Comparing Pavement Condition – Feasibility Study

31 May 2019

Office of Rail and Road

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GLOSSARY

BCD	Base Condition Data
CQC	Customers Quality Cost
CSC	Characteristic Skid Resistance
DBFO	Design Build Finance and Operate
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
GPR	Ground Penetrating Radar
HAPMS	Highways England's Pavement Management System
HGV	Heavy goods vehicle
HMDIF	Highways Maintenance Data Interchange Format
IRI	International Roughness Index
KPI	Key Performance Indicator
KPI8	Pavement Condition metric Highways England is assessed against in RIS1
LA	Local Authority
LPV	Longitudinal Profile Variance
MPD	Mean Profile Depth
NSC	Network Structural Category
ORR	Office of Rail and Road
PMS	Pavement Management System
RCD	Raw Condition Data
RCI	Road Condition Index
RDC0120	DfT data tables for LA managed classified roads where maintenance should be considered, by LA in England
RIS	Road Investment Strategy
RWS	Rijkswaterstaat
SCANNER	Surface Condition Assessment for the National Network of Roads
SCRIM	Sideway-force Coefficient Routine Investigation Machine
SFC	SCRIM Skid Resistance data
SKM	Skid Resistance
SMTD	Sensor Measured Texture Depth
SRN	Strategic Road network
TfL	Transport for London
TRACS	TRAffic-speed Condition Survey
TRASS	TRAffic-speed Structural Survey
TSD	Traffic-Speed Deflectometer

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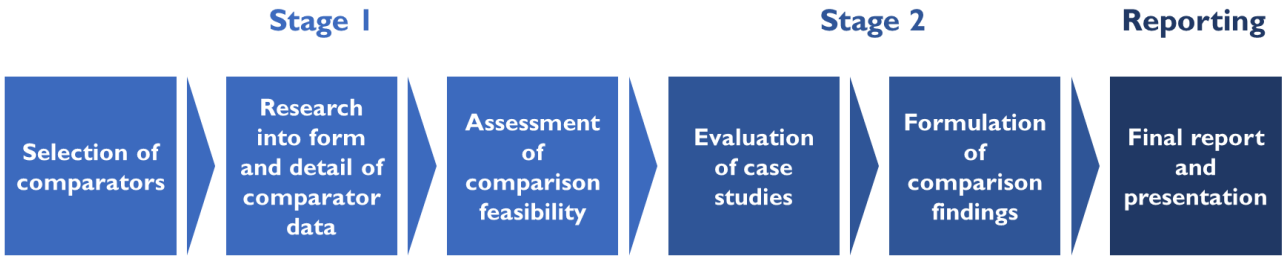
EXECUTIVE SUMMARY

The Office of Rail and Road (ORR) have commissioned CEPA and TRL to consider the composition and level of detail of pavement condition data across highway authorities that are comparable to Highways England. The objective of this project is to assess the feasibility of making direct comparisons of pavement condition data between Highways England and these candidate comparators. To meet ORR's requirements our analysis was split into two stages, as shown in Figure 1 below.

Figure.1: Overall project approach



ASSESSMENT OF COMPARATORS

Table 1 below provides a summary of our findings regarding the feasibility of making direct comparisons of pavement condition between Highways England and the comparators. It provides an indication, by metric, of which road authorities can be compared and whether that comparison requires that the metric be modified.

Table 1: Summary of findings

Authority	Metrics				Parameters
	RIS1	RIS2	Netherlands	LA	
Highways England	✓	✓	m	✓	✓
Scotland	m	m	m	✓	✓ (some)
Wales	m	m	m	✓	✓ (some)
Local Authorities	m	m	m	✓	✓ (some)
Netherlands	m	m	✓	×	✓ (some)
Sweden	×	×	×	×	✓ (some)

Key

× Calculation of metric not possible, required parameters not available

✓ Calculation of metric possible or comparison of parameters possible

m Calculation of a modified version of the metric possible.

Further explanation of these findings is provided below.

Feasibility of comparison using Highways England RIS Pavement Metric

Assessment of the feasibility of comparison between Highways England and the comparator organisations using the Highways England Road Investment Strategy (RIS) pavement metric has revealed that it is not possible to directly undertake comparisons using the RIS1 metric, or proposed RIS2 metric, without modifications to the metric calculations. Undertaking certain modifications would allow for comparisons with

Wales, Scotland and the Netherlands, albeit using modified versions of these metrics and requiring bespoke modification for each road authority.

The data collected and held by Sweden appears to be too different to make any comparison with the Highways England's RIS pavement metrics feasible. Whilst comparison with the Local Authorities (LAs) is possible, it is not recommended due to the level of work required to do so.

Feasibility of comparison using Netherlands metric

As was the case with Highways England's RIS pavement metrics, assessment of the feasibility of comparison between Highways England and the comparator organisations using the Netherlands metric has revealed that it is not possible to directly undertake any comparisons without making modifications to the metric calculations. The main difference between the Netherlands metric and the other comparators is around Fretting. Other authorities either do not collect Fretting data, or do not measure the parameter in the same way. Similarly, Cracking is not measured in the same way in the UK. Therefore, no comparison can be performed with the Dutch metric that includes either of these parameters.

The data collected and held by Sweden appears to be too different to make any sort of comparison with the Netherlands metric feasible. Comparison with the LAs is not recommended due to the level of work required to do so.

The Highways England RIS pavement metrics require different modifications for the Netherlands and Wales/Scotland/LAs. The above analysis has revealed that, unlike the RIS pavement metrics, Highways England, Scotland, Wales, LAs and the Netherlands can all be compared with one another using the same modified version of the Dutch metric, but calculated using only Rutting, Ride Quality and Skid Resistance.

Feasibility of comparison using Local Authority metric

The LA metric will allow for comparison between Highways England, Scotland, Wales and LAs, without requiring modification, pending further investigation of TRAffic-speed Condition Survey (TRACS) and Surface Condition Assessment for the National Network of Roads (SCANNER) Cracking data. This contrasts the previous metrics, which also allow for extensive comparison but require modification to the metric calculations.

For the Netherlands and Sweden, a meaningful calculation of the Road Condition Index (RCI) is not possible and consequently neither is comparison with Highways England.

We conclude that the LA metric (Amber) provides the most straightforward opportunity for comparison of pavement condition for the UK authorities. It does not appear practicable to include international comparators.

Feasibility of comparison using Highways England data

Comparison using components of Highways England data is the alternative option to using whole metrics. Assessment of the feasibility of comparisons using parameters of Highways England's data shows that all of the comparators can be compared with Highways England using some, but not all, of the data components recorded at an individual level.

Highways England, Scotland, Wales and the LAs appear to be comparable with each other for some of the parameters. Including the Netherlands and Sweden in the majority of these comparisons does not appear possible.

A parameter comparison between authorities may be used as a stand-alone measure, or alternatively, as a complementary measure to a metric comparison. The added value of the latter would depend on the parameters and authorities included in the chosen metric. Sweden and the Netherlands can only be compared with Highways England on Rutting and Roughness parameters., Texture, Skid Resistance and possibly Cracking parameters could also be compared between UK authorities.

Considerations for future work

Two potential issues emerge when discussing the actual undertaking of the comparisons discussed in this report, particularly between Highways England and Local Authorities. These would need to be considered during any future work. See Appendix C for further information.

First, Sideway-force Coefficient Routine Investigation Machine (SCRIM) type data is not collected network wide by local authorities, presenting challenges in monitoring changes in Skid Resistance over time in these cases, as a relatively small part of the network is sampled each year. This presents a risk that the sample may not be representative of the road condition of the LA networks in any given year.

Second, practice differs between LAs in terms of how the network condition of the roads not surveyed in the latest year are treated in reporting an overall measure.

SUMMARY

We used case studies to assess the feasibility of taking forward direct comparisons of pavement conditions. This revealed that:

- Regardless of whether the RIS1 or RIS2 version of the Highways England pavement metric is used, it is not possible to directly undertake any comparisons without modifications to the metric calculations.
- Scotland, Wales and the LAs are already closely aligned in terms of the form and structure of the data collected, and as a group are the most feasible comparators for Highways England.
- Among international comparators, Sweden is not a suitable candidate for comparisons, and the Netherlands is a more feasible candidate.
- The Netherlands metric provides the opportunity for the most extensive comparison. The modifications required to undertake the comparison are the same for Highways England, Scotland, Wales and the LA. This means all comparators, except Sweden, can be included in a multi-comparison.
- The LA metric (Amber) provides the best opportunity for comparison of pavement condition between the UK authorities.
- Highways England, Scotland, Wales and the LAs appear to be comparable using some data parameters instead of a metric to undertake comparisons, The Netherlands and Sweden cannot be included in the majority of these comparisons.
- There are some potential limitations with using LAs as comparators that need to be considered during any future work. These may be rectified by selecting as comparators those LAs which manually over-write their road condition databases when improvement works are undertaken.

Assessment of pavement condition between Highways England and other organisations, therefore, appears more feasible using metrics calculated by other organisations, rather than using the Highways England

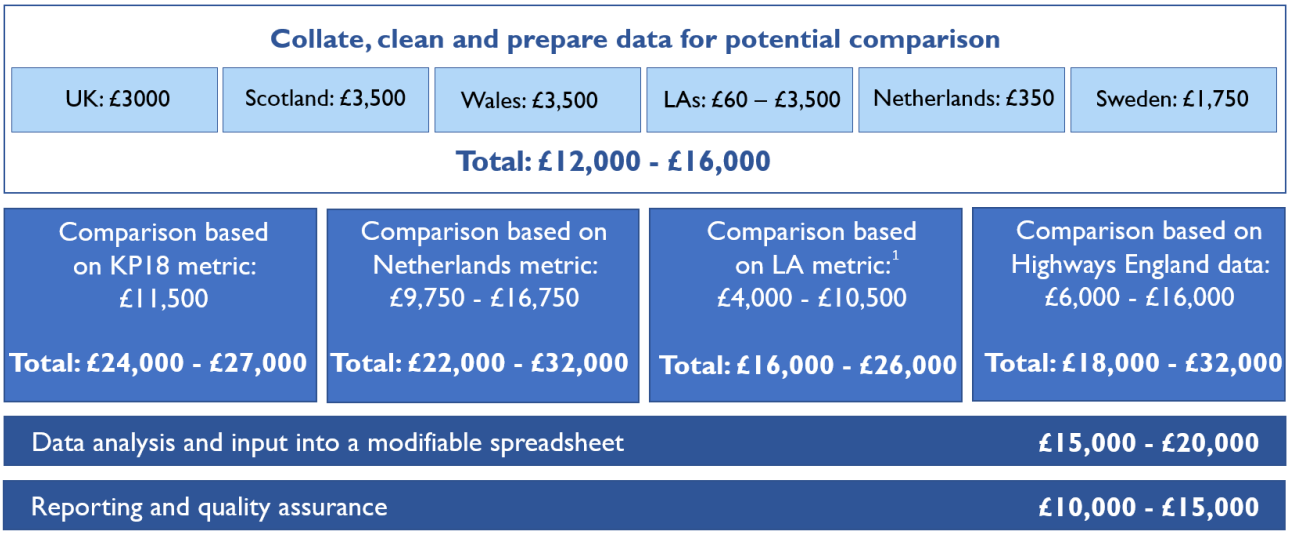
pavement metric. The Netherlands appears to allow for a more extensive comparison than the LA metrics. But the LA metrics are the most straightforward option for a comparison between UK authorities.

A parameter comparison between authorities may be used as a stand-alone measure, or alternatively, as a complementary measure to a metric comparison. The added value of the latter would depend on the parameters and authorities included in the chosen metric. Sweden and the Netherlands can only be compared with Highways England on Rutting and Roughness parameters. Texture, Skid Resistance and possibly Cracking parameters could also be compared between UK authorities.

Undertaking a comparison using the individual data parameters is a simpler process and one that allows for comparison between specific elements of pavement condition. The use of such metrics allows for a more complete picture of pavement condition to be presented in way that is easier to understand and allows for easy comparison across time.

Initial cost estimates for undertaking the comparisons are presented in Figure 2 below.

Figure 2: Indicative cost estimates for comparisons



[1] LA metric does not include costs to collate, clean and prepare data for Sweden and the Netherlands

1. INTRODUCTION

Highways England is responsible for operating, maintaining and improving the Strategic Road Network (SRN) in England. The SRN is an important national asset which generates and supports the growth of the UK.

The ORR monitors Highways England's performance delivery and management of the SRN through a performance scheme, which includes both efficiency and operational performance metrics, as well as investment monitoring.

This performance scheme forms part of the five-year Road Investment Strategy (RIS), through which ORR advises on future strategies, evaluates proposals and monitors Highways England's performance against set targets. Highways England is nearing the end of the first road period (RIS1), which concludes in 2020, and ORR is currently involved in finalising outputs and funding, as well as the performance metrics and targets, for the second period (RIS2).

One of the metrics Highways England is formally assessed against in RIS1 is KPI8, the key performance indicator (KPI) for pavement condition measured as *the percentage of the network that needs no further investigation for possible maintenance*. Highways England is proposing an amended version of this current pavement metric for RIS2, which would instead measure the *percentage of the pavement network in good condition*.

ORR has commissioned CEPA and TRL to consider the composition and level of detail of pavement condition data across highway authorities that are comparable to Highways England. The objective of this project is to assess the feasibility of making direct comparisons of pavement condition data between Highways England and these comparators.

This report builds on our previous work,[1] which considered how pavement metrics are designed and measured across several organisations including Local Authorities (LAs), Transport Scotland, the Welsh Government and internationally. The objective of that work was to assess what other road management agencies do in terms of measuring and monitoring pavement condition, and the extent to which this can be compared to the approach adopted by Highways England.

1.1. STRUCTURE OF DOCUMENT

The remainder of the report is structured as follows:

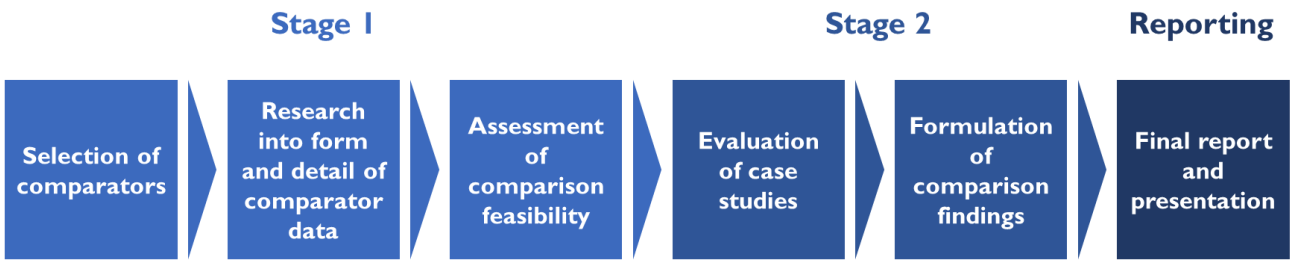
- **Section 2** gives an overview of our approach;
- **Section 3** contains a case study on Highways England's pavement condition data and measurement;
- **Section 4** provides an outline of the comparators selected;
- **Section 5** provides a comparison between Highways England and the organisations identified for analysis; and
- **Section 6** outlines our findings.

[1] Measuring Pavement Condition, ORR, 2018.

