OFFICE OF RAIL AND ROAD

elliott asset management

resilient future solutions

hyperion infrastructure consultancy

Longer-term implications of Highways England's road period 2 delivery

How Highways England is managing congestion and delay

Final Report

Project Ref: ORR CT 20-09 WS1

Client: Office for Rail and Road

Prepared by Elliott Asset Management Ltd

Registered in England and Wales No. 10748779

Title:	How Highways England is managing congestion and delay	Reference:	ORR CT 20-09_WS1_FINAL REPORT_v0.3.docx
Date:	15/02/2021	Version:	Final
Author:	James Elliott, Director and Principal Consultant, Elliott Asset Management Ltd		

Contents

Acronyms

A to N			O to Z	
AD	Asset Delivery		OD	Operations Directorate
APTR	All Purpose Trunk Roads		OMM	Operational Metrics Manual
Austroads	Australian and New Zealand transport agencies		ORR	Office of Rail and Road
BCR	Benefit Cost Ratio		PI	Performance Indicator
CAV	Connected and autonomous vehicles		PIARC	World Roads Association
CEDR	Conference of European Directors of Roads		POPE	Post Opening Project Evaluation
CHARM	Common Highways Agency Rijkswaterstaat Model		RCC	Regional Control Centre
CLEAR	Collision – Lead – Evaluate – Act – Re-opened		RIP	Road Investment Programme
DATEX II	Data exchange specifications for traffic management and information		RIS	Road Investment Strategy
DBFO	Design Build Finance Operate		ROC	Regional Operations Centre
DfT	Department for Transport		RP 1, 2, 3	Road Period (RP1: 2015-20, RP2: 2020-25, RP3: 2026-30)
EAM	Elliott Asset Management		S&P	Strategy & Planning Directorate
FISITA	International Federation of Automotive Engineering Societies		SM	Smart Motorway
HGV	Heavy Goods Vehicles		SRN	Strategic Road Network
HOV	High Occupancy Vehicle lane		SRUS	Strategic Roads User Survey
JESIP	Joint Emergency Services Interoperability Programme		STB	Sub-national Transport Body
KPI	Key Performance Indicator		TOS	Traffic Officer Service
LRF	Local Resilience Forum		TRB	Transport Research Board (USA)
MP	Major Projects Directorate		TDM	Travel Demand Management
MPDT	Major Projects Delivery Transformation programme			
NMMs	Network Management Managers			
NOMS	Network Occupancy Management System			
NRUSS	National Road User Satisfaction Survey			
NTOC	National Traffic Operations Centre			

Executive summary

This project has been commissioned by ORR as part of its review of the longer-term implications of Highways England's Road Period 2 delivery (RP2). It considers the actions that Highways England has taken to reduce congestion and delay and improve the provision of customer information on the strategic network in RP1, and the actions it is planning to take during RP2 and develop for RP3.

The project considers three sources of delay: recurrent delay, delay due to roadworks and delay due to incidents. Other types of delay such as from severe weather are excluded. This project includes how Highways England manages the three delay sources on different parts of its network such as APTR and the implications for future congestion and delay improvements. The project also provides advice to ORR for its future monitoring of Highways England's management of congestion and delay.

The project team has developed the findings and recommendations in this report from a review of published delay management literature, evidence provided by Highways England and from a comparator study of international road operators. EAM would like to thank Highways England for their cooperation and access to staff during the study.

The project scope posed a series of questions to elicit how Highways England is managing congestion and delay. The questions are addressed in the following findings which are followed by our recommendations for Highways England and ORR.

What actions has Highways England been taking to reduce delays on the network and provide improved customer information?

Evidence from this study shows that Highways England continues to deliver and commit to a well-coordinated programme of physical interventions and non-physical improvements to manage recurrent delay, roadworks delay and delay caused by incidents. It has also increased its intelligence and segmentation of traffic and delay information and data during RP1 to provide better insight to its national strategy and planning teams and its regional operations. Examples of interventions delivered during RP1 include:

- Enhancing capacity through the Road Investment Programme (RIP) scheme improvements etc.
- Trialling 60mph speed limits in roadworks to improve traffic flows when safe to do so.
- Developing a Travel Demand Management (TDM) toolkit to influence travel behaviour by managing demand.
- Updating Highways England's Strategic Responders agreement with the emergency services to improve incident coordination.
- Implementing a new network occupancy tool, Network Occupancy Management System (NOMS) to plan and manage roadworks.

Other examples of targeted interventions that aim to build on the management and reduction of delay and improve customer information during RP2 are grouped by delay type, and include:

- Crossover delay (one or more delay source) – Highways England are developing its delay ambition which will provide a long-term delay management strategy. They also aim to roll out TDM initiatives and refresh customer service standards and plans during RP2.
- Recurrent delay – As well as monitoring the causes of recurrent delay at a more granular level through targeted performance measures including the analysis of known delay hotspots, Highways England propose to further reduce recurrent delay through the roll out of motorway improvements and development of its next tranche of congestion improvement schemes during RP2 to be delivered in RP3.

- Roadworks delay – Highways England aim to deliver several key interventions that reduce the delay from roadworks including formalising the outputs of its 60mph speed limit trials and developing operational standards to confirm where this can be implemented. It also aims to improve roadworks coordination with local authorities and utilities through embedding NOMS and improving the data interface with DfT's Street Manager system. Achieving the new RIS2 metric target level for roadworks information timeliness and accuracy by the end of RP2 is forecast to produce a step-change in customer information. Highways England also aims to implement a review of all its diversion routes during RP2 and coordinate this review with local authorities and the emergency services.
- Incident delay – Highways England propose to continue to enhance relationships with the emergency services including through the Joint Emergency Services Interoperability Programme (JESIP) principles and in Local Resilience Forums. It also aims to implement a review of which strategic APTR would benefit from additional monitoring as well as monitoring motorway incident response levels and the causes of incident delay through RIS2 performance measures.

How successful have these interventions been and does the company have good quality evidence to support this?

Evidence shows that Highways England has good processes in place to fully evaluate operational changes or network improvements from their commencement through to implementation. The ability to measure the success of individual delay interventions varies as it is not possible to fully evaluate some physical measures for a number of years and these can either be overtaken by other actions and network changes or are rolled-up into summary performance measures.

For example, one of the summary delay measures, 'average delay', requires Highways England to agree a baseline for its ambition that 'delay will be no worse at the end of RP2 than it was at the end of RP1'. At the end of RP1, average recurrent delay was 9.3 seconds per vehicle mile, an increase of 0.4 seconds per vehicle mile since 2015-16. Although this has coincided with an increase in network traffic during RP1 it has since been affected by the impact of Covid-19, which is likely to continue to affect the company's baseline and ambition for average delay in RP2.

The ability of Highways England to measure the success of interventions can also be limited in some areas such as on APTR where it does not have the equivalent monitoring infrastructure to motorways and for qualitative interventions such as TDM. The reporting of new enhanced measures in RP2 together with stakeholder feedback such as from Transport Focus' Strategic Roads User Survey (SRUS) should enhance Highways England's ability to better monitor the benefits of its delay management interventions.

How well does the company use delay information and data to identify interventions?

Highways England has established data sources, systems, and processes to monitor delay on the Strategic Road Network (SRN) which are used for operational management and identification of interventions as well as to support the reporting of metrics related to delay. These have been in place since RP1 and further developed for RP2. Overall, there is evidence of the line of sight from the type of delay to the intervention, supported by the availability and analysis of data and information.

Alleviation of recurrent delay is a key driver in the identification and development of schemes in Highways England's capital enhancement programme; meta-analyses of benefits evaluation show that around 80% of scheme benefits are accrued in terms of journey time (2015 – most recent available). The Safety and Congestion designated fund in RIS1 also provided a means to deliver targeted improvements at identified locations where flow and/or capacity measures would be of benefit.

Study evidence shows that the RP2 measure for 'roadworks information timeliness and accuracy' has proved a strong driver to further develop systems and procedures for coordination of roadspace occupancy across the delivery arms of Highways England. The measure is also encouraging better engagement and collaboration with key external stakeholders such as local authorities and utility companies. Greater accuracy and reliability in roadworks planning should improve the quality and timeliness of information that can be provided to customers to inform their journey choices. Achieving the target for this measure by the end of RP2 will benefit the management of delay in RP3 and beyond.

Highways England has good, established procedures for responding to incidents and unplanned events and it is evident that recommendations from a recent ORR review of its performance in this area are being taken on board. For motorways, the combination of infrastructure e.g. CCTV and traffic officer patrols generally provide good intelligence to initiate the appropriate incident response. This is supported by relationships with emergency services and the Police in particular. It is evident that Highways England recognises the importance of these relationships and works actively to develop and maintain them. These are also essential for the management of incidents on APTR routes where Highways England acknowledges it has less visibility of incidents and influence on the timeliness and accuracy of when an incident will be cleared.

Are there differences in approach to how delays are managed for major enhancement projects and operational maintenance / renewal works?

Following RP1 it is evident that there is significant pressure, and hence priority, on Highways England's delivery of the capital enhancements programme for RP2. Managing the delivery of the RIS2 schemes programme, which is larger than in RIS1, against the continuing need for maintenance and renewals on the SRN presents challenges and risks in roadspace planning and roadworks for both Major Projects (MP) and Operations (Ops) directorates, which have the respective responsibilities for these programmes. There have been differences in procedure and approach between MP and Ops, but these now appear to be converging through a focus on customer service, supported by the MP 'One Network' and Ops 'Operational Excellence' transformation programmes. The introduction of the 'roadworks information timeliness and accuracy' measure is driving more collaborative behaviours in planning and coordinating roadspace occupation. In addition, Highways England's commitment to review and develop all diversion routes in RP2 should deliver benefits in the management of roadworks delay as well as improve stakeholder relations.

Are there differences in approach to how delays are managed between regions?

Highways England has established central systems (i.e. NOMS) and processes but there is inevitably a degree of localised procedure for the management of delay dependent upon regional or area circumstances, local stakeholders and contractual forms, among other factors. Highways England's focus on outcomes and customer service is driving a convergence of process. This is supported by the roll out of the Asset Delivery (AD) model which gives Highways England greater ownership and control of operations on the network and brings a common operating model with similar staffing structures and roles defining responsibilities which facilitate, for example, escalation of clash resolution in roadspace booking. Our project evidence shows that the measures for providing advance information to customers are proving to be an effective driver in focusing on the required outcomes. The roll out of AD contracts will be completed during RP2 and DBFOs will also be brought under the Regional Operations Centre (ROC) control model to further improve coordination.

