



# Investigation into Network Rail's risk modelling, embedded risk and uncertainty in PR23

## Final Report

Reference J0054-02

Version 2.0

29th Mar 2023

**Author: REDACTED**

**Reviewers: REDACTED**

*Report Prepared By:*

Sirius Analysis Limited

Second Floor South Suite (Room 2.4)

National Maritime Systems Centre

Portsmouth Technology Park, Southwick Road

Portsmouth, Hampshire, United Kingdom

PO6 3RU

Email: **REDACTED**

*Company Registration No. 12326135. Registered in England & Wales*



## CHANGE RECORD

Date	Version	Description
14/03/2023	0.1	Initial Draft
15/03/2023	0.2	First review draft
15/03/2023	0.3	2 <sup>nd</sup> draft
15/03/2023	0.4	2 <sup>nd</sup> Review and updated
16/03/2023	0.5	3 <sup>rd</sup> review and updated
16/03/2023	0.6	Finalised for final review
17/03/2023	1.0	Issue to ORR
29/03/2023	2.0	Re-Issue following comments from NR and ORR

## Executive Summary

### Overview

This report forms the final output of the Investigation for the Office of Rail and Road (ORR) into Network Rail's (NR's) risk modelling, embedded risk, and uncertainty on Periodic Review 23 (PR23) through an evidence-based assessment of the methodology of Round 6 data sets for NR's development of Control Period 7 (CP7).

The investigative review was undertaken by Sirius Analysis in two parts:

1. How are costs, including Regional workbank estimates, derived from historic data.
2. How are Regional estimates combined to create the NR plan.

The methodology included data gathering, document reviews, meetings with key stakeholders and a review of data and models.

### Approach

The approach involved extensive review of supporting documents provided by NR, investigative meetings with Planning & Regulation (P&R), Group Finance teams and all regions and functions and collection of budget submission documents, spreadsheets, and models.

The meetings allowed Sirius to establish a process overview for cost estimation and budgeting with any specific business unit variations. Analysis of the spreadsheets and models, including sampled tracing of calculations provided details of the methodology used to combine costs, factors, and uncertainty to generate the output cost distributions.

### Key Findings

The methodology for generating budget forecasts by business units and for combining these into a central risk model has been an evolving process. It is evident that components of the process including underlying tools and models have been enhanced and extended over time resulting in increased complexity for some areas of the supporting spreadsheets. However, it is noted that building a toolset for budgeting for such a large enterprise is not trivial and will always result in a high level of complexity; though the process could be more streamlined and structured, with end-to-end consistency, than many elements are now. In summary the key findings of the review are:

- Baselineing of unit rates as a fundamental component of NR's cost forecasting approach enables a validated methodology for Workbank costs and, as a toolkit for assurance, allows scrutiny of variances when business units take decisions to deviate from these rates. This follows a best practice approach to scrutiny and assurance in this context.
- Deriving unit rates based on historical exit rates may, in some instances, introduce bias depending on the period used for historical data and events that may have skewed those rates at that time. Impacted risks may have also affected the exit rates and these would be subsumed into the historical baseline rates, as explicit risk tracking had not been in place, and this may be driving costs of impacted risks into the budgeting process.
- The maturity of the costing approach varies across the Regions, some having invested time to develop a more detailed costing approach using cost books and detailed bottom-up approaches, and other Regions have utilised commercial planning tools to standardise the cost forecasting approach.
- Costs are aggregated to higher levels of the cost breakdown structure before Monte Carlo modelling. This prevents the identification of cost drivers by not being able to trace correlation of output costs to individual input cost lines.
- Uncertainty estimation is captured for each asset type but is decoupled from the individual workbank cost lines and therefore does not allow specific uncertainty variation to be recorded and modelled at this lower level. Furthermore, the aggregation of uncertainty to higher levels of the cost breakdown structure causes the modelling to generate broader output cost distributions with higher upper percentile values than if uncertainty was modelled at a lower level of granularity.

- Whilst NR has an Enterprise Risk Management (ERM) framework, risk management, as typically defined in government guidance, is not evidenced as part of the budgeting process, within which there is no identification or quantification of risks and their probabilities and impacts. Therefore, risk analysis as part of the cost modelling cannot be undertaken and included in the modelling output. There is also confusion between the terms of risk and uncertainty and the quantification of these, with the current modelling only including uncertainty analysis.
- Uncertainty estimates are captured for each year with a typically diverging annual profile for later years possibly exaggerating the spread of output costs in later years. This effect could potentially be explicitly captured by annual headwinds and efficiencies alone, but also by risks which are not currently captured or modelled.
- Inflation is not handled consistently with separation of applying inflation for conversion to cash prices independent of applying higher inflation offset factors to asset renewal input costs. The uncertainty modelling of inflation is also not consistent in that the main Consumer Prices Index (CPI) cash inflation variance is modelled in the Monte Carlo model, but any additional input inflation offset is a static factor in the input template.
- The Statement of Funds Available (SoFA) which determines the allocated funding to each business unit is a principle driving the budget submission process and in effect makes the budgeting target-based. Efficiency savings were also target-based, driving the budget submission to achieve cost reductions within a particular timeframe. The combination of planning to achieve pre-set budget and efficiency targets can result in deferral of work.
- The regional strategic plans capture overall assumptions of the budget submissions. However, specific documented assumptions for the basis of estimate are not captured or included within the cost submissions, and therefore variation of values for factors such as inflation, headwinds, efficiencies, and uncertainty cannot be scrutinised or validated.
- The model and template do not follow best practice guidelines for spreadsheet models and tools, increasing the risk of input or calculation errors, particularly when making changes or updates. Review and assurance is also more difficult when calculation sequences cannot be easily traced. Data transfer is achieved by a combination of macros and manual copy and paste operations. This risks erroneous data transfer or corruption of data.
- Model documentation and formal verification and validation are not available for the suite of templates, transfer spreadsheet and aggregation model as might be expected according to government quality assurance guidance. The information and development knowledge of the suite of spreadsheets and their use appears to be highly dependent on key resources in NR Group Finance.

## Conclusions

The conclusions established from this investigation include the following:

- That formal risk quantification is not currently included in the budgeting process to establish the effect of risk on output budget distributions and to help inform decisions on risk contingency funds. This also suggests that the impact of risks on historical exit rates is not identified and may result in impacted risks being embedded in baseline unit rates.
- That the modelled effects of input costs and input factors for uncertainty, headwinds, efficiencies, and input inflation cannot be directly related to output variability as they are aggregated to broader category totals before being modelled in the Monte Carlo simulation. This prevents the identification of cost drivers, by not being able to trace correlation of output costs to individual cost inputs.
- That certain modelling approaches are exaggerating the value and spread of output cost distributions. The effect of applying split indexation rates is causing a small compounding effect on the output costs, and the aggregation of input costs and uncertainties before Monte Carlo modelling is increasing the spread of the output distributions and extending the value of confidence levels such as the P80 figure.

- That NR has the opportunity to extend the Renewals Cost Approach Framework as a common estimating and forecasting methodology, by exploiting more mature approaches for development of cost estimates seen in some regions.
- That the model toolset, consisting of business unit templates, aggregation workbook and @Risk Monte Carlo model would require redevelopment to align with best practice guidance on spreadsheet tools and to allow for ongoing maintainability and manageable future enhancements.

## Recommendations

From the observations and findings detailed above, Sirius make the following recommendations:

1. The Unit Rate Framework should include an assessment of risk or economic bias for historical rates where appropriate.
2. The NR ERM framework should be considered as a basis to allow the assessment and management of risks and to allow the capture of quantified risk impacts as part of budget submissions.
3. The Renewals Cost Approach Framework should be expanded as a common estimating and forecasting methodology, including:
  - a. Exploiting more mature approaches seen for some regions such as utilising a detailed cost book approach undertaken by one region, and a wider use of Rail BI, which could be used for scheduling as well.
  - b. Ensuring a consistent approach for including additional work in Workbanks, whether this is by varying unit rates, adjusting volumes or adding specific explicit activities.
  - c. Providing clarity on the expectation for model inputs such as spot, P50 values and P5 and P95 uncertainty ranges.
  - d. Developing a defined framework for the application of uncertainty ranges for cost estimates based on the maturity of the data from which the point estimate is derived. Such a scale would be similar to the Ministry of Defence (MoD) Data Readiness Levels (DRLs) approach. This will also allow for the assessment of confidence in any contractor prices or SME estimates.
4. Redevelopment of the suite of spreadsheets should be considered to:
  - a. Ensure compliance with best practice model development guidelines and assurance e.g. the Government Aqua Book<sup>1</sup>.
  - b. Have documentation and be accessible for formal verification and validation.
  - c. Avoid aggregation of cost and uncertainty before Monte Carlo modelling and include uncertainty estimation and correlation for individual costs, perhaps based on a data maturity related framework.
  - d. Model cost inflation consistently and allow for adjusted profiles as well as baseline CPI indexation. Uncertainty modelling of indexation variations should be applied to all indexes using the same stated approach.
  - e. Include risk capture, quantification and analysis in the modelling and outputs.
  - f. Capture user notes against model inputs, particularly where factors or values have been changed from default or base figures.
5. A Cost Data and Assumptions List (CDAL) template should be established to capture all modelling assumptions on input costs (unit rates and volumes), uncertainty factors, headwinds, efficiencies, and inflation. This could be included as part of a revised submission template.
6. Undertaking an 'Optimism Bias' (OB)<sup>2</sup> assessment would enable NR to understand how their budget spend may turn out or to adjust the estimates to reduce the probability of overspend during the period i.e. make the estimates more realistic.

---

<sup>1</sup> <https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government>

<sup>2</sup> <https://www.gov.uk/government/publications/green-book-supplementary-guidance-optimism-bias>

The study has found evidence that the treatment of embedded risk costs in the development of NR's estimates impacts in 2 distinct aspects of their development:

1. Since it has not been possible to identify the contribution of the costs of the historic risks that have occurred within the assessed data set, it is considered likely that the calculated workbank cost estimates are high, inflating the overall estimates.
2. Conversely, the NR risk management process does not infuse the anticipated cost impact of risks into the overall estimating process, an omission which will underestimate the required funds.

It is not currently possible to quantify the impact of these 2 effects on the present NR estimates and further emphasises the need and benefits of implementing the recommendations within this report.

