

Appraisal Framework Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport North West Runway

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Executive Summary

This report sets out the assessment of the capital cost to deliver the Heathrow Airport North West Runway scheme, which includes an additional runway, taxiways and terminal infrastructure. The assessment has been undertaken in general accordance with HM Treasury's The Green Book - Appraisal and Evaluation in Central Government, which advises the adjustment of base cost estimates to include risk and optimism bias. The scheme is estimated to cost £18.6 billion with mitigated optimism bias applied and £21.4 billion with unmitigated optimism bias, compared to HAL's estimate of £14.8 billion (excluding surface access costs from HAL's total estimate of £15.6 billion. HAL's estimate does not include optimism bias).

In order to enable the Cost and Commercial Viability study to consider the viability of the scheme investment, the report also summarises the wider cost and revenue context of that investment. Therefore, assessments were made of the underlying investment in airport infrastructure that would be required irrespective of the third runway investment, the ongoing maintenance and replacement of the existing and developed asset, the ongoing operational expenditure relating to the existing and developed asset, the non-aeronautical revenue the existing and developed asset would generate; and, beyond the airport boundary, the surface access works required to facilitate the scheme (along with the operational and maintenance costs of those surface access improvements).

Contents

1	Introduction	1
2	Methodology	2
2.1	Approach	2
2.2	Scheme Capital Cost	2
2.3	Phasing	5
3	Scheme Capital Expenditure	7
3.1	Airports Commission Demand Scenarios	8
3.2	Heathrow Airport Ltd Scheme Capital Expenditure	9
3.3	Annual Scheme Capital Expenditure Summaries	10
	Appendix A Glossary	
	Appendix B Optimism Bias	
	Appendix C Scheme Capital Cost Estimate Breakdown	
	Appendix D Approach to Core and Asset Replacement Capital Expenditure	
	Appendix E Core and Asset Replacement Capital Expenditure Summary	
	Appendix F Operational Expenditure	
	Appendix G Non-Aeronautical Revenue	
	Appendix H Surface Access Capital Expenditure, Operational Expenditure and Maintenance Cost	

1 Introduction

This report sets out the determination of the capital cost estimate to develop the Heathrow Airport North West Runway scheme (hereafter “the scheme”). Section 2 sets out an overview of the methodology adopted, with the analysis presented in Section 3.

Recognising that it is not possible to determine with accuracy a single cost estimate, the primary aim of the study was to establish an estimate upon which it would be reasonable for the assessments within Appraisal Framework Module 13: Cost and Commercial Viability to be conducted.

Details of the scheme costs and supporting detail are presented in Appendices B and C.

In order to enable the Cost and Commercial Viability study to consider the viability of the investment in the scheme, it was necessary to understand the wider cost and revenue contexts of that investment. Therefore, assessments were made of the following:

- *the underlying investment in airport infrastructure that would be required irrespective of the third runway investment, referred to as Core works in this report, as discussed in Appendix D;*
- *the ongoing replacement of the existing and developed asset, as also discussed in Appendix D;*
- *ongoing operational expenditure relating to the existing and developed asset, as also discussed in Appendix F;*
- *non-aeronautical revenue the existing and developed asset would generate as discussed in Appendix G; and*
- *beyond the airport boundary, the surface access works required by the scheme along with the operational and maintenance costs of those surface access improvements as discussed in Appendix H.*

Throughout this report a consistent colour scheme has been adopted to present the cost and revenue estimates developed for each demand scenario. With reference to the demand scenarios presented in Section 0, the scenarios and their respective colours are as given in Table 1-1:

Scenario	
	Assessment of Need Carbon Capped
	Assessment of Need Carbon Traded
	Global Growth Carbon Traded
	Global Fragmentation Carbon Capped
	Heathrow Airport Ltd

Table 1-1 Demand Scenario Reference Colours

2 Methodology

2.1 Approach

Throughout this report consistent nomenclature has been adopted. Estimates were developed for “Core” and “Scheme” costs, where the “Core” works relate to the investment in the airport irrespective of investment in the additional runway works, the additional cost of which is reported as the “Scheme” cost. The Scheme works were established from the promoter’s submission to the Airports Commission. Details of the approach to the Core works and to asset replacement are presented in Appendix D.

2.2 Scheme Capital Cost

The over-arching approach was to assess the reasonableness of the estimate provided by Heathrow Airport Ltd (HAL) in order to reach a view as to an appropriate estimate to be used with the Cost and Commercial Viability assessment. This was undertaken by comparison of the provided costs, or any costs independently determined, against industry expectation. All costs were re-based as necessary to be consistently presented in 2014 values.

The following tasks were undertaken:

- *the scope of work was determined and disaggregated into the greatest level of detail reasonably possible from material provided and appropriate to this stage of analysis;*
- *for each element of the disaggregated works the effective unit rate was determined;*
- *the unit rate was assessed for whether it was in accordance with expectation of a reasonable market rate taking into account the nature, site and location of the works;*
- *amendments were made as appropriate;*
- *the base cost was established and risk and optimism bias were applied as discussed below.*

A 15% project on-cost was added to the base construction cost to allow for design and project management services. This cost was included within the base cost and was therefore adjusted for risk and optimism bias. Optimism bias was applied to the risk adjusted base cost.

Noting the inherent nature of capital expenditure projects to exhibit risk and uncertainty the processes and guidance of HM Treasury’s The Green Book - Appraisal and Evaluation in Central Government¹, and supplementary guidance with respect to optimism bias² were adopted. The guidance recommends making such adjustments on the basis that there is a demonstrated, systematic tendency for project appraisers to be overly optimistic. A risk premium was applied to address the unknown engineering detail of the identified works which would be expected to lead to an under estimate of the cost despite the scope being reasonably defined. For example, geological surveys may find that the tunnels (such as for baggage or transit systems) need to be bored through much harder rock than previously

¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf

expected. Risk premiums of 20% on Scheme costs were adopted to take account of the risk of the costs to deliver the identified scope of works increasing. These allowances are in line with our expectation of typical allowances at this stage of project development.

Scheme costs were assessed in as much detail as possible based upon the extent of information presented by the promoter and as appropriate to this stage of analysis. Engineering judgement and experience were used to assess whether the detailed item rate, or a higher aggregate planning rate, was appropriate for the element of the works, its engineering context and the operational environment within which the works would be constructed. This judgement was based upon Jacobs's experience of similar airport projects within London and within the UK.

The environmental and community impact and mitigation costs are the costs as presented by the promoters. The parallel studies being undertaken on behalf of the Airports Commission have indicated that the scale of the costs proposed are reasonable assumptions, although noting that developing a detailed budget for such costs is difficult at this stage as particular aspects of design can have significant knock on effects and the costs may increase by up to circa 50%. This falls within the range of sensitivities treated within the Commission's financial modelling, further detail of which can be found in 13. Cost and Commercial Viability: Funding and Financing Assessment.

2.2.1 Risk and Optimism Bias

(a) Risk

Based upon our expectation of a reasonable allowance at this stage of project development, a 20% risk premium was applied. We would note that this allowance could be seen as being optimistic and that a higher allowance would not be considered inappropriate. We note however that the individual items of work base costs (the risk and optimism bias unadjusted costs) make due allowance for the environments in which they will be delivered and/or the complexity of the items of work. Therefore, whilst we would observe 20% to be at the lower end of an expected range for projects at this relatively early stage of development, we consider it to be a reasonable base upon which to establish a reasonable cost estimate.

(b) Optimism Bias

HM Treasury's Supplementary Green Book Guidance sets out a detailed calculation method to establish the appropriate level of optimism bias to be applied taking into account a number of factors. Noting that these calculations require judgement across a range of factors, most of which are difficult to establish with accuracy from an external assessment to the organisation reasonable for project delivery, and noting that those assessments are subjective in nature rather than demonstrably objective, the approach to optimism bias was to establish a reasonable allowance, rounded to the nearest 5%, applied consistently to each scheme.

The works were assessed, at a high level, to determine the types of project(s) applicable and the weighting that should be applied based on their percentage of the total budget. The works were assessed to comprise a mixture of Standard Building and Standard Civil Engineering. It could be argued that the T6 works, essentially within the confines of an operational airfield and with restricted site access given the location of the M25, could be considered as non-standard building works. The base

cost for these works were noted to include a greater allowance to reflect the impact of the works location and greater cost of construction; however, we observe that this mixture is open to interpretation and may change as the nature of the scheme develops.

The upper bounds, the starting points for determining the appropriate level of adjustment for optimism bias, are 24% for Standard Buildings and 44% for Standard Civil Engineering. The upper bound figures relate to average historic optimism bias at the outline business case stage for traditionally procured projects. The Green Book approach does not require each component of the scheme to be analysed separately, other than by project type as described above. Based upon a representative distribution between these two construction types, an upper bound of 38% was determined. This rate was adopted as the upper bound/unmitigated estimate of optimism bias.

The upper bound optimism bias can be reduced according to the extent to which various contributory factors have been managed as listed in Appendix B.

The works were assessed to be largely undertaken beyond the current airport boundary, within areas of less well known site conditions, in part out-with extant procurement processes and, given the long time frame and uncertainty of the investment, with a developing business case. The calculations in line with The Green Book are presented in Appendix B. Appendix B also sets out comments and notes of the processes and strategies that the airport would be expected to adopt in support of reducing the optimism bias from the upper bound value. Following this analysis a 20% mitigated optimism bias was adopted.

We note comments made by HAL on the applicability of, and methodology for, the adoption of optimism bias. HAL states that the following rates would be more appropriate:

- *Core works: 3.45%*
- *Scheme works (airport): 3.80%*
- *Scheme works (off-airport): 16.46%*

We note HAL's comments and also that The Green Book methodology is in part subjective and open to differing interpretation or assumption on each mitigating factor. However, we consider HAL's proposed rates to be low at this stage of project development. We consider the adopted rates (mitigated: 20% and unmitigated: 38%) to be appropriate allowances at this stage of project development within the context of the analyses in which these cost estimates are to be used. It would be expected, however, that as the scheme is developed and reaches more advanced stages of design, the estimates for optimism bias are likely to decrease significantly and ultimately reach next to zero as construction begins and risks either materialise or are no longer relevant.

(c) Summary of Adjustments

In summary, the following adjustments for risk and optimism bias were made:

		Scheme
Risk		20
Optimism Bias	Mitigated	20
	Unmitigated	38

Table 2-1 Summary of Risk and Optimism Bias Adjustments to the Base Costs (%)

2.3 Phasing

The Scheme cost estimate was determined in total and by build phase. Reference should be made to the Jacobs’s Heathrow Airport North West Runway Appraisal Module 14: Operational Efficiency Ground Infrastructure report for detail of the individual phases. For the purposes of informing the Cost and Commercial Viability assessments, the capital costs of each build phase were triggered by demand against the requirements of four principal demand scenarios and as shown in Figure 2-1:

- *Assessment of Need Carbon Capped*
- *Assessment of Need Carbon Traded*
- *Global Growth Carbon Traded*
- *Global Fragmentation Carbon Capped*

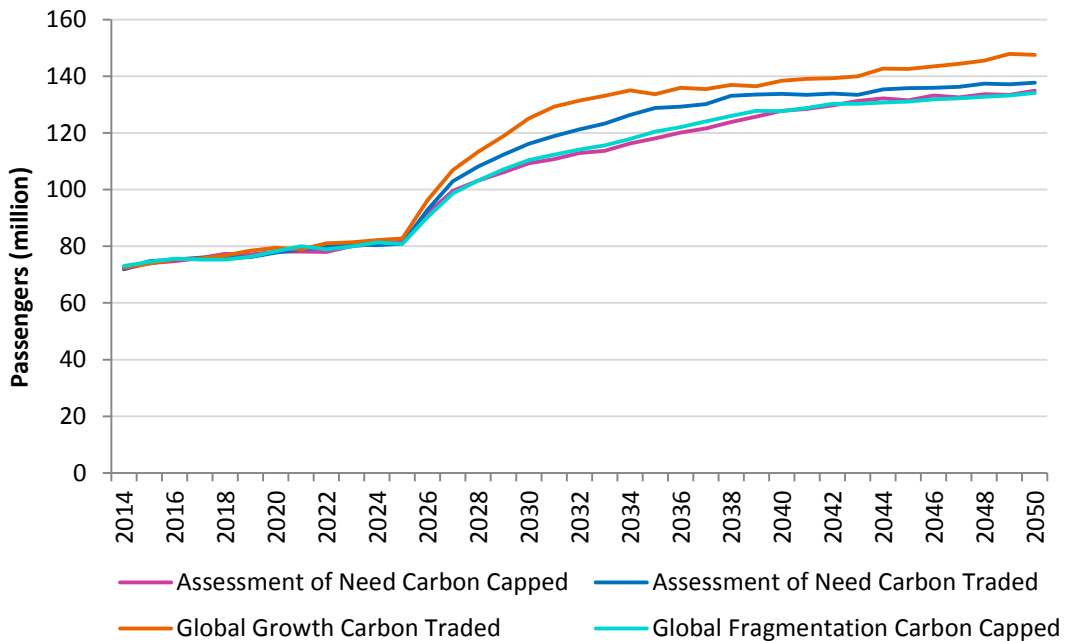


Figure 2-1 Airports Commission Demand Scenarios

Opening of the third runway was driven by air transport movement (ATM) demand exceeding the current capacity irrespective of passenger demand. Although certain demand scenarios exceeded the current 480,000 ATM per annum cap of the existing runways before 2026, the earliest the third runway was assumed to be

opened was 2026, based upon the Airports Commission’s view of the likely timescale required for regulatory and planning processes.

Each phase was assumed to open at the end of the year before demand was forecast to exceed capacity. With reference to the Operational Efficiency Ground Infrastructure report, the following phase capacities were adopted.

Phase	Capacity (mppa)
Existing	80
With T6 Phase 1	85
With T6 Phase 2	100
With T2 Phase 2	110
With T2D	120
With T2 Phase 3	130

Table 2-2 Capacity Provision by Phase

In the years prior to opening of the phase, the estimated cost of the phase was incurred over a period of three to six years depending upon the value of expenditure, following a simplified, but typical sigmoidal curve (S-curve) profile.

3 Scheme Capital Expenditure

Following the approach set out in Section 2.2, the elements of the scheme were disaggregated based upon the data provided by HAL within its submissions. This enabled a statement of quantity and rate by item. The quantities were confirmed against the scheme master plan and the rates compared to our expectation of a reasonable market rate taking into account the nature, site and location of the works. Risk and optimism bias adjustments were applied to the base case. Appendix C presents the resulting build-up of the Scheme works (including mitigated optimism bias) for all phases. The cost was estimated to be £18.6 billion with mitigated optimism bias applied and £21.4 billion with unmitigated optimism bias, compared to HAL’s estimate of £14.8 billion (excluding surface access costs from HAL’s total estimate of £15.6 billion and optimism bias).

With reference to Section 0 and from a comparison of Figure 2-1 and Table 2-2, it can be observed that all demand scenarios require the completion of all phases of the scheme.

Section 3.1 summarises the forecast Scheme capital expenditure, by year, against each of the Airports Commission’s demand scenarios. Given that all scenarios require the full build-out of all phases, the difference between the scenarios is the profile of expenditure required to deliver capacity in line with the differing demand requirements. In all scenarios the total expenditure is £18.6 billion and £21.4 billion with mitigated and full optimism bias respectively. Section 3.2 presents HAL’s Scheme capital expenditure forecast.

In summary, for each scenario, Scheme capital expenditure is as shown in Table 3-1 with mitigated and unmitigated optimism bias. For reference, HAL’s estimate is also stated unadjusted for optimism bias.

