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SUMMARY

Frazer-Nash Consultancy Ltd has completed a cost assurance review for the Office of Rail and Road (ORR). The review considered renewal project costs proposed by HS1 for the contract period CP3 and for CP4 onwards.

We have determined that:

- ▶ A line of sight exists between the key documents that substantiate the proposed financial provisions for CP3 with respect to infrastructure and plant renewal projects.
- ▶ Direct project costs have generally been prepared in a logical manner and appear appropriate given the limited availability of historical data specific to HS1. These have been reviewed and in some cases input to, by the relevant Head of Profession. It is not possible to be definitive as to whether they represent the high, mid or low point of a ranged estimate and are likely to be a combination depending on complexity and novelty.
- ▶ A simple review of key delivery risks has been undertaken at portfolio level and the resultant financial provision appears reasonable. In moving from project-by-project to the programme level risk assessment described above, cost uncertainty has not been dealt with explicitly. In moving to consolidated portfolio level risks, it can be expected that opportunities in some areas will offset higher costs in others. This is more likely to be the case where there are larger 'repeat' volumes of work of a particular type. There is some potential for some layering of risk, but this cannot be quantified.
- ▶ For CP4+, the methodologies for delivery on site have been well thought through and clearly presented. The proposed base estimate costing is optimistic with a generous uncertainty factor applied. The underlying labour rates are generally lower in comparison with CP3 estimates and there are some significant, clearly stated, cost omissions e.g. provision for a materials handling depot to support the increasing workload. Proposals for transportation of materials from source to worksite (and associated costing) are not shown. These omissions should be covered by the uncertainty factor but it is important that stakeholders understand that the actual base costs will be higher than predicted but are unlikely to be as high as the base estimate plus uncertainty.
- ▶ The use of cost overlays for CP4+ broadly follows the same principles as those applied by NR(HS) for CP3. There are, however, some additional layers, hence our assertion that there is the potential for double counting. For example, we take the Delivery Partner overlay to be equivalent to the role currently performed by NR(S) and their Management Fee. HS1 Opex is not clearly defined and it is not clear why it has been included in addition to the Delivery Partner. There is a further overlay line item that covers planning and mobilisation that will, at least in part, be expended in CP3. These two items represent cost provisions valued at up to £107.9m.

This report sets out the background, approach, findings and offers a number of observations on the estimating process.

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1. INTRODUCTION

1.1 HIGH SPEED 1 (HS1)

This 109km railway links St Pancras International station in London to the Channel Tunnel at Cheriton. It was designed to enable trains to operate at speeds of up to 300kph. The first section opened in 2003 with the entire route opening in 2007.

It is currently the only line in the UK able to operate at this speed and given the relatively short service life to date, both are significant issues that have influenced the renewal estimating process.

1.2 ROLES & RESPONSIBILITIES

The Department for Transport (DfT) owns the assets that form HS1 and a 30-year concession to operate and maintain the high-speed link is in place with HS1 Company Ltd. HS1 Company Ltd is a thin shell company and has in turn contracted Network Rail High Speed (NR(HS)) to manage asset maintenance and renewal works on its behalf.

The Office of Rail and Road (ORR) performs a regulatory role for DfT and provides oversight, as shown below:

