Appraisal Framework Module 4.

Surface Access: Dynamic Modelling Report

Heathrow Airport North West Runway

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Contents

1. Introduction

1.1 Background

1.1.1 The Airports Commission (AC) was established in 2012 by the UK Government to examine the need for additional UK airport capacity and to recommend how any additional capacity requirements can be met in the short, medium, and long-term. The AC is due to submit a Final Report to the UK Government by the summer of 2015, assessing the environmental, economic and social costs and benefits of various solutions to increase airport capacity, considering operational, commercial and technical viability.

1.1.2 Shortly after its inception, the AC issued tenders for support contracts to engage independent technical advice on a range of aspects of the Commission's work. Jacobs together with sub-consultants Leigh Fisher and Bickerdike Allen Partners were appointed as the sole supplier on the Airport Operations, Logistics and Engineering Support Contract (ref: RM1082), which runs throughout the AC's lifespan up until the summer of 2015.

1.1.3 A key milestone in the AC's operational life was the delivery in December 2013 of an Interim Report. Following a general call for evidence, the Interim Report detailed the results of analysis of the capacity implications of forecast growth in UK aviation demand and a preliminary appraisal on a long-list of proposals put forward by scheme promoters to address the UK's long-term aviation connectivity and capacity needs. The associated appraisal process identified three short-listed options, two focussed on expanding Heathrow Airport and one on expanding Gatwick. These options were then subsequently further developed and appraised during an assessment that was published for consultation in November 2014.

1.1.4 The pre-consultation assessment with respect to surface access constituted a static appraisal using spreadsheet-based demand-forecasting models, which were developed primarily to assess the surface transport capacity implications of each expansion option. Following feedback from the AC's surface access stakeholders (the Department for Transport (DfT), the Highways Agency (HA), Network Rail (NR), and Transport for London (TfL)), further assessment of the surface access implications of the three expansion options was undertaken during the consultation period from November 2014 to January 2015.

1.2 Study scope

1.2.1 Under the terms of the RM1082 support contract, Jacobs were commissioned to undertake the aforementioned surface access assessment of the short-listed expansion options during the consultation period. This further post-consultation assessment focussed specifically on three key aims as follows:

- Undertaking further sensitivity-testing of the spreadsheet-based pre-consultation models to determine the impact of key variables on airport-related surface access demand, notably incorporating trip distribution forecasts from the DfT's National Air Passenger Allocation Model (NAPAM);
- Providing a more detailed dynamic assessment using network-based models of the capacity and level-of-service implications of airport expansion associated with each short-listed option, accounting particularly for the following:
  - the extent to which road and rail trips (including non-airport trips) change their route to avoid congestion/over-crowding, and the associated knock-on impacts;
  - the extent to which new rail services related to currently uncommitted infrastructure may induce an increase in background demand;
  - the wider impacts of crowding on the rail network providing secondary connections to airport services, notably the London Underground;

- the effect of forecast demand on junction performance and the resulting congestion impacts, both on the strategic road network and on roads in the vicinity of the airports;

- Providing traffic forecasts compatible with the requirements of the air quality assessment that will be undertaken as a part of a separate environmental work-stream - the data requirements for this work-stream are summarised in Appendix A.

1.2.2 The ultimate aim of the study was to provide further guidance to the AC on the feasibility of, and likely surface transport issues associated with each expansion option, with specific reference to three objectives set out in the AC's Appraisal Framework:

- **Objective 1** - to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport;
- **Objective 2** - to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight; and
- **Objective 3** - to enable access to the airport from a wide catchment area.

1.2.3 For reference, the pre-consultation reports are available to download from the AC's website[1]. The aforementioned surface access environmental impacts are considered as part of a separate work-stream.

1.3 Methodology overview

1.3.1 This report is the **dynamic modelling appraisal report** for the post-consultation surface access assessment of Heathrow Airport North West Runway. Three work-streams were undertaken as follows:

- Enhanced distribution/mode-share modelling – this involved enhancements to the pre-consultation spreadsheet models – the air passenger and on-airport employee surface access forecasts arising from the enhanced models provided inputs for the following two work-streams.
- Dynamic rail modelling – rail surface access forecasts from the enhanced spreadsheet models were input into the network-based “Railplan model” (version 7, supplied by TfL) to assess the dynamic impacts of increasing airport-related rail trips on network performance in London and the South-East of England. Railplan was chosen as it is the industry-standard model, used by TfL and Network Rail, to assess all rail schemes in London and the South East.
- Dynamic highway modelling – highway surface access forecasts from the same spreadsheet models were also input into TfL’s West London Highway Assignment Model (WeLHAM) to assess the dynamic impacts of increasing airport-related road trips on network performance in London and the South-East. WeLHAM was chosen as it is a detailed network-based highway capacity model of the South-West London covering the Heathrow Study area. It has been validated to a 2009 base year and is used by TfL to assess road schemes within London. An alternative approach of using the HA’s ‘M25 model’ was investigated, but was rejected for this purpose due to the lack of local network detail around Heathrow and age of model development and validation in our study area.

1.3.2 The pre-consultation assessments focussed on a single AM peak-hour demand forecast for each of the airport expansion options in 2030 – this was the peak-hour for airport passenger trips, which was estimated from flight arrival/departure profiles and assumed terminal lag times as 0700-0800. Post-consultation, the 2030 forecast year was retained but a range of time periods were assessed, driven by the requirements of the dynamic modelling work-streams.

1.3.3 For the highway modelling, an AM peak hour (0800-0900) and a PM peak-hour (1700-1800) was required to be consistent with the WeLHAM modelled time periods, along with an average Inter Peak (IP) hour covering the period 1000-1600. For the Railplan modelling, a 3-hour AM peak (0700-1000) period and a 6-hour inter-peak (1000-1600) period were modelled.

[1] https://www.gov.uk/government/publications/additional-airport-capacity-surface-access-analysis

1.3.4 As a result of the difference in time periods, the outputs from the pre and post-consultation models are not directly comparable. In addition, the capacity analysis undertaken pre-consultation was static in nature – demand associated with a new North West Runway at Heathrow was added to estimates of background demand in the spreadsheet model and the capacity implications were assessed without consideration of the impacts of crowding and congestion on route choice and journey timing. The dynamic nature of the capacity assessments undertaken post-consultation means that the resulting forecasts do account for these elements and are consequently different from those reported pre-consultation.

1.3.5 Furthermore, as discussed in section 2.1 below, the number of passengers assumed to be using Heathrow was different between the pre-consultation (which adopted the HAL forecasts) and post-consultation (which adopted the AC's "Carbon-Traded Global Growth" forecasts) assessments. Similarly, as discussed in section 2.2 below, the number of Heathrow employees was different between the pre-consultation (which adopted the HAL forecasts) and post-consultation (which assumed some productivity efficiencies) assessments.

1.3.6 As with pre-consultation, the post-consultation assessment was undertaken with reference to a Core and an Extended Transport Baseline, which together listed transport infrastructure and services expected or likely to be in place by 2030 regardless of any airport expansion that may be delivered in the UK. Details of the schemes included in these baselines are provided in Appendix B – the Core Baseline only included those schemes that were fully committed and funded when the pre-consultation assessment commenced.

1.3.7 The primary focus of all the analysis was on the Extended Baseline, as by 2030 it was judged very likely that further enhancements to the UK transport network would have been delivered above and beyond the works that were fully committed before the consultation. In addition, as described in our pre-consultation analysis, two rail schemes not included in the Extended Baseline were incorporated in the assessment of the North West Runway, as follows:

- Southern Rail Access (SRA) – the provision of 2 trains per hour (tph) in peak periods, rising to 4tph in off-peak periods, between Heathrow and Waterloo via Staines;
- Crossrail 6tph to Heathrow, increased from the assumed service provision of 4tph in peak periods.

1.3.8 Constructing an appropriate Extended Baseline for a 2030 assessment involved making significant assumptions about the likely state of the transport network by that time, and this was a central factor in the decision not to extend the scope of the surface access assessment to include later years.

1.3.9 There is currently a high degree of uncertainty surrounding some of the included schemes, not just in terms of their delivery but also their final form and characteristics, which in some cases are continually evolving as development work is progressed. The assessment detailed in this report was based on the best assumptions on the state of the 2030 transport network at the time of writing, and was informed by discussions with the AC's stakeholders before the pre-consultation assessments were published for consultation, and some limited technical meetings between the reports author's and the stakeholders during the compilation of this report, mainly related to modelling issues and clarifications on feedback received pre-consultation.

1.3.10 Appendix E provides some indicative examples of road and rail trips between the airport and key locations in the UK in the 2030 'Extended Baseline with SRA' scenario described above, including summary crowding/congestion forecasts derived from the dynamic modelling undertaken during this study and described in the subsequent chapters of this report. The UK locations were identified based on trip distribution forecasts for the North West Runway from the DfT's NAPAM.

1.4 Report structure

1.4.1 The remainder of this report is structured as follows:

- Chapter 2 describes the core and alternative airport expansion scenarios that were tested post-consultation;
- Chapter 3 summarises the enhancements that were made to the pre-consultation spreadsheet models and the sensitivity tests that were undertaken in response to feedback received from the AC's stakeholders pre-consultation, and reports the resulting changes in forecast peak period surface access demand to and from airport as a result;
- Chapter 4 summarises the outputs from the Railplan modelling of the core expansion scenario for a North West Runway at Heathrow;
- Chapter 5 summarises the outputs from the dynamic highway modelling of the core expansion scenario for a North West Runway at Heathrow, using the WeLHAM model;
- Chapter 6 provides a summary of the three work-streams undertaken and draws out key conclusions based on the outputs.

2. Airport expansion scenarios

2.1 Overview

2.1.1 The pre-consultation spreadsheet models forecast demand related to each airport expansion option based on a range of assumptions and parameters used to convert two key headline inputs into peak-hour surface access trips to and from the airport. These key headline inputs are total annual passengers handled by the airport, including the proportion interlining (i.e. transit passengers who do not use surface access modes), and the total number of on-airport employees.

2.1.2 As with all the short-listed airport expansion options, the basis of the pre-consultation analysis for a new North West Runway at Heathrow was the scheme promoter's own forecasts, and sensitivity tests were carried out using the passenger numbers from two AC scenarios. The headline passenger numbers associated with these scenarios are shown in Table 2-1.

Table 2-1: Pre-consultation assessment scenarios

Scenario	Current runway capacity				Capacity expansion (extra/extended runway)			
	Total annual pax	Annual interlining pax	Interlining %	Annual surface access pax	Total annual pax	Annual interlining pax	Interlining %	Annual surface access pax
HAL submission	82,500,000	~	35.0%	53,625,000	103,600,000	~	35.0%	67,340,000
Carbon-Capped Assessment of Need	84,919,152	21,012,136	24.7%	63,907,016	109,264,920	34,912,782	32.0%	74,352,138
Carbon-Traded Global Growth	87,452,728	19,796,496	22.6%	67,656,232	125,153,056	41,171,271	32.9%	83,981,785

2.1.3 In terms of employees, the HAL submission figure of 90,000 on-airport staff associated with the delivery of the North West Runway was used in all the capacity expansion scenarios, while a figure of 72,100 (also sourced from the HAL submission) was used for the airport with two runways.

2.1.4 Post-consultation, it was decided that an appropriate AC forecast should be used as the core scenario rather than the scheme promoter's own figures, and this core scenario was applied in the dynamic rail and highway modelling work-streams. This was to reduce reliance on the scheme promoter forecasts and also to allow the incorporation of trip distribution forecasts derived from the DfT's NAPAM, which was run to generate outputs specifically for each AC scenario. Further details of the outputs from NAPAM are provided in the following chapter of this report and also in the separate Technical Appendices document supporting this report.

2.2 Core scenario

2.2.1 For Heathrow North West Runway, the highest AC scenario in terms of airport passengers in 2030 was the Carbon-Traded Global Growth (CT GG) scenario. The passenger forecasts for this scenario are summarised in Table 2-1, indicating a total of 87.5 million passengers per annum (mppa) using the airport with two runways in 2030, increasing to a total of 125.2mppa with the North West Runway in place in the same year. The proportion of those passengers that were interlining was forecast to rise from 22.6% with two runways up to 32.9% with the North West Runway in place.

2.2.2 In terms of employment, the AC produced two scenarios expressed as ratios of passengers per annum (ppa) per on-airport employee for Heathrow in 2030, summarised as follows:

- 2030 low productivity employment scenario = 911ppa/employee (assumed year-on-year increase of 0.5% in ppa/employee ratio from base 2011 figure);
- 2030 high productivity employment scenario = 1,265ppa/employee (increase of 2.25% in ratio).

2.2.3 For the purposes of the post-consultation assessment, a mid-range of 1,088ppa/employee was used to calculate an estimate of total on-airport employment associated with the CT GG passenger scenario described above. This resulted in the key headline numbers summarised in Table 2-2 forming the core post-consultation scenario that was assessed using Railplan and WeLHAM.

Table 2-2: Post-consultation 2030 core scenario headline inputs for Heathrow North West Runway (Carbon-Traded Global Growth passenger forecasts with mid-range employment ratios)

Airport expansion	Annual passengers	% interliners	Annual surface access passengers	On-airport employees
Current runway capacity	87,452,728	22.6%	67,656,232	80,357
With North West Runway	125,153,056	32.9%	83,981,785	114,999

2.3 Alternative scenarios

2.3.1 In addition to the core scenario, airport-related forecasts were also produced for the two other pre-consultation passenger scenarios summarised in Table 2-1, with one alteration. Pre-consultation, the Carbon-Capped Assessment of Need (CC AoN) sensitivity test was undertaken using the HAL submission employee estimates. Post-consultation, the employee assumptions related to this scenario were updated to incorporate the mid-range AC employee ratio described above. In contrast, for the HAL submission passenger scenario, the HAL employee forecasts were retained. This resulted in the summary headline inputs for the post-consultation alternative scenarios shown in Table 2-3.

Table 2-3: Post-consultation 2030 alternative scenario headline inputs for Heathrow North West Runway

Scenario	Airport expansion	Annual passengers	% interliners	Annual surface access passengers	On-airport employees
Carbon-Capped Assessment of Need (mid-range employee ratio)	Current runway capacity	84,919,152	24.74%	63,907,016	78,029
	With North West Runway	109,264,920	31.95%	74,352,138	100,400
HAL submission	Current runway capacity	82,500,000	35.00%	53,625,000	72,100
	With North West Runway	103,600,000	35.00%	67,340,000	90,000

2.3.2 It should be noted that while revised airport-related demand forecasts were produced for these scenarios alongside the core scenario for comparative purposes using the enhanced spreadsheet models, the impacts were not modelled using Railplan or WeLHAM as part of this study.

2.4 Scenario comparison

2.4.1 The tables above indicate clearly that with the North West Runway in place, the CT GG scenario with the mid-range employee ratio applied produces the highest absolute numbers of passengers and employees in 2030 when compared with the two alternative scenarios.

2.4.2 As well as this, the CT GG scenario also results in the largest net change in annual passengers using surface access (i.e. accounting for interlining trips) at Heathrow in 2030 when the North West Runway expansion option is compared with the two-runway ‘do nothing’ option. This net change in surface access passenger numbers is illustrated for all three scenarios in Figure 2-1. Similarly, Figure 2-2 indicates that the net change in employees as a result of the North West Runway is most pronounced in the CT GG scenario with the mid-range employee ratio applied.

Figure 2-1: Forecast 2030 increase in annual passengers using surface access (Heathrow North West Runway expansion option v ‘do nothing’ option)

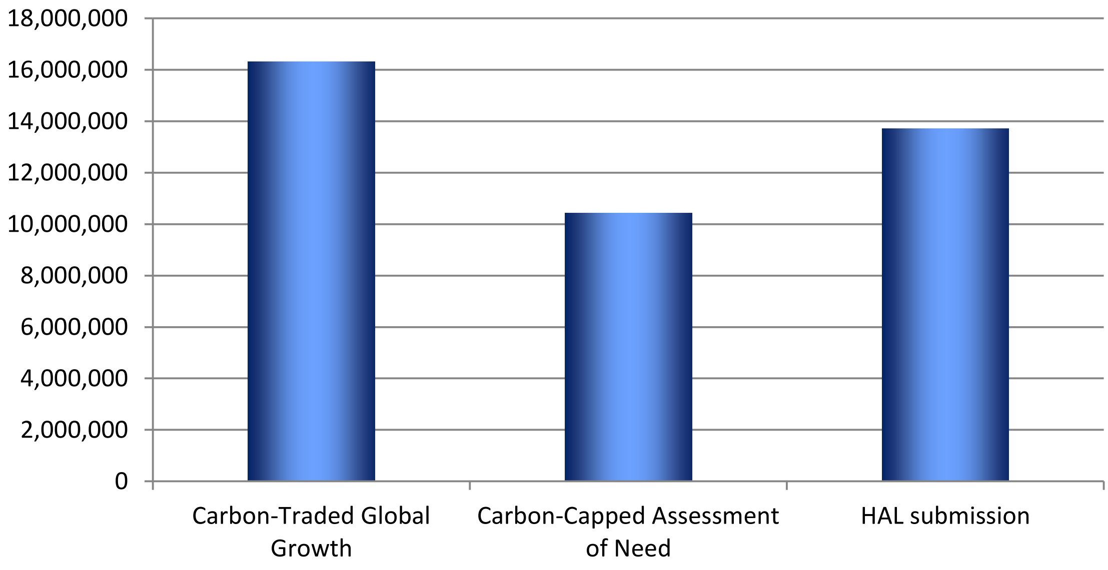
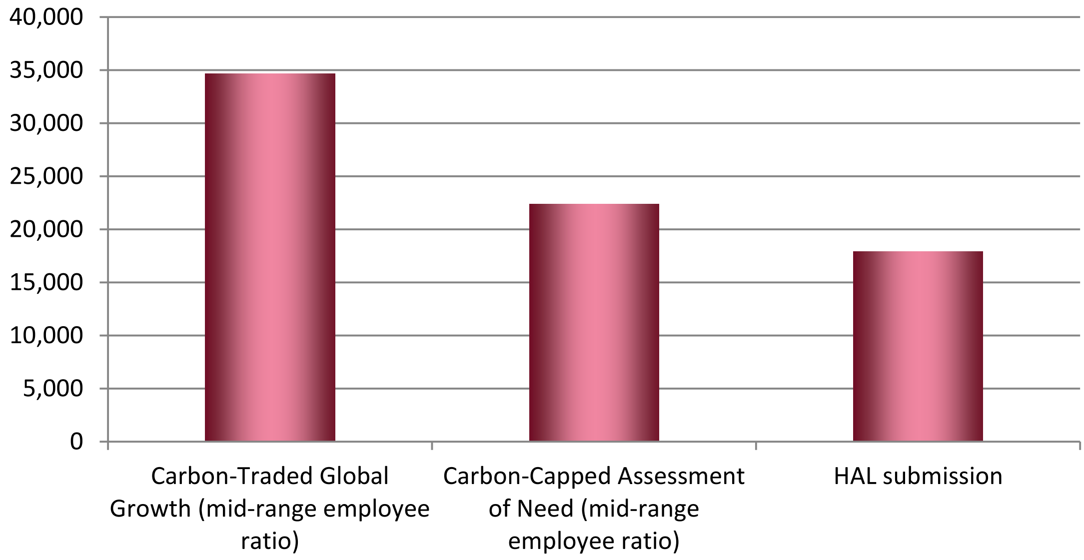


Figure 2-2: Forecast 2030 increase in employees (Heathrow North West Runway expansion option v ‘do nothing’ option)



3. Distribution and mode share modelling enhancements

3.1 Overview

3.1.1 The headline annual passenger and employee inputs described in the previous chapter were used in the spreadsheet models initially developed pre-consultation to generate revised airport demand forecasts for a range of time periods for each scenario. The time periods assessed were dictated by the requirements of the dynamic modelling work-streams as follows:

- For the highway modelling using WeLHAM, three time periods were required:
  - an AM peak-hour (0800-0900);
  - an average Inter-Peak (IP) hour (between 1000 and 1600);
  - a PM peak-hour (1700-1800);
- For the Railplan modelling, two time periods were required:
  - a 3-hour AM peak period (0700-1000);
  - a 6-hour IP period (1000-1600).

3.1.2 Forecasts for the time periods described above were generated using passenger and employee arrival and departure profiles sourced from the HAL submission. A number of enhancements were also made to the pre-consultation model post-consultation to provide more robust forecasts. These enhancements are summarised as follows:

- for the two AC scenarios, the pre-consultation passenger surface access distribution assumptions were replaced with outputs corresponding to each scenario from the DfT's NAPAM;
- employee mode split assumptions were applied at district level to account for the different travel options likely to be available to employees in 2030 based on their home location (pre-consultation a single headline mode split was applied to all employees regardless of their home location) – this process was undertaken with reference to information on current employee travel behaviour sourced from a 2013 employment survey commissioned by HAL[2].

3.1.3 Apart from those inputs listed in paragraphs 3.1.1 and 3.1.2 above and the numbers of Heathrow passengers and employees defined in chapter 2 above, all other inputs to the model post-consultation were retained pre-consultation, as documented in the Technical Appendices document supporting the pre-consultation appraisal report[3].

3.1.4 In addition to the aforementioned enhancements, the district-level outputs from the models also needed to be converted to Railplan and WeLHAM zone-level inputs. In London and the South-East, both zone systems were very detailed, with individual districts divided into multiple zones. The conversion process therefore involved disaggregating demand from a large number of districts, accounting for the forecast 2030 distribution of population and jobs by zone within each district; the proximity of the zones to the airport (in the case of employees); and the accessibility of zones to rail stations. During this process, zones within the airport boundary were assumed to generate no demand.

3.1.5 The surface access demand forecasts produced by the enhanced spreadsheet model are summarised in section 3.2 for both the core and alternative scenarios described in Chapter 2. For the purposes of reporting, the AM and PM peak hours have been used to summarise the difference in impact between the scenarios.

[2] http://www.heathrowairport.com/static/HeathrowAboutUs/Downloads/PDF/TBF_techspec_vol2.pdf - page 334
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371821/4-surface-access--lhr-nwr-appendices.pdf

3.1.6 A number of sensitivity tests were also undertaken on the core scenario 2030 model in response to feedback received from the DfT pre-consultation. These tests and the resultant changes in forecast demand during the peak hours are summarised in section 3.2.21.

3.2 Core and Alternative Scenario model outputs

3.2.1 As described above, peak-hour demand forecasts were produced for the core scenario and the two alternative scenarios using the enhanced spreadsheet model. The resulting difference in model outputs is reported for the following characteristics – each of these characteristics in discussed in more detail in the remainder of this section:

- Trip distribution;
- Mode share;
- Vehicle and rail trip demand.

Trip distribution

3.2.2 The forecast distribution of passenger trips (both without any expansion and with the North West Runway) for the CT GG, CT AoN and the HAL submission scenarios is shown in Figure 3-1. In the case of the AC scenarios the relevant NAPAM distribution was applied while for the HAL submission the 2012 CAA distribution was applied.

3.2.3 The graphs indicate that in the HAL submission test using the CAA data, 51.1% of trips come from Greater London, 23.8% of trips come from the South East of England (excluding Greater London), and 25.1% of trips come from the rest of the UK. In terms of key districts, the City of London accounts for 1.5% of total passenger demand, Kensington and Chelsea 5.1%, Tower Hamlets 2.1% and Westminster 11.8%.

3.2.4 The NAPAM distributions associated with the AC scenarios (i.e. CT GG and CC AoN both with no expansion and with the North West Runway) are very similar to the CAA 2012 distribution at regional level, with London taking a slightly greater share of demand. In the CC AoN scenario both with and without expansion, 51.2% of trips have origins and destinations in London. In the core CT GG scenario with no expansion, London accounts for 51.9% of demand, falling to 51.3% with the North West Runway in place.

3.2.5 The share of demand from key districts in all the AC scenarios is very similar. For example, Westminster's share ranges from 11.2% in the CT GG with North West Runway scenario, to 11.5% in the CT GG no expansion scenario. This contrasts with the HAL submission where it accounts for 11.8%. Kensington & Chelsea's share ranges from 5.1% to 5.4% in the AC scenarios and is 5.1% in the HAL submission test.

3.2.6 In summary, the trip distributions between the 2012 CAA data and the NAPAM forecasts for the two AC scenarios are very similar.

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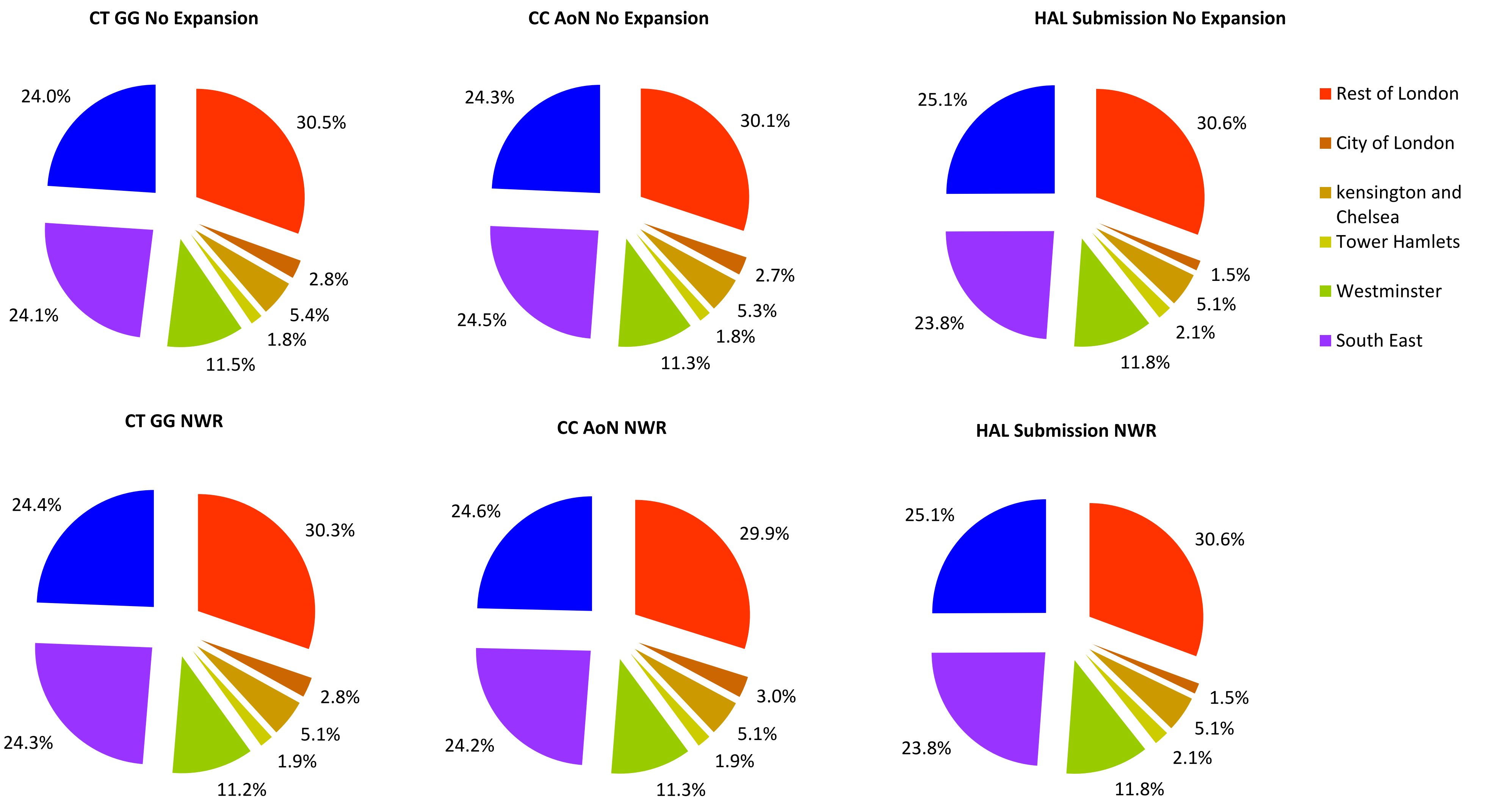
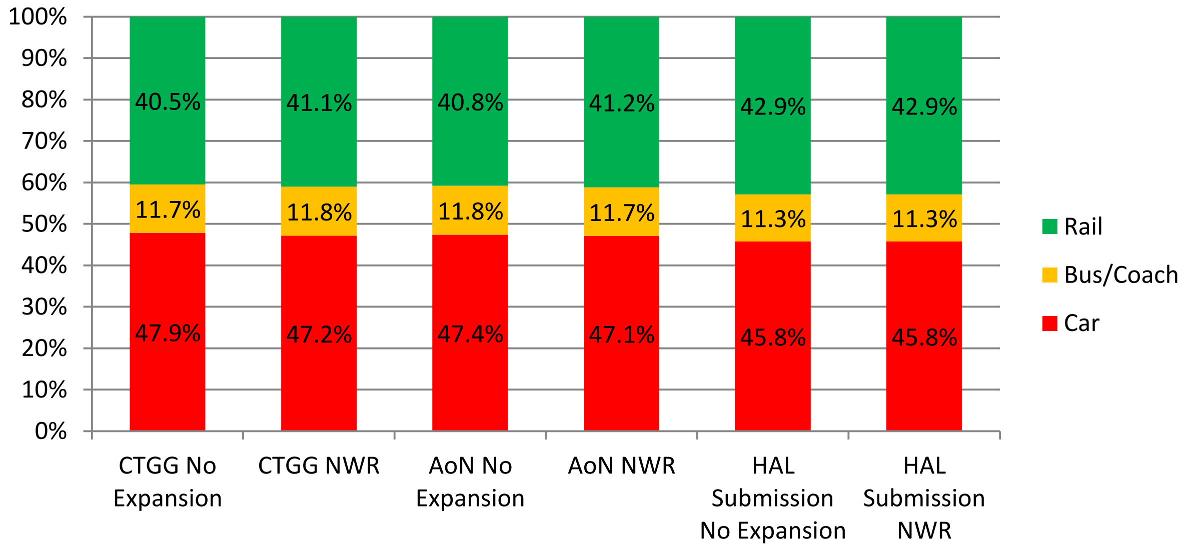
Figure 3-1: Passenger distribution percentage splits



Mode Share

3.2.7 Figure 3-2 shows the headline passenger mode share for the different distributions and expansion options.

Figure 3-2: Headline Passenger Mode Share



3.2.8 The graph indicates that there are only slight variations in passenger mode share between the different scenarios and expansion options. This is expected as the difference in the forecast distributions between the models is also very similar.

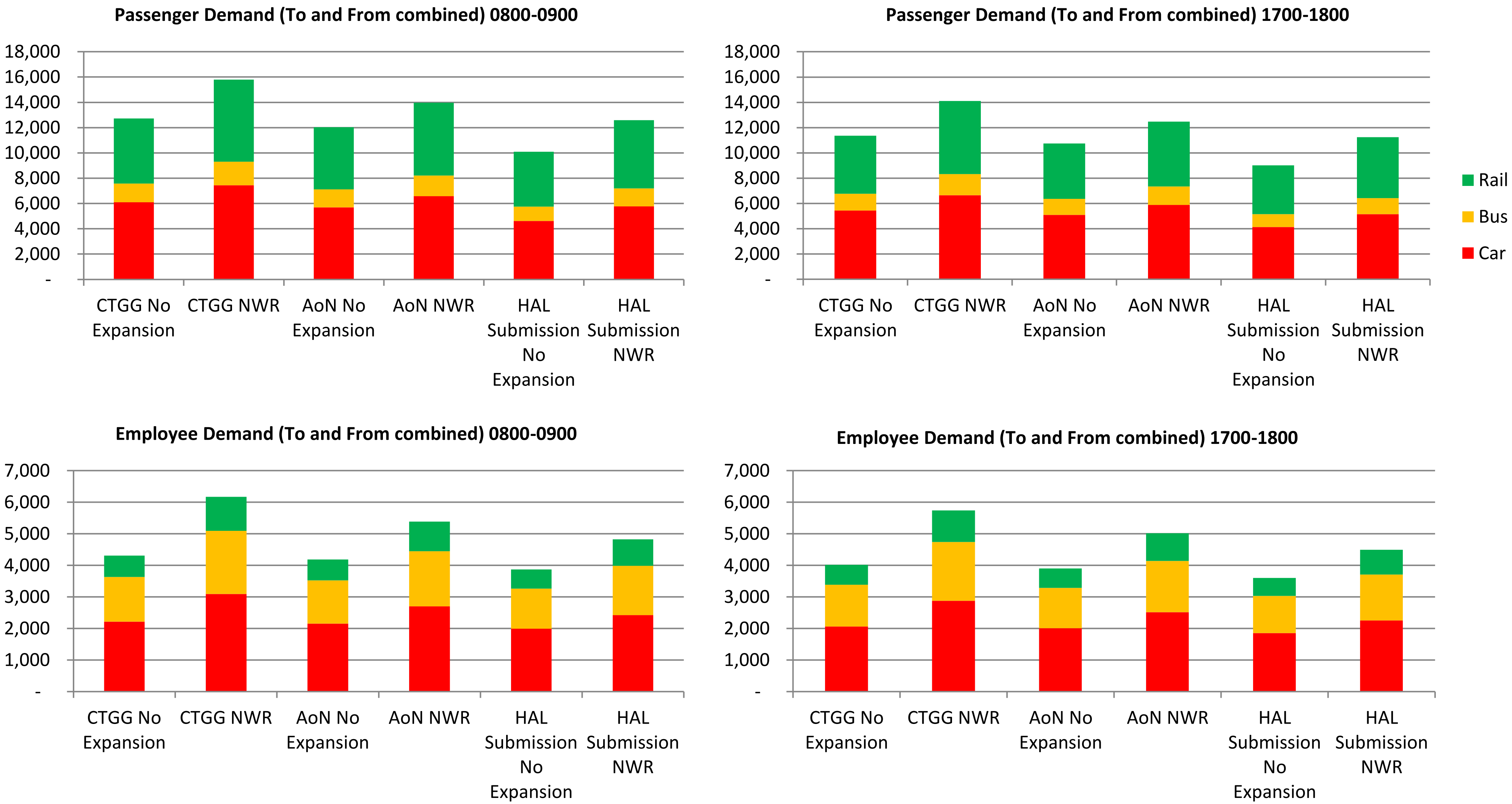
3.2.9 The forecast for rail mode share in the CT GG no expansion scenario is 40.5%, compared with 41.1% for CT GG North West Runway and 40.8% and 41.2% for CC AoN with two runways and with the North West Runway respectively. The bus/coach headline mode share for CT GG both with no expansion and with the North West Runway options is 11.7% and for both CC AoN options is 11.8%. The passenger car share for the CT GG with North West Runway is 47.2% compared with the CC AoN with North West Runway at 47.1%.

3.2.10 There is slightly more difference between the HAL submission and AC scenario mode share forecasts, though again the difference is not large. The HAL submission test forecasts 41.6% rail mode share and 46.5% car mode share, with bus/coach mode at 11.9%. The difference between the HAL test and the AC scenarios is partly related to the slight changes in distribution across the scenarios (as described above) and also because the journey purpose split at district level is different across all scenarios (the split at district level used in the HAL test is sourced from the CAA 2012 passenger survey data).

Total demand forecasts (person trips)

3.2.11 Figure 3-3 shows the total demand, to and from the Heathrow, for both passengers and employees in the AM peak hour (0800-0900) and the PM peak hour (1700-1800).

Figure 3-3 Total Passenger and Employee Demand - Combined To and From Heathrow



3.2.12 Given the similarities in the distribution and mode share forecasts across the core and alternative scenarios, as described earlier in this section, the difference in total demand is largely driven by the difference in headline passenger and employee growth forecasts and interlining ratios associated with each scenario, as summarised in Chapter 2.

3.2.13 As is to be expected, forecast airport demand is higher in all scenarios with the North West Runway in place, and the greatest demand for both employees and passengers occurs in the CT GG scenario, which has the highest forecast of 125.2mppa associated with the North West Runway. AM peak hour forecasts are also higher than the PM peak hour in each scenario, mainly as a result of the distribution of employee trips across the day – many arrive for work during the AM peak but have variable-length shifts meaning that departures from the airport are more evenly distributed throughout the afternoon and evening.

3.2.14 In the CT GG scenario with the North West Runway in the AM peak hour (0800-0900), total employee demand amounts to over 6,000 trips in both directions with passenger trips totalling under 16,000. In the PM peak hour employee trips total under 6,000 while there are over 14,000 passenger trips.

3.2.15 In the CC AoN scenario total demand is lower as the headline passenger input reduces to 109.6mppa with the North West Runway in place. In the AM peak hour, the employee trip forecast is around 5,400 while the passenger trip forecast is around 14,000. In the PM peak hour these numbers reduce to around 5,000 and just over 12,000 respectively.

3.2.16 Demand is lower still in the HAL submission test, which incorporates headline inputs of 103.6mppa and 90,000 employees. Total employee demand with the North West Runway is under 5,000 in the AM peak hour while passenger demand is over 12,000. In the PM peak hour these numbers decrease to around 4,500 and 11,000 respectively.

Demand forecasts by mode

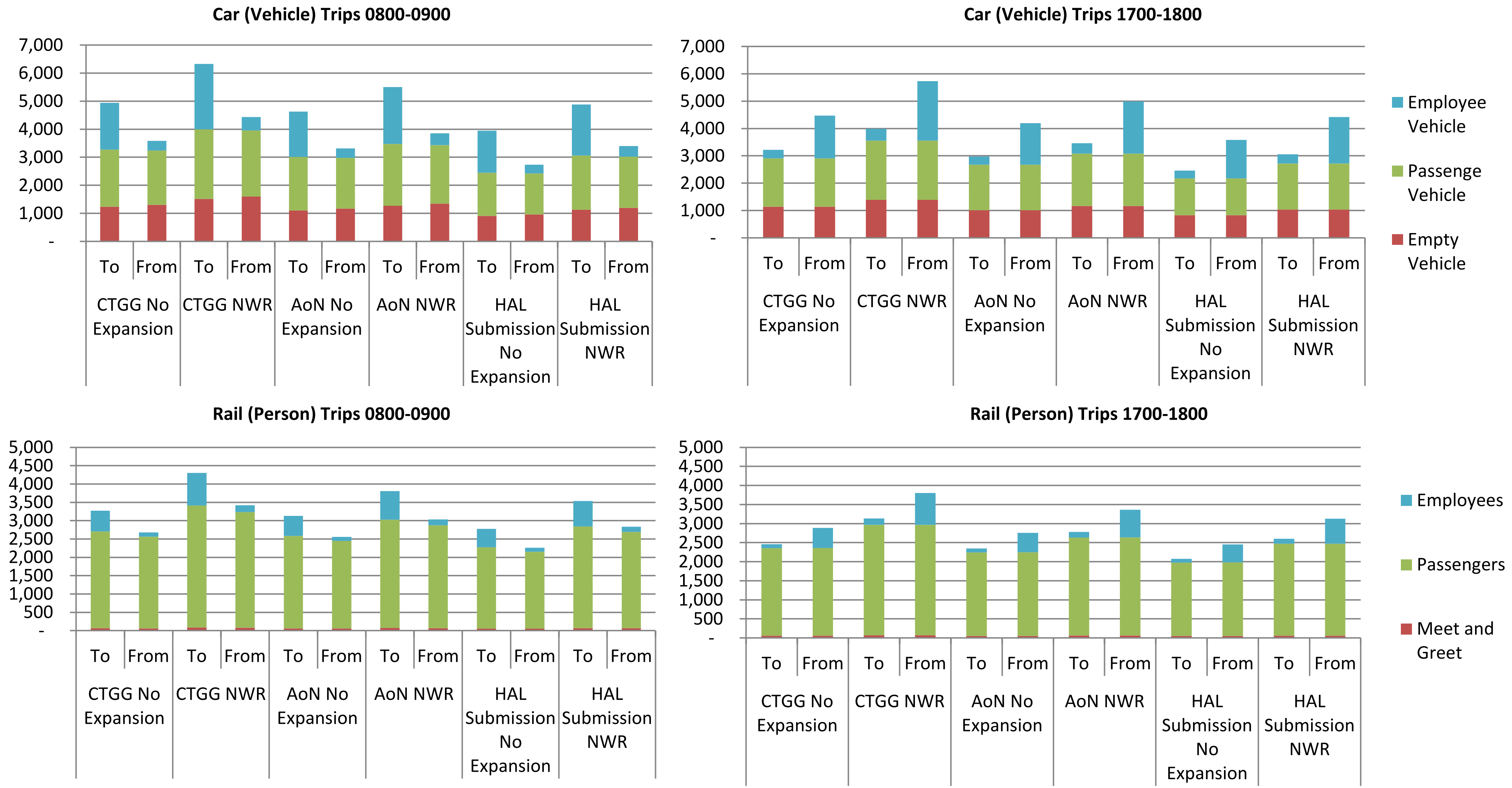
3.2.17 Figure 3-4 summarises the total forecast vehicle trips (accounting for assumptions about average vehicle occupancy and empty taxi/kiss & fly trips) and rail trips (accounting for assumptions about rail ‘meet & greet’ demand) split by direction to and from the airport in each scenario. As indicated above, the difference between the scenarios is largely driven by the changing headline passenger and employee inputs.

3.2.18 For employees, average vehicle occupancy was assumed to be 1.1 and no empty vehicle trips were assumed to be generated as a result of employee travel. For passengers, an average car occupancy rate of 1.53 was assumed, which was a composite of different rates for business and leisure passengers. 78% of taxis were assumed to operate empty on one leg of their journey in and out of Heathrow, and rail meet & greet was calculated at a rate of 2.5% of all airport passenger rail trips. More detail on the sources for these assumptions can be found in the pre-consultation reports published for consultation in November 2014.

3.2.19 The graph indicates that in the CT GG scenario with the North West Runway, the airport generates over 6,000 inbound car trips in the AM peak hour. This reduces to around 5,500 in the CC AoN scenario and under 5,000 in the HAL submission test. In the PM peak hour, under 6,000 car trips leave the airport in the CT GG scenario with the North West Runway, falling to 5,000 in the CC AoN scenario and around 4,500 in the HAL submission test.

3.2.20 In terms of rail demand the pattern is the same, with around 4,250 trips inbound to the airport in the AM peak hour in the CT GG scenario with the extra runway, falling to around 3,750 in the CC AoN scenario and 3,500 in the HAL submission test. The pattern repeats in the PM peak with an overall lower forecast demand.

Figure 3-4: Network Demand, for rail and car; 0800-0900 and 1700-1900



3.2.21 Passenger demand is similar in both directions in both time periods for each scenario tested, but employee demand is much more tidal in nature, with higher flows towards Heathrow in the AM peak hour and away from the airport in the PM peak hour. In the peak direction (to Heathrow in the morning, and from Heathrow in the evening), employee demand is comparable with passenger demand but in the counter-peak direction it is much lower at approximately 20% of passenger demand.

3.2.22 Empty vehicle trips contribute approximately 30% of all road network demand in both directions. As empty vehicle trips are calculated from passenger demand, they are, broadly, evenly split between the peak and counter peak direction for all scenarios. Additional rail demand created by meet & greet trips is very low in all scenarios.

3.3 Sensitivity testing

3.3.1 In addition to testing the core and alternative headline input scenarios, a number of sensitivity tests were also undertaken on the core scenario and the results are described in this section. A number of tests were requested by various stakeholders pre-consultation, as follows:

- Changing the Value of Times (VoT) used to calculate Generalised Cost for business and leisure passengers travelling to and from the airport – requested by the DfT;
- Changing the methodology for calculating base year mode share using the CAA passenger survey data – requested by the DfT;
- Airport passenger luggage space requirement impacts – requested by the AC expert panellists;
- The impact of rail pricing on demand – requested by the AC expert panellists.

3.3.2 For the purposes of undertaking these sensitivity tests, only the forecasts associated with the North West Runway have been reported. As evidenced in the previous section, the ‘no expansion’ tests produce similar results for a lower overall level of demand.

Value of Time (VoT)

3.3.3 The VoTs used in the core scenario are 69p per minute for business passengers and 27p per minute for leisure passengers. These values are composite 2012 values for UK and non-UK resident trips sourced from an SKM report on airport passenger use of HS2[4]. Pre-consultation, a decision was taken to use current VoTs in the models due to the uncertainties surrounding changes in rail fares and car operating costs in future years. This approach was retained in the core scenario post-consultation.

3.3.4 Pre-consultation, the DfT requested that the models be tested using VoTs sourced from the South East and East of England Regional Air Services Study (SERAS) model, which was initially developed in 2001. For the purposes of sensitivity testing post-consultation, two sets of VoTs were applied from SERAS – the 2012 forecast and the 2030 forecast. Table 3-1 summarises these values alongside those used in the core scenario, indicating that while the core scenario business VoT is lower than both SERAS values, the leisure VoT is higher.

Table 3-1: Values of Time (VoT) applied in core scenario and sensitivity tests

Journey purpose	Value of Time (pence per minute)		
	Post-Consultation Core Scenario	2012 SERAS	2030 SERAS
Business	69.2	81.9	119.1
Leisure	27.0	17.7	25.7

[4] http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/rail/pi/highspeedrail/hs2ltd/appraisalmaterial/pdf/airportdemandmodel.pdf

3.3.5 Changing the VoTs in the model impacts on both main mode and rail sub-mode share for passengers and consequently the car and rail demand forecasts. In broad terms, as VoT increases, so does the attractiveness of time saving vis-a-vis other costs (i.e. rail fares, car operating costs) in the model.

3.3.6 Figure 3-5 illustrates the impact of changing VoT on the rail sub-mode forecast from the model for business and leisure passengers. For business passengers, VoT is higher in the SERAS tests, resulting in a shift to Heathrow Express (HEX, which is assumed to be retained as a premium fare service in 2030) from standard fare services. In the core CT GG scenario, 21.3% of business passengers are assumed to use HEX, compared to 25% in the SERAS 2012 test and 30.5% in the SERAS 2030 test.

3.3.7 In contrast, for leisure passengers the highest VoT is applied in the core scenario and the result is that the highest proportion of leisure passengers use HEX in this scenario, at 10.4% of the total. The SERAS 2012 test involves applying the lowest VoT for leisure passengers, resulting in the lowest forecast HEX rail sub-mode share forecast of only 4%.

3.3.8 Figure 3-6 illustrates the impact of changing VoT on the main mode share forecast from the model. The impacts here are less obvious than the rail sub-mode shifts described above, since the relative attractiveness of car, rail and bus/coach by location is more variable than the difference between premium and standard rail options. In the case of business passengers there is very little difference in mode share since trip origins/destinations tend to be clustered in locations where one mode choice is clearly more attractive than the others (i.e. rail in the case of trips to and from central London).

3.3.9 However, the graphs for leisure passengers do indicate an increase in bus/coach mode share in the 2012 SERAS test. This is to be expected since the lowest VoT for leisure passengers is applied in this test, meaning that passengers are more likely to select less expensive modes of transport.

3.3.10 Figure 3-7 illustrates the overall mode share for all passengers in the three VoT tests, illustrating that the uplift in bus/coach trips in the SERAS 2012 test observed for leisure passengers is carried through to the main mode share for all passengers.

Figure 3-5: VoT impact on sub-rail mode share for business and leisure passengers

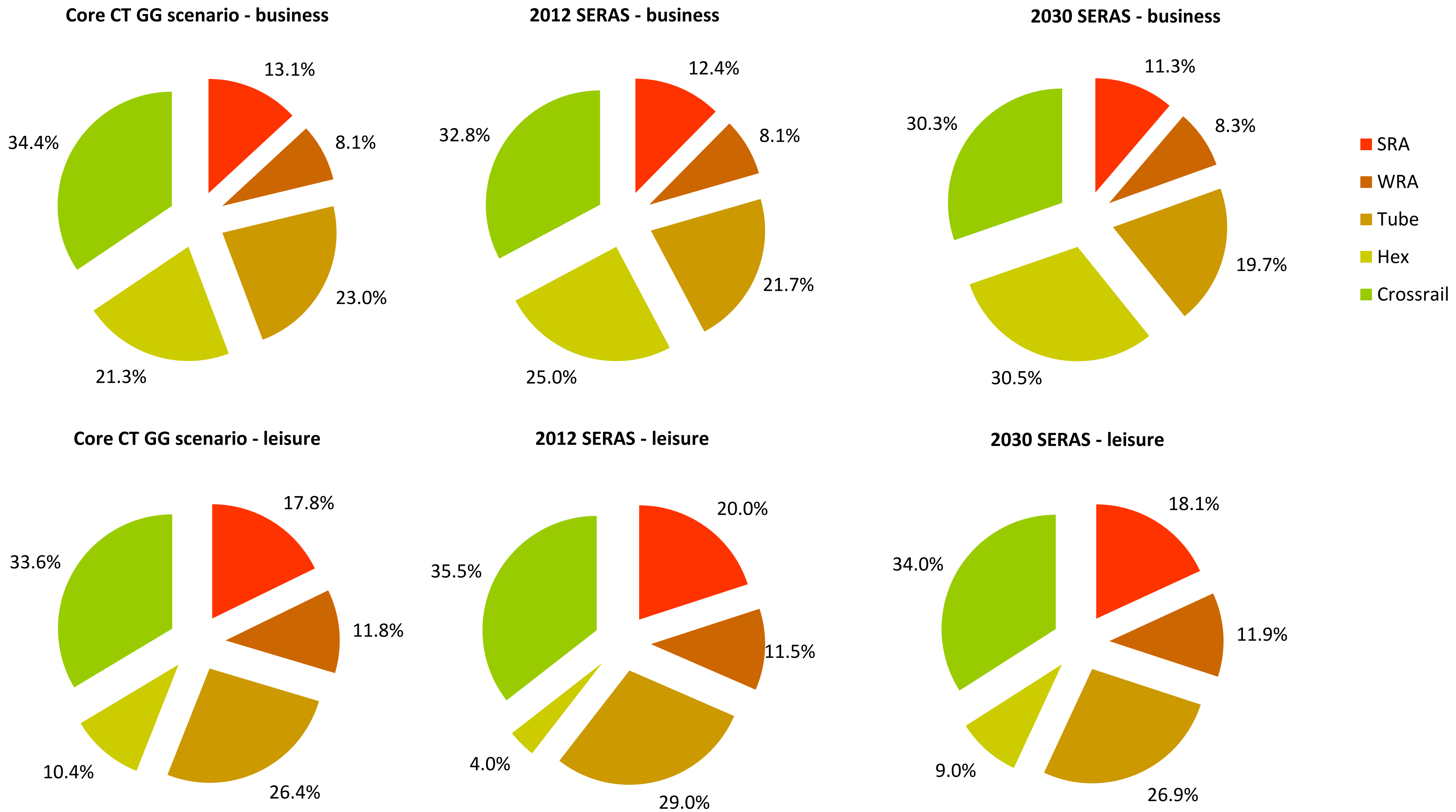
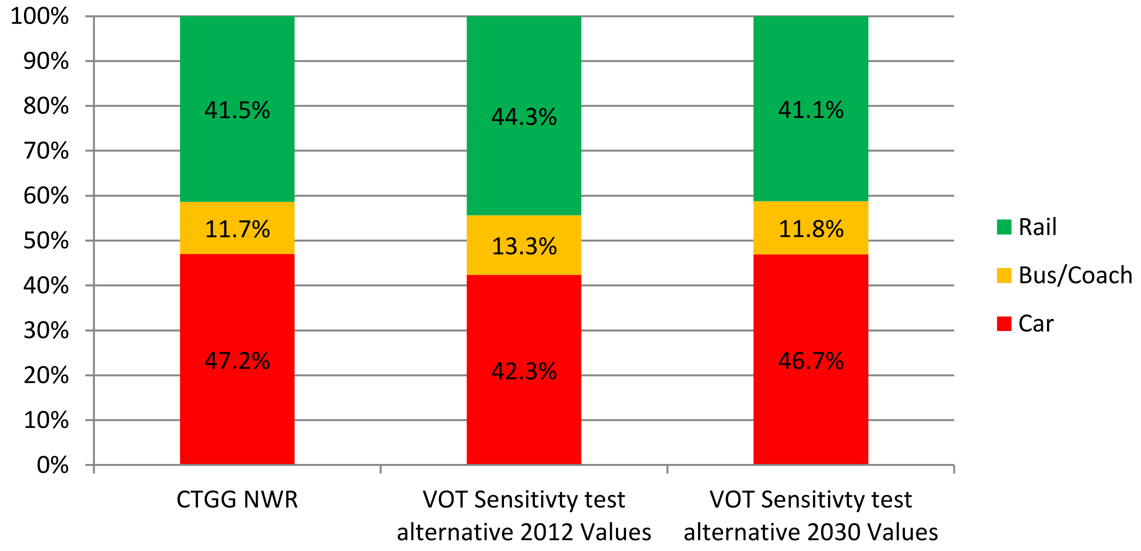


Figure 3-6: VoT impact on main mode share for business and leisure passengers

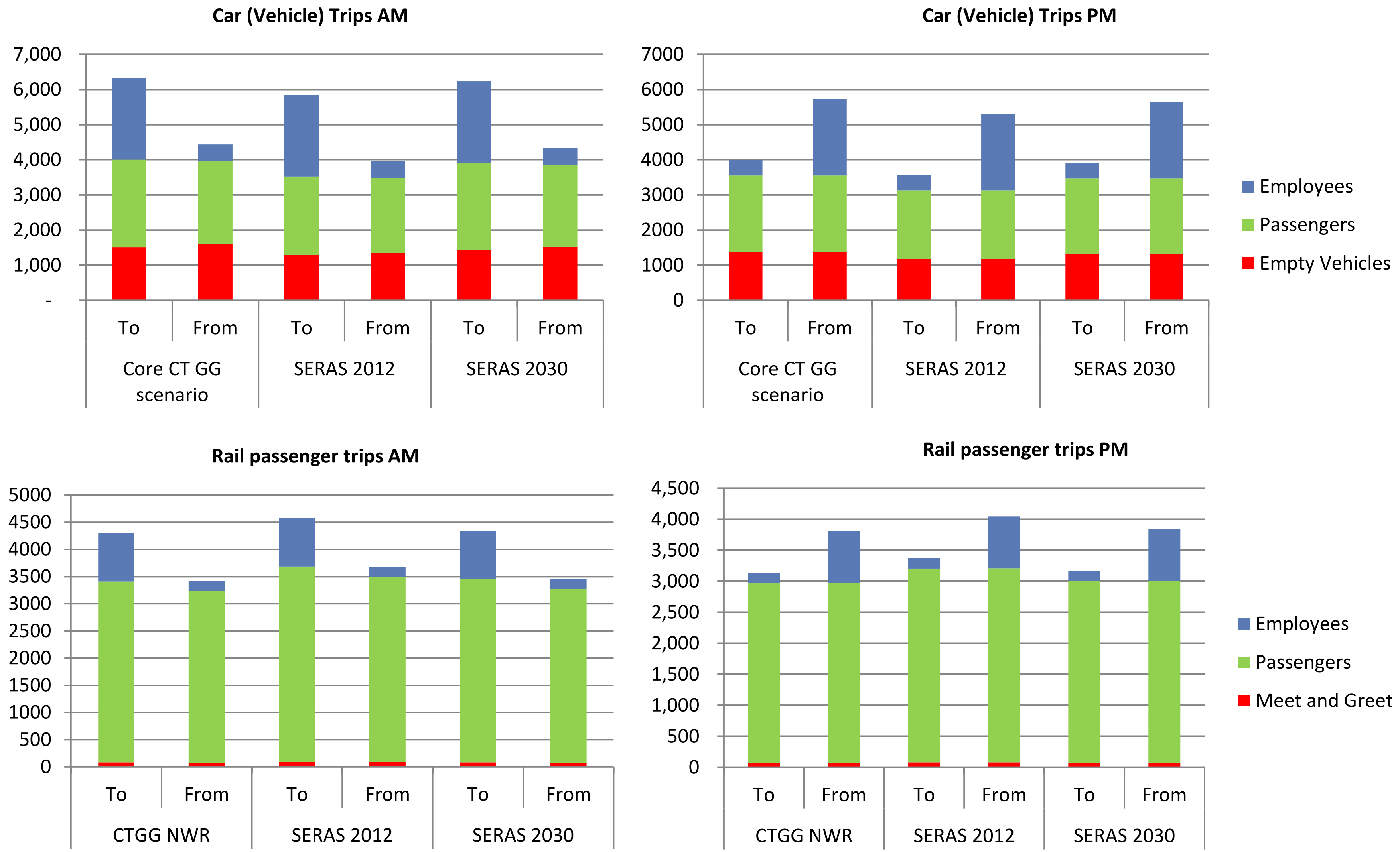
Figure 3-7: VoT impact on main mode share for all passengers



3.3.11 Figure 3-8 summarises the impact of changing VoT on total airport-related car vehicle and rail passenger demand in the CT GG scenario with the North West Runway in place.

3.3.12 The graphs indicate that the Core CT GG scenario generates the highest car demand, in line with the forecast car mode share for passengers, which is higher in this scenario than in the two SERAS tests. For rail conversely, the highest number of trips is generated in the SERAS 2012 test, again linked to the impact of VoT on the mode share forecasts described above.

Figure 3-8: Impact of VoT on car vehicle and rail passenger forecasts



Base mode share assumptions

3.3.13 As with the pre-consultation modelling, the core CT GG 2030 scenario forecast is based on an assessment of the final mode of travel to the airport recorded in the CAA 2012 passenger survey data. It was suitable to retain this approach post-consultation as final/first rail sub-mode airport demand inputs were required from the spreadsheet model for the dynamic rail assessment summarised in the following chapter. In addition, representative districts were identified for more remote regions from the airport to make the spreadsheet model development process more efficient – for example, this meant that Generalised Costs (GCs) only had to be estimated for approximately 120 districts instead of the full list of 370 in the UK. Representative districts were identified partly based on the distribution of trip origins evident in the 2012 CAA survey data, with excluded districts generally generating low current demand volumes.

3.3.14 Pre-consultation, the DfT requested that the model was sensitivity-tested to understand any potential impacts related to the use of final rather than primary mode (which may for example over-emphasise the demand impacts on modes local to the airport, such as courtesy buses), and the use of representative districts for remote regions. The 2012 CAA data indicated that key trip-generating districts in remote regions tended to correlate with regional public transport hubs (Manchester in the case of the North West for example, or Newcastle in the case of the North East), which may therefore result in a forecast that over-estimates public transport demand and under-estimates car demand.

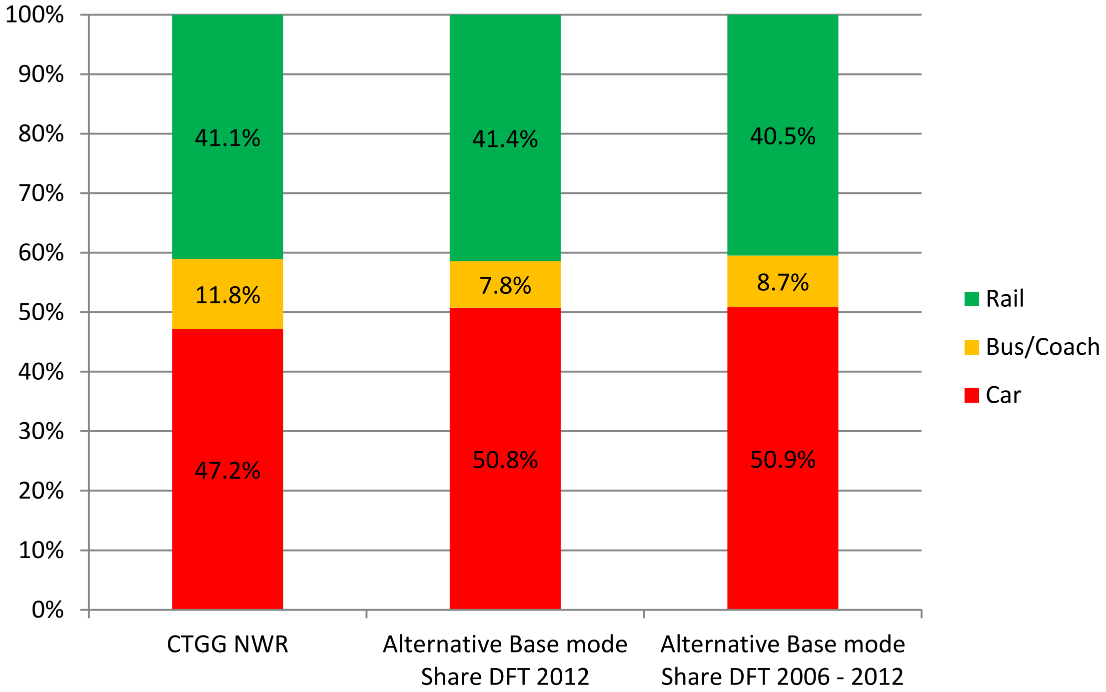
3.3.15 To facilitate these sensitivity tests, the DfT provided summaries of primary mode share by district calculated from CAA passenger survey databases for multiple years up to 2012. Two sensitivity tests were subsequently undertaken, one using the revised 2012 CAA database and another using a composite database for all years between 2006 and 2012. The second includes a larger number of records, providing a more representative data set for regions where the number of annual trips to the airport is low.

3.3.16 Ideally, the tests would be carried out by calculating composite GCs for remote regions rather than identifying a representative district, and then re-calibrating the model parameters in the base year to forecast primary mode rather than final model. These parameters would then be used to re-forecast 2030 mode share. However, it was not feasible to undertake such an exercise within the scope of this study. As indicated during the pre-consultation reporting, the spreadsheet models are incremental in nature, producing a final 2030 forecast by applying the modelled change in mode share between 2012 and 2030 for each district to the observed base year data for that district. As a result, the sensitivity tests were undertaken by replacing the observed final mode share in the 2030 CT GG model with the revised primary mode data provided by the DfT.

3.3.17 The DfT did not provide data on rail sub-mode share (HEX, Heathrow Connect, Tube) or car sub-mode share (Taxi, Kiss & Fly, Parked), therefore these sub-mode share forecasts in the model are retained from the 2030 CTGG scenario. The 2030 distribution from the DfT NAPAM was also retained along with all other parameters.

3.3.18 The impact of the two sensitivity tests on headline passenger mode share when compared with the core CT GG scenario is summarised in Figure 3-9. The graph indicates that the main change is a reduction in bus/coach mode share, from 11.8% in the core CT GG scenario to 8.7% in the 2006-12 test and 7.8% in the 2012 test. This suggests that bus is currently more commonly used as a final non-primary mode, for example as part of a rail-air service or a shuttle service from nearby hotels. Overall 2030 forecast PT mode share is lowest in the 2006-2012 test at 49.1%, compared with 49.2% in the 2012 test, suggesting a very slight shift away from car between 2006 and 2012.

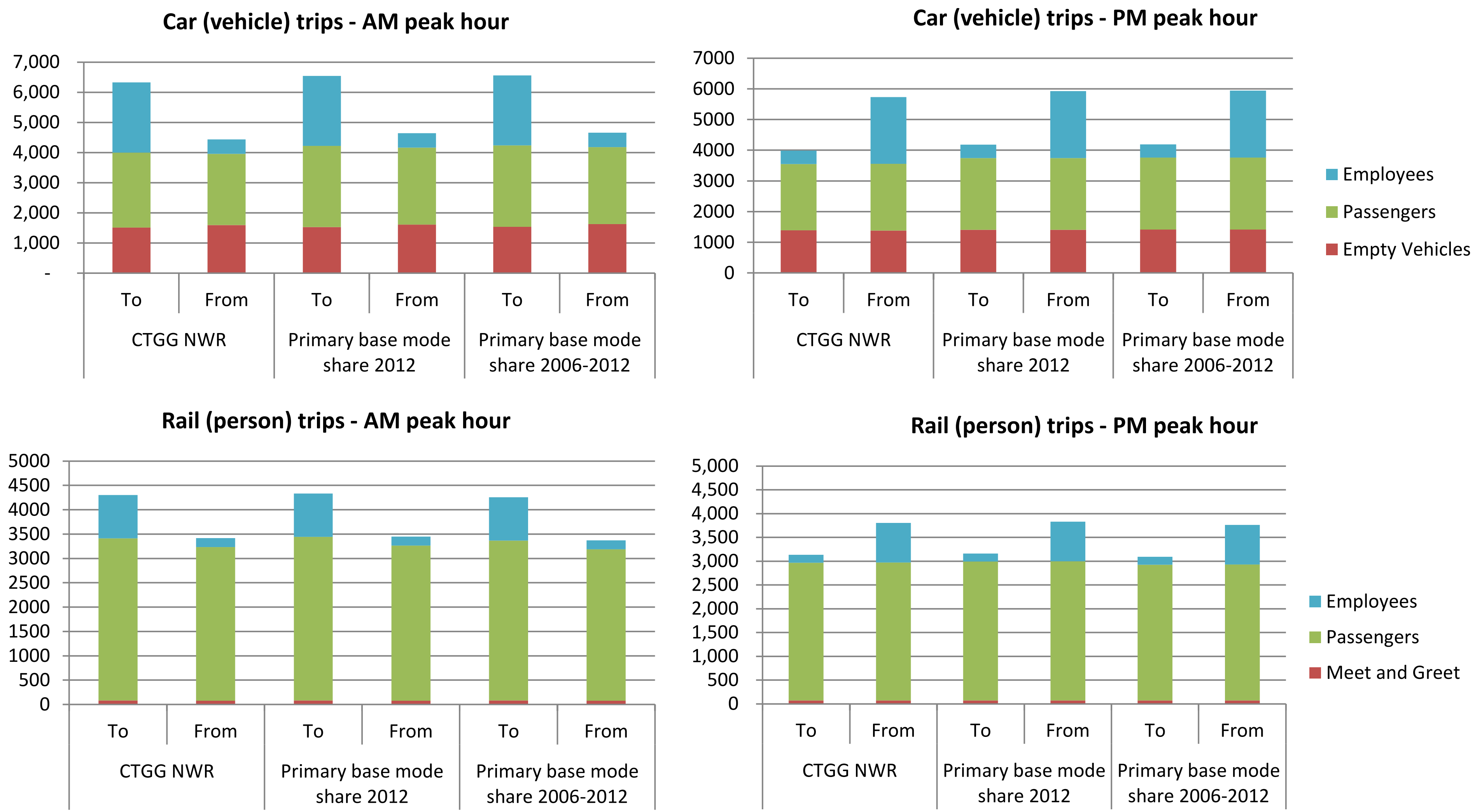
Figure 3-9: Impact of alternative base mode share data on 2030 forecast mode share



3.3.19 Figure 3-10 illustrates the impact of the changes in passenger mode share described above on overall trip demand forecast by the model in 2030, indicating there is very little change in demand as a result. The highest rail mode share was forecast in the alternative 2012 base test, and this corresponds to a forecast of 3,360 airport passengers travelling to Heathrow by rail in the AM peak hour, compared with the forecast of 3,329 in the central scenario.

3.3.20 In terms of vehicle demand, the test with the highest forecast airport passenger car mode share (the alternative 2006-12 base test) results in a forecast of 2,693 airport passenger vehicle trips travelling to the airport in the AM peak hour, compared with 2,490 in the core scenario. This corresponds with the mode share forecast described above, indicating that the highest car mode share was registered in the alternative 2006-12 base test.

Figure 3-10: Impact of base mode share on car vehicle and rail passenger forecasts

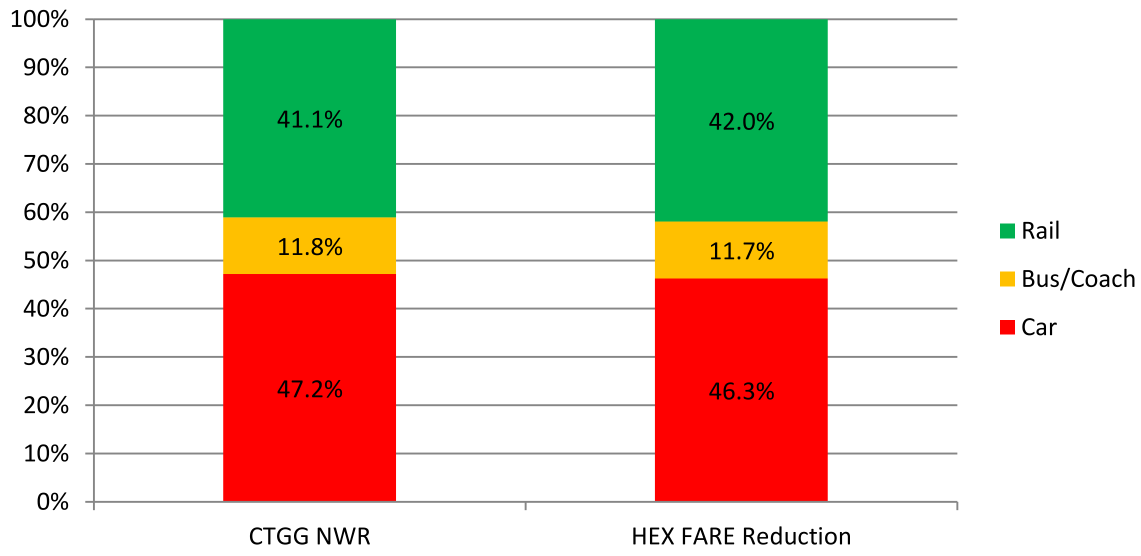


Rail pricing

3.3.21 One of the sensitivity tests requested by the AC's surface access expert panel pre-consultation involved understanding the impact of reducing the fare of premium rail services to provide more effective rail capacity and relieve crowding on standard price rail services. In the case of the Heathrow North West Runway option, one test was carried out on the core CT GG scenario model with the fare of Heathrow Express (HEX) reduced to match standard services such as Crossrail and the Piccadilly Line for comparable journeys.

3.3.22 The impact of this reduction in HEX fare is as would be expected, increasing overall rail share marginally as passengers are attracted from other modes – this slight shift to rail is illustrated in Figure 3-11.

Figure 3-11: Impact of HEX standard fare on core CT GG scenario headline mode share



3.3.23 Reducing HEX fare has more of a pronounced impact on rail sub-mode choice, as illustrated in Figure 3-12. The graphs indicate that among business passengers, HEX sub-mode share increases from 21.3% in the core CT GG scenario to 36.7% with HEX operating with a standard fare. For leisure passengers HEX sub-mode share increases from 10.4% to 21.1%.

