The Leeds Trolley Vehicle System Order

Gordon Robertson: Leeds City Council
Signalled Junction Assessment

APP-6-2: Main Proof of Evidence on behalf of the Applicants

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1. **Introduction**

Qualifications and Experience


1.2. My section is responsible for traffic signals in Leeds, including assessment, design, installation, operation and maintenance. Having worked in Leeds for many years I am familiar with the road network and traffic demands in Leeds, and my section seeks to use traffic signals to minimise congestion and delays.

Scope of evidence

1.3. My evidence will cover the traffic signal designs and the proposed method of operation for junctions along the NGT route. This proof of evidence demonstrates that the Leeds traffic network will operate well with the NGT scheme, without increasing congestion or delays for other traffic. The control system is able to provide the high level of priority promised for NGT and so maintain consistent and reliable journey times. In many places there are improvements for other road users.

1.4. My Proof follows on from that of Jason Smith who describes the scheme design.

1.5. My Proof also relates to that of Paul Hanson who describes the Leeds Transport Model. The LTM requires traffic signal data as input, and outputs traffic flows that I have used in my assessments.
Declaration of truth

1.6. I confirm that insofar as the facts stated in this Proof of Evidence are within my own knowledge, I believe them to be true. In my professional opinion, I believe that this Proof of Evidence represents an unbiased and true assessment.
2. **Outline of Evidence**

2.1. I will start by describing the traffic signal control system used in Leeds, and the software which gives selected vehicles priority at traffic signals.

2.2. I will outline the method used for assessing junction performance. Traffic signal designs are very dependent on detailed traffic flows, so I also explain how I have derived robust figures for the traffic turning movements used in my assessment.

2.3. Next I go through in detail the traffic signals along the NGT route. I explain how the traffic signals will operate for general traffic and for NGT, and where appropriate, comment on facilities for buses, cyclists and pedestrians.

2.4. I will explain abbreviations and technical terms as I go along, but to help the inspector and the inquiry a summary list is proved in Appendix 1 [App 6-3-1].
3. The traffic signal control system used in Leeds

Overview of the system

3.1. Leeds has over 620 sets of traffic signals. The timings of these signals have been determined and are maintained by the UTMC team that I manage. Where coordination between sets of traffic signals is important, or for other reasons precise control is beneficial, the signals are connected to a central computer which controls the time given to each traffic and pedestrian signal, and generally coordinates nearby signals on a common cycle time. Around 320 traffic signals are controlled in this way. The benefits of computer control for traffic signals in an urban environment have been well established, yielding benefits in terms of delay, congestion, smooth travelling (fewer stop-starts) and reduced accidents. Non computer controlled traffic signals are allowed to determine their own signal timings in response to vehicle or pedestrian demand. The majority of these have a dial-up connection to the UTMC computer for fault reporting. Some signals which are normally non-controlled can, if the need arises, be placed under computer control in order to superimpose alternative timings for a specific period.

3.2. Signal timings can be varied by time of day, and aim to cater for the various needs of all users, seeking first to ensure junction operation is safe, and then balancing delay, etc. for all users.

3.3. LCC has a staffed traffic control room with access to CCTV cameras across Leeds. Operators handle fault reports (automatic, phone or email). They also monitor the road network and intervene by changing signal timings if circumstances arise where alternative timings would be beneficial. Live traffic information is published on the internet and Twitter, to assist travellers in the city.

3.4. As a consequence, traffic signals in Leeds function efficiently, faults are dealt with in a timely manner, and manual intervention can easily be implemented.
How we give selected vehicles priority at traffic signals

3.5. Leeds City Council has considerable experience of operating priority for selected vehicles, and consequently can with confidence guarantee a good level of service. In 1998, having identified a need for priority control for the Supertram scheme, Leeds was chosen by the Department for Transport (DfT) for a development project on selected vehicle priority. This led to the development of STM software (Strategic Traffic Management, formerly known as SPRUCE). Over the years STM has been refined, and now provides selective vehicle priority at around 400 traffic signals in Leeds, Calderdale, Sheffield and Bradford. A further development has been to use STM to give Fire Appliances at three Fire Stations in Leeds significant priority when they respond to an emergency call [see Appendix 4 – App 6-3-4].

3.6. The Edinburgh Tram (undergoing final trial runs at the time of writing) also uses STM to deliver a high level of priority through traffic signals in a busy urban area.

3.7. STM is able to deliver very precise priority strategies. A priority vehicle sends a message when passing a predetermined point on the approach to a set of signals. By using a number of logic statements STM can change the traffic signal control pattern sent out by the UTMC computer to manipulate the signal timings at one or more junctions. As the vehicle proceeds, further location messages can adjust the computer control to ensure optimal signal timings. STM then responds to a ‘clear’ message when the vehicle is through the junction and can follow this with compensatory timings to ensure minimum effect on junction capacity and delay for general traffic.

3.8. A number of different priority techniques and strategies are now used in STM, including advancing a green signal, extending a green, hurry calling a stage, picking up an isolated junction to force a stage and coordinate with another isolated junction, offsetting timings for a group of signals, and changing cycle time at one or more junctions.
Current bus priority

3.9. Leeds has been responsible for implementing the priority aspects of the West Yorkshire ‘Traffic Light Priority’ project between 2010 and 2013. Bus priority has been implemented at 240 WY junctions. Of these 182 used STM (94 In Leeds). These were selected on the basis of the junctions where the most benefit could be expected.

3.10. Leeds has also used bus priority in connection with delivering Quality Bus Corridors, in Leeds. These use a variety of techniques including bus priority at traffic signals.

3.11. The majority of buses operating in Leeds are equipped with location equipment that provides information to the West Yorkshire Metro ‘Your Next Bus’ system. This equipment is programmed to send UTMC a message when the bus passes predetermined trigger points. The information includes the bus number and an early/lateness factor.

3.12. Bus priority is currently provided at ten signal controlled junctions and two signal controlled pedestrian crossings on the NGT route. This priority is limited to the ability to request a green to be advanced, extended or offset (3.22 explains the limitations). It is applied to all buses, which saves the average bus a few seconds per priority junction.

3.13. Note that while taxis (Hackney Carriages) are generally allowed in bus lanes in Leeds, they do not call any specific priority at traffic signals.

How we propose to give NGT priority

3.14. NGT vehicles will be given a very high degree of priority – STM software will ensure that wherever possible NGT will not stop at traffic signals. A number of factors make this possible including very reliable vehicle detection methods, dwell time at stops are short and predictable (due to the number of doors and off-vehicle ticketing), travel times are reliable, and the frequency allows time to cater for other traffic and gradually set up the timings ready for the next vehicle.
3.15. The detail of the methods used for NGT priority will vary for each site. The principles are given below, together with some of the signal timing strategies available.

3.16. The NGT vehicle will send a message to the UTMC computers as it passes predetermined locations. There are a number of technologies that could be used for this: the NGT procurement will specify the reliability required, not the precise equipment to be used. This location message is fed into the STM software which will adjust the green signal times at relevant traffic signals appropriately.

3.17. STM has a powerful logic processor, which allows particular strategies to be specified at one or more junctions one or more cycles hence, to ensure the NGT arrives at the junction during a green signal. More logic can control exactly what timings are used for the signal cycles afterwards.

3.18. Occasionally at a junction there will be an NGT vehicle approaching in each direction. At many junctions both NGT vehicles will make use of the same stage, so they will both get priority. If there should be a conflict, in general the NGT travelling in the peak direction will receive the priority

How we propose to apply bus priority with the NGT scheme

3.19. A basic level of priority will be implemented at the majority of signal controlled junctions along the NGT route. This will be applied to late buses, so helping buses to keep to timetable. If a late bus and an NGT call for priority at a junction at the same time then NGT will receive the priority.

3.20. Bus priority will be implemented at all pedestrian crossings. Most junctions will have some bus priority implemented, though at some critical junctions it will not be possible. As a result, over the whole route there will be significantly more bus priority than at present.

3.21. With the NGT scheme bus priority will reinforce the scheduled journey time. It cannot guarantee a journey time improvement for all buses, but it will help buses to run closer to timetable than at present for the following reasons.
• At junctions where buses use the same stage as NGT, they stand to gain the advantage of the NGT green signal.

• Bus priority will be implemented at significantly more junctions and pedestrian crossings than currently.

• By concentrating on late running buses delay reduction can be given where it is needed.

• Some of the layout changes will directly benefit buses.

**Why bus priority has to be limited**

3.22. There are a number of reasons why existing bus services cannot be given the same level of priority as NGT. These factors work together to limit the benefit that buses can expect from implementing STM.

3.23. The frequency of buses does not allow the traffic to recover from any disruption before the next bus arrives. For example, at times at some junctions there can be one bus arriving every cycle of the traffic signals, so the green times need to be the same for every cycle.

3.24. The dwell times for buses at stops are very variable. This is due to having one door, and on-bus ticketing. The result is that the time spent at a stop is unpredictable.

3.25. Travel times for buses are much less predictable on most roads. The NGT scheme is designed to give NGT a smooth run along the route.

3.26. Bus stops can be located very close to traffic signals. There can be very little time between leaving the stop and arriving at the signal stop line. Given the few seconds it takes for a message from the bus to activate changed timings on street there can be no time at all to do anything.

3.27. These problems build up during the peak periods. If buses start running late, then the frequency becomes more uneven and the limitations on priority increase.
3.28. NGT priority relies on being able to predict the arrival of the NGT several minutes away. Traffic signals can therefore be moved gradually and lined up to give the NGT a clear green. As the NGT nears the signals timings can be adjusted by a few seconds to ensure the NGT gets through. Disruption to other vehicles (including buses) is thereby minimised.

3.29. The above factors work together. Tackling each issue piecemeal would only be of minor benefit. A comprehensive approach is needed to deliver minimal delay consistently.

3.30. There is a practical limit to the number of vehicles per hour in each direction that can be offered the highest level of priority at traffic signals. In this case the scheme the NGT frequency and scheme design will allow the highest priority to be given to peak direction NGT vehicles. The larger carrying capacity of NGT means this degree of priority can benefit a larger number of passengers at this frequency.
4. **Junctions assessment methodology**

**General Approach**

4.1. Junctions have been assessed by comparing the operation with and without NGT. This has been done for the opening year, 2020.

4.2. To make these comparisons, four scenarios have been used:

- The ‘Do Nothing’ (DN), the situation as it was in October 2012. This has been used as a reference point, and to calibrate the traffic models.

- The ‘Do Minimum’ (DM), which is the situation which would appertain in 2020 if NGT were not to be constructed.

- The ‘Do Something’ (DS), which models the 2020 flows with the NGT scheme.

- The ‘Design Year’ (DY), which models the 2031 flows with the NGT scheme.

