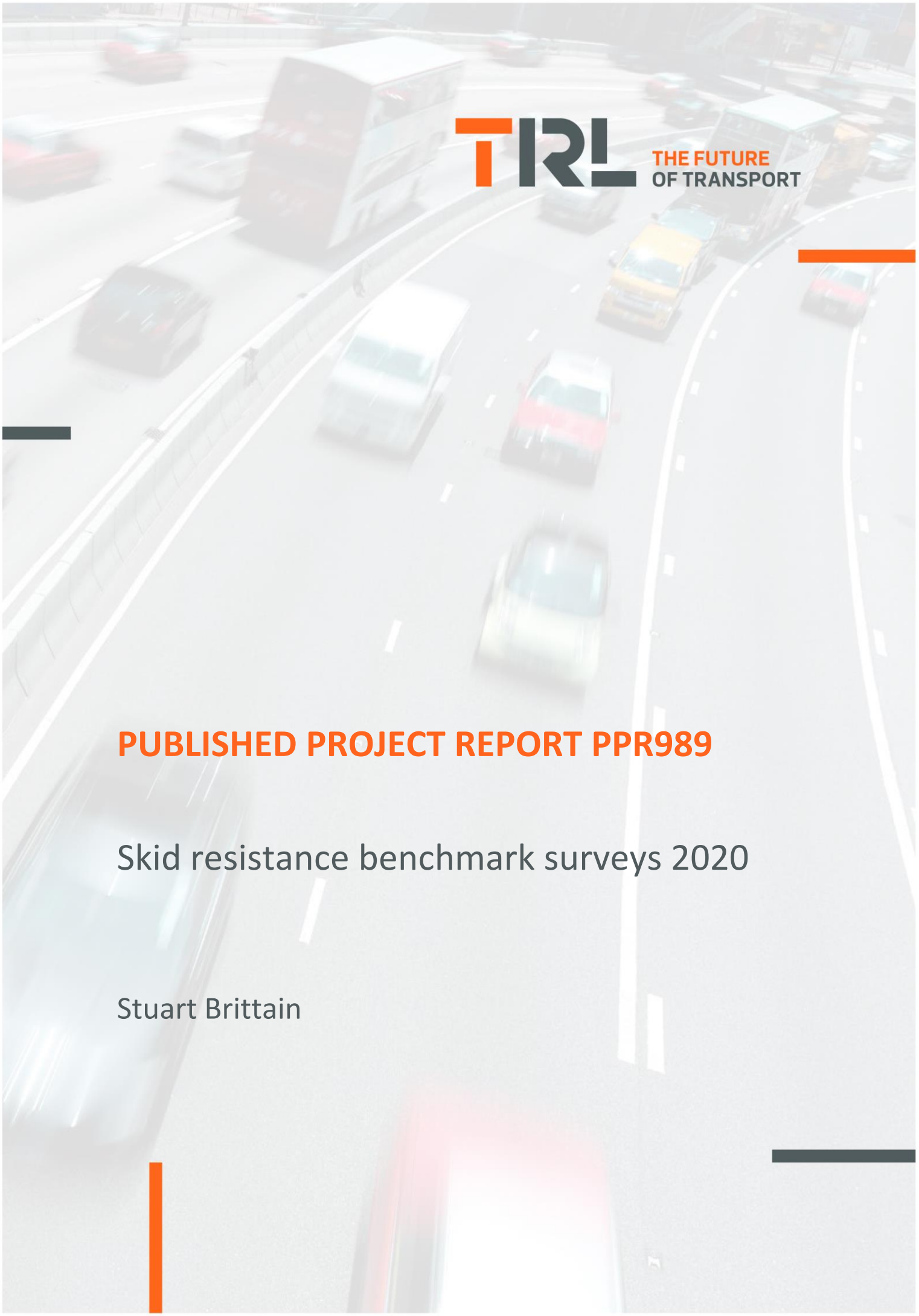

THE FUTURE OF TRANSPORT

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Skid resistance benchmark surveys 2020

Stuart Brittain

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Executive summary

As part of its process for managing skid resistance on the Strategic Road network (SRN), Highways England undertakes single annual skid resistance surveys (SASS). These surveys are carried out over the course of the summer and are split over three survey periods (early, middle and late). It is known that skid resistance varies during the year and between years and the survey data is corrected by the application of correction factors called the "Local Equilibrium Correction Factors" (LECF). To monitor the ongoing trends in skid resistance levels, Highways England established a series of benchmark sites. These sites are surveyed in all three of the survey periods during the survey season. The data collected is then examined for within year and between year trends in the skid resistance levels. This report discusses the analysis of the survey data collected in 2020, and compares the results of the analysis to those from earlier years.

Initially, in 2002, 39 sites were selected as benchmark sites, with two additional sites added in 2008 and a further two in 2009. The initial 39 sites contain mainly asphalt surfaces and the additional four contain mainly concrete surfaces.

One site (site 19) was removed from the long-term reference benchmark site list (sites which have a full survey history and have had no treatment since 2002) during the 2020 analysis. Currently 13 of the original 39 sites are suitable for use in the investigation of trends since 2002. An approach proposed in the analysis of the 2011 data and amended in 2020 to increase the amount of data used, resulted in 392 individual 100m lengths being suitable for use in the investigation of skid resistance trends over the last 10 years.

Comparison of the mean summer skid coefficient (MSSC) values from the benchmark sites suggests that 2020 was an "slightly low skid resistance" year in comparison to the average of the previous three years but an "average skid resistance" year when considering all of the years in the analysis. In addition, the values seen in the early and middle periods were fairly consistent with the late period surveys showing an increase in the values. In 2020 there was a noticeable change in the use of the SRN due to the COVID-19 pandemic. In addition, the majority of the late surveys of the benchmark sites were carried out with a different survey vehicle to the early and mid surveys. Therefore, care should be taken when using the 2020 data in future analyses of change in skid resistance levels on the network.

For the 2020 survey, the between run variation of the data from the concrete sites (3.20 SR) was slightly higher than the expected variation of repeat skid resistance measurements on a given day under the same weather conditions (3 SR). However this variation is seen to be different to the variation of the asphalt sites, and therefore the practice of applying an LECF of 1 to the concrete lengths should continue (as there is not sufficient length to calculate robust stand-alone LECFs for concrete surfaces).

The current analysis procedure uses data collected over the last 10 years for the analysis. This should be repeated in future years, however methods for combining these separate analyses should be investigated in future years so that the trend since 2010 (or 2002 if the results of the long-term analysis can also be incorporated).

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1 Introduction

1.1 Background

In order to investigate long term trends in skid resistance values, Highways England established a series of benchmark sites. These benchmark sites have three surveys in each survey season (one in each survey period) in addition to the routine annual skid resistance survey. These additional surveys allow for the investigation of trends in skid resistance within and between years.

The first of the benchmark site surveys occurred in 2002 and they have been carried out in each year since. Initially there were 39 benchmark sites selected using the following criteria:

1. The site should be well defined (i.e. easily locatable)
2. Safe to test at 50km/h
3. Traffic delays or parked vehicles unlikely
4. Straight and level
5. Typical road surfacings (excluding concrete)
6. Surfacing in good condition

As part of the investigation into the seasonal correction values generated for the network (Donbavand & Brittain, 2007), it was found that concrete did not appear to behave in the same way as asphalt surfaces with regards to seasonal variation. Highways England therefore decided that some concrete sites should be added to the benchmark site investigations. Two sites were added in 2008 (labelled 40 and 41) and a further two were added in 2009 (labelled 42 and 43).

The expected distribution of skid resistance (shown diagrammatically in Figure 1.1) means that skid resistance should be at similar levels in the early and late period surveys with the middle period producing slightly lower results. However, during the analysis of the 2005 benchmark site data it was found that the late surveys did not appear to return to levels similar to the early surveys. It was decided that an additional very late survey (i.e. after the late period survey) would be conducted in 2006 to see if the skid resistance values returned to the levels seen in the early period. This additional survey was also conducted in 2007, 2008 and 2009. A review of the data from the additional very late surveys suggested that the skid resistance was returning to levels seen in the early period during the very late period. Based on these findings, Highways England decided that the survey season should be modified so that the late surveys would produce similar results to the early surveys. The modified survey periods were first used for the 2010 surveys and the survey periods are shown in Table 1.1. Analyses undertaken since 2010 have shown that the revised dates for the survey periods continue to remain suitable.

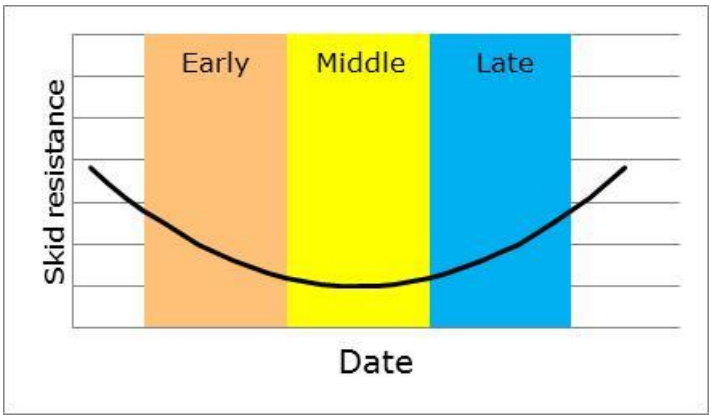

Figure 1.1 Expected seasonal variation of skid resistance over the summer

Table 1.1 Dates for the skid resistance survey periods

		Prior to 2010	2010 onwards
Early	Start	1st May	1st May
	End	20th June	27th June
Middle	Start	21st June	28th June
	End	10th August	24th August
Late	Start	11th August	25th August
	End	30th September	20th October
Very Late[1]	Start	1st October	n/a
	End	31st October	n/a

1.2 Directory of benchmark sites

The location and condition of each benchmark site is detailed within the directory of benchmark sites. The directory is a spreadsheet which contains schematics and summaries of the operators' notes to illustrate the surface changes and condition of each site. This directory is updated after each survey period to reflect the changes observed. The location information from the directory is reproduced in Table A.1 of Appendix A.

[1] The Very Late period was included in the surveys conducted in 2006 to 2009

2 Analysis process

During the analysis of the 2011 skid resistance benchmark sites data (Brittain, 2012) it was proposed that the analysis process should be amended. Prior to the amendment, the process involved examining the data from all of the sites which had not had any treatment or other anomaly since the start of the benchmark site program in 2002. Using this approach meant that, for the report on the 2011 data, only 21 of the 39 sites could be used in the main analysis.

To increase the amount of data included in the main analysis, a new approach was formulated which would only exclude the lengths maintained, rather than removing the whole site. In addition, a new cut-off date for identifying sites with anomalies or resurfaced lengths would be set at 2010 rather than 2002. This new date was selected in part due to availability of the data in a format suitable for this analysis, and partly due to the change in the survey periods which occurred in 2010.

In the analysis of the 2019 skid resistance benchmark sites data (Brittain, 2020) it was proposed that this analysis should be further refined to use a rolling 10 year analysis, i.e. for the analysis of the 2020 surveys, data from 2011 to 2020 would be used. The results from this analysis, incorporating the data from the 2020 surveys, are given in section 4.

Over time this approach will result in overlapping sets of 10 year analyses. Therefore, in future years consideration should be given to identify a suitable approach for combining this data to allow the examination of trends over the whole period.

So that it is still possible to examine trends going back to 2002, an analysis based on the original approach was also undertaken and is reported in Appendix B. In addition to the work on overlapping 10 year analyses discussed above, future analyses may consider if the long term analysis should be dropped due the reduction in data available to make a robust assessment.

3 Survey issues

3.1 Alignment of data

In previous years the survey contractor provided data with markers entered using push button entry. When using these markers to align the data, it was found that the resulting alignments are, in general, good. It is, however, sometimes necessary to shift the locations of the markers by up to 50m (based on a visual analysis of the patterns in the data).