2. APPROACH

To meet ORR's requirements our analysis was split into two stages, as shown below and discussed in the subsequent sections.

Figure 2.1: Overall project approach



2.1. STAGE 1: RESEARCH

The first stage of the project involved:

- selection of comparators;
- researching the form and detail of data held by potential comparators; and
- developing a case study for each comparator.

We revisited our earlier report and selected those comparators that we found to be most comparable to Highways England for the purposes of this research. The Netherlands and LAs were found to be the most comparable and might permit some form of benchmarking, if the data underlying current measures could be obtained and analysed. The highway parameters for Scotland and Wales are similar enough to Highways England's RIS1 pavement metric that a comparison can be made, though a modification would be required for both.

Whilst Sweden was not considered within the previous study, its road condition data is published now online. Therefore, Sweden has also been considered in this research. Further detail is provided in Section 4.

We engaged with each of these comparators, as well as undertaking desk-based analysis, in order to identify and assess the type of data collected to assess pavement condition, and the level of detail available. Table 2.1 below sets out the list of case studies compiled, along with the associated provider and type of road network.

Table 2.1: Case study jurisdictions

Jurisdiction	Provider
Netherlands	Riijkswaterstaat (National Roads)
Scotland	Transport Scotland (Trunk Road Network)
Local Authorities	Various (Local Road Network)
London	Transport for London (Local and Trunk Roads)
Wales	Welsh Government (Trunk Road Network)
Sweden	Trafikverket (National Roads)

For the remainder of Stage 1, for each comparator, we:

- determined how the data could be compared between comparators, with attention paid to the pavement metric currently used by Highways England in RIS1; and

- from this, assessed whether comparisons were feasible and what factors may hinder direct comparability.

We created a standardised case study template that we used to collate our research and analysis on each comparator, as well as to facilitate comparison with our Highways England case study. By the end of Stage 1 we had developed a set of six comparator case studies which covered:

- Type, form, age and structure of data collected.
- Level of detail of data.
- Time required and cost to collate/clean/prepare data and perform comparison.
- Factors that may hinder direct comparability.
- Likelihood of comparison success.
- Steps required to compare data.
- Feasibility of using the comparator's data to obtain a metric equivalent to Highways England's pavement metrics, Netherlands metric and LA metrics.
- Feasibility of using the comparator's data to compare with Highways England data.

2.2. STAGE 2: SYNTHESIS OF RESEARCH

In Stage 2, the case studies were compared in order to draw out the comparisons that we consider feasible. Once the case studies had been evaluated, an analysis of the data amendments and additions that are required in order to facilitate comparison between Highways England and the comparators was undertaken.

3. HIGHWAYS ENGLAND CASE STUDY

This section provides information on the form and detail of Highways England's pavement condition data, as well as outlining the KPI used to measure pavement condition in RIS1 (KPI8) and the proposed metric for RIS2.

3.1. PAVEMENT CONDITION ASSESSMENT

The general approach to pavement condition assessment comprises consideration of:

- structural condition;
- surface unevenness; and
- surface Skid Resistance.

To measure these, Highways England uses the TRAffic-speed Condition Surveys (TRACS) for surface condition, Sideway-force Coefficient Routine Investigation Machine (SCRIM) to measure Skid Resistance and Traffic Speed Deflectometer (TSD) for TRAffic-speed Surveys of Structural condition (TRASS).[2]

These surveys collect the following data:

- TRACS (Traffic Speed Condition Survey) data: Rutting, Ride Quality (3m, 10m and 30m eLPV, and Bump Measure), Texture (SMTD), Cracking, Fretting, Images, Retroreflectivity (road markings), Ground Penetrating Radar (GPR);
- SCRIM data (Skid Resistance): SFC; and
- TRASS (TSD): Deflection data.

A lot of this data is used for directly assessing maintenance interventions, or for using in the calculation of the RIS1 pavement metric. However, some have only been introduced quite recently (e.g. Fretting, GPR) and have not yet been established as robust, whilst parameters such as Texture are only used as proxies for others (Skid Resistance) and therefore, only the more important measure is included in the metric.

3.2. RIS1 PAVEMENT METRIC (KPI8)

Highways England uses the condition data that these surveys collect as the basis for its RIS1 KPI. Its Operational Metrics Manual[3] describes the KPI for pavement condition as *the percentage of the network that needs no further investigation for possible maintenance*. The KPI is based on the condition of each 10m length of Lane 1 of main carriageway (i.e. not lay-bys, slip roads, link roads or roundabouts) on the network and excludes the part of the network managed as a part of Design, Build, Finance and Operate (DBFO) concessions, as Highways England has no direct control of maintenance works undertaken on these roads.

The condition of the pavement for the RIS1 KPI is measured as part of annual TRACS and Skid Resistance surveys of Lane 1 of main carriageways (non-DBFO parts only). The data from these two surveys, which

[2] Data from TRASS, using a relatively new machine, is not currently included in network condition reporting in England, because the measurements and analysis results are not yet considered sufficiently reliable.

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/678303/OMM_Minor_-_PDF_Final_January_2018_.pdf

describe Rutting, (3m, 10m and 30m wavelength) longitudinal profile and Skid Resistance, are used to assess the condition of each 10m length of the network.

Four categories are used to define the pavement condition measured by TRACS:

- Category 1: No visible deterioration;
- Category 2: Low level deterioration and no action required;
- Category 3: Moderate level of deterioration and investigation is required; and
- Category 4: Severe level of deterioration and investigation is required at the earliest opportunity.

Highways England uses Category 3a for the RIS1 Pavement Condition Metric, mid-way between the thresholds for Categories 3 and 4. For Skid Resistance the Investigatory Level is equivalent to Category 3 (i.e. the condition is to be investigated). The target for the RIS1 KPI is to maintain at least 95% of the network (Lane 1) at a level where further investigation is not required for each year of RIS1, defined as Category 3a or better.[4] Table 3.1 below provides a summary of Highways England's approach to pavement condition measurement in RIS1.

Table 3.1: Summary of Highways England's approach to pavement condition measurement in RIS1

Area of interest	Description
Summary of techniques used by Highways England	TRACS – used to measure different elements of pavement surface condition. SCRIM – measures Skid Resistance. TSD – measures the (structural) strength (expressed as the Network Structural Category) of the road pavement. GPR – data used in combination with TSD measurement in the identification of the Network Structural Category (NSC). Deflectograph – measures the pavement deflection (to show the pavement strength); used for targeted investigations only when the other surveys indicate that further investigation is needed.
RIS1 Metric construction	Data on the surface condition (Rutting and evenness) and Skid Resistance of the pavement on the network is used. Not all of the network can be surveyed in a year for a range of reasons, so the length examined is less than the total length of Lane 1 on the SRN, but the annual data coverage is high at >96%. The condition of each 10m length of Lane 1 of the main carriageways is identified using a variety of defects (Rutting, 3m, 10m and 30m longitudinal profile, and Skid Resistance). All defects in each 10m length must be in better condition than Category 3a for the 10m length to be considered as good condition for the KPI analysis. The total length without condition data is assumed to be the same condition (i.e. the percentage length in good condition) as the part of the network with condition data. The targeted condition is for 95% or more of Lane 1 to not require further investigation (i.e. condition better than Category 3a) for the KPI. Anything worse than the thresholds for Category 3a is deemed to require further investigation (i.e. in poor condition for the KPI). Records of completed maintenance are entered into HAPMS. Any 10m length that has been maintained since the condition survey is assumed to be in better condition than Category 3a. The overall % of the network not requiring further investigation is calculated as (Total length of network data not requiring further investigation / Total lane 1 length of the network) *100

Source: CEPA

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/678303/OMM_Minor_-_PDF_Final_January_2018_.pdf

3.3. Proposed RIS2 Pavement Metric

Highways England is proposing an amended version of the RIS1 pavement metric for RIS2. Through this updated Pavement Condition metric, it aims to move from recording the *percentage of the pavement network that does not require further investigation*, to the *percentage that is in good condition*. The RIS2 pavement metric will be based on Rutting, evenness and Skid Resistance data, collected from the same survey types as in RIS1; however, it will use data from all lanes of the main carriageway and will assess performance using 100m lengths. All lengths of pavement that were renewed since the previous survey will be automatically marked as being in 'good' condition.

Part of the proposed update to the pavement metric for RIS2 is the introduction of the Crash model into an altered metric process. Whereas SCRIM identifies areas of the network with Skid Resistance below the Investigatory Level, the Crash Model will now be used to perform additional, more detailed, assessments on these areas. The model results will suggest, of the areas where the Skid Resistance threshold has been breached, the areas where maintenance is likely to be needed due to a higher than normal number of accidents occurring for the type of road. These areas are then followed up with site investigations which, if a need for maintenance is confirmed, will be labelled as not in 'good' condition.

Those areas where the Skid Resistance threshold is breached, but the Crash Model shows no issue, or the inspection in-fact reveals no need for maintenance, will be labelled as being in 'good' condition, unless the Rutting or evenness thresholds are also breached.

It should be noted that Highways England does not yet fully understand the impact that the inclusion of the Crash model will have on the performance of the metric.

3.4. RIS1 KPI vs. RIS2 Proposal

Table 3.2 provides an outline of the differences between the current RIS1 Pavement Condition Metric and the updated version proposed by Highways England for RIS2. These differences mean the approach taken to assessing the feasibility of making comparisons of pavement condition data between Highways England and comparators will differ depending on whether the RIS1 pavement metric is retained for RIS2, or if the proposed updated metric is introduced.

Table 3.2: Summary of differences between RIS1 KPI8 and the proposed pavement metric for RIS2

Component	RIS1	RIS2
Title	% of pavement asset that does not require further investigation for possible maintenance	% of pavement network in good condition
Coverage	Lane 1 main carriageway	All permanent main carriageway lanes[5]
Assessment length	10m	100m
Reporting frequency	Annual	Annual
Measures of condition	Rutting Longitudinal profile (3m, 10m, 30m) Skidding resistance	Rutting Longitudinal profile (3m, 10m, 30m) Skidding resistance
Condition thresholds	Category 3a	Category 3

[5] Whilst data from all lanes will now be used, Skid Resistance data from SCRIM is predominantly recorded in Lane 1. TRACS covers all lanes.

Calculation	Length of network in good condition scaled up for missing condition data for each defect	Only available data is used – no scaling up to account for missing condition data
Maximum metric data age	2 years	2 years

Source: Operational Metrics Manual, Highways England (2019) and Draft Strategic Business Plan – Section D: Performance, Highways England (2019).

Table 3.3 below provides further detail on the threshold changing from Category 3a to 3.

Table 3.3: Condition Parameter Thresholds

Condition Parameter	Category 3a Threshold	Category 2 to 3 Threshold
Rut Depth (mm)	15.5	11
Characteristic Skid Resistance (CSC)[6]	0.05 Investigatory Level	0.05 Investigatory Level
Ride Quality 3m Longitudinal Profile Variance (mm^2)		
Motorways	3.3	2.2
Rural Dual Carriageways	3.3	2.2
Urban Dual Carriageways	3.85	2.2
Rural Single Carriageways	3.85	2.2
Urban Single Carriageways	6.55	3.8
Ride Quality 10m Longitudinal Profile Variance (mm^2)		
Motorways	10.6	6.5
Rural Dual Carriageways	10.6	6.5
Urban Dual Carriageways	15.7	8.6
Rural Single Carriageways	15.7	8.6
Urban Single Carriageways	27.45	18.3
Ride Quality 30m Longitudinal Profile Variance (mm^2)		
Motorways	88	66
Rural Dual Carriageways	88	66
Urban Dual Carriageways	98	75
Rural Single Carriageways	98	75
Urban Single Carriageways	145	97

Source: Operational Metrics Manual, Highways England, 2019 and Design Manual for Roads and Bridges, Volume 7, Section 3, Part 2, HD 29/08

The change of condition threshold from Category 3a to Category 3 means that Highways England will be subject to more stringent condition thresholds (Category 2 to 3 thresholds). This will potentially have a negative impact on reported performance, as condition will now need to be higher across the network in order to not breach the new thresholds.

[6] Investigatory Level is based on road type and geometry and is defined in Table 4.1 of DMRB HD28.

Despite this having a potentially negative impact on reported performance, other changes to the proposed pavement metric for RIS2 have the potential to increase reported performance, particularly relating to the coverage of the metric.

Most road authorities survey the nearside lane only, as this is the lane that typically takes most of the heavy goods vehicle (HGV) traffic, which are the vehicles that do the most damage to the road. By doing this, these road authorities are assuming that the nearside lane is either representative of all other lanes, or that the other lanes are in better condition. Whilst this is not always the case (e.g. if the nearside lane has been recently reconstructed), in general, calculating a metric based on only nearside lane data is likely to give a more pessimistic view of the condition of the road network – the worst-case scenario.

By using data from all lanes, the proposed metric for RIS2 may result in Highways England's network appearing to be in much better condition comparatively than it is in reality, when comparing with other authorities where only nearside lane data is available. The overall impact on reported performance as a result of the proposed changes to the RIS1 pavement metric for RIS2 may therefore, not be negative overall.

3.5. DATA FORM AND DETAIL

As mentioned above, Highways England commissions TRACS, TSD and SCRIM surveys. The survey contractors process raw condition data (RCD files) using MSP software and upload base condition data (BCD) to HAPMS database. Data, reported at 100m intervals, is available to all pavement engineers via the HAPMS database. Data reported at 10m intervals is also available in HAPMS, but special permission is needed to access this.

Raw data for TRACS (longitudinal profile, transverse profile etc.) is also provided to Highways England's Pavement Team and TRL (as the survey auditor). The raw data is stored in text files (RCD files), the format of which is defined by Highways England.

4. SELECTION OF COMPARATORS

4.1. PREVIOUS FINDINGS

ORR previously commissioned CEPA and TRL to consider how pavement condition metrics are designed and measured across road networks managed by several organisations that are in some way comparable to Highways England. Those jurisdictions studied included two LAs, London (TfL), Australia, Austria, Denmark, Netherlands, Scotland and Wales.

Our research indicated that of the organisations studied, the LAs, TfL and the Netherlands were the most comparable to Highways England and might permit some form of benchmarking if the data underlying current measures could be obtained and analysed.

We found that although the LAs and TfL measure similar pavement condition characteristics to Highways England, the metric used to summarise condition for LAs and TfL (the Road Condition Index) is not directly comparable to Highways England's RIS1 pavement metric. Nevertheless, some of the underlying pavement condition data collected by the LAs and reported to the Department for Transport (DfT) could be compared to Highways England.

Our findings also indicated that the Dutch pavement condition metric is quite similar to Highways England's RIS1 pavement metric, but a direct comparison cannot be made on a like-for-like basis because the Dutch metric includes different components, sets different intervention levels for maintenance, and measures Skid Resistance differently. For the two metrics to be comparable, the measured values for each aspect of condition on one network would need to be converted to the scale of values used for the other network and the same indicator then calculated for both networks, or the two indicators would need to be related on a common scale.

4.1.1. Metrics

As well as Highways England's pavement metric, the metrics briefly described below were also identified in the previous work.