Are there differences in approach to how delays are managed on different road types (motorway / APTR)?

There is a difference in the availability of information used to inform Highways England of the occurrence of incidents between motorways and APTR. This is acknowledged by Highways England,

and as well as extensive use of floating Vehicle Data by NTIS, it is looking at other ways to address this such as working closely with 3rd party data providers to understand how access to data may assist operations.. While approximately 60% of incidents on the SRN occur on APTR, these roads are not generally patrolled by Traffic Officers and Highways England has little or no remote detection infrastructure, e.g. CCTV. Therefore, Highways England relies heavily on the Police, other responders, and third-party data sources for initiating response to and managing and providing information about these incidents. The recent refresh of Highways England's Crisis Management Manual and the introduction of the Strategic Road Responders Agreement and AD contract guidance such as GM 703 'Operational requirements for incident management' should help to standardise Highways England's management of incident delay.

Are there differences in approach to how delays are managed through developments in best practice by other road operators?

It is evident from a comparator study undertaken as part of this project that Highways England's management of delay and congestion, including its metrics regime, largely reflects established good practice employed by other road operators. It is also evident that Highways England is actively engaged in multinational forums and programmes in this field, so is well placed to identify, evaluate, and develop emerging good practice for application to the SRN where appropriate. There are a few approaches which other road operators use to manage congestion and delay, principally through constraining network access. These include, road pricing, managed lanes such as High Occupancy Vehicle (HOV) lanes and the selective limitation on HGVs such as overtaking bans and HGV tolling. There are other physical interventions which help other road operators manage delay such as the provision of co-sponsored off-network parking to facilitate transfer modal shift between transport modes or car-pooling, and the introduction of 'move-over-laws' to create channels for emergency vehicles during incidents.

What are the implications of these differences, and the gaps they might imply, for Highways England's future delivery?

From our evidence we conclude that while Highways England has implemented a series of physical and non-physical interventions to better understand and improve its overall management of congestion and delay in RP1, there remain significant differences in how this is managed between motorways and APTR. Although these differences are common across the SRN, they are recognised by Highways England both at a national and regional level. Our evidence points to the continuing convergence to develop a national strategy based on providing customers with a consistently high level of service/experience across the SRN through the development of a delay ambition and other interventions.

The outcomes of Highways England's customer transformation programmes, 'One Network' and 'Controlling our Network' should bring the changes needed to ensure better management of operations and roadworks and improved roadspace planning. The roll out of AD should also support Highways England's consistent control of network operations.

The use of well-designed reporting metrics has clearly been a strong and effective driver to encourage Highways England to develop behaviours and deliver delay management outcomes. Looking ahead, ORR should monitor congestion and delay performance measures and assess whether they continue to provide adequate emphasis for all types of road, in particular APTR, to support an appropriate and consistent level of customer service across the SRN.

The implications of physical interventions used by other road operators (such as constraining access to the SRN or working with local authorities or other partners to provide off-network parking) should be considered in Highways England's plans. However, this is likely to need widescale stakeholder consultation and possibly legislation.

Project recommendations

As Highways England enhances its congestion and delay management capability during the early years of RP2 we have identified a series of recommended actions for Highways England to consider to support their capability. Several of these actions have implications for RP3 and beyond. We have grouped the recommendations into six themes based on our findings which reflect the degree of their impact on congestion and delay.

Alongside the monitoring recommendations for ORR we have identified a set of actions for Highways England which are within their control. Some ORR recommendations align with a Highways England action while others will aid development of ORR's capability. It should be noted that there are multiple factors that influence congestion and delay, and Highways England is not able to control all of these.

We have prioritised our recommendations (1 to 6) according to their potential impact on mitigation of congestion and delay. We have also set out the recommendations within each priority with one of two timescales:

- Near-term delivery, this recommends that recommendations are delivered in the next one to two years; and
- Medium-term delivery, this recommends that recommendations are delivered in the next three to five years.

Table 1 sets out the prioritised recommendations for ORR and Highways England together with their proposed timescales.

Table 1 – Project recommendations for the enhancement and monitoring of congestion and delay

Priority	Theme	1-2yrs	3-5yrs	Recommendation for ORR	Recommendation for Highways England
1	**All-Purpose Trunk Road (APTR)**	Y		[ORR1.1] ORR should ensure that Highways England's focus on delay and delay metrics is applied to both motorways and APTR to monitor and drive the appropriate/desired levels of service. [ORR1.2] As Highways England accepts that it has lower 'visibility' of congestion and delay on the APTR network compared to the motorway network, ORR should ensure that data to support the reporting of metrics is robust and transparent for both motorways and APTR.	[HE1.1] Highways England should continue to compare the 'visibility' of congestion and delay on the APTR network with the motorway network to improve its monitoring. As well as continuing to use NTIS data and the communications with ROCs to inform of delays on non-patrolled parts of the network, it should continue to consider the reliability and assurance of the third-party data it uses to inform customers of delay on APTR and the use of alternative technology monitoring solutions. [HE1.2] Highways England should continue to build on its stakeholder agreements and collaborative relationships with the emergency services in order to improve its network management visibility on APTR and its ability to provide timely and accurate information to customers during APTR incidents.
2a	**Delay metrics**	Y		[ORR2.1] ORR should ensure that the RIS2 expectation for greater detail in Highways England's reporting of delay information is delivered for the benefit of customers. [ORR2.2] ORR should ensure that reported metrics - including those committed for development/implementation during RIS2 - on delay are clear, meaningful and of value to customers.	[HE2.1] As key drivers for future delay and congestion planning, Highways England should continue to develop its focus on regional customer outcomes and customer service and regional performance data as it rolls out its Asset Delivery operational contracts and Regional Operations Centres. [HE2.2] Highways England should continue its collaboration with Transport Focus to investigate road user delay/perception results in SRUS metrics and the lessons learned from the investigation of major incidents. [HE2.3] Highways England should continue to use its feedback from customers to review the accuracy and user confidence in the quality/accuracy of published delay information and the data used to measure its performance metrics.

Priority	Theme	1-2yrs	3-5yrs	Recommendation for ORR	Recommendation for Highways England
2b	**Delay metrics**		Y	[ORR2.3] ORR should continue to monitor Highways England's delivery of capital schemes that are specifically designed to alleviate recurrent delay.	[HE2.4] Highways England should continue to monitor the performance and customer impacts of its congestion and delay enhancements delivered during RP1, including at a regional level, and share feedback and lessons learned into its RP3 development plans and for finessing of RIS2 delivery. [HE2.5] Highways England should continue to monitor the impact of its RIS1 physical interventions and operational improvements to improve capacity and journey times. As information becomes available, the understanding and evaluation of RIS1 scheme benefits and lessons learned should be considered in the design of RIS3 scheme programmes.
2c	**Delay metrics**		Y	[ORR2.4] ORR should monitor Highways England's long term planning approach including the development of roadspace occupation processes for enhancements, renewals and maintenance to support its improvement to network availability/delay performance and provide timely information for the benefit of users and efficient delivery.	[HE2.6] Highways England should continue to optimise its roadspace to maintain a balance between delivery of RP2 capacity enhancements and delivery of asset renewals. This should include the opportunities from longer-term certainty of delivery programmes and diversion route reviews. [HE2.7] Highways England should carry out congestion and delay meta-analysis during RIS2 to share learning and influence future network congestion and delay intervention planning. [HE2.8] Highways England should continue to build on its regional stakeholder relationships to improve roadspace planning collaboration and optimise the volume and duration of roadworks in order to reduce delay. This should include the use of existing stakeholder groups to share roadspace data and best practice.
2d	**Delay metrics**		Y	[ORR2.5] ORR should encourage Highways England to consider developing a contract mechanism to optimise the volume and duration of short-duration roadworks in RP2 to improve roadworks forecasting accuracy.	[HE2.9] Highways England should continue to develop its approach to achieve the KPI target for roadworks information timeliness and accuracy by the end of RP2, including a regional focus on delay data and coordination of roadspace occupation with external stakeholders. [HE2.10] Highways England should continue to monitor actual network occupation to improve the reliability and accuracy of its roadworks data which it uses to provide customer information. [HE2.11] Highways England should continue to monitor the predicted and actual cost of roadworks delay in order to feed into its delay ambition plans. [HE2.12] Highways England should carry out a benefits evaluation of its roadworks planning approach and NOMS system. This should include an evaluation of the information provided to road users and the use of NOMS as a predictive tool as well as the introduction of permitting to improve collaboration between Highways England and third parties such as

Priority	Theme	1-2yrs	3-5yrs	Recommendation for ORR	Recommendation for Highways England
					local authorities and utilities. It should also include the development of interfaces between NOMS and Street Manager. [HE2.13] Highways England should monitor the roadworks planning interface between DBFOs and AD contracts and assess how these are due to change as DBFOs reach their handback. (Note that the RIS2 Delivery Plan states that eight DBFO contracts will reach handback by 2026-27.)
2e	**Delay metrics**		Y	[ORR2.6] ORR should encourage Highways England to consider developing a benefits evaluation approach in RP2 to enable monitoring incident management performance in RP3.	[HE2.14] Highways England should analyse the cost of delay caused by incidents to feed into its Delay Ambition Plans. [HE2.15] As part of its work to review diversion routes and work with third-party data providers, Highways England should carry out an operational review of strategic APTR routes that could benefit from increased information to improve incident response. The review should include the analysis of APTR incidents and the availability of information available to Regional Operations Centres to deploy incident management and inform customers.
3a	**Delay ambition**	Y		[ORR3.1] ORR should continue its dialogue with DfT on setting delay forecasts for RP2 including the levels of RP2 baseline delay.	[HE3.1] Highways England should continue to collect regional performance data and segmental class data such as delay on gateway routes and APTR delay to understand how this can be used to develop its delay ambition. [HE3.2] Highways England should continue to try and understand congestion and delay levers and the effectiveness of its interventions and use this information to refine its delay ambition and annual intervention targets for RP3 and beyond. This includes understanding the impact of interventions on different network types such as APTR and the effectiveness of qualitative interventions such as Travel Demand Management. [HE3.3] Highways England's regions should continue to share the lessons learned from its interventions to improve the accuracy and reliability of roadspace data, and the quality and timeliness of customer information both internally and to external stakeholders, in order to benefit the SRN and the local road network.