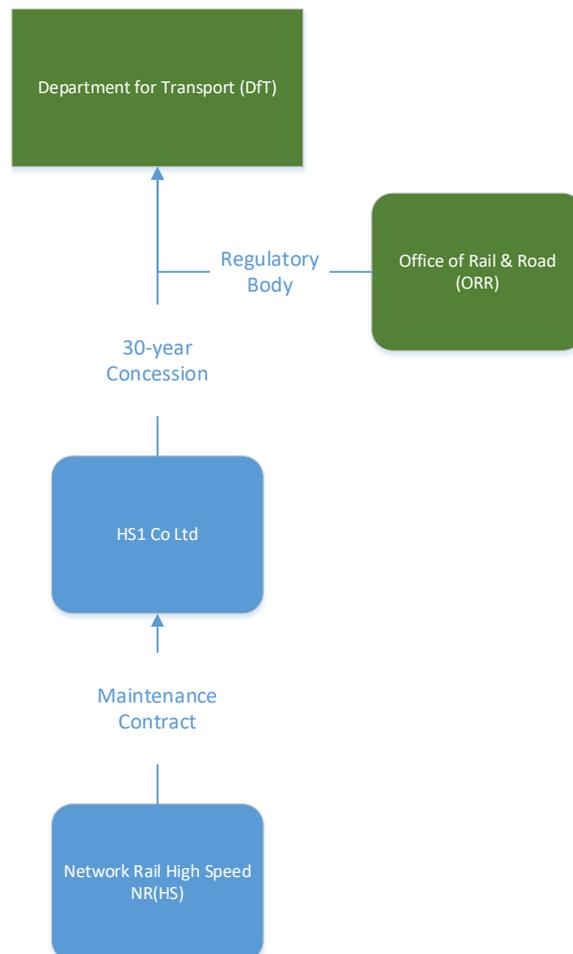


Figure 1 – The commercial framework for HS1

In accordance with the concessionary framework, the ORR is required to undertake periodic reviews of High Speed 1 (HS1) submissions prior to each five-year control period.

This 2019 periodic review (PR19) covers control period 3 (2020-25) and considers proposals for CP4 onwards in high-level terms. CP3 begins on 1 April 2020.

NR(HS) has prepared the Asset Management Plan and Renewal Projects Schedule on behalf of HS1. Mott MacDonald has prepared project estimates for CP3 for NR(HS), in accordance with Network Rail's RMM1 methodology. Bechtel has produced comparable high-level estimates for CP4 onwards for and on behalf of HS1 and used their own pricing methodology.

1.3 FUNDING ARRANGEMENTS

HS1 operational expenditure (maintenance and operation) is recovered through track access charges levied on Eurostar (international passenger services), South-Eastern (UK domestic franchise) and, to a limited extent, freight operating companies.

The Train Operating Companies pay into an Escrow account at the beginning of each control period to fund capital expenditure.

Since HS1 is operated as a concession, DfT requires that sufficient works are planned and funded in accordance with good whole-life asset management practice. HS1 and NR(HS) need to ensure that there is sufficient funding in place to deliver the work and ensure the railway continues to function reliably going forward. The train operators seek to minimise the amount of money they have to contribute. ORR, through a range of measurers, this review being one, undertakes an intermediary role.

1.4 SCOPE OF OUR REVIEW

ORR limited the scope of our investigation to the costs proposed for asset and plant renewal projects; enhancement projects and projects covered by provisional sums, whilst costed in the same manner, were excluded. Furthermore, why the projects were required, together with the determination of work volumes, was addressed by ORR and did not form part of our investigation.

The CP3 programme of works included 81 fully costed renewals projects, some of which should be self-funding and were, therefore, excluded from our review. For CP3, our role was to review the cost estimates used to develop the 46 infrastructure renewals and 5 plant renewals projects (listed in Annex A), with a total estimated cost of £60.7m in CP3.

Although CP3 was the primary focus, we were also asked to review the bases costs used to support Bechtel's projections for CP4 onwards.

2. APPROACH

2.1 CP3 COST ASSURANCE

ORR provided us with a large number of documents for our information and review (see Annex B). The documents were supplied in batches:

- ▶ around the time of the kick-off meeting on 08/04/2019;
- ▶ following the joint meeting on 23/04/2019;
- ▶ following the joint meeting on 22/05/2019.

Having identified the key documents, we focussed our efforts on establishing a clear line of sight between the overall schedule summary, the estimating summary and pricing schedules.

Prior to the joint meeting on 23/04/2019, we had only been provided with summary documents and it was unclear how project estimates had been prepared in detail. During the meeting, key underlying documents (pricing charters) were identified and requested from NR(HS).

HS1 also identified the following activities that had been costed based on similar works undertaken in CP2 (base estimate cost shown in brackets):

- ▶ 2 - Acoustic barriers (£320k)
- ▶ 4 – Boundary fencing (£550k)
- ▶ 38 – Bore hole pumps (£280k)
- ▶ 75 – Local area network renewal (£130k)
- ▶ 76 – Points operating equipment (£1.42m)
- ▶ 79 – Fibre optic cabling (£3.4m)
- ▶ 88 – GSM-R handset renewal (£270k)

On receipt of the pricing charters from NR(HS), we again sought to establish the targeted line of sight. Following our review of the set of key documents for CP3 a number of issues were identified that can be summarised as follows:

- ▶ Throughout the period of investigation, the schedule of works was subject to revision as a result of ongoing reviews between HS1 and NR(HS) – this affected activity, volume and cost to varying degrees;
- ▶ There were inconsistencies in activity references between the summary schedule and estimating documents;
- ▶ We were not able to follow the base price value from estimating documents to the project summary even where the volume of work had not been amended;
- ▶ Risk was determined on a project-by-project basis (with a 60% uplift), but this was changed to consider the risk of delivering the projects as a programme;
- ▶ The pricing schedules contained very limited information in terms of labour, plant, materials, and the provenance of costs or assumptions.

