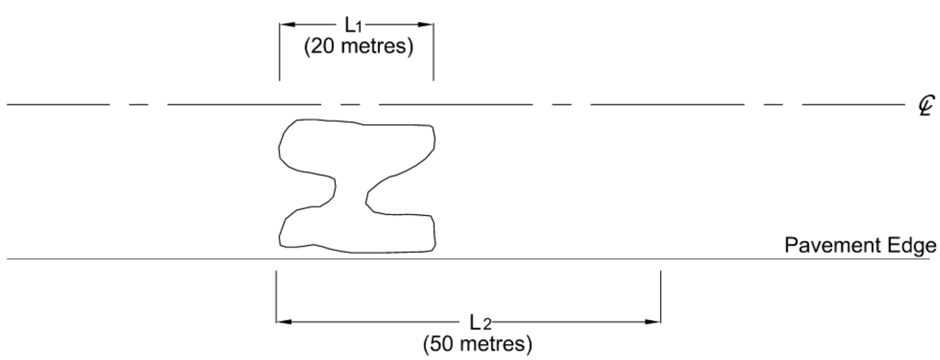
Severity:

Level	Description
Moderate	Noticeable swaying motion; good car control
High	Fair to Poor car control

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{L_2} \times 100\% = \frac{20}{50} \times 100\% = 40\% = L3$$

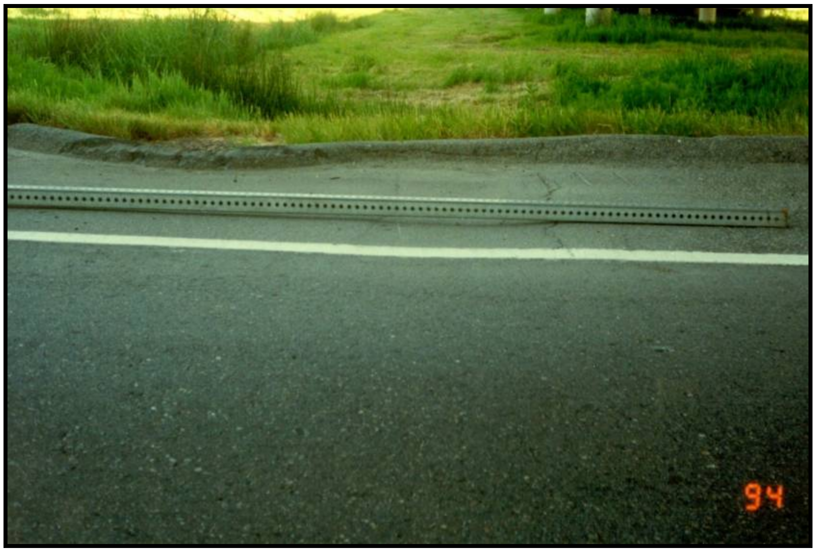


Figure 31 - Moderate Severity DST
(resulting from differential settlement)

Figure 32 - Moderate Severity DST
(example of pavement edge settlement)

4.10 Bleeding (BLD)

Description: Excess bituminous binder on the pavement surface can create a shiny, glass-like, reflective surface that may be tacky to the touch. Bleeding quite often occurs in the wheel paths.

Possible Causes:

- Mix design deficiencies where too high an asphalt content relative to voids results in excess asphalt forced to the surface by traffic, especially on hot days.
- Paving over surfaces with severe bleeding or the application of a heavy prime or tack coat under a new pavement layer may result in excess primer bleeding through the pavement surface over a period of time.
- Poor construction of surface seal coats.

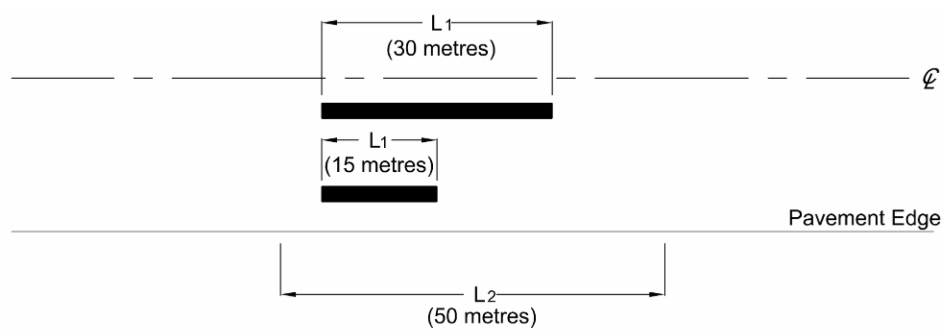
Severity:

Level	Description
Moderate	Distinctive appearance with free excess asphalt
High	Gives pavement surface a wet look; tire marks are evident

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{2xL_2} \times 100\% = \frac{(15 + 30)}{2 \times 50} \times 100\% = 45\% = L3$$

Figure 33 - Moderate Severity BLD

Figure 34 - High Severity BLD

4.11 Potholes (POT)

Description: Bowl-shaped holes of various sizes in the pavement surface.

Possible Causes:

- Thin spot in the asphalt layer.
- Localized drainage problems such as water infiltration through poorly bonded pavement structural layers or segregated spots in the asphalt mix where coarse patches allow intrusion of water
- Asphalt mix design deficiencies.

Severity:

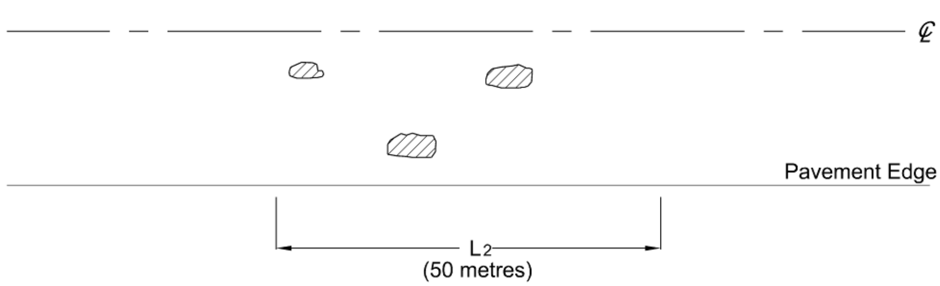
Level	Description
Low	Pothole > 175 cm^2 in area and less than 25mm deep. (~15cm Ø)
Moderate	Pothole > 175 cm^2 in area and 25 to 50mm deep. (~15cm Ø)
High	Pothole > 175 cm^2 in area and greater than 50mm deep. (~15cm Ø)

Density:

Level	Description	Manual Survey		High Speed Survey	
		# Potholes per 50m	% Length Affected	# Potholes per 50m	% Length Affected*
0	None	0	0%	0	0%
1	Few	1-2	< 10%	1-2	5%
2	Intermittent	3-4	10 - 20%		
3	Frequent	5-6	20 - 50%	3-9	35%
4	Extensive	7-9	50 - 80%		
5	Throughout	>=10	80 - 100%	>=10	90%

Note: High speed surveys only include None, Few, Frequent and Throughout.

Example:



Density = # Potholes = 3 = L3

Figure 35 - Low Severity POT (close up view)

Figure 36 - Moderate Severity POT

Figure 37 - High Severity Pothole

Figure 38 - High Severity Pothole with asphalt break up

4.12 Ravelling (RAV)

Description: The progressive loss of the pavement material (both aggregate particles and bituminous binder) from the surface downward, leaving a rough surface, vulnerable to weather deterioration.

Possible Causes:

- Poor adhesion of aggregates due to insufficient asphalt content, clay-coated aggregate, use of wet aggregates or stripping due to water action.
- Fracture of aggregate particles by heavy loads or natural causes. The unbound particles are then removed by traffic, reducing the depth of the asphalt.
- Poor compaction permits infiltration of water and salts which promote asphalt stripping.
- Segregated mix placed during construction.
- Aging and weathering.

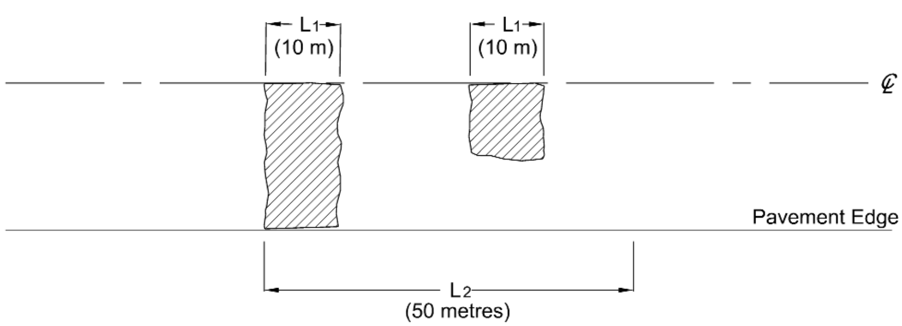
Severity:

Level	Description
Moderate	aggregate and/or binder worn away; surface texture rough and pitted; loose particles exist
High	aggregate and/or binder worn away; texture is very rough and pitted

Density:

Level	Description	Percent Length Affected
0	None	0%
1	Few	< 10%
2	Intermittent	10 - 20%
3	Frequent	20 - 50%
4	Extensive	50 - 80%
5	Throughout	80 - 100%

Example:



$$\text{Density} = \frac{\Sigma L_1}{L_2} \times 100\% = \frac{(10 + 10)}{50} \times 100\% = 40\% = L3$$

Figure 39 - Moderate Severity RAV

Figure 40 - High Severity RAV

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5 Roughness and Rut Depth Guidelines

This chapter provides inspection guidelines for conducting high speed network level pavement roughness and rut depth surveys.

