FINAL STUDY REPORT

West Yorkshire Infrastructure Study

Prepared for

highways england
driving forward

June 2016

ch2m.

Building 304, Bridgewater Place
Birchwood Park, Warrington
WA3 6XG

Contents

Figures

Acronyms and Abbreviations

ALR	All Lane Running
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
ELOR	East Leeds Orbital Road
HOV	High Occupancy Vehicles
HSR	Hard Shoulder Running
HV	Heavy Vehicles
LA	Local Authority
LRN	Local Road Network
LV	Light Vehicles
MLLR	Manston Lane Link Road
MM	Managed Motorway
NAT	Network Analysis Tool
PPP	Pinch Point Programme
RIS	Road Investment Strategy
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SM	Smart Motorway
SRN	Strategic Road Network
SWYMBUS	South and West Yorkshire Making Best Use Study
TEMPro	Trip End Model Presentation Program
TRADS	Traffic Flow Data System
TRICS	Trip Rate Information Computer System
VHD	Vehicle Hours Delay
VHT	Vehicle Hours Travelled
VKT	Vehicle Kilometres Travelled
VSL	Variable Speed Limit
WYIS	West Yorkshire Infrastructure Strategy
WY+TF	West Yorkshire Transport Fund

Executive Summary

This study presents a high level assessment of the potential impact of local plan aspirations on the strategic road network within West Yorkshire up to 2040. The West Yorkshire and Leeds meso models have been applied to consider a 2014 'base,' 2022 'interim,' 2030 'future' and 2040 'horizon' assessment years.

The West Yorkshire and Leeds region meso models have been developed by Highways England using the Dynameq software program and are a key component in the Highway England's toolkit for analysis and appraisal of the future operation of the strategic road network in the region. Meso models allow modelling of dynamic factors leading to congestion, such as weaving, merging, differential lane use, and also the wave effect of flow breakdown. Compared with micro models, they need less detailed network information and have faster run times. As such, much larger network coverage can be achieved for a given resource input. This means that the resultant model can be used to identify wider scheme impacts, both upstream and downstream, when testing indicative potential interventions.

With this study being based on the 2011 validated base meso model, representative traffic growth factors for the period from 2011 to 2014 have been derived from the TRADS database, therefore seeking to replicate the actual growth that has been recorded on the network during that period. Representative trip matrices for Heavy and Light vehicles across the morning (06:00 – 10:00) and evening (15:00 – 19:00) peak periods have been produced.

Beyond the 2014 'base' year, traffic growth has been derived directly from local plan development data. The spatial aspirations of Bradford, Calderdale, Kirklees, Leeds and Wakefield have been reviewed through an interrogation of their local plan data available in March 2015.

The committed network schemes considered in this study are those for which funding has been confirmed and/or assured and will be implemented within the next 5 to 10 years.

The generation and distribution of forecast local plan development trips has been determined through the use of the Network Analysis Tool, which is based on the SWYMBUS SATURN model. The outputs of the meso modelling has been provided in both numeric, visual and written form.

Upon review of the 'do-minimum' assessment outputs, indicative potential highway infrastructure schemes (specific schemes to be identified through further Highways England Study) have been identified with the aim of addressing network operational issues forecast as a result of future traffic growth throughout the region. The identified indicative potential schemes have been assigned to a realistic assessment year (based on feasible construction and deliverability timescales).

The application of the indicative potential schemes to the West Yorkshire and Leeds meso models created the 'do-something' assessments. The outputs of each 'do-something' assessment were compared to their corresponding 'do-minimum' assessment in order to demonstrate the network performance changes in the morning and evening peak periods generated by the indicative potential schemes.

From a global network operational perspective, the indicative potential schemes offer benefits compared to the 'do-minimum' assessments. The benefits offered are more evident within the 2030 'future' year than within the 2022 'interim' year due to the smaller size and scale of the indicative potential schemes which could be feasibly implemented by 2022. That said, in absolute terms, the performance of the network continues to decline between 2022 and 2030 due to the sheer level of forecast traffic growth.

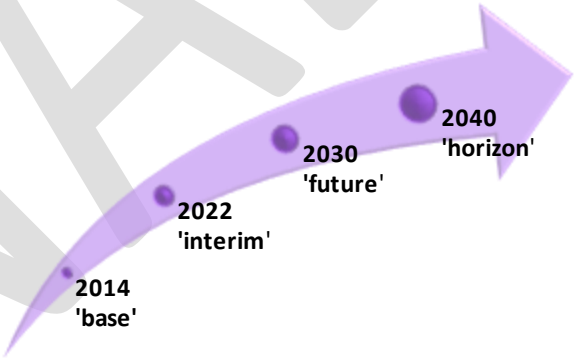
The outcome of this study is a list of indicative potential schemes at locations which should be considered by Highways England for further investigation and refinement as part of their future network enhancement strategic planning.

Introduction

1.1 Study context

The strategic road network [SRN] – the road network under Highways England jurisdiction – in the West Yorkshire region (Kirklees, Calderdale, Bradford, Wakefield and Leeds) is affected by traffic congestion, particularly in peak periods, giving rise to identifiable network issues. Future traffic growth and development aspirations will place additional demands on the SRN in the coming years and this will both exacerbate existing network operational issues and generate new ones. It is therefore essential that these existing and future network issues are identified and understood in order to both facilitate effective network management, inform investment decisions and support future improvement schemes through the appraisal process.

To facilitate this, a mesoscopic [meso] simulation model of the West Yorkshire SRN has been developed. This was calibrated and validated for a base year of 2011[1]. For this West Yorkshire Infrastructure Study [the study], the network and traffic demands have been updated to form a 2014 'base' model, from which subsequent 'interim' (2022), 'future' (2030) and 'horizon' (2040) year assessments can be undertaken. West Yorkshire local authority [LA] development aspirations have been taken into account for the respective assessment years.



Having identified the additional traffic impact generated by the local plan aspirations within the assessment years, a number of indicative potential schemes can be identified which aim to mitigate the forecast network issues. These can also be subsequently modelled to provide an initial indication as to their effectiveness and it is this range of outcomes that this study report ultimately seeks to present. The indicative potential schemes identified are not fixed and have been developed to provide an indication of the likely scale of solution that will be required. The precise form of the solutions will be identified through further Highways England study.

This study should be considered as a 'worst case' forecast assessment as it has been assumed that all LA development aspirations will come to fruition within their respective plan period and the trip rates applied are drawn from the TRICS database. If not all LA development aspirations are constructed within their respective plan period, the actual total level of traffic generated by local plan developments will be lower than forecast within this study. In addition, unforeseen influences such as new public transport schemes, travel behaviour changes or increased travel costs may see a reduction in future trip rates, so that the level of new vehicle trips generated by local plan developments will also be lower than forecast in this study.

In addition, this study can only consider, analyse and pass comment on the study network area which has been been modelled. Whilst in reality there will be influences that impact the performance and operation of the SRN which are located outsde of the study network area, a detailed consideration of these influences is outside the scope of this study. Where relevant, reference to known issues on nearby Local Road Network [LRN] links is made.

[1] For further details refer to the Calibration and Validation report prepared by Halcrow on behalf of Highways England in 2011

1.2 Background

This study builds upon the process and outcomes generated by the original study completed in 2013 [WYIS 2013 study][2]. The WYIS 2013 study featured assessment years of 2013, 2018 and 2028 (allied with the timescales of the local plans at that point in time). In the intervening period, some of the committed schemes within the WYIS 2013 study have been constructed and in other cases, the schemes identified as potential mitigation schemes within the WYIS 2013 study have since become committed schemes which will be constructed within the next 5-10 years. These changes have been fully incorporated into this current study.

Whilst the West Yorkshire meso model has been developed as a multipurpose assessment tool, its main aims are to assist in Highways England's consideration of the spatial planning process, particularly in relation to local plans and as an evidence base to inform future investment planning.

Meso models allow modelling of dynamic factors leading to congestion, such as weaving, merging, differential lane use, and also the wave effect of flow breakdown. Compared with micro models, they need less detailed network information and have faster run times. As such, much larger network coverage can be achieved for a given resource input. This means that the resultant model can be used to identify wider impacts of schemes, both upstream and downstream, when testing potential interventions. They are however not able to incorporate detailed junction geometry information and therefore cannot be seen as a subtitle for traditional micro-simulation models (ARCADY / LINSIG, etc). That said, given the size of the study area, the type of schemes incorporated into the network and detail of trip matrices, the meso models employed as part of this study should be considered fit-for-purpose.

The aim of this study is to detail the forecast impact of LA plan allocations on the SRN through application of the meso model and identified appropriate indicative potential measures. The indicative potential solutions identified are not fixed and have been developed to provide an indication of the likely scale of solution that will be required. The precise form of the solutions will be identified through further Highways England study. At this time, the local plans provide the most substantive estimate of the level and distribution of future development and, accordingly, this study report seeks to assess the impact of such development in relation to the SRN.

1.3 Structure of this report

The structure of this report is as follows:

- Section 2 provides a broad overview of the study, the study area, the strategic road network and existing network operating conditions.
- Section 3 details the methodology of the study, covering assessment years, modelled time periods, base data sources, traffic growth forecasts, traffic distribution/assignment as well as the application and outputs of the Dynameq mesoscopic modelling software.
- Sections 4, 5, 6 and 7 present the 'do-minimum' and 'do-something' assessments for each of the assessment scenarios specified within section 3.
- Section 8 draws together the results of the study and establishes the final conclusions, recommendations and next steps arising from the completion of this study.

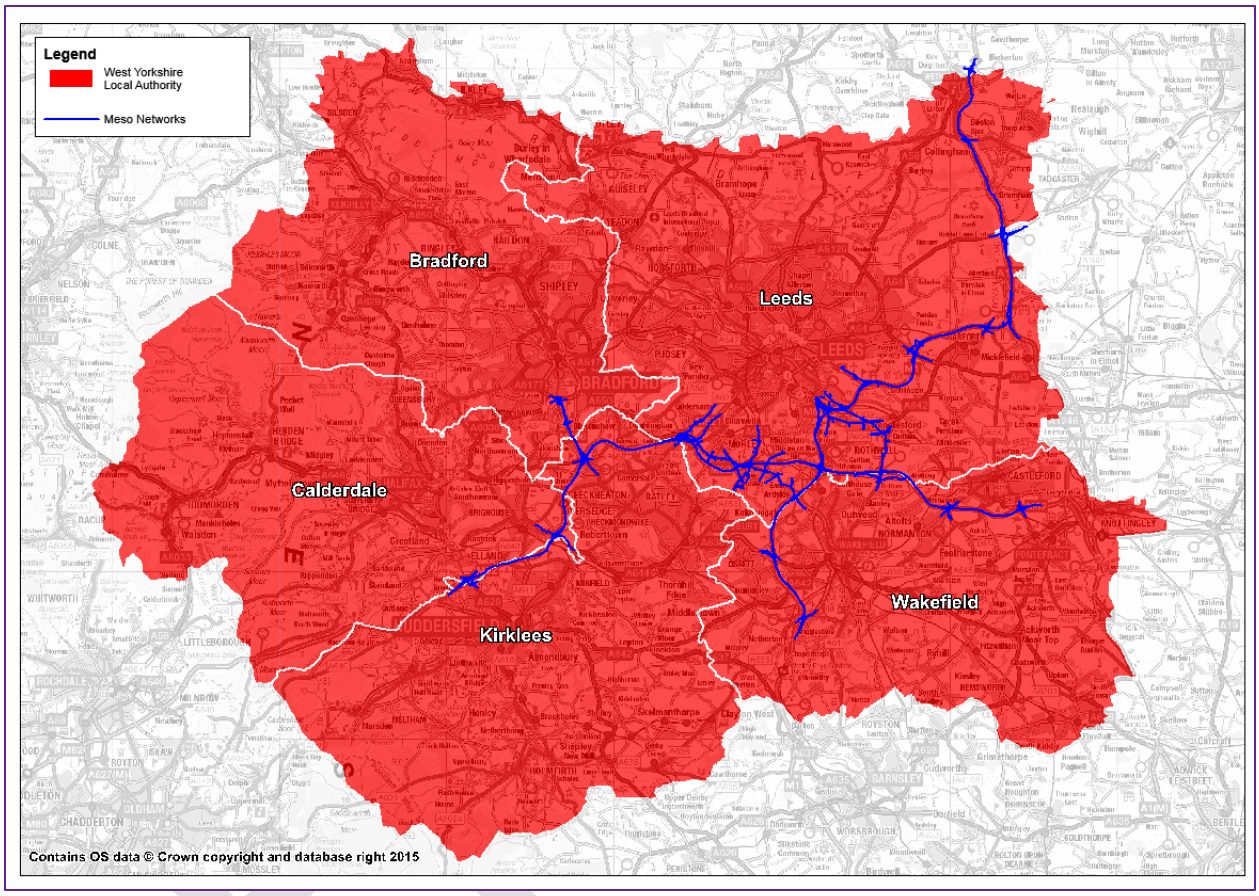
[2] For further details refer to the West Yorkshire Infrastructure Study report prepared by CH2M HILL on behalf of Highways England in 2013

Study components

2.1 Study area

The study area covers the West Yorkshire region which includes the LAs of Bradford, Calderdale, Kirklees, Leeds and Wakefield. This region and LAs are presented within Figure 2.1.

Figure 2.1: WYIS study area



2.2 The strategic road network

The SRN within the study area comprises:

- M1 between junctions 38 (at Wakefield) and 47 (at Garforth);
- M62 between junctions 22 (at Ainley Top, Huddersfield) and 32 (at Castleford);
- M606 (between Bradford and junction 26 of the M62); and
- A1 between junction 36 (A639) and junction 46 (Wetherby).

The Leeds Local Transport Model is expected to be finalised in the coming months. This model will be able to assess the M621 at a greater level of detail than could be completed within this study's methodology and will be able to consider both the Road Investment Strategy [RIS] and local highway authority schemes (outside of Highway England's jurisdiction) in this area. As a result, it has been considered pragmatic to not include the M621 within this study.

2.3 Existing network conditions

2.3.1 Existing conditions

The SRN in West Yorkshire is under a significant level of stress and congestion following a combination of wider socioeconomic influences and more local structural economic changes resulting in national traffic levels in the fourth quarter of 2014 to be higher than at any other time[3]. In addition, over the last 2-3 years, significant sections of the network have undergone a series of road improvement measures including the smart motorways schemes on the M62 between junctions 25 and 30 and on the M1 between junctions 39 and 42. These roadworks, while short term in nature, will have added to the perception of a network which is congested and operating at, or above, capacity.

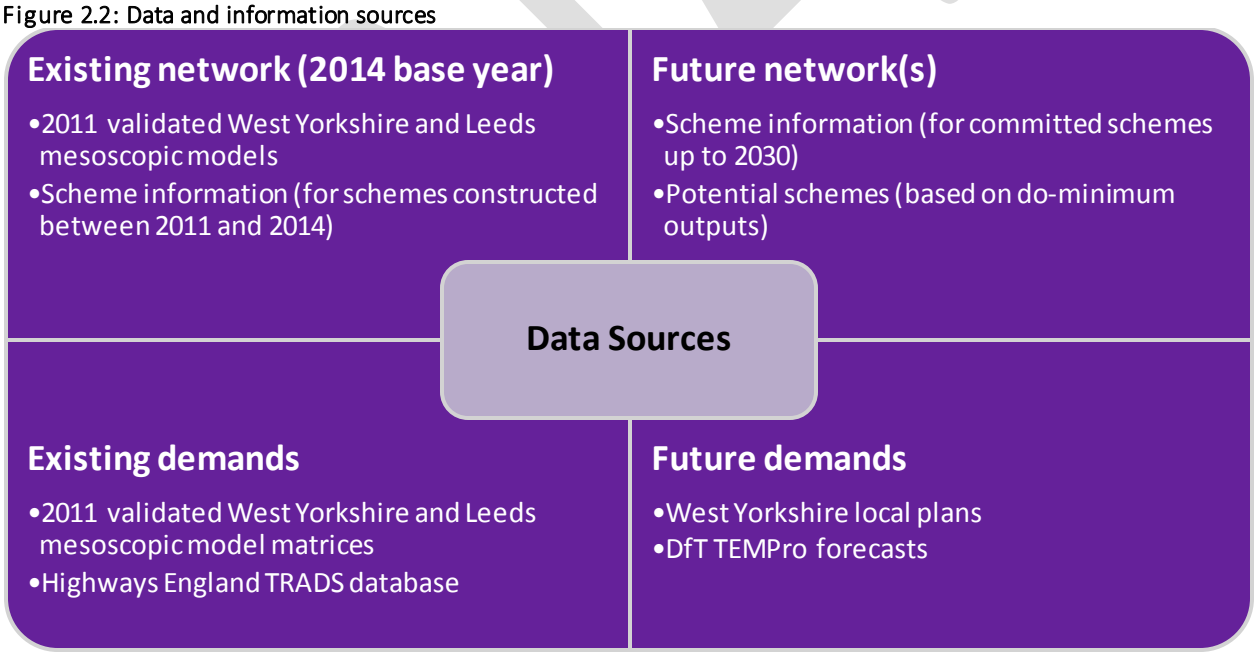
While congestion hot spots vary by peak period, common areas of delay known at the time of writing within the study area include:

- The M62 eastbound between Brighouse and Gildersome, particularly in the morning peak period.
- The M1 northbound and M62 westbound approaches to Lofthouse Interchange.
- The westbound diverge at M62 junction 26 (M606) in the evening peak.

2.3.2 Data and information sources

A range of data sources have been referenced and used as part of this study. Key sources include those identified in Figure 2.2.

Figure 2.2: Data and information sources



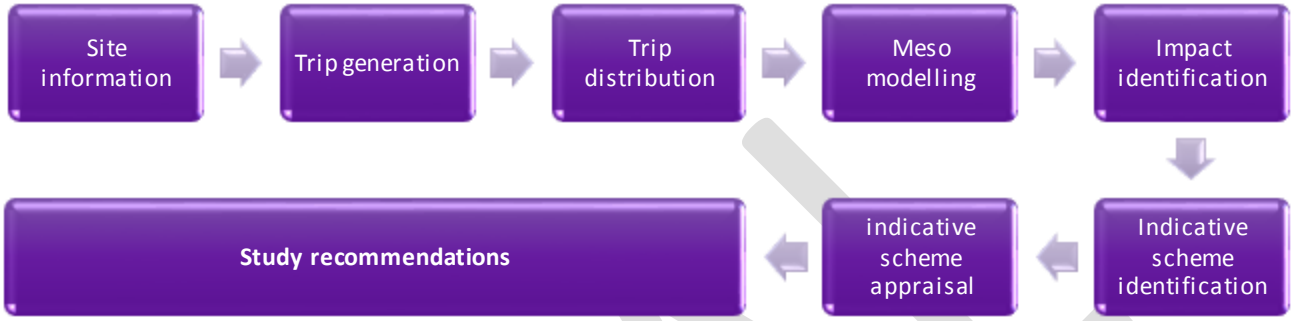
[3] https://www.gov.uk/government/statistics/road-traffic-estimates-for-great-britain-april-to-june-2015

Methodology

3.1 Methodology overview

This section summarises the methodology adopted as part of the study. An overview of this methodology is illustrated in Figure 3.1.

Figure 3.1: Methodology process overview



Further details on the stages presented within Figure 3.1 are set out below along with a reference to the corresponding report section (where relevant) where further information is provided:

- **Site information** – development aspirations have been taken from the West Yorkshire LAs local plans both in terms of the quantum and distribution of sites (Section 3.3).
- **Trip generation** – the Network Analysis Tool [NAT] process incorporates representative trip rates for the development aspiration to derive forecast development trips for the study area (Section 3.6).
- **Trip distribution** – the distribution of development trips is specified within the NAT process (Section 3.6).
- **Meso modelling** – The background and development trip matrices are assigned to the SRN network in the defined assessment years using the West Yorkshire and Leeds meso models (Section 3.7 and 3.8).
- **Impact identification** – A review of the model outputs will identify areas of the network experiencing congestion or operational issues as a result of traffic demands in the assessment years (section 3.8.2).
- **Indicative scheme identification** – A series of indicative potential schemes will be identified in order to address network issues previously identified (section 3.9).
- **Indicative scheme appraisal** – The indicative potential schemes have been built into the meso model networks and re-run in order to demonstrate the scale of operational performance benefits generated by the schemes.
- **Study recommendations** – Taking into account the performance of the indicative potential schemes, a consideration as to which schemes should be taken forward has provided a series of recommendations forming the output of this study.

3.2 Traffic demands

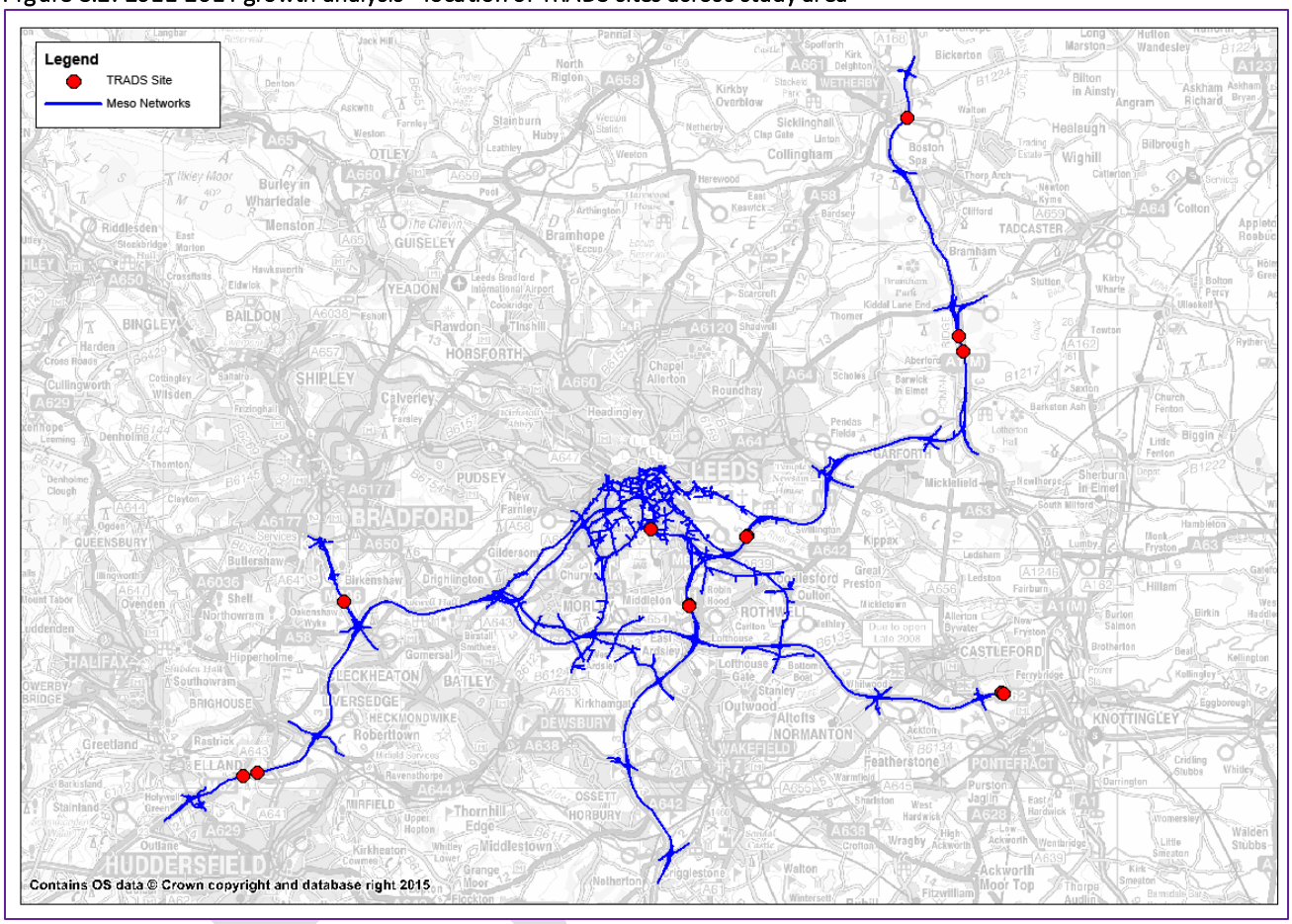
3.2.1 2014 'base' traffic demands

The WYIS 2013 study was founded on matrices for light vehicles [LV], heavy vehicles [HV] and high occupancy vehicles [HOV] and these have been used as a basis to create representative 2014 'base' year matrices.

With the WYIS 2013 study being based on the 2011 validated base model, representative traffic growth factors for the period from 2011 to 2014 have been derived from the TRADS database, therefore seeking to replicate

the actual growth that has been recorded on the network during that period. This has been achieved through the interrogation of traffic flow records for a number of TRADS sites throughout the study area. Due to known roadworks in the study area between 2011 and 2014, sections of the M1 and M62 have been excluded as not to influence the traffic factors derived from the data sample. The sites used were also selected with consideration of the geographic spread of the study area and are presented in Figure 3.2[4].

Figure 3.2: 2011-2014 growth analysis - location of TRADS sites across study area



The data extracted from the TRADS database included monthly classified data for the years 2011 and 2014 across the neutral months of March, May, June, October and November. Where data did not cover all weekdays in a month, that month was excluded from both the 2011 and 2014 sample. Table 3.1 summarises the peak period growth factors that were generated from the dataset.

Table 3.1: 2011-2014 growth analysis - TRADS based peak period growth factors

Peak Period	HV	LV	Combined
AM (07:00 to 10:00)	1.026	1.015	1.016
PM (16:00 to 19:00)	1.015	1.008	1.008

It should be noted that the HOV matrices inherited from the 2011 meso model (which were primarily used for the purpose of modelling HOV lane movements between the M606 to M62) have been combined with the LV matrices prior to the application of the growth factors presented above. Therefore for the remainder of this study, reference to LV trips will include a proportion, albeit small, of HOV trips.

[4] Note that although traffic count locations on the M621 have been included within the data used to derive 2011 to 2014 traffic growth factors, as detailed within section 2.2 the operation and assessment of the M621 is not covered within this study.

TEMPro growth factors were also analysed to provide a comparison of forecast 2011 to 2014 traffic growth with actual growth and substantiate the traffic growth factors derived from the TRADS dataset. The TEMPro growth factors for 2011 to 2014 are presented in Table 3.2.

Table 3.2: 2011-2014 growth analysis - TEMPro growth factors

TEMPro	Area	Urban Motorway	Rural Motorway
AM	West Yorkshire	1.015	1.022
PM	West Yorkshire	1.015	1.022

While the two sets of growth factors are comparable, at the 'peak period' level they are not considered to be sufficient for their intended use due to their uniform application across the entire morning and evening peak periods. As it is known that the network is already at capacity during the morning and evening peak hours, there is little room for further traffic growth in that specific time segment. Yet, as traffic growth has clearly occurred during the peak periods, a degree of peak spreading is considered likely to have occurred. Therefore, growth factors for 15 minute periods across the morning and evening peaks have been calculated from the TRADS database in order to capture this peak spreading trend.

Table 3.3 presents the traffic growth factors across the entire network over the morning and evening peaks broken down across 15 minute periods. These reveal a combined growth of 2-4% earlier in the morning peak compared to suppressed or negative growth towards the end of the morning peak. A similar trend is also seen across the evening peak period. In terms of vehicle class growth, while LV growth factors fluctuate between increasing and decreasing flows, HV growth factors show a clear increase in traffic flow across the length of both peak periods, with the exception of early in the morning peak.

Table 3.3: 2011-2014 growth analysis - TRADS 15 minute period peak period growth factors

AM Peak (time period end)	LV	HV	Combined	PM Peak (time period end)	LV	HV	Combined
07:15	1.047	0.995	1.040	**16:15**	1.022	1.017	1.021
07:30	1.053	0.999	1.047	**16:30**	1.026	1.011	1.024
07:45	1.038	1.018	1.036	**16:45**	1.014	1.015	1.014
08:00	1.021	1.045	1.024	**17:00**	1.004	1.011	1.005
08:15	1.004	1.045	1.009	**17:15**	0.995	1.013	0.997
08:30	0.997	1.049	1.003	**17:30**	0.992	1.014	0.994
08:45	0.998	1.037	1.002	**17:45**	0.987	1.022	0.990
09:00	0.985	1.027	0.991	**18:00**	0.990	1.028	0.994
09:15	0.985	1.019	0.990	**18:15**	0.998	1.027	1.000
09:30	0.990	1.032	0.997	**18:30**	1.006	1.028	1.008
09:45	0.992	1.023	0.997	**18:45**	1.003	1.022	1.005
10:00	1.001	1.019	1.004	**19:00**	0.997	1.019	0.999

3.2.2 Future traffic demands

Beyond the 2014 'base' year, traffic growth has been derived directly from local plan development data. The additional traffic generated by developments contained in the local plans has been added to the 2014 'base' matrices in order to provide forecast trip matrices representative of the 2022 'interim', 2030 'future' and 2040 'horizon' assessment years.

