Protect and Survive
Star Rating England's Trunk Road Network for Safety
Britain wastes 1.5% of GDP on road crashes. That's more than we spend on primary schools or GPs.
How we Star Rate roads

Building a world free of high risk roads

Road deaths and injuries are the result of a complex interaction between the way people behave on the roads, the types of vehicles in use and the speed they are travelling, and the design of the roads themselves. Despite this complexity, creating a road system that is genuinely safe is not rocket science. The well-established "safe system" approach to road safety shows us how, borrowing from lessons learnt in other aspects of our lives, we can prevent death and serious injury.

Take the design of buildings for example. There would be outrage if instead of equipping precarious balconies and stairs with safety handrails, builders relied solely on the hope that people would be careful enough not to slip by accident and fall to their death. Thankfully, such a ridiculous scenario does not occur. Engineers simply require that safety handrails are installed on all balconies. End of story.

This approach to safety - in which there is fundamental recognition that people are fallible, that we all make mistakes from time to time, that humans cannot tolerate severe impacts and that risk can be systematically engineered out of aspects of our lives - can be applied to our high risk roads.

This is not to say that all responsibility for road safety rests with the "built" parts of the road system. It is absolutely crucial that drivers and vehicle occupants obey the law and act with respect for the safety of themselves and others. We all need to wear seat belts, remain sober while driving, travel within the speed limit and reduce distractions such as mobile phones. But the fact remains that along with safe road use and ongoing efforts to improve the safety of cars, there are substantial opportunities to improve the safety of our roads.

Some roads are safer than others. Here’s why

The Road Safety Foundation has previously published colour-coded EuroRAP Risk Maps that draw on historical crash data and illustrate that some roads experience higher rates of death and serious injury than others. The reports show that roads in the high-risk category are around 10 times more risky than those in the low-risk category*. This report takes the next step. It shows how some roads provide greater protection to car occupants in the event of a crash than others. Nationwide, car occupants account for about half of all road deaths.

The Star Ratings are based the EuroRAP 1.0 Star Rating protocol that focuses on three key parts of a road: roadsides, medians and junctions. These elements, together with deaths to vulnerable road-users, are a factor in about 80% of all car occupant deaths in inter-urban rural roads in Britain. Motorways have relatively more rear-end shunts.

Rods

Roadsides

Run-off road crashes into hazardous fixed objects at the side of the road play a part in about a quarter of all deaths on rural main roads in Britain. Trees, poles, steep embankments and cuttings can turn what would be a minor crash into a killer. If these hazards can’t be removed, safety barriers can dramatically lower the risk.

Medians

Head-on crashes account for about a fifth of all deaths on rural roads in Britain. Roads with wide medians and safety barriers can handle high traffic volumes with virtually no chance of a head-on crash. Research has consistently shown that medians and central safety barriers can reduce head-on crashes by as much as 90%.

However, poorly designed medians can in fact increase risk. In the same way that roadsides can be hazardous for cars that run-off the road to the left side, objects such as trees and poles in the centre of the road can present a hazard for cars that run off the road to the right.

Junctions

Crashes at junctions are one of the most common types of problem, accounting for about a quarter of all deaths on rural roads in Britain. When travel speeds are high, the consequence of right-angle crashes at junctions can be brutal.

The best junctions have motorway style on and off ramps (grade-separated), which physically separate traffic flowing along the main road from cross-traffic. Entering traffic merges. Roundabouts are also low risk because they require all traffic to flow in the same direction. This reduces the chance of head-on and right-angle crashes. Roundabouts can also dramatically reduce traffic speeds.


Road Casualties Great Britain (2008), Annual Report, Department for Transport, UK.
How we Star Rate roads

The Star Ratings are produced by assigning a roadside, median and junction score to each 100 metre section of road. The scores are based on detailed inspections and decades of research into the relative risk associated with road infrastructure features. As a simple example, the risk of death and serious injury in a run-off road crash is approximately halved on a road that has side safety barriers in place. Risk factors can be increased more than six-fold on roads where there are unprotected rigid objects such as trees within 7 metres of the road*. The scores are adjusted according to the speed of traffic on the road, such that the higher the speed, the greater the risk of death and serious injury.