5.1 Longitudinal Profiles

The following requirements must be followed for measuring longitudinal profiles:

- Longitudinal profile roughness measurements are to be collected continuously using a laser based Class 1 inertial profiler as defined by ASTM E950, or better.
- Laser sensors with a minimum 32 kHz sampling frequency are to be used with one sensor in each wheel path location.
- The IRI is to be determined in accordance with ASTM E1926 and the recommended “Best Practice Guidelines” contained within “*Standardization of IRI Data Collection and Reporting in Canada (October, 2001)*” as published by the Transportation Association of Canada. This requirement may be relaxed if the contractor can demonstrate that their equipment and operational practices are capable of collecting reliable data beyond the limits specified.
- Longitudinal profile measurement equipment is to be capable of accurately measuring profile in each wheel path as per the accuracy requirements set out in Chapter 7 as a minimum.
- The calculated roughness measurements are to be based on the averaged readings over the preceding 50 metre segment.
- IRI values are to be reported to the nearest hundredth (e.g. 0.01 mm/m).
- IRI values are to be collected and reported for each wheel-path.

5.2 Transverse Profiles

The following requirements must be followed for measuring transverse profiles:

- A minimum of 11 transverse profile measurements, collected continuously across the travelled lane to compute the left and right wheel path rut depths.
- Rut depth measurements are to be equivalent to those that would be achieved manually, via ASTM E1703/E1703M as determined for each individual wheel-path referenced to a 2 metre straight-edge model.

- Measurement equipment is capable of accurately measuring rut depths in each wheel path as per requirements set out in Chapter 7 as a minimum.
- The left and right wheel path transverse profile measurements are to be based on the averaged readings over the preceding 50 metre segment. The maximum left and right wheel path transverse profile measurements are to be reported as the maximum readings within the preceding 50 metre segment.
- The following data is to be reported for each 50 metre segment:
  - Calculated average rut depth for each wheel-path; and
  - Calculated maximum rut depth for each wheel path rounded to the nearest whole millimeter (i.e. 2 mm).

5.3 Additional Operational Requirements

The following additional operational requirements must be followed when measuring longitudinal and transverse profiles:

- High speed data collection contractors are required to obtain a special operating permit (Form T-53) from the Ministry of Transportation prior to conducting surveys on provincial highways and roads.
- High speed network level surveys on undivided highways are to be generally conducted in one direction of travel only (i.e. one lane) and conducted in both directions (i.e. one lane on each side) for divided or multi-lane highways. Data collection in all lanes may be required for other projects.
- Anomalous events are to be identified and their location (start km and end km) referenced according to the linear referencing system.
- Construction areas encountered during surveys are to be bypassed.
- Where truck climbing/passing lanes occur, the vehicle is to move to the outside lane (unless both lanes are being surveyed).

5.4 Anomalous Events

The following anomalous events are to be recorded while conducting high speed network level pavement roughness and rut depth surveys: bridges greater than 50m in length, railway crossings, locations of rumble strips that extend into and/or traverse the traveled lanes being surveyed and construction zones. For each anomalous event, the start / end kilometre chainages and GPS coordinates will be recorded.

6 High Speed Network Level Surveys Locational Referencing

This chapter provides details on the locational referencing method that is to be used when conducting high speed network level surveys.

6.1 General

Within the corporate RPMS, a standardized locational referencing system is used to ensure constant referencing from year to year for the pavement performance data and accurate referencing of attribute data. The Ministry has established a Linear Referencing System (LRS) that is based on highway sections and anchor points (i.e. landmarks).

6.2 GPS Measurements

GPS measurements are collected concurrently with the linear distance measurement instrumentation (DMI). Network level data collection contractors must use a differential GPS system to improve the real time position accuracy.

The spatial referencing system must include at minimum real-time inertially aided GPS with satellite based DGPS, 12 channel receiver and an accuracy of less than 1m horizontal, post processed or with satellite based differential corrections to accurately determine the true location of the data point, in areas where weak GPS signals could affect locational accuracy. The differential corrections are received from Landstar or the Canadian DGPS Service.

6.3 Linear Measurements

Each highway is referenced as a continuous segment from start to end with landmarks established as additional referencing points along the highway. Landmarks are physical, long lasting features such as intersections, bridge abutments or sign posts that are referenced to the highways based on a kilometre point location. Each highway has a defined start point, a defined end point, and an assigned cardinal direction. The interval between each pavement surface condition data roll-up point is 50m in the cardinal direction of the roadway, from the start point toward the end point.

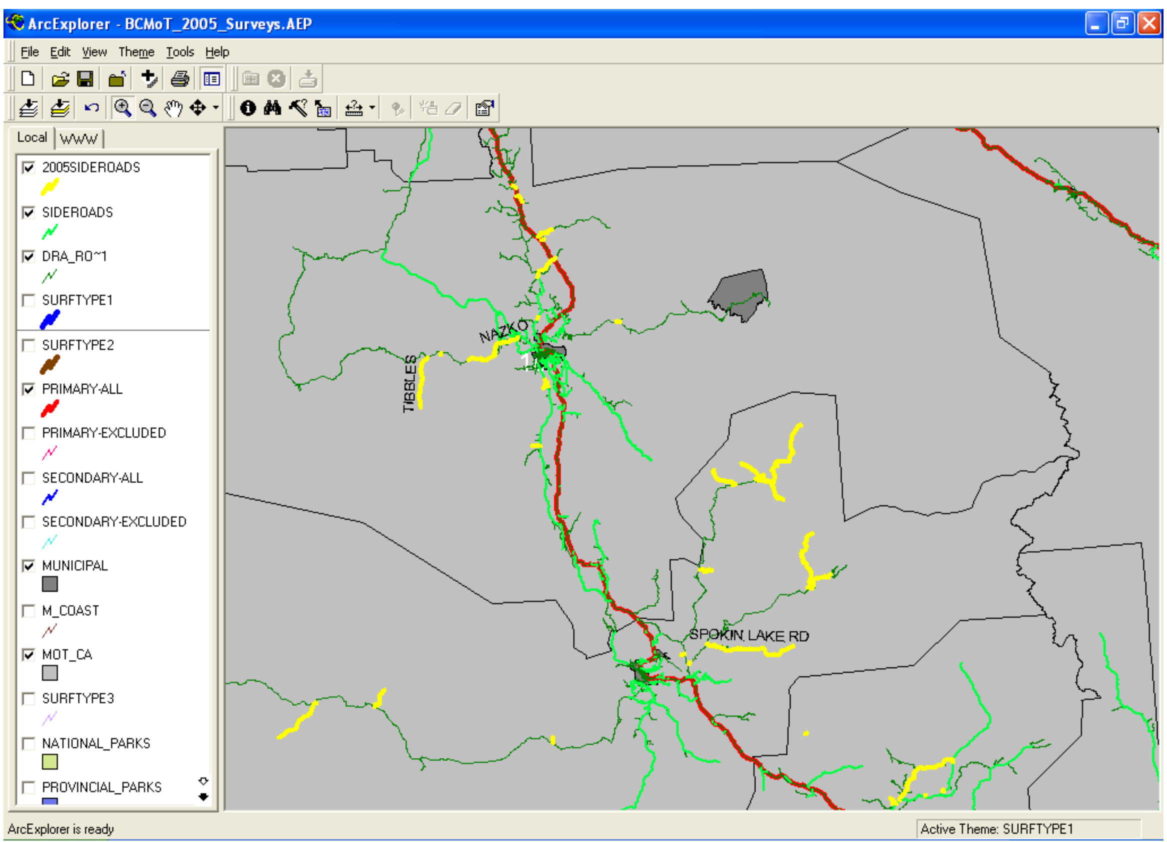
All pavement performance data within the RPMS are referenced to the highways based on the highway ID and the kilometre location as a distance from the start of the highway. During the surveys, the contractor is required to reference the designated survey reference landmarks every 20 to 30 kilometres.