Priority	Theme	1-2yrs	3-5yrs	Recommendation for ORR	Recommendation for Highways England
3b	**Delay ambition**		Y	[ORR3.2] ORR should continue to monitor and analyse current and future events which have the potential to impact travel patterns and levels of congestion and delay. These events have the potential to affect Highways England's delay ambitions and customer's perception of delay, and the development of RP3 delay metrics, and include the consequences of Covid-19, Brexit, wider economic prospects, CAV, car ownership and decarbonisation.	[HE3.4] Highways England should continue to monitor the impacts of key events such as changes in work patterns due to Covid-19 and Brexit to assist operational planning. [HE3.5] Highways England should align its plans for longer-term development of delay ambition with its other network commitments such as responding to strategic growth, keeping the network safe and serviceable and reducing its carbon footprint. Achieving delay ambition should have both organisational and documented line of sight from strategic delay objectives through to delay plans, processes and tools for delay prediction and performance monitoring.
4	**Diversion routes**		Y	[ORR4.1] ORR should continue to monitor progress against the PI 5.5 target to review all unplanned diversion routes and identify improvements with local authority engagement.	[HE4.1] Highways England should seek to review and improve unplanned and planned diversion routes and develop intelligent fixed road signs on local authority networks with local authorities and user groups.
5	**Designated funds**		Y	[ORR5.1] ORR should monitor the progress of Highways England's designated funds to deliver congestion and delay benefits/improvements, particularly those with a customer focus, that are not funded by the main delivery programmes identified in the RIS2 Delivery Plan.	[HE5.1] Highways England should develop a benefits evaluation approach in RP2 for delay management interventions (using the 'Safety & Congestion', 'User & Community' and 'Innovation and Modernisation' designated funds). As part of the evaluation it would be useful to capture feedback from stakeholders including Transport Focus, road users, local authorities and STBs.

Priority	Theme	1-2yrs	3-5yrs	Recommendation for ORR	Recommendation for Highways England
6	**Congestion and delay research**		Y	[ORR6.1] ORR should continue to monitor Highways England's forward planning and preparation for the management of congestion and delay and in particular for recurrent, roadworks and incident delay, using the evidence of RP1 and RP2 to develop forecast scenarios for the medium-longer term.	[HE6.1] Highways England should continue to observe other road operators, including international operators, which have implemented novel physical interventions and procedures to manage congestion and delay. This should include participation in appropriate UK and international industry forums to collaborate and share knowledge and best practice.

1 Congestion and delay context

1.1 Licence requirements

Highways England has several Licence requirements to manage disruption and provide effective operations, efficiency, cooperation, and value for money. These are well understood and provide the basis for Highways England's plans for managing and improving congestion and delay.

To achieve effective operations Highways England is required to minimise disruption to road users caused by planned or unplanned disruption and to provide traffic and other information. Planned disruption includes roadworks while unplanned disruption includes traffic incidents but also the short-term effects of severe weather conditions.

To achieve efficiency and value for money Highways England is required to carry out additional work to ensure network resilience and to reduce or eliminate long-term costs or disruption to the network.

A key Licence commitment is to cooperate with road users and other stakeholders to facilitate the movement of traffic, to manage its impacts and to respond to and manage planned and unplanned disruption to the network. **Annex A** provides an extract of the relevant Licence clauses.

1.2 Delay sources and drivers

Delay is defined by Highways England as:

> "the difference between the time it would take for a road user to travel at the speed limit versus the time it actually took them to travel."

Figure 1 shows the key sources of delay and Highways England's interpretation of the drivers that influence each delay source, taken from its draft Delay Ambition Plan. These delay sources have the potential to cause congestion and impact Highways England's customers (road users).

Figure 1 – Delay lever sources and drivers

Delay source	Delay drivers		
Recurrent delay	Traffic growth	Geometry	HGV levels
Roadworks delay	Physical length / amount of works	Roadworks design	Traffic affected by roadworks
Incident delay	Reducing the number of incidents	Reducing the length / impact of incidents	
***Other delay**	Driver behaviour	Weather	Other

*Note that 'Other delay' was not included in the study scope and is not considered in this report.

Some of the above delay drivers contribute to the incidence of congestion on networks adjoining the SRN and are increasingly used by Highways England to develop joint solutions with local authorities and increasingly Sub-National Transport bodies (STBs).

The capacity of the Strategic Road Network (SRN) to meet current and future traffic needs is monitored by DfT and Highways England. Although the SRN makes up 2% of the entire road network length in England, it carries a third of all traffic and two thirds of lorry vehicles. Using Highways England's regional traffic model outputs and DfT's analysis in 2018 shows that demand for the SRN is

forecast to increase by between 29% and 59% by 2050. This forecast includes several factors including trip rates and driver age profiles and is also likely to be impacted by Covid-19, Brexit, electrification and decarbonisation.

1.3 Delay management enablers

Highways England is using several strategies and interventions (enablers) to optimise the use of its levers to manage congestion and delay. These have been evidenced as part of this project and include:

- Strategies & Plans – these provide the framework and direction to assess and manage congestion and delay and develop improvements. They include Highways England's operational transformation programme 'Controlling our Network', the 'Delay Ambition Plan' (under development) and 'Strategic Road Responders' agreement.
- Stakeholder engagement – these provide a better understanding of stakeholder views and improving customer and stakeholder information. Key stakeholders include Transport Focus and the freight and vehicle recovery industries.
- Performance & feedback – these will monitor congestion and delay mitigation against Highways England's targets and provide analysis and insight to the business and customers to achieve incremental improvement. The performance framework for congestion and delay includes the RP2 performance framework and suite of KPIs, PIs and commitments outlined in the Operational Metrics Manual (OMM).
- Risk management – this will help to understand the gaps in demand capacity, delay performance and the risks to network capacity and resilience and reputation.
- Efficiency improvements – these will allow Highways England to determine the estimated or measured efficiencies from future congestion and delay enhancements, and operational initiatives such as leaner renewals programming.

1.4 Recurrent delay

Highways England's definition of recurrent delay is any delay within the bounds of typical performance for a particular time of day and day type, also known as 'expected delay'. The largest cause of this is congestion, which occurs when levels of demand exceed capacity, resulting in slower speeds and sometimes queuing. Geometric delay is the next biggest cause of recurrent delay, which is on sections of road where it is not possible to travel at the speed limit and therefore (according to the definition of Highways England average delay KPI, delays occur. This type of delay is typically caused by junction features, such as roundabouts.

Monitoring of the overall average delay on the SRN is a key performance Indictor and at the end of RP1 was an average of 9.3 seconds per vehicle mile, an increase of 0.4 seconds per vehicle mile from 2015-16. This has coincided with an increase in network traffic which has been mitigated by Highways England undertaking improvement work as part of its investment programme. The baseline for the average delay ambition to be achieved at the end of RP2 is currently being re-calculated.

Investment to reduce recurrent delay by intervention at congestion pinch points and create capacity to meet forecast demand is part of a wider coordinated aim by Highways England to provide network resilience and maintain the existing network in good condition. Coordinating capacity enhancements with asset renewals on a congested network is an important factor to consider in balancing resilience with condition.

The 2020-2025 Strategic Business Plan sets out Highways England's approach to provide new capacity where it is most needed. This will be achieved through £14.2bn of capital capacity enhancements, as well as junction improvements and delay management initiatives through designated funds. The 'Plan' sets out other initiatives that recognise the changing patterns in traffic such as the forecast increase in demand for freight capacity.

As well as developing those schemes identified during RP1 for construction in RP2, Highways England will be developing its longer-term capacity enhancement plans during RP2 for implementation in RP3/4. Our understanding is that this will be through a phased process of route corridor studies and regional stakeholder engagement to understand the drivers and requirements for economic growth and the estimated demands and constraints on the current network.

As stated above, future risks to capacity also include Brexit, electrification and decarbonisation. A new indicator to measure delay on gateway routes has also been introduced during RP2.

1.5 Roadworks delay

Delay due to roadworks accounts for around 10% of network delay. Improving the planning of roadworks to reduce delay has been a key focus area for Highways England during RP1. This has resulted in several initiatives such as the roadworks transformation strategy, customer implementation toolkit and customer audits for major projects.

During RP2 Highways England is planning to build on these initiatives by implementing 60mph speed limits in roadworks where it is safe to do so (after a safety risk assessment), improving diversion routes jointly with local authorities and trialling Travel Demand Management to influence travel behaviours. Roadworks planning should also improve after the transition to Regional Operations Centres (ROCs) and single network management control of all planned works as part of Highways England's operational excellence transformation programme.

A key performance indicator for roadworks information timeliness and accuracy has been introduced in RP2 to forecast roadworks seven days in advance. The SRUS, which replaces the NRUSS, includes a measure of customer satisfaction for roadworks. The latest NRUSS for 2018-19 reported roadworks satisfaction score at its highest level for five years at 75%. The main reasons for customer dissatisfaction (stated by Transport Focus) were: perceived lack of progress being made with roadworks, not seeing workers onsite, feeling works take too long to complete and perceived lack of signage / information about the roadworks.

1.6 Incident delay

A study into the delay caused by incidents and how Highways England manages incidents was carried out by ORR in 2018. Since then Highways England has taken on board several of the recommendations and during RP1 updated its Crisis Management Manual and published its Strategic Road Responders agreement.

The transition to ROCs and the appointment of National Network Managers based in the National Traffic Operations Centre will also improve the management and coordination of incidents with the emergency services and other stakeholders, either directly or through Local Resilience Forms.

During RP2 Highways England has committed to a number of incident management improvements including: network availability planning, standardising regional multi-agency protocols, the review of diversion routes, implementing motorway enhancements identified in the stocktake and improving incident welfare to road users. As part of its Operational Excellence programme it also proposes to combine its control centres with its maintenance network control centres, currently outsourced, to

establish single regional operations centres (ROCs). This will support a quicker incident response and closer communication and coordination between Traffic Officers and maintenance crews.