## CONTENTS

Executive Summary .....	2
CONTENTS .....	6
1. Introduction.....	9
1.1 Overview.....	9
1.2 Project Background .....	9
1.3 Scope of Work .....	9
2 Methodology Overview.....	11
2.1 Introduction.....	11
2.2 Detailed Methodology.....	11
3 Planning & Data Collection.....	12
3.1 Introduction.....	12
3.2 Documentation Review .....	12
3.3 Investigative meetings.....	12
3.4 Investigative Evidence .....	13
3.5 Process Overview .....	13
4 Serial 1 – Workbank and Historical Cost Analysis .....	16
4.1 Introduction.....	16
4.2 Approach .....	16
4.3 Regional Process Overview .....	17
4.4 Unit Rate Framework .....	19
4.5 Regional Workbank Costs.....	20
4.6 Functions and Cross-Charging to Regions.....	23
4.7 Regional Submission Template Input Data and Costs:.....	23
4.8 Budget Targets .....	25
4.9 Submission Template Output.....	25
4.10 Serial 1 Findings.....	26
4.11 Serial 1 –Recommendations.....	27
5 Serial 2 – Analysis of Regional Estimates and their combination into the NR Plan .....	28
5.1 Introduction.....	28
5.2 Approach .....	28
5.3 Central Process Overview.....	28
5.4 NR Budget Submission and Risk Contingency .....	30
5.5 Serial 2 Findings.....	30
5.6 Serial 2 Specific Observations and Recommendations .....	32

---

6	Key Findings, Conclusions and Recommendations .....	33
6.1	Key Findings.....	33
6.2	Conclusions.....	36
6.3	Recommendations .....	36
7	Abbreviations and Acronyms .....	39
7.1	Abbreviations and Acronyms .....	39
8	References.....	40



## LIST OF FIGURES

Figure 1: Analysis Process	9
Figure 2: Process Flow Chart	11
Figure 3: Stages of the Submission Process	14
Figure 4: Serial 1 Scope	17
Figure 5: Overview of Regional (and Functional) Submission Stages	18
Figure 6: Unit Rate Framework – Example Baseline rates and ranges by asset and Region	19
Figure 7: Regional Unit Rate Deviation Assurance and Scrutiny Using the Unit Rate Framework	20
Figure 8: Example 1 of Regional Workbank Cost Estimation Process Overview	21
Figure 9: Example 2 of Regional Workbank Cost Estimation Process Overview	22
Figure 10: Example of Regional Detailed Bottom Cost Build-up	22
Figure 11: Functional Service Cross-Charging	23
Figure 12: Contingent Activity Funding Basis and Example of Contingent Activity Costs Proportion	24
Figure 13: SoFA Driving Budget Targets	25
Figure 14: Submission Template Cost Transfer to Risk Model	29
Figure 15: Modelling Outputs Comparing Modelling of Uncertainty on Individual Cost Lines and an Aggregated Approach (Example for Regional Renewal Costs and Uncertainties)	31
Figure 16: Effect of Uncertainty Aggregation on Output Distributions	32
Figure 17: Overview of Budgeting Process and Key Findings Related to Each of the Stages	35

## LIST OF TABLES

Table 1: Risk Modelling Output Cost and Income Breakdown Structure Categories.....	29
--	----

## 1. Introduction

### 1.1 Overview

1.1.1 This final report forms Deliverable 5 of the investigation for the Office of Rail and Road (ORR) into Network Rail’s (NR’s) risk modelling, embedded risk and uncertainty on Periodic Review 23 (PR23). The final report presents findings and recommendations gathered as a result of the evidence-based review of the methodology of Round 6 data sets for NR’s development of Control Period 7 (CP7) and an assessment of how NR’s processes conducted to date align with recognised best practice.

### 1.2 Project Background

1.2.1 The ORR is undertaking its PR23 of NR covering the five year period from April 2024 to March 2029, referred to as CP7. A central element of every periodic review is a cost assessment whereby ORR determines the appropriate level of expenditure required to deliver the outputs set by funders.

1.2.2 The System Cost & Efficiency team is part of the Capital Investment, Enhancements, Engineering and Asset Management team in ORR and is focussed on achieving a robust cost assessment as part of the PR23 process.

1.2.3 NR delivered Round 4.5 of its plan to ORR in March 22, this was the final top-down plan. NR then progressed to Round 5, the first stage of bottom-up planning. NR has now moved to Round 6. ORR will receive this plan but wishes to gain confidence that risk and uncertainty is adequately considered as part of NR plans and therefore commissioned a study into the methodology used within NR to develop its budget submission.

1.2.4 The ORR is looking for a review of the methodology and not the data set or a validation of any specific data. The expected output is a clear set of statements as to how NR aligns with best practice and an associated set of clear recommendations of where improvements could be made.

### 1.3 Scope of Work

1.3.1 An analysis and review of two Serials to be undertaken, namely:

1. How costs, including Regional workbank estimates, are derived from historic data.
2. How Regional estimates are combined to create the NR plan.

1.3.2 Figure 1 represents the analysis process that has been followed for this task.

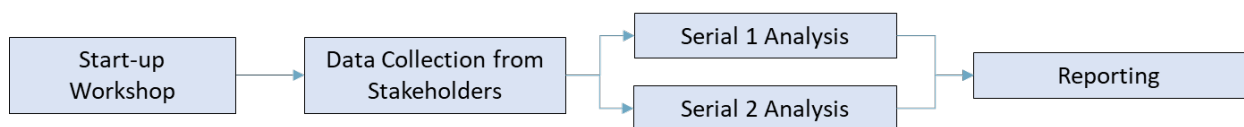


Figure 1: Analysis Process

1.3.3 For Serial 1, the requirement was to:

- Gain an understating of how costs, including Regional workbank estimates, are derived from historic data.
- Develop a clear understanding of what, if any, models are used by NR to develop costs entered into the submission template, particularly any confidence intervals such as the P50 or P80<sup>3</sup> points.

<sup>3</sup> P50 and P80 refer, respectively, to the 50th and 80th confidence levels representing the probability of the cost not being exceeded. Hence, the P80 is the cost that will not, statistically, be exceeded 80% of the time.

- Review how the inputs are checked for currency and applicability.
- Review how they are normalised and combined with any discrete risks to develop confidence intervals.
- Assess NR's methodology against recognised best practice and whether their approach to calculating a P50 is consistent with best practice.

1.3.4 For Serial 2, the requirement was to:

- Gain an understanding of the method used for statistical combination of business unit plans.
- Determine the level of risk within the Regional plans.
- Establish the level of confidence that risk provision is commensurate with risk exposure at a business unit and national level.
- Carry out an assessment of NR's methodology against recognised best practice.
- Establish a clear view of the implications where NR differ from best practice.

## 2 Methodology Overview

### 2.1 Introduction

2.1.1 The methodology has set out to provide an understanding of what NR models have been used to develop their P50 and P80 outputs, how the inputs are checked for currency and applicability, how they are normalised and combined with any specific and discrete risks to develop confidence intervals.

### 2.2 Detailed Methodology

2.2.1 Figure 2 below, builds on Figure 1 and shows a more detailed summary of the analysis process, which is described in more detail in the following sections of this report. Grey areas represent sections of the analysis that required input from the ORR and NR Teams in the form of data delivery, workshops, and meetings, whilst blue areas represent Sirius specific activities.

2.2.2 Further detail is added throughout the report on the methodology used at each stage, included data gathering, cost model development and inputs from ORR, NR and Subject Matter Experts (SMEs).

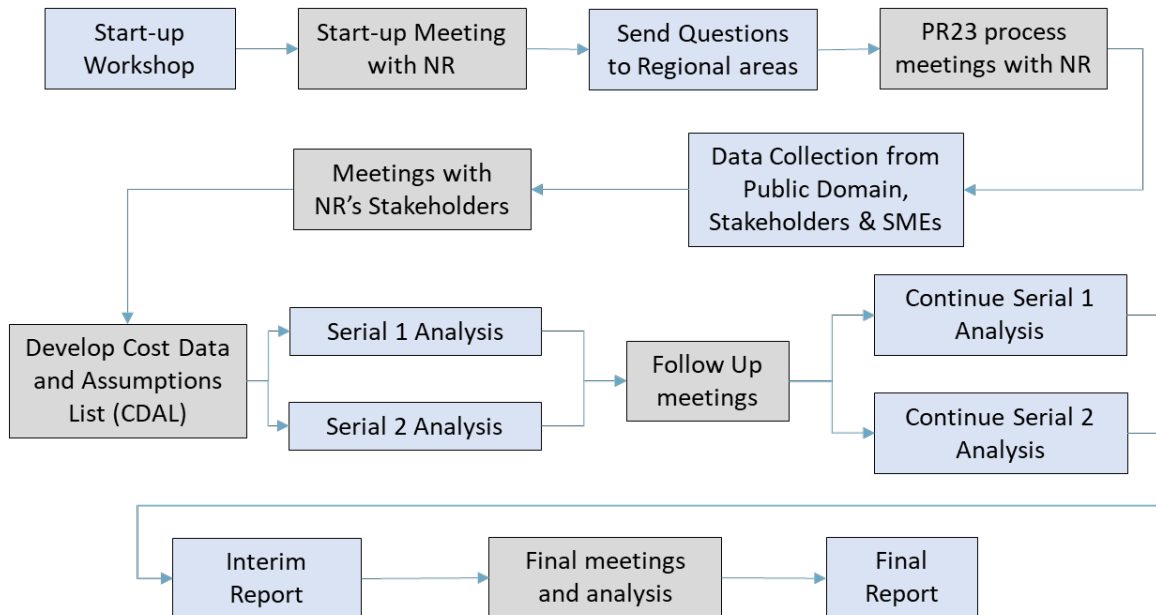


Figure 2: Process Flow Chart

## 3 Planning & Data Collection

### 3.1 Introduction

3.1.1 Planning and data collection was undertaken by reviewing documentation available in the public domain alongside that provided by the NR team. Following this, various meetings with stakeholders were set up and further data and documents were provided as a result of discussions at the stakeholder meetings.

### 3.2 Documentation Review

3.2.1 The initial activity was to understand the planning process and key aspects of guidance and previous review studies.

3.2.2 A number of documents that covered the planning process, framework and assurance were received and reviewed and these included:

- Round 6 CP7 Planning Guidance
- NR Cost Approach Framework
- CP7 Assurance Paper

3.2.3 A key document that was provided and reviewed was the AMCL<sup>4</sup> Report “A Review of NR Regions' Approach to Cost Planning and Unit Rate Development”<sup>5</sup>. This provided a detailed insight into the cost planning activities, unit rate establishment and general maturity of the process across the Regions. Key observations regarding this document were that:

- The AMCL report provided a comprehensive view of the Cost Planning processes including Unit Rate Development and Regional process variations.
- The AMCL report did not cover cost uncertainty or risk in any depth.
- The AMCL report did not cover any of the Network Functions.

### 3.3 Investigative meetings

3.3.1 Investigative meetings were arranged with the majority of stakeholders, covering:

- Meetings with the Planning & Regulation (P&R) and Group Finance teams covering an overview of the submission process, submission template and central model overview.
- A Joint Regional meeting with the majority of the Regions present (all except Northwest & Central (NW&C)).
- Individual Regional meetings, covering:
  - Wales & Western (W&W)
  - Eastern
  - NW&C
  - Southern
  - Scotland

---

<sup>4</sup> Asset Management Consulting Limited (a Turner & Townsend company)

<sup>5</sup> Office Of Rail and Road #29098 CP6 to CP7 Transition - A Review of NR Regions' Approach to Cost Planning and Unit Rate Development, Version: 1.1 Final, Date: 14th November 2022

- Joint Network Function Meeting

3.3.2 These meetings were followed up with further meetings regarding specific areas:

- Regional process detail with W&W on their use of Rail BI<sup>6</sup> as a workbank building tool for signalling work.
- More detail of the cost estimation process with Scotland following the issuing of their Regional Statement of Funds Available (SoFA), which was released later than other Regions.
- Route Services National Function meeting on cost estimation process and also the recharge process to Regions.
- Eastern Region for further insight into the submission template, specially looking at committed and contingent costs, uncertainty, headwind and efficiency inputs.