Having assigned a score for each part of the road, they are then combined to form an overall score and Star Rating. A 4-star road (the safest) is likely to have safety barriers at the side of the road and in the median, and grade-separated junctions. On this type of road, a safe driver in a safe car is significantly less likely to be killed or seriously injured in the event of a crash than if they were travelling on a 1-star road (the worst). Low scoring sections have hazardous fixed objects close to the road, frequent junctions and no head-on protection from oncoming traffic.

Inspecting the Highways Agency network

The focus of this report is on inter-urban sections of the roads in England that are managed by the Highways Agency (HA), known as the HA network. The roads that form this network reach across the entire country. They are the motorways and A roads of national importance. Other A roads in England are managed by local authorities. The HA network consists of:

- motorways
- the major dual carriageway ‘A’ roads (trunk roads)
- the major single carriageway ‘A’ roads (trunk roads).

The HA network is about 7,000km and represents 2% of all roads in England. These roads carry a third of all vehicle traffic and two-thirds of all freight in England. Motorways in England carry as many as 160,000 vehicles per day on the busiest sections; the busiest dual carriageways sections take 100,000 vehicles per day and more. Busy single carriageways have around 30,000 vehicles per day. The HA network experiences about 15% of all deaths in England.

The inspections of this network were carried out in 2007 and 2008 on behalf of the Road Safety Foundation by the German automobile club, ADAC, which has extensive experience of the EuroRAP Star Ratings and in inspecting European roads. The inspections made use of tailor made software installed on a touch-sensitive laptop computer. As the inspectors travelled throughout the network, they recorded road infrastructure features in accordance with the EuroRAP protocol.

Following the completion of the inspections, the road inventory data was analysed using EuroRAP protocols by TRL (Transport Research Laboratory) and Swedish consultants Sweco.

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FINAL DRAFT. 13 JANUARY 2010
Inspecting the Highways Agency network

Where the network scores well and poorly... (and why)

Star Rating for safety

50%
of all motorways are rated 3-star and half are 4-star.

78%
of dual carriageway 'A' roads are 3-star. The remainder are 4-star (20%) and 2-star (2%).

62%
of single carriageway 'A' roads are 2-star. Most of the remainder are 3-star (35%) and less than 1% is 1-star.

Motorways

Dual carriageway trunk roads also score well for head-on protection. 97% is of the highest standard.

Dual carriageways, like motorways, also score poorly on side run-off protection. 90% of dual carriageway does not reach the highest standard.

Many dual carriageway junctions are split-level and are rated at the highest standard. But, for 24% of dual carriageways, junctions are at the same level (“at-grade”), there are minor accesses and frequent lay-bys. These sections are not rated at the highest standard.

Dual carriageway trunk roads

Junctions

Motorways score at the highest possible level for head-on and intersection protection because their carriageways are separated by barriers and they have split-level junctions.

But the level of side run-off protection is more variable, with unprotected steep embankments and trees relatively common.

The 50% of motorways that do not score 4-star do so because of poor side run-off protection. A further 25% of motorway side run-off could also be improved in someway.

Motorways

Overall Star Ratings (above) are comprised of side run-off, head-on and junction components.

Motorways score at the highest possible level for head-on and intersection protection because their carriageways are separated by barriers and they have split-level junctions.

But the level of side run-off protection is more variable, with unprotected steep embankments and trees relatively common.

The 50% of motorways that do not score 4-star do so because of poor side run-off protection. A further 25% of motorway side run-off could also be improved in someway.

Side run-off

Motorways

Side run-off protection is poor. 91% of single carriageway does not reach the highest standard.

Single carriageway surface-level junctions do not rate well – fewer than half (46%) of road sections rate at the highest standard. Sections scoring high for this measure either have no junctions or have a reduced speed limit.

Protection from head-on injury is generally only provided by road markings designed simply to increase the distance between opposing traffic. Only 7% of single carriageway is rated at the highest level for head-on protection and this rating is achieved only because low speed limits have been set on these sections.

