Rail freight forecasts: Scenarios for 2023/24. Final Report

May 2018

MDS Transmodal

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CONTENTS

EXECUTIVE SUMMARY

This report by MDS Transmodal (MDST) was commissioned by Network Rail and presents new forecasts of rail freight in Great Britain for 2023/24. The report represents an update of the 2023/24 forecasts in Network Rail's 2013 Freight Market Study (FMS).

Over the period since 2004/5, total rail freight lifted has fallen from 115m tonnes to 86m tonnes in 2016/17. However, this is primarily a consequence of the Government's decision to phase out electricity generation by coal in order to meet international obligations on CO2 emissions. A limited volume of biomass traffic has replaced some of the coal despatched by rail to the power stations. Coal accounts for under 1% of road freight but in 2004/5 coal to power stations (ESI coal) accounted for 35% of all rail freight lifted. Traffic excluding ESI coal and biomass fell from 74.7m tonnes in 2004/5 to 67.7m tonnes in 2012/13, largely reflecting a decline in UK heavy industry and in the steel industry in particular. However, since then traffic excluding ESI coal and biomass has grown to 73.0m tonnes (+8%). Reflecting that decline in indigenous heavy industry, over the 12 years that are covered in the report (for which consistent rail freight volumes were available), HGV vehicle kms fell by 9% while non ESI and biomass rail freight fell by only 2%.

These flows are summarised in the table below.

Table 1: GB rail freight and road freight, 2004/5 to 2016/7

	2004/5	2008/9	2012/13	2016/17
ESI Coal + biomass rail tonnes (million)	41	45	47	13
Other rail tonnes (million)	75	71	68	73
Total rail tonnes (million)	115	117	115	86
Index: Other rail tonnes (million)	100	95	91	98
Billions HGV kms	29.3	28.6	25.0	26.8
Index all HGV kms	100	98	85	91

Sources: Rail: MDS Transmodal processing of Network Rail data. HGV kms: TSGB for the calendar years 2004, 2008, 2012 and 2016 respectively.

Over the last 5 years, changes in a number of key exogenous drivers that dictate the growth of rail freight have led to rail freight growing less quickly than the FMS forecasts had projected. Traffic excluding ESI coal and biomass had been expected to grow from 67.5m tonnes in the base-year (October 2011 to September 2012) to reach 102.3m tonnes by the financial year 2023/24, a growth rate of 3.0m tonnes p.a. as compared with the 1.2m tonnes growth p.a. that has emerged in the 4.5 years to 2016/7 to reach 73.0m tonnes. Had traffic followed the original forecasts then by 2016/17 traffic excluding ESI coal and biomass would have reached 81m tonnes, although in fact no such mid-point projection was made.

As a consequence and in order to assess how the existing model has behaved, Network Rail asked MDS Transmodal initially to rerun the 2011/12 model using the values for these drivers which were actually experienced. The principal differences in these drivers were that fuel prices did not grow (as Government had hitherto forecast), international container traffic has grown more slowly than had been assumed and new rail linked distribution parks were slower to come on stream (partly as a consequence of the 2009 financial crisis). Three very large parks (DIRFT3, Rossington and Kegworth) are now all coming on stream and others are in the development stage.

Taking these factors into account and estimating a 'mid-term' position in 2016/17 we find that in fact actual performance has been substantially higher than we would have forecast using the values for the drivers which actually occurred. Using the values of the drivers that actually occurred, forecasts for traffic excluding ESI coal and biomass would have been only 64.4m tonnes and not the 73.0m tonnes that was actually carried. This is mainly due to growth in construction materials. Construction materials grew by 7.6m tonnes more than would have been forecast and all other traffic together (including containers) grew by 1.0m tonnes more than anticipated.

This comparative exercise is set out in detail in appendix 2.

As a result of this preliminary exercise, before producing new forecasts we adjusted our approach, principally for aggregates where account was taken of the considerable uplift in the market available to rail through the development of super quarries gradually replacing locally sourced materials. Effectively, the re-forecasts are from a higher base than might have been expected.

On this occasion, instead of using a single set of drivers, 4 different sets of exogenous drivers have been considered based upon the expectations that prevailed in 2017 to cover the next 7 year period to 2023/4.

Table 2: The exogenous drivers behind the different scenarios for 2023/24

	Low market growth	High market growth
Factors which favour rail relative to road	Scenario A2	Scenario B2
Factors which disfavour rail relative to road	Scenario C2	Scenario D2

The results of the new forecasts are as follows (tonnes and tonne kms):

Table 3: Rail freight TONNES forecast for 2023/24 scenarios by sector. Thousand tonnes per year

Sector	Actual 2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	16,213	24,252	27,133	15,320	17,077
Domestic Intermodal	2,481	8,009	8,606	3,281	3,493
Channel Tunnel Intermodal	374	529	578	420	458
ESI Coal	6,284	-	-	-	-
Biomass	6,470	8,464	13,045	8,464	13,045
Waste	1,226	1,165	1,287	1,165	1,287
Construction materials	24,286	33,133	43,383	22,887	29,967
of which spoil	735	997	1,306	733	960
Petroleum	4,710	4,822	5,330	4,470	4,940
Chemicals	899	934	1,032	863	954
Industrial Minerals	1,335	1,580	1,747	1,162	1,284
Metals	7,441	8,226	9,092	6,965	7,698
Automotive	450	468	583	437	548
Ores	4,259	4,046	4,472	4,046	4,472
Coal Other	1,955	1,857	4,052	1,857	4,052
Other	334	368	407	319	353
Empty returns for containers carrying bulks	413	397	439	393	434
NR Engineering	6,657	6,324	6,990	6,324	6,990
Total	**85,786**	**104,574**	**128,175**	**78,371**	**97,052**

Scenario B2 shows the largest growth in tonnes (+49% overall) – particularly for the construction, and intermodal sectors. Scenario C2 shows a slight decline (9%). This is mostly accounted for by the decline in ESI (power station) coal.

Table 4: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector. Million tonne kms per year

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	5,612	8,165	9,108	5,279	5,885
Domestic Intermodal	1,136	3,466	3,726	1,526	1,631
Channel Tunnel Intermodal	94	133	145	106	115
ESI Coal	1,158	-	-	-	-
Biomass	853	1,093	1,673	1,093	1,673
Waste	215	204	225	204	225
Construction materials	4,342	5,242	6,863	4,070	5,330
of which spoil	94	127	166	94	123
Petroleum	1,134	1,141	1,261	1,075	1,188
Chemicals	142	152	168	137	152
Industrial Minerals	234	262	289	213	236
Metals	1,587	1,706	1,886	1,465	1,620
Automotive	146	149	180	141	171
Ores	156	148	164	148	164
Coal Other	267	254	783	254	783
Other	101	112	124	97	107
Empty returns for containers carrying bulks	69	68	75	66	73
NR Engineering	1,714	1,628	1,800	1,628	1,800
Total	**18,962**	**23,923**	**28,472**	**17,502**	**21,152**

Both the FMS and these latest projections are forecasts of *demand* – i.e. they do not include any capacity constraints. However a more realistic representation of 2023/24 is likely to include some bottlenecks where the available capacity cannot satisfy the market demand, particularly for the higher-growth scenarios A2 & B2.

We have incorporated a simple approach to capacity constraint - whereby required rail freight capacity through 7 known bottlenecks across the network is limited to 20% above that required in 2016/17. These capacity constrained scenarios (A3 & B3) are based on the forecast demand in scenarios A2 & B2.

Table 5: Rail freight tonnes and tonne kilometres for the capacity constrained scenarios

	Tonnes (thousand)		Tonne Kilometres (million)	
Sector	2023/24 A3	2023/24 B3	2023/24 A3	2023/24 B3
Ports Intermodal	22,210	21,885	7,486	7,362
Domestic Intermodal	7,758	7,964	3,370	3,482
Channel Tunnel Intermodal	529	578	133	145
ESI Coal	-	-	-	-
Biomass	8,462	12,952	1,092	1,654
Waste	1,164	1,274	204	221
Construction materials	32,527	41,485	5,107	6,457
of which spoil	997	1,169	127	149
Petroleum	4,821	5,328	1,141	1,261
Chemicals	921	1,005	148	159
Industrial Minerals	1,572	1,726	260	284
Metals	8,220	9,045	1,703	1,865
Automotive	433	467	138	145
Ores	4,046	4,472	148	164
Coal Other	1,857	4,052	253	782
Other	368	407	112	124
Empty returns for containers carrying bulks	397	435	68	74
NR Engineering	6,173	6,619	1,587	1,698
Total	**101,458**	**119,692**	**22,952**	**25,879**

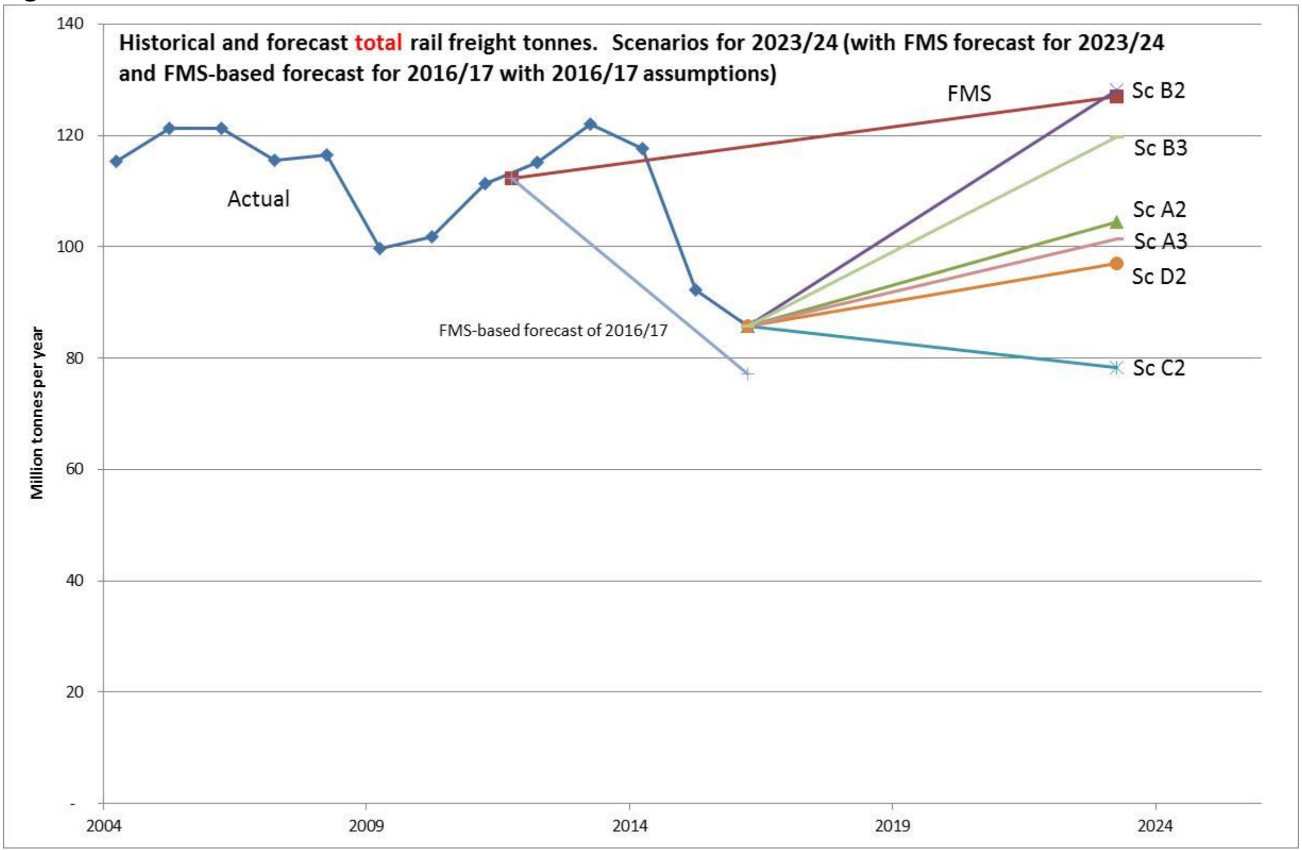
The table and graph below show how the new scenarios compare with the 2023/24 FMS forecasts, along with the historical tonnage traffics from 2004/05. They also show what the FMS forecasts would have been for 2016/17 if out-turn assumptions for 2016/17 had been input into the FMS models (see below).

Table 6: Comparison of new forecasts with the FMS

Scenario	Million Tonnes
2016/17 actual	85.8
2023/24 A2: Factors favouring rail, low market growth	104.6
2023/24 B2: Factors favouring rail, high market growth	128.2
2023/24 C2: Factors disfavouring rail, low market growth	78.4
2023/24 D2: Factors disfavouring rail, high market growth	97.1
2023/24 Average of A2, B2, C2 & D2	102.0
2023/24 A3: A2 with capacity constraint	101.5
2023/24 B3: B2 with capacity constraint	119.7
2012 actual* (from FMS)	112.4
2016/17 forecast from FMS base with 2016/17 assumptions	77.1
Original FMS central case forecast for 2023/24	127.0

* FMS base year for modelling was 12 months to the end of September 2012.

Figure 1

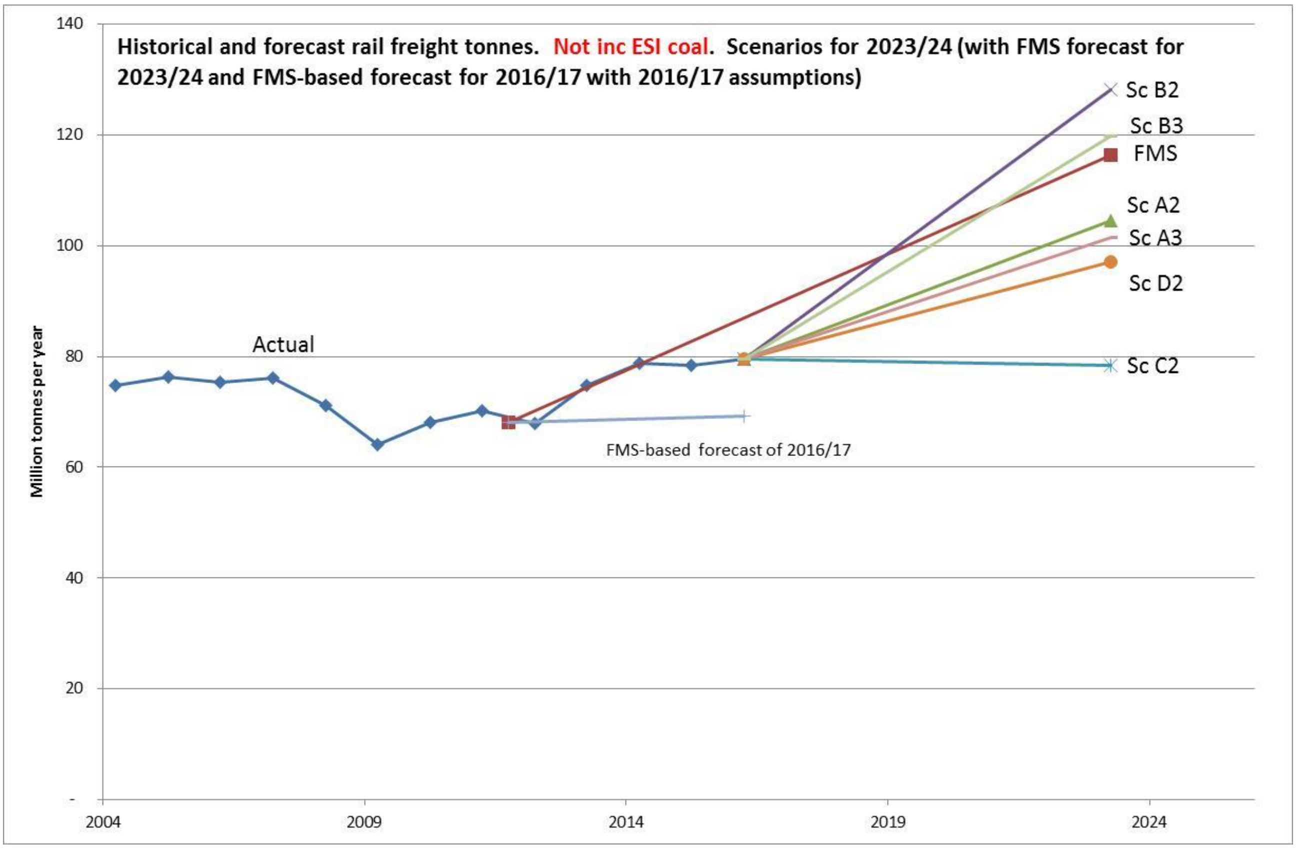


Note the "FMS-based forecast of 2016/17" line shows what a forecast of 2016/17 would have been (77 million tonnes) using

- the FMS base year (12 months to the end of September 2012)
- input assumptions that reflect the true outcome in 2016/17 (such as lower fuel prices)
- the forecasting methods used in the FMS

Volumes of ESI (power station) coal have historically been volatile – and no ESI coal is forecast to be carried by rail in 2023/24. The graph below shows an equivalent graph but with ESI coal excluded. Note that the graph does include biomass, which reflects some conversion of power stations from coal to biomass.

Figure 2



The forecast assumptions for the 2023/24 scenarios were agreed with stakeholders using the available information at the time (June 2017). There may be subsequent changes to some of these exogenous assumptions prior to publication of the final report which have not been taken into account in the modelling and quantified results.

One such change is the assumption on the amount of electricity generation by source. The BEIS projections of January 2017 stated zero electricity generation from coal in 2024, but the November 2017 BEIS projections stated some significant coal-sourced generation remaining - reflecting around 1.6m of ESI coal by rail in 2023/24 (pro rata decrease from 2016 tonnes of ESI coal by rail).

The forecasts therefore do not reflect changes in other official projections, forecasts and policies since June 2017, such as labour and fuel cost assumptions and the Government announcement on changes to the HGV levy (lower levy for cleaner vehicles).

Planned infrastructure upgrades have not been taken into account that could potentially reduce operational costs along certain routes. The forecasts (and routeings) therefore reflect the network of early 2017 and do not reflect any upgrades implemented since then or any planned upgrades.

The forecasts do not reflect changes in rail freight volumes between 2016/17 (the base year for the forecasts) and 2017/18; i.e. the base year has not been updated to 2017/18. The indications are that there has been little change in total volumes in 2017/18 relative to 2016/17.

1. INTRODUCTION

In 2013 MDS Transmodal produced unconstrained rail freight demand forecasts for Network Rail for 2023/24, 2033/34 and 2043/44 for input into their 2013 Freight Market Study (FMS). These had a model base year of 12 months to the end of September 2012.

These forecasts were originally reported in an April 2013 report to Network Rail and were consulted upon. Through that process some input assumptions were revised but the forecasting methodology remained as described in that report.

There have been several exogenous developments since 2013 that were not anticipated in those projections which have had the effect of adversely affecting the competitive position of rail freight in the UK. These include:

- Government energy policy changes resulting in a faster reduction in the role of coal fired power stations and a lower take-up of biomass than expected because of cuts in the level of financial support available
- Lower fuel price growth and wage growth than expected. Fuel prices have declined in real terms. The projections had been based on the then projections being made by the DfT.
- Lower rate of build-out of rail served warehousing sites than expected, consequent on the 'lost years' of the financial crisis which delayed projects that continue to be 'live'.

Another factor which may have adversely affected the competitive position of rail freight is the existence of capacity constraints on the rail network. The FMS forecasts were not capacity constrained and therefore did not take account of these constraints.

There have also been developments that have resulted in higher-than-projected volumes, particularly in the market for transporting construction materials.

Overall these developments have meant that the FMS growth projections (for GB rail freight in total) are not being realised. This supports the need for revised forecasts for Network Rail's Control Period 6 Strategic Business Plan.

Network Rail therefore commissioned MDS Transmodal to produce revised rail freight forecasts for the year 2023/24, with a base year of 2016/17. The modelling methodology varies by sector, but the methods used are in most cases the same as those used in the 2013 forecasts.

Unlike the FMS there is not one central scenario. There are 4 separate scenarios intended to give a range spanning factors favouring rail to factors disfavouring rail, and low market growth to high market growth:

- 2023/24 scenario A2: Factors which favour rail relative to road, with low market growth

- 2023/24 scenario B2: Factors which favour rail relative to road, with high market growth
- 2023/24 scenario C2: Factors which disfavour rail relative to road, with low market growth
- 2023/24 scenario D2: Factors which disfavour rail relative to road, with high market growth

As with the FMS, scenarios A2, B2, C2 & D2 are NOT capacity constrained. In reality, unless more capacity is secured for rail freight at capacity-constrained locations on the network, it is unlikely that high quality paths along preferred routes will be available, and the unconstrained growth forecast in some scenarios may not be achievable.

Additional forecast scenarios (A3 & B3) have also been run incorporating a simple approach to capacity constraint - whereby required rail freight capacity through 7 known bottlenecks across the network is limited.

The project has involved consultation with stakeholders (the Freight Operating Companies (FOCs) and Network Rail) at each stage. Individual interviews with DB Cargo, Freightliner, GB Railfreight, and Colas were conducted to seek their views on assumptions and market conditions in each sector.

This report is structured as follows:

- Section 2 describes the assumptions for each scenario
- Section 3 describes the methods and models employed
- Section 4 summarises the results without the capacity constraints
- Section 5 comments on the results in section 4
- Section 6 describes and shows the assignment of trains and paths to the rail network
- Section 7 introduces capacity and capacity constraint along with the results
- Section 8 gives the rail market shares in each sector
- Section 9 concludes the report.
- Appendix 1 summarises the sensitivity test results for scenarios A4, B4, C4 & D4
- Appendix 2 compares volumes by commodity / sector for the financial year 2016/17 with what the 2012-based models (used for the FMS) would have predicted given the relevant actual input assumptions for 2016/17.

2. ASSUMPTIONS

For each sector there are four main capacity-unconstrained scenarios – with assumptions that vary by sector. The scenarios do not include a central case forecast (unlike the FMS). These 4 scenarios (A2-D2) for 2023/24 are defined as follows:

Table 7: The exogenous drivers behind the different scenarios for 2023/24

	Low market growth	High market growth
Factors which favour rail relative to road	Scenario A2	Scenario B2
Factors which disfavour rail relative to road	Scenario C2	Scenario D2

We would therefore expect scenario B2 to have the highest rail freight volumes and scenario C2 to have the lowest.

2.1 General assumptions (all commodities)

Note that all % changes are in real terms (i.e. the change in costs, if economy-wide inflation were to be zero) for the seven years from the base year (2016/17) to 2023/24.

Table 8: General assumptions (all commodities)

Assumption for 2023/24 relative to 2016/17	Sc: A2	Sc: B2	Sc: C2	Sc: D2
Labour (drivers' wages for road and rail)	+16% for road +8% for rail		+8%	
Source: Work value-of-time, WebTAG, March 2017 gives +12% as a central forecast.[1]				
HGV fuel costs (including duty)	+22%		+2%	
Source: BEIS, March 2017: Data tables 1-19: supporting the toolkit and the guidance (table 8), low and high				
Fuel duty for road and rail	+5%			
Source: Fuel and Electricity Prices and Components, WebTAG table A.1.3.7, March 2017.				
Derived rail fuel costs (including duty)	+43%		-1%*	
Operational days per week	No change			
Train length (and tonnes of cargo per train)[2]	All commodities +5%		No change	

[1] The hypothetical scenarios (A2 & B2) that favour rail in terms of reducing rail costs vs road include a higher HGV wage increase vs rail wages. Two explanations for such a possible outcome are as follows:

- A possible Brexit impact whereby it is more difficult to take advantage of low Eastern European HGV wages. This will have little impact on train drivers.
- Currently there is a relatively free market for HGV drivers, with reasonably easy access for new drivers. This is less true for train drivers. In a rail-market-favouring scenario, we are assuming that the train driver market becomes more flexible with a lower cost of employing drivers. This may be brought about by the short-term impact of reduced demand in sectors such as coal

[2] We assume that there is no increase in HGV length and weight under any of the scenarios

* Note that because the HGV fuel costs (including duty) only increase by 2% but the duty increases by 5%, this means there is a slight reduction in the resource cost of fuel.

The forecasts do not take into account the impact of planned infrastructure projects such as East-West Rail (EWR), and schemes due to be completed by the start of Control Period 6 (2019) such as longer trains on the Southampton – West Coast Main Line (WCML) route and from the Peak District.

Apart from a possible impact on HGV drivers' wages, the forecasts do not take account of an impact of Brexit because there are many uncertainties at this stage. The impact on the rail freight demand could potentially be positive or negative and impact in many different ways. For example

- Customs checks at ports could disadvantage accompanied HGV traffic which would therefore encourage traffic to switch to Channel Tunnel through-rail, lolo containers and unaccompanied ferry routes, which are typically to rail-connected ports
- If Brexit were to reduce economic growth, this could reduce the overall demand for freight movements.

2.2 Commodity-specific assumptions

Note that all % changes are in real terms (i.e. the change in costs, if economy-wide inflation were to be zero) from the base year (2016/17) to 2023/24.

Table 9: Commodity-specific assumptions

Assumption for 2023/24 relative to 2016/17	Sc: A2	Sc: B2	Sc: C2	Sc: D2
Variable Usage Charges by commodity	Already committed for 2018/19:		Already committed 2018/19 + 25% for all commodities. This may in reality be forms of track charges other than VUC	
Construction	+16%			
Chemicals	-15%			
Domestic Automotive	-11%			
Domestic Intermodal	-5%			
Metals	+7%			
Industrial Minerals	+11%			
Source: "Track Usage Price List", Network Rail for 2018/19 vs 2016/17, combined with a distance-and-tonnage-weighted average for each wagon movement in 2016/17. There is an implicit assumption that the wagon mix will not change.				
Freight Only Line Charges and Freight Specific Charges are due to increase. However these are levied on commodities that are deemed to be largely inelastic to changes in track access charges (ESI coal, Ores and the Nuclear industry)				
Maritime containers deep-sea trade growth	+10%	+25%	+10%	+25%
Source: MDST's World Cargo Database (WCD) for deep sea cargo giving a central forecast of +18%				
Container port growth for deep sea cargo. In line with market demand • Low trade growth: Catered for by London Gateway • High trade growth: Catered for by London Gateway and Liverpool • Freightliner's Tilbury rail traffic removed				
Domestic non-bulk traffic market growth	+4.7%	+14.2%	+4.7%	+14.2%
Source: Population growth (+4.7%. Source: ONS for GB) and GDP growth (+14.2%. Source: OBR)				
Channel Tunnel containers trade growth	+10%	+20%	+10%	+20%
Source: MDST's World Cargo Database (WCD) for European unitised cargo giving a central forecast of +15%				
Channel Tunnel bulks growth	-5%	+5%	-5%	+5%

Table 9 continued: Commodity-specific assumptions

<table>
<tr><th>Rail-served warehousing sites. EXTRA thousand m^2 input into the model</th><th colspan="2">Favour rail
(Sc A2&B2)</th><th colspan="2">Disfavour rail
(Sc C2&D2)</th></tr>
<tr><td>DIRFT</td><td colspan="2">305</td><td colspan="2">150</td></tr>
<tr><td>Kegworth (East Midlands Gateway)</td><td colspan="2">232</td><td colspan="2">150</td></tr>
<tr><td>Four Ashes (West Midlands Interchange)</td><td colspan="2">125</td><td colspan="2">0</td></tr>
<tr><td>South Northampton</td><td colspan="2">125</td><td colspan="2">0</td></tr>
<tr><td>Rossington (iPort)</td><td colspan="2">232</td><td colspan="2">150</td></tr>
<tr><td>Howbury Park (Dartford)</td><td colspan="2">83</td><td colspan="2">0</td></tr>
<tr><td>Total</td><td colspan="2">1,102</td><td colspan="2">450</td></tr>
<tr><td>MSRS grants</td><td colspan="2">Retained</td><td colspan="2">Removed</td></tr>
<tr><td colspan="5">Power station (ESI) coal: No rail traffic.
Source: BEIS 2016 Updated Energy & Emissions Projections Annex J (v1.0 26-Jan-2017) projects that there will be zero electricity generation by coal in 2024[3].</td></tr>
<tr><td>Biomass: % increase for traffic to Drax</td><td>+20%</td><td>+80%</td><td>+20%</td><td>+80%</td></tr>
<tr><td>Lynemouth</td><td>0.7m t</td><td>1.4m t</td><td>0.7m t</td><td>1.4m t</td></tr>
<tr><td colspan="5">Drax is currently the only receiver of biomass traffics by rail. They are due to fully convert their third generating unit to biomass. Two are already fully converted to biomass. More may follow</td></tr>
<tr><td colspan="5">Petroleum, Chemicals, Industrial Minerals, Metals and Automotive
No major changes forecast in the overall markets, but fuel prices and drivers' wages will impact on rail's mode share.
Overall market: Low market growth: -5%. High market growth: +5% + specific automotive flows identified as highly likely to happen by 2023/4 due to new rail connections: finished vehicles from Solihull to Southampton.</td></tr>
</table>

[3] See the end of this section

Table 9 continued: Commodity-specific assumptions

Assumption for 2023/24 relative to 2016/17	Sc: A2	Sc: B2	Sc: C2	Sc: D2
Construction materials market growth	+4.7%	+14.2%	+4.7%	+14.2%

The 4.7% figure is based on population growth (Source: ONS for GB).

The 14.2% figure is based on GDP growth (Source: OBR).

Construction

Construction activity appears to be volatile at present so there is uncertainty about future activity.

Fuel prices and drivers' wages will impact on rail's mode share (i.e. scenarios A2 and B2 relative to scenarios C2 and D2). The trend towards super-quarries served by rail may also increase rail's mode share; however this may be offset (at the GB level) by an increase in locally sourced secondary/ recycled materials, not served by rail. We assume that no change in rail market share results from these factors (i.e. that the super-quarries and recycling factors offset each other).

For the high market growth scenario, traffics for specific major one-off schemes and/or quarries or ports should be included. These major schemes could be very rail oriented because the volumes concerned provide the economies of scale ideal for rail. They would exhaust the capability of small local quarries and in some cases could not be easily moved onto site by road (e.g. to Heathrow runway 3 from the M25). Ideally assumptions would be made on which schemes, sources and volumes to include. E.g. HS2, Heathrow runway 3, Nuclear power stations and Thames super sewer.

However there is uncertainty about which schemes will happen and when, along with where the incoming material will come from and where the outgoing spoil will go to. For 2023/24, these schemes are simply represented as a blanket 20% increase in all construction material movements by rail.[4]

The GB totals under each scenario are derived from the above methodology.

Waste, Ore, Other Coal, Other and Network Rail Engineering

Rail traffics assumed stable into the future

Low market growth: -5%.

High market growth: +5%, plus 2million tonnes of coking coal from Whitehaven

These assumptions were chosen using the available information at the time (June 2017). There may be subsequent changes to some of these exogenous assumptions prior to publication of the final report which have not been taken into account in the modelling and quantified results.

[4] This 20% is not a precisely derived factor. However the approximate derivation to give a sense of scale is as follows:
HS2 state that overall excavated material removal for HS2 phase 1 will be around 10 m tonnes (5m cubic metres) (http://assets.hs2.org.uk/sites/default/files/hb_pdf/F3%20-%20Rail%20Freight%20Operations.pdf). Assume phase 2 would be similar. Assume all the other large extra schemes (including construction materials to HS2 for construction) together equate to HS2 phase 1 & 2 spoil, so the total = 40m tonnes. Assume this is split over 8 years = 5m tonnes per year. This represents approximately 20% of the current 24m tonnes of construction materials

One such change is the assumption on the amount of electricity generation by source. The BEIS projections of January 2017 stated zero electricity generation from coal in 2024, but the November 2017 BEIS projections stated some significant coal-sourced generation remaining - reflecting around 1.6m of ESI coal by rail in 2023/24 (pro rata decrease from 2016 tonnes of ESI coal by rail)[5]. Some power station coal traffic by rail is therefore likely to remain in 2023/24 and beyond because coal-fired power stations can now continue to run unconstrained to the end of September 2025 if they adhere to the Industrial Emissions Directive (IED). Ratcliffe power station plans to do this, although at the time of writing it is not clear whether any other coal power stations will continue operating to 2025. Coal power station operators should not be concerned that the low forecasts in this report will affect their ability to operate: timetabled paths for their trains will continue to be maintained as long as the power station remains operational and the paths are occasionally used.

The forecasts therefore do not reflect changes in other official projections, forecasts and policies since June 2017, such as labour and fuel cost assumptions and the Government announcement on changes to the HGV levy (lower levy for cleaner vehicles).

The forecasts do not reflect changes in rail freight volumes between 2016/17 (the base year for the forecasts) and 2017/18; i.e. the base year has not been updated to 2017/18. The indications are that there has been little change in total volumes in 2017/18 relative to 2016/17.

2.3 Tonnes per train by sector

The forecasts are made on an origin to destination tonnage basis. However it is useful to be able to translate these tonnes into numbers of trains. The tonnes per train depends on a number of factors. High volumes of high density cargos to and from terminals able to handle large trains are likely to result in high tonnes per train. Small volumes mean insufficient traffic will be available to fill a full-length train. Similarly it may not be worth waiting for a full trainload for high value or time-sensitive cargo. If a backload is impractical (typically possible for intermodal containers and swap bodies, but normally not practical for bulk commodities), the returning train will be empty thus halving the average tonnes of cargo per train in that market sector.

The tonnes per train varies within a commodity / sector and by origin and destination. However using the sector average gives a means of translating tonnes into an estimate of the number of trains likely to be required to carry the cargo.

[5] This is derived from the November 2017 BEIS reference case projections of electricity generation by source: Coal generated 29.1 TWh in 2016. The forecast for 2023/24 is 6.63 TWh (0.75 of the 2023 figure + 0.25 of the 2024 figure). This is a 77% decline. If we apply this 77% decline to the 2016 ESI coal by rail tonnage (6.8 million tonnes), this gives a forecast of 1.6m tonnes in 2023/24.

The current average tonnes per train have been calculated for each commodity / sector as described below:

- All wagon movements (from Network Rail's PALADIN) for the full year 2016/17 were grouped into trains.
- Loaded wagons have commodity / sector information attached, but empty wagons do not. For all empty wagons, the wagon movement was associated with the commodity / sector of its previous loaded movement.
- If a simple mean average of these trains was calculated, then short distance trains which impinge little on the network would have the same importance as long distance trains that cover a lot of the network.
- To represent the average use of the network, a distance-weighted mean average tonnage per train was found for each commodity / sector.

The average cargo tonnes per train by commodity / sector is shown below

Table 10: Average cargo tonnes per train by commodity / sector

Commodity / Sector	Average Cargo Tonnes per train
Intermodal	507
ESI Coal	759
Biomass	782
Waste	577
Construction materials (not spoil)	694
Spoil	590
Petroleum	943
Chemicals	478
Industrial Minerals	564
Metals	590
Automotive	91
Ores	602
Coal Other	557
Other	400
Empty returns for containers carrying bulks	161
NR Engineering	404
All commodities	**577**

Notes:

- These average cargo tonnages include the empty return. For example if all Petroleum trains were fully loaded in one direction and empty for the return, that would imply the average cargo tonnage for a ***loaded*** Petroleum train is 943 x 2 = 1,886 tonnes.
- For intermodal (and empty returns for containers carrying bulks) the average cargo tonnes per train include the weight of the container.
- For all commodities the average cargo tonnes per train exclude the weight of the locomotive and wagons

For the results tables for each commodity, the total forecast tonnes are translated into trains using these average figures.

In scenarios A2 & B2, train lengths (and therefore tonnes per train) are assumed to increase by 5% for all commodities. In scenarios C2 & D2, they are assumed to remain constant into the future.

2.4 Path utilisation, days per week and hours per day

HGVs can simply access the road network at any time. However in order for freight trains to operate, they need to have agreed timetabled routes from origin to destination ("paths"). Some rail freight sectors such as intermodal operate scheduled services, so the requirement for paths is relatively predictable, and a path can be allocated for each scheduled service, with a confidence that most services will run; resulting in *high* path utilisation.

However in some sectors such as the construction sector, the demand for the cargo is more variable. In order to accommodate such variable demand, it is necessary to have several available paths – often to several different destinations, even though not all of them will be used; resulting in *low* path utilisation.

In the 2013 Freight Market Study, assumptions were made for each rail freight commodity / sector as to the utilisation of paths (i.e. of the allocated timetabled paths, how many are actually used). We have retained these same utilisation factors to convert the forecast for trains into required paths for the base year and 2023/24.

Table 11: Path utilisation by commodity / sector

Commodity / Sector	Path utilisation
Intermodal	85%
ESI Coal	45%
Biomass	75%
Waste	50%
Construction materials (not spoil)	37%
Spoil	50%
Petroleum	56%
Chemicals	50%
Industrial Minerals	50%
Metals	51%
Automotive	50%
Ores	50%
Coal Other	45%
Other	50%
Empty returns for containers carrying bulks	50%

Note: Network Rail's engineering trains operate differently from rail freight carrying commercial cargo. NR Engineering trains are assumed to directly translate 1:1 into required paths.

Similarly in the 2013 Freight Market Study, assumptions were made to convert annual trains into daily trains, and daily paths into hourly paths:

- 5 operational days per week in the base year: 5 days x 52 weeks = 260 operational days per year
- an average of 18 operational hours per day.

We have retained these conversion factors for the base year and 2023/24.

2.5 Other assumptions

- The quantified model outputs are unconstrained by capacity.

Diesel versus electric traction

No assumptions have been made in terms of a possible switch towards more electric traction, and our cost models are based on the use of diesel locomotives. This can be interpreted as an assumption that electric traction will not offer significantly lower costs when all its limitations are taken into account. The market would appear to bear this out in the short term, given that new diesel locomotives are still being bought by the commercial freight operating companies. However if most routes and terminals used by freight trains are electrified, the price of using electric traction rises at a slower rate than using diesel and/or environmental restrictions are put on the use of diesels, then it may become cost effective for the rail freight industry to move faster towards electric traction.