For highways that have not been realigned, the data collection contractor is to ensure that their landmark chainages match those used in the Province's RPMS, and shall rubber-sheet their data if required to make their data collection chainages match the Provinces RPMS chainages.

If the data collection contractor identifies what appears to be an error in the province's RPMS chainages (such as may occur if a highway has been realigned); the data collection contractor is to advise the Ministry of the change, (Highway number, cardinal direction, describe start and end points of variance, provide updated landmark chainage along the revised alignment), such that the variance can be reviewed, and if the province agrees with the contractors findings; the new / correct chainages can then be incorporated into the Provinces RPMS.

6.4 Digital Mapping

The Ministry maintains digital mapping of the provincial roadway network within its Corporate Highway Resource & Information System (CHRIS).



Shape files of all highways and roads included in the annually contracted high speed network level surveys are available to support the surveys. Shape files showing the Digital Road Atlas (The DRA maps all roads in the province - including Municipal Streets, Forest Service Roads, Mine Trails, and MoT Highways) R&B Contract Area boundaries (important, as the Contract Area number is the first two digits of the RFI / Side Road numbering system,) Provincial and Federal Parks, Treaty Indian Reservations, coastline, lakes and rivers, and highway surface type are also available.

The ability to utilize spatial mapping can assist the data collection contractor to quickly identify and locate survey routes using their on-board GPS equipment and mapping software.

Highway Definitions

A highway segment is defined as a length of road that is continuous from the starting location until any of the following conditions occurs:

- Road ends; or
- Segment becomes subordinate when there is an overlap with another highway.

A highway segment shall have:

- A described Start Point and Start Point chainage; and
- A described End Point and End Point chainage.

The highway definition is composed of all of the items that are required to uniquely identify a roadway segment within the Province:

- Route Number – designated route or road number (e.g. Route 97 or 16)
- Route Aux ID – auxiliary identifier (e.g. Route 97B or 3A)
- Contract Area – Ministry designated maintenance contract area
- District Management Area – Ministry designated maintenance sub-area
- Direction – cardinal direction assigned within RPMS for the route / road

Each of fields above has been defined for all highways and side roads within the province and is to be used for pavement surface condition surveys.

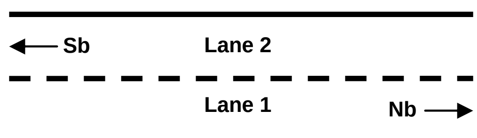
For Primary or Secondary Highways, the Contract Area is always 00 (zero zero) unless otherwise specified. No Primary or Secondary Highways bear the District Management Area Designation - this data field is to be left blank.

6.6 Lane Numbering

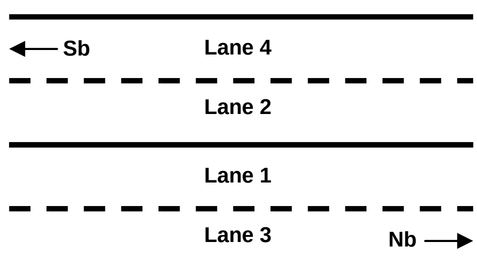
A standardized lane number system has been developed to be used for all high speed network level pavement condition surveys. This ensures consistent referencing of data from year to year.

Primary and Secondary Highways

- Northbound and Eastbound lanes are numbered using odd numbers.
- Southbound and Westbound lanes are numbered using even numbers.
- Lane 1 is the designation for the Northbound and Eastbound inside lane.
- Lane 2 is the designation for the Southbound and Westbound inside lane.



On multi-lane roads, the additional lanes are numbered in ascending order, from the inside lane to the outside lane. (Still using odd or even numbers according to the direction of travel, relative to the cardinal direction of the highway).



- The condition of outside HOV lanes is not to be surveyed during network level pavement condition surveys. Instead the outermost non-HOV (slow vehicle / truck bearing) lane is the lane to be surveyed.
- Where inside HOV or bus only lanes exist, they are considered Lane 1.

Side Roads

Each side road is assigned a cardinal direction. That direction is noted in the digital mapping / RPMS and the landmark chainage should correlate with the cardinal direction. In the event that they do not correlate, please contact your contract administrator for direction.

When travelling in the assigned cardinal direction, from the defined start point to the defined end point; the inside lane in that direction of travel, is lane 1. The inside lane in the opposite direction of travel is lane 2. The chainage will always increase, when travelling from the defined start point to the defined end point. Should it ever be required to survey in the opposite direction of travel - from the defined end point to the defined start point, the lane numbering will not change, but the chainage of the survey findings will decrease as one travels from the defined end point, to the defined start point at km 0.000.

Mapping and RPMS Defined Cardinal Direction	Desired Survey Direction	Lane 1 if the inside Xb lane	Chainage Ascends when Travelling	Chainage Descends when Travelling
N	*Nb*	*Nb*	*Nb*	*Sb*
E	*Eb*	*Eb*	*Eb*	*Wb*
S	*Sb*	*Sb*	*Sb*	*Nb*
W	*Wb*	*Wb*	*Wb*	*Eb*

6.7 Divided Highways

The above lane numbering scheme is also applicable to divided highways. While a divided highway may have different suffixes for the opposite directions of travel (E.g. Hwy 1E and Hwy 1W), and while the pavement surface condition data for each direction of travel is to be collected and submitted separately; the “Eb” and “Nb” lanes will always bear odd numbers, and the “Wb” and “Sb” lanes will always bear even numbers.”

6.8 Lane Location Referencing

For referencing passing lanes, the survey data is to correspond to the full lane width travel portion of the passing lane - end of entrance taper to beginning of exit taper.

6.9 Landmark Referencing

The intersecting centre lines are to be used for identifying the location of roadway landmarks and the first bridge abutment (unless otherwise noted in the landmark description) used for referencing bridge landmarks. The intersecting centre lines are to be used for identifying the location of roadway.

Data collection is to start (or end) adjacent point **4** which is the beginning of the solid line at the front of the gore.

7 High Speed Network Level Survey QA Specifications

This chapter describes the Quality Assurance specifications that are applied by the Ministry for high speed network level surface distress surveys.

7.1 Introduction

Like many provincial and municipal agencies, the BCMoT contracts out the collection of pavement surface condition data. These contractors use multi-function pavement evaluation vehicles that employ automated/semi-automated equipment for measuring surface distress, rutting, roughness and images.

Because BCMoT is committed to contracts with multiple private contractors, quality assurance (QA) plays a critical role ensuring that the data is collected accurately and is repeatable from year to year.

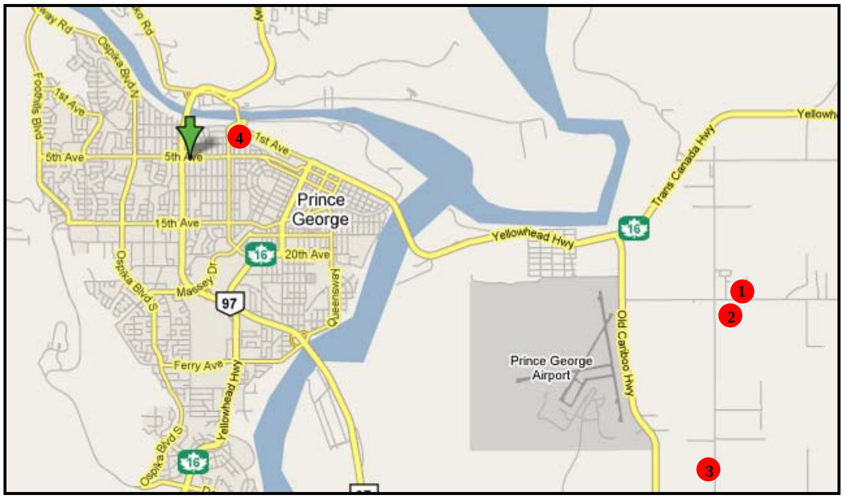
The Ministry has developed and implemented QA procedures that consist of three levels of testing: (a) initial QA tests completed before the surveys commence, (b) blind site monitoring during the production surveys and (c) assessing submitted data files. The following sections describe each.

7.2 Initial Quality Assurance Tests

The initial QA tests are used to ensure that the Contractor is correctly applying the BCMoT pavement surface distress rating system and their roughness/rut-depth instrumentation is operating properly before authorization is given to begin the Production Surveys. The initial QA tests take 2-3 days to complete.

7.2.1 Site Selection

Four test sites are used for the initial QA. The sites are 500 metres in length with a 250 metre lead-in. The sites exhibit a representative variety of distress types, range in pavement deterioration, surface types and operating speed with the intent to be representative of the actual survey conditions. If possible, the sites are also located within close proximity to one another to enable the automated surveys to be conducted in sequence (i.e. site 1, site 2, site 3, site 1, site 2, etc.).