3.3.24 The graphs in Figure 3-13 summarise the impact of reducing HEX rail fare on forecast car vehicle and rail passenger demand in the core CT GG scenario model. As would be expected given the marginal impact on headline mode share described above, the change in trip forecasts is very low. In the AM peak for example, the number of airport passenger car vehicles inbound to Heathrow decreases from 2,490 to 2,444. In terms of rail, inbound airport passenger demand increases from 3,329 to 3,402 in the AM peak.

Figure 3-12: Impact of HEX standard fare on core CT GG scenario rail sub-mode share

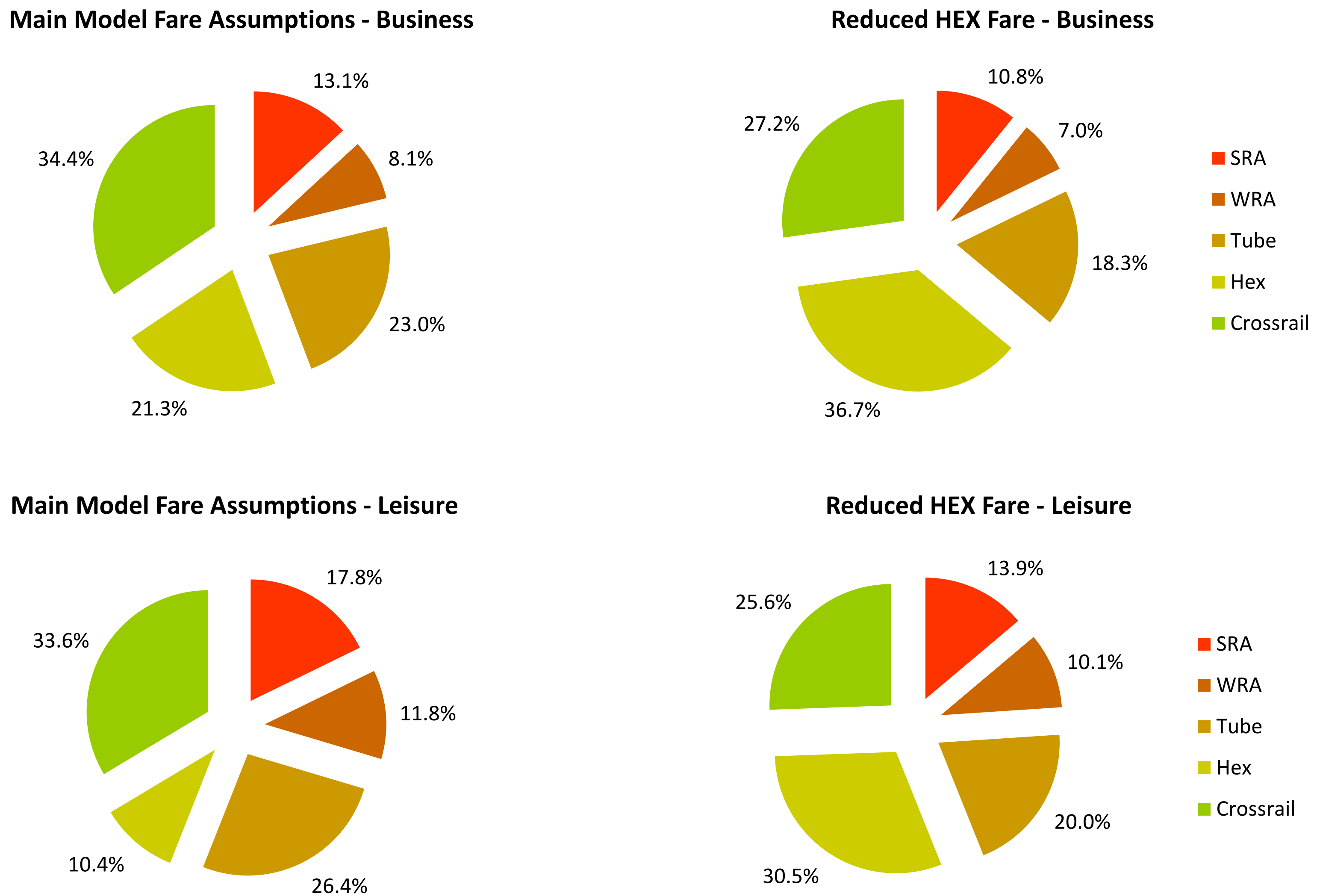
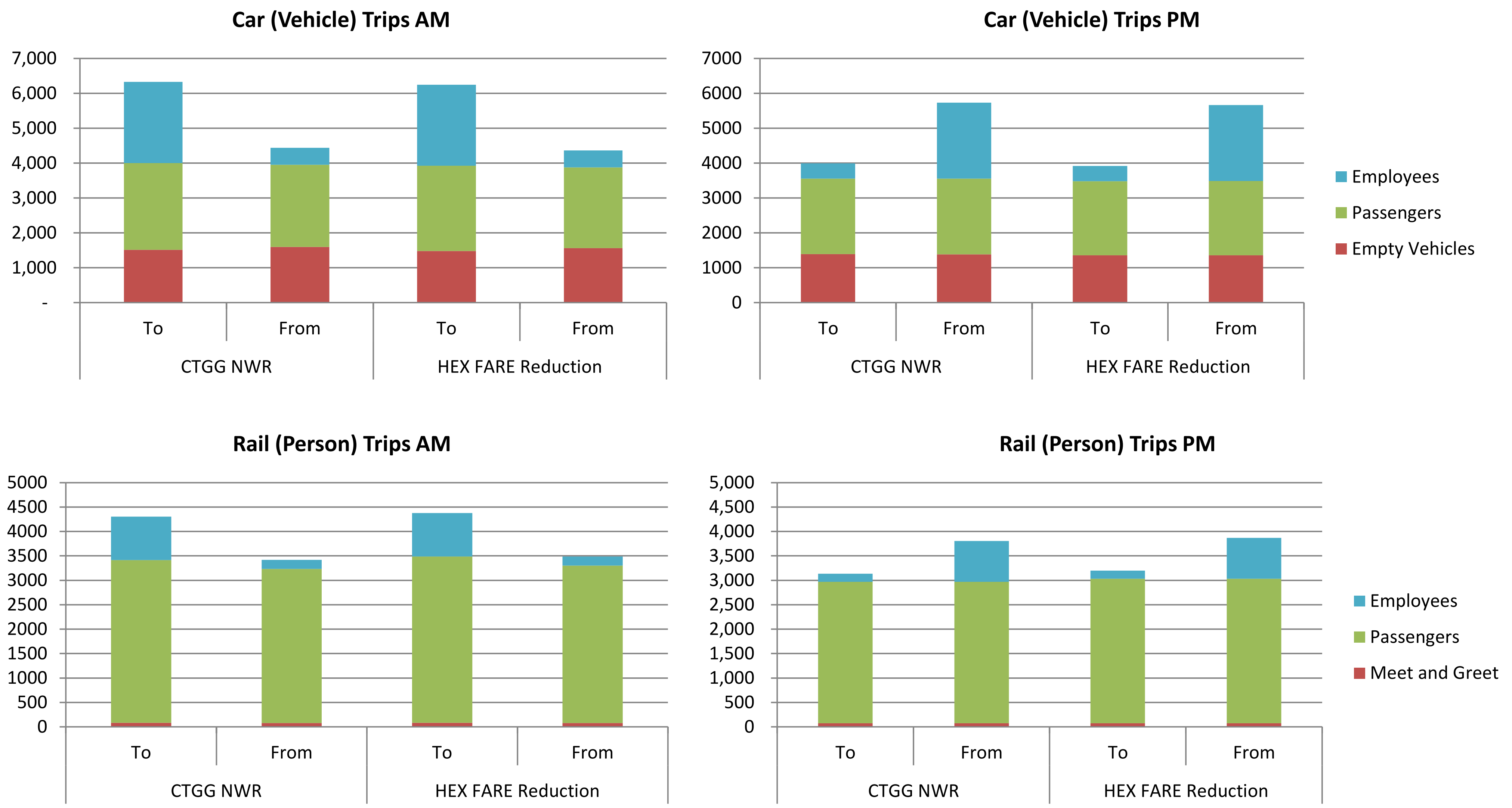


Figure 3-13: Impact of HEX standard fare on core CT GG scenario rail passenger and car vehicle demand forecasts



Airport passenger space requirements

3.3.25 Another sensitivity test requested by the AC's surface access expert panel pre-consultation related to the impact of airport passenger luggage on rail capacity. The nature of the spreadsheet model used to forecast airport demand during this study means that the only way this could feasibly be tested would be by factoring the final rail demand forecasts.

3.3.26 It is clear that some account should be taken of luggage-related impacts when considering the impact of airport passengers on the rail network, since these passengers will by nature carry more luggage than non-airport users. However, developing an appropriate modelling factor would be problematic for the following reasons, and as a result has not been attempted within the scope of this study:

- The lack of credible data on which to base the calculation of a factor linking luggage space impacts to passenger space impacts on rail services;
- The variable impact related to the background level of crowding (i.e. luggage impacts will be more pronounced on crowded services where passengers do not get a seat) and the type of rolling stock (which impacts on the amount of dedicated luggage space provided), suggesting that the impact of luggage should be assessed in relation to capacity rather than demand.

3.3.27 Desktop research indicated that one source that could potentially be used to generate a factor is the European Aviation Safety Agency (EASA) Passenger and Baggage Weight Survey, which was last undertaken in 2008/9[5]. The survey indicated that at Gatwick Airport, which was selected as representative of the UK & Ireland region, the average weight of a passenger was 75.9kg in 2008, while the average weight of carry-on luggage was 5.6kg per passenger and checked-in baggage was 16.8kg per passenger.

3.3.28 These figures suggest that in terms of weight, a factor of 1.3 may be appropriate when applied to passenger weight to forecast the impact of luggage. However, the survey includes no data about mode choice to the airport (car passengers are likely to carry more luggage than rail passengers) and the application of a factor calculated directly from the data would be based on a very crude assumption that space requirements are directly related to weight for both passengers and their baggage.

[5] http://www.easa.europa.eu/system/files/dfu/Weight%20Survey%20R20090095%20Final.pdf

4. Dynamic rail assessment

4.1 Overview

4.1.1 Surface access demand forecasts for Heathrow (with two runways and with the North West Runway in place) in the core scenario referenced in Chapter 2 (CT GG combined with the AC's mid-range employment scenario) provided the inputs for the dynamic rail modelling work-stream.

4.1.2 This work-stream was undertaken using the Railplan model, provided by TfL. Railplan is a strategic public transport model coded in Emme software that covers London and its surrounding area. The model allocates forecast public transport demand from the multi-modal LTS model to National Rail, London Underground, DLR, and Tramlink services and the bus network. Railplan also includes an extensive walk network to represent access to the public transport system, with transfer between different services represented by interchange links. TfL's website provides further details on the LTS model[6] and the Railplan model[7].

4.1.3 TfL has recently developed Railplan Version 7 to represent baseline conditions in 2011. For the purposes of this study, the 2011 model was refined to ensure a better fit to observed counts along key rail corridors serving Heathrow. TfL also provided a Railplan 7 forecast run for 2031 based on the LTS '7031ref6' low car growth scenario, which is the central case currently used by TfL to test public transport scheme impacts. This scenario is based on the following key 2031 planning assumptions for the Greater London Authority (GLA) area, consisting of the 33 London Boroughs:

- total households: 4,119,961;
- total population: 9,839,366;
- total jobs: 5,265,000.

4.1.4 Outside the GLA area, trip forecasts are based on assumptions sourced from the DfT's Trip End Model PROgram (TEMPRO) V6.2, a component of the National Trip End Model (NTEM). The 2031 reference case also includes assumptions about the extent of the transport network in London and the South East, which are summarised in Appendix C of this report.

Process

4.1.5 The following tasks were undertaken to develop the dynamic rail modelling assessment of the North West Runway at Heathrow:

- a review of the LTS '7031ref6' inputs was undertaken with two key aims:
  - to identify the schemes in the AC's Core and Extended Baselines (summarised in Appendix B) that were not included in '7031ref6';
  - to highlight any differences in assumptions between '7031ref6' and the Core/Extended Baselines for schemes that were included;
- adjustments were made to service patterns and rolling stock characteristics on key rail corridors in and around Heathrow in the model to reflect information provided by the AC's stakeholders pre-consultation and published updates since then (notably the Western and Wessex Route Study drafts for consultation[8] published by NR late in 2014) – this included adding coding for the following notable missing schemes:
  - WRA – assumed to be 4 trains per hour between Reading and Heathrow (both T5 and the CTA) in accordance with feedback received from NR pre-consultation;
  - Crossrail 2 regional option;

[6] https://www.tfl.gov.uk/cdn/static/cms/documents/the-london-transportation-studies-model-lts.pdf
[7] https://www.tfl.gov.uk/cdn/static/cms/documents/londons-public-transport-assignment-model-railplan.pdf
[8] http://www.networkrail.co.uk/long-term-planning-process/route-studies/

  - Bakerloo Line southern extension to Hayes;
  - Northern Line extension to Battersea;
  - HS2 Phase 1 (Hybrid Bill scheme) including corresponding amendments to WCML/Crossrail services in accordance with assumptions published by HS2 Ltd in 2013[9];
- a new LTS 2031 'Extended Baseline' run was requested from TfL, including the aforementioned network amendments translated from Railplan – this was to account for any induced demand impacts related to the changes in service provision associated with the Extended Baseline schemes;
  - it should be noted that HS2 is not included in LTS and so amendments were made in the model to associated services at Euston and Old Oak Common to accommodate it, and demand forecasts for HS2 itself were sourced from an associated run of the Planet Framework Model (PFM) and incorporated in the output matrices once the LTS run had been completed;
- two additional schemes beyond the Extended Baseline were also coded in Railplan for the tests involving the expansion of runway capacity at the airport:
  - Southern Rail Access (SRA) – scheme coding was defined following a review of likely options by the Jacobs rail operations team, and further details are provided later in this chapter;
  - Crossrail 6 trains per hour to Heathrow – this scheme was modelled by extending two paths currently planned to terminate at Paddington/Old Oak Common on to the airport;
- airport-related demand forecasts from the resultant LTS runs were then removed from the matrices and replaced with the forecasts derived for the core scenario enhanced spreadsheet model, as summarised in the previous chapter;
- the Railplan Extended Baseline model was then run with associated background and airport-related demand for a range of scenarios, including the airport in its current form and with the North West Runway included.

4.1.6 Two time periods were assessed for each scenario using the Railplan model – an AM peak period (0700-1000) and an inter-peak period (1000-1600). The full list of Railplan runs completed for this study is shown in Table 4-1.

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244033/Updated_economic_case_for_HS2__August_2012__-__Explanation_of_the_service_patterns__January_2013_.pdf

Table 4-1: Railplan model runs for Heathrow North West Runway

Year	Time periods	Transport network	Background demand	AC scenario	Expansion option	Airport demand amendments
2011	AMP	RP7 2011	RP7 2011	N/A	None	No change
2031	AMP	RP 7031ref6	RP 7031ref6	N/A	None	No change
2031	AMP	2031 EB	2031 EB	S1 Global Growth	None	2-runway CT GG forecast
2031	IP	2031 EB	2031 EB	S1 Global Growth	None	2-runway CT GG forecast
2031	AMP	2031 EB + SRA/XR6	2031 EB	S1 Global Growth	HNWR	NWR CT GG forecast
2031	IP	2031 EB + SRA	2031 EB	S1 Global Growth	HNWR	NWR CT GG forecast
2031	AMP	2031 EB	2031 EB	S1 Global Growth	HNWR	NWR CT GG forecast
2031	IP	2031 EB	2031 EB	S1 Global Growth	HNWR	NWR CT GG forecast

4.1.7 A number of elements of the modelling process should be considered when interpreting the outputs from the Railplan assessment described in the remainder of this chapter, as follows:

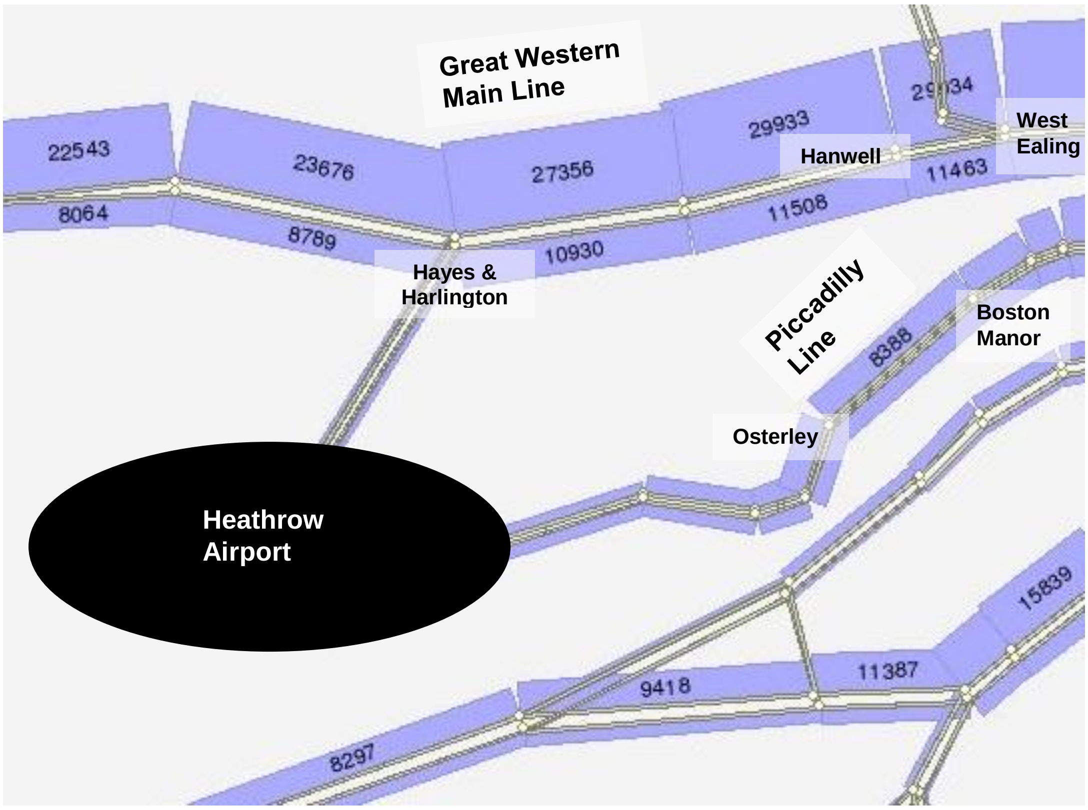
- the assessment did not account for impacts associated with any additional development activity or induced employment growth as a result of airport expansion – 2031 population and job growth forecasts in LTS were provided by the GLA and the DfT's NTEM, and LTS would need to be re-run with associated changes to these forecasts to account for such impacts;
- Railplan does not include any bus services in the Gatwick area or long-distance coach routes between the airports and locations outside London, and the coding of bus services between Heathrow and areas outside the GLA boundary is patchy – given the study timescale, only the rail demand from the enhanced spreadsheet models was imported into Railplan to ensure a consistent assessment across all the airport expansion options;
- rail demand by sub-mode at Heathrow is hard-coded in Railplan and following discussions with the TfL modelling team, this approach was retained in the Extended Baseline assessment – forecasts by final/first rail sub-mode for trips to/from Heathrow were therefore imported directly from the enhanced spreadsheet models, with Railplan forecasting resultant secondary connections and the impact of increased airport demand on non-airport assignment.

4.2 Base Year (2011) model outputs

4.2.1 Figure 4-1 summarises the passenger volumes on the rail network around Heathrow in the 2011 AM peak period Railplan model.

4.2.2 The plan indicates a total of up to 30,000 passengers on the GWML between Hanwell and West Ealing travelling towards Paddington, with around 11,500 travelling in the opposite direction. The volumes travelling to and from Heathrow itself on HEX and Heathrow Connect services via the spur suggest that airport trips represent a small proportion of the total flow on the main line.

Figure 4-1: 2011 AM peak forecast rail demand around Heathrow



4.2.3 The plan also indicates flows on the Piccadilly Line, indicating that around 8,400 people are already travelling on the link between Osterley and Boston Manor towards London in the AM peak, although a relatively small proportion of these originate at the airport itself.

4.2.4 Figure 4-2 summarises crowding on the rail network in Railplan in the 2011 AM peak. The plan indicates in black those links on the network where crowding levels reach in excess of 4 people/m^2 of standing space. For example, this includes links on Windsor Line services east of Richmond approaching Clapham Junction and on sections of the North London Line via Gospel Oak and Barking.

4.2.5 Figure 4-3 summarises crowding on the London Underground network in the same time period, illustrating that extensive sections of the network are over-crowded in the AM peak. Crowding levels reach in excess of 4 people/m^2 on sections of the Northern Line, Jubilee Line, Piccadilly Line and Victoria Line and the Central Line.

Figure 4-2: National Rail and Tramlink crowding – 2011 AM peak

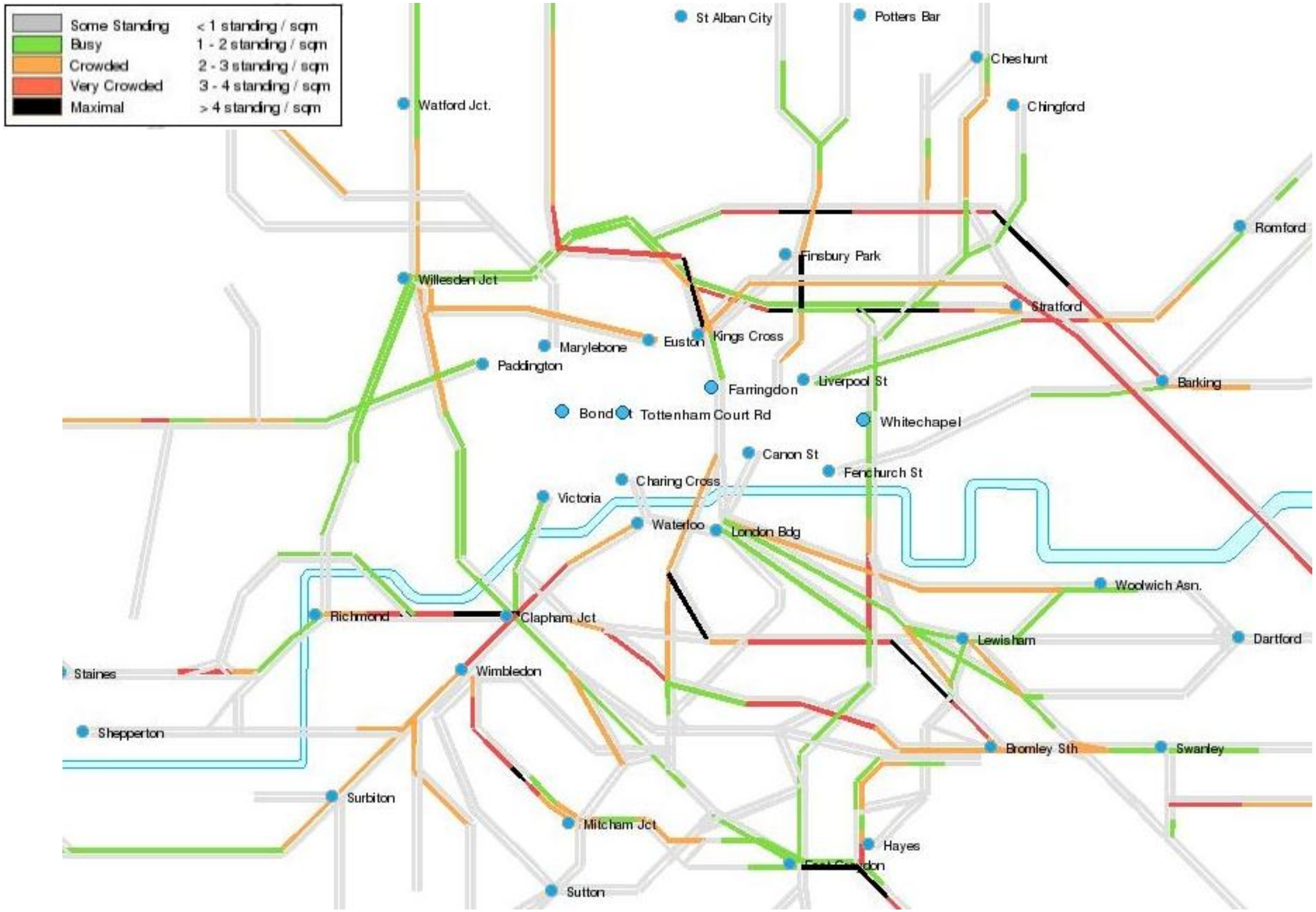
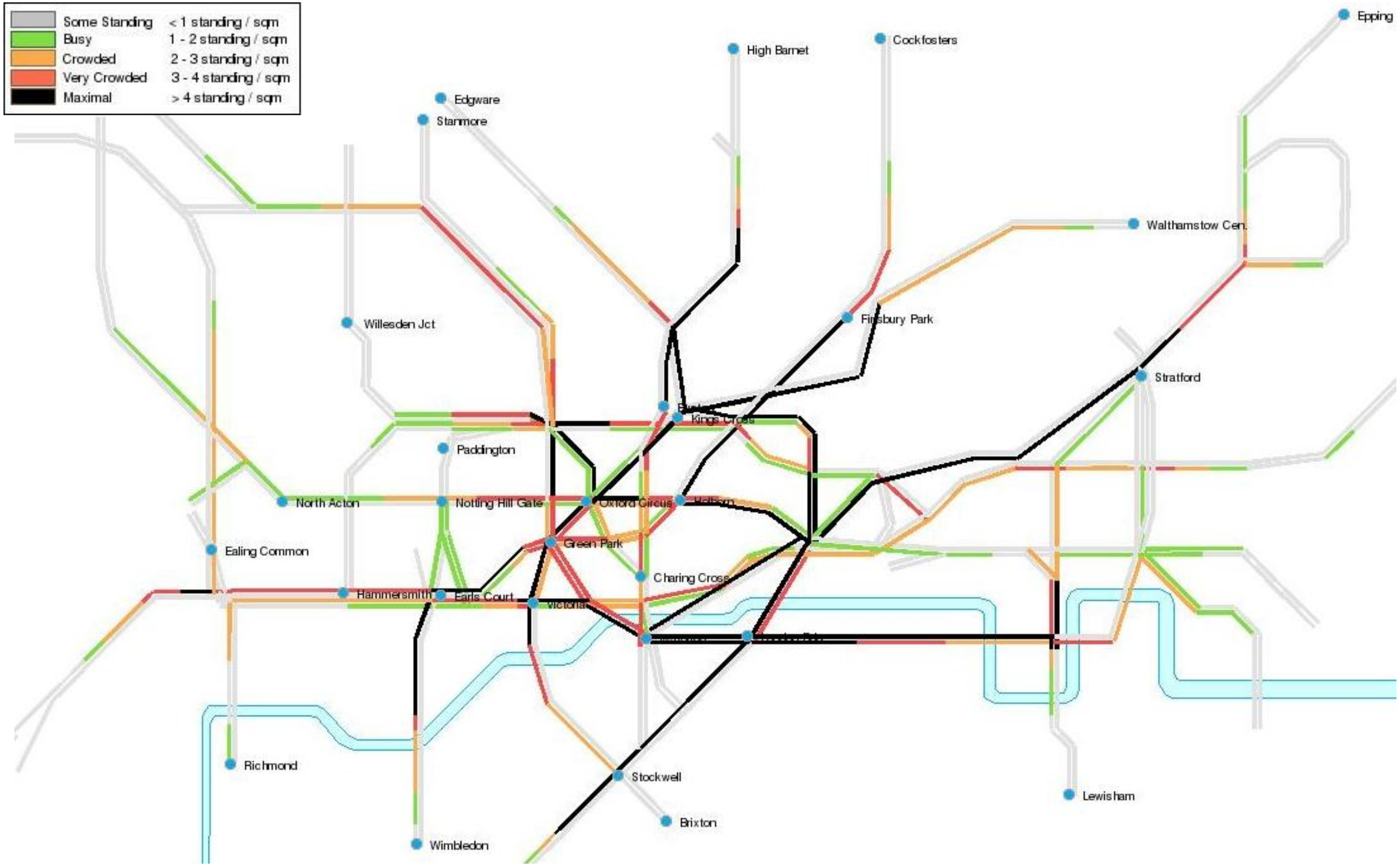


Figure 4-3: London Underground crowding – 2011 AM peak



4.3 Reference case (2031) outputs with a two runway Heathrow

4.3.1 Figure 4-4 summarises forecast link flows in the AM peak from the Railplan 2031 reference case run (the '7031ref6' scenario), indicating that the flow inbound to Paddington is forecast to reach in excess of 60,000 trips between Hanwell and West Ealing. On the Piccadilly Line inbound flow reaches close to 11,000 between Osterley and Boston Manor in the same time period.

4.3.2 Figure 4-5 indicates the change when the 2031 reference case volumes are compared with the 2011 base model, described in the previous section. This indicates that flows on the GWML are forecast to nearly double by 2031 – for example, the inbound flow to London west of Hanwell is forecast to increase by close to the 30,000 trips, an increase of 97.6% on the 2011 base model flow in the same time period. On the Piccadilly Line the increase is less pronounced, amounting to a growth of 28.8% inbound to London between Osterley and Boston Manor, due to the presence of Crossrail in the 2031 ref case, which relieves some pressure on the London Underground line.

Figure 4-4: 2031 ref case AM peak forecast rail demand around Heathrow (7031ref6 scenario)

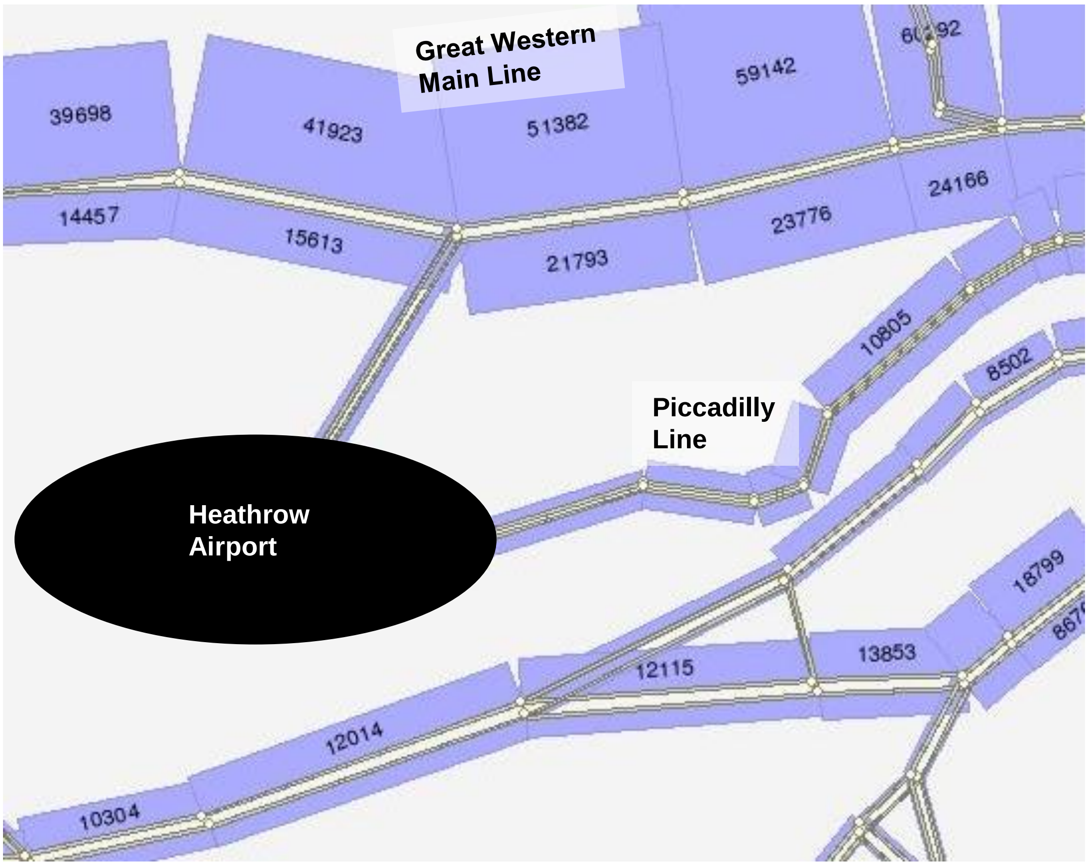
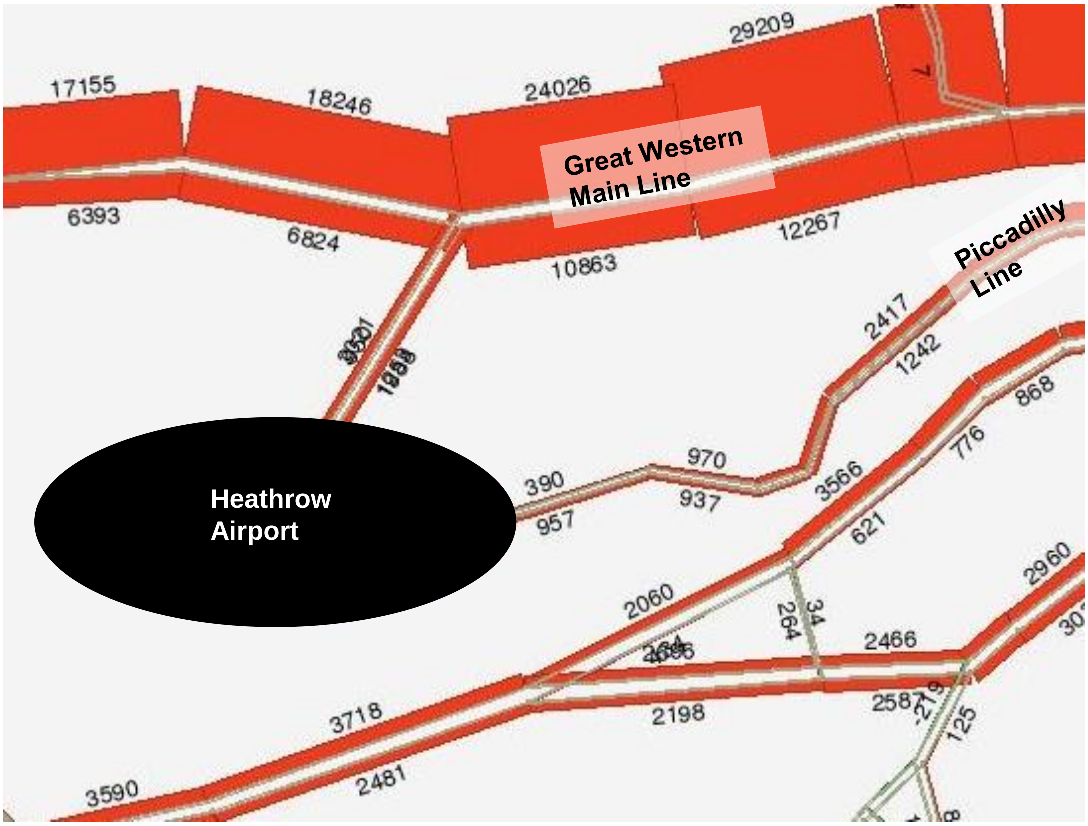


Figure 4-5: Change in AM peak volumes (2031 ref case – 2011 base)



4.3.3 Figure 4-6 illustrates the crowding forecasts during the AM peak in the 2031 reference case. The plan indicates that across London, the additional rail capacity provided on the network in this scenario (see Appendix C) helps to relieve many of the crowding issues identified in the 2011 AM peak.

4.3.4 Overall crowding levels do however appear to increase on services inbound to Paddington in 2031 when compared with 2011 – the 2031 plan indicates between 3 and 4 people/m^2 standing inbound to Paddington in the AM peak. There are two potential explanations for this, as follows:

- Crossrail results in a significant increase in trip volumes on the GWML, as indicated above, due to the significant improvement in service;
- Crossrail rolling stock is designed to accommodate more passengers standing than seated when compared to the stock currently in use on the GWML.

4.3.5 While overall crowding levels may have increased, it is likely that a higher proportion of the demand on the GWML inbound to Paddington consists of shorter journeys from locations within the Crossrail catchment when compared to demand in 2011.

4.3.6 Figure 4-7 illustrates forecast crowding on the London Underground network in the 2031 reference case. The plan indicates that enhanced capacity relieves some of the pressures evident on the network in 2011 (for example, crowding on the Central Line appears to reduce as a result of the introduction of Crossrail), although many lines will continue to be heavily crowded inbound to London in the AM peak.

Figure 4-6: National Rail and Tramlink crowding – 2031 ref case AM peak

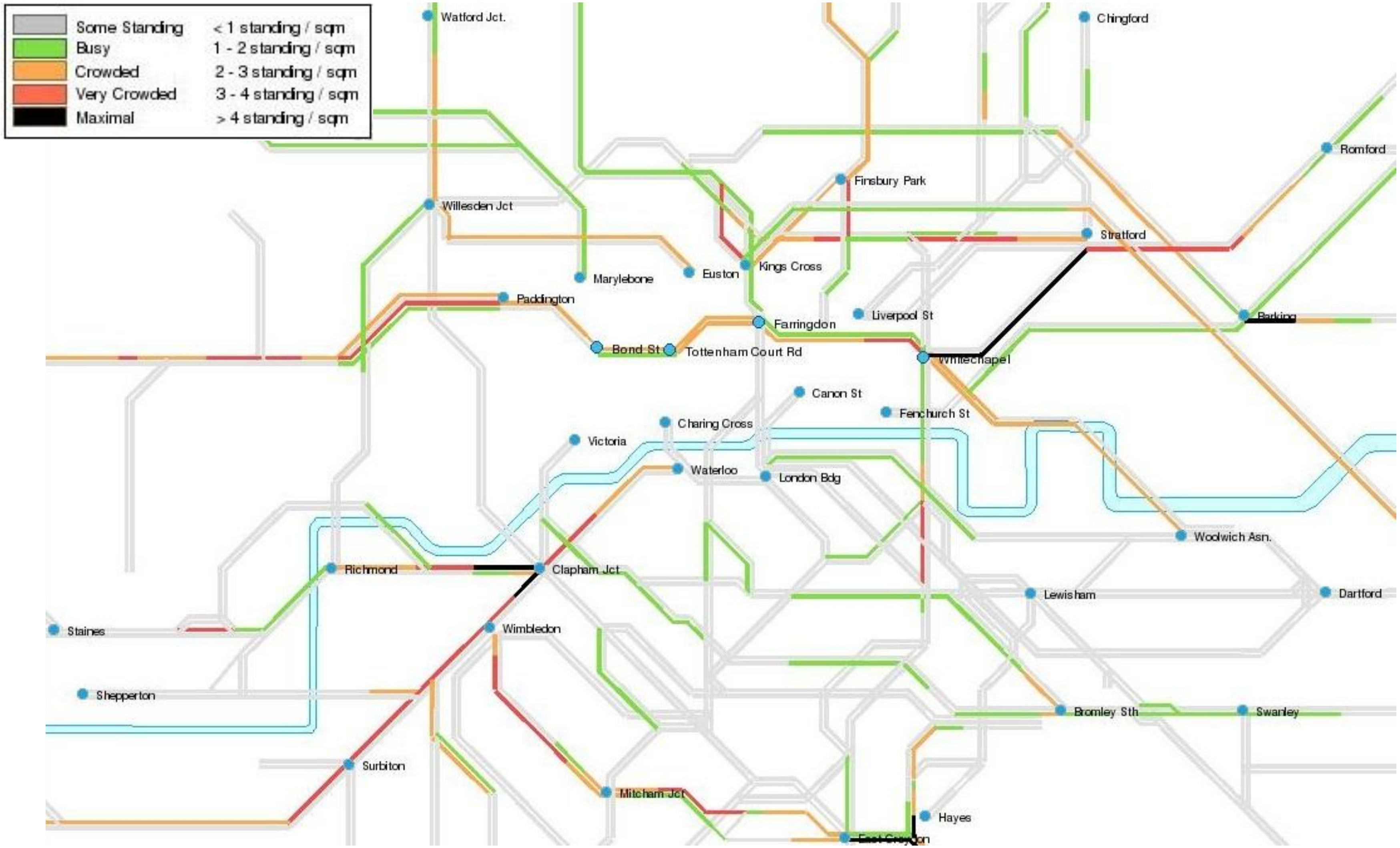
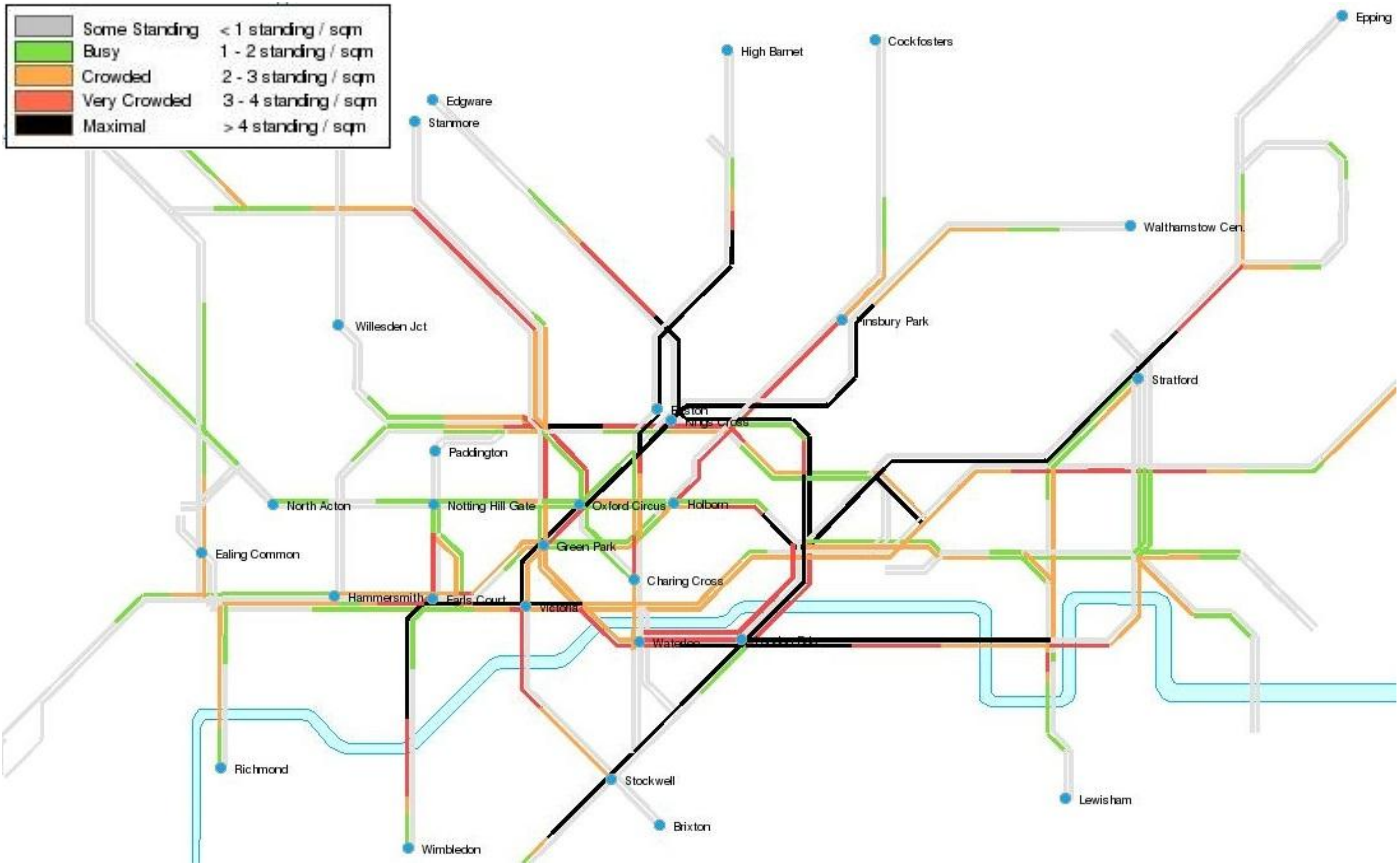


Figure 4-7: London Underground crowding – 2031 ref case AM peak



4.4 LTS Extended Baseline scenario

4.4.1 As mentioned earlier in this report, the dynamic rail modelling stage of this study involved re-running TfL's LTS model to generate a background public transport demand forecast associated with the Extended Baseline scenario. This re-run was undertaken as major public transport schemes included in the Extended Baseline (for example Crossrail 2 and the Bakerloo Line southern extension) will likely induce demand on the public transport network. Assessing the impact of airport expansion using the reference case forecast (7031ref6) would therefore underestimate impacts, since this induced background demand would not be accounted for in the appraisal.

Inputs

4.4.2 The additional Extended Baseline schemes listed in Appendix B (the schemes already included in the reference case are summarised in Appendix C) were coded in Railplan in both the AM peak and IP periods and then converted into LTS format to complete the run. Many of the schemes, particularly new LUL and Overground services, had already been coded by TfL for previous assessments and this coding was supplied and reviewed by Jacobs to assess its suitability for this study. Other schemes such as WRA had to be coded specifically for this study, and assumptions on service patterns were made based on inputs from the AC stakeholders pre-consultation; reviews of the latest NR route studies (notably the Western and Wessex studies); and inputs from the Jacobs rail operations team.

4.4.3 A summary of the additional services included in the Extended Baseline, and the associated modelling assumptions, is provided in Table 4-2. TfL also provided updated coding for South Eastern, TSGN and First Great Western (FGW) services based on new information obtained since the reference case was developed.

Results

4.4.4 When compared with the reference case, the LTS Extended Baseline run indicated an overall increase in PT demand across the forecast day in 2031 as a result of the new services included. Figure 4-8 summarises forecast PT boardings in the AM peak period (0700-1000) in both scenarios, indicating an increase of 99,400 PT boardings across the 3-hour peak in the Extended Baseline when compared with the reference case, an increase of 1.8%. Figure 4-9 indicates that this corresponds to an additional 1.8m passenger-kms travelled on the PT network in the same time period, an increase of 2.3%.

4.4.5 The graphs also indicate that within the overall forecast uplift in PT demand, some transfer from Bus to LUL and National Rail/Tramlink services occurs. In the AM peak, National Rail/Tramlink boardings increase by 134,000, an uplift of 7.1%, while passenger-kms increase by 1.87m (3.1%). In contrast, bus boardings decrease by 4.2% and passenger-kms decrease by 7.0%.

4.4.6 In the inter-peak 6-hour period a similar pattern is evident for all PT services, with an overall uplift in total boardings of 1.8% corresponding to an uplift of 2.8% in total passenger-kms travelled in the Extended Baseline when compared with the reference case. When National Rail/Tramlink services were considered independently, the corresponding increases were 12.7% and 4.4%, indicating that the impact of the Extended Baseline enhancements on demand is more pronounced with regard to National Rail and Tramlink services in the inter-peak than it is in the AM peak.

Table 4-2: Summary of schemes included in LTS Extended Baseline run

Scheme	Source info	Service pattern
HS2 Phase 1 and ancillary schemes	TfL	Phase 1 hybrid bill scheme (Jan 2013 service pattern[10]) and associated amendments to WCML services – LTS does not include HS2 so amendments made to service patterns to simulate demand impacts on other services – demand forecast then included in subsequent Railplan runs, sourced from Planet Framework Model (PFM)
BML schemes (Sussex Route Study)	NR (Phase 2 / Sussex Route Study	Option S3i assumed from Sussex Route Study[11] - extra London Victoria peak-hour train paths (3 x Haywards Heath fast, 1 x Hove fast) and extra London Bridge peak-hour train paths (1 x Eastbourne, 1 x Hove fast); all 12-car Class 377 rolling stock in peak-hour
TSGN amendments	NR (Phase 2)	Current TSGN assumption but with minor amendments: extension of some train paths terminating at Gatwick to Three Bridges; Thameslink Class 700 carriage capacity assumptions amended to 55 seats and 23.3m^2 standing space; GEX rolling stock amended to match current upgrade plan (Class 387/2)
Western Rail Access (WRA)	NR (Phase 2) / coded by Jacobs	Assumed to provide 4tph service calling at Reading, Twyford, Maidenhead, Slough, Heathrow T5 and Heathrow CTA
Crossrail 2	TfL	Regional option (scenario 3b) and related amendments to South West Trains services to Waterloo
DLR enhancements	TfL	Assumed 22.5tph on Stratford Bow Branch (7.5 to Lewisham, 15 to Canary Wharf); 3-car services between Stratford International and Woolwich Arsenal; additional services at 7.5tph between Stratford International and Beckton – no reference in 2050 TfL Infrastructure Plan to DLR extensions so upgrade file incorporating extensions to Bromley excluded
London Overground enhancements	TfL	8-car Class 378's on NLL/ELL/WLL/SLL in AMP; Gospel Oak-Barking Line (GOBLIN) extended to Barking Riverside; extra 2tph between Dalston Junction and New Cross Gate (AMP); extra 2tph between Stratford and Clapham Junction (AMP)
Bakerloo line southern extension	TfL	Current 'central case' assumption (pending appraisal): peak service of 27tph from Elephant and Castle along Old Kent Road (2 new stations) and then Hayes Line to Beckenham Junction and Hayes – corresponding amendments to Southeastern services into London Bridge on parallel routes
Northern Line upgrade	TfL	Full signalling upgrade; full separation (including rebuild of Camden Town station, creation of two separate lines); extension of Charing Cross branch to Battersea via Nine Elms
West Anglia infrastructure	NR (Anglia Route Study) / coding from TfL	Additional train capacity between Liverpool Street/Stratford and Stansted Airport, Cambridge, Kings Lynn, Broxbourne, and Bishops Stortford
Western Route Study Services	NR (Western Route Study)	Minor amendments: Crossrail set as 9-car service; Swansea/Bristol-via-Bath services changed from 8-car to 9-car; some rolling stock seat assumptions amended; amendments to Marlow/Windsor & Eton branch line services

[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244033/Updated_economic_case_for_HS2__August_2012__-_Explanation_of_the_service_patterns__January_2013_.pdf
[11] http://www.networkrail.co.uk/long-term-planning-process/south-east-route-sussex-area-route-study/ - Table 5.4 (page 105)

Figure 4-8: Forecast 2031 AMP 3-hour PT boardings – Extended Baseline v Ref Case

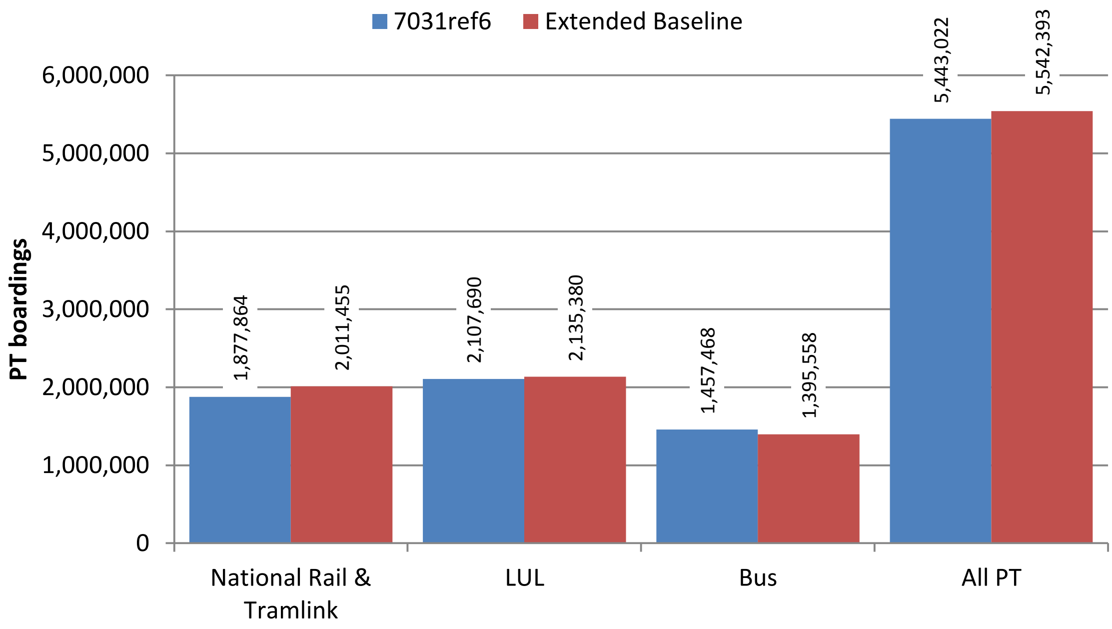
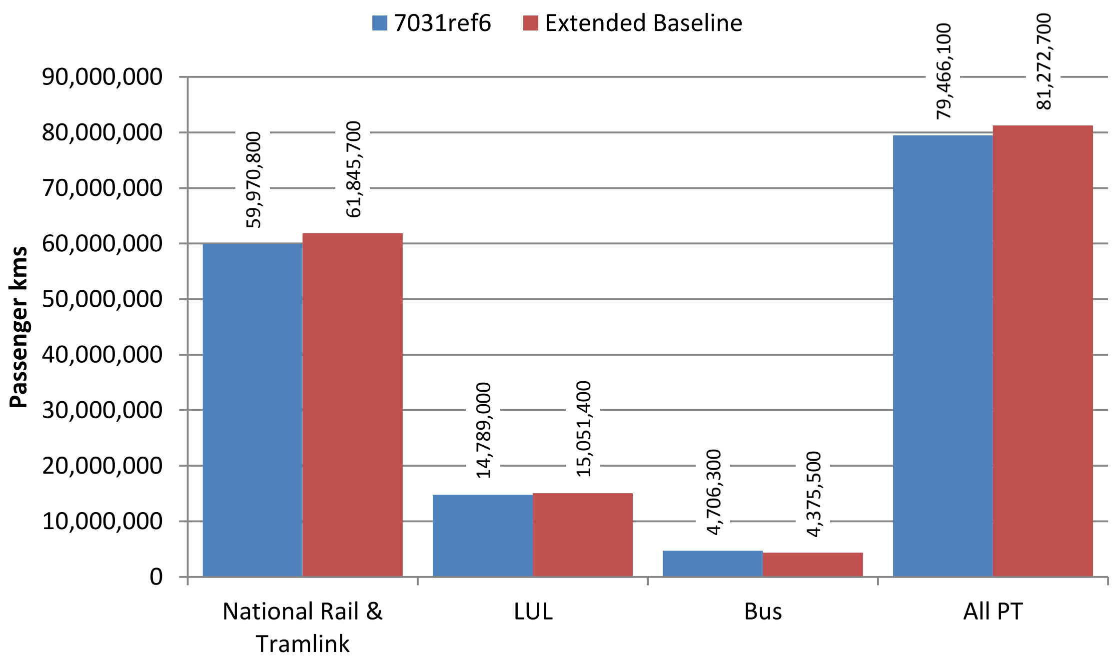


Figure 4-9: Forecast 2031 AMP 3-hour PT passenger kms – Extended Baseline v Ref Case



4.4.7 In terms of the distribution of PT demand, the impact of Extended Baseline schemes can be seen in Figure 4-10 and Figure 4-11. The plans show the % uplift in AM peak PT trip origins and destinations forecast by location in the Extended Baseline when compared with the LTS reference case. The largest % uplifts occur in areas benefitting directly from improved rail connections in the Extended Baseline, including the following locations:

- Areas in Surrey (particularly around Epsom), Kingston-upon-Thames, Merton, Hackney, Enfield and parts of Hertfordshire (around Broxbourne and Cheshunt) all benefit from Crossrail 2 stations in the regional option;

- Bromley and Lewisham benefit from the Bakerloo Line southern extension to Hayes and Beckenham Junction;
- Areas around Watford, Hemel Hempstead and St. Albans all benefit from improvements to suburban services into Euston, taking advantage of the released capacity created by the introduction of HS2.

4.4.8 The plans also indicate an increase in PT trips originating and terminating in other areas of central, north and east London to a lesser extent than those identified above, either because new services do not effect these areas to the same degree, or (in the case of central London) because PT provision in the reference case is already very good so new schemes have relatively less impact on demand.

4.4.9 While PT trip destinations appear to increase in all areas, Figure 4-10 indicates that marginal reductions in PT trip origins are forecast in areas in West London and Berkshire, and also in Kent. In the case of the latter, some rail demand may be replaced by car trip origins in the Extended Baseline rail-heading onto Bakerloo Line services in Bromley. In general however, the demand reductions from these areas are marginal and probably reflect the fact that relative to the areas described above, these areas benefit less from Extended Baseline schemes. LTS indicates that the Extended Baseline schemes increase the number of rail trips on the PT network in central London, which may increase crowding and encourage a marginal shift to other modes for some trips originating in areas that do not benefit directly from the new schemes.

Figure 4-10: % change in AMP PT trip origins (Extended Baseline v Ref Case)

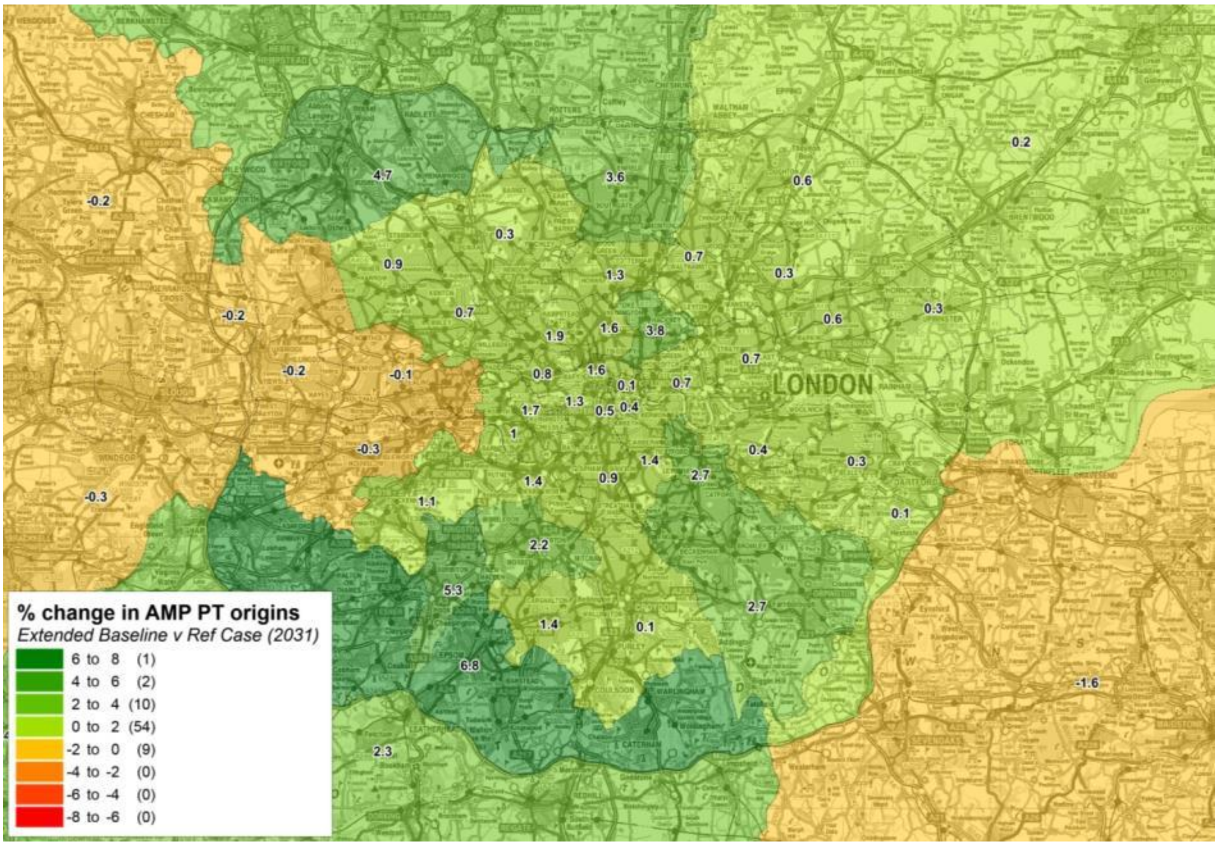
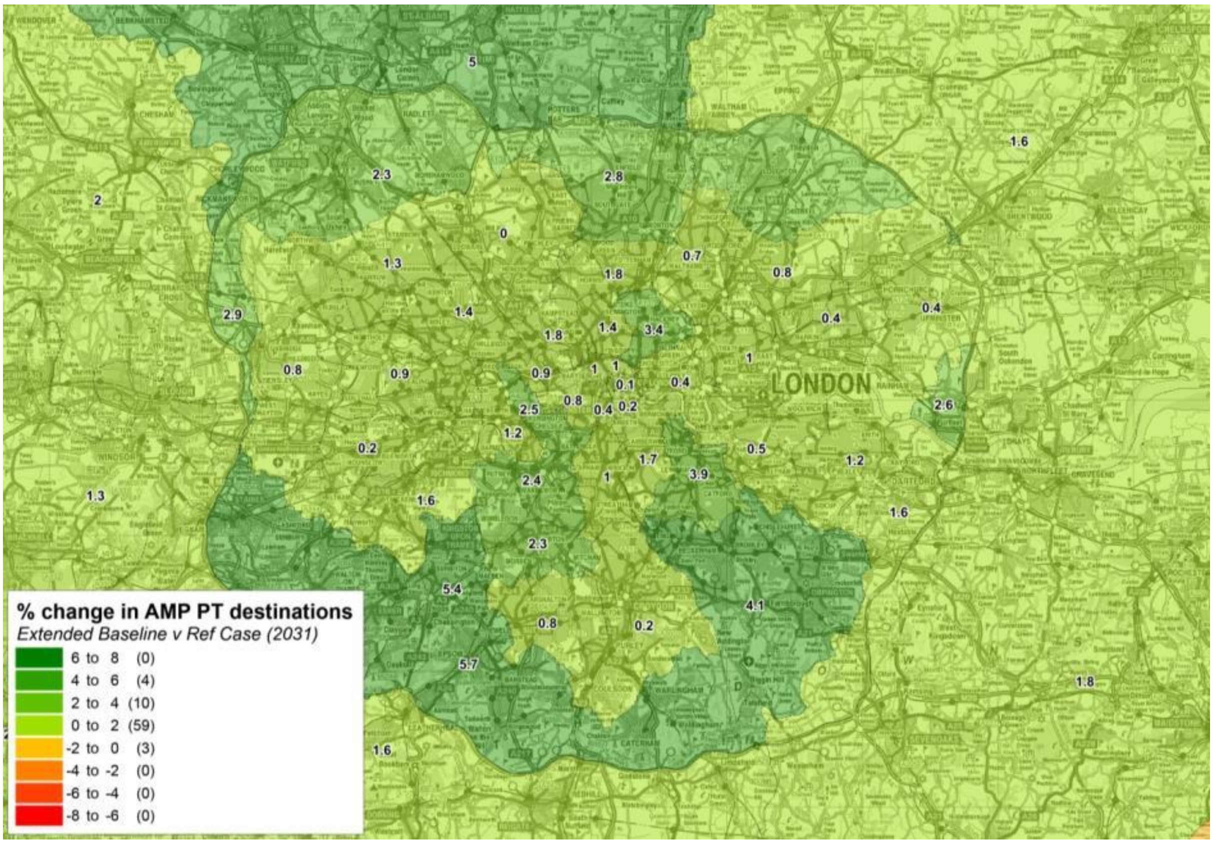


Figure 4-11: % change in AMP PT trip destinations (Extended Baseline v Ref Case)



4.5 Airport demand forecasts

4.5.1 Following the completion of the LTS Extended Baseline run, the corresponding 2031 AM peak and inter-peak demand matrices were imported back into Railplan. The forecast trip origins and destinations associated with Heathrow Airport zones were then replaced with airport-related demand forecasts derived from the enhanced spreadsheet models for four scenarios, as follows:

- Heathrow with no expansion (i.e. the airport in its current form in 2030, with two runways) – this forecast was generated assuming the Extended Baseline transport schemes described above are in place;
- North West Runway assuming the Extended Baseline transport network;
- North West Runway assuming the Extended Baseline transport network plus Southern Rail Access (SRA) and 6 Crossrail trains per hour – applied only in the AM peak period;
- North West Runway assuming the Extended Baseline transport network plus SRA – applied only in the inter-peak period, with Crossrail assumed to revert to 4 trains per hour even if 6 trains per hour is feasible in the AM peak.

4.5.2 Six Railplan runs were then completed, providing AM peak and inter-peak outputs for the four scenarios identified above. These are described in more detail later in this chapter.

Southern Rail Access and Crossrail 6tph

4.5.3 As mentioned above, one of the Heathrow North West Runway scenarios assumed that two schemes beyond the Extended Baseline would be in place at the airport.

4.5.4 For the purposes of this study, the Crossrail 6tph scheme was modelled by extending 2 train paths per hour (assumed in the current Crossrail timetable to terminate at Paddington) to the airport. This consequently increased the peak frequency of Crossrail services between the airport and Paddington from 4tph in the Extended Baseline to 6tph but did not affect frequency through the Crossrail core. This proposal was based on HAL's submissions to the AC pre-consultation.

4.5.5 In the case of SRA, NR released tender documents seeking consultancy support for a 'Provision of services for SRA to Heathrow Study' in September 2014. The tender document indicated that the engineering/option short-listing element of the study is not due to report to the DfT until summer 2015 and therefore, at the time of reporting for this study, no details were available from AC stakeholders on the likely characteristics of the SRA scheme.

4.5.6 As a result, the Jacobs rail operations team conducted a high-level review of potential options for SRA for the purposes of modelling the scheme during this study – this review is described in more detail in Appendix D. In summary, it concluded that any scheme that increased train frequency on the Richmond branch of the Windsor Line to Waterloo is likely to encounter the same opposition regarding waiting times at level crossings that prevented the Airtrack scheme from being progressed, unless significant new infrastructure is provided to grade-separate the line at these locations. Therefore, the most straight-forward proposal for SRA appears to be the introduction of an attaching-detaching service separating at Staines and serving both Heathrow and existing destinations on the Windsor Line to and from London Waterloo. It was also concluded that services between Heathrow and Woking/Guildford are likely to be feasible, but that demand would likely be lower than for a London service, raising a question over viability.

4.5.7 SRA was consequently modelled between Heathrow and Waterloo via Staines and Richmond in the enhanced spreadsheet models used to generate airport-related demand forecasts for the service, as it was pre-consultation. In Railplan, since first/final mode at the airport is hard-coded as described earlier in this chapter, the capacity impacts were modelled by adding a rail link between Heathrow T5 and Staines to add forecast airport demand onto the rail network at Staines, on the basis that an attachment-detachment service would be unlikely to impact significantly on forecast background demand levels on the Windsor Lines. The impact of airport passengers on capacity could therefore be assessed at an aggregate level when added to background demand, assuming that SRA does not increase overall frequency on the branch line through Richmond.

Scenario outputs

4.5.8 The graph in Figure 4-12 summarises the total rail demand forecast to and from Heathrow in the AM peak period (0700-1000) in each of the scenarios described above, consisting of airport passengers, employees, and rail 'meet and greet' trips – the totals illustrated on the graph relate to the core CT GG headline numbers described in Chapter 2 and represent the airport-related demand inputs to the Railplan AMP models described later in this chapter.

4.5.9 The graph indicates a total uplift in demand of some 5,600 rail trips to and from the airport during the AMP in the North West Runway scenario including SRA and Crossrail 6tph when compared with the no expansion forecast – this amounts to an increase of just under 30% in total rail demand between the two scenarios.

4.5.10 The graph also illustrates that rail demand is slightly lower in the North West Runway scenario excluding SRA and Crossrail 6tph, as the additional schemes encourage a marginal shift to rail from other modes as a result of the new connections created.

4.5.11 Figure 4-13 provides the corresponding forecasts for the inter-peak period (1000-1600), illustrating similar trends but based on an overall lower level of demand than in the AMP. The total increase in rail trips between the no expansion and North West Runway scenarios is around 10,700 during this time period, also amounting to an uplift of around 30%.