ORR called another joint meeting on 22/05/2019 at our request. Our concerns, having been raised in advance, resulted in NR(HS) preparing a revised summary sheet. Updated cost estimate summary and associated pricing charters were procured from Mott MacDonald.

NR(HS) and Mott MacDonald explained how the costs had been developed bottom-up, using a selection of example projects. Having established the line of sight, a sample of projects were selected at random to test the estimating process. Where data was available, the estimates were created to reflect historical information (through direct HS1 experience in CP2 or from NR generally) and in discussion it was clear reasonable assumptions had been made. In some cases, quotes had been used and for a small number of projects Rough Order of Magnitude (ROM) costs have been adopted. This provenance was not clear in the pricing charter RMM1 workbooks. We requested that additional information, showing how the base costs were derived, was provided for a sample of 15 renewal projects that accounted for 80% of the overall cost of the CP3 programme.

Asset Type	Activities	Value
Civils	1,13,14,15,16	£5,950,000
E&P	29,48,61	£12,780,000
S&T	71,73,76,79,81,83	£16,060,000
Track	65	£16,000,000

Table 1 – Sample projects selected for detailed review

Updated/annotated pricing charters were provided (where possible) after the meeting.

NR(HS) also explained their portfolio risk analysis, which was based on that used by NRIL for the CP6 costing exercise reviewed by ORR recently. The process is relatively simple and focussed on delivery risks by asset group. The risk drivers and their effect were derived by NR(HS) and reviewed by the relevant Professional Heads. Our review of the portfolio risk analysis is included in the following section.

2.2 CP3 COST UNCERTAINTY

The programme-wide asset summary level risk assessment undertaken by NR(HS) has been used to override the standard application of early GRIP stage cost contingency (60%) proposed by Mott MacDonald at the individual project level.

Some activity lines e.g. 65 – Ballast mid-life refurbishment are well understood based on experience on the NRIL network (with due allowance to reflect the needs for high speed) coupled with a large volume of work (30km); 60% uncertainty would appear excessive. The cost of other areas, such as 81 – ITCS Test Bench Obsolescence, are more uncertain. It is therefore accepted that for a large programme the application of 60% contingency is too pessimistic as there will be a range of outcomes some higher and some lower than the original estimate.

The “portfolio risk” exercise undertaken by NR(HS), focussed on efficiency and delivery risk and does not consider uncertainty in the base estimates. The exercise followed the same process and headings used for the development of the NRIL CP6 budget. The relevant Professional Heads provided input and guidance in the evaluation of likelihood and impact and Monte Carlo analysis was used to estimate the overall effect. There is no evidence of identification of potential mitigation options associated with the risks considered.

Based on this analysis, NR(HS) has proposed a risk provision (at P80) of £21.3m, as indicated in Table 2. The underlying risk register does not differentiate renewals items (infrastructure and plant) from provisional sum activities.

	Estimated Price (2018 Prices)	Estimated Price (P80 Portfolio Risk Application)	Estimated Price (Total Sum CP3)
	J	K	L = J + K
CP3 R&R Cost Estimate	£ 65,340,000	£ 19,374,000	£ 84,714,000
10% NRHS Mark-up	£ 6,534,000	£ 1,937,400	£ 8,471,400
Sub Total	£ 71,874,000	£ 21,311,400	£ 93,185,400
High Speed Projects Function (Renewals)	£ 9,440,896		£ 9,440,896
Grand Total	£ 81,314,896	£ 21,311,400	£ 102,626,296

Table 2 – CP3 Projects Review version 7

Cost uncertainty can be considered at three levels:

- ▶ Base cost estimating (initial labour, plant and materials estimates, working assumptions etc.);
- ▶ Efficiency risks (asset specific risks that materialise once real sites and scope of work defined and contracts are let, causing variance to base estimate);
- ▶ Delivery risks (higher-level cross-asset risks, changes to legislation, exchange rates etc.).

Assessment must be undertaken carefully, however, as there is significant scope for layering risk and double counting.

Having reviewed the updated pricing charters for the sample projects, Table 3 provides a summary of activities by asset group and our qualitative assessment of estimating uncertainty based on the quality of substantiation offered, novelty and volume of work within the scope.