### 3.4 Investigative Evidence

3.4.1 Sirius obtained key documents following the investigative meetings including:

- Examples of the financial template populated by Regions.
- A macro driven aggregation workbook which is used to extract the costs and uncertainties from the financial template and summarise these in a format for transfer to the Risk Model.
- The CP7 Risk Model which utilizes @Risk<sup>7</sup> to perform Monte Carlo analysis.
- Regional and Functional local process overviews.
- Sample data extracts and local models.

### 3.5 Process Overview

3.5.1 The meetings and subsequent process information and documentation allowed Sirius to construct an outline flow diagram of the stages of the submission process conducted by Regions and Functions to build the submissions required before central modelling is undertaken by NR, as shown in Figure 3.

---

<sup>6</sup> Rail BI™ is an unregistered trademark of Insight Software Edinburgh Ltd. BI nominally stands for Business intelligence however the tool is referred to as "Rail BI"

<sup>7</sup> @RISK® is a Palisade add-in for Microsoft Excel that enables Monte Carlo simulations to be performed within Excel.

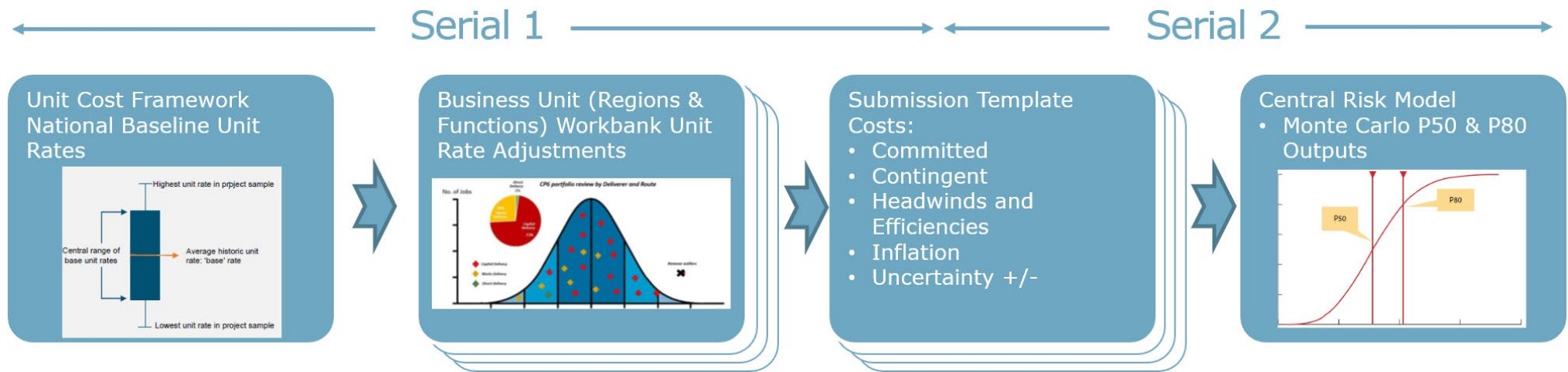


Figure 3: Stages of the Submission Process<sup>89</sup>

<sup>8</sup> P50 and P80 are shown as proposed outputs but the P80 level may be adjusted following SoFA confirmation and final submission decisions.

<sup>9</sup> See Paragraph 4.7.5

- 3.5.2 In the first stage of the process the Renewals Cost Planning Framework provides baseline reference rates based on regional historic data. This is undertaken centrally and for CP7 these were taken as the CP6 exit rates.
- 3.5.3 As seen in Figure 3 above, stage 2 is undertaken by the Regions and Functions to obtain the costs and volumes of their renewals portfolio using the best information available to them, factoring in maturity of the Workbank, recent delivery experience, asset knowledge and policy. The basis of Workbank estimates is defined, at its simplest, by the unit cost rates applied to the volumes of work, but in many cases project costs are developed bottom up.
- 3.5.4 The forecast is provided as Key cost lines (KCL) and Key Volume Lines (KVL) with the baseline unit rates used to assure that project estimates are reasonable.
- 3.5.5 The cost (and volume) of the work is entered into a common submission template, which includes estimates for headwinds, efficiencies and uncertainty.
- 3.5.6 The final stage is undertaken centrally to aggregate all the submitted templates into the central risk model which allows Monte Carlo analysis of the cost variation to produce output costs with corresponding confidence levels.
- 3.5.7 This staged approach to the process is covered here as an introduction and high-level overview and forms the basis of more detailed assessment in the subsequent sections of this report covering each serial in turn.



## 4 Serial 1 – Workbank and Historical Cost Analysis

### 4.1 Introduction

4.1.1 Serial 1 is an investigation into how business unit (Regions and Functions) workbank costs are established, including unit rates, work volume and workbank estimates. This included an overview of historical rate analysis and any risk and uncertainty estimation processes.

### 4.2 Approach

4.2.1 The approach centred on initial documentation research, group and Regional meetings and detailed follow-up meetings to cover specific details or processes.

4.2.2 A typical set of questions used as a prompt for Regional and Functional meetings is shown below:

- What is the process for developing your Regional/Functional estimates?
- How are workbank estimates derived?
- How are unit rates maintained and updated?
- Are composite rates used and how are they derived?
- If historic data is used, how is it validated and normalised?
- How is uncertainty defined and accounted for?
- How is inflation accounted for?
- How is risk accounted for, and how are risks captured and assessed?
- How are Regional or geographic variations derived and captured?
- How are any Regional cost models used to derive the P50 (Most Likely (ML)), Low (Minimum) and High (Maximum) figures?
- How are Functional recharges captured and is there any variation applied to these?
- Does Regional estimating overlap with Functional Area submissions?
- Do Functional Areas require inputs from the Regions?

4.2.3 The scope of the work for Serial 1 covered all the Regions and Functions and meetings with all stakeholders were held either individually with Regions and Functions or in joint meetings. Figure 4 below, shows the scope covered for the Serial 1 investigative work. Scotland is highlighted as the approach for this Region differs from the Regions in England and Wales (E&W) in terms of funding allocation and access to risk or contingency funds.

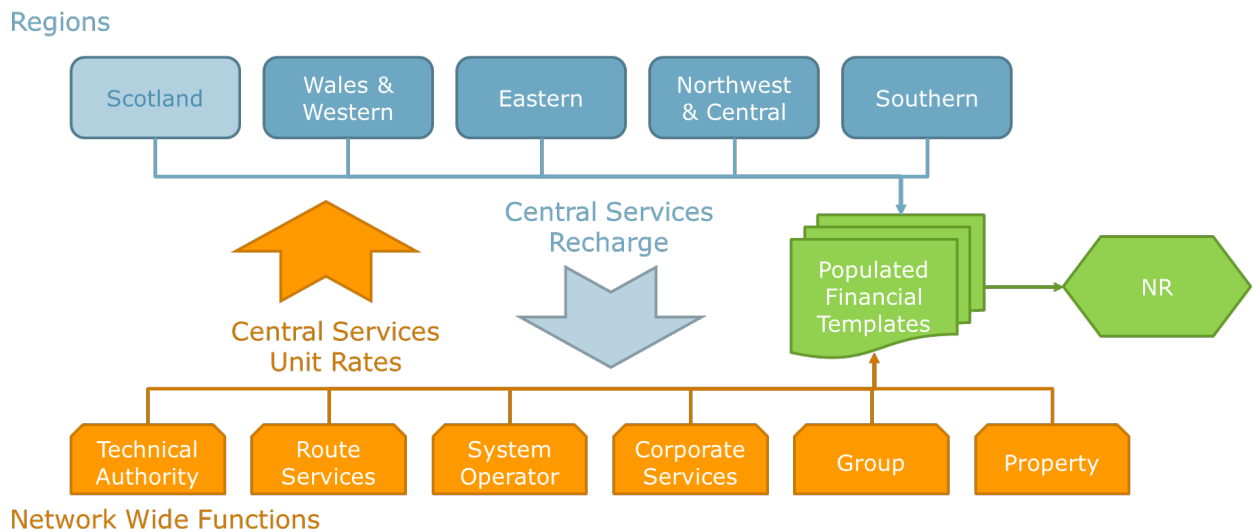


Figure 4: Serial 1 Scope

4.2.4 The figure highlights that the Regional and Functional submissions are collated using common submission templates and that there is recharging of Functional services from the Regions, which require central service costs to be established.

4.2.5 The following meetings were held as listed in the Cost Data and Assumptions List (CDAL):

- Joint Regional meeting
- W&W
- Eastern
- Southern
- Scotland
- NW&C
- Rail BI Tool with W&W
- Scotland follow-up, post SoFA issue
- Joint Functions meeting
- Route Services follow-up
- Eastern follow-up on submission template contingency, headwinds and efficiencies and uncertainty variation estimates.

### 4.3 Regional Process Overview

4.3.1 The stages of the Regional process are a subset of the of the overall process introduced in Section 3, and the stages relevant to Serial 1 Regional investigations is shown in Figure 5 below.

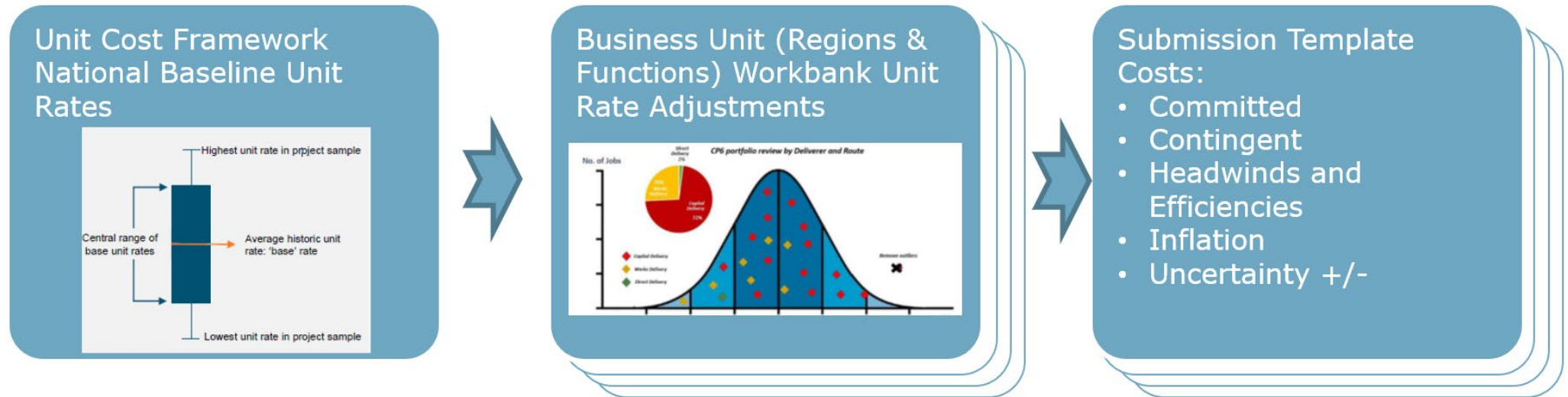


Figure 5: Overview of Regional (and Functional) Submission Stages

4.3.2 Each of these stages will be reviewed in further detail below.

#### 4.4 Unit Rate Framework

4.4.1 The Unit Rate Framework provides the national baseline unit rates for all Regions. The rates are compiled centrally using historical analysis of CP6 exit rates, using Deloitte's methodology as referenced in the AMCL report. The baseline unit rates are Region specific and derived by asset type, with an example shown in Figure 6 below.



