File Note

Date	20 May 2014
Job No/ Name	X552008
Subject	2031 M42J9 Model Assessment

Background

JMP Consultants Ltd were commissioned by the Highways Agency (HA) and Warwickshire County Council (WCC) in January 2014 to develop a 2014 base model of the M42 Junction 9 / M6 Toll interchange (2014 M42 Junction 9 Base), and to use the model to assesses two future year scenarios:

- 2031 Do Minimum (DM) scenario – i.e. the 'reference' case to use the terminology of the West Midlands PRISM model.
- 2031 Do Something (DS) scenario with growth from the Birmingham development plan represented by the Peddimore and Langley Green belt developments (sites C and D from the original BCC options paper).

The 2031 DS model will later be used to assess mitigation measures. This technical note details the development of the two future year scenarios and assesses the model operation for each. We also comment on the likely scale of mitigation and provide some options for further investigation.

Network

The M42 Junction 9 Base model area covers the M42 Junction 9 / M6 Toll interchange / A4091 from its junction with A4091 in the north to Faraday Ave junction in the south / the A4097 / Wishaw Lane / Coleshill Road to the west.

The base modelled network includes the 2014 HA pinch-point scheme.

An LMVR for the model has been supplied to the HA and WCC. This sets out the validation process and confirms

- Using detailed road network and traffic count data, the micro-simulation model has been successfully developed to reproduce traffic conditions for a typical weekday. The model calibrates well to the observed data and meets DMRB acceptability guidelines.
- The model validation demonstrates that the observed and modelled journey times are consistent in terms of average journey times and the variation in journey time across multiple runs throughout the modelled peak periods.
- It is therefore considered that this model is fit for considering future year forecasting, assessing any network enhancements, and for use in any future year testing.

The network is shown in the figure below.

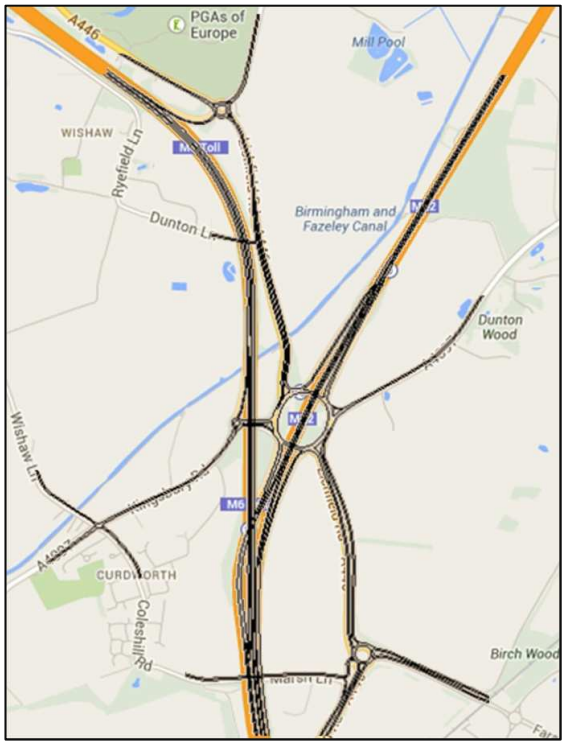

Figure 1. Network Diagram

For the DM and DS Scenarios there are no network changes from the 2014 M42 Junction 9 Base model, both the scenarios use the Base network.

Modelled Demand

Do Minimum (DM)

PRISM derived growth for the M42 Junction 9 from 2011 to 2031 was used to derive the 2031 DM demand matrices. A factor of 0.85 was applied to the PRISM growth to reduce the growth from 20 years to 17 years as the Base model demand is 2014 not 2011. For Origin / Destination (OD) movements that go through M42 Junction 9, the PRISM derived growth for the approach link was applied to the OD movement. For OD movements within the model that do not pass through the M42 junction 9 the average growth from all M42 junction 9 movements was applied. The OD movements that represent the M6 Toll trips that do not pass through the M42 junction 9 were assumed to show zero growth.

The growth for each OD movement was applied to the 2014 M42 Junction 9 Base demand to derive the 2031 M42 Junction 9 DM demand. This process derived a 12.5% AM and 11.9% PM increase in vehicle trips from the 2014 Base to the 2031 DM.

Do Something (DS)

The 2031 M42 Junction 9 DS demand includes the development trips for Peddimore and Langley, supplied in PJA Green Belt Travel Demand Model v1.xlsx. The Peddimore and Langley developments are outside the M42 Junction 9 model boundary but, for the proportion expected to travel to / from the east via M42 J9, they have been assumed to enter / exit the model at Kingsbury Road (West).

The development trips supplied were for the AM 0800-0900 and PM 1700-1800. The M42 Junction 9 model covers a 3 hour AM and 3 hour PM period, the total vehicles to and from the Kingsbury Road (West) zone in

the 2031 DM demand for each modelled hour was used to derive factors to approximate the development trips in the shoulder hours.

The 2031 M42 Junction 9 DM model distribution to and from Kingsbury Road (West) was used to distribute the development trips for each modelled hour. These development trips were then added to the 2031 M42 Junction 9 DM demand matrices to derive the 2031 M42 Junction 9 DS demand. This process derived an increase of 17.3% AM and 16.1% PM vehicle trips in the DS scenario from the 2014 Base.

Model Operation

General

2031 M42 Junction 9 DM

In the AM significant queuing occurs first on Kingsbury Road (West) on approach to the M42 Junction 9, this queuing blocks back to the Kingsbury Road / Wishaw Lane / Coleshill Road junction by 07:45 and causes queuing on Wishaw Lane southbound. By 08:00 there are unreleased vehicles on Wishaw Lane, the level of unreased vehicles here peaks at 08:30 with 130 vehicles queued off the network.

Lichfield Road southbound on approach to the M42 Junction 9 also experiences significant queuing which blocks back to the Dunton Lane junction frequently between 08:00 and 09:00. The AM also experiences some queuing on Lichfield Road northbound approach to the M42 Junction 9 and Kingsbury Road (East) approach.