Scenario	Optimism Bias	
	Mitigated	Unmitigated
Assessment of Need Carbon Capped	18,583	21,371
Assessment of Need Carbon Traded	18,583	21,371
Global Growth Carbon Traded	18,583	21,371
Global Fragmentation Carbon Capped	18,583	21,371
HAL	14,761	

Table 3-1 Total Scheme Capital Expenditure by Demand Scenario (2014 prices, £’million)

3.1 Airports Commission Demand Scenarios

3.1.1 Assessment of Need Carbon Capped

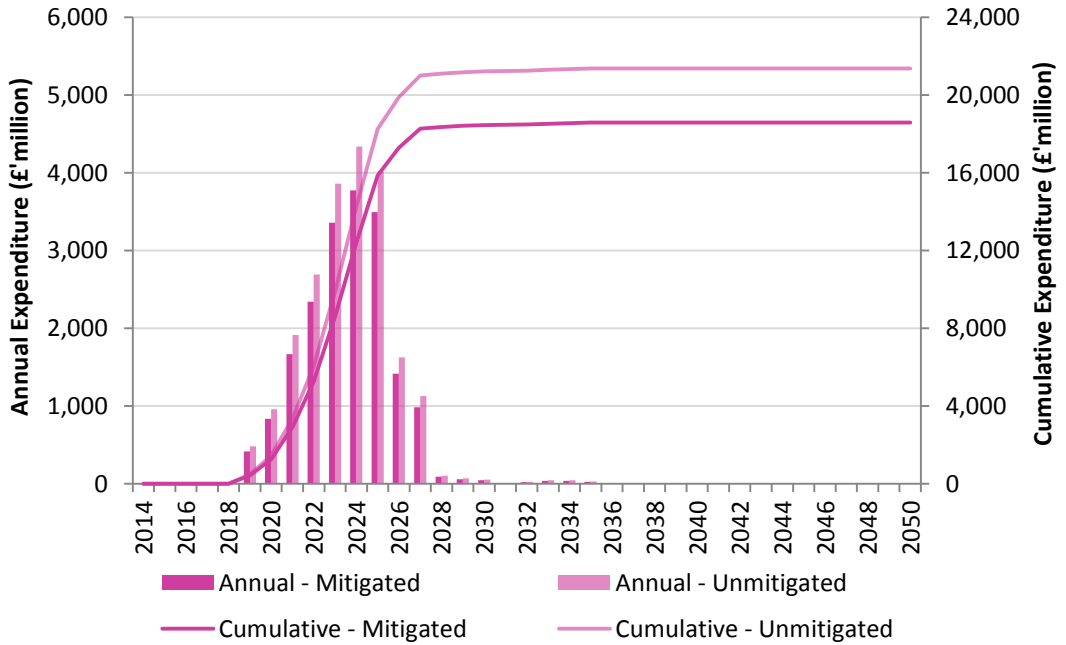


Figure 3-1 Assessment of Need Carbon Capped

3.1.2 Assessment of Need Carbon Traded

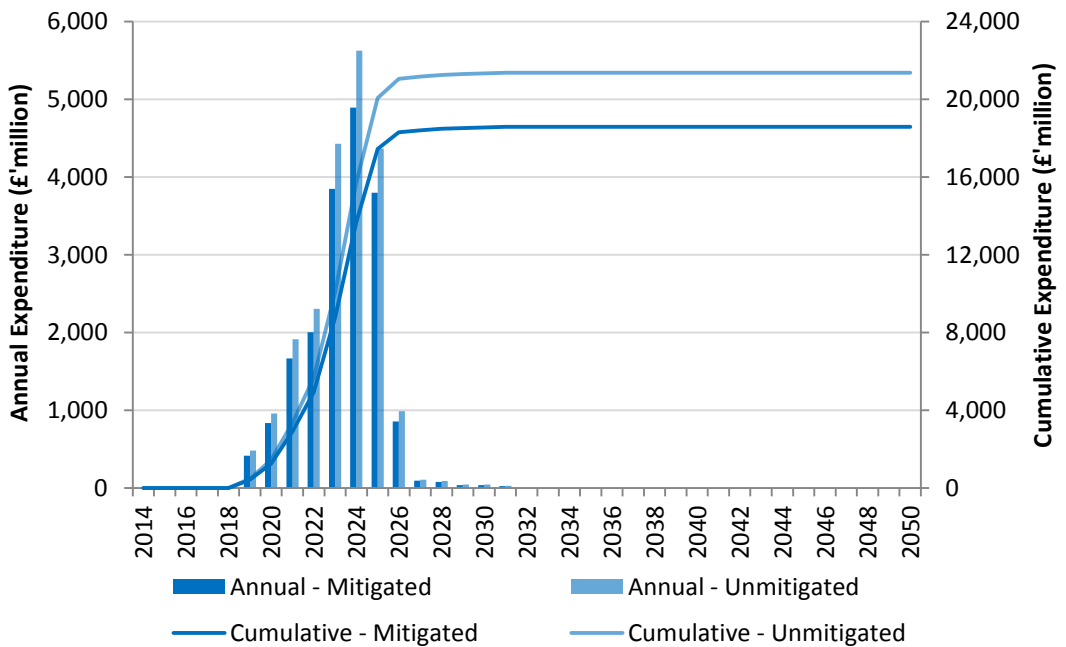


Figure 3-2 Assessment of Need Carbon Traded

3.1.3 Global Growth Carbon Traded

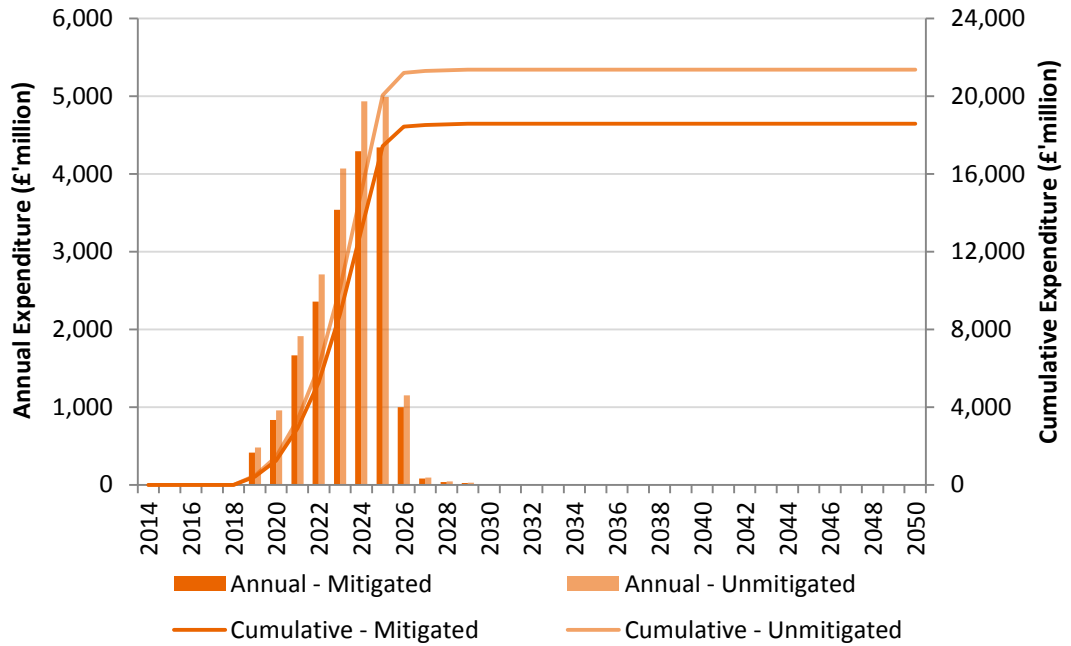


Figure 3-3 Global Growth Carbon Traded

3.1.4 Global Fragmentation Carbon Capped

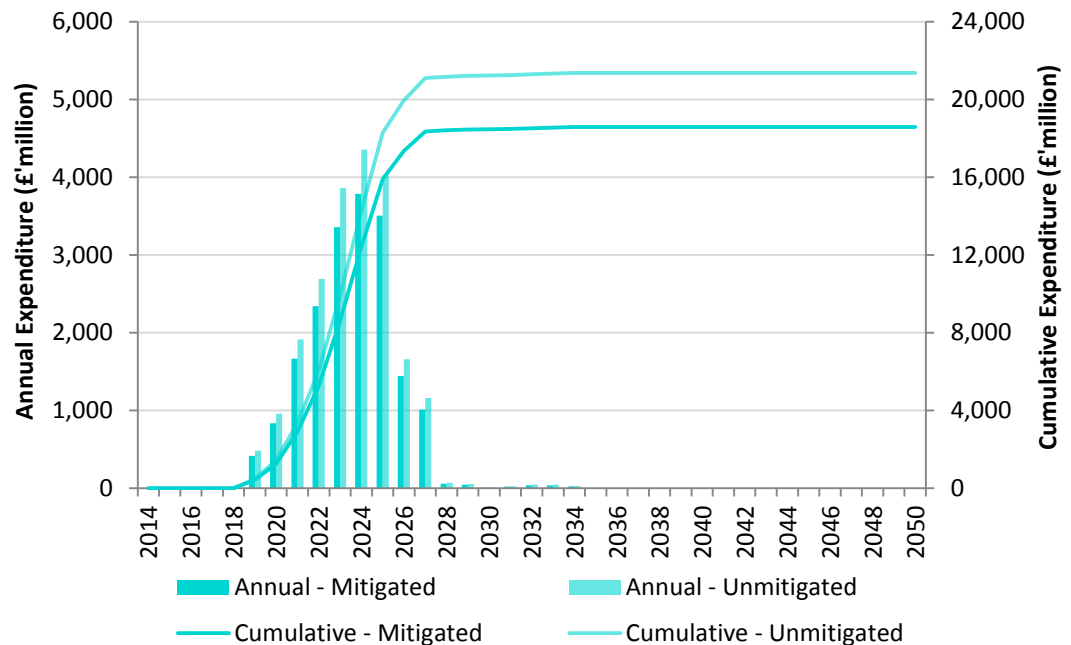


Figure 3-4 Global Fragmentation Carbon Capped

3.2 Heathrow Airport Ltd Scheme Capital Expenditure

HAL estimates a total Scheme expenditure of £14.8 billion (excluding surface access works), incurred across principally six phases (as discussed in the Operational Efficiency Ground Infrastructure report), with a profile of expenditure as presented in Figure 3-5. No adjustments have been made to this presentation

which therefore is unadjusted for optimism bias and includes risk following the methodology adopted by HAL.

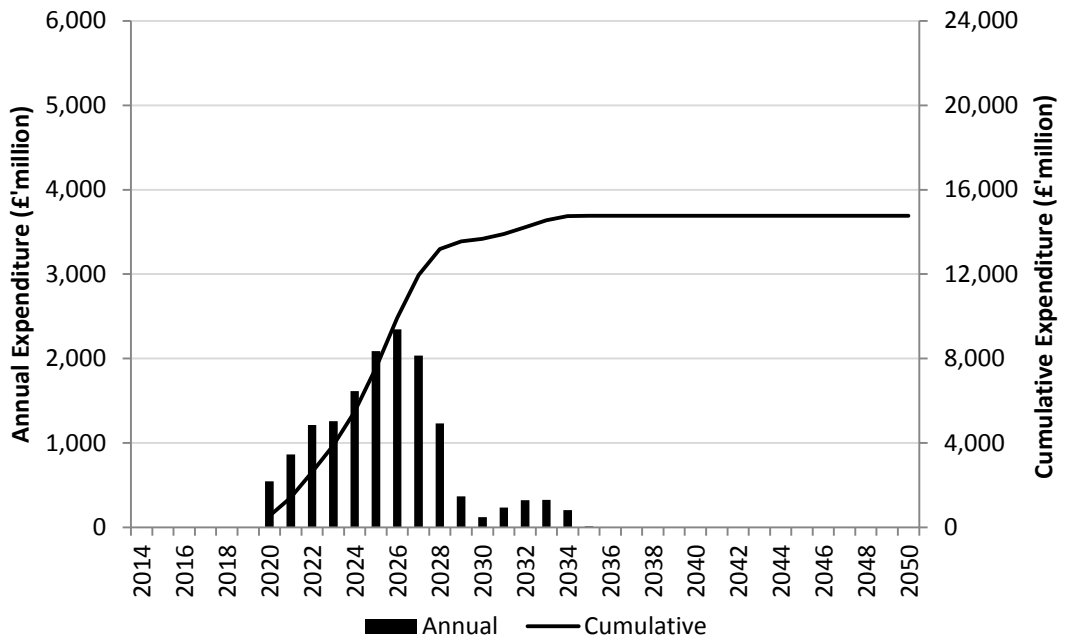


Figure 3-5 HAL Scheme Capital Expenditure

3.3 Annual Scheme Capital Expenditure Summaries

The tables on the following pages present the data underlying the previous figures with mitigated optimism bias. These tables are based upon the detailed breakdown presented in Appendix C, but, for the purpose of enabling the assessment of depreciation, summarises the total expenditure into the following headings. General costs itemised separately with the breakdown presented in Appendix C (enabling works, project management on-cost, etc), are distributed across the below headings in the following tables in proportion to the underlying cost of each cost heading to the total cost.

- *Terminal buildings: passenger terminal buildings including piers and satellites*
- *Plant: building plant (e.g. air conditioning, etc) including utilities and power generation*
- *Transit systems: passenger transit systems above or below ground*
- *Runways: runway and associated instrument landing systems*
- *Taxiways and aprons: taxiways, aprons and their associated systems*
- *Equipment: mobile equipment and baggage handling installations*
- *Land: acquisition of land including commercial businesses and residential properties*
- *Airfield ancillary: other infrastructure elements for example control tower, rescue and fire fighting facilities, fencing, airside roads, etc*
- *Car parks: all car parks whether multi-storey or surface*
- *Third party land users: provision of serviced plots for third party development*
- *Environment: river diversions and environmental compensation and mitigation*
- *Community: community impact compensation*

2014, real prices in £'million - Mitigated optimism bias

Scheme	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	3,481	-	-	-	-	-	-	-	-	266	665	972	962	370	247	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Plant	740	-	-	-	-	-	18	35	71	100	145	161	142	41	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Transit systems	1,356	-	-	-	-	-	6	13	26	124	270	374	356	112	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	187	-	-	-	-	-	9	19	37	37	37	28	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Taxiways and aprons	654	-	-	-	-	-	21	42	84	84	84	75	89	105	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equipment	1,142	-	-	-	-	-	-	-	-	59	147	233	287	250	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Land	2,967	-	-	-	-	-	148	297	593	593	593	445	297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Airfield Ancillary	777	-	-	-	-	-	35	70	140	144	150	120	89	18	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Car Parks	579	-	-	-	-	-	-	-	-	14	36	58	83	86	84	60	40	30	4	13	26	26	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Third Party Land Users	94	-	-	-	-	-	5	9	19	19	19	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Environment	581	-	-	-	-	-	29	58	116	116	116	87	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Community	347	-	-	-	-	-	17	35	69	69	69	52	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Risk	2,581	-	-	-	-	-	58	116	231	325	466	524	485	196	136	12	8	6	1	3	5	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias	3,097	-	-	-	-	-	69	139	277	390	560	629	582	236	163	14	10	7	1	3	6	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total	18,583	-	-	-	-	-	416	832	1,664	2,342	3,357	3,772	3,493	1,413	981	87	58	43	6	19	37	37	25	-	-	-	-	-	-	-	-	-	-	-	-	-		

Table 3-2 Assessment of Need Carbon Capped

2014, real prices in £'million - Mitigated optimism bias

Scheme	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	3,481	-	-	-	-	-	-	-	-	133	839	1,310	993	206	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Plant	740	-	-	-	-	-	18	35	71	85	164	199	146	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Transit systems	1,356	-	-	-	-	-	6	13	26	75	332	485	357	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	187	-	-	-	-	-	9	19	37	37	37	28	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Taxiways and aprons	654	-	-	-	-	-	21	42	84	84	96	133	135	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Equipment	1,142	-	-	-	-	-	-	-	-	29	204	401	369	139	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Land	2,967	-	-	-	-	-	148	297	593	593	593	445	297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Airfield Ancillary	777	-	-	-	-	-	35	70	140	142	153	132	95	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Car Parks	579	-	-	-	-	-	-	-	-	7	51	112	125	97	65	53	26	26	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Third Party Land Users	94	-	-	-	-	-	5	9	19	19	19	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Environment	581	-	-	-	-	-	29	58	116	116	87	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Community	347	-	-	-	-	-	17	35	69	69	69	52	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Risk	2,581	-	-	-	-	-	58	116	231	278	535	680	528	119	13	11	5	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias	3,097	-	-	-	-	-	69	139	277	334	642	816	633	143	16	13	6	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total	18,583	-	-	-	-	-	416	832	1,664	2,003	3,849	4,894	3,799	856	93	77	37	37	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Table 3-3 Assessment of Need Carbon Traded

