HS2 Phase Two

Assumptions Report: PLANET Framework Model version 6.1c

November 2016

D6/CS655_A2

Department for Transport

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1 Introduction

1.1.1 The PLANET Framework Model, or PFM, has been developed by HS2 Ltd as a tool to forecast demand for and benefits of HS2. The current version of the PFM is known as version 6.1c or PFMv6.1c and its methodology is separately described in the report: *PLANET Framework Model (PFMv6.1) – Model description*.

1.1.2 This document provides a summary of the input and forecasting assumptions used by PFMv6.1c to generate what is known as the HS2 standard case, as most recently presented in the separate report, *Economic Case for HS2 Phase 2a*, November 2015.

1.1.3 The remainder of this document is set out using the following structure:

- Chapter 2: Forecasting assumptions;
- Chapter 3: Economic appraisal;
- Chapter 4: Highway and air networks;
- Chapter 5: Rail networks: 'Do Minimum';
- Chapter 6: Rail networks: 'Do Something';
- Chapter 7: Rail reliability assumptions; and
- Chapter 8: General model assumptions.

2 Forecasting assumptions

2.1 Forecasting approach

2.1.1 Forecasts of 'Do Minimum' (without HS2) passenger demand are produced by mode and purpose. These make use of the recommended Department for Transport (DfT) modal forecasting procedures for air, car and rail:

- Rail forecasts are generated in line with WebTAG using the DfT's EDGE[1] model.
- Car forecasts are generated using the National Trip End Model in TEMPro[2].
- Domestic air forecasts are generated using the DfT *Aviation Model*[3].

2.1.2 The following sections in this chapter outline the input assumptions used by these models to produce 'Do Minimum' forecasts for each of these modes.

2.2 Rail demand growth

Elasticities

2.2.1 Rail demand growth is generated by the DfT's EDGE model, which is based on current WebTAG[4] guidance for forecasting rail demand. This uses *Passenger Demand Forecasting Handbook (PDFH) Version 5.1* growth elasticities for all variables except fares that are based on PDFH4 elasticities, and car cost which uses PDFH5.0. In addition, the 'ticket type to journey purpose' conversion is based on parameters from PDFH5.0.

2.2.2 In PFMv6.1c the forecasting approach has been updated to incorporate the recommended PDFHv5.1 variable elasticity values for non-London flows, which previous versions of the PFM did not include, as the functionality did not exist to apply them within EDGE. The exogenous elasticity values for GDP per capita and employment demand drivers now vary over the short and long-term forecasting horizon for non-London Core and Major city flow categories. The forecasting horizons are defined in TAG Unit M4.

Demand drivers

2.2.3 Rail demand growth is generated by the DfT's EDGE model which uses up to 14 different demand drivers to feed into the future year forecasts of rail demand.

2.2.4 The base year of PFMv6.1c is the financial year 2014/15, which was updated from 2010/11 in PFM5.2b. The demand drivers are used to provide the change in demand from the base in 2014/15 to the forecast years in 2026/27 and 2036/37 for PFMv6.1c.

[1] Exogenous Demand Growth Estimation (EDGE). Details are given in *WebTAG TAG Unit M4, November 2014*, Forecasting and uncertainty.
[2] Details of the Trip End Model Presentation Programme (TEMPro) can be found at https://www.gov.uk/government/collections/tempro. Accessed 20 August 2015.
[3] The model is described in 'UK Aviation Forecasts, DfT, January 2013.
[4] TAG Unit M4: November 2014, Table 1.

2.2.5 The demand drivers for the modelling were provided by the DfT. The following sections detail the source data and assumptions used for each of these drivers in PFMv6.1c and, for ease of comparison, we also present the assumptions used in PFMv5.2b, the model used for the *Economic Case for HS2, Autumn 2015*. However, it should be noted that the growth for PFMv6.1c is calculated from the base of 2014/15, whereas the growth in drivers for PFMv5.2b is calculated from its base of 2010/11. It should also be noted that there is further inconsistency between PFMv6.1c and PFMv5.2b in the second forecast year and therefore a direct comparison cannot be made.

Population growth

2.2.6 The growth in population used in PFMv6.1c has been sourced from Office of National Statistics (ONS) population projections, November 2013 (principal forecast which is also used by the GDP forecast used in PFMv6.1c), with regional and national shares-based data provided by the Centre for Economics and Business Research (CEBR), June 2015. Table 2-1 below presents the projected growth of the population for the forecast years from the base used in PFM.

Table 2-1: Regional and national population growth used in rail demand forecasts

Region/nation	Growth in population from 2014/15, PFMv6.1c		Growth in population from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38
North East	3.7%	8.7%	3.5%	7.5%
North West	4.5%	9.5%	4.7%	8.8%
Yorkshire & Humberside	5.8%	10.9%	6.7%	10.9%
East Midlands	7.4%	12.5%	8.7%	13.0%
West Midlands	6.5%	11.6%	7.6%	11.9%
East of England	9.9%	15.2%	12.2%	16.6%
London	13.7%	19.2%	18.7%	23.4%
South East	9.0%	14.2%	11.1%	15.4%
South West	8.1%	13.2%	9.7%	14.0%
Wales	4.7%	9.7%	4.9%	9.0%
Scotland	5.0%	10.0%	5.1%	9.2%
Great Britain	7.8%	12.9%	9.3%	13.6%

Employment growth

2.2.7 The growth in employment used in PFMv6.1c has been sourced from the Office for Budget Responsibility[5] (OBR) *Economic and Fiscal Outlook Report July 2015* (for short-term forecasts) and OBR's *Fiscal Sustainability Report July 2015* (for long-term forecasts), using the ONS principle forecast numbers for population. Regional/national shares are based on CEBR, June 2015.

2.2.8 Table 2-2 below presents the predicted growth in employment as used in PFMv6.1c for the forecast years from 2014/15.

Table 2-2: Regional and national employment growth used in rail demand forecasts

Region/nation	% Growth in employment from 2014/15, PFMv6.1c		% Growth in employment from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38
North East	2.7%	3.9%	5.4%	5.6%
North West	5.3%	6.3%	3.4%	3.3%
Yorkshire & Humberside	4.3%	8.9%	9.5%	13.7%
East Midlands	6.8%	7.9%	10.7%	10.8%
West Midlands	7.0%	11.2%	9.2%	12.8%
East of England	8.4%	11.2%	14.3%	16.4%
London	9.6%	12.9%	17.1%	19.6%
South East	4.7%	6.4%	8.1%	8.8%
South West	3.4%	4.9%	4.7%	5.3%
Wales	2.3%	11.0%	4.8%	13.5%
Scotland	1.8%	6.5%	5.5%	9.6%
Great Britain	5.6%	8.5%	9.0%	11.2%

Growth in gross domestic product per person

2.2.9 As with employment growth, the economic growth (measured as GDP per person) in PFMv6.1c has been sourced from the Office for Budget Responsibility (OBR) *Economic and fiscal outlook report, July 2015* (for short-term forecasts) and OBR's *Fiscal sustainability report, June 2015* (for long-term forecasts)[6], using the ONS principal forecast numbers for population. Regional and national shares are based on CEBR June 2015.

2.2.10 In 2011, ONS changed its method of calculation for the GDP deflator from arithmetic to a geometric mean. This means the GDP deflator now corresponds more closely to a

[5] http://budgetresponsibility.org.uk/. Accessed 20 August 2015.
[6] http://budgetresponsibility.org.uk/. Accessed 20 August 2015.

Consumer Price Index (CPI) measure of inflation than Retail Price Index (RPI), although it is not quite the same as either. ONS back-calculated historic GDP using this new approach, as well as using it in its GDP forecasts.

2.2.11 The PDFH5.1 GDP to rail demand elasticity parameter was estimated using GDP forecasts defined with the previous definition of the GDP deflator (similar to RPI), rather the new deflator (similar to CPI). Consequently, to maintain consistency with the original calibration of the PDFH5.1 the GDP forecasts have to be readjusted to the old GDP deflator.

2.2.12 The OBR has estimated that the new deflator increases real GDP growth by approximately 0.2 percentage points per annum; the real GDP growth forecasts have therefore been reduced by 0.2 percentage points every year to ensure the growth rates are consistent with the elasticities that are applied to them[7]. The resulting growth is shown in Table 2-3. The Great Britain figures are a population-weighted average of the regional figures.

2.2.13 For this reason, the GDP forecasts used for forecasting rail growth are different from the ones used to forecast future Value of Time (VoT). The GDP series used for VoT is discussed in Chapter 3.

Table 2-3: Regional and national GDP growth used in rail demand forecasts

Region/nation	Growth in GDP per capita from 2014/15, PFMv6.1c		Growth in GDP per capita from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38 (cap year)
North East	18.2%	41.7%	23.2%	50.5%
North West	18.1%	41.7%	20.4%	47.0%
Yorkshire & Humber	16.7%	39.9%	18.0%	44.1%
East Midlands	18.2%	41.8%	20.2%	46.8%
West Midlands	17.4%	40.8%	20.6%	47.2%
East of England	19.9%	43.8%	22.5%	49.6%
London	22.4%	46.8%	28.1%	56.4%
South East	22.8%	47.2%	28.5%	56.9%
South West	16.6%	39.9%	17.9%	44.0%
Wales	15.2%	38.2%	21.6%	48.5%
Scotland	20.0%	44.0%	23.1%	50.3%
Great Britain	19.4%	43.2%	22.8%	50.0%

[7] This was described in paragraph 1.1.5 of WebTAG unit 3.5.6, January 2014, http://webarchive.nationalarchives.gov.uk/20140304105410/http://www.dft.gov.uk/webtag/documents/expert/pdf/U3_5_6-Jan-2014.pdf. Accessed 20 August 2015.

National Rail and London Underground fares

2.2.14 All National Rail fares in PFMv6.1c are assumed to grow at a rate of RPI+1% per calendar year, except for the forecast period 2014/15-2019/20, when RPI+0% applies, in line with the Government's current policy on rail fares. Table 2-4 shows the cumulative growth used in the model from 2014/15 to the forecast years 2026/27 and to 2036/37.

2.2.15 The assumption of RPI+1% has been used for London Underground[8] fares in the PFMv6.1c forecast period, except for 2014/15-2015/16, when the actual increase of RPI+0% applies.

Table 2-4: Rail fare growth used in rail demand forecasts

	Growth in rail fares from 2014/15, PFMv6.1c		Growth in rail fares from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38 (cap year)
National Rail	6.4%	17.6%	9.4%	22.0%

Car ownership

2.2.16 The change in car ownership in PFMv6.1c has been sourced from the National Trip End Model (NTEM) in TEMPro version 6.29. This provides forecasts for the number of car-owning households. Table 2-5 shows the growth in car-owning households for key RIFF10 zones within the HS2 corridor.

Table 2-5: Car ownership growth used in rail demand forecasts

RIFF zone	Growth in car-owning households from 2014/15, PFMv6		Growth in car-owning households from 2010/11, PFMv5.2	
	2026/27	2036/37	2026/27	2037/38 (cap year)
Central London	6.6%	11.6%	10.5%	16.4%
Central Manchester	2.7%	4.7%	5.7%	8.0%
Rest of Manchester	2.6%	4.3%	4.9%	6.9%
Central Birmingham	4.9%	8.2%	8.5%	12.3%
Rest of West Midlands	2.0%	3.3%	4.0%	5.5%
Leeds	3.4%	5.7%	6.8%	9.5%
Rest of West Yorkshire	2.6%	4.3%	4.9%	6.8%
Great Britain	2.0%	3.4%	3.8%	5.3%

[8] London Underground fares may be subject to policy change from 2017 given future mayoral elections.
[9] Refer to https://www.gov.uk/government/publications/tempro-introduction. Accessed 20 August 2015.
[10] RIFF zones are groups of areas defined within the EDGE model.

Car journey times

2.2.17 The change in average car journey times used in the EDGE model for PFMv6.1c has been sourced from the DfT's *National Transport Model*[11]. The assumptions for travel times to London from the rest of Great Britain are shown in Table 2-6.

Table 2-6: Car journey time growth used in rail demand forecasts

	Growth in car journey times from 2014/15, PFMv6		Growth in car journey times from 2010/11, PFMv5.2	
	2026/27	**2036/37**	**2026/27**	**2037/38 (cap year)**
Rest of Great Britain to London	4.8%	8.8%	5.7%	9.7%

Car cost

2.2.18 This parameter represents the forecast costs of car use, taking account of growth in car fuel prices and projected changes in the fuel efficiency of the vehicle fleet. This method is consistent with a change in WebTAG since February 2014 to include vehicle efficiency; previously WebTAG had recommended using only car fuel price as a proxy for car cost.

2.2.19 Car costs in PFMv6.1c have been sourced from *WebTAG Databook, November 2014*[12] and are shown in Table 2-7.

Table 2-7: Car cost growth used in rail demand forecasts

	Growth in car cost from 2014/15, PFMv6.1c		Growth in car cost from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38 (cap year)
Great Britain	-17.5%	-14.9%	-24.0%	-21.7%

Bus and coach fares

2.2.20 Bus and coach fares in PFMv6.1c are based on an examination by the DfT of the past trend, and an assumption of a future annual average growth rate of RPI+2% p.a. to 2039/40 after which RPI+0% is assumed. Forecast growth for PFMv6.1c from 2014/5 is shown in Table 2-8; previous figures for PFMv5.2b are presented in comparison, which were based on a growth rate of RPI+2% p.a. to 2034/35.

Table 2-8: Bus and coach fare growth used in rail demand forecasts

	Growth in bus costs from 2014/15, PFMv6	Growth in bus costs from 2010/11, PFMv5.2

[11] Refer to https://www.gov.uk/government/collections/transport-appraisal-and-modelling-tools. Accessed 20 August 2015.
[12] Data based on TAG Databook – see tab M4.2.2 in "webtag-data-book-autumn-2014-forthcoming-change.xls" at https://www.gov.uk/government/publications/webtag-tag-data-book-november-2014 . Accessed 20 August 2015.

	2026/27	2036/37	2026/27	2037/38 (cap year)
Great Britain	29.8%	61.4%	40.5%	68.1%

Bus and coach journey times

2.2.21 The forecast change in average bus and coach journey times in PFMv6.1c has been sourced from the *WebTAG Databook, November 2014*. The change from 2014/15 for travel times to London from the rest of Great Britain is shown in Table 2-9.

Table 2-9: Bus and coach journey time growth used in rail demand forecasts

	Growth in bus journey times from 2014/15, PFMv6.1c		Growth in bus journey times from 2010/11, PFMv5.2b	
	2026/27	2036/37	2026/27	2037/38 (cap year)
Rest of GB to London	7.7%	13.5%	9.1%	15.0%

Bus and coach frequency

2.2.22 The forecast change in average bus and coach frequency[13] used in PFMv6.1c has been sourced from the DfT and is based on the recent reductions in bus subsidies. The change from 2014/11 is shown in Table 2-10.

2.2.23 Bus frequency has been updated since PFMv5.2b.

Table 2-10: Bus and coach frequency growth used in rail demand forecasts

	Growth in bus frequency from 2014/15, PFMv6		Growth in bus frequency from 2010/11, PFMv5.2	
	2026/27	2036/37	2026/27	2037/38 (cap year)
Great Britain	3.0%	7.3%	-6.0%	-4.2%

Air passengers

2.2.24 The forecast change in domestic air passengers used in PFMv6.1c has been sourced from the 2013 outputs of the DfT *Aviation Model*[14]. Table 2-11 shows forecast growth of air passengers from 2014/15, by airport.

Table 2-11: Air passenger growth used in rail demand forecasts

Airport	Growth in air passengers from 2014/15, PFMv6		Growth in air passengers from 2010/11, PFMv5.2	
	2026/27	2036/37	2026/27	2037/38 (cap year)
Gatwick Airport	11.6%	14.8%	25.9%	31.1%
Heathrow Airport	15.2%	19.9%	17.9%	25.7%
Stansted Airport	45.8%	66.4%	72.8%	99.1%
Birmingham Airport	33.7%	141.6%	64.6%	197.0%

[13] In WebTAG, frequency is referred to as 'headway'.
[14] The model is described in *UK Aviation Forecasts*, DfT, January 2013.

Manchester Airport	32.3%	72.4%	40.9%	90.1%
Southampton Airport	47.1%	285.1%	61.1%	315.6%
Cardiff Airport	6.7%	47.1%	-20.2%	15.9%

2.3 Rail demand forecasts

Forecast years

2.3.1 The forecast years for PFMv6.1c are taken as:

- an opening year for the first phase of the scheme – assumed to be 2026/27; and
- a second forecast year of 2036/37.

Appraisal horizon

2.3.2 Using the above rail demand drivers, the EDGE model produces rail growth forecasts for the opening year 2026/27 and the second forecast year 2036/37. The growth is summarised in Table 2-12 for PLD and in Table 2-13 for the regional PLANET models.

Table 2-12: Input forecast PLD matrices – growth in rail demand by journey purpose – PFMv6.1c

Journey purpose	**Growth in rail demand from 2014/15** (growth in PLD matrices only)	
	2026/27	**2036/37**
Commuting NCA	7%	19%
Commuting CA from	21%	46%
Commuting CA to	21%	46%
Business CA from	34%	78%
Business CA to	35%	80%
Leisure NCA	18%	44%
Leisure CA from	32%	74%
Leisure CA to	33%	76%
Total	28%	65%

Note: The car available/no-car available split does not apply for rail business trips.

Table 2-13: Forecast regional PLANET matrices – growth in rail demand PFMv6.1c

Regional model	Journey purpose	**Growth in rail demand from 2014/15** (note this is the growth in regional matrices only)	
		2026/27	**2036/37**
PLANET South (PS)	Business PA	42%	85%
	Business AP	40%	78%
	Leisure PA	43%	82%
	Leisure AP	36%	69%
	Commuting PA	17%	28%
	Commuting AP	18%	30%
	Total	21%	37%
PLANET Midlands (PM)	Business CA	25%	63%
	Business NCA	11%	34%
	Leisure CA	25%	61%
	Leisure NCA	11%	33%
	Commuting CA	19%	45%
	Commuting NCA	6%	19%
	Total	18%	43%
PLANET North (PN)	Business CA	24%	59%
	Business NCA	10%	30%
	Leisure CA	22%	56%
	Leisure NCA	8%	28%
	Commuting CA	15%	35%
	Commuting NCA	2%	11%
	Total	14%	34%

PA = Production attraction. AP= Attraction production. CA= Car available. NCA = No car available.

2.4 Highway demand forecasts

Economic growth

2.4.1 The highway demand forecasts were developed using factors derived from TEMPro v6.2. To ensure consistency between these TEMPro-based forecasts and the rail forecasts, which used a more recent OBR GDP growth forecast, a GDP elasticity was applied to the matrices to correct for the discrepancy.

2.4.2 Use was made of the DfT long-distance model forecasts using a high and low GDP estimate to derive implied arc elasticities of highway demand to GDP. The elasticities that were derived are shown in Table 2-14.

Table 2-14: Implied elasticity of highway demand with respect to GDP

Attribute	Purpose		
	Commuting	Business	Other
Implied elasticity	0.087	0.151	0.147

2.4.3 The elasticities shown above were applied to the relative growth in GDP and global factors were calculated with these values, which are shown in Table 2-15. These values were applied to the forecast matrices to correct for the change in GDP forecast. The 2036/37 highway demand forecasts have been derived by assuming linear growth between the highway demand forecasts for 2026/27 and 2040/41.

Table 2-15: Growth applied highway demand to correct for change in GDP forecasts

Year	Growth applied to TEMProv6.2 outputs		
	Commuting	Business	Other
2026/27	-0.6%	-1.0%	-1.0%
2040/41	-0.6%	-1.0%	-1.0%

Highway forecasts for long-distance trips by purpose

2.4.4 Including the adjustment described above, Table 2-16 shows the highway forecasts applied to the base matrices by the three types of trip.

Table 2-16: Highway forecasts for long distance trips used in PFM6.1c

Journey purpose	Growth in highway trips from 2014/15	
	2026/27	2036/37
Commuting	6%	11%
Business	7%	12%
Leisure	10%	17%
Total	9%	15%

Highway forecasts for short-distance trips

2.4.5 Short-distance trips and goods vehicles trips are represented as preloaded flows on the network. For the base year, these are calculated by assigning the base year PLD matrices onto the highway network and taking the difference between the assigned flows and observed traffic flows. The traffic flow data was taken from the DfT's traffic counts[15].

2.4.6 The preloads were calculated for the forecast years using the NTM traffic forecast component of the *Road Transport Forecasts 2015 (RTF15)*[16]. The key input assumptions to RTF15 are as follows:

- population and employment data – based on NTEM 5.4;
- GDP forecasts – OBR central forecasts; and
- fuel prices – based on DECC's fuel price projections.

2.4.7 While the above assumptions are not consistent with those used for forecasting other modes, they are the latest DfT assumptions and so are the most appropriate source of data.

2.4.8 NTM forecasts traffic levels by region and road type using the DfT's fitting on of regional growth and elasticities (FORGE) mechanism. FORGE is not a traditional assignment model as it uses observed data on the level of traffic, using each link of the road network from its 2003 base year, and then applies elasticities derived from the demand model to forecast future levels of traffic.

2.4.9 The flows for the years required for the study (2014/15, 2026/27 and 2036/37) were derived from Road transport forecasts 2015, scenario 1[17], which shows forecast traffic in calendar years 2010 through to 2035 in five-yearly intervals. The growth implied by interpolation of the average annual growth rates for the required model years is shown below in Table 2-17. The link preloads were uplifted using the following assumptions:

- All projections from the national transport model are subject to a significant level of uncertainty. As this uncertainty is higher for more disaggregate results, a single factor was calculated to be applied globally to all regions.
- The values calculated apply to England only – it is assumed that Wales and Scotland have the same growth factors.
- Car and other vehicle factors are calculated separately as preload values are disaggregated by car and light goods vehicles.
- As the nature of the network modelled is predominantly major roads, the only road types to be considered in the calculation of the growth factors are

[15] http://www.dft.gov.uk/traffic-counts.
[16] https://www.gov.uk/government/publications/road-traffic-forecasts-2015. Accessed 20 August 2015.
[17] https://www.gov.uk/government/publications/road-traffic-forecasts-2015. Accessed 20 August 2015.

motorway, trunk and principal.

Table 2-17: Highway forecasts by vehicle type and road type, England

Vehicle type	Growth from 2014/15 to:	Motorway	Trunk	Principal	All roads
Cars	2026/27	17%	16%	14%	15%
	2036/37	30%	29%	25%	27%
Other vehicles	2026/27	20%	21%	21%	21%
	2036/37	36%	37%	39%	38%

Source: Interpolation of RTF 2015 forecast to 2035

2.5 Air demand forecasts

2.5.1 The *PLANET Framework Model (PFM v6.1c) – Model description* report provides a detailed description of the DfT aviation model and its components. PFMv6.1c uses outputs from the most recently published DfT *Aviation Forecasts*[18], at the time of model development.

2.5.2 The resulting matrix growth used is shown in Table 2-18. It should be noted that the 2014/15 base year air demand matrices were calculated using interpolation from the existing 2010/11 and 2026/27 matrices.

Table 2-18: DfT aviation matrices – Growth in domestic air passengers in PFMv6.1c (annual domestic trips)

	Growth in domestic air passengers from 2014/15	
Journey purpose	2026/27	2036/37
Business	21%	51%
Leisure	17%	45%
Total	19%	48%

Note: There is no air passenger commuting matrix in PFM.

[18] UK aviation forecasts, DfT, January 2013, https://www.gov.uk/government/publications/uk-aviation-forecasts-2013. Accessed 20th August 2015.

3 Economic appraisal

3.1 Background

3.1.1 The appraisal of HS2 requires a range of assumptions to compare costs and benefits in accordance with WebTAG guidance. This section outlines the assumptions that have been adopted and their sources.

3.1.2 The economic appraisal uses outputs from the 'Do Minimum', with HS2 scenarios run in PLD and the regional PLANET models to produce an appraisal of the economic performance of Phase One and the full network over the construction period and 60 years of operation.

3.1.3 The section breaks the assumptions down into different elements used in the appraisal.

3.2 Price base

3.2.1 The costs and benefits presented in the appraisal of HS2 are based on 2015/16 prices using the HM Treasury GDP deflator as a measure of inflation. The definition of this deflator has been changed from being more consistent with an RPI metric to being more consistent with a CPI metric.

