Preparing for RIS3 enhancements

Delivery timescales and risks review

February 2022

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Contents

Introduction

Background

National Highways, formerly known as Highways England[1], was set up by the UK Government in 2015. Its responsibilities include delivery of a major investment programme on England's Strategic Road Network (SRN), as defined in the Department for Transport's (DfT) Road Investment Strategy (RIS).

In March 2020, the DfT published its second RIS (RIS2) covering Road Period 2 (RP2) which runs from April 2020 to March 2025. This allocated £27.4bn of funding to National Highways, of which £14.2bn was for delivery of a defined list of 69 enhancement projects plus early feasibility work on a pipeline of 32 potential future schemes that may be brought forward in later road periods.

In August 2020, National Highways published its Delivery Plan[2] for RIS2, detailing the activities and projects it will deliver for the allocated funding, its approach to efficiency and risk, together with its performance framework, which brings together all of its proposed outputs for RP2.

The Office of Rail and Road (ORR), as independent Highways Monitor, is responsible for monitoring and enforcing the performance and efficiency of National Highways. The ORR also provides advice to the Secretary of State for Transport on the development of plans for future Road Periods.

The third Road Investment Strategy (RIS3) will cover the third Road Period (RP3), from April 2025 to March 2030. National Highways is currently undertaking early strategic planning work in readiness for RIS3, with its draft plans expected to be submitted for scrutiny by the DfT and ORR in early 2023.

ORR has commissioned Nichols to undertake this review to inform how it should approach its responsibilities to the RIS3 development process.

[1] Highways England was rebranded as National Highways in August 2021.
[2] An amended Delivery Plan was agreed with the DfT and published by National Highways in 2021.

Our Remit

Nichols' remit covers two key aspects of National Highways preparation for development of the portfolio of RIS3 enhancement schemes, structured as follows:

- Task 1 assesses National Highways approach to cost estimation and efficiency.
- Task 2 assesses National Highways approach to forecasting project timescales and schedule risks.

This is the report for Task 2, with separate reports covering Task 1.

One of the ORR's key responsibilities within the RIS3 development process is to assess whether the requirements of the RIS are both challenging and deliverable. In respect of the enhancement programme, its objective is therefore to ensure that the portfolio of projects achieves a balance of two competing requirements: firstly, that it is sufficiently stretching such that it represents an efficient use of funding and resources and secondly; that there is a high level of confidence that the projects can be delivered as scheduled.

Task 2 will inform the ORR's assessment of plans for RIS3. It is intended to provide a detailed understanding of how long it takes National Highways to deliver highways schemes, the factors that determine project timescales and the primary risks to projects not being delivered to schedule.

The scope of Task 2 is expressed in the remit as the following three activity stages:

Stage 1a – analyse what factors influence delivery timescales for an agreed framework of National Highways project types, identify the factors that can result in projects being delivered earlier or later than scheduled and; consider the relevant National Highways schedule management processes aligned to its Project Control Framework (PCF) which sets out how it manages and delivers its major improvement projects throughout their lifecycle.

Stage 1b – assess sample data for each project type to establish a suitable and realistic baseline for the time it takes National Highways projects to progress through the principal PCF phases and identify patterns and key influencing factors in this data.

Stage 2 – consider the combined implications of Stage 1a and Stage 1b for the ORR's assessment of the deliverability of the RIS3 enhancement programme; the evidence ORR should expect National Highways to provide; the merits of project-level and portfolio-level schedule assessments and; the role that Quantified Schedule Risk Analysis (QSRA) should play.

Review methodology

The Task 2 review was undertaken between November 2021 and January 2022, and comprised a desktop assessment of National Highways documentation on its plans for its major projects, an analysis of schedule delivery, and its approach to project planning, schedule and risk management; all of which was supported by workshops with its Capital Portfolio Management (CPM) and Major Projects Delivery Services teams.

It is important to note that our review and analysis of project schedules was undertaken before two notable events:

- Confirmation of delays to a number of larger schemes that will result in spending in RP2 being deferred, linked to Government's Spending Review 2021 (SR21) of October 2021. These changes to schedule will be subject to formal change control in early 2022.
- Government's decision[3] to pause the rollout of future smart motorway schemes until a full 5 years' worth of safety data is available. This will impact on development and construction schedules for a number of RIS2 smart motorway schemes that is not reflected in our analysis.

We have flagged where this is relevant to our findings in this summary report.

We would like to thank the National Highway team for its cooperation and support during this review, providing all documents and responding to a series of clarifications requests for detailed evidence to support the review, and assisting in the validation of data schedule quality and causes of schedule movement for its enhancement projects.

Structure of this report

Our findings are set out in Chapter 2. In Chapter 3 we set out our conclusions, and in Chapter 4, recommendations we are making to ORR to inform their preparations for their engagement in the development of the RIS3 portfolio. We also indicate the type of information and evidence that may be required from National Highways to support ORR's involvement and the areas we recommend it should examine in more detail.

[3] Written statement to Parliament, Government to pause rollout of all lane running motorways, 12 January 2022.

Findings

Stage 1A remit: identify the factors that influence delivery timescales and risks, and consider the relevant National Highways schedule management processes aligned to its Project Control Framework (PCF).

National Highways' PCF framework is illustrated in Figure 1 below.