Figure 6: Unit Rate Framework – Example Baseline rates and ranges by asset and Region

4.4.2 The unit rates are provided as baseline reference rates to all Regions as a most likely value and ranges covering the 10<sup>th</sup> to the 90<sup>th</sup> percentile. The Regions would justify using a specific value in the range based on geographical or complexity factors. The Unit Rate Framework therefore provides a basis of assurance by allowing scrutiny of regional rate variations and enabling dialogue on significant deviations, high or low, from the average rate band. This process can be seen in Figure 7 below.

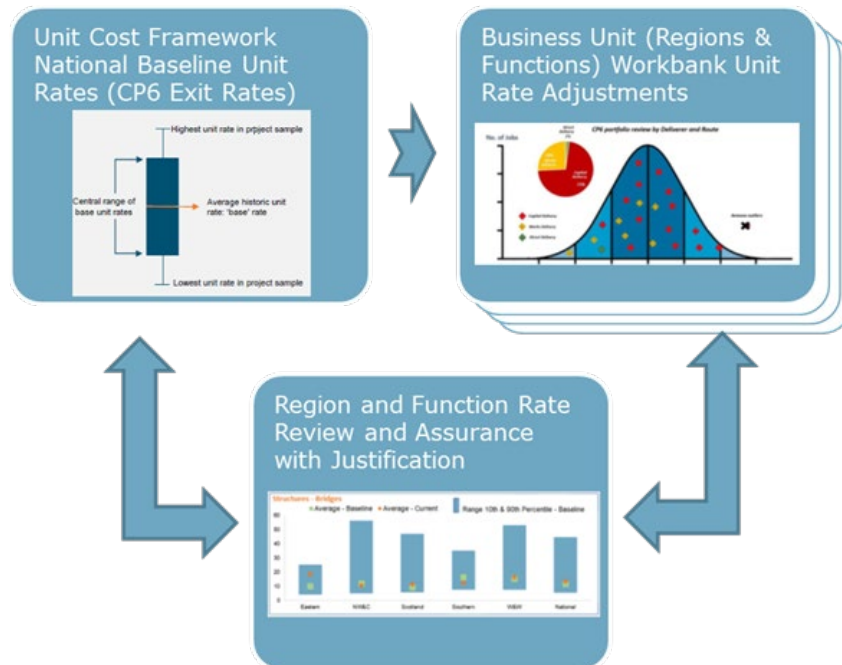


Figure 7: Regional Unit Rate Deviation Assurance and Scrutiny Using the Unit Rate Framework

## 4.5 Regional Workbank Costs

- 4.5.1 Regions have flexibility to use the most appropriate approaches to costing and estimating, embedding local factors such as job, asset, volume and location complexities, in their devolved plans. They may establish specific unit rates based on regional or route specific factors or conduct further historical analysis of local rates and derive costs using the straightforward approach of multiplying work volume, KVL's, by the appropriate unit rate or by more comprehensive bottom up estimation. Irrespective of the approach used the costs and volume of work are used to check the unit rate against the baseline range, where any deviation from to baseline reference rates is explained as part of the submission and assurance process.
- 4.5.2 Figure 8 and Figure 9 shown below, show examples of similar approaches from two different Regions.
- 4.5.3 In some cases the workbank costs may be adjusted by adding additional, explicit activities as 'addons'. Contractor rates or SME estimates may also be used for novel or unique asset technology.
- 4.5.4 Some Regions have a more detailed approach producing a low level 'cost book' and undertake a detailed bottom-up costing approach. An example of this is shown in Figure 10.