Asset Type	Activities	Value	Uncertainty	Comment
Civils	1,13,14,15,16	£5,950,000	L-M	The work types are straightforward. Some cost uncertainty around access road length covered by assumption.
E&P	29,48,61	£12,780,000	M-H	£5.34m linked to rough order of magnitude (ROM) costs for plant/machinery works (agreed with Head of Profession) and represent high uncertainty. Balance is UPS replacement works and an assumed split of different sized installations (medium uncertainty).
S&T	71,73,76,79,81,83	£16,060,000	M-H	£3.4m costed by HS1 based on CP2 experience (low uncertainty). £8.1m with no breakdown or provenance provided (including £1.47m ROM estimate as quote not provided by equipment supplier) represents high uncertainty. The balance (£4.55m) has some supporting material, in part based on CP2 materials supply, but estimate refers to clamplock rather than HPSS points operating equipment.
Track	65	£16,000,000	L	Reasonable volume of work, based on NR norms. Includes provision for additional effort to meet tighter tolerances for high speed. Limited access required to NRIL high output equipment and Eurotunnel locomotives (compatible signalling) considered nominal risk.

Table 3 – Base cost uncertainty for sample projects

The portfolio risk assessment (risk and opportunity) performed by NR(HS) follows a series of common issues or themes, viewed by asset group. The output from which has been analysed and summarised in Table 4.

Driver of range	Overarching drivers	Track drivers	Signalling drivers	Structures drivers	Electrification and fixed plant drivers
Weather and other serious incidents				Planning of works during summer (-5%,0%)	
Availability of access	Include for NR (HS) - Late Running EILs, aborted work (0%,+2%)	Logistics, Transport & Storage - Track Ballasting - at 12.5% premium for HS due to lack of locations, not industry rates as works not undertaken on HS previously. (0%,+12.5%)		Logistics, Transport & Storage - Drain Cleaning & Jetting (0%,+1.5%)	Logistics, Transport & Storage - Cross Passage Doors & Fans (0%,+12.5%)
Understanding of maintenance and/or renewals work banks		Uncertainty on efficiency due to non-continuous locations (-2.5%,+5%)	Adherence to the programme and programme sequence, unplanned events and slippage adversely affect the railway, utilisation of existing staff. Also efficiency. (-1%,+5%)		Lack of methodology for tunnel working for first time replacement (-2.5%,+5%)
Cost of supplier and contractor costs		Experienced supplier not in UK market, not used to handing back at linespeed (-2.5%,+10%)		Delivering Years 4 & 5 in Years 1-3 (-5%,0%)	Existing supplier / economies of scale (-3%,0%)
Deliverability of forecast efficiencies	Efficiency stretch challenge / Target Price contracts (-1%,0%)	Undertaking works during Christmas period (-1%,+1%)	Contracting Strategy and Productivity adjustments (-2%,+2%)		
Operational impact of new assets and systems					New technology (MEF) / commissioning of equipment requires parallel running (0%,+2%)
Changes in policy and practises e.g. asset policies, fatigue management or new standards	Infrastructure Rule Book / Competencies restricts the market from continuously operating on HS1 (0%,+10%)	Track Ballasting - new practises & standards (-5%,+10%)			
Other 1	Schedule 8 - In addition to O&M / 1 incident per annum due to plant failure (£0,+£700k)	Schedule 4 (0%,+5%)			Schedule 4 - at 1% Fans & Cross Passage Doors (0%,+1%)
Other 2	HS1 portfolio management / prolonged decision making, multiple stakeholders, lack of settlement as per NRIL impacts ability to deliver the programme (0%,+10%)	NRIL SuperTrack Contract excludes HS, scarcity of resources and market forces (-1%,+5%)		NRIL Contract excludes HS, scarcity of resources and market forces (-1%,+10%)	
Overall range	-1% to +22% (excluding £700k Schedule 8 risk)	-12% to +48.5% (but only applied in 2021/22 and 2022/23 when bulk of renewals are planned)	-3% to +7%	-11% to +11.5%	-5.5% to +20.5%

(-X%,+Y%) where X% is opportunity to reduce costs and Y% is risk that costs increase

BOTTOM OF TABLE REDACTED

Table 4 – Base cost uncertainty for sample projects

Our analysis found [REDACTED]

- ▶ [REDACTED]
- ▶ [REDACTED]
- ▶ [REDACTED]
- ▶ [REDACTED]