3.3 Appraisal period

3.3.1 In line with WebTAG guidance the appraisal period is based on 60 years of operation of the scheme.

3.3.2 The key assumptions used in the modelling and appraisal by PFMv6.1c are:

- Phase One – opening year January 2026;
- Phase 'Do Minimum' – opening year January 2027;
- Phase 2b – opening year January 2033;
- First forecast modelled year – 2026/27;
- Second forecast modelled year – 2036/37.

3.4 Parameters

3.4.1 Within the PFMv6.1c appraisal process there are a series of weights that are applied to each element by purpose. These are shown in Table 3-1. The comparable weights used in the PFMv6.1c model are given in Chapter 8.

Table 3-1: Generalised cost element weights for rail – PFMv6.1c

Rail element	Business	Commute	Other
In-vehicle time	1.0	1.0	1.0
Wait time	1.0	2.0	2.0
Access/Egress costs PLD	1.0	1.0	1.0
Access/Egress costs regional PLANETs	1.0	2.0	2.0
Board time penalty (mins)	30.0	30.0	30.0

Values of time

3.4.2 The values of time in the appraisal are assumed to increase with income. The measure of income used is GDP per person (as recommended by TAG Unit A1.3[19]).

3.4.3 The appraisal is based on the same GDP and population sources that feed into the PFM demand (choice) model's forecasts as outlined in Chapter 2.

3.4.4 The precise inputs to the appraisal are OBR's GDP growth forecasts published July 2014 and population growth data taken from the DfT WebTAG Databook annual parameters table. GDP growth is measured in real terms using the GDP deflator which is based on CPI (see Table 3-2, *WebTAG Databook, December 2015*).

3.4.5 These inputs to the appraisal differ slightly from their use in the demand model, which is based on mainland Great Britain transport networks that exclude Scottish islands and with income growth adjusted for inflation using the retail prices index.

Table 3-2: Growth in GDP used to derive values of time in the appraisal – PFMv6.1c

Attribute	Growth from 2014	
	2026	2036
GDP, UK	37%	76%
Population, UK	9%	14%
GDP per person, UK	26%	54%

3.4.6 In October 2015, the Department for Transport published the report, *Understanding and valuing the impact of transport investment* (DfT, 2015). The report set out

[19] TAG unit A1.3 User and Provider Impact, November 2014

proposals for changing the way time savings are valued within transport and, particularly, to allow the value of time applied to each impact to vary according to the trip distance.

3.4.7 The values of time by distance band are shown in Table 3-3 along with the previous values.

3.4.8 In line with guidance (*WebTAG Databook, November 2014*), the values of working and non-working time are assumed to increase with income with an elasticity of 1.0.

Table 3-3: Updated values of time by distance band for PFMv6.1c

Purpose/Mode	**Distance band**	**Values of time by purpose (£/hr) (2010/11 prices)**	
		PFMv5.2b	**PFMv6.1c**
Business – Highway driver	0-50km	27.06	9.95
	50-75km		14.21
	75-100 kms		16.92
	100-125 kms		19.48
	125-150 kms		21.75
	150-175 kms		23.65
Business – Highway passenger	175-200 kms	20.52	25.16
	200-225 kms		26.32
	225-250 kms		27.18
	250-275 kms		27.80
	275-kms		28.07
Business – Rail passenger	0-50km	31.96	9.95
	50-75km		14.33
	75-100 kms		18.27
	100-125 kms		22.46
	125-150 kms		26.57
	150-175 kms		30.33
	175-200 kms		33.54
	200-225 kms		36.13
	225-250 kms		38.12
	250-275 kms		39.59
	275-kms		40.41
Commuting	All	6.81	10.01
Other	All	6.04	4.57

*Per person value is calculated using car occupancy per vehicle kilometre travelled for the work journey purpose, all week average, 2010, from *WebTAG Databook, November 2014*, Table A1.3.3.

Annualisation factors

3.4.9 PFMv6.1c provides outputs for an average weekday. In order to undertake an appraisal of HS2, these weekday values are annualised to represent a calendar year. Table 3-4 shows the annualisation factors that have been derived for each mode and journey purpose for use in PLD.

3.4.10 The factors for rail and air are consistent with the method adopted to de-annualise weekday demands from annual matrices. In the case of highway there is no de-annualisation in the matrix development process and the factors have been sourced from an analysis of NTS.

Table 3-4: Annualisation factors – PFMv6.1c PLD

Purpose	Rail	Air	Highway
Business	254	313	275
Commuting	260	n/a	282
Other	429	313	361
Average	314	313	306

3.4.11 In addition, there a set of factors used to annualise information from the regional PLANET models which are given in Table 3-5. The regional PLANET models represent the morning peak period and so higher annualisation factors are used.

Table 3-5: Regional PLANET annualisation factors – PFMv6.1c

Purpose	7AM to 10 AM	10AM to 4PM	4PM to 7PM	7PM to 7AM	Total (incl. Weekend)
Business User	304	539	365	169	1,376
Commuting User	278	86	260	73	697
Leisure User	303	1,181	602	476	2,562
Business Crowding	253	0	304	0	557
Commuting Crowding	253	0	237	0	490
Leisure Crowding	253	0	503	0	756

Fares

3.4.12 In accordance with WebTAG, benefits and costs in the appraisal are presented in real terms using the GDP deflator. As such the definition of inflation used in the calculation of revenue (RPI) and the definition of inflation used in the rest of the appraisal (GDP deflator) are inconsistent.

3.4.13 In order to define fares growth on the basis of the GDP deflator, revenues are uplifted by the difference in the RPI and GDP deflator indices over time. The difference between these indices is around 0.9% per annum; in effect, this means real fares growth defined on the basis of RPI+1% per annum is equivalent to growth of the GDP deflator +1.9% per annum.

3.4.14 For the purpose of our modelling, all National Rail and London Underground fares are assumed to grow at a rate of RPI+1% per year between 2010 and the second modelled year except between 2014 and 2020, when RPI+0% applies. Within the appraisal there is no further real growth in fares for the remainder of the appraisal period beyond that point.

3.4.15 The regional unimodal models do not contain a fares matrix, and revenue is therefore calculated on the basis of average fares per kilometre as shown in Table 3-6.

Table 3-6: Fares yield – PFMv6.1c

Purpose	Fares £/passenger kilometre (2015 prices)		
	PLANET South	PLANET Midlands	PLANET North
Business	0.154	0.173	0.166
Commuting	0.144	0.156	0.176
Other	0.140	0.159	0.154

Ramp-up effects

3.4.16 In order to reflect the demand and revenue assumptions in the early years of the HS2 scheme, a series of ramp up assumptions for demand benefits are applied within the appraisal as shown by Table 3-7.

Table 3-7: Assumptions related to ramp-up effects, PFMv6.1c

Year after opening	Year Phase One	Year Phase 'Do Minimum'	Year Phase 2b	Growth adjustment applied to demand and benefits
0	2026	2027	2033	-20%
1	2027	2028	2034	-10%
2	2028	2029	2035	-5%
3 and beyond	2029	2030	2036	0%

Discount rates

3.4.17 In line with TAG Unit A1.1 and *WebTAG Databook, November 2014*[20] a series of discount rates are applied from 2011. The annual discount rates assumed are:

- until 2046: annual discount rate = 3.5%;
- between 2047 and 2091: annual discount rate = 3.0%; and
- beyond 2092: annual discount rate = 2.5%.

Highway factors used in the appraisal

3.4.18 Vehicle operating costs are derived using the approach outlined in TAG Unit A1.3[21]. Fuel consumption is estimated using the function:

$$L = a / v + b + c * v + d * v^2$$

where: L= fuel consumption, expressed in litres per kilometre;

v = average speed in kilometres per hour; and

a, b, c, d are parameters defined for each vehicle category.

3.4.19 The input for speed of highway traffic, v, is taken from PLD's highway model, which estimates average traffic speed using DfT link type specific volume delay functions and traffic estimates. The vehicle operating cost parameters adopted within the HS2 appraisal are based on the parameters used by TAG Unit A1.3[22].

3.4.20 The impacts of road decongestion are assessed in line with TAG A5.4, December 201523. In the absence of more specific evidence TAG suggests the use of a diversion factor based on results from the DfT's National Transport Model which suggest 26% of a change in rail passenger kilometres would be diverted from car kilometres.

3.4.21 The TAG Unit A5.4 values are used to derive Highway External Costs for 2026 and 2037 are presented in Table 3-8. These have been derived by interpolation and extrapolation of the values quoted in *WebTAG Databook, December 2015*.

Table 3-8: Highway external costs (pence / car km)

Element	Pence/ car km (2015)			Pence/ car km (2026)			Pence/ car km (2036)		
	Motorways	A-road	Other Roads	Motorways	A-road	Other Roads	Motorways	A-road	Other Roads
Congestion (London)	0.1	75.1	50.2	1.2	146.9	78.9	3.2	222.0	109.0
Congestion (Conurbations)	1.7	35.9	25.7	5.9	59.1	44.4	11.5	88.4	64.7

[20] WebTAG Databook, December 2015
[21] TAG unit A1.3 User and provider impacts, November 2014.
[22] TAG unit A1.3 User and provider impacts, November 2014.
[23] TAG unit A5.4 Marginal external costs, December 2015.

Element	Pence/ car km (2015)			Pence/ car km (2026)			Pence/ car km (2036)		
	Motorways	A-road	Other Roads	Motorways	A-road	Other Roads	Motorways	A-road	Other Roads
Congestion (Other urban)	n/a	14.5	11.3	n/a	24.0	16.5	n/a	35.0	21.6
Congestion (Rural)	1.1	2.4	3.2	4.1	4.2	6.0	10.6	6.4	8.6
Infrastructure (London)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Infrastructure (Conurbation)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Infrastructure (Other urban)	n/a	0.1	0.1	n/a	0.1	0.1	n/a	0.2	0.2
Infrastructure (Rural)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Accident (London)	0.0	3.2	3.2	0.0	3.9	3.9	0.0	4.7	4.7
Accident (Conurbations)	0.0	3.2	3.2	0.0	3.9	3.9	0.0	4.7	4.7
Accident (Other urban)	n/a	3.2	3.2	n/a	3.9	3.9	n/a	4.7	4.7
Accident (Rural)	0.0	0.7	0.7	0.0	0.9	0.9	0.0	1.1	1.1
Local air quality (London)	0.2	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.0
Local air quality (Conurbations)	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Local air quality (Other urban)	n/a	0.1	0.1	n/a	0.0	0.0	n/a	0.0	0.0
Local air quality (Rural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Noise (London)	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Noise (Conurbations)	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Noise (Other urban)	n/a	0.2	0.2	n/a	0.3	0.3	n/a	0.3	0.3
Noise (Rural)	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.2
Greenhouse gases (London)	0.9	0.9	1.2	0.7	0.8	1.0	1.1	1.3	1.5
Greenhouse gases (Conurbations)	0.8	0.8	0.9	0.7	0.7	0.8	1.1	1.1	1.2
Greenhouse gases (Other urban)	n/a	0.8	0.9	n/a	0.7	0.8	n/a	1.0	1.2
Greenhouse gases (Rural)	0.9	0.8	0.8	0.7	0.7	0.7	1.1	1.0	1.0
Indirect taxation (London)	-5.2	-5.4	-6.9	-3.9	-4.4	-5.4	-3.5	-4.1	-5.0
Indirect taxation (Conurbations)	-5.0	-5.0	-5.6	-3.7	-3.9	-4.3	-3.4	-3.6	-3.9
Indirect Taxation (Other urban)	n/a	-4.7	-5.3	n/a	-3.6	-4.0	n/a	-3.3	-3.7
Indirect Taxation (Rural)	-5.1	-4.7	-4.6	-3.8	-3.5	-3.5	-3.4	-3.2	-3.2

Wider impacts

3.4.22 The wider impacts of HS2 that are additional to transport user benefits have been estimated in line with *TAG Unit A2.1, January 2014*. The impacts are estimated by using DfT's wider impacts in transport appraisal (WITA) software. In the case of the

output change in imperfectly competitive markets WebTAG recommends these are estimated as being equivalent in value to 10% of the business user transport benefits.

Carbon impacts

3.4.23 The impacts of HS2 on emissions of carbon from highway and diesel train use have been appraised using a bespoke model. It uses PFMv6.1c assumptions. These are:

- Assumptions for car fuel consumption, car emissions and the value of a non-traded tonne of carbon from WebTAG;
- Train kms and highway kms from PFM;
- Car speeds for long distance and local from the DfT's *National Transport Model*; and
- Diesel train energy consumption is sourced from DfT's *Rail Emissions Model*.

4 Highway and air networks

4.1 Background

4.1.1 Within PLD and the regional PLANET models are a series of networks for the 'Do Minimum' and 'Do Something' scenarios. Chapter 4 outlines the assumptions made for the air and highway networks. Chapters 5 and 6 outline the assumptions related to the rail networks.

4.2 'Do Minimum' and 'Do Something' highway networks

4.2.1 For PFMv6.1c no additional highway schemes were added between 2026/27 and 2036/37, hence the 2026/27 and 2036/37 networks are identical. In addition, they are also identical in the 'Do Minimum' and 'Do Something' scenarios.

4.2.2 The schemes that were included in the PFMv6.1c model are listed in Table 4-1. Note the network has been updated from PFMv5.2b as per the DfT's list of under-construction and committed Road Investment Scheme Period 1 (RIS1) infrastructure programmes.

Table 4-1: Highway schemes in PFMv5.2- 2026/27 and 2036/37

Scheme assumed	
A1 Bramham – Wetherby	A11 Fiveways to Thetford Improvement
A3 Hindhead Improvement	A160 / A180 Improvements, Immingham
A421 Bedford to M1 Junction 13	A465 Dualling Scheme between Abergavenny and Hirwaun
M1 Junctions 25-28 Widening Scheme	A556 Knutsford to Bowdon Environmental Improvement
M25 Junctions 16-23 Widening	M1 Junctions 28-31 Managed Motorways
M25 Junctions 27-30 Widening	M1 Junctions 32-35a Managed Motorway
M27 J3-4 Widening	M1 Junctions 39-42 Managed Motorway

Scheme assumed	
M42 J7-9 Hard Shoulder Running	M25 Junctions 23-27 Managed Motorways
M6 J4-5 Hard Shoulder Running	M25 Junctions 5-7 Managed Motorways
M6 Junctions 8-10A Managed Motorways (Birmingham Box Phase 2)	M60 Junctions 15-12 Lane Gain
M74 Completion	M60 Junctions 8-12 Managed Motorways
M80 Stepps to Haggs	M62 Junctions 18-20 Managed Motorway
A1 Dishforth to Leeming Improvement Scheme (A1 Dishforth to Barton)	M8 M73 M74 Motorway Improvements
A23 Handcross to Warninglid	A453 Widening (M1 Junction 24 to A52 Nottingham)
A46 Newark to Widmerpool Improvement	A494 Drome Ewloe Improvement
M1 Junction 10-13 Improvements	A5-M1 Link (A505 Dunstable Northern Bypass)
M4 Junction 19-20 and M5 Junction 15-17 Managed Motorways	A9 Dualling
M4 Junction 3-2 Bus Lane Suspension Scheme	M3 Junctions 2-4a Managed Motorway
M6 Junctions 5-8 Managed Motorways (Birmingham Box Phase 3)	M4 Junctions 3-12 Managed Motorway
M62 Junctions 25 to 30 Managed Motorway	M54 to M6 / M6 (Toll) Link Road
M6 Junction 10A - 13 Managed Motorway	A500 Etruria Valley Widening
A1(M) Jn 5 - 9 Welyn-Baldock	M5 Junctions 4a - 6 south of Birmingham
A1(M) Jn 6 - 8 Stevenage	M53 J11 - 5 Capacity Improvements
M1 J23a – M1 J24 Smart Motorways	M56 J6 - J8
M1 Junctions 13 - 19 south of Rugby	M6 J10a-13 Widening
M1 Junctions 24 - 25 (Long Eaton)	M6 J5-8w Widening. Birmingham Box Ph3
M20 Jn3 - 5 (Maidstone)	M6 Jn16 - 19 Birmingham - Manchester
M23 Junctions 8 - 10 (Gatwick)	M6 Junctions 13 - 15 between Birmingham and Manchester
M25 J 10-12 SM widening	M6 Junctions 2 - 4 between Coventry and Birmingham
M25 J 14-16 SM Widening (a)	M6 Junctions 21a - 26 west of Manchester
M25 J 14-16 SM widening (b)	M60 J1 - 4 Widening (link to M56 Junction 3 not coded)
M27 Junctions 4 - 11 (Southampton)	M60 J24-27 Widening
M3 Junctions 9 - 14 (Southampton)	M60 J8 -12 Widening
M4: Jn 3 (Uxbridge) to Jn 12 (Reading west): upgrading to Smart Motorway, linking Reading to Heathrow	M62 J25 to J30 Widening
M40/M42 interchange: upgrading to Smart Motorway from junction 16 of the M40 and from junction 3 to 3a of the M42	M62 Junctions 10 - 12 (Manchester)

Scheme assumed	
A1 Leeming to Barton Upgrade to Motorway Standard	A5036 Access to Port of Liverpool
A1 Lobley Hill	M4 J3-12 Widening
A14 Cambridge to Huntingdon	M42 J10 to M69 J1 (1) - A5 Hinckley
A19 Norton to Wynyard	M54 to M6 (Toll) Link - [New Road but upgrade A460]
A21 Tonbridge to Pembury	M60 J8 -12 Widening
A5: Hinckley: widening of the section of A5 near Hinckley to dual carriageway where it carries traffic for both the A5 and A47	New junction 11A M1, link road to A5

4.3 'Do Minimum' and 'Do Something' air networks

4.3.1 The air passenger supply in the PFM represents domestic air services wholly within mainland Great Britain, and so excludes services to Northern Ireland, the Channel Islands, Isle of Man and Scottish islands. Within PFMv6.1c the networks were taken directly from the DfT *Aviation Model*[24].

4.3.2 Table 4-2 shows the changes in routes between the various forecast years used in PFMv6.1c.

Table 4-2: Air network changes in PFMv5.1

2026/27 Routes added relative to 2010/11	**2026/27 Routes removed relative to 2010/11**
Exeter – Stansted	Aberdeen – Luton
Inverness – Bristol	Aberdeen – Durham
Inverness – Edinburgh	Edinburgh – Gatwick
Inverness - London City	Edinburgh – Manchester
London City – Inverness	Edinburgh – Stansted
Newquay - Leeds Bradford	Exeter – Edinburgh
Stansted – Exeter	Glasgow – Luton
	Glasgow – Southampton
	Gatwick – Edinburgh
	Luton – Aberdeen
	Luton – Glasgow
	Luton – Inverness
	Manchester – Bristol

[2424] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013

	Manchester – Edinburgh
	Manchester – Norwich
	Durham – Aberdeen
	Prestwick - Stansted
	Stansted – Edinburgh
	Stansted – Prestwick

2036/37[25] Routes added relative to 2026/27	**2036/37 Routes removed relative to 2026/27**
Cardiff – Inverness	Gatwick – Glasgow
Edinburgh – Gatwick	Gatwick – Manchester
Gatwick – Edinburgh	Glasgow – Gatwick
Inverness – Cardiff	Inverness - Bristol
Manchester – Bristol	Manchester – Gatwick
Manchester – Norwich	Stansted – Glasgow
Newquay – Manchester	
Prestwick – Stansted	

Air fares

4.3.3 The networks in PFMv6.1c take the base year domestic air fare matrix unadjusted from the DfT *Aviation Model*, which provides air fares between all modelled airports in constant 2008 prices and values. These are adjusted to the 2014/15 base year and the forecast years using the index of changes in real domestic business and leisure fares supplied by the DfT.

4.3.4 The index of changes in real air fares is shown in Table 4-3.

Table 4-3: Real fare index factors – Air fares, PFMv6.1c

Purpose	Growth in air fares from 2008		
	2014/15	2026/27	2036/37
Business	-3.8%	-1.1%	-0.1%
Leisure	-2.5%	16%	21.3%

[25] 2040/41 air networks have been adopted for 2037/38 in PFMv5.2

5 Rail network: 'Do Minimum'

5.1 Background

5.1.1 The rail networks within PFMv6.1c include a representation of a timetable and its associated capacity. The 'Do Minimum' provides a reference against which the 'Do something' HS2 option is compared.

5.1.2 With a few exceptions, the 'Do Minimum' timetable assumptions are based on future committed schemes only. The 'Do Minimum' makes use of information provided by the DfT for Network Rail services and Transport for London (TfL) for London Underground Limited (LUL) services. The rail and LUL 'Do Minimum' networks are assumed to be identical in the 2026/27 (first forecast year model) and 2036/37 (second forecast year).

5.1.3 These assumptions are designed only for the purpose of providing a suitable reference case for the appraisal of HS2. No decisions have yet been taken about train service requirements – or which stock will operate them – in any of the relevant franchises, and therefore these service patterns should be considered to be indicative.

5.1.4 In the PLD model these assumptions relate to the average service pattern on weekdays. Information used within the regional PLANET models relates to services during the morning peak period. Within these assumptions, no work has been undertaken to review the local commuter services.

5.1.5 A summary of the key assumptions used within the PLD sub-model of PFMv6.1c for the Train Operating Companies affected by HS2 are given in this chapter.

5.2 Chiltern Railways

5.2.1 The 'Do Minimum' service and rolling stock assumptions for Chiltern Railways in PFMv6.1c have not been updated from PFMv5.2b and are described in the following sections.

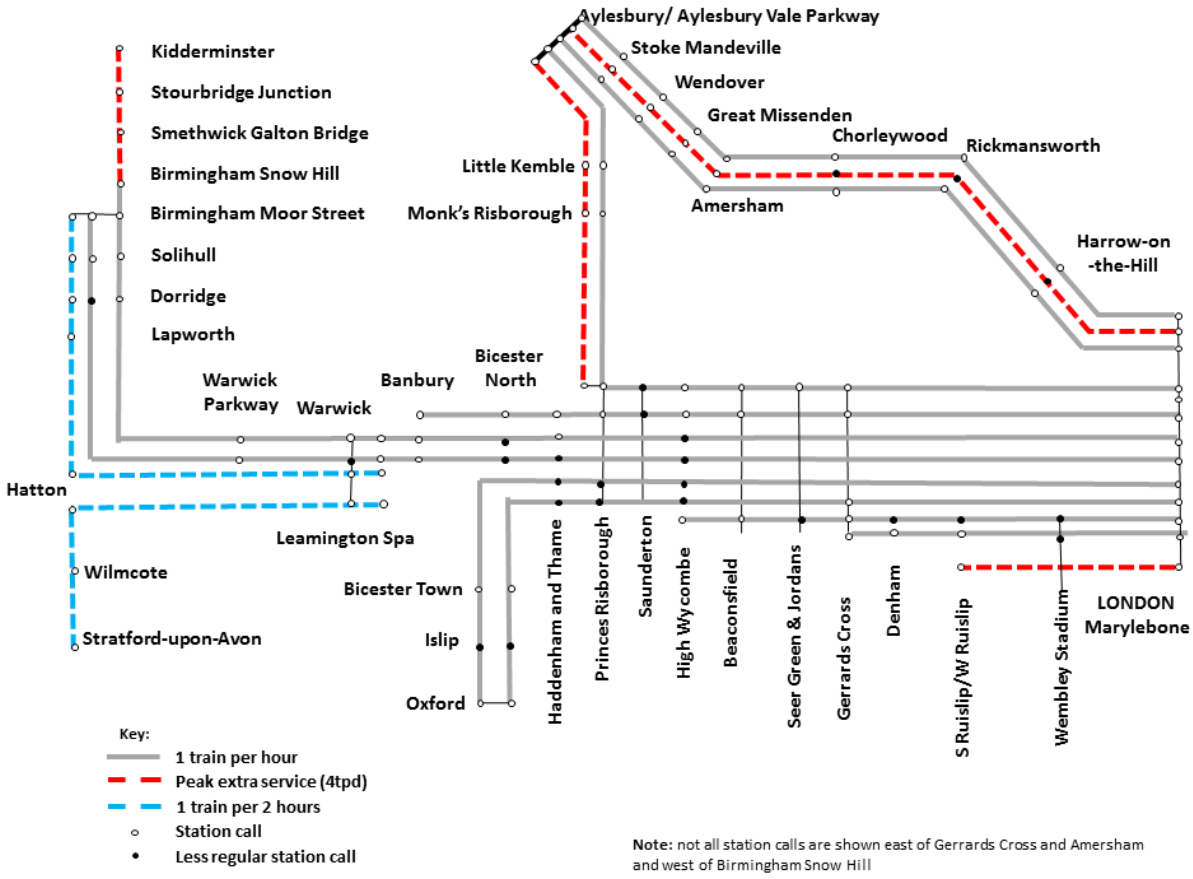
5.2.2 The assumed future year 'Do Minimum' timetable includes Evergreen 3, which allows for new London Marylebone - Oxford services via Bicester Town to be introduced, as well as a small amount of train lengthening on some peak services between Aylesbury and High Wycombe.