DRS have recently started operating bimode class 88 locomotives on the network. Bimode locomotives offer a compromise solution for where parts of the journey are not electrified, and diesel can be used for these sections.

However it is unlikely that by 2023/24, bimode or electric-only locomotives will have made significant inroads into the predominantly-diesel locomotive fleet.

3. METHODS AND MODELS EMPLOYED

3.1 Establishing base year traffics

A base year of 2016/17 has been used as the basis of the forecasting. i.e. beginning of April 2016 to the end of March 2017.

Base year traffics have been calculated by processing Network Rail's traffic movement database (PALADIN).

3.2 GB Freight Model (GBFM)

The default approach for modelling any rail freight sector is to use MDS Transmodal's GB Freight Model (GBFM) - a comprehensive freight transport model available for analysing current and forecasting future freight flows to, from and within Great Britain by mode, origin/destination, routing and commodity. The current version of the model (version 5) consists of several modules, including:

- A multi-dimensional base matrix, built up from several sources, which describes the origin, destination and commodity of goods moving within Great Britain and to/from Great Britain. Sources include the DfT's Continuing Survey of Road Goods Transport (CSRGT), Network Rail movement data, Revenue and Customs trade data and Maritime Statistics;
- Modal cost models, validated against industry data, which replicate transport rates in the market and can be adjusted for different factor costs;
- A calibration process that allows current mode shares to be replicated;
- A road network that allows unit loads to be assigned as a function of minimum cost paths; and
- A rail assignment model that is based upon current operating behaviour (route choice, tonnes/trains by commodity).

Once a base year model is established, future scenarios can be described by:

- Applying long-run cargo demand trends, which includes assuming different growth rates for domestic and international freight;
- Adjusting factor costs such as labour and fuel costs; and
- Adjusting land uses to changes in transport costs through increasing or reducing the proportion of trip ends at rail linked sites.

For this work, planned infrastructure upgrades have not been taken into account that could potentially reduce operational costs along certain routes. The forecasts (and routeings) therefore reflect the network of early 2017 and do not reflect any upgrades implemented since then or any planned upgrades.

Changes in road and rail costs due to congestion are not taken into account. Increased road costs due to worsening road congestion could encourage a mode switch from road to rail for some traffic. Similarly rail 'congestion' or capacity constraint could suppress some rail freight demand as discussed in section 7.

There are some important sectors such as intermodal, where components of GBFM need to be adapted, and/or different approaches adopted. Broadly the approach for most sectors is based on GBFM principles:

1. Establish the traffic in the base year
2. Consider changes to the underlying demand for the cargo (often not relating to transport)
3. Consider potential changes to origins and destinations.
4. Model the impact of changing modal economics
5. Assign results to the rail network

3.3 Intermodal

Intermodal container traffics serve a diverse market, typically for non-bulk traffic, with 3 main distinct markets:

- Maritime containers
- Domestic (non-port) intermodal
- Channel Tunnel

3.3.1 Maritime containers

The transporting of maritime containers is an already well-established rail market with containers travelling between ports and inland terminals. This is typically traffic to/from deep sea container ports, although there are also some traffics from short sea container ports which are discussed below.

We assume that deep sea container port growth will keep pace with demand, as existing and planned developments provide ample capacity for our forecast demand in 2023/24.

Deep sea container ports are defined as those ports which have sufficient deep water and infrastructure to handle the largest container ships. The container shipping industry has decided that using these ports is an effective and economic way of unloading containers from these large container ships to serve Britain. Some deep sea ports are also used for short sea traffic too.

Coastal Shipping (shipping between British ports)

There is also some coastal container traffic by sea between British deep sea ports and regional ports (e.g. Felixstowe to Tees and Felixstowe to Grangemouth). However coastal shipping and rail are often generally considered separate markets - with rail offering a regular quick service, and coastal shipping offering an infrequent but cheaper service for transferring deep-sea containers between ports (and see below for feeder option). We do not foresee significant changes in modal shares between rail and coastal shipping and therefore coastal shipping has not been directly included in these calculations or modelling. We do not foresee port capacity constraints as being a limiting factor restricting the growth in coastal or feeder shipping within the time period covered by these forecasts.

Short sea shipping for maritime containers (international traffic)

As well as deep sea container ships calling directly at British deep sea ports, some deep sea containers are transhipped at continental ports (e.g. Rotterdam) onto smaller ships that then take the containers to other British regional (feeder) ports. Container traffic through these feeder ports is assumed to retain the same (relatively small) proportion of the whole container port market as it has now.

Unitised trade between Europe and Britain is currently dominated by HGVs and trailers on roro ferries (e.g. Dover – Calais. Eurotunnel's Folkestone - Calais HGV shuttle is included in this market too). This HGV-on-ferry traffic is normally unsuitable for rail in Britain and is not considered in these forecasts. However some goods between Europe and Britain are carried in intermodal containers – which are included in the modelling as potential Channel Tunnel traffic, and traffic between British ports and inland.

Deep sea ports typically serve the whole of England and Wales and some of the Scottish market. However ports handling feeder traffic and European traffic typically serve a much more regional market. The short distances between port and regional hinterland tend to favour road instead of rail. This is why the focus for rail is on containers to/from deep sea ports. However, the regional ports handling feeder traffic and European traffic still enjoy some modal shift to rail with the assumed favourable changes in modal economics in the future in scenarios A2 & B2.

It is assumed that short sea container port capacity keeps pace with demand.

Developments inland

The development of inland rail-served warehousing sites (see section 3.3.2) encourages mode switch from road to rail for maritime containers because there is no need for a local road haul between inland terminal and warehouse.

3.3.2 Assumptions for Domestic (non-port) intermodal

Domestic (non-port) intermodal trains are typically carrying fast-moving consumer goods (FMCGs) to, from and between National Distribution Centres (NDSs) and Regional Distribution Centres (RDCs) (warehouses). It is a very large transport market of nearly 1 billion tonnes per year currently dominated by road. For rail it is a relatively small but growing market. As land use planning policy encourages more new-build, large warehousing sites to be rail-served, for any rail journey to/from such a warehouse, a local road haul is not required. This cost saving makes rail an increasingly viable option.

There are approximately 1 million square metres of new large warehousing (warehouses of >9,000 square metres) built each year in Britain. In scenarios A2 & B2, we assume that in the 7 years to 2023/24, 1.1 million square metres will be rail-served[6] – i.e. approximately 16% of the national total. In scenarios C2 & D2, we assume 0.5 million square metres will be rail-served – i.e. approximately 6% of the national total.

This range is broadly in line with recent planning consents and approximately matches the observed aspirations and recent progress of developers.

It is difficult to accurately predict which rail-served warehousing sites will be developed and come on-stream by particular years. The sites listed in section 2.2 (DIRFT, Kegworth (East Midlands Gateway), Four Ashes (West Midlands Interchange), South Northampton, Rossington (iPort) and Howbury Park (Dartford)) may not be the exact locations where development will happen but they are intended to at least be roughly representative of the likely extent of development.

3.3.3 Channel Tunnel through-rail intermodal containers

The Channel Tunnel is in competition with ferry and lolo services to/from the continent. Hence the market is very elastic – highly sensitive to costs and service quality.

The cost change assumptions for road versus rail for each scenario impact on Channel Tunnel traffics as well as the assumptions on market growth.

3.3.4 Methodology for intermodal containers and swap bodies

MDS Transmodal's Multimodal Distribution Park Demand Model (MDPDM) is a model of all non-bulk cargo in Britain. It is based on GBFM cost model and mode share principles. For the forecast year, imports, exports and domestic movements are forecast by origin and destination, for road and rail in

[6] The 1.1 million square metres of new rail-served warehousing is the figure input into the model. This could represent a real-world situation with a greater quantity of new-build rail-served warehousing, but with the freight and logistics industry not yet having fully adjusted to the opportunity.

total. These incorporate the assumptions on deep sea port container growth and capacity, and the growth in short sea and coastal shipping port capacity - to keep pace with demand.

The future rail-served warehousing sites are input into the model. These attract warehouse traffic from their local area - i.e. they substitute for equivalent, road-only warehousing sites. Their stock turnover is based on land area and type of warehouse (with RDCs having double the stock turnover per square metre of NDCs).

For NDCs, incoming cargoes are assumed to come from around the country and as imports. Their outgoing cargoes are to RDCs across the country.

For RDCs, incoming cargoes are from NDCs and imports. Outgoing cargoes are to the local area – all by road.

3.3.5 Cost models and mode share

For all movements (between ports, rail-served warehouses and non-rail-served sites), road and rail cost models are applied along with a mode choice algorithm, which take into account

- the distance
- the volumes involved (more tonnage = more frequent services = more attractive for rail)
- whether the cargo is likely to be time-sensitive (deep sea cargoes are assumed to be less time-sensitive than domestic FMCGs)
- whether the origin and destination are rail-served (no need for a road haul to/from a local rail terminal)

The road & rail cost models are built up from the individual cost components that a road or rail haulier experiences and include

- Capital cost of vehicles & interest rates
- Depreciation
- Fuel cost with associated consumption rate
- Taxes and duty
- Maintenance & insurance
- Labour costs – e.g. drivers' wages
- Overheads and office costs
- Track access charges (rail)

Assumptions include

- Mean speed
- Annual distance travelled per vehicle and hours operational
- Hours worked per employee

- Tonnes of cargo carried per vehicle
- Asset utilisation

Also included for rail journeys are the terminal charges at both ends, along with an internal site shunt where the origin or destination is on-site, and a local road haul where the origin or destination is off-site. If the journey is rail-served at both ends, the overall cost is therefore *lower*. If the rail journey is *not* rail-served at either end, the cost is *higher*.

As described in the earlier assumptions section, several components of the cost model are forecast to change from the base year.

The model outputs the tonnes of non-bulk cargo by road and rail between each port, each rail-served warehouse and non-rail-served sites for the forecast year.

Rail traffic to/from non-rail-served sites will have to use a local intermodal terminal. This may be an existing terminal or a terminal associated with one of the new rail-served warehousing sites. Each inland county's non-rail-served traffic is allocated to a specific intermodal terminal. Where one of the rail-served warehousing sites or a container port is nearby, the county's intermodal traffic is allocated there. Otherwise it is allocated to an existing inland intermodal terminal without on-site warehousing.

3.3.6 Integrating the model's results with present day traffics

As new rail-served warehousing sites with intermodal terminals are built, they will effectively be in competition with existing nearby intermodal terminals. In the very long term, in general, the transport cost savings associated with having on-site warehousing are likely to favour the terminals with on-site warehousing. However at least in the medium term, most existing terminals without on-site warehousing are likely to continue to operate.

To represent this inertia, we make the simple assumption (where there is forecast intermodal rail growth), that all existing terminal to terminal intermodal tonnages continue at their base year level. The model's forecast tonnages are then scaled down and added to the existing traffics such that the *total* forecast intermodal tonnage for ports and domestic is in line with the model's original total forecast tonnage.

For scenarios where intermodal traffic declines, existing traffics are scaled down in order to arrive at the overall modelled total forecast intermodal tonnage for ports and domestic.

This is not a perfect solution as there may be scope for growth at some existing terminals that are near to rail-served sites, and the modelled changes in port choice are not fully represented in the final outputs. However this simple approach avoids the need for a site-by-site analysis of how full sites are, and whether competition from new rail-served warehousing sites could potentially lead to traffic reductions at some existing terminals - e.g. Doncaster versus Rossington.

4. SUMMARY RESULTS

4.1 Historical context

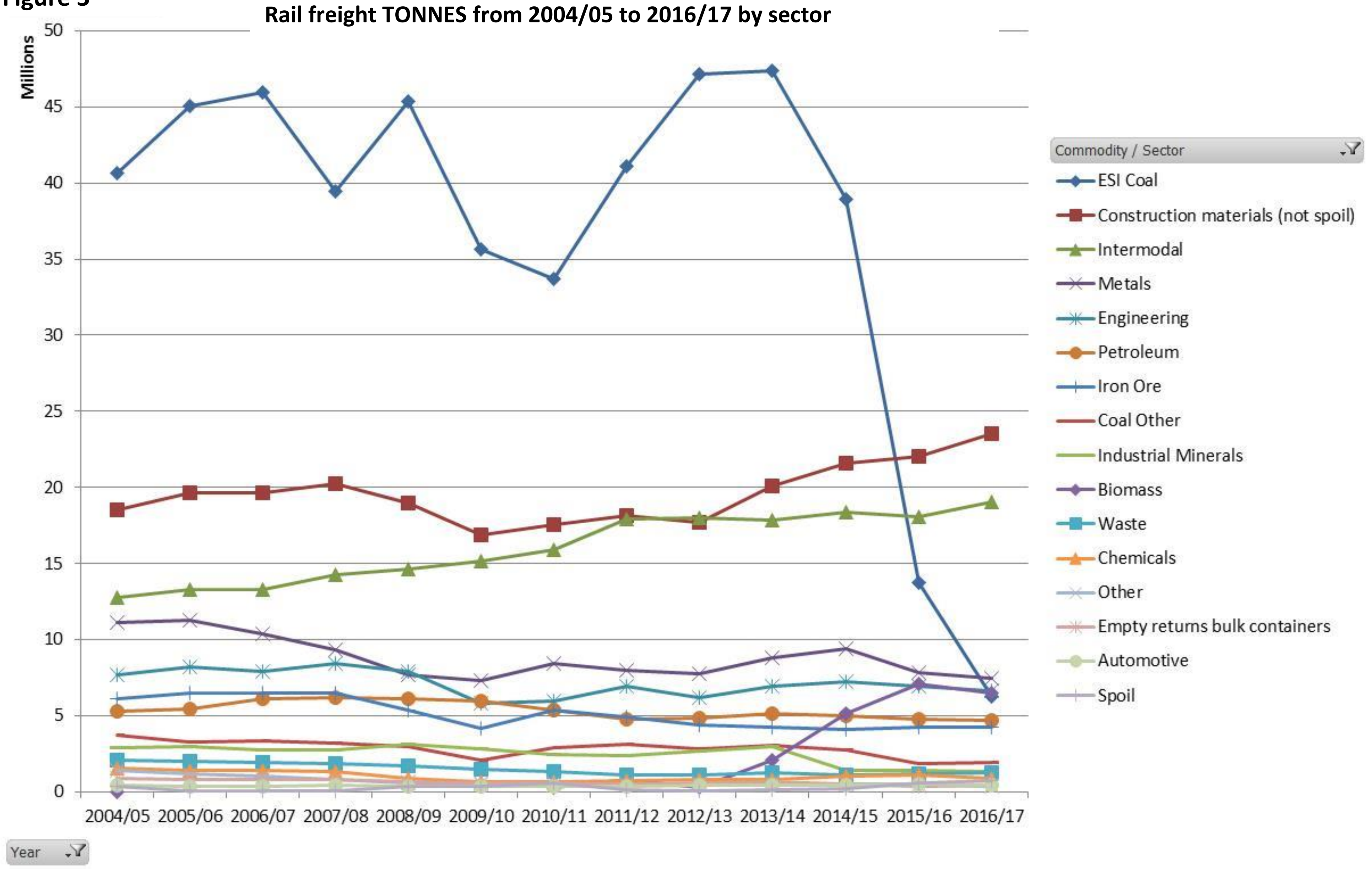
To put the forecasts into context, the rail freight tonnes by sector from 2004/05 to 2016/17 is shown in the table and graph below.

The main change is that ESI (power station) coal used to dominate rail freight, but is now a relatively minor part of the overall picture. Construction dipped in the recession but then recovered strongly. Intermodal rail grew up to the recession and then performed well through the recession, but has since been reasonably stable overall. The lack of growth is partly due to capacity constraint and disruptive changes in port choices by the deep sea shipping lines.

Table 12: Rail freight TONNES by sector from 2004/05 to 2016/17 Million tonnes per year

Sector	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Intermodal	12.7	13.3	13.3	14.2	14.6	15.2	15.9	17.9	18.0	17.8	18.4	18.1	19.1
ESI Coal	40.7	45.1	45.9	39.5	45.4	35.7	33.7	41.1	47.1	47.4	38.9	13.7	6.3
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.3	2.1	5.1	7.1	6.5
Waste	2.1	2.0	1.9	1.8	1.7	1.5	1.3	1.1	1.1	1.3	1.1	1.2	1.2
Construction	18.9	19.6	19.6	20.3	19.4	17.2	18.1	18.3	17.8	20.2	21.8	22.6	24.3
of which spoil	0.4	0.0	0.0	0.1	0.4	0.3	0.6	0.1	0.0	0.1	0.2	0.5	0.7
Petroleum	5.3	5.4	6.1	6.2	6.1	5.9	5.3	4.8	4.8	5.1	5.0	4.8	4.7
Chemicals	1.6	1.4	1.4	1.3	0.9	0.7	0.7	0.7	0.8	0.8	1.0	1.1	0.9
Industrial Minerals	2.9	3.0	2.8	2.8	3.1	2.8	2.4	2.4	2.6	3.0	1.4	1.4	1.3
Metals	11.1	11.3	10.4	9.3	7.6	7.3	8.4	8.0	7.7	8.8	9.4	7.8	7.4
Automotive	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.4
Ores	6.1	6.5	6.5	6.5	5.4	4.2	5.4	4.9	4.4	4.2	4.1	4.3	4.3
Coal Other	3.7	3.3	3.3	3.2	3.0	2.1	2.9	3.1	2.8	3.0	2.8	1.9	2.0
Other	1.4	1.2	1.1	0.8	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.3
Empty ret blk cont	0.9	0.8	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.3	0.4
NR Engineering	7.7	8.2	7.9	8.4	7.9	5.8	6.0	6.9	6.2	7.0	7.2	6.9	6.7
Total	**115.4**	**121.3**	**121.3**	**115.5**	**116.6**	**99.7**	**101.7**	**111.3**	**115.1**	**122.1**	**117.7**	**92.2**	**85.8**
Total not including ESI coal	*74.7*	*76.3*	*75.4*	*76.0*	*71.2*	*64.0*	*68.1*	*70.2*	*68.0*	*74.8*	*78.7*	*78.4*	*79.5*

Figure 3


Rail freight TONNES from 2004/05 to 2016/17 by sector
Millions
50
45
40
35
30
25
20
15
10
5
0
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
Year
Commodity / Sector
ESI Coal
Construction materials (not spoil)
Intermodal
Metals
Engineering
Petroleum
Iron Ore
Coal Other
Industrial Minerals
Biomass
Waste
Chemicals
Other
Empty returns bulk containers
Automotive
Spoil

4.2 Forecasts

This section presents the forecast results without the capacity constraints (note: the constrained results are shown in Chapter 7). The tables and charts below cover the unconstrained forecast annual rail freight tonnes, annual tonne kms, daily trains and hourly paths required by sector for:

- Actual traffic in 2016/17 base year[7]
- 2023/24 scenario A2: Factors which favour rail relative to road, with low market growth
- 2023/24 scenario B2: Factors which favour rail relative to road, with high market growth
- 2023/24 scenario C2: Factors which disfavour rail relative to road, with low market growth
- 2023/24 scenario D2: Factors which disfavour rail relative to road, with high market growth

Table 13: Rail freight TONNES forecast for 2023/24 scenarios by sector. Thousand tonnes per year

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	16,213	24,252	27,133	15,320	17,077
Domestic Intermodal	2,481	8,009	8,606	3,281	3,493
Channel Tunnel Intermodal	374	529	578	420	458
ESI Coal	6,284	-	-	-	-
Biomass	6,470	8,464	13,045	8,464	13,045
Waste	1,226	1,165	1,287	1,165	1,287
Construction materials	24,286	33,133	43,383	22,887	29,967
of which spoil	735	997	1,306	733	960
Petroleum	4,710	4,822	5,330	4,470	4,940
Chemicals	899	934	1,032	863	954
Industrial Minerals	1,335	1,580	1,747	1,162	1,284
Metals	7,441	8,226	9,092	6,965	7,698
Automotive	450	468	583	437	548
Ores	4,259	4,046	4,472	4,046	4,472
Coal Other	1,955	1,857	4,052	1,857	4,052
Other	334	368	407	319	353
Empty returns for containers carrying bulks	413	397	439	393	434
NR Engineering	6,657	6,324	6,990	6,324	6,990
Total	**85,786**	**104,574**	**128,175**	**78,371**	**97,052**

[7] Source: PALADIN billing data provided to us by Network Rail. We process this data to generate an origin-destination database. This total (85.8 mt) is higher than the ORR figure of 79.4mt. See appendix 2 (Section 11.3).

Table 14: Rail freight TONNES by sector. Growth from 2016/17 to 2023/24 (average of the 4 scenarios) Thousand tonnes per year

Sector	2016/17	Average of the 4 2023/24 scenarios	CAGR from 2016/17 to 2023/24 average
Ports Intermodal	16,213	20,945	3.7%
Domestic Intermodal	2,481	5,847	13.0%
Channel Tunnel Intermodal	374	496	4.1%
ESI Coal	6,284	-	
Biomass	6,470	10,755	7.5%
Waste	1,226	1,226	0.0%
Construction materials	24,286	32,343	4.2%
of which spoil	735	999	4.5%
Petroleum	4,710	4,890	0.5%
Chemicals	899	946	0.7%
Industrial Minerals	1,335	1,443	1.1%
Metals	7,441	7,995	1.0%
Automotive	450	509	1.8%
Ores	4,259	4,259	0.0%
Coal Other	1,955	2,955	6.1%
Other	334	362	1.2%
Empty returns for containers carrying bulks	413	416	0.1%
NR Engineering	6,657	6,657	0.0%
Total	85,786	102,043	2.5%
Total excluding ESI coal	79,502	102,043	3.6%

Figure 4: Rail freight TONNES forecast for 2023/24 scenarios by sector

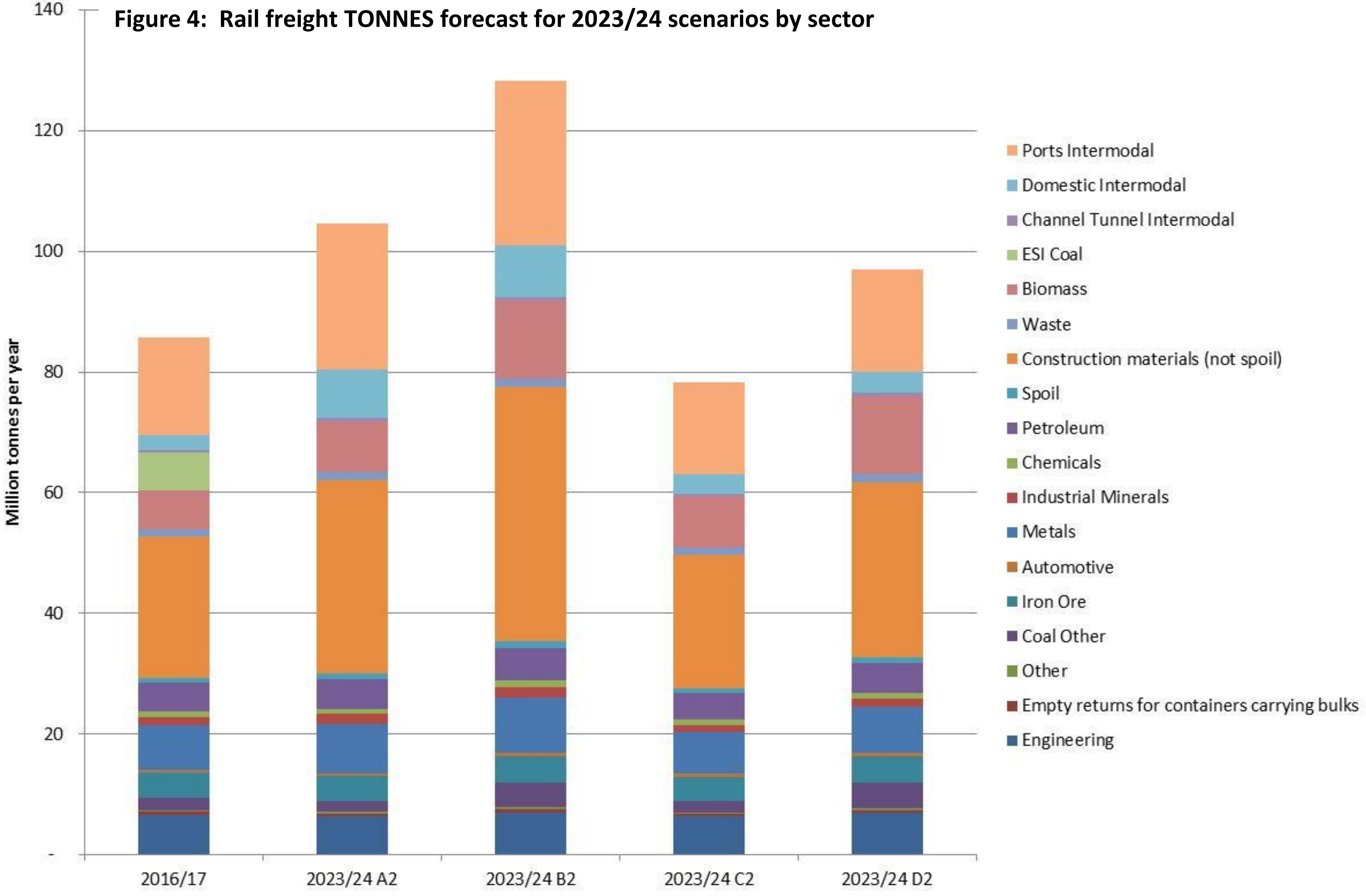


Table 15: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector. Million tonne kms per year

Sector	2016/17[8]	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	5,612	8,165	9,108	5,279	5,885
Domestic Intermodal	1,136	3,466	3,726	1,526	1,631
Channel Tunnel Intermodal	94	133	145	106	115
ESI Coal	1,158	-	-	-	-
Biomass	853	1,093	1,673	1,093	1,673
Waste	215	204	225	204	225
Construction materials	4,342	5,242	6,863	4,070	5,330
of which spoil	94	127	166	94	123
Petroleum	1,134	1,141	1,261	1,075	1,188
Chemicals	142	152	168	137	152
Industrial Minerals	234	262	289	213	236
Metals	1,587	1,706	1,886	1,465	1,620
Automotive	146	149	180	141	171
Ores	156	148	164	148	164
Coal Other	267	254	783	254	783
Other	101	112	124	97	107
Empty returns for containers carrying bulks	69	68	75	66	73
NR Engineering	1,714	1,628	1,800	1,628	1,800
Total	**18,962**	**23,923**	**28,472**	**17,502**	**21,152**

[8] The 18.96 billion tonne kms figure agrees with the ORR data. See the ORR's published table "Freight moved - Table 13.7" (https://dataportal.orr.gov.uk/browsereports) and add the total (excluding infrastructure) (17.25) and the infrastructure (1.71) figures

Figure 5: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector

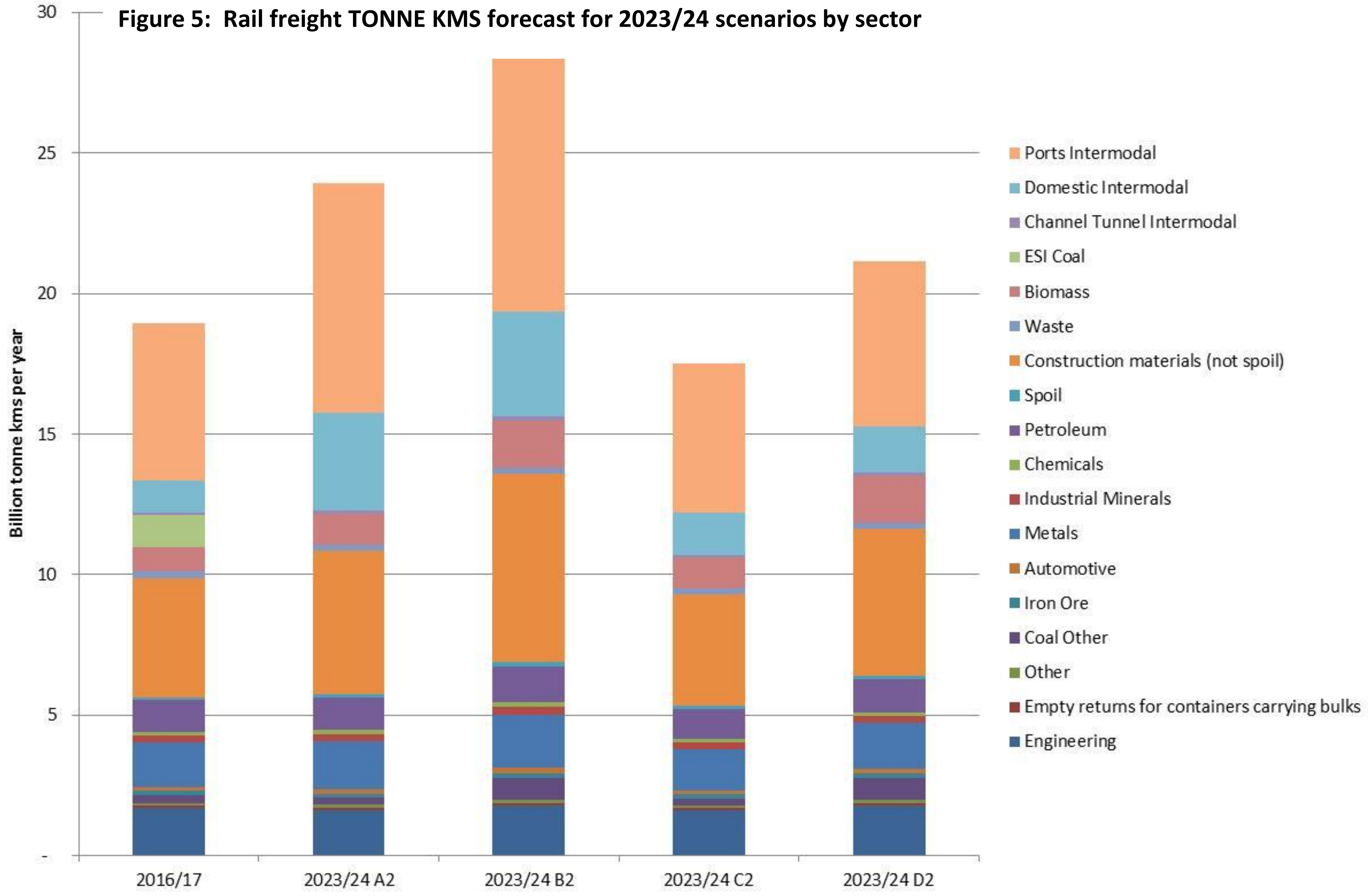


Table 16: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	123	175	196	116	129
Domestic Intermodal	19	58	62	25	26
Channel Tunnel Intermodal	3	4	4	3	3
ESI Coal	32	-	-	-	-
Biomass	32	40	61	42	64
Waste	8	7	8	8	9
Construction materials	135	176	230	128	167
of which spoil	5	6	8	5	6
Petroleum	19	19	21	18	20
Chemicals	7	7	8	7	8
Industrial Minerals	9	10	11	8	9
Metals	49	51	56	45	50
Automotive	19	19	23	18	23
Ores	27	25	27	26	29
Coal Other	13	12	27	13	28
Other	3	3	4	3	3
Empty returns for containers carrying bulks	10	9	10	9	10
NR Engineering	63	57	63	60	67
Total	**572**	**672**	**813**	**530**	**646**

Note:

- These daily trains figures include empty return trains for bulk commodities.
- They are derived from the tonnes data, using the "Average cargo tonnes per train by commodity / sector" table and operational days per year figures in sections 2.3 and 2.4.

Figure 6: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector

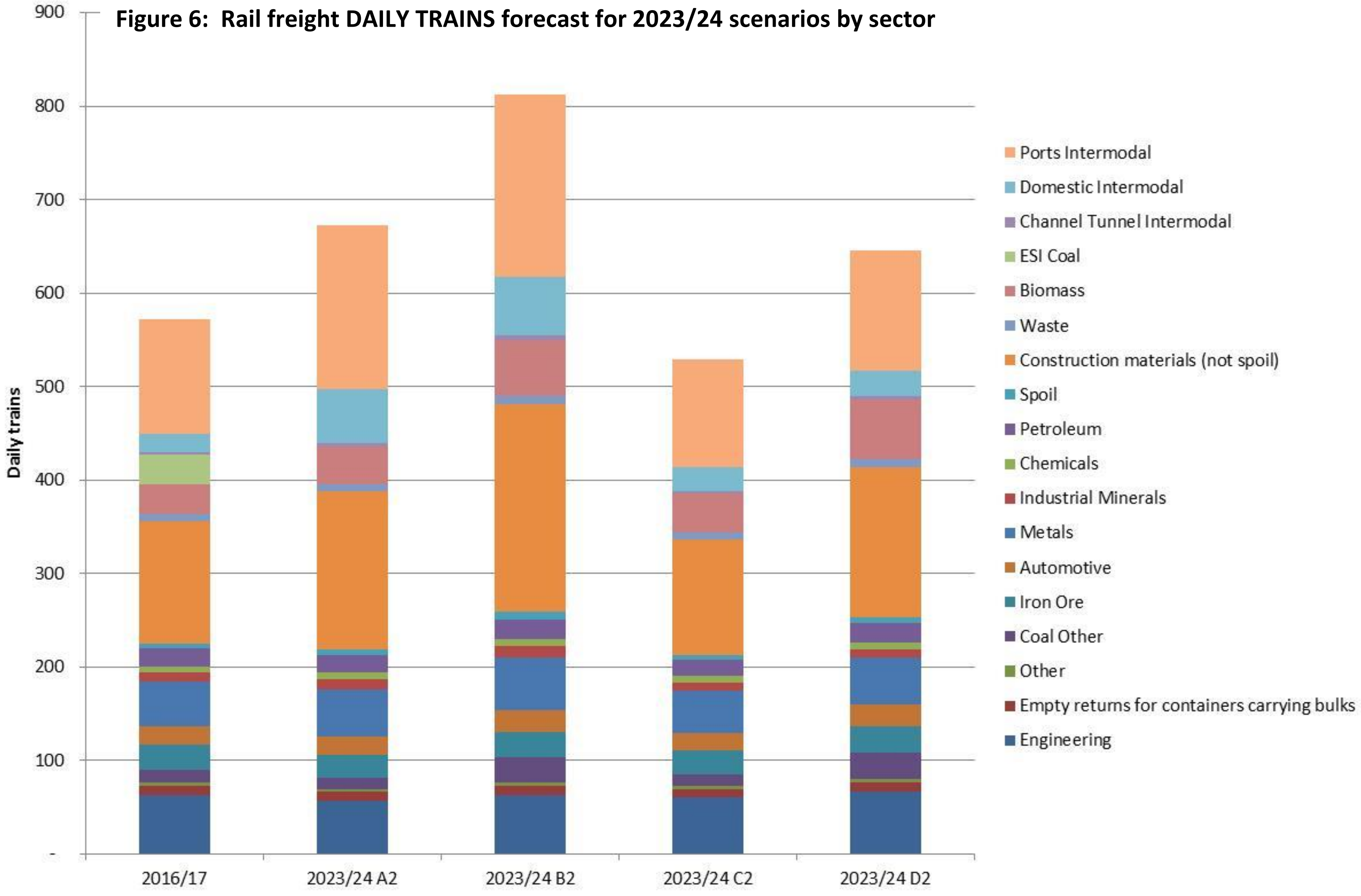


Table 17: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	8.0	11.4	12.8	7.6	8.5
Domestic Intermodal	1.2	3.8	4.1	1.6	1.7
Channel Tunnel Intermodal	0.2	0.2	0.3	0.2	0.2
ESI Coal	3.9	-	-	-	-
Biomass	2.4	2.9	4.5	3.1	4.8
Waste	0.9	0.8	0.9	0.9	1.0
Construction materials	20.1	26.2	34.3	19.0	24.9
of which spoil	0.5	0.7	0.9	0.5	0.7
Petroleum	1.9	1.9	2.1	1.8	2.0
Chemicals	0.8	0.8	0.9	0.8	0.9
Industrial Minerals	1.0	1.1	1.3	0.9	1.0
Metals	5.3	5.6	6.1	4.9	5.5
Automotive	2.1	2.1	2.6	2.0	2.6
Ores	3.0	2.7	3.0	2.9	3.2
Coal Other	1.7	1.5	3.3	1.6	3.5
Other	0.4	0.4	0.4	0.3	0.4
Empty returns for containers carrying bulks	1.1	1.0	1.1	1.0	1.2
NR Engineering	3.5	3.2	3.5	3.3	3.7
Total	57.6	65.7	81.1	52.0	64.7

Note:

- These hourly path figures are derived from the daily trains data, using the "Path utilisation by commodity / sector" table and the 18 hours per day figure in section 2.4.