However, when the alignment of data was being checked for the 2020 survey data it was identified that these markers were not present, and as such all of the data was manually aligned (using the graph shapes and OSGR data).

For future analyses it is recommended that the data is fitted using Machine Survey Pre-processor (MSP) software provided by Highways England to survey contractors to fit data to the network. This could be done by either the survey contractor or the company reviewing the data. Before this can be achieved, route files will need to be created for the sites. These files may need to be based on the aligned data (as the alignment undertaken over the years may vary slightly from the position of the nodes given in Appendix A) or may require realignment of the historic data to this new alignment. Note: as this data would not be entered into HAPMS the route files do not need to be created with HAPMS section labels.

3.2 Issues and observations from surveys

For the 2020 survey data, ten sites (2, 4, 7, 17, 18, 19, 23, 28, 32 and 34) had potential issues identified from the data, the Highways England pavement management system (HAPMS) construction records, the video and/or from the operator's notes (recorded in the directory of benchmark sites).

3.2.1 Site 2

It was seen from the video for site 2 (and recorded in the operator's notes) that during the Early survey the first 250m of the site was undertaken in lane 2 due to road works. Therefore, the first 250m of the site should be considered invalid for the 2020 survey. This treatment is reflected in the HAPMS construction records.

3.2.2 Site 4

The whole of this site was resurfaced between the 2019 and 2020 surveys. This was recorded in the operator's notes and in the HAPMS construction records.

3.2.3 Site 7

The late survey for this site stopped 30m short of the previously aligned data for the site. Therefore, the last 30m of this site should be considered invalid for the 2020 survey.

3.2.4 Site 17

Parts of this site were maintained between the 2019 and 2020 survey as can be seen in Figure 3.1. The lengths identified as maintained were at chainages 210-340m, 450-460m, 600-630m and 1590m to the end of the site.

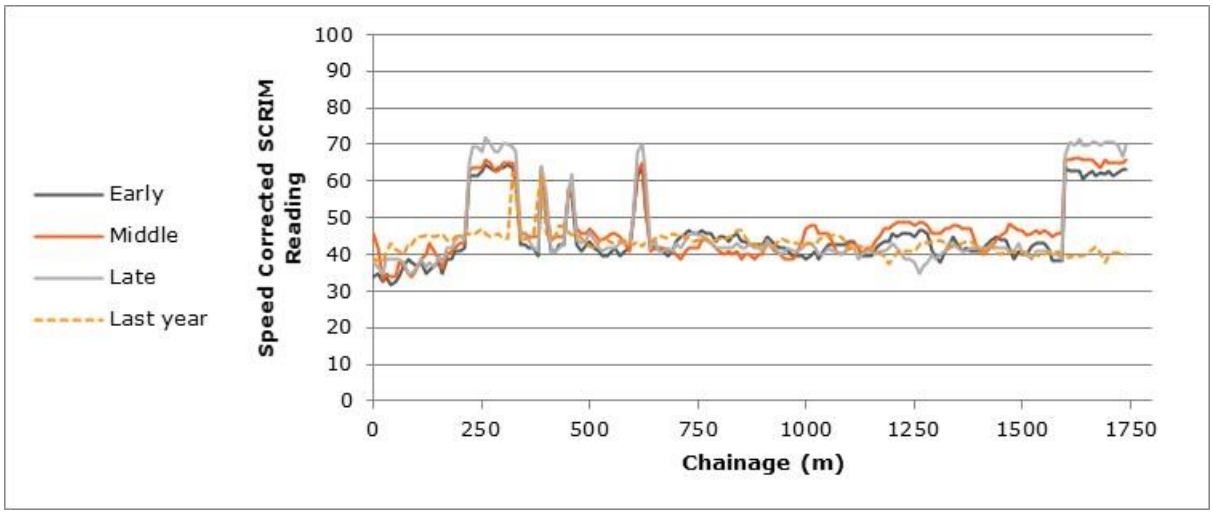

Figure 3.1 Skid resistance values from the 2020 survey for site 17

These lengths appear to match up with the HAPMS construction records and were also partially recorded in the survey notes.

3.2.5 Site 18

This whole of this site was resurfaced between the 2019 and 2020 surveys. This was recorded in the HAPMS construction records but was not noted in the survey notes.

3.2.6 Site 19

This site was not surveyed during the middle period due to resurfacing works. Therefore, the whole of this site should be considered invalid for the 2020 survey. The resurfacing treatment is reflected in the HAPMS construction records.

3.2.7 Site 23

This site was surveyed in lane 2 for all three surveys due to road works. Therefore, the whole of this site should be considered invalid for the 2020 survey. It is noted that this site was surveyed on the hard shoulder for the 2019 surveys and therefore was already excluded from the analyses. These works do not appear to be reflected in the HAPMS construction records at this stage.

3.2.8 Site 28

This site appears to have had some maintenance applied between the early and middle surveys between 570 and 730m as seen in Figure 3.2.

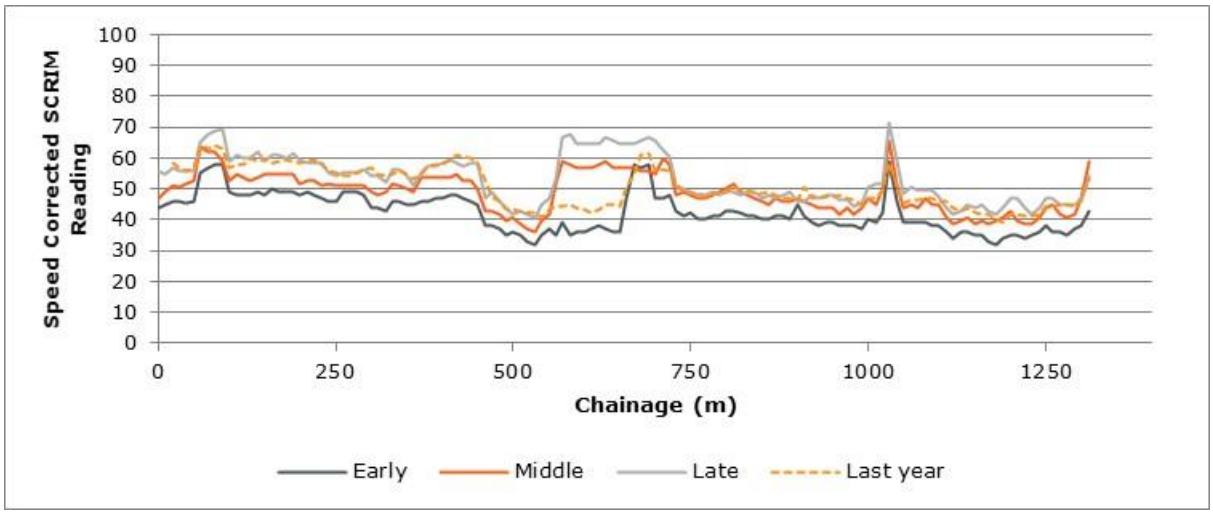

Figure 3.2 Skid resistance values from the 2020 survey for site 28

Therefore, this length (570 to 730m) should be considered invalid for the 2020 survey. The HAPMS records contains some patches undertaken in March 2020, however the treatment between the Early and Middle surveys does not seem to be present yet. In addition, this treatment was not recorded in the survey notes.

3.2.9 Site 32

This site appears to have had some maintenance applied between the middle and late surveys from 1040 to 1190m as seen in Figure 3.3.

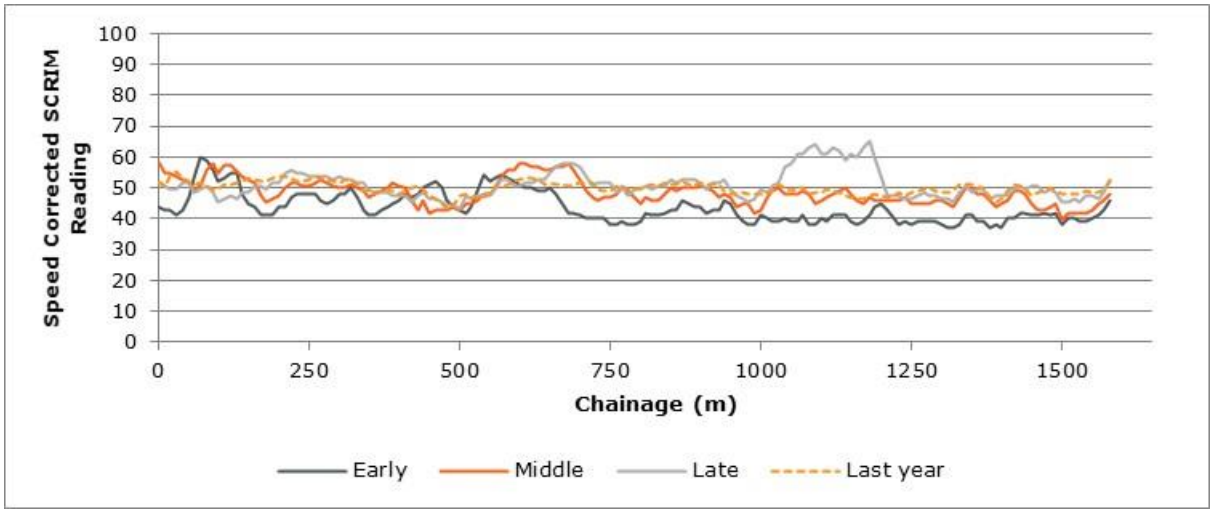

Figure 3.3 Skid resistance values from the 2020 survey for site 32

Therefore, this length (1040 to 1190m) should be considered invalid for the 2020 survey. No maintenance was recorded in the survey notes, or in HAPMS.

3.2.10 Site 34

Examination of the data for this site shows that it appears to have been maintained at the beginning (to approximately 700m) and the end (past approximately 1200m). However,

there are also small changes to the middle part of the site which suggests that this has also been maintained. The data for this site can be seen in Figure 3.4.

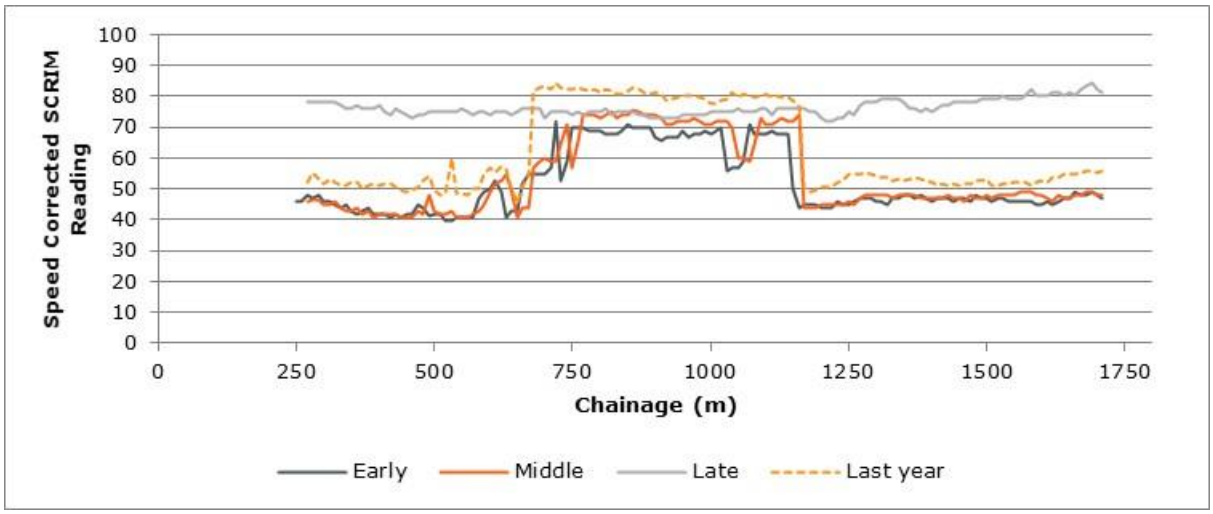

Figure 3.4 Skid resistance values from the 2020 survey for site 34

Therefore, the whole of this site should be considered invalid for the 2020 survey. The maintenance does not appear to be reflected in the HAPMS construction records and was not noted in the survey notes.