In the PM the queuing is mainly northbound with queuing starting on Lichfield Road (North) northbound just after Dunton Lane at the point where two lanes merge into one which blocks back to the M42 Junction 9 by 17:00. Lichfield Road (South) approach to the M42 Junction 9 then starts queuing and reaches the Lichfield Road / Faraday Ave / Marsh Lane roundabout by 17:30. This causes queuing on Faraday Ave and Lichfield Road (south of the roundabout), with peak unreleased vehicles at Lichfield Road South of 170 at 18:00.

The PM period also experiences queuing on the M42 northbound diverge to junction 9. The level of demand being released northbound from the M42 (South) zone is unable to fit on the available lanes which causes unreleased vehicle which peak at 2,300 by 18:30. The forecast growth here is too high for the capacity of the M42. By 19:00 there is still approximately 1600 vehicles unreleased from the M42 (South) zone.

2031 M42 JUNCTION 9 DS

The DS model is similar to the DM model in the AM but with the queuing on Kingsbury Road blocking back to the Kingsbury Road / Wishaw Lane / Coleshill Road junction by 07:30, 15 minutes earlier. This very quickly builds causing unreleased vehicles on Wishaw Lane and also on Kingsbury Road (West) which both have approximately 200 unreleased vehicles by 08:00. The level of unreleased vehicles on Kingsbury Road (West) remains at approximately 200 vehicles though out the simulation but the level of unreleased vehicles on Wishaw Lane continues to grow to approximately 900 vehicles by 10:00.

There is also significant queuing southbound on Lichfield Road on approach to the M42 Junction 9 which blocks back to Dunton Lane by 08:00 and to the Lichfield Road / A4091 roundabout by 08:15. The queuing then builds on the Lichfield Road (North) southbound approach to the roundabout with the A4091, causing unreleased vehicles which peak at 100 vehicles at 08:50.

Lichfield Road (South) northbound approach to the M42 Junction 9 also has significant queuing blocking back to the Faraday Avenue / Lichfield Road / Marsh Lane roundabout from 08:00 until 09:00.

In the PM the queuing again originates on Lichfield Road (North) where the northbound flow merges from two lanes to one. These queues block back to M42 Junction 9 by 17:00 and impact on the operation of the

circulatory and the throughput on the southern approaches. Lichfield Road (South) approach shows queues that reach back to the Lichfield Road / Faraday Ave / Marsh Lane roundabout by 17:15.

The PM period also experiences queuing on the M42 northbound diverge to junction 9. The level of demand being released northbound from the M42 (South) zone is again unable to fit on the available lanes which causes unreleased vehicles. The forecast growth here is too high for the capacity of the M42. This issue is amplified with the inclusion of the development flows.

Network performance

AM Comparison

Figures 2 to 4 show the network wide statistics plotted across the AM period for the 2014 Base, 2031 DM and 2031 DS scenarios.

Figure 2 shows that there is a significant drop in average vehicle speed in 2031 when compared to 2014 reflected the increased congestion.

The total time vehicles are queued off the network is higher in the 2031 DM model than in 2014. However, this issue is significantly worse in the 2031 DS scenario where the off network queue time continues to increase until the end of the simulation, highlghting significant network loading capacity issues.