- ▶ [REDACTED]

- ▶ [REDACTED]

Within the £19.4m base cost uncertainty, it is probable that there will be double counting in a number of areas including (from Table 4):

- ▶ “Changes in policy and practices e.g. asset policies, fatigue management or new standards” where a 10% uplift could be applied twice to track
- ▶ “Other 2” where the uplift for track and structures costs may already be included in the catch-all “HS1 portfolio management / prolonged decision making, multiple stakeholders, lack of settlement as per NRIL impacts ability to deliver the programme” applied to all assets.
- ▶ There are two references in track covering work site locations contained within “Availability of access” and “Understanding of maintenance and/or renewals workbanks”.

The financial impact of the above is obscured by the Monte Carlo analysis which makes their impact difficult to quantify.

Given the base NR(HS) renewals programme management team is funded separately and provided for, it is unclear why a 10% NR(HS) mark-up has also been applied to the base P80 risk value of £19.4m.

In conclusion, it is accepted that the application of a flat 60% contingency on base cost is excessive. Estimating risk has not been dealt with explicitly and may have been omitted. There is probable double counting in the core £19.4m risk provision. In our view, the potential double counting should offset the potential omission of estimating uncertainty. From an assurance perspective, it is not possible to be more definitive without undertaking a more detailed risk assessment, and development of mitigations and costings; in effect a fully detailed Quantified Risk Assessment (QRA).

2.3 CP4+ COST ASSURANCE

At the meeting on 23/04/2019, HS1 provided us with copies of plans developed by Bechtel. These were well detailed and covered asset renewal volumes, activities and detailed methodologies to support the proposed costs. In key areas, they have been developed with input from French track renewal contractor TSO, as well as Bechtel’s own experience. These plans were prepared for HS1 rather than NR(HS) and no reference is made to the Mott MacDonald work for CP3. Proposed productivities have been tempered with HS1 input and incorporated into the version of the Bechtel documents provided for the review.

Given the limited time available, we undertook a brief review focussing primarily on unit costs and the methodology documents, based on our team’s experience, and considered the information against that provided for CP3.

Bechtel have set out a low Base Cost estimate to generate an attractive proposition. This has been achieved using low or very low labour rates. For example, the basic track labour rate looks low (against the CP3 equivalent) and train driver incredibly low especially with minimum shifts likely to be 8 hours midweek and 12 hours at weekends. If a continental contractor is engaged to undertake the track renewal programme, shift rates are likely to be lower than their UK equivalent, however, provision for subsistence and home leave travel would need to be incorporated.

Material rates look generally reasonable but there are some significant inconsistencies in key areas. For example, the forecast cost of a full swing nose crossover is markedly lower than that for a pair of single fixed crossing turnouts, which is not credible.

There are a number of omissions from the Direct Cost Estimate that cover some significant potential cost items, including:

- ▶ Bechtel have set out plans to use continental gauge on-track machines to support track works. These will drive a combination of efficient delivery and capacity in line with the increased workload, but the machines cannot travel on NRIL infrastructure due to their size. It is unclear how Bechtel intends to move rail, ballast, sleepers and junction work to the worksites.
- ▶ Provision of a new depot to support the increase in plant/machinery and engineering trains required for the increased workload.

2.4 CP4+ COST UNCERTAINTY

Bechtel's proposed cost summary is shown in Table 5.

A	Total Direct Cost Estimate		£	691,331,400
B	T2 Management & Fee on 70% of Direct Cost (excluding contingency)	12%	£	72,589,800
C	T1 Prelims (Contractors' Staff on Project)	15%	£	114,588,200
D	T1 Fee on Total Contracted Works (assuming T1 self perform 30% of works)	12%	£	105,421,200
	Total Contracted Works		£	983,930,600
E	Owner Contingency on Total Contracted Works	30%	£	295,179,200
	Total Managed Works		£	1,279,109,600
F	Delivery Partner		£	102,300,000
G	Client OPEX	7%	£	89,537,600
H	2018 - 2025 Planning		£	5,600,000
	Total Renewal Works Estimate (CP4 - CP9)		£	1,476,547,400

Table 5 – Bechtel proposed cost summary

As can be seen, in lieu of a detailed risk assessment, a blanket 30% contingency factor has been applied to cover all cost uncertainty and efficiency/delivery risk. We have assumed this figure would be sufficient to cover the omissions and optimistic rates identified in Section 2.3, and still provide for an appropriate level of delivery risk. More plan development work will need to be undertaken by HS1 to fully close out.