3.3 West Yorkshire local plans

The spatial aspirations of Bradford, Calderdale, Kirklees, Leeds and Wakefield have been reviewed through an interrogation of their current local plans. The data provided was the best available at March 2015 and it is acknowledged that since then some LAs have progressed local plans and new data is now available. Each LA is at a different stage of the local plan process as detailed below:

- **Bradford** – Publication Draft Core Strategy (February 2014)[5];
- **Calderdale** – Preferred Options (Local Plan expected Autumn 2015)[6];
- **Kirklees** – Development data provided by Kirklees in April 2015.
- **Leeds** – Adopted Core Strategy (12 November 2014)[7]; and
- **Wakefield** – Adopted Core Strategy (15 April 2009)[8].

The total level of development projected within each of the West Yorkshire LA areas is presented within Table 3.4. These development aspirations have been taken forward into the NAT process.

Table 3.4: West Yorkshire LA development aspirations

Local Authority	Plan Period Ending	Total Dwellings	Total Employment Site Area (ha)
Bradford District	2030	42,500	135
Calderdale District	2029	10,503	82
Kirklees District	2031	24,862	213
Leeds District	2028	76,679	286
Wakefield District	2026	21,888	313

3.4 Assessment years

The definition of assessment years as part of this study has taken into account both the timescale coverage of the local plans and the projected construction/opening dates of the committed schemes identified. The assessment years considered in the study are as follows:

- **2014 'base' year** – Building upon the 2011 validated base model network used in the WYIS 2013 study, schemes completed up to the end of 2014 have been included in the network. The 15 minute traffic growth factors presented within section 3.2.1 have been applied to the 2011 validated base matrices to provide representative 2014 'base' model trip matrices.
- **2022 'interim' year** – Committed schemes which are considered 'most likely' (either through industry knowledge or realistic assumptions) to have been completed by 2022 have been included within this assessment year. Traffic growth has been based upon the development aspirations specified within the LA local plans up to 2022.
- **2030 'future' year** – All committed schemes have been included as it is assumed that all will be constructed and completed by this date. Traffic growth has been based upon the development aspirations

[5] http://www.bradford.gov.uk/bmdc/the_environment/planning_service/local_development_framework/core_strategy_introduction_dpd.htm

[6] http://calderdale.objective.co.uk/portal/planning_services/cspo/cspo

[7] http://www.leeds.gov.uk/council/Pages/Core-Strategy-Introduction-Page.aspx

[8] http://www.wakefield.gov.uk/residents/planning/policy/local-plan/core-strategy

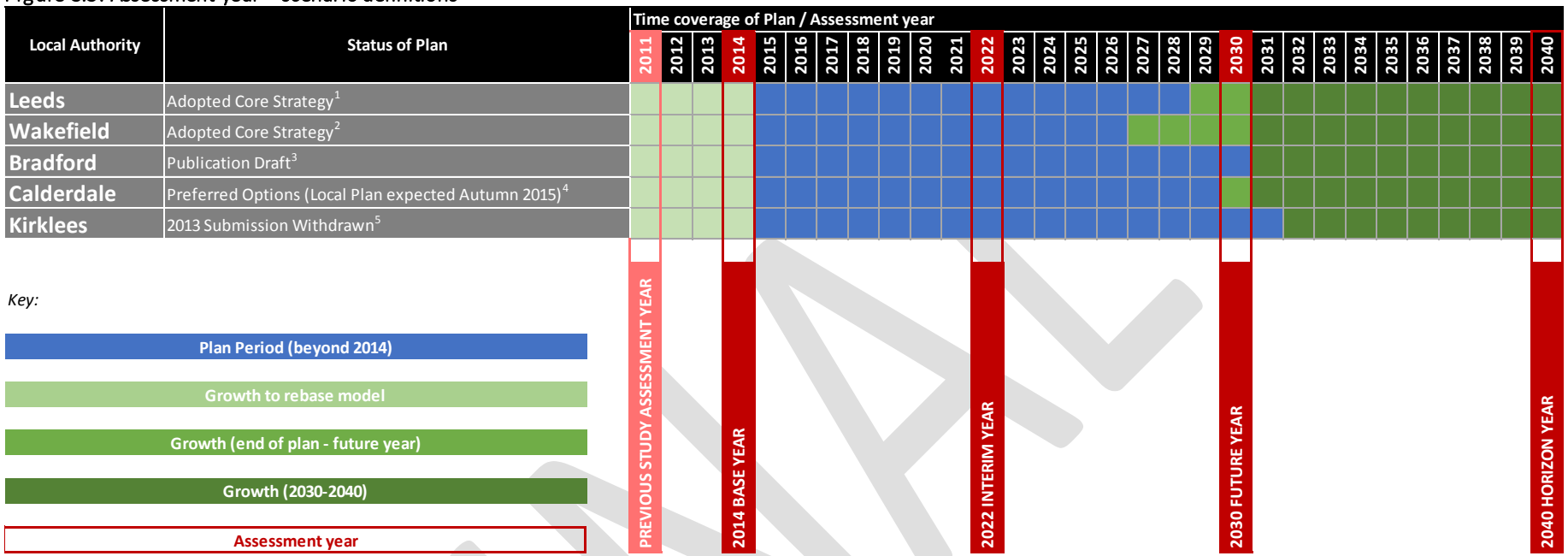
stated within the LA local plans with any gaps between the 'end of plan' period and the 'future' year being covered by the use of TEMPro traffic growth factors.

- **2040 'horizon' year** – No additional committed infrastructure schemes have been built into this assessment year. As all local plans do not cover the period from 2030 to 2040, traffic growth has been based upon the TEMPro database and representative traffic growth factors have been extracted for the relevant LA areas.

A chronological plan of the West Yorkshire local plans and the assessment years specified above, along with the traffic growth requirements, is presented within Figure 3.3 overleaf.

Figure 3.3: Assessment year – scenario definitions

Local Authority	Status of Plan	Time coverage of Plan / Assessment year
Leeds	Adopted Core Strategy[1]	
Wakefield	Adopted Core Strategy[2]	
Bradford	Publication Draft[3]	
Calderdale	Preferred Options (Local Plan expected Autumn 2015)[4]	
Kirklees	2013 Submission Withdrawn[5]	



Key:

- Plan Period (beyond 2014)
- Growth to rebase model
- Growth (end of plan - future year)
- Growth (2030-2040)
- Assessment year

3.5 Committed schemes

3.5.1 Overview

The committed schemes considered in this study are those for which funding has been confirmed and/or assured and will be implemented within the next 5 to 10 years. With a view to their delivery timeframes, these schemes have been incorporated into the appropriate assessment year networks and therefore form part of the 'do-minimum' assessment year networks. Within this study, there are three predominant groups of committed schemes which have been incorporated into 'do-minimum' assessment year networks. These are identified in Figure 3.4.

Figure 3.4: Committed Scheme Types

WYIS 2013 study committed schemes	RIS 2014 schemes	WY+TF schemes
•Committed Highways England schemes from the WYIS 2013 study	•Schemes identified within the Road Investment Strategy [RIS] in late 2014	•As part of the 'City Deal' with government, authorities in West Yorkshire and York are planning to create a Trnasport Fund initially of around £1 billion

In addition to the above there are a handful of additional schemes which have been identified for inclusion within this study. Full details are provided within the subsequent sub-sections.

3.5.2 WYIS 2013 study committed schemes

Within the WYIS 2013 study, there were a number of schemes identified as committed Highways England schemes. Since the WYIS 2013 study, some of these schemes have been constructed while others are in construction at the time of writing. Table 3.5 provides details as to which WYIS 2013 study committed schemes are to be included within each assessment year as part of this study.

Table 3.5: WYIS 2013 study committed scheme list and assessment year network inclusion

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
M62 J25-30	M62 Junctions 25 to 30: Smart Motorway[9]	2013	Yes	Yes	Yes	Yes
M62 J24 Ainley Top	S278 scheme to provide traffic signalisation and circulatory carriageway widening.	2014	Yes	Yes	Yes	Yes
M62 J26 Chain Bar	Capacity enhancements to the circulatory carriageway programmed 2015/16.	2016	No	Yes	Yes	Yes
M62 J27 Gildersome	Capacity improvements to the southern dumbbell roundabout. (Since the modelling was undertaken this scheme has been removed from Highways England's improvements programme).	2016	No	Yes	Yes	Yes
M1 J39-42 Smart motorway	Hard shoulder running and variable speed limit.	2015	No	Yes	Yes	Yes

[9] http://www.highways.gov.uk/roads/road-projects/m62-junctions-25-to-30/

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
M1 J39 Durkar	Signalisation of the off-slips.	2013	Yes	Yes	Yes	Yes
M1 J41 Ardsley	Widen both A650 approaches to three lanes. Widen both M1 approaches to three lanes. Widen circulatory to three lanes. Improved traffic signal control.	2015	No	Yes	Yes	Yes
M1 J44 Rothwell Haigh	Signalisation of both roundabouts. New through-about arrangement to northern roundabout.	2015	No	Yes	Yes	Yes
M1 J46 Colton	Signalisation of northern circulatories alongside closure of links to create a dumbbell arrangement. Elongation of northern dumbbell.	by 2022	No	Yes	Yes	Yes
M62 J31 Normanton	Upgrade of eastbound diverge to a type B taper diverge with auxiliary lane.	by 2015	No	Yes	Yes	Yes
M62 J32 Castleford	PinchPoint scheme: upgrade of eastbound diverge to a type D ghost island diverge.	2015	No	Yes	Yes	Yes
M62 J32 Castleford	Changed geometry and layout to the north of the junction (including lane widening and priority changes) related to the Castleford Tigers / Five Towns Park development scheme.	by 2022	No	Yes	Yes	Yes

3.5.3 Road investment strategy 2014

The RIS is a £15 billion plan to triple levels of spending by the end of the decade which will increase the capacity and condition of England's roads. Schemes included within the RIS were announced in December 2014[10]. Table 3.6 below provides details as to which RIS schemes are to be included within each assessment year as part of this study. RIS 1 schemes are planned to start construction before the end of road period 1 (19/20), other schemes are due to begin scheme development during this period for delivery in later road periods.

Table 3.6: RIS scheme list and assessment year network inclusion

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
RIS1 M1 J45 Improvement	Improvements to J45 to allow increased capacity, and to support the nearby Aire Valley enterprise zone.	2017	No	Yes	Yes	Yes
RIS1 M62 / M606 Chain Bar	M62: J26 (M606 Chain Bar): provision of a slip road to provide a direct link from the M62 westbound to the M606 northbound; reduces congestion from the main part of the existing junction.	by 2030	No	No	Yes	Yes

[10] For full details see https://www.gov.uk/government/publications/road-investment-strategy-for-the-2015-to-2020-road-period

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
RIS1 M62 J20-25 Smart motorway	Smart motorways across the Pennines, from Rochdale to Brighouse. Links 2 existing Smart Motorway [SM] sections to create a continuous smart route from Leeds to Manchester.	by 2022	No	Yes	Yes	Yes
M1 / M62 Lofthouse Interchange	Major enhancement to provide additional capacity at M62/M1 Lofthouse interchange.	by 2030	No	No	Yes	Yes
M1 J35a-39 Smart motorway	Smart motorways to link the existing Smart motorway sections around Sheffield and Leeds, which in turn connects up the trans-Pennine stretches identified in RIS1 and the London to Yorkshire route planned for RIS2.	by 2030	No	No	Yes	Yes

3.5.4 West Yorkshire + Transport Fund

A series of schemes across West Yorkshire have been identified as part of the 'City Deal' with government, authorities in West Yorkshire and York. These West Yorkshire+ Transport Fund [WY+TF] schemes are designed to create a new Transport Fund initially of around £1bn targeted specifically at increasing employment and economic growth across the area[11].

Table 3.7 provides details as to which WY+TF schemes are to be included within each assessment year[12]. The full list of WY+TF schemes considered within the NAT process (see section 3.6) are presented within ***Appendix A*** which also includes reference as to whether the scheme has been included in the NAT network.

Table 3.7: WY+TF scheme list and assessment year network inclusion

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
East Leeds Orbital Road and northern outer ring road junctions	Includes new orbital highway route from the M1 J46 to west of the A58. Upgrade of the A61 and King Lane roundabouts to traffic light controlled junctions. Includes a link road between Manston Lane [MLLR] and M1 J46 and East Leeds Orbital Route [ELOR] from Manston Lane to the west of the A58.	by 2030	No	No	Yes	Yes
Pontefract Northern Bypass (now on site and completed early in 2015)	A new section of highway on the northern extent of the old Prince of Wales Colliery site from Park Road (with a new traffic light controlled junction) to Skinner Lane.	2015	No	Yes	Yes	Yes

[11] For more information see http://www.leeds.gov.uk/news/Pages/%C2%A31.4bn-programme-of-transport-improvements-agreed-for-West-Yorkshire-and-York.aspx

[12] Note that only WY+TF schemes which are considered to require adjustment to the meso model networks are included within Table 3.7.

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
A62 Cooper Bridge Junction, Kirklees	Highway work to deal with congestion in and around the Cooper Bridge Gyratory junction to the east of Huddersfield and facilitate access to the development site. Includes road widening, junction improvements and a new relief road around Ravensthorpe.	by 2030	No	No	Yes	Yes
M62 Junction 24a on A641 Bradford Road south of Brighouse	A new motorway junction to tackle regular delays and queuing vehicles backing up on the M62. A new restricted access grade separated motorway junction with east facing slip roads (to allow vehicles to access the M62 in the eastbound direction and to exit from the M62 westbound).	by 2022	No	No	Yes	Yes

3.5.5 Other schemes

In addition to the above schemes, Table 3.8 provides details as to a number of additional committed schemes that are to be included within each assessment year.

Table 3.8: Other schemes assessment year network inclusion

Scheme name	Scheme details	Scheme timescales and modelled years				
		Opening	2014 'base'	2022 'interim'	2030 'future'	2040 'horizon'
M1 J40 Osset	Pinch point programme [PPP] Scheme to southbound off-slip.	2015	No	Yes	Yes	Yes
M1 Junction 47	S278 scheme improvements to northbound off-slip.	by 2022	No	Yes	Yes	Yes
M62 J28 Tingley	Widening westbound off-slip and circulatory carriageway. (Since the modelling was undertaken this scheme has been removed from Highways England's improvements programme.)	2016	No	Yes	Yes	Yes

3.6 Network Analysis Tool demand forecasting

The Network Analysis Tool [NAT] is a Microsoft excel based forecasting model used to identify the impact of trips on the SRN resulting from LA development aspirations. Within NAT, the feasibility of the development sites can be assessed and those with the largest impact identified, allowing for a more efficient planning process. NAT reports the likely number of vehicles on each link of the SRN and the relative stress that this is likely to cause. The likely impact of development aspirations can be forecast between 2011 and 2030.

NAT covers the whole of the Yorkshire and Humber region and was originally built in 2007, but was updated in January 2012 to predominantly take account of the changing economic climate.

NAT is based on the SWYMBUS SATURN model and this has been transposed into excel so the tool does not require access to SATURN to be run. The SATURN model was updated in 2012 and includes all SRN and A roads across the Yorkshire and Humber region.

The future network in NAT uses the base network and considers two important factors:

- Future year transport schemes; and

- Future year LA development aspirations and trip growth.

To ensure the development information from NAT was in a suitable format for assessment in the meso model, a conversion process was undertaken. This was completed by re-entering the NAT outputs into the SATURN model, allowing the trips to be assigned to the road network and converted into a format suitable for the meso model.

Further details of the development and use of NAT, including the methodology for trip generation and distribution of development trips to the NAT network, can be found in ***Appendix B***.

3.7 Meso modelling

3.7.1 Meso model background

This study uses Highways England's West Yorkshire and Leeds region meso models. These models have been developed by Highways England using the Dynameq software program and are a key component in the Highway England's toolkit for analysis and appraisal of the future operation of the SRN in the region.

Meso models allow modelling of dynamic factors leading to congestion, such as weaving, merging, differential lane use, and also the wave effect of flow breakdown. Compared with micro models, they need less detailed network information and have faster run times. As such, much larger network coverage can be achieved for a given resource input. This means that the resultant model can be used to identify wider impacts of schemes, both upstream and downstream, when testing potential interventions.

The commonly used criteria to demonstrate that a macroscopic model is successfully validated are contained in the Design Manual for Roads and Bridges [DMRB]. DMRB presents validation criteria for UK highway models which are generally used by traffic model developers to demonstrate that their model is sufficiently robust.

The models have also been calibrated with the purpose being to ensure, via an iterative process, that the model flows and journey times are closely replicating available observed data.

Within this study, two meso model networks have been used; the West Yorkshire region meso model and the Leeds region meso model. Although there is overlap within the model networks between these two models, there are differences in the level of detail at certain locations, specifically the Leeds city centre area, as discussed below.

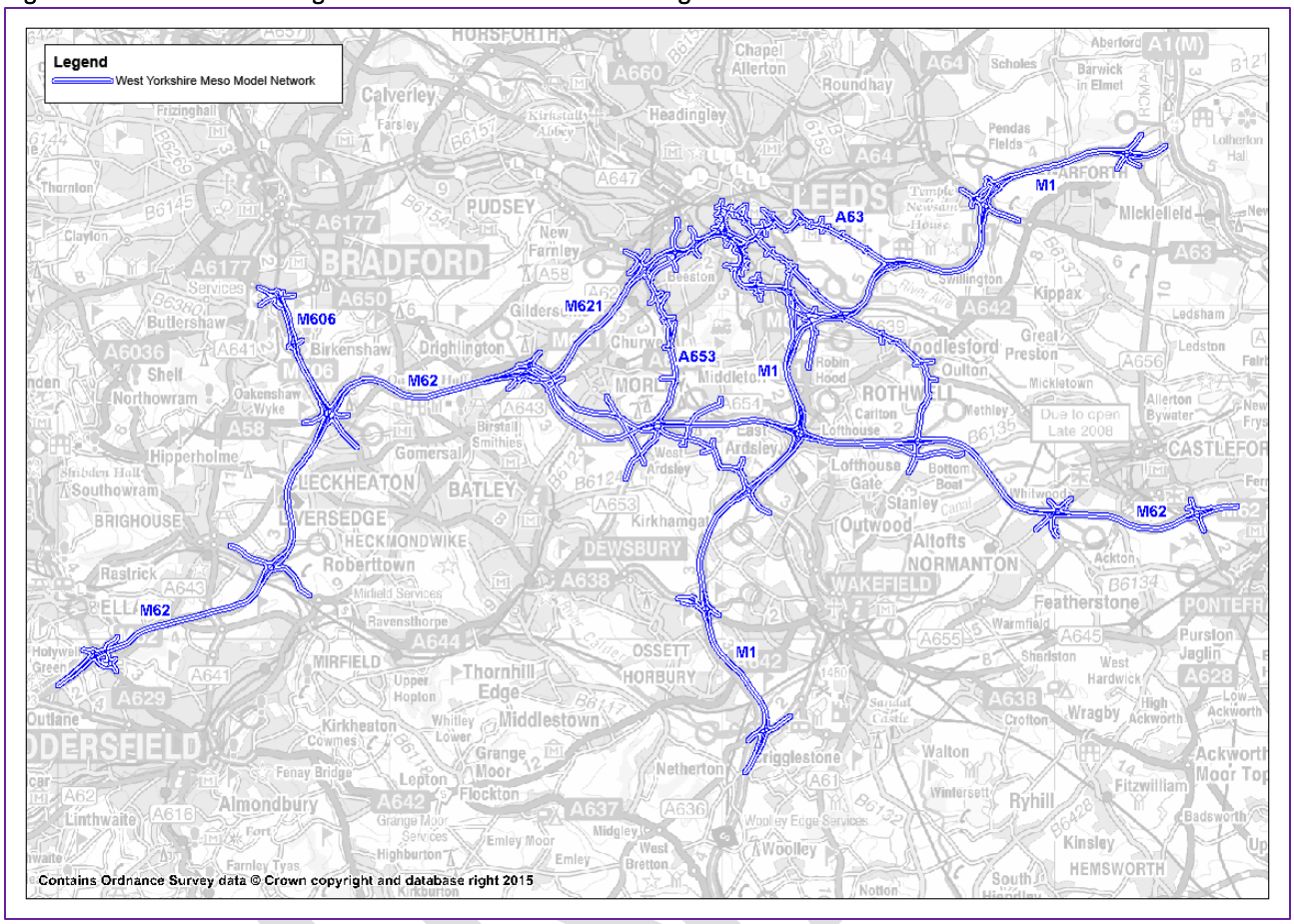
3.7.2 The West Yorkshire region meso model

The West Yorkshire region meso model network includes:

- the M62 from Junction 32 (Castleford) a in the east to Junction 24 (Ainley Top) in the west;
- the M1 from Junction 47 (Garforth) in the north to Junction 39 (Wakefield south) in the south;
- the entirety of the M606;
- the entirety of the M621; and
- small sections of the Leeds ring road and Pontefract Lane.

The extent of SRN and local network covered by the West Yorkshire region meso model is shown within Figure 3.5.

Figure 3.5: West Yorkshire region meso model - network coverage



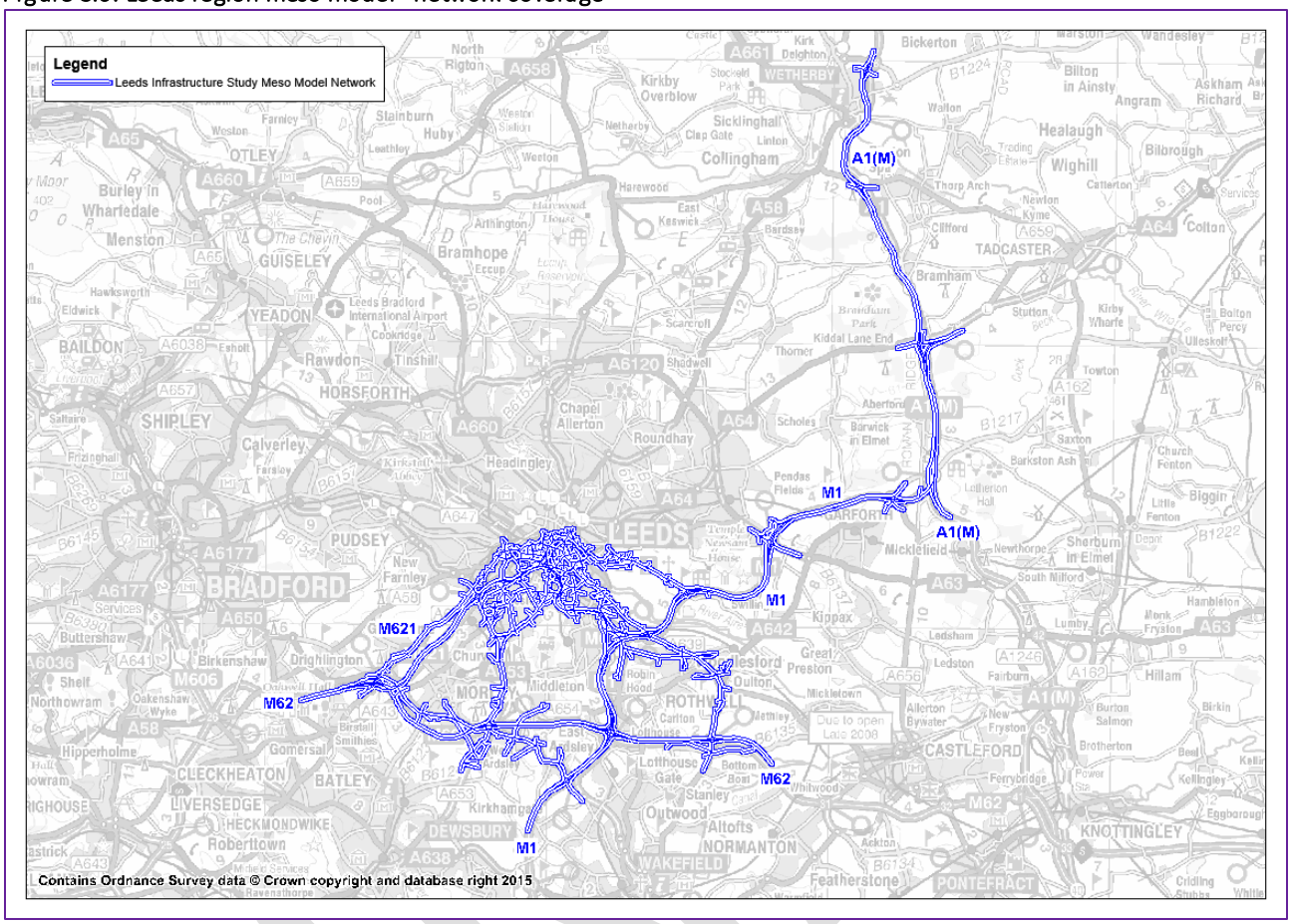
3.7.3 The Leeds region meso model

The Leeds region meso model network includes:

- the M62 from Junction 32 (Castleford) in the east to Junction 27 (Gildersome) in the west;
- the M1 from the A1(M) in the north to Junction 41 (Wakefield north) in the south;
- the entirety of the M621;
- the A1(M) from the M1 near Garforth to J47 at Wetherby;
- Leeds city centre; and
- sections of the Leeds ring road and Pontefract Lane.

The extent of SRN and local network covered by the Leeds region meso model is shown within Figure 3.6. As can be seen, there is a greater level of detail in Leeds city centre compared to the West Yorkshire region meso network.

Figure 3.6: Leeds region meso model - network coverage



As detailed within section 2.2, although the M621 is modelled within the West Yorkshire and Leeds meso model networks, the performance and operation of this strategic route has not been considered within this study.

3.7.4 Meso model results

Given the overlap between the West Yorkshire and Leeds meso models, it is not necessary to consider the modelling outputs twice at certain locations of the network which feature both within the West Yorkshire and Leeds region models. Therefore, for this study, the West Yorkshire model has been used to consider the operational performance on the M62 and M1 (south of the M621) corridors, with the Leeds region model considering the M1 (north of the M621) and A1(M) corridors.

Notwithstanding the above, all committed and indicative potential schemes have been modelled within both model networks wherever network overlaps occur to ensure their wider influences are fully captured.

3.8 Meso modelling output and analysis

3.8.1 Meso model input parameters

As discussed within section 3.7, both the West Yorkshire region and Leeds region meso models have been utilised as part of this study. The networks within each of these has been updated to include the committed schemes to be completed by the 2014 'base', 2022 'interim', 2030 'future' and 2040 'horizon' years as detailed earlier within section 3.5.

Within each assessment year, the performance of the network in both the morning (07:00 – 10:00) and evening (16:00 – 19:00) peak periods has been modelled.

Development trip matrices have been generated by the NAT process for the morning and evening periods for each of the assessment years. These have been assigned in addition to the 2014 'base' year trip matrices for the appropriate assessment year.

3.8.2 Meso model output analysis

The assessment year trip matrices have been assigned to the 'do-minimum' and subsequently the 'do-something' networks within each of the assessment scenario years. For the 'do-minimum' assessments, the performance of the network in the morning and evening peak periods has been reviewed with a consideration of both the general network performance and in comparison to preceding assessment years. For the 'do-something' assessments, the performance of the network in the morning and evening peak periods has been reviewed in comparison to the performance within the corresponding 'do-minimum' assessment.

These reviews have been completed at both a network wide level through the examination of global model outputs and local level through a visual assessment of the modelled network performance. In all, four primary methods of output analysis have been employed; global model outputs, junction operational performance, junction visual outputs and network visual outputs. These are discussed further below.

3.8.2.1 Global model outputs

Global modelling outputs used for analysis will include:

- **VHT** (total vehicle-hours of travel during the interval) — measured in vehicle-hours (v-hr), this measure does not include waiting time on virtual links.
- **VHD** (total v-hr of delay experienced during the interval) — measured in vehicle-hours (v-hr), this does not include vehicles on virtual links: it reflects the portion of VHT that is delay by subtracting the portion that represents free-flow travel time.
- **VKT** (total v-km travelled during the interval) — measured in vehicle-kilometres (v-km), this does not include vehicles on virtual links.
- **Speed** (average network speed during the time intervals) — measured in kilometres per hour (kph).

These high level outputs provide an initial overview of the entire modelled network operation and performance both in comparison to the preceding assessment years within the 'do-minimum' scenarios and in comparison between the equivalent 'do-minimum' and 'do-something' scenarios.

3.8.2.2 Junction operational performance

A qualitative review of the performance and operation of each SRN junction within the study area has been completed and includes commentary as to specific areas of congestion and their cause (if known).

For the 'do-minimum' assessments, this process identifies areas within the modelled network where operational performance is inherently poor or has changed from preceding assessment years (be it due to the impact of development aspirations or the benefits from a committed improvement scheme). In turn, this provides a spotlight as to the areas of the network where indicative potential improvement schemes should be focused.

For the 'do-something' assessments, this analysis has been completed in direct comparison to the corresponding 'do-minimum' assessment with a view to highlighting the changes in operational performance as a result of the indicative potential scheme(s).

