Technical Note TN12028.2
Issue 1.2

Upper Gungate
Staffordshire

21st February 2013

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Technical Note 12028.2
Issue 1.2: Answer outstanding comments from 1.1

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Previous Revisions
TN12028.2 Issue 1.0 Draft
TN12028.2 Issue 1.1 23/01/13

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0.0 Executive Summary

High quality traffic data and on street observations have enabled the construction of a LinSig model of the Upper Gungate network which the modellers believe to be representative. Examination of the model and street observations established that there are key elements along the corridor which contribute to delay and congestion. The delay and congestion is at its peak in the AM. Contributors to the delay and congestion include:

- The school crossing patrol outside Landau Forte Academy
- Northbound blocking by vehicles waiting to turn right into Landau Forte and from Upper Gungate into Croft Street
- Delays at the Upper Gungate/ Salters Lane/Offadrive junction
- Delays at the Aldergate/Lichfield St junction

Initial work identified that there is little scope for major junction improvements due to local constraints but that improvements to the junctions and the wider network (and its operation) can be made which would initially improve the existing situation and provide some extra. capacity for development traffic. The improvements were exhaustively modelled and tested in a proposed network model.

Using household trip rates and distributions supplied by Staffordshire JCT incrementally tested the addition of development houses to the north of the corridor and extracted performance data consisting of Practical Reserve Capacity, Average Delay and key Journey Times. Data were plotted on charts and comparisons with data from the existing network made. The results are discussed in detail in the report but may sensibly allow the following to be concluded:

1) In terms of Practical Reserve Capacity in the most critical AM peak with the suggested improvements it should be possible to accommodate trips from up to an additional 400 houses before the network PRC degrades to that which exists at present.

2) In terms of Average Delay the AM peak could handle the trips from an additional 500 houses and the PM from an additional 300 houses before average journey times match those which exist at present.

3) In terms of Journey Time this is more difficult to pin down but where journey times do correspond between the proposed and existing models they typically correspond around the 400 to 500 house range.

In respect of explaining individual plots there is scope for interpretation and it is impossible to be absolute in arriving at an exact recommended figure for development. But the supply of charts should allow an informed view to be taken with respect to any given proposal and it is likely that if the terms of the brief are retained (i.e. a level of development which delivers an equivalence of performance to the existing) it is likely that permitted development will be between 300 and 500 houses before the AVLR is deemed necessary.

1.0 Introduction

The Upper Gungate/Aldergate Corridor consists of sections of the A513 and B5493 from the Ashby Road/Comberford Road/Upper Gungate junction (Fountains junction) to the Lichfield Street/Silver Street/Church Street/Aldergate junction in Tamworth, Staffordshire.

Tamworth Borough Council has identified the Anker Valley in the north of Tamworth as a potential sustainable urban extension site to accommodate between 1150 and 1400 new homes. A further 1,000 new homes will be required outside the borough boundary and 500 of these, alongside 500 for Lichfield's needs will be provided in a broad location to the north of Tamworth, within Lichfield District.

There are four traffic signal controlled junctions along this corridor and it currently experiences traffic congestion and delay issues, particularly during the morning peak hour. There is also a traffic signal controlled pedestrian crossing on Aldergate just south of its junction with St. John Street and at school times pedestrian crossing patrols are in operation in the vicinity of Fountains Junction.

Tamworth Borough Council expects that the development of a sustainable urban extension on the Anker Valley site will require the construction of the Anker Valley Link Road (AVLR) to alleviate pressure on the Upper Gungate / Aldergate corridor. Additional development located to the north of Tamworth could assist in financing new highway capacity. The impact of development traffic and the point at which the AVLR is required needs to be established to demonstrate the case for the link and to inform development phasing.

JCT Consultancy has been tasked with:

i) Producing calibrated and validated LinSig models that reproduce existing travelling conditions along this corridor at the times of peak demand.

ii) Identifying improvements to maximise the capacity of this corridor at peak times allowing a quantity of development to be delivered whilst still giving an acceptable level of service to all road users.

ii) Testing the model of an improved corridor to establish what level of extra traffic can be accommodated whilst maintaining an acceptable level of service.

JCT worked closely with Staffordshire engineers in developing a brief to these ends.

Whilst formulating the brief it was agreed that JCT should limit its outputs to a series of technical notes which tightly focus on identification of the problems, provide evidence based proposals for improvements and make practical recommendations. This technical note is the second and final of these outputs and will be initially issued in draft format for discussion with Staffordshire engineers. It will refer to Technical Note 1 : **TN120028.1** which is contained in its entirety in Appendix A .

For clarity, the purpose of technical note **TN120028.1** was to:

a) Clarify the brief
b) Describe the survey process
c) Outline the methodology
d) Describe the findings of both the initial modelling and site visits
e) Outline initial proposals for improvements

The purpose of this Technical Note 2: **TN12004.2** is to

f) Combine the individual LinSig models into a LinSig network model
g) Test the proposed improvements from Technical Note 1
h) Develop any further improvements which come out of the network modelling
i) Establish what level of additional flow can be accommodated in peak periods with an acceptable level of service to road users and pedestrians.

The costing of improvement proposals are beyond the scope of this commission and will be undertaken by others.

2.0 Brief

The full (and agreed) brief is contained in full in Technical Note 1 which can be found in **Appendix A** but is summarised below:

(i) JCT will conduct a traffic model based study to quantify the extent of existing problems.

(ii) JCT (with the cooperation of Staffordshire engineers) will use the traffic model and site based observations and measurements to devise measures to tackle existing congestion and build additional capacity into the corridor. JCT will test the new corridor model to the point of breakdown and will use this evidence to inform the decision process with respect to the development aspirations and the trigger point for the new Anker Valley Link Road.

(iii) JCTs outputs will include:

- LinSig3 models
- Technical notes with commentary on modelling assumptions, key results, limitations, and recommendations
- Geometric layout sketches
- LinSig3 Reports which contain Network Layout diagrams summarising key performance data
- Summaries of discussions with Staffordshire engineers and colleagues as appropriate.

3.0 Information Used

Staffordshire provided the following information:

3.1 Ordinance Survey plans showing the highway footprints for for all signal junctions on the corridor.

3.2 Controller specifications for all the signalled intersections on the corridor.

3.3 A proposal for an improvement to the existing Fountains Junction (Ashby Road/Comberford Road/Upper Gungate).

3.4 Commentary on the operation of the existing network at meetings both in the JCT offices (Lincoln) and on site.

3.5 Link travel time and delay data for the corridor.

In addition to the information provided by Staffordshire JCT proposed and coordinated the collection of:

3.6 Site survey data including junction turning counts and queue surveys.

3.7 Video recordings.

3.8 Photographs.

3.9 Site observations.

3.10 Journey times and other associated site based timings (as recorded on site visits).

3.11 Testimonials from Staffordshire engineers.

4.0 Survey Data & Processing

4.1 JCT commissioned survey data be collected as indicated in **Figure 1**.

Figure 1 – Survey data

Surveys were undertaken by "Signal Surveys" on Thursday 20th September 2012 and Saturday the 22nd September 2012 and results provided in spreadsheet format.