Phase	Pre options	Options		Development			Construction	
Stage No.	PCF 0	PCF 1	PCF 2	PCF 3	PCF 4	PCF 5	PCF 6	PCF 7
Stage	Strategy, Prioritisation	Options Identification	Option Selection	Preliminary Design	Statutory Process	Detailed Design	Construction, Commission	Close-out

Figure 1: Summary of PCF phases and stages

Finding 1: National Highways has an existing high-level architecture of project types covering all enhancement schemes that can be used for the purpose of analysing factors that influence project delivery schedules.

The framework is referred to in National Highways CPM reporting to the DfT and ORR. This framework is as shown in Figure 2 below. We considered whether there was merit in expanding this framework to include additional types or sub-types, and concluded that would not add value to the identification of schedule influencing factors. We also found that larger schemes typically comprise one or more of these main types, and differ by size and cost not by scope. We recognise that National Highways cost estimating models and methodology can accommodate sub-types if needed, for example in distinguishing between at-grade or grade-separated and between upgraded or all-new junction improvement projects.

Project type	Smart Motorway	Online Widening	Junction Improvement	Bypass or Offline Widening

Figure 2: National Highways framework of enhancement project types

Finding 2: There is a broad and consistent range of factors that have been reported by National Highways as influencing project timescales during RP1 and in the early stages of RP2 to-date.

These factors are set out in Figure 3 below, based on the framework defined by National Highways in its CPM reports to the DfT and ORR. We have expanded this framework of 10 key factors to include 54 sub-factors that have been identified from National Highways reported evidence of schedule changes (slippage as well as acceleration, planned as well as unplanned schedule movement) across a sample of 125 of its projects that were either delivered in RP1 or that have been or will be delivered RP2.

1. Statutory Planning	2. Scope	3. Stakeholder	4. Construction Issue	5. Environmental	6. Value for Money (VfM)	7. JR / PI	8. Contractor Performance	9. Change in Standards	10. Other
1a. Change in design scope requires DCO	2a. Type/option not defined or changed	3a. DfT (Tier 1 / IPDC) governance delay	4a. Unforeseen ground conditions	5a. Poor air quality design rework	6a. Poor business case - rework	7a. Judicial Review (JR) called	8a. Capacity / resource issue	9a. Reputational / policy impact	10a. Covid impact
1b. Extent of land take	2b. Safety risk	3b. Internal (IDC) governance delay	4b. Stats diversion	5b. Impact on statutory process	6b. Change to WebTAG	7b. Public Inquiry (PI) required	8b. Poor delivery performance	9b. Smart Motorway Stocktake	10b. Programme optimisation / combine schemes
1c. PINS reject application request	2c. Environmental challenge	3c. 3rd party dependency	4c. Archaeology discovery	5c. Biodiversity	6c. WLC issues	7c. Additional public consultation	8c. Contractual issue/behaviours	9c. GD301 Design Standard Changes	10c. Transition to new Road Period
1d. Additional consultation in PINS examination stage	2d. OMR / existing asset integration	3d. Mitigate network disruption	4d. Ops' impact / TM constraint	5d. Flood alleviation	6d. Delay in DfT poor/low VfM approval		8d. Contract change impact	9d. Air Quality assessment standard (eg WebTAG change)	
1e. Delay to PINS recommendation phase stage	2e. Design complexity, buildability	3e. Local stakeholder support	4e. Delay to contract award	5e. Noise level alleviation			8e. Contract price agreement impact		
1f. Delay to SoS approval stage	2f. Local stakeholder impact	3f. Local political support	4f. Scope / design / buildability contract change				8f. Poor safety performance		
1h. Change in design avoids DCO	2g. DfT impact / request	3g. National political impact	4g. Seasonal constraint (e.g. bird nesting)						
			4h. Asset condition						

Figure 3: schedule risk/influencing factors for National Highways enhancement projects

Finding 3: We assessed schedule changes and their associated influencing factors by tracking two key milestones over time: the Start Of Works (SOW) date and the Open For Traffic (OFT) date.

The assessment was based on RIS1 and RIS2 major projects in the period between 2017 (when there was robust portfolio-wide SOW and OFT data available) and late 2021 (when the review was undertaken). To ensure the quality of data, we excluded from our analysis schemes that were stopped/cancelled, for example due to poor Value for Money (VfM), complex projects that involve multiple types within a single scheme, projects delivered by 3rd parties and project where schedules were re-set when schemes were combined.

Our summary findings from our analysis of the sample of 125 projects are as follows:

- Delivery timescales for approximately two-thirds of the sample have been impacted by one or more sub-factors, with planned delivery schedules achieved for the remaining one third of projects. Of those projects that have been impacted, there are many instances of one factor causing knock-on impacts on other factors, notably as a result of the interdependency between Development Consent Order (DCO), design scope, stakeholder requirements/challenge and environmental factors.

- There has been widespread movement of SOW dates across all project types in RP1, although the greatest impact has been experienced on bypass/offline widening schemes where DCO and a range of stakeholder requirements were key influencing factors. There has been a broadly similar, at a lower scale, of schedule movements experienced across junction improvements, online widening and smart motorway projects, which is indicative of lower levels of statutory planning, scope and design/engineering related risks.