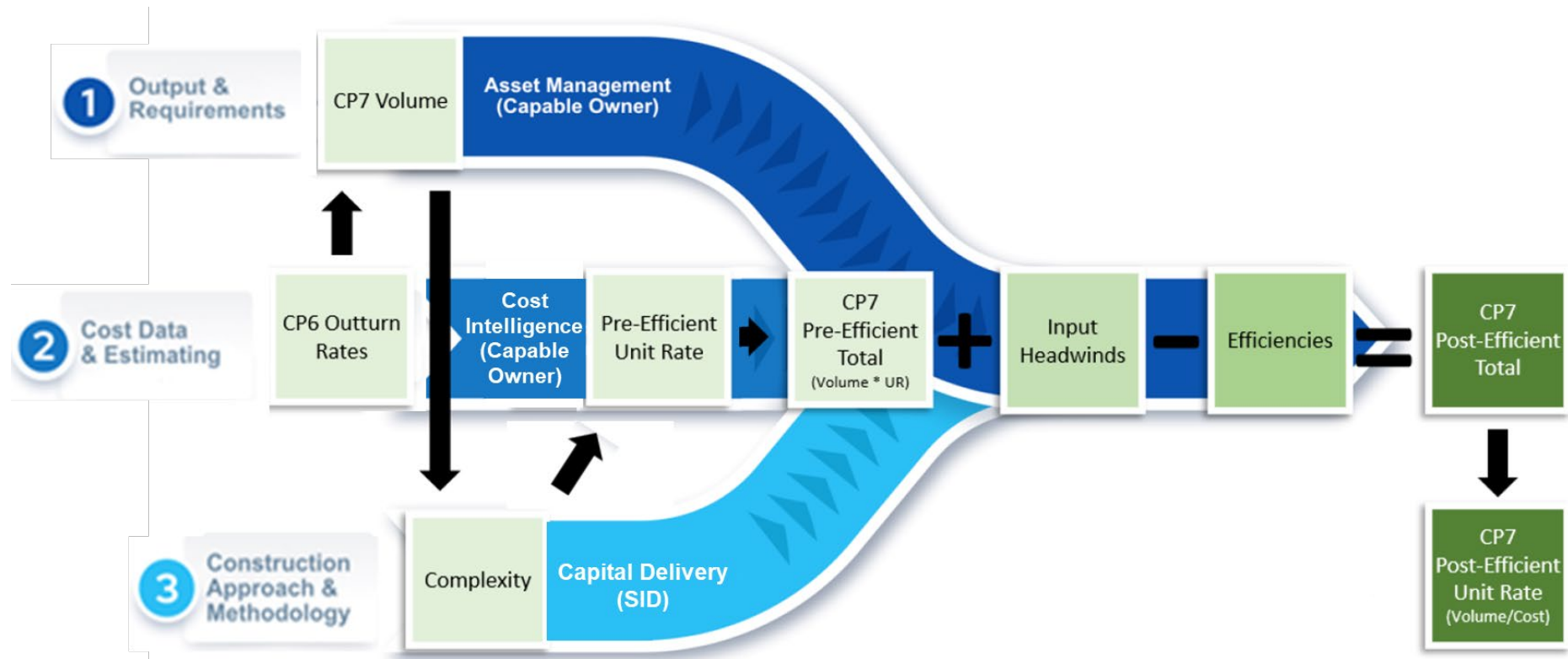


Figure 8: Example 1 of Regional Workbank Cost Estimation Process Overview

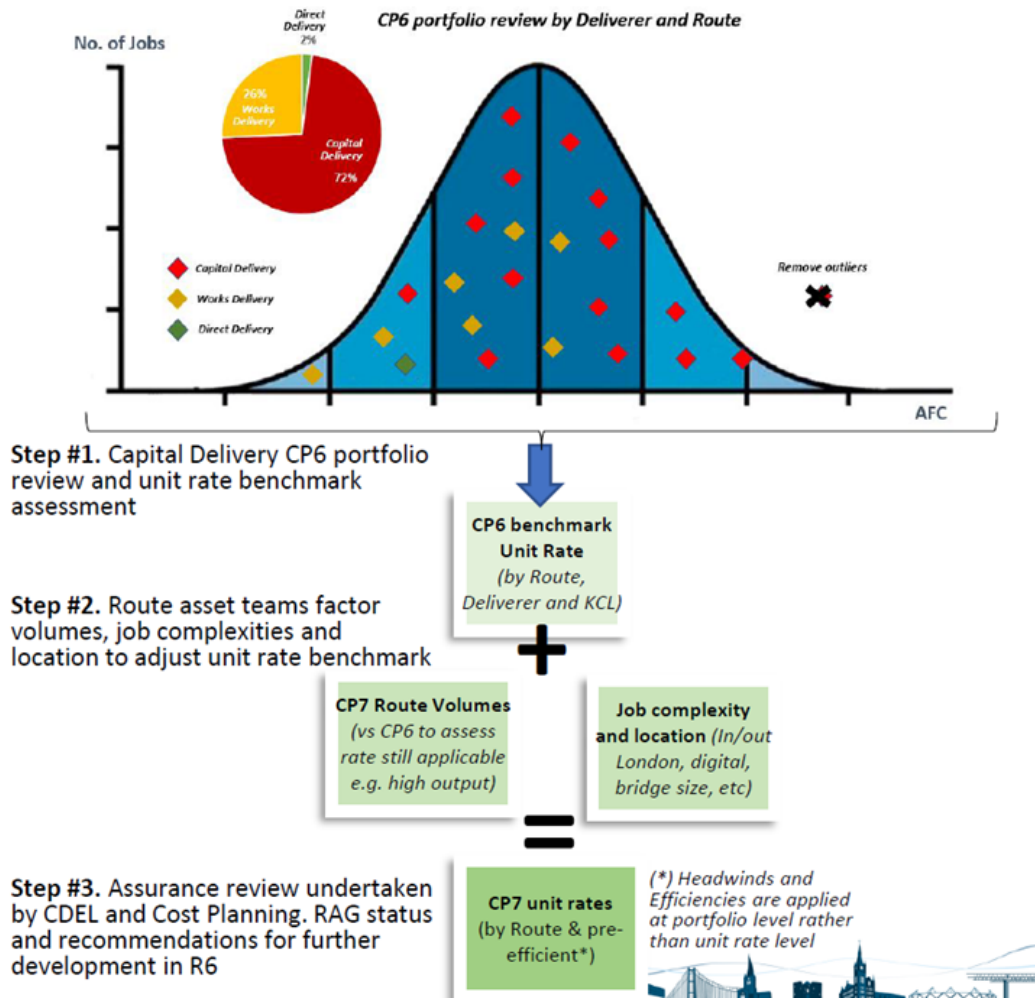


Figure 9: Example 2 of Regional Workbank Cost Estimation Process Overview

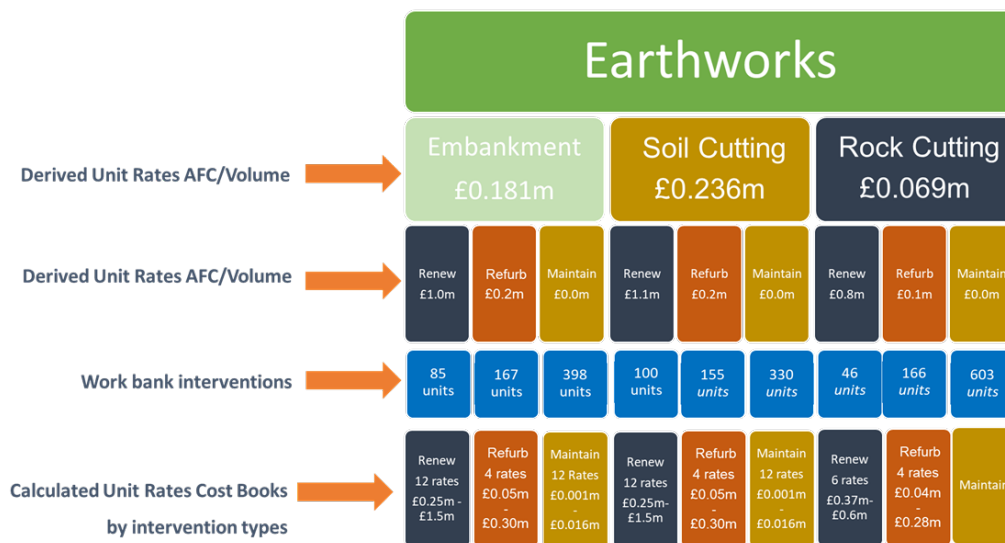


Figure 10: Example of Regional Detailed Bottom Cost Build-up

#### 4.6 Functions and Cross-Charging to Regions

- 4.6.1 Functions tend to rely more on contractor prices and SME input for cost estimation and submissions and may not use the unit cost and volume approach at all. Where they do provide central services that are used by the Regions, they do have historical unit rates available to them.
- 4.6.2 The process undertaken for establishing the unit rate for services provided to the Regions is to firstly request volumes of work for these services from the Regions. The Functions will then establish contractor rates through service agreements based on the volumes and then fix the rate for a period and issue these back to the Regions to use in budgeting. The service costs are then cross charged directly from the Region to the Function<sup>10</sup>. This is shown in Figure 11 below.

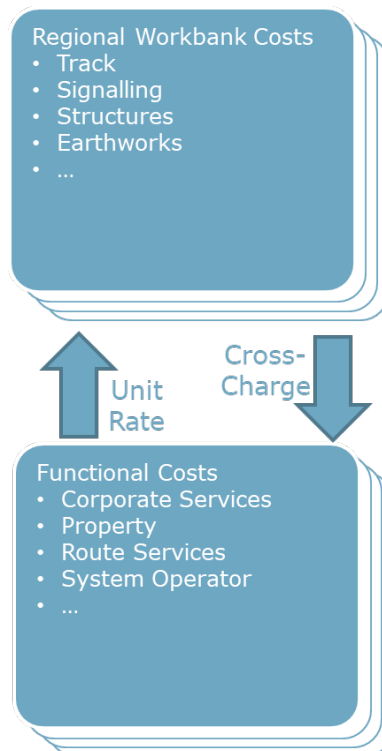


Figure 11: Functional Service Cross-Charging

- 4.6.3 The charges for services provided by the central functions will only appear in the Regional submissions, whereas the cross-charge between the Region and Functions, and the charge paid to the contractor service provider by the function will not be included in the budgeting submission as an “in and out” cost.

#### 4.7 Regional Submission Template Input Data and Costs:

- 4.7.1 Committed Costs: The committed costs form the core essential work forecast by the Regions, covering renewals, maintenance, Operational Expenditure (OPEX), etc. The costs are entered as profiled cost lines and are based on ‘spot’ rates defined as the baseline, most likely value. The submission template labels these costs as P50 (cumulative probability distribution 50% value) but these have not been stochastically modelled by the Regions to provide an exact percentile value. The costs are also pre-efficient, so prior to any headwind or efficiency adjustments.

<sup>10</sup> Confirmed approach with Route Services



- 4.7.2 **Contingent Costs:** These costs are for contingent activities that would be undertaken if above-average levels of financial risk do not materialise. The central modelling process defines an overall spot estimate budget and also a level to allow a tolerance for uncertainty, an upper estimate, which has nominally been discussed as the P80 output distribution level. The contingent activities are set to be achievable within the uncertainty tolerance.
- 4.7.3 Figure 12 below shows the budgeting process whereby a risk contingency is established from Monte Carlo modelling outputs and considered against the available funding. If this risk contingency is not used due to above average levels of risks not materializing, then it could be available for pre-planned contingent activities. At the input budgeting stage, the contingent activities for CP7 are set by P&R at a budget percentage of 5% of the input spot estimates (the Figure below shows this as an example set at 10% contingent funding).

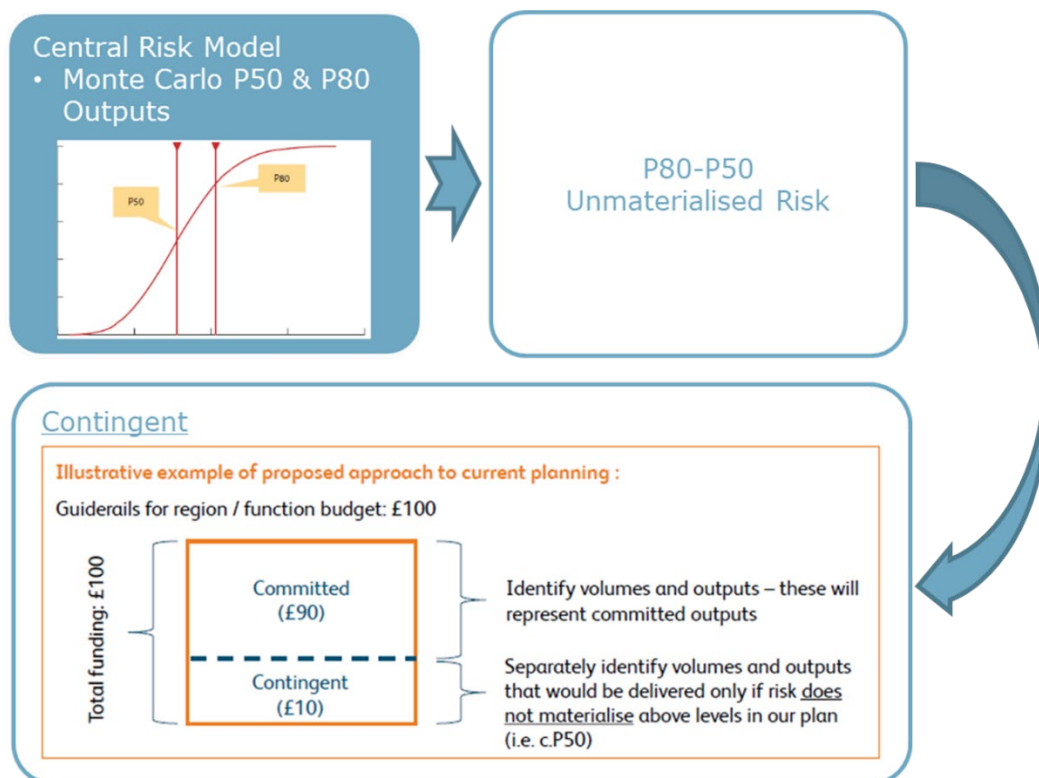


Figure 12: Contingent Activity Funding Basis and Example of Contingent Activity Costs Proportion

- 4.7.4 **Input Price Inflation:** For some asset types and work types a factor (from a pre-modelled selection list) can be applied to account for forecast increases in costs over and above Consumer Prices Index (CPI) inflation. These input price inflation factors are provided as part of the submission template having been derived by the Finance Group from historical costs. Unless justified the Input Price factor is set to ZERO (above CPI).
- 4.7.5 **Headwinds and Efficiencies:** Are defined for both committed and contingent costs and defined by activity. Headwinds, or known issues, are nominally set at 2.0% of asset costs for Financial Year 2029 (FY29) in the template but can be adjusted by the Region. The efficiencies are target-based with 15% of asset renewal cost efficiency savings and 10% of OPEX efficiency savings specified by FY29.
- 4.7.6 **Inflation:** This factor is used to convert the input costs (at current economic conditions) to cash prices and is set by default to CPI.

4.7.7 **Uncertainty Range:** Uncertainty ranges are set in the template as a Low (P5) percentage estimate and for a High (P95) percentage estimate. The uncertainty can be defined by the Regions with more granularity, by asset type, but it is independent of the individual cost lines. The labelling of the Low and High estimates as P5 and P95 implies pre-processing modelling to establish these confidence levels in the inputs, but this may not be the case for these regional inputs, with Regions entering estimated rather than modelled figures. The uncertainty can also be entered as an annual profile varying for each year.

## 4.8 Budget Targets

4.8.1 The funding allocation, based on the SoFA, provided to each Region is a principle driving the budget submission process, as shown in Figure 13 below, and in effect makes the budgeting target-based i.e. imposes an artificial cap, rather than as a reflection of core work that has to be undertaken by a Region during the budgeting period. It should be noted that NR had provided a steady state submission, independent of budget caps, that was reviewed by ORR and Department for Transport, and that the SoFA is not determined by NR.

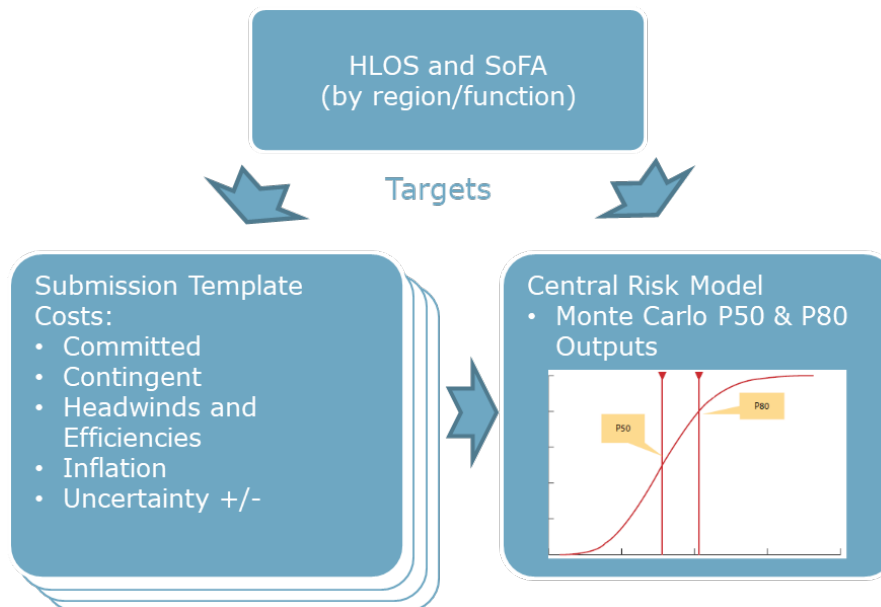


Figure 13: SoFA Driving Budget Targets

4.8.2 Furthermore, the efficiency savings were also target-based, driving the budget submission to achieve cost reductions within a particular timeframe.