Incident management performance will continue to be monitored during RP2 through the incident clearance rate key indicator (which only applies to motorways) and a commitment to reduce the average Traffic Officer response time from 17 to 10 minutes on (some) smart motorways by July 2021.

2 Highways England's delay management strategy

A range of published documents and other evidence provided to us by Highways England have been used to understand how Highways England is managing delay. This currently ranges from policy documents such as Highways England's Licence, five-year Delivery Plan and Customer Service Strategy through to technical guidance aimed at scheme designers such as the Roadworks Guide and Checklist and the emerging Travel Demand Management toolkit. Other published international guidance has also been reviewed.

The following sections describe the key elements of Highways England's proposed strategy to manage congestion and delay during RP2 and be further developed for RP3/4.

2.1 Customer Service Strategy and customer plans

Published in 2016 under RP1, the Customer Service Strategy sets out Highways England's intent to provide better journeys and better conversations with customers through three objectives:

- Consistently delivering the basics;
- Improving the service and network; and
- Developing relationships with customers.

Consistently delivering the basics includes working to manage delays and make journeys as stress free as possible. More specifically seeking the least disruptive option when deciding how to design roadworks, providing clear, reliable and accurate information at all times and working more closely with partner organisations and suppliers to ensure that incidents are cleared quickly and the network returned to normal.

Since the Customer Service Strategy was published, several annual customer service plans with more detailed commitments have been published. The latest, 'Connecting our Customers 2020-21', retains the three customer service strategy objectives and builds on the activities from previous years with a particular focus on recognising the diverse range of customers and improving accuracy, information provision and the highest safe speed through roadworks. Physical improvement activities for 2020/21, which complement the RP2 Delivery Plan, include five service improvement commitments, twelve continuous improvement activities and a series of enabling activities. By the end of 2020/21 customers should expect to see:

- Better information about when Highways England are planning to close roads so customers can plan their journeys more effectively.
- Better information on electronic signs, with speed limits appropriate to the conditions, to help customers feel safer and more in control of their journeys.
- Better digital information.
- More reliable movement of road freight.
- Reduced journey times and better experiences as Highways England increasingly use 60mph speed limits in roadworks.

These improvements will be monitored for success through the Transport Focus Strategic Roads User Survey (SRUS), and RP2 measure to provide 'accurate information about roadworks' seven days in advance.

2.2 'Controlling our network' transformation

As one of six themes under Operations Directorate's (OD) 'Operational Excellence 2025' transformation programme, 'Controlling our network' aims to provide a step-change improvement in Highways England's situational understanding of its network and the key connecting local authority roads by the end of RIS2. Programme benefits include financial efficiencies and supporting safer road use and enhanced customer experience including fewer network disruptions, greater road user awareness and satisfaction, and improved decision-making. Proposed activities within OD between 2020 and 2025 include:

- Optimising network processes i.e. the coordination of planning, scheduling, prioritising and delivering works;
- Improving the day-to-day management of incidents & reactive maintenance; and
- Proactively engaging with customers and stakeholders.

Although the transformation programme has only recently commenced, we have engaged with the national theme lead and been provided with evidence of its rollout to regions including the appointment of regional theme coordinators who will report into a national group. We have also been provided with the programme Charter which sets out the levers and activities to deliver the objectives and capability outcomes. These include a single standard approach to make data driven decisions, the ability to share better network performance information with external parties and road users, and enabling control room staff to make better decisions.

2.3 'One Network' transformation

Major Projects Directorate (MP) has a parallel and complementary 2-year delivery transformation programme (MPDT) called 'One Network'. This commenced in 2020 and will see MP collaborating with OD and other internal stakeholders to better coordinate work, engage external stakeholders and improve customer journeys, increase productivity and maintain customer satisfaction in RP2.

Workstream activities are divided into Planning and Stakeholders. Planning activities aim to create closer planning relationships between MP and Operations to increase productivity during planned works and reduce the need for short-notice cancellations. This workstream should result in several improvements including the reduction and better optimisation of road closures through combining construction, renewals, maintenance and repairs. It should also result in the need for fewer road closure changes.

The Stakeholder workstream aims to increase the medium to long-term efficiency and effectiveness of stakeholder relationship management and support to MP project teams, regions and Highways England nationally. The work under this workstream was reviewed as part of the 2020 ORR study 'Review of HE stakeholder engagement' and when concluded should bring a more standardised approach to stakeholder management and reduce delay to scheme delivery.

2.4 Delay ambition planning

Highways England's Strategy and Planning Directorate (S&P) is developing its delay ambition in 2021. This will set out short and long-term approaches to help reduce delays and improve journey times, including recurrent delay and delay from roadworks, incidents, severe weather etc. This is seen as a positive move to engage and align the whole business to prioritise delay improvements.

The draft delay ambition is aligned with the Customer Service Strategy and other customer plans but does not reference the business transformation programmes within OD and MP that seek to improve congestion and delay by 2025. Highways England needs to ensure its transformation programmes continue to align with its delay ambition.

As well as roadworks and incident delay, Highways England's delay ambition addresses other causes of delay, such as weather and driver behaviour, and their contributing factors. Road geometry for example is estimated to contribute an average of 1.5 seconds to the total average delay of 9.5 seconds recorded at the end of RP1.

The draft delay ambition also describes Highways England's proposals to assess the levers that can influence the drivers for each delay type and rank these to provide its short-term and long-term priorities.

2.5 Travel Demand Management (TDM) (draft in progress)

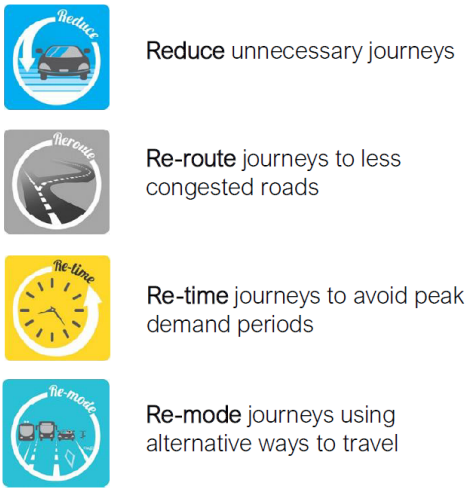
Highways England's Travel Demand Management (TDM) approach has a significant potential to improve customer's journey experience through influencing travel behaviours, leading to more convenient journeys and reducing congestion at critical times and locations.

A TDM roadmap was developed during RP1 as part of Highways England's Customer Service Strategic Plan. Evidence that we have seen includes the draft TDM approach based on '4 R's', shown in **Figure 2.1**.

To date Highways England has developed a TDM methodology which is supported by a TDM toolkit (TDMT).

Highways England will roll out TDM nationally to improve travel choices and journey experiences for customers, assist in maintaining business operations during times of disruption to the road network, and contribute to meeting carbon reduction targets.

Figure 2.1 – the 4 R's of Travel Demand Management (TDM)



2.6 Roadworks planning guidance

During RP1 Highways England developed specific guidance for scheme promoters and designers and regional maintenance providers to consider the impact that roadworks has on customers. This included:

- 'Transforming roadworks – our approach' – a briefing note outlining Highways England's approach to transforming roadworks and providing a better roadworks experience for customers, supply chain and stakeholders.
- 'Roadworks, a customer view - Implementation toolkit' – this describes 20 principles, based on insight from scheme users, to improve the customer experience of planned roadworks. It also provides guidance on how these principles can be applied flexibly to suit different customer needs in the development of each scheme and what steps can be taken to minimise scheme impacts in order to improve customer satisfaction as measured by Customer Audits and SRUS.
- 'Customer focused roadworks – Guide and checklist' – this provides a guide and checklist including key factors affecting customer satisfaction during roadworks and is intended to be used by those planning roadworks (i.e. project managers and scheme designers) those working in roadworks and those driving through roadworks such as route inspectors and Traffic Officers.

2.6.1 Network occupancy planning and monitoring

In RP1 Highways England introduced its Network Occupancy Management System (NOMS). This supersedes Schedule of Roadworks (SRW) as the primary tool for recording planned and actual roadspace occupancy including roadworks. Note that NOMS does not indicate optimal timing or traffic management layouts for delay reduction. Going forward in RP2 NOMS will form part of a group of core systems and tools as follows:

- NOMS – the established system used within Highways England for collating Network Occupancy data. This includes an analytical tool to process the occupancy data and feedback clashes before final access data is reported.
- Street Manager – this is the new GOV.UK online system which Highways England and Utility companies have been asked to use from July 2020 for the application and issuing of permits for Street Works plus status updates. It gives Highways England visibility of works on adjoining road networks and requests for works by external providers on the SRN.
- Primavera P6 – this is the planning and scheduling software used by MP and some parts of OD directorates planning and managing project construction works and collaborating with the supply chain.

The use of the above systems currently involves some manual or semi-automatic processes, for example responding to requests received from Street Manager to identify and manage clashes with NOMS information. To improve network planning, further development will be required during RP2 to automate system interfaces and develop operational protocols.

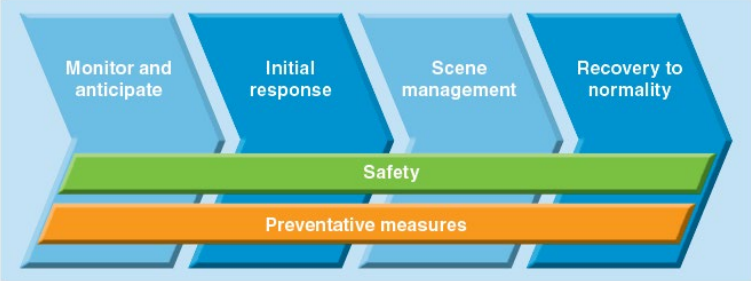
During RP2 Highways England is proposing to carry out research to decide if it wants to become a permitting authority, like local authorities. Permitting would give Highways England more control and intelligence on all works and closures on its network, both by internal scheme promotors and maintainers and external occupiers such as utilities and local authorities. An important consideration if Highways England does become a permitting authority is to be seen as 'independent' and 'fair' in the prioritisation between internal and third-party network occupancy requests.

2.7 Incident management strategy and guidance

The safe management and improvement of response to network incidents is a key objective for Highways England and its customers and is aligned to its broader safety objectives. This includes improving the process and techniques for those involved in responding to incidents and Highways England's relationship with the emergency services.