Figure 4-12: Forecast 2030 AM peak (0700-1000) rail demand (airport passengers and employees)

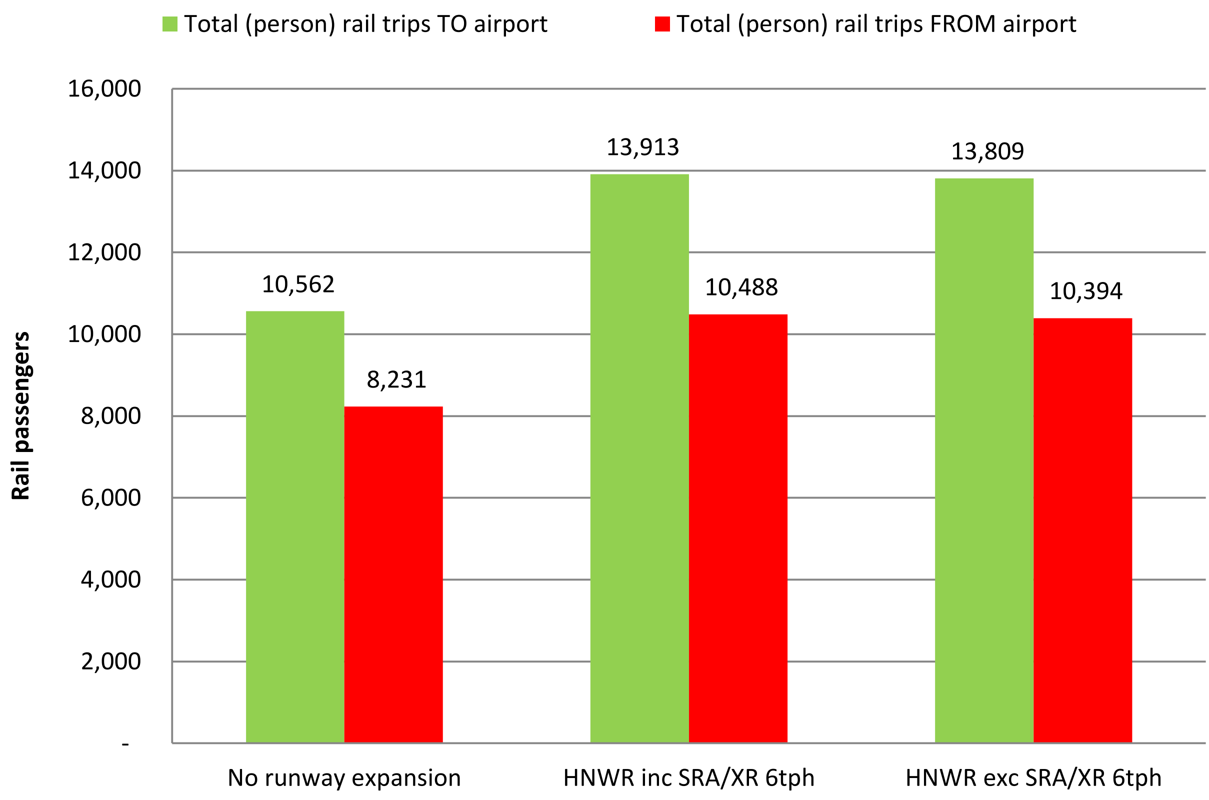
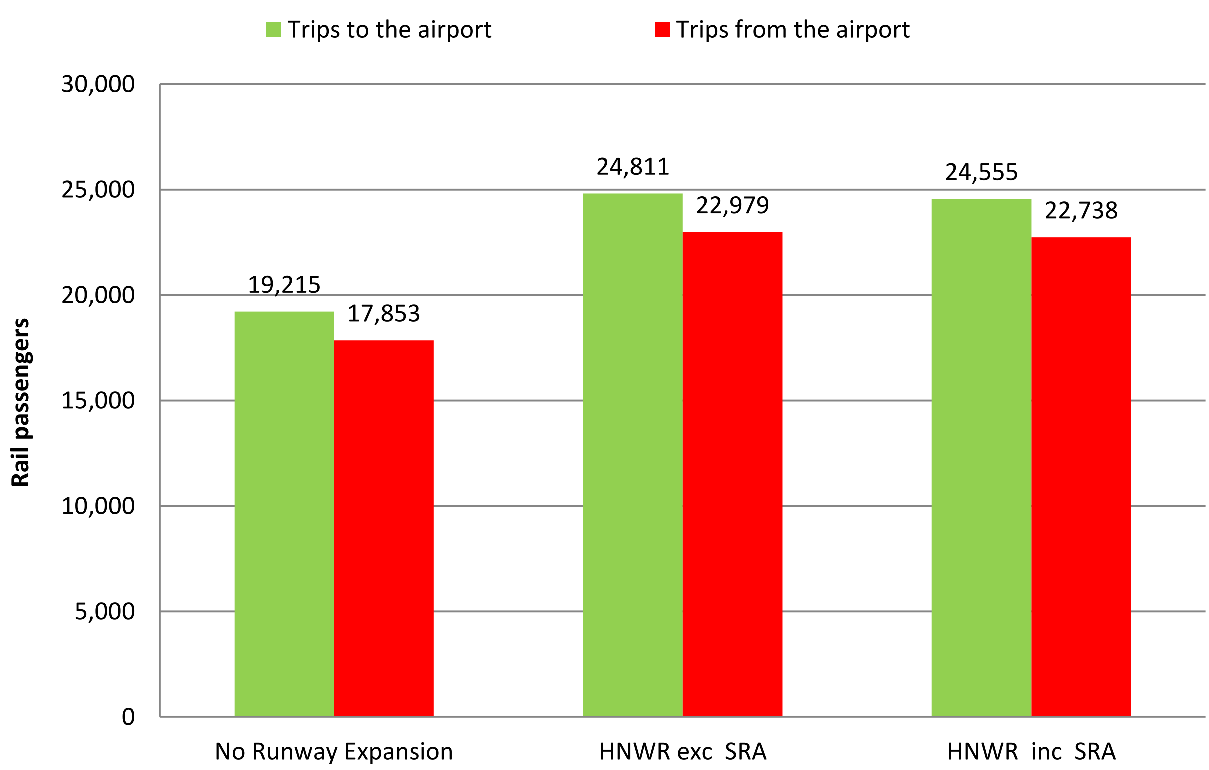


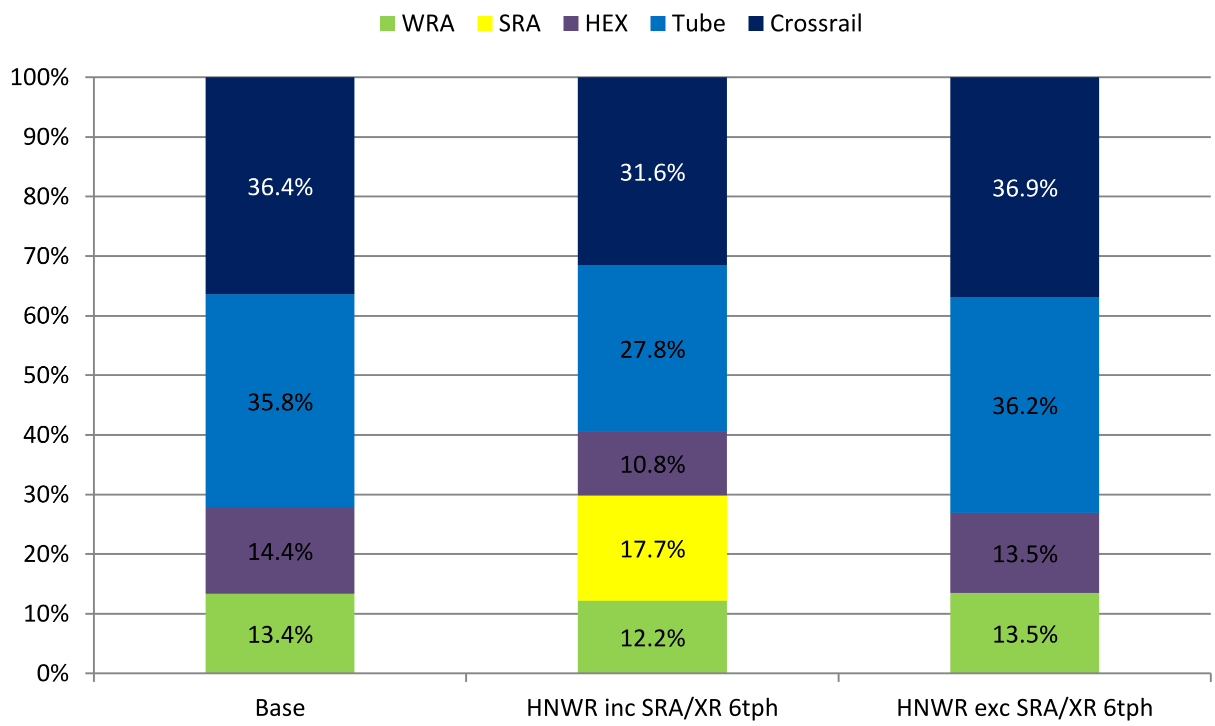
Figure 4-13: Forecast 2030 inter-peak (1000-1600) rail demand (airport passengers and employees)



4.5.12 Figure 4-14 illustrates the total rail sub-mode share forecast to the airport in the AM peak period (0700-1000), indicating the impact that SRA has in the North West Runway scenario where it has been modelled. It should be noted that the graph shows a combined rail sub-mode forecast for both airport passengers and employees, with each group assessed independently in the modelling process.

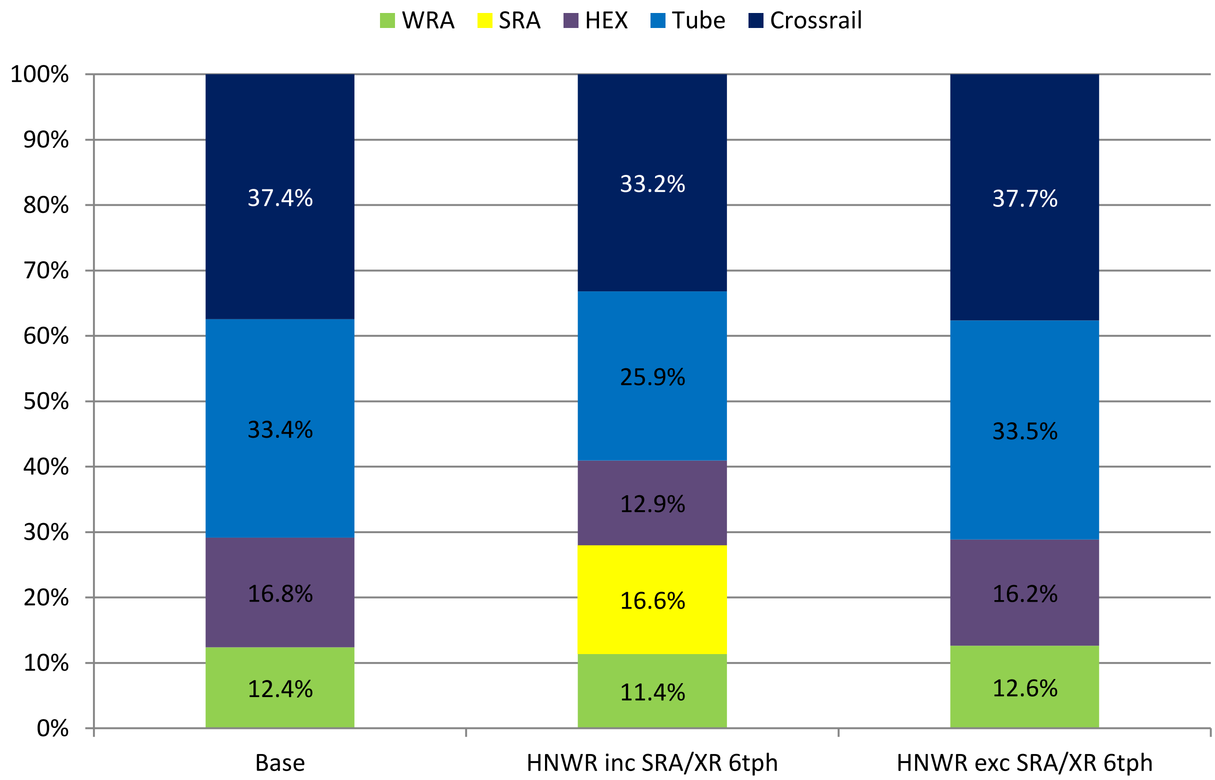
4.5.13 Passenger and employee trips to and from the airport are forecast based on hourly profiles and as a result, the combined mode share changes according to the modelled hour and the direction of travel (since employee travel is more tidal in nature, for example accounting for a greater proportion of total demand to the airport in the AMP than from the airport in the same period).

Figure 4-14: AMP (0700-1000) overall rail sub-mode share TO airport (passengers and employees)



4.5.14 Figure 4-15 illustrates the point made above, indicating how rail sub-mode share changes in the AMP for trips away from the airport. Employees make up a much smaller proportion of total demand in this direction and therefore, the mode share illustrated is more reflective of airport passenger rail choices.

Figure 4-15: AMP (0700-1000) overall rail sub-mode share FROM airport (passengers and employees)

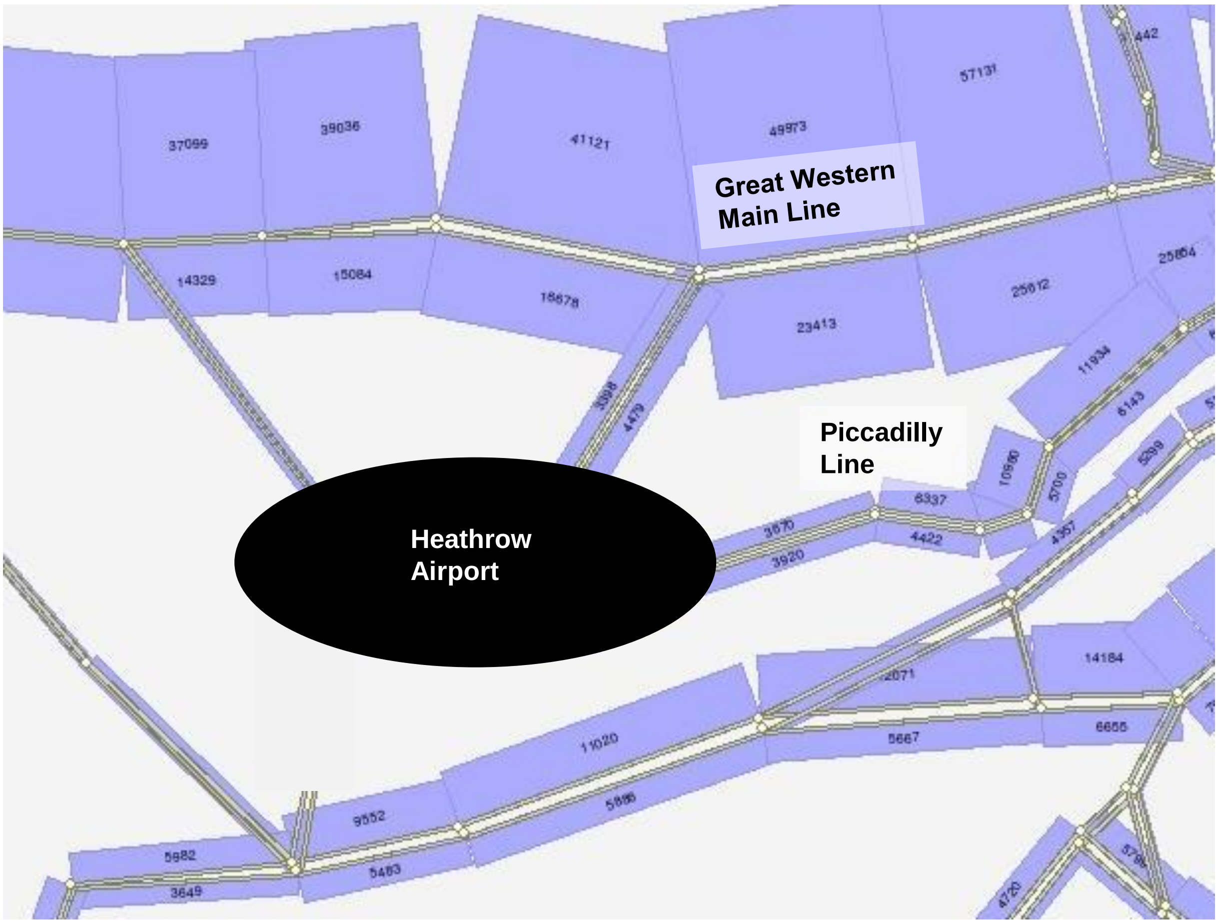


4.6 AM peak Railplan Extended Baseline runs

No runway expansion

4.6.1 The first AMP Railplan run completed was the ‘no expansion’ scenario, consisting of the Extended Baseline transport network and corresponding background demand forecast from LTS, assuming that Heathrow remains in its current form with two runways. Figure 4-16 illustrates the AM peak flows on the network around Heathrow in this scenario, indicating a similar level of demand to that evident in the reference case run described earlier in this chapter, which is to be expected since background and airport demand and available capacity on rail links in this area change very little between the two scenarios. Flows inbound to London reach over 57,000 on the link on the GWML between Hanwell and West Ealing, and around 12,000 on the Piccadilly Line between Osterley and Boston Manor. Flows in the counter-peak direction are approximately 40-50% of that in the peak direction depending on the line.

Figure 4-16: 2031 Extended Baseline AM peak forecast rail demand (no runway expansion)



4.6.2 The flows on links summarised above were compared with available seated and standing capacity on each link in the model to calculate estimates of forecast crowding on the network, measured as the average number of people standing per m^2 on trains on each link across the time period.

4.6.3 Railplan does produce full crowding plots for all National Rail services included in the model, but these outputs have not been included in this report as forecasts for each link represent aggregate estimates of crowding incorporating many different types of service (utilising different types of rolling stock), including non-airport services on the GWML. As a result, these outputs are not detailed enough to draw any meaningful conclusions about the crowding experienced by airport-related passengers on the network. Link-based model outputs for rail services have instead been disaggregated to report crowding impacts on trains serving the airport directly, split by service groups (i.e. HEX, Crossrail, Piccadilly Line etc).

4.6.4 Figure 4-17 summarises the aforementioned crowding impacts on rail services providing direct connections to Heathrow in the AMP ‘no expansion’ scenario. The plot indicates the following:

- There are no crowding issues evident on HEX or WRA services based on the assumed service pattern and rolling stock assumptions for the latter service – it should be noted that these assumptions are subject to change as the scheme progresses through the GRIP process;
- Crossrail becomes heavily crowded eastbound east of Old Oak Common, peaking on the approach to Bond Street at just under 4 people standing per m^2;
- The Piccadilly Line is moderately crowded around Earl’s Court at 2.4 people standing per m^2 inbound to London;
- Although not connected to Heathrow in the ‘no expansion’ scenario, the Windsor Line Richmond branch is severely over-crowded at over 4 people standing per m^2 inbound to London.

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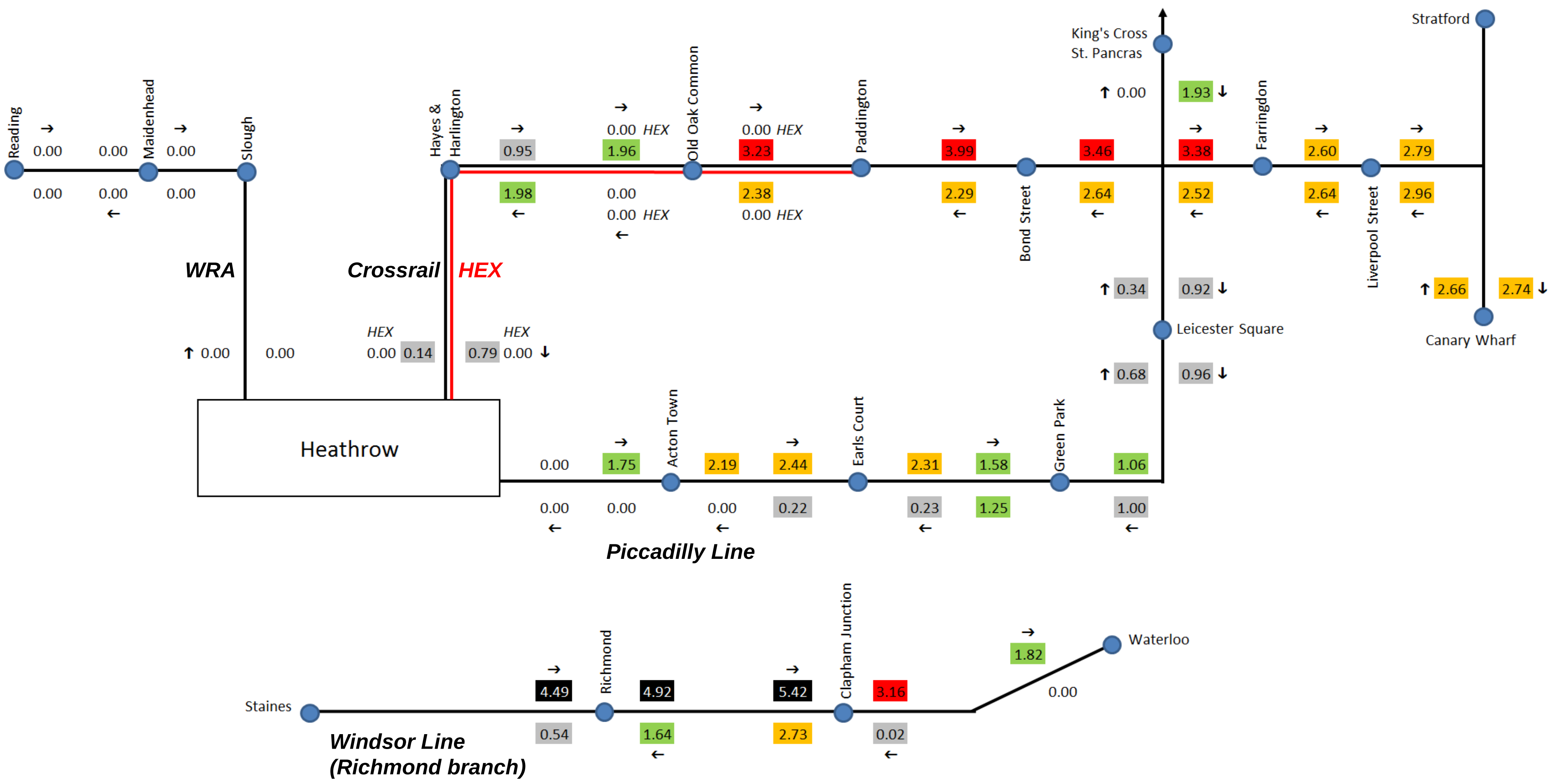
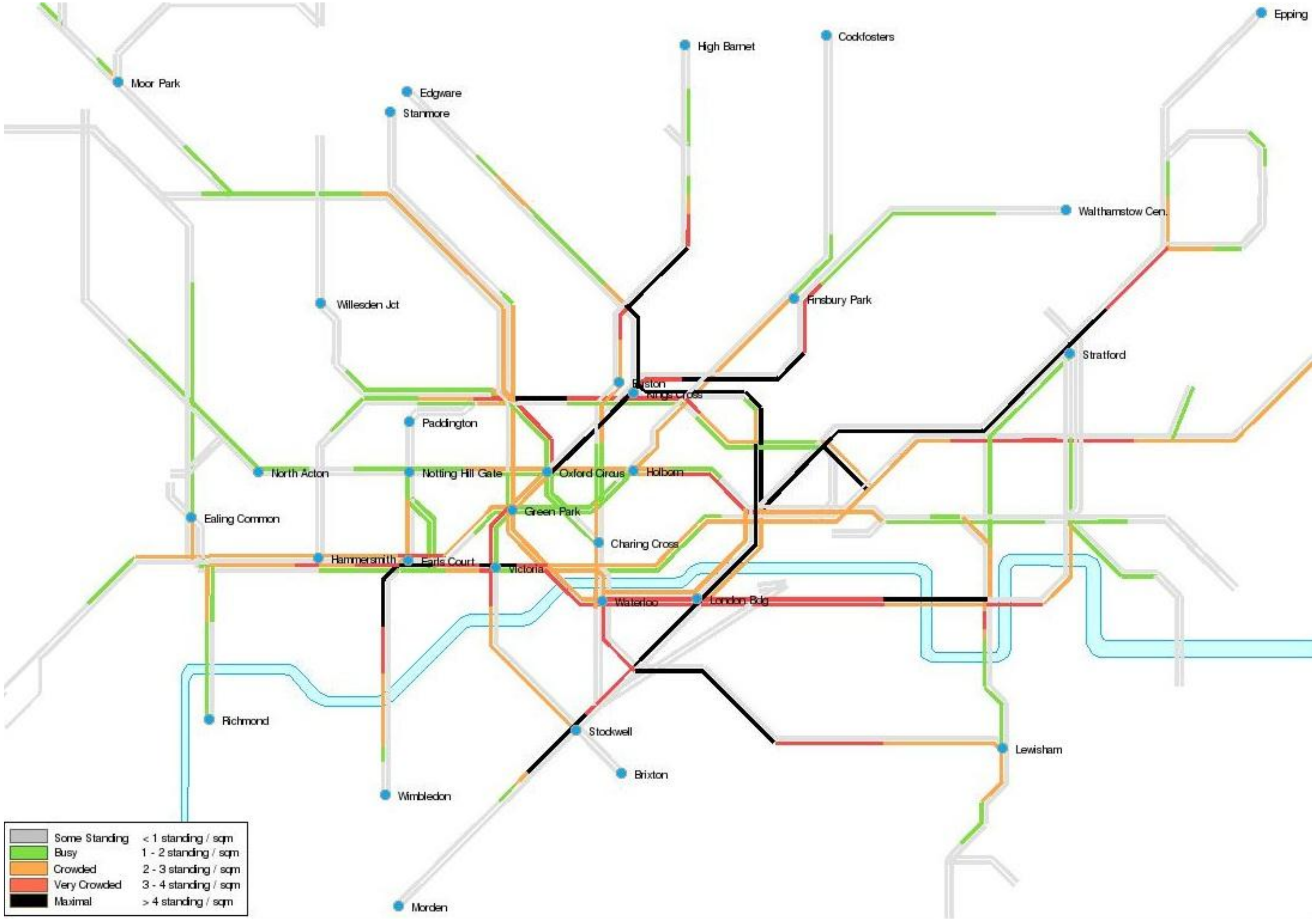
Figure 4-17: 2031 Extended Baseline (no runway expansion) – average passengers standing per m^2 on trains serving Heathrow (AM peak hour)[12]



[12] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting – in the 'no expansion' scenario, SRA is excluded

Figure 4-18: 2031 Extended Baseline LUL crowding (no runway expansion)



4.6.5 Figure 4-18 illustrates the London Underground crowding plot for the AMP 'no expansion' scenario. In contrast to the outputs described above, this plot is a standard output from Railplan and is more appropriate for this report since routes and service/rolling stock types are limited when analysed by line. It should be noted that the calculation for crowding in this figure is incremental, accounting for modelling residuals when compared with observed conditions in 2011 for existing services. As a result, the forecast for the Piccadilly Line for example is slightly different from that illustrated on the schematic diagram above.

4.6.6 The Underground plot indicates that even incorporating a range of schemes to enhance capacity across the network, high crowding levels are forecast on many services by the 2030s regardless of airport expansion, including significant sections of the Northern Line (particularly the Bank branch), the Central Line to the east, and the Victoria Line north of Oxford Circus. The plot also indicates that the new Bakerloo Line southern extension is forecast to become very crowded west of Lewisham in the AMP, reaching in excess of 4 people standing per m^2.

4.6.7 In terms of direct access to Heathrow by London Underground services, the plot indicates that crowding on the Piccadilly Line is lower than that observed in 2011, when the service reached in excess of 4 people per m^2 west of Acton and east of Earl's Court towards Green Park. Crowding also reduces from the base year on services inbound to Central London from the north-east – for example, the section between Finsbury Park and Holborn sees a reduction from in excess of 4 people per m^2 in 2011 to 2-3 per m^2 in the 2031 Extended Baseline 'no expansion' scenario. This improvement is replicated between Holborn and Green Park for a lower level of crowding, and neither model indicates any crowding issues towards Heathrow west of Central London in the AMP.

Runway expansion excluding SRA and Crossrail 6tph

4.6.8 The next AMP Railplan run involved testing the Extended Baseline network with the additional airport rail demand associated with the North West Runway. Both the airport demand forecast and the modelled transport network in this scenario excluded SRA and the scheme to increase Crossrail frequency at the airport to 6tph.

4.6.9 Figure 4-19 summarises the forecast flow on links in the vicinity of Heathrow in this scenario, indicating that flows on the GWML reach around 58,400 inbound to Central London on the link between Hanwell and West Ealing. Flows on the Piccadilly Line reach around 12,500 between Osterley and Boston Manor in the same direction.

4.6.10 Figure 4-20 indicates the change in forecast flows on links in the AM peak in this scenario when compared with the Extended Baseline 'no expansion' scenario. Red bands indicate an increase in demand while green bands indicate a reduction, and since the transport networks and background demand estimates are similar in both scenarios, the plan effectively indicates the growth in demand on links directly as a result of North West Runway-related rail trips.

4.6.11 The plan indicates that the increase in rail demand associated with the North West Runway is concentrated on the GWML and the Piccadilly Line on links between the airport and Central London, and the changes are more pronounced in the direction towards the airport. Demand increases by up to 1,000 trips on links on the GWML towards London and up to 1,300 on links towards the airport. On the Piccadilly Line the increase in the direction towards London is of the order of 600 trips, with around 1,000 travelling towards the airport. On the links in the immediate vicinity of the airport, this amounts to an increase in demand of up to 6% on the GWML and 25% on the Piccadilly Line.

Figure 4-19: 2031 Extended Baseline AM peak forecast rail demand (HNWR excluding SRA & XR 6tph)

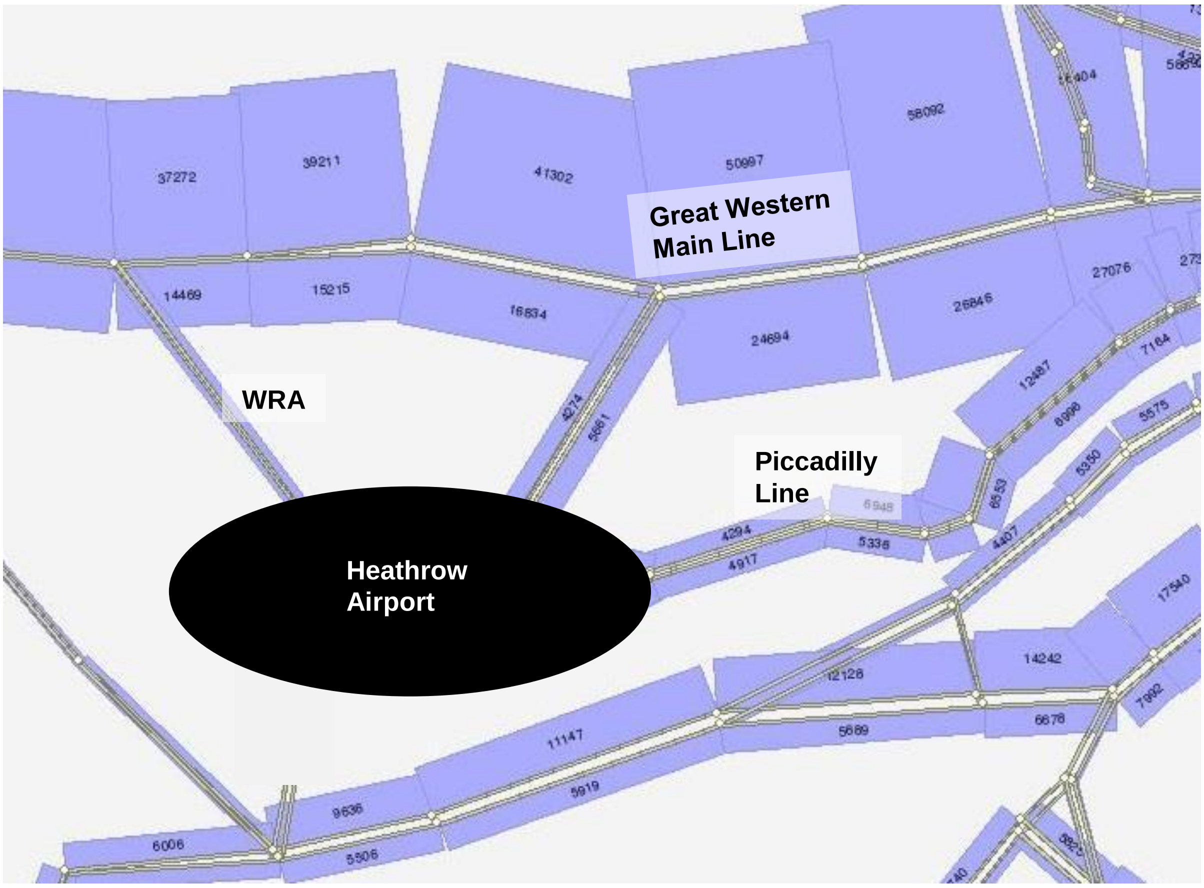
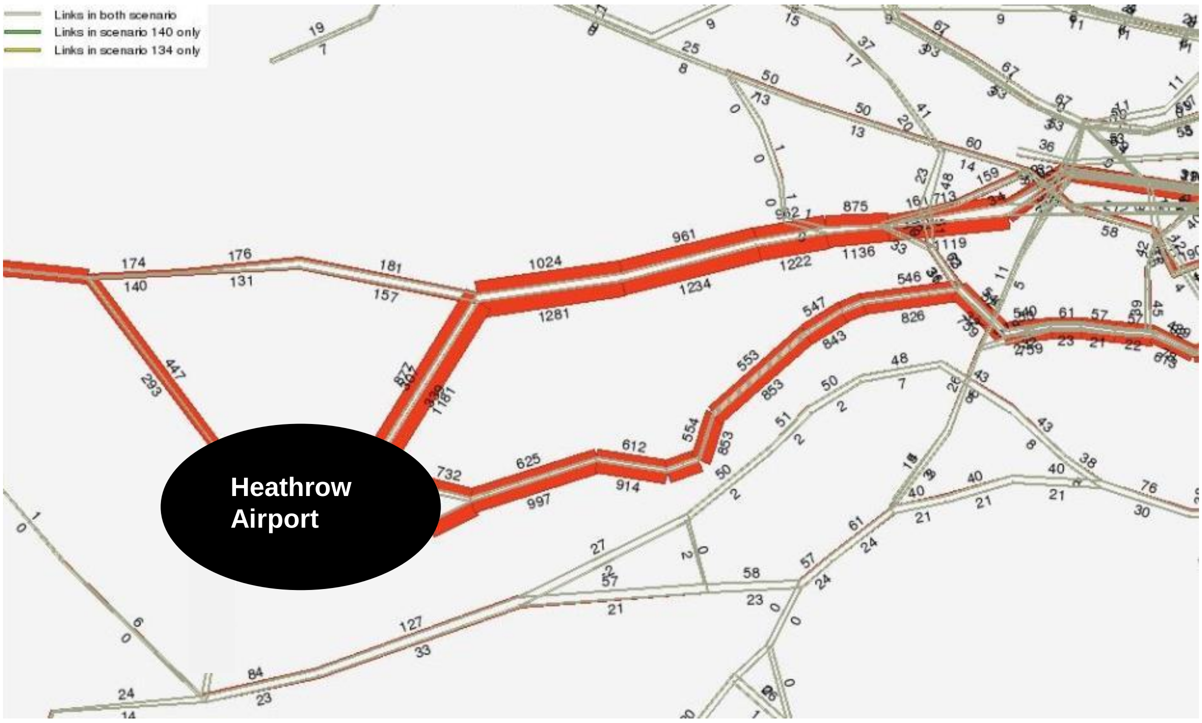


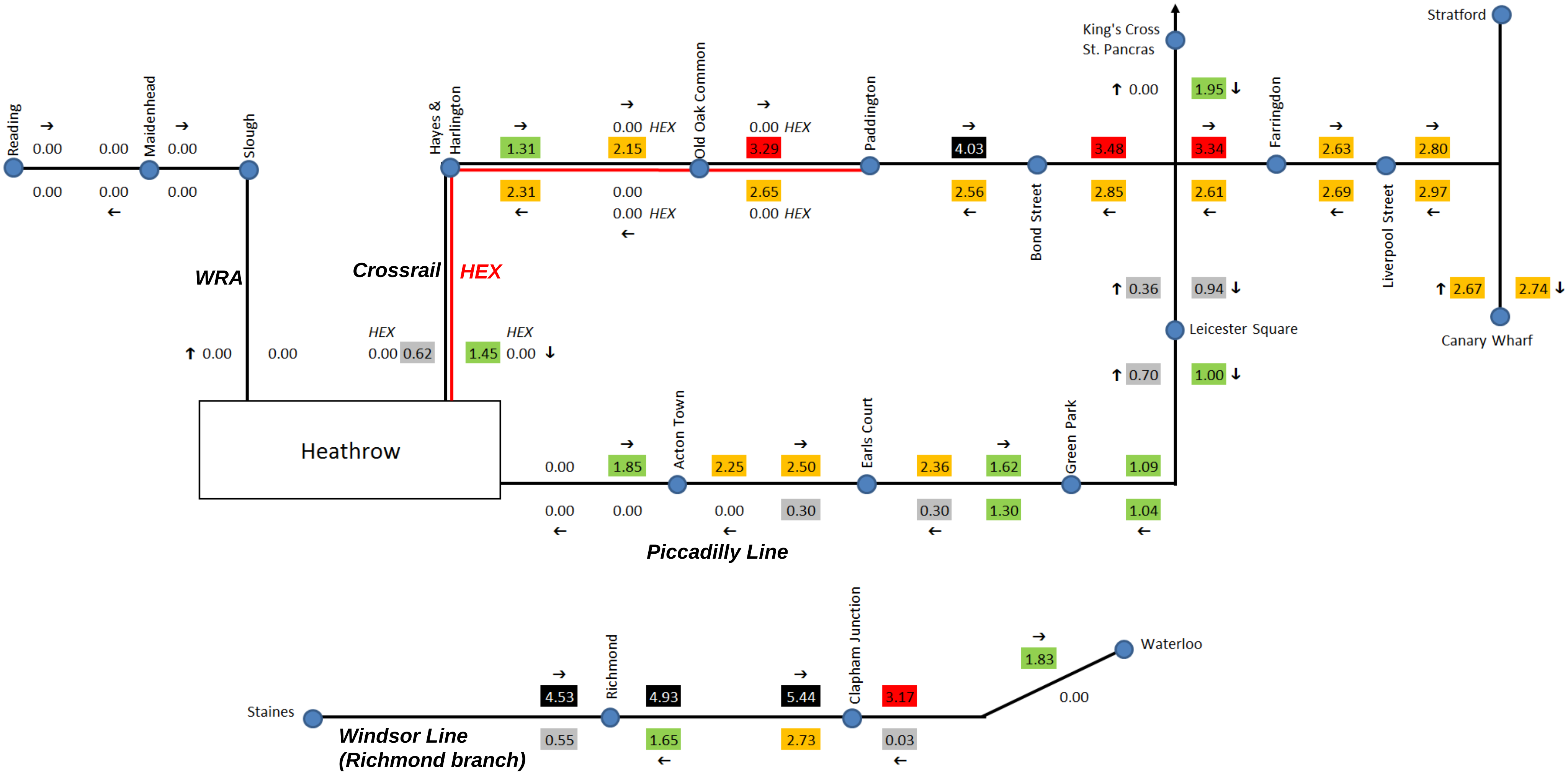
Figure 4-20: Change in AM peak volumes (HWNR excluding SRA & XR 6tph v EB no expansion)



4.6.12 The impact on crowding on rail links providing direct connections to Heathrow is illustrated in Figure 4-21, with the difference from the 'no expansion' scenario summarised in Figure 4-22. As you would expect given the difference plots above, the additional passengers on the network as a result of the North West Runway increase crowding on Crossrail and the Piccadilly Line, although the change on the sections of the line that are already crowded in the 'no expansion' scenario is marginal. For example on Crossrail eastbound, crowding increases from 3.99 people standing per m^2 in the 'no expansion' scenario to 4.03 with the North West Runway in place, an increase of 0.04 people standing per m^2. On the Piccadilly Line the increase on the busiest section of line into Earl's Court is only 0.06 people standing per m^2, pivoting off a lower level of crowding in the 'no expansion' scenario when compared to Crossrail.

4.6.13 Figure 4-23 provides crowding forecasts for London Underground services in the North West Runway excluding SRA and Crossrail 6tph scenario. When compared with the Extended Baseline 'no expansion' forecast, there is very little difference in forecast crowding with the North West Runway in place as the biggest increase in demand occurs on relatively uncongested links in the vicinity of the airport. The only noticeable difference between the scenarios on the Piccadilly Line inbound to Central London is that crowding increases slightly further to the west.

Figure 4-21: 2031 Extended Baseline (HNWR excluding SRA & XR 6tph) – average passengers standing per m² on trains serving Heathrow (AM peak)[13]



[13] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting – in this scenario, SRA is excluded

Figure 4-22: HNWR excluding SRA & XR 6tph – change in crowding compared with 'no expansion' scenario

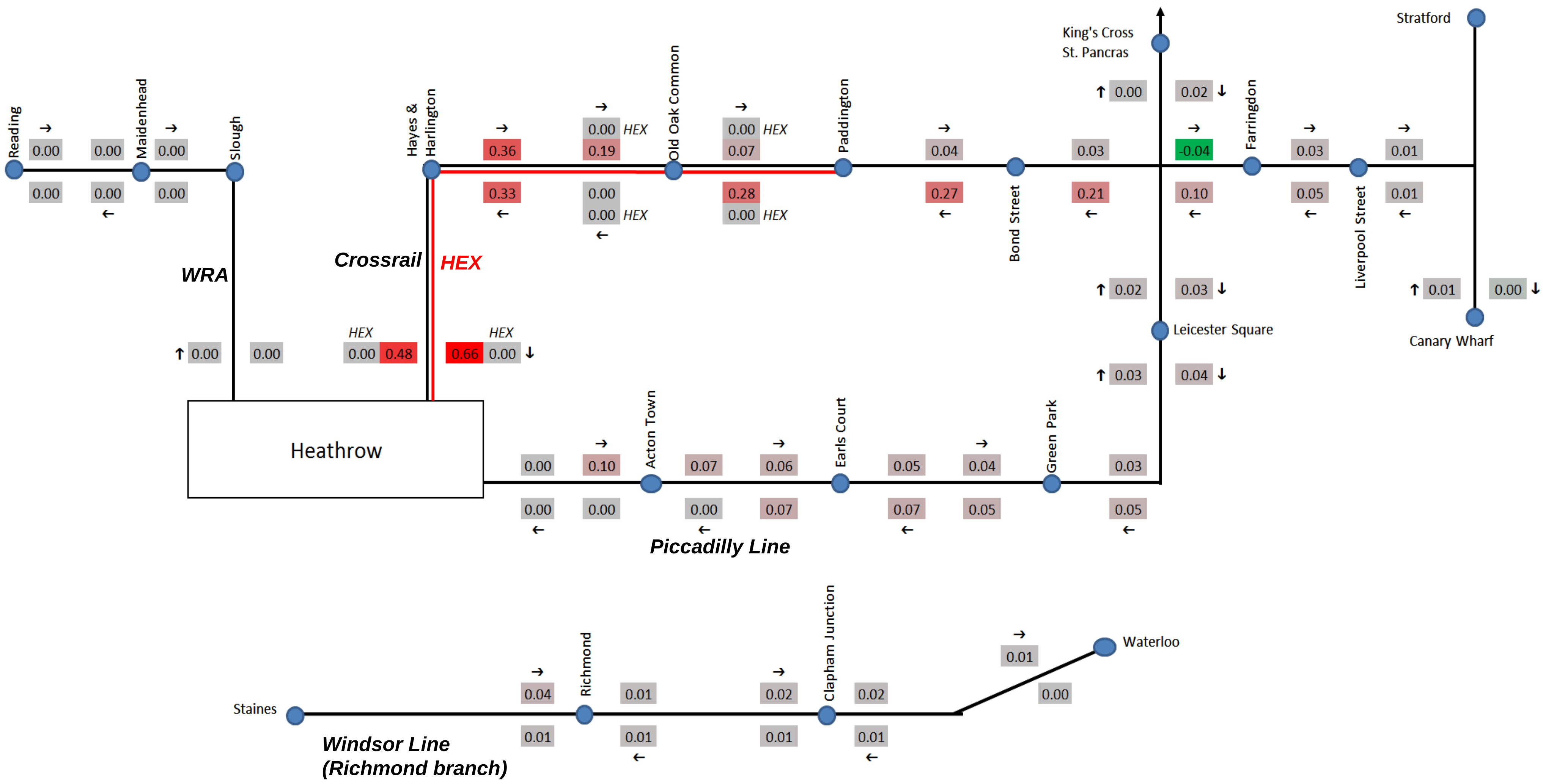
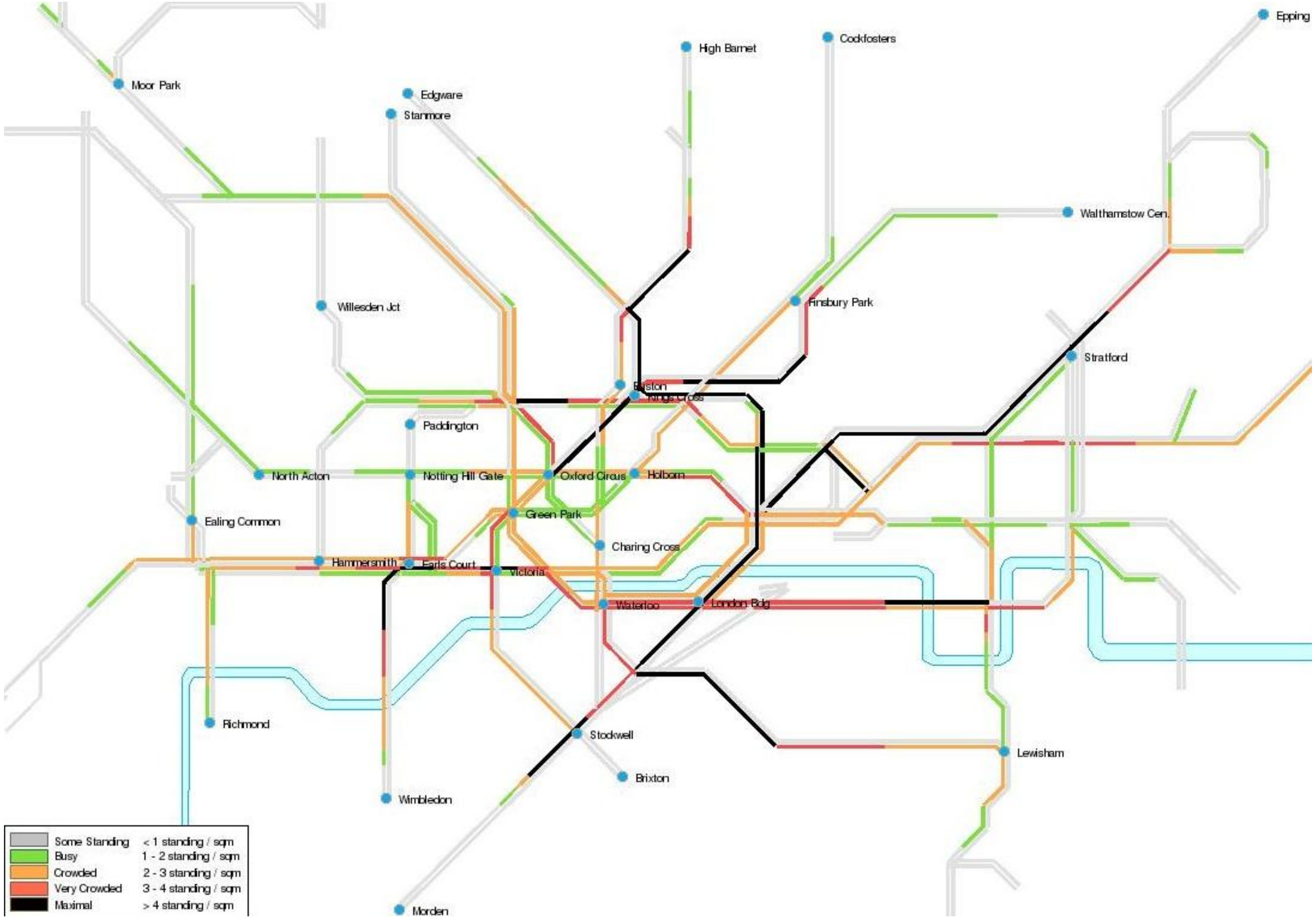


Figure 4-23: 2031 AM peak Extended Baseline LUL crowding (HNWR excluding SRA & XR 6tph)[14]

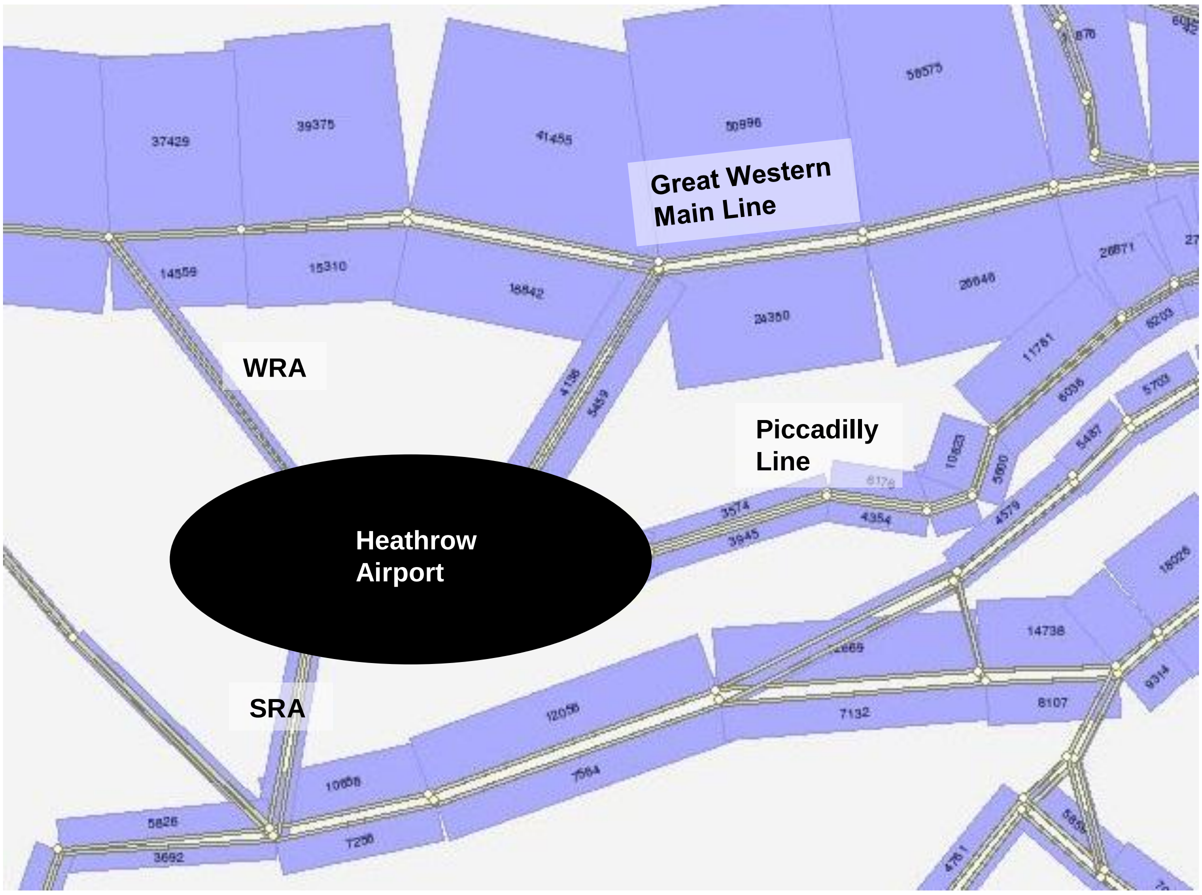


[14] Railplan output based on TfL macro

Runway expansion with SRA and Crossrail 6tph

4.6.14 The final AMP Railplan run undertaken was for the North West Runway airport demand including the impact of SRA and the increase in Crossrail frequency to 6tph serving the airport. Figure 4-24 illustrates the forecast flows on links in the vicinity of Heathrow in this scenario. Flows on the GWML reach close to 59,000 inbound to Central London between Hanwell and West Ealing, and around 11,800 between Osterley and Boston Manor on the Piccadilly Line. The introduction of SRA increases flows on the Windsor Line to over 18,000 east of St. Margaret's Station.

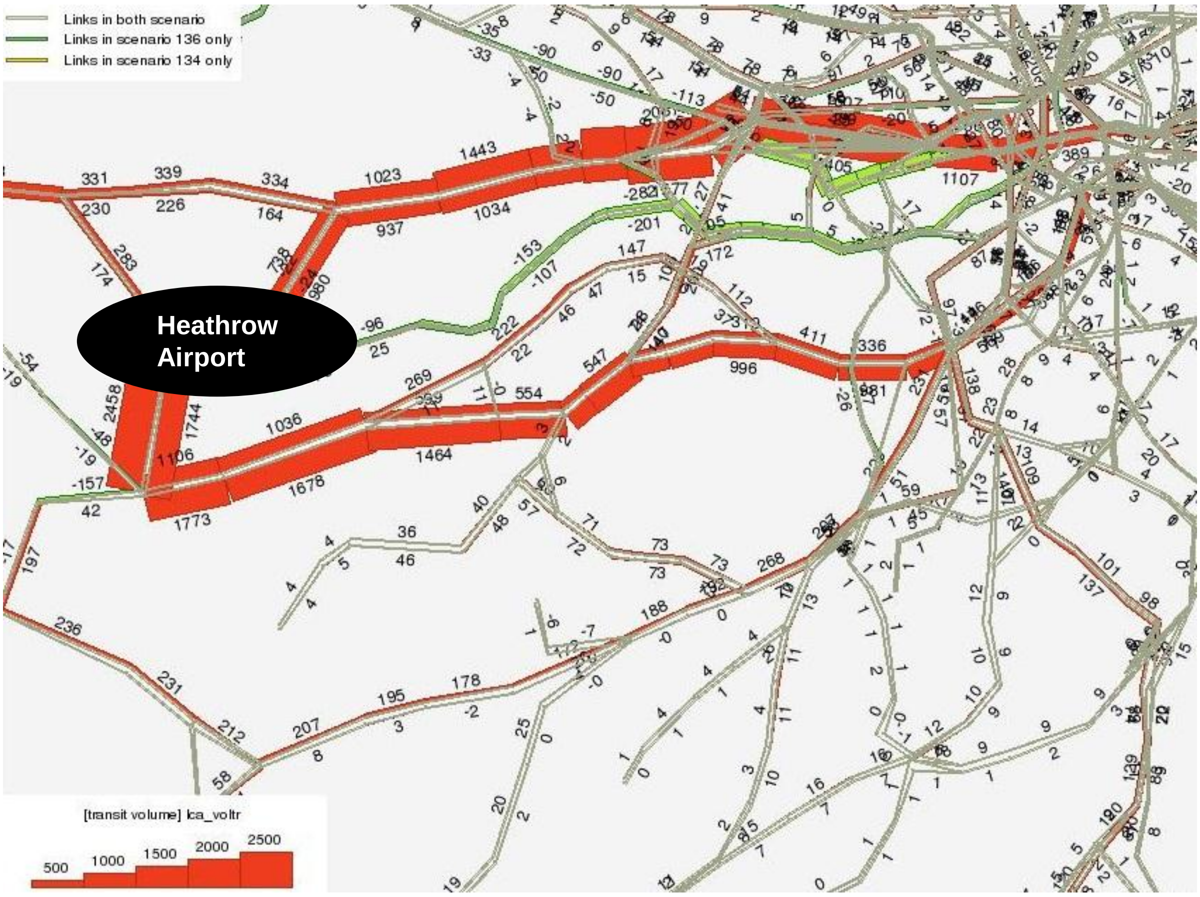
Figure 4-24: 2031 Extended Baseline AM peak forecast rail demand (HNWR with SRA & XR 6tph)



4.6.15 Figure 4-25 summarises the change in demand on links in this scenario when compared with the Extended Baseline 'no expansion' scenario. The plan indicates that the increase in flows on the GWML in this scenario is actually higher than in the North West Runway scenario excluding SRA and Crossrail 6tph, since the added Crossrail capacity between the airport and Paddington results in an increase in background non-airport demand using the service. This is illustrated by the fact that the change is more pronounced in the direction towards London, in contrast to the scenario excluding the 6tph where the biggest change from 'no expansion' was towards the airport.

4.6.16 The impact of SRA in this scenario is clearly evident, both in terms of increasing flows on the Windsor Lines (by around 1,800 trips towards the airport east of Staines and 1,100 on the same link towards London) and slightly reducing forecast flows on the Piccadilly Line when compared with the 'no expansion' scenario.

Figure 4-25: Change in AM peak volumes (HWNR with SRA & XR 6tph v EB no expansion)



4.6.17 The crowding impacts on rail services to and from the airport in this scenario are summarised in Figure 4-26, with the difference from the ‘no expansion’ scenario illustrated in Figure 4-27. In this scenario, forecast crowding on Crossrail and the Piccadilly Line actually reduces marginally with the North West Runway in place due to the combined impact of the provision of additional capacity on Crossrail (with airport service frequency increasing to 6tph) and the introduction of SRA, which reduces Crossrail and Piccadilly Line rail sub-mode share.

4.6.18 However, the model output does raise a question over the viability of SRA, as severe over-crowding is forecast on the Windsor Line Richmond branch in the ‘no expansion’ scenario. On the busiest link inbound to Clapham Junction, modelled crowding reaches 5.4 people standing per m^2, and this increases to 5.6 with the North West Runway in place. This suggests that SRA may not be viable unless a significant increase in capacity can be delivered to meet background demand on the Richmond branch. In this study, SRA was modelled as an attachment-detachment service as a result of the opposition to the Airtrack proposal to increase service frequencies through level-crossings on this branch. The NR-led feasibility study on SRA, which is due to report in summer 2015, will consider this issue in more detail.

4.6.19 London Underground crowding is summarised on the plot in Figure 4-28. This indicates that on the Piccadilly Line, crowding levels revert back to levels similar to the ‘no expansion’ scenario as a result of the forecast reduction in demand due to SRA diverting trips from the service.

Figure 4-26: 2031 Extended Baseline (HNWR including SRA & XR 6tph) – average passengers standing per m² on trains serving Heathrow (AM peak)[15]

[15] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting

Figure 4-27: HNWR including SRA & XR 6tph – change in crowding compared with 'no expansion' scenario

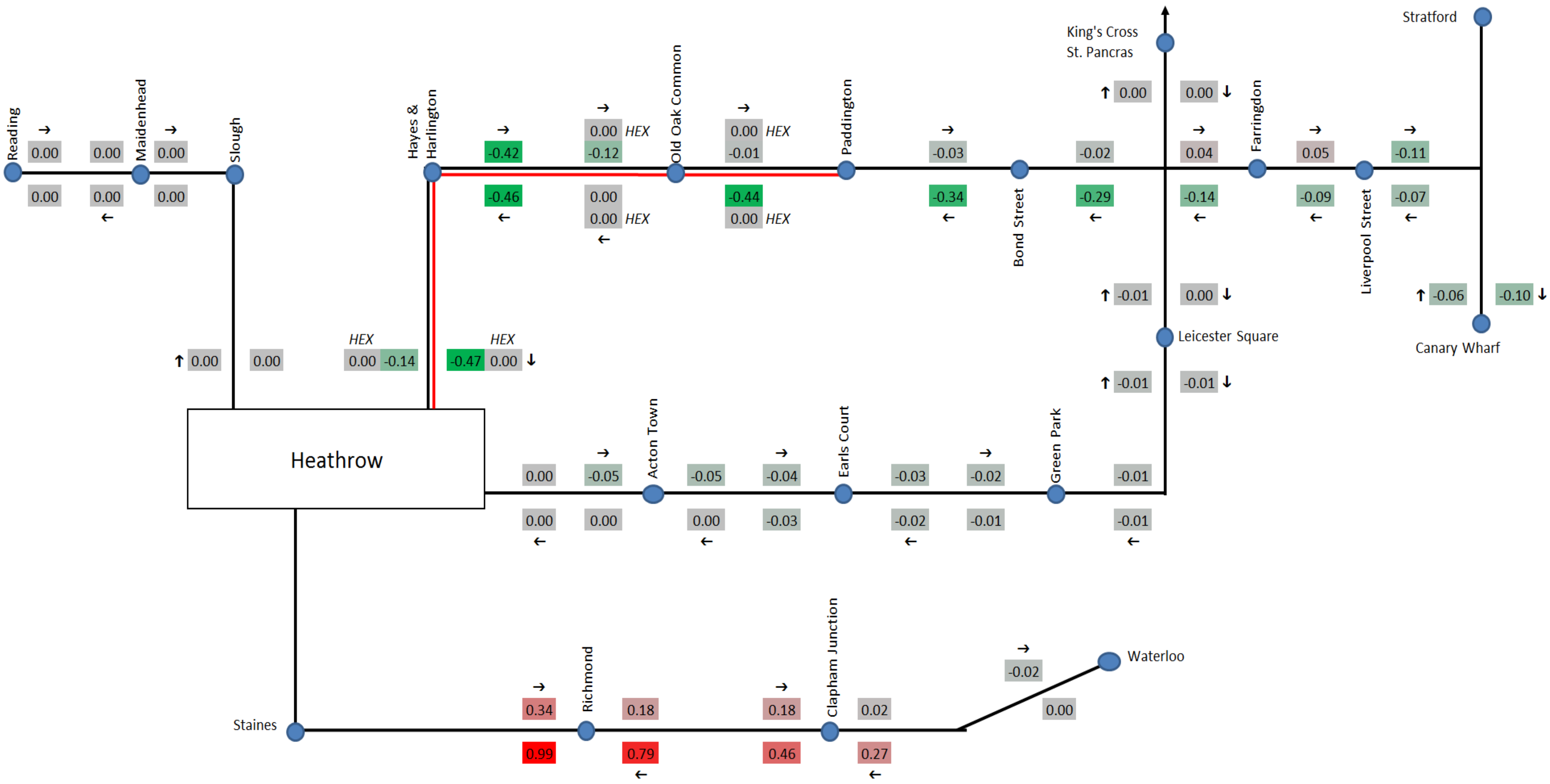
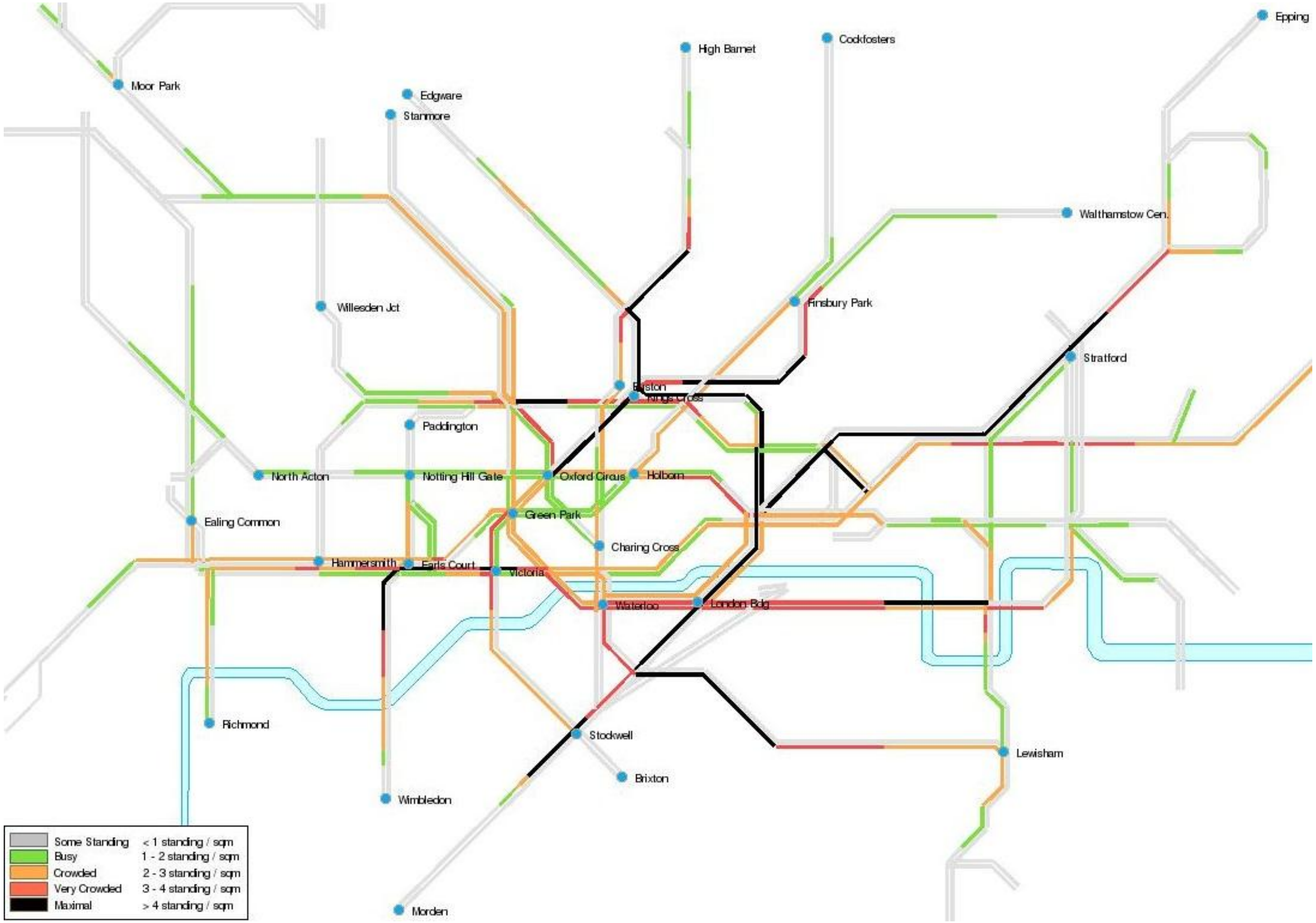


Figure 4-28: 2031 AM peak Extended Baseline LUL crowding (HNWR with SRA & XR 6tph)



Journey time/distance impacts

4.6.20 In addition to demand and capacity-related outputs, the Railplan model also outputs metrics related to journey time and distance travelled. Table 4-5 summarises the total demand and total passenger hours travelled to Heathrow zones in the AM peak in each of the scenarios described above. The table indicates that overall journey times are very similar in all three model runs, with SRA reducing journey times marginally on other services and more significantly on Crossrail, as passengers from South London and the South East transfer to the new service.

4.6.21 Although overall rail journey time is similar in all three scenarios, there is some evidence that the introduction of SRA increases the rail catchment of the airport, meaning that airport-related passengers on average make longer rail journeys. Passenger-kms by destination zone is not a standard output metric in Railplan, but the overall passenger-kms travelled by PT sub-mode in each model run is summarised in Table 4-3.

Table 4-3: AMP total passenger-kms by PT sub-mode in Extended Baseline scenarios

PT sub-mode	No expansion	HNWR exc. SRA/XR 6tph		HNWR inc. SRA/XR 6tph	
		Total	Diff from no expansion	Total	Diff from no expansion
National Rail	51,109,592	51,343,564	233,972	51,451,264	341,672
LUL	14,263,306	14,312,086	48,780	14,247,483	-15,823
DLR	582,386	582,910	524	582,647	261
Buses	4,844,363	4,852,818	8,455	4,843,926	-437
Tramlink	156,889	156,910	21	157,021	132

4.6.22 The table indicates that total passenger-kms travelled on National Rail services increases by around 340,000 in the North West Runway scenario including SRA when compared with the no expansion scenario, while in the North West Runway scenario without SRA it only increases by around 230,000. Since there is very little difference in rail demand between the two expansion scenarios and the background demand matrix is fixed in both, it may be reasonable to assume that airport-related rail passengers are travelling further on average in the scenario with SRA.

4.6.23 Table 4-4 indicates average journey time estimates by rail sub-mode to Heathrow zones from the 2011 AMP model. The overall average time is slightly shorter but broadly comparable with the 2031 Extended Baseline runs, indicating that the rail catchment is significantly larger in the Extended Baseline scenarios in 2031 but with no significant detriment in terms of overall rail journey times to the airport.

Table 4-4: 2011 AMP journey time by rail sub-mode TO Heathrow Airport zones

Rail sub-mode	Assigned demand	Passenger hours	Average time (mins)
Tube	2,463	6,633	162
HEX	1,625	3,430	127
Heathrow Connect	294	804	164
Total	**4,381**	**10,867**	**149**

Table 4-5: 2031 AMP Extended Baseline journey time by rail sub-mode TO Heathrow Airport zones

Rail sub-mode	No expansion			North West Runway (exc. SRA/XR 6tph)			North West Runway (inc. SRA/XR 6tph)		
	Assigned demand	Passenger hours	Average time (mins)	Assigned demand	Passenger hours	Average time (mins)	Assigned demand	Passenger hours	Average time (mins)
Tube	3,777	9,638	153	4,997	12,688	152	3,867	9,709	151
HEX	1,523	3,021	119	1,862	3,717	120	1,499	2,969	119
WRA	1,412	4,312	183	1,859	5,654	182	1,696	5,093	180
SRA	~	~	~	~	~	~	2,458	6,821	167
Crossrail	3,849	9,810	153	5,091	13,060	154	4,394	10,641	145
Total	**10,561**	**26,780**	**152**	**13,808**	**35,119**	**153**	**13,913**	**35,233**	**152**

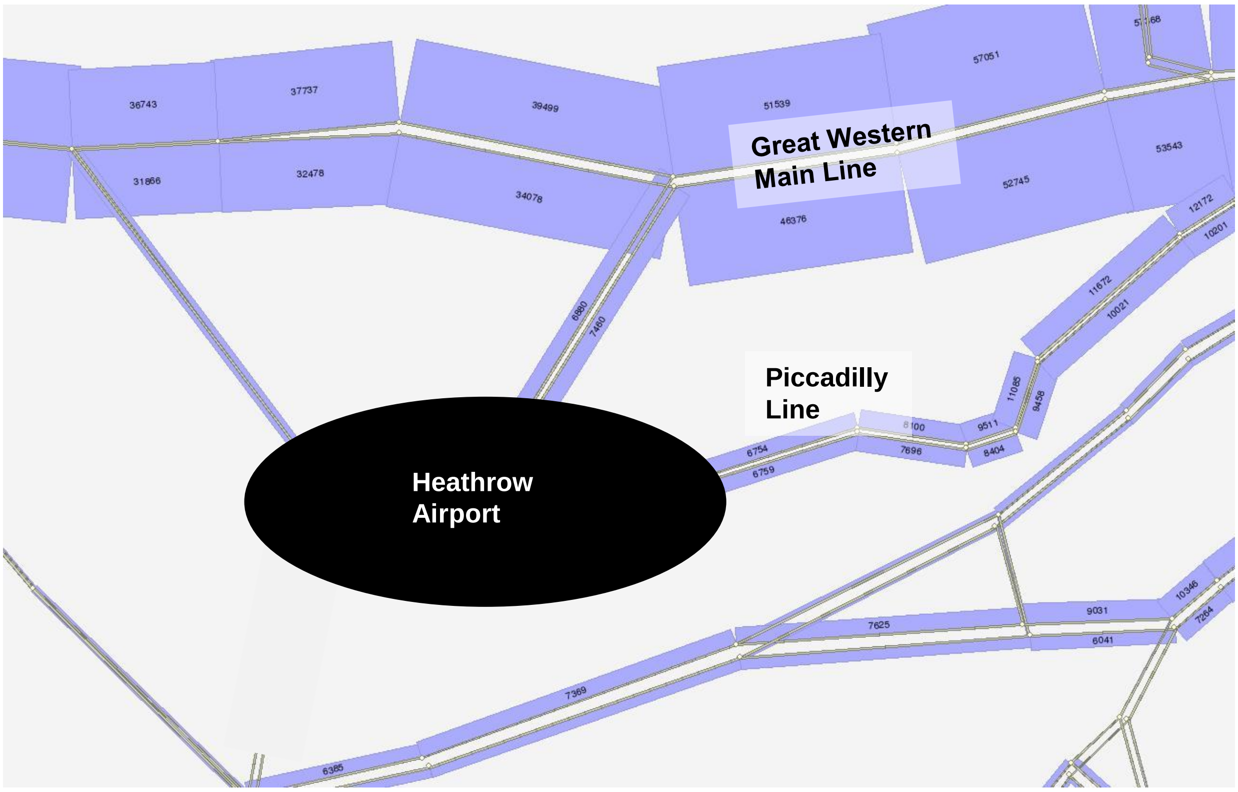
4.7 Inter-peak Railplan Extended Baseline runs

No runway expansion

4.7.1 As mentioned earlier, the inter-peak period covers 6 hours between 1000 and 1600, and all the forecasts referenced in this section are for the whole period.