3.2.11 Summary of issues and observations from surveys

A summary of all the sites which have had any anomalies since the start of the benchmark site programme, which has resulted in them being removed from the long term reference benchmark sites, is shown in Table 3.1. Site 38 is shown in grey italics as it has not been removed but should be removed if any additional issues are found.

If a benchmark site has undergone treatment, is missing surveys or otherwise unsuitable during the analysis period then it can no longer be considered as part of the long term reference set (i.e. used to calculate the average trend in MSSC since 2002). The analysis of the long term reference set is provided in Appendix B.

Table 3.1 Summary of issues and observations

Site Numbers	Year	Comments
5	2005	Resurfaced in 2005
4	2007	The late run in 2007 was carried out in lane 2 instead of lane 1
7, 15, 23 and 33	2007	Resurfaced in 2007
10, 16, 20, 22, 23 and 30	2008	These sites were resurfaced in 2008. Note site 23 was resurfaced in 2007 and 2008
2, 4, 21, 30 and 37	2009	Resurfaced in 2009. Note site 30 received patching treatment in 2008 and 2009
5	2010	Unable to align 2010 data
28	2010	Road works during early 2010 survey
21	2010	Patch(es) between 2009 and 2010 surveys
34	2010	Difference between the early start point and the mid/late start point
41	2010	Unexplained difference in SR between the early and the mid/late survey
4	2011	New surfacing between the 2010 and 2011 surveys
11	2011	Unable to align 2011 data
10 and 30	2012	Resurfaced between 2011 and 2012
5	2012	First 500m of site missing from early and late surveys
39	2012	Invalid data for part of the testing and resurfaced between 2011 and 2012
26	2014	Was not surveyed
28	2014	Was not surveyed in the late period
15	2015	Majority of site was resurfaced between the early and middle surveys
20	2015	Majority of site was resurfaced between the middle and late surveys
29	2015	First half of the site was resurfaced between the early and middle surveys
2	2016	The site was resurfaced between 250 and 500m
3 and 7	2016	The whole site has been resurfaced.
6	2017	Site resurfaced between 780 and 2875m between early and middle surveys
33	2017	Whole site resurfaced before the early survey
4, 17, 18 and 23	2018	Treatment to parts of the sites
34	2018	Hard shoulder surveyed instead of lane 1 for the middle and late surveys
22 and 29	2019	Length resurfaced at end of site
23	2019	Surveys undertaken on hard shoulder due to road works
28	2019	Length resurfaced at the start of the site
38	*2019*	*Short length maintained at end of site (should not be removed from long term analysis at this stage)*
19	2020	No middle survey

One site (site 19) was removed from the long term reference benchmark sites this year. There are currently 13 long term reference benchmark sites and these are listed in Table 3.2.

Table 3.2 Reference benchmark sites

Site	Road
1	A30
8	M20
9	A23
12	A12
13	A47
14	A1
25	M40
27	A616
31	M6
32	M58
35	A66
36	M6
38	A1

An approach proposed in the analysis of the 2011 data (and amended following a review of the 2019 data) to increase the amount of collected data used, enabled skid resistance trends of individual 100m lengths to be analysed from 2011 onwards.

For the 2020 surveys, following the removal of unsuitable lengths, 288 (of 627) individual 100m lengths were available for the investigation of skid resistance trends over 10 years for the asphalt sites and 104 (of 109) 100m lengths for the concrete sites. This is a reduction from last year's analysis of 36 individual 100m lengths for the asphalt sites and an increase of 35 individual 100m lengths for the concrete sites.

4 Results from the 2020 surveys

4.1 Average SR and between survey variation

The process implemented to examine data may in some years result in some of the sites reducing to very short lengths. These shorter sites should not have as much input into the overall benchmark statistics as longer sites. To allow a sensible weighting of the data, each site is split into 100m lengths, with the average values for each 100m length being averaged together to produce the overall average for the benchmark sites. The results from the 2020 surveys are given in Table 4.1.

Using this process means that the lengths used in the benchmark site analysis change each year, and as such the data provided in previous years' reports will not always be directly comparable to that in the current year's report. This is because some lengths will be excluded in the current analysis which were not previously excluded. In addition, lengths that were excluded as a result of the data collected 11 years ago would be brought back in for this analysis. To provide a comparison to the results of this year's analysis, the data from the preceding 9 years have be reprocessed using the same lengths used for the 2020 analysis; this analysis is presented in Appendix C.

Utilising 100m averages for this analysis also allows for the investigation of between run variation using the criteria from the accreditation trials for sideway-force skid resistance devices (TRL, 2020) as a comparison; i.e. if the road conditions remain the same, the upper limit on the acceptable between run standard deviation is 3 SR. This means that if seasonal variation is occurring then it would be expected that the variation between the early, middle and late runs would be larger than 3 SR. Note, the between run standard deviations have been averaged together using the root mean square approach (the standard approach for calculating averages of standard deviations).

For the 2020 data the between run standard deviation (BRSD) is above 3 SR for both the asphalt and the concrete sites. The BRSD is larger for the asphalt sites in comparison to the concrete sites. This is consistent with expectations and results in previous years (with the exception of 2015 where the deviation for the concrete sites was higher than for the asphalt sites).

Table 4.1 2020 survey data

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	70.1	64.1	62.1	4.51	65.4
2	5	67.5	62.1	58.3	4.70	62.6
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	58.3	54.1	58.7	2.53	57.0
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	60.1	55.4	57.4	2.70	57.6
9	13	45.7	43.9	51.9	5.50	47.2
10	15	62.3	56.7	56.8	3.43	58.6
11	0	-	-	-	-	-
12	8	64.5	55.7	60.9	4.69	60.4
13	11	48.9	52.6	54.6	3.12	52.0
14	16	58.7	60.6	66.4	4.23	61.9
15	1	41.5	44.9	45.8	2.26	44.1
16	18	56.3	50.0	59.3	5.01	55.2
17	10	42.1	43.3	41.4	2.26	42.3
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	52.9	54.5	62.1	5.12	56.5
22	17	68.9	75.8	74.0	3.99	72.9
23	0	-	-	-	-	-
24	10	56.9	55.6	58.8	1.96	57.1
25	12	64.5	61.8	66.8	2.78	64.4
26	0	-	-	-	-	-
27	16	60.2	62.0	70.5	5.57	64.2
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	47.1	53.5	62.6	7.87	54.4
31	18	54.2	60.4	65.6	5.88	60.1
32	12	43.9	48.6	49.9	3.93	47.4
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	59.6	51.4	57.1	4.36	56.0
36	10	50.0	52.0	59.1	4.95	53.7
37	13	52.9	59.0	65.8	6.54	59.2
38	14	56.2	56.6	63.5	4.69	58.8
39	3	57.3	60.2	67.4	5.24	61.6
40	13	54.4	57.6	61.2	3.51	57.7
41	54	47.0	41.8	42.8	3.70	43.9
42	18	50.4	47.0	46.3	2.74	47.9
43	19	47.3	45.9	46.1	1.35	46.5
Asphalt 0-39	288	56.3	56.4	61.0	4.76	57.9
Concrete 40-43	104	48.6	45.4	46.3	3.20	46.8

A summary of between run standard deviations (BRSD) and the average SR values since 2011 are presented in Table 4.2 for the asphalt lengths and in Table 4.3 for the concrete lengths. The averages are also shown in Figure 4.1 along with the trend lines for the data.

Table 4.2 Summary of asphalt site data

Year	BRSD	Average SR
2011	2.77	58.7
2012	2.30	58.6
2013	3.54	55.2
2014	5.00	55.7
2015	5.01	57.9
2016	4.02	59.3
2017	6.22	57.2
2018	5.62	59.9
2019	4.79	59.4
2020	4.76	57.9
Average	4.56	58.0

Table 4.3 Summary of concrete site data

Year	BRSD	Average SR
2011	1.58	52.3
2012	2.20	53.4
2013	1.80	49.3
2014	3.53	49.6
2015	5.29	50.7
2016	2.16	53.9
2017	3.93	50.1
2018	4.52	52.0
2019	4.07	51.2
2020	3.20	46.8
Average	3.44	50.9

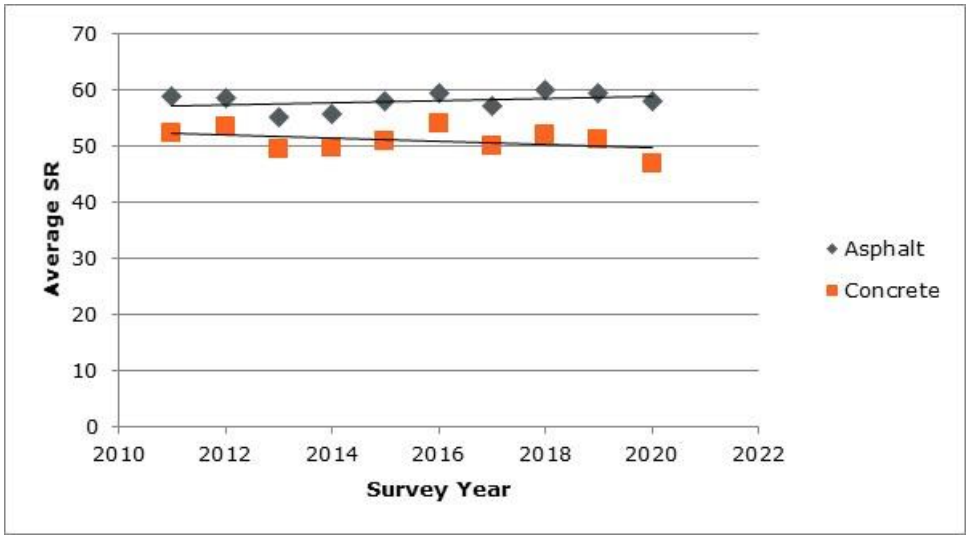

Figure 4.1 Average SR of Benchmark sites over time

These tables and figure show that the between run or between period standard deviation for the asphalt surfaces is highest for the 2014, 2015, 2017, 2018, 2019 and 2020 survey years, and lowest in 2012. In addition it can be seen that for four of the ten years, the between period standard deviation for the concrete lengths (and for the asphalt sections in 2011 and 2012) is lower than the between run standard deviation criteria from the accreditation trials (3 SR). This suggests that the variation seen on the concrete sites (and on the asphalt sites in 2011 and 2012) is likely to be mainly or solely caused by normal machine variation.

4.2 Expected distribution of SC for asphalt sites

In order to visualise the variation of Skid Coefficient (SC) throughout the course of the survey season the ratio of the MSSC value to the measured value (for each period and each 100m length) was calculated. This ratio is approximately equivalent to a Local Equilibrium Correction Factor (LECF) value (although strictly they are not, as they would only correct within year variation and are being applied to 100m lengths). The average MSSC value for the complete 2020 dataset was then divided by these "LECF" values and combined with the survey dates to produce an estimate for the distribution of SC values.

Using this approach allows the current year's data to be compared to previous years on a like for like basis. In particular, differences in average values between years and also within year trends can be investigated. The lines of best fit for the data for the last five years are shown in Figure 4.2.