2014, real prices in £'million - Mitigated optimism bias

Scheme	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	3,481	-	-	-	-	-	-	-	-	266	706	1,095	1,168	247	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Plant	740	-	-	-	-	-	18	35	71	100	149	175	165	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Transit systems	1,356	-	-	-	-	-	6	13	26	124	283	411	418	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Runways	187	-	-	-	-	-	9	19	37	37	37	28	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Taxiways and aprons	654	-	-	-	-	-	21	42	84	84	96	110	147	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Equipment	1,142	-	-	-	-	-	-	-	-	59	174	316	426	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Land	2,967	-	-	-	-	-	148	297	593	593	593	445	297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Airfield Ancillary	777	-	-	-	-	-	35	70	140	144	152	126	99	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Car Parks	579	-	-	-	-	-	-	-	-	25	64	120	174	97	56	26	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Third Party Land Users	94	-	-	-	-	-	5	9	19	19	19	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Environment	581	-	-	-	-	-	29	58	116	116	116	87	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Community	347	-	-	-	-	-	17	35	69	69																												

2014, real prices in £'million - Mitigated optimism bias

Scheme	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	
<i>Terminal buildings</i>	3,481	-	-	-	-	-	-	-	-	266	665	972	962	370	247	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Plant</i>	740	-	-	-	-	-	18	35	71	100	145	161	142	41	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Transit systems</i>	1,356	-	-	-	-	-	6	13	26	124	270	374	356	112	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Runways</i>	187	-	-	-	-	-	9	19	37	37	37	28	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Taxiways and aprons</i>	654	-	-	-	-	-	21	42	84	84	84	75	89	105	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Equipment</i>	1,142	-	-	-	-	-	-	-	-	59	147	233	287	250	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Land</i>	2,967	-	-	-	-	-	148	297	593	593	593	445	297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Airfield Ancillary</i>	777	-	-	-	-	-	35	70	140	144	150	120	89	18	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Car Parks</i>	579	-	-	-	-	-	-	-	-	14	36	68	93	106	104	40	30	4	13	26	26	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Third Party Land Users</i>	94	-	-	-	-	-	5	9	19	19	19	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Environment</i>	581	-	-	-	-	-	29	58	116	116	116	87	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Community</i>	347	-	-	-	-	-	17	35	69	69	69	52	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Risk</i>	2,581	-	-	-	-	-	58	116	231	325	466	526	487	200	140	8	6	1	3	5	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Optimism Bias</i>	3,097	-	-	-	-	-	69	139	277	390	560	631	585	240	168	10	7	1	3	6	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	18,583	-	-	-	-	-	416	832	1,664	2,342	3,357	3,786	3,508	1,442	1,010	58	43	6	19	37	37	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3-5 Global Fragmentation Carbon Capped

Appendix A Glossary

ATM	Air transport movement
CAA	UK Civil Aviation Authority
CAGR	Compound annual growth rate
COPI	Construction price output index
Core	Investment in the airport irrespective of investment in the additional runway works
CPI	Consumer prices index
CUTE	Common user terminal equipment
DfT	Department for Transport
EAC	Electrification access charge
EASA	European Aviation Safety Agency
EC4T	Electric current for traction
HAL	Heathrow Airport Limited
HH	Heathrow Hub
IMF	International Monetary Fund
IPP	Income per passenger
mppa	million passengers per annum
PRM	Passengers with reduced mobility
Q6	Quinquennium 6 (2014 to 2018)
Q7	Quinquennium 7 (2019 to 2023)
RPI	Retail prices index
Scheme	Investment in the additional runway works
tph	Trains per hour
VTA	Variable track access
WebTAG	Web-based Transport Analysis Guidance

Appendix B Optimism Bias

Upper bound values for combined projects

Project Type	CAPEX (%)	Upper bound OB (%)	OB contribution (%)	Resultant OB (%)
Standard Building	30%	24	7.2	
Standard Civil Engineering	70%	44	30.8	
Combined				38.0

Contributory Factors		Standard Building optimism bias (%)	Mitigation Factor (0<x<1)	Reduction in optimism bias	Mitigated optimism bias (%)	Standard Civil Engineering optimism bias (%)	Mitigation Factor (0<x<1)	Reduction in optimism bias	Mitigated optimism bias (%)
Procurement	Late Contractor Involvement in Design	2	0.95	1.9	0.1	3	0.95	2.9	0.2
	Poor contractor Capabilities	9	0.95	8.6	0.5				
	Dispute and Claims Occurred	29	0.70	20.3	8.7	21	0.70	14.7	6.3
Project Specific	Design Complexity	1	0.90	0.9	0.1				
	Degree of Innovation	4	0.80	3.2	0.8				
	Environmental Impact					22	0.50	11.0	11.0
Client Specific	Other					18	0.50	9.0	9.0
	Inadequacy of the Business Case	34	0.80	27.2	6.8	10	0.80	8.0	2.0
	Project Management Team	1	0.90	0.9	0.1				
	Poor Project Intelligence	2	0.80	1.6	0.4	7	0.80	5.6	1.4
Environment	Other - omitted (<1)								
	Public Relations	2	0.50	1.0	1.0	9	0.50	4.5	4.5
	Site Characteristics	2	0.80	1.6	0.4	3	0.80	2.4	0.6
External Influences	Permits/Consents/Approvals								
	Economic	11	0.20	2.2	8.8	7	0.20	1.4	5.6
	Legislation/Regulations	3	0.70	2.1	0.9				
Weighted Total		100			28.6	100			40.6

Adjusted Capital Expenditure Optimism Bias

Project Type	Percentage of CAPEX (%)	Mitigated OB (%)	OB contribution (%)	Resultant OB (%)
Standard Building	30%	6.9	2.1	
Standard Civil Engineering	70%	17.8	12.5	
Combined				14.5

Figure B-1 Core Works

Upper bound values for combined projects

Project Type	CAPEX (%)	Upper bound OB (%)	OB contribution (%)	Resultant OB (%)
Standard Building	30%	24	7.2	
Standard Civil Engineering	70%	44	30.8	
Combined				38.0

Contributory Factors		Standard Building optimism bias (%)	Mitigation Factor (0<x<1)	Reduction in optimism bias	Mitigated optimism bias (%)	Standard Civil Engineering optimism bias (%)	Mitigation Factor (0<x<1)	Reduction in optimism bias	Mitigated optimism bias (%)
Procurement	Late Contractor Involvement in Design	2	0.95	1.9	0.1	3	0.95	2.9	0.2
	Poor contractor Capabilities	9	0.95	8.6	0.5				
	Dispute and Claims Occurred	29	0.70	20.3	8.7	21	0.70	14.7	6.3
Project Specific	Design Complexity	1	0.80	0.8	0.2				
	Degree of Innovation	4	0.90	3.6	0.4				
	Environmental Impact					22	0.40	8.8	13.2
Client Specific	Other					18	0.10	1.8	16.2
	Inadequacy of the Business Case	34	0.70	23.8	10.2	10	0.70	7.0	3.0
	Project Management Team	1	0.90	0.9	0.1				
	Poor Project Intelligence	2	0.70	1.4	0.6	7	0.60	4.2	2.8
Environment	Other - omitted (<1)								
	Public Relations	2	0.20	0.4	1.6	9	0.20	1.8	7.2
	Site Characteristics	2	0.50	1.0	1.0	3	0.50	1.5	1.5
External Influences	Permits/Consents/Approvals								
	Economic	11	0.20	2.2	8.8	7	0.20	1.4	5.6
	Legislation/Regulations	3	0.70	2.1	0.9				
Weighted Total		100			33.1	100			56.0

Adjusted Capital Expenditure Optimism Bias

Project Type	Percentage of CAPEX (%)	Mitigated OB (%)	OB contribution (%)	Resultant OB (%)
Standard Building	30%	7.9	2.4	
Standard Civil Engineering	70%	24.6	17.2	
Combined				19.6

Figure B-2 Scheme Works

Potential actions/processes likely to be adopted by HAL to enable the mitigated optimism bias include:

- *HAL supply chain in place and contractors will be selected that are familiar with procurement procedures, existing facilities and with details of different phases of the scheme.*

- *Contractors to have a proven track record working at airports, excellent health and safety standards and an exceptional record following HAL procedures, reflected by good key performance indicator scores.*
- *Contractors are selected from existing frameworks and a list of preferred contractors that will have extensive knowledge of working on the airport.*
- *HAL has detailed processes to manage the different phases of a project and associated risks.*
- *New staff with relevant expertise expected to be recruited to accommodate project scope.*
- *Construction within live airfield and above an extensive tunnel network, however extensive records available.*
- *No innovative architectural, structural or civils designs proposed and there are no unusual site conditions expected that would call for an innovative solution.*
- *Significant investment made by HAL into environmental mitigation schemes.*
- *Experienced and proven PM team to be appointed.*
- *Extensive surveys are to be carried out in areas of proposed construction and extensive record information for the airport is available electronically to the designers and contractors.*
- *Dispensations from EASA may be required.*

Appendix C Scheme Capital Cost Estimate Breakdown

The table on the following pages sets out the breakdown of the total Scheme cost, for all phases. The breakdown includes mitigated optimism bias.

Ref No	Description	Quantity	Unit	Rate	Total (£)
HAL	Heathrow Airport (Jacobs Estimate)				18,583,044,652
01.	Investment Costs				12,904,892,119
01.01.	Airport Infrastructure Construction				8,172,814,365
01.01.01.	Enabling Works				394,478,438
01.01.01.0001.	Decants / Demolitions				239,408,228
01.01.01.0001.0010	Site Clearance	543	ha	156,326.82	84,951,308
01.01.01.0001.0020	Decants / Demolitions	0.91	sum	170,612,244.90	154,456,920
01.01.01.0002.	Enabling Works				155,070,210
01.01.01.0002.0010	Earthworks	3,932,524	m3	8.21	32,286,023
01.01.01.0002.0020	Site Levelling and Soil Remediation / Stabilisation	270	ha	454,974.30	122,784,187
01.01.02.	Airfield				655,157,015
01.01.02.0001.	Runway				96,697,125
01.01.02.0001.0010	Runways including shoulders	262,500	m2	368.37	96,697,125
01.01.02.0002.	Taxiways & Aprons				315,604,681
01.01.02.0002.0015	Taxiways and Taxi Lanes	856,760	m2	368.37	315,604,681
01.01.02.0003.	Stands				199,248,210
01.01.02.0003.0020	Code C/D Stands	717	m2	448.24	321,388
01.01.02.0003.0030	Contact Stands to satellites	380,580	m2	418.78	159,379,292
01.01.02.0003.0040	Remote Stands	66,836	m2	591.71	39,547,530
01.01.02.0004.	Airfield Instrumentation				43,606,999
01.01.02.0004.0100	Navigational Equipment / Lighting	1,433,027	m2	30.43	43,606,999
01.01.03.	Airfield Ancillary Facilities				329,314,433
01.01.03.0001.	Air Traffic Control				60,000,000
01.01.03.0001.0090	Control Tower	1	sum	60,000,000.00	60,000,000
01.01.03.0002.	Security				19,387,755
01.01.03.0002.0120	Site Security Fence	1	sum	5,428,571.43	5,428,571
01.01.03.0002.0130	Control Posts	1	sum	13,959,183.67	13,959,184
01.01.03.0003.	Rescue and Fire Fighting				3,060,000
01.01.03.0003.0010	Fire Station	1	Nr	3,060,000.00	3,060,000
	Maintenance base				
01.01.03.0004.	Fuel Systems				49,219,049
01.01.03.0004.0080	Fuel Farms	7	Nr	7,031,292.78	49,219,049
01.01.03.0005.	De-icing & Snow Clearance				29,352,522
01.01.03.0005.0010	De Icing Pads	1	sum	29,352,521.74	29,352,522
01.01.03.0006.	Serviced areas for ancillary facilities e.g. Hotels, Offices, Cargo Buildings, Hangars, etc				70,650,300
01.01.03.0006.0010	Serviced areas for ancillary facilities e.g. Hotels, Offices, Cargo Buildings, Hangars, etc	706,503	m2	100	70,650,300
01.01.03.0007.	Surface Water Drainage				24,960,000
01.01.03.0007.0060	Balancing Ponds incl. equipment, pumping, controls * instrumentation, oil interceptors, pipework, etc	83	ha	300,000	24,960,000
01.01.03.0008.	Noise Control Measures				72,684,807
01.01.03.0008.0130	Noise Bund	1	sum	72,684,807	72,684,807
01.01.04.	Terminal Buildings				3,329,441,907
01.01.04.0001.	Terminals				1,559,368,141
01.01.04.0001.0010	T6 Terminal building, Substructure	67,605	m2	3,572.65	241,529,003
01.01.04.0001.0020	T6 Terminal building, Superstructure	67,605	m2	6,732.20	455,130,381
01.01.04.0001.0030	T6 Terminal building, Fit Out	67,605	m2	12,761.02	862,708,757
01.01.04.0002.	Piers & Satellites				1,560,073,765
01.01.04.0002.0040	Satellite Substructure	50,644	m2	2,684.16	135,936,599
01.01.04.0002.0050	Satellite Superstructure	50,645	m2	8,128.90	411,688,141
01.01.04.0002.0060	Satellite Fit Out	50,646	m2	5,612.37	284,244,091
01.01.04.0002.0090	T2E Satellite	21,780	m2	33,434.57	728,204,935
01.01.04.0003.	Fixed Links, VCC, Rotunda/Nodes, PCA and Airbridges				210,000,000
01.01.04.0003.0070	VCC, Airbridge, PCA, nodes and fixed links to new stands	66	Nr	3,181,818	210,000,000
01.01.05.	Airside Infrastructure				1,640,107,579
01.01.05.0001.	Access Roads				332,693,878
01.01.05.0001.0050	Airside Roads & Tunnels	1	sum	332,693,877.55	332,693,878
01.01.05.0002.	Baggage Tunnels				250,819,944
01.01.05.0002.0010	Baggage Tunnels Civils	2,400	m	30,864.14	74,073,936
01.01.05.0002.0040	Baggage Tunnels Fit Out	2,400	m	73,644.17	176,746,008

Ref No	Description	Quantity	Unit	Rate	Total (£)
01.01.05.0003.	TTS Tunnels				516,321,648
01.01.05.0003.0050	TTS Tunnels Civils	6,300	m	57,855.52	364,489,776
01.01.05.0003.0070	TTS Tunnels Fit Out	6,300	m	22,157.44	139,591,872
01.01.05.0003.0080	Additional TTS Cars	6	Nr	2,040,000.00	12,240,000
01.01.05.0004.	TTS Station / Depot				540,272,110
01.01.05.0004.0050	TTS Stations	4	Nr	74,190,476.45	296,761,906
01.01.05.0004.0060	TTS Station Fit Out	1.00	sum	107,795,918.37	107,795,918
01.01.05.0004.0080	TTS Maintenance Base Substructure	1.00	sum	103,142,857.14	103,142,857
01.01.05.0004.0090	TTS Maintenance Base Fit Out	1.00	sum	32,571,428.57	32,571,429
01.01.06.	Landside Infrastructure				967,376,217
01.01.06.0001.	Connectivity				96,938,776
01.01.06.0001.0040	Landside connectivity systems	1.00	sum	96,938,775.51	96,938,776
01.01.06.0002.	Car Parks				500,204,082
01.01.06.0002.0020	Car Park - Surface & Multi Storey Parking	1.00	sum	500,204,081.63	500,204,082
01.01.06.0003.	Power Generation				93,061,224
01.01.06.0003.0020	Energy and Infrastructure	1.00	sum	93,061,224.49	93,061,224
01.01.06.0004.	Utilities				172,163,265
01.01.06.0004.0030	Utilities	1.00	sum	172,163,265.31	172,163,265
01.01.06.0005.	River Diversion / Culverts				105,008,870
01.01.06.0005.0020	Culverts	1.00	sum	28,460,347.83	28,460,348
01.01.06.0005.0030	Waterways	1.00	sum	76,548,521.74	76,548,522
01.01.07.	Equipment				729,755,102
01.01.07.0003.	Baggage Handling Systems				729,755,102
01.01.07.0003.0001	Baggage Equipment Terminal	1.00	sum	299,346,938.78	299,346,939
01.01.07.0003.0002	Baggage Equipment Satellite	1.00	sum	430,408,163.27	430,408,163
01.01.08.	Operational Commissioning				124,081,633
01.01.08.0007.	Development Process Costs				124,081,633
01.01.08.0007.0010	Consents	0.80	sum	135,714,285.71	108,571,429
01.01.08.0007.0020	Operational Readiness	0.80	sum	19,387,755.10	15,510,204
01.01.09.	Operational Handover				3,102,041
01.01.09.0001.	Operational Handover				3,102,041
01.01.09.0001.0030	Aerodrome Manual	0.80	sum	3,877,551.02	3,102,041
01.02.	Purchase of Land & Existing Infrastructure				2,225,973,913
01.02.01.	Purchase of Land & Existing Infrastructure				2,225,973,913
01.02.01.0001.	Purchase of Land & Existing Infrastructure				2,225,973,913
01.02.01.0001.0010	Residential property compulsory purchase	1.00	sum	267,652,173.91	267,652,174
01.02.01.0001.0020	Commercial property compulsory purchase	1.00	sum	1,552,382,608.70	1,552,382,609
01.02.01.0001.0030	Land Purchase	1.00	sum	405,939,130.43	405,939,130