4.2 All traffic counts were processed to PCU, and peak hours identified for each junction. The process revealed that different peak times exist for each junction (as would be expected). It was therefore decided that a generic peak period for the entire network would be identified and used in all models, the following peak hours were identified:

- Mid week AM Peak : 08:00 – 09:00
- Mid week School PM Peak : 16:00 – 17:00
- Mid week PM Peak : 17:00 – 18:00
- Saturday Peak : 11:45 – 12:45

4.3 Additional data were available as a consequence of the survey collection process in the form of video images at all junctions, queue surveys at the signal junctions and data collected on the first site visit conducted on Thursday 18th October. These were used to validate the models.

5.0 Development Aspirations and Potential Impact on the Corridor

5.1 As stated in the introduction : Tamworth Borough Council has identified the Anker Valley in the north of Tamworth as a potential sustainable urban extension site to accommodate between 1150 and 1400 new homes. A further 1,000 new homes will be required outside the borough boundary and 500 of these, alongside 500 for Lichfield's needs will be provided in a broad location to the north of Tamworth, within Lichfield District. Tamworth Borough Council expects that the development of a sustainable urban extension on the Anker Valley site will require the construction of the Anker Valley Link Road (AVLR) to alleviate pressure on the Upper Gungate/Aldergate corridor. Additional development located to the north of Tamworth could assist in financing new highway capacity. The impact of development traffic and the point at which the AVLR is required needs to be established to demonstrate the case for the link and to inform development phasing.

5.2 No development flows were provided by Staffordshire but household trip rates and likely distributions for the AM and PM Peak periods were provided. Staffordshire required the network model to be tested to establish what level of additional flow it can sustain (with improvements) before congestion and journey times reach a point equivalent to that currently experienced at peak times.

6.0 Base Modelling

6.1 Strategy

The base (and all subsequent network) modelling was undertaken using LinSig3 for the signalled intersections. As described in Technical Note 1 Individual LinSig models were constructed for all the signalled junctions on the corridor prior to visiting site. The purpose of this was to direct engineers to potential problems and give a base case for on-site validation and subsequent alterations to the base modelling. The full process is described in Technical Note 1.

The following file was created to represent the existing network:

- *Gungate Network Existing.lsg3x*

LinSig Network Layout views summarising key results are contained in Appendix B

Although a signal controlled pedestrian crossing is located on Aldergate, just south of St. John Street, it was not observed as having a noticeable impact to traffic capacity. Therefore, this was not included in any of the modelling.

6.2 Estimating a matrix

The individual LinSig models were combined into a LinSig network model and a matrix estimated based on individual turning counts. The matrix estimation process in LinSig3 takes an initial estimated origin-destination matrix (the prior matrix) as a starting point and uses traffic count data to update this matrix so that when it is assigned to the model network it more accurately reproduces the traffic counts. In all but the simplest networks it is not possible to exactly reproduce traffic counts and an acceptably close fit between the modelled flows and the observed traffic counts is the objective. In most cases a large number of possible matrices could all reproduce the traffic counts. LinSig3 therefore estimates the mathematically most likely matrix based on the information it has.

The counts for all junctions were undertaken on the same day and showed a good level of correspondence between junctions but it was necessary to undertake some minor balancing to reflect the traffic leaving or joining the network at minor sinks and sources. Only two significant sources / sinks were identified. These being:

1) A minor sink between The Upper Gungate/Offadrive and Aldergate/Hospital Street junctions. Site visits suggest that this must be due to vehicles accessing the filling station and car park. Although vehicles may both enter and leave the network at this point there is an additional exit onto Offadrive (which is outside the modelled network) and the net effect is a loss of vehicles to the network in all modelled periods. To allow for this loss an additional exit arm and internal zone were added.

2) A sink / source between the Upper Gungate/Croft Street and Upper Gungate/School access junctions. Site observations suggest that these are likely to be the result of access / egress from a nursing home, tennis courts and residential driveways. The net numbers are small and were accounted for by the introduction of two internal zones which were coded to supply and receive the net differences only.

The LinSig matrix estimation facility was used to estimate matrices for the four modelled periods and the quality of the matrix established by examining the GEH statistics for the four modelled peaks these were:

- 2.0 for the AM Peak
- 0.7 for the School PM Peak
- 0.7 for the PM Peak
- 0.8 for the Saturday Peak

The reported GEH of 2.0 for the AM Peak is an aberration and relates to an absolute difference of 2 PCU/hr on Corporation Street. The next highest GEH for this peak period is 0.3. The reported GEH statistics are small over all Peaks and show a much better fit than is usually required for larger strategic models where a GEH statistic of 5 is often used as a limit of acceptable fit.

6.3 Selection of cycle times and green splits

All signalled junctions on the existing network work in Vehicle Actuated (VA) mode. Exhaustive examination of DVDs was undertaken to establish true cycle times and VA Phase maximums, these were coded into the LinSig models and the LinSig optimiser used to establish Green Splits.

In respect of the Aldergate/Lichfield Street junction two of the arms (Church Street and Silver Street) are very lightly trafficked and their respective stages appear infrequently in some peaks. In addition the Pedestrian stage is demand dependant and does not appear in every cycle. As such extensive observations of the DVDs were made and stage sequences devised for each modelled period. The junction was then “Double Cycled” to allow the replication of this demand dependency.

7.0 Proposed Modelling

7.1 Strategy

As described in Technical Note 1 the existing junctions were examined and where possible improvements proposed. In addition it was proposed in Technical Note 1 that the existing school crossing patrol outside the Landau Forte Academy be replaced with a signalised crossing. Further work was undertaken after the release of Technical Note 1 to incorporate additional suggestions made by Staffordshire engineers and to incorporate further improvements devised by JCT engineers. The base network was then modified to incorporate the improved junctions and additions. Due to a relatively large number of flow scenarios, separate LinSig models were produced for each peak period, which were:

- *Gungate Network Proposed – With AM Development Traffic.lsg3x*
- *Gungate Network Proposed – With School PM Development Traffic.lsg3x*
- *Gungate Network Proposed – With PM Development Traffic.lsg3x*
- *Gungate Network Proposed – With Sat Development Traffic.lsg3x*

LinSig Network Layout views summarising key results are contained in Appendix B

The improvements to the junctions are described in the following paragraphs.