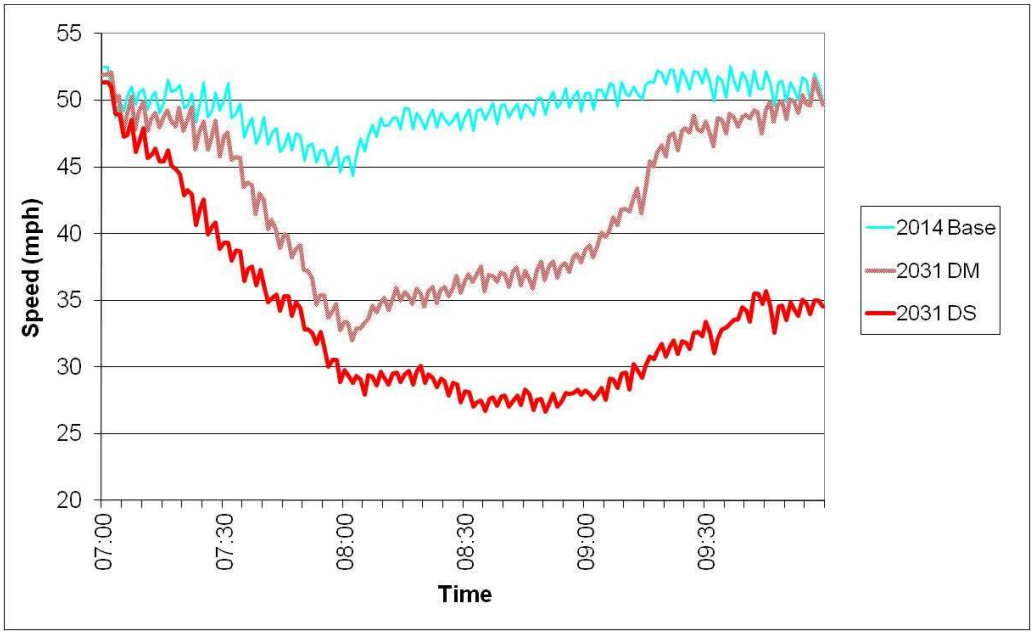

Figure 2: All vehicles average vehicle speed over simulation period AM

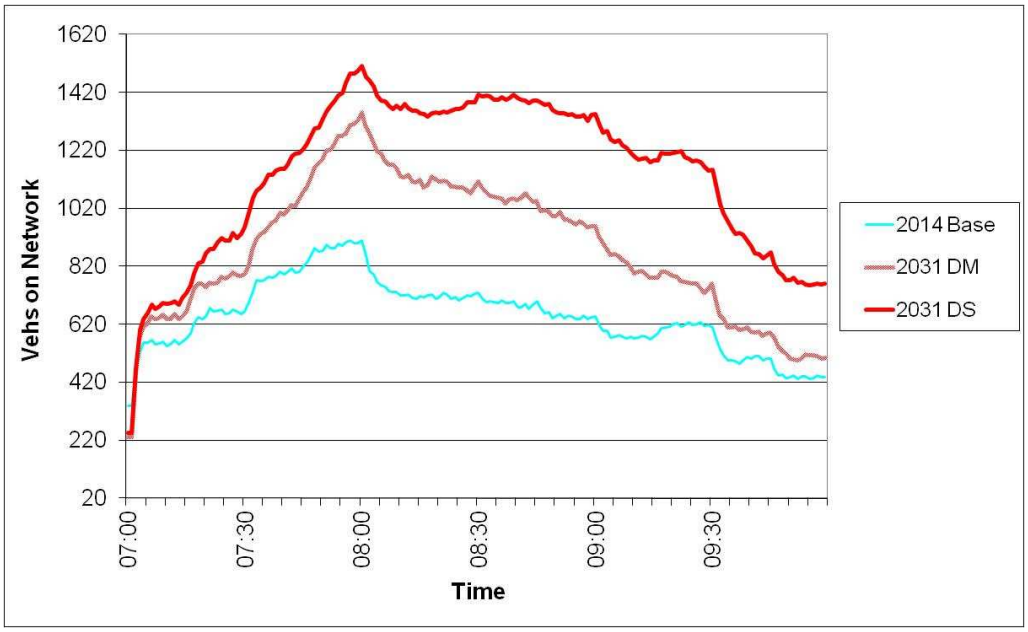

Figure 3: All vehicles on the network over simulation period AM

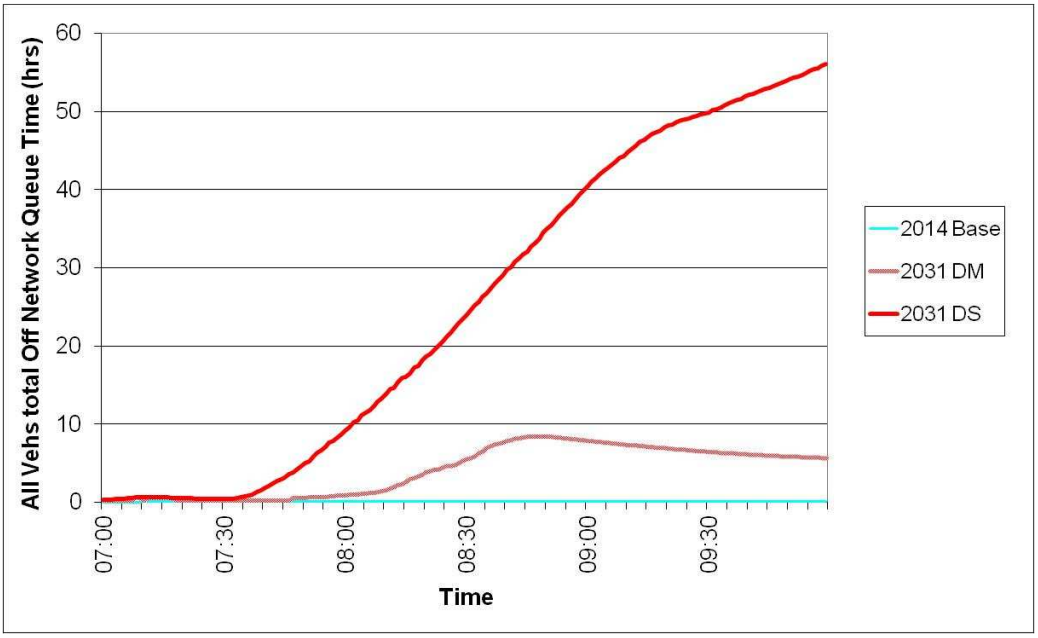

Figure 4: Total off network queue time summed for all vehicles over simulation period AM

PM Comparison

Figures 5 to 7 show the network wide statistics plotted across the PM period for the 2014 Base, 2031 DM and 2031 DS scenarios.

The average network speed in 2031 is significantly lower than in the 2014 Base and once it has dropped to 20mph it fails to recover.

There is also a significantly higher number of vehicles on the network in the 2031 scenarios; part of this is due to higher demand, however part is due to vehicles taking longer to exit the network.

Figure 7 shows a steady increase in vehicle hours queued off the network for both 2031 models, indicating significant loading capacity issues in the PM period.