In comparing the cost overlays shown in Table 5 against the CP3 equivalents, the following should be considered:

- ▶ There is potential for double counting within G - Client Opex and F - Delivery Partner. Delivery Partner is taken to represent the equivalent of HR(HS) programme management in CP3. Client Opex is not clearly defined and doesn't feature in the CP3 datasets;
- ▶ The line item H - 2018 to 2025 Planning is at least in part to be expended in CP3 to cover pre-planning, procurement and mobilisation ahead of CP4.

In combination, this double counting could be valued at up to £107.9m (7.3%).

3. FINDINGS

In completing the cost assurance review, we record the following findings:

CP3:

- ▶ A line of sight exists between the key documents that substantiate the proposed financial provisions for CP3 with respect to infrastructure and plant renewal projects.
- ▶ Direct project costs have generally been prepared in a logical manner and appear appropriate given the limited availability of historical data specific to HS1.
- ▶ Generous provision has been made for risks/opportunities arising from uncertainty of accessing NRIL resources/contracts, changes to standards and, Schedule 8 payments caused by possession overruns, etc.
- ▶ This risk provision does not take account the varying level of uncertainty associated with the Base Cost of the various pricing charters, some of which are well understood and should be quite accurate and others will have a high level of uncertainty.
- ▶ There is the potential for some elements of risk to have been double-counted and others omitted. The true impact of which we cannot quantify without a full QRA.

CP4+:

- ▶ The Bechtel documents provide a comprehensive and detailed build up to the costs with a clear understanding of how the works could be delivered. A blanket 30% uncertainty percentage has then been applied.
- ▶ There are some significant gaps in methodology as no provision has been made for a materials handling depot to support what will be a significant ramp up in work compared with earlier control periods.
- ▶ How materials will be delivered to site or trans-shipped from NR gauge vehicles to European gauge plant is not clear.
- ▶ The labour rates used are variable and look to be low or very low in many areas.
- ▶ It is likely that the large uncertainty provision will cover these issues but HS1 and the stakeholders should not become solely focussed on the initial base cost number.
- ▶ There is the potential for double counting of up to £107.9m included within cost overlays in the Bechtel costs summary.

4. OBSERVATIONS

In undertaking the review, we recorded a number of observations, based on our opinions, which are included as follows:

- ▶ As a thin client company managing a 'new' railway, HS1 has been wholly reliant on a number of suppliers and sub-suppliers to determine asset plans, work volumes and costs. This cost exercise and the clarification sought by Frazer-Nash has proven fundamental to achieving the line of sight. HS1 has largely been as much a 'customer' of the review as ORR.
- ▶ The NR RMM1 methodology and presentation appeared overly complicated without offering much information. The core underlying base estimate information was not easy to find. In many cases, the way costs had been derived was unclear and/or hidden in formulae rather than set out in a form that was easy to follow. A project estimate should clearly show the proposed build-up of labour, plant, materials, working assumptions, productivities, provenance etc. to enable internal review, approval and independent review.
- ▶ In trying to establish the line of sight, it became clear that the E&P group had overwritten the unique project charter reference numbers. This made traceability between documents unnecessarily complicated and we had to rely on work descriptions in a number of cases.

All of the above issues and indeed this review at large, are underpinned by the need for good quality, transparent estimates with appropriate risk identification and management. Clarity at source would have made this process more straight-forward and provide greater confidence to all Stakeholders, in particular, ORR and HS1. The need to improve basic estimating processes and capabilities within the industry are key requirements moving forward.