7.2 Improvements to junctions

7.2.1 Improvements to Ashby Road / Comberford Road (Fountains junction)

The major issue at the Fountains junction is the blocking associated with the school crossing patrol in the AM Peak. As described in Technical Note 1 JCT engineers recommend the replacement of the school crossing patrol with a remote pedestrian facility closely linked to the existing junction. Staffordshire engineers tabled an earlier proposal which involved incorporating signalled pedestrian facilities into the existing junction. It was however thought that the facilities may be too far off the existing (and established) desire line and that the nature of the existing pedestrians (risk takers) would result in poor utilisation of the facilities. In their tabled proposal Staffordshire engineers also included kerb realignment and white lining to introduce a right turn flare for south bound vehicles on the B5493 Ashby Road. Site observations showed that the existing junction is vulnerable to right turn blocking but at present (due to relatively low right turn flows) this is infrequent. Given however that the development aspirations may increase this right turn flow and increase the likelihood of blocking it was deemed sensible to retain this element. A concept sketch by JCT showing the inclusion of a right turn flare and remote pedestrian facility was produced “Upper Gungate Concept/01” which is contained in Appendix C. It should be noted that in respect of the remote pedestrian facility JCT engineers undertook site measurements to establish that it can be safely accommodated. A LinSig model incorporating the changes was produced and used in the “Proposed” network.

The inclusion of the pedestrian facility required a third signal stage. Stages 1 and 2 run the main road (Upper Gungate and Ashby Road) and side road (Comberford Road) respectively. Stage 3 runs the pedestrian crossing, while the northbound traffic at the junction receives a green signal. A phase delay was included from Stage 2 to 3 to provide a suitable clearout period for southbound traffic. The three stage sequence is assumed to run during the AM and School PM peak periods, when pedestrian demand is high. The pedestrian stage does not run in the model during the PM and Saturday peak periods, as demand is likely to be low. The cycle time was restricted to 70 seconds to keep pedestrian waiting times within acceptable limits.

7.2.2 Improvements to Upper Gungate / Croft Street

As summarised in Technical Note 1 there is an issue with occasional blocking of north bound vehicles by vehicles waiting to turn right into Croft Street. Google Earth suggests that a small right turn bay used to exist at this junction but it was sub-standard size and has been removed (although a 1.5m wide hatched area remains). JCT conducted site measurements which suggest that with some minor kerb realignment a right turn bay of approximately 2.5m wide could be re-introduced, this would require approximately 1.0m width of footway to be converted to carriageway. Measurements were taken during the site visits showing that this could be achieved without reducing existing footway widths to less than 2.0m which is usually considered an acceptable width. A schematic cross section is shown below in figure 1a:

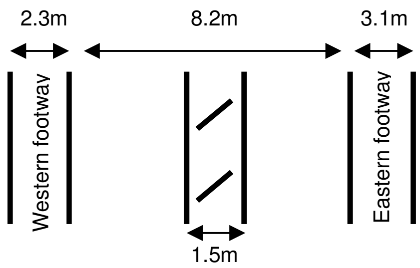

Figure 1a schematic cross section of Upper Gungate adjacent Croft Street

A drawing showing this “Upper Gungate / Croft Street Concept/02” was produced and is contained in Appendix C. A LinSig model incorporating this right turn bay was produced and used in the “Proposed” network.

7.2.3 Improvements to Upper Gungate / Salters Lane / Offadrive junction

As summarised in Technical Note 1 the existing junction generally performs well but its footprint is tightly constrained by the railway bridge giving little or no scope for physical changes. Due to the existing flows the junction does operate close to capacity in the AM Peak and due to the “Peaky” nature of flows queues do sometimes propagate. This queuing was observed on site visits. The junction currently operates in VA mode but provision has been made to operate it under SCOOT control. JCT undertook extensive works to examine alternative control strategies including:

i) Reducing the existing three stage arrangement to two stages and controlling in a more conventional manner (main roads stage one with a clear out of internal reservoirs followed by side roads running into empty reservoirs and stopping before being released by stage 1) see Figure 2

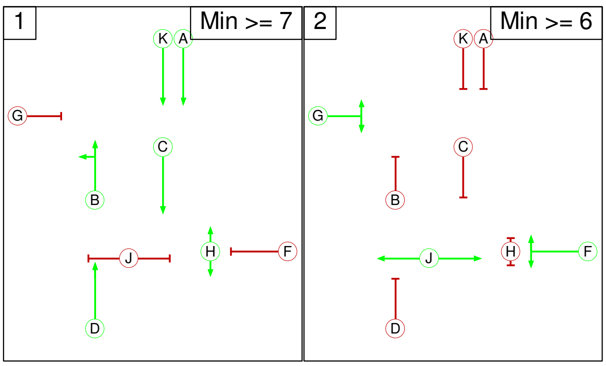

Figure 2 Two stage arrangement for Upper Gungate / Salters Road / Offadrive

ii) Splitting the Upper Gungate Salters Lane and Upper Gungate Offdrive elements into separate streams

Neither strategy proved satisfactory:

The rationalisation to two stages required significant lost time to be introduced in order to keep the reservoirs clear and prevent blocking by the side roads.

The splitting into separate streams did give additional flexibility for the tidal nature of the flows but would mean presenting drivers with what would appear to be a changing sequence over the day and may result in poor compliance with red signals and introduce safety issues.

Finally a “raw” design exercise was undertaken and a stage and phase control strategy devised from first principles in LinSig. The result was a near identical phase and stage sequence to that currently operating. This was taken as validation that the existing design is in all likelihood the optimum for the given footprint. Importantly however the design exercise did produce different phase delays from those currently operating and these did appear to produce a design less vulnerable to internal blocking.

The existing stage sequence starts the green of southbound Phases K and C at the same time. However there is a run out from the side road (Phase D) which means that the internal reservoir (phase C) is empty which in turn means that phase K could start earlier than phase C. The proposed model starts Phase K five seconds before Phase C, which gets the southbound traffic moving earlier and southbound traffic should receive a green signal at the subsequent stop line (phase C) just as it approaches.

7.2.4 Improvements to the Aldergate / Hospital Street Junction

As summarised in Technical Note 1 the existing junction generally performs well. Both the base LinSig modelling and site observations suggest that the junction works well within capacity across all peaks. There are a significant number of pedestrian phases on the junction and these all run in a pedestrian only stage, this coupled with some long intergreens means that there is a significant amount of lost time in the sequence but there is little scope for reducing this. As such no improvements were suggested for this junction (other than SCOOT and cycle time changes – to be discussed elsewhere) so the LinSig model of the existing junction was incorporated into the “Proposed” network.