4.3. The main assessment is to compare the forecast junction operation in the DS and the DM. This shows the difference in traffic flows, capacities, and queues etc. that arise as a consequence of implementing NGT. Assessments have been undertaken for the morning peak hour (8-9am) and the evening peak hour (5-6pm) in 2020. I have used the standard UK method to model signalled junctions and networks, which is the TRANSYT program. For junctions that are give ways or roundabouts in the existing situation and are signalled with the NGT scheme, the PICADY and ARCADY programs have been used to get existing situation capacities.

**Derivation of turning counts for junction assessment**

4.4. Figure 1 shows the process described below in flow chart form.

4.5. The DN flows quoted in Appendix 3 [APP-6-3-3] are an estimate of the traffic flows for the AM and PM peak hours on an average weekday in Oct 2012. They are based on traffic counts taken between July 2012 and July
2013, adjusted to Oct 2012 using factors based on local annual traffic data. A common month means the flows are consistent (month to month variations have been taken account of). October is generally regarded as a ‘neutral month’ – schools and universities have started but traffic has not yet built up to a winter peak. The hours 8-9am and 5-6pm have been used for consistency – the precise peak hour period varies from day to day and place to place, though the difference in flow is marginal.

4.6. Forecast flows for 2020 have been derived using detailed information from the traffic counts and data from the LTM traffic model produced by AECOM.

4.7. The LTM uses a representation of the road network, including junctions controlled by traffic signals. The LTM forecasts the effect of traffic growth and any re-routing of traffic between the main route corridors, as well as changes in mode share resulting from new schemes being implemented. It then assigns traffic to routes given the network constraints. Aecom have used the model for the years 2016 and 2031. The flows output by the LTM model are a reasonable representation of likely traffic flows at a strategic link level.

4.8. Junction assessment and design require forecast turning flows at each individual junction, a level of detail which the model is not designed to fully represent. To get this detail, the DN turning flows were factored to 2020 levels using the annual growth rate for each link obtained by comparing the LTM 2016 and 2031 flow predictions. These were used as the DM flows.

4.9. To get DS junction turning flows a detailed methodology was used. First the LTM results with and without NGT were compared. The changes LTM forecast as a consequence of the NGT scheme were then superimposed on the DM flows. The junctions were assessed and designs refined to accommodate the requirements of the forecast flows. These design changes were then represented within the LTM model and assignments run to understand the impacts. In addition, for some turning flows the origins, destinations and routeings of all traffic making that movement were analysed. The detailed network representation of loading points for traffic
emanating from critical zones was also checked. Combining these factors gives a robust and realistic estimate for future traffic turning movements.

Fig 1 – Process for deriving junction turning flows
4.10. The traffic assignments reflect two significant factors.

- Traffic throughout Leeds will generally reroute to find what each driver perceives to be the best route. This means that where a junction design changes the capacity on different approaches, traffic will generally reroute to make use of any capacity created (and other traffic reroutes to fill up gaps left behind on other roads). This effect is seen especially at Lawnswood Roundabout, where the proposed traffic signals allow traffic that in the existing situation has diverted to other routes, to make use of the new signalled roundabout.

- There are capacity restraints that the NGT scheme does not alter. For example, Otley Road/North Lane is not part of the NGT scheme and the capacity remains unchanged. Therefore it is a critical junction in determining how much traffic uses the A660.

**TRANSYJT analysis**

4.11. The capacity of each signalled junction has been modelled using TRANSYJT (see Core Doc G-4-23). TRANSYJT is an industry standard traffic signal network analysis program written by the UK Transport Research Laboratory (now TRL Ltd.) which has been used throughout the world for many years. It uses details of signal staging and timings, road capacities, and forecast traffic flows to calculate capacities, vehicle delays and queues on each approach. It has an optimisation algorithm to determine optimal signal green times. Ref 2 gives more details of how TRANSYJT has been applied for NGT.

4.12. For each junction, given the flow and how the junction operates, TRANSYJT outputs for each approach a ‘Degree of Saturation’ (DoS). The DoS, which is given as a percentage, is the forecast traffic flow divided by the maximum flow possible on a particular link (given the modelled green signal time). A Dos of 90% is used as a target figure, as this allows for cycle by cycle variation in traffic demand. When DoS gets close to 100%, although all the
flow gets through the signals significant queues can build up due to the variability of traffic arrival. Over 100% DoS means that the queue keeps growing until the flow reduces towards the end of the peak period.

4.13. TRANSYT also outputs a ‘Mean Max Queue’ (MMQ). MMQ is the forecast queue just after the end of the red period for that traffic flow, i.e. the maximum for each cycle of the signals. As cycle by cycle variation is not taken account of in TRANSYT, this is a ‘mean’ or average over the period being evaluated.

4.14. Within the UTMC system there is the ability to fine tune signal timings within the peak hour, using specific settings to match any predictable variations in traffic demands. The computer can implement specific timings for a short period (e.g. reallocating green time or increasing the cycle time during the peak of the peak hour), or in response to an external input such as a queue detector. Some more isolated junctions may benefit from operating under vehicle actuation for a short period rather than centrally controlled timings.

4.15. TRANSYTs have been run for the DM to show the situation that would apply if NGT is not constructed. The DS TRANSYTs show the situation when the NGT scheme is built. Comparing the DM and DS shows the effect of building the NGT. More details of how NGT has been modelled in TRANSYT are in Appendix 2 [APP-6-3-2].

ARCADY and PICADY outputs

4.16. These programs output Ratio of Flow to Capacity (RFC), which is equivalent to the DoS from TRANSYT, though it is recognised that there is greater variability minute by minute at give ways than at traffic signals. Any value over 1.000 indicates the approach is overloaded and queues will continue to increase. To allow for the randomness of arrivals it is generally accepted the desirable RFC threshold is 0.850.

4.17. A queue is also output for each period considered within the peak hour (normally four periods of 15 minutes). The maximum value of this queue
has been used as the maximum queue (Max Q). Note that this is represents an average queue and is does not reflect cycle to cycle variations.
5. **Junction assessments**

**General approach**

5.1. I will now comment on each set of signals along the route. I comment briefly on signalled pedestrian and cycle crossings. For signalled junctions I give a summary of the existing situation, and the proposed design. I will comment on the capacity of the junction, with reference to TRANSYT model runs. This narrative will relate to the plans and tables in Appendix 3 [APP-6-3-3]. I will also summarise how NGT priority will be implemented at the junction. Other issues such as bus priority measures and how cyclists use the junction will be included as appropriate.

**Pedestrian crossing by Holtdale View**

5.2. This is a staggered crossing to allow maximum flexibility and responsiveness for pedestrians. If a northbound NGT is approaching, the crossing will stay on green to traffic to allow the vehicle through. A southbound NGT will call the pedestrian stage across the southbound lane to allow NGT to egress safely and without delay.

5.3. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this northbound is reduced due to the proximity of the bus stop.

**Pedestrian crossing on Otley Old Road, north of Holtdale Approach**

5.4. This is a staggered pedestrian crossing.

5.5. As well as providing a signalled facility for pedestrians to cross the road, an approaching NGT will call the pedestrian stage across the southbound lane to allow NGT to turn safety into Holtdale Approach or to exit from Holtdale Approach.

5.6. An approaching bus will hold off the appearance of the pedestrian stage.

**Pedestrian signal by Tinshill NGT stop**
5.7. This is a straight across pedestrian crossing.

5.8. The pedestrian stage will be called when NGT in either direction has passed through the signals and is at the stop. This is for two reasons, first so that pedestrians can cross the road safely behind NGT, and secondly as an additional safety factor to ensure that cars do not overtake a stationary NGT vehicle.

5.9. An approaching bus will also hold off the appearance of the pedestrian stage.

Otley Old Road/Tinshill Lane signals

5.10. See data sheet in Appendix 3 [APP-6-3-3] page 1.

5.11. There is no change to the junction layout, though NGT priority and bus priority will be implemented. There is slightly more traffic going through the junction, but it is still operating well within capacity. Queue lengths are shown to have increased, but as the capacity is under 90% (actually 82%) there is potential to reduce the queues from those modelled as outlined in 4.14.

Pedestrian signal by Hospital Lane NGT stop

5.12. This is a straight across pedestrian crossing.

5.13. The pedestrian stage will be called when NGT in either direction has passed through the signals and is at the stop. This is for two reasons, first so that pedestrians can cross the road safely behind NGT, and secondly as an additional safety factor to ensure that cars do not overtake a stationary NGT vehicle.

5.14. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this northbound is reduced due to the proximity of the bus stop.

Pedestrian signal by Raynel Approach
5.15. This is a straight across pedestrian crossing.

5.16. If an NGT is approaching, the crossing will be held off allowing the vehicle through.

5.17. An approaching bus will also hold off the appearance of the pedestrian stage.

Pedestrian signal by Wise Owl NGT stop

5.18. This is a straight across pedestrian crossing.

5.19. If an NGT is approaching, the crossing will be held off allowing the vehicle through.

5.20. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this northbound is reduced due to the proximity of the bus stop.

Lawnswood & Park and Ride area

5.21. Existing situation. There are no signals here at the moment.

5.22. Principles of proposed design and operations. There are 3 new junctions associated with the Park and Ride facility: one designed to manage traffic in and out of the Park and Ride facility, and two to allow NGT to turn into the stop and exit again.

5.23. NGT priority. NGT will be coordinated through the two junctions, with the following exceptions. If two NGTs approach from different directions, the peak direction vehicle will get priority. The NGT turning from the P&R to Otley Old Road requires a different priority strategy to the southbound NGT. It is expected that the NGT detection system will include information about which direction the NGT is travelling (as the bus system in use in Leeds has), enabling an early priority call specifically for right turning NGTs. If not, it will be identified once it moves into the right turn lane, which would limit the degree of priority.
5.24. Buses. All traffic including buses will be coordinated in the peak direction.

5.25. Cyclists. Cycle lanes and ASLs are provided.

5.26. Pedestrians are provided with signalled crossings across Otley Road and the entrances to the P&R and NGT stop.

**Lawnswood & Park and Ride traffic access**

5.27. See data sheet in Appendix 3 [APP-6-3-3] page 3.

5.28. Capacity. The highest DoS is 87% for the morning peak southbound traffic. This could reduce in practice if the low flows out of the P&R occasionally allow a stage to be omitted.

**Lawnswood & Park and Ride NGT and drop-off junctions**

5.29. See data sheet in Appendix 3 [APP-6-3-3] page 4

5.30. Capacity. The highest DoS is 68%, so there is plenty of spare capacity.

**Otley Road/Otley Old Road junction**

5.31. See data sheet in Appendix 3 [APP-6-3-3] page 5

5.32. Existing situation. The current layout has Otley Old Road joining Otley Road at a give way. The speed of traffic on the A660 can make it difficult for Otley Old Road right turning traffic to cross the two lanes of northbound Otley Road and merge in the offside lane of the southbound A660, so queues develop (PICADY shows DM Max Q of 10 pcus, which is in practice exceeded on occasion). There are no pedestrian signals.