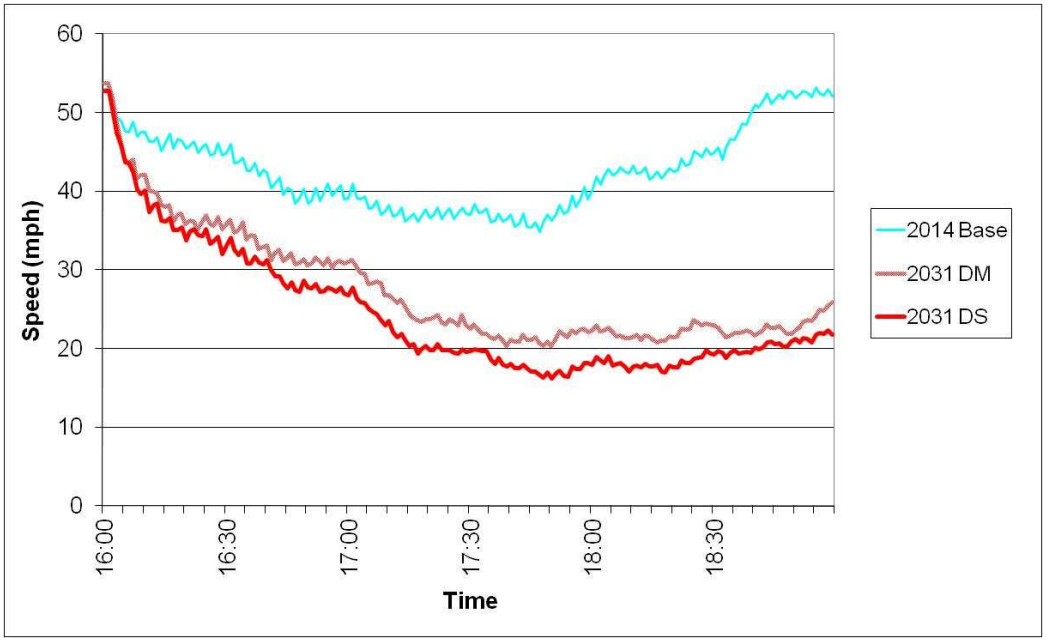

Figure 5: All vehicles average vehicle speed over simulation period PM

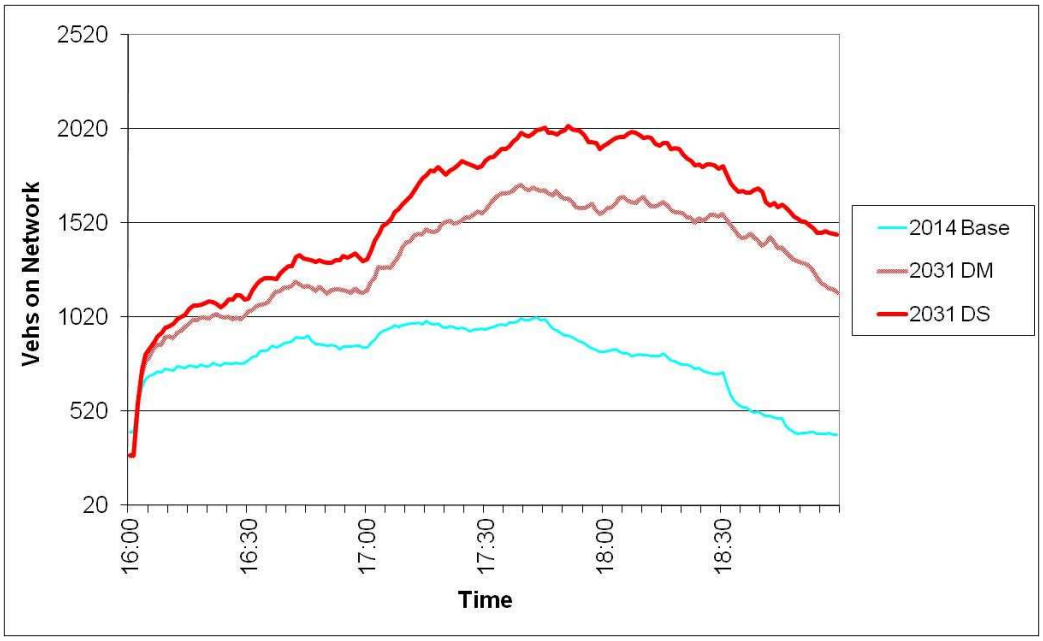

Figure 6: All vehicles on the network over simulation period PM

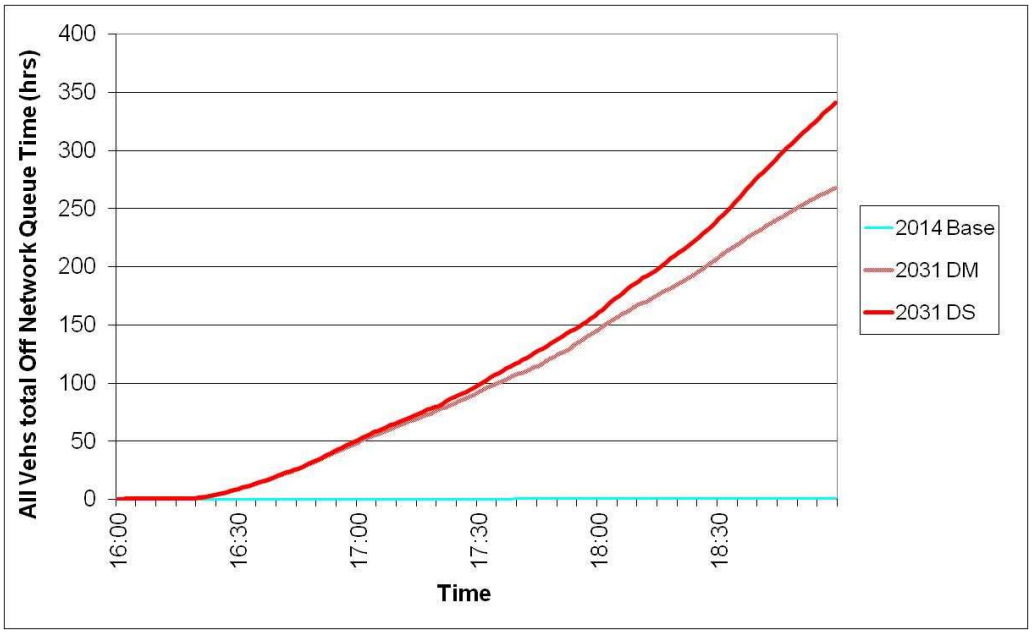

Figure 7: Total off network queue time summed for all vehicles over simulation period PM

Journey Times

Four journey time paths have been analysed for this assessment, shown in Figure 8. The Red path shows the northbound and southbound route and the bright blue path shows the Kingsbury Road eastbound and westbound.

The average journey time for all vehicles and the minimum / maximum range (provided as a measure of reliability) have been plotted below for each scenario.

Figure 8: Journey Time Paths

AM Comparison

Figures 9 to 12 show the journey times for the 2014 Base, 2031 DM and 2031 DS models during the AM period.

The journey times recorded on Lichfield Road northbound in the AM begin to increase at 07:45 and by 08:00 the 2031 DM is showing journey times of approximately 3 minutes longer than in the 2014 Base.

The 2031 DS model shows an even steeper increase in average journey time on the northbound route and continues to increase until 08:45, peaking at an average of 12 minutes, approximately 10 minutes longer than the 2014 Base at this time.

The journey time range for the northbound movement also widens with some journeys taking a maximum of over 30 minutes to travel northbound on Lichfield Road.