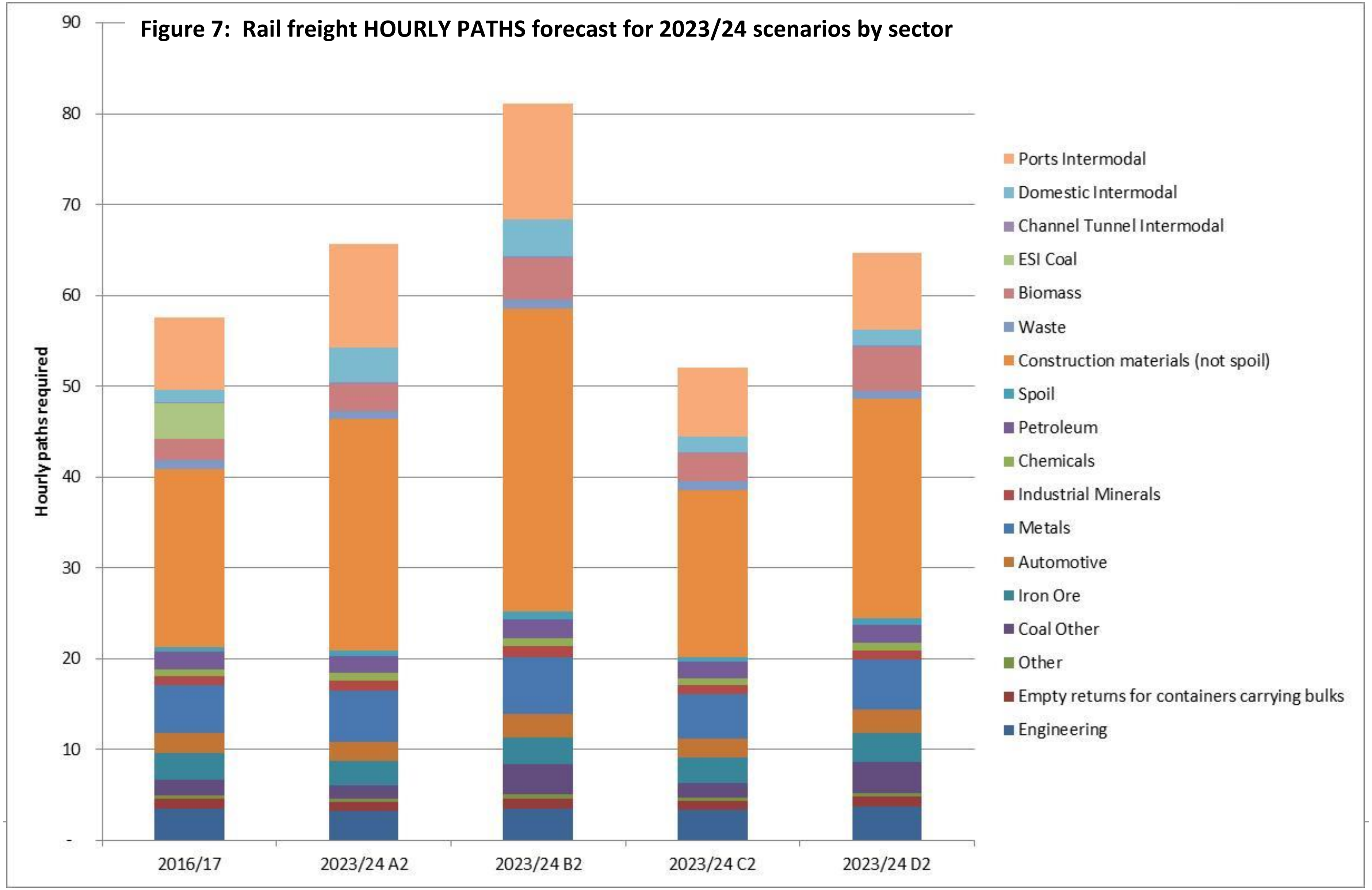
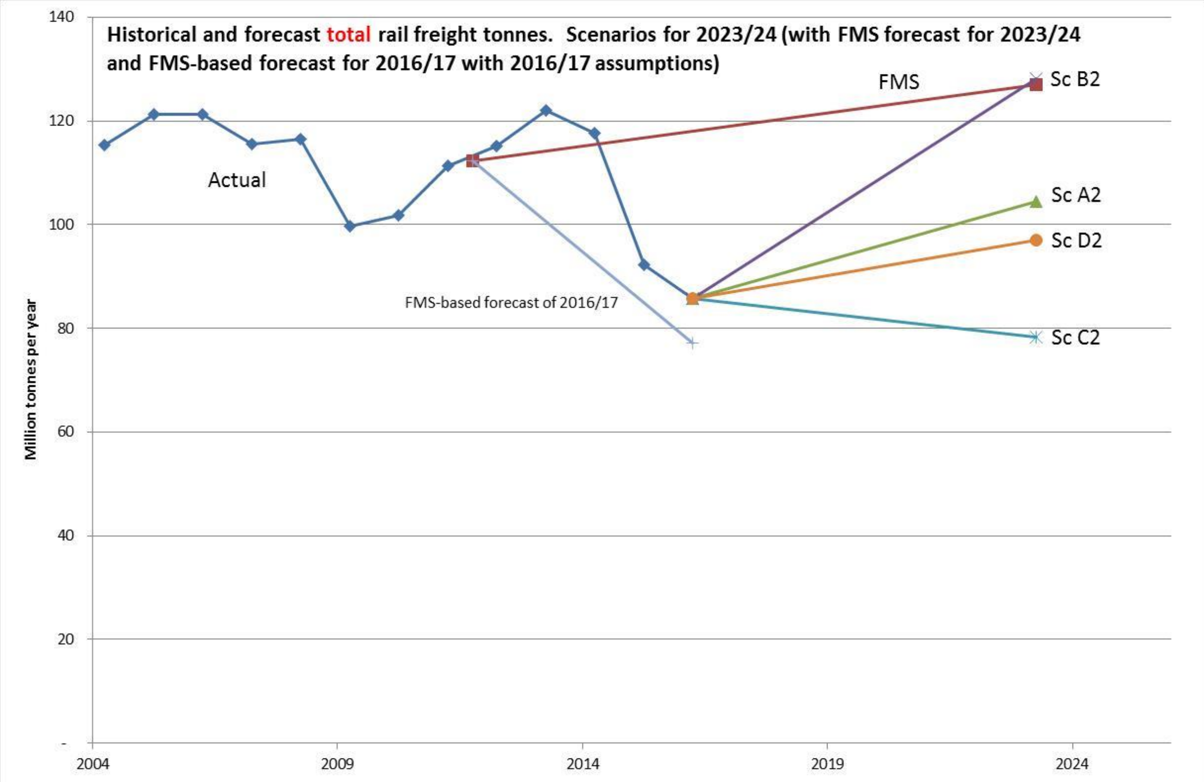


Figure 7: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector
Hourly paths required
90
80
70
60
50
40
30
20
10
-
2016/17
2023/24 A2
2023/24 B2
2023/24 C2
2023/24 D2
Ports Intermodal
Domestic Intermodal
Channel Tunnel Intermodal
ESI Coal
Biomass
Waste
Construction materials (not spoil)
Spoil
Petroleum
Chemicals
Industrial Minerals
Metals
Automotive
Iron Ore
Coal Other
Other
Empty returns for containers carrying bulks
Engineering

The graph below shows how the new scenarios compare with the 2023/24 FMS forecasts, along with the historical traffics from 2004/05. It also shows what the FMS forecasts would have been for 2016/17 if out-turn assumptions for 2016/17 had been input into the FMS models (see below).

Figure 8



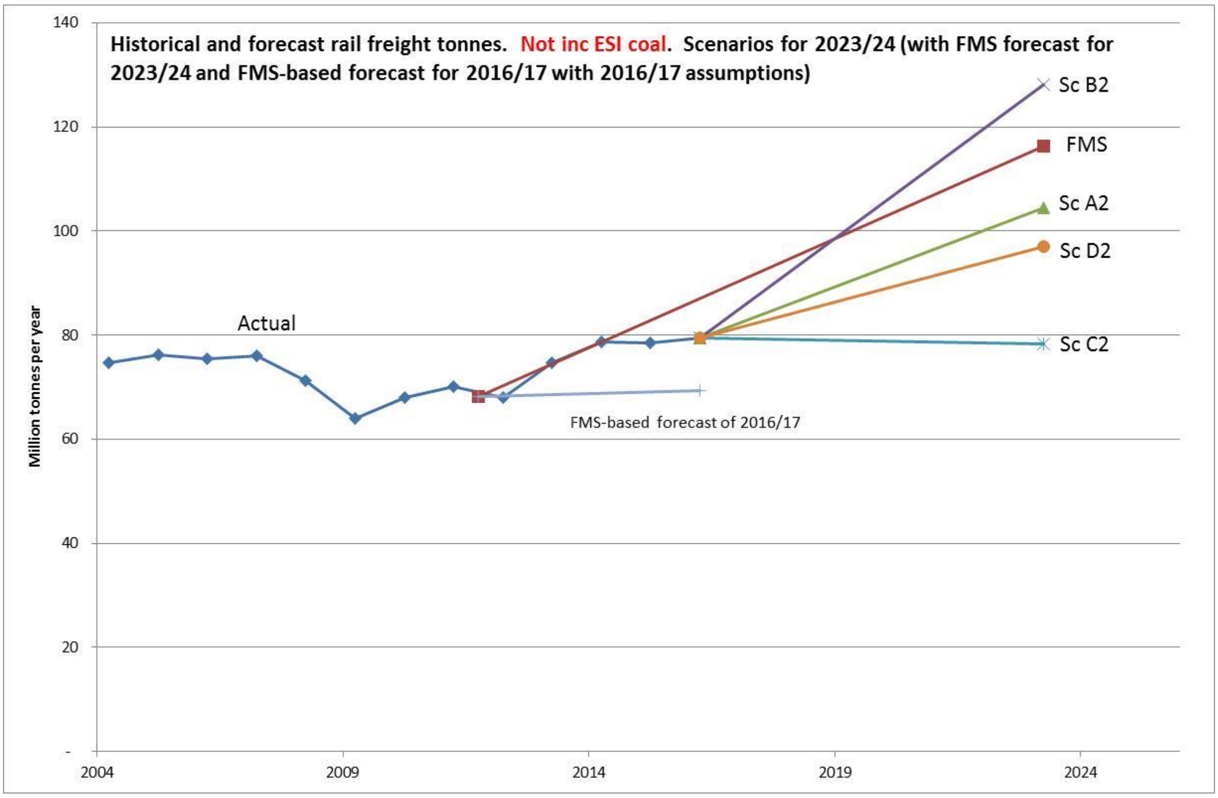
Note the "FMS-based forecast of 2016/17" line shows what a forecast of 2016/17 would have been (77 m tonnes) using

- the FMS base year (12 months to the end of September 2012)
- input assumptions that reflect the true outcome in 2016/17 (such as lower fuel prices)
- the forecasting methods used in the FMS

See appendix 2 for further details

ESI (power station) coal has historically been a volatile commodity – and is no longer forecast to be carried by rail in 2023/24. The graph below shows an equivalent graph but with ESI coal excluded (where FMS = 116 m tonnes). Note that the graph does include biomass, which reflects conversion of power stations from coal to biomass.

Figure 9



MDS Transmodal

5. COMMENTARY

The results from the modelling of the 4 2023/24 capacity-unconstrained scenarios demonstrate that differences in exogenous circumstances have a large effect on the rail freight industry. If the factors that *favour* rail come to pass (scenarios A2 & B2), there will be overall growth, but if the factors that *disfavour* rail come to pass (scenarios C2 & D2), there will be an overall decline in rail freight tonnage in scenario C2, with a small increase in scenario D2. Unsurprisingly the result for the high market growth scenarios (scenarios B2 & D2) show larger traffic volumes than their respective low market growth scenarios (scenarios A2 & C2).

5.1 Coal & Biomass

ESI coal is eliminated as per the defined assumptions. Some of the large increases in coal other and biomass in scenarios B2 & D2 are due to commodity-specific defined assumptions.

5.2 Construction materials

Construction materials also had a defined assumption about growth in the high-market-growth scenarios. However around half of the construction materials growth in scenario B2 is due to the rail mode share increases resulting from the rail-favouring assumptions (increased fuel and wage costs and slightly longer trains).

In scenario C2, the model results suggest that rail would lose some of its construction materials traffic due to the increase in track access charges. When producing results, the model implicitly assumes that a market equilibrium has been reached. However the present-day reality is that the industry is buying wagons and investing in infrastructure on the expectation of growth, and that track charges will not significantly increase. This gives some inertia to the market. Another factor not included in the modelling is that several super-quarries have planning restrictions on their road freight volumes, thus limiting the scope to which they could easily switch mode to road. Both of these factors suggest that if the assumptions in scenario C2 were to come to pass, the slight decline that the model suggests may not materialise in the real world.

5.3 Intermodal

Ports intermodal shows large growth for scenarios A2 & B2 due to the inland rail-served warehousing, trade growth, increased fuel and wage costs, slightly longer trains and retention of MSRS grants. However scenario C2 shows a slight decline – due to the increase in track access charges and removal of MSRS grants.

Domestic intermodal follows a similar pattern to ports intermodal but is particularly boosted by the building of rail-served warehousing. The market can easily switch between road and rail and is highly price sensitive. The huge potential market for domestic non-bulk traffic is currently largely untapped by rail.

As with the construction sector, there may be some inertia in the intermodal market, with the industry taking some time to adjust, such that growth may take a few years to catch up with the potential traffic that the modelling suggests for scenarios A2 & B2.

There are several factors encouraging the high port and domestic intermodal growth in scenario B2. The table below shows the modelling results if the scenario components are gradually built up.

Table 18: Building up port & domestic intermodal scenario B2, with several scenarios adding the assumptions one by one (Intermodal rail tonnes (thousand) per year)

Scenario components	Port	Domestic	Port + Dom
Actual Base year (2016/17)	16,213	2,481	18,693
Modelled Base year (2016/17)[9]	14,752	2,684	17,437
2023/24 modelled			
Domestic & Trade Growth & container ports	17,031	2,980	20,012
..and Track charges -5% & Train length +5%	17,528	3,123	20,651
..and Drivers' wages (+16% road, +8% rail)	22,055	4,512	26,567
..and Fuel +22% HGV at-pump price	26,270	6,706	32,976
..and the warehousing (i.e. scenario B2)	27,133	8,606	35,738

This gives some indication as to the impact and relative importance of each factor affecting port and domestic intermodal traffic by rail.

This shows that in scenario B2, drivers' wages and fuel are the two factors that have the most impact on ports intermodal traffics – with traffic switching from road to rail. Wages and fuel also have a large impact on domestic intermodal, but the introduction of the rail-served warehousing has the largest impact.

[9] See appendix 2

6. ASSIGNMENTS TO THE RAIL NETWORK

It can be easier to visualise the impact of these forecasts by assigning the base year and forecast traffic to the rail network. It is often more meaningful to describe the number of freight trains on each route, rather than the tonnage. In terms of capacity and timetabling, the number of hourly paths required on each route is often the most useful means of quantifying rail freight demand.

All freight trains using the network are assigned to the network for each of the 365 days separately in the base year 2016/17. For each individual train, the traffic is scaled up in line with the origin to destination by commodity tonnage forecasts. This ensures that for each train, the routing and the tonnes per train are maintained in the forecasts (i.e. base year routings are assumed to continue). In scenarios A2 & B2, all base year traffics are subject to the 5% increased tonnage per train, so the number of trains required to carry the same cargo is scaled by 1.0/1.05.

The maps show the routes that the trains actually take in the base year; primary routes as well as timetabled secondary and diversionary routes. For example for trains from Southampton to the West Midlands and beyond, the main route is via Winchester with many trains, and the main diversionary route is via Laverstock junctions with just a handful of trains. For all commodities (excluding additional intermodal), because the base year assignments include the diversionary routes, these same diversionary routes are included in the forecasts.

The exception to this is for forecast ***additional*** intermodal traffic, because this is often to/from new sites for which there are no base year trains to scale up. For intermodal trains, the current average cargo tonnage per train is 507 tonnes.

By default routes for ***additional*** intermodal traffic are assumed to be along the shortest path between sites, along a route with a loading gauge of at least W8 – for example Felixstowe to the West Midlands and North West is via Peterborough and Nuneaton, not London. Diversionary routes are not considered. However for various terminal to terminal flows, we have stipulated specific en-route ‘via-points’, to ensure that those routes are more realistic – with a preference for W10 routes.

No infrastructure upgrades, or active re-routings have been considered. For example trains on the East Coast Main Line (ECML) have NOT been diverted to the GN/GE route via Lincoln and existing trains using cross-London routes have NOT been diverted to the cross-country Felixstowe to Nuneaton route. We have not taken account of planned schemes such as East West Rail.

As the assignments shown in this chapter are unconstrained forecasts of demand, the routings for all trains do not take into account any future timetabling / capacity issues etc. There is therefore the potential to re-route some of these forecast freight trains onto less congested routes where appropriate.

Once a freight train assignment has been made for each day in each base and forecast year, they can be averaged to give a daily average for each year. There are fewer freight trains on Saturdays, Sundays and on bank holidays, so to give a more representative picture of the typical weekday traffic volumes, all Saturdays, Sundays and bank holidays are discarded when calculating the daily average.

In the raw train movement data, each train route travelled is recorded as a series of en-route 'via-points' including the origin and destination. The network does not include every origin and destination location (Stanox) code in the network. Therefore some trains do not appear to start at the correct location on their branch line, and only appear at the first recognised junction. For example trains from Peak Forest Cemex in Derbyshire appear to start at Chinley East junction. The assignment maps are therefore best suited to quantifying traffic on main lines rather than branch lines.

The following 5 maps show the forecast number of freight trains per weekday along each route – sum of both directions:

- Base year: 2016/17
- 2023/4 scenario A2
- 2023/4 scenario B2
- 2023/4 scenario C2
- 2023/4 scenario D2

These same 5 assignment maps are then shown zoomed in to the Birmingham & West Midlands area – with labels on routes indicating the number of freight trains per weekday.

The equivalent maps are then displayed showing *hourly paths* (sum of both directions).

Pdf maps are also provided in association with this report with labels attached to each link, so the number of base year and forecast trains and paths can be seen on each link across the whole network.

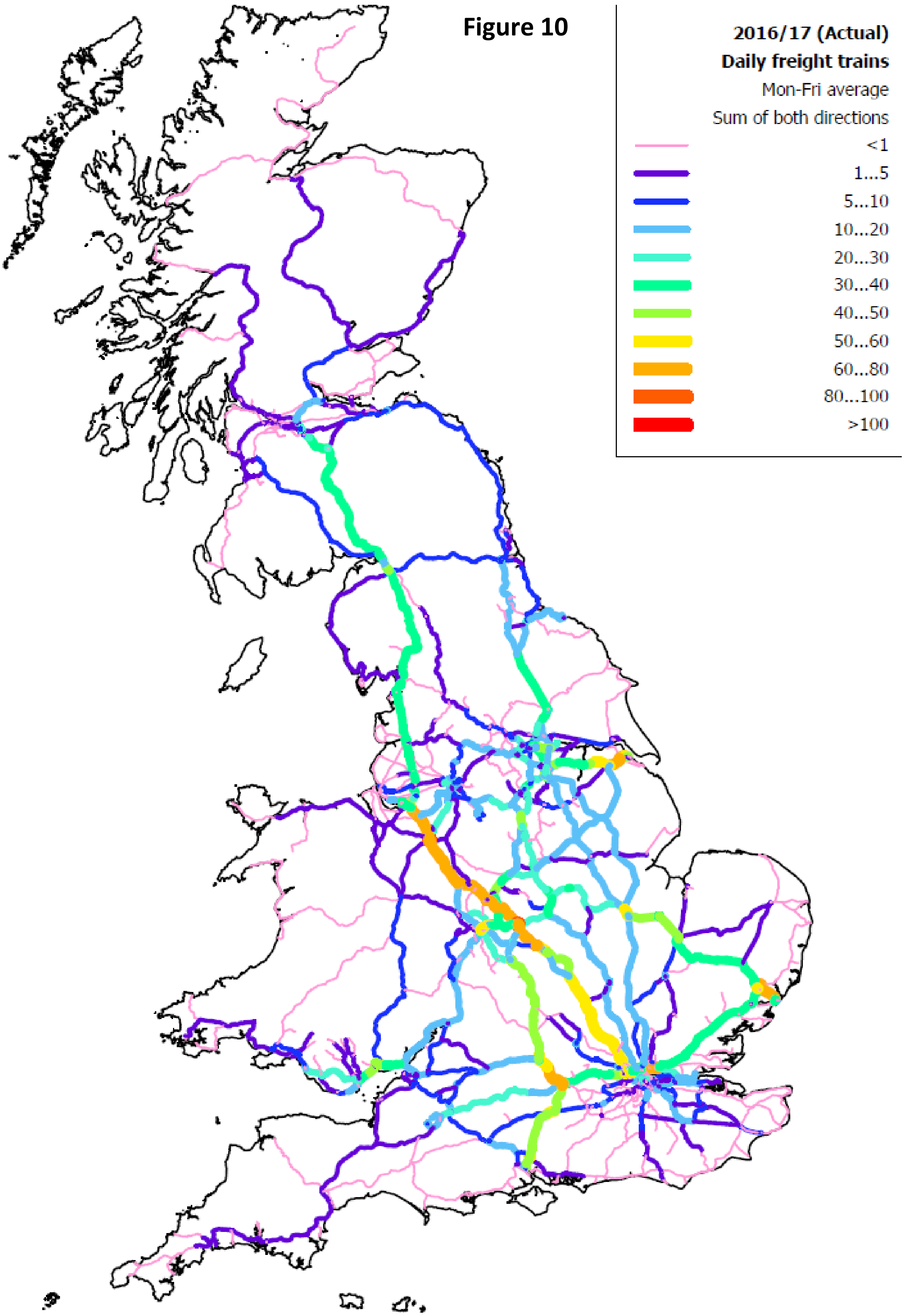


Figure 10
2016/17 (Actual)
Daily freight trains
Mon-Fri average
Sum of both directions
<1
1...5
5...10
10...20
20...30
30...40
40...50
50...60
60...80
80...100
>100

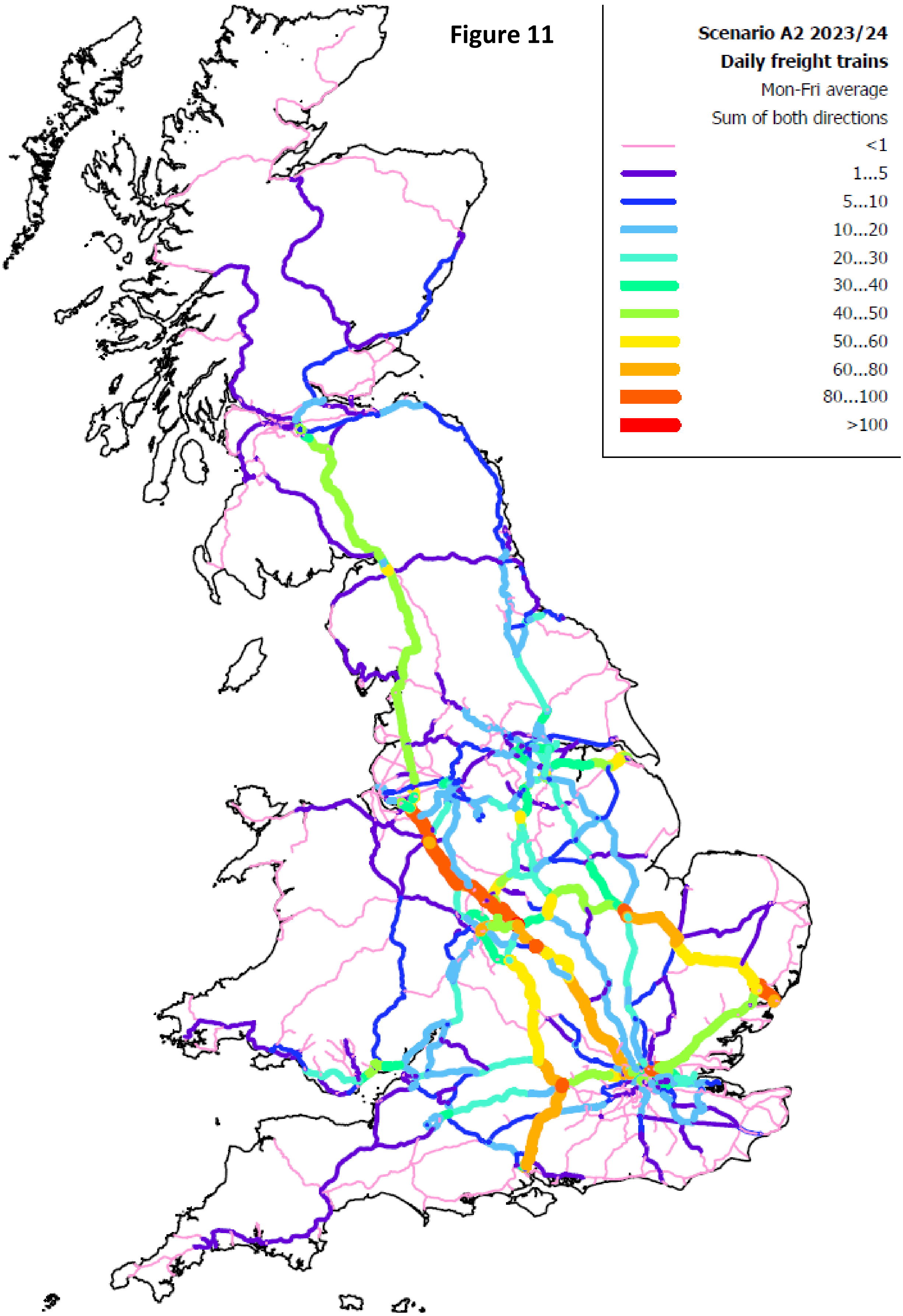
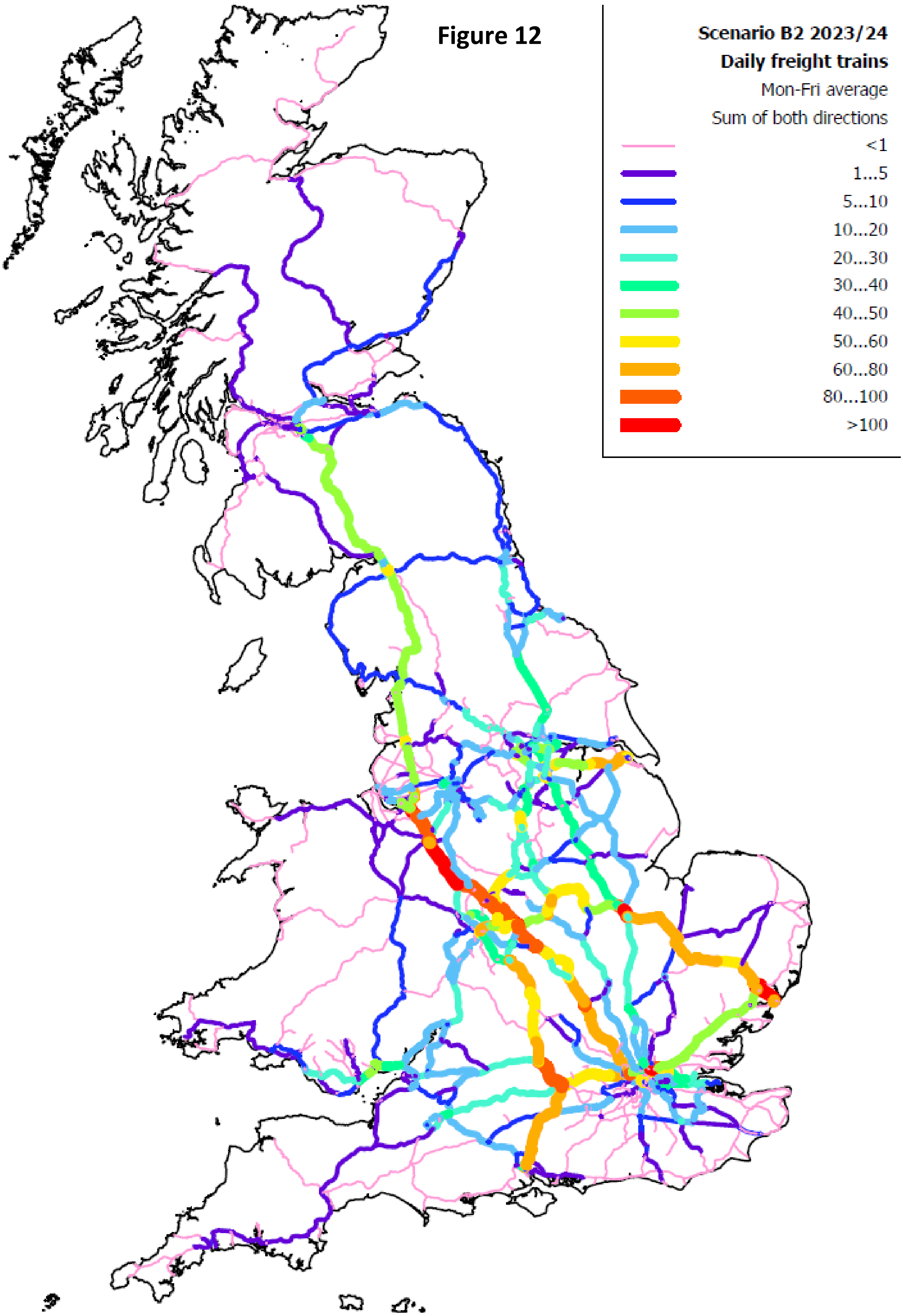
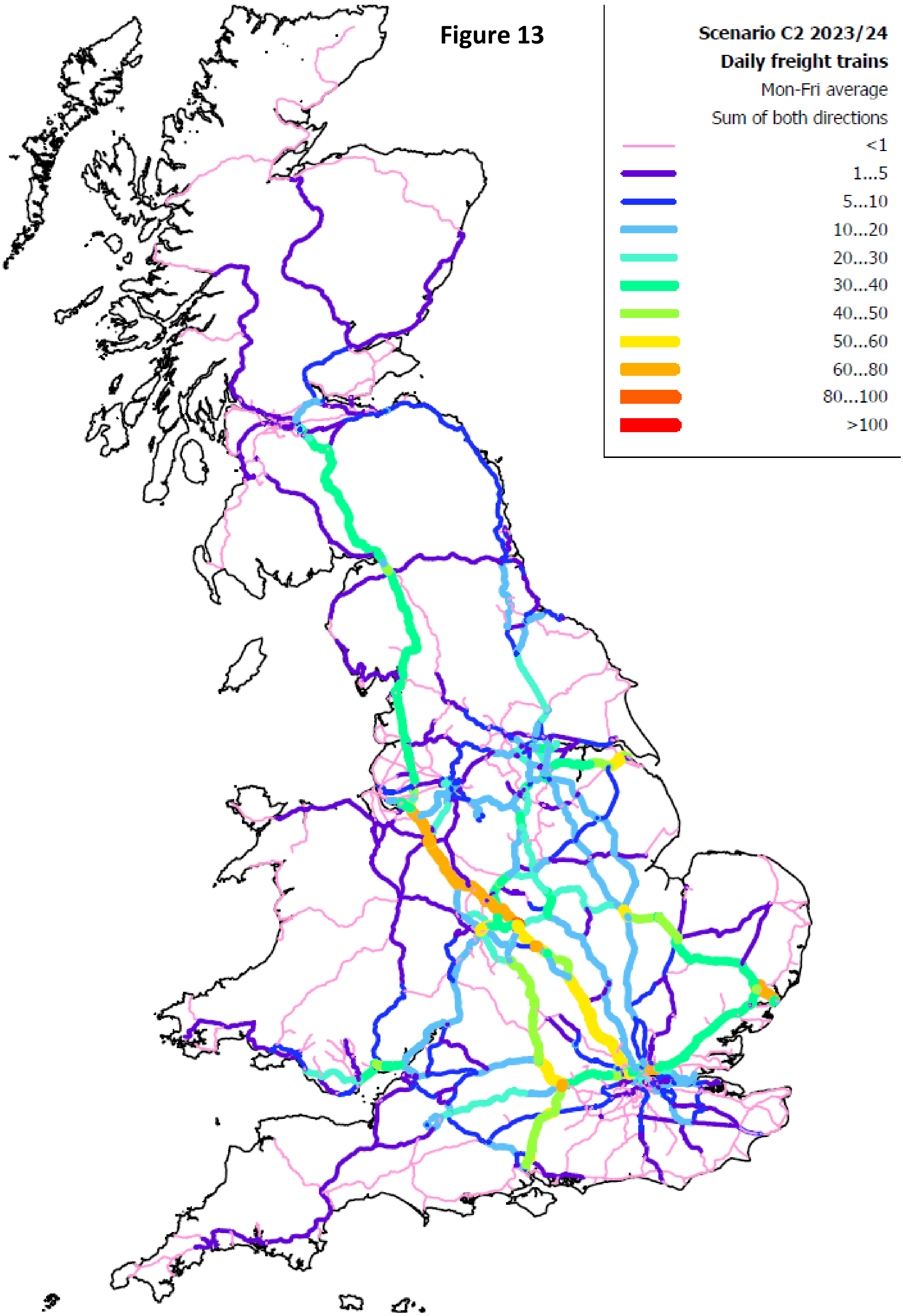


Figure 11
Scenario A2 2023/24
Daily freight trains
Mon-Fri average
Sum of both directions
<1
1...5
5...10
10...20
20...30
30...40
40...50
50...60
60...80
80...100
>100

Figure 12


Scenario B2 2023/24
Daily freight trains
Mon-Fri average
Sum of both directions
<1
1...5
5...10
10...20
20...30
30...40
40...50
50...60
60...80
80...100
>100



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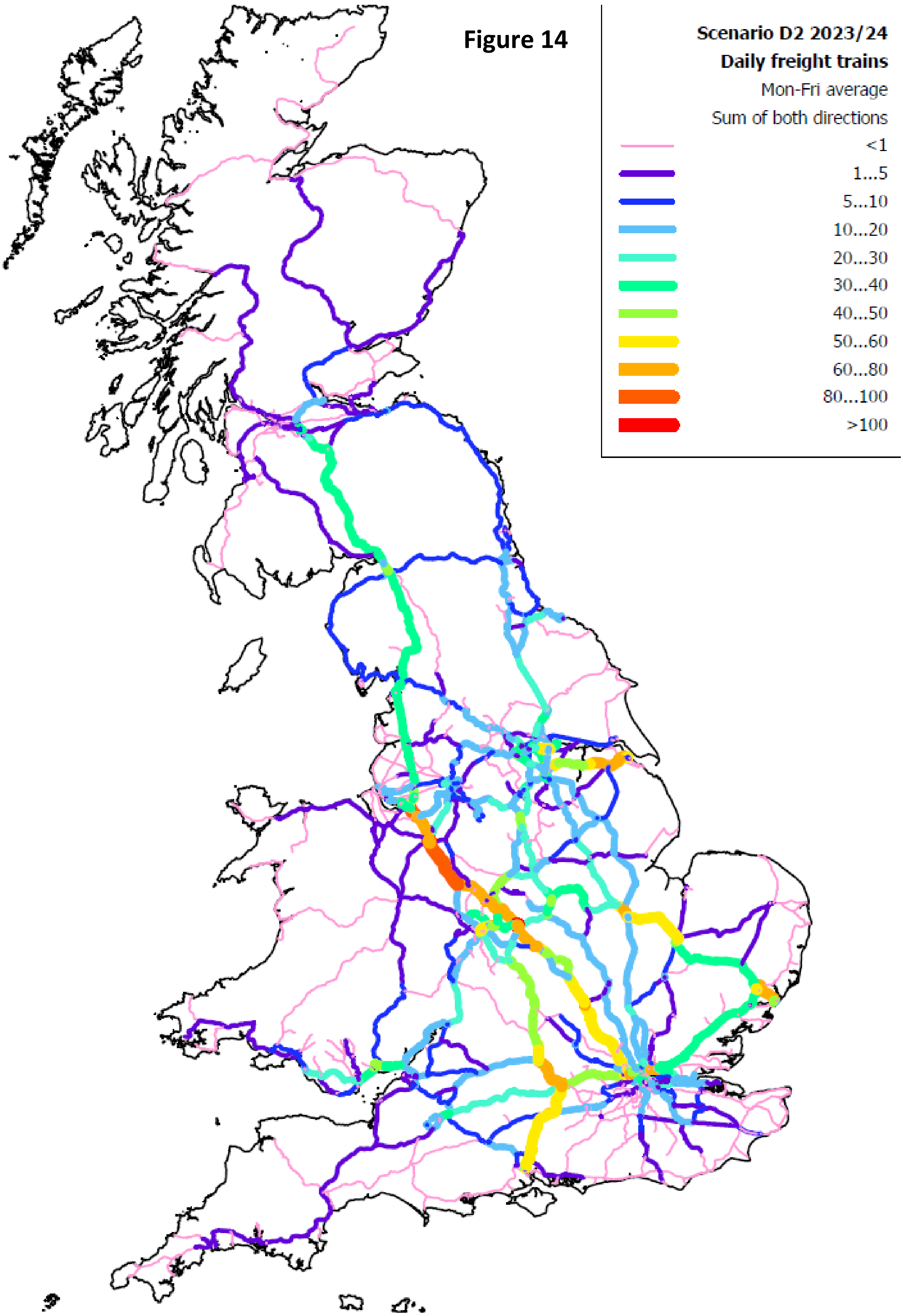


MDS Transmodal

Figure 15: Base year: 2016/17 (Actual). Average freight trains per weekday. Sum of both directions. West Midlands area