- The highest proportion (approximately 60%) of schedule movements have occurred during the development phase of projects, when various stakeholder, design, scope, environmental and statutory planning processes all come to the fore as key influencing factors. For RP1, this included realisation of risks related to schedule commitments that were made for many projects in the early stages of the PCF process when setting RIS1.

- Schedule movements have also occurred during the construction phase, but in overall terms the level experienced is much lower than during development, and has further improved since the latter stages of RP1. There are few examples of poor supply chain performance and, where this has occurred, it generally reflected issues with design maturity and change. The majority of movements to OFT dates, either achieved or forecast, result from the knock-on effect of movements to SOW dates experienced during development. Only smart motorway projects have experienced notable schedule movements during construction since 2020, which reflects the impact of the Stocktake[4], which has required additional design and construction work to be undertaken before schemes can open for traffic. As noted previously, further delays to a number of committed smart motorway schemes will result from the Government's decision to pause roll out of these schemes, and which, given the timing of this announcement, are not included in our assessment.

[4] DfT's 'Smart Motorway Safety Evidence Stocktake and Action Plan' dated 12 March 2020.

- Some of the schedule movements can be attributed to the 'optimisation' exercise undertaken by National Highways in mid-RP1, to re-programme the portfolio and reschedule or cancel 32 schemes to ensure VfM, respond to stakeholder feedback, address schedule risks, mitigate road user disruption associated with starting 54 schemes in 2019/20, and to integrate adjacent schemes on route corridors. A similar initiative was undertaken to baseline the RIS2 Delivery Plan, which focused on a top-down assessment of delivery risks and resulted in a reset of SOW and OFT commitments for 23 schemes.

- We did not find evidence of a consistent and direct correlation between instances of schedule movements and cost variances, despite the fact that delays would typically be expected to increase outturn project costs. In several cases this was because development phases were extended by National Highways to undertake additional work to address scheme cost and VfM risks, i.e. the impact of schedule changes on costs and funding has been effectively managed, including through change control governance, addressing delivery risk in informing Government spending reviews, and improvements in planning and baseline management since the start of RP1.

- There is a broad correlation between schedule variance and scheme cost, i.e. on average, the more complex, higher cost schemes have tended to experience greater schedule movements over their lifecycle, with the majority of this impact taking place in the development phase. By contrast, there is no obvious correlation between scheme cost and schedule movement in the construction phase. Overall, therefore, scheme cost is a potential 'leading indicator' of development phase schedule risk. However, it is not the underlying root cause of delays, as this is due to stakeholder requirements, scope complexity, design/buildability challenges and statutory planning aspects (and the mitigations for these factors).

Finding 4: Whilst a broad range of factors have influenced movements of project schedules, four are the most prevalent and have had the greatest overall impact across the portfolio during RP1 and in RP2 to date, notably during the development phase of projects.

These four factors are:

Statutory planning process – there is a clear correlation between instances of development stage schedule movements and the need for / impact of DCOs; reflecting that greater schedule risk and elongated statutory processes timescales have become normalised in recent years.

Scope – including changes required during the scheme options and development phases, in order to address design complexity, the need for additional public consultation stages and to mitigate cost and buildability challenges.

Stakeholder requirements – movements due to various changes to schemes designs in order to meet local requirements and concerns, to address lack of support for scheme plans, and to manage dependencies on other route corridor schemes, organisations and funding and approvals.

Construction issues – variously including ground conditions, archaeology, environmental factors, additional diversion of utilities, 3rd party interfaces, asset condition and contract change (the latter including the impact of the recent policy 'Stocktake' for smart motorways which has impacted on plans to complete schemes already in construction).

While the above four factors are the underpinning direct causes of the majority of schedule movements analysed, there were also schedule changes arising from two formal reviews of the RP1 portfolio whereby planned dates were agreed to be adjusted to optimise the delivery of the overall portfolio, typically as a result of these factors. These two review points were:

- A portfolio level 'optimisation' process undertaken in mid-RP1 which, as well as managing reputational risk associated with road user disruption, also addressed the then over-programming of the portfolio.
- At the 'RP1 to RP2 transition' through a change control process undertaken at the start of RP2.

Finding 5: Whilst the above factors have been the greatest cause of schedule movements across the portfolio of enhancement projects in RP1, the resultant effect or impact of these factors varies per project type.

Figure 4 summarises the scale of impact of each of the four factors on each of the four project types in RP1, with the lowest overall impact for smart motorways, rising to medium impact for online widening and junction improvement schemes, and highest impact for bypass/offline widening schemes which have experienced the greatest risks due to statutory planning and stakeholder requirements.

Factor	Smart Motorway	Online Widening	Junction Improvement	Bypass / Offline Widening
Statutory Planning	Low	Medium	Medium	High
Scope	Low	High	Medium	High
Stakeholder	Low / High (see note)	Medium	Medium	High
Construction	Medium	Medium	Medium	Medium

Smart motorway: 'Low' throughout RP1; 'High' recently due to Stocktake and Government pause

Figure 4: impact of key influencing factors per project type

We believe the same relationships between schedule movement factors and project types are valid for RP2 projects when evaluating schedule risks in future years, and as learning that can be applied to the forthcoming RP3 planning process.