5.33. Principles of proposed design and operations. The scheme signals the A660 against Otley Old Road, and provides pedestrian signals across Otley Old Road (pedestrians across the A660 are provided by the P&R to the north).

5.34. NGT priority. NGT vehicles pass through the junction in the central reserve. The number of NGT movements through this junction will limit the extent of
the priority deliverable, especially when two NGTs arrive in different directions. A northbound NGT will be detected approaching the junction and the signals will change to green (if not already at green) as it nears the signal stop line. Otley Road southbound will be coordinated with the NGT exit from the P&R site, so that southbound NGTs are given a green signal. NGT vehicles from the P&R making the right turn to Otley Old Road will be detected as they move into the right turning lane, which will change the northbound traffic signal to red. NGTs on Otley Old Road will be detected as they leave the upstream stop. Progress will be tracked towards the junction, which will change to a green signal in time to clear any traffic queue in the left hand lane and allow NGT to make the left turn onto A660.

5.35. While NGT northbound and southbound along A660 run in the same stage (with A660 traffic), the right turn and Otley Old Road NGT will occasionally conflict with the northbound A660 NGT and incur some slight delay.

5.36. Capacity. The junction is shown by TRANSYT to be virtually at capacity in the AM peak, with a DoS of 95% on Otley Old Road right turn and 94% on Otley Road southbound. While 95% is high the junction does handle the forecast traffic, albeit with a forecast MMQ queue of 19 pcus. The flows include the rerouting forecast by the LTM in response to changes in the road network (e.g. signalling this junction and Lawnswood Roundabout). In practice traffic will only divert off their existing route if the new route is considered preferable, so the DoS and queues predicted may well not materialise. The PM peak has spare capacity (highest DoS is 72%).

5.37. Buses. Buses will be mixed in with traffic on A660, thus getting the main road green. Buses on Otley Old Road will benefit from the short length of bus lane if they are turning left.

5.38. Cyclists. ASLs and Toucans have been provided where needed for cycle routes.

Lawnswood Roundabout

5.40. Existing situation. This is a very busy roundabout. Over the years it has been reshaped a number of times to reduce accidents and make it easier to use, but it remains a difficult area with fast moving traffic and many lanes. There is no provision for cyclists and no signals to assist pedestrians to cross.

5.41. Principles of proposed design and operations. By making this a signalled roundabout the junction becomes much easier for general traffic, cyclists and pedestrians. Traffic is signalled safety through the roundabout, being coordinated on the straight ahead movements. Right turning traffic will incur a slight delay, but this is minimal as the whole system operates on a short second cycle time (80 sec AM peak, 60 sec PM peak).

5.42. NGT priority. NGT vehicles pass through the middle of the central island. They can do this during the stage that is used by A660 ahead traffic in both directions. The approach of an NGT will advance/retain this stage with minimal effect on traffic. The northbound NGT vehicle will be detected on the approach to the Lawnswood School stop, the roundabout signals will advance to or stay in a stage such that when NGT sets off the signals can change to allow NGT through. Any lost green time on other approaches will be compensated for in subsequent cycles.

5.43. Capacity. For the Do Something, the LTM forecasts that more traffic will be attracted to use the junction as it is so much easier to negotiate. This is not surprising as traffic will fill up any available green time to its maximum at some point on a radial in the morning peak (see para 4.10). TRANSYT shows the A660 southbound approach as having the highest saturation, at 98%. Despite this increased flow, the average queues and delays in the DS are comparable with the existing situation (note the queue figures are a total for all approach lanes). For the DM the ARCADY outputs an average queue length which does not take account of minute by minute variability. Observed queues vary but can be greater than the ARCADY output.

5.44. Buses. Buses will also find the signalled roundabout easier to use than the existing roundabout.
5.45. Cyclists. Cyclists will find using the junction much easier than the existing roundabout, whether they choose to ride with traffic or use the Toucan crossings.

5.46. Pedestrians. Pedestrian crossings are provided, with Toucan crossings on three out of four roads. Pedestrians wanting to cross the A660 on the south side have a signalled crossing outside the school.

**Lawnswood School pedestrian crossing/Weetwood Hall crossover**

5.47. See data sheet in Appendix 3 [APP-6-3-3] page 8

5.48. Existing situation. A separate pedestrian crossing is provided across each 2 lane carriageway.

5.49. The signals across the single northbound traffic lane will operate as a standard pedestrian crossing. The signals across the NGT lane and the southbound traffic lane provide pedestrians with a signalled crossing over Otley Road and the NGT, while also controlling southbound traffic and the exit from Weetwood Hall, and allowing NGT to cross safety over to the bus lane.

5.50. NGT northbound will be detected and call priority so will not stop at the signals. NGT southbound will approach the stop while the signals are at red and will use the predicted dwell time to ensure a green signal on departure.

5.51. Capacity. The junction operates within capacity with a max DoS of 85%. Outside the main school times the pedestrian stage will come in less often.

5.52. Bus priority will be implemented at the crossings, so an approaching bus will hold off the appearance of the pedestrian stage.

**Otley Road/Spen Road, West Park roundabout and bus gate**

5.53. See data sheet in Appendix 3 [APP-6-3-3] page 9
5.54. Existing situation. The island is referred to as a roundabout, but rather than having the usual roundabout priorities Otley Road in both directions has priority through the junction. There is a staggered signalled pedestrian crossing south of the roundabout.

5.55. Principles of proposed design and operations. Slight alterations to kerb lines and island size will improve the roundabout operation, and help pedestrians to cross Spen Road. The existing crossings south of the roundabout are retained. A new staggered signalled crossing is provided north of the roundabout. The signals will be coordinated along Otley Road so that in normal circumstances traffic will not stop at more than one crossing. If there is a possibility that right turning traffic could block a main road movement, vehicle detection will be used to call the appropriate pedestrian crossing, to create a gap in the traffic flow. A bus gate is included for northbound traffic by Welburn Drive.

5.56. NGT priority. A northbound NGT approaching the bus gate will call a red to traffic. Traffic will be held until the NGT vehicle is about to leave the stop, and will then be allowed to proceed.

5.57. Capacity. The modelling shows the RFC to improve from 1.019 in the DM (in the DN, 0.926) to 0.600, due the improved geometry and less traffic using Spen Road to travel southbound.

5.58. Buses. Buses will also benefit from the northbound bus gate. They will be able to call a red to general traffic provided that this has not been called in the previous cycle. Providing a give way for buses ensures they are not delayed unnecessarily if traffic still has a green signal but they are able to enter the general traffic lane safely.

Thornbury Avenue signals

5.59. See data sheet in Appendix 3 [APP-6-3-3] page 11.
5.60. Existing situation. The junction is signalled. A second stop line is placed just south of the junction to provide a staggered signalled crossing of Otley Road for pedestrians.

5.61. Principles of proposed design and operations. It is not proposed to change the signals or how they operate, apart from implementing NGT priority.

5.62. NGT priority. NGT will be detected approaching these signals and will advance/retain the main road stage.

5.63. Capacity. The TRANSYT output shows the signals will operate with maximum DoS of 89% at a 90sec cycle time. This is close to the DM DoS of 83%, and in practice there will be additional benefit from better coordination northbound.

5.64. Buses. Bus priority has already been implemented here. This will continue to operate in the same way for late buses.

Glen Road/Churchwood Avenue

5.65. See data sheet in Appendix 3 [APP-6-3-3] page 13

5.66. Existing situation. The side roads meet Otley Road on give ways. There is a significant amount of turning traffic, which can cause some congestion and delay to through traffic. Pedestrians cross Otley Road using staggered pedestrian signals.

5.67. Principles of proposed design and operations. The proposed design signals both side roads to provide safe and easy access to A660. The slight offset of the two roads means that Glen Road and Churchwood Avenue need to have separate green periods. To maintain through traffic capacity and so as not to encourage people to use Glen Road as a through route, in the evening peak each side road will run in alternate cycles.

5.68. NGT priority. NGT will be detected approaching these signals and will advance/retain the main road stage.
5.69. Capacity. TRANSYT shows the junction to operate within capacity, having 83% DoS in the morning peak, while in the evening peak the highest DoS is 87%.

5.70. Buses. Buses travel through the junction in the main road stage. Bus priority for late buses will be implemented.

Weetwood Lane/St Chad’s Road

5.71. See data sheet in Appendix 3 [APP-6-3-3] page 15

5.72. Existing situation. Both St Chad’s Road and Weetwood Lane join Otley Road with give way lines. In-between these two roads there is a signalled crossing of Otley Road. The long flashing green man causes some pedestrians concern as they don’t feel as protected with flashing amber to traffic.

5.73. Principles of proposed design and operations. Weetwood Lane is closed and traffic is diverted to use St Chad’s Road. St Chad’s Road is signalled which makes it easier for vehicles to enter Otley Road – especially if making the right turn.

5.74. NGT priority. NGT will be detected approaching these signals and will advance/retain the main road stage.

5.75. Capacity. TRANSYT shows the junction to have 87% DoS in the morning peak, on a 90 sec cycle time. In the evening peak the highest DoS is 88%

5.76. Buses. Buses travel through the junction in the main road stage. Bus priority for late buses will be implemented.

5.77. Pedestrians. A new signalled crossing facility is incorporated into the north side of the design of the new signals. The existing crossing is replaced by a new staggered crossing slightly further south. It is necessary for this to be a staggered crossing for safety and coordination reasons, due to its proximity to the new signals.

St Chad’s Drive pedestrian crossing
5.78. This is a new staggered pedestrian crossing. It will be coordinated with the bus gate and the signals at Shaw Lane, so that in general main road traffic will not stop twice.

5.79. If an NGT is approaching, the crossing will hold off allowing the vehicle through.

5.80. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this northbound is reduced due to the proximity of the bus stop.

Shaw Lane and Alma Road area

5.81. See data sheet in Appendix 3 [APP-6-3-3] page 17 and Appendix 3 [APP-6-3-3] page 19.

5.82. Existing situation. The signals at Shaw Lane currently run on a 120 sec cycle time during the peak periods, and 90 seconds at other times. The pedestrian phase across Shaw Lane and St Anne’s Road run at the same time as Otley Road north and south get ahead green arrows. Vehicles frequently violate the ahead arrows and turn into one or other side road, while pedestrians are still on the crossing. Pedestrians who choose not to wait for the green man find crossing Shaw Lane difficult as it’s a 3 lane crossing and traffic can come from different directions. Alma Road is currently a give way. Traffic can find it difficult to turn right out of Alma Road.

