UK ROADS BOARD

SCANNER surveys for Local Roads

User Guide and Specification

Volume 3

Advice to Local Authorities:

Using SCANNER survey results

Version 1.0

2011 Edition

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Acknowledgement

This SCANNER User Guide has been developed from the SCANNER specification used in 2009. It incorporates many detailed changes based on experience of using the SCANNER specification in 2005/06 2006/07 and 2009, the TTS specification before that in 2003/04 and 2004/05 and a wide range of comments from interested parties. It includes the results of research on developing SCANNER commissioned on behalf of the UK Roads Board.

The previous SCANNER specifications were based on the original "TRACS Type Surveys for the Principal Road Network – Specification and Advice Note" produced for the UK Roads Board by the Chris Britton Consultancy and TRL Limited.

Throughout the development of the TTS and SCANNER specifications, considerable assistance and support has been given by members of the SCANNER Implementation Group, including local authority representatives, by TRL Limited, by the Chris Britton Consultancy, by SCANNER survey contractors, by Halcrow, by Nick Lamb Consultancy Ltd and by UKPMS developers.

This document was prepared by TRL Limited, under the PCIS support contract

Contents

Foreword

This document is one of a series of five describing the requirements for SCANNER Surveys (Surface Condition Assessment of the National Network of Roads).

It replaces the revised SCANNER specification first published in March 2006, and subsequent updates of February 2007 and 2009.

The five Volumes are:

1. Introduction to SCANNER surveys
2. Advice to Local Authorities – Procuring Surveys
3. Advice to Local Authorities – Using SCANNER Survey Results
4. Technical requirements – SCANNER Survey Data and Quality Assurance
5. Technical requirements – SCANNER Survey Parameters and Accreditation

This Volume 3, Using SCANNER survey results, explains the background to SCANNER Surveys and gives further guidance on the interpretation of processed SCANNER data. It contains advice on receiving and using SCANNER data, interpreting the results for local asset management and maintenance, and producing and understanding performance indicators.

Volume 1 provides a brief introduction to the requirements for SCANNER surveys, and is intended to be read as a free standing document, as well as providing an overview of the other four volumes. It includes a glossary of terms and a list of the SCANNER parameters as annexes.

Volume 2 contains advice to Local Authorities about procuring SCANNER surveys under the SCANNER Specification and is to be read in conjunction with the other documents. It includes advice on preparing contact documents, inviting bids, assessing tenders and managing contracts. It includes a model contact document as an annex.

Volume 3, Using SCANNER data, explains the background to SCANNER Surveys and gives further guidance on the interpretation of processed SCANNER data. It contains advice on receiving and using SCANNER data, interpreting the results for local asset management and maintenance, producing and understanding performance indicators, and reporting NRMCS results.

Volume 5, Technical requirements for SCANNER Survey Parameters and Accreditation defines the technical requirements for the parameters provided by the machine developer, including acceptance and consistency testing and accreditation. It describes the requirements for accreditation of the Equipment. It also describes the requirements for consistency testing and for the reporting and delivery of data from SCANNER accredited surveys.

Typical survey vehicles

Jacobs RST26 vehicle

WDM RAV4 vehicle

Yotta (DCL) ARAN1 vehicle

1 Introduction

1.1 What is SCANNER?

1.1.1 SCANNER stands for “Surface Condition Assessment for the National Network of Roads” and is a specification for automated road carriageway condition surveys.

1.1.2 The specification defines the set of data that should be collected by survey vehicles on local roads, and how this should this processed and delivered.

1.1.3 The specification also defines the required level of accuracy for the data and how survey vehicles (machines) will be tested to ensure that they are compliant with the specification (acceptance testing), in order to obtain an accreditation certificate.

1.1.4 The specification includes the requirement for annual re-testing for continuing compliance with the specification to secure further annual accreditation certificates.

1.1.5 The parameters delivered by the SCANNER survey are intended for use within a pavement management system to report the condition of the road and to guide and aid road carriageway maintenance management decisions, as part of an overall asset management system.

1.2 SCANNER surveys

1.2.1 SCANNER surveys have been developed to provide a consistent method of measuring the carriageway surface condition of classified local roads throughout the United Kingdom. They have been developed to support five different requirements (Figure 1.1):

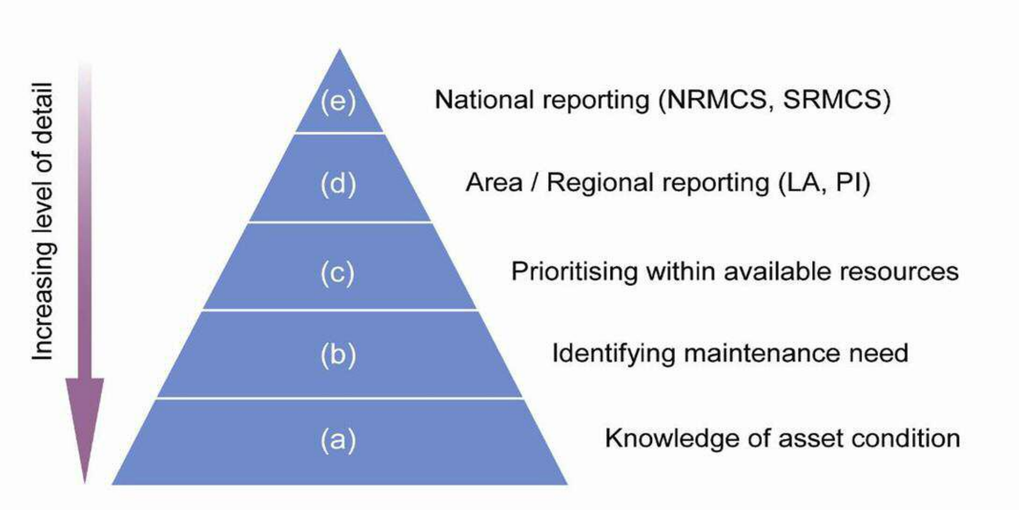
(a) As the basis for developing a detailed knowledge of the current condition and value of the paved carriageway asset.

(b) Replacing CVI and DVI surveys as the basis for defining the optimum treatment selection on classified roads, and the optimum timing of treatment, to prioritise treatment and minimise the whole life cost of maintenance at a scheme or project level.

(c) Replacing CVI and DVI surveys as the basis for indicative treatment selection and budget estimation, to enable local authorities to plan carriageway maintenance at a network level.

(d) As an indication of the overall condition of a defined road network, to replace network level Deflectograph and CVI surveys.

(e) As an indication of the overall condition of a specific length of road carriageway, or of an area of a road network, to establish long term



trends in road maintenance condition, replacing CHART in NRMCS.

Figure 1.1 Use of condition data (after Ekins and Hawker, 2003)

1.2.2 SCANNER surveys collect a number of different measurements and process them to produce a number of “parameters” that describe the condition of the road surface. These include:

(a) The longitudinal profile along the road, which characterises the ride quality of the carriageway (the service level experienced by the road user) and can be an indicator of structural condition (the maintenance requirement).

(b) The transverse profile across the road, including the presence of ruts, which can be an indicator of structural condition (maintenance requirement) and may also affect ride quality and safety (service level experienced by the road user).

(c) The condition of the edge of the road, which can be an indicator of the need for an edge treatment (maintenance requirement) and may also affect serviceability and safety.

(d) The texture depth, which may be required for serviceability and safety, and the texture depth variability which may be an indicator of surface deterioration.

(e) The presence and extent of surface cracking, which can be an indicator of surface or structural deterioration and the need for maintenance.

1.2.3 SCANNER surveys are not visual inspections. They do not identify the condition of a road in the same terms as a visual inspection. In a visual survey a trained and experienced inspector interprets the visible signs in the overall context and reports the condition of a length of road carriageway. In SCANNER surveys a machine measures parameters, which have to be interpreted to produce a meaningful result.

2 SCANNER Parameters

2.1 Introduction

2.1.1 This section describes the SCANNER measurements, the parameters derived from those measurements, and the parameters delivered to UKPMS (in an HMDIF file) for subsequent processing.

2.1.2 The descriptions presented in this section are presented as guidance for users. The formal technical requirements for the delivered data are specified in Volume 4.

2.1.3 Further technical information on the measurement and use of the SCANNER parameters is also given in Annex 1.

2.2 Location referencing

2.2.1 All data delivered by the SCANNER survey is provided in reference to the Employer's road network.

2.2.2 The fitting of the data to the network is carried out by the Contractor. Contractors often achieve this by manually recording the location of section change points during the survey (e.g. with a manual event marker installed in the survey vehicle). Following the completion of the survey the events recorded are aligned with the network information provided by the Employer so that the survey data can be delivered (within an HMDIF file) relative to distance travelled within section and lane.

2.2.3 By aligning SCANNER data with the UKPMS defined road network (i.e. ensuring that the network provided to the Contractor is the same as that defined within the Employer's UKPMS) it can be used with other survey data (such as visual inspection data) and with historic data that is referenced directly to the UKPMS network. The data can also be used with any functionality specified through UKPMS, such producing the SCANNER Road Condition Indicator.

2.2.4 In addition, the position of the survey vehicle during a SCANNER survey is reported at intervals of approximately 10m along the survey route. The three SCANNER position co-ordinates are reported as:

UKPMS code LCOO	SCANNER survey parameter
OBVAL\30 =	SCANNER or TTS "x" co-ordinate
OBVAL\31 =	SCANNER or TTS "y" co-ordinate
OBVAL\32 =	SCANNER or TTS "z" co-ordinate

2.2.5 The "x" and "y" co-ordinates are OSGB36 National Grid Co-ordinates (eastings and northings) and the "z" co-ordinate is altitude (height). These co-ordinates can be used to assist in accurately locating the data on the Employers road network.

2.2.6 Experience has shown that Contractors sometimes have difficulty aligning SCANNER survey data with road networks. Problems occur where road networks have not been kept up to date, where section start and end points have not been accurately defined, or have not been clearly defined.

2.2.7 To improve the fitting of SCANNER data the Employer is required to provide National Grid Co-ordinates of the section start and end points to the Contractor. This enables Contractors to align SCANNER survey data using the measured position co-ordinates.

> The requirements for identifying section start and end points are specified in Volume 4, section 2.2, with outline guidance on selecting section start and end points for SCANNER surveys.

2.3 Road Geometry

2.3.1 SCANNER measures the gradient, the cross-fall and the radius of curvature, which are reported at intervals of approximately 10m as UKPMS codes:

UKPMS code	SCANNER survey parameter
LCRV =	SCANNER or TTS (radius of) Curvature
LFAL =	SCANNER or TTS Crossfall
LGRD =	SCANNER or TTS Gradient

2.3.2 SCANNER measures road geometry from the vehicle, not on the road itself. Therefore there may be differences between the values measured on the path the vehicle follows and those that a surveyor might measure carrying out a detailed total station survey. There may be slight differences between the values on the road centreline and the centre of each lane, and between the centrelines in each lane. However, research has shown that these differences are likely to be relatively small in most places on local roads.

2.3.3 It is recommended that Curvature (the inverse of radius of curvature) is used when presenting geometry information along the length of a road, rather than radius of curvature. Curvature is larger where the road bends and smaller where it is straight, and is more easily interpreted by eye (e.g. on a graph) than radius of curvature.

2.4 Longitudinal profile

2.4.1 SCANNER reports the longitudinal profile of the road, in both the nearside and offside wheel paths, as a number of parameters, each reported at intervals of approximately 10m as UKPMS codes:

UKPMS code	SCANNER survey parameter
LV3 =	SCANNER or TTS 3m moving average LPV (left / nearside)
LL03 =	SCANNER 3m enhanced LPV (left / nearside)
LV10 =	SCANNER or TTS 10m moving average LPV (left / nearside)
LL10 =	SCANNER 10m enhanced LPV (left / nearside)
LLBI =	SCANNER Bump intensity (CDM) (left / nearside)
LR03 =	SCANNER 3m enhanced LPV (right / offside)
LR10 =	SCANNER 10m enhanced LPV (right / offside)
LRBI =	SCANNER Bump intensity (CDM) (right / offside)

2.4.2 The longitudinal profile is the shape of the road in the direction of travel (Figure 2.1). Longitudinal profile variance (LPV) is a measure of how much the road undulates. This can be reported at any scale, from a small scale, where it is a measure of "bumpiness" to a large scale, where it is a measure of the topography. LPV is important for two reasons – it is the main factor controlling ride quality and hence user perception of road condition, and it can be a good indicator of defects in the surface course, the binder course and the base (road base).

2.4.3 The SCANNER research programme recommended a number of changes to the SCANNER specification that were introduced from 2007 onwards. In summary,

(a) the measurement of longitudinal profile is required in both wheel paths

(b) a new method of analysing the data was added to give the *enhanced LPV* as well as the *moving average LPV*

(c) a new measurement of "bump intensity" was introduced

(d) 30m LPV is no longer reported

2.4.4 Research showed that users' perceptions of ride quality on local roads are significantly affected by the longitudinal profile in the right (offside) wheel path as well as the left (nearside) wheel path. Therefore the SCANNER specification has been extended to include measurements in both wheel paths. At present only the measurement in the left (nearside) wheel path is used in the SCANNER RCI and in UKPMS indicative treatment selection.

2.4.5 The enhanced LPV has been introduced to replace moving average LPV. Enhanced LPV correlated with users' perceptions of ride quality better than moving average LPV, and is a more stable, and hence a more reliable, parameter. The moving average LPV measurements in the left (nearside) wheel path have been to enable comparison with the values measured using TTS in 2004 and SCANNER in 2005 and 2006. However, once there is a reasonable overlap between the moving average and the enhanced LPV measurements, the requirement to report moving average LPV may be dropped.