Netherlands Metric

The metric for pavement condition, used for national roads in the Netherlands (including motorways and connecting roads), is measured as the percentage of the network that needs no further investigation for possible maintenance. The calculation is based on data reported over 100m lengths and the parameters used to calculate it are:

- Rutting;
- Ride Quality (IRI);
- Skid Resistance (SKM);
- Cracking (longitudinal and transversal); and
- Ravelling (Fretting).

Table 4.1 provides summarised thresholds that are applied by Rijkswaterstaat (RWS), the Dutch roads and waterways administration, to measurements from the Dutch road network.

Table 4.1: Netherlands Metric thresholds

Defect	Intervention limit per 100 m	Remarks
Rut Depth	17 mm	Only measured on nearside lane
IRI	3.5 m/km	Only measured on nearside lane
Skid Resistance	0.51 for porous asphalt 0.53 for dense asphalt	Only measured on nearside lane Skid Resistance is expressed by subtracting the intervention limit of the weighted average value of the last two years. For example: *The weighted average is: 0.60* *The intervention limit is: 0.51* *The value in the excel file is then: 0.09*
Longitudinal Cracking	60 m moderate Cracking	Measured on all lanes Moderate = cracks with a width of 3 – 20 mm Longitudinal Cracking also includes alligator Cracking
Transversal Cracking	7 moderate transversal cracks	Measured on all lanes Moderate = cracks with a width of 3 – 20 mm
Ravelling	50 m wheel track with moderate Ravelling	Measured on all lanes Moderate = 10 – 20 % of the stones are missing per square meter

Local Authority Metric

The metric for pavement condition used for local A roads in the UK, Single Data List item 130-01 (former National Indicator 168), is the percentage of principal classified roads where maintenance should be considered. This is also known as the "Red Length", where the SCANNER RCI is ≥100. The calculation is based on data reported over 10m lengths and the parameters used to calculate it are:

- Rutting;
- Ride Quality (3m and 10m LPV);
- Cracking; and
- Texture (SMTD).

Some English local authorities are members of the CQC Efficiency Network, a benchmarking club of 92 local highways authorities in England. In addition to calculating the percentage of "Red" lengths on their network, these authorities also calculate the percentage of "Amber" lengths on their network (the lengths that might need to be considered for maintenance in the next few years). This metric is calculated with the same parameters as for the "Red" lengths but is where the SCANNER RCI is ≥40 but <100.

4.2. Comparator Selection

As noted above, the organisations previously studied included LAs, Netherlands, Scotland, Wales, London (TfL), Australia, Austria and Denmark. The former four comparators were selected to be taken forward for this feasibility study. All of these organisations are responsible for a road network that is at least somewhat comparable to the SRN, considering traffic volumes, network length, surface material and climate. This creates the potential for a useful benchmarking exercise. Additionally, comparisons with Highways England pavement metrics and some parameters is possible, albeit a modified version for the former.

Whilst Sweden was not considered within the previous study, the Swedish road authority, Trafikverket, now publishes its road condition data online. The road network in Sweden has limited comparability to the SRN, but some comparisons are possible with Highways England parameters. Thus, in order to include an additional international comparator, data from Sweden has also been considered in this research.

A summary of whether it would be possible to perform a comparison between the data from these authorities and Highways England is presented in Table 4.2, indicating the reasons for selection. Appendix A provides further detail.

Table 4.2: Summary of possibility of comparison

Country/Road Authority	Is the road network comparable?	Are Highways England's metric parameters comparable?			Can parameters be compared?	Could a comparison with Highways England's pavement metrics be made?	Metric published?	Can metric be calculated from Highways England data?	Should this authority be considered for comparison?
		Rutting	Roughness	Skid Resistance					
Australia	No	Y	~	Y	Y	Yes* but comparison may be meaningless, due to lack of similarity between networks.	-	N/A	No
Austria	No	Y	~	N	Some	No	-	N/A	No
Denmark	No	Y	~	N	Some	No	-	N/A	No
Netherlands	Somewhat - similar network, traffic and climate, different surface material.	Y	~	~~	Y	Yes*	Yes	Yes*	Yes
Scotland	Somewhat - similar climate and surface material, less traffic, shorter network.	Y	Y	Y	Y	Yes*	No	No	Yes
Sweden	Limited - similar surface material, different climate, short network, less traffic.	Y	~	N	Some	No	-	N/A	Yes
UK Local authorities	Variable between LAs. A-roads only (partial). Shorter network carrying less traffic, including HGVs.	Y	Y	Y†	Y	Yes*	Yes	Yes	Yes
UK Transport for London	No	Y	Y	Y	Y	Yes* but comparison may be meaningless,	-	N/A	No

Country/Road Authority	Is the road network comparable?	Are Highways England's metric parameters comparable?			Can parameters be compared?	Could a comparison with Highways England's pavement metrics be made?	Metric published?	Can metric be calculated from Highways England data?	Should this authority be considered for comparison?
		Rutting	Roughness	Skid Resistance					
						due to lack of similarity between networks.			
Wales	Somewhat - similar climate and surface material. Less traffic, short network.	Y	Y	Y	Y	Yes*	-	N/A	Yes

~ = somewhat – these countries calculate IRI, which can be calculated from raw Highways England data, or estimated from 3m and 10m eLPV but is not directly comparable to eLPV

~~ = somewhat – the same measurement principle is used but a different tyre and post-processing is applied, so values are subtly different.

* a modified version of the metric could be calculated.

† Some Skid Resistance measurements are made but only on selected lengths of the network.

5. ASSESSMENT OF COMPARATORS

This section provides an assessment of the feasibility of making direct comparisons of pavement condition data between Highways England and the comparator organisations, as well as cost estimates for undertaking the comparisons. See Appendix B for the full case studies.

5.1. DATA

Table 5.1 below gives a summary of the type of data collected/held by each organisation, as well at its form/ structure, providing an introductory overview for the assessments undertaken in the subsequent sections.

Table 5.1: Overview of data held by each organisation

Comparator	Type of data collected/held	Form, structure and level of detail
Highways England	• TRACS (Traffic Speed Condition Survey) data: Rutting, Ride Quality (3m, 10m and 30m eLPV, and Bump Measure), Texture (SMTD), Cracking, Fretting, Images • SCRIM data (Skid Resistance): SFC • TRASS (TSD): Deflection data	Survey contractors process raw condition data (RCD files) using MSP software and upload base condition (BCD) to HAPMS database. Data is reported at 100m intervals. Data reported at 10m intervals is also available in HAPMS. Raw data for TRACS is stored in text files (RCD files), the format of which is defined by Highways England.
Scotland	• SCANNER data (i.e. Rutting, Ride Quality (LPV), Texture, Cracking, Edge Deterioration, Texture Variability) • SCRIM data (Skid Resistance): SFC • Deflection data (Deflectograph)	Survey contractors deliver processed data over 10m reporting lengths and this is stored in the Scottish pavement management system (PMS). Raw data is not stored but may be requested from the contractor, in special circumstances.
Wales		As with Scotland, the survey contractors deliver processed data over 10m reporting lengths and this is stored in the Welsh pavement management system (PMS). Raw data is not stored but may be requested from the contractor, in special circumstances.
Local Authorities		Survey contractors either deliver HMDIF files, which contain processed data and can be loaded into the pavement management system (UKPMS) by the authority, or the contractors load processed data straight into the pavement management database. The data is provided over 10m reporting lengths. The authorities may be able

Comparator	Type of data collected/held	Form, structure and level of detail
		to request raw data from the contractors.
Netherlands	• Surface condition data (Rutting, Ride Quality (IRI), Cracking (longitudinal and transversal), Ravelling) • Skid Resistance data • Calculated residual life span for each of the defects.	Processed (parameter) data for 100m section lengths is stored in the Rijkswaterstaat (RWS) database, along with the residual life span for the 5 years ahead. Raw data is stored separately but is not readily accessible for most people.
Sweden	• Surface condition data (IRI, Edge Deterioration, Texture (MPD), Rutting) • 5 years forecast data (IRI, Rutting, Edge Deterioration).	Processed data for 20m lengths of all the roads managed by Trafikverket are stored in the PMSv3 pavement management system, which is free and open to public, research asset management and commercial use. Forecasted individual parameter data for the each of the next 5 years are calculated and provided for 100m lengths. Raw data is stored separately - not readily accessible to all.

Source: CEPA analysis

In terms of the comparators' willingness to engage, all either publish the data publicly (LAs and Sweden), therefore removing the need for engagement, or were willing to cooperate in a comparison study and were eager to see the results (Scotland, Wales and Netherlands). This provides confidence that data access issues should not present a large issue if undertaking the below comparisons was required in the future.

5.2. Feasibility of comparison using Highways England's RIS Pavement Metrics

Assessment of the feasibility of comparison between Highways England and the comparator organisations has revealed that it is not possible to directly undertake any comparisons using the RIS1 pavement metric, or proposed for RIS2, without modifications to the metric calculations. The steps required to undertake the comparisons using the RIS1 metric, or proposal for RIS2, can be found in the case studies in Appendix B.

Undertaking certain modifications would allow for comparisons with Wales, Scotland and the Netherlands, albeit using different modified version of the RIS1 and RIS2 metrics and therefore, not allowing comparison across the three comparators and Highways England (see Appendix B for the steps required to undertake the comparisons).

The data collected and held by Sweden appears to be too different to make any sort of comparison with Highways England's pavement metric feasible. Comparison with LAs, whilst in theory possible, is not recommended due to the high amount of work required to do so.

The methods used by Wales, Scotland and LAs to measure and calculate Rutting are very similar to that used by Highways England, and the methods used for Skid Resistance are identical. For all three comparators however, the SCANNER surveys only collect 3m and 10m Longitudinal Profile Variance (LPV), whilst the RIS pavement metric also requires 30m. Calculation of a modified metric, excluding 30m LPV, would therefore

be required in order to undertake a comparison of pavement condition between Scotland, Wales, LAs and Highways England using the RIS1 pavement metric, or RIS2 proposal.

To provide robust data from such a comparison however, several LAs should be considered, requiring permission to be sought to use their data. To obtain a sufficient amount of SCRIM data for the LAs would require a large amount of effort as this is not collected network-wide by LAs – a relatively small part of the network is sampled per year. This presents a risk that the sample may not be representative of the road condition of the LA networks in any given year. This additional data collection may outweigh the benefit of performing a comparison given the lack of similarity between the SRN and the much of the local road network. It is therefore recommended that LAs are not included in the comparison using Highways England's pavement metrics.

As is the case with Wales and Scotland, comparison of a modified version of Highways England's RIS1 or RIS2 pavement metric should be possible for the Netherlands. The Dutch data is reported over 100m lengths whilst the RIS pavement metric is calculated for every 10m length of the network, but the Rutting, Roughness and Skid resistance data collected is somewhat similar to that collected by Highways England, although all require alterations, set out in Appendix B, to enable comparison.

In Sweden, data is reported for every 20m length, whereas Highways England's pavement metrics require reporting lengths of 10m lengths, and Skid Resistance data is not collected. Comparison is possible, but only through the use of two individual parameters, (Rutting and Roughness) which would be used to calculate a modified version of the pavement metrics. As is the case with the LAs, a significant amount of effort would be required to complete a comparison between Sweden and Highways England using the RIS1, or proposed RIS2, pavement metric, and may not provide additional benefit relative to comparing individual data parameters directly. Comparison is therefore not recommended.

5.3. FEASIBILITY OF COMPARISON USING NETHERLANDS METRIC

As was the case with the Highways England metrics, assessment of the feasibility of comparison between Highways England and the comparator organisations using the Netherlands metric has revealed that it is not possible to directly undertake any comparisons without making modifications to the metric calculations.

The main difference between the Netherlands Metric and the other comparators is around Fretting, with other authorities either not collecting Fretting data, or not measuring the parameter in the same way. Similarly, Cracking is not measured in the same way in the UK. Therefore, no comparison can be performed with the Dutch metric including either of these parameters. See Appendix B for the steps required to undertake the comparisons.

The data collected and held by Sweden appears to be too different to make any sort of comparison with the Netherlands metric feasible, and comparison with the LAs is not recommended due to the high amount of work required to do so.

As described previously, the Highways England metrics required different modifications for the Netherlands and Wales/Scotland/LAs. The above analysis has revealed that, unlike the RIS1 and proposed RIS2 metrics, Highways England, Scotland, Wales, LAs and the Netherlands can all be compared with one another using the same modified version of the Dutch metric, calculated using only Rutting, Ride Quality and Skid Resistance.

For Highways England, a comparison using the Dutch metric, calculated using only Rutting, Ride Quality and Skid Resistance should be possible. RWS in the Netherlands has provided data from all the highways it manages, which should enable an equivalent metric to be calculated for the Dutch road network and a comparison between Highways England and the Netherlands. The Rutting data collected by Highways England

is very similar to that collected by the Netherlands. The Roughness and Skid Resistance data collected by Highways England is different, but an adjustment for both can calculated.

The Dutch Cracking and Ravelling (Fretting) measurements and parameters are very different from those reported by Highways England. It is, therefore, not appropriate to try to include these parameters in the metric without a further understanding of any relationship that exists between them. Any comparison to determine if a relationship existed between these parameters would require either the current TRACS device to collect survey data on the Dutch road network, or for the Dutch device to survey some of the SRN. It likely that the cost and effort involved for this would outweigh the benefit of this analysis.

The Rutting data collected in Wales and Scotland, and by LAs, is very similar to that collected by the Netherlands. The Roughness and Skid Resistance data collected is different, but an adjustment can be calculated for both. The Dutch Cracking measurements and parameters are very different from that reported by Wales, Scotland and LAs, and Fretting is not a parameter that any of these comparators collect at a network level.

For Scotland, Wales and LAs, a comparison of a modified metric, calculated using only Rutting, Ride Quality and Skid Resistance, should be possible. However, as was the case with the Highways England pavement metrics, to provide robust data from such a comparison, several LAs should be considered, requiring permission to be sought to use their data. To obtain a sufficient amount of SCRIM data for the LAs would require a large amount of effort as this is not collected network wide by LAs – a relatively small part of the network is sampled per year. This presents a risk that the sample may not be representative of the road condition of the LA networks in any given year. This may outweigh the benefit of performing a comparison given the lack of similarity between the SRN and the local road network. It is therefore recommended that LAs are not included in the comparison using the Netherlands metric.

In Sweden, data is processed and reported over 20m lengths, while the Dutch data is over 100m lengths, and the Skid Resistance, Cracking and Ravelling data used to calculate the Dutch metric is not collected. As was the case with the Highways England pavement metrics, comparison is possible but only through calculation of a modified Netherlands metric using two individual parameters (Rutting and Roughness). A significant amount of effort would be required to make this comparison and may not provide additional benefit relative to comparing individual data parameters directly. Comparison is therefore not recommended.

5.4. Feasibility of comparison using Local Authority metric

The LA metric (RCI) will allow for comparison between Highways England, Scotland, Wales and LAs, without requiring modification, pending an investigation of TRACS and SCANNER Cracking data. This contrasts the previous metrics which also allowed for extensive comparison but required modifications to the metric calculations.

For the Netherlands and Sweden however, a meaningful calculation of the RCI is not possible and therefore, neither is comparison with Highways England.

The LA metric provides the most straightforward opportunity for comparison of pavement condition for the UK authorities. However, it does not appear suitable for inclusion of international comparators.