7.2.5 Improvements to the Aldergate / Lichfield Street Junction

As summarised in Technical Note 1 the junction currently has the flexibility to run five stages with each of the four arms and the pedestrian facility appearing in its own stage. The junction operates in VA mode which means that some stages can be skipped when there is no demand. The main traffic flows are from Aldergate to Lichfield Street and vice versa. Investigations undertaken as part of Technical Note 1 showed that if the Aldergate and Lichfield Street phases could run in the same stage the performance of the junction can be significantly improved. Site observations did show however that if such a strategy were to be employed within the current footprint there is a danger of large vehicles (predominantly buses) turning from Lichfield Street into Aldergate coming into conflict with vehicles leaving Aldergate (this is due to the tight radii and swept paths). Discussions with Staffordshire engineers also revealed that the junction used to operate this strategy and that this was a recognised issue. JCT engineers did however undertake site measurements which suggest that the installation of a hatched section (and a right turn bay) could minimise this phenomena and that further, if some minor kerb realignment could be undertaken, the risk of conflict could be further reduced or eliminated. Two sketches were produced “Aldergate / Lichfield Street Concept/03 Do Minimum” and “Aldergate / Lichfield Street Concept/04 Ideal Layout”, both are contained in Appendix C. If the “Ideal Layout” were to be adopted

(Concept/04) it would be necessary to convert a small amount of footway to carriageway (as illustrated). There is generous footway width in this area apart from a pinch point as shown in Google street view image Figure 2a

Figure 2a Pinch point at Aldergate

The drawing produced takes account of this pinch point and does not compromise pedestrian width further.

Note: swept path analysis has not been undertaken on either sketch at this stage. Assuming that such a control strategy could be employed a LinSig model was produced utilising this and incorporated into the "Proposed" network.

7.3 Production of a proposed network

The base network was modified to incorporate the changes to junction design and control strategies as discussed.

7.3.1 Matrix used

The base Origin Destination Matrices were copied from the base model and pasted into the new Proposed network models

7.3.2 Selection of cycle times and signal timings in the proposed model

As discussed in Technical Note 1 Staffordshire engineers have undertaken preparation work to incorporate SCOOT control onto some of the junctions in the network. Being in close proximity, the obvious candidates for this are the Aldergate/Hospital Street and Upper Gungate/Salters Lane/Offadrive junctions. The other two signal controlled junctions are probably too far removed to consider for inclusion in a SCOOT region. Localised testing of the improved Upper Gungate/Salters Lane/Offadrive junction also showed by adopting a relatively short cycle time internal queuing is minimised and further that the Aldergate/Hospital Street junction can perform adequately at a lower cycle time than that which currently prevails. As such the Proposed network was initially coded with the Upper Gungate/Salters Lane/Offadrive and Aldergate/Hospital Street junctions on a common cycle time of 60 seconds in all peak periods except the PM peak, in which a cycle time of 70 seconds was implemented. The facility within LinSig to incorporate different cycle times within a network was utilised to allow the other two remaining junctions to run at different (and more optimal) cycle times. The effect of this on the network model is to allow LinSig determine the optimal offset between junctions on a common cycle time and to assume random arrival patterns of traffic to and from junctions with different cycle times.

In order to select signal timings (stage change points) the LinSig optimiser was used. In a similar manner to SCOOT LinSig calculates Splits and Offsets at individual junctions to balance and minimise Degrees of Saturation (DOS) and maximise the Practical Reserve Capacity (PRC) for individual junctions and the network. The LinSig model suggests average timings for the modelled period (usually one hour) so it does not replicate exactly what SCOOT will deliver (as SCOOT adapts every cycle) but LinSig should give a reasonable estimate of likely performance over the modelled period. The LinSig signal timings will often be used to inform the setting of SCOOT base plans.

8.0 Testing of the Proposed Network with Development Flows

8.1 The brief required the testing of the proposed network to establish what additional level of flow the network can accommodate until its performance falls below acceptable levels (the initial acceptable level being that of the existing network under prevailing conditions). A simple methodology was adopted to establish this and is described in the following paragraphs.

8.2 **Adding development traffic to the base matrix**

Staffordshire asked JCT to test the network assuming that all development flow will access and egress via Ashby Road (LinSig model zone A). Staffordshire provided JCT with distribution patterns and Household Trip Rates for the AM, School PM and PM peak hours only. To enable the underlying base distribution patterns and the development distribution patterns to be modelled in parallel additional zones were added to the AM, School PM and PM Peak models. The Saturday model assumes that development traffic distributes in the same proportions as the base traffic

Component and formula flow groups were used in LinSig to establish new matrices which incrementally added trips associated with new households.

The supplied distribution of additional development trips indicated a small percentage of the southbound traffic turning right into Salters Lane. Since this right-turn is not permitted, it was decided that traffic intending to reach this area would instead either turn right into Comberford Road or turn right into Hospital Street, and so that small percentage was split between these two alternatives.

As trip rates were provided, results were displayed as “Number of Houses” when testing development traffic on the network. The additional traffic was presented as a percentage of the existing traffic volume entering and leaving the network at Zone A for the Saturday Peak.

8.3 **Testing**

New scenarios were created to reflect the incremental steps of household addition and in each scenario the network was re optimised. Key performance indicators were extracted at each scenario and recorded, these were:

1) Worst Practical Reserve Capacity (signalled junctions)
2) Average Network Delay
3) Journey Time

The collection of these data allowed a series of graphs to be plotted which show the sensitivity of the network to an increase in households, these are shown in paragraphs 9.

Due to there being a number of key routes through the network, the following journey times were plotted:

Zone A – M: Ashby Rd – Lichfield Rd (Southbound)
Zone M – A: Lichfield Rd – Ashby Rd (Northbound)
Zone A – K: Ashby Rd – Offadrive (Southbound)
Zone K – A: Offadrive – Ashby Rd (Northbound)

9.0 Results & Commentary

9.1 Impact on network Practical Reserve Capacity (PRC)

The degree of saturation of a lane is the ratio of flow / capacity expressed as a percentage. A lane is considered to be over-capacity once the degree of saturation exceeds 90%.The network PRC is based on the worst degree of saturation within the network. A value of 0% would mean the highest degree of saturation is 90%, a positive value means all degrees of saturation are below 90%, while a negative value means at least one degree of saturation is over 90%. The value itself indicates by what percentage the critical traffic flows in the network would need to be scaled to make the worst degree of saturation equal 90%.

Note: PRC is heavily dependent on cycle time, with higher cycle times often producing improved PRC values.