4.7.2 The first inter-peak Railplan run completed was the ‘no expansion’ scenario, consisting of the Extended Baseline transport network and corresponding background demand forecast from LTS, assuming that Heathrow remains in its current form with two runways. Figure 4-29 illustrates the inter-peak flows on the network around Heathrow in this scenario. Flows inbound to London reach over 57,300 on the link on the GWML between Hanwell and West Ealing, and around 11,700 on the Piccadilly Line between Osterley and Boston Manor. Unlike the AM peak, there is no obvious tidal flow during the inter-peak with forecast passenger volumes generally similar in both directions on each service.

Figure 4-29: 2031 Extended Baseline IP forecast rail demand (no runway expansion)



4.7.3 The flows on links summarised above were compared with available seated and standing capacity on each link in the model to calculate estimates of forecast crowding on the network. As with the AM peak results, link-based model outputs for rail services were disaggregated to report crowding impacts on trains serving the airport directly, split by service groups.

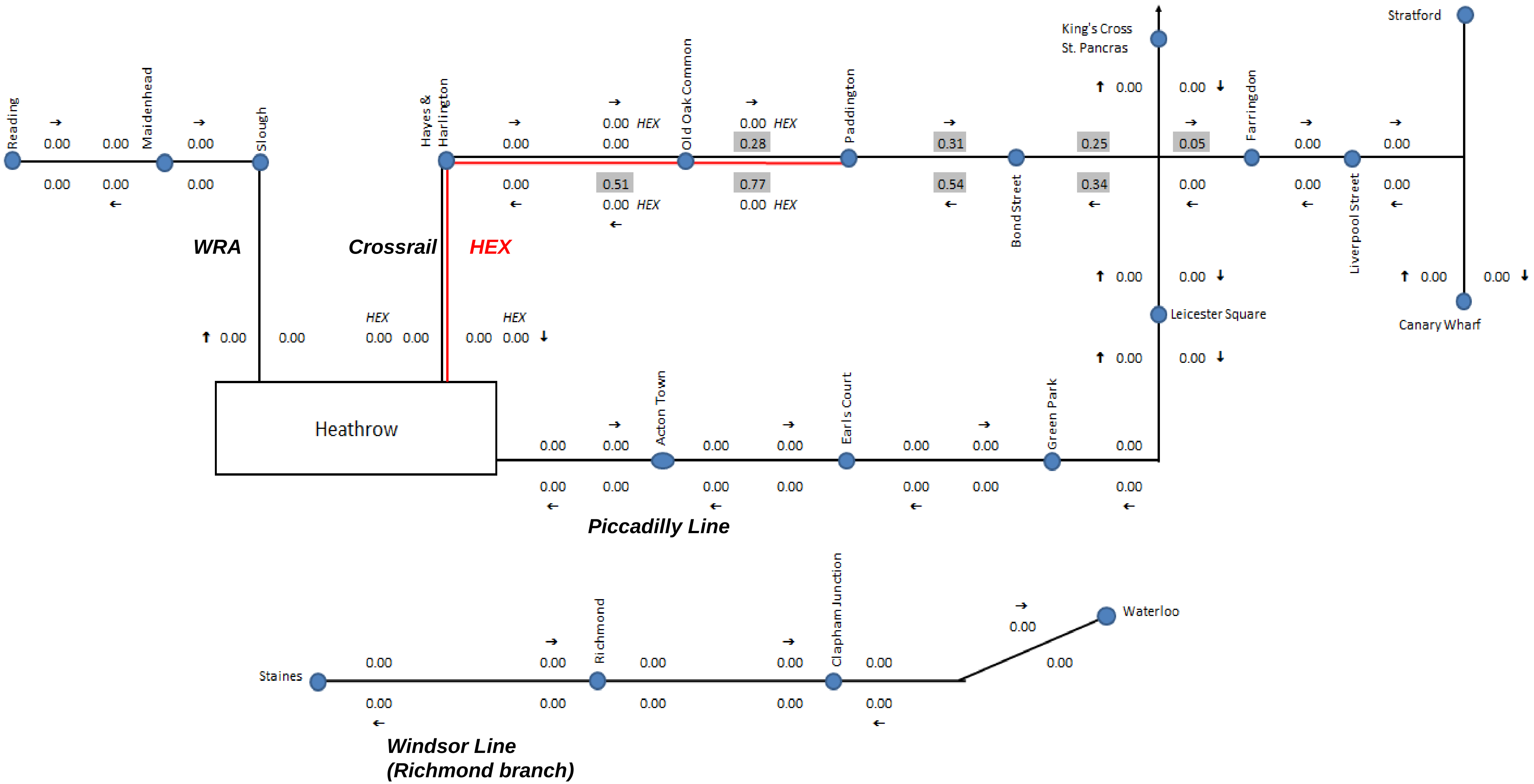
4.7.4 Figure 4-30 summarises the aforementioned crowding impacts on rail services providing direct connections to Heathrow in the IP ‘no expansion’ scenario. The plot indicates the following:

- There are no crowding issues evident on HEX or WRA services based on the assumed service pattern and rolling stock assumptions for the latter service – it should be noted that these assumptions are subject to change as the scheme progresses through the GRIP process;

- Crossrail crowding levels are significantly lower than forecast in the AM peak period, reaching 0.3 passengers standing per m^2 inbound to central London and 0.8 passengers standing per m^2 on trains towards Heathrow;
- No standing passengers are forecast on the Piccadilly Line;
- Although not connected to Heathrow in the ‘no expansion’ scenario, no standing passengers are forecast on the Windsor Line Richmond branch.

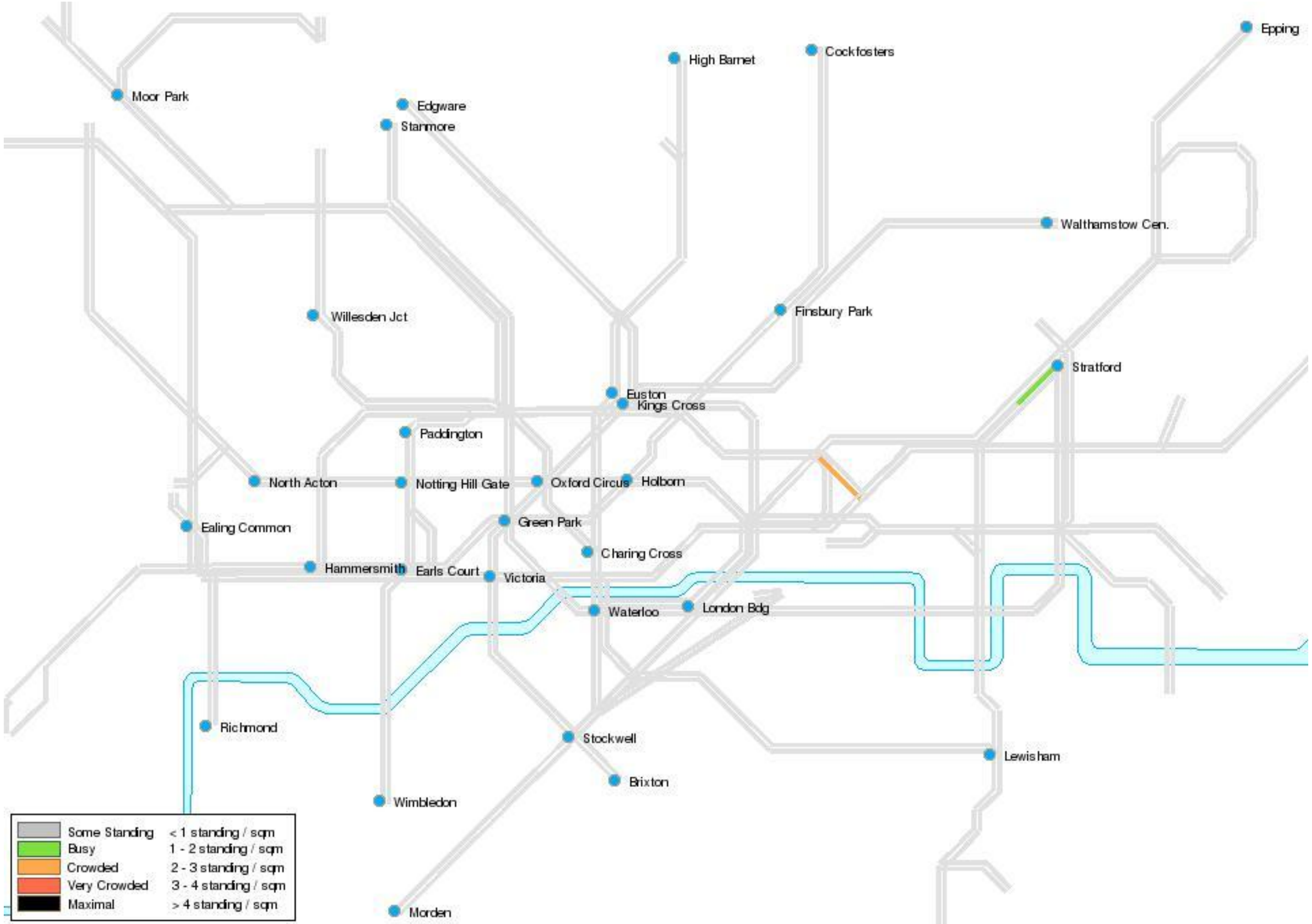
4.7.5 Figure 4-31 illustrates the London Underground crowding plot for the IP ‘no expansion’ scenario. In contrast to the outputs described above, this plot is a standard output from Railplan and is more appropriate for this report since routes and service/rolling stock types are limited when analysed by line. The plot indicates that very little crowding is forecast across the London Underground network during the inter-peak in this scenario.

Figure 4-30: 2031 Extended Baseline (no runway expansion) – average passengers standing per m² on trains serving Heathrow (IP average hour)[16]



[16] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting – in the 'no expansion' scenario, SRA is excluded

Figure 4-31: 2031 Extended Baseline LUL crowding (no runway expansion)



Runway expansion excluding SRA

4.7.6 The next inter-peak Railplan run involved testing the Extended Baseline network with the additional airport rail demand associated with the North West Runway. Both the airport demand forecast and the modelled transport network in this scenario excluded SRA.

4.7.7 Figure 4-32 summarises the forecast flow on links in the vicinity of Heathrow in this scenario, indicating that flows on the GWML reach around 59,600 inbound to Central London on the link between Hanwell and West Ealing. Flows on the Piccadilly Line reach around 13,000 between Osterley and Boston Manor in the same direction.

4.7.8 Figure 4-33 indicates the change in forecast flows on links in the inter-peak in this scenario when compared with the Extended Baseline 'no expansion' scenario. Red bands indicate an increase in demand while green bands indicate a reduction, and since the transport networks and background demand estimates are similar in both scenarios, the plan effectively indicates the growth in demand on links directly as a result of North West Runway-related rail trips.

4.7.9 The plan indicates that the increase in rail demand associated with the North West Runway is concentrated on the GWML and the Piccadilly Line on links between the airport and Central London. Demand increases by up to 2,500 trips on links on the GWML towards London and the same on links towards the airport. On the Piccadilly Line the increase in the direction towards London is of the order of 1,500 trips, with around 1,600 travelling towards the airport. On the links in the immediate vicinity of the airport, this amounts to an increase in demand of up to 4% on the GWML and 25% on the Piccadilly Line.

Figure 4-32: 2031 Extended Baseline IP forecast rail demand (HNWR excluding SRA)

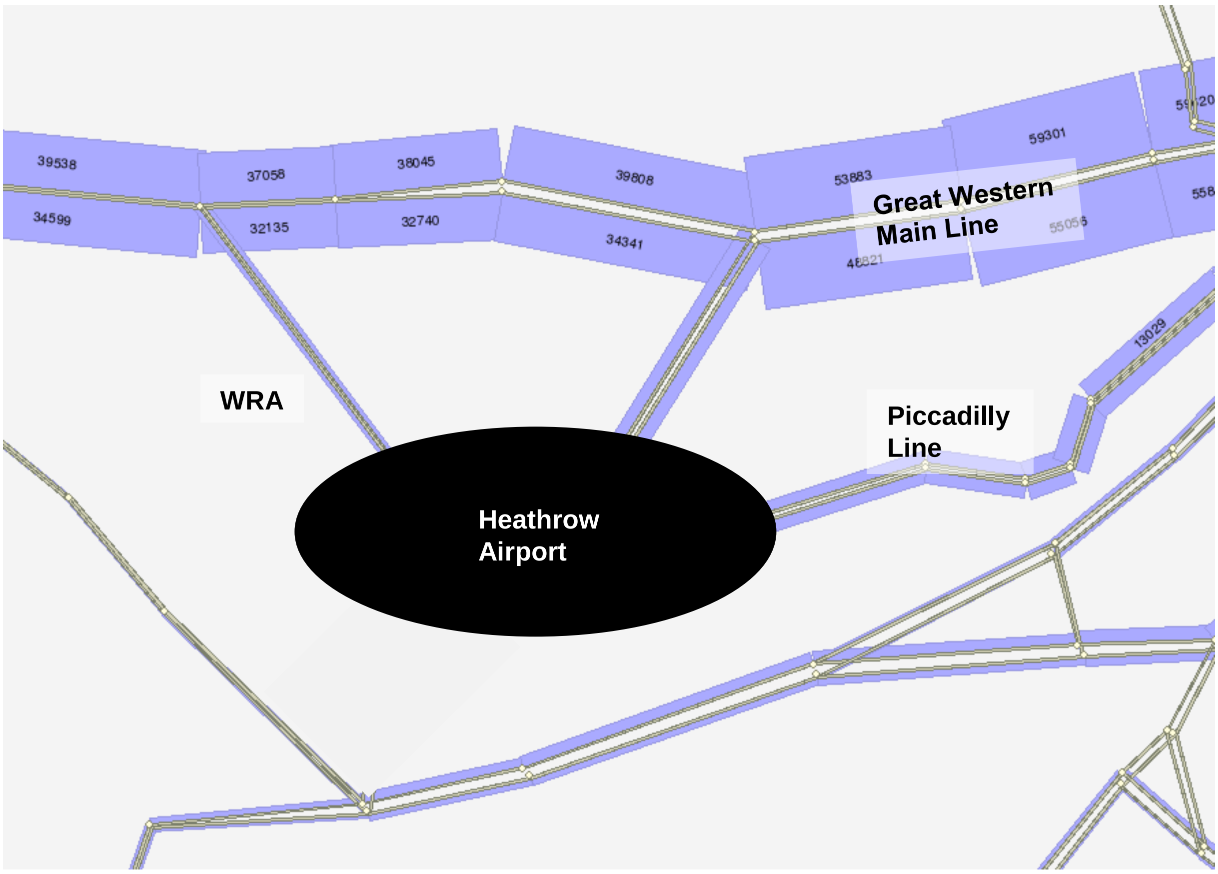
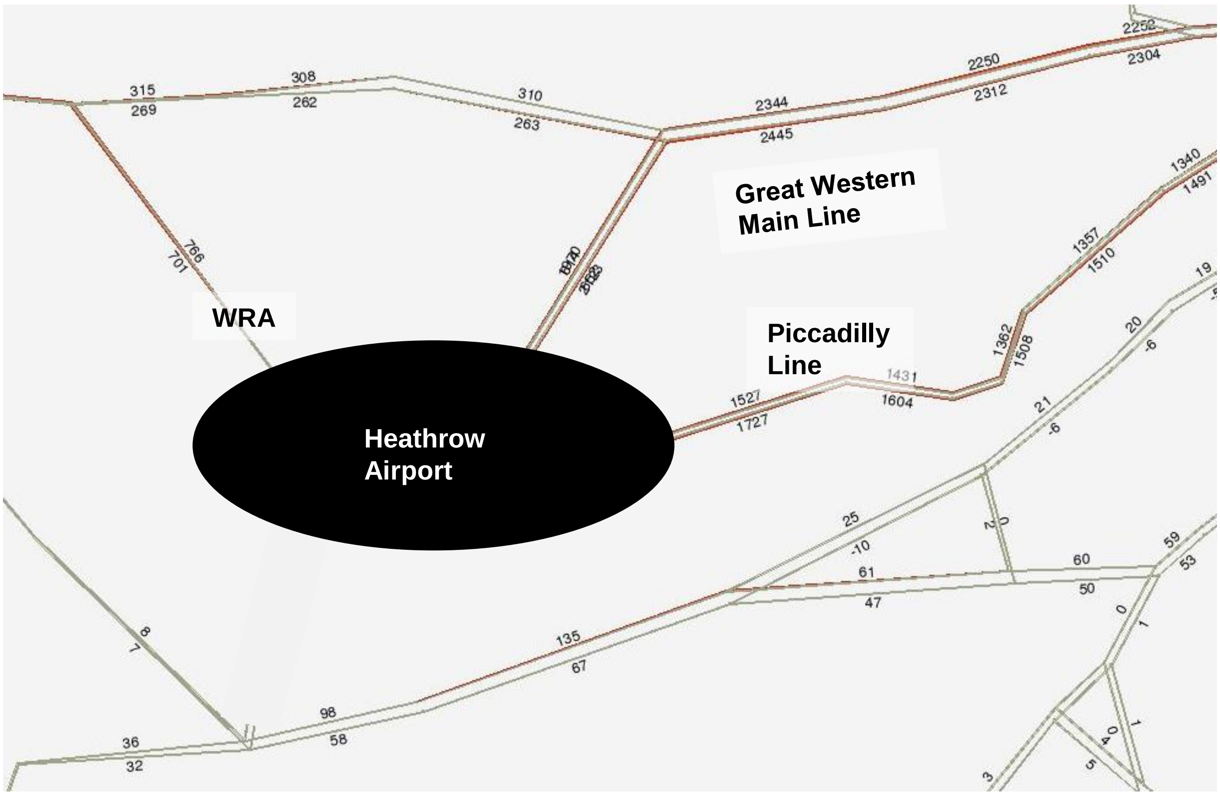


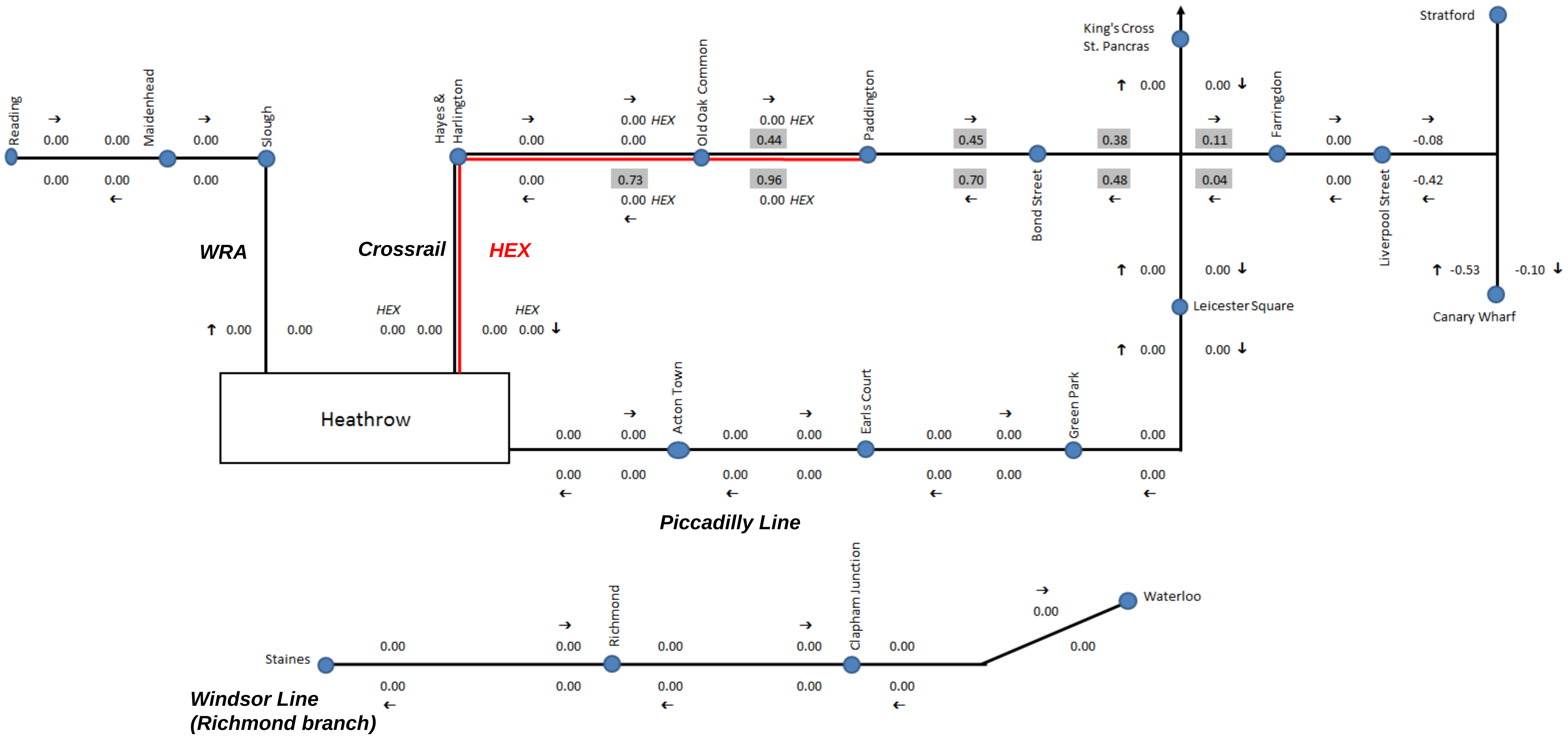
Figure 4-33: Change in IP volumes (HWNR excluding SRA v EB no expansion)



4.7.10 The impact on crowding on rail links providing direct connections to Heathrow is illustrated in Figure 4-34, with the difference from the 'no expansion' scenario summarised in Figure 4-35. As you would expect given the difference plots above, the additional passengers on the network as a result of the North West Runway increase crowding on Crossrail although the change does not result in significant levels of crowding, with the worst case link between Old Oak Common and Paddington still under 1 person standing per m^2 in the IP period. On other services such as the Piccadilly Line, forecast flows with the North West Runway in place are still within seated capacity and so the standing passenger forecast remains at 0.

4.7.11 Figure 4-36 provides crowding forecasts for London Underground services in the North West Runway excluding SRA scenario. When compared with the Extended Baseline 'no expansion' forecast, there is very little difference in forecast crowding with the North West Runway in place.

Figure 4-34: 2031 Extended Baseline (HNWR excluding SRA) – average passengers standing per m² on trains serving Heathrow (IP)[17]



[17] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting – in this scenario, SRA is excluded

Figure 4-35: HNWR excluding SRA – change in crowding compared with 'no expansion' scenario (IP)

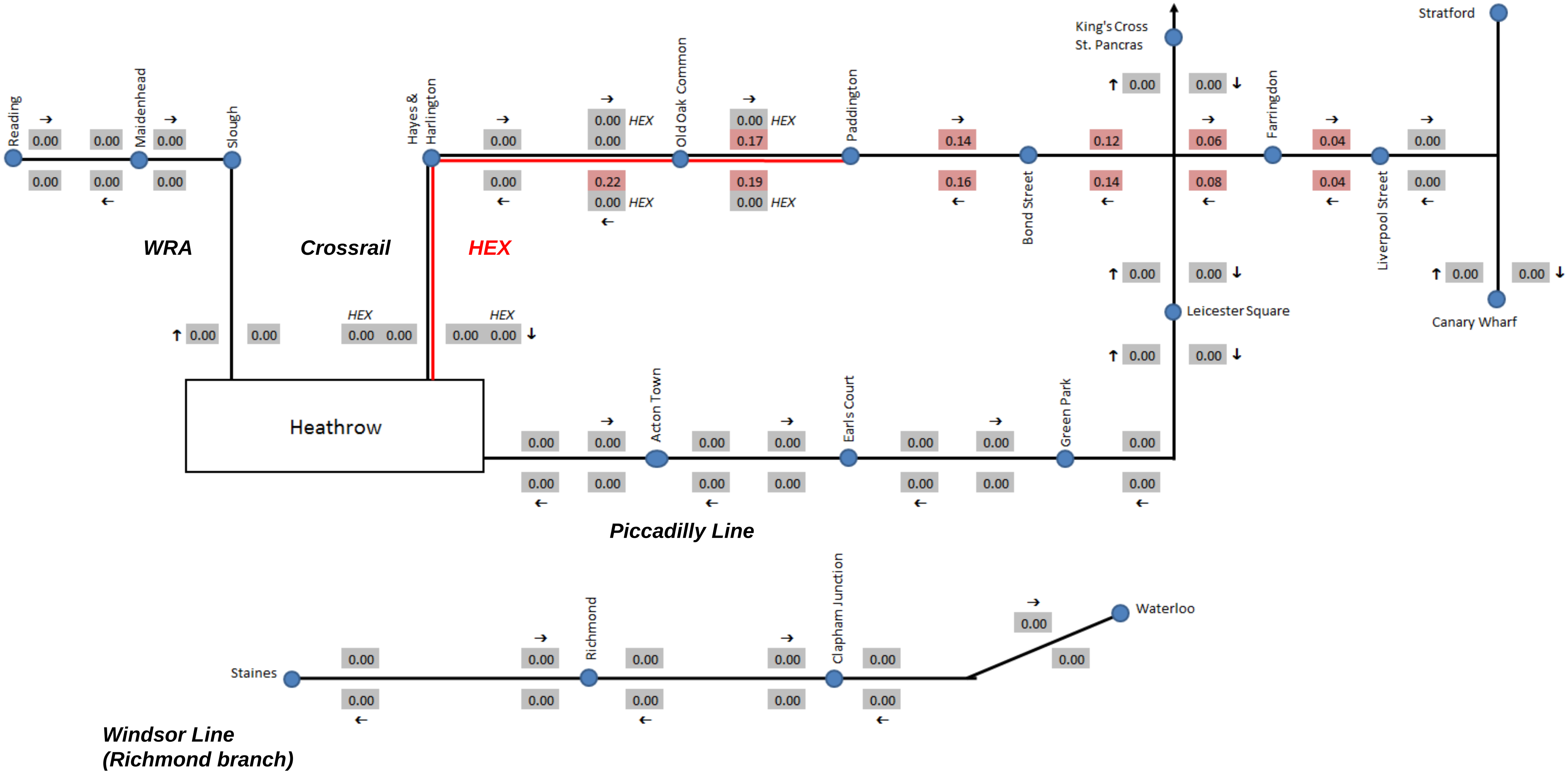
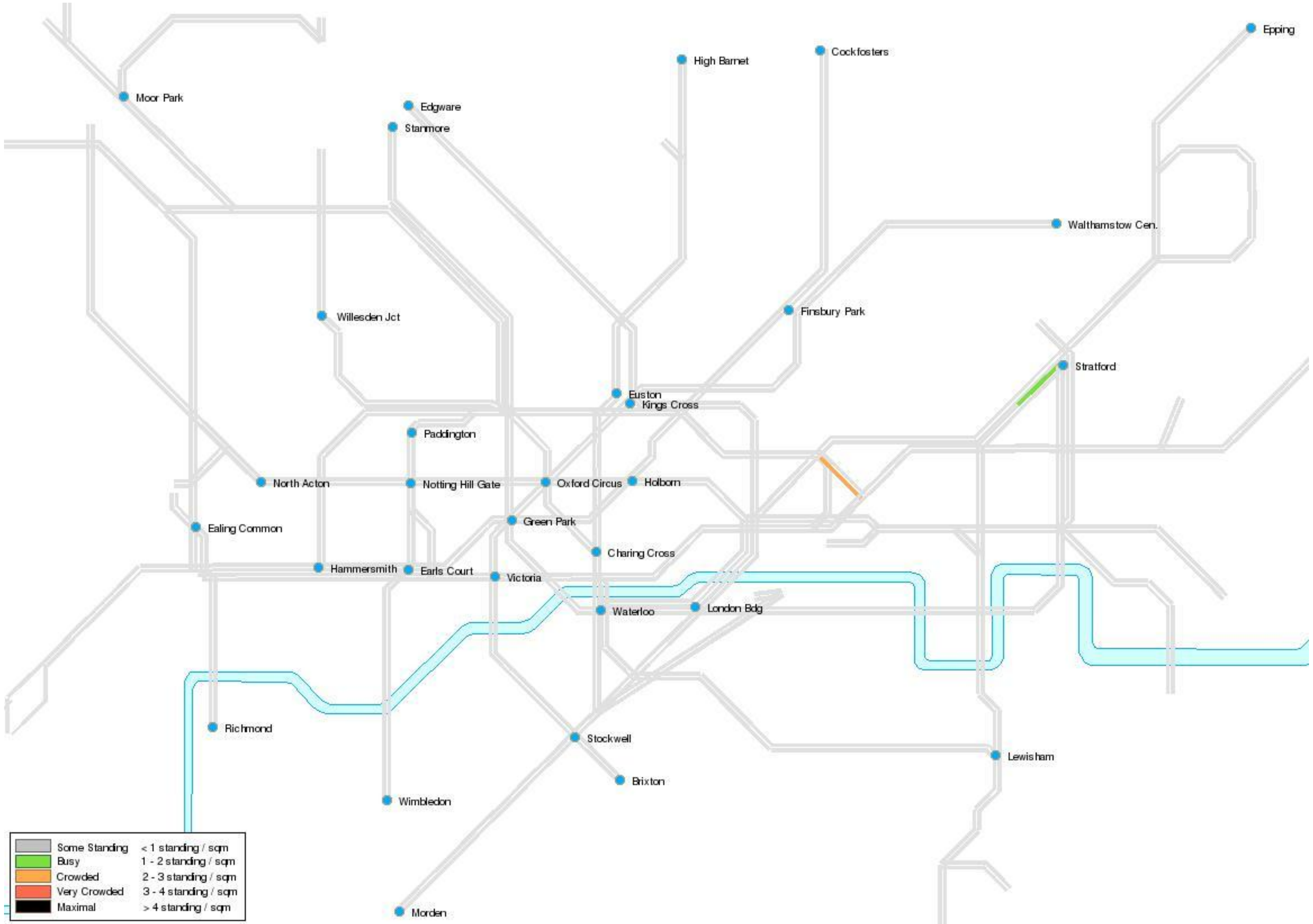


Figure 4-36: 2031 IP Extended Baseline LUL crowding (HNWR excluding SRA)[18]

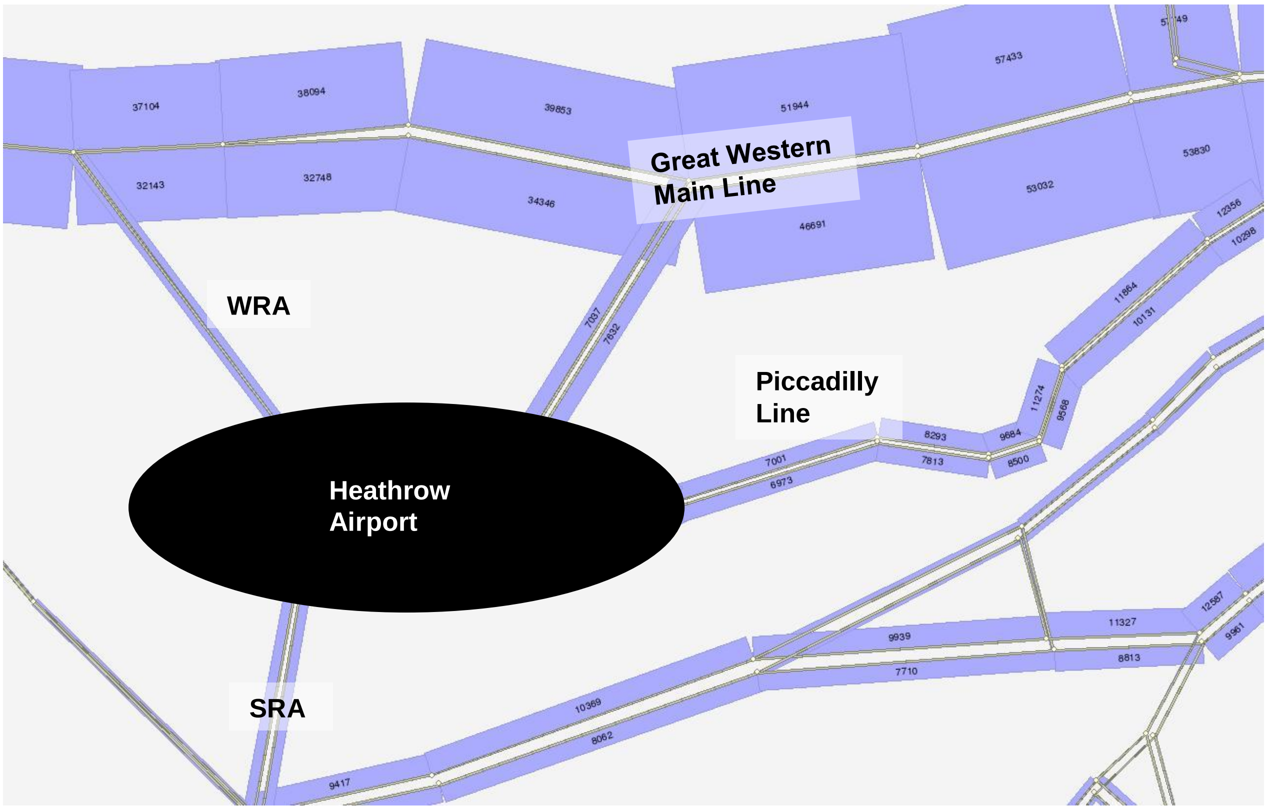


[18] Railplan output based on TfL macro

Runway expansion with SRA

4.7.12 The final inter-peak Railplan run undertaken was for the North West Runway airport demand including the impact of SRA serving the airport. Figure 4-37 illustrates the forecast flows on links in the vicinity of Heathrow in this scenario. Flows on the GWML reach 57,700 inbound to Central London between Hanwell and West Ealing, and around 11,800 between Osterley and Boston Manor on the Piccadilly Line. The introduction of SRA increases flows on the Windsor Line to over 12,000 west of St. Margaret's Station.

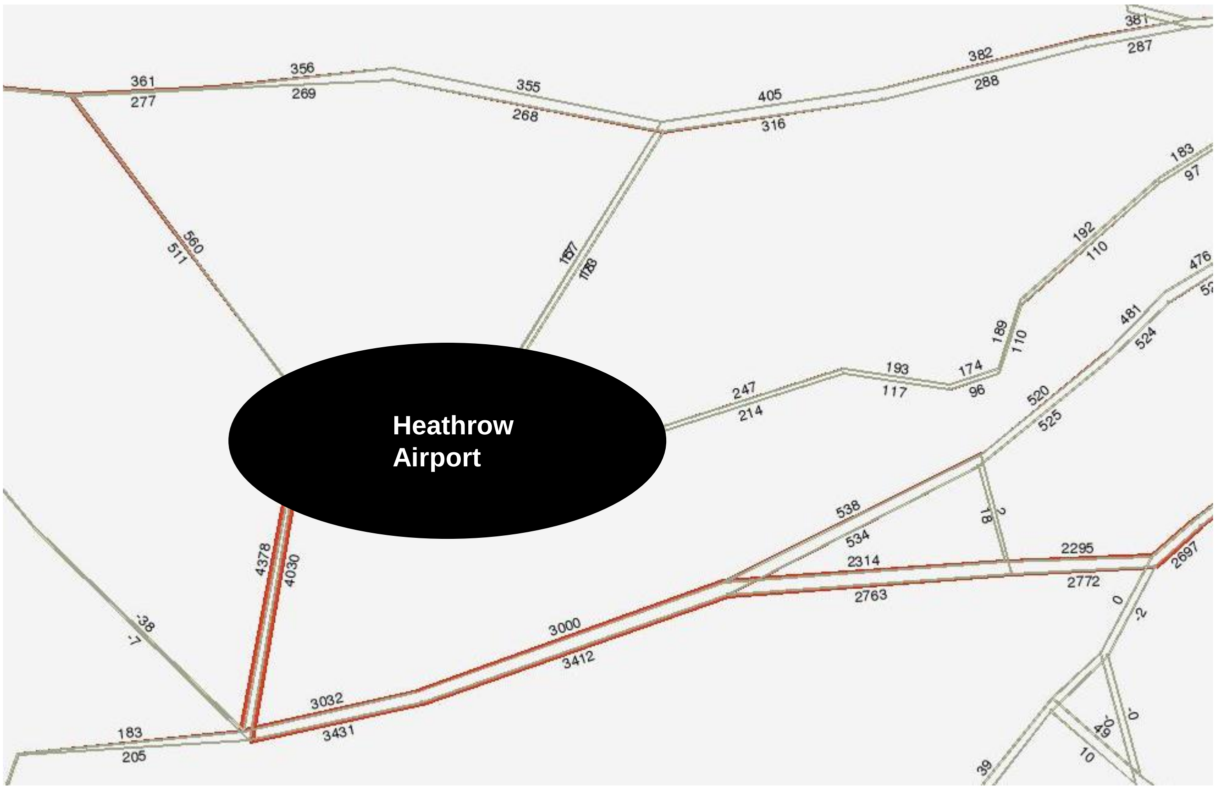
Figure 4-37: 2031 Extended Baseline IP forecast rail demand (HNWR with SRA)



4.7.13 Figure 4-38 summarises the change in demand on links in this scenario when compared with the Extended Baseline 'no expansion' scenario. The plan indicates that the impact of the overall increase in rail demand associated with the North West Runway on Crossrail and the Piccadilly Line is off-set by the transfer of some of that demand to SRA.

4.7.14 SRA in this scenario increases flows on the Windsor Lines by around 3,000 trips towards London east of Staines and 3,500 on the same link towards the airport.

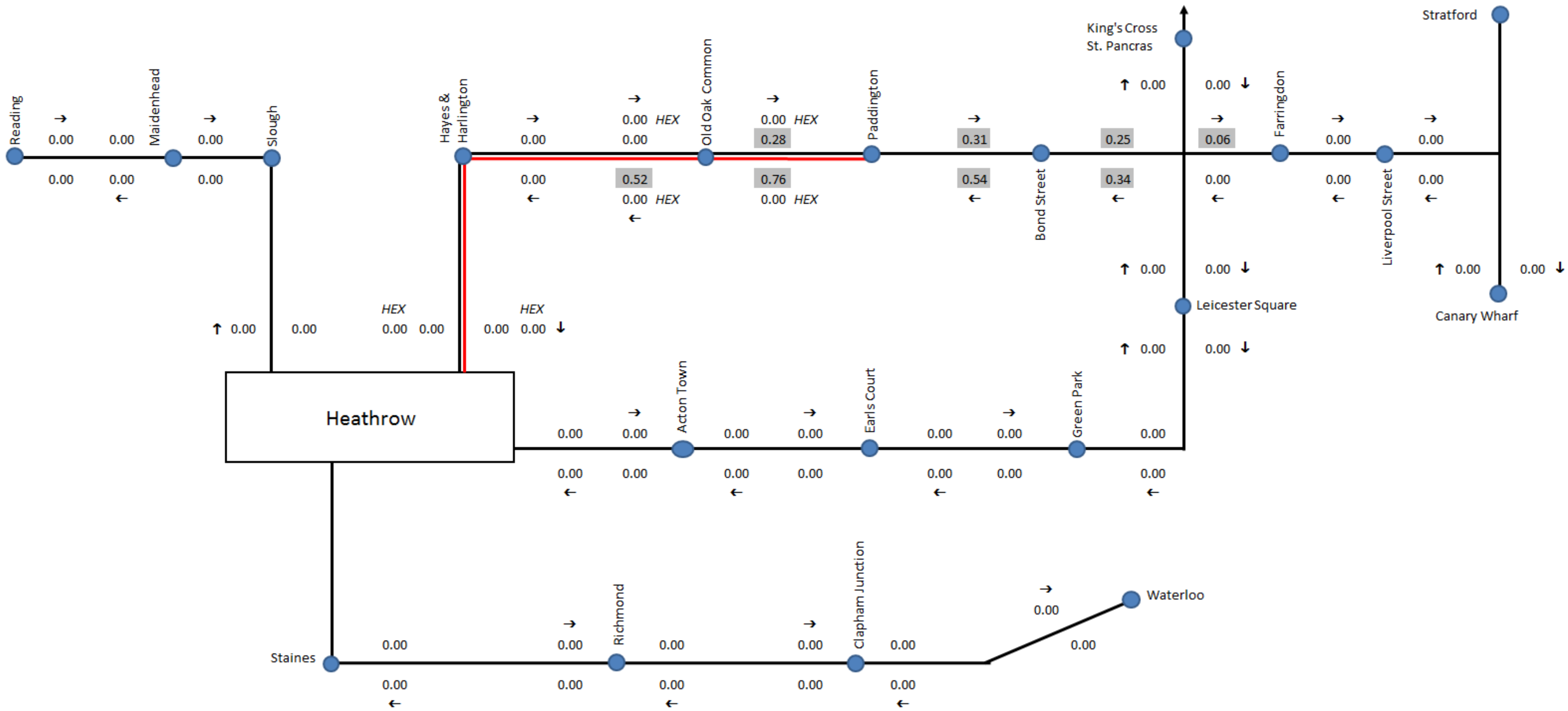
Figure 4-38: Change in IP volumes (HWNR with SRA v EB no expansion)



4.7.15 The crowding impacts on rail services to and from the airport in this scenario are summarised in Figure 4-39, with the difference from the ‘no expansion’ scenario illustrated in Figure 4-40. The impact on SRA in transferring demand from Crossrail is evident, with no change in forecast Crossrail crowding levels when compared with the ‘no expansion’ scenario. As indicated above, demand on the Windsor Lines increases with SRA in place but does not exceed seated capacity.

4.7.16 London Underground crowding is summarised on the plot in Figure 4-41. As indicated in previous scenarios, there is no significant crowding seen in the IP time period.

Figure 4-39: 2031 Extended Baseline (HNWR including SRA) – average passengers standing per m² on trains serving Heathrow (IP)[19]



[19] On the Windsor Line (Richmond branch), crowding forecasts refer to all trains serving Staines, as paths for SRA have not been defined at the time of reporting

Figure 4-40: HNWR including SRA – change in crowding compared with ‘no expansion’ scenario

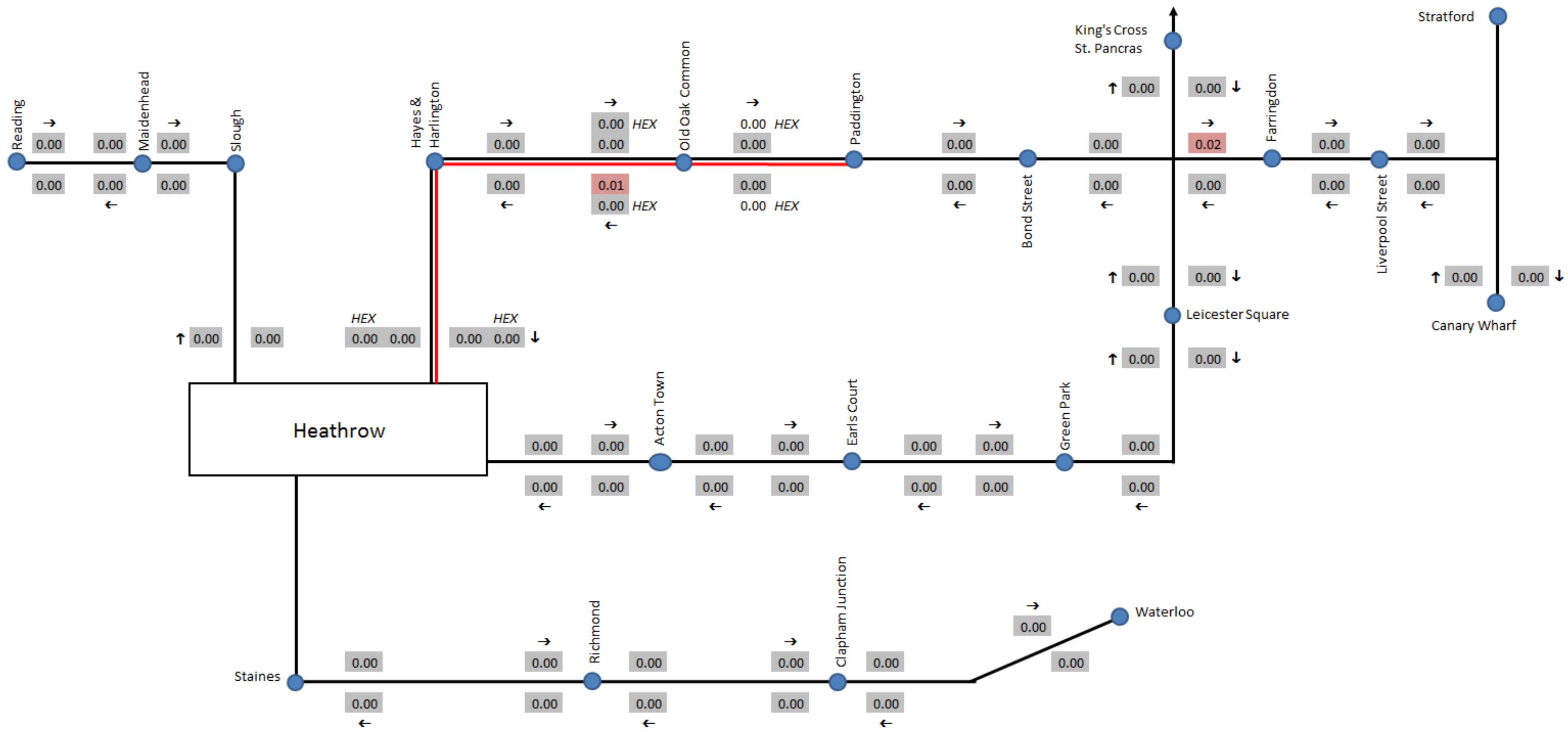
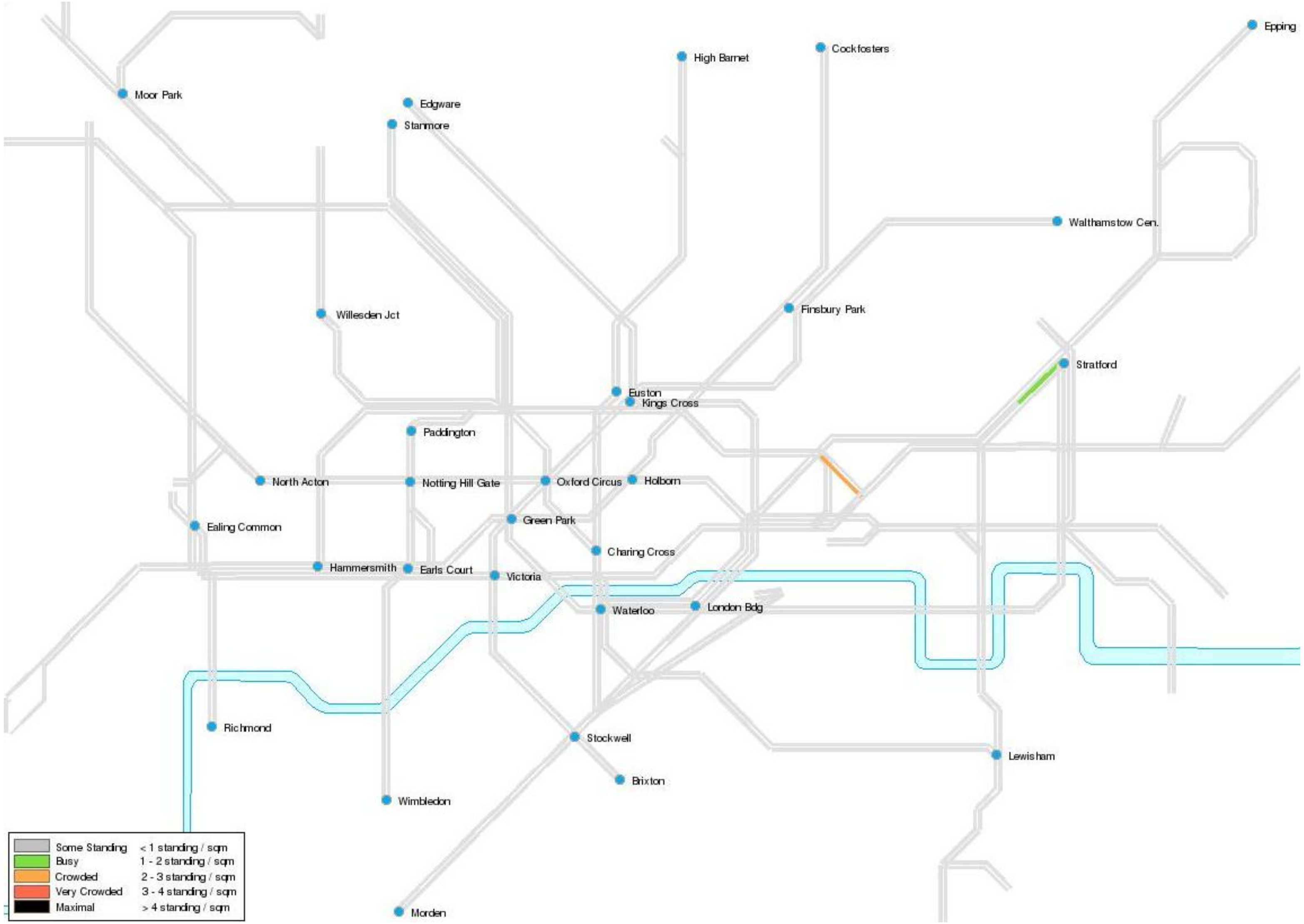


Figure 4-41: 2031 Inter peak Extended Baseline LUL crowding (HNWR with SRA)



4.8 Summary of rail modelling conclusions

4.8.1 In terms of the AM peak period (0700-1000), the following key conclusions can be drawn from the analysis summarised in this chapter in terms of the impacts of the North West Runway on the rail network:

- In the 'no expansion' 2031 scenario, Crossrail is forecast to reach crowding levels of just under 4 people standing per m^2 in central London, meaning that airport passengers using the service to travel into London in the AM peak will experience heavily crowded conditions on trains, although they will not have any issues boarding trains at the airport – there are no forecast crowding issues on services in the counter-peak direction from central London to the airport during this time period;
- There are no other significant crowding issues forecast on any other lines serving the airport in the 'no expansion' scenario – flows on the Piccadilly Line in the vicinity of Heathrow are expected to increase by around 40-50% from 2011 but planned improvements to Piccadilly Line capacity and other new services included in the AC's baselines mean that crowding levels on the line are actually forecast to improve when compared with 2011;
- The addition of the North West Runway (without SRA and Crossrail 6tph) increases crowding marginally on the Piccadilly Line although conditions are still forecast to be an improvement on 2011;
- The North West Runway (without SRA and Crossrail 6tph) also increases crowding marginally on Crossrail, for example from 3.99 people standing per m^2 on Heathrow trains on the section of the line west of Bond Street to 4.03, an increase of 0.04 people per m^2;
- The introduction of a 6tph Heathrow Crossrail service has the potential to relieve this marginal increase in crowding, although further investigation is required to determine whether this increase is feasible given the other demand on train paths on the GWML;
- The introduction of SRA has further benefits in terms of reducing demand on Crossrail and the Piccadilly Line when compared with the expansion scenario where it is excluded;
- However, the SRA attachment-detachment option, which was modelled to avoid increasing overall train frequency through level-crossings in the Richmond area on the Windsor Line, adds airport demand to a service that is forecast to be severely over-crowded in the 'no expansion' scenario – while further assessment will be undertaken by NR on SRA options, this analysis appears to suggest that a service is not viable unless additional capacity can be provided on the Windsor Line through Richmond;
- Rail journey times to Heathrow are similar in all three scenarios tested, although model metrics indicate that SRA increases the rail catchment of the airport, meaning that rail passengers on average travel from further afield to reach Heathrow than they do in the scenarios where SRA is excluded – overall rail journey times in the 2031 Extended Baseline model runs are broadly comparable with those in the 2011 model, where the airport has a significantly smaller airport catchment.

4.8.2 In terms of the IP period (1000-1600), there is little crowding in evidence across the rail network in general. Among services providing direct connections to Heathrow, passengers only appear to be standing on Crossrail and the forecast never exceeds 1 person per m^2 in any of the scenarios tested.

5. Dynamic highway assessment

5.1 Overview

5.1.1 Dynamic highway modelling of road surface access to Heathrow Airport has been undertaken to assess the impact of increased airport related traffic on the strategic and local road network surrounding Heathrow Airport. A network-based dynamic modelling approach has been adopted in order to capture the effect of capacity constraints on vehicle route choice, allowing for assessment of impacts due to vehicle re-routing.

5.1.2 All highway modelling has been completed using the SATURN software package. SATURN is an industry standard modelling package, widely used to inform the design and appraisal of highway projects both within the United Kingdom and internationally. The existing TfL WeLHAM SATURN model was provided to Jacobs by TfL for use on this project, forming the base for highway modelling of Heathrow Airport.

5.1.3 WeLHAM is one of five SATURN models developed by TfL which together cover the whole of greater London. Each model covers the whole of London, but differ in the area coded as “simulation”, defined as detailed junction coding of traffic signals, roundabouts and priority junction. The highway network detail within the WeLHAM model is illustrated in **Figure 5-1**. Whilst the whole of London is coded, the simulation area is defined as the West London sector, and includes the boroughs of: Brent; Ealing; Harrow; Hillingdon and Hounslow. The area of interest for this study, **Figure 5-3**, is entirely contained within the WeLHAM detailed modelled area.

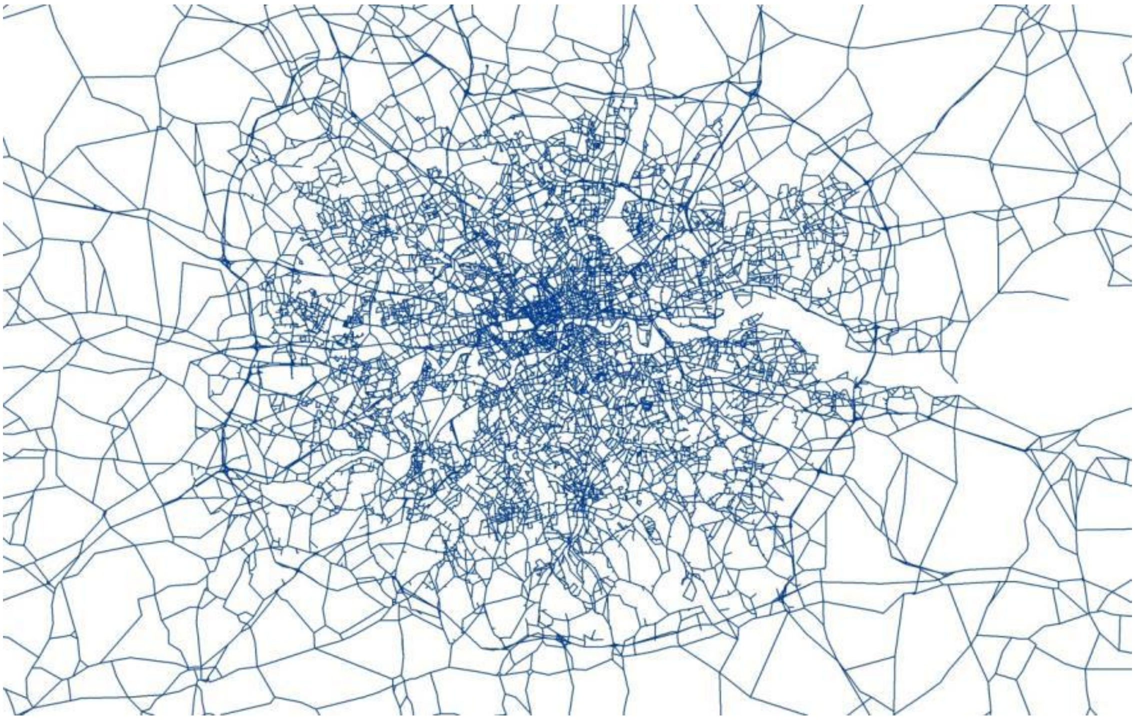
5.1.4 The model has been calibrated to a base year of November 2009 and covers three time periods (AM 08:00 – 09:00, inter peak average hour 10:00 – 16:00 and PM 17:00-18:00). Traffic demand is segmented into 5 user classes, each with a distinct demand matrix:

1. Car (London Based)
2. Car (External to London)
3. Taxi
4. Light Good Vehicles (LGV)
5. Other Good Vehicles (OGV)

5.1.5 For further details regarding the WeLHAM model, please contact TfL[20].

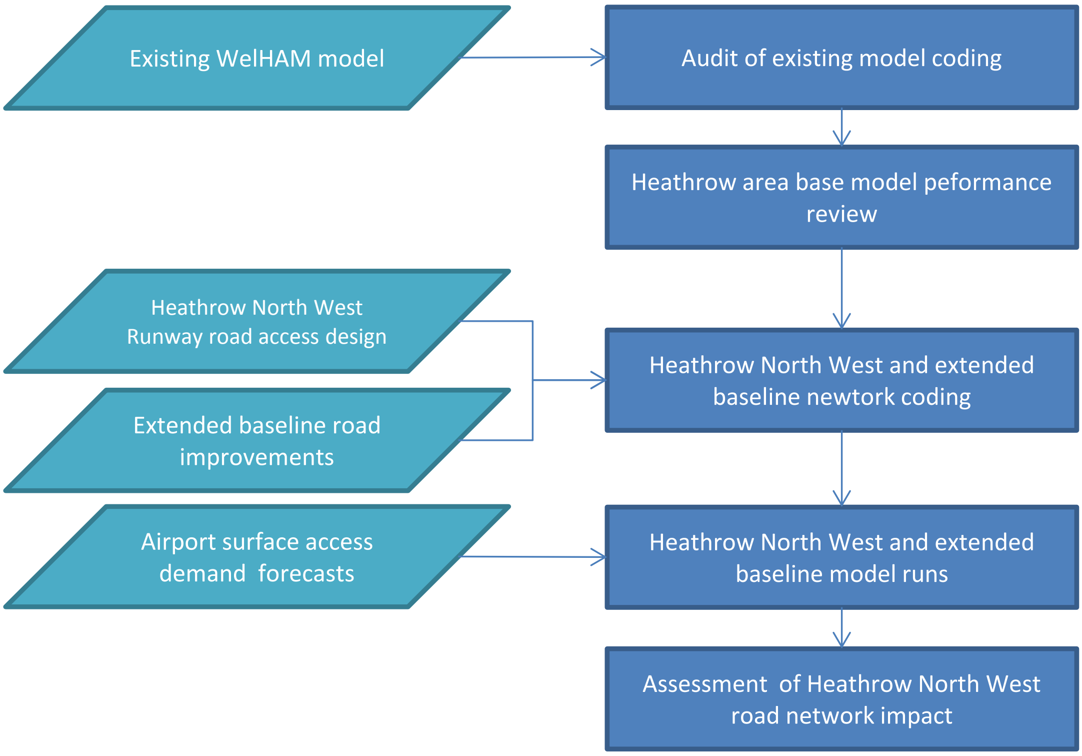
[20] https://www.tfl.gov.uk/

Figure 5-1: WeLHAM London road network



5.1.6 Broadly, the dynamic highway modelling component of the Heathrow North West runway appraisal followed the process illustrated in **Figure 5-2**.

Figure 5-2: Dynamic highway model development process



5.2 Base model development

Model scope

5.2.1 A two-level study area has been adopted for the dynamic highway assessment of Heathrow airport. The outer area incorporating all major strategic routes to Heathrow, bounded by the following key roads, as illustrated in **Figure 5-3**:

- The A40 to the north;
- The A316/M3 to the south;
- The North/South Circular (A406/A205) to the east - this incorporates the Chiswick Roundabout junction with the M4, the eastern-most extent of the motorway; and
- The A335/A332 to the west

5.2.2 The inner area covers a smaller area centred on Heathrow and focussing on access to and from the Airport. This area incorporates the following key roads, as illustrated in **Figure 5-4**:

- The M25 from junction 13 and 15; and
- The M4 from junction 3 to 5;

Figure 5-3: Study area – Outer area

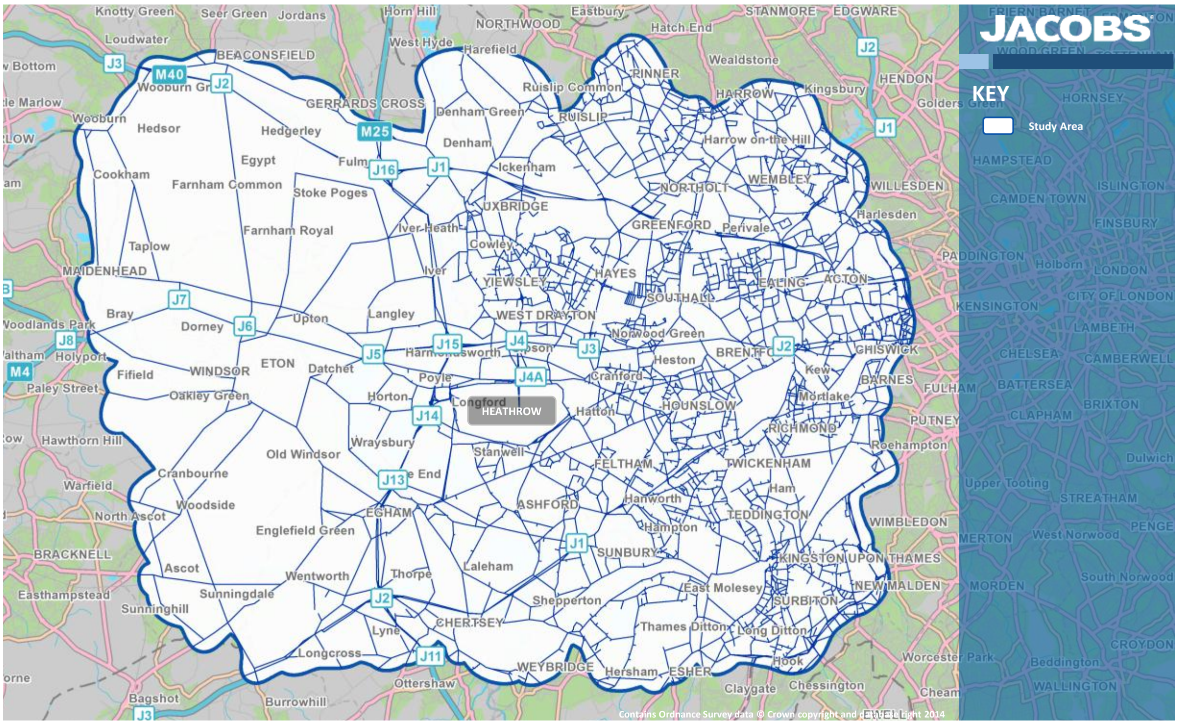
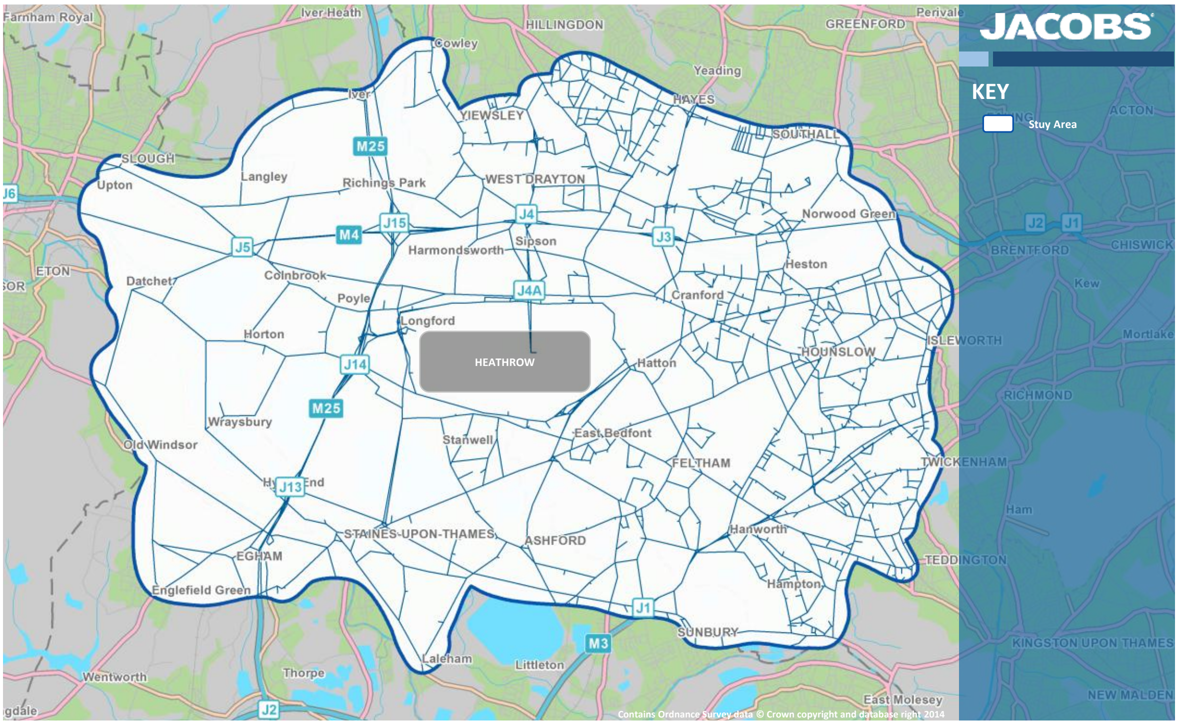


Figure 5-4: Study area – Inner area



Existing model audit

5.2.3 To ensure the WeLHAM model produces logical results around Heathrow, a comprehensive audit of base network coding and outputs within the study area was completed by Jacobs. As part of this the following network checks were undertaken:

- Roads: directionality, user class bans, free flow speed, delay, length, capacity; and
- Junctions: Numbers of entry lanes, junction type, turn allocations and saturation flows.

5.2.4 Additionally, select link analysis of all Heathrow zone loading points was run to check that traffic to and from the airport would generally take the expected route for all directions of travel.

5.2.5 The model base audit revealed no critical issues in regards to route choice and model output, however, a number of network coding issues were identified. The majority of these were deemed to be minor and unlikely to substantially alter model results. **Table 5-1** highlights two changes made to address the major inconsistencies identified.

Table 5-1: Network coding changes

Location	Change made to network	Justification
Signalised roundabout between A408 and Stockley Road	Removal of east west direct through movement (forecast models only)	East west direct connection recently removed
Heathrow east boundary	Removal of link between Northern Perimeter Road and Eastchurch Road	No publicly accessible connection exists between the roads

Heathrow area model performance review

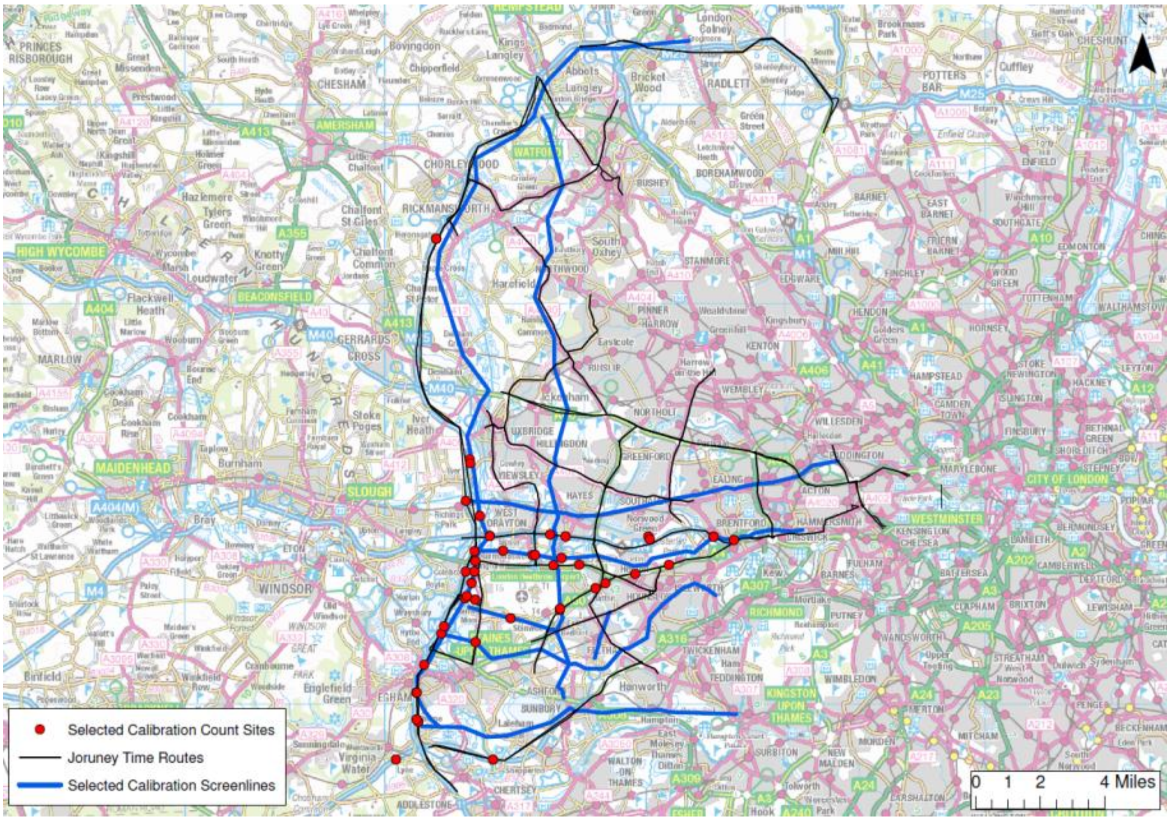
5.2.6 Although the overall WeLHAM model is well validated, with key calibration statistics (journey time, link flow, screenline flow) within WebTAG guideline criteria, to ensure the model is fit for purpose to assess traffic conditions surrounding Heathrow, an additional localised review of summary statistics was undertaken.