Example of Initial QA Site Locations

7.2.2 Advance Manual Surveys

Manual surface distress, roughness and rut depth surveys are conducted at all of the test sites in advance of the initial QA testing.

Class I Roughness Survey

Manual Distress Survey

Rut Depth Survey

The manual surface distress surveys are typically done by walking the site and rating the distress types present for each 50 metre segment according to this pavement condition rating manual. The rut depth manual survey involves taking manual transverse profile measurements in each wheel path at 10 metre intervals and the IRI measured for each wheel path using a Class 1 profiler.

7.2.3 On-Site Review

The purpose of this exercise is to ensure that the Contractor is well versed with the BCMoT surface distress rating methodology.

The Contractor completes a survey of the start-up site and summarizes the distress ratings as required. The Contractors survey output are compared to the manual ratings, to assess both the distress rater's findings and keyboarding ability as well as confirm that the Contractor's keyboard, data processing algorithms and computer systems coding.

The Contractor and BCMoT personnel then walk over the site comparing their results to the manual ratings. The ensuing discussions assist in resolving ambiguities and if necessary, adjustments may be required to the rating procedures and revisions to the manual ratings.

7.2.4 Surface Distress Rating Tests – Windshield Survey

Surface distress rating tests are completed at all four test sites to assess the Contractors ability to accurately and repeatedly rate pavement distress according to the Ministry rating system. The survey vehicle completes a series of five runs over each site. The distress ratings are generated at 50 metre intervals and compared to the manual values for each run.

Three criteria are used to assess the Contractors surface distress rating ability:

- Pavement Distress Index - calculated using the PAVER model, the PDI value is used to compare the Contractors surveys to the manual surveys and assess the repeatability of the Contractor's surveying;
- Keystroke Totals - severity and density rating totals for each distress type present over the entire site to compare the Contractor's surveys to the manual surveys at a very detailed level to assess the rating accuracy; and
- Kappa Statistic - an additional diagnostic tool to evaluate the level of agreement between the manual benchmark survey and the automated rating for surface distress.

A spreadsheet program is used to generate the average PDI value, keystroke totals and kappa statistics from the distress ratings for both the manual and contractor surveys. The Contractor is required to produce a report with their on-board software that indicates the severity/density ratings for each distress type as shown.

Distress Severity and Rating Form

Chainage	LWP		LJC		PEC		TC		MLC		AC		POT		DST		BLD	
(m)	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D
0-50	1	3					2	3										
50-100	1	3					2	3										
100-150	1	3					2	3										
150-200							2	3										
200-250							2	3										
250-300							2	3										
300-350	3	5					2	3					2	2				
350-400	3	5									1	2						
400-450	3	5			3	3					1	2						
450-500	2	5			3	3												

Severity: 1 – Low 2 – Moderate 3 – High D**ensity**: 1- Few (<10%), 2- Intermittent (10-20%), 3 - Frequent (20-50%), 4 - Extensive (50-80%) and 5 - Throughout (80-100%)

While the PDI is the main criteria used to assess accuracy and repeatability, the keystroke summaries and kappa statistics are also used as a diagnostic tool to assist in highlighting discrepancies between the Contractors and manual severity/density ratings. If necessary, the Contractor and BCMoT personnel will walk over the site (s) comparing their results to the manual ratings. The ensuing discussions assist in resolving ambiguities and if necessary, adjustments may be required to the rating procedures and revisions to the manual ratings.

7.2.5 Roughness Tests

The roughness testing consists of validating the Contractor's instrumentation by field comparisons to the known longitudinal profile at each test site. The survey vehicle completes a series of five runs over each site to assess both accuracy and repeatability. The IRI values for each wheel path are generated at 50 metre intervals and compared to the manual values.

Comparing roughness measurements from digital profiler survey for a test site.

The Contractor is required to produce a report with their on-board software that specifies the IRI value for each wheel path at 50 metre intervals as shown.

Chainage (m)	IRI Left	IRI Right
0-50	2.11	2.16
50-100	2.11	2.15
100-150	2.10	2.13
150-200	2.00	2.11
200-250	2.12	2.11
250-300	2.20	2.18
300-350	2.16	2.15
350-400	2.17	2.22
400-450	2.12	2.24
450-500	2.21	2.23
Average	2.13	2.17

The average IRI value is calculated for each wheel path for the 500 metre test site for review as per the acceptance criteria.

7.2.6 Rut Depth Tests

The rut depth QA tests validate the Contractor's instrumentation by field comparisons to the known transverse profiles. The Contractor is required to conduct multiple runs over all four sites to measure the accuracy and repeatability of the rut bar measurements. This test is representative of actual survey conditions as it accounts for the possibility of the survey vehicle wandering over the travel lane. The rut depth values for each wheel path are generated at 50 metre intervals and compared to the manual values for each run.

The Contractor is required to produce a report with their on-board software that specifies the rut depth value for each wheel path at 50 metre intervals as shown.

Chainage (m)	Rut Left	Rut Right
0-50	5	9
50-100	7	13
100-150	6	12
150-200	8	9
200-250	8	10
250-300	7	11
300-350	10	10
350-400	11	10
400-450	12	12
450-500	9	12
Average	8	11

The average rut depth value is calculated for each wheel path for the 500 metre test site for review as per the acceptance criteria.

7.2.7 Acceptance Criteria for Initial QA Tests

The quality assurance acceptance criteria for the accuracy and repeatability of the surface distress, roughness and rut depth measurements as part of the initial QA tests are indicated in Table 1.

Table 1: Initial QA Acceptance Criteria

Category	Criteria	Acceptance Criteria Value
Surface Distress	Measure	PDI value
	Calculation	500 m average based on 50 m values
	Unit	lane
	Accuracy	+/- 1 PDI value of manual survey
	Repeatability	+/- 1 standard deviation of the PDI values for five runs
Roughness	Measure	IRI
	Calculation	500 m average based on 50 m values
	Unit	outside wheel path
	Accuracy	10% of Class I profile survey
	Repeatability	0.1 mm/m standard deviation for five runs
Rutting	Measure	rut depth (mm)
	Calculation	500 m average based on 50 m values
	Unit	averaged for both wheel paths
	Accuracy	+/- 3 mm of manual survey
	Repeatability	+/- 3 mm standard deviation for five runs

Should the Contractor fail to meet the criteria for acceptance, it is their responsibility to provide remedy until such time that the acceptance criteria are met and BCMoT representative is satisfied. This may necessitate, but not be limited to, the following:

- Additional on-site discussions with BCMoT;
- Repeat of the surveys;
- Equipment repairs/modifications; and/or
- Retraining and/or replacement of rating staff.

Once the Contractor has satisfactorily completed the initial QA testing as described herein, they are authorized to begin the production surveys. BCMoT provides written confirmation.

7.3 Production Survey Quality Assurance

The accuracy of the Contractor's surface condition rating and equipment is also closely monitored during the production surveys as a further measure of quality assurance. This QA is primarily done using blind sites that are situated along various highways in each Region that have been manually surveyed in advance and are of unknown location to the contractor. For larger surveys, the initial QA tests sites are also resurveyed periodically.

7.3.1 Blind Site Locations

The number and location of the blind sites is defined based on the contract quantities and using the Contractors routing schedule, which is provided to BCMoT in advance of the production surveys. Blind sites are generally scheduled once every three days during the surveys.

7.3.2 Advance Manual Surveys

If possible, manual surface distress, roughness and rut depth surveys are conducted at all of the test sites. The surveys are done in advance of the Blind site QA testing. The manual surface distress surveys are done by walking the site and rating the distress types present for each 50 metre segment according to this rating manual. The same person is used to rate all Blind sites throughout the province to ensure consistency. The rut depth manual survey involves taking manual transverse profile measurements in each wheel path at 10 metre intervals using a 2 metre rut-measuring gauge. The longitudinal profile and IRI in each wheel path is obtained using a Class 1 profiler.

7.3.3 Monitoring Process

Each day during the production surveys, the Contractor is required to update the BCMoT representative as to their progress. At this time, the Contractor is informed if they have passed over a site on the previous day and is provided with the site location kilometre chainages. The Contractor is required to produce a report with their on-board software that indicates the distress ratings at 50 metre intervals along with the IRI and rut depth values for each wheel path also reported at 50 metre intervals. For the purposes of this exercise and because of possible referencing differences, the Contractor is required to submit 1.0

kilometre of data within 250 metres on either side of the Blind site. The surface distress survey ratings, roughness and rut depth measurements as well as digital images for the site are submitted electronically to BCMoT for evaluation as per the acceptance criteria.