ORR undertook a review of incident management in 2018 from which there were a series of recommendations. Evidence provided by Highways England during this study shows that some of the recommendations have been considered and actioned, for example an updated Strategic Road Responders agreement between Highways England, the Association of Ambulance Chief Executives, the National Fire Chief's Council and National Police Chiefs' Council. This agreement outlines a partnership working approach and roles and responsibilities based on Joint Emergency Service Interoperability Principles (JESIP) principles. The agreement also defines the common phases of an incident shown in **Figure 2.2**.

Figure 2.2 – Highways England's incident management phases



An area of operational change which could improve Highways England's incident management capability is the transition from Regional Control Centres to Regional Operations Centres (ROCs), where a single leadership structure will control incident management and operational response.

2.7.1 Incident management on APTR

A key area for consideration outlined in ORR's 2018 Incident Management Review report and reviewed in ORR's 2019 Roadside Technology Study was the visibility and management of live traffic and incidents on APTR compared with that on motorways, which can cause an inconsistent customer experience. At the time these reports were written this was due to a lack of technology including CCTV and detection technologies and intelligence coming into Regional Control Centres, the absence of Highways England traffic officer patrols and the operational practices of the Police who lead most incidents and sometimes deploy less experienced officers to attend incidents. However for technology to be made comparable with motorways it would need significant infrastructure funding and maybe physically difficult to install given the nature of the roads.

Evidence from this project shows that APTR intelligence is still an issue although Highways England is focused on learning from long-duration incidents on APTR and improving its service within these constraints. Since 2018, as well as improving its protocols with the emergency services through its Strategic Road Responders guidance, Highways England is developing a revised operational approach to improve its control of incidents on APTR. The approach will include better coordination with the Police, investing in third-party data such as mobile floating data to improve visibility and investigating the need for increased patrolling.

2.8 Diversion route management

Highways England is committed to the review of all its established diversion routes (which number approximately 2,700) during RIS2. Progress will be monitored by the measure 'Working with local highway authorities to review diversion routes for unplanned events.' The review programme will be monitored by the national Operations Portfolio Office and implemented by regional leads. The 'Users & Communities' designated fund will be available to invest in diversion route improvements during RIS2. Aligned to the diversion route review and based on customer feedback, Highways England plans to work with Transport Focus to develop better and more appropriate information on diversion route signs. It also plans to develop driver education campaigns to increase understanding of diversion route signs and symbols and provide better integration of SatNav data with use of diversion routes during incidents or planned works.

Highways England has also developed a DMRB standard GG903 'Customer service standard for diversion routes for unplanned events.' A similar standard for diversion routes for planned events is scheduled for publication in 2021/22. The diversion route standards provide guidance on the factors to consider when reviewing existing diversion routes or planning new ones. This includes an annual requirement to inspect 20% of diversion routes and to liaise with local authorities to confirm that these are fully operational. There is also an expectation for Highways England to consult with stakeholders 12 weeks prior to any planned closures on the SRN which use diversion routes on local authority networks.

2.9 Congestion and delay intervention benefits evaluation

Highways England uses scheme level POPE analysis and meta-analysis to carry out scheme level congestion and delay benefits evaluation to understand the impact of some aspects of recurrent delay such as journey time. The proportion of total monetary benefits arising from schemes that benefit journey time is in the order of 80% (from Highways England Major Schemes 2015 meta-analysis report). During RIS2 Highways England will be developing future meta-analysis focus areas targeted at delay and aligned with the Delay Ambition Plan in order to apply RIS1 scheme learning to influence RIS3 scheme development. An extract from the 2015 POPE of Major Schemes meta-analysis report, highlighting traffic and economy summary benefit statements is shown in **Annex C**.

The 2015 meta-analysis shows that new bypasses, widening schemes and schemes upgrading A-roads to motorways significantly improve journey time reliability, but recorded peak hour journey time savings are lower than forecast. The analysis also shows that most schemes, of all types, do not appear to have resulted in induced traffic but this could be because of the economic downturn between 2008 and 2009.

Schemes with the highest traffic and economic benefits are widening schemes and motorway / smart motorway upgrade schemes. The meta-analysis shows that although forecasting accuracy has improved since 2000, journey time savings benefits are still only moderately accurate with 28% of schemes within 15% of forecast and 74% of schemes within 50%. The average Benefit Cost Ratio (BCR) of major schemes is 2.7 and 73% of schemes achieved 'high value for money' (those with a BCR>2.0) while 88% achieved 'medium or high value for money'. Regional factors do not appear to impact BCR. Highways England also reported anecdotal evidence in the meta-analysis that Major Schemes assist local and regional economic development through congestion reduction and improved journey time reliability, such as providing improved access to potential employment centres.

2.10 Observations from other Highways England documents

The following observations have been summarised from a literature review of other Highways England documents which relate to the management of congestion and delay.

Road Investment Strategy 2 2020-2025 – this includes the Performance Specification which details the metrics used to monitor Highways England's performance. The outcomes of relevance to delay and congestion are 'Providing fast and reliable journeys' and 'Meeting the needs of all road users'.

Strategic Business Plan and Delivery Plan 2020-2025 – Highways England has several commitments to improve congestion, roadworks, incident management and information to road users in their Strategic Business Plan and Delivery Plan. These documents also set out the physical interventions that will be implemented during RP2 and the improvements that will be developed in RP2 for implementation in RP3/4 and include:

- Capacity provision – increasing capacity and managing and improving safety and resilience to reduce recurrent delay but also mitigate the potential for accidents.
- Customer experience – providing accurate and timely information and data to influence journeys and driver education and campaigns to influence behaviours.
- Roadworks management – optimising the planning and duration of roadworks for both major works and asset renewals within a centralised regional control structure.
- Incident management – managing and improving the response and coordination to incidents on all route types but focussed on motorways and smart motorways.

A list of the relevant commitments from the Delivery Plan is included in **Annex B**.

Connecting our customers 2020-2021 – this is Highways England's current annual customer service plan and includes the interventions that Highways England has identified as necessary to support the management of delay and congestion (some of these support/are driven by the performance measures in the RIS2 Performance Specification). These include:

- Improving the provision of information, particularly with regard to roadworks;
- Phased introduction of increased 60mph speed limit for roadworks;
- Quicker incident clearance;
- Improved diversion routes; and
- Travel demand management.

The other contextual documents reviewed are more general in presenting Highways England's plans for the management and operation of the SRN, though there are themes consistent with other strategy documents and identified actions to support the management of delay and congestion, ie:

- Management of incidents;
- Management of roadworks;
- Provision of information;
- Improvements to capacity/flow; reliability/resilience; and
- Management of travel demand.

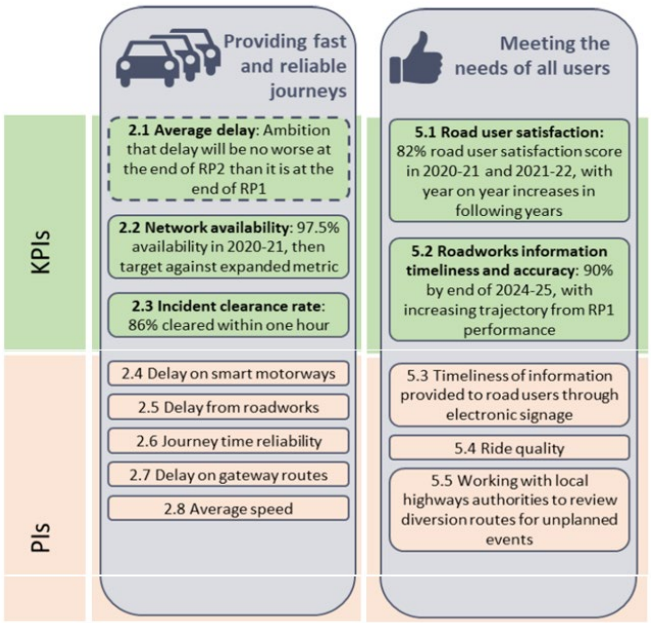
Efficiency and Inflation Monitoring Manual (EIMM) – this guidance sets out Highways England's approach to define, demonstrate and provide evidence of its delivery of efficiency in RP2. Evidence will be collected through a combination of performance against delivery of outputs/outcomes against RIS2 funding, a basket of activity metrics and detailed register build-up and case studies. These will enable Highways England to demonstrate their targets against three efficiency drivers (economy, productivity and effectiveness) and the overall efficiency target of £2.23bn capital and operational expenditure by the end of RP2.

3 Monitoring delay

Five Highways England performance related documents have been reviewed in this project including the RIS2 Operational Metrics Manual (OMM) which details how the RIS2 Performance Specification will be implemented. Our review has also included a summary of Highways England's performance in 2019/20, which is important for calculating the first RIS2 year baseline for three relevant KPIs, although the impacts of Covid-19 on traffic volumes and travel patterns introduces a significant element of uncertainty. A further element of this review has been to compare RIS2 metrics with their RIS1 counterparts to understand how Highways England's network delay monitoring has developed. This includes those metrics (PIs) that will be developed during RIS2 for future roads periods.

The RIS2 metrics relevant to delay management come under two outcomes 'Providing fast and reliable journeys' and 'Meeting the needs of all road users' and are shown in **Figure 3.1** and summarised below. **Annex D** provides further details of the RP2 metrics.

