Phase 2 Report

Reviewing and testing safety camera site selection criteria

PHASE 2 REPORT

Reviewing and testing safety camera site selection criteria

CONTENTS

REPORT OUTLINE

This report into the findings and proposals from the first phase of the project has been based on the criteria set by Transport Scotland. The project has been split into several parts:

Phase 1a *A review of existing site selection criteria will be undertaken to help ensure safety cameras continue to be deployed in Scotland where they have the greatest potential to reduce injury collisions. This will involve a review of established national and international practice on selecting sites, including a literature review and examination of policy documents.*

Phase 1b *A facilitated workshop for road safety professionals where data requirements, previous experience and other considerations will be discussed to enable a greater understanding of the limitations of the existing system. The alternative methodologies will be reviewed at the meeting.*

Phase 1c *A review of the current criteria as published and implemented by Transport Scotland with reference to recent changes in collision numbers and the severity of those collisions. Several alternative criteria will be proposed using evidence gathered in phase one, plus consideration for additional datasets including telematics data.*

Phase 2a *A simulation of three preferred scenarios using sample datasets.*

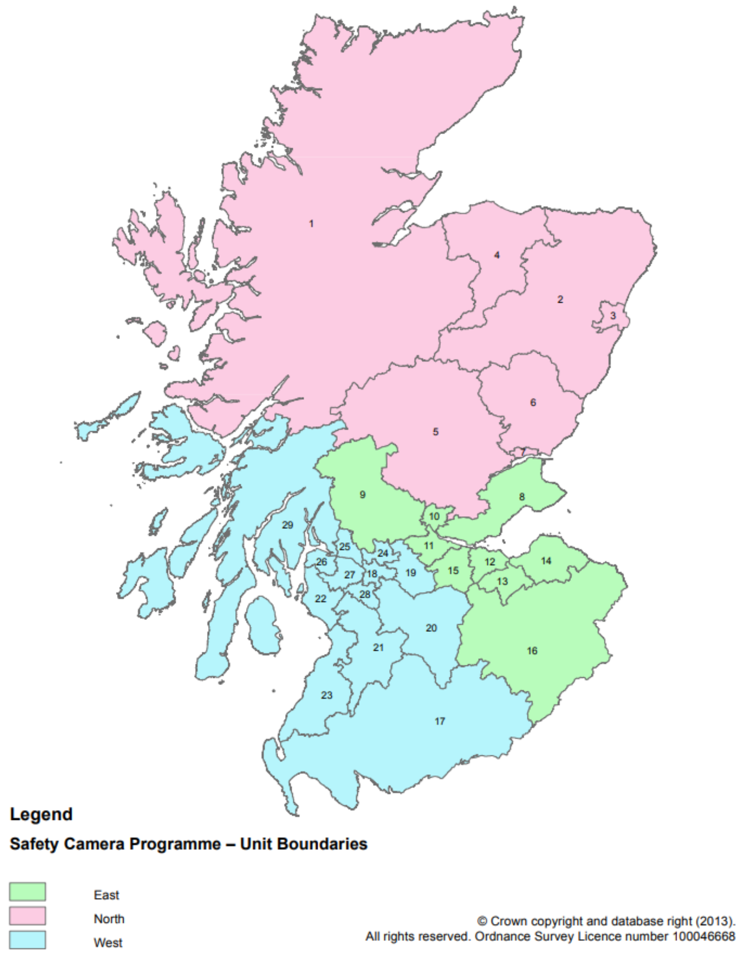
Phase 2b *A final report summarising the project and providing recommendations*

This report covers the whole of the second phase incorporating the modelling of different site selection criteria options for consideration, followed by subsequent recommendations for analysing collision data and reviewing sites.

INTRODUCTION

At the end of the previous phase the following options for testing were recommended and agreed:

- 5 years of data versus 3 years
- New weightings for severities versus old weightings
- Double points for collisions involving VRU versus no extra weighting
- Points thresholds per km of between 7 and 10
- Use either 85th percentile above ACPO threshold or an absolute number of vehicles per hour.



It was also agreed that the North unit would be used as the test area as it was the one that had previously struggled to identify new sites using the current criteria.

Agilysis was already in possession of collision data for the period 2012-2016 (5 years, inclusive) and proposed to match collisions to the OS Open Roads network using an automated technique to define analysis 'routes'. Routes would be created on M, A and B classification roads only.

Information about speeds and vehicles at 180 previously-analysed locations was provided by Transport Scotland with the aim of estimating the number of vehicles at or above the ACPO threshold [1] as well as whether the 85th percentile speed exceeded this value.

During the analysis process it became clear that there was no significant extra burden in analysing all of Scotland's roads and results are therefore provided for all three units. Routes were also matched to local authority boundaries, although as routes were not terminated at boundaries the decision was made to allocate routes to a single authority to avoid duplication.