5.2.3 The main characteristics of the service specification are:

- 2 trains per hour (tph) + peak extras between London Marylebone and Aylesbury Vale Parkway/Aylesbury via Amersham;
- 2tph London Marylebone – Birmingham Snow Hill/Birmingham Moor Street;
- 2tph London Marylebone – Oxford;
- 1tph London Marylebone – Gerrards Cross;
- 1tph London Marylebone – Banbury;
- 1tph London Marylebone – High Wycombe;
- 2tph London Marylebone - Aylesbury Vale Parkway/Aylesbury via Princes Risborough;
- 0.5tph Leamington Spa – Birmingham Moor Street;
- 0.5tph Stratford-Upon-Avon – Leamington Spa;
- 5 trains per day (tpd) Princes Risborough – Aylesbury; and,
- 4tpd peak only London Marylebone – West Ruislip.

5.2.4 Figure 5-1 shows a summary of the service and service pattern assumed in the 'Do Minimum'.

Figure 5-1: Chiltern - Average service pattern used in PFMv6.1b – 'Do Minimum'



5.3 Cross country

5.3.1 The 'Do Minimum' assumptions for cross country in PFMv6.1c are updated compared to PFMv5.2b for some journey times between Birmingham and Nottingham and Birmingham and Sheffield.

5.3.2 The future year 'Do Minimum' timetable includes electrification, with an all-electric fleet, of 5-car Intercity Express Programme (IEP) trains on the cross country network with the exception of the Cardiff to Nottingham route which remain as Class 170 trains.

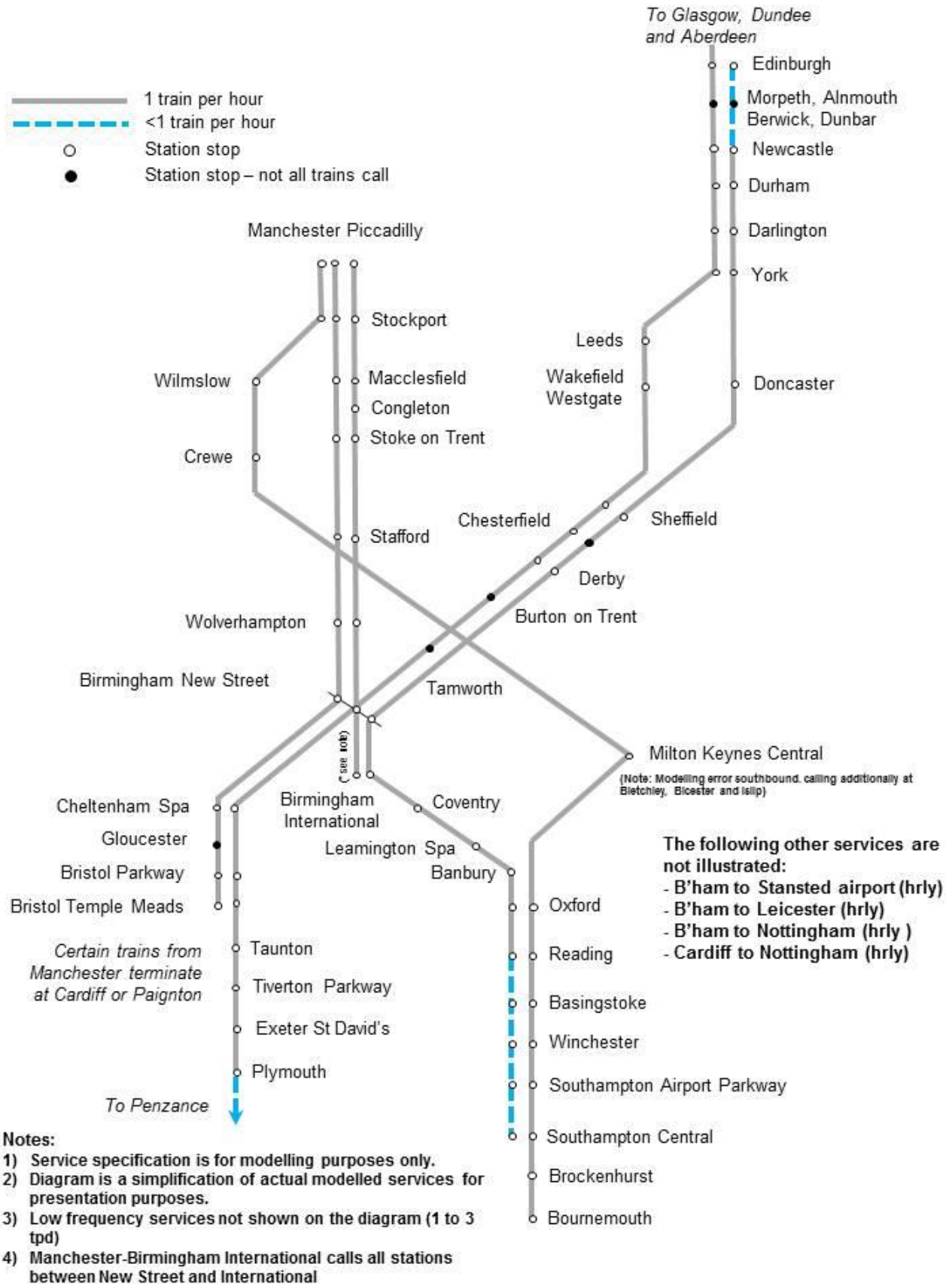
5.3.3 There are small changes in the future year 'Do Minimum' timetable from the modelled base year. A notable exception is the addition of an hourly service between Manchester and Birmingham International which was added due to extra train paths becoming available as a result of some Cross Country services being re-routed via East-West Rail to take advantage of journey time improvements through electrification and to maintain Stockport/Macclesfield/Stoke-on-Trent frequencies to Birmingham New Street and Birmingham International.

5.3.4 In PFMv6 there was a partial update to the DM scenario to better reflect journey times for cross country services on the section of the network between Birmingham and Derby, and Birmingham and Nottingham. This is the section of the network that is in direct competition with the high speed (HS) services in Phase 2 of the HS2 scheme.

5.3.5 The capacity of the IEP trains is 328 seats and standing capacity for 181 using a factor of 2.5 passengers per metre square.

5.3.6 Figure 5-2 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for cross country services.

Figure 5-2: Cross country- Average service pattern used in PFMv6 – 'Do Minimum'



5.4 East Coast Main Line

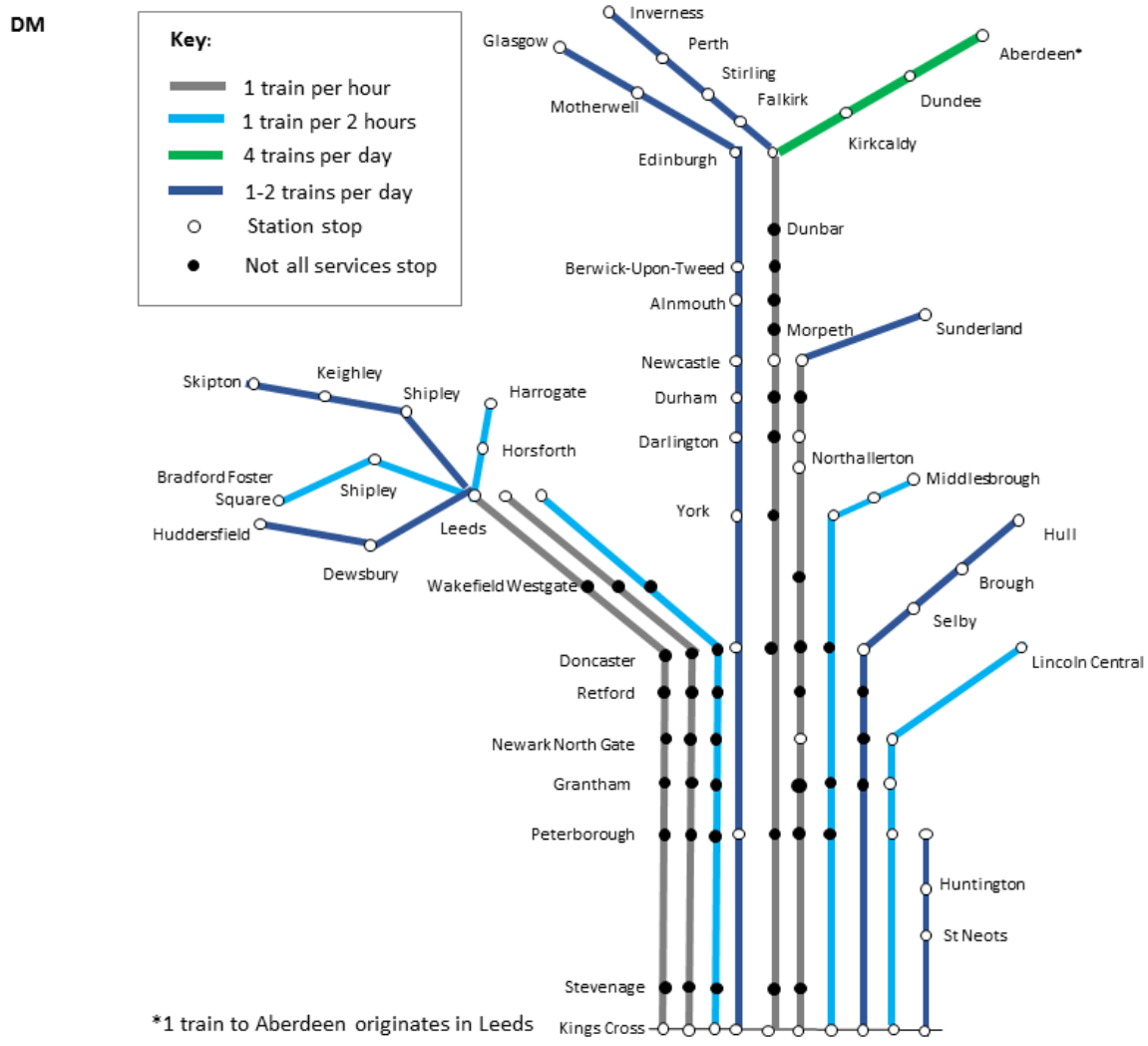
5.4.1 The 'Do Minimum' assumptions for East Coast in PFMv6.1c have not changed from PFMv5.2b.

5.4.2 The future year 'Do Minimum' timetable uses the Intercity East Coast (ICEC) May 2020 weekday timetable developed by the new Virgin Trains East Coast franchisee. Note that the modelled timetable reflects what was assumed in the franchisee's bid and does not reflect the subsequent decision by the Office of Rail and Road (ORR) regarding these services and the introduction of a new Open Access service between London and Edinburgh. This timetable incorporates 5 and 9 car electric and bi-mode IEP trains and reduced formation class 91/Mk IV (2+7), replacing class 91/Mk IV (2+9) and high speed train formations. The key features of this timetable are:

- 26tpd between Edinburgh and London King's Cross with the fastest journey time of four hours; three trains extend to Aberdeen, and one each to Glasgow, Stirling and Inverness;
- 1tph between Newcastle and London King's Cross, with two services extending to Sunderland;
- an additional train every two-hours between Middlesbrough and London King's Cross (six down and seven up);
- 35tpd serving Leeds, averaging 2tph with a journey time of two hours. Of these trains, 6tpd travel onwards to each of Harrogate and Bradford, and 1tpd travels onwards to each of Huddersfield and Skipton;
- 3tpd from London King's Cross to Doncaster, 1tpd from Doncaster to London King's Cross, along with 1tpd from each of Newark and Peterborough to London King's Cross; and
- One train every two hours between Lincoln and London King's Cross.

5.4.3 Figure 5-3 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for East Coast Main Line services.

Figure 5-3: East Coast Main Line – Average service pattern used in PFMv6.1c – 'Do Minimum'



5.5 Great Western

5.5.1 The 'Do Minimum' assumptions for Great Western services within PFMv6.1c have been completely updated since PFMv5.2b to reflect the latest timetable for December 2019 which has been provided by the DfT.

5.5.2 A summary of the main assumptions in PFMv6.1c are the following:

- Over four trains per hour serving Oxford.
- Hourly service to Worcester Foregate Street, half of these travelling onwards to Hereford. One train an hour to Cheltenham Spa.
- Two trains per hour to Cardiff Central, one of which travels onwards to Swansea.
- Four trains per hour serving Bristol Temple Meads, half of these route via Bristol Parkway and half via Bath.
- One train per hour serving Plymouth, with half of these services travelling onwards to Penzance. Two trains per hour serving Newbury.

5.5.3 Paddington to Birmingham New Street services are modelled to retain the same level of service between Oxford and Birmingham when cross country services get re-routed via East-West rail in the future year scenario. This is achieved by extending one hourly fast Oxford service to Birmingham New Street.

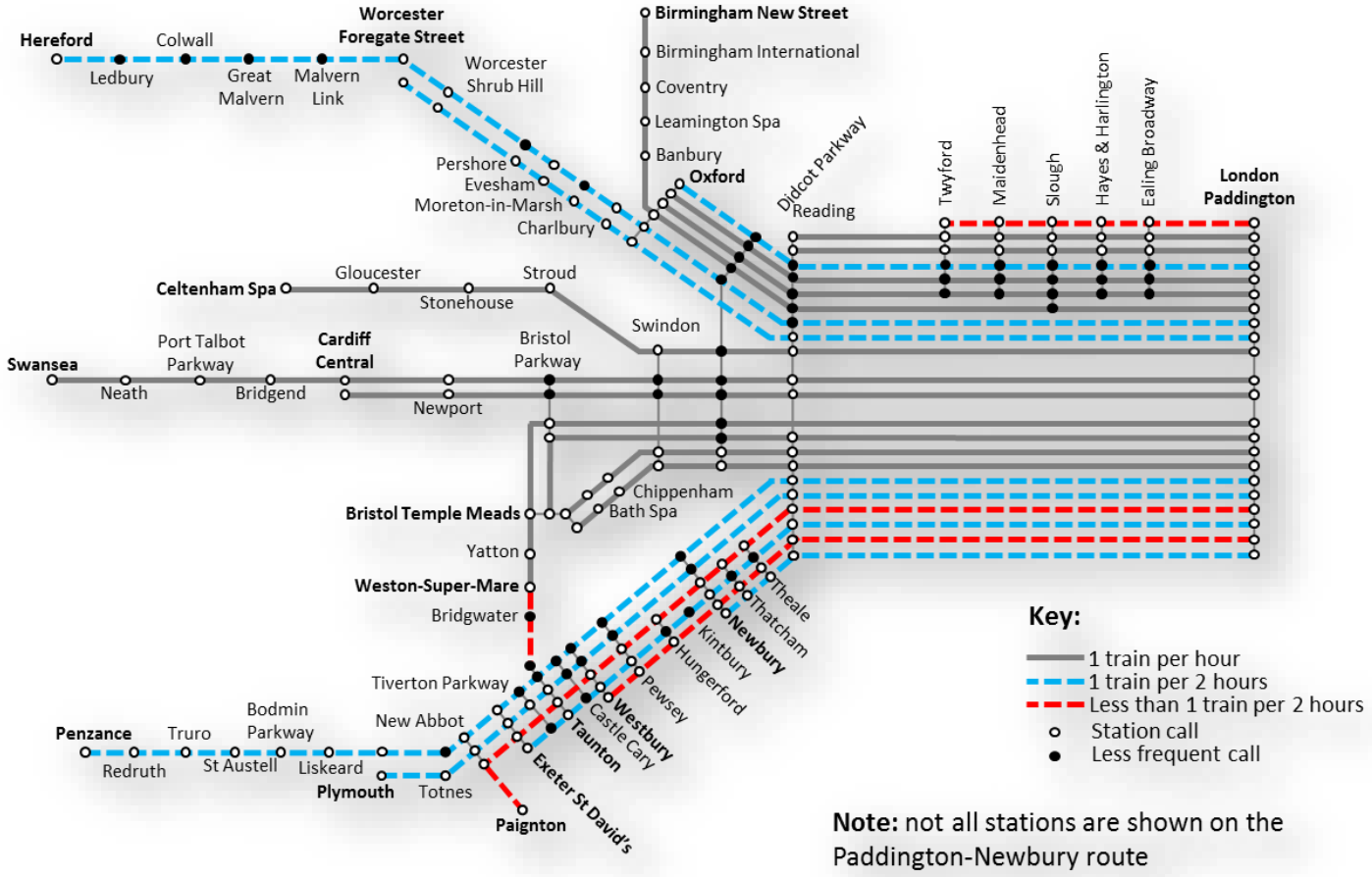
5.5.4 The vehicle types for the new GW services have been fully updated in PFMv6.1c. Three primary data sources have been used to add stock types to the Great Western timetable modelled within the PFM.

- Firstly, data was provided by the DfT for parts of the Great Western network, primarily for service groups linked to Paddington and the Thames Valley area. Outside of this area and where information was deemed to be out of date further sources of data were required.
- Secondly, a press-release by First Great Western which was released to coincide with the extension of the franchise was printed in Modern Railways March 2015 edition and information within this has been used to fill the gaps in the specification. Where information in the press-release has been deemed to be more up to date than information within the DfT specification this has superseded the latter.
- Finally, where information on stock types for some routes was not held within either of the first two documents a view was taken further research was carried out to best ascertain the vehicle type to use.

5.5.5 The additional stock types that have been coded in PFMv6.1c for use within the Great Western timetable are presented in section 5.14.

5.5.6 Figure 5-2 shows a summary of the service frequency and stopping patterns assumed in the 'Do Minimum' for Great Western services.

Figure 5-4: Great Western – Average Service Pattern used in PFMv6.1c – 'Do Minimum'



5.6 London Midland

5.6.1 The 'Do Minimum' assumptions for London Midland have not changed since PFMv5.2b.

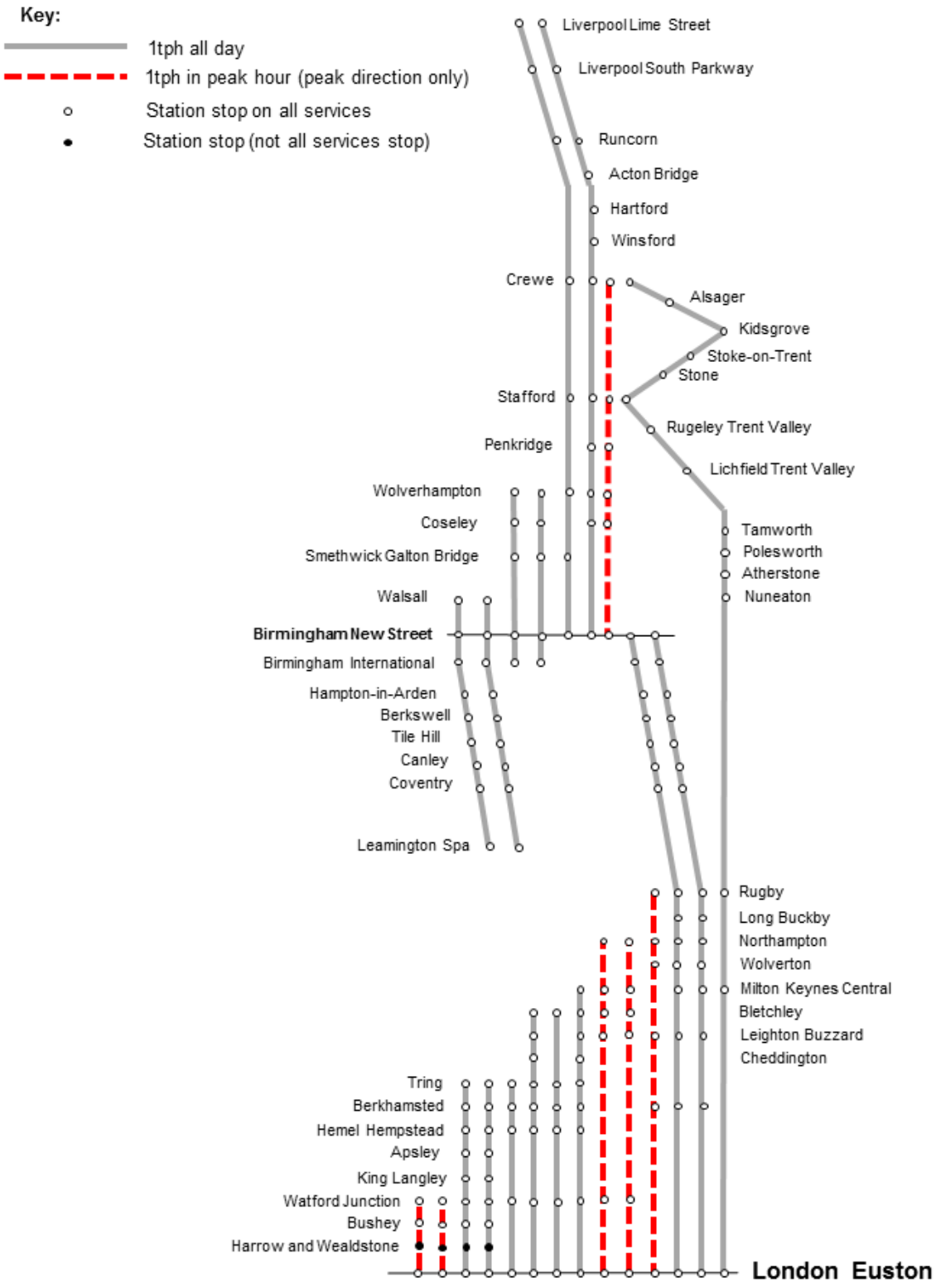
5.6.2 The London Midland future year 'Do Minimum' timetable allows for 110mph running on the fast lines and some train lengthening. Three trains per hour are scheduled to run at 110mph between London Euston and Ledburn Junction (south of Leighton Buzzard) which means that all Crewe services, most Northampton services, and some of the through Birmingham services benefit from accelerated journey times.

5.6.3 Key points of the London Midland specification are:

- 3tph between Birmingham New Street and London Euston;
- 1tph (peak period service only) between Coventry and Birmingham New Street;
- 1tph between London Euston and Crewe (via Trent Valley);
- 1tph between Birmingham International and Birmingham New Street;
- 1tph peak services between London Euston and Northampton;
- 2tph between Birmingham New Street and Liverpool Lime Street; and,
- Services starting at Northampton, Milton Keynes Central and Tring to London Euston.

5.6.4 Figure 5-5 shows a summary of the service and stopping pattern assumed in the PFMv6.1c 'Do Minimum' for London Midland services.

Figure 5-5: London Midland – Average service pattern used in PFMv6 – 'Do Minimum'



5.7 East Midlands

5.7.1 The 'Do Minimum' assumptions for East Midlands PFMv6.1c are the same as PFMv5.2b, with the exception of 10-car IEP trains being modelled in the peak on the Midland Mainline. 5-car trains are modelled during the off-peak.