Junctions

Single carriageway trunk roads lack the substantial protection offered to vehicle occupants on motorways and dual carriageways.

Side run-off protection is poor. 91% of single carriageway does not reach the highest standard.

Single carriageway surface-level junctions do not rate well – fewer than half (46%) of road sections rate at the highest standard. Sections scoring high for this measure either have no junctions or have a reduced speed limit.

Protection from head-on injury is generally only provided by road markings designed simply to increase the distance between opposing traffic. Only 7% of single carriageway is rated at the highest level for head-on protection and this rating is achieved only because low speed limits have been set on these sections.

Head-on

*100m sections with roadside protection or median protection recorded as settlement (e.g. village, or blank) were removed from the data before the distribution of ratings was calculated since the focus of EuroRAP is on inter-urban roads. Percentages may not sum to 100% because of rounding.
Inspecting the Highways Agency network

Road sections with low average Star Ratings

The tables below show the sections of road that have the lowest average Star Rating in each road category - motorway, dual carriageway and single carriageway.

The routes listed below can be checked for where improvements could be made, what countermeasures are available and what the likely cost-benefit opportunities are. This can be done by investigating the components of the total Star Rating on the routes and using both local knowledge the safety history of the routes, and the experience and expertise of the road engineer.

Motorways

The list below shows the sections of motorway with the lowest Star Ratings. They all score 3-star and are ranked showing the least safe at the top.

Each of the low-rated motorway links has intersections and head-on protection rated at the highest standard. Therefore the sections included in Table 1 have low total Star Ratings due to low side run-off protection ratings.

Table 1: Motorway sections with the lowest average 3-star rating

<table>
<thead>
<tr>
<th>Road</th>
<th>Description</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M40</td>
<td>M40 J15 to M42 J3A</td>
<td>17</td>
</tr>
<tr>
<td>M50</td>
<td>M5 J8 to M50 J4</td>
<td>34</td>
</tr>
<tr>
<td>M4</td>
<td>M4 J14 to J16</td>
<td>20</td>
</tr>
<tr>
<td>M11</td>
<td>M11 J4 to J8</td>
<td>23</td>
</tr>
<tr>
<td>M20</td>
<td>M20 J8 to J10</td>
<td>26</td>
</tr>
<tr>
<td>M45</td>
<td>M45 J17 to M45 J1</td>
<td>12</td>
</tr>
<tr>
<td>M25</td>
<td>M25 J20 to J22</td>
<td>12</td>
</tr>
<tr>
<td>M1</td>
<td>M1 J26 to J28</td>
<td>14</td>
</tr>
<tr>
<td>M34</td>
<td>M34 J10 to J17</td>
<td>34</td>
</tr>
<tr>
<td>M42</td>
<td>M42 J0 to J3</td>
<td>15</td>
</tr>
<tr>
<td>M53</td>
<td>M53 J1 to J5</td>
<td>22</td>
</tr>
</tbody>
</table>

In Tables 1-3 only sections >10km are listed.

Half of our motorways score 4-star. The other half does not reach the highest rating because side run-off is inconsistent and lacking.

*Tables 1-3 are based on the Star Ratings for each EuroRAP link given by the RPS1.0 calculator. Sections listed are formed from the same road network as that used in producing the EuroRAP Star Rates Map for the Trunk Road network. The average section length of this network is 26km. The Star Rating listed is therefore an average of the sections included in the section. Correspondingly, Sections in Tables 1-3 show the Star Rating due to the lowest rating section in the list above. Star Ratings for lengths as short as 3km can therefore be identified from the maps.
Dual carriageway trunk roads

Table 2 shows those lengths of dual carriageway scoring lowest, ranked by Star Rating. They all score 3-star with roads with the lowest score at the top.

As with motorways, the low-rated dual carriageways mostly have low total star ratings due to low side protection ratings, but may also score low due to at-grade junctions, other low-quality accesses, lay-bys and central reservation gaps.