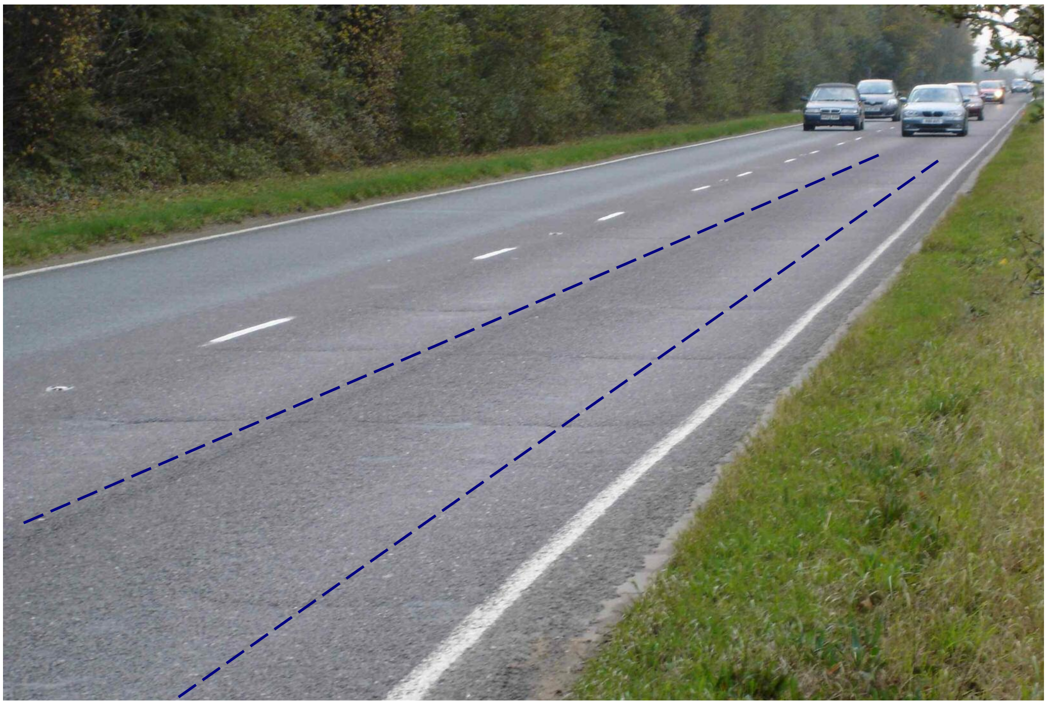


Figure 2.1 Example of a principal road where poor ride quality has been reported

2.4.6 Research showed that, although users' perceptions of ride quality can be related to longitudinal profile variance, the LPV was not always successful in identifying large local bumps arising from features such as large local depressions (e.g. failed patches). The bump intensity has been introduced to identify these features. The measure simply reports the presence (or not) of severe bumps in each 10m length. This measure is currently not used in the SCANNER RCI.

2.4.7 The requirement to report 30m moving average LPV is no longer part of the SCANNER specification. Research showed that it did not correlate with user perception of road condition, and that it can be affected by road geometry. 30m LPV is not used either in the SCANNER RCI, or in treatment selection in UKPMS.

2.4.8 Note that longitudinal profile measurements may be affected by factors such as traffic calming features and vehicle speed and acceleration. The Contractor is required to identify the presence of these features and remove the longitudinal profile data that may be affected. This will lead to gaps in the reported LPV parameters.

2.5 Transverse profile

2.5.1 SCANNER measures the transverse profile of the pavement. The measurements of the transverse profile are analysed to produce the derived SCANNER parameters, which are reported as average values at intervals of approximately 10m using UKPMS codes:

UKPMS code	SCANNER survey parameter
LLRT =	SCANNER or TTS left wheel path rut depth
LLRD =	SCANNER nearside rut depth from cleaned profile
LRRT =	SCANNER or TTS right wheel path rut depth
LRRD =	SCANNER offside rut depth from cleaned profile
LTAD =	SCANNER absolute deviation of 1st derivative of transverse profile

Figure 2.2 Example of a principal road where ruts are beginning to form

2.5.2 Rut depth determined from SCANNER surveys corresponds to a measurement made with a 2m straight edge and wedge. Rutting is a symptom of deterioration in the wearing course or the foundation and is an indicator of the need for structural maintenance, either a wearing course treatment or reconstruction. (Figure 2.2) Engineers and asset managers may use rut depth measurements from SCANNER exactly as they would use machine measured rut depth in UKPMS, or as they would use rut depth measured by trained and experienced inspectors. Average rut depth in the left (or nearside) and right (or offside) wheel paths contributes to UKPMS indicative treatment selection rules. Rut depths are also used in the SCANNER RCI.

2.5.3 SCANNER also reports a further measurement of rutting called Cleaned Rut Depths. The SCANNER research programme identified that rutting can be affected by the presence of features at the edge of narrow roads such as verges that result in erroneously high rut depths. The Cleaned Rut Depth represents the results of calculating the rutting following the application of an algorithm to identify the road edge, hence removing edge features from the rut calculation. The Cleaned Rut Depth is currently undergoing a trial phase to determine its stability and accuracy, and is not included in the SCANNER RCI or treatment selection. Users may wish to compare the Cleaned Rut Depth data with standard rut depths on narrow roads, in particular when the standard rut depths are unexpectedly high.

2.5.4 SCANNER also reports transverse profile unevenness (LTAD), which is a measure of the Absolute Deviation of the First Derivative (ADFD) of the Transverse Profile. This parameter assesses how much the slope of the transverse profile changes from point to point across the carriageway. An even surface would have a low ADFD value, whereas a saw-tooth profile would have a high ADFD value. SCANNER transverse profile unevenness (LTAD) does not contribute to either the SCANNER RCI or the UKPMS indicative treatment selection rules. The measure may be of use when assessing a narrow road where the transverse profile is uneven, but is not appearing as deep rutting.

2.5.5 Note that the research programme recommended that two transverse profile parameters required in earlier versions of the SCANNER specification should be discontinued. However, these are retained within UKPMS, to enable all the data reported in 2005 and 2006 to be processed in future:

UKPMS code	SCANNER survey parameter
LLAD =	SCANNER absolute deviation of 1st derivative of nearside of transverse profile
LRAD =	SCANNER absolute deviation of 1st derivative of offside of transverse profile

2.5.6 Note that transverse profile measurements may be affected by factors such as traffic calming features. The Contractor is required to identify the presence of these features and remove the transverse profile data that may be affected. This will lead to gaps in the reported transverse profile parameters.

2.6 Edge Condition

2.6.1 SCANNER measures the edge condition profile of the pavement. The measurements of edge condition are actually derived from the measured transverse profile, which are analysed to produce the derived SCANNER edge condition parameters. These are reported at intervals of approximately 10m using UKPMS codes:

UKPMS code	SCANNER survey parameter
LTRV =	SCANNER transverse variance
LEDR =	SCANNER edge roughness
LES1 =	SCANNER road edge step L1 (between 20 and 50mm step down)
LES2 =	SCANNER road edge step L2 (greater than 50mm step down)
LEDC =	SCANNER edge coverage

2.6.2 The SCANNER measurement of edge deterioration is based on the initial identification of the road edge within the transverse profile. This is used to separate the verge from the road, and enables the calculation of various parameters.

2.6.3 SCANNER transverse variance (LTRV) is the difference in the average variance of the transverse profile height in the left and right halves of the transverse profile, after the edge of carriageway has been detected and any profile measurements to the left of the edge of carriageway have been suppressed. It is a measure of the difference in the condition of the two halves of the carriageway (Figure 2.3).

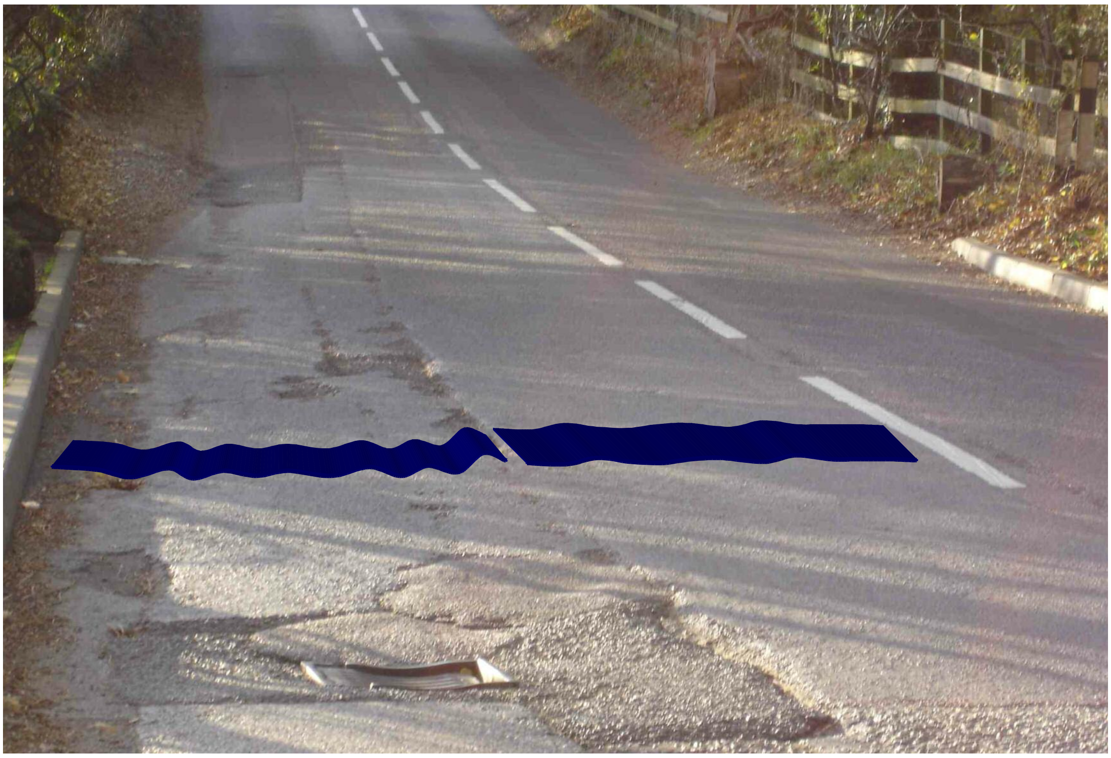


Figure 2.3 Illustration of the principle of the LTRV measurement on a minor road

2.6.4 SCANNER edge roughness (LEDR) is obtained from analysis of the laser profile heights reported within consecutive transverse profiles (along the road). The method reports the roughness within a half metre wide strip adjacent to the road edge.

2.6.5 This SCANNER edge roughness measure (LEDR) can indicate where the road surface at the road edge is likely to be in poor condition, but it cannot identify which particular surface defects are likely to be present. The measure indicates irregularities in the edge surface but would not identify a regular surface containing surface deterioration in the form of cracking or crazing (Figure 2.4).

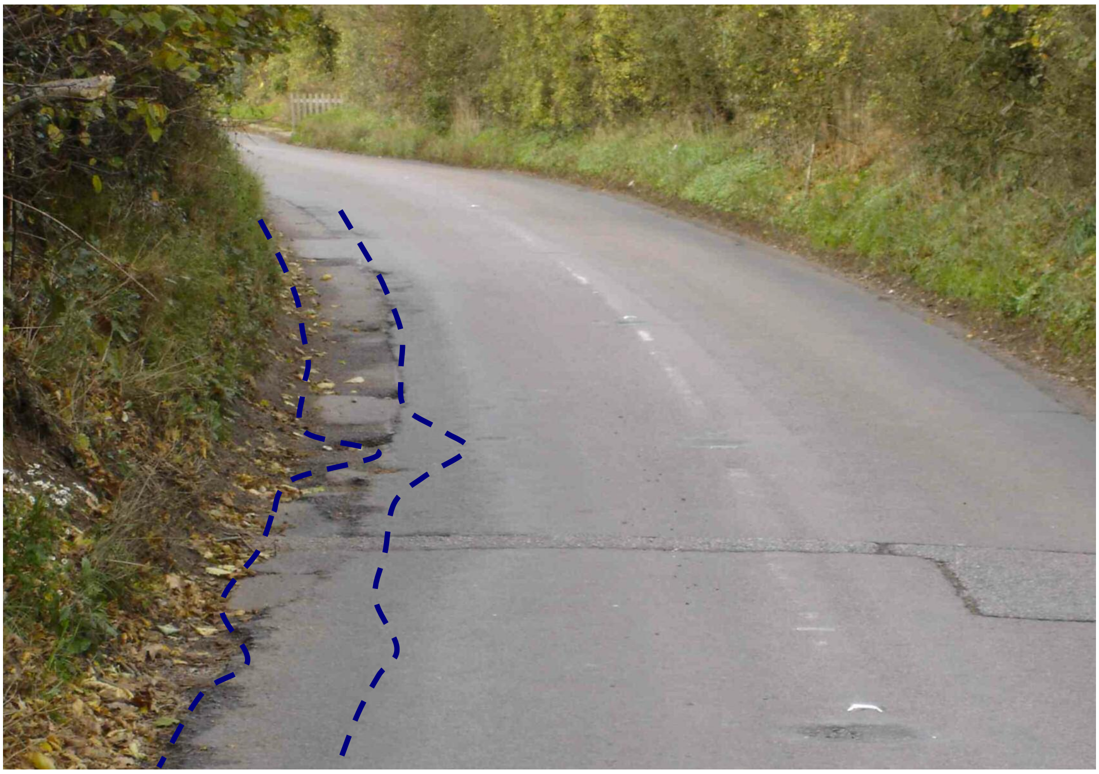


Figure 2.4 Illustration of the principle of LEDR measurement on a minor road

Figure 2.5 Examples of edge steps LES1 and LES2 identified by SCANNER on a minor road

2.6.6 SCANNER edge steps (LES1 and LES2) assess the height of the stepping present within the transverse profile adjacent to the identified road edge (Figure 2.5):

(a) "LSL1" (LES1) = Percentage of reporting length with small step down at the road edge (20 to 50mm).

(b) "LSL2" (LES2) = Percentage of reporting length with large step down at the road edge (greater than 50mm).

2.6.7 The SCANNER edge step measurement seems to provide a good indication of verge over-riding on rural roads. It can also be used to provide an indication of the level of edge support, and an implied indication of the condition of the verge.

2.6.8 Trials have shown that the transverse profile measurement does not always extend over the edge of carriageway and, even when it does, the edge detection method does not always detect the edge of carriageway, because there is no particular feature in the transverse profile. For example, in an urban area there may be a kerb (which is easily detected) or a drive entrance flush with the road surface (which is not detected). In a rural location there may be a grassy verge with a definite step up or step down (which is easily detected) or an extent of bare ground level with the carriageway (which is not detected).

2.6.9 Therefore it is very important to know the number of transverse profiles within which the edge of the carriageway has been detected. This is reported as SCANNER edge coverage (LEDC). This value indicates the percentage of the reporting length where the profiles have been measured over the edge of the road. Where the value is low less confidence should be placed, in particular, on the measure of edge stepping.

2.6.10 The SCANNER edge condition measurements are not used in the SCANNER RCI. Neither are they used in UKPMS for treatment selection. A single SCANNER edge deterioration indicator has been proposed that combines the results of edge deterioration measurements (transverse variance, edge roughness and edge step –Figure 2.6), which is based on the same type of approach as the SCANNER RCI. A single indicator for edge deterioration would reduce the work required in managing the multiple edge parameters delivered by the SCANNER survey. It would offer a degree of continuity with the edge condition indicator offered by current CVI surveys and would be more appropriate for the network level assessment.