[1] https://www.cps.gov.uk/legal-guidance/road-traffic-offences-guidance-fixed-penalty-notices

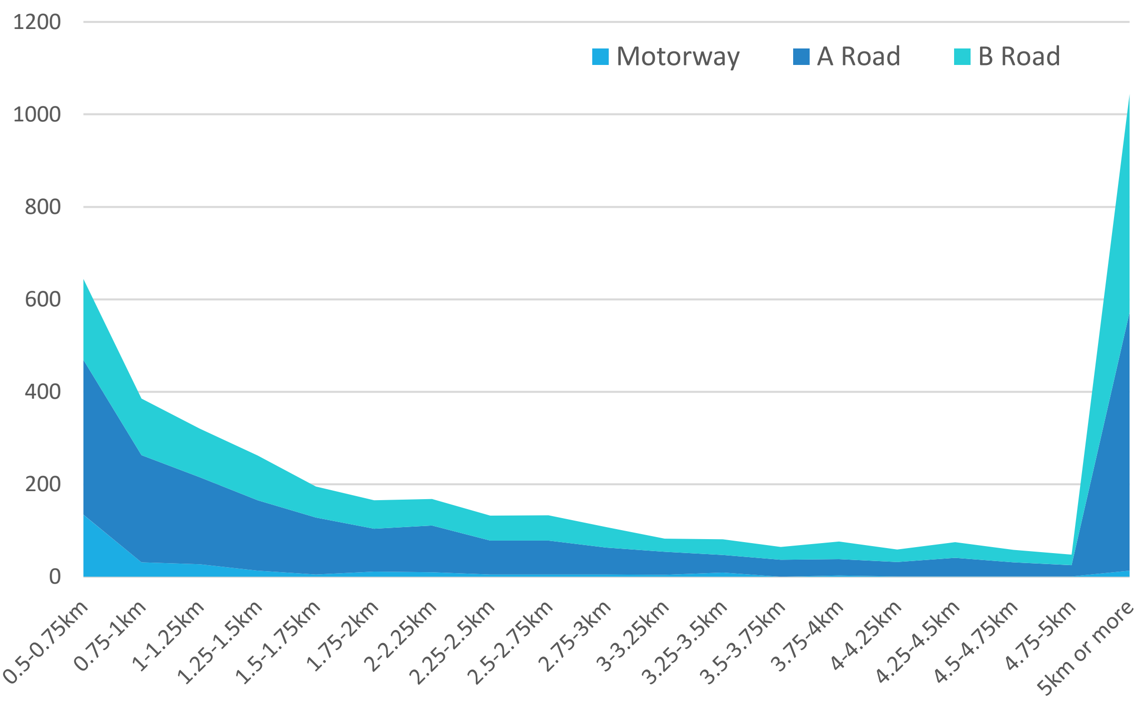
SCOTLAND CAMERA ANALYSIS METHODOLOGY

Creating the network and matching collisions

The first stage of the analysis was the creation of a mapping layer of classified roads in Scotland. Using the OS Open Roads layer[2] a series of transformations were made to create a network of 'routes' that would be suitable for analysis as a part of the modelling process. Routes were first created for each unique road number then split at intersections with other classified roads, or major road features such as interchanges or roundabouts. This approach will hopefully ensure a reasonable level of homogeneity along each route whilst still generating roads long enough to be analysed robustly.

The result of this network generation exercise was 12,930 sections with an average length of 1.42km. The vast majority were still below an acceptable length threshold (500m) and in the final analyses just 4,098 routes over 500m were used. The distribution of road lengths is shown in Figure 1 below.

Figure 1 – Distribution of routes by length



A further request was submitted during the analysis phase to estimate whether each route was rural or urban in nature. The urban / rural classifications supplied by the Scottish Government[3] were used together with the published shapefiles showing urban boundaries to classify each route. For the purposes of this exercise, routes that had the majority of their length within urban boundaries of settlements with a population over 10,000 people were classified as urban. All other settlements or sparsely populated rural areas were marked as rural.

[2] https://www.ordnancesurvey.co.uk/business-and-government/products/os-open-roads.html
[3] https://www.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification

Collision data for 2012 to 2016 was taken from the STATS19 Accident Statistics, collected by Transport Scotland and provided to Road Safety Analysis for inclusion in MAST Online. Agilysis acknowledge that Transport Scotland operate an open collision database that is subject to change following the publication of the annual dataset (in this case the data matches Reported Road Casualties Scotland 2016 Results).

This data includes collision location, severity, and the involvement of the following vulnerable road users: *motorcyclists*, *pedal cyclists*, *pedestrians* and *horse riders*. This data was then spatially matched to the routes on the aforementioned network, using a combination of spatial proximity and road number. It is therefore possible that collisions which were not accurately plotted or that contained an incorrect road number would not be matched and therefore the subsequent analysis may not include all of the recorded collisions.

Applying the alternative criteria

The following twelve sets of weighting criteria were devised to assign points to each collision. The assignment of points is based on the collision severity, the involvement of vulnerable road users, and the year in which the crash occurred.

Figure 2 – Initial list of criteria

Criterion	Slight	Serious	Fatal	Vulnerable Road Users	Years
1	1	4.5	7.1	No effect	2014-2016
2	1	4.5	7.1	Doubles for any vulnerable road user involved	2014-2016
3	1	4.5	7.1	Doubles for each type of vulnerable road user involved	2014-2016
4	1	2	3	No effect	2014-2016
5	1	2	3	Doubles for any vulnerable road user involved	2014-2016
6	1	2	3	Doubles for each type of vulnerable road user involved	2014-2016
7	1	4.5	7.1	No effect	2012-2016
8	1	4.5	7.1	Doubles for any vulnerable road user involved	2012-2016
9	1	4.5	7.1	Doubles for each type of vulnerable road user involved	2012-2016
10	1	2	3	No effect	2012-2016
11	1	2	3	Doubles for any vulnerable road user involved	2012-2016
12	1	2	3	Doubles for each type of vulnerable road user involved	2012-2016