Ref No	Description	Quantity	Unit	Rate	Total (£)
01.04.	Environmental Compensation & Mitigation				476,069,043
01.04.01.	Environmental Compensation & Mitigation				476,069,043
01.04.01.0001.	Ecology				12,222,783
01.04.01.0001.0010	Ecology	1.00	sum	12,222,782.61	12,222,783
01.04.01.0002.	Landscape				138,019,304
01.04.01.0002.0010	Habitat Reprovision	1.00	sum	26,497,565.22	26,497,565
01.04.01.0002.0020	Landscape	1.00	sum	111,521,739.13	111,521,739
01.04.01.0003.	Surface water flood mitigation				137,840,870
01.04.01.0003.0010	Surface Water Flood Mitigation	1.00	sum	120,175,826.09	120,175,826
01.04.01.0003.0050	Sundries	1.00	sum	17,665,043.48	17,665,043
01.04.01.0004.	Listed Building Decants				45,500,870
01.04.01.0004.0010	Listed Building Decants / Relocations	1.00	sum	21,412,173.91	21,412,174
01.04.01.0004.0020	Archaeology	1.00	sum	24,088,695.65	24,088,696
01.04.01.0005.	Energy / Water / Waste (Sustainability)				43,900,000
01.04.01.0005.0010	Energy / Water / Waste (Sustainability)	1.00	sum	43,900,000.00	43,900,000
01.04.01.0006.	Noise Mitigation				98,585,217
01.04.01.0006.0010	Noise Bunds	1.00	sum	77,262,260.87	77,262,261
01.04.01.0006.0020	Local Road Resurfacing	1.00	sum	14,453,217.39	14,453,217
01.04.01.0006.0030	Acoustic fence	1.00	sum	6,869,739.13	6,869,739
01.05.	Community Impacts				346,788,000
01.05.01.	Community Impacts				346,788,000
01.05.01.0001.	Community Impacts				346,788,000
01.05.01.0001.0010	Noise Insulation and Compensation	1.00	sum	223,043,478.26	223,043,478
01.05.01.0001.0020	Community Infrastructure Levy	1.00	sum	53,262,782.61	53,262,783
01.05.01.0001.0030	Other Community	1.00	sum	70,481,739.13	70,481,739
01.06.	Project / Design Team Fees				1,683,246,798
01.06.01.	Project / Design Team Fees				1,683,246,798
01.06.01.0001.	Project / Design Team Fees	15%			1,683,246,798
01.06.01.0001.0010	Project / Design Team Fees on 01.01		%		1,225,922,155
01.06.01.0001.0020	Project / Design Team Fees on 01.02		%		333,896,087
01.06.01.0001.0030	Project / Design Team Fees on 01.03		%		0
01.06.01.0001.0040	Project / Design Team Fees on 01.04		%		71,410,357
01.06.01.0001.0050	Project / Design Team Fees on 01.05		%		52,018,200
03.	Risks & Optimism Bias				5,678,152,533
03.01.	Risks (Design, Construction & Employer Risk)				2,580,978,424
03.01.01.	Risks (Design, Construction & Employer Risk)				2,580,978,424
03.01.01.0001.	Risks (Design, Construction & Employer Risk)	20%			2,580,978,424
03.01.01.0001.0010	Risk Contingency on 01.01		%		1,634,562,873
03.01.01.0001.0020	Risk Contingency on 01.02		%		445,194,783
03.01.01.0001.0030	Risk Contingency on 01.03		%		0
03.01.01.0001.0040	Risk Contingency on 01.04		%		95,213,809
03.01.01.0001.0050	Risk Contingency on 01.05		%		69,357,600
03.01.01.0001.0060	Risk Contingency on 01.06		%		336,649,360
03.02.	Optimism Bias				3,097,174,109
03.02.01.	Optimism Bias				3,097,174,109
03.02.01.0001.	Optimism Bias	20%			3,097,174,109
03.02.01.0001.0010	Optimism Bias on 01.01		%		1,634,562,873
03.02.01.0001.0020	Optimism Bias on 01.02		%		445,194,783
03.02.01.0001.0030	Optimism Bias on 01.03		%		0
03.02.01.0001.0040	Optimism Bias on 01.04		%		95,213,809
03.02.01.0001.0050	Optimism Bias on 01.05		%		69,357,600
03.02.01.0001.0060	Optimism Bias on 01.06		%		336,649,360
03.02.01.0001.0070	Optimism Bias on 03.01		%		516,195,685

Appendix D Approach to Core and Asset Replacement Capital Expenditure

The approach to the Core works and Asset Replacement estimates was based upon the estimates provided by HAL. This approach recognised that HAL has greater knowledge relating to the condition of the current assets and the detail of its plans in the absence of the third runway Scheme works. However, recognising The Green Book guidance to correct for the systematic tendency for project appraisers to be overly optimistic, HAL’s estimates post Q6 were adjusted for optimism bias.

Following the approach to optimism bias set out in Section 2.2.1, the Core works were assessed to be undertaken in a more known environment comprising established procurement methodologies and supply chains, and within the footprint of the current site, therefore, with reference to Appendix B, it was considered that optimism bias could be reasonably mitigated to a greater extent than that applied to the Scheme works, and a consistent 15% allowance was determined. As per Section 2.2.1, we note HAL’s comments, but consider 15% to be an appropriate allowance at this stage of project development within the context of the analyses in which these cost estimates are to be used.

In summary, therefore, adjustments were made as follows:

		Core		Asset Replacement
		Q6	Post Q6	(Post Q6)
Risk		0	0	20
Optimism Bias	Mitigated	0	15	20
	Unmitigated	0	15	38

Table D-1 Summary of Risk and Optimism Bias Adjustments to the Base Costs (%)

D.1 Core Works

HAL provided estimates of its Core works, primarily commencing in financial year 2019. Therefore, in order for the capital cost estimate to commence in 2014, the whole of the Q6³ capital expenditure requirement were adopted. HAL’s cost estimate was adopted as presented without adjustment for risk, as this was assumed to be already included, but it was adjusted to include optimism bias at the reduced Core rate of 15% as discussed above. In the absence of confirmation to the contrary, HAL’s values were assumed to be in 2014 values⁴.

D.1.1 Q6

The CAA set out in CAP 1151 the minimum capital expenditure required as a condition of HAL’s licence. These costs are presented in Table D-2 on the following page:

³ Q6 is the current five year regulatory period adopted by the Civil Aviation Authority (CAA). The Q6 settlement or ‘notice granting the licence’ is a binding commitment between the airport and the CAA covering the period April 2014 to December 2018 inclusive.

⁴ Other financial values in HAL’s submission were indicated as being based in other year’s, however, capital expenditure was unstated and therefore assumed to be in current values.

£ million	9 mo. 2014	2015	2016	2017	2018	Total
Capex	439.1	669.0	645.6	528.8	533.9	2,816.4

Table D-2 Q6 Capital Expenditure (Source: CAP 1151, CAA)

The 2014 calendar year for HAL was inflated pro-rata for the 9 months of 2014. The costs within CAP1151 are presented in 2011/12 prices. These were inflated into 2014 prices using the Construction Output Price Index (COPI), which represented a 4.9% increase to the above values. The costs were adopted, unadjusted for risk and optimism bias as they had gone through the airport’s capital cost development, constructive engagement and the CAA’s regulatory processes.

As instructed by the Airports Commission, the HAL Q6 cost was modelled as asset replacement with the exception of an element of work identified by HAL during Q6 which was considered to be Core expansion.⁵

D.1.2 Core Works Cost Estimate

The key elements of Core work were identified as being:

- *completion of the “toast rack” including satellites and corresponding ramp areas, with the exception of T2E which is included within the Core works;*
- *Phases 2 and 3 of T2;*
- *completion of the tracked transit and baggage systems to connect T5 to T2; and*
- *accommodating works to enable the above.*

The total cost of the works was £13.1 billion including adjustment for optimism bias at 15%.

D.2 Asset Replacement

The allowance for asset replacement sought to cover expenditure relating to:

- *routinely maintain the assets condition and capacity;*
- *periodic major investment to restore the assets deteriorated condition and capacity; and*
- *invest in improvements to condition and capacity of the existing infrastructure.*

It is recognised that the asset replacement category of cost is difficult to estimate with accuracy. Most notably the final allowance, to improve the condition or capacity of the existing asset within the confines of the existing asset, is the most ill-defined as it seeks to ensure a number of unknown, but likely to be incurred, costs are adequately included. For example, it represents investment in existing infrastructure to increase efficiency, improve passenger experience, respond to changing regulatory requirements, or to support an enhanced business case (for example, a new CIP lounge for a new entrant airline), which by their nature are unknown across the planning horizon. Whilst such investments would be subject to their own business case at the time, it is not clear to what extent it can be assumed that traffic would continue to grow without investment in improved services within the extant infrastructure, or that non-aeronautical revenues would not deteriorate without such

⁵ HAL included a c £55 million investment in the Q6 period within its Core works estimate. This was included as Core works (as presented by HAL) and therefore the Q6 (and therefore asset replacement) expenditure within the relevant years was reduced to ensure the Q6 annual and total expenditure remained as the licence condition.

investment. Such improvements are often undertaken in conjunction with more clearly expansionary works, further clouding the uncertainty of this cost element, but noting that the Scheme works do not allow for any such contemporaneous investments it is necessary to ensure that the cost is separately identified. Even in the absence of purely expansionary works, it is reasonable to assume that HAL would seek to improve the condition and capacity of its existing infrastructure, either driven by regulation or to remain competitive within its national and international markets.

D.2.1 Approach

The asset replacement costs proposed by HAL were assessed on a per passenger basis. This considered HAL’s presented total asset replacement estimate against the corresponding traffic forecast. The resulting average per passenger rate, adjusted for risk and optimism bias, was used in the differing Airports Commission’s demand scenarios.

D.2.2 Asset Replacement Cost Estimate

HAL confirmed that, based upon its asset management model, it forecasts an investment of £9,440 million from 2019 to 2050 (i.e. for the period beyond Q6). With reference to the above methodology, this investment can be interpreted into a per passenger rate as follows:

Total investment (£’million)	9,440
Total passengers (millions, 2019-2050)	3,541
Average investment per passenger (£)	2.67
Plus 20% risk allowance (£)	3.20
With mitigated optimism bias (20%)	3.84
With unmitigated optimism bias (38%)	4.42

Table D-3 Determination of HH Asset Replacement Cost per Passenger

This asset replacement rate per passenger was assessed in the context of market expectation and considered to lie towards the lower end of, but within an expected range. As such, as discussed above, the resulting expenditure may provide an adequate budget to cover the first two identified elements of asset replacement (routine and major intervention maintenance expenditure), but may constrain the potential for investment in the third element (investment in improvements to the condition and capacity of the infrastructure that would exist at that time, for example, response to changing regulatory requirements or new business opportunities requiring investment within the existing infrastructure as discussed above). Nonetheless, the rate was considered to be reasonable for the purposes of this assessment.

In addition to the adoption of the above per passenger rates from 2019 onwards, the Q6 capital expenditure requirement was included as asset replacement as directed by the Airports Commission. Consequently, across the assessed demand scenarios, driven by the differing passenger flows, total asset replacement over the forecast period varied from £16.8 to £18.0 billion with mitigated optimism bias and from £18.8 to £20.3 billion with unmitigated optimism bias.

Appendix E Core and Asset Replacement Capital Expenditure Summary

The tables on the following pages summarise the annual capital expenditure relating to the Core and asset replacement works under each of the demand scenarios set out in Figure 2-1. The summaries are presented with mitigated optimism bias applied.

2014, real prices in £'million - Mitigated optimism bias

Core Works	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	6,858	-	-	-	-	-	-	-	24	51	100	398	636	723	818	716	325	104	77	462	795	815	590	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Transit systems	943	-	-	-	-	-	-	-	-	-	54	113	146	178	185	147	70	44	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Taxiways and aprons	1,295	-	-	9	20	25	-	31	105	123	135	129	105	62	-	-	232	258	-	26	22	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equipment	620	-	-	-	-	-	-	-	3	6	9	11	12	26	133	148	39	25	21	35	44	46	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	
Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Airfield Ancillary	1,406	-	-	-	-	-	-	-	91	223	311	331	283	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Car Parks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Third Party Land Users	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Environment	250	-	-	-	-	-	-	-	16	33	44	49	47	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Risk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Optimism Bias	1,697	-	-	-	-	-	-	5	36	66	98	155	184	179	174	152	100	65	16	78	129	131	94	36	-	-	-	-	-	-	-	-	-	-	-	-	-	
Core Works Total	13,069	-	-	9	20	25	-	36	275	503	751	1,185	1,413	1,374	1,332	1,163	766	497	120	601	991	1,005	722	279	-	-	-	-	-	-	-	-	-	-	-	-		

Asset Replacement	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Asset Replacement	12,589	614	702	668	535	535	206	208	208	213	215	218	245	266	275	283	291	295	301	303	310	315	320	324	330	335	341	343	346	350	352	351	355	354	356	360		
Risk	1,907	-	-	-	-	-	41	42	42	43	43	44	49	53	55	57	58	59	60	61	62	63	64	65	66	67	68	69	69	70	70	71	71	71	71	71	72	
Optimism Bias	2,288	-	-	-	-	-	49	50	50	51	52	52	59	64	66	68	70	71	72	73	74	76	77	78	79	81	82	82	83	84	85	84	85	85	85	86	85	
Asset Replacement Total	16,784	614	702	668	535	535	296	300	300	307	310	314	352	382	396	408	419	425	434	436	446	453	461	467	475	483	491	493	498	504	508	505	511	509	513	513		

Table E-1 Assessment of Need Carbon Capped

2014, real prices in £'million - Mitigated optimism bias

Core Works	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	6,858	-	-	-	-	-	-	24	60	82	355	699	986	1,034	702	496	795	815	590	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Transit systems	943	-	-	-	-	-	-	-	4	58	116	174	207	195	139	44	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Taxiways and aprons	1,295	-	-	9	20	25	-	31	105	123	135	129	105	62	232	285	22	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equipment	620	-	-	-	-	-	-	3	6	9	11	25	40	138	161	62	52	51	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Airfield Ancillary	1,406	-	-	-	-	-	-	91	191	277	318	291	196	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Car Parks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Third Party Land Users	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Environment	250	-	-	-	-	-	-	-	16	33	44	49	47	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Risk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias	1,697	-	-	-	-	-	-	22	57	87	147	205	237	226	189	133	131	132	94	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Core Works Total	13,069	-	-	9	20	25	-	172	439	670	1,126	1,572	1,816	1,735	1,445	1,020	1,007	1,011	722	279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Asset Replacement	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Asset Replacement	12,981	614	702	668	535	535	203	207	210	213	215	214	216	248	274	288	300	310	317	323	329	337	344	345	347	355	356	357	356	357	356	361	362	363	363	366	367	
Risk	1,985	-	-	-	-	-	41	41	42	43	43	43	43	50	55	58	60	62	63	65	66	67	69	69	69	71	71	71	71	71	72	72	73	73	73	73	73	
Optimism Bias	2,382	-	-	-	-	-	49	50	51	51	52	51	52	59	66	69	72	74	76	78	79	81	82	83	83	85	85	86	85	86	85	87	87	87	87	88	88	
Asset Replacement Total	17,348	614	702	668	535	535	293	299	303	307	310	309	311	357	395	415	431	446	456	466	474	485	495	496	500	511												