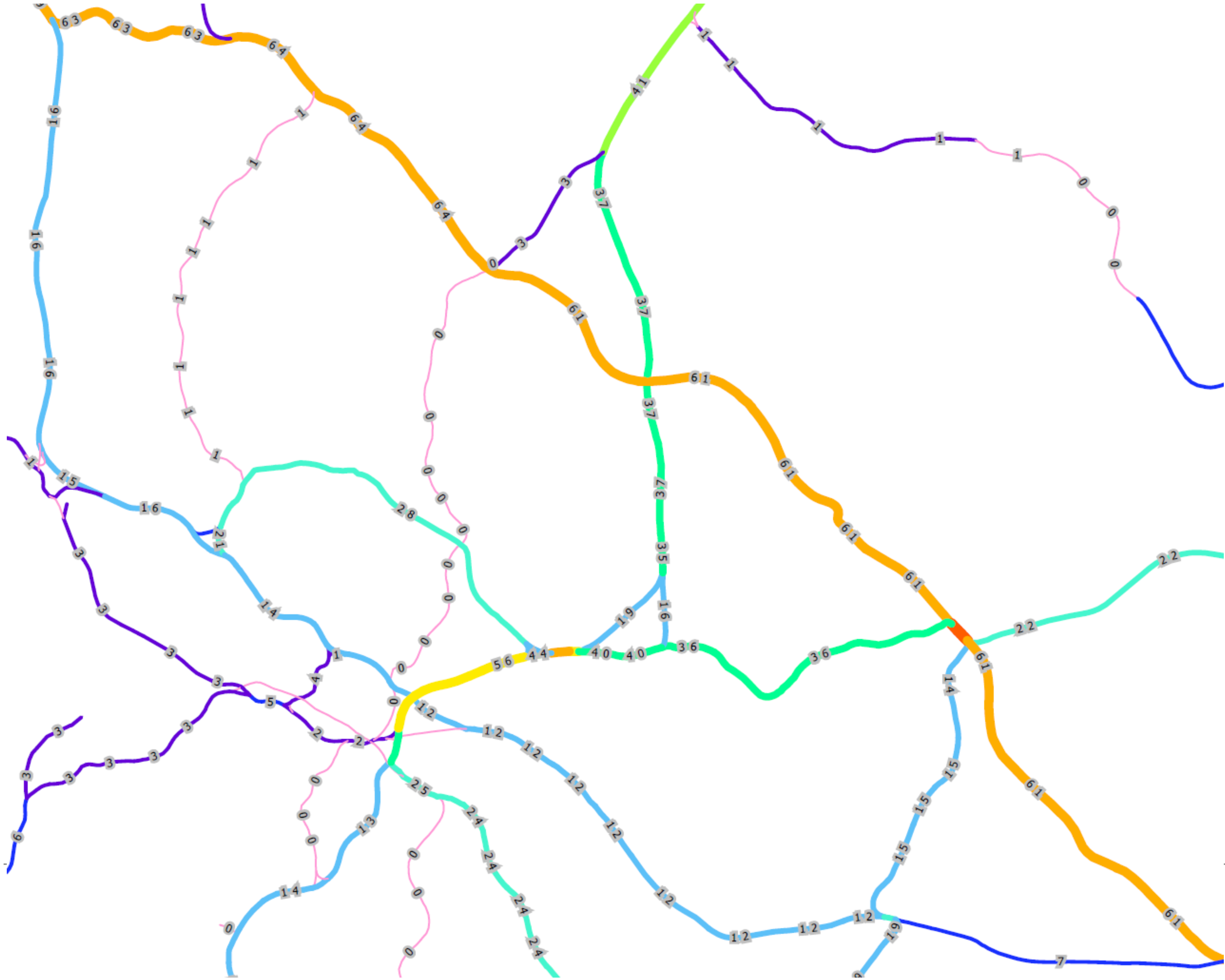


Figure 16: 2023/24 Scenario A2. Average freight trains per weekday. Sum of both directions. West Midlands area

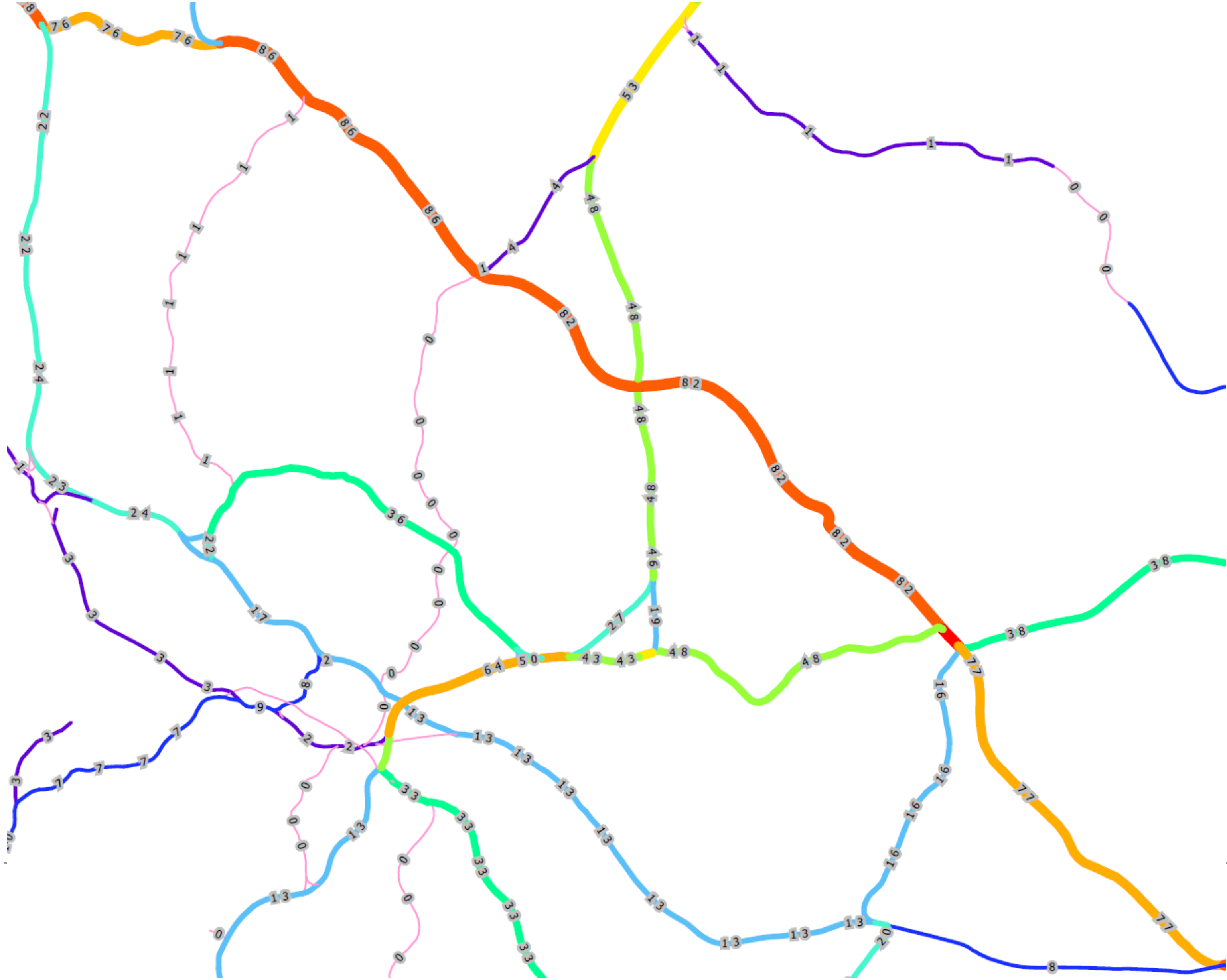


Figure 17: 2023/24 Scenario B2. Average freight trains per weekday. Sum of both directions. West Midlands area

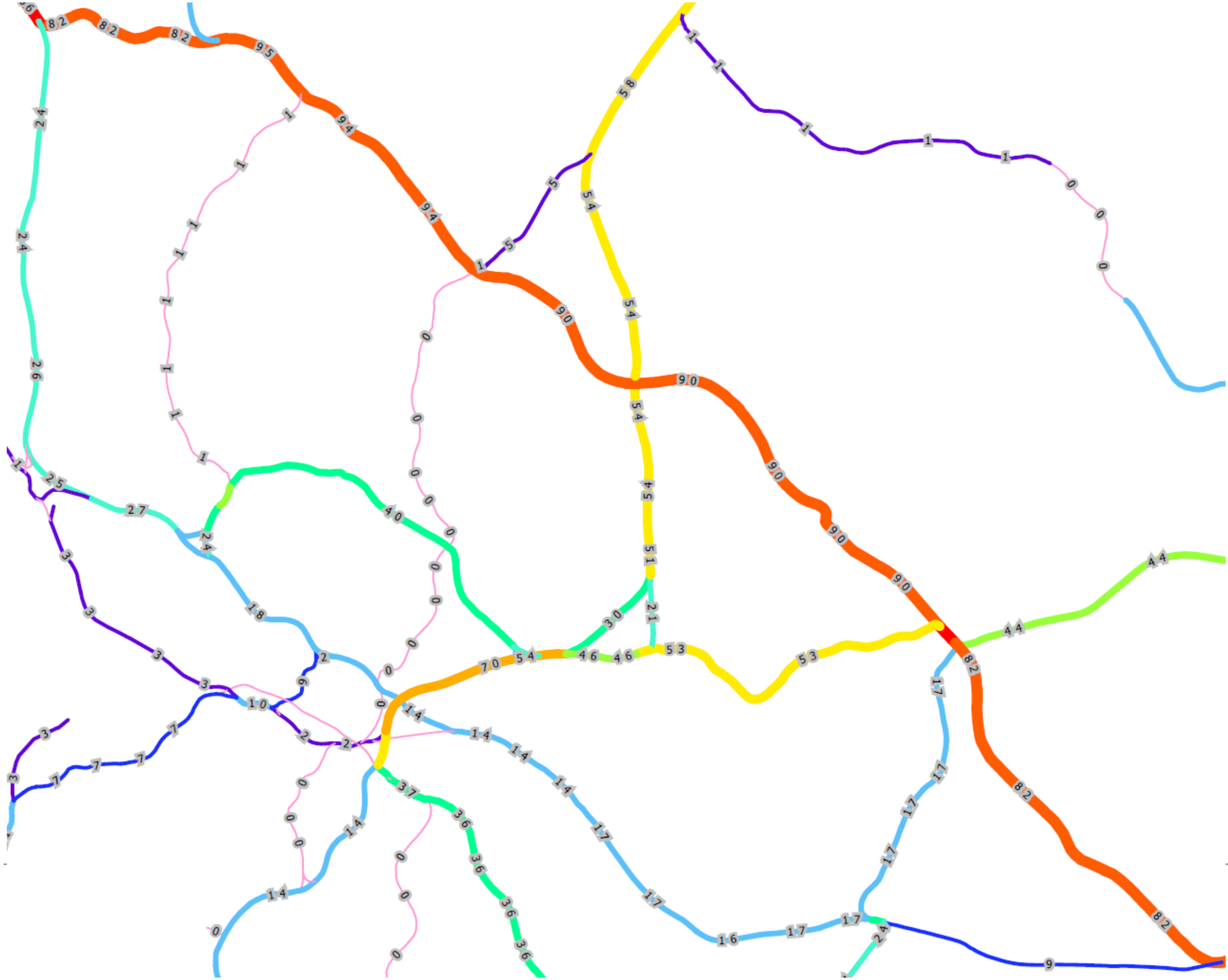


Figure 18: 2023/24 Scenario C2. Average freight trains per weekday. Sum of both directions. West Midlands area

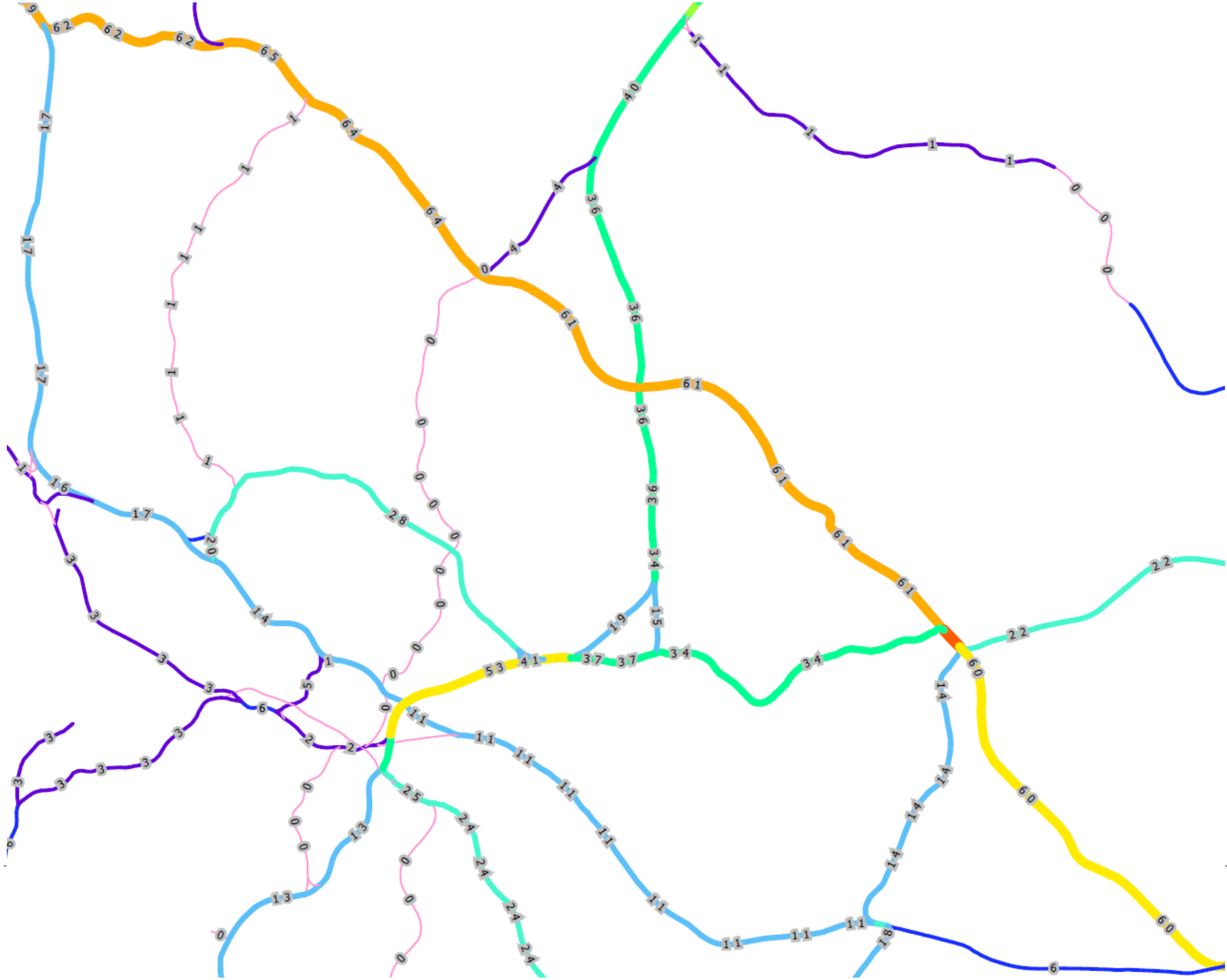


Figure 19: 2023/24 Scenario D2. Average freight trains per weekday. Sum of both directions. West Midlands area

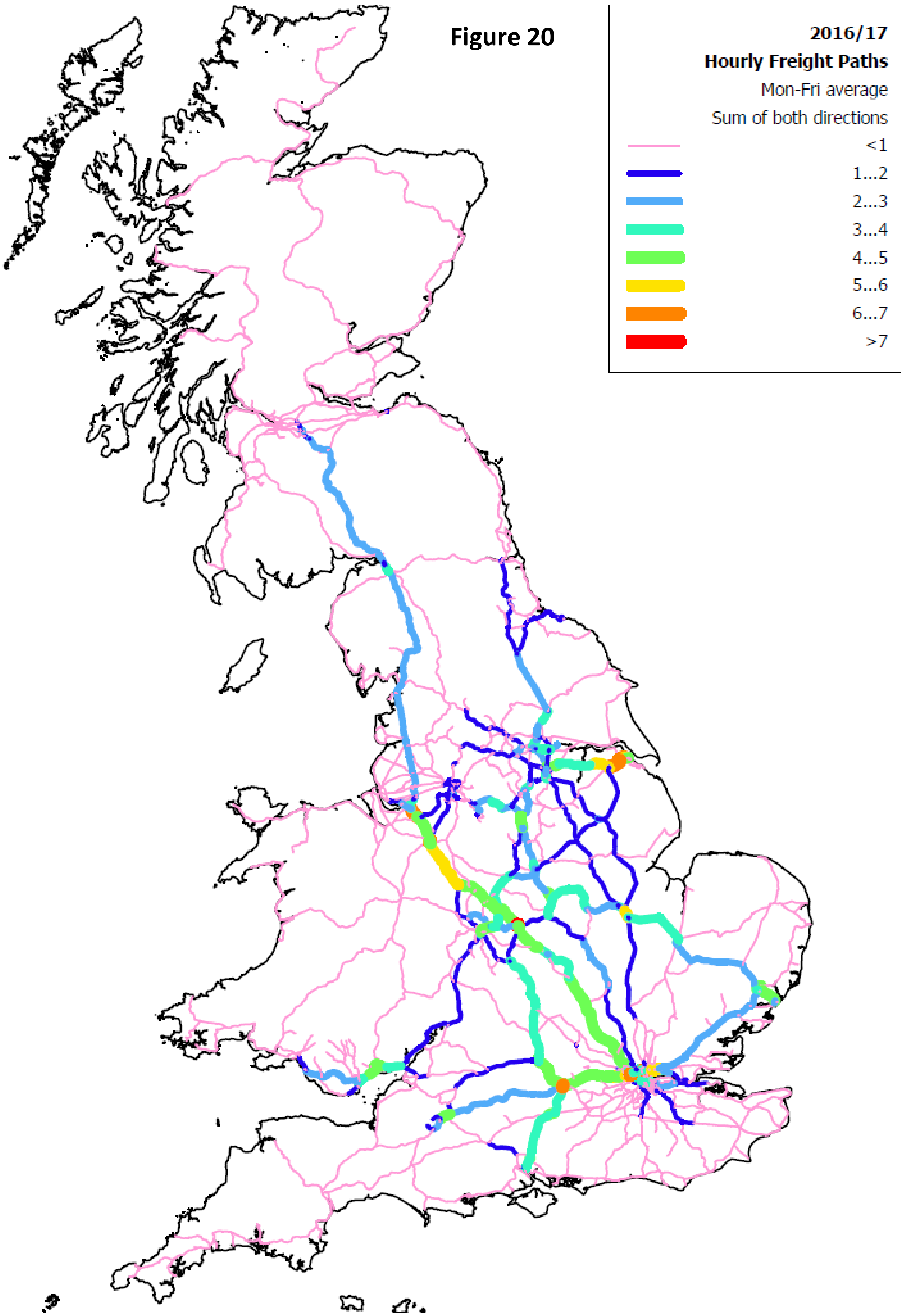


Figure 20
2016/17
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

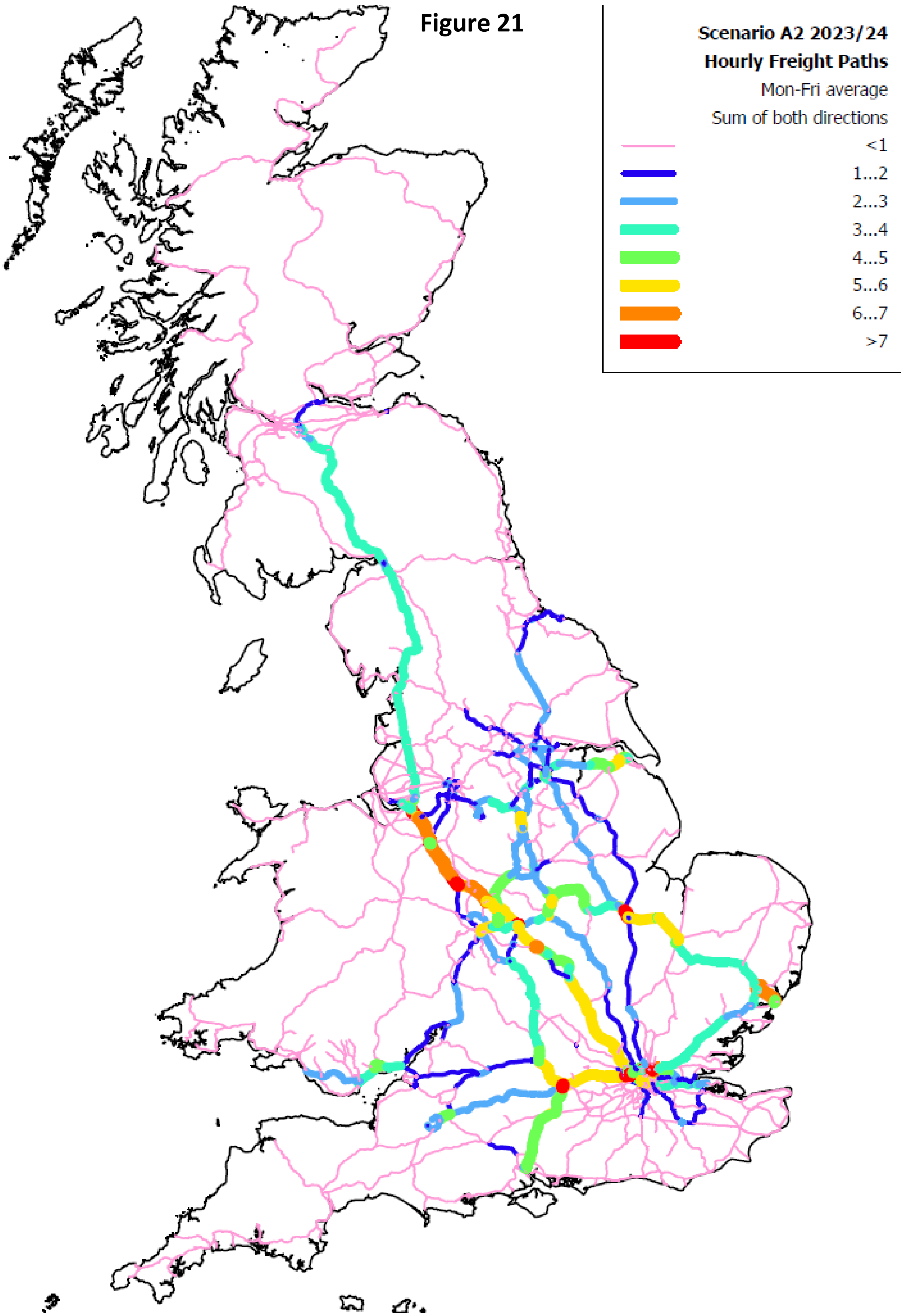


Figure 21
Scenario A2 2023/24
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

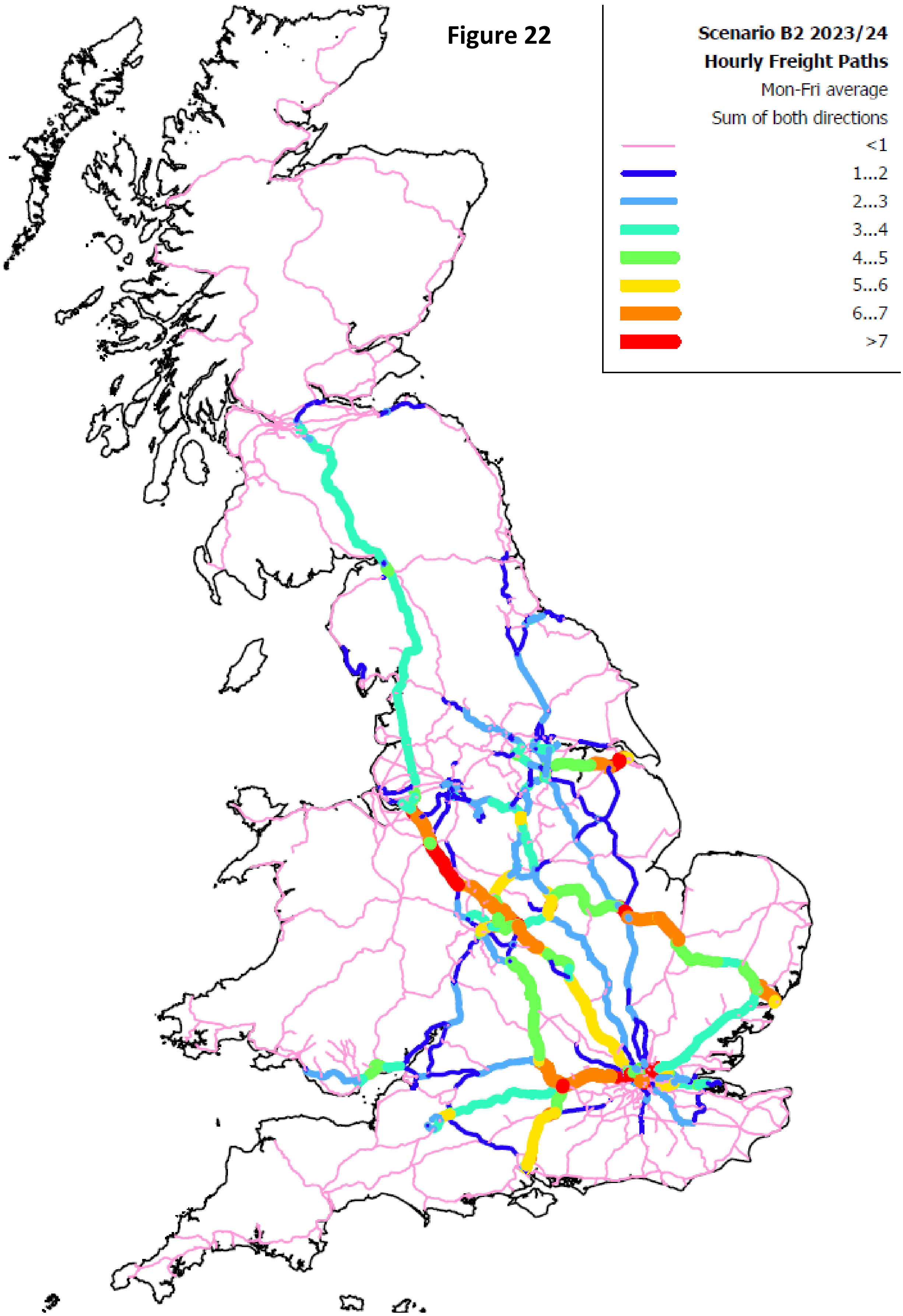


Figure 22
Scenario B2 2023/24
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

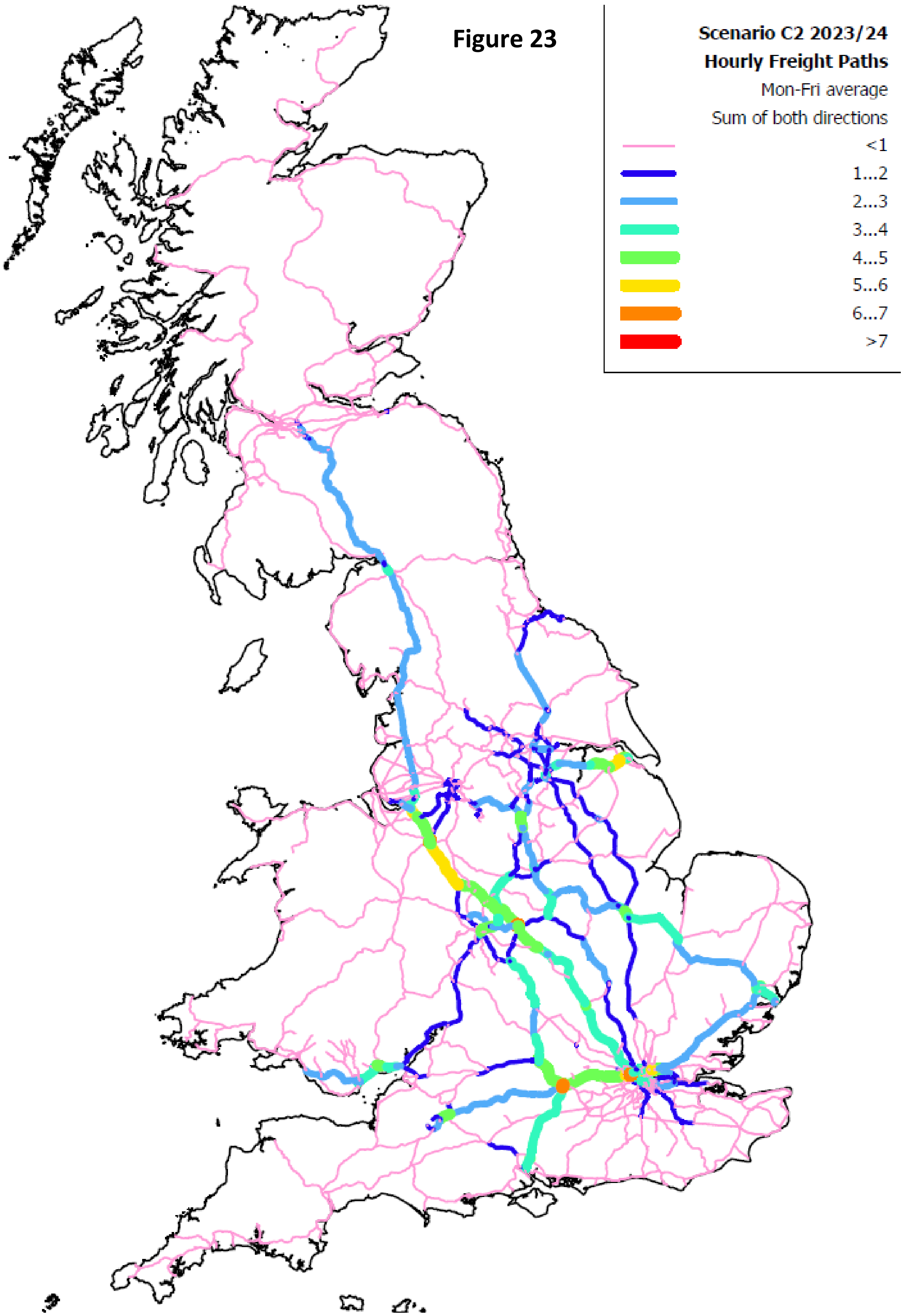


Figure 23
Scenario C2 2023/24
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

Figure 24

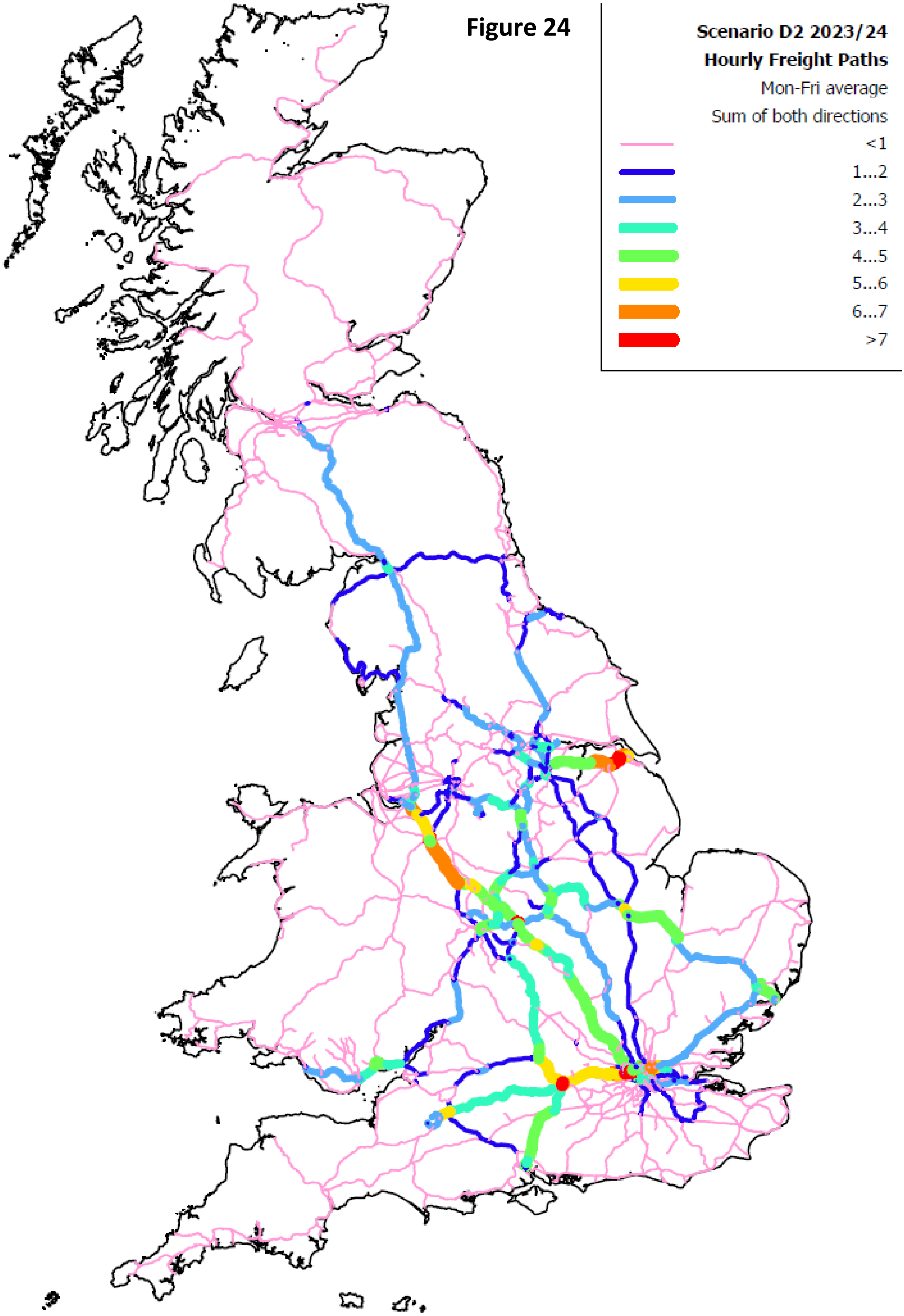

Scenario D2 2023/24
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

Figure 25: Base year: 2016/17. Hourly paths required. Sum of both directions. West Midlands area

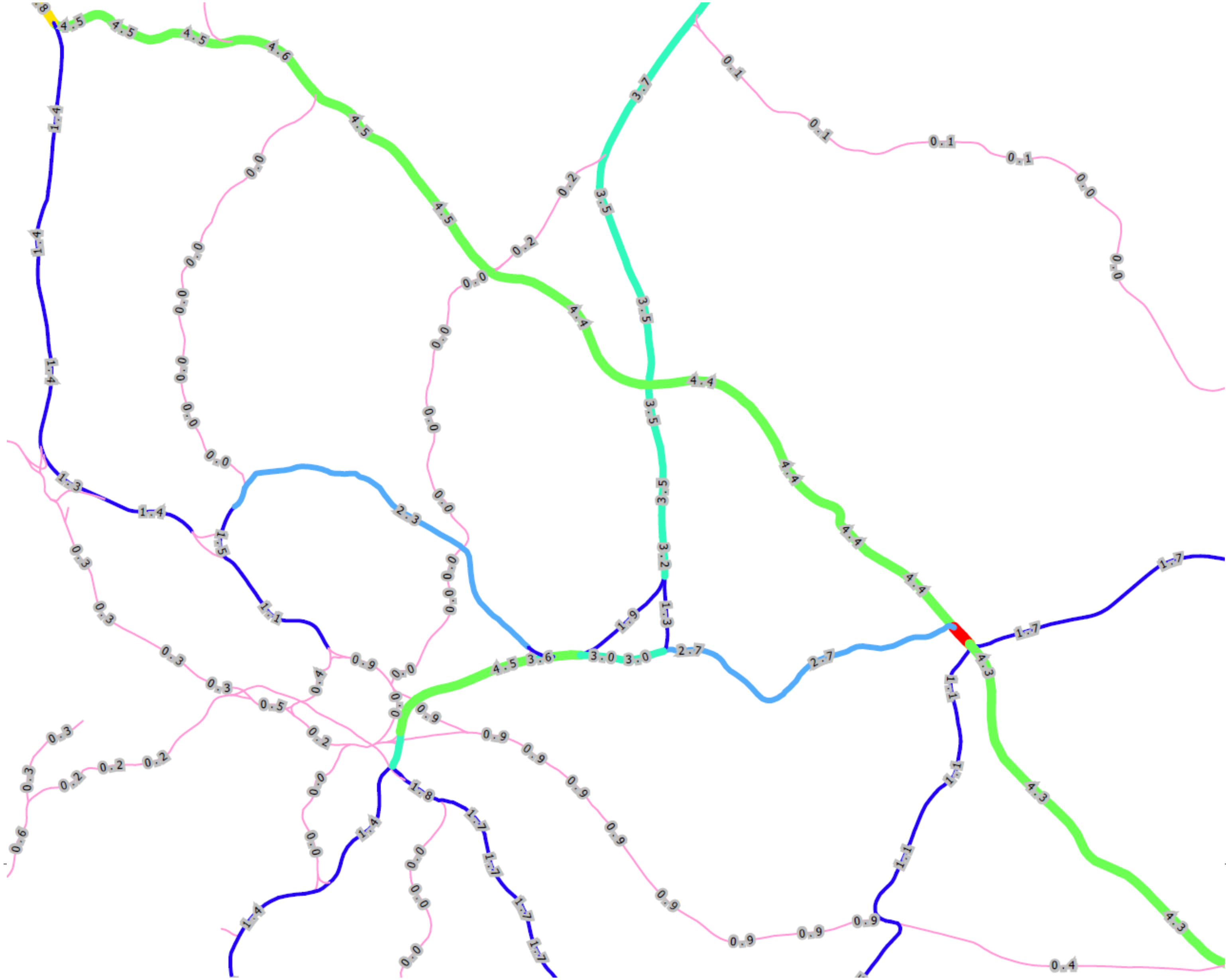


Figure 26: 2023/24 Scenario A2. Hourly paths required. Sum of both directions. West Midlands area