5.7.2 The future year 'Do Minimum' PFMv5.2b timetable is based on the latest East Midlands (EM) Trains timetable which assumes electrification of the Midland main line and some line speed improvements. It includes the following:

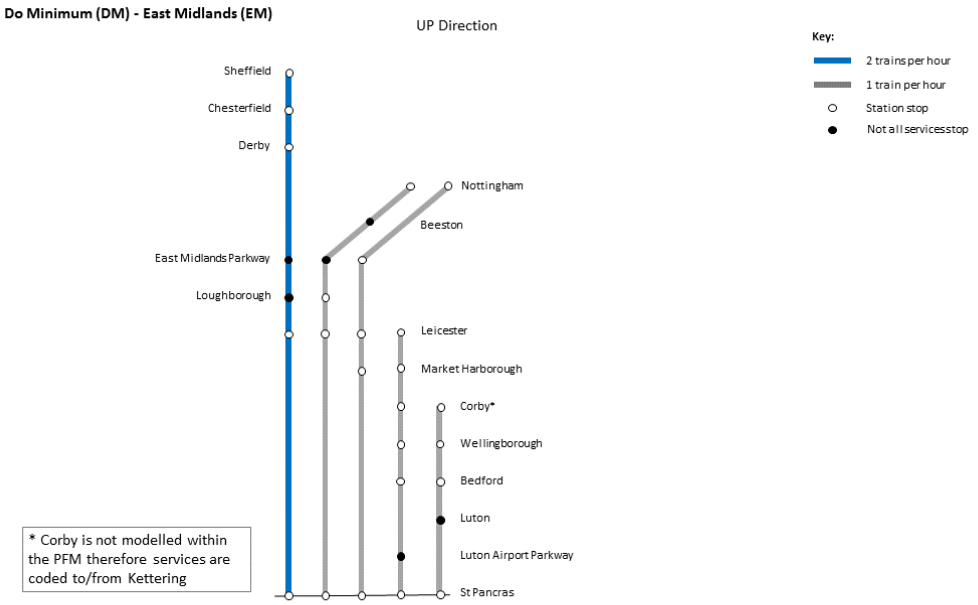
- 1tph between Corby and London St Pancras (where the service is coded between Kettering and London St Pancras, as Corby is not included in PFM);
- 1tph between Leicester and London St Pancras;
- 2tph between Nottingham and London St Pancras; and
- 2tph between Sheffield and London St Pancras.

5.7.3 Elsewhere on the network the timetable changes are summarised as follows:

- The EM service between Leicester and Liverpool has been truncated at Manchester, and re-routed to serve Derby rather than Nottingham;
- The Nottingham to Worksop service has a reduced headway of 16 trains per day from 24; and
- Numerous small variations in headway and journey time.

5.7.4 Figure 5-6 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for East Midland services.

Figure 5-6: East Midland – Average service pattern used in PFMv6.1c – 'Do Minimum'



5.8 West Coast Main Line

Virgin West Coast services

5.8.1 The 'Do Minimum' service and rolling stock assumptions for West Coast in PFMv6.1c has not changed since PFMv5.2b.

5.8.2 The 'Do Minimum' network includes:

- London – Scotland through services, routed via the West Midlands to either Edinburgh or Glasgow Central at alternating hours of the day in each direction per day as a result of the joining together of the hourly Scotland-Birmingham services to Wolverhampton/Birmingham to London Euston services;
- A daily service between Blackpool North and Euston and vice versa;
- 2tpd between Shrewsbury and Euston (extended from Wolverhampton);
- Preston to Euston is modelled as a peak hourly service pattern dependant on direction, with additional single peak services to both Blackpool North and Lancaster;
- Increase in seating capacity of the Class 390 9-car Pendolino;
- Increase in total capacity of the Class 390 11-car Pendolino;
- Introduction of a 2 x 5-car Class 222 Super Voyager to model doubled up 5-car

'Super Voyager' trains[26]

Open access services

5.8.3 The 'Do Minimum' assumptions for West Coast open access services (GNWR, Great North Western Railways, operating as Grand Central) are newly included within PFMv6.1c.

5.8.4 A review was undertaken by HS2 Ltd to specify the timetable for open access services to be included within the 'Do Minimum' scenario. The resulting assumptions applied from the TAG paper are:

a) The London terminus for the Euston-Blackpool services in both directions would be modelled as Queen's Park (QPW) rather than Euston.

b) The journey time between Queen's Park and the next stop (Milton Keynes Central) would maintain the Milton Keynes Central to Euston travel time.

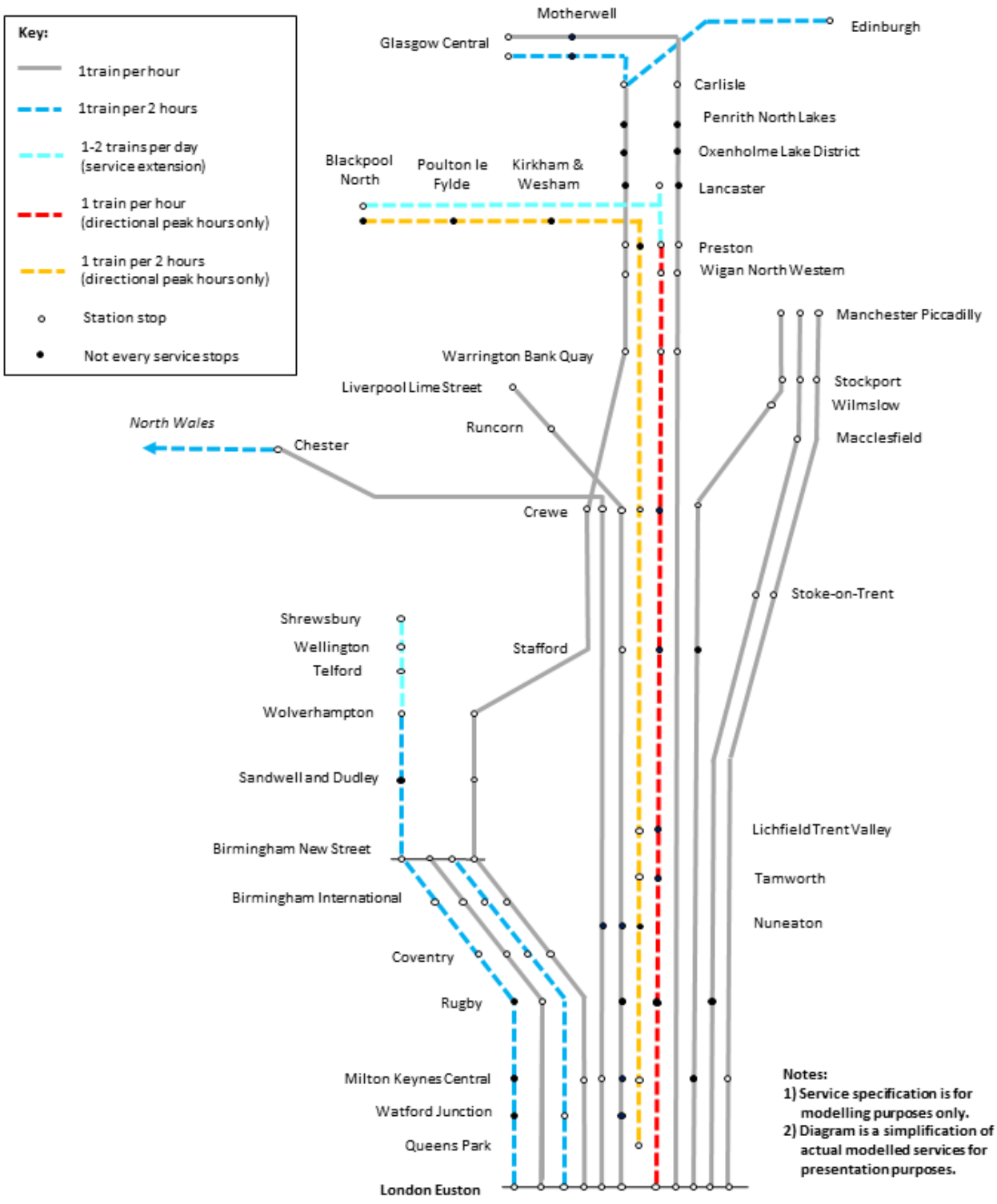
5.8.5 The 'Do Minimum' network includes:

- 6 trains Blackpool North – Queens Park (proxy for Euston).
- 5 trains Queens Park (proxy for Euston) – Blackpool North, plus 1 extra train Queens Park (proxy for Euston) – Crewe.

5.8.6 Figure 5-7 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for West Coast Main Line services with the open access additions overlaid.

[26] The operating cost model treats 10-car Super Voyager units as vehicle type 222 to avoid spurious results.

Figure 5-7: West Coast Main Line – Average service pattern used in PFMv6.1c – 'Do Minimum'



5.9 TransPennine

5.9.1 The 'Do Minimum' services in PFMv6.1c for TransPennine have been fully updated from PFMv5.2b. The updates are based on December 2019 timetable and a train plan including stock information and peak loading points.

5.9.2 On the TransPennine routes the PFMv6.1c future year timetable assumes the following services through the Manchester – Leeds core:

- 2tph between Manchester and Hull via Leeds;
- 5tpd between Liverpool Lime Street and Newcastle;
- 4tpd between Manchester Airport and York Via Leeds ;
- 1tph between Manchester Airport and Middlesbrough Via Leeds; and,
- 11tpd between Manchester Airport and Newcastle.

5.9.3 A further 1tph operates between Manchester Airport alternately to Edinburgh or Glasgow via the West Coast main line.

5.9.4 The following stock type assumptions were included within the TransPennine timetable in PFMv6.1c and were accurate at time of coding:

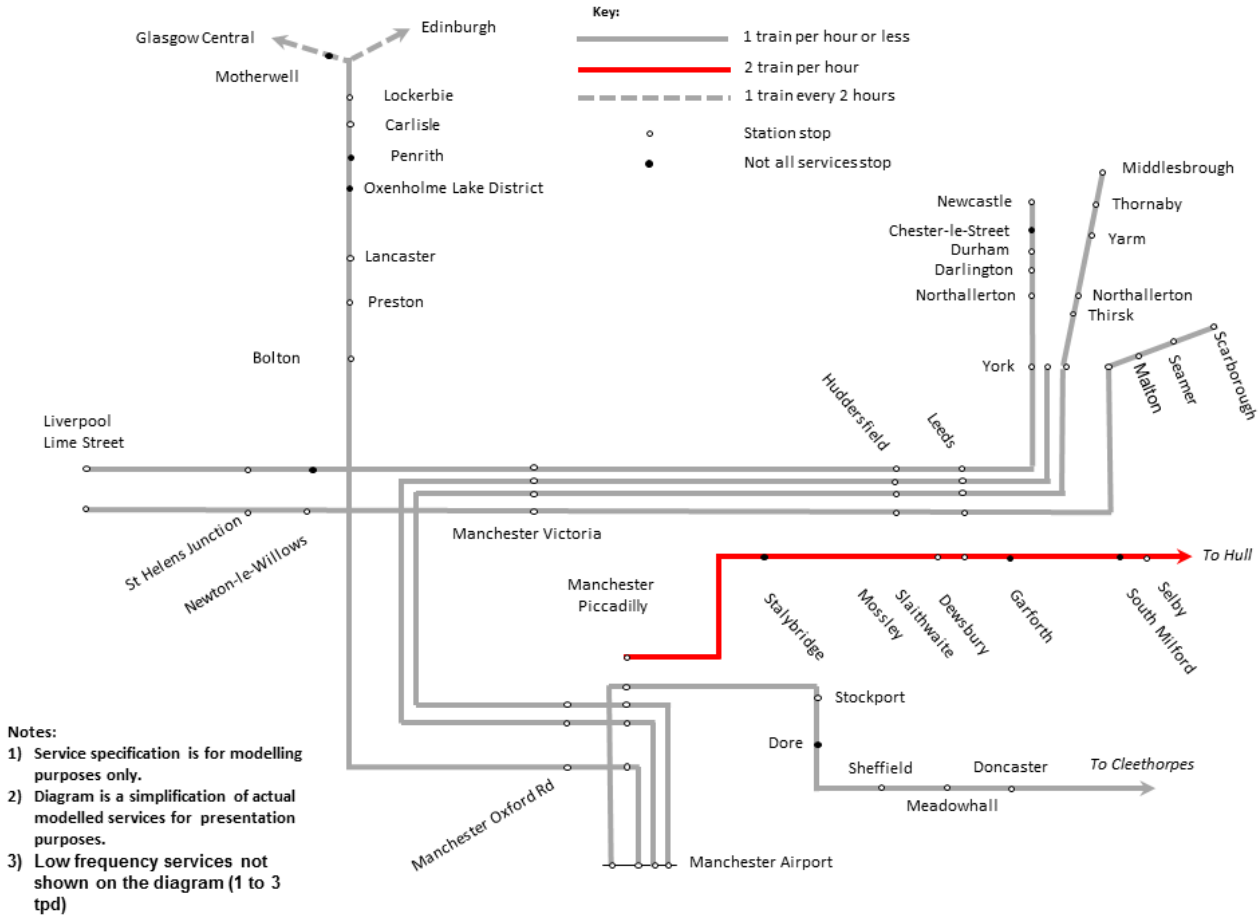
- Class 350 EMUs on Manchester Airport to Edinburgh/Glasgow services are replaced by 5-car EMUs (125mph 23m CAF);
- All Class 185s on Leeds/Hull services replaced by 6-car EMUs (125mph 23m vehicles as per CAF trains for Manchester–Scotland);
- Newcastle and Edinburgh services to become 6-car EMUs (125mph 23m vehicles as above); and,
- Scarborough and Middlesbrough services become 5-car bi-mode AT300.

5.9.5 The following characteristics were included within the TransPennine service pattern in PFMv6.1c:

- Retain pre-electrification stops between Stalybridge and Huddersfield (exclusive) for TPE Manchester Piccadilly to Leeds/Hull services;
- Removal of all stops from TPE Manchester to Leeds/Hull services except for Dewsbury; and,
- Extend TPE Man Piccadilly–Leeds service to Selby and Hull, replacing a segment of Northern Bridlington–Hull–Leeds–Bradford – Huddersfield. In the peaks the extended service calls at all stations Leeds to Selby, and then as per replaced Bridlington DMU service. In the off-peak the service is fast from Leeds to Selby, then as per superseded Bridlington DMU service as far as Hull (and no further).

5.9.6 Figure 5-8 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for TransPennine services.

Figure 5-8: TransPennine – Average service pattern used in PFMv6.1c – 'Do Minimum'



5.10 Northern Railway

5.10.1 The 'Do Minimum' services in PFMv6.1c for Northern Railway have been fully updated from PFMv5.2b. The updates are based on December 2019 timetable and a train plan including stock information and peak loading points.

5.10.2 For key corridors in the Northern Railway network, the PFMv6.1c future year timetable assumes the following services through the corridors:

- On the Leeds–Doncaster corridor the following services to/from Leeds:
  - 1tph Bradford Interchange to Nottingham via Leeds;
  - 1tph Leeds to Knottingley via Wakefield Westgate;
  - 1.5tph to Sheffield via Rotherham stopping service; and
  - 1tph to Doncaster calling all stations.
- On the South Manchester corridor, the following services to/from Manchester Piccadilly:
  - 1tph to Crewe via Stockport;
  - 1tph to Alderley Edge via Stockport;
  - 1tph to Macclesfield;
  - 1tpd to Stoke on Trent semi-fast;
  - 1tph to Crewe via Manchester Airport;
  - 4tph all day Manchester–Hazel Grove with 2tph to New Mills Newtown and 1tph to Buxton;
  - 2tph all day Manchester–Stockport–Greenbank with 1tph to Chester;
  - 1tph all day semi-fast Manchester Victoria–Warrington Bank Quay–Chester, extended to Calder Valley; and
  - Fast services via Chat Moss and CLC routes swap between Northern and TPE, with Northern operating Liverpool–Warrington–Manchester Airport fast service.
- On the Calder Valley corridor, the following services to/from Leeds:
  - 1tph to Huddersfield via Bradford;
  - 1tph York to Blackpool North;
  - 3tph to Manchester Victoria, extended to Liverpool, Chester and Southport;
  - 1tph Bradford Interchange to Manchester Victoria and Manchester Airport; and
  - 2tph Manchester Victoria–Rochdale stopping service enabling all through trains to

Yorkshire to be non-stop on this section.

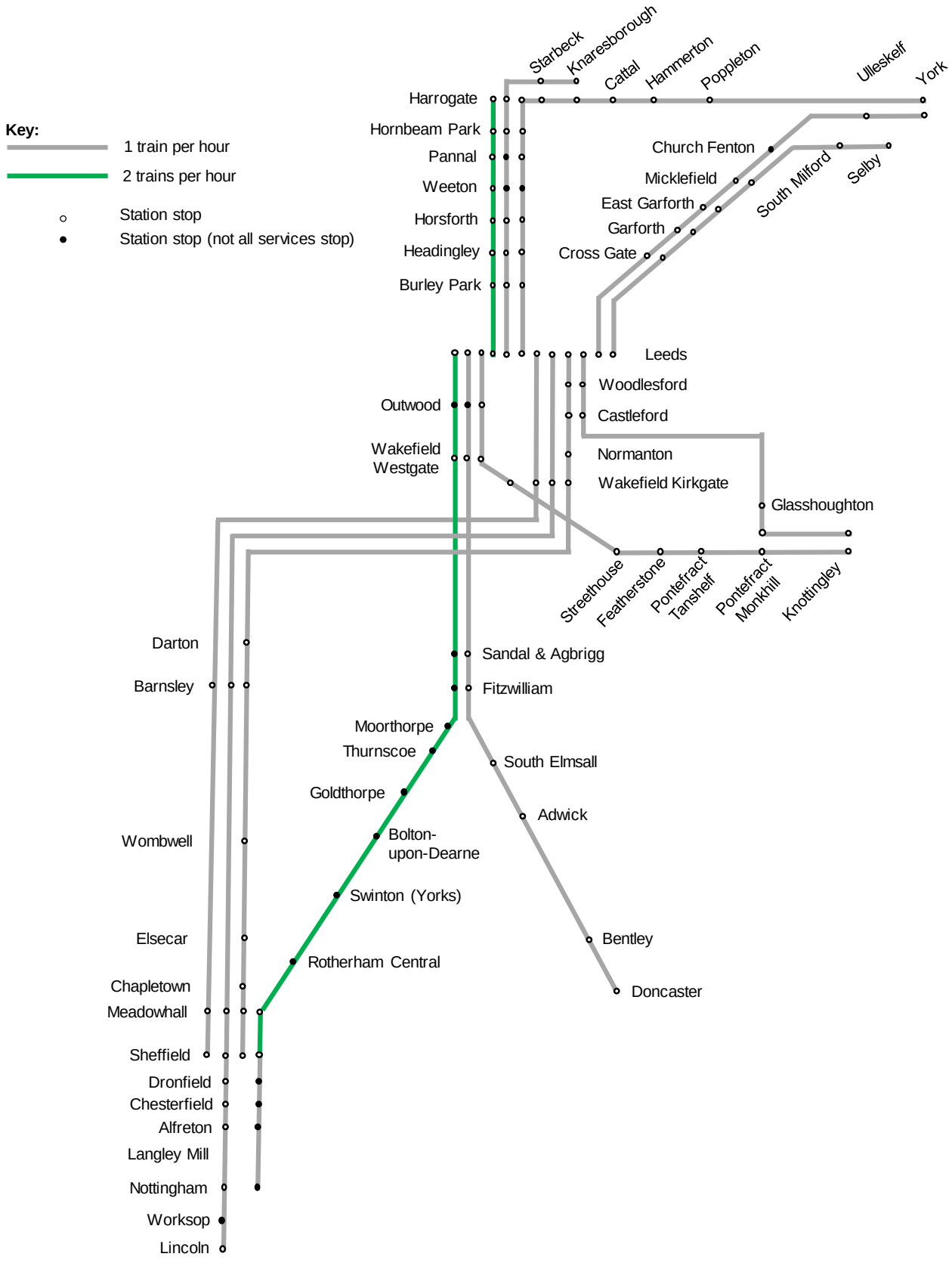
- On the North West Electrification corridor, the following services to/from Manchester Piccadilly / Manchester Victoria:
  - 2tph to Blackpool via Bolton;
  - 1tph to Preston;
  - 1tph to Wigan Wallgate;
  - 1tph to Kirkby;
  - 2tph to Blackburn, of which 1tph to Clitheroe;
  - 1tph to Southport (from Calder Valley);
  - 1tph to Southport stopping service;
  - 1tph Liverpool Lime Street stopping service; and
  - 1tph Liverpool Lime Street fast service (from Calder Valley).

5.10.3 The additional service specification includes:

- York – Hull service becomes 1tph all day with DMU prior to TransPennine and Hull electrification;
- Retain peak direction only Manchester Piccadilly–Huddersfield stopping service;
- Remove all stops other than Church Fenton from Northern Blackpool–York DMU, with 2tph stopping service to Selby;
- New 1tph Middlesbrough–Newcastle via Durham in addition to existing service via Sunderland. New train calls at Thornaby, Stockton, Durham and Chester-le-Street;
- Darlington–Bishop Auckland hourly as extensions of Saltburn services;
- Extension of Bridlington–Hull services via Selby to Leeds;
- 4tph all day Leeds–Harrogate; and
- 1tph Knottingley–Wakefield extended to Leeds, with 1tph Huddersfield–Wakefield extended to Castleford.

5.10.4 Figures 5-9 to 5-12 show a summary of the service and stopping pattern assumed in the 'Do Minimum' for Northern services.

Figure 5-9: Northern Railway – Average service pattern used in PFMv6.1c – 'Do Minimum'



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

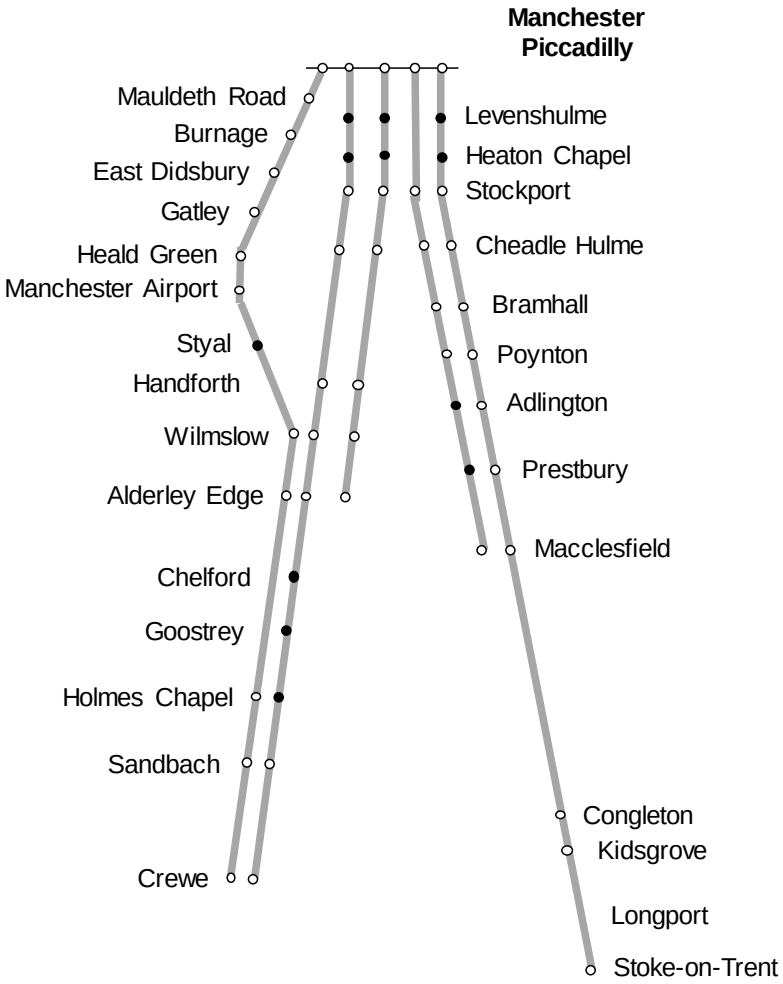
Figure 5-10 Northern Railway – Average service pattern used in PFMv6.1c – 'Do Minimum' (continued)

Key:

1train per hour

Station stop

Station stop (not all services stop)

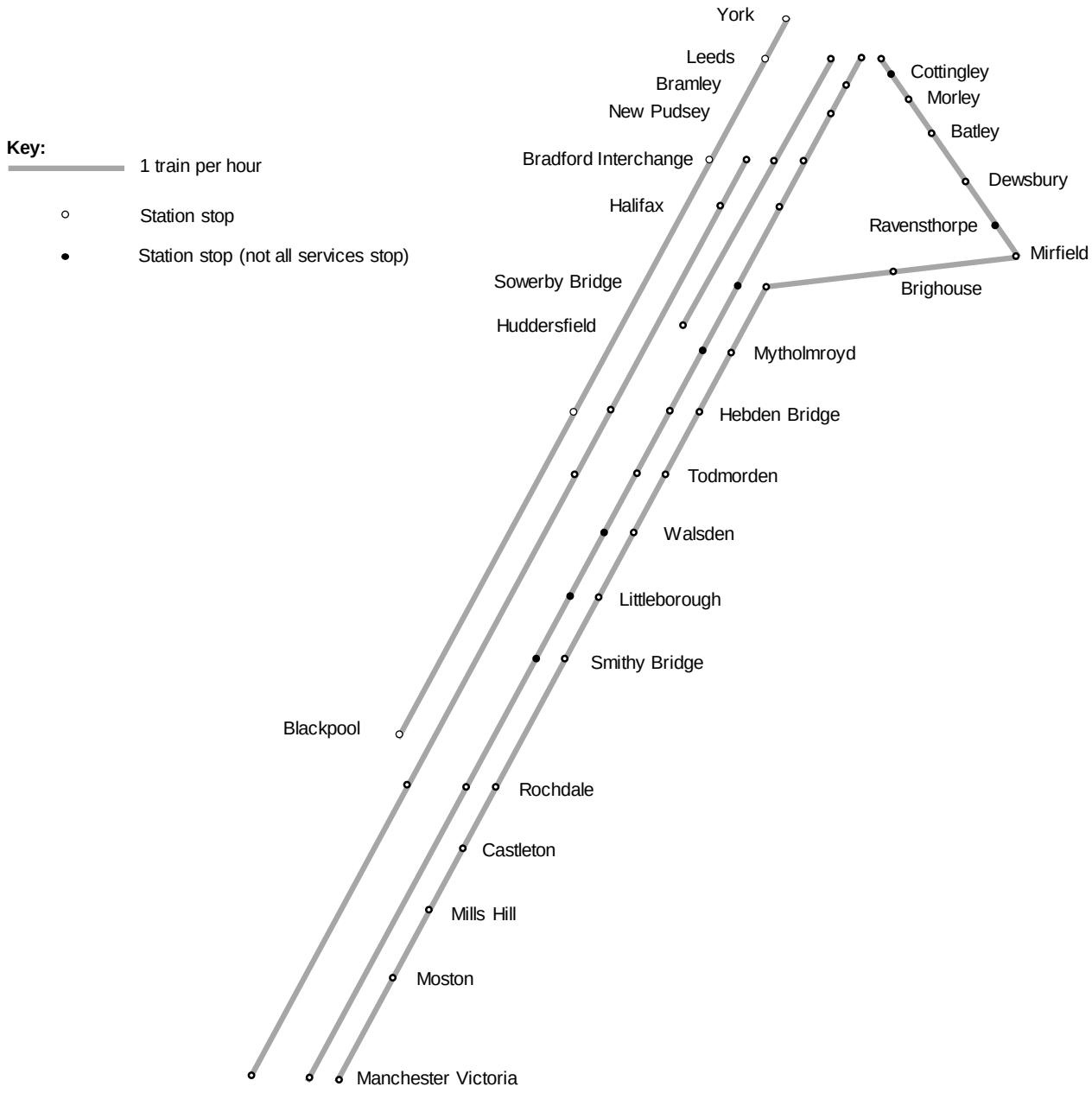


Notes:

1) Service specification is for modelling purposes only.