3.8.2.3 Network visual outputs

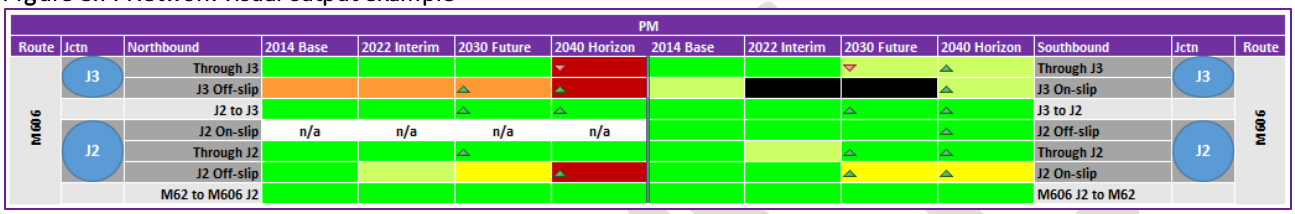
In order to demonstrate the SRN network performance along a route, a series of tabulated outputs have been produced which represent the level of delay on the SRN links between junctions, on the slip roads and through the junctions. The colour coded outputs will follow the same thresholds as those for the junction visual outputs upon which the network visual outputs will be based.

For the majority of SRN sections between junctions, there are more than one link within the meso model and each link will have their own output level of delay. The network visual outputs are therefore reported as the most representative congestion band for the entire section being reported.

The network visual outputs are reported by each peak period and for each direction. The 'do-minimum' and 'do-something' assessments are presented separately but within the 'do-something' outputs an indicative positive or negative symbol is provided to demonstrate a change in the level of congestion on that section of the SRN compared to the 'do-minimum'.

In the interests of presentation, network visual outputs for all 'do-minimum' and 'do-something' assessments are presented within ***Appendix C***. An example of the 'do-something' network visual output is provided within Figure 3.7.

Figure 3.7: Network visual output example



In addition, network schematics presenting the delay ratio across the entire meso network are also provided within the main body of this report.

3.8.2.4 Junction visual outputs

Visual meso model outputs are provided for a single 15 minute time interval as it is impractical to show images for all time periods. The time interval presented is consistent in order to enable a comparative view between the assessment scenarios.

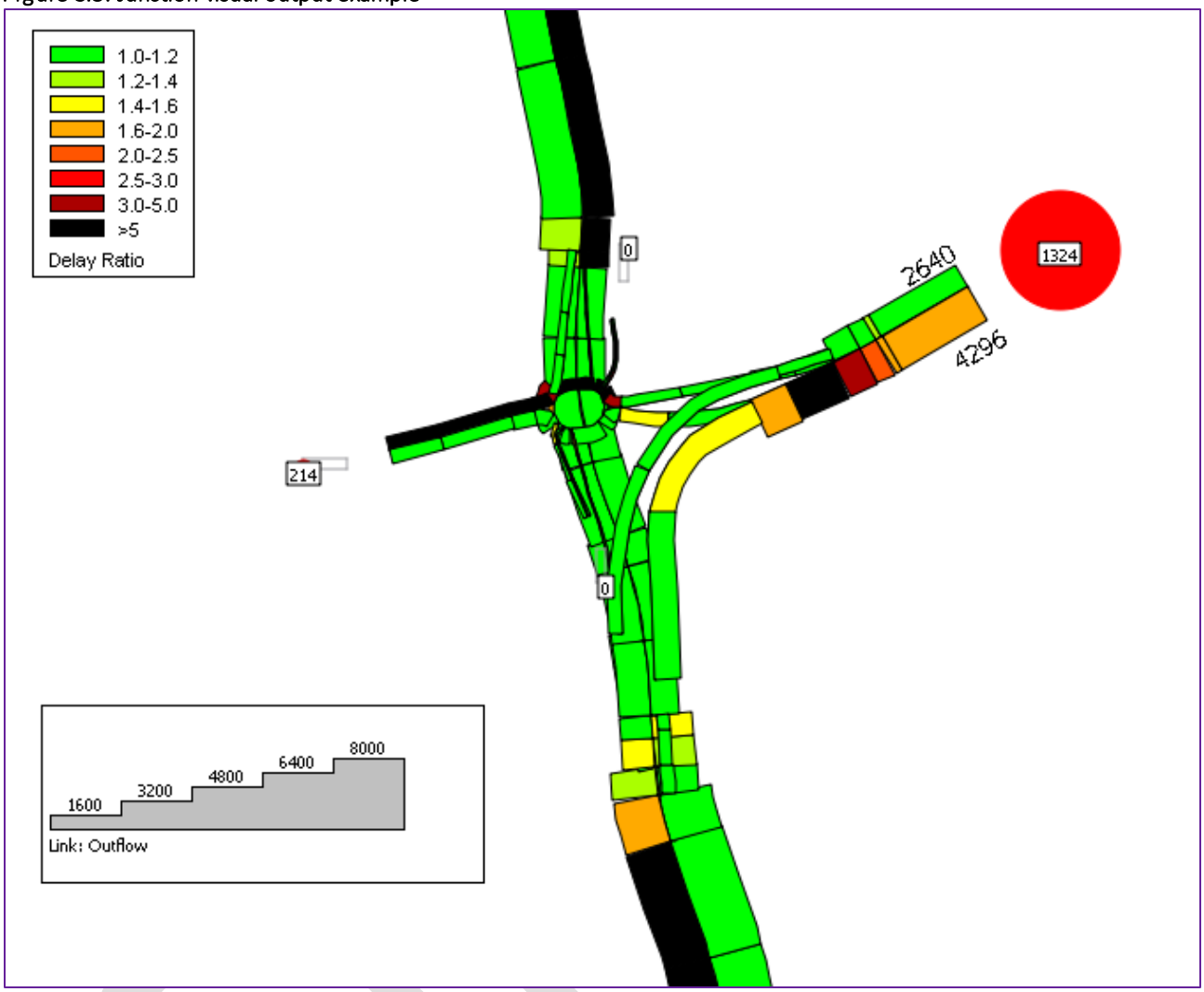
The visual outputs are provided in the format presented within Figure 3.8 below as an example. Specifically:

- The bar widths are indicative of outflow from a particular link in the 15 minute time interval, represented in hourly terms. A bandwidth legend is provided.
- The bar colour represents the ratio of modelled journey time to the free flow journey time for a particular link. For example, if it takes 10 seconds to travel on a link in free flow conditions, but the output shows 'dark red' – link time ratio of 3.0-5.0 – this indicates that the journey time on the link is between 30-50 seconds in congested conditions. A colour legend is provided.
- The boxed numbers at the link entry points indicate the number of vehicles that the queueing off the network. This value is also reflected by the size of the red centroid.

In the case of queuing off the network, it is not necessarily the case that the traffic will be queuing from the point shown as constraints on the local network may meter traffic prior to the model entry link in some cases. It should be noted that while more traffic could potentially be allowed to access the SRN from some of the junctions shown, in certain periods, to do so would jeopardise the operation of the network at downstream pinch points, hence restraint has been applied. Consequently, traffic exiting the network at the junctions is actual flow, not the demand flow that would result if traffic was not constrained upstream.

In the interests of presentation, junction specific model visual outputs for all 'do-minimum' and 'do-something' assessments are presented on a single page within ***Appendix D*** for the morning peak period and ***Appendix E*** for the evening peak period. This will also aid assessment year comparison and intervention scheme effectiveness. When making comparisons, it may be that operational changes may be observed at some junctions where no intervention schemes were implemented due to interventions elsewhere.

Figure 3.8: Junction visual output example



3.9 Indicative potential scheme identification and appraisal

Following on from the 'do-minimum' network assessments, a collaborative workshop was held with Highways England and their managing agents to discuss the results of the 'do-minimum' network assessments and identify indicative potential schemes to address the operational issues identified. Therefore, the indicative potential schemes identified should be considered as suitable for mitigating the assessment year network operational issues, contributed to by the local plan development traffic impacts upon the SRN in the study region.

The indicative potential schemes identified have been considered from a high level implementation and feasibility perspective, but not from a detailed costing and benefit appraisal point of view. The precise form of the solutions will be identified through further Highways England study. Each scheme has been allocated to a study assessment year based on both the network need and achievability in terms of construction timescales.

The assessment year trip matrices have been assigned to the 'do-something' networks within each of the assessment years. The performance of the network in the morning and evening peak periods has then been reviewed with a consideration of both the general network performance and in comparison to the corresponding 'do-minimum' assessment. This process has allowed for a review as to the benefits offered by the indicative potential schemes identified and included within the 'do-something' networks. In turn, this review has formed the basis upon which the study recommendations and conclusions are founded.

3.10 Indicative potential scheme analysis considerations

Following the inclusion of the indicative potential schemes into the meso model 'do-something' networks, the trip matrices have been reassigned and the changes to network operation in the vicinity of the schemes can be reviewed both at a network wide and location specific level.

The forecast development trip matrices themselves have been recalculated through the NAT process, which has incorporated the network changes identified. This means that new or alternative routes which are now available to development trips are incorporated into the development trip matrices. The most significant network change is the addition of M62 J24a, which upon review of the trip matrices, does induce a substantially higher level of traffic onto the SRN. Consideration of this and other trip matrix differences between the 'do-minimum' and 'do-something' assessments is covered within subsequent analysis.

Upon retrospective review of the 'do-something' assessments, a number of items have been noted which should be taken into account when considering the 'do-something' assessment outputs. These items are detailed as follows:

- Some schemes are more significant than others, which in turn also applies in terms of network operational benefits. The mesoscopic modelling shows some schemes to have clear benefits (e.g. M1 J44 – J45 All Lane Running), while for others, due to their small nature, their benefits are not as clear (e.g. ramp metering).
- Not all schemes were as effective as they were intended, be it due to their small scale being "hidden" within the wider mesoscopic model outputs (e.g. ramp metering on the northbound on-slip at M1 J46).
- As discussed above, the addition of M62 J24a results in more traffic being assigned to the SRN. This in turn increases the level of congestion and delay on some parts of the network however the total level of traffic flow is higher as a result as this traffic makes use of spare existing capacity or new capacity offered by complimentary mitigation schemes.
- The "opening up" of the network in some areas results in more traffic demand at other areas of the network as traffic is able to get through areas of congestion modelled in the 'do-minimum' quicker within the 'do-something'. This in turn results in higher congestion at areas of the network in the 'do-something' at an earlier interval than what was modelled within the 'do-minimum'. This is particularly noticeable at Lofthouse Interchange which suffers a decreased operational performance in the 'do-something' at the expense of network improvements elsewhere such as at M1 J44 for southbound movements and M62 J30 for westbound movements.
- Linked to the above, the "opening up" of the network on the A1(M) northbound has resulted in severe congestion at A1(M) J45 northbound off-slip. Therefore, an additional scheme has been identified as detailed within the previous section.
- Some schemes benefit the operation of the LRN rather than the SRN, albeit to no detriment to the SRN (e.g. the schemes at M1 J39, J40 and J44). Changes to the operation of the LRN are commented upon where relevant.
- Conversely, some LRN congestion issues "back up" onto the SRN, masking any scheme benefits within the reported time interval (e.g. the 2030 scheme at M1 J44 to upgrade the eastbound merge).

Caution should also be taken when considering the results of the 2040 'horizon' year outputs. This assessment is forecasting traffic conditions 25 years from the present, over which time a huge number of contributory factors could greatly change the traffic demand trends applied to the model. This is particularly true given the lack of development aspiration information beyond 2030 and hence the uniform application of traffic growth rates on top of origin and destination movements derived for the 2030 'future' assessment. A greater focus therefore should be placed on the outputs of the 2022 'interim' and 2030 'future' assessments.

2014 'base' network assessment

4.1 Overview

This section presents the modelled assessment of the meso networks within the 2014 'base' year. For this assessment year, only committed schemes have been incorporated into the network. The outputs of the 2014 'base' will provide a reference scenario to which the 2022 'interim,' 2030 'future' and 2040 horizon can be compared.

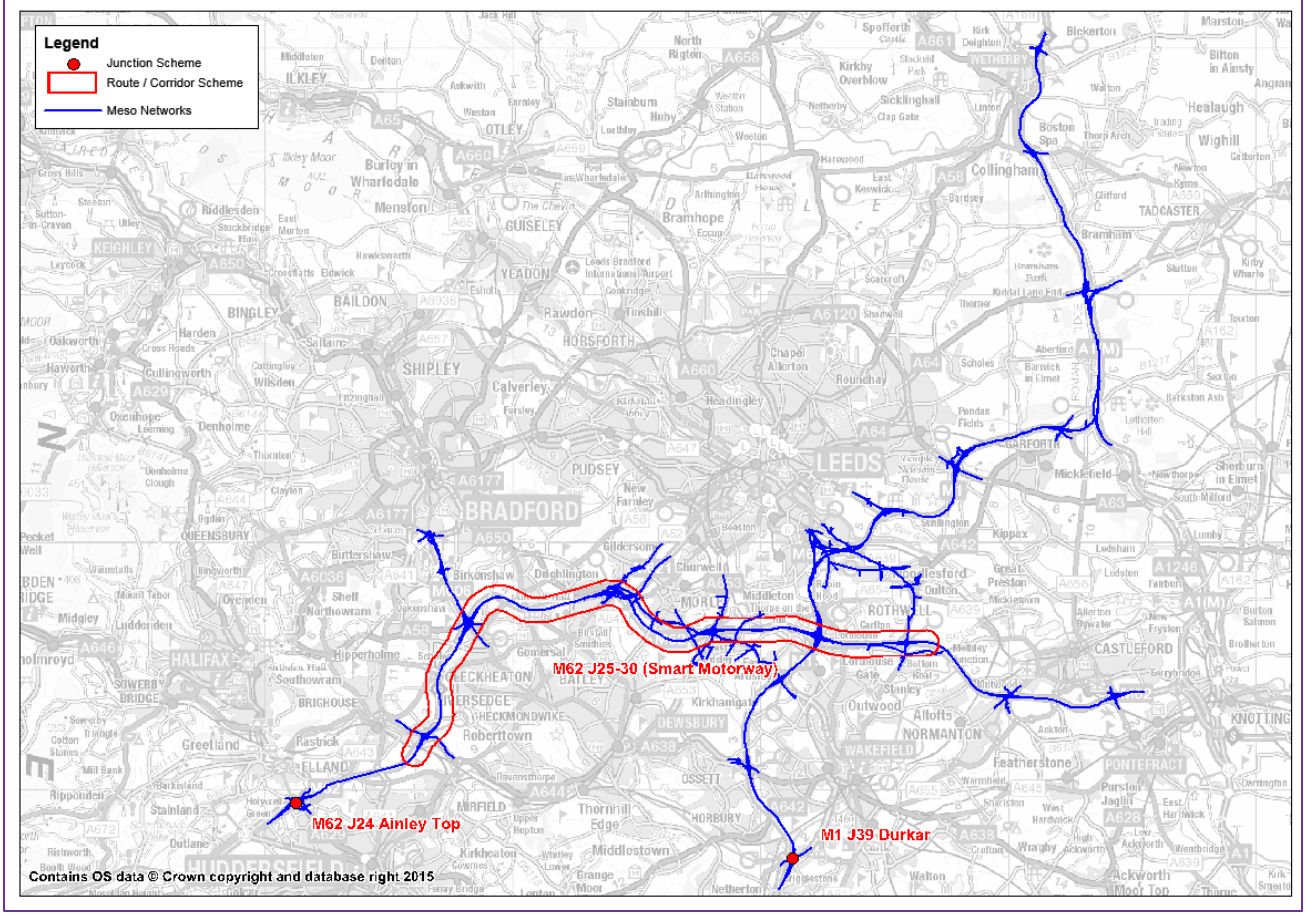
4.2 Committed schemes

The committed schemes which have been coded into the 2014 'base' meso networks are detailed within Table 4.1 and presented within Figure 4.1.

Table 4.1: 2014 'base' – committed schemes list

Scheme name	Scheme details
M62 J25-30	M62 Junctions 25 to 30: Smart Motorway
M62 J24 Ainley Top	S278 scheme to provide traffic signalisation and circulatory carriageway widening.
M1 J39 Durkar	Signalisation of the off-slips.

Figure 4.1: 2014 'base' - committed schemes plan



4.3 2014 'base' global network performance review

The global network outputs modelled within the 2014 'base' is presented within Table 4.2. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 4.2 and Figure 4.3.

Table 4.2: 2014 'base' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	5,284.45	7,166.38	5,999.87	5,155.62	6,899.67	6,135.67
Vehicle Hours of Delay (v-hr)	1,151.86	2,459.27	1,868.66	1,041.51	2,183.79	2,066.70
Vehicle Kilometres (v-km)	348,890.78	397,621.98	353,510.28	345,739.53	396,417.25	345,099.28
Average Network Speed (kph)	67.00	55.42	59.26	67.33	57.50	56.82

The 2014 'base' WYIS network experiences more delay and congestion in the AM peak compared to the PM peak despite the level of traffic demand being relatively similar. With reference to Figure 4.2 and Figure 4.3, key network pinch points identified as generating the congestion within the AM peak are the eastbound merge at M62 junction 26 and the northbound merge at M1 junction 41. In the PM peak, issues of note are observed at M1 junction 40, the westbound off-slip at M62 junction 31 and the northbound off-slip at M1 junction 46. Moderate delays on off-slips are modelled at a number of junctions across the network, but these generally are not severe enough to back up onto the SRN mainline.

4.4 2014 'base' junction performance review

A more location specific performance review has also been undertaken, with a focus on the performance of the network at and around SRN junctions. Table 4.3 presents a summary of the network performance at the SRN junctions featured within the study area network. Graphical outputs can be found within ***Appendices D and E***, for the morning and evening peaks respectively.

Table 4.3: 2014 'base' - junction performance summary

Junction	AM Peak	PM Peak
M1 J39 Durkar	Northbound merge congestion early within the modelled time periods which backs up and causes circulatory congestion which remains throughout the peak periods. This results in LRN congestion on the approach to the junction from Wakefield.	
M1 J40 Ossett	Circulatory congestion resulting in LRN congestion on the approach from Wakefield.	Severe circulatory congestion and LRN congestion. This results in southbound off-slip congestion which backs up onto the M1 southbound mainline.
M1 J41 Carr Gate	Queuing on the northbound on-slip is observed as a result of the merge with the M62 carriageway. This impacts upon circulatory operation and congestion onto the LRN and southbound approach. Southbound movements unaffected.	Congestion is modelled on the M1 southbound carriageway as a result of queuing traffic from J40. No congestion is modelled for northbound movements.
M1/M62 Lofthouse	Queuing traffic is modelled on the M1 northbound off-slip and the M62 eastbound off-slip. There are also merge issues on the M62 westbound to the west of the junction.	The junction operates well during the modelled period, although congestion is modelled on approach to the junction on the M1 from the M621/M1 merge.
M1 J43 / M621	Small disruption to free flow traffic movements are modelled for a short distance in the vicinity of the M1 merge/diverge with the M621.	Severe delay at this location, predominately backing up towards the M621.

Junction	AM Peak	PM Peak
M1 J44 Rothwell Haigh	Circulatory congestion results in queuing on both the M1 southbound off-slip and the A639 approach from Rothwell.	Minimal delay is modelled at this location in this time period.
M1 J45 Pontefract Lane	Minimal delay is modelled at this location in both the AM and PM periods. The off-slips are moderately congested, but this delay does not back up onto the SRN mainline.	
M1 J46 Colton	Minimal delay is modelled at this location.	Northbound off-slip congestion causing moderate delays on M1 northbound main carriageway.
M1 J47 East Garforth	Minimal delay is modelled at this location.	Northbound and southbound off-slip congestion. No issues on mainline.
A1(M)/M1	Minimal delay is modelled at this location in both the AM and PM periods.	
A1(M) J44	Minimal delay is modelled at this location in both the AM and PM periods.	
A1(M) J45	Minimal delay is modelled at this location in both the AM and PM periods.	A small level of congestion on northbound off-slip
A1(M) J46	Minimal delay is modelled at this location in both the AM and PM periods.	
M62 J24 Ainley Top	Junction largely operates well despite high levels of traffic around the southern circulatory.	
M62 J25 Brighouse	Minimal delay is modelled at this location in both the AM and PM periods.	
M62 J26/M606	Severe congestion is modelled on the eastbound carriageway as a result of merging traffic. This congestion backs up to J27. Congestion is also modelled on the westbound off-slip.	Lower levels of congestion are modelled at this junction and on approach to this junction in the PM than the AM peak.
M62 J27/M621	Eastbound traffic is free flowing. Westbound congestion is observed as a result of the off-slip diverge.	Lower levels of congestion are modelled at this junction and on approach to this junction in the PM than the AM peak.
M62 J28 Tingley	Mainline traffic is free flowing in both directions. The southern half of the circulatory is congested but this does not impact upon the SRN. Queuing on LRN within AM peak.	
M62 J30 Rothwell	Minimal delay is modelled at this location in both the AM and PM periods. Small level of congestion on westbound off-slip.	
M62 J31 Normanton	The northern and southern junction circulatories operate well throughout the peak periods.	The northern and southern circulatories are more heavily congested in the PM than the AM peak. There is moderate congestion on the M62 eastbound mainline on approach to the junction diverge.
M62 J32 Castleford	Minimal delay is modelled at this location.	Queuing traffic is modelled on the eastbound off-slip. The M62 mainline is free flowing through this junction.

Figure 4.2: 2014 'base' – AM peak network schematic (model interval to 09:00)

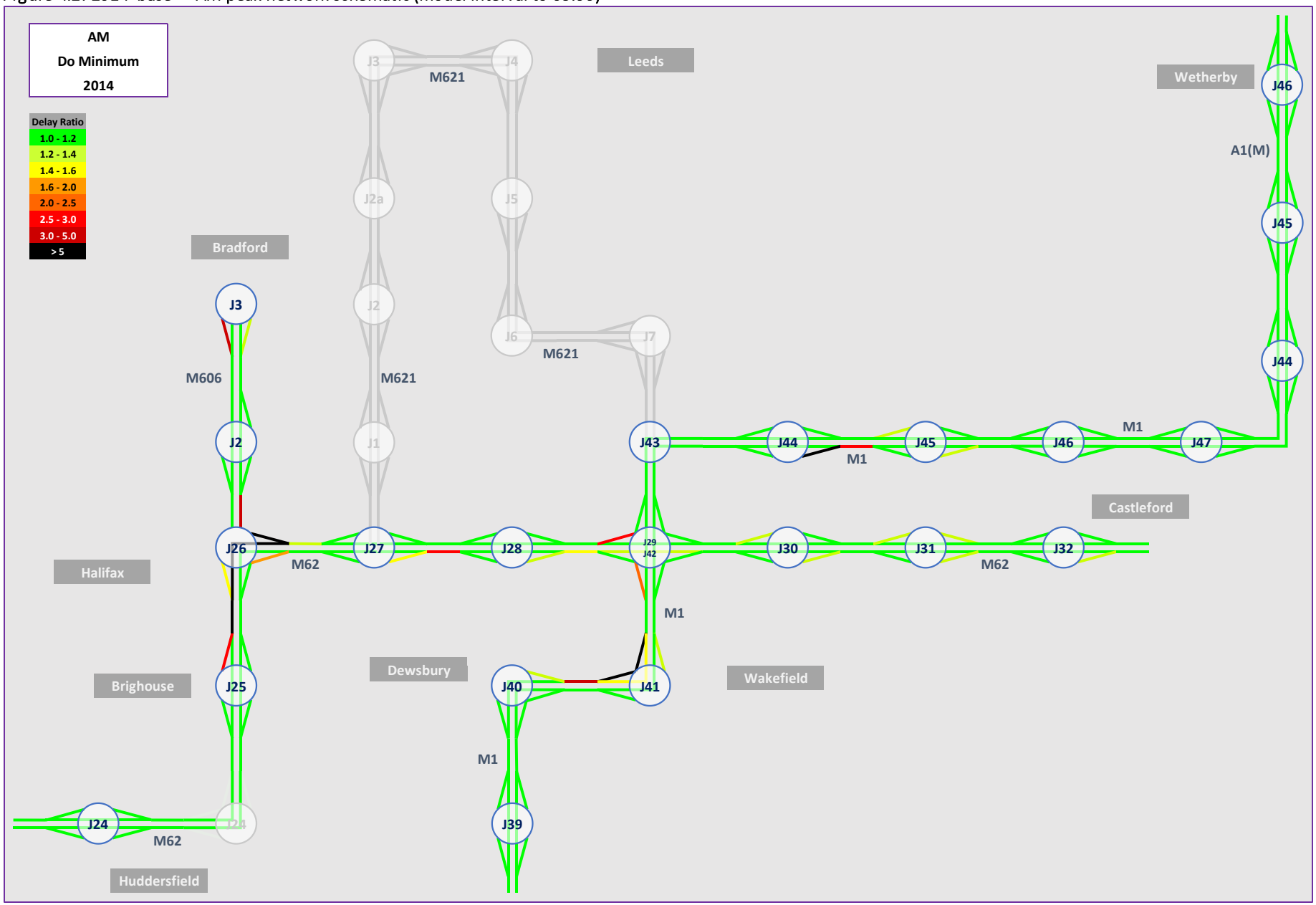
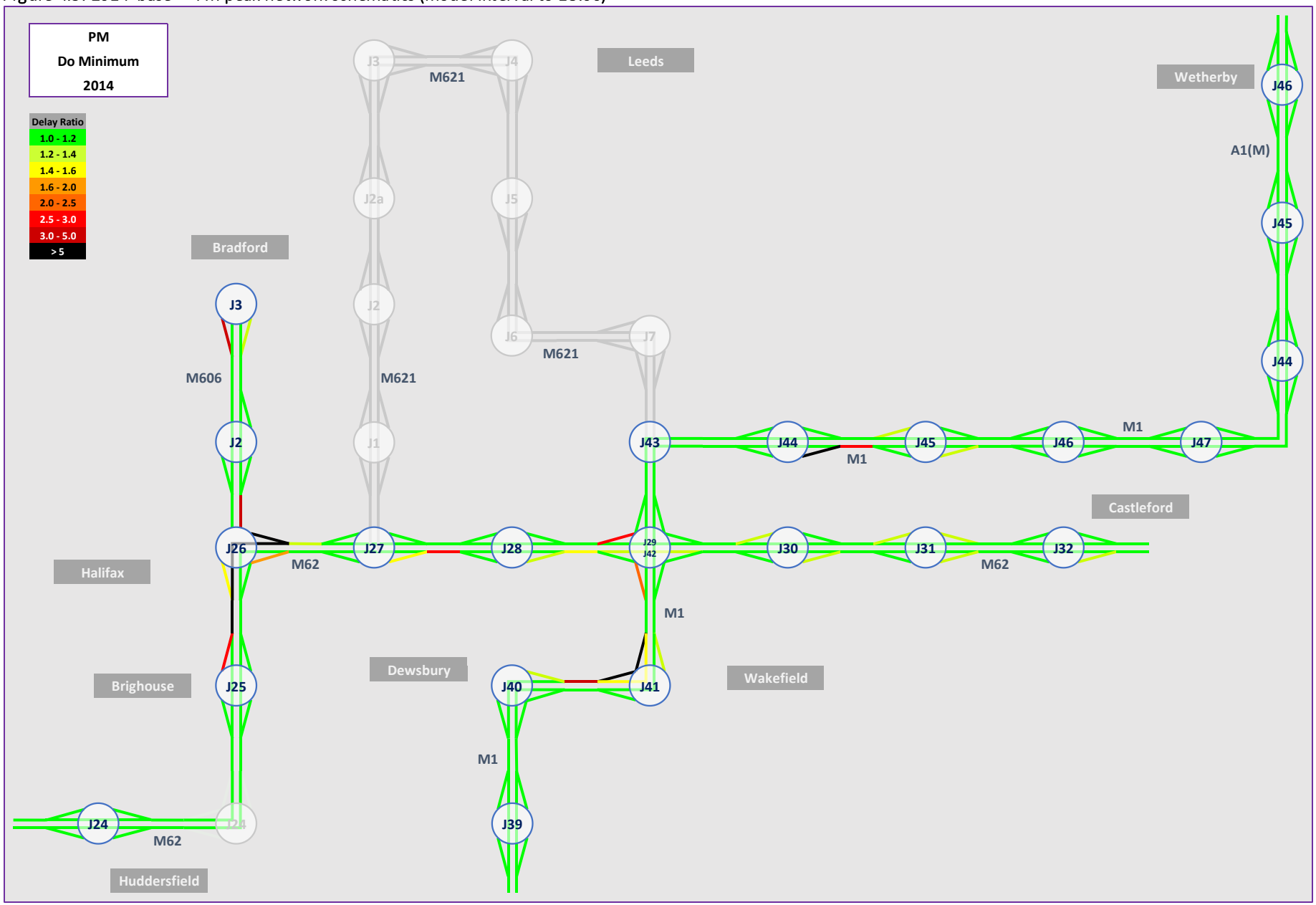


Figure 4.3: 2014 'base' – PM peak network schematics (model interval to 18:00)



2022 'interim' network assessment

5.1 Overview

This section presents the modelled assessment of the meso networks within the 2022 'interim' year. For the 'do-minimum', committed schemes have been incorporated into the meso network which is then assessed. Following an analysis of the 'do-minimum' assessments, appropriate indicative potential schemes have been identified and built into the meso network to create the 'do-something' assessment network.