Highways England's pavement condition data is available in HAPMS at either 10m or 100m reporting lengths, meaning the 10m reporting lengths needed to calculate Red and Amber length are available. The measurement and calculation of Rutting used by Highways England is very similar to that carried out by LAs, and the measurement and calculation of Texture is the same. The measurement of Roughness, however, is different, as is the equipment used to measure Cracking, meaning the parameter delivered may be fundamentally

different. A brief investigation will be needed, using TRACS and SCANNER Accreditation data, to determine comparability.

A comparison between LA road networks and the SRN using the Red Length metric should be possible if the Cracking data is comparable, as the Red Length metric for each English LA is published annually by the DfT. If Cracking data is not comparable, the RCI could be calculated excluding Cracking, which would require individual LAs being approached in order to use their data to calculate this modified metric. Skid Resistance, an important measure for the SRN due to the speed of traffic, is not included in the Red Length metric.

Both Transport Scotland and Wales commission surveys that are very similar to the SCANNER surveys used on local roads. Therefore, all parameters used to calculate the RCI are available in Scotland and Wales and are the same as those for the LAs. Calculation of the RCI and a comparison, using both the Red and Amber Length metrics, should be possible for both Scotland and Wales, with the focus on Amber (see box below).

Focus on Amber road condition

One finding from the CQC Efficiency Network has been that reliance on DfT road condition data for LA managed roads (RDC0120) is not ideal for benchmarking. This is for two reasons:

1. **The date of publication of the RDC0120 single data list metrics is substantially after the financial year end for any given year. For example, the road condition measure for 2017/18 is only available in January 2019. This presents challenges for incorporating most recent data in benchmarking**
2. **More fundamentally, the reliance on the Red measure appears to be incompatible with a more proactive asset management strategy.**
   In general, a cost minimising proactive asset management strategy will intervene on roads before they deteriorate to the Red level, as interventions to this condition of roads is very expensive. As such it makes more sense to focus on the green/(amber + red) trade-off as opposed to the red/(green + amber) trade-off.
   The focus should therefore be on green/not green (Amber) rather than the significantly deteriorated parts of the network, but ideally all three measures would be available for analysis.

To address these two issues, the CQC Efficiency Network requests data directly from participating LAs. The majority of authorities can supply the Amber road condition for A roads. More challenging is Amber road condition for the unclassified network due to the use of a variety of surveying methods, but that is not relevant for comparison with Highways England. Permission for the release of this data could be sought from CQC Efficiency Network members for the next stages of this work.

The Netherlands pavement condition data is available at 100m reporting lengths but 10m lengths are needed to calculate Red and Amber Length of RCI. The measure of Roughness in the Netherlands cannot be split out into similar measures to 3m and 10m LPV and therefore, the Roughness calculation within the RCI would not be possible. Similarly, the measurement of Cracking is fundamentally different to the LAs, and Texture is not routinely delivered. Therefore, given the reporting length and lack of comparable parameters, a meaningful calculation of the RCI and therefore either the Red or Amber Length, is not possible for the Netherlands.

Swedish pavement condition data is available at 20m reporting lengths, Cracking data is not measured, and the Roughness parameter used is different. Therefore, it would only be possible to calculate the RCI based on Rutting and Texture data. Overall, given the reporting length and lack of comparable parameters, a meaningful calculation of the RCI, and therefore either the Red or Amber Length, is not possible.

5.5. FEASIBILITY OF COMPARISON USING HIGHWAYS ENGLAND DATA

Comparison using components of Highways England data is the alternative option to using whole metrics. Assessment of the feasibility of comparisons using parameters of Highways England's data shows that all of the comparators can be compared with Highways England using some, but not all, of the data components recorded at an individual level.

In terms of undertaking a multi-comparison, Highways England, Scotland, Wales and the LAs appear to be comparable with each other for some of the parameters. Including the Netherlands and Sweden in the majority of these comparisons, however, does not appear possible.

For Scotland, Wales and the LAs, most of the main parameters collected are similar to those collected on the SRN (Rutting, Roughness (eLPV or LPV), Texture (SMTD), Skid Resistance (SCRIM)). Cracking is slightly different, but comparison may be possible. The data these comparators collect from the Deflectograph surveys is not generally comparable to that from Highways England's TSD.

Overall for Scotland, Wales and the LAs, a comparison of parameter data on Rutting, Roughness, Texture and Skid Resistance should be possible, and a comparison of Cracking data may be possible. A brief investigation will be needed, using TRACS and SCANNER Accreditation data, to determine comparability.

Several LAs would need to be approached in order to use their data for this comparison, and as for the above metrics, the effort required for this might outweigh any benefit obtained.

In the Netherlands, whilst the measurement of Skid Resistance is similar (sideway-force coefficient measurement), only sections below the Skid Resistance intervention limit are reported in the database. Therefore, a comparison of Skid Resistance data would be very limited and is unlikely to be helpful and would not be recommended. The same is the case for the Netherlands Cracking and Ravelling (Fretting) parameters, but a comparison using Rutting and IRI data should be possible.

Swedish data reporting length is 20m, while Highways England's data reporting length is 10m or 100m, and Skid Resistance is not routinely measured, with Texture (MPD) instead being recorded. Highways England also measures Texture on the SRN, reporting the MPD parameter. Whilst it is therefore possible to compare MPD values, this may not be a fair comparison as acceptable Texture values can vary depending on the pavement surfacing used.

Cracking and Fretting are also not measured in Sweden, and a single Ride Quality parameter (IRI), which cannot be directly compared to Highways England, is used. A comparison between Rutting and IRI on the Swedish and Highways England networks should be possible though.

Table 5.2 below provides a summary of what data parameter comparisons are possible using components of Highways England's data.

Table 5.2: Summary of possibility of comparison

Country/Road Authority	Rutting	Roughness	Skid Resistance	Cracking	Texture
Netherlands	Y	~	~~	N	N
Scotland	Y	Y	Y	Y*	Y
Sweden	Y	~	N	N	Y**
UK Local authorities	Y	Y	Y†	Y*	Y
Wales	Y	Y	Y	Y*	Y

~ = somewhat – these countries calculate IRI, which can be calculated from raw Highways England data, or estimated from 3m and 10m eLPV but is not directly comparable to eLPV

~~ The same measurement principle is used but a different tyre and post-processing is applied, so values are subtly different. Unlikely to be helpful, therefore not recommended.

* A brief investigation will be needed, using TRACS and SCANNER Accreditation data, to determine comparability.

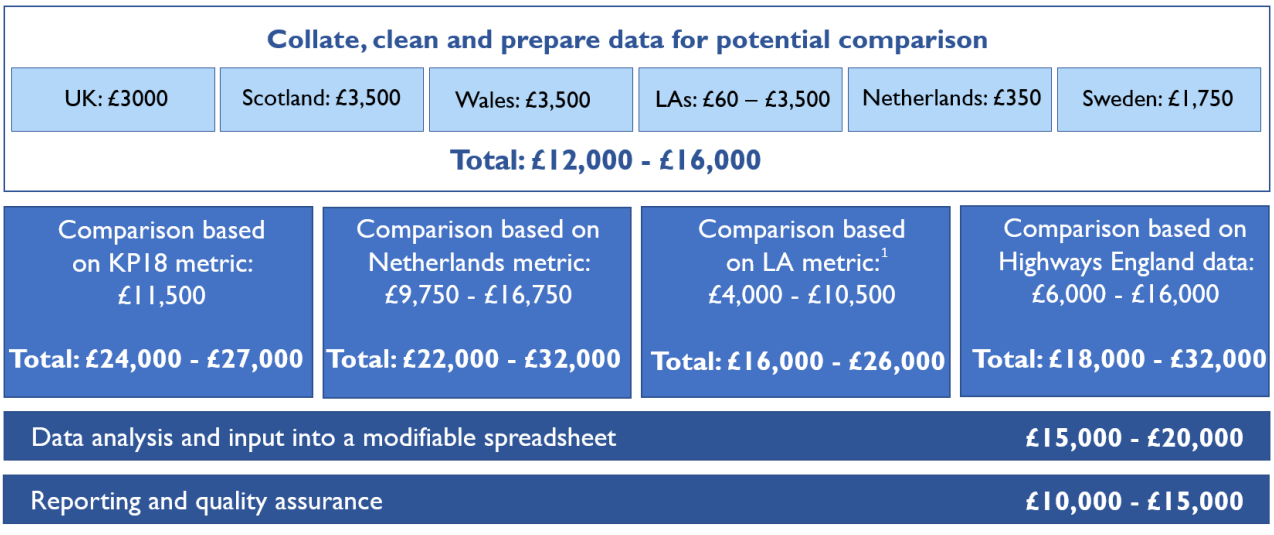
** Possible put difficult to interpret.

† Some Skid Resistance measurements are made but only on selected lengths of the network.

5.6. COST OF COMPARISONS

An initial high-level estimate of the costs to undertake these comparisons is presented in Figure 5.1 below. These figures are subject to considerable uncertainty which is reflected in the ranges given. Preparing the data for comparison has a separate cost for each authority, depending on the format of the data. This step is required regardless of the comparison(s) chosen, with the cost varying depending upon the number of comparators selected. Depending upon the selection of comparisons that are to be taken forward, these cost estimates can be further refined.

Figure 5.1: Indicative cost estimates for comparisons



[1] LA metric does not include costs to collate, clean and prepare data for Sweden and the Netherlands

ORR would be able to select any combination of possible comparisons to undertake. The associated cost will be dependent upon the number of authorities within the comparison, in addition to the level of parameter

comparability and associated modifications across authorities. The comparisons would be carried out in a spreadsheet structured so that it can be easily added to going forward. This would need to be accompanied by a detailed description of the modifications that have been made to enable replication of the comparisons in future. Additionally, we consider that the analysis should then be quality assured, and findings presented in a report. The estimates provided are inclusive of all these costs.

5.7. CONSIDERATIONS FOR FUTURE WORK

To facilitate meaningful, and therefore robust comparisons, there needs to be alignment between data in (at least) two key dimensions:

- geographical coverage – cost and quality should cover the same assets; and
- temporal coverage – cost and quality should cover the same time period and, as importantly, be resampled at the same rate.

Two potential issues emerge when discussing the actual undertaking of the comparisons discussed in this report, particularly between Highways England and LAs, that would need to be considered during any future work. See Appendix C for further information.

5.7.1. Geographical coverage

SCRIM type data is not collected network wide by LAs. This presents challenges in monitoring changes in Skid Resistance over time in these cases, as a relatively small part of the network is sampled each year. This presents a risk that the sample may not be representative of the road condition of the LA networks in any given year.

Also, not all A roads are sampled each year, although this is less of issue assuming that roads are being sampled in a systematic method unrelated to their underlying condition, at least within road class.

5.7.2. Temporal coverage

Most surveys are annual and occur at similar time in the year. This means comparisons in road condition and cost should be valid over time and, perhaps with adjustments to systematic road condition reflecting sampling at different times of year, valid between infrastructure managers.

There is a very important interaction between temporal coverage and geographical coverage. Where the network is not sampled in entirety, there is a challenge to capture changes in road condition which is potentially exacerbated by different data base management processes between infrastructure managers. This issue emerged with specific work undertaken by the CQC Efficiency Network for LAs, highlighting the limitation of relying on data on road condition based on partial surveys of the network.

Limited interview work undertaken as part of the CQC Efficiency Network indicated that practice does differ between LAs in terms of how the network condition of the roads not surveyed in the latest year are treated. Some LAs simply roll over the previous year's survey data, which introduces lags in the response of the road condition measure. Other LAs implement a policy of manually adjusting their PMS system to reflect when they have undertaken improvement work on a road section flagged in the last survey as in need of repair, somewhat circumventing the lag problem.

As such, one solution could be to select LAs for comparison which manually over-write their road condition databases when improvement works are undertaken.

6. SUMMARY

We used case studies to assess the feasibility of taking forward direct comparisons of pavement conditions. This revealed that:

- Regardless of whether the RIS1 or RIS2 version of the Highways England pavement metric is used, it is not possible to directly undertake any comparisons without modifications to the metric calculations.
- Scotland, Wales and the LAs are already closely aligned in terms of the form and structure of the data collected, and as a group are the most feasible comparators for Highways England.
- Among international comparators, Sweden is not a suitable candidate for comparisons, and the Netherlands is a more feasible candidate.
- The Netherlands metric provides the opportunity for the most extensive comparison. The modifications required to undertake the comparison are the same for Highways England, Scotland, Wales and the LA. This means all comparators, except Sweden, can be included in a multi-comparison.
- The LA metric (Amber) provides the best opportunity for comparison of pavement condition between the UK authorities.
- Highways England, Scotland, Wales and the LAs appear to be comparable using some data parameters instead of a metric to undertake comparisons, The Netherlands and Sweden cannot be included in the majority of these comparisons.
- There are some potential limitations with using LAs as comparators that need to be considered during any future work. These may be rectified by selecting as comparators those LAs which manually over-write their road condition databases when improvement works are undertaken.

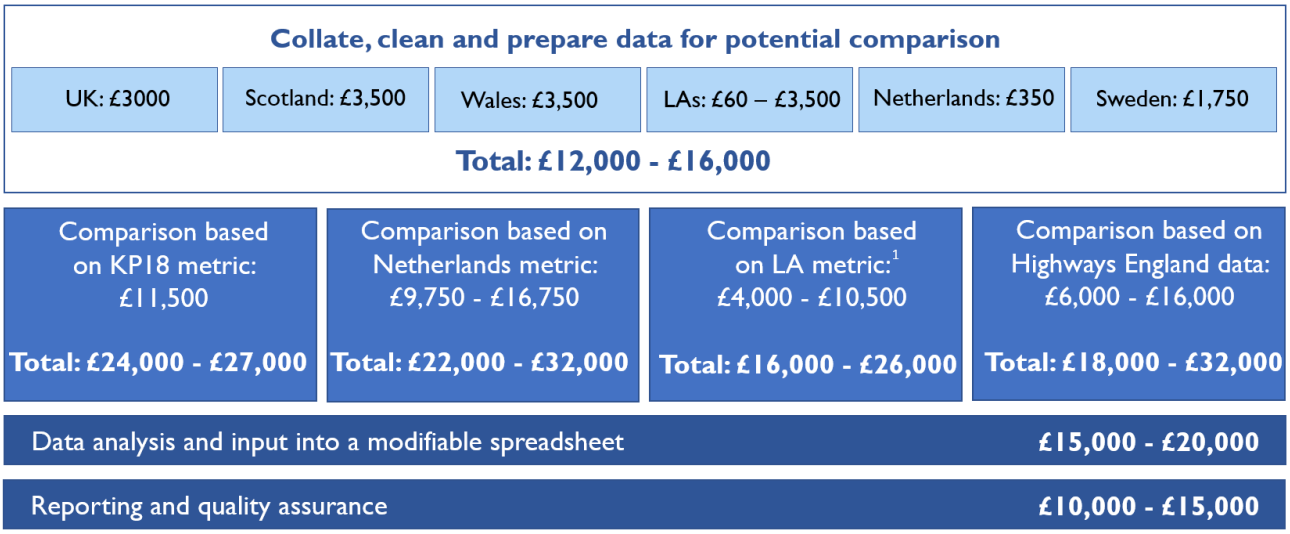
Assessment of pavement condition between Highways England and other organisations, therefore, appears more feasible using metrics calculated by other organisations, rather than using the Highways England pavement metric. The Netherlands appears to allow for a more extensive comparison than the LA metrics. But the LA metrics are the most straightforward option for a comparison between UK authorities.