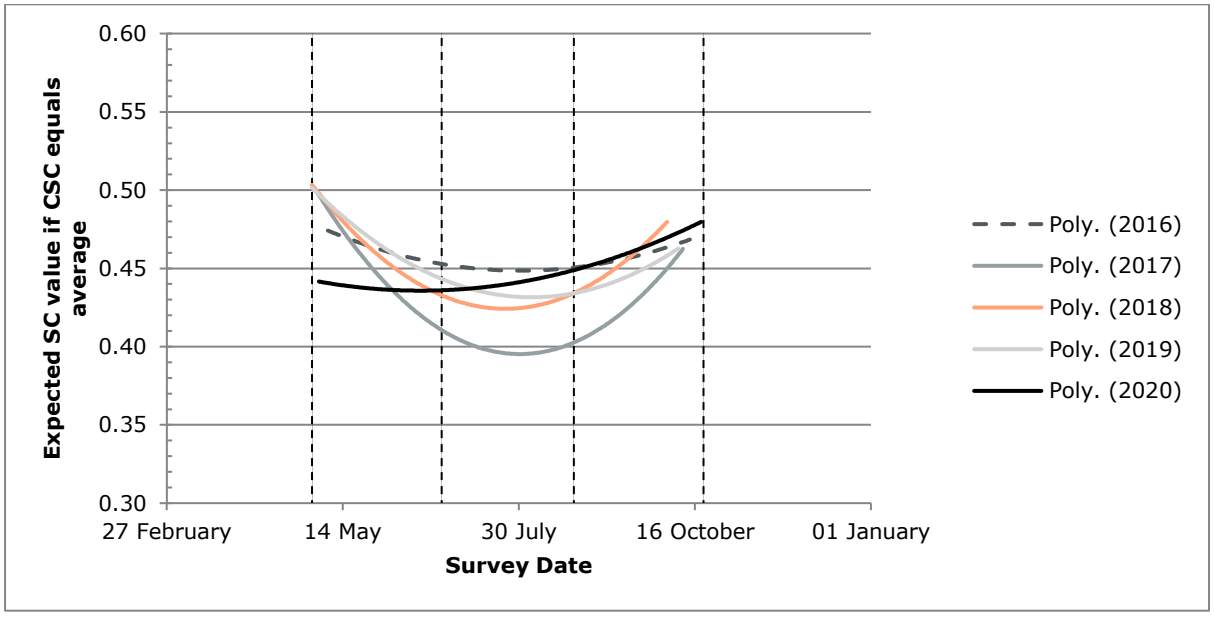

Figure 4.2 Expected SC values (sites 1-39)

It can be seen from Figure 4.2 that the within year seasonal variation, varies slightly from year to year with the largest changes seen in 2017, followed by 2018, 2019 and 2020 (as noted in section 4.1). It can also be seen that for the shape for the 2020 data is noticeably different from the previous years, with the lowest value appearing to be in the early period and an increase in skid resistance for the middle and late surveys. However, on further examination of the data (average SR values can be seen in Table 4.1) it can be seen that the

early and middle data is broadly similar, with the late surveys producing higher values. Figure 4.3 shows the individual 100m data points for the 2020 data.

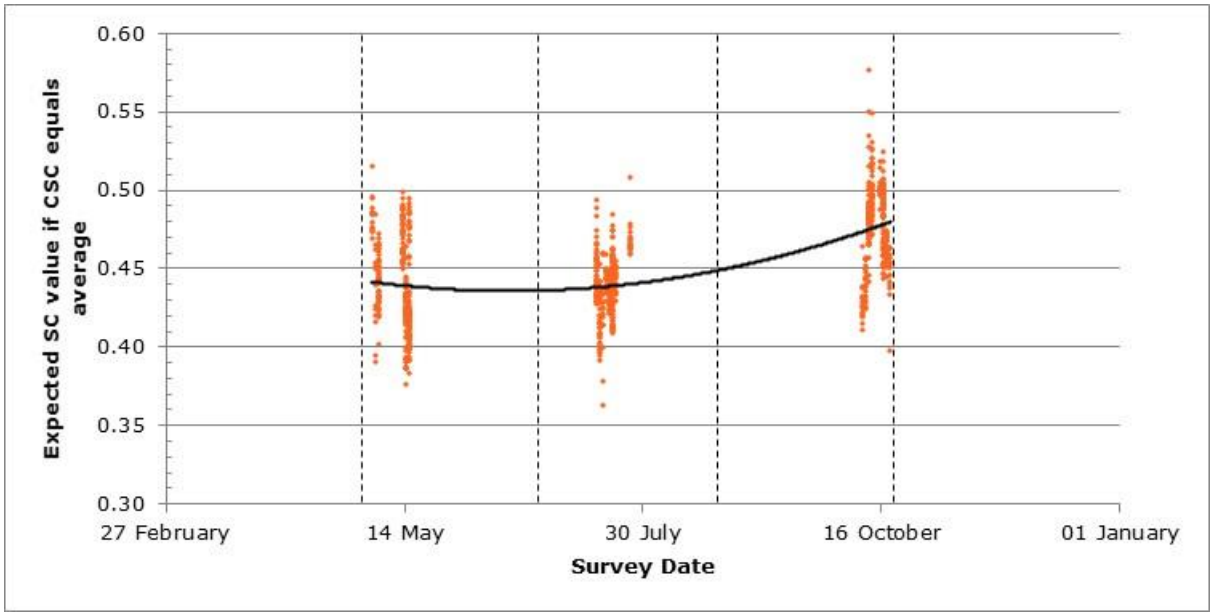

Figure 4.3 2020 100m SC values (sites 1-39)

In 2020 there was a noticeable change in the use of the Highways England Strategic Road Network (SRN) due to the COVID pandemic. In mid-March 2020 the UK went into lockdown and all non-essential travel was banned. This led to a sharp drop in traffic on the SRN (although there was still heavy goods traffic for supplying of supermarkets, etc.). Traffic was seen to increase over the middle of summer with traffic returning to just under normal levels towards the end of summer/early autumn. These changes in traffic levels may be the cause of the different pattern in skid resistance levels seen in the 2020 data. However, it is also noted that the survey vehicle was different for the majority of the late surveys. Due to these factors, care should be taken when using the 2020 data in future analyses of change in skid resistance levels on the network.

The analysis of the 2020 LECFs (Brittain, 2021) suggested that the skid resistance levels were fairly flat during 2020 (with the minimum value in the middle of the middle period). This is reasonably consistent with the pattern seen for the benchmark sites, with the exception of the slight increase in skid resistance values for the late surveys. The LECF analysis provides an estimate of ongoing trends of the overall seasonal variation of the network, however it is complicated by the fact it uses data from different areas for each period to perform the analysis. Therefore, the trend seen from the benchmark sites is generally the more reliable of the two when considering the overall trend in skid resistance over time. However, in terms of estimating future CSC values for the network, the results from the LECF analysis should be used (as it is using the same data that would be used in future LECF calculations).

The analysis of the 2020 LECFs also found that the measured skid resistance over the year was slightly lower than the average of the previous three years. On examination of Table 4.2 it can be seen that average for 2020 was 57.9 and the average of the three previous years (2017, 2018 and 2019) was 58.8.

4.3 Expected distribution of SC for concrete sites

The approach used to visualise the distribution of SC values for asphalt sites (see section 4.2) was also applied to the concrete sites and the results are shown in Figure 4.4.

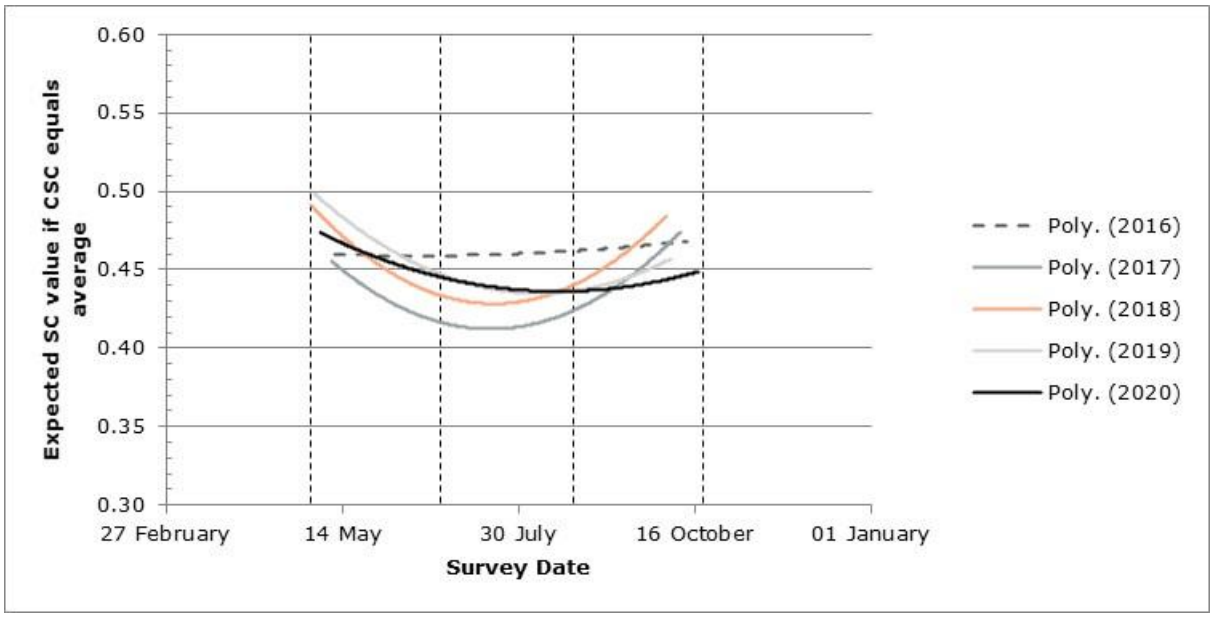

Figure 4.4 Expected SC values (sites 40-43)

The data for concrete sites in 2017 and 2018, and to a lesser extent in 2018 and 2019, suggest that these sites are experiencing within year seasonal variation. However, it is noted that the variation seen is different to that for the asphalt sites and the pattern is absent or reduced in 2016 and a high proportion of earlier years (not shown). Therefore, the practice of applying an LECF of 1 to the concrete lengths on the Strategic Road Network (SRN) should continue (as there is not sufficient length to calculate robust stand-alone LECFs for concrete surfaces).

4.4 Monitoring lengths available for the analysis

Prior to the 2020 analysis, the procedure used data collected since 2010 and excluded any lengths that had been maintained or had incomplete surveys over the period. This meant that the lengths available to the analysis reduced slightly each year. In the analysis of the 2019 data it was proposed that the procedure would be changed to a rolling 10 year cut-off so that lengths previously excluded could be brought back into the analysis. This rolling cut-off was applied to the 2020 analysis meaning data collected since 2011 has been used. The lengths used in the analysis for each survey year is given in Figure 4.5 for asphalt lengths and in Figure 4.6 for concrete lengths.