5.2 2022 'interim' committed schemes

As detailed within section 3.5, committed schemes are those for which funding has been confirmed and/or assured and will be implemented within the next 5 to 10 years. These schemes need to be incorporated into the appropriate assessment year networks (depending on the expected construction timescales) and therefore form part of the 'do-minimum' assessment year networks.

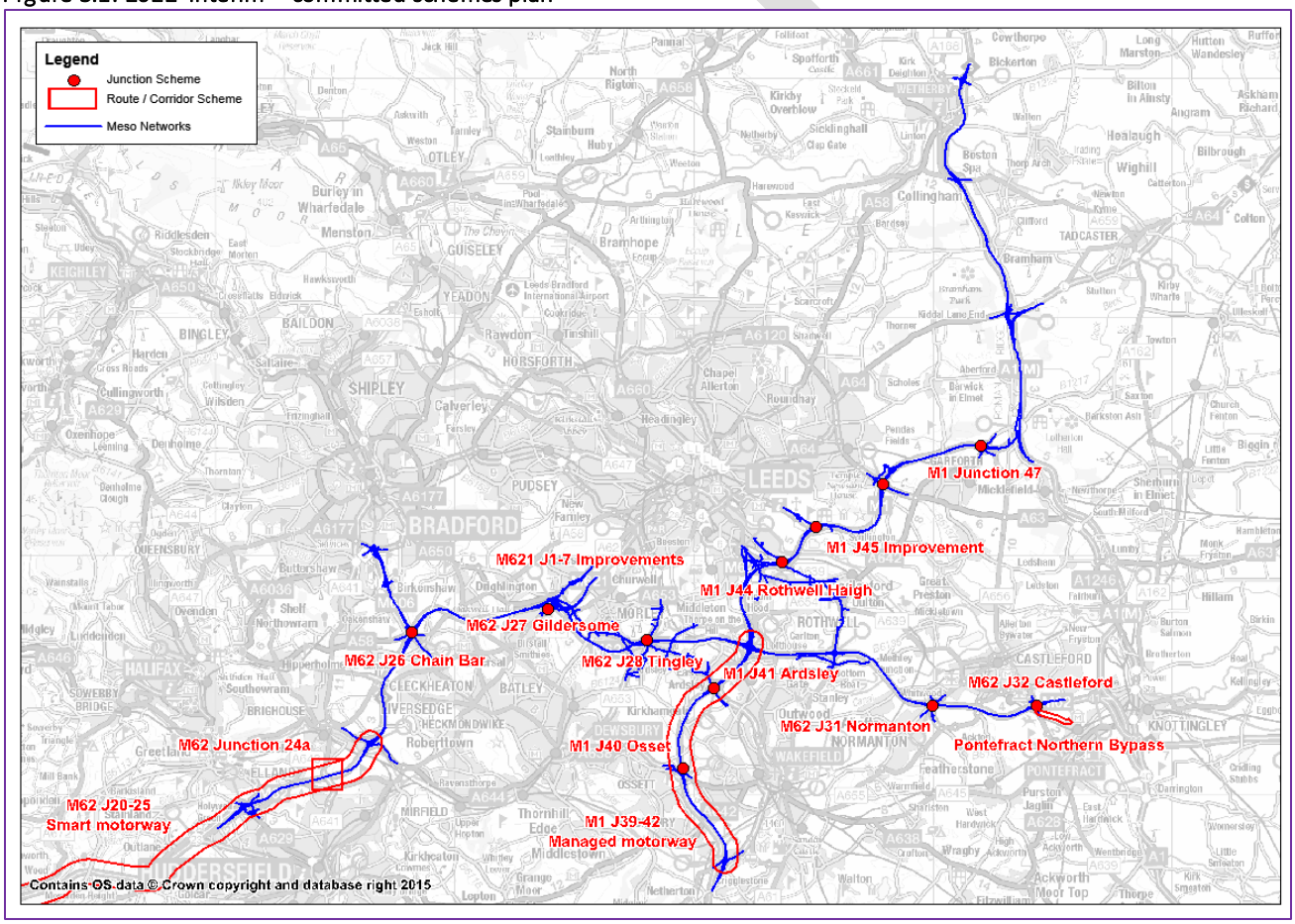
The committed schemes which have been coded into the 2022 'interim' meso networks are detailed within Table 5.1 and presented within Figure 5.1. These are in addition to those schemes coded as part of the 2014 'base'.

Table 5.1: 2022 'interim' – committed schemes list

Scheme name	Scheme details
M62 J26 Chain Bar	Capacity enhancements to the circulatory carriageway programmed 2015/16
M62 J27 Gildersome	Capacity improvements to the southern dumbbell roundabout. (Since the modelling was undertaken this scheme has been removed from Highways England's improvements programme.)
M1 J39-42 Smart motorway	Hard shoulder running and variable speed limit
M1 J41 Ardsley	PPP scheme to widen both A650 approaches to three lanes. Widen both M1 approaches to three lanes. Widen circulatory to three lanes. Improved traffic signal control.
M1 J44 Rothwell Haigh	PPP Scheme: Signalisation of both roundabouts. New through-about arrangement to northern roundabout.
M1 J46 Colton	Signalisation of A6120/A63/M1 southern circulatory. Signalisation of northern circulatories alongside closure of links to create a dumbbell arrangement. Elongation of northern dumbbell.
M62 J31 Normanton	PPP scheme to upgrade of eastbound diverge to a type B taper diverge with auxiliary lane
M62 J32 Castleford	PPP scheme to upgrade of eastbound diverge to a type D ghost island diverge
M62 J32 Castleford	Changed geometry and layout to the north of the junction (including lane widening and priority changes) related to the Castleford Tigers / Five Towns Park development scheme.
M1 J45 Improvement	Improvements to J45 to allow increased capacity, and to support the nearby Aire Valley enterprise zone.
M62 J20-25 Smart motorway	Smart motorways across the Pennines, from Rochdale to Brighouse. Links 2 existing Smart motorway sections to create a continuous smart route from Leeds to Manchester.

Scheme name	Scheme details
Pontefract Northern Bypass (now on site and completed early in 2015 using 30% advance funding from the Fund)	A new section of highway on the northern extent of the old Prince of Wales Colliery site from Park Road (with a new traffic light controlled junction) to Skinner Lane.
M1 J40 Osset	PPP Scheme to southbound off-slip
M1 J47	S278 scheme improvements to northbound off-slip.
M62 J28 Tingley	Widening westbound off-slip and circulatory carriageway

Figure 5.1: 2022 'interim' - committed schemes plan



5.3 2022 'interim' indicative potential scheme identification

The indicative potential schemes identified to address network operation issues in the 2022 'interim' year are presented within Table 5.2 and Figure 5.2.

While the majority of the indicative potential schemes are designed to target specific localised operational issues (e.g. slip road enhancements / junction signalisation), some schemes (e.g. M62 J24a) have the potential to change trip assignment patterns across a wider area. This change needs to be taken into account. To that end, for the 'do-something' assessments, revised NAT outputs were produced in order to provide representative forecast development trip matrices.

Table 5.2: 2022 'interim' - indicative potential schemes list

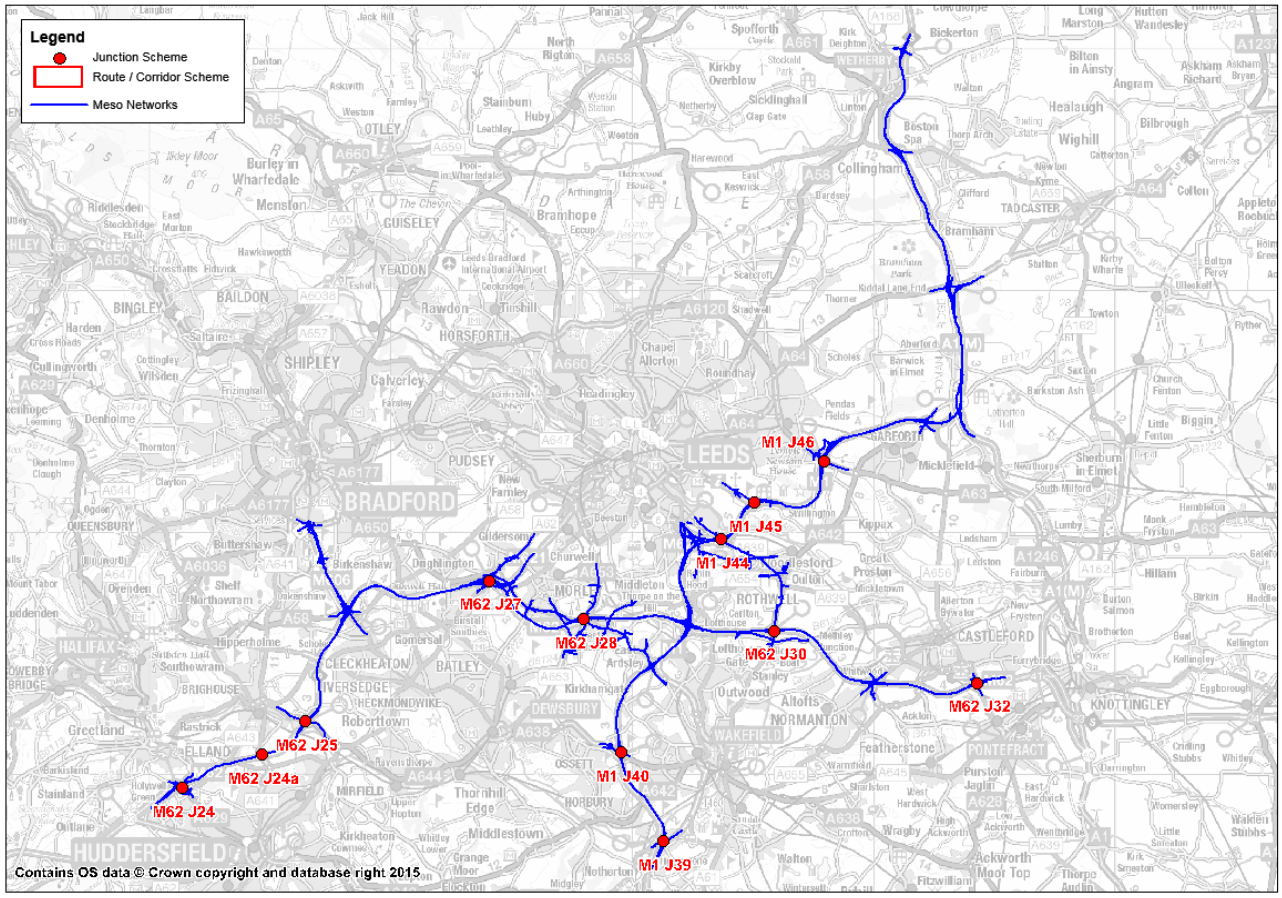
Location	Scheme Summary	Drawing Ref
M1 J39	Signalisation of all remaining non-signalised arms following the committed scheme construction. In addition, LRN approach links to the junction circulatory have been widened from 2 to 3 lanes to provide more stacking capacity	03 SR 3
M1 J40	The existing 3 lane section of the LRN approaches is to be extended to provide more stacking capacity	04 SR 4
M1 J44	Improved junction signal operation (signal timing adjustments)	n/a
M1 J44	The 3 lane section of the southbound off-slip to be constructed as part of a committed scheme is to be extended to provide more stacking capacity	06 SR 6
M1 J45	Northbound on-slip and merge improvements (2 lanes and ghost Type C). As part of 2030 potential network, this merge will change to a lane gain (see Table 6.3).	08 SR 8
M1 J46	Removal of segregated left-turn lane from A63 to M1 South in order to better regulate the flow of traffic onto the southbound slip road. Amended circulatory signal timings also required to reflect demand flow changes.	10 SR 10
M62 J24	Three lanes approach from M62 westbound off-slip on A629 to provide more stacking capacity and weave section.	M62 J24 Plan 3.2
M62 J24a	Add J24a into potential meso network. To be located at the existing A641 bridge and to comprise an all movements signalised junction.	n/a
M62 J25	Signalisation of all arms (in conjunction with the Cooper Bridge scheme)	16 SR 16
M62 J27	Widen eastbound off-slip to 3 and 4 lanes on approach to the junction.	19 SR 19
M62 J28*	Widening of circulatory carriageway to accommodate two lanes dedicated to the movement from the M62 westbound exit slip to the A650. Ramp metering of eastbound merge	430593-SK-01
M62 J30	Provision of traffic signals at the roundabout at the end of the westbound off-slip.	24 SR 24
M62 J30**	Signalisation of the junctions with the A642 of the B6135 Newmarket Lane and Castle Gate	n/a
M62 J32	Westbound on-slip type C merge. As part of 2030 potential network, this merge will change to a lane gain (see Table 6.3).	27 SR 27
M62 J32***	Signals for the new Lady Balk Lane junction to the south	n/a

** It should be noted that the scheme at M62 junction 28 detailed within Table 5.2 was a committed scheme at the beginning of this study. However, since the modelling was undertaken this scheme has been removed from Highways England's improvements programme. Therefore, within this study the scheme is within both the do-minimum and do-something networks. As a result, the benefits of this scheme will not be reflected within the do-something model outputs, however in order to ensure the real requirement for the scheme is captured, it has been included within Table 5.2 and Figure 5.2.*

*** It should be noted that the LRN signalisation scheme to the south of M62 junction 30 should have been included within the committed road network. As a result, the benefits of this scheme will be reflected within the do-something network outputs.*

**** It should be noted that the LRN signalisation scheme at the new Lady Balk Lane junction to the south of M62 junction 32 should have been included within the committed road network. As a result, the benefits of this scheme will be reflected within the do-something network outputs.*

Figure 5.2: 2022 'interim' - indicative potential schemes plan



All indicative potential schemes identified for the 2022 'interim' year 'do-something' network have automatically been incorporated into the 2030 'future' 'do-something' network to which further indicative potential schemes have also been added.

5.4 2022 'interim' global network performance

The global network outputs modelled within the 2022 'interim' 'do-minimum' is presented within Table 5.3. A comparison to the 2014 'base' results is also provided. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 5.3 and Figure 5.5.

Table 5.3: 2022 'interim' 'do-minimum' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	6,226.77	9,338.25	11,345.17	6,069.97	8,581.58	10,006.31
Vehicle Hours of Delay (v-hr)	1,770.22	4,334.28	6,717.84	1,575.32	3,458.79	5,163.96
Vehicle Kilometres (v-km)	374,800.00	421,624.40	395,907.43	375,370.98	429,293.28	412,121.83
Average Network Speed (kph)	62.31	47.18	38.36	62.64	50.45	42.19
Change from 2014 'base'						
Vehicle Hours of Travel (v-hr)	*+942.33*	*+2,171.87*	*+5,345.30*	*+914.35*	*+1,681.92*	*+3,870.65*

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Delay (v-hr)	*+618.35*	*+1,875.00*	*+4,849.18*	*+533.81*	*+1,275.01*	*+3,097.26*
Vehicle Kilometres (v-km)	*+25,909.23*	*+24,002.43*	*+42,397.15*	*+29,631.45*	*+32,876.03*	*+67,022.55*
Average Network Speed (kph)	*-4.70*	*-8.25*	*-20.90*	*-4.69*	*-7.05*	*-14.63*

As would be expected, due to forecast traffic growth between 2014 and 2022, the total vehicle kilometres has increased from the 2014 'base', which logically also contributes towards an increase in the total vehicle hours of travel. However, due to the increased level of demand, congestion has also increased which results in there being a greater number of modelled hours of delay and this in turn is reflected within the lower average network speed. The increase in demand cannot therefore be offset by the capacity and operational benefits provided by the committed schemes.

The global network outputs modelled within the 2022 'interim' 'do-something' assessment compared to the 'do-minimum' is presented within Table 5.4. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 5.4 and Figure 5.6.

The effect that the introduction of M62 J24a is important to note within this study as the level of traffic both released and induced into this area of the network is substantial. There is both a release of supressed demand from the 'do-minimum' as well as a general increase in demand in the local area due to the new junction providing a new preferred route for trips which before did not use the SRN. The model area network in this area also 'funnels' traffic onto the SRN as alternative route options are not available within the meso model network. This will result in modelled traffic congestion to be higher than what would be expected to actually occur as drivers will re-route or change the time of their journey to avoid this congestion.

Table 5.4: 2022 'interim' 'do-something' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	6,402.79	9,684.84	12,726.90	6,256.85	8,838.31	10,305.93
Vehicle Hours of Delay (v-hr))	1,872.49	4,646.98	8,190.02	1,684.84	3,672.68	5,455.66
Vehicle Kilometres (v-km)	380,549.40	423,980.13	389,600.15	382,226.35	433,856.10	415,071.00
Average Network Speed (kph)	61.32	44.53	31.23	62.02	49.33	40.78
Change from 2022 'interim' 'do-minimum'						
Vehicle Hours of Travel (v-hr)	*+176.01*	*+346.59*	*+1,381.73*	*+186.88*	*+256.73*	*+299.62*
Vehicle Hours of Delay (v-hr)	*+102.27*	*+312.71*	*+1,472.18*	*+109.52*	*+213.88*	*+291.71*
Vehicle Kilometres (v-km)	*+5,749.40*	*+2,355.72*	*-6,307.28*	*+6,855.38*	*+4,562.82*	*+2,949.17*
Average Network Speed (kph)	*-0.98*	*-2.64*	*-7.13*	*-0.63*	*-1.12*	*-1.41*

The indicative potential schemes offer an increase in the number of vehicle kilometres travelled throughout the two peak periods which is a reflection of both the increased travel demand within the 'do-something' matrix as a result of the new M62 J24a as well as the benefits provided by the indicative potential schemes identified. There are small increases in the amount of delay within the network, which in turn also results in a marginally lower average network speed, however given the increased traffic demand it can be considered that the network has greater operating capacity and is operating more efficiently.

5.5 2022 'interim' junction performance

A more location specific performance review has also been undertaken, with a focus on the performance of the network at and around SRN junctions. Table 5.5 presents a summary of the network performance at the SRN junctions featured within the study area network. The results of both the 'do-minimum' and 'do-something' assessments are included within Table 5.5 in order to facilitate readability.

Graphical outputs can be found within ***Appendices D and E***, for the morning and evening peaks respectively.

Table 5.5: 2022 'interim' 'do-minimum' and 'do-something'- junction performance summary

Scenario	'Do-minimum'		Indicative potential scheme(s) in vicinity?	'Do-something'	
Junction	**AM Peak**	**PM Peak**		**AM Peak**	**PM Peak**
M1 J39 Durkar	Minimal delay is modelled at this location in this time period.	Northbound merge congestion early within the modelled time periods which backs up and causes circulatory congestion which remains throughout the peak periods. This results in LRN congestion on the approach to the junction from Wakefield.	✓	Small improvement to the junction circulatory and LRN. SRN operation unchanged.	
M1 J40 Ossett	Minimal delay is modelled at this location in either the AM or PM time periods.		✓	Small improvement to the junction circulatory and LRN. SRN operation unchanged.	Junction circulatory is more congested than within the 'do-minimum' as a result of higher LRN travel demand within the 'do-something' matrices. This does not affect the operation of the SRN.
M1 J41 Carr Gate	Queuing on the northbound on-slip is observed throughout the AM peak as a consequence of traffic backing up from the M1/A62 Lofthouse Interchange diverge to the north of J41 Carr Gate. Southbound movements unaffected.	The junction operates relatively well during the PM peak although there is a high level of congestion on the LRN and the north. This does not impact upon the circulatory or M62 mainline.	✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M1/M62 Lofthouse	Severe congestion is modelled at a number of locations. Of note, the northbound off-slip results in congestion back to M1 J42 to the south while congestion is also modelled on the M62 westbound carriageway at both the junction merge and diverge locations. There are also operational issues at the M1 northbound merge sections to the north of the junction. The same trends are apparent during the PM peak albeit at a lower level of intensity.		✗	Operates as per the 'do-minimum', with the exception of the M62 eastbound and westbound diverges which are more congested as a result of higher traffic demand reaching this location by the observed time interval.	Largely operates as per the 'do-minimum' within the PM peak period. Improvement to M62 eastbound diverge congestion.

Scenario	'Do-minimum'		Indicative potential scheme(s) in vicinity?	'Do-something'	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M1 J43 / M621	Disruption to free flow traffic movements are modelled in the vicinity of the M1 merge/diverge with the M621. This congestion is more severe on the southbound M1 carriageway. This is likely to be due to a combination of congestion at Lofthouse Interchange and extant congestion at the weaving section in-between.	Severe congestion modelled for the M1 and M621 southbound through this junction. Northbound movements are free flowing.	✗	Improvement northbound as a result of lower congestion on the M621. Similar level of congestion southbound.	Largely operates as per the 'do-minimum' within the PM peak period.
M1 J44 Rothwell Haigh	Circulatory congestion results in queuing on both the M1 southbound off-slip and the A639 approach from Rothwell. Southbound M1 carriageway slowing as a result of congestion at the M1/M621 merge to the south. Northbound off-slip severely congested which backs up to M1 northbound mainline.	The operation of the junction is impacted upon by congestion on the M1 northbound mainline which in turn is caused by issues at J45. Southbound movements are largely unaffected aside form a small level of queuing on the southbound off-slip.	✓	Greatly reduced congestion levels on the southbound carriageway as a result of improved traffic signal operation and widened southbound off-slip.	Reduced congestion on the northbound on-slip as result of lower congestion on the northbound mainline. Also improved junction circulatory operation.
M1 J45 Pontefract Lane	Circulatory operates well although traffic congestion builds up on the approach from Pontefract Lane.	Northbound on-slip congestion results in queuing traffic back onto the LRN. This also impacts upon M1 northbound mainline movements which results in congestion back to J44. Southbound movements are free flowing except at the point of diverge and merge.	✓	Released traffic from north causes more queuing on the southbound off-slip, but this does not back onto the SRN.	Improved northbound on-slip merge congestion as a result of the indicative potential scheme.

Scenario	'Do-minimum'		Indicative potential scheme(s) in vicinity?	'Do-something'	
Junction	**AM Peak**	**PM Peak**		**AM Peak**	**PM Peak**
M1 J46 Colton	Southbound on-slip merge congestion causing traffic build up on the M1 southbound main carriageway through the junction. Northbound unaffected.	Northbound off-slip congestion causing moderate delays on M1 northbound main carriageway. Southbound movements are free flowing.	✓	Reduced southbound on-slip congestion as a result of the removed free flow link on the circulatory which in effect acts as a ramp meter. Detrimental impact to LRN congestion however. Southbound mainline now uncongested.	Greatly reduced congestion on the northbound off-slip as a result of the indicative potential scheme and subsequent traffic signal adjustments.
M1 J47 East Garforth	Minimal delay is modelled at this location in either the AM or PM peaks.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
A1(M)/M1	Northbound congestion is modelled at this merge. This congestion does not back up to M1 J47. Southbound movements free flowing. This congestion does not occur during the PM peak.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
A1(M) J44	Minimal delay is modelled at this location in either the AM or PM peaks.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
A1(M) J45	Minimal delay is modelled at this location in either the AM or PM peaks aside from a small level of congestion on northbound off-slip.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
A1(M) J46	Minimal delay is modelled at this location in either the AM or PM peaks.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M62 J24 Ainley Top	Junction largely operates well despite high levels of traffic around the southern circulatory in both the AM and PM peaks.		✓	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M62 J24a Bradford Road	n/a		✓	New junction operates well with the majority of traffic passing directly between the LRN arms. The dominant turning movement within the AM peak is onto the eastbound carriageway. Within the PM peak there continues to be a higher proportion of movements to/from the M62 east as opposed to the M62 west.	
M62 J25 Brighouse	There is a small level of congestion on the eastbound on-slip and westbound off-slip, but this does not impact upon the operation of the junction circulatory or M62 mainline.	Minimal delay is modelled at this location in the PM peak period.	✗	Operates as per the 'do-minimum' within the AM peak period.	Increased level of congestion on the eastbound carriageway as a result of the higher network traffic demand.

Scenario	'Do-minimum'		Indicative potential scheme(s) in vicinity?	'Do-something'	
Junction	**AM Peak**	**PM Peak**		**AM Peak**	**PM Peak**
M62 J26/M606	Congestion is modelled on the eastbound carriageway as a result of merging traffic. Westbound, more severe congestion is modelled on approach to the junction prior to the diverge. This congestion backs up towards J27.	Lower levels of congestion are modelled at this junction and on approach to this junction in the PM than the AM peak.	✓	Eastbound movements are as per the 'do-minimum'. Westbound mainline congestion has increased at this location due to higher traffic demand within the network in this area as a result of M62 J24a. The congestion is generated by the diverge at M62 J26. This congestion is lower in the PM peak period.	
M62 J27/M621	Eastbound traffic is free flowing. Westbound, congestion is observed as a result of the off-slip diverge in both the AM and PM peak periods.		✓	The junction circulatory operates as per the 'do-minimum' however the eastbound mainline is more congested as a result of operational issues backing back from Lofthouse Interchange. Westbound carriageway is free flowing as per the 'do-minimum'.	Operates as per the 'do-minimum' within the PM peak period.
M62 J28 Tingley	Mainline traffic is free flowing in both directions. The southern half of the circulatory is congested but this does not impact upon the SRN.	Congestion occurs at both the eastbound off-slip and on-slip. The resulting congestion backs up towards M62 J27. The southern half of the junction circulatory is also heavily congested but this does not impact upon the SRN.	✓	The junction circulatory operates as per the 'do-minimum' however the eastbound mainline is more congested as a result of operational issues backing back from Lofthouse Interchange. Westbound carriageway is free flowing as per the 'do-minimum'.	Operates as per the 'do-minimum' within the PM peak period.
M62 J30 Rothwell	There is a build-up of traffic on the westbound approach to the junction which backs up towards J31.	Minimal delay is modelled at this location in this time period aside from to the south of the junction on the LRN and small congestion on the westbound off-slip.	✓	The indicative potential scheme regulates traffic flow and now prevents traffic backing up on the westbound off-slip and onto the westbound mainline.	
M62 J31 Normanton	The northern and southern junction circulatories operate well throughout the peak periods with only a small level of congestion modelled on the M62 mainline in the vicinity of the merge and diverge locations.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M62 J32 Castleford	Minimal delay is modelled at this location in either the AM or PM peaks.		✓	Operates as per the 'do-minimum' within both the AM and PM peak periods.	