5.83. Principles of proposed design and operations.

- North of Shaw Lane an NGT/bus gate is proposed at the end of the NGT/bus lane. This will stop traffic in the outside lane while allowing vehicles in the NGT/bus lane to progress. Signal timings will be coordinated with the signals at Shaw Lane so that vehicles will generally not get stopped twice. The signals enable buses, cyclists and taxis to get across into the offside lane to go south along Otley Road.
- The single lane through to North Lane eliminates the problematic 2 into 1 lane merge in front of the Arndale Centre. The right turn into St Anne’s Road is prohibited to ensure southbound traffic flow is maintained.

- The Shaw Lane junction benefits from islands in both Shaw Lane and St Anne’s Road. Although this means the side road has to be crossed in two stages, one of those stages will have a green man for most of the cycle. The other stage will be safer as the crossing time runs in the shadow of the side road.

- Alma Road is signalled and red/green men provided to facilitate safe crossing of Alma Road for pedestrians.

- Note that the North Lane/Otley Road junction to the south is not changed with the NGT scheme. This means that the area will continue to be a capacity restraint, with traffic flows through North Lane unchanged.

5.84. Capacity. The derived traffic flows for 2020 show increased flows, which have been used in the TRANSYT analysis. The maximum degree of saturation in the AM peak in both the Do Minimum and Do Something is 107%. The operation of the junction is forecast to improve marginally in the PM peak. The maximum degree of saturation reported in the Do Minimum scenario is 113% which reduces to 103% in the Do Something. Queue detection for southbound traffic will be used to allow the traffic signals to manage the queues and reduce congestion in front of the Arndale Centre, whilst maintaining traffic through Otley Road at North Lane at current levels. The Alma Road junction operates with a max DoS of 77% on Otley Road, and 43% on Alma Road.

5.85. The bus gate, Shaw Lane and Alma Road will be coordinated, so the majority of traffic will either go through the signals on a green or stop at no more than one signal. This means main road traffic will not incur any more signal delay than at the moment.
5.86. Buses. Southbound buses will benefit from the slightly longer bus lane and the NGT/bus gate on the approach to Shaw Lane. When the NGT/bus gate is red to traffic they can proceed directly into the offside lane. If the bus gate is green to traffic buses have until Alma Road to merge into the offside lane. Southbound buses could also benefit from priority given to NGT vehicles, if they are able to make use of the same green signal.

5.87. Cyclists. At the bus gate, cyclists will be in the NGT/bus lane and therefore can proceed through the give way when safe to do so. At all other stop lines Advance Stop Lines (ASLs) are provided.

5.88. Pedestrians. As described above there is an improvement in the facilities for pedestrians.

5.89. NGT priority. NGT southbound will be detected leaving the Weetwood Lane stop, which makes it possible to ensure the NGT/bus gate will go red to traffic as the NGT approaches and the Shaw Lane and Alma Road signals lights will be held green till NGT clears. The northbound NGT will be detected as it leaves the Wood Lane stop. The signal for Otley Road southbound (at Shaw Lane) will shut down. Southbound traffic will clear through the Alma Road junction before Alma Road changes to a green signal in time to let NGT right turn onto Otley Road and through the signals at Shaw Lane. STM will calculate any time lost to traffic movements and compensate in the next cycle. Due to the complexity of this network and the conflicting coordination requirements of southbound and northbound NGT, the non-peak direction NGT will incur some delay.

Shire Oak Road signals.

5.90. Principles of proposed design and operations. This is a new signalled junction on a previously unsignalled road. The signals will be green to traffic on Shire Oak Road and for pedestrians going along Shire Oak Road, except when there is an opposing demand by pedestrians, cyclists or NGT.

5.91. NGT priority. NGT will advance call the NGT stage, and hold off Shire Oak Road traffic.
5.92. Cyclists. The cycle way along the NGT route changes to a shared footway at the junction. Cyclists will be detected on the approach but also have the option of operating a push button to call the Toucan stage.

5.93. Pedestrians. Signalled pedestrian facilities are provided across the NGT route and across Shire Oak Road.

**Headingley Castle access**

5.94. Principles of proposed design and operations. This is a new signalled junction on a previously unsignalled access road. The signals will be green to traffic on the Headingley Castle access road and for pedestrians going along the access road, except when there is an opposing demand by pedestrians, cyclists or NGT.

5.95. NGT priority. NGT will advance call the NGT stage, and hold off access road traffic.

5.96. Cyclists. The cycle way along the NGT route changes to a shared footway at the junction. Cyclists will be detected on the approach but also have the option of operating a push button to call the Toucan stage.

5.97. Pedestrians. Signalled pedestrian facilities are provided across the NGT route and across the access road.

**Headingley Hill bus gate and crossover**

5.98. Principles of proposed design and operations. This is a new junction to allow NGT to access and exit the NGT bypass route. Southbound on Headingley Lane there is a traffic signal which will be called by a pedestrian crossing Headingley Lane or a northbound NGT. Northbound the general traffic lane is signalled to provide a traffic gate. This will be used both to allow a northbound NGT to move into the offside lane, and to provide some queue control for northbound traffic. It will be used in conjunction with a queue detector further north to ensure that enough traffic gets through to ensure current capacity at the North Lane signals is maintained, whilst
much of the existing traffic queue is displaced to be alongside the NGT/bus lane.

5.99. NGT priority. NGT southbound will call the southbound traffic signal just before it leaves the stop, ensuring a smooth exit onto Headingley Lane. A northbound NGT will advance call the signals, and bring both the northbound traffic gate signal and southbound signal to red, allowing NGT to move into the offside lane and across onto the bypass.

5.100. Buses. As well as benefiting from the northbound NGT/bus lane bus delay will be reduced between here and north lane, due to the queue displacement.

5.101. Cyclists. ASLs and cycle lanes are provided. Northbound cyclists are expected to use the NGT/bus lane. Northbound cyclists wanting to turn right onto the route alongside NGT can either move into the right hand lane and use the cycle ‘pocket’ or stay in the nearside lane and use the ‘jug handle’ cycle facility to access the Toucan crossing.

5.102. Pedestrians. A new pedestrian crossing across Headingley Lane is provided.

Grosvenor Road Pedestrian crossing

5.103. This crossing replaces the existing crossing by North Hill Road.

5.104. If an NGT is approaching, the crossing will be held off allowing the vehicle through.

5.105. An approaching bus will also hold off the appearance of the pedestrian stage.

Overview of the Hyde Park area

5.106. I describe how the network as a whole works, and then show the capacity for each junction.
5.107. Existing situation. The Hyde Park Corner junction is very tight on capacity, and consequently runs on 120 second cycle in the morning peak (with DoS 93%), and 100 secs in the evening peak (highest DoS 110%). There are consequent delays for pedestrians who have a long wait for the green man, and substantial delays for traffic. In the morning peak the pedestrian crossing across Woodhouse Street runs at the same time as southbound traffic gets an ahead and right arrow stage, which is often violated as vehicles turn left as the green man is displayed. During the rest of the day this pedestrian greens operates during a stage that runs northbound traffic only (the right turn is banned). The pedestrian crossings across Hyde Park Road and Woodhouse Lane run with a right turn only arrow for Woodhouse Street. There is no pedestrian facility across the north side of the junction: the area is guard-railed to discourage pedestrians from crossing. The data sheet shows the existing junction to be 96% saturated in the morning peak, and 100% saturated in the evening peak.

5.108. Design strategy. Banning additional turning movements allows the junction to operate on two stages only, which increases the traffic capacity of the junction, and allows it to run on a shorter cycle time even during peak periods. The long green times and lack of queues at Hyde Park Corner will minimise delays.

5.109. In order to achieve these benefits, turning traffic will have to use Cliff Road and Rampart Road. The disbenefit of having to go through additional signals will be offset by optimising the coordination of the traffic signals and by the reduced cycle time.

5.110. NGT. NGT will be coordinated through the network in the peak direction. Note that the southbound NGT stops between Victoria Road and Hyde Park Road. Using the average forecast dwell time allows the signals to anticipate the vehicles departure and turn green as NGT approaches.

5.111. Buses. Buses will benefit from the lack of queues, the long green times on each approach, and the absence of turning vehicles blocking the junction.

Victoria Road/Headingley Lane
5.112. See data sheet in Appendix 3 [APP-6-3-3] page 20

5.113. Existing situation. Victoria Road joins Headingley Lane on a give way. Traffic from Victoria Road in the morning peak has to force its way out into a standing queue in front of the signals at Hyde Park.

5.114. Proposed design. This junction will be signalled, and coordinated with the Hyde Park Corner signals. New signalled pedestrian crossings are provided across Victoria Road and Headingley Lane.

5.115. Capacity. Victoria Road will be controlled with a short green to ensure that traffic on Victoria Road does not increase significantly. The max DoS is 58%.

5.116. Pedestrians. A new pedestrian crossing is provided across Headingley Lane, and the existing zebra across Victoria Road is replaced with a signalled crossing.

_**Woodhouse Lane/Hyde Park Road (Hyde Park Corner)**_

5.117. See data sheet in Appendix 3 [APP-6-3-3] page 22

5.118. Capacity. A 90 second cycle is assumed, to coordinate with the Clarendon Road signals. The maximum DoS is 66%, with minimal queues, showing a significant improvement for traffic.

5.119. Pedestrians are provided with a pedestrian green signal across Woodhouse Street and Hyde Park Road signalled green throughout the Headingley Lane/Woodhouse Lane traffic stage. The pedestrian signal across Woodhouse Lane operates throughout the Hyde Park Road/Woodhouse Street stage. This represents a significant improvement for pedestrians due to reduced waiting times.

_**Woodhouse Lane/Cliff Road**_

5.120. See data sheet in Appendix 3 [APP-6-3-3] page 23

5.121. The existing junction is a give way with all movements permitted.
5.122. Proposed design. The junction is signalled, with all movements permitted except the right turn from Woodhouse Lane south.

5.123. Pedestrians. The crossing of Cliff Road is provided with staggered pedestrian signals.

5.124. Capacity. With maximum DoS of 62% the extra turning flow is easily accommodated.

Cliff Road/Woodhouse Street.

5.125. See data sheet in Appendix 3 [APP-6-3-3] page 24

5.126. NGT does not go through this junction, but it is affected by the reassigned flows from Hyde Park Corner.

5.127. Existing situation. The junction is currently give way, with Woodhouse Street having priority.

5.128. Proposed design. As a result of the banned turns at Hyde Park Corner, flow through this junction increases. Signals are provided to enable the increased turning traffic to proceed safely. An all-round pedestrian stage is also provided, so there will be red and green men across each approach.

5.129. Capacity. The signals will operate at a 90 sec cycle and coordinate with Hyde Park Corner and Woodhouse Lane/Cliff Road. At peak hours the TRANSYT's show the junction to be running with max DoS of 77% - this assumes the pedestrian stage comes in every cycle: in practice it will have even more capacity.