Figure 3 shows the impact on the Network PRC (red line) as development traffic is added to the network with the PRC of the existing network shown by the blue line (for reference)

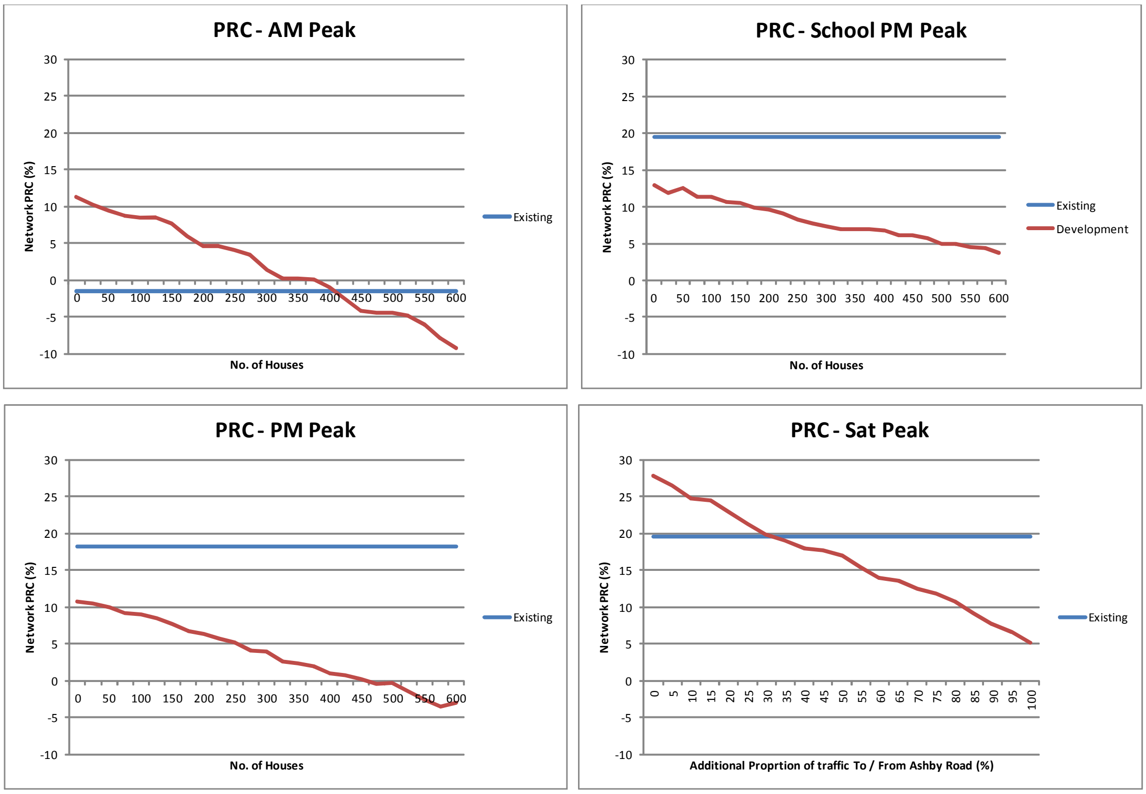

Figure 3 Development Impact on Network PRC

The existing network PRC is most critical during the AM peak (-1.5%), caused by the restricted capacity at the Ashby Road/Comberford Road due to southbound exit blocking. The proposed network will operate within this PRC assuming a development of up to 400 houses. This assumes that the cycle time at the Ashby Road/Comberford Road junction does not exceed 70 seconds. A higher cycle time would improve the PRC in the proposed network further.

The proposed network PRC is predicted to be lower for any number of houses than the existing network PRC for the School PM and PM peak periods. This is because the proposed network assumes much shorter cycle times. Increasing the cycle times in the proposed network to similar values assumed in the existing network would result in significant increases in PRC. This would also be true for the Saturday peak.

9.2 Impact on Average Delays per Passenger Car Unit (pcu)

Due to the sensitivity of the relationship between PRC and cycle time, it is likely that other model outputs would be more useful in comparing the existing and proposed networks.

Figure 4 shows the impact on the average delay per pcu travelling in the network as development traffic is increased.

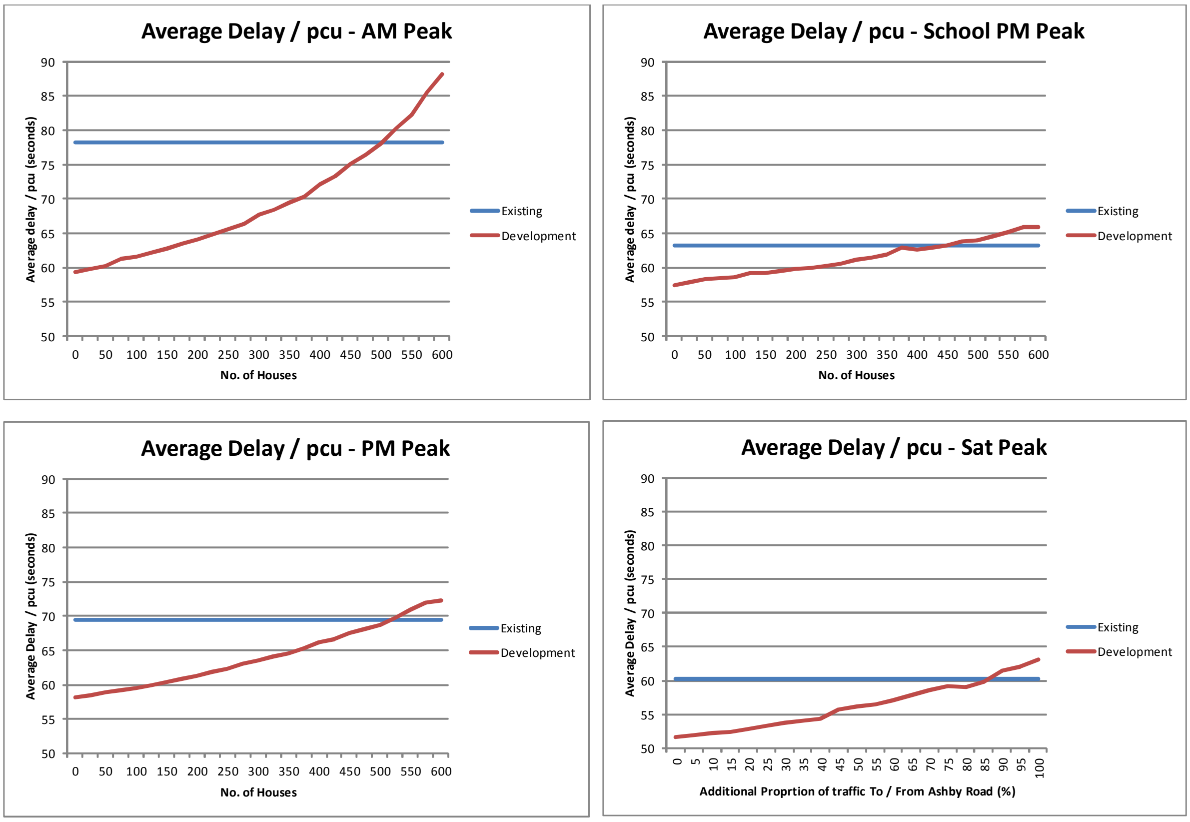

Figure 4 Development Impact on Average Delay per pcu

Perhaps the most critical result is that the proposed network shows the same average delay per pcu, 63.2 seconds, as the existing network in the School PM peak period once 450 houses are added to the development.