Figure 5.3: 2022 'interim' 'do-minimum' – AM peak network schematic (model interval to 09:00)

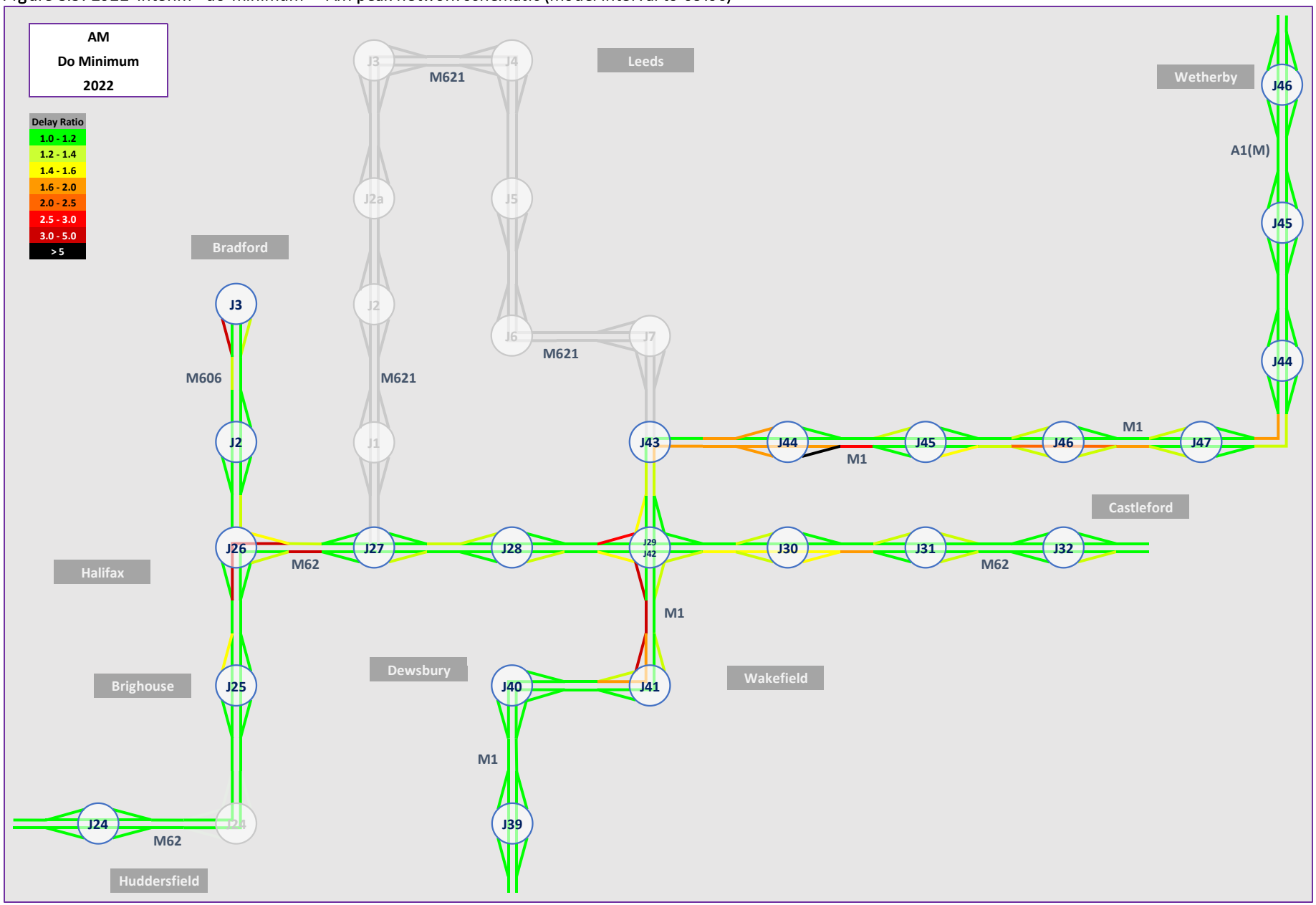


Figure 5.4: 2022 'interim' 'do-something' – AM peak network schematic (model interval to 09:00)

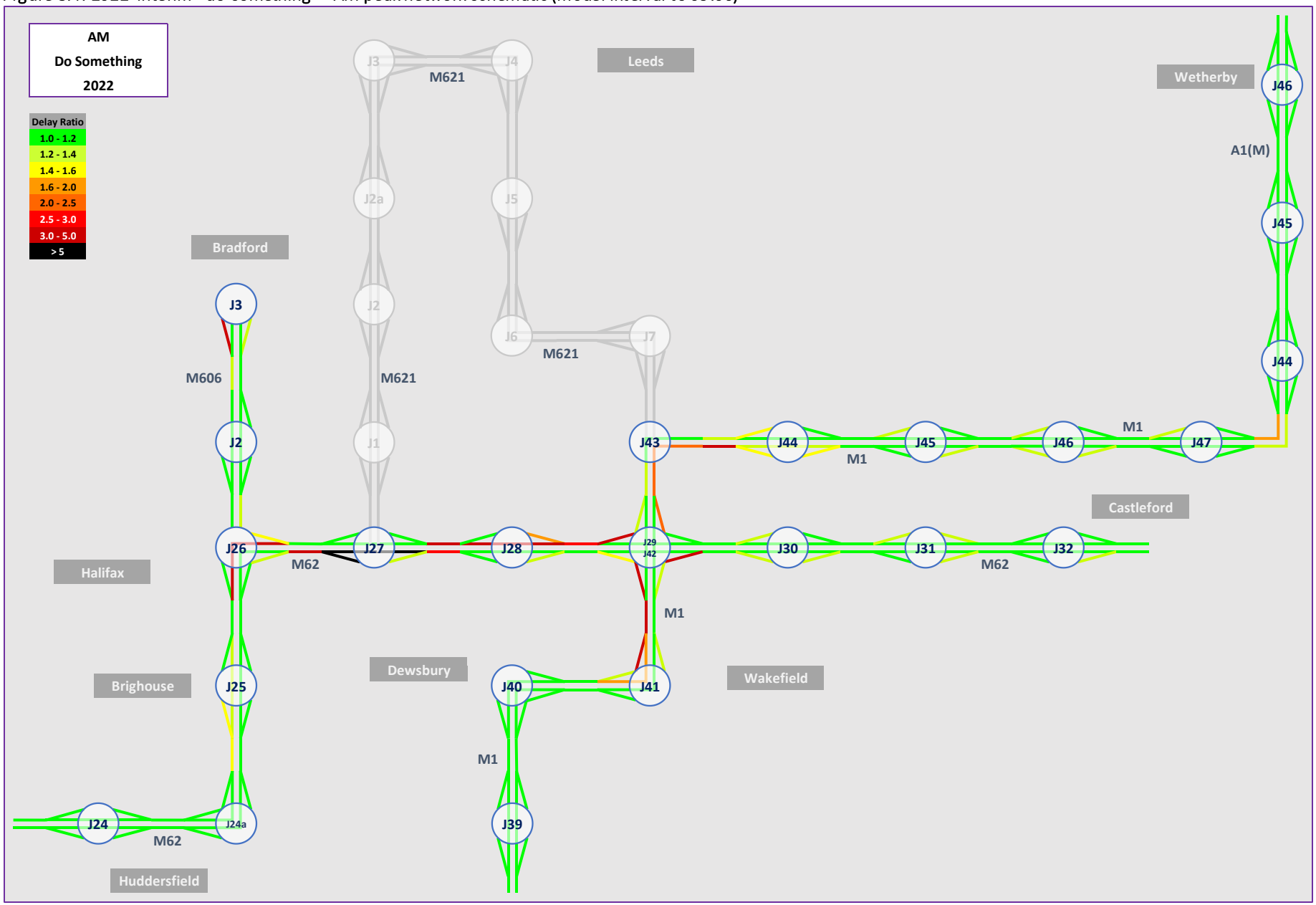


Figure 5.5: 2022 'interim' 'do-minimum' – PM peak network schematic (model interval to 18:00)

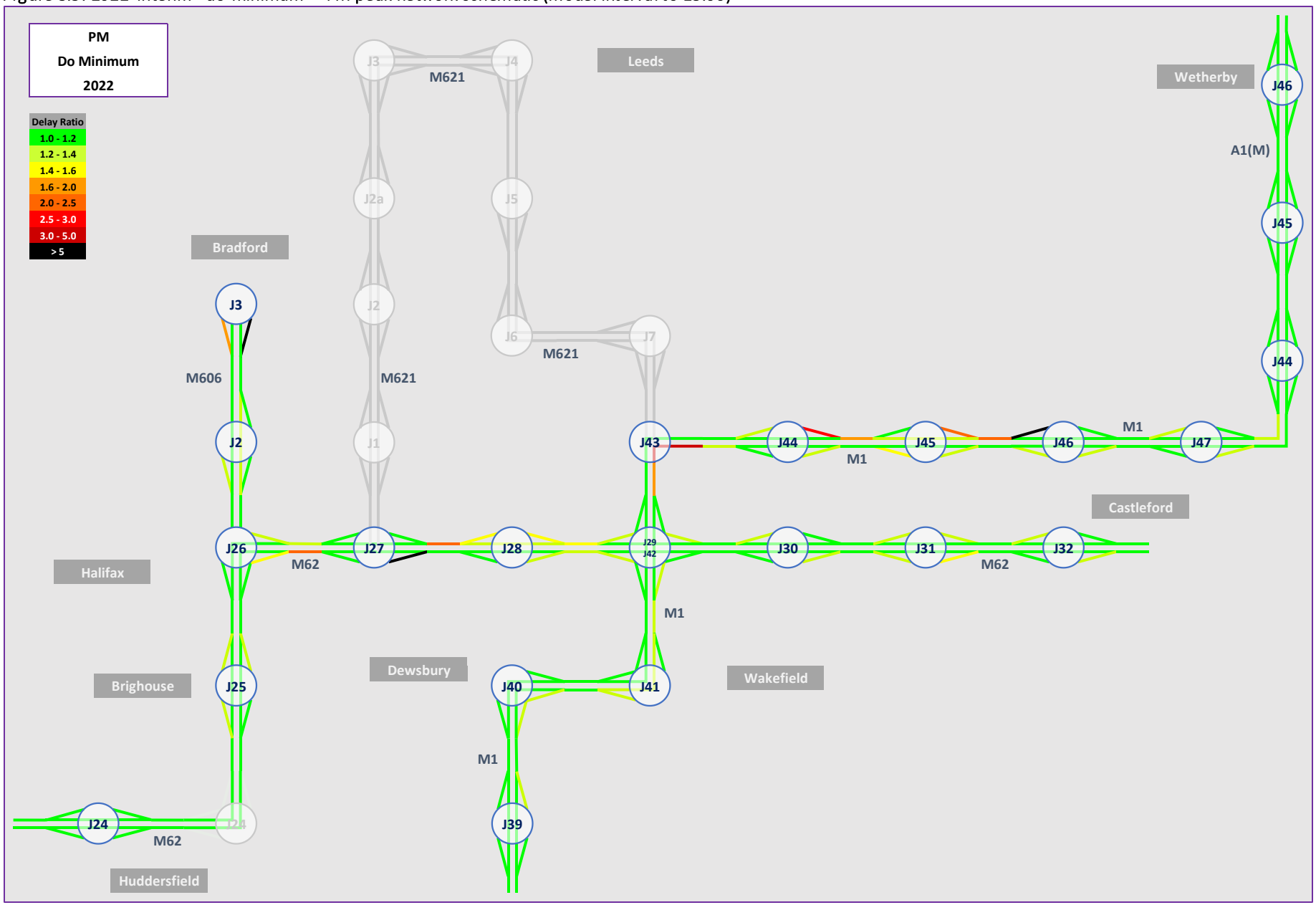
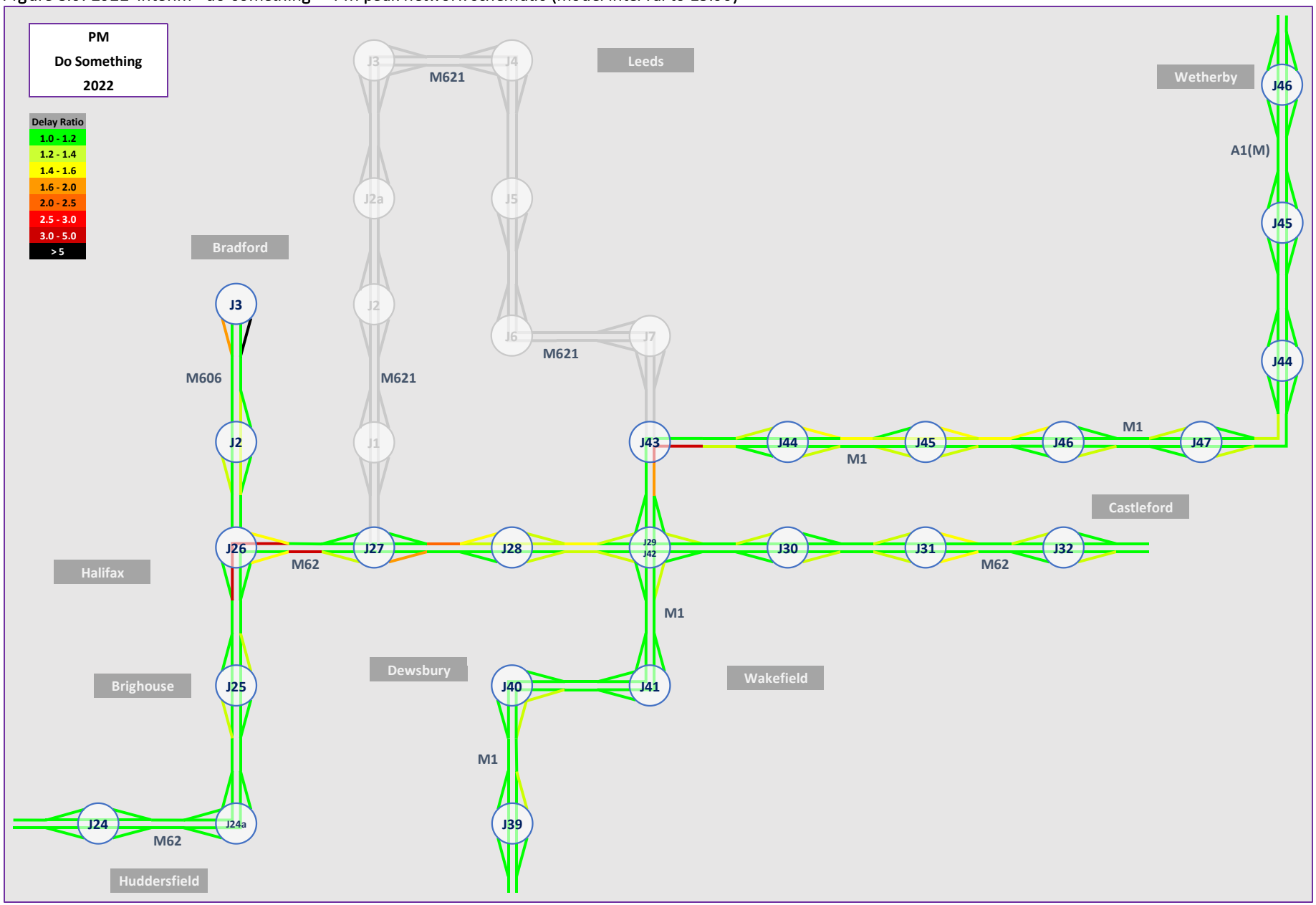


Figure 5.6: 2022 'interim' 'do-something' – PM peak network schematic (model interval to 18:00)



2030 'future' network assessment

6.1 Overview

This section presents the modelled assessment of the meso networks within the 2030 'future' year. For the 'do-minimum', committed schemes have been incorporated into the meso network. Following an analysis of the 'do-minimum' assessments, appropriate indicative potential schemes have been identified and built into the meso network to create the 'do-something' assessment network.

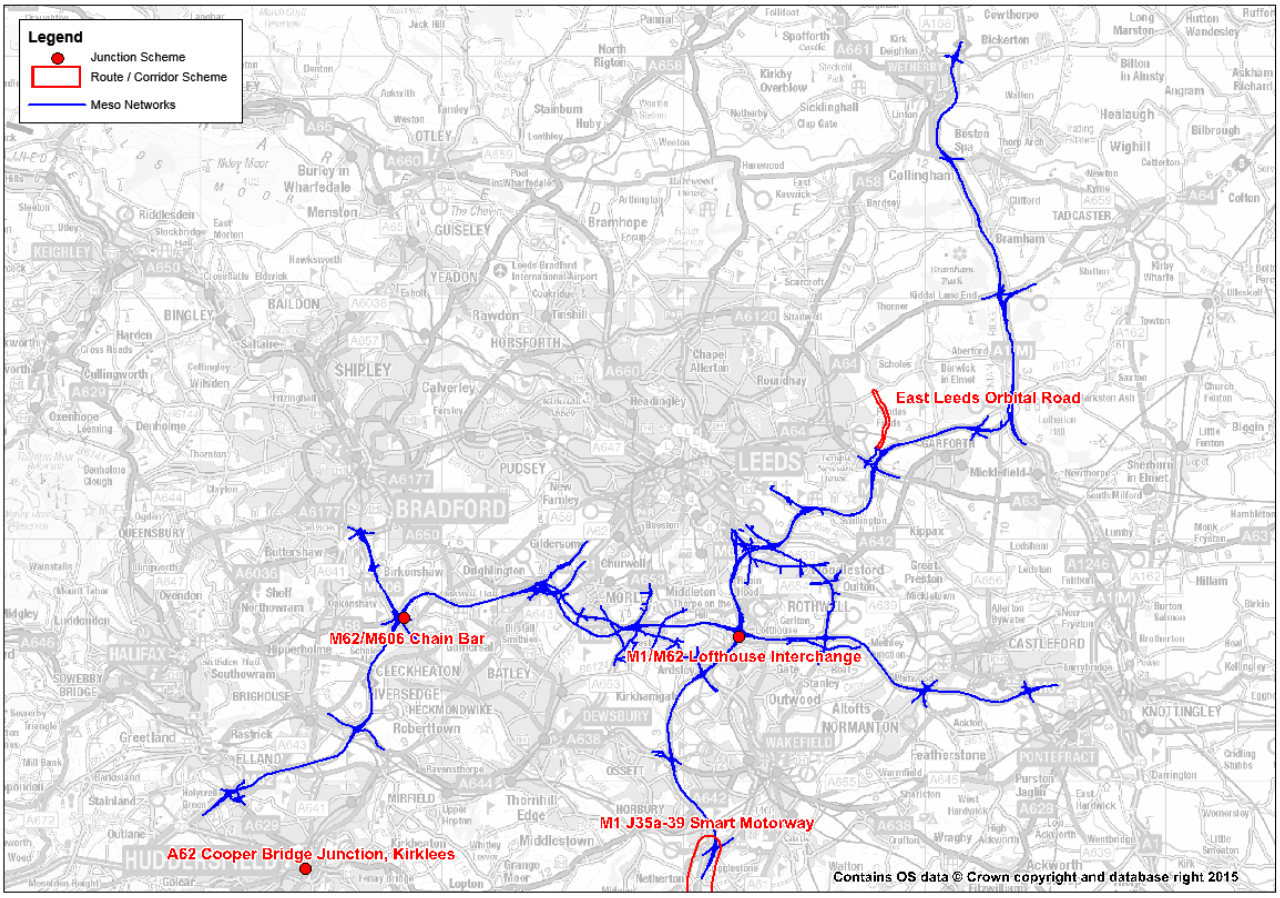
6.2 2030 'future' committed schemes

The committed schemes which have been coded into the 2030 'future' meso networks are detailed within Table 5.1 and presented within Figure 5.1. These are in addition to those schemes coded as part of the 2014 'base' and 2022 'interim' assessments.

Table 6.1: 2030 'future' - committed schemes list

Scheme name	Scheme details
M62 / M606 Chain Bar	M62: J26 (M606 Chain Bar): provision of a direct link from the M62 westbound to the M606 northbound; reduces congestion from the main part of the existing junction
M1 / M62 Lofthouse Interchange	Major enhancement to provide additional capacity at M62/M1 Lofthouse interchange.
M1 J35a-39 Smart motorway	Smart motorways to link the existing Smart motorway sections around Sheffield and Leeds, which in turn connects up the trans-Pennine stretches identified in RIS1 and the London to Yorkshire route planned for RIS2
East Leeds Orbital Road and northern outer ring road junctions	Includes new orbital highway route from the M1 J46 to west of the A58. Upgrade of the A61 and King Lane roundabouts to traffic light controlled junctions. Includes a link road between Manston Lane [MLLR] and M1 J46 and East Leeds Orbital Route [ELOR] from Manston Lane to the west of the A58.
A62 Cooper Bridge Junction, Kirklees	Highway work to deal with congestion in and around the Cooper Bridge Gyratory junction to the east of Huddersfield and facilitate access to the development site. Includes road widening, junction improvements and a new relief road around Ravensthorpe.

Figure 6.1: 2030 'future' - committed schemes plan



6.3 2030 'future' indicative potential scheme identification

Following the 'do-minimum' assessments (detailed within sections 6.4 and 6.5), the indicative potential schemes identified to address network operation issues in the 2030 'future' year are presented within Table 6.2.

Table 6.2: 2030 'future' - indicative potential schemes list

Location	Scheme Summary	Drawing Ref
M1 J45 - 46	Four lanes ALR with lane gain and lane drop at junctions 45 and 46.	09 SR 9
A1(M) J44	Signalisation of all junction arms.	01 SR 1
M1 J44	Eastbound merge upgraded to type D1.	07 SR 7
M1 J46	Ramp metering of northbound on-slip. To tie in with ELOR.	11 SR 11
M1 J47	Eastbound off-slip enhancement and signalisation.	001-004
M62 J24	Two lane provision through top island to M62 westbound. Closure of southern circulatory arc.	14 SR 14
M62 J26	Opening up of the HOV lane to all traffic and signalisation of the M606 approach to the roundabout.	n/a
M62 J26	Upgrade of the M62 westbound diverge to type D1 ghost island or D2 Parallel Diverge.	n/a

Location	Scheme Summary	Drawing Ref
M62 J27	Ramp Metering of the M621 link to the M62 westbound to reduce merging traffic impact.	20 SR 20
M62 J27	New link roads from M621 to M62 South and New Link Road between M62 Westbound and M621 Westbound Slip Road and Associated Segregated Left Turning Lane on A62 South	n/a
M62 J30-J32	Four lanes ALR	26 SR 26
M621 to M1 NB Link	Design and model potentials chemes	n/a
Lofthouse	Three lanes eastbound on M62 through Lofthouse Interchange	40 SR 40

Due to the traffic levels forecast for 2030 and severity of the resulting network operating issues, the schemes identified above are arguably more significant than those identified for the 2022 'interim' assessment year. The effect of the identified schemes in 2030 has the potential to cause a significant change in traffic flows and congestion trends. Initial model runs of the 2030 'future' assessment year has found that some indicative potential schemes result in detrimental impacts to the SRN, while other schemes are successful in 'unlocking' congestion in some places, but then new congestion issues are caused elsewhere on the network as a result.

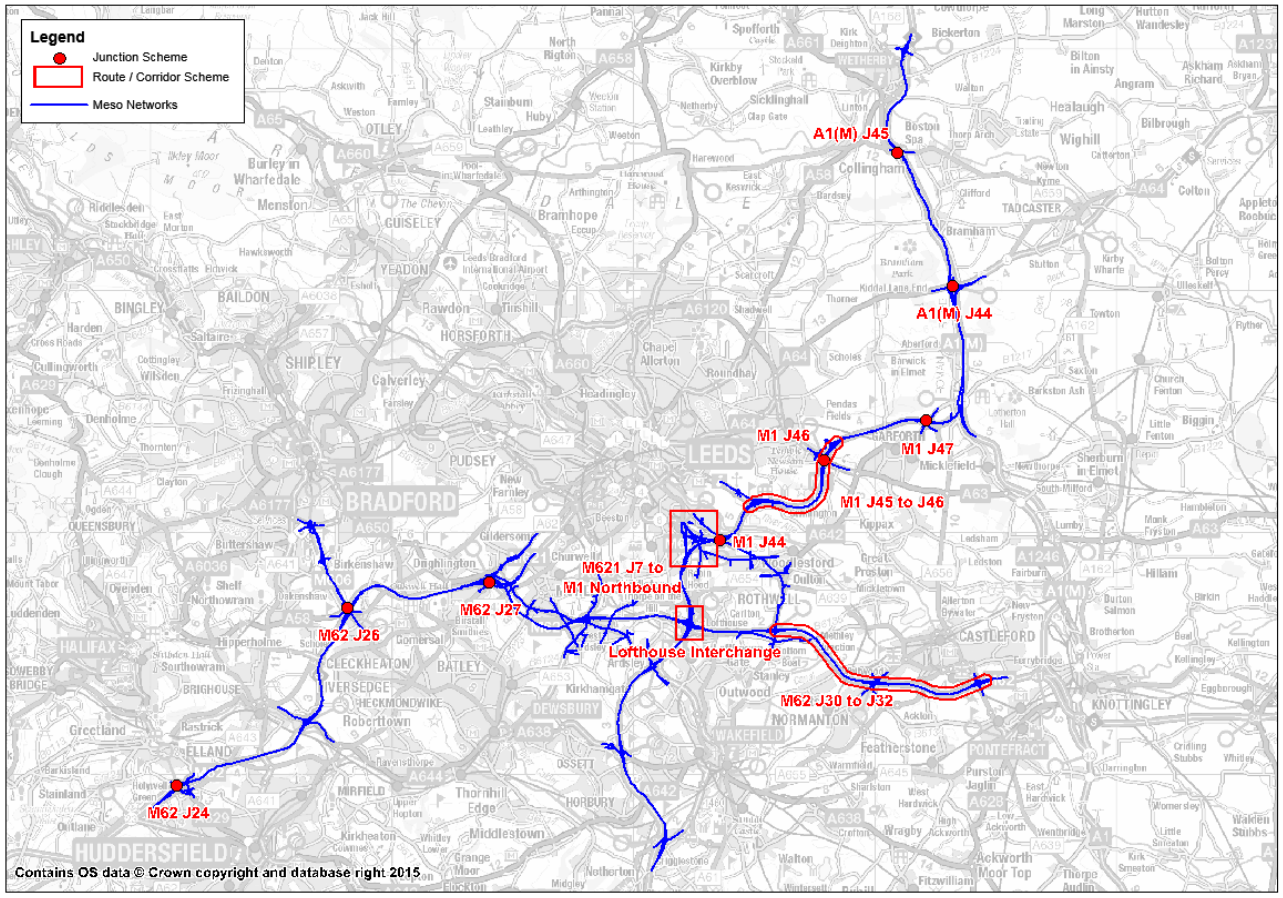
Hence, a retrospective review of the indicative potential scheme list for the 2030 'interim' year has taken place. The result is the removal and addition of schemes, which are detailed within Table 6.3.

Table 6.3: 2030 'future' – retrospective indicative potential schemes changes

Location	Scheme Summary	Change Requirement	Drawing Ref
A1(M) J45	Signalisation of the northbound off-slip	Unlocked congestion on the M1 and A1(M) to the south as a result of other indicative potential schemes results in congestion at this location within the modelled time period within the 'do-something' network.	41 SR 41

The final revised set of indicative potential schemes to be applied to the 2030 'future' year network are presented within Figure 6.2.

Figure 6.2: 2030 'future' - indicative potential schemes plan



6.4 2030 'future' global network performance

The global network outputs modelled within the 2030 'future' 'do-minimum' is presented within Table 5.3. A comparison to the 2022 'interim' 'do-minimum' results is also provided. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 6.3 and Figure 6.5.

Table 6.4: 2030 'future' 'do-minimum' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	7,834.40	14,668.50	19,622.86	7,388.22	11,954.98	15,506.19
Vehicle Hours of Delay (v-hr)	3,194.16	9,961.76	15,900.74	2,569.62	6,699.31	10,944.30
Vehicle Kilometres (v-km)	388,607.28	395,236.75	320,269.23	402,481.13	441,436.55	391,787.95
Average Network Speed (kph)	53.06	27.90	16.88	56.23	37.86	26.87
Change from 2022 'interim'						
Vehicle Hours of Travel (v-hr)	*+1,607.63*	*+5,330.25*	*+8,277.68*	*+1,318.26*	*+3,373.40*	*+5,499.88*
Vehicle Hours of Delay (v-hr)	*+1,423.95*	*+5,627.48*	*+9,182.89*	*+994.30*	*+3,240.52*	*+5,780.35*
Vehicle Kilometres (v-km)	*+13,807.28*	*-26,387.65*	*-75,638.20*	*+27,110.15*	*+12,143.28*	*-20,333.88*
Average Network Speed (kph)	*-9.24*	*-19.27*	*-21.48*	*-6.41*	*-12.58*	*-15.32*

The level of traffic demand in the 2030 'future' 'do-minimum' is clearly exceeding the operating capacity of the West Yorkshire and Leeds SRN network, particularly in the morning peak period where a decrease in the vehicle kilometres travelled is modelled. This will be a result of severe congestion (as reflected by the lower average network speed and substantially higher vehicle hours of delay) throughout the networkThe network is less congested in the evening peak period than the morning peak period, but excessive congestion is modelled later on in the modelled period.

The global network outputs modelled within the 2030 'future' 'do-something' assessment compared to the 'do-minimum' is presented within Table 6.5. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 6.4 and Figure 6.6.

Table 6.5: 2030 'future' 'do-something' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	7,754.95	13,615.42	18,313.48	7,744.03	11,920.88	16,011.04
Vehicle Hours of Delay (v-hr)	2,818.36	8,576.15	14,350.68	2,731.16	6,436.10	11,600.83
Vehicle Kilometres (v-km)	415,727.03	426,799.93	341,407.33	421,645.20	464,034.20	384,215.00
Average Network Speed (kph)	55.95	32.17	19.06	56.02	39.18	24.29
Change from 2030 'future' Year 'do-minimum'						
Vehicle Hours of Travel (v-hr)	*-79.46*	*-1,053.08*	*-1,309.38*	*+355.80*	*-34.11*	*+504.85*
Vehicle Hours of Delay (v-hr)	*-375.80*	*-1,385.61*	*-1,550.06*	*+161.55*	*-263.21*	*+656.53*
Vehicle Kilometres (v-km)	*+27,119.75*	*+31,563.18*	*+21,138.10*	*+19,164.07*	*+22,597.65*	*-7,572.95*
Average Network Speed (kph)	*+2.89*	*+4.27*	*+2.19*	*-0.21*	*+1.32*	*-2.58*

The change in model outputs between the 2030 'do-minimum' and 'do-something' assessments are more positive than between the 2022 'do-minimum' and 'do-something' assessments. This indicates the benefits provided by the 2030 indicative potential schemes are greater than those within the 2022 assessments. There are substantial increases in the total vehicle kilometres in all modelled time periods except the latter end of the evening peak period, yet despite the increased traffic demand, there is an increase in average speed and a reduction in the hours of travel and delay. This suggests a more efficient highway network which is operating more effectively. While these outputs serve to demonstrate at a high level the benefits provided by the indicative potential schemes added to the 2030 network, it should also be noted that significant network operational issues remain at a number of locations and the overall network operation is worse than within 2022, as would be expected given the level of traffic growth forecast.

6.5 2030 'future' junction performance

A more location specific performance review has also been undertaken, with a focus on the performance of the network at and around SRN junctions. Table 6.6 presents a summary of the network performance at the SRN junctions featured within the study area network. The results of both the 'do-minimum' and 'do-something' assessments are included within Table 6.6 in order to facilitate readability.