Finding 6: Despite widespread schedule movements experienced during the development phase of projects, National Highways has missed only a few of the SOW commitment dates formally agreed with the DfT. It has also, in some cases, accelerated delivery of SOW commitment dates.

While this appears contradictory, it reflects two factors. Firstly that large number of projects had an 'end-of-RP1' commitment date set by the DfT in RIS1, and so schedule movements could be absorbed without missing the commitment date. Secondly, that commitment dates for a number of projects have been progressed formally by National Highways through a change control process and agreed governance arrangements with the DfT. This process included changes to respond to emerging schedule risks on individual projects plus the portfolio-wide optimisation process undertaken in RP1 and a similar process to transition the draft Strategic Business Plan (dSBP) forecasts for RP2 into defined RIS2 commitment dates for each project.

Finding 7: National Highways has a more robust and mature Capital Baseline for the project portfolio in RP2 compared to RP1, to enable it to manage (amongst other things) schedule performance.

In 2014 and at the start of RP1 the enhancements portfolio was set when it was immature, with most schemes in the early options and early development phases when there is greater scope, cost and schedule uncertainty. The RP1 portfolio was also defined relatively quickly, with less schedule detail or benchmarks to support targets, and was inherently optimistic as there was no contingency applied to account for schedule risks. One consequence of this was the subsequent cancellation of a number of schemes that did not deliver VfM, and a risk-based rescheduling of other project commitments during RP1.

Compared to RP1, the RP2 portfolio is more developed and therefore less vulnerable overall to schedule risks; with many projects rolling-over from RP1 into RP2 with progressively more robust scheme plans and schedules, and a greater proportion of projects either in the later stages of development or in construction, with a planned package of schedule changes already embedded into the RIS2 baseline delivery plan.

Even though the RP2 portfolio is more developed than RP1, key schedule risk and deliverability challenges remain in RP2. These include those projects that are dealing with elongated statutory planning timescales, very large and complex Tier 1[5] category schemes, and the impact of the recent decision to pause the roll-out of smart motorway schemes.

Finding 8: The RP2 Capital Baseline incorporates a contingency or float 'overlay' to forecast SOW and OFT commitment dates; deterministic project schedules are adjusted with a float allowance for schedule risks to define and track forecast formal commitment dates.

[5] Schemes that are subject to close work with Government during development and delivery, including enhanced staged approvals by the DfT.

In lieu of a more detailed analytical approach or empirical assessment of schedule risk, which we address in the next section of this report (Stage 1B remit), this RP2 float 'overlay' approach appears to be a logical and straightforward and reflects National Highways learning from schedule risks experienced in RP1. The size of float/contingency, which is reviewed on an annual basis, progressively reduces as more tightly-defined commitment dates (i.e. from five years to annual to six months, to quarterly) are agreed. This is due to nearer-term project delivery schedules have greater planning certainty. The standard float duration is not adjusted due to project type, although National Highways has confirmed that the approach could be readily developed to take account of project type. National Highway, by exception, does already tailor the standard float rules for specific projects, to address known schedule risks/opportunities.

While the contingency is applied to the externally facing 'Capital Baseline', National Highways also maintains an internal 'Operational Plan' without this float applied, which ensures clarity in how it monitors and manages progress by projects teams, maintain alignment to supply-chain schedules and act as the baseline if any contractual change control is required.

Finding 9: There is some evidence of a reduction in the number of schemes reporting schedule movements during the later stages of RP1 and in the first year of RP2. This may be indicative of the improving maturity of the overall enhancement projects portfolio compared to the start of RP1, although it is still too early in RP2 to draw definitive conclusions on schedule risk/performance for RP2.

While it is still relatively early in RP2, our analysis of SOW and OFT data indicates that there has been a trend towards fewer incidence of schedule movements reported in recent years, which is consistent with the greater overall development maturity of the portfolio, together with steps taken by National Highways to manage schedule risks.

While this appears to be a positive trend, there are still a large number of enhancement schemes in the development phase, and National Highways has been clear that some are being impacted by related risks, notably for its largest and most challenging projects; Lower Thames Crossing and A303 Amesbury to Berwick Down. The high costs of these schemes means that delays will create a significant forecast underspend in RP2. The outcome of the Government's SR21 settlement will have taken account of this forecast underspend, and schedule delays will be formalised via change control and DfT Ministerial approval in early 2022. Similarly, the Government's recent decision to pause roll-out of smart motorways will result in significant delays to a number of schemes that National Highways has already developed to date.

As noted previously, we have not been able to assess the impact of SR21 and the pause to the smart motorway programme on schedule delays, as these will be confirmed after our review, although there is evidence that the impact of these changes on RIS3 planning is already being defined.

Stage 1B remit: establish a realistic baseline for the time it takes projects to progress through principal PCF phases and identify key factors that influence this.

We assessed schedule data for National Highways RIS1 and RIS2 projects, based on the same framework of four project types assessed in Stage 1A above, i.e. analysing the start dates for pre-options, options, development and construction phases, as shown in Figure 5.