2.6.11 The single edge deterioration indicator can be calculated in UKPMS using the SCANNER Edge CI weighting set.

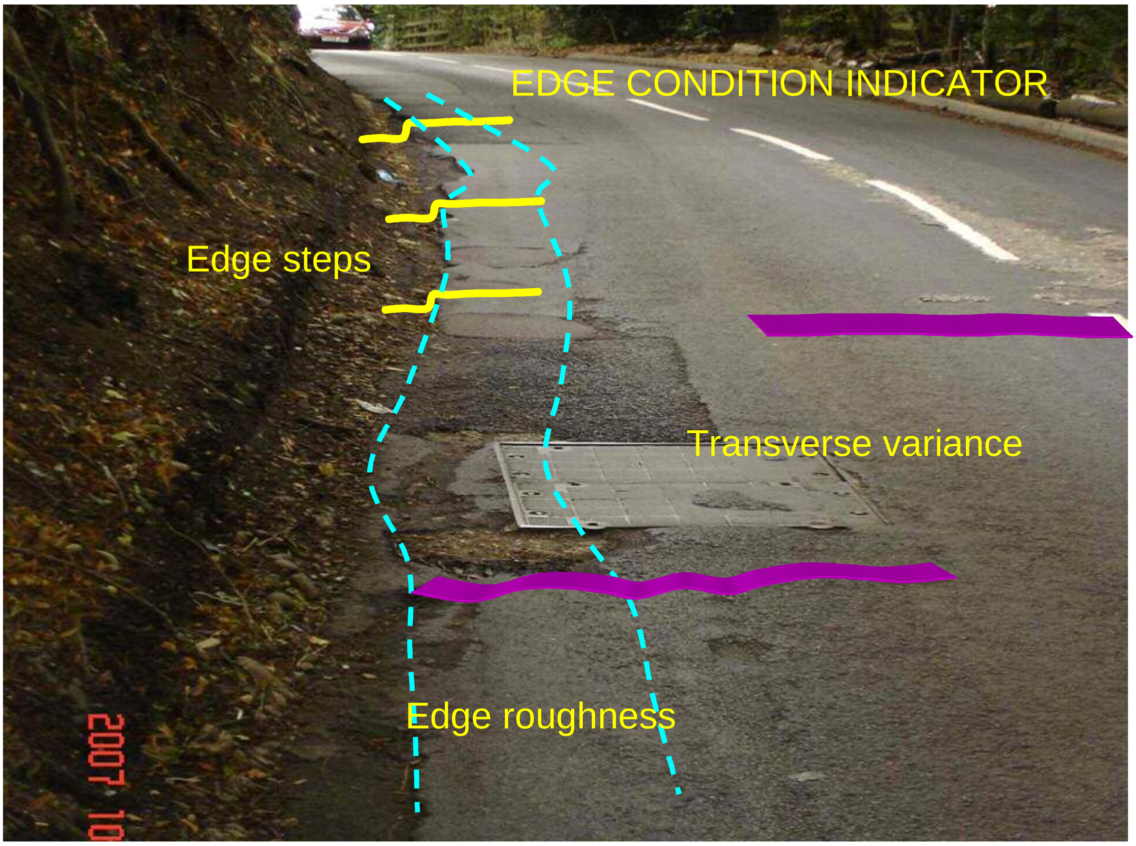


Figure 2.6 Illustration of the components of the edge condition indicator

2.6.12 Note that, because the edge deterioration parameters are derived from the transverse profile, measurements may be affected by factors such as traffic calming features. The Contractor is required to identify the presence of these features and remove the transverse profile data that may be affected. This will lead to gaps in the reported transverse profile and edge parameters.

2.7 Texture depth

2.7.1 SCANNER measures the texture of the pavement. The surface texture depth measured by SCANNER is the coarser element of macro-texture and the finer element of mega-texture of the pavement surface.

2.7.2 SCANNER texture can be separated into two groups – single line and multiple line texture.

2.7.3 The measurements are analysed to produce the SCANNER texture parameters. These are reported at intervals of approximately 10m along the survey route using UKPMS codes:

UKPMS code	**SCANNER survey parameter** **Single Line Texture**
LLTX =	SCANNER or TTS Left Wheel Path Average Texture depth (SMTD)
LLTD =	SCANNER Left Wheel Path Average Texture depth (MPD)
UKPMS code	**SCANNER survey parameter** **Multiple Line Texture**
LLTM =	SCANNER Left Wheel Path Mean RMST Texture depth
LLTV =	SCANNER Left Wheel Path RMST Variance
LCTM =	SCANNER Centre Mean RMST Texture depth
LCTV =	SCANNER Centre RMST Variance
LRTM =	SCANNER Right Wheel Path Mean RMST Texture depth
LRTV =	SCANNER Right Wheel Path RMST Variance
LT05 =	SCANNER Overall Texture Variability - RMST 5th Percentile Value
LT95 =	SCANNER Overall Texture Variability - RMST 95th Percentile Value
LTVV =	SCANNER Overall Texture Variability - RMST Variance

2.7.4 Two texture profile parameters that were required in earlier versions of the SCANNER specification are no longer required. These are retained within UKPMS, to enable all the data reported in 2005 and 2006 to be processed in future:

UKPMS code	SCANNER survey parameter
LCTX =	SCANNER or TTS Wheel Path Centre Average Texture depth (SMTD)
LRTX =	SCANNER or TTS Right Wheel Path Average Texture depth (SMTD)

2.7.5 Single Line Texture

2.7.6 The texture of the surface helps to provide an indication of the high-speed skidding resistance, which may affect road safety. It is in this context that the measured SMTD (LLTX) is applied.

2.7.7 Specifications and thresholds for achieving and maintaining texture depth have been set in the UK for many years on roads carrying large volumes of high-speed traffic in order to maintain skid resistance performance in wet conditions. In this context, “skid resistance” refers to the skid resistance at HIGH SLIP SPEED, i.e. where the tyre is skidding over the surface texture at speeds up to that of actual traffic speed. In contrast “skid resistance” measurement by devices such as the SCRIM or GripTester is made at LOW SLIP SPEED, typically less than 20km/h, because the test wheel is only slipping over the surface at a fraction of the vehicle speed during the test.

2.7.8 As a result, there can be confusion over whether texture depth measurements, such as SMTD or MPD, can be used instead of low slip speed skid resistance measurements.

2.7.9 The SCANNER research established no evidence of any relationship between texture depth measured by laser (SMTD) and low slip speed skid resistance measured by SCRIM. Hence, texture depth cannot be used as a reliable indication of the (low slip speed) skid resistance measured by SCRIM or GripTester.

2.7.10 The skid resistance at low slip speeds is believed to be related to fine scale surface (micro) texture and the relative simplicity of a non-contact, laser measurement of texture depth would make it an attractive alternative to conventional skid resistance measurements, if it were possible to measure texture depth at a sufficiently fine scale. The SCANNER research found that, even at the highest resolution, texture lasers cannot at present produce a good representation of micro texture levels.

2.7.11 However, research into the relationship between texture depth, skid resistance and accident risk has shown that texture depth is a significant variable in explaining accident risk. Research has found that:

(a) There are circumstances where low texture depths can be associated with greater incidence of accidents. This trend appears to hold consistently for accidents on dry roads, but it is not known whether this is because braking performance on dry roads is also better with higher surface texture, or because the distinction between wet and dry is not reported accurately.

(b) For most site categories, no correlation was observed between texture depth and the accident density (accidents per km) or accident rate (accidents per 100 million vehicle km). However, this may reflect the small length of the network with low texture depths.

(c) The trends in accident density were not generally supported by a corresponding trend in accident rate, suggesting that while more accidents occur on low textured surfaces, this could be because there is more traffic on these parts of the network.

(d) The overall picture confirms the importance of maintaining good levels of texture depth, particularly on rural roads, and particularly where the skid resistance is also low.

2.7.12 The average texture depth (SMTD) in the left (or nearside) wheel paths (LLTX) is used both within the SCANNER RCI and also contributes to UKPMS indicative treatment selection rules.

2.7.13 Multiple Line Texture

2.7.14 Simple single line texture depth on its own is often a poor indicator of the surface condition, or the need for maintenance treatment, of a road carriageway surface because it can be acceptable at low, medium or high values:

(a) Where high friction surfacing is used, low texture depth is good. If the average texture depth increases, this may indicate wear, which is not good.

(b) Where a modern negatively textured surface is used, medium texture depth is good. Low texture depth is not good, and may indicate excess bitumen on the surface due to poor mix design or subsequent fatting up. High texture depth is not good, indicating wear and fretting.

(c) Where HRA and surface dressings are used, high texture depth is generally good (although very high texture depth may indicate fretting or chip loss) and low texture depth is not good, indicating wear, embedment of chippings or fatting up.

2.7.15 The SCANNER research showed that measurement of the variability of texture depth along and across road surfaces can be associated with road surface wear (Figure 2.7), although it is also associated with the presence of other features such as road markings.

2.7.16 The SCANNER survey therefore requires the measurement of texture in multiple measurement lines for use in assessing the variability. The minimum requirement is to measure texture profile on at least three lines, including the nearside and offside wheel paths, and the line midway between them (Figure 2.8). However, Contractors can provide measurements in up to 40 lines.

2.7.17 The texture data reported as RMST in each measurement line is averaged for the regions covering the wheel paths and the centreline and reported in the SCANNER HMDIF. These values can be used to assess the variability of the texture and hence identify deterioration. The variability of the RMST texture values are discussed further in Section 6.6.

2.7.18 Neither SCANNER average texture depths (RMST) in the left (or nearside), right (or offside) wheel paths and on the centre line, nor texture depth variability and variance measurements, contribute to the SCANNER RCI or the UKPMS indicative treatment selection rules. Initial values for the thresholds and weightings for SCANNER average texture depths (RMST) and texture depth variance and variability have yet to be developed.

Figure 2.7 Variation in average texture depth across the road surface

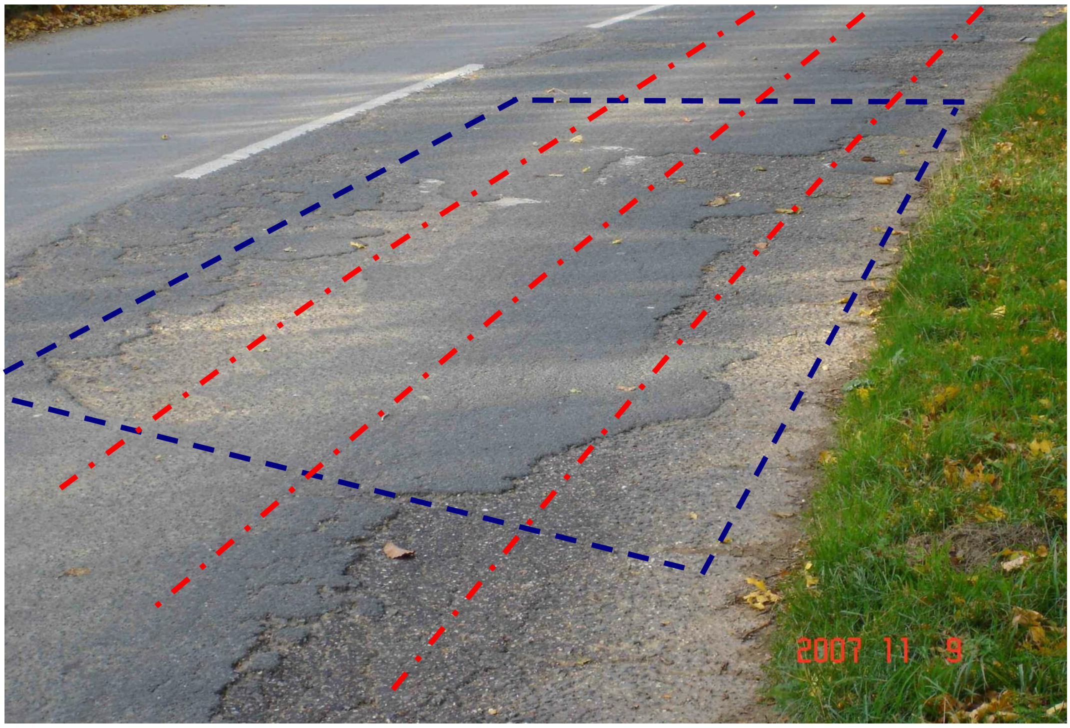


Figure 2.8 Variations in texture depth along and across the road surface

2.7.19 Current laser texture measurement devices work by measuring the distance between the sensor and the road surface. The laser technology used may be affected by the presence of a shiny reflective film of water over the surface. Therefore texture depth measurements can be unreliable on wet roads.

2.8 Cracking

2.8.1 SCANNER measures cracking on the surface of the pavement, which is reported as the location of each crack identified in the form of a crack map. Each crack has UKPMS code LMAP, with parameters:

UKPMS code LMAP	SCANNER survey parameter
OBVAL\2 =	Crack length
OBVAL\23 =	Offset position
OBVAL\24 =	Angle
OBVAL\25 =	Type code (crack or joint)

2.8.2 The crack map is reported in the SCANNER HMDIF, but UKPMS is not currently configured to use this information. In future it may become possible to overlay the crack map on the visual image of the road surface, and to overlay the crack map on a detailed map of the road in a UKPMS accredited system. At present it is only possible to view the crack map using proprietary software provided by the survey companies. This proprietary software differs between companies and has not been standardised as a SCANNER requirement.

2.8.3 The cracks are analysed to produce the derived SCANNER cracking parameters, which are reported as average values within the HMDIF at intervals of approximately 10m using UKPMS codes:

UKPMS code	SCANNER survey parameter
LTRC =	SCANNER or TTS Cracking (whole carriageway)
LWCL =	SCANNER or TTS Left Wheel Track Cracking Intensity
LWCR =	SCANNER or TTS Right Wheel Track Cracking Intensity
LRCR =	SCANNER Transverse/reflection cracking
LSUR =	SCANNER Surface Deterioration Parameter

2.8.4 The SCANNER measurement of cracking typically covers a survey width of 3.2m, although this can vary with the survey vehicle (minimum is 2.9m). Whole carriageway cracking is obtained by overlaying the crack map with a grid covering the whole survey width, and summing up the areas of the grid squares containing cracks. The method by which the whole carriageway cracking intensity is obtained from the crack map is given in volume 5. An example of a cracked road surface is shown in Figure 2.9.