The scenarios were analysed, and, in many cases, there were few differences, notably with the extra points for multiple VRU types. Increasing the analysis period naturally meant that higher scores were allocated to the routes. The following three scenarios were selected from the list of twelve weighting criteria for analysis:

- **Weighting Number 4** is the points system currently used to determine which roads would meet the criterion for collision rates. This assign points to collisions in the past three years, depending on severity, but does not take into account the involvement of vulnerable road users. This criterion is subsequently referred to as *current*;
- **Weighting Number 7** modifies the previous points system to account for the relative cost of collisions[4], depending on their severity. The analysis period has also been extended from three years to five years. These criteria are subsequently referred to as *new*;
- **Weighting Number 8** assigns the same points for severity as with Number 7 and includes the extended time period. In addition, points for each collision double if a vulnerable road user was involved. These criteria are subsequently referred to as *new+VRU*.

For each of the above scenarios, links of road were assigned points for collisions occurring in the set time frames. These were then used to calculate the number of points per kilometre on each link, for each set of criteria.

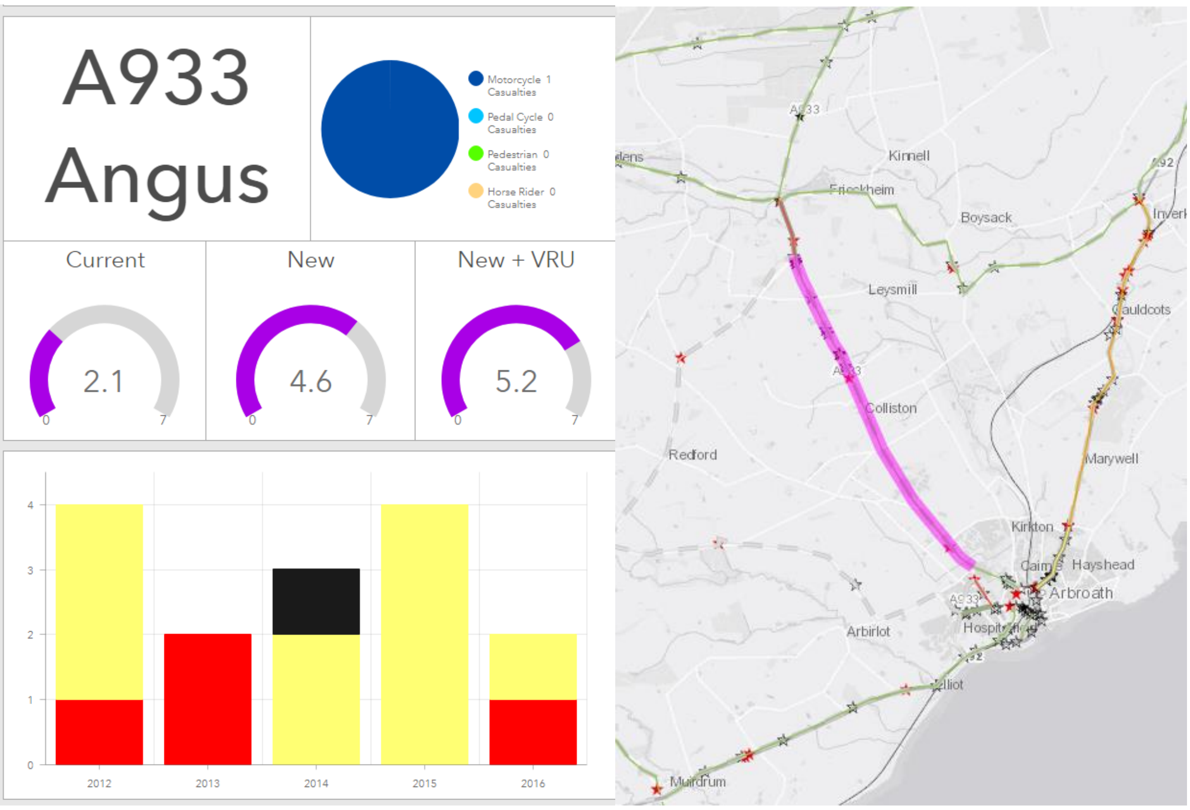
A threshold of points per kilometre has previously been set at 7 using the *current* criterion. This was used as a minimum for the alternative criteria although modelling was carried out based on higher thresholds.

[4] This subject was considered in the Phase One report and results in values of 7.2 for a fatal collision, 4.5 for a serious, and 1 for a slight.

EXAMPLE SITES

The following examples are screenshots taken from the dashboard created by Agilysis to share the information with Transport Scotland. This dashboard includes all of the information used in the analysis, together with drill-down information.