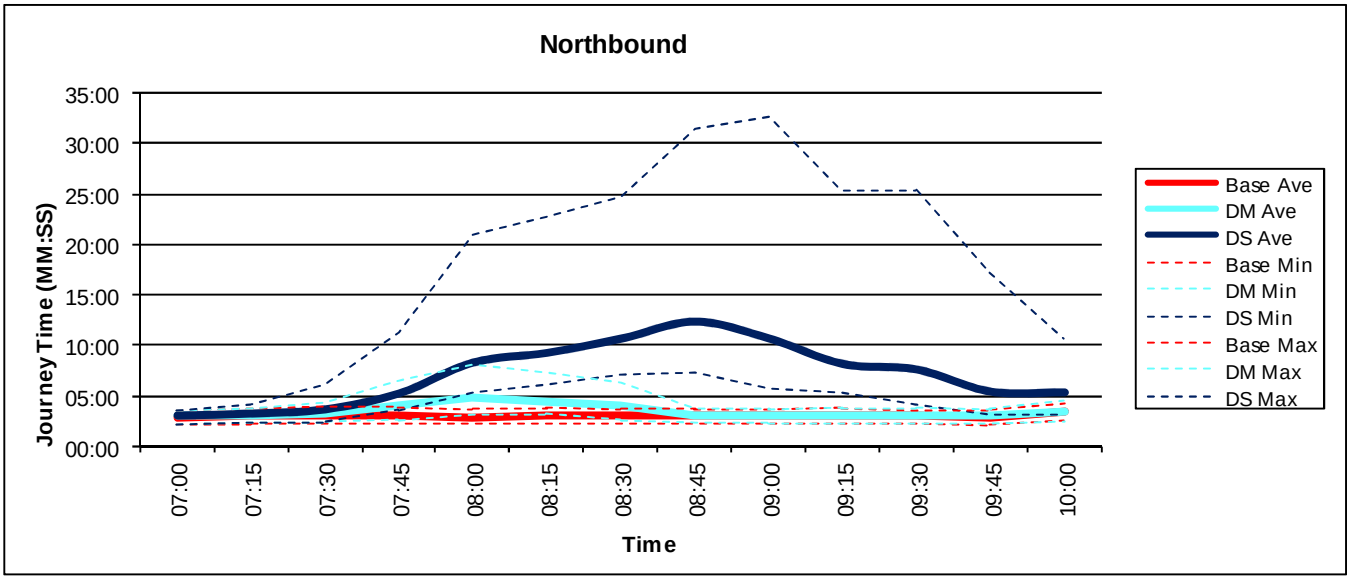

Figure 9: Northbound vehicle journey time, AM

The journey time range remanins relatively consistant for the southbound journey times in all three scenarios. However, the avergae journey times are higher in the 2031 scenarios when compared to the 2014 Base.

The 2014 Base reaches a maximum journey time of apporximately 4 minutes 30 seconds. The 2031 DM journey time at this time is approximately 6 minutes and the 2031 DS approximately 8 minutes. However, the journey tims in the 2014 scenario begin to decrease from this point, whereas the 2031 models continue to increase due to the congestion in the model. The peak average journey time observed in the AM period is 7minutes in the DM model and 9 minutes in the DS model.

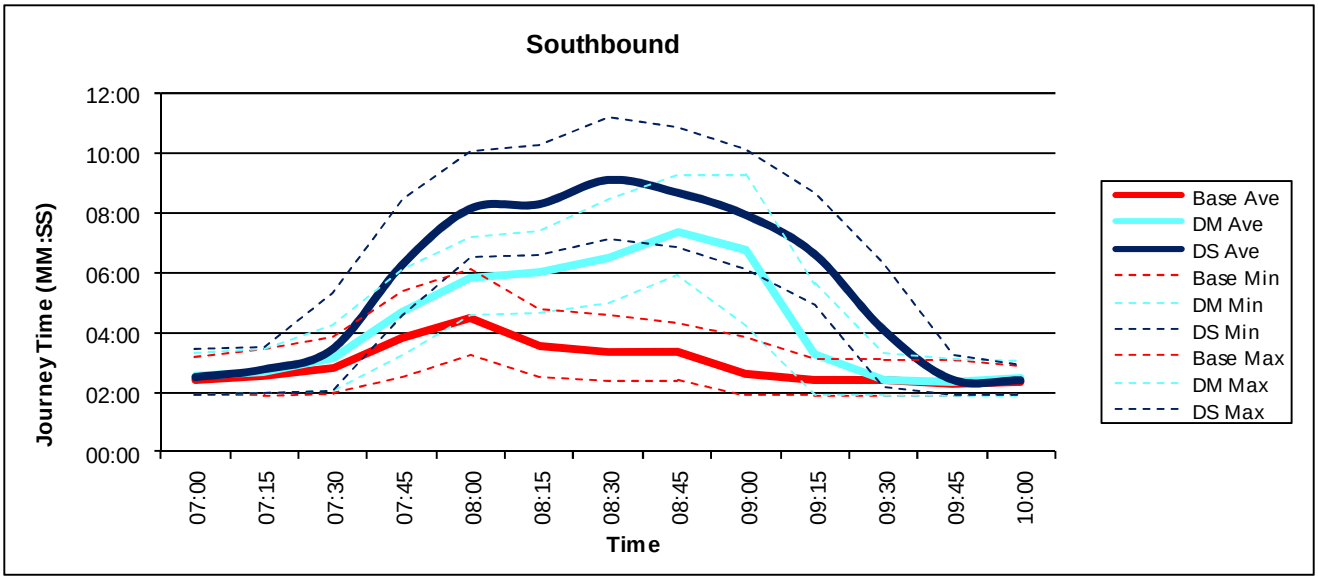

Figure 10: Southbound vehicle journey time, AM

Kingsbury Road eastbound is relatively stable at approximately 2 minutes throughout the 2014 AM modelled period. The 2031 DM demand increases this journey time to peak of just under 8 minutes at 08:00 which then steadily decreases. The additional development traffic in the 2031 DS model increases the average journey time to approximately 9 minutes by 07:30 and due to the high level of unreleased vehicles here the journey time remains high until the end of the simulation period.