ANNEX A - RENEWALS PROJECTS SCHEDULE

A.1 CP3 RENEWALS PROJECTS

Number	Charter Name	Function	Renewal Type (Adjusted) 2/5/2019	Rev 7 Estimated Price (Base Cost) (£)	Rev 7 Estimated Price (Inflation) (£)
1	Access Roads Gates and stairs	Civil	Infrastructure Renewals	£890,000	£30,000
2	Acoustic Barriers	Civil	Infrastructure Renewals	£320,000	£10,000
4	Boundary Fencing	Civil	Infrastructure Renewals	£550,000	£20,000
6	Camley Street Heritage Structures - Bridges	Civil	Infrastructure Renewals	£80,000	£0
8	Corsica Street Head House	Civil	Infrastructure Renewals	£140,000	£10,000
10	Earthworks - Shotcrete	Civil	Infrastructure Renewals	£600,000	£20,000
13	Lineside Buildings doors and Locks	Civil	Infrastructure Renewals	£880,000	£30,000
14	Long Tunnel Drainage	Civil	Infrastructure Renewals	£1,090,000	£40,000
15	Open Route Drainage	Civil	Infrastructure Renewals	£1,720,000	£60,000
16	Passive Drainage Systems	Civil	Infrastructure Renewals	£1,120,000	£40,000
19	Road Expansion Joints	Civil	Infrastructure Renewals	£430,000	£20,000
20	Road Waterproofing	Civil	Infrastructure Renewals	£290,000	£10,000
22	Renewal of Thames Tunnel Fan Controls	E&P	Infrastructure Renewals	£140,000	£10,000
27	Hybrid Auxiliary Power Unit	E&P	Plant Renewals	£270,000	£10,000
29	Renewal of 2 x MPV pairs or 2 x Control System Overhaul	E&P	Plant Renewals	£4,490,000	£160,000
30	Renewal of Fire Suppression Gas bottles through Service/Exchange (IG55)	E&P	Infrastructure Renewals	£220,000	£10,000
31	Renewal of Static Switches	E&P	Infrastructure Renewals	£450,000	£20,000
36	Renewal of Cross Passage Doors	E&P	Infrastructure Renewals	£110,000	£0
37	Building Management Systems for Management of Air Con at Head Houses and Portals	E&P	Infrastructure Renewals	£220,000	£10,000
38	Renewal of Bore Hole Pumps at Stratford (Dewatering System)	E&P	Infrastructure Renewals	£280,000	£10,000
42	Renewal of Ashford nadir Pump Station Controls	E&P	Infrastructure Renewals	£60,000	£0
45	Replacement of electrical Section Status Detection Equipment	E&P	Infrastructure Renewals	£170,000	£10,000
46	Renewal of inverter Drives for Pumps and Non Tunnel Ventilation Fans	E&P	Infrastructure Renewals	£160,000	£10,000
48	Replacement of Uninterruptible Power Supplies, Integral Rectifiers and Batteries	E&P	Infrastructure Renewals	£7,440,000	£270,000
49	DIOM (Digital Input Output Module) Chargers/Rectifiers and Batteries	E&P	Infrastructure Renewals	£230,000	£10,000
50	Damper Mesh Renewals	E&P	Infrastructure Renewals	£160,000	£10,000
51	Renewal of Attenuators	E&P	Infrastructure Renewals	£80,000	£0
53	Renewal of Inverter Drives for Main Axial Fans	E&P	Infrastructure Renewals	£400,000	£10,000
54	Renewal of Pumps and Valves	E&P	Infrastructure Renewals	£560,000	£20,000
55	Replacement of Local Rectifiers	E&P	Infrastructure Renewals	£140,000	£10,000
56	Renewal of Damper Actuators	E&P	Infrastructure Renewals	£490,000	£20,000
60	Windhoff Access Platform Module Replacement (x2)	E&P	Plant Renewals	£400,000	£10,000
61	SRS (Sjolanders) 9m 12m Mobile Elevated Working Platforms (MEWP's) Replacement	E&P	Plant Renewals	£850,000	£30,000
62	Windhoff Jet fan Handler Module	E&P	Plant Renewals	£530,000	£20,000
65	Charter Ballast Mid -Life Refurbishment(FEED)	Track	Infrastructure Renewals	£16,000,000	£580,000
66	Charter RAPs	Track	Infrastructure Renewals	£470,000	£20,000

Number	Charter Name	Function	Renewal Type (Adjusted) 2/5/2019	Rev 7 Estimated Price (Base Cost) (£)	Rev 7 Estimated Price (Inflation) (£)
67	Charter Switchblade design development & deployment	Track	Infrastructure Renewals	£490,000	£20,000
68	Charter Under Sleeper Pads	Track	Infrastructure Renewals	£30,000	£0
71	HPSS St Pancras Upgrades	S&T	Infrastructure Renewals	£3,130,000	£110,000
72	Modbox renewal	S&T	Infrastructure Renewals	£430,000	£20,000
73	ERS/EZP renewal	S&T	Infrastructure Renewals	£570,000	£20,000
74	Local Release Command renewal	S&T	Infrastructure Renewals	£530,000	£20,000
75	Local Area Network	S&T	Infrastructure Renewals	£130,000	£0
76	MCEM91 Point Operating Equipment	S&T	Infrastructure Renewals	£2,780,000	£100,000
78	Fibre Optic Signals at St Pancras	S&T	Infrastructure Renewals	£840,000	£30,000
79	FOAEC replacements	S&T	Infrastructure Renewals	£3,400,000	£120,000
81	ITCS Test Bench Obsolescence	S&T	Infrastructure Renewals	£3,780,000	£140,000
83	Vehicle Health Monitoring Equipment (VHME) – Hot Box Detector System – Hot Box Supervisor (HBS) Obsolescence	S&T	Infrastructure Renewals	£1,470,000	£50,000
88	GSM-R Handsets renewal	S&T	Infrastructure Renewals	£290,000	£10,000
89	Renewal Marker board ID	S&T	Infrastructure Renewals	£290,000	£10,000
93	Relining of culverts	Civil	Infrastructure Renewals	£70,000	£0
				£60,660,000	£2,200,000