2014, real prices in £'million - Mitigated optimism bias

Core Works	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	6,858	-	-	-	-	-	8	41	75	107	416	931	1,148	1,319	1,187	815	590	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Transit systems	943	-	-	-	-	-	-	4	8	61	145	203	217	187	113	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Taxiways and aprons	1,295	-	-	9	20	25	31	105	123	135	129	105	62	258	280	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equipment	620	-	-	-	-	-	3	6	9	11	25	40	62	169	176	54	43	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Airfield Ancillary	1,406	-	-	-	-	-	-	91	191	277	318	291	196	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Car Parks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Third Party Land Users	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Environment	250	-	-	-	-	-	-	-	16	33	44	49	47	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Risk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Optimism Bias	1,697	-	-	-	-	-	6	37	63	94	161	243	260	302	267	133	95	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Core Works Total	13,069	-	-	9	20	25	49	284	485	718	1,238	1,861	1,992	2,314	2,046	1,021	728	279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Asset Replacement	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Asset Replacement	13,463	614	702	668	535	535	209	212	210	216	217	219	221	257	285	302	317	334	345	350	355	360	357	363	361	365	364	369	371	372	373	381	380	383	385	388	394	394
Risk	2,082	-	-	-	-	-	42	42	42	43	43	44	44	51	57	60	63	67	69	70	71	72	71	73	72	73	73	74	74	75	76	77	77	78	79	79	79	
Optimism Bias	2,498	-	-	-	-	-	50	51	51	52	52	53	53	62	68	73	76	80	83	84	85	86	86	87	87	88	87	89	89	89	90	91	91	92	92	93	95	94
Asset Replacement Total	18,043	614	702	668	535	535	301	305	303	311	312	316	318	370	410	435	457	480	496	505	511	519	513	522	520	526	524	532	534	535	538	548	548	551	555	559	568	567

Table E-3 Global Growth Carbon Traded

2014, real prices in £'million - Mitigated optimism bias

Core Works	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Terminal buildings	6,858	-	-	-	-	-	-	-	24	51	100	406	670	933	980	628	104	77	462	795	815	590	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Transit systems	943	-	-	-	-	-	-	-	-	4	58	116	174	207	195	139	44	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Runways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Taxiways and aprons	1,295	-	-	9	20	25	-	31	105	123	135	129	105	62	-	232	258	-	26	22	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equipment	620	-	-	-	-	-	-	3	6	9	11	12	26	40	137	143	25	21	35	44	46	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Airfield Ancillary	1,406	-	-	-	-	-	-	-	91	223	311	331	283	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Car Parks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Third Party Land Users	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Environment	250	-	-	-	-	-	-	-	16	33	44	49	47	38	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Risk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias	1,697	-	-	-	-	-	-	5	36	67	99	156	196	217	200	171	65	16	78	129	131	94	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Core Works Total	13,069	-	-	9	20	25	-	39	279	510	758	1,200	1,500	1,664	1,535	1,313	497	120	601	991	1,005	722	279	-	-	-	-	-	-	-	-	-	-	-	-	-		

Asset Replacement	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Asset Replacement	12,624	614	702	668	535	535	204	209	213	210	213	217	216	241	263	275	286	294	300	304	308	314	321	325	331	336	341	341	344	347	347	349	350	352	353	354	355	358
Risk	1,914	-	-	-	-	-	41	42	43	42	43	43	43	48	53	55	57	59	60	61	62	63	64	65	66	67	68	68	69	69	70	70	70	71	71	71	71	72
Optimism Bias	2,297	-	-	-	-	-	49	50	51	50	51	52	52	58	63	66	69	71	72	73	74	75	77	78	79	81	82	82	83	83	84	84	84	84	85	85	85	86
Asset Replacement Total	16,835	614	702	668	535	535	293	300	307	303	307	312	310	347	379	396	411	424	431																			

Appendix F Operational Expenditure

F.1 Introduction

This appendix sets out the approach used to develop an independent forecast of operating costs for the period 2014 to 2050 for the Heathrow Airport North West Runway scheme.

This appendix contains the following sections:

- *Section F-2 describes the methodology adopted in developing operating cost forecasts for the period, including the modelling assumptions used for all schemes and the approach towards the treatment of risk and optimism bias.*
- *Section F-3 describes the inputs received from the scheme promoter and any specific assumptions used to develop the independent operating cost forecasts.*
- *Section F-4 sets out the operating cost modelling outputs in comparison to the costs submitted by the scheme promoter.*

F.2 Methodology

The approach took as its starting point the CAA's notice granting the licence to HAL (CAP 1151) for the Q6 period (2014-2019), adjusted to 2014 prices and revised to reflect differences in traffic forecasts.

Airport operating costs typically increase in relation to growth in airport activity, measured in passenger numbers. In addition, because a certain proportion of airports' operating costs are fixed, relating to the infrastructure rather than directly to passenger numbers, the addition of new infrastructure brings with it a step-change in fixed costs. Efficient airports take steps to make as much of their operating cost base as possible variable rather than fixed, for example by designing staff rosters to match passenger demand as closely as possible and by switching off lighting in unoccupied areas of the terminal building. Operating cost forecasts for efficient airports therefore tend to adopt higher elasticities to airport activity (i.e., passenger numbers) rather than infrastructure size, since a greater proportion of the total cost is variable. Because airport operating costs can never be fully variable, a relationship with infrastructure size (i.e., terminal gross floor space and airfield area) is appropriate to take account of the step-change in fixed costs.

The independent forecasts developed for each scheme following the Q6 period (i.e. from 2019 to 2050) used a combination of drivers based on passenger growth and infrastructure expansion (see Section 0) to derive annual costs for each category, taking into account the opportunity to implement efficiencies in certain categories over time.

These forecasts were then treated according to The Green Book guidelines to take account of the risk that costs, individually or collectively, could prove higher than forecast, and to adjust for optimism bias, which takes account of unforeseen factors that could cause outturn costs to be higher than forecasted.

F.2.1 Elasticities

Elasticities, where supplied by scheme promoters, were reviewed against comparable benchmarks, and adjusted according to various aspects of each

airport’s operation (e.g. its complexity, existing cost base, current efficiency, level of fixed cost) to reflect the nature of each airport. The resulting elasticities, based on industry experience, were considered to be similar for each scheme.

Elasticities to passenger growth, terminal floor space and the airfield area were applied, and adjustments for efficiency improvements were also provided for.

The following table presents the elasticities used from 2019 onwards for all schemes.

Elasticities	Staff	Routine Maintenance	Utilities	Rent & Rates	Rail	Other
Passenger increase	40%	40%	5%	0%	40%	40%
Gross floor area increase	40%	40%	70%	80%	0%	30%
Airfield increase	5%	5%	5%	20%	0%	5%

Table F-1 Elasticities Used for all Schemes

The model assumed that cost increases for Routine Maintenance should be deferred for two years after terminal or airfield expansion to take account of warranty periods and the likelihood that less routine maintenance will be required on these assets in the first two years.

F.2.2 Efficiencies

Like other businesses, airports continually seek to improve the efficiency of their operations. Efficiency is embedded within the elasticity based approach described above. Over and above this, further efficiencies were assumed across all cost categories, with the exception of Rent & Rates against which the airport has little or no capacity to achieve efficiencies.

Efficiencies of 1% per annum were assumed from 2019, after the Q6 period. These efficiencies were phased out over time reflecting a number of airport-specific factors, including the overall level of efficiency of the airport assumed at the end of Q6 and the scope for further efficiencies thereafter, and the impact that opening substantial new infrastructure would have in terms of transforming the operation of the airport.

F.2.3 Treatment of Risk and Optimism Bias

The Green Book guidance on appraisal and evaluation in Central Government has been adopted for the purposes of determining appropriate adjustments for risk and optimism bias. The guidance recommends making such adjustments on the basis that there is a demonstrated, systematic tendency for project appraisers to be overly optimistic.

Allocations have been made within the Airports Commission’s independent cost estimates for each scheme, seeking to address two unknown factors:

- *Risk: the unknown detail of the identified airport operation which would be expected to lead to an under-estimate of the operating costs although the scope may be reasonably defined. For example, wage rates increasing above inflation; and*

- *Optimism Bias: the unknown scope of all necessary operating activities which could extend significantly to deliver the fully operational scheme. For example, the design of the new terminal requiring a greater number of operational staff than foreseen.*

The allocation for optimism bias is calculated on the risk-adjusted price.

F.2.3.1 Risk

In order to address the risk that operating costs escalate at a greater rate than forecast, a compound real growth increase of 0.5% per annum was applied from 2019 onwards (i.e. after Q6). Risk is already taken into consideration within the Q6 regulatory settlement.

The risk value is applied as a 0.5% real increase in the cost base, calculated using an index with base year 2018 (the final year of the Q6 period). Therefore 2019 is the first year in which risk-adjusted costs are 0.5% higher than the base case forecast. At the end of the forecasting period (2050), this adjustment is equivalent to $(1.005)^{32}$, a 17.3% increase, and is applicable to the operating costs associated with the whole airport (i.e., both the core airport and the scheme).

	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Risk Index (0.5% per annum)	1.000	1.005	1.010	1.015	1.020	1.025	1.030	1.036	1.062	1.116	1.173

Table F-2 Risk Index

This approach to applying risk takes account of the greater certainty of cost estimates at the beginning of the forecasting period in comparison to a much greater level of uncertainty in 2050.

F.2.3.2 Optimism Bias

HM Treasury’s Supplementary Green Book Guidance recommends an upper bound of 41% on ‘Outsourcing projects’, which, in the absence of other data, has been applied to appraisal of operating costs.

Applicable mitigation factors were assessed to determine where a reduction in the adjustment could be justifiable. These included the experience and capabilities of the project management team, the early involvement of the operator in the design phase, the level of innovation and complexity of the proposed operation, and external influences including economic and regulations/legislation.

HM Treasury’s Supplementary Green Book Guidance does not set out a calculation method to establish the appropriate level of optimism bias to be applied to operational expenditure. Noting that the setting of an appropriate rate requires judgement across a range of factors, most of which are difficult to establish with accuracy from an external assessment of the organisation responsible for operational delivery, and noting that those assessments would be subjective in nature rather than demonstrably objective, the approach to optimism bias was to establish a reasonable allowance that was applied consistently to all schemes.

Table F-3, below, sets out the calculation used to derive an appropriate level of mitigated optimism bias used consistently for all schemes.

Operating Expenditure Contributory Factors	HMT Treasury Green Book Descriptions	Outsourcing Optimism Bias (%)	Mitigation Factor (0<X<1)	Reduction in Optimism Bias
Procurement	Late Contractor Involvement in Design	5	0.8	4
	Poor contractor capabilities	15	0.8	12
Project Specific	Design Complexity	5	0.5	2.5
	Degree of Innovation	5	0.5	2.5
Client Specific	Project Management Team	20	0.7	14
	Poor Project Intelligence	10	0.5	5
Environment	Site Characteristics	5	0.4	2
External Influences	Economic	20	0.25	5
	Legislation/Regulations	15	0.25	3.75
Weighted Total		100		50.75
Adjusted Optimism Bias	= 50.75 * Upper Bound (41%)			20%

Table F-3 Optimism Bias Mitigations

The purpose of optimism bias is to address the unknown scope of all necessary costs required to deliver a fully operational scheme and acceptable service standards. Given that the scope of costs is much better understood for the existing core airport operation, it was determined that optimism bias should apply only to the incremental operating expenditure associated with the additional runway and new facilities, and not to the core airport. This also follows the Department for Transport’s Web-based Transport Analysis Guidance (TAG) which recommends that for rail schemes, optimism bias should only be applied to the operating costs associated with the incremental scheme and not to any existing operation. Based on the mitigation calculation set out in Table F-3, a mitigated adjustment of 20% is proposed at this stage of the appraisal process.

Costs have also been modelled with the upper bound optimism bias of 41% applied.

F.2.4 Inflation

The Retail Prices Index (RPI) was adopted as a basis for modelling operating costs. The financial model inputs incorporate real increases or decreases in relation to RPI as appropriate. For instance, staff costs (which reflect a combination of staff numbers, wage rates and other employment costs) are modelled on the basis of RPI, with real efficiency improvements reflected in the forecasts over the long term as appropriate. Contract costs, such as with cleaning providers, suppliers and outsourced maintenance providers, are typically linked to RPI. RPI is more reflective of wage rate increases than the Consumer Prices Index (CPI) and is, therefore, considered appropriate for modelling staff costs. Materials and other non-staff costs are also assumed to increase with RPI.

F.3 Modelling Inputs

HAL supplied total operating expenditure (opex) in chart form for the period 2019-2048, supported by a data table of total operating expenditure summarised by five-year periods. Annual forecasts were derived from the chart and validated against the five-year totals supplied. The CAA’s Q6 settlement was adopted for period 2014-2018 while the chart was extrapolated on a straight line basis to obtain values for 2049 and 2050. A cost breakdown for HAL was developed based upon the CAA’s Q6 settlement and historic data.

Costs supplied by HAL were in 2011/12 prices and were inflated to 2014 prices using a multiplier of 7.453% (Source: UK inflation, average consumer prices. IMF World Economic Outlook Database, April 2014).

F.3.1 Elasticities

Table F-4 sets out the drivers for each cost category stated in HAL’s submission.

Cost Category	Cost Driver	Commentary
Security costs	Linked to passenger numbers, elasticity 0.4 Step up for new terminal opening	Cost category grouped in ‘Staff Costs’ for LeighFisher/PwC model
Operational staff costs	Linked to passenger numbers, elasticity 0.4 Step up for new terminal opening	Cost category grouped in ‘Staff Costs’ for LeighFisher/PwC model
Facilities	Linked to terminal airport size	Cost category equivalent to maintenance
Utilities	Linked to terminal airport size	Cost category used
Rent & Rates	Linked to terminal and runway size	Cost category used
Other Operational Costs	Linked to passenger numbers, elasticity 0.4	Cost category used
Commercial	Linked to passenger numbers, elasticity 0.4 Step up for new terminal opening	Cost category not used in LeighFisher/PwC model. Assumed to be included in ‘Staff Costs’
Rail	Linked to passenger numbers, elasticity 0.4	Cost category used
Central Support Services	Linked to passenger numbers, elasticity 0.4	Cost category not used in LeighFisher/PwC model. Assumed to be included in ‘Staff Costs’
Pensions	Linked to staff	Cost category not used in LeighFisher/PwC model

Table F-4 HAL Operating Cost Drivers

F.3.2 Efficiencies

Our forecasting approach assumes efficiencies of 1% per annum across all cost categories (with the exception of Rent & Rates). For this scheme, the efficiency factor was reduced to 0.5% per annum after 2030. HAL forecasts assume an efficiency factor of 0.5% year on year for all cost categories throughout the forecasting period.

Table F-5 below illustrates the efficiency factors that have been applied for each category and how these have been phased out over time. Efficiencies are shown as negative values in the table below since they reduce operating expenditure.

Year	Staff	Routine Maintenance	Utilities	Rent & Rates	Rail	Other
2019-34	-1.0%	-1.0%	-1.0%	0%	-1.0%	-1.0%
2035-50	-0.5%	-0.5%	-0.5%	0%	-0.5%	-0.5%

Table F-5 Real Efficiency Factors by Category

F.4 Independent Operational Expenditure Forecast

This section presents graphical outputs of the independent operating cost model, compared with the costs presented by, or inferred from, the scheme promoter’s submission.