A933 Angus

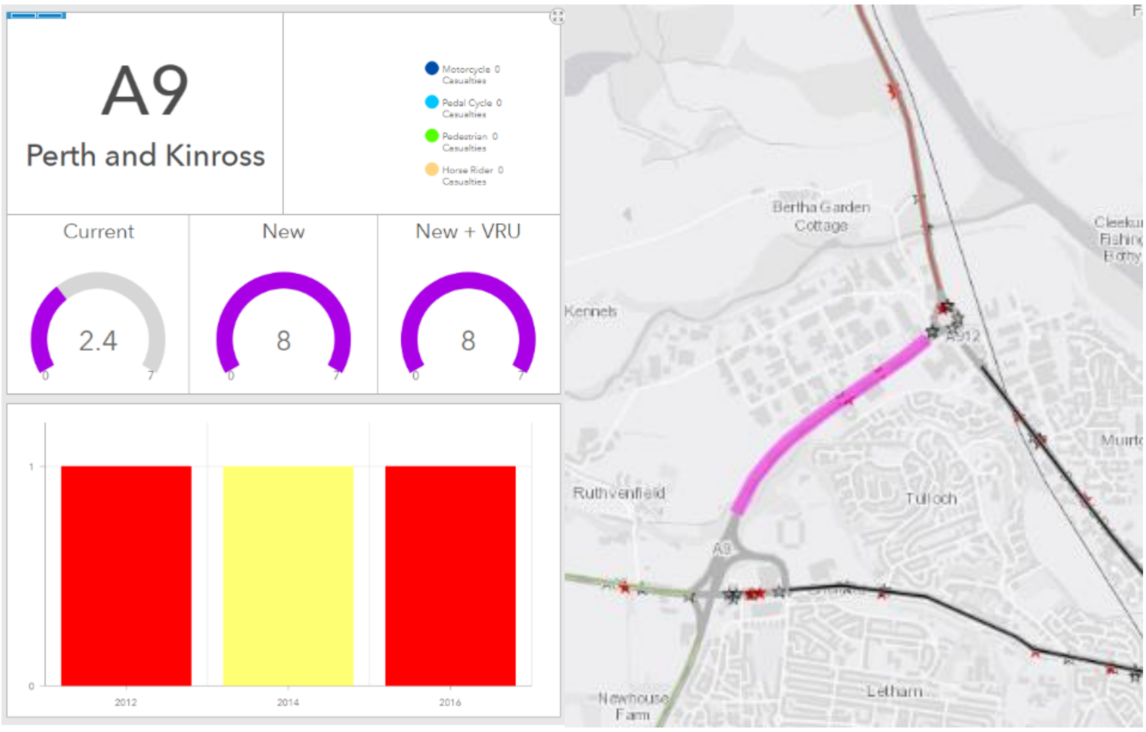


The A933 from Arbroath north-west, past Colliston, towards Forfar would not be considered as a site under the *current* criterion. Using either of the proposed systems, the entire route of 7.6km would also not meet the *new* criteria.

However, the collisions were not distributed evenly as all but one of the collisions occurred in the northern section of the route, in the 3.5km between Colliston and Legaston. In the five years between 2012 and 2016, there was one fatal, 3 serious and 10 slight casualties in this northern section of the route, totalling 30.6 points using the proposed system, equalling 8.74 points per km and thus meeting the *new+VRU* criteria (assuming a threshold of 7 points per km).

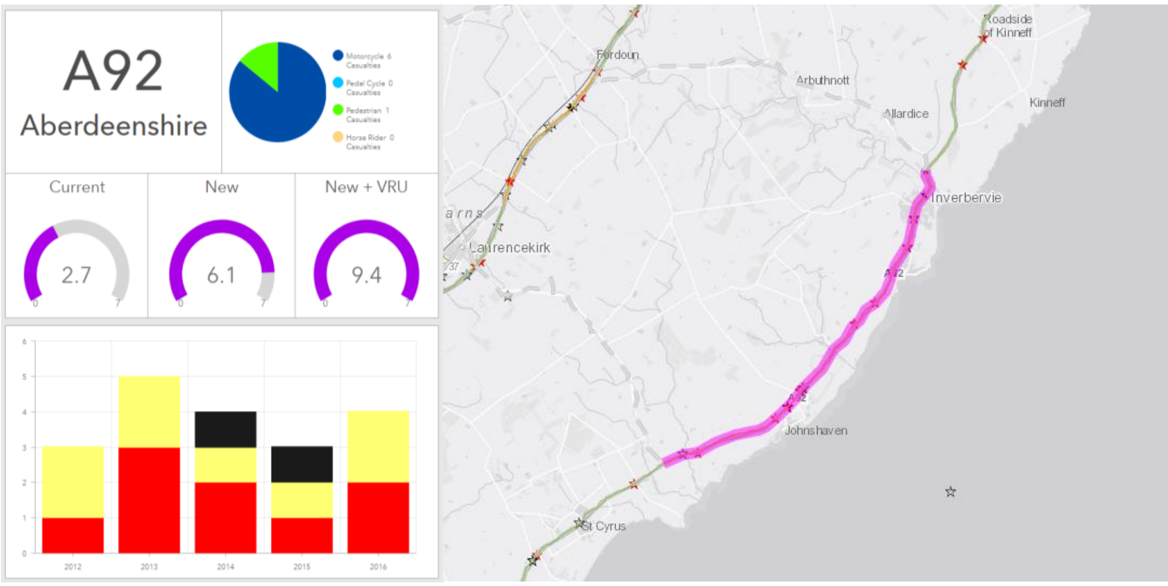
The length of site and its rural location may suggest mobile enforcement as a solution (if a speed survey indicates non-compliance).

A9 Perth and Kinross



The A9 between the A85 and A912 on the north-west of Perth was also not eligible for consideration under the *current* criteria. The 1.25km from the roundabout towards the south-west is where the collisions occurred and could be considered for a fixed camera site. There were 2 serious and 1 slight casualties over the five years, amounting to total points of 10 and a rate of 8.77 points per km, meeting the *new* criteria.