2.8.5 Wheel track cracking intensity is reported over two tracks, each of width 0.8m, centred on the wheel paths. Consequently the area considered for wheel track cracking is typically about 50% of the area considered for whole of carriageway cracking. SCANNER wheel track cracking is very different from classic, visually recognised wheel track cracking. This is because the engineer or inspector takes account of the orientation of the crack, along the wheel path, before recognising and reporting it. Whereas SCANNER only takes account of whether the crack lies mainly within the defined wheel track.

2.8.6 Both whole carriageway cracking and wheel track cracking contributed independently to the “original” SCANNER RCI, used in 2006 and 2007. Currently only the whole carriageway cracking contributes to the “revised” SCANNER RCI.

2.8.7 Both whole carriageway cracking and wheel track cracking contribute independently to the UKPMS indicative treatment selection. Whole carriageway cracking contributes to “strengthen”; “resurface” and “surface treatment”. Wheel track cracking only contributes to “strengthen” and “resurface”.

2.8.8 SCANNER identifies cracking by collecting video images and analysing them automatically. The automatic detection and measurement of cracking on a road surface is technically very challenging. Most road surfaces are essentially “grey” and images of the road surface have “visual texture” in terms of variability in the grey scale across the image. The variation in the “visual texture” across the image tends to mask the cracks, which are normally visible (in the image) as darker features.

Figure 2.9 Longitudinal and transverse cracking on a minor road

2.8.9 The identification of cracking relies on interpretation of the image recorded by the particular crack identification software. The resolution of crack detection systems employed on current SCANNER survey equipment typically limits the minimum crack width detected to around 2mm. The automatic systems quantify the extent of cracking in a different way from a visual inspection. Consequently SCANNER cracking intensity does not replicate visual survey cracking data, but will generally report a much lower percentage area of cracking than would be reported from a visual inspection.

2.8.10 The SCANNER research developed further algorithms for the reporting of crack parameters from the SCANNER crack map, including transverse cracking and surface deterioration.

2.8.11 The method of identifying transverse / reflection cracking is described in Volume 5. SCANNER transverse / reflection cracking (LRCR) has been developed as a way of differentiating surface cracking by their cause, as a guide to treatment selection. Appropriate treatment options are likely to depend on construction type.

2.8.12 The method of identifying surface deterioration is also described in Volume 5. The SCANNER surface deterioration parameter (LSUR) has been developed as a way of detecting isolated areas containing crack like defects, as opposed to continuous cracks.

2.8.13 Both of these new parameters are undergoing a trial period to assess their value and are not used in the SCANNER RCI or in treatment selection.

3 The SCANNER Road Condition Indicator

3.1 Requirements of a Road Condition Indicator

3.1.1 There are a number of differing requirements for a road carriageway condition indicator.

(a) To identify lengths of road where the condition has deteriorated and the level of service may also have deteriorated. (As an input to planning detailed investigation and maintenance)

(b) To summarise the condition of a section or length within a network. (As an input to maintenance planning)

(c) To rank the lengths of road where the condition has deteriorated and maintenance treatment may be required. (As an input to allocating resources between different lengths of road requiring treatment)

(d) To identify the type or types of treatment required on a length of road. (As an input to estimating the overall requirement for resources)

(e) To summarise the overall condition of a road network so that some value can be ascribed to the network. (As an input to asset valuation and management)

(f) To summarise the overall condition of a road network, so that comparisons can be drawn between different areas. (As an input to performance indicators).

(g) To summarise the overall condition of a road network, so that trends in condition can be observed from year to year. (As an input to national or local monitoring).

3.1.2 The SCANNER Road Condition Indicator (RCI) has been developed as a way of characterising the condition of the road carriageway, which fulfils some, but not all, of the requirements. It identifies lengths where the condition is poor and enables their condition to be summarised and ranked. It can also be used to summarise the overall condition of part or all of a road network, so that comparisons may be made between different areas, and trends in condition can be observed from year to year

3.1.3 It has specifically NOT been developed as a method of identifying the TYPES OF TREATMENT required on a length of road, or to ascribe a VALUE to a network.

3.2 Developing the SCANNER RCI

3.2.1 The SCANNER RCI has been developed through a process of research, development, testing and refinement. This was carried out in three stages

(a) Preliminary research leading to the “TTS Defects Index Preliminary Analysis” (Cartwright and Pickett, 2004).

(b) A review of the proposals and recommendations by the Defects Index Working Group, set up by the UK Roads Board, in 2005, supported by tests of the RCI on principal roads (McRobbie, 2006). This led to the original values used in the SCANNER RCI in 2006 on 2005/06 survey data.

(c) Review of the results with the initial values by the SCANNER RCI Working Group, set up by the UK Roads Board, in 2006, supported by further tests on classified roads (McRobbie et al, 2007). This led to recommendations for a revised set of values used for reporting in 2007 and 2008.

3.3 How the SCANNER RCI value is calculated

3.3.1 Table 3.1 shows the parameters used within the calculation of the original and extended RCI. To obtain an RCI value each parameter is scored between two thresholds – a lower threshold below which there is no need to consider maintenance, and an upper threshold above which further deterioration does not increase the score. These thresholds were based on engineers' experience of each parameter. The score increases linearly between the lower and upper threshold from zero at the lower threshold to 100 at the higher. Figure 3.1 demonstrates this procedure for rutting.

3.3.2 The thresholds for each parameter are given in Annex 2.

3.3.3 The score for each parameter is then multiplied by two factors, each having a value between zero and one. One factor reflects the "relevance" or importance of the measurement to the maintenance condition of the road. The other reflects the "reliability" of the method of measurement.

(a) The values used in the **original** SCANNER RCI for surveys carried out in 2005/06 and 2006/07 (and reported in 2006 and 2007) are given in Table 3.2

(b) The values to be used in the **revised** SCANNER RCI for surveys carried out in 2007/08 and subsequent years (and reported in 2008 and subsequent years) are given in Table 3.3.

UKPMS code	**SCANNER survey parameter**	**Original RCI**	**Revised RCI**
Ride quality (LV3)	3m longitudinal profile variance in nearside (left) wheel path	✓	✓
Ride quality (LV10)	10m longitudinal profile variance in nearside (left) wheel path	✓	✓
Rut depth (LLRD)	Average rut depth measured in the nearside (left) wheel path	✓	✓
Rut depth (LRRD)	Average rut depth measured in the offside (right) wheel path	✓	✓
Cracking (LTRC)	Whole carriageway cracking intensity	✓	✓
Cracking (LWCL)	Wheel track cracking intensity measured in the nearside (left) wheel path	✓	x
Cracking (LWCR)	Wheel track cracking intensity measured in the offside (right) wheel path	✓	x
Texture depth (LLTX)	Average SMTD measured in the nearside (left) wheel track	✓	✓

Table 3.1 SCANNER parameters used in calculating the SCANNER RCI

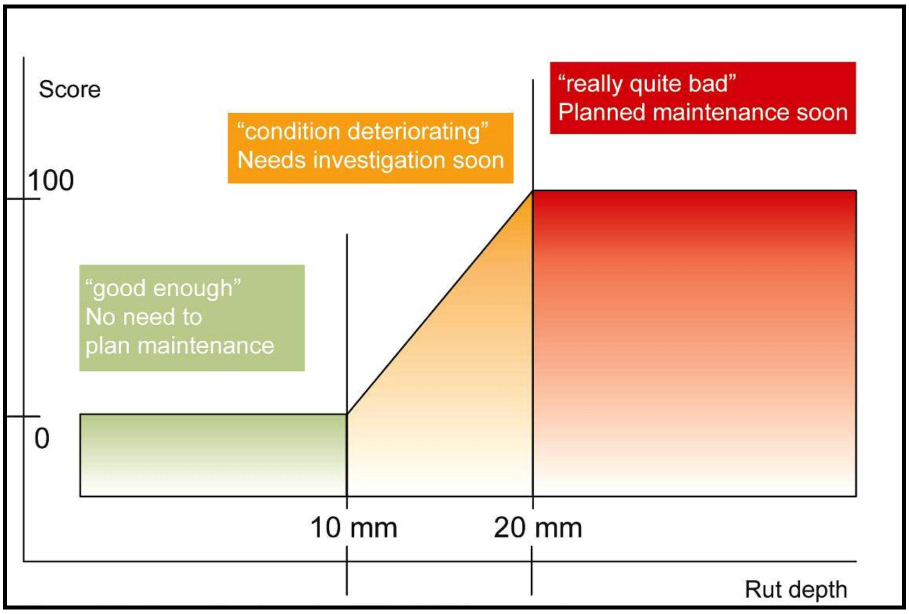


Figure 3.1 Example of scoring a SCANNER parameter – average rut depth

Family	UKPMS Code	Importance factor	Reliability factor	Overall factor	Maximum points
Rut depth (greater of nearside and offside)	LLRT LRRT	0.9	1.0	0.9	90
3m LPV	LV3	0.8	1.0	0.8	80
10m LPV	LV10	0.6	1.0	0.6	60
Whole carriageway cracking	LTRC	0.9	0.55	0.5	50
Wheel track cracking intensity (greater of nearside and offside)	LWCL LWCR	0.9	0.44	0.4	40
Nearside wheel track texture depth	LLTX	0.5	1.0	0.5	50
Maximum total points					370

Table 3.2 Relevance and reliability factors for original SCANNER RCI used with 2005/06 and 2006/07 surveys

Family	UKPMS Code	Importance factor	Reliability factor	Overall factor	Maximum points
Rut depth (greater of nearside and offside)	LLRT LRRT	1.0	1.0	1.0	100
LPV (higher scoring of) 3m and 10m	LV3 LV10	0.8 0.6	1.0	0.8 0.6	80 or 60
Whole carriageway cracking	LTRC	1.0	0.6	0.6	60
Nearside wheel track texture depth	LLTX	Varies 0.75 to 0.3	1.0	Varies 0.75 to 0.3	75, 50 or 30
Maximum total points					315 to 270

Table 3.3 Relevance and reliability factors for revised SCANNER RCI used with 2007/08 surveys and subsequent years

3.3.4 The values are then summed for each nominally 10m subsection of the survey, giving a value

(a) between zero (no reported deterioration) and 370 (maximum score on all parameters) for the original SCANNER RCI.

(b) between zero (no reported deterioration) and 315 (maximum score on all parameters) for the revised SCANNER RCI.

3.3.5 The maximum value does not have any special significance, it simply represents a sub-section on which all the parameters exceed the upper threshold value.

3.3.6 There is no way to convert a score from the revised RCI to the original RCI, or vice versa. Either the original or the revised RCI may take a higher value.

3.3.7 Many lengths of road will have a score of zero, and this will include carriageways in a wide range of conditions, from "nearly new" and "nearly perfect" to "quite worn" and "quite old".

3.3.8 The resulting values can be divided into three bands representing the overall condition of the sub-section.

Band	Condition	Threshold – Original RCI	Threshold – Revised RCI
"RED" condition = (plan maintenance soon)	Lengths in poor overall condition which are likely to require planned maintenance soon (i.e. within a year or so) on a "worst first" basis. There may be justification for postponing major repairs, and only carrying out minor repairs to keep the road safe and serviceable, in order to minimise whole life costs. i.e. "economic prioritisation".	>100	>100
"AMBER" condition = (plan investigation soon)	Lengths where some deterioration is apparent which should be investigated to determine the optimum time for planned maintenance treatment. There may be justification for carrying out a lesser maintenance treatment sooner, rather than more extensive treatment later, in order to minimise whole life costs.	>20	>40
"GREEN" condition	Lengths where the carriageway is generally in a good state of repair.	N/A	N/A

Table 3.4 Definitions of red, amber and green carriageway condition

3.4 Reporting road condition using the SCANNER RCI

3.4.1 As the road condition deteriorates, and as the SCANNER measured parameters change, the score on a subsection length will start to increase, depending on which parameters are changing. As each parameter increases, the individual score will gradually increase to a maximum value, at which point it will increase no further. Consequently certain values of SCANNER RCI will be more common than others. These are sub-sections where one or more parameters have reached a maximum score, and the other parameters are not yet contributing.

3.4.2 This effect can be seen in Figure 3.2, which shows data from a representative sample of 16 local authorities in England and Scotland.

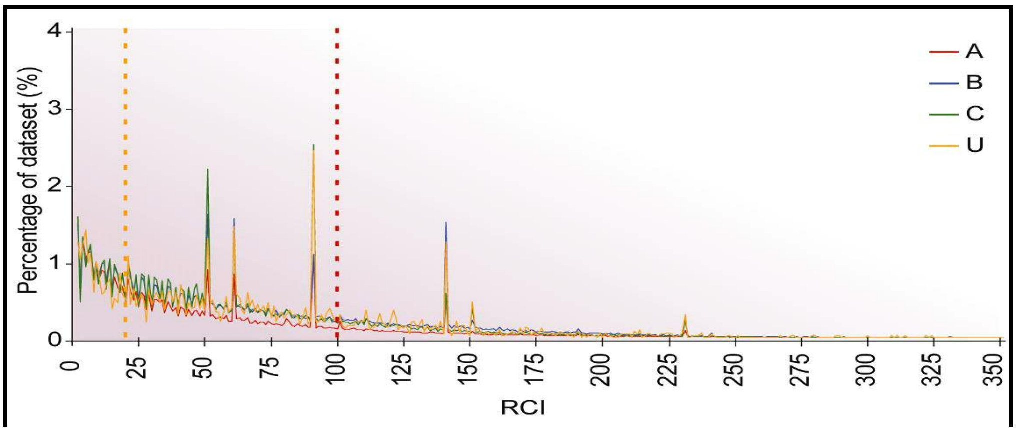


Figure 3.2 Distribution of original SCANNER RCI values from a representative sample of local roads

3.4.3 The research programme has carried out extensive investigation into the behaviour of the RCI using data from sample authorities. A few of the observations made in that work are presented here to provide a context in which to place locally obtained RCI values.

(a) Figure 3.3 shows the percentage of lengths classified as Red, Amber and Green within a sample of 16 authorities, for the original RCI and where the amber threshold has been set at 20.