4.8.3 The approach of planning to achieve pre-set budget and efficiency targets can result in deferral of work, this potential issue was identified in the AMCL report observations.

## 4.9 Submission Template Output

4.9.1 The output from the submission template consists of costs and uncertainties summarised by the follow categories:

- OPEX (Controllable and Non-Controllable)
- Income
- Renewals:
  - Track
  - Off Track
  - Signalling

- Level Crossings
- Structures
- Earthworks
- Drainage
- Buildings
- Electrification & Fixed Plant
- Telecoms
- Other Renewals

4.9.2 The output costs have had Input Price inflation applied, been adjusted for headwinds and efficiencies, and include CPI inflation to result in cash prices.

4.9.3 The output uncertainties have been combined to provide low and high delta (difference) figures for the aggregated category costs. The implications of aggregating uncertainties in this way is discussed later in 5.5.6 and 5.5.7.

#### 4.10 Serial 1 Findings

4.10.1 The following are key findings identified as part of the Serial 1 examination of the budgeting process and cost estimation undertaken by Regions and Functions:

1. The processes and framework detailed in the AMCL report was evident from our investigative meetings.
2. The Unit Rate Framework, where rates are baselined and any regional deviations are reviewed and scrutinised against the national ranges, conforms with best practice.
3. Some Regions have a more mature approach, such as Southern which has a comprehensive detailed bottom-up approach using low level cost book or W&W that uses the Rail BI system as a workbank building tool for signalling work.
4. Using historical CP6 exit costs for unit rates could be introducing inherent risk (where they impacted CP6 expenditure) into the basis for CP7.
5. Uncertainty estimation input into the submission template (i.e., the Low and High range) is not directly related to specific KCLs, KVLs or unit rates and appears as a separate section to populate in the template.
6. Uncertainty estimates are captured for each year with a typically diverging range of uncertainty for later years. This is not a common approach, and each cost input would be expected to have just one uncertainty range, with any additional annual variation related to risk, inflation or known issues (headwinds and efficiencies). As it stands the template applies widening uncertainty as well as annual headwind and efficiency effects, potentially exaggerating the spread of output costs in later years.
7. The basis for input unit rates as spot estimates for the P50 is not consistent. These could use a number of approaches across Regions/Functions:
  - National baseline unit rate.
  - Adjusted unit rates for local historical or geographical impacts.
  - Bottom-up costing.
  - Contractor quoted rates (for new, unique or novel work).
  - Pre-processing risk modelling to derive the P50 input cost value.

8. Where Regions have modelled P50 input costs (i.e. spot rates not estimated by other means), the variance (low/high uncertainty range) around the P50 input value cannot be associated with the input line in the submission template.
9. Risks are not explicitly recorded or quantified in the budget submissions. While there is an NR ERM framework, it does not appear to have been used to explicitly to assess and quantify risks for inclusion in the financial modelling and output budget distributions.
10. Scotland build a separate risk fund into their budget as the Region would not have access to any 'contingency' funds (over the P50 output cost) assigned to E&W.
11. Functions submit templates but don't have repeatable workbank (data) so generally use Contractor or SME estimates to develop a plan of work and estimate the cost.

#### 4.11 Serial 1 –Recommendations

4.11.1 The following summarises areas where improvements could be made to the process:

1. There is an opportunity to exploit good practice, such as utilising the detailed cost book approach undertaken by one Region, and a wider use of Rail BI, which could be used for scheduling as well.
2. A more consistent approach for including additional work in workbanks could be adopted. In some instances unit rates or volumes are adjusted; in some cases additional, explicit activities are included.
3. Documentation could be made available to provide clarity for the P5 and P95, low and high, input uncertainty range assumptions.
4. A common risk assessment and quantification framework should be adopted to capture key risks and include the associated costs in budget submissions for modelling.
5. A record of key assumptions made by the Regions in deriving estimates should be recorded in the submission templates, particularly for uncertainty ranges. A CDAL is a standard requirement for cost estimating.

## 5 Serial 2 – Analysis of Regional Estimates and their combination into the NR Plan

### 5.1 Introduction

5.1.1 Serial 2 is an investigation into how business unit submissions are combined to create the NR Plan. The work covered reviewing and gaining insight into the following:

- The method used for statistical combination of business unit plans.
- How risk and uncertainty are captured in the business unit plans and modelled in the combined NR plan.
- That risk provision is commensurate with risk exposure at a business unit and national level.
- An assessment of NR's methodology against recognised best practice.
- A clear view of the implications where NR differ from best practice.

### 5.2 Approach

5.2.1 A number of meetings were held with the P&R and Group Finance teams to review the processes and gain an overview of the submission template and risk model. Sample populated submission templates were obtained as well as a version of the central aggregation risk model.

### 5.3 Central Process Overview

5.3.1 The business unit submission templates are collated, and the output costs and data are transferred to the central risk model. The output costs, transferred from the regional templates, consist of committed and contingent costs and have Input Price inflation applied (over CPI, if any). The costs are also adjusted for headwinds and efficiencies, referred to at this stage as Post Efficient Costs. The costs are converted to Cash Prices using CPI indexation to result in the output costs for transfer to the risk model.

5.3.2 This transfer is achieved through a bridging spreadsheet with an automated macro to transfer the cost data from each business unit submission template into an aggregation worksheet. The costs and uncertainty ranges are summarised by key elements shown below in Table 1 for each business unit (Region or Function), and then copied into a 'landing' worksheet in the risk model.

Table 1: Risk Modelling Output Cost and Income Breakdown Structure Categories

Controllable OPEX
Non-controllable OPEX
Maintenance
Schedule 4 costs <sup>11</sup>
Schedule 8 costs <sup>11</sup>
Renewals
Other single till income incl. property sales
Access charges (inc. Stations and Sch. 4 ACS) <sup>12</sup>
FTAC <sup>13</sup>
Network Grant

5.3.3 Uncertainty ranges are also aggregated as a low and high delta from the aggregated category costs and then converted back to low and high percentage offsets by dividing by the total category cost as part of the risk model inputs. Figure 14 below shows how the submission template costs transfer to the risk model.



Figure 14: Submission Template Cost Transfer to Risk Model

5.3.4 The risk model uses the Post Efficient cash prices and uncertainty ranges to generate 3-Point Estimates for Monte Carlo modelling<sup>14</sup> as:

- Uncertainty Low – 5% estimate (input)
- P50 (Most Likely)
- Uncertainty High - 95% estimate (input)

5.3.5 The Monte Carlo modelling provides output costs with confidence levels by the cost breakdown categories shown in Table 1 and can be run using just the Committed input costs or the Committed and Contingent input costs.

5.3.6 Costs are also aggregated to the national level for E&W and separately for Scotland due to the budget and risk provision determined through a devolved process for Scotland.

5.3.7 Additional outputs are also produced for each of the Regions, Functions and at a national level providing output costs with CPI variation included to allow CPI risk effects to be analysed.

<sup>11</sup> Schedule 4 and Schedule 8 cost regimes are mechanisms within track access contracts between Network Rail and train operators which are designed to compensate train operators for the financial effects which occur when the level of disruptive possessions and performance respectively deviates from predetermined benchmark levels. Schedule 4 compensates train operators for the impact of planned service disruption, and Schedule 8 compensates train operators for the impact of unplanned service disruption.

<sup>12</sup> ACS – Access Charge Supplement

<sup>13</sup> FTAC – Fixed Track Access

<sup>14</sup> The modelling uses the @Risk Trigen distribution with 5% and 95% tails.

## 5.4 NR Budget Submission and Risk Contingency

- 5.4.1 The risk model is run to produce total output cost distributions for E&W and separately for Scotland. Separate runs are used to produce figures with committed costs and, separately, the combined committed and contingent costs, as well as variations excluding and including indexation uncertainty.
- 5.4.2 P&R with the Finance Group will then use a subjective approach to look at the variation between static spot total costs and the P80 value of the modelled output distributions (other output distribution percentiles may also be considered) and compare this with SoFA and with contingent total costs.
- 5.4.3 A risk contingency figure is then set for E&W and allocated to the regions according to the total costs of contingent activities, with the remainder retained centrally, to establish the risk adjusted plan. If any risks occur the impact will be covered by the risk contingency budget and at a regional level contingent activities may need to be re-planned and adjusted to allow for the resulting reduced contingency budget.
- 5.4.4 Scotland does not have access to E&W funding, with Scotland’s Railway (SR) having a ring-fenced funding envelope and receives funding from the common budgeting process through Transport Scotland. SR therefore manages a risk contingency budget directly and without allocating this fund to contingent activities. This is achieved through entirely planning all activities to establish the committed budget only, and with limited uncertainty variation, where this is zero for any renewals and only OPEX has ±10% uncertainty variation.

## 5.5 Serial 2 Findings

- 5.5.1 The application of inflation as a two-stage process may be marginally exaggerating the inflation effects (over and above CPI) where the inflated input prices are then further indexed by CPI after headwinds and efficiencies are applied.

The application of CPI is calculated as (excluding the addition of headwinds and efficiencies for simplicity in the formula):

$$\text{COST} \times [1 + \text{CPI}_{\text{INPUT}}] \times [1 + \text{CPI}_{\text{MAIN}}] = \text{COST} + \text{COST} \times \text{CPI}_{\text{INPUT}} + \text{COST} \times \text{CPI}_{\text{MAIN}} + \text{COST} \times \text{CPI}_{\text{INPUT}} \times \text{CPI}_{\text{MAIN}}$$

But this should be calculated as:

$$\text{COST} \times [1 + \text{CPI}_{\text{INPUT}} + \text{CPI}_{\text{MAIN}}] = \text{COST} + \text{COST} \times \text{CPI}_{\text{INPUT}} + \text{COST} \times \text{CPI}_{\text{MAIN}}$$

The red text shows the extra term included if using the existing approach in the submission template.

- 5.5.2 The application of headwinds and efficiencies is by percentage factors, and these are applied to spot costs after input inflation has been applied (“input price effect”).
- 5.5.3 There needs to be clarity on whether the headwinds and efficiencies should be scaled by input inflation or whether they should be used to calculate costs on the spot values prior to application of input inflation.
- 5.5.4 The modelling of CPI variation does not take into account the input inflation factors over and above CPI which are not modelled with any specific CPI uncertainty variation.

- 5.5.5 The risk model calculates the Min, ML and Max numbers by aggregating the Min, ML and Max for all categories and does not model the uncertainty of the individual cost lines. This results in the risk range being exaggerated (overestimated for high confidence and underestimated at lower confidence). Analysis of this is shown in the 2 charts below as Figure 15 and Figure 16. Figure 15 shows how a particular percentile (80%) for an output cost will be higher due to aggregating the uncertainty before modelling, while Figure 16 shows how the spread of the whole output distribution is affected and is wider where the uncertainty was aggregated first.
- 5.5.6 Within the scope of the modelling undertaken by NR and the Regions, there are many costs which are expected to vary, collectively, in similar ways over time. For example, raw material costs or manpower costs will increase or decrease by similar proportions. Modelling best practice would expect the sampled uncertainties for these individual cost lines to be modelled individually but correlated in the Monte Carlo simulation.
- 5.5.7 Whilst the aggregation of costs and uncertainty before Monte Carlo modelling has a small effect, of the order of approximately 1.3% at the P80 level (the example shown is consistent with asset renewals from all sampled regions), the aggregation of cost lines to category level prevents the identification of cost drivers, by not being able to trace correlation of output costs to individual input cost lines.