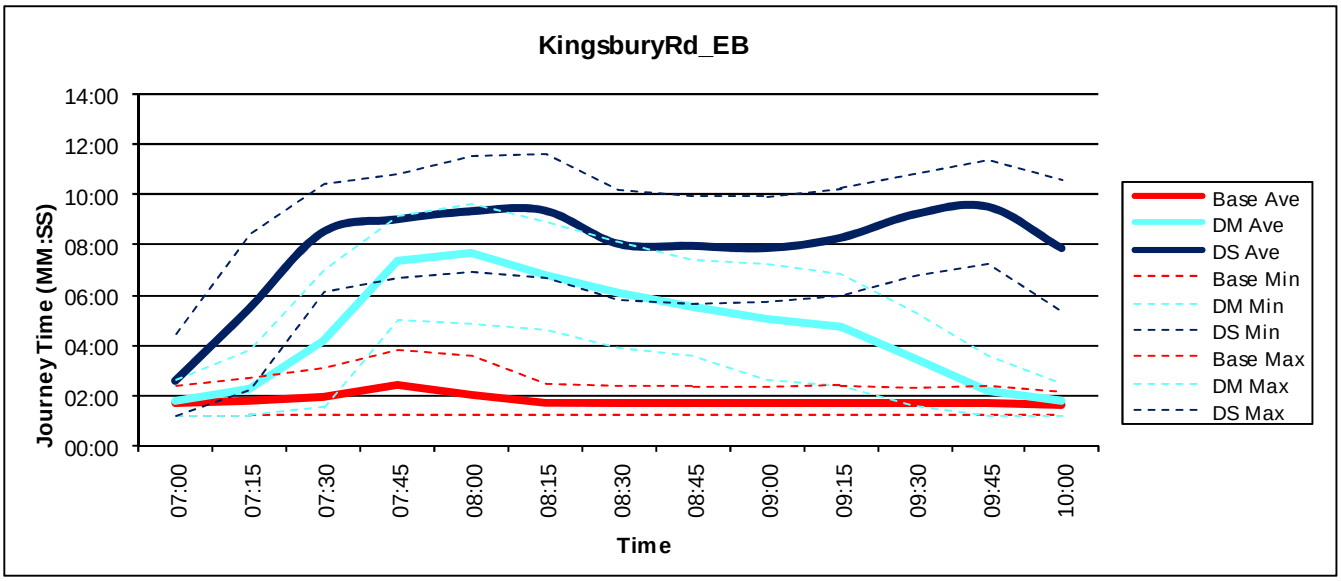

Figure 11: Kingsbury Road Eastbound vehicle journey time, AM

Kingsburgh Road westbound journeyt time is relatively stable at approximately 1 minute for all three models.

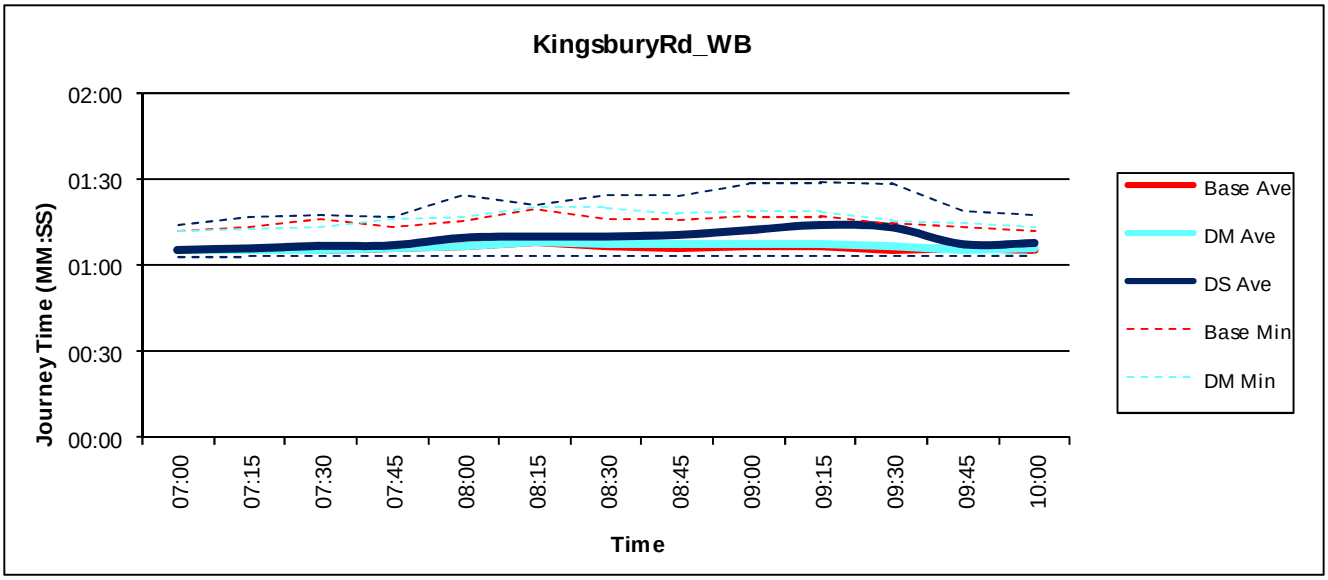

Figure 12: Kingsbury Road Westbound vehicle journey time, AM

PM comparison

Figures 13 to 16 show the journey times for the 2014 Base, 2031 DM and 2031 DS models during the PM period.

The northbound journey time in the PM significantly increases due to the forecast demand from 2014 to 2031. The northbound average journey time peaks around 17:30 at approximately 18 minutes in the 2031 scenariosand remains high until the end of the simulation period. The peak average journey time for the 2014 Base is 5 minutes, 13 minutes faster than the peak in both 2031 models.