We may however consider that the highest average delay per pcu in the existing network is 78.2 seconds, experienced during the AM peak period. This is matched in the proposed network once 500 houses are added to the development. At this stage, the School PM peak period has a predicted average delay of 68.6 seconds, only 5.4 seconds longer than the existing network during this period.

On a Saturday, the existing network was predicted as having an average delay of 60.2 seconds. The average delay in the proposed network is below 60.2 seconds until the volume of traffic to/from Ashby Road increases by 85% of the current volume. This would equate to an additional 256 PCU from the development onto the network and 218 PCU from the network onto the development.

9.3 Impact on Average Journey Time between Ashby Rd – Lichfield Rd

The graphs in Figure 5 show the impact of the development on average southbound journey times between Zone A (Ashby Road) and Zone M (Lichfield Road).

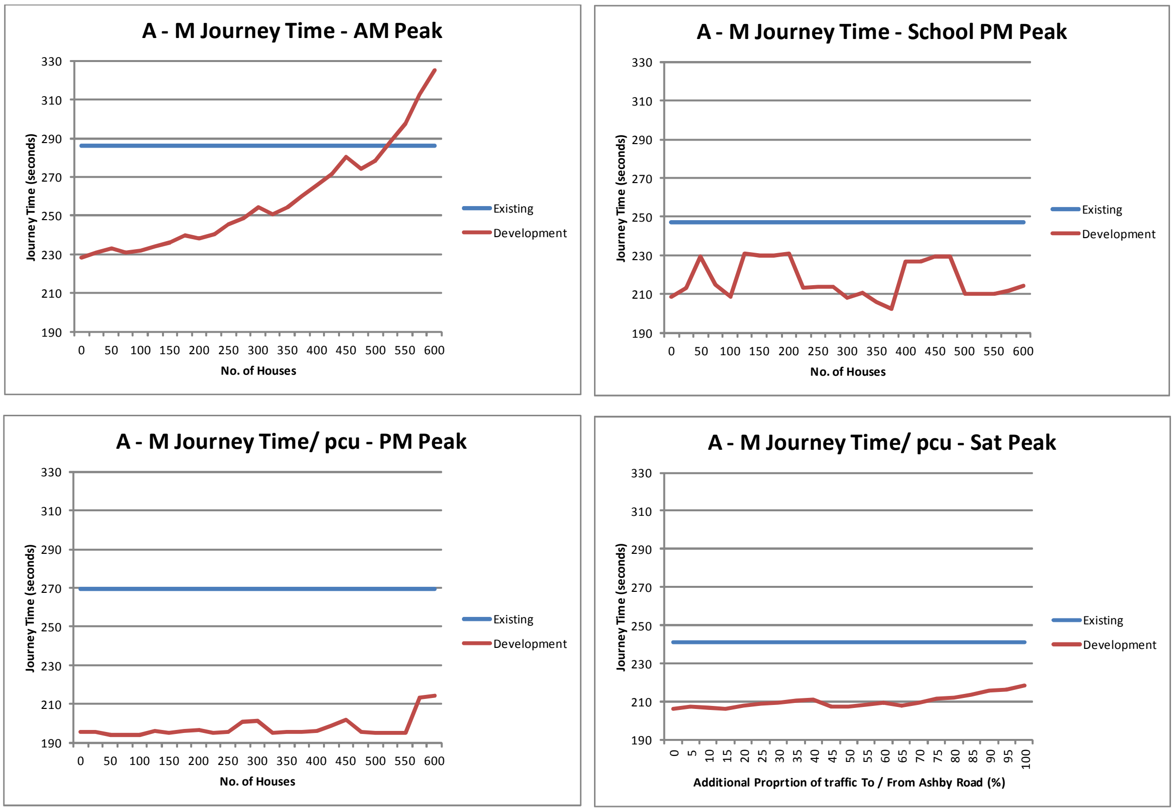

Figure 5 Development Impact on Zone A – M Journey Time (Southbound)

The average A – M journey time for the existing network in the AM peak period is 286.2 seconds. With a development of 500 houses, the proposed network has a predicted journey time of 278.1 seconds, and this increases to 288.4 seconds with 525 houses.

There is little increase in average journey times during the PM and School PM peak periods as development traffic increases. During these periods, the majority of development traffic is travelling northbound and LinSig has the opportunity to optimise the signals to provide more green to northbound traffic. As northbound and southbound traffic run together in all signal stages, then southbound movements also get more green time and so average journey times show little increase in that direction.

9.4 Impact on Average Journey Time between Lichfield Rd – Ashby Rd

The graphs in Figure 6 show the impact of the development on average northbound journey times between Zone M (Lichfield Road) and Zone A (Ashby Road).

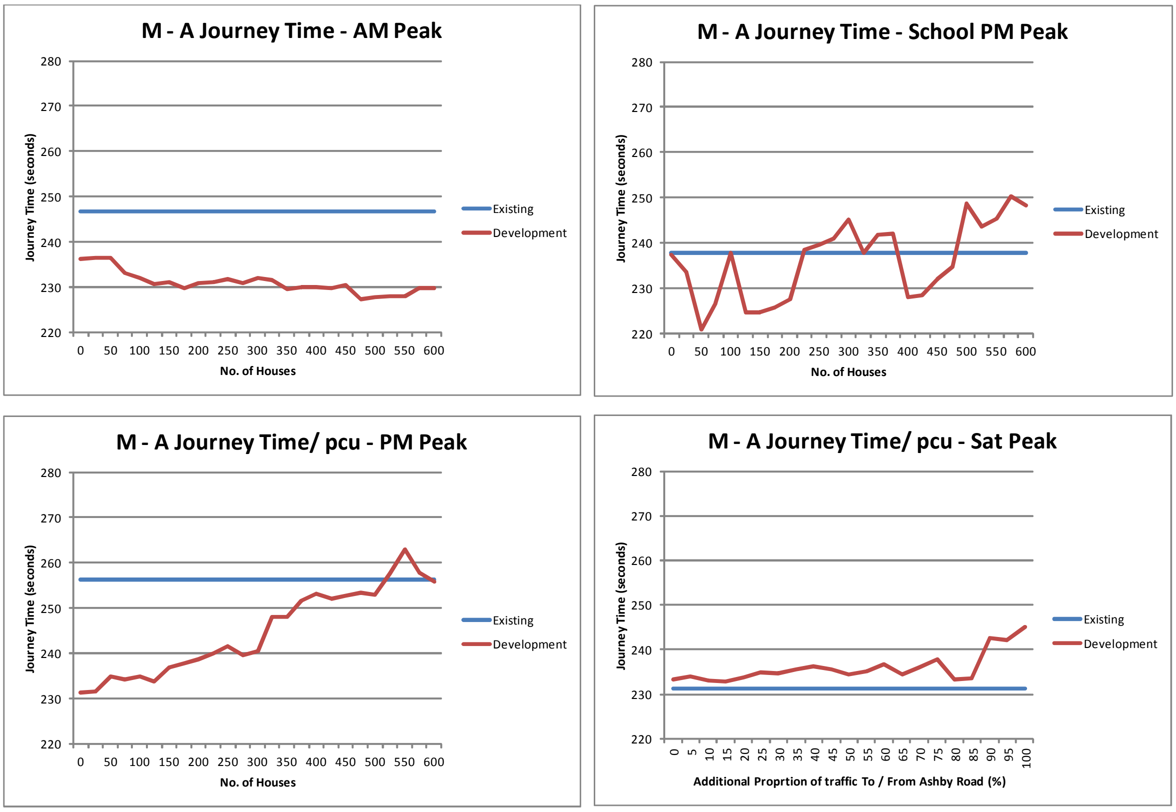

Figure 6 Development Impact on Zone M – A Journey Time (Northbound)