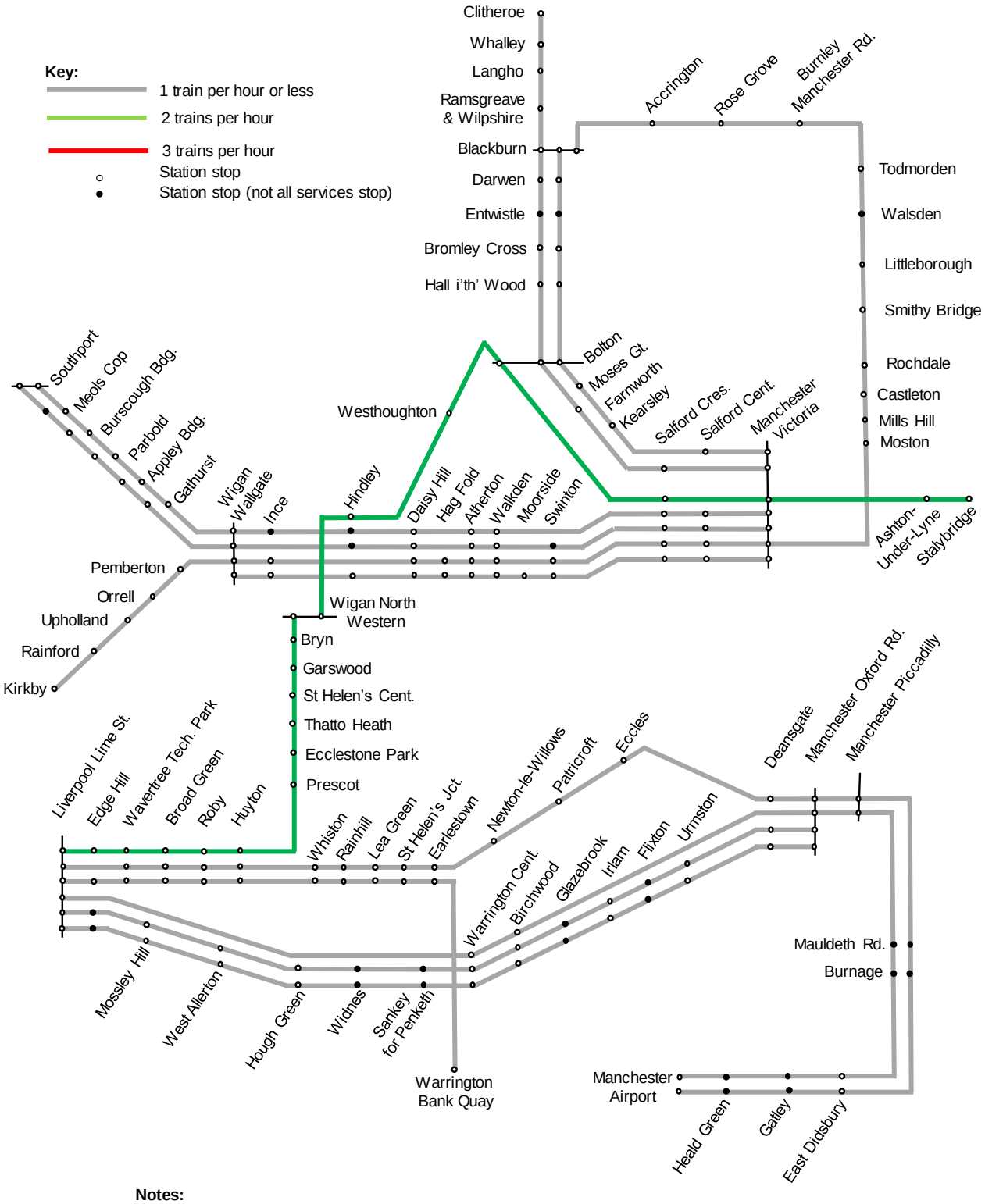
2) Diagram is a simplification of actual modelled services for presentation purposes.

Figure 5-11 Northern Railway – Average service pattern used in PFMv6.1c – 'Do Minimum' (continued)



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

Figure 5-12 Northern Railway – Average service pattern used in PFMv6.1c – 'Do Minimum' (continued)



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

5.11 East-West Rail

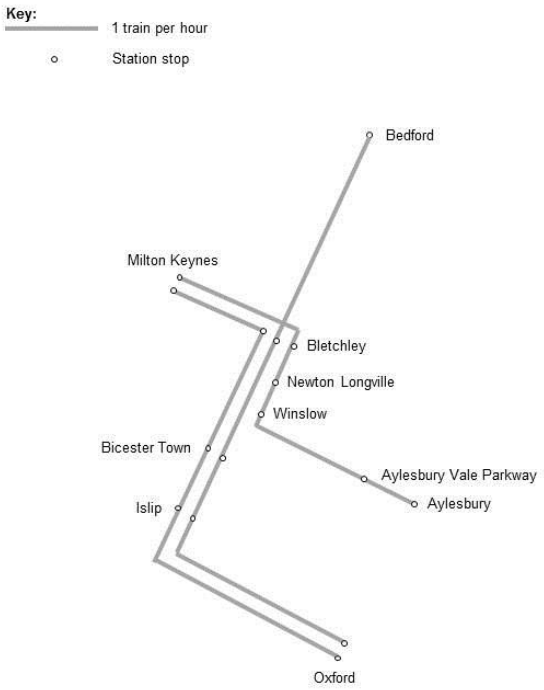
5.11.1 The 'Do Minimum' assumptions for the East West Rail Link in PFMv6.1c are the same as used in PFMv5.2b.

5.11.2 The East-West Rail western section (between Oxford and Bletchley) is assumed within PFMv6.1c based on the DfT view of the likely service patterns as late 2012. Figure 5.13 shows a summary of the service pattern assumed in the 'Do Minimum' for East-West Rail services.

5.11.3 This assumes hourly services as follows:

- Oxford and Bedford;
- Oxford and Milton Keynes; and
- Aylesbury and Milton Keynes.

Figure 5-13: East-West Rail – Average service pattern used in PFMv6.1c – 'Do Minimum'



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

5.12 Other services

5.12.1 The 'Do Minimum' assumptions for CrossRail in pFMv6.1c have been updated. The 'Do Minimum' service pattern assumes:

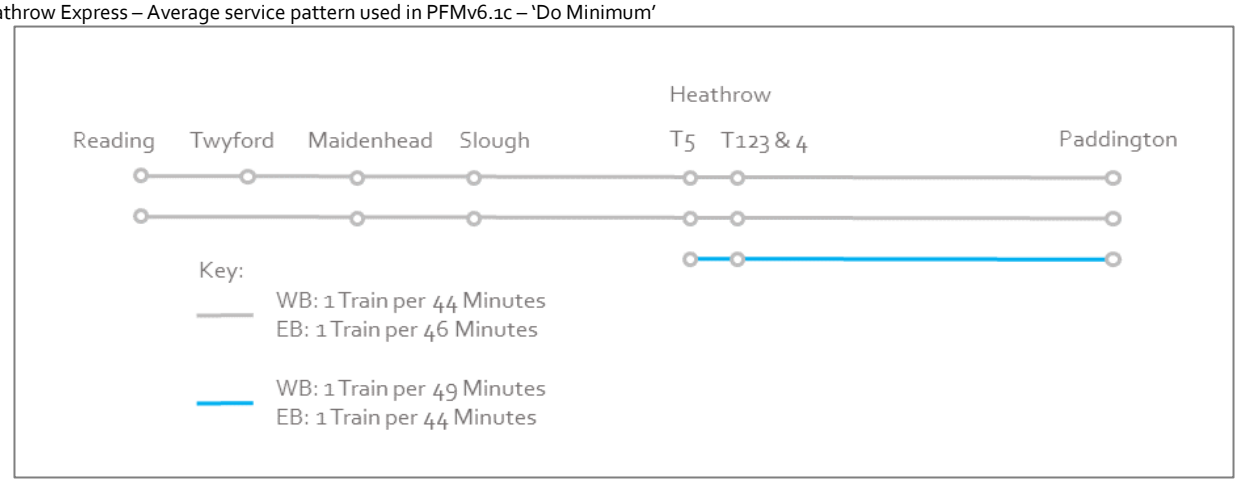
- A service every half an hour on the full length of the route between Shenfield and Reading in both directions.
- A service every 15 minutes between Shenfield and Maidenhead.
- Services on the Heathrow spur run every 15 minutes from Abbey Wood[27].
- A service approximately every three minutes on the core section of the route between Liverpool Street and Paddington.
- Around one train per hour east to Gidea Park from London.

5.12.2 A Western access to London Heathrow has been included within PFM4.3. The Heathrow Express service pattern is assumed to utilise this. Figure 5-14 shows a summary of the service pattern assumed in the 'Do Minimum' for Heathrow Express services.

5.12.3 The service pattern in terms of frequency, journey time and stopping pattern was provided by the DfT. Supplementary Heathrow Express services between London and Heathrow Terminals are also modelled to ensure that a 15-minute frequency is maintained.

5.12.4 The vehicle types used in the Heathrow Express timetable coded into the PFM have been reviewed and updated. All services have been coded as 8-car Class 332s, which provide a seated capacity of 370. The total capacity of 612 has been calculated using the same ratio of seated to total capacity that was previously used for these services.

Figure 5-14: Heathrow Express – Average service pattern used in PFMv6.1c – 'Do Minimum'



[27] In practice, this is coded into the model as starting/terminating at Liverpool Street, as Abbey Wood is not represented in the PFM.

5.13 London Underground

5.13.1 The 'Do Minimum' assumptions for London Underground in PFMv6.1c are the same as used in PFMv52b and are assessed to remain valid.

5.13.2 TfL supplied London Underground network and vehicle type data extracted from TfL's Railplan model.

5.14 National Rail – rolling stock

5.14.1 PFM holds a selection of rolling stock types as defined vehicles within the model. The assumptions used or combinations of these, for example Class 165 and Class 172 on Chiltern, are shown in Table 5-1 and have been sourced from DfT.

Table 5-1: Rolling stock capacity assumed in PFMv6.1c

Rolling stock type	Seated capacity	Total capacity
Class 67 with 5 Mk iii coaches incl. first class	360	435
Class 67 with 6 Mk iii coaches	432	488
Class 67 with 6 Mk iii coaches incl. first class	390	480
Class 91 9-car	477	747
Class 150 3-car	194	285
Class 150 4-car	248	380
Class 150 6-car	388	570
Class 156 2-car + Class 150 2-car	276	429
Class 156 2-car	152	239
Class 156 4-car	304	478
Class 156 2-car + Class 158 2-car	290	456
Class 158 2-car (MML specific)	138	217
Class 158 2-car (Generic)	134	232
Class 158 4-car	276	433
Class 158 2-car + Class 170 3-car	329	543
Class 165 2-car (Chiltern specific)	184	244
Class 165 3-car (Chiltern specific)	276	366
Cl165 2-car (Generic)	186	323
Cl165 3-car (Generic)	292	507
Class 165 2 x 2car	368	488
Class 165 2car & Class 165 3car	460	610
Class 165 2car & Class 172 2car	328	462
Class 165 2 x 2car & Class 165 3car	644	854
Class 165 3 x 2car	552	732
Class 168 3-car	204	348
Class 168 3car & Class 168 4car	476	812

Class 168 2 x 3car & Class 172 2car	552	914
Class 168 3car & Class 172 2car	348	566
Class 168 4-car	272	464
Class 168 4car & Class 165 2car	456	708
Class 170 2-car	117	205
Class 170 3-car	191	326
Class 170 4-car	234	409
Class 170 5-car	308	531
Class 172 2-car	144	218
Class 172 2car & Class 165 3car	420	584
Class 176 2-car	124	221
Class 176 3-car	284	469
Class 176 4-car	248	442
Class 176 5-car	408	690
Class 176 6-car	372	663
Class 180 5-car	284	434
Class 185 3-car	169	301
Class 185 6-car	338	602
Class 185 9-car	507	903
Class 220 4-car	190	310
Class 221 5-car	252	410
Class 221 2 x 5-car	504	820
Class 222 4-car	190	310
Class 222 5-car	242	386
Class 222 7-car	343	520
Class 222 10-car	484	772
Class 225 7-car	409	644
Class 319 3-car	217	294
Class 319 4-car	289	392
Class 323 3-car	284	498
Class 333 4-car	301	558
Class 350 4-car	226	396
Class 350/1 4-car	224	392

Class 350/1 8-car	448	785
Class 350/1 12-car	672	1177
Class 350/2 4-car	267	468
Class 350/2 8-car	534	936
Class 350/2 12-car	801	1404
Class 365 4-car	264	383
Class 365 8-car	528	766
Class 365 12-car	792	1149
Class 377 3-car	185	294
Class 377 4-car	247	392
Class 377 5-car	309	490
Class 377 8-car	494	784
Class 377 12-car	741	1176
Class 380 4-car	275	399
Class 380 8-car	550	798
Class 386 3-car	204	346
Class 386 4-car	284	464
Class 387 8-car	450	714
Class 387 12-car	675	1071
Class 390 6-car	335	518
Class 390 9-car	468	798
Class 390 11-car	597	982
Class 392 6-car	335	518
HST 5-car	271	436
HST 6-car	325	523
HST 8-car	446	658
IEP 5-car (Cross Country and Great Western)	328	763
IEP 5-car (East Coast)	303	477
IEP 5-car (East Midlands)	318	499
IEP 9-car (East Coast)	611	963
IEP 9-car (Great Western)	651	1001
IEP 2x 5-car (Great Western)	656	1018
Bi Mode 125mph 5-car	318	450

EMU125 5-car	262	418
EMU125 6-car	322	478
EMU125+EMU125 12-car	524	836
AT300 5-car	328	509
AT300 2x 5-car	656	1018
AT300 9-car	651	1001

6 Rail Network: 'Do Something'

6.1 Introduction

6.1.1 To understand the costs and benefits of the scheme, our modelling requires assumptions on a service specification for HS2 and a specification for the revised service pattern on the classic network enabled by capacity being released due to the transfer of passengers to HS2. These assumptions are set out in the following sections.

6.1.2 The released capacity assumptions set out in this section have been derived for transport modelling purposes only. They are not a future proposed or agreed service specification.

6.1.3 There are many potential options for future service specifications across the network. DfT's strategic case sets out the high level principles that will be followed in making best use of released capacity, including:

- To ensure that all places with a direct London service today retain a broadly comparable or better service after HS2 opens;
- To provide additional commuter capacity where it is most needed;
- To spread the benefits of long-distance and inter-regional services to the many towns and cities that can be served by the capacity created on the existing rail network;
- To integrate HS2 services fully into the wider national rail network;
- To provide capacity for the growing rail freight sector; and
- To improve performance by making timetables more robust.

6.1.4 Decisions on future services will be taken much nearer the time. What is set out here are a set of assumptions for modelling purposes.

6.1.5 In the following sections the HS2 service assumptions and assumptions on the classic network are set out separately. Within the PFMv6.1c model the impacts of these are combined.

6.2 HS2 service patterns

Phase One

6.2.1 There are four stations assumed on the Phase One route: Birmingham Curzon Street, Birmingham Interchange, Old Oak Common and London Euston.

6.2.2 The Phase One service pattern is the same as used in PFMv5.2b, with some small updates to journey times. It is shown in Figure 6-1 and comprises:

- London Euston to Birmingham Curzon Street;
- A series of services that are 'classic compatible', i.e. they use the HS2 link between London and its connection with the West Coast Main Line and then switch to the classic network;
- London Euston to Manchester Piccadilly (three trains per hour);
- London Euston to Liverpool Lime Street (two trains per hour);
- London Euston to Preston (one train per hour); and
- London Euston to Glasgow Central (one train per hour).

Phase 'Do Minimum'

6.2.3 Phase 'Do Minimum' is assumed to have the same service pattern as Phase One. This means that we assume the same number of services, and stopping pattern, as presented in the 2013 Economic Case, but some services gain the benefit of a reduced journey time by using the new high-speed section of track. The following HS2 services take advantage of that journey time saving:

- London Euston to Glasgow Central service;
- London Euston to Preston service;
- London Euston to Liverpool Lime Street stopping at Crewe, Runcorn and Liverpool; and
- Three London Euston to Manchester Piccadilly services using the high speed track.

6.2.4 Phase 'Do Minimum' would become operational in 2027. It is shown in Figure 6-2.

Figure 6-1: HS2 service pattern used in PFMv6.1c – Phase One

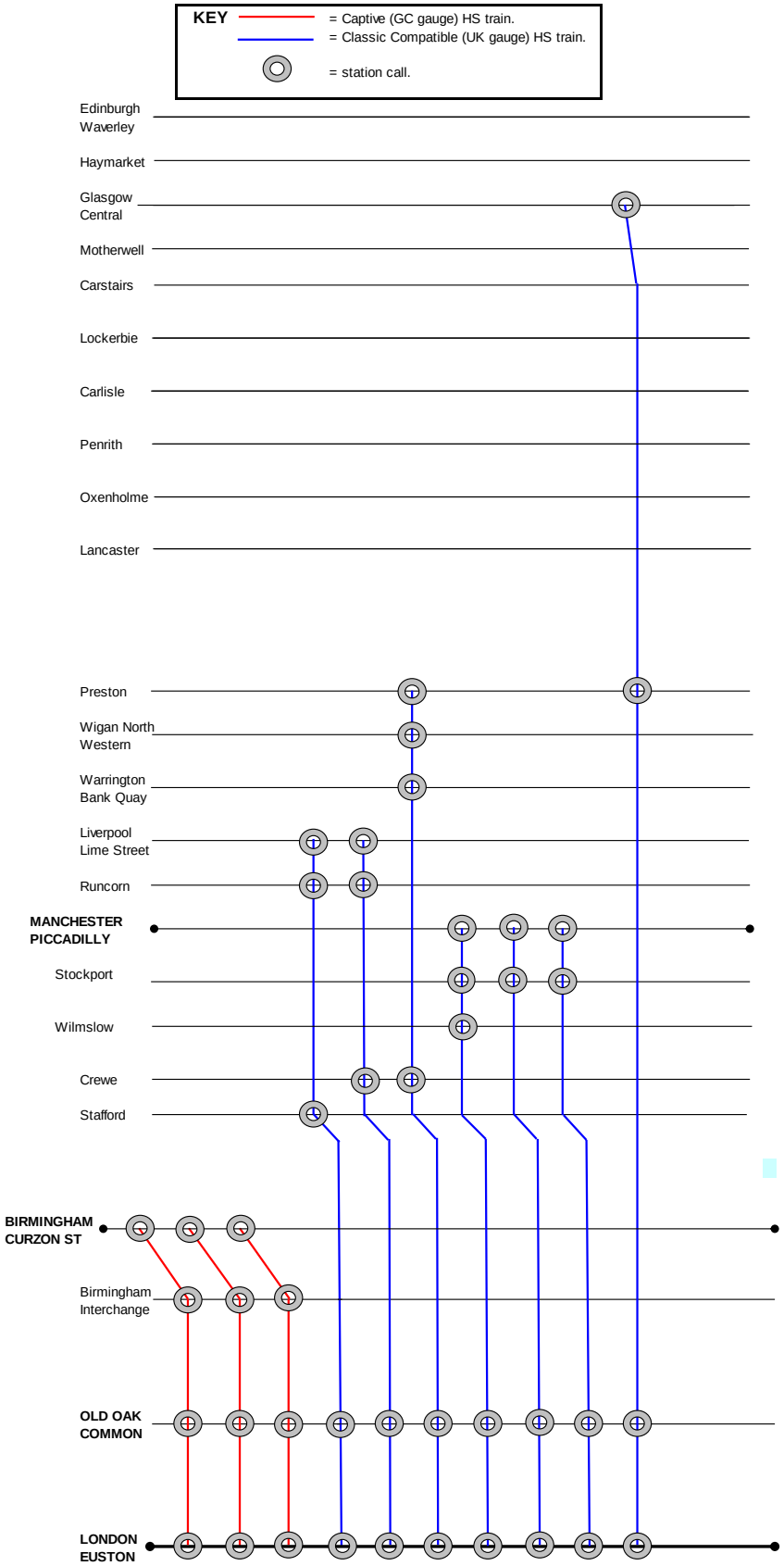
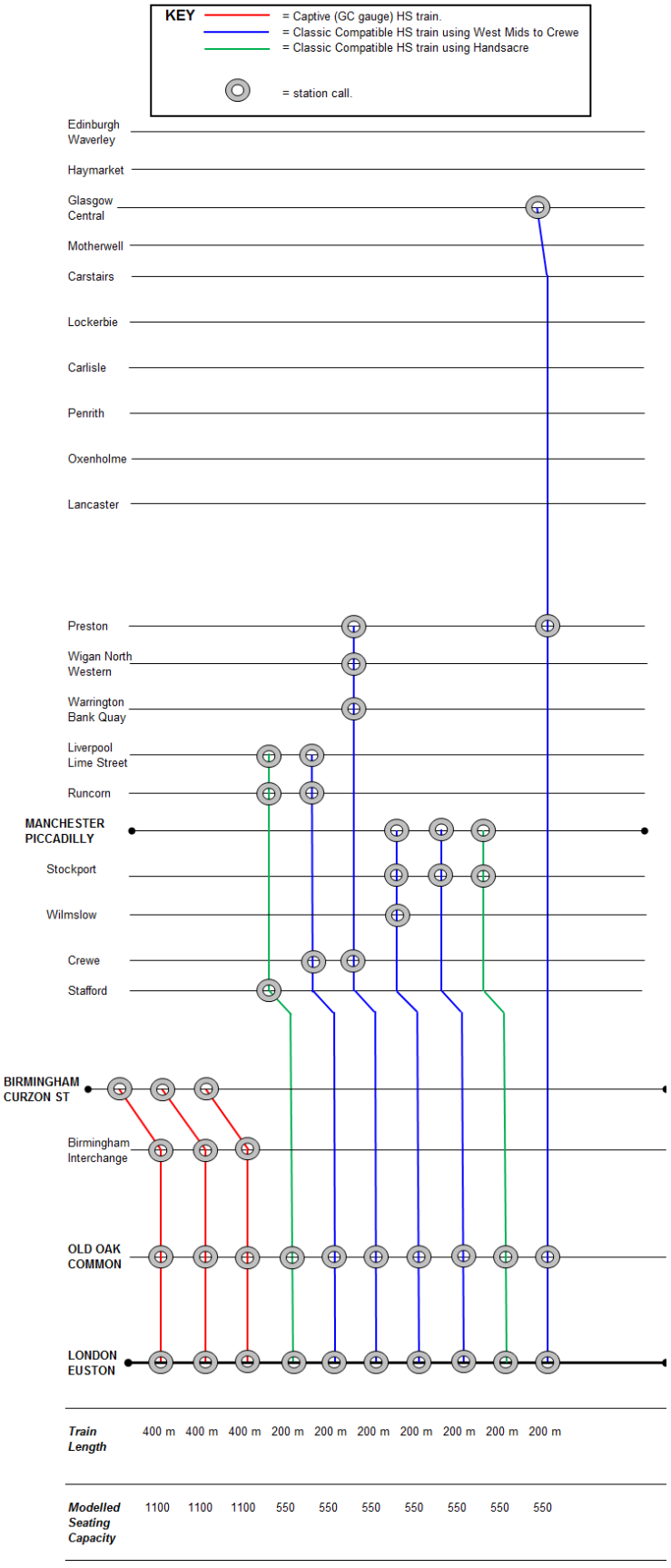