Graphical outputs can be found within ***Appendices D and E***, for the morning and evening peaks respectively.

Table 6.6: 2030 'future' 'do-minimum' and 'do-something' - junction performance summary

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	**AM Peak**	**PM Peak**		**AM Peak**	**PM Peak**
M1 J39 Durkar	Minimal delay is modelled on the SRN at this location although there is queuing traffic on the LRN.		✓	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M1 J40 Ossett	The junction circulatory and northbound movements are impacted upon from congestion on the northbound mainline. This congestion is due to issues at junction 41. Southbound movements are free flowing.	Severe circulatory congestion but no effect on SRN mainline. There is however queuing traffic on the off-slips and waiting traffic off the LRN links.	✓	Significant improvement in operation as reduced congestion backing up from M1 J41.	Operates as per the 'do-minimum' within this peak period. Slightly lower congestion on the southbound off-slip.
M1 J41 Carr Gate	Queuing on the northbound on-slip is observed throughout the AM peak as a consequence of traffic backing up from the M1/A62 Lofthouse Interchange diverge to the north of J41 Carr Gate. This impacts upon the northbound mainline, circulatory operation and congestion onto the LRN. Southbound movements unaffected.	Congestion is modelled on the junction circulatory but this does not affect the SRN mainline. There is however queuing traffic on the off-slips and severe congestion on the LRN.	✗	Junction remains congested as within the 'do-minimum', albeit at a lower level of severity. Congestion originating from the M62 westbound merge at Lofthouse Interchange.	Operates as per the 'do-minimum' within this peak period.
M1/M62 Lofthouse	The new free flowing interchange operates well, however congestion on the westbound M62 is modelled as a result of the merge and traffic backing up from M62 J28, J27 and J26. M1 northbound congestion is also modelled as a result of queuing traffic on the M621. Southbound and eastbound movements are relatively clear.	The interchange operations better within the PM peak than the AM peak. There is however still a degree of congestion at all merge and diverge locations. The new free flow links themselves operate well.	✓	Operates as per the 'do-minimum', with the exception of the M62 westbound diverge to the M1 northbound and M1 northbound diverge to M62 westbound which are both more congested as a result of upstream operational issues.	Increased congestion on the merge for the M62 eastbound carriageway which backs up towards the M1, but does not impact upon the mainline.
M1 J43 / M621	Northbound congestion on M621 link originating from issues within Leeds city centre. M1 northbound movements are clear after the diverge.	Severe congestion modelled for the M1 and M621 southbound through this junction as a result of traffic merging from the M1 and M621.	✗	Increased delay on M1 northbound, possibly as a result of 'released' traffic from the M1 south. There is an improvement at this location within the PM peak.	

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M1 J44 Rothwell Haigh	Circulatory congestion results in queuing on both the M1 southbound off-slip and the A639 approach from Rothwell. There is also congestion on the northbound off-slip as a result of this which backs up onto the M1 main carriageway.	The junction circulatories are heavily congested during the PM peak period, however despite queuing traffic on the off-slips, this does not back up onto the M1 mainline. The M1 southbound mainline is heavily congested as a result of issues at the merge with the M621.	✓	Improved southbound off-slip operation prior to LRN congestion impact within modelled time period. Northbound off-slip congestion remains.	Significantly improved junction and mainline operation at this location.
M1 J45 Pontefract Lane	Severe delays due to traffic backing up from Pontefract lane. This affects the operation of the circulatory and the southbound off-slip. This congestion backs up into the M1 southbound carriageway. The northbound carriageway is free flowing.	The northbound SRN link is congested on approach to the diverge. LRN congestion to the south.	✓	Improvement to the junction circulatory as well as reduced congestion on the southbound off-slip. LRN congestion to the north remains.	Improved northbound on-slip merge congestion as a result of the indicative potential scheme as well as reduced queuing on the LRN following signal adjustments.
M1 J46 Colton	Severe congestion on the southbound main carriageway impacts upon the operation of the southern roundabout. The northern roundabout operates well, as does northbound movements in general. There is a small amount of congestion on the northbound off-slip.	Minimal delay is modelled at this location in this time period.	✓	Reduced congestion on the southbound main carriageway as a result of the additional lane. The southbound on-slip remains congested and there is a detrimental impact to LRN congestion as a result of the removal of the filter lane.	Reduced congestion on the northbound off-slip as a result of the indicative potential scheme and subsequent traffic signal adjustments.
M1 J47 East Garforth	Operational issues are modelled due to M1 northbound mainline congestion from the A1(M) merge. This congestion backs up through the junction. Southbound, the off-slip is uncongested but the on-slip is congested as a result of traffic backing up on the southbound mainline from J45.	Congestion on the M1 northbound carriageway north of this junction does not back up through the junction as it does within the AM peak. As a result there are no operational issues at this junction.	✓	Marked improvement in congestion at this location in both directions. Northbound off-slip scheme also reduced congestion.	Operates as per the 'do-minimum' within the PM peak period.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
A1(M)/M1	There is severe congestion at the northbound merge between the A1(M) and M1. There is minor congestion at the southbound diverge in the AM peak but not in the PM peak.		✗	Marked improvement in congestion at this location in both directions within both the AM and PM peak periods.	
A1(M) J44	Severe delays at the southbound off-slip, causing congestion on the southbound mainline back to J46.		✓	Marked improvement on the southbound off-slip as a result of the indicative potential scheme within both the AM and PM peak periods.	
A1(M) J45	Operational issues and waiting traffic off the network modelled as a result of southbound congestion caused by the off-slip at A1(M) J44. Northbound movements free flowing although there is a small amount of queuing on the northbound off-slip.		✓	Circulatory operates as per the 'do-minimum' within both the AM and PM peak periods. Level of performance maintained through signalisation indicative potential scheme which has been implemented following initial model runs.	
A1(M) J46	Minimal delay is modelled at this location within either the AM or PM peak periods.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M62 J24 Ainley Top	Due to a lane restriction on the northern roundabout, congestion backs up through the southern roundabout and onto the westbound off-slip. This causes congestion on the westbound mainline within the AM peak.		✓	Greatly improved operation as a result of the indicative potential scheme. Minimal congestion modelled.	
M62 J24a Bradford Road	n/a		✓	New junction operates well with the majority of traffic passing directly between the LRN arms. However the junction is heavily congested within this scenario as a result of congestion backing up from M62 J25 and J26.	
M62 J25 Brighouse	Eastbound on-slip traffic volume results in congestion back onto the circulatory. The A644 approach from the south is congested as a result of queuing traffic on the eastbound on-slip.	Congestion on the eastbound M62 mainline from J26 results in queuing traffic on the eastbound on-slip. This in turn results in LRN queuing. Westbound, traffic is relatively free flowing.	✓	Higher traffic levels are modelled in this area due to the new J24a inducing traffic and providing better access to the SRN. Congestion is greatly increased at the junction circulatory as well as on the eastbound carriageway as a result of congestion backing up from J26.	
M62 J26/M606	Congestion is modelled on the eastbound carriageway as a result of merging traffic. Westbound, more severe congestion is modelled on approach to the junction prior to the diverge. This congestion backs up through J27 and beyond.	Lower levels of congestion are modelled at this junction and on approach to this junction in the PM than the AM peak.	✗	Operates as per the 'do-minimum' within this peak period.	Reduced congestion on the M606 owing to adjusted signal timings.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M62 J27/M621	Severe congestion is modelled on the westbound carriageway as a result of M621 traffic merging with the congested M62. Eastbound congestion is also modelled through the junction as a result of issues at J28.	Compared to the AM peak, eastbound congestion remain due to issues at J28 whereas the westbound merge with the M621 is free flowing, possibly due to severe congestion within Leeds City Centre restricting traffic exiting the area.	✓	The eastbound off-slip is less congested as a result of the indicative potential scheme and the westbound off-slip scheme also appears to improve movements to the south. The free flow links to/from the M621 and M62 east are barely used. The mainline is more congested as a result of increase traffic demand.	As within the AM peak, there is an improvement in eastbound mainline movements. Westbound the carriageway operates as per the 'do-minimum'. The junction circulatories are congested, although the westbound off-slip scheme also appears to improve movements to the south. The free flow links to/from the M621 and M62 east are used more within the PM peak than the AM peak.
M62 J28 Tingley	The circulatory is very heavily congested throughout the peak periods. This is a result of the merge at the eastbound on-slip, which backs up through the circulatory and causes congestion on the LRN as well. Congestion on the eastbound M62 mainline backs up through J26. Westbound flows are affected by issues generated at J26.		✓	Improved traffic flow on the mainline carriageways, particularly westbound. The junction circulatory is also less congested although there remains substantial congestion on some LRN arms.	Small improvement in traffic flows on the eastbound carriageway. Westbound, traffic flows are free flowing as per the 'do-minimum'. The junction circulatory is also less congested although there remains substantial congestion on some LRN arms.
M62 J30 Rothwell	Eastbound movements are unrestricted. Westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which causes congestion on the westbound on-slip.	Lower levels of congestion are modelled at this junction and on approach to this junction in the PM than the AM peak.	✓	The indicative potential scheme regulates traffic flow and now prevents traffic backing up on the westbound off-slip and onto the westbound mainline. The westbound mainline carriageway is also significantly less congested.	
M62 J31 Normanton	As at J30, eastbound movements are unrestricted but westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which causes congestion on the westbound on-slip and southern circulatory.	The junction circulatories are congestion during the PM peak period, however this does not impact upon the SRN mainline.	✓	The westbound mainline carriageway is now significantly less congested. The junction operates well overall.	Operates as per the 'do-minimum'.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M62 J32 Castleford	As at J30, eastbound movements are unrestricted but westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which causes congestion on the westbound on-slip, circulatory and LRN.	There is queuing traffic on the LRN and junction circulatory, but this does not impact upon the slip roads or SRN itself.	✓	The westbound mainline carriageway is now significantly less congested. The junction operates well overall.	Operates as per the 'do-minimum'.

Figure 6.3: 2030 'future' 'do-minimum' – AM peak network schematic (model interval to 09:00)

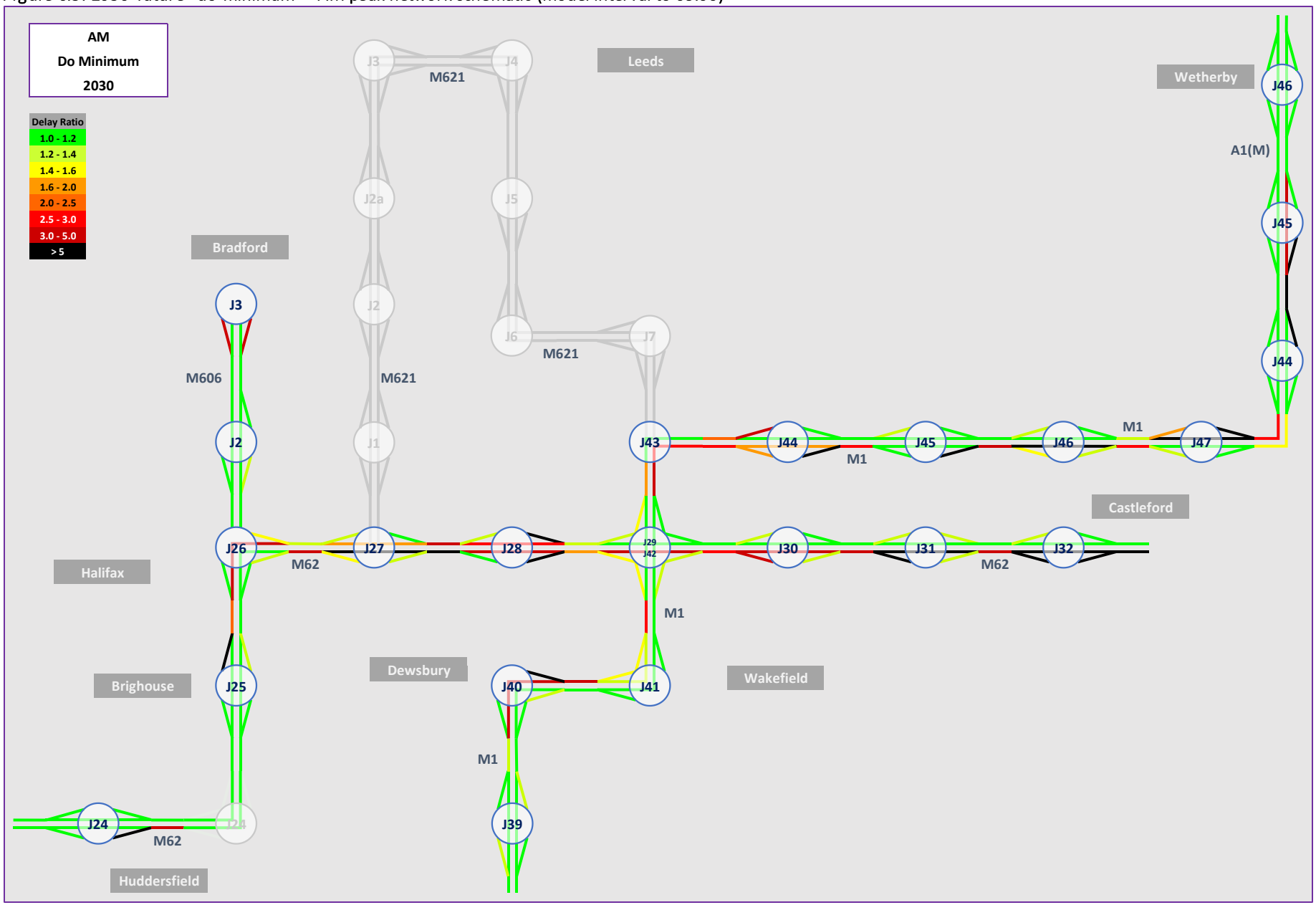


Figure 6.4: 2030 'future' 'do-something' – AM peak network schematic (model interval to 09:00)

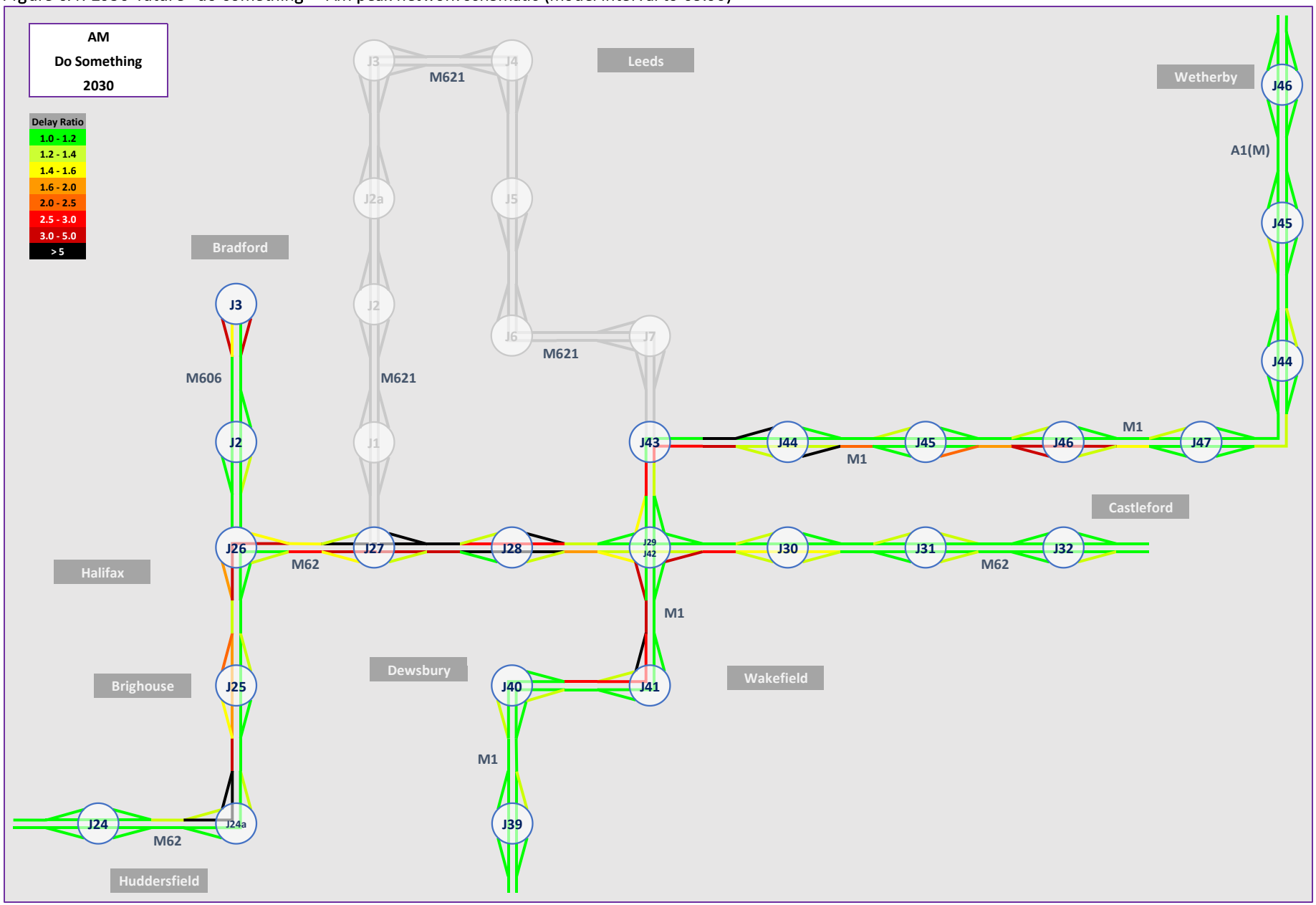


Figure 6.5: 2030 'future' 'do-minimum' – PM peak network schematic (model interval to 18:00)

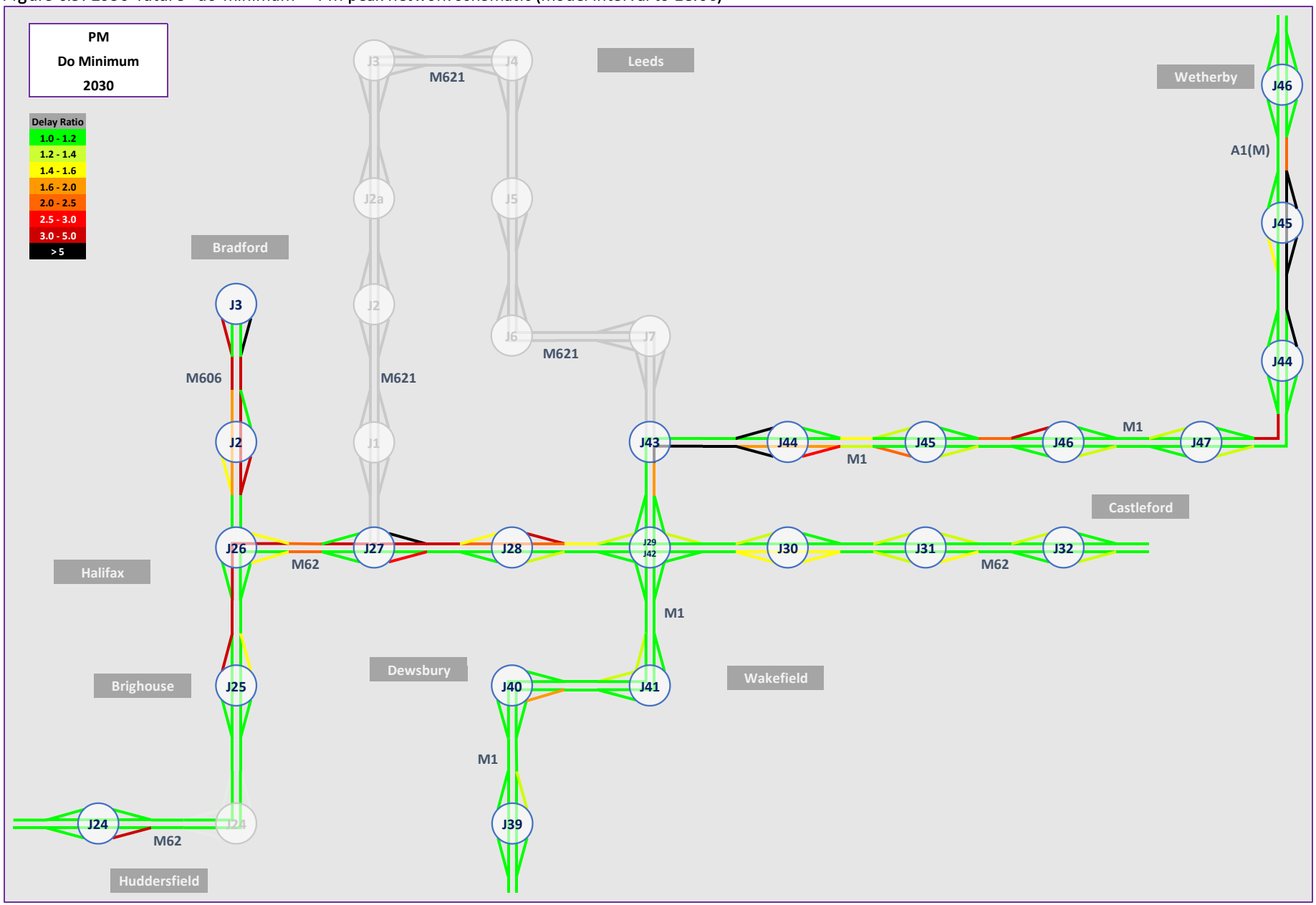
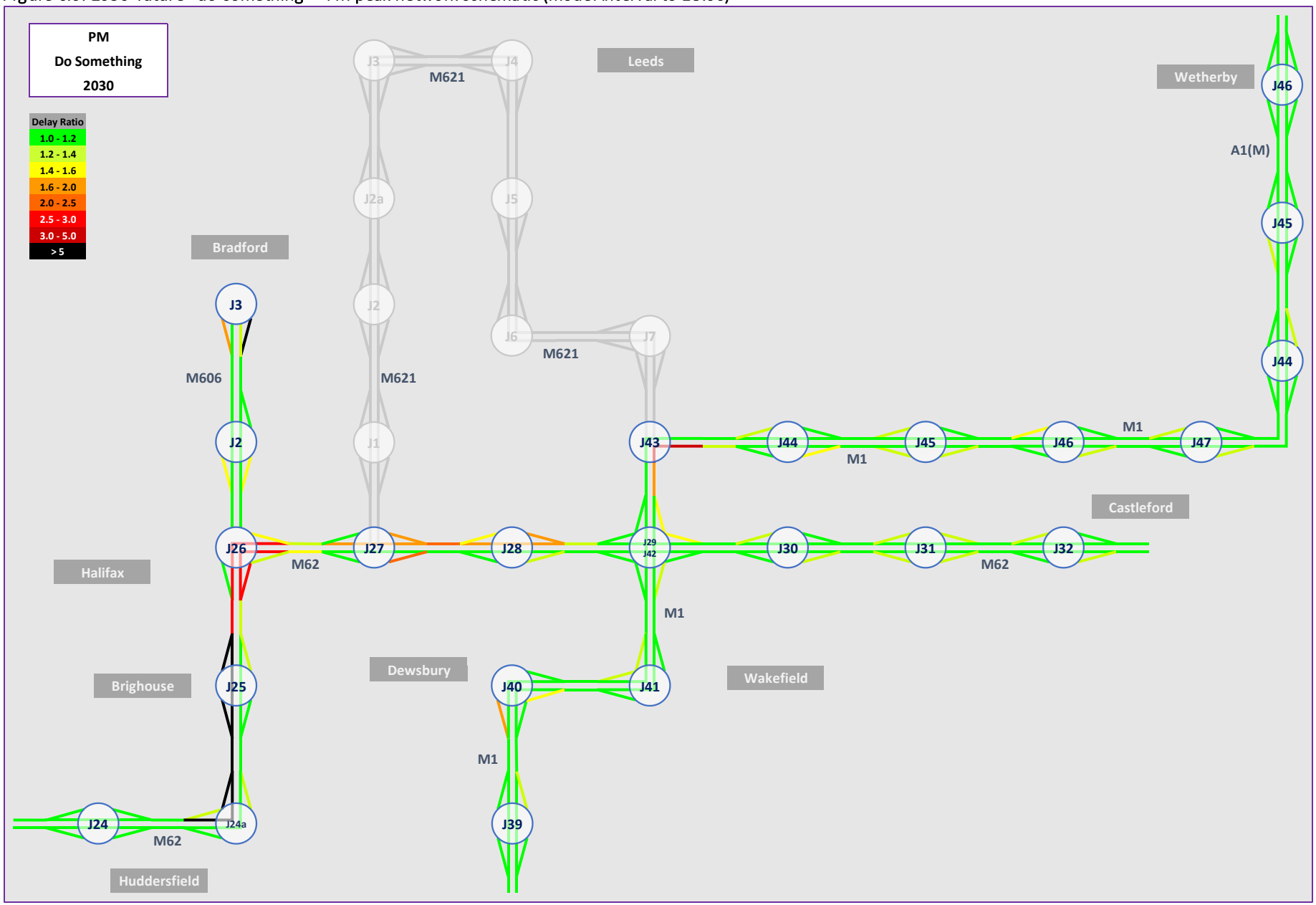


Figure 6.6: 2030 'future' 'do-something' – PM peak network schematic (model interval to 18:00)



2040 'horizon' network assessment

7.1 Overview

This section presents the modelled assessment of the meso networks within the 2040 'horizon' year. For the 'do-minimum', committed schemes have been incorporated into the meso network which is then assessed. Following an analysis of the 'do-minimum' assessments, appropriate indicative potential schemes have been identified and built into the meso network to create the 'do-something' assessment network.

The outputs of the 2040 'horizon' 'do-minimum' assessments will be compared to the 2030 'future' assessment, while the 2040 'horizon' 'do-something' will be compared to the 2040 'horizon' 'do-minimum'.

7.2 2040 'horizon' committed schemes

The committed schemes which have been coded into the 2040 'horizon' 'do-minimum' are the same as those included within the 2030 'future' 'do-minimum' networks (see Table 6.1 and Figure 6.1). No further committed schemes have been identified for completion between 2030 and 2040.

7.3 2030 – 2040 traffic growth

The local plans in the West Yorkshire region do not extend to 2040, so it is not possible to derive traffic growth from this source. Traffic growth between 2030 and 2040 has therefore been based upon the DfT's TEMPro database and representative traffic growth factors have been extracted for the relevant LA areas. The traffic growth factors applied to the 2030 trip matrices are presented within Table 7.1. As the meso matrices cannot be segregated into geographical area, the traffic growth factor for West Yorkshire has been uniformly applied to the 2030 trip matrices.

Table 7.1: 2030 to 2040 derived TEMPro growth factors

Local Authority	AM	PM
Bradford	1.136	1.135
Calderdale	1.114	1.115
Kirklees	1.099	1.100
Leeds	1.141	1.138
Wakefield	1.105	1.108
West Yorkshire	**1.125**	**1.124**

7.4 Inidicative potential scheme identification

All indicative potential schemes identified for the 2022 'interim' and 2030 'future' year networks have automatically been incorporated into the 2040 'horizon' year network. No further schemes have been identified specifically for the 2040 'horizon' year.

7.5 2040 'horizon' global network performance

The global network outputs modelled within the 2040 'horizon' 'do-minimum' is presented within Table 7.2. A comparison to the 2030 'future' 'do-minimum' is also provided. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 7.1 and Figure 7.3.

Table 7.2: 2040 'horizon' 'do-minimum' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	9,133.06	17,806.77	23,349.77	8,754.98	15,213.14	20,190.31
Vehicle Hours of Delay (v-hr)	4,349.47	13,183.01	19,864.66	3,729.96	9,974.03	15,956.01
Vehicle Kilometres (v-km)	400,009.10	389,165.93	295,271.25	419,876.10	439,646.23	363,559.20
Average Network Speed (kph)	47.87	22.48	13.00	50.62	29.81	18.67
Change from 2030 'future'						
Vehicle Hours of Travel (v-hr)	*+1,298.66*	*+3,138.27*	*+3,726.91*	*+1,366.75*	*+3,258.16*	*+4,684.12*
Vehicle Hours of Delay (v-hr)	*+1,155.31*	*+3,221.25*	*+3,963.93*	*+1,160.35*	*+3,274.72*	*+5,011.71*
Vehicle Kilometres (v-km)	*+11,401.83*	*-6,070.83*	*-24,997.98*	*+17,394.98*	*-1,790.33*	*-28,228.75*
Average Network Speed (kph)	*-5.20*	*-5.42*	*-3.88*	*-5.61*	*-8.05*	*-8.20*

With further traffic growth between the 2030 'future' year and 2040 'horizon' year, network operating conditions continue to deteriorate. In both the morning and evening peak periods a decrease in the vehicle kilometres travelled is modelled despite the higher travel demand – in essence, traffic cannot reach the modelled network due to excessive congestion. This will be a result of congestion throughout the network which is unable to cope with the high level of travel demand at the beginning of the peak periods. The resulting congestion is reflected by the lower average network speed and higher vehicle hours of delay.