(b) Figure 3.4 shows the percentage of lengths classified as Red, Amber and Green within a sample of 16 authorities, for the original RCI and where the amber threshold has been set at 40

(c) Figure 3.5 shows the percentage of lengths classified as Red, Amber and Green within a sample of 16 authorities, for the revised RCI and where the amber threshold has been set at 40

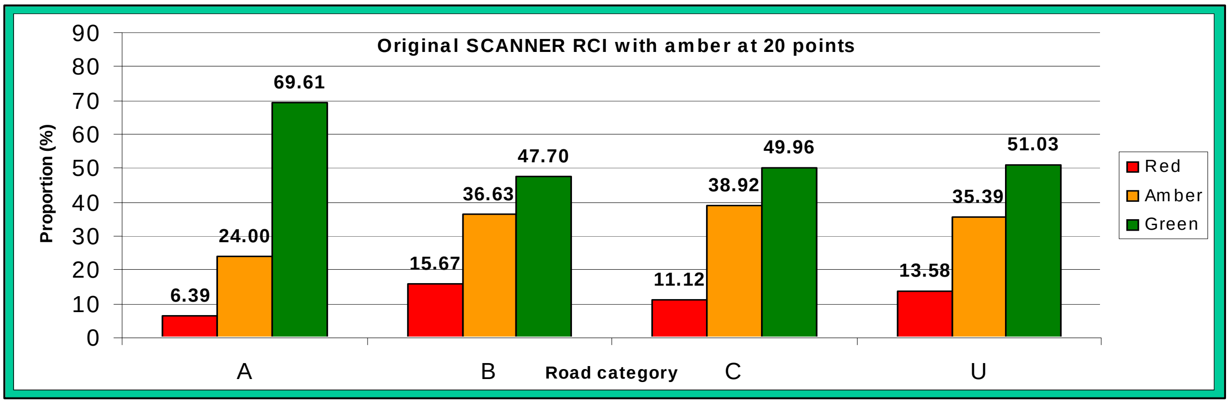


Figure 3.3 **Percentage length of red, amber and green from a representative sample of local roads, using the original SCANNER RCI**

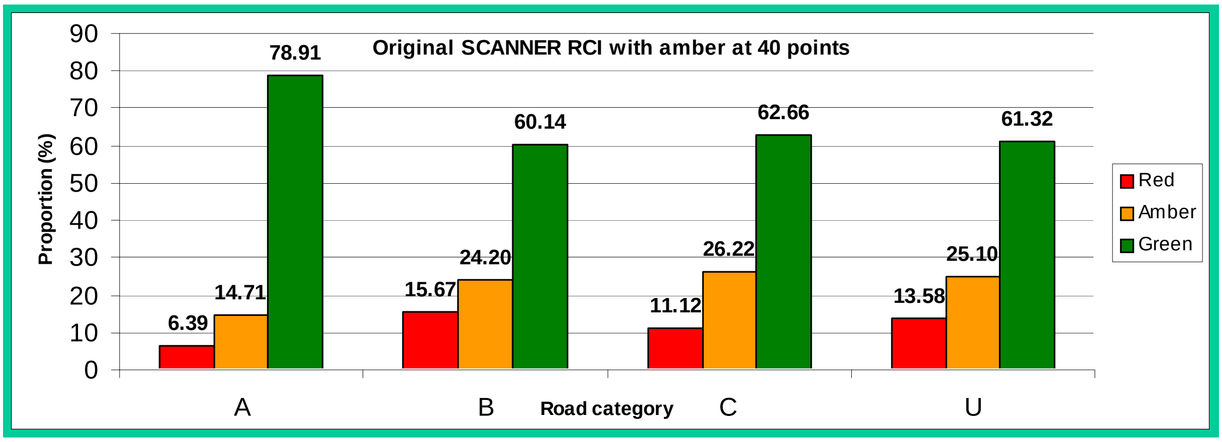


Figure 3.4 **Percentage length of red, amber and green from a representative sample of local roads, with original SCANNER RCI, and amber / green threshold at 40 points**

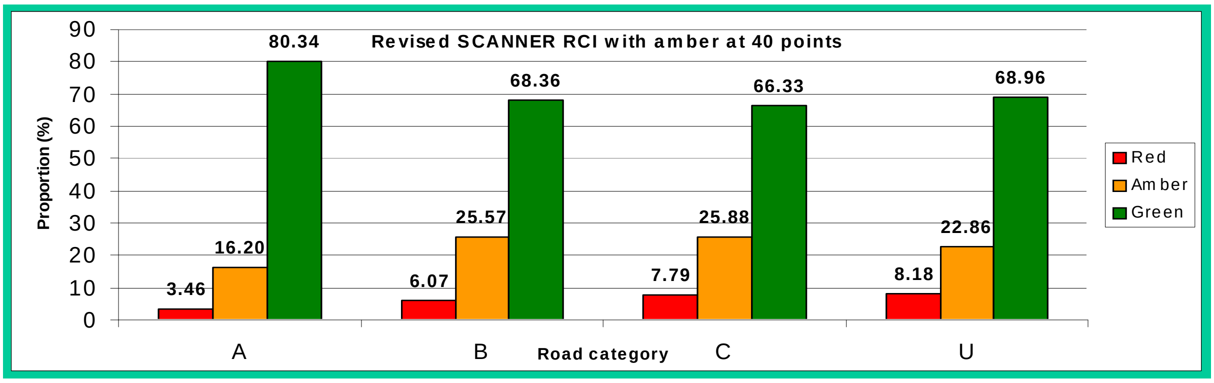


Figure 3.5 **Percentage length of red, amber and green from a representative sample of local roads, with revised SCANNER RCI, and amber / green threshold at 40 points**

3.4.4 Note that, because of the accuracy of the network referencing, the precise start and end position of each 10m sub section length will change from year to year. Therefore care must be taken when aligning subsections and comparing results from year to year. In order to make comparisons between years, it is more appropriate to combine the results along routes, sections or networks.

3.5 National reporting

3.5.1 Until 2009 the SCANNER RCI was used to report, at the national level, the condition of principal (BV223) and other classified (BV224a) road networks. These indicators report the length (as a %) of an authority's network that falls within the red band.

3.5.2 In 2009 BV223 and BV224a were replaced by NI168 and NI169 respectively. More information about the English requirements is available on the Department for Transport website (Department for Transport, 2007).

3.5.3 The original SCANNER RCI was used as the basis for reporting the English BV223 and Bv224a up to 2007, based on the most recent survey results (i.e. from 2005/06 and 2006/07 for reporting in 2007).

3.5.4 The revised RCI was used for reporting BVPI/NI from 2008, again based on the most recent survey results (i.e. from 2006/07 and 2007/08 for reporting in 2008).

3.5.5 The results in England are reported by the Audit Commission.

3.5.6 Note that, during 2005/06 there were problems with the automatic software used to detect cracking in the images collected by one of the machines used in England. This made the reported amounts of both whole carriageway and wheel track cracking unreliable. Therefore the SCANNER RCI was not a reliable method of for comparison between those authorities that used that survey machine, compared with other local authorities, and year on year. There was no way of adjusting these results to make reliable comparisons. Therefore the Audit Commission did not make any comparison between the results in terms of quartiles. Neither were the results used as part of the Comprehensive Performance Assessment (CPA) scores.

3.5.7 The following discuss a few of the observations made during the research, and review of the nationally reported indicators:

(a) There is evidence to suggest that there is a relationship between the percentage of built-up principal roads in an authority (i.e. roads with a speed restriction of 40mph or less) and BV223. This may be associated with two factors. Principal roads in towns (a) have more numerous junctions and (b) have more excavation and reinstatement by utility companies. The junctions affect the longitudinal profile measurements (ride quality) and the reinstatements can affect both ride quality and crack detection, giving rise to some apparent cracking where there is none.

(b) There is little evidence of a relationship between the percentage red length and the percentage of built-up roads on other classified roads.

(c) The work undertaken on the development of the revised RCI led to quite significant changes in the thresholds, and lesser changes in the weightings, that are likely to markedly change the % red and % amber lengths in many local authorities, and hence lead to significantly different BV224a.

3.5.8 From 2007-2008, road condition in Scotland has similarly been reported on the basis of the RCI. However, unlike England, the reported figure applies to the total public road network, including unclassified roads, and reports on the portion falling in both the red and amber bands. Although not statutory performance indicators, the RCI results for each road class are also available, specifying separately the portions falling in the red and amber bands. Prior to 2007_08 the Scottish results were reported on the basis of the "SPI", which did not include data on cracking.

3.5.9 In Scotland a single national survey contract has been awarded to collect the data, from which the results are provided to individual local authorities for local maintenance management purposes and for reporting to Audit Scotland as part of their annual statutory PI returns. Details of the Scottish results can be found on the SCOTS' website www.scotsnet.org.uk by following the link on the home page to "Road Condition Surveys".

3.6 Benchmarking between local authorities

3.6.1 The SCANNER research has investigated whether there is any evidence for grouping English local authorities for "benchmarking" comparisons, in the same way that Scottish local authorities seem to fall into a number of natural groups based on the percentages of their networks that are urban or rural. On the basis of a detailed analysis of the results from 2005/06 surveys the work (McRobbie et al, 2007) has concluded:

(a) There are possibly three main groups of English highway authorities for comparing principal road networks, but the groups overlap considerably.

(b) There are no obvious groups of English highway authorities for comparing other classified road networks.

3.6.2 English local authorities are much more diverse in their make-up than Scottish local authorities, and there are fewer obvious groupings for benchmarking purposes. Therefore English local authorities would probably do better to select a limited number of other authorities to compare their performance in managing road networks, based on a wider range of environmental, social and economic factors, rather than a limited number of characteristics of their road networks.

3.7 Future development of the SCANNER RCI

3.7.1 The SCANNER RCI Working Group used the experience of using the SCANNER RCI on 2005/06 survey data, in the development of the revised RCI. The Working Group subsequently recommended that an "extended" SCANNER RCI should be introduced in the future (perhaps as early as 2009), via a new weighting set that would include the new (e.g. edge, bump) parameters.

3.7.2 However, the Road Performance Management Group recommended, postponement of the introduction of an extended RCI whilst the revised RCI was fully implemented and accepted by authorities. The UK Roads Board therefore decided that the "revised" set of parameters thresholds and weightings for the SCANNER RCI should be retained for the immediate future, at least until local authorities are more familiar with the interpretation of SCANNER survey results.

4 Using SCANNER results

4.1 Knowledge of asset condition

4.1.1 At the simplest level the engineer or asset manager responsible for managing a road network needs to know:

(a) Which roads they are responsible for

(b) What condition they are in

(c) What maintenance is required and

(d) The best time to carry it out.

4.1.2 The SCANNER accredited survey vehicle measures carriageway condition from the perspective of a moving vehicle. It surveys one lane of the carriageway at a time and produces numbers – a quantitative measure of carriageway condition.

4.1.3 SCANNER produces vastly more data than visual surveys, and therefore requires a much greater capacity in the pavement, asset management and data storage systems, both software and hardware. To be able to use SCANNER survey data effectively, the engineer or asset manager will need comprehensive IT support, both commercial software programmes such as pavement management systems and asset management systems, linked to geographic information systems (GIS), and the hardware to support them in terms of display screens, personal computers, servers, network capacity (bandwidth) and data storage systems.

4.1.4 SCANNER makes four sorts of measurement:

(a) The profile of the road in the direction of vehicle travel along the road (the longitudinal profile). This is important for two reasons – it is the main factor controlling ride quality and hence user perception of road condition, and it can be a good indicator of defects in the surface course, the binder course and the base (roadbase).

(b) The profile of the road across the direction of travel (the transverse profile). This includes measuring rut depth. This is important for two reasons – ruts or other transverse unevenness features can affect steering or cause water to pond, both of which may affect road safety, and it can be a good indicator of defects in the surface course, the binder course and the base (roadbase).

(c) The texture of the surface. This can be important for two reasons. It helps to provide high speed skidding resistance on fast roads, which may affect road safety. Variations in texture depth along or across the road can indicate surface wear and the presence of defects in the surface course.

(d) Cracking visible at the surface. This can be important for two reasons. It may indicate deterioration of the surface course, or of deeper seated defects in the binder course and base. It may allow water to penetrate through the pavement layers and weaken the foundations.

4.1.5 SCANNER measures the survey parameters more or less continuously along the road. The survey contractor processes the measurements, either on the survey vehicle during the survey, or in their offices after the survey [post processing], fits the survey data to the road network, and reports the results as "characteristic" values every few metres along the road.

4.1.6 Most of the parameters are reported as average values over survey subsection lengths, which are approximately 10m long, along the road. They are reported using a UKPMS HMDIF file (Smith, 2006) which can be loaded into any UKPMS accredited pavement management system. The reported survey parameters are described in more detail in section 3.

4.1.7 SCANNER does not measure the condition of footways, cycle paths or verges, nor does it measure the appearance of the street from the perspective of a local resident.

(a) Quantitative information on the condition of footways, cycle paths and verges could be gathered by visual inspections and combined with information from SCANNER surveys in a pavement management system.

(b) Qualitative information about the appearance of the street could be gathered through visual inspections or photographic surveys and combined with information from SCANNER surveys in an asset management system.

4.1.8 Although not part of the SCANNER core requirements, SCANNER survey contractors will often offer video surveys as an extra dataset in conjunction with their SCANNER surveys. This video data can be very useful, both as a way of checking SCANNER survey coverage and of carrying out more detailed investigation of specific lengths of road.

(a) The video survey information provides a qualitative record of the condition of the road at the time of survey and complements the quantitative data gathered by SCANNER. Together they can provide most of the information an engineer or asset manager needs to have a detailed record of the carriageway asset condition at a particular time, as well as qualitative information about the appearance of the street including footways, verges and street furniture.

(b) Increasingly local authorities are building detailed inventories of their road assets. SCANNER provides quantitative information about the condition of the carriageway, and a simultaneous video record can be a useful way of checking for the presence, location and appearance of the asset inventory items at a particular time.

4.1.9 Typically the video survey data consists of a sequence of good quality digital images along the survey – often taken at 5m intervals. These can be strung together to produce a "virtual video" of progress, or viewed individually for more detailed examination. These will require greater capacity in the data storage system and development of the pavement or asset management system to enable the SCANNER results to be compared with the photographic images in a GIS presentation. This can be a large data storage and management exercise – particularly if a video survey is carried out with every SCANNER survey.

4.1.10 SCANNER does NOT measure surface skidding resistance or the stiffness of the pavement layers.

(a) Surface skidding resistance can be measured using systems like SCRIM or Griptester. Research carried out as part of SCANNER development has shown that surface texture CANNOT be used as a proxy for skidding resistance on local roads in the UK (Viner et al., 2006).

(b) The stiffness of the pavement layers can be measured using systems such as Deflectograph or Falling Weight Deflectometer (FWD) and interpreted as a measure of pavement strength and “residual life”, in the case of the Deflectograph. SCANNER measurements CANNOT, at present, be interpreted to give a measure of residual life.

4.1.11 Measurements of skidding resistance and pavement deflection (stiffness) can be combined with SCANNER measurements in pavement and asset management systems.

4.1.12 Other measurements, such as ground penetrating radar, and the results from coring and test pits, can also be combined with SCANNER results in some asset management systems.

4.1.13 The reports from visual inspections can also be combined with SCANNER measurements in UKPMS and used in pavement and asset management systems.