Figure 6-2: HS2 service pattern used in PFMv6.1c – Phase 'Do Minimum'



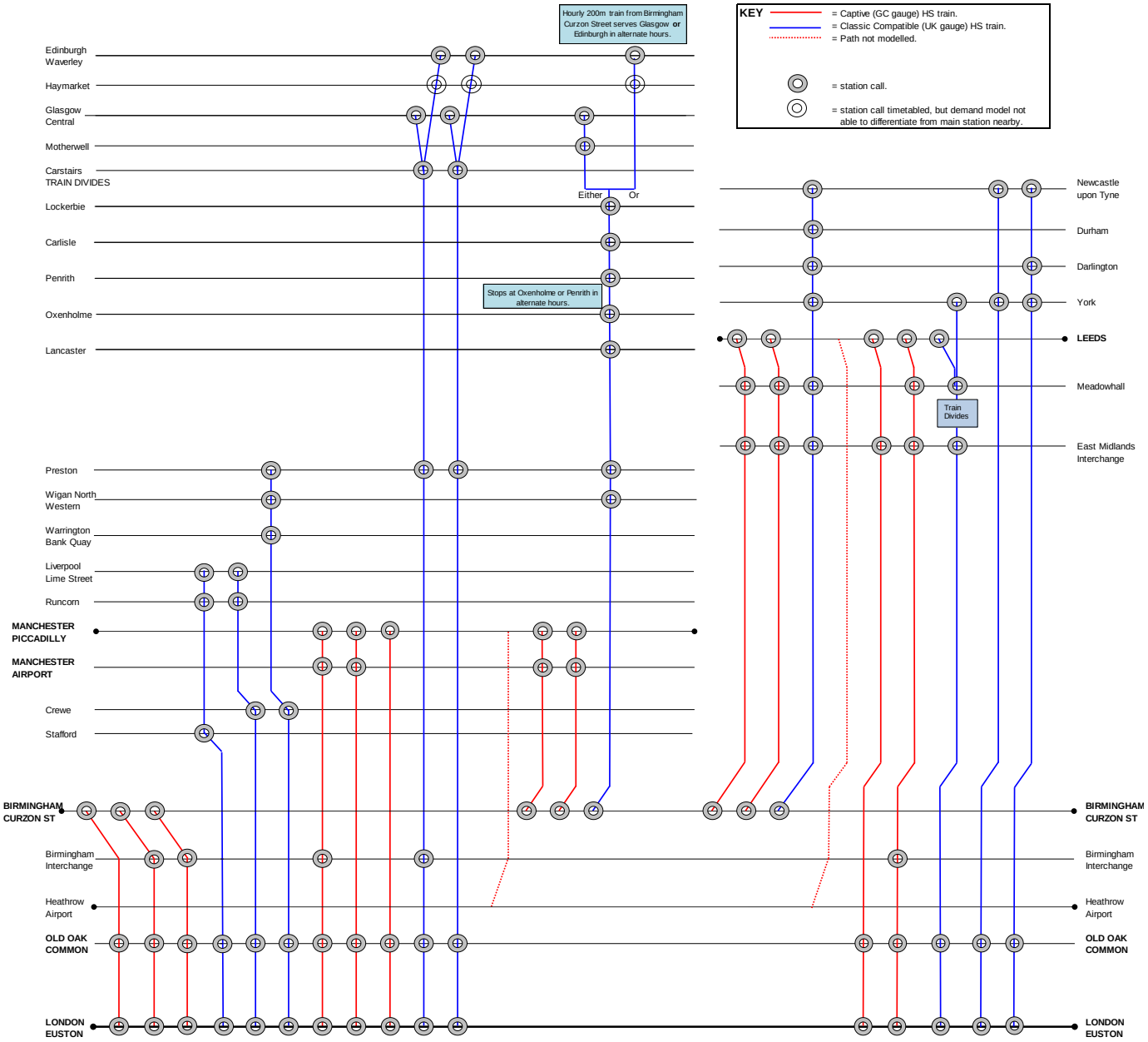
Full network

6.2.6 The full network service pattern is based on the preferred route set out in the Phase Two consultation. It is shown in Figure 6-3 and comprises:

- HS2 services:
  - London Euston to Birmingham Curzon Street (3tph);
  - London Euston to Manchester Piccadilly (3tph);
  - London Euston to Leeds (3tph[28]);
  - Birmingham Curzon Street to Manchester Piccadilly (2tph); and
  - Birmingham Curzon Street to Leeds (2tph);
- And a series of services that are classic-compatible, i.e. they use the HS2 link from London Euston and switch to the classic network at the appropriate location:
  - London Euston to Liverpool Lime Street (2tph);
  - London Euston to Preston (1tph);
  - London Euston to Glasgow Central/ Edinburgh Waverley (2tph);
  - Birmingham Curzon Street to Glasgow Central/ Edinburgh Waverley (1tph);
  - Birmingham Curzon Street to Newcastle (1tph);
  - London Euston to Leeds/ York (1tph[29]); and
  - London Euston to Newcastle (2tph).

[28] Two trains operate entirely to Leeds, the third combines/splits at Meadowhall to serve Leeds and York (the next footnote also refers to this service).
[29] A Leeds train combines/splits with a classic-compatible York service at Meadowhall.

Figure 6-3: HS2 service pattern used in PFMv6.1c – Full network



6.3 Released capacity

6.3.1 With the introduction of HS2, the specification of some classic rail services has been amended:

- to remove any duplication between classic and HS2 services;
- to ensure that HS2 and classic rail services are fully integrated; and
- to make use of the capacity freed up by the introduction of HS2 to improve the rail services to certain locations.

6.3.2 These changes to the classic rail services are referred to as the released capacity specification.

6.3.3 Assumptions about released capacity have been included within the PFMv6.1c modelling. There are many other potential combinations of released capacity. The assumptions in PFMv6.1c represent one possible set of assumptions for business case modelling purposes. **They have been developed for demand modelling purposes and they do not infer that this will be the specification implemented.**

6.3.4 The released capacity specification varies between Phase One and Full Network of HS2. The train operating companies (TOCs) where services are modified as a result of the introduction of HS2 in Phases One and Full Network are summarised in Table 6-1. Note that the Phase 'Do Minimum' released capacity specification is the same as that for Phase One.

Table 6-1: TOCs impacted by released capacity specification

Train operating company	Phase One and Phase 'Do Minimum'	Full network
West Coast Main Line	✓	✓
East Coast Main Line		✓
London Midland	✓	✓
East Midland Trains		✓
Trans Pennine Trains	✓	✓
Cross Country	✓	✓
Southern Trains	✓	✓
Great Northern Trains		✓
Thameslink Trains		✓
Northern Railway		✓
East West Rail		✓
Crossrail	✓	✓
Great Western	✓	✓
Heathrow Express	✓	✓

6.4 West Coast

6.4.1 A summary of services and stopping patterns for the West Coast is included in figure 6-4 for Phase One.

6.4.2 The service pattern for Phase Two is shown on figure 6-5.

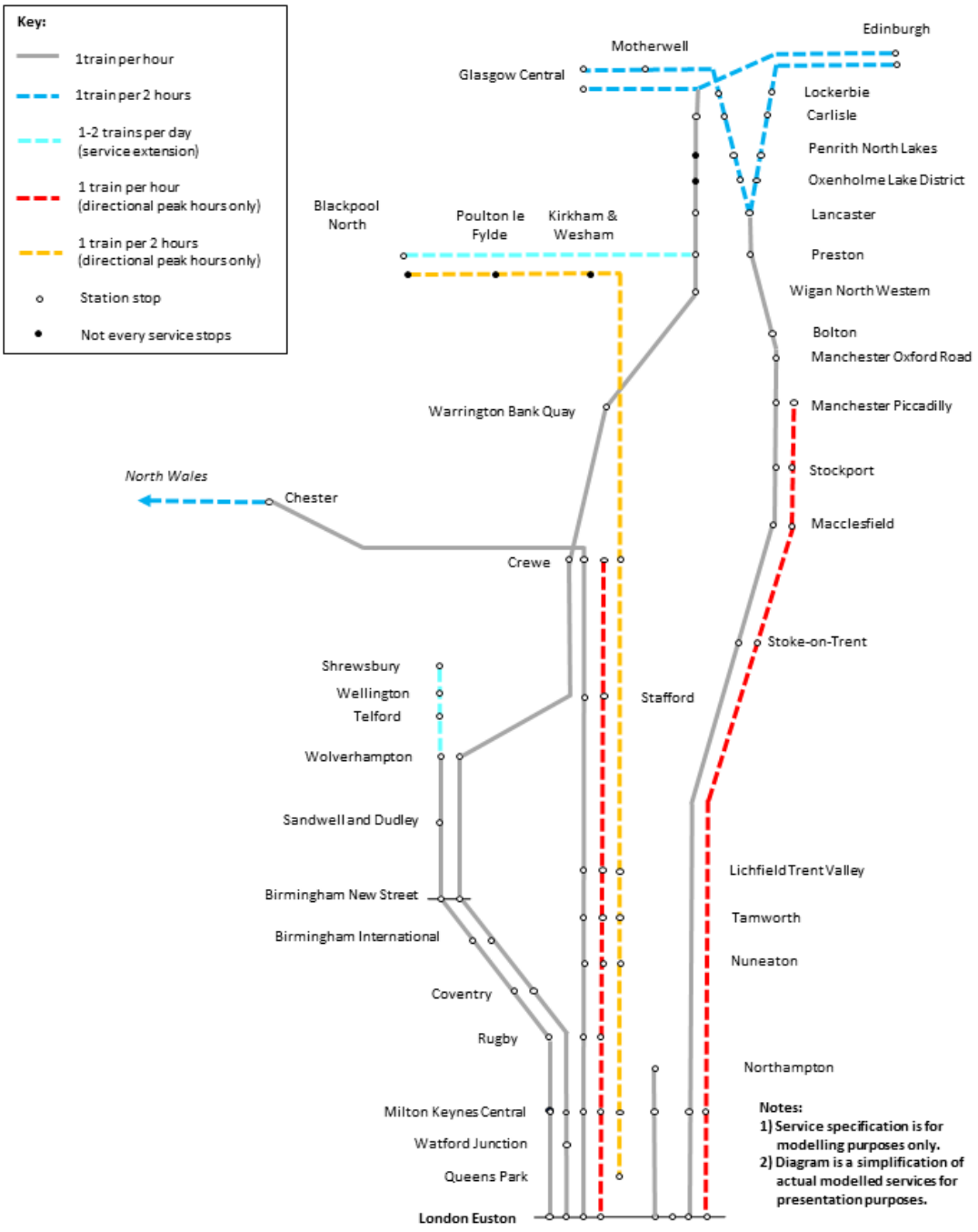
6.4.3 The Phase One timetable assumes the following services to/from London Euston:

- 1tph to Wolverhampton (2 trains per day extension to Shrewsbury);
- 1tph to Scotland via Birmingham (alternating between Glasgow and Edinburgh);
- 1tph peak shuttle service between Preston and Blackpool North;
- 1tph to Chester (7–8 trains per day extension to North Wales) with a regularised stopping pattern compared to the do-minimum along the Trent Valley;
- one train per peak hour in the peak direction from/to Crewe;
- 1tph to Northampton (in addition to LM services);
- 1tph to Scotland via Manchester (alternating between Glasgow and Edinburgh); and
- one train per peak hour in the peak direction to Manchester.

6.4.4 Train types used are similar to those by service in the new 'Do Minimum', but with all Pendolino trains being of 9-car length alone, and the same mix of Voyagers on those services worked by diesel trains.

6.4.5 There is no change to the West Coast Mainline open access services under released capacity.

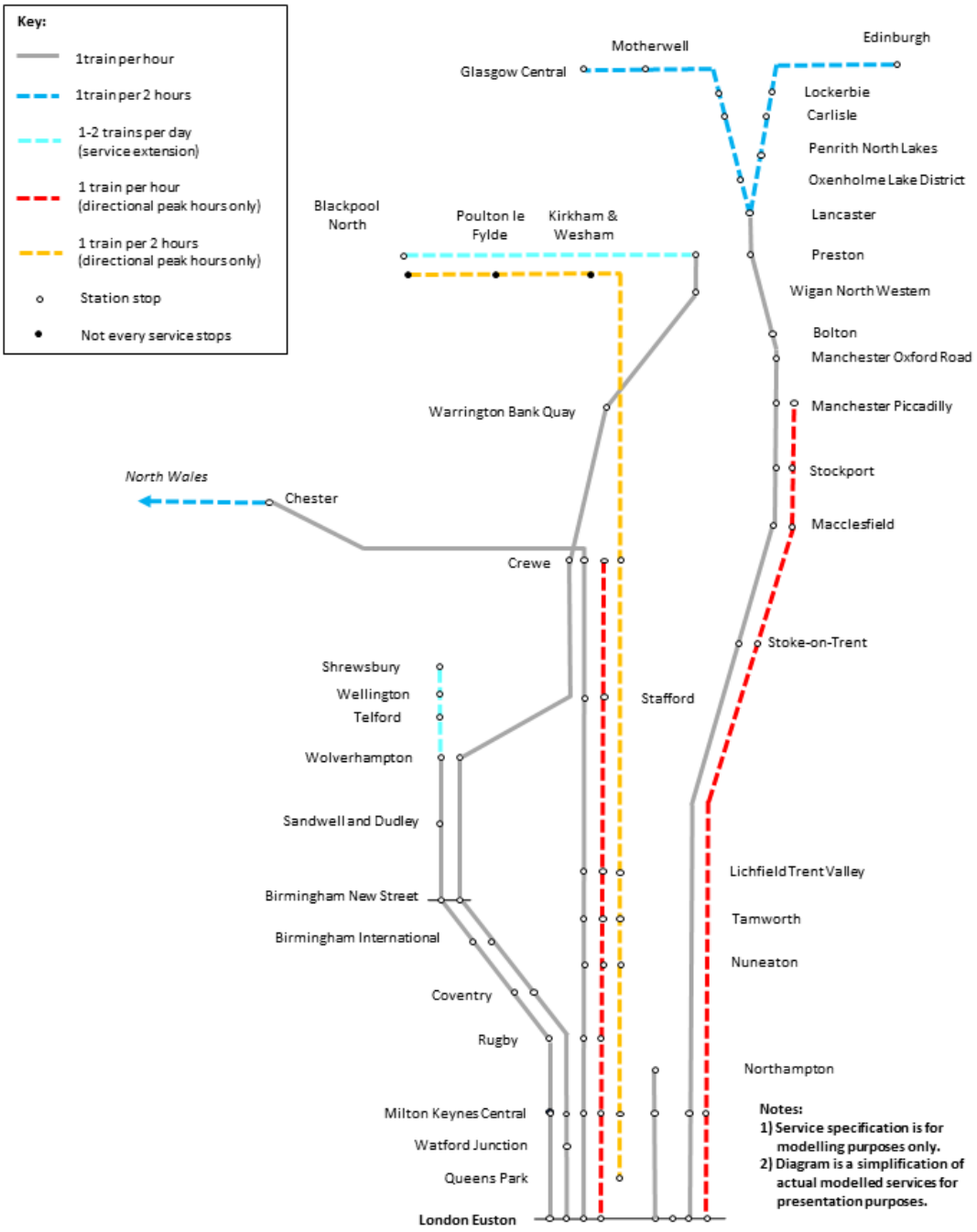
Figure 6-4: West Coast long-distance services assumed in PFMv6.1c – Phase One



6.4.7 Phase Two is identical to the Phase One specification, with the exception being that the hourly service from Euston to Scotland via the West Midlands (alternating between Glasgow and Edinburgh) only runs to Preston in the Phase Two specification.

6.4.8 Train types adopted are as used in Phase One.

Figure 6-5: West Coast long-distance services assumed in PFMv6.1c – Phase Two



6.5 East Coast Main Line

6.5.1 The Phase One timetable is unchanged from the 'Do Minimum'.

6.5.2 The Phase Two timetable assumes the following services to/from London:

- 1tph to Leeds, with same two hourly service frequency as the 'Do Minimum' continuing to Bradford and Harrogate, and the peak Skipton service;
- 1tph to Edinburgh;
- 1tph to Newcastle;
- The additional two-hourly service between Middlesbrough and London King's Cross in the DM is maintained with an extra intermediate stop at Doncaster; and
- 1tph to between Lincoln and London King's Cross;

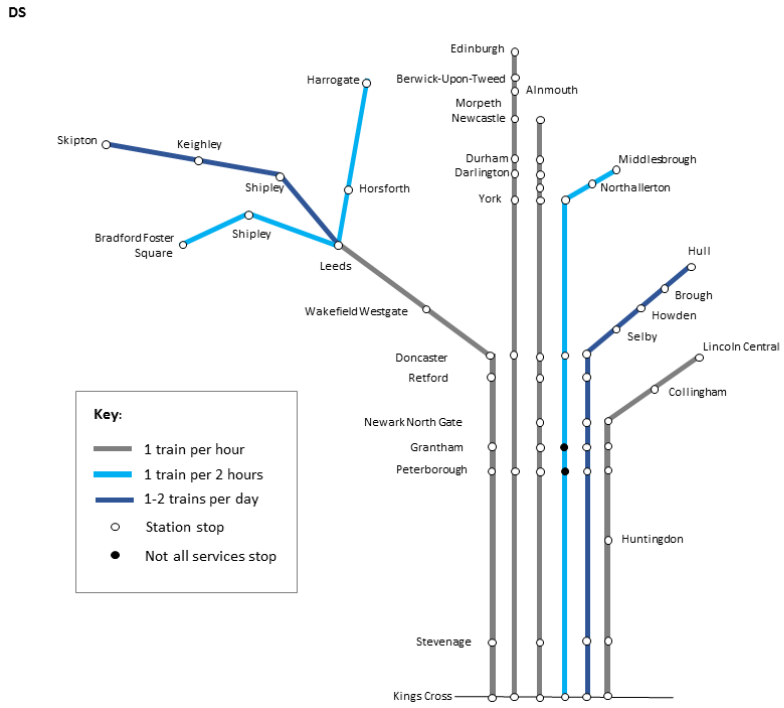
6.5.3 IEP journey time improvements introduced with the 'Do Minimum' timetable are incorporated in the 'Do Something' coding.

6.5.4 ECML Sunderland services from the 'Do Minimum' have been recoded under the Northern TOC. In addition, one train per hour has been coded between Leeds and Doncaster under the Northern TOC to retain the same level of service provision on this section of network as in the 'Do Minimum' scenario.

6.5.5 ECML services north of Edinburgh, have been recoded as ScotRail services.

6.5.6 A summary of services and stopping patterns for East Coast Main Line in Phase Two is included in figure 6-6. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-6: East Coast Service – Average service pattern used in PFMv6.1c – Phase Two



6.6 London Midland

6.6.1 The 'Do Something' LM network is consistent with the 'Do Minimum' and the same in both Phase One and Full Network scenarios.

6.6.2 The 'Do Something' timetable assumes the following services to/from London Euston:

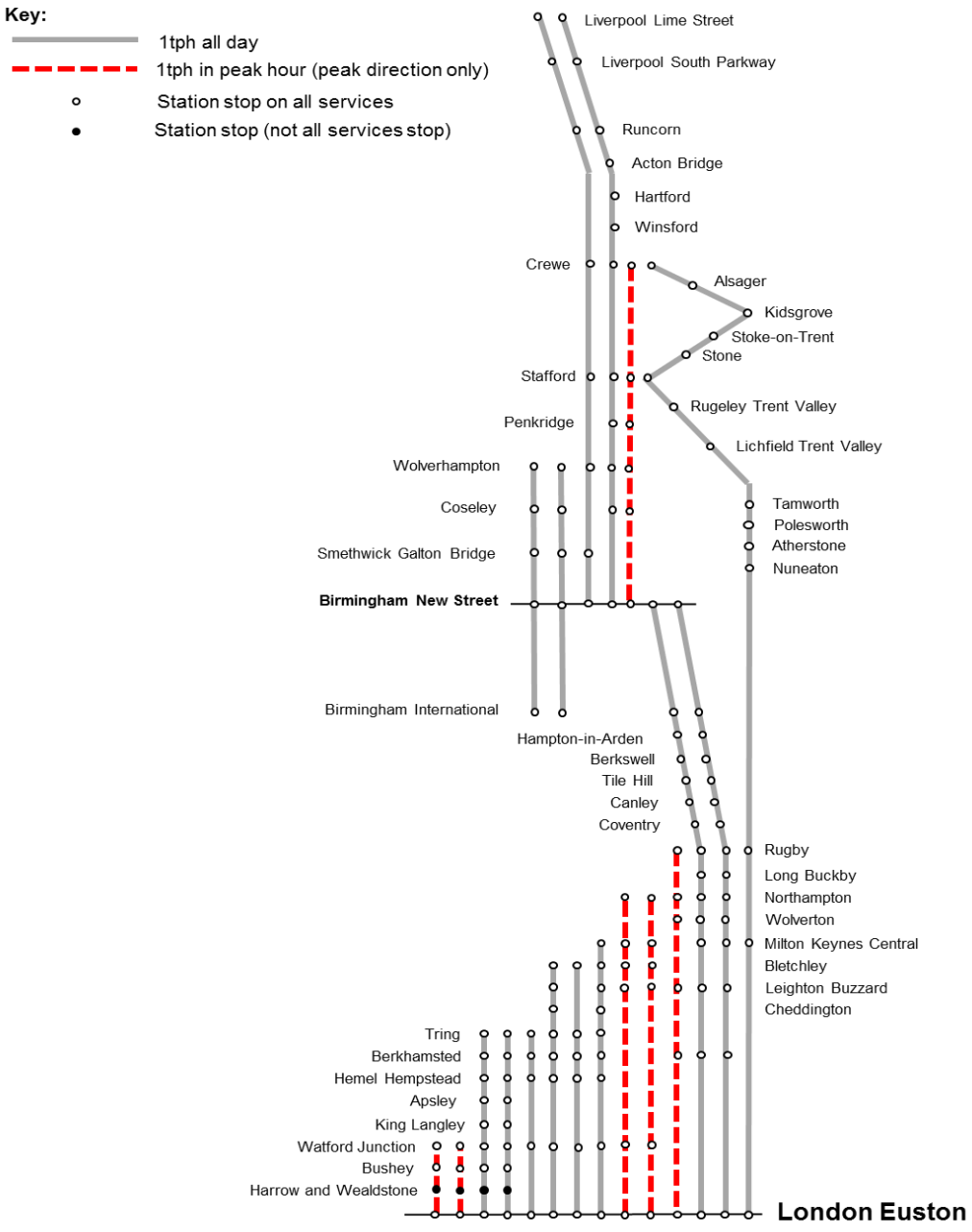
- 2tph peak services between London Euston and Watford Junction;
- 3tph between London Euston and Tring;
- 2tph between London Euston and Bletchley;
- 1tph between London Euston and Milton Keynes;
- 2tph peak services between London Euston and Northampton;
- 2tph peak services between London Euston and Rugby;
- 2tph between London Euston and Birmingham New Street; and
- 1tph between London Euston and Crewe (via Litchfield Trent Valley).