7.3.4 Retest Initial QA Sites

Additional QA testing is carried out during the production surveys for larger projects where the contractor is required to work in multiple regions and/or if the surveys require more than one month to complete. In these cases, the initial QA test sites are used to verify that the Contractor is correctly applying the BCMoT pavement surface distress rating system and their roughness/rut-depth instrumentation is operating properly.

The survey vehicle completes a series of five runs over each site in order to assess both accuracy and repeatability. The data is summarized as noted previously, submitted to BCMoT and compared to the manual values for each run. The quality assurance acceptance criteria for the accuracy and repeatability of the surface distress, roughness and rut depth measurements of the initial QA tests and remedial requirements are described.

7.3.5 Acceptance Criteria for Blind Site QA Tests

The quality assurance acceptance criteria for the surface distress, roughness and rut depth measurements for blind site QA are indicated.

Table 2: Blind Site QA Acceptance Criteria

Category	Criteria	Acceptance Criteria Value
Surface Distress	Measure	PDI value
	Calculation	500 m average based on 50 m values
	Unit	lane
	Accuracy	+/- 1 PDI value of manual survey
Roughness	Measure	IRI
	Calculation	500 m average based on 50 m values
	Unit	outside wheel path
	Accuracy	10% of Class I profile survey
Rutting	Measure	rut depth (mm)
	Calculation	500 m average based on 50 m values
	Unit	averaged for both wheel paths
	Accuracy	+/- 3 mm of manual survey

Should the Contractor fail to meet the criteria for acceptance, it is their responsibility to provide remedy until such time that the acceptance criteria are met and BCMoT representative is satisfied. This may necessitate, but not be limited to, the following:

- Additional on-site discussions with BCMoT;
- Review of the digital images with BCMoT;
- Repeat of the surveys;
- Equipment repairs/modifications; and/or
- Retraining and/or replacement of rating staff.

Once the Contractor has satisfactorily completed the Blind site QA test as described herein, they are authorized to continue with the production surveys.

7.4 Submitted Data Quality Assurance

Quality assurance assessment of submitted data is considered an integral part of the overall survey QA process. The Ministry uses a 3-step process that involves both manual and system checks to assess submitted surface distress, roughness and rut depth data files.

7.4.1 Manual Review

The first step consists of conducting a thorough manual review of the submitted data files and includes verifying the following:

- Data exists for all road segments;
- Highway traversal definitions for all road segments;
- Correct data file structure;
- Start and end boundaries for all road segments;
- All lane references and chainages according to provided data files;
- Screening all data for null and negative values; and
- Screening all data according to max/min tolerance parameters.

The initial QA results are summarized and provided to the contractor for correction.

7.4.2 Prior Year Comparison

The second step involves comparing the current year submitted survey data to prior collected data. This provides an effective means to determine if there are any significant variations from cycle to cycle. In the past, network averages by functional class were calculated, but starting in 2001 this is being expanded to include defined sample segments for a more detailed assessment. This is possible since the same road segment directions are surveyed each cycle.

7.4.3 PMS Data Upload Tests

The final step then involves uploading the distress, roughness and rut depth data to the Ministry's corporate pavement management system. The system includes functionality that conduct internal standardized and user defined verification tests. Afterwards, the PMS generates a log report listing all discrepancies which can be reviewed, confirmed and input data corrected and reloaded as required. All of this is documented on file as well for future reference.

7.5 Data File Specifications

The following tables describe the file format specifications for RPMS pavement condition data files. All files are to be provided in DBF and CSV formats.

7.6 File Examples

The following are examples of high speed network level surface distress and pavement roughness / rut depth RPMS input data files.

Distress Data File

Description	Field Name	Units	Type	Width	Decimal
Route Type	ROUTE_TYPE	-	C	2	0
Route Number	HIWY_ID	-	N	5	0
Route Aux ID	AUX_ID	-	C	1	0
Contract Area	CA	-	N	2	0
Direction	DIRECTION	-	C	1	0
Area Manager (Area) and Sub Area	AMSA	-	C	2	0
From Distance	START_KM	km	N	8	3
To Distance	END_KM	km	N	8	3
Lane ID	LANE	-	N	1	0
Survey Date	SURVEY_DAT	yyyymmdd	D	8	0
Pavement Type (Asphalt =1)	PAVE_TYPE	-	N	1	0
% Longitudinal Wheel Path Crack Low Severity	LNGC_L	%	N	3	0
% Longitudinal Wheel Path Crack Moderate Severity	LNGC_M	%	N	3	0
% Longitudinal Wheel Path Crack High Severity	LNGC_H	%	N	3	0
% Longitudinal Joint Crack Low Severity	LCJT_L	%	N	3	0
% Longitudinal Joint Crack Moderate Severity	LCJT_M	%	N	3	0
% Longitudinal Joint Crack High Severity	LCJT_H	%	N	3	0
% Pavement Edge Crack Low Severity	EDGE_L	%	N	3	0
% Pavement Edge Crack Moderate Severity	EDGE_M	%	N	3	0
% Pavement Edge Crack High Severity	EDGE_H	%	N	3	0
% Transverse Cracking Low Severity	TRNC_L	%	N	3	0
% Transverse Cracking Moderate Severity	TRNC_M	%	N	3	0
% Transverse Cracking High Severity	TRNC_H	%	N	3	0
% Meandering Longitudinal Crack Low Severity	MEAN_L	%	N	3	0
% Meandering Longitudinal Crack Moderate Severity	MEAN_M	%	N	3	0
% Meandering Longitudinal Crack High Severity	MEAN_H	%	N	3	0
% Alligator Cracking Moderate Severity	ALGC_M	%	N	3	0
% Alligator Cracking High Severity	ALGC_H	%	N	3	0
% Potholes Low Severity	POTH_L	%	N	3	0
% Potholes Moderate Severity	POTH_M	%	N	3	0
% Potholes High Severity	POTH_H	%	N	3	0
% Bleeding Moderate Severity	BLDG_M	%	N	3	0
% Bleeding High Severity	BLDG_H	%	N	3	0
Corporate Performance Measure	CPM	-	C	2	0
Latitude –NAD83(CSRS)	LATITUDE	Decimal degrees	C	10	0
Latitude Direction	LATDIR	N	C	1	0
Longitude - NAD83(CSRS)	LONGITUDE	Decimal degrees	C	11	0
Longitude Direction	LONGDIR	E	C	1	0
Elevation	ELEVATION	metres	N	9	3

Notes:

- Route Type: Primary Highway = P, Secondary Highway = S, Side Road = SR
- See Chapter 6 for further explanation of the Route Number, Route Aux ID, Contract Area, Direction, Area Manager Area and Lane ID fields shown above.
- Pavement Type: Asphalt =1
- Corporate Performance Measure: Network Level (NL) and Project Level (PL)
- The latitude and longitude coordinates correspond to the From Distance chainage point
- Longitude values should be prefixed with a negative sign (-)

Roughness and Rutting Data File

Description	Field Name	Units	Type	Width	Decimal
Route Type	ROUTE_TYPE	-	C	2	0
Route Number	HIWY_ID	-	N	5	0
Route Aux ID	AUX_ID	-	C	1	0
Contract Area	CA	-	N	2	0
Direction	DIRECTION	-	C	1	0
Area Manager (Area) and Sub Area	AMSA	-	C	2	0
From Distance	START_KM	km	N	8	3
To Distance	END_KM	km	N	8	3
Lane ID	LANE	-	N	1	0
Survey Date	SURVEY_DAT	yyyymmdd	D	8	0
Left Wheel path IRI	LIRI	-	N	5	2
Right Wheel path IRI	RIRI	-	N	5	2
Left Wheel path Rut Depth	LRUT	-	N	2	0
Right Wheel path Rut Depth	RRUT	-	N	2	0
Maximum Left Wheel path Rut Depth	MAX_LRUT	-	N	2	0
Maximum Right Wheel path Rut Depth	MAX_RRUT	-	N	2	0
Corporate Performance Measure	CPM	-	C	2	0
Latitude – NAD83(CSRS)	LATITUDE	Decimal degrees	C	10	0
Latitude Direction	LATDIR	N	C	1	0
Longitude - NAD83(CSRS)	LONGITUDE	Decimal degrees	C	11	0
Longitude Direction	LONGDIR	E	C	1	0
Elevation	ELEVATION	metres	N	9	3

Notes:

- Route Type: Primary Highway = P, Secondary Highway = S, Side Road = SR
- See Chapter 6 for further explanation of the Route Number, Route Aux ID , Contract Area, Direction, Area Manager Area and Lane ID fields shown above.
- If IRI and/or rut depth values cannot be obtained for a segment, a 0 is placed in the field.
- Corporate Performance Measure: Network Level (NL) and Project Level (PL)
- The latitude and longitude coordinates correspond to the From Distance chainage point
- Longitude values should be prefixed with a negative sign (-)