Figure F-1 below shows HAL’s forecast total operating costs against the independent forecasts for each of the demand scenarios. The independent forecasts include risk applied to total costs and optimism bias at the mitigated level of 20% applied to scheme operating costs.

The stepped increases in our cost forecasts are in line with increases in terminal floor space and airfield area. The phasing of terminal development differs between scenarios, accounting for the stepped increases occurring at different times.

HAL forecasts total operating costs to decrease in real terms once the final phase of expansionary development is complete, against continuing increases in passenger numbers. While our forecasts apply a similar efficiency factor at this time, this is offset by a corresponding Risk premium.

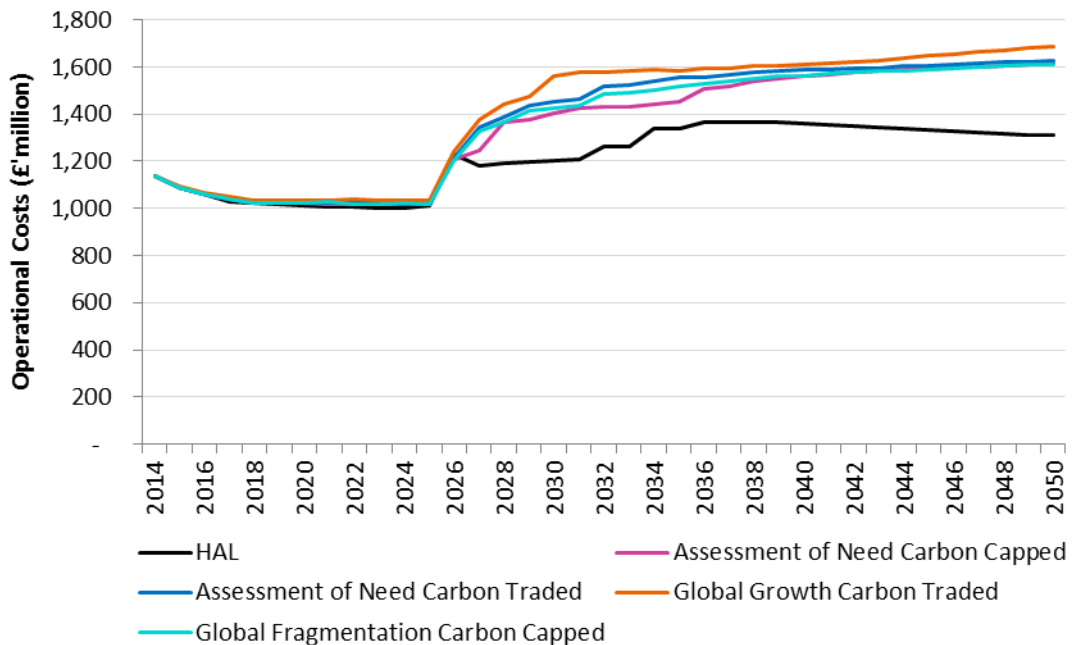


Figure F-1 Heathrow Airport North West Runway Scheme Forecast Operating Expenditure (Risk Adjusted and Mitigated)

On a per passenger basis, operating costs are forecast to decrease over the longer term in all demand scenarios. Figure F-2, below, shows operating costs on a per passenger basis.

Temporary increases occur during the period following the opening of new infrastructure. When new terminal buildings open, there is a marked increase in fixed costs. Over time, as passenger numbers increase to fill the terminal buildings, costs become more efficient on a per passenger basis.

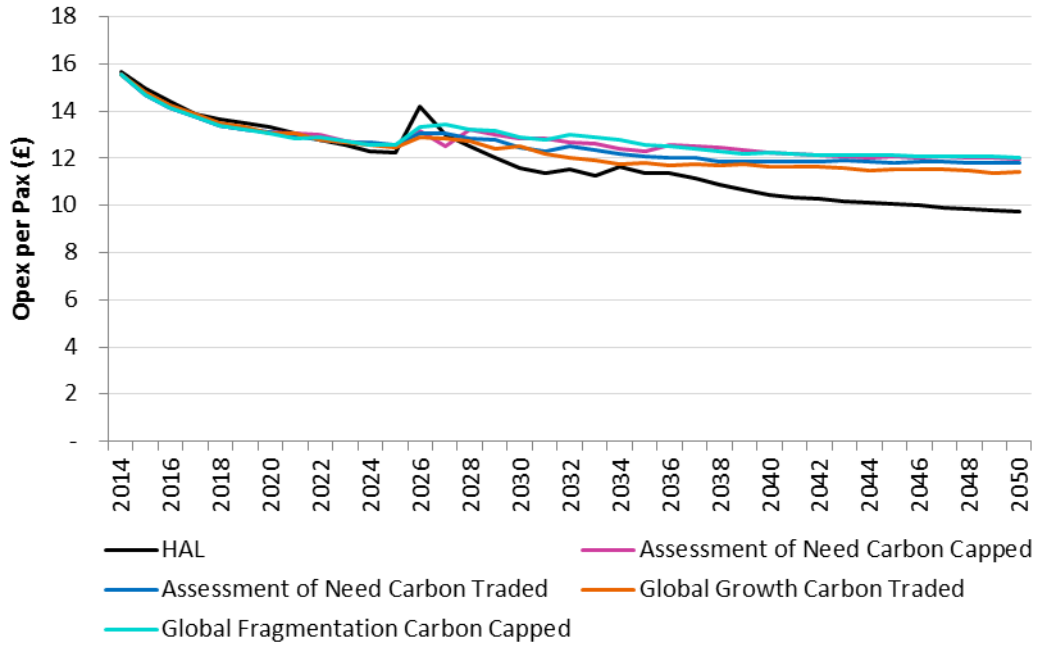


Figure F-2 Heathrow Airport North West Runway Scheme Forecast Operating Expenditure per Passenger (Risk Adjusted and Mitigated Optimism Bias)

Appendix G Non-Aeronautical Revenue

G.1 Introduction

This appendix sets out the approach used to develop an independent forecast of non-aeronautical revenues for the period 2014 to 2050 for the Heathrow Airport North West Runway scheme.

This appendix contains the following sections:

- *Section G-2 describes the data inputs received from scheme promoters, including their own non-aeronautical revenue forecasts for the period, and the passenger traffic forecasts against which these were developed.*
- *Section G-3 describes the independent non-aeronautical revenue forecasting methodology.*
- *Section G-4 provides commentary on the non-aeronautical revenue model outputs.*

G.2 Non-Aeronautical Revenue Forecast Data Inputs

HAL supplied total non-aeronautical revenues in chart form, supported by a data table of 'Other revenues' summarised by five-year periods. The total non-aeronautical revenue data has been extrapolated from the graphical summary of HAL's forecast over the period 2019 to 2048, to give HAL's view. A non-aeronautical revenue breakdown was developed using an independent forecast for non-aeronautical revenue breakdown, in the form of yearly category shares applied to the total.

Non-aeronautical revenues supplied by HAL were in 2011/12 prices and were inflated to 2014 prices using a multiplier of 7.453% (Source: UK inflation, average consumer prices. IMF World Economic Outlook Database, April 2014).

Terminal gross floor space was derived from the capacity analysis work presented in Section 0. The timing of the phases of expansion of terminal buildings, which differs under each demand scenario, formed a key input to the non-aeronautical revenue modelling work.

G.3 Independent Non-Aeronautical Revenue Forecasts

G.3.1 General Forecast Commentary

All non-aeronautical revenues are presented in real 2014 prices.

Forecasts have been developed for the following non-aeronautical revenue categories:

- *Retail (Duty and Tax Free, Food and Beverage, Other Retail)*
- *Car Parking*
- *Property Rental*
- *Other Revenue*

The 'Other Retail' sub-category includes:

- *Specialist Retail*
- *Bureaux de Change*
- *Other Retail*

The 'Other Revenue' category includes:

- *Passengers with Reduced Mobility (PRM)*
- *Staff Car Parking*
- *Operational facilities and utilities income' (common user terminal equipment (CUTE), baggage systems, utility cost recovery)*

The forecast base year is 2014, which reflects the most recent available data on non-aeronautical revenue performance. Additionally, 2014 should reflect the revenue performance in the absence of one-off events such as the Olympics, a terminal opening, or a terminal commercial space reconfiguration.

The independent non-aeronautical revenue forecasts have taken into consideration the attributes of the airport scheme, in terms of:

- *Passenger mix: high share of transfer traffic, impacting terminal concessions spend*
- *Surface access options (i.e., Crossrail), as well as price disincentives to discourage driving to the airport, impacting car parking revenues*
- *Terminal commercial space design: Heathrow's non-aero revenue historic performance reflects the opening of commercially optimised terminals (i.e., T5)*

G.3.2 Impact of Overcapacity

Under the Global Growth Carbon Traded scenario, there are periods towards the end of the forecasting period in which the provided terminal capacity is exceeded by forecast passenger demand. A modelling approach has been introduced to take account of the impact that passenger congestion would be likely to have upon retail revenues. This retail impact may manifest itself through retail space being sacrificed to be used for passenger processing, by congestion in the terminal deterring or preventing passengers from making purchases they would otherwise have made, or a combination of the two.

According to the modelling approach adopted, terminals are assumed to operate at up to 105% of intended capacity without any detrimental impact on retail revenues. When capacity is assessed to have exceeded 105%, a proportionate decrease in passenger airside dwell time occurs, based on an assumed average of 45 minutes departure lounge dwell time. A benchmark value of £0.10 per passenger per minute of dwell time lost was applied.

The resulting decrease in retail revenue is split between Duty Free, Other Retail, and Food & Beverage according to their original proportions.

Under the Global Growth Carbon Traded scenario, overcapacity above the 105% threshold occurs from 2038 onwards.

G.3.3 Risk and Optimism Bias

The Green Book guidance suggests that revenue forecasts should be adjusted for both risk and optimism bias.

Adjustments for risk are intended to take account of the potential for foreseeable negative impacts on revenues to occur. Adjustments for optimism bias are intended to take account of inherent optimism when forecasting revenues and for the potential for unforeseeable negative impacts to occur.

Whereas the approach adopted for applying optimism bias to operating costs considers only the incremental operating costs of the scheme, to be incurred when operating the expanded facilities as a result of a new runway being built at the airport, this approach would be less robust for non-aeronautical revenues since any risk factors would be likely to apply to the whole airport rather than just the new facilities. For example, if retail revenues at a new terminal were to fall short of forecast levels as a result of an aspect of design, it can be expected that airport management would take the necessary steps to reconfigure the space to address the shortfall. If, however, retail revenues fell short of forecast levels as a result of a general trend away from airport shopping, then this could be expected to impact revenues at the existing terminal as well as the new terminal.

Setting appropriate levels for risk and optimism bias is a matter of professional judgement rather than robust evidence available from benchmarks or best practices. Although peaks and troughs in revenues can be expected through the forecasting period, a sustained period of underperforming non-aero revenues would likely be met with remedial action by management. It was proposed that a compound 0.25% per annum reduction in non-aeronautical revenues would be appropriate to take account of risk across the portfolio of non-aeronautical revenues. For optimism bias, a further 0.25% per annum reduction would apply to the risk-adjusted non-aeronautical revenue value. Both adjustments have been implemented from 2019, the first year after the Q6 regulatory period has ended. The same adjustments are applicable to each airport scheme.

By 2050, the risk adjustment of 0.25% per annum with a further 0.25% per annum for OB applied to the risk-adjusted value results in a 15% reduction in annual non-aeronautical revenues. The risk-adjusted reduction is 7.7% by 2050.

G.3.4 Historical Trends

As shown in Figure G-1, net non-aeronautical revenue per passenger has increased at a compound annual growth rate (CAGR) of 1.1% over the FY07 – FY13 period. Net non-aeronautical revenues have grown at a 2.2% CAGR over the same period, in the context of 1.1% passenger growth.

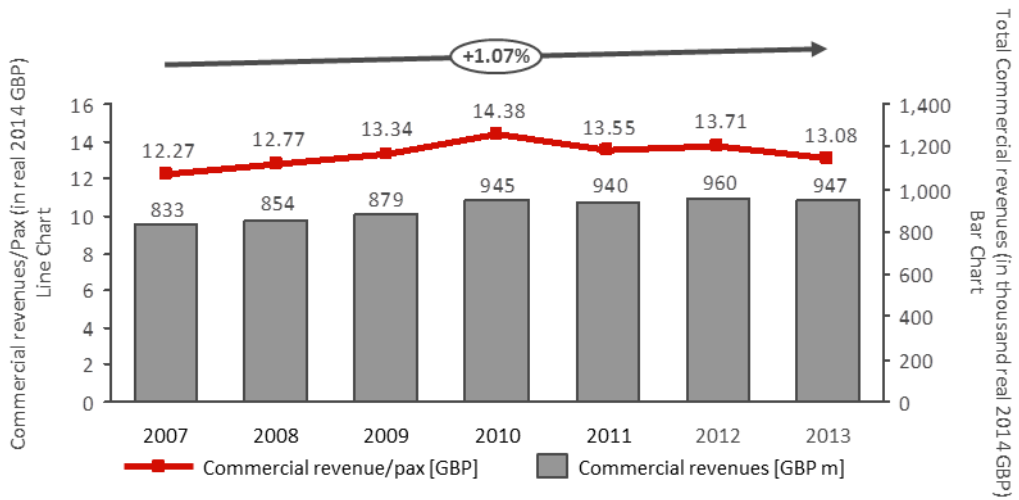


Figure G-1 Heathrow Airport Historical Non-Aeronautical Revenue in Real 2014 GBP

Net retail revenue (including duty free, catering, and other retail) has increased at a 4.2% CAGR over the same 7-year period, while revenue per passenger has increased at a CAGR of 3.1%.

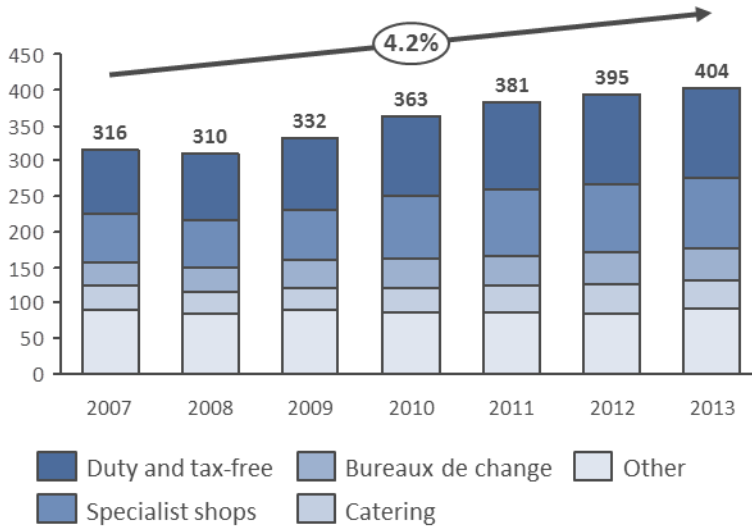


Figure G-2 Heathrow Airport Historical Retail Revenue Split in Real 2014 GBP

G.3.5 Non-Aeronautical Revenue Forecast Assumptions by HAL

HAL’s submission specifies the following non-aeronautical revenue drivers:

Category	Driver
Car parks	Linked to passenger numbers, elasticity of 0.9 Adjustment to reflect CPI trend rather than RPI
Retail and Concessions	Linked to passenger numbers, elasticity of 0.9 Adjustment to reflect CPI trend rather than RPI Uplift to retail sales per new passenger of 20% to reflect opening of new retail space in new terminal buildings
Property	Linked to terminal and runway size
Rail	Linked to passenger numbers, elasticity of 1 Adjustment to reflect CPI trend rather than RPI
Other commercial income	Linked to terminal airport size
Other regulated revenues	50% of the income linked to passenger numbers, elasticity of 0.9 Adjustment to reflect CPI trend rather than RPI

In terms of staff access to the airport, HAL’s submission assumed the following modal split:

Mode	2013	2030	2040
Car driver (alone)	50.9%	24.4%	10.4%
Car share	2.7%	17.0%	15.2%
Public transport	36.9%	49.1%	64.9%
Other	9.5%	9.5%	9.5%

The HAL car parking and rail revenue forecast takes into consideration the expected changes in modal split.