Figure 3.1 – Extract of KPIs, PIs and commitments from Highways England's 2020 Operational Metrics Manual (OMM)



Commitment	Concept completion date
Providing fast and reliable journeys	
Network availability KPI: Existing metric to be replaced by a new expanded metric with target based on baselining work undertaken during 2020–21	
Working with Transport Focus, investigate the development of new metrics on journey time reliability which reflects more accurately road users understanding of reliability, and delay in roadworks.	Q3 2020–21
Investigate new PIs on delays from incidents and delays on the local road/SRN boundary, and an alternative performance measure for smart motorway operation to keep track that these roads are delivering their intended journey-time related objectives.	Q3 2020–21
Meeting the needs of all road users	
Work with Transport Focus to develop satisfaction surveys for cyclists and pedestrians that can be used, if possible, as the basis of a PI later in RP2.	
Work with Transport Focus to develop satisfaction surveys for logistics and coach managers that can be used, if possible, as the basis of a PI later in RP2.	
Review SRUS performance in year 2 of RP2 to determine the road user satisfaction targets for post 2021-22.	N/A
Develop with Transport Focus during RP2 a measure of ride quality which reflects road users' experience of the network.	Q2 2020–21
Investigate expanding the scope of the working with local highways authorities PI to include diversion routes linked to planned roadworks.	Q3 2020–21
Investigate expanding the scope of the timeliness of electronic signage information PI to potentially include the time taken to adjust and clear signs.	Q3 2020–21

3.1 Road Period 2 delay performance measures

The following metrics have been carried over from RIS1 into RIS2:

- KPI 2.1 Average delay - time lost per vehicle per mile.
- KPI 2.2 Network Availability - the percentage of the SRN available to traffic.
- KPI 2.3 Incident clearance rate - the percentage of motorway incidents cleared within one hour.
- PI 2.7 Delay on gateway routes - time lost per vehicle per mile on Gateway Routes.
- PI 2.8 Average Speed - Average speed.
- KPI 5.1 Road user satisfaction - based on the SRUS survey (previously NRUS) and response 'very satisfied' or 'fairly satisfied' to the SRUS question: "Taking everything into account, how satisfied were you with your journey?"

Several new metrics as well as commitments to develop further metrics have been introduced for RP2 including:

- PI 2.4 Delay on smart motorways - average delay to road users on smart motorways.
- PI 2.5 Delays from roadworks - overall delay experienced by road users that is caused by roadworks.
- PI 2.6 Journey time reliability - delay experienced by road users when compared with their normal journey time.
- KPI 5.2 Roadworks information timeliness and accuracy - percentage of overnight road closures that are accurately notified by Highways England seven days in advance.
- PI 5.3 Timeliness of information provided to road users through electronic signage - average median time to set signs and signals on (all) motorways after Highways England has received notification of an incident, that requires signs and signals to be manually set.
- PI 5.5 Working with local highways authorities to review diversion routes for unplanned events - percentage of local highway authorities which Highways England engaged with, to review diversion routes for unplanned events.

During the development of metrics for RIS2 Highways England decided to develop a different approach to delay metrics based on feedback from stakeholders that they were not easily understood or used for improvements. The RIS1 suite of journey time related metrics were supplemented with a smart motorway delay and delay in works metric. In RIS2 the same number of metrics has been retained with more focus and with journey time reliability taking the place of planning time index and acceptable journeys.

As well as the above KPIs and PIs, Highways England is committed to developing several additional delay metrics during RIS2 under two desired outcomes:

- Providing fast and reliable journeys:
    - Network availability KPI: Existing metric to be replaced by a new expanded metric with target developed from baselining work undertaken during 2020–21.
    - Working with Transport Focus to investigate the development of new metrics on journey time reliability which reflect more accurately road users' understanding of reliability, and delay in roadworks.
    - Investigate new PIs on delays from incidents and delays on the local road/SRN boundary, and an alternative performance measure for smart motorway operation to monitor whether these roads are delivering their intended journey-time related objectives.
- Meeting the needs of all road users:
    - Work with Transport Focus to develop satisfaction surveys for logistics and coach managers that can be used, if possible, as the basis of a PI later in RP2.
    - Review SRUS performance in year 2 of RP2 to determine the road user satisfaction targets for post 2021-22.
    - Investigate expansion of the scope of the work with local highways authorities PI, to include diversion routes linked to planned roadworks.
    - Investigate expansion of the scope of the timeliness of electronic signage information PI, to potentially include the time taken to adjust and clear signs.

3.2 Observations on RIS2 metrics

Our review of the RP2 performance framework and metrics has highlighted the following observations, some of which could impact the ability of Highways England to understand and improve all aspects of network delay:

- There could be greater clarity of the approach to calculating delay metrics, in particular the new PIs in the RIS2 OMM and how Highways England intend them to be successfully deployed for the intended positive effect.
- Several measures have a calculation approach that could be modified. This could be to improve the integrity of the calculation where data is unavailable reliably, or because a modified calculation is a truer reflection of what the message of the indicator is supposed to demonstrate. As well as the calculation being transparent, ORR should be able to understand/assess the quality of the data it is based on i.e. completeness, currency, accuracy etc. Note DfT agrees the basis of metrics with Highways England.
- Three metrics apply to motorways only, i.e. do not apply to APTR where 60% of incidents occur. The focus on motorways although of strategic importance could be seen as reducing the importance of APTR. Where metrics do apply to APTR, we understand there may be issues around assurance and completeness of data, due to the lack of roadside technology, which requires manual adjustment (infilling) by Highways England.
- The use of network availability as a meaningful link/measure relating to delay and congestion should be evidenced through cause and effect analysis from NOMS data. This measure is due to be replaced during 2020-21.
- Some measures, notably KPIs 2.1, 2.2 and 5.2, require baselining from the end of RIS1 when traffic volumes and travel patterns started to be impacted by Covid-19. We understand that Highways England is carrying out work to estimate a suitable baseline for agreement with DfT but this carries with it the risk that the metric targets have a margin of uncertainty. This also applies to the longer-term impacts of Covid-19, Brexit and electrification on future travel patterns and volumes.
- The current Network Availability KPI has the exclusion “but excluding roundabouts and slip roads” which requires further explanation by Highways England as to the logic behind this rationale. It follows that if the recording of actual occupancy on the network in NOMS is done well there is no obvious reason for this exclusion, except that journey times and delays are not calculated for these sections of the SRN.

3.3 Observations on data related aspects of delay management

There have been historic challenges concerning the quality of NOMS planned occupancy data. Some of these challenges exist in the reliability of forward planning data (for which there are limited metrics), but also the reliability that can be placed in NOMS being a good source of truth about occupancy that has actually occurred on the network. From a KPI perspective for network availability, the potential lack of quality and completeness is difficult and in effect ‘network availability gets better the less you record’.

Although the introduction of Street Manager will improve collaboration with local authorities and utilities there are no current metrics or targets to capture this improvement. This also applies to the measurement of permitting when this is developed and implemented. NOMS has the capability to include local authority and statutory undertaker notices across a much wider network than the SRN, such as for foresight of disruptions and maintenance sequencing on the SRN and LHA diversion routes, but it is unclear whether Highways England uses this capability. The SRN/Local Road Network interface therefore needs to be a consideration during RP2 for designing RP3 metrics.

From our review of NOMS data and analysis reports which provide Highways England and its regions with better segmented data, there is a significant quantity of roadworks that get cancelled either because of change of circumstances, overbooking, incidents etc. This implies that any predictions of the actual effect of roadworks related delay and congestion is always going to be at significant variance with actual roadworks and there is no overall accurate foresight nationally of what the current roadworks related delay is expected to be for tomorrow, next week or next month. The new RIS2 measure 'Roadworks information accuracy and timeliness' should help to improve network occupancy planning.

Highways England use infilling to complete the picture of traffic information which is used to calculate some delay metrics. For example, infilling is used where existing traffic monitoring stations do not supply suitable data concerning speeds, flows, occupancy and HGV mix or where network sections have no traffic stations and proxy data is used. On occasion when outages or errors occur within monitoring stations, historic profiles and values from adjacent monitoring sites are used to create estimated data values. During metric delivery actual journey times and speeds are moderated so that they do not exceed the legal speed limit.

Highways England also use telemetry data for vehicle movements (so-called floating vehicle data, or probe vehicle data) on both the motorways and APTR. From discussions with Highways England, the mix of vehicle types being used as probe vehicles is only known to Highways England at a general level and at a national level. This could affect the reliability and assurance of this data and require infilling when sample sizes are too small, or quality metrics imply low levels of confidence in the data.

4 UK and international delay comparators

A comparator review of how other UK and international road operators manage delay has been carried out from a sample of published materials including from CEDR (Conference of European Directors of Roads), PIARC (World Roads Association), TRB (Transport Research Board) and AustRoads (representing Australia and New Zealand).

Findings from this review highlight that Highways England is seen as a leader in several areas of delay management and has participated in several international comparator studies. For example, Highways England already cooperates with the Netherlands through its CHARM initiative and is an active participant in CEDR. There are some interventions which other organisations use which could be of future interest to Highways England to manage delay. These include:

- Road pricing;
- Managed lanes such as High Occupancy Vehicle (HOV) lanes;
- The provision of parking to facilitate mode transfer or car-pooling;
- Selective limitation on HGVs, eg overtaking ban, HGV tolling; and
- 'Move-over-laws' to create channels for emergency vehicles during incidents.

As Highways England develops its Delay Ambition Plan and considers the future interaction of connected vehicles on the SRN it could consider the work PIARC has carried out into the challenges and opportunities for road operators and the potential for improvements in road safety, traffic management and traffic information. We have also identified references to a joint task force between PIARC and FISITA (The International Federation of Automotive Engineering Societies) and the work of the PIARC Road Network Operations & ITS technical committee which has recently started its 4-year cycle (2020-2024) and is carrying out international research including updates to its on-line RNO manuals and case studies.

Publications from Austroads cover a variety of delay management guidance and some of these could be of interest to Highways England as they develop their Delay Ambition Plan and delay management interventions. Areas for Highways England to consider include:

- Checks against Highways England's delay levers and analysis of the cost of congestion.
- The evaluation of Travel Demand Management (TDM) initiatives.
- Linkage between asset management strategies and network management and Safe System strategies to integrate delay management and incident detection systems.
- Critical learnings in network operations, congestion management relief initiatives and planned activities.
- Forecasts for the uptake of selected technologies in new types of passenger vehicles up to 2030 and the penetration of these technologies into the vehicle fleet in order to consider the impacts on network intelligence and delay management from changes to vehicle fleets.
- The development of the Performance Indicator (PI) to improve sign messaging as well as a comparator review of customer feedback to VMS.

An email exchange was also been carried out with road agencies who are part of the European DATEX II community. DATEX II is the electronic language used in Europe for the exchange of traffic information and traffic data. It is EU funded with stakeholder cooperation hosted by CEDR. There was a limited response to our request to participate and of the two responses received from Germany and Norway neither has an approach to managing congestion and delay which is likely to lead to opportunities for Highways England.

Annex E provides further information from the comparator review.