6.6.3 The 'Do Something' timetable also assumes the following services starting at Birmingham New Street:

- 2tph peak services between Birmingham International and Wolverhampton;
- 1tph peak services between Birmingham New Street and Crewe; and
- 2tph between Birmingham New Street and Liverpool Lime Street.

6.6.4 A summary of services and stopping patterns for London Midland services in Phase One and Phase Two is shown in figure 6-7.

Figure 6-7: London Midland service pattern used in PFMv6.1c – Phase One and Full network



6.7 East Midlands trains

6.7.1 The Phase One 'Do Something' timetable for East Midlands Trains has been updated with exactly the same changes as the 'Do Minimum' scenario as there are no HS2 Phase One effects on this service.

6.7.2 The Phase Two timetable assumes the following service pattern for London services on the Midland main line:

- 1tph between Nottingham and London St Pancras[30];
- 1tph between Sheffield and London St Pancras[31];
- 1tph between Derby and London St Pancras, which routes via the East Midlands High Speed station at Toton[32];
- 1tph between Corby (Kettering) and London St Pancras. Note that services to and from Corby are coded to and from Kettering as Corby is not a station that is directly represented in PLD; and
- 1tph between Leicester and London St Pancras.

6.7.3 London services are assumed to be 10-car IEP trains in the peak and 5-car IEP trains in the off-peak.

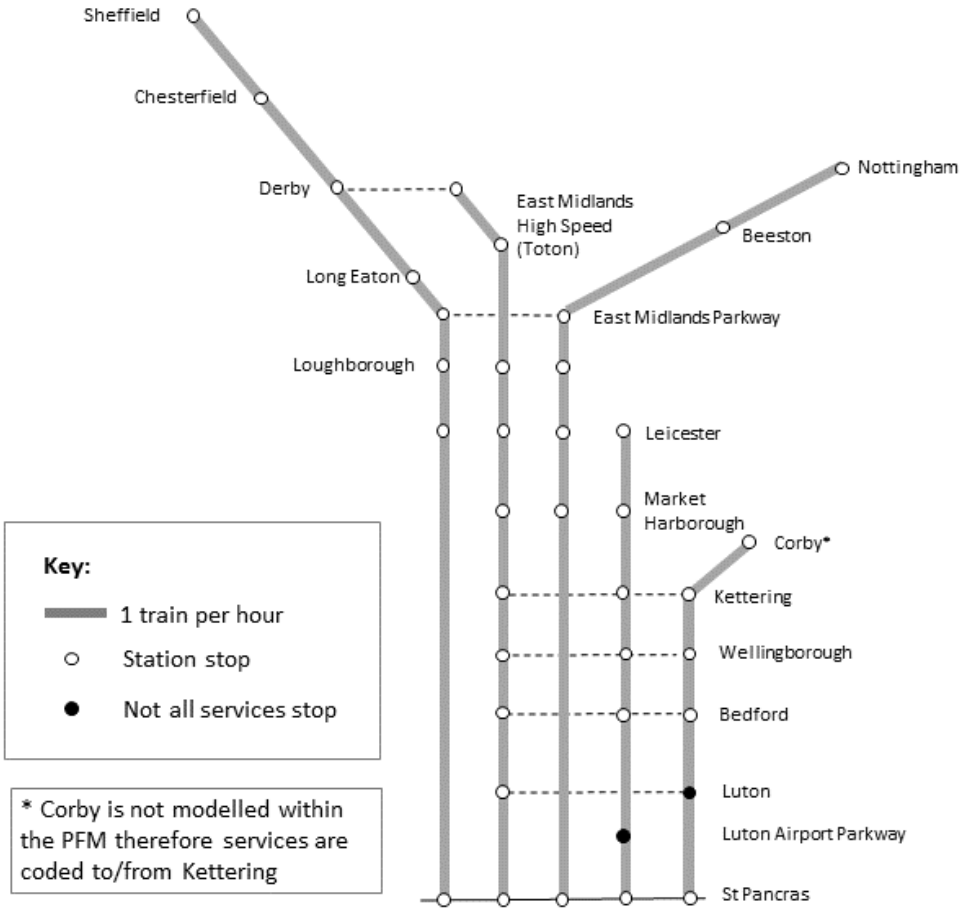
6.7.4 A summary of services and stopping patterns for East Midlands Trains services to/from London in Phase Two is included in figure 6-8. Phase One is not presented as it is unchanged from the 'Do Minimum'.

6.7.5 The Phase 2 timetable is also amended within the East Midlands area to allow for released capacity and connectivity of the East Midlands high speed station[33]:

- The Liverpool to Norwich services group is re-routed in Phase 2 to stop at Toton. This incurs increases journey time by six minutes. The Nottingham to Norwich variant is extended to start/terminate at Toton incurring an additional 14-minute journey time.
- Both the Matlock to Nottingham and Derby to Nottingham service groups are re-routed via Toton in Phase 2, incurring an additional 14-minute journey time.

[30] The East Midlands Nottingham services have been coded with variable stopping patterns, therefore not all services stop at Beeston, East Midlands Parkway and Market Harborough.
[31] The East Midlands Sheffield services have been coded with variable stopping patterns, as a result these services are missing intermediate stops at Loughborough and Long Eaton.
[32] The East Midlands Derby services are missing intermediate stops at Luton, Bedford, Wellingborough, Kettering and Market Harborough.
[33] The connections to Toton for the following East Midlands services have not been included in this model release version.

Figure 6-8: East Midlands service pattern used in PFMv6.1c – Phase Two



6.8 TransPennine Trains

6.8.1 Released capacity assumptions for TransPennine changes to the 'Do Minimum' timetables are applied initially in Phase One and Phase 2a. This initial release, includes truncation of Manchester Airport–Scotland services at Manchester Piccadilly (removing the section to Scotland).

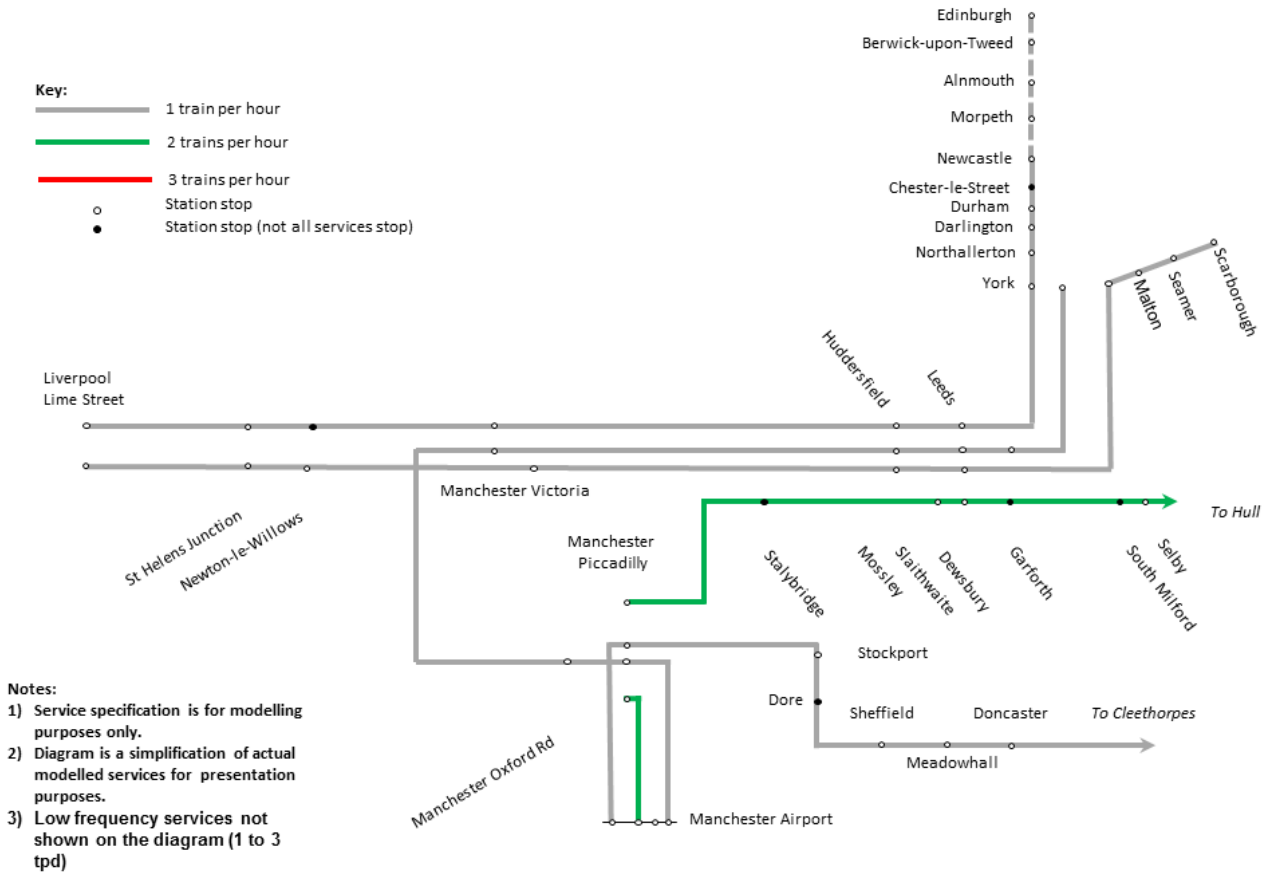
6.8.2 Further released capacity assumptions for TransPennine are applied in Phase Two with the Liverpool–Newcastle services extended to Edinburgh.

6.8.3 The Phase Two timetable for TransPennine Trains assumes:

- 2tph between Manchester and Hull via Leeds;
- 1tpd between Manchester Airport and Doncaster via Sheffield;
- 1tpd from York to Middlesbrough;
- 5tpd between Liverpool and Newcastle (via Manchester, Leeds and York);
- 1tph between Liverpool and Scarborough (via Manchester, Leeds and York);
- To / from Manchester Airport:
  - 4tpd to York;
  - 1tph to Manchester Piccadilly (the truncation of the 'Do Minimum' Manchester Airport–Scotland service);
  - 1tph to Cleethorpes via Sheffield.

6.8.4 A summary of services and stopping patterns for TransPennine Train services is included in Figure 6-9 for Phase Two. Phase One services for TransPennine are not shown as they are the same as the 'Do Minimum'.

Figure 6-9: Trans Pennine service pattern used in PFMv6.1c – Phase Two



6.9 Northern Railway

6.9.1 The Phase One and Phase 2a timetables are unchanged from the 'Do Minimum'.

6.9.2 Released capacity assumptions for Northern Railway are applied within the Phase Two timetable only.

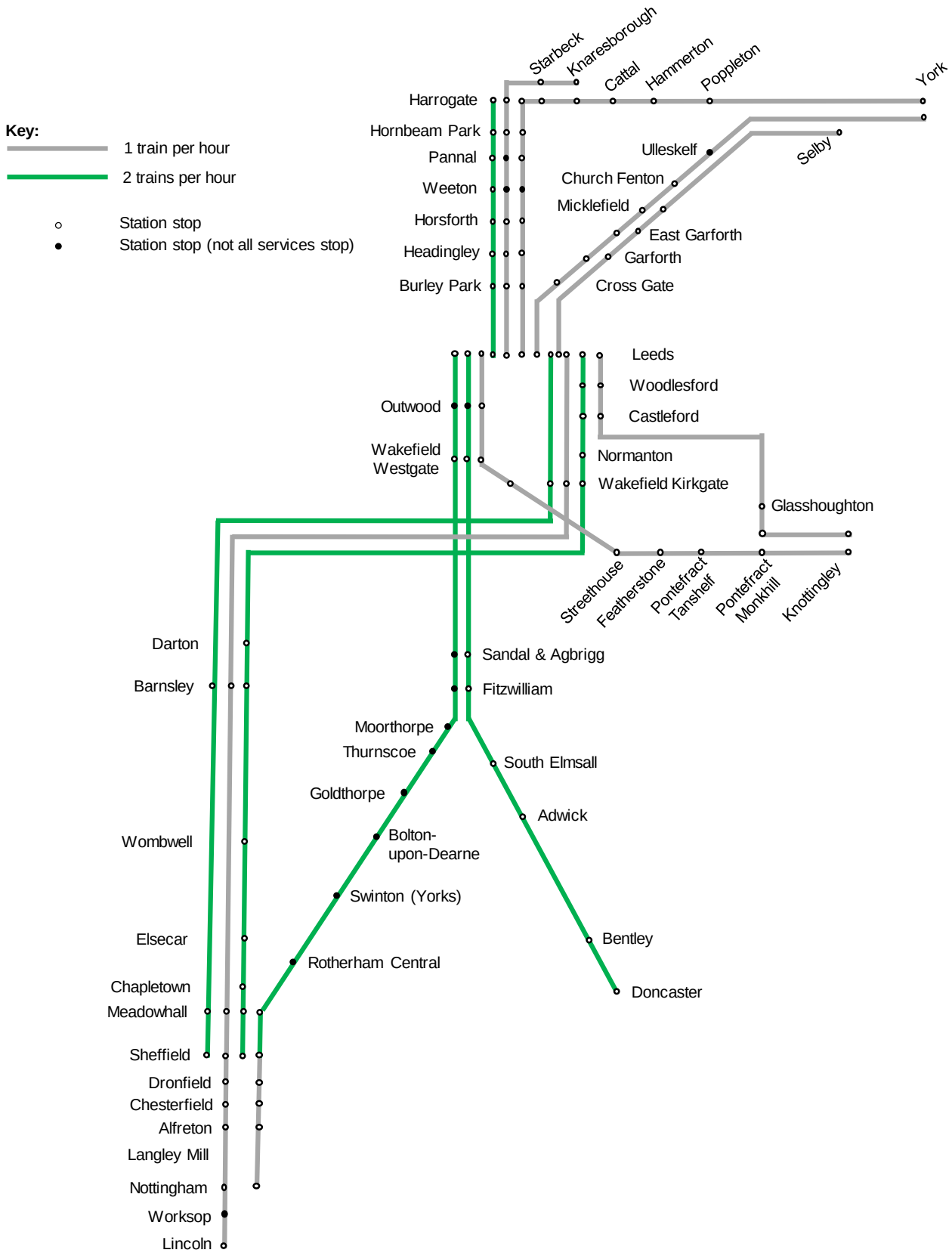
6.9.3 The Phase Two timetable assumes the following for each corridor.

- On the Leeds–Doncaster corridor the following services to/from Leeds:
  - 2tph to Sheffield;
  - 1tph to Sheffield via Rotherham stopping service;
  - 1tph to Doncaster calling all stations; and
  - 1.5tph to Doncaster semi-fast (backfilling for removed East Coast services).
- On the South Manchester corridor, the following services to/from Manchester Piccadilly:
  - 2tph to Crewe via Stockport;
  - 1tph to Alderley Edge via Stockport;
  - 2tpd to Stoke on Trent stopping service;
  - peak extra services to Macclesfield; and
  - 1tph to Crewe semi-fast.
- On the Calder Valley corridor, the following services to/from Leeds:
  - 3tph to Huddersfield;
  - 1tpd to Manchester Victoria; and
  - 1tpd Bradford Interchange to Manchester Victoria.
- On the North West Electrification corridor, the following services to/from Manchester Piccadilly / Manchester Victoria:
  - 1tph Wigan Wallgate;
  - 1tph Kirkby;
  - 1tpd Clitheroe;
  - 4tpd Southport;
  - 1 tpd Liverpool Lime Street stopping service;
  - 1tpd Liverpool Lime Street peak fast service; and

- 2tph Liverpool Lime Street to Manchester Airport.

6.9.4 A summary of services and stopping patterns for Northern services on the key corridors are presented in Figures 6-10 to 6-13 for Phase Two. Phase One services for Northern Railway are not shown as they are the same as the 'Do Minimum'.

Figure 6-10: Northern Railway Services- Leeds–Sheffield & Doncaster Corridor service pattern used in PFMv6.1c – Phase Two

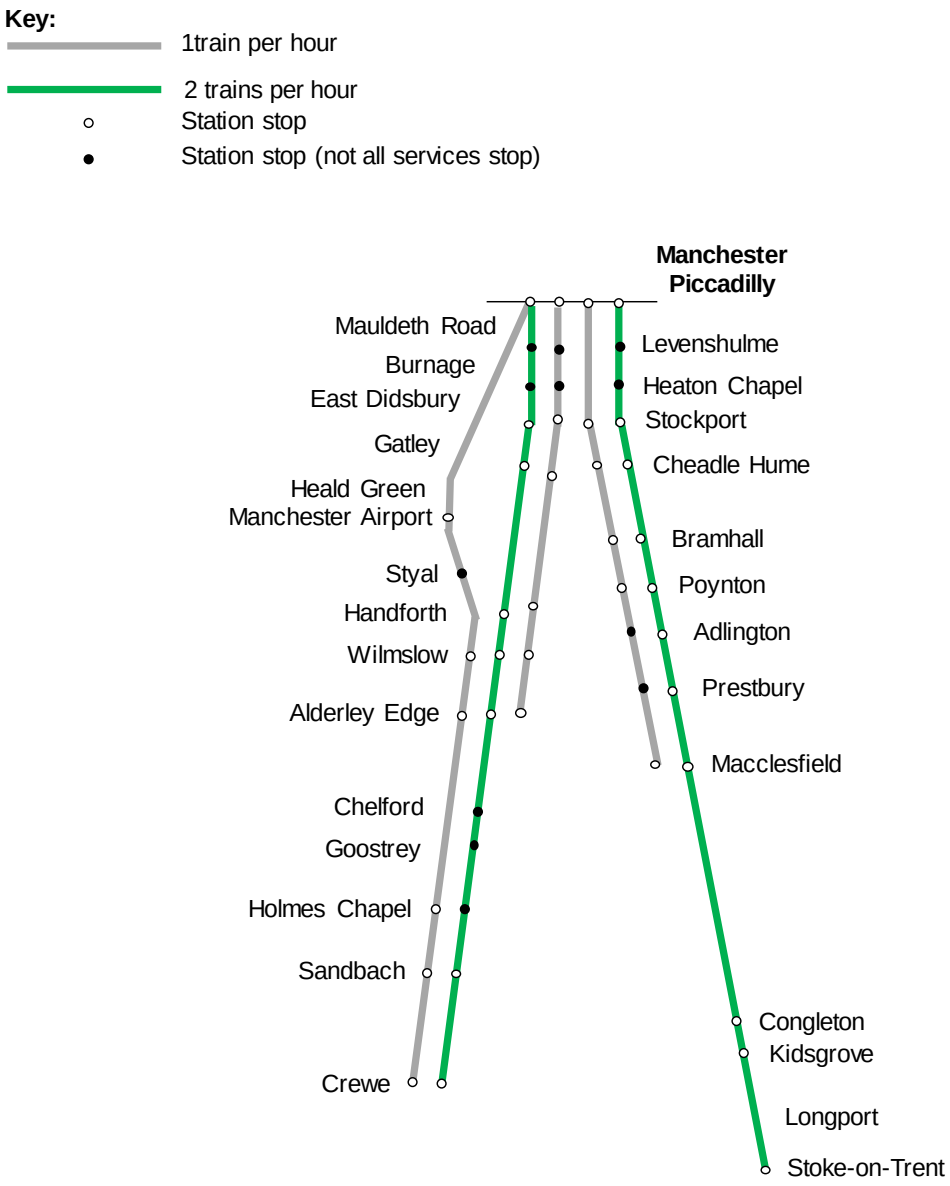


Notes:

1) Service specification is for modelling purposes only.

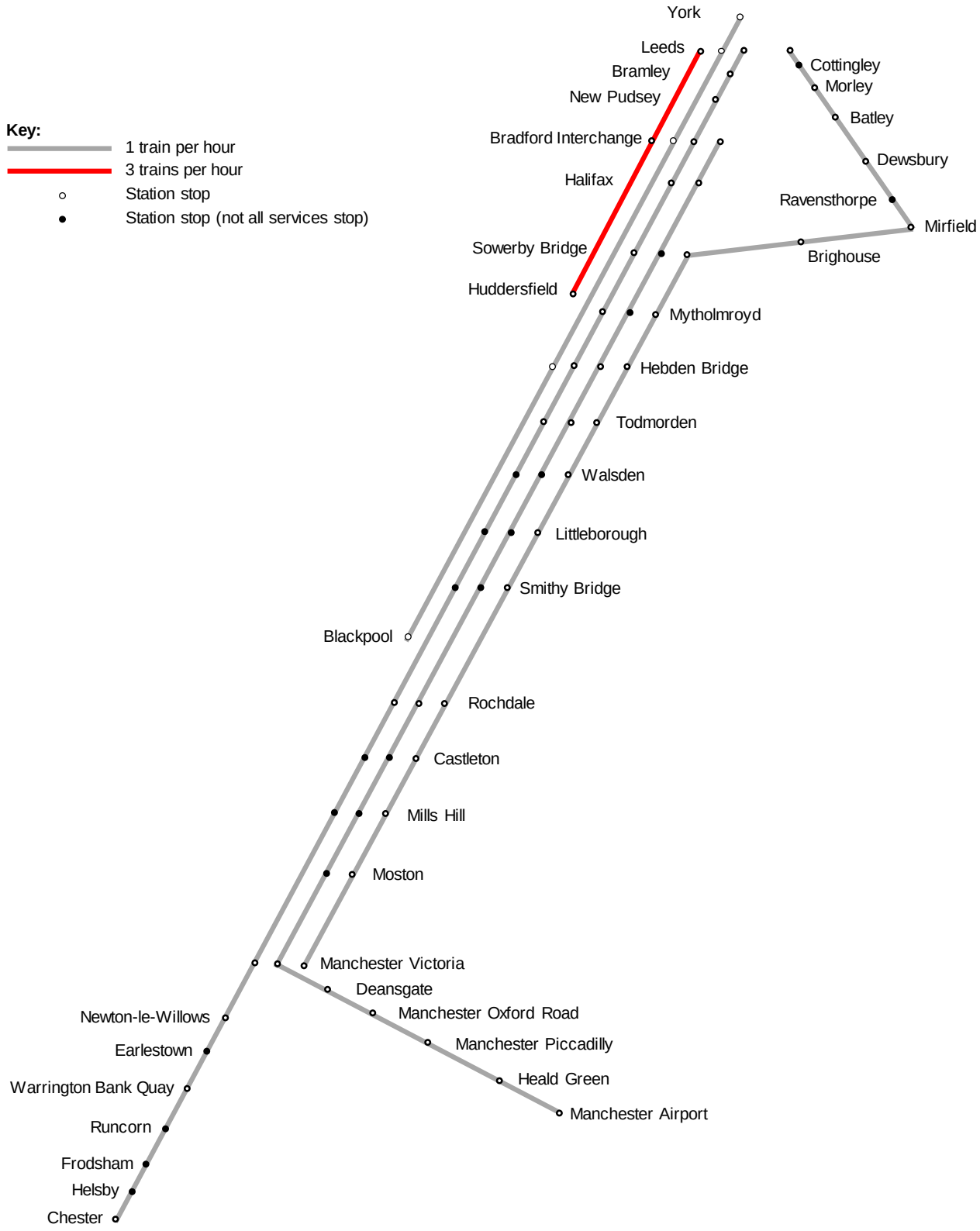
2) Diagram is a simplification of actual modelled services for presentation purposes.