A92 Aberdeenshire



The A92 section south of Inverbervie did not meet the *current* site selection or the *new* proposed criteria without VRU weighting. The 10.3km route saw 2 fatal, 9 serious and 8 slight casualties over the five-year analysis period, which resulted in a total of 62.7 points, equalling 6.1 points per km (using the new values). However, six of the casualties were motorcyclists and one was a pedestrian, thereby the VRU weighting increases the points total to 9.4 per km, which meets the VRU-weighted criterion.

This route shows a consistent, high severity casualty problem along the whole length and has particular issues with motorcyclists. This site, if speed compliance was identified as an issue, could be considered as a mobile site, given its length (with multiple enforcement locations) or an average speed camera site.

RESULTS

The following analyses only cover the 17,425 km of routes that met the minimum length of 500m. It is worth acknowledging here that the full safety camera criteria, as published in the Handbook, mentions that fixed camera sites should have a maximum length of 1km and mobile site should have a maximum length of 10km. The sites in this analysis range between 500m and 72km (A838) and have not been amended to suit either of these pre-conditions.

As previously mentioned, each route was associated with one of the three safety camera areas and these are used to provide further insight during the following analyses. Routes are also broken down according to whether they were predominantly rural or urban.

Current Criteria

Using the current criterion, a total of 420km of routes met the 7 points per km threshold which is 2.4% of the total length analysed. There were significant differences in the percentage of routes that met the criterion in each of the three areas with very few (0.4%, 32.3km) meeting the requirement in the North area.

Figure 3 – Summary of routes with current criterion applied

Area	Met Criterion	Road Length (km)	Percent Urban
East	4.2%	157.8	79%
North	0.4%	32.3	70%
West	4.2%	230.4	89%
TOTAL	**2.4%**	**420.5**	**84%**

It is also worth noting that the current criteria very frequently identify urban sites as being suitable for enforcement, with only 16% in total being in rural areas. A review of the split by road class indicates that only 5.5% of the roads by length were motorways with almost three quarters being A roads. This is to be expected with a set of rules that uses a collision density measure (collision per km) rather than a risk rate (collisions per million vehicle KM tavelled) as the chances of collisions are higher when there is more traffic.

Figure 4 – Summary of routes by road class with current criterion applied

Road Class	Distribution by length
Motorway	5.5%
A Road	73.7%
B Road	20.8%

New Criteria

Using the new criteria, a total of 1,153km of routes met a 7 points per km threshold, which is 6.6% of the total length analysed. If the number of years considered remained at three rather than five, then 816km of routes would have met the threshold. This is only a 41% rise against an expected 66.6% when using two extra years of data. This suggests that there may be a non-linear distribution of points with larger proportions of routes having much higher points per km than the threshold value.

There were still significant differences in the percentage of routes that met the criteria in each of the three areas, with fewer meeting the requirement in the North area. The changes compared to the current criterion are seen more clearly in the North area, however with a 5.9x increase in road length versus 2.8x in the East and 2.3x in the West.

Figure 5 – Summary of routes with new criteria applied

Area	Met Criteria	Road Length (km)	Percent Urban
East	11.6%	436.4	48%
North	2.3%	190.91	45%
West	9.6%	525.69	64%
TOTAL	**6.6%**	**1153**	**54%**

The distribution of routes in urban and rural areas has changed significantly with a much better balance achieved across the whole road network, although there is more of an urban bias in the West area. A review of the split by road class shows little significant change verus the current critrion, with A class roads accounting for around three quarters of the routes identified by length.

Figure 6 – Summary of routes by road class with new criteria applied

Road Class	Met Criteria
Motorway	5.7%
A Road	74.4%
B Road	20.0%

New + VRU Criteria

Using the new + VRU criteria, a total of 1,759km of routes met a 7 points per km threshold which is 10.1% of the total lengths analysed. As this is now a much more significant length of road and over four times that seen with the current criterion, consideration has been given to changing the points threshold to 8, 9 or 10 points.

As the threshold changes, there are significant reductions in the number of routes that qualify. Once the threshold reaches 10 points, the total length of sites is now 10% lower than if the new criteria was applied without VRU at the 7 point threshold. The changes are broadly similar across the three areas, although the West area sees a slightly lower drop when the threshold changes from 7 to 10 points (34% versus 48% and 43% in the East and North respectively).

Clearly the number of extra sites depends which threshold is used but at the lower threshold, there would be an extra 60% of roads by length meeting the criterion in the East, 69% in the North and 40% in the West.

Figure 7 – Summary of routes with new+VRU criteria applied with different points thresholds per km

	7 points per km		**8 points per km**		**9 points per km**		**10 points per km**	
	Percentage	Length	Percentage	Length	Percentage	Length	Percentage	Length
East	18.6%	698	14.7%	554	12.4%	467	9.6%	360
North	3.9%	323	3.1%	256	2.7%	224	2.2%	183
West	13.5%	738	11.6%	631	10.6%	576	8.9%	487
TOTAL	**10.1%**	**1759**	**8.3%**	**1440**	**7.3%**	**1267**	**5.9%**	**1030**

As the weighting requirement increases, so does the proportion of routes identified as urban. This is unsurprising as there are are more VRU casualties in urban areas than rural ones.

Figure 8 – Summary of routes by urban classification with new+VRU criteria applied

	Percentage Urban
7 Points	45%
8 Points	51%
9 Points	54%
10 Points	60%

The distribution of routes by road class does not seem to be affected too significantly by the change in the weighting. When compared to the new classification with VRU weighting, there is more of a move towards non-motorway roads.