Rampart Road/Woodhouse Lane

5.130. See data sheet in Appendix 3 [APP-6-3-3] page 25

5.131. Existing situation. The junction is give way. While current delays are slight there can be issues with northbound Woodhouse Lane traffic waiting to turn right and ahead traffic (sometimes at speed) moving into the nearside lane to undertake.
5.132. Principles of proposed design and operations. The junction is signalled as more traffic will be making turns at this point due to the banned turns at Hyde Park Corner. In addition it is at this point that NGT leaves the nearside to have a segregated route through the moor. The Toucan across the northbound lane only conflicts with northbound traffic, and so its timings can be set to coordinate northbound traffic with minimal delay for all vehicles.

5.133. NGT priority. As northbound and southbound are independent, NGT can be given a priority green that coordinates with the green at Hyde Park Corner.

5.134. Capacity. The highest degree of saturation is 58% - there is plenty of spare capacity. The junction operates at a 90 second cycle time to coordinate with the nearby junctions.

5.135. Buses travelling south will move into the offside lane. Travelling north there is a bus lane.

5.136. Cyclists and Pedestrians. A new staggered Toucan crossing is provided across Woodhouse Lane. Pedestrian facilities are added across Rampart Road. ASLs are provided.

Clarendon Road/Woodhouse Lane

5.137. See data sheet in Appendix 3 [APP-6-3-3] page 26

5.138. Existing situation. This is a signalled junction, with a staggered pedestrian crossing of Woodhouse Lane and a Toucan across Clarendon Road. Queues can develop in the peak periods.

5.139. Principles of proposed design and operations. NGT southbound emerges into the east side of the junction and calls its own stage. NGT northbound uses the NGT/bus lane to approach the junction.

5.140. NGT priority. Southbound NGTs will be detected on the approach, allowing the traffic signals to be moved to an appropriate stage. STM will use an
estimated dwell time at the stop (10 secs in the AM peak), and will ensure the signals are held ready to change. As the NGT leaves the stop it will call the NGT stage. In the other direction NGT runs with the northbound traffic, and so uses a normal priority call.

5.141. Capacity. With NGT this can be run at a 90 sec cycle time in the AM peak (currently 120 sec in AM peak). The maximum DoS is forecast to be 91%, significantly better than the over capacity situation shown in the DM (121% and 103% DoS).

5.142. Buses. Northbound buses will benefit from the increased bus lane provision.

5.143. Cyclists. ASLs are provided, the right turn into Clarendon Road having its own feeder lane.

5.144. Pedestrians. There is no change to pedestrian facilities, although the lower cycle time in the AM will be beneficial due to reduced waiting times.

St Mark’s Avenue pedestrian crossing

5.145. Existing situation. This is a straight across crossing across three lanes. The total pedestrian green time plus clearance time means it can create queues. Also due to its proximity to Clarendon Road poor coordination is an issue – southbound traffic can come round the corner and have to stop at a red signal. The southbound sight line for the nearside signal heads is poor.

5.146. Principles of proposed design and operations. Replacing this with a staggered crossing deals with many of the above concerns. Traffic can be coordinated in both directions. The peak hour direction will operate on a 90 second cycle time to coordinate with Clarendon Road. The non-peak half of the crossing will double cycle at 45 seconds, reducing significantly the extra delay that a second crossing would impose on pedestrians.

5.147. NGT priority. NGT in both directions will hold off the appearance of the pedestrian stage.
5.148. Late buses will get similar priority to NGT, as they share the same green phase.

**St Mark’s Road/Woodhouse Lane/Blenheim Walk junction**

5.149. See data sheet in Appendix 3 [APP-6-3-3] page 27

5.150. Existing situation. With the Woodhouse Lane right turn and St Marks Road requiring to be signalled separately, the junction is close to capacity, however constraints at junctions either side on the corridor mean that there are not significant queues.

5.151. Principles of proposed design and operations. The scheme puts two way traffic on Blenheim Walk, while restricting traffic going down Woodhouse Lane in front of the Parkinson building. This junction is where the cycle time of the network changes to 72 secs. The shorter cycle time for the city centre is Leeds’ policy generally, as it reduces delay to pedestrians and queues for traffic. However coordination between Clarendon Road on a 90 sec cycle time and here is varied.

5.152. NGT will run two way on Woodhouse Lane, going past the main Parkinson Building. Both northbound and southbound NGTs will call priority their green stage, which will stop the main northbound traffic but allow southbound to continue. There will on some cycles be a short delay to NGT due to the change in cycle time.

5.153. Capacity. TRANSYT shows the maximum DoS to be less than the DM in both peaks, indicating a slight improvement overall. DS has 89% on the AM peak northbound and southbound right turn; DM has 99% on the southbound movement.

5.154. Buses. Bus operators may choose to route all buses past the Parkinson Building. Depending on their arrival time, some buses will benefit from the green signal called by NGT.

5.155. Cyclists. Cycle lanes and ASLs are provided where possible.
5.156. Pedestrians. There are signalled pedestrian crossings all round the junction.

**University Stop pedestrian crossing**

5.157. If an NGT is approaching, the appearance of the pedestrian stage will be held hold off allowing the vehicle through.

5.158. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this northbound is reduced due to the proximity of the bus stop.

**Blackman Lane/Blenheim Walk**

5.159. See data sheet in Appendix 3 [APP-6-3-3] page 29

5.160. Existing situation. This is a busy junction with the IRR slip as an entry into the signals. The mouth of Blackman Lane (east) is bus and cycle only. Crossing Blackman Lane (west) requires 3 separate signalled pedestrian crossings.

5.161. Principles of proposed design and operations. Rerouting A660 northbound traffic through this junction changes the design significantly. Existing pedestrian facilities are retained, though crossing Blenheim Walk requires a staggered crossing and Blackman Lane (west) becomes a straight across crossing. NGT does not go through this junction.

5.162. Capacity (TRANSYT). The AM has roughly the same capacity as existing (90% DoS instead of 86%), while the PM shows an improvement (82% instead of 98%)

**Woodhouse Lane/IRR slip road to A64 (M)**

5.163. See data sheet in Appendix 3 [APP-6-3-3] page 30

5.164. Existing situation. Currently with one way traffic southbound on the main road this junction consists of a pedestrian crossing over the left slip to the IRR
5.165. Principles of proposed design and operations. The new junction provides for a right turn to the IRR for traffic coming out of the city centre. The signalled pedestrian route is maintained.

5.166. Capacity. The junction will operate on a 72 sec cycle with a max DoS of 84%, which is acceptable.

**Woodhouse Lane/Portland Way**

5.167. See data sheet in Appendix 3 [APP-6-3-3] page 31

5.168. Existing situation. A small signalled gyratory that handles the existing flows from Portland Way, Woodhouse Lane northbound and southbound, and the IRR slip.

5.169. Principles of proposed design and operations. The new design is a slightly bigger gyratory, also signalled, to cater for the revised traffic routing, and to allow NGT to cut through the junction.

5.170. NGT priority. The junction is operating near capacity, and traffic coordination northbound is required to avoid queuing back into the previous junction. NGT priority will be limited to a short period of advance/retain for the required stage.

5.171. Capacity. The forecast DS traffic flows are slightly higher than the DM flows, reflecting some rerouting as a result of the network changes. The result is that this junction is a capacity restraint with DoS between 91% and 96% on critical links in both peak periods.

5.172. Buses. Buses coming southbound have their own entry road into the gyratory.

5.173. Cyclists can use the NGT lanes, and so will be able to go through the junction easily – though they do not call any priority.

**Woodhouse Lane/Portland Crescent**

5.174. See data sheet in Appendix 3 [APP-6-3-3] page 33.
5.175. Existing situation. Portland Crescent is a one way road going south from Woodhouse Lane. General traffic can only access Portland Crescent from the east, but the right turn into Portland Crescent is permitted for cyclists only.

5.176. Principles of proposed design and operations. The NGT route crosses the north end of Portland Crescent. Traffic signals are used to control this crossing and the junction with Woodhouse Lane. The central reservation is closed as cyclists can use the NGT lane. Woodhouse Lane southbound is not part of this junction.

5.177. NGT priority. NGT flows with Woodhouse Lane northbound, and will get priority over the side road.

5.178. Capacity. Traffic flows are low so there is plenty of spare capacity (max DoS is 33%).

5.179. Buses. Buses on Woodhouse Lane will be coordinated from the previous set of signals, so will not experience delay.

5.180. Cyclists are permitted to use the NGT lane.

Woodhouse Lane/Clay Pit Lane

5.181. See data sheet in Appendix 3 [APP-6-3-3] page 34.

5.182. Existing situation. Cookridge Street is a one way road into the junction.

5.183. Principles of proposed design and operations. The direction of traffic on Cookridge Street is reversed, and restricted to cycles and access only.

5.184. NGT does not go through these traffic signals.

5.185. Capacity. The proposals remove one entry into the junction, which increases its capacity. The maximum DoS is 68% on the right turn into Clay Pit Lane (in the DM it is 103%).

5.186. Buses. Buses will benefit from reduced delay due to the increased capacity.
Cookridge Street/Great George Street

5.187. See data sheet in Appendix 3 [APP-6-3-3] page 35.

5.188. Existing situation. Great George Street is one way eastbound, and forms part of the city centre ‘Loop’ route. Cookridge Street is also one way, northbound. At the time of writing LCC are implementing a scheme with a cycle contraflow southbound along Cookridge Street. There is currently no crossing facility on the east side of the junction. Although the LCC scheme provides an informal crossing with dropped kerbs it is not being provided with pedestrian signals.

5.189. Principles of proposed design and operations. Cookridge Street is made two way, but for NGT, cycles and access only. Banning the turning movements into Great George Street (east) allows the pedestrian crossing on the east side to be signalled.

5.190. NGT priority. NGT will get limited advance/retain priority here as coordination of traffic on The Loop is critical.

5.191. Capacity. The junction operates well within capacity, with maximum DoS of 63%.

5.192. Cyclists can use Cookridge Street in both directions.

5.193. Pedestrians have a new signalled facility across Great George Street East. The crossing on Cookridge Street south is unsignalled due to the change to a pedestrian dominated environment.

Great George Street/Dudley Way

5.194. See data sheet in Appendix 3 [APP-6-3-3] page 36.

5.195. Existing situation. The LCC scheme mentioned in 5.188 makes Dudley Way two way at this point, but does not signal it.
5.196. Principles of proposed design and operations. As St Anne’s Road Way is closed off with bollards, traffic signals will be provided here. This enables easy egress from Dudley Way to any lane on Great George Street.