4.2 Identifying maintenance need

4.2.1 The results from the SCANNER survey can be expressed as the SCANNER Road Condition Indicator (RCI). This is a measure of the overall condition of each (nominally 10m) subsection. The combination of parameters in the SCANNER RCI is specified for local authority and national reporting purposes, but has been designed to reflect the maintenance priority for the local authority engineer or asset manager.

4.2.2 The SCANNER RCI is described in greater detail in section 3, where it is noted that the SCANNER RCI scores each subsection (using rules that depend on the road classification and speed restriction). This can then be divided into three categories:

(a) GREEN = lengths where the carriageway is generally in a good state of repair.

(b) AMBER = lengths where some deterioration is apparent which should be investigated to determine the optimum time for planned maintenance treatment.

(c) RED = lengths in poor overall condition which are likely to require planned maintenance soon (i.e. within a year or so) on a "worst first" basis.

4.2.3 When the SCANNER RCI values are plotted on a map of the road network, they appear as a patchwork of red, amber and green lengths. An example is shown in Figure 4.1 and Figure 4.2.

4.2.4 Figure 4.1 shows the SCANNER RCI marked on three roads: the B3314, the B3266 and the B 3267, either side of the A39 in Cornwall. It can be seen that the red, amber and green subsection lengths tend to cluster together, giving a visual impression of the overall condition of road lengths.

4.2.5 Figure 4.2 shows a detail of a short section of the B3267 between the A39 junction at Knightsmill and through the village of St Teath. The length between the two purple circles was identified as a potential scheme length.

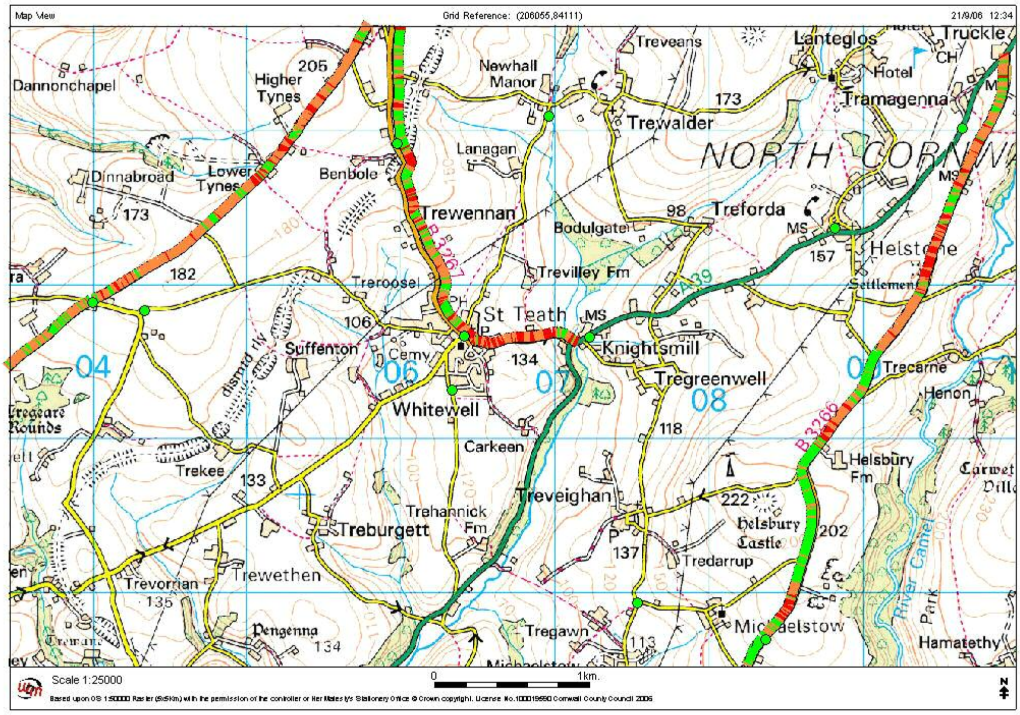


Figure 4.1 SCANNER RCI data overlaid on a map of part of Cornwall (picture courtesy of Cornwall County Council and WDM Limited)

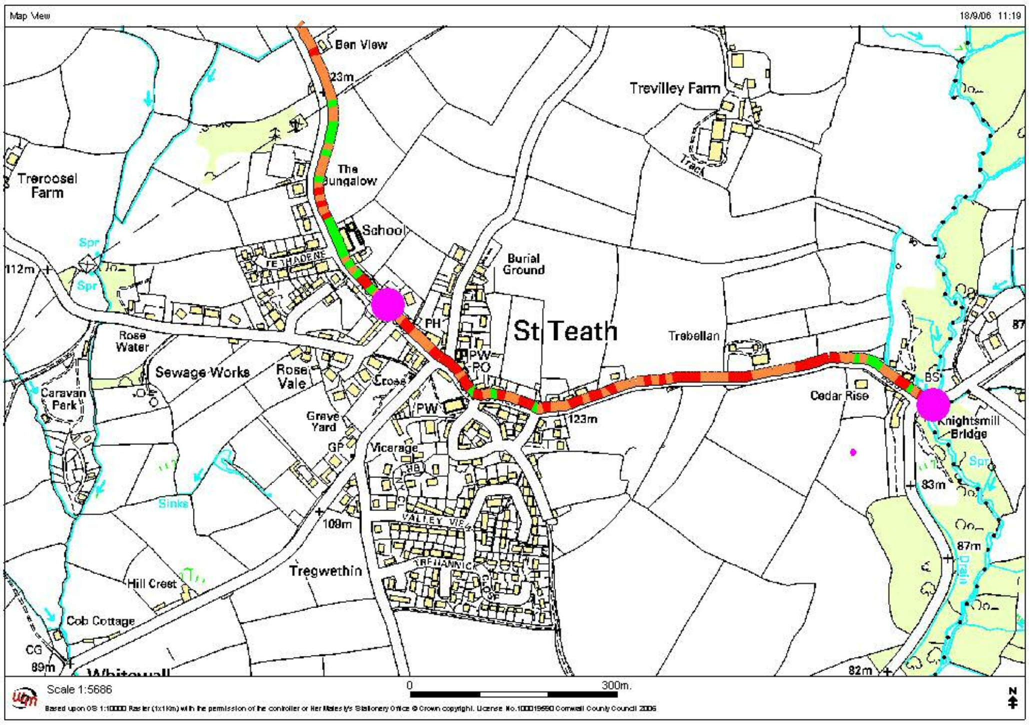


Figure 4.2 Detail of SCANNER RCI values overlaid on B3267, St Teath, Cornwall (picture courtesy of Cornwall County Council and WDM Limited)

4.2.6 Three photographs shown in Figure 4.3, Figure 4.4 and Figure 4.5 extracted from the forward facing video illustrate the general condition of the section.

Figure 4.3 Forward facing video image, B3267 in St Teath, Cornwall (picture courtesy of Cornwall County Council and WDM Limited)

Figure 4.4 Forward facing video image, B3267 near St Teath, Cornwall (picture courtesy of Cornwall County Council and WDM Limited)

Figure 4.5 Forward facing video image, B3267 near St Teath, Cornwall (picture courtesy of Cornwall County Council and WDM Limited)

4.2.7 Using the more detailed information from the SCANNER survey contained within the pavement management system, and the forward facing video, structural patching and thin surfacing was the recommended treatment for this scheme.

4.2.8 It is apparent from this example, that the maintenance scheme on this section will treat red, amber and green subsection lengths, with red and amber lengths predominating. However, as can be seen in Figure 4.2, the section to the west of St Teath contains isolated red and amber subsections within predominantly green section lengths. Here it might not be practical to devise a planned maintenance scheme. Isolated red and amber sections that do not form part of a proposed scheme should be investigated to determine whether any local repairs are necessary to maintain minimum standards of safety, or to arrest deterioration of road condition.

4.2.9 UKPMS also provides an approach to identifying treatments from SCANNER data. More information is available on the UKPMS website. UKPMS identifies three "indicative" treatments from SCANNER data. These are:

(a) "Strengthen" based on rut depth, 3m longitudinal profile variance, whole carriageway and wheel track cracking intensity values.

(b) "Resurface" based on rut depth, 3m longitudinal profile variance, whole carriageway and wheel track cracking intensity values.

(c) "Surface treatment" based on texture depth and whole carriageway cracking values.

4.2.10 These indicative treatments are broadly consistent with the results from the SCANNER RCI, but which also includes 10m longitudinal profile variance and gives slightly different emphasis to the relative importance the various parameters.

4.2.11 Over a wider area, a number of schemes may be identified, treatments selected and costs estimated, using a pavement or asset management system. These can be assembled into a planned maintenance programme to be delivered over a number of years.

4.3 Prioritising within available resources

4.3.1 It is possible that the length of road categorised as "requiring planned maintenance soon" may exceed the annual budget available. The SCANNER RCI provides one way of prioritising maintenance schemes on a "worst first" basis. The average value of the SCANNER RCI can be calculated over the length of each of the proposed schemes. This enables the schemes to be ranked in the order of their SCANNER RCI scores. In the St Teath scheme example shown above, the average RCI score was 104 (based on the **original** SCANNER RCI)

4.3.2 However there is nothing special about an average SCANNER RCI score. The same average value could be obtained from a combination of very high scoring lengths with lower scoring lengths, or by a consistent run of medium high scoring lengths.

4.3.3 Equally, there is nothing special about adopting a "worst first" approach.

4.3.4 The engineer or asset manager should consider the SCANNER RCI value together with all the other information available about the current condition and likely future changes in condition of the carriageway, and the local authority's current and expected future service requirements for the road, before deciding on the most cost effective treatment and the optimum timing for the treatment of the road.

4.3.5 A high SCANNER RCI score does not, of itself, indicate that the road is in an unserviceable or unsafe condition. A high SCANNER RCI score only indicates that the carriageway subsection is likely to need planned maintenance soon. Regular safety inspection, in accordance with the highway authority's policies, should be the basis for ensuring that the road remains in a safe and serviceable condition.

4.3.6 At present UKPMS does not provide condition projection for the SCANNER RCI or SCANNER parameters.

4.4 Area or region condition reporting

4.4.1 SCANNER provides a numerical (RCI) score for each subsection of the road network. There are at least two ways that these scores may be combined to characterise the condition of a length of road, or a network over an area.

(a) One is simply to average the score over the length. This gives a single value, which may be useful for considering the "average condition", and ranking the relative condition of lengths, or areas. This is most useful when comparing schemes on a "worst first" basis.

(b) An alternative is to count the number of lengths in a condition worse than a pre-determined standard. This is the approach taken in England for national reporting, where the "red" length (i.e. total length of the network with >100 points) has been adopted to report the overall condition of principal roads, as BV223 / NI168) and other classified roads, as BV224a / NI169.

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6 Annex 1 – SCANNER parameters

6.1 Road Geometry

6.1.1 Road geometry is INVENTORY not CONDITION information. It does not change (much) from year to year, and does not generally indicate the need for maintenance. The absolute values of road geometry (i.e. the values measured by a total station survey) are unlikely to change from year to year, except where major work is carried out on the road leading to a change in alignment or surface profile. Therefore any slight changes in SCANNER measured road geometry from year to year are more likely to be due to variations in the driving line and the relative positions of the sub-section lengths over which the averages are reported, rather than physical changes on the road.

6.1.2 However changes from year to year may be used to detect physical changes in the network (for example, a new roundabout at a junction giving access to a new development) or inaccuracies in aligning the SCANNER survey data with the existing network. These changes would have to be isolated from changes arising from the variability in the SCANNER equipment. The extent to which small changes in values are to be expected from year to year (and hence the thresholds for detecting gross changes) have not been formally quantified, and may vary depending on road geometry. However, the SCANNER accuracy requirements for geometry would lead us to expect that measurement differences from year to year should not exceed 1.5% (absolute).

6.1.3 In general, the road geometry has either been designed (to the standards then prevailing) or improved (to the standards then prevailing) to meet the changing requirements of traffic over the past 100 years. In most cases road geometry is "more or less" acceptable for the current use of the road. Places where it is wholly unacceptable will have been identified by experience in service. Places where the requirement for the road changes significantly (e.g. due to development) will be identified and improved as part of traffic and network management. Therefore, when using SCANNER road geometry data the engineer is looking for places where the road geometry is "somewhat" unacceptable, for some reason. Or where the geometry is "unusual" and affects the quality of service (including safety). One particular example would be the use of SCANNER data to identify some of the site categories for implementing a skidding resistance policy.

6.1.4 However, road geometry is not easily altered by maintenance. Improvement requires realignment or reconstruction. If SCANNER data is analysed to show places where the road geometry does not provide an acceptable level of service, low cost traffic management (signs and / or speed restrictions) may be as cost effective on minor local roads as realignment or reconstruction.

6.1.5 The SCANNER research identified several potential uses for road geometry information. However many of these uses are associated with combining the geometry data with other datasets within a user’s PMS. One of the main barriers to using it effectively is therefore relative lack of accuracy of position location information in the other relevant data sets. This makes it difficult to match the geometry data with the information in the other data sets.

6.2 Longitudinal profile

6.2.1 There are at least two different methods of measuring the longitudinal profile, one based on using accelerometers (sometimes referred to as the GM method) and the other using a reference beam (sometimes referred to as the HRM or TRL method). The GM method requires forward motion, and testing to establish the minimum survey speed and maximum acceleration and deceleration at which it is reliable. In principle the HRM method is capable of being operated at any speed, including under stop start conditions. Therefore the SCANNER acceptance testing requires the vehicles to be tested under acceleration and deceleration conditions.

6.2.2 Comparative research has shown that both methods are capable of meeting all the requirements of the SCANNER specification (Benbow, E; Nesnas, K and Wright, MA, 2006). The GM method is better suited for conditions where the vehicle can be operated with less stopping and starting, and where the road winds or there are a lot of turns. The HRM method is better suited for conditions where there is more frequent stopping and starting and less bends or turns.

6.2.3 Engineers consulted during the SCANNER research expressed concern about measuring ride quality. As well as general ride quality, which is measured through the longitudinal profile parameters, engineers were concerned about isolated “bumps” which affect ride quality but do not show up clearly in the average LPV values. As part of the SCANNER research (Benbow, E; Nesnas, K and Wright, MA, 2006), an entirely new measure has been developed to identify isolated bumps, based on the central difference method (CDM).

6.2.4 The bump intensity is reported in UKPMS as a single value – either 0, indicating no significant bump within the sub-section length, or 1, indicating one or more significant bumps within the sub-section. The SCANNER Bump intensity is not used in either the SCANNER RCI or the UKPMS treatment rules.