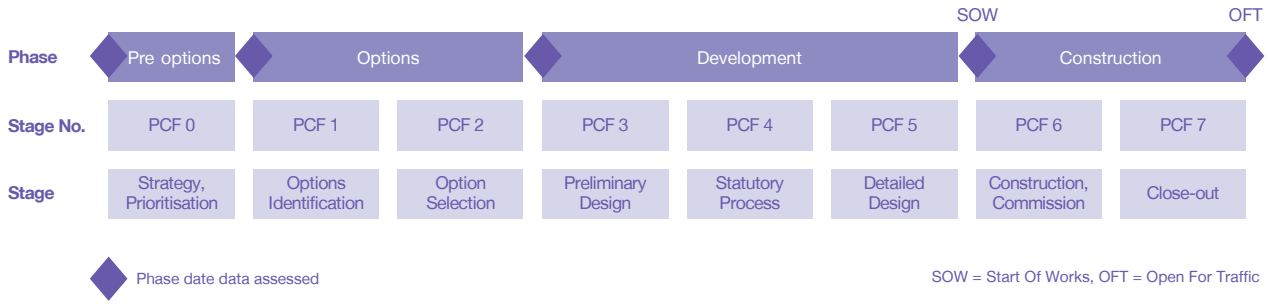

Figure 5: data points for assessment of timescales for completion of principal PCF phases

To improve the quality of the dataset for our analysis, we did not include a number of pre-RIS projects that commenced before the start of RP1 which did not have robust documented phase data, or those that were paused for a significant period of time while awaiting funding approval and limited number of small, low cost junction improvement projects delivered by National Highways Operations Directorate. Similarly, we also excluded a limited number of projects that were cancelled or where schedules were re-set when two or more schemes were combined into one.

Finding 10: Whilst the time it takes schemes to progress through the principal PCF phases varies as a result of project-specific factors, we identified a number of key patterns from our assessment.

These patterns are:

- There is a similar pre-options phase length of 0.5 to 1 year for all four project types, although care is required in forming a view on a baseline duration for a pre-options phase length as this is not a formal PCF phase and is strongly influenced by policy considerations and also the process and timescales to formulate and endorse projects within a RIS every five years.
- Options phase lengths vary per project, reflecting the extent of optioneering required. For example, smart motorway projects (which run to an amended lifecycle process and do not require a range of options to be assessed) have shorter options phase durations, and bypass/offline widening projects take longest as these invariably require more extensive optioneering work to assess scope, cost, VfM and stakeholder factors and typically take 2.5 to 3 years to complete.

- There is a broadly similar development phase length of typically 3 to 5 years for bypass/offline widening and online widening schemes, due to the need to address design and constructability challenges, to carry out surveys and investigations, secure local/national stakeholder support and to address environmental impact and land acquisition requirements. The development phase length is typically shorter on average at 2 to 3.5 years for junction improvements and less than two years for smart motorways, with the latter reflecting an amended project lifecycle process compared to PCF and lesser need for optioneering activity. In all four project types, the development phases are longest when a DCO is required.

- We also found that there is a correlation between development and construction phase lengths and scheme costs, i.e. durations increase with cost. Being cautious about generalised assumptions, scheme cost could be a potential 'leading indicator' of development phase schedule risk, although from evidence we have assessed, is not the underlying root cause of it.

Finding 11: We identified that project durations relate primarily to four key influencing factors, that are consistent with findings on schedule risks addressed in Stage 1A (previous section).

Scope – historic data reveals a range of schedule variations within any type and/or size of project, where the precise scope of work for any given project, and its implications for construction, has primacy in defining project timescales.

Statutory planning process – projects of all types take longer as a result of needing a DCO, and as they are exposed to multiple related risks to scheme options and scope/design, with additional and lengthy statutory processes and schedule risks further elongating the development phase for many projects.

Construction issues – a range of factors effect scheme delivery timescales, where these do not conform to any specific pattern or impact on project durations; for example due to unforeseen ground conditions, archaeological findings and unplanned stats diversions.

Strategic – emerging factors that create portfolio-level changes to delivery schedules for 'batches' of projects; for example, the optimisation exercise undertaken in 2018 to adjust timescales for 32 projects to minimise disruption, and manage delivery risks and costs and, more recently, to manage the impact of the smart motorway Stocktake review on nine projects in development and construction.

Stage 2 remit: consider the combined implications of Stage 1a and Stage 1b for the ORR's assessment of the deliverability of the RIS3 enhancement programme and the evidence ORR should expect National Highways to provide.

Finding 12: Our analysis of historic schedule data demonstrates that a project-specific assessment of schedule risk will be of value for RIS3 planning.

Historic project data held by National Highways provides a rich source of information that can be used to create a library of schedule duration benchmarks and schedule risk data. A project-specific assessment of schedule risk can draw on this data, with a tailored application for each future enhancement project to reflect an agreed and documented understanding of the risks that relate to its project type, phase and key characteristics that together inform its overall risk profile. This will enable a project-specific schedule and schedule contingency allowance to be assessed.

A project-specific assessment will be particularly important for new RIS3 projects entering the portfolio, and which will inevitably be in the earlier stages of the project lifecycle; typically at stages up to and including PCF stage 3, when an accurate and detailed schedule is not available. This assessment can then, in turn, enable project teams to focus on mitigating the key schedule risks identified in the assessment, as well as considering potential credible opportunities to outperform benchmark schedule assumptions.

Finding 13: 'Reference Class Forecasting' is recognised as good practice for the management of schedule risks in the early-stages of projects, and may be appropriate as the basis of the method for the aforementioned project-specific schedule risk assessment, both for existing committed schemes in options and early development phases and potential new schemes in the pipeline that may enter the portfolio in RIS3.