Annex A – Highways England Licence requirements to manage congestion and delay

The 2015 Licence created when Highways Agency transitioned to Highways England sets out specific duties under three areas to manage network disruption (planned and unplanned) and provide sufficient information on disruption to road users. These requirements are highlighted below.

Effective operation

5.1 In complying with 4.2(a) and relevant statutory duties, including the general duties relating to network management under the Traffic Management Act 2004, the Licence holder should:

a. Seek to minimise disruption to road users that might reasonably be expected to occur as a result of:

i. Planned disruption to the network (including from road works);

ii. Unplanned disruption to the network (including from incidents on the network and the short-term effects of extreme weather conditions)

b. Proactively and reactively provide relevant, accurate and timely information about traffic and conditions on the network to road users, including when there is disruption.

Efficiency and value for money

5.12 In complying with 4.2(d), the Licence holder **must**:

…Have due regard to circumstances in which it may be appropriate to carry out additional work as part of proposals where these can reduce or eliminate long-term costs or disruption to the network.

Cooperation

5.17 In complying with 4.2(f) and its general duty to cooperate under section 5(1) of the Infrastructure Act 2015, the Licence holder should co-operate with other persons or organisations in order to:

a. Facilitate the movement of traffic and manage its impacts;

b. Respond to and manage planned and unplanned disruption to the network;

Annex B - Highways England's RP2 commitments to reduce congestion and manage delay

The following commitments to improve congestion, roadworks, incident management and information to road users have been extracted and summarised from Highways England's 2020 – 2025 Strategic Business Plan and Delivery Plan. They represent an ambitious statement of intent and include developments in RP2 that will be implemented and have benefits in RP3/4 and beyond.

Improving congestion

- Saving customers over 20 million vehicle hours by tackling congestion during RP2.
- Implementing a £14.2bn programme of enhancements to tackle congestion through smart motorways, complex infrastructure and regional investments.
- Delivering interventions that improve safety, reduce congestion and support economic development using the Safety and Congestion fund, including support measures at a local level, such as improving traffic flow and journey reliability from junction improvements. This includes high-risk roads, accident-cluster locations and potential suicide-cluster areas with a focus on those A-roads where accident rates are higher.
- Setting speed limits that are appropriate for the road conditions, and signals to help save customers' time.

Improving roadworks

- Working to minimise disruption as part of scheme delivery with for example setting 60mph speed limits within roadworks across our major schemes, where safe to do so.
- Incentivising the supply chain in Regional Delivery Partnerships to deploy shorter, more accurate and better managed roadworks.
- Improving customers' experiences of roadworks - building customers' needs into the design and construction of all projects using 'Roadworks: A customer view' which contains 20 principles and provides a customer view to plan and design traffic management and engage and communicate with customers.
- Better planning of maintenance, operations and renewals - delivering frontline services more effectively to increase capacity and improve customer service and respond to incidents as quickly and effectively as possible, at least 90% of the information published about roadworks is accurate.
- Collaboration with Transport Focus to identify new ways of improving customers' experiences of roadworks, including when they are using diversion routes.
- Monitoring and measuring roadworks performance such as roadworks information timeliness and accuracy, delay from roadworks and working with local highways authorities to review diversion routes linked to planned roadworks.

Improving incident management

- Managing incidents more effectively and reducing the risk of secondary accidents through Highways England's frontline services including refreshing the tools and equipment Traffic Officers need, equipment to remove broken down vehicles from live lanes, spillage management and lighting.
- New control room technology to improve effectiveness, resilience and ability to deploy people more flexibly at busy times or during emergency incidents as well as working in partnership with others to support smooth and delay-free journeys from beginning to end.
- implementing a package of activities to prevent incidents promote safer roads, safer people, safer vehicles and a coordinated collision response.

- Operational Excellence including roll out of Regional Operations Centres (ROCs) to allow quicker incident response and closer coordination between Traffic Officers and maintenance crews.
- Working with the recovery industry and building on a partnership agreement to review touchpoints and activities and develop a plan for improving engagement and partnership working.
- A commitment to monitor and measure incident management performance including incident clearance rates on motorways and a separate commitment to investigate delays from incidents on the local road or SRN boundary.
- Using performance data to develop deployment strategies from new and existing traffic officer base sites, helping to achieve the one-hour incident clearance target more often.

Improving information

- Providing high-quality and trusted information to road users (Digital for Customers) without having to seek it out to make them feel safe, better informed and in control of their journeys.
- Improving the information provided to customers such as introducing new types of variable messages to explain what is happening when roads are disrupted and more specific information during and after accidents.
- Developing new fixed roadside signs focusing on diversion routes to help customers understand where they are on the route and the distance until they rejoin the SRN.
- Providing customer insight and feedback to improve how, when and what is put on electronic message signs and help customers feel safer by setting messages that will help them make timely decisions about their journeys.
- Using the Safety and Congestion fund to develop and improve information about, and during, roadworks.
- Improving road user information - replacing the National Traffic Information Service with an integrated solution that will keep customers better informed about incidents and roadworks.
- Providing insight from data and research to better understand the causes of incidents through collecting, analysing and sharing data and research.
- Making information available to Sat Nav providers to allow identification of emergency areas on their systems by March 2021.

Annex C – Extract from Post Opening Project Evaluation (POPE) of Major Schemes Main Report Meta-analysis 2015

Traffic - Presents the impacts of schemes on traffic flows, journey times and journey time reliability, and compares them to forecast.

Do Major Schemes improve journey time reliability?

New bypasses, widening schemes and schemes upgrading A-roads to motorways significantly improve journey time reliability, with bypass schemes showing the greatest improvements.

Are Highways England traffic models accurately predicting traffic volumes?

A majority (68%) of schemes accurately forecast traffic flows (to within +/-15%), but there is much variability in accuracy between schemes. There is evidence to suggest that the accuracy of traffic forecasting has improved over time.

Are Highways England traffic models accurately predicting journey times?

The limited forecast data available indicates that recorded peak hour journey time savings are lower than forecast. Journey time forecasts are more accurate for less congested periods, such as inter-peak and off peak, when compared to busy peak periods.

Does more complex traffic modelling improve forecasting accuracy?

Modelling guidance has changed to encourage consideration of the impact road schemes have on the demand for travel. Use of 'elasticity models' has improved forecasting accuracy compared to fixed demand models. There are currently too few variable demand models to draw any conclusions as to any advantage over elasticity models

Is there evidence of induced traffic?

Sometimes road improvements can lead to more people travelling. This is phenomenon is referred to as 'induced traffic'. The majority of schemes, of all types, do not appear to have induced traffic. It should be noted that the lack of induced traffic in recent years may be due to the economic downturn. The reduced background traffic growth may also have masked any induced traffic.

Is there evidence of a change in peak spreading?

The limited data available on peak spreading shows a reduction for the majority of schemes. However, the general rerouting of traffic onto the schemes from other routes, increasing traffic flows for all hours, can mask a reduction in peak spreading.

Economy - presents the outturn economic results and compares them against forecast, together with an assessment of whether Major Schemes are delivering value for money

What are the main benefits of Major Schemes?

Journey time benefits are the key monetary benefits derived from Major Schemes, accounting for 79% of all monetary benefits. Safety benefits (as measured by reductions in numbers of injury collisions) form the second largest contribution. The average total monetary benefit for schemes appraised over the standard 60 years is £117.5million, and £86.7million for schemes appraised over 30 years. Other impacts which are appraised using a monetary value, positive or negative, include changes to the users' vehicle operating costs, indirect tax impact for the Treasury, and cost of delays during construction and future maintenance periods. In total, these average only an average 1% net impact. The Treasury is expected to benefit from many schemes through a net increase in indirect tax revenue but, on average, this impact is less than £1million. Widening schemes have substantially

higher average total benefits per scheme than bypass and junction schemes. However, the greatest benefits are seen in the four schemes which were an upgrade to motorway and the one smart motorway scheme; all of these where larger schemes. Safety benefits are the highest for bypass schemes which is due to these types of scheme including the greatest step change in road standard.

How accurate is the forecasting of Major Scheme benefits?

Benefits arising from journey time savings are moderately accurate for most schemes. 28% of schemes have journey time benefits within 15% of that forecast and 74% of schemes are within 50%. Safety benefit forecasts, however, are inaccurate for the majority of schemes with only a third having outturn benefits within 50% of forecast. Net change in Vehicle Operating Costs and indirect tax impacts are mostly lower than forecast. There is some indication of an improvement in benefit forecasting accuracy since 2000.

How accurate is the forecasting of Major Scheme costs?

Half of the Major Schemes had estimated costs in the business case within 15% of the outturn cost. Since 2004, accuracy of cost estimating in scheme appraisal has been consistently improving.

What is the average cost of a Major Scheme?

Major Schemes cost £39.5million on average and 60% of schemes costs below £50m.

Are Major Schemes offering value for money?

Post opening evaluation shows that the average Benefit Cost Ratio of major schemes is 2.7, which means that on average, for every £1 spent on the scheme, the return will be £2.70 in long term economic benefits. 73% of schemes achieved high value for money and 88% achieved medium or high value for money. A scheme is high value for money if the benefits are over double the cost.

Has value for money improved over time?

In recent years, from 2008 onwards, the proportion of schemes achieving high value for money has improved compared with that seen in the earlier part of the decade.

Do value for money assessments vary between Highways England's regions?

There is no evidence in the outturn value for money assessments of Major Schemes differing between the regions.

Are Major Schemes stimulating economic development?

There is anecdotal evidence to show that Major Schemes have assisted local and regional economic development through congestion reduction and improved journey time reliability which provides improved access to potential employment centres.

Annex D – RIS2 congestion and delay metrics

A comparison of the RIS2 and RIS1 Operational Metrics Manual (OMM) and the relevant congestion and delay metrics has been carried out in our literature review and is summarised below in **Table D1**.