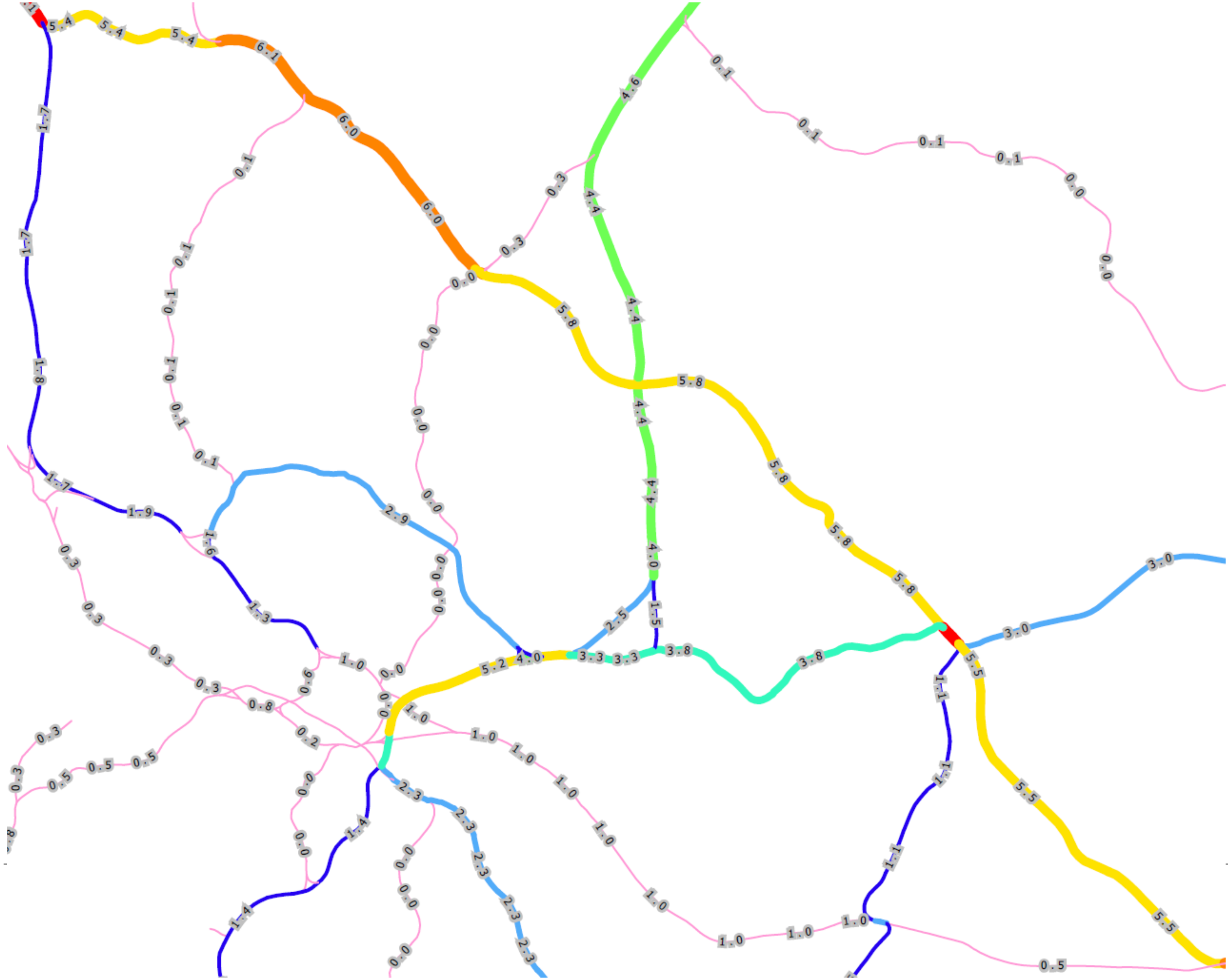


Figure 27: 2023/24 Scenario B2. Hourly paths required. Sum of both directions. West Midlands area

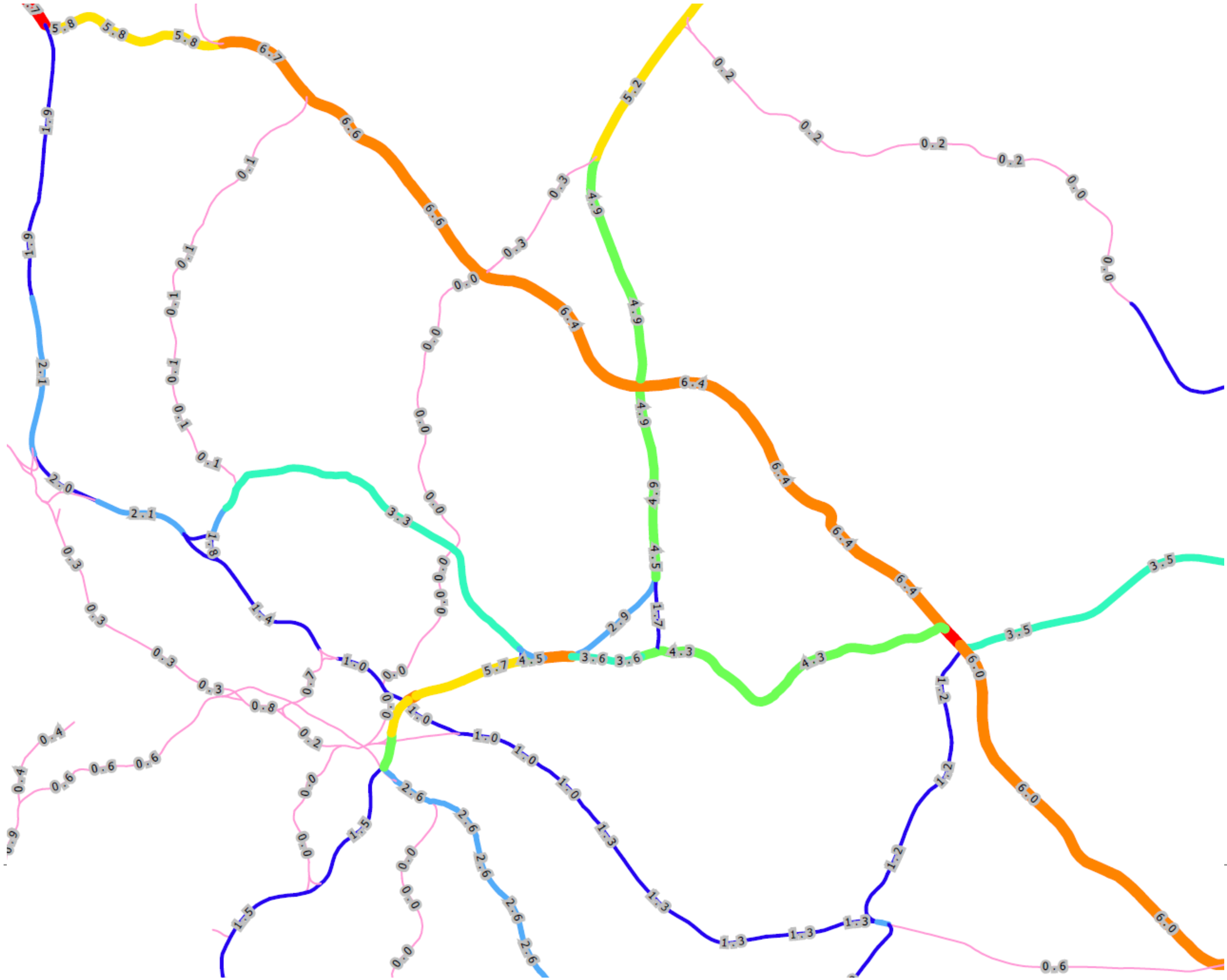


Figure 28: 2023/24 Scenario C2. Hourly paths required. Sum of both directions. West Midlands area

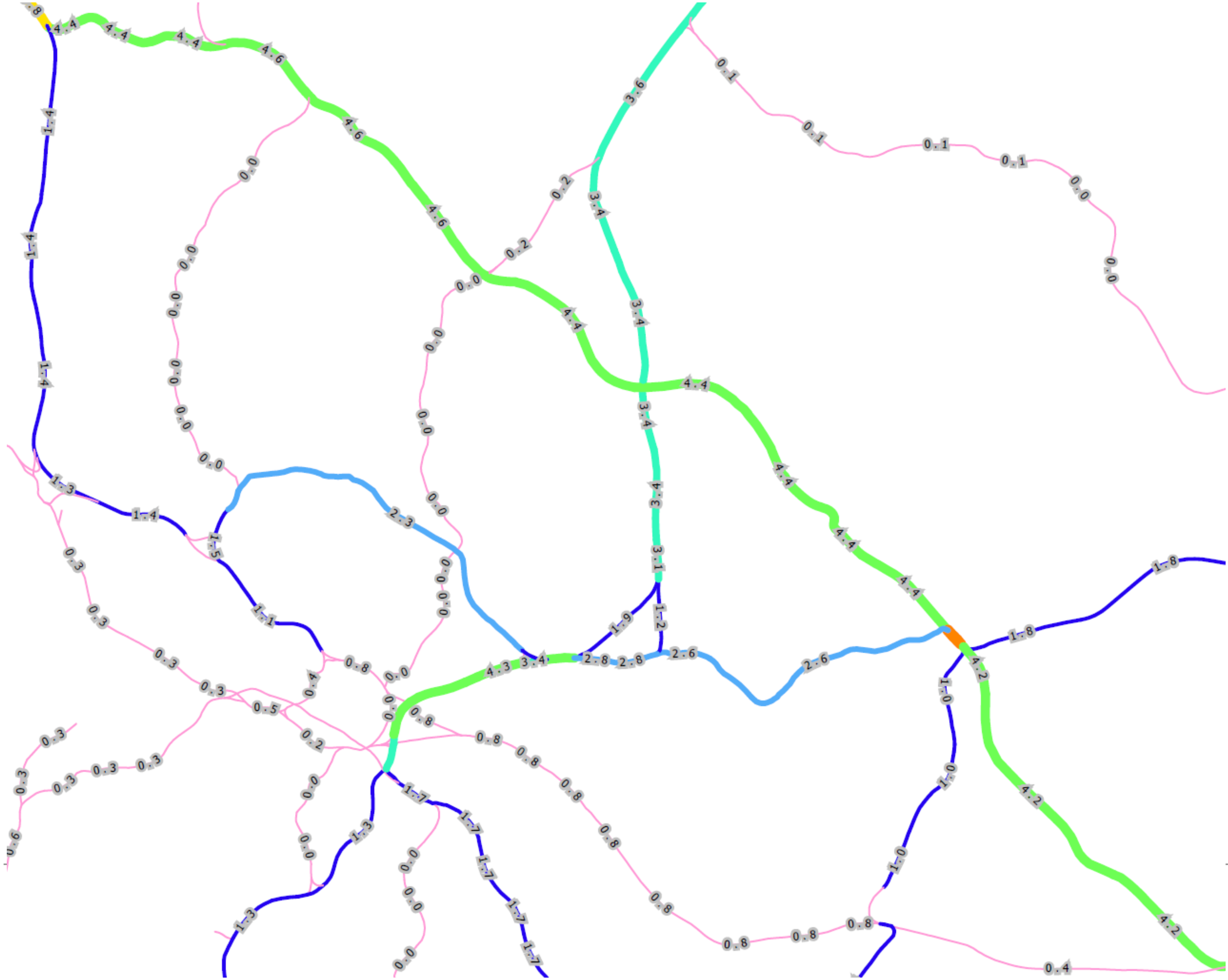
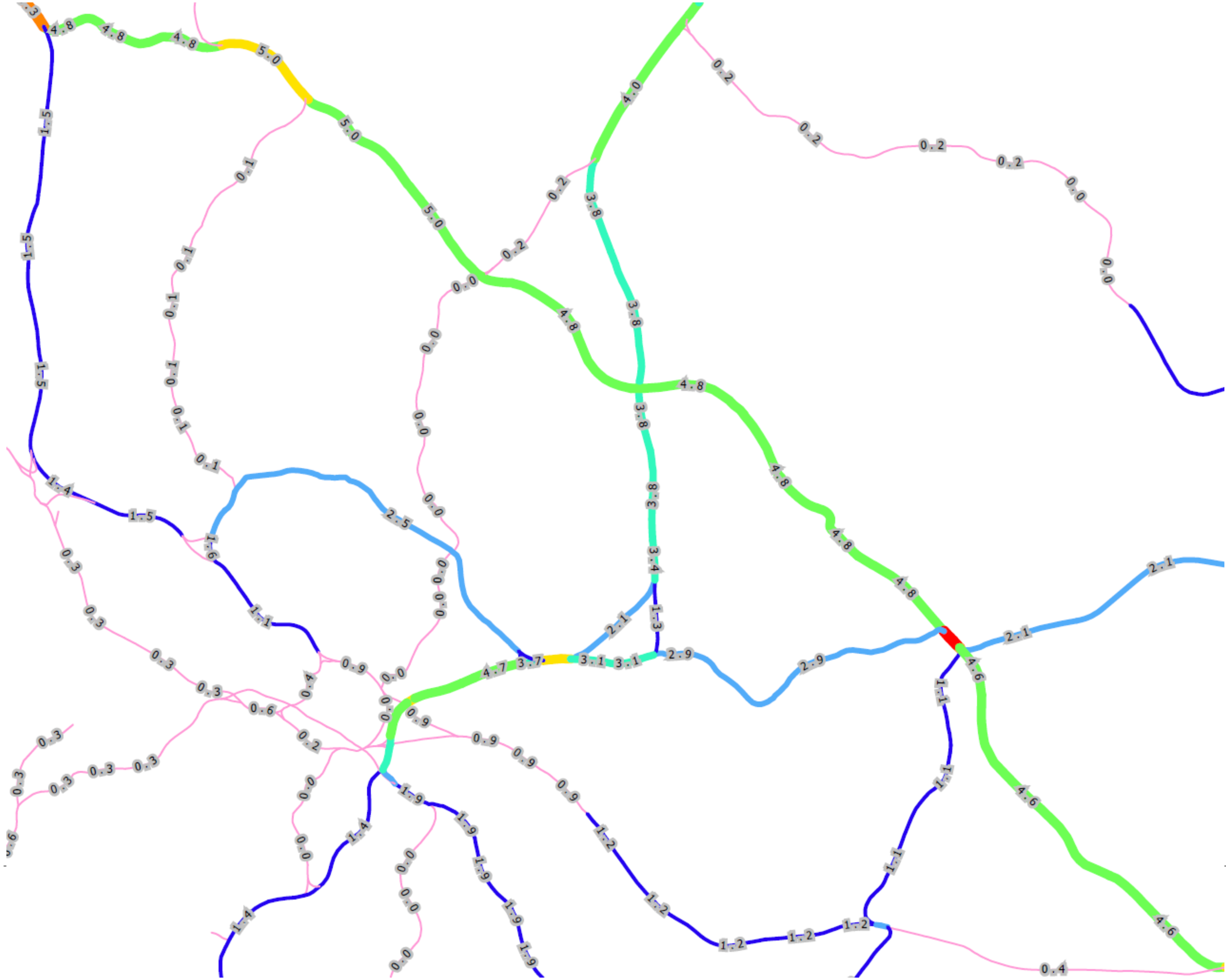


Figure 29: 2023/24 Scenario D2. Hourly paths required. Sum of both directions. West Midlands area



7. CAPACITY AND CAPACITY CONSTRAINT

There are many issues that affect available capacity for freight such as:

- Infrastructure capability (number of tracks, grade separated junctions, signalling, long passing loops etc)
- Passenger train movements
- Relative speeds of freight versus passenger trains
- Timetabling priorities such as acceptable reliability and robustness of the timetable

The above information is not represented within the model. Therefore for all of the modelled outputs described so far, we have assumed that there are no capacity constraints.

7.1 Capacity required to meet demand

The table below shows the forecast hourly paths required (sum of both directions) through a number of key locations on the network for each scenario.

Table 19: Forecast hourly freight paths required at selected locations (sum of both directions)

		2023/24			
Location	2016/17	A2	B2	C2	D2
Felixstowe branch line	4.0	6.1	6.7	4.0	4.4
Forest Gate junction	5.2	6.8	7.8	5.0	5.7
Colchester	2.3	2.9	3.1	2.2	2.4
March	3.7	5.3	6.1	3.5	4.1
Huntingdon	1.3	1.8	2.1	1.3	1.5
Kettering	2.3	2.5	3.0	2.2	2.6
Water Orton	5.0	5.8	6.5	4.7	5.2
Tring	4.1	5.0	5.4	3.8	4.2
Pangbourne	4.8	5.7	6.6	4.7	5.5
Winchester	3.7	4.7	5.5	3.5	4.2
Swindon	1.6	1.9	2.2	1.5	1.8
Weaver Jn	6.3	7.1	7.9	6.0	6.5
Hope (Peak District)	3.0	3.2	3.9	2.8	3.3
Chesterfield	4.6	5.2	6.0	4.1	4.8
Barnetby	6.5	5.4	7.1	5.4	7.2
Newark North Gate	1.4	2.2	2.5	1.4	1.6
Penrith	2.3	3.2	3.4	2.4	2.6

However unless more capacity is secured for rail freight at capacity-constrained locations on the network, it is unlikely that high quality paths along preferred routes will be available, and the unconstrained growth forecast in scenarios A2 & B2 may not be achievable.

7.2 Capacity constraint

There are various levels of sophistication of potential methods that can be considered for capacity constraining the forecast demand.

A thorough approach to capacity constraint would require a calculation of hourly paths available to rail freight in 2023/24 at all bottlenecks throughout the network. This would involve considering all the issues mentioned at the start of this chapter including committed infrastructure upgrades.

Once demand in excess of capacity was established, re-routing options would have to be considered and a decision taken for each excess traffic as to whether

- infrastructure could be enhanced to cater for it
- it should be re-routed or suppressed
- compromises could be made to passenger services to enable additional freight paths through some bottlenecks (e.g. slowing down fast passenger trains between Winsford and Weaver junction)

This would be a large and contentious task with many considerations to take on board.

We have adopted a simpler approach:

1. Choose 7 bottleneck locations throughout the network (guided by Network Rail)
2. For each of these locations, find the hourly freight paths required to cater for the traffic in 2016/17
3. For each location, estimate the 2023/24 rail freight capacity available. We have simply added 20% to the 2016/17 hourly freight paths required, to give an indicative estimate of 2023/24 capacity.
4. Note the unconstrained 2023/24 demand at each location
5. For locations where 2023/24 demand exceeds capacity, calculate a 'required scale factor' that can be applied to the demand through that location to scale down the demand to the capacity.

The table below shows the above steps for the 7 locations for scenario B2 (the largest traffic scenario)

Table 20: 2023/24 Demand vs Capacity and required scale-down factors for scenario B2
All figures in hourly rail freight paths (sum of both directions)

Location	2016/17 Paths	2023/24 Capacity	2023/4 Demand	Required scale- factor
Whittlesea	3.7	4.5	6.1	0.73
Bramley	3.4	4.0	5.0	0.81
Camden Road	6.1	7.3	8.9	0.83
Diggle Junc	0.3	0.4	0.5	0.80
Woodgrange Park	3.2	3.8	5.3	0.72
Forest Gate Junc	5.2	6.2	7.8	0.80
Kensal Green Junc	3.9	4.6	4.9	0.95

Following these calculations, all of the junctions in question are over-capacity and therefore require some forecast traffic to be removed. If all of the locations were entirely independent such that there were no trains that passed through more than one of the 7 locations, then all paths through each of the locations could be scaled by the 'required scaled-factor' such that demand was reduced to the available capacity at each location.

Whittlesea, Bramley, Diggle junction and Woodgrange Park are indeed independent of each other (with very few trains passing more than one of these locations). Therefore the traffic through each of these locations can be scaled as per their 'required scaled-factor'.

However there are many trains passing through Woodgrange Park that also pass through Camden Road (3.2 paths). There are also some trains through Bramley that pass through Camden Road (0.2 paths).

Therefore scaling down all the trains through Woodgrange Park (X 0.72) and Bramley (X 0.81) also reduces trains through Camden Road to: 8.9 – (1-0.72) X 3.2 – (1-0.81) X 0.2 = 7.9 paths.

Once traffic through both Woodgrange Park and Camden Road is excluded from the calculation (and traffic through both Bramley and Camden Road is also removed), that leaves a remaining number of trains through Camden Road (that could be further scaled down if required): 8.9 – 3.2 – 0.2 = 5.4 paths.

The capacity available for these remaining trains is the full capacity available (7.3) minus that used for those trains through Woodgrange Park (3.2 X 0.72 = 2.3) and Bramley (0.2 X 0.81 = 0.18) leaving 4.8 paths available.

So through Camden Road, we have 5.4 remaining paths of demand to fit into capacity of 4.8 remaining paths – giving a required scale factor for the remaining paths of X 0.89. Adding back in the paths through Woodgrange Park and Bramley, through Camden Road we have (5.4 X 0.89 = 4.8) + (3.2 X 0.72 = 2.3) + (0.2 X 0.81 = 0.18) = 7.3 paths.

Applying this 0.89 scale factor to all remaining paths through Camden Road results in Camden Road's paths matching its capacity. Scaling down paths through Woodgrange Park and Camden Road as described above has the by-product of reducing paths required through Forest Gate Junction to the available capacity, such that there is no need for any further scaling down of traffic. For Kensal Green Junction, the scaling-down results in demand being 0.6 paths below the capacity.

After scaling down the paths through the locations as described above, the resulting paths through these locations in scenario B2 becomes:

Table 21: Scaling down paths in B2

All figures in hourly rail freight paths (sum of both directions)

Location	2023/24 Capacity	2023/4 Demand	2023/4 Demand after scale-down	2023/4 Suppressed traffic	Spare capacity
Whittlesea	4.5	6.1	4.5	1.6	-
Bramley	4.0	5.0	4.0	0.9	-
Camden Road	7.3	8.9	7.3	1.5	-
Diggle Junc	0.4	0.5	0.4	0.1	-
Woodgrange Park	3.8	5.3	3.8	1.5	-
Forest Gate Junc	6.2	7.8	6.2	1.6	-
Kensal Green Junc	4.6	4.9	4.0	0.9	0.6

Because the demand in scenario A2 is lower than that in scenario B2, the required scale down factors and therefore the amount of traffic suppressed impact the results less.

We have only applied this capacity constraint to scenarios A2 & B2 because these are the scenarios with the largest forecast traffic demand.

The suppressed traffic is incorporated into the detailed tonnage and tonne km OD matrices, and summarised below for scenarios A3 and B3.

Rail freight assignment maps (hourly paths required (sum of both directions)) for scenarios A3 and B3 are also shown below.

Table 22: Rail freight TONNES forecast for 2023/24 scenarios A2 & A3 by sector. Thousand tonnes per year

Sector	2016/17	2023/24 A2	2023/24 A3: After capacity constraint	Suppressed traffic
Ports Intermodal	16,213	24,252	22,210	2,042
Domestic Intermodal	2,481	8,009	7,758	251
Channel Tunnel Intermodal	374	529	529	0
ESI Coal	6,284	-	-	-
Biomass	6,470	8,464	8,462	2
Waste	1,226	1,165	1,164	1
Construction materials	24,286	33,133	32,527	606
of which spoil	735	997	997	0
Petroleum	4,710	4,822	4,821	1
Chemicals	899	934	921	13
Industrial Minerals	1,335	1,580	1,572	8
Metals	7,441	8,226	8,220	6
Automotive	450	468	433	35
Ores	4,259	4,046	4,046	0
Coal Other	1,955	1,857	1,857	0
Other	334	368	368	0
Empty returns for containers carrying bulks	413	397	397	0
NR Engineering	6,657	6,324	6,173	151
Total	**85,786**	**104,574**	**101,458**	**3,116**

Table 23: Rail freight TONNE KMS forecast for 2023/24 scenarios A2 & A3 by sector. Million tonne kms per year

Sector	2016/17	2023/24 A2	2023/24 A3: After capacity constraint	Suppressed traffic
Ports Intermodal	5,612	8,165	7,486	679
Domestic Intermodal	1,136	3,466	3,370	95
Channel Tunnel Intermodal	94	133	133	-
ESI Coal	1,158	-	-	-
Biomass	853	1,093	1,092	0
Waste	215	204	204	0
Construction materials	4,342	5,242	5,107	134
of which spoil	94	127	127	0
Petroleum	1,134	1,141	1,141	0
Chemicals	142	152	148	4
Industrial Minerals	234	262	260	2
Metals	1,587	1,706	1,703	3
Automotive	146	149	138	11
Ores	156	148	148	-
Coal Other	267	254	253	0
Other	101	112	112	0
Empty returns for containers carrying bulks	69	68	68	0
NR Engineering	1,714	1,628	1,587	41
Total	**18,962**	**23,923**	**22,952**	**971**

Figure 30

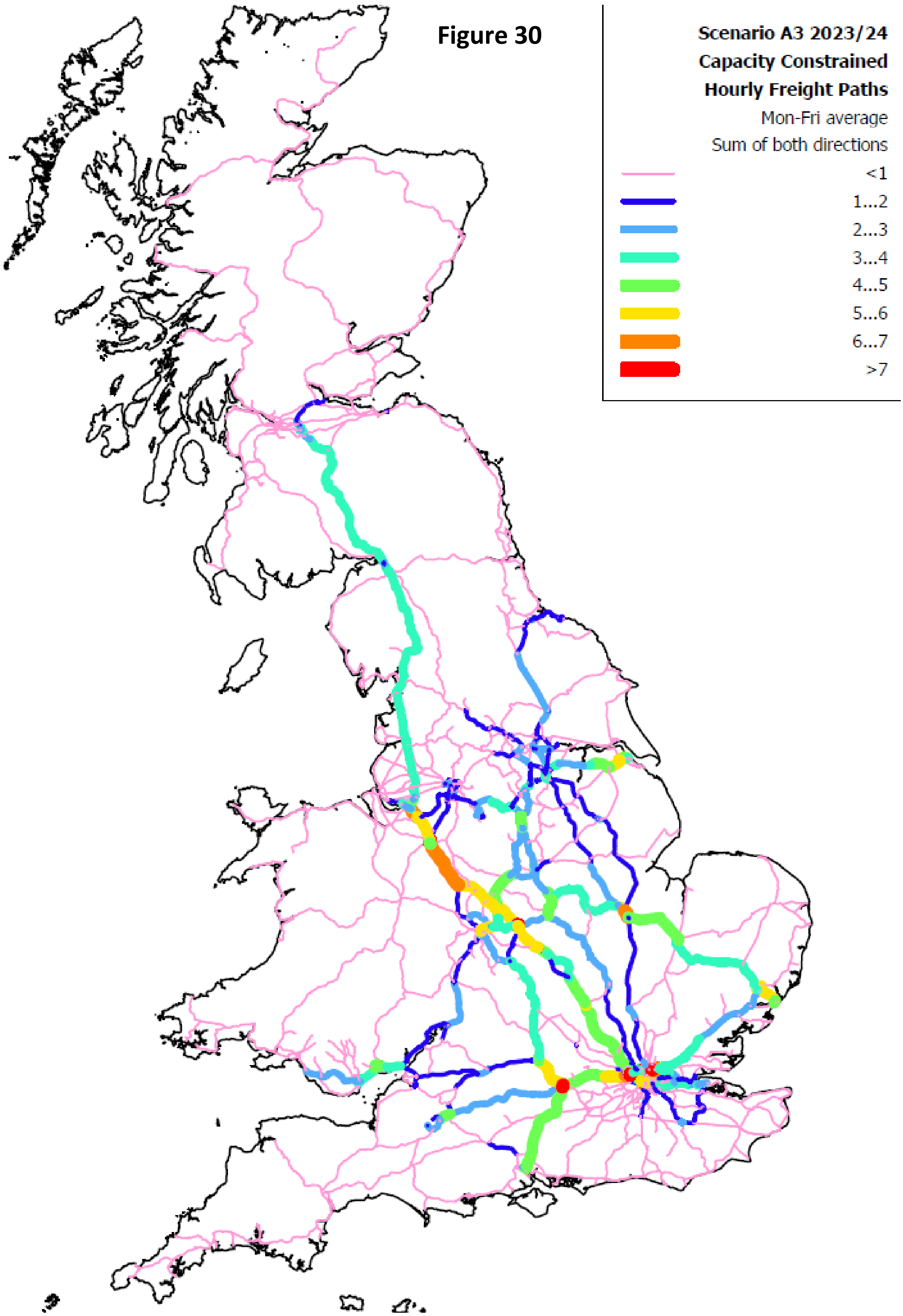

Scenario A3 2023/24
Capacity Constrained
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

Table 24: Rail freight TONNES forecast for 2023/24 scenarios B2 & B3 by sector. Thousand tonnes per year

Sector	2016/17	2023/24 B2	2023/24 B3: After capacity constraint	Suppressed traffic
Ports Intermodal[10]	16,213	27,133	21,885	5,248
Domestic Intermodal	2,481	8,606	7,964	642
Channel Tunnel Intermodal	374	578	578	0
ESI Coal	6,284	-	-	-
Biomass	6,470	13,045	12,952	93
Waste	1,226	1,287	1,274	13
Construction materials	24,286	43,383	41,485	1,898
of which spoil	735	1,306	1,169	137
Petroleum	4,710	5,330	5,328	2
Chemicals	899	1,032	1,005	27
Industrial Minerals	1,335	1,747	1,726	21
Metals	7,441	9,092	9,045	47
Automotive	450	583	467	116
Ores	4,259	4,472	4,472	0
Coal Other	1,955	4,052	4,052	0
Other	334	407	407	0
Empty returns for containers carrying bulks	413	439	435	4
NR Engineering[11]	6,657	6,990	6,619	371
Total	**85,786**	**128,175**	**119,692**	**8,483**

[10] At first glance, it may be surprising that the ports intermodal tonnes figures are higher under scenario A3 than under B3, when scenario B2 includes the high market growth and is therefore higher than A2.
However both capacity constrained scenarios (A3 & B3) have the same capacity limitations at the 7 locations. Very nearly all port intermodal traffic (Felixstowe, Southampton, Tilbury & London Gateway) goes through one of the capacity constrained locations, so we may therefore expect that port intermodal traffics would be broadly similar in A3 & B3 - which they are.
However in B3, there is generally more traffic trying to get through the 7 bottlenecks, so competition for the limited paths is more intense in scenario B3. It just so happens that through the 7 bottlenecks, the increase in demand from A2 to B2 is slightly higher for the other commodities than it is for port intermodal, so port intermodal traffic is 'squeezed out'.
Consider a simplified hypothetical example for traffic through Bramley (between Reading and Basingstoke). Suppose A2 & B2 were exactly the same apart from the added automotive traffic to Southampton in B2. All traffic in B2 would have to be scaled down slightly more in order to be reduced to the available capacity through Bramley. This would mean port intermodal traffic in B3 would be lower than A3 because it was being crowded out by the extra automotive traffic.

[11] We have treated Network Rail Engineering traffics the same as commercial traffics. However in reality Network Rail would ensure that their Engineering traffic was not suppressed

Table 25: Rail freight TONNE KMS forecast for 2023/24 scenarios B2 & B3 by sector. Million tonne kms per year

Sector	2016/17	2023/24 B2	2023/24 B3: After capacity constraint	Suppressed traffic
Ports Intermodal	5,612	9,108	7,362	1,746
Domestic Intermodal	1,136	3,726	3,482	244
Channel Tunnel Intermodal	94	145	145	-
ESI Coal	1,158	-	-	-
Biomass	853	1,673	1,654	19
Waste	215	225	221	4
Construction materials	4,342	6,863	6,457	406
of which spoil	94	166	149	18
Petroleum	1,134	1,261	1,261	1
Chemicals	142	168	159	9
Industrial Minerals	234	289	284	5
Metals	1,587	1,886	1,865	21
Automotive	146	180	145	36
Ores	156	164	164	-
Coal Other	267	783	782	0
Other	101	124	124	0
Empty returns for containers carrying bulks	69	75	74	1
NR Engineering	1,714	1,800	1,698	101
Total	**18,962**	**28,472**	**25,879**	**2,593**

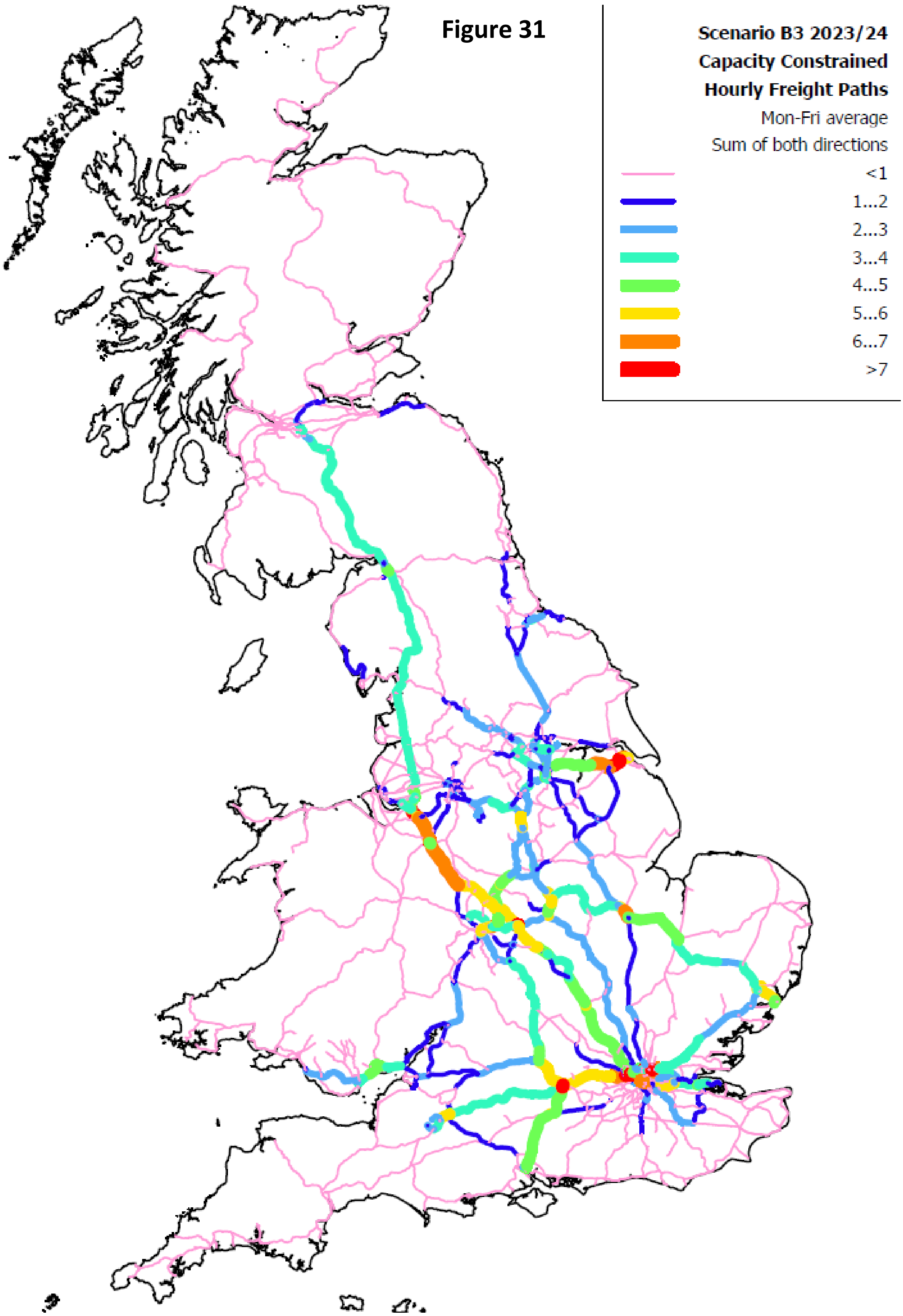


Figure 31
Scenario B3 2023/24
Capacity Constrained
Hourly Freight Paths
Mon-Fri average
Sum of both directions
<1
1...2
2...3
3...4
4...5
5...6
6...7
>7

We are likely to be under-constraining the forecast demand in some areas because we are limiting our analysis to just 7 locations. There may well be other locations in the network that would be over capacity in 2023/24.

However we are also likely to be over-suppressing some traffic because we are ignoring the potential options to re-route.

A capacity analysis would ideally be done more thoroughly. This approach could be extended:

- to incorporate more capacity-constrained locations
- to consider a more bespoke representation of available 2023/24 freight capacity for each location
- to consider the options for re-routing traffic (or revising the available capacity) at each stage of the capacity constraint in order to avoid suppressing traffic unnecessarily

However the simple approach we have adopted should give a broadly realistic indication as to the impact of capacity constraint.

8. RAIL MARKET SHARES

In the base year (2016/17) there were 1.9 billion tonnes lifted and 170 billion tonne kms by road (source: DfT's Continuing Survey of Road Goods Transport (CSRGT)). Therefore the base year rail mode share is 4.4% by tonnes and 10% by tonne kms.

Road traffic data for individual commodities / sectors is not always available in a consistent way to enable a direct comparison of road versus rail traffics. For example it is difficult to precisely define a road equivalent for rail's "domestic intermodal", and road data does not distinguish between ESI (power station) coal and "other coal".

However an indication of the road traffic and therefore rail's mode shares is given below for each rail sector. For the base year this is based on the rail data and the DfT's CSRGT. For 2023/24, the road data is scaled up/down using the sectoral market growths described in the assumptions.