Table 2: Dual carriageway sections with the lowest average 3-star rating

<table>
<thead>
<tr>
<th>Road</th>
<th>Description</th>
<th>Length (km)</th>
<th>Deficiency</th>
<th>Side run-off</th>
<th>Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A419</td>
<td>Swindon – Cirencester</td>
<td>27</td>
<td>S, J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A168</td>
<td>Darlington – Thirsk</td>
<td>12</td>
<td>S, J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A25</td>
<td>M3 – Brighton</td>
<td>26</td>
<td>S, J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A19</td>
<td>Thirsk – Middlesbrough</td>
<td>35</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A11</td>
<td>M11 J4A – A1384 Newmarket</td>
<td>19</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A19</td>
<td>Sittingbourne – A1/M65</td>
<td>32</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A303</td>
<td>M3 – Beacon Hill (A338)</td>
<td>36</td>
<td>S, J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A42</td>
<td>M2, J11 – M1, J13</td>
<td>49</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A14</td>
<td>Ipswich – Felixstowe</td>
<td>30</td>
<td>S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Complex junctions, where traffic crosses at the same level, lower the Star Rating

Rigid roadside objects also lower the Star Rating
Single carriageway trunk roads

Table 3 shows single (and some mixed single-dual) carriageway with the lowest average rating. They are all 2-star. There were no single carriageways with a Star Rating averaged over the network of 1-star although some sub-section examples may be identified from the map.

Many of the sections listed here have a particularly poor head-on rating. This contributes to the overall rating being low. The low head-on score is often due to a high posted speed limit and traffic separated only by white lining. Similarly, frequent junctions, accesses and the presence of unprotected aggressive roadside objects will also mean that head-on and side run-off protection rates poorly.

Table 3: Single carriageway sections* with the lowest average 2-star rating

<table>
<thead>
<tr>
<th>Road No</th>
<th>Description</th>
<th>Length (km)</th>
<th>Deficiency**</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5</td>
<td>Daventry - Rugby (A428)</td>
<td>16</td>
<td>S, J, H</td>
</tr>
<tr>
<td>A46</td>
<td>Alcester - M40 J15</td>
<td>21</td>
<td>S, J</td>
</tr>
<tr>
<td>A65</td>
<td>Long Preston – M6 J36</td>
<td>42</td>
<td>S, J</td>
</tr>
<tr>
<td>A62</td>
<td>Bingham – Grantham</td>
<td>21</td>
<td>S, J, H</td>
</tr>
<tr>
<td>A49</td>
<td>Hereford - Ross-on-Wye</td>
<td>22</td>
<td>S, J</td>
</tr>
<tr>
<td>A49</td>
<td>Leominster - Tewkesbury</td>
<td>40</td>
<td>S, J</td>
</tr>
<tr>
<td>A5*</td>
<td>Bletchley – Daventry</td>
<td>36</td>
<td>S, J</td>
</tr>
<tr>
<td>A46</td>
<td>Bingham - Newark</td>
<td>19</td>
<td>S, J</td>
</tr>
<tr>
<td>A5*</td>
<td>M1 J6 - Bletchley</td>
<td>32</td>
<td>S, J</td>
</tr>
<tr>
<td>A64*</td>
<td>York - Scarborough</td>
<td>69</td>
<td>S, J</td>
</tr>
<tr>
<td>A120*</td>
<td>Grantham – Kirby Toy</td>
<td>19</td>
<td>S, J</td>
</tr>
</tbody>
</table>

*Includes some short lengths dual carriageway, often at the start or end of the section

**Single carriageways by definition have little or no head-on protection. Those marked “H” had a particularly low head-on score and/or relatively high speed limit for the amount of median protection offered. Therefore the Star Rating could be improved by either installing median protection or by reducing speed limits, or a combination of both.
Summary and conclusions

Some 20,000 people will be killed or seriously injured on England’s trunk roads over the next decade if current death and injury rates continue. The cost of emergency services, hospitalisation, long term care, damage and other costs will exceed £11bn well before the end of the decade.

Serious road crashes are no longer tightly clustered at blackspots that can be treated after a short study of crash records. Most deaths are dispersed over the network on roads with layouts which are known from research to carry higher risks. This EuroRAP Star Rating of trunk roads provides the first overview of the in-built risks in national roads using the same basis on which new cars are crash tested.