Figure 9 – Summary of routes by road class with new+VRU criteria applied

	7 points per km	8 points per km	9 points per km	10 points per km
Motorway	4.4%	4.4%	3.8%	4.7%
A Road	73.2%	73.4%	74.5%	74.9%
B Road	22.4%	22.2%	21.7%	20.5%

Vehicle Speeds

As well as the collision criteria, this study has also considered the impact of the rule that a speed survey must show that 15 percent of vehicles are travelling at a threshold that would be enforceable under the ACPO guidelines. This 85th percentile speed is a binary criterion with no weighting and not passing the test would result in the rejection of the site.

Agilysis was provided with speed survey data for 179 sites which was then analysed to estimate the number of routes that would be rejected if the sample was a suitable representation of typical roads across the country. Of the 179 sites, 14 were removed as the data seemed to be unreliable in one or more ways. The majority (94) were in 30mph limits with 11 in 40mph limits, five in 50mph limits and 49 in 60mph limits.

85TH PERCENTILE SPEEDS

Thirty three of the 179 sites met the 85th percentile criteria (20.8%) which would lead to the rejection of the majority of routes. All but three of the sites meeting the criteria were in 30mph limits, which suggests that this rule biases against higher-speed rural roads where consistent speeds in excess of the limit by a significant number of drivers occurs rarely.

NUMBERS OF OFFENDERS

One alternative measure that could be applied, either on its own or as a supplementary consideration when a site does not meet the 85th percentile rule, is the number of speeding vehicles per hour. It would seem reasonable that targeting volumes is just as meaningful as targeting those with high rates of offending.

Unfortunately the data did not contain a value for the absolute number so the value had to be estimated using the following methodology:

For each enforcement site the average speed, percentage of vehicles above the speed limit, 85th percentile speed and the percentage of vehicles greater than 15mph above the speed limit were used to estimate the percentage of vehicles above the ACPO limit. This was done by fitting a smooth curve through these four known data points, treating the average speed as an approximate median value, approximating the percentage of vehicles travelling above each speed. This curve was then used to interpolate at the ACPO limit. The fitting of the curve was done in R using the splines package, which determines a monotonic Hermite spline passing through the known points using the Fritsch-Carlson method.

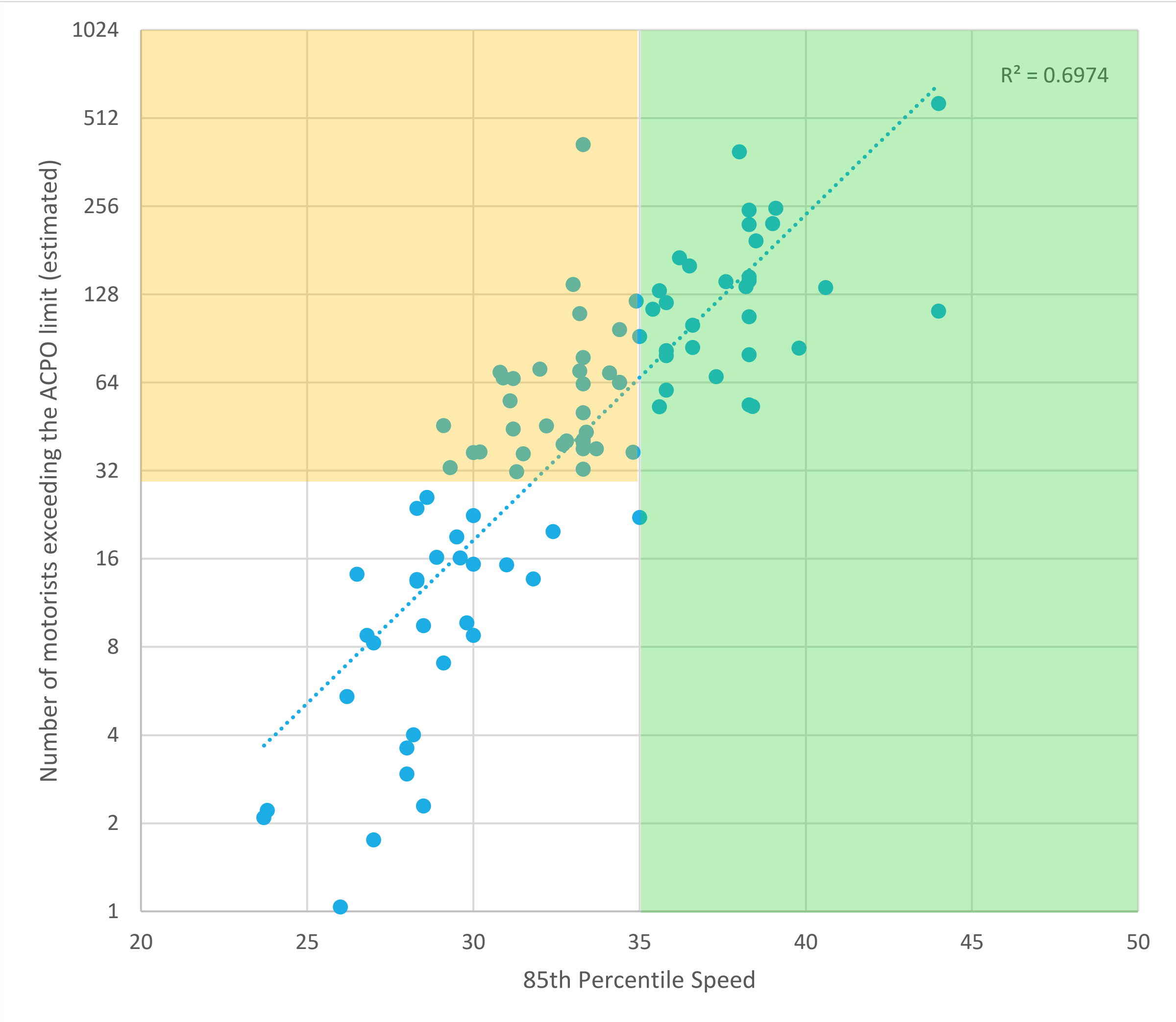
Given the small numbers of surveys in 40 and 50mph limits these results were not analysed.