5.197. NGT does not go through this junction.

5.198. Capacity. The signals operate well within capacity, with maximum DoS of 82% in the PM peak.

5.199. Pedestrians. The scheme provides a new signalled crossing across Great George Street.

Cookridge Street/The Headrow

5.200. See data sheet in Appendix 3 [APP-6-3-3] page 37

5.201. Existing situation. Cookridge Street is one way northbound for general traffic. All traffic is permitted on it. The LCC scheme mentioned in 5.188 creates a contraflow lane for cyclists.

5.202. Principles of proposed design and operations. NGT (and cyclists and access traffic) only are permitted on Cookridge Street, which become two way. The right turn is permitted at The Headrow/East Parade junction in order to provide for traffic currently turning right from The Headrow (east) to Cookridge Street (see para 6.9).

5.203. NGT priority. NGT will get priority in both directions - The Headrow traffic can be held as The Headrow coordination is not significant.

5.204. Capacity. The signals operate well within capacity, with maximum DoS of 60% (it is 93% in the DM).

5.205. Buses benefit from the proposed traffic arrangements, which frees up some capacity by not having a separate stage for the right turn from The Headrow (east). The DoS for eastbound traffic on the Headrow reduces from 93% to 60% in the PM.

5.206. Cyclists can use Cookridge Street in both directions.
5.207. Pedestrians. The crossing on Cookridge Street is unsignalled due to the change to a pedestrian dominated environment.

Park Row/South Parade

5.208. This junction operation is unchanged from the existing situation, apart from NGT priority being included.

Park Row/Bond Court

5.209. This pedestrian crossing operation is unchanged from the existing situation apart from NGT priority being included.

Park Row/City Square


5.211. Existing situation. As Park Row meets Infirmary Street and enters City Square traffic signals are used to control traffic. Pedestrian crossings are provided, and a Toucan crossing for cycles coming from the City Square plaza.

5.212. Principles of proposed design and operations. NGT northbound is a new entry into the junction, and will run in its own phase. To facilitate this, the Park Row stop line is moved to the north.

5.213. NGT priority. NGT southbound will normally get a green signal. NGT northbound will get a lower level of priority due to the proximity of the NGT stop and the fact it only runs in one stage.

5.214. Capacity. The maximum DoS is reduced on Infirmary Street (improved from 37% to 23%), but increases slightly on Park Row (17% to 28%). This is still well below capacity.

5.215. Buses on Infirmary Street will benefit from a lower DoS, though buses on Park Row may notice a slight delay when NGT northbound calls its stage.

5.216. Cyclists. Existing cycle facilities are retained.
5.217. Pedestrians. Existing pedestrian facilities are retained.

City Square/Boar Lane pedestrian crossing

5.218. See data sheet in Appendix 3 [APP-6-3-3] page 39.

5.219. Existing situation. There is a pedestrian crossing over the lane on traffic from City Square into Boar Lane.

5.220. Principles of proposed design and operations. NGT from City Square is signalled separately. NGT from Boar Lane can proceed into City Square. Two pedestrian crossings are provided, one across the single lane as existing, and another across the new two way route.

5.221. NGT priority. NGT will get priority through these signals.

5.222. Capacity. The maximum DoS is 47%, for traffic on the route from City Square to Boar Lane. This is well under capacity, with minimal delays. In practice it is likely that the spare capacity will be used to give pedestrians a longer crossing time, with delays minimised to traffic by use of detection.

5.223. Buses. Bus times will not be affected on cycles where there is no NGT.

5.224. Pedestrians. This is a busy pedestrian area. It will be possible to increase the length of the green time on the existing crossing. The new crossing will have a longer green time than the existing.

Boar Lane/New Station Street

5.225. See data sheet in Appendix 3 [APP-6-3-3] page 40.

5.226. Existing situation. Albion Street is a signalled entry into this junction, albeit as a pedestrianized area it is not in use most of the day. Full pedestrian facilities are provided.

5.227. Principles of proposed design and operations. The operation does not change with NGT.

5.228. NGT priority. NGT will get priority through these signals.
5.229. Capacity. The max DoS is 70%, which is well within capacity.

Boar Lane/Briggate

5.230. See data sheet in Appendix 3 [APP-6-3-3] page 41.

5.231. Existing situation. Briggate to the north is a signalled entry into this junction, albeit as a pedestrianized area it is not in use most of the day. Full pedestrian facilities are provided, with two staggered crossings across Boar Lane.

5.232. Principles of proposed design and operations. Southbound NGT and cycles are permitted on Lower Briggate.

5.233. NGT priority. Detection of an approaching eastbound NGT will terminate the green signal on Boar Lane westbound to enable an unopposed right turn. Northbound NGT will advance call a green signal to clear any traffic queuing on Lower Briggate.

5.234. Capacity. A result of the pedestrian improvements is to reduce capacity. The DoS is still acceptable at a maximum of 87% on Boar Lane with an acceptable queue of 8 pcus.

5.235. Buses. Bus delays will increase slightly reflecting the higher DoS. This DoS is acceptable and less than many other city centre junctions in the peak period.

5.236. Cyclists. A new cycle route southbound on Lower Briggate is provided.

5.237. Pedestrians. The pedestrian crossings across Boar Lane and Duncan Street are changed to straight across. The pedestrian crossing across Lower Briggate is shorter.

Lower Briggate/Call Lane

5.238. See data sheet in Appendix 3 [APP-6-3-3] page 42.

5.239. Existing situation. Bridge End has two way traffic, meeting Call Lane which is the one way city centre Loop Road. Traffic exits onto Swinegate and
Lower Briggate, both of which are one way. There are pedestrian crossings on three arms of the junction.

5.240. Principles of proposed design and operations. The NGT travels southbound on Lower Briggate, making this road two way. A southbound NGT/cycle will get a green signal at the same time as traffic from Bridge End.

5.241. NGT priority. NGT will get priority through these signals.

5.242. Capacity. TRANSYT predicts that the max DoS will increase from 81% to 90%. This is largely due to the 25% increase in flow output by the traffic model. With this increase the signals still operate satisfactorily, albeit with a 15 pcu queue.

5.243. Cyclists are able to use Lower Briggate two way.

**Bridge End/Meadow Lane/Waterloo Street**

5.244. See data sheet in Appendix 3 [APP-6-3-3] page 43

5.245. Existing situation. Waterloo Street comes into Hunslet Road on a give way T-junction. Hunslet Road then gives way onto Meadow Lane with a left turn only give way. The only pedestrian signal (actually a Toucan) is across Bridge End.

5.246. Principles of proposed design and operations. Waterloo Street is made the through movement into Meadow Lane, with Hunslet Road joining it at a signalled junction. The NGT route to the east is parallel to Waterloo Street and has its own signalled entry.

5.247. NGT priority. NGT in each direction will advance call the required stage. Southbound NGT will run with general traffic on Bridge End/Meadow Lane. Northbound NGT will call a red signal on the other approaches.

5.248. Capacity. The junction is forecast to operate within capacity, with a max DoS of 79%.
5.249. Buses will incur a small delay. Currently both directions of travel have one stop line for a pedestrian signal/Toucan in both directions, which will go to red for traffic only on a pedestrian/cycle demand. With NGT the new junction signal is likely to be called every cycle.

5.250. Cyclists. A southbound cycle lane and ASL are provided.

5.251. Pedestrians. Additional signalled crossing are provided across Waterloo Street and Hunslet Road.

Waterloo Street/Hunslet Road

5.252. See data sheet in Appendix 3 [APP-6-3-3] page 44

5.253. Existing situation and principles of proposed design and operations are covered in the previous chapter.

5.254. NGT priority. NGT approaching from either direction will call the appropriate stage.

5.255. Capacity. With forecast flows all DoS are less than 71%.

5.256. Signalled pedestrian facilities are provided across Hunslet Road and Waterloo Street.

Crown Point Road/Black Bull Street

5.257. See data sheet in Appendix 3 [APP-6-3-3] page 46.

5.258. Existing situation. The only traffic signals are a pedestrian crossing across Crown Point Road and another pedestrian crossing across Black Bull Street.

5.259. Principles of proposed design and operations. Traffic signals are used to allow NGT to cross the road network. Additional pedestrian signals are provided. Chadwick Street becomes one way southbound for general traffic.

5.260. NGT priority. NGT will get priority through these signals.
5.261. Capacity. The max DoS is 58%. The forecast queue is spread across 2 lanes and is less than in the DM.

5.262. Buses. Late buses will request an advance/retain green at the signals.

5.263. Pedestrians. Extra signalled crossings are provided.

**Chadwick Street/Chadwick Street South**

5.264. Existing situation. This is an unsignalled T-junction.

5.265. Principles of proposed design and operations. Traffic signals are provided to handle all the movements.

5.266. NGT priority. The NGT is signalled through the junction, and will be given traffic signal priority. As Chadwick Street north of this junction is one way southbound for general traffic, the turning movements are limited.

5.267. Pedestrians. Signalled pedestrian crossings are provided.

**Carlisle Road/Sayner Road.**

5.268. Existing situation. Saynor Road/Carlisle Road provides a through route between Hunslet Road and Clarence Road.

5.269. Principles of proposed design and operations. Saynor Road is closed. Chadwick Street South runs straight into Carlisle Street. NGT is signalled across this road, with pedestrian signals provided.

5.270. NGT priority. NGT will get priority at these signals.

5.271. Pedestrians. New signalled crossings are provided

**South Accommodation Road/Hunslet Road**

5.272. See data sheet in Appendix 3 [APP-6-3-3] page 48.

5.273. Existing situation. What used to be a very busy junction has eased following the construction of the IRR stage 7 flyover.
5.274. Principles of proposed design and operations. NGT crosses South Accommodation Road through the north side of the signalled junction.

5.275. NGT priority. NGT in both directions runs with the Hunslet Road straight ahead movements, so does not have a major effect on the junction operation. It will priority call this stage.

5.276. Capacity. The forecast flows show that NGT seems to reduce traffic flows slightly from the DM situation, resulting in slight reduction in the DoS (from 90% to 81%). The junction performs well at this level.

5.277. Buses. Existing bus priority will be retained for late buses. In addition there is some slight benefit from this DoS reduction.

5.278. Pedestrians. All pedestrian facilities are retained.

**Hunslet Road/Pym Street**

5.279. See data sheet in Appendix 3 [APP-6-3-3] page 50

5.280. Existing situation. Pym Street is a left in, left out access road.

5.281. Principles of proposed design and operations. In order to maintain access, a left slip is signalled across NGT. There is no direct egress to Hunslet Road at this point.

5.282. NGT priority. The signals will be green to traffic on the slip until NGT arrives, which will call priority.

5.283. Capacity. The junction operates well under capacity. Since the slip road only stops for NGT, which will get a minimum green time, there is very little chance of a queue developing back to Hunslet Road.