Surface Distress

ROUTE_TYPE	HIWY_ID	AUX_ID	CA	DIRECTION	AMSA	START_KM	END_KM	LANE	SURVEY_DAT	PAVETYPE	LNGC_L	LNGC_M	LNGC_H	LCJT_L	LCJT_M	LCJT_H	EDGE_L	EDGE_M	EDGE_H	TRNC_L	TRNC_M	TRNC_H
P	2			N		0.000	0.050	1	24/06/2008	1	0	0	17	0	0	0	0	0	0	0	0	0
P	2			N		0.050	0.100	1	24/06/2008	1	0	8	15	0	0	0	0	0	0	0	0	5
P	2			N		0.100	0.150	1	24/06/2008	1	0	8	0	0	0	0	0	0	0	0	25	5
P	2			N		0.150	0.200	1	24/06/2008	1	0	11	0	0	0	0	0	0	0	0	35	0
P	2			N		0.200	0.250	1	24/06/2008	1	0	13	0	0	0	0	0	0	0	0	35	0
P	2			N		0.250	0.300	1	24/06/2008	1	0	13	0	0	0	0	0	0	0	0	35	0
P	2			N		0.300	0.350	1	24/06/2008	1	0	0	0	0	0	0	0	23	0	0	35	0
P	2			N		0.350	0.400	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	25	15
P	2			N		0.400	0.450	1	24/06/2008	1	0	11	0	0	0	0	0	0	0	0	35	0
P	2			N		0.450	0.500	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	40	0
P	2			N		0.500	0.550	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	50	0
P	2			N		0.550	0.600	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	35	0
P	2			N		0.600	0.650	1	24/06/2008	1	0	0	0	0	24	0	0	0	0	0	20	0
P	2			N		0.650	0.700	1	24/06/2008	1	0	0	0	0	20	0	0	0	0	0	5	0
P	2			N		0.700	0.750	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	5	0
P	2			N		0.750	0.800	1	24/06/2008	1	0	7	0	0	0	0	0	0	0	0	5	0
P	2			N		0.800	0.850	1	24/06/2008	1	0	3	0	0	0	0	0	0	0	0	5	5
P	2			N		0.850	0.900	1	24/06/2008	1	0	0	0	0	18	0	0	0	0	0	5	0
P	2			N		0.900	0.950	1	24/06/2008	1	0	0	0	0	0	0	0	0	0	0	0	30

MEAN_L	MEAN_M	MEAN_H	ALGC_M	ALGC_H	POTH_L	POTH_M	POTH_H	BLDG_M	BLDG_H	CPM	LATITUDE	LATDIR	LONGITUDE	LONGDIR	ELEVATION
0	0	0	1	0	0	0	0	0	0	NL	55.480989	N	-120.002118	W	750.629
0	0	0	0	0	0	0	0	0	0	NL	55.481092	N	-120.002888	W	750.255
0	0	0	0	0	0	0	0	0	0	NL	55.481195	N	-120.003658	W	749.664
0	0	0	0	0	0	0	0	0	0	NL	55.481298	N	-120.004429	W	748.925
0	0	0	0	0	0	0	0	0	0	NL	55.481401	N	-120.005200	W	747.982
0	0	0	0	0	0	0	0	0	0	NL	55.481503	N	-120.005971	W	747.081
0	0	0	0	0	0	0	0	0	0	NL	55.481608	N	-120.006741	W	746.454
0	0	0	0	0	5	0	0	0	0	NL	55.481709	N	-120.007512	W	745.867
0	8	0	0	0	0	0	0	0	0	NL	55.481810	N	-120.008283	W	745.328
0	0	0	0	0	0	0	0	0	0	NL	55.481915	N	-120.009052	W	744.894
0	0	0	0	0	0	0	0	0	0	NL	55.482017	N	-120.009822	W	744.635
0	0	0	0	0	0	0	0	0	0	NL	55.482119	N	-120.010593	W	744.529
0	0	0	0	0	0	0	0	0	0	NL	55.482220	N	-120.011364	W	744.311
0	0	0	0	0	0	0	0	0	0	NL	55.482321	N	-120.012135	W	744.524
0	0	0	0	0	0	0	0	0	0	NL	55.482423	N	-120.012905	W	744.951
0	0	0	0	0	0	0	0	0	0	NL	55.482524	N	-120.013674	W	745.282
0	0	0	0	0	0	0	0	0	0	NL	55.482625	N	-120.014444	W	745.741
0	0	0	0	0	0	0	0	0	0	NL	55.482730	N	-120.015213	W	746.018
0	0	0	0	0	0	0	0	0	0	NL	55.482832	N	-120.015983	W	746.355

Roughness and Rutting

ROUTE_TYPE	HIWY_ID	AUX_ID	CA	DIRECTION	AMSA	START_KM	END_KM	LANE	SURVEY_DAT	LIRI	RIRI	LRUT	RRUT	MAX_LRUT	MAX_RRUT	CPM	LATITUDE	LATDIR	LONGITUDE	LONGDIR	ELEVATION
P	2			N		0.000	0.050	1	24/06/2008	2.22	2.22	2	2	32	17	NL	55.480989	N	120.002118	W	750.629
P	2			N		0.050	0.100	1	24/06/2008	0.84	1.21	2	1	9	9	NL	55.481092	N	120.002888	W	750.255
P	2			N		0.100	0.150	1	24/06/2008	0.76	1.09	2	1	6	5	NL	55.481195	N	120.003658	W	749.664
P	2			N		0.150	0.200	1	24/06/2008	0.83	1.04	2	1	6	6	NL	55.481298	N	120.004429	W	748.925
P	2			N		0.200	0.250	1	24/06/2008	0.86	0.86	2	1	11	8	NL	55.481401	N	120.0052	W	747.982
P	2			N		0.250	0.300	1	24/06/2008	0.90	0.99	2	1	7	6	NL	55.481503	N	120.005971	W	747.081
P	2			N		0.300	0.350	1	24/06/2008	0.93	1.25	4	2	6	7	NL	55.481608	N	120.006741	W	746.454
P	2			N		0.350	0.400	1	24/06/2008	1.15	1.37	3	2	17	8	NL	55.481709	N	120.007512	W	745.867
P	2			N		0.400	0.450	1	24/06/2008	0.67	0.76	3	1	10	9	NL	55.48181	N	120.008283	W	745.328
P	2			N		0.450	0.500	1	24/06/2008	0.63	0.71	3	1	10	9	NL	55.481915	N	120.009052	W	744.894
P	2			N		0.500	0.550	1	24/06/2008	0.74	0.73	2	1	5	8	NL	55.482017	N	120.009822	W	744.635
P	2			N		0.550	0.600	1	24/06/2008	0.62	0.58	2	1	7	7	NL	55.482119	N	120.010593	W	744.529
P	2			N		0.600	0.650	1	24/06/2008	0.85	0.92	2	1	7	7	NL	55.48222	N	120.011364	W	744.311
P	2			N		0.650	0.700	1	24/06/2008	0.77	0.73	2	1	5	9	NL	55.482321	N	120.012135	W	744.524
P	2			N		0.700	0.750	1	24/06/2008	0.69	0.81	2	1	9	7	NL	55.482423	N	120.012905	W	744.951
P	2			N		0.750	0.800	1	24/06/2008	0.60	0.58	2	1	6	6	NL	55.482524	N	120.013674	W	745.282
P	2			N		0.800	0.850	1	24/06/2008	1.00	0.77	2	1	6	9	NL	55.482625	N	120.014444	W	745.741
P	2			N		0.850	0.900	1	24/06/2008	0.82	0.78	2	1	5	5	NL	55.48273	N	120.015213	W	746.018
P	2			N		0.900	0.950	1	24/06/2008	0.75	0.84	2	1	6	6	NL	55.482832	N	120.015983	W	746.355

7.7 Right of Way Digital Image Specifications

The following section describes the right of way digital image specifications for high speed network level pavement surface condition surveys. They are based on using a single high resolution camera mounted onto the vehicle to record the right of way view of the pavement surface.

7.7.1 View

Right-of-Way (ROW) view - continuous images of the full pavement width, shoulders and roadside features such as signs, structures and guardrails. The horizon line shall be at approximately 80 percent of the way up the frame.

7.7.2 Image Resolution

The minimum image resolution is to be a minimum 1300 x 1030 colour image.

7.7.3 Media and Format

The recording media is to be digital and provide a minimum 12 bit color images in JPEG format. The desired image file size is 100 to 150 kbytes. The equipment is to be capable of delivering quality images, during all of the various conditions that the Production Survey may be undertaken. The equipment is to be progressive scan, or equivalent to yield clear images from a moving vehicle. Images will be taken at 10 metre intervals.