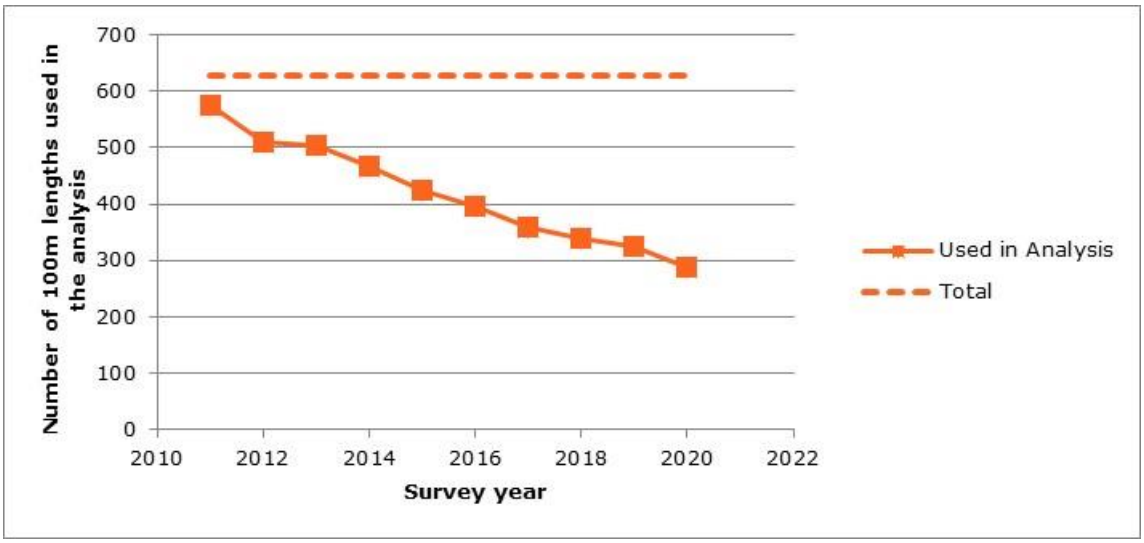

Figure 4.5 Number of 100m asphalt lengths used in the anlaysis

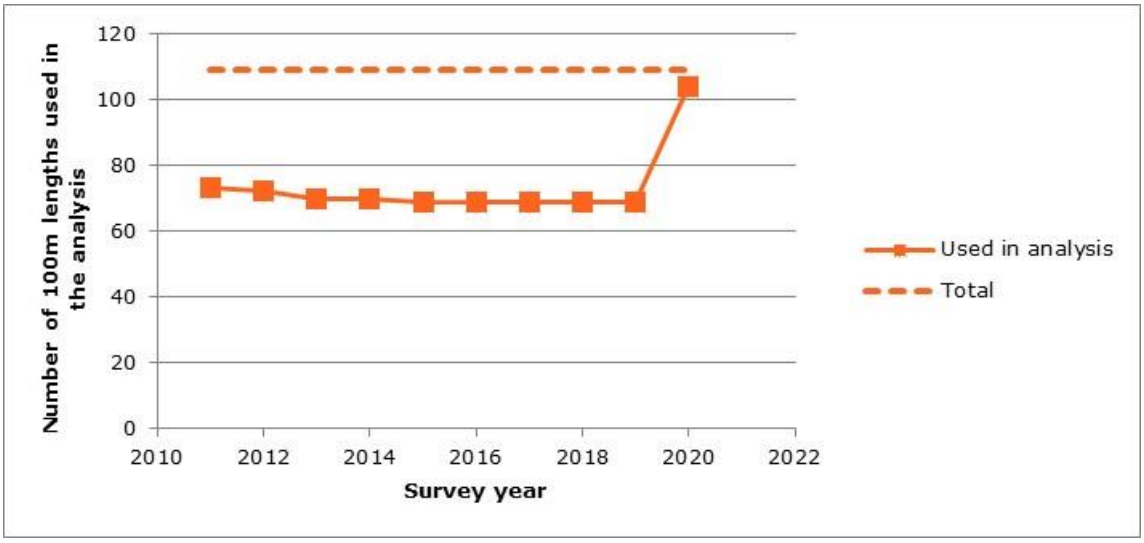

Figure 4.6 Number of 100m concrete lengths used in the anlaysis

It can be seen from these two graphs that the asphalt lengths used in the current analysis have dropped slightly from last year and the concrete lengths have increased from last year. The increase in concrete lengths is due to maintenance conducted during the 2010 surveys excluding data from previous analyses. Overall, 46% of the asphalt lengths were used in the current analysis, and 95% of the concrete lengths.

5 Conclusions and recommendations

5.1 Data coverage

One site (site 19) was removed from the long-term reference benchmark site list (sites which have a full survey history and have had no treatment since 2002) in the analysis of the 2020 data. Currently 13 of the original 39 sites are suitable for use in the investigation of trends since 2002 (given in Appendix B) and 392 individual 100m lengths (288 asphalt lengths and 104 concrete lengths) are suitable for use in the investigation of trends over the last ten years.

5.2 Alignment of data

It is recommended that, for future analyses, the survey data is fitted based on the OSGR coordinates using MSP. This could either be done by the survey contractor or the company reviewing the data. The plots of the resulting alignment should, however, still be checked for anomalies.

Before this can be achieved route files will need to be created for the sites. This may need to be based on the aligned data (as the alignment undertaken over the years may vary slightly from the position of the nodes given in Appendix A) or may require realignment of the historic data to this new alignment.

5.3 Results

Investigation into the average SR values suggests that 2020 was close to the average SR value of the last 10 years and slightly below the average when compared to the last three years. This is consistent with the analysis of the 2020 LECFs (Brittain, 2021).

The analysis also found that the SR values for the early and middle surveys of the benchmark sites were reasonably consistent, but the late surveys were slightly higher. The analysis of the 2020 LECFs suggested that the SR values appeared to be relatively consistent throughout the survey season. Due to differences in the data used for the two analyses, the results from the benchmark sites are generally more robust when considering the overall trend in skid resistance over time for the Highways England network, while the results from the LECF analysis should be used when estimating future CSC values for the network. However, it is noted that the majority of the late surveys on the benchmark sites were conducted with a different survey vehicle.

In 2020 there was a noticeable change in the use of the Highways England Strategic Road Network (SRN) due to the COVID-19 pandemic. In mid-March 2020 the UK went into lockdown and all non-essential travel was banned. This led to a sharp drop in traffic on the SRN (although there was still heavy goods traffic to supply, for example, supermarkets). Traffic was seen to increase over the middle of summer with traffic returning to just under normal levels towards the end of summer/early autumn. Due to these factors (and the change in survey vehicle for most of the late surveys), care should be taken when using the 2020 data in future analyses of change in skid resistance levels on the network.

For the 2020 data the between period standard deviation for the concrete sites was just above 3 SR suggesting that this variation is likely to be in part caused by seasonal variation. However, this variation was still quite low (3.20) and is seen to be different to the variation on the asphalt sites. Therefore, the practice of applying an LECF of 1 to the concrete lengths should continue (as there is not sufficient length to calculate robust stand-alone LECFs for concrete surfaces).

5.4 Further development of the analysis procedure

The current analysis procedure for each year of benchmark site data uses a rolling 10 year cut-off for the analysis. This means that over time (as more years are added) this approach will result in several overlapping sets of 10 year analyses. Therefore, in future years consideration should be given to identifying a suitable approach for combining this data to allow examination of trends over the whole period.

So that it is possible to examine trends going back to 2002, an analysis based on the original approach was also undertaken. Due to the reduction in available sites, this analysis will become less robust with each passing year. Therefore, consideration should be given in future years to drop this analysis or to merge the conclusions from it into the combined 10 year analyses dataset.

References

Note: this list of references contains both unpublished reports (UPR) and client project reports (CPR) produced for Highways England. Please make a personal application to Highways England if you wish to obtain a copy.

Brittain, S. (2012). *SCRIM Benchmark surveys 2011 (CPR 1298).* Wokingham: TRL.

Brittain, S. (2020). *Skid resistance benchmark surveys 2019 (PPR 950).* Wokingham: TRL.

Brittain, S. (2021). *Calculation of Local Equilibrium Correction Factors for the 2020 Skid Resistance surveys (PPR xxx).* Wokingham: TRL.

Donbavand, J., & Brittain, S. (2007). *Task 3: Review of Correction Factors (UPR/IE/213/06).* Wokingham: TRL.

TRL. (2020). *Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices v4.1 [online]. [Accessed 4th March 2021].* Available from World Wide Web: https://ukrlg.ciht.org.uk/ukrlg-home/guidance/road-condition-information/data-collection/skid-resistance/.

Appendix A Benchmark site locations

Table A.1 Location details of the benchmark sites

Site No.	Area	Route	Direction	Section(s)	Length (m)	Description	Nodes
1	1	A30	E/B	0800A30/400	2260	Studs under A3076 bridge at Mitchell to studs at 2260m	21435-21460
2	1	A30	W/B	1100A30/115	1180	End of slip On from A377 to studs at 1180m	492-431
3	2	M5	S/B	3300M5/210, 3300M5/220	1694	End of slip On at Jct 22 to studs at 1694m	15179-15184-15185
4	2	M4	E/B	3900M4/162	1226	End of slip On at Jct 17 to studs at 1226m	448-446
5	3	M3	S/B	1700M3/383, 1700M3/391	1003	Start of slip Off at Jct 7 (A30) to studs at 1003m	75990-75940-75897
6	3	M4	E/B	0300M4/393, 0300M4/391	2875	End of slip On at Jct 15 to studs at 2875m	35593-35941-35489
7	3	A31	E/B	1200A31/461, 1200A31/467	1358	Exit from Ameysford Rbt to studs under B3072 bridge	12071-12076-12999
8	4	M20	E/B	2200M20/290	1634	End of slip On at Jct 9 (A20/A28) for 1634m	5230-1859
9	4	A23	N/B	3800A23/340	1402	Studs just after bridge over approx. 1050m after B2110 (bridge over at Handcross) to studs under footbridge at 1402m	13078-13216
10	M25 DBFO	M11	N/B	1500M11/114, 1500M11/116	2473	Start of slip Off at Jct 5 (A1168) to start of concrete	70050-70060-70070
11	M25 DBFO	M4	W/B	5540M4/244	976	Start of slip Off to Heston Services to end of Slip On	32828-32830
12	6	A12	N/B	1500A12/294	1053	Studs at Suffolk boundary to start of slip road off to B1029	40560-42270
13	6	A47	E/B	2600A47/145, 2600A47/147	1348	Studs under bridge at centre of Terrington St John interchange to bridge at 1348m	5027-5733-50343
14	7	A1	N/B	2500A1/110	2150	End of slip On from South Witham to Jct Left (to North Witham)	7005-7015
15	7	A1	N/B	3000A1/345	1426	Jct L to Elkesley Village (744m N of B6387) 1426m to Jct Rt	20125-20129
16	8	A1(M)	S/B	1900A1M/58	1946	End of slip On at Jct 7 to studs under bridge at 1981m	1530-11489
17	7	A14	E/B	2800A14/120	1728	Studs under bridge 3742m W of A508 (bridge over) to studs under bridge at 1728m	1820-2022
18	2	M5	N/B	1600M5/138	1264	Studs under A4019 bridge at Jct 10 to studs under next bridge	4231-30034
19	9	A49	N/B	1800A49/320	1760	Jct R (to Stoke Prior) to River Bridge	43133-43134
20	9	A5	W/B	3200A5/293	1641	Exit from A49/A5112 Rbt to studs under bridge at 1641m	50293-50289
21	10	M56	W/B	0600M56/419, 0600M56/422	1898	End of slip On at Jct 10 (A49) to studs at 1898m	63410-63501-63601
22	7	A5	S/B	2400A5/50	2007	Studs near start of 2 lanes 2.5k S of Jct B577 for 2007m to studs near end of 2 lanes (studs are at start and end of grassed central reserve).	20067-20049