**Hunslet Road/IRR slip roads.**

5.284. See data sheet in Appendix 3 [APP-6-3-3] page 51

5.285. Existing situation. Signals control traffic on Hunslet Road and the slip roads.
5.286. Principles of proposed design and operations. NGT runs on a parallel route east of the junction. The construction of the IRR flyover has taken traffic off the original road network, allowing the right turn from Hunslet Road to the IRR to be reduced from two lanes to one.

5.287. Capacity. Hunslet Road southbound shows that the lane reduction has increased the DoS to 87%. This is still acceptable. Note that the MMQ figure of 15 pcus is based on random arrival - coordination from the upstream junction will ensure that the forecast queue does not occur.

5.288. Buses have some slight benefit from this DoS reduction.

5.289. Pedestrians. All pedestrian facilities are retained.

Hunslet Road/Forster Street

5.290. See data sheet in Appendix 3 [APP-6-3-3] page 53

5.291. Existing situation. Forster Street enters Hunslet Road on a give way. The right turn from Hunslet Road also operates with a give way.

5.292. Principles of proposed design and operations. NGT crosses over Hunslet Road on the west side of this junction. The existing junction of Forster Street is unchanged, but the crossover is signalled.

5.293. NGT priority. NGT will call a red to Hunslet Road and will get a green signal.

5.294. Capacity. The maximum DoS is 53%, which is well within capacity.

5.295. Buses on Hunslet Road are unaffected as they will not incur any increase in delay which exists currently due to the signals at the Hunslet Road/IRR slip roads junction.

Joseph Street

5.296. See data sheet in Appendix 3 [APP-6-3-3] page 55.
5.297. Existing situation. Joseph Street is an unsignalled junction joining Low Road, a 5 lane road.

5.298. Principles of proposed design and operations. NGT is signalled as it crosses Joseph Street. The junction of Joseph Street and Low Road is also signalled to link with the NGT signals and to improve the existing junction.

5.299. NGT priority. NGT will call the NGT stage, which runs with Hunslet Road northbound and southbound.

5.300. Capacity. The maximum DoS is 41%, so the junctions operates well within capacity.

Church Street/Grove Road

5.301. See data sheet in Appendix 3 [APP-6-3-3] page 57.

5.302. Existing situation. There is an unsignalled T-junction and a signalled pedestrian crossing across Church Street.

5.303. Principles of proposed design and operations. NGT enters Church Street just east of Grove Road. Signals are provided with a pedestrian crossing incorporated into the junction.

5.304. NGT priority. NGT southbound will have its own stage to enter the junction. It will be detected on the approach and call a NGT stage. NGT northbound uses the traffic lane, and will advance/retain the junction in the appropriate stage to pass through without delay.

5.305. Capacity. With a max DoS of 60% the junction is well within capacity.

5.306. Pedestrians are signalled across Church Street with a staggered crossing facility.

Church Street/Balm Road

5.307. See data sheet in Appendix 3 [APP-6-3-3] page 59.
5.308. Existing situation. The junction is signalled with four traffic stages in order to handle the traffic demands. As a result, it is at capacity in the evening peak.

5.309. Principles of proposed design and operations. The junction staging is slightly altered to facilitate the NGT more efficiently. This improves junction capacity.

5.310. NGT priority. NGT southbound runs in two stages so can easily be given priority. NGT northbound requires the right turn stage and shares the lane with other traffic. NGT will advance call this stage early, in order to clear any traffic queue.

5.311. Capacity. The maximum DoS reduces from 111% to 93%, so general traffic will have an improved situation.

5.312. Buses. Buses will benefit from the reduced DoS.

5.313. Cyclists. ASLs are provided on all approaches.

**Balm Road Moor Road/Woodhouse Hill Road Pedestrian crossing**

5.314. The existing staggered pedestrian crossing is retained, with a slightly improved layout.

5.315. NGT priority. If an NGT is approaching, the pedestrian stage will be inhibited until the NGT has gone through.

5.316. An approaching bus will also hold off the appearance of the pedestrian stage, although the benefit of this is reduced due to the proximity of the bus stops.

**Belle Isle Road/M621 junction 6**

5.317. See data sheet in Appendix 3 [APP-6-3-3] page 61.

5.318. Existing situation. The slip roads are not signalled. Queues can develop on the off slip.
5.319. Principles of proposed design and operations. The slip roads are signalled to allow all movements to take place safely. The M621 off slip is widened slightly to allow a two lane exit. This junction also allows NGT northbound to move from the offside to the nearside.

5.320. NGT priority. NGT southbound runs with Belle Isle Road, which gets the longer green, so NGT priority can be delivered. NGT northbound conflicts with northbound traffic and will need this stage advancing as NGT leaves the Belle Isle stop.

5.321. Capacity. The maximum DoS is 86% (on the M621 off slip), which is satisfactory. Belle Isle Road has a max DoS of 66%, with adequate spare capacity.

5.322. Cyclists. Cycle lanes are provided on Belle Isle Road

East Grange/West Grange

5.323. See data sheet in Appendix 3 [APP-6-3-3] page 63

5.324. Existing situation. East Grange Drive and West Grange Drive form a cross roads with Belle Isle Road, operating on give ways. Well used zebra crossings are provided for pedestrians on either side of this junction. South View Road forms a separate junction just to the north.

5.325. Principles of proposed design and operations. To accommodate the major turning movements and allow NGT through, a small partially signalled gyratory has been designed.

5.326. NGT priority. NGT runs with Belle Isle Road and will hold that stage as it approaches.

5.327. Capacity. The max DoS is 86%. The queue on Belle Isle Road northbound (MMQ is 16 pcus) will be monitored by use of queue detectors, and the green extended if the queue should exceed this.
5.328. Buses. The zebras can cause substantial queues in the existing situation. Traffic signals will operate in a more consistent way and will reduce the maximum queue.

5.329. Cyclists. Cycle lane and ASLs are provided on the Belle Isle Road junction approaches.

5.330. Pedestrians. Crossings north and south of the gyratory are maintained, with traffic signal control to tie in with the gyratory and provide safe crossings.

**Belle Isle Circus**

5.331. See data sheet in Appendix 3 [APP-6-3-3] page 65

5.332. Existing situation. This is a large unsignalled roundabout, with four entry roads.

5.333. Principles of proposed design and operations. NGT is signalled against the internal roundabout flow, as it enters and exits the roundabout. The remainder of the roundabout continues to operate with give ways. Winrose Drive becomes NGT and cycles only eastbound.

5.334. NGT priority. NGT will priority call a red signal for circulating traffic, allowing NGT to proceed through a green signal.

5.335. Capacity. The roundabout continues to operate within capacity.

5.336. Buses on Belle Isle northbound are unaffected. Buses southbound will get a small delay when an NGT calls the signals to enter/exit Winrose Drive.

5.337. Cyclists are permitted on Winrose Drive in both directions.

5.338. Pedestrians. Two new signalled crossings are introduced in connection with the NGT signals.

**Winrose Grove/Ring Road Middleton**

5.339. See data sheet in Appendix 3 [APP-6-3-3] page 66
5.340. Existing situation. The junction is an elongated roundabout where Winrose Grove, Ring Road Middleton and Middleton Road meet.

5.341. Principles of proposed design and operations. The roundabout is replaced by a signalled crossroads, including the NGT access to the Park and Ride, with Ring Road Middleton joining Middleton Road at a give way to the south.

5.342. NGT priority. NGT will call priority as it enters and leaves the P&R.

5.343. Capacity. The highest DoS is 88%, which means the junction operates within capacity. Note that the modelling has assumed the pedestrian stage is called every cycle, a robust assumption. In practice the DoS will be less.

5.344. Cyclists. ASLs are provided.

5.345. Pedestrians are signalled across all arms of the signalled junction.

M621 junction 7 (Stourton Roundabout).

5.346. See data sheet in Appendix 3 [APP-6-3-3] pages 68 and 70

5.347. Existing situation. Part time signals control the entry from M621 southbound off slip onto the roundabout. These are operated by the Highways Agency, not LCC.

5.348. Principles of proposed design and operations. The roundabout will be fully signalled (apart from Valley Farm Road). Signals are also used for the M621 off slip/A61 and for the P&R exit onto the A61. The P&R exit also has a signalled cross roads within the site to allow NGT to cross. The signals will be controlled by LCC, so that the whole road network operates efficiently, with the P&R exit, entry and NGT crossing coordinated. This design has been discussed and agreed with the Highways Agency.

5.349. NGT priority. NGT does not go through the roundabout. It will get priority at the signals within the P&R where it crosses the P&R exit.
5.350. Capacity. We have liaised with the HA in modelling this junction. The traffic flows used for analysis are the ones used by the HA for all their motorway assessments. This uses the future year 2023. In a similar way to other junctions, the LTM DM to DS change has been calculated and this has been applied to the Do Minimum flows to derive Do Something flows. In this way the DS flows are compatible with the HA network flows, but include the effects of NGT and the P&R access. The TRANSYT analysis shows the max DoS in the AM peak is 82% on the A61/A639 entry to the roundabout from the south. In the PM peak, the highest DoS is 81% on the A639 Wakefield Road entry from the North which means the junction operates within capacity in both peak periods.

5.351. Cyclists will find a signalled roundabout slightly easier to negotiate.
6. **Impact of changed flows on the wider road network**

6.1. I have looked at the forecast traffic flows across the wider network with and without NGT. Plots were done of DM flows compared with DS flows for the Leeds area (from the Parkway at Lawnswood to the M1) to see if any potential rerouting might cause significant flow increases. Flow changes of 10% or 60 pcus change were highlighted, and the network assessed to determine if changes were required at any signalled junctions, or if any junctions needed to be signalled as a result of changes in traffic flow.

6.2. The only sites where the flow change was identified as requiring a change in design are given below.

**St Helen’s Lane/Otley Road**

6.3. See data sheet in Appendix 3 [APP-6-3-3] page 72.

6.4. Flow changes justifying design. The traffic making the left turn from St Helen’s Lane is forecast to increase from 57 in the DM morning peak to 131 in the DS.

6.5. Principles of design and operations. A very short length of flare is provided on St Helen’s Lane where it joins Otley Road. This increases capacity slightly so that the junction handles the flow (forecast maximum RFC is 0.661).

**Church Lane/Otley Road**

6.6. See data sheet in Appendix 3 [APP-6-3-3] page 73.

6.7. Flow changes justifying design. The traffic making the left turn from Church Lane is forecast to increase from 146 in the DM morning peak to 208 in the DS.