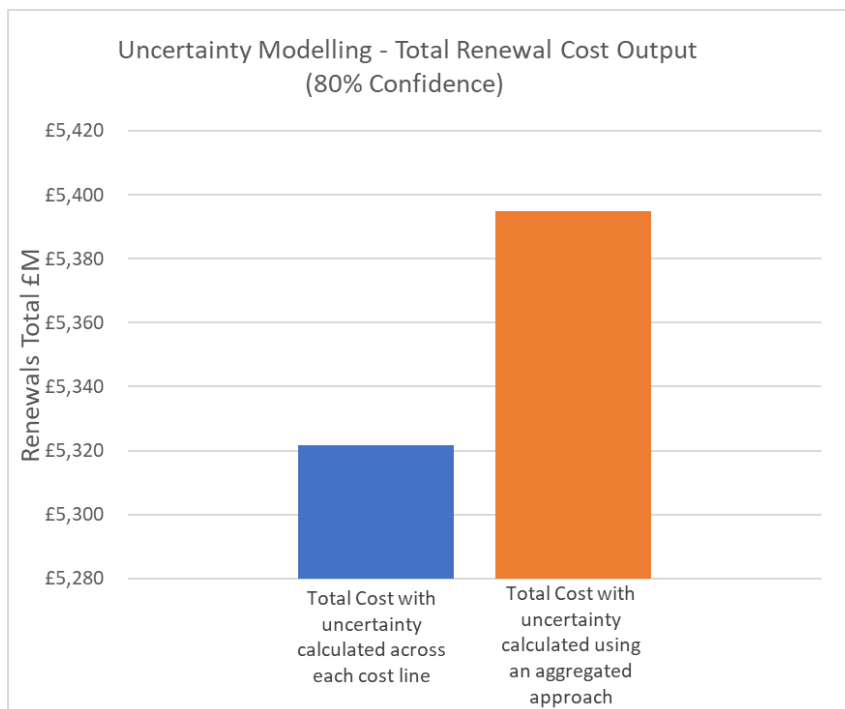


Figure 15: Modelling Outputs Comparing Modelling of Uncertainty on Individual Cost Lines and an Aggregated Approach (Example for Regional Renewal Costs and Uncertainties)



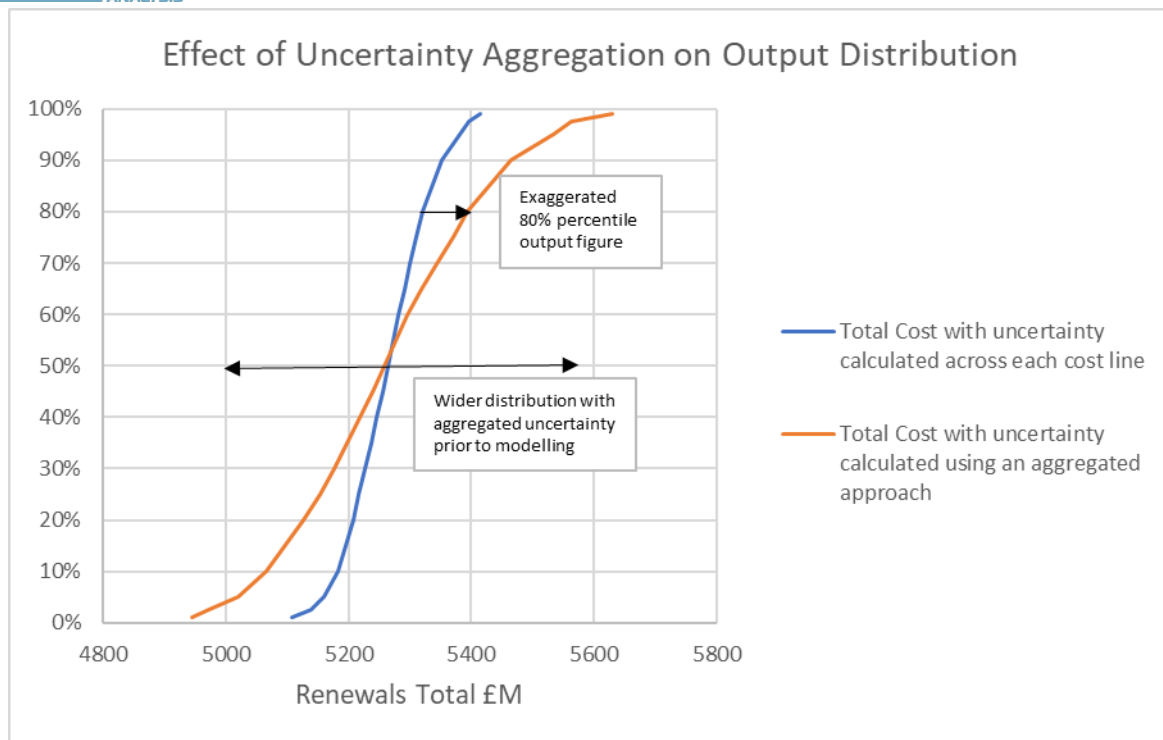


Figure 16: Effect of Uncertainty Aggregation on Output Distributions

## 5.6 Serial 2 Specific Observations and Recommendations

5.6.1 In reviewing the models provided, and tracing calculation chains, to scrutinise the application of risk and uncertainty, Sirius would advise best practice improvements in the following areas for the cost aggregation risk model and the Regional submission templates:

1. The Submission Template and Risk Model do not follow best practice left to right sheet and cell calculation order. This approach would make it easier to understand the calculation flow and cost build up process and would help particularly when making changes or updates.
2. Cell locking, to avoid modification of calculations, is not present. Enabling this would avoid any inadvertent changes by the user to calculations or pre-set values.
3. Colour coding of cells to clearly identify input ranges is not consistent. Consistency in this practice would enable users to clearly see where inputs are expected and where values can be modified.
4. Formulas use 'Address' and 'Indirect' functions which make traceability of calculations extremely difficult and are discouraged by best practice guidelines.
5. A mix of macros and manual copy and paste to transfer values could potentially introduce errors.
6. Input costs, uncertainty ranges, headwinds and efficiencies, and inflation selections have no notes or rationale, particularly where they deviate from initial or default settings.

## 6 Key Findings, Conclusions and Recommendations

### 6.1 Key Findings

6.1.1 The methodology for generating budget forecasts by business units and for combining these into a central risk model has been an evolving process. It is evident that components of the process including underlying tools and models have been enhanced and extended over time resulting in increased complexity for some areas of the supporting spreadsheets. However, it is noted that building a toolset for budgeting for such a large enterprise is not trivial and will always result in a level of complexity, though the process could be more streamlined and structured, with end-to-end consistency, than many elements are now.

6.1.2 The previous sections provided details of findings and observations by each serial of investigation. Figure 17 shown below, shows a summary of the key findings and how they map on the overall process. In summary the key findings of the review for risk and uncertainty are:

- Baselining of unit rates as a fundamental component of NR's cost forecasting approach enables a validated methodology for Workbank costs and as a toolkit for assurance allows scrutiny of variance from these rates when business units take decisions to deviate from these. This follows a best practice approach to scrutiny and assurance in this context.
- Deriving unit rates based on historical exit rates may introduce bias in some instances depending on the period used for historical data and events that may have skewed those rates at that time. Impacted risks may have also affected the exit rates and these would be subsumed into the historical baseline rates, as explicit risk tracking had not been in place, and this may be driving costs of impacted risks into the budgeting process.
- The maturity of the costing approach varies with some regions further ahead, having invested time to develop a more granular costing approach using cost books and detailed bottom-up approaches, and other regions have utilised commercial planning tools to standardise the cost forecasting approach.
- Costs are aggregated to higher levels of the cost breakdown structure before Monte Carlo modelling. This prevents the identification of cost drivers by not being able to trace correlation of output costs to individual input cost lines.
- Uncertainty estimation is captured for each asset type but is decoupled from the individual workbank cost lines and therefore does not allow specific uncertainty variation to be captured and modelled at this lower level. Furthermore, the aggregation of uncertainty to higher levels of the cost breakdown structure causes the modelling to generate broader output cost distributions with higher upper percentile values than if uncertainty was modelled at a lower level of granularity.
- Whilst NR has an ERM framework, risk management, as typically defined in government guidance<sup>15</sup> is not evidenced as part of the budgeting process, with no identification or quantification of risks and their probabilities and impacts. Therefore, risk analysis as part of the cost modelling cannot be undertaken and included in the modelling output. There is also confusion between the terms of risk and uncertainty and the quantification of these, with the current modelling only including uncertainty analysis.

---

<sup>15</sup> Management of risk in government: framework - <https://www.gov.uk/government/publications/management-of-risk-in-government-framework>

- Uncertainty estimates are captured for each year with a typically diverging annual profile for later years possibly exaggerating the spread of output costs in later years. This effect could potentially be explicitly captured by annual headwinds and efficiencies alone, but also by risks which currently are not captured or modelled.
- Inflation is not handled consistently with separation of applying inflation for conversion to cash prices (CPI) independent of applying higher inflation offset factors (above CPI) to asset renewal input costs. The uncertainty modelling of inflation is also not consistent in that the main CPI cash inflation variance is modelled in the Monte Carlo model, but any additional input inflation offset is a static factor in the input template.
- The SoFA which determines the allocated funding to each business unit is a principle driving the budget submission process and in effect makes the budgeting target-based. Efficiency savings were also target-based, driving the budget submission to achieve cost reductions within a particular timeframe. The combination of planning to achieve pre-set budget and efficiency targets can result in deferral of work.
- The regional strategic plans capture overall assumptions of the budget submissions, however, specific documented assumptions for the basis of estimate are not captured or included within the cost submissions, and therefore variation of values for factors such as inflation, headwinds, efficiencies and uncertainty cannot be scrutinised.
- The model and template do not follow best practice guidelines for spreadsheet models and tools, potentially allowing input or calculation errors, particularly when making changes or updates. Review and assurance are also more difficult when calculation sequences cannot be easily traced. Data transfer is a combination of macros and manual copy and paste operations. This again risks erroneous data transfer or corruption of the spreadsheets.
- Model documentation and formal verification and validation are not available for the suite of templates, transfer spreadsheet and aggregation model as might be expected according to government quality assurance guidance<sup>16</sup>. The information and development knowledge of the suite of spreadsheets appears to be highly dependent on key resources in NR Group Finance.