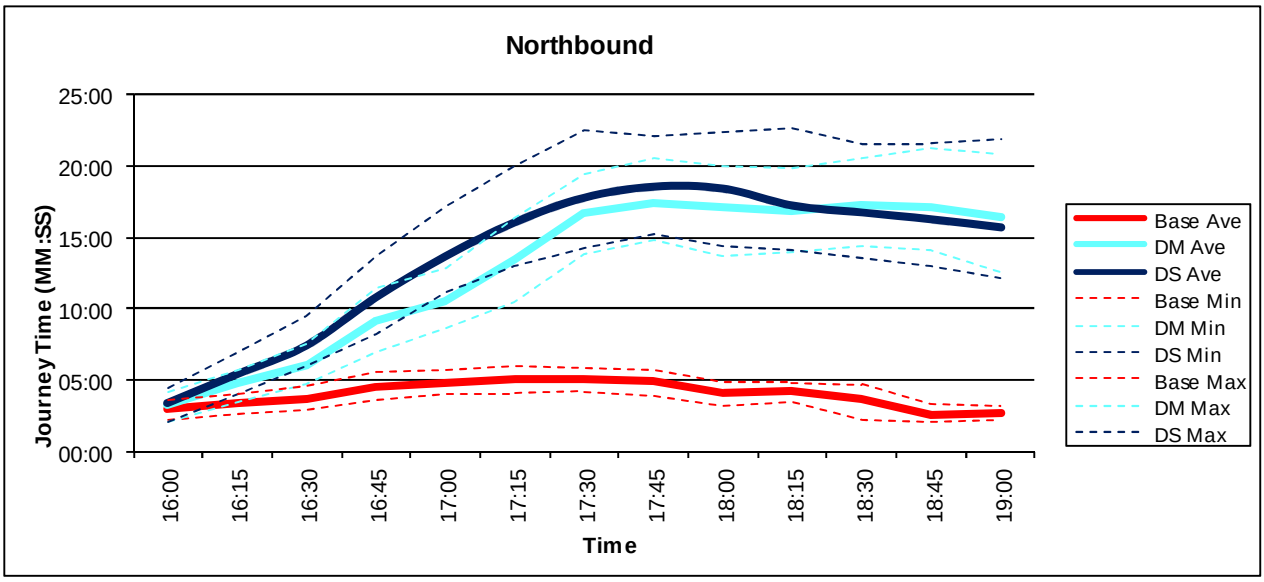

Figure 13: Northbound vehicle journey time, PM

The average southbound journey time increases with the additional demand in 2031 compared to the 2014 Base and then increases further with the impact of the development traffic. The average journey time at the peak (18:00) is approximately 5 minutes longer in the 2031 DM scenario and 10 minutes longer in the 2031 DS when compared to the 2014 Base.

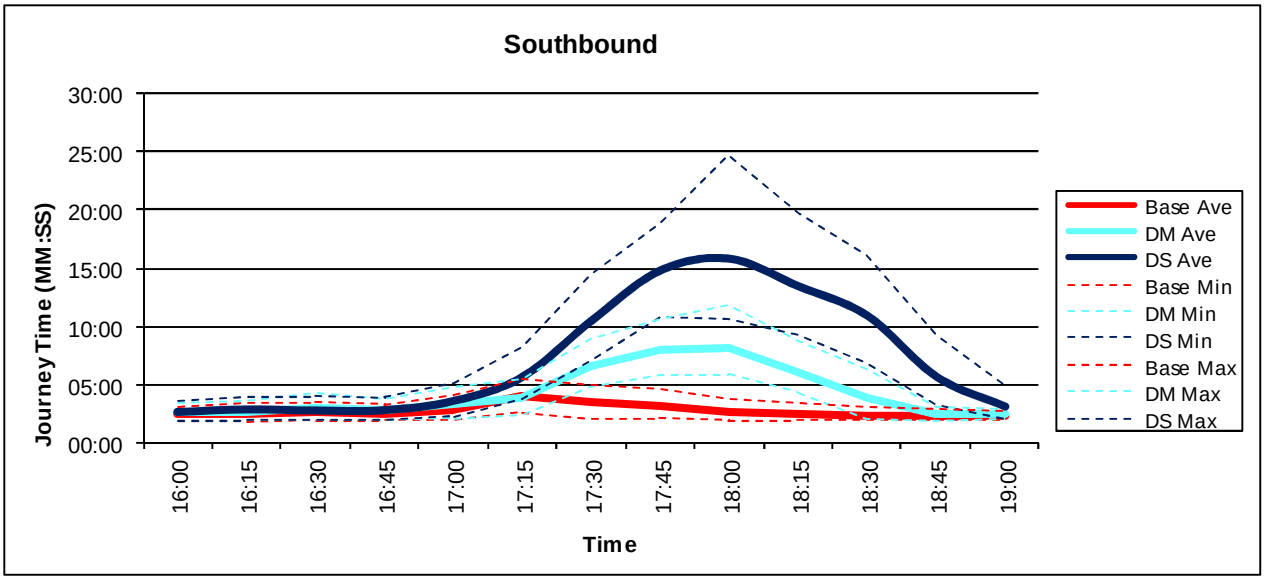

Figure 14: Southbound vehicle journey time, PM

The 2014 Base and 2031 DM models have a relatively stable average journey time of approximatly 2 minutes throughout the full PM period. The additional development traffic in the 2031 DS model causes additional journey time delay which peaks at 5 minutes at 17:45, a 3 minute increase on the Base and 2031 DM.