7.7.4 Review of Trial Images

During the initial QA testing, the camera angles and magnification will be adjusted and defined by a series of test runs with the Ministry representative to determine the appropriate views. Once the appropriate view has been established, the Contractor must take all necessary measures to ensure that the image angle and magnification remain consistent throughout the Production Surveys, and brightness settings are constantly adjusted to yield high quality images. This is particularly critical if the recording system requires camera to be dismounted and remounted each day.

7.7.5 Quality Assurance

During the Production Surveys, the Contractor will be required to provide the Ministry Representative with a sample copy from the ongoing survey for review based on the blind site QA survey limits. A 500 metre sample of digital images shall be provided electronically to the Ministry representative for review. The overall quality of the image must be acceptable as well as the composition of the images. This review will ensure that the correct camera positions and field of view are being captured as well as general adherence to the specifications. The survey crew shall be notified of any changes required.

7.7.6 Folder Naming Convention

The digital images are to be delivered in electronic format, using the following folder naming convention.

Primary and Secondary Highways

For Primary and Secondary Highways, the images shall be place in folders named as follows. These folders shall be within a folder named "YYYY Highway Images" - where YYYY is the year the images were taken (Note: each information item immediately follows the preceding item, no spaces):

- The single character H;
- The numeric highway number – variable # of characters up to a maximum of four;
- The highways single alpha suffix if applicable (no placeholder needed if not applicable);
- An underscore (_);
- The single character alpha cardinal direction of the highway;
- An underscore (_);
- The two digit numeric Contract Area if applicable (used when another non-contiguous highway with the same number exists in a different Contract Area – 00 placeholder needed if NA);
- An underscore (_);
- For Project Level Survey data only, the letter 'L' followed by the single digit numeric lane number that Project Level images are for;
- An underscore (_);
- The two letters 'km'; and

- The four digit numeric that identifies the start chainage of the first image in that folder – rounded down to the nearest km.

Examples:

a) For most highways _ no alpha suffix or Contract Area and when more than one folder is needed (i.e. for the images for Highway 31, with images for ~20 km of highway in each folder):

H31_E_00_km0000
H31_E_00_km0020
H31_E_00_km0040 etc...

b) For highways with an alpha suffix and a Contract Area and when and more than one folder is needed (i.e. for the images for Highway 3A, with images for ~20 km of highway in each folder):

H3A_E_10_km0000
H3A_E_10_km0020
H3A_E_10_km0040 etc...

c) For Project Level survey images (i.e. for the additional survey of the Wb lane of a two lane segment of Hwy 3A at the same time as the network level survey of the Eb lanes was undertaken, the images for the Wb lanes shall be in folders named_:

H3A_E_10_L2_km0000
H3A_E_10_L2_km0020
H3A_E_10_L2_km0040 etc...

Side Roads

For Side Roads, the images shall be placed in folders, named in accordance with the CASHH of the roadway, using the following convention. These folders shall be within a folder named “YYYY SideRoad Images” - where YYYY is the year the images were taken (Note: each information item immediately follows the preceding item, no spaces):

- The two digit numeric Contract Area designation;

- An underscore (_);
- The single alpha character Area Manager (AM) Area designation;
- The single character (alpha or numeric) Area Manager Sub Area (SA) designation;
- An underscore (_);
- The five digit (leading zero's required) road number identifier;
- The side road's single alpha suffix if applicable (no placeholder needed if not applicable);
- An underscore (_);
- The single alpha character cardinal direction of the Side Road;
- An underscore (_);
- For Project Level Survey data only, the letter 'L' followed by the single digit numeric lane number that Project Level images are for;
- An underscore (_);
- The two letters "km"; and
- The four digit numeric that identifies the start chainage of the first image in that folder – rounded down to the nearest km.

Examples:

a) For side road 1234R located within Contract Area 1, AMSA B@; with the cardinal direction East:

01_B@_01234R_E_km0000

b) For Project Level survey images (i.e. for the additional survey of the Wb lane of side road 1234R located within Contract Area 1, AMSA B@; at the same time as the network level survey of the Eb lanes was undertaken, the images for the Wb lanes shall be in folders named):

01_B@_01234R_E_L2_km0000

7.7.7 Image Naming Convention

The digital images are to be delivered in electronic format, using the following image naming convention.

For Primary Highways, Secondary Highways, and for Side Roads – The image names shall duplicate the folder names, but the characters following “km” shall be the driven distance along each highway that the image was taken at.

Examples:

a) For the first image along Highway 1 Eb, at Km 0.000

H1_E_00_km0000.000

b) For the image taken 12.345 kilometres along Highway 3A in CA 10 - Eb,

H3A_E_10_km0012.345

c) For the image taken 1.230 km along side road 1234R located within Contract Area 1, AMSA B@; with the cardinal direction East:

01_B@_01234R_E_km0001.230

d) For the ‘Project Level’ Survey images taken at km 1.230 of the westbound lanes of side road 1234R located within Contract Area 1, AMSA B@ - with the cardinal direction East:

01_B@_01234R_E_L2_km0001.230

7.7.8 Image Header

Each image, shall contain a header showing:

Left side of Header:

- Date and time image taken;
- For Primary and Secondary Highways - The Traversal Code;

- For Side Roads – CASHH, or CA_AMSA_HIWY_ID and AUX_ID, and DIRECTION (i.e. 01_B@_1234R E); and
- The word “Lane” followed by a space, and the LANE number.

Right side of Header:

- The MILEPOST;
- LATITUDE;
- LONGITUDE; and
- ELEVATION.

Example: *(Note: without time, as time was not requested in 2007 data submission.)*

7.7.9 Format for File required for loading images into RPMS and Photolog

The Contractor shall create a shape file representing the location of each of the images collected. The format of the data shall be as noted in the following specifications for the Image Loading Data File. This file shall be submitted in both DBF and CSV formats.

The images shall be referenced back to the linear chainage / DMI and offset from the nearest significant Landmark.

Description	Field Name	Units	Type	Width	Decimal
Route Type	ROUTE_TYPE	_	C	2	0
Route Number	HIWY_ID	_	N	5	0
Route Aux ID	AUX_ID	_	C	1	0
Contract Area	CA	_	N	2	0
Direction	DIRECTION	_	C	1	0
Area Manager (Area) and Sub Area	AMSA	_	C	2	0
Lane ID	LANE	_	N	1	0
Corporate Performance Measure	CPM	-	C	2	0
Survey Date for RPMS	SURVEY_DAT	YYYYMMDD	D	8	0
Survey Date and Time for Photolog	TAKEN_DATETIME	YYYY/MM/DD HH24:MI:SS	C	20	0
Driven distance from start of road to point image taken.	MILEPOST	Km.mmm	N	8	3
Image Number – the sequential or frame number of the image.	IMAGE_NUMBER	-	N	20	0
Directory - where the image is located.	IMAGE_FOLDER_NAME	-	C	100	0
Image file name as described in section 7.7.7 of this Manual.	IMAGE_FILENAME	-	C	30	0
Traversal Code	TRAVERSAL_CODE	-	C	20	0
Location Description	LOCATION_DESC	-	C	150	0
Reverse Direction Flag	REVERSE_DIRECTION_FLAG	-	C	1	0
Camera Direction	CAMERA_DIRECTION		C	1	0
Latitude – NAD83 (CSRS)	LATITUDE	Decimal degrees	C	10	6
Longitude – NAD83 (CSRS)	LONGITUDE	Decimal degrees	C	11	6
Elevation	ELEVATION	metres	N	9	3

Notes:

- Route Type: Primary Highway = P, Secondary Highway = S, Side Road = SR
- See Chapter 6 for further explanation of the Route Number, Route Aux ID , Contract Area, Direction, Area Manager Area and Lane ID fields shown above.
- Corporate Performance Measure - CPM: Network Level (NL) and Project Level (PL)
- Survey Date and Time for Photolog – TAKEN_DATE

  Format the TAKEN_DATETIME string as follows:
  YYYY/MM/DD HH24:MI:SS
  Where:

  - YYYY is the year including century
  - MM is the month 01 for January, 12 for December
  - DD is the day of the month
  - HH24 is the hour in 24 hour notation. Must be in the range 0 - 23
  - MI are the minutes. Must be in the range 0 - 59
  - SS are the seconds. Must be in the range 0 - 59

    Examples: 2009/04/29 06:20:45
    2009/04/30 23:59:59

- Directory - where the image is located. Does not include drive letter and must have a backslash at the end (i.e. “2005 SIDE ROAD Images\Folder Name\” where Folder Name is as described in section 7.7.6 of this Manual).
- Traversal Code – A compilation of:

  For Primary and Secondary Highways:
  - the prefix ‘H’
  - The Route Number
  - The Route Aux ID
  - An Underscore (_)
  - Direction

  For Side Roads:
  - the prefix ‘SR’
  - the Contract Area
  - an Underscore (_)
  - the AMSA
  - an Underscore (_)
  - the Route Number
  - The Route Aux ID
  - An Underscore (_)
  - Direction
- Location Description – A description of the road the image was taken on, comprised of: ,<direction of travel>, <Traversal Code>, <driven distance>, past <last significant RPMS landmark>, <general geographic location description>.