5.2.7 The localised Heathrow area summary statistics review was completed using a subset of the 2009 WeLHAM observed data, comprising of the following:

- All count sites and screenlines within the area of interest; and
- All journey time routes passing through key links within the area of interest, selected by visual assessment.

5.2.8 All count sites and journey time routes used are shown in **Figure 5-5** and form a watertight coverage of trips to/from the airport from all directions.

Figure 5-5: Calibration and validation data



5.2.9 Heathrow area WeLHAM model performance statistics were compared with validation criteria outlined in WebTAG unit M3.1, Highway Assignment Modelling (DfT, 2014). Key statistics for each model time period are presented in **Tables 5-2** to **5-4**. Observed vs modelled link flow plots for each time period are presented in **Figure 5-6** to **Figure 5-8**, and a relative error frequency plot covering all time periods is shown in **Figure 5-9**.

Table 5-2: AM peak statistics

Criteria	Achieved	Guideline aspiration
Link flow GEH < 5[21]	73%	85%
Link flow within WebTAG criteria[22]	83%	85%
Screenline[23] flow difference < 5%	94%	85%
Journey time routes – time difference < 15 %	73%	85%

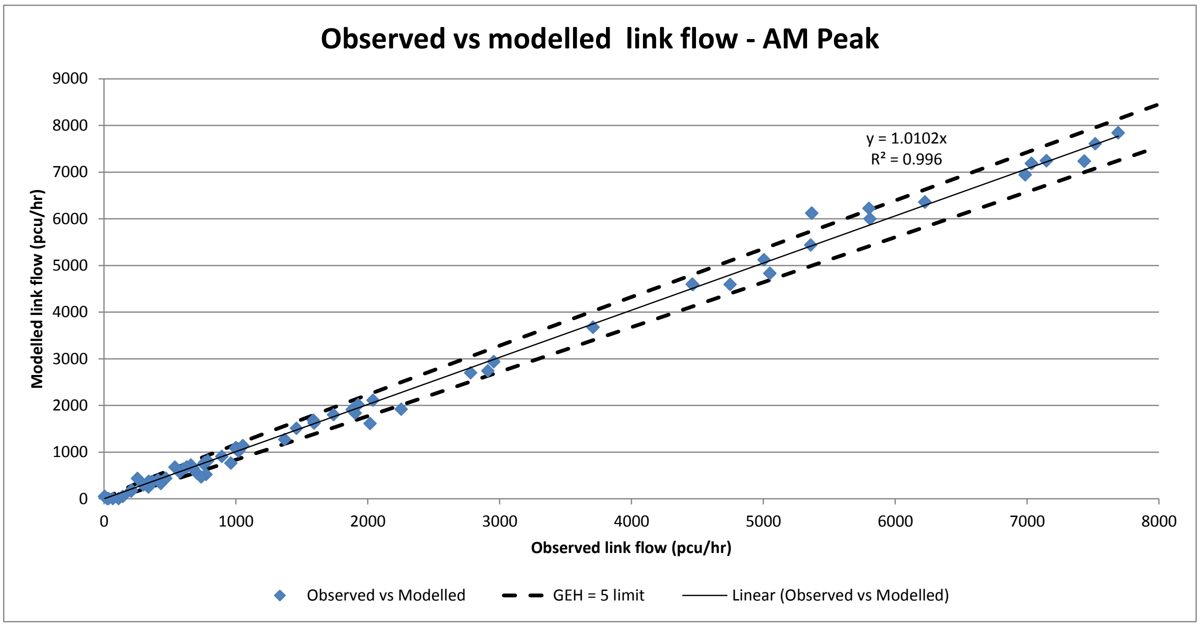
Table 5-3: Inter peak statistics

Criteria	Achieved	Guideline aspiration
Link flow GEH < 5	74%	85%
Link flow within WebTAG criteria	82%	85%
Screenline flow difference < 5%	100%	85%
Journey time routes – time difference < 15 %	85%	85%

Table 5-4: PM peak statistics

Criteria	Achieved	Guideline aspiration
Link flow GEH < 5	73%	85%
Link flow within WebTAG criteria	77%	85%
Screenline flow difference < 5%	94%	85%
Journey time routes – time difference < 15 %	78%	85%

Figure 5-6:AM peak link flow regression plot



[21] The GEH statistic is a measure of fit incorporating both relative and absolute errors. Refer TAG Unit M3.1 section 3.2.7
[22] Refer TAG Unit M3.1 Table 2
[23] A screenline is a collection of traffic counts which together provide a measure of total traffic flow across a defined boundary

Figure 5-7: Inter peak link flow regression plot

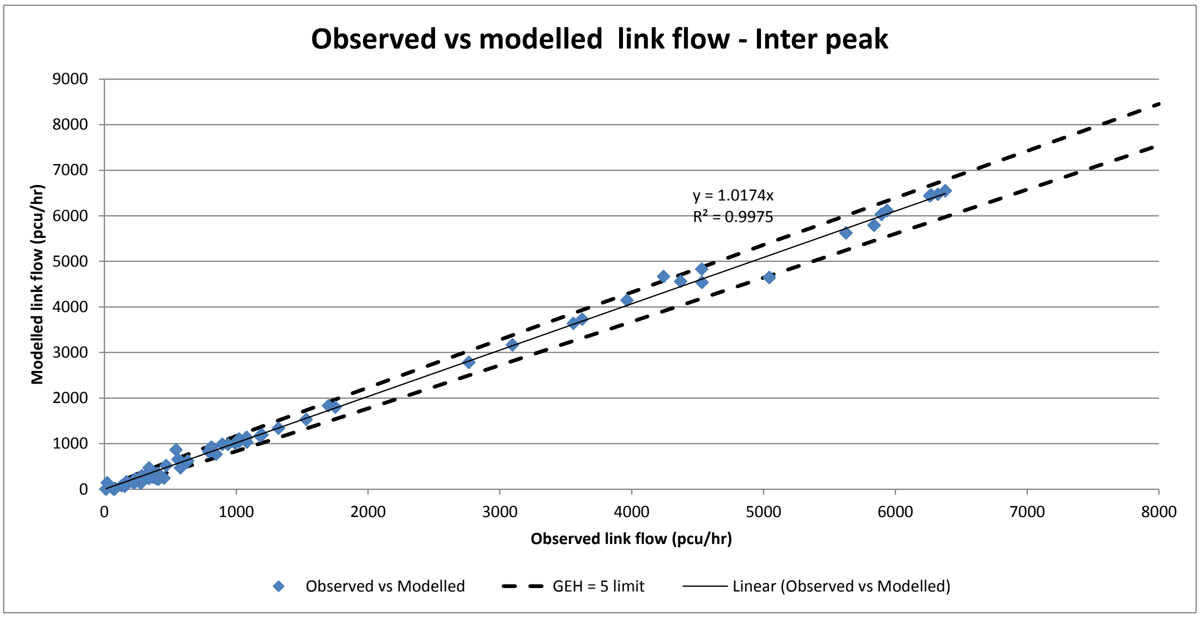


Figure 5-8: PM peak link flow regression plot

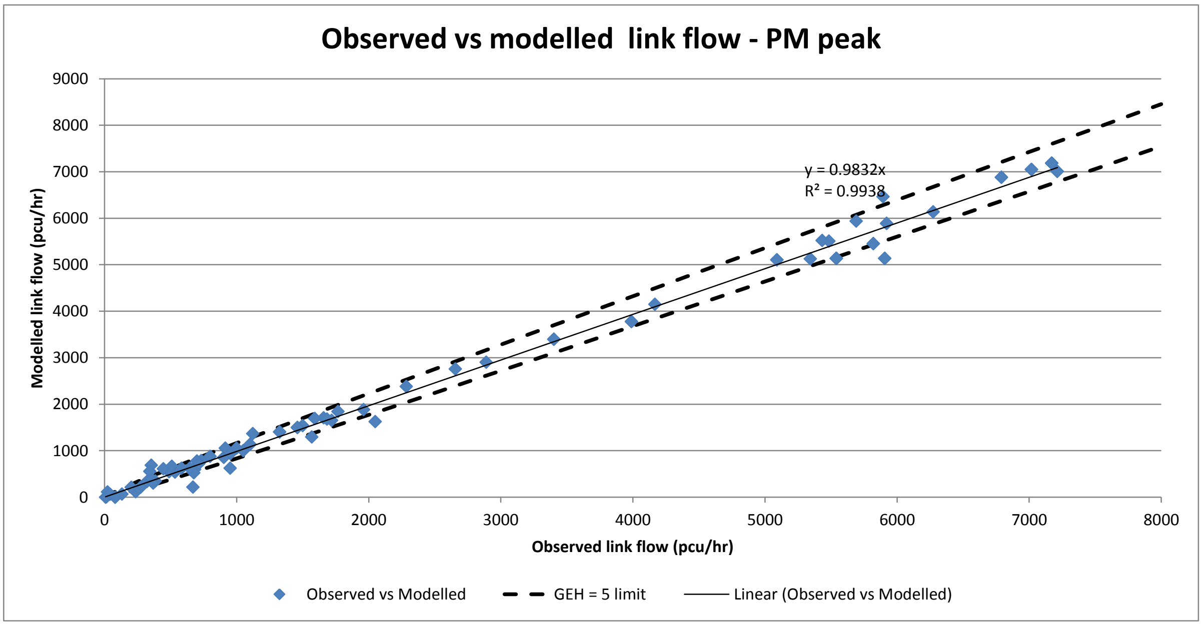
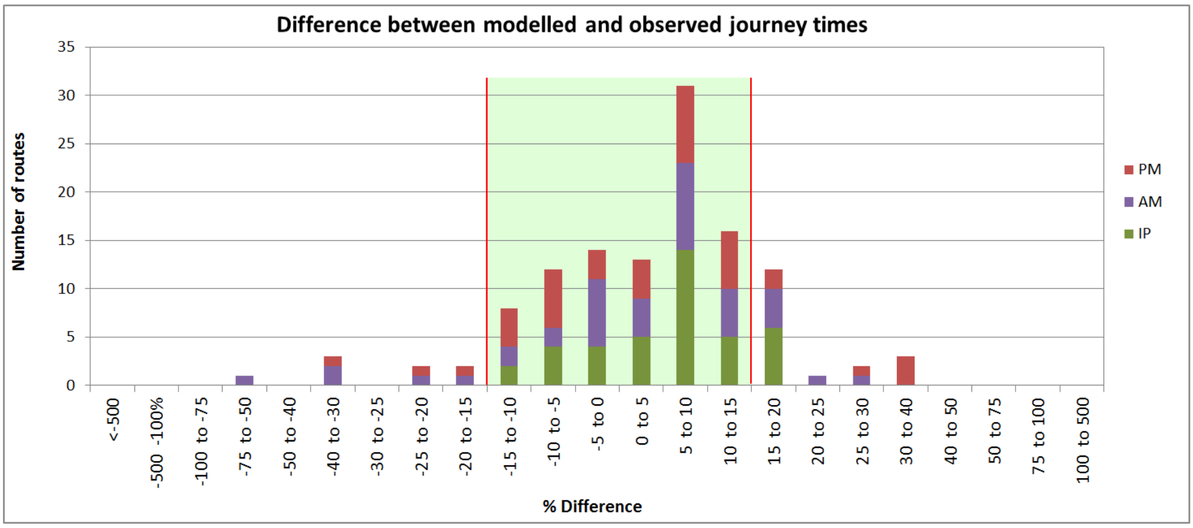


Figure 5-9: Travel time difference



5.2.10 The validation summary statistics show that across all time periods, model performance exceeds screenline requirements with all screenlines within WebTAG guidelines. A high level of screenline validation provides confidence in the models' ability to replicate broad travel movements through the Heathrow area. However, when comparing observed and modelled traffic volumes, the proportion of individual roads meeting WebTAG guidelines were marginally below the required levels.

5.2.11 Reviewing the link flow regression plots provided additional insight into the fit between observed and modelled link flow counts. Across all time periods, the majority of count sites with a GEH of greater than 5 were within the flow range of 0 to 1000 PCUs and there were no systematic outliers across the entire flow range. This, combined with the very good screenline fit, indicated that at the strategic road network level, the model was accurately replicating observed travel patterns.

5.2.12 Route journey time replication marginally failed to meet WebTAG guidelines for the AM and PM peak periods. However, **Figure 5-9** indicates that among the routes for which the relative error was outside the guideline range (±15%), there was no substantial bias towards either high or low journey times, indicating there was no systematic issue with journey time replication within the model.

5.2.13 Overall, the performance summary statistics showed that the model replicated observed screenline flows and strategic road link flows (flow greater than 1000 pcu/hr) within acceptable limits. Replication of journey time and link flows for minor roads was less accurate. However, journey time replication only marginally failed to meet WebTAG criteria and the results showed no systematic issues. Given the objectives of this study were primarily concerned with activities that impact on the strategic road network, local road link flows that did not meet guideline calibration criteria were not considered critical issues. On this basis, it was considered that the WeLHAM within the Heathrow area of interest was fit for purpose and no further updates to the model within the Heathrow area were required.

5.3 Forecast Year Demand

5.3.1 WeLHAM traffic forecasts were provided to Jacobs by TfL for both 2021 and 2031. Given the uncertainty surrounding growth to 2031, no further adjustments were made to non-airport traffic to match the airport demand forecast year of 2030, and as such all further references to traffic forecasts in this report refer to a forecast year of 2030. Thus, with the exception of trips to/from Heathrow Airport, the future year trips for all zones in the WeLHAM model were adopted.

5.3.2 Two separate processes were used to forecast demand to/from Heathrow Airport: one covering cars and taxis and another covering LGVs and HGVs.

5.3.3 Calculation of car and taxi demand to Heathrow airport was based on the headline assumptions for Heathrow annual passenger volume and number of employees. For the Extended Baseline with existing runway capacity and Heathrow North West Runway, the adopted 2030 passenger volumes are 87 MPPA and 125 MPPA respectively; and the numbers of employees are 80,000 and 115,000 respectively, as detailed within **Chapter 2**.

5.3.4 From the passenger and employee headline assumptions, final hourly demand was calculated though a series of steps taking into account a range of factors including annual and daily arrival and departure profiles, employee shift times, and the proportion of vehicles making empty trips to/from the airport. Airport passenger and employee demand was calculated for 3 different time periods based on observed daily profiles of arrivals and departures at the airport in accordance with the requirements of the WeLHAM model. The following time periods were assessed:

- AM peak-hour: 0800 to 0900;
- Inter peak average hour between 1000 and 1600 (one hour average of the six hour period);
- PM peak-hour: 1700 to 1800.

5.3.5 Total hourly demand then feeds into the distribution and mode share models (as described in **Chapter 3**), producing the final car and taxi demand for each model period, as shown in **Table 5-5**. A summary of the steps to derive hourly vehicular trips is listed below:

- Employees are assumed to generate no empty vehicle returns and are also assumed not to use taxis – therefore, to calculate employee car trips, total person trips were divided by the headline car occupancy rate;
- Passenger vehicle trips are split by sub-mode share (for private car and for taxi) using the observed sub-mode split by district from the 2012 CAA passenger survey – the resulting values for private car and taxi person trips are then divided by the respective vehicle occupancy values to calculate an initial vehicle trip demand estimate for private cars and taxis;
- Empty vehicle trips in each direction (i.e. the leg of a kiss-and-fly or taxi round trip to and from the airport where no airport passengers are carried) are then calculated – to calculate the empty trips, the total number of initial trips by type *in the opposite direction* were divided by the estimated empty return rate for each vehicle type by district – all kiss-and-fly trips were assumed to make one leg of the journey empty along with a proportion of taxis based on survey data;
- For each vehicle type, the empty return value was then added to the initial passenger/employee-related forecast to calculate a total number of car journeys by type – these were added together to calculate total car vehicle demand for each zone.

Table 5-5: 2030 Heathrow car and taxi travel demand by time period (veh/hr)

Region	To Airport			From Airport		
	AM	IP	PM	AM	IP	PM
Extended Baseline						
All areas	4,940	4,507	3,220	3,583	4,266	4,470
All London Boroughs	2,467	2,259	1,633	1,820	2,150	2,234
South east	334	298	199	221	277	303
Remaining UK	2,139	1,950	1,387	1,541	1,989	1,933
Heathrow North West Runway						
All areas	6,327	5,719	3,989	4,438	5,390	5,734
All London Boroughs	3,166	2,866	2,013	2,243	2,713	2,872
South east	443	391	254	281	362	402
Remaining UK	2,718	2,462	1,722	1,913	2,315	2,460

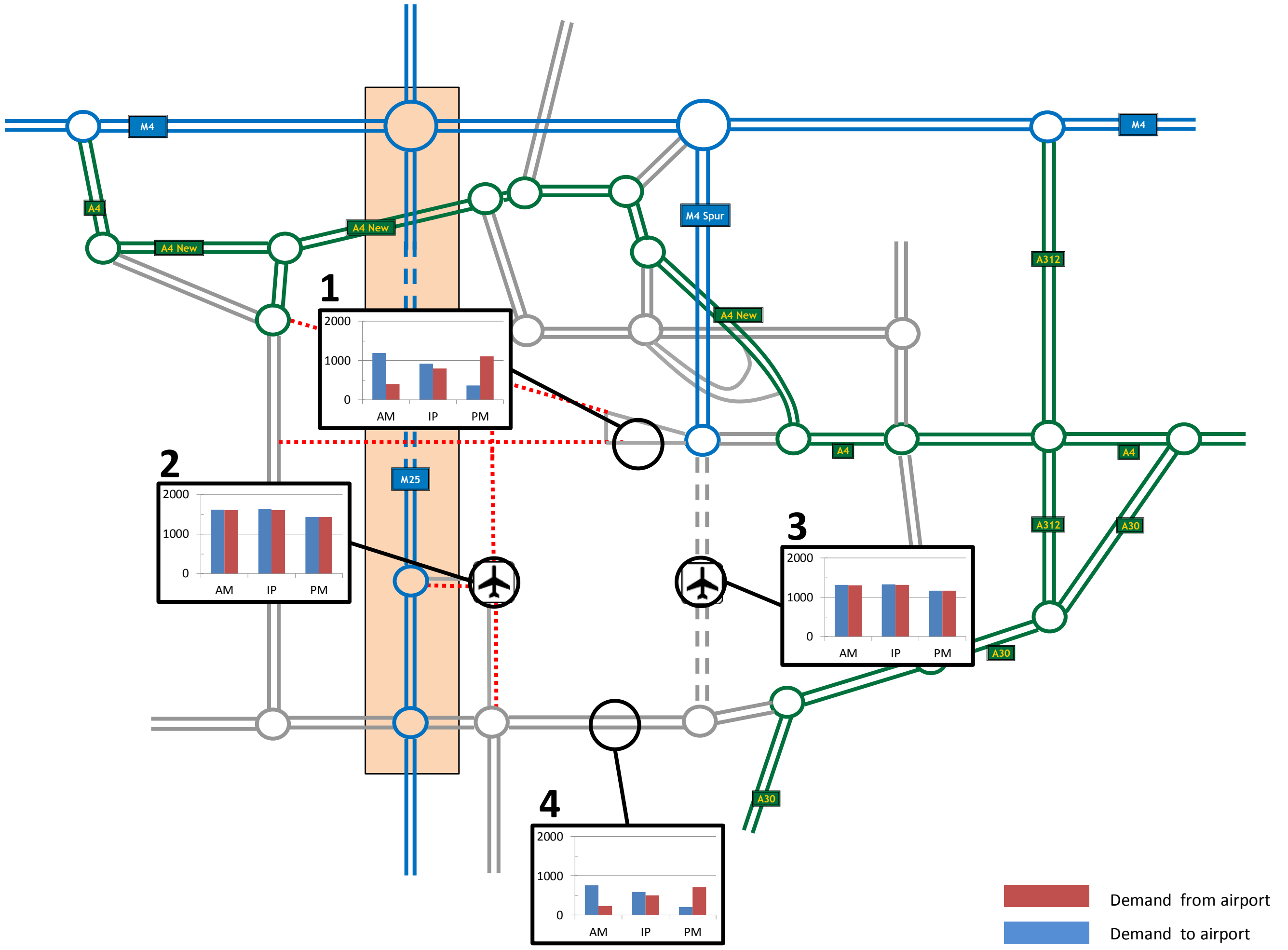
5.3.6 The growth in HGVs and LGVs at Heathrow Airport was calculated by using a linear growth factor of the passenger numbers (in mppa) between 2009 and 2030. No allowance has currently been made on changing patterns of goods vehicle delivery, as there is little published data on this. Total HGV and LGV demand for each model period is shown in **Table 5-6**.

Table 5-6: 2030 Heathrow HGV and LGV demand by time period (veh/hr).

User class	To Airport			From Airport		
	AM	IP	PM	AM	IP	PM
Extended Baseline						
HGV	387	224	127	269	297	162
LGV	755	598	599	551	544	751
Heathrow North West Runway						
HGV	554	321	182	385	425	232
LGV	1,080	855	858	789	779	1,075

5.3.7 A visualisation of travel demand to and from Heathrow across all time periods, at key locations within the Airport is shown in **Figure 5-10** and **Figure 5-11**.

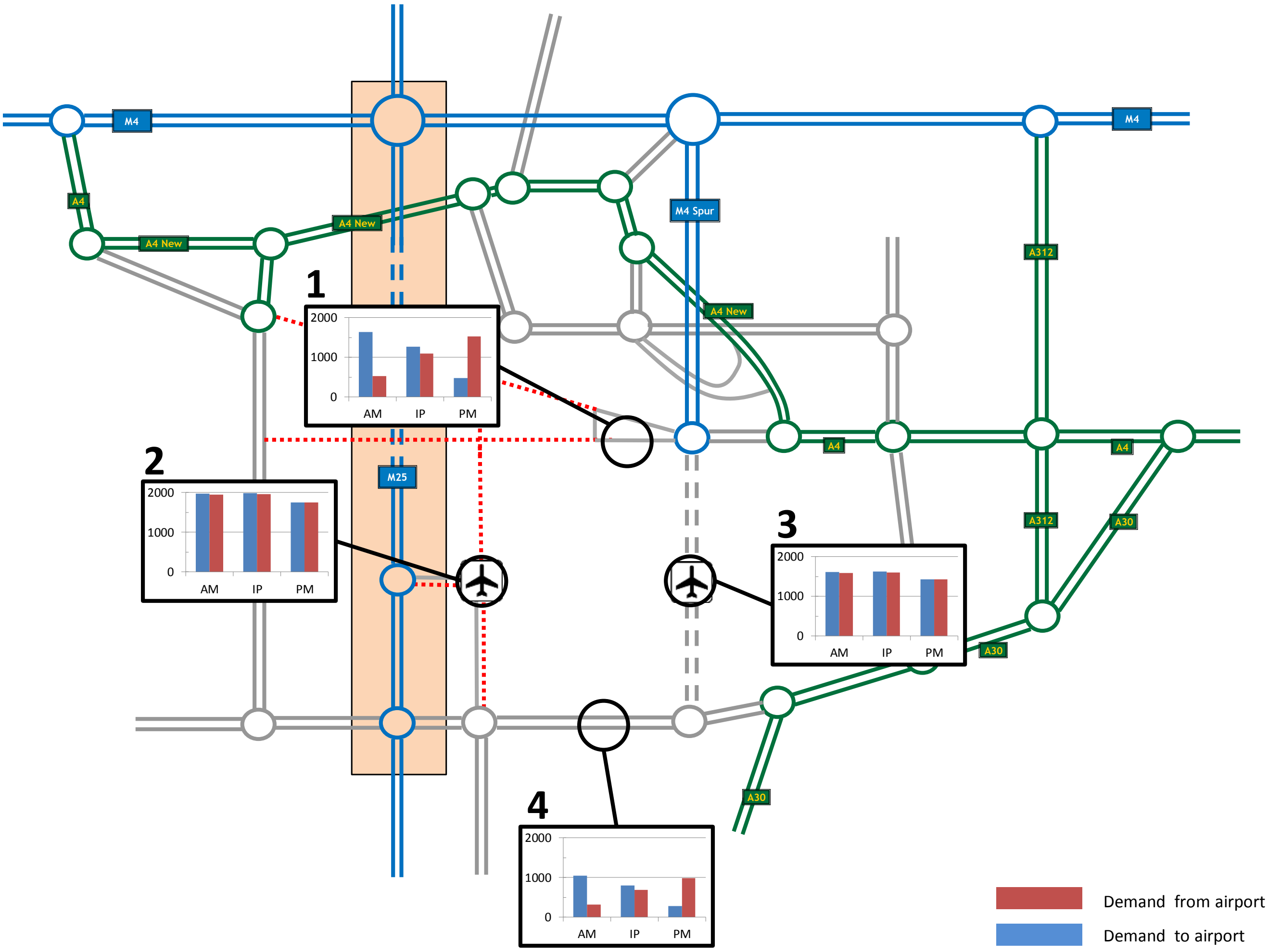
Figure 5-10: Extended Baseline car and taxi demand loading diagram (veh/hr)



5.3.8 Location reference:

1. Employee and long stay parking – north;
2. T5 short stay parking and drop off;
3. CTA short stay parking and drop off; and
4. Employee and long stay parking – south.

Figure 5-11: Heathrow North West Runway car and taxi demand loading diagram (veh/hr)



5.4 Definition of highway assignment model terms

5.4.1 Before we describe the WeLHAM model outputs in detail, it is useful to define a number of highway assignment model terms. These are as follows:

- *Demand flows*. Demand flow is the total unconstrained volume of traffic wanting to travel through a particular location; representing total desire for road travel at the location.
- *Actual flows*. Actual flow represents the volume of traffic determined by detailed simulation taking into account real world metering of traffic through intersection capacity constraints and subsequent bottlenecks and queueing of traffic. It represents the volume of traffic feasibly able to travel through a location. A large difference between demand and actual flow would indicate a large desire for travel unable to be met by the road network traffic capacity.
- *Queued flows*. Queued flow represents the amount of traffic demand unable to reach its intended destination at the end of the traffic assignment due to an upstream source of delay, such a traffic signals or a congested motorway ramp.
- *Volume over capacity (V/C) ratios.* Drawing from a large body of empirical research, the theoretical traffic capacity per lane for a particular stretch of road can be estimated based on the standard of design, speed limit and a number of additional environmental consideration. The capacities within the WeLHAM model are derived from TfL's coding manual, which take into account such criteria. Volume over Capacity (V/C) is a ratio representing the degree of saturation of a particular stretch of road, with values closer to 0 representing free flow conditions and values approaching or greater than 1 indicating high levels of congestion. Observations on many roads

has shown that delay rise steeply at v/c ratios of above 0.85, and that severe delays occurs at v/c ratios of above 1.00. Two v/c ratios can be output from the model: the *demand flow/capacity ratio*, which compares the unconstrained flow against the link capacity and the *actual flow/capacity ratio*, which compares the traffic flow feasibly able to get through the link against the link capacity

- *Select link analysis*[24] *(SLA)*. A select link analysis is a useful modelling tool, which identifies the "paths" of all trips using a particular link. Thus, for example, a SLA on the access roads to Heathrow Airport, will identify not only the origins and destinations of trips using that link, but the routing of those trips. Thus it is a powerful analysis tool.

5.5 Extended Baseline Assessment (2030)

Extended baseline network

5.5.1 The Extended Baseline highway network includes the existing road network; committed and funded improvement schemes included in the AC's Core Baseline; and a set of Extended Baseline schemes. At the time of writing, none of the Extended Baseline schemes are committed or funded, but are judged highly likely to be required and in place by 2030 to accommodate forecast demand on the UK highway network, regardless of any airport expansion. A full list of the schemes defined in the Extended Baseline is provided in **Appendix B**. The following highway schemes around Heathrow Airport were included in the Extended Baseline network:

- M23 junction 8 to 10 smart motorway (all lane running);
- M25 junction 23 to 27 smart motorway (all lane running);
- M25 junction 5 to 7 smart motorway (all lane running);
- M3 junction 2 to 4a smart motorway (all lane running); and
- M4 junction 3 to 12 smart motorway (all lane running).

5.5.2 Additionally, a review of the local road network serving Heathrow Airport was undertaken, with a number of minor improvements judged necessary to accommodate 2030 demand included in the Extended Baseline network.

Assignment and review of performance

5.5.3 Detailed review of the Extended Baseline model performance has been undertaken to ensure the forecast year traffic assignment produces reasonable results and is a suitable point of reference for assessment of impacts arising from the Heathrow North West Runway project. This review covered all the modelling aspects defined in S**ection 5.4.1** above.

5.5.4 The full set of Figures are contained in a separate document entitled 'Supplementary Figures Report'. In total there are around 150 figures., covering all six model outputs, by two model areas (local road network and full study area) and three time periods (AM peak, Inter-peak and PM peak).

5.5.5 The figures (contained in the Supplementary Figures Report) relating to the Extended Baseline assessment are defined below.

- Demand traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 1,4,7);
- Actual traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 10,13 16);
- Demand traffic flows ratios on the strategic road network surrounding Heathrow (Figs 19,22,25);
- Actual traffic flows on the strategic road network surrounding Heathrow (Figs 28,31,34);

[24] Select link analysis provides insight into vehicle routing to and from a particular location by summing volumes along the travel route for all trips passing through the location.

- Demand flow v/c ratios on the strategic road network surrounding Heathrow (Figs 37, 40, 43);
- Actual flow v/c ratios on the strategic road network surrounding Heathrow (Figs 46, 49 52);
- SLA routing of traffic traveling to/from Heathrow East Terminal (Figs 55, 58, 61, 64, 67, 70);
- SLA routing of traffic travelling to/from Heathrow West Terminal (Figs 73, 76, 79, 82, 85, 88);
- SLA queued flow of traffic traveling to/from Heathrow East Terminal (Figs 91, 94, 97, 100, 103, 106);
- SLA queued flow of traffic travelling to/from Heathrow West Terminal (Figs 109, 112, 115, 118, 121, 124);

5.5.6 **Figures 5-12** to **5-15** below present the peak hour actual traffic flows as well as select link analyses of traffic to the Heathrow central and western terminals in the AM peak hour.

Figure 5-12: AM Extended Baseline Flows

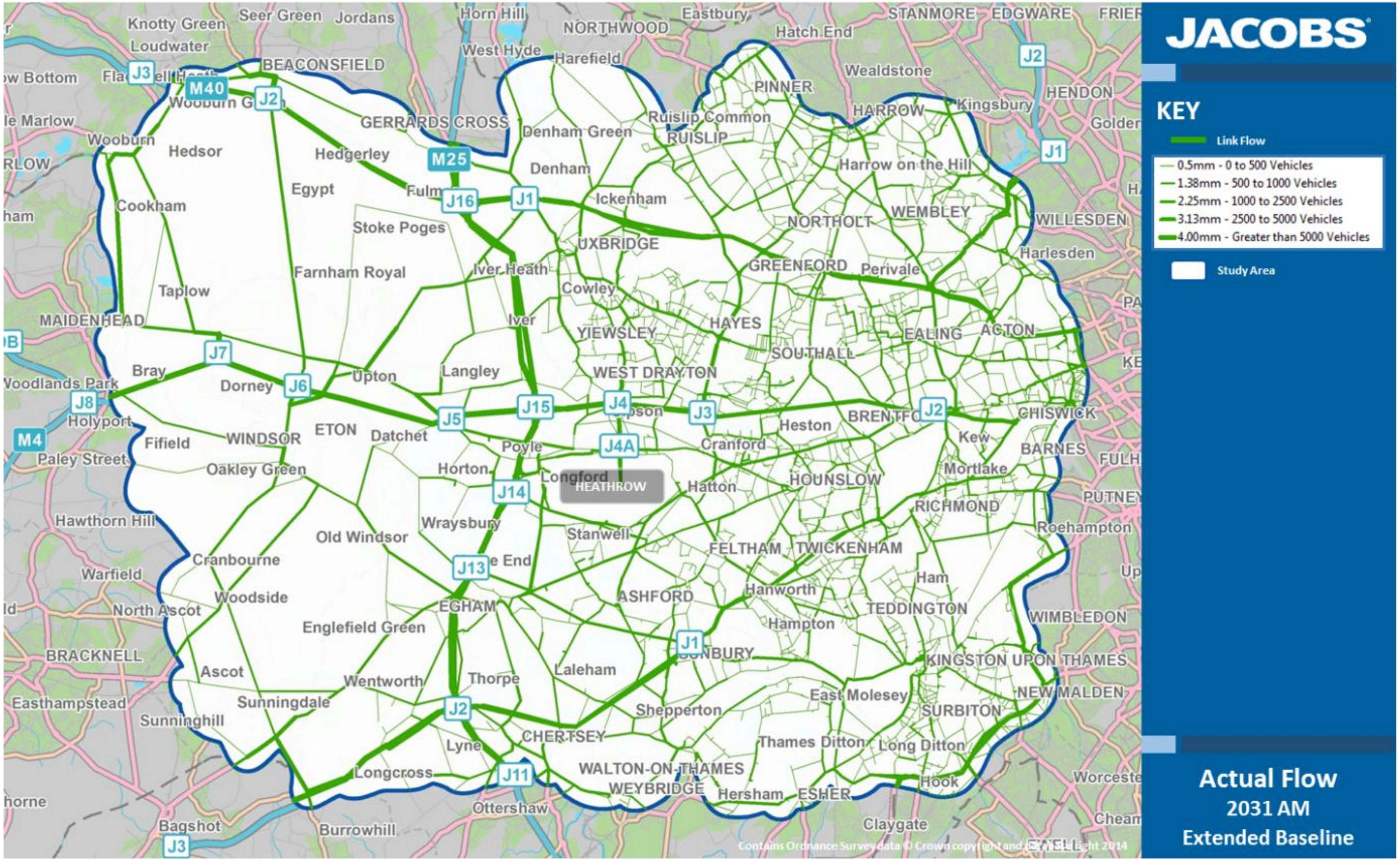


Figure 5-13: PM Extended Baseline Flows

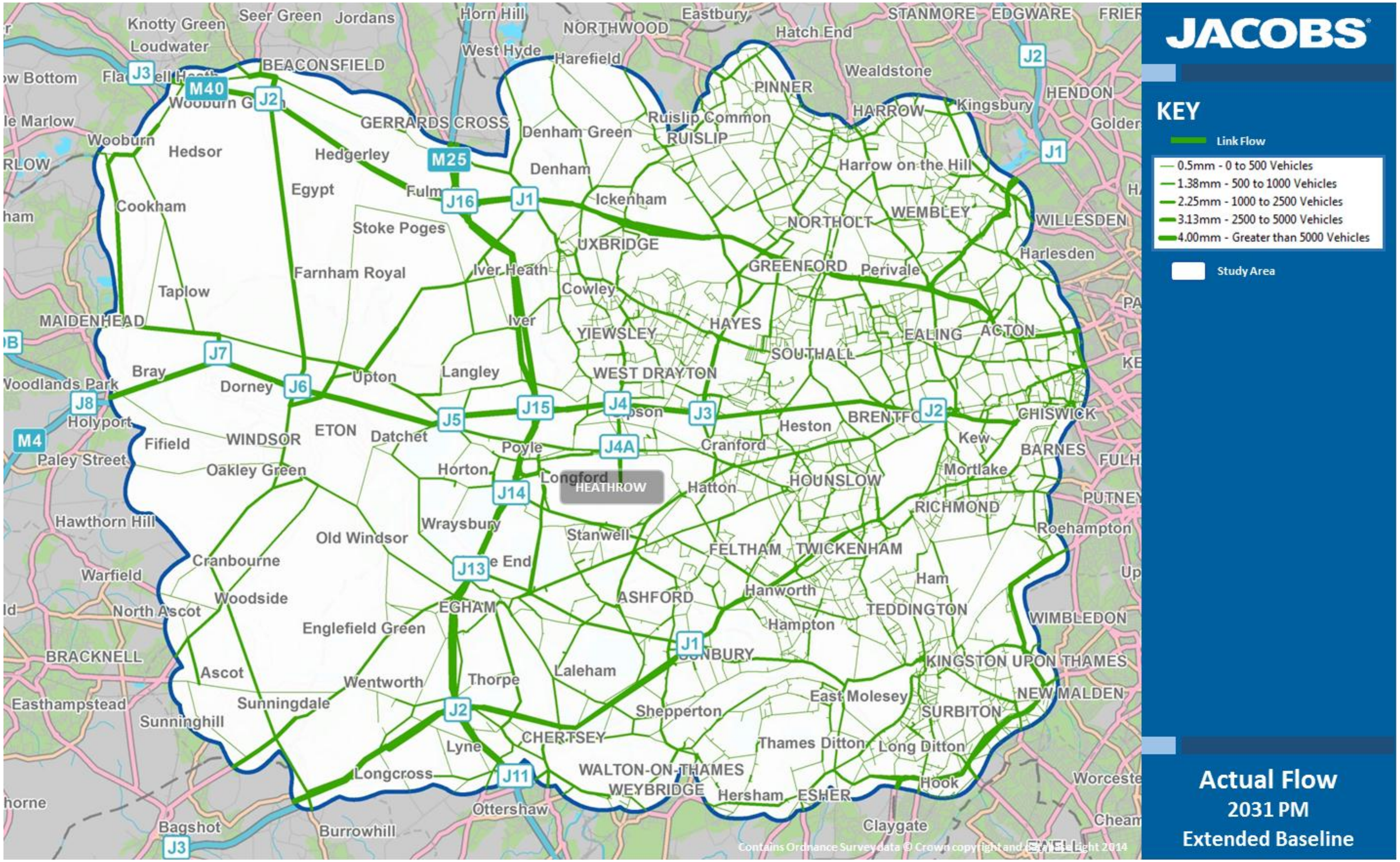


Figure 5-14: AM SLA Inbound to Eastern Terminal

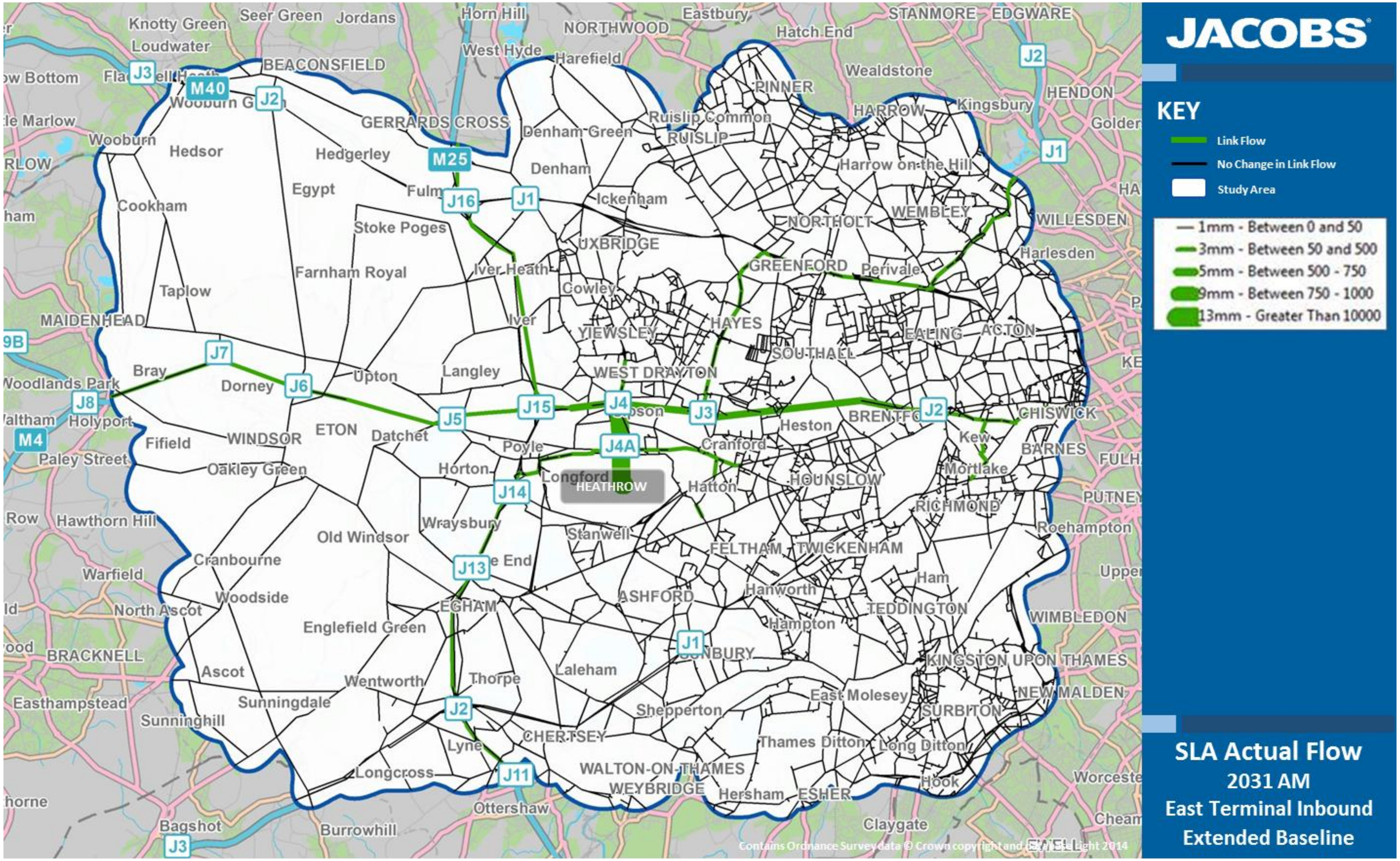
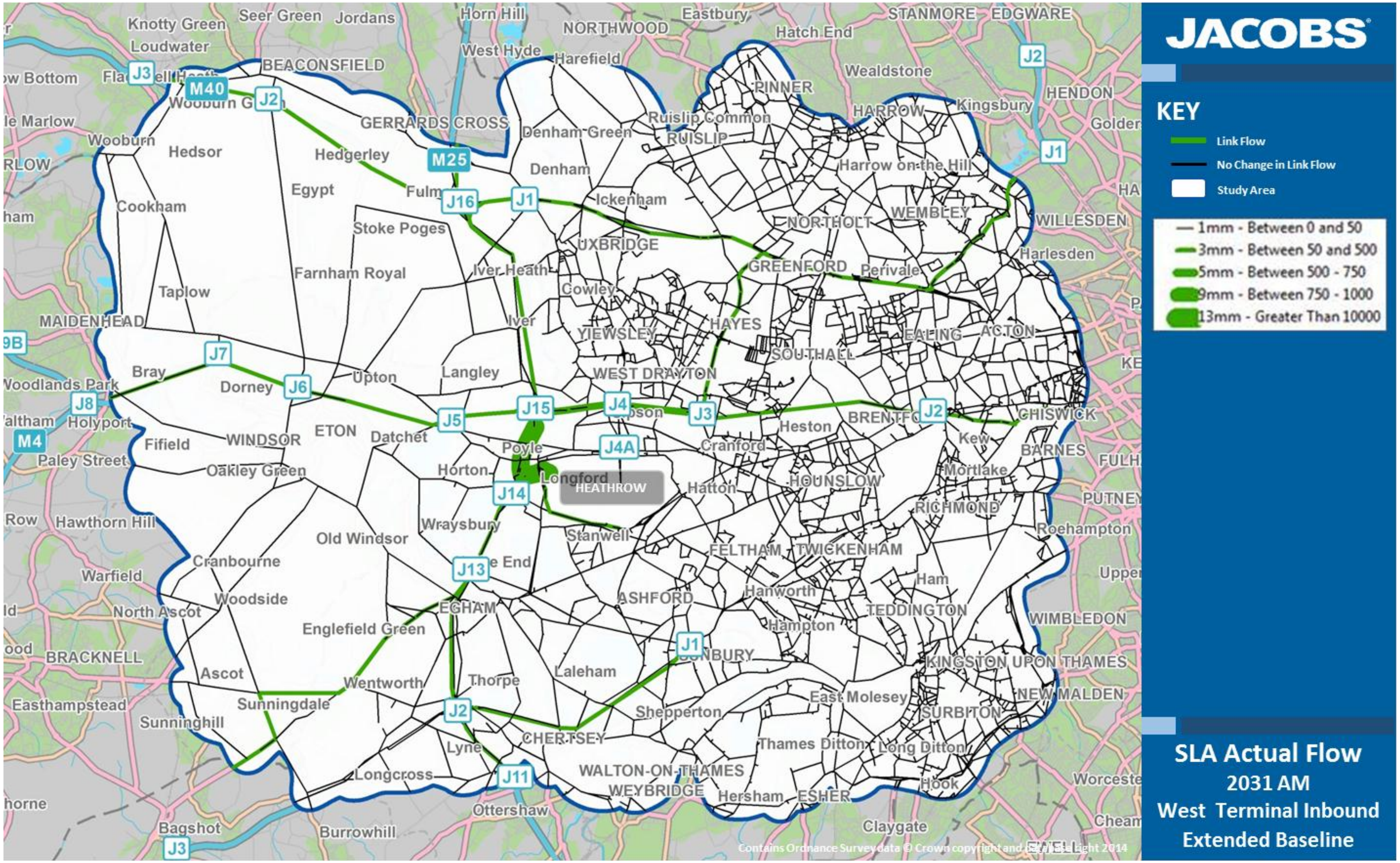


Figure 5-15: AM SLA Inbound to Western Terminal



5.5.7 A summary of our analysis of these figures is as follows:

- Traffic volumes in the vicinity of Heathrow are concentrated on the Motorway (M25, M4), and A road (A30, A312, A40) network. The M25 and M4 form major parts of the London strategic road network, and as such, should be expected to carry large volumes of traffic. Traffic on the A40 can be attributed to it providing a direct route to central London. The A312 is a key link between the A40 and M4/Heathrow while the A30 is the main access route to Heathrow south from London, providing a reasonable basis for high volume on these roads.
- The V/C figures show that, largely following the pattern seen in the traffic flow plots, areas with a high V/C ratio are concentrated around the strategic road network (M25, M4, A40). These roads attract large volumes commuter and goods traffic from a broad catchment area and even under present travel demand frequently experience high levels of congestion. As such, it is considered a reasonable result for the model to report congestion at these locations.
- The SLA figures show that traffic to/from Heathrow East Terminal the is generally using the strategic road network. Traffic the north and south is arriving via the M25, traffic from the west via the M4 and from the east traffic is primarily using the M4 with a minor proportion using the A40/A312. This route choice behaviour is in line with what would be reasonably expected and represents the rational choice for each direction of travel. As would be reasonably expected, the plots show that route choice for vehicles leaving Heathrow largely mirror that for travel to the Airport.
- The SLA figures show that traffic to/from Heathrow West Terminal is generally using the strategic road network. Traffic the north and south is arriving via the M25, traffic from the west via the M4. As would be reasonably expected, the plots show that route choice for vehicles leaving Heathrow largely mirror that for travel to the Airport.

5.5.8 In summary, our review of the Extended Baseline performance shows that the model is producing results that are considered reasonable in relation to the capacity and connectivity of the road network surrounding Heathrow. Large traffic volumes and areas of high congestions are shown to be largely confined to the strategic road network, while travel to and from Heathrow follows a logical route for all directions of travel.

5.5.9 Based on the outcomes of this review, it is considered that the Extended Baseline model provides a suitable point of reference for assessment of the Heathrow North West Runway.

5.6 Heathrow North West Runway Assessment (2030)

Additional airport capacity improvements

5.6.1 The Heathrow North West Runway highway network incorporates the highway access concept design proposed by Heathrow Airport Limited as well all Extended Baseline Improvements. Key changes and improvements proposed as part of the airport expansion scheme are as follows:

- Realignment of the M25 and associated motorway access roads between junction 14a and 15, including a new tunnelled section beneath the proposed third runway. This includes reconfigured access to the motorway to increase segregation of local traffic and reduce weaving;
- Realignment and reconfiguration of access to T5 from M25 junction 13/14, creating a counter clockwise loop between the terminal, the M25 and the southern perimeter road;
- Construction of a new tunnel providing direct access between the Southern Perimeter Road and the CTA; and
- Diversion of the A4, between Colnbrook and the Emirates roundabout, around the proposed third runway footprint.

5.6.2 The Heathrow North West Runway highway access scheme is illustrated conceptually in **Figure 5-16** and **Figure 5-17**.

Figure 5-16: Heathrow North West Runway Local Road Layout

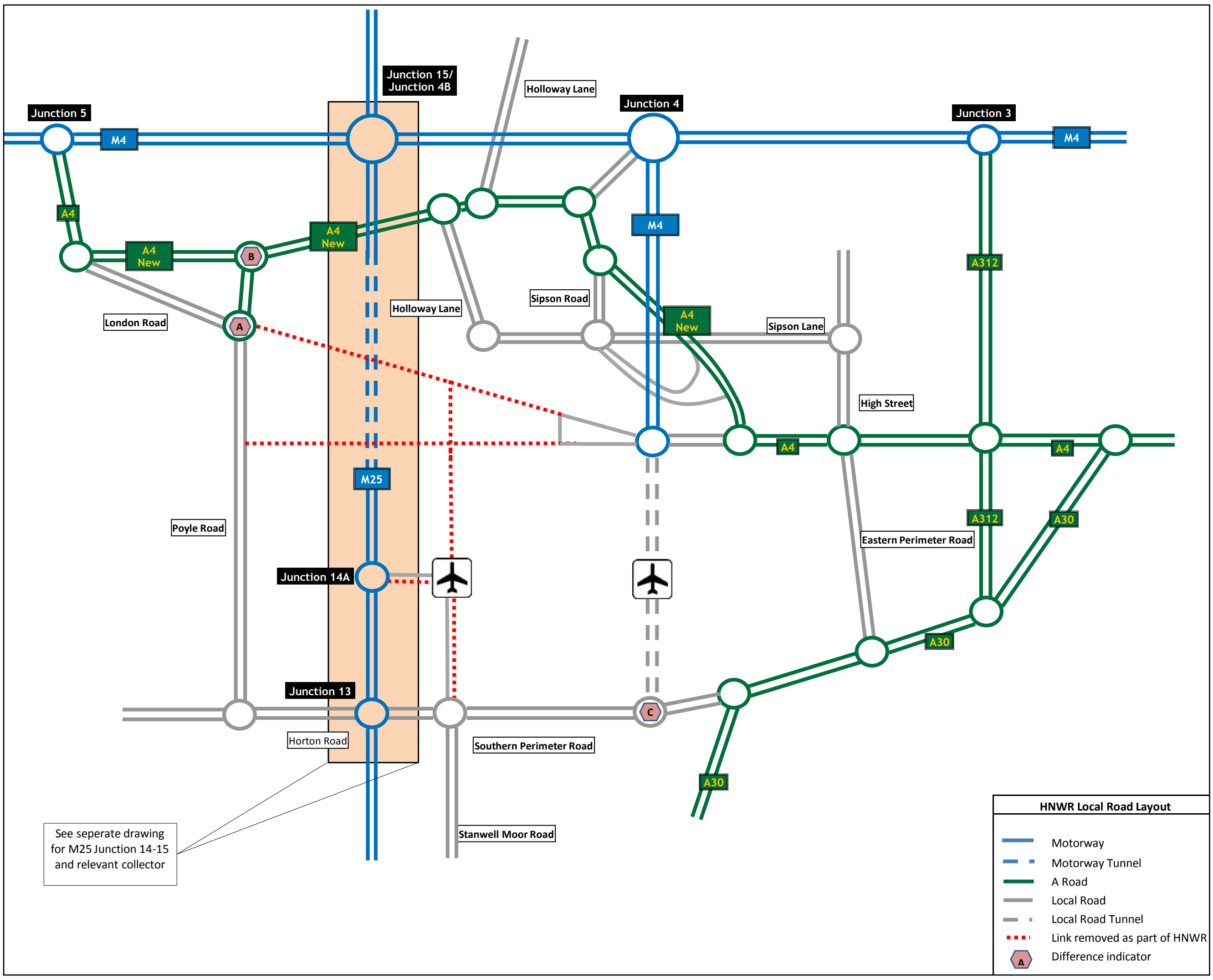
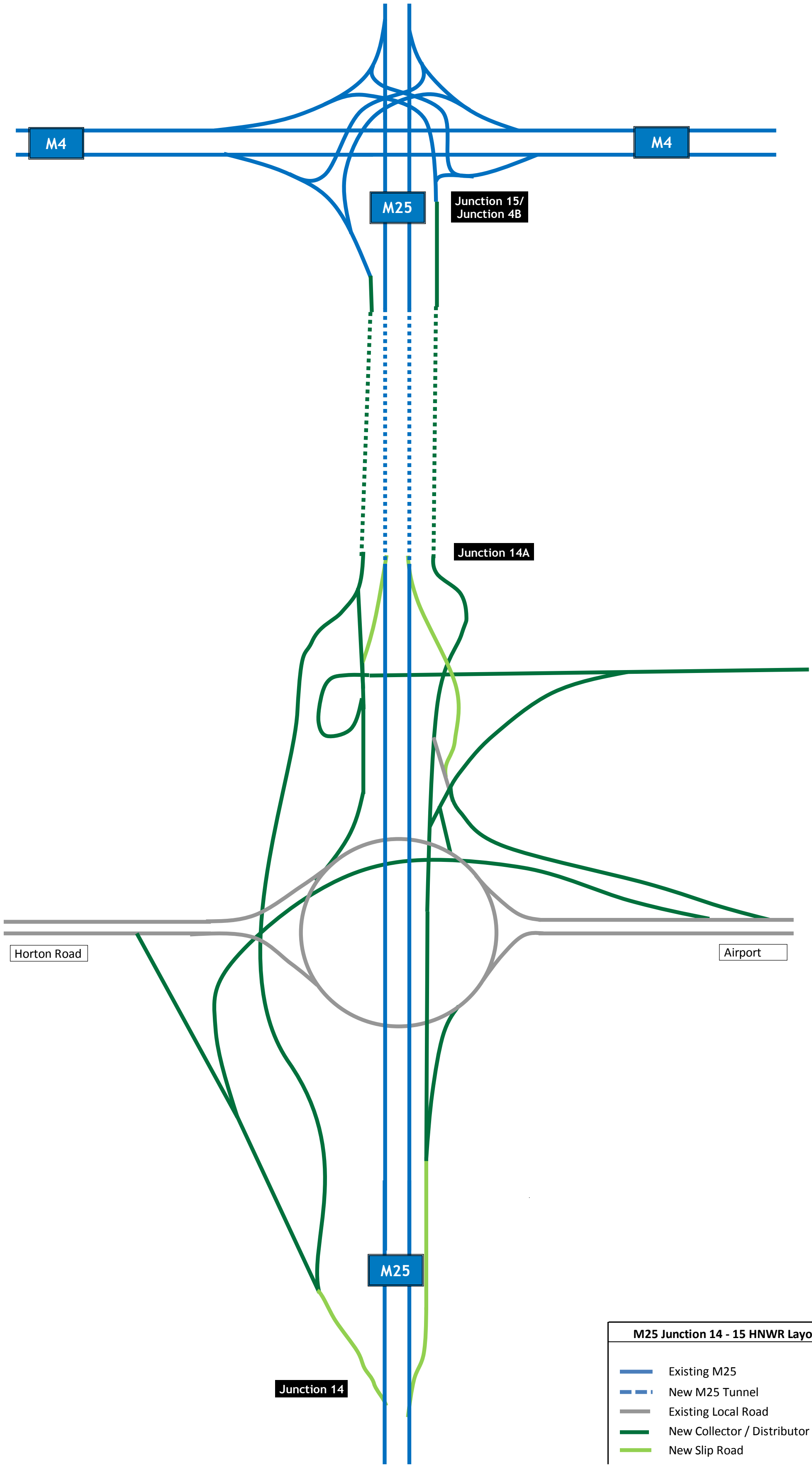


Figure 5-17: Heathrow North West Runway M25 functions 14 to 15 layout



5.6.3 At a number of locations, intersection configurations as modelled in SATURN were altered from what is shown on the scheme promoters plans. The alterations made were purposefully limited in scope and intended to alleviate localised capacity issues arising due to the limited level of design development at the time of writing. None of the alterations meaningfully altered the overall intent of the scheme design. A summary of all network alterations is shown in **Table 5-7**.

Table 5-7: Network alterations

Ref	Variance	Justification
A	Change of junction type from roundabout to signalised	Roundabout shown on promoter plans does not have capacity to accommodate demand flows and a larger roundabout would not be appropriate for the in situ road environment.
B	Addition of left turn slip east to south	Required to improve junction capacity such that demand flows can be accommodated
C	Change of junction type from large roundabout to large signalised.	Due to large and unbalanced flows, a roundabout could not provide sufficient capacity to accommodate demand.

Assignment and review of performance

5.6.4 A detailed review of the Heathrow North West Runway model performance has been undertaken to ensure the assignment produces reasonable results reflecting the intent of the projects highway access concept design. This review covered the same key results assessed as part of the Extended Baseline model review.

5.6.5 The figures (contained in the Supplementary Figures Report) relating to the Heathrow North West Runway Assessment are defined below.

- Demand traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 2,5,8);
- Actual traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 11,14 17);
- Demand traffic flows ratios on the strategic road network surrounding Heathrow (Figs 20,23,26);
- Actual traffic flows on the strategic road network surrounding Heathrow (Figs 29,32,35);
- Demand flow v/c ratios on the strategic road network surrounding Heathrow (Figs 38, 41, 44);
- Actual flow v/c ratios on the strategic road network surrounding Heathrow (Figs 47, 50 53);
- SLA routing of traffic traveling to/from Heathrow East Terminal (Figs 56, 59, 62, 65, 68, 71);
- SLA routing of traffic travelling to/from Heathrow West Terminal (Figs 74, 77, 80, 83, 86, 89);
- SLA queued flow of traffic traveling to/from Heathrow East Terminal (Figs 92, 95, 98, 101, 104, 107);
- SLA queued flow of traffic travelling to/from Heathrow West Terminal (Figs 110, 113, 116, 119, 122, 125);

5.6.6 **Figures 5-18** to **5-21** below present the peak hour actual traffic flows as well as select link analyses of traffic to the Heathrow central and western terminals in the AM peak hour.

Figure 5-17: AM peak hour North West Runway flows

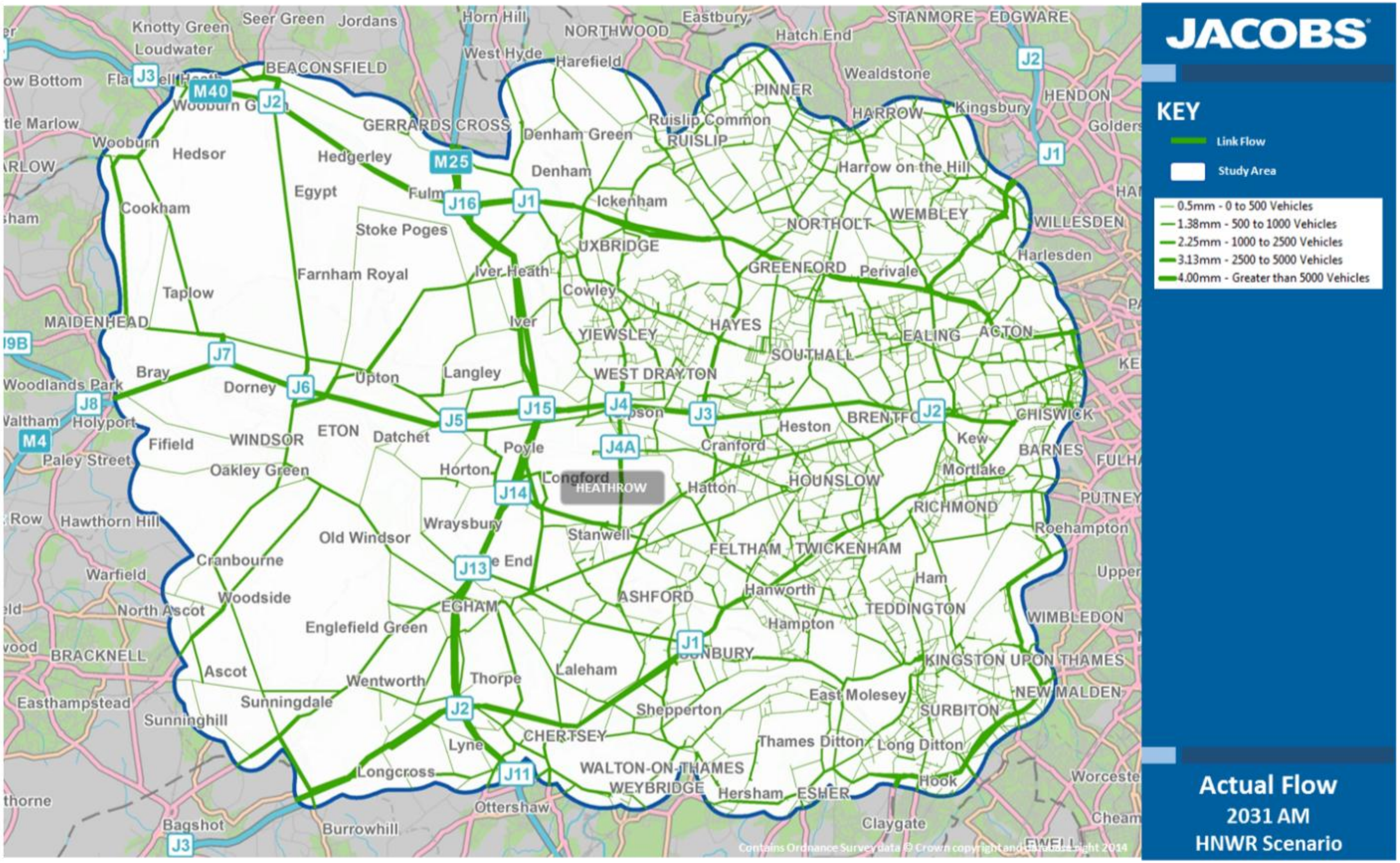


Figure 5-18: PM peak hour North West Runway flows

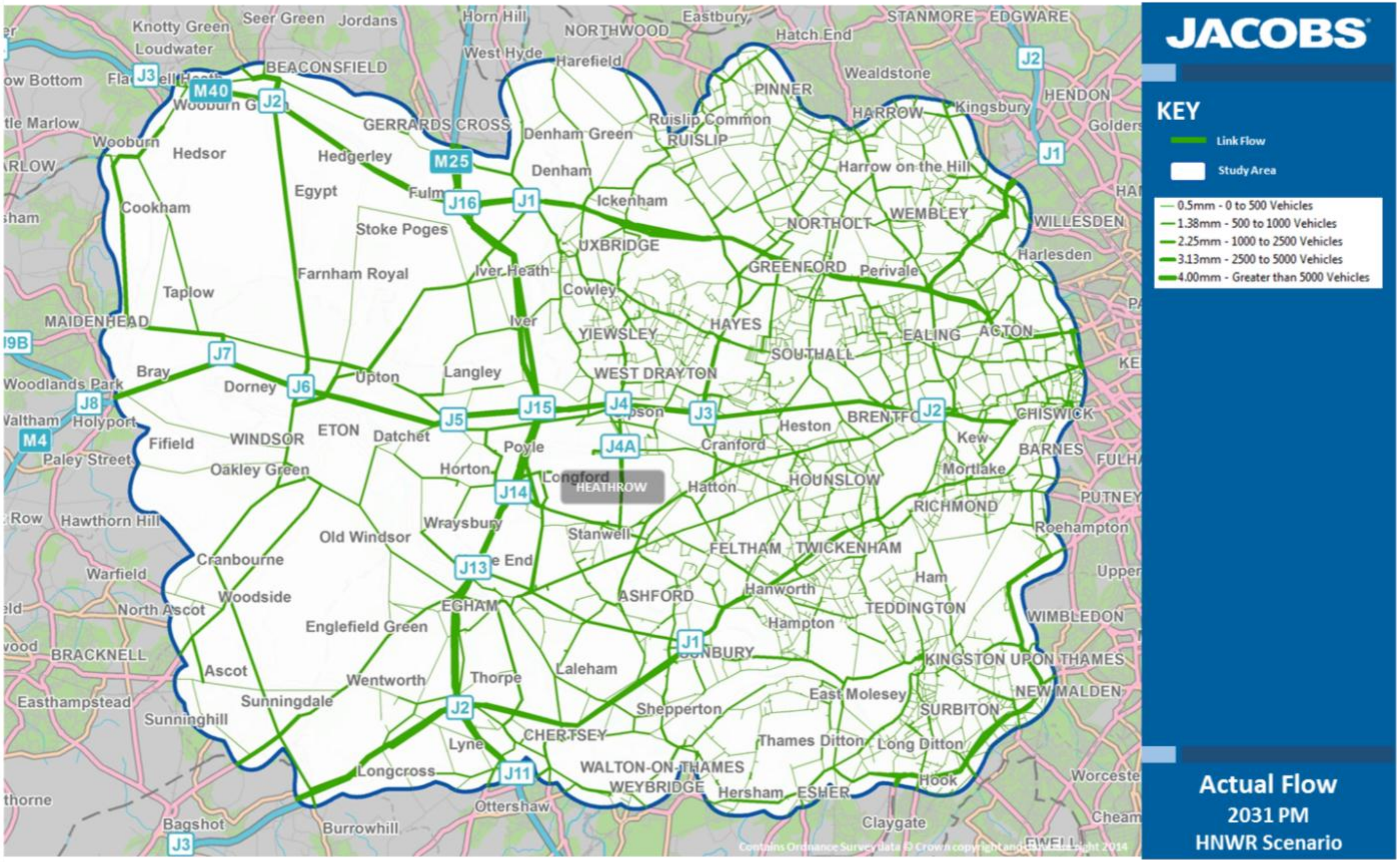


Figure 5-19: AM SLA Inbound to Eastern Terminal

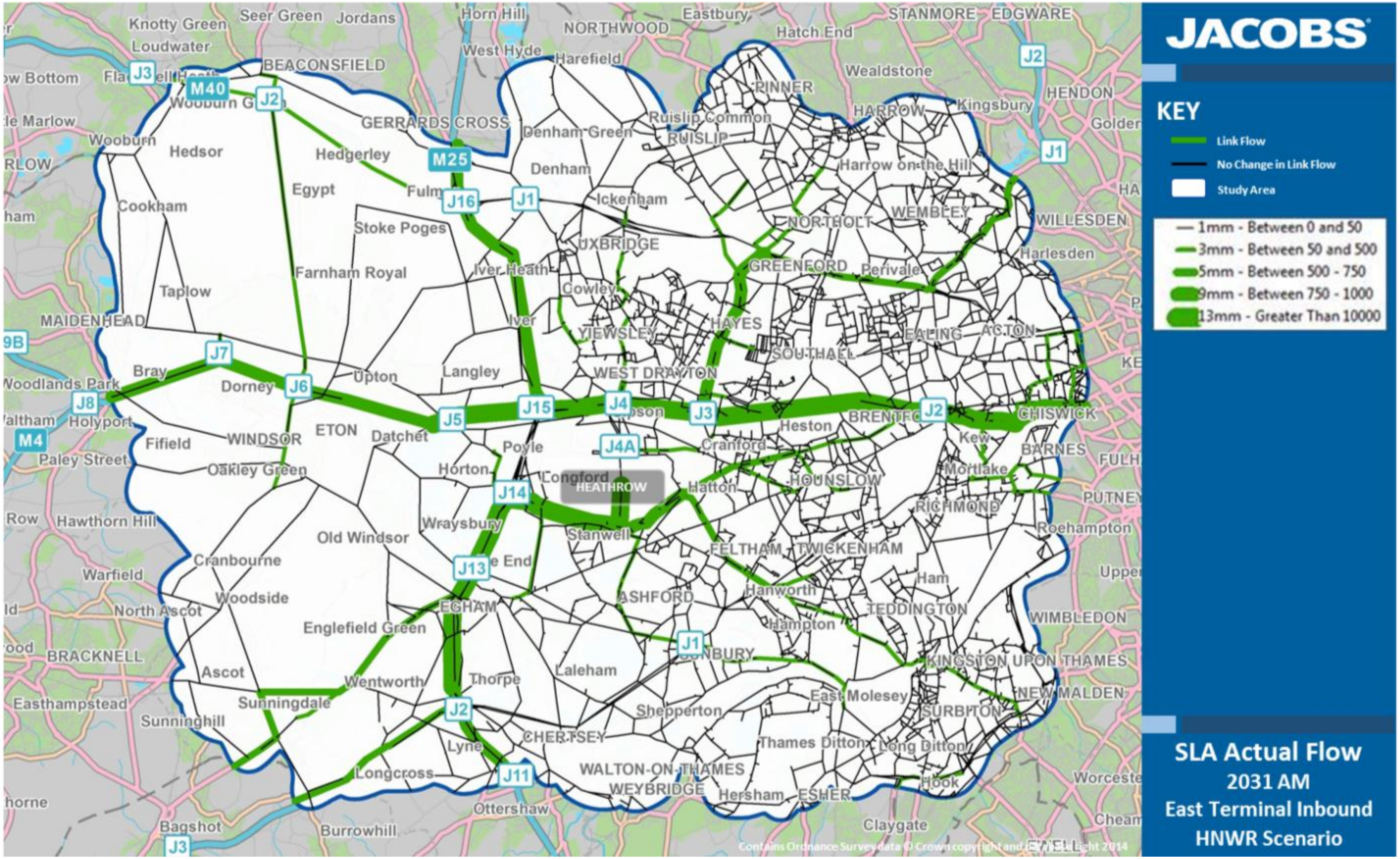
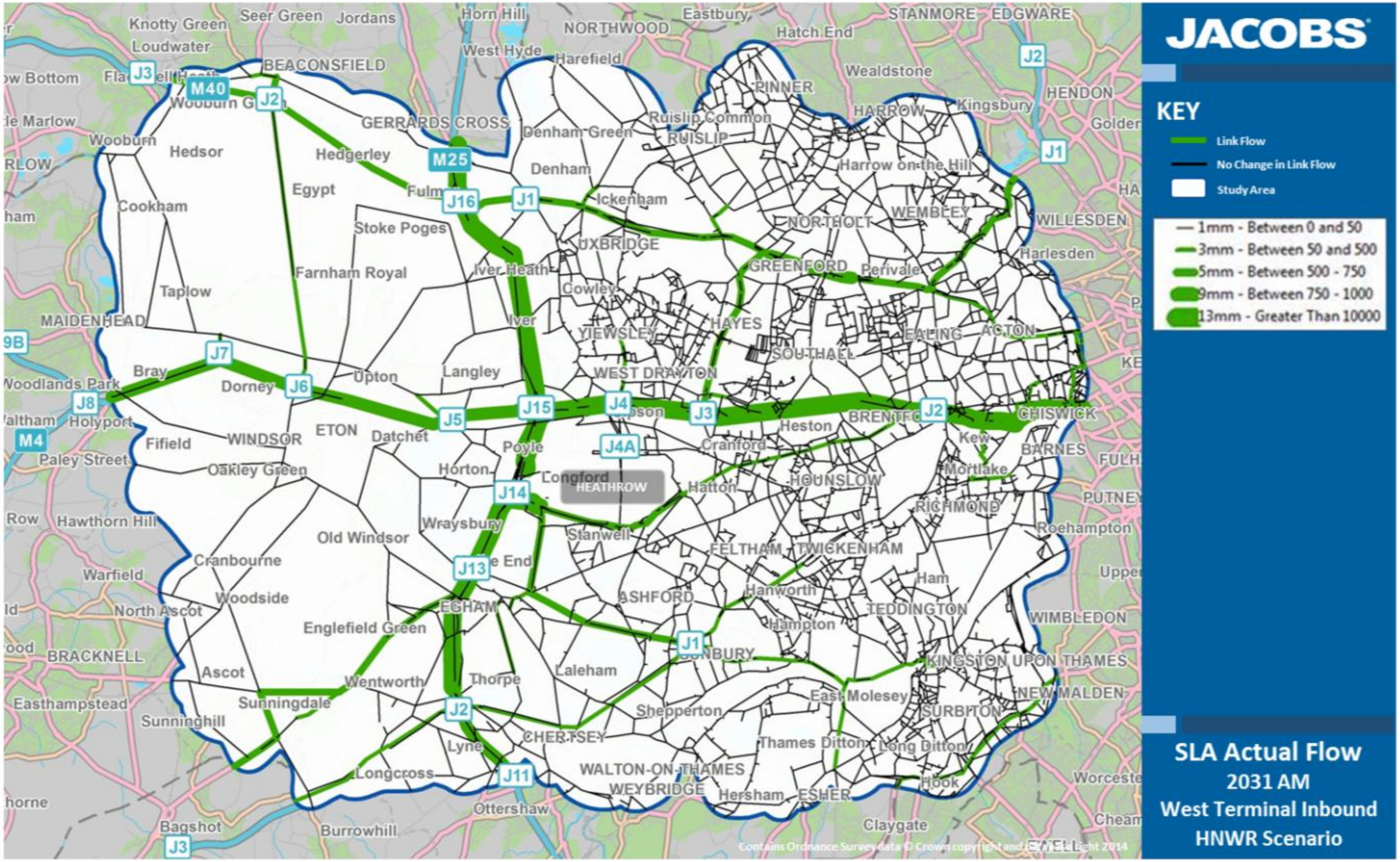


Figure 5-20: AM SLA Inbound to Western Terminal



5.6.7 A summary of our analysis of these figures is as follows:

- Traffic volumes surrounding Heathrow are concentrated on the Motorway (M25, M4), and A road (A30, A312, A40) network.
- The Heathrow North West Runway will not substantially alter the strategic road network for trips not relating to Heathrow. As such, it is expected that at a strategic level, the concentrations of traffic would broadly reflect what is forecast in the Extended Baseline model.
- The V/C ratio figures largely reflect the Extended Baseline model results. Again, the Heathrow North West Runway will not substantially alter the road network for trips not relating to Heathrow. This is considered reasonable.
- The SLA figures show a substantial shift in travel behaviour to/from Heathrow East Terminal compared with the Extended Baseline model due to the revised road network. A number of key changes around vehicle access to the airport will be made under the Heathrow North West Runway Scheme, these being a new tunnel connecting the CTA to the southern perimeter road and a new M25 access road connecting M25 junction 15 to the southern perimeter road. Thus under the revised road network, traffic approaching Heathrow from the south is shown to shift to the new access via the southern perimeter road while a minor proportion of traffic is also shown to make use of the new M25 / southern perimeter road connection. Travel from the east and west is largely unchanged. This route choice behaviour is in line with what would be reasonably expected given the available access points and represents the rational choice for each direction of travel.
- The SLA figures for traffic to/from Heathrow West Terminal show similar travel patterns to the Extended Baseline model results.