Figure 6-11: Northern Railway Services- South Manchester Corridor service pattern used in PFMv6.1c – Phase Two



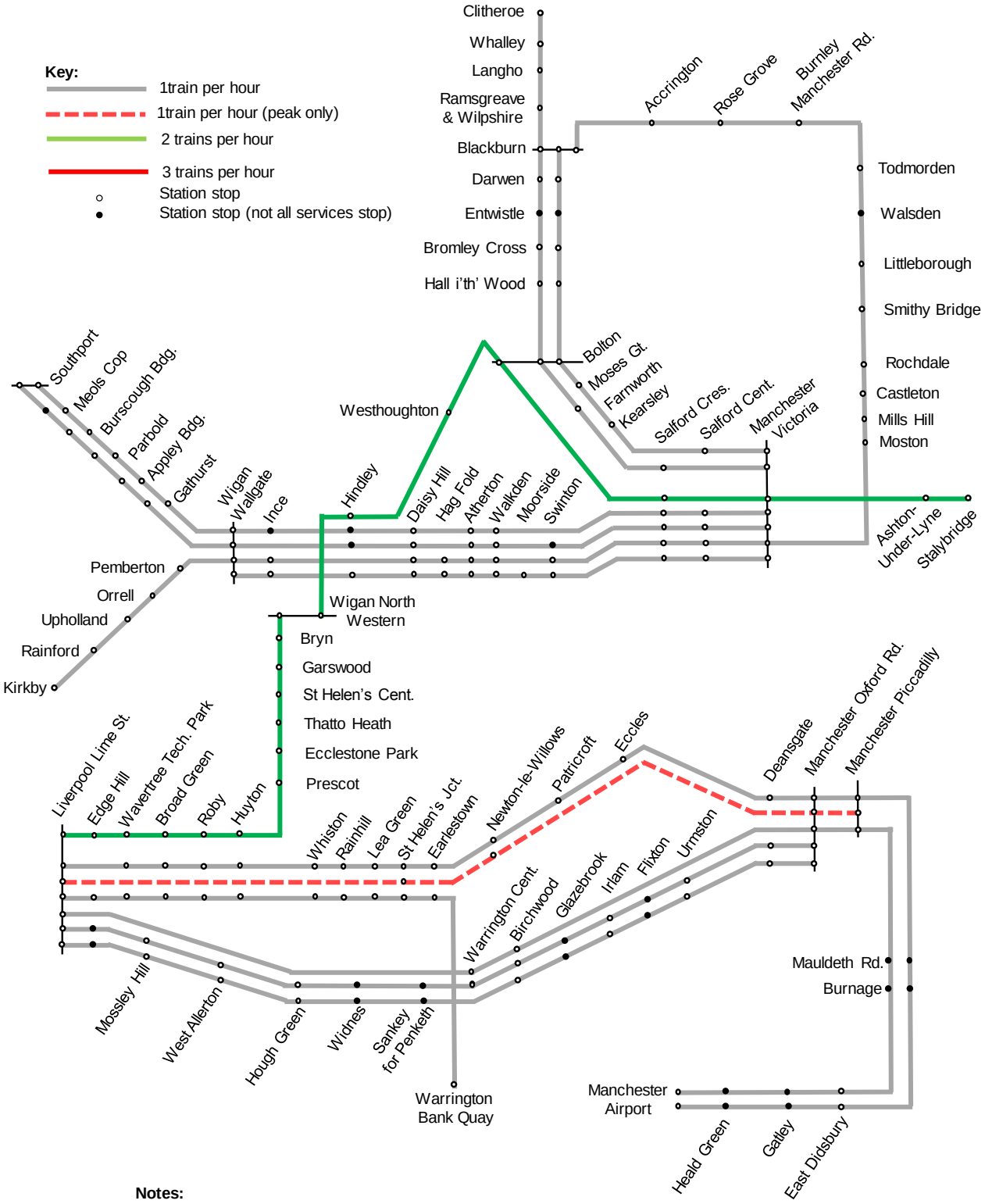
Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

Figure 6-12: Northern Railway Services- Leeds-Sheffield & Doncaster Corridor service pattern used in PFMv6.1c – Phase Two



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

Figure 6-18: Northern Railway Services- South Manchester Corridor service pattern used in PFMv6.1c – Phase Two



Notes:

1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

6.10 Cross country

6.10.1 The Phase One timetable for cross country services is as assumed for the 'Do Minimum' in PFMv6.1c.

6.10.2 The Phase Two timetable is broadly the same as that in the 'Do Minimum' in PFMv6.1c except for the following:

- additional calling points are provided at Meadowhall, Chesterfield, Burton-on-Trent and Tamworth on all services to Edinburgh and York; and Congleton and Macclesfield on services to Manchester; and
- Reading to Newcastle services are cut back to terminate at York (and vice versa).

6.10.3 This provides a service pattern as follows:

- 1tph between Manchester and Bournemouth via Milton Keynes;
- 1tph between Manchester and Bristol via Birmingham (with some services continuing on to Cardiff or Paignton);
- 1tph between Manchester and Birmingham International;
- 1tph between Plymouth and Edinburgh, with some services continuing on to Penzance in the South West or Glasgow, Dundee or Aberdeen in Scotland; and
- 1tph between Reading and Newcastle, with some services continuing on to Southampton or Guildford in the south, or Edinburgh in the north.

6.10.4 In PFMv6.1c the 'Do Minimum' journey time changes between Birmingham and Nottingham and Birmingham and Sheffield have been incorporated into Phase Two.

6.10.5 A summary of services and stopping patterns for cross country services in Phase Two is included in figure 6-11. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-11: Cross country service pattern used in PFMv6.1c – Phase Two

6.11 Southern

6.11.1 Within PFM the changed assumptions for Southern relate to the service operating to Milton Keynes. In both Phase One and Phase Two an hourly service is assumed, with a second train per hour in peak times, between East Croydon and Milton Keynes Central.

6.11.2 A summary of services and stopping patterns for Southern Trains in Phases One and Two is included in figure 6-12.

Figure 6-12: Southern Trains service pattern used in PFMv6.1c – Phase One and Phase Two

6.12 Thameslink and Great Northern Trains

6.12.1 The Thameslink specification presented here relates to selected Thameslink services in the corridors impacted by the released capacity specification, that is, the Midland route to Bedford and the Great Northern route to Peterborough.

6.12.2 Phase One is unchanged from the 'Do Minimum' and assumes the following:

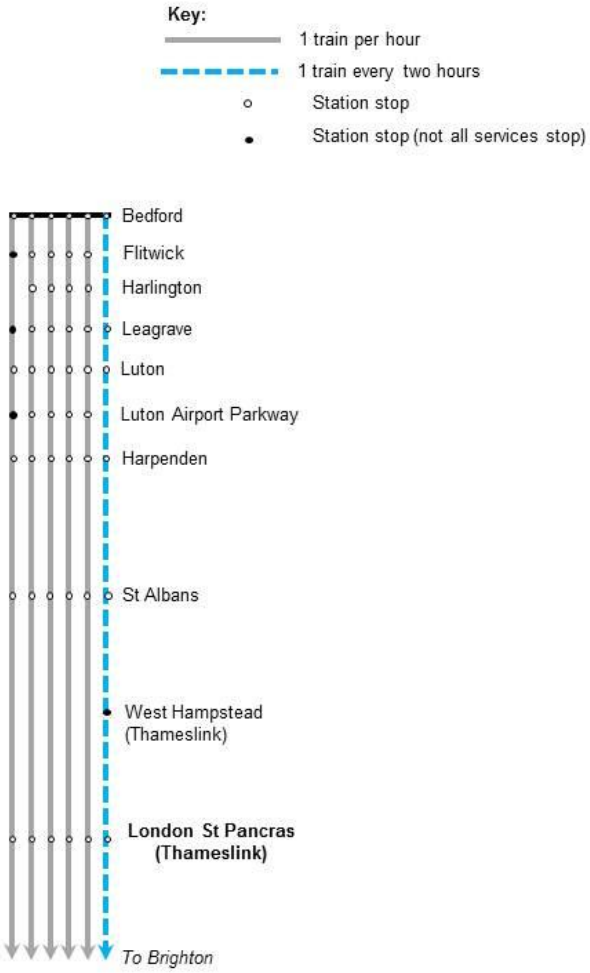
- On the Thameslink Midland corridor:
  - 5.5tph between Bedford and Brighton via central London;
- And on the Great Northern Peterborough corridor:
  - 1tph peak only between King's Cross and Peterborough;
  - 2tph between Three Bridges and Peterborough via central London.

6.12.3 Phase Two assumes the following:

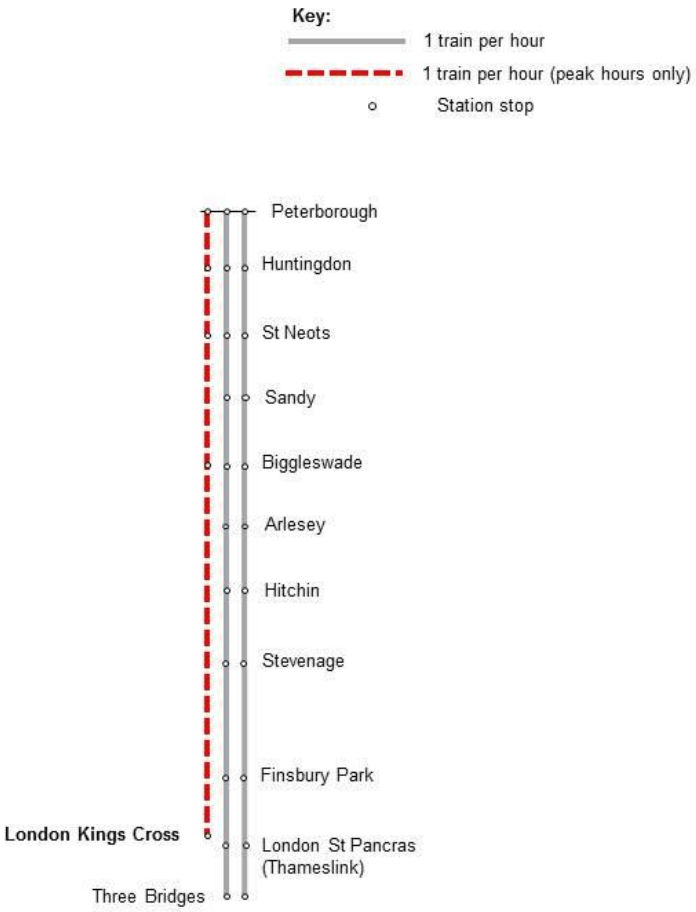
- On the Thameslink Midlands corridor:
  - 5.5tph between Bedford and Brighton via central London;
  - 1tph between Bedford and London St Pancras semi-fast.
- And on the Great Northern Peterborough corridor:
  - 1tph peak only between King's Cross and Peterborough semi fast;
  - 1tph peak only between King's Cross and Peterborough stopping service;
  - 2tph between Three Bridges and Peterborough via central London;
  - 1tph between King's Cross and Peterborough semi-fast.

6.12.4 A summary of services and stopping patterns for Thameslink Midland and Thameslink Great Northern services is presented in figure 6-13 for Phase One and figure 6-14 for Phase Two.

Figure 6-13: Thameslink- Midlands and Great Northern service pattern used in PFMv6.1c – Phase One

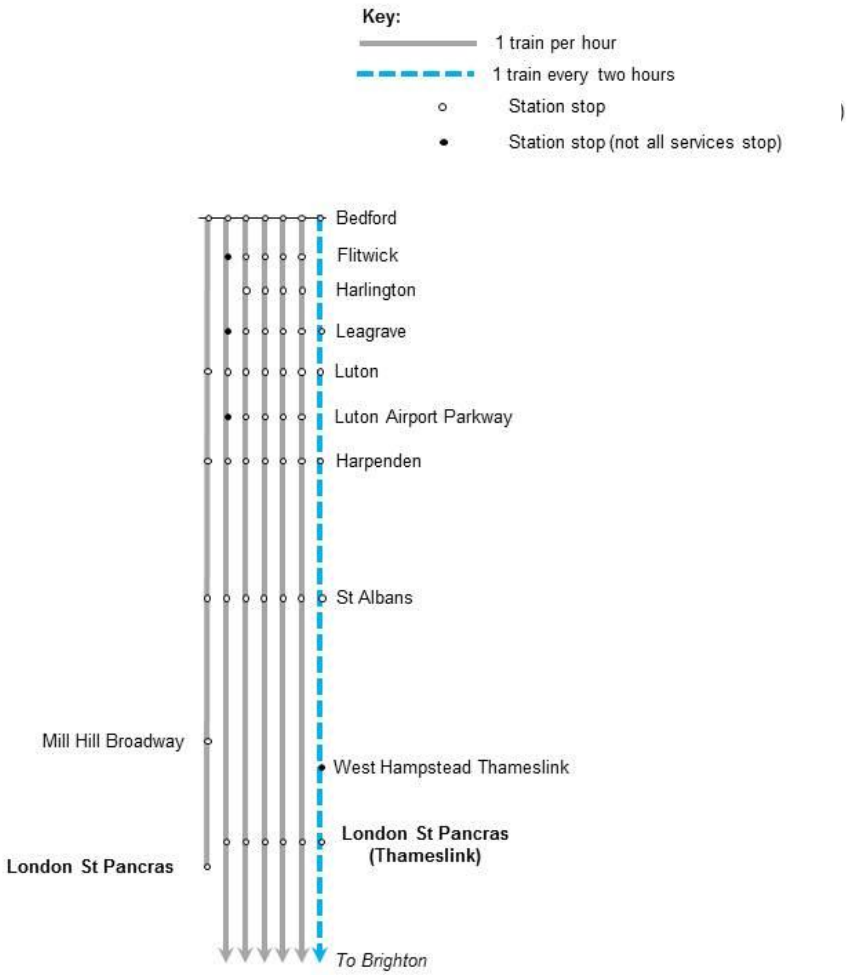


Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Bedford, plus any released capacity services**



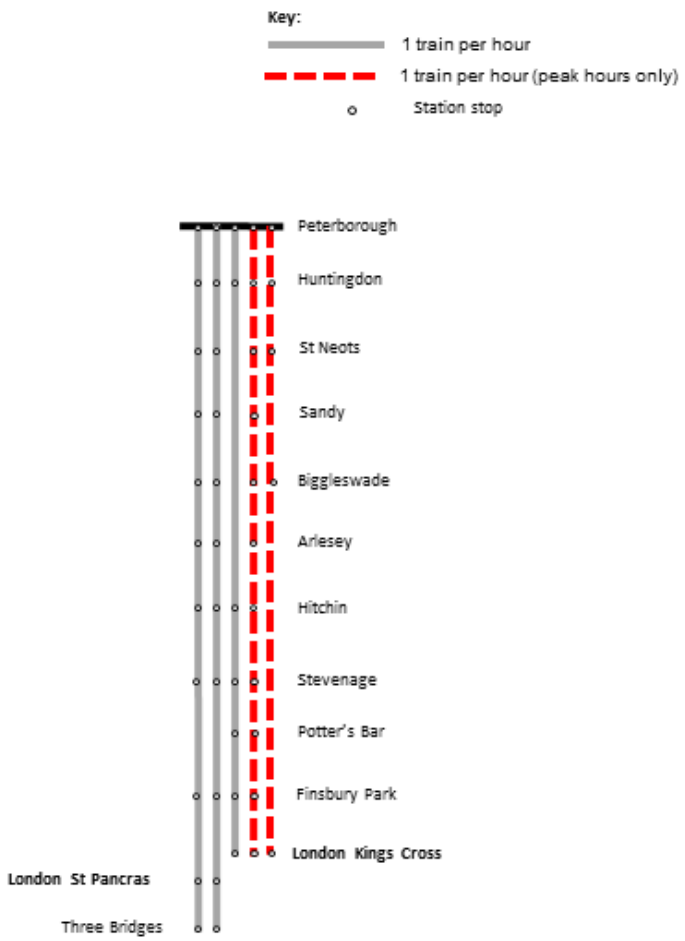
Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Peterborough, plus any released capacity services**

Figure 6-14: Thameslink – Midlands and Great Northern service pattern used in PFMv6.1c – Phase Two



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.
3) Only shows trains starting at Bedford, plus any released capacity services

Figure 15 – Great Northern Trains
Average Service Pattern – Phase 2



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

East-West Rail

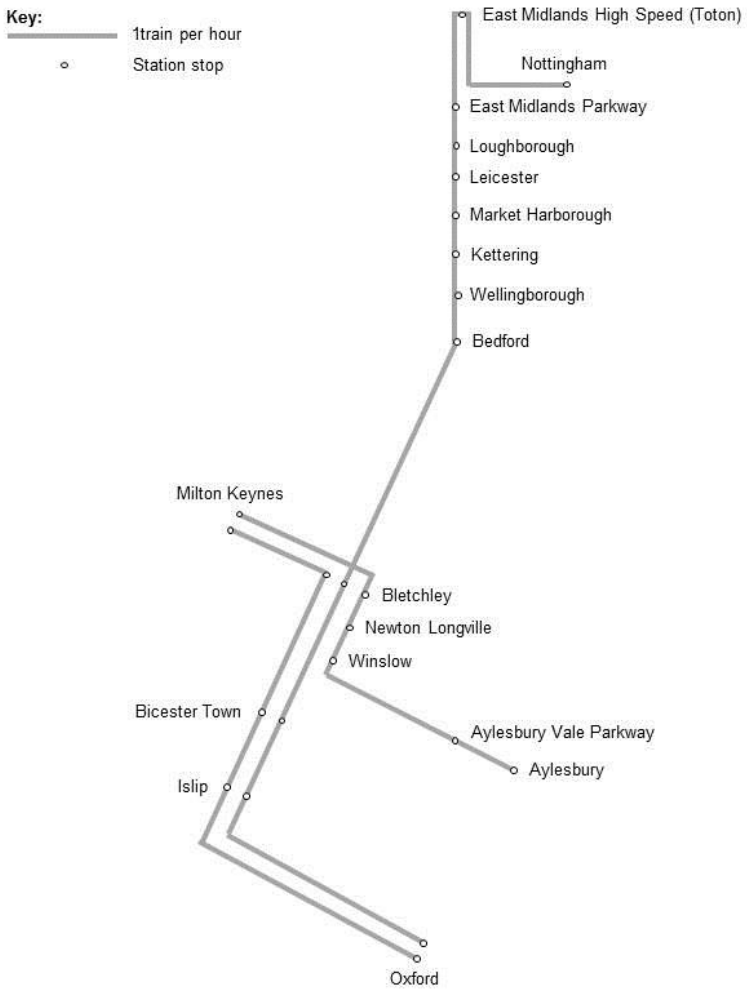
6.12.5 The Phase One timetable is as the 'Do Minimum' specification.

6.12.6 The Phase Two timetable assumes:

- 1tph between Oxford and Nottingham via Bedford (projected on from the 'Do Minimum' Oxford-Bedford service);
- 1tph between Oxford and Milton Keynes; and
- 1tph Aylesbury and Milton Keynes.

6.12.7 A summary of services and stopping patterns for East West Rail is included in Figure 6-17. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-17 East-West Rail service pattern used in PFMv6.1c – Phase Two



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

6.13 Old Oak Common - Great Western and Heathrow Express

6.13.1 All Crossrail, Great Western and Heathrow Express services between Paddington and the west call at Old Oak Common in both Phases One and Two. The impact of stopping at Old Oak Common is an increase in journey time of between two and four minutes.

6.14 Old Oak Common - Crossrail

6.14.1 All Crossrail trains that travel the western section towards Heathrow and West Drayton/Maidenhead/Reading in the 'Do Minimum' additionally call at Old Oak Common in the 'Do something' scenario

6.14.2 In addition, services that start/end at Paddington are extended to serve Old Oak Common. The maximum capacity for turnaround at Old Oak Common is 12 trains per hour; therefore 12 trains per hour are extended in the morning and evening peaks, and eight trains per hour have been extended in the off-peak. This extension is split equally between the Paddington to Shenfield, and Paddington to Abbey Wood[34] services.

[34] In practice, these services are modelled to start/terminate at Liverpool Street as Abbey Wood is not represented in the PFM.

7 Rail reliability assumptions - PFMv6.1c

7.1.1 The approach to modelling reliability in PFMv6.1c involves making adjustments to the journey times for HS2 and classic services as a proxy for changes in reliability. The approach considers the potential improvement in reliability that HS2 can deliver by examining one measure of reliability – average minutes' lateness (AML).

7.1.2 Improvements in AML as a result of HS2 are converted into an equivalent journey time-saving based on evidence in PDFH and WebTAG[35]. PFM assumes that all passengers value one AML as equivalent to three minutes of journey time[36]. This perceived reduction in journey time is then input into the model to forecast the change in demand due to reliability improvements.

7.1.3 PFM uses HS2 Ltd's design assumption that on dedicated HS2 track the average delay will be 0.003 minutes/km; this is equivalent to an average of 30 seconds' delay between Old Oak Common and Birmingham Curzon Street. For 'Do Minimum' services running on classic lines an average delay of 0.014 minutes/km delay is assumed (taken from PEARS data, 2012).

Table 7-1: Reliability Benefits of HS2 in Phase One, selected services

HS2 service group	AML classic rail	Forecast AML with HS2	Change in AML	Equivalent journey time reduction (i.e. 3 times AML)
London - Birmingham	2.6	0.5	2.0	6
London– Phase One connection to WCML	2.9	0.5	2.3	7

Table 7-2: Reliability Benefits of HS2, Full network, selected services

HS2 service group	AML classic rail	Forecast AML with HS2	Change in AML	Equivalent journey time reduction (i.e. 3 times AML)
London–Birmingham	2.6	0.5	2.0	6
London–Liverpool via Crewe	3.5	0.7	2.8	9
London–Sheffield	3.8	0.8	3.0	9
London–Manchester	4.1	0.9	3.3	10
London–Leeds	4.7	0.9	3.7	11
Birmingham–Manchester	1.9	0.5	1.4	4
London–Phase 2 connection to WCML	4.4	0.9	3.5	11

[35] WebTAG unit 3.15.4
[36] PDFH5.1 recommends a weighting of 3.0 for London inter-urban non-commuting trips.

8 General model assumptions

8.1 Introduction

8.1.1 The *Model Development Overview* report provides details of the parameters and assumptions that are used within PFMv6.1c. This section outlines the weights used within the model.

Generalised cost element weights for rail

8.1.2 Within PFMv6.1c there are a series of weights applied to each element to derive generalised costs of travel. The modelled values are given in Table 8-1.

Table 8-1: Generalised Cost Element Weights for Rail – PFMv6.1c

	Model values (all purposes)		
Rail Element	**PLD**	**PLANET South**	**PLANETs Midlands and North**
IVT	1.0	1.0	1.0
Wait Time	2.0	2.0	2.0
Walk Time (for connections)	2.0	2.0	2.0
Access/Egress Time*	1.0	2.0	1.0
Board Time Penalty (mins)	30.0	3.5	20.0

* Values shown are for the assignment model, different values are used in the SCM (PT access IVT=1.0 and highway access IVT=2).

Glossary

AML	Average minutes' lateness
AP	Attraction to production
ATOC	Association of Train Operating Companies
CA	Car available
CAA	Civil Aviation Authority
CEBR	Centre for Economics and Business Research
CPI	Consumer Price Index
DECC	Department of Energy & Climate Change
DfT	Department for Transport
DM	Do Minimum
DS	Do Something
EDGE	Endogenous Demand Growth Estimator – forecasting framework for rail demand growth in Great Britain (DfT)
GDP	Gross domestic product
HAM	Heathrow Access Model
HSR	High Speed Rail
HS2	High Speed Two (the project)
HS2 Ltd	HS2 project promoter
ICWC	Inter City West Coast
IEP	Intercity express programme
IVT	In vehicle time
LASAM	London Airports Surface Access Model
LUL	London Underground Limited
MOIRA	Rail forecasting software and database. Maintained on behalf of ATOC members for rail demand and revenue forecasting.
NAPALM	National Air Passenger Allocation Model (DfT)
NAPDM	National Air Passenger Demand Model (DfT)

NCA	Non-car available
NTEM	National Trip End Model (DfT)
NTM	National Transport Model (DfT)
OBR	Office for Budget Responsibility
ONS	Office of National Statistics
ORR	Office of Rail and Road
P/A	Production/Attraction
PDFH	Passenger Demand Forecasting Handbook
PFM	PLANET Framework Model
PLD	PLANET Long Distance
PM	PLANET Midlands
PN	PLANET North
PS	PLANET South
PT	Public transport
RIFF	Rail Industry Forecasting Framework
RPI	Retail Price Index
RTF	Road Traffic Forecasts (DfT)
SCM	Station Choice Model
TEMPro	Trip End Model presentation Program (DfT)
TfL	Transport for London
TOC	Train Operating Company
WebTAG	DfT's web-based Transport Appraisal Guidance