'Reference Class Forecasting' is defined as the method of predicting the future through looking at similar past situations or projects [in order to] predict the outcome of a planned action or project based on actual outcomes in a reference class of similar projects to that being forecast. It is typically applied 'top-down', rather than 'bottom-up' work breakdown/detailed scheduled planning. It is the underpinning principle that has been used to define Optimism Bias uplifts within HM Treasury's Green Book guidance.

'Reference Class Forecasting' is most appropriate in early-stages of a project with the greatest level of schedule uncertainty, where historic data can be used to benchmark (in this case) schedule durations and risks. We have seen or been involved in work on its application to infrastructure efficiency, Crossrail 2 (based on Crossrail 1 'should take' durations for a range of works categories and risks) and High Speed 2, so we believe it is a suitable method for National Highways for RIS3 planning.

Finding 14: We suggest that there is a package of additional evidence that ORR may need from National Highways to support its preparation for the development of the portfolio of RIS3 enhancement schemes.

This evidence includes:

- Details of the key project characteristics and hence schedule risk factors that apply per project, as per Findings 2, 3, 4 and 5, and how these have been considered (and/or mitigated) in plans/schedules.
- Details of capital baseline planning assumptions, including any adjustments to standard contingency/float assumptions applied to specific project commitment dates, as per Finding 6 and 7.
- Assumptions for the likely set of early-stage 'RIS3 pipeline' schemes that (when confirmed) are expected to be taken forward in RP3, including the proportions of each project type and PCF phase lengths assumptions. This information will help provide an overview of the overall risk profile of this set of new projects.
- Schedule risk and schedule scenario information for the key Tier 1 schemes that either carry-over into or start in RP3. This is because this very small number of schemes has the biggest impact on the portfolio as a whole, due to the scale of potential schedule risk, as exemplified by the Lower Thames Crossing and A303 Amesbury to Berwick Down schemes that have both incurred schedule movements during their development phases in late RP1 and in early RP2.
- A pragmatic 'portfolio-level' assessment of RIS3 deliverability/risks to complement the project-specific assessment noted in Finding 12. In addition to any other factors National Highways identifies, this should include consideration of: the overall maturity of the RP3 portfolio, the proportion of each project type and related schedule risks and influencing factors; the overall split between RP2 carryover projects vs. RIS3 new projects and; potential portfolio-level slippage scenarios.
- Whether there is a case for the planned over-programming of the enhancement projects portfolio to be built into future RIS plans. This would need to consider, for example, the level of maturity and schedule risk/uncertainty of the portfolio, the impact of slippage to baseline commitments to improve the SRN and to key stakeholders, Government's funding requirements, and use of a central portfolio risk reserve funding pot.

Finding 15: There is an opportunity to enhance the use of Quantified Schedule Risk Analysis (QSRA) for RIS3 planning, and National Highways has already started to implement a plan to strengthen this schedule management capability in RP2.

QSRA modelling represents good practice across a range of UK infrastructure clients, although its use is not appropriate during the early-stages of projects; until there is a defined scheme option, scope and robust activity schedule, so its primary use and value is to inform and provide confidence in construction durations (PCF stage 5 and 6). QSRA also requires an accurate, detailed, deterministic and logic-linked schedule with defined critical path and mature risk register as inputs to model a probabilistic range of forecast delivery dates. These inputs are not typically available until PCF stage 4. As a consequence, QSRA is less appropriate prior to PCF stage 4 and has more limited use in modelling development phase risks and SOW deliverability.

National Highways acknowledges that it does not yet have a mature QSRA capability in place across the organisation and its supply chain, although it is actively developing and deploying this, led by its risk team in collaboration with the planning team, intended to embed and grow use of QSRA during RP2 in a deliverable way, targeting tranches of projects and building on learning that results in subsequent tranches.

In line with the above, National Highways has a documented process defining the use of QSRA from PCF stage 5 ('Construction Preparation') onwards. During earlier stages of projects (PCF stages 2 to 4) it uses a simpler 'risk and planning integration tool' that maps out the impact of key risks based on project team inputs, though this is not explicitly based on historic scheme schedule data.

We believe that greater use of adapted QSRA techniques may be important in assessing schedule risks during the development phase, when the greatest proportion of schedule movements take place. In contrast the construction phase has a higher level of spend and cost risk. Use of QSRA at PCF stage 4 could enhance visibility and assessment of schedule risks and validate and refine schedule float assumptions. However, as noted, outputs will depend heavily on the quality of inputs and assumptions being made for each project, and may be less appropriate for quantifying major external risks, such as statutory planning process delays.

Finding 16: National Highways is currently enhancing its capital investment portfolio management capability (covering scope, cost, schedule and VfM) via the deployment of a new Enterprise Portfolio Management (EPM) system, which is planned to be rolled-out across the business in 2022.

Amongst a number of other benefits, the new EPM system is intended to enhance schedule performance data for the RIS3 pipeline including: more effective integration of planning, change, value and delivery risk scenario modelling; establishing a clearer 'line of sight' in reporting to schedules from projects/supply chains; tracking of schedule movements and early warnings of these compared to baseline milestones and; additional statistical analysis of delivery risks and schedules based on historical data and scheme characteristics.