5.6.8 In summary, our review of the Heathrow North West Runway performance has shown that the model is producing results which are considered reasonable in relation to the capacity and connectivity of the revised road network. As expected, large strategic traffic volumes and areas of congestion are shown to be concentrated on the strategic road network in a similar pattern to the Extended Baseline model, while travel to and from Heathrow follows a logical route for all directions of travel under the revised access arrangement.

5.6.9 Based on the outcomes of this review, it is considered that the Heathrow North West Runway model provides results which logically reflect the changes in travel behaviour which would be expected under the proposed highway scheme.

5.7 Comparative appraisal between the Extended Baseline and Heathrow North West Runway Options

5.7.1 The figures contained in the **Supplementary Figures Report** relating to a comparison between the Extended Baseline and the Heathrow North West Runway Assessment are defined below.

- Demand traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 3,6,9);
- Actual traffic flows on the local road network within the immediate vicinity of Heathrow (Figs 12,15 18);
- Demand traffic flows ratios on the strategic road network surrounding Heathrow (Figs 21,24,27);
- Actual traffic flows on the strategic road network surrounding Heathrow (Figs 30,33,36);
- Demand flow v/c ratios on the strategic road network surrounding Heathrow (Figs 39, 42, 45);
- Actual flow v/c ratios on the strategic road network surrounding Heathrow (Figs 48, 51 54);
- SLA routing of traffic traveling to/from Heathrow East Terminal (Figs 57, 60, 63, 66, 69, 72);
- SLA routing of traffic travelling to/from Heathrow West Terminal (Figs 75, 78, 81, 84, 87, 90);

- SLA queued flow of traffic traveling to/from Heathrow East Terminal (Figs 93, 96, 99, 102, 105, 108);
- SLA queued flow of traffic travelling to/from Heathrow West Terminal (Figs 111, 114, 117, 120, 123, 126);

5.7.2 Our comparative assessment of the impact of the Heathrow North West Runway on traffic levels is addressed under the following headings: Airport Demand; Strategic Road Network and Capacity Constraints.

Airport Demand

5.7.3 In both scenarios, there is significant queued traffic in the network unable to reach its final destination at Heathrow Airport. Comparing the Extended Baseline and Heathrow North West Runway scenarios, the proportion of airport passengers not able to reach the airport within the assignment period increases from 7% to 9% in the peak period. This is illustrated in the queue difference plots, which show an noticeable increase in queued flow for airport demand approaching from the east, indicating insufficient capacity in the road network to accommodate all the additional airport highway demand.

5.7.4 This suppressed traffic is evident on the M4 through to the Chiswick Roundabout. In addition the A312 and A40 suffer from congestion, not allowing all demand to arrive at Heathrow Airport in Peak periods. The M25 also suffers from congested conditions, with all traffic unable to arrive at the Heathrow Airport within peak periods.

5.7.5 In practice the passengers represented by the queued flow are likely to be aware of the congestion issues and travel time required to get to Heathrow during the peak periods and are likely schedule their departure time accordingly. The impact of this being will be increased peak spreading[25] on the roads surrounding Heathrow.

Strategic Road Network

5.7.6 **Figures 5-21** to **5-23** demonstrate the flow changes brought about by the Heathrow North West Runway in the AM, IP and PM peak periods respectively. Green bandwidths are used to indicate flow increases in the expansion option, whereas blue bandwidths indicate a decrease. These figures are derived directly from the SATURN models and show the impact of the new runway on the links that are present in both the Heathrow North West Runway and Extended Baseline scenarios. It does not show traffic flow change on the new links introduced only as part of the Heathrow North West Runway.

5.7.7 These figures, along with the flow difference figures in the **Supplementary Figures Report** reveal that substantial changes to traffic volumes between the Extended Baseline and Heathrow North West Runway scenarios are mainly confined to the area surrounding Heathrow, these being:

- M25 between junctions 14 and 15 – volume decrease;
- Southern perimeter road – volume increase;
- M4 spur / terminal access tunnel – volume increase;
- Poyle road – volume increase; and
- A3044 adjacent to M4 junction 4 – volume increase.

[25] Peak spreading refers to the phenomenon of AM and PM peak traffic periods increasing in duration over time. This is typically due to travel demand during the peak periods exceeding available road capacity, leading to a proportion of travellers scheduling their trips to occur either side of the peak.

Figure 5-21: AM Difference in Traffic Volumes, HNWR – Extended Baseline

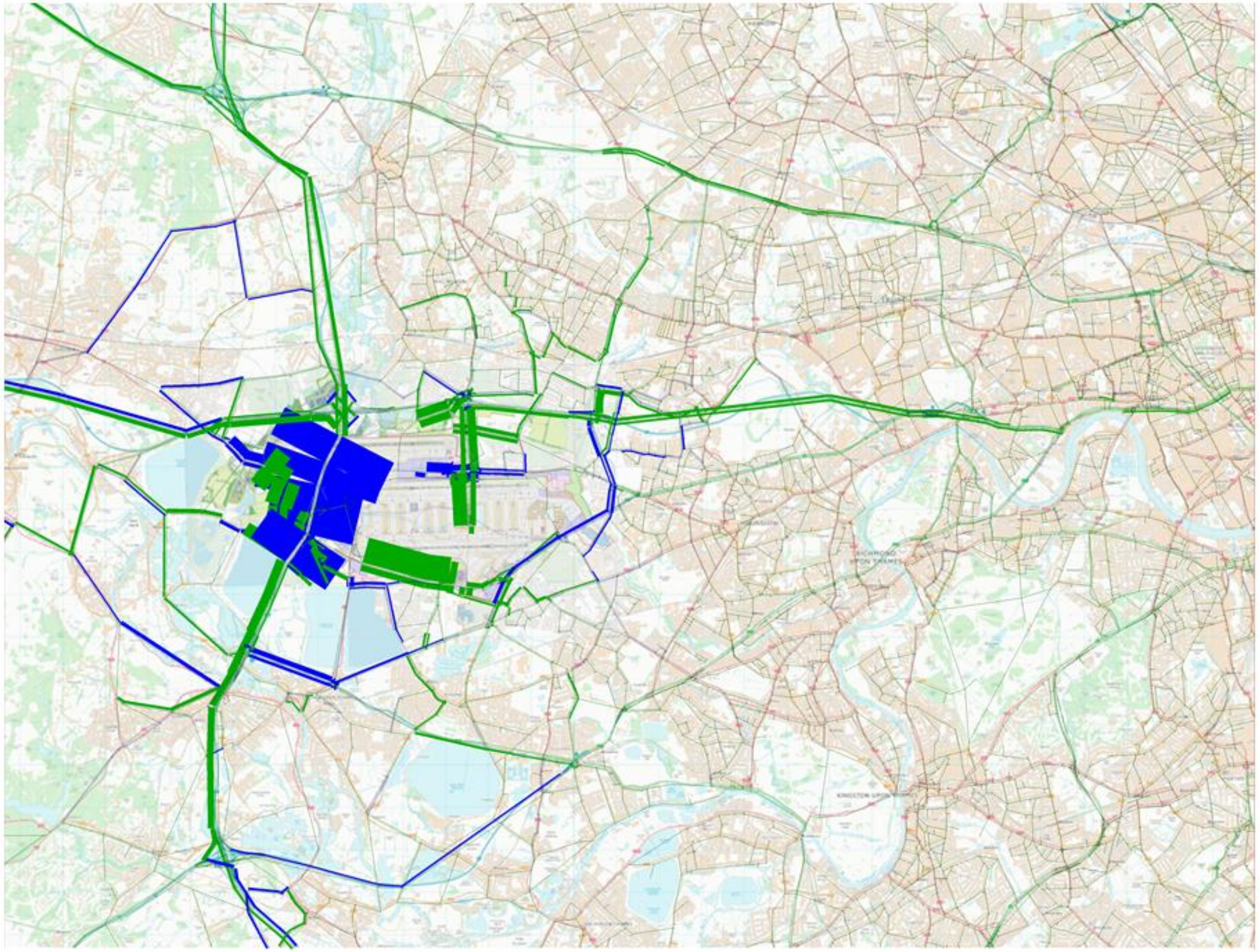


Figure 5-22: IP Difference in Traffic Volumes, HNWR – Extended Baseline

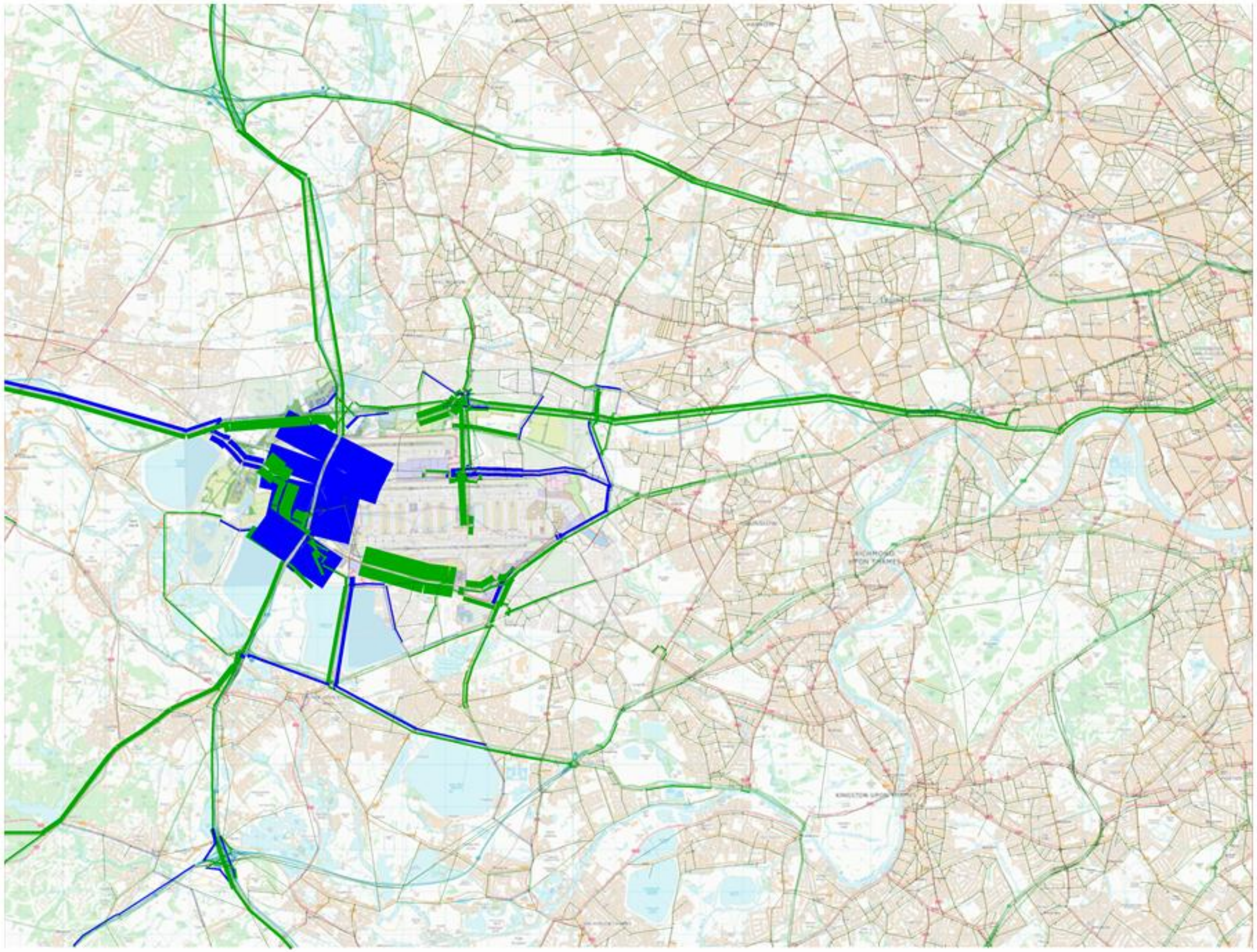
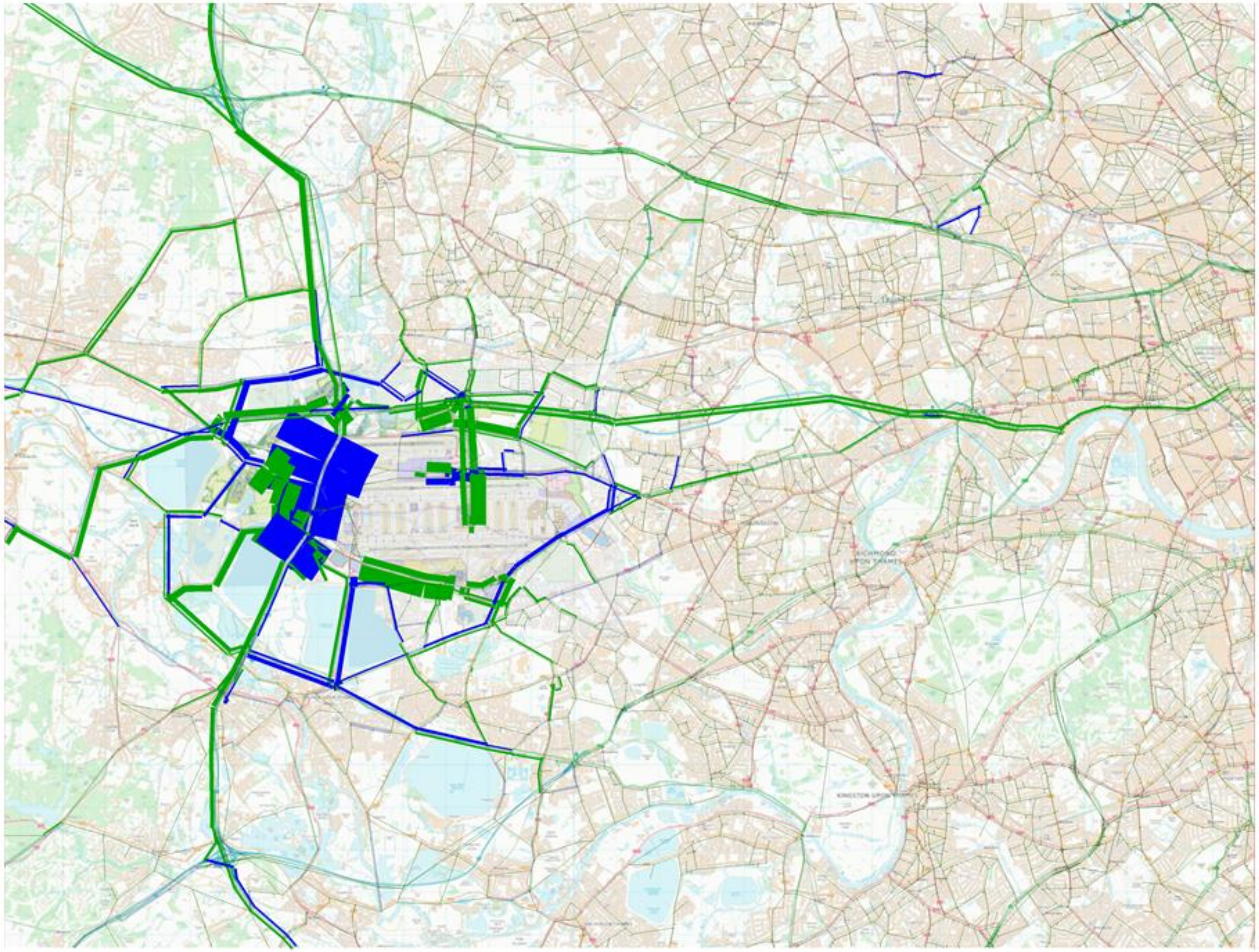


Figure 5-23: PM Difference in Traffic Volumes, HNWR – Extended Baseline



5.7.8 The highway access design for Heathrow North West Runway incorporates new M25 northbound and southbound access roads, separated from the main motorway corridor, catering to local and airport traffic. The reduction in traffic on the M25 between junctions 14 and 15 can be attributed to traffic previously using the main corridor switching over to the access roads.

5.7.9 A key aspect of the revised highway access strategy under the Heathrow North West Runway project is the construction of a new tunnel linking the CTA to the southern perimeter road. As a result, the most logical route for Heathrow traffic to and from the south will be via the southern perimeter road and the new tunnel. As such, an increase in volume on the southern perimeter road is a reasonable result.

5.7.10 Despite the changes to highway access to Heathrow, the M4 spur will remain a major access point for travel to Heathrow CTA from the North, East and West. Given the expanded airport will generate an additional 250 peak hour trips over the existing airport northbound and between 400 and 470 peak hour trips southbound, an increase in traffic at this location is expected and not unreasonable.

5.7.11 To accommodate a third runway, the Colnbrook Bypass (A4) will be realigned and Bath Road will be terminated just east of Poyle. As a result, the number of east-west routes for traffic from Colnbrook and Poyle will be consolidated from two to one. This has had the effect of concentrating traffic into a single route, increasing traffic volume on Poyle Road.

5.7.12 A small section of the A3044 will form part of the realigned A4 under the proposed highway scheme. The increase in traffic at this location is reflective of the higher volumes carried by the A4 compared to the existing A3044.

5.7.13 Other minor changes to traffic volume changes in the wider study area can be attributed either to the larger overall traffic generation at Heathrow or some model noise resulting from differences in the traffic assignment convergence.

Capacity Constraints

5.7.14 **Figures 5-24** to **5-32** highlight the links that are forecast to exceed capacity in the Extended Baseline and Heathrow North West Runway scenarios. These are presented in turn for the AM, IP and PM periods. For each time period the following three figures are provided:

- Links over capacity in the Extended Baseline (in green);
- Links over capacity with the Heathrow North West Runway in place (in green);
- Links over capacity with the Heathrow North West Runway in place (links in blue are also forecast to operate over capacity in the Extended Baseline scenario, links in red are forecast to operate over capacity only with the introduction of the Heathrow North West Runway.

5.7.15 The figures demonstrate that the road network surrounding Heathrow Airport is forecast to experience capacity issues regardless of the introduction of the Heathrow North West Runway, particularly in the AM and PM time periods. There are a number of key strategic links forecast to operate above capacity, and these include the M25, M4, A4 and A40.

5.7.16 Whilst the majority of the over capacity links that are forecast in the North West Runway scenario are also forecast in the Extended Baseline scenario, there are also a number of links that are expected to operate above capacity only with the introduction of the third runway. This is discussed further in the paragraphs following the figures.

Figure 5-24: AM Over Capacity Locations – Extended Baseline

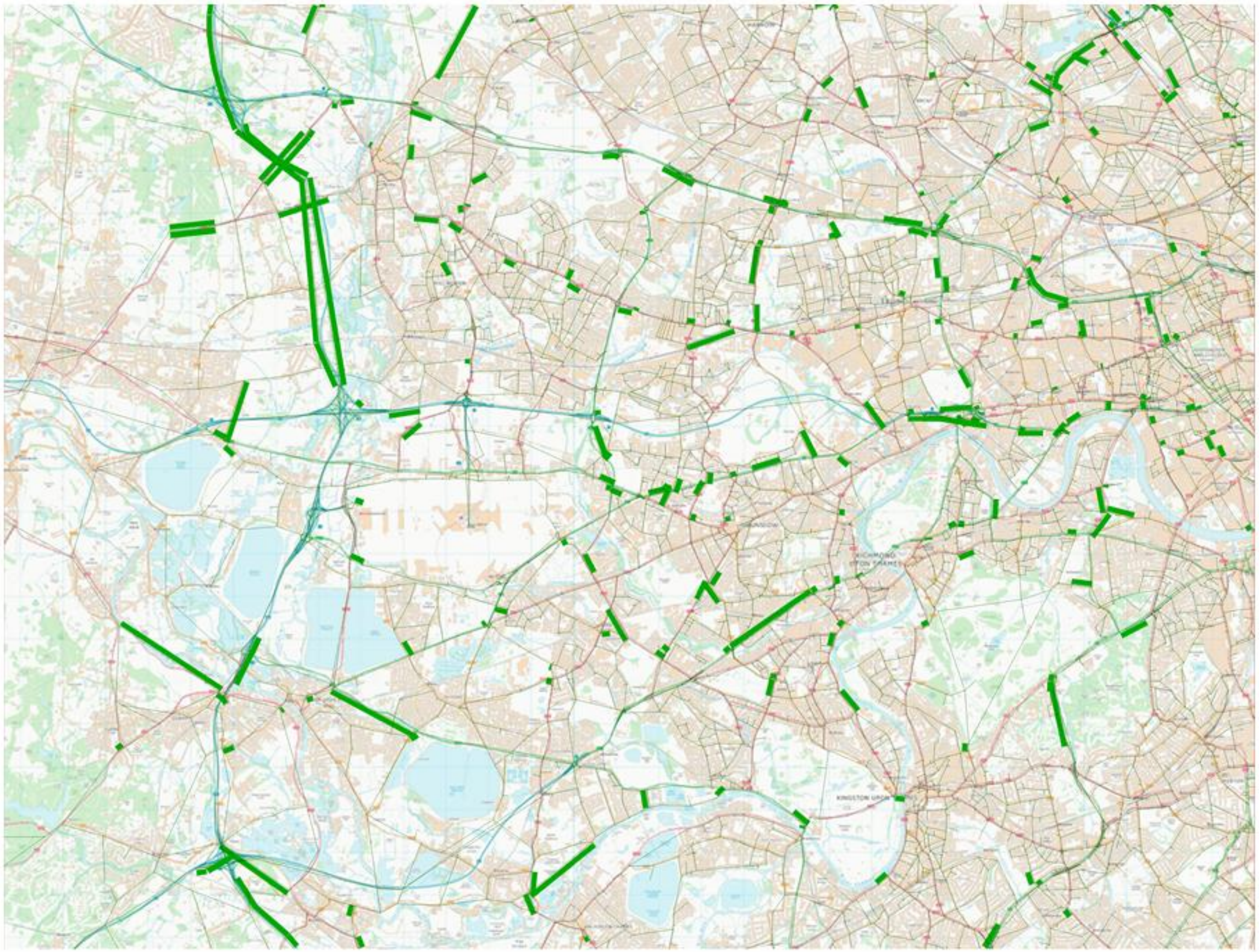


Figure 5-25: AM Over Capacity Locations – Heathrow North West Runway

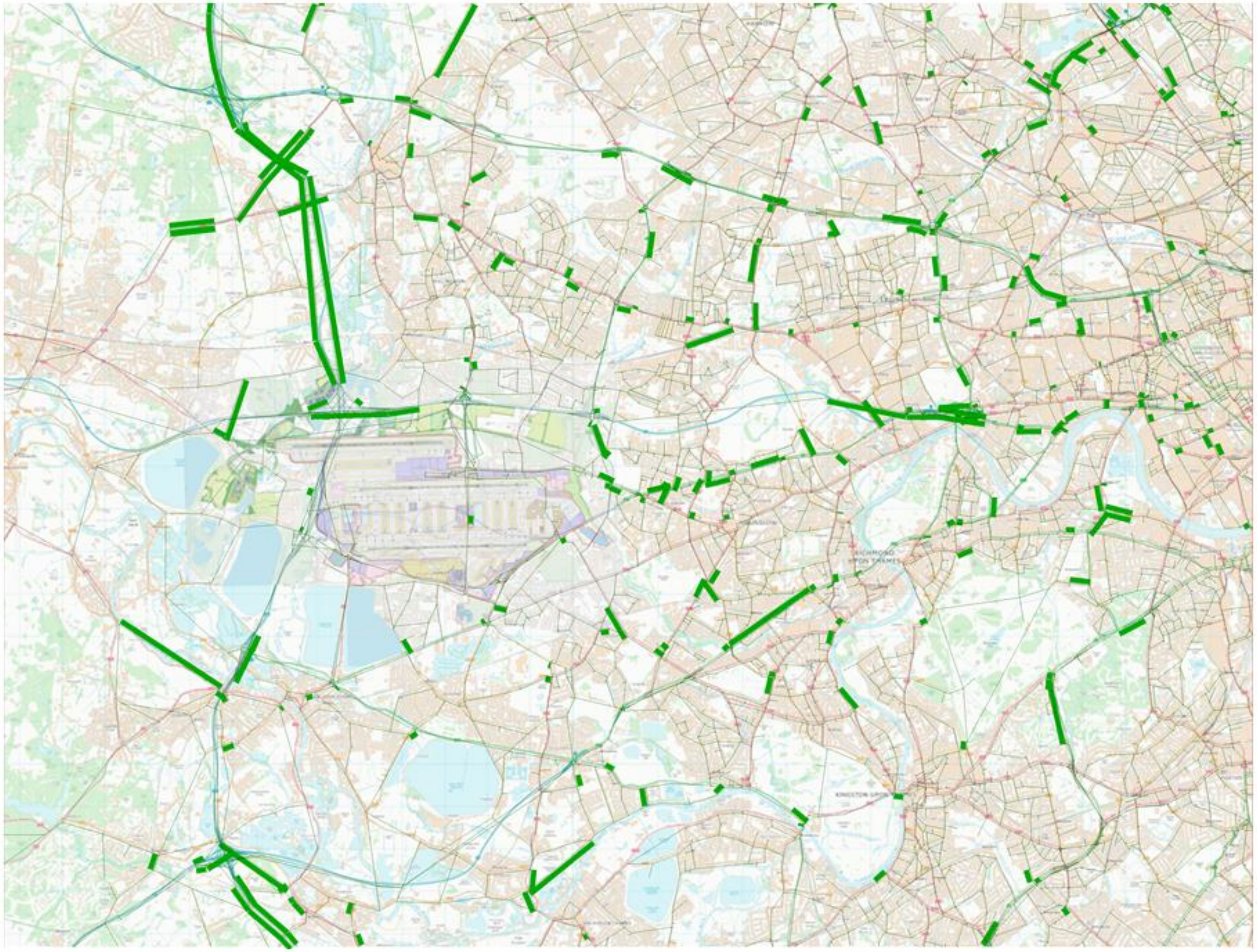


Figure 5-26: AM Over Capacity Locations – Heathrow North West Runway (expansion-only capacity exceedances in red)

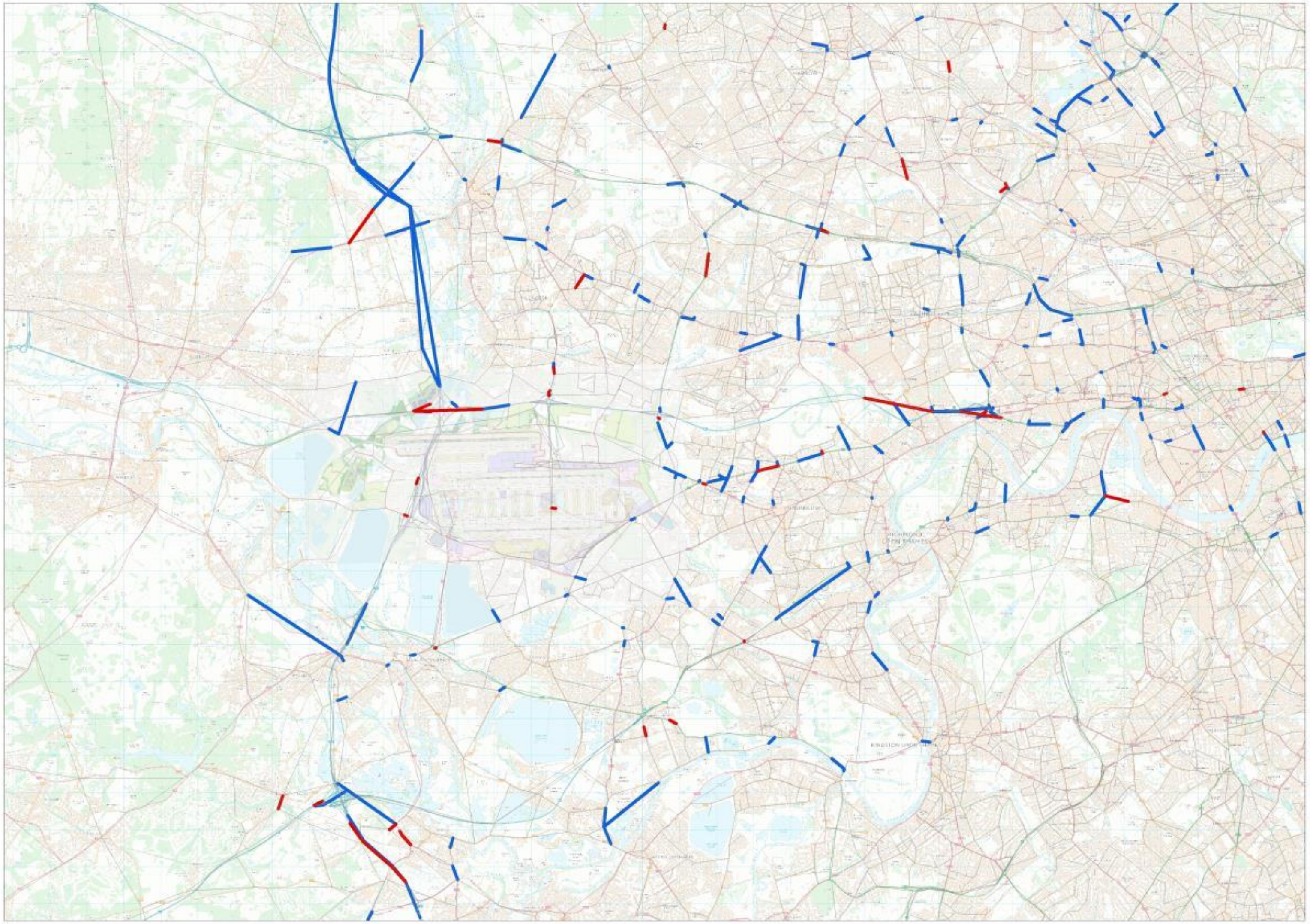


Figure 5-27: IP Over Capacity Locations – Extended Baseline

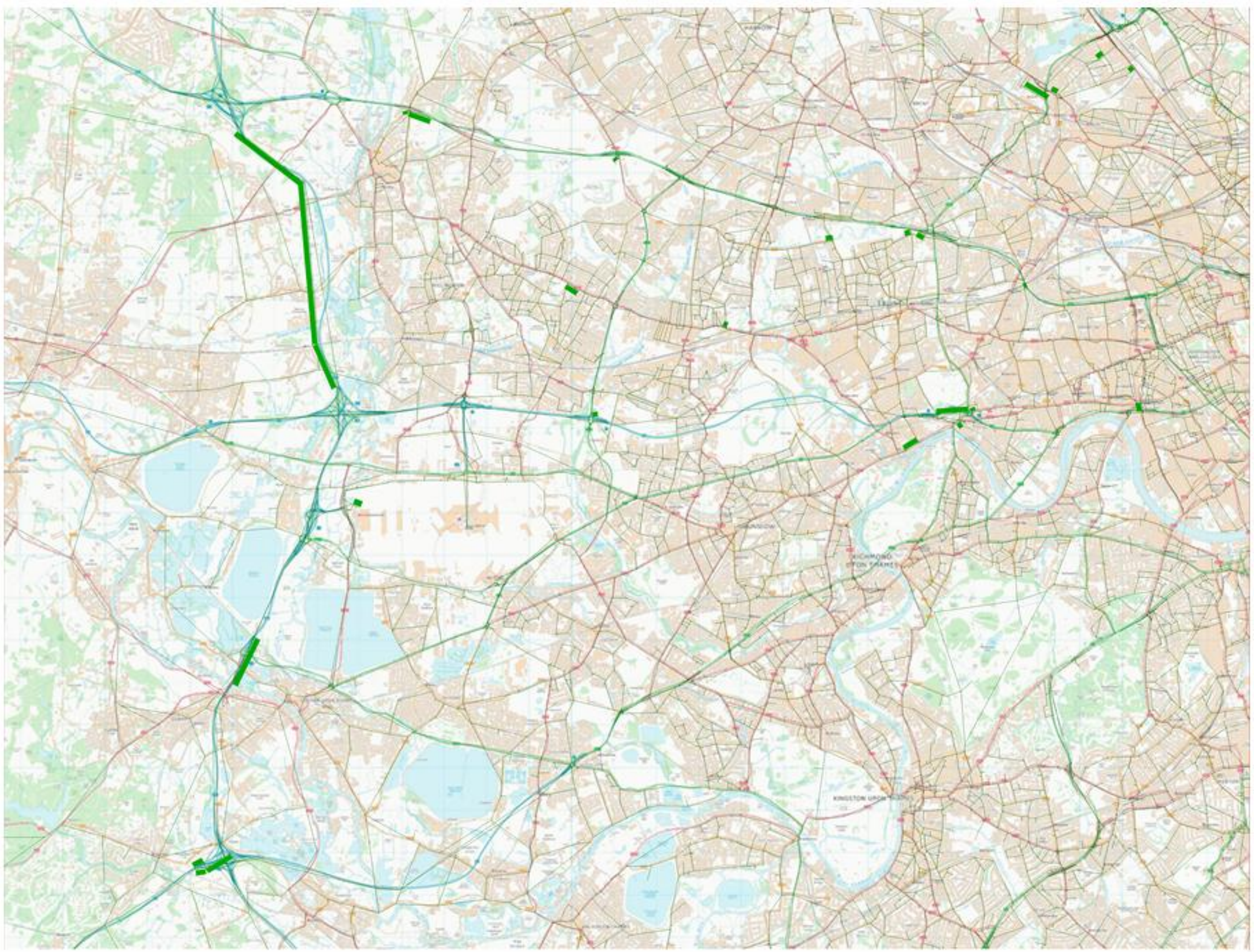


Figure 5-28: IP Over Capacity Locations – Heathrow North West Runway

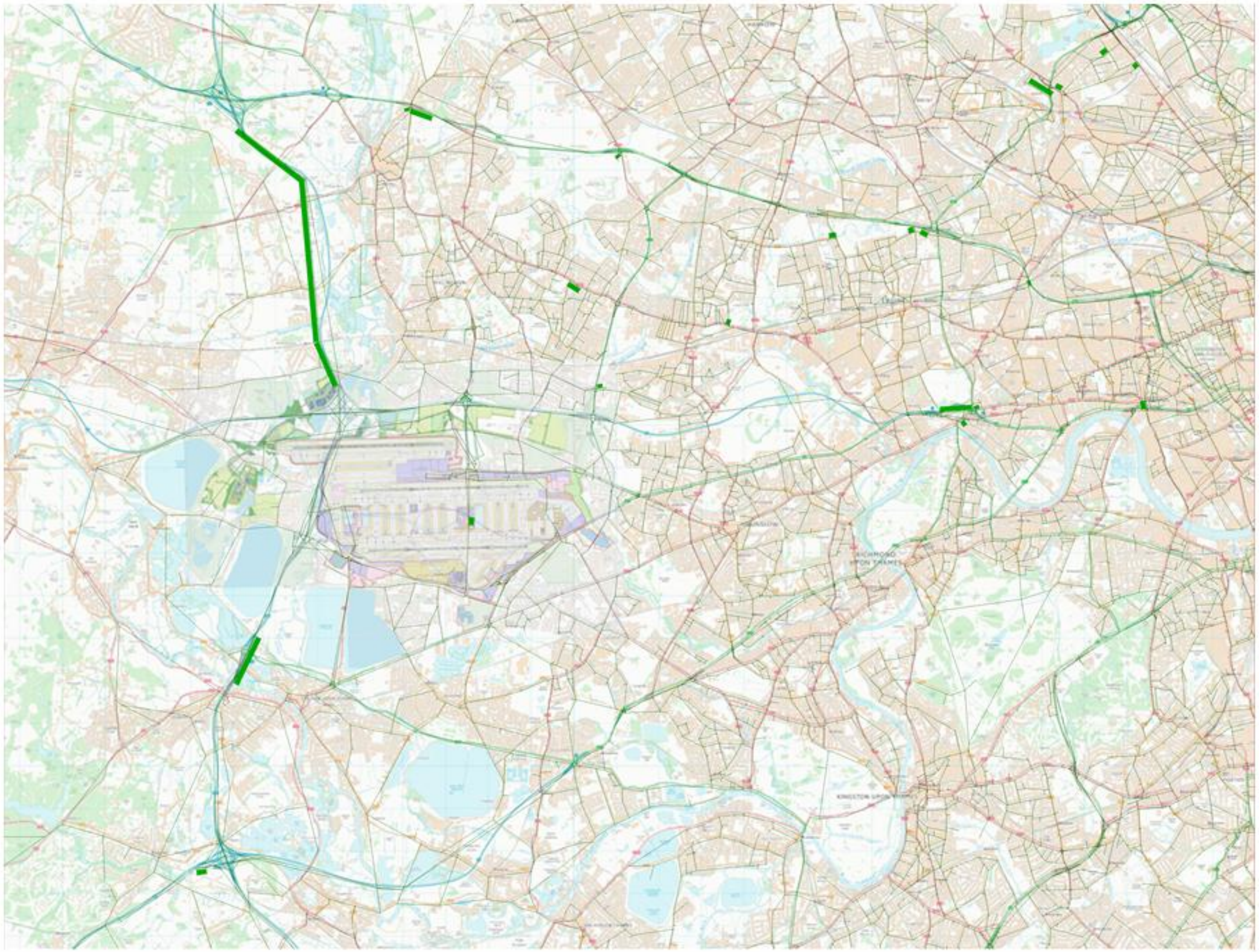


Figure 5-29: IP Over Capacity Locations – Heathrow North West Runway (expansion-only capacity exceedances in red)

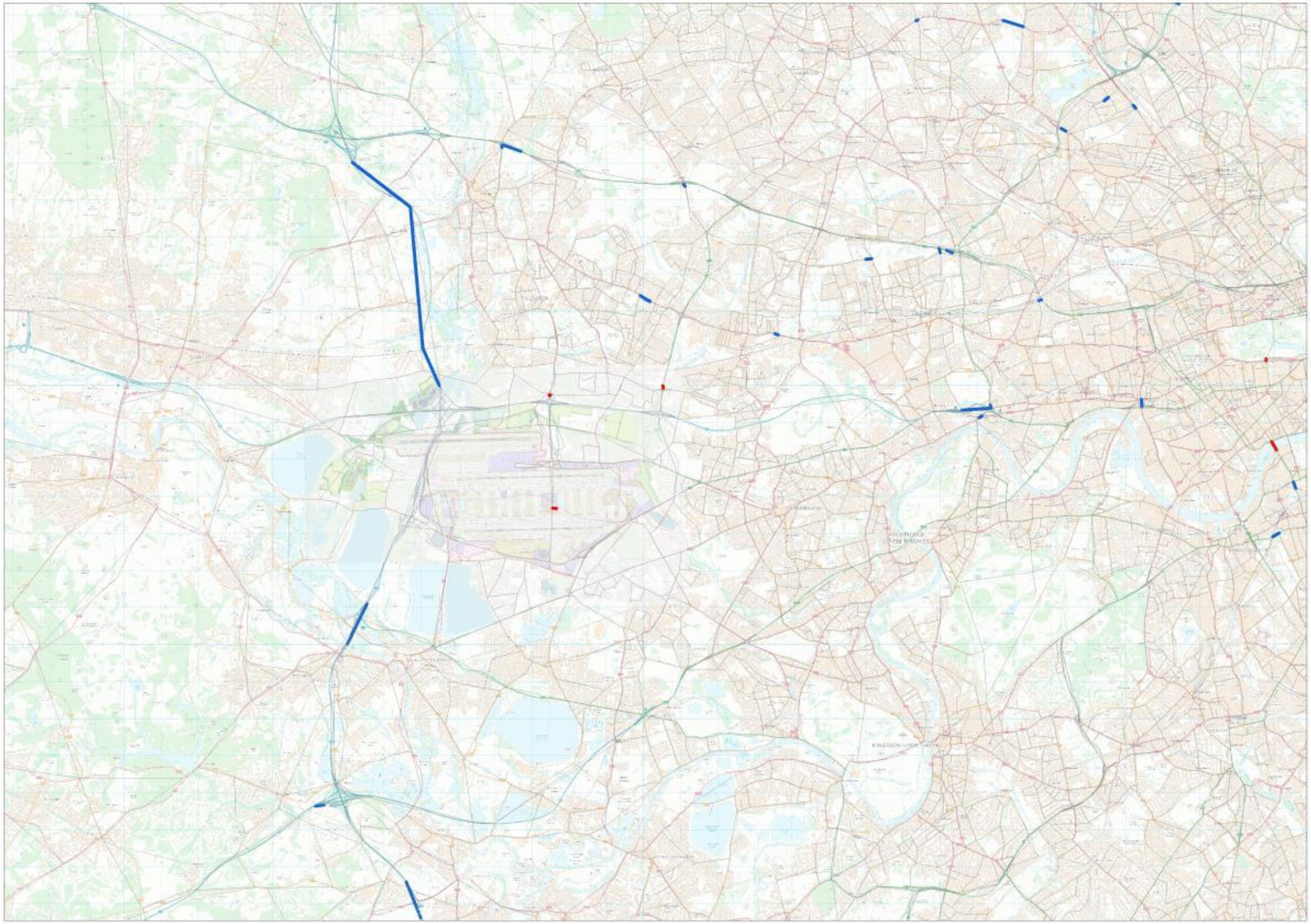


Figure 5-30: PM Over Capacity Locations – Extended Baseline

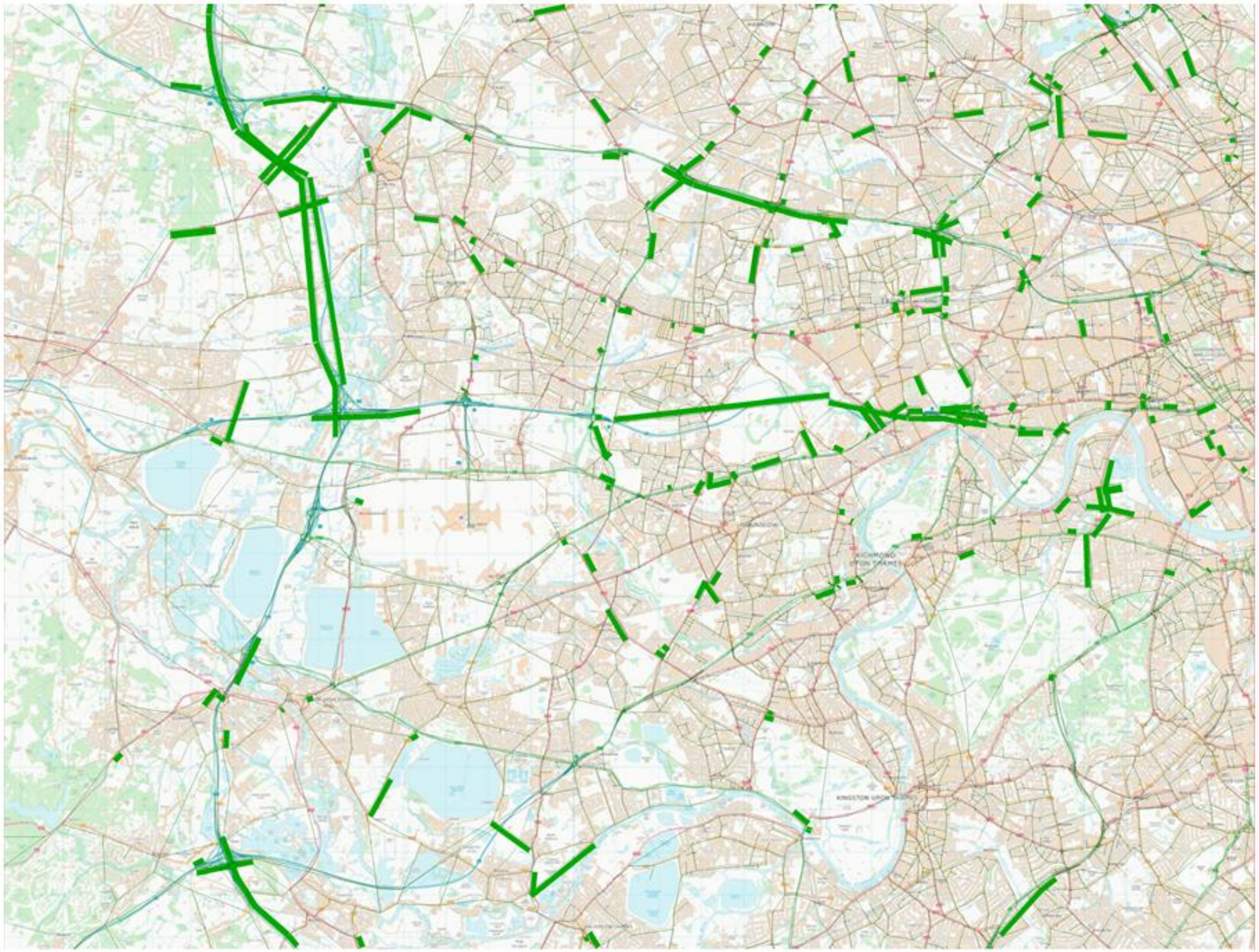


Figure 5-31: PM Over Capacity Locations – Heathrow North West Runway

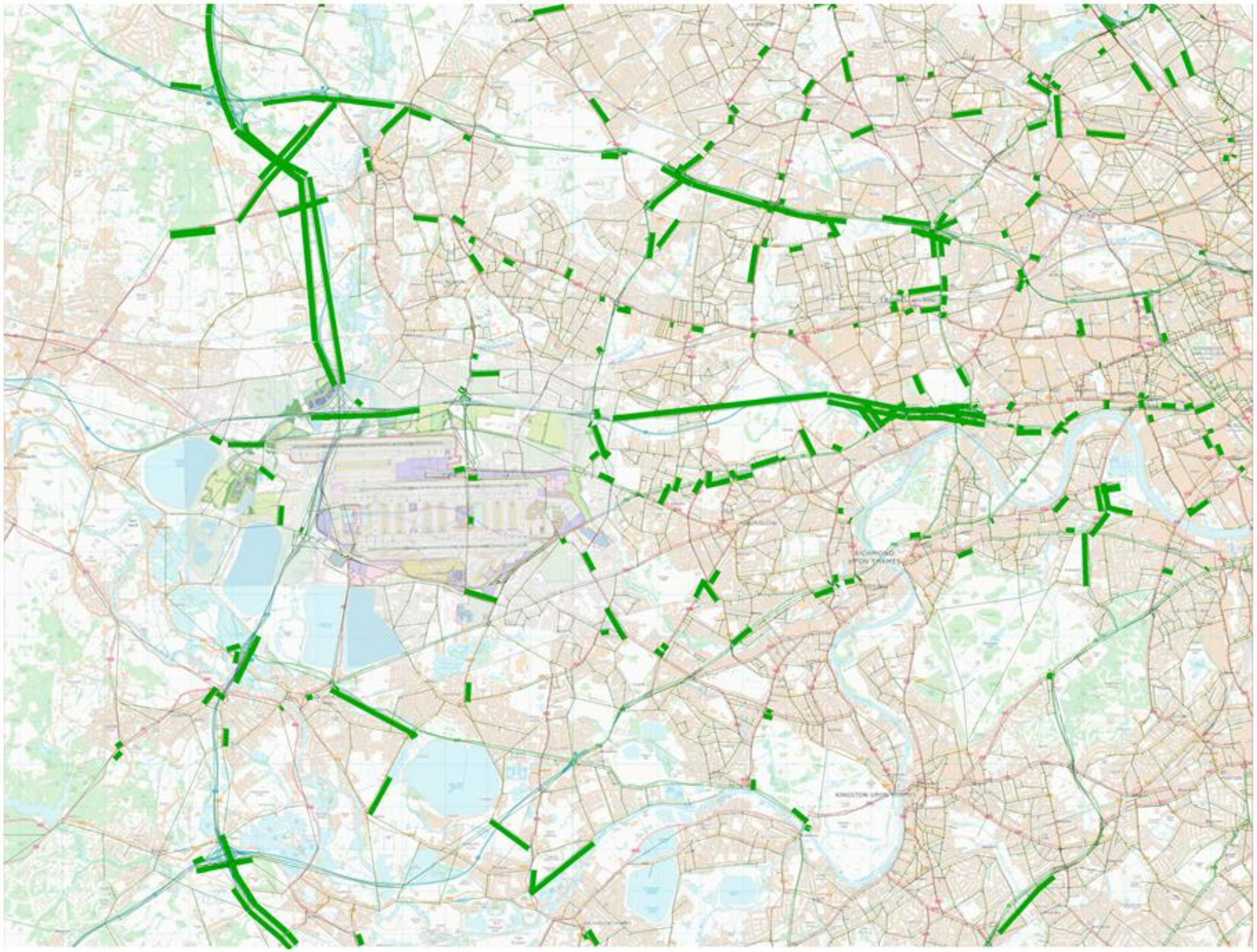
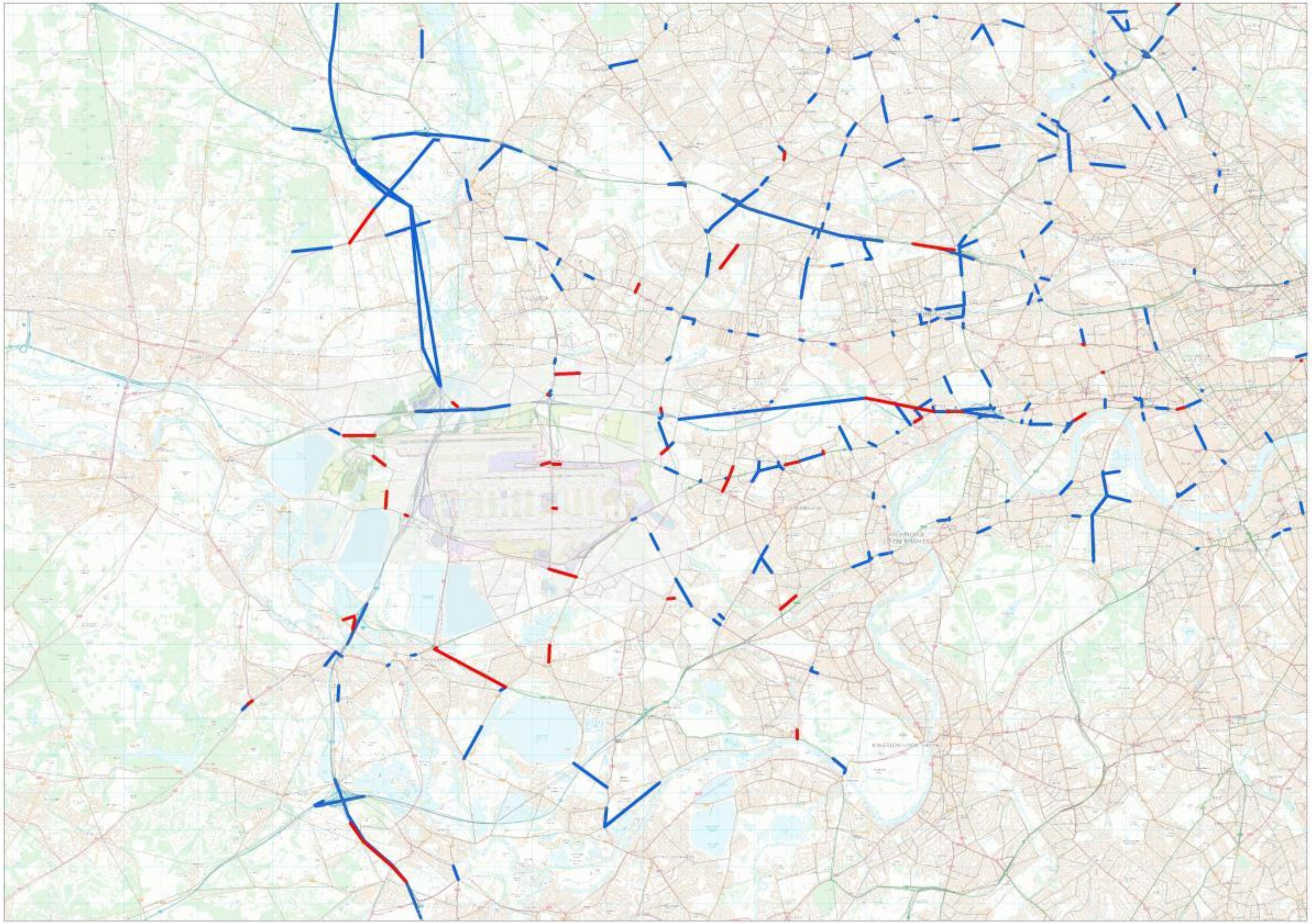


Figure 5-32: PM Over Capacity Locations – Heathrow North West Runway (expansion-only capacity exceedances in red)



5.7.17 A full v/c analysis (separately for demand and actual flows) for the all strategic links within the study area (over 600 links) in the Extended Baseline and Heathrow North West Runway scenarios is presented for all model periods in the tables in the **Supplementary Figures Report**. As well as defining the v/c ratios on each link, the number of Heathrow Airport bound trips on each link are also tabled, enabling one to determine whether the increase in v/c is due to additional traffic to/from the Heathrow North West Runway.

5.7.18 From this full analysis, we have extracted two sets summary tables which are included in this report. The first set of summary tables (presented in **Tables 5-8**, **5-9** and **5-10**) identify those links that are predicted to be overcapacity (defined as having a V/C ratio of over 1.00) in the Extended Baseline, and which are predicted to have higher v/c ratios in the Heathrow North West Runway scenario, i.e. the Heathrow North West Runway is increasing delays on an already overcapacity link. Such links identified include sections J1-2, J2-3 and J4-4B of the M4, and J15-16, J16-17, J17-18, J18-19, J19-20 and J20-21 of the M25. The **additional** number of Heathrow Airport trips attributable to the North West Runway contributing to these increased v/c ratios varies from around 500 trips/hour on the M4 J4-4B link, to around 250 trips/hour on the M4 J1-2 and J2-3 links and between 150-200 trips/hour on the M25 links previously identified. V/c ratios with the Heathrow North West Runway reach up to 1.31 on the M25 J18-19 link.

5.7.19 The second set of summary tables (presented in **Tables 5-11**, **5-12** and **5-13** in this report for the AM, IP and PM peak periods respectively) identify those links that are predicted to be less than full capacity (defined as having a v/c of over 1.00) in the Extended Baseline, but overcapacity in the Heathrow North West Runway scenario, i.e. the Heathrow North West Runway is causing the links to go overcapacity. increasing delays on an already overcapacity link. In preparing these figures, a threshold of a 50 airport PCUs on each link has been used, to ensure that only links related to Heathrow are identified. The location of these links is not identical across the AM and PM peak periods due to the tidal nature of roads surrounding the Heathrow Area, which carry a high proportion of commuter traffic. The **additional** number of Heathrow Airport trips attributable to the North West Runway contributing to these links reaching a v/c ratios of above 1.00 varies by around 200-400 trips/hr in each direction.

5.7.20 While reading these tables, the following should be noted:

- The location of these links is not identical across the AM and PM peak periods due to the tidal nature of roads surrounding the Heathrow Area, which carry a high proportion of commuter traffic;
- There are a number of locations under the North West Runway scenario where V/C ratio substantially worsens despite reduced demand. In these cases, the increased V/C is due to changes in opposing flows at the next junction downstream of the link resulting in a reduction of the links discharge capacity. For example, the minor approach to a give-way junction may experience a worsening of its V/C ratio despite lower demand if there was a substantial increase in demand to the major junction approaches which have a higher priority; and
- Our criteria for selecting over capacity links includes the definition that the additional number of Heathrow Airport trips attributable to the North West Runway scheme must be greater than 50 PCUs/hour on each individual link. For cases where additional airport demand amounts to less than 50 PCUs/hour, it is considered that the impacts directly attributable to the airport scheme are more negligible and these links have thus not been selected for this analysis.

5.7.21 The tables show the link V/C ratio under both the Extended Baseline and North West Runway Scheme, the difference in traffic demand between the schemes and the year which the link is predicted to go over capacity without additional runway capacity. This prediction gives an indication of how far construction of the North West Runway will bring forward the point where links are reaching capacity.

5.7.22 Key strategic links identified to be overcapacity in the Extended Baseline Scenario and to worsen in the North West Runway scheme are presented in **Tables 5-8**, **5-9** and **5-10** and include:

- M4 J1-2, J2-3 and J4-4B;

- M25 J12, J15-16, J16-17, J17-18, J18-19, J19-20 and J20-21;
- M3 J2; and
- Various locations along the A4 and A40.

5.7.23 It is notable that in the IP period only 3 links are forecast to operate above capacity in the Extended Baseline scenario and experience a worsening of conditions with the Heathrow North West Runway. These are limited to the M25 southbound through Junction 11, the M25 northbound between junctions 15 and 16, and the A40 westbound on-slip from Hanger Lane Roundabout.

5.7.24 For large periods of the day (10:00-16:00) the North West Runway is therefore not expected to have a wide-scale impact on links that would already be operating above capacity even without its introduction. For the aforementioned links that are impacted, the V/C values are typically expected to increase by less than 1%.

5.7.25 Consistent with the methodology adopted in our pre-consultation analysis, whilst identifying links that are predicted to experience greater over-capacity ratios with the Heathrow North West Runway option, these links are predicted to be over-capacity in the Extended Baseline scenario with general background traffic growth and therefore the responsibility to address these issues rests with the DfT.

5.7.26 In comparison, the second set of tables identify links that are predicted to go over-capacity due to the additional traffic from the Heathrow North West Runway scenario and the responsibility to address these issues should rest with the scheme developer.

5.7.27 Key strategic links identified to be under capacity in the Extended Baseline Scenario and over capacity in the North West Runway scheme are presented in **Tables 5-11**, **5-12** and **5-13** and include links at the following locations:

- M4 J1-2, J2-3, J3 and 4B;
- M25 J11-12, J17-18, J15;
- M3 J2; and
- Various locations along the A4, A312, A316, A408, and A30, as well as the Emirates Roundabout.

5.7.28 It is notable that in the IP period only the southbound approach to the A312 / Hayes Road Roundabout is forecast to go from under capacity in the Extended Baseline scenario to over capacity with the introduction of the North West Runway. For large periods of the day (10:00-16:00) the North West Runway is therefore not expected to cause wide-scale capacity issues.

5.7.29 Options available to relieve the capacity restraint include: mainline road widening; the construction of parallel “collector-distributor links”; policy levers within the control of HAL to reduce car-based airport traffic (e.g. airport car park pricing or airport congestion charging) and policy levers outside the control of HAL, (e.g. national congestion charging, policies to encourage home working). Further discussion is required on these options.

Table 5-8: AM worsened over capacity locations

	2031 Forecast Year			
Location	Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
A4 / B317 Junction: Eastbound Approach from A4 Talgarth Road	108.53	109.40	24	2011
A4 Great West Road Chiswick, Eastbound - Mainline	106.11	106.89	34	2015
A4 Ellesmere Road / Sutton Ct Road Junction: Westbound Approach from A4	102.74	105.60	90	2023
M4 Through Junction 2: Westbound Mainline	106.20	109.11	170	2025
M4 Junction 1 to Junction 2: Westbound Mainline	107.73	110.43	111	2023
Hogarth Roundabout: Southbound Approach from Great West Road, Chiswick	101.95	103.33	52	2028
M4 Junction 2 towards Junction 3 (where A4 / M4 Alignments Separate)	100.28	102.95	115	2031
A4 Great West Road, Chiswick: Eastbound from Hogarth Roundabout	106.12	106.89	34	2015
A40 Western Avenue: West of Hanger Lane Roundabout, Westbound	106.38	107.05	30	2016
A40 Western Avenue: West of Hanger Lane Roundabout, Eastbound	103.38	104.12	33	2011
A40 Hanger Lane Roundabout - Circulating	100.62	101.19	14	2026
A40 Western Avenue: Eastbound Over A40 / Greenford Rd Roundabout	101.38	102.34	94	2028
White Hart Roundabout: Northbound Approach from A312 The Pkway	100.64	101.04	7	2026
A40 / A312 Roundabout: Northbound Approach from A312	105.23	105.84	8	2020
Hendon Link	107.62	108.17	12	Expansion Only
M25 Junction 16 to Junction 15: Southbound Mainline	101.4-107.2	103.1-109.8	219	2019
M25 Junction 15 to Junction 16: Northbound Mainline	104.17	105.72	130	2028
M25 Junction 16 to Junction 17: Northbound Mainline	101.40	102.43	87	2031
M25 Through Junction 16: Northbound Mainline	102-104.8	102.6-105.9	68	2027
M25 Junction 18 to Junction 19: Northbound Mainline	103.02	104.34	111	2030
M3 Junction 2: Westbound On Slip from M25	106.83	107.45	22	Expansion Only

Table 5-9: IP worsened over capacity locations

Location	2031 Forecast Year: Extended Baseline V/C	2031 Forecast Year: North West Runway V/C	2031 Forecast Year: Demand Change	Year V>C Without Airport Expansion
A40: Westbound On Slip from Hanger Lane Roundabout	101.65	102.21	13	2026
M25 Junction 15 to Junction 16: Northbound Mainline	102.5-103.22	103.6-105.5	92	2030
M25 Through Junction 11: Southbound Mainline	148.14	148.73	26	Expansion Only

Table 5-10: PM worsened over capacity locations

Location	2031 Forecast Year: Extended Baseline V/C	2031 Forecast Year: North West Runway V/C	2031 Forecast Year: Demand Change	Year V>C Without Airport Expansion
A4 Talgarth Road / Giddon Road Junction: Eastbound Approach from A4	104.93	107.93	91	2025
A3220, Northbound - Approaching A40 Westway Roundabout	102.41	102.68	6	2025
Harlington Road E, Northbound - Approaching A244 Signals	104.38	104.68	3	Expansion Only
A4, Eastbound -From A30 Junction to alignment split with M4	103.80	105.23	26	Expansion Only
A4 Ellesmere Road / Sutton Ct Road Junction: Westbound Approach from A4	115.79	118.25	71	Expansion Only
M4 Junction 2 to Junction 1: Eastbound Mainline	104.80	108.90	145	2026
M4 Through Junction 2: Westbound Mainline	111.44	115.56	212	Expansion Only
M4 Junction 3 to Junction 2: Eastbound Mainline	103.6-106.8	107.0-109.8	147	2027
M4 Junction 1 to Junction 2: Westbound Mainline	103.33	107.02	151	2020
M4 Junction 2 to Junction 3: Westbound Mainline	101.22	104.98	165	2028
M4 Junction 3 Roundabout (Circulating)	106.5-108.1	107.9-110.2	47	2020
Hogarth Roundabout: Southbound Approach from Great West Road, Chiswick	110.64	111.18	19	Expansion Only
M4 Junction 2 towards Junction 3 (where A4 / M4 Alignments Separate)	103.58	107.42	165	2020
M4 Junction 4 to Junction 4B: Westbound Mainline	105.42	107.26	136	2021
A40 / A312 Roundabout (Circulating)	108.77	110.23	30	2009
A40 / A312 Roundabout: Westbound Approach from A40	103.75	106.01	61	2023
A40 / A312 Roundabout: Northbound Approach from A312	113.70	114.51	9	2012
M25 Junction 16 to Junction 15: Southbound Mainline	103.09	103.83	63	2029

Location	2031 Forecast Year			
	Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
M25 Junction 15 to Junction 16: Northbound Mainline	113.2-118.9	116.1-123.3	244	2025
M25 Junction 16 to Junction 17: Northbound Mainline	116.59	119.56	249	2024
M25 Through Junction 16: Northbound Mainline	117.1-123.4	120.1-126.8	225	2018
M25 Junction 20 to Junction 21: Northbound Mainline	109.19	112.13	247	2026
M25 Junction 19 to Junction 18: Southbound Mainline	101.99	102.59	50	2031
M25 Junction 19 to Junction 20: Northbound Mainline	109.40	112.09	226	2026
M25 Junction 18 to Junction 19: Northbound Mainline	125.1-128.3	127.7-131.2	244	2017
M25 Through Junction 17: Northbound Mainline	107.15	110.07	246	2029
M25 Junction 17 to 18: Northbound Mainline	117.23	120.12	242	2023
M25 Through Junction 20: Northbound Mainline	116.46	119.59	218	2023
Through M4 Junction 4B: Westbound	108.24	108.38	-15	Expansion Only
M4 Junction 4B: Westbound On Slip	102.96	106.70	118	2023
M3 Junction 2: Eastbound Off Slip	102.22	102.33	4	2030
M25 Through Junction 12, Southbound	106.69	107.21	34	2025

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Table 5-11: AM new overcapacity locations

Location	2031 Forecast Year: Extended Baseline V/C	2031 Forecast Year: North West Runway V/C	2031 Forecast Year: Demand Change	Year V>C Without Airport Expansion
A4: Westbound to A4 / A30 Junction	99.78	102.72	45	2032
M4 Junction 2 to Junction 1: Eastbound Mainline	97.74	100.03	81	2038
M4 Junction 2 to Junction 3: Westbound Mainline	98.00	100.61	115	2037
M4 Junction 3 Roundabout (Circulating)	97.52	110.05	223	2036
A316 / Hampton Road Roundabout - Circulating	99.51	100.30	17	2033
A312 The Pkway: North of Willow Tree Roundabout, Southbound	97.48	101.61	56	2035
A408 Heathpark Golf Course Roundabout: A408 Southbound Approach	99.05	101.06	41	2036
M4 Junction 4B: Eastbound Off Slip	98.87	100.57	60	2034
M25 Junction 17 to 18: Northbound Mainline	98.97	100.06	91	2033
Horton Road: Westbound Approach to M25 J14 Roundabout	82.62	100.09	400	Expansion Only
Through M4 Junction 4B: Westbound	96.19	103.12	-35	Expansion Only
M4 Junction 4B: Westbound On Slip	93.65	101.07	404	Expansion Only
M25 Junction 11 to Junction 12: Northbound Mainline	99.61	100.93	115	2033
M3 Junction 2: Eastbound Off Slip	99.27	101.19	68	2035

Table 5-12: IP new overcapacity locations

Location	2031 Forecast Year: Extended Baseline V/C	2031 Forecast Year: North West Runway V/C	2031 Forecast Year: Demand Change	Year V>C Without Airport Expansion
A312 / Hayes Road Roundabout: A312 Southbound Approach	98.91	100.94	32	2037

Table 5-13: PM new overcapacity locations

	2031 Forecast Year			
Location	Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
A4 / B317 Junction: Eastbound Approach from A4 Talgarth Road	97.57	100.99	105	2035
A4 Great West Road Chiswick, Eastbound - Mainline	98.93	101.80	126	2033
Through M4 Junction 2: Eastbound	98.47	102.48	161	2034
A30 Junction with Stanwell Road: South-eastbound Approach from Stanwell Road	90.36	102.63	99	2048
M4 Junction 3: A312 Southbound Approach	98.46	103.32	-62	2039
M4, Eastbound - Junction 3 to 2 - Mainline	96.59	100.09	147	2038
A4 Great West Road, Chiswick: Eastbound from Hogarth Roundabout	98.93	101.80	126	2033
Emirates Roundabout: Eastbound Approach from Newport Road	97.26	101.43	-88	Expansion Only
Emirates Roundabout: Westbound Approach from Nene Road Roundabout	59.18	102.27	436	Expansion Only
M25 Junction 15 Link to M4: Eastbound	95.33	102.42	251	2035
B455 / Broadmead Road Junction, Greenford: Northbound Approach from Broadmead Road	95.98	100.34	51	Expansion Only
B377 / B378 Roundabout: Southbound Approach from A30 Great South-West Road	95.97	101.55	57	Expansion Only
M25 Junction 11 to Junction 12: Northbound Mainline	98.97	100.35	116	2033

5.8 Conclusions

5.8.1 In 2030, even with the infrastructure enhancements assumed in the Extended Baseline, the level of increase in background demand is such that many links on the strategic road network are predicted to be operating at above capacity (defined as actual flows/capacity ratios of above 1.0). These links include J1-2, J2-3 and J4-4B of the M4, and J15-16, J16-17, J17-18, J18-19, J19-20 and J20-21 of the M25. Furthermore, 7% of the car demand to Heathrow Airport is predicted to be queued on the network and be unable to reach its destination in the modelled hour. In reality, such trips would leave earlier and contribute to peak spreading.