6.2.5 Longitudinal profile variance is the main factor controlling ride quality and hence user perception of road condition (service level experienced by the road user). It can be an indicator of defects in the surface course, the binder course and the base (roadbase) and of the structural condition. Most roads have been constructed to have an adequate ride quality, so deterioration in ride quality can also be an indicator of pavement deterioration and distress.

6.2.6 SCANNER measures longitudinal profile variance (LPV). The short, medium and long wavelength features found to have the most effect on vehicle ride are represented by 3m, 10m and 30m LPV respectively. The ride quality of the road surface is also affected by the size (length) and speed of vehicles. In practice the shorter wavelengths tend to affect all vehicles, whereas the longer wavelengths tend to affect longer and faster moving vehicles.

6.2.7 The relevance of LPV data will be affected by traffic calming measures such as speed humps, cushions and gateway treatments.

6.2.8 High levels of 3m variance typically arise from short wavelength features such as faulting, potholes and poor reinstatements (including patches) that cross the wheel-path.

(a) Extremely high levels of 3m variance may also be linked with the presence of severe wheel-path cracking or rutting

(b) Very high levels of 3m variance over long sections of the road network may indicate the need for extensive repairs, including possibly reconstruction.

(c) Very high levels of 3m variance over short lengths may be related to traffic calming features, or to failures in local reinstatement.

6.2.9 10m variance is influenced by both short and medium length undulations. The medium length undulations possibly arising from localised subsidence of reinstatements and subsurface utilities, and bay irregularities on concrete roads.

(a) Extremely high levels of 10m variance may indicate extensive pavement distress.

(b) Very high levels of 10m variance over long sections of the road network may indicate the need for extensive repairs, including possibly reconstruction.

(c) Very high levels of 10m variance over short lengths may be related to traffic calming features, or to local reinstatement failures, and require localised reconstruction.

(d) High levels of 10m variance may be associated with road camber and profile changes at junctions.

6.2.10 30m variance is influenced by short, medium and longer length undulations. It includes the longer wavelength features that may indicate subsidence or large scale foundation distress (such as a road built on embankment over soft ground, or through an area of mining subsidence). It mainly affects vehicles travelling at high speeds (over 50mph) and particularly vehicles with a longer wheel base (such as buses, coaches and rigid bodied trucks) travelling at high speed. On most local roads the measured value of 30m variance is affected much more by road geometry than on trunk roads and motorways, and does not seem to correlate with any specific maintenance requirements. Therefore it is of little practical relevance on the majority of local classified and unclassified roads.

6.2.11 High levels of profile unevenness do not only affect ride quality. High levels of profile unevenness, particularly in the 3 m and 10 m wavelength ranges, have been shown to contribute to increased dynamic loading of the pavement, hence accelerating the structural deterioration. Extremes of profile unevenness can also lead to increased stopping distances, and can have an adverse effect on vehicle manoeuvrability.

6.2.12 Both 3m and 10m LPV in the left (nearside) wheel path contribute to the SCANNER RCI. In the original SCANNER RCI, used until 2007, they contributed independently (i.e. the scores are added together). However there is an overlap between lengths with high 3m variance and lengths with high 10m variance, partly because the shorter wavelength features that are measured by 3m variance also contribute to 10m variance, so they are not wholly independent measures. Therefore they are treated as related measures, with only the higher scoring of the two contributing to the overall score, in the “revised” SCANNER RCI, used from 2008 onwards.

6.2.13 Only the 3m LPV in the left (nearside) wheel path contributes to UKPMS indicative treatment selection rules.

6.2.14 Values of 3m and 10m LPV and the SCANNER bump intensity can be displayed on road network maps using pavement and asset management systems that include a GIS or are linked to a GIS. One approach is to divide the measurements into a number of colour coded bands, so that lengths of road with high values are readily apparent. A first approach would be to use the thresholds defined in the SCANNER RCI, for the individual parameters, and colour code the lengths green, amber and red. This could be used to show where both 3m and 10m variance are high together, and where the values in both wheel paths are high together, as the basis for identifying lengths where ride quality is poor and targeting maintenance treatments designed to improve ride quality.

6.2.15 Alternatively other thresholds could be set – either to give more condition bands, or to adjust the percentage of the network falling within a band, as a way of identifying the lengths in the worst condition.

6.3 Transverse profile and rut depth

6.3.1 In addition to the familiar measurement of rutting, SCANNER also provides a number of measures derived from the transverse profile. The transverse unevenness (ADFD) is a totally new approach to defining the transverse shape of a pavement and there is little practical experience of how well it correlates with either user perception of the surface condition of a road, the surface or structural condition or the need for maintenance. However, research has shown the new measure correlates well with measured rut depth, and that it also detects misshapen pavements where the ruts are not well defined. Therefore the measure will sometimes be “higher” than the measured rut depths, and sometimes “lower”. With experience, and once realistic thresholds have been determined for the different types and classes of local road, this will become a practical indicator of deterioration in the surface shape.

6.3.2 At present there is no specific guidance on how transverse profile unevenness may be used, but one simple approach would be to apply thresholds to the data to identify those lengths with the highest values, and compare the results with the measurements of rut depth on a map basis. (Perhaps choosing the 85% threshold to set an “amber” level and the 97.5% threshold to set a “red” level.) Lengths where the unevenness is high and the rut depth is low are likely to require inspection to determine whether maintenance is required, and if so, what treatment to apply, and when.

6.3.3 The SCANNER research developed a technique for identifying the edge of carriageway in a transverse profile that extends over the edge of the carriageway (Nesnas, K; McRobbie, SG and Wright, MA, 2004). This method enables the removal of features at the edge of carriageway from the transverse profile that may sometimes contribute to incorrectly high measurement of rut depth, particularly in the left (nearside) wheel path. Thus it is possible to calculate a rut depth from the “cleaned” transverse profile that is a more reliable and consistent measurement of the actual rut depth (i.e. the rut depth that an inspector would measure with a 2m straight edge and wedge).

6.3.4 The rut depths from the cleaned transverse profile (LLRD and LRRD) have been introduced to replace the standard SCANNER or TTS rut depths (LLRT and LRRT). In principle there should be no difference between them, except that the rut depths from the cleaned profiles should be a more accurate and reliable measurement. At present the standard method is retained so that the results from the two methods may be compared over a wider set of data across the full range of local roads. Preliminary experience indicates that the cleaned rut depth may be substituted directly for the standard rut depth values in subsequent calculations. The standard rut depth is used in the initial SCANNER RCI and will be used in the revised SCANNER RCI. The cleaned rut depth may be used in an “extended” SCANNER RCI

6.4 Edge condition

6.4.1 There is one principal cause of edge deterioration – the carriageway is too narrow for the traffic currently using the road. This may be for a number of reasons. For example:

(a) The volume of traffic may have increased since the road was built, so that a single traffic lane is unable to cope with frequent two way traffic without encroaching on the edge of pavement or overrunning the verge.

(b) Queues forming at right turning junctions, with vehicles trying to squeeze past on the left, with one wheel overrunning the verge.

(c) The size of vehicles may have increased so that wheel loading is closer to the carriageway edge – for example larger farm tractors, or LGV using a road only suitable for smaller vehicles.

6.4.2 There are two main aspects to the problem:

(a) Deterioration of the pavement edge due to excessive vehicle loading near the edge combined with inadequate foundations, inadequate lateral support or water penetration

(b) Deterioration of the verge caused by vehicle overrun, leading eventually to dangerous conditions such as potholes forming adjacent to the carriageway.

6.4.3 In urban areas there can also be problems at the joint between kerb and surface course exacerbated by local failure of the drainage system. This can be difficult to measure and identify where the edge of carriageway is hidden by parked cars, or where the problems relate to local gradients and crossfall and ineffective surface drainage with local ponding and water penetration of the base and foundations.

6.4.4 The SCANNER research has delivered several parameters for the measurement of edge deterioration, and has proposed the use of a single SCANNER edge deterioration indicator, combining the transverse variance, edge roughness and edge step, based on the same type of approach as the SCANNER RCI (Watson, P; Wright, A and McRobbie, S, 2006).

6.4.5 Hence each parameter is given a score based on its value and a weighting, and the scores are combined to deliver the overall edge indicator value. The research proposed the values in Table 6.1 for the lower and upper thresholds. Values below the threshold score 0, values above the threshold score 1.

SCANNER parameter	UKPMS code	T_{lower}	T_{upper}
Edge roughness	LEDR	0.035	0.161
Transverse variance	LTRV	7.24	71.1
Small edge step	LES1	0	5.00
Large edge step*	LES2*	0	0
*Note that for LES2, both thresholds are zero. This means that any non-zero value for the parameter LES2 is normalised to 1.			

Table 6.1 Recommended thresholds for SCANNER edge parameters

6.4.6 The value of the SCANNER edge deterioration indicator (EDI) is calculated as:

$$\text{SCANNER EDI} = W_r \times Score_{LEDR} + W_{tv} \times Score_{LTRV} + W_{E1} \times Score_{LES1} + W_{E2} \times Score_{LES2}$$

6.4.7 The weightings identified in the research are given in Table 6.2.

Parameter	UKPMS code	Symbol	Value
Edge roughness	LEDR	Wr	= 30
Transverse variance	LTRV	Wtv	= 15
Small edge step	LES1	WE1	= 25
Large edge step	LES2	WE2	= 30
SCANNER EDI maximum value		EDI	= 100

Table 6.2 Parameter weightings for SCANNER Edge Deterioration Indicator

6.4.8 The SCANNER Edge Deterioration Indicator can be calculated over greater reporting lengths by averaging the values reported for each 10m length over the required reporting length. The research found that better agreement between the EDI and the manual reference was obtained with reporting lengths of 1km, indicating that the measure was good for network level assessment of rural local roads, but less efficient at identifying particular 10m lengths containing deterioration. However, a practical and realistic network level reporting tool would be to use average values over 100m reporting lengths.

6.4.9 The research suggested that the following thresholds be applied to the SCANNER EDI to classify lengths:

Green	≤ 10 points	indicating 100m lengths likely to be in generally good condition;
Amber	≥ 10 points and ≤ 30 points	indicating 100m lengths with some defects, likely to need further investigation soon, and
Red	≥ 30 points	indicating 100m lengths with more extensive defects, likely to need planned maintenance soon.

Table 6.3 SCANNER Edge Deterioration Indicator overall scores

6.4.10 Neither the SCANNER Edge Deterioration Indicator, nor any of the individual edge condition parameters is used in the initial SCANNER RCI or in UKPMS indicative treatment selection rules.

6.4.11 The simplest approach to using the current SCANNER edge deterioration indicator for scheme development would be to display the averaged values over 100m lengths on a road network map, to identify the places where red and amber lengths cluster for more detailed investigation. This would also give the possibility of comparing the SCANNER EDI with the SCANNER RCI on a map basis, to identify places where the need for general carriageway maintenance and edge treatment coincide, and places where only edge treatment may be required.

6.4.12 The simplest approach to using the SCANNER edge condition parameters for UKPMS indicative treatment selection would be to use the SCANNER ECI over 100m lengths as a direct substitute for the UKPMS edge condition indicator based on CVI surveys and to select values of the SCANNER edge deterioration indicator over 100m reporting lengths to match the UKPMS Edge CI thresholds:

UKPMS description	UKPMS Edge Condition Indicator	UKPMS Indicative treatment
Negligible edge deterioration	= 0 points	no treatment required
Local edge deterioration	≥ 0 points and < 40 points	edge patch
Partial edge deterioration	≥ 40 points and < 70 points	edge reconstruct partial depth
General edge deterioration	≥ 70 points	edge reconstruct full depth

Table 6.4 Matching SCANNER EDI to UKPMS CVI edge deterioration

6.4.13 Alternatively it would be possible to develop a more detailed approach, using the individual SCANNER edge condition parameters, or the value of the SCANNER edge deterioration indicator over 10m reporting lengths, to build up an indicative treatment selection.

6.5 Texture depth measurements – single line

6.5.1 Texture measurement devices work by measuring the distance between the sensor and the road surface. As the sensor moves along the road, changes in this distance are recorded at short intervals (the sampling interval is typically 1mm), due to the surface texture. The measured texture profile of the surface is analysed by firstly removing (filtering) large features arising from the longitudinal profile and then generating a characteristic value from the filtered data.

6.5.2 Both the SMTD and MPD algorithms can be described in these terms. The main difference between these two methods is in the way that the height of the texture is estimated: the SMTD measurement is essentially a root mean square (RMS) measure of the texture both above and below the mean level, whereas MPD measures the height of the highest peaks above the mean level.

6.5.3 The measures are correlated, but the relationship between the two measures will depend on the shape of the surface texture and, therefore, on the type of surface. This is illustrated in Figure 6.1 (see Viner et al., 2006), which compares two hypothetical surface shapes with the same SMTD value. For one surface, the MPD value is higher than the SMTD value and for the other surface the MPD value is lower than the SMTD value.

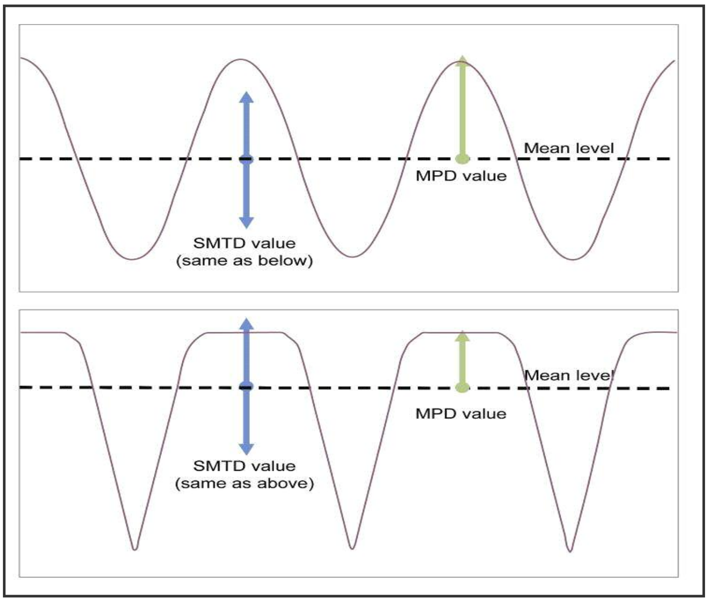

Figure 6.1 Illustration of SMTD and MPD on different surface profiles

6.5.4 In the UK the texture depth is typically obtained as the Sensor Measured Texture Depth (SMTD). The Mean Profile Depth is the standard method for specifying texture depth in Europe. It is the basis of the texture measurement that is needed to implement the European Friction Index as a harmonised scale of friction measurement and is likely to form the basis for texture measurement within European Performance Indicators for road pavements.