6.8. Principles of design and operations. Right turn lanes are provided from Otley Road into Farrar Lane and Otley Road into Church Lane. This increases capacity slightly so that the additional flow is catered for with a maximum DoS of 78% (the DM DoS is 80%).
Headrow/East Parade

6.9. See data sheet in Appendix 3 [APP-6-3-3] page 75.

6.10. The right turn from The Headrow into Calverley Street is permitted with the scheme, to accommodate traffic diverted from the Cookridge Street junction, where the right turn from The Headrow is not permitted with NGT.

6.11. Flow changes justifying design. The traffic flow predicted to make this right turn is low. The junction alteration proposed means this can be accommodated without reducing capacity.
7. **Statement of matters**

I have addressed item 7(a) of the statement of matters, and shown aspects of “the effects of the proposed trolley vehicle system on other public transport services, highway capacity, traffic flow, vehicle parking, pedestrian and cyclist movement and road safety”.
8. **Response to particular issues raised by objectors**

8.1. A number of objections have been made to the draft Transport and Works Act (TWA) Order submitted in respect of the NGT scheme. This chapter addresses some of the concerns and comments made in relation to the design and operation of traffic signals, and the priority given to NGT.

**Issue 1 – Congestion will increase, traffic signals will cause queues.**

8.2. Congestion has been mentioned by a number of objectors, some in very general terms, including 171, 510, 514, 591, 728, 772, 998, 1354, 1624, 1644, 1727, 1733.

8.3. I do not consider that congestion in general will increase. I have dealt with the question of capacity and queues on a junction by junction basis in chapter 5 above.

8.4. It has been shown that in many places there is an increase in capacity, with some reduction in queuing. In other places local rerouting has led to an increase in traffic flow, but that is because there is the capacity in the junctions to handle it. There remain pinch points on the route where there is no improvement in capacity (but no worsening either). Traffic in a congested situation will generally reroute to find what the driver considers an optimal route.

**Issue 2 – The proposed signals at Lawnswood roundabout will cause problems.**

8.5. Objectors concerned about this include 527, 998, 1354, 1624.

8.6. I have covered the operation of Lawnswood Roundabout in chapter 5.39, with data found in Appendix 3 [APP-6-3-3] page 6. Despite the increased flow the junction is shown to operate well. I consider this operation to be a significant improvement on the current situation for most users. Signals increase the capacity, provide pedestrian/cycle crossing, allow an element of control over traffic movements, can be adjusted by time of day, and make the roundabout easier for drivers to negotiate.
8.7. Leeds has considerable experience of signalling roundabouts. As an example, I was personally involved in the installation of signals at Armley Gyratory many years ago. Since then we have signalled many roundabouts, treating each individually. Dawson's Corner on the Ring Road to the west has successfully reduced queues and provided pedestrians and cycle facilities. It operates different plans to reflect the different traffic demands during the day.

Issue 3 – The proposed signals at Otley Old Road/Otley Road will cause problems.

8.8. Objectors concerned about this include 527.

8.9. I have covered the operation of this junction and the P&R junctions in chapter 5.39 and following, with data sheets found in Appendix 3 [APP-6-3-3] pages 3, 4 & 5. The junctions are shown to operate well. Signalling Otley Old Road is an improvement for traffic turning right out of Otley Old Road, and for pedestrians.

Issue 4 – The proposed signals at St Chad’s Road will cause delays and increase rat running on Moor Road.

8.10. Objectors concerned about this include 1354, 1727.

8.11. I have covered the operation of this junction in para 5.39. The traffic signals have capacity to handle the forecast traffic, and indeed make it easier for right turning traffic to make the manoeuvre. There is no reason for additional traffic to divert onto Moor Road.

Issue 5 – Bus priority at traffic signals could give significant benefits

8.12. I have dealt with the limitations of bus priority in para 3.22 and following.

8.13. LCC has been working with Metro to implement bus priority where it is most effective, which I mention in para 3.9. We consider that at these junctions we have done as much as is possible without disrupting other traffic excessively.
8.14. Whereas it is possible to implement small scale improvements, to achieve a significant step change in delay reduction at traffic signals for public transport a whole package of measures would need to be introduced – broadly equivalent to having an NGT type vehicle on an NGT type route using NGT type infrastructure.

Issue 6 – Queues on the Headingley Castle access could stretch back onto Headingley Lane.

8.15. Objector 461 refers to this.

8.16. I have dealt with the design of this crossing in para 5.94 and following.

8.17. The traffic signals will move between green to NGT and cyclists on the parallel route, and green to traffic on the access road. They will react to vehicle and pedestrian demands. With the relatively low traffic flows using the access queuing will not be an issue. If the traffic flow ever got as high as 200 pcus an hour (unlikely due to the limited parking on the site), the traffic that would queue during the 17 seconds red time required to give NGT a green and adequate clearance times would average 1 pcu.

Issue 7 – Quality of the traffic survey data

8.18. Objector 728 refers to superficial and inadequate traffic surveys. Mr Hanson will explain the strong data base behind the LTM. I have mentioned the junction turning count surveys in para 4.5.

8.19. Every junction with significant traffic flows has been surveyed. I consider this a strong basis for the design.

Issue 8 – Control of traffic through Headingley

8.20. Objector 278 refers to the way traffic is currently filtered through Headingley, and the way buses are coordinated by the traffic signals.

8.21. While I agree that the current system operates as well as it can, it still has many shortcomings. The way southbound traffic filters into Leeds as described by the objector has developed historically in response to some of
the problems on the route, for example some people avoid Lawnswood Roundabout, others try to avoid the queue of traffic alongside the bus lane. Using traffic signals in the proposed scheme allows a higher degree of control. Lawnswood becomes easier to use. Traffic passing through Headingley is measured through in one lane, which has advantages in easing congestion in the vicinity of the Arndale Centre and reducing delay to inbound buses.

8.22. The objector points out the benefit to buses of the existing Otley Road bus lane, which delivers buses to the Arndale Centre. However there are still significant delays in getting from the bus lane to the Arndale bus stops (with traffic congested and weaving between lanes). There are further bus delays at Hyde Park and other places. NGT delivers a comprehensive solution that tackles and improves many of these issues.

8.23. Furthermore the objector expresses satisfaction with bus operation southbound, but does not mention northbound. In the evening peak buses can be in queuing traffic from Victoria Road to Thornbury Avenue. The NGT scheme improves this situation significantly.

Issue 9 – Use of 5-6pm for analysis

8.24. Objector 1719 suggests the analysis is invalid because it does not look at 6-7pm flows.

8.25. Many of the traffic counts were actually done from 7am to 7pm, so we have taken note of variations. In general if there is an increase in outbound flow there is a corresponding decrease in other traffic using the junction.

8.26. As I say in para 4.5 there is a need for consistence along the corridor. We have compared DM and DS for the same period for each junction, so the results show clearly the effect of NGT.

Issue 10 – No optimisation used in the DM analysis.
8.27.  Objector 1719 suggests the analysis is flawed because the timings used in the TRANSYT modelling was optimised for the Do Something flows but not for the Do Minimum.

8.28.  The timings used for the DN calculations were those currently being used by UTMC at each existing signal junction, which have been fine-tuned over the years to maximise junction efficiency.

8.29.  These were retained for the DM as there is no significant redistribution of flow. To do otherwise would lead to inconsistencies as the LTM DM uses these timings.

8.30.  Optimising the DS modelling is essential as traffic routing changes, and many junctions have new designs. This gives a realistic forecast of the capacity and queuing at junction on the scheme.

**Issue 11 – Traffic will queue on Woodhouse Moor.**

8.31.  Objector 998 suggests that vehicles will queue on Woodhouse Moor, wasting fuel and causing pollution. Objector 1624 also refers.

8.32.  I have covered the operation of this junction in chapter 5.39 and following, with data sheets found in Appendix 3 [APP-6-3-3] – 255. The analysis shows that queues at the Clarendon Road junction will decrease.

**Issue 12 – Queuing on A660 will cause traffic to divert to parallel routes such as Queenswood Drive and Meanwood Road.**

8.33.  Objectors mentioning this include 510, 998.

8.34.  There is no reason for drivers to divert off the A660 since the capacity on this route is maintained. Comparing the DM and DS flow assignments as mentioned in para 6.1 confirms this.

**Issue 13 – Congestion in Headingley will increase**

8.35.  Objectors mentioning this include 591, 1354, 1624.
8.36. I have described how the traffic signals will control traffic through Headingley in para 5.81 for southbound traffic and para 5.98 for northbound traffic. Using the bus/NGT gates to meter traffic through Headingley will result in less queuing in the Headingley centre without reducing traffic capacity.

**Issue 14 - Glen Road becomes problematical**

8.37. Objector 1733 refers.

8.38. I cover the operation of Glen Road in para 5.65. This junction is actually quite a problem at the moment. The two side roads are slightly offset. Turning traffic into and out of both side roads is difficult – traffic turning right out can wait in the middle of the junction for a gap. Signalling the side roads will make the traffic flow smoother for all movements.

**Issue 15 - Alma Road queuing**


8.40. The analysis of the Alma Road signals in Appendix 3 [APP-6-3-3] – 18 has a predicted queue of 1 vehicle. My experience of this exit from the Arndale centre is that the queues now are very variable, due in part to the difficulty of turning right into Otley Road. I consider that signalling Alma Road will reduce the maximum queue and make it easier to use.

**Issue 16 – Hyde Park Corner will be a bottleneck**

8.41. Objectors 591, 1624 refer.

8.42. I have shown in para 5.106 and flowing how the scheme improves Hyde Park Corner. There will be spare capacity and much better pedestrian green times. The scheme replaces the existing bottleneck with a greatly improved facility.
Conclusion

8.43. I believe that all other material objections to the NGT Scheme relevant to this proof of evidence on the subject of traffic signals have been addressed in earlier chapters.
9. Summary and conclusion

9.1. I have described the computer technology used by LCC to control traffic signals. I have summarised the system used to give priority to selected vehicles, which will be used to give NGT priority through traffic lights, and explained how it can deliver a high level of priority for NGT.

9.2. The traffic figures used to assess the junction designs are robustly derived, and appropriate for the purpose.

9.3. I have looked at each signalled junction along the NGT route, describing the salient features of its operation. I have assessed its capacity in the DM and the DS situations.

9.4. The NGT scheme has been designed to handle the forecast traffic flows. This has been demonstrated to be the case on a junction by junction basis.

9.5. While there are significantly more traffic signals along the route, coordinating the green times in the peak direction will minimise the effect of these. Some traffic signals will be used to control traffic flow specifically to ease congestion, while others provide new road crossings to the benefit of pedestrians.

9.6. The use of appropriate signal design combined with automatic STM priority enables the NGT to progress smoothly through the majority of traffic signals without incurring significant delay.

9.7. The implementation of bus priority for late buses at most traffic signals along the route will help improve journey time reliability.

9.8. I have shown that the NGT scheme will handle forecast traffic, will not increase congestion, and will facilitate NGT priority through traffic signals.