Site No.	Area	Route	Direction	Section(s)	Length (m)	Description	Nodes
23	9	M6	S/B	3400M6/430	995	Studs 2255m before start of slip Off at Jct 14 to studs at 995m	23101-23001
24	9	M42	N/B	3700M42/334	1090	Studs 1090m before start of Slip Off to Jct 10 (A5) to start of Slip Off	28687-28685
25	9	M40	S/B	3700M40/183	1403	End of slip On at Jct 17 (M42 Jct 3a) to start of slip Off at Jct 16	29504-29503
26	7	M1	S/B	1000M1/216	1600	End of slip on at Tibshelf services to studs at “Jct 28 1 mile” sign	10054 (now 9997)-10052
27	12	A616	W/B	4405A616/30	1717	Studs L Jct A629 to studs on river bridge at 1717m	61630-61644
28	10	M62	E/B	4200M62/450	1308	End of slip On at Jct 21 to studs at 1308m	22105-22107
29	12	M18	S/B	4400M18/108	1681	End of slip On at Jct 4 (A630) to studs at 1681m	4308-321
30	12	A63	W/B	2000A63/409	2378	End of slip On at A1034 to studs at bridge over 2378m	2002-30482
31	13	M6	S/B	2300M6/291	1973	End of slip On at Jct 33 to start of slip Off to Lancaster services	18323-18239
32	10	M58	W/B	2300 M58/431	1570	End of slip On at Jct 5 to start of slip Off at Jct 4	8618-20005
33	A1DDD BFO	A1	N/B	2700A1/242, 2700A1/252	1864	End of slip On at Bramham to start of slip Off to A659 (may now be DBFO)	21488-21422-21184
34	14	A1(M)	N/B	1300A1M/212, 1300A1M/216	1426	End of slip on at Jct 59 (A167) to studs at 1426m	17-18-19
35	13	A66	E/B	0900A66/142	1860	Studs on bridge over B5292 (1950m E of A5086 Rbt) to studs at 1860m	31347-31507
36	13	M6	S/B	0900M6/373, 0900M6/379	1121	Start of slip Off at Jct 37 (A684) to end of slip On at Jct 37	14192-14187-14181
37	13	M6	S/B	0900M6/351	1385	Start of slip Off to Southwaite services to end of slip On from services	14779-14766
38	14	A1	S/B	2900A1/106	1727	Studs (road under) 2.22km before A19 bridge over to studs at 1727m (25m after Newcastle sign and 45m before start of slip off to A19)	14063-14002
39	14	A1	N/B	2900A1/380	2200	Jct Rt B6347 (to Christon Bank) to studs at start of dual c/way central reserve	11030-11101
40	9	M54	E/B	3200M54/784	1434	Asphalt/PQC surface change @ marker post 27/7 to start slip off to J4	54006-40100
41	6	A14	E/B	3500A14/632 to 3500A14/716	5601	End slip on J54, Sproughton to start slip off J56, Wherstead	90366-90301
42	6	A12	S/B	1500A12/158	1960	Baddow Park Overbridge to Slip off	40950-40960
43	M25 DBFO	M25	C/W	3600M25/464	2004	MP55/0 to MP57/0	21543-21541

Appendix B Benchmark site data processed using the old analysis procedure (asphalt sites only)

B.1 2020 survey results

The average speed corrected skid readings (speed corrected SR) and the range between the highest and lowest average speed corrected SR for the 2020 surveys are shown in Table B.1. These values may differ from those in Table 4.1 in the main analysis as the data in that table will have any lengths with maintenance over the last 10 years removed (whereas Table B.1 includes the whole length of the site). In this table, ten sites are shown in grey text due to anomalies in the surveys. These anomalies are discussed in section 3.2.

Table B.1 Results of the 2020 surveys

Site	Speed corrected SR			Average	Range
	Early	Middle	Late		
1	65.09	59.14	58.53	60.92	6.56
2	67.63	63.30	59.71	63.55	7.92
3	62.15	56.14	62.61	60.30	6.47
4	57.19	50.13	53.04	53.46	7.06
5	61.03	55.44	58.08	58.18	5.59
6	59.82	57.17	59.89	58.96	2.72
7	59.90	54.26	56.15	56.77	5.64
8	59.90	54.27	55.74	56.64	5.63
9	45.56	43.61	51.91	47.03	8.30
10	61.20	55.81	55.86	57.62	5.38
11	69.21	63.96	73.99	69.05	10.03
12	64.65	55.41	61.28	60.45	9.24
13	49.14	52.59	54.54	52.09	5.41
14	58.18	60.26	66.12	61.52	7.93
15	50.54	53.28	57.08	53.63	6.54
16	56.51	50.27	59.50	55.43	9.23
17	45.37	47.10	46.45	46.31	1.73
18	64.67	61.50	66.65	64.27	5.16
19	52.92	-	64.76	-	-
20	57.06	58.60	56.96	57.54	1.64
21	52.45	53.94	61.57	55.99	9.12
22	67.99	74.44	72.88	71.77	6.45
23	59.55	59.25	82.75	67.18	23.51
24	56.76	55.54	58.72	57.01	3.18
25	64.31	61.62	66.66	64.19	5.04
26	59.88	61.57	67.56	63.01	7.68
27	60.66	62.46	70.98	64.70	10.32
28	42.28	48.90	53.19	48.13	10.91
29	49.66	51.86	59.75	53.76	10.09
30	47.84	53.84	62.80	54.83	14.96
31	54.16	60.17	65.35	59.90	11.19
32	43.55	48.49	50.94	47.66	7.39
33	59.90	61.82	70.30	64.01	10.40
34	51.96	53.77	76.28	60.67	24.33
35	59.71	51.54	57.34	56.20	8.17
36	50.18	51.98	58.89	53.68	8.71
37	52.82	58.73	65.34	58.96	12.52
38	56.03	56.26	62.90	58.40	6.87
39	53.82	55.39	62.23	57.15	8.41

B.2 Mean Summer Skid Coefficient

The average of the reference benchmark sites over the course of the benchmark programme (since 2002) is produced in Figure B.1. The reference benchmark sites are the sites with a full survey history and which have not undergone treatment during the course of the program. These sites are further discussed in section 3.2.

The very late surveys (conducted in 2006, 2007, 2008 and 2009) are excluded from this calculation and the surveys undertaken under the old survey period dates are shown as empty diamonds. Due to COVID-19 traffic levels on the road network were noticeably lower in 2020. To mark this data as a potential outlier it is highlighted as an orange diamond.

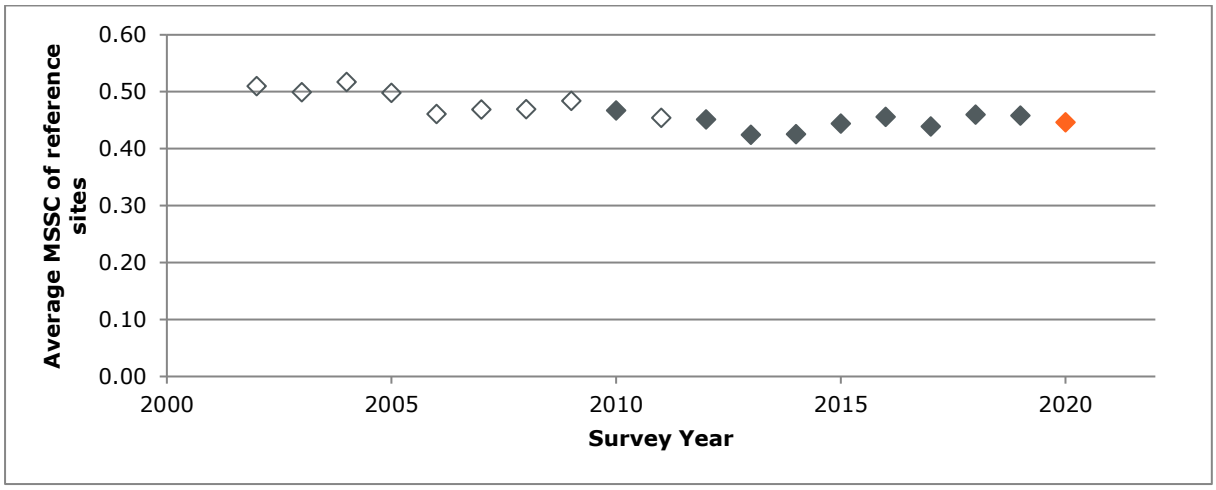

Figure B.1 Average MSSC of reference sites since 2002

Initial examination of Figure B.1 suggests a slight downward trend over time. However it is also possible that the equilibrium state of the benchmark sites has changed between two levels. The first level running from 2002 to 2005 around an average of 0.5 and the second running from 2006 onwards around an average of 0.45. It will not be possible to determine which of these scenarios is applicable (or if there is a different pattern) until further years of data is collected.

The changes seen in the skid resistance of the sites over time (either a downward trend or change in equilibrium levels) could be due to longer term seasonal changes, e.g. climate change or a reduction in the skid resistance performance of the sites (possibly as a result of a change in traffic levels for the sites compared to those assumed in the design of the surfacings).

MSSC values (excluding the very late surveys) produced for each of the asphalt benchmark sites over the course of the benchmark site programme are provided in Table B.2. The non-reference benchmark sites are also shown but are highlighted in grey and italics in the table. In addition, surveys conducted on the reference benchmark sites using the old survey periods (as discussed in section 1.1) are highlighted in red. The change in survey periods should result in a slightly higher MSSC value (due to the expected higher value for the late survey) for any years which are using the new survey boundaries relative to the old boundaries.

Table B.2 MSSC values for the asphalt sites (1-39)