---

<sup>16</sup> Department for Business, Energy & Industrial Strategy - Quality Assurance (QA) modelling: guidance for models  
<https://www.gov.uk/government/publications/quality-assurance-guidance-for-models>

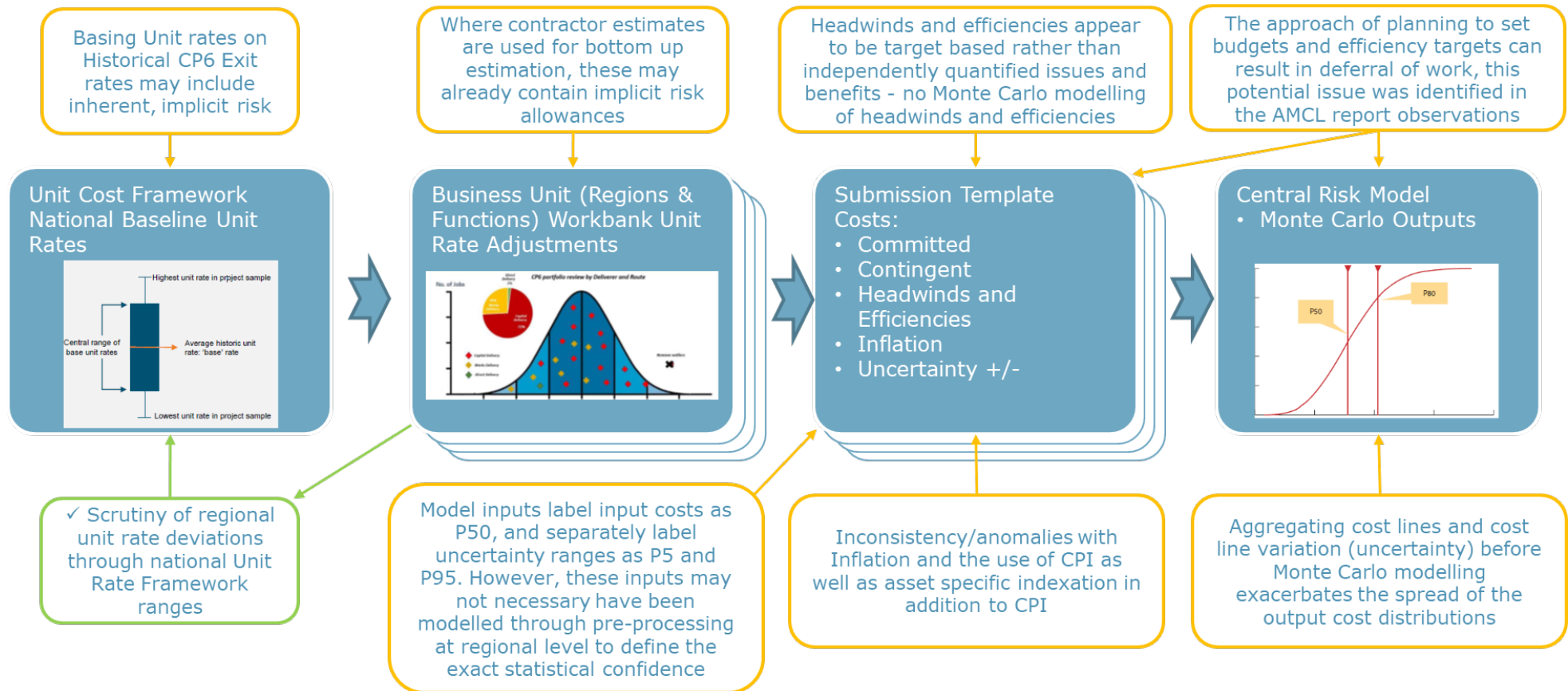


Figure 17: Overview of Budgeting Process and Key Findings Related to Each of the Stages

## 6.2 Conclusions

6.2.1 The conclusions established from this investigation include the following:

1. That formal risk quantification is not currently included in the budgeting process to establish the effect of risk on output budget distributions and to help inform decisions on risk contingency funds. This also suggests that the impact of risks on historical exit rates is not identified and may result in impacted risks being embedded in baseline unit rates.
2. That the modelled effects of input costs and input factors for uncertainty, headwinds, efficiencies and input inflation cannot be directly related to output variability as they are aggregated to broader category totals before being modelled in the Monte Carlo simulation. This prevents the identification of cost drivers, by not being able to trace correlation of output costs to individual cost inputs.
3. That certain modelling approaches are moderately exaggerating the value and spread of output cost distributions. The effects of applying split indexation rates are causing a small compounding effect on the output costs, and the aggregation of input costs and uncertainties before Monte Carlo modelling are increasing the spread of the output distributions and extending the value of confidence levels such as the P80 figure.
4. That NR has the opportunity to extend the Renewals Cost Approach Framework as a common estimating and forecasting methodology, by exploiting more mature approaches for development of cost estimates seen in some regions.
5. That the model toolset, consisting of business unit templates, aggregation workbook and @Risk Monte Carlo model would require redevelopment to align with best practice guidance on spreadsheet tools and to allow for ongoing maintainability and manageable future expansion.

## 6.3 Recommendations

6.3.1 From the observations and findings detailed above, Sirius make the following recommendations:

1. The Unit Rate Framework should include an assessment of risk or economic bias for historical rates where possible.
2. The NR ERM framework should be considered as a basis to allow the assessment and management of risks and to allow the capture of quantified risk impacts as part of budget submissions. This will also allow for assessment of inherent risks in contractor prices or SME estimates.
3. The Renewals Cost Approach Framework should be expanded as a common estimating and forecasting methodology, including:
  - a. Exploiting more mature approaches seen for some regions such as utilising a detailed cost book approach undertaken by one Region, and a wider use of Rail BI, which could be used for scheduling as well.
  - b. Ensuring a consistent approach for including additional work in Workbanks, whether this is by varying unit rates, adjusting volumes or adding specific explicit activities.
  - c. Providing clarity on the expectation for model inputs such as spot, P50 values and P5 and P95 uncertainty ranges.

- d. Developing a defined framework for the application of uncertainty ranges for cost estimates based on the maturity of the data from which the point estimate is derived. Such a scale would be similar to the Ministry of Defence (MoD) Data Readiness Levels (DRLs) approach. This will also allow for assessment of confidence in any contractor prices or SME estimates.

6.3.2 Redevelopment of the suite of spreadsheets should be considered to:

1. Comply with model development guidelines and best practice.<sup>17</sup>
2. Have documentation and be accessible for formal verification and validation.
3. Avoid aggregation of cost and uncertainty before Monte Carlo modelling and include uncertainty estimation and correlation for individual costs perhaps a data maturity based framework.
4. Model inflation consistently and allow adjusted profiles as well as baseline CPI indexation. Uncertainty modelling of indexation variations should be applied to all indexes using the same approach.
5. Include risk capture, quantification and analysis in the modelling and outputs.
6. Capture user notes against model inputs, particularly where factors or values have been changed from default or base figures.

6.3.3 A CDAL template should be established to capture all modelling assumptions on input costs (unit rates and volumes), uncertainty factors, headwinds, efficiencies, and inflation. This could be included as part of a revised submission template.

6.3.4 It has long been recognised that a contributory factor causing projects to overrun in time and cost and fall short in performance delivery is a tendency for designers, planners and estimators to be optimistic. This 'Optimism Bias' (OB) manifests in many areas of project delivery, from an expectation that activities can be completed faster and consume fewer resources, but also through a failure to identify and manage the risks that may impact successful project delivery. His Majesty's Treasury 'Green Book: appraisal and evaluation in central government'<sup>18</sup> provides guidance<sup>19</sup> on the sources of 'OB' relevant to different sectors and factors to be considered to adjust project time and cost estimates to compensate for the effect.

6.3.5 The absence of evidence that the CP7 risks have been incorporated into the cost and time forecasts suggest that the NR estimates may exhibit OB i.e. that the estimated costs and durations of the activities are optimistic and hence, either the costs are too low or the timescales too short, or both. Undertaking an OB assessment would enable NR to understand how their budget spend may turn out or adjust the estimates to reduce the probability of overspend during the period i.e. make the estimates more realistic.

6.3.6 The study has found evidence that the treatment of embedded risk costs in the development of NR's estimates impacts in 2 distinct aspects of their development:

1. Since it has not been possible to identify the contribution of the costs of the historic risks that have occurred within the assessed data set, it is considered likely that the calculated workbank cost estimates are high, inflating the overall estimates.
2. Conversely, the NR risk management process does not infuse the anticipated cost impact of risks into the overall estimating process, an omission which will underestimate the required funds.

---

<sup>17</sup> Reference Aqua Book - <https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government>.

<sup>18</sup> <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

<sup>19</sup> <https://www.gov.uk/government/publications/green-book-supplementary-guidance-optimism-bias>

- 6.3.7 It is not currently possible to quantify the impact of these 2 effects on the present NR estimates and further emphasises the need and benefits of implementing the recommendations within this report.

## 7 Abbreviations and Acronyms

### 7.1 Abbreviations and Acronyms

<b>Term</b>	<b>Description</b>
AMCL	Asset Management Consulting Limited (Turner & Townsend)
BI	Business Intelligence
CP	Control Period
CDAL	Cost Data and Assumptions List
CPI	Consumer Prices Index
DRL	Data Readiness Levels
E&W	England and Wales
ERM	Enterprise Risk Management
FTAC	Fixed Track Access Charge
FY29	Financial Year 2029
HLOS	High-Level Output Specification
KCL	Key Cost Line
KVL	Key Volume Line
ML	Most Likely
MoD	Ministry of Defence
NR	Network Rail
NW&C	Northwest and Central
OPEX	Operational Expenditure
ORR	Office Of Rail and Road
PR23	Periodic Review 2023
P&R	Planning & Regulation
SoFA	Statement of Funds Available
SoW	Statement of Work
SME	Subject Matter Expert
SR	Scotland's Railway
W&W	Wales And Western



## 8 References

- Office Of Rail and Road #29098 CP6 to CP7 Transition - A Review of NR Regions' Approach to Cost Planning and Unit Rate Development, Version: 1.1 Final, Date: 14th November 2022
- Asset Management Consulting Limited (a Turner & Townsend company)
- Rail BI™ is an unregistered trademark of Insight Software Edinburgh Ltd. BI nominally stands for Business intelligence however the tool is referred to as “Rail BI”
- Management of risk in government framework:  
<https://www.gov.uk/government/publications/management-of-risk-in-government-framework>
- Department for Business, Energy & Industrial Strategy - Quality Assurance (QA) modelling: guidance for models <https://www.gov.uk/government/publications/quality-assurance-guidance-for-models>
- The Data Readiness Level (DRL) framework is a method developed by the Ministry of Defence (MoD) Cost Assurance and Analysis Service (CAAS) to communicate the maturity and suitability of estimates to support investment decisions. DRL’s are used by MoD and other government departments. The DRL framework is analogous to the Technology Readiness Level (TRL) and System Readiness Level (SRL) structures initiated by NASA.
- Reference Central Government Aqua Book: guidance on producing quality analysis for government - <https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government>
- The Green Book: appraisal and evaluation in central government:  
<https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>
- Green Book supplementary guidance: optimism bias:  
<https://www.gov.uk/government/publications/green-book-supplementary-guidance-optimism-bias>