A parameter comparison between authorities may be used as a stand-alone measure, or alternatively, as a complementary measure to a metric comparison. The added value of the latter would depend on the parameters and authorities included in the chosen metric. Sweden and the Netherlands can only be compared with Highways England on Rutting and Roughness parameters. Texture, Skid Resistance and possibly Cracking parameters could also be compared between UK authorities.

Undertaking a comparison using the individual data parameters is a simpler process and one that allows for comparison between specific elements of pavement condition. The use of such metrics allows for a more complete picture of pavement condition to be presented in way that is easier to understand and allows for easy comparison across time.

Initial cost estimates for undertaking the comparisons are presented in Figure 6.1 below.

Figure 6.1: Cost estimates for comparisons



[1] LA metric does not include costs to collate, clean and prepare data for Sweden and the Netherlands

APPENDIX A **COMPARATOR SELECTION**

A.1. **AUSTRALIA**

The Australian road network is not comparable to the SRN. The network is much longer, more dispersed and carries less traffic than the SRN. The road authority uses equipment that is, to a considerable degree, comparable to the equipment used on the SRN and the measurements of pavement characteristics are very similar, apart from the measurement of Roughness. There is no published metric and, currently, each state tends to use their own indicator to determine condition.

It may be possible to calculate a version of Highways England's pavement metrics using Australian data, with modification to account for the different Roughness parameter. However, as the network is so different, it is unlikely that this would enable direct comparison to Highways England.

A comparison between data from Australia and Highways England is not recommended.

A.2. **AUSTRIA**

The Austrian motorway network is not comparable to the SRN, being shorter in length and with much lower traffic volumes. The pavement type is also different. Similar equipment to TRACS is used to measure surface condition but very different equipment is used for Skid Resistance and deflection. Thus, whilst the parameters delivered describe similar pavement characteristics, they are not similar enough to enable a comparison.

A comparison with Austria's motorway network is not recommended.

A.3. **DENMARK**

The Danish road network is somewhat comparable to the SRN, as are the measurement systems used. The measurements made are very similar. But they do not have a pavement network condition indicator, and it would not be possible to calculate Highways England's pavement metrics, as their Skid Resistance measurements are different. Thus, whilst the parameters delivered describe similar pavement characteristics, they are not similar enough to enable a comparison.

A comparison with the Danish road network is not recommended.

A.4. **SCOTLAND**

The network in Scotland is somewhat comparable to the SRN, with similar construction materials, but is shorter in length and has lower traffic volumes. The equipment used to measure condition is the same as that used for the UK local road network, hence similar to that used for the SRN.

The metric calculated in Scotland includes data from Deflectograph surveys (pavement strength), which are not routinely carried out on the SRN. Thus, it would not be possible to perform a direct comparison with Highways England using the Scottish metric. However, the data collected is similar enough to enable comparison using other metrics e.g. Highways England's pavement metrics.

A comparison between motorways and major A roads in Scotland and the SRN should be possible.

A.5. SWEDEN

Sweden was not considered in the previous research but the national road authority (Trafikverket) publishes the condition data collected annually on their road network.[7] The Swedish motorway network has limited comparability to the SRN as the traffic volumes are much lower. Also, since the network is covered by snow for a large part of the year, the approach to maintenance and monitoring is different e.g. they do not currently measure Skid Resistance.

The published data includes Rutting, Roughness (IRI), Texture (MPD), and Edge Deterioration, reported over 20m lengths.

Not enough parameters are available to calculate any of the considered metrics (e.g. Highways England's pavement metric) but the parameters are similar to those collected by Highways England and thus some comparison should be possible.

*A comparison between the **parameters** collected on the Swedish motorway network and the SRN should be possible. However, a comparison of metrics would not be possible.*

A.6. THE NETHERLANDS

Of the authorities considered for the previous work, the Netherlands has the most similar network to Highways England in terms of characteristics. The network lengths, climates, and traffic levels are comparable but the surface materials, mainly porous asphalt, used in the Netherlands are not actively used by Highways England, where porous asphalt is permitted but not common.

The pavement characteristics measured are similar but, whilst Skid Resistance is measured using the same principle as in the UK, different tyres are used, thus the values are subtly different. The Roughness parameter is also different from Highways England. A modified version of the RIS1, or proposed RIS2, pavement metrics, using different thresholds applied to skid data and accommodation of the different Roughness parameter, would need to be calculated in order to perform a comparison.

The Dutch calculate a metric based on similar parameters to Highways England's pavement metrics (Rutting, Roughness, Skid Resistance) but with Cracking and Fretting parameters included in addition. The Roughness parameter is different but can be calculated from Highways England data. However, the Cracking and Fretting parameters are different to those collected by Highways England. Thus, a modified version of this metric would need to be calculated to enable a comparison.

*Thus, a comparison between the Dutch national road network and the SRN **should** be possible.*

A.7. UK LOCAL AUTHORITIES

Cornwall and South Lanarkshire were considered in the previous work, but most LAs take a very similar approach to measurement of condition.

The A roads in most UK LAs are comparable with A roads on the SRN to a degree. However, traffic volume and the number of HGVs using the roads are much lower, and only the more major roads could be considered comparable. Many authorities use equipment that is, to a considerable degree, comparable to the equipment used on the SRN and the measurements of pavement characteristics are very similar.

[7] Data available at: https://pmsv3.trafikverket.se/

The DfT publish the metric used on local roads annually, so it should be possible to perform a comparison with the metric, calculated with equivalent data for A roads on the SRN without needing to involve individual LAs.

*Therefore, a comparison between major A roads in a local authority and A roads on the SRN **should** be possible.*

A.8. TRANSPORT FOR LONDON

The major A roads in Transport for London's network are comparable with A roads on the SRN, but the proportion of HGVs using the roads is lower. The equipment used to measure condition is comparable to a considerable degree and the parameters describing pavement characteristics similar. Thus, the data collected is similar enough to enable a comparison.

Whilst DfT publishes the metric used on all roads owned by LAs, no metric is published for TfL. The condition of the TfL network is likely to be similar to other UK LAs and thus the effort required to obtain a metric for TfL's network is unlikely to be outweighed by any benefit gained.

*Therefore, a comparison with Transport for London's network is **not** recommended.*

A.9. WALES

The situation is very similar for Wales as in Scotland, in that the major road network is comparable to the SRN, but traffic volumes are lower. The pavement characteristics measured, and parameters delivered are similar enough to enable a comparison.

*Therefore, a comparison between motorways and major A roads in Wales and the SRN **should** be possible.*

APPENDIX B **DETAILED CASE STUDIES**

B.1. **ENGLAND**

Country: England (Highways England) 	
Data	
Type of data collected/held	TRACS (Traffic Speed Condition Survey) data: Rutting, Ride Quality (3m, 10m and 30m eLPV, and Bump Measure), Texture (SMTD), Cracking, Fretting, Images, Retroreflectivity (road markings), GPR; SCRIM data (Skid Resistance): SFC; TRASS (TSD): Deflection data.
Form, structure and level of detail of data	TRACS, TSD and SCRIM surveys are commissioned by the Highways England. The survey contractors process raw condition data (RCD files) using MSP software and upload base condition (BCD) to HAPMS database. Data, reported at 100m intervals, is available to all pavement engineers via the HAPMS database. Data reported at 10m intervals is also available in HAPMS, but special permission is needed to access this. Raw data for TRACS (longitudinal profile, transverse profile etc.) is also provided to Highways England's Pavement Team and TRL (as the survey auditor). The raw data is stored in text files (RCD files), the format of which is defined by Highways England.
Would the road authority be willing to engage?	Highways England have given their permission to use their data only for the purposes of this specific project in accordance with the agreed specification. Permission allows access to the raw RIS1 metric data if the analysis and interpretation is conducted by TRL.
Common steps required to compare data	Obtain TRACS and SCRIM data (including SCRIM categories) at 10m and 100m reporting intervals. Obtain section category data from HAPMS and align this with TRACS/SCRIM data. TRL have access to HAPMS, and thus this data.
Time required and cost to collate/clean/prepare data for potential comparison	**Total: 24 hours (£2,963)**
Comparison of RIS1 (KPI8) and proposed RIS2 metrics	
Steps required to compare data - What calculations would need to be undertaken on the data?	Results of the current RIS1 metric (KPI8) calculation are published by the DfT. However, it is not possible to calculate the true metric from other authority's data, so any comparisons performed using KPI8 will require calculation of a modified metric from Highways England's data. It would, however, be worthwhile calculating KPI8 and comparing with published results, to ensure understanding of the metric and correct calculation. Calculate the proposed RIS2 metric. *It is suggested that only Lane 1 data is used (as with current metric), as all lane data is not available from other authorities. Also, that Skid Resistance is assessed as currently, without consideration of the Crash Model. No other authority measures 30m eLPV, so this will also need to be excluded from the calculation.*
Time required and cost	• Calculate the RIS1 metric and compare with results published by DfT: 4 hours (£494). • Calculation of the proposed RIS2 metric excluding 30m eLPV: 4 hours (£494). • Calculation of the proposed RIS2 metric: 4 hours (£494). **Total: 12 hours (£1,481).**

Country: England (Highways England)	
Feasibility to use the country's data to obtain a metric equivalent to Netherlands metric	
What factors regarding the data used the road authority may hinder direct comparability	The Rutting data collected by Highways England is very similar to that collected by the Dutch. Thus, it would be appropriate to apply the Dutch threshold to Highways England data (i.e. 17mm). The Roughness data collected by Highways England is different but an approximation for IRI can either be calculated using eLPV data or can be calculated directly from raw profile data. Thus, it would be appropriate to apply the Dutch threshold to IRI calculated from Highways England data (3.5 m/km). A formula to convert eLPV values to IRI is given in TRL CPR 1553: $\text{IRI} \approx \max\text{imum}(\sqrt{(10 * 3\text{m eLPV})/3} + \sqrt{10\text{m eLPV}} - 0.1, 0)$ The Skid Resistance values collected in the Netherlands are likely to be 4-8% higher than UK ones, due to the different test tyre used. Also, the values are reported for a speed of 80km/h, not 50km/h and they do not apply the 0.78 adjustment factor used in the UK. Therefore, it would not be appropriate to apply the Dutch threshold directly to UK data: It is proposed that a reduced value is used 0.53*0.78*1.083/1.06 = 0.42. The Dutch Cracking and Ravelling (Fretting) measurements and parameters are very different from those reported by Highways England. Thus, it is not appropriate to try to include these parameters in the metric, without further understanding of any relationship that exists between them. Any comparison to determine if a relationship existed between these parameters would require either the current TRACS device to collect survey data on the Dutch road network, or for the Dutch device to survey some of the SRN. It is unlikely that the cost and effort involved for this would be outweighed by the benefit of this analysis. Therefore, it is recommended that the Dutch metric is calculated using only Rutting, Ride Quality and Skid Resistance.
Likelihood of success - How possible is the comparison?	A comparison using the Dutch metric, calculated using only Rutting, Ride Quality and Skid Resistance should be possible. RWS in the Netherlands have provided data from all the highways managed by them, which should enable an equivalent metric to be calculated for the Dutch road network. Hence it should be possible to perform a comparison of Highways England and Dutch data.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate IRI values – either use estimate based on eLPV values or recalculate from raw profile data (more robust approach/challengeable dataset). Obtain SCRIM values from previous year and calculate the average. Apply thresholds to Rutting, IRI and Skid Resistance values and calculate the percentage of the network where none of these parameters exceed the thresholds. Recalculate Netherlands metric using only Rutting, IRI and Skid Resistance from Dutch data.

Time required and cost to perform comparison	• Calculation of IRI parameter:
	  ○ Estimating from eLPV values – 8 hours (£988); or
	  ○ Calculating from raw data – 24 hours (£2,963); or
	  ○ Both of the above – 32 hours (£3,950).
	• Obtaining average SCRIM values: 6 hours (£741).
	• Calculate Dutch metric using Highways England data: 5 hours (£617).
	• Calculate Dutch metric using Dutch Rutting, IRI and Skid Resistance data: 5 hours (£617).
	Total: 24 hours (£2,963), 40 hours (£4,938) or 48 hours (£5,925).

Feasibility to use the country's data to obtain a metric equivalent to local authority metrics	
What factors regarding the data used by the road authority	Highways England pavement condition data is available in HAPMS at either 10m or 100m reporting lengths, thus the 10m reporting lengths needed to calculate Red and Amber length are available.

Country: England (Highways England)	
may hinder direct comparability	The measurement and calculation of Rutting used by Highways England is very similar to that carried out by local authorities. Similarly, the measurement and calculation of Texture is the same. Thus, these parameters can be used directly for the calculation of Red or Amber lengths. However, the measurement of Roughness is different – the eLPV parameter is used by Highways England, whilst LPV is used on the local road network. LPV was replaced by eLPV on the SRN in 2004. LPV data may be calculated from the raw data, or equivalent thresholds determined for eLPV. The equipment used to measure Cracking is also very different and therefore, the parameter delivered may be fundamentally different. A brief investigation will be needed (using TRACS and SCANNER Accreditation data) in order to determine comparability. If the Cracking data is not determined to be comparable, then a version of the RCI, excluding Cracking data, could be calculated.
Likelihood of success - How possible is the comparison?	A comparison of the Red Length metric should be possible, if the Cracking data is comparable, as the Red Length metric for each English Local Authority is published annually by the DfT (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775446/rdc0120.ods). If Cracking data is not comparable, it has been suggested that the RCI could be calculated excluding Cracking. If this is needed, individual local authorities will need to be approached in order to use their data to calculate this modified metric. A comparison of Amber should be possible with countries for which the RCI is being calculated by TRL (i.e. Scotland, Wales). However, there will be a need to obtain permission to use several CQC local authorities' data should comparison with LAs be required.
Steps required to compare data - What calculations would need to be undertaken on the data?	Determine how comparable the Cracking data is (use data from SCANNER and Accreditation tests for this work) – are they similar enough to apply the same thresholds? Obtain LPV data (this will require processing raw TRACS data) or apply equivalent thresholds to the eLPV data (thresholds for both LPV and eLPV are given in the DMRB). If the Cracking is comparable, calculate the RCI and the percentage of 10m lengths where RCI ≥100 for Highways England data, download the published results for LAs. If the Cracking is not comparable: • If comparison with local authorities is required, contact a selection of local authorities to ask permission to use their data, obtain data and calculate RCI excluding Cracking. • Calculate the Highways England RCI excluding Cracking and the percentage of 10m lengths where this modified RCI ≥100. A comparison of Amber (i.e. where 100>RCI ≥40) should be possible with countries for which the RCI is being calculated by TRL (i.e. Scotland, Wales) If there is a need to compare Highways England Amber with local authorities, there will be a need to obtain results from several LAs in the CQC.