6.5.5 The SCANNER research investigated the relationship between SMTD and MPD measured on typical local roads in England (Viner et al, 2006). Figure 6.2 shows the results of grouping the SMTD values into bands with a width of 0.1mm SMTD and plotting the average MPD values for each band, with the error bars encompassing @95% of the values in the band. It is apparent that the relationship between SMTD and MPD is only approximately linear: at higher texture depths, increases in SMTD produce smaller increases in MPD and the overall trend flattens off. The trend can be represented by the equation:

$$MPD = 1.42 \times SMTD^{0.840}$$

6.5.6 This is also plotted as the solid line in Figure 6.2.

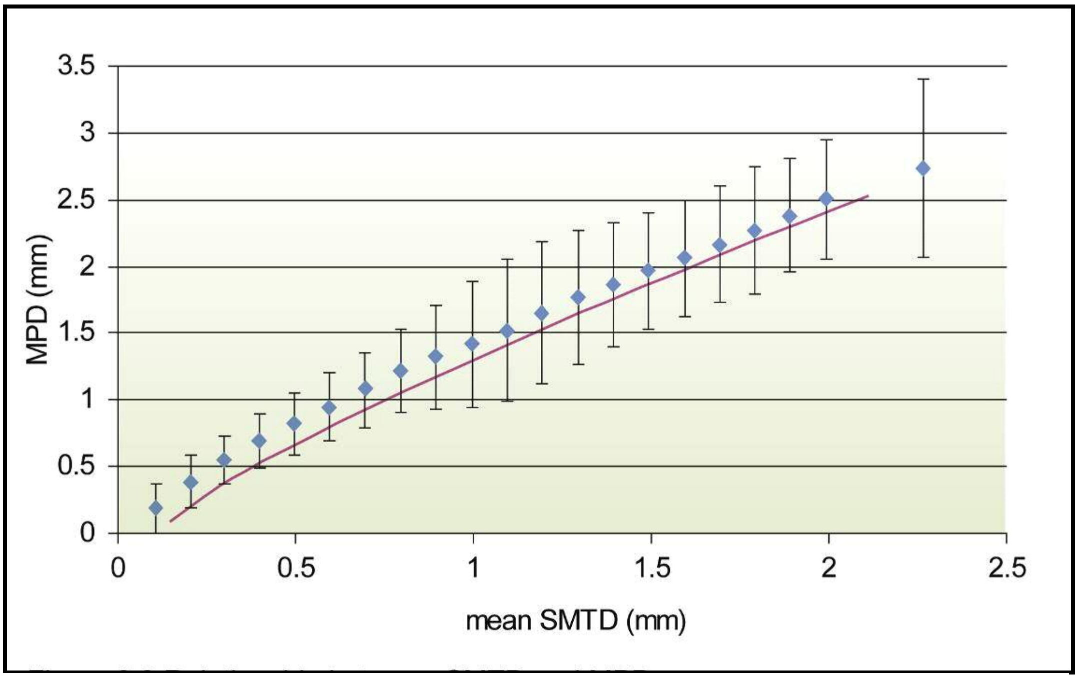

Figure 6.2 Relationship between SMTD and MPD measured on a sample of local roads

6.6 Texture depth measurements – multiple line

6.6.1 Average texture depth on its own is a poor indicator of the surface condition, or the need for maintenance treatment, of a road carriageway surface because it can be acceptable at low, medium or high values:

(a) Where high friction surfacing is used, low texture depth is good. If the average texture depth increases, this may indicate wear, which is bad.

(b) Where a modern negatively textured surface is used, medium texture depth is good. Low texture depth is bad, and may indicate excess bitumen on the surface due to poor mix design or subsequent fatting up. High texture depth is bad, indicating wear and fretting.

(c) Where HRA and surface dressings are used, high texture depth is generally good (although very high texture depth may indicate fretting or chip loss) and low texture depth is bad, indicating wear, embedment of chippings or fatting up.

6.6.2 Therefore average texture depth is an unsatisfactory parameter for measuring surface condition because, without knowing the surface type, it is impossible to determine what range of texture depths is “desirable”, what range is “acceptable” and what range is “undesirable”.

6.6.3 The SCANNER research (Viner et al, 2006) has shown that it is possible to measure the variability of texture depth along and across road surfaces, and that this can be associated with road surface wear, although it is also associated with the presence of other features such as road markings. The SCANNER survey therefore requires the measurement of texture in multiple measurement lines for use in assessing the variability. The minimum requirement is to measure texture profile on at least three lines, including the nearside and offside wheel paths, and the line midway between them. However, Contractors can provide measurements in up to 40 lines.

6.6.4 The texture data reported as RMST in each measurement line is averaged for the regions covering the wheel paths and the centreline and reported in the SCANNER HMDIF. These values can be used to assess the variability of the texture and hence identify deterioration.

6.6.5 The differences between the average values in the wheel paths and midway between them can be a useful diagnostic tool.

(a) For example, where all three average values are consistently low, this may indicative a surface designed with a low texture, such as a high friction surface (HFS)

(b) Where the average value midway between the wheel paths is consistently slightly lower than the values in the wheel paths, this may indicate a negatively textured surface, such as a porous asphalt or SMA. (Initially the values would be similar, but traffic may keep the negative texture more open in the wheel paths than between them, where dust and debris may reduce apparent texture depth measurements.)

(c) Where the average value midway between the wheel paths is consistently higher than the values in the wheel paths, this may indicate wear such as fatting up or chipping embedment in the wheel tracks.

(d) Where the average values in the two wheel paths are significantly different from each other, this may indicate wear – either fatting up and embedment, or the onset of fretting.

(e) Wherever there is variability in texture depth, this is likely to indicate wear and surface deterioration.

6.6.6 The variability of texture depth along and across the pavement can be a useful indicator of surface condition (Viner et al., 2006). Explained very simply, a newly laid surface tends to have a consistent average texture depth with low variability. Over time the variability may increase due to a number of factors. Particularly due to the effects of:

(a) traffic wearing away the surface;

(b) the environment over time, ageing, drying and stiffening the binders (leading to localised loss of chippings); and

(c) local reinstatement or maintenance treatments creating a patchwork of areas with differing average texture depth values.

6.6.7 Different approaches may be taken to analysing the SCANNER data on surface texture variability. These need to be tested against data from a representative range of local road surface types.

(a) Comparing average texture depth between left and right wheel paths (LLTM versus LRTM)

(b) Comparing average texture depth between the centre line and the wheel paths (LCTM versus LLTM and LRTM) (Or, alternatively LCTM versus average of LLTM and LRTM)

(c) Comparing the variation in texture depth (along the road) between left and right wheel paths (LLTV versus LRTV)

(d) Comparing the variation in texture depth (along the road) between the centre line and the wheel paths (LCTV versus LLTV and LRTV) (Or, alternatively LCTV versus the higher of LLTV and LRTV)

(e) The overall variation in texture depth across the road (LTVV)

(f) Extreme values of texture depth (LT05 and LT95)

6.6.8 For (a) - comparing the average texture depth between left and right wheel paths (Comparing LLTM and LRTM). A road surface in good condition would be expected to have similar values. Therefore dissimilar values are likely to indicate a road surface that is not in a good condition, unless the SCANNER wheel paths are on dissimilar materials, for example where patching or reinstatement has taken place. A similar approach would be taken when considering (b), (c) and (d).

6.6.9 A road in good condition would be expected to have a relatively low variation in texture depth unless the sub-section included lengths of dissimilar materials. Therefore a high variation in texture depth (LTVV) is likely to indicate a road surface that is not in good condition. The absolute value of variance is likely to vary with the average texture depth, being lower on a low textured surface in good condition (such as high friction surface) and somewhat higher on a coarse textured surface (such as HRA or surface dressing). As the centreline value is the value least likely to have been affected by traffic wear, and therefore closest to the value when the surface was laid, it could be used to normalise the texture variability.

6.6.10 Currently there is insufficient information to propose rules for the application of extreme values of texture depth (LL05 and LL95).

7 Annex 2 – SCANNER RCI Definitions

Thresholds and weightings for principal roads in England in 2005/06 and 2006/07 (BV223)				
Family	UKPMS Defect Code	Lower threshold	Weighting	Upper threshold
Rut depth	LLRT LRRT	10mm	Linear	20mm
Longitudinal profile 3m variance	LV3	$4mm^2$	Linear	$10mm^2$
Longitudinal profile 10m variance	LV10	$21mm^2$	Linear	$56mm^2$
Whole carriageway cracking intensity	LTRC	0.15 %	Linear	2.0 %
Wheel track cracking intensity	LWCL LWCR	0.5%	Linear	5%
Nearside wheel track texture depth	LLTX	0.6mm	Linear	0.3mm
SCORE		**0 points**		**100 points**

Table 7.1 Thresholds and weightings for principal roads in England in 2005/06 and 2006/07 (BV223)

Provisional thresholds and weightings, other classified roads in England in 2005/06 and 2006/07 (BV224a)					
Family	UKPMS Defect Code	Class	Lower threshold	Weighting	Upper threshold
Rut depth	LLRT LRRT	B & C	12mm	Linear	25mm
Longitudinal profile 3m variance	LV3	"B"	4mm^2	Linear	10mm^2
		Urban "C"	7mm^2	Linear	17mm^2
		Rural "C"	15mm^2	Linear	25mm^2
Longitudinal profile 10m variance	LV10	"B"	21mm^2	Linear	56mm^2
		Urban "C"	45mm^2	Linear	90mm^2
		Rural "C"	45mm^2	Linear	130mm^{2}2
Whole carriageway cracking intensity	LTRC	B & C	0.15%	Linear	2.0%
Wheel track cracking intensity	LWCL LWCR	B & C	0.5 %	Linear	5.0 %
Nearside wheel track texture depth	LLTX	B & C	0.6mm	Linear	0.3mm
SCORE			**0 points**		**100 points**

Table 7.2 Thresholds and weightings for other classified roads in England in 2005/06 and 2006/07 (BV224a)

Relevance and Reliability factors for SCANNER RCI 2005/06 and 2006/07					
Family	UKPMS Defect Code	Importance (relevance) factor	Reliability factor	Overall (combined) factor	Maximum points
Rut depth (greater of nearside and offside)	LLRT LRRT	0.9	1.0	0.9	90
Longitudinal profile 3m variance	LV3	0.8	1.0	0.8	80
Longitudinal profile 10m variance	LV10	0.6	1.0	0.6	60
Whole carriageway cracking	LTRC	0.9	0.55	0.5	50
Wheel track cracking intensity (greater of nearside and offside)	LWCL LWCR	0.9	0.44	0.4	40
Nearside wheel track texture depth	LLTX	0.5	1.0	0.5	50
Maximum total points					**370**

Table 7.3 Relevance and Reliability factors for SCANNER RCI 2005/06 and 2006/07

SCANNER RCI REVISED values for principal (A) roads						
Parameter	Lower threshold	Upper threshold	Importance	Reliability	Weighting	Maximum score
Average rut depth, greater of LLRT, LRRT						
LLRT LRRT	10mm	20mm	1	1	1	100
Ride quality, higher scoring of LV3 and LV10						
LV3	$4mm^2$	$10mm^2$	0.8	1	0.8	80
LV10	$21mm^2$	$56mm^2$	0.6	1	0.6	60
Whole carriageway cracking intensity, LTRC						
LTRC	0.15%	2%	1	0.6	0.6	60
Average texture depth, nearside wheel path, LLTX						
Non built-up	0.7mm	0.4mm	0.75	1	0.75	75
Built-up	0.6mm	0.3mm	0.5	1	0.5	50
Maximum point score for each (nominally 10m long) sub section						**315 or 290**

Table 7.4 Revised parameter thresholds and weightings for SCANNER RCI on principal (A) roads

SCANNER RCI REVISED values for non-principal classified (B) roads						
Parameter	Lower threshold	Upper threshold	Importance	Reliability	Weighting	Maximum score
Average rut depth, greater of LLRT, LRRT						
LLRT LRRT	10mm	20mm	1	1	1	100
Ride quality, higher scoring of LV3 and LV10						
LV3	5mm^2	13mm^2	0.8	1	0.8	80
LV10	27mm^2	71mm^2	0.6	1	0.6	60
Whole carriageway cracking intensity, LTRC						
LTRC	0.15%	2%	1	0.6	0.6	60
Average texture depth, nearside wheel path, LLTX						
Non built-up	0.6mm	0.3mm	0.75	1	0.75	75
Built-up	0.6mm	0.3mm	0.5	1	0.5	50
Maximum point score for each (nominally 10m long) sub section						**315 or 290**

Table 7.5 Revised parameter thresholds and weightings for SCANNER RCI on non-principal classified (B) roads

SCANNER RCI REVISED values for non-principal classified (C) roads						
Parameter	Lower threshold	Upper threshold	Importance	Reliability	Weighting	Maximum score
Average rut depth, greater of LLRT, LRRT						
LLRT LRRT	10mm	20mm	1	1	1	100
Ride quality, higher scoring of LV3 and LV10						
LV3	$7mm^2$	$17mm^2$	0.8	1	0.8	80
LV10	$35mm^2$	$93mm^2$	0.6	1	0.6	60
Whole carriageway cracking intensity, LTRC						
LTRC	0.15%	2%	1	0.6	0.6	60
Average texture depth, nearside wheel path, LLTX						
Non built-up	0.6mm	0.3mm	0.5	1	0.5	50
Built-up	0.6mm	0.3mm	0.3	1	0.3	30
Maximum point score for each (nominally 10m long) sub section						**290 or 270**

Table 7.6 Revised parameter thresholds and weightings for SCANNER RCI on non-principal classified (C) roads

SCANNER RCI REVISED values for unclassified (U) roads						
Parameter	Lower threshold	Upper threshold	Importance	Reliability	Weighting	Maximum score
Average rut depth, greater of LLRT, LRRT						
LLRT LRRT	10mm	20mm	1	1	1	100
Ride quality, higher scoring of LV3 and LV10						
LV3	$8mm^2$	$20mm^2$	0.8	1	0.8	80
LV10	$41mm^2$	$110mm^2$	0.6	1	0.6	60
Whole carriageway cracking intensity, LTRC						
LTRC	0.15%	2%	1	0.6	0.6	60
Average texture depth, nearside wheel path, LLTX						
Non built-up	0.6mm	0.3mm	0.5	1	0.5	50
Built-up	0.6mm	0.3mm	0.3	1	0.3	30
Maximum point score for each (nominally 10m long) sub section						**290 or 270**

Table 7.7 Revised parameter thresholds and weightings for SCANNER RCI on unclassified (U) roads