Site	Ref	MSSC 2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	y	0.60	0.57	0.59	0.58	0.55	0.55	0.54	0.57	0.54	0.55	0.52	0.46	0.47	0.51	0.49	0.50	0.52	0.50	0.48
2	n	0.56	0.54	0.55	0.54	0.54	0.54	0.52	-	0.50	0.51	0.51	0.46	0.47	0.51	0.47	0.49	0.50	0.48	
3	n	0.55	0.52	0.53	0.52	0.50	0.47	0.47	0.53	0.48	0.49	0.47	0.44	0.44	0.47	0.46	0.48	0.48	-	0.47
4	n	0.61	0.60	0.60	0.59	0.58	-	0.56	-	0.53	0.47	0.48	0.44	0.44	0.47	0.45	0.46	0.47	0.47	0.42
5	n	0.55	0.55	0.58	-	0.53	0.53	0.53	0.49	-	0.51	0.53	0.47	0.50	0.50	0.50	0.51	0.50	0.48	0.45
6	n	0.54	0.52	0.52	0.53	0.51	0.51	0.51	0.53	0.52	0.48	0.50	0.47	0.46	0.52	0.51	0.50	0.47	0.49	0.46
7	n	0.54	0.52	0.51	0.52	0.49	-	0.50	0.52	0.51	0.51	0.51	0.47	0.51	0.49	0.49	0.46	0.49	0.47	0.44
8	y	0.55	0.53	0.53	0.51	0.50	0.50	0.49	0.51	0.51	0.47	0.49	0.45	0.45	0.45	0.46	0.45	0.50	0.48	0.44
9	y	0.46	0.44	0.44	0.44	0.39	0.39	0.39	0.41	0.40	0.38	0.40	0.39	0.35	0.37	0.37	0.37	0.38	0.38	0.37
10	n	0.55	0.54	0.57	0.55	0.54	0.55	-	0.55	0.51	0.50	0.51	0.45	0.44	0.46	0.47	0.47	0.48	0.47	0.45
11	n	0.55	0.54	0.57	0.56	0.51	0.51	0.51	0.55	0.56	0.53	-	0.49	0.49	0.50	0.52	0.52	0.51	0.53	0.54
12	y	0.42	0.42	0.59	0.50	0.45	0.44	0.49	0.46	0.45	0.43	0.44	0.41	0.43	0.43	0.46	0.43	0.45	0.46	0.47
13	y	0.45	0.45	0.47	0.45	0.40	0.41	0.43	0.42	0.41	0.40	0.37	0.35	0.36	0.41	0.40	0.36	0.40	0.42	0.41
14	Y	0.57	0.55	0.57	0.55	0.53	0.52	0.51	0.53	0.49	0.48	0.48	0.47	0.44	0.50	0.50	0.46	0.48	0.50	0.48
15	n	0.49	0.48	0.48	0.47	0.45	-	0.43	0.44	0.42	0.42	0.42	0.38	0.39	0.47	0.41	0.41	0.43	0.45	0.42
16	n	0.54	0.56	0.56	0.51	0.51	0.52	-	0.49	0.49	0.47	0.46	0.41	0.42	0.43	0.43	0.43	0.44	0.43	0.43
17	n	0.39	0.38	0.39	0.37	0.35	0.36	0.36	0.37	0.34	0.32	0.32	0.32	0.32	0.36	0.33	0.31	0.33	0.34	0.36
18	n	0.54	0.49	0.48	0.45	0.44	0.44	0.43	0.48	0.45	0.44	0.41	0.41	0.40	0.43	0.43	0.45	0.45	0.45	0.50
19	n	0.50	0.47	0.47	0.46	0.43	0.44	0.42	0.46	0.45	0.42	0.43	0.39	0.40	0.43	0.43	0.44	0.43	0.42	
20	n	0.38	0.35	0.34	0.34	0.31	0.34	-	0.42	0.40	0.39	0.39	0.35	0.39	0.46	0.50	0.46	0.48	0.47	0.45
21	n	0.44	0.42	0.43	0.42	0.39	0.39	0.39	-	0.44	0.47	0.46	0.44	0.44	0.45	0.48	0.45	0.45	0.47	0.44
22	n	0.49	0.50	0.48	0.46	0.48	0.46	-	0.52	0.51	0.51	0.54	0.52	0.55	0.56	0.57	0.54	0.58	0.57	0.56
23	n	0.45	0.44	0.47	0.45	0.41	-	-	0.49	0.45	0.46	0.45	0.44	0.44	0.46	0.47	0.45	0.47	-	
24	n	0.49	0.49	0.51	0.49	0.49	0.49	0.45	-	0.46	0.44	0.44	0.44	0.44	0.46	0.47	0.44	0.46	0.46	0.44
25	y	0.55	0.53	0.54	0.53	0.51	0.53	0.49	0.54	0.51	0.51	0.51	0.48	0.55	0.53	0.55	0.51	0.52	0.51	0.50
26	n	0.48	0.45	0.47	0.45	0.43	0.43	0.41	0.44	0.50	0.47	0.48	0.42	-	0.43	0.54	0.50	0.51	0.51	0.49
27	y	0.46	0.56	0.52	0.52	0.48	0.50	0.49	0.50	0.48	0.47	0.47	0.45	0.44	0.46	0.53	0.49	0.50	0.51	0.50
28	n	0.43	0.42	0.39	0.41	0.37	0.35	0.38	0.41	-	0.36	0.37	0.36	-	0.37	0.38	0.37	0.39	0.40	0.38
29	n	0.49	0.46	0.47	0.47	0.42	0.43	0.43	0.43	0.42	0.41	0.42	0.40	0.39	0.51	0.44	0.43	0.43	0.47	0.42
30	n	0.50	0.46	0.48	0.46	0.45	0.44	-	-	0.45	0.44	0.43	0.39	0.39	0.41	0.42	0.40	0.43	0.45	0.43
31	y	0.58	0.55	0.54	0.54	0.48	0.50	0.52	0.51	0.50	0.50	0.49	0.46	0.45	0.48	0.48	0.48	0.50	0.48	0.47
32	y	0.47	0.44	0.43	0.42	0.38	0.38	0.38	0.42	0.39	0.38	0.38	0.38	0.36	0.38	0.40	0.38	0.38	0.39	0.37
33	n	0.56	0.52	0.54	0.51	0.50	-	0.48	0.50	0.50	0.50	0.50	0.48	0.49	0.50	0.48	0.56	0.50	0.51	0.50
34	n	0.44	0.39	0.44	0.41	0.40	0.38	0.38	0.42	-	0.42	0.43	0.41	0.43	0.43	0.46	0.46	-	0.48	0.47
35	y	0.51	0.49	0.49	0.47	0.43	0.47	0.44	0.45	0.46	0.44	0.43	0.40	0.40	0.42	0.42	0.44	0.45	0.42	0.44
36	y	0.49	0.47	0.49	0.47	0.43	0.45	0.47	0.47	0.45	0.43	0.44	0.40	0.41	0.42	0.43	0.42	0.45	0.44	0.42
37	n	0.53	0.50	0.52	0.50	0.48	0.47	0.45	-	0.49	0.48	0.47	0.43	0.46	0.45	0.46	0.47	0.49	0.47	0.46
38	y	0.52	0.49	0.51	0.48	0.45	0.46	0.46	0.48	0.49	0.47	0.43	0.41	0.42	0.42	0.44	0.41	0.44	0.46	0.46
39	n	0.44	0.40	0.42	0.40	0.36	0.38	0.36	0.39	0.38	0.36	0.44	0.40	0.44	0.46	0.47	0.46	0.46	0.46	0.45
Ref sites		0.50	0.49	0.50	0.48	0.45	0.46	0.46	0.47	0.46	0.44	0.44	0.41	0.42	0.44	0.44	0.43	0.46	0.46	0.45

Appendix C Historic data processed using the current defined site lengths

Table C.1 2011 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	68.7	70.4	74.7	3.19	71.2
2	5	63.4	66.4	67.1	2.04	65.7
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	70.4	66.2	71.3	2.71	69.3
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	57.4	60.4	61.0	2.14	59.6
9	13	48.0	51.0	48.4	2.30	49.1
10	15	59.3	62.1	62.7	1.94	61.4
11	0	-	-	-	-	-
12	8	52.9	55.7	53.7	1.57	54.1
13	11	52.6	46.8	53.4	3.62	51.0
14	16	62.7	58.3	60.5	2.29	60.5
15	1	53.0	49.5	51.5	1.76	51.4
16	18	59.7	60.4	59.4	0.76	59.8
17	10	42.7	40.2	38.9	2.01	40.6
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	64.6	57.5	60.0	4.41	60.7
22	17	66.4	65.1	65.1	1.03	65.5
23	0	-	-	-	-	-
24	10	58.7	57.9	52.9	3.19	56.5
25	12	66.8	65.5	64.1	1.35	65.5
26	0	-	-	-	-	-
27	16	64.1	58.4	57.5	3.66	60.0
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	58.1	51.6	54.3	3.65	54.7
31	18	67.2	61.6	62.8	2.95	63.9
32	12	50.1	46.7	49.8	2.29	48.9
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	59.7	54.8	56.0	2.63	56.9
36	10	57.1	52.1	54.2	2.60	54.5
37	13	64.3	61.2	61.0	1.91	62.2
38	14	66.2	59.0	59.2	4.21	61.5
39	3	62.1	56.4	55.5	3.64	58.0
40	13	60.9	63.0	59.1	2.08	61.0
41	54	51.2	52.5	53.5	1.58	52.4
42	18	52.7	52.9	55.6	1.74	53.7
43	19	44.3	45.2	45.2	0.82	44.9
Asphalt 0-39	288	60.3	57.6	58.2	2.77	58.7
Concrete 40-43	104	51.4	52.5	53.0	1.58	52.3

Table C.2 2012 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	67.7	68.6	69.3	2.07	68.6
2	5	65.3	66.3	64.4	1.07	65.3
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	72.4	67.7	69.8	2.33	70.0
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	62.4	58.7	63.1	2.42	61.4
9	13	53.8	49.3	50.8	2.82	51.3
10	15	64.8	62.1	63.6	1.45	63.5
11	0	-	-	-	-	-
12	8	56.8	53.9	55.6	1.55	55.4
13	11	49.0	47.2	46.3	1.47	47.5
14	16	62.9	58.3	64.6	3.94	61.9
15	1	52.0	49.5	51.0	1.23	50.8
16	18	63.5	57.0	57.6	3.65	59.3
17	10	40.7	42.6	39.5	1.57	40.9
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	60.7	61.1	57.3	2.38	59.7
22	17	69.3	68.8	71.1	1.33	69.7
23	0	-	-	-	-	-
24	10	56.9	56.2	57.4	0.80	56.8
25	12	65.6	65.4	66.7	1.02	65.9
26	0	-	-	-	-	-
27	16	62.5	59.2	60.2	1.75	60.6
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	55.9	54.7	53.5	1.59	54.7
31	18	62.9	64.9	62.6	1.48	63.5
32	12	49.7	48.5	48.7	1.04	49.0
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	56.5	56.2	51.6	2.77	54.7
36	10	57.8	57.3	55.9	1.50	57.0
37	13	62.4	63.2	56.3	3.78	60.6
38	14	58.4	56.2	53.5	2.52	56.0
39	3	58.4	55.7	53.4	2.55	55.8
40	13	63.3	60.9	60.2	1.78	61.5
41	54	51.8	52.3	55.5	2.22	53.2
42	18	57.2	54.4	57.0	1.81	56.2
43	19	46.8	42.9	48.0	2.71	45.9
Asphalt 0-39	288	59.7	58.2	57.9	2.30	58.6
Concrete 40-43	104	53.2	52.0	55.0	2.20	53.4

Table C.3 2013 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	65.9	63.1	62.5	1.94	63.8
2	5	61.5	58.4	57.0	2.31	59.0
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	66.5	61.1	61.4	3.04	63.0
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	57.4	59.1	58.0	1.01	58.1
9	13	45.5	61.4	43.2	10.07	50.1
10	15	58.0	57.5	56.2	1.05	57.2
11	0	-	-	-	-	-
12	8	55.9	52.1	48.7	3.61	52.2
13	11	47.1	44.9	44.2	1.63	45.4
14	16	62.8	65.3	52.9	7.26	60.3
15	1	45.3	48.7	43.1	2.86	45.7
16	18	56.0	52.0	50.9	2.73	52.9
17	10	41.4	40.6	39.9	0.78	40.6
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	57.8	57.7	55.9	1.57	57.1
22	17	68.0	65.7	66.4	1.43	66.7
23	0	-	-	-	-	-
24	10	56.1	58.4	54.5	2.09	56.3
25	12	62.5	60.6	60.8	1.12	61.3
26	0	-	-	-	-	-
27	16	57.6	56.9	59.1	1.21	57.9
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	49.0	50.3	51.3	1.49	50.2
31	18	58.1	54.6	63.2	4.38	58.6
32	12	51.0	48.2	48.5	1.80	49.3
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	51.9	48.1	52.7	2.50	50.9
36	10	52.9	48.6	54.0	2.97	51.8
37	13	55.9	51.9	57.7	3.04	55.2
38	14	56.0	50.1	54.4	3.10	53.5
39	3	56.0	49.2	55.8	3.96	53.7
40	13	56.8	58.8	57.8	1.07	57.8
41	54	47.4	47.8	47.1	1.16	47.5
42	18	49.3	51.1	48.2	1.52	49.5
43	19	51.9	47.8	46.0	3.31	48.6
Asphalt 0-39	288	56.1	54.9	54.6	3.54	55.2
Concrete 40-43	104	49.8	49.8	48.4	1.80	49.3

Table C.4 2014 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	67.7	60.5	66.8	4.25	65.0
2	5	64.6	54.7	61.5	5.13	60.3
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	70.4	60.8	67.2	4.88	66.1
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	58.7	56.3	57.4	1.28	57.5
9	13	47.1	45.2	44.6	2.79	45.6
10	15	59.5	51.2	57.7	4.68	56.1
11	0	-	-	-	-	-
12	8	59.4	50.2	56.4	4.86	55.3
13	11	46.9	42.6	47.2	2.89	45.6
14	16	59.8	52.0	58.7	4.45	56.9
15	1	49.8	38.4	43.8	5.73	44.0
16	18	55.5	52.4	55.2	1.95	54.4
17	10	45.6	37.0	40.6	4.38	41.1
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	59.2	53.9	55.8	3.04	56.3
22	17	76.1	65.5	69.6	5.41	70.4
23	0	-	-	-	-	-
24	10	63.2	53.2	52.5	6.04	56.3
25	12	87.5	60.4	63.7	14.77	70.5
26	0	-	-	-	-	-
27	16	61.2	50.6	56.1	5.41	55.9
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	56.1	45.2	47.3	5.86	49.5
31	18	60.7	55.3	59.5	2.93	58.5
32	12	47.1	46.9	45.5	1.55	46.5
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	54.0	49.0	52.1	2.62	51.7
36	10	53.7	50.1	52.5	2.24	52.1
37	13	65.6	56.6	56.3	5.40	59.5
38	14	58.5	53.0	53.5	3.53	55.0
39	3	61.3	60.4	53.7	4.36	58.5
40	13	61.8	56.9	61.2	2.73	60.0
41	54	50.9	44.8	49.0	3.52	48.2
42	18	51.8	44.9	53.1	4.49	49.9
43	19	48.5	43.0	47.1	2.95	46.2
Asphalt 0-39	288	59.6	52.2	55.2	5.00	55.7
Concrete 40-43	104	52.0	46.0	50.9	3.53	49.6