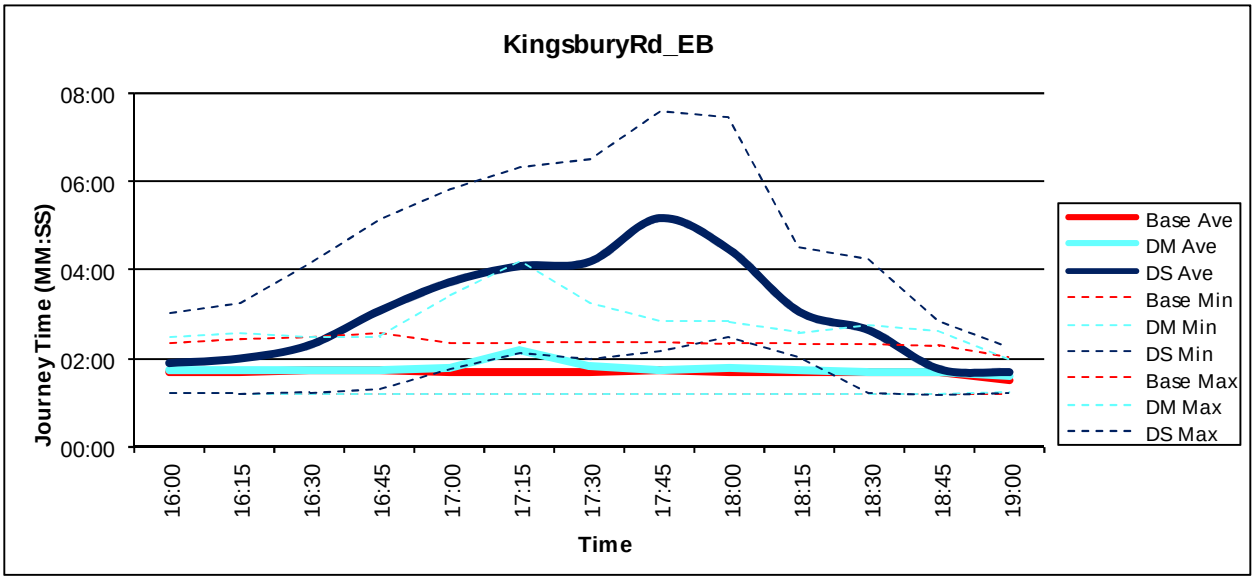

Figure 15: Kingsbury Road eastbound vehicle journey time, PM

Kingsbury Road westbound in the PM is similar to the AM and shows a constant 1 minute average journey time throughout the full period in all three scenarios.

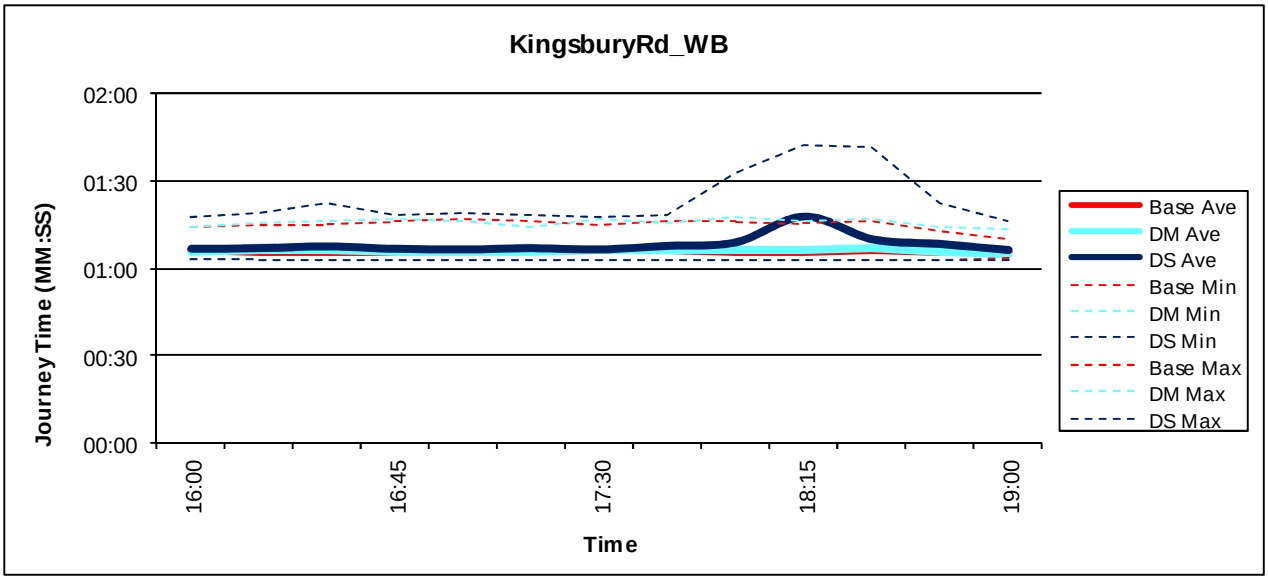

Figure 16: Kingsbury Road westbound vehicle journey time, PM

Summary

M42 Junction 9

The 2031 M42 Junction DM and 2031 M42 Junction 9 DS models experience significant congestion throughout the AM and PM simulation period that results in significant queuing at Junction 9 on the following approaches:

- Lichfield Road (North)
- Lichfield Road (South) and
- Kingsbury Road (West)

To reduce the level of congestion to an acceptable level improvements are required to increase the throughput of the three approaches. It should be noted that the current capacity appears to be constrained at times by queues blocking back from the Lichfield Road (North) exit.

Local Considerations

In the 2031 scenarios issues are highlighted in the PM period on the north-westbound A446 Lichfield Road where the lane-drop prior to the A446 / A4091 roundabout results in queues reaching back to the circulatory at M42 Junction 9.

In the 2031 DS scenario the A4097 Kingsbury Road eastbound approach to M42 junction 9 sees significant increases in queuing. Our initial view is that this direct impact of the development traffic will need to be mitigated.

Potential Capacity Enhancements

The initial review of the model's performance in 2031 has highlighted various areas where highway improvements could be focussed. Follow on work looking into improving the network operation and potentially mitigating development impact should consider the following:

1. A446 northbound two lane approach to A4091 roundabout.

2. Review A446 eastbound approach to M42 junction 9 for capacity.

3. A466 to M42(S) direct on-slip
4. A4097 Kingsbury Road eastbound approach to M42 junction 9 additional capacity and revised lanes (see also item 7).
5. M42(N) to A4097 westbound direct off-slip.
6. Curdworth Lane / A4097 junction improvements - signals?
6. Curdworth area amenity scheme.
7. Replace M6 toll slip roundabout with on-demand signals for M42 junction 9 to M6 Toll on-slip movement. (may combine with item 4 or replace it).
8. Signal and lane allocation optimisation on M42 junction 9 circulatory.

Distribution

Name/ Signed Lána Pennycook / Lee White