Table 26: 2016/17. Million tonnes by road and rail by sector, and rail mode shares

Sector	Rail	Road	Total	Rail mode share	Notes
Automotive	0.4	46.0	46.4	1.0%	
Biomass	6.5	20.0	26.5	24%	1
Chemicals	0.9	51.0	51.9	1.7%	
Coal Other	2.0	8.0	10.0	20%	2
Construction materials (inc spoil)	24.3	467.0	491.3	4.9%	
Empty returns for containers carrying bulks	0.4	0.0	0.4	100%	3
NR Engineering	6.7	0.0	6.7	100%	
ESI Coal	6.3	0.0	6.3	100%	4
Industrial Minerals	1.3	4.0	5.3	25%	5
Channel Tunnel Intermodal	0.4	0.0	0.4	100%	
Domestic Intermodal	2.5	836.8	839.3	0.3%	6
Ports Intermodal	16.2	79.2	95.4	17%	7
Ores	4.3	0.0	4.3	100%	
Metals	7.4	47.0	54.4	14%	
Other	0.3	0.0	0.3	100%	8
Petroleum	4.7	63.0	67.7	7.0%	
Waste	1.2	262.0	263.2	0.5%	
Grand Total	**85.8**	**1,884**	**1,970**	4.4%	

Notes:

1. Road tonnes probably includes more than just biomass, so rail's mode share is probably understated
2. Some road coal may perhaps be to power stations

3. Not easy to find equivalent tonnage in road data
4. Some road coal may perhaps be to power stations, so the true rail share may be slightly lower than 100%
5. Difficult to define consistently with road data
6. Assumed to be the non-bulk cargoes, although difficult to consistently define for road
7. Road deduced from DfT's Port Freight Statistics minus transhipment and rail traffic. For Tonne km mode share, average length of haul for road is calculated based on adjusted CSRGT data
8. Difficult to define consistently

Table 27: Rail mode shares for the base year and 2023/24 scenarios. Tonnes

		2023/24					
Sector	2016/17	A2	B2	C2	D2	A3	B3
Automotive	1.0%	1.1%	1.2%	1.0%	1.1%	1.0%	1.0%
Biomass	24%	30%	40%	30%	40%	30%	39%
Chemicals	1.7%	1.9%	1.9%	1.8%	1.8%	1.9%	1.8%
Coal Other	20%	20%	33%	20%	33%	20%	33%
Construction materials (inc spoil)	4.9%	6.4%	7.7%	4.4%	5.3%	6.3%	7.4%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	25%	31%	31%	23%	23%	31%	31%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	0.3%	0.9%	0.9%	0.4%	0.4%	0.9%	0.8%
Ports Intermodal	17%	23%	23%	15%	15%	21%	19%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	14%	16%	16%	14%	14%	16%	16%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	7.0%	7.5%	7.5%	6.9%	6.9%	7.5%	7.5%
Waste	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Grand Total	**4.4%**	**5.2%**	**5.8%**	**3.9%**	**4.4%**	**5.0%**	**5.4%**

Note: For derivation of 2016/17 figures, see table on previous page

Table 28: 2016/17. Billion tonne kilometres by road and rail by sector, and rail mode shares

Sector	Rail	Road	Total	Rail mode share
Automotive	0.1	5.7	5.9	2.5%
Biomass	0.9	2.0	2.8	30%
Chemicals	0.1	6.5	6.6	2.2%
Coal Other	0.3	0.6	0.9	30%
Construction materials (inc spoil)	4.3	26.1	30.5	14%
Empty returns for containers carrying bulks	0.1	0.0	0.1	100%
NR Engineering	1.7	0.0	1.7	100%
ESI Coal	1.2	0.0	1.2	100%
Industrial Minerals	0.2	0.4	0.6	38%
Channel Tunnel Intermodal	0.1	0.0	0.1	100%
Domestic Intermodal	1.1	87.8	88.9	1.3%
Ports Intermodal	5.6	15.7	21.4	26%
Ores	0.2	0.0	0.2	100%
Metals	1.6	5.1	6.7	24%
Other	0.1	0.0	0.1	100%
Petroleum	1.1	5.2	6.4	18%
Waste	0.2	13.9	14.1	1.5%
Grand Total	**19.0**	**169.1**	**188.0**	**10%**

See notes to above table “2016/17. Million tonnes by road and rail by sector, and rail mode shares”

Table 29: Rail mode shares for the base year and 2023/24 scenarios. Tonne Kilometres

		2023/24					
Sector	2016/17	A2	B2	C2	D2	A3	B3
Automotive	2.5%	2.7%	2.9%	2.5%	2.8%	2.5%	2.3%
Biomass	30%	36%	47%	36%	47%	36%	47%
Chemicals	2.2%	2.4%	2.4%	2.2%	2.2%	2.4%	2.3%
Coal Other	30%	30%	70%	30%	70%	30%	70%
Construction materials (inc spoil)	14%	16%	20%	13%	15%	16%	19%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	38%	44%	44%	36%	36%	44%	43%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	1.3%	3.7%	3.7%	1.6%	1.6%	3.6%	3.4%
Ports Intermodal	26%	35%	35%	23%	23%	32%	28%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	24%	27%	27%	23%	23%	27%	26%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	18%	19%	19%	18%	18%	19%	19%
Waste	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Grand Total	**10%**	**12%**	**14%**	**9.1%**	**10%**	**12%**	**12%**

Note: For derivation of 2016/17 figures, see table on previous page

9. CONCLUSION

This report describes rail freight forecast demand results for 4 different 2023/24 scenarios (A2, B2, C2 and D2) spanning factors favouring rail to factors disfavouring rail, and low market growth to high market growth. These are presented in terms of tonnes, tonne kms, daily trains and hourly paths required.

The rail-favouring scenarios (A2 & B2) show significant growth in demand across the network. However in reality there are likely to be capacity constraints at some locations. We have incorporated a simple approach to capacity constraint - whereby required rail freight capacity through 7 known bottlenecks across the network is limited to 20% above that required in 2016/17. These capacity constrained scenarios (A3 & B3) are based on the forecast demand in scenarios A2 & B2.

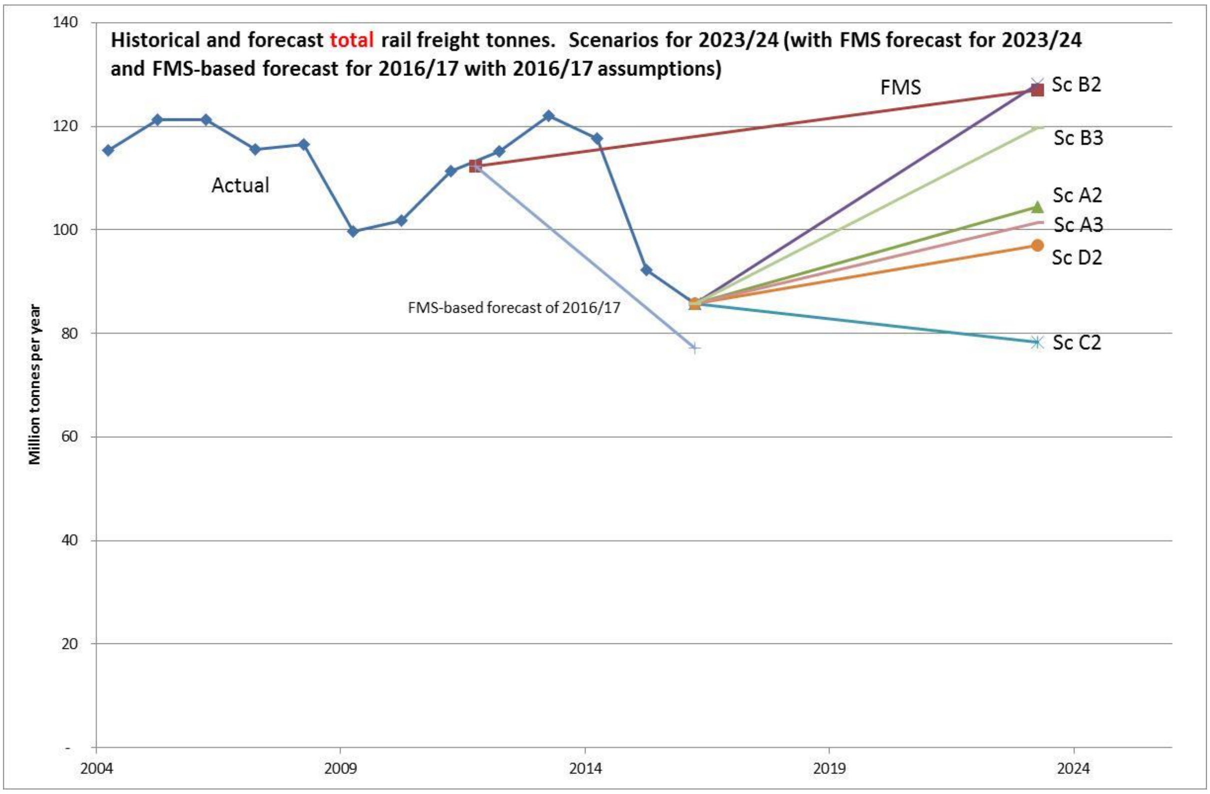
The table and graph below show how the new scenarios (including the two scenarios with the capacity constraint) compare with the 2023/24 FMS forecasts, along with the historical traffics from 2004/05. They also show what the FMS forecasts would have been for 2016/17 if out-turn assumptions for 2016/17 had been input into the FMS models (see below).

Table 30: Comparison of new forecasts with the FMS

Scenario	Million Tonnes
2016/17 actual	85.8
2023/24 A2: Factors favouring rail, low market growth	104.6
2023/24 B2: Factors favouring rail, high market growth	128.2
2023/24 C2: Factors disfavouring rail, low market growth	78.4
2023/24 D2: Factors disfavouring rail, high market growth	97.1
2023/24 Average of A2, B2, C2 & D2	102.0
2023/24 A3: A2 with capacity constraint	101.5
2023/24 B3: B2 with capacity constraint	119.7
2012 actual* (from FMS)	112.4
2016/17 forecast from FMS base with 2016/17 assumptions	77.1
Original FMS central case forecast for 2023/24	127.0

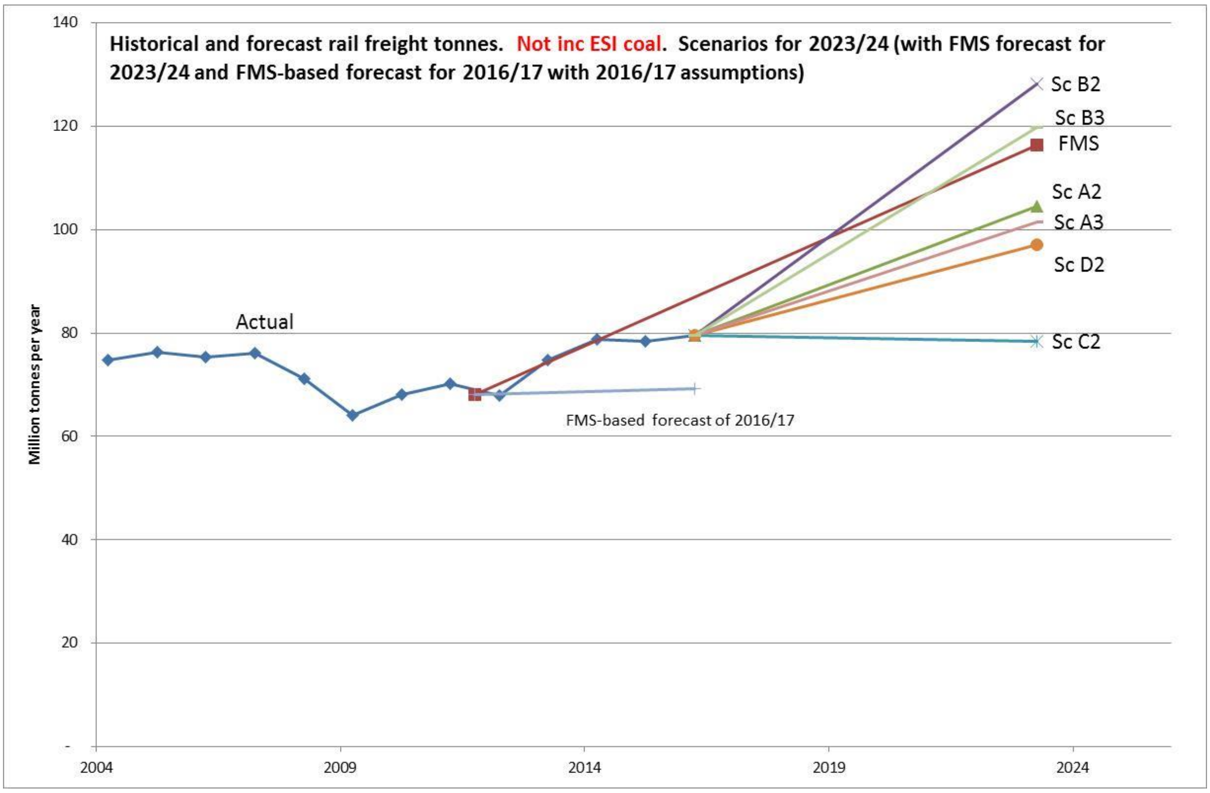
* FMS base year for modelling was 12 months to the end of September 2012.

Figure 32



ESI (power station) coal has historically been a volatile commodity – and is no longer forecast to be carried by rail in 2023/24. The graph below shows an equivalent graph but with ESI coal excluded (FMS = 116 m tonnes). Note that the graph does include biomass, which reflects conversion of power stations from coal to biomass.

Figure 33



Base year and forecast daily trains and hourly paths are assigned to the network and displayed as maps.

The report describes the assumptions and methods for the various sectors, and a market share analysis.

These results should enable Network Rail to estimate the range of their likely income from track access charges.

These forecasts demonstrate that differences in exogenous circumstances can have a large impact on the rail freight industry, with the total 2023/24 forecast rail freight tonnage ranging from 78 million tonnes in scenario C2 to 128 million tonnes in scenario B2. The average of the 2023/24 unconstrained scenarios (A2, B2, C2 & D2) is 102 million tonnes. This represents a 2.5% growth per year from 2016/17, or a 3.6% growth per year if ESI coal is excluded.

Fuel prices in particular impact on rail's ability to compete with road – with high fuel prices adversely affecting road more than rail, thus encouraging a switch from road to rail. Drivers' wages are also important, as is the development of rail-served warehousing for domestic intermodal traffic.

It should be noted that the model implicitly includes the assumption that the market will have fully adapted to the market conditions input into the model. However in the real world, many of the investments in assets are long-term – which gives the rail freight sector some inertia. The market is therefore unlikely to have fully adapted to very different conditions over a 7 year period. Some of the modelled large increases or declines may therefore be less extreme in reality than shown in these results.

Introducing the capacity constraint described above results in a suppression of 3% of tonnes in scenario A3 and 7% in B3.

The project included a forecast of 2016/17 from a 2012 base year – see appendix 2. This work showed that overall the revised 2012-based 2016/17 tonnage forecast based on actual input assumptions for 2016/17 was 10% lower than the actual traffic in 2016/17. The principal difference lay in the construction materials sector.

A comparison to the 2013 Freight Market Study shows that the total tonnage forecast in the FMS is similar to the latest 2023/24 highest growth scenario (B2). If ESI coal is excluded, scenarios B2 & B3 exceed the total tonnes forecast in the FMS.

APPENDIX 1: FURTHER SENSITIVITY TESTS: A4, B4, C4 & D4

Sensitivity tests A4, B4, C4 & D4 have also been modelled. These are based on scenarios A2, B2, C2 & D2 but assume a faster take-up of rail-served warehousing and a more radical increase in track access charges for the scenarios that disfavour rail (C4 & D4). These differences are summarised below.

A1.1 Assumptions

Table A1.1: Assumptions for scenarios A4, B4, C4 & D4 that differ from scenarios A2, B2, C2 & D2.

Rail-served warehousing sites. EXTRA thousand m^2 input into the model	Sc A2 & B2	Sc A4 & B4
DIRFT	305	609
Kegworth (East Midlands Gateway)	232	464
Four Ashes (West Midlands Interchange)	125	250
South Northampton	125	250
Rossington (iPort)	232	464
Howbury Park (Dartford)	83	167
Total	**1,102**	**2,204**
Rail-served warehousing sites. EXTRA thousand m^2 input into the model	Sc C2 & D2	Sc C4 & D4
DIRFT	150	300
Kegworth (East Midlands Gateway)	150	300
Four Ashes (West Midlands Interchange)	0	0
South Northampton	0	0
Rossington (iPort)	150	300
Howbury Park (Dartford)	0	0
Total	**450**	**900**
Variable Usage Charges by commodity	Already committed 2018/19 + 25%	Already committed 2018/19 + 100%[12]

As with scenarios A2, B2, C2 & D2, scenarios A4, B4, C4 & D4 do not include any consideration of capacity constraint.

[12] This +100% increase in track charges for all commodities is in line with options that were considered in the track access review for CP5. This may in reality be forms of track charges other than VUC. Even greater increases were also considered for some commodities. The ORR's review of track access charges for CP6 (2019/20 - 2023/24) is ongoing. The all-commodity +100% assumed in scenarios C4 & D4 (assumptions that disfavour rail) is intended to represent an outcome that would be considered worse-than-expected news for the rail freight industry.

A1.2 Results

The summary results tables and bar charts below show the forecast annual rail freight tonnes, annual tonne kms, daily trains and hourly paths required by sector for

- Actual traffic in 2016/17 base year[13]
- 2023/24 scenario A4: Factors which favour rail relative to road, with low market growth
- 2023/24 scenario B4: Factors which favour rail relative to road, with high market growth
- 2023/24 scenario C4: Factors which disfavour rail relative to road, with low market growth
- 2023/24 scenario D4: Factors which disfavour rail relative to road, with high market growth

Table A1.2: Rail freight TONNES forecast for 2023/24 scenarios by sector. Thousand tonnes per year

Sector	2016/17	2023/24 A4	2023/24 B4	2023/24 C4	2023/24 D4
Ports Intermodal	16,213	25,078	27,959	14,388	15,984
Domestic Intermodal	2,481	10,457	11,075	3,351	3,522
Channel Tunnel Intermodal	374	529	578	393	429
ESI Coal	6,284	-	-	-	-
Biomass	6,470	8,464	13,045	8,464	13,045
Waste	1,226	1,165	1,287	1,165	1,287
Construction materials	24,286	33,133	43,383	13,315	17,434
of which spoil	735	997	1,306	266	348
Petroleum	4,710	4,822	5,330	4,304	4,757
Chemicals	899	934	1,032	802	887
Industrial Minerals	1,335	1,580	1,747	766	847
Metals	7,441	8,226	9,092	5,456	6,030
Automotive	450	468	583	436	547
Ores	4,259	4,046	4,472	4,046	4,472
Coal Other	1,955	1,857	4,052	1,857	4,052
Other	334	368	407	307	340
Empty returns for containers carrying bulks	413	397	439	392	433
NR Engineering	6,657	6,324	6,990	6,324	6,990
Total	85,786	107,849	131,470	65,768	81,058

[13] Source: PALADIN billing data provided to us by Network Rail. We process this data to generate an origin-destination database. This total (85.8 mt) is higher than the ORR figure of 79.4mt. See appendix 2 (Section 11.3).

Table A1.3: Rail freight TONNES by sector. Growth from 2016/17 to 2023/24 (average of the 4 scenarios) Thousand tonnes per year

Sector	2016/17	Average of the 4 2023/24 scenarios	CAGR from 2016/17 to 2023/24 average
Ports Intermodal	16,213	20,852	3.7%
Domestic Intermodal	2,481	7,101	16.2%
Channel Tunnel Intermodal	374	482	3.7%
ESI Coal	6,284		
Biomass	6,470	10,755	7.5%
Waste	1,226	1,226	0.0%
Construction materials	24,286	26,816	1.4%
of which spoil	735	729	-0.1%
Petroleum	4,710	4,803	0.3%
Chemicals	899	914	0.2%
Industrial Minerals	1,335	1,235	-1.1%
Metals	7,441	7,201	-0.5%
Automotive	450	509	1.8%
Ores	4,259	4,259	0.0%
Coal Other	1,955	2,955	6.1%
Other	334	356	0.9%
Empty returns for containers carrying bulks	413	415	0.1%
NR Engineering	6,657	6,657	0.0%
Total	**85,786**	**96,536**	**1.7%**
Total excluding ESI coal	**79,502**	**96,536**	**2.8%**

Figure A1.1: Rail freight TONNES forecast for 2023/24 scenarios by sector

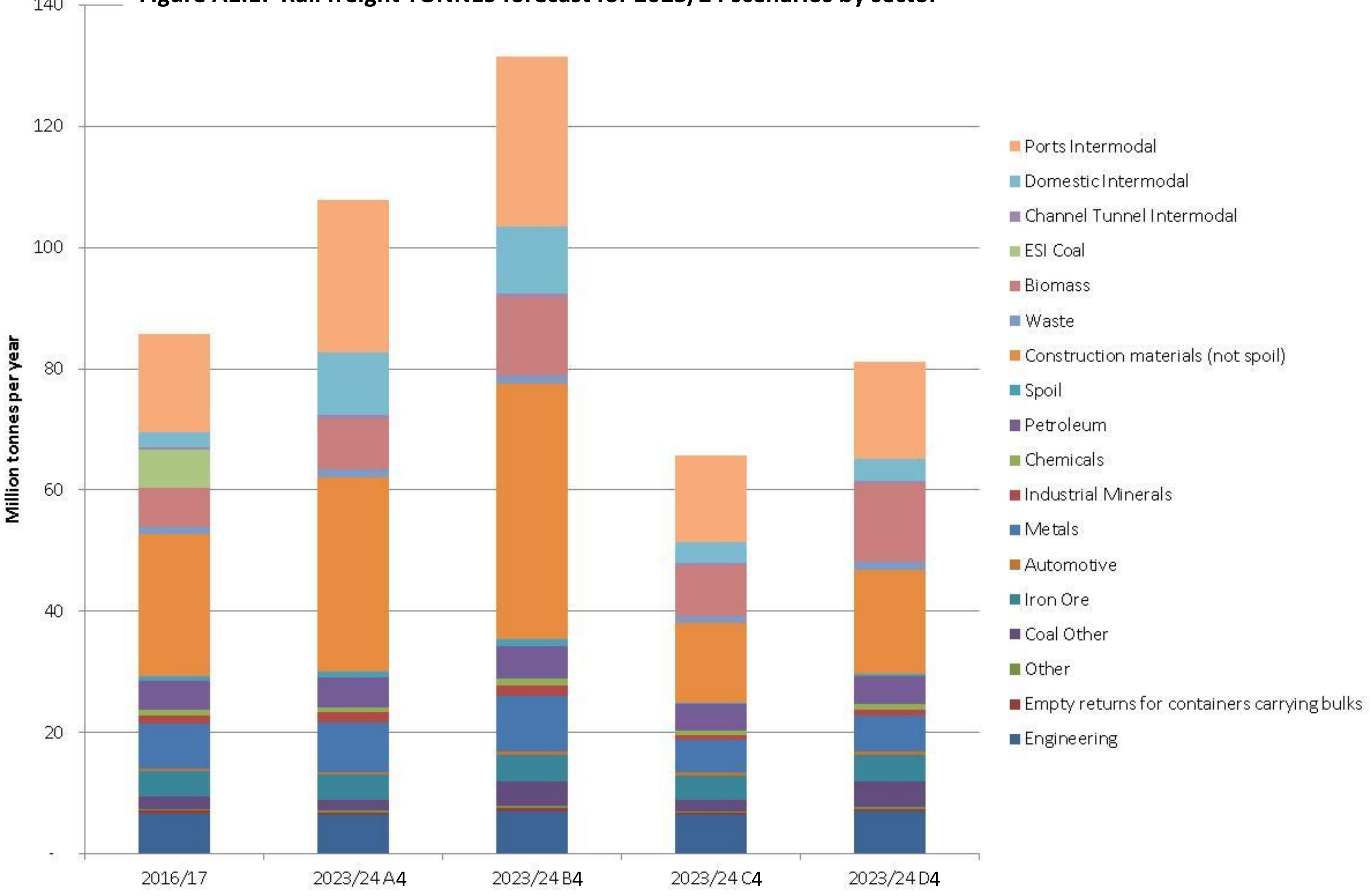


Table A1.4: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector. Million tonne kms per year

Sector	2016/17[14]	2023/24 A4	2023/24 B4	2023/24 C4	2023/24 D4
Ports Intermodal	5,612	8,364	9,302	4,952	5,499
Domestic Intermodal	1,136	4,392	4,664	1,562	1,648
Channel Tunnel Intermodal	94	133	145	99	108
ESI Coal	1,158	-	-	-	-
Biomass	853	1,093	1,673	1,093	1,673
Waste	215	204	225	204	225
Construction materials	4,342	5,242	6,863	2,336	3,059
of which spoil	94	127	166	33	43
Petroleum	1,134	1,141	1,261	1,040	1,149
Chemicals	142	152	168	124	137
Industrial Minerals	234	262	289	149	165
Metals	1,587	1,706	1,886	1,139	1,259
Automotive	146	149	180	141	171
Ores	156	148	164	148	164
Coal Other	267	254	783	254	783
Other	101	112	124	93	103
Empty returns for containers carrying bulks	69	68	75	65	72
NR Engineering	1,714	1,628	1,800	1,628	1,800
Total	**18,962**	**25,048**	**29,602**	**15,026**	**18,014**

[14] The 18.96 billion tonne kms figure agrees with the ORR data. See the ORR's published table "Freight moved - Table 13.7" (https://dataportal.orr.gov.uk/browsereports) and add the total (excluding infrastructure) (17.25) and the infrastructure (1.71) figures

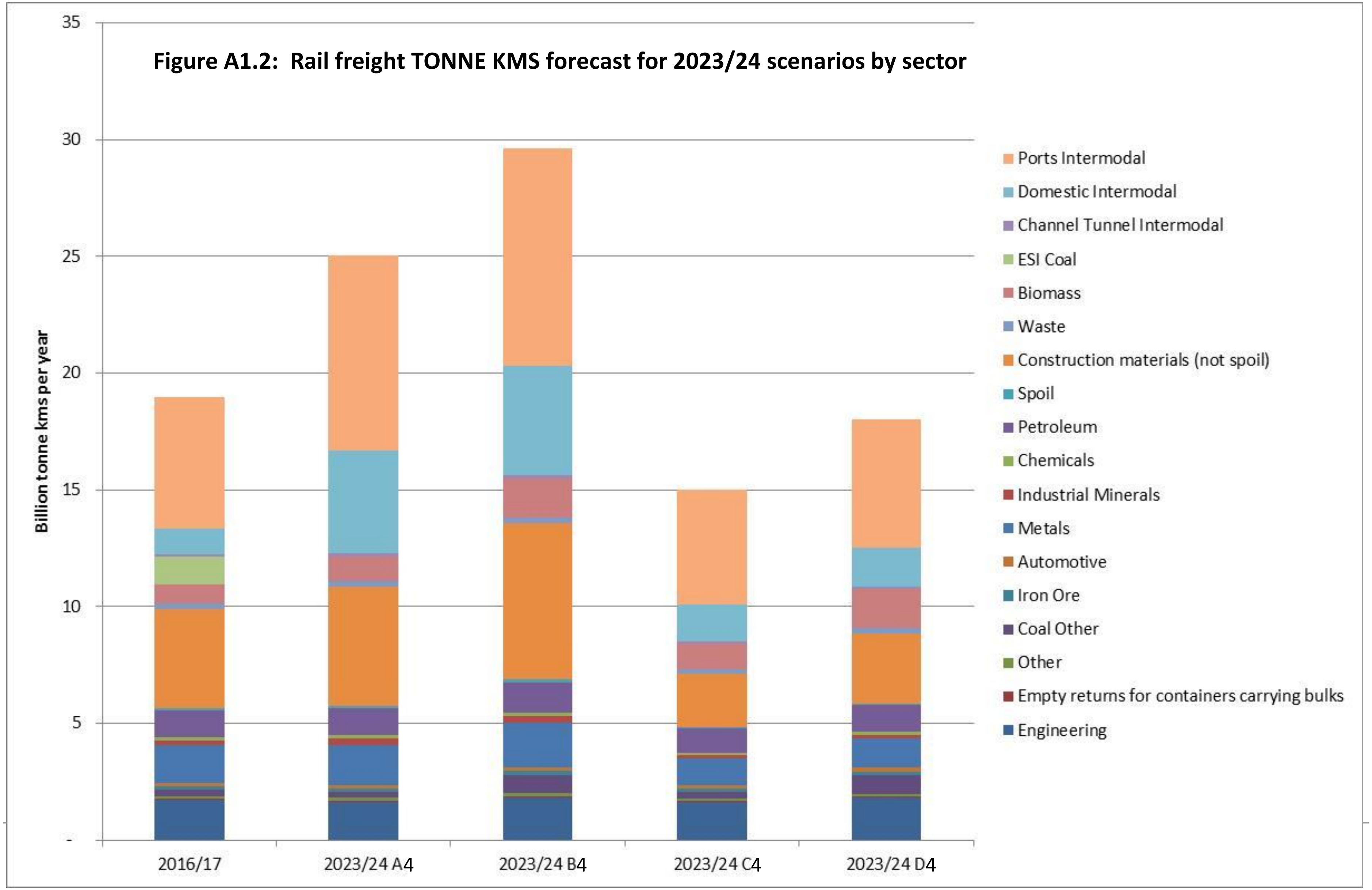


Figure A1.2: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector
Billion tonne kms per year
35
30
25
20
15
10
5
-
2016/17
2023/24 A4
2023/24 B4
2023/24 C4
2023/24 D4
Ports Intermodal
Domestic Intermodal
Channel Tunnel Intermodal
ESI Coal
Biomass
Waste
Construction materials (not spoil)
Spoil
Petroleum
Chemicals
Industrial Minerals
Metals
Automotive
Iron Ore
Coal Other
Other
Empty returns for containers carrying bulks
Engineering

Table A1.5: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A4	2023/24 B4	2023/24 C4	2023/24 D4
Ports Intermodal	123	181	202	109	121
Domestic Intermodal	19	76	80	25	27
Channel Tunnel Intermodal	3	4	4	3	3
ESI Coal	32	-	-	-	-
Biomass	32	40	61	42	64
Waste	8	7	8	8	9
Construction materials	135	176	230	74	97
of which spoil	5	6	8	2	2
Petroleum	19	19	21	18	19
Chemicals	7	7	8	6	7
Industrial Minerals	9	10	11	5	6
Metals	49	51	56	36	39
Automotive	19	19	23	18	23
Ores	27	25	27	26	29
Coal Other	13	12	27	13	28
Other	3	3	4	3	3
Empty returns for containers carrying bulks	10	9	10	9	10
NR Engineering	63	57	63	60	67
Total	**572**	**696**	**836**	**455**	**552**

Figure A1.3: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector

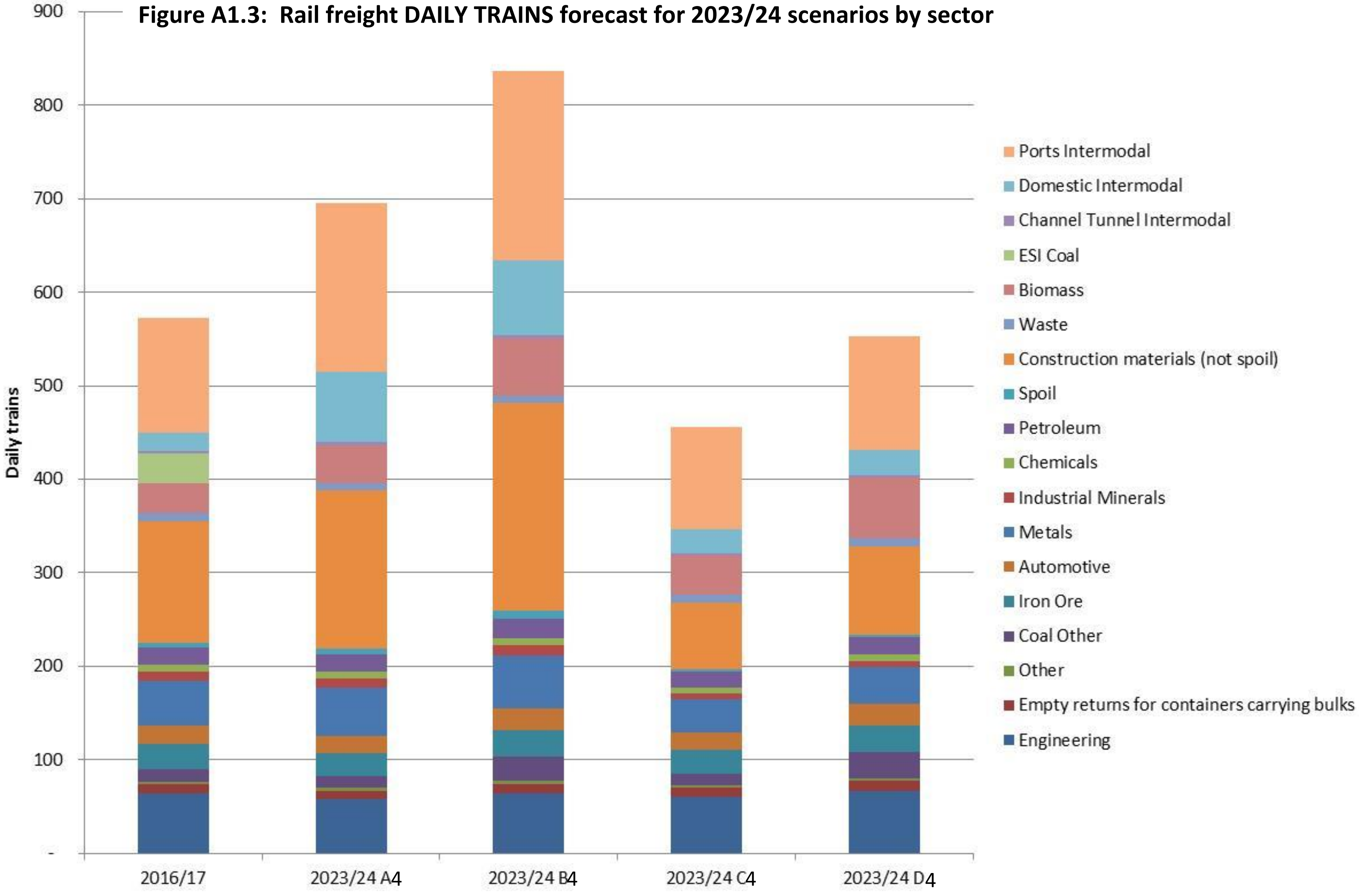


Table A1.6: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A4	2023/24 B4	2023/24 C4	2023/24 D4
Ports Intermodal	8.0	11.8	13.2	7.1	7.9
Domestic Intermodal	1.2	4.9	5.2	1.7	1.7
Channel Tunnel Intermodal	0.2	0.2	0.3	0.2	0.2
ESI Coal	3.9	-	-	-	-
Biomass	2.4	2.9	4.5	3.1	4.8
Waste	0.9	0.8	0.9	0.9	1.0
Construction materials	20.1	26.2	34.3	11.1	14.5
of which spoil	0.5	0.7	0.9	0.2	0.3
Petroleum	1.9	1.9	2.1	1.7	1.9
Chemicals	0.8	0.8	0.9	0.7	0.8
Industrial Minerals	1.0	1.1	1.3	0.6	0.6
Metals	5.3	5.6	6.1	3.9	4.3
Automotive	2.1	2.1	2.6	2.0	2.6
Ores	3.0	2.7	3.0	2.9	3.2
Coal Other	1.7	1.5	3.3	1.6	3.5
Other	0.4	0.4	0.4	0.3	0.4
Empty returns for containers carrying bulks	1.1	1.0	1.1	1.0	1.2
NR Engineering	3.5	3.2	3.5	3.3	3.7
Total	**57.6**	**67.2**	**82.7**	**42.1**	**52.1**

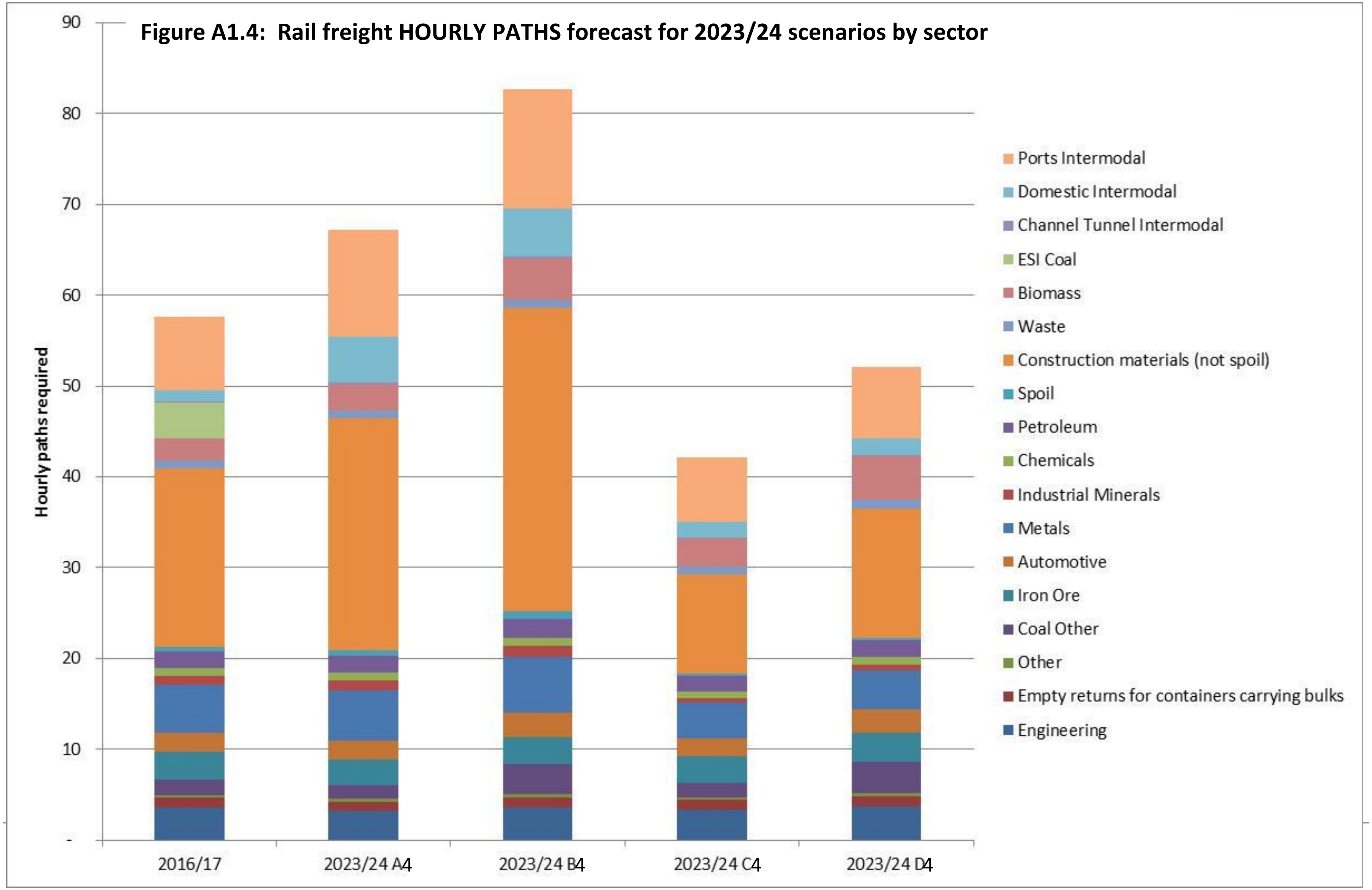


Figure A1.4: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector
Hourly paths required
90
80
70
60
50
40
30
20
10
-
2016/17
2023/24 A4
2023/24 B4
2023/24 C4
2023/24 D4
Ports Intermodal
Domestic Intermodal
Channel Tunnel Intermodal
ESI Coal
Biomass
Waste
Construction materials (not spoil)
Spoil
Petroleum
Chemicals
Industrial Minerals
Metals
Automotive
Iron Ore
Coal Other
Other
Empty returns for containers carrying bulks
Engineering

A1.3 Commentary

Compared to scenarios A2, B2, C2 & D2, the doubling of the extra rail-served warehousing input into the model results in more intermodal traffic in all scenarios. However the doubling of track access charges severely impacts rail traffics in scenarios C4 & D4.