If we examine the most critical School PM Peak graph we can see that the existing network model predicts a zone M to A journey time of 237.9 seconds. The M to A plot of journey time for the proposed network first exceeds this when 100 houses are added, then again at around 225 houses before dropping again at 400 houses. The journey time predictions for this particular zone to zone movement in this particular peak are upward in trend but somewhat unstable making it difficult to select anything other than a range of between 100 and 400 houses causing similar journey times. It should be noted however that the proposed network includes delays caused by the proposed signal crossing at Ashby Road/ Comberford Road running every cycle. Further the existing network takes no account of northbound delays created by the school crossing patrol, and therefore the baseline delay on the existing network is likely to be higher than predicted by the model.

There is little increase in average journey times during the AM peak period as development traffic increases. During this period, the majority of development traffic is travelling southbound and LinSig has optimised the signal timings to provide more green to southbound traffic. As northbound and southbound traffic run together in all signal stages, then northbound movements also get more green time and so average journey times show little increase in that direction.

The results show that the average northbound journey time is slightly higher for all development scenarios than the existing situation during the Saturday peak period. This is a result of shorter cycle times being used at both Offadrive and Hospital Street junctions in the proposed network (used to minimise queues and improve capacity for other critical traffic movements).

9.5 Impact on Average Journey Time between Ashby Rd – Offadrive

The graphs in Figure 7 show the impact of the development on average southbound journey times between Zone A (Ashby Road) and Zone K (Offadrive).

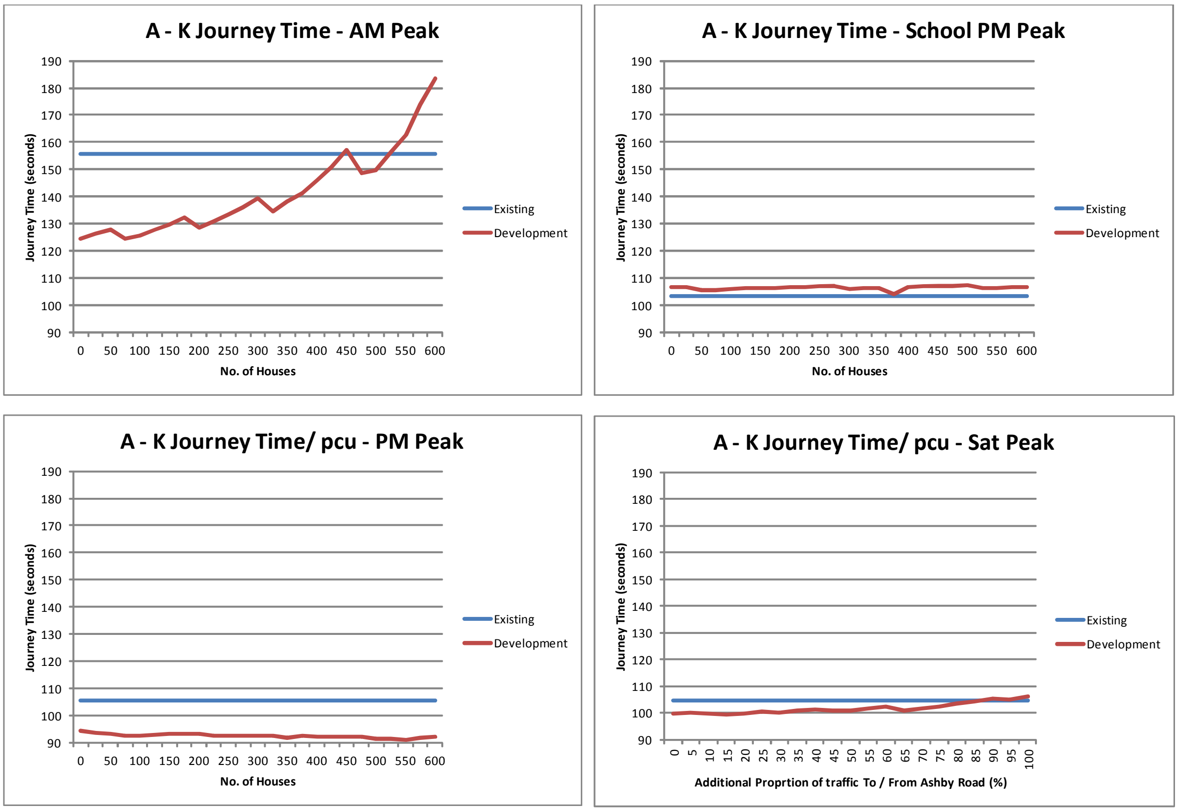

Figure 7 Development Impact on Zone A – K Journey Time (Southbound)

The results show that the A – K journey time is marginally higher at all levels of development during the School PM peak than the existing network. An explanation for this is that the proposed network assumes the pedestrian crossing stage at the Ashby Road / Comberford Road junction is called every cycle. This is unlikely to be the case in reality, and therefore the proposed model provides a robust assessment, and predicted average journey times are likely to be less.

The A – K journey time is predicted as 155.7 seconds in the existing network during the AM peak period. The proposed network broadly remains within this until 500 houses are added to the development.

The A – K journey time is predicted as 104.8 seconds in the existing network during the Saturday peak period. The proposed network broadly remains within this until development flows to/from Ashby Road are 85% higher than current volumes.

The PM peak period has smaller A – K journey times for all development scenarios in the proposed network.

9.6 Impact on Average Journey Time between Offadrive – Ashby Rd

The graphs in Figure 8 show the impact of the development on average northbound journey times between Zone K (Offadrive) and Zone A (Ashby Road).