5.8.2 Consistent with the methodology adopted in our pre-consultation analysis, as these links are predicted to be over-capacity in the Extended Baseline scenario with general background traffic growth, the responsibility to address these issues rests with the DfT.

5.8.3 The construction of the Heathrow North West Runway is predicted to result in an **additional** number of car/taxi trips of 1,400 trips/hr to Heathrow in the AM peak direction, 1,200 trips/hr to/from Heathrow in the Inter-peak and 1,250 trips from Heathrow in the PM peak direction. These additional trips will further increase the levels of over-capacity on the links specified in the paragraph above. Furthermore, 9% of the car demand to Heathrow Airport is predicted to be queued on the network in the Heathrow North West Runway option, an increase of 2% over the Extended Baseline option.

5.8.4 Tables 5-8 to 5-10 above identify those links that are predicted to go over-capacity due to the additional traffic from the Heathrow North West Runway scenario and the responsibility to address these issues should rest with HAL. Options available to relieve the capacity restraint include: mainline road widening; the construction of parallel “collector-distributor links”; policy levers within the control of HAL to reduce car-based airport traffic (e.g. airport car park pricing or airport congestion charging) and policy levers outside the control of HAL, (e.g. national congestion charging, policies to encourage home working). Further discussion is required on these options.

5.8.5 Furthermore, the revised local road layout proposed by HAL has resulted in a change of the routing of some trips to/from Heathrow Airports. The effect of these changes has been as follows:

- M25 between junctions 14 and 15 – volume decrease;
- Southern perimeter road – volume increase;
- M4 spur / terminal access tunnel – volume increase;
- Poyle road – volume increase; and
- A3044 adjacent to M4 junction 4 – volume increase.

6. Summary and conclusions

6.1 Background

6.1.1 The AC was established in 2012 by the UK Government to examine the need for additional UK airport capacity and to recommend how any additional capacity requirements can be met in the short, medium and long-term. The AC is due to submit a Final Report to the UK Government by the summer of 2015, assessing the environmental, economic and social costs and benefits of various solutions to increase airport capacity, considering operational, commercial and technical viability.

6.1.2 The AC published an Interim Report in December 2013 that short-listed three options to address the UK's long-term aviation connectivity and capacity needs, two focussed on expanding Heathrow Airport and one on expanding Gatwick. The short-listed options were then subsequently further developed and appraised during a pre-consultation assessment, which was published for consultation in November 2014.

6.1.3 The pre-consultation assessment with respect to surface access constituted a static appraisal using spreadsheet-based demand-forecasting models, which were developed primarily to assess the surface transport capacity implications of each expansion option. Following feedback from the AC's surface access stakeholders (the DfT, the HA, NR, and TfL), further assessment of the surface access implications of the three expansion options was undertaken during the consultation period, from November 2014 to January 2015.

6.2 Post-consultation Study scope

6.2.1 This report describes the aforementioned surface access assessment undertaken during the consultation period, referenced throughout as 'post-consultation'. The key aims of post-consultation work were as follows:

- To undertake further sensitivity-testing of the pre-consultation models to determine the impact of key variables on airport-related surface access demand, notably incorporating trip distribution forecasts from the DfT's NAPAM;
- To provide a more detailed dynamic assessment of the capacity and level-of-service implications of airport expansion associated with each short-listed option;
- To provide traffic forecasts compatible with the requirements of the air quality assessment that will be undertaken as a part of a separate environmental work-stream - the data requirements for this work-stream are summarised in Appendix A.

6.2.2 The ultimate aim was to provide further guidance to the AC on the feasibility of, and likely surface transport issues associated with each short-listed expansion option, with reference to three objectives set out in the AC's Appraisal Framework as follows:

- **Objective 1** – to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport;
- **Objective 2** – to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight; and
- **Objective 3** – to enable access to the airport from a wide catchment area.

6.3 Methodology overview

6.3.1 The post-consultation surface access assessment was divided into three work-streams, summarised as follows:

- Enhanced distribution/mode-share modelling - this involved enhancements to the spreadsheet models developed pre-consultation - the air passenger and on-airport employee surface access forecasts arising from the enhanced models provided inputs for the following two work-streams;
- Dynamic rail modelling - rail surface access forecasts from the enhanced spreadsheet models were input into the Railplan model (version 7, supplied by TfL) to assess the dynamic impacts of increasing airport-related rail trips on network performance in London and the South-East of England;
- Dynamic highway modelling - highway surface access forecasts from the same spreadsheet models were also input into TfL's West London Highway Assignment Model (WeLHAM) to assess the dynamic impacts of increasing airport-related road trips on network performance in London and the South-East.

6.3.2 The forecast year of assessment was 2030 (as it was in Phase 2) and a range of time periods were modelled in accordance with the requirements of the dynamic modelling work-streams. For the highway modelling, an AM and a PM peak-hour was required along with an average Inter Peak (IP) hour. For the Railplan modelling, a 3-hour AM peak and a 6-hour IP period were modelled.

6.3.3 The assessment was undertaken with reference to a Core and an Extended Transport Baseline, which together listed transport infrastructure and services expected or likely to be in place by 2030 regardless of any airport expansion that may be delivered in the UK. Details of the schemes included in these baselines are provided in Appendix B – the Core Baseline only included those schemes that were fully committed and funded when the pre-consultation assessment commenced. The primary focus of all the analysis was on the Extended Baseline as by 2030 it was judged very likely that further enhancements to the UK transport network would have been delivered above and beyond the works that were fully committed before the consultation.

6.3.4 Constructing an appropriate Extended Baseline for a 2030 assessment involved making significant assumptions about the likely state of the transport network by that time, and this was a central factor in the decision not to extend the scope of the surface access assessment to include later years. There is currently a high degree of uncertainty surrounding some of the included schemes, not just in terms of their delivery but also their final form and characteristics, which in some cases are continually evolving as development work is progressed.

6.4 Airport expansion scenarios

6.4.1 The highest AC scenario for Heathrow North West Runway in terms of airport passengers in 2030 was the Carbon-Traded Global Growth (CT GG) scenario. The passenger forecasts for this scenario included a total of 87.5 million passengers per annum (mppa) using the airport with two runways in 2030, increasing to a total of 125.2mppa with the North West Runway in place in the same year. The proportion of those passengers that were interlining was forecast to rise from 22.6% with two runways up to 32.9% with the North West Runway in place.

6.4.2 In terms of employment, the AC produced two forecasts for Heathrow in 2030 expressed as ratios of passengers per annum (ppa) per employee – a low productivity scenario assuming a year-on-year increase of 0.5% in the ppa/employee ratio from a base 2011 figure, and a high productivity scenario assuming an increase of 2.25%. The mid-point between the two amounted to a ratio of 1,088ppa/employee – when applied to the CT GG passenger scenario described above, this resulted in a forecast of 80,357 employees at the airport with two runways rising to 114,999 with the North West Runway in place.

6.4.3 The passenger and employee figures described above were identified as the core scenario for the post-consultation assessment, and associated demand forecasts from the spreadsheet model were assessed using Railplan and WeLHAM.

6.4.4 In addition, airport-related demand forecasts were also produced for two other scenarios for comparative purposes, as follows:

- AC Carbon-Capped Assessment of Need (CC AoN) scenario – 84.9mppa (24.7% interlining) and 78,029 employees with two runways, rising to 109.3mppa (32.0% interlining) and 100,400 employees with the North West Runway (also assuming the mid-point employee ratio described above);
- Heathrow Airport Ltd (HAL) submission – 82.5mppa (35% interlining) and 72,100 employees with two runways, rising to 103.6mppa (35% interlining) and 90,000 employees with the North West Runway (with the employee numbers sourced directly from the submission rather than calculated using a ratio).

6.4.5 Sensitivity tests were undertaken for these other two scenarios in the spreadsheet-based distribution and mode choice models, but not in the network-based Railplan and WeLHAM models.

6.5 Distribution and mode share modelling enhancements

6.5.1 In addition to amending the spreadsheet model to input the revised airport mppa and employment inputs and to produce forecasts for a range of time periods according to the requirements of the dynamic modelling work-streams, a number of other enhancements were also made post-consultation, as follows:

- for the two AC scenarios, the pre-consultation passenger surface access distribution assumptions were replaced with outputs corresponding to each scenario from the DfT's NAPAM;
- employee mode split assumptions were applied at district level to account for the different travel options likely to be available to employees in 2030 based on their home location – pre-consultation a single headline mode split was applied to all employees regardless of their home location.

6.5.2 All other inputs to the model post-consultation were retained from pre-consultation.

6.5.3 The impact of the changes in the model can be summarised in terms of three elements: trip distribution; mode share and vehicle and rail trip demand.

6.5.4 In terms of trip distribution, the adoption of the NAPAM trip distributions compared to the CAA trip distributions made very little difference, both at a sector level and at a key district level. For example, the proportion of trips coming to/from Greater London was 51.1% from the CAA data and 51.2% from the NAPAM data. Similarly, the proportion of trips coming to/from Kensington and Chelsea was 11.8% from the CAA data and 11.5% from the NAPAM data

6.5.5 In terms of mode choice, there are only slight variations in passenger mode share between the different scenarios and expansion options, with the rail sub-mode share predicted to be 41.6% in the previous pre-consultation analysis, dropping slightly to 40.8%in the CT GG NWR option.

6.5.6 Given the similarities in the distribution and mode share forecasts across the core and alternative scenarios, the difference in total demand is largely driven by the difference in headline passenger and employee growth forecasts and interlining ratios associated with each scenario. As is to be expected, forecast airport demand is higher in all scenarios with the North West Runway in place, and the greatest demand for both employees and passengers occurs in the CT GG scenario.

6.5.7 In response to comments from the stakeholders and AC expert panellists pre-consultation, we also undertook four sensitivity tests, as follows:

- Changing the Value of Times (VoT) used to calculate Generalised Cost for business and leisure passengers travelling to and from the airport – requested by the DfT;
- Changing the methodology for calculating base year mode share using the CAA passenger survey data – requested by the DfT;
- Airport passenger luggage space requirement impacts – requested by the AC expert panellists;
- The impact of rail pricing on demand – requested by the AC expert panellists.

6.5.8 Changing the VoTs in the model impacts on both main mode and rail sub-mode share for passengers and consequently the car and rail demand forecasts. In broad terms, as VoT increases, so does the attractiveness of time saving vis-a-vis other costs (i.e. rail fares, car operating costs) in the model. For business passengers, the impact of using the higher SERAS (2030) business values of time was to increase the mode share of the premium HEX service from 21.3% to 30.5%. For leisure passengers, the impact of using the lower SERAS (2030) leisure values of time was to reduce the mode share of the premium HEX service from 10.4% to 4.0%.

6.5.9 The results of the other three sensitivity tests will be reported at the end of January 2015.

6.6 Dynamic rail assessment

6.6.1 The dynamic rail modelling work-stream was undertaken using TfL's Railplan model, which is a strategic public transport model coded in Emme software that covers London and its surrounding area. Railplan Version 7 has recently been developed to represent baseline conditions in 2011, and TfL also provided a Railplan 7 forecast run for 2031 based on the '7031ref6' low car growth scenario, which is the central case currently used by TfL to test public transport scheme impacts.

6.6.2 This 2031 reference case is based on a forecast population of 9,839,366 and 5,265,000 jobs in the Greater London Authority (GLA) area in 2031. Assumptions are also made about the extent of the transport network in London and the South East in this year – these are summarised in Appendix C.

6.6.3 A review of the LTS '7031ref6' inputs was undertaken to identify the schemes in the AC's Core and Extended Baselines (summarised in Appendix B) that were not included, and to highlight any differences in assumptions between '7031ref6' and the Core/Extended Baselines for schemes that were. Adjustments were then made to service patterns and rolling stock characteristics on key rail corridors in and around Heathrow to reflect information provided by the AC's stakeholders during pre-consultation and recent published updates.

6.6.4 A new LTS 2031 'Extended Baseline' run was then undertaken to account for any induced demand impacts related to the changes in service provision associated with the Extended Baseline schemes. The results of the run when compared with the 2031 reference case indicated an increase in total National Rail/Tramlink boardings of 134,000 across the 3-hour AM peak for the whole model, an uplift of 7.1%, while passenger-kms increased by 1.87m (3.1%) in the same period.

6.6.5 In terms of the distribution of demand, the LTS Extended Baseline run indicated that forecast uplifts in PT demand when compared with the reference case correlated closely with the geography of transport improvements included in the Extended Baseline. The largest % uplifts occurred in areas in Surrey, Kingston-upon-Thames, Merton, Hackney, Enfield and parts of Hertfordshire (as a result of the Crossrail 2 regional option); Bromley and Lewisham (as a result of the Bakerloo Line southern extension); and areas around Watford, Hemel Hempstead and St. Albans (as a result of improved suburban services into Euston, taking advantage of the released capacity created by the introduction of HS2).

6.6.6 Two additional schemes beyond the Extended Baseline were also coded in Railplan for the tests involving the expansion of runway capacity at the airport: Southern Rail Access and Crossrail 6 trains per hour to Heathrow.

6.6.7 Airport-related demand forecasts from the resultant LTS runs were then be removed from the matrices and replaced with the forecasts derived for the core scenario enhanced spreadsheet model. The Railplan Extended Baseline model was then be run with associated background and airport-related demand for a range of scenarios, including the airport in its current form and with the North West Runway included.

6.6.8 In terms of the AM peak period (0700-1000), the following key conclusions can be drawn from the analysis summarised in this chapter in terms of the impacts of the North West Runway on the rail network:

- In the ‘no expansion’ 2031 scenario, Crossrail is forecast to reach crowding levels of just under 4 people standing per m^2 in central London, meaning that airport passengers using the service to travel into London in the AM peak will experience heavily crowded conditions on trains, although they will not have any issues boarding trains at the airport – there are no forecast crowding issues on services in the counter-peak direction from central London to the airport during this time period;
- There are no other significant crowding issues forecast on any other lines serving the airport in the ‘no expansion’ scenario – flows on the Piccadilly Line in the vicinity of Heathrow are expected to increase by around 40-50% from 2011 but planned improvements to Piccadilly Line capacity and other new services included in the AC’s baselines mean that crowding levels on the line are actually forecast to improve when compared with 2011;
- The addition of the North West Runway (without SRA and Crossrail 6tph) increases crowding marginally on the Piccadilly Line although conditions are still forecast to be an improvement on 2011;
- The North West Runway (without SRA and Crossrail 6tph) also increases crowding marginally on Crossrail, for example from 3.99 people standing per m^2 on Heathrow trains on the section of the line west of Bond Street to 4.03, an increase of 0.04 people per m^2;
- The introduction of a 6tph Heathrow Crossrail service has the potential to relieve this marginal increase in crowding, although further investigation is required to determine whether this increase is feasible given the other demand on train paths on the GWML;
- The introduction of SRA has further benefits in terms of reducing demand on Crossrail and the Piccadilly Line when compared with the expansion scenario where it is excluded;
- However, the SRA attachment-detachment option, which was modelled to avoid increasing overall train frequency through level-crossings in the Richmond area on the Windsor Line, adds airport demand to a service that is forecast to be severely over-crowded in the ‘no expansion’ scenario – while further assessment will be undertaken by NR on SRA options, this analysis appears to suggest that a service is not viable unless additional capacity can be provided on the Windsor Line through Richmond;
- Rail journey times to Heathrow are similar in all three scenarios tested, although model metrics indicate that SRA increases the rail catchment of the airport, meaning that rail passengers on average travel from further afield to reach Heathrow than they do in the scenarios where SRA is excluded – overall rail journey times in the 2031 Extended Baseline model runs are broadly comparable with those in the 2011 model, where the airport has a significantly smaller airport catchment.

6.6.9 In terms of the IP period (1000-1600), there is little crowding in evidence across the rail network in general. Among services providing direct connections to Heathrow, passengers only appear to be standing on Crossrail and the forecast never exceeds 1 person per m^2 in any of the scenarios tested.

6.7 Dynamic highway assessment

Use of WeLHAM Model

6.7.1 Dynamic highway modelling of road surface access to Heathrow Airport has been undertaken to assess the impact of increased airport related traffic on the strategic and local road network surrounding Heathrow Airport. A network-based dynamic modelling approach has been adopted in order to capture the effect of capacity constraints on vehicle route choice, allowing for assessment of impacts due to vehicle re-routing.

6.7.2 All highway modelling has been completed using the SATURN software package. SATURN is an industry standard modelling package, widely used to inform the design and appraisal of highway projects both within the United Kingdom and internationally. The existing TfL WeLHAM SATURN model was provided to Jacobs by TfL for use on this project, forming the base for highway modelling of Heathrow Airport.

6.7.3 WeLHAM is one of five SATURN models developed by TfL which together cover the whole of greater London. Each model covers the whole of London, but differ in the area coded as "simulation", defined as detailed junction coding of traffic signals, roundabouts and priority junction. Whilst the whole of London is coded, the simulation area is defined as the West London sector, and includes the boroughs of: Brent; Ealing; Harrow; Hillingdon and Hounslow. Thus the area of interest for this study, is entirely contained within the WeLHAM detailed modelled area.

WeLHAM Model Audit and Validation

6.7.4 To ensure the WeLHAM model produces logical results around Heathrow, a comprehensive audit of base network coding and outputs within the study area was completed by Jacobs. As part of this the following network checks were undertaken:

- Roads: directionality, user class bans, free flow speed, delay, length, capacity; and
- Junctions: Numbers of entry lanes, junction type, turn allocations and saturation flows.

6.7.5 The model base audit revealed no critical issues in regards to route choice and model output, however, a number of network coding issues were identified. The majority of these were deemed to be minor and unlikely to substantially alter model results, but two changes were made to address more significant inconsistencies identified.

6.7.6 Although the overall WeLHAM model is well validated, with key calibration statistics (journey time, link flow, screenline flow) within WebTAG guideline criteria, to ensure the model is fit for purpose to assess traffic conditions surrounding Heathrow, an additional localised review of summary statistics was undertaken.

6.7.7 The localised Heathrow area summary statistics review was completed using a subset of the 2009 WeLHAM observed data, comprising of the following:

- All count sites and screenlines within the area of interest; and
- All journey time routes passing through key links within the area of interest, selected by visual assessment.

6.7.8 Overall, the model performance summary statistics show that the model replicates observed screenline flows and strategic road link flows (flow greater than 1000 pcu/hr) within acceptable limits. Replication of journey time and link flows for minor roads is less accurate. However, journey time replication only marginally fails to meet WebTAG criteria and the results show no systematic issue. Given the objectives of this study are primarily concerned with activities which depend upon the strategic road network, local road link flows outside of guideline calibration criteria is not considered a critical issue. On this basis, it is considered that the WeLHAM within the Heathrow area of interest is fit for purpose and no further updates to the model within the Heathrow area were required. A full assessment of model performance within the Heathrow area is detailed within a Technical Appendices document.

Forecast Year Demand

6.7.9 WeLHAM traffic forecasts were provided to Jacobs by TfL for both 2021 and 2031, based on the uncertainty surrounding growth to 2031 it was assumed that no further adjustment would need to be made to adjust the non-airport traffic to a common year of 2030 and as such all further reference to traffic forecasts will be to 2030. Thus, with the exception of trips to/from Heathrow Airport, the future year trips for all zones in the WeLHAM model were adopted.

6.7.10 Two separate processes were used for forecasting of demand to/from Heathrow Airport: one covering cars and taxis and another covering LGVs and HGVs. For cars and taxis we used the outputs from the spreadsheet-based distribution and mode choice models described in sections 2 and 3 above to over-write the Heathrow row and column totals in the WeLHAM matrices. The growth in HGVs and LGVs at Heathrow Airport was calculated by using a linear growth factor of the passenger numbers (in mppa) between 2009 and 2030. No allowance has currently been made on changing patterns of goods vehicle delivery, as there is little published data on this.

Model runs

6.7.11 The WeLHAM model was run for the following two scenarios:

- 2030 Extended Baseline; and
- 2030 Heathrow North West Runway

6.7.1 In both cases the a detailed review of the model outputs was undertaken to ensure the forecast year traffic assignment produces reasonable results. In summary, our review has shown that the model is producing results which are considered reasonable in relation to the capacity and connectivity of the road network surrounding Heathrow. Large traffic volumes and areas of high congestions are shown to be largely confined to the strategic road network, while travel to and from Heathrow follows a logical route for all directions of travel.

Conclusions

6.7.2 In 2030, even with the infrastructure enhancements assumed in the Extended Baseline, the level of increase in background demand is such that many links on the strategic road network are predicted to be operating at above capacity (defined as actual flows/capacity ratios of above 1.0). These links include J1-2, J2-3 and J4-4B of the M4, and J15-16, J16-17, J17-18, J18-19, J19-20 and J20-21 of the M25. Furthermore, 7% of the car demand to Heathrow Airport is predicted to be queued on the network and be unable to reach its destination in the modelled hour. In reality, such trips would leave earlier and contribute to peak spreading.

6.7.3 Consistent with the methodology adopted in our pre-consultation analysis, as these links are predicted to be over-capacity in the Extended Baseline scenario with general background traffic growth, the responsibility to address these issues rests with the DfT.

6.7.4 The construction of the Heathrow North West Runway is predicted to result in an **additional** number of car/taxi trips of 1,400 trips/hr to Heathrow in the AM peak direction, 1,200 trips/hr to/from Heathrow in the Inter-peak and 1,250 trips from Heathrow in the PM peak direction. These additional trips will further increase the levels of over-capacity on the links specified in the paragraph above. Furthermore, 9% of the car demand to Heathrow Airport is predicted to be queued on the network in the Heathrow North West Runway option, an increase of 2% over the Extended Baseline option.

6.7.5 Tables 6-1 to 6-3 below identify those links that are predicted to go over-capacity due to the additional traffic from the Heathrow North West Runway scenario and the responsibility to address these issues should rest with HAL. Options available to relieve the capacity restraint include: mainline road widening; the construction of parallel “collector-distributor links”; policy levers within the control of HAL to reduce car-based airport traffic (e.g. airport car park pricing or airport congestion charging) and policy levers outside the control of HAL, (e.g. national congestion charging, policies to encourage home working). Further discussion is required on these options.

6.7.6 Furthermore, the revised local road layout proposed by HAL has resulted in a change of the routing of some trips to/from Heathrow Airports. The effect of these changes has been as follows:

- M25 between junctions 14 and 15 – volume decrease;
- Southern perimeter road – volume increase;

- M4 spur / terminal access tunnel – volume increase;
- Poyle road – volume increase; and
- A3044 adjacent to M4 junction 4 – volume increase.

Table 6-1: AM new over-capacity locations

Location	2031 Forecast Year Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
A4: Westbound to A4 / A30 Junction	99.78	102.72	45	2032
M4 Junction 2 to Junction 1: Eastbound Mainline	97.74	100.03	81	2038
M4 Junction 2 to Junction 3: Westbound Mainline	98.00	100.61	115	2037
M4 Junction 3 Roundabout (Circulating)	97.52	110.05	223	2036
A316 / Hampton Road Roundabout - Circulating	99.51	100.30	17	2033
A312 The Pkway: North of Willow Tree Roundabout, Southbound	97.48	101.61	56	2035
A408 Heathpark Golf Course Roundabout: A408 Southbound Approach	99.05	101.06	41	2036
East Term Spigot	30.21	154.03	498	Expansion Only
M4 Junction 4B: Eastbound Off Slip	98.87	100.57	60	2034
M25 Junction 17 to 18: Northbound Mainline	98.97	100.06	91	2033
Horton Road: Westbound Approach to M25 J14 Roundabout	82.62	100.09	400	Expansion Only
Through M4 Junction 4B: Westbound	96.19	103.12	-35	Expansion Only
M4 Junction 4B: Westbound On Slip	93.65	101.07	404	Expansion Only
M25 Junction 11 to Junction 12: Northbound Mainline	99.61	100.93	115	2033
M3 Junction 2: Eastbound Off Slip	99.27	101.19	68	2035

Table 6-2: IP new over-capacity locations

Location	2031 Forecast Year Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
A312 / Hayes Road Roundabout: A312 Southbound Approach	98.91	100.94	32	2037
East Term Spigot	29.73	151.61	490	Expansion Only

Table 6-3: PM new over-capacity locations

	2031 Forecast Year			
Location	Extended Baseline V/C	North West Runway V/C	Demand Change	Year V>C Without Airport Expansion
A4 / B317 Junction: Eastbound Approach from A4 Talgarth Road	97.57	100.99	105	2035
A4 Great West Road Chiswick, Eastbound - Mainline	98.93	101.80	126	2033
Through M4 Junction 2: Eastbound	98.47	102.48	161	2034
A30 Junction with Stanwell Road: South-eastbound Approach from Stanwell Road	90.36	102.63	99	2048
M4 Junction 3: A312 Southbound Approach	98.46	103.32	-62	2039
M4, Eastbound - Junction 3 to 2 - Mainline	96.59	100.09	147	2038
A4 Great West Road, Chiswick: Eastbound from Hogarth Roundabout	98.93	101.80	126	2033
Emirates Roundabout: Eastbound Approach from Newport Road	97.26	101.43	-88	Expansion Only
Emirates Roundabout: Westbound Approach from Nene Road Roundabout	59.18	102.27	436	Expansion Only
East Term Spigot	27.19	139.06	455	Expansion Only
M25 Junction 15 Link to M4: Eastbound	95.33	102.42	251	2035
B455 / Broadmead Road Junction, Greenford: Northbound Approach from Broadmead Road	95.98	100.34	51	Expansion Only
B377 / B378 Roundabout: Southbound Approach from A30 Great South-West Road	95.97	101.55	57	Expansion Only
M25 Junction 11 to Junction 12: Northbound Mainline	98.97	100.35	116	2033

Appendix A. Environmental requirements/specification

Data Format
Please return the traffic data in the spreadsheet templates provided so that pre-prepared tools the team have in place can be used efficiently.

Traffic model link data for Base, DM and DS to be provided in spatially referenced format, i.e. real-world GIS Shapefile or ESRI Shapefile (ArcGIS v9.1.3), using the OS British National Grid 1936 projection.

Please can the Base and DM shapefiles be supplied as early as possible to allow real-worlding of the anticipated study area network. This can be commenced prior to provision of finalised traffic data, as long as the network is not expected to change.

All links should contain IDs that are unique across all scenarios. The Link IDs should be formed based on the from and to node: A_B

If changes in Link IDs between model scenarios can be minimised, this helps speed Environment team model building. Links which change ID between Base/DM/DS to be clearly identified with their corresponding new ID. New links should be added to the bottom of the database with no data in the Base/DM scenario.

AQ: Directional traffic data for each link to be included in this spreadsheet template, with a corresponding link ID.
Noise: For dual carriageways, motorways and other multi-lane highways, traffic data needs to be provided separately for each carriageway, for example a northbound flow and southbound flow separately. For two way, single carriageway roads, total (two way) traffic flow data is required instead.

A detailed plan of proposed scheme real-world road network in ArcGIS v9.1.3 or Autocad DXF version 12 format.

Study Area
See notes in Study Area worksheet. ***These can be critical to programme.***

Traffic Data Comments
AQ: The time periods to be used for the AQ assessments are based on the forthcoming DMRB AQ guidance.

Traffic data should represent the average conditions over the period covered by the following AADT period:
- AADT24: 00:00 - 23:00 (24 hrs)

Traffic data should represent the **average conditions over the period** covered by the following weekday hours (i.e. not a 1 hour traffic model peak period output):
- AAWT24: 00:00 - 23:00 (24 hrs)
- AM: 07:00 - 10:00 (3 hrs)
- IP: 10:00 - 16:00 (6 hrs)
- PM: 16:00 - 19:00 (3 hrs)
- OP: 19:00 - 07:00 (12 hrs)

Therefore: AAWT24 = AM*3+IP*6+PM*3+OP*12

If Weekend traffic data is required, then the traffic team should discuss what time periods are considered to be representative. A technical note explaining the deriviation of the data should also be supplied.

HDV is defined as vehicles greater than 3.5 tonnes gross (OGV1, OGV2, PSV – COBA Classifications)

The AQ team require link average speeds, including trip delays.

Please confirm what speeds have been provided. It is assumed that queue length data is not validated or available.

Noise: With the introduction of a night-time assessment in the latest DMRB guidance, there are now 3 options as to the traffic data required. It is recognised that data may not be available for these options, and the templates are set to the Intermediate Option. The traffic team should discuss what parameters will be available with the Noise team at project inception for input to the ASR.

Preferred Option:
The preference is for hourly AAWT flows for the full 24-hour period to enable accurate predictions of daytime and night-time noise levels. Hourly % Heavy Vehicles and Vehicle Speeds also required for this method.

Intermediate Option:
Requires AAWT flows, % Heavy Vehicles and Vehicle Speeds for the following periods:
- 06:00 to 24:00 (18-hours)
- 07:00 to 19:00 (12 hours daytime)
- 19:00 to 23:00 (4 hours evening)
- 23:00 to 07:00 (8 hours night-time)

Least Favoured Option:
Daytime 18-hour AAWT flows for the period (06:00 to 24:00) can be used as a minimum. A correction factor can be applied to generate estimated night-time noise levels. Roads will need to be classified as “Motorways” (where traffic flows are relatively uniform throughout the day, evening and night-time periods), or “Non-Motorways” (where traffic flows reduce significantly overnight). % Heavy Vehicles and Vehicle Speeds also required.

% Heavy Vehicles - Heavy vehicles are defined as those with an unladen weight of greater than 3.5 tonnes.

Vehicle Speeds - Where traffic models have been used to provide hourly flows, they should also be used to estimate hourly traffic speeds. Where traffic models have been used to provide 18-hour AAWT flows, the inter-peak flow group should be used as a proxy for the daytime and night-time periods, providing the speeds are appropriate for the link. In some situations, it may be possible to use observed speeds if the measurements are robust.

Road Surfacing Type - For new road schemes or road improvement schemes, a low noise road surfacing will often be specified. Furthermore, for many motorways, low noise road surfacing may already be in use, or planned for installation in the near future. Details of the road surfacing to be assumed for the various roads within the noise model should be provided separately for the Do Minimum Opening Year, Do Something Design Year, Do Minimum Design Year and Do Something Design Year.

It should be noted that traffic data is to be presented as the total number of vehicles for each road link and not passenger car units (PCUs).

Traffic Validation Information

The air quality team also needs to understand how the traffic model has performed, and where model performance is poor for both total flow and HDVs. HDVs represent over half of total vehicle emissions and therefore whilst total flow model performance may be good for a particular link, poor HDV performance on that link can lead to poor air quality model performance.

The air quality team therefore requires the traffic validation results at each traffic count site inside the detailed traffic model area. This can be critical to the interpretation of the air quality model results, and also allows us to understand areas of weakness in the assessment which could be highlighted or challenged.

The Base worksheet has fields for identifying traffic model performance on a traffic period basis for total flow, HDV and speed. Where validation has been undertaken please identify the difference between modelled and monitored values for each link and time period. Please feel free to edit this section of the spreadsheet if necessary, or to provide this information in a GIS format, if that is more convenient.

Scenarios

Please provide traffic data for the following scenarios and years:
Base year
DM (opening & design years)
DS (opening and design years)

Please can the traffic team **<u>confirm the Assessment Base and Opening Years as early as possible</u>** so that the AQ team can collect relevant baseline information. In some cases it maybe necessary to adjust the base year to allow AQ model verification against existing AQ monitoring data.

Micro-Sim Outputs <<If relevant for projects>>
The model links to be provided should be agreed with the AQ & Noise teams to avoid too many very short links being supplied.

Micro-sim models can remove vehicles from the model at junctions between nodes where delays are occuring. If this occurs at a different rate between DM & DS scenarios this could alter the conclusions of the Environment assessments.

Please flag locations where vehicles are removed by the micro-sim model, and quantify the number per scenario.

Study Area

The air quality study area will be defined primarily by the AQ Scoping criteria specified in DMRB HA207/07. These are change between DM and DS scenarios:

+/-1,000 vehicles AADT24, or +/-500 in AQMAs
+/-200 HDVs AADT24
+/-10kph average daily speed
+/-20kph peak hour speed

This can lead to a study area many junctions beyond the scheme extents.

Please review whether the traffic model coverage is sufficient to meet these criteria.

In some cases it may be necessary to extend the study area to cover additional areas of risk, or to allow AQ model verification against existing AQ monitoring locations.

Please provide a diagram showing the boundary of the detailed model area, beyond which would be considered buffer modelling.

Appendix B. Core and Extended Baselines

B.1 Core Baseline

B.1.1 Rail infrastructure (excluding high speed)

In addition to the existing network and services, the rail Core Baseline will include all of the schemes identified in the Network Rail (NR) Control Period 5 (2014-19) Enhancement Delivery Plan, with the exception of Western Rail Access to Heathrow, which does not yet have a fully secured funding package. This is available online at http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/cp5-delivery-plan/.

Elements of relevance to proposals may include (but not be limited to):

- Crossrail;
- Reading Area Station redevelopment;
- Thameslink programme;
- ERTMS in-cab signalling roll-out;
- East Coast Main Line capacity enhancements;
- West Anglia Main Line enhancements;
- Great Eastern Main Line capacity enhancement (Bow Junction);
- East Kent re-signalling;
- Redhill Station additional platform;
- London Victoria Station capacity improvements;
- London Waterloo Station capacity improvements;
- Great Western Main Line electrification;
- Intercity Express Programme roll-out;
- Thames Valley branch line enhancements;
- Oxford Corridor capacity improvements;
- Swindon to Kemble redoubling; and
- Birmingham Gateway development.

Scheme promoters are encouraged to consult the Enhancement Delivery Plan for the full details and delivery timescales for schemes.

B.1.2 Rail services (excluding high speed)

The Department for Transport (DfT) is responsible for the design and procurement of new and replacement rail franchises on the national rail network for which it is the franchising authority. The DfT is in the process of tendering a number of rail franchises, details of the rail franchise schedule can be found at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301976/rail-franchise-schedule.pdf. This includes information on the timing and scope of competitions for future franchises. Each individual franchise has its own specific requirements and addresses a particular set of challenges and so the requirements set out in each franchise competition are tailored to meet the needs of the areas they serve. The DfT has moved towards more output-based specifications to give greater flexibility to bidders while recognising the need for Government to protect essential service levels for all passengers. Details of the Department's activities during each of the stages of a franchise competition can be found at https://www.gov.uk/government/publications/franchise-competition-process-guide.

In developing the baseline the Commission will assume that service levels will be broadly similar as they are today unless an infrastructure scheme or introduction of new rolling stock triggers a change. Details of the investment programme for 2014-19 can be found at http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/cp5-delivery-plan/.

The Commission will monitor the results of current franchise competitions and, when the outcomes of these competitions become known, will discuss the implications of the franchise with scheme promoters. The Commission recognises that dialogue on this issue will need to continue after the receipt of revised scheme proposals.

The outcome of the competition for the Thameslink, Southern and Great Northern franchise is clearly of particular relevance to scheme promoters and understanding and discussing the components of this will be a priority for the Commission.

B.1.3 Rail – High Speed

In respect of the High Speed 1 link and the Channel Tunnel, the Commission will assume for its baseline no fundamental changes to infrastructure or services, though it will use existing demand forecasts for both passenger and freight traffic to inform its baseline for capacity utilisation.

In respect of the High Speed 2 link, the Commission has noted that the “phase 1” route between London Euston and Birmingham and the “phase 2” route from Birmingham to Manchester and Leeds represents stated Government policy and has cross-party support. The Commission has, therefore, decided to include these elements of the scheme in its Core Baseline. The Commission has also noted, however, the Secretary of State for Transport’s statement that he will delay a decision on whether to proceed with a spur from HS2 to Heathrow Airport until after the Airports Commission’s Final Report. This spur will not, therefore, form part of the Core Baseline.

For an overview of the HS2 programme, scheme promoters are encouraged to consult the following documents:

- https://www.gov.uk/government/publications/hs2-strategic-case
- https://www.gov.uk/government/publications/high-speed-rail-investing-in-britains-future-phase-two-the-route-to-leeds-manchester-and-beyond

The Commission has also noted that the recent review by Sir David Higgins made a number of recommendations regarding the delivery of HS2. On the basis of this, the Government has already taken the decision not to proceed with a link between HS2 and HS1. This link will not, therefore, form part of either baseline. It is possible that the Government may suggest further changes to the timing and phasing of the HS2 delivery programme on the basis of Sir David’s report; the Commission will monitor developments and incorporate any material changes into the baseline. Sir David’s report is available at: http://assets.hs2.org.uk/sites/default/files/inserts/Higgins%20Report%20-%20HS2%20Plus.pdf.

B.1.4 London Underground, London Overground and Docklands Light Railway

The Commission has taken advice from TfL on the status of various forthcoming enhancements to the London Underground, Overground and DLR networks. On the basis of information provided, the Commission will include the following schemes in the Core Baseline:

- London Underground Subsurface upgrade – Signalling and rolling stock replacement, complete by 2018;
- Croxley link – Metropolitan line link to Watford Junction, planned to complete by 2021;
- Northern line upgrade – planned to complete by 2020;

- Victoria line upgrade – planned increase in service frequency to 36tph;
- Piccadilly line upgrade – planned for completion by 2026;
- Bakerloo line upgrade – planned for completion by 2031;
- Central line upgrade – planned for completion by 2031;
- London Underground station redevelopments – e.g. Bank and Victoria;
- Waterloo & City Line Upgrade – Planned for completion by 2031;
- London Overground extension of class 378s to 5 car – deployed by end 2015;
- Gospel Oak to Barking electrification – complete by 2019;
- DLR 3-car upgrade Poplar to Stratford – complete by 2026; and
- DLR Inter-peak service enhancements (base service plan A) – due September 2014.

B.1.5 Strategic roads network

Following discussions with the Highways Agency (HA), the Commission's view is that the following schemes should be included in the Core Baseline:

- M23 Junction 8 to 10 "smart motorway" (all lanes running) – subject to value for money and deliverability assessment;
- M25 Junction 23 to 27 "smart motorway" (all lanes running) – complete by 2015;
- M25 Junction 5 to 6/7 "smart motorway" (all lanes running) – complete by 2014; and
- M3 Junction 2 to 4a "smart motorway" (all lanes running) – complete by 2016.

B.2 Extended Baseline

B.2.1 Rail infrastructure (excluding high speed)

The Commission has held discussions with NR, the DfT and other parties with an interest in the process regarding rail schemes which are likely – but not certain – to be funded in the coming years to meet growth in background demand regardless of decisions on airport expansion. These include:

- Western Rail Access to Heathrow: which forms part of the Control Period 5 settlement (meaning it is highly likely to progress) but does not yet have a fully agreed funding package. Should the funding package be secured, this scheme would become part of the Core Baseline.
- Gatwick Airport Station redevelopment: recommended as part of the Commission's interim report. Discussions are ongoing between Government, NR and the airport regarding the nature and scale of the redevelopment.
- Proposed capacity enhancements to the Brighton Main Line: Currently under development and may potentially be identified for funding as part of the CP6 (2019-2024) programme. Components include:
  - Windmill Bridge Junction area re-modelling (new flyover for Up London Bridge Fast line, new flyover carrying the Down London Bridge Fast over the Wallington and Victoria Slow lines, reusing the current dive under for realigned Up London Bridge Slow services removes path conflicts of current flat junction, new 6th track between East Croydon and Windmill Bridge);
  - East Croydon Station remodelling and additional platforms
  - Selhurst Spurs lengthened to provide 12-car signal standing – removes current conflicts
  - Stoats Nest Junction grade separated junction for Up Redhill trains to join the Up Fast line
  - London Victoria re-designation of platform 8 and new access from platform 9 approach

  - Clapham Junction area alterations to allow for additional train paths (no feasibility work yet undertaken)
  - Keymer Junction – third track to enable Up Lewes train to join main line whilst an Up train is passing and enables the Brighton Main Line to remain open when the junction is unusable.
- Potential outcomes of the Wessex, Sussex and East Sussex route studies: which will inform the future development of infrastructure and services on those routes.
- London Victoria: further redevelopment beyond 2019, subject to business case.
- Clapham Junction: further redevelopment beyond 2019, subject to business case.
- Crossrail 2 – subject to significant further specification and assessment.

B.2.2 Rail Services (excluding high speed)

As with the development of the Core Baseline, the Commission will monitor progress on the DfT's refranchising programme. Where the outcomes of franchise competitions are not known, but the Invitation to Tender gives clear indications regarding the probable contents of the franchise, these will be incorporated into the Extended Baseline.

B.2.3 High Speed Rail

The Government has deferred a decision regarding a spur from HS2 to Heathrow Airport until after the Airports Commission publishes its final report. This spur will, therefore, be placed within the Extended Baseline. The Commission notes, however, that the need to progress the HS2 hybrid bill through Parliament may result in changes in Government policy in this area and will keep any such developments under review, in respect of the relationship of the spur to the baselines.

B.2.4 London Underground, London Overground and Docklands Light Railway

The Commission has taken advice from TfL on the status of various forthcoming enhancements to the London Underground, Overground and DLR networks. On the basis of information provided, the Commission will include the following schemes in the Extended Baseline:

- Jubilee line upgrade: increase to 34tph, requires additional stock;
- Northern line extension to Battersea: subject to TWA approval, potentially open in 2020;
- Northern line full separation: potentially by 2026;
- Bakerloo line southern extension: aspirational only at present;
- London Overground additional 2 tph all day between Clapham Junction and Stratford via West / North London Lines – planned for 2019, but dependant on additional rolling stock;
- London Overground additional 2tph on East London Line – dependant on additional rolling stock;
- London Overground Gospel Oak to Barking extended to Barking Riverside – possible by 2021;
- London Overground 6- and 8-car operation on East, North and West London Lines – possible in 2020s / 2030s;
- DLR new franchise service plan – by 2016/17;
- North route double tracking phase 2 – requires additional rolling stock;
- DLR Royal Rocks initial capacity enhancements – requires additional rolling stock;
- DLR full 3-car operation – requires additional rolling stock;
- DLR extension to Catford – aspirational only at present; and
- DLR extension to Bromley – aspirational only at present.

B.2.5 Strategic Roads

Following discussions with the HA, the Commission's view is that the following schemes should be included in the Extended Baseline:

- M4 Junction 3 to 12 "smart motorway" (all lanes running) – subject to value for money and deliverability assessment;
- Lower Thames Crossing – work progressing, but no decision yet as to nature of any option that might proceed.

Appendix C. LTS '7031ref6' infrastructure assumptions

C.1 Public Transport

Schemes added to 2011 Base Network		
Exact Rail/UG schemes not known - as provided by Railplan 2031 Coding - LTS		
RP7 Ref Cases etc LTS 29-Jan-2014.xlsx		
LTS scheme/assumption summary		**Year**
HS2 Schemes		
HS2_AMDS_2026_ES_v3		
HS2_AMDS_2026_GWML_v2		
HS2_AMDS_2026_OV_v3		
HS2_AMDS_2026_SO		
HS2_AMDS_2026_XR_v2		
Bus		
4% global increase in bus frequency over B7.0 2011	2031bus	2021
National Rail		
Chiltern Evergreen 3 Phase 1		2016
Chiltern Evergreen 3 Phase 2		2016
HLOS1 - West Anglia Services		2016
HLOS1 - South West Trains Services		2016
HLOS1 - London Bridge		2016
HLOS1 - Victoria		2016
HS1 Enhancement		2016
London Midland Project 110 (Full)		2016
Thameslink KO1.1 - Through Services		2016
West Coat Pendolino Lengthening (35x11car, 21x9car)		2016
New Lea Bridge Station		2016
Extend all class 378's to 5 car		2016
Devolution - West Anglia Inners		2016
London Overground SLC3 - East London Line Phase 2b to Clapham Jn		2016
Chiltern Speed Adjustment (Metropolitan)		2021
Crossrail 1 (Abbey Wood / Shenfield - Heathrow / Maidenhead)		2021
Thameslink KO2 - Blackfriars Services		2021
Thameslink KO2 - Cannon St Services		2021
Thameslink KO2 - Charing Cross Services		2021
Thameslink KO2 - GN Moorgate Suburban Services		2021
Thameslink KO2 - GN Kings Cross Suburban Services		2021
Thameslink KO2 - London Bridge Services		2021
Thameslink KO2 - Through Services		2021
Thameslink KO2 - Victoria (SE) Services		2021
Thameslink KO2 - Victoria (South Central) Services		2021
Paddington GWML Suburban Electrification		2021
Paddington GWML Long Distance Electrification		2021
HLOS2 - East West Rail (Aylesbury - Milton Keynes, Oxford - Bedford)		2021
HLOS2 - West London Line		2021
HLOS2 - Lea Valley mainline		2021
HLOS2 - Main Line		2021

HLOS2 - Whole TOC		2021
HLOS2 - Whole TOC		2021
HLOS2 - Sydenham route		2021
HLOS2 - Brighton main line (BML)		2021
HLOS2 - Main Line		2021
HLOS2 - Main suburban		2021
HLOS2 - Windsor Lines		2021
HLOS2 - Main Line		2021
HLOS2 - Main Line and Aylesbury route		2021
HLOS2 - London Midland		2021
HLOS2 - Main Line		2021
HLOS2 - Main Line and Hertford Loop		2021
West Anglia Upgrade		2021
Gospel Oak - Barking Electrification and longer (4 car) trains		2021
London Overground Speed Adjustment (Watford DC - Bakerloo)		2026
LUL		
Full Upgrade inc new NGT stock	Bakerloo Line	2031
Full Upgrade inc new NGT stock	Central Line	2031
36 tph Jubilee line	Jubilee Line	2021
Croxley Link	Metropolitan line	2016
PPP Upgrade - phase 1 (signalling upgrades)	Northern Line	2016
PPP Upgrade - phase 2 (revised service patterns)	Northern Line	2021
Northern Line Extension to Battersea	Northern Line	2021
Full Upgrade inc new NGT stock	Piccadilly Line	2026
Phase 1 - New Stock	Subsurface	2016
Phase 2 - Full upgrade	Subsurface	2021
33 tph in operation 2012, potential to increase to 36	Victoria Line	2016
New stock in line with Deep Tube upgrade and enhanced frequency (30 tph peaks)	Waterloo & City	2031
DLR		
Poplar - Stratford 3 car upgrade		2016
IP Service Enhancement		2016
North Route Double Tracking Phase 1 (Base Service Plan B)		2016
TRAM		
Therapia Lane 2012		2016
Wimbledon higher frequency		2016

C.2 Highway schemes

Schemes added to 2011 Base Network	
Highway Scheme Name	**LTS Scheme No.**
A3 Hindhead Improvement	70007
Tottenham Hale Gyratory	70012
Dartford Toll Plaza Removal	70013
M25 Widening to Dual 4 J29-30	3601
HAM FY Schemes	
A205 Brownhill Rd / St Mildreds Rd Torridon rd to Helder Grove	
A24 Balham High Road Northbound bus lane	
A24 Balham High Road/ Tooting Bec Road	
A41 Cricklewood Lane / Hendon Way - right Turning	
ASLs at junction A10 High Road, Broad Lane, West Green Road	
NEW/H/5/005 Modifications to Traffic Movements at the Junction of the A1020 and Jenkins Lane	
Old Oak Common Lane / A40 Westway	
Route 38 - Bloomsbury Way	
Strand outside Courts of Justice	
A4 Sutton Court Road	
Acton Town Centre Enhancement Scheme	
Cycle Superhighways Route 5 - Kennington Lane / Durham Road Scheme	
Fulham Palace Rd / Talgarth Rd slip road (Route 220, Phase 2)	
Greenwich Reach	
Greenwich Town Centre Pedestrianisation Scheme	
Lea Bridge Road Regeneration Scheme (Formal Sub)	
Portman Square-Phase 2	
Southall Broadway Boulevard	
Stonecutter Street Closure - Road Danger Reduction Scheme	
Strand-Aldwych-Lancaster Place	
Bloomsbury Way (bus priority)	
Bounds Green environmental and safety schemes (A406)	
Brent cross at North Circular junction with A5, M1, A41 Hendon way, as well as further local improvements	
Elephant and Castle	
Euston Circus	
Exhibition Rd	
Henley Corner environmental and safety schemes (A406)	
Kender Street and Besson Street A2/A202	
Kender Street Triangle	
Piccadilly 2-way	
Russell Square	
Sydenham Road Area Based Scheme A212	
Tottenham Hale gyratory (Made Two-way)	
Wimbledon Town Centre (Destination Wimbledon)	

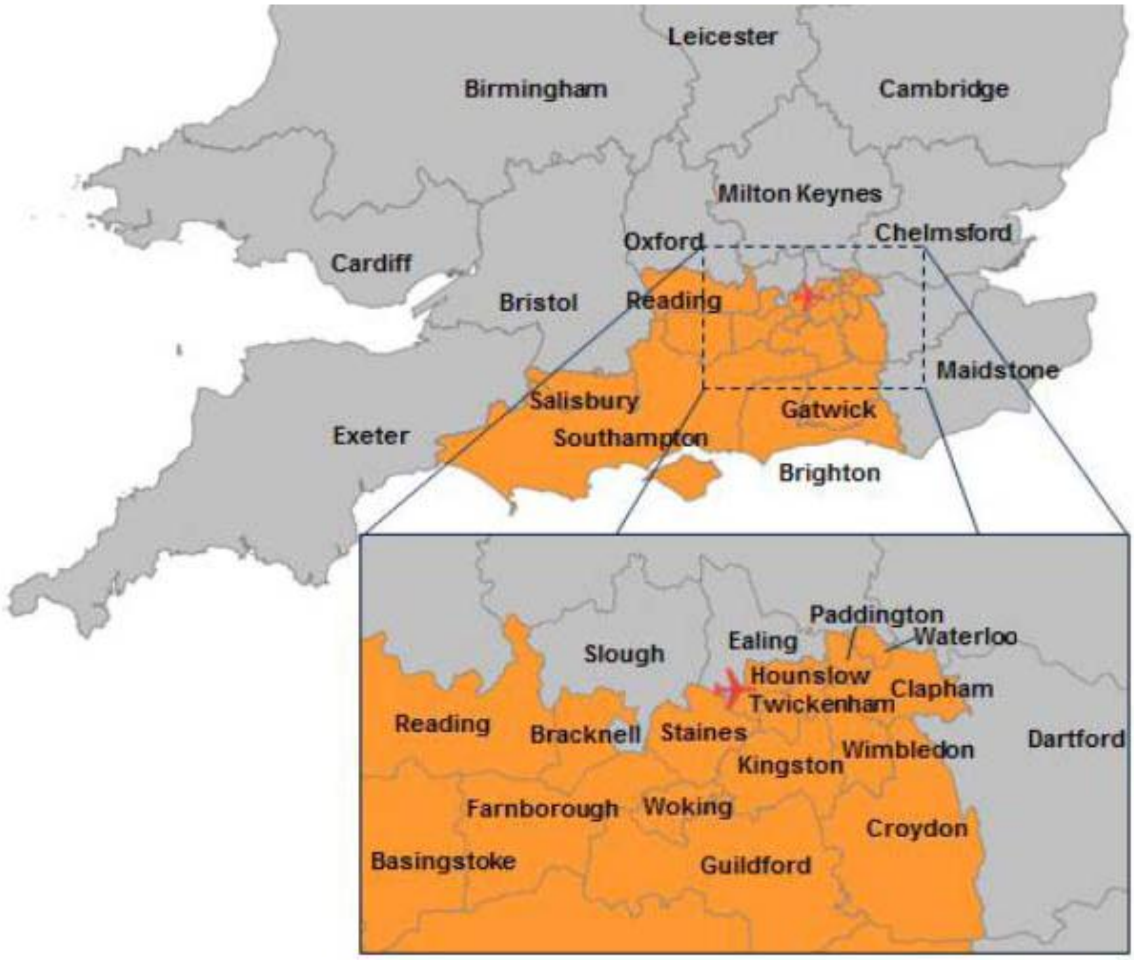
Appendix D. Jacobs review of SRA options

D.1 History

According to the Airtrack Forum, "*the principle of a rail connection to Heathrow from the south has been the subject of considerable study, at intervals, for more than 30 years. Since 1960 there have been more than 10 studies or proposals*". The Airtrack Scheme, promoted by BAA, was submitted in July 2009 for authorisation under the Transport and Works Act. However, in November 2010 BAA announced that the "*public enquiry remains deferred*". One of the major objections to the proposal was the increase in waiting times at level crossings from the increased train service. Objections were raised about the Richmond-to-Barnes section and the Egham area.

The Airtrack-Lite scheme proposed by Wandsworth Council and the subsequent 2013 study focused only on Heathrow-Waterloo services and, while recognising the Level Crossing issues, sought to overcome the restrictions by identifying additional capacity on the Hounslow Loop and a rebalancing of services to potentially offer 2 semi-fast trains per hour from Heathrow to Waterloo and possibly 2 stopping trains per hour from Heathrow to Waterloo.

In 2014, the DfT asked Network Rail to manage a further study into SRA to Heathrow. The geographical scope of this study clearly identifies Sussex and Wessex as markets to be considered, as indicated in the figure below.



Jacobs conducted this independent high-level review of the potential options for SRA based on publically available information and professional opinion. No discussions were held with the DfT or NR due to the legal position of both stakeholders vis-à-vis the AC during the consultation period, which ended on the 3rd February 2015.

D.2 Network Rail Wessex Route Study

NR issued the draft Wessex Route Utilisation Study on the 20th November 2014. The draft study does not consider options for SRA to Heathrow, stating that *"the Wessex Route Study does not provide choices for funders to address southern access to Heathrow by rail as these will be delivered through the specific study remitted by the DfT, due to report in June 2015. The emerging outputs of this study will be included in the final Wessex Route Study".*

Therefore, the study is focused on looking at issues while deliberately excluding Heathrow options. As noted previously, the issue of level crossings between Barnes and Richmond is highlighted: *"the key constraint of level crossing down time on the line via Richmond prevents any services being routed this way without further invention in future control periods. Therefore for this Route Study it is assumed that the additional four trains per hour, to make 20 trains per hour in the busiest hour, are routed via the Hounslow Loop and not Richmond".*

In the choices for funding, NR is clear about capacity issues on the Windsor Line, stating that *"as established in Chapter 6 it is not envisaged that additional capacity will be required in CP6 for Windsor line services. Platform lengthening completed in CP4 and 5 coupled with the reintroduction of Waterloo International Terminal (WIT) platforms allows for 10-car operation which achieves the capacity conditional outputs to the end of CP6.Initial investigations for beyond CP6 involved analysis of what would be required to meet capacity (and connectivity) conditional outputs on the Windsor Lines, with choices covering either additional or lengthened services. To enable an increase in the number of services on the Windsor Lines, in the high peak hour, beyond the baseline frequency, several significant constraints would need to be addressed:*

- *further additional track capacity through Queenstown Road above that provided in CP5;*
- *additional track capacity via Richmond and/or via Hounslow;*
- *resolution of level crossing downtime issues on the route via Richmond and Hounslow;*
- *potential grade-separation at Barnes Junction to segregate the Hounslow and Richmond flows;*
- *the possibility of additional platform capacity at London Waterloo;*
- *capacity through Feltham.*

Removing these constraints could allow an increase from 20 trains per hour up to 24 trains per hour, without impacting on main line service growth. It would however be both extremely costly and highly disruptive, to rail and road users, during construction. For these reasons, accompanied with the increase in capacity not being sufficient to meet the conditional output requirement and there being an alternative choice, no further development has been carried out on this option"[26].

Jacobs' interpretation of this statement is that NR believes that the current programme of improvements will meet forecast demand on the Windsor Lines out of Waterloo (excluding Heathrow services) until the end of CP6 in 2024. Any additional demand is likely to require additional or lengthened services. The infrastructure constraints related to additional services are detailed above. Although not listed, the issues related to further lengthening of services should not be underestimated.

D.3 Likely areas of demand

Although the DfT Scope of Services includes Waterloo in its geographic scope, it is reasonable to assume that, given the likely journey time of any service from Heathrow to Waterloo, passengers are more likely to use Heathrow Express and Crossrail services to access central London.

[26] Wessex Route Study draft for consultation – page 130

As previously identified by Wandsworth Council and others, Clapham Junction is a major interchange that would provide connections to Sussex, Surrey and the wider Wessex Region. Given that it would be difficult to terminate services at Clapham Junction, it is likely that SRA services would have to run to Waterloo. The target time from Clapham Junction to Heathrow was set by Wandsworth Council as "*as close to 30 minutes as possible*". By comparison, the standard off-peak timing for semi-fast services from Clapham Junction to Staines is 24 minutes via Richmond. Any service with additional stops or routed via Hounslow is unlikely to achieve this objective.

When considering the routing of Heathrow services a number of factors must be considered. Firstly, the stations on the NR Hounslow Loop are geographically close to the Piccadilly Line which already provides a service to Heathrow. A stopping service routed this way is unlikely to attract a significant increase in the use of public transport for either passengers or employees. Richmond provides interchange with the District Line and the North London Line. Twickenham stadium hosts both Rugby and other events that attract international visitors, often using Heathrow. Airport employees in this area do not have easy access to the Piccadilly line and must rely on road transport to reach the airport.

While Clapham Junction would provide access to services to Surrey, Hampshire and further south west, a service to Woking and Guildford might be attractive, offering interchange to the south west main line at Woking and the Portsmouth and North Downs line at Guildford. Additional services on this route would have to pass through Egham, where a local campaign opposed Airtrack due to the impact on the local level crossings.

The original Airtrack proposal also included services to Reading via Wokingham. Local opposition was organised in Wokingham, again centred on the anticipated down time of level crossings. As Reading is likely to gain direct access to Heathrow through WRA, the benefits of this option are reduced, while the infrastructure issues still have to be overcome.

When considering the Airtrack and Airtrack-Lite studies in conjunction with the arguments above and other public information, it can be argued that a minimum viable service would link Heathrow to Waterloo operating as a semi-fast service with a minimum 2 trains per hour. This service would operate via Twickenham and Richmond. An additional 2 tph operating as a stopping service might add value, especially if it can be routed via Twickenham.

A service of 2tph from Heathrow to Guildford could also be a reasonable aspiration, operating via Chertsey and Woking, although the viability of such a service would depend heavily on establishing that there is sufficient demand to warrant its introduction.

Given the difficulties to be overcome to deliver the above services, it is not thought that a service from Reading via Wokingham will be a priority for SRA, although it could be considered at a later date. Passengers could travel on that route with a single change from the proposed services.

D.4 Rolling stock

A key question to be considered is whether SRA would have dedicated rolling stock or utilise additional vehicles compatible with existing fleets. Part of the answer to this question is whether the existing south western fleet can be adapted to operate under 25kv AC Overhead Line Equipment (OLE). The simplest proposal for any service, and probably the cheapest, is for SRA to operate to Terminal 5 only. In this situation, it is likely that 3rd rail will be sufficient for the service. If however it is required to operate the service to either the CTA or T4, possibly via new tunnels, then it is possible that traction will only be provided by OLE. In this scenario, all southern stock will have to be dual voltage compatible. It is possible that additional stock will be required for the service and that it will be ordered as dual voltage but fully compatible with existing SWT stock.

As SRA is not envisaged as a premium service for passengers, rolling stock compatible with the existing SWT fleet is thought the most likely outcome.

D.5 Delivering the service

Given the difficulties in increasing the number of services operated via Richmond, as identified by NR, consideration must be given to how Heathrow services might be delivered. A proven format for maximising capacity and minimising operational costs is by attaching and detaching coaches in order for a single train to serve different destinations. This has been common practice in the south of England and continues to the present day including on High Speed 1. The critical loadings on existing services are in the AM peak towards Waterloo and in the PM peak away from Waterloo.

Forecasts derived from the enhanced spreadsheet models indicated that loadings on a potential service at Heathrow would not match existing patterns of background London-related flows. For example, employees travelling to Heathrow in the AM peak would predominantly travel in the opposite direction to the main peak flow. Furthermore, some passengers boarding at Heathrow would likely alight at stations approaching London (particularly Clapham Junction), allowing commuters along the line space to board.

If loadings were forecast to be acceptable in an attachment-detachment scenario, then both the Windsor and Reading services could be considered for this role, with the detachment-attachment taking place at Feltham or Staines depending on the exact route to Heathrow.

If multi-portion trains are not considered acceptable, the other way a semi-fast service could be delivered is via the use of the additional 4 paths on the Hounslow loop and the rearrangement of existing services. While it would probably be possible to provide 2 tph via Hounslow using the new paths available, as identified above, the route is not attractive to airport users or competitive in terms of journey time. A rearrangement of services would require an existing service routed via Richmond to be routed via Hounslow, probably at a cost to journey times to allow a new Heathrow service to operate via Richmond. This change to services and the likely impact on regular users is likely to be strongly resisted.

One service that offers potential benefits is the present Waterloo-Weybridge via Staines service. This has been previously identified as offering a potential solution to the Guildford service and Waterloo stopping service challenges. Although it would require pathways through Woking and platform capacity at Guildford, the present Weybridge-Waterloo service could be modified at the western end to provide the Guildford-Heathrow service without increasing the down time of level crossings at Egham if a western chord is provided.

The counterpart to this proposal is that a stopping Heathrow-Waterloo service could be operated in the timings of the Weybridge service. While initially attractive, the Weybridge service is routed via the Hounslow loop. If this service was operated from Heathrow in addition to the services via Richmond, it would require additional platform time. While not impossible, it would increase the risk to operational performance. Alternatively, if an existing service via Richmond was rerouted into these timings it would increase the through journey time as described above. Potentially, the initial solution is that 2tph are operated from Heathrow via Richmond and two are operated as a stopping service in the Weybridge service timings, offering connections into faster services and improving connectivity.

D.6 Conclusions

The ideal solution of 4tph semi-fast from Heathrow to Waterloo via Richmond is not feasible without major infrastructure works on the route, although it can remain an aspiration. If a southern connection was constructed, from the information available, the easiest way that a semi-fast service could be delivered is via the detachment-attachment of a unit, probably on a Windsor service. This would be supplemented by a Heathrow-Waterloo stopping service in the timings of the Weybridge Waterloo service. Connections off this service towards Richmond could be provided at Feltham.

A Heathrow-Guildford service, also replacing the Weybridge service through Egham and Chertsey, could serve demand in the south west and replace the Woking Coach connection, although there is currently a question-mark over the viability of such a connection that does not provide a route between the airport and London. With 4 trains to be handled in two platforms at Heathrow, turnaround times of approximately 10 minutes are achievable and deliverable.

If the semi-fast service proved successful, it could be doubled by using the same process on the Reading service. If loadings are forecast to be too great for this proposal and full trains are required, then either existing services will have to be rearranged or the major infrastructure works will have to be undertaken.

Appendix E. Customer experience

E.1 Methodology

The following diagrams aim to visually depict the surface access experience between Heathrow Airport and a range of locations in the UK by road and rail in 2030 with the North West Runway in place.

The locations were selected with reference to the DfT's 2030 NAPAM forecast distribution for Heathrow North West Runway in the Carbon-Traded Global Growth scenario. The top 5 surface access trip generating districts within London and the top 5 districts outside of London (including one district outside of South East England) were identified. Districts within 10km of the airport were excluded from the analysis due to the wide range of potential journey options from different parts of large districts in close proximity to the airport, for example Hillingdon.

The direction of travel depicted (i.e. to or from the airport) represents the worst case travel conditions forecast in the AM peak period in 2030, and the routes reflect the lowest modelled Generalised Cost trip, which attracts the largest number of travellers.

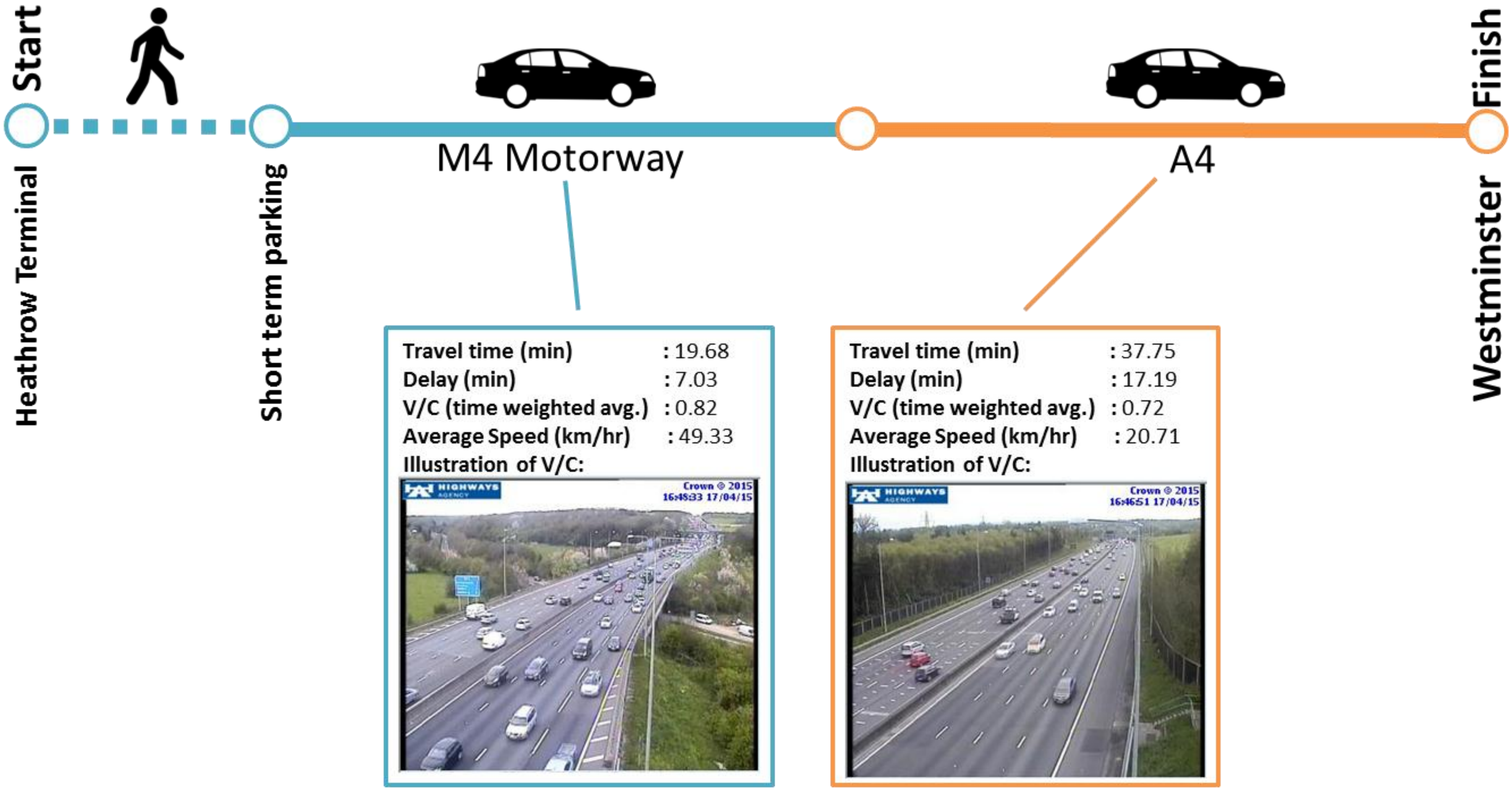
Within London the following districts were identified from the NAPAM outputs:

- Westminster;
- Kensington and Chelsea;
- Camden;
- City of London;
- Tower Hamlets.