As the EPM system supplier was in the process of being brought onboard by National Highways at the time of our review, we cannot verify how the system can be used to address our findings on schedule performance/risk management, although its objectives suggest that there is an opportunity to do so to via enhancement of capital portfolio management capability including more effective integration of planning, change, value and delivery risk scenario modelling; and in relation to our recommendations on project-specific and portfolio-level schedule risk assessments for RP3 enhancement planning.

Conclusions

Project Types and Schedule Influencing Factors

From our analysis of data from RP1 projects, there are links and relationships between 'type' of National Highways project and the extent of schedule movements experienced. There are 10 broad factors that influence project schedule movements, of which four have been the most common causes. These are:

1. The statutory planning process and specifically the various challenges associated with DCOs.
2. Scope/design complexity and design change.
3. The impact of stakeholder requirements and stakeholder dependencies, as well as mitigation of disruption.
4. Construction issues, which include (for example) changes in standards, smart motorway Stocktake and addressing environmental issues.

Overall, the greatest impact of schedules movements has been during the development stages of projects, causing delays to the original forecasts of SOW dates, and hence change control to published SOW commitment dates, as well as the majority of the knock-on delays to Construction phase timescales and OFT dates. In contrast, there has been a much lower level of schedule movement experienced during construction.

Again, in overall terms, the greatest level of schedule movement has been felt on bypass/offline widening schemes, with online widening and junction improvement schemes experiencing a medium level of movement and smart motorways a relatively low level of movement in RP1.

As the analysis undertaken considered the first year of RP2, and as there are only 13 new RIS2 schemes, the majority of the schedule data we assessed in this study was from the RIS1 portfolio. Notwithstanding this, there are signs of reduced levels of slippage in recent years compared to earlier in RP1, despite the facts that some projects schedules have been delayed due to the causes described above. However, it is important to note that our analysis was undertaken before anticipated delays to the commitment dates for a number of

larger schemes in development that is subject to change control arising from SR21, and also Government's decision to pause the rollout of future smart motorway schemes.

Based on the framework of schedule influencing factors set out in Figure 3 and our assessment and analysis of patterns of schedule movements across the sample of enhancement projects, we have identified a number of key project characteristics that are typical 'indicators' of a higher degree of potential schedule risk. They are a mix of qualitative and quantitative characteristics summarised in Figure 6 below.

Characteristic	Rationale
Bypass/offline widening Type	Highest frequency and scale of historic schedule movement in RP1 and RP2 to-date
DCO required	Figure 3 influencing factor 1 – applicable to all project Types; hence a leading indicator for schedule influencing factor 2 (scope), 3 (stakeholders) and 5 (environment)
'High design complexity	Figure 3 influencing factor 2 – challenge via complexity/buildability, novel scope/technology, ground/topography conditions, safety/ops' implication and factor 4 (construction issue)
'High' stakeholder impact	Figure 3 influencing factor 3 – scale of impact due to risks to support/acceptability, legal challenge, reputation and high risk of scope/design change
'High' environmental impact	Figure 3 influencing factor 5 – scale of impact on any of carbon, noise, biodiversity, air quality, flooding/water quality, cultural heritage
'Low' or 'Poor' VfM	Figure 3 influencing factor 6 – higher risk of extended or repeated options and/or development phases (and risk of scheme cancellation) as VfM falls
High cost categories >£250m	Leading indicator of schedule movement, though not a root cause, given correlation between scheme cost and scale of slippage in RP1
Part of route corridor programme	Greater risk of programme optimisation (to defer or to accelerate), merger of adjacent schemes and need to re-time schemes for disruption mitigation

Figure 6: Project characteristics as indicators of higher potential schedule risk

Typical Durations

Whilst the time it takes schemes to progress through the principal PCF phases varies as a result of project-specific factors, there are a number of key patterns evident that relate to the type, size and risk profile of projects that can be used as baselines to estimate schedule durations for comparable future RIS3 schemes that are at the early stages of development. Figure 7 shows the typical durations based on our analysis of project data.

Type/phase	Pre Options Note 1	Options	Development Note 2	Construction Note 3	Close out Note 4
Bypass/Offline Widening	0.5 to 1.0 year	2.5 to 3.0 years	3.0 to 5.0 years	2.0 to 3.5 years	0.5 to 1.0 year
Online Widening		1.5 to 2.0 years	3.0 to 5.0 years	1.75 to 3.0 years	
Junction Improvement		1.5 to 2.0 years	2.0 to 3.5 years	1.75 to 3.0 years	
Smart Motorway		2.0 to 4.0 years		1.5 to 3.0 years	

Figure 7: indicative durations for completion of principal PCF phases

Notes to Figure 7

1: Pre-Options indicative as subject to RIS planning cycles and policy factors/decisions, and not a formal PCF stage.
2: Statutory planning (for example, DCO) risks that crystalise as delays can, from experience, add circa 1-year to this duration.
3: Indicative as durations vary more per scheme-specific scope, construction methodology, scale/cost, than they do by scheme type.
4: Close-out indicative as post-OFT duration varies per scheme type and extent of commercial and site-specific activity.