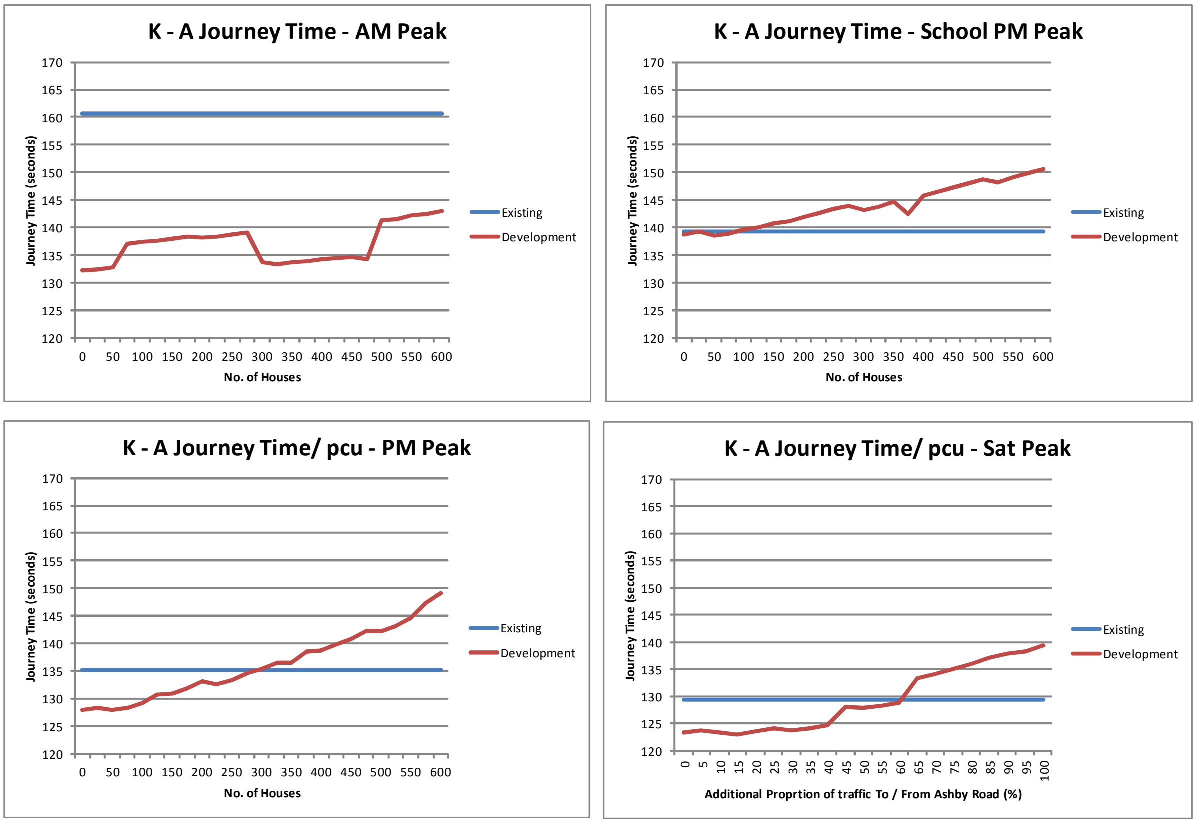

Figure 8 Development Impact on Zone K – A Journey Time (Northbound)

The results show the K – A journey time increases beyond that experienced in the existing network, as development in added during the School PM peak. However, the proposed network assumed the proposed pedestrian stage at the Ashby Rd/Comberford Rd junction is called every cycle, thus increasing the delay of northbound traffic. Furthermore, the model of the existing network does not include delay created by the school crossing patrol. Therefore, the existing delay to northbound traffic is likely to be a little higher than predicted by the model, while the results for the proposed network provide robust predictions.

9.7 *Detailed Modelling Results*

Network Layout Diagrams for all modelled scenarios are contained in Appendix 2, which include assumed junction cycle times, degrees of saturation, mean maximum queues and PRC's.

For ease of reference, the order in which the modelled scenarios appear are:

- Existing Model
- Proposed Model – AM Peak
- Proposed Model – School PM Peak
- Proposed Model – PM Peak
- Proposed Model – Saturday Peak

10.0 Conclusions and Recommendations

10.1 A major issue during the AM peak period is the significant build up of queues on Ashby Road and Comberford Road, in the southbound direction. These are caused by exit blocking, a significant contribution to this exit blocking is made by the school crossing patrol just south of the junction. This problem may be mitigated by providing a signalled pedestrian crossing just south of the junction, operating within the same stage stream as the junction. This will provide timings that ensure southbound traffic does not block back from the pedestrian crossing. Another advantage of this is that it provides pedestrian facilities during all times of the day, rather than solely during the school peak periods.

10.2 The right-turn from Upper Gungate into Croft Street (college access) frequently blocks northbound traffic, and at times results in long queues blocking back into the Salters Lane/Offadrive junction. With some minor kerb realignment a right-turn flare bay could be provided, helping to alleviate this problem.

10.3 Adjusting some phase delays at the Salters lane / Offadrive junction, along with an average cycle time of about 60 seconds in the AM peak period, will assist in the reduction of southbound queues.

10.4 Implementing SCOOT at the Salters Lane/Offadrive and Hospital Street/Lower Gungate/Albert Road junctions, on the Upper Gungate corridor, should help improve the co-ordination and efficiency of the junctions.

10.5 Providing a junction layout, at the Aldergate/Lichfield Street junction, that enables traffic on Lichfield Street and Aldergate to run together in the same stage, would significantly improve capacity.

10.6 A number of network output parameters were plotted to demonstrate how increasing levels of development impacted on the proposed network, in comparison with the existing network with no development. These were:

(i) Practical Reserve Capacity (PRC)

The PRC of the proposed network reaches the same level as the existing network during the AM peak period (most critical) once the development contains about 400 houses. However, the proposed network generally runs lower cycle times than the existing, with the aim of improving delays to pedestrians and traffic.

(ii) Average delay per pcu

The highest delays in the existing network are experienced during the AM peak period, approximately 78 seconds per pcu. A similar level of delay occurs on the proposed network once the development contains about 500 houses.

(iii) Southbound Average Journey Times

Southbound journey times steadily increase during the AM peak period as development increases. This journey time is predicted as being similar to that experienced in the existing network once the development contains about 500 houses.

(iv) Northbound Average Journey Times

Northbound journey times steadily increase during the PM and School PM peak periods as development increases. Journey times reflect those in the existing network once the development contains 200 – 400 houses during the School PM peak period. However, it is important to note that the existing model does not include any delay to northbound traffic caused by the school patrol lady, whereas the proposed model does include the delay created by the new signal pedestrian crossing at the Ashby Road / Comberford Road junction, which is assumed to run every cycle. Therefore, journey times in the existing network are likely to be a little higher than predicted by the model, while those in the proposed network somewhat lower as the signal crossing is unlikely going to be called every cycle.

APPENDIX A

Technical Note 1

APPENDIX B

LinSig Network Layout Diagrams

APPENDIX C

Concept Sketches