Speeding in 30mph limits

The profile of 85th percentile speeds to the number at ACPO is exponential and as such Figure 10 shows numbers of offenders on a log scale to aid interpretation. The R value of 0.6974 shows there is a positive relationship and the level of fit is quite good. There are some sites that appear either side of the trend line but there are no siginficant outliers.

The green box highlights the sites which met the 85th percentile criteria and the orange box shows those that would additionally meet a value of 30 speeding vehicles per hour. The figure of 30 was not derived from a statistical analysis but is merely an example. There are a total of 35 extra sites that would then be considered further, more than double than if 85th percentile was used on its own.

Figure 10 – Speed survey results for 30 mph roads

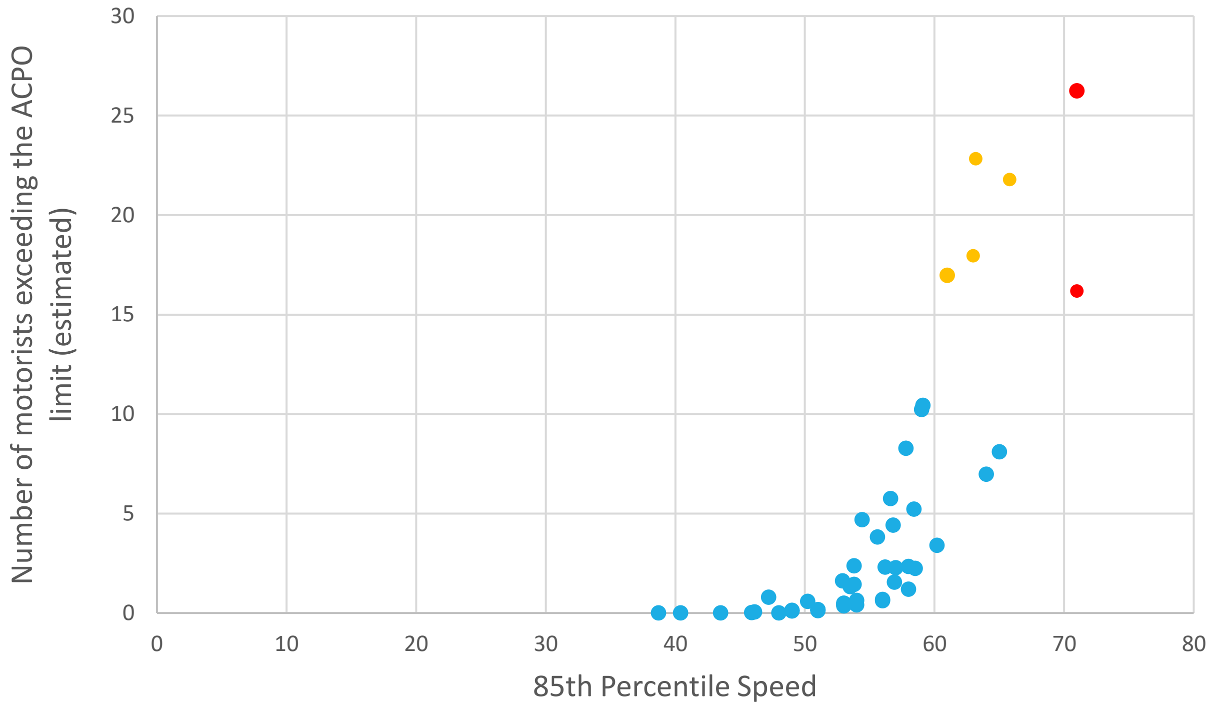


Speeding in 60mph limits

The profile of 85th percentile speeds to the number at ACPO is also exponential but the numbers exceeding ACPO are quite small so the axis is displayed without a log scale.

There were two sites (4%) that met the 85th percentile criteria and the maximum number of speeding motorists per hour was 26 compared to 574 in 30 mph limits. If an alternative criteria of 15 motorists per hour was applied to the sites surveyed then an extra 8% of sites would become eligible.