Around 7,000 km of the Highways Agency’s road network were inspected and safety rated using the EuroRAP 1-4 Star Rating scale. The scale measures the extent to which a car occupant is protected from severe injury at the posted speed limit once a crash occurs.

Outside built-up areas, people die in three main ways:

- head-on crashes
- running off the road and striking aggressive objects
- brutal side impacts at junctions

The Star Rating measures the protection provided by the road’s median (by its width, road markings or presence of a central barrier); by the junction types along the road; and by what a vehicle is likely to strike and where it will end up if it leaves the carriageway.

Although motorways have the highest speeds, the risks for drivers are the lowest of all British road types because protection standards are generally engineered to match the permitted speed. But English motorways are very heavily trafficked and so there is high exposure to any raised risk. The survey showed that half of English motorways achieved the maximum 4-star rating. Nonetheless, because run-off protection is inconsistent or lacking, half of motorways achieved a 3-star rating.

The survey shows trunk road dual carriageways are not as safe as motorways with approximately 80% achieving a 3-star rating. The run-off problems seen on dual carriageways were more widespread than on motorways. In addition, there were junctions where side road traffic was permitted to cross high speed traffic. There were also many accesses and lay-bys where vehicles join busy high speed roads and the layouts do not have adequate acceleration lanes for safe merging.

The survey showed that just a third of trunk single carriageways achieve a 3-star rating. With their lower speed limits, single carriageways can achieve a 3-star rating where there are well laid out junctions and good run-off protection. Some leading countries are now achieving 4-star single carriageways, and reporting serious crash rates lower than motorways, by the innovation of adding wire-rope protection in the median.

This report shows the differences in safety rating between different types of trunk road. It shows where, how and why Star Rating varies between the same road type. It provides a new platform from which the Highways Agency can lead Britain’s road authorities in rating infrastructure safety. It can help achieve the government’s proposed goal for the next road safety strategy – to make Britain’s roads “the safest in the world”.

Recommendations

The results from the survey have been mapped in 3km lengths showing where the ratings are high and low. They should be used in three ways:

- to assess overall network standard and the business case for investment
- to help, alongside crash data, identify priority routes and layouts for treatment
- to help, alongside crash data, identify treatments

Network Standard.

Other leading countries have examined the costs and benefits of raising their network Star Rating. For example, the Dutch government has pledged to raise its network to a minimum EuroRAP 3-star standard by 2020. However, this has only been done following study of the high returns available from investment to reduce deaths and serious injury. The British government’s April 2009 consultation document on road safety strategy expresses concern that evaluation of safety programmes is not carried out on the same basis as other investment.

It is recommended that the Highways Agency carry out an evaluation of the returns that can be made by raising the Star Rating and reducing the £1.2bn annual cost of crashes on its network on the basis of the savings over the economic life of the investment.

Identify Priority Routes and Layouts

It is recommended that:

- the Agency identifies priority routes and layouts for improvement where most deaths and serious injuries will be saved for the money available
- the Road Safety Foundation prepares Crash Cost maps alongside Risk Rate and Star Rating maps.

Identify Treatments

Dozens of potential countermeasure treatments include:

- run-off protection using safety fencing and returning tree lines to safe distances
- providing protected right-turns at busy junctions
- ensuring that lay-bys meet standards
- ensuring edge-of-carriageway marking and shoulder sealing
- use of lower-cost split-level junctions types (“compact grade-separation”)  
- trialling innovative 4-star single carriageway types

The Star Ratings, alongside crash and other data, can assist in the detailed study and evaluation of specific road sections and layouts. Detailed recommendations have been made to incorporate Star Ratings in the Agency’s routine assessment tools.

It is recommended that:

- the assessment tools are piloted in the Highways Agency’s areas over the next two years
- programmes are developed so safety is systematically implemented during routine maintenance and rehabilitation cycles.

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The Star Rating of the HA network was financially supported by the Highways Agency. The Agency has also been involved in a trial of the Road Protection Score in south-east England and in work producing guidance for engineers in the use of the techniques described here.