The global network outputs modelled within the 2040 'horizon' year 'do-something' assessment compared to the 'do-minimum' is presented within Table 7.3. Network visual outputs for this assessment are presented within ***Appendix C***, while at the end of this section, corresponding network delay schematics are provided in Figure 7.2 and Figure 7.4.

Table 7.3: 2040 'horizon' 'do-something' - global model outputs

West Yorkshire and Leeds Meso Network	AM Period			PM Period		
	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00
Vehicle Hours of Travel (v-hr)	9,042.18	16,580.88	21,230.07	8,978.45	14,697.99	19,850.21
Vehicle Hours of Delay (v-hr)	3,936.25	11,712.84	17,513.29	3,735.29	9,079.19	15,485.24
Vehicle Kilometres (v-km)	431,145.40	414,328.00	318,449.25	440,470.88	474,270.05	379,485.10
Average Network Speed (kph)	50.64	25.34	15.07	51.13	32.65	19.37
Change from 2040 'Horizon' Year 'do-minimum'						
Vehicle Hours of Travel (v-hr)	*-90.89*	*-1,225.89*	*-2,119.70*	*+223.47*	*-515.15*	*-340.10*
Vehicle Hours of Delay (v-hr)	*-413.22*	*-1,470.17*	*-2,351.37*	*+5.33*	*-894.84*	*-470.77*
Vehicle Kilometres (v-km)	*+31,136.30*	*+25,162.08*	*+23,178.00*	*+20,594.78*	*+34,623.83*	*+15,925.90*
Average Network Speed (kph)	*+2.78*	*+2.86*	*+2.08*	*+0.51*	*+2.84*	*+0.70*

The change in model outputs trends between the 2040 'do-minimum' and 'do-something' assessments are similar to those modelled within the 2030 assessments. Due to the severe network "strain" modelled within the 2040 'do-minimum' assessments, the operational benefits provided by the indicative potential scheme in 'unlocking' key congestion hotspots within the network are much higher. This release in traffic congestion allows for the greater number of vehicle kilometres travelled alongside a higher average network speed. There are also on average fewer hours of vehicle travel and delay as a result across the peak periods.

As per the 2030 'future' year assessment outputs, this suggests a more efficient highway network which is operating more effectively. Further, these outputs serve to demonstrate at a high level the benefits provided by the indicative potential schemes.

It should be reiterated however that within the 2040 'horizon' year assessments the model is operating at its effective limit as reflected by the significant queues throughout the network and exponential increase in the number of assignment iterations required in order to achieve an acceptable level of convergence. It was also required to add an additional LRN intervention in order to prevent the network from 'locking up'. This was the addition of an extra lane (a new third lane) on the northbound approach to the junction between Gelderd Road and the A6110 Ring Road. This location itself is a significant LRN congestion hotspot which is discussed further within section 8.

7.6 2040 'horizon' junction performance

A more location specific performance review has also been undertaken, with a focus on the performance of the network at and around SRN junctions. Table 7.4 presents a summary of the network performance at the SRN junctions featured within the study area network. The results of both the 'do-minimum' and 'do-something' assessments are included within Table 7.4 in order to facilitate readability.

Graphical outputs can be found within ***Appendices D and E***, for the morning and evening peaks respectively.

Table 7.4: 2040 'horizon' 'do-minimum' and 'do-something' - junction performance summary

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	**AM Peak**	**PM Peak**		**AM Peak**	**PM Peak**
M1 J39 Durkar	Queuing on the northbound on-slip results in congestion on the junction circulatory and LRN. This slip road congestion is due to mainline delays originating from J41. Southbound movements are free flowing.	Minimal delay is modelled on the SRN at this location although there is severe queuing traffic on the LRN.	✓	Improvement to junction and northbound mainline due to upstream scheme benefits.	Operates as per the 'do-minimum'.
M1 J40 Ossett	The junction circulatory and northbound movements are impacted upon from congestion on the northbound mainline. This congestion is due to issues at J41. Southbound movements are free flowing.	Severe circulatory congestion but no effect on SRN mainline. There is however a small amount of queuing traffic on the off-slips.	✓	Junction circulatory and mainline remain heavily congested, albeit at a marginally lower level.	Improved LRN congestion although queuing now modelled on southbound off-slip. This does not affect the southbound mainline.
M1 J41 Carr Gate	Queuing on the northbound off-slip is observed throughout the AM peak. There is also congestion on the northbound mainline as a result of weaving traffic prior to the diverge. Southbound movements unaffected but there is queuing on the LRN.	Congestion is modelled on the junction circulatory but this does not affect the SRN mainline.	✗	Detriment to junction operation as a result of 'released' traffic now causing congestion on the northbound carriageway upstream at Lofthouse interchange.	Operates as per the 'do-minimum' within this peak period. Lower level of congestion on the LRN links
M1/M62 Lofthouse	The new free flowing interchange operates well, however congestion on the westbound M62 is modelled as a result of the merge and traffic backing up from J28, J27 and J26. M1 northbound congestion is also modelled as a result of queuing traffic on the M621. Southbound and eastbound movements are relatively clear.	The interchange operations better within the PM peak than the AM peak. There is however still a degree of congestion at all merge and diverge locations. The new free flow links themselves operate well.	✓	Operates as per the 'do-minimum', with the exception of the M62 westbound diverge to the M1 northbound and M1 northbound diverge to M62 westbound which are both congested as a result of traffic being 'released' from indicative potential schemes elsewhere on the network (possibly M62 J30). Also, there is increased congestion through the junction northbound in the PM peak.	

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M1 J43 / M621	Northbound congestion on M621 link originating from issues within Leeds city centre. Also, severe congestion modelled for the M1 and M621 southbound through this junction as a result of traffic merging from the M1 and M621.		✗	Slightly lower level of congestion and delay for southbound movements compared to the 'do-minimum'.	There is an improvement in traffic congestion for northbound movements, but a detriment for southbound movements.
M1 J44 Rothwell Haigh	Circulatory congestion results in queuing on both the M1 southbound off-slip and the A639 approach from Rothwell. There is also congestion on the northbound off-slip as a result of this which backs up onto the M1 main carriageway in the AM peak but not in the PM peak.		✓	Minimal congestion for northbound movements and reduced queuing on the northbound off-slip. Southbound, congestion on the mainline has increased, possibly as a result of released traffic from J44 on the A1(M). This restricts access to and from the junction.	The junction and circulatories remain very heavily congested although the southbound mainline congestion is lower, indicating an improvement in the operation of the junction following the indicative potential schemes.
M1 J45 Pontefract Lane	Severe delays due to traffic backing up from Pontefract lane. This affects the operation of the circulatory and the southbound off-slip. This congestion backs up into the M1 southbound carriageway. Northbound movements unaffected. In the AM peak there is also congestion on the southbound mainline. This is also present within the PM peak but to a lesser extent.		✓	LRN congestion to the north remains, as does congestion on the southbound off-slip, albeit at a lower level than within the 'do-something'. Southbound mainline movements are also less congested, potentially as a result of the additional lane.	Reduced congestion for southbound mainline movements. Also reduced queuing on LRN.
M1 J46 Colton	Severe congestion on the southbound main carriageway impacts upon the operation of the southern roundabout. The northern roundabout operates well, as does northbound movements in general. There is a small amount of congestion on the northbound off-slip.	The M1 mainline is free flowing in both directions during the PM peak. The southern circulatory is congested and the northern off-slip does incur a degree of congestion, however this does not back up onto the mainline itself.	✓	Reduced congestion on the southbound main carriageway as a result of the additional lane. The southbound on-slip remains congested and there is a detrimental impact to LRN congestion as a result of the removal of the filter lane.	Reduced congestion on the northbound off-slip as a result of the indicative potential scheme and subsequent traffic signal adjustments.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M1 J47 East Garforth	Operational issues are modelled due to M1 northbound mainline congestion from the A1(M) merge. This congestion backs up through the junction. Southbound movements are relatively uncongested.	Congestion on the M1 northbound carriageway north of this junction backs up through the junction as it does within the AM peak. Southbound movements are unaffected.	✓	Marked improvement in congestion on the northbound mainline. Northbound off-slip scheme also reduced congestion in the AM peak.	
A1(M)/M1	There is severe congestion at the northbound merge between the A1(M) and M1. Southbound movements are free flowing.		✗	Marked improvement in congestion at this location in both directions within both the AM and PM peak periods.	
A1(M) J44	Severe delays at the southbound off-slip, causing congestion on the southbound mainline back to J46.		✓	Marked improvement on the southbound off-slip as a result of the indicative potential scheme within both the AM and PM peak periods.	
A1(M) J45	Operational issues and waiting traffic off the network modelled as a result of southbound congestion caused by the off-slip at A1(M) J44. Northbound movements free flowing.		✓	No longer impacted upon by southbound queuing traffic as a result of congestion at J44. Level of performance maintained through signalisation indicative potential scheme which has been implemented following initial model runs.	
A1(M) J46	Operational issues modelled as a result of southbound congestion caused by the off-slip at A1(M) J44. Northbound movements free flowing.		✗	Operates as per the 'do-minimum' within both the AM and PM peak periods.	
M62 J24 Ainley Top	Due to a lane restriction on the northern roundabout, congestion backs up through the southern roundabout and onto the westbound off-slip. This causes severe congestion on the westbound mainline. The eastbound mainline is free flowing.		✓	Greatly improved operation as a result of the indicative potential scheme on the westbound carriageway. Now severe congestion on the eastbound carriageway as a result of operational issues at J25 and J26.	
M62 J24a Bradford Road	n/a		✓	The new junction is well used, with a high proportion of junction users passing directly between the LRN arms. The junction operates well at the beginning of the peak periods, however it becomes congested later in the peak periods as a result of congestion backing up from M62 J25 and J26. Congestion at this junction therefore is a result of issues elsewhere on the network.	

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M62 J25 Brighouse	Westbound, issues originating from J24 also impact upon the operation of J25 in the AM peak. Similarly eastbound, congestion originating from J26 also impact upon junction operation.		✓	Higher traffic levels are modelled in this area due to the new J24a inducing traffic and providing better access to the SRN. Congestion is increased at the junction circulatory as well as on the eastbound carriageway as a result of congestion backing up from J26.	Eastbound mainline carriageway remains heavily congested. The junction circulatory remains heavily congested, however there is lower congestion on the LRN as a result of the indicative potential scheme.
M62 J26/M606	Congestion is modelled on the eastbound carriageway as a result of merging traffic. This congestion backs up to J25. Westbound, more severe congestion is modelled on approach to the junction prior to the diverge. This congestion backs up through J27 and beyond.		✗	Operates as per the 'do-minimum' within this peak period.	While the junction circulatory and M62 mainline through the junction operates as per the 'do-minimum', there are significant improvements to upstream eastbound traffic flows on route to J27 and downstream from J27.
M62 J27/M621	Severe congestion is modelled on the westbound carriageway as a result of M621 traffic merging with the congested M62. Eastbound congestion is also modelled through the junction as a result of issues at J28.	Compared to the AM peak, eastbound congestion remain due to issues at J28 whereas the westbound merge with the M621 is less congested, possibly due to severe congestion within Leeds City Centre restricting traffic exiting the area.	✓	As per the 'do-minimum', the eastbound mainline is extremely congested and is approaching gridlock. Conversely, there is a small improvement on the westbound carriageway. The junction circulatories remain very heavily congested. The new free flow links to/from the M621 and M62 east are barely used.	As within the AM peak, there is an improvement in eastbound mainline movements. There are also improvements westbound. The junction circulatories are congested, particularly the southern roundabout which results in congestion back towards the M621 and M62 mainline carriageways. The free flow links to/from the M621 and M62 east are used more within the PM peak than the AM peak.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M62 J28 Tingley	The circulatory is very heavily congested throughout the peak periods. This is a result of the merge at the eastbound on-slip, which backs up through the circulatory and causes congestion on the LRN as well. Congestion on the eastbound M62 mainline backs up through J26.	As per the AM peak, congestion on the eastbound carriageway is generated through issues at the on-slip merge which causes congestion back through the J25. Westbound movements are less congested although there is severe congestion on the off-slip.	✓	There are no noticeable improvements in congestion levels in the vicinity of J28. Congestion remains very high.	Small improvement in traffic flows on the eastbound carriageway. Westbound, traffic flows are free flowing through the junction as per the 'do-minimum' although there is now a build-up of traffic on approach. The junction circulatory is also less congested although there remains substantial congestion on some LRN arms.
M62 J30 Rothwell	Eastbound movements are unrestricted. Westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which causes congestion on the westbound on-slip.	Eastbound movements are unrestricted as per the AM peak. Westbound, there is queuing traffic on the off-slip which backs up onto the westbound carriageway.	✓	The indicative potential scheme regulates traffic flow and now prevents traffic backing up on the westbound off-slip and onto the westbound mainline. However, there is a detriment to through traffic on the M62 westbound mainline as a result of congestion between the M62 and M1 northbound at Lofthouse Interchange.	The indicative potentialscheme regulates traffic flow and now prevents traffic backing up on the westbound off-slip and onto the westbound mainline.
M62 J31 Normanton	As at J30, eastbound movements are unrestricted aside from queuing traffic on the off-slip which backs up onto the mainline. Westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which also causes congestion on the westbound on-slip.	The junction circulatories are congested during the PM peak period, however this does not impact upon the SRN mainline.	✓	Significant improvements to congestion levels throughout this junction (which are now more compressed at locations upstream).	Operates as per the 'do-minimum' within this peak period.

Scenario	Do-minimum		Indicative potential scheme(s) in vicinity?	Do-something	
Junction	AM Peak	PM Peak		AM Peak	PM Peak
M62 J32 Castleford	Eastbound movements are unrestricted but westbound, the M62 carriageway is congested as a result of issues at J26, J27 and J28 which causes congestion on the westbound on-slip.	There is queuing traffic on the LRN and junction circulatory, but this does not impact upon the slip roads or SRN itself.	✓	Significant improvements to congestion levels throughout this junction (which are now more compressed at locations upstream).	Operates as per the 'do-minimum' within this peak period.

Figure 7.1: 2040 'horizon' 'do-minimum' – AM peak network schematic (model interval to 09:00)

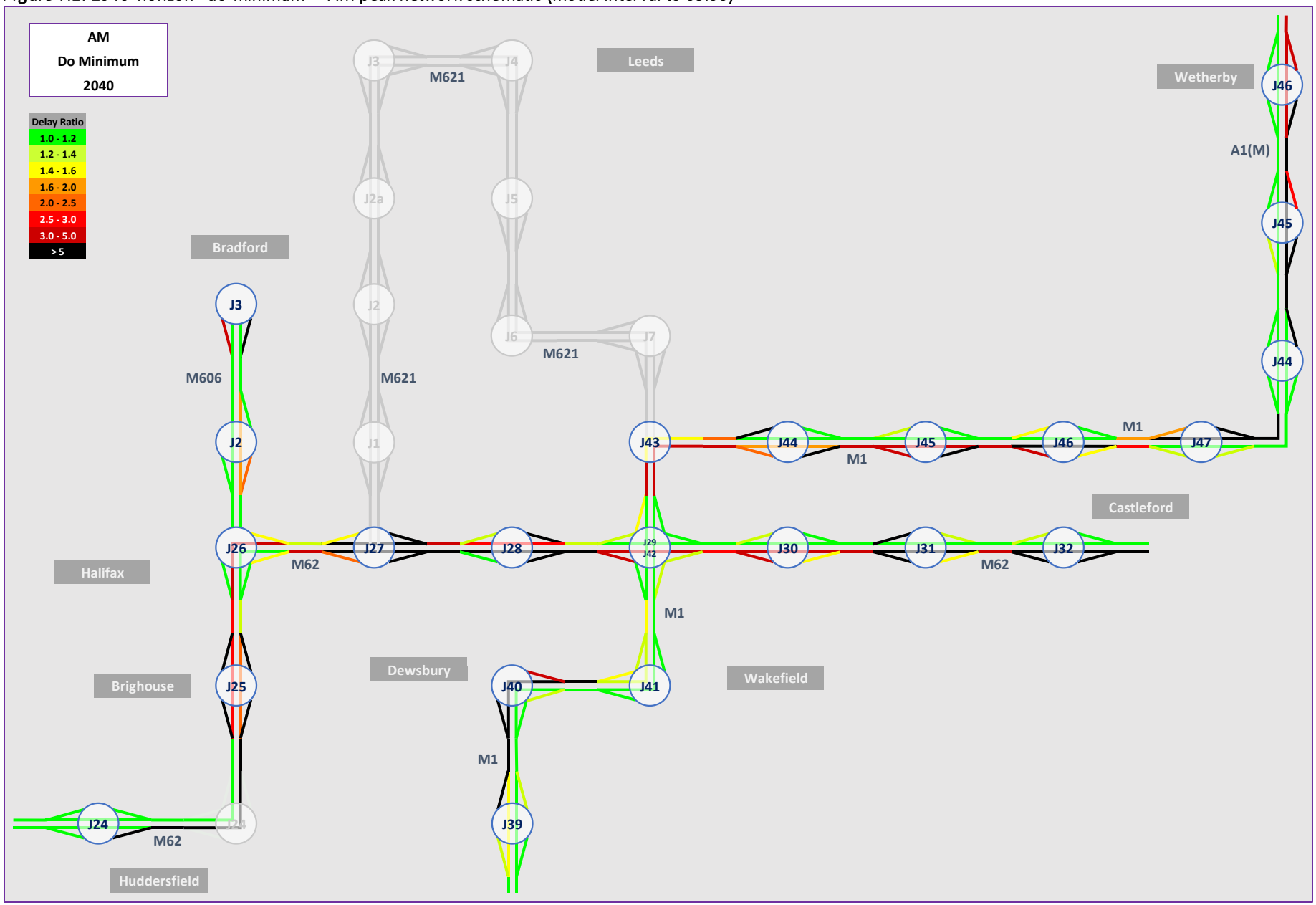


Figure 7.2: 2040 'horizon' 'do-something' – AM peak network schematic (model interval to 09:00)

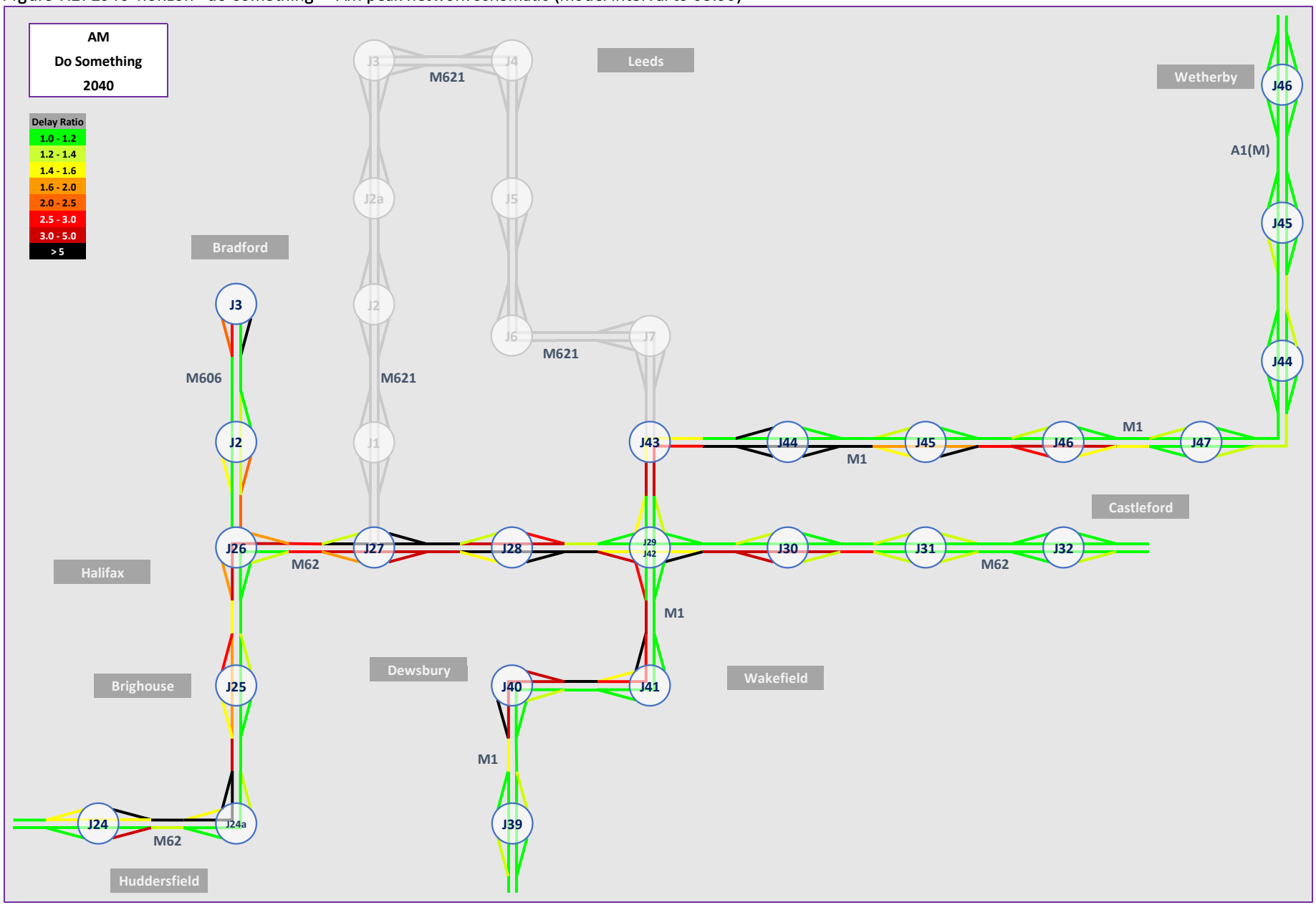


Figure 7.3: 2040 'horizon' 'do-minimum' – PM peak network schematic (model interval to 18:00)

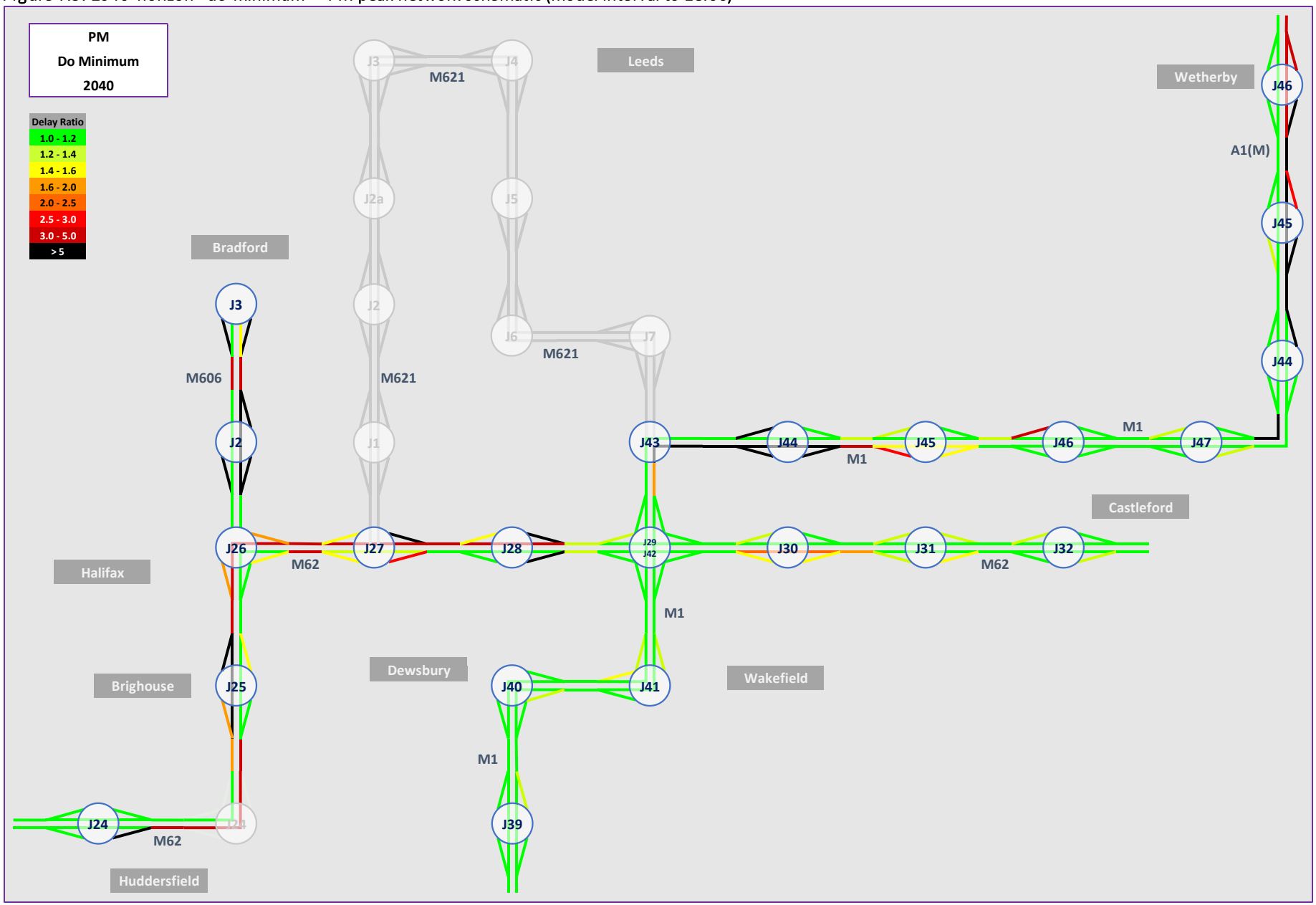
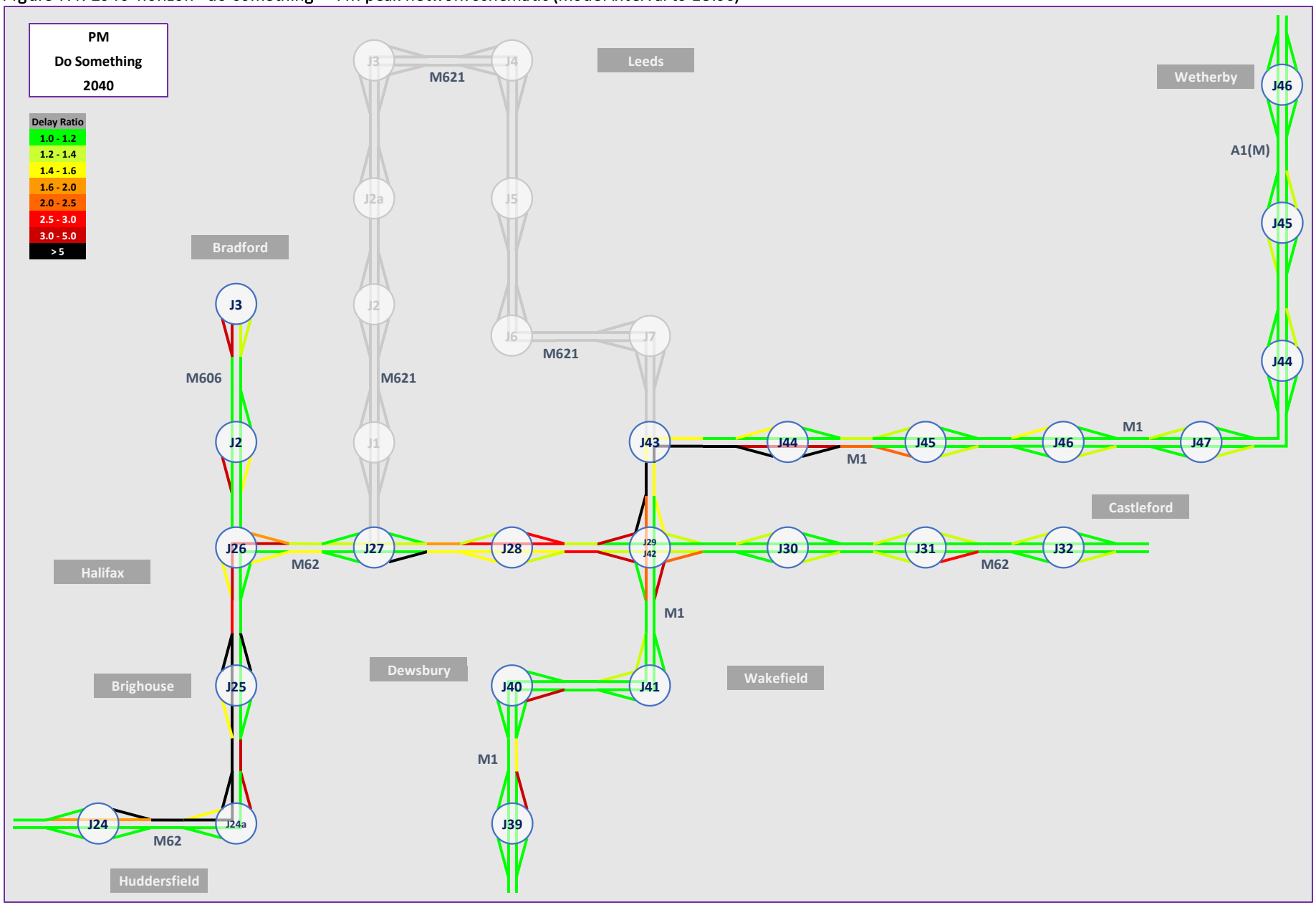


Figure 7.4: 2040 'horizon' 'do-something' – PM peak network schematic (model interval to 18:00)



SECTION 8

Study conclusions

8.1 Summary

This study has presented an assessment as to the potential impact of local plan allocations on the SRN through application of the West Yorkshire and Leeds meso models from a 2014 'base' year through to a 2040 'horizon' year. These assessments have taken into account both LA development aspirations as well as committed highway infrastructure improvement schemes.