Figure 11– Speed survey results for 60 mph roads

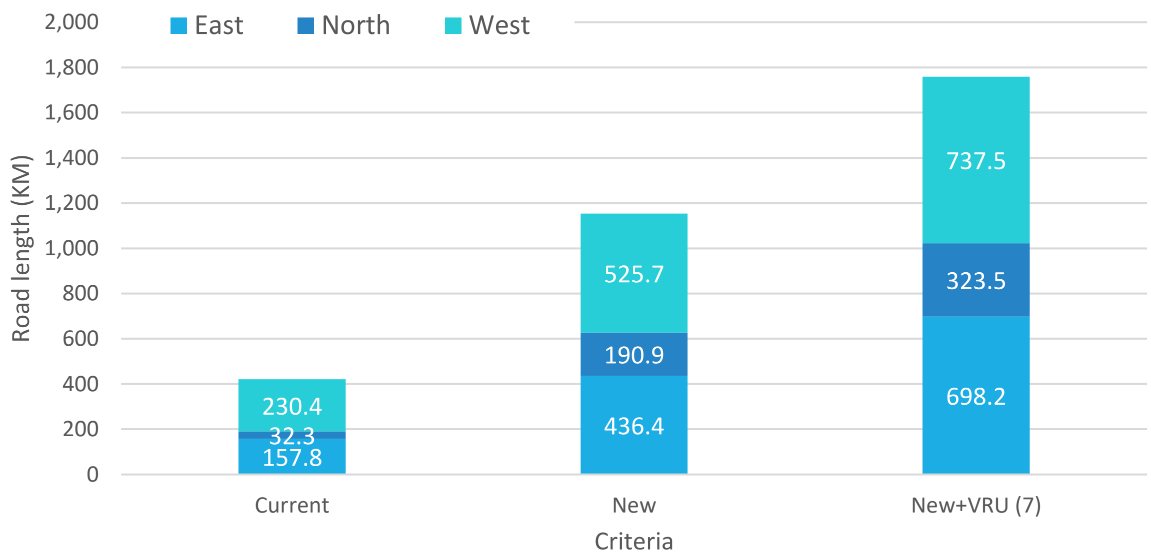


SUMMARY AND RECOMMENDATIONS

Following the conclusion of this exercise it is clear that the current set of criteria do not effectively allow for high-risk roads to be targeted. There is a bias towards urban areas and little differentiation between the relative cost of collisions of different severity. Furthermore, the 85th percentile criteria once again creates a bias against rural roads, which often have higher speed limits but proportionality lower offending levels.

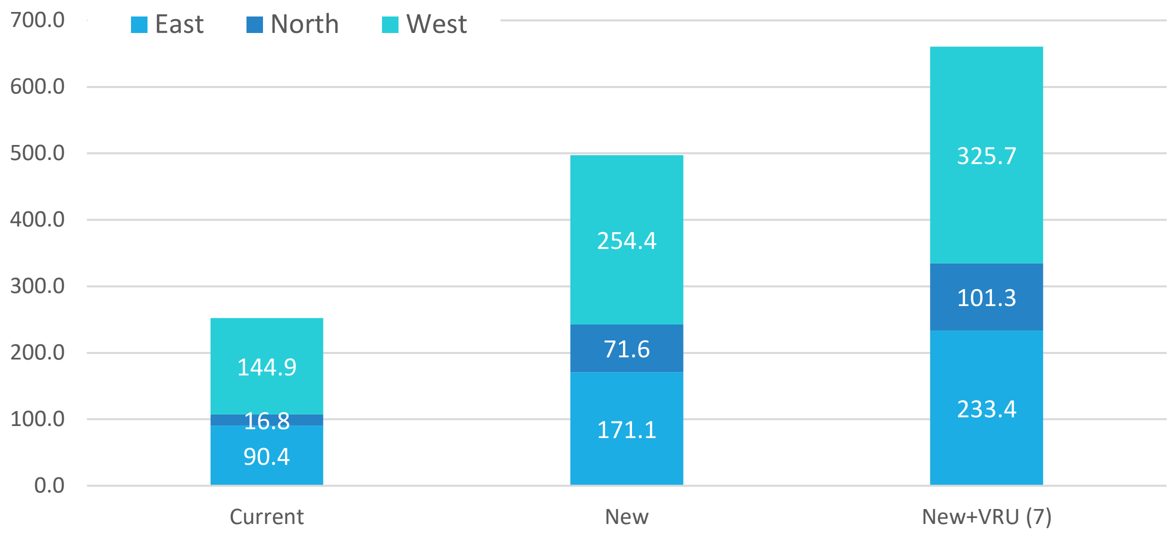
Adding in extra data from the most recent five years significantly increases the number of potential sites. Similarly, adding in extra weighting for VRU collisions increases the total length of road available for further investigation. Consideration could therefore be given to increasing the points per km threshold required but once speed survey data is taken into account, this could reduce the number of candidate sites drastically. If the points threshold is kept at 7, it allows a creation of a long list from which suitable sites can be analysed and prioritised according to the various elements of the criteria. Based on the casualty criterion, this would result in 1,759 km of roads (10.1 percent) meeting the collision-based criterion.

Figure 12– Distribution of routes under the three criteria



The next stage of the process would be to undertake speed surveys and if the results in the demonstration set are typical, only around 20% of sites in 30mph limits would be accepted and only 4% in 60mph limits. Unfortunately, no map of speed limits in Scotland exists so an estimation of the impact of this criterion is difficult to carry out but if they broadly matched with the rural and urban classifications for the routes then a calculation can be made.

Figure 13– Distribution of routes under the three criteria along with modelled reductions following speed surveys



Around 141.6km of urban road would be left and only 23.4km of rural roads if the speed surveys were similar. Using an additional and alternative tie-breaker based on 50 speeding vehicles per hour in urban areas and 15 in rural ones, then there would be 543.6km of urban roads and 116.8km of rural roads considered suitable for speed enforcement.

agilysis.co.uk

27 Horse Fair | Banbury | Oxfordshire | OX16 0AE
+ 44 1295 731810 | info@agilysis.co.uk | www.agilysis.co.uk

An associated company of Road Safety Analysis
A company registered in England, Company Number: 10548841
VAT Reg No: 260474119

agilysis