The inspection of the English trunk road and motorway network was undertaken by the German motoring club ADAC, with data processing by Swedish consultants Sweco.

The analysis of results, a matching of Road Protection Score and crash data, and an assessment of the methodology, was undertaken by TRL (Transport Research Laboratory). The technical report from the study produced by J Martin, D Lynam and L Crinson (2009). EuroRAP Road Protection Score, Highways Agency Network Stage II Results, TRL Report RPN 296.

The project was supervised by Dr Steve Lawson and James Bradford of the Road Safety Foundation using protocols developed by the European Road Assessment Programme www.eurorap.org. The Road Safety Foundation is especially grateful to Raphael Dziub and Marcus Thiel of ADAC for conducting the inspections and to David Lynam, formerly Chief Scientist TRL, and Jonathan Turley of the Highways Agency for special help and advice.

The views expressed here are those of the Road Safety Foundation and EuroRAP AISBL and do not necessarily those of any other individual or entity.

Photos: page 5 top - Cheshire County Council; page 9 both - Highways Agency (Crown Copyright); page 14-15 - Sue Adair; back cover - Highways Agency (Crown Copyright).

**Table 5: Single vehicle collisions with roadside objects, British motorways 2008**

<table>
<thead>
<tr>
<th>Object hit</th>
<th>Fatal</th>
<th>Serious</th>
<th>Slight</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road sign/Traffic signal</td>
<td>1</td>
<td>15</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>Lamp post</td>
<td>3</td>
<td>7</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>Tree</td>
<td>9</td>
<td>15</td>
<td>105</td>
<td>149</td>
</tr>
<tr>
<td>Other</td>
<td>26</td>
<td>130</td>
<td>856</td>
<td>1012</td>
</tr>
<tr>
<td>None</td>
<td>13</td>
<td>16</td>
<td>301</td>
<td>390</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>263</td>
<td>1325</td>
<td>1640</td>
</tr>
</tbody>
</table>

About

Road Safety Foundation
The Foundation was established as a permanent legacy of the 1986 European Road Safety Year as Britain launched its first national casualty reduction target. The charity was initially called the AA Foundation for Road Safety Research in recognition of its major donor at the time. It was modeled on the successful charity, the AAA Foundation for Traffic Safety, founded in the USA by the American Automobile Association.

The objective of the Road Safety Foundation is to carry out or procure research into all factors affecting the safe use of public roads.

The key programme of the Road Safety Foundation is the European Road Assessment Programme (EuroRAP), itself founded as a non-profit association by the Foundation.

Highways Agency
The Highways Agency is an Executive Agency of the Department for Transport, and is responsible for operating, maintaining and improving the strategic road network in England on behalf of the Secretary of State for Transport.

EuroRAP
The European Road Assessment Programme - EuroRAP AISBL - is an international not-for-profit association (Association internationale sans but lucratif) registered in Belgium. Its members are motoring organisations, national and regional road authorities, and experts who have been elected because of the special contribution they have made to EuroRAP.

EuroRAP is a sister programme to EuroNCAP, the independent crash test programme that star rates new cars for the crash protection they provide to passengers and pedestrians. EuroNCAP demonstrates that well-designed crash protection can make family cars safer. Similarly, EuroRAP shows how roads can be made safer, so that the car and road work together to protect life.
“The Highways Agency in England is the UK’s largest road authority. It is the first in Britain to offer its entire network up to independent EuroRAP ‘star rating’ for safety and to consider the results in guiding further improvements. It is to be congratulated for this openness. It will permit national network performance to be tracked alongside leading countries such as the Netherlands and Sweden during the decade ahead, as well as against dozens of other countries worldwide”.

50% of all motorway length on the HA network is rated 4-star and 50% is 3-star.

78% of all dual carriageway ‘A’ road length on the HA network is rated 3-star, with the remainder rated 4-star (20%) and 2-star (2%).

Almost two-thirds (62%) of single carriageway ‘A’ road length on the HA network is rated 2-star, with most of the remainder 3-star (35%). Less than 1% is rated 1-star.