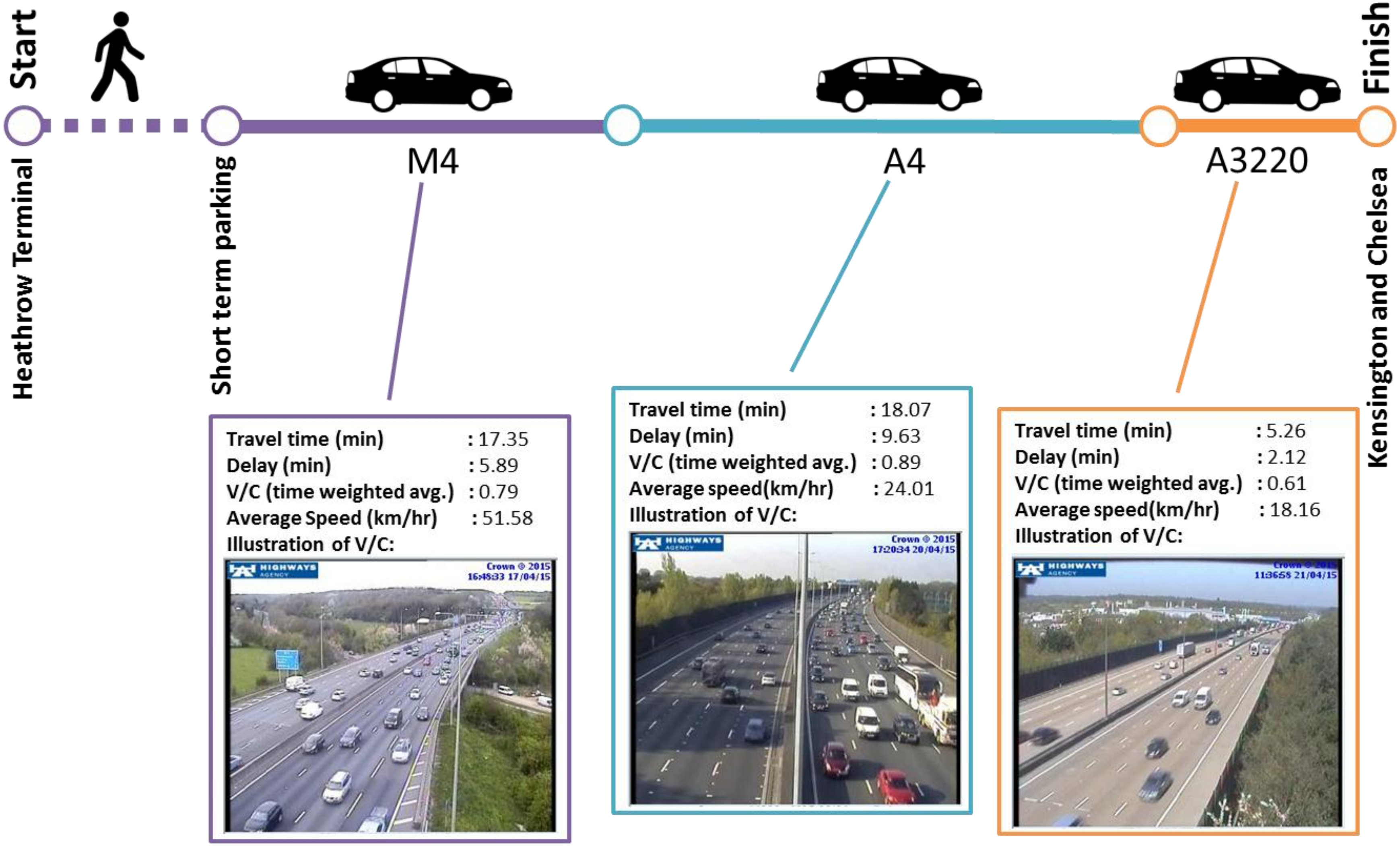
Outside of London the following districts were identified:

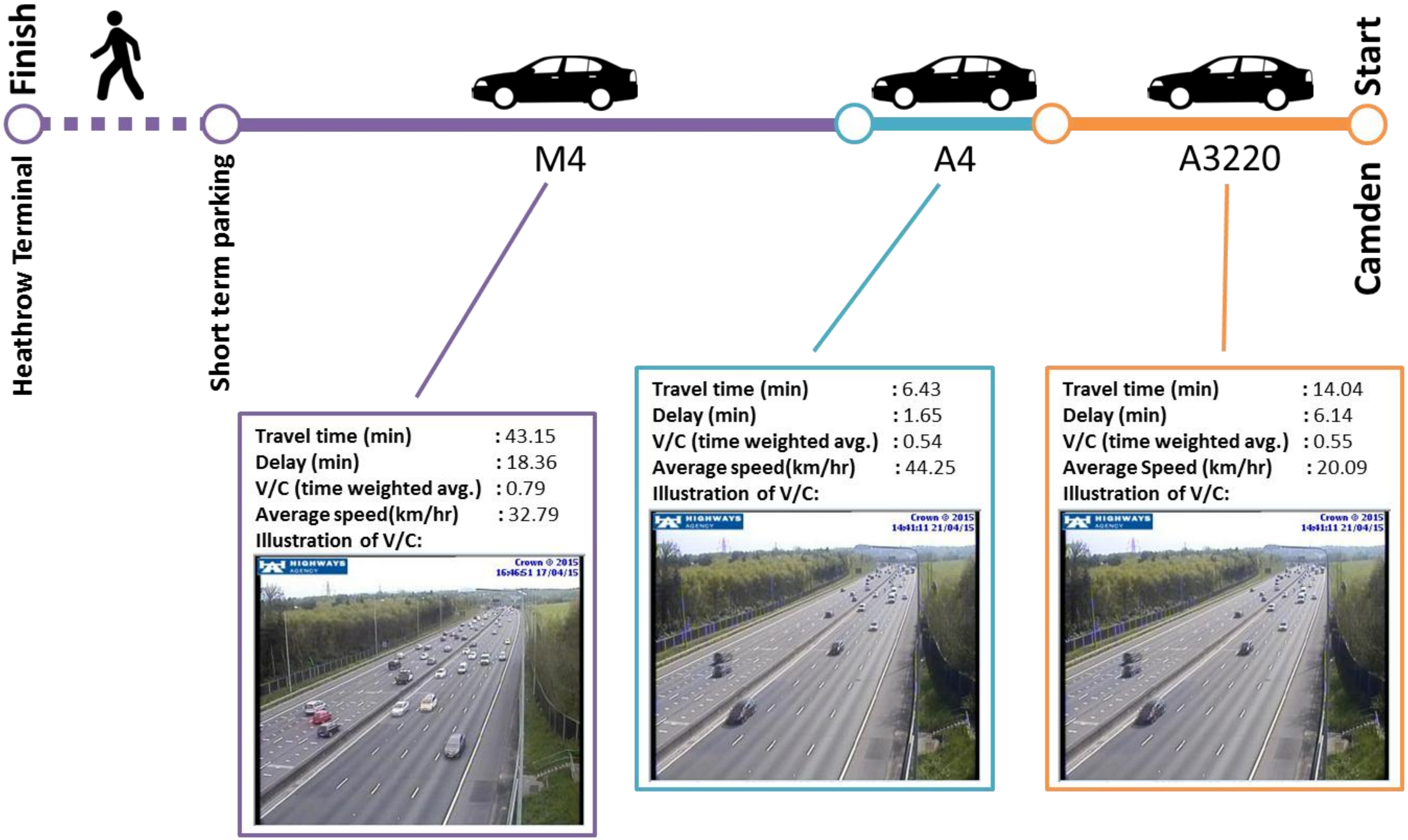
- Oxford;
- Reading;
- Guildford;
- Southampton;
- Birmingham.

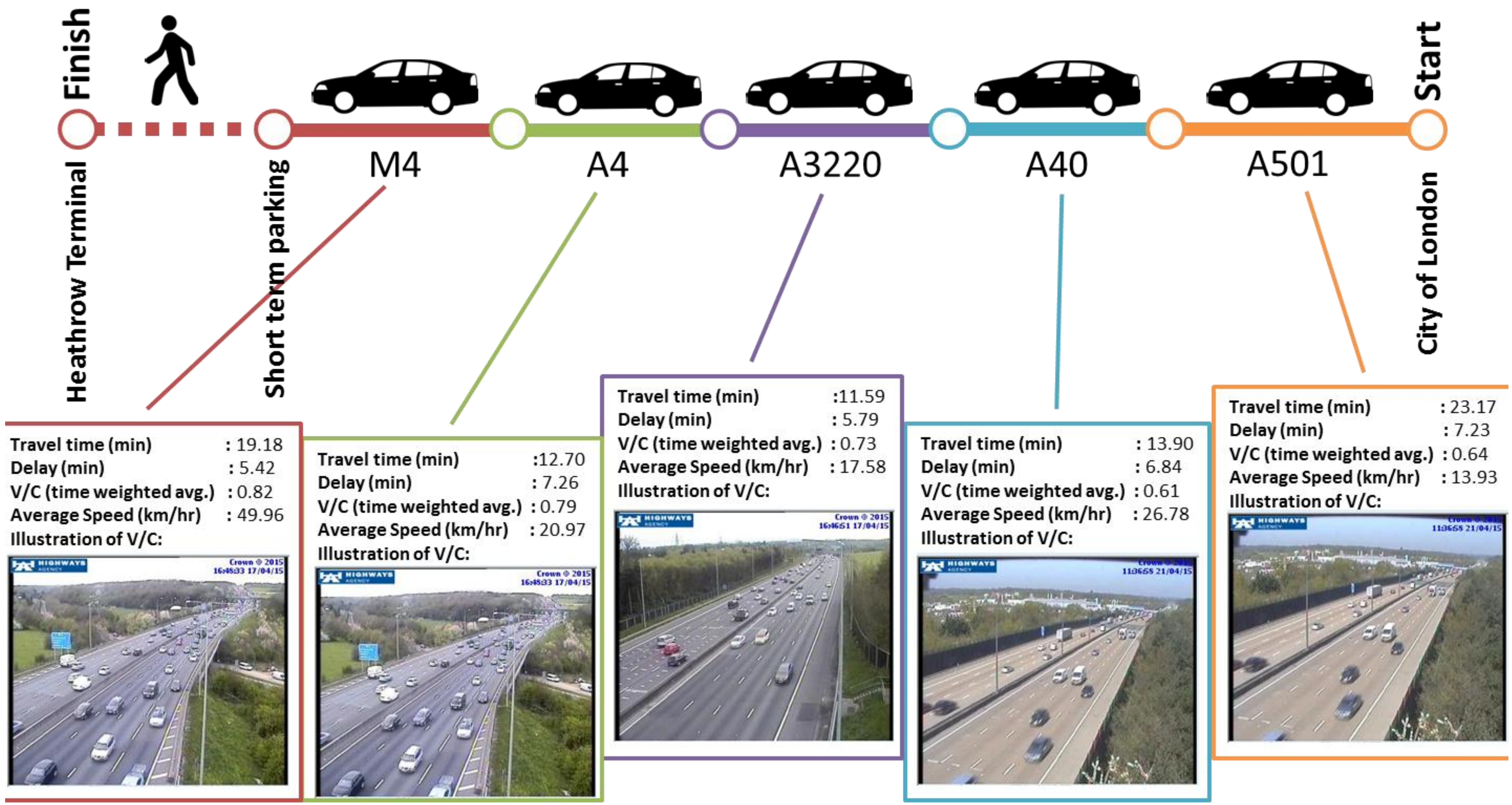
E.2 AM peak Heathrow North West Runway road experience



JACOBS


Start
Heathrow Terminal
Short term parking
M4
A4
A3220
Finish
Kensington and Chelsea
Travel time (min) : 17.35
Delay (min) : 5.89
V/C (time weighted avg.) : 0.79
Average Speed (km/hr) : 51.58
Illustration of V/C:
Travel time (min) : 18.07
Delay (min) : 9.63
V/C (time weighted avg.) : 0.89
Average speed(km/hr) : 24.01
Illustration of V/C:
Travel time (min) : 5.26
Delay (min) : 2.12
V/C (time weighted avg.) : 0.61
Average speed(km/hr) : 18.16
Illustration of V/C:


Finish
Heathrow Terminal
Short term parking
M4
A4
A3220
Start
Camden
Travel time (min) : 43.15
Delay (min) : 18.36
V/C (time weighted avg.) : 0.79
Average speed(km/hr) : 32.79
Illustration of V/C:
Travel time (min) : 6.43
Delay (min) : 1.65
V/C (time weighted avg.) : 0.54
Average speed(km/hr) : 44.25
Illustration of V/C:
Travel time (min) : 14.04
Delay (min) : 6.14
V/C (time weighted avg.) : 0.55
Average Speed (km/hr) : 20.09
Illustration of V/C:


Finish
Start
Heathrow Terminal
Short term parking
M4
A4
A3220
A40
A501
City of London
Travel time (min) : 19.18
Delay (min) : 5.42
V/C (time weighted avg.) : 0.82
Average Speed (km/hr) : 49.96
Illustration of V/C:
Travel time (min) :12.70
Delay (min) : 7.26
V/C (time weighted avg.) : 0.79
Average Speed (km/hr) : 20.97
Illustration of V/C:
Travel time (min) :11.59
Delay (min) : 5.79
V/C (time weighted avg.) : 0.73
Average Speed (km/hr) : 17.58
Illustration of V/C:
Travel time (min) : 13.90
Delay (min) : 6.84
V/C (time weighted avg.) : 0.61
Average Speed (km/hr) : 26.78
Illustration of V/C:
Travel time (min) : 23.17
Delay (min) : 7.23
V/C (time weighted avg.) : 0.64
Average Speed (km/hr) : 13.93
Illustration of V/C:

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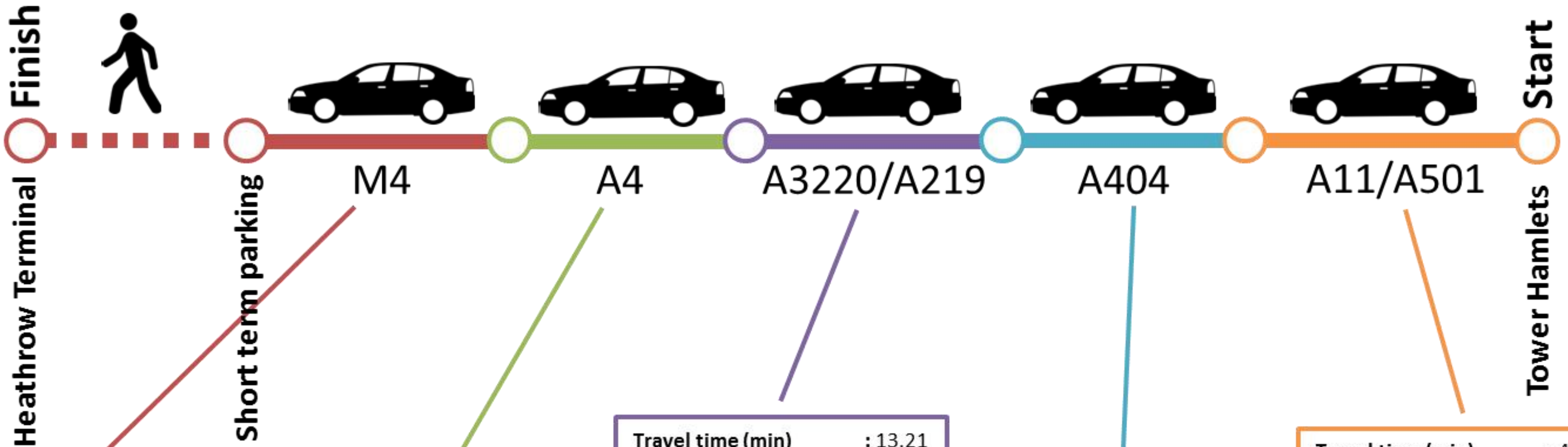


M4

Travel time (min) : 19.18
Delay (min) : 5.42
V/C (time weighted avg.) : 0.82
Average Speed (km/hr) : 49.96
Illustration of V/C:

A4

Travel time (min) : 11.08
Delay (min) : 6.50
V/C (time weighted avg.) : 0.83
Average Speed (km/hr) :21.24
Illustration of V/C:

A3220/A219

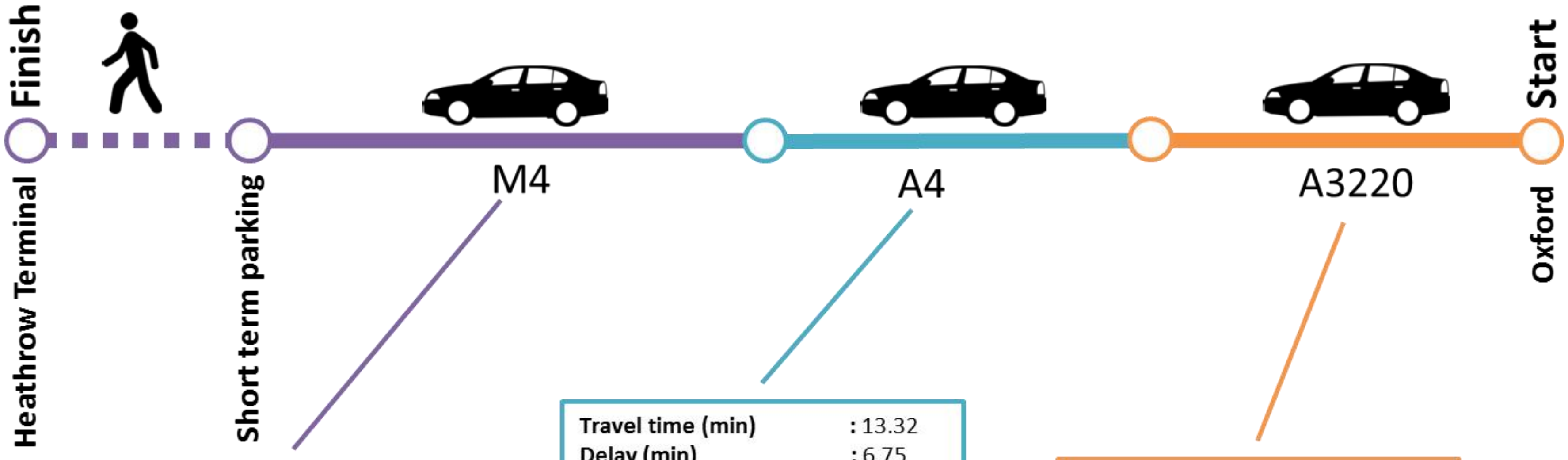
Travel time (min) : 13.21
Delay (min) : 6.55
V/C (time weighted avg.) : 0.70
Average Speed (km/hr) :17.77
Illustration of V/C:

A404

Travel time (min) : 3.69
Delay (min) : 0.37
V/C (time weighted avg.) : 0.51
Average Speed (km/hr) :62.33
Illustration of V/C:

A11/A501

Travel time (min) : 47.10
Delay (min) : 15.46
V/C (time weighted avg.) : 0.60
Average Speed (km/hr) : 16.34
Illustration of V/C:



M4

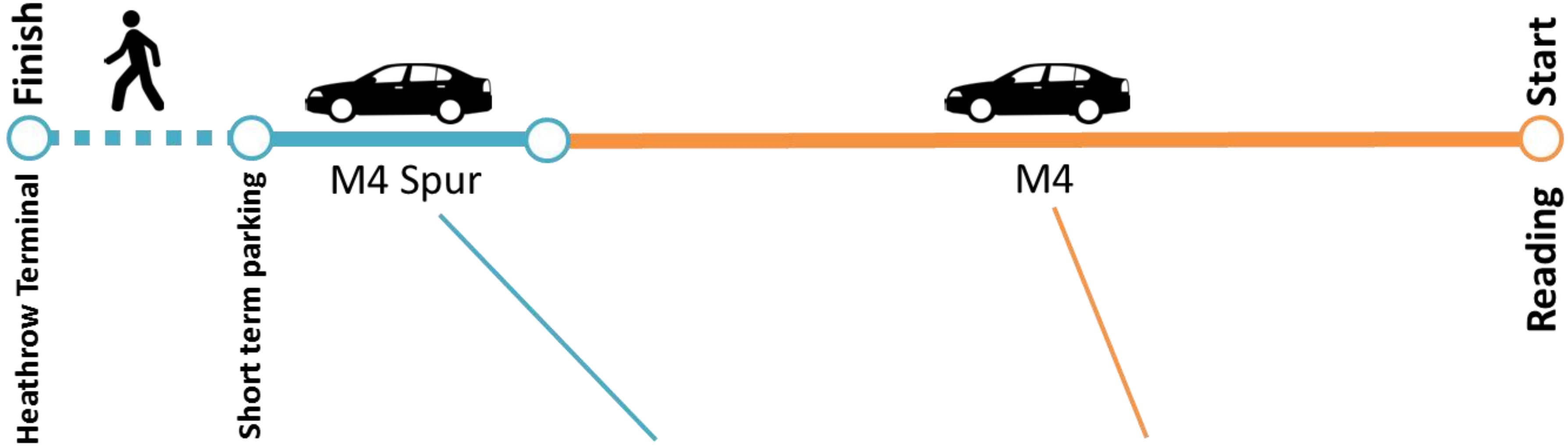
Travel time (min) : 19.18
Delay (min) : 5.42
V/C (time weighted avg.) : 0.82
Average speed(km/hr) : 49.96
Illustration of V/C:

A4

Travel time (min) : 13.32
Delay (min) : 6.75
V/C (time weighted avg.) : 0.88
Average speed(km/hr) : 25.17
Illustration of V/C:

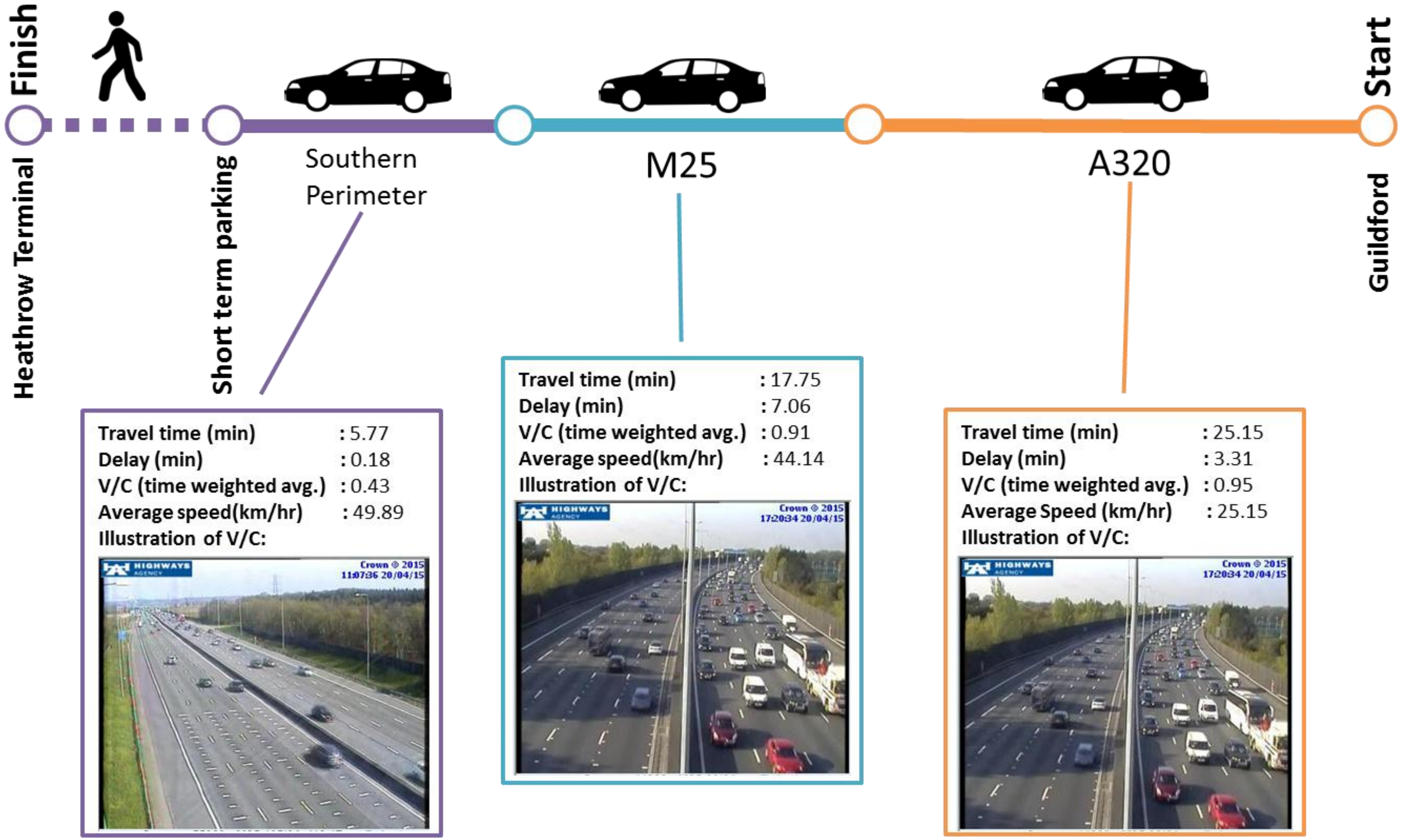
A3220

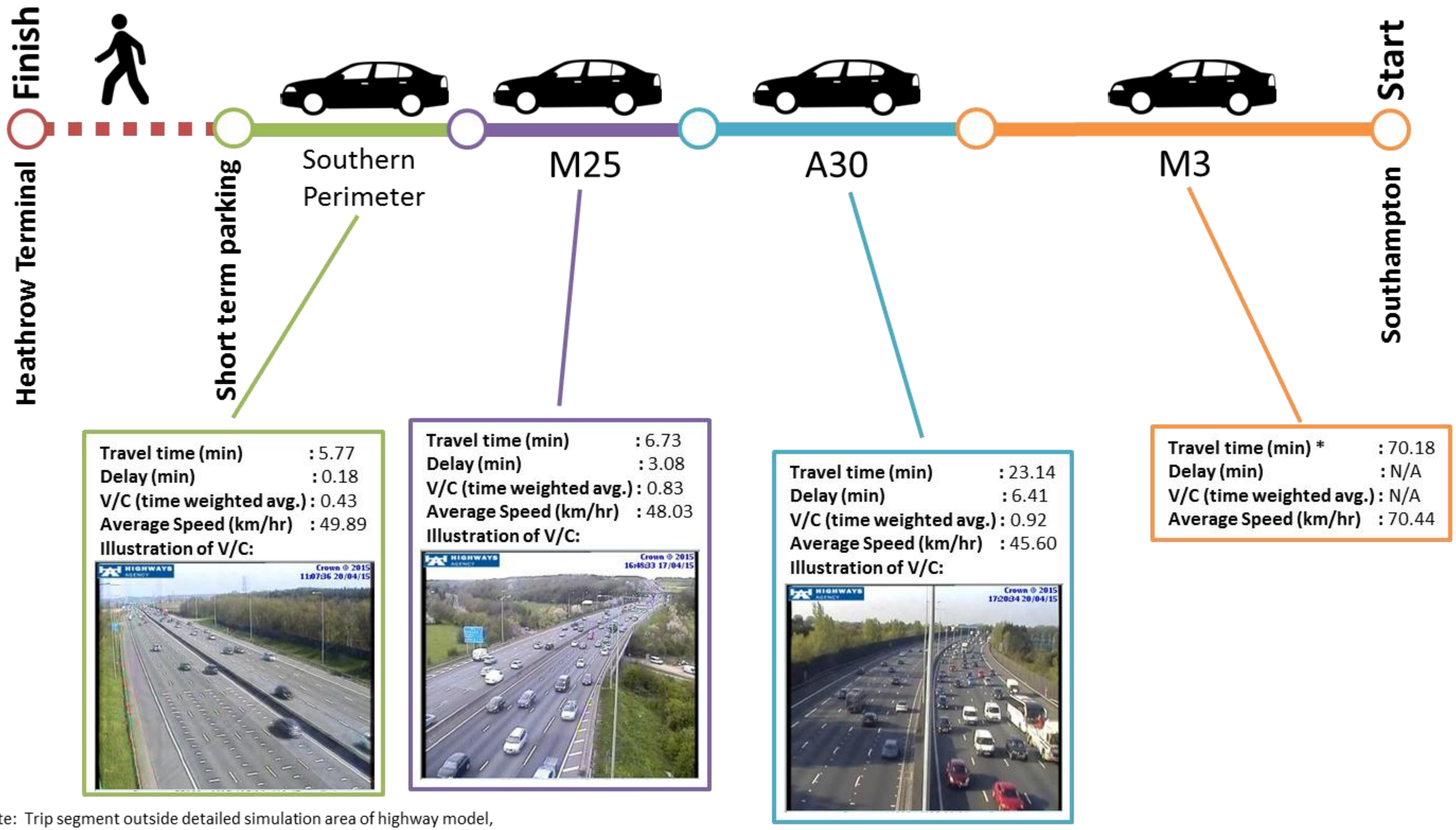
Travel time (min) : 7.32
Delay (min) : 3.99
V/C (time weighted avg.) : 0.61
Average Speed (km/hr) : 14.70
Illustration of V/C:



Travel time (min) : 6.80
Delay (min) : 2.10
V/C (time weighted avg.) : 0.60
Average speed(km/hr) : 33.00
Illustration of V/C:

Travel time (min) : 38.58
Delay (min) : 1.42
V/C (time weighted avg.) : 0.9
Average Speed (km/hr) : 64.45
Illustration of V/C:


Finish
Start
Heathrow Terminal
Short term parking
Southern Perimeter
M25
A320
Guildford
Travel time (min) : 5.77
Delay (min) : 0.18
V/C (time weighted avg.) : 0.43
Average speed(km/hr) : 49.89
Illustration of V/C:
Travel time (min) : 17.75
Delay (min) : 7.06
V/C (time weighted avg.) : 0.91
Average speed(km/hr) : 44.14
Illustration of V/C:
Travel time (min) : 25.15
Delay (min) : 3.31
V/C (time weighted avg.) : 0.95
Average Speed (km/hr) : 25.15
Illustration of V/C:



* Note: Trip segment outside detailed simulation area of highway model, as such, detailed travel statistics not available. Additionally, travel time and speed results may be unreliable

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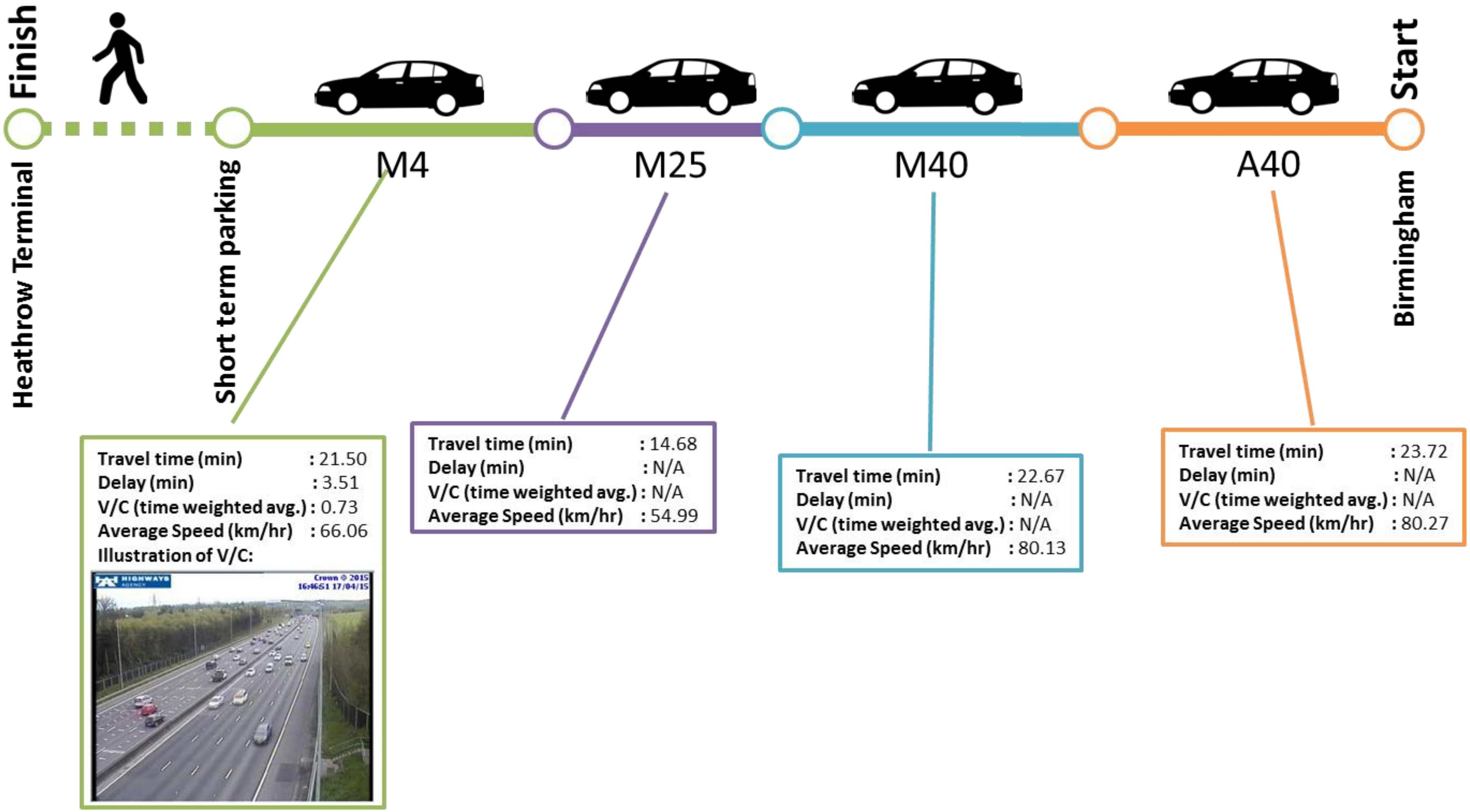
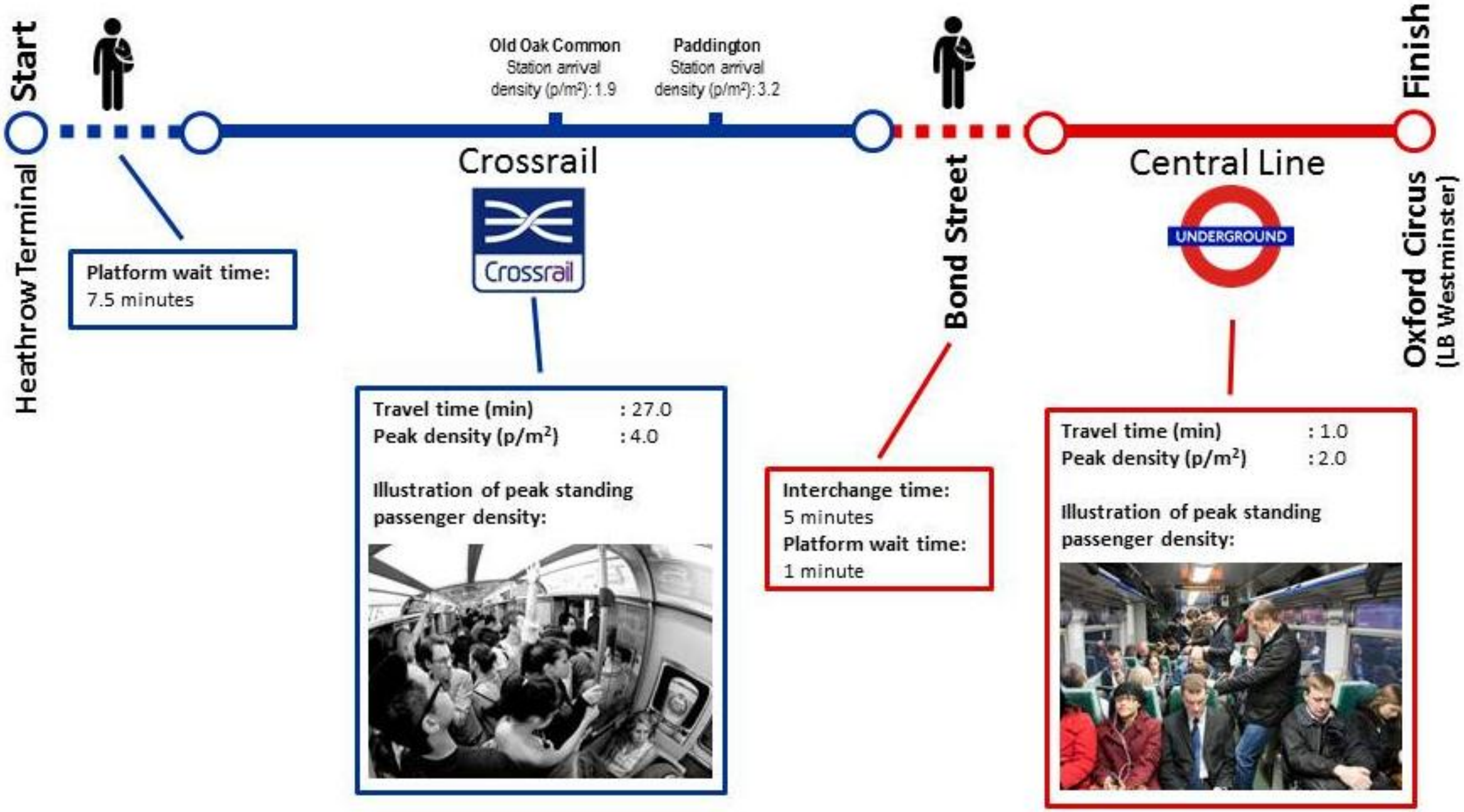
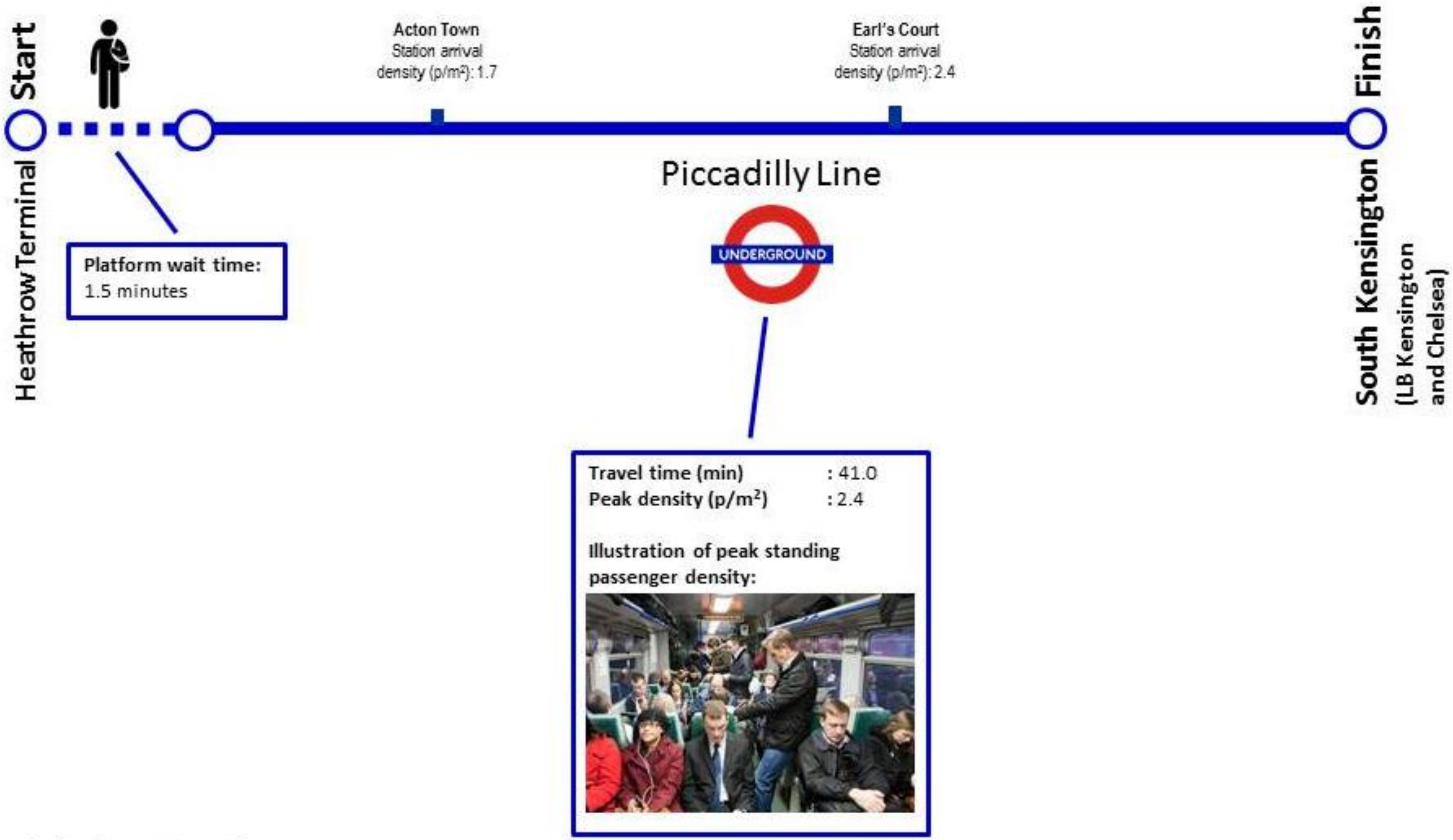


* Note: Trip segment outside detailed simulation area of highway model, as such, detailed travel statistics not available. Additionally, travel time and speed results may be unreliable

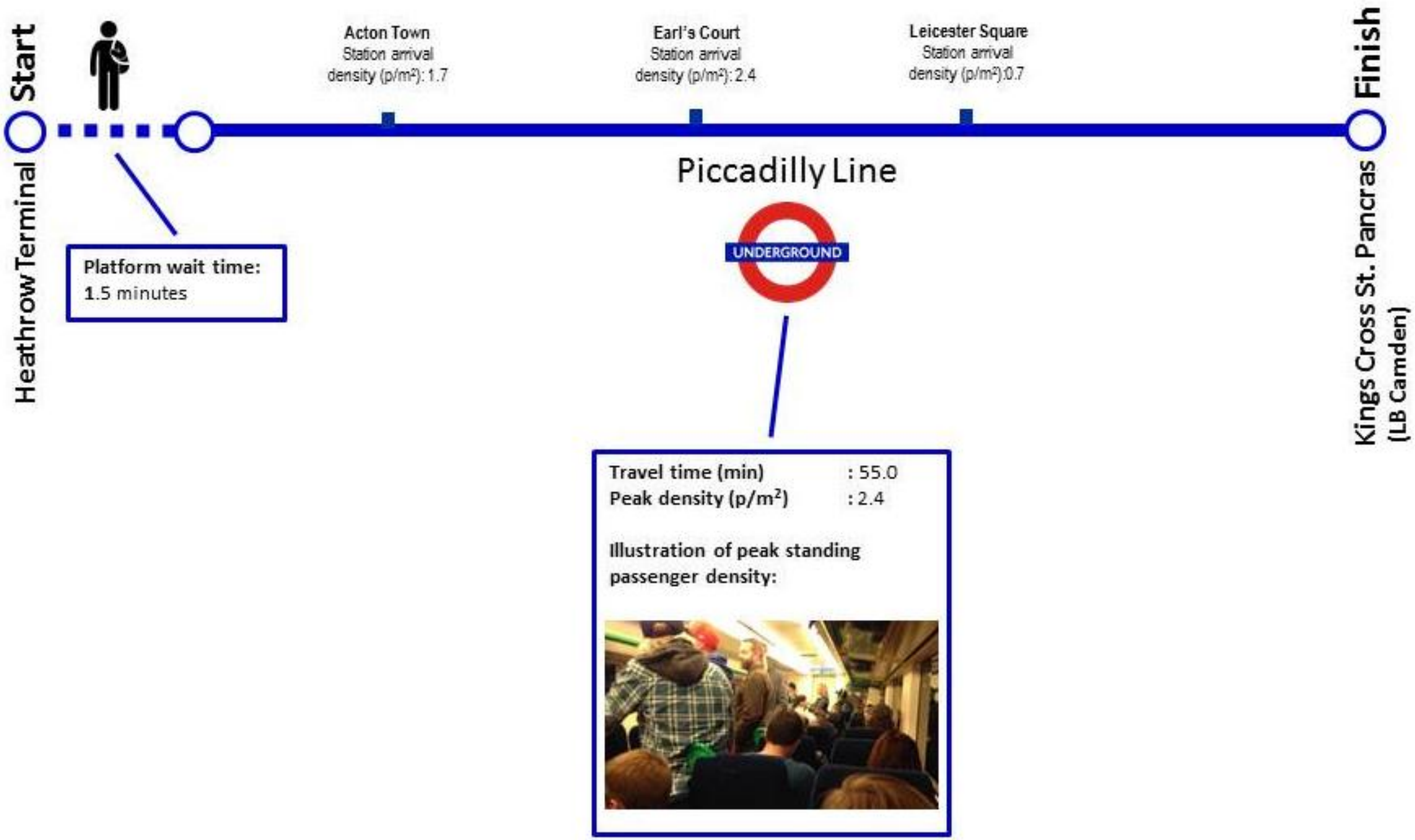
E.3 AM peak Heathrow North West Runway rail experience



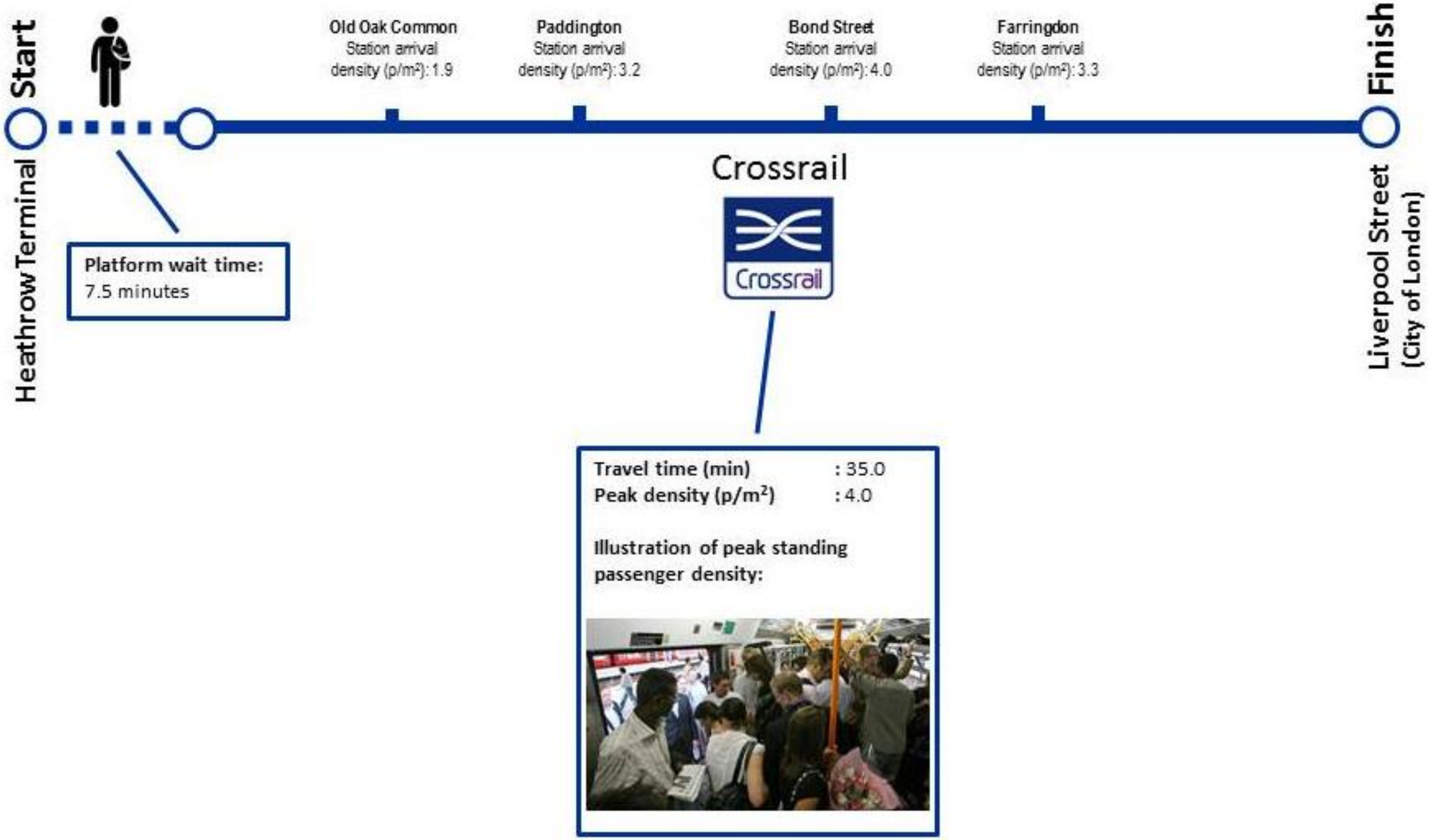
p/m² = number of standing passengers per m²



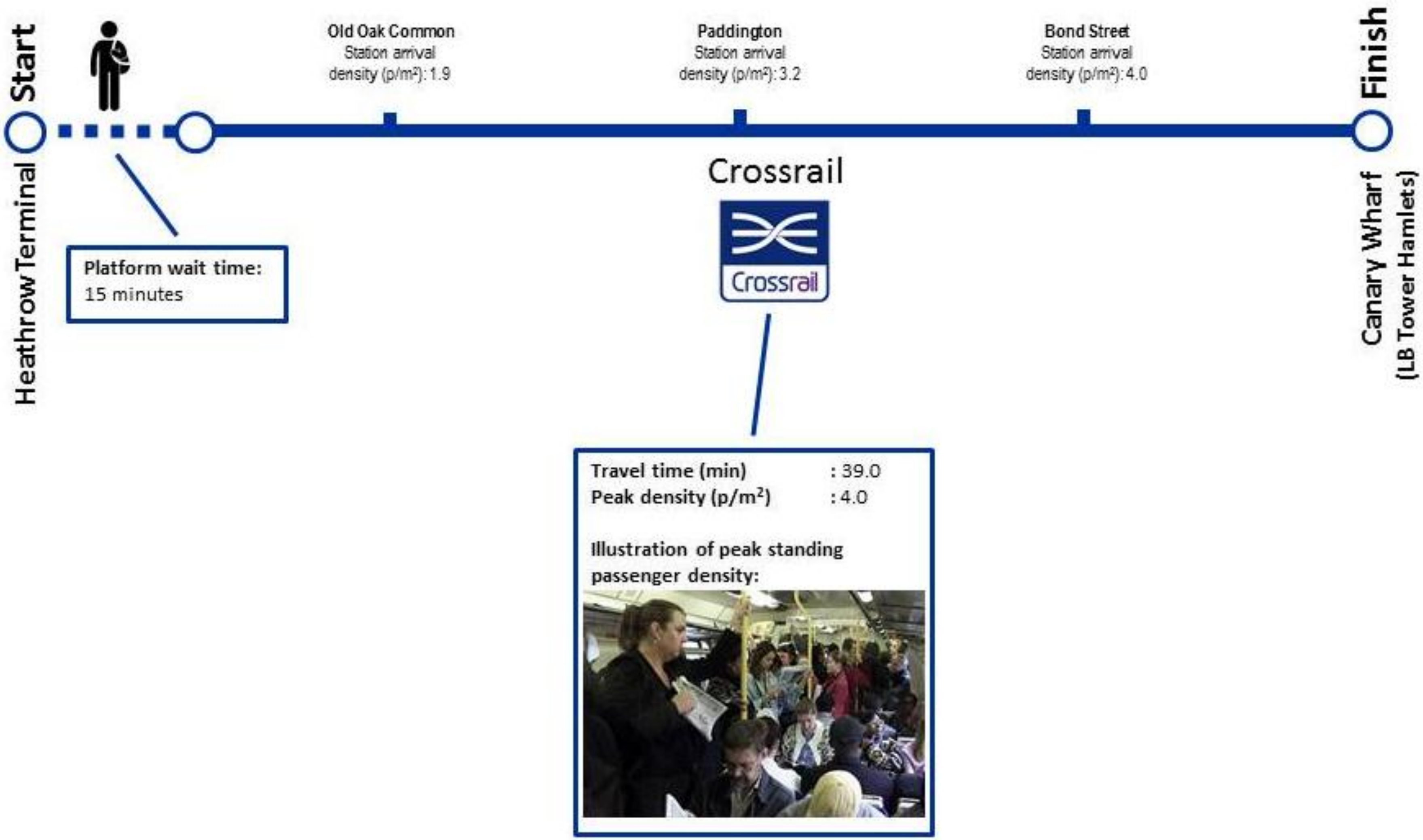
p/m^2 = number of standing passengers per m^2



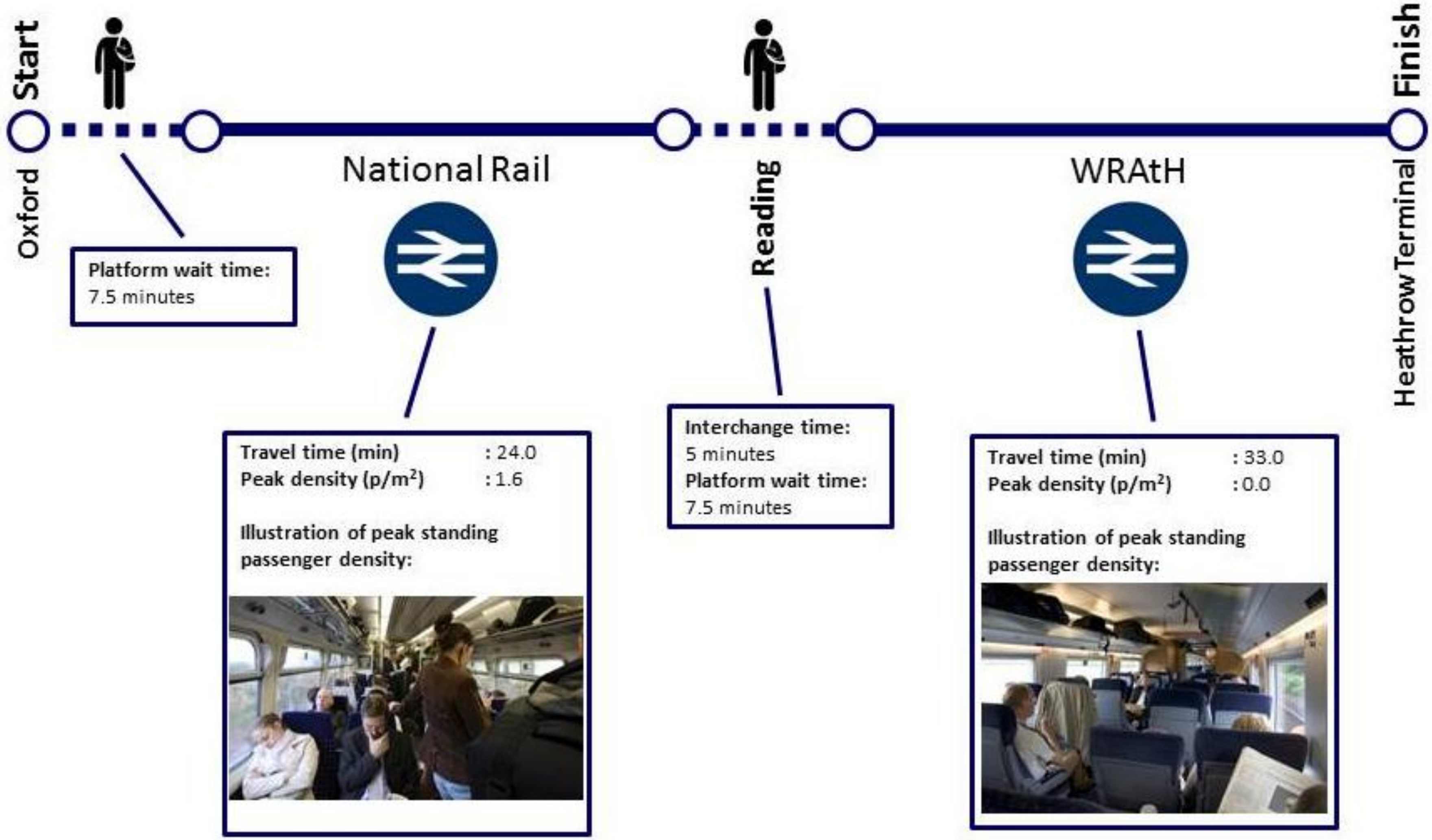
p/m² = number of standing passengers per m²



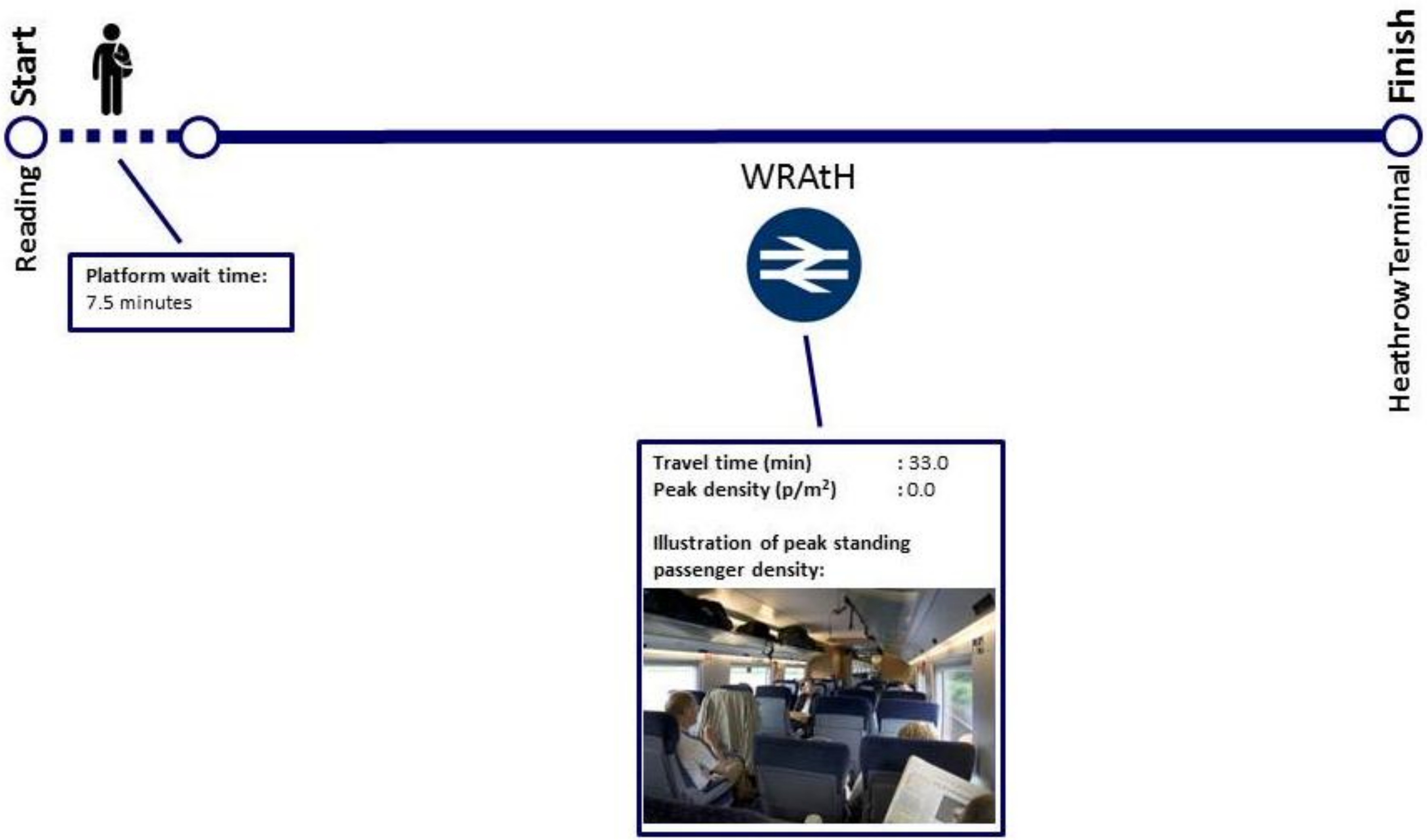
p/m^2 = number of standing passengers per m^2



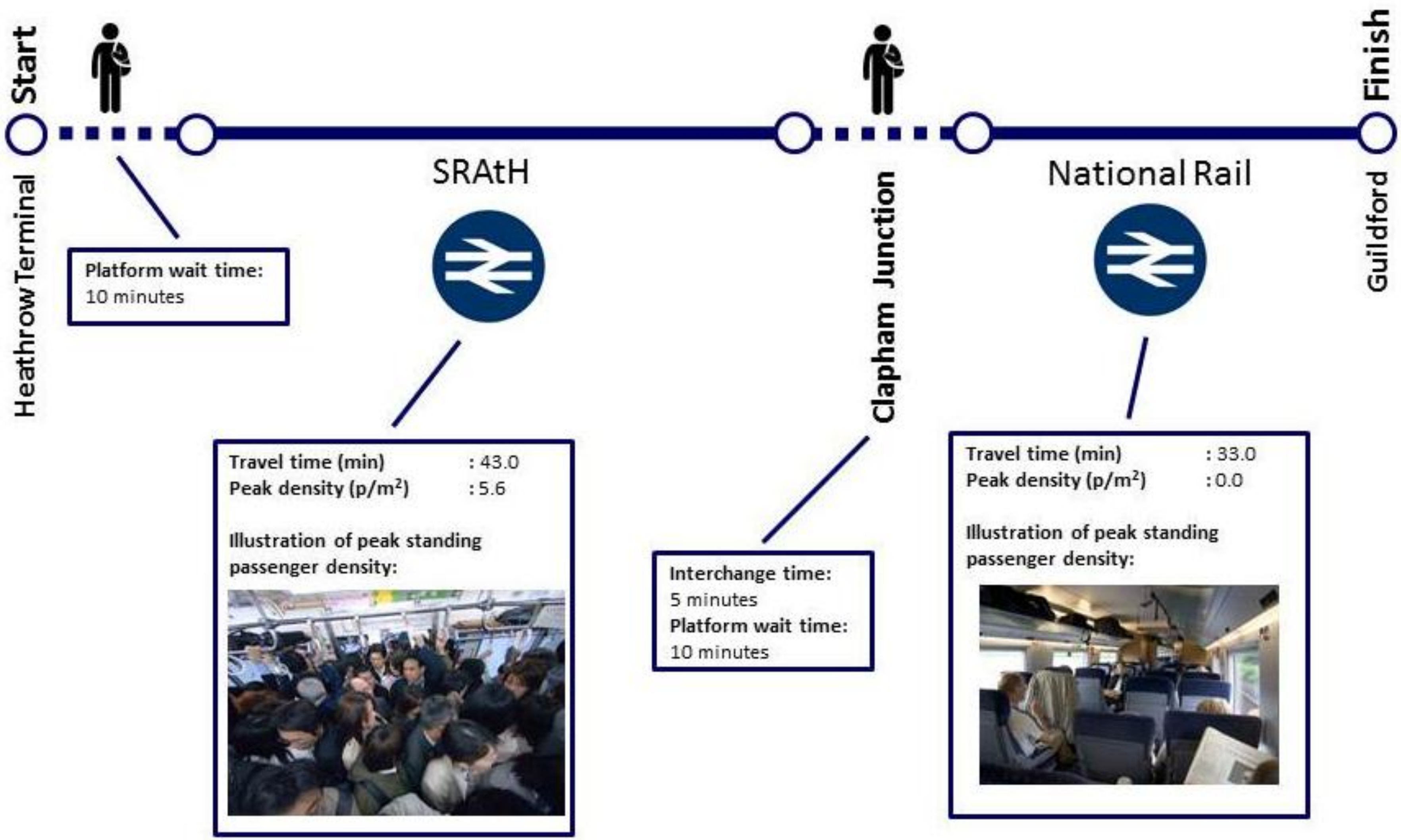
p/m² = number of standing passengers per m²



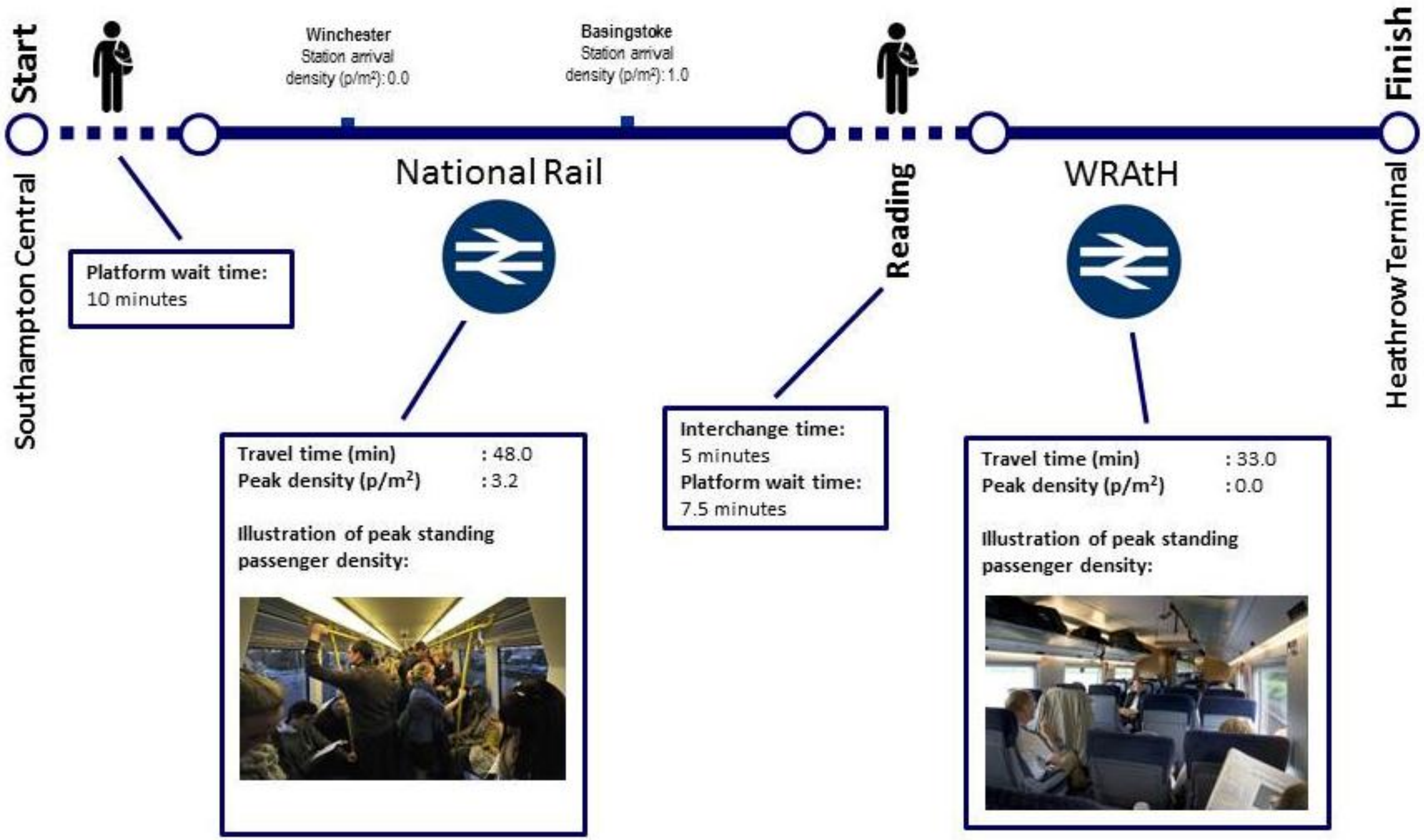
p/m² = number of standing passengers per m²



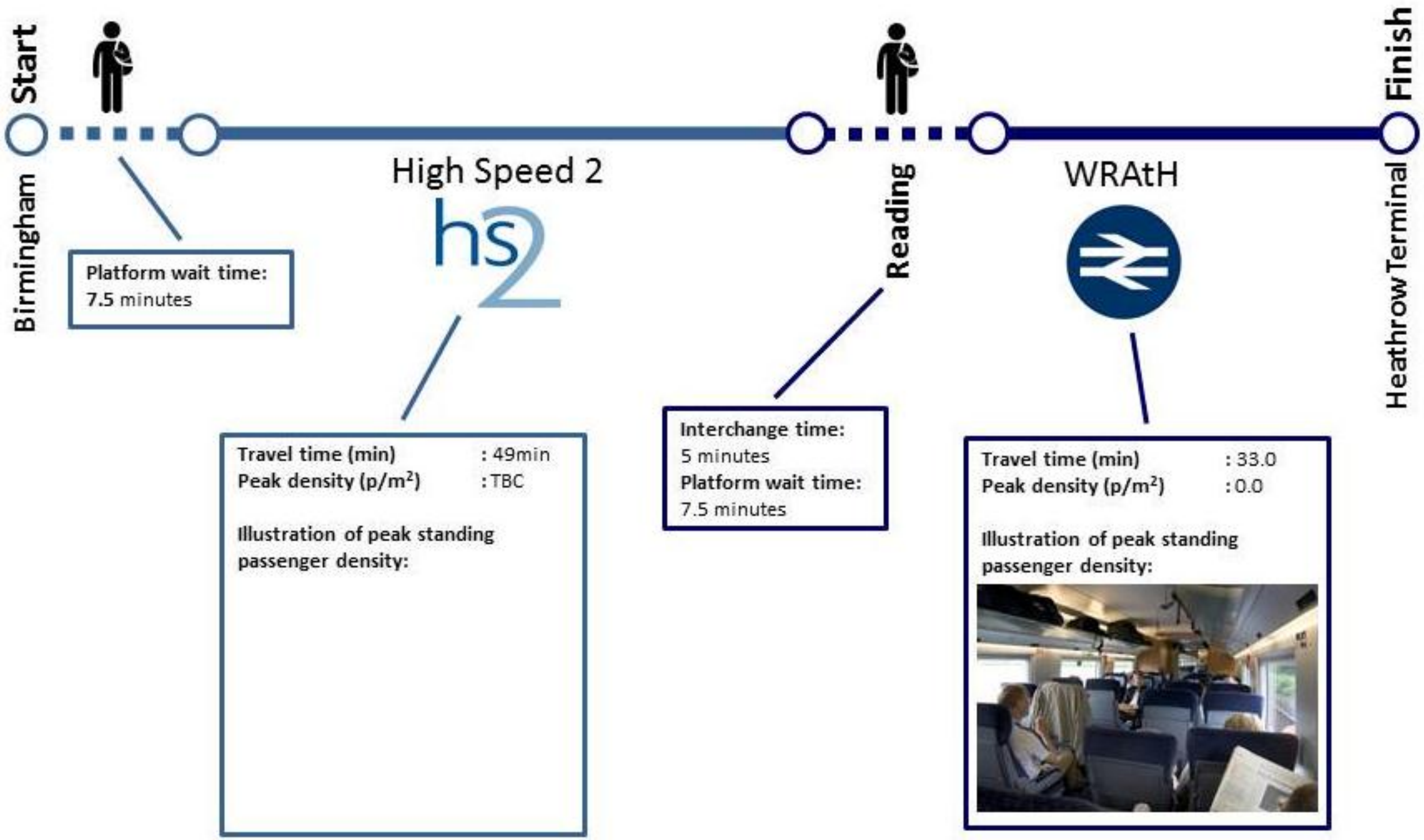
p/m² = number of standing passengers per m²



p/m² = number of standing passengers per m²



p/m² = number of standing passengers per m²



p/m² = number of standing passengers per m²