Time required and cost to perform comparison	• Determine comparability of Cracking data using existing data from vehicle QA: 12 hours (£1,481).
	• Obtain LPV data: 24 hours (£2,963) or 1 additional hour (£123) if combined with IRI calculation.
	  ○ OR Apply equivalent thresholds to eLPV data: 0.5 hours (£62).
	• Calculate the RCI if Cracking is comparable: 6 hours (£741).
	• If the Cracking is not comparable:
	  ○ If comparison with local authorities is required: 24 hours (£2,963).
	  ○ Calculate Highways England RCI excluding Cracking: 6 hours (£741).
	• Calculation of Amber length: 0.5 hours if in addition to Red Length calculation (£62).
	• If Amber comparison with local authorities required: 2 hours (£247), additional to any hours required for Red Length comparison.

Country: England (Highways England)	
	Total: 18.5 hours (£2,284) to 68.5 hours (£8,456) depending on comparability of Cracking and the options chosen

B.2. SCOTLAND

Country: Scotland (Transport Scotland)	
Data	
Type of data collected/held	SCANNER data (i.e. Rutting, Ride Quality (LPV), Texture, Cracking, Edge Deterioration, Texture Variability); SCRIM Skid Resistance data (SFC); Deflection data (Deflectograph).
Form, structure and level of detail of data	SCANNER, Deflectograph and Skid Resistance surveys are commissioned by the Transport Scotland. The survey contractors deliver processed data over 10m reporting lengths and this is stored in the Scottish pavement management system (PMS). TS do not store the raw data themselves but may be able to request this from the contractor, in special circumstances.
Would the road authority be willing to engage?	Transport Scotland (TS) have given their permission to use their data to investigate the feasibility of the comparison, on the provision that they can have a copy of the report.
Common steps required to compare data	Obtain latest SCANNER and SCRIM data, at 10m reporting intervals. As SCANNER auditor, TRL has access to this data but SCRIM data would need to be obtained from TS or directly from the survey contractor. Inform TS that their data is going to be used for benchmarking and publishing the results. Confirm that they are happy with this.
Time required and cost to collate/clean/prepare data for potential comparison	• Obtain latest SCANNER data: 12 hours (£1,481). • Obtain latest SCRIM data, plus SCRIM categories: 16 hours (£1,975). • Inform TS of data use and confirm participation: 0.5 hours (£62). **Total: 28.5 hours (£3,518)**
Feasibility to use the country's data to obtain a metric equivalent to Highways England's RIS pavement metric	
What factors regarding the data used by the road authority may hinder direct comparability	The measurement and calculation of Rutting used in Scotland is very similar to that carried out by Highways England. Similarly, the measurement of Skid Resistance is identical and thus these parameters can be used directly in the calculation of the RIS1, or proposed RIS2, metric. The measurement of Roughness used for assessment (LPV) is different but eLPV data is also calculated from SCANNER data, thus should be available for Scotland. SCANNER surveys only collect 3m and 10m eLPV, whereas 30m eLPV is also used to calculate the RIS1, or proposed RIS2, metric. Thus, a modified metric, excluding 30m eLPV would need to be calculated for both TS and Highways England data.
Likelihood of success – How possible is the comparison?	It should be possible to calculate a modified version of the RIS1, or proposed RIS2, metric (excluding 30m eLPV) for Scottish motorways and major A roads.
Steps required to compare data – What calculations would need to be undertaken on the data?	Calculate the RIS1 metric excluding 30m eLPV. To enable comparison using the proposed RIS2 metric: Obtain TS data at 100m reporting lengths (calculate average); Calculate modified proposed RIS2 metric, excluding extra steps for Skid Resistance data and excluding 30m eLPV.
Time required and cost to perform comparison	• Calculate the RIS1 metric excluding 30m eLPV: 4 hours (£494). • Obtain TS data at 100m reporting lengths, then calculate the proposed RIS2 metric: 6 hours (£741). **Total: 10 hours (£1,234)**

Country: Scotland (Transport Scotland)	
Feasibility to use the country's data to obtain a metric equivalent to Netherlands metric	
What factors regarding the data used the road authority may hinder direct comparability	The Rutting data collected by TS is very similar to that collected by the Dutch. Thus, it would be appropriate to apply the Dutch threshold to TS data (i.e. 17mm). The Roughness data collected by TS is different but an approximation for IRI can be calculated using eLPV data, assuming this is available. Thus, it would be appropriate to apply the Dutch threshold to IRI calculated from TS data (3.5 m/km). The Skid Resistance values collected in the Netherlands are likely to be 4-8% higher than Scottish ones, due to the different equipment and test tyre used. Also, the values are reported for a speed of 80km/h, not 50km/h and they do not apply the 0.78 adjustment factor used in the UK. Therefore, it would not be appropriate to apply the Dutch threshold to UK data. It is proposed that a reduced value is used: 0.53*0.78*1.083/1.06 = 0.42. The Dutch Cracking measurements and parameter are very different from that reported by TS. Also, Fretting is not a parameter collected at a network level by TS. Thus, it is not appropriate to try to include these parameters in the metric.
Likelihood of success - How possible is the comparison?	A comparison of a modified metric, calculated using only Rutting, Ride Quality and Skid Resistance should be possible.
Steps required to compare data - What calculations would need to be undertaken on the data?	Obtain TS data at 100m reporting lengths (calculate average from 10m data); Calculate estimated IRI values using eLPV. Apply thresholds to Rutting, IRI and Skid Resistance values and calculate the percentage of the network where none of these parameters exceed the thresholds. Recalculate Netherlands metric using only Rutting, IRI and Skid Resistance from Dutch data.
Time required and cost to perform comparison	• Obtain TS data at 100m reporting lengths: 4 hours (£494) (may have already been done as part of the proposed RIS2 metric calculation). • Calculate estimated IRI values using eLPV: 4 hours (£494). • Calculate metric: 5 hours (£617). • Recalculate modified Netherlands metric using Dutch data: 0 hours (will have already been done for Highways England comparison). **Total: 13 hours (£1,605)**
Feasibility to use the country's data to obtain a metric equivalent to local authority metrics	
What factors regarding the data used by the road authority may hinder direct comparability	TS commissions surveys that are very similar to the SCANNER surveys used on local roads. Thus, all parameters used to calculate the RCI are available in Scotland and are the same as those for the local authorities.
Likelihood of success - How possible is the comparison?	Calculation of the RCI should be possible, thus a comparison of the Red Length metric should be possible. A comparison of the Amber length metric should also be possible between Highways England and TS.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate the RCI (possibly modified, if TRACS/SCANNER crack data not comparable). Calculate the percentage of 10m lengths where RCI ≥100. Calculate the percentage of 10m lengths where 100>RCI ≥40.
Time required and cost to perform comparison	• Calculate the RCI: 5 hours (£617).

Country: Scotland (Transport Scotland)	
	• Calculate the percentage of 10m lengths where RCI ≥100 and 100>RCI ≥40: 1 hour (£123). **Total: 6 hours (£741)**
Feasibility to use the country's parameter data to compare with Highways England data	
What factors regarding the data used by the road authority may hinder direct comparability	Most of the main parameters, collected on the TS road network, are similar to those collected on the SRN (Rutting, Roughness (eLPV or LPV), Texture (SMTD), Skid Resistance (SCRIM)). Cracking is slightly different, but it may still be possible to compare values. Data from Deflectograph surveys is not generally comparable to that from the TSD.
Likelihood of success - How possible is the comparison?	A comparison of Rutting, Roughness, Texture and Skid Resistance parameter data should be possible. A comparison of Cracking data may be possible. A brief investigation will be needed (using TRACS and SCANNER Accreditation data) in order to determine comparability.
Steps required to compare data - What calculations would need to be undertaken on the data?	Include Cracking parameter in the analysis, if this has previously been shown to be comparable. Analyse the distributions of values for each parameter considered. Apply appropriate thresholds (RIS1 or proposed RIS2 metrics, RCI).
Time required and cost to perform comparison	**Total: 12 hours (£1,481)** if Cracking included in analysis, **10 hours (£1,234)** otherwise.

B.3. WALES

Country: Wales (Welsh Government)	
Data	
Type of data collected/held	SCANNER data (i.e. Rutting, Ride Quality (LPV), Texture, Edge Deterioration, Texture Variability); SCRIM Skid Resistance data (SFC); Deflection data (Deflectograph).
Form, structure and level of detail of data	SCANNER, Deflectograph and Skid Resistance surveys are commissioned by the Welsh Road authority's (part of the Welsh Government (WG)). As with Scotland, the survey contractors deliver processed data over 10m reporting lengths and this is stored in the Welsh pavement management system (PMS). WG do not store the raw data themselves but may be able to request this from the contractor, in special circumstances.
Would the road authority be willing to engage?	Welsh Government (WG) have given their permission to use their data to investigate the feasibility of the comparison and would like to see the results.
Common steps required to compare data	Obtain latest SCANNER and SCRIM data, (including SCRIM categories), at 10m reporting intervals. As SCANNER auditor, TRL has access to this data but SCRIM data would need to be obtained from WG or directly from the survey contractor. Inform WG that we plan to use their pavement condition data for benchmarking purposes and confirm that they are still happy for this.
Time required and cost to collate/clean/prepare data for potential comparison	• Obtain latest SCANNER data: 12 hours (£1,481). • Obtain latest SCRIM data, plus SCRIM categories: 16 hours (£1,975). • Inform WG of data use and confirm participation: 0.5 hours (£62). **Total: 28.5 hours (£3,518)**
Feasibility to use the country's data to obtain a metric equivalent to Highways England's RIS pavement metric	
What factors regarding the data used by the road authority may hinder direct comparability	The measurement and calculation of Rutting used in Wales is very similar to that carried out by Highways England. Similarly, the measurement of Skid Resistance is identical and thus these parameters can be used directly in the calculation of the RIS1, or proposed RIS2, metric. The measurement of Roughness used for assessment (LPV) is different but eLPV data is also calculated from SCANNER data, thus should be available for Wales. SCANNER surveys only collect 3m and 10m eLPV, whereas 30m eLPV is also used to calculate the RIS1, or proposed RIS2, metric. Thus, a modified metric, excluding 30m eLPV would need to be calculated for both Welsh and Highways England data.
Likelihood of success - How possible is the comparison?	It should be possible to calculate a modified RIS1, or proposed RIS2, metric (excluding 30m eLPV) for Welsh motorways and trunk roads.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate RIS1 metric excluding 30m eLPV for both Highways England and Welsh data. To enable comparison using proposed RIS2 metric, will need to: Obtain Welsh data at 100m reporting lengths (calculate average); Calculate the proposed RIS2 metric, excluding extra steps for Skid Resistance data and excluding 30m eLPV.
Time required and cost to perform comparison	• Calculate RIS1 metric excluding 30m eLPV: 4 hours (£494). • Obtain WG data at 100m reporting lengths, then calculate proposed RIS2 metric: 6 hours (£741).

Country: Wales (Welsh Government)	
	Total: 10 hours (£1,234)
Feasibility to use the country's data to obtain a metric equivalent to Netherlands metric	
What factors regarding the data used the road authority may hinder direct comparability	The Rutting data collected by Welsh Government is very similar to that collected by the Dutch. Thus, it would be appropriate to apply the Dutch threshold to Welsh data (i.e. 17mm). The Roughness data collected by Welsh Government is different but an approximation for IRI can be calculated using eLPV data (assuming this is available). Thus, it would be appropriate to apply the Dutch threshold to IRI calculated from Welsh data (3.5 m/km). The Skid Resistance values collected in the Netherlands are likely to be 4-8% higher than UK ones, due to the different equipment and test tyre used. Also, the values are reported for a speed of 80km/h, not 50km/h and they do not apply the 0.78 adjustment factor used in the UK. Therefore, it would not be appropriate to apply the Dutch threshold to UK data: It is proposed that a reduced value is used 0.53*0.78*1.083/1.06 = 0.42. The Dutch Cracking measurements and parameters are very different from that reported by Welsh Government. Also, Fretting is not a parameter collected at a network level by Welsh Government. Thus, it is not appropriate to try to include these parameters in the metric.
Likelihood of success - How possible is the comparison?	A comparison of a modified metric calculated using only Rutting, Ride Quality and Skid Resistance should be possible. TRL as auditor has access to Welsh SCANNER data, but Skid Resistance (SCRIM) data would need to be obtained from WG or directly from the SCRIM survey contractor.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate estimated IRI values using eLPV. Apply thresholds to Rutting, IRI and Skid Resistance values and calculate the percentage of the network where none of these parameters exceed the thresholds. Recalculate Netherlands metric using only Rutting, IRI and Skid Resistance from Dutch data.
Time required and cost to perform comparison	• Obtain TS data at 100m reporting lengths: 4 hours (£494) (may have already been done as part of the proposed RIS2 metric calculation). • Calculate estimated IRI values using eLPV: 4 hours (£494). • Calculate metric: 5 hours (£617). • Recalculate modified Netherlands metric using Dutch data: 0 hours (will have already been done for Highways England comparison). **Total: 13 hours (£1,605)**
Feasibility to use the country's data to obtain a metric equivalent to local authority metrics	
What factors regarding the data used by the road authority may hinder direct comparability	Welsh Government commissions surveys that are very similar to the SCANNER surveys used on local roads. Thus, all parameters used to calculate the RCI are available in Wales and similar to those for the local authorities.
Likelihood of success - How possible is the comparison?	Calculating the RCI should be possible, thus enabling comparison of the Red Length metric with Highways England. Similarly, for the Amber length metric.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate the RCI. Calculate the percentage of 10m lengths where RCI ≥100 and where 100>RCI ≥40.

Country: Wales (Welsh Government)	
Time required and cost to perform comparison	• Calculate the RCI: 5 hours (£617). • Calculate the percentage of 10m lengths where RCI ≥100 and 100>RCI ≥40: 1 hour (£123). **Total: 6 hours (£741)**
Feasibility to use the country's parameter data to compare with Highways England data	
What factors regarding the data used by the road authority may hinder direct comparability	Most of the main parameters, collected on the Welsh road network, are similar to those collected on the SRN (Rutting, Roughness (eLPV or LPV), Texture (SMTD), Skid Resistance (SCRIM)). Cracking is slightly different, but it may still be possible to compare values. Data from Deflectograph surveys is not generally comparable to that from the TSD.
Likelihood of success - How possible is the comparison?	A comparison of Rutting, Roughness, Texture and Skid Resistance parameter data should be possible. A comparison of Cracking data may be possible. A brief investigation will be needed (using TRACS and SCANNER Accreditation data) in order to determine comparability.
Steps required to compare data - What calculations would need to be undertaken on the data?	Determine how comparable the Cracking data is (use data from SCANNER and Accreditation tests for this work). Analyse the distributions of values. Apply appropriate thresholds (RIS1, or proposed RIS2, metric, RCI).
Time required and cost to perform comparison	**Total: 12 hours (£1,481)** if Cracking included in analysis, **10 hours (£1,234)** otherwise.