G.3.6 Independent Non-Aeronautical Revenue Forecast Approach and Assumptions

Table G-1 summarises the independent non-aeronautical revenue assumptions.

Revenue Category	Driver	Assumptions
Car parking	<ul style="list-style-type: none"> Originating passengers 	A decreasing elasticity to originating passenger traffic growth has been assumed to reflect the impact of Crossrail starting operations in 2019, as well as various proposed initiatives to encourage the increased usage of public transport
Retail	Drivers per sub-category	Assumptions per sub-category
<i>Duty Free</i>	<ul style="list-style-type: none"> Total passengers Elasticity to GDP by region 	Elasticities to GDP in the range of 20% to 30% have been assumed per world regions (UK, LDCs, NICs, OECs, West Europe) and correlated to the corresponding passenger traffic categories, in order to capture the changes in passenger mix over time, as well as the different spending patterns by region. A 50% elasticity to passenger traffic growth has been assumed. The long term forecasts, in particular the last 10 year period leading to 2050, reflect a more

Revenue Category	Driver	Assumptions
		conservative view as well as the impact of terminal capacity constraints
<i>Other retail</i>	<ul style="list-style-type: none"> Total passengers Elasticity to GDP by region for the Specialist Retail category 	The same assumptions applied to Duty Free revenues have been reflected in the Specialist Retail revenue sub-category forecast. Bureaux de Change and Other Retail revenues have not been linked to GDP growth
<i>Catering</i>	<ul style="list-style-type: none"> Total passengers 	An elasticity of 70% to passenger traffic has been assumed, accounting for the share of transfer traffic (i.e., limited stop-over times)
Property rental	<ul style="list-style-type: none"> Terminal size 	A 10% elasticity to terminal size growth has been assumed, reflecting the stepped increases in terminal space, which would allow for more revenue from spaces such as airline lounges and offices to be accrued. The assumption represents a conservative view, which also takes into consideration the terminal capacity constraint during the last 10-year period of the forecast
Rail	<ul style="list-style-type: none"> O&D passengers 	The category represents revenues accrued as a result of the Heathrow Express operation. The near term forecast assumes a 100% elasticity to O&D passenger traffic growth, as does HAL, however the elasticity is assumed to decrease following 2019, reflecting the introduction of Crossrail as a surface access option
Other revenues	<ul style="list-style-type: none"> Total passengers Terminal size Utilities category linked to OpEx by applying the same drivers 	<ul style="list-style-type: none"> Category includes 'Operational Facilities and Utilities Income sub-category' and 'Other Revenues' (PRM, Staff Car Parking). The Utilities Income represents the recovery of utility costs from airport tenants. The independent forecast estimates a 40% cost recovery share, and the actual GBP amount is obtained by applying this share to the FY 2013/14 utility costs. This amount, which represents the base of the Utility Income forecast, represents 13% of the Operational Facilities and Utilities Income. Utility cost (e.g., OpEx) drivers have been applied to the Utility Income forecast in order to maintain the 40% cost recovery share over the forecast period A 10% elasticity to terminal size has been assumed for the operational facilities revenues (87% share of the sub-category) to account for the additional CUTE systems to be employed as terminal size increases. The low elasticity also reflects the large share of scheduled airlines (BA, VS) which have their designated check-in areas, as opposed to making extensive use of the CUTE systems In the absence of a detailed split of the 'Other Revenues' category, a low elasticity to passenger traffic has been applied to the whole category to reflect PRM revenue increases Heathrow Airport proposes to significantly reduce

Revenue Category	Driver	Assumptions
		staff accessing the airport by car, and encourages the use of shared car usage, as well as the use of public transport (see paragraph 2.2.4). In this context, only a low elasticity to terminal size and passenger traffic, both drivers capturing the increase in staff numbers, has been assumed

Table G-1 Independent Non-Aeronautical Revenue Assumptions

G.4 Non-Aeronautical Revenue Modelling Outputs

This section presents graphical outputs of the independent non-aeronautical revenue model, compared with the revenues presented by, or inferred from, the scheme promoter’s submission.

The independent forecasts for non-aeronautical revenues under all demand scenarios commence at a lower revenue base than HAL’s forecast for 2019. However, by 2023, the independent revenue forecast value, excluding the risk and optimism bias adjustment, reaches the level forecast by HAL under the AoN Carbon Traded and Global Growth Carbon Traded demand scenarios.

The risk and optimism bias adjusted independent forecast for the 2019 to 2050 period shows non-aeronautical revenues increasing at between 0.8% and 1.0% Compound Annual Growth Rate (CAGR) compared with HAL’s non-aeronautical revenue forecast which sees performance increasing at 0.8% CAGR.

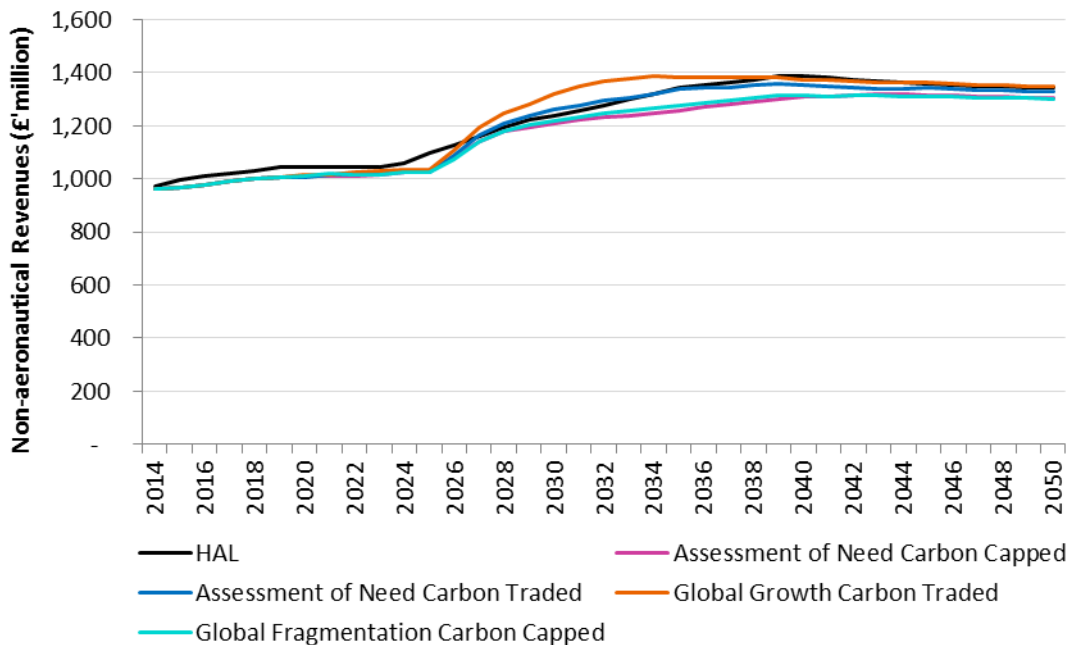


Figure G-3 Heathrow Airport North West Runway Scheme Forecast Non-Aeronautical Revenue (Risk Adjusted and Optimism Bias)

Non-aeronautical revenue per passenger is forecast to decrease at between 0.9% and 1.1% CAGR over the 2019-2050 period, depending on demand scenario, when risk and OB adjustments are included. Revenue per passenger is forecast to reduce as a result of the change in the mix of passengers, a trend towards increased use of

public transport to access the airport, resulting in lower car parking revenues per passenger, and the relatively flat relationship between passenger growth and certain revenue streams such as Property and Other.

HAL assumes a decrease of 1.1% CAGR over the same period. The historical trend shows an increase of 1.07% over the 2007-2013 period. Various factors influenced the retail revenue per passenger performance in the past, such as the weak sterling impacting revenues positively, and the EU enlargement in 2004/05 or the new security regime adopted in 2006/07 impacting negatively. In the context of these factors, it is reasonable to expect that total non-aeronautical revenue per passenger will not decline at a rate as significant as reflected in the HAL forecast.

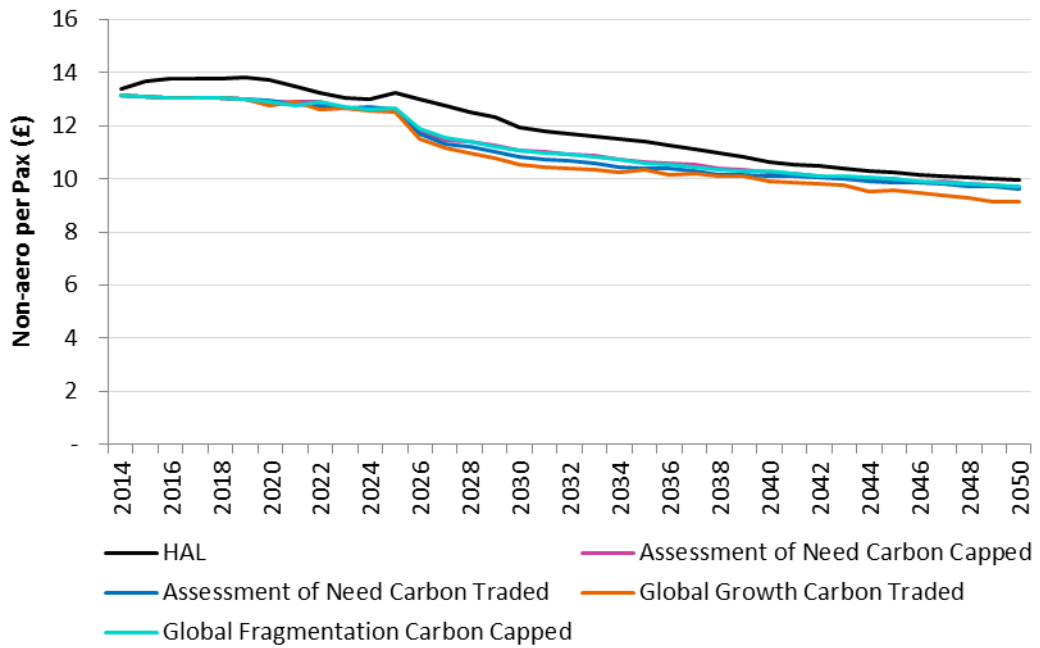


Figure G-4 Heathrow Airport North West Runway Scheme Forecast Non-Aeronautical Revenue per Passenger (Risk Adjusted and Optimism Bias)

Table G-2, on the following page, sets out the independent forecast.

2014, real prices in £million

HAL	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Car parking	3,478	69	74	76	79	82	74	75	76	77	79	81	85	87	90	93	96	96	98	100	101	103	105	105	106	107	107	107	107	107	106	106	105	104	104	103	102	102
Total retail	20,882	398	428	447	454	461	445	445	446	448	450	458	476	489	510	532	554	562	578	592	605	620	634	641	651	660	669	672	671	663	661	658	655	653	650	650	647	647
Duty and tax-free	7,438	127	137	144	147	150	145	146	147	148	150	154	161	166	175	185	194	199	206	212	219	225	232	236	240	245	249	251	251	247	246	245	244	243	243	243	242	242
Other retail	11,372	232	248	259	262	265	256	256	256	256	256	260	269	275	285	295	305	307	314	320	326	333	339	342	346	350	353	354	353	350	348	347	345	344	342	342	340	340
Food and beverage	2,071	39	42	44	44	45	43	43	43	43	44	44	46	48	50	53	55	56	58	59	60	62	63	64	65	66	66	67	67	66	66	66	66	65	65	65	65	
Property rental	4,130	111	114	113	114	113	116	115	114	112	111	111	114	116	116	116	115	115	115	115	115	114	114	113	112	111	110	109	108	108	107	106	105	105	104	103	103	
Rail	7,238	128	121	124	133	140	143	144	147	149	151	155	163	169	176	182	189	192	197	203	209	215	220	223	227	231	235	237	238	240	241	242	243	244	245	246	247	248
Other revenue	9,566	266	258	250	242	234	265	262	259	256	252	253	258	268	268	269	269	271	270	269	270	269	269	270	267	265	263	260	257	256	254	252	250	248	246	245	243	242
Non-aero	45,293	972	995	1,011	1,022	1,030	1,042	1,042	1,042	1,042	1,042	1,058	1,096	1,128	1,160	1,193	1,225	1,236	1,257	1,279	1,300	1,322	1,343	1,354	1,365	1,375	1,386	1,386	1,381	1,375	1,370	1,365	1,359	1,354	1,349	1,349	1,343	1,343
Non-aero/pax (£)	-	13.39	13.67	13.77	13.80	13.80	13.85	13.73	13.49	13.26	13.04	13.02	13.27	13.00	12.75	12.53	12.32	11.93	11.82	11.71	11.61	11.51	11.42	11.27	11.12	10.98	10.85	10.64	10.56	10.48	10.40	10.32	10.24	10.17	10.10	10.08	10.01	9.98

Assessment of Need Carbon Capped	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Car parking	3,597	66	66	68	69	71	73	74	76	77	79	81	82	88	95	99	101	102	103	104	105	106	107	109	109	110	112	113	113	114	115	116	116	116	116	116	116	116
Total retail	21,812	407	412	417	423	428	433	438	442	443	449	457	462	489	532	560	577	592	605	616	625	636	649	660	671	683	696	706	712	717	724	730	731	734	736	738	740	744
Duty and tax-free	7,819	130	132	135	137	140	142	144	146	147	150	153	156	167	185	197	205	212	217	222	227	231	237	243	248	253	259	263	266	268	271	274	274	275	277	277	278	280
Other retail	11,834	237	239	242	244	246	249	251	253	256	258	260	262	274	293	306	314	321	327	332	336	341	347	352	357	362	368	373	376	378	381	384	384	385	387	387	389	390
Food and beverage	2,159	40	41	41	41	42	42	43	43	43	44	44	45	49	53	56	58	59	61	62	62	63	65	66	67	68	69	70	71	72	72	72	73	73	73	73	74	
Property rental	4,239	108	111	111	111	111	111	111	111	111	111	111	111	114	114	116	116	116	116	116	116	116	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	
Rail	7,603	126	126	130	133	137	140	143	145	146	151	154	158	173	187	194	199	204	208	212	216	220	225	230	234	239	243	248	252	256	261	265	267	271	273	276	278	282
Other revenue	9,886	253	253	253	253	253	253	253	252	252	252	252	252	264	264	272	272	272	274	273	273	273	273	277	277	277	277	277	277	276	276	276	276	276	275	275	275	
Non-aero	47,137	961	969	979	989	999	1,009	1,019	1,026	1,029	1,042	1,055	1,065	1,127	1,192	1,241	1,264	1,286	1,306	1,322	1,335	1,351	1,370	1,393	1,409	1,426	1,445	1,460	1,471	1,481	1,494	1,505	1,506	1,513	1,518	1,522	1,526	1,534
Non-aero (incl. risk and OB)	43,589	961	969	979	989	999	1,004	1,009	1,010	1,009	1,016	1,023	1,028	1,083	1,139	1,180	1,196	1,211	1,223	1,233	1,239	1,247	1,259	1,273	1,281	1,290	1,300	1,308	1,311	1,313	1,318	1,321	1,316	1,315	1,313	1,310	1,307	1,307
Non-aero/pax (£)	-	13.13	13.09	13.08	13.07	13.07	12.99	12.92	12.93	12.92	12.69	12.66	12.58	11.80	11.44	11.43	11.27	11.08	11.04	10.92	10.89	10.73	10.66	10.60	10.53	10.42	10.34	10.23	10.20	10.12	10.03	9.99	10.00	9.87	9.90	9.80	9.79	9.68

Assessment of Need Carbon Traded	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Car parking	3,730	66	66	68	69	71	73	74	76	78	80	81	82	88	97	103	106	108	110	112	113	115	117	118	117	118	119	119	118	118	118	119	119	119	119	119	119	
Total retail	22,509	407	412	417	423	428	433	438	443	449	455	457	459	491	543	579	602	623	640	655	668	682	698	708	714	726	737	739	739	739	743	749	751	752	756	758	760	
Duty and tax-free	8,116	130	132	135	137	140	142	144	147	149	152	153	154	167	189	205	216	225	232	239	245	251	258	263	266	271	277	277	278	278	279	282	283	283	285	286	287	
Other retail	12,153	237	239	242	244	246	249	251	253	256	258	260	260	274	298	315	326	335	343	350	356	362	369	374	376	382	387	388	388	388	390	392	393	393	394	396	397	
Food and beverage	2,240	40	41	41	41	42	42	43	43	44	44	44	44	49	55	59	61	63	65	66	67	69	70	71	71	73	73	73	73	73	74	75	75	75	75	75		
Property rental	4,247	108	111	111	111	111	111	111	111	111	111	111	111	114	116	116	116	116	116	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117		
Rail	7,889	126	126	130	133	137	140	143	146	150	153	154	156	174	193	203	210	216	222	228	233	239	246	248	251	256	260	261	262	265	267	271	275	277	280	284	286	
Other revenue	9,926	253	253	253	253	253	253	253	252	252	252	252	252	264	272	273	274	274	278	278	278	278	278	278	278	278	277	277	277	276	276	276	276	276	276	275	275	
Non-aero	48,301	961	969	979	989	999	1,009	1,018	1,029	1,040	1,050	1,055	1,060	1,130	1,221	1,273	1,309	1,338	1,363	1,390	1,410	1,432	1,456	1,469	1,477	1,496	1,510	1,513	1,513	1,516	1,517	1,526	1,536	1,540	1,543	1,551	1,556	
Non-aero (incl. risk and OB)	44,649	961	969</																																			

Appendix H Surface Access Capital Expenditure, Operational Expenditure and Maintenance Cost

H.1 Introduction

This appendix briefly sets out the approach used to develop an independent forecast of surface access costs for the Heathrow Airport North West Runway scheme.