ORR's assessment of RIS3 schedule deliverability

ORR will be assessing the schedule deliverability of the RIS3 enhancement programme when it is defined. To prepare for this assessment ORR should agree expectations with National Highways on the schedule evidence and schedule risk assessment it will provide to support their assessment.

The following evidence-set would be helpful for this purpose:

1. A project-specific assessment of the schedule influencing factors and key characteristics of each enhancement scheme that indicate the degree of schedule risk (as per Figure 3) that applies.

2. Details of how project-specific schedule risk assessment aligns with and supports the float/contingency levels defined and applied to Delivery Plan commitments for each project and project type.

3. For projects at an early stage of development (PCF Stages 1 to 4) a schedule risk assessment based on project type, influencing factors and using typical schedule durations from completed projects. This assessment should be based on Reference Class Forecasting principles.

4. For projects identified as having a sufficiently robust scope, design, schedule and risk profile; utilise QSRA techniques to assess and model schedule risks for schemes in construction and potentially in PCF stage 4.

5. A proportionate portfolio-level assessment of deliverability and risks using the above.

Recommendations

We have made a limited number of recommendations to ORR in respect of Task 2 on delivery timescales and risks associated with National Highways' enhancement projects. These are intended to support its preparations for the RIS3 enhancements investment plan process development, and to identify potential activity or evidence that could be agreed with National Highways as to be progressed in the period leading up to confirmation of, and in support of, the baseline dSBP for RIS3.

No.	Recommendation to ORR
1.	**Work with National Highways to agree plans for it to build a 'library' of historic schedule data, linked to project type and with reference to the common causes of schedule risk/change it has experienced since the start of RP1.** Key points: • To be with a view to the library informing and support preparations for the RIS3 enhancements investment planning process. • The library can build on the CPM directorate's existing schedule data; the analysis undertaken and discussions held during this review, and potentially also to draw on relevant learning from development and use of the library that the National Highways Commercial Services Division hosts for project costs. • Data to be held on both schedule risks and baseline durations (per project type) to progress through primary PCF phases. • To enable a check and challenge of schedule assumptions, and consider how deliverability risks impact on the timing of new RIS3 projects and alignment with associated portfolio funding requirements / constraints. • National Highways to consider whether/how to integrate this library within its new EPM system's management information and reporting functionality.

No.	Recommendation to ORR
2.	**Work with National Highways to consider the approach to schedule planning and schedule risk assessment for early-stage projects based on the principles of Reference Class Forecasting.** Key points: • The assessment methodology to draw on the schedule data and key metrics within the library in Recommendation 1. • To be applied on a project-specific basis, primarily targeted at early-stage projects. • Ensure sufficient emphasis is given to the development stage of projects which, while not high in cost, terms are prone to highest levels of schedule risk. • Complement and support assessment of any potential plan for the over-programming of the RIS3 portfolio.
3.	**Work with National Highways on plans to include a proportionate portfolio-level assessment of deliverability and schedule risks as part of the RIS3 planning process.** • A 'top-down' assessment to complement the 'bottom-up' (i.e. project-specific) assessment in Recommendation 2. • To be proportionate to the emerging nature and scale of the RIS3 portfolio and scheme composition when this is better defined, i.e. the degree of focus and effort required may be reduced if few new or large schemes are planned to be committed in RIS3. • To consider overall RIS3 portfolio maturity, the proportions of project types and related schedule risk factors, specific risks related to Tier 1 schemes that have the greatest impact on portfolio-level planning and funding, and the potential approach to over-programming of the RP3 portfolio to manage schedule risks. • Supported by ongoing regular review of portfolio level risks that are likely to impact across a number of schemes, to ensure that existing commitments are clearly understood in planning the RIS3 portfolio. • Results to be assessed alongside other relevant RIS3 strategic planning and prioritisation factors, for example, policy considerations, VfM, carbon, regional funding allocations, digital initiatives and future plans for smart motorways.

No.	Recommendation to ORR
4.	**Work with National Highways to assess and model schedule risks for schemes in construction and potentially at PCF stage 4 using QSRA techniques.** • Proposed as development phase schedule risks are the most prevalent and have had the highest impact on the enhancement projects portfolio. • Target projects identified by National Highways as having a sufficiently robust scope, design, schedule and risk profile available as prerequisite inputs to QSRA modelling. • Target projects with schedule risk factors highlighted in this study and/or those where the main contractor is on board earlier such as for the Regional Delivery Partnership (RDP) and Smart Motorway Alliance frameworks. • To review the quality of results after trialling of QSRA on an initial tranche of projects.

Table 1: summary of review recommendations

Abbreviations

CPM	Capital Portfolio Management
DfT	Department for Transport
dSBP	Draft Strategic Business Plan (for RP2)
EPM	Enterprise Portfolio Management
OFT	Open For Traffic
ORR	Office of Rail and Road
PCF	Project Controls Framework
QSRA	Quantified Schedule Risk Analysis
RIS1	Road Investment Strategy 1
RIS2	Road Investment Strategy 2
RIS3	Road Investment Strategy 3
RP1	Road Period 1 (2015/16 to 2019/20)
RP2	Road Period 2 (2020/21 to 2024/25)
RP3	Road Period 3 (2024/25 to 2029/30)
SOW	Start of Works
SRN	Strategic Road Network
SR21	Spending Review 2021
VfM	Value for Money