ANNEX B - DOCUMENTS REVIEWED

Background documents relating to CP2 etc.

- NR HS Vol v27 - GT Gross Rates 13 09 03 v00.xlsx
- NRHS Vol v27 - NRHS Gross Rates 13 09 03 v00.xlsx
- PR14 benchmarking - final Interfleet report.pdf
- PR14 benchmarking - Leigh Fisher Final report.pdf
- PR14 ORR approval.pdf

Documents relating to CP3

- 1. HS1 Five Year Asset Management Statement.pdf
- 7. Whole Life Cost on a page.pdf
- 11. Benchmarking - Rebel Group OMR Effectiveness Study.pdf
- ADST Sensitivity Analysis Report v1.0 (issued).pdf
- Slides for CP3 workshop 2018 09 14 version_SENT.pdf
- Action Log - 010219.pdf
- Action Log Supplementary Detail - 010219.pdf
- CP3 Renewals Projects Review 23-11 -2018.pdf
- Resp to Action 2 - HS1 Route Map.jpg
- Resp to Action 6 - Cost Initiatives by 5YAMS Category.pdf
- 2018-11-29 ADST ORR Technical Assurance Review - Final.pdf
- 20181105 Mott M review of NRHS CP3 renewals costs.pdf
- GHD cost review question and answer log.xlsx
- NR(HS) CP3 Projects Review ver 5.pdf
- CP3 Projects Review ver 5 updated 3.5.2019.pdf
- CP3 Projects Review ver 7a.xlsx
- Final Slides for CP3 workshop on 22 June 2018.pdf
- *51x Pricing Charter spreadsheets*
- 20190509 v1 (At risk swapped out)_1.xlsx
- CP6 financial uncertainty input template (NR HS) Renewals Only - May 19.xlsx

Documents relating to CP4+

- Final Slides for CP3 workshop on 22 June 2018.pdf
- HS1 Estimate Classification and Accuracy.pdf
- HS1 Route Renewal Master Plan - Cost Estimate and Rate Book.xlsx
- Bechtel CP4-10 Study Phase 2 Master Plan.pdf
- PR18 final determination review of NRIL proposed costs.pdf

ANNEX C - SCHEDULE OF MEETINGS

Table C1 below sets out the key meetings held, organisations represented and the high-level objectives and outcomes:

Date	Meeting Attendees	Objectives	Outcomes
8/4/2019	ORR, FNC	<ul style="list-style-type: none"> Project Kick-off Meeting 	<ul style="list-style-type: none"> Background and context explained and initial documentation provided; Scope of work refined to focus on base costs with commentary on broader provisions.
23/4/2019	FNC, ORR, HS1, NR(HS), Pell Frischmann	<ul style="list-style-type: none"> Understanding of how the detailed estimating had been undertaken, methods of working, assumptions for both CP3 and CP4+. 	<ul style="list-style-type: none"> Base cost estimating documents to be provided; Bechtel plans provided.
22/5/2019	FNC, ORR, HS1, NR(HS), Mott MacDonald	<ul style="list-style-type: none"> Establish consistent line of sight; Explanation of cost estimating process and underlying detail; Walkthrough of the NR(HS) risk programme risk process. 	<ul style="list-style-type: none"> Line of sight traced based on version 7 of the project cost summary; Estimating process walked through and understood for a small sample of projects with more information promised to facilitate completion of our review; The risk process undertaken by NR was explained and understood.

Table C1 – Schedule of project meetings

ANNEX D - THE REVIEWERS [REDACTED FOR DATA PROTECTION PURPOSES]



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