This appendix should be read in conjunction with Appraisal Module 4. Surface Access: Heathrow Airport North West Runway.

This appendix contains the following sections:

- *Section H-2 describes the road projects required for the scheme*
- *Section H-3 describes the rail projects required for the scheme*
- *Section H-4 summarises the estimates of capital and operational expenditure, and asset replacement costs for both road and rail projects*

H.1.1 Adjustment for Risk and Optimism Bias

In general the guidance of WebTAG has been followed to apply risk and optimism bias to the base cost estimates. Optimism bias was applied to the risk adjusted base cost.

H.1.1.1 Capital Expenditure and Asset Replacement

WebTAG guidance suggests that at this stage of project development, optimism bias should be applied at the level of 44% for road projects and 66% for rail projects.

For rail schemes, WebTAG states that at this stage of early development, no additional allowance for risk is required in addition to adjusting for optimism bias.

The same approach has been followed for road schemes. WebTAG guidance suggests that a quantified risk assessment be undertaken for each non-Highways Agency scheme. Due to the difficulties in understanding the full scope of works required at this stage, in addition to many of these schemes involving Highways Agency works, a separate risk premium is not considered appropriate, given that the upper bound of optimism bias has also been applied for road schemes. However, a 10% risk allocation has been tested as a sensitivity, presented in the output section below.

H.1.1.2 Operational Expenditure

WebTAG guidance suggests that at this stage of project development, optimism bias should be applied at the level of 44% for road projects and 41% for rail projects.

For rail schemes, WebTAG states that at this stage of early development, no additional allowance for risk is required in addition to adjusting for optimism bias.

For road schemes, as per the approach to risk provision for capital expenditure, with agreement of the Airports Commission, no separate allocation for risk has been

applied. However, a 10% risk allocation has been tested as a sensitivity, presented in the output section below.

H.2 Surface Access - Roads

H.2.1 Capital Expenditure

It was determined that the following works would be needed to support the opening of the Heathrow Airport North West Runway scheme. These are separated below into Highways Agency network projects and local road projects that would be the responsibility of Transport for London and/or relevant local authorities.

Highways Agency network capital costs include the following schemes:

- *M4 J3-J4, hard shoulder running in both directions and additional road widening*
- *M4 airport spur, road widening in both directions*
- *M4 J2-J3, road widening in both directions*
- *M4 J4 and J4B, additional road widening in both directions*
- *M4, large M4 J4b replacement*
- *M4, higher capacity J4a*
- *M25, tunnelling costs (south of J15)⁶*
- *Capacity improvements to existing main airport tunnel⁷*

M25 tunnelling and large M4 schemes are assumed to be phased over three years, scheduled to commence in 2022. Other Highways Agency and local road schemes are assumed to commence in 2024 and are phased over two years for completion before runway opening in 2026.

Local road capital costs include the following schemes:

- *Diversion of A4 Road alignment, dual carriageway*
- *Diversion of A3044 Road alignment, dual carriageway*
- *Airport Way/Southern Perimeter Road Interchange, grade separated junction and flyover/bridge structures*
- *Southern Road Tunnel/Southern Perimeter Road Interchange*
- *One way system for western campus*

A Southern Road Tunnel project linking the Central Terminal Area with the Southern Perimeter Road is also included, and is scheduled to be constructed over a three year period from 2019-2022.

We note that HAL has included within its Core Capital Expenditure plan £430m of surface access costs associated with a T5 Landside road scheme. This scheme has not been included within the independent core capital expenditure forecasts and is assumed to refer to the Southern Road Tunnel scheme which is expected to be in the same order of magnitude of costs.

⁶ For the purposes of this analysis, the full costs of the M25 tunnelling works have been categorised as surface access improvements, rather than “scheme capital expenditure” works which ordinarily include engineering projects within the airport boundary. We note that the airport operator has suggested funding 50% of these works, with the remaining 50% borne by the public sector. The Airports Commission has not taken a view as to the split of funding between private and public sources and believes that this would be a matter for negotiation should the scheme be taken forward.

⁷ Not a Highways Agency project, but directly related to the M4 Airport Spur works.

Descriptions of schemes and costs are contained in Appraisal Module 4. Surface Access: Heathrow Airport North West Runway.

H.2.3 Asset Replacement Costs

Asset replacement (or Heavy Maintenance) costs were determined using Highways Agency published data (Source: <https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile>). 2011/12 costs were uplifted to 2014 prices using a multiplier of 1.07453 (Source: UK inflation, average consumer prices. IMF World Economic Outlook Database, April 2014).

The Highways Agency (England) figure of £43k per lane mile was used to calculate Highways Agency network maintenance costs while the South East cost of £52k per lane mile was used to calculate local road network maintenance costs.

Road maintenance costs are assumed to begin to be incurred in the year following road scheme completion and to continue thereafter.

H.2.4 Operating Costs

Road operating costs include activities such as lighting, drainage and landscaping. Annual cost estimates have been derived on the basis of DfT Cost and Benefit Analysis guidance (2006). For Highways Agency roads, Road Type 11 was selected (£45k per km); for local roads, Road Type 6 was selected (£30k per km). Costs were inflated from 2002 to 2014 prices (Source: UK inflation, average consumer prices. IMF World Economic Outlook Database, April 2014).

Road operating costs are assumed to begin to be incurred in the year following road scheme completion and continue thereafter.

H.3 Surface Access – Rail

H.3.1 Capital Expenditure

Rail infrastructure costs comprise the Southern Rail Access scheme to Waterloo, including a train depot. The Southern Rail Access scheme providing a link to Woking has not been included because it is unlikely to deliver sufficient benefits at this stage.

Jacobs's cost estimate was adopted at £487.5m (before risk and optimism bias), phased over three years from 2023-25. The scheme is scheduled for completion in advance of the 3rd runway opening.

Western Rail Access is assumed to be a committed scheme, as it is currently in Network Rail Draft CP5 Enhancements Delivery Plan and the Government has stated it is committed to the project. Therefore it has not been included in this assessment.

H.3.2 Asset Replacement Costs

Asset replacement costs comprise track maintenance and renewals for which an infrastructure fee is payable by the train operator to Network Rail. This fee has been derived according to industry data on per route mile charges paid to Network Rail by existing franchise operators.

H.3.3 Operating Costs

Southern Rail Access operating costs include an additional four trains per hour between Heathrow and Waterloo.

Crossrail costs include an additional two trains per hour.

Operating costs include staff, train leasing, train cleaning and maintenance, variable track access charges, electric current for traction, and other costs.

Operating costs associated with the Heathrow Express are included within the core and scheme airport operating costs rather than surface access costs since the train operation is owned by Heathrow Airport Holdings.

H.3.4 Heathrow Airport North West Runway scheme Rail Operating Cost Assumptions

H.3.4.1 Unit Assumptions

	Heathrow Crossrail +2tph	Heathrow Southern Access
Operating Days p.a.	363	363
Additional train sets required	2	7
Number of vehicles per train	9	10
Additional single journeys	76	152
Mileage per single journey	15	22.75
Train crew: Additional daily diagrams	3	16

Table H-1 Unit Assumptions

Operating days per annum is assumed to be every day excluding Christmas Day and Boxing Day.

The assumptions for the number of additional trains are based on the indicative timetable drawn up for each option. An additional two Crossrail trains per hour would require an additional two trains based on a journey time between London Paddington and Heathrow T4 of 30 minutes. The Heathrow Southern Access scheme would require an additional seven trains based on a requirement to increase the service to four trains per hour with a journey time of 35 minutes.

The additional train crew requirements (drivers and hosts) are based on the number of additional daily diagrams. This is calculated from the number of additional trains required, and with additional trains running throughout the day an allowance is made for shift length and breaks. The required additional establishment of drivers and hosts is calculated from the number of additional diagrams with a multiplier of 2.5 to account for days off, annual leave and sickness and training days. It is assumed no train hosts will be required for the Heathrow Crossrail services.

H.3.4.2 Operating Cost Assumptions

The annual costs for drivers and train hosts are based on an assumed salary + NI contributions and benefits of £55k and £40k respectively, in 2014 prices.

The assumptions of costs for electric stock are based on the known costs for a 4 car train as shown below, from which a cost per car has been calculated. The costs per

car together with the assumed number of additional cars required is used to calculate the total costs for capital leases, maintenance, cleaning, electric current for traction (EC4T), variable track access (VTA) and electrification access charge (EAC).

	4 car 100mph	£ per car
Capital lease £k p.a.	168	42000
Maintenance £ pvm	0.315	0.315
Cleaning £k pv p.a.	8.2	8200
EC4T £ pvm	0.277	0.277
EAC £ pvm	0.012	0.012
VTA £ pvm	0.0484	0.0484

Table H-2 Operating Cost Assumptions

The Heathrow Southern Access scheme includes an assumption for costs of depot facilities for train maintenance of the additional fleet of trains. It is assumed that they are maintained as part of a larger fleet of trains in existing depots, with one-off investment required to provide additional equipment at an estimated cost of £500k. For the Heathrow Crossrail option which only requires 2 additional trains, it is assumed they can be maintained in existing depot facilities.

The infrastructure maintenance cost is calculated from an assumed Long Term Charge for infrastructure of £1.017 per mile, based on a benchmark of the South West Trains' annual charge in CP5 divided by their annual train miles.

H.4 Outputs

Table H-3, below, shows the scheme promoter's surface access costs and the independently assessed costs, including the impact of a sensitivity test in which a 10% risk allowance is added to road capital costs (capital expenditure and asset replacement).

		0% Risk	10% Risk	HAL
Roads	Total Asset Replacement	83	91	
	Total Opex	69	75	
	Total Capex	3,966	4,363	831
Rail	Total Asset Replacement	76	76	
	Total Opex	726	726	
	Total Capex	809	809	
Total Opex		794	801	
Total Capex		4,934	5,339	831

All costs in 2014, real prices and incl. risk and optimism bias - £'million

N.B. HAL costs exclude £430m surface access costs which HAL has included within its Core airport capex, assumed to be the Southern Road Tunnel scheme

Table H-3 Summary Costs and Risk Sensitivity Test

Tables H-4 and H-5, on the following page, set out summaries of the capital, operational and asset replacement costs by road and rail project, including adjustments for risk and optimism bias.

HAL Highway/Local Road/Rail	Route	Length (km)	Unit Cost (£'million per km)	Estimated Cost (£'million)	Risk	Optimism Bias	Total (£'million)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	
Highway	M4 J3 to J4	3.8	50	190	-	83.6	273.6					63	63	63																										
Highway	M4 Airport Spur	2.8	50	140	-	61.6	201.6					70	70																											
Highway	M4 J2 to J3	17.6	50	880	-	387.2	1267.2					293	293	293																										
Highway	M4 J4 and J4B	4.7	50	235	-	103.4	338.4						118	118																										
Highway	M4		150	150	-	66	216						75	75																										
Highway	M4		40	40	-	17.6	57.6						20	20																										
Highway	M4		40	40	-	17.6	57.6						20	20																										
Highway	M25	4	100	400	-	176	576					133	133	133																										
Local Road	Diversions of A4 Road alignment, dual carriageway	3.5	25	87.5	-	38.5	126						44	44																										
Local Road	Diversions of A3044 Road alignment, dual carriageway	1	25	25	-	11	36						13	13																										
On-Airport Road	Southern Road Tunnel	5.2	100	520	-	228.8	748.8	87	173	173	87																													
Local Road	Airport Way/Southern Perimeter Road Interchange, grade separated junction and flyover/bridge structures	1	35	35	-	15.4	50.4				18	18																												
Local Road	Southern Road Tunnel/Southern Perimeter Road Interchange	1	10	10	-	4.4	14.4				5	5																												
Local Road	One way system for western campus	1	2	2	-	0.88	2.88							1	1																									
Rail	SRA to Staines		487.5	487.5	-	321.75	809.25					163	163	163																										
Total				3,242	-	1533.73	4775.73	125	250	282	619	1,157	1,493	850	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Highway Maintenance	Source: Highways Agency website inflated from 2011/12	32.9	0.046	1.51																																				
Local Road Maintenance	Source: Highways Agency website inflated from 2011/12	12.7	0.056	0.71																																				
Total Road Asset Renewal /year				57.39	-	25.25	82.64	-	-	-	-	0.58	0.58	1.39	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20		
Highway Opex	Source: DfT COBA (2006), road type 11, inflated from 2002 to 2014	32.9	0.045	1.48																																				
Local Road Opex	Source: DfT COBA (2006), road type 6, inflated from 2002 to 2014	12.7	0.03	0.38																																				
Total Road Opex /year				47.63	-	20.96	68.58	-	-	-	-	0.31	0.31	0.95	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68		
Rail Asset Renewal /year	Source: LeighFisher analysis	-	1.75	45.50	-	30.03	75.53	-	-	-	-	-	-	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91		
Rail Opex /year	Source: LeighFisher analysis	-	19.80	514.80	-	211.07	725.87	-	-	-	-	-	-	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92	27.92		
GRAND TOTAL (£'million)							5,728.35	125	250	282	619	1,158	1,494	883	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37		

Table H-4 Summary Costs

HAL	Total 2014-50	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050			
Roads																																									
Capex	2,754.5	-	-	-	-	-	86.7	173.3	195.8	242.5	616.3	849.8	590.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Asset Replacement Capex	57.4	-	-	-	-	-	-	-	-	-	0.4	0.4	1.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2		
Opex	47.6	-	-	-	-	-	-	-	-	-	0.2	0.2	0.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9		
Rail																																									
Capex	487.5	-	-	-	-	-	-	-	-	162.5	162.5	162.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Asset Replacement Capex	45.5	-	-	-	-	-	-	-	-	-	-	-	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8		
Opex	514.8	-	-	-	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8		
Risk on Capex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias on Capex	1,589.0	-	-	-	-	-	38.1	76.3	86.2	214.0	378.6	481.3	261.3	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1		
Risk on Opex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Optimism Bias on Opex	232.0	-	-	-	-	-	-	-	-	-	0.1	0.1	0.4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
Total Capex (inc. Risk & OB)	4,933.9	-	-	-	-	-	124.8	249.6	282.0	619.0	1,157.7	1,494.0	854.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1			
Total Opex (inc. Risk & OB)	794.5	-	-	-	-	-	-	-	-	-	0.3	0.3	28.9	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6			

Table H-5 Summary Outputs