Upon review of the above 'do-minimum' assessments, further additional indicative potential schemes have been identified with the aim of addressing network operational issues forecast as a result of future traffic growth throughout the region. These indicative potential schemes have also been modelled within the West Yorkshire and Leeds meso models, in 'do-something' assessments, to both test their effectiveness and network operational benefits. The outcome of this study is a list of indicative potential schemes at locations which should be considered by Highways England for further investigation and refinement as part of their future network enhancement strategic planning.

Not all indicative potential schemes have been identified as being as effective as they were intended in this study, be it due to their small scale being "hidden" within the wider mesoscopic model outputs (e.g. ramp metering on the northbound on-slip at M1 J46), or due to their consequential detrimental impact on neighbouring links. Other schemes were more effective in "unlocking" traffic congestion, which while providing significant network operational enhancements in the vicinity of the scheme, also resulted in deteriorating conditions downstream as a result of the higher traffic demand which was now able to reach that location within the modelled time period. It would be necessary therefore, to consider, model and assess any of the indicative potential schemes using an appropriate modelling and assessment methodology which can quantify the benefits of the scheme at a refined local level.

The effect of the introduction of M62 J24a is important to note within this study as the level of traffic both released and induced into this network area of the network is substantial. As detailed further below, the resulting congestion in this area serves to 'hide' some of the benefits provided by the indicative potential schemes when reviewing the global network performance metrics.

From a global network operational perspective, the indicative potential schemes offer benefits compared to the 'do-minimum' assessments both in terms of the network capacity, hours of delay and average speeds. These benefits are visually presented within Figure 8.1 to Figure 8.4 and summarised below.

- The **hours of travel decreases** within the 'do-something' assessment compared to the 'do-minimum' assessment in the 2030 'future' and 2040 'horizon' year, while there is a slight increase in the 2022 'interim'. This is despite there being a substantial increase in total travel demand in the 'do-something' from the 'do-minimum' due to the presence of the new M62 J24a inducing traffic onto the SRN.
- The **hours of delay also decreases** within the 'do-something' assessment compared to the 'do-minimum' assessment in the 2030 'future' and 2040 'horizon' year, while there is a slight increase in the 2022 'interim'. Given the increase in traffic demand from the 'do-minimum' this indicates a more efficiently operating network.
- Corresponding with the above, the **total vehicle kilometres travelled also increases** within the 'do-something' assessment compared to the 'do-minimum' assessment.
- There is an **improvement in the average speed** within the 'do-something' assessment compared to the 'do-minimum' assessment in the 2030 'future' and 2040 'horizon' year, while there is a slight increase in the 2022 'interim'. This correlates with the outputs in regards to the other global network outputs.

For some metrics, the global model outputs indicate a reduced performance in the 2022 'do-something' compared to the 'do-minimum'. This can be attributed to the higher level of traffic demand within the network as a result of induced traffic from the provision of M62 J24a coupled with the fact that the indicative potential schemes in this area for 2022 are not sufficient to cope with this increased level of traffic demand. This is not to say that the 2022 indicative potential schemes are ineffective (as benefits on other areas of the network are modelled), more that the increase in SRN traffic in the M62 J24a areas of the network results in substantial concentrated delay in these areas.

In contrast, the network benefits of the indiciative potential schemes are more evident within the 2030 'future' and 2040 'horizon' 'do-something' assessments despite further traffic growth from the 2022 'interim' year. This is a reflection of the scale and additional network capacity of the indicative potential schemes being much greater than those identified for the 2022 'interim' year (partly due to the feasibility of construction timescales). Such schemes include ALR between M1 J45 and J46, ALR between M62 J30 and J32 and the new free flow link between the M621 and M1 northbound.

Notwithstanding the benefits provided by the indicative potential schemes, in absolute terms there will continue to be a detriment to SRN network performance and operation onwards to 2040 as demonstrated by increased hours of delay and reduced average speeds within both the 'do-minimum' and 'do-something' scenarios. For example, the benefits provided by the schemes within the 2030 'future' year are greater than those offered by the 2022 'interim' year schemes. This is logical given the size and scale of schemes which can realistically be completed by 2022 compared to 2030. However in absolute terms, even with the indicative potential schemes there is a continued decline in network performance in 2030 compared to 2022 due to the sheer volume of traffic growth forecast. Of note, key pinch point locations in 2030 include M62 J27 and M62 J26.

That said, caution should be taken when considering the results of the 2040 'horizon' year outputs. This assessment is forecasting traffic conditions 25 years from the present, over which time a huge number of contributory factors could greatly change the traffic demand trends applied to the model. This is particularly true given the lack of development aspiration information beyond 2030 and hence the uniform application of traffic growth rates on top of origin and destination movements derived for the 2030 'future' assessment. A greater focus therefore should be placed on the outputs of the 2022 'horizon' and 2030 'future' assessments.

Figure 8.1: Global model outputs – comparative overview - hours of travel

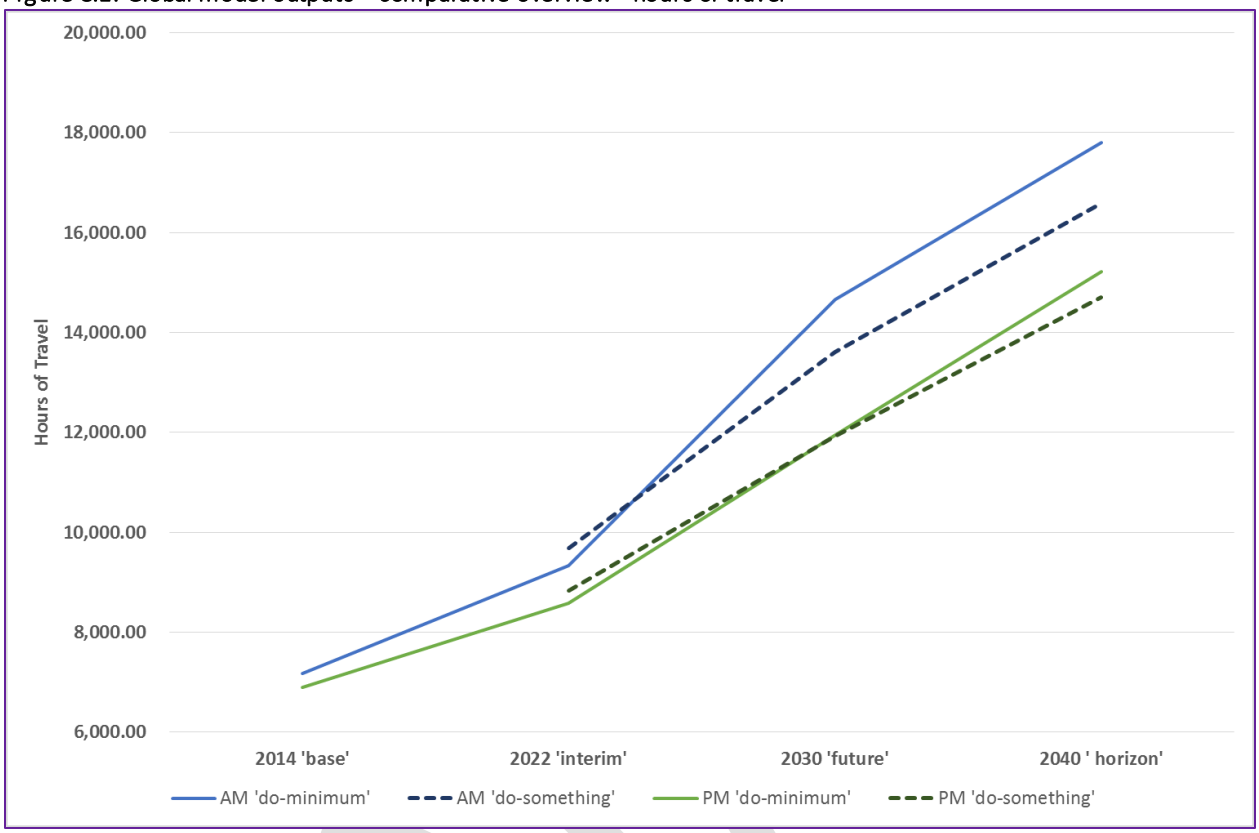


Figure 8.2: Global model outputs – comparative overview - hours of delay

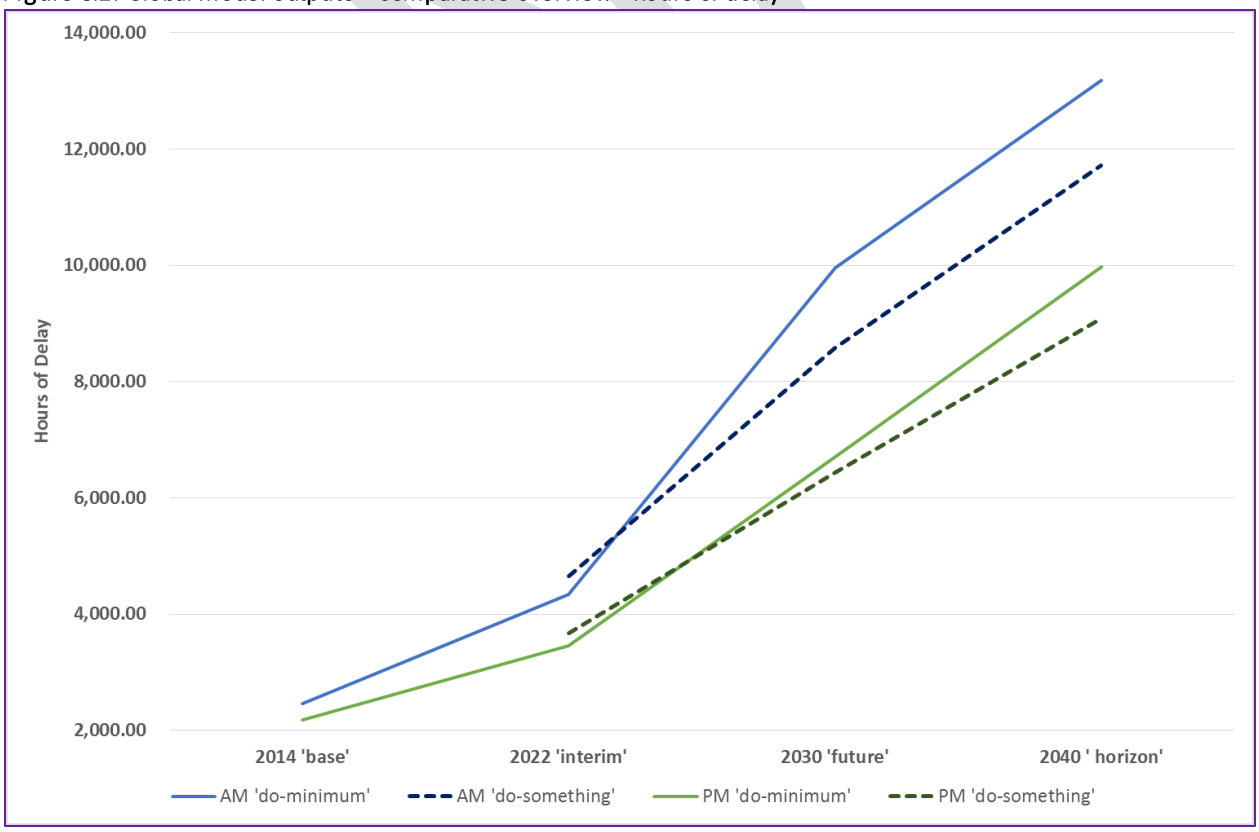


Figure 8.3: Global model outputs – comparative overview - vehicle kilometres

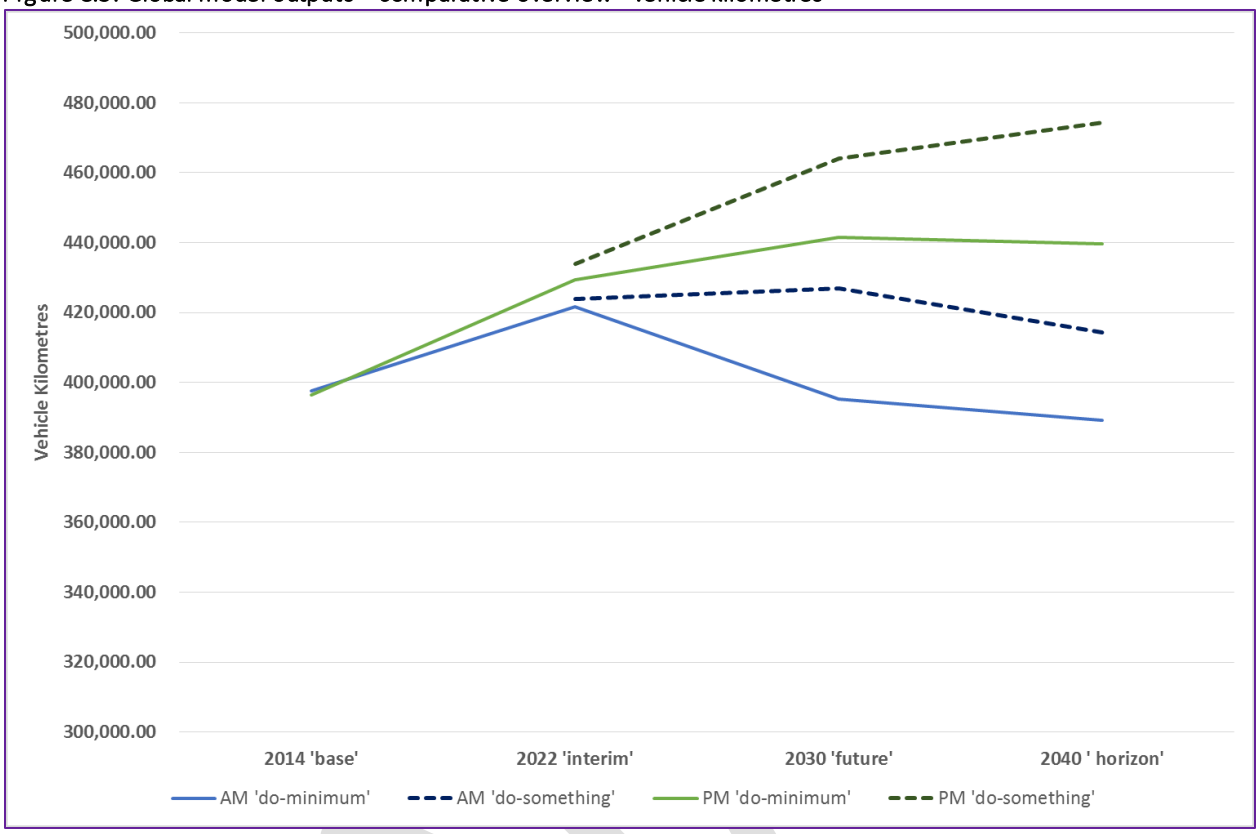
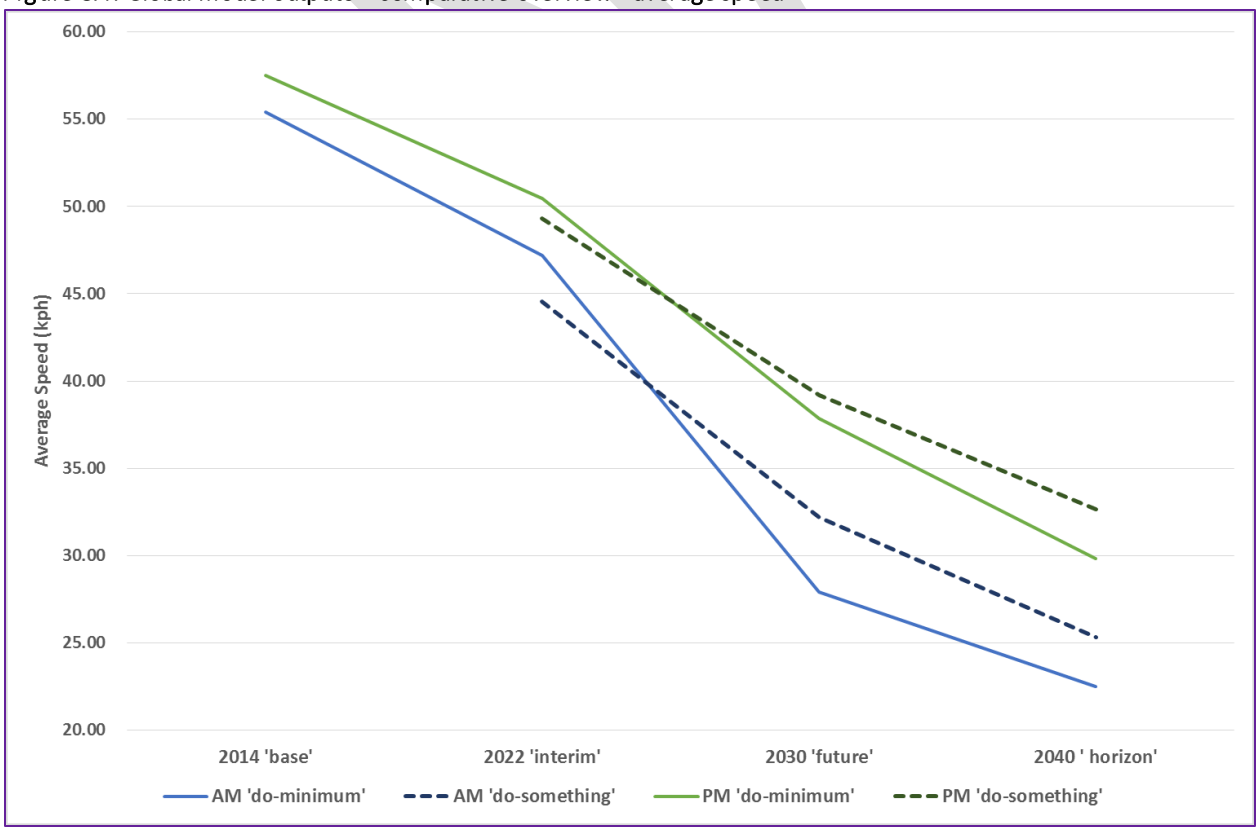


Figure 8.4: Global model outputs – comparative overview - average speed



As demonstrated above, despite the application of the indicative potential schemes, there remain areas of the network which remain congested and act as restrictive 'pinch points' or bottlenecks. Developing

effective solutions for these congestion hotspot locations would offer substantial further operational benefits (but, as has been found within this study, may well shift the congestion to another location on the network). Key network locations continuing to require mitigation schemes include:

- M62 J29 (Lofthouse Interchange) westbound merge sections;
- M1 southbound between J43 and J42;
- M621 / M1 J43 southbound merge section;
- M62 J26 (Chain Bar) at the westbound diverge and eastbound merge;
- M62 J25 (Brighouse) eastbound merge; and
- M1 J44 (Rothwell Haigh).

In many cases it is capacity issues at junction and on the LRN which cause congestion to back up onto the SRN which results in SRN congestion, rather than SRN congestion itself. Key sections of the SRN which are detrimentally affected by issues at junctions include:

- M62 J24a to J26 eastbound – caused by merging traffic at M62 J26; and
- M1 northbound and southbound to J44 - caused by LRN congestion to the north of J44.

A visual representation of the SRN sections identified above, along with other section not listed here, can be found within the network schematics in sections 4, 5, 6 and 7.

In other cases, the SRN network was impacted upon from network issues on the LRN, outside of the jurisdiction of Highways England. In many cases, these links were unable to cope with the forecast level of traffic growth from LA local plan development aspirations and hence, the operation of the SRN was impacted upon as a result, be it through traffic unable to access or exit the SRN. Only a small number of LRN schemes were incorporated into the 'do-something' assessments, predominately in the vicinity of Leeds city centre.

Key LRN hotspot locations which caused significant congestion (both on the LRN and SRN) include:

- The A639 / Pontefract Road junction in Stourton; and
- The A639 / A61 junction within Hunslet.

8.2 Recommendations

Taking into account the outputs and analysis of the study, a consideration as to the perceived 'success' of the indicative potential schemes can be completed. A summary of the indicative potential schemes modelled, along with their forecast network operational benefits is provided within Table 8.1. This table also provides a view as to what next steps / actions could be.

All schemes featured within Table 8.1 should be considered as indicative potential measures for the operational issues identified within this high level study. They should not be viewed as committed schemes or included within any Highways England future network enhancement works programme as a result of their inclusion within this report. The schemes featured below have been identified to address forecast operational issues at their respective location on the network. As such, it is the location of the schemes which should be viewed as likely to require some form of mitigation in the future, the form of which might not be that described within Table 8.1. The exact form of such a scheme will need to be defined within more detailed and site specific studies.

Table 8.1: Indicative potential scheme summary

Scheme	Scheme summary	Year	Modelled Benefit
M1 J39	Signalisation of all remaining non-signalised arms following the committed scheme construction. In addition, LRN approach links to the junction circulatory have been widened from 2 to 3 lanes to provide more stacking capacity	2022	Small improvement to the junction circulatory and LRN.
M1 J40	The existing 3 lane section of the LRN approaches is to be extended to provide more stacking capacity	2022	Small improvement to the junction circulatory and LRN.
M1 J44	Improved junction signal operation (signal timing adjustments) The 3 lane section of the southbound off-slip to be constructed as part of a committed scheme is to be extended to provide more stacking capacity	2022	Substantial improvement to junction circulatory operation and slip road congestion.
M1 J45	Northbound on-slip and merge improvements (2 lanes and ghost Type C). As part of 2030 potential network, this merge will revert to a lane gain.	2022	Improved northbound on-slip merge congestion.
M1 J46	Removal of segregated left-turn lane from A63 to M1 South in order to better regulate the flow of traffic onto the southbound slip road. Amended circulatory signal timings also required to reflect demand flow changes.	2022	Improved southbound merge conditions but substantial increase in congestion on the LRN.
M62 J24	Three lanes approach from M62 westbound off-slip on A629 to provide more stacking capacity and weave section.	2022	Benefits offered through improved stacking capacity.
M62 J24a	Potential new junction to be located at the existing A641 bridge.Modelled as an all movements signalised junction.	2022	LRN and SRN network benefits through increased connectivity and network resilience.
M62 J25	Signalisation of all arms (in conjunction with the Cooper Bridge scheme).	2022	Level of circulatory operation maintained despite increased traffic flows.
M62 J27	Widen eastbound off-slip to 3 and 4 lanes on approach to the junction.	2022	Benefits offered through improved stacking capacity.
M62 J28	Widening of circulatory carriageway to accommodate two lanes dedicated to the movement from the M62 westbound exit slip to the A650. Ramp metering of eastbound merge.	2022	Enhanced junction operating capacity. Limited benefits offered by the ramp metering scheme within the meso model.
M62 J30	Provision of traffic signals at the roundabout at the end of the westbound off-slip road. Signalisation of the junctions with the A642 of the B6135 Newmarket Lane and Castle Gate.	2022	Both schemes offer substantial operational benefits on both the LRN and SRN.
M62 J32	Westbound on-slip type C merge. As part of 2030 potential network, this merge will revert to a lane gain. Signals for the new Lady Balk Lane junction to the south.	2022	Improvement to both the merge and traffic management on the LRN to the south.
M1 J45 - 46	Four lanes ALR with lane gain and lane drop at junctions 45 and 46.	2030	Greatly improved link capacity and congestion on this section.

Scheme	Scheme summary	Year	Modelled Benefit
A1(M) J44	Signalisation of all junction arms.	2030	Essential in order to facilitate effective circulatory operation and manage slip road congestion.
M1 J44	Eastbound merge upgraded to type D1.	2030	Improvement to merging traffic conditions.
M1 J46	Ramp metering of northbound on-slip. To tie in with ELOR.	2030	Limited benefit / detriment shown within the meso modelling.
M1 J47	Eastbound off-slip enhancement and signalisation.	2030	Small improvement to circulatory operation and slip road congestion.
M62 J24	Two lane path through top island to M62 westbound. Closure of southern circulatory arc.	2030	Essential in order to manage circulatory and slip road congestion at this location.
M62 J26	Signalisation of the M606 approach to the roundabout and removal of the segregated free flow left turn. Upgrade of the M62 westbound diverge to type D1 ghost island or D2 Parallel Diverge.	2030	Enhanced junction operating capacity. Diverge scheme offers increased capacity at this location which will also compliment junction circulatory operation.
M62 J27	M621 Ramp Metering of the M621 link to the M62 westbound to reduce merging traffic impact.	2030	Limited benefit / detriment shown within the meso modelling.
M62 J27	New link roads from M621 to M62 South and New Link Road between M62 Westbound and M621 Westbound Slip Road and Associated Segregated Left Turning Lane on A62 South	2030	Extremely low use of the free flow links within the AM peak. More use within the PM peak. Segregated left turning lane offers benefits to southbound movements.
M62 J30-J32	Four lanes ALR.	2030	Substantial benefits to link operating capacity and congestion.
M621 to M1 Northbound Link	Design and model potentials chemes.	2030	Well used link, potentially removing traffic from either Lofthouse interchange and/or M621 J7 through Valley Business Park.
A1(M) J45	Signalisation of the northbound off-slip.	2030	Essential in order to facilitate effective circulatory operation and manage slip road congestion.
Lofthouse	Three lanes eastbound on M62 through Lofthouse Interchange.	2030	Improved link operating capacity and congestion.

Due to the feasibility of construction timescales, more significant indicative potential schemes were applied to the 2030 'future' year rather than the 2022 'interim' year. As a result there are some smaller schemes featured within the 2022 'interim' year do not provide sufficient mitigation of forecast traffic

growth impacts. As a result it is also recommended that further schemes feasible for implementation by 2022 are identified at specific locations on the network. One such example is M62 eastbound through J26.

In addition to both the above and the contents of Table 8.1, further consideration into additional extensive enhancement schemes at the following SRN locations should be investigated for beyond 2022 (to allow feasible construction timescales). These further schemes are required not necessarily because the identified schemes within this report are insufficient, more there has been a shift in congestion hotspots around the network as a result of traffic being unlocked from existing pinch points.

- M62 J29 (Lofthouse Interchange) westbound merge sections;
- M621 / M1 J43 southbound merge section;
- M62 J26 (Chain Bar);
- M62 J25 (Brighouse); and
- M1 J44 (Rothwell Haigh).

Engagement with local highway authorities should also be sought in regards to highlighting issues and progressing feasibility improvement schemes at the following locations.

- The A639 / Pontefract Road junction in Stourton; and
- The A639 / A61 junction within Hunslet.

8.3 Conclusions

In conclusion, this study has demonstrated that if local plan development aspirations in West Yorkshire are fully realised, the SRN will become exceptionally congested by 2030, i.e. forecast traffic demand cannot be accommodated by committed schemes alone. It is therefore necessary, in order to maintain an acceptable level of network operation, to identify and implement a series of additional indicative potential schemes.

Largely, the indicative potential schemes identified within this study do offer network operational benefits. The mesoscopic modelling shows some schemes to have clear benefits (e.g. M1 J44 – J45 ALR), while for others, due to their small nature, their benefits are not as clear (e.g. ramp metering).

The more significant and effective schemes also have their issues, in that while providing significant network operational enhancements in the vicinity of the scheme, they also caused deteriorating conditions downstream as a result of the higher traffic demand which was now able to reach that location within the modelled time period. This means that despite the modelling of indicative potential schemes offering clear benefits in some locations, new operational issues have arisen. Network locations requiring further consideration beyond the indicative potential schemes have been highlighted within the preceding section.

The LRN is also significantly impacted upon by forecast traffic growth, yet as this study has been focused on identifying indicative potential schemes for the SRN, the LRN arguably requires investment to a level as significant as that required on the SRN. Key LRN locations requiring further enhancement have also been highlighted within the preceding section.

Notwithstanding the benefits provided by the indicative potential schemes, this study indicates that in absolute terms there will continue to be a detriment to SRN network performance and operation onwards to 2040 as demonstrated by increased hours of delay and reduced average speeds within both the 'do-minimum' and 'do-something' scenarios.

That said, all schemes featured should be considered as indicative potential measures for the operational issues identified within this high level study. They should not be viewed as committed schemes or included

within any Highways England future network enhancement works programme as a result of their inclusion within this report. The schemes featured have been identified to address forecast operational issues at their respective location on the network. As such, it is the location of the schemes which should be viewed as likely to require some form of mitigation in the future, the form of which might not be that described within this report. To summarise, in order to fully understand, visualise and quantify the benefits provided by the indicative potential schemes, more refined operational assessments should be completed to support the case for the schemes and accurately define their design. This will require the completion of a more detailed and site specific studies

Appendices