B.4. LOCAL AUTHORITIES

UK Local Authorities (DfT)	Department for Transport
Data	
Type of data collected/held	SCANNER data (i.e. Rutting, Ride Quality (LPV), Texture, Edge Deterioration, Texture Variability); Skid Resistance data (SFC, SCRIM); Deflection (Deflectograph).
Form, structure and level of detail of data	SCANNER surveys are carried out by all English local authorities. The survey contractors either deliver HMDIF files, which contain processed data and can be loaded into the pavement management system (UKPMS) by the authority, or the contractors load processed data straight into the pavement management database. The data is provided over 10m reporting lengths. The authorities may be able to request raw data from the contractors, but this would be a special request and the raw data is not generally stored by the local authorities. Skid Resistance (SCRIM) surveys also deliver data reported over 10m lengths and the data stored in UKPMS. Raw data is not generally stored by the local authorities.
Would the road authority be willing to engage?	DfT publishes the Red Length metric calculated for each local authority in the UK. Should comparison of other metrics or parameters be required, several local authorities would need to be approached to request permission to use their data.
Common steps required to compare data	Download the published results from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775446/rdc0120.ods Should comparison of other metrics or parameters be required, and local authorities give permission to use their data, there would be a need to obtain the most recent SCANNER and SCRIM data, at 10m reporting intervals. As SCANNER auditor, TRL has access to this data but SCRIM data would need to be obtained from the local authority or directly from the survey contractor.
Time required and cost to collate/clean/prepare data for potential comparison	• Download published results: 0.5 hours (£62). • Obtain permission for data use from local authorities: 4 hours (£494). • Collate SCANNER and SCRIM data: 24 hours (£2,963) **Total: 0.5 hours to 28.5 hours (£62 - £3,518)**
Feasibility to use the country's data to obtain a metric equivalent to Highways England's RIS pavement metric	
What factors regarding the data used by the road authority may hinder direct comparability	The measurement and calculation of Rutting used in LAs road networks is very similar to that carried out by Highways England. Similarly, the measurement of Skid Resistance is identical and thus these parameters can be used directly in the calculation of the RIS1, or proposed RIS2, metric. However, SCRIM surveys are usually only carried out on selected lengths of the network, not the whole network and thus there may be a limited amount of this data, which could be misleading if it only represents arbitrary perceived problem points on the network. The measurement of Roughness used for assessment (LPV) is different but eLPV data is also calculated from SCANNER data, thus should be available for a LA. SCANNER surveys only collect 3m and 10m eLPV, whereas 30m eLPV is also used to calculate the RIS1, or proposed RIS2, metric. Thus, a modified metric, excluding 30m eLPV would need to be calculated.
Likelihood of success - How possible is the comparison?	To provide robust data from such a comparison, several LAs should be considered and this would require permission to be sought from these LAs, in order to use their data. To obtain a sufficient amount of SCRIM data would require a large amount of effort. This may not be outweighed by the benefit of performing such a comparison, given the lack of

UK Local Authorities (DfT)	
	similarity between the SRN and the local road network. Thus, this comparison would not be recommended.
Steps required to compare data - What calculations would need to be undertaken on the data?	Request permission from several Local Authorities to use their data for RIS1, or proposed RIS2, metric calculation, benchmarking and publishing the results. Identify LAs that have SCRIM data. Obtain SCANNER data (TRL have access to this) and SCRIM data (this will need to be either from the individual Local Authorities or the survey contractor). Calculate a modified RIS1 metric (excluding 30m eLPV). To enable comparison using the proposed RIS2 metric, will need to: Obtain data at 100m reporting lengths (calculate average); Obtain data at 100m reporting lengths, then calculate modified proposed RIS2 metric, excluding extra steps for Skid Resistance data and excluding 30m eLPV.
Time required and cost to perform comparison	• Obtain permission for data use: 8 hours (£988) • Identify LAs that have SCRIM data: 4 hours (£494) • Obtain SCANNER data: 8 hours (£988) • Obtain SCRIM data: 12 hours (£1,481) • Calculate a modified RIS1 metric (excluding 30m eLPV): 4 hours (£494). • Obtain data at 100m reporting lengths, then calculate a modified proposed RIS2 metric: 6 hours (£741) **Total: 42 hours (£5,184)**
Feasibility to use the country's data to obtain a metric equivalent to Netherlands metric	
What factors regarding the data used the road authority may hinder direct comparability	The Rutting data collected by LAs is very similar to that collected by the Dutch. Thus, it would be appropriate to apply the Dutch threshold to LAs data (i.e. 17mm). The Roughness data collected by LAs is different but an approximation for IRI can either be calculated using eLPV data (assuming this is available). Thus, it would be appropriate to apply the Dutch threshold to IRI calculated from LAs data (3.5 m/km). The Skid Resistance values collected in the Netherlands are likely to be 4-8% higher than UK ones, due to the different equipment and test tyre used. Also, the values are reported for a speed of 80km/h, not 50km/h and they do not apply the 0.78 adjustment factor used in the UK. Therefore, it would not be appropriate to apply the Dutch threshold to UK data. It is proposed that a reduced value is used: 0.53*0.78*1.083/1.06 = 0.42. The Dutch Cracking measurements and parameters are very different from that reported by LAs. Also, Fretting is not a parameter collected at a network level by LAs. Thus, it is not appropriate to try to include these parameters in the metric.
Likelihood of success - How possible is the comparison?	To provide robust data from such a comparison, several LAs should be considered and this would require permission to be sought from these LAs, in order to use their data. To obtain a sufficient amount of SCRIM data would require a large amount of effort. As for the RIS1, or proposed RIS2, metric, the effort required for this might outweigh any benefit obtained. Thus, this comparison would not be recommended.
Steps required to compare data - What calculations would need to be undertaken on the data?	Request permissions from LAs to allow using their pavement condition data for benchmarking purposes. Identify LAs commissioning SCRIM surveys and obtain this Skid Resistance data (either from LAs or survey contractor). Calculate IRI values – use estimate based on eLPV values. Apply thresholds to Rutting, IRI and Skid Resistance values and calculate the percentage of the network where none of these parameters exceed the thresholds. Recalculate Netherlands metric using only Rutting, IRI and Skid Resistance from Dutch data.

UK Local Authorities (DfT)	Department for Transport
Time required and cost to perform comparison	• Obtain LA data at 100m reporting lengths: 4 hours (£494). • Calculate estimated IRI values using eLPV: 2 hours (£247). • Calculate metric: 5 hours (£617). • Recalculate modified Netherlands metric using Dutch data: 0 hours (will have already been done for Highways England comparison). The following steps are only needed, if comparison of the RIS1, or proposed RIS2, metric values has not been performed: • Obtain permission for data use: 8 hours (£988) • Identify LAs that have SCRIM data: 4 hours (£494) • Obtain SCANNER data: 8 hours (£988) • Obtain SCRIM data: 12 hours (£1,481). **Total: 11 hours (£1,358)** if RIS1, or proposed RIS2, metric comparison already performed or **43 hours (£5,308)** otherwise.
Comparison of local authority metrics	
Likelihood of success - How possible is the comparison?	The Red Length metric for each English Local Authority is published annually by the DfT (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775446/rdc0120.ods). Thus, comparison with these published results is possible. Whilst the Amber Length metric is not published, it may be possible to obtain this statistic from some of the LAs in the CQC.
Steps required to compare data - What calculations would need to be undertaken on the data?	Access the data provided by the DfT. If a comparison with Amber lengths is required, request this data from several LAs in the CQC.
Time required and cost to perform comparison	• Access the data provided by the DfT: 0.5 hours (£62). • If a comparison with Amber lengths is required: 4 hours (£494). **Total: 0.5 to 4.5 hours (£62 to £555)**
Feasibility to use the country's parameter data to compare with Highways England data	
What factors regarding the data used by the road authority may hinder direct comparability	Most of the main parameters, collected on the LAs major roads network, are similar to those collected on the SRN (Rutting, Roughness (eLPV or LPV), Texture (SMTD), Skid Resistance (SCRIM)). Cracking is slightly different, but it may still be possible to compare values. Data from Deflectograph surveys is not generally comparable to that from the TSD.
Likelihood of success - How possible is the comparison?	A comparison of Rutting, Roughness, Texture and Skid Resistance parameter data should be possible. A comparison of Cracking data may be possible. A brief investigation will be needed (using TRACS and SCANNER Accreditation data) in order to determine comparability. Several LAs would need to be approached to use their data for this comparison. As for the RIS1, or proposed RIS2, metric, the effort required for this might outweigh any benefit obtained.
Steps required to compare data - What calculations would need to be undertaken on the data?	Request permissions from several LAs to allow using their pavement condition data for benchmarking purposes. Obtain SCANNER data (TRL have access to this) and SCRIM data (this will need to be either from LAs or the survey contractor).

UK Local Authorities (DfT)	
	Determine how comparable the Cracking data is (use data from SCANNER and Accreditation tests for this work). Analyse the distributions of values. Apply appropriate thresholds (the RIS1, or proposed RIS2, metric, RCI).
Time required and cost to perform comparison	Analysis of parameter data: 12 hours (£1,481) if Cracking included in analysis, 10 hours (£1,234) otherwise. The following steps are only needed, if comparison of RIS1, or proposed RIS2, metric values has **not** been performed: • Obtain permission for data use: 8 hours (£988) • Identify LAs that have SCRIM data: 4 hours (£494) • Obtain SCANNER data: 8 hours (£988) • Obtain SCRIM data: 12 hours (£1,481). **Total: 10-12 hours (£1,234 to £1,481) or 42-44 hours (£5,184 to £5,431)**

B.5. THE NETHERLANDS

<table>
<tr><th colspan="2">Country: The Netherlands (Rijkswaterstaat)</th></tr>
<tr><td colspan="2">Data</td></tr>
<tr><td>Type of data collected/held</td><td>Surface condition data (Rutting, Ride Quality (IRI), Cracking (longitudinal and transversal), Ravelling);
Skid Resistance data (sideway-force coefficient values below intervention limit)
Calculated residual life span for each of the defects (rut depth, IRI, Skid Resistance, Cracking, Ravelling).</td></tr>
<tr><td>Form, structure and level of detail of data</td><td>Processed (parameter) data for 100m section lengths is stored in the Rijkswaterstaat (RWS) database, along with the residual life span for the 5 years ahead.
Raw data is stored separately but is not readily accessible for most people.</td></tr>
<tr><td>Would the road authority be willing to engage?</td><td>Yes - RWS have provided data from all of the highways managed by them to enable comparison of Highways England and Dutch data. They would like to see the results of the comparison.</td></tr>
<tr><td>Common steps required to compare data</td><td>Calculate the Dutch metric excluding Fretting and Cracking.</td></tr>
<tr><td>Time required and cost to collate/clean/prepare data for potential comparison</td><td>3 hours (£370)
Total: 3 hours (£370)</td></tr>
<tr><td colspan="2">Feasibility to use the country's data to obtain a metric equivalent to Highways England's RIS pavement metric</td></tr>
<tr><td>What factors regarding the data used by the road authority may hinder direct comparability</td><td><u>Reporting length:</u> Dutch data is reported over 100m lengths, whilst the RIS1, or proposed RIS2, metric is calculated for every 10m length of the network.
<u>Rutting:</u> The Rutting data collected by RWS is very similar to that collected by Highways England.
<u>Roughness:</u> The Netherlands use IRI as a single Roughness parameter, whilst the RIS1, or proposed RIS2, metric includes 3 parameters – 3m, 10m and 30m eLPV. IRI is related to both 3m and 10m eLPV (TRL CPR 1553) but is not correlated with either individual parameter. Additionally, there is no relationship between IRI and 30m eLPV. So, to include Dutch Roughness measurements in this comparison would require new thresholds to be determined for IRI and also for a modified version of the RIS1, or proposed RIS2, metric to be calculated for the SRN using IRI values, not eLPV.
It is possible to use the estimate of IRI from eLPV (TRL CPR 1553) to calculate equivalent thresholds that could be applied to IRI in order to calculate a modified RIS1, or proposed RIS2, metric. A 100m length is considered in "good" condition if the value of both 3m eLPV and 10m eLPV are below the Category 3.5 threshold. Thus, the threshold for IRI has been calculated as the smallest value for which 3m or 10m eLPV might exceed their respective thresholds:
<table>
<tr><th></th><th>IRI m/km</th></tr>
<tr><td>Motorways and rural dual carriageways</td><td>3.3</td></tr>
<tr><td>Urban dual carriageways</td><td>3.6</td></tr>
<tr><td>Rural single carriageways</td><td>3.6</td></tr>
<tr><td>Urban single carriageways</td><td>4.7</td></tr>
</table>
</td></tr>
</table>

Country: The Netherlands (Rijkswaterstaat)	
	Skid Resistance: The measurement of Skid Resistance is similar but different devices and test tyres are used for the measurement. These give Skid Resistance values that are 4-8% higher than the tyres used in the UK. Also, for historical reasons, an adjustment factor of 0.78 is applied to UK data. Additionally, Dutch data is reported for a speed of 80km/h, whereas UK data is reported for 50km/h. An equation for correction to a speed of 50km/h is given in the DMRB (HD28/15): $SR(50) = SR(v)*(-0.0152*v^2 + 4.77*v + 799)/1000$ So, for Skid Resistance measured at a survey speed of 80km/h, the correction factor to obtain Skid Resistance at 50km/h would be 1.083. Thus, any threshold(s) applied to UK data would need to be suitably increased before being applied to the Dutch data, using the following correction factor: 1.06/(0.78*1.083). Different investigatory levels are defined in the DMRB (HD28/15) for Skid Resistance depending on the site category e.g. a carriageway with two-way traffic will normally have a higher Skid Resistance requirement than a carriageway with one-way traffic. The RIS1, or proposed RIS2, metric is calculated by applying a threshold of the investigatory level - 0.05 to the measured Skid Resistance for each 100m length. Since the Dutch apply only a single threshold to their skid data, they do not store site category information and thus it would not be possible to apply different thresholds for different sites. It is suggested that the threshold applied to non-event carriageways with two-way traffic in the UK (0.40) be applied. As discussed above, this would need to be adjusted for speed, differences due to test tyres and the correction factor, before being applied to the Dutch data i.e. using a threshold of 40*1.06/(0.78*1.083) = 0.50 would be suggested. In the Netherlands, Skid Resistance values for 100m lengths are calculated by subtracting the intervention limit from the weighted average value of the last two years, whilst the RIS1, or proposed RIS2, metric uses measured Skid Resistance data of one year only. Only road sections that are below the intervention limit have a value reported in the database, therefore Skid Resistance thresholds that are lower than the Dutch thresholds could not be applied to the full Dutch dataset. Since the threshold suggested above (0.5) is lower than the Dutch thresholds (0.51 and 0.53), it would be possible to use Dutch data for RIS1, or proposed RIS2, metric calculation.
Likelihood of success - How possible is the comparison?	Comparison of a modified RIS1, or proposed RIS2, metric should be possible.
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate modified RIS1, or proposed RIS2, metric using Dutch data, applying the thresholds suggested above. Obtain IRI values (100m lengths) from Highways England data (either estimate using eLPV or calculate from raw data). Calculate the same modified RIS1, or proposed RIS2, metric as for the Dutch data: Consider 100m reporting lengths, apply a single threshold of 0.4 to SCRIM data and the thresholds suggested above to IRI.
Time required and cost to perform comparison	• Calculate modified RIS1, or proposed RIS2, metric using Dutch data: 4 hours (£494) • Obtain IRI values (100m lengths) from Highways England data: 1 hour (£123) (assuming that IRI has already been calculated for previous comparisons). • Calculate modified RIS1, or proposed RIS2, metric for Highways England data: 5 hours (£617). **Total: 10 hours (£1,234)**
Comparison of Netherlands metric	
Steps required to compare data - What calculations would need to be undertaken on the data?	Other authorities either do not collect Fretting, or do not measure this parameter in the same way. Similarly, Cracking is not measured in the same way in the UK. Thus, the parameters are unlikely to be comparable. Therefore, no comparison can be performed with the Dutch metric including either of these parameters. Thus, there is a need to calculate the Dutch metric excluding these parameters.