Table C.5 2015 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	73.7	65.2	71.9	4.79	70.3
2	5	69.2	58.2	66.4	5.86	64.6
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	67.5	64.0	71.0	3.47	67.5
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	62.3	53.7	59.5	4.53	58.5
9	13	53.2	41.8	47.9	6.69	47.6
10	15	66.3	53.1	56.7	6.87	58.7
11	0	-	-	-	-	-
12	8	62.4	48.3	53.7	7.18	54.8
13	11	53.1	45.0	58.7	6.95	52.3
14	16	67.3	55.9	70.9	7.91	64.7
15	1	48.4	42.1	54.5	6.23	48.3
16	18	60.2	50.9	52.7	5.04	54.6
17	10	45.2	40.4	51.6	5.85	45.7
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	61.6	56.2	55.1	3.95	57.6
22	17	73.7	67.8	73.9	3.54	71.8
23	0	-	-	-	-	-
24	10	63.8	55.3	59.6	4.37	59.6
25	12	73.2	59.2	71.5	7.70	68.0
26	0	-	-	-	-	-
27	16	63.6	56.9	57.4	3.83	59.3
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	53.2	51.2	55.4	2.41	53.3
31	18	61.3	60.9	61.4	1.58	61.2
32	12	50.9	46.3	48.2	2.97	48.5
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	57.9	50.8	51.6	4.05	53.5
36	10	53.2	51.9	55.6	2.45	53.6
37	13	61.7	55.1	57.1	3.70	57.9
38	14	59.2	52.9	52.2	4.02	54.8
39	3	61.3	58.4	58.5	1.86	59.4
40	13	71.1	57.8	68.3	7.07	65.7
41	54	53.4	44.3	47.8	5.02	48.5
42	18	57.1	48.8	49.1	4.81	51.7
43	19	51.4	42.1	44.5	5.01	46.0
Asphalt 0-39	288	61.3	53.9	58.5	5.01	57.9
Concrete 40-43	104	55.9	46.4	50.0	5.29	50.7

Table C.6 2016 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	63.8	63.2	75.7	7.20	67.6
2	5	60.6	60.5	65.6	3.09	62.2
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	71.0	64.3	64.5	3.83	66.6
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	58.9	59.5	62.5	2.11	60.3
9	13	48.0	45.8	48.0	3.05	47.3
10	15	62.1	59.4	59.3	1.89	60.3
11	0	-	-	-	-	-
12	8	60.8	57.7	57.8	2.51	58.7
13	11	51.8	49.1	53.6	2.73	51.5
14	16	70.6	61.8	60.0	5.81	64.1
15	1	43.5	46.3	48.3	2.38	46.0
16	18	57.0	51.3	55.9	3.28	54.8
17	10	45.1	41.0	41.6	2.38	42.6
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	65.9	61.0	58.4	4.14	61.8
22	17	76.9	70.9	73.9	3.33	73.9
23	0	-	-	-	-	-
24	10	64.1	56.0	61.2	4.29	60.4
25	12	75.6	65.4	68.8	5.38	69.9
26	0	-	-	-	-	-
27	16	62.0	77.0	66.2	7.99	68.4
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	54.5	51.4	54.3	2.94	53.4
31	18	64.3	58.7	63.6	3.19	62.2
32	12	50.4	50.1	50.9	1.98	50.5
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	55.6	52.3	54.8	2.35	54.2
36	10	59.0	52.6	54.0	4.15	55.2
37	13	60.8	56.4	61.4	2.81	59.6
38	14	53.9	56.3	60.5	3.51	56.9
39	3	60.2	64.3	64.4	2.39	63.0
40	13	64.5	62.7	63.8	1.92	63.7
41	54	51.9	51.5	52.6	1.96	52.0
42	18	52.1	57.4	55.1	2.86	54.8
43	19	53.1	49.7	53.0	2.08	52.0
Asphalt 0-39	288	60.6	57.7	59.6	4.02	59.3
Concrete 40-43	104	53.7	53.6	54.5	2.16	53.9

Table C.7 2017 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	76.3	58.9	71.5	9.05	68.9
2	5	75.1	53.9	59.9	11.02	63.0
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	66.6	62.1	62.5	2.51	63.7
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	63.4	51.4	61.7	6.47	58.8
9	13	50.8	43.0	48.5	4.46	47.4
10	15	68.0	52.8	61.0	8.27	60.6
11	0	-	-	-	-	-
12	8	55.8	49.6	58.1	4.57	54.5
13	11	49.1	41.5	49.5	4.62	46.7
14	16	65.3	50.3	61.2	7.85	58.9
15	1	49.8	42.5	48.4	3.90	46.9
16	18	59.6	48.8	55.1	5.54	54.5
17	10	44.8	34.8	40.9	5.11	40.2
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	60.6	52.2	60.6	5.09	57.8
22	17	76.3	61.7	69.9	7.42	69.3
23	0	-	-	-	-	-
24	10	62.7	49.4	55.6	6.71	55.9
25	12	72.4	57.8	65.0	7.30	65.1
26	0	-	-	-	-	-
27	16	64.4	58.4	65.1	3.86	62.6
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	52.7	48.2	51.8	2.74	50.9
31	18	66.2	56.4	62.6	5.05	61.7
32	12	54.1	43.6	47.9	5.42	48.5
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	61.7	48.5	57.9	6.79	56.0
36	10	61.0	47.8	54.8	6.69	54.6
37	13	66.5	53.3	62.1	6.87	60.7
38	14	57.2	48.4	57.2	5.15	54.3
39	3	64.9	57.0	64.9	4.61	62.3
40	13	60.1	55.7	62.4	3.66	59.4
41	54	49.6	44.9	50.6	3.71	48.4
42	18	49.7	46.0	54.0	4.24	49.9
43	19	50.2	43.8	51.8	4.37	48.6
Asphalt 0-39	288	62.1	51.0	58.5	6.22	57.2
Concrete 40-43	104	51.1	46.2	52.9	3.93	50.1

Table C.8 2018 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	77.9	66.1	71.3	6.06	71.8
2	5	71.3	60.9	61.9	5.76	64.7
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	67.4	61.2	62.0	3.39	63.6
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	67.6	59.4	73.6	7.56	66.9
9	13	53.9	42.7	49.9	6.38	48.8
10	15	68.1	54.7	63.7	6.91	62.2
11	0	-	-	-	-	-
12	8	66.9	47.8	58.5	9.67	57.7
13	11	57.7	46.2	50.4	5.94	51.4
14	16	70.3	53.9	62.2	8.28	62.1
15	1	52.0	43.4	48.3	4.32	47.9
16	18	65.0	47.5	56.0	8.87	56.2
17	10	47.6	36.3	43.4	5.84	42.4
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	61.6	52.0	61.9	5.97	58.5
22	17	78.7	73.5	73.1	3.21	75.1
23	0	-	-	-	-	-
24	10	61.3	57.1	59.7	2.27	59.4
25	12	67.8	66.0	68.3	1.42	67.4
26	0	-	-	-	-	-
27	16	67.8	59.6	65.0	4.29	64.1
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	61.0	48.6	57.2	6.47	55.6
31	18	64.1	59.9	66.9	3.71	63.7
32	12	51.8	43.9	51.1	4.76	48.9
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	57.0	55.6	60.2	2.51	57.6
36	10	59.4	53.7	60.8	4.06	58.0
37	13	65.5	59.5	63.7	3.31	62.9
38	14	61.6	54.2	58.0	3.90	57.9
39	3	65.3	60.3	64.5	2.83	63.4
40	13	60.4	60.8	65.4	3.12	62.2
41	54	53.1	45.1	51.0	5.04	49.7
42	18	55.5	51.0	56.8	3.28	54.4
43	19	53.1	43.9	50.3	4.78	49.1
Asphalt 0-39	288	63.9	54.7	60.9	5.62	59.9
Concrete 40-43	104	54.4	47.9	53.7	4.52	52.0

Table C.9 2019 benchmark surveys using the current defined lengths

Site	Number of 100m lengths	Average SR			Between run standard deviation	Average
		Early	Middle	Late		
1	10	68.9	64.6	72.7	4.27	68.7
2	5	63.6	58.7	64.5	3.50	62.3
3	0	-	-	-	-	-
4	0	-	-	-	-	-
5	1	61.5	59.5	62.6	1.60	61.2
6	0	-	-	-	-	-
7	0	-	-	-	-	-
8	7	62.1	59.7	65.2	3.00	62.4
9	13	47.1	49.3	50.5	3.30	48.9
10	15	61.3	59.3	62.4	2.06	61.0
11	0	-	-	-	-	-
12	8	65.5	54.5	56.6	5.95	58.9
13	11	58.0	48.7	53.5	4.71	53.4
14	16	72.6	59.0	64.1	7.12	65.2
15	1	54.9	48.3	44.7	5.16	49.3
16	18	57.5	53.4	52.9	2.86	54.6
17	10	49.5	39.1	40.5	5.71	43.1
18	0	-	-	-	-	-
19	0	-	-	-	-	-
20	0	-	-	-	-	-
21	18	65.8	55.6	60.1	5.51	60.5
22	17	80.2	69.3	73.7	5.77	74.4
23	0	-	-	-	-	-
24	10	63.9	55.9	56.0	4.86	58.6
25	12	69.7	62.4	64.3	3.83	65.5
26	0	-	-	-	-	-
27	16	72.5	60.1	64.4	6.45	65.7
28	0	-	-	-	-	-
29	0	-	-	-	-	-
30	13	61.2	51.0	59.5	5.81	57.2
31	18	67.0	56.8	61.8	5.23	61.9
32	12	52.8	47.5	49.8	3.25	50.0
33	0	-	-	-	-	-
34	0	-	-	-	-	-
35	17	58.3	50.4	54.2	4.17	54.3
36	10	61.3	51.4	55.3	5.34	56.0
37	13	63.4	56.3	59.3	3.77	59.7
38	14	62.6	57.9	56.0	3.91	58.9
39	3	67.5	62.4	62.3	3.11	64.1
40	13	62.5	55.1	60.5	4.06	59.3
41	54	54.4	46.9	47.9	4.51	49.7
42	18	57.1	48.9	51.6	4.40	52.5
43	19	47.2	48.2	49.9	1.76	48.4
Asphalt 0-39	288	63.4	55.8	59.1	4.79	59.4
Concrete 40-43	104	54.6	48.5	50.5	4.07	51.2

Skid resistance benchmark surveys 2020

Highways England manages levels of skid resistance on their network (the Strategic Road Network or SRN) by carrying out single annual skid resistance surveys (SASS). These surveys are carried out over the course of the summer and are split over three survey periods (early, middle and late). It is known that skid resistance varies during the year and between years and the survey data is corrected by the application of correction factors called the "Local Equilibrium Correction Factors" (LECF). To monitor the ongoing trends in skid resistance levels, Highways England established a series of benchmark sites. These sites are surveyed in all three of the survey periods during the survey season. The data collected is then examined for within year and between year trends in the skid resistance levels. This report discusses the analysis of the survey data collected in 2020, and compares the results of the analysis to those from earlier years.

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TRL
Crowthorne House, Nine Mile Ride,
Wokingham, Berkshire, RG40 3GA,
United Kingdom
T: +44 (0) 1344 773131
F: +44 (0) 1344 770356
E: enquiries@trl.co.uk
W: www.trl.co.uk

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