Construction materials

In scenario C4, the model results suggest that rail would lose nearly half of its construction materials traffic due to the more-than-doubling of track access charges. When producing results, the model implicitly assumes that a market equilibrium has been reached. However the present-day reality is that the industry is buying wagons and investing in infrastructure on the expectation of growth, and that track charges will not double. This gives some inertia to the market. Another factor not included in the modelling is that several super-quarries have planning restrictions on their road freight volumes, thus limiting the scope to which they could easily switch mode to road. Both of these factors suggest that if the assumptions in scenario C4 were to come to pass, the steep decline would be less severe in the real world than the model suggests.

Intermodal

Ports intermodal shows large growth for scenarios A4 & B4 due to the increase building of inland rail-served warehousing, trade growth, increased fuel and wage costs, slightly longer trains and retention of MSRS grants. However scenarios C4 & D4 show a slight decline – largely due to the doubling of track access charges.

Domestic intermodal follows a similar pattern to ports intermodal but is particularly boosted by the extensive building of rail-served warehousing. The market can easily switch between road and rail and is highly price sensitive. The huge potential market for domestic non-bulk traffic is currently largely untapped by rail.

As with the construction sector, there may be some inertia in the intermodal market, with the industry taking some time to adjust, such that growth may take a few years to catch up with the potential traffic that the modelling suggests for scenarios A4 & B4.

APPENDIX 2: FORECAST OF 2016/17 FROM 2012 BASE YEAR

A2.1 Introduction

This appendix describes the first output of the project: to establish volumes by commodity sector for the financial year 2016/17 and compare them with what the 2012-based models would have predicted given the relevant actual assumptions for 2016/17. The purpose of this output is

- to build confidence in the methods used for forecasting
- to explain differences between modelled results and reality, and
- to make any changes to the modelling for the new 2023/24 forecasts, where such changes are justified by the analysis.

The modelling work has:

- used the same methodology as used in the earlier work. This is described in the original report (which is attached as an appendix to this report)
- used the same base year as the FMS (i.e. 12 months to the end of September 2012)
- used the same sectors as the FMS (i.e. the same commodity sectors and the three intermodal sub-sectors - Maritime, Domestic and Channel Tunnel).

As with the FMS, these model outputs are NOT capacity constrained.

A2.2 General assumptions for 2012-based 2016/17 forecasts

Many of the assumptions for these forecasts are for specific commodities. These are detailed in the relevant sections below. However the forecasts are also based on the following general assumptions, which cover all sectors. Note that all % changes are in real terms (i.e. the change in costs had general inflation been zero) from the base year (12 months to the end of September 2012) to 2016/17

- Labour (drivers' wages for road and rail) increased by 7% from the base year to 2016/17. Source: Work value-of-time, WebTAG, March 2017
- HGV fuel costs *decreased* by 24% from the base year to 2016/17. Source: monthly AA price reports up to March 2017.
- Fuel duty (both road and rail) decreased by 7% from the base year to 2016/17. They have remained constant in terms of £ per litre in “current prices”, so have therefore fallen in real terms.
- Derived rail fuel costs decreased by 38% based on the above.
- No significant changes in track access charges in real terms for 2016/17. However significant changes are due towards the end of CP5, for Variable Usage Charges (VUC), Freight Only Line

Charges and Freight Specific Charges for certain commodities. Source: "Track Usage Price List", Network Rail

- Tonnes per train have remained broadly similar for most commodities although Biomass is up by 42%, Intermodal is up by 10% and Construction is up by 6%. Source: MDST analysis of Network Rail billing data
- Operational days per week have remained largely constant. Source: MDST analysis of Network Rail billing data
- Routings of trains remain as they were in the base year. New flows generally use the shortest suitable path
- Our cost models are based on the use of diesel locomotives, with the implicit assumption that electric traction does not offer significantly cheaper transport costs.

A2.3 Modelling limitations

In an ideal world where the model was able to accurately reflect all factors affecting rail freight, the model's output would exactly reflect real world traffics. However a model is a simplification of the real world that attempts to reflect the most important drivers that are likely to affect rail freight volumes. We would expect some differences between the model's output and the real world, and we comment on those differences below.

One key omission from the FMS modelling of real world conditions is capacity constraint. For example, the model may forecast unconstrained volumes above those observed on key routes that are capacity constrained such as the Felixstowe branch line and the cross country route via Ely.

The model assumes an equilibrium has been reached such that the market has fully adjusted to the costs in the forecast year. However in reality, the market can take time to adjust.

Comparison to ORR published tonnes lifted figures

The source of the rail tonnes lifted figures in this report is PALADIN billing data provided to us by Network Rail. We process this data to generate an origin-destination database by filtering out double-counting and en-route terminals, to arrive at just one cargo tonnage record from wagon journey start to wagon journey finish. Our overall tonnage for 2016/17 is 85.8 million tonnes, of which 8.2 million is coal.

Rail tonnes lifted data is also published by the ORR. The data is sourced separately from each of the largest 4 Freight Operating Companies (FOCs) (DB Cargo, Freightliner, Direct Rail Services (DRS) and GB Railfreight)[15]. Their total (79.4 million tonnes) does not include the smaller operators (such as Colas and Devon & Cornwall Railways) and is slightly below our total (85.8 million tonnes). They report 12.0 million tonnes of coal (compared to our 8.3m t). It is difficult to directly compare these coal figures because there may be other cargo categories associated with the coal industry that some FOCs may have included within the coal business sector such as gypsum, limestone and pulverised fly ash, and possibly biomass.

If the ORR data was available at greater disaggregation (both by commodity and geographically for origins and destinations), it would be possible to investigate the differences further.

[15] Source: ORR Freight rail usage quality report: www.orr.gov.uk/__data/assets/pdf_file/0016/22903/freight-usage-quality-report.pdf

A2.4 Intermodal

Intermodal container traffics serve a diverse market, typically for non-bulk traffic, with 3 main distinct markets:

- Maritime containers (ports intermodal)
- Domestic (non-port) intermodal
- Channel Tunnel

Additional assumptions for intermodal traffic from base year to 2016/17:

- 10% longer trains (more tonnes per train). This is an average – but is applied to all intermodal traffic. Source: MDST analysis of Network Rail billing data. There has been no equivalent increase in road productivity over the period.
- In the FMS forecasts for 2023/4, we made assumptions about unitised trade growth based on MDS Transmodal's World Cargo Database (WCD) - separately for deep sea and short sea. Similarly for these 2016/17 forecasts, we have used WCD to represent trade growth for deep sea (+17%) and short sea (+13%) trade growth for imports[16] from the base year. WCD incorporates uptodate trade data, so 2016/17 outputs are now based on real trade data, not forecasts.
- In the FMS forecasts for 2023/4, we made assumptions about which deep sea container port developments would come on stream to match demand, and we split the forecast trade accordingly. There is currently excess deep sea container port capacity, so the most meaningful way to follow the principles of the FMS in representing *available* capacity <u>*that is used*</u>, is to split the traffic on the basis of ***used*** capacity. This is taken from Maritime Statistics[17].
- The assumed growth in domestic non-bulk all-mode transport market is based on the average of population growth (+3.3%) and GDP growth (+10.2%) = +6.8%[18]
- Rail-served warehousing sites development has been slower than expected. The rail-served sites we have input into MDS Transmodal's Multimodal Distribution Park Demand Model (MDPDM) to represent 2016/17 are: DIRFT 600,000m^2, 3MG (Ditton) 100,000m^2, Hams Hall 300,000m^2, Wakefield 200,000m^2 and Birch Coppice 100,000m^2. [19]

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[16] The container shipping market for the UK is largely driven by import tonnes. As there are many empty containers being exported, changes in ***tonnes*** exported in containers is unlikely to have a significant impact on the ***number*** of containers carried because the empty containers will be utilised.

[17] Eurostat table: mar_go_qmc with 2016 Q4 & 2017 Q1 estimated growth based on MDST's World Cargo Database (WCD)

[18] Although the latest published figures for road freight (DfT's Continuing Survey of Road Goods Transport) are for 2015, this shows a broadly similar picture for non-bulk tonnage growth: up 8.5% from 2011 to 2015.

[19] We represent base year rail-served warehousing as DIRFT 500,000 m^2, 3MG (Ditton) 100,000 m^2, Hams Hall 300,000 m^2, Wakefield 200,000 m^2 and Birch Coppice 50,000 m^2. I.e. growth is represented as 150,000 m^2: 100,000 m^2 at DIRFT and 50,000 m^2 at Birch Coppice. It is difficult to relate actual warehousing to rail-served

- Channel Tunnel growth is assumed to be static, given security concerns. Note: the revised forecast volumes for 2016/17 for Channel Tunnel intermodal – see below - do not take account of the short sea trade growth figures quoted above

The figure and table below show maritime container tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.1

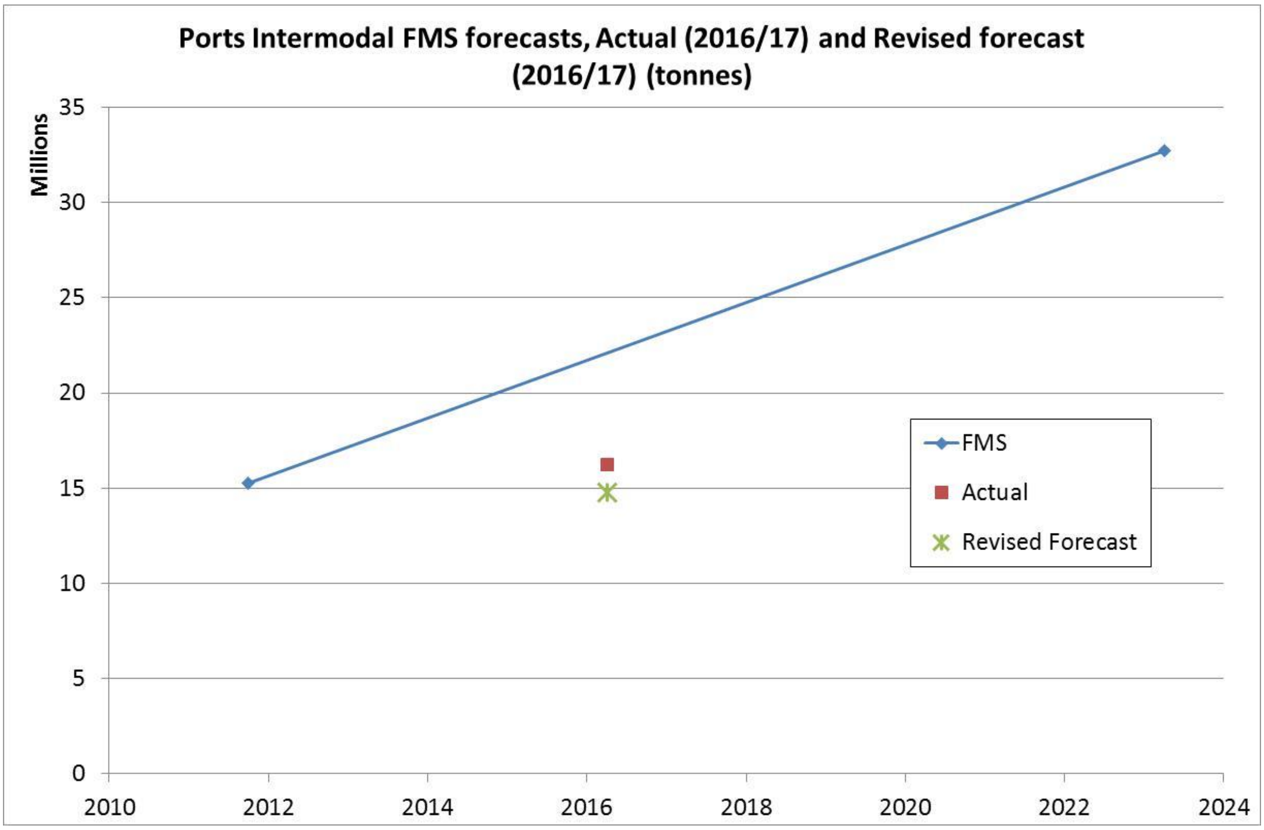


Table A2.1: Ports Intermodal FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	15.3
FMS 2023/24	32.7
Actual 2016/17	16.2
Revised forecast for 2016/17	14.8
2016/17 Difference	-9%

warehousing in the model in a consistent manner because there are warehouses that despite being rail-served, do not operate fully as rail-served warehouses.

The FMS forecasts envisaged a doubling of ports intermodal by 2023/4. However there has been little growth since the base year. This is predominantly due to lower than expected fuel prices. Fuel prices are a large component of road costs but a much smaller component of rail costs. Therefore any reduction in fuel costs helps road haulage to compete with rail. Containers can easily switch mode between road and rail.

Inputting the revised assumptions representing 2016/17 into the MDPDM, results in a forecast 9% lower than the actual volume of traffic.

There have been some adjustments in the deep sea container market since the base year:

- Major changes in the ownership, control and organisation of services whereby almost all global services are now operated by the three Alliances
- The main growth in port traffic has been at London Gateway. However largely due to economies of scale, their rail mode share is lower than at Felixstowe and Southampton
- Felixstowe's port growth has been modest (+3%) but has increased its rail traffic by 21% – largely due to the new terminal and longer trains, plus a small increase in available paths per day
- Southampton has experienced large growth in port traffics (+47%). Rail traffics have also increased (+17%), but therefore with some loss of rail mode share.
- Thamesport has suffered a decline in port traffic of over 50% and rail services have ceased.
- Tilbury has lost traffic to London Gateway and its Freightliner terminal has closed.

The figure and table below show domestic intermodal tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.2

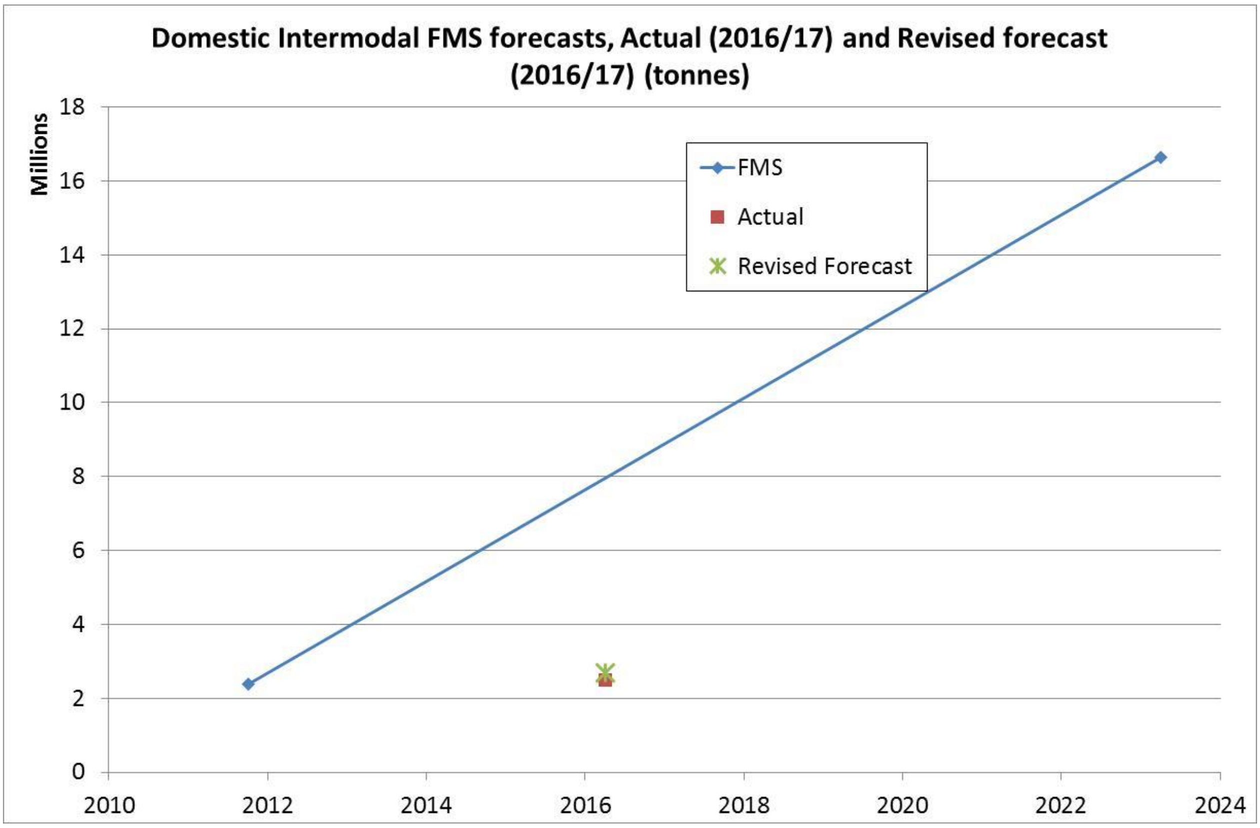


Table A2.2: Domestic Intermodal FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	2.4
FMS 2023/24	16.6
Actual 2016/17	2.5
Revised forecast for 2016/17	2.7
2016/17 Difference	8%

Similarly to maritime containers, the FMS forecasts envisaged a large increase in domestic intermodal by 2023/4. However there has been little growth since the base year. Again this is predominantly due to the lower than expected fuel prices, along with slower development of rail-served warehousing than expected.

In the FMS we did not make explicit assumptions about how much rail-served warehousing there would be in 2016/17. We would have expected development to be faster in the later years leading up to 2023/4 as the merits of rail-served warehousing became more apparent (higher fuel prices & drivers wages etc boosting rail's competitiveness versus road). However we expected an increase of 4.255 million square metres from the base year to 2023/4. The actual increase to 2016/17 has been around 150,000 m^2, depending on the definitions of what is counted as a rail-served warehouse. This would not appear to be on target for the FMS 2023/4 forecasts.

Inputting the revised assumptions representing 2016/17 into the MDPDM, results in a forecast 8% higher than the actual volume of traffic.

The figure and table below show Channel Tunnel intermodal tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.3

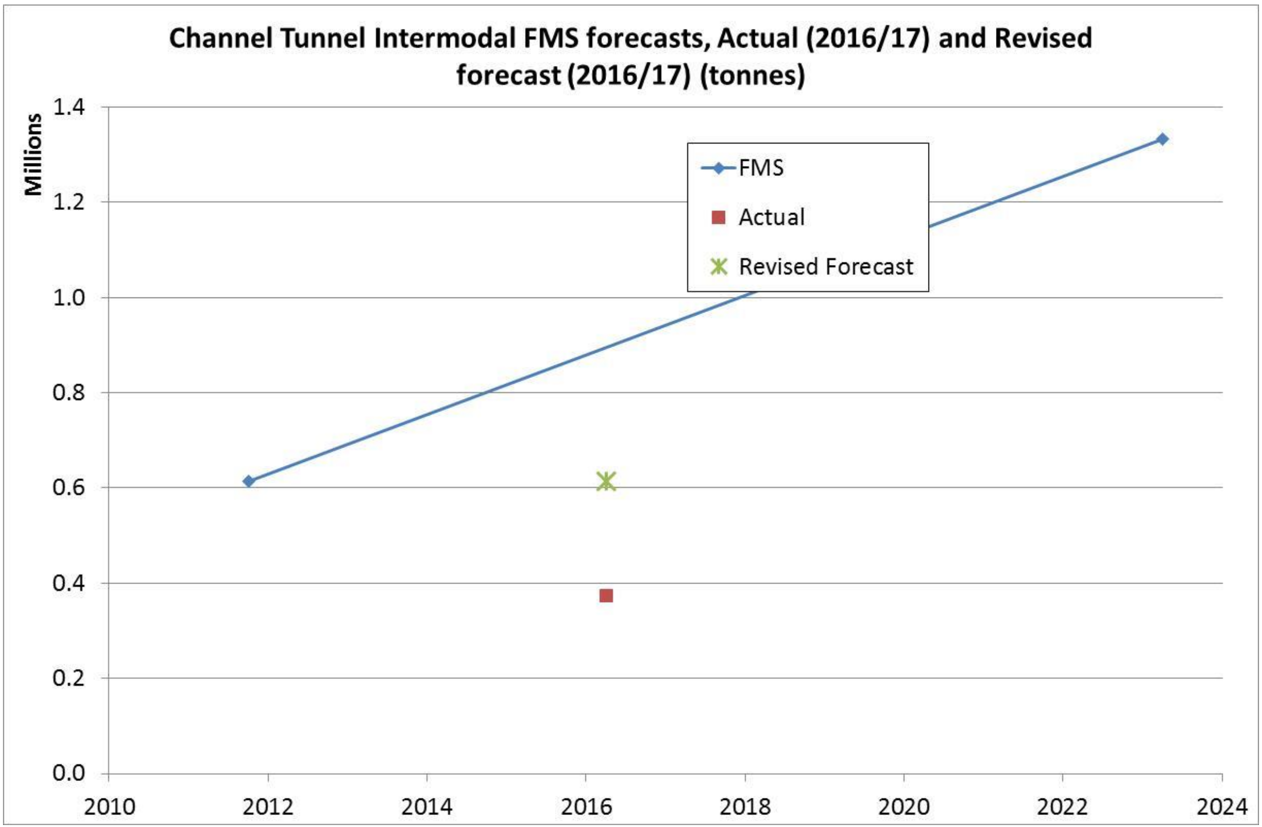


Table A2.3: Channel Tunnel Intermodal FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	0.6
FMS 2023/24	1.3
Actual 2016/17	0.4
Revised forecast for 2016/17	0.6
2016/17 Difference	64%

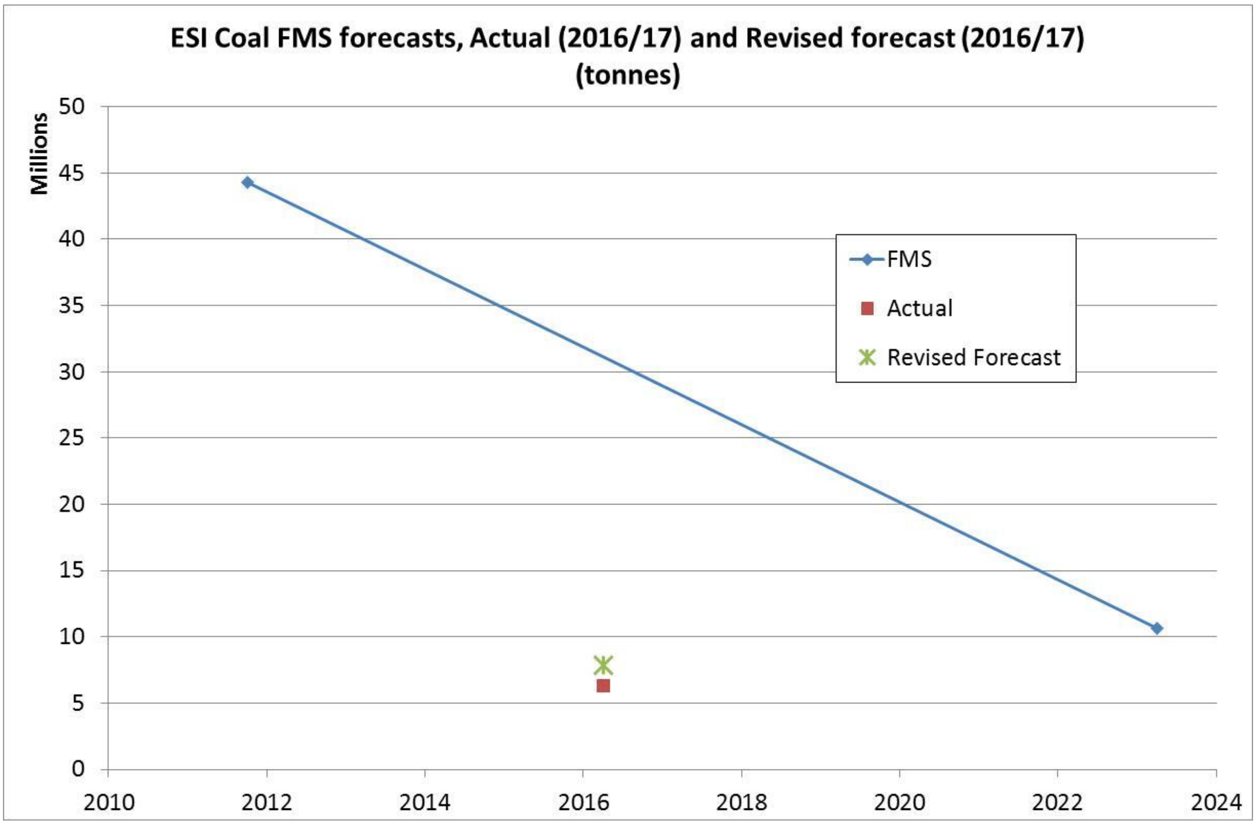
The improvements anticipated in the market for carrying containers through the Channel tunnel[20] have not materialised, and the Channel Tunnel has lost market share[21].

Security issues have made it much harder to reliably operate trains – thus increasing costs and discouraging customers.

A2.5 ESI (power station) coal

The figure and table below show coal tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.4



[20] Some combination of reduced Channel Tunnel Tolls, French Eco tax on HGVs, Low sulphur zone (SECA) for shipping, the DfT's charging scheme for overseas-registered HGVs, improved quality on French rail network equating to the equivalent of £20 per container

[21] The short sea unitised market has grown by 13% (source WCD)

Table A2.4: ESI Coal FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	44.2
FMS 2023/24	10.6
Actual 2016/17	6.3
Revised forecast for 2016/17	7.8
2016/17 Difference	25%

Our FMS projections were based on forecasts made by DECC in Oct 2012 for percentage reductions in coal consumption at power stations. The reality has been a faster decline.

Using historic data[22], there is a decline in coal used in electricity generation in 2016/17 to just 18% of that used in the base year.

Scaling down the ESI coal rail tonnes results in a 2016/17 forecast of 7.8m tonnes. The actual 2016/17 rail traffic was 6.3 m tonnes. There is likely to be some difference between forecast and actual traffics due to power station choice, mode choice, stockpiles etc.

[22] Source: BEIS "Fuel used in electricity generation and electricity supplied". For 2017 Q1, an estimate is made based on the % change from 2016 Q4 in rail tonnes of ESI coal.

A2.6 Biomass

The figure and table below show biomass tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.5

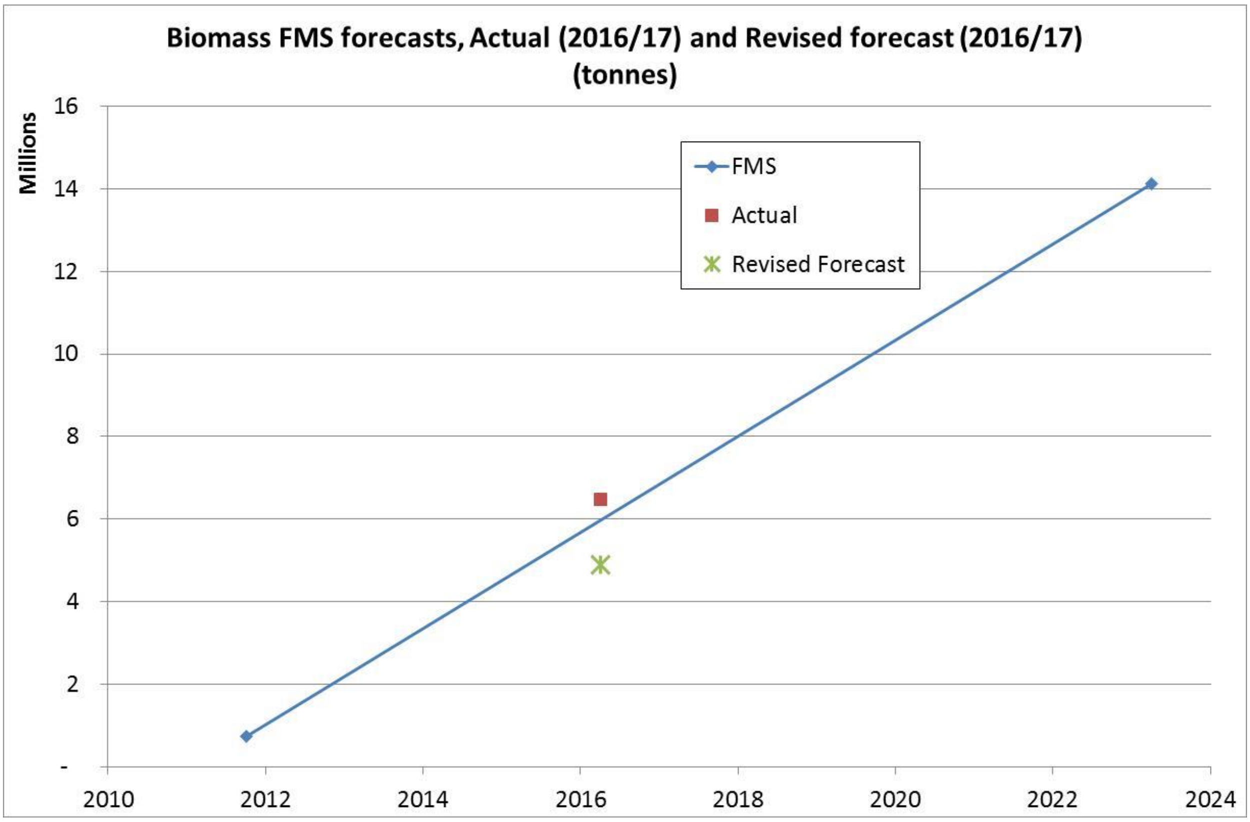


Table A2.5: Biomass FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	0.7
FMS 2023/24	14.1
Actual 2016/17	6.5
Revised forecast for 2016/17	4.9
2016/17 Difference	-24%

Our assumptions were based on what would happen in the biomass power station market. We adopted a general approach – assuming that coal power stations would switch 30% of their generating units to biomass by 2023/4, while recognising that a more realistic assumption would be that some power stations switch much more than 30% to biomass, and others do not switch at all.

The reality has been that Drax converted 2 of its 6 generating units to biomass, but no other rail-served power station has converted to biomass. Note that Ironbridge was consuming significant volumes of biomass, but this was a short term arrangement that has now stopped.

The calculation in our FMS forecast was:
"Given the lack of concrete plans, we have assumed that all rail-fed coal power stations (excluding Ironbridge, Didcot and Cockenzie which are closing by 2016 – see section 5) switch 30% of their generating units to biomass by 2023/4. Biomass has lower energy per tonne, so for any generating unit to retain its generating capacity when it switches to biomass, it will have to increase the tonnes of fuel it receives by approximately 46%. We assume that typically 80% of the incoming biomass tonnage will be by rail such that the future biomass-by-rail tonnage is an additional 35% of the coal tonnage currently arriving by rail to each coal power station: 30% switching X 146% for lower energy per tonne X 80% rail mode share = 35%."

Drax has converted 2 of its 6 units to biomass along with a partial upgrade for a third unit[23]. If we consider this as equivalent to a 42% switch to biomass, following the logic above, that would mean our 2016/17 forecast for Drax's biomass-by-rail tonnage would be 49% of its 10 million tonnes of coal arriving by rail in the base year: 4.9m tonnes. Drax's actual biomass consumption by rail in 2016/17 was 6.5 million tonnes.

There are various possible explanations for this:

- Drax was already co-firing biomass with coal in its units that were not fully converted to biomass, so some of the remaining units may be consuming some biomass.
- The rail mode share for Drax's biomass may well be greater than 80%.
- The utilisation of the generating units is implicitly assumed to be the same for the coal units in the base year and the converted units in the forecast year. However power stations do not always operate at consistent levels of utilisation.

[23] Drax history for 2015: https://www.drax.com/about-us/our-history/

A2.7 Waste

The figure and table below show waste tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.6

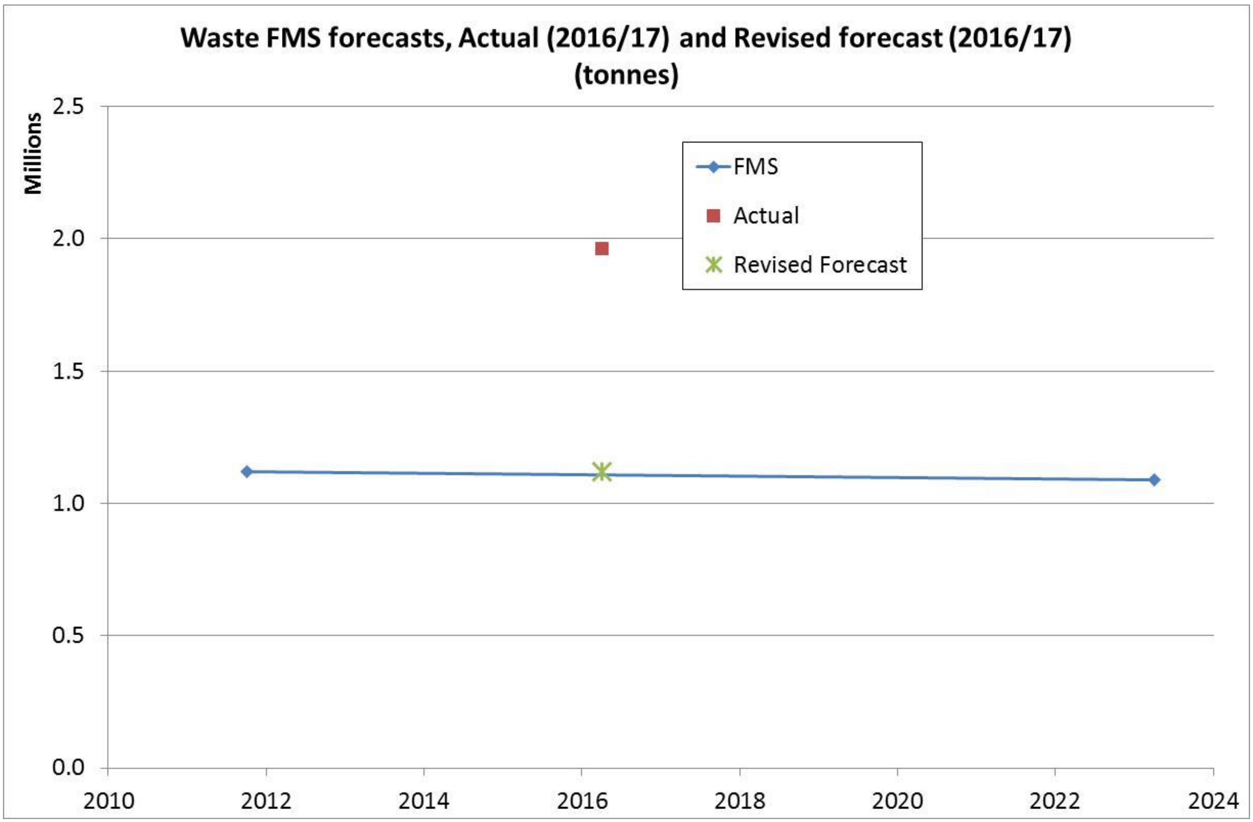


Table A2.6: Waste FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	1.1
FMS 2023/24	1.1
Actual 2016/17	2.0
Revised forecast for 2016/17	1.1
2016/17 Difference	-43%

Note that in the above table and in the FMS, "Spoil" was included in "Waste". However in the main body of this report, spoil is included and separately identified within the construction sector.

Our forecasts were for the overall tonnage to remain constant. However there has been a significant increase in tonnes. In the base year 96% of this waste traffic was household waste.

Household waste has remained relatively stable – with a 13% increase in rail tonnage. A few new rail-served sites have come on stream including Folly Lane (Runcorn), Severnside and Wilton EfW, but much of their traffic is transferred from other household waste destinations.

The main change in the market that we did not anticipate has been a large growth in spoil by rail. This has increased from 40,000 tonnes to 740,000 tonnes – largely made up of traffic from London to Barrington and Calvert. This explains the majority of the difference in forecast tonnage.

Note: there is a good case for including this spoil traffic within the construction materials sector rather than the waste sector. For the 2023/4 forecasting work, we intend to class them as construction materials, but identify them separately.