<table>
<tr><th colspan="2">Country: The Netherlands (Rijkswaterstaat)</th></tr>
<tr><td></td><td>Calculation of the Dutch metric for 2018 found that the percentage of the network falling below the threshold for individual parameters was:
<table>
<tr><th>Defect</th><th>Percentage below intervention limit</th></tr>
<tr><td>Rut Depth</td><td>0.02 %</td></tr>
<tr><td>IRI</td><td>0.21 %</td></tr>
<tr><td>Skid Resistance</td><td>0.52 %</td></tr>
<tr><td>Cracking</td><td>0.11 %</td></tr>
<tr><td>Ravelling</td><td>0.65 %</td></tr>
</table></td></tr>
<tr><td>Time required and cost</td><td>Calculate modified Dutch metric: 4 hours (£494)
Total: 4 hours (£494)</td></tr>
<tr><th colspan="2">Feasibility to use the country's data to obtain a metric equivalent to local authority metrics</th></tr>
<tr><td>What factors regarding the data used by the road authority may hinder direct comparability</td><td>Dutch pavement condition data is available at 100m reporting lengths but 10m lengths are needed to calculate Red and Amber length of RCI.
Also, the contribution of Roughness to the SCANNER RCI is calculated as follows:
Roughness contribution = maximum (3m LPV contribution, 10m LPV contribution).
The measure of Roughness in Netherlands is the IRI. This cannot be split out into similar measures to 3m and 10m LPV and thus the above calculation would not be possible.
Similarly, the measurement of Cracking is fundamentally different to both Netherlands and the local authorities, and Texture is not routinely delivered.</td></tr>
<tr><td>Likelihood of success - How possible is the comparison?</td><td>Given the reporting length and lack of comparable parameters, a meaningful calculation of the RCI and therefore either the Red or Amber length, is not possible.</td></tr>
<tr><td>Steps required to compare data - What calculations would need to be undertaken on the data?</td><td>N/A</td></tr>
<tr><td>Time required and cost to perform comparison</td><td>N/A</td></tr>
<tr><th colspan="2">Feasibility to use the country's parameter data to compare with Highways England data</th></tr>
<tr><td>What factors regarding the data used by the road authority may hinder direct comparability</td><td>Whilst the measurement of Skid Resistance is similar (sideway-force coefficient measurement), only sections below the Skid Resistance intervention limit are reported in the database. Therefore, a comparison of Skid Resistance data would be very limited and would be unlikely to be helpful. Thus, it would not be recommended that such a comparison is performed.
The Netherlands use IRI as a single Ride Quality parameter. If IRI is estimated from eLPV values or calculated from raw Highways England data, it would be possible to compare IRI from the two networks.
The Dutch Cracking and Ravelling (Fretting) measurements and parameters are very different from those reported by Highways England. Thus, it is not appropriate to try to include these parameters in the metric.</td></tr>
<tr><td>Likelihood of success - How possible is the comparison?</td><td>A comparison between Highways England and Dutch Rutting and IRI data should be possible.</td></tr>
</table>

Country: The Netherlands (Rijkswaterstaat)	
Steps required to compare data - What calculations would need to be undertaken on the data?	Calculate IRI values using Highways England data – either use estimate based on eLPV values or recalculate from raw profile data. Analyse the distributions of values. Apply appropriate thresholds (RIS1, or proposed RIS2 metric, RCI, Dutch metric).

Time required and cost to perform comparison	• Calculation of IRI parameter from Highways England (likely to have already been done for other comparisons):
	  ○ Estimating from eLPV values – 8 hours (£988); or
	  ○ Calculating from raw data – 24 hours (£2,962).
	• Analysis of parameter data: 12 hours (£1,481) if Cracking included in analysis, 10 hours (£1,234) otherwise.
	Total: 10-36 hours (£1,234 - £4,444) or **16-32 hours (£1,975 – 3,950)** if IRI needs to be calculated from Highways England data as part of this task

B.6. SWEDEN

Country: Sweden (Trafikverket)	
Data	
Type of data collected/held	Surface condition data (IRI, Edge Deterioration, Texture (MPD), Rutting); 5 years forecast data (IRI, Rutting, Edge Deterioration).
Level of detail within data	Processed data for 20m lengths of all the roads managed by the Swedish Transport Administration (Trafikverket) are stored in the PMSv3 pavement management system, which is free and open to public, research asset management and commercial use (https://pmsv3.trafikverket.se/). Forecasted individual parameter data for the each of the next 5 years are calculated and provided for 100m lengths.
Form and structure of data	Swedish pavement condition data is available to the public online (https://pmsv3.trafikverket.se/). Rutting, Roughness (IRI), Texture (MPD), and Edge Deterioration data is reported over 20m reporting lengths. The survey contractor delivers processed data to Trafikverket but VTI (the Swedish equivalent of TRL) also store the raw data. This is only available to those with permission.
Would the road authority be willing to engage?	Yes – the data is publicly available.
Common steps required to compare data	Access https://pmsv3.trafikverket.se/ and download the data for Swedish motorways. Calculate data for 100m reporting lengths
Time required and cost to collate/clean/prepare data for potential comparison	• Download data and extract motorway sections: 12 hours (£1,481) • Calculate data over 100m reporting lengths: 2 hours (£247). **Total: 14 hours (£1,728)**
Feasibility to use the country's data to obtain a metric equivalent to Highways England's RIS pavement metric	
What factors regarding the data used by the road authority may hinder direct comparability	Swedish data is reported for every 20m length, whereas the RIS1, or proposed RIS2, metric requires reporting lengths of 10m lengths. Sweden does not collect any Skid Resistance data. Sweden use IRI as a single Ride Quality metric. This could be incorporated into a modified version of the RIS1, or proposed RIS2, metric, as for the Dutch data.
Likelihood of success - How possible is the comparison?	Comparison is possible but only using two individual parameters (Rutting and Roughness) to calculate a modified RIS1, or proposed RIS2, metric. A lot of effort would be required to make this comparison and may not provide benefit over just comparing the individual parameters directly.
Steps required to compare data - What calculations would need to be undertaken on the data?	Obtain Highways England Rutting data over 20m reporting lengths (average 10m lengths). Obtain Highways England IRI data for 20m reporting lengths. Calculate a modified version of the RIS1, or proposed RIS2, metric including only Rutting and IRI from Swedish and then Highways England data.
Time required and cost to perform comparison	• Highways England Rutting data over 20m reporting lengths: 1 hour (£123) • Highways England IRI data for 20m reporting lengths: 1 hour (£123) in addition to calculating IRI values (see previous) • Calculate a modified version of the RIS1, or proposed RIS2, metric including only Rutting and IRI from Swedish and then Highways England data: 8 hours (£988).

Country: Sweden (Trafikverket)	
	Total: 10 hours (£1,234)
Feasibility to use the country's data to obtain a metric equivalent to Netherlands metric	
What factors regarding the data used the road authority may hinder direct comparability	Swedish data is processed and reported over 20m lengths while the Dutch data is over 100m lengths. Sweden does not collect Skid Resistance, Cracking and Ravelling data which is used to calculate the Dutch metric.
Likelihood of success - How possible is the comparison?	Comparison is possible but only using two individual parameters (Rutting and Roughness) to calculate a modified Netherlands metric. A lot of effort would be required to make this comparison and may not provide benefit over just comparing the individual parameters directly. Hence a comparison would not be recommended.
Steps required to compare data - What calculations would need to be undertaken on the data?	Obtain Swedish data over 100m reporting lengths (average 20m lengths). Calculate a modified version of Netherlands metric including only Rutting and IRI from Swedish, Dutch and also, Highways England data.
Time required and cost to perform comparison	• 100m reporting lengths: 2 hours (£247). • Calculate a modified version of Netherlands metric using Swedish data: 4 hours (£494) • Calculate a modified version of Netherlands metric using Highways England data: 4 hours (£494) • Calculate a modified version of Netherlands metric using Dutch data: 4 hours (£494) **Total: 14 hours (£1,728)**
Feasibility to use the country's data to obtain a metric equivalent to local authority metrics	
What factors regarding the data used by the road authority may hinder direct comparability	Swedish pavement condition data is available at 20m reporting lengths, Cracking data is not measured, and the Roughness parameter used is IRI. Thus, it would only be possible to calculate the RCI based on Rutting and Texture data.
Likelihood of success - How possible is the comparison?	Given the reporting length and lack of comparable parameters, a meaningful calculation of the RCI and therefore either the Red or Amber length, is not possible.
Steps required to compare data	N/A
Time required and cost to perform comparison	N/A
Feasibility to use the country's parameter data to compare with Highways England data	
What factors regarding the data used by the road authority may hinder direct comparability	Swedish data reporting length is 20m while Highways England's data reporting length is 10m or 100m. Sweden does not routinely measure Skid Resistance on their road network, instead measuring Texture (MPD). If MPD is lower than 0.5 on a length, this means that further investigation of the Skid Resistance is needed. Highways England also measures Texture on their network and the SMTD and MPD parameters are reported. Whilst it would be possible to compare MPD values, this may not be a fair comparison, as acceptable Texture values can vary depending on the pavement surfacing used. Cracking and Fretting are not measured in Sweden.

Country: Sweden (Trafikverket)	
	Sweden use a single Ride Quality parameter IRI, which cannot be directly compared to eLPV.
Likelihood of success - How possible is the comparison?	A comparison between Rutting and IRI on the Swedish and Highways England networks should be possible. A comparison of MPD values would also be possible but may be difficult to interpret, due to lack of information of surfacing type on the Swedish network.
Steps required to compare data - What calculations would need to be undertaken on the data?	Resample Swedish data to 100m reporting lengths. Calculate IRI values from Highways England data – either use estimate based on eLPV values or recalculate from raw profile data. Analyse the distributions of values. Apply appropriate thresholds (RIS1, or proposed RIS2, metric, RCI, Dutch metric).

Time required and cost to perform comparison	• Resample Swedish data to 100m reporting lengths: 2 hours (£247).
	• Calculation of IRI parameter from Highways England (likely to have already been done for other comparisons):
	  ○ Estimating from eLPV values – 8 hours (£988); or
	  ○ Calculating from raw data – 24 hours (£2,963).
	  ○ Likely to have already been done for other comparisons, so no additional cost
	• Analysis – 6 hours (£741).
	Total: 8 hours (£988) or **16-32 hours (£1,975 - £3,950)** if IRI needs to be calculated from Highways England data as part of this task.

APPENDIX C **REFLECTIONS ON THE USE OF ROAD CONDITION DATA FOR BENCHMARKING**

This Appendix has been prepared by Dr Phill Wheat of the University of Leeds Institute for Transport Studies, drawing on his experiences of implementing road benchmarking through the CQC Efficiency Network.

This report provides a comprehensive description and analysis of the extent to which the measurements between road condition measures across different organisations can be compared. In this Appendix, reflections are provided on the use of the road condition measures in benchmarking and the implications for the collection of the road condition survey data underpinning them.

Benchmarking requires relating two or more metrics to each other in a meaningful way. Obvious candidates are cost (opex and/or capex) and asset quality (captured here as road condition). The interest is whether there are trade-offs between various benchmarking metrics and whether some infrastructure managers are able to achieve better cost and quality outcomes than others. This requires comparisons across infrastructure managers and across time.

To facilitate meaningful, and therefore robust comparisons, there needs to be alignment between data in (at least) two key dimensions:

- Geographical coverage – cost and quality should cover the same assets
- Temporal coverage – cost and quality should cover the same time period and, as importantly, be resampled at the same rate

The following potential issues emerge, particularly when comparing Highways England data to LAs.

Geographical coverage

An immediate concern is comparing SCRIM type data when this is not collected network wide, for example for LAs. This presents substantial challenges in monitoring changes in Skid Resistance over time in these cases, as a relatively small part of the network is sampled per year. This presents a risk that the sample may not be representative of the road condition of the LA networks in any given year.

A lesser issue from a geographical perspective (but see temporal discussion below) is that not all A roads are sampled each year. This is less of issue assuming that roads are being sampled in a systematic method unrelated to their underlying condition, at least within road class.

Temporal coverage

Most surveys are annual and occur at similar time in the year, or in a worst case, where different infrastructure managers' survey at different time of the year, for each infrastructure manager the time of the year is the same. This means comparisons in road condition and cost should be valid over time and, perhaps with adjustments to systematic road condition reflecting sampling at different times of year, valid between infrastructure managers.

More fundamentally, there is an important interaction between temporal coverage and geographical coverage. Where the network is not sampled in entirety, there is a challenge in capturing changes in road condition which is potentially exacerbated by different data base management processes between infrastructure managers.

This issue emerged with specific work undertaken by the CQC Efficiency Network for LAs, highlighting the limitation of relying on road condition data based on partial surveys of the network. What is sought is data on road condition which tracks variations in expenditure from year to year. This is essential for robust benchmarking as there is a clear trade-off between increased expenditure and *improvements* in road condition,

followed by improved road condition and thus lower ongoing expenditure. Any benchmarking framework needs to recognise the upfront cost and longer-term cost gains from investments; capturing this subtle but important impact is very important in assessing performance.

DfT[8] outline that the RDC0120 measures in the single data list are based on rolling averages of two years of survey data. A minimum of 45% of the A road network is surveyed each year with no less than 90% of the network required to be included within the metric.

The spreading of the computation over two years presents an ambiguity as to how long it takes for improvements in road condition to filter through to the measure of road condition. This in turn presents challenges for relating measured changes in road condition to changes in expenditure. The limit for A roads is two years, but there is some uncertainty as to whether to expect a random relationship between improvement work and roads sampled in a year (implying 50% adjustment in Yr1 and the remainder in Yr2) or something more structured.

Indeed, limited interview work undertaken as part of the CQC Efficiency Network has highlighted that practice does differ between LAs in terms of how the road network condition of the roads not surveyed in the latest year are treated. Some LAs simply roll over the previous year's survey data, as would seem to be implied by the DfT guidance. Clearly this introduces the lags in response of the road condition measure as described in the previous paragraph.

Other LAs implement a policy of manually adjusting their PMS system to reflect when they have undertaken improvement work on a road section flagged in the last survey as in need of repair. This essentially gets around the problem of a lag in the response of the road condition variable, as improving road condition in a given year immediately impacts on the road condition metric. A similar approach has been proposed for Highways England in RIS2: "*All lengths of pavement that were renewed since the previous survey are automatically marked as being in 'good' condition*." One limitation of this approach is that it is asymmetric: improvements in road condition are captured in the year that they arise, but deteriorations may take two years to feed through.

As such, one solution could be to select those LAs for comparison that manually over-write their road condition databases when improvement works are undertaken, mirroring the proposal by Highways England.

This problem is more acute when B, C and (particularly) U roads are considered, as these are surveyed at a lower annual rate. Given the purpose of collecting road condition data will be to inform robust regulatory analysis regarding the SRN, the issue is valid for the A road case only.

[8]DfT (2019). Technical Note: Road Condition and Maintenance data, v1.4 Available here.