Table D1 – RIS2 delay metrics and RIS1 comparison

RIS2 OMM (June 2020) metrics and comparison with RIS1		
Metric	**Comparison with RIS1**	**Target**
Outcome 2. Providing fast and reliable journeys		
KPI 2.1 Average delay	[Similar to the 2019 KPI metric - average delay (time lost per vehicle per mile)]	**Ambition** – Performance to be no worse at the end of Road Period 2 than it is at the end of Road Period 1. This KPI does not have a target.
KPI 2.2 Network Availability	[Similar to the 2019 KPI metric - the percentage of the SRN available to traffic]	Achieve 97.5% lane availability in 2020-21. A new target will be set after 2020-21.
KPI 2.3 Incident clearance rate	[Similar to the 2019 KPI metric - the percentage of motorway incidents cleared within one hour – but the calculation approach may be modified]	86% of motorway incidents cleared within one hour.
PI 2.4 Delay on smart motorways	[No equivalent 2019 metric - average delay to road users on smart motorways]	No target
PI 2.5 Delays from roadworks	[No equivalent 2019 metric - overall delay experienced by road users that is caused by roadworks]	No target
PI 2.6 Journey time reliability	[No equivalent 2019 metric - delay experienced by road users when compared with their normal journey time]	No target
PI 2.7 Delay on gateway routes	[Similar to the 2019 PI metric – average delay (time lost per vehicle per mile) on Gateway Routes – but the calculation approach may be modified]	No target
PI 2.8 Average Speed	[Similar to the 2019 PI metric – Average speed (car journeys) – but the calculation approach may be modified]	No target
Outcome - 5. Meeting the needs of all road users		
KPI 5.1 Road user satisfaction	[Similar to the 2019 metric BUT based on the SRUS survey instead of NRUS. Based on the response 'very satisfied' or 'fairly satisfied' to the SRUS question: "Taking everything into account, how satisfied were you with your journey?"]	Achieve an 82% road user satisfaction score in 2020-21 and 2021-22, with year-on-year increases in the following years. The exact targets for 2022-23, 2023-24, and 2024-25 will be set during 2021-22.
KPI 5.2 Roadworks information timeliness and accuracy	[New metric - percentage of overnight road closures that are accurately notified by Highways England seven days in advance]	Achieve 90% accuracy of roadworks information seven days (rolling) in advance of works by

RIS2 OMM (June 2020) metrics and comparison with RIS1		
Metric	**Comparison with RIS1**	**Target**
		2024-25, with an increasing trajectory of improvement through Road Period 2 from the level of performance achieved by the end of Road Period 1
PI 5.3 Timeliness of information provided to road users through electronic signage	[New metric - the average median time to set signs and signals on (all) motorways after Highways England has received notification of an incident, that requires signs and signals to be manually set]	No target
PI 5.5 Working with local highways authorities to review diversion routes for unplanned events	[New metric - the percentage of local highway authorities which Highways England engaged with, to review diversion routes for unplanned events]	No target

Metric data sources

Input data for RIS2 metrics comes from several sources including:

- Flow data - obtained from Traffic Monitoring Unit (TMU), Traffic Appraisal, Modelling and Economics (TAME) and Motorway Incident Detection and Automatic Signalling (MIDAS) counting sites and accessed from the Roads Information Framework (RIF).
- Journey time data - sourced from the INRIX Fused Journey Time fields in the fused floating vehicle and sensor data (FVD) tables in RIF. Note that the National Traffic Information Service Network Model is based on the "HERE" (a map product used by INRIX) and adapted for Highways England use by Network Information System (NIS).
- Permanent lanes (network length) information - held on the asset management system.
- Lane impacting incidents and duration - obtained from Highways England's Incident Management System (ControlWorks).
- Roadworks and closures information - from the Network Occupancy Management System (NOMS). Data is entered into NOMS by Highways England staff, suppliers and contractors.
- SRUS survey data from Transport Focus – specifically the percentage of customers stating that they are 'very satisfied' or 'fairly satisfied' with their journey.
- Electronic signage - a sample of data is sourced from Control Works and is then provided to the Operations Performance and Intelligence team by the Performance Analysis and Modelling team.
- Local authority diversion route engagement - data from regional contacts

Annex E – Comparator review summary

Table E1 summarises our review of comparator road organisations from published literature and the interventions that they use to manage delay which could be of interest to Highways England as they develop their plans for RP2 and RP3/4. Table D1 describes the organisations and published information that we have selected based on our literature review:

- CEDR – Conference of European Directors of Roads
- PIARC – World Roads Association
- TRB – Transportation Research Board (USA)
- AustRoads - collective of the Australian and New Zealand transport agencies, representing all levels of government.

Table E1 – comparator review summary

Publication source		Summary
CEDR	Reducing congestion with integrated network management (INM). CEDR. 2017	Highways Agency/Highways England has participated in most of the tasks and is an active participant in CEDR so should be well aware of these programmes & outputs
	CEDR Contractor Report 2017-04. Call 2013: Traffic Management METHOD, UNIETD and PRIMA projects. CEDR. 2017	NL emerges as a leader in good practice, along with Highways England, and Highways England already collaborates closely with NL, eg CHARM Much of the CEDR output is aimed at identifying existing practice and, hence, synthesising frameworks/options for policy/strategy approaches, rather than specific detail of implementation. Interventions/levers not (widely?) used by Highways England but identified through CEDR • Pricing • Provision of parking to facilitate mode transfer or car pooling • Selective limitation on HGVs, eg overtaking ban, HGV tolling
	Comparison of Congestion Policies of national road authorities. CEDR. 2011	
	Delft University of Technology. Human factor guidelines for the design of safe in-car traffic information services. 2016.	
	Traffic management to reduce congestion. CEDR. 2012	
PIARC	Connected Vehicles 30795,2019R11EN	This international review of pilot studies and challenges and opportunities for road operators from connected vehicles includes surveys/case studies from UK such as A2/M2, Autodrive, CITE and GATEway. Potential improvements for road operators have been identified in road safety, traffic management and traffic information. As this includes non-UK practice it could be useful as a comparator when Highways England is developing its Delay Ambition Plan and considering the future interaction of connected vehicles on the SRN.
	Strategies for Road Network Operations (RNO) 2012R26-EN	This provides an international review and suggests strategies for road network operations (RNOs) including those proposed from a joint task force between PIARC and FISITA (The International Federation of Automotive Engineering Societies). Although the report is now dated (2012) it does reference the PIARC Road Network Operations & ITS technical committee which has recently started its 4-year cycle (2020-2024) and is carrying out

<table>
<tr><td></td><td></td><td>international research including updates to its on-line RNO manuals and case studies.</td></tr>
<tr><td rowspan="7">TRB</td><td>US Dot Federal Highway Administration. Freeway Management and Operations Handbook. Final Report. September 2003 (Updated June 2006)</td><td rowspan="7">US interventions/levers not already used by Highways England:
Pricing and Managed lanes
Table 1. Brief definitions for various managed lanes.<table><tr><th>Type of Facility</th><th>Brief Definition</th></tr><tr><td>High-occupancy vehicle lane</td><td>Managed lane restricted primarily to high-occupancy vehicles (no tolling applied)</td></tr><tr><td>High-occupancy toll lane (also referred to as value-priced lanes)</td><td>HOV lane that is electronically tolled for single- or lower-occupancy vehicles and free to higher-occupancy vehicles</td></tr><tr><td>Truck lane/roadway</td><td>Dedicated lane(s) for trucks</td></tr><tr><td>Bus lane, busway, or transitway</td><td>Managed lane dedicated primarily for buses</td></tr><tr><td>Express lane</td><td>Managed lane that restricts access or, according to the MUTCD definition, a managed lane that employs electronic tolling in a freeway right-of-way with or without access restrictions</td></tr><tr><td>Toll lane (or road)</td><td>Any lane/road that employs manual or electronic tolling (may not be a managed lane if travel benefits are not assured)</td></tr><tr><td>Express toll lane(s)</td><td>Managed lane employing electronic tolling that charges users a toll except those exempted</td></tr></table></td></tr>
<tr><td>FINAL REPORT. Synthesis of Active Traffic Management Experiences in Europe and the United States. FHWA March 2010. Publication # FHWA-HOP-10-031.</td></tr>
<tr><td>Us Dot Federal Highway Administration. Ramp Metering: A Proven Effective Strategy. September 2014.</td></tr>
<tr><td>Us Dot Federal Highway Administration. 2017 Urban Congestion Trends Measuring, Managing, and Improving Operations in the 21st Century</td></tr>
<tr><td>NCHRP. Guidelines for Implementing Managed Lanes (2016)</td></tr>
<tr><td>NCHRP. Resilience in Transportation Planning, Engineering, Management, Policy, and Administration (2018)</td></tr>
<tr><td>NCHRP. Leveraging Big Data to Improve Traffic Incident Management (2019)</td></tr>
<tr><td rowspan="3">Austroads</td><td>VTPI Australia 2014 ITED_congestion.pdf</td><td>Congestion Evaluation Best Practices through an analysis of AUSNZ and international research, mainly from the USA. Although this is dated 2014 it could provide a useful comparator to check against Highways England's delay levers and analysis of the cost of congestion. Also evaluates Travel Demand Management (TDM).</td></tr>
<tr><td>AGTM04-20_Part_4_Network_Management</td><td>General network demand guidance including travel demand management as well as linkages between asset management strategies and network management and Safe System strategies. Although Highways England has all these capabilities it could provide a useful comparator for Highways England's travel demand management development and embedding a safe systems approach to asset management and network operations.</td></tr>
<tr><td>AGTM09-20_Part_9_Transport_Control_Systems</td><td>Introduction to systems used to manage demand, incident management and control of traffic including with ITS, based around a Safe System of Work. Could provide a useful comparator for integrating Highways England's various delay management and incident detection systems.</td></tr>
</table>

	AP-R600-19_Case_Studies_of_Critical learnings in network operations	Case Studies of critical learnings in network operations, congestion management relief initiatives and planned activities. Could provide Highways England with a useful comparator to the strategic and operational activities, initiatives and treatments that Austroads member agencies are implementing.
	AUSTRALIA AP-R623-20_Future_Vehicles_2030	This report provides forecasts for the uptake of selected technologies in new Australian passenger vehicles up to 2030 and the penetration of these technologies into the vehicle fleet. This could be useful as a comparator for Highways England when considering the impacts on network intelligence and delay management from changes to vehicle fleets.
	AP-R627-20_Guidance_and_Readability Criteria for Traffic Sign Recognition Systems Reading Electronic Signs	This guidance could be useful for Highway England's development of its Performance Indicator (PI) to improve sign messaging as well as a comparator review of customer feedback to VMS.