A2.8 Construction materials

The figure and table below show construction materials tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.7

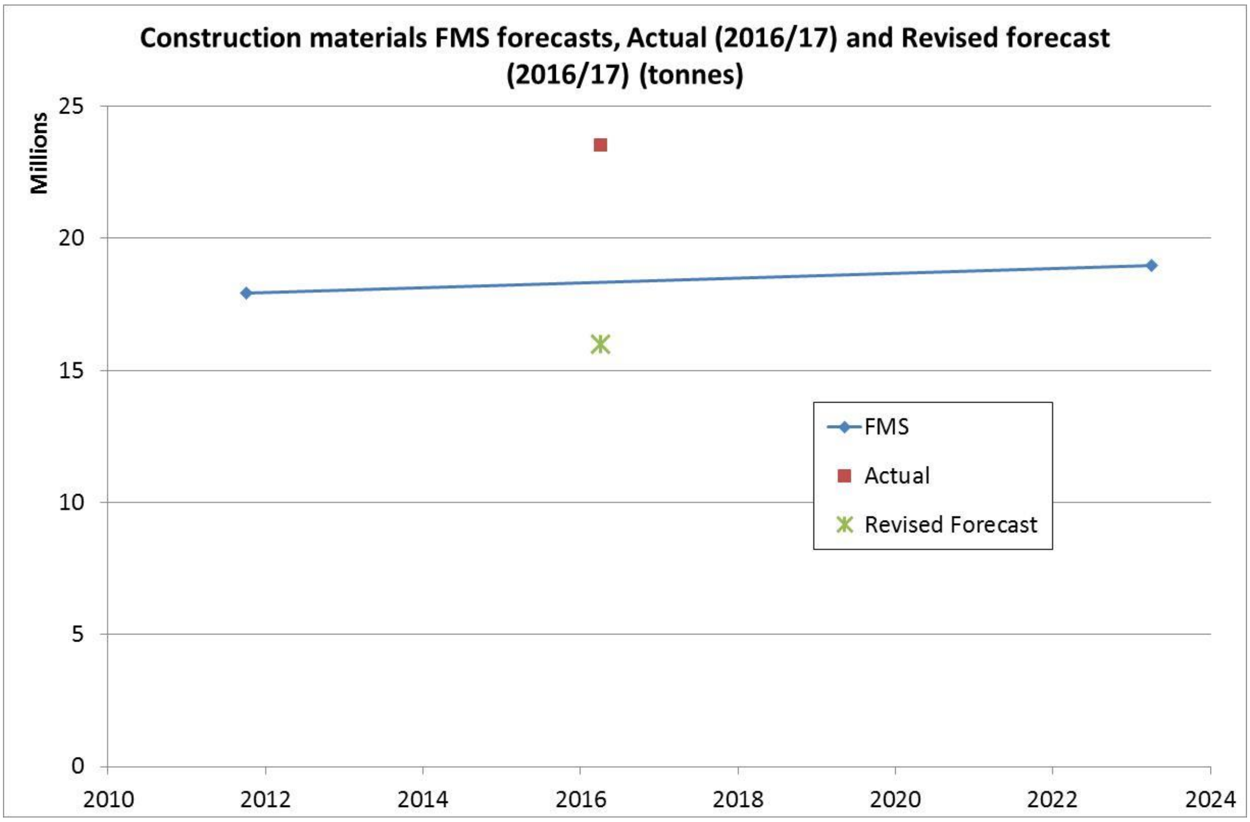


Table A2.7: Construction materials FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	17.9
FMS 2023/24	19.0
Actual 2016/17	23.6
Revised forecast for 2016/17	16.0
2016/17 Difference	-32%

Note that in the above table and in the FMS, "Spoil" was included in "Waste". However in the main body of this report, spoil is included and separately identified within the construction sector.

Our forecasting methodology for the FMS related growth to population growth, and favourable modal economics versus road (wages and fuel costs increasing to 2023/24). Following that same

method (population up by 3.3%) with the lower fuel prices for 2016/17 results in a forecast decrease in rail traffic as road becomes more economic. Increasing the length of trains by 6% reduces the cost per tonne of using rail, but not enough to counteract the fuel cost induced switch to road.
Actual traffics have grown by 31%. There is a trend towards “super quarries” (typically rail-connected) gradually taking over the supply of crushed rock from smaller local quarries (typically not rail-connected). The rail connections at these “super quarries” allow distant markets to be served. “Super quarries” in Somerset, Derbyshire, Leicestershire & North Yorkshire compete to serve the major cities and construction projects in England. Around half of the crushed rock from these counties travels by rail. However this effect was not well represented in our FMS forecasts but will be represented in our revised 2023/4 forecasts.

The difference between the actual and the revised forecast may also be partly due to the total market growing faster than population growth, due to growth in spending on infrastructure.

A2.9 Petroleum, Chemicals, Industrial Minerals, Metals and Auto

The figure and table below show petroleum tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.8

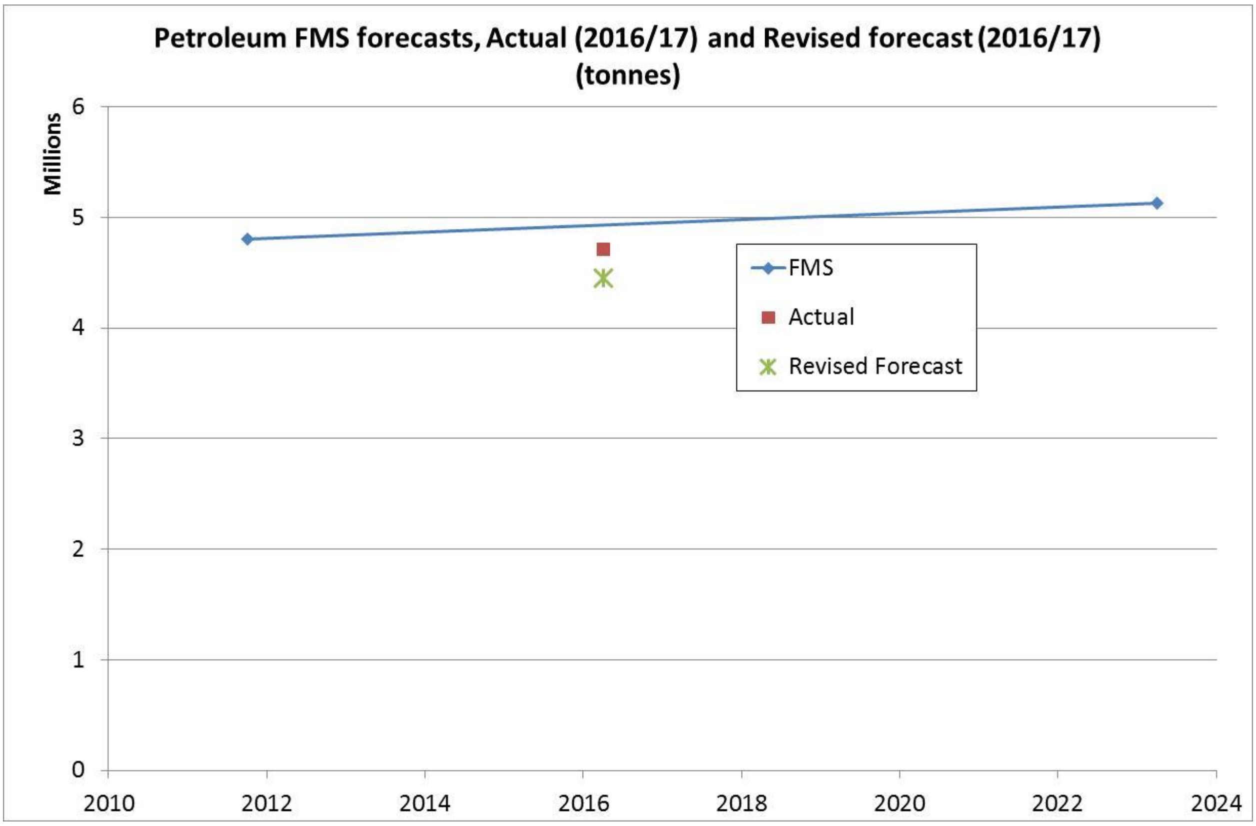


Table A2.8: Petroleum FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	4.8
FMS 2023/24	5.1
Actual 2016/17	4.7
Revised forecast for 2016/17	4.5
2016/17 Difference	-5%

The figure and table below show chemicals tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.9

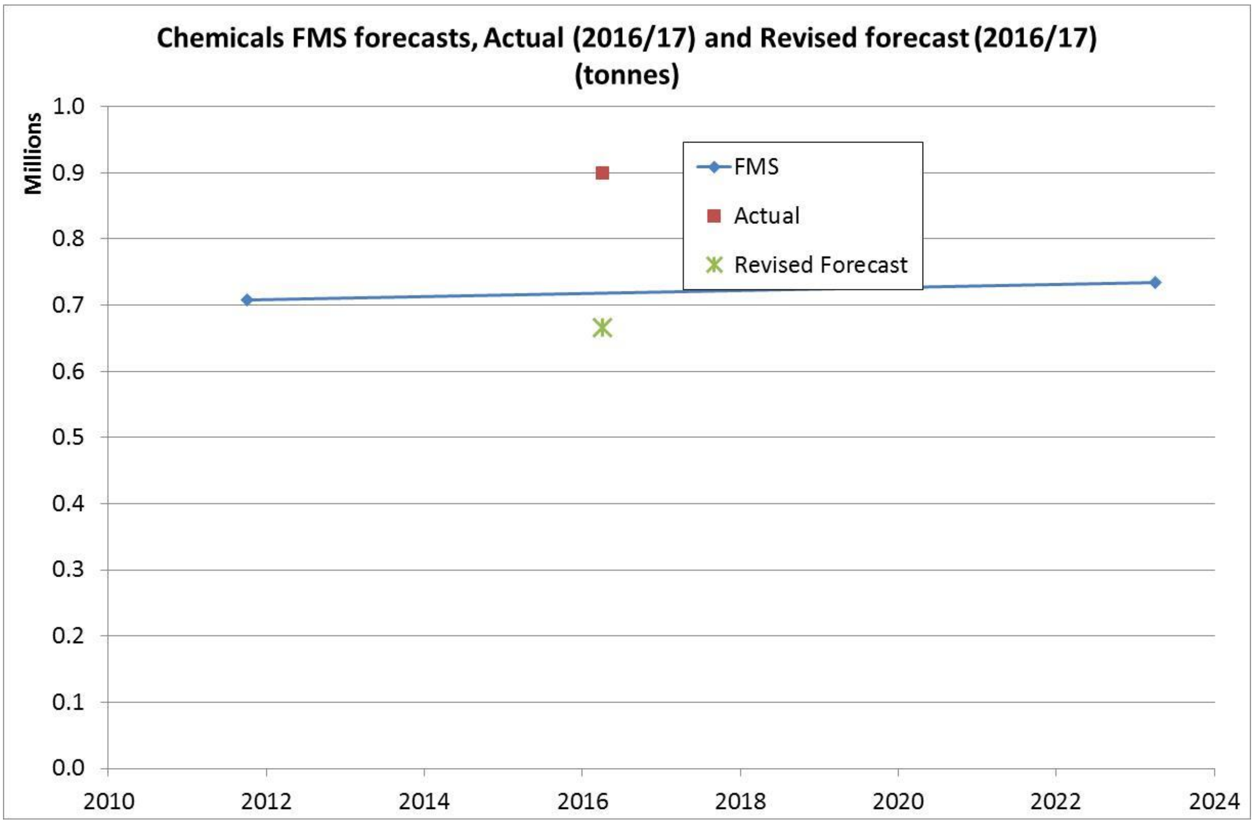


Table A2.9: Chemicals FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	0.7
FMS 2023/24	0.7
Actual 2016/17	0.9
Revised forecast for 2016/17	0.7
2016/17 Difference	-26%

The figure and table below show industrial minerals tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.10

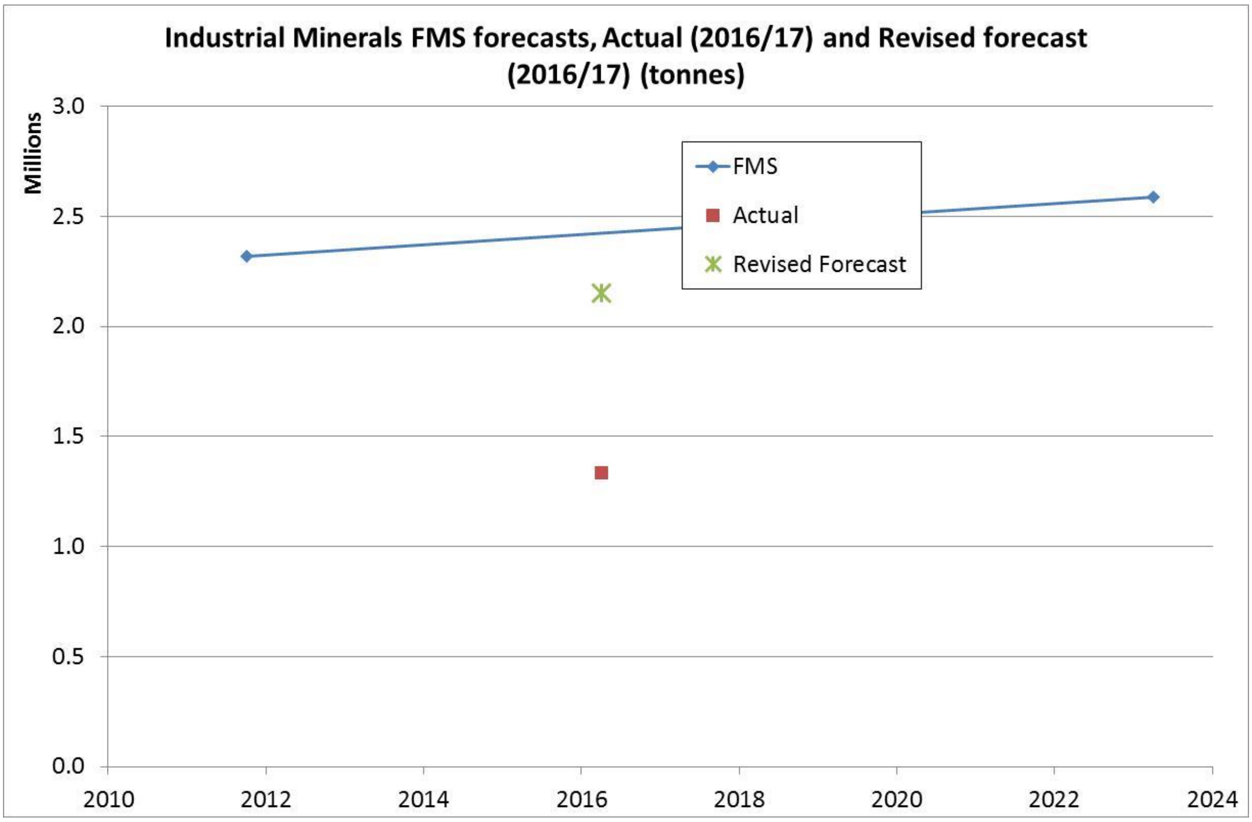


Table A2.10: Industrial Minerals FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	2.3
FMS 2023/24	2.6
Actual 2016/17	1.3
Revised forecast for 2016/17	2.2
2016/17 Difference	61%

The figure and table below show metals tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.11

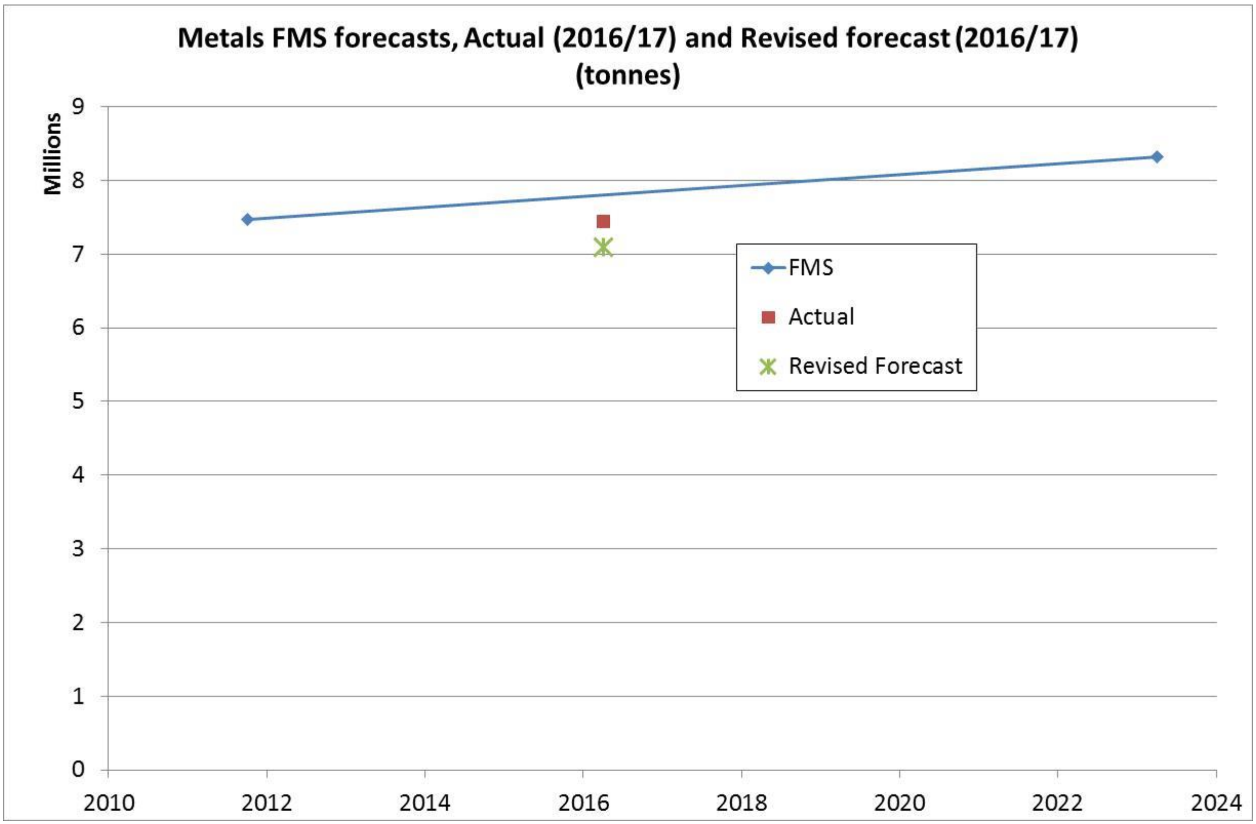


Table A2.11: Metals FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	7.5
FMS 2023/24	8.3
Actual 2016/17	7.4
Revised forecast for 2016/17	7.1
2016/17 Difference	-5%

The figure and table below show automotive tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.12

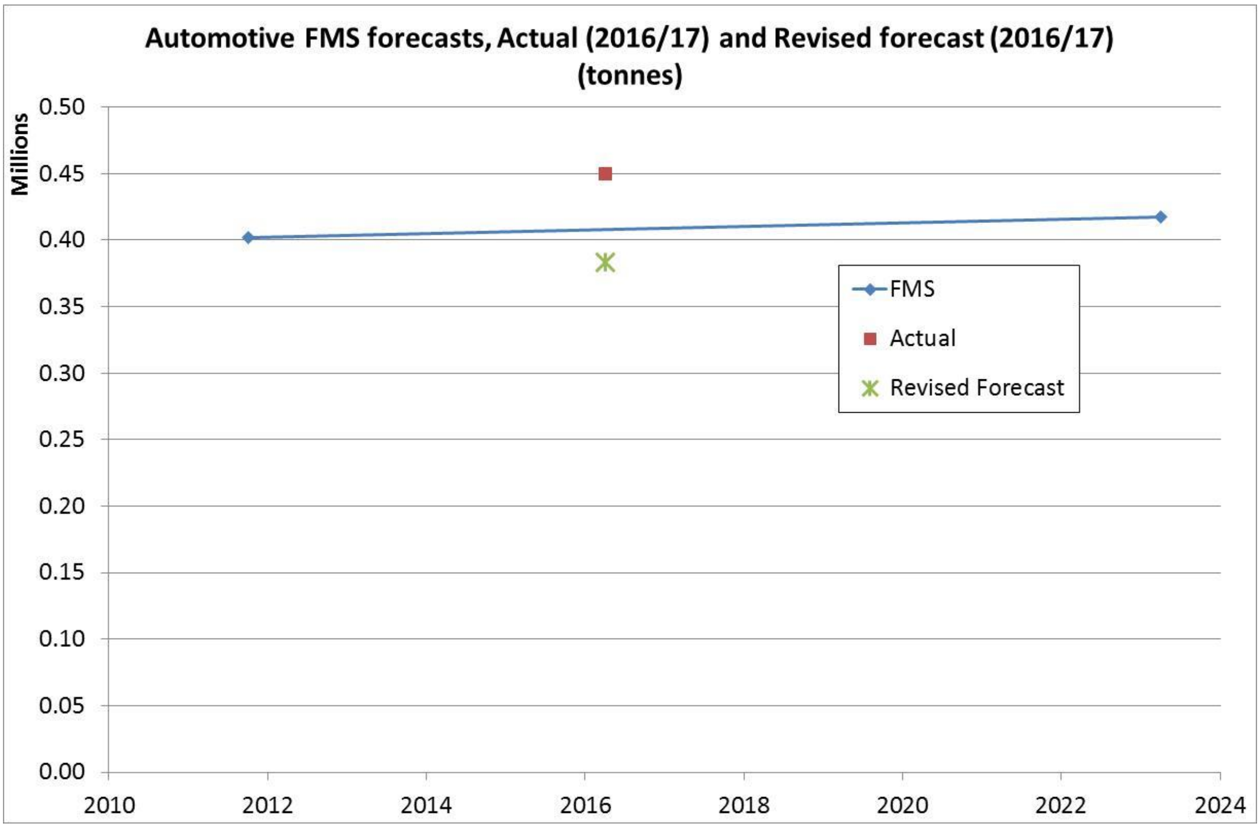


Table A2.12: Automotive FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	0.40
FMS 2023/24	0.42
Actual 2016/17	0.45
Revised forecast for 2016/17	0.38
2016/17 Difference	-15%

Similarly to construction materials, the FMS forecasting methodology for these sectors responded to changes in modal economics – whereby rail gained market share over road. The actual 2016/17 fuel prices favoured road, resulting in a 2016/17 forecast lower than the base year for each of these sectors.

The reality has been

- a very slight decrease in rail tonnes for petroleum
- a 27% increase in rail tonnes for chemicals
- a large fall in industrial materials traffic (down 42%). This is down to specific changes at key industrial facilities such as at Boulby Mine
- no change in metals
- a 12% increase in automotive. This may be due to the total market growing faster than forecast (no growth)

A2.10 Ore, Other Coal and Other

The figure and table below show ore tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.13

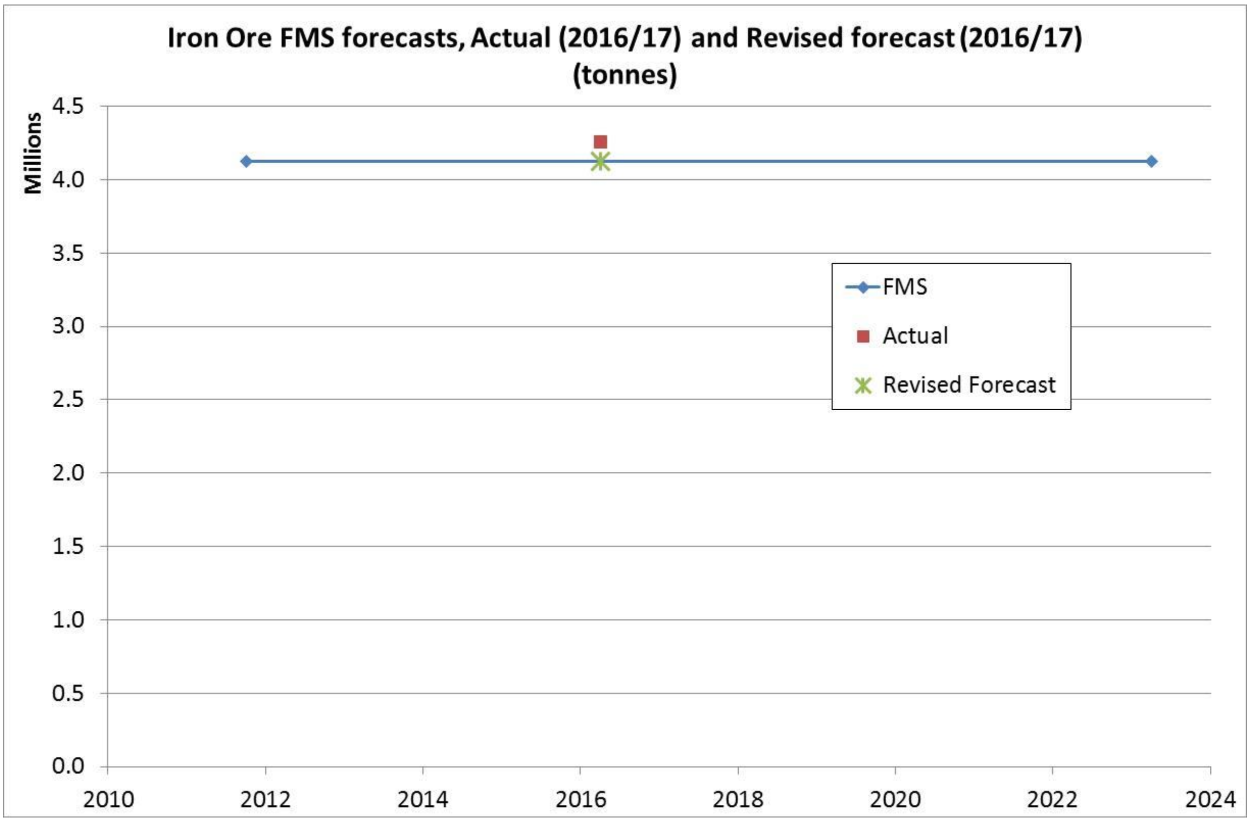


Table A2.13: Iron Ore FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	4.13
FMS 2023/24	4.13
Actual 2016/17	4.26
Revised forecast for 2016/17	4.13
2016/17 Difference	-3%

The figure and table below show other coal tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.14

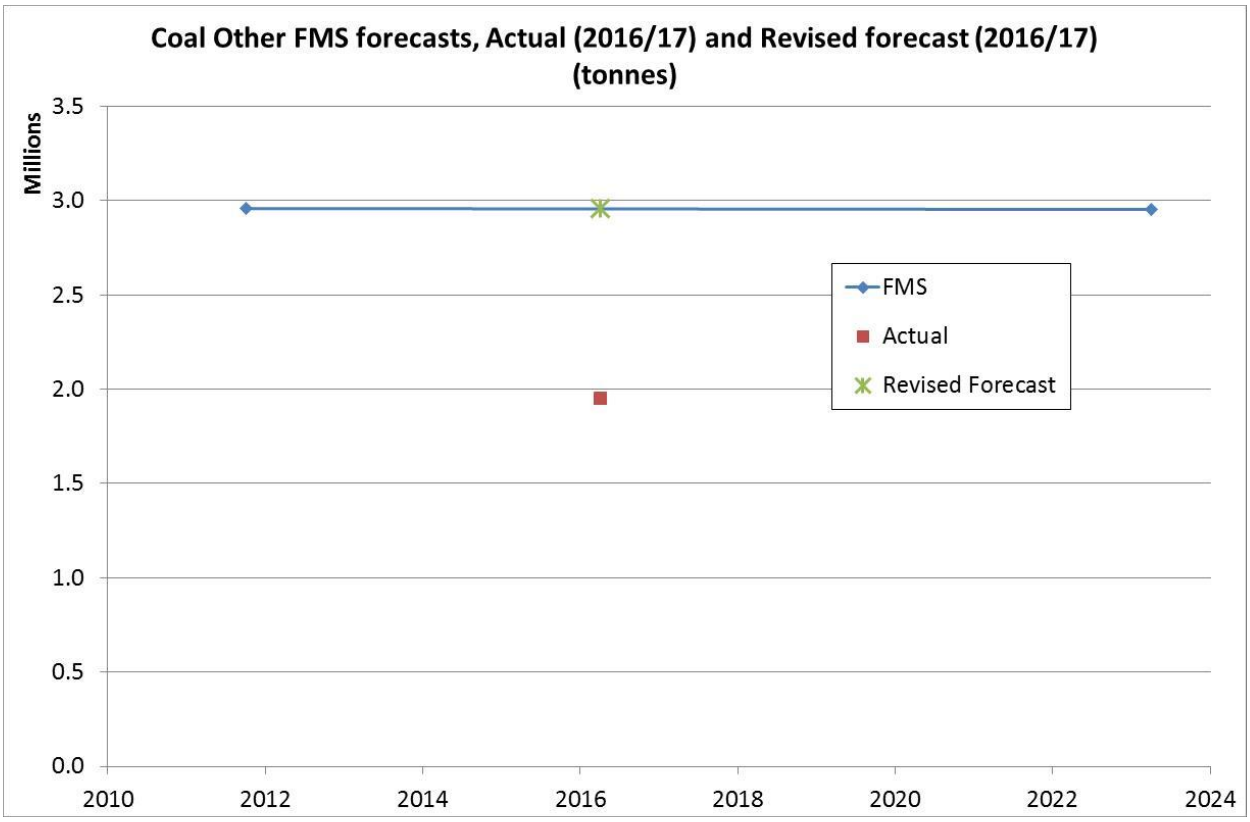


Table A2.14: Other Coal FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	2.96
FMS 2023/24	2.95
Actual 2016/17	1.95
Revised forecast for 2016/17	2.96
2016/17 Difference	51%

The figure and table below show other tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.15

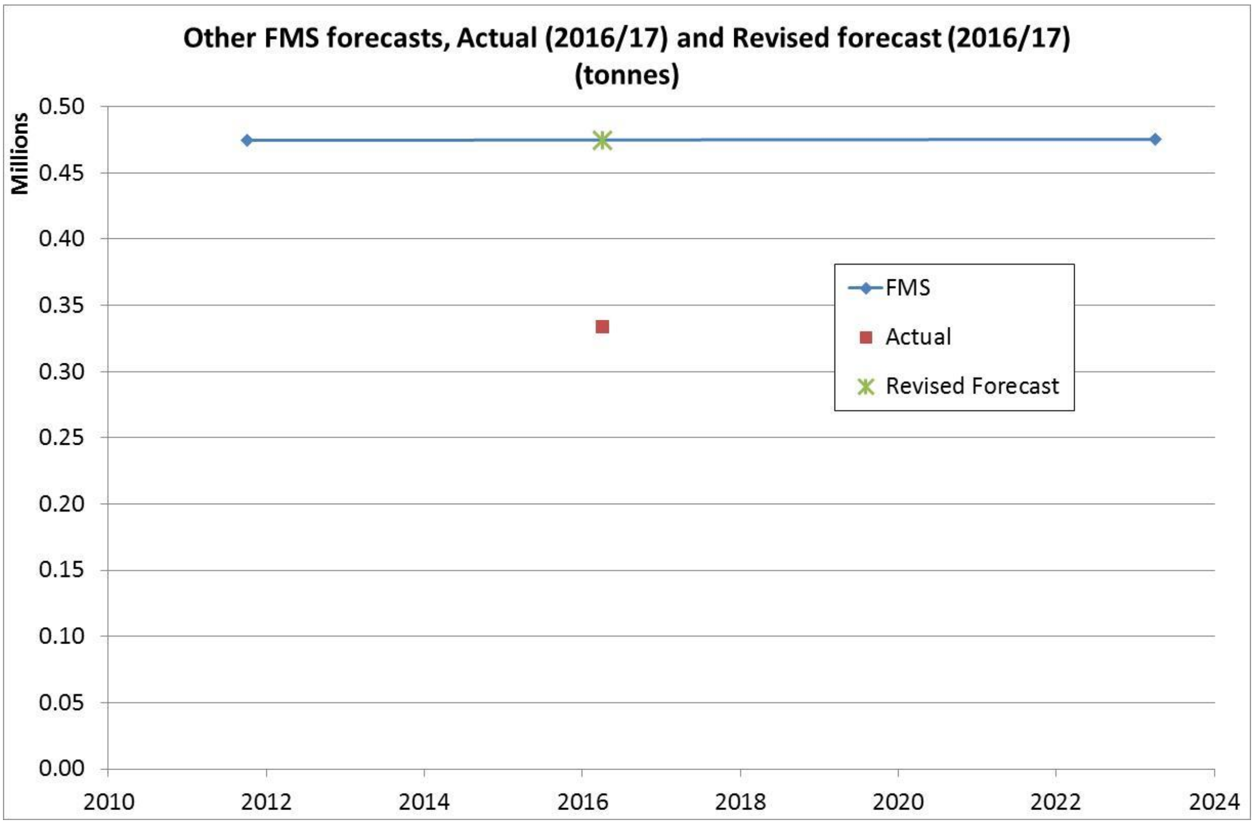


Table A2.15: Other FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	0.47
FMS 2023/24	0.48
Actual 2016/17	0.33
Revised forecast for 2016/17	0.47
2016/17 Difference	42%

For each of these sectors, the FMS methodology was simply to assume no change in the tonnes from the base year. For ores, traffics have been stable, but for other coal and other, traffics have significantly declined.

A2.11 Network Rail Engineering

The figure and table below show Network Rail Engineering tonnes carried by rail in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Figure A2.16

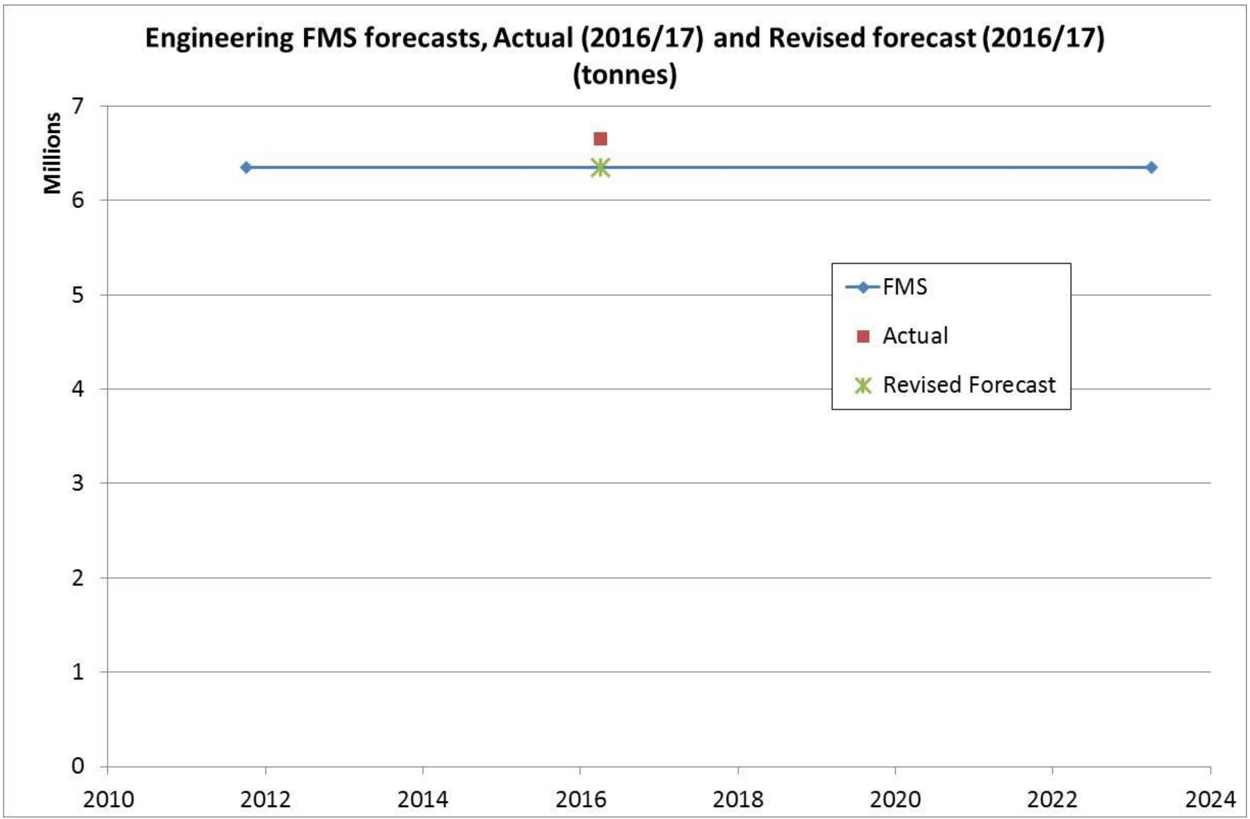


Table A2.16: Engineering FMS forecasts (2023/24), Actual (2016/17) and Revised forecast for (2016/17)

Year	Million Tonnes
Base year	6.36
FMS 2023/24	6.36
Actual 2016/17	6.66
Revised forecast for 2016/17	6.36
2016/17 Difference	-5%

The FMS methodology was simply to assume no change in the tonnes from the base year.

A2.12 Summary and conclusions for forecast of 2016/17 from 2012 base

The table below summarises the tonnes carried by rail for each sector, in the base year, the actual traffic in 2016/17, the FMS forecast for 2023, and the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17.

Table A2.17: Tonnes carried by year and scenario

Sector	Base year**	FMS 2023/24	Actual 2016/17	Revised forecast for 2016/17	2016/17 Difference
Ports Intermodal	15.3	32.7	16.2	14.8	-9%
Domestic Intermodal	2.4	16.6	2.5	2.7	8%
Channel Tunnel Intermodal	0.6	1.3	0.4	0.6	64%
ESI Coal	44.2	10.6	6.3	7.8	25%
Biomass	0.7	14.1	6.5	4.9	-24%
Waste *	1.1	1.1	2.0	1.1	-43%
Construction materials *	17.9	19.0	23.6	16.0	-32%
Petroleum	4.8	5.1	4.7	4.5	-5%
Chemicals	0.7	0.7	0.9	0.7	-26%
Industrial Minerals	2.3	2.6	1.3	2.2	61%
Metals	7.5	8.3	7.4	7.1	-5%
Automotive	0.4	0.4	0.4	0.4	-15%
Ores	4.1	4.1	4.3	4.1	-3%
Coal Other	3.0	3.0	2.0	3.0	51%
Other	0.5	0.5	0.3	0.5	42%
Empty returns for containers carrying bulks	0.5	0.4	0.4	0.5	29%
NR Engineering	6.4	6.4	6.7	6.4	-5%
Total	**112.4**	**127.0**	**85.8**	**77.1**	**-10%**

* Note that in the above table and in the FMS, "Spoil" was included in "Waste". However in the main body of this report, spoil is included and separately identified within the construction sector.
** The modelled base year was October 2011 to September 2012.

Overall the revised 2012-based 2016/17 forecast based on actual input assumptions for 2016/17 is 10% lower than the actual traffic in 2016/17. The principal explanation for the difference lies in the construction materials sector as described in section 11.8.

As a result of the analysis in this report, the modelling methodology for the 2023/24 forecasts for the construction sector in the high market growth scenarios was changed: to represent major schemes a blanket 20% increase in all construction material movements by rail was added.