  Example: Nb H5 E, 1.403 km past intersection with Vavenby Bridge Road, East of 100 Mile House.
- Reverse Direction Flag
  - N is for images taken with increasing driven distances, and
  - Y if for images taken with decreasing driven distances
- Camera Direction - The direction the camera faces, relative to the vehicle.
  - F = Forward
  - R = Reverse

  Will only be needed if we require a forward facing and a rear facing camera to capture signs etc. in opposite direction of travel.
- The latitude and longitude coordinates shall record the GPS Coordinate position of the survey vehicle at the time each image was captured.

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8 Miscellaneous Ratings

In addition to the distress types described previously, there are some other related defects that can be rated during pavement surface condition surveys. This includes the following:

- Drainage Conditions;
- Crack Sealing; and
- Patching.

Please note that these additional defects are not included in the high speed network level pavement surface conditions surveys.

8.1 Drainage Conditions

During the pavement surface condition rating process, observation and general rating of adjacent drainage conditions is performed. This information is for general regional use and may, in some cases, provide an explanation to the occurrence of specific distress types. Local drainage conditions are rated as Acceptable, Borderline or Unacceptable according to the criteria specified below:

ACCEPTABLE
• Cross section and drainage are fully adequate. • Concealed underground storm drains in good repair. • Open ditching with no free-standing water and no silt bottom layer or obstructed culverts, etc. • Open ditching with free-standing water or bull rushes in the ditch and the fill height is greater than 1.5 metres.
BORDERLINE
• If the ditch grade line, cross-section elements and/or culvert and/or ditch capacity are somewhat below the standard that would be provided if the road and ditches were rebuilt. • Roads with acceptable design characteristics, but poorly maintained ditching, requiring work to be brought up to an acceptable level. Work required should generally fall into a category that could be completed by gradual cleaning of ditches, grading of shoulder areas and minor culvert repair.
UNACCEPTABLE
• Free-standing water in ditches, grass and other debris, requiring more than minor work to be brought up to an acceptable standard; granular washout of shoulder areas, etc. • Conditions could impede safe traffic movement. • Areas with lack of grade could possibly flood. • Catch basins are in a very poor state of repair with obvious pavement deterioration and free-standing water. • Water channels onto driven portion of road. • Road drains onto adjacent occupied properties

Figure 41 – Acceptable Drainage

Figure 42 – Unacceptable Drainage

8.2 Crack Sealing

During the pavement surface condition rating process, observation and general rating of crack sealing is performed. This information is for general regional information purposes and may provide further explanation as to the pavement deterioration. The crack sealing rating is applied based on a combined visual assessment of all crack types within the rating segment.

- Level 1 - < 30% of cracks are sealed
- Level 2 - 30% to 60% of cracks are sealed
- Level 3 - > 60% of cracks are sealed

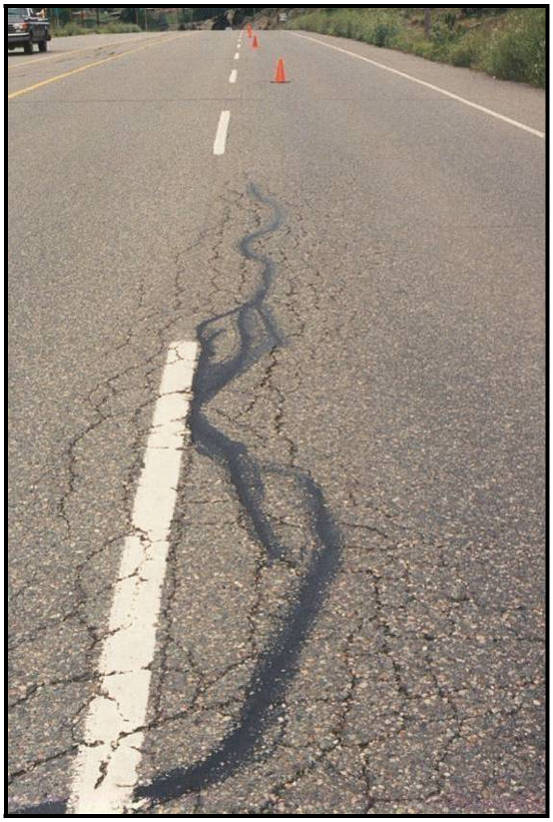

Figure 43 - Level 1 Sealing

Figure 44 - Level 3 Sealing

8.3 Patching

During the pavement surface condition rating process, observation and general rating of patching is performed. This information is for general regional information purposes and may provide further explanation as to the pavement deterioration. The rating of patching rating is applied based on a visual assessment of patched surface area within the rating segment.

- Level 1 - Few small localized patches
- Level 2 - Several larger patches
- Level 3- Full lane patching

Figure 45 - Level 1 Patching

Figure 46 - Level 2 Patching

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9 Pavement Condition Forms

The following forms are provided for reference purposes and for conducting manual surface distress rating surveys:

- Pavement Distress Rating System – Severity Levels
- Pavement Distress Rating System – Density Levels
- Pavement Distress Survey – Evaluation Form
- Pavement Distress Survey – Crack Mapping Form

Pavement Distress Rating System – Severity Levels			
Distress Type	Low Severity	Moderate Severity	High Severity
Longitudinal Wheel Path Cracking (LWP)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Longitudinal Joint Cracking (LJC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Pavement Edge Cracking (PEC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Transverse Cracking (TC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Meandering Longitudinal Cracking (MLC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Alligator Cracking (AC)	Not rated	Interconnected cracks forming a complete block pattern; slight spalling and no pumping	Interconnected cracks forming a complete block pattern, moderate to severe spalling, pieces may move and pumping may exist
Rutting (RUT)	Less than 10mm	10 to 20mm	Greater than 20mm
Shoving (SHV)	Barely noticeable to noticeable	Rough ride	Very rough ride
Distortion (DST)	Not rated	Noticeable swaying motion; good car control	Fair to Poor car control
Bleeding (BLD)	Not rated	Distinctive appearance with free excess asphalt	Free asphalt gives pavement surface a wet look; tire marks are evident
Potholes (POT)	Less than 25mm deep and greater than 175cm2 in area. (~15cm Ø)	25 to 50mm deep and greater than 175cm2 in area. (~15cm Ø)	Greater than 50mm deep and greater than 175cm2 in area. (~15cm Ø)
Ravelling (RAV)	Not rated	Aggregate and/or binder worn away; surface texture rough and pitted; loose particles exist	Aggregate and/or binder worn away; surface texture is very rough and pitted

Pavement Distress Rating System – Density Levels							
Distress Type	Units	None	Few	Intermittent	Frequent	Extensive	Throughout
Longitudinal Wheel Path Cracking (LWP)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Longitudinal Joint Cracking (LJC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Pavement Edge Cracking (PEC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Transverse Cracking (TC)	Number	0	1-2	3-4	5-7	8-10	>10
Meandering Longitudinal Cracking (MLC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Alligator Cracking (AC)	Area	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Rutting (RUT)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Shoving (SHV)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Distortion (DST)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Bleeding (BLD)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Potholes (POT)	Number	0	1-2	3-4	5-6	7-9	>10
Ravelling (RAV)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%

Pavement Distress Survey – Evaluation Form			Page ___ of ___
Rater:	Road #:	Name:	Drainage: A B U
Date:	Start:	Lane #:	Sealing: L1 L2 L3
Weather/Temp:	End:	Width:	Patching: L1 L2 L3

Distress Types		Severity Levels			Density Levels					
		L	M	H	None	Low	Intermittent	Frequent	Extensive	Throughout
Longitudinal Wheel Path Cracking	LWP									
Longitudinal Joint Cracking	LJC									
Pavement Edge Cracking	PEC									
Transverse Cracking	TC					1-2	3-4	5-7	8-10	>10
Meandering Longitudinal Cracking	MLC									
Alligator Cracking	AC									
Rutting	RUT									
Shoving	SHV									
Distortion	DST									
Bleeding	BLD									
Potholes	POT					1-2	3-4	5-6	7-9	> 10
Ravelling	RAV									

Comments:

Pavement Distress Survey – Crack Mapping Form

Road #:________ Name:___________________________ Dir: N S E W

IWP OWP

50m

40 m

30 m

20 m

10 m

0 m

Start Km: _________________ Lane#_____________ Page ____ of ____